FISCAL YEAR 1983
RESEARCH AND DEVELOPMENT PROGRAM (U)

A Summary Description

30 March 1982

Defense Advanced Research Projects Agency
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DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

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INTRODUCTION

The overall investment objective for science and technology within the Department of Defense is to ensure that the total technology effort meets future systems needs--that we maintain our technological superiority across all defense related technologies and are not surprised by any militarily significant technological development of our potential adversaries. This objective is shared by the Services, the Defense Nuclear Agency (DNA), and the Defense Advanced Research Projects Agency (DARPA).

A. DARPA Role and Challenges

The traditional role of DARPA in meeting this objective has been to selectively accelerate efforts where it is perceived that technology has not moved fast enough for the military need; to undertake those programs of high technological risk, yet potentially high payoff; and to pursue promising revolutionary approaches where they can be identified. The DARPA program, therefore, should both reflect the leading edge of promising new defense technology and address particularly those areas where our defense technology requires improvement.

Within this traditional investment strategy, the DARPA FY 1983 Research and Development Program has been further influenced by two basic challenges, one arising from the growing military power of the Soviet Union, the other from the manpower constraints within which the United States must meet its military needs.

The Soviet Union has been and is still investing a large portion of their national wealth in military power. We have seen an increasing number of new Soviet weapons systems undergoing development and an increasing technological proficiency in these systems. At the same time, the Soviets have continued to deploy new military hardware in large numbers while refusing to phase out older weapon systems.

> The First Challenge: The evolving Soviet technological capacity, the persistence of Soviet numerical superiority, and the future military threat implications of both.

The U.S. must meet this challenge by continuing to rely on our technical superiority to overcome quantity with qualitative superiority. Further, we must achieve this while drawing from a manpower pool that will continue to decrease. The non-military competition for skilled personnel will doubtlessly increase throughout the rest of the century.

> The Second Challenge: The current complexity of weapons systems, the decreasing availability of experienced and trained personnel and the future defense cost implications of both.

Taken together, these two challenges provide an apparent dichotomy of needs for our future military systems--requiring, on the one hand, increasing sophistication, while on the other decreasing complexity.

Our future weapons sytems must possess the qualitative superiority necessary to overcome quantitively superior threats (which are increasing in quality as well). Historically, this has driven us to ever higher levels of complexity. Further, the evolving Soviet technological capacity has increased the possibility that the U.S.S.R. may achieve some singular, highly sophisticated technological breakthroughs. We must identify possible areas of major military impact and hedge against possible surprise in the future.

Yet, system performance requirements in the face of the quantitative imbalances we will face will continue to drive us to more complex systems. Therefore, we must pursue technologies that provide "transparent complexity" in our new systems.

These two basic challenges and the apparent dichotomy of needs that result from them constitute the "threat" that the defense technology base must counter. Clearly, the defense technology base program must address both challenges beginning with our basic research and continuing through our exploratory development. It is also evident that we have not given sufficient weight in the past to the second.

B. Basic Requirements

If we are to fulfill our mission against this "threat," we must meet three basic requirements:

1. We must exploit those techniques that will lead to weapon systems and platforms that are simpler to operate and maintain yet more capable than those we are acquiring today. The components and materials that make up these systems must be easier to fabricate but must perform their functions better than the products of our contemporary technology.

   Here we are dealing with potential hardware that must be produced in quantity and operated by many. Our aim is to prove that technological sophistication can indeed produce more capability at less cost and operating complexity. Among the current efforts that are responsive to this requirement are: "Fire-and-forget" seeker technologies for precision guided munitions, advanced composite materials, and microelectronics to provide "transparent" technical complexity with substantial increased capabilities.

2. We must give added emphasis to developing those areas that will enhance our future capability for rapidly employing forces where they will be most effective--better surveillance, target acquisition, and force control systems.

   We view these areas as embodying those efforts most appropriately called "the leading edge" of defense technology today. Technologies impacting these areas have not received the breadth of exploration provided to areas more directly related to weapon systems with the result that the inherent capacities of our weapons outdistance our capability to apply them in the right place at the right time. The fluid conditions of future conflicts will require new tradeoffs between mobility, agility, and firepower. Among the specific technologies that become important are those that will permit us to locate and track hostile forces continuously, to provide real-time information management, to counter hostile acquisition systems, and to ensure high firepower and availab'lity in extreme environments (chemical warfare/radiation/temperature).

3. We must continue, at the same time, to explore the technological frontier, where a breakthrough could evolve to systems with major military impact--even if these systems appear to us today as exotic, perhaps very complex, and/or expensive. This is the area of so called high-risk/high-payoff technology, that, if successful, could make a difference. Initiatives in space-based laser technology are probably most representative of DARPA's pioneering research in this area.

II. THE DARPA BUDGET REQUEST - FY 1983

The DARPA Fiscal Year 1983 Budget request is $756.8 million, an increase of $80.5 million over the FY 1982 appropriation. These resources support DARPA's major thrusts and R&D objective as follows:

> $63.6 million--Advanced Cruise Missile Technologies: engine improvements for greater range and payload, enhanced homing and guidance technologies to improve accuracy, and an improved understanding of detection and tracking phenomena to maintain the ability of cruise missiles to penetrate sophisticated air defenses.
>
> $65.5 million--Air Vehicles and Weapons: innovative concepts such as the X-Wing, the Forward Swept Wing technologies, and exploration of new composite materials, which could offer dramatic improvements in aircraft performance.
>
> $93.3 million--Information Science and Communications: technologies for survivable computer communciations, secure message and information systems, improved crisis management and command systems, and submarine laser communications.
>
> $62.1 million--Land Combat: target acquisition and weapon delivery technologies that provide options to offset the Soviet armored vehicle assault capability, including advanced seeker technology, all-weather targeting and guidance, and advanced armor anti-armor technology.
>
> $85.5 million--Naval Warfare: development of integrated submarine sonar technology and exploration of non-acoustic submarine signatures.
>
> $19.2 million--Nuclear Test Verification: development of detection and identification techniques for monitoring other nations' compliance with agreements limiting nuclear testing.
>
> $135.5 million--Science Initiatives: development of intelligent automated systems and initiatives in electromagnetic propulsion, rapid solidification technologies, electronic and optics materials research, and particle beam technology.
>
> $116.6 million--Space Defense: high-efficiency infrared chemical lasers, large space optics, and pointing and tracking techniques to demonstrate the feasibility of high-energy laser system technology for space-related applications.

$107.4 million--Space Surveillance: sensor technologies for target detection with countermeasure protection, improved missile surveillance, and new options for early warning on both strategic and non-strategic levels.

In addition, the budget request includes $8.1 million for management and support to include salaries, rent, travel, equipment, and supplies.

III. TECHNOLOGY THRUSTS

A. Advanced Cruise Missile Program

1. Autonomous Terminal Homing (ATH)

The ATH program is developing an advanced, day-night and adverse weather, precision guidance system for application to cruise missiles. The ATH system will employ advanced sensor, scene matching and reference preparation technology to provide a dramatic improvement in warhead delivery accuracy over current cruise missile guidance techniques. Examples of new cruise missile capabilities using the ATH guidance technique include provision for an autonomous damage assessment capability (which offers a technique for efficiently concentrating kills on high priority targets) and utilization of the high precision available to permit missile use with conventional tactical strike and Rapid Deployment forces.

During FY 1981, the development of a ground-based Scene Matching Laboratory was initiated. This laboratory will be used to perform scene matching evaluations with flight test imagery. Other efforts included design of advanced Terrain Following/Obstacle Avoidance (TF/OA) algorithms and development of a simulation laboratory for investigating TF/OA system tradeoffs and performance potential. Fabrication of two brassboard imaging sensors was initiated. During FY 1982, construction of the two imaging sensors will be completed and flight testing, in dual pod-mounted configurations, will begin. The 1-year flight test/data collection effort will be completed in mid-FY 1983. Development of the two competing scene matching algor chms will also be completed; they will be delivered to the Scene Matching Laboratory where processing of flight test imagery with synthetic references will begin. Detailed design of an operational reference preparation workstation will be completed. TF/OA sensor/processor design requirements will be finalized, and a decision either to integrate ATH and TF/OA or to pursue separate TF/OA development will be made.

2. Advanced Delivery Concepts

The Advanced Delivery Concepts Program is directed toward developing the technology needed to counter evolving threats to the present cruise missile. Unconventional vehicle designs and launch modes and a variety of synergistic subsystem technologies will be examined that may provide substantial increases in performance. In FY 1982, techniques were investigated to greatly increase range and to develop a cruise missile optimal flight path system, techniques to reduce cruise missile cost were developed for an employment concept was formulated, and munition requirements were established. Development of a damage assessment system will be continued during FY 1983.

3. Advanced Cruise Missile Engine

High payoff engine concepts are being investigated that have the potential to utilize new high energy fuels, to increase thrust, and to reduce fuel consumption by a significant amount relative to the current cruise missile engine (F-107). A compound cycle turbofan engine (CCTE) with a two-stroke, high-speed diesel engine and an eccentric engine, consisting of a three-spool turbofan with the third spool (or high pressure compressor, combustor, and turbine) mounted off-axis to the other two spools, are being developed. In addition, a recuperative engine that utilizes a coated carbon-material for fabricating high temperature subcomponents is under investigation.

Development and testing of the CCTE single cylinder test rig have been completed. The CCTE single cylinder demonstrated the forecasted engine speed, pressurization, and temperature. The design of the eccentric engine third spool has been completed, and fabrication has begun. Testing of the third spool at full pressure and temperature for one hour with columbium turbine blades is scheduled for late FY 1982. The system design phase of the recuperative engine project has been completed by the two competing contractors. Proposal evaluation for the next phase, critical subcomponent development, was completed in February 1982. Selection of a single contractor will occur at that time.

