The Department of Defense

DoD DEPARTMENTS/AGENCIES:

Department of the Navy

Department of the Air Force

ARPA Advanced Research Projects Agency

Special Operations Command

Defense Nuclear Agency

BMDO Ballistic Missile Defense Organization

PROGRAM SOLICITATION 94.1
CLOSING DATE: 14 JANUARY 1994

FY 1994 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 94.1

Small Business Innovation Research Program

IMPORTANT

The DoD is updating its SBIR Mailing list. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E), found at the back of this solicitation, to DTIC. Failure to send the form will result in no future mailings of the DoD SBIR Program Solicitation to your address.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Closing Date: JANUARY 14, 1994

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Navy, Air Force, Advanced Research Projects Agency, Defense Nuclear Agency, Ballistic Missile Defense Organization and U.S. Special Operations Command hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Section 8.0 are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0 hereof.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any monies

expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research or research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research or research and development has commercial potential in the private sector.

Proposers who feel that their research or research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II, a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. General Information. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
OSD/SADBU
U.S. Department of Defense
The Pentagon - Room 2A340
Washington, DC 20301-3061
(703) 697-1481

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Section 8.0 of this solicitation. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

b. Requests for Copies of DoD SBIR Solicitation. *To remain on the DoD SBIR Mailing list, send in the Mailing List form (Reference E) to DTIC.* Additional copies of this solicitation may be ordered from:

Defense Technical Information Center
Attn: DTIC/SBIR
Building 5, Cameron Station
Alexandria, Virginia 22304-6415
(800) 225-3842 toll free
(703) 274-6903 commercial

c. Outreach Program. The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. We have a special outreach effort to socially and economically and disadvantaged firms and to small companies that are negatively affected by the Defense down-sizing.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any federal agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic. Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages (excluding company commercialization report).
- Use a type size no smaller than 12 pitch or 11 point.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a Red Copy of Appendix A and Appendix B as part of the Original of each proposal.
- Do not use a proportionally spaced font on Appendix A and Appendix B.
- Include a company commercialization report listing all SBIR Phase I and Phase II projects and the commercialization status of Phase II projects (see Section 3.4.n).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding commercialization record summary, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding commercialization record summary) will not be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed red copy of Appendix A and Appendix B.

a. Cover Sheet. Complete RED COPY of Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete RED COPY of Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal. The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, will not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Describe:

(1) Whether and by what means the proposed project appears to have potential use by the Federal Government.
(2) Whether and by what means the proposed project appears to have potential private sector application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of <u>two-thirds</u> of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by <u>name</u> as well as by number of <u>hours</u> dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may

include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.

(3) Cost for travel funds must be justified and related to the needs of the project.

(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

n. Prior SBIR Awards. For Phase I proposals, if the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit a Company Commercialization Report that lists the name of awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each Phase I and Phase II project, and commercialization status for each Phase II. All Phase II proposals must include a Company Commercialization Report. (This required proposal information shall not be counted toward proposal pages count limitations.)

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation. Each proposal must contain a Red Cover Sheet (Appendix A), a Red Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4.n) regardless of the number of Phase II awards received. Copies of Appendices along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government and the nation considering the following factors.

a. The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution

b. The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization

c. The adequacy of the proposed effort for the fulfillment of requirements of the research topic

d. The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

a. The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution

b. The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization

c. The adequacy of the proposed effort for the fulfillment of requirements of the research topic

d. The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

A proposal's commercial potential can be evidenced by:

(1) the small business concern's record of commercializing SBIR or other research,

(2) the existence of second phase funding commitments from private sector or non-SBIR funding sources,

(3) the existence of third phase follow-on commitments for the subject of the research, or

(4) the presence of other indicators of commercial potential of the idea.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than July 14, 1994. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 900 Phase I awards from this solicitation.*

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of

Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the government*, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract. See special instructions for each DoD Component in Section 8.

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. Specific instructions are provided by each DoD Component in Section 8.

5.3 Reports

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A Sample SF 298 is provided in Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:

(a) Distribution authorized to U.S. Government Agencies only; report contains proprietary data produced under SBIR contract. Other requests shall be referred to the performing organization in Block 7 of this form.

(b) Approved for public release; SBIR report, distribution unlimited.

(3) The report abstract (Block 13 of the SF 298, "Report Documentation Page") must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract may be published by the DoD, it must not contain any proprietary or classified data.

c. Submission. SIX COPIES of the final report on each Phase I project shall be submitted within the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, Cameron Station, Alexandria, VA 22304-6145.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 90% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices

A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a reasonable time period to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the government shall have the limited right to use such data for government purposes and shall not release such data outside the government without permission of the contractor for a period of four years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the four-year period, the government shall retain a royalty-free license for government use of any technical data delivered under an SBIR contract whether patented or not. See FAR clause 52.227-20, "Rights in Data - SBIR Program".

5.9 Cost Sharing

Cost sharing is permitted for proposals under this

solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information

contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED RED COPY OF APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY), AND A COMPANY COMMERCIALIZATION REPORT (see Section 3.4.n).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's section of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, January 14, 1994. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than January 7, 1994 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is

subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding company commercialization record). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small business may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DoD. DTIC prepares a Technical Information Package (TIP) on each SBIR topic. The package includes information such as a reference list of related technical reports and expanded topic description from the topic author. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DoD-sponsored Information Analysis Centers (IACs), where specialists in mission areas assigned to these IACs perform informational and consultative services.

Many of the small business requesters who responded to previous DoD SBIR Program solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DoD funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DoD sponsored work currently in progress in their proposal topic areas.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DoD. Call, or visit by prearrangement, DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA, address.

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 225-3842 (Toll Free)
(703) 274-6902 (Commercial)

DTIC Boston Regional Office
DTIC-BLNB
Building 1103, 5 Wright Street, Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
DTIC-BLNA
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles Regional Office
DTIC-BLNL
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

DTIC MATRIS Office
ATTN: DTIC-AM, Sally Ames
San Diego, CA 92152-6800
(619) 553-7008

Use Reference B at the back of this solicitation or telephone DTIC to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible.

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600
(703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
237 Wisenbaker Engineering Research Center
College Station, TX 77843-3401
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburg, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Information Strategists
814 Elm Street
Manchester, NH 03104
(603) 624-8208

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

National Technology Transfer Center
Wheeling Jesuit College
316 Washington Ave
Wheeling, WV 26003
(800) 678-6882 (all services at no cost)

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or

discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical problems for which DoD Components requests proposals for innovative R&D solutions from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B and C follow the Component Topic Sections. Appendix A is a red-printed Proposal Cover Sheet, Appendix B is a red-printed Project Summary form, and Appendix C is an outline for the Cost Proposal. An original red-printed copy of Appendix A and Appendix B must be included with each proposal submitted.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research. The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. Vincent D. Schaper
ONR 4130 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-4286

SBIR proposals shall not be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

The Navy's SBIR program has been redirected for FY 1994 from one that was integrated with the needs and requirements of the Navy through engineering development headquarters activities to one that is primarily integrated with the needs and requirements of the Navy through its science and technology program while providing "dual-use " topics. The program is a balance between twelve science (S) and eighteen technology (T) areas (shown in Table (1)) that the Navy has identified as necessary to meet its mission responsibilities. While a total of 30 S&T areas has been identified, all of these areas may not be funded equally during the two annual DOD SBIR solicitations in which the Navy participates. The Navy will fund topics according to priority it has established to meet its mission goals and responsibilities.

This solicitation contains 125 technical topics that meet the mission requirements of the Navy and PL 102-564 to which small R&D businesses may respond. As in the previous solicitation the Navy will provide potential awardees the opportunity to reduce the gap between phases I & II by providing a $70,000 Phase I proposal award and a $30,000 Phase I Option award or small businesses may elect to just submit a Phase I proposal. If small businesses choose the former, the Option effort should form the initial part of the Phase II work. Only companies whose Phase II proposal has been selected for award will be funded for the Phase I Option. Therefore, those who have finished or almost finished their "initial Phase I" portion should submit their Phase II proposal with an "initial Phase II" portion and an option. The Phase II proposal should contain a plan of how the proposer will commercialize the technology to the government (and the private sector) in addition to the technology demonstration portion of the proposal. At the end of the "initial Phase II" portion, a determination will be made by the Navy as to whether the proposer has satisfied the commercialization plan sufficiently for the government to fund the "Phase II option" portion of the proposal. The Phase II option should address the further R&D or test and evaluation aspects of the proposal. The total Phase II funding will not exceed $750,000 with 80% going to the "initial Phase II" portion and 20% for the "option Phase II" portion.

Selection of Phase I proposals is based upon technical merit and evaluation criteria contained in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY		SCIENCE
Computers	Training Devices	Computer Sciences
Software	Navigation, Guidance, and Vehicle Control	Mathematics
Sensors		Cognitive and Neural Sciences
Communications Networking	Industrial Production	Biology and Medicine
Electronic Devices	Vehicle Structures	Terrestrial Sciences
Environmental Quality	Light and Optical Systems	Atmospheric and Space Science
Materials and Processes	Medical Devices	Ocean Science
Energy Storage		Chemistry
Propulsion and Energy Conversion		Physics
Design Automation		Electronics
Human-System Interfaces		Materials
Modeling and Simulation		Mechanics

NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY CATEGORY INDEX
NAVY FY94.1 SBIR TOPICS

SCIENCE/TECHNOLOGY	TOPIC NO
Biology and Medicine	29-33
Communications Networking	1, 4, 5, 11, 14-16, 92-94, 121
Computers	17, 34, 48, 72, 74
Design Automation	85
Electronic Devices	6-8, 34, 49, 50, 95, 106-108
Energy Storage	2, 35, 51-53, 102
Environmental Quality	13, 58, 59, 62, 68, 69
Human-System Interfaces	36, 70, 75, 97
Light and Optical Systems	54, 82, 86, 87, 98, 109, 110
Materials	9, 78, 99
Materials and Processes	19-21, 40, 41, 80, 83, 101, 103, 115
Medical Devices	111
Modeling and Simulation	10, 25, 37-39, 66, 67, 71, 73, 75, 79
Navigation, Guidance, and Vehicle Control	88-91, 100
Ocean Science	26
Physics	113, 114
Propulsion And Energy Conversion	3, 42, 43, 60, 61
Sensors	12, 24, 44-46, 81, 104, 116-119
Software	22, 47, 56, 57, 75
Terrestrial Sciences	105, 120
Training Devices	23, 27, 28, 122, 123
Vehicle Structures	55, 63-65, 84

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

	Administrative SBIR Contact
Topic Nos. N94-001 through N94-003	

Mail Address:

Commander
Marine Corps Systems Command
Attn: Code AW, SBIR Program, Topic No. N94-_____
2033 Barnett Avenue, Suite 315
Quantico, VA 22134-5010

Mr. Joseph Johnson
(703) 640-4801/2761

Handcarry Address:

Commander
Marine Corps Systems Command
Attn: Code AW, SBIR Program, Topic No. N94-_____
Building #3097, 2nd Deck
Quantico, VA 22134-5010

Topic Nos. N94-004 through N94-012

Mail/Handcarry Address:

Commander
Space and Naval Warfare Systems Command
Attn: Code SPAWAR OOK, SBIR Program, Topic No. N94-_____
Crystal Park #5, Room 110
2451 Crystal Drive
Arlington, VA 22245-5200

Ms. Betty Geesey
(703) 602-6092

Topic No. N94-013

Mail/Handcarry Address:

Commander
Naval Supply Systems Command
Attn: Code SUP 422B2, SBIR Program, Topic No. N94-_____
Crystal Mall #3, Room 710
1931 Jefferson Davis Highway
Arlington, VA 22241-5360

Ms. Linda Whittington
(703) 607-1648

Topic Nos. N94-014 through N94-024

Mail/Handcarry Address:

Commander
Naval Air Systems Command
Attn: Code AIR-05TE2, SBIR Program, Topic No. N94-_____
1421 Jefferson Davis Highway
Jefferson Plaza #1, Room 444
Arlington, VA 22243-5003

Ms. Cathy Nodgaard
(703) 692-7393

Topic Nos. N94-025 through N94-028

Administrative
SBIR Contact

Mail/Handcarry Address:

Commanding Officer
Naval Training Systems Center
Attn: Code PDR2, SBIR Program, Topic No. N94-_____
12350 Research Parkway
Orlando, FL 32826-3224

Ms. Janet Weisenford
(407) 380-8276

Topic Nos. N94-029 through N94-033

Mail Address:

Commanding Officer
Naval Medical Research and Development Command
Attn: Code NMRDC-42, SBIR Program, Topic No. N94-_____
Bethesda, MD 20889-5606

LT CDR Paul Knechtges
(301) 295-0885

Handcarry Address:

Commanding Officer
Naval Medical Research and Development Command
Attn: Code NMRDC-42, SBIR Program, Topic No. N94-_____
8901 Wisconsin Avenue
Building #1, 11th Floor
Bethesda, MD 20889-5606

Topic Nos. N94-034 through N94-047

Mail/Handcarry Address:

Commander
Naval Sea Systems Command
Attn: Code 06HE, SBIR Program, Topic No. N94-_____
Crystal Plaza #5, Room 924
2211 Jefferson Davis Highway
Arlington, VA 22242-5160

Mr. William Degentesh
(703) 602-3005

Topic Nos. N94-048 through N94-057

Mail Address:

Commander
Naval Surface Warfare Center
Dahlgren Division
Attn: Code R05, SBIR Program, Topic No. N94-_____
Silver Spring, MD 20903-5000

Mr. Donald Wilson
(301) 394 -1279

Handcarry Address:

Commander
Naval Surface Warfare Center
White Oak Detachment
Attn: Code R05, SBIR Program, Topic No. N94-_____
Building #1, Reception Room
Silver Spring, MD 20903-5000

Topic Nos. N94-058 through N94-066	Administrative SBIR Contact

Mail Address:

Commander
Naval Surface Warfare Center
Carderock Division
Attn: Code 0112, SBIR Program, Topic No. N94-_____
Bethesda, MD 20084-5000

Mr. Frank Halsall
(301) 227-1094

Handcarry Address:

Commander
Naval Surface Warfare Center
Carderock Division
Attn: Code 0112, SBIR Program, Topic No. N94-_____
Building #1, Room 216M
Bethesda, MD 20084-5000

Topic No. N94-067

Mail/Handcarry Address:

Commander
Naval Surface Warfare Center
Attn: Code 183, SBIR Program, Topic No. N94-_____
300 Highway 361
Building #120
Crane, IN 47522-5001

Mr. James Linn
(812) 854-1352

Topic Nos. N94-068 through N94-070

Mail Address:

Commander
Indian Head Division
Naval Surface Warfare Center
Attn: Code 830U, SBIR Program, Topic No. N94-_____
101 Strauss Avenue
Indian Head, MD 20640-5035

Ms. Beth Klapach
(301) 743-4250

Handcarry Address:

Commander
Indian Head Division
Naval Surface Warfare Center
Attn: Code 830U, SBIR Program, Topic No. N94-_____
101 Strauss Avenue
Building #D340
Indian Head, MD 20640-5035

Topic No. N94-071	Administrative SBIR Contact

Mail Address:

Commander
Naval Undersea Warfare Center
Detachment New London
Attn: Code 0911, SBIR Program, Topic No. N94-_____
New London, CT 06320-5594

Mr. Jack Griffin
(203) 440-4116

Handcarry Address:

Commander
Naval Undersea Warfare Center
Detachment New London
Attn: Code 0911, SBIR Program, Topic No. N94-_____
Building #39
New London, CT 06320-5594

Topic Nos. N94-072 through N94-075

Mailing Address:

Commander
Naval Air Warfare Center Aircraft Division
Flight Test and Engineering Group
Attn: Code CT22, SBIR Program, Topic No. N94-_____
Patuxent River, MD 20670-5304

Mr. Daniel Watters
(301) 826-1144

Handcarry Address:

Commander
Naval Air Warfare Center Aircraft Division
Flight Test and Engineering Group
Attn: Code CT22, SBIR Program, Topic No. N94-_____
Building #304/3169
Patuxent River, MD 20670-5304

Topic No. N94-076

Mail Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Trenton
Attn: Code PE 34, SBIR Program, Topic No. N94-_____
Trenton, NJ 08628-0176

Mr. Robert Dobrowolski
(609) 538-6754

Handcarry Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Trenton
Attn: Code PE 34, SBIR Program, Topic No. N94-_____
250 Phillips Boulevard
Trenton, NJ 08628-0176

Topic Nos.	Administrative SBIR Contact
Topic Nos. N94-077 through N94-081	

Mail Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Warminster
Attn: Code 01B. SBIR Program. Topic No. N94-_____
P.O. Box 5152
Warminster. PA 18974-0591

Ms. Carol Van Wyk
(215) 441-2375

Handcarry Address:

Commanding Officer
Naval Air Warfare Center
Aircraft Division Warminster
Attn: Code 01B. SBIR Program. Topic No. N94-_____
Street Road/Jacksonville Road
Warminster. PA 18974-0591

Topic Nos. N94-082 through N94-085

Mail Address:

Commander
Naval Air Warfare Center
Weapons Division
Attn: Code C002. SBIR Program. Topic N94-_____
China Lake. CA 93555-6001

Ms. Lois Herrington
(619) 939-2712

Handcarry Address:

Commander
Naval Air Warfare Center
Weapons Division
Attn: Code C002. SBIR Program. Topic N94-_____
515 Blandy Avenue. Annex A1
China Lake. CA 93555-6001

Topic Nos. N94-086 through N94-092

Mailing/Handcarry Address:

Commander
Naval Air Warfare Center
Weapons Division
Attn: Code P3410. SBIR Program. Topic N94-_____
512 9th Street. Building 50. Room 1076
Point Mugu. CA 93042-5001

Mr. Eugene Patno
(805) 989-8801

Topic Nos. N94-093 through N94-101

Administrative SBIR Contact

Mail/Handcarry Address:

Commanding Officer
Naval Command, Control and Ocean
Surveillance Center (RDT&E) Division
Attn: Code 0144, SBIR Program, Topic No. N94-_____
53560 Hull Street
San Diego, CA 92152-5001

Dr. Richard November
(619) 553-2104

Topic Nos. N94-102 through N94-105

Mail/Handcarry Address:

Commanding Officer
Naval Civil Engineering Laboratory
Attn: Code L03B, SBIR Program, Topic No. N94-_____
560 Laboratory Drive
Port Hueneme, CA 93043-5003

Mr. Daniel Zarate
(805) 982-1057

Topic Nos. N94-106 through N94-120

Mailing Address:

Commanding Officer
Naval Research Laboratory
Attn: Code 3204, SBIR Program, Topic No. N94-_____
Washington, DC 20375-5326

Ms. Patricia Schaefer
(202) 767-6263

Handcarry Address:

Commanding Officer
Naval Research Laboratory
Attn: Code 3204, SBIR Program, Topic No. N94-_____
4555 Overlook Avenue, SW
Building, 222, Room 115
Washington, DC 20375-5326

Topic Nos. N94-122 through N94-123

Mail Address:

Commanding Officer
Navy Personnel Research and Development Center
Attn: Code 13, SBIR Program, Topic No. N94-_____
San Diego, CA 92152-7250

Dr. Meryl S. Baker
(619) 553-7681

Handcarry Address:

Commanding Officer
Navy Personnel Research and Development Center
Attn: Code 13, SBIR Program, Topic No. N94-_____
53335 Ryne Road
San Diego, CA 92152-7250

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SUBJECT/WORD TOPIC NO

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MARINE CORPS SYSTEMS COMMAND

N94-001 TITLE: Innovative Approaches to Wide Area Networking for C4I

CATEGORY: Exploratory Development; Communications Networking

OBJECTIVE: Develop innovative solution approaches to providing secure, jam-resistant, high-bandwidth, networks between fixed and mobile C4I computer nodes under battlefield conditions.

DESCRIPTION: This topic seeks innovative approaches to providing networking between current and future C4I nodes within a Marine Expeditionary Force (MEF) engaged in a mobile combat environment. Current approaches to providing this inter-system connectivity are deficient in terms of bandwidth and security assurance. The desired capability set requires an approach that provides a high reliability, all-weather, multi-level secure, EMI and jam-resistant, wireless network with a node to node bandwidth exceeding 1 Mbps. The network should be capable of supporting more than 100 nodes and should not rely on line of sight propagation directly between nodes due to the likelihood of terrain being hilly or covered with heavy vegetation. The likelihood that some of the nodes may be aboard amphibious ships must be taken into account. Use of an airborne relay as a relay device is a potential strategy providing that the relay, including power source, is light enough to be an Unmanned Aerial Vehicle (UAV) payload. Security provisions should account for protection against network disruption through introduction of viruses, worms, etc. as well as for multi-level security protection of data on the network.

Phase I: Conduct a six month study effort to identify potential technological approaches using current and near-term future commercial networking technologies. Perform a comparative analysis of the ability of these approaches to satisfy the requirement using commercial LAN simulation tools in conjunction with a simulation or model accounting for the impact of the battlefield environment on communications connectivity and security.

Phase II: Design and construct a laboratory prototype of the most promising technological approach. Perform testing with the prototype to assess its strengths and weaknesses and report on the ability of the design to meet detailed requirements.

Phase III: Transition to an acquisition program if phase II results are sufficiently promising.

Commercial Potential: Technology developed under this initiative is directly applicable to civilian applications requiring networking between mobile facilities.

N94-002 TITLE: Smaller and Lighter Uninterruptable Power Supplies (UPS)

CATEGORY: Exploratory Development; Energy Storage

OBJECTIVE: Develop Uninterruptable Power Supplies (UPS) for critical C4I tactical systems that are smaller and lighter than current commercial UPS by an order of magnitude.

DESCRIPTION: Critical C4I systems need protection from power failure in the field environment. Commercially available UPS provide this protection but are prohibitively large and heavy. Development of UPS-like power assurance devices with an order of magnitude reduction in size and weight would allow incorporation of these devices into critical C4I nodes across the battlefield thus providing for reliable power to digital communications and computer systems even in the face of the uncertainties of tactical generator power. The objective is to provide uninterrupted power to systems for a period of about fifteen minutes during which time the normal power source would be restored or an orderly shut down conducted. The device must provide for smooth system power in the event of voltage and frequency variation (common with tactical generators) as well as when power has entirely failed.

Phase I: During a six month time period, survey the capabilities of current commercial UPS in order to establish a baseline and then research power technologies under development and on the drawing board which might provide order of magnitude size and weight improvements. Provide a report detailing any promising approaches which have been identified. Include in the report estimates of size and weight improvements feasible, estimates of cost for development and procurement, and information concerning environmental, equipment, and personnel safety issues which would have to be resolved.

Phase II: Design, build, and test prototype systems for the most promising technologies.

Phase III: Transition to an acquisition program if phase II results are sufficiently promising.

Commercial Potential: Widespread. The commercial demand for UPS to supply reliable power to computer and communication systems is well-established; the commercial market would welcome significant size and weight improvements.

N94-003 TITLE: Three-Stage Filter Separator

CATEGORY: Advanced Development; Propulsion and Energy Conversion

OBJECTIVE: Develop a filter medium, with vessel, for DOD use, that permits the coalescence of free water regardless of all known additives that may act as surfactants and still provide adequate solid contaminant filtration as outlined in American Petroleum Institute (API) Publication 1581 and Mil-F-8901. The medium surface area must handle 250% of the flow rate of Mil-F-8901.

DESCRIPTION: Current DOD filter separators were designed to handle petroleum propellants commensurate with the technology that existed 20 to 30 years ago. Advances in petroleum refinement techniques, new and improved additives have limited the effectiveness of that design.

Phase I: Provide a detailed description of the technology indicating the size, weight and cost of the system capable of coalescing and filtering 350 - 600 gallons per hour (GPM) of petroleum propellants with a specific gravity (SPGR) range of 0.75 to 0.85. A model should be developed detailing all contaminate and known surfactants for filter medium qualification.

Phase II: Construct a demonstration model.

Phase III: The new technologies developed could replace aging DOD filter separator designs and significantly improve fuel quality to the force.

Commercial Potential: There is considerable application for commercial use of this technology in the petroleum industry.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N94-004 TITLE: Increased Data Throughput on UHF SATCOM

CATEGORY: Advanced Development; Communications Networking

OBJECTIVE: Develop new modulation and encoding methods to increase the user data throughput on 5 Khz bandwidth and 25 Khz bandwidth Ultra High Frequency (UHF) Satellite Communications (SATCOM) channels.

DESCRIPTION: The Navy currently uses two types of UHF SATCOM channels, 5 Khz bandwidth and 25 Khz bandwidth, with a maximum data throughput of 3,000 symbols per second (sps) and 32,000 sps, respectively. Given the ever increasing demand on satellite communications and the limited number of satellites and satellites channels, improving this data throughput by implementing more robust modulation and encoding methods offers a cost-effective approach for significantly improving UHF SATCOM DAMA and Non-DAMA capacity.

Phase I: Develop the basics of a modulation and encoding method to double the current data throughput rates on both 5 Khz bandwidth and 25 Khz bandwidth UHF SATCOM DAMA and Non-DAMA channels. The modulation and encoding method must operate within the power and bandwidth constraints of the UHF Follow-On (UFO) satellites and existing Navy UHF SATCOM Terminal equipment.

Phase II: Develop, test and operationally demonstrate a UHF SATCOM modem which implements the encoding methods formulated under the Phase I SBIR effort. The modem shall be operable at both 5 Khz bandwidth and 25 Khz bandwidth UHF SATCOM channels. The modem shall be of a modular, open-architecture design to facilitate upgrades (e.g., integrating an enhanced DAMA protocol over the higher data rate channel) and integration into the Navy's Copernicus TADIXS communications architecture.

Phase III: Produce a UHF SATCOM modem that implements the encoding methods demonstrated in the Phase II SBIR effort.

Commercial Potential: New methodology can be used on narrow band width limited communications links.

N94-005 TITLE: Receiver Performance Improvements

CATEGORY: Advanced Development; Communications Networking

OBJECTIVE: Explore the possibility of using front end signal processing techniques to improve the performance of existing Ultra High Frequency satellite communications.

DESCRIPTION: To increase the data rate and reduce the error rate of existing Ultra High Frequency satellite channels requires either more transmitted power or larger antennas. It is too expensive to increase the transmit power of satellites and in many application it is physically difficult to increase the size of antennas. The contractor should explore the possibility of using front end signal processing techniques to improve receiver performance in the presence of both random noise and interfering signal.

Phase I: Investigate existing satellite communication systems to determine how receiver performance in the actual environment is affecting communication quality. Explore the feasibility of using signal processing techniques to improve receiver performance.

Phase II: Develop a prototype receiver and perform testing over actual satellite systems.

Phase III: Develop a production model of receiver and support a joint service effort to produce a military standard for the incorporation of the improvements within existing satellite communication systems.

Commercial Potential: New techniques could be applied to communications links to increase data throughput deficiencies.

N94-006 Title: Near Field Transient Adaptive Beamforming

CATEGORY: Exploratory Development; Electronic Devices

OBJECTIVE: Design, Develop and Demonstrate an Adaptive Beamformer Optimized for Detection of Near Field Short Duration Signals.

DESCRIPTION: The traditional Navy threat was nuclear powered submarines operating in deep water. Existing beamformers are optimized to operate in this environment providing large array gains against plane wave arrivals of long duration signals. as a result these beamformers suffer severe performance degradation against near field non-plane wave signals having a relatively short duration which are more representative of signals from diesel/electric submarines operating in shallow water. A new generation of beamformers must be designed which provide array gain and directional noise rejection against intentionally and unintentionally emitted short duration, near field signals.

Phase I: Design and model a near-field Transient Adaptive Beamformer (TABF). Modeling must demonstrate an array gain improvement over existing beamformer approaches on short duration signals. The deliverable is a preliminary design document that includes the results of the modeling efforts.

Phase II: Modify the model to process government furnished ocean data and demonstrate array gain against near-field transient signals. Design a real time implementation of the transient adaptive beamformer. Deliverable products are a demonstration of TABF showing improvements of array gain and a design document for the real time TABF processor.

Phase III: Develop a real time transient adaptive beamformer and demonstrate the processor at a Navy installation for transition to ADS. Expected commercialization of the development for oil exploration may warrant a Cooperative Research and Development Agreement (CRDA) with a Navy laboratory.

Commercial Potential: The technology has application in the private sector in oil exploration and three dimensional phased radars for air traffic control.

N94-007 TITLE: Realtime Recording

CATEGORY: Exploratory Development; Electronic Devices

OBJECTIVE: To provide a state-of-the-art, low-cost data recording capability for Sea Range realtime data.

DESCRIPTION: Develop a PC-based realtime recording capability that would allow realtime recording at a sustained data rate of 3-5 Mbytes/second while supporting simultaneous non-realtime reading of the realtime data at a sustained rate of 1-2 Mbytes/second. The purpose is to allow near-realtime processing of realtime telemetry and TSPI (radar) data for quick-look

and quick-turnaround data packages. System should be low-cost and based on commercial technology (e.g. Pcs or low-cost UNIX workstations, etc.).

Phase I: The contractor shall research the issues and the available technology. The contractor shall then design and submit a proposed solution specifying the technology to be utilized. The contractor will provide cost estimates for the final product.

Phase II: The contractor will, after approval of phase I, develop, test, and document one PC-based realtime recording device. He shall then thoroughly test the device and measure the exact performance capabilities. He shall then demonstrate the device to the government and provide the device to the government for further government testing and evaluation.

Phase III: The contractor shall provide additional units to the government if the results of phase II determine the device to be useful and cost effective to the government.

Commercial Potential: The realtime recording capability is a technological capability that could be marketed to any customer requiring simultaneous writing and reading of large amounts of data. It might be used in highway traffic monitoring, air traffic control, water or power monitoring, and possibly dozens of other fields.

N94-008 TITLE: Wigner Transform Spectral Analysis

CATEGORY: Exploratory Development; Electronic Devices

OBJECTIVE: Develop and test algorithms for spectral analysis using the Wigner transform.

DESCRIPTION: Specific algorithms are sought for a discrete version of the Wigner Transform suitable for signal detection and analysis. The Wigner transform yields excellent time-frequency resolution if only one frequency component is present. For instance, the Wigner transform of a linear FM chirp is a straight line on a time-frequency plot. However cross-terms result when more complex signals are transformed. Recently, some researchers have shown that these cross-terms can be separated and deleted if a signal is first expanded in terms of Gabor coefficients prior to the Wigner transform. However, the Gabor analysis coefficients, used in the Gabor expansion, are not unique. A recent paper outlines a method to optimally compute the Gabor coefficients but does not offer a specific procedure. Algorithms are required to efficiently compute the Gabor coefficients and the Wigner transform. These algorithms must be tested against a variety of non-stationary signals such as PSK and FSK.

Phase I: Develop theoretical foundation for proposed algorithms. Define algorithms and test their performance against a range of signal types. Compare with conventional spectral analysis techniques. Fully document results.

Phase II: Implement algorithms on PC compatible DSP board, test and demonstrate.

Phase III: A prototype manufacturing product in the form of a signal frequency processor for test equipment use.

Commercial Potential: General purpose high-performance spectral analysis equipment.

N94-009 TITLE: Application of Coherent Measurement Methodology to Shielding Effectiveness Measurements

CATEGORY: Research; Materials

OBJECTIVE: Extrapolate and apply current coherent measurement techniques to problems associated with Shielding Effectiveness (SE) measurements.

DESCRIPTION: The Navy is looking for a proposal where coherent measurements are used to develop a SE test method where phase as well as magnitude information is retained from the measurement.

Phase I: During the Phase I effort, a theoretical basis should be established such that using the scattering parameter information associated with the method, on can calculate the SE of large objects as both a function of frequency and wave impedance. The theoretical statistical analysis also would be accomplished during the Phase I effort in order to determine the repeatability of this method.

Phase II: Perform SE tests using the aforementioned test method in order to determine inter-compartmental SE as a function of both wave impedance and frequency. This data then will be compared head-to-head with data using the methods described in IEEE 299, MIL-STD-285 in NSA Standard 65-6. If successful, the method developed in Phase I and demonstrated in Phase II will form the basis for a next-generation SE standard.

Phase III: Transition the test method for new architectural shielding designs where composites are used for shielding effectiveness.

Commercial Potential: The techniques developed will have wide applicability in the design of composite materials such

as Glass Reinforced Plastics (GRP) and conductive impregnated paper, in the construction and testing of shielded facilities and other structures, and in medical technology such as magnetic resonance imaging.

N94-010 TITLE: Surveillance of Buried Command and Control Centers

CATEGORY: Exploratory Development; Simulation and Modeling

OBJECTIVE: To determine types of sensing that could be used to detect, survey, and monitor activities used to establish and operate buried command, control, communications, computers and intelligence (C^4I) facilities.

DESCRIPTION: A large numbers of countries are using deep underground command centers. The construction, activation, and operation of these centers are well concealed. The question to be answered is whether sophisticated sensing systems, such as acoustics, unmanned ground sensors, lasers, chemical detectors, etc. can be used to support targeting, mission planning, weapons research and development, and intelligence collection.

Phase I: At the end of six months, a concept study should be completed. The study should address the types of sensors that have capabilities to support this surveillance need; an approach to how the sensors would be deployed; how many sensors would be needed per specific sized area; and how the sensors would communicate their data/information to collection centers for analysis and reporting.

Phase II: At the end of two years, an in-depth concept study should be completed that validates the approach and applicable sensor types through use of models and simulations to determine accurate estimates of sensor performance, concept of operations, and cuing data and information transfer capabilities. The final step in Phase II is development of a test plan to validate or discredit the approach and sensors identified in the study. The plan should also show the sensitivity to sensor selection, topography, soil and environmental conditions, and communications.

Phase III: Conduct a ground test that demonstrates successfully the sensor systems and approach validated in the Phase II study.

Commercial Potential: Many commercial applications exist for this type of technology from development of highly sensitive sensors able to determine the adverse heath risk if any from prolonged exposure to various levels of electromagnetic radiation, to sensors supporting recovery of people buried in ruble during mine disasters, terrorist bombings or earthquakes.

N94-011 TITLE: Advanced Systems and Technologies for Future Naval Warfare

CATEGORY: Exploratory Development; Communications, Sensors

OBJECTIVE: Enhance Navy's future warfare capabilities in C4I, and wide area surveillance with emphasis in undersea and space-based surveillance sensors.

DESCRIPTION: Navy is seeking new, innovative, high risk/payoff ideas in technologies and/or advanced systems concepts that support the Navy's mission in the years 2000 and beyond. Ideas are required to enhance and solve technology problems detailed in the objective statement.

Phase I: At the end of the six month effort, work should have demonstrated the feasiblity of a system concept or technology, identified critical subsystems or technologies that must be matured for transition into the Navy's acquistion system. Work must also be performed in preparation for a Phase II effort to demonstrate technical feasibility and increase the potential of the technology or systems concept to transition.

Phase II: At the end of a two year effort, the technology or systems concept must have been developed enough to bring critical subsystems or technologies for transition to maturity. Sufficient work must be completed to enable the technology to transition to an advanced technology demonstration, or into a higher category RDT&E, or become the basis for a concept for Navy applications.

Phase III: A Navy Phase III effort is anticipated.

Commercial Potential: The products identified to enhance Navy's warfare capabilties will find commercial applications in communications (radio, television, telephones), environmental monitoring and fishing.

N94-012 TITLE: Bioluminescence Test Bed

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Research is required to explore the feasibility of using naturally occurring, waterborne, bioluminescence phenomena for potential military and civilian applications in areas of harbor security and sensor systems.

DESCRIPTION: Vieques harbors contain plankton and other biological material which emits light when it is disturbed by objects moving through the water such as a boat or a swimmer. Establishing Vieques harbor as an experimental test bed may reveal potential military and civilian applications for this phenomena. A methodology could be developed to measure the emitted light intensity in relationship to the size, velocity, and location of the disturbance. As a result, the phenomena could be most useful in the areas of harbor security, such as detecting a terrorist diver in the process of planting a bomb. Since the phenomena is naturally occurring, it would be impossible to disable it as is the case of conventional security systems.

Local universities have been working on the phenomena for the past several years.

Phase I: In conjunction with knowledgeable institutions, prepare engineering analysis to determine concept feasibility and develop an engineering model for the test bed and potential applications to be tested.

Phase II: Using results of Phase I, test potential applications, analyze results and prepare report.

Phase III: Depending on the results of Phases I and II, implement applications by military and civilian users.

Commercial Potential: Security systems for installation in harbors or their bodies of water will detect, and therefore protect, ships and water-side facilities from illegal access, i.e., terrorists, criminals.

NAVAL SUPPLY SYSTEMS COMMAND

N94-013 TITLE: Deterioration Sensors on Hazardous Material Containers

CATEGORY: Exploratory Development; Environmental Quality

OBJECTIVE: Reduce hazardous waste generation and requirements for new hazardous material acquisition.

DESCRIPTION: Approximately 80% of the hazardous material turned in for disposal by the Navy is unused and in its original packaging. Much of this material is being turned in simply because assigned shelf-life periods have expired. A study conducted by the Navy during 1992 showed that many assigned shelf-life periods bear little relationship to the true deterioration characteristics of hazardous material or its packaging and that the true life of the material considerably longer than assigned shelf-life codes indicate. This leads to the conclusion that shelf-life periods are artificial and much of the Navy's hazardous waste generation would be avoided if users of hazardous material had a simple way to tell whether or not their on-hand material was still good. One way to do this would be to develop sensors that detect hazardous material deterioration and put the readouts for the sensors on the exterior of all hazardous material containers. With such sensors, users would use their material until the sensor indicated that the material was no longer usable. Artificial shelf-life periods would no longer force material into premature disposal.

Phase I: Develop/justify concept.

Phase II: Coordinate with manufacturers of high volume materials and develop, test and demonstrate standard sensor systems for hazardous material containers.

Phase III: Develop training system to introduce government personnel to the new sensors. Be prepared to defend validity of the sensors within DOD logistical and engineering communities.

Commercial Potential: Extensive...all users of HM in government and industry will benefit. Sensors will reduce laboratory costs, requirements for new purchases, and hazardous waste volume.

NAVAL AIR SYSTEMS COMMAND

N94-014 TITLE: Optical Amplifiers for Airborne Applications

CATEGORY: Advanced Development; Communications Networking

OBJECTIVE: Development and packaging of optical amplifiers for airborne applications.

DESCRIPTION: The ability to implement optical networks and sensors in aircraft has been impaired by the large optical attenuation incurred when a large number of in-line connectors must be used and the system must operate over environmental extremes. The telecommunications industry has shown the potential benefits of optical amplification and is planning implementation of transcontinental undersea links using this technology. Optical amplification can be achieved through the use of rare earth doped optical fibers (or rods) which are pumped with semiconductor light sources or through the use of stimulated emission in semiconductor materials. It is therefore the intent of this solicitation to develop optical amplifiers utilizing the above mentioned or alternative technical approaches. The amplifiers must be capable of operation in severe avionic applications. The proposed approach should emphasize low cost, weights and size and have the ability to survive the temperature, shock and vibration of a high performance aircraft. Since the length of fibers on aircraft is relatively short, the gain of these amplifiers may not necessarily be as high as that of typical telecommunication amplifiers. The design should emphasize low noise performance and suitability for both analog and digital applications. Optical amplifiers operating in the 850, 1300, and 1500 nanometer wavelengths are desired with the specific technical approach keyed to a particular wavelength.

Phase I: Detailed design concept and definition of a preferred packaging approach.

Phase II: Amplifier fabrication, test and performance evaluation in a rugged package suitable for use on high performance aircraft.

Phase III: Transition of the delivered hardware into a demonstration network to show the performance benefits.

Commercial Potential: Applicable to all networks where high reliability and survivability is of prime importance such as commercial aviation, factory automation, medical imaging and telecommunications networks.

N94-015 TITLE: A Real-Time Fiber Optic Network for "Fly-By-Light" and Vehicle Management Systems (VMS) Applications

CATEGORY: Advanced Development; Communications Networking

OBJECTIVE: Design, fabricate, and test the digital interface for a real-time fly-by-light network

DESCRIPTION: There is a need for development of a real-time deterministic and fault tolerant network for fly-by-light control systems which has growth capability for future system enhancements. A commercial standard for such a bus has been developed and is designated as Society of Automotive Engineer (SAE) Standard AS4075, High Speed Ring Bus Standard. The commercial fiber distributed data interface (FDDI) standard American National Standard Institute (ANSI) X3T9.5 has also been suggested for real-time applications although this protocol was not specifically designed for such applications. Alternative high speed network protocols are also being developed commercially which might be utilized in real time flight critical applications. The purpose of this program is therefore to characterized and validate the real-time behavior determinism, reliability, and survivability of an optimum bus protocol and associated fiber optic network topology leading to development of flight-qualified hardware for "fly-by-light" applications.

Phase I: Detailed trade study comparing the AS4075, X3T9.5, and alternative high speed protocols for real-time control applications. The trade study should specifically address the features of each bus protocol standard including, but not limited to, data rates, critical timing delays and determinism. The network topology options should also be analyzed with respect to data integrity and fault isolation and circumvention. The built-in-test capability of the networks should also be analyzed and an optical power budget for multi-terminal networks shall be performed. Based on the above analysis, computer modeling tools shall be utilized to arrive at an optimum design of a real time network for aircraft flight-critical applications.

Phase II: Computer modeling tools shall be used to design and optimize breadboard model of a multi-terminal high speed ring bus for flight critical applications based on the above analysis. In the event that commercial chipsets are not utilized, Very High Speed Integrated Circuit Hardware Description Language (VHDL) tools will be used to perform circuit design and to generate test vectors to ensure compliance with the standard. The necessary circuit design for control of the physical layer should also be included complete with an investigation of available optical hardware including transmitter.s receivers, switches, couplers and fiber cables. A complete design package which can be reduced to a standard electronic module format E (SEM-E) modular implementation shall also be produced.

Phase III: Transition of the selected design to flight-worthy hardware and into a demonstration program to show the performance benefits.

Commercial Potential: Applicable to all networks where high reliability and survivability is of prime importance such as commercial aviation, factory automation, medical imaging and command-and-control networks.

N94-016 TITLE: Monolithic Switched Photodiode Arrays and Receivers for High Speed Fiber Optic Networks and Optical Neural Networks

CATEGORY: Advanced Development; Communications Networking

OBJECTIVE: Design and fabrication of monolithic photodiode array including receiving and switch circuitry for communication and neural networks.

DESCRIPTION: Advanced fiber optic communications and computer networks utilize PIN photodiodes and low noise receiver circuitry to convert optical signals to electrical form for use by the network nodes. In order to provide fault tolerance in a network, it is highly desirable to accommodate a multiplicity of fiber optic input lines into a terminal with the ability to switch the most desirable input signal or signals to the receiver circuit(s) with minimal time delay based on the amplitude of the input signals. The use of an array of PIN photodiodes with a switchable bias voltage applied to individual array elements can perform such a function. A monolithic chip implementation of such a switchable array complete with an amplitude detection and threshold circuits, low noise receivers, and decision logic can dramatically reduce the cost of such circuitry. These monolithic circuits can also be used for electro-optic crossbar switches. The addition of optical circuitry to sum the input signals from the photodiodes prior to thresholding can make such an array useful in optical neural networks. It is desirable for these circuits to operate in the 850 nanometer optical wavelength for silicon compatibility. Alternative materials implementation in the 1300 and 1500 nanometer optical wavelengths is also highly desirable to accommodate the loss minima in optical fibers.

Phase I: Circuit analysis and design with computer aided tools with detailed packaging analysis and design to accommodate an array of input fibers in a hermetic package.

Phase II: Circuit fabrication, test and performance evaluation in a hermetically sealed package.

Phase III: Transition of the delivered hardware into a highly survivable demonstration network to show the benefits.

Commercial Potential: Applicable to all networks where high reliability and survivability is of prime importance such as commercial aviation, factory automation, medical imaging and telecommunications networks.

N94-017 TITLE: Low-cost Fault Tolerant Flight Controls for UAVs

CATEGORY: Exploratory Development; Software

OBJECTIVE: Develop low-cost solutions for providing fault-tolerant flight control systems for unmanned aircraft and other vehicles. Systems that rely on software, rather than redundant hardware systems, are particularly desired.

DESCRIPTION: Teleoperated and autonomous unmanned systems require provisions for fault detection and handling. Multiply-redundant schemes typically used in aerospace applications are prohibitively expensive for general application, especially where low cost or small size are critical.

New control strategies are sought which offer the potential for low-cost fault-tolerant control of parameter systems that will be applicable to a wide range of air, marine, or ground vehicles. For example, a "monitoring observer", or failure detection filter, could run a real-time simulation of the controlled system in parallel with the actual system, compare outputs of the two systems, and appropriately interpret discrepancies to detect system faults or failures. The system would then be reconfigured to operate on a reduced sensor or actuator set. Both the failure detection and control reconfiguring would take into account the parameter dependent nature of the system.

Phase I: Develop the concept and algorithms, primarily through computer-based simulation. Lab demonstrations, if not already available, should be provided in this phase.

Phase II: Provide a flight demonstration using an existing UAV and "simulated" faults in sensors or actuators. Contractor should state which UAV will be used and give a full explanation of how flight safety will be maintained.

Phase III: Develop and utilize the system in operational unmanned vehicles, and diffuse into other applications.

Commercial Potential: Fault-tolerant systems of the type envisioned here will have a wide variety of applications in (a) military, scientific and commercial unmanned aircraft, (b) commercial aircraft, and (c) advanced ground vehicles, such as the Intelligent Vehicle Highway System (IVHS).

N94-018 TITLE: Vertical Cavity Surface Emitting Laser Packaging for Avionics Applications

CATEGORY: Advanced Development; Communications Networks

OBJECTIVE: Design, develop and fabricate optical packaging concept for vertical cavity surface emitting laser capable of operation in avionic environments.

DESCRIPTION: Vertical cavity surface emitting lasers have unique properties which make them potentially attractive for avionics applications. The devices require low threshold currents and emit in a circular output beam pattern, and can operate over military temperature ranges without the need for thermoelectric coolers. There is a need to develop a packaging concept for these lasers which would make the devices suitable for avionics applications. The package should provide a hermetic seal for the enclosed devices as well as an optimum thermal transfer path for the devices to assure reliable operation. The package should provide the necessary optical elements to couple the optical output very efficiently to an array of optical fibers. All required electronics should be contained in the array package with an efficient bonding method for the enclosed devices. An optimized method for attaching the package to both ceramic and or silicon substrates as well as printed circuit cards shall be explored.

Phase I: Detailed analysis of all optical, electrical, mechanical and thermal properties of the selected surface emitting laser arrays to optimize a packaging concept. The package should be modular in design to accommodate arrays with a diverse number of elements. Thus the package should be expandable from a single laser to a linear array and finally to a two dimensional array if possible. All optical elements shall be analyzed including discreet lenses or lenslet arrays. Sealing and bonding methods shall be investigated to assure automation to achieve low cost. Analysis shall be made with respect to typical avionic environments. A final design package including a CAD/CAM design package will be delivered.

Phase II: Fabrication and demonstration of a prototype package in accordance with the above selected design. Detailed manufacturing and assembly techniques will be explored and documented to achieve high volume low cost production. All materials options will be investigated and implemented to achieve an optimum package. Delivery of prototype packaged devices to validate the optical, mechanical, electrical and thermal properties. Demonstration of the coupling to optical fiber arrays as well as the attachment methods to substrates and circuit boards will be required. A complete design package which can be applicable to a standard electronic module format E (SEM-E) modular implementation shall also be produced.

Phase III: Transition of the selected design to flight-worthy hardware and into a demonstration program to show the performance benefits.

Commercial Potential: Applicable to fiber optic networks or optical computing where high reliability and survivability is of prime importance such as commercial aviation, factory automation, medical imaging and automotive applications.

N94-019 TITLE: Finding Cracks Underneath Coatings On Ferromagnetic Metals

CATEGORY: Advanced Development: Materials and Processes

OBJECTIVE: Develop nondestructive inspection (NDI) techniques enabling detection of circumferential cracks beneath electroplated nickel or chrome on ferromagnetic substrate materials.

DESCRIPTION: Currently magnetic particle inspecting cannot be performed with coatings in place that could prevent the detection of surface defects in a ferromagnetic substrate. Normally such coatings include paint or metal plating greater than 0.08 mm (0.003 inch) in thickness or ferromagnetic coatings such as electroplated nickel greater than 0.03 mm (0.001 inch) in thickness. A number of engine and landing gear components have failed due to the inability of magnetic particle inspection to detect circumferential cracks and machine grindings that led to stress cracks beneath these coatings. The barkhausen noise measurement method shows promise towards the evaluation of stress related phenomenon in metals. Additionally, this method has proven to be useful in the evaluation of various processing steps.

Phase I: Identify and demonstrate the feasibility of barkhausen noise process control. Preliminary testing shall focus on provisions for measuring or monitoring process parameters.

Phase II: Process control shall be developed and thoroughly evaluated by the contractor. The primary goal shall be the evaluation of stress related defects location under the various coatings proposed. The design, development, and testing of a prototype unit shall be accomplished.

Phase III: Once prototyped and certified, the test unit shall be made available for Navy and commercial or other use.

Commercial Potential: This NDI process has application in the commercial maintenance industry, aerospace and automotive.

N94-020 TITLE: Near IR Absorbing Pigments

CATEGORY: Advanced Development; Materials and Processes

OBJECTIVE: To develop pigments for use in white paint or in fluorescent lamps that absorb near infrared (rear IR) emissions.

DESCRIPTION: In order to achieve good red color in night vision imaging systems (NVIS), compatible displays filter elements must be added to reduce light emissions in the near IR wavelengths. Because of the sensitivity of night vision goggles in red light, NVIS compatibility of full color displays is very difficult to achieve. This would be significantly reduced if near IR absorptive mechanisms were present in the backlighting module. Since most of the surface area in a backlighting module is coated with a highly reflective white paint, an ideal mechanism would be near IR absorbing pigment that could be added to a white paint with little or no loss of reflectance. A similar pigment mixed with the lamp phosphor of the fluorescent lamps used to backlight LCDs could also have a large impact.

A more efficient mechanism would be through the development of a so-called "anti-stokes" phosphor. This phosphor would absorb two or more photons, include at least one undesirable near IR photon, then release energy in a more energetic visible wavelength. Near IR spectral scans of typical fluorescent lamps would identify the near IR line emission(s) to be absorbed by this phosphor.

Phase I: A study will be performed to identify existing materials and explore the feasibility of developing new materials. A report will describe these materials, describe the difficulties in developing them, calculate the reduction of near IR emissions that could be achieved as well as their impact on system efficiency, and propose a development program.

Phase II: A development program will be completed. Sample pigments, paints, and fluorescent lamps will be fabricated and tested.

Phase III: Integrate into future aircraft production as recommended.

Commercial Potential: This is a "dual use" topic. Requirement exists in the private sector in photography and in the law enforcement area.

N94-021 TITLE: Development of a Durable Anti-Reflective Coating Suitable for Application to a Complex Surface

CATEGORY: Advanced Development; Materials and Processes

OBJECTIVE: Develop an anti-reflective coating that can be applied economically to complex curved surfaces of silica glass, stretched acrylic and polycarbonate windows. The anti-reflective properties should be tuned for maximum effect in the visible and near IR wavelengths. The anti-reflective coating should not cause significant optical distortion, or radiant attenuation over the operating range. The coating should be durable enough to withstand repeated cleaning over the service life of the application. If re-application is required, the methods should not be cost- prohibitive. The anti-reflective coating should also be low maintenance so as not to require special materials or techniques to clean.

DESCRIPTION: As aircraft cockpits modernize with electronic displays and automobile interiors look more like aircraft, the need for a durable anti-reflective coating will increase industry-wide. Also, digital electronic color displays provide a tremendous capability in all types of displays. The displays, however, cause a very disagreeable reflection on the interior surfaces of windscreens, canopies and windshields. In some cases the reflections make viewing impossible. At present, there are anti-reflective coatings on the market. However, there are no coatings durable enough for commercial or military applications on complex curved surfaces like windscreens, canopies and the "new" styled auto windshields.

Phase I: A study will be performed to identify existing anti-reflective coatings and explore the feasibility of developing new coatings. A report will describe these materials, describe the application methods, and difficulties involved with their use. The results achieved by the anti-reflective coating will also be provided in the final report.

Phase II: A development program will be completed. Sample coatings will be tested and the results documented.

Phase III: Integrate into future aircraft as recommended.

Commercial Potential: This is a "dual use" topic. The commercial potential for this technology would be automobile windows, as well as commercial and military applications. In addition, the use of this technology in commercial observation points like lounges and restaurants, with a curved window where the ambient light levels are higher at the inner surface, would be beneficial.

N94-022 TITLE: Small/lightweight Electric Vertical Take-off and Landing (VTOL) Unmanned Aerial Vehicle (UAV)

CATEGORY: Exploratory Development; Software

OBJECTIVE: To perform a feasibility study necessary to characterize a small/lightweight electric VTOL UAV.

DESCRIPTION: A small, lightweight (less than 30 lbs) electric VTOL UAV with an imagery payload would be very cost effective for performing reconnaissance and surveillance missions of about one hour. Such a system could be launched from anywhere and thus be independent of the need for takeoff and landing space. Electric power would simplify logistics by eliminating the need for liquid fuels and would also provide a system that was extremely quiet. Low cost would allow the system to be considered expendable in certain missions.

Military applications include: (1) Army land forces -Detect targets at short ranges, i.e. , over the next hill. (2) Naval amphibious forces - Conduct beach and surrounding area surveillance prior to assault. (3) Air Force - Survey air fields for damage, indications of intrusion, or terrorist activities.

Phase I: Phase I would generate conceptual designs which would be validated through analysis and simulation.

Phase II: Phase II would consist of fabrication and integration of the ELECTRIC VTOL UAV proof of concept.

Phase III: Phase III would plan to design and build demonstration air vehicle as well as pursue Navy and commercial application of the electric VTOL UAV via demonstration.

Commercial Potential: There are numerous para-military and commercial applications for small, lightweight VTOL UAVs. examples of uses include: monitor traffic, assist in search and rescue operations, assist in urban riot control, survey hazardous waste sites, monitor fish and game movement, detect forest fires, detect oil spills, assist in mapping and mineral/oil exploration, and monitor suspected drug or other criminal activity at specific locations.

N94-023 TITLE: Virtual Simulation for Terminally-Guided Weapons

CATEGORY: Advanced Development; Training Devices

OBJECTIVES: Improve the procedural weapon skills of the tactical strike aircrew through the injection of virtual reality (VR) technology and techniques into either existing and/or new training devices.

DESCRIPTION: Establishing proficiency with terminal guidance skills for the man-in-the-loop air-to-ground weapons used by the Strike community has been difficult with current training devices. In employing these weapons, the AGM-84E Standoff Land Attack Missile (SLAM) and the AGM-62 TV Walleye, the operator steers the weapon to the target using infrared and television guidance, respectively, and a hands-on slew stick. Simulating this process in a two-dimensional space, as observed in present part-task training devices, provides little operator realism. Using a three-dimensional display and employing concepts of virtual reality, the operator's point of view can be placed either in the cockpit or in the seeker head of the weapon, at his option. This will enable the operator to improve his timing and performance by acquiring a better understanding and "feel" for the weapon's response to the slew stick.

Phase I: Examine a number of design approaches for injecting the virtual representation of the SLAM and Walleye missiles into the a Navy trainer. Determine the feasibility of the best approach.

Phase II: Develop a "virtual world" representation for SLAM and Walleye terminal guidance and specify any dedicated hardware and/or peripherals, such as a helmet-mounted display, and their interface required for installation into the trainer selected in Phase I. Develop a prototype, using this trainer as a testbed. The Navy will be responsible for testing and validation.

Phase III: Install the software and any required hardware into the Navy trainer used in Phases I and II. Potential exists for converting these products for use with Air Force and Army trainers as well.

Commercial Potential: Direct application for use in video games, recreational simulations, computer-based training, and entertainment devices.

N94-024 TITLE: Secondary Sensor for High Speed Anti-Radiation Missile(HARM)

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Devise a sensor for targeting critical ground-based radar components that does not rely on electro-magnetic (EM)

emission from targets.

DESCRIPTION: HARM missiles home on a radiating electro-magnetic source and are especially effective as a defense suppression weapon. However, when the threat EM source is shut off for countermeasure purposes or fails to radiate during pre-emptive launch, the HARM must maintain course without additional guidance information from the radiating source. Several incidents during Operation Desert Storm highlight the lack of ARM's ability to identify and guide toward a selected/specified target in a "shutdown" environment. In order to significantly increase the probability of kill (Pk) and reduce the probability of fratricide, a secondary sensor is needed to supply guidance information during the terminal flight phase. Novel proposals are sought for a secondary sensor that will also provide an aimpoint select capability and address the need for Battle Damage Assessment. Contractors should consider sensor and guidance candidates that are compatible with the current HARM airframe.

Phase I: Perform an investigative study of the proposed secondary sensor system that provides proof-of-concept using computer simulations and models and/or a partial breadboard system.

Phase II: Construct a brassboard system that demonstrates critical elements of the sensor concept and prepare a documentation package that is suitable for taking the concept to Advanced Development. Conduct studies validating the performance of the proposed system.

Phase III: Advanced Development -- Develop prototype missile systems to undergo laboratory, field, environmental, captive flight and free flight test and evaluation that validates the concept. Prepare a documentation package that is suitable for taking the concept to Engineering Manufacturing Development.

Commercial Potential: Secondary sensor technology can potentially apply to vehicular or site identification and image processing in law enforcement and drug interdiction initiatives.

NAVAL TRAINING SYSTEMS CENTER

N94-025 TITLE: Portable 3D Data Acquisition Technology for Computer Image Generation (CIG) Visual Databases

CATEGORY: Advanced Development; Modeling and Simulation

OBJECTIVE: Develop a portable system for capturing surface/low altitude 3D data for use in visual systems.

DESCRIPTION: Realistic visual systems use geometric shapes and texture to portray oceans, navigational cues in ports, and terrain. New technology is available for potential use in capturing and manipulating the data to convey the detail needed for effective training. This technology includes digital cameras, GPS receivers and CIG work stations which capture geometric shapes and textures.

Phase I: Develop a work plan for Phase II development of an integrated Data Acquisition System incorporating portable video and photographic devices for surface/low altitude 3D data acquisition of geometry and texture.

Phase II: Develop, demonstrate and evaluate a prototype portable 3D Data Acquisition System by developing ship handling and aircraft visual databases using data acquired from shipboard, surface vehicles, helicopters and low altitude aircraft.

Phase III: Produce commercial product based on the prototype.

Commercial Potential: Commercial simulators with visual systems (navigation training, entertainment, medicine).

N94-026 TITLE: Special Effects for Ocean Computer Image Generation (CIG) Visual Simulation

CATEGORY: Advanced Development; Ocean Science

OBJECTIVE: Develop low cost simulation of certain dynamic ocean effects.

DESCRIPTION: Simulations of certain ocean effects (whitecaps, foam, spray from the bow of a ship as it goes through water) are not currently available on existing commercial or military simulators. These effects present cues for landing helicopters. This task will develop the simulation of special effects for dynamic ocean simulation using the latest low cost CIG workstation capabilities.

Phase I: Survey existing commercial/military ocean effects databases; identify the special effects to be simulated and define the characteristics of the databases to be developed in Phase II.

Phase II: Develop and evaluate prototype databases to demonstrate the special effects using the latest texture and low cost CIG workstation capabilities.

Phase III: Produce commercial database applications as products based on the low cost prototype (less than $15k).

Commercial Potential: Commercial simulators for both military and civilian training and possibly entertainment applications.

N94-027 TITLE: Low Cost, PC-Based Navigational Skills, ATC and Crew Coordination Training Tool

CATEGORY: Advanced Development; Training Devices

OBJECTIVE: Develop a PC-Based Crew Coordination and Navigational Skills training tool that could be used for aviator training.

DESCRIPTION: Aviators do not have enough opportunity to practice navigation and crew coordination skills in actual aircraft or simulators. A PC-Based training aid would provide an opportunity for practice when deployed away from conventional training sites. In addition to piloting an aircraft, maintaining proficiency in the combined task of following ATC instructions, navigation, and crew coordination can be difficult. The PC-Based simulation would have a simulated ATC and other voice traffic that the pilot would have to listen and follow. In addition, several systems could be networked together to provide a total system for the additional feature of crew coordination training. The system will consist of a low fidelity flight simulation system with a database with user definable attributes that could be used with actual air charts. Also, to be included, development tools to allow the user to create simulated radio traffic. The system should include representative flight models, user definable weather conditions, and software tools to provide an analysis of the training session. The use of existing software and hardware is encouraged. Low cost flight controls that may add to the fidelity training environment are not required but are encouraged and, if provided, should be representative of actual flight controls (yoke, stick, collective, etc.).

Phase I: Examine the current technology base for applicable products. Develop a system that would be an effective Navigational/ATC/Crew Coordination training tool.

Phase II: Design and construct a prototype Navigational/ATC/Crew Coordination training tool.

Phase III: Demonstrate, evaluate, and commercialize the training tool in both military and commercial aviation communities.

Commercial Potential: Interest in this tool has been expressed by both the civilian and military aviation training communities.

N94-028 TITLE: Low-Cost Real-Time Stereoscopic Multiplanar Display Development for Future Navy Battle Management Training Systems

CATEGORY: Advanced Development; Training Devices

OBJECTIVE: Develop a prototype for a low-cost Battle Management System which utilizes a stereoscopic Multiplanar display to create true three-dimensional training scenes in real-time (update of 30 frames per second). The display subsystem must create a true real-time three-dimensional image which occupies a volume and can be viewed from all sides by several people.

DESCRIPTION: Most current Navy Battle Management Training Systems utilize terrain boards of two-dimensional graphics to simulate three-dimensional scenes for modeling geographic areas. Terrain boards lack simulation of time of day, atmospheric effects, and special cues. Two-dimensional graphics lack true parallax motion cues that real-world images give. These limitations can be overcome by generating a true three-dimensional simulated scene. The Battle Management System must meet the following requirements:

- Full color
- Air/ground operation station
- Minimum update rate of 30 Hz
- Rapid database loading
- Interface with IOS
- Image made within 3-D space
- Terrain and Feature modification capability
- Terrain and Features database derived from DTED and DFAD
- Atmospheric effects simulation
- Special effects simulation
- Multiperson off-angle viewing
- Time of day (day, dusk, night)
- No eyeglasses for viewing optics
- Moving model simulation

Two-dimensional PC or workstation displays which give the illusion of three dimensions (perspective drawing) are not permitted.

Stereo-pair displays which require special eyeglasses or optics to produce virtual images are not permitted because ten percent of the population cannot fuse images and off-angle viewing is very limited. Holographic displays are not permitted because their characteristics change with viewing angle and the images cannot be updated in real-time. Successful completion of this effort will result in low-cost three-dimensional display technology.

Phase I: Perform and finalize preliminary concept design.

Phase II: Construct a prototype which will be available for testing in Marine Corps training facilities.

Phase III: Transition to battle management, air traffic control, and medical training applications; explore video game potential.

Commercial Potential: These simulations have commercial potential for video games and medical simulations (where real-time 3-D simulation is desirable)

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND

N94-029 TITLE: Blocking Agents for Human Blood Transfusion

CATEGORY: Exploratory Development; Biology and Medicine

OBJECTIVE: Develop antibody blocking reagents which will block a blood transfusion reaction in humans caused by giving mismatched blood to an incompatible recipient.

DESCRIPTION: ABO mismatched transfusion reactions are caused by the binding of naturally occurring anti-A or anti-B agglutinins present in the plasma of the recipient with the corresponding antigens on the surface of the donor erythrocytes. This binding leads to intravascular agglutination and hemolysis of the transfused erythrocytes, and these events lead to severe hypotension, shock, acute renal failure, hemorrhagic diathesis, and subsequent death of the recipient. Reagents are to be developed which will block the binding of the anti-A and anti-B antibodies to the erythrocyte antigens and thus prevent the destruction of the transfused red cells. If such reagents were available, then blood from any donor could be safely transfused into any recipient without fear of a subsequent transfusion reaction.

Phase I: Develop high affinity mouse monoclonal antibodies to A and B blood group antigens to be used as blocking reagents for A and B antigens on red blood cells.

Phase II: By genetic engineering, prepare cDNA clones of the heavy and light V regions for the anti-A and anti-B monoclonals to prepare short polypeptide variable region chains to be ligated to human constant region genes.

Phase III: By genetic engineering, ligate the variable region polypeptide H and L chains to H and L truncated human antibody constant region to prepare humanized blocking reagents to be transitioned to the Navy laboratories for testing in a SCID mouse model.

Commercial Potential: The blocking of transfusion reactions would have application in the private sector as well as in military medicine.

N94-030 TITLE: Color Coding for CRT Displays

CATEGORY: Exploratory Development; Human-Systems Interfaces

OBJECTIVE: Develop a method for color coding self-luminous displays which is based on color science (i.e., the CIE system, color vision theories, fundamental data of color perception and physiological optics). The method should account for discrimination of color symbology in terms of symbol color (including luminance), symbol size, and surround color. Existing Navy and NATO symbology are of particular interest.

DESCRIPTION: Color science has provided methods with which to infer the conspicuousness and confusability of segments of color images, based on measurements of the light from the segments. Highly-discriminable color symbols may be engineered using these methods. Applicability of these methods is severely limited because practical symbols are smaller in subtense than the segment sizes upon which the methods are based. Symbols of realistic sizes are less discriminable than would be predicted based on these methods. In addition, the methods are based on neutral gray surrounds for the segments. Colored surrounds alter the apparent color of the symbols in ways not contemplated by existing methods. A theoretical empirical approaches to these problems are ineffective because the combinations of surround color, symbol colors and symbol sizes are virtually limitless. A general approach, based on color science, is required to predict the effects of symbol and surround colors and symbol size

on symbol discriminability. The effectiveness of the approach should be demonstrated using existing Navy and NATO symbologies.

Phase I: Develop a theoretical approach to design of color codes for self-luminous displays, accounting for symbol size, symbol color, surround color, and ambient light. Provide convincing data from a "laboratory demonstration" that the approach works.

Phase II: Demonstrate the method works with existing Navy and NATO symbology in the context of Navy ship and aircraft workstations.

Phase III: Participate in Cooperative Research and Development of a new workstation and symbology in the U.S. Department of Defense (preferably in the Navy). Apply the method to optimize the workstation symbology.

Commercial Potential: Commercial aircraft cockpit displays, automotive display symbologies, map design, situation displays, computer assisted design symbologies, arrival-departure type displays, process control displays, display of data, highlighting items in text, data-base browsing aids.

N94-031 TITLE: Injury Preventing Helmet Servo-Support System for High Performance Aircraft

CATEGORY: Exploratory Development; Biology and Medicine

OBJECTIVE: To develop an aviator helmet-support that allows full pilot head movement and provides protective support during ejection.

DESCRIPTION: Aviator helmets not only protect the pilot's head but are used as platforms for additional systems such as night vision goggles, FLIR displays, HUD displays, laser protection devices, laser protection devices, earphones, visors, and so on. The end result of this proliferation is increased weight and a concomitant decrease in the pilot's ability to maneuver his head effectively, support the load without strain or eject without the inertial loading resulting in a neck injury. A great deal of effort has gone into reducing the weight on an aviator's helmet by reducing the weight of components but this approach is limited. Furthermore, as new technologies progress, there will be increased pressure to place more equipment on the helmet, not less. The solution is to support the helmet by means of mechanical servo mechanisms, thereby taking the weight of the helmet off the pilot and placing it onto the airframe. Proposers should include a preliminary design of a helmet-support system with their proposals.

Phase I: At the end of the six month effort the expected product is a set of detailed technical drawings of a prototype system to be fabricated in the following two years.

Phase II: Develop fully functioning prototype helmet-support system that works within the specifications described in the preceding objective and descriptive sections of this document.

Phase III: Refine the prototype system; prepare and deliver pre-production units

Commercial Potential: This technology has application in the robotics industry.

N94-032 TITLE: Genetic Constructs To Produce Rickettsial Antigens.

CATEGORY: Exploratory Development; Biology and Medicine

OBJECTIVE: Develop genetic constructs which are optimal for high level expression, proper folding state and rapid purification of recombinant antigens.

DESCRIPTION: Current methods for serodiagnosis of rickettsial diseases require antigens purified from infected yolk sacs or tissue culture cells. It is very expensive and hazardous to prepare large amounts of rickettsial antigens by present methods. Substitution of native antigens with recombinant antigens will revolutionize the serologic diagnosis of rickettsial diseases. The genetic constructs of immunodominant genes should be designed with three criteria to permit 1) high level expression, 2) proper folding, and 3) rapid purification.

Phase I: Subclone genes for selected scrub typhus antigens from pBR322 to pUC, and evaluate expression of subcloned genes under strong promotor control.

Phase II: Express the subcloned genes to meet following criteria: the level of expression should be $\geq$ 5% of total protein; antigen should be properly folded to conserve antigenic sites; specific tag or fused protein should be added for affinity purification.

Phase III: This effort is needed for the refinement of the system to increase the level of expression, minimize

proteolytic degradation, or change signal sequences to direct the cellular location of recombinant protein to further simplify purification.

Commercial Potential: The technology has application in the private sector since in recent years a remarkable increase in the incidence of infection due to rickettsiae has occurred in several countries including the United States. Misdiagnosis is common and may result in delay or inappropriate treatment and even mortality.

N94-033 TITLE: Production of Infectious Dengue-1 RNA.

CATEGORY: Exploratory Development; Biology and Medicine

OBJECTIVE: To construct a full-length dengue-1 CDNA clone that can be used to develop a genetically engineered vaccine.

DESCRIPTION: DNA sequencing studies are being conducted at NMRI to determine the genetic mutations responsible for dengue-1 virus attenuation. The attenuating mutations will be engineered into full-length dengue 1 CDNA clones by site-directed oligonucleotide mutagenesis. Infectious mutated RNA clones will be transcribed *in vitro* from the CDNA and packaged into infectious attenuated virions to use as a vaccine candidate.

Phase I: Construct a CDNA plasmid library of dengue 1 overlapping subclones that contain fragments representative of the entire dengue 1 genome.

Phase II: Connect the dengue 1 fragments and clone into a transcription vector to form a full-length infectious dengue CDNA clone.

Phase III: The infectious CDNA clones will be transitioned to the Naval Medical Research Institute and used to engineer a live attenuated dengue 1 vaccine candidate.

Commercial Potential: Dengue is wide spread throughout the tropics and subtropics. Travelers from the U.S. are at high risk and periodic outbreaks have occurred in the Southern U.S.A. A vaccine would have commercial application in preventing such infections.

NAVAL SEA SYSTEMS COMMAND

N94-034 TITLE: Active Noise Control

CATEGORY: Advanced Development; Electronic Devices

OBJECTIVE: By application of active noise control, reduce shipboard airborne noise from selected in-service system or component while demonstrating additional benefits of the control application (such as substantial weight or fuel savings).

DESCRIPTION:

Phase I: Focus concepts on a specific type of application of active noise control to a known ship problem where airborne noise reduction together with ancillary benefit represents an attractive ship and commercial application. For example, diesel exhaust mufflers are very large and heavy. Substitution of an active noise control package will save considerable weight and space as well as save fuel through the reduction in back pressure. Identify performance goals.

Phase II: Develop and demonstrate through laboratory testing an application package that will reduce airborne noise and offer an added feature that will reduce ship system cost, and meet performance goals.

Phase III: Build and install the application package on a naval combatant. Support the evaluation and document system operation and performance.

Commercial Potential: Offending airborne noise is common to many combatant shipboard and commercial vehicle and other industrial applications. This effort will be conducted as an unclassified task and be applicable to commercial use.

N94-035 TITLE: Unmanned Undersea Vehicle (UUV) Long Endurance Energy Sources

CATEGORY: Advanced Development; Energy Storage

OBJECTIVE: The Navy requires energy sources for tactical sized UUVs which are submarine compatible and provide long endurance.

DESCRIPTION: The long endurance energy system should have an energy density of greater than 150 W-hr/lb (including all necessary auxiliaries) when discharged in 12 hours (i.e. Li-SOCl2 equivalent or improvement). The energy source should also have very low rate discharge during periods when the UUV is dormant. The energy source should be capable of power levels between 3-10 KW, storage between -40 and 160 deg F, and have a shelf life of 5 years or more (at room temperature). The long endurance energy system will be required to be carried aboard submarines and should not employ materials or components which will preclude its certification for use aboard a submarine.

Phase I: Phase I should include detailed conceptual designs, and critical component sub-scale testing. Phase I designs and tests, in addition to meeting the above requirements, should address concerns associated with submarine certification of the energy source (fault tolerance, failure modes and mitigations, compatibility with submarine atmospheric controls, sub-safe issues, and potentially MIL-STD-2105A type testing).

Phase II: Phase II should include the development and demonstration of full scale prototype(s), including special safety demonstrations in certification critical areas.

Phase III: The Navy will utilize the results of phase II efforts in the design of specific UUV systems for performing operations.

Commercial Potential: Results could be used in underwater search and rescue vehicle or in a underwater robot.

N94-036 TITLE: Application of Advanced 3-D Visualization Techniques to Tactical Decision Aids for Naval Warfare

CATEGORY: Advanced Development; Human-System Interfaces

OBJECTIVE: This project will examine areas of potential contribution of 3-D visualization technology to the Sensor Performance Prediction Program and will also address the implementation of a 3-D display development environment which has considerable military and commercial potential in developing advanced displays.

DESCRIPTION: Graphic presentation of the tactical decision process has the potential to make trade-offs associated with alternative system parameters easier to grasp and evaluate than current processes.

Phase I: The Phase I effort will examine the 3-D rendering features of X Window system version X11R5 and other emerging 3-D graphics languages to define potential applications of 3-D real-time rendered displays in representing tactical performance data (such as shallow water active sonar performance assessment). This effort will further establish a 3-D toolkit for use in creating Tactical Decision Support Displays, and demonstrate the utility of the 3-D toolkit by implementing a prototype active sonar performance assessment display.

Phase II: The Phase II effort will design and develop a full scale documented environment for development and testing of tactical 3-D displays.

Phase III: Implementation of the 3-D development environment in advanced tactical decision aids, simulations, and training systems.

Commercial Potential: This project is applicable to a broad spectrum of commercial display applications including automated control systems and others which require display of complex information.

N94-037 TITLE: Two Body Hydrodynamic Models

CATEGORY: Advanced Development; Modeling and Simulation

OBJECTIVE: Development of models and algorithms for predicting UUV vehicle dynamics when operating within the influence of the submarine flow field.

DESCRIPTION: The Navy is focusing considerable effort in the development of Unmanned Undersea Vehicles (UUV). Many of the missions of these UUV's may require that the UUV be launched and recovered from a submarine. A requirement of the design effort will be to model the hydrodynamic flow when the vehicle is within the influence of the submarine flow field. This model is necessary to define many aspects of the vehicle design such as type and size of the vehicles propulsors and to evaluate recovery system design approaches. The recovery operation requires complex maneuvering and vehicle control when the vehicle approaches and is in the proximity of the submarine. The goal of this task is to develop a two body hydrodynamic model to support the design of UUV control systems.

Phase I: Phase I efforts should include development and/or modification of algorithms into a partial model capable of predicting the dynamics of the UUV under limited conditions.

Phase II: Phase II should include development and demonstration of a full model for representa .ve environments. The model should be capable of handling a full range of parametric analysis for various UUV control designs.

Phase III: The Navy will utilize the results of phase II efforts in the design of specific UUV systems for performing operations from submarines.

Commercial Potential: Simulate undersea maneuverability of ROV/UUVs in a high current environment near submerged structures such as oil platforms and shipwrecks.

N94-038 TITLE: Ship Construction Process Modeling

CATEGORY: Advanced Development; Modeling and Simulation

OBJECTIVE: To create a higher quality and better integrated design package by utilizing commercially available software to develop innovated modeling components that facilitate the communication of shipbuilding production concepts without building prototypes.

DESCRIPTION: Modeling components are independent of ship type, therefore this generic design package has equal applicability to commercial shipbuilding as to U.S. Naval shipbuilding.

Phase I: Model the hull block construction of a recent U.S. Naval ship showing the sequencing. Satisfactory completion and demonstration of the modeling allows transition to Phase II. Deliverables are reports documenting the model development and a videotape showing, in real time, the process.

Phase II: Model representative detailed subassemblies and completely outfitted modules containing habitability spaces. Incorporate the above detailed models into the model from Phase I. Utilize commercially available human factors programs to analyze habitability spaces and determine benefits gained from such an approach both in terms of shipyard assemble and in terms of day to day living. Satisfactory completion and demonstration of the modeling allows transition to Phase III. Deliverables are reports documenting the model development and approach analysis and a videotape showing, in real time, the process.

Phase III: Develop a generic ship hull block construction sequencing procedure and modelling method that incorporates prefabricated and outfitted modules. Demonstrate technique by modeling a recent or proposed commercial ship. Deliverables are reports documenting the model development, a videotape showing, in real time, the process, the software used, a training course on how the software modeling is accomplished, and a menu driven system for walking through the process. All software utilized and developed must be compatible with on going ARPA/DON efforts in this area.

Commercial Potential: The software tools developed would be ship generic and could just as easily be used to develop designs for commercial ships (both new and overhaul). Commercial shipyards could also use this software to help them better fabricate new acquisition U.S. naval ships.

N94-039 TITLE: Integrated Communications Network

CATEGORY: Advanced Development; Modeling and Simulation

OBJECTIVE: To develop an integrated Communications Network

DESCRIPTION: Present communications modeling techniques address each area of communications separately. With the increased emphasis on wireless communications there exists a real need for a model that will allow the designer to see how these systems will interact/interfere in an integrated communications architecture that addresses voice, video, and data requirements. This type of modeling would have direct applicability to the emergency services arena, ie police, fire and emt services.

Phase I: Identify technical issues, using the Navy's current and projected systems, that must be addressed in an integrated modeling system. Propose an approach that will meet the objective. Deliverables would include, but not be limited to engineering/Technical analysis', progress reports, and a final report.

Phase II: Building on the tasks performed under Phase I, a model shall be developed and tested using a using a target configuration agreed upon by the navy and contractor. Deliverables shall include, but not be limited to, engineering/Technical analysis', software documentation, progress reports, and a final report.

Phase III: A final simulation model shall be developed and delivered to the Navy. The model shall meet all requirements identified and agreed upon during Phase I and II efforts.

Commercial Potential: This modeling approach would allow communities to better integrate their communications systems and provide better service to the taxpayer. Exact $ value is hard to calculate, but every county and large metro area

has a need to integrate these services.

N94-040 TITLE: Thermal Insulation for Piping Systems

CATEGORY: Exploratory Development; Materials and Processes

OBJECTIVE: Develop an alternative thermal insulation material to polyphosphazene (MIL-I-24703) that can be used onboard submarines for piping systems and has a strong commercial market.

DESCRIPTION: Submarine thermal insulation material is used in piping applications above 125°F and below 40°F, as well as being used for anti-sweat purposes between 28°F and 99°F. The material must produce be low levels toxicity when in use or exposed to fire or hot surfaces. The ideal material shall support combustion and will not obscure vision when exposed to direct flame or extremely hot surfaces. The material needs to be flexible in order to be applied to numerous sizes of pipe as well as in sheet form for larger components. The ideal material will flex to follow pipe bends. The material needs to limit absorption of heat from an external source which would be detrimental to the system. Low volume and light weight materials are preferred. The material would be used on piping systems such as the chilled water system, refrigeration systems, and seawater systems. The material and thickness requirements of MIL-STD-769 are to be used as guidance. The material developed would be acceptable for use on surface ships as well as commercial ships and industrial process systems.

Phase I: Identify alternative material options which are comparable to polyphosphazene and identify planned testing to determine acceptability of materials. Materials must exceed the capabilities of MIL-P-15280 insulation. Insulation to MIL-P-15280, while low cost, has been identified as a potential fire source/problem on submarines. Preliminary testing should be conducted to aid in material selection. The end product of Phase I should be the recommended alternative material.

Phase II: Produce the alternate material and qualify the material for use onboard submarines.

Phase III: Upon successful completion of Phase II and given funding, Phase III will pursue further development or field installation.

Commercial Potential: This material would be useful in commercial buildings and industrial plant application where thermal insulation and fire resistance is required.

N94-041 TITLE: Polymer Current Limiters

CATEGORY: Advanced Development; Materials and Processes

OBJECTIVE: To develop a 100, 250 and 400 amp continuous current limiting device made of polymer materials which operates multiple times to replace single use current limiting fuses in electrical distributions systems in Navy ships, commercial ships and manufacturing facilities.

DESCRIPTION:

Phase I: Develop, build and test a prototype 100 amp continuous polymer current limiter. The performance characteristics are to limit a 100,000 amps short circuit to a maximum 6000 amps, operate in a 65° or 75° C ambient temperature, transition from the low impedance to high impedance in less than 0.5 millisecond, and operate in the high impedance mode for 20 milliseconds. The technical data includes a prototype 100 amp test device and a technology cost savings evaluation report and a test report. Next phase transition depends on successful test and evaluation of the device and cost evaluation.

Phase II: Develop, build and test a prototype 250 and 400 amp continuous polymer current limiters. The performance characteristics are to limit a 100,000 amps short circuit to a maximum 6000 amps, operate in a 65° or 75° C ambient temperature, transition from the low impedance to high impedance in less than 0.5 millisecond, and operate in the high impedance mode for 20 milliseconds. The technical data includes a prototype 250 and 400 amp test devices and a detailed technology cost savings evaluation report and a test report. Next phase transition depends on successful test and evaluation of the devices and detailed cost evaluation.

Phase III: Develop manufacturing processes, build and test a 100, 250, and 400 amp continuous polymer current limiters. The performance characteristics are to limit a 100,000 amps short circuit to a maximum 6000 amps, operate in a 65° or 75° C ambient temperature, transition from the low impedance to high impedance in less than 0.5 millisecond, and operate in the high impedance mode for 20 milliseconds. The technical data includes a manufactured 100, 250, and 400 amp commercial devices and a test report.

Commercial Potential: Replace fuses in Commercial shipboard applications and manufacturing facilities.

N94-042 TITLE: Neural Networks for Fast Predictions of Transients and Diagnostics in Shipboard Electrical Distribution Systems and Machinery

CATEGORY: Advanced Development; Propulsion and Energy Conversion

OBJECTIVE: Develop capability for real-time predictions of transients produced by shipboard electrical casualty faults and by electrical system reconfiguration and the detection and classification of electrical machinery status. End products will lead to improve circuit protection controls and devices.

DESCRIPTION: Shipboard electrical casualty faults can produce destructive voltage transients and outages that impair ship capacity to fight hurt and for casualty fight through. Circuit protective devices are being developed that will be capable of switching power busses and feeders in several microseconds; these devices will greatly enhance the survivability of generators, solid-state components, distribution systems, and loads if intelligent switching decisions are made in real time (i.e., several microseconds). Conventional prediction methods, even those methods that used reduced-order models require excessive computational throughput to achieve accurate, affordable real-time predictions.

Phase I: In Phase I, the contractor is to apply recent developments in dynamic artificial neural networks suitable for real-time predictions of transient responses of complex systems and define an appropriate neural network approach that will fuse the features from both vibration and electrical signatures to classify the condition of electrical machinery and allow detection of component deterioration in very early stages. Training algorithms should be able to have low complexity and be readily implementable in low-cost, off-the-shelf Digital Signal Processing (DSP) hardware. The contractor should postulate a representative, simplified power distribution system acceptable to the sponsor, use conventional methods to create a database of simulated transients for a variety of faults appearing in the postulated system, synthesize real-time prediction neural networks from the simulation data, and validate these neural networks on data from independent simulation runs.

Phase II: In Phase II, the contractor shall extend the real-time prediction work to include more comprehensive distribution systems and fault cases. Distribution system switching strategies shall be developed. These shall use classification neural networks to translate the transient and diagnostic predictions into appropriate switching decisions that affordably protect shipboard electrical circuits to enhance casualty fight through and survivability. The contractor shall prepare a plan for transfer of this technology to affordable shipboard and terrestrial power systems, and implement the paradigm on low-cost DSP hardware and demonstrate its utility.

Phase III: The Phase III effort should involve joint development for naval and terrestrial system markets, of advanced, affordable, modular, circuit protection product by teams of small-business contractor and industry suppliers.

Commercial Potential: Commercial potential exists in the commercial shipbuilding and retrofit markets, in small-scale terrestrial electrical power systems, and ultimately in large scale terrestrial systems. Affordable automated intelligent machinery diagnostic tools can improve reliability, reduce down time and provide significant savings in the areas of maintenance and repair by providing early detection of incipient failures for critical electrical machinery components.

N94-043 TITLE: Seawater Distilling Plant 3-way Bypass Solenoid Valve

CATEGORY: Advanced Development; Propulsion and Energy Conversion

OBJECTIVE: Develop a design for a noise-quiet, cost-effective seawater distilling plant three way bypass solenoid valve for use on submarines. This valve is also targeted for use in processing and power plants where existing commercial valves do not meet OSHA acoustic requirements.

DESCRIPTION: The Navy needs a low noise and low cost three way bypass solenoid valve for use in the condensate/distillate piping of seawater distilling units aboard submarines. Innovative low cost concepts are sought which meet distilling plant requirements and the SSN21 acoustic requirements.

Phase I: Develop multiple design concepts for Navy consideration. Provide a report with concept drawings which discusses the limitations, pros and cons of each design. Compare the production and life cycle costs of each design. Identify possible changes to Spec 1000-386 which would lower procurement costs while satisfying the valve functional requirements. Provide supporting rationale and analyses for recommended changes to Spec 1000-386 for each concept. Emphasis of design attributes will be quietness, manufacturing cost, simplicity of concept, reliability and life cycle cost.

Phase II: Design and build a prototype of the valve concept selected by the Navy and evaluate performance and acoustic capabilities by testing. Design the valve to satisfy 1000-386 with cost reduction changes, as approved by the Navy. Develop a manufacturing process plan prior to manufacture. Manufacture the valve and document the manufacturing process as it actually occurs. Simulate full scale production during the manufacturing process vice single prototype fabrication methods. Test the acoustic and functional performance of the valve. Make design changes and manufacturing process changes, based on manufacturing feedback and test results. Manufacture the new valve design and document the manufacturing process as it actually occurs. Test the acoustic and functional performance of the new valve.
Document both valve designs and changes, manufacturing processes and changes, test results, and lessons learned in a final report. Identify recommendations which could further improve valve performance and reduce manufacturing cost.

Phase III: Upon successful completion of Phase II, Phase III efforts will pursue complete first article qualification (e.g. endurance, shock and vibration) for use on SSN21 and other Navy ships.

Commercial Potential: This valve has potential applications in processing and power plants where existing commercial steam valves do not meet OSHA acoustic requirements.

N94-044 TITLE: Application of Fuzzy Logic to Emitter Classification Algorithms in Submarine Electronic Support Measures (ESM) Systems.

CATEGORY: Exploratory Development; Software

OBJECTIVE: Development of Fuzzy Logic Algorithms and Software for ESM Systems to Resolve Emitter Classification Ambiguities.

DESCRIPTION: Present submarine tactical ESM systems use library lookup tables to compare measured frequency, PRI, PW, chirp, agility, scan and other parameters of target emitter signals to classify the signals. In cases where the measured parameters are near the boundaries of library classifications, ambiguities and failures result. Fuzzy logic technology has matured to the point where it offers the potential of resolving these cases. A fuzzy logic algorithm augmenting present emitter classification routines will provide more reliable, robust ESM system performance.

Phase I: Analyze present ESM system emitter classification failures and identify fuzzy logic algorithms and software capable of correct classification in marginal cases. Define breadboard classification software system and prepare Phase II Program Plan.

Phase II: Develop breadboard fuzzy logic algorithms and software and integrate with ESM system emitter classification system. Prepare analysis of expected performance. Test combined classification system in Submarine Tactical ESM system against emitter signals now causing classification ambiguity and failure

Phase III: The fuzzy logic emitter classification upgrade will be transitioned to deployed ESM systems to provide improved target emitter classification performance

Commercial Potential: Improved emitter classification systems will have application to law enforcement activities requiring intercept of emitter signals, such as drug interdiction.

N94-045 TITLE: 94 Ghz Space Fed Phased Array

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Develop and characterize passive phase-shifters (reflectors or two-port devices) for use at millimeter-wave frequencies.

DESCRIPTION: Elements are needed for use in beamforming applications for antennas. Such elements are required to produce compact phased-array antennas without the cost of an individual transmitter for each element. Of particular interest are phase shifters suitable for conformal or non-planar arrays for air vehicles, particularly guided projectiles, which have constrained volumes that make a conical or pyramidal arrays preferable over flat plates.

Phase I: Conduct design studies, using analytic and computer methods, for phase shift elements and arrays. The phase shift elements should be suitable for MMIC construction techniques. The primary application is a 5 inch guided projectile seeker with a 25 watt peak power transmitter, with the ability to steer the beam 20° off the nose.
Specific matters to be studied are:
- Element and array patterns, including array beamwidth and side and backlobe levels

- Suitability for mass and MMIC production. Low cost is critical for use in gun ordnance and for commercial uses.
- Impedance and loss of elements
- Alternatives for the transition from free space to guided wave within the elements.
- Noise added by phase-shifters (for radar receiver and passive radiometer applications)
- Polarization of elements, array, and feed.

This work shall include analytic studies and computer models, and limited physical studies if needed to determine basic parameters for the models. The final result of Phase I shall be a technical report, a set of designs for a small number of prototypes of elements and arrays, and a statement of work for Phase II.

Phase II: Produce prototypes of elements and arrays to validate the analyses of Phase I. These prototypes do not necessarily have to be form and fit. The parameters calculated in Phase I for these designs (pattern, noise, polarization, etc), shall be measured in Phase II. The final product shall be an optimized design for correct-scale production, corrected models of its performance, and a test plan to characterize the performance of the optimized design.

Phase III: Produce a prototype of the most promising Phase II design. This item will be dimensionally suitable for use in the ogival nose of a 5" gun projectile seeker with a diameter of 100 mm and length of 355 mm. It is required to survive gun launch gee-forces (30,000 Gs for 5 Ms) and the temperatures of supersonic flight. Characterize the radiation pattern, noise figure, polarization, beam width, and gain of this model.

Commercial Potential: Applications to compact radars for vehicle and highway use, aircraft wing icing detection, and passive sensors for remote sensing and land resource management. Passive millimeter-wave radiometry has unique abilities to differentiate metal from non-conductors, combining radar and infrared characteristics.

N94-046 TITLE: Probability of Detection of Spread Spectrum Signals with Specified System Parameters

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Determine the probability of detection (Pd) of emitters in the communications frequency band using parameters of present and future submarine Electronic Support Measures (ESM) systems. The goal is to develop frequency search or prediction algorithms that will enable the ESM system to find and track spread spectrum signals.

DESCRIPTION: The present electromagnetic energy environment has been observing an increasing number of spread spectrum signals. Since the communications signals can be greatly increased in bandwidth (factors of 10 to 10,000 are common), the energy is spread over such a wide bandwidth that many times the signal is below the noise floor of a conventional acquisition system, which cannot detect the presence of the signal. Types of spread spectrum signals that interest the Navy include frequency hopping, direct sequence, stacked carrier, chirp, and time hopping signals.

Phase I: Conduct a six-month study to demonstrate the feasibility, based on a realistically modeled signal environment, of developing a prediction algorithm for use in a submarine ESM system.

Phase II: Construct and demonstrate performance of a prediction algorithm for spread spectrum signals. The effort shall produce a fully programmed computer model of the algorithm that will confirm and demonstrate the practicality of the spread spectrum signal prediction system.

Phase III: The technology will be transferred to the Government for use in surface and subsurface platforms that are concern with spread spectrum signal detection and identification.

Commercial Potential: The technology has application in the private sector in the cellular phone, telecommunications, radio industry, and drug interdiction.

N94-047 TITLE: Automated Ship Active Sonar Mutual Interference Planning

CATEGORY: Advanced Development; Software

OBJECTIVE: Perform advanced development of automated ship active sonar mutual interference planning considering optimum sonar employment, ship positioning, search requirements, environmental concerns, and threat definition, while maximizing search performance.

DESCRIPTION: The system should support evaluation of the effects of mutual interference, both forecast and in-situ, and generate a mutual interference plan to minimize the negative effects on search while maximizing search performance. In

addition, any system developed must allow operator interaction at various levels of the automated process or provide the operator the ability to investigate and override the automated recommendation.

Phase I: The Phase I effort will result in a design for an active sonar mutual interference planning software module that would be compatible with existing decision aids, and a proof of concept software demonstration.

Phase II: The Phase II effort will result in completed development of a prototype active sonar mutual interference planning software module in accordance with the phase I design. The module will be supported by a GOTS/UB-compatible user interface and will be ready for integration within existing fleet tactical decision aids.

Phase III: The Phase III effort will consist of at-sea test and evaluation of the prototype active sonar mutual interference software module

Commercial Potential: Mutual interference planning applies to all commercial underwater active sonar applications where concert operations involving multiple platforms are employed. Examples are: fish harvesting, surveys, and salvage operations.

NAVAL SURFACE WARFARE CENTER/DAHLGREN DIVISION

N94-048 TITLE: Mine Location Processing System

CATEGORY: Advanced Development; Computers

OBJECTIVE: Development of data processing system used in transient electromagnetic location and classification of mines in a marine environment

DESCRIPTION: Very recent experimental work has conclusively shown that it is possible to localize and identify small mines in a marine environment using transient electromagnetic waves. The experimental apparatus consisted of a small tank with separate receiving and transmitting antennas. An electromagnetic wave, whose wavelength had decreased because of the salt water and was comparable to the size of the mine, was emitted from one antenna. A second antenna collected the scattered wave and the fourier transform was taken from this signal. From this, it was observed that different objects in the tank yielded different transform components. However, due to the high attenuation of the wave due to the conductivity of the water, the high dispersion changing the wave shape and the fact that salt water is electrically conductive, data processing played an important part in this system of mine detection.
Would it be possible to optimize the data processing system? Would processing two or three components simultaneously (Ex,Ey, Hz for example) yield a higher detection probability? Would a transmitted square wave signal be superior to a tone burst? Is the fourier transform the optimal transform? Would a statistical approach be better? What about the use of FIR filters vs the fourier transform?

Phase I: Design an optimal signal processing technique and demonstrate its use with Navy supplied data.

Phase II: Construction of dedicated hardware to include transmitting, receiving and data processing equipment.

Phase III: Actual demonstration in the littoral zone

Commercial Potential: Supports research, in automobile guidance by roadway magnets (California). Also, could be used in a sea salvage and for the location of underwater objects such as oil pipelines and telephone cables

N94-049 TITLE: Superconducting Advanced Multichip Module

CATEGORY: Exploratory Development; Electronic Devices

OBJECTIVE: Demonstrate a superconducting multichip module that offers 1000 to 10000 millions of instructions per second (MIPS).

DESCRIPTION: Superconducting circuits and multichip module technology are becoming available to meet embedded systems performance needs. This demonstration will pursue a module that offers large amounts of digital signal processing power and has a power consumption of less than 2 kilowatts, including cooling. Module size should be less than one cubic foot including cooler. The ability to handle numerous analog and digital inputs is needed. One or more RS-232 serial ports are desirable to support system and code development. The architecture will be oriented to very high performance digital signal processing for such tasks as radar processing, beamforming and spectral analysis.

Phase I: Deliverables shall include a study of processors, supercooling hardware, architectures, and interconnection

technologies to choose the best design choices. A detailed design package and supporting documentation are also required in this phase.

Phase II: Implementation of the Phase I SAMM design is required. Three modules and coolers shall be constructed, debugged, tested and delivered along with complete fabrication documentation.

Phase III: Possible Navy applications are airborne radar processors and autonomous underwater vehicles.

Commercial Potential: A superconducting advanced multichip module would have tremendous application in desktop workstations and other high performance uses. It could be the most cost effective technology to improve the computing capability of desktop systems by an order of magnitude.

N94-050 TITLE: High Power Switch

CATEGORY: Advanced Development; Electronic Devices

OBJECTIVE: Develop for manufacturing a high power switch capable of 100 kilowatts average power, 100,000 volts, 100 joules/pulse and operating at 1000 hertz.

DESCRIPTION: The Navy has spent considerable time and money in developing high power switches to support research in particle beam weapons, high power microwave sources and impulse radar. NSWCDD has shown that hydrogen spark gap technology is 100 times faster than other existing technologies.

The twitch is expected to be a pressurized spark gap capable of holding off at least 100 kilovolts before being triggered. The switch will be capable of at least 100 J/pulse and operation of at least 1 kilohertz for long periods of time (minutes). Materials and cooling system will be chosen so that the switch can handle 100 Kw of average power passing through the switch into a low impedance load. Most of the basic technology has already been demonstrated and patented by the Navy. Continuous operation and a commercializable design are the main areas of development.

Phase I: Design of a high power switch along with a plan for its manufacture in small numbers.

Phase II: Manufacture and test of a high power prototype switch and the delivery of several for Navy testing.

Phase III: Source for commercial sales of switches to Navy Research and Development programs.

Commercial Potential: Applicable to particle beam accelerators, nuclear fusion, electron beam formation, materials processing and recycling, ion production, communications and any system that uses high peak powers at high repetition rates.

N94-051 TITLE: Improvement of High Power Silver-Zinc Rechargeable Batteries for Underwater Vehicles

CATEGORY. Advanced Development; Energy Storage

OBJECTIVE: Demonstrate performance capability of bipolar, rechargeable silver-zinc (Ag/Zn) batteries for underwater vehicles.

DESCRIPTION: The Ag/Zn battery has the highest rate capability of any commercially available rechargeable battery. It is also relatively safe and non-toxic. Its high power density stems from a very conductive electrolyte and rapid electrode reactions. To capitalize on these qualities the system needs to be developed in a bipolar configuration which utilizes space efficiently and eliminates intercell connector resistance. A major concern to be addressed is shelf life limitation consequent on common electrolyte leakage currents in the bipolar construction.

Phase I: Maximize bipolar battery energy and cycle life in prismatic cell cases having exterior dimensions of 1.4" x 3.8" x 4.9".

Phase II: Maximize bipolar battery energy and cycle life in prismatic cell cases having exterior dimensions of 2.8" x 5.9" x 6.7".

Phase III: Further development may be supported by the high energy battery project.

Commercial Potential: Applications in TV cameras, lap-top computers, surgical instruments, and electric vehicles.

N94-052 TITLE: Improved Rechargeable Batteries for Underwater Applications

CATEGORY: Exploratory Development; Energy Storage

OBJECTIVE: Improve the stability of rechargeable lithium/lithium cobalt oxide batteries used in underwater targets or vehicles.

DESCRIPTION: Interstitially-lithiated metal oxides are attracting worldwide R&D interest as cathodic materials for undersea target as well as electric vehicle propulsion batteries. The Navy has been developing the most energetic of these, lithium cobalt dioxide (LixCoO2), for underwater vehicles in which Li/LixC02 batteries will replace the present silver oxide/zinc. Prior work, using cells with methyl formate based electrolytes, have demonstrated a small capacity loss when stored at 35 degrees C for three months or at 22 degrees C for nine months. The Navy wants to extend its understanding of the effects of storage at elevated temperature. The following approach is suggested

Quantify degeneration, if any, of LixCoO2 at temperature up to 70 degrees C. Compounds of LixCoO2, lithiated from approximately x = 0.5 to x = 1, will be characterized structurally, e.g., by x-ray analysis, and stored in an inert environment for different periods and temperature. They will be recharacterized after storage to identify degeneration. If degeneration might be reduced for LixCoO2, with minor compositional adjustments, samples of such should be included. Stability of the active material should also be characterized after storage as a cathode component in the presence of electrolyte. One or two different grid materials and one or two different electrolytes should be considered. The upper temperature of storage may be limited by compatibility with, or stability of the electrolyte. Electrodes should be characterized by electrochemical as well as physical methods before and after storage.

Phase I: Identify candidate methods and materials to improve stability in Lithium/Lithium cobalt dioxide cells.

Phase II: Optimize the design and provide cells for storage evaluation (35°C for 3 months or 22°C for 9 months.)

Phase III: Successful designs may transition into the development of a new rechargeable under water vehicle battery.

Commercial Potential: This technology will have private sector application in electric vehicles, under water vehicle battery.

N94-053 TITLE: High Performance Battery for Missile Guidance

CATEGORY: Exploratory Development; Energy Storage

OBJECTIVE: Develop an electrochemical power supply capable of supplying in excess of 2000 Watts for 10 minutes from a four (4) to five (5) pound package demonstrating an 80 watt-hour/pound energy density.

DESCRIPTION: Missile guidance control electronics require increasing power to effect sensor fusion and real-time analysis of multiple data inputs in addition to increasing control actuation power at high voltages for high dynamic maneuvering. Traditionally, molten salt thermal batteries have provided high power density (>700 W/lb) at low energy densities (<20 WH/lb) with limited operational lifetimes (1 to 5 minutes). Lithium organic/inorganic electrolyte batteries have provided high energy densities (>150 WH/lb) but at low to moderate power densities (<100 W/lb) and exhibit thermal management and safety problems. Silver-zinc aqueous electrolyte batteries have provided good (>30WH/lb but <120WH/lb) energy densities at moderate power densities (>100 W/lb but <300 W/lb) and have required special storage and use handling. The goal is to develop a battery which maximizes power and energy density with extended shelf life, wide operating temperature range and low maintenance e.g. deliver 80 watt-hour/pound at discharge rates between 2 and 20 minutes.

Phase I: Design a safe cell capable of high power discharges at high voltage (>100 volts) and having power densities greater than 400 watts/power.

Phase II: Optimize cell design into a prototype cell stack and test. Provide additional cells for independent evaluation.

Phase III: Flight testing of successful prototype in missile flight.

Commercial Potential: Applications in electric vehicle propulsion (rechargeable version) and in aircraft emergency power.

N94-054 TITLE: Electronically Tunable Solid State Laser

CATEGORY: Exploratory Development; Light and Optical Systems; Sensors

OBJECTIVE: Develop an agile electronically tunable laser to provide a real time frequency selectable illuminator for multispectral remote sensing.

DESCRIPTION: Multispectral and hyperspectral imaging techniques have been identified as a powerful tool for the remote detection of targets of military interest. Currently multispectral imaging systems are limited by using the sum as the source of

illumination. It would significantly enhance a multispectral remote sensing systems capability by utilizing an efficient real time electronically tunable solid state laser as a source of illumination. Innovative concepts are sought to design such a laser illuminator. Ideally, the laser would be pulsed with a pulse repetition rate (PRF) of at least 30Hz (video rate) and frequency selectable at the PRF with sufficient plank power to illuminate the ground for the multispectral imager. The primary frequency range of the laser would ideally be 350 to 1100 nm, however other tunable frequency grounds, such as 3-5 um are also of interest.

Phase I: Provide an engineering tradeoff study to show feasibility of designing and later producing or extrapolating from existing technologies a specific device which can meet this proposal. Phase I must determine possible laser technologies, tuning technologies, and system integration capabilities.

Phase II: Develop, build, and deliver a breadboard prototype system which meets all necessary specifications.

Phase III: If Phase II is successful, full-scale development will be considered for future Navy & Marine Corps electro-optical systems.

