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Amended
FY 1992/1993 Biennial
RDT&E Descriptive Summaries

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AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0601101E
 PE Title: Defense Research Sciences

Budget Activity: 1. Technology Base

A. RESOURCES: (\$ in Thousands)

<u>Project Number</u> <u>A Title</u>	<u>FY 1991</u> <u>Actual</u>	<u>FY 1992</u> <u>Estimate</u>	<u>FY 1993</u> <u>Estimate</u>	<u>To</u> <u>Complete</u>	<u>Total</u> <u>Program</u>
CCS-02 Information Sciences	35,335	43,090	51,811	Continuing	Continuing
LV-01 Laser Verification	7,454	0	0	0	7,454
DRH-01 Physical Sciences	4,339	0	0	0	131,015
ES-01 Electronic Sciences	18,921	26,667	42,504	Continuing	Continuing
MS-01 Materials Sciences	16,187	42,653	31,763	Continuing	Continuing
TOTAL	<u>82,236</u>	<u>112,410</u>	<u>126,078</u>		

B. BRIEF DESCRIPTION OF ELEMENT: The Defense Research Sciences program element provides the technical foundation for long-term improvements in military equipment and systems through the discovery of new phenomena and the exploration of the potential of such phenomena for military application. It supports the scientific study and experimentation that is the base for more advanced knowledge and understanding in information, electronic and materials sciences related to long-term national security needs. The Information Sciences Project utilizes high performance computing, information technology and artificial intelligence to develop superior military systems at a reduced cost and size. The Electronic Sciences project demonstrates device, material, and processing concepts that will enhance future electronic and optical systems as well as substantially increasing performance at a reduced cost. The Materials Sciences project concentrates on the development of new materials and concepts for advanced composite structures, synthesis of more efficient/heat resistant polymers, and the development of multi-chip modules.



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AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: 40601101E
 PE Title: Defense Research Sciences

Project Number: CCS-02
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
CCS-02 Information Sciences	35,335	43,090	51,811	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: Develop fundamental technology for smaller, more powerful, less expensive military systems using high performance computing and information technology including artificial intelligence.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Developed Very Large Scale Integrated (VLSI) architecture and design tools to allow development of integrated capabilities for design, fabrication, and test of integrated circuits containing in excess of one million gates and rapid prototyping of systems containing such circuits.
- Initiated demonstration of a Persistent Object Base to allow sharing of information in the correct context for rapid multi-source manufacturing, for logistics planning, and integration of results from simulations in training and warfare.
- Developed algorithms and demonstrated automatic programming of robotic manipulation for complex manufacturing assembly tasks.
- Measured ability of message understanding systems to extract crisis-situation data from news wires.
- Developed 50 Million Instructions Per Second (MIPS) self-timed microsystem node for advanced parallel computers.
- Developed programming tools to define, implement and compose distributed program module.

FY 1992 Planned Program:

- Determine effectiveness of auditory models as preprocessors for robust speech recognition in noise.
- Develop specifications of language to specify interconnections amongst modules in software systems in order to enable heterogeneous software systems.
- Develop initial integrated support system for generic knowledge representations and services.
- Develop chips, synthesis capabilities for fault-tolerant microsystems router.
- Develop 100 Million Instructions Per Second (MIPS) self-timed microsystem processor.
- Develop basic compiler theory for parallelization across different machine configurations.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0601101E
PE Title: Defense Research Sciences

Project Number: CCS-02
Budget Activity: 1. Technology Base

- Prototype architectural based approaches of generation and reuse of sensing and control software for implementation of dynamic control of robotic systems.

FY 1993 Planned Program:

- Develop techniques for using prosodic information to improve the performance of continuous speech recognition and understanding.
- Develop techniques for automatically generating a natural language grammar from a bracketed corpus of text.
- Demonstrate design reuse and automated design history capture in a variety of diverse subject domains.
- Apply component interconnection language to precisely define interfaces in existing systems software in order to facilitate development of systems with high levels of confidence of correctness.
- Evaluate and refine integrated support system for generic knowledge representations and services.
- Develop fault-tolerant microsystem router, perform fault injection experiments.
- Demonstrate new compiler design to exploit parallel computing in embedded system.

D. WORK PERFORMED BY: University of Southern California/Information Sciences Institute, Marina del Rey, CA; Stanford University, Palo Alto, CA; Massachusetts Institute of Technology, Cambridge, MA; University of California at Berkeley, CA; and Carnegie-Mellon University, Pittsburgh, PA.

E. RELATED ACTIVITIES: The basic results developed in this Project (CCS-02) provide the foundation for further developments in Program Element 0602301E, Computer Systems and Communications, Projects ST-10, ST-19 and ST-20.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0601101E
 PE Title: Defense Research Sciences

Project Number: ES-01
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ES-01 Electronic Sciences	18,921	26,667	42,504	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project explores and demonstrates device, material, and processing concepts that will provide: (1) new technical options for future electronic and optical systems used in information transmission, gathering, and processing; and (2) substantial increase in performance and cost reduction per function. Areas included are: new electronic device and circuit concepts, innovative optical materials and devices, artificial neural network (ANN) hardware, and fundamentally new semiconductor processing.

C. PROGRAM ACCOMPLISHMENTS AND PLAN:

FY 1991 Accomplishments:

- Developed high frequency laser modulation techniques for vertical-cavity, surface-emitting lasers.
- Implemented lift-off processing technique for gallium-arsenide (GaAs) lasers and silicon (Si) solar cells to achieve versatile optoelectronic circuits.
- Developed coupled, quantum well optical switches with asymmetric wells in 3mm length.
- Demonstrated multiple quantum device circuits.
- Demonstrated mercury-cadmium-telluride (MCT) on GaAs for infrared focal plane arrays (IRFPAs).
- Demonstrated long-wave infrared response with III-V material, dislocation-free superlattice structure.
- Demonstrated neural nets out-perform conventional image and sonar recognition systems.
- Developed reproducible epitaxial growth process for integrating field effect transistors (FETs) and resonant tunnel diodes (RTD) on the same wafer.

FY 1992 Planned Program:

- Fabricate integrated optical processing modules of photorefractive elements and electronics devices.
- Formulate stable organic electro-optical polymers.
- Demonstrate growth of device quality mercury-cadmium-telluride (MCT) on 3-inch wafers of gallium arsenide by molecular beam epitaxy.
- Integrate polymer waveguide devices with silicon very large scale integrated (VLSI) circuits.
- Investigate nearest neighbor interaction cellular automata architectures, using quantum devices.
- Demonstrate logic elements using quantum devices.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0601101E
PE Title: Defense Research Sciences

Project Number: ES-01
Budget Activity: 1. Technology Base

- Demonstrate high-speed (> 1 billion operations/sec) neural net microchips.
- Demonstrate neural net speech recognizers.

FY 1993 Planned Program:

- Develop diode laser amplifier arrays.
- Develop coupled, quantum-well optical switches.
- Demonstrate blue-green diode laser.
- Demonstrate low-cost, high-responsivity III-V long wave infrared focal plane arrays.
- Integrate neural net microchips into board-level subsystems.
- Initiate development of neural network sensor fusion and autonomous control technologies.
- Initiate visible light emitter program.
- Initiate contracts to develop blue diode lasers.

D. WORK PERFORMED BY: Stanford University, Palo Alto, CA; Lincoln Laboratory, Lexington, MA; California Institute of Technology, Pasadena, CA; Martin Marietta Labs, Baltimore, MD; Intel Corp, Santa Clara, CA; and Mayo Foundation, Rochester, MN.

E. RELATED ACTIVITIES: Efforts in this project are coupled to the Services' program through use of service agents, annual DoD-wide program reviews, and presentations to the Advisory Group on Electron Devices (AGED). These activities assure that no unnecessary duplication of effort occurs.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: MS-01
PE Title: Defense Research Sciences Budget Activity: 1. Technology Base

A. RESOURCES: (\$ in Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MS-01 Materials Sciences	16,187	42,653	31,763	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project is concerned with the development of new materials and concepts for advanced composite structures; synthesis of stronger and more heat resistant polymers; development of high power/energy density electrochemical power sources, including batteries and fuel cells; research into the disposal of future generation toxic chemical wastes; and the development of multi-chip modules with superconducting interconnects for manufacturable, high-performance packaged microelectronics.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Discovered a new family of aromatic/aliphatic copolyester adhesives which can be laminated in the solid state without the evolution of gases.
- Initiated a program to develop a direct oxidation, near ambient temperature fuel cell.
- Monomer materials were prepared and polymerized into soluble, high molecular weight composite matrix resins with a glass transition temperature in the range from 360-430°C.
- Demonstrated continuous successful operation of the automated, solid-state battery laminate production line.
- Initiated a program in electroprocessing of piezoelectric materials for sonar applications.
- Initiated a program to produce advanced boron nitride fibers for composite reinforcement.
- Initiated a program to investigate super critical fluid technology for the safe destruction of toxic military wastes.
- Developed technology for coating fibers to provide chemical compatibility between fiber and matrix.

FY 1992 Planned Program:

- Design and install a continuous process for manufacture of boron nitride fibers.
- Optimize high temperature adhesive properties of new family of polyesters, including matrices for composites and dielectric insulators.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0601101E

Project Number: MS-01

PE Title: Defense Research Sciences

Budget Activity: 1. Technology Base

- Delivery of solid-state batteries for external testing and independent verification of performance; produce prototype primary battery for the FBI.
- Begin development of a facility for fabricating multi-chip modules (MCM) with superconducting interconnects.
- Demonstrate improvement of solid state battery cell life.
- Demonstrate stable, high temperature, nylon piezoelectric polymers.
- Demonstrate prototype high-efficiency direct oxidation fuel cell.
- Demonstrate applicability of Lanxide metal matrix composite technology for thermal management in electronic packaging.
- Initiate a program, the Environmental Research Initiative, to develop environmentally safe manufacturing processes which could replace current unacceptable processes.

FY 1993 Planned Program:

- Demonstrate pilot process for safe destruction of toxic military chemical wastes.
- Development of electrocatalysts for efficient ambient temperature fuel cells.
- Demonstration of high-efficiency direct oxidation fuel cell power module.
- Demonstrate prototype mini-Global Positioning System (GPS) solid state battery.
- Demonstrate a functioning MCM with superconducting interconnects.

D. WORK PERFORMED BY: University of Pennsylvania, Philadelphia, PA; Massachusetts Institute of Technology, Cambridge, MA; California Institute of Technology, Pasadena, CA; Lanxide Corp., Newark, DE; GA Technologies, La Jolla, CA; University of California, Santa Barbara, CA; International Fuel Cells, South Windsor, CT; Owens Corning Fiberglass, Granville, OH; and University of Illinois, Urbana, IL; E-Systems, Greenville, TX; nChip, Sunnyvale, CA; and Cornell University, NY.

E. RELATED ACTIVITIES: DARPA's research in Materials Sciences is coordinated within the DoD and with other federal agencies via the National Science Foundation-hosted Interagency Materials Group, Office of Science and Technology Policy (OSTP) Committee on Materials (COMAT), and various Director, Defense Research and Engineering (DDR&E) sponsored topical workshops on advanced materials. These activities assure that no unnecessary duplication of effort occurs.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and
Communications Technology

Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project</u> <u>Number &</u> <u>Title</u>	<u>FY 1991</u> <u>Actual</u>	<u>FY 1992</u> <u>Estimate</u>	<u>FY 1993</u> <u>Estimate</u>	<u>To</u> <u>Complete</u>	<u>Total</u> <u>Program</u>
ST-01	JASON 1,380	1,300	1,300	Continuing	Continuing
ST-10	Strategic Computing (98,173)*	78,158	69,551	Continuing	Continuing
ST-11	Intelligent Systems 31,415	35,823	38,753	Continuing	Continuing
ST-12	Advanced Quantum Electro-Optics and Electronic Warfare 13,754	12,682	9,211	Continuing	Continuing
ST-15	Gallium Arsenide 23,030	8,286	1,186	0	139,570
ST-16	High Temperature Superconductivity/Ceramics 25,272	26,500	(22,735)**	(Continuing)**	(Continuing)**
ST-18	DARPA Initiative in Concurrent Engineering (DICE) 24,719	20,000	0	0	74,719
ST-19	High Performance Computing (HPC) 115,411	114,729	162,912	Continuing	Continuing
ST-20	Distributed Information Systems/C ³ (36,306)***	(34,570)***	36,310	Continuing	Continuing
ST-21	Software Engineering Institute (SEI) (19,000)***	(17,100)***	17,100	Continuing	Continuing
ST-22	Software Technology for Adaptable Reliable Systems (STARS) (15,222)***	(25,234)***	23,900	Continuing	Continuing
ST-23	Surveillance Research (26,052)***	19,663***	16,877	Continuing	Continuing
TOTAL	234,981	297,478	377,100		

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and Budget Activity: 1. Technology Base
Communications Technology

*Shown here for purpose of continuity. The FY 1991 portion of this program was executed under ST-19 in accordance with the FY 1991 Appropriation Act.

**Beginning in FY 1993, the High Temperature Superconductivity/ Ceramics program will be funded under the Materials Processing Technology Program Element 0602712E, Project MPT-06. The FY 1991 and FY 1992 program accomplishments and plans are stated in Project MPT-06.

***The following new projects reflect the FY 1993 Program Element/Project consolidation and realignment within DARPA. The FY 1991 and FY 1992 funding and program accomplishments and plans are stated in these new Projects for continuity purposes.

<u>New Project</u>	<u>FY1991/92 PE</u>	<u>Previous Project</u>
ST-20	0602708E	IC-01 and IC-02
ST-21	0603756E	CS-01
ST-22	0603756E	CS-02
ST-23	0602714E	NM-01

B. BRIEF DESCRIPTION OF ELEMENT: This Program Element funds research and development projects directed toward the application of advanced, innovative computing systems and communications technologies. These projects include: developing systems concepts and software; strategic computing; intelligent systems; advanced quantum electro-optics for sensor protection; computer modeling and simulation; surveillance and engagement techniques; manufacturing technology; advanced high performance computing and computer communications technology; developing and demonstrating technology for information processing; accelerating transition through the Software Engineering Institute of software technology and advancing the state of software engineering practices; generating elements upon which to build a coordinated DoD software solution; and enhancing U.S. surveillance capability for monitoring worldwide nuclear explosions.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #602301E
 PE Title: Computing Systems and
 Communications

Project Number: ST-01
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-01 JASON	1,380	1,300	1,300	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project supports the JASONS, an independent group of distinguished individuals dedicated to sophisticated scientific and technical research and analysis in support of the National Security Community. JASON membership is carefully balanced to provide a wide spectrum of expertise in theoretical and experimental physics, materials, information sciences, and other allied disciplines.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments: The JASON Group has conducted extensive investigations of topics including advanced phase array technology, foliage penetration radar, condensed charge technology, high energy density explosives, impulse radar, and structural acoustics.

FY 1992 Planned Program: The JASON Group will conduct extensive investigations of topics such as: acoustic warfare, structural acoustics, and critical mobile targets.

FY 1993 Planned Program: Continuing evaluations of new technical issues as they arise.

D. WORK PERFORMED BY: Mitre Corporation, McLean, VA.

E. RELATED ACTIVITIES: Not applicable.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-10

PE Title: Computing Systems and
Communications Technology

Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-10 Strategic Computing	*(98,173)	78,158	69,551	Continuing	Continuing

*Shown here for purpose of continuity. The FY 1991 portion of this program was executed under ST-19 in accordance with the FY 1991 Appropriation Act.

B. BRIEF DESCRIPTION OF PROJECT: Develop a new generation of advanced computing technology for defense embedded systems and other defense applications. Develop advanced computational methods, including symbolic, numeric, and combined approaches from artificial intelligence and computational mathematics. Create embeddable versions of high performance computing modules for use in defense systems, requiring low power, high density, and heterogeneity. Develop systems software for scalable, portable, and trusted heterogeneous computing. Create advanced software capabilities for computationally intensive defense uses including image understanding, signal understanding, antisubmarine warfare, speech recognition, logistics support, and vehicle design. Create foundations for supporting advanced acquisition technology that will enable the design, development, manufacturing, and logistics support for weapon systems, as well as command and control, and mission critical information processing.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated a new generation vision system architecture enabling near-real time navigation on and off road.
- Developed flexible planning and scheduling system used in Desert Shield and Desert Storm.
- Prototyped a large-scale aerodynamic simulator on a 10 gigaops scalable parallel computing system.
- Demonstrated operation of a smart 32x32 2-dimensional optical detector array.
- Developed manufacturable, reliable 3-dimensional memory for clock rates above 100 MHz.
- Developed compression techniques for sound and image data using wavelet methods.
- Developed computer simulations of microlithographic processing for submicron scale features.