The engine demonstration (validation phase) will be initiated and will continue with design and fabrication of the full integrated engine. Completion of the validation phase is scheduled upon demonstration of the anticipated thrust specific fuel consumption reduction relative to the current cruise missile turbofan engine.

4. Cruise Missile Detection Technology (CMDT)

CMDT program objectives are directed toward developing an understanding of the physical phenomena that limit the capability of defensive systems intended to counter cruise missiles. Radar masking, clutter, propagation data, and infrared (IR) background data are being collected and analyzed in order to establish a database. Validated phenomenological data will be used to modify and refine analytical models of defensive system performance and to predict the survivability rate of cruise missiles. These data are being provided to the cruise missile research, development, test, and engineering community to provide a basis for maximizing U.S.

cruise missile survivability against current and evolving Warsaw Pact defense systems.

During FY 1982, clutter measurements were initiated for both ground-based and airborne radar. Propagation phenomena were collected and analyzed. An all-wheel-drive truck with an X-band radar and digital recording system measured and recorded clutter data at over 70 sites as a precursor to a more elaborate, five-frequency set of equipment that will visit these sites in early FY 1982. Studies of terrain masking and ground clutter at selected sites were conducted. Measurements and analysis of IR clutter backgrounds were also performed. An initial multi-frequency clutter model will be produced. Propagation and IR background measurements will be made. Refinement of a cruise missile functional model that includes propagation and clutter effects will continue. Cruise missile test range support with both the propagation and clutter instrumentation will also continue on a request basis on cruise missile test ranges.

A preliminary five-frequency clutter model will be defined by the beginning of FY 1983 and will be refined as it is tested against the collected data. Site-specific analysis of phenomena will continue, and models will be formulated and tested in an attempt to generalize such characteristics to a manageably small number of generic site descriptors, which will permit prediction of masking, clutter, and propagation without need for actual specific site measurements.

In FY 1983, joint DARPA/Air Force funding will begin. An expansion of the basic program will cover in-flight measurements to establish survivability rates of a number of U.S. air vehicles, including cruise missiles.

5. Path Optimization Technology

DARPA has embarked on a novel approach for selecting the optimum path for the flight of an aircraft to a target. This path selection technique can be performed on the ground, aboard a launch platform, or onboard the aircraft during its flight. The objective of the technology is to decrease the likelihood of aircraft being destroyed by defense systems through (1) improved mission planning and (2) onboard detection and routing around pop-up defense elements such as radars, missiles, and aircraft interceptors. The ability to achieve real-time threat avoidance of airborne interceptors is a major breakthrough in the program and represents an essential future capability.

Algorithm work will be completed. In addition, the detailed design of the onboard processor hardware and software will commence. The onboard processor will be assembled, software developed, and the final assembly tested. A flight test plan for testing the path optimization processor and algorithms onboard a cruise missile or aircraft will be developed.

Those mission planning portions of this program that have been completed have been transferred to the Air Force.

B. Air Vehicles and Weapons

1. Radial Wafer Blade

The Radial Wafer Blade development program is conducted jointly by DARPA and the Air Force. Efforts include development of vastly improved vane and blade alloys for jet engines through rapid solidification rate technology, new cooling designs based on bonded wafers, and demonstration of the process with scale-up to production volume requirements. The program will demonstrate a high durability component for a future derivative of the F-100 engine in the 1985 time frame. In addition to improving component performance through a combination of rapid solidification technology and more effective component cooling, significant production cost savings and reduced use of critical materials such as cobalt and chromium will be realized.

Accomplishments to date include a significant improvement to the rapid solidification rate powder-making equipment through the installation of a helium gas recirculator. This will greatly expand the powder production capacity and reduce costs. Two radial wafer blades have been run in an F-100 test engine, including 25 Tactical Air Command full mission cycles. Blade alloy optimization studies have resulted in a tenfold improvement in oxidation resistance without sacrificing high-temperature strength. A vane alloy has been developed with intrinsic oxidation resistance better than that provided by the many coatings added for this protection. Rapidly solidified alloys have exhibited the ability to be cold-rolled to final wafer thickness, which will lead to improved process control and further cost reductions. Transition plans include component performance demonstrations in an advanced turbine engine gas generator (ATEGG) and development of complete component processing specifications.

2. Nondestructive Testing and Evaluation

A scientific foundation for ultrasonic acoustic emission and electromagnetic nondestructive measurement techniques is being developed. This technology, combined with failure models and accept/reject decision criteria, will provide a new capability for increasing safety, reducing cost, and increasing the in-Service rates of deployed Service systems.

This joint DARPA/Air Force effort will emphasize development of these technologies to demonstrate retirement-for-cause as a new method of achieving longer life for F-100 engine disks. This will permit us to obtain the maximum safe life from each system component by discarding only those components that do not have sufficient remaining life for return to service. The current procedure is to retire all engine disks in the fleet after a predetermined amount of time. When this method is incorporated into Air Force maintenance procedures, the costs for F-100 engine maintenance will be reduced by approximately $5 to $10 million per year.

The conceptual design phase of this program is completed, and development of the specific techniques required to meet the program objectives is under way. In addition to extending the DARPA nondestructive evaluation science base, the retirement-for-cause program will enable characterization of defects in materials and evaluation of the effects of these defects on specific requirements. As part of the joint program, the Air Force has initiated a manufacturing technology program to develop the necessary equipment to use retirement-for-cause evaluation methods at an Air Logistics Center in 1985.

3. <u>Forward Swept Wing (FSW) X-29A</u>

This program is designed to demonstrate that advanced composite structures can solve the aeroelastic divergence phenomenon, a static structural instability experienced by forward but not aft swept wings. Demonstrating the divergence solution will allow a thorough investigation and exploitation of the benefits long attributed to the FSW configuration:

improved maneuverability, better low speed and high angle of attack performance, higher aerodynamic efficiency, and considerable design flexibility. Flight testing will ensure a credible audit trail from theoretical analysis through design, fabrication, and test; and will enable rapid maturation and application of the pertinent technologies.

A manned FSW demonstrator made possible with an advanced composite structure, a digital fly-by-wire flight control system, and a set of related advanced technologies has been designed, is being fabricated, and will be flight tested to investigate and quantify the aerodynamic characteristics and performance capabilities of this integrated advanced technology vehicle. The program has the potential to achieve major technological breakthroughs in the areas of structures, aerodynamics, stability and control, and configurational design freedom. All of the technologies being developed will have a direct bearing on future fighter designs. The flight test will develop confidence in numerous individual technologies; make them viable design options for advanced flight vehicles; and reduce the risk, time, and cost associated with their future application.

Analysis indicates that an FSW tactical aircraft could be as much as 25 to 30 percent lighter than an equivalent aft swept aircraft or have equivalent range/payload performance improvements. The excellent low-speed stability and control characteristics, higher lift capabilities of the FSW design, and enhanced transonic performance, available without transonic drag penalties, indicate significant new capabilities where runway denial or operation from small ships is a concern. Wind tunnel tests have documented increased aerodynamic efficiency through improved lift characteristics and reduced drag levels. Large-scale aeroelastically tailored composite wings were designed, fabricated, and tested and have conclusively demonstrated the ability to solve the aerodynamic structural divergence problem. Successful analysis, design, and test of a flight control system with a man-in-the-loop simulation have demonstrated the capability to control the high static instability in the FSW configuration. Final demonstrator design has been completed and fabrication has begun--first flight is scheduled for early FY 1984. A joint DARPA/NASA/Air Force demonstrator flight test is planned that includes transition of data to the Services as part of the flight test program.

4. X-Wing

The X-Wing is a major innovation in vertical takeoff and landing (VTOL) aircraft design which, by stopping the rotor in flight, combines the vertical lift efficiency of a helicopter with the speed, range, and altitude performance of a transonic fixed-wing aircraft. The objective of this effort is to design, fabricate, and flight test a demonstration vehicle with size representative of an operational aircraft. The unique X-Wing capability is made possible through circulation control, a system by which the lift on each rotor blade can be selectively controlled by varying the momentum flux of air flow through tangential slots along each rotor trailing edge. The X-Wing aircraft uses a circulation control rotor and wing system to produce lift and achieve stability and control of the vehicle during all flight modes, including inflight stopping/starting of the rotor wing. Design analysis indicates that an operational X-Wing vehicle would have approximately three times the range, speed, and altitude performance of a conventional helicopter with equivalent payload lifting capability. Such characteristics would greatly enhance all current helicopter missions and could provide flexible seabasing and deployment options for the Navy and a low observables, highly survivable aircraft for the Army and Air Force.

The X-Wing program will demonstrate the synergistic impact of basic advances achieved in such diverse areas as advanced composite materials, FSW aerodynamics, advanced fly-by-wire controls, and active vibration control. In addition, a joint DARPA/NASA convertible turbofan/shaft engine program is being conducted in parallel to demonstrate a new and more efficient propulsion system for the X-Wing VTOL program. This engine technology provides a basis for Service research on related vertical/short takeoff and landing aircraft (VSTOL) concepts.

During the third quarter of FY 1980, a flight assessment of the concept with operational similitude was conducted. During FY 1981, multi-Service application studies, detailed design of a large-scale rotor and control system, preliminary design of operational-size flight demonstrator vehicles, and examination of some 12 different cost-benefit options were accomplished. A low-cost modification of the TF-34 engine is being pursued as part of the convertible fan/shaft engine program to produce both forward thrust and shaft power for the X-Wing vehicle. Successful modification could provide a developed, operational engine for approximately five percent of the cost of a new VTOL engine.