Commercial Potential: For the tunable laser, the possibilities are numerous: entertainment, medical, remote sensing of the environment, including oil prospecting, geological mapping and exploration, agricultural and forest monitoring, and so on.

N94-055 TITLE: Oxidation-Resistant Composite Materials for High-Temperature Applications

CATEGORY: Exploratory Development; Materials and Processes

OBJECTIVE: Identify and demonstrate improved oxidation-resistant, refractory diboride-based composite materials.

DESCRIPTION: Refractory diboride composite materials (based on ZrB2 and HfB2) were investigated in the 1960's for potential use as high-temperature, oxidation-resistant leading-edge materials for hypersonic vehicles. Silicon additions, as SiC or MoSi2, were found to provide the highest oxidation resistance, although additions of al, Y, Cr, and other elements were also attempted. It is believed that other diboride alloy compositions may provide substantially greater high-temperature oxidation resistance than the Si-alloyed ZrB2 and HfB2 materials. Improved materials could have application in commercial and DoD hypersonic vehicle nosecaps and leading edges, solid and liquid rocket nozzles, air-breathing propulsion hot sections, high-temperature furnace heating elements, and possibly electrodes for Al production.

Oxidation resistance improvement may be possible by several approaches. A direction that has not been explored is the alloying of diborides other than the group IV metals, such as the group V or group VI metals. Metal-oxide free energies of formation (FEOF) increase in the progression of group IV to V to VI transition metals. This suggests that the latter metal borides show the highest promise of exhibiting enhanced oxidation resistance with alloying additions of Al, Si, or possibly Cr. Another possible direction is the addition of Be, even into groups IV diborides, taking advantage of the very low FEOF and slow diffusion properties of BeO.

Phase I: Provide analytical calculations and experiments which show potential of a candidate material.

Phase II: Produce an optimized oxidation-resistant composition.

Phase III: Identify and optimize low-cost processing techniques to fabricate sub and full-scale composite components.

Commercial Potential: Commercial aircraft engine improvement.

N94-056 TITLE: Computer Tools for Complex System Design

CATEGORY: Exploratory Development; Software

OBJECTIVE: The development of method and toolset for the representation and the evaluation of the behavior (both static and dynamic) of large-size, complex, and real-time system.

DESCRIPTION: Navy system architectures today are very large-size, complex, and dynamically response to external conditions. The ability to evaluate various system behaviors at many different stages of the design process becomes necessary for the system engineers. Although, methods and techniques for design evaluation exist, they are typically fragmented and are performed independently. Usually, each method only allows system engineers to evaluate certain aspects of the system at a time, and/or it only focuses on certain design stages. The integration of existing methods which allows system engineers to evaluate many system aspects at various design stages is necessary but unachievable at this moment due to the diversity of how information is being represented in these methods.

The method(s) developed within this research should show the understanding of different evaluation techniques for system behaviors at various stages in the system development process. The method(s) should allow the evaluation of both the control behavior of the total system as well as the detail behaviors that are associated with particular system's functions or resources. Hence, the control representations for system behavior has to be addressed in a hierarchical manner to accommodate different levels of fidelity. The hierarchical concept would provide options for system engineers to address the system's behavior at both abstract and detail level of complexity. The method(s) should also supports system engineers as well as domain experts to easily understand the control states of the system. For example undesirable control states has to be recognized by all persons who involve in the system development process. The method also has to allow system engineers to specify the system robustly so that a direct transformation between the representation information and the evaluation techniques can take place.

Phase I: Methodology should be developed in the design of a computer tool. Feasibility should be shown by application of methods to a Navy problem.

Phase II: Work should include the full scale development of the automated tool. Usefulness of the methods and tool should be demonstrated on a sample test case by the end of Phase II to facilitate the transition of the work into Navy systems. The initial methodology report should be updated to incorporate the lessons learned during the development of the tool.

Phase III: Full scale development of the automated tool that was developed in Phase II and its application in a Navy program.

Commercial Potential: Exists in the design of large distributed commuter systems. Examples: air traffic control, stock trading, and banking.

N94-057 TITLE: Tracing Requirements Through the Later Phases of System Development

CATEGORY: Exploratory Development; Software

OBJECTIVE: Develop a method and tool for tracing requirements throughout the entire life cycle. The research should augment the current traceability case tool environment which current concentrates on tracing Requirements throughout the initial stages of system/software development.

DESCRIPTION: It is essential that computer intensive systems being built fully contain the desired and specified functionality and are maintainable over long periods of time. Traceability is essential in achieving these goals. Lack of full traceability causes inefficient systems to be built that do not fully capture all the required functionality. Also systems which lack traceability are extremely difficult to maintain because the effects of changes to parts of the system are unknown and could create disastrous results.

There are several commercially available system/software requirement traceability tools which can be used to solve some of the above concerns. But these tools concentrate on the linking of the requirements to the initial phases of the design cycle (structured analysis, structured design, etc.) Their methodologies fall short in terms of linking throughout the later parts of the design cycle (i.e., simulation, testing, implementation, etc. Generic objects can be created to represent these items but direct tracing to capture representation of these later design phases fail to exist. A more complete traceability methodology which concentrates on the design representation throughout the entire life cycle needs to be developed. A traceability tool will require interfaces that allow the interaction between the different tools which captures each part of the design is also essential along with the ability to link the method to current design and implementation tools.

Phase I: Design of a method and its feasibility shown by application to a Navy system.

Phase II: Full scale development of an automated tool and its demonstration on a Navy system.

Phase III: Transitions into a large-scale navy programs for which the requirements are under development.

Commercial Potential: Exists in all large computer systems, which use developmental or CASE tools. Examples are communications, satellites, automated manufacturing, and air traffic control.

NAVAL SURFACE WARFARE CENTER/CARDEROCK

N94-058 TITLE: Waterless Dish Washer

CATEGORY: Research; Environmental Quality

OBJECTIVE: To acquire the scientific knowledge and understanding necessary for development of shipboard dishwashing technologies that clean dishes to an acceptable level without generating water.

DESCRIPTION: A waterless dishwasher would reduce ship generated graywater generation by over 25 percent. This would reduce the size and cost of subsequent shipboard treatment systems as well as reduce the overall freshwater requirement for Navy ships. At the same time ships would be able to hold graywater for greater periods of time without treatment system.

Phase I: Investigate concepts and techniques for cleaning dishes without the generation of waste water.

Phase II: Develop breadboard model of waterless concept identified in Phase I.

Phase III: Transition to the Navy's Shipboard Environmental Program.

Commercial Potential: This technology has application in the private sector in the appliance industry.

N94-059 TITLE: Waterless Clothes Washer

CATEGORY: Research; Environmental Quality

OBJECTIVE: To acquire the scientific knowledge and understanding necessary to develop shipboard clothes-cleaning technologies that can clean clothes to an acceptable level without generating appreciable quantities of wastewater.

DESCRIPTION: A waterless clothes washer would reduce shipboard graywater generation by up to 21 percent. Reductions in wastewater generation will reduce the size, cost, and complexity of subsequent shipboard treatment systems and improve the Navy's ability to comply with expected graywater holding requirements. A waterless clothes washer would also result in reduced freshwater requirements for ships.

Phase I: Investigate techniques that are applicable to the cleaning of clothes to reduce/eliminate wastewater.

Phase II: Build laboratory apparatus, a working breadboard model to evaluate the process.

Phase III: Transition to the Navy's Shipboard Environmental Protection Program.

Commercial Potential: This technology has application in the private sector in the appliance sector.

N94-060 TITLE: High Current Switchgear

CATEGORY: Advanced Development; Propulsion and Energy Conversion

OBJECTIVE: The objective of this topic is to develop switches, flexible joints, and interconnection schemes for high current (50,000 to 200,000 Amp), low voltage (less than 1000 volts) a.c. or d.c. power distribution systems. In addition, for signature and safety reasons, stray electromagnetic fields must also be controlled.

DESCRIPTION:

Phase I: Develop designs for high current switch(es), flexible joint(s) and connectors which minimize stray magnetic fields.

Phase II: Construct and test prototype hardware for selected design(s).

Phase III: Develop manufacturing processes for high current components.

Commercial Potential: Electric utilities are becoming increasingly concerned about the biological effects of electromagnetic fields. Techniques developed could be transitioned to electric utility applications, albeit at higher voltage and power levels.

N94-061 TITLE: Flexible Coupling for a Liquid Cooled Coaxial Transmission Line

CATEGORY: Exploratory Development; Propulsion and Energy Conversion

OBJECTIVE: Develop and Demonstrate a flexible coupling for a 30,000 ampere coaxial transmission line which is liquid cooled.

DESCRIPTION: Superconducting systems require large currents at full power to develop the necessary horsepower to propel a ship. To minimize the external magnetic fields created by the transmission of large currents coaxial transmission lines are used. The lines are liquid cooled to remove heat from the transmission line. Integration of coaxial transmission lines into a ship requires the line be able to with stand a Navy environment which includes shock, vibration and hull contractions. Development of a flexible coupling to meet such needs is important to future application of coaxial transmission lines on ships.

Phase I: Tradeoff study selecting and developing drawings for the best design to meet Navy needs.

Phase II: Develop and construct 30,000 ampere flex coupling for test at Navy scaled test facility. Deliver to the Navy the flex coupling and associated fabrication documentation.

Phase III: Possible applications are for Navy electric propulsion candidate system.

Commercial Potential: The potential impact of magnetic fields generated by transmission lines is point of environmental concern in both military and commercial transmission lines. Coaxial transmission lines reduce the magnetic field external to transmission lines, and Flexible couplings are required to account for environmental factors such as movement of the Coaxial transmission lines during thermal expansion, wind, and deformation of supporting structures. Naval and Maritime benefits include reduced own-ship magnetic signature, and a large market potential exists in the utility industry overhead power lines, and other instances where large currents must be transmitted by the utilities.

N94-062 TITLE: Non-invasive Sensors for Shipboard Sewage Systems

CATEGORY: Research; Environmental Quality

OBJECTIVE: To develop a non-invasive sensor for shipboard sewage.

DESCRIPTION: Two major maintenance problems for Navy shipboard blackwater and graywater systems are excessive scaling of pipe and fouled level sensors for tanks. It is very costly and time-consuming to identify the point at which piping has become clogged, and then to replace that piping. A non-invasive process for identifying the amount of scale in shipboard waste piping would allow ships force to diagnose clogging problems and to predict future clogging sites. Sewage tank levels sensors become caked with grease and often fail. The cost and safety problems associated with opening these tanks could be read without depending on internal tank components would eliminate these problems.

Phase I: Investigate concepts and techniques for a non-invasive means for measuring wastewater pipe scale and measuring liquid levels in tanks.

Phase II: Develop and test model of best technology identified in Phase I.

Phase III: Transition to shipboard use.

Commercial Potential: This technology has application in the private sector in the wastewater treatment and chemical industries.

N94-063 TITLE: Affordable Maxwell Solver for Large Objects

CATEGORY: Exploratory Development; Vehicle Structures

OBJECTIVE: Develop an affordable technique for computing Maxwell Equation solutions for electromagnetically large objects.

DESCRIPTION: Develop an accurate and affordable technique for solving Maxwell Equations in the scattering of the electromagnetic waves from large objects such as naval ships or ship sections. The rigorous determination of electromagnetic interactions is required to evaluate and predict the radar cross section of ships and the performance of a wide variety of antennas mounted on ships. The frequencies of interest range from 6MHz to 100GHz. Current computational techniques used by the Navy are less than rigorous and use approximation techniques such as Physical Optics and Physical Theory of Diffraction. Attempts at rigorous Maxwell solutions have so far been too computationally intensive to be of practical use.

Phase I: Determine the range of computational approaches to developing a rigorous Maxwell solver. Evaluate these approaches to determine the effectiveness and practicality of each. Determine the applicability of various computer hardware platforms to the best approaches and estimate the costs of performing RCS and antenna performance analysis of naval ships using the best approaches with the most appropriate computer platform.

Phase II: Based on the information obtained during Phase I, select the most appropriate computational approach and develop algorithms that demonstrate the accuracy and cost effectiveness of the approach. The demonstration shall include objects large enough to establish the practicality of extending the approach to full scale naval ships and shall also include canonical shapes that verify the accuracy of the computation.

Phase III: If Phase II is successful, a full ship computational Maxwell solver will be developed.

Commercial Potential: An affordable Maxwell solver for large objects will have application for installation of communication systems on ships, airliners, trains, buildings and other large structures as well as the design of large antennas. In addition, the techniques developed for a Maxwell solver may be applicable to other computationally intensive problems.

N94-064 TITLE: Multi-Spectral Signature Control Air Induction Systems, Effluent Ducts, and Exhaust Systems

CATEGORY: Exploratory Development; Vehicle Structures

OBJECTIVE: Investigate air induction systems, effluent ducts and exhaust systems that provide integrated structure and signature control for infrared, visual, radar, and acoustic spectra.

DESCRIPTION: Openings in ships to either introduce air or permit the dumping of effluents or exhaust gases must have signature control in multiple spectra. Many of these subsystems are above the KG of the ship and any parasitic signature control makes the KG of the ship worse. Additionally, many of the treatments for one signature spectra are incompatible with other signature treatments. An integrated signature control system is needed that has the following characteristics:

a. Lighter weight than existing systems;
b. Incorporates infrared, radar, visual, and acoustic treatments;
c. Compatible with normal Navy maintenance and painting practices;
d. Does not involve VOC's or toxic materials;

Phase I: Develop concepts for inlet systems, effluent ducts, and exhaust systems; perform trade-off analysis based on selection criteria; select best systems approach; demonstrate feasibility of approach with laboratory model; prepare a final report that documents Phase I activities and design for a prototype field system application.

Phase II: Develop, test, and evaluate subsystem which has the capabilities described above and principles demonstrated in Phase I. Prepare a final report that documents all Phase II activity.

Phase III: A Phase III effort is anticipated for field application of successful subsystems to US Navy ships. Commercial application of subsystems is possible for some subsystems to counter terrorist threats to commercial shipping.

Commercial Potential: The technology has application in the private sector in the ship building industry.

N94-065 TITLE: Composite Inner Liner for New Tanker and Tanker Retrofit to Double Hull Configuration

CATEGORY: Exploratory Development; Vehicle Structures

OBJECTIVE: Develop a low cost method of providing double hull protection to existing oil tankers

DESCRIPTION: Develop a method of providing double hull oil spill protection to existing oil tankers with a minimum impact on payload. The design must be low cost and have a minimum impact on schedule. The design should be capable of being installed at pier side or with minimal shipyard support (no dry dock). No extensive (expensive and time consuming) tank cleaning or purging shall be required. The inner hull must be tough and durable and resist puncture even with major impact.

Phase I: Perform a full feasibility analysis on the candidate design(s); perform material evaluation and test, installation methodology and evaluation; prepare a final report that documents all Phase I activity.

Phase II: Conduct detailed design and fabricate test samples to develop design allowable; perform full system design for an application; fabricate sub scale hull for model basis evaluation; install double hull in a full scale hull section; prepare a final report that documents all Phase II activity.

Phase III: If Phase II is successful, full scale development will be considered for oil tanker retrofits.

Commercial Potential: The technology has application in the private sector in the oil tanker industry.

N94-066 TITLE: RGS Based Modeling and Panelization for CFD Simulation

CATEGORY: Computational Fluid Dynamics; Simulation and Modeling

OBJECTIVE: Develop techniques for creating parametrically varied geometric surface models and discretizations for input to computational fluid dynamics (CFD) codes to predict flows around ships and submarines, and waves and currents in coastal regions, for both military and commercial design applications.

DESCRIPTION: Geometric models and their discretizations into panels and grid cells for incompressible and subsonic flow analysis are typically generated by ad hoc programs committed to specific topologies. There are few general-purpose low-cost

surface panelizing tools, and those that exist have very limited parametric or associative capability. As a result, the use of CFD for analysis of parametric series of geometries, or for systematic optimization within a parametric design space, is tedious, labor-intensive and error-prone.

Relational Geometric Synthesis (RGS) is an emergent CAD technology providing a formalism and environment for extremely flexible and rapid creation of 3-D models having very strong parametric and associative properties.

Phase I: Conduct a 6-month study to assess the potential for application of RGS to panelization problems. Use existing RGS tools to develop examples of typical geometries. Identify required extensions of RGS to fulfill panelization needs.

Phase II: Develop and implement required RGS extensions as preprocessors, postprocessors, and new RGS entities. Apply the techniques to several real hydrodynamic,aerodynamics and coastal flow simulations. Connect RGS at a pilot level to several standard flow codes.

Phase III: The technique will be developed into an integrated workstation or PC program for creation and panelization of models; generation and verification of flow-code input decks; and display of flow code results such as surface pressures, singularity densities, and streamlines.

Commercial Potential: Panelization is required for application of CFD to design of vehicles of all types, including ships, aircraft, and automobiles, as well as pumps and other types of devices involving fluid flows.

N94-067 TITLE: Photonic Systems Simulation

CATEGORY: Exploratory Development; Modeling and Simulation

OBJECTIVE: To develop a photonics simulations software package for use in advanced radar systems design and photonic component development.

DESCRIPTION: A physics based numerical simulation of lasers, photodetectors, modulators, multiplexers, couplers, optical waveguides, and lightwave amplifiers is needed. The simulation should run on a Unix workstation and have two and three dimensional simulation capability. Algorithms compatible with the monolithic integration of optical components are required.

Phase I: Should address the critical technical issues. Analysis and design sufficient to indicate a good probability of success package for an on-going NAVSEA program.

Phase II: Should provide a high quality a high-quality versatile photonics simulation package for an on-going NAVSEA program.

Phase III: Full development for commercial, military, and university research applications is envisioned. Target commercial industries include communications, aerospace, and optical monitoring and remote sensing industries.

Commercial Potential: Strong commercial potential exists. Photonics simulation software has been identified as an outstanding need for both military uses and commercial communications applications. Medical, biological, environmental, and materials sciences would also benefit from the availability of such software.

NAVAL SURFACE WARFARE CENTER/INDIAN HEAD

N94-068 TITLE: Biologic Methods for Degradation of Waste

CATEGORY: Exploratory Development; Environmental Quality

OBJECTIVE: Determine the biologic methods such as white-rot fungus for d mposition applicability of: 1) nitrate-ester-based substances, such as Otto Fuel II, metriol trinitrate (MTN), butanetriol trinitra TN); 2) binders, such as carboxyle-terminated polybutadiene (CTBN), hydroxyl-terminated polybutadiene (HTBN), and p thane; and 3) explosives, such as Explosive D (ammonium picrate).

DESCRIPTION: Biologic methods have been shown capable of degrading munition ingredients such as TNT and RDX, but no work has been found on application to nitrate-ester-based substances or to the binder/complete formulation. Extension of this type technique to nitrate-ester-base substances and to polymeric-backboned/multi-based propellant might yield a feasible disposal method.

Phase I: Evaluate the applicability of biologic methods for decomposition of: 1) nitrate-ester-based substances, such as Otto Fuel II, metriol trinitrate (MTN), butanetriol trinitrate (BTTN); 2) binders, such as carboxyle-terminated polybutadiene (CTBN), hydroxyl-terminated polybutadiene (HTBN), and polyurethane; and 3) explosives, such as Explosive D (ammonium

picrate). Include in the evaluation potential decomposition of polymeric-backboned & multi-based propellants and ingredients.

Phase II: Development of a prototype scale-up demonstration to assess the optimizing the technical and economic feasibility of the process.

Phase III: Potential military follow-on efforts to advance state of the art technology with particular application to reclamation of "Explosive D". Explosive D is a toxic substance with no known reclaiming process to date. Anticipated support for this follow-on effort by Navy Ordnance Environmental R&D Program (IHD/NSWC) and Navy Ordnance Reclamation Program (Crane).

Commercial Potential: Industries that utilize oil, fertilizers, pesticides, nitrate ester, stabilizers, and plastics.

N94-069 TITLE: Inline Gas/Air Monitoring System for Development and Small Scale Production in Processing Facilities

CATEGORY: Exploratory Development; Environmental Quality

OBJECTIVE: Identify gas/air monitoring techniques and incorporate them into a system that will allow pilot plant facilities for R&D and small scale production of Defence Critical Technologies to comply with the environmental and National Institute for Occupational Safety and Health (NIOSH) regulations due to take effect by the year 2000.

DESCRIPTION: Inline gas/air monitoring techniques have to be identified, procured, and incorporated into a system that will allow pilot plant facilities for R&D and small scale production of Defence Critical Technologies to comply with the environmental and NIOSH regulations due to take effect by Year 2000. The monitoring system should allow small plants to monitor stack emissions for air permits required by the EPA. Currently, pilot plant facilities have to calculate emission by theoretical methods intended for large scale plants that produce a single chemical. The theoretical methods seriously hinder the function of pilot facilities by not providing a realistic estimate of low level emissions. The use of empirical methods for emission will provide the needed realistic data to maintain capabilities. The engineering problem involves developing an on-line system for pilot plant environments which is able to continually monitor an air steam for 15 or more different types of chemicals in trace amounts. The system will be used to develop a data base for modeling and baseline testing. The system must adaptable to a generic manufacturing environment by being user friendly, easily maintained, and cost effective.

Phase I: Identify and develop gas monitoring sensors and techniques for use in R&D and small scale processing facilities. Using the 150 Gallon Advanced Vertical Mixing Facility at Indian Head Division, Naval Surface Warfare Center (IHD/NSWC) as a test bed. The system designed must be generic and transferable to any small scale processing application. To verify the Phase I design, prepare a test program which detail methods that accurately characterize the facility's processes.

Phase II: Fabricate and install the prototype gas monitoring system in the 150 Gallon Advanced Vertical Mixing Facility at IHD/NSWC. Conduct test plan from Phase I to verify design and process. Make necessary modifications for efficiency. Document capabilities of system for public release. Develop data base for modeling and baseline testing.

Phase III: Solicit identified candidates for their particular requirements and tailor Phase II system to produce the baseline data for technology transfer to industry. Potential follow-on effort with particular application to the AEPS programs.

Commercial Potential: Industries where emissions need to be monitored to meet NIOSH regulations as well as military pilot plant facilities.

N94-070 TITLE: Infrared Sensor Integration for Wearable Damage Control Monitoring

CATEGORY: Exploratory Development; Human-System Interfaces

OBJECTIVE: Develop a wearable computer system with infrared optical sensors for shipboard emergency damage control operations.

DESCRIPTION: During emergency conditions aboard ship, supervisors must make split-second decisions with thought to a large and diverse amount of information specific to the emergency arena critical to safe operations under stress. There is a need to provide damage control supervisors with a wearable computing system that is capable of "seeing" through smoke and obscurants while simultaneously providing access to large amounts of computer-based data. Such a system would increase situational awareness and safety.

Phase I: Develop a wearable computer system with infrared sensors to be worn under extreme adverse conditions found during damage control operations.

Phase II: Design, test, and demonstrate prototype wearable computer that will comfortably integrate to current damage

control personnel protective equipment (PPE) on board ship without impacting personnel movement and safety. Demonstration must also show the viability of a scale-up application for transitioning into Phase III.

Phase III: Potential follow-on efforts are anticipated for the Safety, Survivability, and Damage Control Program. Scale-up system to meet the needs of industries that produce fire protection, emergency medical care, rescue operation, or hazardous materials removal equipment.

Commercial Potential: Commercial potential exists in:
1) fire fighting and advanced life support; 2) hazardous/explosive materials control and removal operations; and 3) all highly technical, yet physically interactive fields requiring hands-free applications.

NAVAL UNDERWATER WARFARE CENTER/NEWPORT

N94-071 TITLE: Electronic System Analytical Model Capabilities

CATEGORY: Advanced Development; Modeling/Simulation

OBJECTIVE: To provide automated data input tools and additional capabilities to existing computer models to assess the reliability, maintainability, and availability of complex electronic systems. Such tools would have use in design of both commercial and military equipment.

DESCRIPTION:

Phase I: Computer models are being used that estimate the reliability, maintainability, and availability (RM&A) of shipboard electronic systems using stochastic methods to predict the functional influence of failures. Substantial effort is expended in modeling the connectivity of functional elements of the system and the interrelationships of potential failures. These modeling steps are performed with manual labor that translates system design data into appropriate computer model inputs. Changes to the system during the evolution of its design require substantial rework of input data for the computer model. Automation in developing model inputs from design data would speed the modeling effort, and allow model reliability, maintainability, and availability predictions to be effective in the overall system design process.

Elements of system performance that are treated with modest fidelity in current computer models include the influence of software errors and the system maintenance concept. The computer models do not have the capability to include performance modeling and fault localization (PM/FL) capability, maintenance action effects, logistic delays, the availability of replacement parts, and the capability of maintenance technicians in the assessment of system reliability, maintainability, and availability. Including the effects of these system performance capabilities and logistic support limitations would allow the computer models to be more effective in the overall system design and logistics support process.

Phase II: Identify automation techniques to improve the computer model data input process; demonstrate an approach to implementing an automation technique in the computer model. Identify additional capabilities to be added to the computer model to address the impacts of system PM/FL capabilities and the planned system logistics support. Demonstrate an approach to implementing the additional capabilities in the computer model.

Phase III: Implement and demonstrate improvements identified in Phase I.

Commercial Potential: Make computer modeling techniques available, with potential Navy endorsement, to prime contractors developing and supplying electronic systems to the Navy. These analytical modeling techniques will be of use to electronics contractors in designing competitive systems for evaluation by the Navy. Use of these same techniques in development of commercial equipment is also practical.

NAVAL AIR WARFARE CENTER/AIRCRAFT DIVISION/PATUXENT RIVER

N94-072 TITLE: Options to Improve Basic Flight Testing

CATEGORY: Advanced Development; Computers

OBJECTIVE: Use areas of research, like expert systems and speech recognition systems, combined with flight test data management systems, to reduce the time required to plan and report flight test results.

DESCRIPTION: The time required for test plans, flight testing, data reduction, and reports needs to be minimized. Expert systems, speech recognition systems, and flight test data management systems could be used to significantly reduce the time

required to plan and report test results. A commercially available Test Plan Automation System (TPAS) could be used to help reduce the time required to develop test plans, especially for junior engineers. At the same time, OSD is using expert systems to develop a prototype system to facilitate Test and Evaluation Master Plan (TEMP) development. The TPAS concept could be extended to include flight test reports, and a voice recognition front-end could be added to make the system more user friendly. A flight test data base management system, with appropriate software, could be added to reduce the flight test data processing time. The goal is to have all this capability at the engineer workstation, to help optimize the individual engineer's output productivity. The program should also be compatible with on-going OSD efforts to automate TEMP development.

Phase I: Review existing commercial and military flight test plan automation programs and related expert system flight test applications. Also review applicable voice recognition systems, rotorcraft flight data reduction software, and flight test data management systems. Develop a plan for integrating these technologies for all types of rotorcraft test programs, and for presenting the information to the individual engineer workstations. Start developing the knowledge base required for the program.

Phase II: Implement the plan at a selected military or commercial activity. Develop the required knowledge base for each type test program. Also develop a plan for extending the system to joint services rotorcraft testing, and also to the fixed wing testing.

Phase III: A Navy funded Phase III program to extend this effort to fixed-wing aircraft testing is anticipated.

Commercial Potential: The program is also an excellent candidate for Phase III acquisition by the major commercial aircraft flight test activities.

N94-073 TITLE: Advanced Avionics Architecture Stimulator System

CATEGORY: Advanced Development; Modeling and Simulation

OBJECTIVE: Develop a modular avionics/advanced avionics architecture stimulator system which can be used as a development and risk reduction tool to support RDT&E of new avionics, modular avionics, and advanced avionics architectures.

DESCRIPTION: Complexity of emerging modular avionics systems and increased data rates projected in advanced avionics architectures requires the development of engineering tools capable of simulating and analyzing systems level performance. This system could best be defined as a "smart rack" which serves as the backbone for modular avionics integration. The system must be capable of stimulating modular avionics processors and associated embedded software with laboratory-generated or high fidelity recorded data to provide a realistic and dynamic development environment. The type of information required includes aircraft state data together with communication, navigation, identification and sensor data. The system must allow interface between integrated avionics racks populated with modular avionics via backplane and standard signal interfaces with current MIL-STD-1553 based avionics architectures; i.e. to demonstrate advanced avionics in an actual aircraft avionics architecture.

Phase I: Complete a detailed development plan, conduct required trade studies, perform of engineering design and analysis, and complete detailed system design.

Phase II: Construct a prototype system which can be used and refined on avionics test programs planned at Naval Air Warfare Center.

Phase III: Manufacture systems as defined in Phase II for DOD requirements. These requirements will be identified in phase II.

Commercial Potential: This topic has tremendous potential for "dual use" application. Of the eleven broad areas which have been identified by the Defense Technology Conversion Council as key dual-use technologies, this topic could be placed in either the "information infrastructure" or "aeronautical technology" area. Its application throughout the DOD RDT&E community is clear. It also has application to commercial aviation as well as manufacturers with high speed data requirements. Customers for this are NASA and the FAA; and Avionics, Aviation, Electronic, and Computer Equipment Manufacturers.

N94-074 TITLE: Rotorcraft Handling Qualities and Flight Control System Specification Personal Computer Tutorial and Database

CATEGORY: Advanced Development; Computers

OBJECTIVE: Develop a rotorcraft handling qualities and flight control system specification PC tutorial and database to enhance rotorcraft flight testing.

DESCRIPTION: The Army made considerable progress in advancing rotorcraft handling qualities criteria during the 1980's. Their work included developing a proposed revision to MIL-H-8501A and the associated background information users guide (BUIG). Aeronautical Design Standard 33C (ADS-33C) was developed for future Army LH testing. Recent Army flight tests were conducted to validate ADS-33C requirements for the AH-64A and OH-58C helicopters. The Army is currently working to get the proposed rotorcraft handling qualities specification approved as a joint MIL-SPEC. Commercial activities producing aircraft for the Army, and other services like the Navy are currently involved or will be involved in the near future. It is important to get commercial and military flight test engineers and pilots up-to-speed on the proposed rotorcraft handling qualities, and frequency domain specification requirements as soon as possible.

Phase I: Review all previous, current, and proposed rotorcraft handling qualities and flight control system criteria and specifications. Development a proposal to show how this information could be incorporated into a PC tutorial to be used by flight test engineers. Also develop a proposal to show which flight test data are required for the tutorial and how the data can be obtained from typical flight tests to build a flight test database.

Phase II: Develop the rotorcraft handling qualities specification and flight control system PC tutorial and install it at a specified military or commercial activity and tie the PC tutorial into an existing network system. Assist and support two flight test programs to check-out and validate the PC tutorial, showing how flight test data can be added to the database.

Phase III: An Army/Navy funded Phase III effort is anticipated.

Commercial Potential: The PC tutorial will be used by commercial rotorcraft manufacturers, as well as, academic institutions teaching rotorcraft handling qualities theory, and commercial flight test activities.

N94-075 TITLE: Aircraft Store Separation Analysis Methodology

CATEGORY: Advanced Development; Software

OBJECTIVE: Develop efficient methodologies and software for store separation analyses using unstructured grids.

DESCRIPTION: Due to its inherent capability to handle complex geometries with ease, unstructured grid methodology has developed rapidly over the past several years. Unstructured grids are able to efficiently incorporate adaptive refinement and moving boundaries. Technology is currently available to model and analyze complex 3-D configurations using unstructured inviscid codes. This technology has been applied recently to aircraft store separation problems using single block tetrahedral fixed meshes. Aircraft store separation is a viscosity dominated, multi-body interaction problem. The Navy is soliciting innovative approaches utilizing extensions (like moving grids and adaptive refinements) to the unstructured grid technology to the aircraft store carriage and separation problem.

Phase I: The objective is to explore application of advanced unstructured grid methodology to the store separation problem and to arrive at a set of guidelines for further development.

Phase II: The objective is the development of a comprehensive, interactive method and software to analyze and predict multi-body store separation behavior.

Phase III: During this phase, utilization of the software would be funded by Navy test projects requiring advanced aerodynamic-structural integration analyses.

Commercial Potential: The objective is to use the software in complex aerodynamic interaction problems between aircraft and stores. The Navy, Air Force, Army and commercial airframe manufacturers would be able to use the software to reduce requirements for expensive and hazardous flight testing.

NAVAL AIR WARFARE CENTER/AIRCRAFT DIVISION/TRENTON

N94-076 TITLE: Decision Aid to Assess Propulsion Technology Impact on Availability

CATEGORY: Exploratory Development; Modeling and Simulation

OBJECTIVE: Develop a model that can perform trade analyses to determine the impact of advanced propulsion technologies on engine availability. This decision aid will evaluate whether a particular advanced technology will improve availability when compared to a baseline technology.

DESCRIPTION: The propulsion technology development community's main focus has been on performance. Some promising technologies were never transitioned because it was determined during acquisition they were too difficult to support. Some were

transitioned, but support capability wasn't fully secured for several years because supportability issues were addressed too late. This effort will help decision makers identify and pursue the technologies that are more supportable. Also, it will help bring to light any critical supportability issues early in the development and design of future systems. Availability is achieved by design characteristics such as: reliability, maintainability etc. along with support system characteristics like: repair and inspection capability and spares posture. Technologies should be developed and transitioned into fleet engines that optimize the relations between these parameters.

Phase I: Develop a model identifying the relations between all critical parameters for a propulsion system that affects availability. Develop a representative set of metrics to quantify the parameters of this model. Develop a set of decision rules that establish weights (relative importance) between the parameters. Provide a detailed report documenting all Phase I efforts.

Phase II: Develop a database that provides baseline technology metrics for each parameter for all major parts of an engine. This should incorporate the support requirements (equipment and procedures) for each major part. Develop a detailed model and the software for the decision aid. Construct a computer-based, prototype system. Conduct a simulation of the decision aid by imputing a list of advanced propulsion technologies and their metric values to determine their impact on availability when compared to a baseline. Assess the viability of the results.

Phase III: Based on favorable results of Phase II, further develop this model for actual application.

Commercial Potential: This decision aid will be easily modified for applications to commercial aircraft systems. Also many other technical areas are confronted with decisions of technology insertion and their impact on availability.

NAVAL AIR WARFARE CENTER/AIRCRAFT DIVISION/WARMINSTER

N94-077 TITLE: Low Cost Six Degree of Freedom Accelerometer

CATEGORY: Advanced Development: Human - System Interfaces

OBJECTIVE: Develop an accurate, low cost, light-weight, miniaturized six D.O.F. accelerometer for use in evaluating injury potential of aircraft crew escape systems.

DESCRIPTION: Injuries sustained during escape from aircraft are dependent on numerous factors, including the type of maneuver under way, crewmember positioning at escape initiation, helmet impact with canopy, crewmember physiology and anthropometry, etc. As surrogates, manikins are widely used for evaluating escape system performance and potential for injury. The techniques which can be used to relate manikin dynamic responses to prediction of injury, generally require measurement of several parameters, including the linear and angular accelerations of various anatomical segments.
Current six D.O.F. measurement techniques based on cluster accelerometry alone, or in combination with other angular measurement devices, are judged to be too expensive for this application.
A need, therefore, exists for a low cost, accurate, light-weight, miniaturized accelerometer capable of measuring linear and angular accelerations about three perpendicular axes. Errors from cross talk, bias offset, thermal effects, etc., should be small.

Phase I: Phase I should result in a detailed conceptual design, analysis and proof of concept.

Phase II: Phase II consists of prototype development, demonstration, validation and hardware delivery.

Phase III: See Commercial Potential

Commercial Potential: Commercial Aircraft Inertial Navigation Systems, Automotive Navigation Systems, Automotive Crash Dummy Investigations (Auto, Insurance Labs, DOT).

N94-078 TITLE: Microindenter System for the Fabrication of Microcracks

CATEGORY: Basic Research: Materials

OBJECTIVE: To develop a new computer controlled microindenter system that will allow the operator to introduce simultaneously two indentations in close proximity and in perfect alignment on a crystalline substrate. The device will be capable of controlling, via a computer, the applied load, the indenter orientation and the positions of the indentations on the substrate. The substrate support and the diamond indenter head will be independently temperature controlled via the computer and the process will take place in an inert gas atmosphere.

DESCRIPTION: A completely new approach for microelectronics device fabrication consists in the incorporation of cleavage microcracks on an otherwise crack free material. Once the microcracks are introduced, they can be filled with different

electronic materials to achieve the desired electronic properties. In order to succeed in this new approach, a controlled way of introducing microcracks in crystalline substrates is required.

Commercial microindenters have been used to introduce microcracks in crystalline substrates. Unfortunately, they have only one diamond pyramid in the indenter head and the positioning of the substrate relative to the indenter is performed manually. As a result, alignment of the indentation marks is difficult and poor microcracks develop. This problem can be solved by incorporating two aligned diamond pyramids in a single indenter head. The diamond pyramid tip to tip separation being approximately 2000 mm. A computer controlled substrate positioning table would allow for the incorporation of multiple microcracks in one substrate for multielectronic device fabrication. The applied loads will range between 100g and 2000g. The substrate and indenter head temperature control would allow the cracks to grow without introducing further plastic deformation. Finally the controlled gas atmosphere would prevent contaminants from entering the crack region.

Phase I: Development of two perfectly aligned double Vickers indenter heads for use with a standard Tuckon 300 commercial microindenter from Wilson Industries. One of the double Vickers indenter will be fabricated so that the pyramids have a common side while the other will be fabricated so that the pyramids have a common vertex. The tip to tip separation in both cases will be approximately 200 mm. Also, a final report will be produced that will outline the approach which will be undertaken to pursue the requirements for Phase II.

Phase II: Development of the complete computer controlled diamond indenter system. The indenter will include the optics, computer controlled positioning and loading, substrate and indenter head temperature control, software and double diamond pyramid indenter heads.

Commercial Potential: This device will have the capability of measuring many mechanical properties of materials, such as: Elastic Modulus, Hardness, Fracture Toughness, wear resistance, interfacial properties and all at several temperatures. Potentially new electronic devices could be fabricated with this device.

N94-079 TITLE: Active Control of Aircraft Vibrations using Chaos Theory

CATEGORY: Exploratory Development: Modeling/Simulation

OBJECTIVE: To devise a methodology that is based on Chaos Theory that suppresses vibrations and improves the ride quality of helicopters. The usefulness of the methodology needs to be demonstrated with an application to either a military or a civilian helicopter.

DESCRIPTION: At the Naval Postgraduate School, Chaos Theory has recently been applied to vibration reduction in helicopters. The flight test sensor data that was used was divided into two components: (1) Harmonic Component and (2) Chaotic Component. The harmonic component was deemed controllable, with the associated benefits being possible vibration reduction and improvement in structural life. Chaos Theory has been applied in various scientific disciplines, chiefly sponsored by the Office of Naval Research. However, the theory has not reached a stage where it can be put to practical use in an aircraft. Further research is needed to establish the usefulness of Chaos Theory to the active control of nonlinear vibrations in helicopters. Also, other potential applications to aircraft need to be investigated.

Phase I: Phase I of the SBIR should involve a clear methodology to suppress vibrations in helicopters based on Chaos Theory. Other possible applications of Chaos Theory should be stated. Also, the implementation aspects of the methodology need to be discussed.

Phase II: Phase II would involve analysis of flight test data and feasibility demonstration of the active control strategies via simulation and testing.

Phase III: Phase III funding depends on the significance of benefits demonstrated in Phase II.

Commercial Potential: Helicopters are used for civilian applications such as transportation of medical patients, police patrol, etc. Thus, the associated benefits of vibration reduction and increase in structural life carry over to the private sector also.

N94-080 TITLE: Development of a Fine Water Mist Nozzle System

CATEGORY: Advanced Development: Materials and Processes

OBJECTIVE: To develop a Fine Water Mist Nozzle System to disperse 10 micron diameter droplets. The successful system will rapidly produce high velocity droplets for turbulent mixing in aircraft compartments for fire protection and explosion suppression.

DESCRIPTION: Fine Water Mist technology is being researched and developed for Naval aircraft fire protection and explosion suppression. Currently, air atomizing and hydraulic type atomizing nozzles are being studied. A need exists to develop a converging-diverging nozzle to produce high velocity small diameter droplets. The successful nozzle system must be small and light weight, activate in a temperature range of 65°F to +300°F, conform to MIL STD 704E Aircraft Electrical Power Characteristics and conform to an aircraft environment. It is important that droplet size be small (10 microns) so that a large surface area con be covered by a relatively small volume of water. It is of equal importance that droplet velocity be high, especially in the case of explosion suppression. The droplet velocity and system response must be faster than the velocity of the pressure wave of the deflagration of a JP-4 or JP-5 fuel-air mixture to successfully prevent an explosion. Both droplet size and droplet velocity must be verified.

Phase I: A Fine Water Mist Nozzle System design is expected as a deliverable of Phase I. The system will include the successful nozzle design for dispersion of high velocity small diameter droplets. A final report must be provided, outlining the Computational Fluid Dynamics process used to determine the prototype design.

Phase II: Testing by the contractor is required to determine droplet diameter, droplet velocity and system response. It is expected that the contractor will conform to aircraft parameters for weight and electrical requirements. Verification tests will be accomplished by the government to determine system parameters and performance including: droplet diameter; droplet velocity; time response of the system; temperature performance; fire extinguishment/explosion suppression capability; weight requirements and aircraft electrical requirements.

Phase III: The Phase III effort anticipated is to replace all Halon fire extinguishment systems with the Fine Water Mist Systems. Further, additional aircraft fire protection would be provided by the successful Fine Water Mist System where there is currently no fire protection/explosion suppression capability.

Commercial Potential: The commercial potential is enormous for this effort. Commercial use of the nozzle could include: Commercial Fire Protection, Chemical Processes, Evaporative Cooling, Moistening and Wetting, Dust Suppression, Humidifying and many additional applications.

N94-081 TITLE: Narrowband Optical Filter for Laser Radar Applications

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: To develop a narrow linewidth optical filter for use in a laser radar receiver. The linewidth must be less than 5 angstroms and have a transmission of greater than 80%. The filter must be scaleable to at least 6.5 cm clear aperture and have a field of view of at least 15 degrees full angle. The filter need not be tunable, but it must be able to be designed to operate anywhere in the green wavelength region (510-550 nm). The filter must be able to be used in an imaging receiver system.

DESCRIPTION: Presently the Navy is exploring the use of Laser Radar for underwater detection near the water surface where the acoustic techniques are limited. There are a number of programs that are developing systems to perform these tasks. One of the issues with these systems is the solar background, which limits the daytime performance. To achieve equal daytime/nighttime operation a narrow linewidth optical filter is needed to reject all light except within a narrow width centered at the transmitter wavelength. Presently a 2 nm interference filter with 70% transmission is being used as a base line. If a filter is used with a transmission linewidth ratio greater than the base line it will reduce the requirements for the laser transmitter or enhance the performance depth. The transmission can be smaller, however the ratio of the transmission per bandwidth must be greater than 16%/angstrom. The field of view can be reduced or enlarged if the aperture is changed while holding the aperture-field of view product constant (100 degrees cm).

Phase I: Should address the design and critical technical issues associated with the production of these new filters.

Phase II: Should provide a high quality prototype filter with the maximum bands of 0.5 angstrom, field of view of 15 degrees full angle, clear aperture of 6.5 cm and at least a 20% transmission.

Phase III: At least two classified 6.2 programs exist which would use this technology.

Commercial Potential: Any filtering device developed can be used in any system hampered by the solar background, for example, remote sensing of chemical pollutants and astrological observing.

NAVAL AIR WARFARE CENTER\WEAPONS DIVISION\CHINA LAKE

N94-082 TITLE: Fiber Optic Interface for High Power Density Laser

CATEGORY: Advanced Development; Light and Optical Systems

OBJECTIVE: The objective of this project is to design, fabricate, and test a fiber optic interface device which will improve coupling of high energy, pulsed lasers into commercial fiber optics at a low cost per device.

DESCRIPTION: Development of low cost laser initiation systems for ordnance applications has been frustrated by the difficulty of interfacing high power, short rise energy pulses into an optical fiber. Energy losses are unacceptable due to high reflectance at the fiber surface and damage to the fiber due to absorptive imperfections.

Phase I: Develop preliminary design approaches and evaluate feasibility.

Phase II: Design and demonstrate prototype devices. Design goals are:

Reflective loss: <10% at device input, <10% at device output
Internal losses: <15%
Input diameter: 2000 um
Output diameter: not to exceed 200 um
Peak power density: 5 MW/mm2
Pulse duration: 50 nsec
Cost in quantities >100: not to exceed $ 80 each

Phase III: Transition to military ordnance community. Determine interest in medical/surgical community and industrial welding, heat treating, and material removal applications.

Commercial Potential: An improved coupling technique for high power lasers would have immediate application in industrial processing and laser surgery systems. Specifically, elimination of mirrors would result in savings in system size, weight, and complexity.

N94-083 TITLE: New Nonlinear Optical Material for High Speed Optical Signa Processing

CATEGORY: Exploratory Development; Materials and Processes

OBJECTIVE: Prepare 2nd-order nonlinear optical polymer (NLOP) film material for integrated optical microcircuits (optical chips).

DESCRIPTION: Optical chips, employing electro-optical waveguides, to be fabricated from the NLOP, require a material with macroscopic polar order. An electric field, applied across the NLOP waveguide, switches the light at rates > 60 Ghz.

Phase I: Deliver two grams of an amorphous, organo-soluble, film-forming, polymeric material in which the chromophore is chemically part of the polymeric material. Specific targets for this material are as follows:

1) the wavelength of the electronic charge-transfer absorption maximum in the bulk material should be greater than 400 nm,
2) the absorption coefficient at a wavelength of 1.3 microns in the bulk material should be less than $0.5cm^{-1}$,
3) the chromophore concentration in the bulk material should be greater than 10×10^{20} chromophores per cubic centimeter,
4) the ground-state dipole moment of each chromophore should be greater than 5 D,
5) the glass transition temperature of the NLOP, in the finished optical waveguiding form, should be greater than 210°C,
6) the NLOP must be chemically stable, should not contain azo nor other groups that undergo thermal or photolytic isomerization.

A final report will be delivered which summarizes results of phase I work, and outlines the approach for phase II work.

Phase II: Deliver ten channel waveguides of high optical quality, prepared from the successful NLOP, that have an aged, electro-optic coefficient (r_{33}) greater than 30 pm/V, retain 95% of this value after heating to 125°C for 24 hours, and have less than 1.0 Db/cm optical waveguiding loss. Deliver ten grams of optimized second-order nonlinear optical polymer (pre-film material) and 50 grams of optimized buffer-layer polymer. Deliver a final report that recommends preferred processing conditions (e.g., solvents, baking and poling conditions). Deliver an environmental impact statement for producing larger batches of the polymer. The final report will summarize results of phase II work, and outline the approach for phase III work.

Phase III: A pilot plant will be built for production runs of NLOP. The technology will be transitioned to commercial and/or government R&D polymer chemical facilities. Optical chip fabrication will be done at China Lake and/or at the U.S. Army's MICOM laboratory (Huntsville, AL), IBM (Almaden, CA), Lockheed (Palo Alto, CA), COMSAT (Clarksburg, MD), Electrical Eng. & Computer Sci. Dept. U.C. (Davis, CA).

Commercial Potential: Optical signal switches, phase shifters and modulators will find wide commercial use in fiber-optic communications systems, avionic systems and hybrid computers.

N94-084 TITLE: Deployable Airfoils

CATEGORY: Exploratory Development; Vehicle Structures

OBJECTIVE: Explore concepts and develop solutions for close-coupled, deployable airfoil deceleration and stabilization subsystems and recovery subsystems for use in tactical aircraft emergency egress systems.

DESCRIPTION: As documented in the Reference (1), the conditions associated with the use of Naval emergency escape systems are extremely severe, primarily because of operational environments aboard aircraft carriers. As a result, the majority of current Naval aircrew fatalities and injuries occur during low-airspeed, low-altitude escapes, with half of the fatalities due to ground or water impact before seat/man separation or before the recovery subsystem can be fully inflated. Deployable airfoils, powered by the ejection propulsion system, are capable of much faster inflation and offer greatly enhanced flight cont' and maneuverability characteristics than parachutes. A joint Navy/Air Force program exists to develop advanced technology for an ejection seat with controlled flight and vertical-seeking capability through thrust vector control of the propulsion system. The successful conclusion of this technology development will provide an opportunity to use rapid opening deployable airfoils for deceleration/stabilization and final recovery.

Phase I: Conduct a six-month study to explore various alternative concepts deployable airfoils, and define the most promising concept(s). The preferred concept(s) must be appropriate for use in ejection seats.

Phase II: Demonstrate the concept(s) chosen during Phase I by constructing, testing, and evaluating deployable airfoils to verify performance.

Phase III: Transition the technology to a contractor where the deployable airfoil will be produced for use in advanced aircraft emergency egress systems. In turn, the contractor will gain the technical and production knowledge associated with the deployable airfoil which later can be marketed for commercial use.

Commercial Potential: The technology has application in the private sector in the ultra-lightweight aircraft industry.

N94-085 TITLE: Low Cost Integrated Circuit Design and Fabrication using Shared Mask Methodology

CATEGORY: Exploratory Development; Design Automation

OBJECTIVE: Design and develop a system of manufacturing integrated circuits (IC) in small volumes using shared masks for gate arrays (similar to the ARPA funded "MOSIS" process for standard cell IC's).

DESCRIPTION: DoD typically has requirements for small volumes of integrated circuits (<1000 IC's). Full Custom and Standard Cell methodologies are high cost/long lead time/high volume items compared to gate-array technology. However, there are still significant costs associated with processing and mask fabrication. By sharing the processing/masking costs across several customers, the costs can be reduced by a factor of at least ten. While this process is similar to the MOSIS process in philosophy, it is different in that it is applicable to gate-arrays (semi-custom IC's).

Phase I: This phase will include the design, fabrication and testing of sample gate arrays.

Phase II: This phase will include a full scale multi-project gate array fabrication run.

Phase III: This phase will include COMMERCIALIZATION of the service for both DoD and Industry.

Commercial Potential: This process could be used by commercial vendors as well as the military industrial complex, for any IC development program where small quantities are required. For example - signal processors, computers, high resolution TV, communications, college lab courses, state machine implementations, digital neural nets, etc. The applications for this program are endless.

NAVAL AIR WARFARE CENTER/WEAPONS DIVISION/PT MUGU

N94-086 TITLE: Binary Optics for Electro-Optical Sensors

CATEGORY: Exploratory Development; Design Automation

OBJECTIVE: Assess the utility of binary optics to airborne electro-optical sensors

DESCRIPTION: Binary optics is a term to categorize optical elements made by a relatively new manufacturing process that eliminates most of the steps previously required for lens making. Desired shapes are etched directly to the surface of the optical material using integrated circuit manufacturing techniques. These techniques permit creation of intricate monolithic microlens structures. Lens packing densities can exceed 20,000 per square centimeter. Diffraction effects are used to control light instead of the conventional refraction. As a result, binary optical techniques are well suited to directing laser light. Because very small lenses can be produced with high quality, binary optics arrays are well suited as sensor systems focusing and relay optics, scanning optics and transducers.

Phase I: Devise methods to improve onboard, aircraft sensors and missile seekers through the utilization of binary optics. Predict sensor and seeker performance improvements. Predict vulnerability impact to onboard, countermeasures devices due to missile seekers employing binary optics.

Phase II: Validate predictions by making laboratory measurements of the effectiveness of one or more of the devised techniques.

Phase III: This binary optics effort will be transitioned into a brass board sensor development.

Commercial Potential: Binary optics will find many commercial applications including medical instruments.

N94-087 TITLE: Low Altitude Station Keeping Optical Instrumentation Platform

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: The object of this Topic is development of a small unmanned airborne optical data collection system.

DESCRIPTION: The Navy currently uses high accuracy mounts which carry cameras outfitted with telescopes to record weapons tests. Most of these systems are mounted in precisely surveyed towers located at strategic locations on a test range. A few of these systems, equipped with special stable platforms, are mounted in aircraft. The systems on the ground are often unusable because of low altitude haze or fog. The aircraft mounted systems are often unusable because of the cost of deploying the aircraft and because the aircraft cannot be brought close enough to the test, for safety reasons, to collect adequate optical information. The desired characteristics of this topic's optical instrumentation platform are as follows: Ability to remain on station for periods of up to 8 hours at wind speeds of up to at least 35 knots; ability to collect optical information annotated with the direction the telescope was pointed and the time of day for which the data applies, ability to detect and record high speed encounters such as a MACH 4 missile approaching head on to a MACH 3 aircraft. The Navy can furnish certain items such as radio down uplinks and downlinks for controlling the system as it is directed to and from its station keeping location. While a total system is desired the Navy will consider proposals to develop parts of the system. The Navy will support contractor testing at a Navy test range.

Phase I: Development concepts, test high risk devices, prepare specifications for a prototype.

Phase II: Develop and flight test a prototype.

Phase III: Produce 10 to 15 units for verification of produceability and field testing.

Commercial Potential: This technology has application in situations where a close-up airborne view is needed but the situation is too hazardous for manned aircraft or airships. Typical applications would be riots, burning ships or oil platforms, forest fires, assessing damage during bad weather, and detecting personnel or aircraft crossing international borders.

N94-088 TITLE: GPS Translator For Small Missiles

CATEGORY: Exploratory Development; Navigation, Guidance, and Vehicle Control

OBJECTIVE: Develop a Global Positioning System (GPS) translator system, for use in small, highly dynamic, air launched missiles. The system receives position and time information from four or more satellites and translates the information to signals

that can be digitally multiplexed on IRIG standard telemeters.

DESCRIPTION: The typical small air launched test missile has a volume of up to fifteen cubic inches allocated to radar beacons to aid determining time, space, position information during test firings on instrumented ranges. The tracking of missiles with radar requires line of sight coverage during missile flight. The flight envelopes of current and future missiles make it impractical to provide line of sight radar coverage at land ranges and virtually impossible at ocean ranges. Also, the position accuracy obtained by the best range instrumentation radars is not sufficient to evaluate end game results without additional complex instrumentation. The requirement is for a four or more channel GPS receiver and data link capable of providing the accuracy for unaided end game evaluation, over the horizon coverage, inertial interpolation of position sufficient for ten to fifteen updates per second, and one second launch initiation. The massive commercial market for GPS equipment is stimulating rapid advances in GPS engine components. The telemeters used in test missiles provide an available transmission link for GPS signals. Inertial data available through test instrumentation in missiles undergoing development could provide the needed source of interpolation information between GPS updates. The merging of these data sources would provide the opportunity for meeting the requirements of missile test instrumentation.

Phase I: Conduct a 6 months study to identify components and interfaces of the elements of a small missile GPS translator system that meets the above needs.

Phase II: Design, fabricate and test a breadboard design of the small missile GPS translator including antennas, GPS engine, inertial interface, and telemeter interface.

Phase III: Design, fabricate, and test three prototype models of the small missile GPS translator and document the design for transition into a production program.

Commercial Potential: The technology has application in the private sector where small sized, rugged GPS sensors are needed. When interfaced with new or existing communications links, this technology would provide long distance, precise position information to central control centers on aircraft and commercial land vehicles for many functions including: emergency search and rescue location, crash location, and traffic control.

N94-089 TITLE: GPS Processing for Scoring

CATEGORY: Advanced Development; Navigation, Guidance, and Vehicle Control

OBJECTIVE: Develop techniques for using signals from the Global Positioning System (GPS) for scoring the engagement between a guided missile and a target (aerial or surface).

DESCRIPTION: GPS provided both Time-Space Position Information (TSPI) and, if processed for this purpose, velocities and accelerations.

Multiple GPS receiving antennas on the same vehicle, observing the same GPS satellites, can provide attitude. Combination of these outputs allows definition of vectors in space to describe vehicle dynamics. Comparison of the dynamic vectors for two vehicles passing each other in space is a definition of scoring wherein both the vector miss distance and attitude at the time that the weapon would detonate is determined. Processing of the GPS signals from the missile and the target could be accomplished on the target vehicle and the results transmitted to the remote control station; or the GPS signals received at each vehicle could be transmitted independently to the remote control station for resolution.

Phase I: Examine the parameters of this technique and the physical and dynamic characteristics of current and planned weapon/target engagements to determine the extent to which this technique will apply to the wide dynamic range of potential engagements (scenarios).

Phase II: Presuming that this technique applies, assemble an engineering development model that can be demonstrated in conjunction with support by the NAWCWPNS, Point Mugu.

Phase III: Presuming a successful demonstration, assemble six pre-production prototypes (six missile and six target systems) and specification for competitive procurement. Conduct test and evaluation (T&E) on the six prototypes systems to determine performance capabilities and produce a final report.

Commercial Potential: Although scoring is considered peculiar to weapons and DOD applications, there are other possible adaptations that include use for formation operation of unmanned vehicles (including targets), close approach of two independently controlled vehicles (space vehicle docking or aircraft approach warning) and automated control of two approaching vehicles so that they do not collide.

N94-090 TITLE: GPS Synchronized Time Code Generator for Airborne PCM Applications

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Develop a time code generator that can continuously read and synchronize to time information available on the GPS (Global Positioning System).

DESCRIPTION: The ability to insert accurate time information into PCM data is a prime requirement in modern test programs that require the time correlation of multiple events. Until now, time code generators could be synchronized only before the test and allowed to free run for the duration of the test. This has meant that time errors would increase dramatically as test times increased. With the advent of GPS and the availability of GPS receivers for virtually any application, the means now exist to have the correct time information inserted into PCM data at all times.

The time code generator would include an accurate clock source and output the time whenever requested by the data acquisition system. It would use the serial data from the GPS receiver to resynchronize at specified intervals. This design approach would assure that time information is still available even if there was a failure in the GPS receiver.

Phase I: Perform a detailed design including all electrical and mechanical specifications. Submit detailed documentation to the sponsor for review and approval.

Phase II: Manufacture and test five prototypes. Deliver prototypes to sponsor for evaluation.

Phase III: Full Qualification and Limited Production Run serving both Military and Commercial environments.

Commercial Potential: This type of technology has both Military and Commercial applications for accurate location and communications for air, ground, and ocean vehicles.

N94-091 TITLE: Universal Two Stage GPS/INS Integration for Test Range Applications

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: The objective of this program is to develop and test an innovative estimator for combining GPS with inertial measurement systems which will be universal in the sense that it will not require custom filter design. Such universal integration with virtually any inertial system would save both non recurring engineering and software development cost.

DESCRIPTION: Recent work on closed form nonlinear estimators for solving the GPS pseudorange equations has provided a method for integrating GPS with inertial systems which promises both increased accuracy and simplified, cheaper GPS/INS integration. By using different norm constraints to estimate the solutions to the pseudorange equations, different robustness and accuracy requirements can be met, reducing transient effects and the need for data editing schemes which may cause filter divergence. By prelinearizing the integrating filter with these point estimates, it is possible to develop a universal integration method for virtually any inertial system. Such a scheme would allow integration with the need for custom filter design, thereby reducing non recurring engineering and software development cost.

Phase I: Develop and test software prototypes of universal integration schemes using point estimators based on various norm constraints designed for robustness to outliers, near sufficiency, minimum variance, noise suppression and mitigation of the effects of large deviations.

Phase II: Develop and flight test a hardware prototype.

Phase III: This technology has application to military test and training ranges and commercial, private and military aircraft.

Commercial Potential: This type of integration scheme could result in substantial savings and simplification for navigation equipment for commercial aircraft. It could also provide a ready source of inexpensive off the shelf navigation equipment for private aircraft.

N94-092 TITLE: Digital Relay, Reporter, and Responder

CATEGORY: Exploratory Development; Communications Networking

OBJECTIVE: To use modern digital techniques to perform chirp waveform generation and pulse compression in a reprogrammable device. This device could then be used as a Relay, Reporter, and Responder (R-cubed) unit, and be reconfigured on-the-fly to emulate other data link transceivers.

DESCRIPTION: The existing R-cubed units have characteristics that are favorable for sea range applications, including a single hop transmission distance that meets requirements. One disadvantage is the restrictions imposed by the frequency allocation, i.e. no land range use is allowed. With the trend towards interoperability between sea and land ranges, being pushed by the littoral zone combat scenario, a modernization of data links is required.

Phase I: Conduct a 6 month study to determine if existing digital technology has advanced enough to make digital R-cubed feasible. Design a capable R-cubed unit.

Phase II: Fabricate and test a digital R-cubed prototype.

Phase III: The results of this effort would be combined with related efforts, such as the Standard Interoperable Datalink System (SIDS), to produce the next-generation data link transceiver.

Commercial Potential: The existing R-cubed units are being sold to other countries, so any improved version would have customers. One of the features of digital technology is an ability to change frequencies of operation, and this would benefit customers in other countries with different frequency allocation considerations.

NAVAL COMMAND, CONTROL AND OCEAN SURVEILLANCE CENTER/RDT&E DIVISION (NRAD)

N94-093 TITLE: Hopping Adaptive Interference Canceler

CATEGORY: Exploratory Development; Communications Networking

OBJECTIVE: Develop, demonstrate and test a Hopping Adaptive Interference Canceler (HAIC) to suppress radio frequency interference among collocated hopping UHF radios.

DESCRIPTION: Command and Control Systems require multiple radios operating in close proximity. All services are incorporating frequency hopping radios in their Command and Control Systems. Multiple radios of this type operating in close proximity suffer from degradation due to collocation interference problems. A HAIC will substantially reduce the degradation by suppressing interfering signals at the receivers. The HAIC must be capable of adapting quickly to each frequency hop to suppress noise sidebands.

Phase I: Design and development of a two channel UHF HAIC breadboard model for laboratory evaluation.

Phase II: Design and developme: t of a four channel VHF/UHF HAIC suitable for limited field test with hopping radios. Demonstrate improvement in Bit Error Rate performance of the collocated radios with the HAIC operating.

Phase III: Transition to SPAWAR and UAV PEO to support development of multiple channel collocated frequency hopping VHF/UHF Communication Systems.

Commercial Potential: This technology has commercial application to mobile telephone systems and wireless networks including aircraft, vehicle, and fixed site systems.

N94-094 TITLE: Digital Compression and Error Correction for Video Images

CATEGORY: Exploratory Development; Communications Networking

OBJECTIVE: To measure the performance of various video compression techniques when a channel introduces noise or distortion.

DESCRIPTION: The goal of this project is to identify a video compression technique appropriate for use with JTIDS. Because of high bandwidths necessary to transmit video information, compression schemes are generally required; however, the subjective effects of compressing an image, corrupting the compressed image via voice or channel effects, and then uncompressing, are not clear. This project will determine the level of corruption that various image compression techniques can tolerate. Variables include the amount of noise, other types of corruption, and the compression technique. In order to evaluate compression techniques, a software tool will be developed and used. This tool will compress a video image according to a candidate compression scheme, introduce noise or distortion, then uncompress and display the image.

Phase I: During a six month period, the necessary software tool will be designed. Because of the need for an interactive, flexible simulation, an object-oriented design is expected. Also during this period consideration will be given to how the test images will be obtained or generated (video image boards, etc.).

Phase II: Write and test simulation software, and integrate any hardware identified in Phase I. Identify, test, evaluate and report on a range of candidate compression and error correction schemes under a variety of channel conditions.

Phase III: The successful compres..ion technique(s) will transition into an applique for transmission by a JTIDS terminal using existing Reed-Solomon encoding or unencoded formats.

Commercial Potential: This work has applications in HDTV.

N94-095 TITLE: Develop A Strategic Industrial DUAL-USE Domestic Capability for High Performance 6-in and 8-in Silicon-on-Sapphire (SOS)

CATEGORY: Exploratory Development; Electronic Devices

OBJECTIVE: To develop a viable, affordable domestic capability of dual-use high performance, high device-quality, very thin layer (0.03 to 0.1 micrometer) silicon on sapphire substrates for use by the U.S. semiconductor/integrated circuit industry in the fabrication of high-performance electronic components required by both the military and the commercial market of the late-mid nineties-early 2020's. These requirements cannot be met by current silicon wafers; they can, however, be satisfied by thin film silicon on insulator (TFSOI). And sapphire is the most optimum insulator.

DESCRIPTION: Today, the diameter of Sapphire substrates is no greater than 5-in. Very soon, all domestic suppliers of microchips will migrate to the 8-in and larger diameters. To accelerate SOS acceptance by industry-at-large, the supply of high quality, large diameter-sapphire is required to insure the manufacturability, affordability at competitive prices and realize the economic impact (yield, cost/cm^2 of processed silicon die).

Phase I: The technical issues hampering the growth of large diameter sapphire substrates will be clearly defined and solutions established experimentally demonstrating unequivocally the manufacture of large-sized sapphire substrates (6- and 8-in. in diameter), monocrystalline, free of defects, dislocations, lineages and other crystalline imperfections.

Phase II: Pursuant the availability of defect-free large-diameter (6- and 8-in) sapphire, the potential contractor shall develop the techniques to provide highly uniform (less than 5% total thickness variation across the whole wafer) thin film (0.03 to 0.1 micron) silicon on sapphire (TFSOS).

Phase III: The technique will be transitioned to the Joint Directors of Laboratories (JDL)/Tri-Service Technology Panel on Electron Devices (TPED)/Reliance Project as the implementation substrates for radiation-hardened high performance signal and data processors (Office of Naval Research PE 0602234N, Project RS34M40, Microelectronics Block CS2A). Another possible application is improved, low power, low-cost cellular communications.

Commercial Potential: Exists in the computers, communications, multimedia, wireless personal communications/telecommunications industries.

N94-096 TITLE: Human-Computer Interaction with Voice/Eye Tracking

CATEGORY: Exploratory Development; Human - Systems Interfaces

OBJECTIVE: To develop a human-computer interface (HCI) that integrates voice recognition and eye tracking to interact with a 3-D display on a UNIX graphics workstation.

DESCRIPTION: Eye tracking and voice recognition are now viable technologies, but they are not integrated together. Since they are new technologies, the HCI for their integration with each other and with the computer interface has not been developed. Once this HCI integration is accomplished th chnologies can be used as needed.

Phase I: Using available eye tracking and voice recognition devices, develop an interactive interface on a computer platform of choice. Investigate various HCI techniques to control 3-D scenarios, including pointing, selecting, menu control, activating buttons and potentiometers or knobs, inputting data, changing scene characteristics such as color and size, and moving objects around. Based on Phase I findings, propose a Phase II system that would optimize the HCI eye tracker-voice recognition interface on a 3-D UNIX graphics workstation.

Phase II: Develop a system and techniques that would optimize the HCI eye tracker-voice recognition interface on a 3-D UNIX graphics workstation that is adaptable to various scenarios that use 3-D models, 3-D rendered images, and simulation software on various forms of displays including head mounted and large projected displays. Prepare detailed documentation to guide potential system users through the HCI techniques, details on the setup, interface, and operation of the developed system.

Phase III: These concepts will be transitioned to an ASW sonar and surface search radar system. Major commercial application to benefit from these concepts are medical computer systems, entertainment industry (virtual reality), and disabled

persons support systems.

Commercial Potential: The technology has immediate application in medical systems, entertainment industry (virtual reality), and disabled persons support systems, and future application in generic computer interfaces for offices and manufacturing.

N94-097 TITLE: Tactile and Proximity Sensing Sheet

CATEGORY: Exploratory Development; Human-System Interfaces

OBJECTIVE: Develop a lightweight, low power collision detection/ tactile feedback distributed sensor sheet that conforms to a variety of surfaces to facilitate control of a multiple-degree-of-freedom robotic system in cluttered environments.

DESCRIPTION: For typical robotics applications, the devices available for sensing contact with or proximity to an object only produce discrete, directional information about the environment relative to the sensor's location on the robotic system. This limits maneuverability of multiple-degree-of-freedom systems in cluttered environments. An ideal solution for this problem would be to develop a sensor "sheet" that provides information physically similar to that of human skin (where the skin provides tactile, force and temperature information, and the hairs provide proximity information).

Phase I: Conduct a six month study that will determine the operational requirements, preliminary design, and feasibility of this sensor sheet. Determine the types of sensors to be used, the power and processing requirements, and performance metrics. The proposed sensor sheet should emphasize simplicity wherever possible, provide, as a minimum, tactile and close proximity (less than 2 inches) information, and should be flexible enough to conform to contoured surfaces.

Phase II: Build a prototype system based on the design proposed in Phase I. Perform rigorous testing on the sensor sheet to determine performance and system reliability. Establish any difficulties associated with heat dissipation, processing, and sensor interference. Document test results and provide suggestions for improvement. Summarize results in terms of performance metrics established in Phase I.

Phase III: The resultant sensor shall be transitioned to a Government Laboratory for integration with available robotic system testbeds. Potential commercial applications include manufacturing, hazardous waste disposal, virtual reality I/O products, and the medical profession.

Commercial Potential: This sensor can be applied to any system which requires collision detection and avoidance capabilities, as well as continuous tactile feedback information for fine motion control. It could be used not only on a robotic system, but also as a means of providing a comfortable lightweight "suit" for interfacing with a human (in this case it would be an effector sheet). This would be particularly useful for Virtual World as well as training simulator applications. It could also be used in hazardous environments where contact with a particular object or explosive could be fatal if quick action is not taken. In the medical field, this sensor sheet should be used by handicapped or paralyzed individuals who can not sense pain or collision.

N94-098 TITLE: Photonic Noise and Vibration Monitoring System

CATEGORY: Advanced Development; Light and Optical Systems

OBJECTIVE: Develop a small, low cost, very low power, robust unit for detecting mechanical noise (and other modes of) vibration and radiated signals for equipments and platforms, assessing the condition of and displaying same (e.g. failure of pump seal, excessive generator noise, engine preignition).

DESCRIPTION: Current implementations of noise and vibration (signal) monitoring use hybrid analog and digital technology. The need is more sensors count and processing capacity which is a limitation for digital technology.

Phase I: consists of concept exploration, a photonics adaption feasibility study, selection of approach, followed by the design and production of demonstration prototypes

Phase II: primarily addresses the certification of the broad application and dual use theory; economies of cost and production engineering. It will produce additional prototypes units, provide for both military and commercial demonstrations, technical and operational testing additional sensor types and complimentary processing.

Phase III: will focus on transitioning of technology to both direct end use and embedding in larger surveillance systems, e.g. the all optical eillance system. Defense technology conversion funds will be requested to make production cost and units sizes drop, wh. increasing reliability and performance.

Commercial Potential: There is a potential commercial market for units in continuous service, personal vehicles, home appliances, etc.

N94-099 TITLE: Diamond Electronic Packaging Technology

CATEGORY: Research; Materials

OBJECTIVE: To develop a process for burying metal in polycrystalline diamond substrates that would be suitable for the fabrication of a hermetic electronic package.

DESCRIPTION: The increase in computational density in present and future electronic systems increases the amount of power that is used to operate these systems. Current high speed semiconductor circuits dissipate up to 10 W/cm^2 with predictions of future devices dissipating up to 100 W/cm^2 by the year 2000. If the military and commercial markets are to benefit from advances in semiconductor technology, innovative research for advanced materials used for thermal management in electronic packaging must be performed. One of the most promising materials for thermal management is polycrystalline diamond (PD). PD has a thermal conductivity of 1000-1800 W/m K, higher than any oth- prospective packaging material. PD is currently being used as a heat spreader in many applications, but has not been used .s material for an electronic package due to lack of buried metalization.

Phase I: Develop and demonstrate process for incorporating buried metalization in PD films. The buried metalization used is to be suitable for the distribution of electrical signals such as used in conventional electronic packaging.

Phase II: Develop and demonstrate process for multilayer metalization with vias for inter layer signal conduction. Multilayer metalization and vias are to accommodate 0.012 inch lines on a 0.025 inch pitch. To demonstrate developed process, a typical lead frame style electronic package will be constructed.

Phase III: Transition to commercial high power, high speed digital electronics such as DEC ALPHA or digital signal processing applications. Transition to Navy Microelectronics Block Program, ARPA Physical Electronics Packaging.

Commercial Potential: Commercial potential for a diamond electronic package is high due to diamond' .igh thermal conductivity and low dielectric constant (Er=5). This makes a diamond electronic package desirable for high power and high speed applications.

N94-100 TITLE: Antimultipath Capability for Global Positioning System Receivers

CATEGORY: Exploratory Development; Navigation, Guidance and Vehicle Control

OBJECTIVE: To develop a subsystem to automatically protect GPS receivers from the degrading effects of multipath propagation.

DESCRIPTION: Global Positioning System (GPS) and differential GPS navigation receivers have found widespread military and commercial use following Operation Desert Storm. Their accuracy has become so good that the propagation environment at L-band is the principal source limiting accuracy in some applications. Multipath propagation due to ship superstructure, reflection from the sea, hills, etc., causes pseudorange errors due to code clock jitter or false lock by the receiver channels. Attempts to solve the multipath problem by adaptive nulling arrays are expensive and require multiple antennas. There exists a requirement for a GPS receiver subsystem to suppress the unwanted multipath components, thereby permitting the existing GPS signal processing system to function as it would in the absence of multipath.

Phase I: A feasibility study will be performed to evaluate the concept and to optimize the parameters for C/A and P-code use. Computer simulation will be employed to verify the design concept and to evaluate the limitations of performance for the candidate design with several multipath scenarios.

Phase II: Implementation of Phase I design in the fabrication of two engineering development models capable of being evaluated in a controlled laboratory and tested i- ship, air or shore environment. Test data to be collected to verify antimultipath performance capabilities. Data to be co ted with both C/A and P-code signals and with a simple (FRPA) antenna and (if GFE available) an ECCM (CRPA) antenna array. Test data and implementation documentation will be provided in a final evaluation report.

Phase III: This product in hardware or software form would lend itself to commercialization as well as to Navy applications. Technology advancement in DSP chips will make low cost commercial applications attractive and competitive with the MLS at airports.

Commercial Potential: Exists for automatic IFR weather landing system for commercial aircraft; highly accurate land surveying.

N94-101 TITLE: Ceramic Composite Electronic Packaging Technology

CATEGORY: Exploratory Development; Materials and Processes

OBJECTIVE: To develop a process for laminating a low temperature cofired ceramic (LTCC) with a dielectric constant less than 5 to a highly thermally conductive ceramic substrate such as aluminum nitride (AlN).

DESCRIPTION: Ceramic materials such as aluminum nitride have a relatively high thermal conductivity (180 W/m-K) but have a high dielectric constant (8.5 - 8.7). It is desirable to have a low dielectric constant material supporting signal i/o because the signal transit time is inversely proportional to the square root of the dielectric constant. LTCC materials have a low dielectric constant but suffer from a poor thermal conductivity (1 - 2 W/m-K). The combination of these two materials provides an optimal solution to the trade off between high thermal conductivity and high speed operation normally encountered in electronic packaging.

Phase I: Develop and demonstrate process for hermetically bonding LTCC to AlN. The minimum sample size used to demonstrate this process shall be 2 inch by 2 inch. The reliability will be demonstrated by subjecting samples to 100 temperature cycles of -65°C to 150°C.

Phase II: Further develop and demonstrate process for laminating a picture frame of LTCC material to AlN. The picture frame of LTCC must contain buried metalization similar to that found in a ceramic electronic package. The multilayer metalization with vias for inter layer signal conduction. Multilayer metalization and vias shall accommodate 0.012 inch lines on a 0.025 inch pitch. To demonstrate developed process, a typical lead frame style electronic package will be constructed. This package shall contain a fixed impedance i/o structure at 50 ohms.

Phase III: Transition to ARPA MMIC phase III, Global Positioning Systems, Distributed Wireless Networking, or other applications fixed impedance, requiring mixed signal or ultra high speed digital packaging solutions.

Commercial Potential: Commercial potential for a ceramic composite electronic package is high due to AlN's high thermal conductivity and LTCC's low dielectric constant (Er=5). This makes a ceramic composite electronic package desirable for high power and high speed applications.

NAVAL CIVIL ENGINEERING LABORATORY

N94-102 TITLE: Mobile Battlefield Power Support System

CATEGORY: Exploratory Development; Energy Storage

OBJECTIVE: Utilize advanced technology to develop a mobile hybrid modular high quality power system with reduced pollution, acoustic and thermal signature and which is compatible with standard power requirements of existing government field equipment.

DESCRIPTION: Generators produce excessive noise, heat, and pollution, requiring electrical sources to be located farther from the user. An alternative family of low signature power systems would provide forward command posts with complete electrical support without the need for labor intensive sound and heat shields, while also reducing the need for logistic support in bulk fuels. A modular system design would allow the system to meet various load demands and configurations. Man portable units in the 3, 7.5, 15, 30, and 60 KiloWatt size ranges (larger KW sizes achieved through modularity) would also support the increasing need of for tactical command and control (C2) power supplies. The ideal system should operate from within USMC tactical operations center tentage.

Phase I: Submit an initial architecture design of the mobile modular power system, identifying fuel sources appropriate for deployment to the field and interface capabilities/requirements to make the designed system compatible with existing equipment. Include as part of the design package a unit which would be man-portable, and the modular ability to expand or reduce the load handling capacity of the system. Show that the design will comply with environmental regulations for air and noise pollution, using the strictest state and federal regulations as a guideline.

Phase II: Continue development of the prototype modular power system, demonstrating operation under a load profile representative of field requirements. Demonstrate performance of the man-portable module and life cycle performance

expectancies. Improve design to be operable in all weather conditions, reduce maintenance, and improve reliability. Also improve the quality of the power supplied, making it dependable for computer applications. Demonstrate environmental compliance with the strictest state and federal air quality standards, noise and pollution control requirements.

Commercial Potential: Commercial potential exists in the successful demonstration of reliable high quality power supplies which significantly reduce noise and air pollution while providing adequate and varied load profile performance. The modular nature of this system will allow for the application of this power supply to various load requirements.

N94-103 TITLE: Man Portable Vehicle Barrier

CATEGORY: Exploratory Development; Materials and Processes

OBJECTIVE: Develop Vehicle Barrier that can be deployed by several people without the aid of lifting/handling equipment. The barrier will have the option of being deployed by vehicle or helicopter when circumstances dictate. The barrier will perform on hard and soft surfaces without surface preparation. The barrier will employ the weight/mass of the vehicular threats to stop the vehicle.

DESCRIPTION: There are many vehicle barriers in commercial/Government use. All of these barriers rely on their own weight, size, and mass to dissipate a vehicle's kinetic energy. None of the current barriers in use address the need to deploy barriers on a short notice by only a few people. Without the aid of some type of handling equipment it would be impossible to deploy them at all.

The barriers that have been developed as man portable have proven to be highly ineffective. The systems rely only on tire deflation as a means to stop vehicle threats. The deflation of a vehicle's tires at high speed does not effectively disable the vehicle. A vehicle can continue to run on deflated tires and the barrier can be averted by filling the tires with foam or other materials in anticipation of such an action.

Phase I: Determine operational/physical requirements. These requirements will be based on intended uses, available materials, and methods of deployment. Evaluate existing concepts. Investigate possible abstracts of concepts. Select most desirable concepts for prototype design, test, and evaluation.

Phase II: Prove barrier design theory through modeling and testing. Develop proven design and provide prototype fabrication drawings for barrier system. Manufacturer a working prototype of the designed barrier, conduct full scale tests and provide test results report.

Phase III: The product is expected to be transitioned to other services within the Government requiring portable vehicle barriers. This would encompass all military branches of service, Justice department, Department of Transportation, Treasury Department, Department of Energy, and the Secret Service.

Commercial Potential: Potential applications for temporary traffic control is believed to far exceed the need for permanent controls. Military applications are include temporary and/or advanced base operations requiring traffic control. May fill temporary needs until "permanent" structures are built.

N94-104 TITLE: High Reliability Remote In-Line Fuel Booster Pump

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Investigate and develop reliable, remote (at sea) in-line, self powered, booster pump.

DESCRIPTION: In-line pumping technology is currently focused on land based units that are too heavy. In an amphibious operation near shore bathymetry may require an oil tanker to anchor miles off shore and that distance may exceed the capabilities of existing systems to efficiently transfer products ashore. An in-line booster pump may be stationed 2 miles from either the shore or the ship. Attending to the remote pumping station will increase man power requirements for assault unit. In order to reduce the maintenance burden, a reliable, remotely operated and monitored, product line sensing, self-powered, pumping system must be developed.

Phase I: Investigate state of the art technology in pumps and power supply. Determine characteristics and requirements to achieve the goals of the objective. Develop specifications for the self powered pump and sensors.

Phase II: Design and fabricate prototype system for lab and field testing. Develop tests, evaluate criteria for the prototype.

Phase III: Conduct the test and evaluation of the prototype system. Develop the design specifications for a field

system.

Commercial Potential: Uses include temporary product transfer in remote areas, at-sea, or for emergency replacement of existing pumping facility. Development may extend to in line processing.

N94-105 TITLE: Use of Microseisms to Predict Seismic Ground Motion Amplification

CATEGORY: Exploratory Development; Terrestrial Sciences

OBJECTIVE: The objective is to develop a means to determine seismic ground motion amplification at marginal sites using microseism recordings and fourier analysis eliminating the need for soil sampling, soil testing and traditional dynamic response analysis.

DESCRIPTION: The Navy sustained a $125 million loss during the Loma Prieta earthquake as a result of amplification of ground motion in marginal soils. Current procedures for predicting seismic ground motion amplification are inadequate to accurately predict the amplification and requires soil tests to determine material properties. Microseismic data can be recorded on soil and on rock and a transfer amplification function can in theory be developed. If this is achieved, a revolutionary breakthrough will be made by eliminating the reliance on soil testing to determine a site's properties and then using those properties in an analysis. Use of microseism data will permit the direct computation of a site amplification function through the recorded time history data converted to spectra from which an amplification transfer function is determined. However, major fundamental unknowns exist in our ability to use the low amplitude microseism data to predict amplification under large magnitude earthquakes. Nonlinear ground response effects and magnitude scaling are key factors which must be evaluated before we can consider microseism data as capable of predicting site amplification for earthquakes.

Phase I: Microseisms are the numerous small earthquake events which occur daily. Strong motion data such as the 1989 Loma Prieta event recorded on Treasure Island and Yerba Buena is to be processed by Fourier analysis to compute a transfer function which will serve as a full scale benchmark of actual observed amplification. Yerba Buena is a rock outcrop while Treasure Island is a site of known high amplification. Instrumentation is to be installed on Treasure Island and on the bed rock at Yerba Buena Island in the same locations as the earthquake strong motion instrumentation is installed and microseism data is to be recorded. Results will be evaluated and reported.

Phase II: Some nonlinear effects of the ground response which will influence the amplification functions are expected. An independent method using material properties and nonlinear analysis will be used to validate microseism amplification results and predictions. The nonlinear response and earthquake magnitude effects which will influence the amplification functions are to be evaluated using finite element analysis and wave propagation analysis. A fundamental part of this research is to develop an understanding of the basic process of site amplification.

Phase III: Develop procedures, equipment and supporting documentation to permit systems to be obtained and procedures defined for conducting analysis. Provide technology transfer in the form of training sessions at Navy Engineering Field Divisions.

Commercial Potential: This research has full potential for non-DOD applications. It will impact civilian construction both at waterfront areas and at other sites where high plasticity clays are found. Users are the civil engineering profession and construction industry.

NAVAL RESEARCH LABORATORY

N94-106 TITLE: Bond and Etchback Silicon on Insulator (BESOI) Materials for Enhanced Fully Depleted CMOS Applications

CATEGORY: Exploratory Research: Electronic Devices

OBJECTIVE: Gain the advantages offered by BESOI (Bond and Etchback Silicon On Insulator) materials of low capacitance and fully depleted field effect transistors to develop high speed silicon integrated circuits.

DESCRIPTION: Analyses indicate that fully depleted Si MOSFETs (Metal Oxide Silicon Field Effect Transistors) fabricated in silicon-on-insulator materials will give substantial speed improvements over bulk designs. However, there is little experimental work to demonstrate that the gains can be economically realized in practice. This project will demonstrate these gains by building an integrated circuit utilizing fully depleted deep sub-micrometer gate length FETs on BESOI material. The primary technological issue to be addressed is the ability to produce uniform, undoped, thin (500Å to 1000Å thick) superficial

silicon on insulator layers.

Phase I: Deliver a final report which: 1) Determines the optimum technique to produce the BESOI material on 150 mm diameter substrates that can be upgraded to 200 mm diameter substrates; 2) Identifies a supplier of the BESOI material; 3) Proposes a demonstration circuit; 4) Performs a first cut analysis to support that choice; 5) Proposes a process flow for fabrication of fully depleted submicron silicon FETs; and 6) Outlines a testing matrix to verify device performance gains and uniformity.

Phase II: Fabricate fully depleted FETs and demonstration circuit on 150 mm diameter substrates. Perform detailed analysis of the fully depleted FETs and demonstration circuit. Using these results, refine the device and circuit models. Provide 50 working test circuits to the government.

Phase III: A navy funded Phase III effort is anticipated.

Commercial Potential: If performance gains and device uniformity are realized, the thin SOI market could be $1B by year 2000.

N94-107 TITLE: High Voltage Field Effect Switching Transistor

CATEGORY: Exploratory Development; Electronic Devices

OBJECTIVE: To develop a high voltage field effect switching transistor.

DESCRIPTION: This High Voltage Field Effect Switching Transistor (HVFET) would be used to construct High Voltage Modulators for Radar transmitters.

Radar transmitters use pulsed Magnetrons, Traveling Wave Tubes or Extended Interaction Oscillators/Amplifiers. The drive pulses are provided by High Voltage Modulators, which are usually very expensive and complicated. As switching elements are currently used vacuum tubes, thyratrons or Silicon Controlled Rectifiers (SCR's), which all have significant drawbacks.

Recently, in an exploratory developments carried out under contract to NRL, VARIAN has developed a working model of a Magnetron modulator, using paralleled strings of cascaded field effect switching transistors, employing commercially available transistors with relatively low drain voltages. Therefore, very many transistors were required, making the design expensive and relatively large.

The millimeter wave EIKA tube which creates 1 Kw pulses at 94GHz requires a 3 kV keying pulse at its grid. The modulator that supplies this switching pulse is commercially available. It uses vacuum tubes as switching elements. The design is very complex; the modulator costs upwa 's of $ 40k.

Clearly, a better switching element is needed. The proposed switching transistor would have these specifications: Complementary Pair, one NPN and one PNP transistor, enhancement types:

Peak source/drain voltage	5 Kv
On resistance, max.	10 Ohm
Peak Current (pulse)	5 A
Gate Threshold Voltage, max.	100 V
Power Dissipation min.	100 W
Turn On - Time, max.	20 ns

Phase I : Theoretical Study to arrive at required technology

Phase II: Manufacture of 10 each PNP/NPN transistors

Phase III: Construct Lab Model of modulator for EIKA tubes as proof of concept.

Commercial Potential: Proposed devices have application in commercially built radars for commercial, industrial, military and private uses, further for flyback switching transistors in TV sets.

N94-108 TITLE: Enhanced Eye Tracker

CATEGORY: Exploratory Development; Electronic Devices

OBJECTIVE: Improve the real-time performance of the available eye trackers by providing enhancements that reliably and consistently provide an eye position at least 60 times a second.

DESCRIPTION: NRL currently uses an Applied Science Laboratories eye tracker, which calculates an eye position for each video frame 60 times a second. However, there are often brief periods during which the eye tracker fails to identify the eye position correctly. These are much less serious for the non-real-time experimental uses for which such systems were originally developed than for use in a real-time user-computer interface, such as that being developed at NRL. The eye tracker was designed primarily for collecting eye position data that would be analyzed retroactively. The real-time capability needs enhancement. Improvements in eye tracking technology are thus sought to improve the reliability of every single eye position in the data stream.

Phase I: Analyze the real-time capability of existing corneal reflection/pupil eye trackers such as the Applied Science Laboratories equipment, which represents the current state of the art.

Phase II: Develop and implement improvements or new approaches to oculometry that consistently provide more robust eye position measurements at least 60 times a second with no lost positions.

Phase III: The enhancements will be transitioned to the eye movement testbed at NR, for use as an input device to a computer system that recognizes object selection by eye gaze. This improvement would make eye gaze a reliable computer input techniques and greatly expand the use of eye gaze in computer interfaces. Enhancements could be added to the existing equipment at NRL or new equipment could be provided to replace it.

Commercial Potential: The technology has application in the private sector in faster and more reliable communication via computer for handicapped individuals who have no verbal communication capabilities and only restricted movement.

N94-109 TITLE: Non-Linear Optical and Solid State Laser Materials

CATEGORY: Exploratory Development; Materials and Processes

OBJECTIVE: To develop materials suitable for direct or frequency converted operation of laser-pumped (especially diode laser) laser operation with tunable or fixed frequency operation from 260nm to 12um wavelength.

DESCRIPTION: Laser and frequency converted solid state laser sources have operated at wavelengths across this whole range of interest but generally with poor efficiency or average power or both. While reasonable one micron sources exist and these have been efficiently converted to 530nm to 2um at reasonable average power, outside this range the average power capability declines abruptly to a few watts or less. Deficiencies are most notable in the deep ultraviolet (<350nm) or the mid-wave IR (2-5um) or long wave IR (8-14um).

Phase I: will consist of evaluation and characterization of the fundamental properties of the proposed material to show suitability of the material for the proposed application as well as evaluation and selection of appropriate growth technology. An estimate of likely obstacles to successful growth such as color centers, undesired valence state of dopants' impurities and proposed methods of resolution will also be performed.

Phase II: will consist of development of growth processes to demonstrate capability to produce crystals at a large enough size scale and of a quality to allow experimental evaluation of suitability for applications.

Phase III: production of crystalline laser and/or EO materials on a commercial basis to support Navy and commercial programs.

Commercial Potential: The materials developed here will have utility for devices uch as compact blue/green lasers for read/write optical disc (CD) memory devices, compact IR sources for pollutant sensing and industrial process monitoring and improved industrial and medical lasers.

N94-110 TITLE: Large Length, High Frequency Detector

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: The goal of this work is to develop new, large-area, high-bandwidth, 840 nm wavelength, single-element photodetectors for coherent systems. Previously, low-speed, large-area photodetectors have been developed. This work is to develop high-speed, large-area, photodetectors for use in coherent systems critically needed for tactical Navy aircraft. Technical goals are given in Table I. Additional information about the applications can be obtained from NRL Codes 5721, 5730, or 6813 if necessary.

DESCRIPTION: The photodetectors will be used in coherent systems as heterodyne detectors. The design goals of the photodetectors are given in Table I. These items include the short term and long term goals for the bandwidth, dimensions (the

larger of large dimension goals should be seriously addressed in the short term), dynamic range, wavelength, transfer characteristic, uniformity across the focal plane, the maximum optical signal, minimum signal-to-noise ratio, and sensitivity. Bidders should have adequate clearance so that selected contractors can receive classified information at the Secret level. Contractors will not generate classified information.

Phase I: will be a design phase during which the contractor will develop the first level design to be used for the short term goals and develop an outline of a suggested approach for the long term goals. The deliverable will consist of a final report. Either or both sensitivity levels given in Table I may be addressed.

Phase II: The deliverable hardware will be 40 packaged photodetectors fabricated to satisfy the performance goals. All delivered hardware shall be completely tested for all performance goals. A complete final report describing all technical work in detail shall be delivered.

Phase III: A Navy funded Phase III is expected.

Commercial Potential: The large-area, high-frequency detector may have application to laser radar for environment monitoring and to laser ranging.

Table I. Coherent Photodetector Needs

Parameter	Photodetector A		Photodetector B	
	Short Term	Long Term	Short Term	Long Term
Frequency (bandwidth)	1.5 Ghz	5.0 Ghz	1.5 Ghz	5.0 Ghz
Dimension (large)	1 mm	5 mm	1 mm	5 mm
(small)	50 mm	100 mm	50 mm	00 mm
Dynamic range†	40 Db (10^4)	60 Db (10^6)	40 Db (10^4)	60 Db (10^6)
Wavelength	0.80 mm	0.80 mm	0.80mm	0.80mm
Transfer characteristic	linear	linear	linear	linear
Uniformity	10 %	5 %	10 %	5 %
Maximum optical signal	67 Mw	67 Mw	1.1 Mw	1.1 Mw
Min signal-to-noise	10 Db (10^1)	10 Db (10^1)	10 Db (10^1)	10 Db (10^1)
Sensitivity*	220 Nw	22 Nw	3.7 nW	370 nW

†Useful dynamic range above minimum signal-to-noise ratio optical power level.

*Determined on basis of heterodyne factor $2(P_sP_r)^{1/2}$. P_s: power in signal beam; P_r power in reference beam.

N94-... TITLE: Fiber Optic Biosensor

CATEGORY: Exploratory Development; Medical Devices

OBJECTIVE: Design and fabricate fiber optic biosensors and fiber optic immunoprobes for detection of infectious disease agents.

DESCRIPTION: Rapid, highly sensitive fluorescence immunoassays can be performed at the surface of an optical fiber using evanescent wave sensing techniques. A portable fiber optic biosensor is required which employs a diode laser and reusable, but easily replaced fiber probes. The device should analyze multiple fiber probes simultaneously and produce a sensitivity comparable to ELISA with response times of 10-15 minutes.

Phase I: Design portable fiber optic biosensor and test breadboard.

Phase II: Build manufacturable prototype of instrument capable of testing multiple fiber probes and develop fiber optic probes suitable for mass production.

Phase III: Test antibody-coated fiber optic probes and fiber optic biosensor for analysis of serum samples for an analyte of concern for safety testing.

Commercial Potential. The technology has application for blood banking, diagnosis of infectious disease, pollution control, detection of biological warfare agents, and process monitoring.

N94-112 TITLE: Altimeter Applications in Shallow-Water Areas

CATEGORY: Exploratory Development; Ocean Sciences

OBJECTIVE: Develop techniques, particularly automated techniques, for extracting oceanographic information in shallow water and coastal regions from satellite altimeter data.

DESCRIPTION: Currently and in the near future there will be an unprecedented wealth of satellite altimeter data, both from U.S. (e.g. TOPEX-Poseidon, GEOSAT Follow-On) and foreign (e.g., ERS-1) satellites. At the same time, the U.S. Navy will be shifting the focus of its interest to shallow-water areas. Various problems such as loss of tracker "lock" for tracks proceedings from land to sea, sometimes for several seconds (which translates to tens of kilometers or more), has reduced the amount of altimeter data available near coastlines. However, new altimeter systems and new data analysis techniques should improve this situation. The deep-water application of altimetry presented a set of unique problems, and it can be expected that a new set of problems will be associated with the shift to shallow water.

Phase I: Develop recommendations concerning techniques, and conduct a pilot study to illustrate the value of selected techniques.

Phase II: Develop a system, incorporating the most successful techniques and procedures, and test that system in a geographical area or areas specified by the Government.

Phase III: Transition the system to the Government. Conduct/participate in an operational evaluation, in preparation for a potential transition to operational use.

Commercial Potential: Oil companies drilling in the Gulf of Mexico, and other shallow-water areas, have a need for the type of information about oceanographic features and conditions that altimetry can provide.

N94-113 TITLE: Tunable, Short-Pulse and Compact Source of X-Rays

CATEGORY: Research; Physics

OBJECTIVE: Develop a compact, tunable source of ultrashort pulse x-rays based on the interaction of an electron beam with a pulsed laser.

DESCRIPTION: At the present time, conventional x-ray tubes are broadband and generate x-rays over a large solid angle. Therefore, these sources have relatively low brightness and, as a result, large and unwieldy x-ray machines are required in materials processing, condensed matter research and in medical applications. Similarly, in vivo microscopy of living organisms is limited by a lack of bright sources of x-rays in the water window. The laser synchrotron source (LSS) has the potential to remedy this situation by providing a compact, powerful and tunable generator of x- rays.

Phase I: Conduct a six month study to design a laser synchrotron source for use in materials processing, condensed matter and medical research. The design must be compact and make use of the lowest energy electrons possible, consistent with the desired wavelength. The brightness of the x-rays generated is a key figure-of-merit for this project.

Phase II: Conduct experiments based on the Phase I design parameters to demonstrate the generation of x-rays. Characterize the radiation by measuring the brightness, the pulse duration and the wavelength. Demonstrate tunability of the x-rays over a limited wavelength band. Facilities at NRL may be made available for the Phase II portion of the program.

Phase III: Transition to industry.

Commercial Potential: The technology has applications in the private sector for materials processing, medical procedures, and in x-ray microscopy.

N94-114 TITLE: Compact, Tunable Infrared Source of Radiation

CATEGORY: Research; Physics

OBJECTIVE: Develop a compact, tunable source of infrared radiation based on the interaction of an electron beam with a diffraction grating.

DESCRIPTION: There is currently a lack of powerful, compact and tunable radiation sources operating in the infrared (IR) and far-infrared (FIR) wavelength regimes. There are many gaps in the wavelength coverage provided by conventional lasers, and their power is often limited. Free-electron lasers based on magnetostatic wigglers and operating in the IR are not suitable for Naval use, due to their large size and weight. A diffraction-grating-based free-electron laser (FEL) can fulfill the Navy's need for a truly compact and tunable source of IR with high-power capability.

Phase I: Conduct a six month study to design a grating-based FEL operating in the IR. The design must be compact,

using moderate energy, high quality electron beams. The output power and efficiency are key figures-of-merit for the design.

Phase II: Conduct experiments based on the Phase I design parameters to demonstrate the generation of the IR radiation. Characterize the radiation, i.e., wavelength, power, and efficiency of generation. Demonstrate tunability over a limited wavelength band. Facilities at NRL may be made available for the Phase II portion of the program.

Phase III: Transition to industry.

Commercial Potential: The technology has application in the private sector for chemical analysis, surgery and air traffic control.

N94-115 TITLE: Carbon Fiber Reinforced Phthalonitrile Resin Fabrication

CATEGORY: Exploratory Development; Materials and Processes

OBJECTIVE: To develop advanced composites based on phthalonitrile polymer resins for high temperature applications.

DESCRIPTION: Polymeric composites are seeing increasing use in primary and secondary components for aerospace and marine applications due to their high specific strength and stiffness versus metals. The high density of steel severely limits its use in aerospace applications, and while titanium is less dense, it is expensive and costly to process. Thus, replacement of these metals by organic polymeric composites would effect substantial weight, cost, and energy savings, and improve performance. In addition to their limited temperature capability, conventional composite matrices suffer such shortcomings as complicated logistics of handling due to low temperature storage requirements of the prepregs, poor processability, brittleness, significant knock-down factors due to water absorption and reduction in the glass transition temperature (T_g), and delamination resulting from water penetration into the interface between the matrix material and the reinforcing fiber. The chemical principles used in the successful design of the phthalonitrile resins appear to have yielded a breakthrough in the desired performance, processing, shelf-life and cost characteristics, setting the stage for detailed engineering and optimization studies.

Phase I:
- (a) Optimization of conditions for prepregging, sizing and fabrication
- (b) Mechanical, thermal, solvent testing

Phase II:
- (a) Part selection/design
- (b) Tooling fabrication
- (c) Prototype part fabrication

Phase III: Provide detailed engineering and optimization of parameters of detailed parts.

Commercial Potential: The phthalonitrile resins will provide advanced materials to meet numerous Naval needs for lightweight, high-performance and advanced aircraft, missiles, and marine vessels; engine component applications; heat resistant and flame resistant composite components for usage in the vicinity of an aircraft engine; intrinsic electrical composite conductors as EMI shields and RAM for aircraft and marine applications; high temperature molding materials for the fabrication of electronic devices; and temperature sensors. The phthalonitriles have projected low cost in high volume commercial-scale production. The phthalonitrile-prepolymer is presently being produced at the pilot-scale level and can be purchased for $150/lb.

N94-116 TITLE: Focal Plane Array Radar Experiment

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Conduct test of pattern detection potential of 94 Ghz focal plane array radar incorporating existing airborne instrumentation.

DESCRIPTION: A MMW array of receiving elements placed in the focal plane of a MMW lens is analogous to IR and video cameras. Each element of the focal plane detector surface defines one of many "beams" simultaneously receiving energy scattered (or emitted in a passive mode) from the corresponding directions. Focal plane array elements suitable for the active/passive concept have already been demonstrated [1] in the form of a 1" square, 4X4 element "tile" on monolithic GaAs. An array of such tiles would be placed in the focal plane of a 2 to 3 foot Rexolite lens. In the active mode, an EIO transmitter illuminates the set of .2 degree beams with 10 us pulses at about 1000 per second. Energy received at each element is range-gated and integrated for an exposure time slightly less than the normal 1/30 second TV frame interval. Stored video will be conventionally sampled and displayed on a TV monitor.

It has been shown [2] that reliable, real-time detection of important target patterns can only be accomplished by such a radar. Although the cost of a focal plane array radar will eventually be comparable to conventional radars, hard evidence of

this claim is needed prior to model development.

Phase I: A 4-month study will result in a test plan involving airport runways, ship wakes, and other topology typical of militarily important targets. The study will also focus on computer models to provide means for extrapolating single-beam experimental data to expected multiple-beam images of a focal-plane array radar.

Phase II: At least one light twin-engine aircraft with suitable 35 Ghz and 94 Ghz instrumentation is known to exist. Side-looking 94 Ghz radar video will be recorded for important target configurations; conventional video from the same targets will be recorded with the radar in the scanning mode for comparison.

Phase III: Results of the test will be analyzed and assembled with supporting data from earlier similar experiments at X-band. About 8 months should be adequate for Phase II and III.

Commercial Potential: All-weather landing monitors are of interest to commercial airlines.

References:
1. W.M. Waters, "Monolithic GaAs Antenna/Detector Array for 94 Ghz Imaging", 1992 NRL Review, p.162.
2. W.M. Waters, "Airborne Target Pattern Detection", (In review, IEEE, AESS), Oct 1992
3. M.A. Dornheim, "MMW Radar Shows Commercial Utility", Aviation Week, Nov 2, 1992, pp.55-59

N94-117 TITLE: Tunable (UV to IR) Narrow Band Filter

CATEGORY: Research; Sensors

OBJECTIVE: Develop a narrow band, tunable filter with high out-of-band rejection that can be manufactured over a wide range of the spectrum, for detection of optical signatures in the space, terrestrial and laboratory environments.

DESCRIPTION: Emission spectra can provide essential information about radiating objects (e.g., the sun, earth, laboratory plasma), providing that specific diagnostic lines can be suitably isolated. Narrow band optical isolation filters are needed for this. Most such filters are the Lyot type, manufactured in Germany from optical calcite, the sole existing source for which is the Nanking Optical Works in China. Aside from the lack of a US source, the Lyot filter has other shortcomings. It is complex, fragile and limited to the 5000 to 8000 Angstrom bandpass. As well, side-band suppression is not always adequate. Utilizing holographic or other modern optical techniques, it should be possible to develop a narrow band filter with a bandpass as narrow as 0.125 Angstrom that could be manufactured for use at any wavelength in the region from the UV to the IR, tunable for at least 1 Angstrom about the central wavelength. Furthermore, it should be relatively small, lightweight and sturdy, constructed of material that can withstand long exposure to the space environment and is relatively insensitive to vibration. Wavelength stability should be better than 0.05 Angstrom, and peak transmission at least 10%.

Phase I: Develop a concept/breadboard filter as described above with tunability at red wavelengths. Demonstrate that the capability can be extended to the ultraviolet spectral region.

Phase II: Develop the techniques to fabricate the required narrow band, tunable filters at multiple wavelengths across the spectrum. Fabricate the filter(s) into a small, robust package for field deployment, including in the vacuum environment. Demonstrate long term stability in wavelength and performance under harsh operating conditions, and over long periods of operation.

