Appendix D. Defense Technology Objectives
Completed From FY96–FY99

Information Superiority

A.09 Semiautomated Imagery Processing ACTD

The goal of this DTO was to significantly improve an imagery analyst's ability to provide accurate, timely situation awareness to the warfighter. This system allows analysts to exploit the output of an increasing quantity of imagery collection assets. Field tests commenced in March 1997 with the XVII Airborne Corps using the Enhanced Tactical Radar Correlator ground station as a radar interface. There were also several subsequent successful XVIII Airborne Corps evaluations during field exercises. System residuals were provided to the Army and Air Force in FY99.

A.16 Navigation Warfare ACTD

The NAVWAR ACTD successfully developed and demonstrated three prevention (jamming) capabilities and an enhanced handheld GPS receiver during the conduct of eight demonstrations. In addition, a NAVWAR Concept of Operations was developed and a number of GPS vulnerabilities were observed and identified for the warfighter. All legacy prevention assets will be transferred to the 746th Test Squadron where they will be made available to the warfighter for operations and exercises by U.S. Joint Forces Command (JFCOM). The continued development and demonstration of the avionics protection (antijam) receivers will be sponsored by JFCOM and conducted by the Joint GPS Combat Effectiveness joint test and evaluation.

A.17 Joint Task Force ATD

The technologies developed under this DTO will be used to support the crisis planning, monitoring, and execution at USCINCPAC through the Advanced Course Of Action ACTD (US-CINCPAC J30OPT is the operational sponsor of this ATD). The services, development tools, and a model-driven composability process developed under this ATD represent a major step forward in the development of efficiently implementing and managing complex, distributed, object-oriented systems for industry and the DoD. The tools and services resulting from the JTF ATD will and have provided for rapid experimentation with various architectures and new technologies focused on distributed collaborative decision aids and crisis planning applications. The JTF ATD project has created a revolutionary model-driven approach to the composition of software components, and demonstrated this ability with a number of services within the Common Object Request Broker (CORBA) domain for the ACOA ACTD, JL ACTD, and JFACC projects. DISA’s Advanced Information Technology Services Joint Program Office (AITS JPO) continually evaluates the tools, services, and model-driven code generation process for possible adoption by the DII COE. The JTF ATD project’s model-driven approach to software generation has also been extended to other domains (e.g., Enterprise Java Beans (EJB), the Biological Warfare Defense (BWD) and National Cancer Institute (NCI) projects, which demonstrates this approach's extensibility. Use of the tools, services, and model-driven code generation process from the JTF ATD project has provided for the rapid development and minimum maintenance costs of complex distributed collaborative applications in support of CINCs’ and JTF commanders’ warfighting requirements, and is directly applicable to industry.
A.24 Unattended Ground Sensors ACTD

The UGS ACTD evaluated the military utility of two distinct unattended ground sensors: the Unattended MASINT Sensor (UMS)—both the Steel Eagle (air drop) and Steel Rattler (handemplaced—and the Remote Miniature Weather Station (RMWS). For 24 months, the UGS ACTD demonstrated and fielded improvements in the UMS’s capability to detect, locate, identify, and report time-critical targets, primarily theater ballistic missiles. Exercised in conjunction with Special Forces (SF) detachments, UMS proved itself to be a force multiplier, and allowed SF for the first time to make operational decisions based on the UMS reports. In addition, RMWS, through close coordination with multiple users and during multiple demonstrations over 24 months, proved its utility when requested by U.S. European Command in support of the Kosovo Operation “Noble Anvil.” RMWS proved itself to operational forces through reports that helped them to determine safest routes of travel and transit. RMWS is in the process of becoming a standard Air Force program through Air Force OS21. UMS is currently in transition to acquisition with the U.S. Air Force.

Precision Fires

B.22 Hammerhead ATD

The Hammerhead program, conducted by the Munitions Directorate of the Air Force Research Laboratory, set out to evaluate the applicability of low-cost synthetic-aperture radar (SAR) seeker technology to precision munitions. Completed in 1999, Hammerhead demonstrated the ability of a SAR seeker to achieve a less than 3-meter CEP in adverse weather conditions—a significant advancement over current seekers which have limited use in adverse weather conditions. The ability of the SAR seeker to perform precision guidance in steep dive trajectories was a major technical barrier that was overcome by careful theoretical analysis and rigorous captive flight testing. Obtaining precision velocity and acceleration measurements in a highly dynamic steep dive flight environment was also a formidable challenge. Careful implementation of acceleration smoothing techniques and motion compensation software adequately addressed this challenge for the Hammerhead demonstrations. The SAR seeker technology demonstrated under this program provides a revolutionary air-to-surface precision guidance capability in adverse weather, allowing for the successful attack of fixed or stationary targets anytime anywhere by Air Force and Navy attack/bomber aircraft. The Hammerhead approach addresses the needs of the Joint Direct Attack Munition (JDAM) program to achieve a precision, adverse weather weapon delivery capability for a high-altitude direct attack scenario. The Navy and Air Force JDAM program offices participated in the Hammerhead program. Other programs expressing interest in the Hammerhead program include the Joint Air-to-Surface Standoff Missile (JASSM), AGM–130/GBU–15, the Tomahawk cruise missile, and the Hard and Deeply Buried Target program initiative.