During FY 1982, complementary contractor/DTNSRDC technical programs to extend the database from the earlier subscale to full-scale parameter values will be completed. These data will be used to complete flight demonstrator options: (1) the NASA/Army Rotor Systems Research Aircraft (RSRA) and (2) an Austere Existing Components Aircraft (AECA). Program definitization and contractor downselection are planned for late FY 1982 or early FY 1983. Army, Navy, and Air Force participation in the demonstration program will also be sought.

C. Information Sciences and Communication

1. Computer Science Research

Basic computer science research is developing fundamental new information processing technology that will form the basis for future military systems. Such technology includes research in certifiably secure operating systems and computer architectures to support multilevel security applications, distributed processing for increased functionality and survivability, and system programming environments based on the high-level language, ADA, developed by DARPA. Efforts are also directed toward applying machine intelligence concepts to make information systems easier to use and toward developing architectural alternatives for command, control, and communications (C^3) applications, including distributed message systems, which are at the core of military communication requirements.

The results of this research will form the technological basis for building secure, geographically distributed information systems as well as systems that can exhibit a high degree of intelligent behavior. A distributed file system has been implemented that supports reliable updating of multiple file copies; in FY 1983, it will be extended to deal with the effects of partitioned networks (inconsistent updating). Distributed computing systems for local networks of personal computers are being implemented in FY 1982, and demonstrations are planned for FY 1983. The design of a distributed message system is being completed in FY 1982, and implementation of a capability for handling multimedia messages will begin in FY 1983. An advanced programming environment for distributed systems is being developed. Research results from this program will be transferred to the Services through the various testbed programs.

2. Computer Communications Technology

The packet communication technology program is exploring computer-based methods for controlling, allocating, and accessing a variety of information transmission media (e.g., mobile radio, broadcast satellites, coaxial and optical cable, leased telephone circuits). Packet technology can achieve both highly dynamic demand allocation of transmission resources and efficient utilization of communications. Collections of networks are interconnected to each other by means of small gateway computers. End-to-end security is being developed for these packet-switched networks, and applications such as multimedia message systems and real-time packet-switched voice are being used to test and evaluate the overall inter-network performance.

Packet radio control software is being implemented to permit reliable operation of packet radio network; in FY 1982, development of a low-cost version of the packet radio is continuing for use in large-scale network testing, and prototypes are anticipated in FY 1983. A single processor packet radio security system is being developed and is expected to be certified for use at the Fort Bragg testbed in FY 1983. A new concept for robust satellite networking is being developed based on a system of low-cost satellites in low earth orbit capable of communicating with each other and with the ground using packet radio technology. A highly proliferated satellite system using this architecture would be both survivable and cost effective.

In FY 1982, multi-user voice communications experiments are being conducted over a wideband (3 Mbps) satellite channel using packet voice terminals to demonstrate the feasibility of packet voice multiplexing. Internet experiments will be conducted in FY 1982 including electronic message forwarding, real-time voice, and ARPANET connection to commercial packet-switched networks. In FY 1983, techniques will be developed for gateway congestion control, monitoring, and failure recovery in support of the Strategic C^3 Reconstitution Experiment. Most of the technology developed in this program will be transferred to the Defense Communications Agency (DCA) and the Services through joint technology or testbed programs, but some will be transferred by means of the DoD protocol standardization effort for which DCA acts as the executive agent.

3. Machine Intelligence

Machine intelligence research combines fundamental investigations of the limits of the digital computer's capabilities for intelligent information processing with relevant military concept demonstrations. The program is developing techniques to represent large bodies of specialized knowledge in computers and is using that knowledge on the complex and dynamic problems of situation assessment, planning, and control in the command and control (C^2) environment. Methods are being developed to extend the computer's capabilities in problem solving, natural language processing, and image understanding. The goal is to make it possible for computers to assist or relieve military personnel in complex or routine decisionmaking tasks that are information intensive, personnel intensive, tedious, dangerous, or in environments that can present unexpected situations.

Success in this effort will amplify our ability to interpret and act upon information in many forms--text, imagery, sensor signals, databases--in an intelligent and timely manner. Military applications of the technology include intelligent remote sensors, cartography, adaptive network communications, and a wide range of C^2 situations.

Image understanding techniques are being applied to passive navigation, and the results of image understanding are being integrated into the Cartographic Workstation, which is jointly sponsored with the Defense Mapping Agency. Expert systems research has developed a high-level rule-oriented language, ROSIE, for implementing expert systems; this language has been demonstrated in a prototype system for tactical targeting. Natural language research has focused on systems that are portable to different application domains and that can be instructed in English. In FY 1983, more extensive use of knowledge bases will be applied to data-intensive planning systems and to very high level programming systems. A prototype expert system will be developed to assist in planning aircraft launch and recovery operations. Research will be initiated to apply image understanding techniques to tracking mobile targets and to autonomous navigation.

4. <u>Very Large Scale Integration (VLSI) Research</u>

The VLSI program is developing design methods, innovative computing architectures and computer-aided design, and test/simulation tools to make VLSI technology readily accessible to a much broader community of digital system implementors than had been possible before. A key step in this effort has been decoupling the logic design from detailed consideration of the physics of integrated circuits (ICs) through development of process-dependent design rules that are not tied to any single fabrication line. In a parallel research effort in device physics, materials and fabrication concepts are being explored to increase yield, reliability, circuit density, and speed of operation that will lead to new technological capabilities and smaller feature size for the logic designer.

The circuit design and fabrication times and the cost of providing custom VLSI chips for military systems will be significantly reduced through the use of network-based design methodologies, support systems, and process simulation aids being developed under this program. Various innovative architectures such as multiprocessor systems, language oriented architectures, and high-performance special purpose systems are being explored to exploit VLSI technology. When combined with advanced processing control capability, these will lead to signal/data processing systems having small power, weight, and volume requirements, but with orders of magnitude greater processing capabilities than current large-scale integration techniques permit.

A technique has been developed for restructuring a large area IC after initial fabrication; in FY 1982, it is being used to demonstrate restructurable logic with a 100,000 transistor circuit. A new multicomputer architecture called a "tree machine" will be developed for highly parallel computations, and a working version is being demonstrated in FY 1982. A high performance graphics system that utilizes a custom "geometry engine" chip is being built. Research is ongoing and will continue in the development of VLSI design tools, languages, and systems to aid in synthesizing designs with a million or more gates. In FY 1983, research will continue into the development of highly parallel architectures, including both the processor architecture and the interconnect structure. Techniques from artificial intelligence research will be incorporated into the design systems to assist in managing the complexity of large designs. Fast turnaround fabrication will be provided to the designers, including both NMOS and CMOS technologies and minimum feature sizes of 3 microns.

Important gains have been made in understanding the physical process controlling silicon oxidation. Control of these processes can drastically improve yield, circuit density, and speed. A fabrication process simulation program developed under this program has been made widely available to U.S. industry and university contractors. With the aid of this model, the smallest feature size (0.1 micron) ever fabricated was realized through innovative use of conventional optical lithographic techniques.

5. Submarine Laser Communications (SLC)

The SLC program is a joint DARPA/Navy effort to develop the technology necessary to deploy a critical communication system using blue-green laser transmitters. This communication capability would be provided from satellites using blue-green laser pulses capable of penetrating clouds and water with suitable data rates. Key technology elements are being investigated to determine the best candidate for the first end-to-end communication experiment with residual operational capability, the submarine laser communication satellite (SLCSAT-1). A fully deployed system would provide four payoffs that will substantially enhance our submarine force fighting effectiveness:

(1) Increase robustness and survivability of the SSBN C^3 system.

(2) Provide critical messages to SSBNs in the pre-, trans-, and post-SIOP at depth without compromising the submarine's natural convertness.

(3) Allow the SSN to work most effectively in its own environment while providing it threat and target intelligence info!mation without requiring it to break off its operations to receive data on or near the surface.

(4) Control a broad variety of pre-placed underwater assets, such as minefields and acoustic arrays.

The program has a nearer-term payoff in a tactical airborne SLC capability that will be operationally tested in FY 1984 and 1985.

Major accomplishments include the demonstration of communications from an aircraft through clouds and water to a Navy submarine at appropriate depths. Aircraft and submarine equipments are being developed to support communications down to considerable depths.

The first generation experimental SLC receiver (MARK I) used for the SLCAIR-81 aircraft-to-submarine tests had an 8-cm aperture and a ±15 deg field of view and bandpass of two augstroms, a thousandfold improvement over past equipment. Results of this initial test will permit development of a second generation system that will be compatible with installation on many attack submarines as well as the research submarine. Laboratory tests on the completed MARK II receivers will be conducted. The tactical airborne SLC portion of the program will transfer to the Navy following tests that will be accomplished as part of operational exercises.

For the ground transmitter/reflecting satellite approach, atmospheric compensation for the passive mirror-satellite was thoroughly demonstrated in laboratory experiments in FY 1981. In late FY 1982, the equipment will be installed in the laser beam director at the AMOS optical transmitter station on Maui for a series of uplink experiments. These experiments are expected to demonstrate full compensation of low-power laser beam transmission to a sounding rocket at a 600-km altitude.

For the satellite-borne laser transmitter approach, a competitive design effort initiated during FY 1981 produced a mercury bromide laser that exceeded design goal power and efficiency. A more spaceworthy design was fabricated, which also exceeded design goals. Several other promising blue-green pulse laser technologies are also being investigated in this laboratory. These include xenon flouride, copper vapor, diode pumped neodymium glass slab, and others. One or more of these will be used to develop a 200-watt breadboard with extended life.