Phase III: Transition to a commercial device that can be easily deployed for a wide variety of optical sensing applications, such as in solar and terrestrial observatories, as well as optical fiber laboratories.

Commercial Potential: Filters of this type have important applications in fiber optic communication, where narrow bandpasses make possible multi-channel communication. There is a need to establish a US source of these filters for scientific and commercial application, since no such source is now available.

N94-118 TITLE: Integrating Diamond UV, X-ray and Particle Detectors.

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Develop device structures using diamond as an active electronic material that allow the fabrication of integrating 2 dimensional imagers similar to silicon CCD's but designed around diamond's strengths and weaknesses.

DESCRIPTION: Diamond based sensors for UV, X-ray, and particle detection promise to deliver high quantum efficiency in these regions without suffering the dark current, radiation damage, contamination susceptibility, visible light sensitivity,

and mechanical fragility of silicon detectors. Such sensors are useful in scientific and military missions as well as medical and industrial applicatic 's. Great progress has recently been made in the growth of diamond and in the fabrication of electronic devices in natural and synthetic diamond. Solar blind, low dark current response has been observed in diamond photoconductors, and integrating photoresponse has been seen in diamond MIS devices. However, diamond suffers from a lack of shallow dopants.

It also lacks a native oxide. This facilitates stable, VUV detection but makes it difficult to fabricate high performance charge transfer devices.

Phase I: Describe a diamond device that performs one function required for the construction of an integrating imager-ie photosite, storage well, pixel readout technique, etc. Conduct a study using computer simulation or laboratory demonstration as appropriate to determine the expected performance of the proposed device. Provide a schematic of a complete imager design that would incorporate the proposed device. Perform a comparison to known competing designs. Designs which are inherently incapable of exceeding silicon devices in at least one parameter or cannot be integrated into an imager design will not be considered.

Phase II: Fabricate the structure studied in phase I along with any required support devices to demonstrate that the expected performance can be achieved. Characterize the device with quantum efficiency measurements in the relevant spectral region or electrical measurements as appropriate. Deliver several devices to NRL for further study along with a report describing possible complete imager designs.

Phase III: Design and fabricate an imager using methods developed in Phase II. This imager should be useful for scientific or industrial applications and should have at least some of the following attributes: more than 100x100 pixel arrary size, pixel size less than 50 microns, negligible dark current and visible light response, quantum efficiency over 20% in the region of interest (not necessarily the entire UV, X-ray, particle spectrum), dynamic range $ > 1000:1$, fabricated in currently available synthetic diamond.

Commercial Potential: The requested imager has great potential for use in X-ray imaging for industrial and medical applications. Closely related products include diamond DRAM's that are similar to silicon DRAM's but require no refreshing and hence, consume less power.

N94-119 TITLE: Affordable Phased Array Radar for Ship Self Defense

CATEGORY: Exploratory Development; Sensors

OBJECTIVE: Develop an affordable phased array radar for short-range air-defense using the principles of a Diode Lens (Bulk Phaseshifting)

DESCRIPTION: Under the ONR Surface Surveillance Block (RL1B), NRL is investigating the applications of affordable phased array technology for short-range air defense. A planar phased array for scanning in one dimension is currently being assembled. A promising method for adding two-dimensional scanning in an affordable manner is the incorporation of a diode lens in front of the one-dimensional-scan phased array. To reduce the size, weight, cost, insertion loss and to increase its bandwidth of the diode lens, a research study should be performed.

Phase I: Conduct a 6 month study of risk reduction associated with diode lens antenna. The risk reduction objectives are (1) Reduce the size, weight and insertion loss of the diode lens (2) Increase bandwidth of the diode lens. To reduce the size, weight, cost and insertion loss of the diode lens, a research study should be performed to increase the maximum phase shift per diode strip to 45 degrees (It is presently 22.5 degrees) and increase the spacing between diode strips.

Phase II: For an affordable phased array radar, the combination of a diode lens (to scan in the elevation plane) and a slotted waveguide array with a high power phase shifter associated with each column (in order to scan the beam in the azimuth plane) should be integrated. Thus, in phase II a diode lens will be built, integrated, and tested with NRL's 6.2 ONR radar.

Phase III: Low-altitude, low-observable, anti-ship missiles are a serious threat to the U.S. surface Navy. NAVSEA has recently created a new program office (NSEA-06D) to deal with this problem. An affordable phased array will help solve these problems.

Commercial Potential: The technology has application in the private sector in Air Traffic Control.

N94-120 TITLE: Cavity-type Radiometer (UV to Far IR) System for High Precision Sensing

CATEGORY: Research; Sensors

OBJECTIVE: Utilize state-of-the-art, cavity-type radiometers to develop a sensing system with spectrally flat, linear response, high stability and high sensitivity for high precision long term monitoring.

DESCRIPTION: The energy balance of the terrestrial environment depends on the incoming solar radiation and outgoing terrestrial radiation. Environmental changes may result from very small (tenths percent) changes in total incoming solar radiation or from larger (few percent) changes in incoming ultraviolet radiation. Small changes in energy balance over long periods of time must be detected independently of instrumental drifts. State-of-the-art cavity, electrical-substitution radiometers have been developed that promise to achieve this, but they have yet to be integrated into an operational, robust system for field use on remote platforms.

Phase I: Develop a concept/breadboard radiometric sensing system with flat spectral response from the UV to the far IR, capable of reliable long term monitoring. The radiometer sensitivity should be significantly increased over existing cavity-type radiometers. Ultraviolet filters to use with the radiometer s should be identified and incorporated into the system design, and have high out-of-band blocking when the sensor is illuminated with solar radiation.

Phase II: Fabricate the radiometric sensing system by combining a number of the radiometers and ultraviolet filters (for redundancy), into a small, compact,robust sensing device which requires modest resources, is suitable for field applications that may include ground or space deployment, in both vacuum and ambient environments, and that maintains its precision after extensive operation.

Phase III: Transition to a commercial instrument that can be easily deployed for a wide variety of radiometric sensing applications.

Commercial Potential: High-sensitivity, stable, radiometers that operate with flat response over a wide spectral region are needed as laser power meters to accurately measured the output of low-power (milliwatt) diode and gas lasers. They are also are needed to accurately and efficiently measure the emittance from material surfaces, in the production of various coatings and surfaces. A reliable, robust radiometric standard has commercial application in transferring NIST calibration standards to laboratory and field sites. Thus this small, robust radiometric sensor has dual-use application.

NAVAL PERSONNEL RESEARCH AND DEVELOPMENT CENTER

N94-121 TITLE: Human Performance Feedback Network

CATEGORY: Advanced Development; Communications Networking

OBJECTIVE: Develop a performance feedback network for the aggregation and reporting of human performance data.

DESCRIPTION: Measures of Effectiveness (MOE) are quantitative expressions of how well an item of equipment or system performs in a combat role. Though humans play a critical role in the successful functioning of complex Navy systems, measures for assessing their ability to function as part of the system are often ignored. Current Navy research is focused on correcting this problem. However, the collection of human performance data is only one aspect of the problem. A means to aggregate the data and a communications network which rapidly transmits data in a useable form to training and operational commands is required.

Phase I: Conduct a 6 month study to determine the feasibility of developing a feedback network which rapidly provides human performance data to both Navy training and operational commands.

Phase II: Develop a prototype communications network which rapidly provides human performance data to both Navy training and operational commands.

Phase III: The prototype communications network will be transitioned to operational use. Options for commercialization of the network for the private sector will be available.

Commercial Potential: This technology will be readily transferable to either civilian vocational schools or industry for data networking purposes.

N94-122 TITLE: Systems for Producing Readable Technical Text

CATEGORY: Exploratory Development; Training Devices

OBJECTIVE: To develop a computer-based system to aid writers of technical documentation, such as training materials and

technical manuals, to produce optimally clear and readable materials. The system would integrate several systems recently proven to be effective by research, into a single system operating on a standard PC.

DESCRIPTION: The Navy and other services have supported considerable research investigating how to improve the readability of technical documentation to enhance user comprehension. This includes the work of Thomas Bever (U. of Rochester) on text formatting, David Kieras (U. of Michigan) and Bruce Britton (U. of Georgia) on computer-based text critiquing systems, and George Miller (Princeton U.) on the lexical WordNet database and associated 'filter' that tells the writer when rare and unfamiliar words are being used. These systems represent a considerable advance over current commercial software because they are based on the latest cognitive and linguistics theory. Now, they can be incorporated into a single, user-friendly, system for writers. Since current standards for technical documentation often require the use of a readability formula, the system should also incorporate the capability to compute an accepted readability formula. The contractor should have expertise in computational linguistics and HCI interface design.

Phase I: Based on an assessment of the existing applications, design a system to aid writers and demonstrate insofar as possible by linking together existing software. System design should consider the following design issues: (a) -Design of the writer's interface; (b) -The optimal type of feedback to writers that affects text usability; (c)-Providing writers the option and the rationale for choosing between an approach (e.g., Kieras) which requires conforming to language that the system can parse, or an approach (e.g., Britton) that aids writers to do a similar manual analysis of their text; (d) -How to advise writers about preparing text for readers' cognitive strategies; (e) -How writers can use readability scores in conjunction with other system facilities to improve writing.

Phase II: Build integrated system and make available to Navy for testing by authors of training materials. Conduct a test and evaluation.

Phase III: Make the system available for preparation of technical text materials. Commercialize for use in 1 -preparing industrial training/technical materials and materials for civilian educational use.

Commercial Potential: The technology has potential for transfer to educational systems, commercial training, and publishing technical material in general.

N94-123 TITLE: Damage control training in a Virtual Environment

CATEGORY: Advanced Development; Training Devices

OBJECTIVE: Demonstrate techniques for integrated Damage Control (DC) team training in a Virtual Environment

DESCRIPTION: The skills for recovering from a shipboard casualty when under attack are critical to the survival of the ship. Training these skills is difficult since integrated team practice for Damage Control, Engineering, and Combat Systems personnel in a shipboard environment is not performed on a regular basis, and is not an experience that can be practiced to improve performance. Virtual environment technology may be suited for training teams in a simulated dangerous shipboard environment. The demonstration must support multiple participants experiencing a mass conflagration situation, real-time instructor intervention, and embedded instructional techniques.

Phase I: Relate VE techniques to existing multimedia and instructional system development techniques to determine the methods of developing and evaluating team skills in a virtual environment. Identify the strengths and weaknesses of the VE approach, and estimate the options and relative difficulty of each aspect of the approach. Develop system specifications for a prototype VE capability for TSS team training.

Phase II: Develop a prototype Virtual Environment Damage Control training scenario and evaluate its training effectiveness. The scenario must allow students to experience the consequences of their decisions, and should, with practice, improve their responses to rapidly changing Damage Control, Engineering, and Combat Systems events.

Phase III: The prototype VE training system will be integrated into a Damage Control training course.

Commercial Potential: The technology has application in the private sector for police, fire, and emergency disaster training.

AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Materiel Command Deputy Chief of Staff for Science & Technology. The Air Force SBIR Program Manager is R. Jill Dickman. Do NOT submit SBIR proposals to the AF SBIR Program Manager under any circumstances. Inquiries of a general nature or problems that require the attention of the Air Force SBIR Program Manager should be directed to her at this address:

Department of The Air Force
HQ/AFMC/STXB (AF SBIR Program Manager)
4375 Chidlaw Rd
Suite 6
Wright-Patterson AFB OH 45433-5006

No additional technical information (this includes specifications, recommended approaches, further refinement, the limiting of topic areas, and the like) can or will be made available by Air Force personnel during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Information is key to successful proposal preparation and research; however, locating pertinent information is often difficult. For this reason the DoD SBIR Program is working on better ways to serve the small business community with information support. In this solicitation Phillips Laboratory is participating in a pilot reference information project by supplying, in most cases, up to 5 technical references that provide background or insight to the topic. Additional references are available for each topic in the Technical Information Packages (TIP) prepared by DTIC. Please refer to section 7.1 in this solicitation for further information on DTIC.

The maximum amount of SBIR funding used for any Air Force Phase I award shall be $60,000. Also firms are encouraged to submit a proposal for an option task which would be performed during the period between Phase I completion and Phase II contract award not to exceed $20,000. The basic Phase I proposal shall be evaluated exclusive of the option task and must therefore be proposed and priced separately. Any option proposal must be submitted at the same time and place as the basic Phase I proposal and shall not be included in the basic Phase I limitation to not exceed 25 pages. The option shall detail work that would logically transition a feasibility determination during Phase I into a practical application during Phase II. The transition work shall be included as an option in the Phase I contract and evaluated for unilateral Air Force exercise at any time after Phase I award through the conclusion of the Phase I contract reporting period. Exercise of any option shall be at the sole discretion of the Air Force and shall not obligate the Air Force to make a Phase II award. It is anticipated that the option portion of the proposal shall be 10 pages or less, not exceed $20,000, not exceed 3 months in duration, and be evaluated using the same evaluation criteria as for Phase I. Any resultant Phase I contract containing an option shall include a provision that sets forth the Air Force right to obtain the option effort at the previously agreed to price by providing written notice of same on or before the conclusion of the Phase I contract reporting period.

PROPOSAL SUBMISSION INSTRUCTIONS

For each Phase I proposal, send one original (with red appendices A and B) and three (3) copies to the office designated below. Also, send an additional set of red appendices A and B, which are not stapled or mutilated in any way. Be advised that any overnight delivery may not reach the appropriate desk within one day.

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS (Name and number for mailing proposals and for administrative questions)	CONTRACTING AUTHORITY (For contractual questions only)
AF94-001 thru AF94-006	Arnold Engineering Development Center AEDC/DOTP Arnold AFB TN 37389 (Kevin T. Zysk, (615) 454-6507)	Dowe Jones (615) 454-4423
AF94-007 thru AF94-013	Air Force Office of Scientific Research AFOSR/XPP (Chris Hughes) 110 Duncan Avenue, Suite B115 Bolling AFB DC 20332-0001 (Chris Hughes, (202) 767-5015)	Harry Haraldsen (202) 767-4990
AF94-014 thru AF94-036	Armstrong Laboratory AL/XPTT 2509 Kennedy Circle Brooks AFB TX 78235-5000 (Belva Williams, (512) 536-2838)	Sharon Shen (512) 536-9393
AF94-037 thru AF94-068	Rome Laboratory RL/XPX 26 Electronic Parkway Griffis AFB NY 13441-4514 (Robert Falk, (315) 330-2912)	Mary Lovett (315) 330-2804
AF94-069 thru AF94-078	Phillips Laboratory - Space & Missile Technology Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Room 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Roger Shinnick (505) 846-5935 Ext 147
AF94-079 thru AF94-083	Phillips Lab - Advanced Weapons & Survivability Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave. S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Rudy Fourzan (505) 846-6877

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
AF94-084 thru AF94-092	Phillips Laboratory - Rocket Propulsion Directorate OL-AC Phillips Laboratory/TO (Attn: Ms Sandra Borowiak) 5 Pollux Dr., Bldg 8419 Rm 12 Edwards AFB CA 93524-7048 (Ms Sandra Borowiak, (805) 275-5617)	Ms. Donna James (805) 277-8813
AF94-093 thru AF94-098	Phillips Laboratory - Geophysics Directorate OL-AA Phillips Laboratory/XPG 29 Randolph Rd, Bldg 1107 Rm 240 Hanscom AFB MA 01731-3010 (Noreen Dimond, (617) 377-3608)	Mr. John Flaherty (617) 377-2529
AF94-099 thru AF94-105	Phillips Lab - Ballistic Missile Organization PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave. S.E. Kirtland AFB, NM 87117-5776 (Ms Della Hinesley, (714) 382-5371 or Bob Hancock, (505) 846-4418)	Mr. Roger Shinnick (505) 846-5935 Ext 147
AF94-106 thru AF94-113	Phillips Laboratory - Lasers & Imaging Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Dave Tuttle (505) 846-8133
AF94-114 thru AF94-115	Phillips Lab - Operations And Plans & Programs Directorates PL/XPI (Attn: Bob Hancock) Bldg 497 Room 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Maj Ron Unruh (505) 846-1346
AF94-116 thru AF94-118	Phillips Laboratory - Space Experiments Directorate PL/XPI (Bob Hancock) Bldg 497 Rm 236-B 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Maj Ron Unruh (505) 846-1346
AF94-119 thru AF94-133	WL/AAOP Bldg 22 2690 C St, Ste 3 Wright-Patterson OH 45433-7410 (Sharon Gibbons, (513) 255-5285)	Terry Rogers or Bruce Miller (513) 255-5830

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
AF94-134 thru AF94-141	WL/ELA Bldg 620 2241 Avionics Circle Ste 29 Wright-Patterson, OH 45433-7331 (Howard Romaker, (513) 255-6723)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-142 thru AF94-157	WL/FIOP BLDG 45 2130 Eighth St, Ste 21 Wright-Patterson, OH 45433-7562 (Madie Tillman, (513) 255-5066)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-158 thru AF94-172	WL/MLIP BLDG 653 2977 P St Wright-Patterson, OH 45433-6523 (Frank Borasz, (513) 255-7175)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-173 thru AF94-187	WL/POMX Bldg 18 1921 Sixth St Ste 5 Wright-Patterson OH 45433-7650 (Betty Siferd, (513) 255-2131)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-188 thru AF94-192	WL/MTX BLDG 653 2977 P St, Ste 6 Wright-Patterson, OH 45433-7739 (Timothy Swigart, (513) 255-7363)	Terry Rogers or Bruce Miller (513) 255-5830
AF94-193 thru AF94-198	ASC/XRP, Bldg 56 2100 Third St Ste 2 Wright-Patterson OH 45433-7016 (Fred Strawn, (513) 255-6673)	Arnette Long (513) 255-6134
AF94-199 thru AF94-204	Wright Laboratory - National Aerospace Plane ASD/NAF Wright-Patterson OH 45433-6523 (Dr. Kervyn Mach, (513) 255-1858)	Cathy Doyle (513) 255-9637
AF94-205 thru AF94-226	Armament Directorate WL/MNPB 101 West Eglin Blvd, Suite 143 Eglin AFB, FL 32542-5434 (Richard Bixby, (804) 882-8591	Lyle Crews, Jr (904) 882-4284
AF94-227 thru AF94-235	ASC/SMEM, Bldg 22 2690 C St, Ste 5 Wright-Patterson AFB, OH 45433-7412 (Bob Andes, (513) 255-3442)	

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AIR FORCE TOPIC DESCRIPTIONS

AF94-001 TITLE: Rain Erosion For Engine Airframe Component Testing

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a technique to simulate erosive rain environments for testing of aircraft components and materials.

DESCRIPTION: Liquid water in the form of droplets on the order of one to one-and-a-half millimeters in diameter can exist in the atmosphere. Aircraft encountering these drops can be subject to erosion of forward facing surfaces. A facility that can provide a sustained simulation of erosive rain is needed. The goal of this effort should be to conceptualize and develop a technique to achieve erosive rain simulation in a test facility at the Arnold Engineering Development Center. The simulation should be applicable to a 12 to 18 inch diameter freejet test facility. The simulation should cover flight speeds in the subsonic regime from Mach 0.3 to 0.9. The simulation technique must be expandable to facilities where larger test articles can be tested. The facilities envisioned are on the order of three to four feet in diameter at the test section.

Phase I: Phase I should identify the governing parameters of subsonic erosive rain simulation. A technique to simulate the erosive rain should be conceptualized and demonstrated on a subscale basis.

Phase II: Phase II should result in the hardware and a technique needed to provide realistic erosive rain simulation in AEDC test cells.

Dual Use Commercialization Potential: This project has commercial applications in the development of advanced materials and abrasion resistant coatings. Derivative technologies may be applicable to cleaning or machining industries.

AF94-002 TITLE: Smooth Ultrahard Coatings On Metals

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a technique to produce smooth ultrahard surfaces on machined metal surfaces.

DESCRIPTION: Arc heater segments fabricated from oxygen free high conductivity copper (OHFC) need an effective means of dissipating high heat flux loads from the inner bore surface while maintaining electrically non-conducting surfaces. Surface coatings that equal or exceed the heat transfer characteristics of the substrate of the arc heater segments and that are electrically non-conductive are needed. The use of smooth ultrahard thin films without any intermediate bonding material offers the potential to meet these needs. Mechanical loading of the segments (compressive stress) and thermally induced movement require any coating to be compliant with the copper substrate. The extremely high arc temperature (above 15,000K) and high pressure air (200 atmospheres) combine to form a highly oxidizing environment. Conventional thin film application methods result in a rough surface that is subject to high temperature oxidation and is a source of microcracks that weaken the coating. A coating surface that is smooth on the nanometer level will be resistant to oxidation and have a reduced number of microcracks making it less susceptible to brittle fracture.

Phase I: Phase I should demonstrate a technique to produce smooth (on a nanometer level) ultrahard coatings on conventionally machined OFHC and optimize the coating parameters.

Phase II: Phase II should result in a prototype system for use in producing smooth (on the order of nanometers) ultrahard coatings on arc heater segments fabricated from OFHC and on other metallic substrates.

Dual Use Commercialization Potential: This project has commercial applications in high speed optoelectronic switches for computers and communication, optical and electronic sensors, optical windows, optics used in lasers, moving mechanical devices (bearings and linear actuator devices), analytical instrumentation, and improved resolution of optics for eyeglasses.

AF94-003 TITLE: Non-Intrusive Measurements of Inlet Airflow Parameters For Ground Testing of Turbine Aircraft Engines

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop techniques to measure inlet flows during ground testing of turbine aircraft engines.

DESCRIPTION: This is a synopsis of the actual description. Submitters need to respond to the actual description which can be found in the technical information package available from the DTIC for this topic number. (See section on scientific and technical information in the DoD program description elsewhere in this booklet.) Should there be a difference in interpretation between this synopsis and the actual description, the latter will govern. In the ground testing required in the development of both military and commercial turbine engines there is a need to measure essential parameters of the airflow distributions entering engines at the compressor face in ways that do not disturb these flows. The flows are atmospheric air. There is to be no flow "seeding" of any kind: No addition of gas, liquid, or solid in even minute amounts. The measurements are to be made through the sides of a circular duct delivering air to the compressor face of an engine under test. The measurement apparatus is to be non-intrusive: there can be no material protrusion into the ducts in which measurements are to be made. Any transparent material used in the wall of the duct must maintain the smooth circular interior surface of the duct. Individual proposals are to be submitted to address the individual sub-topics (specify subtopic by letter) except if it is a selling point that one instrument system can address more than one of the following subtopics. a. Structure of the time-averaged velocity of the inlet distorted flow field at the compressor entrance face is required to meet vital aero-mechanical needs. b. Measurement of rapidly fluctuating velocity components in the inlet flow at the compressor entrance face is required for engine operational stability testing. c. Airflow density distribution at the compressor entrance face is required for performance determination. d. Airflow static-temperature distribution at the compressor entrance face is required for performance determination. e. Mass flow in the boundary layer of the duct. The entrance to the duct is bell shaped and near. The mass flow in the duct boundary layer, which is typically transitioning, is needed. Only this measurement could gain optical access from upstream of the duct entrance.

Phase I: Phase I should perform the analysis required for instrument development and demonstrate the principle of operation in a subscale laboratory environment.

Phase II: Phase II should produce a prototype instrument capable of operating for at least 8 hours and up to 30 hours without personnel attendance.

Dual Use Commercialization Potential: This project will have use in ground test facilities involved in commercial and military turbine aircraft engine development.

AF94-004 TITLE: Room Temperature Infrared Focal Plane Array Imaging Radiometer

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop an instrument that operates at room temperature and makes high resolution imaging measurements in the infrared (IR).

DESCRIPTION: Current IR focal plane arrays (detectors) require cooling to cryogenic temperatures to function properly. AEDC has a need for an imaging radiometer (camera) based upon a room temperature focal plane array (FPA) that will operate in the 2 - 15 micron spectral range. The FPA should have at least 256 X 256 pixels with a high degree of uniformity and sensitivity adequate to be used at video rates and provide discrimination of 0.1 degree C at room temperature. The system should operate in hostile environments; the FPA should be insensitive to high noise levels and vibrations as might be experienced in harsh test cell applications.

Phase I: Phase I should provide the concept and demonstrate the availability of an appropriate FPA (detector).

Phase II: Phase II should result in a prototype system for use in AEDC test cell applications.

Dual Use Commercialization Potential: This project has commercial applications in all instrumentation which make IR radiation measurements (thermal imaging, spectrometers, radiometers, intrusion alarm systems, etc.).

AF94-005 TITLE: Fast Response Balance

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a balance system with a fast response (high natural frequency) and a high sensitivity (low natural frequency).

DESCRIPTION: A new area of fluid dynamic phenomenon needing investigation is non-steady-state flight. This requires the ability to make measurements of small high-frequency or transient loads. Re-entry vehicles using pulsed jets for control, fighter aircraft wanting enhanced point and shoot capability, and vehicles maneuvering in space near other vehicles need fast response balance measurements for their operating systems. Such measurements require a balance system with a fast response (high natural frequency) and a high sensitivity (low natural frequency). A traditional strain gage balance can not be made sensitive enough to measure small loads of less than a pound-force (lbf) accurate to within 5% and also have a natural frequency of 100 hertz (Hz). This project will develop a three component (normal force, pitching moment, and axial force) fast response balance that has a 0 to 10 lbf load range accurate to within 5% and a natural frequency range of 10 to 100 Hz. The balance must also be less than two inches in diameter, less than six inches long, and support at least 200 lbf of normal force.

Phase I: Phase I should develop the concept for the fast response balance and demonstrate at least two (normal and pitching) components of the balance in a laboratory environment.

Phase II: Phase II should provide a prototype six degrees of freedom component fast response balance for use in AEDC test cells.

Dual Use Commercialization Potential: This project has commercial use in applications requiring vibration monitoring. It will be valuable for vibrational analysis of rotating machinery.

AF94-006 TITLE: Long Taper Hone

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Industrial Production

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a device that can hone bores with a taper over lengths up to 100 feet.

DESCRIPTION: A device is needed that can efficiently hone bore diameters of between 2.50 inches to 3.50 inches with a taper ranging from 0.30 - 0.100 inches over bore lengths up to 100 feet. Small discrete steps are permissible but not desirable. The device should have the capability to either continuously monitor the bore diameter or measure it upon command without lengthy interruption of the honing. The device should be compact and be easily removable so that it does not interfere with normal operations. It should provide substantial savings in time over the current method in use; e.g., 40 hours for a honing taper of 0.045 inches.

Phase I: Phase I should develop the concept for the hone and demonstrate the concept on a 10 foot length of steel tubing with a bore of at least 2.5 inches.

Phase II: Phase II should result in a fully functional device for use at AEDC.

Dual Use Commercialization Potential: This honing device will have commercial application in the precision machining of short and long tubular products.

AF94-007 TITLE: User-friendly Microcomputer Interface with Optimization Languages

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop an interface between microcomputer software and powerful optimization languages

DESCRIPTION: Mathematical optimization has been increasingly used since the late 1940's to improve the efficiency of large-scale logistic operations. Now the microcomputer and user friendly software are beginning to bring this tool to the individual user in the field, which has tremendous implications for improved efficiency at all levels. Although initial implementations of mathematical optimization in the spreadsheet environment have found widespread use, they are limited by deficiencies of this environment: inability to scale smoothly with data, inability to expand in dimension, and difficulty of model documentation. Existing modeling languages that overcome these deficiencies such as GAMS, AMPL, and LINGO are too cumbersome for typical users. The introduction of a new class of multidimensional spreadsheet by two major software firms, Improve from Lotus Development Corp. and Compete from Computer Associates, appears to overcome these drawbacks and enable the development of software that is both mathematically powerful and usable by people who are not technically trained.

Phase I: The project will develop software to translate a model in Improve or other comparable software into one or more of the mathematical modeling languages cited above and to return the results of the optimized model to the underlying modeling language.

Phase II: Improve or other comparable software will be extended to be functionally equivalent to one or more of the languages above. Alternatively, new software combining the properties of a multidimensional spreadsheet and a special purpose language for the specification of mathematical programs can be developed. The resulting software should contain additional modeling capabilities such as the automatic generation of statements involving logical variables and the ability to develop network models through the manipulation of graphical objects.

Phase III: Optimization software will be bundled with advanced spreadsheets and commercialized as is the case today with Excel and Lotus optimization "solvers".

Dual Use Commercialization Potential: As conceived, the end product will be a powerful analytical tool with wide applicability in the commercial and military markets.

AF94-008 TITLE: Low-Cost Robotics Research Platform

CATEGORY: Basic Research

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop low-cost anthropomorphic robotics research and development tool

DESCRIPTION: Agile, anthropomorphic robots have many potential applications in the military and commercial sectors. Application examples include: automated supply operations, aircraft bomb loading, industrial operations in environments hostile to humans, precise surgical intervention, and support of quadriplegic. Robotics research is generally regarded as costly in terms of money, time, and experience. Thus many research and development teams are deterred from performing much need work in this key area. The intent of this project is to build a general purpose robotics research device which can be easily interfaced to existing workstations and microcomputers. Of particular interest is a complete system with a simple interface and real-time command shell that can be remanufactured at low cost for use in multiple university research projects. Each component should be developed in a way that guarantees the greatest flexibility with future modifications. The effort would include development of the device, interfacing, and the development of a sample controller.

Phase I: Identify the design of the total system. Prototype the interface, software, and a single physical subsystem. Demonstrate closed-loop control of that subsystem.

Phase II: Develop the complete anthropomorphic system. Quantify the system's utility by demonstrating, installing, and evaluating use at government, industrial, and university sites.

Phase III: Finalize the system using lessons learned from the Phase II research; manufacture and market the final product.

Dual Use Commercialization Potential: The general-purpose robotics device will provide universities, industrial firms, and government organizations with an affordable research and development tool.

AF94-009 TITLE: Remote Atmospheric Sensor System

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop improved systems or techniques for remotely sensing the atmospheric environment.

DESCRIPTION: The Air Force is interested in advanced techniques for surface-, airborne-, and/or satellite-based remote sensing of the troposphere and stratosphere. It is particularly interested in more accurately determining the vertical profiles of temperature, pressure, winds, water vapor, and aerosols at higher spatial and temporal resolutions. Current operational systems are inadequate to support the expected mesoscale numerical weather prediction models of the future. Rawinsondes are too infrequent and too far apart geographically, and satellite soundings are too inaccurate. New methods will be needed to support battlefield and

relief operation forecasts anywhere in the world, even where conventional weather observations may not be available.

Phase I: Conceptualize and design new system/techniques for the remote sensing of the atmosphere.

Phase II: Build a prototype system and then perform laboratory or field experiments to test the Phase I design.

Phase III: Refine the new system and then market it to government agencies and the commercial sector for deployment aboard weather satellite or ground-based platforms.

Dual Use Commercialization Potential: Many government and commercial operations are dependent upon an accurate knowledge of atmospheric conditions. Commercial aviation strives for increased fuel economy and passenger comfort through computer-generated flight plans that factor in weather conditions. Governments are interested in issuing accurate severe weather warnings and improved atmospheric pollution monitoring. Agricultural application of herbicides and insecticides is highly dependent on accurate weather forecasts. World-wide markets exist for the instrumentation and techniques resulting from this research effort.

AF94-010 TITLE: Opto-Electronic Components from Non-Stoichiometric III-V Materials

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Explore applications of highly non-stoichiometric GaAs and related materials for opto-electronic components, devices and subsystems.

DESCRIPTION: It has been shown that GaAs grown via molecular beam epitaxy (MBE) at unusually low growth temperatures has unusual and potentially useful structural, electronic, and optical properties. The unusual properties include an excess of arsenic, high resistivity, high dielectric breakdown fields and very fast photo-induced carrier recombination times. This growth approach has been applied with varying success to other III-V binary and ternary compounds. Opto-electronic demonstrations include ultrafast photocunductive switches and optical waveguide structures. This project seeks new, promising concepts in which these materials are used in opto-electronic structures and devices. Applications include, but are not limited, to the examples given above. The monolithic integration of electronic and opto-electronic functionalities is encouraged.

Phase I: The feasibility of the concept should be demonstrated through modeling and/or processing and fabrication.

Phase II: The concept should be carried to the point of demonstrating military/commercial potential and producibility.

Phase III: Develop the controlled manufacturing process procedures, including repeatable growth techniques and reliable fabrication techniques including delineated growth or isotropic etch of arbitrary patterns. Specific devices should result that are manufacturable at competitive cost for marketable applications.

Dual Use Commercialization Potential: The end product should have great potential to serve as a key component in communication and sensing systems with applications in the military and commercial sectors of the market place.

AF94-011 TITLE: Compact Light Sources Based on Non-Linear Optics

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop efficient, compact, moderate power, coherent, visible or infrared light sources using nonlinear optical techniques.

DESCRIPTION: Many important uses exist for compact, efficient, coherent light sources. Such energy sources have, for example, applications in high density data storage and in large area display devices. A variety of promising demonstrations have shown that nonlinear techniques such as second harmonic generation, sum frequency generation, and up conversion of existing laser sources are capable of providing such sources. This program seeks to demonstrate all of the elements required to make practical, economical sources, using these or any other nonlinear optical techniques.

Phase I: Develop detailed designs and show feasibility of critical concepts.

Phase II: Develop and demonstrate complete prototype light source, and demonstrate it meets goals and specifications originally targeted.

Phase III: Modify prototypes, as necessary, and develop volume manufacturing plans, capabilities, and facilities, and appropriate marketing plans to OEMs and end users.

Dual Use Commercialization Potential: The end product would serve as a key component in data storage devices and in large area displays, both of which are used throughout the civilian economy and in defense applications.

AF94-012 TITLE: Detectors for Hidden Chemical Corrosion

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Development of depot-level instrumentation to indicate chemical corrosion at the nanometer scale.

DESCRIPTION: Because less money is available for new aircraft in post-Cold War budgets, aircraft in the current Air Force inventory will remain in service longer. The commercial airlines are also curtailing the purchase of new aircraft, effectively resulting in aging commercial fleets. In each case the aircraft maintenance community is challenged to ensure the aging aircraft have the requisite structural integrity to meet the stresses imposed by operational conditions. Current logistics efforts by both the Air Force and the Federal Airline Administration (FAA) aim at developing instruments to perform nondestructive evaluation (NDE) of hidden corrosion and material degradation with high degrees of accuracy, sensitivity, and versatility. Understanding the fundamental chemistry of corrosion is essential for designing future instruments for aircraft depot maintenance, along with future aircraft design and construction methods. Research proposals must address the effects of surface chemistry, the atmosphere, and major atmospheric pollutants on the initiation of the corrosion process. Experimental studies of corrosion initiation at the nanometer scale must be correlated with chemical kinetics and macroscopic structural damage parameters of component lifetimes to meet the overall goals of this program. Proposals are sought which address both Air Force and FAA needs.

Phase I: Develop and implement a research effort which better identifies surface regions where corrosion is most likely to occur.

Phase II: Develop improved methods for early corrosion detection and identification of better methods and processes to use for surface modification to prevent corrosion. Develop, test, and refine corrosion detection instruments and associated techniques.

Phase III: Final development, manufacturing, and marketing of an instrument and associated techniques which are capable of detecting the initiation of hidden corrosion in aircraft.

Dual Use Commercialization Potential: The end products of this research would be used by both the Air

Force and commercial airlines for early detection of hidden corrosion in aircraft and aircraft components.

AF94-013 TITLE: Embedded Heat Transfer Sensors for Turbomachinery

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative high temperature heat transfer sensors and arrays for turbomachinery applications.

DESCRIPTION: Unsteady flow phenomena play a central role in gas turbine heat transfer processes. Measurement of unsteady heat flux in turbomachinery is essential to fully understand the basic physics of turbomachinery heat transfer processes. Present sensors are limited in frequency response, spatial area coverage, and range of sensing temperatures. Improved, high temperature microsensors for heat transfer measurements in turbomachinery flows are needed to provide greater area coverage, higher frequency response, and better reliability and affordability than present sensors. This announcement seeks innovative ideas leading to surface heat transfer rate measurement capability at temperatures to 600 degrees Celsius, with sensor arrays providing spatial coverage in the range of 1 to 20 square centimeters, with spatial resolution on the order of 0.1 mm and frequency response to as much as 50 kHz. Ideally, sensor arrays would be embedded, rugged, self calibrating, and self testing.

Phase I: Develop the heat transfer sensor concept. Identify the sensor's critical components and functions. Demonstrate the concept's feasibility by theoretical, computational, or experimental means.

Phase II: Design, fabricate, and test a prototype embedded sensor with performance characteristics approaching those described above.

Phase III: Develop and market operational heat transfer sensor arrays for research, development and control applications in high temperature environments such as gas turbine engines.

Dual Use Commercialization Potential: The end product will have direct applicability to turbomachinery (e.g., jet engines and electric power plant gas turbines) used in both the military and commercial market.

AF94-014 TITLE: Human Systems/Subsystems Research

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: Proposers may submit ideas to enhance human performance as an integral part of Air Force systems and operations. Five directorates perform a full spectrum of basic and applied research including exploratory and advanced development: (Specify subtopic by letter).

a. The Human Resources Directorate conducts research in manpower and force management, training systems, and logistics technologies. The objective is to improve the operational readiness and effectiveness by developing technologies enabling more effective training, selection, assignment, and retention of personnel.

b. The Crew Systems Directorate conducts research to assure optimal man-machine integration. Goals include understanding the limitations of humans to mechanical stresses (noise, vibration, acceleration, and impact), providing design criteria for weapon system development/enhancement, proposing protection devices, and improving human/weapon system interface.

c. The Aerospace Medicine Directorate addresses the medical selection, protection and enhancement of humans in Air Force systems and operations. Mission-related research and specialized operational support are conducted in aeromedical consultation, epidemiology, drug testing, and hyperbaric medicine. Clinical sciences

research is conducted to develop standards for aviator selection and retention.

d. The Occupational and Environmental Health Directorate assesses risks to personnel from hazardous materials, noise, electromagnetic radiation, and occupational processes and conducts research to reduce those risks. The goal is to mitigate impacts on health and to enhance the scientific understanding of the underlying biological mechanisms.

e. The Environics Directorate conducts research on the environmental behavior, transport, and ultimate fate of chemicals in air, soil, or water; advanced containment characterization and pollutant monitoring technology; destruction of pollutants including biodegradation as well as physical chemical means; contamination cleanup technologies; hazardous waste minimization for processes of significance to the Air Force and new and innovative concepts to eliminate, substantially reduce, or mitigate environmental consequences of Air Force operations.

AF94-015 TITLE: Chemical and Biological Warfare Defense Detection and Decontamination Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Chemical and Biological Systems

OBJECTIVE: Develop sensors to detect and identify chemical/biological agents and methodology for biological decontamination.

DESCRIPTION: This requirement is for novel methods to detect and identify highly toxic chemicals and pathogens and technology to decontaminate pathogens. (Specify subtopic by letter)

a. A need exists for a continuous monitor to rapidly identify and warn of the presence of chemical agents in either liquid or vapor phase.

Phase I: Phase I will result in the design and fabrication of a laboratory prototype system which shall demonstrate the proof of principle and detect and identify nerve and blister agents in either a vapor or liquid phase.

Phase II: The Phase II will optimize the detector system, laboratory and field test it against stimulants and at least two agents, and fabricate a breadboard for testing at a designated facility.

Dual Use Commercialization Potential: This technology can be adapted to address the concerns of the environment by including the ability to detect industrially produced hazardous materials and other environmental pollutants. Technology may be applied to on-site monitoring of hazardous materials at industrial or hazardous waste sites or random-site monitoring of environmental pollutants at any location.

b. There is a need to produce a biological warfare detector. An ancillary need is to rapidly ascertain viability and virulence of nonmotile microbes. In order to integrate into currently developing biosensor programs, technology should be based on physical parameters such as optical or electronic assessment of unaltered or tagged microbial samples. Other nonphysics-based technologies for assessment of viability/virulence will also be considered.

Phase I: Phase I will result in design and fabrication of a laboratory prototype system which shall illustrate efficient and rapid evaluation of viability and/or virulence of technology.

Phase II: Phase II will result in production of a prototype device and more in-depth evaluation of the device characteristics.

Dual Use Commercialization Potential: This technology will be useful in environmental protection, clinical diagnostic, and therapeutic areas. Technology can be used for a blood clinical diagnostic system or as a hospital operating room monitor.

c. This requirement is to develop a simple and facile method to rid aircraft interiors and other equipment (which is difficult to decontaminate), of biological threat agents. The optimal technique will involve an inexpensive material and/or device, that will be highly mobile, effective against a wide variety of biological threats, non-toxic to personnel, and rapid, and will not degrade aircraft interior materials.

Phase I: Phase I will result in design and fabrication of a laboratory prototype system which shall demonstrate the proof of principle and a demonstration on a wide range of microbes, viruses, and/or biotoxins.

Phase II: Phase II will require an in-depth analysis of the technology in a real aircraft and large-scale

production of reagents or related analogs with different properties or production of a prototype device for biological decontamination.

Dual Use Commercialization Potential: The technology developed applies to the environmental protection, clinical diagnostic, and therapeutic areas. Technology may be applied for on-site contamination control of industrial contaminants.

AF94-016 TITLE: Human Health Standards for Groundwater Contaminants

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Provide scientifically defensible drinking waterstandards for selected organic contaminants found in groundwater.

DESCRIPTION: This requirement is for developing weight of evidence criteria for classification of chemicals as carcinogens, and developing mechanistic data for dose-response modeling to extrapolate rodent experimental findings to humans. Billions of dollars are spent on environmental clean-up of landfills using US EPA derived approaches for assessing health risks. These methods for risk assessment are not defensible based on science. This research effort will provide scientifically based approaches for assessing the human health risks for five common organic contaminants found on Air Force bases.

Phase I: Phase I will result in a documented indepth evaluation of the weight-of-evidence methods used by the US EPA and others (countries, states, industry, etc.) for five organic chemicals and will include detailed state-of-the-art technical approaches to develop scientifically defensible health assessments for the five organic chemicals. Such approaches could include epidemiologic evaluations, statistical analyses, pharmacokinetics and pharmacodynamic laboratory experiments and pathologic examinations.

Phase II: Phase II activities may include: identifying chemical specific mechanisms of action that can be used in dose-response modeling of the five organic chemicals, demonstrating the use of mechanistic data in dose-response modeling, incorporating weight of evidence in quantitative risk analyses, and conducting collaborative research between the Toxicology Division and the awardee and use of biomarkers.

Dual Use Commercialization Potential: Phase III may result in the commercialization of risk assessment software, mathematical techniques for assessing health risks or laboratory methods to establish target organ dose response biomarkers for use in risk assessment.

AF94-017 TITLE: Electromagnetic Radiation Effects and Measurement Devices

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

OBJECTIVE: Develop human body exposure/response algorithms and monitor interfaces associated with electromagnetic radiation.

DESCRIPTION: This requirement is for the development of numerical algorithms which can calculate the response of the human body to ultrashort microwave and laser pulses. The modern occupational environment is such that a worker may encounter novel electromagnetic fields produced by either microwave or laser devices. The safety of these electromagnetic fields is determined, at least in part, by the amount of energy deposited into living tissues

by these fields. When the environmental fields are constituted by continuous wave radiation, the amount of energy entering various living tissues and organs can be estimated using numerical algorithms that run smoothly on modern digital computers. However, when the environmental fields are pulsing in nature, the calculations become much more difficult because of the dispersive nature of human tissue. Dispersion means that each frequency component in the pulsing field is treated differently by the living tissue.

Phase I: Phase I will result in numerical algorithms that properly calculate ultrashort pulse propagation in strongly dispersive, irregularly shaped objects such as the tissues and organs of the human body.

Phase II: The Phase II effort will result in software algorithms for use by safety, health, and regulatory agencies. Our interest is with environmental fields penetrating the human body and doing potential damage there. However, our interest also resides in using low-level electromagnetic fields to image the human body to search for disease and analogously to visualize wastes buried or seeping in soils.

Dual Use Commercialization Potential: Phase III potential is for numerical algorithms for detection technologies and for imaging technologies for the purposes indicated.

AF94-018 TITLE: Improved Assessment of Vestibular System Function

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop innovative concepts, models, and diagnostic tools for evaluation of vestibular system performance.

DESCRIPTION: A properly functioning vestibular system is critical in dealing with the multisensory environment of flight. Standard clinical tests of vestibular function may not always detect operationally significant levels of vestibular dysfunction. Producing improved vestibular tests may result by upgrading existing tests or by devising new ones. Existing tests could benefit from improved stimulus delivery systems, advanced data collection methodology, innovative data analysis, and improved interpretation. New tests could incorporate novel stimulus modalities and/or response measurement technologies. Other improvements could include development of mathematical models of vestibular function, or other conceptual frameworks, to aid in test data interpretation.

Phase I: Phase I will identify, rationalize, and evaluate an approach to the improved assessment of vestibular function. This approach may consist of a completely new testing concept, a significant enhancement of a standard testing concept, or a significant component for such a testing system.

Phase II: Phase II will develop the concept to the prototype stage, producing a working model of the vestibular testing system and demonstrate the efficacy of the concept.

Dual Use Commercialization Potential: An improved system for testing vestibular function will be of interest to Otologists, Otolaryngologists, and Neurologists. The currently available commercial testing devices lack the sensitivity and specificity required for the accurate diagnosis of vestibular dysfunction. Once validated, a significantly improved testing system could successfully compete in the commercial marketplace.

AF94-019 TITLE: Cardiac Output/Stroke Volume Pulsed Doppler Flowmeter (FM)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop a pulse-Doppler volumetric flowmeter to determine beat-to-beat cardiac output in the ascending aorta.

DESCRIPTION: Develop a blood volumetric flowmeter that is much more accurate than commercially available

pulse Doppler or electromagnetic flowmeters and is suitable for use on the ascending aorta and/or pulmonary artery. The flowmeter must output beat-to-beat estimates of cardiac output and stroke volume data, and instantaneous vessel diameter, in addition to the normal Doppler flowmeter outputs of range, phasic and mean velocity, and direction-detected Doppler shift auditory output. The flowmeter system will use pulse Doppler crystals attached at known angles to the compliant vessel wall and will calculate the instantaneous velocity profile within the vessel and the instantaneous diameter many times during pulsatile flow. From the flow velocity profile and the vessel diameter, the volumetric flow can be estimated. The Doppler transducer will be chronically implantable and measure velocity and diameter simultaneously. The probe must not significantly alter the local vessel compliance. The Doppler signal conditioner should minimally appropriately excite 5 and/or 10 Mega Hertz (MHz) piezoelectric crystals with a fixed sine wave (5 or 10 MHz, respectively). Fixed Doppler excitation frequencies of 5 and 10 MHz are of primary importance. Future applications may necessitate use of 20 MHz excitation frequencies. Frequency modulated (chipped) crystal excitation should also be considered. FM excitation frequencies would be centered on the fixed frequencies with a worst-case bandwidth of +/- 10 MHz and a probable bandwidth of +/- 5 MHz. The system should be designed to function with a vessel diameter range of 2 to 28 mm. State- of-the-art analog techniques to maximize the signal-to-noise ratio and provide an enhanced Doppler-shift demodulation/phase detector should be implemented, where possible. Advanced real- time frequency and time domain analysis techniques should be considered.

Phase I: Phase I will be a survey and analysis of current technology and identification of potential.

Phase II: One or more of the most promising will be developed to the prototype lead; and test and evaluation will be conducted, especially on engineering aspects.

Dual Use Commercialization Potential: Commercial applications include feedback control for pulsatile cardiac assist and by-pass pumps, and post-surgical evaluation of cardiac or vessel replacement procedures.

AF94-020 TITLE: Coronary Catheter-based pH Probe

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a pH coronary catheter capable of measuring beat-to-beat changes in local bold pH.

DESCRIPTION: Develop a pH meter and catheter system that is usable in small coronary arteries for extended periods of time. The device should accurately and safely measure local coronary bold pH for periods to exceed 4 hours. It should have a time constant that is short enough to accurately determine beat-to-beat blood pH. The pH catheter should be sized and designed to allow for placement in the coronary arteries via standard cardiac catheterization approaches. The catheter must be capable of considered "disposable." It must be easily calibrated in a sterile environment. Temperature stability or compensation is also a major design criterion. Solid state or fiber optic pH transducer technology is suggested.

Phase I: Phase I will review the state of the technology and analyze possible approaches/designs, critique them, and propose an approach.

Phase II: Phase II will develop one or more prototypes of the best potential design, conduct preliminary tests and evaluation, particularly on engineering aspects, and submit the prototypes and specifications.

Dual Use Commercialization Potential: Applications include coronary artery disease state and angioplasty effectiveness.

AF94-021 TITLE: Emission Control for Particulate Air Toxic Substances

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Demonstrate technical and economic feasibility of novel particulate air toxic emissions control for industrial operations.

DESCRIPTION: In Title 3 of the Clean Air Act Amendments, the list of 109 air toxic substances subject to emission standards includes a number of involatile substances that are likely to be emitted only as dusts or suspensions in air. Because Title 3 enforcement is only beginning, the experience base in technologies for compliance with these requirements and at the lower levels to be expected is minimal. Recirculation or discharge of air from processes as metal finishing, abrasive depainting, or spray painting, etc. requires treatment to lower the amounts of air toxic substances to less than the applicable industrial hygiene or air quality standard. Technologies investigated may be process-specific or general; they may include one or more air toxic particulate substances; and they may include or exclude volatile air toxic substances. The concept as presented may be a complete treatment technology, or it may augment a separate treatment method.

Phase I: Phase I effort should result in experimentally generated data indicating whether or not the technology will be useful as a treatment method. Furthermore, it should identify processes or air toxic substances for which the technique is applicable and it should accomplish a preliminary economic analysis of the technology compared to existing treatment methods.

Phase II: The Phase II effort will establish the economic and technical feasibility of the technology when used to control air toxic particulate contamination locally in or around one or more AF industrial operation(s). The Phase II will also produce all information needed to implement the technology.

Dual Use Commercialization Potential: This requirement is common to many DOD and commercial industrial operations.

AF94-022 TITLE: <u>Treatment of Firefighter Training Facility Process Water and Wastewater</u>

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Method for treating aqueous firefighting foam,hydrocarbons, and their byproducts in firefighter training facility
water.

DESCRIPTION: Innovative methods are needed for treating process water and wastewater prior to recycling or discharge. Water at firefighter training facilities becomes contaminated with hydrocarbons (including benzene, toluene, ethylbenzene and xylene), partially burned hydrocarbons, aqueous firefighting foam, degradation byproducts and dust/dirt. When released to a sewage treatment plant on receiving waters, Aqueous Firefighter Foam contaminated water can kill aquatic life as well as producing a highly visible foam. Evidence suggests the aqueous firefighting foam, as in accidental discharges and real world use, is also of interest and is considered a secondary objective.

Phase I: In Phase I, a promising technology for treatment of process and wastewater will be tested in the laboratory at bench scale. Results of the bench scale tests will provide the basis for estimating economics of the treatment method.

Phase II: In Phase II, a prototype system will be designed, built, and tested. Following testing at the contractor's facilities, it is anticipated that the unit will be demonstrated at two Air Force Firefighter Training Facilities-one designed for LPG fuel with total water recycle and one typical of those using jet fuel.

Dual Use Commercialization Potential: The technology will be applicable to both military and civilian firefighter training facilities. There is also potential for application to Aqueous Firefighting Foam and degradation byproducts encountered during remediation of firefighter training facilities.

AF94-023 TITLE: Characterizing Bacteria Using Arbitrarily Primed Polymerase Chain Reaction (AP-PCR) Techniques

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an innovative method for determining bacterial degradative capabilities using AP-PCR techniques.

DESCRIPTION: Recently Investigators have begun using arbitrarily primed polymerase chain reaction (AP-PCF) techniques in order to generate strain specific amplification patterns from bacterial Deoxyribonucleic Acids (DNA). The technique is powerful because it is rapid, repeatable, relatively simple, and allows differentiation of bacterial isolates at the sub-species level. The Polymerase Chain Reaction is used to generate a pattern of amplicons from purified bacterial DNA and a random oligomer primer. The pattern is dependent upon the distribution of annealing sites for the primer within the bacterial genome. The pattern is readily established by agarose gel electrophoresis, and it is different for even closely related species of bacteria. It can be used as a means of identifying environmental or clinical isolates in much the same way as human fingerprints are used in forensic science. The limitation of the technology also parallels that of forensics; the establishment of a data base is critical to the broad use of the technology. The initial development of the technology requires the establishment of AP-PCR patterns for a large number of bacterial strains which can subsequently be used to identify unknown microbial isolates.

Phase I: Phase I work should address the collection of strains, the classification of those strains (if not already established) by well-established methods, and the compilation of AP-PCR data. Priority in establishment of the data base should be given to those organisms with known or suspected biodegradative capabilities. Proposers must have demonstrated competence in microbial systematics and propose innovative methods for the coding, storage, and retrieval of AP-PCR pattern data. Once this data base is compiled, bacteria isolated from contaminated sites on non-selective culture media or by selective enrichment on specific carbon sources could be rapidly fingerprinted and identified in order to predict the degradative capability in-situ. Such information would be valuable in determining the remediation processes to be used at a given site.

Phase II: Phase II will involve the direct isolation of nucleic acids from groundwater sediment samples in order to assay for the presence of bacteria without the use of culture techniques. The establishment of methods for the production of community-based patterns or individual patterns from next DNAs should be considered only after establishment of the data base the pattern comparison protocols.

Dual Use Commercialization Potential: This technology is common to many DOD and commercial industrial operations

AF94-024 TITLE: Dense Nonaqueous Phase Liquid Aquifer Remediation

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a treatment process to decontaminate aquifers containing Dense NonAqueous Phase Liquids (DNAPLs)

DESCRIPTION: Hazardous waste sites contaminated with DNAPLs (usually chlorinated solvents) present special

problems to remediation activities. The dense organics sink to the bottom of the aquifer to form pools or disassociated droplets (ganglia) of pure phase product. This pure phase then slowly leaches into the surrounding aquifer, providing a long-term source of contamination.

Phase I: Phase I is the development and proof of concept of a treatment system to remediate a 10-cubic-foot test cell contaminated with trichloroethylene. It will also provide scale-up and operating parameters for a Phase II effort. Restoration verification of the test cell will include soil analysis down to the parts per million level and water analysis down to the parts per billion level.

Phase II: Phase II will be the operation of the treatment system at a contaminated Air Force approved site. Bioremediation and "pump-and-treat" technologies are outside the scope of this topic.

Dual Use Commercialization Potential: Full-scale development and commercialization of the treatment system.

AF94-025 TITLE: Biological Methods for Complete Destruction of Nitro- Substituted Contaminants

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop innovative biological methods for the degradation of nitro-substituted compounds in contaminated soil or water.

DESCRIPTION: Knowledge surrounding the biodegradation of nitrogenous contaminants such as energetics, missile fuels, and nitroaromatic solvents, and explosives is limited. Early research led to the conclusion that nitro compounds either resist biodegradation or are reduced to amines which are more toxic than the parent compounds. Novel oxidation reactions may completely detoxify nitrogenous contaminants. These discoveries suggest that biological treatment will be effective for degrading nitrogenous compounds. Current technologies include composting and incineration. The composting process produces unknown, potentially toxic, intermediates, and incineration is an extremely expensive treatment option. There is an ongoing need to understand the biochemical mechanisms and to develop new biological processes for complete destruction of these compounds.

Phase I: Phase I will identify novel processes for the complete biodegradation of nitro-substituted contaminants including nitrobenzenes, nitrotoluenes, RDX, HMD, and TNT that could lead to the development of a biotreatment system for contaminated soil or waste streams.

Phase II: This effort will implement the development and testing of such a system using contaminated material.

Dual Use Commercialization Potential: Full-scale development and commercialization of a in-situ or ex-situ bioreactor system

AF94-026 TITLE: Landfill Remediation Techniques

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a chemical/physical treatment process to remediate landfills containing hazardous chemicals

DESCRIPTION: Past operation of landfills allowed the discharge of what are now considered hazardous materials.

These may have been released in dumped waste liquid form or from leaking drums filled with toxic liquids. Leachate from landfills could contaminate large areas downstream from the site. The technology sought would remove, neutralize and/or destroy the source of the contamination, not just collect the leachate and treat it. In this manner, long-term source reduction of toxic threats to the environment is achievable.

Phase I: Phase I should cover the development and proof of concept of a treatment system to remediate a 10-cubic-foot test cell representative of a typical landfill. Phase I should also provide scale-up and operating parameters for a Phase II effort. The measure of meri' will be the amount of contamination removed, destroyed, or neutralized.

Phase II: Phase II will be the operation of the treatment system at a contaminated Air Force selected landfill site.

Dual Use Commercialization Potential: Full-scale development and commercialization of the treatment system

AF94-027 TITLE: Concentrated Oxygen and Storage Technologies

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop innovative state-of-the-art, light-weight, compact, and self-contained oxygen separator and storage technologies.

DESCRIPTION: A need exists to generate and store significant quantities of oxygen on-board aircraft to support multi-man aircrews. In addition, significant quantities of oxygen are needed for patient care during all phases of the aeromedical evacuation mission. Current technology is limited in the amount and quality of oxygen that can be generated and stored while in flight on-board aircraft. This effort seeks to initiate innovative state-of-the-art oxygen generation and storage technologies to produce systems capable of generating and storing oxygen to support many individuals while in flight. Emphasis should be place on increasing oxygen recovery rates, maximizing oxygen concentration, minimizing weight, minimizing size, and reducing power consumption. Major innovative technologies would include: oxygen concentrator, oxygen storage, oxygen delivery, and associated controls.

Phase I: The Phase I effort will involve a preliminary engineering design.

Phase II: The Phase II effort would involve the detailed design, construction, and testing of the complete system.

Dual Use Commercialization Potential: The commercial spin-off technology would be applied to generate and store oxygen for medical, industrial, and commercial aerospace purposes. Medical applications include oxygen for respiratory therapy. Other applications in the industrial area include filling of oxygen bottles, biotechnology, environmental waste reduction, and chemical processes.

AF94-028 TITLE: Human Sensory Feedback in Air Force Telerobotic Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop sensory feedback technology for intuitive human operation of robotic systems in hazardous environments.

DESCRIPTION: Concepts for human control of robots in hazardous unstructured Air Force environments combine

the cognitive abilities of the human with the hardiness and heavy manipulation capabilities of robots. By capitalizing on human judgment and the robot's ability to operate in conditions lethal to humans, the advantages of each "system" can be exploited. Human operator awareness (feedback) of the robot's work environment adds significant flexibility to mission capability. The challenge is to develop quality feedback from the robot to the operator. Two specific current challenges are: (Specify subtopic by letter)

a. Force Feedback to Small Exoskeletons: Fine manipulation using human-sized robotic hands requires human-sized hand exoskeletons for intuitive control. Force Feedback to these small exoskeletons requires small-volume, high-efficiency, semi-linear actuator mechanisms. Actuators are needed to provide human range forces and velocities to exoskeletal systems used by operators of dexterous manipulators.

Phase I: Phase I could result in actuator technology demonstration prototypes.

Phase II: Phase II product could be miniaturized actuators on prototype hand exoskeleton.

Dual Use Commercialization Potential: Small-volume, high-efficiency, semi-linear actuators can be applied to many commercial products. These actuators could power miniature robots, servo mechanisms, human hand prosthetics, manipulation aids for handicapped people, etc. Any actuation technology that can meet the size, speed, and power requirements of the small exoskeletons, can be scaled upward to improve the design of a plethora of larger applications.

b. Force Feedback from Synthetic Environments: Current human interfaces to Virtual Reality and Synthetic Environments consist of audio and visual feedback only. The next dimension to operator immersion in Synthetic Environments for training and simulation is to generate synthetic forces that represent the "feel" of the objects in the synthetic environment. Algorithms and methodologies must be developed which allow existing computer systems to fabricate realistic forces from graphical models in real time.

Phase I: Phase I could result in algorithms that synthesize interaction forces for geometry primitives.

Phase II: Phase II product could be a computer program that displays graphical simulations and computes interaction force vectors between simulated objects.

Dual Use Commercialization Potential: The algorithms used to model force interaction among synthetic objects in a synthetic environment will be directly applicable to training and entertainment industries. Once we can make a person feel the simulated objects that they can now see in virtual reality systems, the usefulness of simulation for training will increase by an order of magnitude. The algorithms will contribute to next-generation arcade games, virtual training systems for a host of industries, and will enhance computer-aided design (CAD) software packages by allowing CAD users to intuitively manipulate their designs without fabricating prototypes in hardware.

AF94-029 TITLE: Crew Protection Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-Systems Interfaces

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Enhance crew protection systems in Air Force operational environments

DESCRIPTION: A requirement exists for effective voice communications, crew safety, and human performance in environments that are based on natural, intuitive interfaces using innovative abilities and requiring no learning or training for efficient operation. The intuitive interfaces facilitate operator task performance, reduce workload and fatigue, and improve personal safety. These intuitive interface technologies include but are not limited to: 1) auditory system modeling and neural network for robust signal processing of speech; 2) digital audio technology to allow integration into aircraft systems; 3) voice communications countermeasures/counter-countermeasures; 4) noise-induced hearing loss sound protection; 5) active noise reduction; and 6) 3-dimensional auditory display for spatial awareness and communications.

Phase I: Phase I efforts would provide an assessment of the state of the art and an approach to develop

an appropriate intuitive interface technology.

Phase II: Phase II efforts would provide a demonstration and validation of the intuitive interface technology.

Dual Use Commercialization Potential: Commercial applications of these technologies are possible in the commercial aviation, entertainment, industrial safety, and health care fields.

AF94-030 TITLE: Systems to Remove Electroencephalographic Artifacts and Develop Functional Brain Atlas

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop software to remove electroencephalographic artifacts and methods for development of cognitive function brain atlas. (Specify subtopic by letter)

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter).

a. This requirement is for the development of a software system which will correct/remove artifacts from ambulatory
psychophysiological data.

Phase I: Phase I will result in a plan to identify and correct physiological artifacts from psychophysiological data.

Phase II: Phase II will result in a software system, written in transportable code, that can be used to produce "clean" ambulatory data. The collection of ambulatory data from operators performing their daily tasks is becoming more common and the largest problem remaining is artifact contamination of the data. Ambulatory recording of physiological signals is used for monitoring the effects of workload, situational awareness, fatigue, and other factors. The main source of data artifacts is physiological in origin and is produced by movement, muscle artifacts, eye blinks, heart beats, etc. These "physiological" artifacts contaminate the signals of interest, brain waves, heart rate, eye blink, and respiration. On-line removal is required in systems that provide in-the-loop physiological data. By developing methods to detect and correct the physiological artifacts, it will be possible to create on-line systems for the monitoring of operator workload and state. The elimination of these artifacts will permit the widespread use of physiological data to monitor operator state and workload. Several off-line methods are available, but an on-line system for dealing with all types of physiological artifacts must be developed.

Dual Use Commercialization Potential: This software would be very useful in several commercial applications including clinical and research neurology and psychiatry and test and evaluation.

b. This requirement is for the development of analysis methods and the format for the development of a functional atlas of cognitive brain electrical activity. Multichannel brain wave data is currently being collected in a number of aircraft and simulators. New and validated methods are required for the analysis of the huge amount of data produced which permit meaningful interpretation with regard to cognitive brain function. However, very little laboratory data exists from controlled multi-task laboratory experiments. An analysis system is required that will permit the development of a database of brain activity in multitask situations so that the flight data can be properly interpreted. This includes research in the areas of human cognition and workload. A system is required which uses all aspects of the available brain wave data and permits the development of normative data. Methods must be developed which are mathematically valid and physiologically meaningful.

Phase I: Phase I will result in the development of a strategy for data analysis and database development.

Phase II: Phase II will result in a system for the analysis of brain topographic data and the beginning of a database for a functional brain atlas based on brain wave data.

Dual Use Commercialization Potential: Commercial applications would include psychiatry, neurology and basic cognitive research laboratories.

AF94-031 TITLE: Case-Based Reasoning/Retrieval Technology for Design Groups

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop intelligent groupware for support of design teams distributed at remote, geographical sites.

DESCRIPTION: Design groups often involve the interaction of many participants which can vary in time, place, culture, knowledge, and ability. Frequently this requires an elaboration of design rationale, the uncovering of design histories, and the progressive deepening of knowledge. These design activities are highly contingent on design context, vary with individual team member perspectives, are highly dependent on situated memory, tend to undergo rapid shifts that are not linear in nature, and are subject to much disagreement when tradeoffs or other forms of decision making are transacted in group settings. Although design rationale may be useful for developing policy decisions, issue exploration, compromises, and tradeoffs, it typically only exists in a single member's mind and thus is not available for other member's use. When multiple perspectives are available to examine design problems from differing viewpoints, there is a basis to translate design requirements into workable design solutions. A case-based reasoning/retrieval product for design groups would provide a distributive design environment to afford team members the means to distribute ideas, engage in group-centered policy decisions, discuss issues, capture concepts and designs, and generate multimedia representations; all of which are important considerations for the Computer-Aided Systems Human Engineering and Collaborative Design Technology projects at the Armstrong Laboratory. It would allow design teams to engage in collaborative case-based reasoning about particular design situations. Satisfying the objective requires software capable of providing: a) design apprenticeship, b) intelligent retrieval of design cases, c) conceptually-indexed design cases, d) case-based reasoning using indexed cases and learning classification techniques, and e) design brainstorming/editing methods. This captures the emerging collaborative design process, then supports this process by merging intelligent retrieval/search technology with computer-supported cooperative work functions. The major research challenge involves development of "design cases" which improve as a function of their use by multidisciplinary design teams. The usefulness of design case models is based on the premise of transforming design team members' characteristic errors (i.e., misconceptions which represent members' initial conceptualization about how they think they can explore the design space to get to the information they need) into potentially constructive learning experiences.

Phase I: Phase I work must contain: real world knowledge/design cases for the development and testing of the product; perspectives involving machine learning, computer-supported collaborative work, and conceptual indexing; an operational design of the product; an electronic storyboard documenting the use of the product; and a research plan for in situ evaluation involving design teams working on a specified human engineering design problem.

Phase II: Phase II work requires the actual development of the case-based/retrieval technology as a product for design communities. Once the product has been developed for operational utility, it may be validated in accordance with the test plan developed in Phase I. Based on evaluation of the performance with an actual collaborative design group, feedback can be used to propagate additional design changes as required.

Dual Use Commercialization Potential: At this point the general architecture of the product may be elaborated for use in other design domains. Case-based Reasoning/Retrieval Technology will be useful for commercial applications as it will provide a basis for business/industry to intelligently retrieve, distribute, index, and transfer design knowledge across a number of remote geographic locations involved in real world design processes. The commercially available product would enhance design team brainstorming techniques and act as an aid for design problem solving resulting in increases in the quality of designs while providing more efficient design support.

AF94-032 TITLE: PC-Based Measurement of Situational Awareness Aptitude

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-Systems Interfaces

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop a PC-based synthetic task that assesses pilot applicants' potential for developing situational awareness.

DESCRIPTION: Situational awareness can be defined as the pilot's mental model of the tactical situation. Combat pilots in fighter, attack, and bomber aircraft each require situational awareness for their unique missions. Our working hypothesis, however, is that there is a core process of attaining and maintaining situational awareness common to all combat missions, and that pilots acquire skill in situational awareness with experience, and vary in asymptotic skill level. We are interested in identi- fying the cognitive and perceptual abilities that enable some pilots to develop the highest levels of situational awareness. This requirement is for a microcomputer-based synthetic task capable of training flight-naive subjects to pilot a simulated general purpose combat aircraft and perform various missions under multiple threat environments. The synthetic task should record and evaluate the appropriateness of the pilot responses to events built into each mission's scenario. The ideal system would employ multiple measurement procedures, each designed to measure a subject's performance in terms of situational awareness. The end product of this research will be a PC-based synthetic task requiring approximately 40 hours to complete, that assesses a person's aptitude for developing situational awareness. The synthetic task will be used as a criterion measure in laboratory studies of the cognitive and perceptual correlates of situational awareness.

Phase I: Phase I will result in the preliminary design of the synthetic task and an executable prototype.

Phase II: Phase II will be the full-scale development of the synthetic task, and proof of concept of the synthetic task's reliability and validity as a measure of situational awareness. Proposers should assume that the synthetic task will be hosted on a 80486/33 computer equipped with joystick and rudder pedals.

Dual Use Commercialization Potential: The synthetic task described above could result in several marketable products. First, the synthetic task could be sold to Allied and friendly nations for use in pilot selection programs in combat training programs; this would require a minimum of system modification. Second, the synthetic task could be tailored to the commercial airline and transport mission and marketed as either a selection or training system. Third, the synthetic task could be marketed as a performance assessment battery. Performance assessment batteries are used with increasing frequency to determine if the operators of vehicles or heavy equipment are psychologically fit for duty. They are also used in scientific research to determine the effects of acute changes, e.g., drugs or stress, and of chronic changes, e.g., aging, on performance. Fourth, the synthetic task could be marketed as a video game. The video game version of the task would not need the full performance evaluation module.

AF94-033 TITLE: Design/Redesign for Supportability

CATEGORY: Exploratory Development

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop tools to better incorporate supportability considerations into any weapon system design and modification.

DESCRIPTION: This requirement is for supportability analysis and communication tools that will enable designers to better incorporate supportability considerations into the weapon system acquisition and modification process. Today's digital computer technology offers the design team tremendous potential to identify supportability problems earlier, to communicate supportability issues and solutions efficiently, and to ensure supportability is effectively incorporated into the design. The following areas are of interest: (Specify subtopic by letter)

a. Collaboration in the design/redesign activity requires effective discussion of design-related issues and the sharing of design-related information. There is a need for a tool that allows anonymous discussion of issues

and the capability to create lists of alternatives that can be evaluated by members of the design team.

Phase I: Phase I will address tool architecture and the feasibility of using such a tool in the design process.

Phase II: Phase II will yield an Ada-based tool that works across multiple computer systems in a client/server environment.

Dual Use Commercialization Potential: The tools could be used for supportability design improvement in virtually any defense-related system or any commercial product that requires ongoing maintenance or logistics.

b. There is a growing need to provide environmental technical and regulatory information to a system designer. This information (regulatory data, pertinent governing policy, and lessons learned), when collected in a "data repository" tool, will aid in environmentally sound decision making during design.

Phase I: Phase I will define the functional requirements for such a tool, including potential data sources.

Phase II: Phase II will develop a prototype tool capable of storing, managing, and presenting this data in a useable format.

Dual Use Commercialization Potential: The tools could be used for supportability design improvement in virtually any defense-related system or any commercial product that requires ongoing maintenance or logistics.

c. Current methods for determining system effectiveness rarely analyze system effectiveness as employed in expected use scenarios. Needed are software tools that will allow predictive analysis of system effectiveness under its expected use conditions. Further, these types of analysis are generally conducted late in the acquisition process when results have little impact on basic design decisions.

Phase I: Phase I will develop generic methods to define and analyze performance and lifecycle design factors with respect to mission accomplishment.

Phase II: Phase II will develop software tools with an open architecture to allow easy integration of the design factors into other software simulation applications.

Dual Use Commercialization Potential: The tools could be used for supportability design improvement in virtually any defense-related system or any commercial product that requires ongoing maintenance or logistics.

AF94-034 TITLE: Low-Cost, Field-Deployable, Binocular Head-Tracked Helmet-Mounted Display

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop a prototype field-deployable helmet-mounted display for squadron-level flight training devices.

DESCRIPTION: A low-cost, self-contained, helmet-mounted visual display system which will provide full color, wide field-of-view, high-resolution imagery to a pilot sitting in the cockpit of a flight training device is required. The display must be rugged and easy to use, and must contain an integral head-tracking device with only a remote sensor fixed to the cockpit. Supporting electronics may be located off the helmet but must be packaged compactly enough to integrate within the cockpit.

Phase I: Phase I will examine various approaches to building such a display and result in a proof of concept. Optics should have: (a) wide field of view; (b) >50% see-through transmission; (c) high efficiency (imagery >80% of the image source brightness); (d) high resolution; (e) high image quality; (f) flat object plane to accommodate flat image sources; (g) light weight; and (h) little or no adjustment necessary for eye separation distance of user. Image source should explore sources which can provide a bright, high resolution, i.e. 1 million pixels or more, light weight image source in a small image size (25 mm) which is compatible with the optics. Safety issues, such as the proximity of high voltages close to the head, shall be considered. Head-tracking device must be inexpensive and unobtrusive, consisting of an emitter array and a sensor. The device must be insensitive to ambient noise and have sufficient resolution and signal-to-noise ratio to support the high resolution of the display system. Explore head movement prediction algorithms capable of negating system lags or latencies of up to 150 msec without adding noise.

Phase II: Develop two or more prototypes which incorporate the Phase I technology. These should be

designed to validate the concept and serve as tools to gather information in areas Phase I was unable to explore. The contractor will quantify the performance of the prototypes and recommend further requirements. The helmet displays developed should have the potential for refinement to a production version be serviceable in the flight training environment, and for applications outside of flight training areas such as remote presence and virtual environments.

Dual Use Commercialization Potential: Any production version of this helmet display has the potential for application in civilian flight training environments and for other applications requiring high-fidelity information display, such as remote presence and virtual environments.

AF94-035 TITLE: Development and Presentation of Electroni. Technical Data for Maintenance

CATEGORY: Exploratory Development

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop improved technologies for developing/presenting electronic technical manuals for use by aircraft maintenance technicians.

DESCRIPTION: The DOD and industry are rapidly moving toward the implementation of electronic technical manuals to support aircraft maintenance. Although the basic technology exists to implement electronic technical manuals, there are many research opportunities to develop improved techniques for developing and presenting technical data. (Specify subtopic by letter)

a. Research is needed to identify, develop, and test electronic information display devices which improve over small, special-purpose portable computers, which are often limited in their capability by such things as work space.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested promising technologies.

b. Research is required to develop innovative techniques to present maintenance technical data (currently displayed as large graphics such as schematics and wiring diagrams) in a simplified graphic or nongraphic format on a small computer so it is easily understood and used by the technician.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in a full-scale test of the most promising technologies.

c. Research is needed to develop techniques to present technical data for maintenance in an easily understood manner which does not require strong reading skills.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested technologies.

d. Research is needed to automate all, or major portions of, existing technical data into an electronic technical manual technology to be used on already fielded systems and to remain in inventory for several years.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested technologies and software.

e. Research is needed to develop technologies to automatically generate electronic technical data from computer- aided design data bases, which are used for design of weapons systems and maintenance instructions. Much of the information currently is extracted manually and entered into the maintenance technical data system.

Phase I: Phase I will result in the identification and preliminary tryout of candidate technologies.

Phase II: Phase II will result in fully tested technologies and software. electronic technical data from the computer-aided design data bases.

Dual Use Commercialization Potential: The research needs described below are for the development of technologies needed to more effectively present and more economically develop electronic technical manual systems to support the maintenance of complex equipment. The technologies are applicable to the development and presentation of electronic technical manuals for the maintenance of any complex equipment, including automobiles, aircraft, ships, computers, and industrial equipment. Applications of the technology are unlimited.

AF94-036 TITLE: Improvements in Life Support Personal Protective Equipment and Altitude Diagnostic Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-Systems Interfaces

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop low resistance breathing system; develop decompression/denitrogenation computer for real-time risk
prediction.

DESCRIPTION: Specific areas include the following: (Specify subtopic by number)

a. Flow resistance imposed by current aircraft oxygen systems limits delivery of breathing gas to the crewmember. High breathing resistance adds stress, discomfort, and distraction to the high workload flight environment. Inspiratory resistance may reduce high acceleration (G) tolerance by decreasing the effectiveness of respiratory straining maneuvers. Current systems fall short of international standards and produce abnormal respiratory gas exchange which may also contribute to episodes of hypoxia. Design changes to include low resistance components are needed to advance development of these systems toward adequate breathing gas delivery and compliance with these standards.

Phase I: Phase I efforts will identify design changes for components which contribute to breathing resistance.

Phase II: Phase II will produce a brassboard low-resistance breathing system including components beginning with the regulator and downstream to the protective oronasal mask.

Dual Use Commercialization Potential: Applications for personal protective breathing systems with reduced breathing resistance include respirators for the personal protection of workers in environmental cleanups and toxic materials waste removal and disposal, as well as others working in toxic atmospheres, such as firefighters.

b. Develop advanced decompression/denitrogenation computer algorithms for real-time assessment and prediction of decompression sickness risk. High-altitude exposures in aircraft, in hypobaric chambers, and with extravehicular activity (EVA) in space result in an inherent risk of decompression sickness (DCS). In the past, general guidelines for safer altitude exposures have been developed through costly, time-consuming studies, each specific to unique scenarios of altitude exposure. The results of these studies are often difficult to apply to other operational altitude requirements. New, time-consuming studies must therefore be undertaken. Rapidly changing technology in aircraft design dictates improved capability for decompression risk assessment. In recent years the altitude ceiling of private, general aviation aircraft with unpressurized cabins has been rising, thus exposing the occupants, both pilot and passengers, to the hazards of high- altitude decompression problems. Data bases exist for the development of a standardized altitude decompression/denitrogenation model, such as exists on diving decompression computers. Computer algorithms for altitude are needed for both real-time DCS risk information, as well as DCS risk predictive capabilities.

Phase I: Phase I will develop the software program for the decompression model.

Phase II: Phase II will provide a hardware prototype for further operational development assessment.

Dual Use Commercialization Potential: Utilization of such hardware is anticipated in aircraft cockpits, or hypobaric chamber control stations, in EVA suits, in commercial and private general aviation aircraft, and as operational mission planning computers for high altitude.

AF94-037 TITLE: C3I Systems/Subsystems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop innovative concepts for increasing warfighting capabilities of the Air Force command, control, and communications systems or subsystems.

DESCRIPTION: Proposals may address any aspect of AF C3I systems not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, C3I concepts for: Fixed and mobile command centers; tactical operations; special forces operations; AF ground-based or early warning systems; AF mobility issues. Also of interest are: mission support system planning tools; innovative methods for employing commercial off-the-shelf communications technology; innovative approaches to modeling the cost of C3I system ownership, and to the reduction of life cycle cost; decision analysis tools for determining the optimum C3I system maintenance level; IDEF2-5 tools/methodologies. This topic offers great flexibility for proposers to offer solutions to AF C3I problems.

Phase I: Provide a report describing the proposed concept in detail and show its viability and feasibility.

Phase II: Fabricate and demonstrate a prototype device or subsystem or software program.

Dual Use Commercialization Potential: All solutions proposed must have potential for use/application in the commercial as well as military sector, and potential commercial applications must be discussed in the proposal. Proposal titles must reflect the specific C3I and problems being addressed.

AF94-038 TITLE: Innovative C3I Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop innovative technologies for enhancing the performance, availability and affordability of C3I systems and subsystems.

DESCRIPTION: Proposals may address any aspect of C3I pervasive technologies not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, innovative concepts and technologies in: signal image and speech processing, computer science, including software engineering, computer systems technology and artificial intelligence, electromagnetic technology, including phased array antennas, null steering and scattering, superconductive electronics and EM materials and components, photonics, including optical memory, processing, devices and materials and reliability and diagnostic technology. This topic offers great flexibility for proposers to offer innovative technologies with revolutionary impact on C3I systems and subsystems.

Phase I: Provide a report describing the proposed concept in detail and show its viability and feasibility.

Phase II: Fabricate and demonstrate a prototype device or subsystem or software program.

Dual Use Commercialization Potential: The C3I technologies all have substantial dual use potential and will impact competitiveness and performance of the commercial sector as well as the military sector.

AF94-039 TITLE: Three Dimensional Optical Storage Medium

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop Optical memory media to be employed in a practical memory architecture.

DESCRIPTION: Three dimensional optical storage has not been incorporated into modern systems due to a lack of a practical media. Present storage media does not work at ambient temperatures, and cannot use laser diodes for both read and write applications. Future applications will require huge amounts of data storage capacity (at least 10E12 bits). Read/write operations should accommodate gigabit to terabit throughput rates; and have a persistence

of long periods of time (months). Architecture should include fast (100's of nanosecond) access times.

Phase I: Identify candidate media and characterize the optical properties with respect to writing energy, recording time, dynamic range, storage density, and crosstalk.

Phase II: Incorporate this media into a usable architecture.

Dual Use Commercialization Potential: Optical Memory "will have" tremendous impact on today's storage and retrieval community in the fields of medicine, computer memories, data handlers, etc.

AF94-040 TITLE: Photonic Interconnects

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop advanced photonic interconnects for improved digital signal processing and computing systems.

DESCRIPTION: Ultra-high throughput optical or hybrid opto-electronic digital signal processing and computing capability is required for global C3I surveillance and command and control / intelligence functions in future military and commercial systems. Research and development efforts, in the general area of optical interconnects, including significant collaborative interaction between in-house and contractual high pay-off technology solutions. Photonics Center and Rome Laboratory resources, including state-of-the-art optics laboratories, devices, and photonic test instrumentation, as well as device fabrication capabilities, operational radar systems, and other Rome Laboratory-developed technologies are available as GFE or GFP for such subsystem demonstrations. Innovative R&D is sough to address problems such as the development of: surface-relief diffractive optics for broadcast and N-to-N general interconnects, and fixed and reconfigurable
Collaborative phase 2-D polymer waveguide clock distribution and 3-D free-space gate-level interconnects, multichip-module chip-to-chip interconnects, and wafer-scale / board-to-board interconnects, and integrated optical crossbar switches.

Phase I: Demonstrate feasibility of the photonic interconnect technology and develop a demonstration plan for Phase II.

Phase II: Demonstrate a full-up and well defined collaborative multichannel electronic computer interconnect demonstration, involving greater than 100 channels at bit transfer rates greater than 100 MHz, in the Photonics Center, performing an interconnect function traceable to a well defined signal processing problem.

Dual Use Commercialization Potential: The potential for dual commercial use of DoD-developed photonic interconnect technology is great. Commercial computing technology will certainly utilize optical interconnects in the near-term due to speed, power, crosstalk and interference, and reliability advantages.

AF94-041 TITLE: Optoelectronic Processors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop advanced hybrid photonic-electronic processing and computing systems.

DESCRIPTION: Ultra-high throughput optical or hybrid opto-electronic digital signal processing and computing capability is required for global surveillance and command and control / intelligence functions in future AF systems. Subsystem development efforts, in the general area of opto-electronic processors, including significant collaborative interaction between in-house and contractual researchers conducted partly in the AF Photonics Center, are desired to provide near-term application-oriented technology solutions. Photonics Center and Rome Laboratory resources,

including state-of-the-art optics laboratories, devices, and photonic test instrumentation, as well as device fabrication capabilities, operational radar systems, and other Rome Laboratory-developed technologies are available as GFE or GFP for such subsystem demonstrations. Collaborative phase I feasibility experimentation will lead to a well-defined phase II working prototype demonstration in the Photonics Center. All efforts should be designed to ultimately address a specific AF processing problem. Specific areas of interest are: Applications-oriented development of massively parallel monolithic opto-electronic hybrid smart pixels and circuits for use in ultra-high speed massively parallel digital processors, including GaAs and InP, and silicon-hybrid technology.

Phase I: Should demonstrate feasibility via a collaborative interaction involving the Photonics Center and its resources, and develop a demonstration plan for phase II.

Phase II: Should involve a full-up and well defined collaborative signal processing demonstration in the Photonics Center, potentially including real-time radar processing, operating with throughputs greater than 1 GOps.

Dual Use Commercialization Potential: Commercial high performance computers are primary targets for the technology. The development of photonic and electronic "highways" will provide significant market potential for hybrid opto-electronic machines which can be applied to medical data transfer, and distributed design/manufacturing capabilities.

AF94-042 TITLE: Photorefractive Materials and Devices

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop high speed, high sensitivity photorefractive materials and devices for real time optical signal processing.

DESCRIPTION: The photorefractive effect can be utilized in many photonic system designs. A current need exists for photorefractive materials with fast response times at moderate intensity levels, responsitivity in both the visible as well as near infrared, and good sensitivity. Specific areas of interest are materials with response times of less than 1 msec at intensities of 10 mW/cm2, operating at wavelengths of 830-850 nm, and providing diffraction efficiencies of greater than 3%. Proposals are requested for production of materials meeting the above requirements for applications such as optical correlations and integration.

Phase I: Demonstrate feasibility of the growth of photorefractive materials with high speed and sensitivity in visible or near infrared. The contractor shall deliver a prototype material at the end of Phase I.

Phase II: Optimization of the photorefractive materials production and photorefractive characterization for commercialization.

Dual Use Commercialization Potential: These photorefractive devices are commercially applicable to robotics, machine vision, assembly line monitors, and sorting.

AF94-043 TITLE: Advanced Signal Processing Concepts for C3I

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: *Computers*

OBJECTIVE: Develop advanced signal processing algorithms and architectures for real time multi-function and multi-sensor system applications.

DESCRIPTION: Future and upgraded surveillance systems will have signal processing requirements which constantly grow and exceed the capabilities of today's technology. The development of artificial intelligence and numerical algorithms will support sensor requirements of detection, tracking and identification. These complex

algorithms also demand processors with high throughput, high internodal communications with substantially reduced size, weight, and power requirements. To meet these challenges, signal processing architectures and hardware must be flexible and adaptable to permit growth, and upgrade of processing components without change in the fundamental architecture. In addition, packaging signal processing systems in smaller volumes, with accompanying reductions in size and power, and an increase in the bandwidth between parts of the processing system are critical platform and portability requirements. Open system interconnect concepts will assure graceful upgrade ability and lower life cycle costs. However, these advantages must not come at the expense of programmability or design time. Innovative concepts in the following specific areas are of interest: interconnect bandwidth using Electro-optic interconnects; increased density by the use of Hybrid or Monolithic Wafer-Scale Integration (HWSI, WSI) in both two and three dimensions (stacking of substrates); open systems interconnect (OSI); real time fault tolerant support;rapid prototyping; artificial intelligence or knowledge-based techniques; and efficient use of numerical methods.

Phase I: A phase I contract will involve analysis and trade-offs for advanced algorithms, architectures and packaging technologies and how to rapidly prototype and implement the proposed design.

Phase II: Phase II will involve the demonstration of advanced concepts using a prototype system and implementation at Rome Laboratory's Surveillance Facility.

Dual Use Commercialization Potential: Commercial application for high performance processors in small packages are highly desirable for desktop workstations and portable instrumentation equipment.

AF94-044 TITLE: Advanced Information Fusion Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Development of new all-source data fusion technology applied to distributed environments.

DESCRIPTION: Data Fusion has been defined (Joint Directors of Laboratories (JDL) Technology Panel on C3 (TPC3), Data Fusion SubPanel (DFSP)))as: "Information processing that deals with the association, correlation, and combination of data and information from single and multiple sources to achieve refined position and identity estimation, complete and timely assessments of situations and threats, and their significance in the context of mission operation. The process is characterized by continuous refinement of its estimates and assessments, and by evaluation of the need for additional sources, or modification of the process itself, to achieve improved results." Current data fusion techniques beyond Level-1 (correlation) are mainly manual and cannot keep pace with the highly mobile, dynamic forces likely to be faced in the future. Current Level-1 fusion techniques only support limited sources, not all-source information. In addition, distributed data fusion is currently not available. This topical area will address advanced computing technologies for all-source data fusion, as well as distributed data fusion.

Phase I: Phase I will investigate advanced computing techniques (e.g., statistical, artificial intelligence, artificial neural networks, fuzzy logic) applicable to all-source data fusion. Phase I will result in a detailed plan and prototype software, which demonstrates the feasibility of a potential Phase II effort.

Phase II: Phase II will develop, implement, and demonstrate the advanced computing techniques applicable to all-source data fusion, as well as distributed data fusion, recommended in Phase I.

Dual Use Commercialization Potential: This topical area has dual-use potential wherever data from different (or even similar) sources are required for decision making. Examples of potential industries include: drug enforcement/ interdiction, medical, environmental, aerospace, automotive, and manufacturing.

AF94-045 TITLE: Advanced Infrared Sensor Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop innovative concepts in infrared (IR) sensor technology for improved detection, track, identification and navigation.

DESCRIPTION: Infrared sensor systems are an important part of any C3I system. Operation in a passive mode allows for both covert and autonomous operation which is often important in military missions. As such, IR can be an important adjunct to active radar which will allow for improved system effectiveness and enhanced data collection in battle. Infrared sensor systems need to be developed toward providing for increased survivability of future surveillance platforms and assured detection and tracking of ground, airborne, and theater ballistic missile threats. Most current sensor systems are based on line scanners and require complex optical and electronic support. The next generation of IR sensors must be simpler, driving system designs to staring operation, resulting in improved system reliability, lower cost and enhanced target discrimination. The heart of any IR sensor is the Focal Plane Array (FPA) which has detectors (pixels) in an x-y format. Current technology uses FPA's having more than 300,000 (480x640) pixels that can be fashioned into extremely high definition sensors with a small IFOV. Future FPA's will have more than one million (1040x1040) IR pixels and will be ideal for the long range surveillance mission. Current large format FPA's operate in the Midwave Infrared (MWIR) band, which is suitable for most atmospheric missions. Future growth of these large staring arrays into the Longwave Infrared (LWIR) band is anticipated and enhanced target information will be available from dual band operation. In addition, exploitation of their full capability is subject to the advantageous use of optimizing processing methods such as advanced frame to frame registration and clutter suppression techniques. The innovative concept should show promise of producing a performance improvement over current state-of-the-art. Improved infrared sensitivity, greater signal to noise ratio, enhanced spectral coverage, lower cost and improved MTBF are examples of desired performance enhancements. Areas of interest include but are not limited to infrared sensors, sensor systems, focal plane arrays, signal processing, and data processing.

Phase I: Develop the concept for advanced infrared sensor technology in sufficient detail for a feasibility determination to be made, perform an analytical evaluation of the concept, and perform a simplified simulation analysis of the concept.

Phase II: Develop a prototype of the concept for advanced infrared sensor technology. Perform detailed analyses of its overall performance and of its performance with respect to the most applicable mission for the concept. Perform an analysis to determine failure modes as well as to determine other, less critical weaknesses.

Dual Use Commercialization Potential: Infrared sensors have found only limited use for commercial applications because of high cost. New IR sensors based on low cost, staring FPA's will be more affordable and can be used by law enforcement, fire fighters and medicine. Advanced sensors must have both lower cost and improved reliability for commercial success.

AF94-046 TITLE: Self Organizing Database Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop automated tools/testbeds to evaluate self organizing heterogeneous database solutions to intelligence database deficiencies.

DESCRIPTION: This topic area addresses high priority needs in the area of data base technology and data organization. The effort will apply advanced mathematical techniques such as Complexity Theory, Chaos Theory, Catastrophe Theory, Genetic Algorithms, Neural Networks, and Case Based Reasoning to the problem of organizing huge amounts of unstructured data of heterogeneous type into a repository that clusters data by concept and relevance.

Phase I: Phase I efforts will develop the specification of a testbed for the evaluation of self organizing

database techniques.

Phase II: Phase II efforts will be the implementation of a testbed, including databases and measurement software for the evaluation of different approaches to self-organizing database systems.

Dual Use Commercialization Potential: The topic has dual-use potential use in the aerospace, financial, medical, and manufacturing industries. Advances in the technology of information systems and the accesses to multiple heterogeneous data bases are driving drastic changes in the frequency and ways that organization are requesting information. A variety of advances in mathematical techniques, and data models provide potential solutions to many of the technical problems that must be addressed by information oriented industries as it is driven by these changes.

AF94-047 TITLE: Speech Segmentation in Noise

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Development of algorithms to improve speech segmentation for improved speech processing.

DESCRIPTION: Current speech recognition and coding algorithms were developed to operate with clean speech inputs. This approach assumes an ideal situation and has limited application in the real world. Communications are often contaminated with noise (both acoustic and electrical) that causes rapid degradation in the performance of these algorithms. A key element in the algorithm degradation is the inability of the algorithms to dissect the speech signal into its components parts. This effort will develop a method to automatically segment speech in a noisy environment for subsequent speech recognition and coding. The capability to perform this type of segmentation on operational type signals is fundamental to the successful field implementation of speech recognition functions such as automatic word recognition, speaker identification, and speech coding.

Phase I: Develop methods to automatically and accurately segment noisy signals into voiced, non-voiced, and background (silence/noise).

Phase II: Develop methods to perform intraword segmentation for speech understanding and improved coding performance.

Dual Use Commercialization Potential: This topical area has dual-use potential in the medical, automotive, and aviation industries.

AF94-048 TITLE: Portable Language Translation Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop a field deployable machine aided voice translation system.

DESCRIPTION: There are a wide variety of military and commercial applications for which automatic speech translation, that is, the translation of spoken input in one language into spoken output in another language, would be useful. Although there has been some success in the development of very rudimentary systems, significant research must be performed to provide a highly capable, easily transportable form of this technology.

Phase I: Develop software systems which combine automatic speech understanding, machine translation, and speech generation; individual components that may be incorporated into such systems, and other possible media components that might be introduced into a spoken language translation system to determine the feasibility of utilization for spoken language translation in a portable system. Design a field-deployable spoken language translation unit fro use in a wide variety of mobile applications (vehicles, aircraft, ships).

Phase II: Develop a field-deployable prototype of an existing spoken language translation system and incorporate that system into a selected mobile environment.

Dual Use Commercialization Potential: This topic area has dual-use potential in providing translation at international meetings, as a tourist travel aid, in law enforcement query and as an aid in multi-national military operations.

AF94-049 TITLE: Digital Cartographic Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop software to enhance the operation of common mapping data structures and application tools.

DESCRIPTION: Standardized cartographic tools, applications software and common cartographic data formats have been developed to support a wide range of Air Force weapon systems that have requirements for digital maps and related products. Many of these developments have already found use in operational systems and will be maintained under configuration management as standards. Current effort is in progress to implement cartographic data sets and tools in sophisticated client-server structures on distributed networks to foster efficiency and interoperability. In spite of these successes, problem areas remain to be resolved. One specific area of interest concerns accurate registration of imagery and digital feature analysis data (DFAD) with gridded elevation data. Because of variations in scales, accuracies and formats registration of elevation data to imagery and DFAD, based simply on given coordinate values has not provided good results. The basic problem results from a lack of well defined features and feature prominent points in the elevation data that are common to features in the imagery and DFAD data, and which could be used to obtain accurate registration. This effort will seek to develop software techniques for extracting features from gridded elevation data which are common to imagery and DFAD features and can form the basis for accurate registration of the three data types. This will permit merging of the image grey scale values and vector features with the corresponding elevation data to enable accurate perspective view display rendering. A further goal of this effort will be to develop automated techniques for extracting the elevation features and automated techniques for accomplishing the subsequent registration process.

Phase I: Proof of Concept. Develop and prototype approaches for extracting common features in elevation image and DFAD data products for purposes of automated registration of all three products.

Phase II: Fully demonstrate automated extraction of features from gridded elevation data sets and demonstrate accurate, automated registration with imagery and DFAD products over the same area.

Dual Use Commercialization Potential: This technology has dual use potential for applications that involve the use of digital maps for land resource management, city planning and regional development, forest conservation and similar applications where interrogation and display of earth surface features is needed.

AF94-050 TITLE: Intrusion Prevention Systems

CATEGORY: Exploratory Development

OBJECTIVE: Provide technology which will assure the physical security of a wide variety of facilities.

DESCRIPTION: Innovative approaches are sought in two aspects of intrusion detection and prevention: a. Development of a portable video assessment system with wireless video transmission capability which would allow security personnel to quickly determine the actual cause of an alarm and its validity. Effort would consist of analyzing requirements and revising and evaluating advances in technology and products which may be applicable. b. Study and identification of possible countermeasures which could be applied against state-of-the-art intrusion technology and development of adequate responses (counter-countermeasures) to identified threats.

Phase I: Would be a feasibility study applied to a typical area requiring protection and would identify possible countermeasures to existing physical and perimeter control technology.

Phase II: Would develop a working prototype which would apply identified methodology/processes to the fabrication, testing, and use of the identified countermeasure techniques, devices, and materials.

Dual Use Commercialization Potential: Results of this effort would be useful for any business, industry, or government function which requires protection of an area from intruders. This could include factory sites, transportation facilities (airports, railroad yards and track facilities, truck terminals, dock areas), prisons, retail stores, office buildings, and banks.

AF94-051 TITLE: Electromagnetic Interface Design Tool (TDE)

CATEGORY: Exploratory Development

OBJECTIVE: Develop a computer-aided-design tool to minimize electromagnetic interference (EMI) on printed circuit (pc) cards and laminae.

DESCRIPTION: Software would evaluate the extent of EMI by calculating switching rates, spectral characteristics, oscillator frequencies, voltage and current values, pc layout parameters, power filtering, logic device capacitive coupling and decoupling, and attenuation and resonance effects. The resulting display would be a color-coded image of the pc indicating the EMI hotspots; a contour map and associated printout of predicted EMI levels would be provided.

Phase I: Provide a report describing the proposed concept in detail and showing its viability and feasibility.

Phase II: Fabricate and demonstrate a prototype software program.

Dual Use Commercialization Potential: Successful results of this effort would be immediately applicable to the electronics industry and could be incorporated into the standard suite of printed circuit design software tools.

AF94-052 TITLE: Robust Planning Technology in Uncertain Situations

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop feasible methods for specifying military plans considered robust by military experts.

DESCRIPTION: Automated techniques for generating military plans are being developed using Artificial Intelligence (AI) planning and scheduling techniques. These techniques have been demonstrated to support the rapid, accurate and efficient creation and modifications of plans for use in various operational environments with little uncertainty. However, the optimization criteria used in current knowledge engineering methods (usually embodied in heuristics, utility functions, etc.) do not capture the military planners' notion of robustness in a partially known environment. For instance, one measure of robustness to a planning technologist could be the ability of the system to backtrack through a search space of plan representations, while to a military planner it could be the ability to replan in response to changes in the real world situation. Equivalent definitions of robustness, one understandable to military planners and the other understandable to planning and scheduling researchers are needed.

Phase I: In Phase I the offeror shall develop optimization criteria that embody equivalent definitions of robustness and implement a small scale prototype embodying the developed robustness criterion, and analyze its computational complexity. Phase II: In Phase II the offeror shall use the proposed techniques to plan against standard scenarios selected in cooperation with the government, and shall instrument the implementation to facilitate meaningful comparisons with other techniques.

Dual Use Commercialization Potential: Robust knowledge-based planning technology will be applicable

to a wide range of planning, scheduling, and resource allocation problems in diverse fields such as manufacturing, logistics, transportation and environmental planning, etc. These applications differ only in the degree to which the plans are unique, the rate at which changes occur during plan execution or to the goal structure upon which the plan is based, and the temporal, causal, resource and task complexities of the plan.

AF94-053 TITLE: Technology for Building Large Scale Knowledge-Based Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop techniques and tools for use in the implementation of quality, robust, large-scale knowledge-based systems

DESCRIPTION: This technology program focuses on innovative research investigations to identify new methods for the design, integration and evaluation of intelligent functionality in software. Investigations in the following five areas are of interest: 1) techniques for behavior certification of AI software including verification techniques, performance assessment via learning, and minimum competency (fail safe); 2) integration techniques for knowledge sharing and reuse, distributed knowledge bases; 3) new AI software acquisition methodologies including techniques for behavioral requirements specification, quality assurance; 4) knowledge acquisition methods enhancing knowledge discovery in massive multimedia databases while exploiting high performance computing mechanisms; and 5) AI techniques for simulation modeling and simulation development environments.

Phase I: Phase I efforts will investigate the feasibility of developing promising techniques.

Phase II: Phase II will implement Phase I techniques and demonstrate feasibility on both military and commercial application domains.

Dual Use Commercialization Potential: A mature knowledge-based systems engineering technology will fill gaps in existing approaches to multi-function integration, system level design, performance evaluation and system acquisition. New tools can provide gains in development time and cost for large-scale commercial applications equal to those for similar military applications. Currently cost and risk is so overwhelming that many important large-scale developments cannot be undertaken without undue risk. This technology could have major impact on applications such as nuclear power plant control, autonomous vehicles, aircraft operation, hospital life support systems, decision support systems, and military command and control.

AF94-054 TITLE: Distributed Information Systems Resource Management

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop mechanisms which will provide uniform control over the combined networking and processing resources which together make up a distributed information system.

DESCRIPTION: The trend in information systems technology is toward large, multi computer distributed information systems which must support the uniform access to globally distributed data under varying conditions of load, required response time, user model and external environment. The processors which are being developed provide orders of magnitude increase in computational power, while the interconnecting networks are approaching gigabit speeds. To effectively harness this new capability in a cohesive system which can dynamically respond to widely varying conditions it is necessary to abandon many of the current paradigms which treat the computers

and the communication as discrete entities, with little or no concept of integrated resource management, and develop new mechanisms. In this new model the user/application is the controlling element which provides to the system resource manager the necessary information to optimize performance. For example, in an air traffic control system, if an overload could include reallocation of communications links, reallocation of processing elements, shedding of lower priority tasks, etc. All of this would be accomplished under a policy specification pre-existing in the system. To effectively accomplish this a uniform object model representation of all of the resources must be developed. Mechanisms must be incorporated which can translate system state parameters and application model definitions into configuration parameters. The final capability would be demonstrated on a local cluster configuration.

Phase I: Develop a characterization of the object model to control a local cluster composed of high performance workstations interconnected by an set of ATM communications links. The configuration should support distributed shared memory, global object identification and uniform process control across the configuration.

Phase II: Implement the basic object model on a three node configuration to demonstrate the resource reconfiguration capability based upon application specified parameters.

Dual Use Commercialization Potential: This technology will be equally applicable for distributed command and control systems for the DoD, air traffic control information handling systems for the FAA, global financial transaction systems for the banking and investment community, etc. As the telecommunications innovation drives the interconnection of ever larger numbers of computers, the need for these global resource management mechanisms will become ever more important for all segments of the economy.

AF94-055 TITLE: Data Management for High Performance Computing

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: The objective of the effort is to develop tools and techniques for finding a solution to storage access problems associated with high performance computing (specifically, massively parallel computers in heterogeneous systems).

DESCRIPTION: The world of high performance computing provides a capability for significant gains in overall system/software throughput. However, these performance gains are often not up to expectations due to limitations in the way data is accessed and other input/output limitations. In particular, concurrent access to and from files in secondary storage is a critical problem that hinders parallel processing effectiveness due to the low physical bandwidth between the processors and disks, thus creating a bottleneck in the system. Software methods of obtaining high bandwidth data I/O where physical bottlenecks exist, needs to be investigated as one possible solution to the storage access problem currently associated with high performance computing. Software tools and techniques are required that will automate or simplify the process of designing and handling concurrent queries into disk systems with greater efficiency and ease of use. Such tools will be capable of assisting the engineer in the decomposition of data into a usable format on single or arrays of disks. This decomposition will provide to the programs executing on homogeneous or across heterogeneous systems, the means to utilize the data in the most efficient manner. Finally these tools will provide greater ease-of-use for programmers to access to parallel file systems found in today's newer systems.

Phase I: The work to be accomplished in Phase I will provide new and/or significantly improved software engineering capabilities to examine, develop, prototype, and demonstrate advanced data management techniques, particularly in the high performance computing domain.

Phase II: Efforts undertaken in Phase II will concentrate on taking the design and demonstratable prototype provided in Phase I and follow through with a full data management for high performance computing development process to deliver an operational prototype tool.