Chemical/Biological Defense

CB.02 Joint Warning and Reporting Network

This DTO was completed during FY99 and demonstrated technology to support the Joint Warning and Reporting Network (JWARN) P³I objective system that will seamlessly integrate into the Global Command and Control System (GCCS), including warning and reporting software, hazard prediction, and situation management. The technology will allow automated integration of sensors into the GCCS using secured two-way communications in compliance with the Automated Battlefield Management System (ABMS). In FY99, a tradeoff analysis was completed. Parameters were a cost target of $300 per unit, and 57.6-kb continuous wireless and 1-Mb continuous wired data transmission rates. A capability was demonstrated using at least two different sensors
and a minimum of ten linkages. This technology provides an automated capability to link (in real time) sensor data into the GCCS to permit situational awareness on multiple command levels allowing commanders to make the appropriate decisions. Information will be displayed at different levels of complexity depending on the need, from a single sensor to all sensors overlaid onto the battlefield. In addition to the real-time displayed information, a projection of the threat can be provided through the use of the Hazard Prediction Tool (HPT). Real-time data can be integrated with other GCCS-available data (meteorological, geography, intelligence, etc.) through the HPT to provide a display of time-lapsed threat analysis that permits commanders to formulate strategic plans. In comparison to current capabilities, this technology will be lower in cost, higher in data handling capabilities (factor of 10 to 100), self-aware and self-organizing, modular in design for rapid upgrading, and able to provide information at greater speeds and in more detail.

**CB.21 Chemical Agent Prophylaxes**

This DTO was completed during FY99, and demonstrated an improved medical protection capability against the threat of nerve agents. The specific technology developed through this effort is a genetically engineered human cholinesterase for use as a pretreatment for nerve agent exposure. Protein-based bioscavengers were identified that protect against five LD50s of nerve agent in animal models without additional therapy or operationally significant physiological or psychological side effects. These capabilities were transitioned to advanced technology development (concept exploration phase). In comparison to currently fielded nerve agent countermeasures, achievement of this technology objective provides a capability for extended protection against a wide spectrum of nerve agents without causing side effects, behavioral effects, or the need for extensive post-exposure therapy. Improved prophylaxes for chemical warfare agents deters their use by the enemy and increases the capability of U.S. forces and allies to sustain operational tempo and provide full-dimension protection.

**Military Operations on Urbanized Terrain**

**E.03 Objective Individual Combat Weapon ATD**

The OICW ATD, completed in FY99, will transition to the PM for Small Arms (PMSA) in FY00. The OICW ATD conducted safety, technical and live-fire troop testing in 4Q99 at Aberdeen Proving Ground, MD. PMSA is planning for a Milestone I decision in 1Q00 followed by a 2-year program definition and risk reduction effort. First Unit Equipped is scheduled for FY07. All metrics in Operational Payoffs of DTO have been met, with a slight weight overage (.1–.2 lb).

**Joint Readiness and Logistics and Sustainment of Strategic Systems**

**F.16 Logistics Technologies for Flexible Contingency Deployments and Operations**

This work was accomplished under the Logistician's Contingency Assessment Tools (LOGCAT) program. The work included an analysis of the deployment process to identify process improvements and the development of automated tools to assist the contingency planning process. The LOGCAT tools (1) automate the worldwide collection, storage and retrieval of deployment site survey information (Base Support Plan Part I); (2) compare deployment site capabilities against deploying forces bed-down requirements and identifies resource shortfalls, overages, or limiting factors to sortie production (Base Support Plan Part II); and (3) automatically develops or tailors deploying force packages based on individual deployment scenarios. The tools were tested in EFX98–99. Transition for operational use is in process through the Systems Design Group.
**Force Projection/Dominant Maneuver**