During FY 1982, a SLCSAT-1 spacecraft design and laser space worthiness engineering effort were started to allow allocation of scarce resources on those laser techniques that promise early operational application. By the end of FY 1984, sufficient technical and utility data will be available to support a decision on the configuration of the first end-to-end SLCSAT-1. SLCSAT is expected to resolve the remaining technical and operational issues and to have a limited but significant operational capability. A FY 1984 configuration decision could permit development and launch of SLCSAT-1. Technical and operational data obtained from SLCSAT-1 are expected to permit operational system configuration decisions and program transfer to the Navy in accordance with the DARPA/Navy Memorandum of Agreement.

6. Fort Bragg Packet Radio Testbed

Based on a Memorandum of Understanding among DARPA, U.S. Army Training and Doctrine Command, Development and Readiness Command, and the XVIII Airborne Corps, the DARPA/Army data distribution system (ADDS) testbed is a jointly operated system used by the Corps to evaluate experimentally the operational and doctrinal impact of computer communications on the tactical battlefield. A packet radio network at Fort Bragg, North Carolina, is connected through gateways to the ARPANET and provides the Corps with access to selected computing resources to support expe-imental field and in-garrison operations.

This testbed effort is the basis for Army-designed experiments in field use of packet radio to support command, control, and logistics functions. This plan calls for securing the system in FY 1983 to allow the technology to be employed in classified field exercises, which will provide feedback to the Army on operational and doctrinal impacts and information to DARPA on system performance.

The packet radio testbed provides potential tactical users early access to computer communications technology to assess its utility on the battlefield. This testbed effort is also based on the DARPA-developed internetting technology that allows a wide variety of packet networks to be interconnected to support computer communication across and among systems connected to any of the constituent networks. Proven application software (e.g., message and database management systems) as well as experimental applications (e.g., automated airborne load planning, tactical status reporting, and fire control) form the core of the user utilities supported by the combined packet radio and ARPANET system.

The packet radio network at Fort Bragg consists of 20 nodes. The automated, airborne load planning system is being expanded to support additional aircraft types and will be used for official load planning in the 1982 GALLANT EAGLE exercise. Early in FY 1982, packet radios were successfully used to support experiments with automated fire control at Fort Sill, Oklahoma. The system will be secured during FY 1983 when the program is completed.

7. Strategic C^3 Experiment

The Strategic C^3 Experiment is a cooperative project of DARPA, DCA, and the Strategic Air Command (SAC) to demonstrate the feasibility of using information processing technology to support survivable trans- and post-nuclear attack C^2.

The program specifically focuses on reconstituting surviving communications and strategic forces following a nuclear attack in the context of the broader national C^2 mission. An experimental system is being created in which technologies such as airborne packet radio, end-to-end network security, and distributed databases may be evaluated and used to reconstruct selected C^2 capabilities during and after a major attack on this country. Staff at SAC Hq have been introduced to computer communication networking concepts through the installation of ARPANET facilities. The communication range of the existing packet radio technology is being extended for airborne use, and concepts are being developed to facilitate automated support of distributed C^2 using packet radios on the ground and in the airborne command post. The experiment will develop and demonstrate concepts for communications reconstitution to the SAC Hq staff. Doctrine for employing such facilities for crisis management can be established by SAC and tested in concert with technological development.

Airborne experiments with existing low-power packet radios have been conducted successfully at short range (tens of miles) to validate the system's operation with aircraft and to simulate SAC airborne and ground mobile C^2 activities. Airborne testing has been initiated on military aircraft and will continue in FY 1983. A high-power packet radio amplifier will extend the packet radio range to 200-250 miles. The distributed database management system developed for the Advanced Command and Control Architectural Testbed will be extended and utilized to replicate databases for data survivability.

8. Distributed Sensor Networks

The Distributed Sensor Network program is investigating a novel surveillance concept based on the use of packet radio technology to link together multiple low-cost distributed sensors. The goal of the program is to develop a system architecture capable of detecting and tracking individual targets such as low flying air vehicles. A fully distributed, low-cost surveillance system offers a non-nodal, highly survivable system that can be installed, repaired, and upgraded modularly. It appears to be the most effective approach for detecting and tracking low-flying air vehicles, and the architecture can be adapted to many other surveillance situations.

A six-node prototype network with three mobile nodes is being fielded in FY 1982 and will undergo extensive testing and evaluation.

Efficient distributed signal processing algorithms have been developed and are being evaluated in the testbed environment. Distributed machine intelligence techniques are also being developed for situation assessment. The major contribution of this program will be a system architecture and computational algorithms for distributed sensor networks, which will be made available to the services for use in the detection, characterization, and tracking of selected military targets.

D. Land Combat

1. Bistatic Alerting and Cueing (BAC)

BAC is a joint DARPA/Army program to provide timely and accurate alerting and cueing target information to such battlefield weapons as Stinger, DIVADS, SHORADS, and NURADS. This information is currently not available with the requisite timeliness and accuracy via existing C^3 links.

BAC uses existing airborne monostatic radars such as the Airborne Warning and Control System (AWACS) as the illuminating source, with a small, lightweight, low-cost bistatic radar receiver colocated with each fire unit and platoon. In addition to the projected improvement in engagement capability, BAC offers survivability improvements, since no radio transmissions are required from colocated sensors during the surveillance period. It also offers a significant potential for an ambush capability.

The BAC program began in the second quarter, FY 1981. Following successful field demonstrations in FY 1983, the program will transition to the Army for incorporation into its SHORADS-C^2 testbed.

2. Advanced Seeker Technology (Formerly Tank Breaker)

The objective of the Advanced Seeker Technology program is to eliminate the seeker sensor deficiencies inherent in currently fielded command guided or laser beamrider weapon systems.

Fire-and-Forget sensor concepts that have been investigated include two millimeter wave radar seekers and one other sensor. Four additional seeker techniques are being examined during FY 1982. Critical design issues for all seekers include the ability to survive the shock of to provide autonomous target identification, target lock-on, and terminal guidance. In addition, the current phase will demonstrate the seeker capabilities of the other sensor in combination with multimode trackers through helicopter captive flight tests.

The Advanced Seeker Technology program emerged as a result of the success achieved under the DARPA fire-and-forget seeker program. Under that program, the ability to acquire and track targets at significant ranges was demonstrated with field tests in August 1979. Contractors demonstrated this capability with a brassboard seeker. The focal plane array seeker/tracker is considered to be the high-risk component of any weaponization, and successful demonstration of the seekers and trackers should be achieved before weaponization options are undertaken.

3. Critical Node Targeting

The major thrust in the land combat area has been aimed at acquiring and destroying tanks in both the first and second echelon. Over the past several years, anti-armor sensors and weapon delivery concepts have been developed and are well on their way toward proof-of-concept demonstrations. Recent attention has again focused on acquiring and destroying other battlefield targets. These targets, called "critical nodes," consist of a number of functional elements.

In FY 1982, a baseline set of critical nodes was established with their associated data. In addition, a candidate system construct was performed. The system construct clearly identified the sensor and integration technology issues. A series of demonstrations using existing equipment was planned to validate the approach and determine the value of the sensor techniques being examined.

Multiple contracts will be issued to perform competitive. system designs concentrating on the technology issues identified in the current system design. The system design will define the sensor suite and support systems required to operate on the combat nodes already identified. The multiple system designs will then be evaluated, and consideration will be given to proceeding with a demonstration.

4. Digital Radar

A new technology thrust in FY 1983 is the development of techniques to accomplish the functions of RF signal processing and phase shifting, which are normally done in hardware for large phase array radars, using advanced digital computers made possible by recent developments in VLSI and very high speed integrated circuits (VHSICs). These functions currently account for a significant portion of a radar's cost and, because they are hardware, limit the radar's flexibility to accomplish multiple missions or accommodate new technology after it is built. If successful, digital processing and beam forming techniques have the potential for reducing a radar's cost while increasing its flexibility and capability.

5. Armor/Anti-Armor Research and Technology

The Armor/Anti-Armor Research and Technology program was established during FY 1982 by combining objectives of the exploratory development program, Advanced Armor Technology, and the basic research program, Target Penetration Research. Objectives of the new program are: (1) to conduct exploratory development in advanced armor technology and anti-armor munitions technology; (2) to perform basic research and exploratory development in penetration mechanics and in design of advanced focused energy devices and armor systems; (3) to conduct basic research on selected phenomena; and (4) to explore and advance new theories and better scientific understanding of the deformation of materials under conditions of high stress, strain rate, or temperature.

Recently, full-scale demonstrations of specific armor configurations were conducted. These armor configurations were not perforated by projectile impact. Other armor configurations investigated in the laboratory also demonstrated significant performance improvements.

New munitions configurations and alternative designs have demonstrated record performance. Application of these new techniques to weapon systems may enable use of projectiles with significantly decreased flyout time, which may provide a dramatic improvement in gun system hit and kill probabilities.

Current technical activities are jointly sponsored with laboratories of the Army, Navy, Air Force and Marine Corps. Heavy armor system technology will be transferred to the Army. Lightweight armor system technology will be transferred to the Navy and Marine Corps. Advanced warhead techniques will be transferred to the Navy and Army.

6. Electromagnetic Force (EMF) Gun

The EMF Gun program is jointly sponsored by the U.S. Army Armaments Research Command (ARRADCOM) and DARPA. This program explores the technology of accelerating objects using the forces generated by very large electric currents and the magnetic fields they produce. A major goal is to demonstrate the feasibility of this technology for military use by developing alternative laboratory launcher systems, with subsequent technology demonstration prototypes for air defense, armor, or artillery applications. Theoretically, the exit speed of projectiles launched by electromagnetic means is almost unlimited; hypervelocity weapons become feasible with this technology. Since the EMF Gun technique does not require chemical propellants, the vulnerability of the gun platform is significantly reduced. Also, projectile storage volume is considerably less than that required for chemically propelled projectiles.