Dual Use Commercialization Potential: The underlying scope of the research to be performed in this endeavor is applicable to a wide range of high performance computing systems, and is very generic in nature. As

such, it possesses significant application to the development of a number of commercial computer and software systems in such arenas as the aerospace industry, the automotive industry, banking/finance fields, as well as medical related activities.

AF94-056 TITLE: Self-Healing Communications Networks

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop advanced technologies to support survivable communications networks that are able to adapt to dynamic topology changes.

DESCRIPTION: As efforts continue to extend computer and communications networks as far into the battlefield as possible, managing and configuring these networks becomes increasingly difficult. The battlefield theater environment is vastly different from the traditional environment communications networks were initially developed for. Traditionally, networks have existed in stable locations and changes were allowed to the network configuration only after careful consideration of the impact to the overall network. In the war fighting theater of the very near future, elements of a communications network may change locations, transmission media or traffic types as they move about the theater. Such changes will be dictated by battlefield conditions and the network will have no choice but to adapt. As elements in the theater move about (or cease to exist), the network must be able to reconfigure (or "heal") itself, without interrupting the integrity of the network. To accomplish this, routing and management schemes need to be developed which can adapt quickly and without human intervention.

Phase I: Phase I is expected to investigate the feasibility of implementing self-healing protocols and hardware for the theater environment.

Phase II: Phase II should produce actual implementations of demonstrable protocols and hardware that would allow the concept of a self-healing network to be demonstrated and explored in a laboratory environment that simulates the actual theater conditions.

Dual Use Commercialization Potential: This topic has dual-use potential in the telecommunications, data-communications and mobile telephone industries.

AF94-057 TITLE: Virtual Environment Systems Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop techniques to provide enhanced visualization and input to a synthetic user environment.

DESCRIPTION: State of the art display technology is currently limited primarily to portraying two dimensional full color high resolution graphics. Recent advances in both the computing and display area have resulted in prototypes of synthetic, virtual reality environments which have the potential to revolutionize the use of computers for simulation, training and command and control. These environments provide the capability to interactively display and manipulate both static and dynamic data having three dimensional form and position. It can encompass terrain and feature data, natural phenomena such as clouds and weather, man made structures and obstacles, and allow the user to navigate thru the environment sensing the visual, auditory and tactile sensations. To make these environments practical there are numerous technical obstacles that must be overcome. One of these deals with the mapping of multiple resolution display images which may be both live and synthetic, originating from

multiple sources onto a common high resolution display surface, couple with innovative environmental sensing technology.

Phase I: Investigate and design innovative mechanisms for the sensing and displaying the common mapping format described above.

Phase II: Prototype the capability investigated under Phase I

Dual Use Commercialization Potential: The use of virtual environments has already occurred in the entertainment area, and has potential usage in numerous other commercial areas. Its use as a training vehicle, design and diagnostic tool and simulation environment have all been well documented. The underlying technology is the same whether we are considering DoD or commercial applications.

AF94-058 TITLE: Intelligent Design Tools

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Development of knowledge-based tools providing intelligent assistance for formal design, development, and maintenance processes.

DESCRIPTION: This effort will support transition of technology developed in the Knowledge-Based Software Assistant (KBSA) program into commercial products. The KBSA is an ongoing research program to improve software quality and reduce cost. The fundamental principles of KBSA are: 1) all processes and products are formally represented; 2) iterative development and validation of a specification are emphasized; 3) maintenance activities are indistinguishable from development; and 4) all activities are computer mediated and assisted. Proposed research should adhere to the KBSA principles but may explore applicability to other domains and enhancement beyond its software development focus. In addition to these principles, the following characteristics are desirable: (1) all objects and actions should be represented in a mathematical formalism to enable automation and intelligent assistance;(2) informal and familiar abstractions should be provided to support user interaction; and(3) a formal specification should be derivable from the abstractions and play a central role in any product. Specific areas of interest are tools related to software development and support activities, system engineering, hardware design, facility design, platform design, and process design and enactment.

Phase I: Phase I of this SBIR would result in a demonstration of the feasibility of the proposed product and a functional specification and operational concept document.

Phase II: Phase II would result in a prototype implementation of the proposed design tool and a system specification suitable for subsequent product development.

Dual Use Commercialization Potential: This technology area is domain neutral and is of greater potential benefit as a commercial product than as a purely defense related product. Design and process automation are cost and quality drivers and can provide a competitive edge in any market.

AF94-059 TITLE: Indium Phosphide Componentry for Microwave, Millimeterwave, and Digital Systems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop low loss microwave and high speed digital components and devices.

DESCRIPTION: Recent developments in Indium Phosphide-based technology clearly show superiority over Gallium-Arsenide devices in terms of speed, frequency of operation and bandwidth. When this material is incorporated into components, applications will enable a significant increase in data throughput capability, while at

the same time lowering cost, power and weight requirements. Innovative research for the applications of this material includes but is not limited to monolithic millimeterwave transmit and receive components for phased-array antennas, data processing, and switching terminal applications. Examples of components needed include oscillators, amplifiers, mixers, filters, isolators, circulators and antenna feed structures. Research to develop digital technology such as A/D converters (18 Bit, 100 MHz), shift registers, signal processing and data switching circuits is desired. Electronically variable ways to control amplitude, phase, or time delay in electrically large, wideband phased arrays are of interest. Innovative, monolithic, phased-array elements are needed. Improved design models are needed for millimeterwave Indium Phosphide High Electron Mobility Transistors on materials optimized for power applications. Approach here would require excellent knowledge of semiconductor physics and could utilize Rome Laboratory in-house experimental measurements.

Phase I: The contractor should identify a specific indium phosphide component or technology area for innovative research, perform preliminary design or analysis, evaluate critical elements, and perform preliminary experiments to clearly demonstrate technical feasibility of the concept.

Phase II: A Phase II contract will require design, fabrication, test and delivery of a prototype indium phosphide component or, for modeling work, successful prediction of device performance.

Dual Use Commercialization Potential: The civilian need for EHF communications and data highway technology eventually will grow as fast in the civilian sector as it is currently expanding in the DoD. Among many civilian applications are geosynchronous and low-earth orbit communications satellites capable of handling multigigabit data streams; commercial conformal antenna arrays and terminals on aircraft for crew and passenger data links via satellite to ground; conformal antennas and terminals on automobiles and trucks for navigation, communication and avoidance radar applications on the "smart" highway of the future; and commercial and residential antennas and terminals for data highway applications.

AF94-060 TITLE: Multifunction Radio Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate radio and adaptive speech compression technology which supports theater extension for global communications (Global Reach/Global Power).

DESCRIPTION: The US has a global communications requirement to enable rapid application of air combat power via assured connectivity with timely, reliable, responsive, yet affordable, dissemination of information from HQ's down to the lowest, mobile, tactical force elements. The AF needs innovative research to enhance our ability to transfer large amounts of data, quickly, accurately, and securely. Researchers must identify promising communication technologies which will provide substantial immunity to hostile action (electronic warfare), maintain connectivity in the face of battle damage (link outages), meet requirements for high performance in capacity and timeliness, be user-friendly, and enable transparent connection and interoperation with other services and friendly forces. Special task areas for innovative research include methods and techniques that: a) enhance throughput, streamline interfaces to global communications assets and advanced radio architectures, and increase modularity, programmability, security (including LPI/D and AJ techniques), commonality and compatibility throughout various military and civil services and across the frequency spectrum; b) through signal detection, waveform recognition, parameter estimation, passive surveillance and interference excision, enable radios to sense and dynamically adapt to the signal environment to optimize performance; c) exploit adaptive rate speech compression techniques to adaptively manage the simultaneous transmission of secure voice and data over fixed narrowband channels for survivable communications networks; d) provide efficient means to couple wideband transceivers to either a singular wideband antenna, or multiple single-band antennas, that cover the range of 2 MHz to 2 GHz, are low-loss, small-size, and capable of supporting instantaneously, wideband spread spectrum, and fast-hopped waveforms; e) enable radio operators, via flexible, user-friendly Man Machine Interfaces (MMI), to quickly and efficiently manipulate functions within integrated communications assets, with minimal errors and training. Virtual control panels or pull-down trees are avenues for consideration and comparison.

Phase I: Identify techniques, explore algorithms, design interfaces, analyze and define designs for task

areas a-e above. Provide comparison and simulation support for design decisions and detail trade-offs. Supply test and analysis data.

Phase II: Develop and demonstrate improvements attained through the application of Phase I concepts, techniques, and designs.

Dual Use Commercialization Potential: The commercial sector is urgently in need of secure, reliable, and flexible communications which are free of benign interference and noise. Advanced communications techniques such as spread spectrum, LPI/D, interference excision, waveform recognition, etc., perform as well to counter noise, interference, spectral congestion, and other civil communications difficulties. Innovations in multi-band antennas and couplers, wideband transceivers, and MMT techniques are also transferable to the commercial user. Newly developed Frequency Domain Speech Compression techniques provide flexibility, security and high quality speech reproduction. Conversely, commercial communications developments will be exploited extensively for military use. Programmable and flexible interfaces between military radio equipment and commercial networks will enlarge dual-use potential.

AF94-061 TITLE: High Temperature Superconductive Components for Multi-media Communications

CATEGORY: Basic Research

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop low loss microwave and high speed digital superconductive electronic components.

DESCRIPTION: Recent accomplishments in superconductivity invite new advances in communications technology. Applications will enable a significant increase in data throughput capability, while at the same time lowering cost, power and weight requirements. Innovative research for the applications of superconductivity include but are not limited to monolithic EHF transmit and receive phased-array antennas, data processing, and switching terminal applications. Examples of components needed include oscillators, mixers, filters, isolators, circulators and antenna feed structures. Research to develop superconductive digital technology such as A/D converters, shift registers, signal processing and data switching circuits are desired. Electronically variable ways to control amplitude, phase, or time delay in electrically large, wideband phased arrays are of interest. Innovative, monolithic, phased-array elements are needed which are compatible with thin-film superconducting feeds, and efficient radiators that provide thermal isolation of the superconducting feed circuits from ambient free-space temperatures. Where possible high-temperature superconductive digital and high power analog circuits are required. For this it is necessary to develop high-temperature weak link structures and thin-films capable of handling high power, i.e., 1.0 KW. The development of a practical technique for making a large number of reproducible junctions from high-temperature superconducting films, and the fabrication of logic circuits and shift registers using these junctions is necessary.

Phase I: The contract should analyze the theoretical background, and perform preliminary experiments to clearly demonstrate the technical feasibility of the proposed concept.

Phase II: The contract will require the development, test, analysis and conclusive proof by prototype demonstration of the component. Specific plans for transitional to Phase III will be detailed.

Dual Use Commercialization Potential: The civilian need for EHF communications and data highway technology eventually will grow as fast in the civilian sector as it is currently expanding in the DoD. Among many civilian applications are geosynchronous and low-earth orbit communications satellites capable of handling multigigabit data streams; commercial conformal antenna arrays and terminals on aircraft for crew and passenger data links via satellite to ground; conformal antennas and terminals on automobiles and trucks for navigation, communication and avoidance radar applications on the "smart" highway of the future; and commercial and residential antennas and terminals for data highway applications.

AF94-062 TITLE: Multifunction Conformal Antennas

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop affordable array antenna technology for future air vehicles.

DESCRIPTION: Military, commercial, and private air, ground and sea vehicles of the future will require sophisticated but affordable antennas. Diverse requirements in areas such as video, voice, data and fax links, GPS connectivity, surveillance and collision avoidance radar, emergency communications, and multi- gigabit per second digital connections. Performance requirements will vary from high gain, multi-element arrays to low gain, multiple function single elements with broad spatial coverage. Sensor systems will operate in narrow bands or in multiple bands within the full microwave spectrum. Recent developments in digital array beamforming, adaptive control and neural networks show promise of leading to far more flexible and ultimately less expensive sensors for commercial as well as military systems. These new capabilities include smart control for array antennas that can sense failures and correct or compensate antenna patterns, super-resolution and neural network techniques that can perform accurate direction finding with smaller systems using less accurate, lower cost components. Automatic system calibration based upon the use of available beacons in the case of mobile collision avoidance, and adaptive cancellation of interference for mobile satellite terminals. These capabilities allow the use of small, low cost radar and communication sensors with increased capability due to the flexibility of digital adaptive and smart control. Since most of this flexibility will be implemented by and under computer control, the development of low-cost, digital beamformer modules containing all components from radiating element to analog to digital converter is key to this initiative.

Phase I: The contract should target a specific antenna application, refine the concept by a thorough theoretical analysis, trade study and error analysis, and perform preliminary experiments on key subsystems that will test the overall idea.

Phase II: The contract should demonstrate the full r-f performance expected by a prototype operating in a realistic environment, and deliver a component, subsystem, or full system implementation so as to attract Phase III venture capital with a working prototype.

Dual Use Commercialization Potential: An expanding commercial use of high technology products will include radar and communication capabilities for a variety of portable and mobile systems. Included are mobile links to Global Positioning Satellites, manpack and vehicle mounted satellite links, collision and high data rate links for voice, video, data and fax. These systems will face increasing demands for improved performance while maintaining pressure to continually lower cost.

AF94-063 TITLE: In-Line Real Time Wafer Level Monitoring Techniques

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop advanced integrated circuit wafer-level in-line real-time techniques for monitoring integrated circuit reliability, thereby decreasing overall manufacturing costs and increasing the reliability of fielded systems.

DESCRIPTION: Most integrated circuit reliability testing is performed on a post fabrication basis. Therefore, a reactive response is required should the data show problems exist. Testing performed this way increases manufacturing costs through greater quantities of scrap, material usage and employee time. Also, not only is the wafer lot, which tested positive for the problem affected, but everything in production since then will be subject to the same problem. By moving to an in-line real-time monitoring system, manufacturer's will realize a cost reduction by positioning themselves for proactive solutions before multiple product lots are affected. This will

necessitate changes in the parameters measured, as they will now be geared to the parameters (i.e., temperature, time, air purity, etc.) creating the material (i.e., oxide, metal, etc.) affected by the failure mechanism (i.e., oxide breakdown, hot carrier degradation, electromigration, etc.) and not the failure mechanism directly.

Phase I: Phase I will research process parameters suitable for monitoring reliability failure mechanisms and propose monitoring techniques.

Phase II: Phase II will implement the monitoring techniques and demonstrate the improved reliability of the process.

Dual Use Commercialization Potential: In-line monitoring techniques are applicable to all commercial integrated circuit production lines to assure manufacturability and cost competitiveness.

AF94-064 TITLE: Low Cost Dual Use Environmental Measurement Device (EMD)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Build a small, reliable, low cost EMD using off-the-shelf components.

DESCRIPTION: An EMD will be designed and built using innovative environmental sensors. The design shall emphasize low cost, reliability, small size, and low weight. The module would be tailored to broad general use within government and industry for applications such as weather data collection, monitoring transportation of equipment, warranty verification, and operational environment determination. The EMD, capable of performing a 30 days operation shall weigh less than 20 lbs. Data will be obtained for the device using the RS-232 based computer. Research into methods for debriefing by modem from an ac line shall also be preformed.

Phase I: Complete plans, sufficient for construction or repair, and a prototype, adequate for test and evaluation will be supplied.

Phase II: Prototype units will be developed for subsequent test and evaluation.

Dual Use Commercialization Potential: Environmental measurement devices are applicable to the automotive, airline and ground transportation industries for monitoring failure causing hazards. They also are needed for the machine tool manufacturing industry as well as any automated production line.

AF94-065 TITLE: Tools for Reliable and Manufacturable VLSI Microcircuits

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Development of methods and software tools for the optimization of gate level VLSI designs based upon reliability, speed, power, and area.

DESCRIPTION: Present methods for optimizing designs of VLSI circuits are based on VHDL gate level descriptions and employ a trade-off of speed with power or area or both. Reliability is not considered; but is important because of the need to shorten the time from concept to delivery, and to help assure that the delivered circuit does not contain a reliability time bomb. Reliability in this context means susceptibility to end of life failure mechanisms such as electromigration, hot electron degradation and/or short term reliability considerations such as ground bounce, voltage drop in power buses or latchup. This effort would develop methods and software tools for optimizing designs based on the reliability impact of the design implementation (fan-out of gates; functional implementation; power bus widths; and circuit application in the case of ASICs) and the trade-offs of reliability with speed, power and area.

Phase I: Define an approach and outline the methods for the optimization.

Phase II: Fully develop the methods and implement them in software tools; evaluating the tools against design test cases.

Dual Use Commercialization Potential: The software tools are critical for developing high reliability medical electronics (pacemakers/health monitoring systems) and safety related technology (automotive and aircraft control electronics).

AF94-066 TITLE: Visualization Techniques for Computational Electromagnetics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Design Automation

OBJECTIVE: Develop innovative uses of graphics workstations to assist the interactive analysis and design of electromagnetic radiating and scattering systems using a variety of computational electromagnetics tools.

DESCRIPTION: A variety of computation-l electromagnetic analysis programs exist for the design of large antennas and scattering systems and to anal ze their interaction with the environment and electronics. The simultaneous, interactive use of these programs is becoming possible. Also, computer graphics work stations permit the analysis of large scale, optically illuminated scenes and the workstations permit interactive viewing of the scenes with a variety of illuminations and reflecting and refracting surface textures. The use of these same graphics work stations to analyze electromagnetic systems with monochromatic, coherent illumination has been demonstrated (IEEE Antennas and Propagation Magazine, April 1993). This work will explore the marriage of graphics work stations and large scale computational electromagnetic analysis programs to permit more effective computer aided analysis of large, complex antenna and scattering systems. Emphasis should be placed on techniques to permit the design engineer to visualize the mechanical and material properties of the structure or sub-structure being analyzed, visualize the large mass of technical data developed to assess design trends and to focus on effective modeling and analyses of sub-structures in the context of the larger design problem. Methods to verify and validate the design results with novel measurement and analysis techniques will be considered also.

Phase I: Identify innovative concepts which can be applied to increase the efficiency, effectiveness and applicability of current computational electromagnetic tools by the use of graphics work stations. Demonstrate the engineering design advantages by creating software to analyze one, limited class of important problems. Analytically estimate the advantages for an extended class of design problems.

Phase II: Develop, document and demonstrate an interactive, computational electromagnetic design program for an extended class of problems. Conduct preliminary testing of the design program to include limited testing and commentary with design engineers and experimental confirmation of the accuracy of the design data. The potential exists for joint testing with the Rome Laboratory using Government design engineers and measurement facilities.

Dual Use Commercialization Potential: Visualization tools are key for effective computer aided design and manufacturing of large antennas and the analysis of electromagnetic interference and compatibility problems in future, high data rate communications systems. Also, the tools developed will be useful in the education of engineers, and in the design of medical imaging systems, non destructive testing of large structures, and in the analysis of electromagnetic interference effects on airplanes and automobiles.

AF94-067 TITLE: High Reliability and Efficiency Microwave Solid State Power Generation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Eliminate the diffusion-related gain degradation problem present in microwave power heterojunction

bipolar transistors (HBT).

DESCRIPTION: For microwave power generation, HBT technology is emerging as a potentially cost-effective alternative to the metal-semiconductor field-effect transistor (MESFET)-based technology, as it requires only one power supply instead of two. Although digital HBTs are meeting today's specifications, the viable use of high power HBTs has been diminished by reliability problems. These devices, with the current state-of-the-art fabrication technology, are plagued by thermal problems, caused by diffusion of dopant from the p-type layer at high temperatures. A new low-temperature molecular beam epitaxy (MBE) growth method is needed to grow highly doped (5.0 E +19 cm^-3) epitaxial layers to assure a very sharp p-n junction with no diffusion. These devices must have a forward DC characteristic with low offset voltage and very sharp turn-on compared to FETs in order to achieve high current gain and high RF output power. Novel approaches to producing high current gain, high reliability, high performance, and high power HBTs will be considered. Fabrication of simple test structures will be required for conducting accelerated stress life tests in order to verify that the new technology is capable of producing high reliability devices.

Phase I: Investigate possible approaches, selecting one or more candidate approaches. Design new product devices based on selected approach.

Phase II: Fabricate new product devices and test structures using selected approach and carry out long-term accelerated life test followed by detailed failure analysis.

Dual Use Commercialization Potential: Microwave communication devices exemplify dual military/commercial uses because the same technology used to make solid state radar can be commercialized for satellite communication via cellular phones.

AF94-068 TITLE: <u>Integrated Diagnostics for Multi-Chip Modules (MCM) Technologies</u>

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop/Verify Built-in-Test (BIT) Techniques to assure cost effective/comprehensive methodologies for performing diagnostics for MCM and DOD/Industry applications.

DESCRIPTION: Integrated testability diagnostic technologies are a critical elements for improving the support capability of AF weapon systems. The ability to design testability into a system and exploit the BIT as an integral part of the diagnostic process must be establish via a chip through system diagnostic approach. This technical capability will provide logistics organizations with a significantly improved maintenance capability in recognition of the consequences of reductions in force structure and resources. Technology needs exist in both the development of new diagnostic technology and the integration of existing tools and techniques for diagnostics. Chip-Through-System testability techniques need to be established to integrate test and diagnosis vertically by considering the top-down allocation and bottom-up implementation of system wide testability. This integrated chip-to-system approach for testable and diagnosable design must address all levels of system indenture. MCM design and analysis techniques for testability must be established to link the BIT capability developed for the MCM with the system level diagnostic strategy. Efficient and effective diagnosis for faulty electronics requires elaborate BIT techniques be developed within the MCM and be assessable by any diagnostic subsystem performing a verification of functional status. This MCM diagnostics technology will provide a systematic process for design, test, and verification techniques and, in turn, a more productive and cost effective diagnostic and maintenance capability.

Phase I: This effort will develop built in test approaches for MCMs which will satisfy specific DOD and commercial requirements.

Phase II: This effort will use the developed built-in-test approaches to prove effectiveness and cost savings associated with these approaches as well as demonstrate the diagnostic capabilities on both a commercial and DOD application.

Dual Use Commercialization Potential: With the ever increasing push to add more capability into smaller,

lighter weight applications, research into multichip modules has seen a significant increase in interest by both the DOD and industry. Cost to test these complex devices has become a technology roadblock to transition MCM technologies into the market place. This effort will reduce test times and cost as well as increase the diagnostic capabilities of these devices in system applications.

AF94-069 TITLE: Applications of Ultra-Thin Semiconductors in Space Systems

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop and demonstrate techniques for thinning "as-built" wafers and/or separated integrated circuit devices to hyper-thin dimensions (<25 microns).

DESCRIPTION: Techniques must be developed and demonstrated in a manner which allows their subsequent packaging and reliable operation in space environments. The expected benefits of this technology are that the density, thermal transport, and radiation performance of semiconductor devices will be improved. This technology provides a complementary alternative to other existing and contemplated approaches which provide these enhancements. Furthermore, other radical, intriguing possibilities exist. For example, it may be possible to implement the design of conformable electronic systems that need not be affixed to planar substrates. Rather, it is conceivable that electronics subsystems and components could be mounted on curved or perhaps other irregular surfaces, such as those found in the interior of a missile or spacecraft. It is currently common practice in the Japanese semiconductor industry to backgrind memory components for inclusion in the class of chip carriers known as thin, small outline packages (TSOPs). The motivation for this approach is to improve the density and thermal dissipation characteristics of memory components. As such, portable computer systems can easily accommodate dozens of memory components within their small physical form factors. The dimensional range for these thinning operations roughly spans 7-10 mill-inches (up to 250 microns). Thinning silicon and other semiconductors to well below these dimensions (<<5 mill-inches or 125 microns) opens an intriguing if not challenging realm, hereafter referred to as "hyper-thinning." Of course, with hyper-thinned silicon, additional density is gained and thermal transport is improved since the heat produced by the component has a shorter exit path. Beyond the obvious, however, are new possibilities which have been postulated but remain to be adequately understood. For example, hyper-thin silicon loses its brittleness, and it has been indicated that components prepared in this manner might even be conformable to a wide variety of irregular surfaces. Additionally, some speculate that hyper-thinning certain silicon circuits might improve their radiation performance. In other cases, it has been suggested that stacks of sensitive, hyper-thinned wafers (set apart by less than 50 microns) might constitute a superior new form of a particle detection system. Innovative applications of silicon in the hyper-thin regime to space systems are sought.

Phase I: Proposals should explore in depth the appropriate treatment procedures of a candidate semiconductor process for hyper-thinning. Teaming with established, spacegrade microcircuit manufacturers is encouraged in order to access superior baseline process technologies. The basis for a suitable application complementary with the hyperthinning technology must be thoroughly evaluated.

Phase II: A typical Phase II program would implement reliability investigations of the hyperthinned components along with the development of a demonstration application. A successful phase II program would bridge the thinned component process technology and/or the candidate application into other applications.

Dual Use Commercialization Potential: Although the technology will enable military requirements, the importance of establishing an infrastructure for availability through commercial catalyst applications can not be overemphasized. The basis for suitable military and merchant application complimentary with the hyperthinning technology must be thoroughly evaluated and established to define demonstratable Phase II applications.

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AF94-070 TITLE: Applications of Micro-Machining Technology in Space Systems

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop and demonstrate micromachinging techniques applied to advanced microelectronics packaging and other space-critical technology areas.

DESCRIPTION: New advances in the fields of micromachining are expected to provide enabling benefits in the capability of space systems. Among the many problems faced by space systems are the need for improved thermal management, sensor integration, and embedded electronically-activated actuator assemblies. Micromachining technologies, especially those pertaining to silicon, have evolved over the last several decades. Micromachined features and components offer extraordinary efficiencies in their functional domain as compared to similar "macromachined" equivalents, alleviating extra bulk, structural interfaces, and cooling/heating requirements. While many intriguing and promising developments have been reported, some of the most salient micromachining concepts are still considered lab curios. For example, in advanced packaging, micro-channel cooling technologies, with tremendous heat removal capacity, are well-known in the literature and simple to replicate in the laboratory, but they have not been transitioned into applications that could benefit from them. Innovative improved advanced packaging technologies through the development, insertion, and demonstration of novel micromachining concepts are sought.

Phase I: Phase I proposals will address practical techniques to improve particular aspects of space system design and fabrication. Technologies that allow enabling, systematic reductions in size, weight and power while maintaining or improving performance and reliability are of keen interest. The categories for improvements include (but are not limited to): advanced packaging, improved thermal management, micro-encapsulated cryogenic coolers (for infrared focal plane arrays and detectors), positive component securing techniques, embedded micro-mechanical relays, micro-mechanical solenoids, and inertial referencing components (accelerometers, gyroscopes). Practical technology insertion must be addressed, particularly noting: 1) the space environmental context of prospective applications, which will drive reliability and ruggedness, and 2) the tremendous potential for cost reduction, establishment of manufacturing infrastructure, and enhancement of domestic competitiveness through commercialization of these technologies.

Phase II: Demonstrate the repeatable, quality formation of components. Cooperation and leveraging one or more already existing multi-chip module (MCM) technologies is highly encouraged, as it is not the desire or intent of this topic to invent a new MCM approach.

Dual Use Commercialization Potential: The results of a successful Phase II approach would lead to superior micromachined applications that could be inserted in space-based and other military and commercial

applications.

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AF94-071 TITLE: Component Enhancement of AMTEC Devices

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop components which enhance the performance, reliability, lifetime, and cost of AMTEC devices.

DESCRIPTION: AMTEC (Alkali Metal Thermal to Electric Conversion) is a relatively new energy conversion concept, related to the sodium sulfur battery, which, when used with a solar thermal or nuclear heat source, could provide efficient, low mass, low cost, high reliability, long-lived power systems for Air Force satellites. This topic seeks innovative component technologies to further improve the life, reliability, performance, and cost of AMTEC power systems.

Phase I: The contractor shall identify such technologies and determine their usefulness to meeting the solicitation goals when incorporated into a power system. The contractor shall also formulate a development and testing plan for integrating the technology(ies) into an AMTEC cell.

Phase II: The contractor shall construct one or more AMTEC cells incorporating the innovative components and test them to determine their overall utility. The contractor shall also assess the applicability of these components to other energy conversion systems.

Dual Use Commercialization Potential: The components could be further developed to meet the specifications for a particular application, including adaptation to meet the requirements of a sodium-sulfur battery. Potential applications of the power conversion technology developed by this effort include primary and secondary space and terrestrial power systems. Specific potential commercial applications include serving as the thermal to electric conversion device in an external combustion/battery/electric motor automobile power plant, cogeneration of electricity from process heat, and self-powered, high efficiency water heaters.

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AF94-072 TITLE: High Temperature, Radiation Resistant Power Management And Distribution Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Energy Storage

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop high temperature, radiation resistant power management and distribution technologies for space reactor power systems.

DESCRIPTION: Space nuclear reactor power systems typically generate high currents and have long separation booms requiring long power cables. The combination leads to large resistive losses in the power transmission system, which imply that an efficient, low mass power management device could provide significant mass savings for the power system. To be most effective, the power management device needs to be as close to the reactor power source as possible, but the high temperature, high radiation environment causes problems for most power management technologies.

Phase I: The contractor shall develop the conceptual design of one or more fault tolerant, high temperature, radiation resistant power management systems designed to handle 5,000 watts (electric). For each candidate power management system in Phase I, the contractor shall identify electrical characteristics, materials of construction, interface requirements, development status, life limiting machanisms, scaling implications (to 50 kWe units) of the technology, the level of modularity of the system, and key enabling technologies of the system.

Phase II: The contractor shall develop a working prototype of the converter as a proof-of-principle device. In addition, the contractor shall investigate systems to determine the performance of the technology in comparison with established power management systems.

Dual Use Commercialization Potential: The prototype could be further developed to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost, and manufacturability. Potential applications of the power management technology developed by this effort include primary and secondary space and terrestrial power systems.

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AF94-073 TITLE: On Chip Temperature Sensor

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop, design, and fabricate an on chip temperature for a hybrid array.

DESCRIPTION: Ideally, in the first phase a sensor capable of monitoring and determining the temperature of a hybrid operating from 300 to 9K will be developed and researched. The sensor should be compact and easily integrated into existing hybrid designs involving HgCdTe or Si: As detector and silicon readout technologies. The sensor can be placed on the detector or on the readout. The sensor must not interfere with the hybrid's detecting abilities or cause extensive noise. A prototype sensor at the scale of present hybrid technology and in the material used for either the detector or readout will be fabricated and tested. In the second phase of this project, the resulting temperature sensor design will be incorporated into a hybrid design which will be fabricated and tested to determine the sensor's capabilities. A variety of hybrids will be charaterized to determine the reliability of the device and the effects on the hybrid's operability.

Phase I: To proceed to Phase II, critical design aspects must be met. T' design of a temperature sensor must be successfully incorporated into the particular material without serious mate ial defects. The resulting test data from the prototype must be proven to work at the required temperatures, and at the scale required for integration into existing hybrid technology.

Phase II: Success of Phase II will hinder on successful integration of the sensor to an existing hybrid design. The design will the be inserted into a processing line and various hybrids fabricated and tested to determine reliability and producibility.

Dual Use Commercialization Potential: Hybrid arrays are used for cameras in medical, astronomical, and environmental uses. The technology has potential for being integrated into these arrays or the processing lines used to fabricated them.

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AF94-074 TITLE: Integral Bilateral Electronic Components Technology for Spaceworthy Multi-Chip Modules

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop techniques that allow bilateral, passive components (e.g., resistors, capacitors, inductors, transformers) to be realized in multi-chip module technologies.

DESCRIPTION: Passive electrical components are a :rt of every electronics assembly. While great strides have been made in massive integration of active components (e.g., transistors, diodes) into integrated circuits, passive components are often attached discretely to the next level of assembly, whether a hybrid, multi-chip module (MCM), or printed wiring board. Specialized, low-profile resistor and capacitor components have been traditionally employed

in hybrids and MCMs. However, these components and the labor associated with inserting them into an MCM is significant. Even in highly automated assembly operations, the expense of inserting passive components is greater than that of the components themselves. This problem will be exacerbated as more designs migrate from discret analog and mixed signal assemblies to MCM form, which require many more passive components than the digital designs that currently comprise over 95 percent of all MCM applications today. By incorporating the components into the fabrication process directly, the expense of procuring, screening, and assembling dozens of components is practically eliminated. The net benefit to space systems is a reduction in size, weight, power, and cost, with a collateral benefit in improved performance, particularly in mixed signal systems which often require complex networks of these components. Furthermore, integral components will provide for a greater overall substrate efficiency, resulting in smaller, more efficient, and more reliable MCMs. Innovative solutions to improve MCM technologies through the development and demonstration of integral passive components are sought.

Phase I: Phase I proposals will address techniques to form these components within the interconnection system itself. Alternately, but less desirable are those approaches that depend on a particular type of substrate. Component electrical quality is of primary concern, as is the ability to closely and repeatably form these components to a degree of precision adequate for analog instrumentation and signal processing applications. Preferably, this solution would be applicable and transferable to high performance polymeric-based MCM technologies. This approach is preferred over the development of a new, unique MCM technology, in light of the significant existing base of these technologies.

Phase II: Phase II would demonstrate the repeatable, quality formation of components. Leveraging against one or more already existing MCM technologies is highly encouraged, as it is not the desire of this solicitation to invent a new MCM approach. The results of a successful Phase II approach would lead to a superior integrated passive circuit technology that could be transferred to a number of candidate MCM approaches.

Dual Use Commercialization Potential: The results of a successful Phase II approach would lead to a superior integrated passive circuit technology that could be transferred to a number of candidate MCM approaches, both military and commercial.

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AF94-075 TITLE: Innovative Small Space Power Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Energy Storage

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop innovative, low cost, reliable, low mass, long life 500 watt satellite power systems.

DESCRIPTION: As part of the drive to reduce defense costs, most system program offices are reducing the cost and size of their satellites while striving to maintain mission performance, lifetime, and reliability. Similar trends

are seen in NASA and commercial satellites. Since the electrical power systems is roughly a third of the mass and a tenth of the cost of a satellite, one good way of supporting this trend is to provide smaller, cheaper power systems. The challenge for the innovator is to combine performance, reliability, durability, and affordability into one system at acceptable risk.

Phase I: In Phase I, the contractor shall produce the conceptual des gn of one or more power systems and identify thermodynamic characteristics, materials of construction, interface requirements, development status, life limiting mechanisms.

Phase II: In Phase II, the contractor shall develop a working prototype of the system (possible subscale) as a proof-of-principle device. In addition, the contractor shall perform system studies to determine the performance of the technology in comparison with established space power systems.

Dual Use Commercialization Potential: In Phase III, the prototype could be further developed to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost and manufacturability. Potential applications of the power system and associated technologies developed by this effort include DoD, NASA, and commercial satellites, as primary and secondary power sources, and terrestrial power systems, including cogeneration applications. Specific potential commercial applications include a follow-on to the proposed Irridium communications satellite constellation and serving as the power plant for remote vehicles such as mine rescue robots. In view of the general trend toward smaller satellites, the potential market for a successful small power system is quite large.

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AF94-076 TITLE: Military Networks Fast Packet Satellite Switches

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Create a smooth infusion of fast packet switching technology by developing a compatable space and communication link.

DESCRIPTION: The future of communications is migrating towards fast packet switching technology (e.g.,Broadband Integrated Services Digital Network). This migration is seen in both the efforts of the commercial world and the Department of Defense (DOD) efforts to combine all the military area networks. The result of this technology will be increased bandwidth (155Mbps to 2.3 Gphs) and many services that are not presently available in military networks. The development of the current military communications technology is only expected to increase the space communication link data transmission rate capacity from its current rate capacity of 10Mbps to

20Mbps. In order to take full advantage of the fast packet switching technology's data transmission rate capacity, the space communications link will also have to migrate towards a compatable technology. The space communications link would infuse developing fast packet satellite switches, such as the switches under research and development at COMSAT laboratories. The impacts to military communications would be communications system that would supply the military's communications needs, services, and quality of service (QOS) guarantees for any far term requirements.

Phase I: Research and identify the current developments of fast packet satellite switches in the commercial world. Next, research and identify military communications development and design requirements that must be applied to fast packet satellite switch technology development. This phase will conclude with the design of a fast packet satellite switch that will be compatible with future fast packet switching technology infusion.

Phase II: Based on the Phase I design, physically develop a fast packet satellite switch that meets and exceeds current military requirements. The military fast packet satellite switch will be deliverable upon completion of the Phase II technical efforts. This developed technology has a direct impact on the smooth infusion of fast packet switching technology into the military communications segment.

Dual Use Commercialization Potential: The introduction of public networks, such as the Asynchronous Transfer Mode (ATM) networks that will be offered by regional Bell operating companies by 1994, has increased the need to develop fast packet satellite switches in the commercial world. The need to offer these networks and their associated network services over the continental United States and eventually the World will be the main driver for the development of these satellite switches. Of course, a more general but critical commercial application wil be fast packet switching satellite communications.

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AF94-077 TITLE: Multimedia In Space Systems Operations

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop a prototype system depicting how space operations would be conducted utilizing multimedia technology.

DESCRIPTION: Currently space operations uses various computer systems with different operating systems, software, training, hardware, configurations, and skills required to operate in a command and control environment

Multimedia technology proposes that with an environment that has the potential to display multiple data sources simultaneously, process real-time data, voice and video, operations can be conducted from one or multiple generic multimedia stations located throughout the network. The research will delve into what technologies are needed to arrive at or meet operational requirements in a space systems environment. It will also address what capabilities will be derived from multimedia and what possible scenarios would evolve from this environment. The research will also describe what benefits or limits are placed on space operations by introducing multimedia into a command and control environment. The integration of multimedia into space operations would facilitate the network's ability to meet its goals in terms of a reduction in personnel and skill levels for conducting operations.

Phase I: Assess current technologies, determining the status of multimedia as it is presented today. Define what evolution is taking place with multimedia and what technologies will play a role in how multimedia will mature in the future. Develop a multimedia environment implementation plan which conceptually defines how AFSCN operations would be conducted and contains a preliminary prototype design.

Phase II: Develop a prototype system that depicts a concept of how operations will be performed in a multimedia environment. Define the software and hardware requirements, costs, risks and feasibility involved in implementing multimedia a Command and Control environment.

Dual Use Commercialization Potential: Multimedia has numerous commercial applications. Uses of the technology derived from this research include: educational applications for geographically constrained students, home voting, real-time surveying, worker and student training or retraining, government agencies information services, and a number of law enforcement applications such as real-time video identification and/or interactive uses.

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AF94-078 TITLE: Space Systems Technology Development

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Innovative developments for improving performance, endurance and survivability of future advanced space and missile systems.

DESCRIPTION: Advanced space systems need a host of integrated technology developments in order to meet improved performance requirements. We are seeking innovative approaches and technology developments which will provide improved space system performance, endurance and survivability. The proposed approaches should emphasize "dual use technologies" that clearly will have private sector as well as military applications. Some dual use examples include High Definition Television (HDTV), advanced communications, energy, and environmental conservation technologies plus many more. Specific area of interest include:

PASSIVE SENSORS: Required are innovative approaches for developing ultraviolet to very long wavelength infrared detectors, readouts, focal planes, and sensors. Innovative concepts dealing with multi-spectral sensors and passive microwave sounder are needed. Also needed is data fusion, simulation, and integration for improved sensor desi... and performance.

ACTIVE SENSORS: Innovative approaches in active sensor concepts including LIDAR, RADAR and associated signal processing, signal conditioning, plus related devices and subsystems are needed.

SPACE COMMUNICATIONS: Needed are advanced concepts in space systems communication electronics and developments in antennas, devices and processing for RF, and laser inter-satellite links, plus TT&C systems.

SPACE POWER SYSTEMS: Innovative approaches that will lead to higher specific power at lower cost are needed. Specifically, long life, high energy density batteries, advanced solar cell designs, light weight solar arrays, and power control electronics.

CRYOCOOLERS: We need innovative concepts that will improve the efficiency,reliability and performance of existing designs.

SPACE ELECTRONICS: Innovative approaches in design and development of advanced processors, memory, ASICS and other electronic devices, packaging technology, micro-electro-machines, and micro-electro mechanical devices are desired. Also required are insulated devices and cryogenic electronics.

SPACE SYSTEMS SOFTWARE and SIMULATION: Advanced concepts in reusable software, spacecraft autonomy and spacecraft control and scheduling are needed. Object oriented programming for interactive simulations, hardware in the loop simulation tools, neural networks for enhanced signal, data processing and sensor fusion techniques are needed. Also desired are advanced orbital dynamics and on-orbit simulation tools.

SPACE STRUCTURES: Innovative minimum weight structural concepts are needed that can withstand high-G space launch and ambient environment effects. Active and passive vibration suppression, control, advanced material applications, designs and analysis methods are needed.

Phase I: Develop the concept and perform the necessary analysis required in order to select the promising approach. Develop preliminary plans, designs and possible laboratory scale demonstration.

Phase II: Complete the Phase I designs and develop a demonstrator or prototype. All hardware and software developed under both phases shall be delivered to the Phillips Laboratory upon completion of the Phase II effort. Document the R&D and develop a technology transition and insertion plan for future systems and commercial ventures.

Dual Use Commercialization Potential: Space systems for DoD and commercial use require advanced technology that is highly reliable, high performance, and is survivable to a variety of man made and natural environments. These technologies have immediate and definite commercialization potential in consumer goods and infrastructure improvements such as highway safety, environmental monitoring, etc.

AF94-079 TITLE: Built-In-Test for Electromagnetic Shielding

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop a built-in diagnostic test system for monitoring electromagnetic shielding of aircraft cables and electronics enclosure.

DESCRIPTION: Military aircraft make extensive use of shielded cables and enclosures to protect sensitive electronics from electromagnetic induced transients. The electromagnetic environments encountered by these aircraft

range from normal operating environments created by radios and radars to war time threats such as nuclear Electromagnetic Pulse (EMP), High Power Microwave (HPM), Ultra Wide Band (UWB), and other advanced electromagnetic threats. To maintain the shielding properties of these cables and enclosures, periodic testing is required. These tests are time consuming, resource intensive, and cause the aircraft to be out of service for extended periods of time. Increases in normal electromagnetic environments, advances in electromagnetic weapons, and increased use of low power, high speed electronics place a greater demand on the maintenance of cable and enclosure shielding. Studies and experiments have demonstrated that electromagnetic radiated white noise, at levels at or below the ambient electromagnetic noise level, can be used to measure the transfer functions of shielded cables and enclosures. Using stochastic correlaiton techniques, the measured signals within the shielded systems can be statistically correlated to the external radiated electromagnetic white noise. It has also been demonstrated, in a limited case, that non-white or "colored" noise can also be used for the same purpose. Military combat aircraft generate a colored electromagnetic noise environment which should be sufficient to allow on-board monitoring of shielded systems. Miniature current and voltage sensors mounted within shielded enclosures to measure the noise present on wires combined with sensors to measure the external electromagnetic noise would provide the necessary data to monitor the shielding. It may also be possible to eliminate the need for the real time external measurements and rely on one time measurements and statistical approaches. The use of stochastic, fuzzy logic, or other techniques to correlate the external and internal measurements would then allow unacceptable degradations in the shielding to be logged to a central computer for correction during routine maintenance activities.

Phase I: The Phase I effort will develop preliminary hardware and demonstrate technical feasibility of a real time shielding monitoring system for shielded cables and enclosures.

Phase II: In Phase II, the contractor will develop a working model of an actual monitoring system with sensors and microcircuit electronics integrated into an existing avionics subsystem installed on one of the Phillips Laboratory's testbed aircraft.

Dual Use Commercialization Potential: Commercial aircraft and other systems, such as high speed bullet trains, computer-controlled manufacturing systems, and communication systems, are exposed to hazardous electromagnetic environments. All these systems must be protected to these through electromagnetic shielding. They would benefit from this technology in terms of safe and reliable operaiton and reduced maintenance costs.

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AF94-080 TITLE: Computer Model for GaAs Photoconductive Semiconductor Switch

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Software

OBJECTIVE: Develop an accurate computer model of a photoconductive semiconductor switch.

DESCRIPTION: The use of semiconductor wafers as a pulsed power RF switching device is a relatively new innovation. GaAs devices exhibit a non linear mode of operation known as "lockon." This mode is achieved when

the electric field across the device and the laser energy used to trigger the device are above a given threshold. Approximate threshold values can and have been established for laser energy and electric field for specific devices. In general, the laser energy required is inversely proporational to electric field strength provided the E-field is greater than 8KV/cm (the "lockon" field) across the device. The "lockon" phenomenon is not well understood or defined. Development of an accurate computer model for this switching device may entail determining the major material variables, contact attachment processes, and geometrical properties (switch and contact) that affect the electrical operating characteristics of this type of device. The effect of the laser trigger parameters (wavelength, energy temporal and spatial intensity profile) on the operation of the switch is also of concern. A computer model of a GaAs photoconductive semiconductor switch is desired to aid in the design and development of transmission line circuitry utilizing this device. The model should reasonably predict the switch closure time, "lockon" field level, and switch jitter for a given set of parameters. The ability to use this model with existing PC based circuit simulator computer software such as PSPICE is highly desirable.

Phase I: Phase I of this program is to determine the feasibility of creating an accurate circuit model based on material and process variables for two different switch geometries. Examples of variables to be defined for the material: mobility, resistivity, dopant concentrations, laser cross-section energy absorption, etc. Examples of process variables would include ion implant, contract fabricatin, annealing, metalization, epitaxy, etc. Experiments would be proposed to obtain the required information that is not currently available.

Phase II: Phase II of this program is to create the computer model. This includes all experiments necessary to characterize the various variables identified in Phase I. Sufficient copies (5) of this prototype software and document, user guidance, etc., must be delivered for government use.

Dual Use Commercialization Potential: PCSS devices have several potential commercial applications: e.g., radar, microwave, and power switching. Shipboard radar, microwave ovens and similar devices could utilize the PCSS as the microwave generation component since the power required is relatively low and within the ability of present devices. Power switching which currently uses SCR devices could use the PCSS device and in some applications the addition of electrical trigger isolation may be advantageous. These commercial applications would greatly benefit from the ability to model such devices for their particular planned usage. This SBIR, if successful, will provide industry such a model.

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AF94-081 TITLE: High Power, Wideband, Transmission Line Geometry Converters

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Demonstrate innovative approaches and designs of efficient, low dispersion geometry converters for use in high power ultrawide bandwidth microwave generators.

DESCRIPTION: Wideband, high power microwave sources often deliver the majority of the energy in a mode (such as coaxial transverse electromagnetic, or TEM) which does not radiate in a desirable pattern. Conventional baluns (which can convert coaxial TEM (unbalanced) to parallel plate TEM (balanced)) do not possess the high-power, nondispersive characteristics that are required. Design of high gain systems for fast-risetime operation is impractical using traditional frequency domain techniques since these do not fully express the transient nature of the electromagnetic phenomena. Thus, the design of these converters must be approached in a fundamentally different way. Innovative techniques are required to design efficient hardware meeting the needs of the Air Force, including (but not limited to) the application of optics and the use of lenses, as well as recent developments in multiconductor transmission line techniques and composite ferrites.

Phase I: Phase I work shall identify and investigate new and innovative approaches to the design of efficient, high power, fast risetime, non-dispersive transmission line geometry converters. TEM geometries of interest include coaxial, planar, conical, as well as others. Phase I should include the design and construction of models (computational and/or actual), as well as measurement and evaluation of performance.

Phase II: Viable approaches identified and formulated in Phase I will be applied to the practical development and implementation of converters for high power, fast risetime applications. Phase II hardware shall be capable of handling at least millions of volts and hundreds of gigawatts of peak power and convert a coaxial TEM pulse possessing less than an 80 picosecond risetime into a planar TEM pulse while introducing no more than 15% risetime degradation or energy loss.

Dual Use Commercialization Potential: This technology is of interest to the private sector because it is essential for the transmission of wideband transient microwave energy. Applications include radars for mapping buried objects. This will provide enabling technology for use in identifying and characterizing old waste sites (i.e. locating buried waste drums and other hazards). Similar radars could also be used in airborne and terrestrial vehicles for collision avoidance.

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AF94-082 TITLE: Wide Bandwidth Analog Fiber Optic Data Links

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop low cost, wide bandwidth analog fiber optic data links.

DESCRIPTION: Presently, wide bandwidth analog fiber optic data links for use in electromagnetically noisy environments are either unavailable or very expensive. A prototype analog fiber optic data link with the following characteristics will be developed and tested: (1) the 3dB bandwidth will be at least 500 MHz; (2) the power source will be self-contained, rechargeable, and capable of operating for 8 hours without recharging; (3) the data link will be immune to the electrical noise generated by the high energy pulsed power systems; and (4) the input impedance will be 50 ohms. This proposed investigation and development is unique due to the simultaneous requirements of a wide bandwidth, noise immunity, and low cost.

Phase I. The Phase I effort will be a feasibility study and design of a complete low cost, wide bandwidth analog fiber optic data link capable of low noise operation in a harsh electrical environment (multi-megajoule, several hundred terawatt pulsed power systems). The input to the data links will be fast, single event signal pulses ranging from a few millivolts to several tens of volts in amplitude. The transmitter portion of the link may be electrically connected to systems which rise several hundreds of kilovolts during the event. Therefore, the

transmitter power source should be independent of the AC mains.

Phase II: In Phase II, the effort will involve the development and manufacture of operational fiber optic data link prototype system capable of being incorporated into existing data acquisition systems used on in a very noisy electromagnetically noisy environment.

Dual Use Commercialization Potential: This technology has a great potential for future commercialization. A manufacturable product as described above will be specifically of great benefit and use in any high speed communications systems such as national phone, data, TV, cable, etc. linkages. In addition, such technology will be applicable to anyone collecting test data where it is required to do so in an electromagnetically noisy environment.

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AF94-083 TITLE: Advanced Weapons Source Development, Effects Measurements and Satellite Survivability Modeling

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Survivability and Hardening

OBJECTIVE: Develop advanced weapons concepts such as high power microwaves (HPM) and plasmas, and to produce new models of various threat conditions on satellites.

DESCRIPTION: The Phillips Laboratory (PL) is in need of new, innovative approaches in the development and demonstration of compact, light weight, microwave sources for potential weapons applications. The technology sought should address our requirements of gigawatt level power delivered in microsecond and shorter pulses. Both narrow band and wide band sources are of interest. The technical issues that may be addressed in this effort include the pulsed power, HPM tubes, transmission lines, converters, and antennas necessary to make such a technology feasible. In addition to source development, new concepts for the measurement of radio frequency (RF) effects of gigawatt pulses in the tens to hundreds of gigahertz frequencies. These measurement techniques must be relevant to conducting test programs of the coupling of this RF radiation into complex test objects without perturbing the testing conditions. PL also solicits innovative approaches towards further development of advanced weapons concepts in high density, high energy plasma production, measurement, and exploitation. Using the Shiva Star facility (a large capacitor bank capable of dumping 10 megajoules of energy in microsecond times) to create these plasmas, concepts are sought which will demonstrate substantial improvements over current capability in modeling of the physical processes involved, and measuring of the pertinent plasma properties. In addition, PL solicits new, innovative approaches to satellite survivability modeling. Modern US satellites are faced with many threats which

have the potential to upset, degrade, or eliminate proper operation of its subsystems. These threats range from normally occurring actions suc ı as thruster firings, space debris, and orbit-dependent chemical reactions with naturally occurring species. They also include hazards due to attack from nuclear, RF radiation, and lasers. New, innovative models are required which are capable of analyzing the fundamental processes which occur during such events, and perform assessments of the likely outcome of the event on the affected satellite. Special attention must be given to the ability of the model to be integrated into existing techniques, the ease of use of the model, and the time of execution, and the manipulation of created and existing databa: .s.

Phase I: In the initial phase of this effort, a feasibility study will be conducted which identifies, through the process of analysis, the best approach from those chosen to solve the problem. A proposed schedule for implementing the chosen approach will be included in the final report.

Phase II: In Phase II, the selected approach from Phase I will be implemented, producing a prototype model and/or device which has been demonstrated to be effective either at full operation, or scaled to lab bench parameters. Any prototype computer model (and its associated documentation) delivered in Phase II, will be provided in sufficient number (5) for the government to conduct validation testing.

Dual Use Commercialization Potential: Many of the necessary technologies required for advanced weapons design have commercial applications. For example, the development of pulsed microwave source technology will be of potential benefit to ground and subsurface radar concepts, collision-avoidance radar systems, and to medical imaging technologies. Also, the weapons effects models developed for electromagnetic scattering of RF fields can be applied to commercial industry design of better protected systems to high intensity radiated fields.

AF94-084 TITLE: Advanced Materials Applications for Liquid Rocket Engines

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Demonstrate advanced materials and processing tecnologies showing performance or cost improvements in liquid rocket engine components or systems.

DESCRIPTION: Innovative concepts for application of advanced materials to liquid rocket engines are being sought. New advanced material structures may decrease the weight of components such as nozzles, gas-generators/preburners, combustion chambers, housings, and ducts by 10-50%. New thermal barriers could eliminate or greatly reduce the need for convective cooling. Environmental barriers may permit conventional materials to operate at high temperatures, free from corrosion or embrittlement by propellant gases. New classes of high temperture materials could permit devices such as turbines to operate at much higher temperatures and top speeds, resulting in performance improvements. New materials may also lead to innovative design approaches, accomplishing the same task, but in bold new ways.

Cryogenic rocket propulsion systems demand the lightest possible weight and highest possible performance from each of their component parts. Transportation, construction, and power generation equipment demand similar qualities of their components, however, the operating environments of liquid rocket engines are particularly harsh. Combustion chamber gases approach 6000 F in either reducing or oxidizing environments. Turbopump turbine inlet temperatures can exceed 1600 F, also in reducing or oxidizing environments, while requiring turbine top speeds in excess of 1600 ft/sec. Repeated starts induce extreme thermal shock and fatigue. Fuel pumps only feet away form these high temperature turbines operate near -420 F and discharge pressures can exceed 10,000 psi. Recent advances in materials technology can substantially increase liquid rocket engine performance by enabling higher temperature operation, lighter weight component structures, and significantly higher system reliability. Substantial propulsion improvements are required to assure low-cost access to space, global force projection and intelligence collection/targeting of strategic relocatable targets. Advanced materials technology can lead to such performance increases. These technologies can also be applied to such diverse commercial areas as civilian launch vehicles, high speed civil transports, electrical power generation systems, automobiles, and high temperature toxic waste disposal systems.

Phase I: The Phase I effort will consist of one or more of the following: material characterization in a simulated rocket engine environment, component fabrication demonstrations, or innovative component designs. Projected or demonstrated performance or weight improvements resulting from Phase I research will be the basis for selecting a Phase II effort.

Phase II: The Phase II effort will apply Phase I research through component development, test and evaluation, or detailed design and analysis. Deliverables will include one or more of the following: advanced material componenet(s), component test and evaluation results, andvanced materials database, or detailed innovative component or system design.

Dual Use Commercialization Potential: Historically, advanced materials and processing technologies developed for military aerospace use have had tremendous impacts in commercial industries. For example, carbon fibers developed for rocket nozzle applications have revolutionized bicycles, automobiles, sporting goods, and safety products. The technology developed through this research can be commercialized not only through the rocket propulsion industry but also through aircraft gas turbine, electrical power generation, and commercial transportation industries. The technology will be commercialized through the Liquid Rocket Propulsion industry. Advanced material components can be marketed through other high technology industries such as the aircraft and automotive industries.

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AF94-085 TITLE: Innovative Spray Measurement Techniques for Rockets

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop improved spray measurement techniques for validating CFD codes in rocket engines.

DESCRIPTION: One of the requirements for meeting critical Air Force needs such as assured satellite communications or the ability to kill strategic relocatable targets is to have propulsion systems which guarantee rapid, reliable access to space. Many of these systems will use liquid propellants. However, the development of high performance, stable liquid engines still requires a large degree of costly trial and error testing. Reducing these development costs will be crucial to meeting Air Force missions within existing budget constraints and to maintaining U.S. competiveness in space.

One important way development costs will be reduced is through the improved modeling made possible by Computational Fluid Dynamics. Many codes applicable to liquid rocket engines have been developed, but a

common weakness is that the physical mechanisms contained within them remain unverified under realistic rocket conditions. This topic solicits innovative measurement techniques that will help verify physical mechanisms specifically in the area of spray combustion. Commercially available instruments are currently able to measure drop size and velocity distibutions in a spray, but work best under low pressure, cold flow, dilute spray environments. To be more useful for liquid rocket engine development, these measurements need to be extended to include high pressure cold flow regimes, and/or high pressure hot flow regimes, and/or dense spray regimes. Of particular interest would be in situ measurement of gas/liquid mixture ratios and measurement of condensed phase properties such as drop temperature and composition. Inovative concepts are sought to expand the frontiers of spray measurement technology in these areas.

Phase I: Should identify and demonstrate the feasibility of novel spray measurement technology.

Phase II: Should develop the concept(s) identified in Phase I into a workable prototype instrument.

Dual Use Commercialization Potential: The instrument developed under this program would have widespread commercial applications not limited to rocket propulsion. Examples include automotive gasoline and diesel engines, gas turbine combustors for land, sea, and air applications, fossile fueled furnaces of all types, hazardous waste incineration units, and other noncombustion applications involving particulate flows.

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AF94-086 TITLE: High Flux Gas Phase Atomic Boron or Carbon Source

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop a gas phase, high flux source of atomic boron or carbon, compatible with cryogenic storage of solid hydrogen.

DESCRIPTION: Cryogenic solid propellants may provide revolutionary advances in rocket propulsion. Solid hydrogen with mixtures of energetic atoms are relatively difficult to form and store for long periods of time. If these cryogenic hydrogen fuels containing useful concentrations of atomic additives are to be useful for rocket propulsion, a high flux source of gas phase boron atoms or carbon atoms needs to be developed that will have the following characteristics: a. Must produce greater than 90% pure atoms and must not contain greater than 1% non-boron or non-carbon containing species. b. Must be compatible with mixing into gaseous hydrogen without reaction (for deposition onto cryogenic surfaces) and ultimately for bulk deposition at less than 5K (-268 degrees C). c. Must

produce atomic flux levels adequate to produce at least one gram of solid cryogenic hydrogen containing at least 2 mole percent isolated boron or carbon atoms within one hour.

Phase I: Phase I must include construction and testing of a prototype source and experimental verification of the desired boron atom or carbon atom flux levels. The results of the Phase I effort must include a detailed practical design which will be built in Phase II.

Phase II: The results of the Phase I effort must conform to the above description and include a detailed practical design which will be built and delivered to the Phillips Laboratory, Propulsion Directorate, in a Phase II effort.

Dual Use Commercialization Potential: Phase III efforts will be directed toward integration of this source into production of cryogenic mixtures of boron atoms or carbon atoms in solid hydrogen for use as advanced rocket propellants. Such advanced propellants may increase the comercial capabilities of launch systems. The atom sources may also be used for implantation of boron or carbon into semi-conductors or advanced materials.

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AF94-087 TITLE: Ammonium Nitrate Phase Stabilization and Processing for Environmentally Clean and Safe Propellants

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop a phased-stabilized ammonium nitrate for use in a high energy glycidyl azide polymer (GAP) type, minimum smoke and environmentally clean propellant.

DESCRIPTION: The use of ammonium nitrate as an oxidizer for solid rocket propellants in the past has been unsuccessful due to the temperature and hygroscopic-dependent phase transitions of the ammonium nitrate crystal. Attempts to stabilize these transitions, especially at storage temperatures, with metal oxides has led only to a decrease in ballistic performance, poor mechanical properties and environmentally undesirable combustion byproducts. A non-metal phase-stabilized ammonium nitrate incorporated in a GAP binder system would virtually eliminate these undesirable effects.

Phase I: Select, process and test several candidate stabilizers for methods of inclusion in/on the AN crystal utilizing thermal analysis, IR spectroscopy, hazard/compatibility and ISP data. In addition to stabilization through crystal inclusion, crystal growth and hygroscopic control will be studies using AN coatings, dessicants and process environment control.

Phase II: Conduct small-scale propellant formulations and accelerated aging studies to ascertain the

efficiency of the stabilizer to prevent propellant grain growth. Optimize propellant properties and obtain mechanical, aging, hazards and small-scale ballistic properties. Large-scale (15 lb and 70 lb) ballistic tests will also be conducted.

Dual Use Commercialization Potential: Transition to Phase III will implement environmentally cleaner ammonium nitrate oxidizers as a replacement for presently used ammonium perchlorate in solid propellants.

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AF94-088 TITLE: Reducing Bondline Failure Modes in Solid Rocket Motors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop new techniques and/or sample types required to improve the reliability and reproducibility of solid rocket motor bondlines.

DESCRIPTION: One of the major causes of solid rocket motor failures has been that of bondline failure. In particluar, the case/insulation or insulation/liner/ propellant bondlines have been a source of failure in approximately 53% of solid rocket motor firing failures. There have been several Air Force programs on this subject over many years and there is currently a NASA program addressing various components of this problem. In spite of the previous work, aspects of this problem are still unsolved.

This problem can be addressed by employing new techniques and/or types of samples, to perform bench level testing on case-epoxy-insulation and insulation/liner/inert propellant samples to evaluate techniques and samples for possible utility in solving this problem. All techniques should be applicable to aged specimens. A start at modeling these results should be made. Congnizance of the relationship between sample testing and usefulness of using the results to discuss reliability of rocket motors should be implicit in work performed. This part of the problem has never been adequately treated by the solid rocket motor industry.

Additional work should be performed by scaling up the techniques/sample choices by producing inert solid rocket motors, ending with at least a 70 lb Bates size and demonstrating the applicability of the earlier work. An aging program must be implicit in this part of the program. This phase should include dissection of the motor to test samples and verify the techniques.

Phase I: Should identify the techniques and/or of samples to be used in solving this problem.

Phase II: Should demonstrate applicability to scale-up by producing an inert motor and dissecting it.

Dual Use Commercialization Potential: These results could be commercialized to the composites industry and any commercial venture dealing with adhesion problems.

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AF94-089 TITLE: Health Monitoring Devices for Solid Rocket Motors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop and demonstrate embedded sensor technology applicable to monitor state of health of solid rocket motors.

DESCRIPTION: Solid Rocket motors are relatively simple structural systems consisting of motor case, solid propellant, and the bondline region in between. A considerable amount of effort has been spent on developing intelligent structures by coupling embedded senor technology with the structural system. Embedded sensors can be used to monitor both the physical and chemical changes (like soften, hardening, and loss of strength) as well as chemical changes (like water absorption, ingredient migration, and percent of available plasticizer) that occur in solid rocket motors as they age. As the required useful lifetime of the solid rocket motor fleet increases, assuredness of individual motor health and operability is essential. This research effort is intended to develop and demonstrate those innovative technology areas necessary to transition embedded health monitoring sensors from the lab bench to operational rocket motors. Areas of concern are correlation of sensor data aging affects, affects of embedded sensors on rocket motor performance and aging, design of motors and cases for embedded sensors, and demonstration of health monitoring capabilities.

Phase I: Phase I efforts will assess and demonstrate through bench level testing, concept evaluation, and analysis of supporting technologies, concepts for health monitoring of solid rocket motors.

Phase II: Phase II will demonstrate embedded sensor, health monitoring technologies through bench level and scaled motor testing. Deliverable items will be demonstration article testing results, performance analyses, and instrumented motors for testing and aging surveillance studies.

Dual Use Commercialization Potential: Phase I and II results will be commercialized through the solid rocket motor industry. Other commercial markets can be addressed through investigating bio-compatability for appropriate sensor techniques, remote sensing in high hazard environments, and applicability to composite part manufacture.

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AF94-090 TITLE: Electric Propulsion Thruster for On-Orbit Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop and validate methods of improving the performance of electric propulsion thrusters for on-orbit applications.

DESCRIPTION: Electric propulsion thrusters can achieve on-orbit maneuvering and station keeping capabilities that more than double those of chemically based systems. With an electric system, substantially greater amounts of energy can be deposited in the flow. The performance of these devices increases as more energy is added to the flow, but is finally limited by thruster material properties and system energy loss mechanisms. The goal of this SBIR is to develop and validate innovative electric propulsion (EP) concepts capable of near term application; projects involving both enhancements to existing thruster configurations and new thruster concepts can be considered. Due to the rapid advance of materials technology and numerical and experimental analysis tools, the potential for significantly increasing both the physical capabilities of the thrusters and their underlying operating efficiencies is great.

Phase I: Develop electric propulsion thruster concept with performance capabilities significantly exceeding those of existing EP devices: primary interests are high efficiency, high specific impulse, long lifetime, minimal spacecraft contamination and packageability. The thruster should be optimized for on-orbit maneuvering and station keeping missions. The thruster should maintain high performance operation over a throttlable mean power reange form 2 to 10 KW electric. The emphasis in Phase I is on the validation of the innovative concepts that will provide the stated performance improvements. Experimental and theoretical methods can be considered; government and commercial test and evaluation facilities may be utilized.

Phase II: Apply the results of Phase I to the design, fabrication, experimental validation, and optimization of EP thruster performance capabilities. The design process is expected to be iterative with the thruster with the best overall performance being reproduced and be deliverable at the end of the Phase II period. The technology developed has direct impact on the critical military need of Propulsion and Vehicular Systems Technology. Other military and commercial applications include orbit raising of payloads using scalable systems.

Dual Use Commercialization Potential: Dual use commercialization would occur through the development of flight quality electric propulsion systems for satellite and space experiment applications. Improved electric propulsion thrusters will extend mission lifetime, increase spacecraft maneuverability and reduce system mass. Both mission capability and profitability will increase through the introduction of these thrusters into the marketplace. The outlook for commercialization therfore appears quite favorable.

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AF94-091 TITLE: Environmental Approaches to Solid Propellant Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop enviromentally advanced approaches to solid propulsion technology that will assure full compliance with present and impending environmental legislation.

DESCRIPTION: Increases in environmental restrictions affect production, test, mission, and disposal of Air Force systems using rocket propulsion. To remain in compliance with existing and impending regulations new approaches, materials, and processes will have to be developed. This will include the development of: 1) innovative concepts for solid propulsion which transcend current scavenged, neutralized, clean, and solution propellant approaches; and/or 2) new components or ingredients for environmentally acceptable solid rocket propellant; and/or 3) novel, environmentally enhanced approaches to propellant processing, testing, and disposal and disposal that will lead to program goals such as: waste elimination, waste recycling, solvent reduction/replacements, and toxic exhaust reduction.

Phase I: Will identify and evaluate innovative concepts, outlined in the Description above, that could lead to approaches that are economical, feasible, able to meet current performance (ISP, Burn Rate, Mechanical Properties, ect..) for an existing propulsion system, and be in full compliance with all existing and proposed or impending environmental regulation governing the areas where operations occur.

Phase II: Efforts will produce a technical baseline form which a demonstration of capability as a form, fit, and function for a specific system (as predicted in Phase I) can be demonstrated. Demonstrations in the form of test motors up to 800 lbs. will be performed.

Dual Use Commercialization Potential: Under the Federal Facilities Act 1992 all Federal installations must comply with the same environmental regulations as private, industrial concerns. Consequently, the environmental technology developed in producing, processing, testing, and disposing of propellant will be transferrable to related commercial sectors. Commercial space ventures are in need of environmentally advanced propulsion systems to meet future regulations and restrictions. Similarly, related energetic materials industries (i.e. pyrotechnics and explosives) could benefit from the technology developed in this program. capability as a form, fit, and function for a specified system as predicted in Phase I of the program. The development of environmentally acceptable propulsion systems will be valuable to, not only the services, but to commercial space ventures as well.

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AF94-092 TITLE: Advanced Rocket Propulsion Technology

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: The objective of this effort is to develop innovative rocket component technologies, component manufacturing techniques and component integration technologies which will contribute to the doubling of existing rocket propulsion capabilities by the year 2010.

DESCRIPTION: The Phillips Laboratory (PL) is in need of new, innovative approaches in the development of technologies which can double the existing rocket propulsion capability by the year 2010. Specifically, technologies that can increase the reusability of cryogenic liquid rocket engines from 3 to 100 flights prior to overhaul, decrease the cost and time of manufacturing solid rocket motors by 50%, increase the payload capability of existing launch and upper stage propulsion systems by 7%, reduce the number of parts for a cryogenic turbopump by 80%, integrate high energy density material into future rocket propulsion systems and reduce the environmental hazards of the rocket motors by 80%. Latitude is provided to the innovative scientist and engineer to address propulsion related technologies not specifically addressed by other rocket propulsion topics. For instance, electric propulsion concepts and solar thermal rockets show great promise for space applications. Solar rocket powered orbit transfer vehicles development might include research on solar rocket large space structures, Gossamer structures, payload integration, means for otbital Sun-tracking, optical quality mirrors and measurement devices, energy storage/conversion, solar boiloff propellant tankage, micro-thrust stands, thin film concentrator systems. Other advanced rocket concepts previously mentioned would have an equally lenghty shredout of potential research subjects but are not stated in the detail of the solar example. Research in these advanced rocket propulsion topics are included and structured to provide a maximum of innovative flexibility to prospective investigators.

Phase I: The initial research in this effort will assess existing capabilities and demonstrate through bench scale evaluation of the proposed new approach, the payoff to be derived by implementing the concept.

Phase II: Phase II will demonstrate selected advanced rocket technology concepts beyond bench scale and conduct verification testing of the concept.

Dual Use Commercialization Potential: Advanced rocket propulsion technology will transition to the US commercial space launch industry, thus enabling the US industry to better compete with foreign sources for space launch opportunities by reducing the cost of inserting payloads to space orbit. Advanced rocket propulsion technology also serves the commercial sector by enhancing our ability in remanufacture and maintenance of the US ballistic missile fleet.

AF94-093 TITLE: Improved In-Situ Tropospheric Humidity Sensor for Accurate DMSP Calibration

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a sensor for providing improved mid and upper troposphere humidity measurement on a routine basis

DESCRIPTION: The present standard technique for measuring the amount of water vapor present in the atmosphere as a function of height is the balloon-borne hygristor. Presently used hygristors provide humidity data with large inaccuracies, especially in conditions of low relative humidity. More detailed and accurate measurement of the distribution of water vapor throughout the troposphere is needed for research purposes, such as global change and environment monitoring, and for operational purposes, such as improved weather forecasting and cloud dynamics models, impact assessment on propagation in the microwave and infrared, and on satellite retrieval methodologies. Truly global measurement of water vapor can only be accomplished using satellite platforms. However, the emerging satellite systems require improved in-situ humidity measurements to develop the retrieval techniques which overcome limitations such as biases, poor vertical resolution, inability to measure in the presence of clouds, and problems with varying microwave surface emisivities. The balloon-borne radiosonde is the principle source of upper air humidity data and should be considered the primary operational platform for obtaining measurements with an improved sensor. Consequently, the additional cost of the improved humdity device should not be large relative to the cost of a synoptic radiosonde measurement, which is about $200 per release. The multiplicity of needs for an improved humidity sensor requires that it perform reliably and accurately over the fully range of global tropospheric variability.

Phase I: Phase I should provide a presentation of sensor alternatives, criteria for selecting an optimal alternative, 15 units of a laboratory model of the selected sensor, initial laboratory testing suitable to predict sensor performance characteristics, a test plan to demonstrate its performance and an estimate of the costs for routine production of the sensor.

Phase II: Phase II will produce at least 100 units of engineering test models, performance of the test plan from Phase I, a test report presenting and analyzing the results of the laboratory and field (radiosonde) tests, recommendations for refinements to optimize production units and a detailed cost estimate for production units.

Dual Use Commercialization Potential: An improved sensor developed under this effort has a ready market. The National Weather Service procures over 50,000 radiosondes a year, each containing a humidity sensor. There is also an international market for approximately 150,000 radiosondes per year. Several US radiosonde manufacturers are active in both of these markets.

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AF94-094 TITLE: Geophysical Techniques for Characterizing Hazardous Waste Sites and Remediation Monitoring

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Development of new or enhanced geophysical techniques for characterizing hazardous waste sites and remediation monitoring.

DESCRIPTION: Geophysical techniques can provide fast, cost efficient and non-intrusive means to both characterize and monitor the remediation of hazardous waste sites. A diverse variety of techniques such as seismic, electrical and electromagnetic, ground penetrating radar and magnetometry have been developed by the hydrocarbon and mineral exploration industries. These techniques can provide a complete characterization of the subsurface in terms of its physical properties. The interpretation physics for all of these techniques is applicable only under very limited conditions, e.g., exploration of the deep (greater than 1000 meters) subsurface geology in either seidmentary (oil and gas bearing rocks) or mineral bearing rocks. These same techniques have unlimited potential to provide information regarding the shallow (less than 300 meters) subsurface environment. But, a major impediment in the application of the techniques is our lack of knowledge of the physical response, both seismically and electrically, of shallow unconsolidated soil and fractured rock environments. These are exactly the regimes in which we face the greatest problems in terms of hazardous waste site characterization and remediation. The development of new and novel geophysical techniques are desired that are applicable to hazardous waste site characterization and remediation monitoring to address two outstanding environmental problems: (1) identifying the subsurface location of dense non-aqueous phase liquids (DNAPLs); and (2) effective characterization of fractured bedrock permeability. DNAPLs are heaver than water pollutants such as trichloroethylene (TCE)> When released, they sink to the bottom of aquifers and can pool into a variety of geological traps, e.g., clay lenses, bedrock depressions or bedrock fracture systems, thereby continuing to act as long-term secondary sources and making remediation difficult, if not impossible. The determination of bedrock permeability is a long-standing and important problem whose solution is key to understanding the subsurface environment for the successful design of many remediation programs. Intact crystalline bedrock, commonly found in the northeastern US, has very low permeability. However, if the bedrock is fractured, its permeability can increase several orders of magnitude. Presently, there are no proven techniques, adequate for routine field application, to identify and locate subsurface bedrock fractures or provide an estimate of the effective bedrock fracture permeability.

Phase I: Proposals must demonstrate strong potential for adaptation to field applications. It is recognized that no one technique may be sufficient and the best approach may be one that integrates a number of techniques and methods.

Phase II: Phase II should implement and field demonstrate the concepts developed in Phase I.

Dual Use Commercialization Potential: There is significant potential for the research in this area to lead to commercialized products. There exists a large gap in available techniques and instrumentation for application in the field. Examples include: existing ground penetrating radar (GPR) instruments are cumbersome and generally utilize a short frequency pulse to probe the ground and have little signal analysis or processing capability. This research offers significant advances in producing GPR data analysis techniques, associated data processing algorithms, and subsequent "field ruggedized" instrumentation. Interpretation techniques which integrate electrical and seismic methods have yet to be exploited. This research could lead to a combined field system which samples both electrical and siesmic properties simultaneously in the field. Existing signal processing techniques require too much computer power to be applicable to the field. New techniques are necessary to allow the investigator to have

a "quick look" at the data in the field before returning to the lab.

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AF94-095 TITLE: Lattice-Gas Parallel Supercomputer for Fine-Grained Modeling of Complex Geophysical Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop a billion-site cellular automata machine optimized for lattice-gas simulation of of geophysical processes.

DESCRIPTION: Recently we realized the confluence of two important events: the discovery of a spatially discreet tranpsort theory and the construction of a programmable matter machine. There now exists a first-principles lattice gas automata (LGA) formalism for modeling complex systems. Also, there now exists cheap, fast parallel hardware which LGA can exploit and usual finite-difference methods cannot. Therefore, we propose building a low-cost next-generation cellular automata machine (CAM). The CAM will be used by the Geophysics Directorate of Phillips Laboratory to research atmospheric dynamics. The CAM will support three-dimensional time-evolved atmospheric simulation of convection, conduction, latent heating, and other physical effects involved in the solar and terrestrial radiation-transfer driving a complex background's thermal signature.

Seek bold and innovative research to construct a massively parallel CAM optimized for lattice gas calculations. The CAM should have approximately one-billion processing sites with at least 16-bits of state data per site. The CAM must occupy a volume small enough for easy placement atop or beside a desk and require only air cooling. The CAM may be controlled by a UNIX engineering workstation front- end. Data visualization and frame-buffer hardware should be integrated into the CAM design allowing for video-rate data acquisition. The CAM may also exploit high density hybrid circuit board design technology to reduce weight and power consumption. This CAM will be a prototype for an eventual field-worthy tactical supercomputer used for real-time intensive geophysical calculations.

Phase I: Provide complete design specifications for the tactical CAM architecture including digital schematic capture, board routing, mechanical housing, cooling analysis, and visualization integrated design. Design specifications should also include details determining operating system architecture for handling initialization data, lookup-table formats, display palette tables, etc. The design must include robust error detection in hardware and software.

Phase II: Upon acceptance of the Phase I designs, commence the fabrication of a billion-site CAM. Two prototypes will be constructed and tested with lattice gas automata algorithms provided by the government.

Dual Use Commercialization Potential: Novel parallel computational algorithms and architectures are perhaps the most important and necessary future advance in US high-performance computing technology. It is well recognized by the scientific community that new parallel strategies are needed for solving current grand challenge problems confronting our industrial and governmental laboratories today. Lattice-gas methods, started principally in the mid-1980s and currently undergoing vigorous research, are a promising parallel computing strategy because of their exactly computable nature over a fine-grained simulation space. A large cellular automata machine architecture, optimized for lattice-gases, should be ideal for solving many problems important to the commercial sector. Some of the latest applications being explored at universities include: medical imaging in relation to staining and 3D visualization of tomographic scans, biophysics in the studies of polymer dynamics, and electrical engineering in the studies of gate array logic simulation. Perhaps the most important commercial application to date uses lattice-gas methods to model the flow of immiscible fluids through porous media which is currently suported by and benefitting the oil industry. In short, a large billion-site CAM with its spatially discrete lattice-gas software formalism open the door to new computational opportunities to explore the dynamics of complex collective systems ranging across the spectrum from fluid and biophysical systems to even economic systems.

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AF94-096 TITLE: Realistic Weather Visualization in Computer Simulations of Military Systems and Operations

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop new and innovative approaches to provide realistic, quantitatively accurate weather depictions in computer simulations of military systems and operations.

DESCRIPTION: Natural and man-made environments form the "playing field" on which lifelike computer simulations of military systems and operations take place. This playing field must be accurately modeled in order that the impact of the environment on equipment and operations be similar to what were to happen in the real world. The environmental research community has developed numerous data bases and physics-based computer models to characterize the environment, and to predict its evolution over the course of a simulation. However, they have concentrated on display of the results of their computer models for research purposes, emphasizing visualization of the underlying physics phenomena rather than subjective or perceptual realism. In contrast, the simulation community has been pressed to provide realism in the displays, e.g., making clouds look like clouds even at the

expense of the underlying physical equations. The goal of this effort is to develop the technology that provides both realistic-looking and quantitatively accurate displays of environmental conditions in simulations.

Phase I: Phase I would develop the proof-of-concept of the approach.

Phase II: Phase II would be the design of the system.

Dual Use Commercialization Potential: Commercial potential will be significant as the private sector embraces the simulation for design and operation of commercial systems that operate in the atmospheric environment, for training operators of these systems, and by the TV industry for animated weather displays.

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AF94-097 TITLE: Totally Solar-Blind Ultraviolet Detectors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop and fabricate ultraviolet detectors with insignificant sensitivity to visible/infrared solar radiation.

DESCRIPTION: Innovative ultraviolet detectors are sought to replace the well-known, but inaccurately named "solar-blind" sensors which cannot be used in space applications without cumbersome additional filters. Devices proposed must be intrinsically sensitive to the ultraviolet (about 400 to 10 nanometers), or a portion thereof, and have insignficant sensitivity (or "red-leak") to visible infrared solar flux. Improvement to cesium telluride and similar photocathodes currently used is sought. Additional desirable innovations would be the ability to tailor the onset of ultraviolet sensitivity and improved quantum efficiencies. High work-function materials or other innovative techniques should be suitable for immediate use in space applications, possibly both as single channel and as array detectors, at the conclusion of this effort.

Phase I: Demonstration of materials and techniques that are promising for incorporation into devices will be accomplished in this phase.

Phase II: Fabrication of devices such as image tubes, photomultipliers, and/or photodiodes, or equivalent, suitable for application to ultraviolet atmospheric remote sensing measurements will be the goal of this phase.

Dual Use Commercialization Potential: Opportunities are in the use of both single channel and array imager detectors. One such use is for environmental health monitors of the "UV-B" radiation now increasing globally at the Earth's surface because of loss of stratospheric ozone. Use is made of UV detectors to sense the presence or absence of flames in building heating system boilers, aircraft, and industrial processing. A developing use is in the manufacture of microelectronics components where microlithography in the so-called "Deep UV" region is being widely applied. Finally, the use of UV lamps to cure printing inks in high speed presses depends on UV sensors to keep the process controlled. The sensors being developed here would be simpler and, therefore, more

suitable for printing plant use. Results of this effort will provide cheaper and simpler sensors compared to the current practice.

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AF94-098 TITLE: <u>Synoptic Climatologies for AI Weather Support to the Battlefield</u>

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

OBJECTIVE: Define meteorological entities and processes in computer code suitable for use in future expert weather forecast systems.

DESCRIPTION: Currently, every meteorological expert system developed must include definitions of meteorological entities, together with the appropriate ranges of any measurable quality associated with them. For example, an air-mass is a meteorological object with characteristic moisture, temperature and stability attributes. A warm tropical maritime air-mass has an entirely different range of appropriate values for these quantities than does a cold polar continental air-mass. Each new meteorological expert system that refers to air-masses must redefine them. This laborious task detracts from the effort devoted to generating the knowledge base that is the heart of any expert system. In particular, the lack of a library of common meteorological entities and processes in an appropriate database prevents the development of computerized synoptic climatologies. Synoptic climatology differs from statistical climatology in providing the characteristic weather pattern for a region (including most prevalent air-mass type), rather than simply monthly averages of weather parameters such as temperature and precipitation. In the past, the lack of computerized, accessible synoptic climatologies has hampered Air Force weather forecasters operating in unfamiliar regions under data-sparse conditions.

Phase I: Phase I of this project will consist of collating and defining the majority of commonly encountered meteorological objects and processes and listing their attributes. The minimum objectbase resulting from this effort will contain all the objects necessary to incorporate the synoptic climatology provided to the successful bidder by the government.

Phase II: Phase II will consist of coding of this library into a meteorological database and selecting appropriate values for the attributes, based on physical principles and general climatology. As a test of the completeness and accuracy of the objectbase, all available synoptic climatologies will be incorporated into the system.

Dual Use Commercialization Potential: The resulting meteorological library and synoptic climatologies will form the basis of a domain-specific (meteorology) expert system shell. This will be a viable commercial product with a world-wide market for anyone interested in tailored weather forecasts.

REFERENCES:
USAF Environmental Technical Applications Center, Scott AFB, IL. Walters, R., Arnold, R.D., "Horn of Africa Climate and Weather Executive Summary." USAFETAC/TN-92-006, Dec 1992, (available from DTIC as AD-A260-152).

AF94-099 TITLE: Rocket/Missile Technologies

CATEGORY: Exploratory Development

OBJECTIVE: Develop and/or adapt innovative or commercial derivative technologies to advance environmental acceptability, safety and cost to the user of rocket or missile systems

DESCRIPTION: This category of innovative research and development is intended to solicit technologies, and unique technology applications, that could be applicable for future rocket/booster/missile systems. Three areas of particular interest are environmental acceptability, system safety and cost-to-the-user. Specific interest in these areas does not preclude an offerer form suggesting other innovative technology application. Specific subtopics could include, but not be limited to: environmentally acceptable propellants (production through use), environmentally acceptable processes and resins for the production of nozzles, propellant cases, and thermal protection heatshields; advance positive control and system performance interactive monitoring through adaptations of virtual reality environments, artificial intelligence; advanced system monitoring, fault detection and isolation, and performance implications simulation analysis using derivatives of NDT&E to minimize performance risk and extend the life-cycle of components, subsystems and systems, advanced in-situ monitoring technology; low cost nozzles and thrust vector control subsystems, and modular integration stage designs for large payload flexibility. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

Phase I: Provide preliminary technology designs for innovative technologies proposed in this topic. Designs should serve as a point of departure for government evaluation of the mission and system utility of each candidate Phase I award.

Phase II: Prototype development of technologies sufficient to demonstrate and validate the technology applicability to the long range ballistic missile technology needs.

Dual Use Commercialization Potential: Environmentally acceptable propulsion/launch capability, lower cost critical components to reduce cost per pound.

Reference were not provided since this topic covers such a broad range of technology and is intended as a solicitation for new and creative ideas.

AF94-100 TITLE: Replacement Refrigerant for R-502 Refrigerant Based Environmental Control Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop environmentally acceptable "drop-in" R-502 replacement refrigerant or design a replacement OLDS free refrigerant system.

DESCRIPTION: A need exists to identify innovative coolant systems that are not OLDS refrigerant based and are capable of providing reliable, low maintenance, cooling over long periods of time. The use of R-502 refrigerant ranges from use in the environmental conditioning systems in strategic missile silos to air conditioning of large buildings. Although this material is a blend of chlorofluorocarbon materials, and has an Ozone Depletion Potential of 0.307, it will be banned in the near future, along with other CFC type materials. A critical need exists for an innovative, non-flammable thermodynamically equivalent, environmentally acceptable lubricant compatible, replacement for R-502. Accordingly, the need is for a "drop-in" R-502 replacement which requires no (or minimum) modification to existing environmental conditioning systems. An alternative solution is to develop a low maintenance replacement system, complete with an environmentally acceptable, cost-effective, non-flammable refrigerant. In either situation, the trouble free life of the resulting system should be in the order of magnitude of 20 years and the physical size of a replacement system (if that turns out to be the solution) should be as small and

cost effective as possible.

Phase I: SBIR activity will concern selection of candidate environmentally acceptable, drop-in replacement refrigerants, or design of a replacement equipment/refrigerant system. System designs and operating characteristics will be compared to the current military and commercial R-502 systems. A Phase I demonstration will be conducted to indicate the potential for success in Phase II.

Phase II: SBIR activity will finalize the selected solution, together with construction/modification, test, and qualification of a prototype of the required system.

Dual Use Commercialization Potential: The small business that develops a long-term solution to replace the use of R-502, one of the most widely used commercial refrigerants, will have either developed a highly saleable refrigerant replacement product or a critically needed, commercially acceptable OLDS free refrigerant equipment system.

REFERENCES:

Fischer, S.K. "Analytical Screening of Alternatives for R-502 in Low-Temperature Refrigerating Applications." 1992 American Society of Heating, Refrigerating, and Air Conditioning Engineers Meeting, Baltimore, MD, Jun 27-Jul 1, 92. (Available from NTIS as DE92017162/XAB).

"Search for Alternative Refrigerants Hots Up." Chemical Week (International Ed.), Jul 15, 92, p.14.

"Du Pont Releases R-502 Alternatives." European Chemical News, V.58 #1539, Oct 5, 92, p.31.

"Du Pont Substitute for R-502 Refrigerant." European Chemical News, Chemscope Issue, Jul 6, 92, p.31.

AF94-101 TITLE: <u>Solid Rocket Motor Aging, Reliability, Service Life Estimation, and Performance Evaluation Technologies</u>

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop surveillance sensors and methods which will support estimation of remaining service life, defect aging, and probability of mission failure.

DESCRIPTION: The application of advanced inspection technologies can be applied to allow determination of defects within a solid motor stage propellant grain. What is needed is the development of advanced sensor technologies and methods which can be applied to determine how critical defects identified within solid propellants effect overall motor performance. This topic solicits development of advanced sensor technologies (both external to the motor as well as internal) which can non-destructively identify changes in the chemical composition, physical configuration and eventual motor performance compared to original specifications for candidate solid propellant motors.

Phase I: Provide preliminary technology designs for various service life estimation technologies which enhance the currently procured aging technologies found in the field.

Phase II: Complete prototype technology development for potential demonstration and validation for available solid propellant motors. Demonstration and validation success will serve as the criteria for consideration into a S&T system development effort.

Dual Use Commercialization Potential: Output from this topic could be used to commercially determine aging, manufacturing quality control, aircraft parts non-destructive evaluation during repair and refurbishment.

REFERENCES:
Lloyd, D.K. "Long Range Service Life Analysis/LRSLA/System Trend Analysis Life Estimating Procedure." Institute of Aeronautics and Astronautics, Society of Automotive Engineers, 12th Propulsion Conference, Palo Alto, CA, Jul 26-29, 76, AIAA Paper 76-746.

Vanderhyde, N., Baumgartner, W.E. "Solid Rocket Propellant Shelflife Analysis and Prediction." in Lifetime of Rocket Propellants, Propulsive Charges and Explosive Charges; Proceedings of the Annual Meeting, Karlsruhe, Germany, Sep 29-Oct 1, 71, p.253-274.

Francis, E.C., Jacobs, J.R. "fractur Considerations for Surveillance Programs (Structural Reliability of Solid Propellant Grains)." American Institute of Aeronautics and Astronautics, Society of Automotive Engineers, 11th Propulsion Conference, Anaheim, CA, Sep 29-Oct 1, 75. AIAA Paper 75-1282.

Ekstrom, J.L., et al "Applying Design to Reliability Techniques to a Composite Solid Rocket Motor Case." 32nd Structures, Structural Dynamics, and Materials Conference, Baltimore, MD, Apr 8-10, 91. AIAA Paper 91-1033.

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AF94-102 TITLE: Enhanced Precision Cleaning of Critical Parts and Components

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Enhanced precision cleanning of critical parts/components using innovative cleaning processes that exc.ude Ozone Layer Depleting Substances (OLDS).

DESCRIPTION: The following enhancements are needed for precision cleaning processes used as alternatives for OLDS: (1) provide flourocarbon additives that will remove hydrocarbons, plus facilitate the cleaning of systems that use highly oxidizing substances; (2) provide thorough water removal and improved particle removal in aqueous/semiaqueous processes. Separate or combined proposals are acceptable for the following subtopics.

a. Flourocarbon additives have been developed for highly effective particulate removal. The innovative development of a flourocarbon additive that has the capability to remove hydrocarbon oils, greases, and resin fluxes would result in the creation of a cleaning fluid highly comparable to Freon 113. Such a material will fill a critical need in closed loop, recirculating, precision cleaning processes. In addition, such a solvent may provide an innovative, highly inert, non volatile residue, environmentally acceptable replacement fluid/process to remove highly flamable substance residuals, particulate contaminates, water and other contaminating materials from systems that handle highly oxidizing materials.

b. In aqueous cleaning, the parts are first immersed in an aqueous/ surfactant solution. In semiaqueous cleaning, parts are first immersed in a hydrocarbon based solution. In either case, the contaminate laden solution is flushed from the parts by rinsing the water. A need exists to provide an improved method for removing the rinse water from the cleaned parts. In the past CFC-113/surfactant mixtures have successfully been used as decanting liquids to remove water from the cleaned parts. An alternative might consist of displacing the water by innovative, volatile, nonflammable, immiscible liquid. In addition, both aqueous and semiaqueous cleaning solutions are not effective particulate contaminate removers in the area of < 5 micron particle size. In the case of critical cleaning processes, there is a need to improve the capability of these solutions for removal of small particulate contaminates.

Phase I: Phase I will result in the demonstration of improved flourocarbon, semiaqueous and aqueous cleaning processes applied to selected parts.

Phase II: Phase II will result in the development and implementation of a production precision cleaning process.

Dual Use Commercialization Potential: The contractor who develops OLDS-free enhancements to critical cleaning processes will find wide commercial acceptance for his products. Aqueous, Semiaqueous and fluorocarbon-based processes are OLDS free by nature. Precision cleaning processes utilizaing fluorocarbon materials, contained in currently available closed loop, recirculating cleaning systems are also acceptable from a global warming aspect.

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Marts, K., Howard, J. "CFC Alternative Cleaning Systems. Alternative Processing Techniques and Their Effectiveness in Precision Cleaning." Journal of the IES, V.34 #5, Sep-Oct 91, p.34-40.

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AF94-103 TITLE: Clean Room Approved Packaging Material/Packages

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop Clean Room approved packaging material/packages for temporary storage and transport of cleaned items.

DESCRIPTION: Elimination of CFC cleaning agents has resulted in the creation of localized cleaning centers, which in many instances, are remote from the point of use of the cleaned items. This situation creates the need for innovative, clean room approved, protective, non-contaminating, packaging material and packages in which the cleaned items can be placed for transport to the next location in the production, storage or developmental process. To date, no adequate/convenient packaging method exists that will consistently protect an item from contamination in such a packaging/storage/transport process. A very serious need exists to develop packaging material/packages to protect precision cleaned parts during transit from clean room cleaning centers to assembly areas, test sites, other clean rooms, etc. Required attributes of the packaging material/packages, among others, are: a. Totally impermeable to moisture; b. Completely antistatic; c. cleanroom approved (for up to class 100 clean areas) both inside and out; d. Transparency desirable; e. Conveniently sealable; f. Antishedding/anticontaminating during sealing and opening operations; h. Antishedding/anticontaminating as a result of abrasion of packaged part to packaging material contact and rubbing g. Inert to common solvents, oils and greases.

Phase I: This phase will address innovative material selection/ development, fabrication and sealing processes, validation test procedures, sealing/opening methods, and demonstrate feasibility of approach to the problem.

Phase II: This phase will finalize successful problem solution/ demonstration in actual commercial/DoD production processes.

Dual Use Commercialization Potential: Development of a suitable clean room material and packaging process will have wide commercial and military acceptance throughout all the organizations using clean rooms in their production processes.

REFERENCES:
"Dunmore Introduces Anti-Static Bag Material With 50% Greater Abrasion Resistance and Improved Clarity." Contact Dunmore Corp.., Anti-Static Films Gp, 207 Penns Trail, Newton, PA 18940. 215-968-0442.

"Dynamic New Packaging Concept With Tremendous Environmental Merits Now Available From Sealed Air." News Release Sep 92. Full Text Available on PTS New Products Development Announcements (File 621 Dialog) or contact Sealed Air Corp, 2311 Boswell Rd, Suite 8, Chula Vista, CA 91914. 619-421-9294.

"New Aircap (R) -Fras Fire Retardant Anti-Static Buble Cushioning From Sealed Air Corp. Resists ESD and Fire Damage." News Release Sep 88. Full text available on PTS New Product Announcements (File 621 Dialog) or contact A.B. Isacson Assoc, 545 Eighth Ave, New York, NY, 10018. 212-868-2727.

Lawrence, J.C. "Clean Room Approved Packaging Materials/Packages." (available from D. Hinesley, BMO/CYRR, Norton AFB, CA -909-382-6021.

AF94-104 TITLE: Precision Guidance and Navigation Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Identify, investigate, and develop innovative technologies for guidance and navigation of hypersonic vehicles.

DESCRIPTION: Recent analyses conducted in support of Air Combat Command has considered delivery of hypersonic glide vehicles capable of delivering conventional payloads anywhere in the world. To be feasible, these systems need integrated guidance and navigation subsystems that can provide better accuracy (miss distances of less than 3 meters over ranges in excess of 12,000 KM and lasting almost 2 hours) and significant reduction in the overall cost of ownership than currently available technologies. It is believed that technologies that have multiple applications, especially commercial applications will have a tendency to be more cost effective to procure and to maintain. For this reason, technologies with high commercial potential will be given special consideration. Technologies that are not totally inertial based, but provide for means of position identification or position location error reduction are sought. Due to the hypersonic speeds, constrained weight and available onboard power, size and weight reduction along with low power requirements will be deemed very critical in evaluating prospective technologies. Some of the required guidance and navigation capabilities include: Terminal errors of less than 3 meters; Immunity to active and passive countermeasures; Low procurement costs; Low maintenance costs; and Small size, low weight and low power requirements. Several of the concepts examined might use inertial systems updated by radars, optical sensors, or satellites. Although these concepts would provide good accuracy, they have not been able to meet the combined critical objectives described. Consequently, these concepts serve as a point of departure for innovative techniques and their definition will be made available upon request.

Phase I: Define requirements and design goals for precision guidance and navigation technologies to be further researched and developed in Phase II.

Phase II: Perform analysis, simulations, and complete preliminary designs firmly establishing feasibility. Conduct limited laboratory testing.

Dual Use Commercialization Potential: Small low-cost precision navigation position reference systems could be used commercially for automotive navigation, aircraft control and navigation, commercial transportation, crash avoidance sensors and subsystems, and microminiature manufacturing.

REFERENCES:

Brayden, K., et al "Integrated Inertial Navigation System/Global Positioning System (INS/GPS) for Manned Return Vehicles Autoland Application." IEEE Plans '90: Position Location and Navigation Symposium Record. The 1990's - A Decade of Excellence in the Navigation Sciences, Las Vegas, NV, Mar 20-23, 90, p.74-85.

AF94-105 TITLE: Remanufacture of Ammonium Perchlorate Reclaimed from Demilitarization/Propellant Manufacture

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an ammonium perchlorate reclamation process using manufacturer scrap and demobilized missile propellant in the manufacture of new rocket motors.

DESCRIPTION: Recycling of Ammonium Perchlorate (AP) is an environmentally preferable alternative to open burning or open detonation. Recyclable AP is recovered from: (1) the demilitarization of missile motors, and (2) from manufacture of new AP which is unsuitable for use in motors without additional processing (remanufacturing). The highest value application of the reclaimed AP is in the manufacture of new military and commercial rocket motors. The particle size distribution, crystal shape, density and chemical purity are attributes that are important for ballistic and physical property control in propellant manufacture. Recrystallization of reclaimed AP poses some unique challenges that require innovative solutions. Trace contaminants brought over from other components of the propellant may impact crystal habit (shape of the crystals), nucleation rates and nucleation sites (affecting rate of growth and final crystal size). Also, trace impurities may interfere with propellant curing, burn rate, and mechanical properties. Innovative research is required to develop an efficient, affordable process to remanufacture reclaimed AP in production quantities that satisfies the chemical and physical properties including particle size distribution specified for propellant grade AP. Successful process development will benefit not only environmental concerns but also cost effective manufacture of military and commercial rocket engines.

Phase I: Phase I will define the basic process together with a laboratory-scale demonstration to display its potential for success.

Phase II: Phase II will expand the methodology to a full scale reliable production process, including a production-scale demonstration.

Dual Use Commercialization Potential: This program embodies an environmentally preferred alternative to the disposal of demilitarized rocket fuels coupled with cost effective reuse of surplus/scrap ammonium perchlorate in new military and commercial solid rocket engines and ammonium perchlorate byproducts.

REFERENCES:

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Palanisamy, R., John, P.U. Narasimhan, K.C. "A Cyclic Process for the Production of Ammonium Perchlorate." Proceedings of the Annual Technical Meeting Symposium Met. Colour. Incl. Colour Anodizing Chem. Coloured Coat., Karaikudi, India, 1984, p.45-49

AF94-106 TITLE: Active and Passive Microoptics for Diode Lasers and Amplifiers

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop fabrication and mounting techniques for active and passive microoptics for use with diode lasers and amplifiers.

DESCRIPTION: Semiconductor diode lasers show great promise for both military and commercial applications. One way to achieve the high brightness from some of these applications requires the use of the master oscillator power amplifier approach. In this approach it is necessary to efficiently divide and one-way couple power from the master oscillator to the several amplifiers and then coherently combine the outputs. It has proven difficult to achieve all of the required devices or operations monolithically on one chip. A hybrid approach using microoptics may be more practical. This approach may require anamorphic lenses, beam splitters, phase shifters, polarizers, waveplates, etc., to one-way couple from the master oscillator to the amplifiers and have all the outputs properly phased. This topic is seeking the development of techniques for the design, fabrication, and mounting of such microoptic devices. How the device fits into a whole system should be considered, since it does no good to have a waveguide modulator if there are no microoptics to efficiently and reliably couple into and out of the modulator from the preceding and following devices. Micro mounting techniques as well as microoptics need to be developed.

Phase I: Procedures and processes are developed for the design, fabrication and mounting of individual devices that are compatible with a complete system.

Phase II: A complete system is demonstrated using the procedure, processes and techniques developed in Phase I. The system must demonstrate a significant capability.

Dual Use Commercialization Potential: The dual use commercialization potential is very high for all of the devices and techniques developed as a result of this SBIR topic, because these are devices and operations used in any optical system and are not unique to military applications.

REFERENCES:

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Schaefer, S.R., Gentilcore, L.J., Salour, M.M. "Evaluation of a Modular Fiber-Optic Assembly Technique Based on Results from the Production of Directional Couplers." CURRENT DEVELOPMENTS IN OPTICAL ENGINEERING IV, San Diego, Jul 9-10, 90. SPIE Proceedings V.1334, p.161-168.

AF94-107 TITLE: Optical Filters for Ultra-High Rejection of Noise or Laser Wavelengths

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Fabricate and characterize high throughput (0.8), wide-angle (> 30 degrees), ultranarrow (< 1 GHz), bandpass/band rejection optical filters with high (> 10,000,000) out of band/in band rejection.

DESCRIPTION: Large ground-based telescopes require adaptive optics to correct the blurring effects of atmospheric turbulence on imaging and laser propagation. The USAF has demonstrated the use of laser beacons as a light reference source allowing the adaptive optics sensors to measure the wavefront distortions created by the atmosphere. Laser beacons are created by focusing a laser in the atmosphere. A sensor behind the telescope detects light scattered by the atmosphere and adjusts the surface of a deformable or "rubber" mirror to cancel the distortion. It is only possible to use this concept at night since the strength of the signal scattered back into the telescope is very weak. This signal is completely masked by noise from the bright sky in the daytime. Current optical filters have inadequate throughput, out-of-band rejection, and linewidth to permit daytime operation of adaptive optics using laser beacons. In operating laser beacon adaptive optics the sensor must not be blinded by laser light scattered by the telescope optics as the pulsed laser beam leaves the telescope. It is necessary to sense light scattered only from a small "range gate" in the atmosphere where the beam is focused to a small spot. The optical filter must be switchable from high throughput to high rejection, quickly (100 nanoseconds or less) at repetition rates up to 5,000 times per second. It is important to protect other sensors and cameras from the scattered laser light. Also desirable is the ability to configure the filter to operate in a mode that rejects light from a narrow spectral region centered on the laser line wavelength but have high throughput for all other wavelengths. There are requirements for optical filters operating at copper vapor laser wavelengths of 510.6 and 578.2 nm and at the sodium D2 line of 589 nm.

Phase I: Select a concept, fabricate a laboratory model, and experimentally characterize its performance. Successfully demonstrate the laboratory model (chosen filter concept) to prove it's feasibility and provide quantitative data which satisfies the following specifications: < 1 GHz; transmission: >0.8; out-of-band rejection: > 10,000,000; field of view: >30 degrees full angle; switchable from high throughput to high rejection in tens of nanoseconds at rates up to 5,000 times per second.

Phase II: Produce usable filters for test and evaluation in laser beacon adaptive optics experiments at the Starfire Optical Range, Kirtland AFB NM. The filters will be evaluated for throughput, out-of-band rejection, and ability to serve as a range-gating mechanism to reject near field scatter from optics and the lower atmosphere. This phase also includes packing the filter for use in laser beacon adaptive optics experiments on large telescopes with high power lasers. The filters would be needed as high throughput, high rejection, switchable devices for use with copper vapor and sodium frequency lasers and will be operated on 1.5 and 3.5m telescopes with ultrahigh sensitivity, ultra low noise wavefront sensors and cameras.