**G.09 Advanced Mine Reconnaissance/Minehunting Sensors**

This DTO sought to demonstrate underwater sensing and processing technologies for automated mine detection, classification and data reduction in deep water and littoral environments to enable rapid mine reconnaissance and organic minehunting for naval operating areas, sea logistics lanes, and amphibious operating areas. Technical challenges included high-area-coverage operation in deep water; rejection of clutter in the littoral environment; operation of acoustic, EO, and magnetic sensors in very shallow water; acoustic penetration in sediments at low-grazing angles; real-time motion compensation and processing; automated detection and classification of mines; and data fusion of multisensor information. This program successfully demonstrated toroidal volume search sonar (TVSS), synthetic aperture sonar (SAS), electro-optic imaging (EO), a magnetic gradiometer, and signal and image processing and fusion technologies in a number of operational scenarios. In Fleet Battle Experiment–E (April 1999), EO and SAS systems quantified sensor suite performance vs. bottom mines and clutter in VWS environment; demonstrated reacquisition and identification of mines detected with the AQS–14 sonar; developed tactics for simultaneous SAS/EO minehunting operations; and employed fleet operators to perform EO operations in real-time. This DTO transitioned EO identification technology to AN/AQS–14A systems towed from MH–53 helicopters as well as mature acoustic and EO technologies to the Remote Minehunting System (V–4), the AQS–20/X, and the Long-Term Minehunting Reconnaissance System.

**Electronic Warfare**

**H.11 High-Power Microwave ACTD**

This ACTD successfully demonstrated the feasibility of fielding high-power microwave systems to deny or degrade enemy electronics in specific information operations scenarios. AFRL/Phillips Site completed a fully functional, integrated system in under 16 months to support the final demonstration in April 1999. The JC2WC served as an independent demonstration test director and evaluator. Based on OSD-endorsed criteria, the ACTD scored a number of highly effective ratings against systems of interest. Both the JC2WC and the operational representatives described the system as elegant, safe, well built, and user friendly. Final disposition of the system awaits the JC2WC final report and consideration by potential user organizations.

**Human Systems**

**HS.02 Advanced Hybrid Oxygen System—Medical**

The Advanced Hybrid Oxygen System–Medical (AHOS–M) is a portable, self-producing oxygen system targeted for aeromedical evacuation and field casualty care operations in aeromedical staging facilities, air-transportable hospitals/clinics, and theater-level medical treatment facilities. The system, designed to generate, liquefy, and store medical-grade (99%) oxygen in a single integrated package, will meet warfighter needs documented in HQ USAF MNS 003–96: Aeromedical Evacuation Advanced Capability. Existing Molecular Sieve Oxygen Generating Systems (MSOGS) technology being installed on fighter and bomber aircraft is too large and heavy for aeromedical and transport aircraft applications requiring high oxygen flow rates, cannot generate high-purity oxygen, and cannot store large quantities of oxygen. AHOS–M eliminates these shortcomings by coupling a high performance MSOGS (HP–MSOGS) unit with miniaturized, high-speed turbomachines for oxygen liquefaction. The HP–MSOGS uses multiple molecular sieve beds to produce 30 gaseous liters/minute of 99% oxygen. The cryogenic refrigeration subsystem converts gaseous oxygen to liquid oxygen (LOX) at the rate of 2 liters/hour and has inte-
Appendix D

The system can provide gaseous oxygen for delivery to patients at flow rates up to 72 liters/minute. The FY99 completion of the AHOS–M DTO provides lightweight, high-reliability technology to replace the time-, cost- and maintenance-intensive LOX infrastructure currently required to support aeromedical missions. AHOS–M offers significant warfighter payoffs by reducing deployment support requirements and increasing rapid deployment capability. Developed by the Air Force Research Laboratory's Biodynamics and Protection Division (AFRL/HEP), the technology is being transitioned to the Human Systems Program Office at Brooks AFB in Texas for engineering, manufacturing, and development. Customers are HQ AMC/SG and HQ ACC/SG.

HS.10 Force XXI Land Warrior

The Force XXI Land Warrior (LW) DTO developed and demonstrated advanced technology insertions to the LW system, and measured the individual and operational effectiveness afforded by these advanced technologies. The DTO was completed in FY99 by the Soldier and Biological Chemical Command (Natick Soldier Center) with U.S. Marine Corps involvement. Low-power helmet electronics and an improved helmet suspension system were transitioned to LW EMD in FY97. Integrated technology demonstrations were conducted in FY99 for the system voice control, integrated navigation, and combat ID functionality (to include interoperability with stand-alone Combat ID-Dismounted Soldiers, Multiple Integrated Laser Engagement System (MILES) and MILES 2000 training devices). These demonstrations also proved out the viability of the extended-life batteries utilizing lithium-manganese-dioxide pouch cell chemistry within a dismounted platform. The Future Warrior Architecture (FWA) team developed an objective approach to evaluate and measure a system's physical fightability and recommended a path forward to a future lightweight, low-power, affordable warrior system. These technologies provide enhanced individual and small-unit performance, lethality, mobility, and survivability. Specific benefits include accurate individual geological information when GPS is not available, hands-free control of LW functions, positive ID of friendly LW and non-LW combatants, lower power requirements for LW helmet system, improved helmet adjustment capability, technology leading toward significant weight and bulk reduction for thermal sensors, and concepts for an FWA that helps to focus future S&T efforts on a future lightweight, low-power, affordable warrior system. Based on this effort, the LW operational requirements document has been revised to include integrated navigation and combat ID functionality as threshold requirements. Other capabilities demonstrated are cited as objective requirements of the LW system.