A major element of the program has been the design and construction of a large laboratory railgun capable of accelerating a projectile to high velocity. This device was completed in FY 1982 and transferred to the ARRADCOM facility at Dover, New Jersey, for use in a wide-ranging research program in hypervelocity ballistics, EMF gun component design, and power conditioning. Simultaneously, separate research efforts are under way to develop advanced helical railguns, plasma pinch accelerators, distributed energy storage systems, and EMF gun power supplies, such as advanced homopolar generators.

Technical efforts in FY 1983 will concentrate on techniques for rapid sequential firing and materials science. In addition, the design for the first major technology demonstrator (probably for a large artillery launcher) will be undertaken based on results of the basic technology program and alternative system concept formulations begun in FY 1982.

E. Naval Warfare

1. Long Haul Array Program (LHAP)

The LHAP is a new initiative aimed at developing critical technologies for substantially improved capabilities in performance in signal processing and data transmission relative to the baseline research conducted at the Acoustic Research Center (ARC). Advances in fiber optic technology are also being pursued based on the results achieved from the Fiber Optic Sensor System (FOSS) effort. Present emphasis is on developing an optically cabled acoustic sensor system operated at a significant distance from a shore processing station, with the option of using either arrays or distributed hydrophones on the wet end. As an adjunct to this program, efforts are under way to establish the feasibility of integrating the data from a number of remotely deployed autonomous sensors.

The program will be conducted in three phases. The goal of the first phase will be a near-term engineering demonstration of a selected sensor configuration with optical data transmission using a prototype cable design developed by the Navy. This demonstration will provide valuable initial experience in fiber optic deployment and durability and in optical telemetry for undersea cables. The second phase will address the design of a fiber optic distributed system and signal processing considerations for the distributed approach. A demonstration in a selected geographical area is planned for phase III, conducted concurrently with a high technology emphasis, which will examine further development of low-loss optical fibers; integration of optical hydrophones into the LHAP system; and deployment, telemetry, and processing of the sensor configuration using fiber optic techniques. A major goal of this system is to permit design of even smaller LHAP component size and weight.

2. Advanced Conformal Submarine Acoustic Sensor (ACSAS)

The objective of the ACSAS program is to develop a new technology base applicable to the optimum acoustic design of sensor systems for installation on submarines. The program is jointly sponsored by DARPA, the Office of Naval Research, and the Office of the Chief of Naval Operations (Submarine Warfare) and is intended to provide array design principles and approaches derived solely from acoustical considerations, and thus to determine an architecture optimized initially for sensor performance as a point of departure for specifying the vessel structure. Substantial performance improvements over existing acoustic sensor designs are anticipated.

Accordingly, the present effort is divided into six main subareas, with parallel programs in each: operational utility, flow noise and outer decouplers, hydrophones and inner decouplers, structural noise propagation, beamforming algorithms, and experiments and noise simulations. In each area, industry/government teams are undertaking coordinated research programs intended to establish baseline design requirements. These will then be integrated into a single overall structural/acoustic design that is now expected to coalesce. The resulting conception will be embodied in a quarter-scale model, which will be designed, built, and evaluated. The program will then transition to the Navy for application.

3. Nonacoustic Antisubmarine Warfare (ASW)

Although acoustic submarine detection techniques are well developed, the increasing ambient noise level of the seas, as well as operational factors, suggest that further advances in acoustic detection will be more complex and thus, more expensive and difficult to implement. Low-cost complementary methods may soon be required. For this reason, alternative nonacoustic approaches to submarine detection have been systematically studied by DARPA and the Navy, both to define and investigate areas of technical promise and to assess the vulnerability of our own units to comparable measures.

The Nonacoustic Antisubmarine Warfare program is an intensive research effort directed toward investigating the feasibility of submarine detection based on observable changes in the ocean environment caused by the recent presence of a target. Successful nonacoustic detection requires a full understanding of the ambient ocean environment, as well as relevant submarine-induced observables. An examination of potential detection observables has been underway for some years, and predictions of sensor signal-to-noise ratios for a variety of national systems have been prepared.

In FY 1980, responsibility for continued investigation of selected ocean phenomena was transferred to the Navy. Current DARPA effort is based on the phenomenlogical data collected and is concentrated on two target detection techniques. Work on the first technique included a major experiment performed in FY 1982 and preparations begun to perform a follow-on experiment for detecting an actual target. Work completed on the second detection technique includes an in-depth analytical study that established preliminary feasibility of the detection concept. This program is closely coordinated with on-going Navy nonacoustic detection research and results and transitioned directly into Navy efforts.

4. Remotely Guided Autonomous Lightweight Torpedo (REGAL)

REGAL is a technology base program to investigate the feasibility of using an offboard acoustic sensor to improve the acquisition range of advanced lightweight torpedoes against threat submarines. The basic concept is that of deploying a horizontal planar array and processor capable of guiding and controlling the associated torpedo by means of a fiber optic communication link. On water entry, the sensor commences passive listening. When the target is detected, the weapon is vectored to an intercept course, receiving guidance commands from the sensor.

Successful development of the REGAL approach will provide a substantial increase in target acquisition range and will permit the torpedo to close with the target. The concept is of considerable interest to the Navy for use with the ASW standoff weapon at long target ranges.

The initial REGAL development effort, emphasizing subsystem feasibility and design, produced a prototype that was tested during FY 1980 to evaluate the performance of guidance and control software. In FY 1981, a series of increasingly complex at-sea experiments were initiated that successively introduced more of the system elements needed for operation. During FY 1982, technique feasibility was demonstrated. The purpose of the program is to exercise a complete system configuration that includes both the prototype array and the fiber optic cable. It is expected that transition to the Navy will occur at the end of the current test series.

5. Ocean Tactical Targeting (OTT)

The purpose of the OTT program is to develop an advanced technology base in information management, communication, and display for use in processing the output data of selected sensors that will provide data of sufficient scope and quality to permit timely decisions by the on-scene tactical commander. The OTT concept is based on a multisensor data fusion center that combines raw, intermediate, and output level data from various sources to generate a comprehensive ocean "scene". This unique approach will maximize the utility of existing sensor systems without interfering with their basic missions and may ultimately provide a fundamentally new basis for designing future sensors with adaptiVe feedback control signal processing that responds to external cueing.

The initial OTT research tasks in the areas of sensor level data fusion, artificial intelligence, sensor cueing/feedback control techniques, and sensor level data base management were largely in preparation and support of a major at-sea experiment that was conducted in late FY 1981. A prototype system configuration will be developed and both equipment and software will be prepared for a major Fleet demonstration of the concept. The OTT program, which is closely coordinated with the Navy's research in this area, is a joint DARPA/Naval Electronics Systems Command project, and is scheduled for transition to the Navy Integrated Ocean Surveillance (IOS) program.

6. Fiber Optic Sensor Systems (FOSS)

The FOSS is a joint Navy/DARPA directed research effort to exploit the effects of various energy fields on the optical signal in a fiber waveguide. The program seeks to improve passive detection, localization, classification, and tracking of enemy weapon platforms using an entirely new class of multifunction (i.e., acoustic, magnetic, thermal, and rotational) sensors with the potential for direct coupling to optical cabling and high-powered optical processors. These sensors will be geometrically flexible, lightweight, low-cost, reliable, extremely sensitive, and invulnerable to electromagnetic/radio frequency (RF) interference and electromagnetic pulse.

To date, the program has (1) demonstrated better than sea-state zero equivalent noise performance in an acousto-optic glassboard (i.e., optical breadboard) sensor by replacing laboratory optical components with state-of-the-art optical devices; (2) improved minimum detectable acoustic pressure in fibers by 2-1/2 orders of magnitude; (3) enhanced the acousto-optic coupling coefficient of coated fibers by more than an order of magnitude; (4) demonstrated laboratory magneto-optic sensor capability with 5 db of theoretical prediction; and (5) demonstrated unique opto-electronic components for generic sensor applications.

The DARPA-funded materials research effort, conducted by the Tactical Technology Office and the DARPA Defense Sciences Office, is being transitioned to the Navy's FOSS exploratory development program in FY 1982. DARPA sponsorship will continue, however, for the development of a towed array system using both fiber optic sensors and a telemetry system. Initial field tests of the feasibility demonstration model will take place in FY 1983 with follow-on development in FY 1984 and 1985.

F. Nuclear Test Verification

1. Seismic Data Center Activities

Technology advances in seismic instrumentation allow large dynamic range recording of broadband signals. To realize the significant increase in the information that can potentially be extracted from these signals, it is necessary to develop new automatic data analysis algorithms and management techniques, since increased data volume renders existing methods obsolete. New processing techniques are particularly important for supporting deployment of special monitoring stations for treaty verification purposes, especially since negotiations for future nuclear test ban treaties are likely to provide for international exchange of seismic data. Preliminary studies by a group of experts convened under the U.N. Conference of the Committee on Disarmament have recommended establishing international data centers for this purpose in Washington and Moscow. At present, no facility exists that can meet the technical requirements for effective collection, processing, and analysis of seismic data from a global network of diverse stations. An advanced seismic data center is being developed to support the needed research in signal processing and to serve as a prototype system that can be expanded to support an international test ban treaty, if required.

The accomplishments in this program include development of new signal processing techniques involving automated signal recognition and characterization and a demonstration that those techniques have the potential to replace the need for human visual analysis. A data processing facility to test these concepts has been designed and a prototype system has been used to support U.S. experiments in international data exchange anticipated under future test ban treaties.

2. Yield Estimation Research

This program supports basic research to improve the U.S. capability to estimate the yield of foreign underground nuclear tests; this is necessary to assess Soviet and other foreign nuclear weapon development programs and to monitor Soviet compliance with the Threshold Test Ban Treaty (TTBT), which limits tests to yields of 150 KT or less. The research is concerned with fundamental questions about the structure of the earth and the behavior of geologic materials, especially in the highly deformed region immediately surrounding a nuclear explosion.