Dual Use Commercialization Potential: Laser guide star adaptive optics offer a high value commercial application in transmitting electrical power to geosynchronous communications satellites to extend their operational life. The satellite's life is limited by deep cycling of it's batteries during earth eclipses lasting approximately one hour per day for periods of approximately 45 days twice per year. Charging the satellite's batteries with the use of ground based lasers during these periods can extend the satellite's life 5-15 years, resulting in revenues of 20-50 million dollars per satellite per year. Satellite owners are interested in developing a network of ground based sites that could beam power commercially to their satellites on a world wide basis. A large commercial market for narrow band optical filters exists today. Ultra-narrow, high throughput filters developed under this effort would immediately expand this market and find acceptance in many commercial applications, including medical imaging, non-destructive testing, ultra high resolution spectroscopy, surveillance, astronomical imaging cameras, daytime laser communications with GEO and LEO satellites and deep space probes, solar astronomy, and many other applications.

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Yin, B., Shay, T.M. "Theoretical Model for a Faraday Anomalous Dispersion Optical Filter." Optics Letters, V.16

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AF94-108 TITLE: Environmentally Clean Beam Path Conditioning

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop a new approach to beam path conditioning hardware for optical systems.

DESCRIPTION: Beam path conditioning (BPC) systems in use at optical stations around the world generally either attempt to flow laminar gas through the beam train or else provide a box-like environment to prevent undesirable currents from entering. While these approaches can work well, we are interested in an improved design for high quality optical trains. The selected approach would provide a near-lossless, high Strehl ratio technique which either measured or controlled the deleterious air turbulence, vibration, and thermal gradient effects. In particular, a concept that can be built in Phase II is desired. One function of the hardware package would be to account for any predictable air flow and minimize air turbulence. A good understanding of air flow and turbulence effects on optical performance is essential. Similarly, seismic vibrations in the beam train can cause acoustical coupling or otherwise disrupt the BPC system. Finally, thermal gradients among optical elements, ambient gas, and container sidewalls can induce optical degradations. These effects should be analyzed in considerable detail during Phase I so that the eventual hardware program can be used to validate the design in a brassboard environment. The BPC approach itself is to concentrate on "clean" techniques with recyclable constituents, if applicable.

Phase I: The objective of the Phase I program is to produce a BPC design supported by analysis and/or simulation. The successful small business would have to understand optical system characterizations and fluid flow to verify the design in "software".

Phase II: The second phase will require the development of a BPC system for a scaled down brassboard optical train so that individual effects can be monitored and performance evaluated. The Phillips Laboratory (PL) would provide access to such a brassboard for the final level of checkout. Ideally, in Phase III a commercial package should be developed that could be installed in optical systems around the world to mitigate one adverse effect.

Dual Use Commercialization Potential: We expect that the fields of astronomy, imaging, laser propagation, and optical surveillance would be interested in a clean BPC hardware design. A recent example of how clean beam trains can be commercialized is the Laser Guide Star (LGS) adaptive optics technique, which was developed in the defense department and is now being used in the astronomy community. A final dual use commercial technology which can take advantage of the new BPC technique is the "power beaming" of energy to sustain geosynchronous satellites. These expensive satellites occasionally lose contact with the sun and can be resupplied with energy from the ground, but the optical train required to supply that energy would have severe limitations in delivering energy unless the beam train were conditioned to a high level. commercial package that could be installed in optical systems around the world to mitigate one adverse effect. We expect that the fields of astronomy, imaging, laser propagation, and optical surveillance would be interest in such a hardware design.

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AF94-109 TITLE: Optically Pumped Mid-Infrared (2-5 micron) Semiconductor Lasers

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop and demonstrate a 10-watt average power, optically pumped, mid-infrared (2-5 micron) semiconductor laser.

DESCRIPTION: Present electrically driven semiconductor lasers require small dimensions (=a few microns) between electrodes in order to confine the current flow to a narrow, well defined channel. This requirement stresses materials and bonding technologies, greatly complicates engineering design, and reduces the lasing volume in conventional semiconductor lasers. One option available which may overcome these difficulties is to optically pump a semiconductor laser with another laser source. This option may allow for greater engineering flexibility in the design of mid-infrared semiconductor lasers and higher output power from a single aperture. If developed, this laser source would have many applications in Air Force, DoD, and environmental monitoring areas.

Phase I: Demonstrate a scalable, mid-infrared (2-5 um) laser pumped semiconductor laser operating at average power levels above 0.1 watt. The pump source in Phase I may be either solid-state or a semiconductor laser. Optically pumped oscillators or oscillator/amplifier configurations should be considered. A preliminary design for a 10-watt semiconductor oscillator shall be delivered in this phase.

Phase II: Extend the Phase I demonstration to the 10-watt average power level in the mid-infrared. Modeling and analysis of the 10-watt device should be used to determine the power scaling limits for optically pumped semiconductor lasers. The pump source in Phase II must be a semiconductor laser.

Dual Use Commercialization Potential: Most organic chemical species have spectroscopic signatures in the 2-5 micron range. The mid-infrared semiconductor laser is an ideal handheld source for remote detection of chemical species. In addition, eye-safe laser applications such as wind shear sensing and laser radar are ideal spin-offs of this technology.

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AF94-110 TITLE: Medical Applications Of Semiconductor Lasers

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Investigate medical applications of the fiber-coupled, semiconductor lasers and determine which applications will benefit most from their unique properties.

DESCRIPTION: Recent improvements in materials growth, processing and architecture of semiconductor lasers have made them very attractive for use in medical procedures. Until recently, the semiconductor laser was not able to produce output powers high enough for medical applications and had a very limited wavelength range. Semiconductor lasers are currently emitting watts of output power from a single device and tens of watts from a single bar. Material systems other than the conventional AlGaAs system have been developed allowing the semiconductor laser to lase from 630 nm to 2.2 um at output powers of 100s of mW or more. With these advances, the semiconductor laser has the potential of replacing most existing medical lasers for continuous wave applications. Building a single semiconductor laser system for a variety of medical applications is very difficult, since each application requires different operating parameters. The high power systems being developed need to be refined for specific applications. It is also important that use of semiconductor lasers in an application be advantageous over other conventional procedures.

Phase I: Select a promising application utilizing semiconductor lasers. The contractor shall perform preliminary investigations to determine laser specifications for the chosen application and required system design parameters. At the end of Phase I, a preliminary design will be delivered.

Phase II: Build and optimize the laser system by conducting tests in the environment in which it will be used. A prototype will be delivered the end of Phase II.

Dual Use Commercialization Potential: These semiconductor lasers will be useful for military applications such as a portable battlefield cut, coagulate, and close device or an illuminator. They will also be useful for any type of hospital or doctor's office, either military or civilian. Applications range from PDT therapy to laser scalpel. The high reliability, compactness, continuous wave operation, variety of wavelengths, and high efficiencies will enable these devices to be versatile, portable units that can be carried from operating room to operating room or between doctor's offices.

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AF94-111 TITLE: Nonlinear Optical Generation of Mid-IR Laser Wavelengths

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Demonstrate new optical gain configurations which incorporate nonlinear optics and laser gain in a single cavity.

DESCRIPTION: Most current techniques for generating light in the mid-infrared (2-5 um) require nonlinear optical frequency conversion processes which are inefficient and difficult to implement in fieldable systems. One way to ruggedize the system and possibly increase the efficiency of the process is to develop lasers which incorporate gain and frequency conversion capabilities in one cavity. These sources could be considered monolithic or quasi-monolithic lasers. Additional important considerations involve passive Q-switching and mode-locking methods which could be an integral part of the gain media. These laser sources would have an immediate impact on many Air Force and commercial applications including communications and environmental monitoring.

Phase I: The Phase I effort should be directed toward understanding technical issues associated with laser configurations which incorporate multiple optical processes in a single laser cavity. Experiments, supported by theoretical analysis, should be performed which provide possible candidate nonlinear optical materials and gain media appropriate for generating 2-5 micron laser radiation. Solid-state materials which can be diode laser pumped are required. During this phase, a preliminary design for the Phase II device demonstration should be developed.

Phase II: Phase II should demonstrate a 5 watt, near diffraction limited device which is tunable in the 2-5 micron wavelength region.

Dual Use Commercialization Potential: New 2-5 micron tunable lasers developed under this effort will have a direct impact on commercial solid-state laser applications such as communications, lidar for wind shear and remote sensing, environmental monitoring, materials processing, surgical and therapeutic procedures in the health industry, and other applications which require eyesafe laser wavelengths (greater than ~ 1.5 microns). Current lasers which are used for some of these applications usually use gas as the gain media or use nonlinear optical frequency conversion elements in conjunction with separate solid-state lasers to generate the mid- infrared wavelengths. Both systems are inefficient and usually are physically large. Integrated, single cavity lasers for generating mid-infrared wavelengths should be more compact, reliable and efficient, providing the commercial sector an attractive alternative to existing systems.

REFERENCES:
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Raffy, J. et al. "agGaSe sub 2 OPO Pumped by a LiNbO sub 3 OPO." p.105-107.

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AF94-112 TITLE: Direct Generation of Near/Mid-Infrared Laser Wavelengths

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Investigate existing and new solid-state gain media which lase in the 2-5 micron band and at 1.178 microns.

DESCRIPTION: Current fieldable techniques for generating light in the mid-infrared require nonlinear optical frequency conversion processes which reduce system efficiencies. One way to possibly increase the efficiency of the process is to find solid-state materials which lase directly in the mid-infrared, particularly in the 3-5 micron band. Also of interest are solid-state materials which lase at 1.178 microns. Frequency doubling at 1.06 microns has been accomplished at efficiencies exceeding 70-80 percent (optical to optical), so frequency doubling 1.178 microns to 589 nanometers could produce similar efficiencies. We are seeking proposals in these areas. On-going research in the Air Force, other Government organizations, in the environmental monitoring community, and the astronomical community can benefit from solid-state laser materials research in these areas.

Phase I: The Phase I effort should be directed toward researching the physics associated with solid-state materials which lase in the 2-5 micron band or at 1.178 microns. Nonlinear frequency conversion processes should not be considered. Experiments, supported by theoretical analysis, should be performed which provide possible gain media candidates. Materials which can be diode-pumped are preferred. During this phase, a preliminary design for the Phase II device should also be developed.

Phase II: Phase II should provide expanded proof of concept by fabricating a greater than 10 Watt average power, less than two times diffraction limited, mid-infrared laser source.

Dual Use Commercialization Potential: New 2-5 micron laser materials developed under this effort will have a direct impact on commercial solid-state laser applications such as lidar for wind shear and remote sensing, environmental monitoring, materials processing, surgical and therapeutic procedures in the health industry, and other applications which require eyesafe laser wavelengths (greater than ~1.5 microns). Current lasers which are used for some of these applications usually use gas as the gain media or use nonlinear optical frequency conversion elements in conjunction with solid-state lasers to generate the mid-infrared wavelengths. Both systems are inefficient and usually are physically large, which limits their viability. Laser materials which lase at 1.178 microns will provide a source for frequency doubling to 589 nanometers, a wavelength used both the DoD and the world-wide astronomical community to perform atmospheric compensation research.

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AF94-113 TITLE: New Laser Concepts For Air Force And Private Sector Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

OBJECTIVE: Develop novel lasers for communications, countermeasures, and remote sensing.

DESCRIPTION: The next generation of laser devices for the Air Force must be high power, efficient, and extremely compact sources. Monolithic semiconductor and solid-state sources which incorporate microoptics and high modulation rate optical modulators in a common structure for stability, reliability, and ease of operation are desired. Average output power should be in the 20-50 watt range with near diffraction limited beam quality. Direct lasing devices in the eye safe (1.5-10 micron) and ultraviolet (<0.4 micron) wavelength ranges are of interest. Proposers may submit new concepts for laser devices, microoptics technologies, thermal management, die bonding, materials development, modulation schemes, or other important technologies supporting next generation laser devices for the Air Force and private sector. Novel, broad area, single aperture semiconductor lasers, compact, monolithic solid-state lasers, and unique high power array architectures will have application in future Air Force communications, countermeasures, and remote sensing missions. Commercial applications for this technology include environmental pollution monitoring, wind sensing, read/write data storage, and communications.

Phase I: Develop preliminary designs and perform analysis to select most promising candidate. Laboratory demonstration of the selected concept is preferred but not required.

Phase II: Further develop and demonstrate the chosen Phase I design/concept. The contractor shall deliver any hardware/software developed, document the work performed and develop a plan for technology transition and insertion into future systems and other commercial ventures.

Dual Use Commercialization Potential: The lasers developed under this program will be useful for many civilian applications. The remote sensing applications pollution monitoring of industrial plants and waste sites, process monitoring in manufacturing, identification of agricultural and plant species and growth conditions, and oil surveys. Other spectroscopic techniques include medical applications such as glucose monitoring. Examples of medical applications include photo dynamic therapy for cancer, tissue cutting, and cauterization. Lasers for wind sensing will transfer to commercial aviation for wind shear detection. Short wavelength lasers will apply to high density data storage and retrieval as well as high brightness color video displays.

AF94 114 TITLE: USAF-Phillips Laboratory: Technology Transfer/dual Use

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Stimulate the transition to a national industrial capability providing the most advanced, affordable, military systems and the most competitive commercial products.

DESCRIPTION: The Phillips Laboratory (PL) is the premier DoD organization conducting R&D in military space, missiles, directed energy, and geophysics technology. Ongoing or previous R&D efforts at or on behalf of the PL often result in specific state-of-the-art technological innovations which, due to USAF priorities, are not developed as a product. Many of these technologies, if properly developed and refined, may offer truly innovative solutions to a great many DoD and commercial requirements. Additionally, the proposer may have developed technology that may solve both PL and commercial scientific and/or engineering problems if properly refined or developed. The following are the areas of technical interest to Phillips:

PROPULSION - Advanced concepts involving motors and propellants and test techniques.

GEOPHYSICS - Research to further Air Force understanding of the environment between the earth and the sun and its effects on systems and and operations.

SPACE and MISSILES TECHNOLOGY - Work on spacecraft structures, power and thermal management, sensors, electronics, and navigation technology.

LASERS and IMAGING - Demonstrating the technical and engineering feasibility of lasers and imaging systems.

ADVANCED WEAPONS and SURVIVABILITY - Developing high energy plasma and microwave technologies, electromagnetic pulse hardening, space systems survivability, and advanced techniques and computer simulations for weapons effects.

SPACE EXPERIMENTS - Managing and conducting space experiments in a ground, balloon-borne, aircraft or space mode, along with related ground acceptance and space/launch environmental testing.

Proposers should take care to describe the dual use (both military and commercial) and/or transfer potential of the technology. PLEASE NOTE that proposals submitted under this category will be first be evaluated for relevance to dual use objectives. Relevant Phase I proposals will then be evaluated in accordance with criteria specified in section 4.2 of this solicitation. Emphasis will then be placed on the potential of the proposer to bring a product to market through commercial track record, alliances with others who have successfully commercialized a product, or a strong commercialization strategy.

Phase I: An in-depth assessment of potential commercial and military applications will be require. As a result of this assessment, the initial necessary concept refinements will be determined and designed.

Phase II: Build or fabricate, test and validate a laboratory demonstration model or prototype based on the commercial/military applications assessment and the design refinements.

Dual Use Commercialization Potential: The range of technologies addressed by this topic and of interest to the Phillips Laboratory are expected to positively impact private sector interests in communications, advanced electronics, medicine, transportation, manufacturing, and environmental sciences, as well as a great many other markets.

AF94-115 TITLE: Lightweight Nitrogen Dioxide Vapor Detector

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an inexpensive, lightweight, Nitrogen Dioxide vapor detector for monitoring personnel exposures to oxidizer vapor.

DESCRIPTION: Nitrogen tetroxide is widely used as a rocket propulsion oxidizer in space launch operations. Nitrogen dioxide (NO2) gas exists in chemical equilibrium with nitrogen tetroxide. Because NO2 is toxic, propellant handlers must be protected from exposures to hazardous levels. No reliable personal monitor to detect the presence of low NO2 levels in real time is currently available. A lightweight, real time detector is needed that provides an alarm when the time-weighted-average (TWA) concentration exceeds 500 ppb over any 15 minute period. The detector, therefore, must monitor 15 minute moving-average concentrations of NO2 over a work day. The detector must meet the following requirements:

SENSITIVITY - Register 90% of the final equilibrated response and recovery values within one minute for NO2 concentrations of 50 ppb.

RANGE: - 50 PPB TO 5 PPM

PRECISION/ACCURACY/LINEARITY - Over the 50 ppb to 5 ppm regime, the maximum output deviation from the ideal linearized output shall no exceed plus or minus 25%.

RELATIVE HUMIDITY EFFECTS - The maximum output deviation no to exceed plus or minus 10% over a relative humidity range of 20 to 80% and plus or minus 20% for 10 to 20% and 80 to 100% RH regime.

Phase I: Develop preliminary designs that emphasize not ony sensitivity, reliability, and size, but also operational costs.

Phase II: Optimize the sensor performance characteristics, fabricate and evaluate the prototype sensor, and field test the prototype detectors at an operational space launch facility. A fully engineered prototype device should

be ready for commercialization upon completion of the Phase II technical effort.

Dual Use Commercialization Potential: A highly sensitive nitrogen dioxide sensor will have environmental monitoring applications such as automotive emissions and ventstack effluents from combustion sources.

REFERENCES:

"Monitoring Harmful Gases: Inexpensive, Highly Accurate Instruments Measure Parts Per Million of Hydrazine and Nitrogen Dioxide In Air." NASA Technical Note. (Available from NTIS as PB81-970037).

Shaikhutdinov, Z.G. "Analysis of the Kinetics of the Afterburning Process Upon Injecting Oxidizer Into a High Temperature Flow." FTD-HT-23-1695-72. (Available from DTIC as AD: 756 098).

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AF94-116 TITLE: Fully Integrated, Low Cost "Programmable" PCM Encoder for Aerospace Use

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop a low cost, light weight Pulse Code Modulation (PCM) encoder that has the capability of providing 'on-board' data processing.

DESCRIPTION: New and innovative approaches are being solicited for the development of an integrated, low-cost (per unit) Pulse Code Modulation (PCM) encoder that has the capability of providing real time processing of the encoded data. Current encoders do not provide any on-board processing capability. This encoder should be programmable to meet both engineering and scientific needs. Programming can be done through a computer interface or via firmware. Examples of programmable parameters should include, but not be limited to the following: type of output code; output bit rate--up to 2MBit/sec; word length 8 to 16 bits; number or words per frame; straight, super, sub and super-sub commutation capability; the ability to provide a data point to the PCM stream on a change only basis (for example, often parameters such as battery voltage or temperature are only of interest when they change, or go above or below a certain point); real-time signal processing algorithms (for example, there are times when raw data is of no interest and only the fourier transform, average, root mean square, etc., of the data is required).

IRIG-106-93 should be used as a reference. The output of the encoder must be range compatible. This encoder will be used in sounding rocket and other aerospace applications. The encoder should have the capability to withstand a high vibration, large temperature extreme environment such as seen during a rocket launch or aboard the Space Shuttle. This does not preclude the use of commercial technology or parts. While radiation hardening should be a consideration, it is realized that it would come at a greatly increased cost. Radiation hardening is considered to be beyond the scope of a proposal of this nature.

Phase I: Phase I will provide a comprehensive and workable design, part selection and sample programming. The design should clearly show its flexibility and its low cost approach.

Phase II: Phase II will be the building and testing (both functionally and environmentally) of a working prototype.

Dual Use Commercialization Potential: As a rugged, robust piece of equipment, this encoder could find application in a variety of remotely-operated devices that must transmit telemetry, for example, robotic devices in certain manufacturing processes or environmental cleanup, scientific devices used for deep sea or volcano exploration. Potentially, such a device could also be useful in implementing various "smart highway" schemes for traffic flow control, toll collecting, etc.

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(Pulse Code Modification) Telemetry Systems." AFGL TR-83-0199, Oct 24, 1983. (available from DTIC as AD A137878).

AF94-117 TITLE: <u>Light-Weight Control Moment Gyros for Small Robust Spacecraft</u>

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Navigation, Guidance and Vehicle Control

OBJECTIVE: Develop compact light-weight control moment gyros for robust control of spacecraft weighing under 2000 pounds.

DESCRIPTION: New and innovative approaches are solicited for single and double gimballed control moment gyros that will assist in providing attitude control for spacecraft weighing up to 2000 pounds. The control moment gyros should provide an output torque and storage of an angular momentum that bridges the gap that currently exists between reaction wheels and control moment gyros (i.e., 2 to 10 foot pounds). Secondly, for both the single and double gimballed control moment gyros, it is desirable that only one and not a series of each will be necessary to bridge the gap previously described. Finally, these control moment gyros should be compact, light-weight, consume as little power as possible, and should have a reliability figure of 0.98 after 4 years. The intended use of these control moment gyros are to control small spacecraft (approximately 2000 pounds or less) which have a requirement to provide a rapid maneuvering capability and compensate large unbalanced induced torques.

Phase I: Phase I will develop proof-of-concept approaches for single and double gimballed control moment gyros as described above.

Phase II: Phase II will be the design of the single and double control moment gyros which represent the best approach for each gyro as identified in Phase I.

Dual Use Commercialization Potential: Increasingly, researchers and certain commercial ventures (e.g., cellular telephony) are proposing work to be done in space. One major obstacle is the cost of access to space, which is often driven by launch costs and the size and complexity of spacecraft required. Often, space missions cannot be adequately performed by satellites without "3-axis stabilization;" however, the requisite stabilization systems, including reaction wheels and/or control moment gyros, have historically been either too large or not as accurate as desired. Development of the control moment gyros requested here will open the door to new applications, including precise remote sensing for small spacecraft. The potential market includes almost every spacecraft and satellite manufacturer.

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AF94-118 TITLE: Space or Near Space Flight Experiments Demonstration Support Resources

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop innovative support systems and/or components for space or near space flight experiment demonstration which offer significant improvements over existing support resources.

DESCRIPTION: The Space Experiments Directorate is responsible for the development of a robust infrastructure to support the insertion of new technology into DoD and US space systems. Requirements to validate new technology through demonstration involve a variety of platforms to accomplish space and near space testing (e.g., high altitude balloons, high altitude aircraft, sounding rockets, free flying satellites, and captive space shuttle payloads). Our directorate is interested in any innovative developments in the following areas which can demonstrate significant improvements in ease of operation, cost of operation and acquisition, maximize where possible usefulness/synergy between the above platforms and payloads, mission tailorable, simplifying operation and maintenance, and high reliability (0.95 at 2 years mission duration for free flying spacecraft, 0.99 for all other missions, equipment and software): data acquisition, coding and recording (non-volatile storage); attitude control subsystem and components; command and control subsystem; communication subsystem compatible with existing ground station protocols; electrical power subsystem; structural subsystems; thermal control subsystems; ground station systems; integration and test support equipment; experiment integration development aids (concept to finished product computer aided development system).

Phase I: Phase I will address the aforementioned systems and areas through superior design with as much ground work in analysis and test as possible. They will also clearly address the potential platforms supported by the proposed product, modular scalability of the product, the resulting benefits of the system (should address but is not limited to the above significant improvement issues above), and the approach to manufacturing and space qualifying.

Phase II: This program will construct and comprehensively test prototype products.

Dual Use Commercialization Potential: Topics in this broad area SBIR generally apply to making the use of space systems easier and more routine. Application of advancements in this area will allow greater access to

space systems for universities and small firms than has previously been possible. Further, long-term application of these advancements may lead to space operations that more closely approximate today's use of airspace.

AF94-119 TITLE: Avionics Research

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative concepts in areas associated with avionics hardware and software.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of avionics. Avionics meaning all electronics onboard an aerospace (missile, aircraft, or spacecraft) vehicle. The primary areas include: navigation; reconnaissance; electronic warfare; fire control; weapon delivery; communications; system architecture; information and signal processing; subsystem integration; and software research, development and support. Some examples of specific research areas are: non-cooperative target identification; airborne radar electronic counter-countermeasures; low-cost airborne radar; automatic tuning or adaptive parameter Kalman filters; hierarchical approaches for integrated resource managers; techniques for enhancing real-time avionics computer and software performance; covert radio/data link concepts; innovative global position system (GPS) application and estimation concepts; GPS wind profiling concepts; modeling and simulation approaches for signal level sensor as well as avionics subsystem and systems level investigations; and development of high-fidelity electronic defense simulators representative of threat radar systems. This topic is structured to provide a maximum of innovative flexibility to prospective participants. Therefore, as a part of the Phase I proposal, briefly describe the anticipated Phase II effort and the dual use commercialization potential.

AF94-120 TITLE: Pattern Theory Extensions and Avionics Applications

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Apply pattern theory's robust pattern finding capability to solve avionics information processing problems.

DESCRIPTION: Pattern theory is an established paradigm which provides a robust characterization of patterns. "Robust" is used in the sense that patterns of all types are included, for example numeric patterns, symbolic patterns, string-based patterns, and patterns in images. Recent research provides strong theoretical and empirical evidence that Decomposed Function Cardinality (DFC) provides a robust basis for pattern finding. Applications of DFC-based pattern finding are possible in many areas. However, application development has been hampered because current algorithms are limited to binary functions with a limited number of input variables and a single output variable.

Phase I: The goals of Phase I are to 1) identify innovative applications, and 2) determine the technical merit and feasibility of pattern finding algorithms to meet the requirements of these applications. These applications may require extensions to the current pattern finding algorithms. Examples of such extensions are 1) provisions for multiple output variables, a larger number of inputs, or multiple-valued input and output variables, 2) a treatment of objects that are not functions, or 3) the exploitation of prior knowledge about the pattern. The Phase I effort will

also define approaches to developing any extensions necessary for the identified applications.

Phase II: Will develop the extensions identified in Phase I and demonstrate the resulting product in a specific application. The products of Phase II will include any extensions to the pattern finding algorithms, a demonstration of the extended algorithms in a specific application, and an identification of high payoff areas for further pattern theory extensions.

Dual Use Commercialization Potential: There are two routes that could be pursued. One route is to develop a general purpose software product that would address the need for more robust solutions in the rapidly growing market for computational learning packages. A second route is to use the Phase II results in a specific commercial application, such as logic minimization, computational learning, image processing, or data compression; any one of which has excellent dual use potential.

AF94-121 TITLE: Target Recognition from First-Order and Second-Order Motion Patterns

CATEGORY: Basic Research

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop comprehensive test suite of first-order and second-order motion observed in image sequences.

DESCRIPTION: Current biological research has surmised that certain objects can be identified by the visual cortex of the primate brain based solely on their motion without additional knowledge such as shape and texture. This suggests that motion analysis could enhance current automatic target recognition techniques used by the Department of Defense. In order to test current and future motion analysis techniques, a comprehensive standardized test suite of image sequences which display first-order and second-order motion must be developed. But first, the research must identify as many categories as possible of first-order and second-order motion. Next, the research will develop algorithms to generate image-sequences that display the phenomena. Finally, the test suite will be developed.

Phase I: The contractor shall identify all categories of first-order and second-order motion. The contractor shall develop algorithms and/or techniques to generate image sequences which display the categories of motion. The contractor shall develop a limited suite of image sequences which display the categories of motion. At the conclusion of Phase I, the contractor shall deliver the limited suite of image sequences.

Phase II: The contractor shall implement the full test suite. The contractor shall demonstrate the validity of the test suite which must provide performance measures. The contractor shall test the full test suite against some of the commonly known motion analysis techniques such as spatio-temperal and spatio-temperal frequency techniques. A complete system for measuring the performance of motion analysis techniques will be the goal of Phase II. At the end of Phase II, the contractor shall produce and deliver the test system.

Dual Use Commercialization Potential: Dual use has been identified for the areas of optometry, biomedicine, psychology, robotics and automobiles. Vision specialists can use the motion test suite developed by this SBIR to evaluate patients with a form of motion blindness (Transitory Akinetopsia). Psychologists can use the motion test suite to evaluate the motion processing areas of a person's brain. Robotic engineers can use the test suite to test motion algorithms for robust vision systems. Automobile manufacturers can use the test suite for testing certain classes of crash avoidance mechanisms that are image and motion based. Finally, biomedical specialists can use the motion-based object recognition to enhance analyzing biological image sequences such as image sequences of the moving heart.

AF94-122 TITLE: Fire Control Fusion and Integration for Tactical Aircraft

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop fusion algorithms for tracking, sensor management, and weapon delivery for tactical aircraft operations.

DESCRIPTION: Recent advances in sensor technology and computer processing capabilities have begun to revolutionize tactical fire control. The ability to accomplish sensor management, multisource data fusion and internetted operations in tactical scenarios has greatly influenced weapon system capabilities and tactics. The ability to fuse data from various sources, such as on-board sensors and off-board assets, will lead to improved precision targeting and fire control solutions. Automatic target cueing systems can benefit from fused and electro-optic data, resulting in higher confidence and detection rates with lower false alarms. Enhanced aspect missiles could be employed using trackfiles derived from fused offensive sensors, defensive sensors, and wingman trackfiles. Within this broad area of fusion for tracking, sensor management and weapon delivery, there are two major areas we wish to focus on. The first area of interest involves fusion for air-to-ground precision targeting. Emerging inertial aided munitions will rely on on-board sensors and off-board assets to derive precision target locations. Algorithms that have the capability to integrate information from Forward Looking Infrared (FLIR) systems, Synthetic Aperture Radar (SAR), Inertial Navigation Systems (INS), Global Positioning System (GPS), and off-board information should greatly enhance the capabilities of attack aircraft. Specific areas of interest include the ability to direct, prioritize, and schedule available sensors, perform on-board fusion of information derived by the sensors and off-board assets, and utilize the fused information to develop an improved fire control solution. The second area of interest involves the integration and fusion of offensive sensors, defensive sensors, and wingman trackfiles to obtain the integrated picture of the environment and to coordinate these sensors throughout an air-to-air engagement. The algorithms should coordinate all functions performed by the aircraft: offensive, defensive, navigation, and threat assessment. The overall objective is automated all-aspect coverage by an integrated sensor suite enabling all-aspect weapon delivery. This capability will increase survivability, flexibility, and situational awareness while reducing pilot workload. Primary issues are conflicting timelines between different sensors, changing mission goals, latency of internetted tracks, and accuracy of fire control solutions. This program will build on recent advancements in enhanced aspect sensors, advanced missile control, datalinks, navigation systems, high angle-of-arrival radar warning receivers, and advanced warning systems.

Phase I: The contractor shall produce an algorithm design and implementation plan.

Phase II: The contractor shall implement the selected algorithms and perform detailed evaluation and demonstration of their performance.

Dual Use Commercialization Potential: Several areas for commercial Phase III efforts exist. Prime examples of these include air traffic control, automated manufacturing, multisensor robotics, remote surveying/exploration, and commercial satellite applications. The primary military application is information fusion for enhanced weapon delivery for Air Force tactical aircraft, however, the concepts developed would be applicable to a host of military multisensor platforms with varying missions like surveillance or reconnaissance.

AF94-123 TITLE: Coherent Frequency Hopping (CFH) to Counter Anti-Radiation Missiles (ARM)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative waveforms for airborne radars that prevent acquisition and tracking by an (ARM).

DESCRIPTION: Conventional Doppler radars must operate on a single frequency for the coherent processing interval (CPI). The radar will transmit from 64 to several thousand pulses during the CPI which is typically on the order of 5 milliseconds. Operating on a single frequency for many pulses will facilitate acquisition by an ARM relative to a radar that can change frequency on each pulse. The key issue in CFH is to maintain the necessary pulse to pulse phase coherence that is required for subsequent Doppler processing. Some nonlinear CFH have been suggested in the past that have exhibited dynamic range and sensitivity penalties that were unacceptable. Linear CFH has not been extensively explored because of the increased RF and signal processing required. Modern monolithic RF components and digital processing technology may make these advanced waveforms technically feasible.

Phase I: Candidate nonlinear and linear CFH techniques will be compared analytically. The research will determine the performance and mechanization complexity. The configuration of a test radar that can be assembled primarily from standard test equipment will be defined.

Phase II: The test radar will be assembled, and the recommended CFH technique will be demonstrated.

Dual Use Commercialization Potential: CFH would allow commercial aircraft to utilize a radar as a collision avoidance, all weather landing aid and obstruction avoidance system, in real time.

AF94-124 TITLE: Air-to-Air Combat Simulation

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a low cost simulation and modeling tool designed to evaluate beyond visual range air-to-air combat.

DESCRIPTION: A need exists for low cost simulations which enable analysts to quickly and easily evaluate various tactical scenarios. Improvements in the availability of high performance personal computers now provide the means to accomplish this objective. Work is however required to develop computationally efficient simulations which provide sufficiently detailed results. The simulation will model blue (friendly) and red (enemy) air-to-air radar performance as well as semi-active and active missile performance. The simulation will allow for user defined radar and missile performance inputs to model a wide range of systems. Detailed radar cross section will be input for both friendly and enemy aircraft (1° Azimuth 5° elevation bins). Engagement geometries will allow for pure pursuit and collision course intercepts at different speeds and altitudes. The software should be written to allow for the addition of other air-to-air sensors and weapons (e.g. IRST/IR missiles). The simulation should be menu driven and written to operate on a 486 based PC.

Phase I: Will define the general software architecture and development plan with sufficient detail to indicate a reasonable probability of success and an adequate description of the final simulation capabilities.

Phase II: Will use the approach in Phase I to develop the simulation and deliver to the government for evaluation

Dual Use Commercialization Potential: Commercial applications beyond a Phase II effort involve spinoffs of the simulation technology to other areas. The contractor will have developed a desktop simulation program with advanced windows applications, graphical user interfaces, and evaluation tools. Software of this type is very reusable on other programs and generic enough to apply to commercial areas. A specific instance would be the automotive industry where future changes to car models can be evaluated quickly while testing the impact of fuel consumption and wind drag. Design and testing of new commercial aircraft would also be an application. The primary military application is a desktop tool for rapid simulation of combat engagements with the ability to easily change parameters and make new runs. This tool can be used for the evaluation of proposed weapon systems and upgrades, and their overall impact on the mission.

AF94-125 TITLE: Enhanced Angle Estimation in Adaptive, Low Frequency, Radar Systems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Formulate and simulate innovative adaptive processing radar architectures for enhanced angle measurement accuracy.

DESCRIPTION: Adaptive radar signal processing technology has demonstrated the ability to enable target detection in severe ground clutter and jamming environments. The acquisition of low observable (LO) threats, by both ground-based and airborne radar systems operating in the VHF through L-Band frequency regions, in these difficult interference environments would not generally be possible at militarily useful ranges using conventional techniques. However, state-of-the-art adaptive sidelobe canceler (ASLC) and space-time adaptive processing (STAP) systems' target angle estimation accuracy can be degraded for two main reasons; 1) limited signal-to-interference ratios due to radar implementation and scenario factors including terrain scattered jamming interference entering the radar antenna's main beam and sidelobes, and 2) distortion of the adapted monopulse antenna patterns when encountering main or near-main beam jamming. These degraded radar angle measurement accuracies may be incompatible with achieving the required weapons systems fire control operations. Examples include the inability of a ground-based GCI radar to vector a fighter out to intercept a threat and achieving the air-intercept missile midcourse guidance that assures terminal guidance seeker target acquisition in light of the reduced seeker acquisition ranges associated with the LO threat signatures. Therefore, new adaptive processing radar architectures are being sought that afford the potential of measuring target range, Doppler, azimuth and elevation angles with the accuracies that are consistent with establishing track files for effective fire control.

Phase I: Will formulate and predict the performance, using digital computer radar and environmental simulations, of innovative adaptive processing approaches whose threat state space measurement accuracies are consistent with counter LO missile fire control. Low frequency linear arrays employing element and beam space configurations, ASLC, and STAP techniques are among the architectural features to be considered. For the airborne radar variant, an all target aspect angle capability (target's return competes directly with sidelobe clutter) is desired.

Phase II: Will formulate, design, and conduct a ground-based experiment that demonstrates the feasibility of the enhanced angle estimation architecture. It is envisioned that a real-time, passive radar (receive only) demonstration will be conducted using existing and/or modified Air Force and contractor adaptive processing hardware/software, instrumentations, jamming, and radar assets.

Dual Use Commercialization Potential: The state-of-the-art in digital signal processing, both algorithms and semiconductor electronics, is such that adaptive processing is rapidly becoming viable for commercial communications, navigation, and medical electronic systems. Application of adaptive processing technology to these electronic systems has already been demonstrated or proposed. This SBIR program will develop and demonstrate accurate radar target angle measurement technology and should find near-term commercial application in airport air traffic control radars that must operate effectively in difficult ground clutter and electronic interference environments.

AF94-126 TITLE: Programmable Electronic Warfare Simulator Wide-Band Verification Instrumentation

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a programmable, real-time, wide-band, radio frequency receiver for EW threat environment simulation verification.

DESCRIPTION: Radio Frequency (RF) threat simulators generate dense threat environments to evaluate electronic warfare systems. The threat environments contain radar signals from 0.05 to 18.0 GHz with pulse densities greater than 1 million pulses per second (PPS). Current instrumentation systems use narrow-band tunable receivers and can only monitor preselected signals at preset times. Unexpected signals occurring outside the narrow-band receiver bandpass will not be detected. A wide-band receiver is required that can monitor the total frequency coverage (0.05 to 18.0 GHz) in a manner that will enable the detection of unexpected signals, pulsed Doppler signals, continuous wave signals, and low probability of intercept signals. The wide-band receiver signals must be software reprogrammable, capable of operation under computer control, and capable of accomplishing precision signal measurements in terms of carrier frequency, pulse width, pulse repetition interval, pulse amplitude, pulse modulation, etc.

Phase I: The contractor shall develop a preliminary design with an analysis of feasibility and cost/fidelity trade-offs. Performance demonstrations of critical aspects of the design are desired to evaluate risk in proceeding with Phase II.

Phase II: The contractor shall fabricate, demonstrate, evaluate, and document the proposed design. Along with the delivery of the system, the contractor shall provide recommendations for development and potential Phase III efforts.

Dual Use Commercialization Potential: This SBIR topic has dual use potential in the instrumentation industry. The basic system and architecture can be utilized in systems for electromagnetic interference/electromagnetic compatibility evaluations, for intercept and identification of transient signals, and for verification of commercial radar test environments.

AF94-127 TITLE: Realistic Infrared Spectral Decoys

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop new concepts for countermeasure decoys which eliminate the undesired spectrum of decoy flares.

DESCRIPTION: Current pyrotechnic flares for decoying infrared heat seeking missiles have some radiations different than the targeted aircraft. In certain scenarios, this may make the aircraft more vulnerable to other threats. It is, therefcre, desirable to develop a countermeasure which only contains the appropriate radiation to realistically simulate the infrared signature of the target aircraft. This effort will develop and explore alternative technologies, concepts, or methods for producing the realistic decoy.

Phase I: The contractor shall investigate the technical feasibility and practicality to generate such a reaction or process for this type of countermeasure. The contractor will determine the technical and physical phenomena involved and the important parameters necessary to generate the decoy. Through research and analysis, this effort will show what kind of new spectral decoy can ultimately be achieved with available technology.

Phase II: The contractor will work on implementing the technology into a feasible concept. Experimentation will be used to verify the analysis and to demonstrate the capability of the materials and mechanisms involved in generating a decoy. The contractor will make measurements showing the amount of infrared radiation that can be emitted with the proper radiation spectrum. The best concepts will be scaled to full size for testing. A demonstrated full size decoy concept will be the goal of Phase II.

Dual Use Commercialization Potential: A dual use phase of this effort will investigate and demonstrate the capability of the decoy for commercial applications. This may include law enforcement applications. The

spectral tailorability may provide infrared sources which can illuminate an area to enhance equipment used for night time infrared viewing by law enforcement officials or security personnel. Application of this technology may also aid commercial aircraft using an infrared imager to aid navigation during landing, take off, or taxing in bad or inclement weather.

AF94-128 TITLE: Electronic Warfare Man/Hardware-in-the-Loop Real-Time Simulation Capability

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a reconfigurable, man/hardware-in-the-loop, real-time, electronic warfare simulation capability.

DESCRIPTION: The development of integrated defensive avionics technology requires a real-time, high-fidelity, man-in-the-loop/hardware-in-the-loop, simulation capability. Integrated defensive avionics use data fusion to provide real-time threat situation awareness and response strategy. The development of data fusion algorithms requires high-fidelity interface with the pilot, defensive avionics, and other aircraft avionics. In the laboratory, these interfaces are currently provided by linking real-time simulation capabilities such as the Integrated Defensive Avionics Laboratory (IDAL) and the Integrated Test Bed (ITB). However, these facilities primarily support other avionics technology developments not requiring linked operation and cannot be dedicated full time in the linked configuration. A reconfigurable high-fidelity electronic warfare man-in-the-loop/hardware-in-the-loop real-time simulation capability is required to cost-effectively and rapidly prototype defensive data fusion algorithms.

Phase I: The contractor shall develop a preliminary design with an analysis of feasibility and cost/fidelity trade-offs. Performance demonstrations of critical aspects of the design are desired to evaluate risk in proceeding with Phase II.

Phase II: The contractor shall fabricate, demonstrate, evaluate, and document the proposed design. Along with the delivery of the system, the contractor shall provide a recommendation for further development and potential Phase III efforts.

Dual Use Commercialization Potential: This SBIR topic has dual-use commercial potential in the entertainment industry. The real-time architecture can be utilized in systems transforming flight/combat simulations into virtual reality for home, arcade, and theme park use.

AF94-129 TITLE: Interferometric Laser Warning Technology

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop interferometry concepts and a single aperture device which can effectively perform passive laser threat warning.

DESCRIPTION: Advances in laser-based weapons constitute a real threat to USAF fighter aircraft. A continuing need exists for a small, light, optically simple, passive system for pilot situational awareness and to pass threat information to countermeasure systems, both in near real time. Laser direction of arrival, wavelength, and pulse characteristics are desired for continuous wave and pulsed laser energy within the entire electro-optic spectrum.

Detection of laser energy is desired for both direct illumination of the sensor as well as off-axis out-of-beam illumination of the sensor by scattered laser energy. Off-axis detection is a particularly difficult problem in that it requires extremely high sensitivity and the distributed nature of the source confounds many coherency and direction of arrival techniques. In addition, the system must also have low false alarm rates, high probability of detection, and wide field of view. Special configurations of interferometry technology have the potential to solve the laser warning receiver requirements outlined above without being confounded by distributed sources. Particular emphasis should be placed on concepts that will allow detection of off-axis (out-of-beam) laser energy with at least quadrant DOA resolution and wavelength discrimination.

Phase I: This effort should generate an interferometric design concept and performance expectations for all sensor capabilities described above, including response time. Possible commercial applications/technology transition efforts should also be proposed.

Phase II: The second phase will proceed with actual hardware development, detailed performance measurements and actual delivery of an article for field test on jet fighter aircraft.

Dual Use Commercialization Potential: Commercial applications of this type of technology could possibly be developed for medical diagnostics, police surveillance, communications, manufacturing or process control, remote sensing, and environmental monitoring.

AF94-13? TITLE: Distributed/Hybrid Cooling for Avionics Retrofits

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Design, develop, test, and demonstrate a distributed/hybrid cooling technique for existing aircraft.

DESCRIPTION: Avionics suites of existing aircraft (F-15, F-16, etc.) will be retrofitted with line replaceable modules (LRM) and integrated avionics racks (IAR). These LRMs contain the electrical, optical, and thermal interfaces for a given avionics function. Some of these modules will contain densely packaged electronics that require liquid flow through (LFT) cooling to remove the heat. Current aircraft electronics are cooled with air, either by conduction, or by air flowing over the devices. Next generation avionics such as on the F-22 are liquid cooled and LFT cooled. The air cooled systems are capable of cooing up to 25-watt modules. The liquid cooled systems can dissipate 50 to 70 watts per LRM and up to 200 watts for the flow through modules. In order to install new avionics on existing aircraft, a new cooling scheme that integrates existing air cooled systems with liquid cooled systems must be developed.

Phase I: Will include examining innovative cooling techniques, performing analysis (techniques, cost, manufacturability, aircraft performance impact, environmental control system impact, etc.), establishing a preliminary design, and creating a development plan for the chosen cooling concept(s).

Phase II: Will include the detailed design, prototype development, and testing of an appropriate-sized IAR with LRMs cooled by this novel concept. This will involve demonstrating the cooling of air cooled and liquid cooled LRMs in the same system configuration.

Dual Use Commercialization Potential: Will be considered/applied in all aspects of this effort. Current avionics in commercial aircraft are air cooled. As the electronics become more sophisticated, the packaging of these and, hence the heat load, become more dense, thus requiring liquid cooling. A distributed/hybrid cooling technique will solve commercial avionics thermal problems. Other dual-use areas to be considered include ground-based computers for large database systems requiring massive memory banks that generate large amounts of heat, automobile electronics/computers which have become very sophisticated and can take advantage of the existing liquid cooling within a vehicle, and commercial space applications that use advanced electronic technologies for navigation and guidance systems.

AF94-131 TITLE: Concurrent Software Testing for Real-Time Avionics Systems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a more efficient, comprehensive software testing technique for real-time embedded computer software.

DESCRIPTION: Nearly half of the cost of developing embedded software is devoted to various forms of software testing. Software testing is performed both by the initial software developer and then later by each level in the development process. The testing procedure is accomplished by a progression of test environments, beginning with simulator debuggers, followed by software integration testing, then system integration testing, and finally flight test. The quality of the delivered software product, as well as its cost, is determined largely by the effectiveness of the software test process. In Science News June 6, 1992, pages 382-383, a possible new method of software testing was discussed. The main focus of the article is the evolution and definition of a new software paradigm described by Prof. Manual Blum: "At the root of these developments lies the startling notion of a probabilistic, interactive proof. ... this new technique relies on randomness and the interplay between a 'prover' and a 'checker' to achieve a practically unassailable proof." This software testing technique has been proven in a nonreal-time environment, but needs to be extended to complex real-time avionics software. There exists a potential for a dramatic increase in the quality of delivered software for military and commercial (Dual Use) avionics products. In addition, this research should result in a reduction in software development and maintenance costs.

Phase I: Will be an initial concept definition and the development of a plan to apply this technique to real-time avionics systems. These inputs will form a boundary for the determination of the framework to test this technique.

Phase II: Will be implementation of this technique for a specific test environment. The specific test environment would be based on a real world problem. In addition, the contractor will delivery a fully functioning demonstration version of the product developed in Ada.

Dual Use Commercialization Potential: Research in this area would apply to both military and commercial avionics software. Improvements in real-time software testing would benefit any user of avionics software as well as any user of real-time software.

AF94-132 TITLE: Wideband Covert Airborne Radio (WCAR)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Telecommunications

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop, test, and evaluate a WCAR which uses very low cost, non-conventional, wideband noise waveform technology.

DESCRIPTION: Current conventional low probability of intercept/dection (LPI/D) and jam resistant spread spectrum communication systems are very expensive to develop and manufacture, and are susceptible to a wide range of potential enemy threats. This effort explores the feasibility of using non-conventional radio frequency technology and modulation techniques to develop a very innovative, low cost, jam resistant WCAR for multiple airborne data link applications. This WCAR can be used to covertly transmit Global Positioning System (GPS) position information from a wind dropsonde to a cargo aircraft and improve the drop master's ability to reliably hit

the drop zone. It can also be used as a rescue radio for downed pilot location and communication, a covert beacon for drop site/plane crash location, a covert rendezvous and a refueling coordination radio by Special Operations Forces (SOF), a covert station keeping data link by SOF, and a covert situational awareness and coordination data by Air Combat Command (ACC).

Phase I: The contractor shall design a WCAR to satisfy both the wind dropsonde simplex data link requirement and an air-to-air two way communications and relative location requirement. The contractor shall also analyzes the WCAR design to determine its theoretical performance and unit cost.

Phase II: The contractor shall develop, test, and evaluate two simplex transmit wind dropsonde WCAR terminals and four air-to-air two-way WCAR terminals, which were designed in Phase I.

Dual Use Commercialization Potential: This WCAR technology is directly applicable to the development of police, FBI, Drug Enforcement Agency, and other law enforcement agencies' radios. Joint commercial/government development and multi-service military development is highly probable for this phase.

AF94-133 TITLE: Real-Time Carrier Phase Ambiguity Resolution for High-Dynamic Vehicles

CATEGORY: Basic Research

DOD TECHNOLOGIES: Telecommunications

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop real-time algorithms to resolve phase ambiguities for GPS measurements in high dynamic environments.

DESCRIPTION: Current P-code Ground Positioning System (GPS) receivers provide approximately 16 meter SEP accuracy when pseudorange measurements alone are used for positioning. Carrier phase tracking algorithms can reduce position accuracies on the order of 3-5 centimeters assuming that the phase ambiguity can be resolved correctly. At present, this capability exists in real-time for static or low dynamic applications, but not for high dynamic environments such as a fighter aircraft may experience. In high dynamic environments, carrier phase tracking is not always maintained which prevents one from resolving phase ambiguities real-time to determine position accurately. This effort would develop real-time ambiguity resolution algorithms for high dynamic applications.

Phase I: The contractor would first develop algorithms for real-time ambiguity resolution assuming that carrier tracking is maintained. These algorithms would then be improved to perform real-time ambiguity resolution for the case where carrier tracking is lost for various periods of time. The algorithm performance shall be validated using high fidelity computer simulations, and, if applicable, actual data collected from flight instrumentation. An evaluation will be made of the computational efficiency of the algorithms. The contractor will provide documentation of all algorithm development details and performance results achieved.

Phase II: The contractor shall implement the real-time ambiguity resolution algorithms in Ada and using actual GPS hardware demonstrate their performance in a high dynamic environment. The validation of the algorithms will require the development of a highly accurate time, space and position information (TSPI) system capable of cm position accuracy and velocity of 0.01 fps. The developed TSPI will be applied in a series of flight tests to demonstrate the real-time performance of the developed algorithms.

Dual Use Commercialization Potential: These algorithms have tremendous commercial application in the areas of kinematic surveying, test reference for system validation, and commercial aviation. By developing a real-time cm position accuracy capability, surveys can be accomplished in less time resulting in a tremendous savings. Commercial aircraft can perform instrument landings, reduce airline block times, and reduce the size of safety corridors which will result in a savings of millions of dollars per year Just as the commercial community has found the greatest number of uses for GPS, they too will benefit the most from this real-time capability.

AF94-134 TITLE: Solid State Electronics Directorate Applied Research

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Explore innovative semiconductor, electro-optic, and electromagnetic materials and device technologies, and demonstrate concept feasibility.

DESCRIPTION: The following subtopics describe areas of the Directorate mission responsibility in electronics. This topic number and the specific subtopic letter must be identified and placed with the title on all related requests submitted to DTIC and on proposals submitted to WL/ELA.

A. RESEARCH: Explore revolutionary new device concepts and conduct feasibility demonstration efforts on devices with potential for high frequency microwave/millimeter wave, high-speed electronics, and electro-optical applications.

B. MICROELECTRONICS: Examine new device approaches to logic and electronic processing, ultra high speed digital switching devices, advanced semiconductor fabrication technology, high-speed/density integrated circuit packaging, power/thermal management techniques, computer based tools for electronic equipment design, and on-chip sensor/functional testability.

C. MICROWAVES: Investigate promising solid-state and thermionic devices, monolithic integrated circuits, power and low noise amplifiers, signal control components, transmit/receive modules, and advanced sensor concepts.

D. ELECTRO-OPTICS: Develop improved lasers and incoherent light sources, nonlinear optical devices and interactions, optical processing, beam deflection, modulation and control devices, detectors, and focal plane arrays.

Phase I: Determine the initial feasibility of the concept through design, physical analysis, mathematical modeling, and measurements.

Phase II: Develop key processes, validate the model experimentally, explore critical parameters, and optimize the design.

Dual Use Commercialization Potential: Commercial applications that will benefit from innovative electron device technological
advancements include high temperature electronics for automotive and jet aircraft engines, optical sensors for environmental assessment, high speed digital electronics for computers and communication systems, automotive collision avoidance/warning sensors, and miniaturized diagnostics for the medical industry.

AF94-135 TITLE: High Density, High Efficiency, Card Mounted Low Voltage Power Supply

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop 100-watt, 50-Vdc voltages, card mountable module and switching devices for high efficiency power conversion.

DESCRIPTION: An unacceptable condition is manifesting itself with the development of the new low voltage, high-speed, high density electronic technologies. The power supply will equal the volume of the rest of the subsystem, exceed the weight, and create unmanageable thermal and system response problems. To avoid this, future highly

distributed power architectures must be developed in which power conversion occurs very close to the point of load, that is, on the electronic card. To date, it has not been possible to demonstrate a low voltage (< 5-Vdc) board mounted power module that can achieve an acceptable power volume/weight density and overall conversion efficiency while meeting the power quality requirements.

Phase I: Identify and analyze promising circuit topologies, device materials/structures, and packaging technologies to accomplish the proposed high density, high efficiency on-card power module.

Phase II: Design and fabricate prototype devices and/or power modules for characterization, test, and validation.

Dual Use Commercialization Potential: Commercial applications for high speed, low voltage semiconductor technology include power supply functions in computer workstations and microprocessor based consumer electronics.

AF94-136 TITLE: Design Automation for Low Power Digital Electronics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop innovative design automation tools to produce minimum, low power dissipation electronic systems and components.

DESCRIPTION: The Air Force continuously develops complex electronic components and systems for its weapons. This topic seeks to develop software to perform the automated design, also known as synthesis, of complex *electronics which dissipate a minimum* of power to perform their design function. Low power digital electronic systems typically use techniques that minimize the capacitances and switching events necessary to implement their functions, employ static, complementary, low voltage tolerant, hot-clock, analog, and/or asynchronous circuit, topologies, and incorporate active power management circuits non-volatile storage, optimized output drivers, and optimized and power efficient clocking circuits. Application areas addressed should be those most relevant to Air Force systems, and the relevancy should be clearly described. This tool should be easier to use, produce a design much more rapidly than current methods, handle more complex designs, and yield a better optimized design. The technology to be developed should also be shown not to duplicate current off-the-shelf solutions. Inputs to the tool should adhere to standards such as VHDL (IEEE 1076) where possible and be reasonable and natural for the design application not the implementation. Outputs from the tool should be suitable for design analysis and for direct progression to the next phase of implementation.

Phase I: Phase I of this effort will accomplish the preliminary design of such a synthesis tool. Prototype application areas used for feasibility studies should be those most relevant to Air Force systems.

Phase II: Phase II will include the construction, testing,
demonstration, evaluation, and integration of tool into widely used electronic design environments. Reference manuals and user guides will be developed during testing.

Dual Use Commercialization Potential: Miniaturized high performance, low power electronics support commercial applications such as lap top computers, mobile communications, and digital personal assistants.

AF94-137 TITLE: Bias Dependence Noise Modeling of Heterojunction Bipolar Transistors

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop bias dependence noise models for heterojunction bipolar transistor devices.

DESCRIPTION: Recent advancement in heterojunction bipolar transistor (HBT) technology requires the need to develop sophisticated models for use in device/circuit analysis and design. At present, a majority of the HBT applications are optimized for power and efficiency rather than noise performance. However, there is a need to develop low noise transmitters and oscillators to support both radar and communication systems. HBT technology has demonstrated amplifiers with moderate noise and power performance along with high gain and linearity. Although HBT's have shown improvements over silicon bipolar transistors with regard to microwave noise performance, they are presently inferior to optimized Gallium Arsenide (GaAs) field effect transistors. Consequently, accurate HBT noise models will be required to support future device and circuit design. Much of the noise modeling has been focused on GaAs FET technology and silicon heterojunction bipolar transistors with little being done to apply it to HBT technology. This program seeks to develop HBT bias dependence noise models which can accurately predict the physical mechanisms that generate noise in HBT devices.

Phase I: Investigate and develop heterojunction bipolar transistor physics based noise models.

Phase II: Evaluation and verification of noise models.

Dual Use Commercialization Potential: Commercial applications supported by low noise HBT transistor technology include wireless communication systems, direct broadcast communication satellite systems, and collision avoidance receiver warning systems.

AF94-138 TITLE: Advancement of Multiple Quantum Well Based Infrared Sensors and Modules

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Optimize device structures and develop compatible readout multiplexers for III-V quantum well based infrared sensors.

DESCRIPTION: Quantum Well Infrared Detectors (QWIDs) show great potential as an alternative to HgCdTe long wavelength infrared detectors. Several issues must be explored in greater detail before the full capability of QWIDs is realized. As detector response is directly related to collection of photo-excited carriers, this process needs to be studied in greater depth. The details of carrier transport across the multiple heterostructure interfaces of the devices, and therefore collection of said carriers, is not understood. Models developed during Phase I shall handle at least five periods of a chosen structure, extending to the complete structure by the completion of Phase II. The final model shall allow specification of the detector structure, including material system, device temperature, applied bias, and whether electrons or holes are the charge carriers. Recent studies have revealed that materials other than n-type GaAs/AlGaAs may yield higher performance long wavelength devices. The material systems to be explored may be of type I or II band alignment and be electron or hole based. Because of the flexibility of quantum well design, it is not difficult to envision multicolor detectors. The multicolor response would consist of either several narrow bands within a single atmospheric window or one band in several windows. The first phase shall confirm absorption in at least two separate bands and show how readout of this information separately may be done. Demonstration of arrays with at least 64 by 64 spatially registered pixels, optimization of wavelength coupling, and maximization of detector fill factor shall be conducted during Phase II. A GaAs based readout multiplexer could potentially lead to a monolithic detector/readout multiplexer module. A design evaluation to identify charge capacity, bias range, and impedance requirements for a 64- by 64-pixel readout circuit with individual cell size of 50 um^2 shall be conducted. The resulting multiplexer shall be fully characterized at room and cryogenic temperatures.

Phase I: Material growth characterization and single detector characterization shall be completed.

Phase II: Growth of optimized structures, fabrication and characterization of detector arrays shall be completed.

Dual Use Commercialization Potential: Commercial applications for low cost infrared sensor technology include night imagery sensors for automotive industry, agricultural crop/soil assessment, and residential heating and cooling analysis.

AF94-139 TITLE: Integrated Free-Space Based Optical Interconnect Research For Image Processing

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Investigate optical interconnect technologies and demonstrate best approach for specific image processing systems.

DESCRIPTION: For image processing system applications requiring high interconnection densities and/or fast data transfer, free-space based optical interconnects have several potential advantages over either electronic or integrated optics based interconnects. Free-space interconnects promise a higher bandwidth for increased throughput, ability to globally and arbitrarily interconnect 10,000 nodes per cm^2 for massive parallelism, a lower real estate requirement since interconnections are carried out in three dimensions, a lower power requirement and very high reprogrammability which can contribute to fault tolerance. For those signal processing system applications requiring lower interconnection densities and/or slower processing throughput, integrated optics may prove more advantageous because it is a much more mature technology and is proven compatible with electronic manufacturing techniques. This program will determine and demonstrate the trade-offs between integrated and free-spaced based optical interconnects for specific fault-tolerant, reprogrammable, real-time, image processing applications, including fast Fourier transform (FFT) accelerators for frequency component identification, wavelet transforms for detection of abrupt changes, memory transfer for fast or massively parallel processing and wavefront transformation for pattern matching. The prospective contractor should draw on existing electronic, microwave, opto-electronic, and integrated optical manufacturing and packaging technology during the investigation. Integration with silicon (Si), gallium arsenide (GaAs) and/or practical multichip modules/circuit boards is required depending on the application. Emphasis will be on overall system performance and packaging to optimize processing speed, power and size requirements, fanout and packaging. This type of investigation has become feasible with the recent advancements in the implementation of free-space based optical interconnects. The proposed SBIR will provide the optimally designed interconnection architecture and a scalable implementation for specific real-time image processing systems before they get locked into a nonoptimized selection of an architecture and technology that would be difficult if not impossible to change later on.

Phase I: Determine the best interconnect technology between free-space and integrated optics for a particular image processing application and, at a minimum, demonstrate a few key elements of the better technology.

Phase II: Produce an optimized interconnect design and a scalable demonstration based on the proposed technology determined in Phase I.

Dual Use Commercialization Potential: Optical interconnect technology supports commercial applications such as high data transfer networks for cable and communication systems, and high data rate computers and parallel processors.

AF94-140 TITLE: Nitrogen Source for Molecular Beam Epitaxy (MBE)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop appropriate nitrogen source for MBE growth of GaN and AIN for advanced electronics and photonics applications.

DESCRIPTION: The (Al,Ga)N system has great potential for applications in ultraviolet photonics, high power electronics, and high temperature electronics. However, the growth technology for producing high quality structures in this materials system has been slow in evolving. Although the molecular beam epitaxy (MBE) technique is the best method for producing many III-V structures, only metal organic vapor phase epitaxy (MOVPE) has produced (Al,Ga)N structures of device quality. Previous MBE attempts to produce device quality (Al,Ga)N films so far have largely been limited to electron cyclotron resonance (ECR) cracking of N_2, for supply nitrogen-containing species during growth. This approach is severely limited in capability, and an alternative nitrogen source is sought for use in MBE growth. Although the success of the MOVPE approach may be linked to the use of NH_3, as the nitrogen source, lower substrate temperatures used in MBE suggest that precracking of NH_3, is necessary in MBE. An NH_3, cracker cell may provide high fluxes of a reactive nitrogen-containing species (e.g., N, NH, NH_2 but should not be deleterious to the MBE growth environment. Other nitrogen chemistries (e.g., triethylamine) should be considered for ease of obtaining reactive nitrogen species at the growth surface.

Phase I: Emphasis should be placed on (1) conducting a comprehensive literature search regarding the appropriate chemistry upon which to tailor the source, and (2) assembling a prototype source.

Phase II: The source would be further developed to become a commercially viable produce.

Dual Use Commercialization Potential: Commercial applications that will benefit from the development of economical, high quality semiconductor fabrication techniques include high speed electronic switches and electronic devices capable of operating in high temperature environment of jet aircraft and automotive engines.

AF94-141 TITLE: Gallium Nitride (GaN) Materials for High Temperature Electronics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop semiconductor materials for electronic devices operating at high ambient temperatures.

DESCRIPTION: There is a great deal of interest in using semiconductor devices in high temperature environments. While the device operating principles essentially remain the same at high temperatures, the performance and reliability of electronic systems is reduced due to the degradation of device structure and intrinsic material parameters. The temperature dependency of intrinsic device performance comes from the basic semiconductor properties. The key parameters are the intrinsic carrier concentration, carrier mobility, and lifetime. The existing data indicate that high energy bandgap semiconductors are intrinsically more suitable for high temperature operations. In order to achieve higher operating temperatures than that of the most often used Si, larger bandgap semiconductors such as GaAs, AlGaAs, GaP, and SiC are being pursued. Preliminary results showed that GaN, which has even higher energy bandgap than those of the aforementioned semiconductors, is a promising candidate for high temperature applications. This effort is to develop the necessary technologies to demonstrate the viability of this materials system.

Phase I: Emphasis will be placed on developing a crystal growth technique for GaN.

Phase II: Focus will be on demonstration and optimization of materials growth and characterization, and device fabrication to verify its validity for high temperature operation.

Dual Use Commercialization Potential: Commercial applications for high temperature electronics include

automotive, aircraft, space power stations, geothermal and oil well logging, and mainframe computers.

AF94-142 TITLE: Flight Control Science and Technology

CATEGORY: Basic Research

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop flight control and technology to support air power projection and/or precision strike.

DESCRIPTION: Develop one or more of the following advanced flight control technologies for future aircraft: a) control effectors tailored for high efficiency transports, including laminar flow control, b) devices that facilitate stability and control testing of short take of vertical landing vehicles in ground effect, c) criteria for predicting pilot-induced oscillation, d) software for checking compliance with flying qualities requirements, e) fuzzy logic based aircraft flight control, f) structural response feedback techniques for flight control, g) on-board system diagnostics concepts for highly integrated vehicle management systems, h) control system configuration for nonlinear and time varying flight conditions, i) real-time, high-fidelity multisensor image fusion software for piloted vehicle control.

Phase I: Exceptions include determining the feasibility, preliminary concept identification, requirements definition, and development of Phase II proposals. Some specific examples are the identification of several promising control effector concepts to move into testing, a complete survey and summary of existing Pilot Induced Oscillations (PIO) databases, requirements generation and development plan for PC based flying qualities software, and assessment and selection of one or two multisensor fusion techniques to move into testing.

Phase II: Expectations include hardware fabrication, ground testing, simulation or light testing, and validated, executable software code. Some specific examples are validated designs for one or two high efficiency effectors, simulation and possible flight test of PIO criteria, software development and demonstration of image fusion technique.

Dual Use Commercialization Potential: All of the items in this SBIR topic are equally applicable to the civilian and military aircraft sectors. The technology developed will provide for reduced fuel consumption for transport aircraft, reduced design and development costs for flight control systems, more efficient flight control system architectures, and the ability to operate aircraft in low visibility conditions.

AF94-143 TITLE: Aircraft Drag Reduction Using Active Techniques

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Extend the range of military aircraft through the practical application of Active Drag Reduction Systems

DESCRIPTION: Aerodynamics drag is the major factor limiting aircraft range. Modern aircraft design practices tend to minimize the profile, induced and compressibility drag components by sizing the aircraft for specific mission needs. The friction and interference drag components are not as easily controlled in the design process; however, these drag components can be markedly reduced by the practical application of innovative active drag reduction devices. Recent skin friction drag reduction technology, such as the government sponsored laminar flow control flight experiments, have shown that the pneumatic control of aircraft skin friction drag can have a major impact on

aircraft range improvement. The next big strides in skin friction and interference drag improvement can be made by linking microprocessors with aerodynamic boundary layer control devices to optimize flow control on or near the aircraft surface. The development and application of properly controlled active boundary layer and/or separated flow control devices offers the potential for dramatically improving the range of military aircraft. Also, the technology developed is directly applicable to commercial aircraft.

Phase I: Experimental demonstration of an active drag reduction device that will extend the range of military aircraft by controlling the aircraft boundary layer in a practical way.

Phase II: Active drag reduction device performance validation under simulation flight conditions.

Dual Use Commercialization Potential: Commercial aircraft industry. One of the highest leverage technologies in the competitive commercial aircraft development field is aircraft drag reduction. The US commercial aircraft industry has made great strides in building efficient transport aircraft by applying the latest passive drag reduction techniques to their current production fleet. Application of active drag reduction techniques, such as those to be developed under this program, offer new horizons in commercial aircraft performance that when properly exploited can lengthen the competitive edge our industry holds over commercial aircraft manufacturers throughout the world.

AF94-144 TITLE: Affordable High Performance Airframe Concepts

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop innovative structures technology yielding affordable high performance twenty-first century aircraft.

DESCRIPTION: Significant advances in design and test methods, materials, manufacturing processes, and structural concepts for steady and dynamic states offer far reaching potential for achieving revolutionary advances in structures technology. Exploiting this potential is necessary to achieve long-term goals for reductions in airframe weight, development, acquisition, and operating costs, design margins, and structural responses while maintaining or increasing structural integrity, lifetime, supportability, survivability, and duality of application. Advances in technology are required for lightly to highly loaded and heated structures on operating and advanced high performance aircraft of the twenty-first century. Conventional, adaptive, and smart approaches are sought to aid in achieving goals.

Phase I: Should demonstrate a clear understanding of technical issues and should clearly explain the approach and its innovative qualities. Phase I will establish feasibility of proposed research and development using analytical and/or experimental techniques.

Phase II: Will concentrate on developing structures technologies shown feasible in Phase I.

Dual Use Commercialization Potential: High payoff structures technologies for military will have similar payoffs for commercial aviation and with innovative adaptation and modification may have payoffs in unrelated but structural situations.

AF94-145 TITLE: Embedded Training Applications for the Bomber/Fighter Training System (BFTS)

CATEGORY: Engineering Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop and demonstrate embedded training methodologies and formats for the T-38 Advanced Trainer follow-on aircraft.

DESCRIPTION: As cockpits and the associated avionics become more and more complex, required training also increases. The cost for high fidelity training is great, and as a result, alternative approaches have been addressed. Simulation an ground based training devices are examples, but although effective, they lack the realism and stress of the aerospace environment. Embedded training incorporated into Undergraduate Pilot Training, especially into the T-38 follow-on, could allow for lower cost training of both the Head Up Display and the electronic Head Down Displays in the actual flight environment. Precision approaches, Electronic Warfare including threat recognition and response, Beyond Visual Range Air-to-Air, Air-to-Surface, and Traffic Collision Avoidance System are just a few examples of embedded training possibilities, with the Air Force seeing substantial savings in cost and training time compared to that required in the operational aircraft.

Phase I: Technical and economical feasibility of implementing an embedded training system into the BFTS, or follow-on aircraft.

Phase II: Proposed methodology and display demonstration of embedded training formats.

Dual Use Commercialization Potential: Commercial airlines, private aviation schools, Intelligent Vehicle Highway System (IVHS)

AF94-146 TITLE: Affordable On-Board Fire Protection Concepts for Aviation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop new technologies and approaches in aircraft fire protection that significantly reduce life-cycle cost.

DESCRIPTION: Research in aircraft fire protection is currently very active due to the phaseout of ozone depleting Halon chemicals used as fire suppressants. Once chemical replacements are identified and implemented, further advances in aircraft on-board fire protection technologies will be difficult to implement in future aircraft applications. Fewer new aircraft will be built due to worldwide budget constraints, and existing aircraft already featuring fire protection systems will have extended service lives. New technologies proposed to replace existing systems on these aircraft must overcome initial substantial retrofit costs and unit costs to fare favorably in cost-benefit analyses. Recent advances in fire protection capability lessen the need to expand the fire suppression performance envelope as much as to provide lower cost of ownership for such protection. Life cycle costs for weapons systems and subsystems and the cost reductions new technologies provide will dictate which technologies will be retrofit in the future. This effort is thus oriented to identify and evaluate innovative concepts to provide lower life cycle cost requirements than currently required for existing aircraft fire protection requirements. These innovations can include modifications to existing maintenance and operational procedures, modifications to existing fire suppression and/or detection systems, or entirely new system components. These concepts will be technically evaluated based upon their low risk, life cycle cost savings and return on investment period, including the retrofit costs required. Low cost systems with minimal aircraft modifications will thus be heavily favored under such criteria. It is estimated that savings of 10% or more on life cycle costs may be sufficient to warrant retrofit actions in some applications. Rough estimates of life cycle cost reductions and return on investment period, with rationale and assumptions in the estimates included, shall be required in the proposals to allow proper evaluations and demonstrate technical competence.

Phase I: Phase I will consist of an evaluation of one or more proposed life cycle cost enhancements. Detailed life cycle cost and return on investment period analyses will be performed on each. Concepts will proceed into actual design of the systems for aircraft use, with performance and basic operational requirements included.

A trade-off evaluation of these concepts will be completed based upon the life cycle cost and design studies, with a recommended approach. A mock-up non- or semifunctional demonstrator will be assembled if new hardware is proposed.

Phase II: The concept recommended in Phase I will proceed into full hardware design. Aircraft prototype hardware will be assembled and demonstrated for performance at Wright Laboratory test facilities. Additional demonstration tests for operational suitability shall be performed. If only a procedure is proposed actual field tests will be performed at an air base wing to validate the procedure.

Dual Use Commercialization Potential: These concepts would be expected to be directly attributable to commercial aircraft, which currently use similar fire protection systems to the military. If the cost benefit analysis results are favorable for commercial use and a sponsor is available, further implementation could be readily performed.

AF94-147 TITLE: Infrasound as a Method of Bird/Aircraft Collision Reduction

CATEGORY: Basic Research

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop an infrasound device to reduce bird/aircraft collisions by 50% within airfield boundaries.

DESCRIPTION: The USAF aircraft birdstrike problem is costly and long term: $45 million and 3000-3500 strikes a year since 1987, seven deaths since 1987, and three destroyed aircraft in 1992. 60.3% of USAF birdstrikes occur within the airfield environment (Hamershock 1992): takeoff, landing, final, downwind, and touch-and-go/missed approach. Numerous methods are available to reduce these losses; however, the need for more innovative and effective methods remain. Infrasounds (sounds below 16 Hz) are emitted from natural sources such as mountain ranges, earthquakes, thunderstorms, auroras, and oceans (Kreithen and Quine 1979). It is hypothesized that birds use this sensitivity for navigational purposes. The possibility of ascertaining and reproducing natural avoidance responses of birds to mechanically replicable frequencies of infrasound may prove it as a potential method to substantially reduce the bird/aircraft strike hazard.

Phase I: Characterize the responses of samples of a gull species, raptor species, and waterfowl species to a range of infrasounds. Identify mechanically replicable infrasound frequencies which will invoke an avoidance response by at least two of the three species researched. An avoidance response will be defined as a response that behaviorally inhibits a bird species from physically inhabiting a previously enterable or desirable location, leaving the treated location free from species penetration. Identify levels of habituation of tested species to the repulsive infrasound frequencies.

Phase II: Prototype design, fabrication, and demonstration of capability of efficiently and effectively producing the avoidance response frequency(ies) for field testing. Conduct field tests validating a 50% or greater reduction in airfield bird populations and aircraft birdstrikes. Determine environmental effects of infrasound on other airfield operations and inhabitants.

Dual Use Commercialization Potential: The potential users of an infrasound bird repulsion device are many and include: All branches of the military, airfield managers, biologists, pest control/maintenance employees, government agencies (the Federal Aviation Administration, the US Department of Agriculture), agri-/aquaculturalists, aircraft manufacturers, and homeowners.

AF94-148 TITLE: New Primary Flight Controllers

CATEGORY: Basic Research

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Explore new primary flight hand controllers for both transport and fast jet aircraft.

DESCRIPTION: The fly-by-wire control laws allow for a wide choice of primary flight controllers; however, the stick, yoke, and throttle remain the standard in transports and fast jets to achieve flight and thrust control. Technological advances as well as the desire to keep the pilot's hands on the throttle and stick (HOTAS) have led to the addition of other types of controls on the stick, yoke, and throttle, such as designation control and communication control. The trend to keep adding to the current flight controllers has led to a lack of investigation into new types of hand controllers. New controllers may be better suited to provide the pilot with primary flight control as well as the additional functionality offered by the current stick, yoke, and throttle. This effort will focus on designing new types of primary flight controllers.

Phase I: This phase will focus on the design of at least six new and innovative possible flight controllers. An investigation will be conducted to determine their applicability to perform the military mission. Criteria will be identified for the evaluation of the candidate controllers. Examples of these criteria might include visual access, physical access, precision of control, learning, and overall suitability. An overall assessment of how these controllers satisfy the criteria, and a final ranking of the candidate controllers will be completed.

Phase II: The phase will require the contractor to build at least three of the top primary flight controllers from Phase I. Implementation of these devices into government test facilities will also be required. Testing will be conducted by the government.

Dual Use Commercialization Potential: Commercial aircraft for flight control, computer applications for hand control of specific functions, video games, automobile industry for vehicle control, and train industry of vehicle control.

AF94-149 TITLE: Flight Control and Networked Simulation

CATEGORY: Engineering Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop innovative flight simulation technologies to support precision strike and long haul simulation research.

DESCRIPTION: The Air Force is interested in innovative new flight simulation technologies which will advance the state-of-the-art in long haul networked simulation in support of precision strike weapon delivery research. Research in the area of improved network simulation fidelity, capability, or in cost reduction for simulator hardware on a network are of particular interest. The Distributed Interactive Simulation (DIS) standard is the desired baseline for any research in the area of networked simulation; however, improvements in implementation of the standard, or in variances of the standard which will improve performance are highly encouraged. Emphasis is desired in the area of simulation quality between multiple players on the network. Novel display technologies, lower life cycle cost simulation techniques, or improved techniques for conducting research using networked simulation are also sought. Innovative approaches for the use of large high Definition Television (HDTV) aspect ratio Cathode Ray Tubes (CRTs) in flight simulator instrument panels, or multiline rate video insetting techniques for generation of instrument panel imagery is of interest. Improvements will be considered for any technology, hardware device, or software program which shows potential for flight simulation advancement.

Phase I: The Phase I effort shall define the proposed concept, investigate alternatives, and predict performance of the proposed design. Demonstrations of high-risk portions of the design are encouraged, but not

required. A final report shall be submitted summarizing the results of all analyses and comparing the performance of alternatives.

Phase II: Phase II shall fully implement, demonstrate, and test the Phase I design. Results of the tests and recommendations for improvements and/or alternatives shall be documented.

Dual Use Commercialization Potential: Improvements in flight simulation technology typically have application with some modification to flight simulators used by the airline industry to satisfy FAA training requirements. Advancements to low cost simulators can be applied to private pilot training simulators.

AF94-150 TITLE: High-Strength Damage-Resistant Foam Cored Composites

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop lightweight cored composite structures that inherently possess high-strength damage-resistant qualities.

DESCRIPTION: The Air Force has a continuing goal to reduce the weight and cost of aircraft structure while increasing damage resistance and tolerance. Sandwich structure (or cored composite) is a leading concept for weight reduction. The majority of sandwich structure on Air Force aircraft involves a honeycomb core with adhesively bonded facesheets. Although lightweight, conventional cored composites are not only costly to fabricate, and inherently vulnerable to a variety of environmental threats. Microflaws allow moisture laden air to enter and condense within the part. Internal corrosion, together with frequent disbonds between skin and core, lead to drastic performance changes for parts which are either stiffness critical or have dielectric functions. As a result, repair and replacement of these honeycomb components are frequent. There is a need to develop a durable, low cost, weight competitive alternative to adhesively bonded honeycomb sandwich structure. Organic foam cores can be molecularly bonded to the skins and therefore eliminate the cost and weight associated with relatively weak adhesive bondlines. Some concepts allow for fabrication of the entire sandwich component in onestep. This not only eliminates the need for expensive machining, but results in a part which is dimensionally perfect. The closed-cell nature of organic foam cores precludes moisture absorption and corrosion. Foam cores and stronger skin-core interfaces also have the potential for significant improvements in impact resistance. Although foam cores demonstrate several desirable qualities (all leading to reduced R&M requirements), their shear and compression properties are not presently weight competitive with honeycomb. Overcoming this deficiency is the goal of this program. To make foam cored composites weight competitive with honeycomb composites, the density of current foam has to be reduced from present levels to as little as 6 to 11 lbs/ft3. This must be achieved while maintaining specific shear strengths of 60 to 80 psi/(lb/ft3) under hot/wet conditions of 250.F and 95% relative humidity.

Phase I: Composite sandwich structures of various concepts (having thicknesses ranging from 0.25 to 1.00 inch) will be fabricated, environmentally conditioned (to include solvents), and subjected to shear and compression tests. Goals of the effort will be weight gains (due to moisture absorption) of less than 1% while maintaining strength requirements under hot/wet conditions.

Phase II: Composite sandwich structure concepts having acceptable properties and minimal weight gains (as identified in Phase I) will be scaled up and subjected to advanced environmental, strength, damage resistance, and damage tolerance testing. The goal of the effort will be to identify concepts which meet R&M 2000 requirements.

Dual Use Commercialization Potential: Foam cored composite materials are suitable for nearly any commercial application where structural rigidity is required. Typical examples are primary and secondary aircraft structures (to include floors, doors, and radomes), automobile components (the frame, body, and gas tank), truck beds, boat hulls, and equipment housing.

AF94-151 TITLE: Active Attenuation of Aircraft Vibration via Smart Structures

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Demonstrate the use of "Smart Structures" technologies to attenuate vibration in aircraft structures.

DESCRIPTION: Dynamic response of aircraft structures are a concern in aircraft design. Smart Structures technologies have demonstrated vibration attenuation on laboratory test articles. Using active materials (e.g., piezoelectric, magneto-restrictors, or shape memory alloys), the response of a structure to external disturbances can be controlled. The application of this technology to aircraft structures will improve performance and reduce life-cycle costs. Possible applications include twin-tail buffet, acoustic cavities, active pylons for electronic pods, and active isolation of electrical equipment or sensors. Innovative concepts are sought which address these or other aircraft structural dynamic problems.

Phase I: Analytical demonstration of feasibility for full-scale aircraft structure and Phase II test article.

Phase II: Experimental validation on a representative laboratory test article and preliminary design for the Phase III flight test article.

Dual Use Commercialization Potential: Suppression of vibration and acoustic problems in a wide variety of commercial products such as electronics equipment, where vibration decreases component life, automobiles, where acoustics and vibration are both a rider comfort and component life problem; and the machine tooling industry, where chatter-free tooling operation would allow more exact tolerances at faster cutting speeds. Additionally, the commercial airlines will benefit from reduced vibration and acoustic problems.

AF94-152 TITLE: Adaptive Cockpit Error Monitoring System

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Provide for the detection, correction, and prevention of pilot errors in the cockpit.

DESCRIPTION: Pilots can only endure a finite amount of physical and mental workload during missions before human error becomes a concern. Human errors can occur when workload exceeds a threshold, the pilot is fatigued or bored, as well as several other situations. Those human errors in the cockpit have caused the loss of life as well as significant investments in equipment. This work will categorize and prioritize the full range of potential and probable errors that may occur in cockpits. Also, current mechanisms that identify and correct problems on today's aircraft will be examined. This will facilitate the development of an intelligent system for the detection, correction, and prevention of aforementioned errors in the cockpit.

Phase I: The research will begin with identification and classification for a full range of potential cockpit errors. Additionally, the currently fielded mechanisms for the prevention and correction of errors will be examined. Phase I will culminate in a strawman architecture for preventing, correcting, and predicting pilot errors.

Phase II: Will implement the intelligent system architecture developed in Phase I. The software will be validated and verified during Phase II. The goal of Phase II is a prototype error monitoring system to be applied to cockpit aviation.

Dual Use Commercialization Potential: The immediate commercial market is the civilian air fleet. However, such an error monitoring architecture would benefit any application where human error plays a significant

role in potential loss of lives or property. Nuclear power operations, air traffic control, and ground transportation would be top candidates for such an error monitoring system.

AF94-153 TITLE: Precision Cargo Airdrop Methods for High and Low Altitudes

CATEGORY: Basic Research

DOD TECHNOLOGIES: Unassigned

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop innovative concepts for the precision airdrop delivery of cargo from high and low altitudes.

DESCRIPTION: Airdrop methods have changed very little since World War II. While computer technology, global positioning systems and advanced parachute designs such as parafoils have increased the accuracy of delivery, these methods are costly and leave room for improvement. Cargo airdrop accuracy and cargo aircraft vulnerability are concerns of both the Army's combat ground forces and the Air Force. Airdrop delivery in both war time and peace time demands a far greater accuracy than is achieved by conventional methods.

Phase I: Will provide novel, unconventional, cost effective concepts other than parachutes to accurately deliver air-dropped supplies from high and low altitudes. The design goal for accuracy is a delivery error of less than 100 meters.

Phase II: Will develop a prototype system for test and evaluation by the Army and Air Force. The candidate system for Phase II shall be chosen from those concepts developed in Phase I.

Dual Use Commercialization Potential: Accurate aerial delivery of cargo has numerous applications to disaster relief as well as military operations. A company that developed this technology would be in a good position to provide systems to both the government and private sectors.

AF94-154 TITLE: Behavior Modeling of Anisotropic Composites

CATEGORY: Engineering Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop modeling techniques to characterize the behavior of anisotropic composite materials.

DESCRIPTION: The mobility requirements of the Air Force often lead to operation from minimal facilities referred to as bare bases. Shelter systems for these facilities have to be sufficiently lightweight to be air transportable and still provide a measure of attack resistance. Design of these shelters will require innovative materials and geometries. Candidate composite materials currently being researched are highly anisotropic due to material properties or complex geometric configurations. Material characterizations are needed for use in structure analysis and design methods.

Phase I: Phase I will be the development of numerical material modeling methods in three-dimensions for composite materials that exhibit anisotropy due to material or geometric characteristics. This information will be in a form that can be used for structural design with the material.

Phase II: Phase II will expand on Phase I effort by formulating constitutive materials models that will quantify the material behavior for use in computer based analytical methods.

Dual Use Commercialization Potential: The software would have marketing potential as an analysis and design tool to any industry utilizing composites.

AF94-155 TITLE: Voice-Activated Poor Visibility Emergency Response System (VAPERS)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop a voice-activated poor visibility emergency response system for improved fire protection response.

DESCRIPTION: A voice-activated poor visibility emergency response system (VAPERS) capability will facilitate faster, safer travel to emergency crash fire incidents during night and adverse weather, and provide at least a 90% increase in the ability to sense people, vehicles, and debris at an emergency site. This technology, intended principally for night and adverse weather response, will also enhance daytime response. System components support a wide variety of operational scenarios usable during both nighttime/adverse weather and daytime firefighting incidents. The system will overcome the inability of vehicle operators using vehicle headlight and high intensity lamp technology to see through flames, smoke, and fog. The ability to 'see' will give the vehicle operator significantly increased operational capability. The system will utilize a variety of advanced display and electronic systems which interface to navigation, audio and video sensors. Additional capabilities are required to meet the mission needs of modern crash fire rescue vehicles including a requirement for a data link and a mission and display system to provide enhanced situational awareness for the Fire Chief, Communications Center, and each individual vehicle.

Phase I: Phase I of this work will include mission analysis, preliminary design, proof of technical feasibility, an assessment of operational requirements, and selection of hardware and software concepts for Phase II development.

Phase II: Phase II of this work will include hardware and software development for the voice-activated system and the communications data link, and the development of stabilized platforms for sensors and displays. Phase II also includes the integration of existing fire department communications systems and the demonstrated performance and a single operational system installed and validated at a major forward operating location, qualification of integrated hardware and software designs, validation of selected concepts, and the integration of the concepts into qualified hardware and software.

Duel Use Commercialization Potential: Each Federal, State and local air field installation where commercial and military aviation is under control of an active control tower represents a potential customer.

AF94-156 TITLE: Refuse Derived Fuel Power Generation System

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop a power generation system using paper trash, garbage, used tires, and nonhazardous used POL and motor oil for primary fuel source and other conventional fuel for secondary source.

DESCRIPTION: Air Force installations generate a significant amount of waste that is often disposed of via contract, adding considerably to the base O&M budget. A cost-effective means of utilization that will allow full destruction of base generated waste is required to minimize this expense and meet fuel requirements for power generators. This research effort will include the development of generator adaptor kits to convert existing power

generators into a refuse derived fuel power generator. Increasing concerns for environmental protection, operational cost reduction, and installation sustainability dictate the requirement for better methods for providing base power needs while addressing these issues. Funds normally spent on fuels such as coal, diesel, and other petroleum-base fuel will be greatly reduced as these fuels are substituted with waste by-products. Reduction in solid and liquid waste management costs are anticipated due to a decrease in landfill operations and processing costs for waste liquids.

Phase I: Deliverable will be a concept of operation to include details on suggested design, component specifications, and estimated cost and payback for a typical Air Force system.

Phase II: Validate concept through prototype construction and test.

Dual Use Commercialization Potential: Waste management and electrical power utility.

AF94-157 TITLE: Machine Recognition and Removal of Fusing Mechanisms in Explosive Ordnance

CATEGORY: Basic Research

DOD TECHNOLOGIES: Sensors

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Automate the recognition process for fusing mechanisms that have been partially obligated in explosive ordnance.

DESCRIPTION: Part of Explosive Ordnance Disposal (EOD) range clearance operations is to identify ordnance and remove it from a test range intact (to determine its failure mode). In performing this operation, it is desirable to remove the man from the location of the ordnance and to automate some of the process of removal. A critical element of the removal process is to remove the fusing mechanism from the ordnance. To accomplish this in an autonomous manner, it is necessary to recognize the physical characteristics of the fuse so that a mechanism for removal may be applied through an articulated platform (robotic arm). The recognition process should identify the fusing mechanism to such an extent that the mechanism characteristics for removal from the ordnance is known. The mechanism for removal of the fuse should take the form of an end effector for an articulate platform and should be able to assume the necessary physical characteristics to perform the removal process. A system that can recognize the physical characteristics of the fuse, transfer this information to a system controller, and then remove the fusing mechanism is desired. Since the Enhanced Excavator for EOD Range Clearance Project has existing capabilities for imaging, electronics, and software development, it is desirable that the developer either make use of these resources as government furnished equipment or adhere to the hardware/software standards set by the program.

Phase I: Will determine the method and means of accomplishing this task and identify the necessary hardware and software development. Deliverables or a preliminary software design and demonstration of the recognition process and a graphic simulation of the proposed end effector design.

Phase II: Will proceed with the development and deliver a prototype of the recognition system and end effector. The contractor should perform testing of the prototype system to quantify its abilities.

Dual Use Commercialization Potential: Deliverables could be used by a municipal or state police force and any type of small parts manufacturers that deliver small quantity unique items.

AF94-158 TITLE: Carbon Thermal Management Components

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop high-temperature conductivity materials by reducing minimum gauge, low-cost fibers, and high-conductivity matrices.

DESCRIPTION: Electronics in both DOD and non-DOD applications are advancing at a very rapid rate. Effective implementation of the advancements requires enhanced thermal management. Particularly, increasing high-density electronic component packing, high electrical power requirements, high resolution sensor equipment, and on-board cooling creates an ever increasing need for efficient thermal flow. Future ground, air, and space vehicles will require advanced materials to save weight and maximize thermal performance in electronic packing, battery sleeves, and radiators. Personal computers to the most advanced space systems can benefit from low cost approaches to enhance thermal management through increased thermal conductivity. Materials with an extremely high specific thermal conductivity are desirable. Novel concepts using the high thermal conductivity of carbon are encouraged. In order to be a viable material of choice, the state of the art must be advanced in the following areas: (a) minimum thickness plies; (b) low-cost, high-conductivity, high-strength, weavable fibers; and (c) high thermal conductivity densification methods.

Phase I: Phase I will consist of parametric studies and modeling behavior with small coupon level articles produced.

Phase II: Phase II will continue for the most promising Phase I concepts.

Dual Use Commercialization Potential: The potential of the technology in this topic has vast implications for dual use and commercialization in electronics for consumer, business and miniaturization purposes. The ability to package efficiently from a thermal management standpoint can have far-reaching effects in virtually every application of electronics.

AF94-159 TITLE: Highly Parallelized Software for Atomistic Materials Properties Simulations

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Generic

OBJECTIVE: Discover and code new parallel algorithms for atomistic, molecular level calculations for new organic materials.

DESCRIPTION: Investigations are sought to formulate, implement, and verify new efficient parallelized approaches for molecular
simulations. Areas of emphasis include investigation into (a) Hartree-Fock and (b) correlated, post-Hartree-Fock molecular orbital calculations, (c) molecular mechanics based molecular dynamics simulations, (d) density functional approaches to molecular electronic and geometric structures including optimizations and dynamics, and (e) time dependent variational Hartree-Fock approaches. Focus is on optical, nonlinear optical, electrically conductive, and transport property predictions, with attention given to incorporation of the latest advances in global optimization techniques. Target hardware for implementation will range from multiprocessor workstations to massively parallel systems.

Phase I: The establishment of technically and commercially viable approaches to obtaining advanced software for designing improved nonmetallic materials are sought in Phase I efforts which can be pursued in Phase II follow-on efforts.

Phase II: Phase II will entail software development, implementation, verification, and commercialization assessment, as well as commercial development plan.

Dual Use Commercialization Potential: Phase III efforts would transition functional software for full commercial development and subsequent enhancement of materials development programs for electro-optics organic

materials which could be widely used in the civilian industrial sector including telecommunications, signal processing, and computations.

AF94-160 TITLE: Environmentally Compliant Low Observable Coatings

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop low/zero-VOC materials and/or application techniques suitable for low observable aircraft coatings.

DESCRIPTION: The Air Force is interested in the research and development of aircraft coatings with a minimal detrimental impact on the environment. Of primary interest are aircraft coatings for low observable applications. Specifically, the coatings should address signature control in the visible, infrared, and radar bands of the electromagnetic spectrum. Most conventional coating application systems currently in use produce substantial organic solvent emissions. Some include toxic, noxious, or other smog producing components. New materials and/or application systems that can greatly reduce or eliminate these VOCs (Volatile Organic Compounds) and other undesirable materials are necessary in order to comply with stringent environmental regulations, either currently in effect or likely to be enacted in the near future. Relevant technologies for low/zero-VOC coating development include, but are not limited to, high solids coatings, waterborne coatings, powder coatings, plasma/thermal spray systems, and appliques. Innovative materials, such as binders, pigments, thin films, and their suitability for use in these types of application systems are also of interest.

Phase I: Phase I will address initial formulation, fabrication, evaluation, and application techniques of specific subjects for proof on concept.

Phase II: Phase II will further develop and optimize the material and/or application techniques, and produce larger samples for a full spectrum of evaluations.

Dual Use Commercialization Potential: The requirement to comply with environmental regulations applies equally to the commercial coating industry. As such, much of the technology developed for compliance of military coating systems could be extended to commercial applications. Opportunities for commercialization in the solar energy field also exist. Commercialization of the technology would involve scale-up to production capacity, and production of sufficient quantities of material to coat aircraft or other large objects using an environmentally compliant and commercially viable application technique.

AF94-161 TITLE: C01AF4Environmentally Compliant Solvent Substitutes for Chlorofluorocarbons

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop environmentally compliant replacement solvents for chlorofluorocarbons.

DESCRIPTION: The Air Force is interested in the research and development of environmentally compliant solvents to replace the currently used chlorofluorocarbon solvents. Chlorofluorocarbon solvents are widely used as solvents in the maintenance and repair of mechanical equipment for Air Force systems and ground support equipment. They are effective, fast drying, non-toxic and

nonflammable. All of these properties have led to their wide-spread utilization throughout DOD and commercial industry. The
chlorofluorocarbon solvents are ozone depleting chemicals and are being phased out of production for environmental reasons. New solvent materials are required to serve as environmentally compliant replacements. They must have as many of the attributes of the chlorofluorocarbons as possible, but be in compliance with stringent environmental regulation, either currently in effect or likely to be enacted in the near future. Some of the key environmental considerations are: ozone depletion potential, toxicity and biodegradability.

Phase I: The Phase I effort will address the feasibility of the approaches proposed to achieve the goals of the program.

Phase II: Phase II will further develop and optimize the materials or process demonstrated in Phase I and produce larger samples for more complete evaluations.

Dual Use Commercialization Potential: The potential application of the technology addressed in this topic has wide spread applicability to non-DOD manufacturing, processing and equipment overhaul facilities. The new solvents are required to replace the chlorofluorocarbons which have become the industry standard in most commercial processes, etc. because of their excellent solvency, nonflammability and ease of drying. The potential for commercialization of the replacements being developed under this topic is extremely high because of the high volume requirements for these solvents both in DOD and the private sector.

AF94-162 TITLE: Halon Replacement for Aviation Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop environmentally compliant replacement materials for Halon for Aviation Systems.

DESCRIPTION: The Air Force is interested in the research and development of environmentally compliant replacements for Halon as a fire extinguishing agent for use in military and commercial aircraft. Halon is currently used as a fire extinguishing agent due to its inherent quality to evacuate the oxygen from an area, thereby removing the fuel source of the fire. Halons, as well as other man made emissions, such as chlorofluorocarbons, carbon tetrachloride, and methyl chloroform are known to be contributors to ozone depletion. Stratospheric ozone depletion leads to an increase in the amount of harmful ultraviolet radiation reaching the earth's surface. New fire suppression materials must be developed which utilize the current principals for fire suppression by evaluation of their performance at the molecular level. This can be accomplished through the investigation of the methods of molecular dissociation and recombination of halons in an oxygen rich environment. The materials must meet the requirements for compatibility with current systems while minimizing their contribution to ozone depletion. By December 31, 1995, the US will end production of all ozone depletion chemicals. The AF will need to measure selected materials effectiveness and develop a prototype replacement within this time to avoid a price increase as existing stockpiles are depleted.

Phase I: Phase I will address initial evaluation and formulation of specific subjects to achieve the goals of the program.

Phase II: Phase II will further develop and optimize the materials or process demonstrated in Phase I and produce larger samples for more detailed evaluations.

Dual Use Commercialization Potential: There is clearly a commercialization potential for non-DOD aircraft and dual use potential as a fire suppression method in applications where high value assets (e.g., electronics, computers) must be protected form destruction by fire.

AF94-163 TITLE: High Temperature Structural Materials for Advanced Air Force Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop and characterize advanced high temperature structural materials.

DESCRIPTION: New approaches are requested to develop and characterize (a) advanced high temperature structural ceramic composites (2500 degrees F to 4000 degrees F, excluding carbon-carbon composites), (b) intermetallic materials and composites (2000 degrees F to 3000 degrees F, excluding nickel aluminides and discontinuously reinforced titanium aluminides), and (c) model forming process for advanced structural materials. For ceramic composites, research is limited to continuous ceramic fiber reinforced ceramic matrix systems and may include the following: (a) new, unique ceramic composite development; (b) fiber/matrix interface treatments engineered for toughened behavior and stability; (c) continuous ceramic fiber development; (d) test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain etc.) as a function of temperature and loading history; and (e) analytical modeling of composite behavior. For intermetallic materials, research is limited to (a) new or novel methods for synthesis and processing of composites for intermetallic alloys which emphasize achieving theoretical density, low defect and interstitial content, and low synthesis temperatures; (b) methods for modeling intermetallics and intermetallic composites which lend insight into chemistry selection and control as well as microstructural selection and control; (c) methods of fabricating composites to provide chemistry and microstructural control on submicron scale while maintaining the ability to vary and control the final microstructural scale; and (d) methods for environmental protection of intermetallic composites aimed at providing long life under cyclic oxidation conditions. For modeling of forming processes research may include modeling of (a) the unit forming process; (b) the material behavior in response to the demands of the unit process; (c) the interface between the work piece and the die of mold; and (d) novel methods for obtaining physical property data and constitutive equations for insertion into models.

Phase I: This program will focus on the critical issues which when solved, will provide proof of concept.

Phase II: This program will be structured to develop and refine those feasible concepts to the point where an assessment could be made of the ultimate potential to help meet Air Force advanced materials needed.

Dual Use Commercialization Potential: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchangers, and power turbines, are also pertinent.

AF94-164 TITLE: Aging Systems Nondestructive Evaluation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Develop new nondestructive inspection/evaluation techniques for aging aerospace systems.

DESCRIPTION: Advanced innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation (NDI/E) techniques for the detection, imaging, and characterization of flaws and other integrity-reducing anomalies in aging flight vehicle and engine components. In particular, innovative technical approaches are needed for (a) the detection and characterization of metal corrosion in hidden/inaccessible

airframe locations before significant materials loss has occurred, (b) the detection and characterization of cracking/multisite damage in metallic airframe structures, and (c) the detection, imaging, and characterization of surface and bulk anomalies in metallic and nonmetallic airframe structures or engine components. The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have problems of a very similar nature to those faced by the DoD. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques currently being used in factory and/or Air Force Air Logistics Center inspections, or must identify new inspection and evaluation technologies which have capabilities far superior to those currently used and which have the clear potential for ultimate use in realistic manufacturing or in-service environments.

Phase I: This program will address the initial formulation, fabrication, and evaluation of specific NDI/E techniques for demonstration of proof of concept.

Phase II: This program will perform enhanced development for optimization of the NDI/E techniques investigated in Phase I.

Dual Use Commercialization Potential: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have problems of a very similar nature to those faced by the DoD.

AF94-165 TITLE: Biotechnology for Nanostructures, Electronic, and Optical Applications

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Apply biotechnology to obtain novel processes or materials to solve AF problems.

DESCRIPTION: The Air Force is interested in research and development projects directed toward potential applications of biotechnology to aerospace and commercial requirements. Such programs should address the fabrication of materials with compositions and/or microstructural morphologies of such complexity that they are only obtainable through natural processes. The study of this area could conceivably lead to the development of lower energy processing and materials with very specific electronic and electro-optical properties and contain very few microstructural anomalies. Since biological materials often perform several functions with ease, an investigation of the trade-offs involved in natural material systems could lead to design philosophy for multifunctional materials with, for example, both electro-optical and structural properties.

Phase I: In Phase I, programs in these areas should address the requirements and goals of the proposed efforts, as well as initial formulation, fabrication, and evaluation required for proof of concept.

Phase II: In Phase II, the process or design concepts from Phase I would be developed through optimization and scale-up efforts to establish feasibility for manufacture. Either process or design concepts would lead to a marketable product after a Phase III program.

Dual Use Commercialization Potential: Dual use of this exploratory research is foreseen for new materials for optical storage of information and for other microelectronic devices, micromachines, the inspection of many types of structural and electronic components and for the development of new high performance polymers.

AF94-166 TITLE: Epitaxial Growth of Silicon Carbide (SiC)

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop advanced, innovative epitaxial processes for the growth of silicon carbide for electronic applications.

DESCRIPTION: Advanced Air Force systems will require new and novel semiconducting materials to meet challenging power, frequency, speed, and temperature requirements. Conventional semiconductors such as bulk silicon and gallium arsenide cannot meet these requirements. Silicon carbide has many interesting properties such as wide band gap, high breakdown field and physical strength, which make it attractive for high temperature and high power applications. This task seeks to develop new and innovative approaches for the growth of epitaxial silicon carbide. All polytypes are of interest as well as alloys of heterostructures of silicon carbide with III-V semiconductors. While homoepitaxy of SiC to bulk SiC is of primary interest, growth on new substrates will be considered. The offeror is reminded that this is a materials task and projects that are primarily device development or device processing will be considered nonresponsive.

Phase I: Phase I will address process development and initial testing to show proof of concept. Modeling studies of growth processes or materials properties are appropriate. A deliverable of a representative test sample to the government is encouraged.

Phase II: Phase II will develop the advanced semiconducting material or process to demonstrate the potential application. Modeling studies of growth processes or materials properties are appropriate. Deliverables of test materials to the government for testing is encouraged.

Dual Use Commercialization Potential: Microwave devices made from SiC will exhibit high power, high frequency op..ation (e.g. 20 watts in X-band at room temperature) with higher package density and reduced cooling subsystem requirements. In addition, the high temperature nature of SiC permits the development of a host of harsh environment electronic devices. SiC electronics have many commercial applications. The automotive industry needs reliable materials and devices for the high temperature, corrosive, dirty environment in an automotive engine. Additionally, one of the planned uses in military aircraft, namely, on-engine flame detectors (i.e. in the engine during flight) is directly transferrable to civilian aircraft. The development of improved epitaxial growth processes for SiC will be required for the successful commercialization of these high temperature, high power devices.

AF94-167 TITLE: Nonlinear Optical Materials

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop nonlinear optical materials with superior properties as compared to those presently available.

DESCRIPTION: Nonlinear optical (NLO) materials are required for a variety of Air Force applications including electro-optic
countermeasures, LIDAR, laser radar, optical signal processing, and optical interconnects. These applications require new laser sources (optical parametric oscillators and harmonic generators) and electro-optic devices (directional couplers, guided-wave
interferometers, and spatial light modulators). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, long response times, difficulty in processing for devices, and other factors. Proposed efforts must address material issues for inorganics or organics in either bulk form for optical wavelength conversion or thin film form for electro-optics. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only for the purpose of evaluating and demonstrating the properties of the material(s) as a minor part of a materials effort.

Phase I: The objective is to demonstrate the proposed growth or processing techniques.

Phase II: The objective is to develop advanced nonlinear materials and relevant processes to demonstrate potential.

Dual Use Commercialization Potential: Materials technology is fundamental to all applications, military and commercial. Examples of commercial applications for NLO bulk crystals are LIDAR for environmental monitoring, medical lasers, and scientific instruments. Examples for NLO thin films are optical interconnects for electronic chips and packages, switching networks for communications, and automatic object recognition systems.