HS.16 Interactive Multisensor Analysis Training Technology

The objective of IMAT was to develop and demonstrate new methods for training tactical and analytic tasks employing complex sensor systems in a range of undersea warfare (USW) applications. The project developed new training technologies for acoustic and nonacoustic sensor systems employed by subsurface, surface, and aviation USW communities, including computer models and scientific visualizations of physics phenomena integrated into curricula. IMAT has transitioned to all sonar apprentice schools and over 20 advanced courses across all USW communities at enlisted and officer levels. IMAT is also used for at-sea training for submarine, surface, air, and combined exercises. Evaluation results indicate: 1) In School—IMAT students significantly outperform students in conventional instruction, and often score higher than qualified fleet personnel with 3 to 10 years of experience; IMAT increases instructors’ ability to teach difficult topics, respond to student questions, and reinforce critical principles; IMAT students score higher on measures of attention, relevance, confidence, and satisfaction than students in standard Navy classrooms or in computer-based training; development costs are equivalent to or less than conventional courses, and less expensive than other new training technologies; and 2) At Sea—IMAT-trained submarine crews significantly improved their tactical sonar skills and performance.
MAT-trained submarine crews significantly improved their tactical sonar skills and performance on independent Tactical Readiness Evaluations (according to N–87, this translates to a 10 dB performance advantage); IMAT improved interplatform coordination in combined operations. Payoffs include significant improvement in sensor operator skills through complete revision of submarine and air sonar training and a reduced-cost submarine sonar employment trainer programmed for acquisition in FY00. The IMAT project was completed in FY99 by the Space and Naval Warfare Systems Center, San Diego, and the Naval Surface Warfare Center, Carderock Division.

**HS.18 Precision-Offset, High-Glide Aerial Delivery of Munitions and Equipment**

The objectives of the Precision Offset, High-Glide Aerial Delivery of Munitions and Equipment DTO were to (1) demonstrate revolutionary technologies for the reliable precision-guided delivery of combat-essential munitions, sensors, and equipment; and (2) demonstrate an optional glide augmentation system, providing an offset range of 75 km to 300 km. The DTO was completed by the Soldier and Biological Chemical Command (Natick Soldier Center) in FY99 and will transition to PM Soldier Support in FY01 as part of their airdrop/airborne program. The DTO demonstrated reliable precision-guided delivery using semi-rigid deployable wing technology from a 25,000-feet altitude and 15-miles offset with payload weight of up to 5,000 pounds; demonstrated 6:1 glide ratio and a 200% increase over conventional parafoils; developed and demonstrated modular Global Positioning System (GPS)-based guidance navigation and control system; integrated a glide augmentation system to extend the vehicle range to over 300 km; demonstrated multiple payload/drop zone capability; adapted and integrated novel aerodynamic decelerator designs with airdrop unique materials to increase performance; and interfaced with standard USAF aircraft and Army helicopters.

**HS.19 Rotorcraft Pilot’s Associate ATD**

The flight demonstration for the Rotorcraft Pilot’s Associate ATD was conducted and the contractor’s final outbrief and exit criteria analysis were completed; and government analysis of the contractor report and the flight data will follow. Preliminary results from the Combined Arms II experiment indicate a trend toward improved lethality and survivability in the RPA configuration over the “Comanche-like” baseline. The warfighter has been providing operational pilots for the evaluations and demonstrations. The capabilities of the Cognitive Decision Aiding System (CDAS) have been well received by the operators. Of particular interest to the operational pilots is the increased ability to replan on the move, conduct team-coordinated search patterns, immediately share and hand-off targeting information with teammates, and automatically report own ship and teammate status. Auto-generated visual and voice warnings, including verbal directions to safe masking areas, have been lauded as well-implemented new capabilities. Portions of the RPA’s demonstrated capabilities have been transitioned to other organizations. RPA software (route and battle position planning) has been integrated into the Mounted Maneuver Battlespace Laboratory for ground vehicle simulation exercises. RPA software and hardware is being integrated into the Air Maneuver Battle Laboratory for manned/unmanned vehicle teaming and control exercises. RPA is also targeted for transition to scout and attack helicopters such as Comanche and Apache. RPA has demonstrated application to command and control and is targeting both air and ground future command systems. The RPA software architecture was selected by DARPA as the baseline for the Unmanned Combat Air Vehicle program.
Chemical/Biological Warfare Defense and Protection and Counter Weapons of Mass Destruction

I.03 Airbase/Port Biological Detection ACTD

This DTO developed and demonstrated a biological local warning capability and operational procedures to detect, warn, dewarn, and identify biological warfare (BW) attacks; protect high-value, fixed-site assets, such as airbases and ports, during point and long-line source BW attacks; and decontaminate large areas after an attack. In FY97, a system was demonstrated that provided rapid detection (5-min versus 15-min), semiautomated versus manual warning and reporting of a BW attack using RF links, protection (collective protection and commercial oronasal masks), identification (20-min versus 30-min) and sample handling of eight high-threat agents versus four, and large-area decontamination. This ACTD overcame technical barriers and was able to demonstrate the ability to rapidly identify all BW threat agents. Both a dewarning capability and concepts or capabilities to decontaminate large areas without significant degradation in operational tempo were demonstrated.