Developing a quantitative understanding of the magnitude of these effects and improved procedures to account for them are important objectives of this research. Other objectives are to develop methods to exploit geophysical information like that to be exchanged under the terms of the TTBT and to determine what additional verification measures would, if negotiated, reduce the yield uncertainty.

Current research efforts are directed toward correcting for systematic differences and developing techniques that use less susceptible seismic data features. The program to address these problems includes small-scale laboratory and field experiments, as well as theoretical modeling studies, to quantify phenomenological effects. These sensitivity studies are being combined with information from studies of the geological and geophysical setting of U.S. and foreign explosion test sites to determine the effect on the seismic signals and to guide development of more accurate seismic yield estimation procedures.

DARPA scientists maintain close technical liaison with the Air Force to facilitate transfer (to operations) of technology developed in this program.

3. Marine Seismic System Demonstration

The objective of this program is to enhance the U.S. capability in areas that are inaccessible to land-based systems by developing a Marine Seismic System (MSS) for deployment in broad ocean areas. The MSS, which consists of a high quality sensor and associated signal conditioning electronics, is suitable for long-term emplacement in the deep ocean floor. The seismometer sensors will be emplaced in boreholes several hundred meters deep that are drilled into firm bedrock to achieve the maximum isolation from natural background noise. The program will demonstrate the feasibility of installing and operating a state-of-the-art seismic detector in a borehole in the deep ocean floor and will collect sufficient data to determine the likely improvement to seismic detection capabilities if such a system were operationally deployed.

The MSS incorporates advanced seismometer sensor technology developed under a parallel DARPA research program. Application of the data to detect, locate, and identify underground explosions will depend on analysis techniques developed under the ongoing DARPA program in seismic source and signal propagation theory and advanced data processing.

The program was initiated in late FY 1979, and the design for the system was completed at the end of FY 1980. Techniques and specialized equipment required for emplacing the instrument in boreholes in the ocean floor using the drill ship GLOMAR CHALLENGER were tested in the mid-Atlantic in March 1981. This successful experiment verified the operation of the special equipment and gathered initial data on seismic noise reduction in this environment. The data showed that the signal-to-noise ratio was improved as predicted. The sensor and associated electronics required for data acquisition and storage are being developed for deployment of the system in the summer of 1982. Initial recovery of the data and analysis will begin in FY 1983.

G. Science Initiatives

1. Rapid Solidification Technology

Rapid solidification technology applies to alloy systems that are cooled very rapidly from the molten state to a solid at rates ranging from one thousand to one million degrees per second. Methods for achieving these high solidification rates include atomizing the liquid to fine droplets that produce alloy powder; impinging a stream of molten alloy against a rotating, cooled cylinder, which produces solid alloy ribbon or flake; and melting a thin surface layer by a laser or an electron beam, which rapidly solidifies onto the underlying solid. Such techniques have been applied to aluminum alloys, high-temperature nickel-base superalloys, and high-strength steels.

The principal benefit of rapid solidification is the enormous improvement in alloy chemical homogeneity. When compared with conventional ingot processing methods for nickel-base superalloys, this homogeneity yields alloys with an increased temperature capacity of $200^{o}F$.
Other positive effects include very strong aluminum alloys that have specific physical characteristic properties of titanium, load-bearing

steels capable of carrying tremendous loads, and alloys with greatly improved characteristics for application to batteries, magnets, and catalysts.

DARPA-sponsored efforts in rapid solidification technology have resulted in a superalloy that contains no cobalt and has an over 20-times increase in high-termperature creep resistance; aluminum alloys that have demonstrated a 30 percent increase in specific stiffness and a 100-times improvement in life under cyclic stress; and stainless steels that contain aluminum instead of chromium. DARPA expects to soon demonstrate a scale-up of high specific stiffness aluminum alloys and to expand exploration of new rapid solidification techniques as applied to other high-performance alloy systems. The Air Force and the Navy have initiated programs in rapid solidification technology, and it is expected that several DARPA technology developments will be transferred to these programs and to other Service advanced technology demonstration efforts.

2. Particle Beam Technology

Charged and neutral particle beam concepts are being considered for applications in a variety of advanced weapon systems. The impetus for interest in these concepts is the expectation that particle beams can deliver large amounts of energy at close to the speed of light and lethally deposit them deep within a target with high coupling efficiency.

The key issue for the development of charged particle beam concepts is the capability to propagate electron beams in the atmosphere. Theoretical models for electron beam propagation have been developed and verified by low-energy experiments at subatmospheric densities. However, no electron accelerators of sufficient energy and current have previously been developed in the United States that would permit critical propagation experiments to be performed at full atmospheric densities. Such experiments are essential. Therefore, major objectives of the Particle Beam Technology program are to develop the required high-energy accelerator and to demonstrate the feasibility of predictably propagating powerful electron beams to distances of military interest. Extrapolations of low-energy beam propagation experiments have indicated that an electron beam having substantial energy is necessary to demonstrate propagation at full atmospheric densities. Construction of the Advanced Test Accelerator (ATA) was initiated by DARPA at Lawrence Livermore National Laboratory in FY 1979 to provide such an electron beam. The Experimental Test Accelerator (ETA), which represents the front-end for ATA, has been utilized to demonstrate the efficacy of the ATA design and to perform low-energy propagation experiments.

When completed, ATA will be the free world's most powerful accelerator. ATA performance parameters are greater than the minimum expected to be required for stable propagation of electron beams at full atmospheric densities. Initial experiments will evaluate a propagation mode suitable for experimental ranges. The beam parameters will be modified in subsequent tests to provide a preliminary assessment of propagation modes potentially capable of operationally acceptable ranges.

Electron beams, which deliver large amounts of energy at velocities near the speed of light and deposit them deep within a target, offer a wide range of potential applications. Theoretical and experimental research programs directed toward demonstrating the propagation of charged particle beams in the atmosphere have been under way for over 20 years.

These efforts have been limited to demonstrations of stable beam propagation at low pressures because of a lack of accelerators capable of providing high-energy current and pulse repetition rates at sufficient beam energy. Sophisticated theoretical models have extrapolated these data to predict the beam parameters required for stable propagation at atmospheric air densities.

In FY 1983, charged particle beams research efforts will focus on achieving full operation of the ATA and on developing the models and diagnostics required to interpret ATA propagation experiments.

The critical issue for neutral particle beam system concepts is successful achievement of the system elements that contribute to the final beam divergence, and thus, to the maximum effective range. The Accelerator Test Stand, which will operate with considerable ion energies and currents, is being constructed at Los Alamos Scientific Laboratory. This device will be used to obtain initial beam divergence data.

DARPA is currently working closely with all three military departments to plan important experiments and to prepare for transition, depending on experimental results and evolving application requirements.

3. Very Large Scale Integration (VLSI) Research and Three Dimensional Materials Systems and Devices

Present microelectronic circuits that are based on two dimensional structures are reaching the state where signal delays along the metal connections or busses on the chip are the limiting factors in the integrated circuit processing speed performance. In addition, these busses consume 60 percent to 80 percent of the circuit area. Further progress in chip complexity and performance will require new architectures and innovative uses of the third dimension (both for interconnects and device design). Initial steps in this direction have already shown that DARPA's program is feasible, as for example, the demonstration of the first three dimenstional silicon device structure (a single gate CMOS cell formed by directed energy processing).

4. Staring Infrared Sensor Materials

Most focal plane concepts for the late 1980s and early 1990s are based on large area, monolithic or hybrid mercury cadmium telluride (HgCdTe) sensors. These structures will require HgCdTe starting material qualify equal to or at least approaching that of present-day silicon (Si) if more than one-of-a-kind laboratory curiosities are to be fabricated. Defect densities in present day HgCdTe are higher than in Si. The Staring Infrared Sensor Materials program, initiated in FY 1979, is exploring techniques to realize this needed increase in HgCdTe quality. To date, the program already has demonstrated the feasibility of growing thin HgCdTe films on dissimilar substrates, discovered an unexpectedstabiliiy of damage-free cleaved surfaces, developed a highly precise characterization technique for measuring HgCdTe uniformity, and been the catalyst for a renaissance in basic research on IR sensor materials in the academic community. The feasibility of growing large area thin HgCdTe films by several different techniques will be determined.

5. Electronically Active Polymers and Monomolecular Films

Electronic polymers are an entirely new class of materials whose impact on DoD undoubtedly will be very broad. The present seed program already has led to the possibilities of a new class of lightweight, high-energy density batteries, organic "wires" having near-metallic conductivity but weighing 1/5-1/10 that of metals, and frequency doubling crystals having figures of merit 10-40 times that of today's best materials (e.g., $LiNbO_3$). These materials, invented in DARPA's university-based research programs, have been licensed by industry and are being further developed for specific applications.

Monomolecular and multilayer films also are organic in nature and are formed by the classical Langmuir-Blodget dipping technique. Recent research in Europe (principally England and France) has demonstrated a range of possible electronic applications, including thin dielectric films of great structural perfection, control of Schottky Barrier voltages, flat panel displays, and high resolution lithographic resist material for electron and X-ray lithography (the last has been substantially advanced in the present DARPA research program). There is virtually no research in monolayer and multilayer molecular film technology (government or industrial) in the United States. This effort will explore development and applications of such films to devices of potential importance to DoD.