FY 1992 Planned Program:

- Demonstrate real-time recognition of continuous speech with 1,000-word vocabulary and rapid speaker adaptation.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-10

PE Title: Computing Systems and
Communications Technology

Budget Activity: 1. Technology Base

- Prototype large-scale interactive knowledge-based transportation planning aid.
- Demonstrate 200 MHz Gallium Arsenide crossbar switch in High Density Interconnect and optical crossbar switch.
- Fabricate array of free space, point-to-point optoelectronic interconnects.
- Develop new algorithms for spread spectrum, underwater acoustic transient detection/classification and non-cooperative target recognition.

FY 1993 Planned Program:

- Prototype of spoken language understanding capability.
- Apply advanced machine planning and learning capabilities to DoD planning and assessment needs.
- Develop robust machine vision environment.
- Prototype automated text detection and extraction capability.
- Demonstration of 100 billion ops/second computing system.
- Demonstrate scalable, embeddable computing modules in military applications.
- Demonstrate prototype for spread spectrum communication based on wavelets.
- Develop scalable libraries for military applications (e.g. ASW, signal processing, etc.).
- Develop 2 photon, 3-dimensional optical memory.
- Demonstrate high yield, 100 MHz MCM foundry operation.

D. WORK PERFORMED BY: Carnegie-Mellon University, Pittsburgh, PA; Stanford University, Palo Alto, CA; Intel Corporation, Santa Clara, CA; Massachusetts Institute of Technology, Cambridge, MA and others.

E. RELATED ACTIVITIES: Program Element 0602301E, Project ST-19 High Performance Computing. With the initiation of ST-19, ST-10 (Strategic Computing) will more explicitly focus on defense embedded high performance systems, accelerators for specific defense problem domains, machine intelligence technology for high performance systems, and experimental applications for critical defense problems.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computer Systems and
 Communications Technology

Project Number: ST-11
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-11 Intelligent Systems	31,415	35,823	38,753	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project investigates sciences and technologies that promise fundamentally new software capabilities and intelligent information processing. This will enable computers to amplify or augment military personnel performing complex decision-making, tasks in stressful, time sensitive situations. A major emphasis is rapid prototyping and life cycle support technology of next-generation computing systems for defense needs that are flexible, robust, and cost-effective. Major areas of technical emphasis include languages, algorithms, databases, systems software, and design tools. The major focus continues to be development of artificial intelligence (AI)-based systems and supporting technologies and their transition into software engineering environments, e.g., heterogeneous database integration and maintenance or information fusion.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated capabilities for automatic scene segmentation, initial automatic multiple-goal planning capabilities and automatic geometric reasoning capability for classifying multiple (more than 10) moderately complex objects in a scene.
- Continued research in cooperative problem solving, reasoning with uncertainty, and image understanding, to increase functionality and performance.
- Developed advanced reasoning techniques to capture designs and automatically generated diagnostic and monitoring knowledge.
- Expanded area and scope capabilities of aerial image interpretation, including integration with terrain data bases.
- Demonstrated languages and systems software to support symbolic and numeric processing applications on high performance heterogeneous parallel systems, including network-based systems.
- Demonstrated autonomous navigation in unstructured environments at speeds up to 67 KMH.

FY 1992 Planned Program:

- Develop standards to facilitate reuse of AI methods and knowledge bases.
- Develop common image understanding, planning, and testbed framework machine learning to accelerate research progress.
- Develop generic, intelligent problem solving tools based on the integration of machine learning, knowledge representation, and planning methods.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-11

PE Title: Computer Systems and
Communications Technology

Budget Activity: 1. Technology Base

- Demonstrate new AI tools in very large scale, distributed experiments in areas such as weapon system software design, logistics, and operations planning.
- Develop prototype implementation of high-level language to support rapid prototyping of software systems.
- Demonstrate capabilities of simulated and virtual factory for semiconductor process design.
- Demonstrate autonomous navigation capabilities on surrogate semi-autonomous vehicle in support of OSD Joint Naval Program.

FY 1993 Planned Program:

- Develop robust capability for automatic scene segmentation.
- Demonstrate automatic geometric reasoning capability for classifying many (more than 100) moderately complex objects in a scene.
- Demonstrate complex automatic multiple-goal planning capabilities.
- Develop architecture for software environment to support rapid prototyping and integration of prototype modules into evolving software systems.
- Demonstrate multiple object identification and tracking from a moving unmanned vehicle.
- Develop architecture for a composed system which integrates, interfaces, creates and maintains a single database from multiple heterogeneous intelligence community databases.

D. WORK PERFORMED BY: Stanford University, Palo Alto, CA; University of Southern California, Information Sciences Institute, Marina del Ray, CA; Carnegie-Mellon University, Pittsburgh, PA; Harvard University, Cambridge, MA; University of Massachusetts, Amherst, MA; Computational Logic, Incorporated, Austin, TX; University of California at Berkeley, CA; and Rice University, Houston, TX.

E. RELATED ACTIVITIES: PE #0602301E, ST-10 Strategic Computing is based on machine intelligence research performed under this project. Builds upon the new high performance computing technologies being produced under project ST-19.

F. OTHER APPROPRIATIONS FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computer Systems and
 Communications Technology

Project Number: ST-12
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-12 Advanced Quantum Electro-Optics and Electronic Warfare	13,754	12,682	9,211	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: The purpose of this project is to: (1) advance the technology of quantum electro-optics (EO) for sensor protection and (2) combine computer modeling and simulation with experimentation for a variety of DoD applications including radars, communications, turbulence and distributed memory machines.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated optical limiting at optical gain of 10^6 in nonlinear materials for eye/sensor protection against pulsed tunable laser threats.
- Demonstrated microsurgical treatment of sub-retinal hemorrhage due to laser eye injuries.
- Developed 193 nanometer focusing optics.
- Developed a method for controlling temperature in a chemical vapor deposition reactor for diamond film deposition; simulations show improvement by two orders of magnitude over standard controllers.
- Developed speech and image compression techniques using wavelets. Achieved high compression ratios without degradation of image.

FY 1992 Planned Program:

- Develop prototype protective devices concepts from promising nonlinear materials.
- Transfer to NSA the results and methodology for solving satellite clock-locking problems.
- Test new algorithms for underwater feature detection of sound (ASW) using wavelets and Gabor theory.

FY 1993 Planned Program:

- Evaluate prototype devices for sensor protection.
- Develop intelligent manufacturing process control theory and apply to industrial manufacturing setting.
- Develop full three-dimensional electromagnetic code for calculating radar cross-sections with application to stealth technology.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-12

PE Title: Computer Systems and
Communications Technology

Budget Activity: 1. Technology Base

- Complete simulation code for lithography and provide precise criteria for control of deep ultraviolet and electron beam lithography to submicron scales.
- Develop realistic codes for simulating combustion with application to design of high performance turbine engines.

D. WORK PERFORMED BY: Lincoln Laboratory, Lexington, MA; Boeing Aerospace, Seattle, WA; Rockwell Science Center, Thousand Oaks, CA; Lockheed Missile & Space Company, Palo Alto, CA; Martin Marietta Company, Baltimore, MD; E-Systems, Falls Church, VA; Stanford University, Palo Alto, CA; University of California, Berkeley, CA; Yale University, New Haven, CT; and National Institute of Standards and Technology, Gaithersburg, MD.

E. RELATED ACTIVITIES: The Eye/Sensor Protection Program is coordinated with the Army Advanced Laser Protection Program through a Memorandum of Agreement (MOA) between US Army LABCOS and DARPA. Army and DARPA technology programs complement and support each other. The Applied and Computational Mathematics Program is coordinated with ONR, AFOSR, NSF, and NSA, thus ensuring that there is no undue overlap.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computer Systems and
 Communications Technology

Project Number: ST-15
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-15 Gallium Arsenide Applications	23,030	8,286	1,186	-0-	139,570

B. BRIEF DESCRIPTION OF PROJECT: This project demonstrates the military advantages of digital gallium arsenide (GaAs) subsystems for upgrading fielded systems, including electronic countermeasures, surveillance, and intelligence systems. The DARPA efforts will result in prototypes that the relevant Service program offices have agreed to test, qualify, and procure as upgrades. Complementary efforts are establishing key advanced digital GaAs components. The project also included an effort to demonstrate the technology for conformal microwave transmit/receive (T/R) modules ("smart skins"), an effort that concluded in FY 1991.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated initial GaAs components for 7 times faster On-Board Processor.
- Demonstrated fieldable GaAs digital radio frequency memories (DRFMs) to allow Army tactical aircraft to jam new classes of threat radars.
- Demonstrated AN/PRC-126 small unit radio that can be interoperable with Army standard radios.
- Demonstrated AN/APS-137 radar capable of double present resolution.
- Demonstrated 16K GaAs memory with laser repair for enhanced yield.
- Integrated T/R cells and packaging into 5 working subarrays.
- Demonstrated process for incorporation of high dielectric constant capacitors in memory cells to achieve single event upset (SEU) immunity.

FY 1992 Planned Program:

- Demonstrate advanced jamming capabilities for Navy aircraft based on GaAs.
- Demonstrate 200 megahertz (MHz) gallium arsenide signal processor.
- Demonstrate 1 million operations/second (MOPS) per watt On-Board Processor using digital GaAs technology.
- Demonstrate digital GaAs radio frequency (RF) memory for 200 MHz electronic warfare (EW) application.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-15

PE Title: Computer Systems and
Communications Technology

Budget Activity: 1. Technology Base

FY 1993 Planned Program:

- Demonstrate missile seeker upgrade for 10% cost savings.
- Demonstrate capability to process 8 times as many simultaneous signals based on digital GaAs processor.
- Demonstrate advanced GaAs processor that enables sophisticated target acquisition for OH-58D helicopters.

D. WORK PERFORMED BY: Major contracts include Martin Marietta, Denver, CO, and Orlando, FL; Texas Instruments, Dallas, TX; McDonnell Douglas, Huntington Beach, CA; and Lockheed Sanders Associates, Nashua, NH.

E. RELATED ACTIVITIES: This project is the only DoD effort to insert digital gallium arsenide technology into fielded military systems. The work is coordinated with Service research efforts through the Advisory Group on Electron Devices. These activities assure that no unnecessary duplication of effort occurs.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computing Systems and
 Communications Technology

Project Number: ST-19
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-19 High Performance Computing	*115,411	114,729	162,912	Continuing	Continuing

*In FY 1991, the budget includes the total Strategic Computing and High Performance Computing effort. For FY 1992 and beyond, Strategic Computing (ST-10) and High Performance Computing are separated in order to enable identification of the DARPA part of the Federal High Performance Computing Program and closely related technology projects.

B. BRIEF DESCRIPTION OF PROJECT: Advance High Performance Computing and Computer Communications (HPCC) technologies leading to teraops computing systems, associated software technology, and gigabits networking technology. These results will be used by ST-10 (Strategic Computing) and other DARPA and Defense programs for experimental application to critical defense problems including embedded high performance systems and ST-20 for distributed C³ systems. HPCC program efforts include microsystems component technology and advanced packaging, systems software technology, algorithms and programming tools for parallel heterogeneous systems, switches and protocols for gigabits capacity networks, and early use of experimental systems. Additionally, a major effort in rapid acquisition of application-specific signal processors will demonstrate a capability to rapidly specify, produce and field affordable high performance application-specific signal processors for critical defense applications including automatic target recognition, electronic countermeasures and Signal Intelligence (SIGINT).

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Initiated High Performance Computing Program through a Broad Agency Announcement process.
- Selected designs for teraops computing systems, including systems software.
- Selected major scalable libraries and tools for parallel systems.
- Began experimental use of wide area file system.
- Selected projects to develop advanced network services.

FY 1992 Planned Program:

- Demonstrate 100 gigaops high performance computing systems.
- Prototype software libraries for scalable parallel computers.
- Demonstrate prototype high density interconnect module for future systems.
- Prototype advanced software design tools for parallel software systems.
- Early use of national file system technology for software distribution.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #060230iE
PE Title: Computing Systems and
Communications Technology

Project Number: ST-19
Budget Activity: 1. Technology Base

- Demonstrate heterogeneous operating systems technology for high performance computing system.
- Demonstrate scalable mass storage systems.
- OS support for 1,000 node multicomputers including file systems, scheduling, checkpointing, restart and real-time control.
- Develop five testbed gigabit/second networks which will support tens of sites using several different switching technologies.
- Develop microsystems architectures and prototype components for teraops-scalable modules.
- Initial computational prototyping of semiconductor manufacturing capability.
- Develop scalable, embeddable high-density computing modules with gigaops performance.

FY 1993 Planned Program:

- Distribute prototype HPC software library for experimental use in a wide area file system.
- Define architecture for nationwide gigabit network.
- Demonstrate major modules of one-tenth scale teraops high performance computing systems.
- Demonstrate scalable operating systems suitable for heterogeneous teraops computing.
- Laboratory demonstration of teraop-scalable multicomputer technology.
- Select appropriate demonstration platforms for Application Signal Processors.
- Define languages, interfaces, and libraries for Application Signal Processor baseline demonstrations.

D. WORK PERFORMED BY: Contractors in industry and universities will be selected through a competitive process.

E. RELATED ACTIVITIES: Program Element (PE) #060230iE, Project ST-10, Strategic Computing and PE #0603739E, Project MT-04, Manufacturing Technology.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computer Systems and
 Communications Technology

Project Number: ST-20
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-20 Distributed Information Systems/C ³	*36,306	*34,570	36,310	Continuing	Continuing

*This new project reflects the Project/PE consolidation and realignment within DARPA. The associated FY 1991 and FY 1992 funding and program accomplishments and plans for this project are shown here for continuity purposes.

B. BRIEF DESCRIPTION OF PROJECT: Develop and demonstrate technology for (a) building systems that can fulfill DoD needs for information processing in DoD Command, Control, and Communication (C³) applications and (b) demonstrate technology for secure, survivable networks, utilizing advanced architectures and devices for worldwide command and control. Builds on new high performance computing technology base.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Developed prototype internet mechanisms for integrated operation of 1000 node distributed systems with support for real-time applications and software maintenance while beginning transitions to open system internet (OSI) protocols.
- Developed techniques to exploit new high performance computing systems on C³ applications.
- Demonstrated prototype privacy enhanced mail system.
- Demonstrated digital packet network switch with policy-based routing for data rates up to 45 megabits per second and established a 10-site test bed.
- Demonstrated packet radio for digital and non-real time voice communications.

FY 1992 Planned Program:

- Demonstrate experimental C³ internet in CONUS and Europe at megabit data rates.
- Demonstrate network-based software management, select and plan a military application with a replicated file system to ensure file survivability.
- Demonstrate applications of privacy enhanced mail and digital signatures in C³ applications and associated software system configuration management.

FY 1993 Planned Program:

- Demonstrate prototype object-based technology in experimental C³ internet.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-20

PE Title: Computer Systems and
Communications Technology

Budget Activity: 1. Technology Base

- Expand network-based software management to all major internet back-bone sites.
- Demonstrate applications of new high performance computing technologies to distributed military applications with large object-bases.

D. WORK PERFORMED BY: Stanford University, Palo Alto, CA; Teknowledge Federal Systems, Inc., Palo Alto, CA; Contel Federal System Inc., Chantilly, VA; Naval Sea Systems Command, Dahlgren, VA; Johns Hopkins University, Baltimore, MD.

E. RELATED ACTIVITIES: Builds upon the advanced computing networking technologies developed by the High Performance Computing Program (ST-19) by developing the defense specific technologies and testbeds.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E Project Number: ST-21
 PE Title: Computer Systems and Budget Activity: 1. Technology Base
 Communications Technology

A. RESOURCES: (\$ In Thousands)

Project Number	FY 1991 Actual	FY 1992 Estimate	FY 1993 Estimate	To Complete	Total Program
ST-21	Software Engineering Institute *19,000	*17,100	17,100	Continuing	Continuing

*This new project reflects the Project/PE consolidation and realignment within DARPA. The associated FY 1991 and FY 1992 funding and program accomplishments and plans for this project are shown here for continuity purposes.