AF94-168 TITLE: High Temperature Superconducting Materials

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop processes for fabricating high temperature superconducting thin films and multilayers for electronic and opto-electronic applications.

DESCRIPTION: High temperature superconducting (HTS) materials offer a variety of application opportunities. For example, higher performance microwave circuits, improved infrared sensors, higher density interconnects, and faster signal processing can potentially be achieved. The properties of the materials and interfaces must be controlled in order to fully utilize the value of HTS technology. Development of unique thin film deposition and processing methods for fabrication of superconductor-insulator multilayers, for fabrication of SNS or SIS junctions, or for hybridization with other electronic technologies are examples of topics considered appropriate for this program area. This topic addresses the development of thin film processing techniques, particularly for fabrication of multilayered structures and junctions, and investigation of the superconducting/non-superconducting material interface.

Phase I: Phase I will address process development and initial testing to demonstrate proof of concept. Delivery of a representative test sample or samples to the government is encouraged.

Phase II: Phase II will develop and optimize the process or material to demonstrate the potential application. Delivery of material samples to the government for testing is encouraged.

Dual Use Commercialization Potential: HTS materials technology has great potential for dual use and commercial applications. For example, SQUIDs made using HTS junctions can be used for biomagnetic imaging and for many different nondestructive evaluation applications. Passive millimeter wave components fabricated with HTS thin films offer significant savings in weight and size for commercial communication satellites. HTS materials may also be used in commercial electronics applications to provide improved multichip modules and faster signal processing.

AF94-169 TITLE: New Rigid-Flex Printed Wiring Board Materials

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop new materials for rigid-flex printed wiring boards.

DESCRIPTION: All the currently available materials used in rigid-flex printed wiring boards have difficulties in

meeting performance requirements for military applications. New materials based on organic or inorganic materials are required. Current Air Force avionic hardware has experienced failures which degrade system performance. Problem areas include bonding polyamide and glass epoxy laminates with polyamide flex material and copper foils and being able to survive temperature cycling from -54 degrees C to 125 degrees C without voiding or breaking loose or causing barrel cracking. Current acrylic, epoxy, polyamide and fluoropolymer adhesives each have trade-offs and shortcomings depending on intended applications. Current epoxy adhesives limit flexibility, acrylics melt at 40 degrees C, polyamides have low bond strength to polyamide films; and fluorocarbons are generally dimensionally unstable during soldering. The current adhesives make it difficult for boards to pass thermal stress tests. Voids and adhesive failure develop due to differences in thermal coefficient of expansions and moisture absorption.

Phase I: Phase I should examine existing adhesive/flex system materials, modification of materials, and the potential development of new materials. This effort should examine the feasibility of obtaining identified materials and provide a discussion on their potential advantages over existing materials.

Phase II: A Phase II effort would characterize selected materials and evaluate finished rigid-flex-rigid printed wiring board constructions for use in military avionic systems.

Dual Use Commercialization Potential: The commercial electronics industry is starting to realize that multilayer flex and rigid-flex can offer unique, sophisticated solutions to the ever increasing demand on real estate within an electronic package. In turn, the rigid-flex industry is attempting to re-adjust to the competitive arena of the commercial marketplace and to prepare for the anticipated commercial demand and market growth. Driven by the same density, performance and packaging requirements that the military and aerospace markets have demanded, the communication and information markets are in need of the packaging solutions rigid-flex and multilayer flex can offer.

AF94-170 TITLE: Characterization of Latent Defects in Avionic Hardware

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop techniques for characterizing latent defects in avionics hardware.

DESCRIPTION: Technology advances are required in electronic failure analysis and material characterization in order to develop reasonable failure free operating periods for avionic equipment. The level of reliability achieved by most deployed avionics is significantly less than desired by the user, producer, and developer. Additionally, avionics is becoming the driving force for flight safety. Identifying and characterizing latent defects in electronic assemblies and components is of primary interest. Technology areas of specific interest include printed wiring boards, integrated circuits, and hybrid microcircuits.

Phase I: A Phase I effort should determine the feasibility of identifying a manageable number of defects which are associated with one or more of the identified technology areas. Justification for selecting a given defect should be discussed. Materials behavior and failure analysis experience should be used to discuss how the identified defects can result in hardware failures.

Phase II: A Phase II effort would design and conduct experiments for evaluating latent defects and determining their life limiting characteristics. The environmental conditions necessary to stimulate the failure mechanism associated with the defect would also be evaluated. Methods of reducing the occurrence of given defects and minimizing their effects is the overall goal.

Dual Use Commercialization Potential: Techniques developed from this program would be directly applicable to general commercial aviation and the automotive industry. Developed technique will improve long-term reliability and lower losses by reducing subassembly failures.

AF94-171 TITLE: Material Property Discovery

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Generic

OBJECTIVE: Investigate the application of neural networks, genetic algorithms, and associative memories to material modeling.

DESCRIPTION: Currently approaches to modeling materials include, depending on the profiles of interest, calculations from first principles, continuum models, and macrobehavior models. The massive computation requirements in terms of time and therefore cost significantly limit the usefulness of these approaches. Further, although progress is being made, the widespread application of these approaches is precluded because of the difficulty in applying quantum mechanical equations to materials of engineering interest. An alternative approach would explore experimental data to discover patterns that can be used as predictors of mechanical, crystallographic, and thermodynamic behavior. Neural nets, genetic algorithms, and/or associative memories facilitate such an approach.

Phase I: In Phase I, investigations will be accomplished to determine the utility of neural nets, genetic algorithms, and/or associative memories in modeling materials. Materials of immediate interest include high temperature intermetallics, composites, electro-optical semiconductors, and polymers.

Phase II: Phase II will continue the investigation of promising discovery approaches, emphasizing their application to specific materials. Phase III will develop a few modeling approaches in detail sufficient for widespread application in the materials community.

Dual Use Commercialization Potential: Dual use of this exploratory research is foreseen for process design of microchips and other microelectronic devices, machining and inspection of structural parts, and design of high performance metals, ceramics and polymers.

AF94-172 TITLE: Intelligent Control Systems for Hot Forging and Extrusion Processes

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Generic

OBJECTIVE: Develop advanced control systems for hot deformation of high temperature materials.

DESCRIPTION: A hierarchical control structure based on quantitative and qualitative techniques has been formulated for intelligent control of deformation processes. This methodology for advanced process control employs design axioms and is derived from material behavior and process models. The independence and information axioms are employed to conceptually design the control structure of a given deformation process. The primary deformation processes of interest include the following: forging of TiAl turbine blades, forging of TiAl integral blade and rotors, and forging of TiAl composites.

Phase I: In Phase I, an advanced control strategy involving the identification of required process control technologies will be developed using the control structure and methodology described above. Some intelligent control technologies of interest may include scientific techniques from flight control, flight mechanics, optimization and material science for representing the nonlinear transient material deformation.

Phase II: In Phase II, a prototype control system will be designed and built for at least one forging or extrusion process. The capabilities of the advanced control strategy to improve product will be validated and

demonstrated for practical forging shapes using the available material data. Phase III will develop intelligent control systems for widespread application to hot forging and extrusion processes.

Dual Use Commercialization Potential: This program has a wide range of possible dual use applications in metal forming, especially for commercial aerospace, automotive engine, and land based turbine industries.

AF94-173 TITLE: Advanced Distributed Control Technology for Turbine Engines

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Investigate and develop, robust, fault tolerant, distributed control architectures for advanced technology turbine engines.

DESCRIPTION: State-of-the-art control system architectures that rely on centralized control are rapidly reaching performance limitations as the number of engine control variables continues to increase on advanced turbine engines. Damage tolerance, processing speed, maintainability, and development cost are major deficiencies for centralized control systems. Distributed engine control represents an innovative approach to solving the ever increasing performance demands on the engine control system. Advances in smart actuators, high temperature electronics, fiber-optic communication, and high-speed buss architectures make feasible the development of a high-speed, robust, fault tolerant distributed engine control architecture.

Phase I: The Phase I program goals are to develop a fault tolerant, distributed engine control architecture that is readily transitionable to the turbine engine community. Issues such as distributed architecture performance trade-offs, reliable communication, sensor technology, sensor integration, and smart actuator control authority will be explored.

Phase II: In Phase II, a simulation of the proposed architecture will be conducted. Hardware will be developed and bench tested in a Phase III effort. This will ultimately lead to extended engine testing of the developed system.

Dual Use Commercialization Potential: Distributed control technology has application in commercial aircraft, commercial aircraft engines, as well as industrial process control. Additionally, maintainable, fault tolerant control system architectures, developed to handle increasingly complex control and diagnostic applications could find application in many commercial ventures such as, petroleum refining, ground based gas turbines, and marine power plants. In all of these applications, high speed, data intensive, robust, control and communication is important.

AF94-174 TITLE: Compression System Design Methodology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop enhanced and advanced compression system and secondary-flow design methodologies.

DESCRIPTION: This is to be achieved by numerous theoretical and experimental efforts including such work as computer modeling, cascade testing, bench rig tests, etc., all adequately documented to be acceptable to the technical community. A major trend in compression system hardware is the increased utilization of low-aspect ratio blading,

solid or hollow blisks, and three-dimensional design methodology. The primary and secondary flow system design capability which is currently two-dimensional must be extended fully into three dimensions to adequately exploit these trends. Adequate documentation of this work and its influence on turbomachinery is needed as a comprehensive background document on turbomachinery. Areas of prime technical importance include blade/vane sweep, shock/boundary layer interaction, forced response and mistuning in compression systems, secondary flow design, time unsteady features of the turbomachinery gas path, and secondary flow systems. Areas of particular interest in secondary flow design include counter-rotation, trenching, brush seals, and disk pumping in regions as far back in the engine as the turbine shroud area.

Phase I: Phase I will result in concepts for the development of enhanced and advanced compression systems and methodology for secondary flow design.

Phase II: Phase II will result in software compatible with Wright Laboratory systems dealing with advanced compression system and secondary flow design.

Dual Use Commercialization Potential: All commercial gas turbine engines require compression and secondary-flow systems. The improvements gained in compression and secondary-flow system performance and efficiency will therefore directly benefit commercial turbine engines helping United States engine manufacturers to maintain superiority in the global commercial engine market. Performance and efficiency gains would also translate into monetary savings for commercial airlines by reducing fuel consumption.

AF94-175 TITLE: Further Development of Innovative Concepts for Turbine Engines

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Evaluate feasibility of known innovative concepts for future turbine engine applications.

DESCRIPTION: Fulfill the Phase III and subsequent objectives of the Integrated High Performance Turbine Engine Technology Initiative (IHPTET), further development of many already identified innovative concepts is necessary. There is a need to analyze and further evaluate the significant potential of each of the selected concepts and, from the evaluations, prioritize for their real potential to meet ultimate IHPTET goals. Weight-saving concepts such as magnetically compressed rotors, life cycle cost concepts such as intelligent engine monitoring systems, combuster concepts such as combining diffuser, and dome and environmental concepts such as Ozone production from gas turbine engine exhausts and airborne production of hydrogen are just a few typical candidates.

Phase I: Phase I work will require identification, selection, and technical evaluation of a host of concepts using facts and data already available. The majority of the technical effort will be put into the evaluations, the results of which will enable the concepts to be prioritized with respect to their potential to IHPTET, their compatibility with other advanced materials systems and concepts already selected for IHPTET and their practical, as opposed to theoretical, feasibility.

Phase II: Phase II work will then be focused on demonstration of the critical technology of the most attractive concepts identified in the Phase I effort, so that they can then be transitioned into the IHPTET program.

Dual Use Commercialization Potential: This deliberately broad-based program would have considerable impact on the commercial market. Many, if not all, of the already known innovative concepts would be relevant to commercial engine design or operation, as the common thrust in pursuing the innovations would be to improve efficiency, capability, or performance of gas turbine engines. This program thus offers great scope for dual use.

AF94-176 TITLE: Engine Diagnostic, Trend Monitoring, and Life Management System

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Design of an air-carried diagnostic, trend monitoring, and life management system for gas-turbine engines.

DESCRIPTION: The Integrated High Performance Turbine Engine Technology Initiative (IHPTET) will widely use advanced materials and innovative concepts; it will also demonstrate a significantly greater power and performance capability than any previous gas turbine engines. A comprehensive engine diagnostic, trend monitoring, and life management system is therefore warranted to not only detect incipient failures within the engine but also to routinely perform diagnosis of engine faults and accurately compute life consumption of critical components. The end aims of the system would be to increase engine life on the wing, obtain the maximum safe life from the engine and its components, and to minimize ground maintenance.

Phase I: In Phase I, a paper design of such a system will be carried out with possibly a computer model demonstration. Extensive use will be made of artificial intelligence, neural networks, and any other appropriate emerging technology. The model will also be generic so that it could be easily adapted to any gas turbine engine.

Phase II: In Phase II, a full-scale system will be built for installation on an Advanced Turbine Engine Gas Generator (ATEGG) or a Joint Technology Demonstrator Engine (JTDE).

Dual Use Commercialization Potential: The program is directly applicable to all commercial gas turbine engine operators in both the aircraft and power generation industry. The commercial payoff in the fields of maintenance, life optimization, life cycle costs and safety would be significant and would equate to the benefits which would be enjoyed in the military sector. The potential success of this dual-use technology would, in essence, revolutionize the management of gas turbine engines for all applications. Moreover, because the civil and military use of the proposed system would be identical, there is opportunity to physically standardize the system for any engine, as the only difference would be the installed data and software specific to the particular type.

AF94-177 TITLE: High Mach Combined Cycle Engine Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Vehicular Systems

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop key technologies for combined cycle engines operating from Mach 0 to 6 flight speeds.

DESCRIPTION: Investigations of combined cycle propulsion systems have shown turboramjets and air-turborockets to be very attractive propulsion concepts at Mach 0 to 6 flight speeds. Both concepts combine the flexibility and efficiency of turbomachinery at flight speeds of Mach 0 to 4 with the simplicity, low weight, and high specific impulse of the ramjet in the Mach 3 to 6 flight range. Currently, plans are underway to develop technologies for both a turboramjet and an air turborocket under the High Mach Turbine Engine Technologies (HiMATE) program. Under this program, technologies which would be applicable to either cycle are of primary interest. The proposal must demonstrate an understanding of the HiMATE program and its goals. Examples of technologies which are of interest include air intake systems, exit nozzles, solutions to reduce the length and weight of the inlet and nozzle components, ramburner structures, ramburner fuel injection/flameholding schemes, endothermic fuel reactor/engine integration, heat exchangers using either fuel or a nonexpendable fluid to cool air, ramburner cooling techniques and air driven power generation devices. Proof-of-concept testing is preferred, but analytical investigations will also be considered.

Phase I: The goals of Phase I will be to identify a novel concept, quantify its payoff, and conduct a small-scale experiment to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis

must be performed to demonstrate some degree of concept feasibility and plan experiments for Phase II.

Phase II: Larger scale development would be undertaken in Phase II. The proposal should include plans for Phase II testing, which include identification of appropriate facilities. The goals of Phase III would be to integrate the components developed in Phase II into a combined cycle engine demonstrator and evaluate its performance.

Dual Use Commercialization Potential: Combined Cycle Engines have application to a multitude of vehicles which require efficient acceleration and cruise capabilities. Military application might include long-range, high-speed aircraft for reconnaissance and strike missions and for stand-off missiles. Commercial application might include high-speed civil transport or passenger aircraft similar to the concepts under study by NASA Lewis Research Center. Dual use, military/commercial, recoverable space launch vehicles show promise of greatly reducing the cost of placing payloads in orbit and require airbreathing propulsion for the initial boost phase. Both the PEGASUS launch vehicle and the National Aerospace Plane could benefit from the use of airbreathing boost propulsion.

AF94-178 TITLE: Combined Cycle Propulsion System Exhaust Nozzle Instrumentation

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop advanced instrumentation techniques to measure temperature and species profiles in combined cycle engine exhaust nozzles.

DESCRIPTION: Recent mission studies have shown attractive payoffs for Mach 4 to 6 combined cycle propulsion systems using hydrocarbon fuels for both commercial and military applications. A number of component technologies need to be developed for such propulsion systems, the most critical being the exhaust nozzle. The nozzle will have to operate over a broad range of temperatures and pressures and accommodate expansion ratios as high as 40 to 1. The high temperatures associated with Mach 6 flight lead to dissociation in the combustor, and the lack of recombination of the exhaust products in the nozzle can result in losses in overall performance. Studies have shown that a 1-percent drop in gross-thrust coefficient can result in an 8-percent reduction in net thrust and a significant rise in vehicle takeoff weight. Accurate measurements of temperature and velocity profiles and recombination rates in Mach 4 to 6 nozzles are needed to upgrade kinetics codes and develop design methodologies for high performance exhaust nozzles. Although a number of instrumentation techniques have been and are currently being developed to measure temperatures, velocities and species, these technologies have generally not been applied to Mach 4 to 6 exhaust nozzles at realistic operating conditions. Under this program, innovative advanced instrumentation systems are sought to measure temperatures, species, and velocities profiles in supersonic exhaust nozzles operating at conditions commensurate with Mach 6 flight speeds. Emphasis should be on obtaining data useful for kinetics model development. Both nonintrusive and intrusive techniques for use in a test cell environment rather than a bench top basic research experiment are of interest.

Phase I: The goals of Phase I will be to analyze and demonstrate the feasibility of the proposed system in a small-scale experiment.

Phase II: The goal of Phase II would be to install and demonstrate the proposed system in Wright Laboratory's High Mach Advanced Propulsion Research Facility, Test Cell Building 18. Measurements will be taken in an existing research water-cooled combustor/nozzle system designed for continuous operation at high pressures, temperatures, and levels of vibration. In Phase III, the technology developed would be marketed by the small business for use by the Aerospace community.

Dual Use Commercialization Potential: Combined cycle engine exhaust nozzles have application in commercial high-speed transport planes as well as the first stage of a commercial space-launch system. Additionally, instrumentation techniques developed to measure species and velocity profiles in a high temperature environment could find application in many commercial ventures such as pollution control, chemical processes, and the nuclear

industry. In all of these processes, accurate measurements of exhaust products is critical.

AF94-179 TITLE: Monorotor for Air Turborocket (ATR) Engine

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Design, analytically evaluate, and develop a low cost demonstration of a monorotor ATR.

DESCRIPTION: Promising to combine the efficiency of turbojets in the Mach 0-4 range with the high specific impulse of ramjets in the Mach 3-6 range, the ATR could power a supersonic, fast-strike weapon or boost a transatmospheric vehicle. Past ATR research has proposed the novel concept to use a turbocompressor monorotor composed of fan blades outside to the central ring and of turbine blades inside to the central ring. This monorotor concept could propel an ATR more efficiently due to potential weight and volume savings and more economically due to simple injection-molding manufacturing. The program demonstrates the viability of a monorotor-powered ATR and determines its operating conditions/limitations.

Phase I: Phase I would include as many of the following tasks as possible: literature search to ascertain previous relevant work; conceptual design of a monorotor ATR, and determination of its operational envelope; recommendation of an easy-to-handle and environmentally-clean (possibly solid) propellant; illustration, including weight and dimension estimates of all key ATR components, showing integration of monorotor in the ATR; computer cycle prediction of the monorotor ATR performance; survey of possible materials (metals, ceramics, and composites) used to manufacture the monorotor and bearings; preliminary harmonic (Campbell diagram) and vibratory stress analysis (Goodman diagram) to verify design integrity; test plan development for Phase II work.

Phase II: Phase II work would include a more in-depth analysis to accomplish these tasks and the fabrication, spin testing, and fuel-powered operation of a suitable monorotor for the ATR. This effort should be a simple and low cost demonstration of the monorotor ATR over the defined performance envelope. The demonstrator ATR could be a subscale prototype but should maximize usage of "off-the-shelf" components. The demonstrator must include the monorotor, combustion chamber, fuel delivery system, nozzle, and a means to start and to throttle the engine. The demonstrator should potentially average a minimum specific impulse (thrust/fuel massflow rate) of 600 seconds throughout the envelope.

Dual Use Commercialization Potential: The potential success of this dual-use technology would revolutionize turbocompressor manufacturing for both the military and commercial sectors. A new commercial product (innovative turbomachinery) easier and cheaper to make would show its worth. Several commercial applications are foreseen. Wright Laboratory and NASA have both studied the benefits of ATRs for powering a Pegasus-type vehicle to deliver satellites into orbit. A monorotor ATR would dramatically increase the payload capability of this commercial vehicle. Furthermore, flying hobby vehicles and commercial drones would also be powered by this more compact and cheaper engine. Thus, this innovative technology could aid military propulsion needs and could spin-off to benefit the propulsion requirements of commercial industry.

AF94-180 TITLE: More Electric Aircraft Power System Technologies

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Explore and develop electrical components and devices applicable to future and retrofit "more electric" aircraft.

DESCRIPTION: Proposals should address technologies important to the electrical power system of a more electric aircraft. Under the more electric aircraft concept, troublesome hydraulic, pneumatic, and mechanical subsystems are replaced with a highly reliable electrical generation, distribution, utilization, and energy storage system. Key technology barriers which must be overcome are fault tolerance, thermal management, electrical control and regulation, electromagnetic compatibility, and fault detection.

Phase I: Phase I goals include analyses and proof-of-concept experiments.

Phase II: Phase II goals include demonstrating flight-qualified, flight-ready hardware.

Dual Use Commercialization Potential: Much of the "more electric" aircraft technologies have application to civilian aircraft markets as well as electric vehicle uses and commercial power generation, motors, switching, and electrohydraulic/electromechanical actuator industries.

AF94-181 TITLE: Power Electronics

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Explore and develop power electronic devices, components, and systems for future 1 kW-150 kW aeronautical power system applications.

DESCRIPTION: Proposals should address the development of power electronic devices and components for aeronautical power system application in the power range of 1 kW to 150 kW. Candidate device and component technologies should demonstrate advances in efficiency, power density, and high temperature (greater than 200 degrees C) operation.

Phase I: Phase I goals include analyses and proof-of-concept experiments.

Phase II: Phase II goals include detailed analytical deviations and prototypical devices, components, or hardware demonstrations. Phase III goals include demonstrating flight-qualified, flight-ready hardware.

Dual Use Commercialization Potential: Much of the technology is of direct interest to future commercial utilization by the automotive, power generation, and motor drive industry where high temperature operation, high current fault tolerant switching, and/or high reliability are required.

AF94-182 TITLE: Advanced Energy Conversion and Power Sources

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Characterize and apply advanced energy conversion materials.

DESCRIPTION: Proposals should address the characterization and application of advanced energy conversion materials for aerospace power system application, including aircraft, tactical weapons, life support, survival equipment, and remote basing.

Phase I: Phase I will focus on characterization of properties of these materials as related to envisioned

applications and quantitative assessment of realizable improvements of system performance.

Phase II: Phase II goals will focus on improvement of properties, batch manufacturing methods, and demonstration of the material in a prototypical configuration. Phase III is expected to transition the Phase II products to a specific application via design, resolution of unresolved production and manufacturing issues, or complete demonstration of material compatibility, life, or properties for a specific application.

Dual Use Commercialization Potential: All the technologies of interest have direct relevance to commercial applications related to energy storage, pulse power for medical or scientific diagnostic equipment, mobile/portable power systems. The commercial applications must also consider affordability in the market place.

AF94-183 TITLE: Development of Lubricous Coatings and Composites for Bearings and Separators

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop lubricous coatings and self-lubricating, light-weight composites suitable for gas turbine engine bearing use.

DESCRIPTION: The Department of Defense is currently developing advanced gas turbine engines under the Integrated High Performance Turbine Engine Technology (IHPTET) program that will require lubrication systems to operate from -60 degrees F to 1500 degrees F. Improved lubrication methods, such as self-lubricating mechanical components (i.e., self-contained solid lubricated bearings) are critical for achieving these goals. Currently, there is no satisfactory method of achieving consistent and durable lubricant supply and/or replenishment in self-contained solid lubricated bearings. Additionally, the bearing cage or rolling element retainer has been identified as a limiting component in most of these bearings when operating at high speeds and temperatures.

Phase I: Phase I of this research effort shall investigate the feasibility of using advanced high temperature solid lubricants and high strength composite material technology for developing improved lubricous coatings and a light-weight/high-strength/self-lubricatingcage material for high-temperature/high-speed bearing applications. The suitability of such materials shall be demonstrated for use as durable, effective tribiological coatings and self-lubricating bearing cage materials.

Phase II: Phase II activities shall include development, detailed design, fabrication, and full characterization of selected lubricous coatings and self-lubricating bearing cages. Facilities, including a 60,000-rpm bearing test rig, available at Wright Patterson Air Force Base may be proposed for characterization of selected bearing concepts. Under Phase III the small business shall team with a bearing manufacturer to develop this technology into a viable, marketable product. The ultimate payoff for the Air Force will be the development of a solid lubricated system that will either eliminate the need for or only require a smaller, lighter weight delivery system. Either way, the successful completion of this program will result in a lighter weight lubrication system resulting in increased performance critical to achieving IHPTET goals.

Dual Use Commercialization Potential: The material and/or coatings developed in this effort have many excellent opportunities for dual use in the private sector. Potential commercialization opportunities range from automobile bearings to small and large appliances requiring wear resistance on sliding surfaces.

AF94-184 TITLE: Fuel Combustion Technology

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Demonstrate concepts that improve gas turbine combustor performance goals and design methodology.

DESCRIPTION: The processes important to conventional gas turbine combustion are atomization and evaporation of liquid hydrocarbon fuels, mixing of the fuel vapor with air, and ignition and complete burning of the mixture. These processes should occur very rapidly so that the combustor operation is stable and efficient over a wide range of fuel and air flow rates, consume all the fuel, can be easily ignited at ground and altitude conditions, have an acceptable temperature profile at the combustor exit, and are suitable for the development of a low specific fuel consumption and high thrust-to-weight ratio engine. These characteristics must be achieved in such a way that pollutant emissions of nitric oxides, carbon monoxide, total hydrocarbons, and soot are low at all conditions and the combustor is affordable, has high reliability, and has a long operating life without maintenance. Innovative combustor concepts are sought that will improve performance in gas turbine combustors. Such concepts might include catalytic combustion, methods for rapid atomization and mixing of fuel and air, ways of converting liquid hydrocarbon fuel to gaseous or supercritical fuels in the fuel system, and techniques for efficient injection and burning of these fluids in the combustor. Concepts for high performance low nitric oxides emissions are of particular interest. Next generation combustor design models are also of interest. These could include probability distribution function models, large-scale simulations with improved turbulence, transport, liquid sheet break-up, and atomization models. Improvements in advanced diagnostic techniques that would provide information for making design decisions are also of interest.

Phase I: Phase I efforts should experimentally demonstrate, on a laboratory scale, the potential of a combustor concept or diagnostic technique to improve the performance characteristics of the device as compared to a suitably chosen state-of-the-art concept. Computational support of the concept is advantageous but not sufficient for a Phase I effort. Likewise, potential improvements in computational models must be demonstrated by comparison with state-of-the-art techniques for configurations where experimental data are available.

Phase II: Phase II efforts should provide complete demonstration of significant performance gains and affordability in the combustor concept, model, or diagnostic technique for an application of interest to the Air Force.

Dual Use Commercialization Potential: A high performance, low emissions gas turbine engine combustor is of high value in both military and commercial markets. High performance, manifested in high thrust-to-weight and low specific fuel consumption, affect the economics of operating a competitive commercial aircraft fleet. However, the current commercial market for aviation gas turbine engines is driven by the level of their exhaust emissions. Public attitudes and local legislation have made low emissions a dominant issue, even at the expense of other performance parameters. Technology that yields low engine emissions, while preserving high performance, will dominate in both military and commercial markets.

AF94-185 TITLE: Vapor Lubrication of Gear and High Velocity Sliding Systems

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop vapor lubrication processes and systems for gear and high velocity sliding mechanical components.

DESCRIPTION: Vapor phase lubrication proved promising for high temperature bearing systems, but application to high velocity sliding and high load mechanical systems, such as gears, cams, and pistons has not been done. Systems such as turbine engine gearboxes and adiabatic diesel engine cylinders and cams are prime candidates for use of vapor lubrication. Also, systems that currently use solid or grease lubricants could potentially benefit from

increased load carrying capacity of vapor deposited films which can lift lubrication out of the boundary and into elastohydrodynamic (EHD) regime. This rapidly developing technology can reduce weight and complexity of current liquid lubricated systems and has potential to increase performance and life of current solid and grease lubricated systems.

Phase I: Phase I activities shall include proof of concept and testing of promising vapor lubricants under high velocity sliding and high load conditions within simulated or actual gear, cam, or piston systems. Load carrying capacities and probable operating temperature range for various vapor lubricants in each of these systems shall be determined. A report of the feasibility of vapor phase lubrication for application in systems to replace liquid, solid, or grease lubricants shall be prepared.

Phase II: Phase II effort shall include testing of real high temperature, high load gear and other systems, probably in teaming with engine manufacturers. Design and installation of prototype vapor lubrication systems for evaluation in actual engine test programs is very desirable. Design and testing of real vapor lubrication systems in advanced turbine gearbox, diesel, or other high sliding, high load systems is expected as the major product of the Phase II effort.

Dual Use Commercialization Potential: Vapor lubrication has excellent commercial technology transfer potential for future automotive engines in upper cylinder wall and piston ring lubrication. Cylinder wall lubrication in high temperature diesel engines and gear lubrication in high load transmissions are also possible. Industrial gas turbine bearing and gear systems could benefit from more thermodynamically efficient high temperature operation made possible by vapor phase lubrication.

AF94-186 TITLE: Aero Propulsion and Power

CATEGORY: Basic Research

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Improve performance and reliability or maintainability of propulsion and power technologies.

DESCRIPTION: The Aero Propulsion and Power Directorate (APPD) pursues research and development in four principal areas: Turbine Engines, Fuels and Lubrication, High-Speed Propulsion, and Aerospace Power. The Turbine Engine Thrust centers on the Integrated High Performance Turbine Engine Technology (IHPTET). Associated studies are conducted in compressor research, turbulent flows, gas generators, and uses of composite materials for lightweight, high temperature and low signature applications. The Fuels and Lubrication Thrust addresses challenges introduced by IHPTET for thermal management and high temperature lubrication. Milestones for 1994 are fuels that operate at ambient temperatures up to 425 degrees F and lubricants up to 625 degrees F. Associated work uses computational fluid dynamics and fuel chemistry programs to promote thermal advanced designs, new endothermic fuels, and improved combustors. The third thrust addresses the technologies for high-speed atmospheric flight relevant to the turboramjet (for high Mach speeds) and to missile variable flow ducted rockets and boron-based solid fuel ramjets (for missiles). Thrust from development emphasizes the more-electric airplane, and concepts for generation and distribution of mechanical, electrical, hydraulic and thermal energy. Associated work responds to the need to increase aircraft power levels and reliability. Advanced fault tolerant power systems, power inverters, and efficient batteries provide the infrastructure for these requirements.

Phase I: Explore the feasibility of a new concept or concepts, through analysis or small scale testing to demonstrate the potential merits of the concept.

Phase II: Provide detailed analytical derivations and prototypical device/or hardware demonstrations.

Dual Use Commercialization Potential: The higher performance turbine engines and associated technologies will lead to more efficient, quieter and environmentally acceptable commercial propulsion and power generating systems. The modular engine concepts and new fuels and lubricants developed under this program are suitable for integration into new engines for commercial use or as retrofits and provide low cost, easily maintained systems.

The power developments transition naturally into emergency power sources for large installations, disaster preparedness and efficient utilization of natural gas that is presently flared.

AF94-187 TITLE: Physics of Plasma Processing

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Explore and characterize the plasma physics fundamentals governing interfaces produced by plasma-enhanced deposition.

DESCRIPTION: Proposals should address plasma processing and plasma-enhanced deposition science which is used in making diamond and diamond-like thin films for power semiconductors, thermal control surfaces and mechanical surface treatments. These fundamentals also apply to disposal of hazardous substances.

Phase I: Phase I efforts will focus on identifying physical mechanisms and limitations governing important interfaces and their processing parameters (e.g., uniformity, topography, rates of deposition, defects) related to the plasma, surface interaction problems.

Phase II: Phase II efforts will focus on demonstrating process control and validating improvements. Phase III efforts will demonstrate specific device applications of the improved plasma processing.

Dual Use Commercialization Potential: Plasma deposition processes are pervasive in the commercial semiconductor industry. Therefore, proposals should focus on those aspects of the deposition process which will have direct transfer applicability to commercial processes. Along with deposition processes for semiconductors, commercial application of these processes for applying coatings and insulation are important.

AF94-188 TITLE: Voice Controlled Computing Environment Assistant

CATEGORY: Basic Research

DOD TECHNOLOGIES: Human-System Interfaces

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Provide a complete automated semantics based voice operated (No Hands) assistant for office environment.

DESCRIPTION: The basis of this research is to establish an environment that is capable of performing routine office activities such as E-Mail, word processing, spreadsheet, and telephone message processing using voice and/or sound context semantics processing. Maximum use of commercially available heterogeneous hardware, software, voice synthesis, and natural language processing will be used. Multiple dialects of each language must be processed. The processing scenario should include the computer system start up, application processing, data acquisition and update, storage and retrieval and communications (computer to computer/computer to human) must be accomplished through voice and/or sound semantical interpretation and generation. The lexicon must be rich enough to support a manufacturing production office processing technical and business data.

Phase I: Establish voice computing environment assistant (VCEA) requirements and provide project documentation. Establish the VCEA solution concept and survey industry for available technology. A prototype will be built to validate the VCEA. A technical review board (TRB) will be established for VCEA of potential vendors and end users. Prepare a detailed plan for Phase II.

Phase II: During this phase a production version will be designed and built of VCEA, documentation will be provided, and the design and components will be reviewed with TRB for VCEA. Demonstrations of VCEA will be performed and a training course will be established on each VCEA component. Vendor commitments are to be explored and commitments obtained where possible to produce and market the VCEA components. Standards requirements for the VCEA component technologies will be developed and utilized. A copy of engineering documents and software will be provided.

Dual Use Commercialization Potential: The VCEA has dual use in all areas where computers are interfaced directly (local or remote) with human beings or other audio capabilities. Some specific examples of dual use are:

a. Voice activated telephone, ATMS, household appliances, amusement devices, etc.

b. Transportation vehicle accessories, universal locator, guidance and control systems, unmanned vehicle management (ground, air, water, space, etc.)

c. Design and repair of human, animal and automated equipment systems by audio assistance to the performer of complex procedures lead through in all phases (analysis, disassembly, maintenance, reeducation, testing, return to service process, etc.)

d. Education, training, emulation, simulation, etc.

e. Security is an inherent feature for defense and civil use (voice and speech pattern recognition etc.).

AF94-189 TITLE: Modeling for Sensor-Based Semiconductor Process Control

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Strategic Deterrence

OBJECTIVE: Develop models for sensor-based control of single wafer silicon microelectronics processes.

DESCRIPTION: Recent developments in microelectronics manufacturing have emphasized a high flexibility concept, including single wafer processing in cluster tools, sensor-based, closed loop process control, and factory automation. Indeed these concepts have already been demonstrated. In order for the industry to fully benefit from the implementation of these concepts, continuing advancements are needed in the area of modeling for real-time process control. Typical single wafer processes requiring tight control for silicon device fabrication include chemical and physical vapor deposition, plasma processes, and rapid thermal processes. This solicitation seeks to develop models which will work in conjunction with sensor data to calculate optimal machine settings for the processes mentioned above. The goal is to drive each process to its target.

Phase I: This effort will involve the development of models for sensor-based control of single wafer silicon microelectronics processes.

Phase II: Will include verification of models with actual manufacturing processes, further modification of models as necessary, and planning for the implementation of the models into production.

Dual Use Commercialization Potential: Single wafer processes have been developed for semiconductor processing which has both military and commercial application. Single wafer processing is ideal for low volume production (military and commercial), such as for application specific devices, prototypes, and large diameter wafers, and is also scalable for high volume production, as is typical for commercial commodity parts. Sensor-based process control and modeling optimize the quality and throughput of these processes.

AF94-190 TITLE: Improved Machining Precision with Neural Network Technology

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop neural networks to improve the machining of materials.

DESCRIPTION: Machining errors have systematically been individually addressed with traditional engineering methods. Separate machine design and compensation strategies have been used to reduce static and dynamic deflection, tool wear, control following errors, machine alignment, and general process errors. Artificial neural network has been used to model thermal distortion error. As yet, a comprehensive inclusive strategy has not emerged which collectively addresses all these errors. The need exists to extend neural network capability to comprehensively include all machining errors in a composite fashion.

Phase I: Will research the approach required to an overall composite machining error compensation methodology using artificial neural network. The research should demonstrate how such an overall approach would improve precision machining in a general machine shop environment. The research should build upon recent projects which use neural network techniques for error compensation predication, and demonstrate improved precision by actually machining simple parts. Phase I should also include an assessment of both the technical and commercial viability of using artificial neural network in machining and provide a clear justification for continuation into Phase II.

Phase II: Will extend the Phase I research to investigate production level applicability with a detailed cost benefit analysis compared to the state of the art.

Dual Use Commercialization Potential: Machining of materials is the heart of the industrial base. This technology is not specific to military requirements. Improved precision machining using neural network technology and artificial intelligence can be benefitted by industries ranging from aerospace to automotive to medical.

AF94-191 TITLE: Ceramic Matrix Composite Processing Simulation

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Investigate the processing of advanced high-temperature ceramic matrix composites using computer simulation.

DESCRIPTION: Achieve revolutionary advances in turbopropulsion-powered systems for the next century, advanced high-temperature ceramic matrix composites will be required. Processing of these materials into complex three-dimensional components is often the primary impediment to producing fully dense, defect-free hardware. Fabrication to these advanced materials is still being accomplished by traditional trial-and-error methods. Rarely does this approach lead to an optimized process which yields high quality components at the lowest manufacturing cost. Both oxide and nonoxide ceramic matrix composites are being investigated for potential near term military use as high as 1300 degrees centigrade. Stability at temperatures up to 1925 degrees centigrade are necessary for future civil applications.

Phase I: Will investigate the feasibility of applying computer simulation and materials modeling to the manufacturing processing of advanced high-temperature ceramic matrix composites. Feasibility shall be demonstrated on simple components to show proof of concept.

Phase II: Will build upon the Phase I work to include complex three dimensional shapes and introduction of an intelligent processing of materials approach.

Dual Use Commercialization Potential: Ceramic composite materials are required in ground-based power systems, nuclear power systems, space power systems, and automotive applications. Modeling and process

simulation will lead to lower cost manufacturing and increased use of this specialty material. The most immediate application of this technology would be for the future High Speed Civil Transport (HSCT). The HSCT expects to use extensive amounts of ceramic matrix composites for the combustor and exhaust sections. Advanced process simulation can assist in significantly reducing manufacturing costs.

AF94-192 TITLE: Carbon-Carbon Manufacturing

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Demonstrate preproduction manufacturing methods for producing low cost carbon-carbon composites.

DESCRIPTION: The use of carbon-carbon composites for such applications such as thermal protection, thermal management of both structures and electronic components, and high temperature components has inhibited the cost of manufacturing these components and limited lifetimes demonstrated to date in oxidizing environments. Coating and other protective systems are available and emphasis is needed on cost to manufacture.

Phase I: Will investigate the use of advanced or innovative materials and processes that hold great potential for the densification of fibrous preforms at a very low cost. The process duration should be measured in days as opposed to weeks and months as is the current state of the art.

Phase II: Would continue to investigate promising materials and processes to eliminate the least promising and determine the limits or constraints characteristics of the Phase I selected materials and processes.

Dual Use Commercialization Potential: Due to the thermal management characteristics of C-C composites, they offer significant potential use in the commercial electronics world. The high temperature features of these composites also allow their use in commercial aircraft engines as well as automotive engines. The inert properties of C-C also make them candidates for prosthetic devices in the medical world.

AF94-193 TITLE: Acquisition Management Information Analysis Center (AMIAC)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Design Automation

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop a process which allows interchange between software tools and integrates technical, business, management and logistics data.

DESCRIPTION: The Acquisition Management Information Analysis Center (AMIAC) is implementing a library of acquisition management tools to provide professional management support services to its customers. The delivery of databases, database processes, format of information, and specific software tools is the objective of this effort. The goal is to focus on a process to improve productivity without getting the user involved in the detail of the data and storage.

The continuing need to upgrade the office systems (both hardware and software) to utilize the benefits of evolving technology is a critical cost driver. Unfortunately, most of the time very little of the existing system or data can be salvaged without extreme cost, and is thrown away. Therefore systems need to be designed with change and evolution in mind.

Phase I: An open framework design and prototype that facilitates the exchange of data and graphical

information between software tools.

Phase II: An open framework implementation that forms a library of acquisition management tools (i.e. process, software, project/program schedules, etc.) needed for acquisition management, integration of technical, business, administrative, and logistics data; and independent integrated databases to manage data and information. The framework must use graphical user interfaces, interprocess communication, process flow management, database management, design-data management, configuration management, programmatic language interface, graphical programming environment that helps merge CALS, EDI, Knowledge Bases, and Expert System efforts to enhance the utilization of development tools and information to management requirements.

Technical Challenge: Must implement an open framework to achieve the integration and exchange of technical, business, logistics, and administrative data. This management tool must have the ability to link software packages of programs, exchange data between programs, and install new capabilities through the use of graphical interfaces without the need for onsite programmers.

Dual Use Commercialization Potential: The potential applications of this phase must be addressed in detail. This technology has potential applications in any business application that requires information exchange between a variety of software tools and databases (examples: Insurance, Banking, Legal, Concurrent Engineering.) A detailed marketing plan for this phase must outline commercial viability and define how commercial ventures will be pursued.

AF94-194 TITLE: New Concepts and Innovations for Aeronautical Systems/Subsystems

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronic Devices

MAJOR S&T THRUST: Air Power Projection

OBJECTIVE: Develop new concepts and innovations for aeronautical systems/subsystems for projected emerging and existing systems.

DESCRIPTION: This topic covers all facets of aeronautical systems/subsystems research, development, and acquisition necessary to address the Functional Capability Requirements/Needs outlined in the industrial version of the Aeronautical Systems Center FY94 Planning Guidance-Systems Descriptions, 23 Dec 92. This general topics covers the full spectrum of Air Force aeronautical missions (i.e. tactical, airlift, mobility, strategic, hypersonics, tactical relocatable targets, etc). Emphasis is placed on potential long-term concepts which address affordability, supportability, maintainability, survivability, etc. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Some representative topics areas are:

Air vehicle:	Low maintenance, all weather/night, etc.
Airframe:	Minimum weight, etc.
Structures:	Damage tolerant, inspectable, reduced manufacturing cost, composites, etc.
Aerodynamics:	High lift, Low drag, etc.
Flight Controls:	Fly-by-wire/light, reduced weight integrated redundant/self repairing, etc.
Landing Gear:	Reduced parts, no jack required, etc.
APU:	Self start, extended operation, etc.
Cargo:	Rapid load/unload, multiple configurations.
Engines:	High T/W, improved SFC, FOD resistant/tolerant, reduced IR/noise signature, integrated w/flight controls, etc.

This topic is structured to provide a maximum of innovative flexibility to prospective participants.

Phase I: In the Phase I proposal briefly address the anticipated Phase II effort and the anticipated commercial application the potential for Phase III.

Dual Use Commercialization Potential: Each proposal must address the dual use, 'Commercial Potential', of the concept/technology presented.

AF94-195 TITLE: Campaign-Level Modeling for Assessing Theater Airlift Capability

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop campaign-level modeling for tool assessing theater airlift capability.

DESCRIPTION: An analytical capability is needed to assess U.S. Military's needs for theater airlift and its impact on warfighting effectiveness. This effort will form a core of mission area assessments (MAA), mission needs analysis (MNA) and cost and operational effectiveness analyses (COEA) tools for acquisition of future theater airlift systems and concepts. Key to this capability is a validated campaign-level model which incorporates theater airlift systems, concepts, and technologies in conjunction with airland battles, and surface logistics transportation. Supporting tools and models may be necessary to assess the impact of airlift factors at the mission level to provide data for the campaign-level analysis. Examples of airlift factors are airlifter characteristics, command and control capability, material handling capability and maintenance and ground support capability. The principal focus on this modeling capability is to provide insight into the impact of theater airlift on warfighting effectiveness. The methodology, with varied databases, can provide a capability for commercial aviation assessment of productivity, cost and efficiency.

The effort will begin with a study of the analysis requirements and an identification of the key processes to be modeled. These processes must be documented in a flowchart with narrative. The second task will construct a comprehensive approach for analyzing theater airlift capability and its impact on war fighting effectiveness. The third task will be to complete a thorough survey of existing analytical tools and sources of data, which could have applicability and where they fit into the overall process identified in task two. The survey will include the organization responsible for model/database, system requirements, and its primary use. The fourth task will assess the capability to model the various elements of the processes defined in task two and recommend enhancements needed to existing models and additional models to be developed. The final task is an overall plan for SBIR Phase II including recommended activities and schedule leading to a full analysis capability. The final product of Phase I is a thorough documentation for the above tasks.

Dual Use Commercialization Potential: The analysis approach and many of the models (e.g., cargo loading models) resulting from this effort has high potential for use in the optimization of commercial transport operations and systems.

AF94-196 TITLE: Sensor Fusion Modeling to Support Combat Identification (CID)

CATEGORY: Basic Research

DOD TECHNOLOGIES: Software

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop an analytical tool to access multi-spectral sensor fusion.

DESCRIPTION: Provide the Air Force with analytical tools to access the contribution of unambiguous, multi-spectral sensor fusion to mission success and fratricide reduction.

The SBIR contractor must demonstrate an understanding of CID technology developments to define the analysis requirements. The contractor will perform a survey of existing sensor fusion studies. The contractor will derive and document an analysis approach and develop a prototype model to demonstrate the feasibility of his

solution. The identification fusion process must include sensor information from both on-board and off-board sensors. Activities necessary to provide a full analysis capability will be detailed in a comprehensive plan for Phase II and documented in a final report.

Dual Use Commercialization Potential: The model has civilian/commercial application. This analytical tool can be used to access multi-sensor data requirements necessary for identification and positive position tracking of civil air traffic.

AF94-197 TITLE: ENSIP Inspection of Engine Components

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an Engine Structural Integrity Program (ENSIP) Inspection system that does not require cleaning parts.

DESCRIPTION: Under current ENSIP guidelines, large areas of the engine parts must be inspected for flaws in the .03 inch to .07 inch range and some selected small areas down to .01 inch. Currently a combination of Fluropenetrant Inspection (FPI) and Eddy Current (EC) techniques are used to perform these inspections. The major drawbacks of both of these inspections systems are that parts must be cleaned to an "as new" condition, the FPI process is labor intensive, and EC is slow. The cleaning process itself is a labor intensive effort. In addition, numerous hazard substances are currently used in this process. The use of these chemicals will be prohibited in the future, and we need to be able to reduce our usage of them in the near term. There are several new inspection technologies, such as Magneto Optic Eddy Current Imaging and Laser Holography, that may be able to inspect the parent metal in the part without cleaning the part. The major difficulties with the inspection of engine parts is the flaw-size inspection requirements and the complex geometries of the parts. Also, due to the high volume of parts and accuracy requirements of the inspections, a rapid automated system is mandatory.

Phase I: Recommend the best technology to solve the ENSIP Inspeciton problem and demonstrate that technology in the engine depot inspection environment.

Phase II: Develop an automated inspection system that can demonstrate the image processing techniques that are required to build a production automated system.

Dual Use Commercialization Potential: FAA is considering the addition of this type of inspection. However, the use of this technology goes far beyond the ENSIP inspection requirements. This type of inspection is required of all new engines to ensure flaws are not present. Currently this inspection is done immediately after machining and prior to finishing. Industry requires a process by which they can inspect completed parts.

AF94-198 TITLE: New Concepts and Innovations for Aeronautical and Support Equipment FACTS Parts

CATEGORY: Basic Research

OBJECTIVE: Develop FACTS parts to improve reliability/maintainability of existing and emerging aeronautical systems and support equipment.

DESCRIPTION: FACTS parts are the small hardware items that make up the mechanical infrastructure of aircraft and support equipment, they are the: fasteners, relays, connectors, hand tools, seals, etc. In contrast to the reliability gains in electronics and engines, the reliability improvements of FACTS items has been static. The topic in innovative concepts is intended to cover all facets for acquisition of aeronautical and support equipment of FACTS parts research and development. It is intended to provide latitude to the innovator to include areas not addressed

by other specific aeronautical or FACTS topics. Innovations in technologies that are currently available only from foreign sources or from limited sources in the United States are specifically encouraged. Additionally, innovation proposals which address Logistic Technology Needs are encouraged. Some areas of interest are improvements to fastening systems and electronic connectors. This topic is structured to provide a maximum of innovative flexibility to the prospective participants.

Phase I: The Phase I proposal should address/convey a good understanding of the current problem, potential solutions and the anticipated Phase II effort and potential for Phase III.

Dual Use Commercialization Potential: Many FACTS items such as fasteners and connectors are common to both commercial and military aircraft and their associated support equipment. FACTS maintenance problems are generally the some for both military and commercial operators. Improvements in the reliability and maintainability of military FACTS items, will have direct application to commercial aviation fleets. The goal of any proposed solution should be its acceptance as a commercial standard.

AF94-199 TITLE: Innovative Control Effectors for Hypersonic Vehicles

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop innovative flight control effectors to increase control power for hypersonic vehicles.

DESCRIPTION: Present hypersonic vehicle designs lack adequate control power from conventional elevators, rudders, and ailerons to stabilize and control the vehicle at every speed without imposing large performance penalties. Additionally, propulsion systems require close tolerances on angle of attack and sideslip during normal flight operations and demand even closer tolerances during maneuvering flight. In order to control the vehicle with such precision, there is a need to develop innovative control effector concepts that will generate forces and moments to stablize and control hypersonic vehicles. These concepts should be effective in generating forces and moments at vehicle speeds ranging from take off to hypersonic cruise to landing. Direct gas jet control effectors, also known as reaction control systems, are not considered new and innovative. The amount of time needed to generate the forces and moments should be similar to the response time of a conventional control surface deflection.

Phase I: Identify concept, show feasibility, show superiority to conventional movable surfaces and gas jets.

Phase II: Develop concept, demonstrate via wind tunnel testing and computational fluid dynamics.

Dual Use Commericalization Potential: Conventional aircraft, STOL aircraft, space launch systems.

AF94-200 TITLE: Advanced Copper Heat Exchanger Structure

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop high thermal conductivity heat exchangers for use at 1400 oF to 1500 oF.

DESCRIPTION: The engine structures for future aerospace vehicles (e.g. NASP) will operate in severe thermal and acoustic environments. In order to meet vehicle performance goals, lightweight actively cooled structures are needed. To survive in the high heat flux environments, high thermal conductivity in the short transverse direction and a high conductivity coating are required. To reduce component weight, the material strength must be

maximized. This combination of requirments leads to a need for heat exchanger structures which have the short transverse thermal conductivity of copper and a high temperature strength approximately twice that of copper.

Phase I: Demonstrate appropriate architectures with desired thermal conductivity and strength.

Phase II: Fabricate and test appr ·priate heat exchanger subelements in representative environments.

Dual Use Commercialization Potential: Conventional aircraft, automobile radiators, air conditioners.

AF94-201 TITLE: Damage Tolerance of Structural Ceramic Composites

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop damage tolerance analysis methods for structural ceramic composites.

DESCRIPTION: The damage tolerance and residual strength analysis of structural ceramic composites including Carbon-Carbon, C/SiC, and SiC/SiC composites with geometric discontinuities such as cracks and notches is complex due to their anisotropic properties and inhomogeneous make-up, damage initiation, growth, and failure modes. Structural life and strength prediction methods for these materials are required to assure structural integrity of hypervelocity vehicles.

Phase I: Demonstrate the concept of the method.

Phase II: Develop the method should be fully and verify by tests under cyclic loads and temperatures.

Phase III: A marketable computer code for damage tolerance analysis of aerospace structural ceramic composites should be available.

Dual Use Commercialization Potential: Materials for automobile engines, materials for gas and steam turbines, structural materials for buildings, bridges, etc.

AF94-202 TITLE: Emerging Technologies Resulting in Lighter Aircraft, Increased Engine Performance, and Improved Design Tools

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Propulsion and Energy Conversion

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Improve aircraft structure, scramjet performance, and aerodynamic design technologies

DESCRIPTION: The National Aero-Space Plane is providing a quantum jump in aerospace technologies by investigating new and innovative solutio[illegible] Its goal is a Mach 25 air-breathing scramjet vehicle capable of single stage to orbit. Emerging technologies [illegible]iding significant performance improvements for the aircraft will be considered. Computational fluid dynamics, materials science, and scramjet performance are of special interest.

Phase I: Show experience and understanding of the relative importance of the technologies. Provide detailed drawings, specifications, and test procedures for the proposed application of the technologies.

Phase II: Prototype and associated test results demonstrating decreased weight, increased scramjet performance, or improved aerodynamic design tools without increased liabilities.

Dual Use Commercialization Potential: The NASP Industry Team, Government laboratories, the computer industry, and the automotive industry, commercial aircraft manufacturers.

AF94-203 TITLE: Develop High Temperature Hydraulic Fluid for Engine and Flight Controls of Hypersonic Vehicles

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop high temperature hydraulic fluid for engine andflight controls of hypersonic vehicles.

DESCRIPTION: The fluid needs to be usable from -54oC to 315oC. It must be a fully formulated, thermally stable fluid containing antiwear and antioxidant additives or demonstrate equivalent performance.

Phase I: Selection and bench test demonstration of the appropriate base fluid and performance improving additives into a prototype fluid.

Phase II: More extensive bench evaluation, pump evaluation, and demonstration of pilot plant fluid production.

Dual Use Commercialization Potential: Commercial aircraft, ground equipment for arctic use.

AF94-204 TITLE: Nondestructive Evaluation of Advanced Materials Substructures

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials and Processes

MAJOR S&T THRUST: Assured Access to Space

OBJECTIVE: Develop nondestructive evaluation (NDE) techniques formatrix and reinforcing substructures in advanced composite materials.

DESCRIPTION: Advanced innovative approaches are needed to develop new and improved nondestructive evaluation techniques for the detection, imaging, and characterization of flaws and other integrity-reducing anomalies in flight vehicle and engine materials, including metals and metallic and nonmetallic matrix composites. Improved techniques are also needed for real-time monitoring of the manufacturing processes used to fabricate aerospace components from these materials. In particular, innovative technical approaches are needed to determine the condition of matrix and reinforcing substructures in advanced composite materials.

Proposed technical approaches must clearly and significantly improve current standard techniques used in factory or field inspections, or must identify new inspection and evaluation technologies far superior to current techniques. The technologies have the potential for ultimate use in realistic materials development, manufacture, or in-service environments.

Phase I: Initial formulation, fabrication, and evaluation of specific NDE techniques for demonstrating the concept.

Phase II: Development for optimization of the techniques investigated in Phase I and to bring the technique or equipment to a marketable state.

Dual Use Commercialization Potential: Materials for automobile engines, materials for gas and steam turbines, structural materials for buildings, bridges, etc.

AF94-205 TITLE: Armament Research

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air delivered non-nuclear munitions and armaments. These include bombs, submunitions, warheads, projectiles, fuzes (including safe and arm devices for air-to-air missiles), dispensers, seekers, explosives, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid-state inertial components, exterior ballistics, lethality and vulnerability assessment techniques, and conventional weapon environmental, demilitarization and disposal techniques. Some examples of desired research are: low drag/observable weapon airframes; conformal/internal carriage techniques; millimeter wave-seekers for mid-course and terminal guidance; sensor fusion; self-forging fragment warheads; shaped charges; long-rod penetrators; reactive fragment warheads; computational fluid dynamics including interactive grid-generati techniques, and warhead hydrocode-assessment techniques; hard-target weapon technology; and autonomous guidance.

Dual Use Commercialization Potential: Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

AF94-206 TITLE: High Explosives for Combined Military/Commercial Application

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop commercially producible high explosives for use by the military and/or industry.

DESCRIPTION: Military explosives, for the most part, exhibit good performance characteristics, have long shelf-lives, require special production facilities, are not easily removed from warheads or rendered inert, and are generally not environmentally friendly during manufacture or demilitarization. Considerable effort is still being put forth by the military to develop new explosives or formulations with increased performance, e.g. increased blast or detonation pressures. While new materials are being developed and some increases in performance are being achieved, only minor progress is being made in the environmental areas of demilitarization and hazardous waste reduction. Commercial explosives, on the other hand, usually do not exhibit properties that are considered compatible with military objectives or safety requirements, e.g. long shelf-life, small critical diameter and high performance. Examples of these explosives are the aqueous emulsions used primarily by the mining industry. The primary goal of this program is to develop a new energetic material or formulation that exhibits the performance and safety properties required by the military, is suitable for use by both the military and industry, can be produced relatively cheaply in non-specialized (commercial) facilities, and that is easily demilitarized and rendered inert with minimal effect on the environment. Phase I of this program includes small scale characterization tests on selected formulations and selection of two or more formulations for further testing in Phase II. Areas of importance for this initial selection are cost of materials, production characteristics associated with ingredients, formulation and demilitarization issues, hazardous waste minimization, and predicted performance characteristics. Phase II of this program will demonstrate the usefulness of selected formulations to the military and industry through appropriate testing. All issues are to be addressed including performance, safety, shelf-life, cost, producibility, and environmental concerns.

Dual Use Commercialization Potential: Explosive formulations developed under this program should be shown to have commercial potential in mining, blasting, demolition, oil and gas exploration, and/or excavation.

This program is considered to be a "spin-on" Technology Transfer demonstration.

AF94-207 TITLE: Motion Video and FPA Digitization and Compression Chip-Set

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Global Surveillance and Communication

OBJECTIVE: Develop an application specific integrated circuit (ASIC) chip-set that will digitize, compress, and modulate fast motion video and focal plane array waveforms.

DESCRIPTION: A subminiature telemetry technology has been developed that will collect up to 64 analog and 128 digital, low bandwidth data types, serialize, encrypt, and microwave transmit the data to DOD ground stations. While this baseline technology meets requirements for telemetering weapon fuzing and many other functions, it does not meet requirements for telemetering focal plane array (FPA) and full motion video seeker information. Simultaneously, efforts to miniaturize high speed, high resolution charge coupled device imagers for aircraft and weapon testing have resulted in a need to transmit the resulting high bandwidth data. In all cases, encryption is a driving requirement, implying that the analog video and FPA data be digitized. Efficient use of the telemetry transmission spectrum is also a driver, suggesting that unique data compression and modulation techniques be applied to decrease transmission bandwidth while maintaining image quality. Several levels of quality must be defined, each dependent upon the specific application. Real-time compression (lossless and lossy) and transmission is also a requirement for some applications. This entire functionality must be developed, then miniaturized to be captured entirely within a monolithic chip-set that will integrate and function with the subminiature telemetry chip-set. Programmability of the chip-set is desired so that one product may satisfy many applications. Phase I of this program will begin by studying the various applications and requirements for the chip-set. It is envisioned that one or more commercial applications will be included in the requirements study. The subminiature telemetry technology must be thoroughly studied to ensure eventual compatibility. Algorithms and architectures (including those of existing products) will be studied to determine what best meets the requirements. In Phase II, one or more breadboards will be constructed and demonstrated in the laboratory, both isolated from and interconnected with a subminiature telemetry module. Miniaturization methods will be researched, compared, and recommended.

Dual Use Commercialization Potential: In Phase III, prototype chip-sets will be produced, packaged in a multi-chip module, and tested. Integration with the subminiature telemetry will be accomplished. The sponsor will demonstrate the prototype in a flight test program. At the completion of this program, the chip-set will be available for dual use in commercial applications such as communications, telemetry, and space.

AF94-208 TITLE: Sabot Design for High-Velocity Projectile Launch

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop sabot design principles for projectile testing in aeroballistics research facilities.

DESCRIPTION: The Aeroballistics Research Facility (ARF) at Eglin AFB performs tests on a wide variety of projectiles ranging from small caliber munitions to subscale missile models. Projectile velocities vary from Mach 0.4 to Mach 10. A significant amount of data is lost and substantial damage to the ballistic range occurs due to poor

sabot separation from the projectile. Experience has shown that some sabot designs work well at high velocities but perform poorly at low velocities. No criteria allowing the test engineer to properly match launch environment to sabot design presently exist. Although literature discussing sabot design for various applications exists, no systematic literature review and distillation of sabot design principles has been done. A handbook detailing sabot design principles for a wide range of launchers and launch velocities would formalize what is presently a trial and error process. Successful definition of sabot design principles could reduce lost data and prevent projectile damage to range equipment. Phase I includes an in-depth search for sabot designs required to identify concepts for aeroballistic testing. As a result of this search a preliminary set of design guidelines will be determined. Phase II includes building and testing various sabot designs to validate preliminary design guidelines developed in Phase I. A test program will be carried out to develop design principles for concepts identified for further research in Phase I. The second phase should produce a sabot design handbook based on analysis of literature and the Phase II test program.

Dual Use Commercialization Potential: A better understanding of sabot design and application will allow more complex and fragile models to be tested in interior ballistic ranges. Well designed sabots will allow approximation of aerodynamic properties of new aircraft and missile configurations from scale models fired in the ballistic range. Many configurations can be quickly and inexpensively evaluated prior to expensive wind tunnel testing of larger instrumented models. Improved sabot technology will make the interior ballistic range an important aircraft and missile design tool which will pay-off for the commercial aerospace industry. Possible joint programs between the Air Force and industry may develop in this area.

AF94-209 TITLE: Solid State Flight Data Recording

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Investigate design architectures exploiting high density packaging of random access memory circuits to provide transient recording of high speed digital data.

DESCRIPTION: This area of research will exploit advances in high density/low power random access memory and 3-dimensional integration via high density interconnect. The goal is to achieve a data cache that can support data rates of 15 gigabits per second. The driving requirement is to develop a modular approach for the memory packaging and input/output support circuitry that can be used in embedded telemetry systems, survivable event records (fuze-well), and for high speed imagery/electronic signal recording. For instance, parallel output image sensors are under development for infrared and visible imaging which have 2 to 64 outputs with pixel rates up to 50 MHz each, and dynamic range of 4 to 16 bits per port. A typical requirement for this type of sensor entails several channels of data flowing in at 10 to 15 gigabits per second with a total storage requirement of from 1 to 10 seconds. The driving requirements for this technology are density (10 seconds in less than 150 cubic inches), power, and cost comparability to current instrumentation recording technologies. The other main requirement is to survive the high G shock environment of a weapon penetration through a target or launch from a gun barrel. Phase I should consist of an architectural design considering several commercial approaches for Multi-Chip Module (MCM)/Laminated Substrate or other high density integration of memory devices. Producibility aspects will be considered as well as unit cost. Deliverables will be designs, simulations, samples of the system components, and proposals to bread/brassboard modules into candidate demonstration systems in Phase II. Phase II will refine the proposed designs from Phase I and fabricate medium density breadboard and limited capability brassboards for actual environmental and operational testing. Sensor acquisition front ends will be adapted in Phase II to provide proof-of concept for eventual Phase III customers.

Dual Use Commercialization Potential: Phase III will develop and package modules for customer specific technical applications in sensor data and weapon performance recording as well as commercial applications in high

performance computing, telecommunications, entertainment and environmental monitoring.

AF94-210 TITLE: Remote Holographic Interferometry System (RHIS)

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Produce remote holographic interferograms of outdoor dynamic events involving weapons test.

DESCRIPTION: Great progress has been made by the holography community in developing pulsed holographic interferometry. This remote holographic interferometry system (RHIS) should provide high resolution holograms and interferograms. To produce an interferogram, an initial hologram must be produced of the test arena with no disturbances. Next, a second exposure must be made of the test arena while an actual event is occurring. This provides a true 3-dimensional view of the event and the capability to observe fragments (formation and impact), projectiles (missiles), and structures (impact damage). The interferogram results from combining the undisturbed hologram with the distribute hologram of the same interest field. The fringe patterns on the interferograms provide important flow diagnostic information around projectiles and fragments. It also shows the stress and strain of impact between projectiles and structures. This system is needed to produce holograms and interferograms in the following areas: projectiles (missiles) striking large concrete and/or steel structures; detonation of shaped charges and warheads; and other explosive events at test ranges. Phase I of this SBIR task is to design potential techniques to apply this technology to outdoor testing facilities where the test equipment is located beyond lethal range. The task will provide a preliminary system design, proof of principle tests, and recommendation of a candidate approach to be demonstrated in Phase II. Phase II is expected to produce a prototype to demonstrate the outdoor feasibility and resolution of the holograms and interferograms. This task will also develop a quantitative data reduction package.

Dual Use Commercialization Potential: Phase III is expected to package the prototype from Phase II. This Remote Holographic Interferometry System can ultimately be manufactured and can be used on all DOD test ranges and for commercial structural and vehicle testing.

AF94-211 TITLE: Active RF Microwave/Millimeter Wave Raw Data Fusion

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Exploit data fusion techniques for an active microwave and millimeter wave RF multi-sensor seeker.

DESCRIPTION: Multi-sensor raw data (signal level) fusion offers the potential to enhance detection performance of missile seekers for air targets in clutter and in countermeasures. This data fusion technique leads to a new system that fuses the sensor observations before declaring a detection and provides for full integration of each sensor observation. Fusing of dissimilar sensor data from millimeter wave and infrared sensors has already shown a wide variety of improved gains over varying environmental conditions - from 10 decibels (dB) in correlated clutter conditions to less than a tenth of dB in other conditions. Similar improvements are anticipated for raw data fusing of active RF microwave and millimeter wave sensors. Present solutions to overcome these difficulties are too inflexible to be generally adaptable to a large number of scenarios and applications. An artificial neural network can increase the efficiency of correlation and track fusing of multisensors by being independent of any explicit data

processing algorithms and "learning" the algorithms. Application of an artificial neural network to raw data fusion of similar and dissimilar sensor data should also improve their fusing efficiency. A neural network's flexibility and adaptability to accommodate operational variances for many conditions and targets may significantly enhance the success of raw data fusing of a microwave and millimeter wave sensor suite. Phase I of this SBIR program includes identifying artificial neural network systems appropriate for this data fusion task. If appropriate, an abbreviated artificial network will be developed to demonstrate the concept. Detailed analysis of candidate friendly air target signatures and phenomenology, observational conditions, and microwave and millimeter wave sensor's characteristics will be done leading to the development of processing parameters and a raw data fusion algorithm to dictate a design and an implementation. Phase I will culminate in a non-real time demonstration of the implementation of a raw data fusion algorithm using an artificial neural network with several synthetic generated microwave and millimeter wave multi-sensor data sets. Phase II of this SBIR program will develop and fabricate a real time artificial neural network to demonstrate this raw data fusion implementation. A large number of synthetic microwave and millimeter wave data sets will be generated for training sets to teach the network.

Dual Use Commercialization Potential: A demonstration of commercial applications of this technology such as in smart vehicles, transportation routing, commercial space and commercial air will take place in Phase III. A commercialization plan will be required in Phase II.

AF94-212 TITLE: Diode Laser for Use in Low Cost Laser Radar Applications

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Laser, Optics and Power Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a diode laser to be used as the source of a low cost eye safe laser radar system.

DESCRIPTION: Current laser radar systems have experienced a great deal of success using solid state media as the laser's source. Diode lasers have been considered as a source in an effort to reduce the cost and weight of these systems. Currently diode lasers with wavelengths longer than 1.4 micrometer have limited peak power and poor beam quality. The goal of this program is to design and develop a diode laser and associated driver circuitry with high peak power, high pulse repetition frequency (PRF), and good beam quality. To lower the cost of the overall laser radar system the laser should operate in the 1.4 to 26 micrometer region. This will allow room temperature detectors to be used in the system. A line width of less than 4 nanometers is required. The pulse repetition frequency should be at least 5 kilohertz, preferably higher. We are interested in approaches that result in good beam quality as compared to master oscillator power amplifier (MOPA) configurations used in GaAlAs devices. Phase I of this SBIR task is to conduct a search of potential materials that could be used to make the diode laser that will meet the above criteria. A preliminary design of the diode laser will be presented. Phase II of the SBIR is to manufacture and deliver three diode laser and driver units from the Phase I design. Additionally, a unit production cost estimate will be accomplished to demonstrate that the diode laser is a low cost alternative to diode pumped solid state lasers.

Dual Use Commercialization Potential: Commercial applications of this technology will also be pursued during Phase II. Many possible areas of application exist such as control systems, low cost commercial radar (both airborne and ground based), and medical applications. A commercialization plan will be required in Phase II.

AF94-213 TITLE: Composite Weapon Technology

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop reliable composite weapon production and inspection processes and repairability methods

DESCRIPTION: Before composite materials will be fully accepted and utilized in future weapon systems, it is imperative that quality control issues, such as process repeatability, process controllability, non-destructive inspection, environmental
susceptibility, and repairability issues be defined and designed into future systems. Previous technology programs have ' ionstrated the potential of composite materials to lower the weight and cost of systems. Up to a 30 percent savings in cost and weight is achievable through application of composite materials rather than metal. However, variances in production tolerances, uneven wet-out, and temperature control has resulted in varying strength and stiffness properties. Also, uncertain susceptibility to environmental conditions, and undefined methods for non-destructive evaluation and repairability, prevent composite materials being readily used for production of weapon airframes. Phase I of this program will include design and development of techniques to eliminate the problems associated with production, inspection, environmental exposure and repairability of composite weapon airframe components. Phase II of the program will implement the techniques of Phase I through production of prototype major weapon components such as uppershell, lowershell, or dispense tubes. Selected NDI/NDE techniques, quick repair methods, and accelerated environmental test will be used to demonstrate process improvement.

Dual Use Commercialization Potential: Commercial Phase III payoff will transition this technology to the automotive, aircraft and boat manufacturing industries. A commercialization report will be required in Phase II.

AF94-214 TITLE: Weapon Design Optimization

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop weapon shaping optimization methods employing interactive techniques or optimal control theory.

DESCRIPTION: Designing aerodynamically advanced weapon airframes is often a trial-and-error process involving wind tunnel testing on a variety of candidate configurations. This process is very long and tedious and also quite expensive. Traditional theoretical optimization methods use calculus of variations to solve aerodynamic shaping problems. This procedure is too cumbersome especially when applied to three dimensional, full vehicle design optimization. Interactive solution techniques involving linear and/or non-linear programming methodology offer potential to solving weapon design problems by minimizing the difference between desired aerodynamic performance and those predicted by an aerodynamic code on a configuration that is interactively determined. Of specific interest is subsonic/transonic design regime. Another potential method is using optimal control theory to optimize vehicle design. Traditionally used in missile autopilot design, optimal control theory can be extended to vehicle design problems by changing the control and performance variables used in autopilot control schemes. Either of the techniques could be extended to other than aerodynamic optimization. They could also be applied to optimizing radar cross section performance or structural performance. Ideally, the problem could be solved from a multivariable approach that optimizes overall vehicle performance. Phase I of the program would evaluate optimization schemes as described above and select a preferred method. In Phase II algorithm development will be accomplished for the aerodynamic optimization problem, and several test cases will be evaluated. Algorithm development for radar cross section and structural optimization will be accomplished and a complete multivariable optimization code will be developed.

Dual Use Commercialization Potential: Commercial Phase III payoff will be investigated in the aircraft, automotive, and the civil engineering industry. A commercialization plan will be required in Phase II.

AF94-215 TITLE: Compact Ultra-Short Pulse Antenna for Fuzing

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a shock-survivable, compact antenna for radiating and receiving extremely transient pulses.

DESCRIPTION: It is desired to transmit and receive fast rising (less than 100 picoseconds) short duration (less than 150 picoseconds) transient pulses of electromagnetic energy. The antenna must occupy a volume of 500 cubic centimeters or less and accommodate ultra-wideband radiation effectively. The Air Force is envisioning the use of these ultra-short pulses for fuze sensing applications. Since this is an emerging immature technology, new designs quite different from many traditional antenna structures will be needed to meet the requirement. In addition to the antenna design, ' ıay be necessary to develop a sound and viable basic model to analyze and describe interactions of an ultra-short electromagnetic pulse. This model should be able to analyze and predict many observed reflection and transmission processes adequately. Only a limited number of studies describing the interaction of these pulses with solid material exist. Particularly, its reflection from the front and back interfaces of solid matter and the transmission characteristics through layers of material are of keen interest. Phase I of this program would emphasize design and modeling of the proposed antenna along with proof of principle experiments. Characteristics (size, strength, shock-survivability, operating limitations) of the proposed design should be defined. Phase II of the program will emphasize an optimization of antenna parameters, antenna fabrication, and experimental verification in the actual working environment. Any model developed should be optimized and verified with experimental results.

Dual Use Commercialization Potential: Although the Air Force is interested in this technology for fuzing applications, many commercial uses exist if the state of the art can be pushed to allow sensing to 150-200 foot depths. Geological surveys for mineral deposits would be possible. Civil engineering applications such as determining underground utilities, buried structures, building layout, and city planning are realistic. Environmental engineering applications include site surveys, locating buried waste and reclamation.

AF94-216 TITLE: High Blast Explosives

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop explosives with improved, metal-induced blast characteristics resulting from high detonation temperatures

DESCRIPTION: The military has routinely added metals to explosive fills in the form of particles, sponge, liners or follow-through to improve blast, cratering, heave, bubble energy or incendiary characteristics and other, more easily oxidized, longer reacting metals for incendiary purposes. Typical examples for the latter purpose are zirconium, both sponge and liners, titanium sponge, mischmetal liners and depleted uranium follow-through. Aluminum additive reacts with an oxidizing medium, e.g. detonation products, oxygen in the air or, perhaps, oxidizing functional groups associated with the explosive fill, to tailor the rate of energy delivery by the expanding detonation gases. Success in both blast-type and incendiary areas has been achieved, the degree of which depending on specific goals. The formation of aluminum oxide (Al_2O_3) is extremely exothermic and can effectively be used

to increase the temperature of the expanding detonation products and influence the distribution of the equilibrium products. A detrimental aspect in using aluminum is that the oxide coating associated with each particle does not slough off with increasing thickness. The primary goal of this effort is to develop an explosive fill incorporating particulate metal that provides improved air blast, cratering, or heave properties over those of existing explosives. Sensitivity to shock, fragment or flyer plate-like impact and those forces associated with hard target penetration must be minimized. Phase I would include a comprehensive search for candidate energetic materials/formulations that will cause the complete and rapid oxidation of incorporated particulate metal during detonation. This search should cover a range of conditions that may provide insight into the effective use of metal as an air-blast, cratering, or heave enhancing agent when incorporated into a specially designed explosive. Initial syntheses of new energetic materials with the predetermined characteristics should be formulated.

Environmentally friendly materials and procedures must be utilized during this development and environmentally sound demilitarization procedures should be proposed. Phase II would include synthesis/formulation work and the necessary testing to verify the new explosive as having improved blast/cratering/heaving characteristics. Issues to be addressed include performance, sensitivity, and environmental soundness.

Dual Use Commercialization Potential: Commercial applications of the explosive developed under this program will be persued. Applications include spin-off to the mining, blasting, and demolition fields. A commercialization plan will be developed in Phase II.

AF94-217 TITLE: Role of Strain Hardening on Directed Energy Warhead Performance

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Understand strain hardening during liner production and warhead formation and methods of improving warhead performance

DESCRIPTION: All metals of interest for Explosively Formed Penetrator (EFP) application experience strain hardening to varying degrees during manufacturing and penetrator formation. In order to adequately describe the constitutive equations of state used in design, it is necessary to gain a better understanding of the forming processes and input the results and knowledge gained into these equations. For example, strain hardening that occurs during tantalum liner production is known to have significant effect on the formation behavior of the warhead. If we are to understand the strain hardening process that occurs during penetrator formation, it is absolutely necessary to understand manufacturing processes. The scope of this work effort should be restricted to copper and tantalum. Phase I will result in an understanding of strain hardening during manufacturing/processing and present new and novel concepts of the role of strain hardening in penetrator formation. The final report should demonstrate both the feasibility and validity of the technical approach to integrate strain hardening effects in design and production of metal liners. Phase II will apply the newly developed concept and equations of state to predict warhead performance. A test program will be used to verify predicted improvements. The product should be a new and unique approach relating manufacturing proceses for directed energy warhead liners to design and performance.

Dual Use Commericialization Potential: Additional emphasis is placed on the utility of the resultant approach for non-DOD commercial applications. Phase III is expected to produce results applicable to related areas such as tool and die manufacturing, space vehicle, and manufacturing processes. A commercialization plan will be required in Phase II.

AF94-218 TITLE: Photoinitiated Explosives

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop an explosive photoinitiated by high intensity coherent light.

DESCRIPTION: The Air Force needs safer, less sensitive explosives. To this end, an explosive is desired that can be initiated solely by the excitation of a particular chromophore in the molecule/formulation. In principle, the explosive would be undetonable unless excited by a particular frequency and with a high intensity of light. Fuses and boosters can be redesigned for simpler operation with this technology. Perhaps a biphotonic transition could be exploited. Such an explosive, could, in principle, be simultaneously detonated throughout its volume, as contrasted with normal explosives which are initiated at one end. Phase I will be comprised of a comprehensive search for energetic materials with the appropriate electronic transitions and for photosensitizers that might be used to indirectly excite these transitions. Experiments will be designed to demonstrate the feasibility of the system. Phase II will demonstrate the practicality of the system and develop an economic analysis. Complete testing should be conducted on candidate systems. Environmental aspects of recommended systems will be documented.

Dual Use Commercialization Potential: Commercial applications for the explosive formulations will be sought. Possible applications include mining, blasting, and demolition. Photoinitiated explosives would allow safer operation in these applications. A commercialization plan will be delivered in Phase II.

AF94-219 TITLE: Narrow Band Receiver For Optical Fuzing

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Demonstrate a narrow band receiver that can track the center frequency of a diode laser as its output frequency varies over temperature.

DESCRIPTION: Optimization of the signal-to-noise ratio for optical fuze sensors is needed for the sensor to meet more demanding performance requirements. Overall sensor performance could be increased with improved optical filter/detector combinations that have more desirable operating characteristics. Optical bandpass filters are used to limit the amount of background energy that can impinge the detector elements. Two considerations when using these devices are the diode laser frequency change versus temperature and the acceptance angle of the received energy. Diode laser devices have a significant center frequency shift versus temperature when compared to the ideal bandpass filter required to optimize system signal-to-noise ratio. Active temperature control of the diode lasers is not an option; therefore, the device needed is a bandpass filter or filter/avalanche photodetector combination that can be configured to track the frequency changes of the diode laser versus temperature. A passive technique would be preferred, but active techniques that could be operational at fuze power-up (less than 50 microseconds) would be acceptable. The final technique needs to work with diode lasers that range from 800-970 nanometer wavelength and should be no larger than current interference filter techniques. Although the current acceptance angle of interference filters is adequate, a device with a larger acceptance angle would also be preferred. The Phase I program design should show feasibility of the concept and minimum package size along with baseline operating characteristics. Phase II of the program would emphasize construction of several demonstration devices and testing to show bandpass filter tracking operation over the temperature range.

Dual Use Commercialization Potential: Commercial applications for the technology developed will be sought. Possible areas of applications are space communications, optical processing, and medical instruments. A commercialization plan will be developed in Phase II.

AF94-220 TITLE: Parallel and Distributed Processing for Vulnerability Simulations

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop innovative techniques utilizing parallel and/or networked distributed processors for vulnerability simulations on workstations and PC computers.

DESCRIPTION: Weapon lethality and target vulnerability methodologies have been developed and used over the past several years to assess weapon performance. The complexity of targets, weapon delivery conditions, and a broad range of kill mechanisms lead to very large numbers of vulnerability/lethality assessments that must be performed to accurately quantify the effectiveness of a weapon or system. Presently, the Warheads Branch of the Wright Laboratory Armament Directorate has a study underway that requires 500,000 individual sub-simulations on four computers over eighteen months. The results of the vulnerability assessments are required in the weapon design/redesign process. This can only occur if the assessments are run in a timely manner. Recent developments in the computer industry might be applied to reduce vulnerability assessment run times and thus affect design decisions. The Phase I effort should characterize various platforms (including workstations and personal computers) and connectivity methods for performance criteria affecting parallelization/distribution. Computer languages such as FORTRAN 90 should be addressed. With an understanding of the class of problem (vulnerability simulations), the development and evaluation of different approaches for solving distributed parallelization should be performed. A recommendation of the best approach(es) for the determined criteria should be made and a limited prototype developed. Phase II would complete the design and development of the prototype and demonstrate its applicability. If more than one prototype is recommended because of the differences in workstations and personal computers, several will be characterized.

Dual Use Commercialization Potential: Phase III involves the commercialization of the approach(es) (less the vulnerability methodology) which, if successful, would be readily adaptable to a variety of computing environments and classes of problems. A commercialization plan will be developed in Phase II.

AF94-221 TITLE: Reagent for N-NO2 Scission

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a reagent to safely demilitarize nitramine explosives

DESCRIPTION: The Air Force has a vast inventory of nitramine based explosives (HMX, RDX, tetryl). Demilitarizing these could be a laborious, costly, and dangerous procedure. We desire a reagent to gently break the N-NO2 bond in these compounds, rendering them less dangerous or inert. Concentrated sulfuric acid can effect this cleavage (probably via protonation of the amine nitrogen and subsequent loss of nitronium ion), but it poses a serious disposal problem. The reagent of choice will be environmentally benign or readily recycled. Phase I will

be comprised of a comprehensive search and preliminary small scale screening of proposed reagents against model nitramines. The best two or three reagents will be selected for larger scale studies based on cost, efficiency, yield, and
"environmental friendliness." Phase II includes scale up to kilogram scale on the model nitramines, small scale studies on actual nitramine explosives, and development of an economic analysis of the process.

Dual Use Commercialization Potential: Phase III will scale up explosive treatment to kilogram scale and demonstrate commercial feasibility of the full scale process. A commercialization report will be required in Phase II which should outline other possible applications such as environmentally safe recycling of nitramine based compounds.

AF94-222 TITLE: Interdisciplinary Optimal Design of Advanced Missile Airframes

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Computers

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a multidisciplinary optimization scheme involving Computational Fluid Dynamics (CFD), structural statics and dynamics, heat transfer, and Radar Cross Section (RCS) analysis.

DESCRIPTION: The study of advanced missile airframes involves computer aided analysis of structural response involving statics, dynamics, and heat transfer. In addition, the low observable properties of candidate missile designs must also be taken into consideration, the primary concern being minimization of RCS. CFD is also used to compute air loads. Multidisciplinary optimization can be used to consider several effects by the use of direct or indirect methods, creating an objective function. Appropriate constraints can then be applied and the design problem can then be solved. As of now, the multidisciplinary design optimization tools for finite element analysis for structural statics and dynamics currently exist, however, there is no coherent approach for considering all relevant effects in a fully three dimensional problem. CFD can be used to give the loadings on a body in flight. Finite element analysis is the usual approach taken to perform computer oriented structural studies. A displacement oriented approach is typically used to solve for structural static and dynamic effects. Heat transfer analysis results in a temperature distribution profile and heat fluxes. RCS analysis obtains an equivalent cross section, usually measured in decibels per square meter. The technical challenge is the combination of all of these effects into one design optimization scheme which would include three dimensional effects. Phase I of this SBIR is to search for methods of optimization and identify and report on the most appropriate approach for three dimensional multidisciplinary analysis. An outline of the proposed computer code together with some working modules is expected from Phase I. Phase II of the SBIR task is expected to create a three dimensional code that can be used as a tool in multidisciplinary design studies. Shape optimization should also be considered. The code will be tested against a broad class of problems involving the design of advanced missile airframes.

Dual Use Commercialization Potential: Phase III is expected to produce a commercially acceptable code, compatible with MSC/NASTRAN finite element models. It should be capable of interfacing with a commercially available graphics pre- and postprocessor such as MSC/XL or PATRAN.

AF94-223 TITLE: Recycling of Advanced Composite Materials Used in Weapons Systems

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Determine recycling methods and applications for advanced composite materials used in weapons systems.

DESCRIPTION: Advanced composite materials are being increasingly used in weapon systems because of their strength, stealthy qualities, and other desirable characteristics. Currently, composite materials are disposed of in landfills with little regard for environmental effects or considerations for reuse. With the increasing quantities of these materials being used in munitions, the selection of materials and the recycling/reuse potential of the materials are of increased importance for environmental, waste minimization, and life cycle cost considerations. This task will involve identifying the composite materials used in weapon airframes and warheads, and then investigating and demonstrating the reuse/recycling of these composite materials in an environmentally acceptable manner. Reuse and recycling considerations for the selection of composite materials will be identified and made available to weapons designers for incorporation into new weapon system designs/technologies. Phase I of this SBIR task includes a survey of the composite materials used in weapon systems, e.g., airframes and warheads and analysis of possible approaches to recycling and secondary or alternate use strategies. Phase I will culminate with a report on the potential strategies for reuse and recycling of the various materials with the advantages and disadvantages associated with the methods discussed. The Phase I report will recommend one or more promising candidate approaches for further investigation in Phase II. Phase II will consist of further investigation and small scale demonstrations of candidate reuse and/or recycling technologies. The most promising technology(s) will be recommended for a Phase III pilot study. A recycling/reuse considerations guide for the composite materials investigated will be produced.

Dual Use Commercialization Potential: In Phase III, potential applications to industry will be identified and a small pilot plant demonstration will be conducted to further validate the most promising recycling/reuse technology(s). The knowledge gained by completing this task would be of great interest to other users of composite materials such as the automotive industry and makers of recreational equipment.

AF94-224 TITLE: Reclamation/Recycle of Depleted Uranium and Heavy Metal Alloy Residue from Soils

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Provide an environmentally safe reclamation/recycle technology for recovery of depleted uranium and heavy metal alloys from soil.

DESCRIPTION: Many thousands of tons of munitions in the Air Force inventory contain depleted uranium (DU) as a weapons component. Other uses of DU as warhead materials will generate larger quantities in the near future. In addition, other heavy metals such as tungsten and tantalum are being developed as warhead materials by the services. Contamination of the soil with DU and other heavy metals as a result of test and evaluation is a major problem within the Department of Defense (DOD) and Department of Energy (DOE). Disposal of DU in low level radioactive waste disposal sites is becoming increasingly expensive and alternatives to disposal have not been developed and demonstrated. This project will allow DU and other heavy metals from conventional munition test firings to be recovered from soils and recycled, thus avoiding burial. Cost of new materials and disposal combine to make new methods of recovering heavy metals from soils essential. The recovered materials may be used for other military or commercial applications while reclaiming the test site for unrestricted use by DOD and DOE. The goal of this task is to identify and/or develop a technology to recover DU and heavy metal alloys from soil and recycle them. The primary emphases of this effort should be removal of particle sizes less than two millimeters. The goal of this program is to reduce soil contamination to less than six micrograms of DU per gram of soil. Phase I of this SBIR will consist of an analysis of recovery/recycle methods for heavy metal alloys from contaminated soil. Methodology for recovery and recycle will be demonstrated in Phase

II. During Phase II, implementation will be demonstrated by recovering and recycling DU and other heavy metal alloys using the selected process.

Dual Use Commercialization Potential: Depleted uranium and other heavy metals can be recycled for many commercial applications such as heavy equipment counterweights, ballast in aircraft and armored cars, radioactive shielding, and as balance weights for drill collars, tool holders, and flywheels. A commercialization plan will be required in Phase II.

AF94-225 TITLE: New Approaches to Conductive Polymer Engineering

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Explore new methods for developing conductive polymers and to characterize their behavior with regard to electrical conductivity, chemical stability/compatibility, and mechanical processability.

DESCRIPTION: Past efforts in conductive polymer development have generally involved doping of available polymers to achieve non-insulating behavior. This is often accompanied by drastic changes in physical and mechanical properties. New experimentation/ theoretical approaches are needed to further develop conductive polymers to suit a broad range of applications. Starting from fundamental premises, the Phase I effort should be to develop and verify a method to create new polymers with enhanced conductivity, thermoplasticity, and chemical stability. It may be possible to understand the behavior of junctions between different conductive polymers using models applicable to conventional diode junctions. Carrier generations, Fermi levels, and optical absorption/emission are important considerations for such models. Potential end products for Phase II development are multilayer polymer film infrared sensors or photovoltaic cells and high surface area polymer electrodes for double layer capacitors.

Dual Use Commercialization Potential: Commercial applications include low cost IR sensors and low cost power sources for retail products. A commercialization plan will be developed in Phase II.

AF94-226 TITLE: Sealed Bipolar Lead-Acid Battery

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: Precision Strike

OBJECTIVE: Develop a compact lead-acid battery which does not have individually partitioned cells but instead consists of a sealed multicell stack.

DESCRIPTION: The problem of miniaturizing the standard lead-acid battery may be overcome with modern technology. Prior to the past decade it made little sense to attempt to do so, since it was thought that the individual cells themselves had to be vented; they were neither sealed nor maintenance-free. Having overcome this restriction, the present issue is how to fabricate anode and cathode back-to-back for a high energy density battery of a desired voltage. The two-terminal, or bipolar battery design must be extremely rugged and offer relatively high energy density. In addition, it must have a high degree of rechargeability and be well-suited to -55 degree centigrade operation for weapons application. The Phase I effort should focus upon development of a rugged 10-volt, 10 cubic centimeter device that is rigidly potted for subsequent high-G shock, low temperature testing. Phase II should

explore several different battery configurations of bipolar arrangement to address a variety of military and commercial applications.

Dual Use Commercialization Potential: The sealed bipolar lead acid battery would find many commercial applications such as retail products (toys and power tools) and remote sensors and/or instrumentation packages.

AF94-227 TITLE: Visualization of Circuit Card Electromagnetic Fields

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

MAJOR S&T THRUST: Technology for Training and Readiness

OBJECTIVE: Provide a means of visually observing the electromagnetic field patterns around an active circuit card.

DESCRIPTION: Create a method by which the electric and/or magnetic fields around a circuit are translated into patterns discernible with visual spectrum light. This will provide the tester with an immediate impression of what parts of the card are active, and the level of activity. It is hoped that this image can be used to train a neural network to automatically diagnose faults in a circuit card under test. Phase I will consist of research and evaluation of potential methods for providing the image of the electromagnetic fields around the card. The best result will be graded on its resolution, passivity (does not alter fields by its presence), and speed. Phase II will generate a working model of the electromagnetic imaging system, and obtain a representative circuit card, induce faults and evaluate the ability of the imaging system to detect differences in the card. The contractor will also generate a report of the effectiveness of the technology, how it can be implemented and potential improvements.

Dual Use Commercialization Potential: This technology will have applicability to all forms of circuit card testing, both commercial and within the DOD. All circuit card manufacturers use quality control testing prior to card shipment, and major electronics firms possess in house diagnostics and repair capability. The ability to "see" the electrical and magnetic fields would provide a fast means of identifying and isolating faults on most circuit cards.

AF94-228 TITLE: Development of Technologies for Environmetnal Stress Screening of Electronic Circuit Card Assemblies

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop technologies to adapt Commercial Off the Shelf (COTS) testing hardware to perform Environmental Stress Screening of electronic circuit card assemblies.

DESCRIPTION: Environmental Stress Screening (ESS) is utilized to improve the reliability of critical flight electronic hardware during its development, production, and repair life cycle process. ESS consists of functionally testing electronic hardware while applying environmental temperature or vibration stresses that simulate actual operating conditions. Currently, complex and specialized Automated Test Equipment (ATE) are the electronic stimulus and measurement equipment that functionally test these Units Under Test (UTTS). During the ESS test troubleshooting process, there are instances where this specialized ATE can fault isolate only to a group of components within the CCA. There exists Commercial Off the Shelf (COTS) ATE that can provide functional and in circuit testing of CCAs. The following requirements are needed in order to utilize COTS ATE board/component level testers in the ESS vibration and temperature testing of CCAs: (1) capability to satisfactorily perform board level and component level testing at the operating frequency range of current applications (50 MHz maximum) and

for future applications (200 MHz maximum). (2) capability to perform functional (board level) testing and in circuit (component level) testing, both with learning capability. (3) capability to properly interface the CCA to the COTS ATE and COTS ESS hardware during ESS testing without affecting performance measurement testing of the CCA, while providing the above board level and component level testing requirements. Phase I will determine the feasibility of adapting and developing interface requirements and test procedures for a jet engine controller digital microprocessor CCA of medium frequency range (less than 20 MHz) operating with and existing Government Furnished Equipment (GFE) COTS digital tester and existing GFE COTS ESS hardware and identify those COTS tester and ESS hardware and interface requirements with the greatest potential success for current (50 MHz maximum) and future (200 MHz maximum) applications. Phase II will demonstrate the concept by acquiring the integrating COTS tester and ESS hardware and developing the interface requirements for a COTS tester and ESS hardware. Test this concept under government approved acceptance test procedures.

Dual Use Commercialization Potential: The Development of Technologies for Environmental Stress Screening (ESS) of Electronic Circuit Card Assemblies has direct and immediate dual use commercial potential through the introduction of Commercial Off-The-Shelf (COTS) Automatic Test Equipment (ATE) in ESS applications. This SBIR project would have application for many DOD or commercial critical flight and field electronic hardware during its development, production, repair, and testing life cycle. This would serve to significantly reduce the cost of replacing existing obsolete ESS test equipment with faster, lower cost, and easier to maintain COTS ATE.

AF94-229 TITLE: Remote Determination of Composite Chemical Characterization

CATEGORY: Basic Research

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop fiber optics for chemical characterization of composite cure process in an autoclave.

DESCRIPTION: Future high performance aerospace vehicles will use composite materials extensively. Composite material costs are very high (greater than $20 per pound in the raw state and as much as $1000 per pound in a finished product). If the curing process fails, the composite must be scrapped. The development of using fiber optics in conjunction with Fourier Transform Near Infrared Raman spectroscopy is needed to allow the actual monitoring of the chemical reactions within the composite material during the cure process. If an optical fiber can be inserted into the raw composite material, then the Raman spectrum could be accumulated in real time, thereby increasing material cure reliability and efficiency.

This remote sensing technique could be used to monitor the material while curing which laboratory. Thus, provide a chemical characterization of the material while curing which would eliminate the high costs resulting from scrapping material due to improper curing. The insertion fo fiber optics into composite materials at critical stress point might also be used to monitor the internal stresses and condition of the material throughout its service life. Phase I effort will involve analysis of the theoretical background of the concept along with preliminary experiments and tests to clearly demonstrate the feasiblity of the proposed remote characterization of composite materials. Phase II will consist of the development, test, and analysis of a prototype system.

Dual Use Commercialization Potential: One use is to improve the yield rate and the useful lifespan of composites during the production of commercial aircraft. Recent studies have indicated that good use of composite products is to repair aging aircraft. So, one of the most important possibilities for process would be to allow field "patching" of corroded aircraft. Typically the failure rate of field applied composites is too high for good commercial utilization.

AF94-230 TITLE: Mass Producible, High Intensity, Subminiature, Infrared Emitters/Sources

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Develop the techniques required to mass produce low-cost, subminiature, high-intensity infrared sources.

DESCRIPTION: The Air Force, as well as the other services, has been developing techniques to test and evaluate infrared guided weapons by laboratory simulation. A testing method has been developed that requires a rectangular array of 64,000 to 1,000,000 subminiature infrared sources or emitters. Each DOD facility that employs this testing methodology will require an array of thousands of these emitters. The goal of this effort is to develop the components necessary to permit implementation of this method of generating real world equivalent infrared scenes. The emitters technical challenge is to successfully meet the following criteria: (1) Mass producible, orders for lots of 10,000 to 1,000,000 emitters would be typical; (2) low cost, a per bulb price of less than $1; (3) high intensity infrared output, a radiant intensity of 2.0 to 7.0 with sr measured in the 4 to 5 micron band; (4) short thermal time constant, less than 30 milliseconds; and (5) subminiature size, size same as and plug in replacement for the subminiature JKL-7376 bulbs currently on the market. Phase I of this SBIR task is to develop the required technology. Phase II of this SBIR is to further refine the emitter performance and to deliver a set of at least 300,000 bulbs, all meeting the technical requirements. The set of bulbs delivered in Phase II will be delivered in reproducing infrared video scenes from a source of RF-170 (gray scale) composite video.

Dual Use Commercialization Potential: Large arrays of these emitters will be used to evaluate air superiority and defensive systems from prelaunch through terminal impact. Potential commercial applications include precise temperature control for closed systems and convert illumination of high security areas.

AF94-231 TITLE: Laser Photography of Explosive Events

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Munitions Devices and Energetic Systems

MAJOR S&T THRUST: More Efficient Acquisition

OBJECTIVE: Exploit development in laser technology to design and develop a system to photograph explosive events.

DESCRIPTION: Over the last several years, the use of laser photography has been demonstrated in laboratory environments to record events for which, historically, only photography using chemical bombs for the light source has been possible. This has been done by examining the spectrum of photon emissions from the event and finding the portion of the event where the intensity level is low; selecting a laser which operates in this range; filtering a camera (or using a film which is responsive) in this range; and conducting the test. This task will transfer this technology from a laboratory environment to a standard test environment. The associated technical challenges will be many. The spectrum of the event may be broad and the intensity may be high across the frequency range. The system will need to be robust; able to survive the blast environment, able to operate in an outdoor climate, including dust, dirt, rain, humidity, etc. The cameras used will have to be those with demonstrated reliability in this environment. The laser system used will have to be those with demonstrated reliability in this environment. Phase I of this SBIR task is to conduct a survey of the current technology in this area, analyze the spectrums of various explosive events, recommend the materials needed for a full-scale demonstration in Phase II. Phase II of this SBIR

task will be to demonstrate the method defined in Phase I during actual operational tests at the 46 Test Wing. This demonstration/redesign phase will include evaluations involving different types and sizes of explosive events to fully understand the capability of the system.

Dual Use Commercialization Potential: Dual use potential will be primarily in fields where explosive devices are used, such as the oil and mining industries.

AF94-232 TITLE: Contaminated Soil Remediation Utilizing Photolectric and Thermal Energy

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Chemical and Biological Systems

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Design and develop soil remediation cell which uses photoelectric energy and thermal convection.

DESCRIPTION: With the many recent technological advances in remediation of petroleum contaminated soils and more efficient photoelectric cells, the development of solar powered blowers and thermal convection to inject a controlled air flow of variable temperature into specially designed cells should now be viable. This task is to integrate existing technologies with the development of components needed for construction of 360-degree containment remediation cells that rely totally upon ambient energy storage. A constraint to the design is compliance with all applicable state and federal regulations. Phase I of this SBIR task is to design a permanent cell of approximately 1 X10-6 permeability that will contain 150 cubic yards of petroleum contaminated soil. This cell should be capable of homogeneous flow of air, yet any integral piping within the cell must be easy to disconnect as soil is removed. A convection oven would be connected in line with the blower influent line. By adjusting the rate of flow for the two parameters, the system could be used for hot-air injection, bioremediation, or combined technologies. The entire system must be ruggedly constructed, with an easily removable covering, and capable of being entered by heavy equipment. Phase I will culminate with the recommendation of a candidate system at Eglin's Receiver Landfill. Phase II of the SBIR task will be to construct a prototype cell according to design and to evaluate the remedial efficiency of the cell.

Dual Use Commercialization Potential: Petroleum contamination is the most widespread form of pollution affecting soil. With most large industries chronic discharge is inevitable, therefore commercialization of these systems provides an environmentally friendly form of remediation with no waste stream.

AF94-233 TITLE: Automatic Sensor Distinguishing between Biological and Petrochemical Fuels

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an Automated sensor which can shutdown fluid-flow systems (local and remote) when dangerous levels of "foreign" combustible fluids are detected.

DESCRIPTION: Currently, illegal disposal of highly flammable and toxic petrochemical fuels into fluid flow channels causes a mission threat, as well as a health and safety danger. The development of a sophisticated sensor system which can distinguish between biological and hydrocarbon fuels would allow identification of these dangerous situations to insure compliance with Code of Federal Regulation 40CFR. The sensor must be capable of surviving in harsh environments and contain an output capable of driving a servo system to shut down control systems and

activiating an alarm system would alert disaster preparedness and environmental emergency response teams for rapid response and quick resolutation of the emergency. Phase I define the characteristics of hazardous chemicals to be detected and determine the feasibility of sensing levels of these chemicals in the presence of biological material. Phase II would develop a sensor and demonstrate the capability of detecting petrochemicals in fluid flow channels in concentrations of less than 1 part per million.

Dual Use Commercialization Potential: This sensor would have application in all major cities and manufacturing facilities for safety and early detection of dangerous conditions.

AF94-234 TITLE: Treatment of Technologies for Dioxin Contaminated Soils

CATEGORY: Basic Research

DOD TECHNOLOGIES: Chemical and Biological Systems

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop an innovative treatment technology and disposal technique for the treatment of Dioxin contaminated soils.

DESCRIPTION: Tetrachlorodibenzo-p-dioxin (TCDD) is produced in small amounts as an impurity used in the manufacture of herbicide compounds and products. Other known uses are for tests for flame-proofing polyesters and a method for control of insects and wood destroying fungi. However, at the present time, its primary use is in chemical research. This task is to develop an innovative treatment technology and disposal technique to eliminate dioxins from a particular location. Treatment technologies are generally defined as processes able to change or destroy contaminated materials so they are less hazardous or are no longer hazardous. Immobilizing dioxins can also be developed as a viable costs effective treatment solution. However, technical methods should be investigated first for recovery or removal such as incineration at high temperatures, oxidation destruction with the aid of a catalyst, biodegradation by fungus, photochemical destruction, and/or stabilization. Phase I of this SBIR task is to conduct a survey of existing dioxin remedial applications and techniques, in addition to exploiting new treatment technologies for recovery and removal of dioxins. Potential technologies should be reported and should include preliminary designs, advantages, disadvantages, and estimated costs for development. Finally, the Phase I task will result in a recommended concept based on research documentation and the evaluation needed to prove feasibility, including a candidate approach to be demonstrated in the Phase II task. The Phase II SBIR is to develop a treatability pilot-test to evaluate the recommended treatment technologies potential for success.

Dual Use Commercialization Potential: Development of a treatment/disposal technique for the elimination of dioxins from contaminated sites has application in many industrial, as well as military, locations.

AF94-235 TITLE: Simulation of Dynamic Angle of Arrival Signals for Intercept Radars

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Sensors and Electronic Combat

MAJOR S&T THRUST: Air Superiority and Defense

OBJECTIVE: Develop an intercept radar stimulation system for evaluating directional finding capabilities in an anechoic chamber.

DESCRIPTION: Increasing emphasis is being placed upon the capabilities of modern, airborne intercept radars with electronically steered arrays to passively locate and track other aircraft with a high degree of accuracy. This supports the need for test methods and systems capable of quantifying the performance of these radars in measuring

angles of arrival for target signals under a variety of conditions. Completed studies and analysis attest to the feasibility of using signals with phase/amplitude variations from stationary sources in ground test facilities to create apparent changes in angle of arrival to a radar system under test. These techniques must be tried with real avionics components or respective emulation in a typical ground test configuration and subsequently a test guide/report and system description should be written that details the design used and approaches taken with their respective applicability and limitations. The radar field of view to be considered for the tests should be no more that 90 degrees horizontally and 60 degrees vertically. Phase I will design and develop a test system. Phase II would demonstrate a prototype system in the Benefield Anechoic Changer at Edwards AFB CA.