6. Low-Power, Radiation Tolerant Gallium Arsenide (GaAs) Integrated Circuits (ICs)

The potential impact of GaAs low-power, radiation-tolerant ICs continues to grow. This year, a large scale integration GaAs IC has been subjected to an ionizing radiation dose and showed little or no sign of deterioration. The complexity of this circuit is more than an order of magnitude greater than that of circuits previously tested, which also withstood the exposure. Previous experience with silicon ICs indicated that total dose tolerance decreased as circuit complexity increased. The smaller GaAs ICs also have been tested for transient radiation effects and have shown exceptionally promising resistance to upset. Based on these total dose and transient radiation effects measurements, DARPA has initiated a development of a low-power, radiation-tolerant GaAs memory IC in support of space-based signal processing systems. The GaAs materials and processing capabilities established by DARPA's Defense Research Sciences program in FY 1977-FY 1981 are cruicial to fabricating GaAs ICs that will withstand the environmental and power dissipation demands unique to space applications.

7. Fiber-Optic Sensor Systems (FOSS) and Fiber-Optical Materials

FOSS and Fiber-Optical Materials is a joint Navy/DARPA research and exploratory development effort whose goals are to: (1) fabricate and demonstrate passive sensors made of optical fibers with exceptional sensitivity for motion and acoustic, magnetic, and other energy fields and (2) identify and develop ultra-low optical loss glass compositions that could be used in optical fiber links hundreds or thousands of kilometers long, without the need for repeaters. Such low-loss fibers may also provide the opportunity to optically transmit power to distant locations. Achieving these goals will provide revolutionary new capabilities for passive detection, localization, classification, and tracking of weapon platforms. During the past year, the program has demonstrated a brassboard acoustic sensor module that passed all environmental tests required of operational hydrophones and had the predicted acoustic sensitivity.

Based on this success, the Navy and DARPA are jointly assessing the performance of a towed acoustic sensor array. The research on ultra-low-loss optical fiber materials has led to the discovery and development of a complex fluoride-based glass composition that has mechanical properties suitable for drawing into long length fibers. Current efforts are directed toward developing advanced methods of glass purification to determine whether or not the theoretical very low optical loss can be realized.

8. Ballistic Intercept Missile

The Ballistic Intercept Missile program will develop a nonnuclear weapon capable of killing a number of targets. System concepts were identified in FY 1980-1981. These concepts are being carried through FY 1982 to a detailed design, when one will be selected for development and test. A captive flight test demonstration is planned. A decision to continue development or to transfer technology to the Air Force will be made based on the captive flight test results.

H. Space Defense

1. Advanced Laser Optics

The Advanced Laser Optics program supports new and innovative ideas in the areas of optics and sensors and control systems for adaptive optics subsystems. A major element in this program is the Large Optics Diamond Turning Machine (LODTM) that is being developed and constructed at the Lawrence Livermore National Laboratory for precision fabrication of optical components. This program contributes directly to the optics technology required by the Large Optics Demonstration Experiment (LODE) program and the Chemical Laser Device Technology Demonstration program (ALPHA).

The FY 1981 program provided the assessment of a new imaging tracker and completion of a breadboard support system demonstration. The development of suitable mirrors proceeded through the conceptual design review (CDR) stage into prototype fabrication. The LODTM program completed the design of the machine and started construction of the building to house the machine. In FY 1982, the second round of optics development is being completed. Prototypes of new high-performance primary optics will be completed, and the analyses of beam control optics will be extended. The LODTM building will be completed and occupied this year, the machine will be installed, and assembly will begin. Efforts to support the LODTM are being initiated. Planned analysis and modeling efforts will concentrate on performance of the LODE equipment; a program aimed at the actual measurement of vibration inputs will be initiated. Performance and thermal distortion tests will be completed on newly developed optics. The LODTM will be completed and acceptance tests will be performed in preparation for fabricating actual ALPHA optics. High-power component tests will be completed and, based on the results, new developments will be initiated.

2. Acquisition, Pointing, and Tracking

Advanced space-based laser weapons designed to engage strategic aircraft and ballistic missiles will require acquisition, tracking, and pointing performance levels beyond those that are currently projected for the Talon Gold demonstration. Substantial improvements in pointing precision and the development of rapid acquisition and retargeting capabilities will be necessary. In response to these projected requirements, DARPA has initiated advanced technology programs in the areas of acquisition and tracking, target identification, aimpoint selection, and precision pointing mounts.

Between FY 1980 and FY 1981, the acquisition and tracking technology base development included the evaluation of a technique for rapid acquisition and tracking. Improved algorithms for tracking faint targets have also been developed. Studies conducted in FY 1980 showed that simple aimpoint selection techniques can substantially increase the lethality of wepaon systems. In FY 1981, DARPA initiated a program to evaluate techniques for real-time aimpoint selection and track maintenance of strategic aircraft. Also during FY 1981, a brassboard model of an advanced precision pointing mount was completed. In FY 1982, additional acquisition and tracking brassboard activities will be initiated to continue the development of precise, rapid retargeting capabilities. Emphasis in FY 1983 will be placed on inertial reference techniques to provide substantially improved beam stabilization and fire control techniques to improve the engagement timeliness.

3. Chemical Laser Technology Program

The objective of the Chemical Laser Technology program is to resolve the critical chemical laser device efficiency, wavelength, and waveform. In addition to providing the technology base for the ALPHA demonstration project, this program is continuing to advance component technology with scaled laboratory testing of advanced resonator concepts for both the near-term and the far-term chemical lasers. Such testing includes evaluation of optical-transfer devices and resonator concepts. In FY 1982, advanced resonators and performance models for chemical lasers are being investigated in addition to completion of testing for new resonator concepts on test beds. Gain medium and resonator performance model validation are under way with data acquired with the test beds. A novel resonator development for chemical lasers will be completed. Advances will continue improving efficiency and fabricability in small-scale nozzle tests and establishing the saturation parameters needed to predict scaling to megawatt powers.

4. Visible Laser Program

The objective of the DARPA Visible Laser program is to develop the technologies required to demonstrate the feasibility of using long-range, ground-based, and eventually space-based visible lasers for strategic applications. The earliest application would utilize visible lasers directly to negate satellites at long ranges from ground-based visible lasers to provide defense against strategic aircraft, to defend U.S. satellites, and, in the longer term, to provide ballistic missile defense (BMD).

There are two major thrusts of the Visible Laser program. Both of these lasers are projected to be scalable with high electrical efficiencies. Major accomplishments of the FY 1980 program included subscale demonstration of many of the repetitive pulse technologies and preparations for proof-of-principle experiments to demonstrate the predicted high efficiency. In FY 1981, a very high energy was extracted from one recently fabricated laser, thereby confirming predictions, and efforts were begun to demonstrate closed cycle operation. A high energy laser device will be used for experiments in support of the SLC program. A subscale, medium energy laser program to demonstrate the integration of all of the required technologies will be initiated with two competitive design contracts. Work will begin on operating the high energy laser in a repetitively pulsed mode. The feasibility of the pulsed power portion of the modification will be demonstrated. An average power upgrade will be initiated. Laser experiments that determine the feasibility of high efficiency operation will be completed, and accelerator modifications will begin for operation in the visible spectrum. Laboratory experiments to develop the atmospheric turbulence correction necessary for a specific application will be initiated. Technology development for space optics either in conjunction with a high-power, ground-based visible laser or for space-based visible lasers, will be initiated.

5. Talon Gold

Significant improvements in fire control and precision beam direction must be achieved to enable a laser weapon to be effective in space. The objective of the Talon Gold program is to develop and test the requisite capabilities including target acquisition, tracking, and precision pointing. The space test activities will consist of a low-power laser pointing experiment that utilizes a scaled acquisition, tracking, and pointing payload. The experiments will be conducted as a sortie flight of the space shuttle. The test program will utilize both high-altitude aircraft and space targets to obtain realistic target kinematics, signature, and backgrounds. The performance goals of the experiments represent a significant improvement over current capabilities for pointing and tracking. This experiment will establish the feasibility of achieving the fire control performance levels required for operational missions and will provide the necessary database for designing a first generation laser weapon system.

The Talon Gold program utilizes laser radar techniques developed under its technology base program to achieve the required tracking precision. The potential of this approach was evaluated in a ground-based laser radar tracking program at the MIT Lincoln Laboratory, where enhanced signature satellites were tracked with high precision. Extensions of this technique in conjunction with improved inertial reference platforms, sensors, and alignment systems recently developed by DARPA and Service laboratories are expected to enable Talon Gold to achieve the required performance levels.

The Talon Gold program was initiated for DARPA by the Air Force Space Division in FY 1979 as a competitive conceptual design effort. The contractors' design concepts were presented at a system design review (SDR) held in early FY 1980. Both contractors continued their activities through the preliminary design phase, which was expanded to include brassboard hardware development. The preliminary design review (PDR) was conducted in FY 1981. In FY 1982, a single contractor was selected for hardware development, based on their proposals, the PDR, and their brassboard activities. A total program interim design review will be held in mid-FY 1983 to define the experiment content. The Talon Gold experiment is now scheduled to be launched as part of the Air Force Space Test program. The program includes two flights. The results of this demonstration will be transferred to the Air Force and Army by direct dissemination of analyses of the design requirements, future system approaches, and potential performance of operational systems.

6. ALPHA

ALPHA is a high-power, chemical laser, ground-based demonstration intended to establish operational feasibility. Emphasis in this effort is on the ground-based test and evaluation of a low-pressure, high specific fuel efficiency, chemical laser scalable to high power levels.

Near-term mission applications of this program center on the demonstration of the laser device technology required for a long kill range space laser weapon to defend and attack satellites. Other applications of this project, which forms the laser device technology portion of the "Space Laser Triad," include defense against strategic aircraft and ballistic missiles. The High Power Chemical Laser program provides the technology base support for the ALPHA demonstration. The design concepts for ALPHA integrate the high-efficiency, chemical laser nozzle technology with other subsystem and alighment components developed in the technology base program.