B. BRIEF DESCRIPTION OF PROJECT: This project funds the Software Engineering Institute (SEI) to accelerate transition of software technology into the Services and industry to meet the demands for quality software and to advance the state of software engineering practice for use in development of weapon systems. The SEI identifies software engineering concerns critical to defense systems, identifies research that could be applied to such problems, and then works with the research community, industry and government organizations to rapidly transition appropriate technology to defense use. The need for the SEI was documented in the reports of the Department of Defense (DoD) Joint Task Force for Software Technology for Adaptable, Reliable Systems, March 1983, and by the blue-ribbon industry/Academia SEI Study Panel administered by the Institute for Defense Analysis for the Office of the Deputy Under Secretary of Defense, Research and Advanced Technology (R&AT), November 1983 and reaffirmed by the SEI Joint Advisory Committee in January 1989.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Delivered tool for managing software configuration.
- Initiated development of improvement technique for DoD software program management.
- Initiated intelligent interactive requirements elucidation system development.
- Completed preliminary data analysis and initial forecast for software capacity model.
- Produced initial version of Software Technology for Adaptable, Reliable Systems (STARS) process building blocks and metrics definition.
- Produced initial software risk assessment capability.
- Licensed software process assessment methodology.
- Completed requirements definition for Ada 9x.
- Initiated technology transition efforts in support of domain specific software architectures program.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-21

PE Title: Computer Systems and
Communications Technology

Budget Activity: 1. Technology Base

FY 1992 Planned Program:

- Extend software process assessment capability.
- Support evaluation and transfer of STARS environment technology.
- Evaluate and extend software engineering education capabilities, including curriculum, course materials.
- Extend software risk assessment capability.
- Initiate software process building block analysis.
- Develop initial core set of standard software metrics.

FY 1993 Planned Program:

- Continue to operate and improve Computer Emergency Response Team (CERT). Initiate collaborative computer system protection research.
- Apply and extend software risk management capabilities.
- Extend and accelerate use of Ada technology.
- Extend initial core set of standard software metrics.
- Continue workshops, conferences, seminars, and specialized direct support.
- Baseline and implement next generation of software process assessment capability.

D. WORK PERFORMED BY: Management and support will be performed by DARPA and the Military Services as appropriate. Major contractor is Carnegie-Mellon University, Pittsburgh, PA. The SEI is a federally funded research and development center.

E. RELATED ACTIVITIES:

0603756E Consolidated DoD Software Initiative (FY 1992 and prior years)
0602301E Intelligent Systems (ST-11)
0602301E STARS (ST-22)
0601101E Information Science (CCS-02)

The activities are managed by a team of software program managers under the control of DARPA's Software and Intelligent Systems Technology Office, to ensure that there is no duplication of effort among the programs.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E Project Number: ST-22
 PE Title: Computer Systems and Budget Activity: 1. Technology Base
 Communications Technology

A. RESOURCES: (\$ In Thousands)

<u>Project</u> <u>Number &</u> <u>Title</u>	<u>FY 1991</u> <u>Actual</u>	<u>FY 1992</u> <u>Estimate</u>	<u>FY 1993</u> <u>Estimate</u>	<u>To</u> <u>Complete</u>	<u>Total</u> <u>Program</u>
ST-22	STARS *15,222	*25,234	23,900	Continuing	Continuing

*This new project reflects the Project/PE consolidation and realignment within DARPA. The associated FY 1991 and FY 1992 funding and program accomplishments and plans for this project are shown here for continuity purposes.

B. BRIEF DESCRIPTION OF PROJECT: Software is one of the top items on the DoD Critical Technologies list. The Software Technology for Adaptable, Reliable Systems (STARS) program is generating three key integrating elements upon which to build a coordinated DoD software solution: a set of Software Engineering Environments (SEEs); a set of modern, tailorable software life-cycle process building blocks; and a software asset library capability to facilitate software productivity. The SEEs will be composed of commercially-supported products with open interfaces to stimulate the Computer Aided Software Engineering (CASE) tools marketplace. The SEEs will reinforce use of modern process models, have seamless interfaces to reuse libraries and will be evaluated on current DoD programs, thus ensuring a new technology base for future DoD software programs.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Established STARS baseline software engineering environment (SEE) open architecture.
- STARS' Asset Source for Software Engineering Technology (ASSET) library opened.
- Determined STARS-SEE evaluation applications areas and initiated selection process.
- Developed the STARS Domain Analysis Process Model, establishing a repeatable procedure with tangible outputs.

FY 1992 Planned Program:

- Initiate three integrations of Software Technology for Adaptable, Reliable Systems (STARS)-Software Engineering Environments (SEE) architectures.
- Select SEE evaluation applications projects.
- Begin integration of process mechanisms and reuse asset library mechanisms into the three SEEs.
- Evaluate and extend STARS software asset library capabilities.
- Begin populating STARS SEEs with tools.
- Begin software process building block capture.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-22

PE Title: Computer Systems and
Communications Technology

Budget Activity: 1. Technology Base

FY 1993 Planned Program:

- Complete STARS-SEE initial operational capability.
- Establish SEE evaluation capabilities.
- Evaluate and extend software asset library capabilities.
- Tailor STARS SEEs, asset libraries, and process building blocks for use on evaluation application Projects.
- Complete initial population of STARS-SEE tool capabilities.
- Plan for transition of software asset library to become self supporting.

D. WORK PERFORMED BY: Boeing Aerospace Corporation, Kent, WA; IBM Systems Integration Division, Gaithersburg, MD; UNISYS, McLean, VA, and their subcontractors.

E. RELATED ACTIVITIES:

- 0604740F, Computer Resource Management Technology.
- 0601101E, Information Science (CCS-02).
- 0602301E, Intelligent Systems (ST-11).
- 0602301E, Software Engineering Institute (SEI) (ST-21).

The DARPA PE activities above are managed and controlled by DARPA's Director, Software and Intelligent Systems Technology Office to ensure that there is no duplication of effort among the programs.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: # 0602301E
 PE Title: Computer Systems and
Communications Technology

Project Number: ST-23
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ in Thousands)

<u>Project</u> <u>Number &</u> <u>Title</u>	FY 1991 <u>Actual</u>	FY 1992 <u>Estimate</u>	FY 1993 <u>Estimate</u>	To <u>Complete</u>	Total <u>Program</u>
ST-23 Surveillance Research	26,052*	19,663*	16,877	Continuing	Continuing

*This new project reflects the Project/PE consolidation and realignment within DARPA. The associated FY 1991 and FY 1992 funding and program accomplishments and plans for this project were funded in program element #0602714E, project #NM-01 and are shown here for continuity purposes.

B. BRIEF DESCRIPTION OF PROJECT: This multifaceted research program is conducted to enhance U.S. surveillance capabilities for monitoring worldwide nuclear explosions and to develop methods for detecting and characterizing radiation from nuclear sources. Additionally, this program provides the required technical support for U.S. participation in both bilateral and multilateral form, including U.S. efforts in the Conference on Disarmament for the development and testing of an International Seismic Data Exchange System. The advanced surveillance technologies developed in this program are adapted into existing operational nuclear monitoring systems. Better technical understanding is required to assess the value of the data from worldwide nuclear explosions, and to support international cooperative measures for nuclear monitoring.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Began testing and evaluation of a prototype advanced signal processing system, including yield determination. Incorporated data from the international cooperative programs, including the stations in the Soviet Union.
- Carried out a large-scale test, involving 36 countries, of a global monitoring system under the auspices of the Conference on Disarmament involving the U.S. International Data Center.
- Developed new methodologies for analysis of on-site measurements for yield determination using data collected at Soviet nuclear test inspection sites.
- Developed and transferred advanced seismic sensor equipment to Defense On-Site Inspection Agency (OSIA) for use in the Soviet Union.

FY 1992 Planned Program:

- Demonstrate prototype Intelligent Monitoring System incorporating data from a network of high frequency arrays and high performance stations.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: # 0602301E

Project Number: ST-23

PE Title: Computer Systems and
Communications Technology

Budget Activity: 1. Technology Base

- Initiate cooperative international programs for collection and analysis of data for nonproliferation monitoring.
- Complete and transfer technologies to utilize data collected during on-site inspections.
- Provide technical support to nuclear testing negotiations, including the Conference on Disarmament.

FY 1993 Planned Program:

- Begin transfer of the technology of high frequency seismic arrays and Intelligent Monitoring data processing system to the Air Force and incorporate this system into the U.S. Atomic Energy Detection System.
- Complete transfer of technology from the advanced yield estimation program into operational monitoring system.
- Prototype smart surveillance systems for collection of monitoring data on a global scale.
- Initiate program in machine learning for classification of detected events.
- Provide technical support to international negotiations on nuclear testing.

D. WORK PERFORMED BY: Major performers include: Teledyne Geotech, Garland, TX; Science Applications International Corporation, San Diego, CA; University of Florida, Gainesville, FL; Southern Methodist University, Dallas, TX; California Institute of Technology, Pasadena, CA; and Columbia University, New York, NY.

E. RELATED ACTIVITIES: Complementary research is conducted by the National Laboratories of the Department of Energy and by the Air Force Technical Applications Center (AFTAC) for operational applications. These efforts are coordinated through existing interagency agreements and periodic working level coordination meetings. No duplication of effort is conducted.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Agreements with Norway, the Federal Republic of Germany and China call for joint activities in seismic facilities in those countries. The United Nations' Conference on Disarmament, with U.S. concurrence, has formally agreed on large-scale global tests of the international monitoring system.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E

PE Title: Tactical Technology

Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
TT-03 Undersea Warfare Technology	47,210	53,881	45,237	Continuing	Continuing
TT-04 Close Combat Technology	16,189	25,304	20,978	3,956	243,538
TT-05 Advanced Targeting Technology	19,607	20,522	16,682	Continuing	Continuing
TT-06 Advanced Tactical Technology	13,772	15,853	19,602	Continuing	Continuing
TT-07 Aeronautics Technology	28,480	9,275	6,801	Continuing	Continuing
TT-09 Counter Narcotics	6,500	0	0	0	6,500
Total	<u>131,758</u>	<u>124,835</u>	<u>109,300</u>		

B. BRIEF DESCRIPTION OF ELEMENT: This program element is dedicated to the advancement of research and development of concepts and technologies directed toward next generation tactical systems. The goal is to advance non-nuclear, tactical, combat capabilities to counter the expanding tactical threat. The major development objectives are: (1) to enhance undersea warfare technology by focusing on Anti-Submarine Warfare capabilities by exploring the limits of sensor systems and maximizing information processing technology; (2) to support the final phases of lighter, more deployable forces in close combat technology and increase efforts for ground combat, Identification Friend or Foe (IFF); (3) to develop sensors and processors for future tactical weapons, reconnaissance and surveillance systems with emphasis on technologies enabling direct connectivity between sensors and weapon delivery systems; (4) to develop advanced lasers for a broad spectrum of tactical military applications in tactical directed energy technology; to include electronic warfare; and (5) to produce effective and affordable aerospace technology systems that enhance capability to perform battle management and battle execution functions.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology

Project Number: TT-03
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ in Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
TT-03 Undersea Warfare Technology	47,210	53,881	45,237	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: Develop and demonstrate technologies that will improve Anti-Submarine Warfare (ASW) capabilities. Explore the limits of ASW sensor systems used separately and in combination with other ASW sensors. Develop innovative technologies for Acoustic Warfare to help ASW decision-makers understand and utilize current environmental conditions, provide effective countermeasures, improve source cueing capability, and support management of platforms and search systems, particularly long-range active systems.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Developed and evaluated technology for acoustic warfare battle management, signal processing, countermeasures and Low Frequency Active (LFA) sensor sources.
- Demonstrated significant Surveillance Towed Array Sensor System (SURTASS) performance gain using adaptive focused beamforming.
- Completed neural network classifiers target data analysis.
- Demonstrated baseline low frequency active bi-static prototype system.

FY 1992 Planned Program:

- Perform Fleet exercise demonstration of multi-beam broadband processing system.
- Perform at-sea test of advanced bi-static processor technology.
- Perform at-sea demonstration of passive-acoustic, sonar scene-description system.
- Demonstrate full-beam automated processing at an ocean surveillance naval facility.

FY 1993 Planned Program:

- Demonstration of an Acoustic Warfare Battle Management Decision Support System for Fleet commander.
- Demonstrate ASW multi-sensor fusion system using real time data.
- Fleet exercise demonstration of passive-acoustic, sonar scene-description system.
- Surveillance Towed Array Sensor System (SURTASS) sea trial of full, on-board automated processing system.
- Transition automated processing system to the Navy.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-03
Budget Activity: 1. Technology Base

D. WORK PERFORMED BY: AT&T-Bell Laboratories, Whippany, NJ; Orincon Corporation, San Diego, CA; Science Applications International Corporation, McLean, VA; Johns Hopkins University, Laurel, MD; and Naval Undersea Systems Center, New London, CT.

E. RELATED ACTIVITIES: Coordinated with Space and Naval Warfare Systems Command (SPAWAR) and Office of Naval Technology Anti-Submarine Warfare (ASW) programs to preclude duplication of effort.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology

Project Number: TT-04
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
TT-04 Close Combat Technology	16,189	25,304	20,978	3,956	243,538

B. BRIEF DESCRIPTION OF PROJECT: This project has been used through FY 1991 to support the joint Armor Anti-Armor program. Starting in FY 1992, it completes some important work in smart mines, advanced mine detection techniques, a turbocharged rotary diesel engine that works at extremely high pressures and efficiency, and a hypervelocity projectile launch program in cooperation with the British. It also includes increases for ground combat Identification Friend or Foe (IFF) in order to reduce unnecessary American casualties. This program includes a near-term component, and a longer range one for higher confidence non-cooperative IFF in the future.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Provided first lightweight, affordable ceramic armor protection to United States Marine Corps light armored vehicles (LAVs) in field test.
- Completed, and transferred to the Army, armors for LOS-F-H and LOSAT.
- Successfully developed smart mine communication link and transitioned to Army.
- Performed field tests of Phase I Anti-Helicopter mine; denies nap of earth flight to threat helicopters.
- Began Phase II of anti-helicopter mine with extended range.
- Completed successful tribological tests of advanced turbo-rotor compound diesel engine.
- Developed new electro-optical stand-off mine detection technique; tested advanced detectors using earth-penetrating radar and exploiting chemical and particle emissions.
- Completed cooperative development program with French on insensitive energetics for responsive armor.
- Developed advanced power supply and launcher technology in cooperative United Kingdom electric gun integration program.

FY 1992 Planned Program:

- Complete tests of test unicylinder turbo-rotor compound engine test rig (begin 3-cylinder turbo-rotor compound engine with high pressure air units). Begin design of engine to power Army's Composite Armored Vehicle (CAV).
- Complete United Kingdom cooperative electromagnetic gun projectile program.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-04
Budget Activity: 1. Technology Base

- Complete development, field testing and down selection of five near-term systems for ground combat Identification Friend or Foe (IFF) in cooperation with the Army.
- Begin advanced technology development for improved non-cooperative IFF in longer term.
- Perform integrated component testing of brassboard hand-held and vehicle-mounted mine detector.
- Begin follow-on vehicle mine detection program to support faster detection for expeditious breaching operations and advances.

FY 1993 Planned Program:

- Design, build 3-cylinder high performance turbo-roto compound diesel.
- Fabricate and test anti-helicopter mine brassboards.
- Transition hand-held mine detectors to Army.
- Flight test airborne mine detector technology.
- Continue longer term Identification Friend or Foe technology development program, including vehicle integration simulation.

D. WORK PERFORMED BY: The major performers are Lawrence Livermore National Laboratory, Livermore, CA; University of Texas, Austin, TX; Detroit Diesel Corporation, Detroit, MI; Engine Corporation of America, Anaheim, CA; Texas Instruments, Dallas, TX; Sandia National Laboratory, Albuquerque, NM; Kaman Science Corporation, Colorado Springs, CO; and Textron, Waltham, MA.

E. RELATED ACTIVITIES: The DARPA Joint Armor/Anti-Armor Program is coordinated with the U.S. Army (PE 0602618A, Project AH81) and Marine Corps (PE 0603635N) programs in this area. Other related DARPA programs are covered in PE 0603226E, Project EE-21, Close Combat. Balanced Technology Initiative (BTI) PE 0603737D funds also support Mine/Countermine technology.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: A cooperative program with the UK on Electromagnetic Gun hypervelocity projectile launch integration will be completed in FY 1992.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology

Project Number: TT-05
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
TT-05 Advanced Targeting Technology	19,607	20,522	16,682	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project develops sensors and processors for future tactical weapons, reconnaissance, and surveillance systems. Level of technology developed within this task is commensurate with detection and classification of projected mobile and fixed targets employing advanced deception concealment, decoying, and reduced observables (including camouflage) techniques. Emphasis is on technology that can perform effective search and strike against existing and future targets, and provide flexible non-nuclear solutions for worldwide force projection in limited warfare and Third World conflicts. Concepts developed may be applied equally to find and attack fixed and mobile high value targets, as well as for peacetime monitoring and intelligence correlation. This project will also emphasize technologies enabling a direct connectivity between sensors and shooters to ensure rapid prosecution against fleeing targets. This will involve technologies focusing on improvements to existing command and control systems.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Applied tactical ballistic missile garrison monitoring and terrain illustration technologies in support of Desert Shield/Storm.
- Developed mature process for producing Acoustic Charge Transport (ACT) signal microprocessor.
- Developed infrared microdetector array capable of 10x improvement in sensitivity.
- Measured targets using new, non-imaging infrared sensor.