Dual Use Commercialization Potential: The technology of signal phase and amplitude control techniques developed for this project have application to commercial communication and television systems which employ satellites and narrow beam antenna systems.

ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out ARPA's SBIR Program rests with the Office of Administration and Small Business. The ARPA Coordinator for SBIR is Ms. Connie Jacobs. ARPA invites the small business community to send proposals directly to ARPA at the following address:

ARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448

The proposals will be processed in the Office of Administration and Small Business and distributed to the appropriate technical office for evaluation and action.

ARPA has identified 86 technical topics, numbered ARPA 94-001 through ARPA 94-086, to which small businesses may respond in the first fiscal year (FY) 94 solicitation (94.1). Please note that these are the only topics for which proposals will be accepted at this time. Proposals can no longer be accepted on those previously advertised 87 technical topics which were numbered ARPA 93-033 through ARPA 93-119. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. The topics originated from ARPA technical offices.

ARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the ARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow. In the early years of the SBIR program most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. ARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II awards are limited to $375,000; however, additional funding may be available for optional tasks.

ARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, ARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the ARPA mission. As a result, ARPA may fund more than one proposal in a specific topic area if the technical quality of the proposals in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to ARPA must have a topic number and can only respond to one topic.

ARPA has prepared a checklist to assist small business activities in responding to ARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to ARPA. Do not include the checklist with your proposal.

ARPA 1994 Phase I SBIR

Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______
   b. Project Summary - Appendix B ______
   c. Identification and Significance of Problem or Opportunity ______
   d. Phase I Technical Objectives ______
   e. Phase I Work Plan ______
   f. Related Work ______
   g. Relationship with Future Research and/or Development ______
   h. Post Potential Applications ______
   i. Key Personnel ______
   j. Facilities/Equipment ______
   k. Consultants ______
   l. Prior, Current, or Pending Support ______
   m. Cost Proposal - Appendix C
   n. Prior SBIR Awards

2) Bindings

   a. Staple proposals in upper left-hand corner. ______
   b. <u>Do not</u> use a cover. ______
   c. <u>Do not</u> use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 25 pages inclusive of cost proposal (Appendix C) and resumes. ______
   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

4) Submission Requirement for Each Proposal

   a. Original proposal, including signed **RED** Appendices A and B. ______
   b. Four photocopies of original proposal, including signed Appendices A and B. ______
   c. One additional photocopy of Appendices A and B only. ______

SUBJECT/WORD INDEX TO THE ARPA SBIR SOLICITATION

Subject/Keyword	Topic Number

Subject/Keyword	Topic Number

INDEX OF ARPA FY 94 TOPICS

ARPA 94-023	Prototype Implementations of Scalable High Performance Computing (HPC) Software
ARPA 94-024	Smart Materials and Structures Technology for Hydrodynamic and Aerodynamic Vortex Control
ARPA 94-025	Intelligent Low Cost Processing of Titanium Based Continuous Filament Metal Matrix Composites for Propulsion Application
ARPA 94-026	Affordable Manufacturing Processes for Ceramic Fibers
ARPA 94-027	In-Situ Composites for High Temperature Structural Applications
ARPA 94-028	Wavelet-Based Methods for Information Processing in Communications Systems
ARPA 94-029	Novel Methods for Automatic Target Detection and Recognition
ARPA 94-030	Laser Applications in Medicine
ARPA 94-031	New Concepts and Applications of Binary Optics
ARPA 94-032	Plasma Processing of Materials in Microelectronics and Photonics
ARPA 94-033	Advanced Battery Technology
ARPA 94-034	Development of Non-Invasive Sensors of Biomedical Vital Signs and Body Chemistry Based Upon High-Temperature Superconducting Devices
ARPA 94-035	Exploitation of Novel Thin-Film Materials Such as Ferroelectrics, Ferrites, and High Temperature Superconductors (HTS), for Microelectronic Circuitry
ARPA 94-036	Development of Sensors for High-Resolution Imaging Systems with Applicability to Medical and Nonmedical Structural Issues
ARPA 94-037	Biomedical Technology
ARPA 94-038	Computer Aided Modeling of Millimeter-Wave Frequency Monolithic Integrated Circuits (IC)
ARPA 94-039	3-D Electromagnetic Simulation of Microwave and Millimeter Wave Multi-Chip Packages and Sub-Arrays
ARPA 94-040	Development of Quasi-Optical Circuits for Millimeter-Wave Frequency Operation
ARPA 94-041	Cost-Effective Multi-Chip Integration Technologies
ARPA 94-042	Multi-Chip Module (MCM) Application Development
ARPA 94-043	Real Time Printing of Fine Line Patterns on Printed Wiring Boards
ARPA 94-044	Sensor Fusion Using Neural Networks, Fuzzy Logic Systems and Parallel Processing Techniques
ARPA 94-045	Low-Cost, Real-Time Image Processing
ARPA 94-046	Noise Abatement
ARPA 94-047	Advanced Fiber Winding and Design Techniques
ARPA 94-048	Development of Ultra-Miniature Fiber Sensing Coils for High Accuracy Fiber Optic Gyroscopes

ARPA 94-049	Lateral Storage and Loss Moduli of Optical Fibers Under Line Contact Loads
ARPA 94-050	Development of Magneto-Optical Spatial Light Modulator Using Rewritable Optical Disk Technology
ARPA 94-051	Covert Ultra-Wideband Radio Frequency (RF) Data Link
ARPA 94-052	Moving Signal for Highway Safety Under Obscured Conditions (Sensor/Beacon)
ARPA 94-053	Reconfigurable Ocean Structures, Including Materials, Joinery, Propulsion, Generators, Automation, and Robotics
ARPA 94-054	Acoustic Lenses for Affordability in Sonar and Bio-Medical Applications
ARPA 94-055	Novel Actuation Schemes to Convert Various Forms of Energy into Proportional Mechanical Outputs for Servo-Controlled Applications
ARPA 94-056	Use of Advanced Compression Techniques to Transmit Video-Based Products Via Very Small Bandwidth Satellites and Twisted-Pair Circuits
ARPA 94-057	Non-Invasive Communication with Embedded Sensors in Composites
ARPA 94-058	Automatic System Identification Techniques and Micromechanical Sensors and Actuators for Active Vibration and Noise Control in Precision Fabrication
ARPA 94-059	Chaotic Modeling for Supply and Inventory Management and Command Center Message Traffic Management (Chaos in Distributed Systems)
ARPA 94-060	Sensors and Control Systems for Intelligent, Flexible Manufacturing of Electronics
ARPA 94-061	Etching of Complex Oxide Thin-Films
ARPA 94-062	Focused Ion-Beam Deposition of Nano Structures
ARPA 94-063	On-Chip Processing for Multi-Spectral Imaging Sensors
ARPA 94-064	Process Control for Lithography
ARPA 94-065	Lattice Matched Substrates for Long Life, Reliable Semiconductor Diode Lasers
ARPA 94-066	Design of Hybrid Neural Network/Digital Computer Architectures
ARPA 94-067	Compact, Mobile, Air Sampling Equipment for Rapid Deployment as an Air Pollution or Weapons of Mass Destruction (WMD) Monitoring System
ARPA 94-068	Multi-Dimensional Visualization of Data to Identify Seismic Events or for Other Complex, Multi-Dimensional Data Problems
ARPA 94-069	Innovative Techniques for Delivering Power Via Fiber Optical Links for Cooling, Signal Conditioning and Signal Processing Devices
ARPA 94-070	Small, Compact, Highly Linear Analog-to-Digital (A/D) Converters With Power Supplies
ARPA 94-071	Analysis of Low Grazing-Angle Forward Scatter Data from the Mountain-Top Propagation Experiment
ARPA 94-072	Techniques to Reduce Fiber-to-Fiber Optical Insertion Loss in Gallium Arsenide (GaAs)

ARPA 94-073	Airborne Surveillance Radar Detection, Tracking and Handover Concept Demonstrations
ARPA 94-074	Real-Time Processor Packaging Concepts for Tactical Missiles
ARPA 94-075	Verification and Validation of Distributed Artificial Intelligent
ARPA 94-076	Application of Self-Referential Logics and Related Mathematics to Autonomous Systems and Interactive Environments
ARPA 94-077	Planning and Decision Aids: Decision Theory-Based Economic Analysis
ARPA 94-078	Voice Recognition for Identity Monitoring and Validation
ARPA 94-079	Spatial/Semantic Database
ARPA 94-080	Image Understanding Architectures Suitable for Hybrid Neural Net/Conventional Computers
ARPA 94-081	Common Automated Test Systems (ATS) for Factory and Field Use
ARPA 94-082	Spoken Language for Hands-Free Applications in Health Care
ARPA 94-083	Simulation Query Languages
ARPA 94-084	Software to Acquire Remote Objects
ARPA 94-085	Hand-Held Computing for Highly Mobile Use
ARPA 94-086	Low-Cost Virtual-Reality Environments

ARPA 94-001 TITLE: High Information Rate High Frequency (HF) Radio Link as an Extension to ATM/SONET for Supporting Integrated Services Digital Network (ISDN)

CATEGORY: 6.2 Exploratory Development; Telecommunications

OBJECTIVE: Develop, simulate, and test, in on-the-air real time, modulation, coding and beam forming algorithms, and protocols necessary to interoperate an HF radio link with an Asynchronous Transfer Mode/Synchronous Optical Network (ATM/SONET) backbone supporting ISDN or broadband ISDN (B-ISDN) applications.

DESCRIPTION: The HF band (2-30 MHZ) is of interest to military and commercial mobile users because it is one of the few propagation media, along with meteor burst and satellite, that, with modest equipment size and power, can support beyond line-of-sight (BLOS) communication over 1800 kilometers (km) without intermediate relays. One of HF's unique characteristics is that it can propagate over hundreds of kilometers with little more than distance-squared spreading losses. Although HF is generally used as a narrowband channel, it has been known for some years that HF can theoretically support information rates almost as high as an otherwise equivalent non-fading white Gaussian noise channel. To realize high rates at HF, however, the energy from multiple paths must be efficiently used, and undesired directional signals or external noise must be reduced to near-thermal levels. In order to support modern integrated voice and data services applications, the link must be automatically managed to cope with the ever-changing ionosphere and to efficiently control errors. Interfaces with an ATM/SONET backbone network must be transparent to the user of the application. The goal of this SBIR is to demonstrate at least an order of magnitude or greater information rate improvement over conventional HF radio using a path that is at least 1600 km long. The goal rate is 64 Kbps. Another goal is to demonstrate transportable BLOS HF radio extension to an ATM/SONET backbone network using ISDN or B-ISDN standards. Applications for high rate HF include emergency long haul communication to support disaster relief to manage crises, and to link remote operations centers with a corporate network. High rate HF also supports inter-echelon communication in a battlespace. In all potential applications, remote sites can be on land or on ships at sea.

Phase I: Identify the design approach, algorithms and signal processors, and radio frequency (RF) equipment needed to achieve reliable use of the HF channel at rates up to 64 Kbps and to support near-seamless ISDN/B-ISDN interfaces. Analyze or simulate the performance of the proposed design over a variety of sunspot numbers, interference, and channel conditions. Produce a final report on the approach and results of the analysis/simulations. Prepare a cost/performance trade-off study comparing the 5-year operating cost of a high rate HF link compared to commercial alternatives for linking remote or mobile stations with an ATM/SONET backbone.

Phase II: Select and acquire the real time signal processing equipment. Implement the signal processing and beam forming, and link and network algorithms in digital signal processors and/or general purpose computers to run in real time on a simulated channel. The channel should be sufficiently complex so as to stress the performance limits of the system, but the channel need not be a general purpose channel simulator. Prepare a final report on the test results, including an analysis of the performance of the system design in the simulated channel. Identify and analyze significant differences between predicted and actual performance, and identify corrective design actions.

COMMERCIAL POTENTIAL: The use of HF to link remote, mobile, or land-based nodes to an ATM/SONET network recognized for crisis management, emergency communications, or as a cost-effective and/or private alternative to existing commercial satellites.

ARPA 94-002 TITLE: Modulation and Coding Concepts to Achieve Jamming Suppression for High Data Rate Global Grid Communications

CATEGORY: 6.2 Exploratory Development; Communications Networking

OBJECTIVE: Investigate and demonstrate innovative methods of modulation and coding for high data rate Global Grid communications in jamming environments. Evaluate the performance of these methods in suppressing various jammer effects.

DESCRIPTION: Global Grid is a concept for a future global communications infrastructure serving the full complement of DoD communications needs. To satisfy this concept, Global Grid will encompass services for both fixed users, such as those provided

by a fiber optic grid, and for mobile and tactical users. These untethered mobile users must gain access to the fiber grid, primarily through radio and satellite links, to exchange data and function as a part of a joint operating force. To achieve full operational effectiveness, high data rate service will be needed to exchange a variety of mission-related information. Satellite links have a unique value in being able to interconnect isolated cells of forces with no restrictions on operating range. However, satellite links can be vulnerable to a variety of jammer types and jammer power levels. Of particular interest are tactical threat level jammers. Modulation and coding techniques have been developed and implemented to enable operation of satellite links at low and medium data rates in the presence of jammers. The evolving applications of untethered users to be served by Global Grid will require reliable communications at data rates greater than 1.544 Mbps. This research is to investigate and develop innovative modulation and coding methods that are effective in permitting operation of satellite links with low bit error rates at data rates greater than 1.544 Mbps in a variety of jamming environments. The investigator will evaluate proposed modulation and coding techniques for performance against a variety of jammer types and levels. The investigator will also identify feasible data rates at selected jammer power levels. Proposed methods that provide sufficient performance improvement over methods currently in use or currently being implemented will be considered for further development and implementation. If this development is successful, opportunities will exist to incorporate implementations of these methods into the next generation of military satellite terminal equipment or upgrades of existing military equipment to support expanded capabilities of satellite communications in the Global Grid.

Phase I: Identify and describe proposed modulation and coding methods and perform a theoretical analysis of the performance of those methods in a jamming environment. Performance, in terms of the maximum feasible user link data rates, will be estimated for a representative sample of jamming signal types and power levels. Satellite, earth terminal, and jammer capabilities and constraints used in the analysis will be identified. The investigator will compare the results obtained with the results achievable using existing or planned modulation and coding methods.

Phase II: If the performance improvement of the proposed method over existing methods is sufficient, determine the feasibility of implementing the proposed method and demonstrate a prototype capability. This portion of the research will include development of functional algorithms and may include development or modification of equipment items or software. The implementation should be developed to a sufficient level of prototyping to demonstrate the methods proposed and to verify that the methods can achieve the estimated performance levels.

COMMERCIAL POTENTIAL: This work may lead to modulation and coding techniques that could support multiple access protocols for commercial systems, analogous to the relationship of commercial CDMA techniques and military spread spectrum techniques.

ARPA 94-003 TITLE: <u>Adaptive Intelligent Signal Processing Concepts for Identification and Exploitation of Spectral Signatures in Communications Systems</u>

CATEGORY: 6.2 Exploratory Development; Communications Networking

OBJECTIVE: Investigate and demonstrate concepts for using adaptive signal processing techniques to identify and exploit radio frequency (RF) spectral signatures used in communications systems.

DESCRIPTION: Modulation and coding techniques used for RF transmissions vary within and between frequency bands. These differences prevent direct interoperability between users with different equipment or missions. To overcome these differences, interoperability is traditionally established by using multiple sets of equipment, interchanging equipment modules, or routing traffic through gateways to translate protocols and signals. Limited capability interoperable modes of operation are being introduced as new types of equipment are fielded. These techniques generally will not provide acceptable levels of performance and capacity to future untethered users of the Global Grid communications infrastructure. These users must be able to communicate, without prior knowledge of local network capabilities and directly with other mobile users, as well as with fixed users accessed through fiber optic grid connections points. To overcome the limitations of current interoperability techniques in a future Global Grid communications network, innovative new ways of adapting equipment to a variety of modulation and signal waveforms are required. The use of digital signal processing techniques in RF communications equipment implementations provides an opportunity to develop adaptive systems. With such a system, if the desired network signal waveform is known, the radio can be programmed to transmit and receive compatible signals for network interoperability. Under the envisioned application, this concept would be expanded to enable a radio to identify RF networks of interest through spectral signature analysis and adapt itself to be interoperable with the desired signal. The investigator should develop and evaluate methods of implementing this concept using intelligent signal processing techniques to identify spectral signatures and to adapt the radio to one or more signature waveforms of choice for network access and operation. A further application may

be to extract desired signals from other user signals, noise, or jamming signals by virtue of exploitable spectral properties of the desired signals.

Phase I: Develop methods of analyzing spectral signatures of RF communications signals and define algorithms for implementing those methods using digital signal processing techniques. In addition, a process for activating transmit and receive waveforms that are compatible with the selected spectral signature will be developed that can be implemented using digital processing techniques.

Phase II: The methods developed in Phase I will be prototyped to a level that permits the functionality of spectral signature recognition and adaptive waveform processing to be demonstrated for several common waveform types used in military radio communications.

COMMERCIAL POTENTIAL: If this development is successful, opportunities will exist to incorporate implementations of these methods into both military and civil radio communications equipment.

ARPA 94-004 TITLE: Electric and Hybrid Vehicle Power Control

CATEGORY: 6.2 Exploratory Development; Propulsion and Vehicular Systems

OBJECTIVE: Develop and prototype a full four-quadrant electric motor controller for use in electric passenger vehicles.

DESCRIPTION: The regulation and control of electric power within an electric vehicle (EV) or a hybrid electric vehicle (HEV) is key to the efficient and safe operation of the vehicle. Advanced power controllers are sought with reduced cost, improved efficiency and increased capability to control onboard auxiliary power sources. The controllers must provide full four-quadrant control of an AC induction, DC brushless or DC brush commutated electric motor in the 60 to 80 horsepower range. Solid state power electronics such as Insulated-Gate Bipolar Transistors (IGBTs) or MOS Controlled Thyristors (MCTs) may be proposed provided that the completed design can be cost-effectively mass produced using devices that are likely to be commercially available within two years. Control characteristics must include high starting torque, good efficiency over the full speed/torque envelope, and smooth control of both motor torque and output speed. The combination of the motor and controller must be sufficient to provide a 4,200 pound vehicle with gradeability of at least 20 percent and a top speed of at least 55 mph. If a multi-ratio gearbox is required, the power controller shall have the capability of controlling electric motor speed during the shift.

Phase I: Design a full four-quadrant electric motor controller for use in electric passenger vehicles. The controller shall be designed for an AC induction, DC brushless or DC brush commutated motor of 60 to 80 horsepower such that the controller/motor combination offers the greatest possible overall motor/controller efficiency over the full speed/torque envelope of the motor while concurrently providing a low cost design that can concurrently accept and control power input from an auxiliary power unit. Define experiments and strategy to test the design.

Phase II: Develop, prototype, and demonstrate the full four-quadrant electric motor controller. Integrate into an electric or hybrid electric vehicle and demonstrate. Extrapolate costs for production. Deliver associated documentation and testing strategy to compare to predictions.

COMMERCIAL POTENTIAL: Significant commercial potential exists with current and future commercial vehicles.

ARPA 94-005 TITLE: Critical Process Modeling of Economic and Production Systems Supporting Development and Proliferation of Weapons of Mass Destruction (WMD)

CATEGORY: 6.2 Exploratory Development; Industrial Production

OBJECTIVE: Demonstrate a proof-of-concept model of the economic/industrial infrastructure supporting the development and proliferation of WMD. The model should simulate critical inputs, processes/procedures, internal and external relationships, and outputs in the WMD acquisition process as conducted by either national or extra-national entities (e.g., terrorist organizations).

DESCRIPTION: The pursuit of WMD by developing nations and extra-nationalist organizations (e.g., terrorist groups) has emerged as a critical national security issue. In order to provide warning of an attempt by a country or organization to acquire nuclear, chemical, or biological weapons; conduct a successful diplomatic, economic, or military counter-proliferation policy; or seek to interdict the flow of knowledge and technology, it is first necessary to understand the processes by which potential adversaries of any kind would acquire WMD or proliferate them to second and third parties. Modeling the critical economic

and industrial processes associated with WMD acquisition is the first step in determining (1) the potential threat caused by a proliferator and (2) the critical nodes and key weakness that could be exploited to halt, reverse, or neutralize the acquisition of WMD. This SBIR solicitation calls for the development of a proof-of-concept critical processes model which will support investigations into the following areas with respect to the activities of potential proliferators: (1) Intent to develop WMD: Given the acquisition of certain materials, personnel, data, etc. and the current indigenous technological infrastructure in a given country, what is the likelihood that these activities point to an effort to acquire WMD?; (2) Type of WMD and/or delivery system(s) sought: What kind of WMD capability do the inputs indicate is being pursued?; and (3) What are the critical nodes in the acquisition path chosen by the potential adversary: How can the effort to acquire WMD be interdicted and neutralized, and precisely where are the critical nodes in the process?

Phase I: Demonstrate a proof-of-concept capability to model the critical economic and production processes associated with the development and proliferation of WMD. The model should be generic in that it is not "hard wired" to a certain type or family of WMD (e.g., nuclear weapons). The demonstrated proof-of-concept can focus on a single type of WMD and/or delivery system; however, the accompanying technical report must discuss the model's capacity for incorporating other types of WMD and delivery systems and the methods by which such a scale-up will be achieved in Phase II. The proof-of-concept model must demonstrate the potential to support the WMD proliferation warning, monitoring, interdiction, and elimination missions. Thus, the model must involve a dynamic portrayal of the critical linkages within the economic and industrial processes that produce nuclear, chemical, and biological weapons and their associated delivery systems. The model must demonstrate the capability to assimilate and display the consequences of varying key input parameters such as material, expertise, time, existing technical and military infrastructure, etc.

Phase II: Develop an operational prototype, which can be evaluated by subject matter experts, with respect to historical proliferation cases. The prototype will be robust enough to demonstrate the utility of this type of technology by operating against one or more WMD proliferation case studies. The number of case studies targeted by the developer should vary inversely with the complexity of the given cases. The operational prototype must be capable of demonstrating analytical value-added to the proliferation warning, monitoring, interdiction, and elimination missions within the context of a given case study. The user interface for the Phase II model must support demonstrations for, and model evaluations by, subject matter experts in WMD proliferation who will have varying levels of computer literacy.

COMMERCIAL POTENTIAL: The commercial potential of critical economic and production process modeling is significant. In the areas of market planning and quality control, this type of technology will allow commercial organizations to sharpen their competitive edge in international markets by understanding the ability of a target country's economy and industry to absorb and utilize a given product, as well as what type of customization is required to match a given product line to an overseas market niche.

ARPA 94-006 TITLE: Selective Area and Facility Denial Technologies

CATEGORY: 6.2 Exploratory Development; Sensors and Electronic Combat

OBJECTIVE: Develop and demonstrate a new method(s) that will allow U.S. commanders the capability from a standoff location to selectively deny an adversary access to facilities/areas that are nominally under adversary control.

DESCRIPTION: An option available to policy makers in time of war (or pre war) is to declare "exclusionary zones," i.e., areas or regions that are not being occupied. This is useful for halting the use of buildings/facilities that are determined to be producing weapons of mass destruction (WMD) and for countering infiltration across customs boundaries. The methods currently available include passive measures such as mines and/or active surveillance coupled with detection-response measures. The need exists for new methods to keep personnel out of areas and facilities that are selective to small regions (< 1 km square), have minimum collateral damage, are easily detectable without special equipment, are difficult for targeted individuals to counter, are readily disabled by friendly forces or authorities, have long persistence (> 1 month) and are affordable from both an initiation and maintenance perspective. The methods of employment to be considered may include aircraft-delivered agents, standoff irradiation, robotics (nano-, micro-, standard), and manual emplacement.

Phase I: Design and analyze selected denial technologies/approaches. The approach presented must be examined for its ability to deny access, its detectability, ease of countering, persistence, and cost. A selected laboratory or prototype demonstration would also be useful.

Phase II: Demonstrate the method's ability to provide the capabilities addressed in Phase I. The demonstration could be either in the field or within a laboratory environment, and would show critical performance factors. A design is also required that shows how the demonstrated approach would scale to operational values.

COMMERCIAL POTENTIAL: The ability to rapidly and selectively cordon off areas or buildings has commercial potential for law enforcement and security providers as aids in controlling access to protected areas.

ARPA 94-007 TITLE: Computational Models of Human Organization Dynamics

CATEGORY: 6.2 Exploratory Development; Human-Systems Interfaces

OBJECTIVE: Develop a model that is both descriptive and predictive of the dynamic interactions within an organization and the input/output relationships of the organization. Demonstrate the model's utility on selected case studies and extend the modeling capability to organizations in general.

DESCRIPTION: At the top level, the behavior of an organization is evidenced by the observed behaviors of the individual entities that compose it. Taken separately, the individual behaviors often appear chaotic and/or random. Key to understanding and predicting the behaviors of adversaries and allies alike is the ability to place the point observations made about specific individuals within the context of their parent organization. This is usually done by organization "experts" or analysts that are familiar with the context of the parent organization. The resultant process is subject to bias and can be in itself subject to the same forces that made the initial observation set difficult to interpret. Models are required to give this analysis and interpretation activity structure and rigor. The models must account for the evolution of strategies, behavior selective mechanisms, transactions between and among sub-organizations and the reinterpretation of external observables into internal constructs.

Phase I: Demonstrate a selected approach to modeling organizational dynamics applied to either a case study of a particular organization or a simulated one. The utility of the model to measuring behaviors at the aggregate and specific entity level must be shown. Summaries of the behaviors that show intent and evolution of organizational strategies would also be useful.

Phase II: This effort requires the in-depth modeling of an organization of specific interest to the problem of counter proliferation. A specific organization (friendly or hostile) will be selected and the model will be developed using the principles established in Phase I. Key parameters such as organizational efficiency, intent, and stability will be measures.

COMMERCIAL POTENTIAL: The modeling product would be very useful in analyzing markets and predicting internal behaviors of companies from both the inside and outside.

ARPA 94-008 TITLE: Multi/Hyperspectral Image Characterization

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Identify/define innovative algorithms for pre-processing spectral sensor data to form quantitative representations of objects. Automated spectral signature recognition of objects would facilitate direct use of multispectral data in civil and defense applications by a moderately trained operator.

DESCRIPTION: Multi/hyperspectral imagery has demonstrated value in a broad range of civil and defense applications. Landsat Thematic Mapper data sets are perhaps the most widely used today, but advanced Landsat 7, HYDICE, and others promise superior performance in the near future. A vital application of this data for both government and commercial applications is classification/characterization of the various components (materials composing objects and features) of the imaged scene. Several algorithms have been developed and applied in the past using high level multipixel approaches. ARPA wishes to examine the application of more innovative and capable approaches and algorithms, and prototype them into readily usable, quantifiable, and possibly automated products. The algorithms should perform sub-pixel analysis using purely spectral characteristics, operate on a data processing system software platform capable of simultaneously handling images from hundreds of different spectral channels, and be hosted on a widely used open system. These algorithms should produce a quantitative characterization of a scene, in terms of the materials creating the spectral signature, and the end product should be directly interpretable by a modestly trained user.

Phase I: Identify and describe the necessary algorithms/approach to be developed, including a preliminary quantification of performance and identification of Phase I objectives. The Phase I final report shall include a plan for development, description of the final product, and a description of the commercial product.

Phase II: Develop/demonstrate a prototype software package, implementable in commercially available hardware. Test and evaluate algorithms using example DoD and commercial applications.

COMMERCIAL POTENTIAL: Intelligent pre-processing of multispectral data for commercial applications could broaden its commercial appeal by reducing the analysis burden for the customer, thus making it more cost effective. Image processing algorithms developed for DoD could be applied directly to civilian problems by substituting the characteristic signatures which are of interest to the customer into the algorithm.

ARPA 94-009 TITLE: Virtual Air Combat Adversary

CATEGORY: 6.2 Exploratory Development; Human-Systems Interface

OBJECTIVE: Develop and implement methodology to link high-performance airborne vehicle(s) with manned or unmanned ground-based air vehicle simulators to replicate close-in-combat conditions and evaluate tactics.

DESCRIPTION: Aircraft such as the X-31 Enhanced Fighter Maneuverability (EFM) demonstrator are designed for a high degree of agility to enhance effectiveness in close-in aerial combat. Anticipated maneuver tactics of these types of vehicles involve rapid motions and excursions to large angles of attack, as well as extremely close proximity of combatants, thus creating a potentially hazardous flight environment. The ability to electronically link a high-performance airborne vehicle with a manned or unmanned ground-based air vehicle simulator to replicate an air battle would provide an invaluable aid for pilot training, close-in-combat tactics and evaluation, and cockpit display development. Furthermore, this capability would provide a mechanism for evaluating advanced air vehicle concepts against available, contemporary hardware. Combat scenarios could be created, played out, and re-enacted under relatively benign conditions. The development of a network and real time methodology capable of linking single or multiple ground simulators (including domed facilities) with an inflight vehicle is desired. Implementation should consider such factors as simulated vehicle performance models and their limitations, vehicle tracking and orientation, pilot awareness (both airborne and simulator-bound), simulated weapons modeling, and availability of advanced hardware/software technologies.

Phase I: Develop and refine several alternative network concepts and approaches to implementation, and/or investigate how elements of critical enabling technologies could be integrated into the overall hybrid environment architecture.

Phase II: Develop a preliminary (top level) design for a selected concept, including an evaluation of development risk factors. Demonstration of key technology elements and their integration may be required in this phase.

COMMERCIAL POTENTIAL: This technology could be expanded and tailored to provide traffic advisory information for collision avoidance. It could also be employed for evaluation of commercial/civil design concepts. Moreover, it could be used as a primary, low-cost tool in civil aviation training.

ARPA 94-010 TITLE: Development of Affordable Reconfigurable Table-Top Maintenance Diagnostic and Test Equipment Emulators

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Develop a prototype table-top simulator that can be user reconfigured to emulate different military diagnostic and test equipment. These simulators must also be capable of having embedded training exercises and performance recording/reporting loaded for use with the simulator.

DESCRIPTION: Army National Guard units and soldiers frequently do not have the equipment available to them that they would be expected to use in wartime to perform their jobs. When equipment is available, it is frequently too far away to be used and requires another skilled individual present if training is to occur using the equipment. Additionally, equipment in these units changes frequently and single-use simulators are then obsolete, their single-use restricts the exploitation of modern technology. This project will demonstrate the construction of relatively inexpensive table-top reconfigurable simulators that a soldier could feasibly sign-out from his/her unit and take home to train on. Further, the device should be relatively easily reconfigured so that different users can use it to emulate different equipment available in the unit. In this way, soldiers will be able to train on their job skills individually as they have time or while in transit to a theater of operations (e.g., on board ship or plane). The objective of this project will be to design a flexible, inexpensive, portable device, as described above, and to breadboard the critical components. A full working prototype would be required in Phase II. A wide variety of equipment is available for emulation including mechanical and electrical diagnostic and test equipment.

Phase I: Develop the design for a reconfigurable simulator and build functional key components as agreed upon

between the contractor and the government representative. The components will demonstrate the ease and functionality of the software approach proposed and how analog requirements would be handled (e.g., alligator clip, probes). The components would also function as a risk reduction measure for Phase II. The key components and a detailed proposal of the functionality of the prototype, the approach and software methods to be used, and the hardware to be used would be the Phase I product.

Phase II: Build a working prototype of the device as described in Phase I which would demonstrate the ability to emulate two or more target pieces of equipment identified by the government. A final report would describe how these devices could be produced and modified to emulate a wide range of existing equipment and notional equipment.

COMMERCIAL POTENTIAL: The type of equipment to be emulated is widely used throughout the commercial sector by mechanics and technicians who face the same training constraints as those in the National Guard. These devices could be readily used in vocational training programs.

ARPA 94-011 TITLE: Development of Affordable and Portable Defense Simulation Internet (DSI)

CATEGORY: 6.2 Exploratory Development; Communications Networking

OBJECTIVE: Design a low cost mobile DSI Node that will enable mobile modern Army Virtual Simulators to enter the DSI network from remote locations.

DESCRIPTION: ARPA currently operates a simulation network backbone that will utilize T-1 through T-3 bandwidth capabilities for simulators at disparate locations to internet into a virtual world in real time. Army National Guard units cannot use this system in a cost effective way because it requires installing a dedicated high bandwidth telephone line. The using units have mobile simulators, therefore, a given line is used infrequently. Instead, these mobile simulators need to have a mobile node that can travel with the simulator and access the network. The node would need to be able to handle a bandwidth of between 13,500-16,200 kilobytes to enable dynamic vehicles to interact in real time in a shared virtual space. The test bed for the technology will be a mobile version of the Army's Simulation Networking (SIMNET) simulator and its successor, the Close Combat Tactical Trainer. Past solutions attempted have included the use of compression techniques on landlines or the use of satellites, which have both been unacceptable to date. The compression techniques have either omitted data packets or slowed the simulations down to less than real time. Moreover, satellite links have had too much latency in transmission time to carry data packets fast enough to keep up with tank rounds fired in virtual battles. Lower capacity solutions using high speed modems have worked, but do not currently carry the bandwidth necessary. This project seeks innovative potential solutions to this problem and the development of a prototype.

Phase I: Produce a workable breadboard prototype that will demonstrate the capabilities previously described.

Phase II: Develop a prototype and report describing a manufacturing methodology. The prototype will be more concerned with compactness, reliability when moved, overall operational reliability, and ease of manufacture and quality control.

COMMERCIAL POTENTIAL: This capability has wide commercial potential. Internetted virtual simulation is rapidly expanding in the military, and is being actively explored for entertainment, training and teleconferencing.

ARPA 94-012 TITLE: Develop PC or Work Station Based One-on-One Interactive Simulation for Exercising/Training Army Battalion/Brigade Logistics Officers (S-4s)

CATEGORY: 6.3 Advanced Development; Software

OBJECTIVE: Develop and demonstrate a prototype interactive simulation hosted on commercial off-the-shelf (COTS) hardware for exercising/training Logistics Officers. The simulation must present realistic cues and stimulate realistic responses.

DESCRIPTION: Army National Guard Battalion/Brigade Logistics Officers are provided infrequent opportunities to practice their skills, except at lengthy training schools or as part of a full staff in an exercise. Even then, the full array of skills are usually not able to be practiced. This project seeks innovative approaches to exercise the logistics officers with hardware that is amenable for use at home. The software technologies may use 3-D, virtual reality, spoken language, or other innovative approaches.

Phase I: Produce a report and prototypes of key components of the proposed simulation. The report will describe the array of tasks for training in a full-up simulator and the technical approach for developing such a training simulation. The

prototype in Phase I will demonstrate a sufficient sample of the array of tasks to adequately demonstrate the viability of the technology and its effects on training. The tasks to be demonstrated will be selected by the contractor and the government representative.

Phase II: This effort will result in a full capability simulator for the Battalion Logistics Officer and/or the Brigade Logistics Officer.

COMMERCIAL POTENTIAL: This technology is applicable to commercial logistics problems such as networks and transportation planning/decision making. It is also usable in academic settings for teaching these skills.

ARPA 94-013 TITLE: Extraction of Environmental Conditions from Radar Data/Imagery

CATEGORY: 6.2 Exploratory Development; Environmental Effects

OBJECTIVE: Develop techniques to automatically extract environmental conditions from real-beam or synthetic aperture radar (SAR) imagery, including both conventional two-dimensional SAR and three-dimensional interferometric radars (IFSAR).

DESCRIPTION: Real-beam radars, conventional SARs and, more recently, IFSARs have often been used for sensing environmental conditions in both the atmosphere and on the surface of the ocean or land. For example, real-beam radars produce clutter maps which reveal surface conditions, and weather or other type radars commonly monitor atmospheric conditions including turbulence, wind, and precipitation. SARs and IFSARs produce two- or three- dimensional imagery which, obviously, yields surface or terrain features and, less obviously, conditions such as soil moisture, surface roughness, vegetation type, soil or geologic constituents, and subsurface conditions. The emphasis in this topic is on the automatic extraction of such information regarding land surfaces from SAR or IFSAR imagery, though other types of radars or environmental conditions are not excluded.

Currently, extraction of environmental conditions from such imagery is limited in scope and/or accuracy, using algorithms based on limited data. The exploitation of IFSAR data for this purpose is even less developed. As ARPA is currently engaged in a significant development of SAR and IFSAR technology, innovative approaches to automatically exploiting high quality SAR/IFSAR imagery are required to efficiently produce the more complete picture of the battlefield that such radars are capable of supporting.

Phase I: Develop techniques for automatically extracting environmental conditions from SAR imagery or real-beam radar returns, and performance prediction of those techniques using real or synthetic data. However, it could also include laboratory demonstrations or field experiments in relation to critical technical issues, or for performance prediction.

Phase II: Improve upon the techniques identified/developed during Phase I, with supporting laboratory or field experiments, validation of algorithm performance with real data, and the implementation of the extraction techniques in a workstation environment.

COMMERCIAL POTENTIAL: Significant commercial potential exists for the extraction techniques developed under this topic in several industries and technology areas, including construction, flood and earthquake prediction, environmental monitoring, energy exploration, pollution control, sea ice charting, and the entire realm of cartographic mapping. The automatic extraction of environmental conditions from radar data and imagery will vastly improve the quality, timeliness and cost of products currently used in the application areas listed above. These improvements are due to both the day/night, all weather capability of radar and the automation of the extraction techniques.

ARPA 94-014 TITLE: Technology for Improving the Anti-Jam and Convertness Characteristics of Projected Personal Communications Systems (PCS)

CATEGORY: 6.2 Exploratory Development; Communications Networking

OBJECTIVE: Provide a hardware demonstration of a working hardened PCS in the presence of real or synthetic jamming with quantified performance against pre-established measures of effectiveness.

DESCRIPTION: The intent of this program is to explore and develop techniques for improving the anti-jam and convertible characteristics of PCS. Preferably, techniques should be established which are compatible with unmodified existing or projected PCS infrastructure (example, Motorola's IRIDIUM system would include AT&T's EO systems, Apples Newtons systems, etc.);

however, techniques for modifying the infrastructure will be considered if they can be easily implemented. In either case, the relevant cellular system(s) should be identified. Threats include both unintentional and deliberate jamming. If modifications to the switching system or infrastructure are required, they must be identified. Costs shall be defined for all items requiring modification.

Phase I: Provide a thorough assessment of the technique described, define measures of effectiveness and projected performance, and culminate in breadboard demonstrations of the system or critical subsystems. If hardware demonstrations cannot be accomplished, detailed simulations may be employed.

Phase II: Refine the measures of effectiveness and projected performance, and should develop and demonstrate one or more brassboard hardware units.

COMMERCIAL POTENTIAL: This has significant commercial potential for sensitive operations such as banks, financial markets, industrial development teams, and crisis situations.

ARPA 94-015 TITLE: Software Partitioning, Mapping, and Assessment for Distributed Processors

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Provide concept analysis and a preliminary design of an integrated software suite to assist with software partitioning, mapping, and performance assessment of distributed computer systems.

DESCRIPTION: Embedded multiprocessor architectures are now being developed for numerous military applications These powerful machines allow for real-time solutions of complex problems such as automatic target recognition, synthetic aperture radar image formation, and infrared search and track. As the degree of parallelism in the system architecture increases, it becomes more challenging to efficiently partition and map the software to the hardware. Typical issues that must be considered include throughput and/or latency and the hardware constraints associated with memory and processors. The three general categories of tasks are: partitioning, mapping, and assessment. Partitioning includes those activities necessary to identify the various elements of the algorithm chosen for implementation. These elements must be structured to allow some tasks to be performed in parallel while other tasks are performed serially. Often this process is not intuitive and may require modification of the algorithm to achieve an elegant solution. Mapping of the partitioned algorithms to the hardware is the next sequential step. A thorough knowledge of the system architecture is required to perform this function properly and optimally. Once the software elements are mapped to the hardware, it must be possible to evaluate the results of the first two steps. It is necessary that this assessment be performed quickly and iteratively to evaluate and modify a system design until a near optimal solution is reached based on user selected parameters and measures of effectiveness. There is a critical need for automated links to exist between system analysis and design tools and the performance analysis tools. Fundamental requirements are the ability to transfer information and results among all of the tools comprising the development environment, and the ability of all the tools to operate efficiently as elements of an integrated suite.

Phase I: Develop and design an integrated tool suite that will provide: (1) A user friendly interface for a distributed system definition; (2) an optimizer to assist with the partitioning of software elements and their mapping to distributed processors; and (3) an analyzer to provide system and software performance statistics. The automated integration of components should also be addressed. The conceptual design should result in a generic process, but focus can be placed on an interesting architecture to clarify principles.

Phase II: Develop a prototype system from the design of the tool suite from Phase I. This system will permit a design engineer to define system software and hardware components with the user interface, automatically port the descriptive data to the partitioning and mapping optimizer, and then demonstrate an iterative process between the optimizer and the performance analyzer with the intent of maximizing a selected measure of system effectiveness.

COMMERCIAL POTENTIAL: Commercial applications of multiprocessor systems are expanding and these systems are no longer confined to the research laboratory. As this proliferation increases, inexpensive tools will be required to assist the user in the efficient operation of these systems.

ARPA 94-016 TITLE: Integrating Personal Digital Assistants (PDAs) into a Productivity Enhancing and Mobile Work Process

CATEGORY: 6.2 Exploratory Development; Human-Systems Interfaces

OBJECTIVE: Develop and implement a work process which maximizes the productivity of professionals and office workers using PDAs in conjunction with existing desktop, home, and notebook computers. The process must improve productivity, be reliable, be easy to use, be easy to learn, and support a mobile office worker.

DESCRIPTION: Researcher will explore ways of integrating evolving Commercial Off The Shelf (COTS) PDAs, similar to the Apple Newton or Sharp PDA, into a productivity improving tool and process. Researcher will review "how" professionals and office workers work, and then develop a process by which these users can maximize their productivity using a COTS PDA. The process developed must take into account various user's ability and desire to incorporate a PDA into their work style. The researcher must consider scenarios in which the office worker already has access to LAN and WAN connected desktop computers, and may or may not have access to a home computer and/or mobile "notebook" computer. Researcher will provide a deliverable which includes their implementation plan, all assumptions and caveats made by the Researcher, and estimates of expected productivity gains and acceptance rates by all types of users identified as potential PDA users. Specific functions desired of a PDA include, but are not limited to: electronic mail (one way, two way, and offline deferred), forms routing, digital signatures, calendaring (scheduling, To Do's, load leveling, multi-user coordination), and voice/telephone. Specific concerns arising from the mobile nature of PDAs include communication links which may be: unreliable, low speed, two way, one way, local infrared, or deferred. Other concerns include automatic data synchronization (to the user's other computers) at the file and record level, as well as achieving, backup, and integrity of PDA data. Researcher will evaluate, procure, and field a prototype fleet of emerging PDAs, such as the Apple Newton, as part of the Phase I project. The Phase I PDA fleet should include 15-20 units.

Phase I: Study work patterns of professional office workers who already have a desktop computer, and who probably also have a home computer and/or notebook computer. Determine how these workers could best use a PDA to improve their productivity. Researcher must consider, identify, report, and explain those factors which may affect the successful implementation of PDAs into the office worker's environment. As part of Phase I, 15-20% of the target workers should be provided with PDAs and the experiences of these workers used to develop and optimize the PDA implementation plan. The final Phase I deliverable should be a report that details and summarizes the implementation plan, Phase I implementation, and other work performed by the Researcher.

Phase II: Measure and document productivity gains of workers with and without Phase I PDAs. Review second and third generation PDAs and COTS software for enhancements which might differ from Phase I. Review and improve the Phase I implementation plan. Acquire and deploy PDAs among all professional office workers at ARPA. Develop a training plan, and provide training according to that plan to all Phase II PDA recipients and interested office workers. Measure and document productivity gains of workers with and without Phase II PDAs. Solicit feedback and document comments and suggestions from users of Phase II PDAs.

COMMERCIAL POTENTIAL: PDAs will be widely available over the next two years. Having a plan for effectively integrating them into a productivity enhancing work process should benefit office worker productivity and job satisfaction and reduce commuting and energy consumption.

ARPA 94-017 TITLE: Implementation of Novel Internet Services for Directories, Databases, Multi-Media, and Mobile Networking

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Conduct research leading to new services, algorithms, and systems which provide novel Internet services for directories, databases, multi-media, and mobile networking. Distributed services capable of indefinite expansion and commercial application are sought.

DESCRIPTION: Existing Internet services in the subject areas have failed to achieve a wide implementation base and/or effective integration in the Internet reference model. New services which overcome these deficiencies are sought. The typical service will demonstrate an innovative approach, have immediate application, and be capable of exploiting scalable computing and networking infrastructure.

Phase I: Define in detail the service to be provided and demonstrate its feasibility through early prototypes, simulation, or thorough analysis. Compare the new service to existing approaches and justify the costs of new service introduction in terms of new applications which are enabled.

Phase II: Develop and demonstrate the service. The service must be capable of operation over standard Internet infrastructure with nationwide capability. Evidence of its ability to transition to a self-supporting basis must be provided.

Performance and scalability must be demonstrated.

COMMERCIAL POTENTIAL: New Services, as described, are an enabling technology for future dual-use of networking and the national information infrastructure (NII). Phase III projects that employ the results will have direct commercial potential, as will as application to DoD future systems.

ARPA 94-018 TITLE: Development of Scalable High Performance Input/Output (I/O) Hardware and/or Systems Software for High Performance Computing (HPC) Systems

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Develop and prototype new ideas for I/O components usable in both networks of workstations and scalable parallel computers to achieve higher speed, greater capacity, and expanded functionality.

DESCRIPTION: Prototype implementations are sought for innovative ideas to advance I/O components applicable to both scalable parallel computers and networks of workstations. This includes affordable devices and interfaces, enhancements to systems software, tools for analyzing the I/O components, etc. The prototype must be scalable, have wide applicability, be system independent, and have clearly defined and open interfaces. Collaboration with academia, government laboratories, or industry is encouraged.

Phase I: Provide a detailed design, develop cost information, and devise a complete plan for implementation on networks of workstations and scalable parallel computers. Describe the novel ideas and key features and how to use them. Provide expected performance, comparative trends, and trade-offs.

Phase II: Develop hardware and/or software which implements the new technology or concept. Demonstrate and test its effectiveness. Provide documentation that clearly describes the system interfaces, any external interfaces or requirements, any architectural impacts, and how to use the hardware and/or software. For hardware, provide a working demonstration, test results, and drawings. For software, provide a demonstration, test results, documentation, hardcopy, and a magnetic media copy of the code.

COMMERCIAL POTENTIAL: Phase I and Phase II results have excellent potential for Phase III commercial opportunity. Higher processing capabilities, higher network speeds, and very high data rate needs occurring in wide commercial applications as well as future DoD systems are driving the need for significant advances in high performance I/O. Resulting Phase III projects have outstanding direct dual-use potential in future computing systems.

ARPA 94-019 TITLE: Low-Energy Architectural, Circuit, and Signaling Techniques for General Purpose Scalable Computing

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Novel techniques are sought at the architectural, circuit, and/or integrated circuit (IC) process level that significantly reduce the energy consumed per megaflop by a general purpose scalable computer.

DESCRIPTION: Techniques have been developed to reduce the energy consumed by special purpose processors, such as signal processors and those found in watches. Scalable general purpose processors also benefit from reduced energy consumption. This effort should address techniques to be applied specifically to general purpose computers that scale in performance to teraflops and above.

Phase I: Identify techniques to be applied; quantify effects on energy through simulations; identify how and under what constraints techniques are to be applied. Devise small-scale experiments to validate results.

Phase II: Perform small-scale experiments to validate results. Refine model and develop tools to aid in exploitation of techniques by others.

COMMERCIAL POTENTIAL: Higher computer performance per watt of consumed power is a critical goal across all of computing from miniature embedded systems in wrist watches to the largest supercomputer. This problem is pervasive in both military as well as commercial applications. Military computing systems of the future will leverage commercial architectures, and the computing performance goals of both military and commercial systems will be achieved only through increased power efficiency computers.

ARPA 94-020 TITLE: Novel Applications of Multi-Chip Module (MCM) Technology to Rapidly Prototype New Parallel System Architectures

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Devise techniques and approaches to exploit performance of MCMs to rapidly and inexpensively prototype new parallel computing system architectures.

DESCRIPTION: As computing system clock rates continue to increase, traditional prototyping technologies will no longer be adequate. MCMs provide the performance required for packaging new generation systems but are too costly and too difficult to modify to be generally useful for system prototyping. Rapid prototyping techniques are sought that address cost and ease of use; i.e., reconfigurable, reprogrammable, or even rapid full custom techniques.

Phase I: Clearly define approach, quantify parameters, and verify techniques through simulation. Define interfaces required and how techniques would be implemented. Quantify what classes of applications will be served by the approach, and define limitations.

Phase II: Perform experiments to develop a physical model of the proposed MCM techniques and validate capabilities against simulated results. Develop user interfaces and supporting software and hardware. Fabricate and demonstrate one or more prototyping models.

COMMERCIAL POTENTIAL: The costs and risks of prototyping new parallel computing architectures is dramatically increasing with the incorporation of advanced technology. Techniques to facilitate cost-effective prototyping of new architectures are essential to both the military and commercial markets. Computing architectures developed with these prototyping techniques will be used for dual-use applications since military computing needs of the future will be supported and leveraged off the commercial baseline.

ARPA 94-021 TITLE: Analysis and Performance Evaluation of Scalable Networking Protocols

CATEGORY: 6.2 Exploratory Development; Telecommunications

OBJECTIVE: (1) Discover and analyze performance limitations inherent in the design of existing networking protocols, and (2) Develop new classes of protocols which will scale performance in gigabit and beyond networks.

DESCRIPTION: TCP and the entire range of ISO transport protocols (TP0-TP4) were designed with the then current 64K Bit networks in mind. They have some hard and fast design limitations which will prevent them from getting the most out of the high speed networks of the near future. Analysis of those limitations (even in the face of the extensions to TCP for large windows) and limitations of other protocols (such as SMTP, FTP,etc) are sought, as are improvements or new protocols which will scale well in performance for gigabit and beyond networks. Approaches must either be compatible with existing internet protocols or provide convincing evidence that compatibility would adversely effect performance.

Phase I: Deliver a detailed analysis, design for improvement, and cost information as well as complete plans for implementation. Protocols demonstrating feasibility are desired.

Phase II: Deliver a full implementation and demonstration of the new or improved protocol, as well as specific information on the theoretical range of use and limitations. Complete user documentation, source code, and system designs must be supplied.

COMMERCIAL POTENTIAL: Protocols as described must be continually evaluated and improved in the future to support the goals of the national information infrastructure (NII) and the evolution of high performance networking. Phase III projects may implement the results above, and have direct dual-use commercial potential.

ARPA 94-022 TITLE: System and Technology Computer Aided Design (CAD) on a Scalable Computing Base

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Conduct research leading to the development of new electronic technology CAD algorithms that have potential

to execute on workstations and massively parallel computers.

DESCRIPTION: New algorithm families implemented in design tools are sought for approaches leading to innovations in systems level and technology computer aided design (TCAD). These algorithms will be the basis of the next generation of design for advanced electronic devices, processes, packaging, or electromechanical subsystems, and must be capable of executing on computing systems ranging from certain workstations to massively parallel computers. Such algorithms should support the goals of the Federal High Performance Computing and Communications (HPCC) program.

Phase I: In detail, define the application, algorithm(s), trade-offs, and comparisons to existing approaches, along with supporting evidence of success such as early prototyping experiments or simulation results.

Phase II: Develop and demonstrate a tool, implementing the algorithm, along with supporting documentation and test cases, which clearly demonstrate its feasibility. Evidence of its ability and performance running on scalable parallel computer or network of workstations must be delivered.

COMMERCIAL POTENTIAL: System and Technology CAD is an important area that has great potential for commercialization in Phase III. Innovative results of Phase I and II may be incorporated in new categories of design tools needed by DoD and the commercial sector This area extends capabilities of existing frameworks and systems, and provides the potential for incorporating results with standard interfaces.

ARPA 94-023 TITLE: Prototype Implementations of Scalable High Performance Computing (HPC) Software

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Explore novel ideas for advancing high performance computing environments.

DESCRIPTION: Innovative and novel concepts are sought for advancing high performance computing environments. These concepts include, but are not limited to, the following: Compiling technology for scalable parallel computers; tools to support development of scalable parallel programs; tools for visualizing, measuring, profiling, analyzing, and debugging parallel programs; run-time system technology, tools, or libraries; scalable algorithms for application software library modules; and novel concepts for supporting scalability in libraries, either run time or application. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces. Focus should be on scalable computing systems. Collaboration with ongoing research in academia, government laboratories, or industry is encouraged.

Phase I: Provide a detailed specification of the proposed concept, principle, or algorithm. Describe new or novel ideas or concepts. Describe the concept's or idea's key features. Demonstrate or describe how the new concept, principle, or algorithm would be used. Finally, describe the path or process for implementation on advanced processors or scalable parallel systems.

Phase II: Develop the software prototype, subsystem, or module which implements the new technology, concept, or idea. Demonstrate the effectiveness of the new technology. Provide documentation that clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

COMMERCIAL POTENTIAL: Results demonstrated in Phase I and II have significant opportunity for dual-use commercial potential in Phase III. Users of HPC systems are demanding new capabilities which can be incorporated in to the next generation software base. Tools and environments supporting the scalable parallel technology base will be needed for a variety of platforms and incorporation in to existing systems, crating commercial potential for these results.

ARPA 94-024 TITLE: Smart Materials and Structures Technology for Hydrodynamic and Aerodynamic Vortex Control

CATEGORY: 6.1 Basic Research; Materials and Processes

OBJECTIVE: Develop a combination of analytic models and experimental investigations to demonstrate the feasibility of hydrodynamic and aerodynamic vortex breakdown using smart materials and structures technology to control the location of vortex breakdown.

DESCRIPTION: Longitudinal vortex flows, often created by lifting surfaces, create undesirable noise sources for submarines

and place limitations on commercial aircraft traffic control. Current theory supports the concept that the ultimate control of vortex breakdown can be addressed by controlling the relative axial and rotational content of the longitudinal vortex flow. Spiral, or helical, breakdown is desirable rather than bubble, or axisymmetrical, breakdown because it involves far more mixing with the external flow and is more dissipative. Control of vortex breakdown by excitation in the early stages may provide a mechanism to ensure a spiral breakdown as opposed to a bubble breakdown. Integration of an excitation source into the structure near the structure-fluid interface could provide the necessary capability. Development of flow sensors, appropriate excitation actuators, and control capability and their integration into the structure will allow aircraft to safely follow large transport planes at closer distances near airports. This will help relieve airport congestion and improve safety. In submarine applications, the trailing longitudinal vortices are entrained in the propeller and subsequently generate considerable noise. A successful control application will substantially reduce submarine noise signature.

Phase I: Approaches that may be supported include: 1) Analytical models which delineate the location and nature of the excitation required to break up longitudinal flows; 2) Computational fluid dynamics simulations; 3) Experimental studies involving sensing and actuation of flow fields; 4) Materials optimization technologies; and 5) Control algorithms.

Phase II: Demonstrations that may be supported include: 1) Integration of vortex control models with structural response requirements; 2) Integration of sensors, actuators, and control systems with the structural components; and 3) Experimental demonstrations of vortex control systems.

COMMERCIAL POTENTIAL: Technology has applications to commercial and military aircraft, submarines, and commercial and military surface ships.

ARPA 94-025 TITLE: Intelligent Low-Cost Processing of Titanium Based Continuous Filament Metal Matrix Composites for Propulsion Applications

CATEGORY: 6.2 Exploratory Development; Propulsion and Vehicular Systems

OBJECTIVE: Develop innovative intelligent synthesis processes for titanium based continuous filament metal matrix composites for propulsion applications. Process modeling and simulation of unit and sequential synthesis steps, process sensors, and real-time process control technology, are desired.

DESCRIPTION: Titanium based continuous filament metal matrix composites have the potential to provide high-strength, low-density components suitable for propulsion applications. However, the current processes used to synthesize these materials are costly and lack reproducibility. This hinders the introduction of the composites into propulsion applications. One way to address the impediments is to apply intelligent materials processing technology to innovative low cost synthesis techniques. Development of process models, sensors, and control schemes, as well as their application to low cost synthesis techniques, can provide the technology needed to overcome the barriers to their application.

Phase I: Approaches that may be supported include: 1) modeling of unit metal matrix composite synthesis processes; 2) sensor development for monitoring and controlling synthesis processes; 3) technology to model sequential synthesis processes; and 4) innovative low cost synthesis processes.

Phase II: Demonstrations that may be supported include: 1) integration of process modeling, sensors, and control for use in a low cost metal matrix composite pilot line; and 2) component synthesis for use in propulsion applications.

COMMERCIAL POTENTIAL: Applications to commercial and military jet engines and auxiliary turbine power plants are expected.

ARPA 94-026 TITLE: Affordable Manufacturing Processes for Ceramic Fibers

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Develop a manufacturing process for advanced structural ceramic fibers which have service temperature capability greater than 1500 degrees centigrade, and a selling price of less than $200 per pound at a volume of 100,000 pounds per year.

DESCRIPTION: Ceramic fiber ceramic matrix composites (CMCs) are candidates for high temperature structural applications where cooled metal structures are impractical. Such applications include gas turbine engines for man-rated and non-man-rated engines of interest to the DoD as well as a host of commercial applications including heat exchangers, reheat furnaces and

radiant tube burners. At present, the high cost of fibers, fiber coating, and component fabrication has prevented the commercial exploitation of these advanced materials. High strength and creep resistance at temperatures up to 1500 degrees centigrade will be required of fibers used in CMC's. In most cases, the textile grade fibers will be required for weavability which usually requires fiber diameters less than ~15 microns. Innovative ideas for the fabrication of low cost (~$200 per pound) high performance fibers are sought. Technical approaches may include, but are not limited to: Eutectic growth in salt-oxide systems with post solidification removal of the salt phase; use of oriented seeds for secondary grain growth which will allow for the self-assembly of polycrystalline fibers into single crystal fibers; use of displacive reactions [i.e., $Ax+By = Ay+Bx$] or phase transitions in the presence of a liquid phase giving rise to elongated faceted growth; spinning of low cost polymer ceramic precursors; or, *Chemical Vapor Transport* (CVT) *in a thermal gradient* combined with Vapor Liquid Solid (VLS) growth of whiskers. Manufacturing approaches which integrate fiber coatings for debonding and chemical barrier layers are also of interest.

Phase I: Demonstrate that the manufacturing method chosen is capable of producing fibers with a 1500 degree centigrade capability. Establish the key processing variables to achieve the fiber properties, and develop a cost-volume model for the manufacturing process.

Phase II: Scale-up the process developed in Phase I to a capacity of greater than 200 pounds per week. Conduct factorial designed experiments to relate fiber cost and performance to manufacturing operating variables.

COMMERCIAL POTENTIAL: Commercial applications for the fibers include ceramic matrix composites for land-based gas turbines, radiant tube burners, diesel particulate filters, and steel reheat furnaces.

ARPA 94-027 TITLE: In-Situ Composites for High Temperature Structural Applications

CATEGORY: 6.2 Exploratory Development: Materials and Processes

OBJECTIVE: Develop in-situ composites for high temperature structural applications with high strength and fracture toughness, and low creep at temperatures up to 1500 degrees centigrade in air. Strengths and fracture toughnesses comparable to commercially available silicon nitrides are desired with greatly reduced manufacturing costs.

DESCRIPTION: Silicon nitride is a model material for the type of in-situ composites desired. An elongated grain shape results from the solution reprecipitation process associated with the alpha to beta phase transition. The elongated grain structure and a thin intergranular grain boundary phase combine to give a material with high strength and fracture toughness. It is also significant that the C-axis is the fast growth direction during liquid phase densification. Liquid phase densified silicon carbides or alumina ceramics also show faceted grain growth during densification, but with the A-axis being the fast growth direction. These ceramics have good fracture toughness; however, because the grain shape is plate like, the flaw size increases with the plate size, and the resulting strengths are less than observed for silicon nitrides. In-situ composites are of interest because they offer the potential for both low cost and high performance. The suggested technical approach for this topic is to combine theoretical modeling and exploratory composition work to develop controls for both grain shape and grain boundary chemistry during liquid phase densification. Silicon nitride chemistries are NOT of interest for this topic.

Phase I: Develop in-situ composites with bend strength and fracture toughness comparable to commercially available silicon nitrides.

Phase II: Further develop and optimize the mechanical properties of the most promising materials developed in Phase I, and complete the thermophysical characterization needed for design purposes.

COMMERCIAL POTENTIAL: High component costs greatly limit the applications of advanced ceramics. A material with the desirable mechanical properties of silicon nitride, but much lower cost, will open up many new markets where advanced ceramics are not yet cost-effective.

ARPA 94-028 TITLE: Wavelet-Based Methods for Information Processing in Communications Systems

CATEGORY: 6.2 Exploratory Development: Communications Networking

OBJECTIVE: Exploit recent developments in wavelets and multiresolution methods to provide adaptivity and efficient use of spectrum/bandwidth in communications.

DESCRIPTION: Wavelets combine several properties which may be exploited for communications, including time/frequency (scale) localization, orthogonality, and fast algorithms. In addition, several approaches, such as multiresolution and best-basis methods, offer the promise of providing adaptivity to communications. ARPA seeks methods to maximize data rates in a given bandwidth with robust performance and computationally efficient methods. Application of wavelets to coding, modulation, orthogonal signalling, and efficient filtering are among the areas to be exploited with these methods. A desirable outcome is improved methods which can deliver high data rates with adaptivity to channel characteristics, and can provide compression as required, and low probability of intercept transmission upon demand. The purpose of this effort is to investigate a general approach to the design of communications systems based upon wavelets and multiresolution methods to achieve some subset of the desired outcomes listed above.

Phase I: Define methods and derive algorithms. Perform simulations to demonstrate benefits of this approach to design multi-user communications systems. Provide a theoretical justification for anticipated benefits of this approach.

Phase II: Complete development of theoretical foundations and algorithms. Derive a general approach to the design of multi-user communications systems based upon wavelet or multiresolution methods. Demonstrate applicability of approach and improvements in performance to realistic scenarios of interest to ARPA. Perform preliminary design studies for implementation.

COMMERCIAL POTENTIAL: These methods have applications to many areas of commercial communications where current data rates and bandwidth use capabilities are limited.

ARPA 94-029 TITLE: Novel Methods for Automatic Target Detection and Recognition

CATEGORY: 6.2 Exploratory Development; Human-System Interfaces

OBJECTIVE: Develop novel multi-scale/multi-resolution signal processing methods for detecting and recognizing objects from sensor data, and demonstrate computationally feasible methods on real data.

DESCRIPTION: Many applications which require automatic detection and recognition of objects from sensor data share common signal processing problems. These include: removal of clutter/noise from signal; dealing with variations in background, object, and viewing aspect; as well as the computational complexity associated with standard algorithmic approaches. Wavelets and associated multi-scale methods offer the potential to overcome some of these problems by exploiting natural scales inherent in the problem, as well as offering computationally efficient methods by processing information at coarse-to-fine resolutions. This effort seeks novel algorithmic approaches to automatic detection and recognition of objects using wavelet and/or multi-resolution approaches. A diverse range of applications is of interest, including automatic detection and recognition of targets which may be partially obscured and/or embedded in ground clutter, and detection and recognition of objects in medical imagery for diagnostic assistance. Of interest is the development of computationally efficient methods for extracting features at scales which may be relevant to detection and recognition of objects, and doing so in a manner which exploits both the nature of the sensor/imaging system itself as well as a multi-resolution/multi-scale framework for processing the information. Proposals should address a specific application of interest to ARPA, along with a specific set of sensors/imaging techniques, as the context for development and validation of algorithms and for application of results.

Phase I: Develop an approach based upon wavelet/multi-resolution methods, as well as a set of algorithms for detection and/or recognition of objects. Show, using synthetic or real data, along with a theoretical justification, that this approach has significant potential for enhancing the ability to automatically detect and/or recognize objects in situations of practical interest to ARPA.

Phase II: Refine algorithms from Phase I and complete theoretical foundation for analysis of performance bounds. Develop software based upon algorithms and approach defined in Phase I. Demonstrate results on real data of interest to ARPA to validate method across a range of scenarios. Develop a design for practical implementation in hardware or software, as appropriate for the application.

COMMERCIAL POTENTIAL: This technology has applications that could assist in medical diagnosis for pre-screening and other situations where one needs fast algorithms for processing sensor data and for automatic recognition of objects.

ARPA 94-030 TITLE: Laser Applications in Medicine

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop new therapeutic and diagnostic applications of lasers in medicine.

DESCRIPTION: Lasers have been used in medicine as scalpels and welders. Many laser procedures are done outside the body. The most challenging use of lasers for surgery is for procedures done inside the body. The critical issues are the ideal laser wavelength and optimum delivery system. Optical fibers can deliver the laser energy through the body's natural passages, or can be inserted through needles. The focus of this effort is to develop flexible fiber optic laser delivery systems for surgical and optical tissue diagnostic applications. Optimum delivery systems can be developed with collaboration between clinicians and the laser industry.

Phase I: Develop concepts and perform proof-of-principle demonstration of an optimum fiber optic laser delivery system for surgical and diagnostic applications, working with clinicians in research hospitals.

Phase II: Demonstrate a prototype fiber optic delivery system and conduct clinical trials.

COMMERCIAL POTENTIAL: Fiber optic delivery of laser energy for surgical and diagnostic applications will have a beneficial impact on general medicine and health care costs by reducing the time and expense involved with many medical procedures.

ARPA 94-031 TITLE: New Concepts and Applications of Binary Optics

CATEGORY: 6.2 Exploratory Development; Sensors and Electronic Devices

OBJECTIVE: Develop high volume applications for binary optics and establish affordable fabrication processes.

DESCRIPTION: The optical properties of binary optics are based on the surface profile of the optical element. Passive optical elements with surface structures are fabricated using semiconductor processing technology. Binary optics is used in applications such as in optical sensors, optical communications, displays, and beam steering, to name a few. Each of these applications uses binary optics to improve their performance and reduce weight. These binary optics products have unique fabrication requirements. The fabrication process should match the accuracy of the optical designs, and be able to handle many designs and substrates. In addition, the fabrication process must be reliable and affordable. Future applications will depend on innovation in optical design and improvements in the fabrication process.

Phase I: Develop new concepts for applications of binary optics, and establish the fabrication process.

Phase II: Demonstrate the concepts developed in Phase I and establish the proof-of-principle fabrication procedures.

COMMERCIAL POTENTIAL: Binary optics will have many applications in medicine, optical communications, data storage, entertainment, displays, and electronic imaging systems.

ARPA 94-032 TITLE: Plasma Processing of Materials in Microelectronics and Photonics

CATEGORY: 6.2 Exploratory Development; Materials and Processing

OBJECTIVE: Develop and characterize the performance of advanced plasma etching techniques for sub-micron structures.

DESCRIPTION: Future microelectronic and photonic device fabrication demands high anisotrophy, line width loss less than 10%, and line width dimension approaching atomic scale. Conventional processing, such as wet and chemical etching techniques cannot accomplish the necessary pattern transfer fidelity. Plasma etching techniques for sub-micron structures which can fulfill the requirements of anisotrophy, selectivity, and uniformity are solicited. Emphasis will be on, but not limited to, electron cyclotron resonance techniques. Initial phase of the research should be devoted to the basic understanding of the process using computer simulation and analytical scalings. Individual codes, such as chemistry and transport codes, should be integrated to simulate the etching process self-consistently.

Phase I: Perform simulation and analysis on multi-dimensional plasma etching techniques. Perform initial design of proof-of-principle experiment.

Phase II: Finalize the design of proof-of-principle experiment. Construct and perform experiment with appropriate diagnostics.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the semiconductor industry.

ARPA 94-033 TITLE: Advanced Battery Technology

CATEGORY: 6.2 Exploratory Development; Energy Storage

OBJECTIVE: Demonstrate novel battery technology for dual-use, portable electronics applications.

DESCRIPTION: ARPA is interested in receiving innovative proposals for exploratory R&D on novel battery concepts such as organic batteries, and rechargeable metal/air and Ni/Zn batteries for dual-use portable electronics applications. Innovative approaches are sought for one or more of the following exampled list: 1) new or improved electrolyte chemistries which will provide a wide range of battery operating temperatures and interface stabilities; 2) new anode, cathode, and current collector materials which offer high-energy, high-power density and the opportunity for high cycle life and storageability; 3) the exploration of reactions occurring at electrolyte/electrode interfaces, and the identification and modification of failure, aging and life limiting mechanisms; and, 4) the construction and evaluation of prototype cells and batteries, including methods for fabricating and manufacturing high energy/power density batteries with highly reproducible charge/discharge capabilities, and the production and testing of same.

Phase I: Define, in detail, candidate battery technology, technical approach, trade-offs and risks for portable electronics applications. Support this effort with early prototyping and experimental data which demonstrates the feasibility of the technology.

Phase II: Develop and deliver prototype batteries with associated documentation and testing to compare to predictions. Demonstrate strategy and technical approach for the rapid prototyping of batteries of various shapes, sizes and capacities.

COMMERCIAL POTENTIAL: Commercial potential exists in portable electronics, cellular phones, laptop computers, communications equipment, and law enforcement technology.

ARPA 94-034 TITLE: Development of Non-Invasive Sensors of Biomedical Vital Signs and Body Chemistry Based Upon High-Temperature Superconducting Devices

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop and characterize the performance of non-invasive sensors for biomedical vital signs and body chemistry, based upon high-temperature superconductor (HTS) materials, for introduction into biomedical detection and imaging equipment.

DESCRIPTION: HTSs can be fashioned into a variety of highly sensitive detectors of electromagnetic radiation or static fields. Examples of such configurations are loop antennas, superconducting quantum interference devices (SQUIDs), and bolometers, which are responsive to radio frequency (RF) signals, small magnetic fields, and thermal radiation, respectively. Biomedical instrumentation can benefit from the introduction of such sensors, resulting in enhanced ability to understand biochemical function and/or image body structures.

Phase I: Construct and characterize the performance of a non-invasive sensor fashioned from HTS materials. Analyze its potential for the detection of biochemical activity or for enhanced imaging of body structures.

Phase II: Analyze the performance of a complete diagnostic system incorporating the non-invasive sensor, including trade-offs affecting the utilization of practical equipment. Construct, as far as is practicable, equipment for such a diagnostic procedure.

COMMERCIAL POTENTIAL: Hospital (both Veterans and civilian) utilization of biomedical sensor equipment (such as ultrasound, magnetic resonance imaging (MRI), etc.) is widespread and increasing in importance. Enhanced sensitivity, such as that afforded by HTS sensors, is of great commercial potential.

ARPA 94-035 TITLE: Exploitation of Novel Thin-Film Materials Such as Ferroelectronics, Ferrites, and High-Temperature Superconductors (HTS), for Microelectronic Circuitry

CATEGORY: 6.2 Exploratory Development; Electronic Devices

OBJECTIVE: Develop a process for incorporating new thin-film materials, such as ferroelectrics, ferrites, and HTS, into

miniature cost-effective configurations with integrated circuit (IC) devices, extendable to a monolithic fabrication which would eliminate conventional bulky electronics.

DESCRIPTION: Electronics equipment and systems presently are the result of utilizing IC chips, packaged in different forms onto boards, with other discrete components needed to complete the system. For radio frequency (RF) communications equipment, discrete components might include circulators, isolators, filters, delay lines, etc., which consume space and power. This effort should examine the methods to apply thin-film materials for accomplishing these functions, not necessarily limited to the case given for RF communications, resulting in a monolithic process for obtaining microelectronics with extended applicability.

Phase I: Assess the appropriate film growth technology for monolithic circuit applications. Develop innovative designs for configurations which replace the current hybrid technology with low-cost, small-size, high-performance alternatives.

Phase II: Develop accurate computer assisted design tools which represent the operation of the various devices in a monolithic configuration. Apply these tools to a specific system function, and develop a procedure for manufacturing an improved version of the system.

COMMERCIAL POTENTIAL: This technology can improve both military and commercial microelectronics by extending monolithic fabrication to more of the discrete components in the circuitry. A low-cost procedure for accomplishing this would be very valuable.

AR''A 94-036 TITLE: Development of Sensors for High-Resolution Imaging Systems with Applicability to Medical and Nonmedical Structural Issues

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop novel sensors with improved sensitivity and/or resolution for imaging applications, either for existing modalities or for other detection regimes.

DESCRIPTION: High resolution imaging systems generally are dependent upon the detection of x-rays, radio frequency (RF) radiation, or sound waves for the operation of such equipment as computed tomography (C-T), magnetic resonance imaging (MRI) or ultrasound imaging, respectively. Improvements in image quality will depend upon the development of better sensors, as well as the concurrent improvement in processing capability. However, new imaging modes will require the introduction of novel sensors.

Phase I: Present an analysis of the performance of a sensor of novel design, based upon physical principles which were delineated in the proposal. Design and build such a sensor, and compare its performance with the previous analysis.

Phase II: Present an analysis of the system performance using such a sensor, based upon the application and its required instrumentation which were given in the proposal. Design and build, as far as is practicable, the instrumentation for the demonstration of the performance enhancement with the novel sensor.

COMMERCIAL POTENTIAL: The potential of utilizing novel sensors in medical imaging applications is very great, in conjunction with other modalities such as MRI and C-T scan. Nonmedical structural applications also have great potential.

ARPA 94-037 TITLE: Biomedical Technology

CATEGORY: 6.3 Advanced Development; Materials

OBJECTIVE: Develop and further exploit the defense technology and knowledge base in an effort to revolutionize the accessibility and quality of health care delivery while reducing national aggregate health care costs.

DESCRIPTION: Advances in key DoD technology base areas (e.g., biotechnology, computer graphics, computational and synthetic chemistry, and imaging technology) offer a unique opportunity to significantly improve the quality and delivery of health care to military and civilian populations. Proposals are invited that would improve national capabilities in: (1) the rapid treatment of distributed shock (systemic inflammatory response syndrome) - to prolong the "golden hour" of trauma care and to reduce mortality/morbidity associated with intensive/critical care; (2) the non-invasive monitoring of blood analytes and blood gases; and (3) non or minimally invasive (digital) imaging of the skeletal system and tissue/vital organ function. Work on the

development of novel "contrast" reagents that can be exploited for functional analysis may also be included under item (3) above. Offerors may submit in response to any of the three identified areas shown above.

Phase I: Develop proposals which identify novel methodological and technological concepts and focus efforts on central research issues with reasonable proof of technical progress.

Phase II: Provide initial proof-of-concept demonstrations.

COMMERCIAL POTENTIAL: Progress in this area impacts both military battlefield and peacetime health care, and is broadly applicable to civilian needs in preventive medicine, advanced diagnostics, trauma care, and remote care delivery.

ARPA 94-038 TITLE: Computer Aided Modeling of Millimeter-Wave Frequency Monolithic Integrated Circuits (ICs)

CATEGORY: 6.3 Advanced Development; Electronics

OBJECTIVE: Provide models for millimeter-wave monolithic integrated circuits. Emphasis should be placed upon the development of models that accurately predict device/circuit performance from processing parameters.

DESCRIPTION: Solid state millimeter-wave devices and integrated circuits are expected to be used in a wide range of military and commercial applications. However, to accurately and inexpensively develop more effective integrated circuits, models of both active devices and passive components that accurately reflect millimeter-wave performance are needed. This program focuses upon the development of those models. Of particular interest are models which can be used to relate processing parameters to circuit design parameters.

Phase I: Select one or more solid-state devices or integrated circuit configurations which operate at frequencies between 20 and 100 GHz. Develop models which result in accurate prediction of device and/or circuit performance. Provide a clear indication of accuracy and needed improvements for the model. Consideration should be given to how proposed models will extend computer aided design (CAD) capabilities beyond those afforded by use of existing models and the compatibility of the models with existing commercially supported software packages and workstations.

Phase II: Complete model development and write appropriate software descriptions that can be used in conjunction with commercially supported software and workstations. A goal should be to produce commercial software products for sale by an established microwave CAD vendor so that they can be used by the widest possible number of people.

COMMERCIAL POTENTIAL: Accurate models will greatly help in lowering production costs of millimeter wave circuits. Commercial applications for these circuits include automotive radar, communications, and "vision" through smoke, fog, and other adverse weather conditions.

ARPA 94-039 TITLE: 3-D Electromagnetic Simulation of Microwave & Millimeter Wave Multi-Chip Packages & Sub-Arrays

CATEGORY: 6.3 Advanced Development; Electronics

OBJECTIVE: Accurately simulate the effects of interconnections and packages on the performance of combinations of microwave and/or millimeter wave monolithic integrated circuits (MMICs), associated digital circuits, and photonic circuits. Three dimensional electromagnetic simulation techniques are of particular interest.

DESCRIPTION: Combinations of MMICs, digital circuits, and possibly photonic circuits are expected to be used to implement radar transmit/receive (T/R) module and sub-array functions at microwave and millimeter wave frequencies. However, the ability to accurately simulate the performance effects of interconnections between integrated circuit chips, as well as the effects of the enclosures (packages) upon the performance of the circuits is of critical importance to reducing the cost of these implementations and achieve necessary performance characteristics. This program seeks to develop computer-aided design (CAD) programs, particularly using three-dimensional electromagnetic simulation techniques, that accurately simulate performance, at microwave and millimeter wave frequencies, of these enclosed (packaged) interconnections of several integrated circuits.

Phase I: Select one or more integrated circuit configurations that are intended to perform radar T/R module or sub-array functions. Develop an approach that will use three-dimensional electro-magnetic simulation techniques to provide accurate models of the performance of the interconnections between circuits, the enclosures (packages), and needed improvements for the simulator. Consideration should be given to how the proposed simulation approach(es) will extend capabilities beyond those

afforded by use of currently existing techniques and software programs and the compatibility of the approach with existing commercially supported software packages and workstations.

Phase II: Complete simulator development and write appropriate software descriptions that can be used in conjunction with commercially supported software and workstations. A goal should be to produce commercial software products for sale by an established microwave CAD vendor so that they can be used by the widest possible number of people.

COMMERCIAL POTENTIAL: Accurate models will greatly help in lowering production costs of T/R modules and sub-arrays. Commercial uses of T/R modules include automotive collision avoidance radar, communication systems, and identification and tracking of trucks, buses or automobiles.

ARPA 94-040 TITLE: Development of Quasi-Optical Circuits for Millimeter-Wave Frequency Operation

CATEGORY: 6.2 Exploratory Development; Telecommunications

OBJECTIVE: Develop quasi-optical millimeter wave frequency circuits which have superior performance characteristics compared to those of conventional millimeter-wave monolithic integrated circuits.

DESCRIPTION: Quasi-optical components have been developed that have the potential for low-cost production and promising performance at millimeter-wave frequencies. However, additional work must be performed to achieve higher power output and efficiency, greater levels of integration, and develop techniques and capabilities for low-cost production.

Phase I: Identify promising approaches for producing quasi-optical components such as millimeter-wave power sources, power amplifiers, mixers, low noise amplifiers, or combinations of these circuits. Focus upon approaches that will result in batch fabrication capabilities leading to low-cost manufacturing. If possible, produce initial circuit samples and evaluate them for millimeter-wave performance characteristics.

Phase II: Continue development of quasi-optical millimeter-wave frequency circuits with emphasis on low-cost production. Evaluate yield and millimeter-wave performance of components that are produced.

COMMERCIAL POTENTIAL: These devices are expected to be used at millimeter wave frequencies to perform functions that cannot be readily accomplished using older technologies. Millimeter wave circuits have commercial application to communications systems and "vision" through fog and smoke.

ARPA 94-041 TITLE: Cost-Effective Multi-Chip Integration Technologies

CATEGORY: 6.3 Advanced Development; Electronic Devices

OBJECTIVE: Accelerate the emergence of a viable, domestic merchant multi-chip module (MCM) infrastructure. In particular, we are interested in efforts which will lower the cost of designing, manufacturing, and testing MCMs through the application of new software tools, equipments, materials, and processes.

DESCRIPTION: Despite doubling of integrated circuit (IC) density roughly every 18 months, we see a continuing need to cost-effectively interconnect multiple die without adding substantial overhead in terms of performance, volume, weight, or reliability. Conventional single chip packages and printed circuit board technology have not kept pace with advances in IC performance and density making it difficult or expensive to implement many next-generation products in the computing, communications, automotive, and defense markets. As a result, alternative approaches such as MCMs have emerged as a way to close the gap. While the potential for these technologies has been demonstrated, widespread acceptance by systems users has not taken place due to perceived risks and high costs. The purpose of this effort is to produce an order-of-magnitude reduction in MCM cost, develop a domestic supplier infrastructure, and accelerate the acceptance and insertion of advanced multi-chip integration technologies. In particular, we hope to develop the software to produce error-free, manufacturable, and testable designs as well as the key manufacturing equipment, materials, and processes necessary to manufacture, assemble, and test modules that meet the needs of the aforementioned markets in a cost-effective and environmentally responsible manner. Areas of particular interest include techniques for die and wafer level burn-in; large format (>400x400mm) manufacturing equipment for thin-film processes; cost-effective large format substrate materials; equipment, processes, and materials for significantly increasing the wiring and via densities of thin, low-cost, laminate substrates; design tools for digital and analog modules; test strategies and software tools for testing completed modules; and computer-integrated manufacturing (CIM) systems.

Phase I: Define market requirements for new software tool, equipment, material, or process to be developed under

a Phase II effort. Establish performance and cost matrices, identify major risk factors, develop customer and supplier relationships, and prepare business plan. Perform top-level design. Demonstrate feasibility of approach through risk reduction experiments or early prototypes.

Phase II: Complete detailed design. Develop and prototype product in collaboration with suppliers and customers. Demonstrate performance against matrices defined in Phase I.

COMMERCIAL POTENTIAL: MCMs are a generic dual-use technology required by a broad range of military and commercial electronic systems. Products (software, equipment, materials, processes, etc.) resulting from this effort would be sold to merchant manufactures of MCMs.

ARPA 94-042 TITLE: Multi-Chip Module (MCM) Application Development

CATEGORY: 6.3 Advanced Development; Communications Networking

OBJECTIVE: Accelerate the emergence of a viable, domestic merchant MCM infrastructure. In particular, to stimulate market demand by demonstrating exciting new dual-use products which leverage, or are enabled by, MCM technology.

DESCRIPTION: Despite doubling of integrated circuit (IC) density roughly every 18 months, we see a continuing need to cost-effectively interconnect multiple die without adding substantial overhead in terms of performance, volume, weight, or reliability. Conventional single chip packages and printed circuit board technology have not kept pace with advances in IC performance and density, making it difficult or expensive to implement many next-generation products in the computing, communications, automotive, and defense markets. As a result, alternative approaches such as MCMs have emerged as a way to close the gap. While the potential for these technologies has been demonstrated, widespread acceptance by systems users has not taken place due to perceived risks and high costs. The purpose of this effort is to encourage systems designers to become early users of MCM technology by funding the design and prototyping of dual-use products which leverage the emerging technology. Other ARPA programs may co-fund pilot-production of selected MCMs. The success of this effort will lower perceived risk by demonstrating successful insertions and lower MCM cost by generating high-volume applications. Example motivations for using MCM technologies include: (1) implementing high performance systems which cannot be implemented using conventional packaging technologies due to signal propagation delays; (2) reducing the size and weight of existing subsystems to enable them to be inserted into new applications; (3) increasing the functionality of systems now limited by size/weight through higher levels of integration; (4) enabling the integration of multiple IC technologies into a single component; (5) integration of sensors, actuators, and displays with information processing components; (6) reducing system cost or increasing system reliability through the elimination of multiple expensive single-chip packages; (7) early implementation of next-generation Ultra-Large Scale Integration (ULSI) components before monolithic IC solutions become feasible; (8) exploitation of very high MCM interconnect and chip input/output densities to realize radical new computer architectures. Example high-volume, dual-use MCM products include: (1) high performance general purpose or special purpose processors that combine microprocessors with memory and interface logic; (2) PCMCIA card-based computing, memory, communication, or positioning systems; (3) personal navigation systems combining micro-mechanical sensors with global positioning and computing electronics; (4) integrated flat-panel display products which incorporate processor and drive electronics; (5) scalable computing elements which exploit MCM technology; (6) ubiquitous, personal wireless communicators; and (7) automotive or aerospace products exploiting MCM performance and reliability to enable real-time engine control.

Phase I: Define market requirements for the new product. Establish performance and cost matrices; identify major risk factors; develop customer and supplier relationships; estimate market size; and develop business plan. Perform top-level MCM design. Select MCM technology and suppliers.

Phase II: Complete detailed design. Develop and prototype product in collaboration with suppliers and customers. Demonstrate performance against metrics defined in Phase I.

COMMERCIAL POTENTIAL: Electronics is a $600 billion world market. Demand for smaller, lighter, more portable systems means that MCM technology could become a pervasive enabling technology as well as a product differentiator in many key markets.

ARPA 94-043 TITLE: Real Time Printing of Fine Line Patterns on Printed Wiring Boards

CATEGORY: 6.3 Advanced Development; Materials and Processes

OBJECTIVE: Investigate innovative methods for high speed direct writing of circuit patterns on printed wiring board photoresists.

DESCRIPTION: Printing of fine line patterns onto photographic masters has been possible for several years. Photoplotters capable of imaging fine lines on film are available from several manufacturers. Transfer of the image from the master to the photoresist on the printed wiring board (PWB) is difficult when conventional phototools and photoresists are used. A possible solution is to image fine line patterns directly on the photoresist to avoid the problems inherent in the contact printing approach used to transfer images from the phototool. Several companies have developed laser direct imaging systems, similar to laser photoplotters. These imaging systems have two inherent problems: 1) The lasers used in these systems are inefficient and unreliable; and 2) laser replacement is expensive. The systems are very slow (compared to conventional contact printing) due to the large number of pixels required in the generation of a fine line pattern. To make direct imaging systems compatible with conventional PWB lines, it will be necessary to print patterns at a rate of 5 to 6 sq. ft. per minute with a .2 mil resolution.

Phase I: Evaluate various methods of achieving the speed required for real time imaging of circuit patterns on PWB photoresists. Determine applicability to multi-chip module substrate patterning. Evaluate the preferred approach in a breadboard assembly. Develop cost comparison with standard PWB processing. Complete a design concept for a full-scale real-time imaging system.

Phase II: Complete the detailed design and build a prototype system capable of real time printing of fine line patterns on PWBs. Test the system to determine capabilities, areas needing improvement, and applicability and modifications needed for multi-chip module (MCM) applications. Develop concept for a "factory hardened" version of the prototype machine.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the electronic manufacturing industry.

ARPA 94-044 TITLE: Sensor Fusion Using Neural Networks, Fuzzy Logic Systems and Parallel Processing Techniques

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Develop a robust, efficient, and transportable methodology for performing real-time data/sensor fusion in the air defense environment.

DESCRIPTION: In the modern battlefield, threat information can come from a number of sources, each with its own particular strengths and weaknesses. This can lead to ambiguities in threat assessment and location information. As a result, the efficiency and efficacy of the fire unit operator is degraded. It follows that any efforts to improve the fire unit operator's comprehension of the battlefield situation will produce corresponding reductions in fatalities due to friendly fire. A system or methodology is desired, processor-based or microprocessor-based, which can take data with an associated degree of uncertainty from multiple sources and combine it to produce a target identification and location solution with a significantly higher degree of accuracy and, when unable to do so, put bounds on the uncertainty of the result.

Phase I: Define a set of targeting information data sources with which the fusion system will work. Based upon that set, choose several neural and fuzzy logic-based paradigms which appear promising, and develop the associated networks and rule bases required to implement the problem solution using them.

Phase II: Evaluate the various paradigms selected under Phase I using computer generated threat laydowns based upon the statistical parameters of the data sources. The best of these shall be selected for examination for potential use on air defense weapon systems.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the manufacturing controls industry.

ARPA 94-045 TITLE: Low-Cost, Real-Time Image Processing

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Digitize, image process, and compress full-screen, high-resolution video in real time at frame rates of at least 30 frames per second, using a low cost, single board approach.

DESCRIPTION: A requirement exists for a programmable board or board set for a personal computer that would digitize and process video images in real time at a minimum of 30 frames per second. An approach which emphasizes low-cost, high-performance, and selectable image processing is desired. The system should be able to handle 8-bit color or 256 shades of grey, or better. It should also be able to apply a variety of commonly needed image processing methods such as shadowing,

sharpening, noise removal, contrast optimization, and convolutions. Moreover, it should be able to compress spatially and/or temporally to achieve at least a 100 to 1 reduction in storage space requirements as compared to uncompressed video.

Phase I: Consists of system conceptual design, hardware specification, algorithm selection, and hardware design. This phase should result in a prototype that can at least perform the video digitizing and compression, and can be demonstrated using video data supplied by the government.

Phase II: Implement the required image processing methods and algorithms, and proving operation of the system in a real time, live environment in government test labs.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the area of communication and the entertainment industry.

ARPA 94-046 TITLE: Noise Abatement

CATEGORY: 6.2 Exploratory Development; Propulsion and Vehicular Systems

OBJECTIVE: Explore the possibilities for a noise abatement system for internal combustion engines.

DESCRIPTION: There is a requirement in both the military and the commercial arenas for noise abatement. The elimination of the muffler and various resonators from automobiles would have a dramatic increase on engine performance and efficiency. In the military this is important for cost and efficiency reasons. In addition, the military has requirements to silence equipment associated with forward area operations. This requirement takes on new significance with the development of acoustic sensors which are being implemented in the bat smart submunition. Some successful work has been done in the commercial sector toward this end, suggesting that such silencing may be possible.

Phase I: Investigate and perform a study to determine the feasibility of such a concept for military applications.

Phase II: Develop and fabricate a prototype for evaluation.

COMMERCIAL POTENTIAL: Advances in engine performance and efficiency have significant commercial potential in the automotive industry.

ARPA 94-047 TITLE: Advanced Fiber Winding and Design Techniques

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Advance the development and fabrication of ultra-miniature fiber sensing coils for fiber gyroscopes that result in improved performance for ultra-miniature sizes.

DESCRIPTION: Optical Fiber Sensing Coils wound with polarization-maintaining (PM) fibers tend to degrade gyroscope performance as the coils become smaller and smaller. New winding and design techniques need to be developed before ultra-miniature fiber optic gyroscopes can be inserted into high accuracy systems which require the performance of the PM fibers. There is a need for very small fiber sensing coils which maintain the performance levels of the larger sensing coils being utilized now.

Phase I: Develop an approach for fabricating ultra-miniature fiber sensing coils (outer coil diameter < 1 inch) that leads to improved performance for fiber gyroscopes.

Phase II: Design and fabricate prototype ultra-miniature sensing coils. Evaluate the performance characteristics of the coils. Evaluate the performance of the coils within fiber gyroscope systems. Provide a detailed set of the procedures, including a description of the necessary equipment and facilities, for producing ultra-miniature fiber sensing coils.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the transportation industry.

ARPA 94-048 TITLE: Development of Ultra-Miniature Fiber Sensing Coils for High Accuracy Fiber Optic Gyroscopes

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Advance the development and fabrication of ultra-miniature (outer diameter less than 1 inch) fiber sensing coils for high accuracy (< 1 deg/hr) fiber optic gyroscopes.

DESCRIPTION: The type of material selected for the fiber sensing coil is a critical factor which determines how the gyroscope will perform over a given temperature range. Elimination of the core material can eliminate the thermal expansion problems experienced in high accuracy applications. A formless coil or freestanding fiber optic coil held together with adhesives could lead to high accuracy gyroscopes which are insensitive to material expansion problems.

Phase I: Develop an approach for fabricating formless fiber optic sensing coils for high accuracy applications. The approach should take into consideration the minimization of thermal gradient effects.

Phase II: Fabricate prototype formless coils and evaluate the performance characteristics. The solicitor will provide a detailed set of the procedures, including a description of the necessary equipment and facilities for producing the high accuracy, formless fiber sensing coils.

COMMERCIAL POTENTIAL: Significant commercial potential exists with commercial navigation equipment.

ARPA 94-049 TITLE: Lateral Storage and Loss Moduli of Optical Fibers Under Line Contact Loads

CATEGORY: 6.2 Exploratory Development; Communications Networking

OBJECTIVE: Develop the methodology, software, and equipment required to characterize the lateral storage and loss moduli of parallel optical fibers under line contact load as a function of time and temperature.

DESCRIPTION: The optical fiber data link is a critical component of Fiber Optic Guided Vehicle (FOG-V) dispensers designed for high speed payout. During dispenser fabrication, layers of fiber are wound onto a bobbin at precise tensions. After winding, the residual tension profile of the fiber layers decreases with time due to viscoelastic processes. The purpose of this research is to use this information to obtain a better understanding of the lateral deflection of the fibers due to contact pressure. A system is needed to measure the storage and loss moduli of parallel fibers under a lateral contact pressure. The system must be able to perform reliable measurements of optical fiber deflections due to lateral contact pressures of between 10 grams to 2000 grams, over a temperature range of -80 C to +80 C and a minimum frequency range of 0 Hz (static load) to 10 Hz. The system must have a 0.5 micrometer repeatability and resolution for deflection measurements between adjacent fiber turns.

Phase I: Perform analysis and design/fabricate a breadboard system. Demonstrate the system by measuring the lateral deflection of adjacent fibers in a parallel array of optical fibers under ambient conditions with the resolution and repeatability shown above for static loads between 10 grams and 2000 grams.

Phase II: Complete development of the system. Perform studies to determine the curves for storage and loss moduli for the fiber buffer coatings in contact as a function of buffer diameter, distance between fiber turns on the same layer, frequency, and temperature. Perform modelling of optical fiber properties under static and dynamic conditions to determine the effects of the properties investigated. Make recommendations for an optimum optical fiber for high speed payout applications.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the communications industry.

ARPA 94-050 TITLE: Development of Magneto-Optical Spatial Light Modulator Using Rewritable Optical Disk Technology

CATEGORY: 6.2 Exploratory Development; Electronic Devices

OBJECTIVE: Develop a device that will spatially encode and store magneto-optical material (i.e. a rewritable optical disk) with an image, and also be capable of encoding a laser beam with that stored image.

DESCRIPTION: Rewritable optical disks store digital information by taking advantage of the magneto-optical Kerr effect. A laser beam is used to heat a particular spot on the optical disk above its Currie point in the presence of a magnetic field. The molecules of the optical disk in the heated spot will align themselves with the magnetic field. The laser is then turned off and the disk is allowed to cool while still in the magnetic field. This causes the spot that was heated to have a grouping of molecules that have aligned magnetic moments. When an unpolarized light beam is incident on this group of aligned molecules, that beam

will be polarized a given amount. It should be possible to create a spatial light modulator from this technology which can adjust magnetic field strength and direction in order to achieve a large number of grey scales. Also, pixel sizes could be as small as the focal spot size of the laser beam, enabling a large number of pixels to be placed in a small area.

Phase I: Create a method of spatially encoding and reading optically rewritable material. A prototype device that encodes the optical material and uses that material to encode a laser beam should be constructed.

Phase II: Refine the design of Phase I such that the device can display real-time video signals (such as NTSC video output from a video camera or recorder) on the spatial light modulator. This device should be constructed with the intent of being utilized in an optical processing system such as an optical correlator.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the electro-optical communications industry.

ARPA 94-051 TITLE: Covert Ultra-Wideband Radio Frequency (RF) Data Link

CATEGORY: 6.2 Exploratory Development; Telecommunications

OBJECTIVE: Develop a covert, ultra-wideband (UWB), radio frequency (RF) data link for the transmission of digital data.

DESCRIPTION: UWB is defined as having an instantaneous bandwidth greater than 25% of the center frequency. UWB signals are generated by use of a short-duration pulse. The advantages of UWB include: (1) minimal multipath distortion, (2) immunity to EW jammers, and (3) the ability to transmit through foliage and obstacles. Innovative ideas are sought for the design and implementation of a UWB RF data link with the following attributes: (1) digital data rate of at least 100 kb/s (desired of 100 Mb/s), (2) instantaneous bandwidth greater than 25% of center frequency, and (3) center frequency between the values of 4 to 30 GHz. The UWB RF data link should include an interface for digital data, modulator, transmitter, transmit antenna, receive antenna, receiver, and demodulator, as well as any other hardware to make a complete and operational system for evaluation. Proposal should contain detailed description of the design of the UWB RF data link as well as the implementation. Designs which show innovation in the areas of modulation techniques, pulse generation, receiver technology, and digital data rate will be given priority.

Phase I: Provide detailed analysis of the proposed design including experimental evaluation plan.

Phase II: Develop hardware and perform laboratory and field demonstrations to verify the technical approach.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the communications industry.

ARPA 94-052 TITLE: Moving Signal for Highway Safety Under Obscured Conditions (Sensor/Beacon)

CATEGORY: 6.2 Exploratory Development; Navigation, Guidance, and Vehicle Control

OBJECTIVE: Build and demonstrate prototype sensor/beacon devices to pace traffic when fog or smoke obscures roadways.

DESCRIPTION: Roadway embedded units similar to lane reflectors would sense the passage of individual vehicles and turn on a self-contained Light Emitting Diode (LED) beacon for a period after vehicle passage. This produces an effective light tail which extends behind the vehicle and acts to provide a visible distance buffer to the following driver, who cannot see the leading vehicle itself. More complex functions of traffic control could also be executed if the individual sensor/beacons are netted and centrally controlled.

Phase I: Analyze requirements for visibility and safety parameters. Negotiate nominal requirements with National Highway Transportation Safety Agency (NHTSA) or other authority in the transportation field. Build a small number of prototypes and conduct a parking-lot-scale demonstration.

Phase II: Build a large number of prototypes and place them in a roadway known to be afflicted with obscurations, such as a mountain highway or industrial zone. Conduct testing.

Phase III: Analyze the requirements for a netted system and design a system having multiple functions of traffic control. For example, pacing of traffic in tunnels and on bridges.

COMMERCIAL POTENTIAL: Significant commercial potential exists in the transportation industry.

ARPA 94-053 TITLE: Reconfigurable Ocean Structures, Including Materials, Joinery, Propulsion, Generators, Automation, and Robotics

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Develop concepts for advanced open-system, modular, reconfigurable, and rapidly deployable ocean platforms and crafts, including high-risk, high-value, scalable components, such as advanced materials, joinery/connectors, engines, motors, generators, automated control systems, and robotic assembly fixtures and machines.

DESCRIPTION: The focus of this program will be on modular components that can be reconfigured into multiple mission-specific configurations. The program will examine scalable systems and high value components that can be tailored to meet multiple defense missions and are applicable for commercial uses. The systems and high value components must be "open" in nature, i.e., composed of standard primitive elements that can be joined and integrated into more complex high value components and systems. This "open systems" approach will facilitate more affordable initial development and operations, diminish the possibility of long development cycles after technological surprise, and support the mission specific tailoring of components and systems for future distributed war fighting scenarios. This program is divided into three main areas: families of large modular systems; families of small modular systems; and high value components. Large modular systems include Mobile Offshore Bases (MOBs) and portable ports. MOBs are extremely large floating structures that have the potential to reduce the amount of strategic sea lift required in support of contingency operations. Substantial forces and supplies could be pre-positioned near the theater in international waters, obviating the need for host country support. Portable ports provide the ability to rapidly discharge cargo at coastal locations having limited or no port facilities. At the other end of the size spectrum are the small modular systems deployed in constellations to perform their mission. For example, families of reconfigurable small craft with multi-mission capabilities could be deployed in support of operations such as surveillance, mine warfare, strike warfare, or counternarcotics. The patrol class size vessels would be rapidly deployable by air or ship and quickly assembled and configured near or in theater for specific missions. The third area of the program is the high-value components that make up each module. Such high-value components typically account for approximately one third of the acquisition and life cycle costs of maritime platforms. High-value components include advanced engines and propulsion, electric motors, generators, and cranes. Advanced engines and propulsion with high-efficiency, modular construction, and multi-fuel capability at low emissions and noise levels would be applicable in all ocean structures, platforms, and ships. Advanced motors, generators, and controllers with high power densities, compact modular designs, and low noise would also be applicable to all ocean structures, platforms, and ships. Advanced integrated electric drive and power distribution systems represent reduction in weight, volume, and acquisition and life cycle costs, while improving performance. Cranes with robotic capabilities would allow automated construction and repair of ocean platforms, facilitate rapid cargo handling, and compensate for relative motion between large structures at sea.

Phase I: Develop concept designs, subscale demonstrations, and proof-of-concepts in high-risk mitigation areas for modular systems and components. Conduct laboratory investigations and perform a laboratory demonstration which furnishes proof-of-principle for the proposed solution.

Phase II: Develop refined preliminary design documentation and additional subscale demonstrations in high risk mitigation areas and full scale prototypes, as appropriate.

COMMERCIAL POTENTIAL: If successful, this program would have tremendous impact across multiple disciplines. The design and manufacturing technologies for modular systems would be brought to state-of-the-art levels, driven by the need for reduced cost. Quality and performance improvements to high-value components would increase U.S. competitiveness in the worldwide maritime industry. For example, MOBs have tremendous dual-use potential in commercial structures such as floating airports, large industrial processing plants, and ocean power generation systems. Even missile and satellite launch sites could be built economically. Portable ports and causeway construction have dual-use potential in commercial structures such as piers, bridges, port facilities, and traveling bridges for highway bypasses during road repair and construction operations. For reconfigurable small craft, open systems design and modular construction would allow rapid deployment by air or sea and rapid mission specific reconfiguration near or in theater. Local law enforcement agencies, as well as the entire maritime industry, would be the recipients of this technology. Selective and effective infusion of technology into high-value components would have significant payoff for the maritime industry.

ARPA 94-054 TITLE: Acoustic Lenses for Affordability in Sonar and Biomedical Applications

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop compact and relatively low cost acoustic lenses for application to hand-held sonar systems, unmanned vehicle sonar systems, and medical ultrasound systems.

DESCRIPTION: Sonars are critical tools for underwater obstacle avoidance, bathymetry, acoustic imaging, and search and navigation. In general, one wants the sonar to sense a surface or volume with high resolution within a large field or view and have the interrogations updated as frequently as possible. Acoustic lenses provide a relatively compact and inexpensive sensor that can transmit, then receive multiple conical or rectangular beams using no beamforming electronics. Acoustic lenses have the potential for widespread applications including hand-held sonar systems, unmanned vehicle sonar systems, and medical ultrasound systems. Reduction in size and cost of acoustic lenses can lead to increased affordability of underwater survey and navigation equipment and reduction in cost of medical ultrasound equipment. Development of acoustic lens technology is not desired, but application of acoustic lens technology toward reduction of sonar size and cost is desirable. Also, applications for use of acoustic lens technology in commercial and medical devices is sought.

Phase I: Demonstrate the application of acoustic lens technology and its effectiveness in reducing overall system size and cost, compared to existing systems.

Phase II: Perform laboratory testing of a prototype system.

COMMERCIAL POTENTIAL: Acoustic lens technology has applicability to medical ultrasound devices, underwater survey, underwater searches, and marine salvage.

ARPA 94-055 TITLE: Novel Actuation Schemes to Convert Various Forms of Energy into Proportional Mechanical Outputs for Servo-Controlled Applications

CATEGORY: 6.2 Exploratory Development; Propulsion and Energy Conversion

OBJECTIVE: Develop computer controllable actuation schemes to convert alternative energy sources into proportional mechanical outputs usable for device drivers.