I.04 Integrated Biodetection ATD

This DTO was completed in FY99 and demonstrated two technologies; one that provides a pre-exposure warning for a biological attack, and another that provides an order-of-magnitude increased sensitivity to agents while adding a first-time virus identification capability with significantly reduced logistics. These logistical improvements include automated operation, 5X reduction in size/weight, reduced storage requirements, and reduced consumables. In FY97, a demonstration of a remote biological aerosol warning capability using microUV-fluorescent, laser-based particle counting technology was completed. This technology provides pre-exposure warning of biological agent attacks for protection of personnel and high-value battlespace assets. A point biosensor capability that incorporates an automated DNA diagnostic technology to identify biological agents with the highest known degree of reliability and sensitivity was demonstrated in FY98. In FY99, products were demonstrated separately and as an integrated force protection suite in future battle lab warfighting experiments. This DTO overcame technical barriers, including developing a passive long-range (2-km) standoff biodetection and identification capability, especially one that is not limited by path losses (e.g., atmospheric absorption) and the natural background.

I.05 Chemical Add-On to Airbase/Port Biological Detection ACTD

This ACTD demonstrated an integrated biological and chemical detection and warning capability at sites within the designated areas of operation associated with the DTO I.03, Airbase/Port Biological Detection ACTD. The chemical add-on capability used mature and available technology (passive IR spectrometry and ion trap spectroscopy) to automatically detect and identify chemical threat agents in near real time (less than 30 sec). In addition, a Joint Warning and Reporting Network (JWARN) with hardware and software interfaces between three or four different biological and chemical detectors for the automatic generation of NBC 1 and 3 reports was demonstrated in FY98. This ACTD developed the concept of operations and doctrine associated with the add-on capability at fixed-site assets. This chemical enhancement ACTD provided the CINCs with a first-time capability to network legacy and emerging biological and chemical detectors, and produce automated warnings and reportings for enhanced battlefield visualization and force protection as defined in Joint Vision 2010.
J.03 Counterproliferation I ACTD

The CP I ACTD developed technologies, demonstrated prototype systems in an operationally realistic environment, supported operators in the definition of the concept of operations, and provided combatant commanders with enhanced capabilities to hold weapons of mass destruction (WMD)-related facilities at risk while minimizing collateral effects. The ACTD focused on four major technology challenges that resulted in the ACTD deliverables: (1) improved target planning and collateral effects prediction tools, (2) improved direct-attack weapon systems, (3) new sensor systems to aid in target characterization and bomb damage assessment, and (4) a well-defined concept of operations to tie capabilities together into an effective warfighting capability. This was USEUCOM’s highest ranked ACTD. Phase I demonstrated the application of current warhead technology augmented with a programmable, void-sensing/depth-of-burst-sensing hard-target smart fuse (HTSF). Planning tools for targeting (Integrated Munitions Effects Assessment (IMEA)) and collateral effects prediction (Hazard Prediction and Assessment Capability (HPAC)) were also demonstrated. In Phase II, Phase I technologies were supplemented by (1) the Advanced Unitary Penetrator (AUP), which improved the penetration capability of the BLU–109 by a factor of two, (2) tactical unattended ground sensors (TUGSs), which provided target characterization, facility operating mode change detection, and support for battle damage assessment (BDA), and (3) a modified tactical forward-looking infrared pod modification, which improved BDA by providing detonation confirmation and enhanced digital imagery of the target. TUGS has proven valuable as an independent confirmation of time of impact and higher-order detonation. IMEA (with HPAC) has been designated as the NATO standard for planning and assessing NBC-related facility attacks. The USAF has accepted lead service responsibility for the FMU–157/B HTSF.