FY 1992 Planned Program:

- Demonstrate Infrared microdetector with linear array.
- Evaluate advanced signal processing concepts for radar and electro-optical/infrared (EO/IR) sensors focusing on improvements to wide area coverage and automatic target recognition.
- Expand Tactical Ballistic Missile tracking capability to additional critical mobile targets and geographic regions; transition to critical mobile targets.
- Initiate design of unattended ground sensors and human intelligence technology with a focus on critical mobile targets.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-05
Budget Activity: 1. Technology Base

- Complete Acoustic Charge Transport (ACT) development by focusing on production issues, unit cost and reliability, providing a robust source of devices for insertion into DoD and commercial systems.
- Initiate development of advanced automated operational planning technologies.
- Develop command/control concept to support rapid sensor to shooter target insertion.

FY 1993 Planned Program:

- Demonstrate adaptive target fusion using neural networks to combine multi-sensor inputs.
- Demonstrate unattended ground sensors and intelligent facility plans; transition to critical mobile targets.
- Continue development of advanced automated operational planning technologies.
- Demonstrate infrared microdetector.
- Demonstrate feasibility of Command/Control connectivity to support rapid sensor to shooter target data flow.

D. WORK PERFORMED BY: Martin Marietta, Orlando, FL; ERIM, Ann Arbor, MI; LTV, Dallas, TX; Lincoln Laboratories, Lexington, MA; Texas Instruments, Dallas, TX; and Westinghouse, Baltimore, MD.

E. RELATED ACTIVITIES:

- 0603226E, Project No. EE-30 (Smart Weapons Application Program) and Project No. EE-40 (Critical Mobile Targeting) are outgrowths of technology developed in this project.
- This project is a part of the DARPA contribution to the Joint DoD Advanced Technology Demonstration for Global Surveillance and Communication/Precision Strike. The specific projects have been coordinated and fully integrated with Army, Navy, and Air Force plans to ensure nonduplication and compatibility with the integrated demonstration.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology

Project Number: TT-06
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
TT-06 Advanced Tactical Technology	13,772	15,853	19,602	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project is focused on the technology and applications of lasers and microwaves to improve the performance of some critical DoD Systems. Applications of these technologies include electronic warfare, radars, electronic display, sensors and communications. Three broad technology areas are being investigated: (a) compact, efficient, frequency-agile, diode-pumped, solid-state lasers for laser radars and sensors; (b) narrowband and wideband microwave source development for radars and decoys; and (c) vacuum electronics for smaller and better microwave tubes.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated efficient fiber coupling of diode pumps to solid-state laser materials for high average power operation.
- Completed compact ultra-wideband microwave source for electronic warfare applications and transitioned it to Army.
- Initiated three areas in vacuum electronics: vacuum microelectronics, high performance millimeter (mm) wave amplifier, and mm wave power module.
- Initiated an ultra-wideband high resolution radar technology program.

FY 1992 Planned Program:

- Demonstrate laboratory breadboard operation of high average power diode-pumped solid state lasers operating at one and two micron wavelength.
- Initiate program to develop linear and two-dimensional arrays of microlasers for laser radars.
- Optimize 94 giga hertz (GHz) power amplifier gun design.
- Demonstrate high frequency modulation and uniform current emission of microcathode.

FY 1993 Planned Program:

- Demonstrate field transportable brassboard/lasers operating at high average power in the visible and mid-infrared spectral regions.
- Demonstrate 10 elements linear array of microlasers.
- Demonstrate high power operation of 94 gigahertz (GHz) amplifier.
- Demonstrate microcathode operation at 1 GHz modulation and 5 ampere per centimeter square emission.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TI-06
Budget Activity: 1. Technology Base

D. WORK PERFORMED BY: Major performers include: Hughes Aircraft Company, El Segundo, CA; Science Research Laboratory, Somerville, MA; TRW, Redondo Beach, CA; Lockheed/Sanders, Nashua, NH; Varian Associates, Palo Alto, CA; Honeywell, Bloomington, MN.

E. RELATED ACTIVITIES: All programs are coordinated with Services' R&D programs to promote technology transfer and avoid duplication of effort.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Defense Advanced Research Projects Agency (DARPA) is also an active participant in the US-UK Information Exchange Program on laser and microwave weapon technology and effects.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology

Project Number: TT-07
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
TT-07 Aeronautics Technology	28,480	9,275	6,801	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: As DoD attention focuses on enhancing conventional defenses, the requirement to produce effective, survivable and affordable weapon systems becomes increasingly more important. The timely development of cost-effective system options and enabling subsystem technologies to satisfy this requirement is the objective of the Aeronautics Technology Project. The results of this project form the basis for future selection and development of affordable, conventional weapon systems that will greatly enhance our ability to perform both "battle management" and "battle execution" functions.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Completed flight test of developmental optical air data system.
- Designed, fabricated and rig-tested components for miniature low cost turbine engines.
- Completed demonstration of advanced infrared coatings on a NASA F-15 aircraft.

FY 1992 Planned Program:

- Enter Phase II in the development of a flight weight optical air data system.
- Finalize designs of complete miniature turbine engines.
- Proceed with design of an air vehicle incorporating miniature engine technology.
- Complete tests of a large model of an advanced system.
- Complete design studies for fuel cells with application to air vehicles.
- Complete large system demonstration of advanced infrared coatings on an F-117 aircraft.
- Initiate development of a Long Wave Infrared (LWIR) cooling panel.

FY 1993 Planned Program:

- Complete design for a flight weight advanced optical air data system.
- Assemble, bench check and performance test miniature low cost turbine engines.
- Conduct a test of a radar-compatible infrared coating on a flight vehicle.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-07
Budget Activity: 1. Technology Base

- Perform demonstration of surrogate vehicle utilizing miniature turbo-jet engines.
- Complete design phase of Long Wave Infrared (LWIR) cooling panel.

D. WORK PERFORMED BY: AeroVironment, Inc., Monrovia, CA; Institute for Defense Analyses, Alexandria, VA; Sunstrand Power Systems, San Diego, CA; Teledyne CAE, Toledo, OH; Lockheed, Burbank, CA; International Fuel Cells, Hartford, CT; and Deposition Sciences, Inc., Santa Rosa, CA.

E. RELATED ACTIVITIES: None.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E

Budget Activity: 1. Technology Base

PE Title: Materials/Electronics Technology

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MPT-01 Materials Processing	57,176	78,881	18,197	Continuing	Continuing
MPT-02 Electronics Processing	21,068	19,061	15,646	Continuing	Continuing
MPT-03 Optoelectronics/GaAs	10,238	14,664	15,222	Continuing	Continuing
MPT-04 X-Ray Lithography	60,000	0	0	0	90,000
MPT-05 IR Crystal Growth Technology	10,000	0	0	0	10,000
MPT-06 High Temperature Superconductivity (HTSC) *(25,272)		*(26,500)	22,735	Continuing	Continuing
Total	158,482	112,606	71,800		

*This project is the result of the Project/PE consolidation and realignment within DARPA. The associated FY 1991 and FY 1992 funding and program accomplishments and plans are shown here for continuity purposes. This work was previously funded in PE 0602301E, Project ST-16 in FY 1992 and prior years.

B. BRIEF DESCRIPTION OF ELEMENT: The objective of this program element is to develop technology related to those materials and devices that make possible a wide range of new military capabilities. The Materials Processing project (MPT-01) focuses on the development of novel materials and processing routes to demonstrate advanced composites; development of metal matrix composite materials for advanced aerospace structures; and research on diamond films for thermal management in electronic packaging. The Electronics Processing (MPT-02) goal is to develop and implement next-generation electronic devices, circuits, and advanced semiconductor manufacturing and applications. The Optoelectronics/GaAs project (MPT-03) includes advanced component development and applications of quantum-well devices to circuits. The current emphasis of the HTSC (MPT-06) is focused on the insertion of superconductivity technology into real military hardware (microwave components, analog/digital converters, motors, bearing, accelerometers, and SQUIDS).

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-01
 PE Title: Materials/Electronics Technology Budget Activity: 1. Technology Base

A. RESOURCES: (\$ in Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MPT-01 Materials Processing	57,176	78,881	18,197	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: The major goal of this project is to develop novel materials, processing routes, and fabrication strategies for production of advanced high temperature, structural composites with improved performance at lower manufacturing costs. A major area of concentration is the application of process modeling, sensors, and expert systems to materials manufacturing, and biosensors for surveillance. Other areas emphasized are: research into metal matrix composites as advanced aerospace structural materials to upgrade gas turbine engines and airframe components, synthesis of diamond films for thermal management in electronic packaging and insertion of state-of-the-art ceramics into military systems components (bearings, armor, gas turbine engine components).

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Initiated test rig evaluation of ceramic composite static components (combustor cover) for use in a gas turbine engine.
- Experimentally demonstrated theoretical predictions of vapor phase transport for silicon nitride coating of carbon-carbon composites for oxidation protection.
- Demonstrated continuous manufacturing process for high strength multifilament ceramic fiber reinforcement for metal matrix composites.
- Manufactured by chemical vapor deposition, 4-inch by 4-inch by 0.014-inch thick free-standing diamond substrate for thermal management in electronic packaging.
- Demonstrated detection of anti-metabolic agents in thawed cells.
- Initiated ceramic insertion program to enhance performance of weapons system which require improved advanced structural material ceramics such as bearings, armor and gas turbine engine components; demonstrated ceramic applique armor on USMC Land Autonomous (LAV) in Operation Desert Storm.

FY 1992 Planned Program:

- Demonstrate diamond film growth rates of greater than 150 microns per hour over 10 centimeter diameter area in a system which incorporates intelligent process control.
- Evaluate in burner rig, ceramic composites supplied by various manufacturers for extended component use in a gas turbine environment.
- Initiate manipulation of cellular 2nd messenger system for signal amplification.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01

PE Title: Materials/Electronics Technology Budget Activity: 1. Technology Base

- Demonstrate torque noise reduction in naval vessel pumps by insertion of ceramic bearings.
- Demonstrate hot isostatic pressing schedule to achieve full consolidation of 40% continuous fiber metal matrix composite specimens and demonstrate feasibility of roll bonding consolidation technique for composite sheets.
- Demonstrate feedback intelligent control of chemical vapor deposition of silicon nitride coatings for carbon-carbon composites; transition technology to industrial coating manufacturer.
- Initiate research to process microlaminate metallic composites for DoD applications.
- Establish at least three advanced materials synthesis, processing and commercialization partnerships with the private sector; emphasis will be on research aimed at developing cost-effective materials synthesis and processing technologies.
- Demonstrate continuous manufacturing process for thin film coating and uniform fiber metallization of 112-end alumina fiber tows.
- Demonstrate continuous titanium matrix deposition on spread alumina fibers and non-damaging substrate release of green metal matrix composites (MMC) monotape.

FY 1993 Planned Program:

- Demonstrate thermal management capability of high conductivity diamond films in an electronic package.
- Demonstrate high temperature performance of stationary ceramic components (flaps and seals) in gas turbine engines.
- Demonstrate device gain by manipulation of transfected receptor density.
- Demonstrate ceramic components performance in Aircraft Auxiliary Power Units (APUs).

D. WORK PERFORMED BY: Major performers are: United Technologies Research Center, East Hartford, CT; General Electric Corporation, Schenectady, NY; Sandia Laboratories, Livermore, CA; Norton Company, Northboro, MA; Williams International, Wald Lake, MI; 3M Corporation, St. Paul, MN; Allied Signal Aerospace Company, Phoenix, AZ; and Pratt & Whitney, West Palm Beach, FL.

E. RELATED ACTIVITIES: DARPA's research on Materials Processing is coordinated within the Department of Defense (DoD) and with other federal agencies via the National Science Foundation-hosted Interagency Materials Group, Office of Science and Technology Policy Committee on Material (COMAT), and various Director of Defense Research and Engineering (DDR&E) sponsored topical workshops on structural materials and materials processing. These activities assure that no unnecessary duplication of effort occurs.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01

PE Title: Materials/Electronics Technology

Budget Activity: 1. Technology Base

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-02
 PE Title: Materials/Electronic Technology Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MPT-02	21,068	19,061	15,646	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project emphasizes the development and implementation of future generation electronic and optoelectronic devices, materials, and circuits, as well as the development of advanced semiconductor processing equipment designed to reduce the cost of a wafer manufacturing facility by an order of magnitude.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated the capability to conduct all necessary semiconductor fabrication steps in individual ultraclean modules rather than large clean rooms.
- Fabricated optoelectronic integrated circuits for optical interconnects and latching logic/memory devices.
- Completed unit testing of initial Microelectronics Manufacturing Science and Technology (MMST) object-oriented computer-integrated manufacturing (CIM) software.
- Demonstrated light-weight/low-cost material for absorbing electromagnetic energy.
- Developed mature process for producing Acoustic Charge Transport (ACT) signal microprocessor.
- Demonstrated immune response using ultrasonically emulsified immunomodulator.
- Initiated 4,000-gate-complexity manufacturing demonstrations using ultraclean modules.
- Investigated 0.35-micron lithography approaches for the MMST effort.

FY 1992 Planned Program:

- Develop the second version of the MMST object-oriented CIM software.
- Demonstrate two modular processing systems with five process modules capable of performing fabrication steps for low-volume, state-of-the-art integrated circuits.
- Demonstrate closed-loop control of MMST processes.
- Initiate efforts to develop high-speed, low-power analog-to-digital converters (ADCs), digital-to-analog converters, and multiplexers for advanced military signal processing needs.
- Show biosensor signal gain and thru-chip fluidics.
- Demonstrate neural net system for recognizing electronic signal signatures.
- Initiate procurement of Application Specific Electronic Module (ASEM) program.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-02

PE Title: Materials/Electronic Technology

Budget Activity: 1. Technology Base

FY 1993 Planned Program:

- Demonstrate Microelectronics Manufacturing Science and Technology (MMST) fabrication cycle-time and yield.
- Demonstrate MMST fabrication flexibility by processing two distinct process flows.
- Demonstrate MMST capability to fabricate an externally designed circuit.
- Demonstrate analog multiplexers for wide-dynamic range signals to significantly reduce the power consumed in processing sensor data.
- Demonstrate heterojunction bipolar transistor (HBT) ADCs for ultra-high-speed conversion of microwave signals to digital form for advanced signal processing.
- Develop neural net automatic target recognizer.
- Develop high performance (10-100 billion operations per second) neural net hardware boards.

D. WORK PERFORMED BY: Texas Instruments, Dallas, TX; Lincoln Lab, Lexington, MA; Georgetown University, Washington, DC; and Intel Corporation, Santa Clara, Ca.

E. RELATED ACTIVITIES: The work is coordinated with Service research efforts through the Advisory Group on Electron Devices and via annual government-wide program reviews. These activities assure that no unnecessary duplication of effort occurs. The MMST contract is a cost-shared effort between DARPA and the Air Force.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-03
 PE Title: Materials/Electronic Technology Budget Activity: 1. Technology Base

A. RESOURCES: (\$ In Thousands)

<u>Project Number</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MPT-03	Optoelectronics/Gallium Arsenide (GaAs)				
	10,238	14,664	15,222	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project is to develop and demonstrate next-generation electronics and optical processors for military use. Emphasized are: non-volatile ferroelectric memory technology, advanced semiconductor processing, and military optical processors.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated Integrated Circuit (IC) fabrication based on limited reaction processing.
- Completed one-dimensional process modeling for GaAs heterostructures.
- Demonstrated optically controlled phased array subsystem.
- Advanced the state-of-the-art of high performance vertical-cavity, surface-emitting lasers by completing an accurate electrical and thermal model.
- Demonstrated first functional ferroelectric memory cells on gallium arsenide.

FY 1992 Planned Program:

- Demonstrate non-destructively read, non-volatile ferroelectric memory cells.
- Develop smart spatial light modulators for applications in optical instrument and image processing.
- Fabricate acousto-optic, 2 gigahertz (GHz) spectrum channelizer for field test.
- Fabricate optical associative memory module for field test in data base management.
- Demonstrate optical, binary phase only, matched filter module for pattern recognition.
- Fabricate quantum well lasers (lattice-matched and strain layers) for ultra-low thresholds.

FY 1993 Planned Program:

- Develop process for low-cost ferroelectric non-volatile memory.
- Develop ferroelectric capacitors for extremely long lifetime non-volatile memories.
- Develop accelerated lifetime tests for ferroelectric memories.
- Demonstrate real time, compact synthetic aperture radar (SAR) with spotlight mode.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-03

PE Title: Materials/Electronic Technology

Budget Activity: 1. Technology Base

- Demonstrate steering of wide-band radar beam with optical control module.

D. WORK PERFORMED BY: Harris, Melbourne, FL; McDonnell Douglas Electronics Systems Company, Hunting Beach, CA; Texas Instruments, Dallas, TX; Hughes, Malibu, CA; General Electric, Syracuse, NY; Martin Marietta, Denver, CO; and Cornell University, New York.