Nozzle technology scaling module tests completed in FY 1979 confirmed the feasibility of achieving high fuel energy with high-power chemical lasers. These tests provided the critical nozzle performance data to initiate preliminary design of the ground-based device in early FY 1980. Conceptual designs were successfully concluded in mid-FY 1980, when two of the three contractors were selected to proceed to preliminary design of the ground-based demonstration laser. The engineering drawings for the laser, with their supporting analyses, were completed in FY 1981 for the gain generator, optical resonator, and exhaust manifold assemblies. These efforts concluded with a PDR for both contractors in the fourth quarter of FY 1981. A single contractor was selected in early FY 1982 to proceed to detailed design, fabrication, and testing. In FY 1983, the detailed design of laser subsystems will be completed with a critical design review. Subsequently, fabrication of the laser will be initiated, the detailed design of the test facility will be initiated, and long-lead materials will be ordered. This program will transition to the Air Force when system feasibility is demonstrated.

7. Large Optics Demonstration Experiment (LODE)

The LODE will demonstrate critical beam control and optics technology in a series of ground-based experiments that simualte the space environment. LODE is one of the "Triad" of DARPA laser programs that will collectively demonstrate the key technologies essential for space-based chemical laser weapons. These technology developments, initially targeted at supporting relatively near-term system concepts will in large part provide technology scalable to even more capable laser weapon systems. This program builds on previous accomplishments by the Air Force and Navy in high energy laser (HEL) beam control, but extends the technology significantly to larger size, higher performance levels, and the space environment. Specific program objectives include demonstrating the ability to manufacture a large aperture mirror that includes complex interactive control systems, and energy management in an overall beam control system that yields high optical quality and is consistent with the required pointing accuracy in a simulated operational environment. The actual demonstration will be conducted in ground-based facilities using low-power laser and simulator techniques to establish with high confidence the required beam control performance. The advances contemplated in this program will, when coupled with device and tracking and pointing developments, make the strategic applications of space-based HEL systems possible.

The FY 1981 program continued major efforts in the conceptual design of the LODE demonstration and the initiation of the design program for primary mirrors. It was decided to design a full-scale prototype optics. This effort will continue to advance the technology of the concepts that have real growth potential for larger diameters and will yield information on the impact of the mirror design on beam control and beam expander system designs. The design study for LODE has achieved major milestone objectives in completing the definition of system flowdown requirements, mirror requirements, and the PDR on the conceptual design of the LODE experiment. This has established the future scope of the program based on both technical requirements and available resources. After proposal evaluation, a single contractor source will be selected and the detailed design of LODE will be initiated. Simultaneously, detailed design of the LODE primary mirror will be under way with completion of the PDR planned by mid-FY 1983.

The major FY 1983 event in this program will be the completion of the preliminary design of the LODE experiment and risk reduction breadboard activities at the component or subsystem level. The preliminary design of test and simulation facilities will also be completed. A late-year PDR will allow a detailed screening for the engineering concepts proposed and thorough analysis of system trades. For the prototype, optics the brassboard subscale mirror will be used to validate the various fabrication techniques for the full-scale mirror. During the year of the actual LODE hardware demonstration, the mirror and beam control technology will be transitioned to the Air Force for ground-based integration and ultimate space demonstrations.

I. Space Surveillance

1. Space-Based Radar

This effort is designed to eliminate the technical risk associated with a space-based, phased array radar. Developments have been in progress since FY 1979 in critical technology areas. The program is oriented to complete silicon component technology and GaAs component technology and to consider major subsystem development. This technology will contribute to development of a radar that can detect and track bombers and ships. Presently, several major milestones have been achieved: an antenna membrane has been developed and tested, and significant breakthroughs have been achieved in weight and cost. These results have made it possible for this technology to be applied in areas other than space-based radar. Therefore, this technology is being transitioned to the Services as it develops.

2. High Resolution Calibrated Airborne Measurements (HI-CAMP)

The HI-CAMP sensor is an advanced IR measurement system designed to make high resolution (spectral, spatial, and temporal), two dimensional measurements of earth backgrounds and mobile and stationary air, sea, and land targets.

The HI-CAMP sensor was the first proof-of-principle for staring mosaic IR-sensitive charge couple device (IRCCD) sensors and has measured the IR signatures of aircraft, surface, and sea targets. Many of these measurements were coordinated and supported by the Services. A new, more sensitive instrument will be designed and developed to demonstrate substantially improved performance. The new system is being designed to measure aircraft at long ranges, medium-range targets, and to support the Teal Ruby experiment as an airborne, multispectral calibration instrument. The new focal plane will be more sensitive with improved uniformity. An improved correlation tracker will allow the sensor to be operated under day or night conditions.

The information provided by the HI-CAMP sensor is vital to DARPA's advanced surveillance programs such as the Teal Ruby experiment, the Advanced Sensor Demonstration program, the HALO Technology program, and the Joint (DARPA/Air Force) Technology program. In addition, this effort will continue to provide the aircraft and background IR data supporting the Service IR surveillance activities, such as the Navy Integrated Tactical Surveillance System (ITSS) and the Air Force/Navy Infrared Search and Track (IRST) program.

The technology of the HI-CAMP sensor and the data measured are being transferred to the Services via technical direction meetings, reports, and presentations at a classified symposia.

3. Monolithic Extremely High Frequency (EHF) Integrated Circuits

A challenging approach to space systems' signal throughput problems is to develop EHF phased array antenna technology that will operate at high frequencies, e.g., the 94-GHz and perhaps even the 140-GHz atmospheric windows. The higher operating frequency will greatly increase bandwidth, reduce antenna size requirements, and with phased array processing provide for immunity from jamming as well as a degree of security. The materials and device problems of achieving 95-GHz transistor structures suitable for phased array use are substantial, but recent advances in molecular beam epitaxy, metal-organic chemical vapor deposition, and electron and ion beam processing technologies provide a research opportunity in EHF devices that can result in an advance of significance to space-based electronics. In FY 1982, DARPA initiated efforts to explore new EHF device concepts made possible by these advances in materials processing.

4. Space Signal Processing

The Space Signal Processing program is designed to develop an advanced onboard signal processor (AOSP) that is optimized to support military space missions through the year 2000. The processor will have multi-mission capability; will be power, weight, and volume conservative; and will be able to survive in space without performance degradation. For surveillance missions, this processor is designed to process the raw data onboard the satellite and to relieve the communication system of the need to transmit large amounts of data, thus greatly decreasing the space resources allocated to the communication function. For communications missions, this processor will enable considerable sophistication in several technical performance parameters--all of which will protect the communication system from jamming and from other electronic countermeasures.

This processor was initially designed to process raw data for space-based radar. As the design matured, it became clear from analyses that the design was general enough to encompass all of the known space signal processing requirements foreseen through the year 2000. The design of the processor has been completed at both the register and gate levels and includes several levels of support simulation. Breadboard construction has been started on the array computing element, which is the building block in the AOSP design. Communication between array computing elements has been demonstrated in hardware. Efforts have also started on GaAs circuit development to provide greater capability and higher radiation resistance.

This program is a jointly funded DARPA/Air Force effort as part of the Air Force Space-Based Radar program.

5. Teal Ruby Experiment

Teal Ruby is a space-based experiment, incorporating first generation DARPA advanced IR technology, which will be launched by the shuttle in early FY 1984 and operate in space for a minimum of one year. The sensor utilizes the staring concept for detection of targets. Teal Ruby is the primary payload of the Air Force Space Test Program satellite P80-1. The DARPA Infrared Technology program is based on the concept of multimission strategic surveillance from high-altitude space platforms. The stabilization and pointing systems of the Teal Ruby experiment are designed to emulate the geometry of such a platform from orbit. Because of the lower altitude, a modest sized telescope and a small staring focal plane can be used. Teal Ruby's primary mission is to provide a proof-of-concept for spaceborne detection. In addition, Teal Ruby will provide proof-of-concept for other multimission surveillance functions and space quality first generation advanced surveillance technology.

The Teal Ruby Experiment was made possible by technology base programs at DARPA and the Services. Development of the surveillance sensor was conducted by DARPA under the STARE program and the HALO technology program. These developments made feasible the fabrication of the Teal Ruby sensor as the first large-scale implementation of this advanced sensor technique. The DARPA HALO technology program developed the lightweight techniques used to design and manufacture the Teal Ruby telescope.

During FY 1981, the critical sensor subsystem components were tested and inventoried for flight use. Key qualification components were fabricated, and delivered to the prime contractor. Integration of the qualification testing will be completed; and the flight model sensor will be assembled, tested, and delivered for integration to the Air Force P80-1 satellite for an FY 1984 launch.

The Teal Ruby technology and experiment results will be transitioned to several Air Force programs. The mission planning activities have been increased to evaluate Teal Ruby for use in supporting several DoD programs.

6. Advanced Sensor Demonstration

The Advanced Sensor Demonstration program is an aggressive technology development for second generation DARPA IR staring technology. The development is planned to allow for detection and tracking of selected targets. The preliminary concept of the sensor incorporates optics, detector, and signal processing that controls the system and can convert sensor data into target track information for use by small ground terminals.

The primary thrust of the effort is to provide a demonstration of subsystem technology to establish sufficient confidence in the concept of advanced IR surveillance for multiple military missions. The demonstration of various DARPA technologies designed into experimental subsystems in an integrated surveillance platform is essential to decision milestones for future operational military systems.

Technology development to support this experiment was initially carried out under the DARPA Space Surveillance and Advanced Optics Project. Component developments were initiated and demonstrated under the HALO technology program. This demonstration program was made possible by major technology milestones achieved in FY 1978 and 1979.

A preliminary demonstration concept has evolved, and the system requirements review, considering all potential surveillance missions, has been completed. Significant intermediate milestones in the cooler, processor, and detector array development programs have also been achieved. Detailed engineering will be pursued for a ground demonstration SDR.