Information Systems Technology

IS.15 Assured Distributed Environment Support

Technology barriers overcome included development of distributed computing environments with system state management, dynamic reconfigurability, and scalability over widely disparate communications backbones, heterogeneous systems, and multiple clusters or domains. The earliest investigations included a pre-CORBA distributed computing environment called CRONUS, used primarily by the AF and Navy. This prototype was used to focus on military critical capabilities (survivability, robustness, and load balancing) needed from the developing CORBA international standard. In time CRONUS was restructured to become the first GOTS CORBA software package, named CORBUS. CORBUS has shown communications agility by being demonstrated over multiple military and commercial communications backbones. This DTO has led to other developments such as the JTF ATD's development of the Next-Generation Information Infrastructure, the CORBA real-time specification, and the CORBA fault tolerance specification. The major transitions have been to standards bodies such as the Object Management Group that develops the specifications for CORBA. Industry has responded to CORBA with a wide array of COTS products providing the government with a broad industrial base. The major payoff to the military is that it can now procure distributed systems from industry using commercial products and standards with military critical capabilities. The added combat capability for the warfighter includes robust and timely collaboration with CONUS and reachback to information bases. This DTO was jointly funded and coordinated by the Air Force and Navy. (DARPA and NSA also funded work in this area.) Use of COTS and the intellectual base derived from within this DTO have become the cornerstone for military critical distributed computing systems.
IS.24 Multimode, Multiband Information System

The primary achievements of this DTO came from the multiservice program known as SPEAKEasy. It demonstrated multimode operation and bridging of voice circuits during JWID–94. Numerous studies were accomplished (i.e., RF conversion, synthesizer, FFTs, DSPs, and INFOSEC designs). The Army's CECOM–RDEC managed design studies for wideband/multiband antennas. SPEAKEasy resulted in a fully programmable open-system design that was field tested in 1997 at the Army Task Force XXI Advanced Warfighting Experiment. The system demonstrated over-the-air communications using a wideband RF front end and software-implemented versions of standard military radio waveforms, extensive voice bridging, software downloading, and COTS repair in the field. All technologies developed were transitioned to the Joint Tactical Radio System Program Office in 1998. AFRL, DARPA, and CECOM facilitated the formation of the Modular Multifunction Information Transfer System Forum, which grew to include numerous international participants, commercial wireless developers, service providers and regulators. It has since evolved into a not-for-profit corporation that is world renowned. In 1993, the Future Multiband Multiwaveform Modular Tactical Radio (FM³TR) was started and placed under the AF's Long Term Technology program, a four-power initiative with the U.S., U.K., France, and Germany. In 1998, the FM³TR program conducted the first demonstration between two international software programmable radios. The four-power group has focused on future efforts to host new waveforms on various platforms. In summary, two transition paths have been implemented that will assure that this technology will be available for military application. The JTRS Program Office will effect the transition of this technology into the service acquisition agencies and the SDR Forum will assure a commercial technology base will be available.

IS.29 Software Technology for High-Performance Computing

The objective of this DTO was to develop and demonstrate software tools, languages, and algorithms to enable the cost-effective application of high-performance (HP) computers to new domains, such as modeling and simulation. This DTO addressed the development of architecture-independent scalable software libraries, HP languages, and runtime services that enable parallelization and efficient communication. The largest distributed battlefield simulation ever was demonstrated at the 1998 TARA review. A record-breaking 100,298 vehicles were simulated on 13 parallel computers comprising 1,386 processors through the use of the Caltech/SPAWAR developed Synthetic Forces Express (SFE) simulation engine. SFE incorporates a scalable communications architecture based on interest management to significantly reduce message traffic. Prior to this work, a 100 K vehicle simulation capability had not been envisioned until 2002. Rice University developed an advanced prototype high-performance FORTRAN compiler that was used to automatically parallelize NASA's Numerical Aeronautical Simulation (NAS) benchmarks, achieving execution times within 0%–21% of highly optimized, hand-coded versions of NAS Code transformations. The techniques have doubled the performance of MAGI, an Air Force particle hydrodynamics code. An electromagnetic scattering code for predicting radar cross sections (RCS) scalable to massively parallel computers was developed by Boeing. The code, called ParaDym, scales linearly on massively parallel machines and permits RCS prediction for important targets with fine geometric detail. Several widely used engineering codes critical to the development of defense systems have been parallelized and are now commercially available, including a parallel version of MSC/NASTRAN, the most widely used finite-element code for stress analysis; and the Parallel Spectrum Solver, the first parallel commercial-grade software for multiphysics simulation.
Combating Terrorism

L.02 Surveillance and Tracking

This DTO successfully demonstrated video surveillance capabilities that allow an operator to detect individuals at ranges of 2 miles or more under adverse weather conditions. This development of advanced standoff visual surveillance systems has enabled and improved the identification, monitoring, and tracking of individual terrorists in the field, reducing the threat to U.S. military and other government personnel, facilities, and infrastructure. The lightweight, through-wall surveillance system capable of distinguishing terrorists from hostages for both interior and exterior constructions in real time will not be executed, and no funds will be applied. This operational need should be referred to Basic Research and Exploratory Development Programs to identify and develop enabling technologies.

L.08 Tactical Operations Support

A reduction in blooming and halo effects in night vision goggles by at least 60%, compared to current systems, was demonstrated in FY99. This improved capability will increase mission success for a variety of operations, including both pre-emptive strike and retaliatory action. Casualties, including those caused by fratricide will be minimized. This new capability was tested by Special Mission Units who are planning to procure the new system.