E. RELATED ACTIVITIES: Efforts in this project are coupled to the Services' programs through use of service agents, annual DoD-wide program reviews, and coordination through the Advisory Group on Electron Devices (AGED). These activities assure that no unnecessary duplication of efforts occur.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E
 PE Title: Materials/Electronics
Technology

Project Number: MPT-06
 Budget Activity: 1. Technology Base

A. RESOURCES: (\$ in Thousands)

<u>Project</u> <u>Number &</u> <u>Title</u>	<u>FY 1991</u> <u>Actual</u>	<u>FY 1992</u> <u>Estimate</u>	<u>FY 1993</u> <u>Estimate</u>	<u>To</u> <u>Complete</u>	<u>Total</u> <u>Program</u>
MPT-06	High Temperature Superconductivity (HTSC) *(25,272)	*(26,500)	22,735	Continuing	Continuing

*This new project reflects the Project/PE consolidation and realignment within DARPA. The associated FY 1991 and FY 1992 funding and program accomplishments and plans were funded in PE 62301E, S1-16 project and are shown here for continuity purposes.

B. BRIEF DESCRIPTION OF PROJECT: The astounding increase in the threshold for superconductivity since 1987 has presented an opportunity for enhancing the performance of materials in electronic devices and circuitry, energy storage and transmission, and propulsive machinery. The DARPA program is aimed at developing not only the underlying fabrication technology (thin films, wires and other forms) but also real military hardware (microwave components, analog and digital (A/D) converters, motors, bearings, accelerometers, SQUIDS, and other devices). The current emphasis is insertion of the technology into specific military platforms, primarily as avionics systems.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Demonstrated High Temperature Super Conductor (HTSC) wire with 10X improvement over last year's capability, namely 100,000 A/cm² at 77K and 1 Tesla magnetic field.
- Constructed superconducting motor using flux-trapped HTSC materials.
- Demonstrated IR sensor array based on HTSC microbolometer elements.
- Contracted for eight additional efforts integrating passive HTSC microwave components into Electronic Warfare and communications systems.
- Vendors under DARPA contract have achieved 2-inch diameter HTSC film deposition capability.

FY 1992 Planned Program:

- Produce and evaluate wire of bismuth-based HTSC material with higher transition temperature and better current carrying capability within magnetic fields.
- Demonstrate 2-dimensional addressable HTSC sensor array with broadband IR response for 2D sensor arrays.
- Demonstrate HTSC microwave component operation in Navy satellite space experiment.
- Initiate development of superconducting interconnects in multichip modules for performance improvement and enhanced

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602712E
PE Title: Materials/Electronics
Technology

Project Number: MPT-06
Budget Activity: 1. Technology Base

manufacturing capability, increased yield in high packing density requirements.

- Initiate cryoelectronics program unifying standard Complementary Metal Oxide Semiconductors (CMOS) Integrated Circuits (IC) technology with closed-cycle cryogenics.

FY 1993 Planned Program:

- Undertake insertion of multichip modules employing High Temperature Super Conductor (HTSC) interconnects into digital signal processors and general purpose computers.
- Demonstrate systems application of integrated HTSC radio frequency components in electronic warfare and communications systems.
- Initiate active digital cryoelectronics development based on flux-trapped quantum logic, applied to high resolution analog and digital (A/D) converter or digital rf memory.

D. WORK PERFORMED BY: Major performers include: Superconductor Technologies, Inc., Goleta, CA; GA Technologies, La Jolla, CA; Massachusetts Institute of Technology, Cambridge, MA; University of California, Santa Barbara, CA; University of Houston, Houston, TX; Honeywell Corp., Minneapolis, MN; and Ceramic Process Systems, Milford, MA.

E. RELATED ACTIVITIES: Research on high temperature superconductors (HTSC) is coordinated within DoD and with other federal agencies via the Office of Science and Technology Policy (OSTP) Committee on Materials (COMAT), HTS Coordinating Committee, the NSF-hosted Interagency Materials Group, and numerous workshops involving industry, universities and government laboratories.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATION AGREEMENTS: None.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Budget Activity: 2. Advanced Technology
 PE Title: Experimental Evaluation of Development
 Major Innovative Technologies

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
EE-21 Close Combat	27,373	11,179	3,174	Continuing	Continuing
EE-23 Enhanced Fighter Maneuverability	16,850	9,800	5,000	0	95,449
EE-27 Advanced Space Technology Program	34,384	30,340	48,559	Continuing	Continuing
EE-30 Smart Weapons Application Program	10,900	27,160	10,695	5,865	58,853
EE-34 Guidance Technology	6,198	7,538	7,835	Continuing	Continuing
EE-36 Advanced ASW Technology	7,052	12,000	11,239	Continuing	Continuing
EE-37 Advanced Simulation	13,925	34,799	51,948	Continuing	Continuing
EE-39 Unmanned Undersea Vehicle Systems	² (19,594)	19,079	18,797	Continuing	Continuing
EE-40 Critical Mobile Targets	³ (20,957)	³ (28,340)	16,678	Continuing	Continuing
Total¹	176,487	249,550	270,867		

¹Total includes classified projects not identified herein.
²Funded in PE 0603707E, Advanced Prototyping, Project PP-01.
³Related efforts previously funded in PE 0603227E, Project RT-01.

B. BRIEF DESCRIPTION OF ELEMENT: This program element is dedicated to the demonstration and evaluation of advanced research and development concepts. Individual project descriptions are with each project.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E
 PE Title: Experimental Evaluation of
 Major Innovative Technologies

Project Number: EE-21
 Budget Activity: 2. Advanced
 Technology Development

A. RESOURCES: (\$ In Thousands)

Project Title: Close Combat

<u>Popular Name</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
Close Combat EE-21	27,373	11,179	3,174	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: This project was used through FY 1991 to support the joint Armor Anti-Armor program. In FY 1992, much of the effort is focused on simulation of advanced models of future vehicles. This will demonstrate the credibility of simulations to screen developmental technologies for smart acquisition. In FY 1993, EE-21 will support an OSD Technology Thrust in Advanced Vehicles, a deployable, survivable composite vehicle with high strategic mobility and tactical agility. Such a light vehicle is required to defeat foreign heavy forces, while minimizing U.S. casualties in contingency operations that are increasingly likely due to global instabilities.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Began Phase II armor development of advanced designs for Army's next generation combat vehicle program.
- Successful component tests of Vehicle Survivability Program technology, promising increased protection, reduced weight and cost.
- Identified new armor materials and defeat mechanisms in cooperative armor development with Germans.
- Initiated near-term program to give small arms an anti-light armor capability using gel propellant, composite case and special bullet.
- Discovered dynamic jetting method for deep target penetration.
- Developed small, light, effective main charge and innovative precursor fortandem warhead in UK Nunn program.
- Successful range tests of first segmented penetrator dispenser.
- Tested high efficiency rigid body penetration with composite rod.
- Developed new rod-in-tube projectile for increased penetration.

FY 1992 Planned Program:

- Simulate advanced combat vehicles to determine operational requirements, measure utility of candidate technologies.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-21

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced
Technology Development

- Improve realism/credibility of acquisition simulation including motion-based simulator and enhanced prototyping environment.
- Simulate Identification Friend or Foe for ground vehicles to determine optimum approaches, minimum signatures.
- Initiate advanced vehicle technology program, in support of the Advanced Land Combat Vehicle S&T panel, to dramatically enhance survivability and crew performance.
- Finish advanced armor technology program with Germany.
- Perform studies on special survivability enhancement technologies.

FY 1993 Planned Program:

- Continue participation in joint Advanced Land Combat Vehicle programs for survivable, deployable vehicle with electronic crew augmentation and battle management capabilities.
- Initiate improved special survivability technology development program.

Program To Completion:

- Integrate special survivability technologies.
- Define, develop and test concepts for advanced combat vehicles in 21st Century battlefield environment.
- Use virtual battlefield simulations to develop advanced concepts and functionality and develop state-of-the-art acquisition simulation process applied to the Advanced Land Combat Vehicle.

D. WORK PERFORMED BY: The major performers are Battelle, Columbus, OH; Lawrence Livermore National Lab, Livermore, CA; FMC, San Jose, CA; Loral Corporation, Orlando, FL; University of Texas, Austin, TX; Texas Instruments, Dallas, TX; General Motors Delco, Los Angeles, CA; General Dynamics, Warren, MI; Dupont, Wilmington, DE; and Alliant Tech Systems, Minneapolis, MN.

E. RELATED ACTIVITIES: This program has been coordinated with the Army and Marine Corps to ensure there is no duplication of effort.

- U.S. Army PE 0602618A, Project AH81.
- Marine Corps PE 0603635N. DARPA PE 0602702E/TT-04 is the related technology project.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: A cooperative armor/anti-armor international program with the United Kingdom on advanced tandem warheads will be completed in FY 1992. A cooperative program with Germany will complete delivery of advanced armor materials in FY 1992, but may be extended to permit vehicle integration/analysis in FY 1993.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E	Project Number: EE-23
PE Title: <u>Experimental Evaluation of</u> <u>Major Innovative Technologies</u>	Budget Activity: <u>2. Advanced</u> <u>Technology Development</u>

A. RESOURCES: (\$ In Thousands)

<u>Project</u> <u>Number</u> <u>& Title</u>	<u>FY 1991</u> <u>Actual</u>	<u>FY 1992</u> <u>Estimate</u>	<u>FY 1993</u> <u>Estimate</u>	<u>To</u> <u>Complete</u>	<u>Total</u> <u>Program</u>
EE-23 Enhanced Fighter Maneuverability (X-31)	16,850	9,800	5,000	0	95,449

B. BRIEF DESCRIPTION OF PROJECT: The Enhanced Fighter Maneuver-ability (EFM) program will integrate and demonstrate a number of emerging technologies that collectively have the potential to significantly increase fighter aircraft agility, improve close-in combat (CIC) exchange ratios and increase long-range aircraft performance. Two unique, low cost flight vehicles will be designed, fabricated and flight-tested to demonstrate the payoff of high agility at high angles of attack, using thrust vectoring, integrated flight and propulsion control systems, and tailored configuration design. The aircraft will explore the technical and military implications of dynamic post-stall maneuvers for close-in aerial combat. Results will provide critical design and performance data for assessing the utility and cost benefit of employing EFM technologies to retrofit existing operational fighters for integration into future fighter aircraft.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Complete airworthiness flights of two aircraft.
- Completed conventional envelope expansion flights (78 total flights through end of FY 1991).
- Completed initial government pilot evaluation flights.

FY 1992 Planned Program:

- Initiate envelope expansion toward full, dynamic, post-stall flight.
- Initiate Air Force and Navy combat utility evaluations.

FY 1993 Planned Program:

- Completion of post stall maneuver/combat tactics development.
- Multi-Service assessment of military utility.
- Analysis, documentation, and design synthesis of flight-test results.

D. WORK PERFORMED BY: Rockwell International Corporation, Los Angeles, CA; Naval Air Systems Command, Arlington, VA; NASA Langley Research Center, Hampton, VA; and NASA-Dryden Flight Research Facility, Edwards, CA.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-23

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced
Technology Development

E. RELATED ACTIVITIES:

- The Navy and the USAF have allocated funds in FY 1992 and FY 1993 to participate in this joint EFM technology evaluation with the German government under the Following Program Elements:

PE 0603245F Advanced Fighter Technology Integration

PE 0602122N Aircraft Technology

- Participation by NASA-Dryden flight engineers contributes unique expertise necessary to reduce DoD costs and lower program risks. This effort does not duplicate any other known program within the DoD.
- A U.S. Government Agility Steering Group whose membership includes DARPA, NASA, Navy, and the Air Force, coordinates high angle of attack research activities between relevant flight test programs (e.g. X-29), to avoid duplication and assure uniqueness in flight test objectives.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: The X-31 Enhanced Fighter Maneuverability program is a joint program with the Federal Republic of Germany (FRG) initiated under the provisions of the Nunn-Quayle NATO Cooperative Research and Development Initiative. The program operates under a Memorandum of Agreement between DARPA and the German Federal Ministry of Defense, with German participation in all phases of the program. Messerschmitt-Bolkow-Blohm, the German prime contractor, developed the flight control system requirements, designed and fabricated the wing and thrust vector vanes. The X-31 program was initiated in 1986. This cooperative program is transferring significant technical data on post-stall maneuver and flight control to the U.S. industrial base.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E
 PE Title: Experimental Evaluation of
 Major Innovative Technologies

Project Number: EE-27
 Budget Activity: 2. Advanced
 Technology Development

A. RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Advanced Space Technology Program					
<u>Popular</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>	<u>To</u>	<u>Total</u>
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
LIGHTSAT					
EE-27	34,384	30,340	48,559	Continuing	Continuing

B. BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEMS

CAPABILITIES: The Advanced Space Technology Program (ASTP) is a multi-disciplinary technology development aimed at enhancing the access to space and reducing the cost of space systems. The ASTP has four components: development of enabling technologies, sponsorship of the initial launches of the PEGASUS Air Launch Vehicle (ALV), development and demonstration of a Standard Small Launch Vehicle (TAURUS), and launch of experimental lightweight satellites (LightSats). These technology areas form the foundation for developing affordable, responsive space capabilities that will be demonstrated in the Advanced Satellite Technology and EHF Communications (ASTEC) project. This joint DoD project develops the enabling technologies to support future global communications. Successful demonstration of these technologies will reduce the risk and permit the introduction of new, and potentially more affordable, technical alternatives into future communication architectures. These efforts are directly responsive to the DDR&E stated vision for Global Surveillance and Communications.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Launched second PEGASUS with seven Microsat Communications Satellites.
- Evaluated Microsat Communications Satellites.
- MACSATs used to support Operations Desert Shield and Desert Storm.
- Conducted tactical demonstrations of MACSAT and Microsat Satellites in cooperation with the military services and U.S. Space Command.
- Awarded one technology development contract and exercised options on seven existing contracts.

FY 1992 Planned Program:

- Initiate development of an advanced standard, small satellite bus that builds upon the DARPA developed technologies and demonstrates the feasibility of doubling the payload mass fraction that is currently possible today.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E
PE Title: Experimental Evaluation of
Major Innovative Technologies

Project Number: EE-27
Budget Activity: 2. Advanced
Technology Development

- Continue to develop the DARPA classified satellite.
- Transition the PEGASUS ALV to the U.S. Air Force.
- Transition MACSATs to users.

FY 1993 Planned Program:

- Launch and evaluate the first TAURUS launch vehicle and DARPA classified satellite.
- Continue development of an advanced standard, satellite bus.
- Initiate development of the Extremely High Frequency communications technology demonstration payload.
- Initiate development of an advanced surveillance payload.
- Initiate Milsatcom Ground Terminal Technology Insertion Projects.
- Conduct on-orbit demonstrations of the DARPA classified satellite.
- Evaluate on-orbit performance of Global Positioning System (GPS) receiver and lightweight reaction wheel launched on Air Force satellite.
- Transition the DARPA classified satellite to the user.
- Transition the TAURUS standard small launch vehicle to the U.S. Air Force.
- Transition technologies to the Services.

Program to Completion: Launch and demonstrate EHF payload and surveillance payload using Advanced Standard Satellite Bus. Demonstrate technology insertion into Milsatcom terminals. Integrate satellite into joint DoD Global Surveillance Communications Command Control and Precision Strike Demonstration program. Transition satellites and technologies to users.

D. WORK PERFORMED BY: Orbital Sciences Corporation, Chandler, AZ; Defense Systems, Inc., McLean, VA; Space Applications Corporation, Arlington, VA; Lincoln Laboratories, Lexington, MA; Hughes Aerospace, Los Angeles, CA; SAIC, San Diego, CA; Ball Aerospace, Boulder, CO; Honeywell, Minneapolis, MN; and others.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: The program has been slightly realigned to develop and demonstrate technologies for Global surveillance and communications as well as affordability; and to reflect joint participation with the Air Force, Army, Navy and other government organizations. The increase in FY 1993 supports the initial development of system-level EHF technology demonstration satellite.

F. PROGRAM DOCUMENTATION:

- NASA (DRYDEN)/DARPA MOA dated 25 July 1988.
- U.S. Air Force/DARPA MOA dated 14 November 1988.
- U.S. Navy/DARPA MOA dated 13 December 1988.
- NASA (GODDARD)/DARPA MOA dated 1989.
- U.S. Army MOA dated 8 January 1990.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E
PE Title: Experimental Evaluation of
Major Innovative Technologies

Project Number: EE-27
Budget Activity: 2. Advanced
Technology Development

- Joint DARPA/Army/Air Force/Navy MOA (in process).