DESCRIPTION: ARPA is investigating innovative techniques to control the movement of robot components, machines that move control vanes, ducts, ducting mechanisms, blocking devices, passages, control surfaces, and flow control devices, etc. There are many types of energy sources, i.e., chemical, mechanical, biological, etc., some of which have high energy densities. ARPA is seeking those sources whose actuation can be finely controlled by computer. The actuated movements that are required have vastly different quantities, such as speed, torque, bandwidth (large bandwidth desired), stiffness/softness, reliability, weight, force (high force per unit weight), etc. The entire required system support in any potential actuation schemes - energy source, power take off, conversion, control, etc., and emissions produced from such schemes, e.g., sound, vibration, radiation, etc. - must be considered. These systems should be made as small as possible, and therefore, macro (array) application of micro systems should be considered. Consider any new manufacturing technology required to develop these energy conversion schemes.

Phase I: Define and develop innovative alternative energy sources, conversion techniques, actuators, control systems, and manufacturing techniques applicable to finely controllable devices that lend themselves to computer control. The key technologies or components should be demonstrated.

Phase II: Test and demonstrate a complete system in the laboratory and the field. Develop production techniques and cost estimates for proposed systems.

COMMERCIAL POTENTIAL: Anticipated products are personal generators, devices for controlling flow in aircraft engines and on flight control components, and actuation devices in automobile engines for control of engine functions or within the interior for personal comfort, etc.

ARPA 94-056 TITLE: Use of Advanced Compression Techniques to Transmit Video-Based Products Via Very Small Bandwidth Satellites and Twisted-Pair Circuits

CATEGORY: 6.3 Advanced Development; Communications Networking

OBJECTIVE: Develop advanced hardware and/or software, including data compression techniques, which will allow real-time video transmissions for virtual boardroom applications between remote or mobile sites via Navy UHF satellites, twisted-pair

wiring, or other limited-bandwidth media.

DESCRIPTION: Many recent advances in data compression techniques are applicable to increasing the capabilities or lowering the costs of communications networks commonly used for data and still picture transmission. The development of commercial real-time teleconferencing (including videophones) is driving the need for developing techniques/technologies with special applicability to real-time video transmissions. Video transmissions are inherently different from normal data transmissions due to two factors: the large amount of data required for full screen updating of real-time transmissions; and, the (often) large degree of correlation from one video frame to the next. This correlation makes video a particularly attractive target for data compression, where improvements on the order of 50:1 may be achievable.

Widespread commercial acceptance of video-based services will rely on the development of low-cost technologies for transmission. In turn, the utility of these transmissions will be based on the development of new and innovative data compression techniques to support the real-time interchange of video information. The development and implementation of these advanced data compression techniques is the goal of this SBIR.

There is a large potential for dual use in this project. Specific applications include advanced/lower cost video telephones (including mobile video or "cellular videophones"), video teleconferencing, distributed video incorporated in industrial training and new, smart-road video display systems. The development of advanced data compression envisioned in this project is for use with relaying a variety of video-based services. These services include primary imagery dissemination, mission planning data, video teleconferencing, telemedicine images, television programming, and training video images. The anticipated communications path includes a 48 KHz UHF satellite system with potential expansion to twisted-pair circuits.

Phase I: Investigate the data compression required for video-based services. Determine the required data transmission rates to support primary imagery dissemination, mission planning data, video teleconferencing, telemedicine images, television programming, and training situational images and compare to the bandwidth available with a 48 KHz UHF satellite system and with twisted-pair circuits. Propose specific software and/or hardware technologies to perform compression for each transmission regime. Conduct laboratory investigations and perform a laboratory demonstration which furnishes proof-of-principle for the proposed solution.

Phase II: Perform laboratory testing and preliminary builds of solution hardware and software technologies. Conduct a demonstration of the proposed compression techniques in a fixed-base to fixed-base setting. Conduct a demonstration of the proposed compression techniques in a fixed-base to mobile (e.g., ship or airborne) platform.

COMMERCIAL POTENTIAL: Data compression for video services can be used in any current commercial video teleconferencing system, video phones, airline pilot trainers, and smart-road systems utilizing video displays of maps with environmental and situational overlays.

ARPA 94-057 TITLE: Non-Evasive Communication with Embedded Sensors in Composites

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop systems for communicating non-evasively with various embedded sensor systems in composites.

DESCRIPTION: Various sensors have been successfully embedded in thick composites during fabrication. Algorithms are being developed to convert sensor signals into engineering data, all of which is communicated via fiber optic links. The next step is to remotely interrogate the embedded sensors during fabrication and service life to acquire real-time information on the health of the structure. Many parameters can be evaluated, such as temperature, pressure, stress, strain, etc., and combined into meaningful information.

Phase I: Demonstrate ability to remotely interrogate sensors embedded in thick composites, and obtain useful engineering data. Identify system requirements and constraints for use in thick composite structures.

Phase II: Demonstrate system functionality by loading a thick composite embedded sensor structure. Subject it to varying loads and environmental stresses while interrogating internal sensors for its structural integrity.

COMMERCIAL POTENTIAL: Commercial potential exists in the monitoring of the fabrication processes, assessment of structural health of composites during service, and an indicator when service/repair/replacement is required. This technology will provide confidence in using composites in "hard to inspect applications" as well as provide feedback information on the adequacy of the design such as bridges, dams, buildings, and transportation structures.

ARPA 94-058 TITLE: Automatic System Identification Techniques and Micromechanical Sensors and Actuators for Active Vibration and Noise Control in Precision Fabrication

CATEGORY: 6.3 Advanced Development; Sensors

OBJECTIVE: Develop the capability to perform on-line real-time automatic system identification for general purpose active noise and vibration control systems targeted for precision fabrication applications, and develop scalable families of micromechanical sensors and actuators for use in these active vibration control systems.

DESCRIPTION: Many precision fabrication applications require precise control of very small structures (e.g., the emitter tip of an electron gun used for integrated circuit exposure mask production and repair). This, in turn, requires sensors that can accurately and practically measure very small forces, accelerations, and displacements, and demands mechanical actuators that can apply the required control forces with the required accuracy, authority, stroke, and delay. Such sensors and actuators must be scalable (within bounds) from a common design and be practical to produce in quantity. Recent advances in construction of micromechanical sensors and actuators have opened new doors in the area of active vibration and noise control in Precision Fabrication Systems. This has created a need to develop new and innovative approaches to performing and automating the traditional System Identification process. System Identification involves the determination of system properties from designed inputs and observed outputs. Its application in the active control of vibration is to the maintenance of a predictive model for the dynamics of the system to be controlled. Such a predictive model (and the means to adaptively estimate it) is an important element of every control system that must maintain the desired physical condition. A necessary feature of any real-world active control system is the ability to perform System Identification both efficiently and on-line. The efficiency requirement is critical in applications involving manufacturing processes. Gains in precision levels and/or overall throughput which are realized by the use of an active control system will be rapidly lost if the time and expense of recalibrating the control system is prohibitive. This is especially true if the particular manufacturing activity must be shut down while the recalibration takes place. Thus the requirement to perform recalibrations on-line. The most desirable version of such processes is an automated on-line System Identification capability which requires little or no operator intervention beyond initial set-up and occasional maintenance. The ability to automate the System Identification process for an active vibration control system is essential to its commercial feasibility.

Phase I: Automatic System Identification modules of active control systems must have four major functions: Data Preconditioning, System Monitoring, Test Signal Generation, and Model Estimation. These four functions will be present in some form in virtually every self-tuning control system. A successful Phase I proposal will focus on the design and implementation of key aspects of each of these four functions and a representative simulation environment of interest to ARPA. A successful Phase I proposal will build on and extend the existing ARPA technology base and demonstrate its applicability to actual System Identification design problems related to active vibration control and the use of micromechanical sensors and actuators in Precision Fabrication Systems.

Phase II: If Phase I is deemed successful, Phase II work will focus on extending the results of Phase I work in a real-world implementation of an Automatic System Identification module with one or more functioning active control system(s). The active control system(s) will be chosen from those related to Precision Fabrication Systems of the type ARPA is building now and is likely to design in the near future.

COMMERCIAL POTENTIAL: Technology could result in major reductions in production cost, and major increases in product quality, reliability, and service life for industries that produce or use precision machine tools, optics fabrication equipment, or microelectronic/flat panel display production tools.

ARPA 94-059 TITLE: Chaotic Modeling for Supply and Inventory Management and Command Center Message Traffic Management (Chaos in Distributed Systems)

CATEGORY: 6.3 Advanced Development; Software

OBJECTIVE: Determine if tools for the analysis of chaotic data are applicable to distributed systems in communications or logistics networks.

DESCRIPTION: Analysis tools developed to study chaotic systems are showing great potential for improved methods in many

areas. One of the great surprises is the prevalence of chaos in both nature and man-made systems. Another surprise is that the tools developed to study chaos also provide novel and powerful methods for studying systems that are not necessarily chaotic. Distributed systems are natural candidates for study and exploitation with chaotic tools because the technical conditions for the existence of chaos are met. Many distributed systems, such as communications and computer networks, and intermediate and end-provider inventory depots, can be modeled as local agents with feedback. For example, a logistics depot (or auto wholesaler) makes decisions locally based on little data --perhaps last week's deliveries to customers. Simple systems with nonlinear rules are classically candidates for chaotic behavior. It is possible that messages in a queue or logistics depot inventory levels are chaotic. If so, several issues can be addressed: Is chaos present? It may not be, even if the prerequisite conditions exist. Is chaos contextually good or bad? Nature teaches us that chaos is good because it is robust. With this knowledge can we better design distributed systems to either take advantage of, or avoid, chaos? Is it possible to force a hostile system into an undesirable mode with very little effort (i.e., little cost to the friendly forces)? The purpose of the project is to answer these questions and develop methods using existing chaotic data analysis tools.

Phase I: Use existing chaotic data analysis tools to study representative real data from one or more distributed systems. Determine if these data are chaotic and if the observed mode of operations is desirable. Describe the systems architecture of an end-user system to exploit these data.

Phase II: Develop a local end-user system for exploitation of the chaotic conditions.

COMMERCIAL POTENTIAL: Commercial applications include optimum control of distributed processing and communications networks and inventory control. These methods may be used to better control routing and queuing in communications, data, and computing networks. They may be useful in the control of manufacturing, wholesale, and retail inventory levels.

ARPA 94-060 TITLE: Sensors and Control Systems for Intelligent, Flexible Manufacturing of Electronics

CATEGORY: 6.1 Basic Research; Materials and Processes

OBJECTIVE: Develop sensors and control systems for flexible, intelligent manufacturing of electronic and photonic components.

DESCRIPTION: Future electronic and photonic components will demand more accurate processing capabilities. In addition, the capability to produce multiple components on the same manufacturing line will require the ability to rapidly adjust processes. In-situ monitoring and process control are needed for such flexible, intelligent manufacturing of electronics. These sensors and control systems must be low cost, non-invasive, and reliable.

Phase I: Identify crucial parameters for semiconductor wafer processing. Develop concepts for appropriate sensors and control systems.

Phase II: Develop sensors and control systems for crucial processing parameters identified in Phase I. Demonstrate effectiveness of the system.

COMMERCIAL POTENTIAL: Sensors and control systems for flexible, intelligent manufacturing will enable low cost, high yield production of future electronic parts for the civilian and military markets.

ARPA 94-061 TITLE: Etching of Complex Oxide Thin-Films

CATEGORY: 6.1 Basic Research; Materials and Processes

OBJECTIVE: Develop processes and equipment for etching of thin-film, multi-component oxide materials.

DESCRIPTION: Many complex oxide materials are of interest for thin-film, monolithic electronic applications. Among these materials are high dielectrics, ferroelectrics, pyroelectrics, piezoelectrics, and high temperature superconductors. Etching equipment needs to be developed which will be low cost, reliable, environmentally benign, and uniform over large area wafers, have a rapid etch rate, and cause little or no damage to remaining nearby structures.

Phase I: Develop and demonstrate the etching process.

Phase II: Optimize the etching process. Explore breadth of applicability to multiple classes of multi-component oxide thin films. Design and develop prototype etching equipment.

COMMERCIAL POTENTIAL: Thin-film, multi-component oxides have many uses in electronics, photonics, sensors, and micro-electro-mechanical systems (MEMS) for both civilian and military applications.

ARPA 94-062 TITLE: Focused Ion-Beam Deposition of Nano Structures

CATEGORY: 6.1 Basic Research; Materials and Processes

OBJECTIVE: Develop focused ion beam deposition equipment suitable for the direct deposition in ultra-high vacuum of multi-layered, multi-element metallic electronic components upon semiconductor substrates.

DESCRIPTION: Current focused ion beam technology is becoming widely used in the United States for point cutting and metallization in integrated circuit fabrication, in order to salvage or modify a complicated chip needing a few alterations. Recent Japanese work has shown that simple electronic circuit elements themselves may be directly fabricated using this same technology. Although the Japanese work was carried out to demonstrate direct deposition of electrical contacts and leads onto semiconductor substrates, recent developments in the U.S. and Europe indicate that new classes of all-metal electronic devices may be directly fabricated using focused ion beam deposition. These devices are composed of overlapping layers of magnetic and non-magnetic metals, and depend for their operation upon magnetic manipulation of spin-polarized current through their elements. The performance of these devices improves as their dimensions decrease, hence they require small scale fabrication (< 1 micron critical feature size). Current research on these devices is hampered by the complexity and time-consuming process in which metallic multi-layered films are deposited and then lithographically patterned, etched, masked, re-deposited with additional metal components, repatterned, etc., before simple prototype research devices may be tested. Direct fabrication of these devices using focused ion beam deposition from a multi-element liquid metal source would reduce this research time dramatically and prove a major impetus to device development.

Phase I: Prepare and provide a complete design of an ultra-high-vacuum focused ion beam deposition system capable of depositing from liquid metal sources the elements: Al, Ag, Au, Co, Cr, Cu, Fe, Ni, and Mn. This system must be capable of rapidly (less than 1 millisecond) changing from element to element during a single deposition run, and providing complete computer control and secondary electron imaging of the patterning process. Spot size should be less than 0.050 microns, and the sticking coefficient of the deposit should be maximized to permit greater than 0.005 micron/minute deposition rates. The substrate stage should permit rapid turnaround through a vacuum load-lock, computer control of stage motion to 0.005 microns, and liquid nitrogen cooling of the substrate.

Phase II: Fabrication of a successful Phase I design and delivery to a designated DoD laboratory (Naval Research Laboratory (NRL)) for testing.

COMMERCIAL POTENTIAL: Successful completion of this project will provide U.S. industry with equipment to develop new, high-density, all metallic electronic components at a significant reduction in research costs.

ARPA 94-063 TITLE: On-Chip Processing for Multi-Spectral Imaging Sensors

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop concepts for the utilization of integrated multi-spectral infrared detector arrays for military systems, environmental monitoring, and manufacturing process control. The concepts will be supported by analytical models and test devices validating the concept.

DESCRIPTION: Multi-spectral infrared devices are utilized for many system applications requiring spectroscopic information. The detectors are usually discrete devices physically assembled into multi-spectral detector arrays. The spectral sensitivity ranges from 0.4 micrometers to greater than 20 micrometers. The information from the sensor array is read off the sensor chip for further processing. The data rates are usually high, which increases the cost of the system and limits the amount of information that can be processed. This program is directed toward concepts which improve the effectiveness of multi-spectral sensor use. New concepts for sensor architecture and for pre-processing the sensor information are being sought. The sensor system applications range from concepts for environmental monitoring, controlling manufacturing processes, and guidance and target acquisition for military systems. The scope of the project is to define a model which describes the benefit to be derived from the utilization of multi-spectral sensor data, design and/or simulation of a test device, and validation of the benefits to be derived from the new configuration of multi-spectral sensors.

Phase I: Define the application base for the multi-spectral sensors. A specific application will be selected and the current utilization of multi-spectral devices will be described. The contractor will also define a model which describes the benefit of improvements to be made in the multi-spectral sensor system. The model shall document the benefits, such as reduction in sensor cost, speed of system integration, and product performance improvement and/or yield to be derived from use of the integrated multi-spectral sensor. A design concept will be established for development of the multi-spectral/pre-processor system, and if feasible, the prototype components will be demonstrated.

Phase II: Further develop the concept for multi-spectral sensor integration. The sensor concept will be "bread-boarded" and evaluated. A system integrator will be involved in the program to facilitate the plans for integration into a system.

COMMERCIAL POTENTIAL: Multi-spectral imaging sensors are currently used in commercial applications for environmental monitoring and pollution detection. Cost reduction of the sensor package will open doors for utilization of multi-spectral sensors in manufacturing and process control.

ARPA 94-064 TITLE: Process Control for Lithography

CATEGORY: 6.3 Advanced Development; Materials and Processes

OBJECTIVE: Improve pattern placement and size control of small features (nominally 0.25 microns and below) in the fabrication of semiconductor devices.

DESCRIPTION: The fabrication of advanced semiconductor devices requires the patterning of small features (0.25 microns and below) on the semiconductor wafer. Further, several layers (> 10) of these patterns are required during the sequence of processing steps to form the transistors, and each of these layers must register to previous layers to within 10-20% of these line widths. The lithographic tools used to print these patterns must have improved control in placement and line width control over increasingly larger print fields. New approaches that will address any of these issues are being sought. In-situ sensing and control is ideal, but off-line approaches may be considered. Potential areas for consideration include dosimetry, vibration and temperature control, reduced charging, modeling, alignment schemes, metrology, new materials, and appropriate feedback systems. All approaches will be evaluated for effectiveness when implemented into the production line. A path to eventual implementation through a commercial product will be outlined. Lithography exposure sources of interest include deep ultraviolet, x-ray, e-beam, and ion-beam.

Phase I: Fully define the plan, outline the detailed design, and begin initial experimentation that will provide the required improvement.

Phase II: Develop and build a breadboard unit to demonstrate successful achievement of the goals. Provide a detailed plan for implementation into tooling commercially available to the industry.

COMMERCIAL POTENTIAL: All these developments lead to improved manufacturing of integrated circuits such as memory chips, micro processors, and micro electronics in general. These serve both military and commercial applications in electronics.

ARPA 94-065 TITLE: Lattice Matched Substrates of Long Life, Reliable Semiconductor Diode Lasers

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Grow and fabricate epi-ready substrates for use in the manufacturing of visible light emitting diodes (LEDs) and laser diodes.

DESCRIPTION: LEDs and laser diodes require efficient radiative recombination of carriers. These minority carrier devices need to have-high quality pn-junction without dislocations, defects, and excessive strain in order to achieve long lifetimes. Lattice matched substrates are necessary for perfect epitaxial growth. Low differential thermal coefficient between the epitaxial growth and the substrate is also important to minimize strain. Lattice matched substrates are not available for blue and green LEDs and laser diodes at the present time. A developmental effort leading to their availability is sought.

Phase I: Fully define the approach; design the growth equipment; and experimentally verify the concept.

Phase II: Grow and characterize substrate crystals. Provide detailed plan for scalable implementation. Deliver epi-ready, 2-inch substrates to device houses for experimental proofing.

COMMERCIAL POTENTIAL: Visible diodes will have dual-use potential in displays and optical storage.

ARPA 94-066 TITLE: Design of Hybrid Neural Network/Digital Computer Architectures

CATEGORY: 6.1 Basic Research; Computers

OBJECTIVE: Design and develop a hybrid neural network/digital computer architecture suitable for implementing image understanding algorithms. This solicitation is coordinated with a companion topic entitled, "Image Understanding Algorithms Suitable for Hybrid Neural Network/Digital Computer Systems." (ARPA 94-080)

DESCRIPTION: Highly capable hybrid neural network/digital computing architectures are sought to provide a development environment for image understanding algorithms. The proposed system should make appropriate use of emerging high-speed neural network chips in the design. The systems proposed should enable development of end-to-end vision architectures capable of analyzing high-resolution images at video rates. The system design should account for the interfaces between the neural network and digital components. It should also describe the data flow between these components.

Phase I: Develop a detailed design for the hybrid system. This should include specification of hardware components and descriptions of interfaces, software support, and databases. The system description should also specify the functionality offered and should clearly delineate the cost and speed advantages of the proposed system over existing conventional computing architectures.

Phase II: Build a small-scale version of the designed system.

COMMERCIAL POTENTIAL: This hardware could enable a number of industrial applications, including quality control diagnosis and monitoring in factories, medical image interpretation, intelligent teleconferencing and human-computer interfaces.

ARPA 94-067 TITLE: Compact, Mobile, Air Sampling Equipment for Rapid Deployment as an Air Pollution or Weapons of Mass Destruction (WMD) Monitoring System

CATEGORY: 6.3 Advanced Development; Environmental Effects

OBJECTIVE: Develop for deployment an air pollution or WMD proliferation monitoring system that collects and analyzes particles or gases.

DESCRIPTION: The proliferation of WMD (nuclear, chemical, and biological) and air pollution are of considerable interest to world leaders. Although both seem to be exclusive, the technology for monitoring portions of both exists. For this topic, the envisioned compact, mobile air sampling system would serve the monitoring purpose. The system would be portable for deployment to any worldwide location where power would be provided by portable generator or utility connection. The sensors would include radiation, chemical, and biological agent detectors for sensing the presence of particulates or gases. Once the particulates, or gases of interest are detected, measurements of intensity or concentration would be recorded by the data acquisition system for storage or transmission by satellite or land line back to a municipal, state, national, or international data center. Sample handling and measurements would be conducted automatically with a minimum of on-site attention.

Phase I: Evaluate technologies for incorporation into a compact system. Examine size, weight, detector resolution, transportability, cost, air sampling capacity, sensitivity, power requirements, and data handling. Provide conceptual designs of the system.

Phase II: From the conceptual design, develop a laboratory prototype functioning as a compact monitoring system.

COMMERCIAL POTENTIAL: The commercial potential from this project is an affordable air monitoring system for quick setup in almost any location for use by a commercial industry or government entity interested in monitoring air pollution or possible WMD production beyond its borders.

ARPA 94-068 TITLE: Multi-Dimensional Visualization of Data to Identify Seismic Events or for Other Complex, Multi-Dimensional Data Problems

CATEGORY: 6.3 Advanced Development; Sensors

OBJECTIVE: Develop a visualization subsystem for the discrimination of different types of detected seismic events; test the visualization subsystem with the ARPA Intelligent Monitoring System; and demonstrate its potential application to other multi-dimensional data problems.

DESCRIPTION: ARPA is developing a global system for monitoring nuclear proliferation activities and for potential use in verifying compliance with a Comprehensive Test Ban Treaty. The system will collect data from a worldwide network of seismic stations and arrays, as well as sensors deployed for air, particulate, and other types of environmental sampling. The seismic system alone will have to process data from several hundred monitoring stations for tens of thousands of detected earthquakes and explosions per year. Results of final analysis must be available within 24-48 hours of the occurrence of the events. Achieving this goal within the available resources will require automated data processing, and ARPA is exploring technologies such as machine learning, machine discovery and visualization methods to aid in the data interpretation. For this topic, the contractor is to develop novel visualization techniques to aid in interpreting the results of multi-variate seismic discrimination analysis, particularly for small seismic events detected at regional distances out to 2,000 km. The techniques are to be tested with data being acquired at the ARPA Center for Seismic Studies and processed by the Intelligent Monitoring System at the facility. The contractor is to demonstrate how the visualization techniques can be applied to the general problem of monitoring the proliferation of weapons of mass destruction with multi-dimensional data. The contractor will also demonstrate how the techniques may be used for the solution of other problems involving such data.

Phase I: Develop concepts for a visualization subsystem to be used for seismic event discrimination, and define the techniques and components that would be included within such a subsystem.

Phase II: Develop the visualization subsystem, install it on the Intelligent Monitoring System at the ARPA Center for Seismic Studies in Rosslyn, Virginia, and demonstrate that it is capable of aiding human analysts in interpreting data from the global seismic monitoring system.

COMMERCIAL POTENTIAL: The commercial potential for this project is the development of a visualization subsystem to aid in the solution of generic multi-dimensional or multi-variate problems. This could include topics ranging from environmental monitoring to air traffic control.

ARPA 94-069 TITLE: Innovative Techniques for Delivering Power Via Fiber Optical Links for Cooling, Signal Conditioning, and Signal Processing Devices

CATEGORY: 6.2 Exploratory Development; Electronic Devices

OBJECTIVE: Develop an optical fiber power delivery system capable of providing 5-10 watts of electrical power at a remote location. The system should demonstrate compact packaging, robust performance, and long life in severe environments, as well as the potential for low cost production.

DESCRIPTION: While some fiber optic links for remote sensing, and antenna remoting applications have the potential to be all passive (no electrical power at the sensing end), many such links require ancillary power at the sensing device to provide heating/cooling, signal conditioning, signal processing, and control functions. In the case of thermo-electric cooling, the power requirements relative to that required by the photonic components in the link, are large, and usually require a conventional copper power line to meet them. In the case of a directly modulated link, power is also required to bias the laser or light emitting diode (LED). The goal of this research is to develop novel means for delivering significant electrical power via fiber optic lines to eliminate the need for copper power wires. The use of wires or free space methods for delivering power defeats many of the advantages of using optical fiber in the sensor data transmission link, i.e., the dielectric nature of optical fiber, operation in harsh environments, and immunity from electromagnetic interference. Therefore, it is highly desirable to use optical fibers to deliver the power as well. In most cases, only a modest amount of power (5-10 watts) is required per sensor head. This is within the present capability of a single laser diode, and perhaps achievable using LEDs. However, some applications require many sensor heads, so that more powerful sources and a corporate architecture may be cost effective. Compact size and high efficiency at the sensor head is required.

Phase I: Design, develop and build a prototype fiber optic power delivery link at least 2 km long. Special attention will be given to component reliability, power handling capability, efficiency, size, and cost. Analysis will also be conducted to address the scalability of the concept to arrays of sensors, and longer links.

Phase II: Develop/refine the design, components, and associated packaging and build at least five (5) form-factored optical fiber power delivery links. These will be subjected to environmental and accelerated life testing. A low cost producibility plan will also be developed.

COMMERCIAL POTENTIAL: The resulting technology will greatly expand the design options for fiber optic applications in remote sensing, environmental monitoring, materials testing, fly-by-light systems, and telecommunications. Present externally modulated links are the only option because of their low (even zero) power requirements. With the capability developed here, directly modulated links as well as a wider range of externally modulated links can be used.

ARPA 94-070 TITLE: Small, Compact, Highly Linear Analog-to-Digital (A/D) Converters with Power Supplies

CATEGORY: 6.3 Advanced Development; Electronic Devices

OBJECTIVE: Develop 14-Bit A/D converter with 5 MHz sample rate (minimum), with integral power supply and necessary digital interfaces. Size objective is 10 cubic inches.

DESCRIPTION: Present A/D converter technology has been pushed to the point that A/D converters are now available in single integrated circuit chips. This is a significant achievement, but the technology must be pushed further to include all the necessary components for a complete A/D -- e.g., power supply, digital interface hardware, and timing and control hardware. The size goal for this effort should be about 10 cubic inches.

Phase I: Develop a prototype A/D converter which demonstrates size and performance goals. The performance goal is to show a minimum of 85 dB spurious free dynamic range at sample rates from 1 to 5 MHz (minimum) without external linearization hardware.

Phase II: Develop manufacturing techniques for the prototype converter so that automated manufacturing techniques can be employed with minimal manual intervention to assemble, test, and calibrate each unit.

COMMERCIAL POTENTIAL: The successful converter will have applications in the cellular telephone and wireless communication technology arenas, where it can be employed in inexpensive base stations which use adaptive processing techniques to eliminate interference among many base station users.

ARPA 94-071 TITLE: Analysis of Low Grazing-Angle Forward Scatter Data from the Mountain-Top Propagation Experiment

CATEGORY: 6.3 Advanced Development; Telecommunications

OBJECTIVE: Develop new ideas for processing the VHF/UHF scatter data collected at the Pacific Missile Range Facility under the Air Defense Initiative (ADI) Mountain-Top Program. Develop processing techniques and apply them to the data with the ultimate objective of developing or validating forward scatter models.

DESCRIPTION: Under the ARPA-sponsored ADI Mountain-Top program, data was collected over a calibrated communications link between the ocean surface and a mountaintop site. This data has been reduced under Rome Laboratories contract F3062-90-D-0105 by Science Applications International Corporation to the extent that the data has been logged, calibrated and stored in an easily readable MATLAB format. This solicitation seeks novel ways to further analyze this data, with the objective of correlating the measured forward scatter with the VHF/UHF scatter environment measured by a wave-rider buoy and atmospheric instruments.

Phase I: Develop a detailed processing plan to reduce a selected subset of the mountain-top database in such a way as to bring out the unique features of the data (e.g., spectral content, isolating scatterers in range). The processing algorithm will be coded and integrated with the Mountain-Top data format.

Phase II: Reduce the selected subset of the database according to the algorithm developed during Phase I. The reduced data will be collected into a database that allows for correlation of the signal feature space with the environment. Reduced data will be delivered to the Mountain-Top Program in the Mountain-Top data format. A statistical analysis will be performed on the features under study to determine their distributions and correlation with independent parameters. A report will be generated detailing the solicitor's findings. The solicitor will review the available scatter models to determine if any of the models fit the trends observed. A study will be made of how well each model fits the data. Where discrepancies exist, a new model will be developed to describe the impact of the environment on radio frequency (RF) scattering at the frequencies under study.

COMMERCIAL POTENTIAL: The ability to communicate from transmitters near the ocean to distant receivers has application in the maritime communications field. Emergency beacons and search and rescue systems would benefit from an understanding

of long-range radio-frequency communications over the water.

ARPA 94-072 TITLE: Techniques to Reduce Fiber-to-Fiber Optical Insertion Loss in Gallium Arsenide (GaAs)

CATEGORY: 6.2 Exploratory Development; Electronic Devices

OBJECTIVE: Develop a highly reliable, very low loss method of coupling single mode optical fibers to GaAs devices.

DESCRIPTION: GaAs semiconductors have a number of desirable properties for applications to photonics, including low optical waveguide loss, a favorable match between electrical and optical wave propagation velocities, and perhaps most importantly, ease of integration with GaAs microwave and millimeter wave monolithic integrated circuits. However, the mode field mismatch between single mode waveguides in GaAs and single mode optical fiber at typical wavelengths used for optical communication make it difficult to achieve low loss coupling. This problem is especially difficult over extremes in temperature and vibration.

Phase I: Develop a novel technique for maintaining very low coupling losses from single mode optical waveguides in GaAs and single mode optical fibers under vibration and over wide temperature extremes. This technique is to be demonstrated and tested in Phase I.

Phase II: Consideration will be given to automation of the technique developed in Phase I. This will result in the preliminary design of an automated assembly station for attaching optical fibers to GaAs semiconductor devices of various types.

COMMERCIAL POTENTIAL: The technique has civilian applications in advanced computing, antenna, and communications systems.

ARPA 94-073 TITLE: Airborne Surveillance Radar Detection, Tracking and Handover Concept Demonstrations

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop and test advanced airborne surveillance radar concepts from a mountain-top site in Kauai, Hawaii.

DESCRIPTION: The Mountain-Top Program (MTP) is an ARPA-sponsored effort under the Air Defense Initiative aimed at testing advanced airborne surveillance radar concepts from a cliff-top location, thereby avoiding the cost and risk inherent in airborne test programs. Mountain-Top is an umbrella program with five major thrusts: Sensor technology; adaptive signal processing architecture development; adaptive signal processing algorithm development; phenomenology; and, joint testing with other surface-based or airborne assets. This solicitation seeks to develop and test new radar sensor or processing concepts consistent with the Air Defense Initiative goal of long-range detection, tracking and handover of advanced targets.

Phase I: Identify a concept with application to airborne surveillance radar that meets a current DoD need. This concept should be testable from a mountain-top site and the results should extrapolate to an airborne scenario. The solicitor may test out the concept on the UHF multi-channel radar that will be installed on a 1500 ft. cliff on the Pacific Missile Range Facility in Kauai, Hawaii. Information on this radar can be found in the reference cited below. The solicitor will develop a detailed test plan for the proposed experiment. If the experiment involves validating an algorithm, the algorithm and its utility should be explained in detail in the test plan.

Phase II: Conduct the test defined in Phase I. The Mountain-Top facility staff will provide assistance, if required. Following the experiment, a report will be prepared describing the results of the test and the implications for airborne application. Data collected from the experiment will be stored under the MTP database in the MTP format.

Phase III: The Phase III effort is anticipated to transition the Phase II results to demonstration aboard an airborne platform.

COMMERCIAL POTENTIAL: Adaptive processing algorithms tested at the Mountain-Top site have wide application in such fields as medical imaging and cellular communications.

ARPA 94-074 TITLE: Real-Time Processor Packaging Concepts for Tactical Missiles

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Develop new ideas and approaches for repackaging current digital signal and data processors, applicable to Surface-to-Air (SA), Air-to-Air (AA), and Air-to-Ground (AG) missiles using active, passive, or multi-mode guidance seekers.

DESCRIPTION: Advanced missiles detect and guide themselves to targets in land or sea clutter, against electronic jamming and other countermeasures. This environment increases waveform complexity and requires signal processing algorithms and guidance logic. The resulting digital computational speed and storage requirements can become very demanding, especially given missile volume, weight, power, heating, and environment constraints. This solicitation seeks to explore the range of possible missile digital processor capabilities and how to repackage the missile processors to fit within existing SA, AA, and AG missiles.

Phase I: Determine the physical and environmental requirement constraints on future SA, AA and AG missile processors using current missiles as a baseline. For each class of missile, create a representative set of requirements, i.e., volume, power, weight, heating, vibration, acoustics, etc., which will constrain the repackaged processors proposed in Phase II. Perform an initial assessment of potential processors for each missile class. The government will supply representative missile processor computational requirements, for each missile class, that are a blend of serial and parallel processing.

Phase II: Select the most promising processor(s) for each missile class and propose a repackaging of the processor(s) to meet the constraints developed in Phase I. The government will then select a specific, existing missile for further integration work. The solicitor will then develop detailed integration requirements, build and demonstrate selected, critical repackaging elements, and deliver a technology demonstration plan for Government evaluation.

Phase III: The Phase III effort is anticipated to transition the Phase II products to a specific demonstration of a repackaged processor.

COMMERCIAL POTENTIAL: The repackaging of a current processor to meet the physical and environmental demands of a missile would be readily usable by any commercial application where volume is limited and/or the environment is hostile, e.g., spacecraft, aircraft, or robotic machinery operating in an arctic region or underwater.

ARPA 94-075 TITLE: Verification and Validation of Distributed Artificial Intelligence

CATEGORY: 6.1 Basic Research; Software

OBJECTIVE: Provide tools for the verification and validation of distributed systems that are being introduced into military and commercial environments.

DESCRIPTION: Most large-scale, distributed environments combine a variety of information sources and types of processing (e.g., text, graphics, simulations, analytic methods, knowledge bases, databases, and so forth). One of the critical hurdles in making use of these diverse resources is the ability to verify, validate, and integrate the different types of information and processes. Over the last 10 years, new methods have been developed in verifying and validating knowledge-based systems. These now need to be integrated with conventional software testing and analysis methods to create the appropriate development and evaluation methods for the hybrid and distributed environments currently being built.

Phase I: Projects would focus on key problems in combining methods for testing conventional and artificial intelligence software.

Phase II: First-year results would be applied to the large-scale, distributed engineering, manufacturing, and educational environments currently being developed for several ARPA and National Information Infrastructure (NII) programs.

COMMERCIAL POTENTIAL: This technology has dual-use application. It can enhance the reliability of military and commercial software products.

ARPA 94-076 TITLE: Application of Self-Referential Logics and Related Mathematics to Autonomous Systems and Interactive Environments

CATEGORY: 6.1 Basic Research; Computers

OBJECTIVE: Enhance autonomous system and interactive environments in military and commercial products.

DESCRIPTION: The basic mathematics underlying the computational sciences is out of step with many requirements of modern

programs and processes. The ability to have formalisms powerful enough to represent and process upon themselves would greatly enhance the processing necessary both for autonomous systems and for the monitoring and integration services for large-scale, distributed systems, such as those envisioned in the National Information Infrastructure (NII).

Phase I: A number of recent lines of work in mathematics and logic would be brought together (including work on self-referential logic, "situated" logics, and non-well-founded sets) through workshops and small projects designed to identify the critical outstanding research questions in these areas.

Phase II: These new formalisms would be applied to two application areas: (1) the integrative and monitoring services necessary for manufacturing and educational environments, and (2) autonomous systems for robots.

COMMERCIAL POTENTIAL: This technology will enhance autonomous systems.

ARPA 94-077 TITLE: Planning and Decision Aids: Decision Theory-Based Economic Analysis

CATEGORY: 6.2 Exploratory Development; Computer

OBJECTIVE: Investigate the potential for use of increasingly accessible software-based network services to enable remote access to a library of composable modelling tools.

DESCRIPTION: A library of influence diagrams (or other decision theory representations) could be readily tailored and integrated to form the basis for a more powerful economic analysis capability, which in turn could support DoD budget related decision making.

Phase I: Describe at least three use scenarios and develop the specifications for a model library and model composition tools. The model composition tools and the resultant models must utilize techniques from artificial intelligence to provide visibility and understanding of model results and to support the automated construction of decision rationale.

Phase II: Construct a prototype (based on the Phase I results) and a demonstration of the prototype on two or more test cases that will be developed in consultation with the program manager.

COMMERCIAL POTENTIAL: The project could form the basis for more powerful strategic planning tools which would have wide commercial applicability.

ARPA 94-078 TITLE: Voice Recognition for Identity Monitoring and Validation

CATEGORY: 6.2 Exploratory Development; Human-Systems Interfaces

OBJECTIVE: Create a technology able to support reliable and automatic identification and tracking of individuals in on-line processing of field speech data and in off-line processing of archived speech data. This technology is required to improve the security in accessing classified data and to support acquisition of intelligence information.

DESCRIPTION: The project is a speech technology development effort for voice identification and tracking technology, using ARPA's successful R&D paradigm of directing the effort with an application task focus, existing corpus support, and periodic formal evaluation.

Phase I: Develop a successful technology to identify and track voices using the Switchboard telephone speech corpus. This corpus is available through the Linguistic Data Consortium, 441 Williams Hall, University of Pennsylvania, Philadelphia, PA 19104-6305. Telephone (215) 898-0464, FAX (215) 573-2175; Email: ehodas@unagi.cis.upenn.edu.

Phase II: Develop a successful demonstration of voice recognition technology to identify and track voices in a specific application context.

COMMERCIAL POTENTIAL: Many of the same security needs experienced by DoD are also experienced by industry. In particular, the need for broad-based access to information will dictate spoken language interaction. Note: ARPA's Air Travel Information Service (ATIS) program is an example. Along with the emergence of such information services will come the need to control access to data by voice, for a variety of reasons.

ARPA 94-079 TITLE: Spatial/Semantic Database

CATEGORY: 6.1 Basic Research; Software

OBJECTIVE: (1) Develop systems capable of searching a large image database using an "image snippet" (a piece of another image) as the input query or (2) Organize an image database and an associated semantic database so that reasoning operations related to images can be carried out.

DESCRIPTION: Large databases of images are currently being accumulated both in military and civilian applications. There are two problems that arise when trying to use these databases: (1) It is difficult to locate desired images, and (2) it is difficult to reason about the images. Methods are sought for organizing a spatial database related to images and a semantic (knowledge) database so that reasoning operations involving imagery and related to tactical data fusion can be carried out. Also of interest are techniques for retrieving images from a large image database (that is either unindexed or has an automatically produced index) using "image snippets" as the search request.

Phase I: Develop either a retrieval approach based on image snippets or a method for an image database to interact with a semantic database to allow reasoning about images. In either case, any indexing required must be automatic and not manual. Although the approach can be demonstrated using a small database (say 200 images), the approach must be scalable to large databases containing tens of thousands of images.

Phase II: Using the approach of Phase I, make the system "user-friendly." Extend the system so that it can work on a large database. Demonstrate the user-friendly system on a large database.

COMMERCIAL POTENTIAL: Image retrieval from a video tape archive using an image snippet is of interest to TV and cable networks. Reasoning about images is of interest to decision-making systems in which images play a large role.

ARPA 94-080 TITLE: Image Understanding Architectures Suitable for Hybrid Neural Net/Conventional Computers

CATEGORY: 6.1 Basic Research; Software

OBJECTIVE: Exploit the combine the advantages of neural networks and conventional computers to obtain an improved system for image understanding (IU) by developing a hybrid architecture and the associated IU algorithms.

DESCRIPTION: Neural networks have the advantage of being able to solve classification and categorization problems at very high speeds. They cannot, however, effectively deal with symbolic manipulation; this is the domain of the conventional digital computer. It is of interest to combine neural networks and digital computers for IU and automatic target recognition applications. The goal of this effort is to develop and test a suitable architecture and the corresponding image understanding algorithms for this architecture that would utilize a hybrid neural net/digital computer combination.

Phase I: Design a hybrid architecture , and the corresponding algorithms, that addresses an IU problem, e.g. target recognition.

Phase II: Develop, implement, and test the designed system.

COMMERCIAL POTENTIAL: This effort will have significant impact on military and commercial systems in such areas as autonomous systems.

ARPA 94-081 TITLE: Common Automated Test Systems (ATS) for Factory and Field Use

CATEGORY: 6.3 Advanced Development; Computers

OBJECTIVE: Investigate the feasibility of using common ATS hardware and software architecture/interfaces to meet both production and field maintenance needs with the objective of reducing system life cycle cost. The production activities encompassed in this research and development (R&D) are design, manufacturing, and acceptance testing.

DESCRIPTION: Factory test equipment and production tests are significant cost drivers in defense system manufacturing. Field maintenance covers all echelons at which testing, diagnostics, removal, and replacement occur, from line replaceable units at the organizational level to board components at the depot or intermediate levels. DoD now pays for duplicative development

of software and hardware to perform production and field maintenance testing and diagnostics. The proposed research will investigate the feasibility of increased commonality to reduce both production and field maintenance cost.

Phase I: The R&D will determine the most appropriate ATS design and support elements to standardize for the development of common ATS hardware and software which meet production and field maintenance needs. Offerors will use emerging industry standards as their baseline for the definition of ATS architectures and interfaces. For example, the Institute for Electrical & Electronics Engineers (IEEE) A Broad Based Environment for Test (ABBET) Committee 1226 document set defines the concept and sketches a multiple layer architecture and interfaces for interfacing production and field testing/diagnostic processes. Offerors will identify modifications to activities and documentation in the ATS acquisition process which would meet the requirements of both manufacturing and field test needs while reducing life cycle cost. Investigations will focus on determining what limitations or opportunities might exist for the use of commercial automatic test hardware and software.

Phase II: Based on successful completion of Phase I, Phase II efforts would prototype the key hardware and software interfaces to demonstrate the feasibility of common hardware or software modules for factory and field use.

COMMERCIAL POTENTIAL: Automated test systems are applicable to a wide range of commercial, as well as military, products in electronics, aerospace and automotive sectors.

ARPA 94-082 TITLE: Spoken Language for Hands-Free Applications in Health Care

CATEGORY: 6.2 Exploratory Development; Human-Systems Interfaces

OBJECTIVE: Create a component technology able to support reliable speaker independent spoken language recognition of medical phrases and user interface commands in noisy environments (such as the battlefield, accident scene, or emergency room). This technology supports hands-free data entry and interface commands from healthcare providers during the delivery of care.

DESCRIPTION: The project is a speech technology development effort to develop voice recognition technology suitable for use in noisy, hands-free medical environments. This project will leverage ARPA's Human Language Technology and Domain Specific Software Architecture context to produce a voice recognition component for associate systems.

Phase I: Identify successful technologies to recognize interface commands and selected medical phrases in noisy environments.

Phase II: Develop a successful demonstration of voice recognition technology to recognize medical phrases and user interface commands in a trauma/combat casualty application context. Integrate the voice recognition component into an associate system application for trauma/combat casualty care.

COMMERCIAL POTENTIAL: Numerous noisy environment application domains (crew stations, cockpits, emergency response systems, medical) require hands-free operation. The need for ready and ubiquitous access to information will dictate easy-to-use intelligent "front ends" that use spoken language interaction.

ARPA 94-083 TITLE: Simulation Query Languages

CATEGORY: 6.1 Basic Research: Software

OBJECTIVE: Reduce the time and cost of composition, maintenance, and evolution of software systems involving simulations. An underlying assumption is that these systems will operate on a High Performance Computer and Communication (HPCC) Network. Systems for composing simulations may require new programming environments.

DESCRIPTION: There is a need for a query language to obtain results from simulation programs. Such language should allow access to simulation services in a manner that mirrors database access via SQL (ANSI X3H2) or knowledge base access via Knowledge Query and Manipulation Language (KQML) and KIF (ref. Neches). Simulation is important in planning and decision making. However, most simulation programs are executed under direct control of a user, who provides input data and inspects the results. The results are combined by the user with other information, including results of other simulations. The language should be algebraically sound and complete, so that multiple simulations could be combined in parallel, hierarchically, or sequentially. Inter-operation with other service systems is desirable. Proposals can be domain-specific, i.e., focus on specific applications of simulations and incorporate assumptions about the domain, or be generic. Such domains can range from financial

and budget planning, now commonly using spreadsheets, to engineering and war-gaming.

Phase I: Define the scope, the approach to method, or language design and validation, a demonstration scenario, and the milestones of progress that can be applied to measure progress in this field. Planning of linkages to realistic experiments in Phase 2 of a possible award will be important.

Phase II: Build and bring to an alpha-test phase a compiler for the language and its linkages to programs performing simulations. The simulation themselves should either be pre-existing or adequately model useful simulations.

COMMERCIAL POTENTIAL: Simulation is an essential tool in business and military planning. Developing the means to integrate simulation into planning systems will benefit both communities.

ARPA 94-084 TITLE: Software to Acquire Remote Objects

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Develop examples and methods to enable interoperation of diverse applications through sharable object information. Adherence to existing, proposed and/or emerging standards for object-oriented data will be important, since the objective is not to develop new representations, but rather to broaden the access to existing ones. Flexibility and evolvability, as these standards develop, will be important.

DESCRIPTION: Data-storage in object oriented form is becoming common for many engineering and manufacturing applications. However, software systems dealing with such data typically provide only local storage and only interact with data they have stored. We also require software to access information from remote sites. Remote in this sense means any or all of the following: on other computer systems; on other operating systems; using other programming languages; using other standards for object representation; and, other aspects of heterogeneity. Since in heterogeneous systems the object-oriented data is typically removed from its original context, such access must also provide access to descriptive meta-data, such as the object model, the class definition, and to methods attached to the class definition.

Phase I: Define the scope, the approach, and methods proposed to access remote object-oriented data and meta-data. The choices should be justifiable. Also state the limits of the approach clearly. Provide a demonstration scenario, an example, and the milestone of progress that can be applied.

Phase II: Build and demonstrate application interfaces for one or more aspects of heterogenous object-oriented data access. The data themselves should be realistic in scope and magnitude.

COMMERCIAL POTENTIAL: Software development for DoD and private sector systems occurs primarily in the commercial sector. The envisioned interoperation will not only benefit both communities, but enable interoperation among them.

ARPA 94-085 TITLE: Hand-Held Computing for Highly Mobile Use

CATEGORY: 6.3 Advanced Development; Human-Systems Interfaces

OBJECTIVE: Develop and deploy new communication mechanisms including (but not limited to) speech, language, and gesture (both verbal and physical pointing, with a finger or a pointing device), for use with highly portable, keyboardless, personal digital assistants (PDAs).

DESCRIPTION: Highly portable PDAs require the development and deployment of new ways of using computers. Since there is no room for keyboards, interaction with the devices must be mediated through alternative input mechanisms including, but not limited to, speech, language, and gesture (either verbal or physical pointing, with a finger or a pointing device). These media must be integrated to provide robust system interaction under real-world conditions of use. Application software must be easily tailored to use these media for interaction. Moreover, the resultant system must provide easy access to various communication pathways and distributed information sources (e.g., networks, modems, wireless links). Proposed solutions may be primarily software, hardware, or a combination.

Phase I: Submit detailed proposals for technology development and productization, with demonstration of feasibility of proposed technology.

Phase II: Achieve productization of the proposed technology with demonstration of significant, real-world deployment/use under conditions consistent with its proposed usage.

COMMERCIAL POTENTIAL: These communication mechanisms have a broad array of commercial/industrial applications requiring portability and/or hands-free operation. They are applicable to the education sector and the military.

ARPA 94-086 TITLE: Low-Cost Virtual-Reality Environments

CATEGORY: 6.3 Advanced Development; Human-Systems Interfaces

OBJECTIVE: Field products in consumer and educational markets based on virtual-reality technologies at a cost that will greatly accelerate virtual-reality application development and deployment.

DESCRIPTION: Virtual-reality or augmented-reality environments allow users to partially immerse themselves in computer-supported artificial contexts which may be based on real-world scenarios or imagined worlds. In either case, as tools for learning and entertainment, the technology offers great potential for new educational and commercial applications. The current high costs for the software and hardware necessary to develop and deploy these environments are a barrier to their evaluation and potential use in a broad array of application areas. The technology proposed may be either software or hardware, or a deployment of virtual- or augmented-reality environments. Proposals for hardware development should represent technologies that offer substantial increments in price-performance over immediately forthcoming (1993) devices for the game market (e.g., Sega, Nintendo, etc.).

Phase I: Submit detailed proposals for technology development and productization, with demonstration of feasibility of proposed technology.

Phase II: Achieve productization of the proposed technology with demonstration of significant, real-world deployment/use under conditions consistent with its proposed usage.

COMMERCIAL POTENTIAL: This technology can be used in education, entertainment, and military and industrial training.

DEFENSE NUCLEAR AGENCY

Submission of Proposals

The Defense Nuclear Agency is seeking small businesses with a strong research and development capability and experience in nuclear weapon effects, phenomenology and operations. (Note: we are not interested in nuclear weapon design or manufacture.) DNA invites the small business community to send proposals directly to the following address:

Defense Nuclear Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

The proposals will be processed, then distributed to the appropriate technical office for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Nuclear Agency
ATTN: AM, Mr. Billy Burks
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-5021

DNA has identified 24 technical topics, numbered DNA 94-01 through DNA 94-24, to which small businesses may respond in this solicitation (94.1). Please note that these are the only topics for which proposals will be accepted. The current topics and the full topic descriptions are included below. These topics were initiated by DNA technical offices which manage the research and development in these areas. Note several of the topics are intentionally broad to ensure any innovative idea which fits within the mission of DNA may be submitted. Proposals do not need to cover all aspects of these broad topics. Questions concerning the research topics should be submitted to:

Defense Nuclear Agency
ATTN: OTA, Mr. James M. Gerding
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-1217

DNA selects proposals for funding based upon technical merit, criticality of the research, and evaluation criteria contained in this solicitation document. As funding is limited, DNA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, DNA may fund more than one proposal in a specific topic area if the technical quality of the proposals are deemed superior; or it may fund no proposals in a topic area. Proposals which cover more than one DNA topic should only be submitted to DNA once.

DNA has not set aside funds for bridge funding. As such, proposers should not rely upon bridge funding to cover the time gap between Phase I and Phase II.

Subject Index to the DNA SBIR Solicitation

DEFENSE NUCLEAR AGENCY
FY 1994 SBIR TOPIC INDEX

DEFENSE NUCLEAR AGENCY

FY 1994 TOPIC DESCRIPTIONS

DNA 94-001 TITLE: Nuclear Weapon Effects Calculation and Presentation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the accuracy, runtime, or visualization of output of nuclear weapon effects calculations.

DESCRIPTION: Accurate, efficient, user-friendly methods of calculation of nuclear weapon effects and display/presentation of such calculations are of major concern to DNA. Areas of interest include more accurate calculations, faster running calculations, desktop versions (where appropriate) to enable use by a wide audience, and new and improved ways to enable users (be they advanced nuclear weapons effects researchers, weapon systems developers, or managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects and the survivability/ vulnerability of structures and equipment to these effects. Nuclear weapon effects include airblast; ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; dust cloud formation; and the effects of these on personnel, materials and structures. Structures of interest include deep underground, land-based, sea-based, and aerospace structures.

During Phase I, the research will demonstrate the feasibility of the proposed methodology to calculate and display/present nuclear weapon effects and/or the response of materials and structures to these effects.

During Phase II, the research concepts developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into appropriate codes.

COMMERCIAL POTENTIAL: Computer codes related to earthquake effects, pollution transport.

DNA 94-002 TITLE: Response of Materials to Nuclear Weapon Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Measure the response of new and existing materials to nuclear weapon effects and develop methods to improve the survivability of these materials.

DESCRIPTION: Of interest to DNA is the response of materials, structures, and systems to nuclear weapons effects. Materials of interest include metals, ceramics and composites. New materials capable of being used as a structural members for aircraft, missiles, ships, submarines and military vehicles are of particular concern. The response of underground structures such as missile silos, command and control facilities and communications facilities are especially important. Concepts and techniques which will improve the survivability (decrease the response) of these types of systems to nuclear weapons effects are required. New materials with enhanced electromagnetic shielding properties are also of interest.

During Phase I, testing plans and feasibility studies on the material will be completed.

During Phase II, the material will be tested and conclusions from the test results will be drawn.

COMMERCIAL POTENTIAL: Material improvements for structures, aircraft and vehicles.

DNA 94-003 TITLE: Nuclear Weapon Effects on Electronics and Communications

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Explore the effects of nuclear weapon explosions on electronics and communications.

DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear weapon produced radiation on electronics, electronic systems, opto-electrical devices, sensors, and communication systems in the phenomenology areas of a)

Transient Radiation Effects on Electronics (TREE); b) Electromagnetic Pulse (EMP); c) System Generated EMP (SGEMP); and d) atmospheric effects (blackout, redout, etc.) are of interest to DNA. Particular areas of concern include; methods by which designers of space, strategic and tactical systems can assess their susceptibility to these effects; technologies to reduce the susceptibilities of electronic systems and devices (especially those with submicron feature sizes) to acceptable levels; and methods to demonstrate survivability under specified threat criteria. Concepts and techniques to improve the survivability (decrease the response) of systems against these nuclear weapons effects are required.

During Phase I, initial feasibility studies will be completed to demonstrate the viability of the proposed approach.

During Phase II, continue the investigate began in Phase I to fully develop the proposed approach.

COMMERCIAL POTENTIAL: Commercial satellites and electromagnetic interference/compatibility.

DNA 94-004 TITLE: Nuclear Weapon Effects Simulation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the state-of-the-art in nuclear weapon effects simulation.

DESCRIPTION: Simulators are needed to: (1) provide experimental data for development of numerical simulations of nuclear weapons effects; (2) simulate one or more nuclear weapons effects at laboratory size scale; (3) predict what will occur during an underground nuclear test; (4) calibrate gauges used in the large scale simulators; (5) develop new gauges; and (6) dust lofting tests (centrifuges).

Simulation requirements include airblast over various surface conditions, dusty flow, dust lofting, shock propagation in rock, water shock, thermal radiation, EMP, and nuclear radiation.

Existing large scale simulators are often expensive and time consuming to operate, and require travel to an explosive test site. Small scale simulators are needed to provide extensive data to supplement the limited amount of data available from the large scale simulators. Innovative simulators are needed which are economical and simple to operate. Innovative ideas are needed on how to use very small scale simulators to produce useful information. A joint proposal with a government laboratory may be helpful because the simulator can then remain at the government laboratory where it will be readily available for future use.

During Phase I, build the basic simulator and demonstrate that it functions properly.

During Phase II, use the simulator to produce useful data and improve the simulator as necessary.

COMMERCIAL POTENTIAL: Numerical analysis and metrology.

DNA 94-005 TITLE: Instrumentation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop new instrumentation or improve existing instrumentation used in nuclear weapon effect simulators and in underground nuclear testing.

DESCRIPTION: Instrumentation is used for measuring nuclear weapon effects, phenomenology parameters, the response of test items exposed to real or simulated nuclear weapon effects and control of advanced accelerators used to simulate weapon effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in underground nuclear tests, high explosive tests, or tests involving high levels of x-ray, gamma, or neutron radiation. Instrumentation is needed for the following types of tests: airblast, dusty flow, dust lofting, water shock, shock propagation in rock, HE, nuclear radiation thermal radiation, electromagnetic pulse (EMP), and underground nuclear tests and for data acquisition. Desirable improvements in capability include improved reliability, ease of operation, ease of calibration (preferably on site) and improved maintainability.

During Phase I, build a prototype instrument or instrument system and demonstrate its performance in laboratory tests.

During Phase II: design, build, and test a full scale instrument system demonstrating its performance in its intended working environment. This may involve coordination with DNA to schedule testing in a simulator or underground nuclear test.

COMMERCIAL POTENTIAL: Metrology

DNA 94-006 TITLE: Structural Response to Nuclear Weapon Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the design and hardness assessment of structures to weapons effects.

DESCRIPTION: Improved designs of hardened structures are needed as well as a better understanding of failure mechanisms of structures. Type of structures include deep underground, land-based (fixed and mobile), sea-based (floating and submerged) and aerospace structures. Designs are needed to resist conventional as well as nuclear weapons effects. Improved methods are needed for analysis and model testing of structures to large deflection and collapse damage levels.

During Phase I, the research will demonstrate the feasibility of the proposed designs/methodology to determine structural response to nuclear weapon effects.

During Phase II, the research concept developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into other existing methodology/codes.

COMMERCIAL POTENTIAL: Earthquake resistant buildings and improved ship, plane, and vehicle design.

DNA 94-007 TITLE: Nuclear Hardening and Survivability

CATEGORY: Exploratory Development, Survivability Hardening

OBJECTIVE: Develop techniques to improve the nuclear hardening and survivability of defense systems.

DESCRIPTION: Techniques for nuclear hardening and survivability of systems, structures, or personnel against nuclear weapons effects are required. These techniques should protect the structure or system against the combined effects of blast, thermal, nuclear radiation, and in the cases of structures or materials, and should also provide protection against electromagnetic and radiation effects wherever any electronic capabilities are involved. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulses is required. Systems include planned and operational strategic and tactical ground mobile systems, missiles, aircraft, spacecraft and their subsystems and components.

During Phase I, demonstrate the feasibility and usefulness of the proposed technique.

During Phase II, fully develop the proposed technique and characterize its usefulness in both technical and cost terms.

COMMERCIAL POTENTIAL: Improved buildings, electronics, aircraft, satellites and better electromagnetic shielding

DNA 94-008 TITLE: Security of Nuclear Weapons

CATEGORY: Exploratory Development, Sensors

OBJECTIVE: Improve the security of US nuclear weapons against all types of threats.

DESCRIPTION: Measures to improve the security of nuclear weapons against all possible threats are required. These methods are expected to include weapon storage facility designs, transportation facility designs, new security sensors and sensor system development, methods to improve the secure handling of nuclear weapons, and methods to improve the effectiveness and efficiency of nuclear weapon security operations. Security measures include detection, assessment, and denial systems. Proposals should describe how they will improve protection against known and predicted threats and should emphasize weapon concealment where appropriate.

During Phase I, demonstrate the feasibility and potential usefuln[illegible]f the proposed security measures.

During Phase II, fully develop the proposed security measures s[illegible] can be compared to existing techniques.

COMMERCIAL POTENTIAL: Commercial Security Systems

DNA 94-009 TITLE: Theater Nuclear Forces (TNF) Survivability

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the survivability of US nuclear weapons.

DESCRIPTION: The prelaunch survivability (PLS) of the TNF is of vital concern. New and innovative concepts to improve PLS are needed to retain a viable nuclear strike capability and to enhance deterrence. The threats to the TNF include enemy forces conducting unconventional, conventional, chemical and nuclear warfare during periods of peacetime, transition to war, and war. Long range program thrusts include peacetime and field storage, deceptive/OPSEC practices, theater nuclear force movements, and operational survivability of theater nuclear systems (aircraft, missiles, and cannon systems). Survivability concepts are warranted for the period of the 1990's and beyond. Concepts should employ innovative ideas and make use of new and emerging technologies.

During phase I, demonstrate the feasibility and potential usefulness of the proposed survivability measures.

During Phase II, fully develop the proposed survivability measures so they can be compared to existing techniques.

COMMERCIAL POTENTIAL: Commercial Security Systems

DNA 94-010 TITLE: Operational Planning and Targeting

CATEGORY: Exploratory Development, Communications Networking

OBJECTIVE: Improve the ability of US nuclear commanders to plan for nuclear engagements and target their nuclear weapons.

DESCRIPTION: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments should be improved. Improvements desired include development of automated planning systems, techniques to determine target damage objective and criteria, post strike target damage assessment capabilities, and automated nuclear weapon employment codes. Techniques to account for electromagnetic effects in operational planning and exercises are also desired.

During Phase I, develop the proposed technique in sufficient detail to demonstrate its feasibility.

During Phase II, continue the development of the proposed technique to the point it can be incorporated into existing planning/targeting methodologies.

DNA 94-011 TITLE: Underground Nuclear Testing

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the design, execution, and evaluation of underground nuclear tests.

DESCRIPTION: Underground nuclear effects tests are used in situations for which no suitable above ground simulator exists. Areas of interest include improvements in the design and execution of tests (horizontal/vertical line of sight and cavity), the design of new experiments which extend the capability of current test beds, and innovative test concepts to meet future needs. To improve our understanding of the results improvements to the mathematical methods used to perform various calculations within the test design and analysis program are needed. New methods of characterizing existing materials which are used in critical portions of the test bed (such as the A box) and new materials for such applications, new approaches to the geological problems encountered in the construction of the test beds, and new methods for all test activities (excavation, fabrication, assembly in the tunnel complex, recording data, transmission of data) are also of interest to DNA.

During Phase I, demonstrate the feasibility of the proposed test/experiment improvement. This will be done using laboratory and/or above ground testing.

During Phase II, demonstrate the proposed techniques with underground nuclear testing and/or above ground testing.

COMMERCIAL POTENTIAL: Improved Satellite Lifetime, mining technology.

DNA 94-012 TITLE: Verification Technology Development

CATEGORY: Advanced Development, Sensors

OBJECTIVE: Improve/develop US technical capability to verify/ monitor compliance with existing and potential future arms control treaties and agreements, e.g., START, INF, CW, CFE, NTT, SNF, and Presidential Initiatives.

DESCRIPTION: New arms control measures are being negotiated which could drastically alter existing inventories of nuclear weapons. New verification technologies and methods will be required to accurately monitor compliance to the provisions of any treaties or agreements that could result from the on-going negotiations. The problem will basically involve being able to distinguish between permitted activities and prohibited activities where the technical signatures between the two could be very minor. New technologies and methods of monitoring proliferation of weapons are also required for possible future nonproliferation agreements.

Phase I - Demonstrate the feasibility of the proposed technology in relation to a specific arms control application.

Phase II - Develop a proof of design to demonstrate the proposed technology.

COMMERCIAL POTENTIAL: Inventory Systems, Chemical Monitoring Systems.

DNA 94-013 TITLE: Nuclear Weapon Effects on Propagation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the effects of nuclear weapon explosions on radio signals and the subsequent performance of communication and radar systems. Investigate the effects of nuclear weapon created optical clutter backgrounds on optical sensor systems. Develop methods to mitigate the above effects. Develop effects simulators to test DoD systems when exposed to those effects.

DESCRIPTION: The Defense Nuclear Agency is interested in the basic physical processes which describe the interaction of nuclear weapons with the atmosphere, which create environments that degrade the propagation of communication and radar signals and that contain optical clutter backgrounds which degrade optical sensor systems. Part of DNA's mission is to predict effects on and determine mitigation methods for DoD systems such as satellite communications, VLF/LF communications, HF/VHF communications, radar systems, and optical sensor systems. Areas of interest include mechanisms for the coupling of nuclear weapon energy to the atmosphere; the development of structure in weapon produced plasmas and molecular emitters; the chemical processes which give rise to the optical emissions; the transport and final deposition of nuclear debris; the effects of degraded signal propagation on the performance of communication systems and radars; and the prediction of the effects of optical clutter backgrounds on the performance of optical sensor systems. Areas of interest also include the development of improved communications and sensor methods to mitigate atmospheric effects on systems and the development and application of simulators to test DoD systems to atmospheric effects.

During Phase I, demonstrate the feasibility of the proposed investigation to advance the understanding in any of the areas described above.

During Phase II, continue the investigation to the development of a product or results that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Commercial communication systems, sunspot effects.

DNA 94-014 TITLE: Novel Application of Pulsed Power Technology

CATEGORY: Exploratory Development, Energy Storage

OBJECTIVE: Development of new applications of existing pulse power technology.

DESCRIPTION: Recent advances in energy storage and switching now make possible the application of DNA pulsed power technology to such areas as armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; air, surface, and subsurface systems; high power microwave weapons; etc. Concepts proposed should be highly innovative and make full use

of the emerging pulse power technology.
During Phase I, demonstrate the feasibility of the proposed pulsed power application.
During Phase II, continue the development of the concept to an engineering model and conduct tests of the effectiveness of the idea.

COMMERCIAL POTENTIAL: Power devices to clean up smoke stack effluents and environmental pollution control.

DNA 94-015 TITLE: Advances in Pulsed Power Technology

CATEGORY: Exploratory Development, Energy Storage

OBJECTIVE: Dramatic Improvements in energy storage, switching, and power conditioning state of technology

DESCRIPTION: Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance. Innovative approaches for component or subsystem development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed power applications include operation at kilovolts to megavolts, kiloamperes to megaamperes, and repetition rates from single pulse to 10 kilohertz.
During Phase I, demonstrate the feasibility of the proposed concept.
During Phase II, develop, test, and evaluate proof-of-principle hardware.

COMMERCIAL POTENTIAL: Power devices to clean up smoke stack effluents and environmental pollution control.

DNA 94-016 TITLE: X-Ray Source Development

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Innovative concepts for the production of x-ray radiation used in nuclear weapon effects testing.

DESCRIPTION: Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts for producing soft x-rays (1-5 kev), warm x-rays (5-15 kev), and hot x-rays (>15 kev). Soft x-rays are used for optical and optical coatings effects testing. Warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.
During Phase I, demonstrate the feasibility of the proposed concept.
During Phase II, develop, test, and evaluate proof-of-principle x-ray source capability.

COMMERCIAL POTENTIAL: Satellite lifetime improvement, nuclear reactor instrumentation.

DNA 94-017 TITLE: Directed Energy Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the effects of directed energy and identify materials which may survive effects of directed energy weapons.

DESCRIPTION: The effects of directed energy sources on materials, structures and systems are of interest to DNA. Of particular interest is the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and mechanisms by which the directed energy sources actually interact with target materials/structures.
During Phase I, demonstrate the feasibility of the proposed investigation.
During Phase II, characterize the effects of directed energy on materials, structures, etc.

COMMERCIAL POTENTIAL: High energy welding

DNA 94-018 TITLE: Debris Mitigation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop advanced means of delaying, mitigating, and eliminating debris created from radiation sources in Above Ground Test (AGT) radiation simulators.

DESCRIPTION: Present Plasma Radiation Source (PRS) x-ray sources generate copious amounts of debris (material, atomic charged particles, sub-KeV photons). Debris production will become an even greater concern for the fluence levels of simulators currently under development. Measurements and analysis are required to characterize the source and the debris generated from wire array and z-pinch PRS sources in order to better understand debris sources and mitigation. Existing debris shield systems must be improved to support larger exposure areas and cleaner test environments while minimizing fluence degradation. New methods, or combination of methods, need to be developed to stop, mitigate, and/or delay debris generated for DECADE class radiation simulators.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test, and evaluate proof-of-principle hardware.

COMMERCIAL POTENTIAL: Very fast closing valves.

DNA 94-019 TITLE: X-Ray Simulator Diagnostics

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative diagnostics for use in Aboveground Test (AGT) radiation simulators.

DESCRIPTION: Diagnostic systems are used to monitor, measure, record and analyze simulator machine performance, source output, and test asset response. Diagnostics are required for detecting, recording, and evaluating radiation sources for soft (< 10 KeV) and hard (> 10 KeV) x-rays. Plasma parameters within simulator sub-
systems such as plasma opening switches and plasma sources used in radiation simulators. Test response diagnostics are required to measure the full time history of the radiation pulse across the breadth and width of the test asset as well as the response of the test asset during and after irradiation. Pulsed power diagnostics are required for accurate, in-situ measurement of voltages and currents within the various simulator subsystems in order to monitor and characterize simulator performance. Diagnostic systems include required sensors/detectors, cabling, recording equipment and media, and, if necessary, computer systems and software.

During Phase I, design, build and test a prototype diagnostic system in a laboratory environment.

During Phase II, demonstrate the diagnostic system in its working environment on an AGT radiation simulator. This will involve coordination with DNA to schedule testing in a aboveground test simulator.

COMMERCIAL POTENTIAL: Nuclear instrumentation.

DNA 94-020 TITLE: Superconducting Magnetic Energy Storage

CATEGORY: Exploratory Development, Energy Storage

OBJECTIVE: Develop components and systems needed to commercialize Superconducting Magnetic Energy Storage (SMES) technology

DESCRIPTION: DNA solicits proposals for research, developmental engineering, and operational tests leading to commercial Superconducting Magnetic Energy Storage (SMES) systems for transmission, distribution, pulsed power, and load shifting applications. Commercial SMES systems for these applications will be cold-supported (hoop supported), factory manufactured, have storage capacities of 5 - 50 megawatt-hours, and have power ratings of 100 to 1000 megawatts. Suitable topics include,

but are not limited to, SMES designs incorporating non-solenoidal coils, liquid helium coolant above 2.2 K, or coolants other than liquid helium; innovative refrigerator designs, including magnetic refrigerators; innovative power conditioning systems; developing high-temperature superconductor down-leads; developing ductile, high-field, high-current, high-temperature superconductors; innovative techniques for collecting helium, or other coolants, following catastrophic quenches; innovative techniques for protecting humans and other fauna from effects of magnetic fields associated with SMES systems; and other, offeror-proposed topics.

During Phase I, demonstrate the viability of proposed approaches. DNA is receptive to discussing developing conceptual designs in Phase I.

During Phase II, successful offerors will develop test, and evaluate proof-of-principle hardware.

COMMERCIAL POTENTIAL: Transmission, distribution, and some pulsed power applications in the electric utility industry, and load shifting and pulsed power applications in the military.

DNA 94-021 TITLE: Forecasting Environments in the Troposphere and Space (FORETS)

CATEGORY: Exploratory Development, Environmental Effects

OBJECTIVE: To investigate the effects of the natural and disturbed environments on atmospheric and space forecasting methods. Develop techniques to mitigate these effects, account for physical processes contributing to chaotic environments, and improve performance predictions.

DESCRIPTION: The Defense Nuclear Agency (DNA) is interested in the basic physical process which describes the effects of the natural and disturbed environment on the employment of various weapon systems. These environments may create situations that degrade the propagation of communication and radar signals, optical sensor systems, and weapon system employment. Part of DNA's mission is to predict effects the environment will have on these systems. Areas of interest include development of models and model predictions to forecast the effects of clouds on the theater of operations; the identification and streamlining of a model for support of theater operation; the development of a coupled space weather model to predict particle fluences and spectra; and the development of cloud and scintillation climatologies.

During Phase I, demonstrate the feasibility of the proposed areas of investigation to advance the understanding in any one of the areas.

During Phase II, continue the investigation leading to the development of models/products that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Weather prediction

DNA 94-022 TITLE: Advanced Lethality Technologies

CATEGORY: Exploratory Development, Munitions Devices and Energetic Materials

OBJECTIVE: Demonstrate innovative applications of advanced non-nuclear technologies for enhanced target lethality or nuclear effects simulations.

DESCRIPTION: Of interest to DNA is the development and demonstration of capabilities which may significantly extend weapons range-to-effect or enhance lethality against hard targets. The response of a hardened bunker complex or of intrinsically hard ballistic missile sub-munition warhead payloads are of particular interest. Novel applications of explosives technology, hyperkinetic technologies, or directed energy (DE) concepts will be of interest.

During Phase I the research will develop concept feasibility through either analysis or laboratory scale demonstration.

During Phase II the concepts will be further developed through more definitive experiments and/or sophisticated computational analyses.

COMMERCIAL POTENTIAL: Hypervelocity, advanced explosives.

DNA 94-023 TITLE: Radiation Hardening of Microelectronics

CATEGORY: Exploratory Development, Electronic Devices

OBJECTIVE: Develop and demonstrate technology to: (1) radiation harden; (2) improve reliability and electrical performance;, (3) improve radiation hardness and reliability assurance methods;, and (4) characterize the radiation and reliability response of semiconductor devices (microelectronics and optoelectronics) including warm and cold operation metal oxide semiconductor (MOS), bipolar, and compound material technologies.

DESCRIPTION: The trend in semiconductor integrated circuits and sensors is toward increasingly higher levels of integration density, higher speeds, higher on-chip circuit complexity, lower voltage and power, and larger die size. All of these trends have exacerbated the problems associated with radiation hardening (i.e., maintaining acceptable levels of performance vice increased hardening), reliability, and testability. In addition, improvements in material science have lead to the introduction of a wide variety of compound semiconductor materials into microelectronic and opto-electronic applications. The radiation and reliability responses of these materials is lacking or unknown.

Thus, it is the objective of this topic to develop and demonstrate innovative methods and technology, for advanced microelectronics and opto-electronics, to (1) ensure that these devices can operate in a radiation environment, (2) improve reliability and capability to operate in stressing environments (e.g., very high temperature), (3) improve producibility and yield, and (4) identify and characterize the radiation and reliability response of these devices and associated materials. The development of enhance reliability, producibility, and yield will support the commercial semiconductor sector. In addition, the development of methods to improve the survivability of microelectronics in severe stressing environments is directly related to the commercial semiconductor and electronics industries.

During Phase I, the research will demonstrate the feasibility of the proposed technology and methods concepts.

During Phase II, the research concepts developed in Phase I will be demonstrated or reduced to engineering practice.

COMMERCIAL POTENTIAL: Microelectronics, Satellites

DNA 94-024 TITLE: Standard Set of Objects for Radio Frequency (RF) Testing

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: To formulate and promulgate a standardize, generic set of objects to facilitate RF upset/damage concept assessment.

DESCRIPTION: Select a standardize, generic set of electronics based upon availability, cost, and military significance to promulgate for standardized RF test comparison. This set of unclassified objects will be used to compare source and effects testing results. Most tests are one of a kind because they are accomplished with one of a kind objects. This test set would provide a low cost method for initial assessment while being comparable with other tests.

During Phase I, initial feasibility studies will be conducted to select types of end quantities of objects.

During Phase II, the proposed test set will be subjected to rigorous examination and testing to ensure the necessary inherent qualities are present to support generic RF testing.

COMMERCIAL POTENTIAL: Electromagnetic Interference/compatibility testing.

BALLISTIC MISSILE DEFENSE ORGANIZATION (BMDO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Send Phase I proposals (five copies of the full proposal, PLUS two copies of Appendices A and B only) by US mail to:

Ballistic Missile Defense Organization
Attn: DTI/SBIR
Washington, D.C. 20301-7100

For Administrative Help ONLY: Call 800-937-3150

Proposals delivered by other means (commercial delivery service or handcarry) must be delivered to Room 1D110, The Pentagon, Washington, D.C. **WARNING: Only persons with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a Pentagon entrance is not sufficient.** BMDO will acknowledge receipt of proposals only if the proposal includes a self-addressed stamped envelope and a form (like Reference B) that needs only a signature by BMDO.

BMDO seeks the most innovative technology that might enable a defense against a missile in flight - lighter, faster, smarter, more reliable components. Proposers need not know details of possible BMDO systems.

BMDO seeks to invest seed-capital, to supplement private capital, in a product with a future market potential (preferably private sector) and a measurable BMDO benefit. BMDO SBIR will not further develop concepts **already mature enough to compete** for private capital or for government development funds. Phase I will show the concept feasibility and the merit of a Phase II for a prototype or at least a proof-of-principle. Phase I proposal competition will be judged mostly on degree of technology innovation. Phase II competition will also be judged strongly on future market potential. Phase II proposals may be submitted anytime after Phase I starts. Projects showing time sensitivity will be considered for Phase II start-up funding and Phase I proposals may include a post-Phase I optional task that will permit rapid contracting if Phase II is approved. Principal Investigators who are tenured faculty are not considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract. Any waiver must be requested explicitly with a justification showing a compelling national need. BMDO expects to grant no waivers.

BMDO intends Phase I to be only an examination of the merit of the concept with an average cost under $60,000. Although proposed cost will **not** affect selection for negotiation, contracting may be delayed if BMDO reduces the cost ceiling.

Because BMDO seeks the best nation-wide experts in innovative technology, proposers may suggest technical government reviewers by enclosing a cover letter with the name, organization, address and phone number (if known), and a rationale for each suggestion. BMDO promises only to consider the suggestion.

BALLISTIC MISSILE DEFENSE ORGANIZATION TOPICS

BMDO 94-001	Directed Energy Concepts
BMDO 94-002	Kinetic Energy Weapons
BMDO 94-003	Sensors
BMDO 94-004	Nuclear Space Power
BMDO 94-005	Non-Nuclear Space Power and Power Conditioning
BMDO 94-006	Propulsion and Logistics
BMDO 94-007	Thermal Management
BMDO 94-008	Survivability
BMDO 94-009	Lethality
BMDO 94-010	Computer Architecture, Algorithms, and Language
BMDO 94-011	Optical Computing and Optical Signal Processing
BMDO 94-012	Structural Concepts
BMDO 94-013	Structural Materials
BMDO 94-014	Electronic Materials
BMDO 94-015	Superconductive Materials
BMDO 94-016	Surprises and Opportunities

BALLISTIC MISSILE DEFENSE ORGANIZATION TOPIC DESCRIPTIONS

BMDO 94-001 TITLE: Directed Energy Concepts

DESCRIPTION: Innovative applied research in the generation and propagation of directed energy beams. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, gamma-ray lasers, free electron lasers, and hybrid approaches. Interests include the full range of embodiments, i.e., low mass spaced-based, ground-based, and pop-up systems. Included are such topics as weapon pointing, beam control, acquisition, tracking and pointing, mirrors, beam propagation through natural and disturbed environments, optics, and countermeasures.

BMDO 94-002 TITLE: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons candidates presently include a variety of ground and space based interceptors including their propulsion. System elements include ground-based launchers, divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: the booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C.G. Control algorithms, fast frame and UV Seekers, acquisition and track; target discrimination, seeker operational environments, lethality/miss distance; aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermal-structural integrity, non-nuclear kill warhead performance, target acquisition in a nuclear environment, performance and survivability of electronics in nuclear environment; HVG lifetime, firing rate, projectile guidance and control and projectile launch survivability; and, common among all systems reliability; producibility, maintainability, and low cost/low mass.

BMDO 94-003 TITLE: Sensors

DESCRIPTION: Sensors and their associated systems will function as the "eyes and ears" of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from decoys and other penetration aids are sought. Sensor-related device technology is also needed. Examples of some of the specific areas are: cryogenic coolers (open and closed systems), superconducting focal plane detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet: novel information processing to maximize resolution while minimizing detector element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based BMD application (uv-sub-mm wave), new optics and optical materials. Entirely new approaches are also sought.

BMDO 94-004 TITLE: Nuclear Space Power

DESCRIPTION: Weapons, sensing, and communications systems under consideration for strategic defense have diversified power requirements and a wide spectrum of power and power conditioning situations. Nuclear power concepts and the associated components are of interest for unmanned spacecraft. The power duty cycles to be considered include: hundreds of MW power for pulse applications, sustained tens of kW for electric propulsion, continuous tens to hundred kW power for house keeping, tracking, etc. The energy conversion approaches include thermionic and Rankine cycles. New approaches leading to controlled wide excursions of power and burst mode power are sought. As part of Topic 94-007, innovative thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainability, and reliability of space nuclear power systems are sought.

BMDO 94-005 TITLE: Non-Nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of Topic BMDO94-04, non-nuclear approaches are sought for high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained tens of kW to MW power for electric propulsion, continuous tens of W to a few kW for house keeping, communications, etc. Specific topics include novel very long life battery concepts, chemically driven systems for burst power, advanced solar collectors and high efficiency multibandgap or thin film converters, inductive and capacitive stores, space-based MHD generators, heat dissipation systems, signature control, plasma switches, and high temperature power electronics. Also, concepts and systems that improve maintainability and reliability of space power systems (e.g. low loss insulation and cable) are sought. Very light weight and affordable technologies are also sought as are concepts that can work in the van Allen belt.

BMDO 94-006 TITLE: Propulsion and Logistics

DESCRIPTION: Missile defense places unprecedented demands on all types of space transportation and propulsion systems: launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids (e.g. H_2 and Ze), reduction of contamination from effluent, and sensors and controls for autonomous operation. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of and solar power demonstration missions incorporating electric thrusters, BMD seeks 10 to 30 kW electric thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit). With the advent of small surveillance satellites, low power (0.5 to 2 kW) electric propulsion is being considered for station keeping and orbit transfer; for such systems emphasis is being placed on achieving higher power densities for components of the integrated system (thruster, power conditioning unit, fuel control, gimbals, and fuel storage). Low mass interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid).

BMDO 94-007 TITLE: Thermal Management

DESCRIPTION: The high power levels for space stations must dissipate heat at state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for both power generation systems and space platform payloads. Some space platforms will require years of storage of large amounts of cryogens with minimum cryogen loss and high cryogen delivery rates under condition of zero-g, concept and devices for all types of space-based power cycles, nuclear and non-nuclear, and can satisfy these projected space platform requirements.

BMDO 94-008 TITLE: Survivability

DESCRIPTION: Missile defense elements must survive determined attacks against the system, and the natural space environments (atomic oxygen, space radiation and micrometeorites/debris). Survivability technology is needed for threat sensing, creation of false aim points, and passive hardening. Contributions are sought in materials development and processing, component hardware, systems, design and analysis.

Threat sensors enable the defense elements to detect nuclear, laser and radio frequency weapon attacks, and to respond appropriately. Sensors which can characterize the threat according to direction of attack, and spectral characteristics are particularly noteworthy. Technologies to create false aim points are needed to operate against the threat support sensors, including radar, passive visible/IR sensors and seekers, and laser radar.

Passive hardening against the nuclear, laser, RF and pellet/debris environments is needed, in addition to hardening against the natural space environments. Elements have common mission critical subsystems. Sensor systems, communications antennas (RF and laser), attitude sensors, solar power, propulsion, structure and thermal control are all directly exposed to nuclear, laser, RF and pellet/debris in addition to the natural space environments. Materials and component designs which are intrinsically

hard to these environments, and/or protective devices are needed. A key area is sensor subsystems, the components of which (baffle materials, mirrors, optics, structures, and focal plane arrays/read out electronics) must survive the laser, nuclear and IR environments. Nuclear and laser hard baffle materials, and devices for protection against unknown or agile lasers and rejection of RF energy are of particular interest. Structures and coatings providing appropriate thermal characteristics, stability under mechanical impulses and hardness to laser and RF radiation are needed. Processors capable of operating in unique nuclear environments presented by the strategic application (i.e. multiple burst environments) while retaining full functionality are essential.

BMDO 94-009 TITLE: Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. Innovative ideas or concepts for measurement of radiation of particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off. New concepts to produce higher probability of kill-given-a-hit.

BMDO 94-010 TITLE: Computer Architecture, Algorithms, and Language

DESCRIPTION: Missile defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of interest are:

- New computer architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.

- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.

- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular system, for tasks (for instance, the execution of a phase retrieval algorithm for interferometric imaging). Includes neural networks.

- Language design to develop code optimized for highly parallel processed architectures.

- Testing techniques that will provide a high level of confidence in the successful operation of concurrent, real-time, distributed large-scale software systems. Examples include sensitivity analysis, data flow testing, mutation testing, static concurrency analysis, and dependency analysis.

- Computer network and communications security. R&D for trusted computer systems in accordance with DoD 5200.28.STD; integration of COMPUSEC with COMSEC (DoD 5200.5).

- Self-adaptive processing and simulation. Algorithms and architectures for advanced decision making.

- Neurocomputing and Man-Machine Interface - rule-based AI and neural networks combined for decision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, high volume scenarios.

- Software architectures for embedded computer networks that especially facilitate incremental system and software integration, hardware and software maintenance, and system evolution, without significant performance degradation.

- Hardware and software self-diagnostic capabilities for monitoring the operational readiness and performance of space and ground systems incorporating embedded computer networks.

BMDO 94-011 TITLE: Optical Computing and Optical Signal Processing

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. In particular, non-linear optical materials advancements and new bistable optical device configurations are of interest.

BMDO 94-012 TITLE: Structural Concepts

DESCRIPTION: Minimum weight structures are needed to withstand high-g loading, acoustic and thermal environment of ground based interceptors and to provide solid bases for space systems pointing and tracking. Such structures will benefit from : (1) innovative vibration control techniques, (2) innovative fabrication approaches to cut structure cost, and (3) innovative use of advanced materials and/or design approaches to minimize structure weight. For instance, techniques and experimental verification are needed for active and/or passive methods to measure and control vibrations caused by thermo-mechanical flutter, thruster firing or structure borne noise caused by on-board mechanisms. "Active" structural elements containing materials and electronics to provide predictable mechanical displacement in response to applied electrical signals are of interest. Maximization of displacement, mechanical strength, and reliability; parameter stability over extended temperature ranges; and minimization of driving voltage, power, and weight of these elements are desired. Producibility improvements for curved d31 mode actuator elements, flextensional, and other integrated motion amplifiers are of interest. Fabrication approaches that provide minimum weight with reduced assembly, inspection, and scrap rates for conventional, advanced composite, and "active" structures are needed to reduce costs. Of course, clever design and material usage to reduce structure weight while maintaining or increasing capability are always desirable goals.

BMDO 94-013 TITLE: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 94-012 will depend on major improvements in *material properties* and cost effectiveness. Space structures supporting seekers and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Surface launched interceptors must withstand high g loads, aerothermal heating and structural vibration without compromising tracking accuracy. Lightweight materials are very beneficial for both ground and spaced based systems.

Specific goals require advanced techniques and processes that include imparting oxidation resistance and damage tolerance to composites and creating high elastic modulus composites for use over a broad range of temperatures. The following are sought: (1) innovative manufacturing methods for producing high modulus, fiber-reinforced glass, light metal (i.e., aluminum or magnesium), or resin matrix composites; (2) innovative procedures for the production of instrumentation, sensors and software for on-line process monitoring and evaluation of high modulus, fiber-reinforced composites during fabrication; (3) novel approaches to tailor fiber/matrix interfaces to maximize capability in advanced composites; (4) novel methods to cut fabrication cost of metallic and/or composite spacecraft and interceptor structures; (5) innovative tooling techniques for near-net shape production of advanced composites; (6) novel low-to-no outgassing joining/bonding techniques for advanced composites; (7) innovative surface modifications to promote wear resistance; (8) new methods for integrating instrumentation (e.g., embedded sensors) into advanced composite materials and structures; and (9) novel instrumentation for determination and telemetry of material properties and data from space. Advances are also sought in materials for optical system components, mechanical moving assemblies, and protective coatings.

BMDO 94-014 TITLE: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many missile defense applications will require advances in electronics materials.. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/superlattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest. Among the many BMD electronic needs are advances in high frequency transistor structures, solid

state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

BMDO 94-015 TITLE: Superconductive Materials

DESCRIPTION: BMD wants to demonstrate both high temperature superconductor (HTS) and low temperature superconductor (LTS) devices to enable or improve strategic defenses. Emphasis in HTS technology is in components integrated with state-of-the-art cryoelectronics for communications systems at K- and V- bands and radar systems in the X-band. The demonstration of HTS materials to BLIP limited detection of radiation in the optical, IR, MWIR, and LWIR bands as well as for signal processing applications is also of interest. The emphasis in LTS technology is the development and demonstration of high sensitivity detectors, digital electronics and memory enabling on-focal plane array signal processing and operating at temperature greater than 10K. Efforts should address packaging and interface issues and systems integration with cryocoolers and stored cryogens.

BMDO 94-016 TITLE: Surprises and Opportunities

DESCRIPTION: Since BMD is an exploration at technology's leading edge, it recognizes that surprises and opportunities may arise from creative minds. BMD will consider proposals in other technologies where they present an unusual opportunity for BMD. The proposer should take special care to describe the technology and why BMD would benefit from exploring it. Proposers should note that proposals in this topic will receive preliminary screening that may reject them as too far afield without the full technical review received by proposals in the topics already listed. This open call is for new technology, not for recycling of old ideas.

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Special Operations Command's (USSOCOM) missions include developing and acquiring unique special operations forces (SOF) equipment, r aterial, supplies and services. Desired SOF operational characteristics for systems, equipments and supplies include: lightweight and micro-sized; low signature and low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extreme temperature environments; water depth and atmosphere pressure proof; certified transportable by aircraft, ship and submarine, and deployable by paradrop; LPI/LPD jam resistant C3; electronic warfare capable of disruption and deception; near real-time surveillance and intelligence; highly lethal and destructive; and compatible with conventional force systems. USSOCOM is therefore seeking small businesses with a strong research and development capability and understanding of the necessity for consideration of these SOF operational characteristics for systems. The topics on the following pages represent an introduction to a portion of the problems encountered by the SOF in fulfilling its mission.

USSOCOM invites the small business community to send its proposals directly to the following address:

United States Special Operations Command
Attn: SOKS/SBIR Program, Topic No. SOCOM94-_____
2408 Florida Keys Ave
MacDill Air Force Base, Florida 33621-5316

The proposals will be processed, then distributed to the appropriate technical office for evaluation. Inquiries of a general nature or questions concerning the administration of the SBIR program and proposal preparation should be addressed to:

United States Special Operations Command
Attn: Ms. Paulette Widmann
2408 Florida Keys Ave
MacDill Air Force Base, Florida 33621-5316
Tel: (813) 840-5443

The USSOCOM has identified four technical topics for this, the first of two SBIR Solicitations to be released during FY 1994 by DOD, to which small businesses may respond. The topics listed are the only topics for which proposals will be accepted. The topics were initiated by USSOCOM technical offices that manage the research and development in these areas. No direct communication with the topic author is possible.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in this solicitation. As funding is limited, USSOCOM reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals are deemed superior, or it may fund no proposals in a topic area.

US SPECIAL OPERATIONS COMMAND

FY 94.1 SBIR TOPIC INDEX

SOCOM 94-001	Advanced Combat Rubber Raiding Craft (Small)
SOCOM 94-002	Miniature RF Receiving Antennas
SOCOM 94-003	Molded Photovoltaic Case for Electrical Equipment
SOCOM 94-004	Small Virtual Receiving Antenna

SUBJECT/WORD INDEX TO THE USSOCOM SOLICITATION

US SPECIAL OPERATIONS COMMAND

FY 94.1 SBIR TOPIC DESCRIPTIONS

SOCOM94-001 TITLE: Advanced Combat Rubber Raiding Craft (Small)

CATEGORY: Advanced Development; Marine Systems

OBJECTIVE: To design and demonstrate an advanced small craft, which has excellent sea keeping ability and can be launched from submarines for use by SOF personnel in littoral waters.

DESCRIPTION: Presently the Navy SEALs use small rubber craft which have poor seakeeping ability. The present craft are difficult to remove from the submarine's escape trunk. This difficulty requires additional time to extract the boat from the submarine, take it to the surface and insert the rigid floorboards. The seakeeping ability of this type of craft is extremely bad at a low rate of speed.

A craft is desired that is approximately 15 foot long, unts a 35 HP outboard motor, can carry approx 1200 lbs of personnel and equipment (excluding motor), and can achieve approx 30 knots.

PHASE I: Develop and document craft design.

PHASE II: Refine design, build development models and test in laboratory and field conditions.

COMMERCIAL POTENTIAL: Non-military applications exist in the leisure craft and commercial work boat industries.

SOCOM94-002 TITLE: Miniature RF Receiving Antennas

CATEGORY: Advanced Development, Telecommunications

OBJECTIVE: Design and develop miniature radio frequency (RF) antenna and/or antennas allowing reception of high frequency (HF), very high frequency (VHF), and ultra high frequency (UHF) signals.

DESCRIPTION: Design, develop, and test antennas which can be attached to existing receivers that will be extremely low physical profile, yet allow reception in the HF, VHF, and UHF frequency ranges. Antenna(s) must be very small (man-packable), light weight and not increase weight, logistics and/or support requirements normally associated with radio communication equipment. The deliverables will be one or more antennas and any supplementary equipment necessary to support the antenna(s). The effort will focus on the design of the antenna(s) vice using advanced materiels. The antenna(s) will be such that they do not in any way adversely effect existing interfaces or system performance of common radio communication equipment, and operate with the same interfaces.

PHASE I: Design, fabricate, and lab test a prototype capability.

PHASE II: Refine, design, build and test engineering prototypes in field conditions.

Commercial Potential: Antennas for commercial fixed sites for cellular, radio, wireless data networks, and mobile vehicles, aircraft, and ships.

SOCOM94-003 TITLE: Molded Photovoltaic Case for Electrical Equipment

CATEGORY: Advanced Development, Laser, Optics & Power Systems

OBJECTIVE: Design and develop ›lded photovoltaic case for electrical equipment. The case would be used for continual trickle charge of system's power supply and/or provide primary power to system contained within the case.

DESCRIPTION: Design, develop, and test material which can be molded as a case for an electronic device and function as a trickle charge capability to the electronic device or as it's primary power. The objective case would be configured in such a way as to replace the existing case (external shell) of an electrical device, yet maintain the physical support, rigidity and

protection provided by the original container. The case, as a unit, should be of the voltage and peak power delivery capability as the military BA-5590 and BB-590 batteries. It should be designed in such a way as to not dramatically increase the size or weight of the electronic device to which attached. The initial delivery would provide a demonstration of the capability, and the objective delivery would be the complete case/container of an electronic device selected by the government. The design of the material/item/shell will be such that it does not adversely effect existing interfaces or system performance of common radio communication equipment, and operate with the same interfaces.

PHASE I: Design, fabricate, and test a prototype capability.

PHASE II: Refine design, build and test production prototypes in field conditions.

Commercial Potential: Cases for laptop/notebook computers and cellular telephones that increase battery life.

SOCOM94-004 TITLE: Small Virtual Receiving Antenna

CATEGORY: Exploratory Development, Telecommunications

OBJECTIVE: Design and develop a single, small, electronically tunable virtual receiving antenna capable of duplicating electronically, but not physically, the wide variety of antennas necessary to receive high frequency (HF), very high frequency (VHF) and ultra high frequency (UHF) radio frequency (RF) signals.

DESCRIPTION: Design, develop, and test an electronically tunable antenna using advanced materiels which can be attached to existing receivers that will be extremely low profile, yet allow reception in the HF, VHF, and UHF frequency ranges. Antenna must be very small (man-packable), light weight and not increase logistics and/or support requirements normally associated with radio communication equipment. The deliverable will be one antenna, any supplementary equipment necessary to support the antenna, and supporting documentation. The design of the antenna will use advanced concepts and be such that it does not in any way adversely effect existing interfaces or system performance of common radio communication equipment, and operate with the same interfaces.

PHASE I: Design, fabricate, and lab test a prototype capability.

PHASE II: Refine design, build and test engineering prototypes in field conditions.

Commercial Potential: Tunable antenna to be used for a variety of communications by automobiles, trucks, aircraft, and boats, to include cellular telephone, television, Global Positioning System (GPS), radio, data transmission, and facsimile.

APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to [illegible] [illegible] may cause your proposal to be disqualified

[illegible] ______________________

[illegible] ______________________

FIRM NAME ______________________

[illegible] ______________________

[illegible] ______________________ STATE ________ ZIP ________

PROPOSED COST ______________ PHASE I OR II PROPOSAL ______ PROPOSED DURATION IN MONTHS ______

[illegible]

▶ [illegible] as described in paragraph 2.2 ☐ ☐

▶ [illegible] disadvantaged business as defined in paragraph 2.3 ☐ ☐
(Collected for statistical purposes only)

▶ [illegible] woman-owned small business as described in paragraph 2.4 ☐ ☐
(Collected for statistical purposes only)

▶ [illegible] submitted to other US government agency, agencies, or DoD components, or other [illegible] SBIR office [illegible] ☐ ☐

______________________ ______________________

______________________ ______________________

▶ [illegible] including all affiliates (average for preceding 12 months) ______________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR | CORPORATE OFFICIAL (BUSINESS)

NAME ______________________ NAME ______________________

TITLE ______________________ TITLE ______________________

TELEPHONE ______________________ TELEPHONE ______________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ______________________

SIGNATURE OF PRINCIPAL INVESTIGATOR ______ DATE ______ SIGNATURE OF CORPORATE BUSINESS OFFICIAL ______ DATE ______

(Nothing on this page is classified or proprietary information/data)

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six)

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 225-3842 (Toll Free)
(703) 274-6902 (Commercial)

APPENDIX B

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

Failure to use a RED Copy as the original for each proposal ... in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER ____________________

PROPOSAL TITLE ____________________

FIRM NAME ____________________

PHASE I or II PROPOSAL ____________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

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OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

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Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 225-3842 (Toll Free)
(703) 274-6902 (Commercial)

APPENDIX C

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

Reference A

TO: ______________________________

Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 94.1

Topic No. ____________

Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____

Fill in name of organization to which you will send your proposal.

______________________________ ____________

Signature by receiving organization Date

Reference B

To: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program Solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires January 14, 1994, the DoD SBIR Program Solicitation No. 93.2 closing date.

REQUESTER ______________________________
Name

ORGANIZATION NAME ______________________________

ADDRESS ______________________________
Street

______________________________ PHONE ______________
City State Zip Code Area Code/Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1 ________	6 ________		11 ________	16 ________
2 ________	7 ________	*PLEASE TYPE OR PRINT IN THE*	12 ________	17 ________
3 ________	8 ________	*ORDER TOPICS APPEAR IN THE*	13 ________	18 ________
4 ________	9 ________	*SOLICITATION*	14 ________	19 ________
5 ________	10 ________		15 ________	20 ________

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation.

This is our first request during the current solicitation: yes____ no____.

____
Signature of Requester

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Cameron Station
Alexandria, VA 22304-6145

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Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD SOUTH
ATTN: Howard Head, Jr.
805 Walker Street
Marietta, GA 30060-2789
(800) 551-7801 (Toll Free-GA)
(800) 331-6415 (Nationwide)
(404) 590-6196
(404) 590-2612 (FAX)

DCMAO Atlanta
ATTN: Evelyn Taylor
805 Walker Street
Marietta, GA 30060-2789
(404) 590-6197

DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, N., Suite 104
Birmingham, AL 35203-2376
(205) 226-4304

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, Room 640
PO Box 50500
Dallas, TX 75202-4399
(214) 670-9205

DCMAO Orlando
ATTN: Russell Nielson
3555 Maguire Boulevard
Orlando, FL 32803-3726
(407) 228-5113/5260

DCMAO San Antonio
ATTN: Thomas Bauml
615 E. Houston Street, PO Box 1040
San Antonio, TX 78294-1040
(512) 229-4650

DCDM INTERNATIONAL
DCMAO Puerto Rico
ATTN: Victor Irizarry
209 Chapel Drive
Navy Security Group Activity
Sabana Seca, PR 00952
(809) 795-3202

DCMD NORTHEAST
ATTN: John McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 348-1011 (Toll Free MA Only)
(800) 321-1861 (Toll Free Outside MA)
(617) 451-4317/4318
(617) 451-3174 (FAX)

DCMAO Boston
ATTN: Gerald Hyde
495 Summer Street
Boston, MA 02210-2184
(617) 451-4108/4109/4110

DCMAO Bridgeport
ATTN: Otis Wade
555 Lordship Boulevard
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DCMAO Garden City
ATTN: John Richards
605 Stewart Avenue
Garden City, NY 11530-4761
(516) 228-5724

DCMAO Hartford
ATTN: Frank Prater
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ATTN: John Castellane
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New York, NY 10014-4811
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DCMAO Syracuse
ATTN: Ralph Vinciguerra
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Syracuse, NY 13204-2408
(315) 423-5664

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMAO San Francisco
ATTN: Robert Lane
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7041

DCMAO San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 200
San Diego, CA 92111-2241
(619) 495-7459/7467

DCMAO El Segundo
ATTN: Debbie Tatum
222 N. Sepulveda Boulevard
El Segundo, CA 90245-4320
(310) 335-3511

DCMAO Seattle
ATTN: Alice Toms
Corporate Campus, East 111
3009 112th Ave., NE, Suite 200
Bellvue, WA 98004-8019
(200) 889-7317

DCMAO Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92712-2700
(714) 836-2913

DCMAO Van Nuys
ATTN: Diane Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 904-6158

DCMAO Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6177

DCMD MID-ATLANTIC
ATTN: Thomas Corey
2800 S. 20th Street
Philadelphia, PA 19101-7478
(800) 843-7694 (Toll Free PA Only)
(800) 258-9503 (Toll Free-DC,DE,MD,NJ,VA,WV)
(215) 737-4006

DCMAO Baltimore
ATTN: Gregory Prouty
200 Towsontown Boulevard West
Towson, MD 21204-5299
(410) 339-4809

DCMAO Cleveland
ATTN: Herman Peaks
1240 East 9th Street
Cleveland, OH 44199-2064
(216) 522-5446

DCMAO Dayton
ATTN: Betty Adams
c/o Defense Electronics Supply Center
Building 1, 1507 Wilmington Pike
Dayton, OH 45444-5300
(513) 296-5150

DCMAO Detroit
ATTN: David Boyd
905 McNamara Federal Bldg, 477 Michigan Ave.
Detroit, MI 48226-2506
(313) 226-5180

DCMAO Philadelphia
ATTN: Julia Graciano
2800 S. 20th Street, PO Box 7699
Philadelphia, PA 19101-7478
(215) 737-5818

DCMAO Pittsburg
ATTN: Fred Fundy
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926

DCMAO Reading
ATTN: Thomas Knudsen
45 South Front Street
Reading, PA 19602-1094
(215) 320-5012

DCMAO Springfield
ATTN: Charles Ferraro
955 South Springfield Ave.
Springfield, NJ 07081-3170
(201) 564-8204

DCMD NORTH CENTRAL (DCMDC-DU)
ATTN: James Kleckner
O'Hare International Airport
10601 West Higgins Road
PO Box 66926
Chicago, IL 60666-0926
(800) 637-3848 (Toll Free)
(312) 825-6020
(312) 825-5914

DCMAO Ceder Rapids
ATTN: Norma Kirkley
1231 Park Place, NE
Ceder Rapids, IA 52402-2023
(319) 378-2009

DCMAO Chicago
ATTN: Norma Thorpe
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021/6866

DCMAO Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381

DCMAO Grand Rapids
ATTN: Kay Hamilton
Riverview Center Building
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620

DCMAO Indianapolis
ATTN: Robert Staton
Building 1
Fort Benjamin Harrison, IN 46249-5701
(317) 542-2015

DCMAO Milwaukee
ATTN: Paul Roppuld
Henry S. Ruess Federal Plaza
310 West Wisconsin Avenue
Milwaukee, WI 53203-2216
(414) 297-4339

DCMAO St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5392

DCMAO Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloominton, MN 55425-1911
(612) 335-2003

DCMAO Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
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