Force Projection/Dominant Maneuver

M.08 Enhanced Fiber-Optic Guided Missile ATD

This program sought to confirm a man-in-the-loop, precision standoff engagement capability against high-priority ground and helicopter targets under, day, night and adverse weather conditions out to a range of 15 km. Such a capability would provide positive target engagement and thus increased lethality, and contribute to fratricide avoidance. GTV2 and GTV3 flight tests demonstrated the missile's ability to mark targets en route and precisely engage them. This DTO successfully completed an end-to-end ordnance section sled test, delivered three InSb flight seekers for integration; and integrated a multicorrelator into the autotracker.

Materials/Processes

MP.04.01 Materials and Processes for Reentry Vehicle Technology

The Air Force and Navy have always coordinated the reentry vehicle materials and process (M&P) activities over the years; while there are slightly different systems requirements, the major M&P activities are similar. This DTO enabled significant coordination and collaboration. These activities have produced numerous accomplishments over the life of the DTO. Inorganic resin matrix composite antenna windows were developed, characterized, and flight tested. They met current transmission and ablation requirements, and were developed and transitioned to the Air Force ICBM SPO and available for Navy SSP evaluation. In addition, the Army is evaluating these materials for Patriot radomes. Finally, these materials can transmit and receive, both extending the capability of the current vehicles and allowing for growth and expanded capabilities for future systems. Direct replacement heatshield materials were developed, characterized, flight tested, and transitioned to the ICBM SPO. In addition, alternative materials were developed, characterized, and ground tested and are available for evaluation and flight testing by the ICBM SPO and SSP. This DTO investigated and resolved the potential for aging of strategic system heatshield and antenna window materials, which was a fleet sustainment issue. Fleet sustainment
is critical due to the inability to replace heatshields and antenna windows (no longer available) and loss of current assets due to follow-on test and evaluation flights. This DTO also developed M&P technologies to provide form-fit-function replacements for current systems (heatshield and antenna windows) and to extend capabilities for future reentry systems. The ICBM SPO and Navy SSP have supported ground and flight testing of these new materials to demonstrate systems capabilities.

MP.12.11 Higher Sea State Logistics Support for Expeditionary Forces ATD

This ATD addressed the problem of transporting large quantities of bulk cargo and fuels from amphibious/sealift ships to the shore in support of landing forces. Its objective was to demonstrate an Amphibious Cargo Beaching Lighter (ACBL) for ship-to-shore cargo movement in higher sea states. Without adequate port facilities, power projection requires operational capability of Joint Logistics Over the Shore (JLOTS) operations in wind and wave conditions through Sea State 3 (SS3). The ACBL will support the transfer of supplies for JLOTS for all of the military services. Lighters are large, open barges used in loading and unloading larger ships (e.g., container vessels) wherever shallow waters prevent them from coming to the shore. Lighter operations are highly weather-, surf-, and sea-state-dependent. The ATD concept uses an innovative module design with advanced connector technologies to make the module connections and assembly operable in SS3 conditions. The ACB Lighter modules, at 40-ft long, 24-ft wide, and 8-ft high, have several advantages. They are easy to transport by sea and over land. For overland transport, the module is separated into three 8-ft-wide intermodal assemblies. Aboard ship, the 24-ft module either spans adjacent ISO container cells in the ship's hold (similar to the Navy Seashed) or is “deck loaded.” A major full-scale realistic demonstration by the Navy amphibious elements in the open ocean waters off the coast of Virginia in 1998 confirmed the ability to assemble the modules into various platform configurations. The platforms are quick to assemble, fewer are needed in theater, and the various sizes and configurations meet changing needs at a forward logistics site. With the feasibility of an SS3-capable causeway system established, the Army and Navy have decided to pursue acquisition of the technology through its design of a Joint Modular Lighter System (JMLS).

MP.18.11 Life-Extension Capabilities for the Navy’s Aging Waterfront Infrastructure ATD

This ATD was designed to increase the structural strength and extend the service of the Navy’s older deteriorating waterfront structures. It incorporates composites for increased structural strength in both the vertical and the lateral directions, and a corrosion arrestment system that stabilizes the deterioration of reinforced concrete exposed to harsh marine conditions. The first of three demonstration projects to apply external composite reinforcing to increase the strength of Navy piers was completed in December 1996. Naval Station Norfolk selected Pier 11 for the demonstration of strengthening methods for two crane-operating lanes to allow unrestricted operation of 90-ton capacity cranes. The second of three projects completed in April 1998 demonstrated advanced technologies to repair and strengthen the 47-year-old Pier 12 at Naval Station, San Diego. Prefabricated, fiber-reinforced plastic (FRP) shells was used for pile reinforcement. Carbon rods were inset into the top deck for reinforcement and pultruded uniaxial carbon strips were used for deck reinforcement in positive moment areas on the underside of the deck. The third demonstration at Wharf B25 at NAVSTA Pearl Harbor was completed in October 1998. This project integrated an impressed current cathodic protection system to stabilize corrosion to extend the service life by over 20 years. Composites were used for deck strengthening to support operation of 50-ton cranes. Each of these repair and strengthening demonstrations, which cost under $1M, postponed for at least ten years the need to demolish and replace the existing pier with a new structure. New structures generally cost about $40 million. With 75% of the Navy’s
piers more than 40 years old and with increasing deterioration due to age, many existing piers cannot safely perform their required missions such as in accepting large mobile crane loads for conducting pierside maintenance and overhaul.