G. RELATED ACTIVITIES:

- DARPA MOAs with Army, Navy and Air Force.
- Navy launched two DARPA Ultra High Frequency Satellites on a SCOUT vehicle.
- First TAURUS demonstration launch will include a satellite payload developed by the Air Force.
- Close coordination is maintained with Military Services to eliminate unnecessary duplication.
- DARPA-developed Global Positioning System Receiver and Lightweight Reaction Wheel will be flown on an Air Force satellite.
- DARPA-developed Advanced Altitude Control and Navigation System, and Inflatable Solar Array will be launched and demonstrated as part of the Tri-Service Space Test Program.
- This project is a part of the DARPA contribution to the joint DoD Advance Technology demonstration for global surveillance and communication. The specific projects have been coordinated and fully integrated with Army, Navy and Air Force plans to ensure nonduplication and compatibility with the integrated demonstration.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Dec 90	Completed BAA awards for technology development.
Jan 91	Provided MACSAT support to Operation Desert Storm.
Jul 91	Second PEGASUS launch (and orbit of Microsats).
Aug 91	Initiate demonstration of Microsats.
Jul 92	Initiate Advanced Standard Small Satellite Bus (ASSSB) development.
Oct 93	Initiate EHF Communications payload development.
Dec 93	Initiate Milsatcom ground terminal technology insertion projects.
Jan 94	Initiate surveillance sensor payload development.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: 40603226E

Project Number: EE-30

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

A. RESOURCES: (\$ In Thousands)

Project Title: Smart Weapons Application Program

Popular

<u>Name</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
Thirsty Saber EE-30	10,900	27,160	10,695	5,865	58,853

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES:

This joint DARPA/Army project utilizes state-of-the-art sensors and processing to demonstrate autonomous weapon system concepts that will provide flexible worldwide non-nuclear force projection options to attack critical tactical targets such as tactical ballistic missiles, mobile air defense or command and control units, including those that are open partially concealed or that employ modest camouflage.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Completed hardware and software design for integration onto airframe.
- Completed Avionics test vehicle design.
- Initiated coordination of DARPA/Army Test Plan.

FY 1992 Planned Program:

- Initiate design of munition for use from airframe dispenser system.
- Code and test automatic target recognition software through hardware-in-loop simulation.
- Begin system and subsystem hardware fabrication.

FY 1993 Planned Program:

- Integrate system and subsystem hardware onto airframe for demonstration.
- Initiate Joint DARPA/ARMY flight test program.
- Complete Army and other Service requirements analysis.
- Complete design of munition.

Program To Completion:

- Complete flight test program.
- Demonstrate real-time, multi-sensor, automatic target recognition.
- Transition to Army and other Services for full-scale development.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-30

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

D. WORK PERFORMED BY: Martin Marietta, Orlando, FL; General Dynamics, San Diego, CA; Texas Instruments, Dallas, TX; Science Applications, Inc., Arlington, VA; and Lincoln Labs, Lexington, MA.

E. COMPARISON WITH FY 1992 DESCRIPTIVE SUMMARY: Initial fabrication of system and subsystem hardware moved from late FY 1991 to 1stQ FY 1992.

F. PROGRAM DOCUMENTATION: DARPA/ARMY MOA (Classified) dated 13 July 1990.

G. RELATED ACTIVITIES:

- Program Element 0602702E/TT-05 Advanced Targeting Technology has related work in FY 1992 and beyond.
- This project is a part of the DARPA contribution to the Joint DoD Advanced Technology Demonstration for Global Surveillance and Communication/Precision Strike. The specific projects have been coordinated and fully integrated with Army, Navy, and Air Force plans to ensure nonduplication and compatibility with the integrated demonstration.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
May 90	Project contract award
Jul 90	MOU with Army
Apr 91	Preliminary Design Review
Nov 91	Critical Design Review
Sep 93	First Test Flight
Jun 94	Complete Flight Tests

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E
 Title: Experimental Evaluation of
 Major Innovative Technologies

Project Number: EE-34
 Budget Activity: 2 Advanced
 Technology Development

A. RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Guidance Technology					
<u>Popular</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>	<u>To</u>	<u>Total</u>
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
EE-34	Guidance Technology				
	6,198	7,538	7,835	Continuing	Continuing

B. BRIEF DESCRIPTION OF PROJECT: Fire-and-forget stand-off weapons require high-precision navigation capabilities to effectively eliminate prime targets with minimal collateral damage in the target area and minimal risk to the launch platform. This program develops a high-accuracy, low-cost navigation system required for both the next generation stand-off weapons, as well as for upgrading current weapon inventories. Potential programs that could be impacted include the Advanced Interdiction Weapon Systems (AIWS), AGM-130, the Tomahawk Land Attack Missile (TLAM-conventional), and unmanned, long-endurance airborne battlefield support vehicles. Specific research areas include the following: (1) Advanced all solid-state, low-cost navigation-grade miniature inertial measurement unit (MIMU) systems; (2) multi-channel-on-a-chip, high dynamics, miniature Global Positioning System (GPS) receivers (MGRs); (3) develop high-precision (0.001 degrees/hour), low-cost navigation-grade MGR/MIMU system, called the GPS Guidance Package (GGP Phase 1); and (4) Upgrade GGP to a 0.003 deg/hr capability (GGP Phase 2). DARPA and the Air Force will jointly develop a specialized GGP brassboard for use on Minuteman II/RV Flight Test. Discussions have been initiated between DARPA and the Cruise Missile Joint Program Office to evaluate a specialized GGP for the TLAM Block IV Upgrade.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Completed GGP preliminary design reviews.
- Completed lifetime tests of IFOG pump-sources.
- Evaluated and characterized performance of IFOG integrated optical circuit components.

FY 1992 Planned Program:

- Conduct GGP critical design review.
- Begin development of a flyable navigation brassboard.
- Begin Ballistic Missile Office (BMO) GGP brassboard development.

FY 1993 Planned Program:

- Complete GGP flyable navigation brassboard.
- Complete BMO GGP brassboard development.
- Begin GGP upgrade procurement.
- Complete GGP brassboard contractor tests.
- Begin GGP brassboard government tests.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-34

Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced
Technology Development

D. WORK PERFORMED BY: The Naval Ocean Systems Center, San Diego, CA; Charles Stark Draper Laboratory, Boston, MA; Galaxy, Philadelphia, PA; Litton Industries, Woodlawn, CA; Texas Instruments, Dallas, TX; Honeywell, Phoenix, AZ; and Rockwell International/Collins Division, Cedar Rapids, IA.

E. RELATED ACTIVITIES: Joint funding of GGP Phase 1 with Air Force Ballistic Missile Office (BMO) under PE 0603311F, Maneuvering Vehicle Testbed.

F. OTHER APPROPRIATION FUNDS: None.

G. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E
PE Title: Experimental Evaluation of
Major Innovative Technologies

Project Number: EE-36
Budget Activity: 2. Advanced Technology
Development

A. RESOURCES: (\$ In Thousands)

Project Title: Advanced ASW Technology

<u>Popular</u> <u>Name</u>	<u>FY 1991</u> <u>Actual</u>	<u>FY 1992</u> <u>Estimate</u>	<u>FY 1993</u> <u>Estimate</u>	<u>To</u> <u>Complete</u>	<u>Total</u> <u>Program</u>
Advanced ASW Technology EE-36	7,052	12,000	11,239	Continuing	Continuing

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEMS CAPABILITY:

Demonstrate applications of advanced Anti-Submarine Warfare (ASW) target detection, classification, and localization capabilities using high performance computing (HPC) technologies. Our goal is to restore ASW capabilities lost due to Soviet submarine quieting in recent years and the emergence of the Third World diesel submarine threat. The ability to demonstrate autonomous relocalization has the potential to revolutionize ASW systems. The effort involves two primary areas of focus. The first is the demonstration of autonomous target detection, localization, and tracking algorithms from a distributed field of active and passive sensors. This effort is referred to as the Autonomous Target Acquisition and Relocalization System (ATARS). The second is the demonstration of automated detection and classification algorithms for combining non-acoustic sensor data with both active and passive acoustic data in a sonobuoy sized system. This effort will demonstrate the value added of fusing non-acoustic and acoustic sensor data for selected ASW missions and is referred to as the Multi-Sensor Fusion (MSF) Buoy.

This capability will permit the use of strike/attack aircraft-assets as ASW units. Other applications of autonomous relocalization include: tactical decision aids, off-board sensors, unmanned vehicles, long-range stand-off weapons, exploitation of long-range sensor system detections, and shallow water barrier and surveillance systems.

C. PROGRAM ACCOMPLISHMENTS AND PLANS

FY 1991 Accomplishments:

- Completed Autonomous Target Acquisition and Relocalization System (ATARS) concept evaluation.
- Awarded MSF contract.

FY 1992 Planned Program:

- Demonstrate ATARS relocalization and attack (Duct Environment).
- Complete MSF requirements specification.
- Complete MSF algorithm development and testing.

FY 1993 Planned Program:

- Demonstrate ATARS relocalization and attack (Convergence Zone Environment).

Program to Completion: This is a continuing program.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-36

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

D. WORK PERFORMED BY: General Dynamics, Arlington, VA; Bolt Beranek and Newman (BBN), Inc., Arlington, VA; and Lockheed Missiles and Space Company, Sunnyvale, CA.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: The FY 1992 program included three general areas: One activity was to demonstrate autonomous localization of a submarine target using low frequency active sonar. A second activity was to develop an automated sonar test bed that would improve ASW surveillance tracking and reduce crew size. A third activity was to demonstrate an ASW Battle Management Prototype that would address low frequency active sonar issues of interoperability and Acoustic Warfare (AcW). FY 1992 funding for the second and third activities was transferred by the Congress to the Submarine Technology Program.

F. PROGRAM DOCUMENTATION: Not Applicable.

G. RELATED ACTIVITIES: This program has been fully coordinated with the following programs to ensure no duplication of effort.

- Unmanned Undersea Vehicles are being developed under Project EE-39, Unmanned Undersea Vehicles Systems.
- Surveillance, signal processing and acoustic science technology are being developed under Program Element 0602702E, Tactical Technology.
- Supporting high performance computing efforts are ongoing under Program Element 0602301E, Computer Systems and Communications.
- Acoustic Signal Processing efforts are being pursued under Program Element 0602702E, Tactical Technology.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
FY92	Autonomous Target Acquisition and Relocalization System (ATARS) relocalization and attack demonstration (Duct Environment).
FY92	Complete Multi-Sensor Fusion (MSF) Buoy requirements specification.
FY92	Complete MSF development and testing.
FY93	Complete ATARS relocalization and attack demonstration (Convergence Zone Environment).
FY94	MSF at-sea demonstration.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-37
 PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology
 Major Innovative Technologies Development

A. RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Advanced Simulation					
<u>Popular</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>	<u>To</u>	<u>Total</u>
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
EE-37	Advanced Simulation				
	13,925	34,799	51,948	Continuing	Continuing

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEMS CAPABILITY:
 Developing a distributed, seamless warfighting simulation environment for the DoD, aimed at worldwide operation using organic command, control, communications, computing and intelligence (C4I) resources. Focus is on development of interoperable technology which integrates simulations used by the Services at tactical and operational levels with instrumented ranges and new generations of high fidelity simulation to provide optimum force readiness through the right mix of field and computer-assisted exercises involving all echelons of command. This same technology supports the acquisition process through early and continuous prototyping and evaluation of new weapons and support systems as part of the total planned force structure, and will become a powerful new tool for military operation as simulation becomes embedded in C4I systems. An advanced multi-service theater-level warfighting capability involving real and synthetic objects will be demonstrated at existing national ranges in the southwestern United States.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Initiated process to develop a wargaming application protocol suite, using multiagency panel, which will eventually broaden to an open standards process.
- Demonstrated an initial suite of application protocols for interoperation of wargames, using standard ground and air models.
- Deployed and demonstrated advanced network for distributed wargaming testbed in cooperation with NATO.
- Developed advanced hybrid simulation for terrain visualization and situation analysis.
- Initiated development of Intelligent Gateways which can couple dissimilar warfighting simulations and support expansion to global scale over wide-area networks.

FY 1992 Planned Program:

- Demonstrate interoperation of multiple wargaming models in a secure distributed network between Europe and continental United States.
- Demonstrate prototype Intelligent Gateway supporting interoperation of aggregated simulation models with networks of individual weapon platform simulators.
- Deploy CINC-level testbed combining distributed C4I with advanced mission planning and simulation capabilities.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

- Initiate development of low-cost high performance networked aviation simulation and knowledge engineering for aviation intelligent automated forces.
- Demonstrate man-in-the-loop simulation as a tool for acquisition streamlining.
- Capture stressing critical mobile targets scenario and associated system architecture/statistical representation from recent Desert Storm experience.
- Develop and demonstrate capability to network real mobile objects in a field environment for battalion-level simulation.

FY 1993 Planned Program:

- Demonstrate expanded Intelligent Gateway supporting networked interoperation of joint simulation models representing 10,000 weapons platforms as individual objects on the battlefield..
- Develop technology for rapid generation of 3D terrain data bases on demand.
- Demonstrate technology for land/sea/air simulation limited to line-of-sight range exercises.
- Create critical mobile targets technology simulation/ development network testbed with six major sites.
- Demonstrate intelligent automated forces with adaptive behavior for developmental evaluation of experimental aviation systems.
- Create and demonstrate a mobile simulation/rehearsal node integrated with a CINC-level C4I system.
- Demonstrate an integrated approach to acquisition using concurrent engineering processes and a validated operator-in-the-loop simulation environment for advanced concept demonstrations.

Program to Completion:

- Demonstrate seamless land/sea/air warfighting simulation using 100,000 low-cost, networked, high fidelity models.
- Demonstrate intelligent gateways for major critical aspects of simulation aggregation, communications, and live exercise interoperation.
- Demonstrate limited land, sea, and air field exercises and simulation/wargames at theater level, capable of worldwide maneuver area mixing real and virtual objects and terrain.

D. WORK PERFORMED BY: Bolt, Baranek, and Newman, Cambridge, MA; Los Alamos National Laboratory, NM; MITRE Corporation, McLean, VA; SRI International, Menlo Park, CA; University of Central Florida, Orlando, FL; and Illusion Engineering, Inc., Westlake Village, CA.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: Results in Desert Storm emphasized the critical importance of a highly trained military force using advanced simulation technology as well as the value of simulation technology for many other essential operational activities, especially mission planning and after action review and assessment. Given forecast reductions in the training and operational O&M accounts, DARPA is strengthening its R&D investment in advanced simulation technology. The goal is to meet DoD challenges in training and

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

readiness, operations, acquisition, and test and evaluation with a Defense simulation infrastructure based upon a common interoperable standard protocol that allows seamless simulation across DoD joint needs. The FY 1993 request increase reflects the new reality of a leaner O&M budget which could partly be offset through the application of the next generation of advanced simulation technology, and integration of instrumented ranges with simulation across the DoD.

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES: Related work in technology development is closely coordinated with the new Defense Modeling Simulation Office in OSD to ensure that unnecessary duplication does not occur.

- PE 0602708E/IC-01, Integrated Command and Control Technology (PE 0602301E/ST-20 beginning in FY 1993);
- Service programs in C4I and Warfighting Simulation.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: A Distributed Wargaming Network testbed is being deployed in Europe under a Memorandum of Agreement with SHAPE. Activity is in its second year and is demonstrating the power of combining simulation and C4I at operational level of warfare in multinational environment.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Sep 92	Demonstrate seamless simulation of combined air, ground, naval, and intelligence operations.
Sep 93	Demonstrate joint simulation environment with high performance distributed simulation for acquisition and training.
Sep 94	Demonstrate hybrid simulation environment supporting field training, wargames, and high-fidelity simulation.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-39
 PE Title: Experimental Evaluation of Budget Activity: Advanced Technology
Major Innovative Technologies Development

A. RESOURCES: (\$ In Thousands)

Project Title:

<u>Popular</u> <u>Name</u>	<u>FY 1991</u> <u>Actual</u>	<u>FY 1992</u> <u>Estimate</u>	<u>FY 1993</u> <u>Estimate</u>	<u>To</u> <u>Complete</u>	<u>Total</u> <u>Program</u>
Unmanned Undersea Vehicle (UUV) Systems					
EE-39	*(19,594)	19,079	18,797	Continuing	Continuing

* This project was previously funded in Program Element 0603707E, Project PP-01 (FY 1990/FY 1991)

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEMS

CAPABILITY: Future regional/global conflicts will require the ability to rapidly and covertly deploy and monitor undersea surveillance systems into uncontrolled areas focused against the threats posed by the increasing stockpile of underwater mines and against advanced, stealthy nuclear and non-nuclear submarines. The objective of the Unmanned Undersea Vehicle (UUV) Program is to develop and demonstrate concepts and to pursue critical enabling technologies for the employment of UUVs in counter-mine and other surveillance missions. The UUV program is currently focused on the Mine Search System (MSS), a vehicle that can survey an area for mines or lead a host vessel through a minefield. To make it possible for UUVs to perform more stressing missions, research into advanced UUV technologies is being conducted. Advanced acoustic communications and advanced minehunting sonar technologies are being pursued, a high precision UUV navigation system is being built as part of the MSS program, and a program to develop a high energy density fuel cell for UUV propulsion is underway. In FY 1993, the Deployable Surveillance System (DSS) Program will be included to develop a multisensor fiber-optic coupled surveillance array for the detection of threat submarines. In addition, the DSS Program will address devices and methods for shallow water mine search and countermeasures.

C. PROGRAM ACCOMPLISHMENTS AND PLANS

FY 1991 Accomplishments:

- Initiated advanced acoustic communications research.
- Completed Tactical Acoustic System (TAS) mission demonstration and transition to Navy for full-scale development (FSD).
- Completed design and fabrication of all Mine Search System (MSS) components and commenced integration.
- Continued evaluation of Deployable Surveillance Systems (DSS) applications.
- Awarded UUV fuel cell contracts.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-39

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: Advanced Technology
Development

FY 1992 Planned Program:

- Demonstrate underwater laser communication system.
- Complete Mine Search System (MSS) semi-autonomous mine avoidance demonstration.
- Demonstrate improved navigation for MSS mission.
- Continue design and fabrication of Unmanned Undersea Vehicle (UUV) fuel cells.

FY 1993 Planned Program:

- Complete Mine Search System program.
- Continue fabrication of brassboard UUV fuel cells.
- Begin Deployable Surveillance Systems (DSS) program.

Program to Completion: This is a continuing program.

D. WORK PERFORMED BY: Charles Stark Draper Laboratory, Cambridge, MA; University of Texas Applied Research Laboratory, Austin, TX; Lockheed Missiles and Space Systems, Sunnyvale, CA; International Fuel Cells, South Windsor, CT; Loral Defense Systems, Akron, OH.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: The DSS Program will begin in FY 1993. The high precision navigation system developed previously scheduled to begin in FY 1992 has been incorporated into the DSS Program. Also, the fuel cell brassboard demonstration has been delayed from FY 1993 to FY 1994.

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES: The Navy has established an Unmanned Undersea Vehicle (UUV) Program Management Office under the Program Executive Officer for Submarine Combat Weapon Systems. This office will be the agent for transitioning projects developed under the DARPA UUV Program to the Navy per the Navy/DARPA Memorandum of Agreement.

H. OTHER APPROPRIATION FUNDS: None.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Mar 92	Demonstrate underwater laser communication system.
Jul 92	Complete Mine Search System (MSS) mine avoidance demonstrations including improved communications and navigation.
Oct 93	Complete MSS survey demonstrations.
Oct 93	Begin Deployable Surveillance Systems Program.
Nov 93	Fuel cell brassboard demonstration.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-39

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: Advanced Technology
Development

Sep 94 Complete precision navigation system development.
Sep 95 Complete UUV program.
Sep 96 Complete DSS program.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E
 PE Title: Experimental Evaluation of
 Major Innovative Technologies

Project Number: EE-40
 Budget Activity: 2. Advanced Technology
 Development

A. RESOURCES: (\$ In Thousands)

Project Title: Critical Mobile Targets (CMT)

<u>Popular Name</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
CMT	*(20,957)	*(28,340)	16,678	Continuing	Continuing

*This new project reflects the Project/PE consolidation and realignment within DARPA. The associated FY 1991 and FY 1992 funding and program accomplishments and plans for this project were funded in Program Element #0603227E, Project RT-01 and are shown here for continuity purposes.

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEMS CAPABILITY:

Prosecution of Critical Mobile Targets (CMTs) has long been a concern of the Services as evidenced by past efforts in the areas of Strategic Relocatable Targets and Smart Weapons. Recent experience in Desert Storm has dramatically demonstrated our current inability to prosecute these targets, particularly Tactical Ballistic Missiles (TBM), as well as their military and political importance. DARPA's CMT program will develop advanced technology and systems to enable the detection, identification and prosecution of a wide range of high value mobile tactical targets including TBMs, mobile command posts, tanks and artillery. Key thrusts include Advanced Wide Area Surveillance Technology, Intelligence Correlation Technology, Automated Planning Aids, Automatic Target Recognition (ATR), and advanced weapon systems leading to an ultimate demonstration of an integrated CMT prosecution system.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Developed ATR algorithms using polarimetric synthetic aperture radar (SAR).
- Evaluated near-term detector sensor under varying background and high clutter conditions.
- Lab demonstration of passive three-dimensional (3-D) EO/IR images and their ATR algorithms.
- New revolutionary 3-D SAR concepts were identified.

FY 1992 Planned Program:

- Continue development of high resolution, polarimetric SAR for optimum performance in wide area search.
- Passive, three-dimensional infrared sensor system will be designed and its projected performance assessed.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-40

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

- Complete initial development of a multi-mode, multi-spectral, passive/active electro-optic/infrared (EO/IR) sensor for target discrimination.
- Initiate concept development for an integrated system for sensing, finding, localizing and destroying Critical Mobile Targets (CMT).
- Initiate developments in the area of foliage penetration (FOPEN) radar technology.
- Complete analysis of utility and technical requirements for a 3-D interferometric synthetic aperture radar (SAR) to support targeting CMTs.

FY 1993 Planned Program:

- Complete concept design and initiate development of an advanced high resolution, high area coverage rate, polarimetric SAR system for wide area surveillance.
- Complete concept design and initiate development of a wide area coverage multi-spectral EO/IR sensor.
- Focus development of advanced Automatic Target Recognition (ATR) algorithms for specific application to advanced SAR and Moving Target Indicator (MTI) radar for both wide area and focused surveillance.
- Initiate development of advanced intelligence correlation and automated planning technologies.
- Complete concept development for an integrated system for sensing, finding, localizing and destroying CMTs.
- Continue development in the area of foliage penetration (FOPEN) radar technology.
- Demonstrate the utility of 3-D interferometric SAR in support of targeting critical mobile targets.

Program to Completion:

- Demonstrate advanced SAR, EO/IR and FOPEN sensors.
- Demonstrate automated correlation, mapping, tracking and targeting systems.
- Demonstration of integrated automation and sensor systems for targeting and prosecution of CMTs.

D. WORK PERFORMED BY: (TBD)

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: New project. Prior year funding is consistent with the FY 1992/1993 Descriptive Summary for PE 0603227E, project RT-01.

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES:

- This effort builds directly upon and integrates with ongoing DARPA programs in the areas of Smart Weapons Application Program, (EE-30), PE 0603226E, Advanced Targeting Technology (TT-05), PE 0602702E, Relocatable Targets (RT-01), PE 0603227E, and Advanced Simulation (EE-37), PE 0603226E.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-40

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

- This project is a part of the DARPA contribution to the Joint DoD Advanced Technology Demonstration for Global Surveillance and Communication/Precision Strike. The specific projects have been coordinated and fully integrated with Army, Navy, and Air Force plans to ensure nonduplication and compatibility with the integrated demonstration.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

J. MILESTONE SCHEDULE:

Plan Milestones

OCT 93 Component demonstration of FOPEN radar system.
JUN 95 Demonstrate Automated Target Tracking and Automated Mapping systems.
JAN 96 Demonstrate advanced SAR/MTI sensor.
JAN 96 Demonstrate advanced EO/IR sensor.
MAR 96 Demonstrate Integrated Target Prosecution System.
OCT 96 Demonstrate Intelligence Correlation and Auto-Planning System.
JUN 97 Demonstrate Integrated Wide Area Target Nomination System.
JUN 98 Final Integrated Demonstration.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603569E
 PE Title: Advanced Submarine Technology

Project Number: AS-01
 Budget Activity: 2. Advanced
 Technology Development

A. RESOURCES: (\$ In Thousands)

<u>Project Title: Advanced Submarine Technology</u>					
<u>Popular</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>	<u>To</u>	<u>Total</u>
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
SUBTECH					
AS-01	74,600	72,871	57,900	Continuing	Continuing

B. BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEMS

CAPABILITIES: The objectives of this program are to develop and demonstrate advanced concepts and to pursue critical enabling technologies for future submarine systems. Proliferation of submarine technology and capability to third world countries, coupled with the uncertainties generated by the disintegration of the Soviet Union, constitutes a threat to U.S. maritime interests. As a result, submarine technologies must keep pace with a changing threat and remain immune to technological surprise. The program provides the structure for evaluation and validation of acoustic and hydrodynamic quieting designs through analysis and measurement capabilities that do not exist today. Primary acoustic efforts are in Low Frequency Active (LFA) target strength reduction. Advanced material technologies address composite material applications for use in future submarine design and construction. In addition, technology initiatives such as those involving nickel-cadmium (Ni-Cd) battery design, solid state power control and distribution, electro-optics, magnetohydrodynamics (MHD) propulsion, submarine system and subsystem automation, submarine signature management, and electromagnetic countermeasure launcher design are included in the current program.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Manufactured and tested 1/4-scale propulsor rotor and started full-scale fabrication.
- Installed SUPRELITE propulsor shroud on USS PITTSBURGH.
- Transitioned 14 submarine projects to the Navy.
- Completed comparison of 76 full-scale SSN-688 maneuvers against maneuvering code predictions.
- Completed High Angle of Attack Experiments in David Taylor Research Center (DTRC) 140-foot towing tank using Propulsor Laser Doppler Velocimeter (PDV) and shear stress sensor measurement.
- Completed Phase I of High Reynolds Number Pump (HIREP) propulsor intra blade flow experiment.
- Completed 1/4-scale test of flap assisted controls surface in water tunnel tests.
- Fabricated a 4-foot diameter thermoset process development sphere.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603569E
PE Title: Advanced Submarine Technology

Project Number: AS-01
Budget Activity: 2 Advanced
Technology Development

- Fabricated a 2-foot diameter thermoplastic sphere using a non-autoclave, fiber placement process.
- Successfully embedded fiber-optic sensors in the thermoplastic plates and cylinders.
- Started Intermediate Scale Measurement System (ISMS) hardware/software development.
- Initiated land-based testing of Non-Penetrating Periscope (NPP) system.
- Completed nickel-cadmium (Ni-Cd) 2000 Amp/Hr prototype battery cell testing.
- Constructed and started closed loop magnetohydrodynamic thruster testing.
- Completed design and initiated adjustable speed drive controller fabrication.
- Completed Phase II of in-water Electromagnetic Countermeasure Launcher testing.

FY 1992 Planned Program:

- Transition 22 submarine projects to the Navy.
- Demonstrate Low Frequency Active (LFA) target strength reduction at 30:1 scale model.
- Conduct Radio Control Model (RCM) free running hydrodynamic maneuvering tests; start RCM propulsor laser doppler velocimetry experiments.
- Install CONVEX 3840 four processor computer at the Submarine Hydrodynamic/Hydroacoustic Technology Center (SH/HTC).
- Complete land-based testing of Non-Penetrating Periscope system and transition to Navy.
- Conduct Phase III water test of Electromagnetic Countermeasure Launcher.
- Complete initial design of Stealth Designers Workbench software architecture.
- Complete thermoplastic cylinder with woven fiber thermoset stiffeners.
- Conduct mechanical strength tests of candidate thermoplastic panels having installed embedded sensors.
- Conduct demonstrations of Signature Management System architecture and Submarine Operational Automation System.
- Complete closed loop magnetohydrodynamic thruster tests.

FY 1993 Planned Program:

- Continue fabrication of full-scale propulsor rotor.
- Transition four technology projects to the Navy.
- Install advanced grid point generating program on CONVEX computer.
- Transition Submarine Hydrodynamic/Hydroacoustic Technology Center to Navy.
- Commence development of full-scale flow sensor system.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603569E
PE Title: Advanced Submarine Technology

Project Number: AS-01
Budget Activity: 2. Advanced
Technology Development

- Integrate structural acoustics physics computer code in Stealth Designers Workbench.

Program to Completion: This is a continuing program.

D. WORK PERFORMED BY: AT&T Bell Laboratories, Whippany, NJ; BBN Systems and Technologies, Cambridge, MA; GEC-Marconi, United Kingdom; JASON Associates, Del Mar, CA; Pennsylvania State University/Applied Research Laboratory, State College, PA; McDonnell Douglas Aircraft, St. Louis, MO; General Dynamics/Electric Boat Division, Groton, CT; Grumman Aerospace, Bethpage, NY.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: FY 1992 program funding was increased as a result of Congressional adjustment in order to provide sufficient funding to permit orderly program execution. FY 1993 program funding was increased by DARPA and continues the

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES: Program Elements 0603561N, Advanced Submarine System Development and 0601153N, Structural Acoustics under RDT&E Navy. There is no unnecessary duplication of effort within the Department of Defense.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones:</u>
Sep 92	Transition Non-Penetrating Periscope (NPP) to the Navy.
Aug 92	Transition Electromagnetic Countermeasure Launcher to Navy.
Sep 92	Transition radio control model to Navy.
Sep 93	Initial operational capability of the Intermediate Scale Measurement System.
Dec 94	Complete fabrication of full-scale propulsor rotor.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E
 PE Title: Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

A. RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MT-01 Semiconductor Manufacturing Technology	98,000	100,000	80,000	Continuing	Continuing
MT-02 Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC)	¹ (106,190)	85,518	85,976	Continuing	Continuing
MT-03 IR Focal Plane Array (IRFPA)	² (16,575)	17,923	36,072	Continuing	Continuing
MT-04 Electronic Module Technology	0	4,900	43,577	Continuing	Continuing
MT-05 High Definition Systems (HDS)	³ (74,350)	³ (75,000)	9,775	Continuing	Continuing
Total	<u>98,000</u>	<u>208,341</u>	<u>255,400</u>		

B. BRIEF DESCRIPTION OF ELEMENT: This program element consolidates five major manufacturing technology programs (Semiconductor Manufacturing, MIMIC, IR Focal Plane Array, Electronic Module Technology, and High Definition Systems). With this consolidation, the major thrusts of the Program Element are focused on the development of advanced semiconductor materials, processing, equipments and manufacturing methods for future weapons systems; accelerated development, manufacturing and demonstrations of affordable microwave and millimeter wave analog integrated circuits; the establishment of a manufacturing base for advanced infrared (IR) sensor arrays for major weapons systems to meet system requirements at approximately 1 percent of the current cost; the timely insertion and rapid acquisition of state-of-the-art microsensors and actuators, conformal electronics and affordable, high performance application-specific electronic modules (ASEM) into major military systems including automatic target recognition, electronic countermeasures and Signal Intelligence (SIGINIT); and the manufacture of high definition displays for military systems. Specific project accomplishments and plans are contained in the separate project summaries.

¹The MIMIC project was reported in PE 0603706E, project MM-01, for FY 1991 and prior years.

²The IR Focal Plane Array project was reported in PE 0702807E, project IR-01 for FY 1991 and prior years.

³The High Definition systems project was reported in PE 0602708E, Project IC-03 for FY 1992 and prior years.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E
 PE Title: Manufacturing Technology

Project Number: MT-01
 Budget Activity: 2. Advanced
 Technology Development

A. RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Semiconductor Manufacturing Technology					
<u>Popular</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>	<u>To</u>	<u>Total</u>
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
Semiconductor Manufacturing	98,000	100,000	80,000	Continuing	Continuing

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES:

This project provides for a major Department of Defense (DoD) effort to develop advanced manufacturing methods for semiconductors used in weapon systems. This program will develop semiconductor manufacturing capabilities to correct deficiencies in the industrial base that have been identified by the Defense Science Board (DSB). This program will stimulate the semiconductor manufacturing industrial base to develop advanced semiconductor materials, processing, equipments and manufacturing methods necessary to regain the superior technology needed for future weapon systems of all types. Beginning in FY93, this program will focus on developing and transitioning key technologies needed for state-of-the-art microelectronics manufacturing for many part types at small to moderate volumes.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Completed transfer of 0.8 micron technology to member companies.
- Completed installation of 0.5 micron fabrication tools and equipment.
- Demonstrated modular 0.5 micron unit process technology and transfer to member companies.
- Initiated technology development for 0.35 micron unit processes.
- Developed programs to produce equipment and materials to enable the manufacture of high-quality 0.35 micron semiconductor devices.
- Defined requirements for 0.25 micron and 0.18 um semiconductor fabrication.
- Demonstrated self-sustaining technology and information infrastructure that will enable the continued development of the highest quality materials, equipment, unit processes, fabrication facilities and management systems enabling the manufacture of world competitive semiconductors for military electronics systems.

FY 1992 Planned Program:

- Complete transfer of 0.5 micron technology to member companies.
- Demonstrate 0.35 micron integrated process and produce first 0.35 micron silicon integrated circuits.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Manufacturing Technology

Project Number: MT-01
Budget Activity: 2. Advanced
Technology Development

- Initiate technology development for 0.25 micron unit manufacturing processes.
- Upgrade SEMATECH fab from 6" to 8" wafer processing equipment.