Sensors, Electronics, and Battlespace Environment

SE.27 Microwave SiC High-Power Amplifiers

This DTO significantly improved the technology of silicon carbide transistors for application in advanced microwave high-power amplifiers. Pulsed 3-GHz SiC static induction transistors were improved from the 75-W range to over 300 W. SiC MESFETs for CW operation at 10 GHz were improved from 1 W to around 10 W. The process capability for these devices was improved, resulting in a demonstrated epilayer uniformity of 5%, as well as the first commercial release of a SiC RF power transistor in July 1999. The impact of this technology is a 2X–5X improvement in the power per device, and an increase in operating temperature range from 125°C–250°C. The resulting 2X–5X decrease in the size/weight of RF power amplifiers provides the warfighter improved mobility and reliability in a multitude of radar, communications, and EW systems. This DTO was sponsored by the Air Force, Navy, and DARPA, with tri-service participation. Potential system insertions include the Air Force TPS–75 S-band radar upgrade, as well as multifunction active arrays for the Navy's SC–21 platforms.

SE.28 Low-Power Radio Frequency Electronics

This DTO advanced the technology of miniature digital receiver and waveform generator modules, resulting in an approximate 10X reduction in size and weight. Technologies developed included low-temperature co-fired ceramic multichip assemblies employing embedded passive filters that demonstrated less than 1-dB loss and over 40-dB rejection. Using this technology, a multifunction radar/ESM digital front-end capability was demonstrated. A modular "building block" approach was employed to allow design reuse. This DTO provides the warfighter with an enabling technology for advanced system concepts, especially for UAV and space-based reconnaissance platforms where size weight reductions are critical. This AF-funded and -managed technology has been transferred to the Air Force Modular RF System program, and provides technology to DTOs SE.63, Digital Beamforming Antenna Technology and DTO SE.71, Advanced Multifunction RF System Components.

SE.29 Design Technology for Radio Frequency Front Ends

This DTO advanced the technology of RF multichip assembly design by reducing the total NRE and design-cycle time and improving the accuracy of RF design simulation. Specific improvements demonstrated included 3X faster design capture, 100X faster circuit simulation, and 1000X faster electromagnetic simulation. Simulation accuracy was improved by 4X (from 20% down to around 5%). As a result of these improvements, modules NRE was reduced from 20 person years down to 8, and design-cycle time was reduced from 3 years down to around 2. The payoff of these improvements is to put advanced system technologies in the hands of the warfighter years sooner by reducing the up-front design cycle. Many of the design software improvements demonstrated by this DARPA-sponsored, AF-managed program have been commercialized in the latest version of the Hewlett Packard Microwave Design System. The improved design capability was successfully demonstrated and validated through the design of a variant of the CIDDS Integrated Combat Identification interrogator/transponder.
Weapons

WE.51 Small-Diameter Anti-air Infrared Seeker

This DTO developed and demonstrated a small-diameter (2.75-in) IR imaging seeker that can provide improved target engagement capability for man-portable, lightweight crew-served air defense missile systems. Packaging the seeker electronics within a 2.75-in diameter by 2-in length to fit within the Stinger airframe was the major barrier. The ability to engage helicopter targets in terrain clutter at ranges in excess of 3X the current capability and the ability to engage aircraft deploying IR countermeasures was demonstrated in a number of field tests. This DTO was conducted in conjunction with the Stinger Block II Integration program administered by the SHORAD project office. This program will now become a transition to the Stinger Block II EMD program funded by Stinger PMO. This DTO packaged electronics; developed a tracker; integrated with IRFPA seeker; demonstrated performance meeting Stinger Block II requirements; fabricated four IRFPA seeker heads; fabricated six sets of electronics hardware; developed and integrated trackers and IRCCM software algorithms; developed hardware-in-the-loop simulations; assembled with controller operating in-house; completed acquisition and tracking field tests at RSA Russell Tower, IRCCM testing at EGLIN AFB, and acquisition and tracking field tests against foreign targets; conducted final hardware and software design reviews; and supported Stinger Block II Milestone II EMD decision by producing an IRFPA seeker design and prototype hardware to begin EMD.