FY 1993 Planned Program:

- Initiate projects to produce equipment, materials and factory control systems that will enable the manufacture of high-quality 0.25 and 0.18 micron semiconductor devices in low-cost flexible facilities.
- Establish new technical thrusts in computer modeling and contamination-free manufacturing.

Program to Completion:

- Develop and demonstrate 0.25 and 0.18 micron semiconductor manufacturing equipment, materials, and systems for low-cost, flexible fabrication facilities.
- Reduce the sensitivity of semiconductor product cost to manufacturing volume.
- Provide programmable factory systems capable of responding to process changes with first pass success.

D. WORK PERFORMED BY: The major performer is the SEMATECH Consortium in Austin, TX.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: Consistent with the FY 1992/1993 Descriptive Summary.

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES: Exploratory and advanced development of semiconductor components are being conducted under Army, Navy, Air Force, Defense Advanced Research Projects Agency (DARPA), Strategic Defense Initiative Office (SDIO) Program Elements.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Mar 92	Complete transfer of 0.5 micron technology to member companies.
Jun 92	Produce first 0.35 micron silicon wafers.
Oct 92	Complete installation of 0.35 micron fabrication tools and equipment.
Sep 93	Initiate projects leading to the capability for state-of-the-art, cost-effective microelectronics manufacturing for many part types at small to moderate volumes.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-02
 PE Title: Manufacturing Technology Budget Activity: 2. Advanced Technology Development

A. RESOURCES: (\$ In Thousands)

Project Title: Microwave/Millimeter Wave Monolithic Integrated Circuits

<u>Popular Name</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MIMIC	1(106,190)	85,518	85,976	Continuing	Continuing

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES:

This project provides for a major Defense Advanced Research Projects Agency (DARPA) effort to accelerate the development, manufacturing and demonstration of affordable microwave and millimeter wave analog integrated circuits (ICs). Its primary thrust is to develop affordable circuits operating in the 1 to 100 GHz frequency range with required characteristics and in sufficient quantity to satisfy military systems needs. The use of reliable and maintainable semiconductor devices and circuits for selected system demonstrations will be accelerated and, thus, provide the United States with a technological lead in deploying MIMIC-based military systems.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Completed MIMICs on 1,000 wafers (minimum) per contractor team.
- Continued CAD development, processing enhancements, and manufacturing techniques.
- Delivered all test fixtures, chips, modules, and brassboards from first MIMIC hardware development phase.
- Completed first hardware developer CAD system.
- Delivered final test, reliability and quality assurance (QA) plans and test results from first MIMIC hardware development phase.
- Initiated Advanced Technology and System Demonstrations (MIMIC Phase 2).

FY 1992 Planned Program:

- Continue enhancement of capabilities to produce devices, circuits and subsystems with needed characteristics for DoD systems.
- Continue integration of CAD capabilities with manufacturing lines and on-line test capabilities.
- Begin transfer into MIMIC fabrication lines of advanced materials, devices, design software, packaging and testing technologies which show promise for meeting advanced DoD system requirements.

1Funded in PE 0603706E; MM-01 in FY 1991 and prior years.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-02

PE Title: Manufacturing Technology

Budget Activity: 2. Advanced Technology
Development

- Integrate Multi-Function, Self-Aligned Gate (MSAG) Technology into military radar systems.

FY 1993 Planned Program:

- Deliver first multi-function MIMICs meeting required system specifications.
- Begin assembly of advanced MIMIC modules and system brassboards.
- Continue development of advanced materials, devices, design software, packaging and testing technologies.

Program To Completion:

- Complete, demonstrate, and deliver MIMIC Phase 2 chips, modules, and brassboards.
- Conduct advanced demonstrations of affordability and expanded system usage.
- Increase emphasis on combined digital, microwave and millimeter wave and optical processing functions on individual chips (or within same package on individual substrates).
- Develop higher performance MIMIC chips from newer material combinations such as indium phosphide based compound structures.
- Continue development of higher power, higher efficiency millimeter wave devices, circuits and subsystems.
- Augment computer-aided design capabilities to allow rapid translation of system requirements into circuit and processing specifications.

D. WORK PERFORMED BY: Work will be performed by: Department of the Army, U.S. Army Laboratory Command Electronics Technology & Devices Laboratory; Department of the Navy, Naval Air Systems Command, U.S. Naval Research Laboratory; Department of the Air Force, Wright Research & Development Center, Rome Air Development Center.

Hardware development phase prime contractors are: Hughes Aircraft Company, El Segundo, CA; General Electric, Syracuse, NY; Martin Marietta, Orlando, FL/Roanoke, VA; Raytheon, Bedford, MA; Texas Instruments, Dallas, TX; and TRW, Redondo Beach, CA.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: Consistent with FY 1992/1993 Descriptive Summary.

F. PROGRAM DOCUMENTATION:

- Management Structure for the MIMIC Program, 9/85.
- Program Plan for MIMIC, 5/86.
- Acquisition Plan No. DoD 86-X for MIMIC Program, 10/86.
- MIMIC Program Security Classification Guide, DoD Instruction 5210.80, 8/87.
- Acquisition Plan No. DoD 87-X for MIMIC Program, 10/87.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-02
PE Title: Manufacturing Technology Budget Activity: 2. Advanced Technology
Development

G. RELATED ACTIVITIES: Exploratory and advanced development of gallium arsenide monolithic components are being undertaken within Army, Navy, and Air Force RDT&E program elements.

The related program elements and titles are:

- Program Element #0602705A, Electronics and Electronic Devices
- Program Element #0602234N, Systems Support Technology
- Program Element #0602204F, Aerospace Avionics

The work performed under this project within Program Element #0603739E is complementary to the work performed in the above program elements. There is no unnecessary duplication of effort within the Agencies/Services or the Department of Defense.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Jan 92	Initiate Advanced Technology and System Demonstrations.
Jan 92	Begin development of microwave and millimeter wave circuit chips from advanced compound semiconductors.
Jan 93	Develop advanced CAD capabilities.
Aug 94	Deliver MIMIC Phase 2 demonstration chips, modules and brassboards.
Jan 95	Complete integrated design/fabrication/test capabilities at MIMIC Phase 2 contractors.
Sep 97	Demonstrate integrated digital, analog and optical function modules in system brassboards.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-03

PE Title: Manufacturing Technology

Budget Activity: 2. Advanced
Technology Development

- Completed fabrication and evaluation of 960x4, 64x64, 128x128 and 480x512 focal plane arrays meeting system sensitivity requirements.
- Established the feasibility of dry etching for the manufacture of infrared detector arrays.

FY 1992 Planned Program:

- Implement improved material screening to qualify wafers for Infrared Focal Plane Array (IRFPA) manufacturing.
- Demonstrate in-process sensors for IR material growth to control material uniformity over large wafers.
- Demonstrate infrared diode arrays produced with the dry etching process.

FY 1993 Planned Program:

- Integrate into the manufacturing line vapor phase growth with improved doping and composition control.
- Demonstrate improved screening of infrared material; x2 increase in the arrays passing wafer-level evaluation.
- Implement manufacturing technology for 3-inch substrates, incorporating 100 64x64 IRFPAs.
- Manufacture 480x4 IRFPA with improved reliability (greater than 2,000 thermal cycles without failure).

Program to Completion:

- Demonstrate manufacturing technology for 64x64 staring arrays with greater than 90% operability at a cost of less than \$2,000 per array.
- Demonstrate 128x128 IRFPAs on a silicon substrate for greater ease of material handling in manufacturing.
- IRFPA manufacturing demonstration with 4-inch wafers.
- Demonstrate large area 512x512 mercury cadmium telluride IRFPA on a silicon substrate.
- Complete the development of an integrated manufacturing capability for large area (4-inch wafers) infrared semiconductors demonstrating a 100 times cost reduction for both scanning and staring arrays.

D. WORK PERFORMED BY: Contractors include: Rockwell, Anaheim, CA; Texas Instruments, Dallas, TX; Santa Barbara Research Center, Santa Barbara, CA; and Perceptronics, Woodlawn Hills, CA.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: Consistent with FY 1992/1993 Descriptive Summary.

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES: Development of Infrared Focal Plane Array (IRFPA) technology and devices is being undertaken under Army, Navy, Air

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-04
 PE Title: Manufacturing Technology Budget Activity: 2. Advanced
 Technology Development

A. RESOURCES: (\$ In Thousands)

<u>Project Title: Manufacturing</u>					
Popular	FY 1991	FY 1992	FY 1993	To	Total
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
Electronic Module Technology	0	4,900	43,577	Continuing	Continuing

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES:

Electronic Module Technology supports miniature distributed systems and the timely insertion of state-of-the-art electronic modules to be used in forward deployed weapons systems. This project has the following thrusts: (1) Microsensors and Actuators; (2) Conformal Electronics; (3) Application Specific Electronic Modules (ASEM), especially multi-chip modules (MCMs) for high density packaging of digital electronics; (4) Rapid Acquisition of Application Specific Signal Processors.

The Microsensors and Actuators program will explore new ideas on microdynamical devices, design and simulation tools that combine mechanical and electrical analysis on high-performance computers, techniques and processes for microfabrication and assembly, applicable metrology technology, materials design and characterization, and languages for describing products, process and factories.

Conformal Electronics is form-factor oriented electronic packaging that acknowledges that, in many cases, the electronics need to be not only small but conform to, rather than dictate, the system form-factor. The long-range goal is to produce technology that allows the system designer to intermingle information technology, sensors, sources, actuators, and mechanical structures.

The ASEM/MCM Technology will make affordable advanced digital packaging available for dual-use applications. The initial insertion effort will provide immediate 10-100X volume and weight savings to fielded military subsystems. Simultaneous development of higher speed packaging technology will allow advanced circuits to operate at their intrinsic multi-GHz clock rates without packaging limitation. Initial insertions will provide weight and volume savings for systems at present-day clock rates at lower cost and with greater reliability. Similarly, development of optoelectronic modules will enable electronic systems to exploit the cost, size, weight, and reliability benefits of photonics technology.

Rapid acquisition of application-specific signal processors will demonstrate a capability to rapidly specify, produce and field

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affordable high performance application-specific signal processors for critical defense applications including automatic target recognition, electronic countermeasures and Signal Intelligence. Capabilities will be developed and demonstrated in three areas: domain-specific hardware and software design capability, specific flexible manufacturing and test capabilities, and standard signal processor interfaces for the chosen domains. The program will demonstrate insertion of affordable embedded signal processing which is at the state of the art when the system is fielded, as opposed to state of the art when designed.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments: Not applicable.

FY 1992 Planned Program:

- Defense-relevant applications chosen for microsensors and actuators with key interface applications defined.
- Initial contract awards for multi-chip module designs.
- Low dielectric constant materials and fabrication processes designed for GHz MCMs.

FY 1993 Planned Program:

- Select appropriate demonstration platforms for Application Signal Processors.
- Multidisciplinary simulation of processing and temperature-induced stresses in conformal electronics devices. Several new microdevices and processes demonstrated. Multiple domain device simulators for display hardware for head-mounted visualization systems, and high-speed gimbal or beam-steering devices for missile seekers.
- High yield, 100-250 MHz Multi-Chip Module (MCM) demonstrations.
- System Insertion Plan developed for 100-250 MHz MCMs.
- Initiate efforts to integrate planarized structures with advanced optoelectronics packaging technology.
- Define languages, interfaces, and libraries for Application Signal Processor baseline demonstrations.

Program To Completion:

- Demonstrations of manufacturable defense-relevant devices and microsystems.
- Intermingled information technology (computation, control, and communication); microsensors, sources, and actuators; and mechanical structures in affordable systems.

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- The ASEM/MCM insertion projects are the key means for technology transfer: they will result in prototypes of electronic subsystems that the Service agencies will test, evaluate, and procure.
- Establish rapid prototyping capability for Optoelectronic modules.

D. WORK TO BE PERFORMED BY: To be determined by competitive selection.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: Added programs in conformal electronics, microsensors and actuators and application-specific signal processing.

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES: This effort will be closely coordinated with Program Element 0602301E, ST-19, DARPA High Performance Computing and Communications (HPCC) and Program Element 0603739E, MT-05, High Definition Systems (HDS) programs which will provide vehicles for demonstrating the new technologies.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: None.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Mar 1992	200 MHz GaAs digital integrated circuits in High Density Interconnect.
Sep 1992	Low dielectric constant materials, and fab processes for GHz MCMs.
Dec 1993	High yield, 100-250 MHz MCM demonstrations.
Jun 1993	Demonstrate manufacturability of microactuator.
Sep 1993	System Insertion Plan for 100-250 MHz MCM.
Sep 1993	Demonstrate manufacturability of conformal electronics packaging technology.
Mar 1994	0.25-2 GHz MCM demonstrations.
Mar 1994	Demonstrate distributed microelectromechanical device.
Jul 1994	Conceptual design of optoelectronic modules including integration of micro-optics and advanced packaging techniques.
Sep 1994	Demonstrate integrated microsensors/conformal electronics device.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E
 PE Title: Manufacturing Technology

Project Number: MT-05
 Budget Activity: 2. Advanced
 Technology Development

A. RESOURCES: (\$ In Thousands)

Project Title: High Definition Systems

<u>Popular Name</u>	<u>FY 1991 Actual</u>	<u>FY 1992 Estimate</u>	<u>FY 1993 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
HDS	*(74,350)	*(75,000)	9,775	Continuing	Continuing

*This new project reflects the Project/PE consolidation and realignment within DARPA. The associated prior year funding and program accomplishments and plans for this project were funded in PE 0602708E, Project IC-03 and are shown here for continuity purposes.

B. BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES:

This program is a major DoD effort to develop the technology for high definition displays to be used in a variety of military systems. This technology is important for virtually all DoD applications which involve visual and graphic information. Major applications of this technology include small combat durable displays for fighter aircraft cockpits, armored vehicles, submarines, AEGIS cruisers, military simulators, command centers and security police. This technology will provide greater resolution for the smaller intelligence and reconnaissance platforms required for potential future conflicts and greater combat durability for these displays based upon modular design concepts.

C. PROGRAM ACCOMPLISHMENTS AND PLANS:

FY 1991 Accomplishments:

- Initiated procurements in the areas of enabling technology; prototype facilities; storage technology; imagers; and processors under a Broad Agency Announcement.
- Designed deformable mirror devices (DMD) projector -- the world's most complex micromechanical device with over 2 million moving parts and over 2 million transistors.
- Developed 17-inch, full-color plasma flat panel display.
- Initiated effort in head-mounted displays.
- Demonstrated 19-inch, full color plasma flat panel display.

FY 1992 Planned Program:

- Build 20-inch flat tension mask Cathode Ray Tube using interchangeable mask process.
- Demonstrate full color electroluminescent display.
- Complete design of 2 megapixel deformable mirror devices, associated projection optics, and drive electronics.

FY 1993 Planned Program:

- Complete development of 1280x1024 monochrome helmet mounted display.

AMENDED FY 1992/1993 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Manufacturing Technology

Project Number: MT-05
Budget Activity: 2. Advanced
Technology Development

D. WORK PERFORMED BY: The major performers are: Xerox Corporation, Palo Alto, CA; Magnascreen Corporation, Pittsburgh, PA; Photon Dynamics, Inc., San Jose, CA; XMR, Inc., Santa Clara, CA; Texas Instruments, Dallas, TX; MRS Technology, Inc., Chelmsford, MA; Planar Systems, Beaverton, OR; Sarnoff Research Center, NJ; and Zenith Corporation, Chicago, IL.

Service support is provided by the U.S. Army Electronics Devices and Technology Laboratory, Ft. Monmouth, NJ, and the U.S. Air Force Wright Laboratory, Wright Patterson Air Force Base, OH.

E. COMPARISON WITH FY 1992/1993 DESCRIPTIVE SUMMARY: New project. Prior year funding is consistent with the FY 1992/1993 Descriptive Summary, PE 0602708E, Project IC-03.

F. PROGRAM DOCUMENTATION: Not applicable.

G. RELATED ACTIVITIES: This project is coordinated with the advanced display technology being developed by the U.S. Army Electronics Devices and Technology Laboratory and the U.S. Air Force Aircraft Cockpit Integration Directorate and Manufacturing Technology (MANTECH) Directorate at Wright Laboratory.

H. OTHER APPROPRIATION FUNDS: None.

I. INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Jul 1992	Build 20-inch flat tension mask Cathode Ray tube.
Sep 1992	Demonstrate full color electroluminescent display.
Jun 1993	Complete design of 2 megapixel deformable mirror device and associated projection optics.
Jun 1993	Complete development of 1280x1024 monochrome displays in both liquid crystal and electroluminescent technology.

