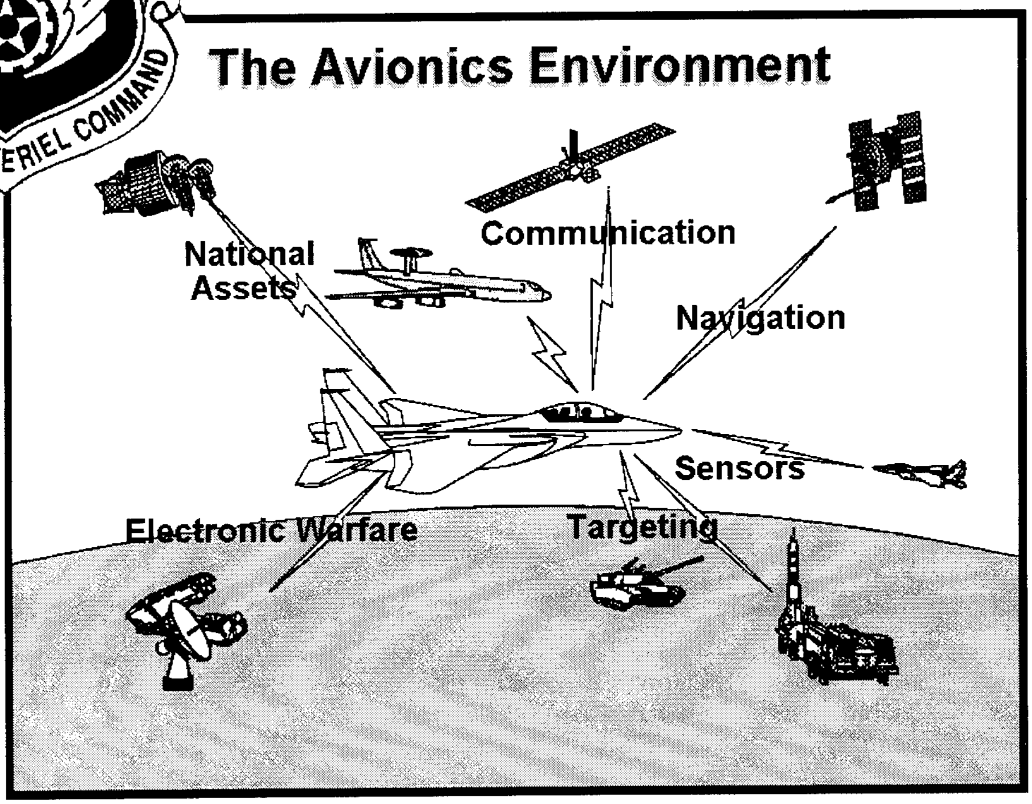
WL-TR-96-1000

FY96
AVIONICS
TECHNOLOGY AREA PLAN

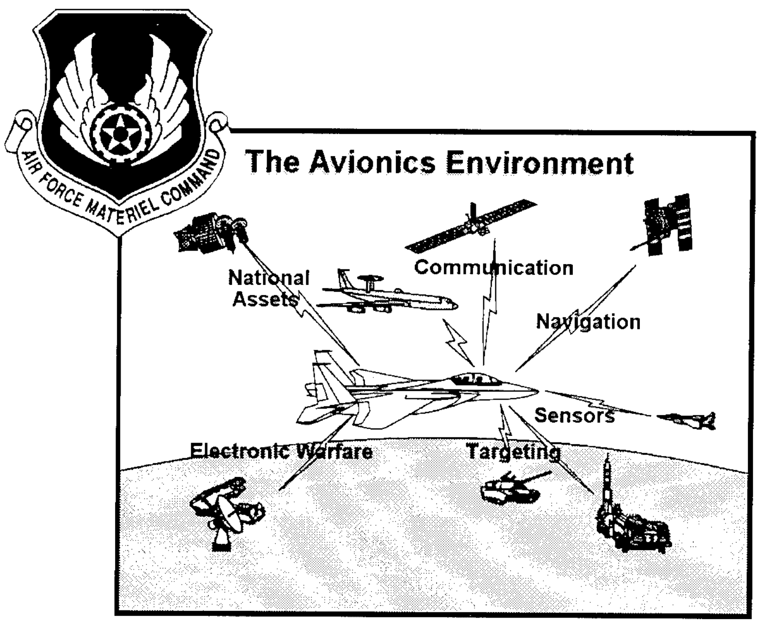


APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

HEADQUARTERS AIR FORCE MATERIEL COMMAND
DIRECTORATE OF SCIENCE AND TECHNOLOGY
WRIGHT-PATTERSON AFB, OH

"Note: This Technology Area Plan (TAP) is a planning document for the FY96-02 S&T Program, and is based on the President's FY96 Budget Request. It does not reflect the impact of the FY96 Congressional Appropriations and FY96 budget actions. You should consult WL/XP, DSN 785-2532, or Commercial (513) 255-2532 for specific impacts the FY96 appropriation may have had with regard to the contents of this particular TAP. This document is current as of 1 May 1995."

...About the cover



Pictured is an aircraft operating in an electromagnetic environment, both natural and man-made. In such an environment, the aircraft operator must have the most advanced, affordable, and supportable avionics suite possible to perform the Communication, Navigation, Identification Friend or Foe (IFF) and other key functions to accomplish the mission. The avionics suite must also aid the aircraft operator in effective use of multiple sensors through sensor fusion algorithms. To effectively achieve the weapon system's mission, the operator must also have the capability to maximize the use of information from multiple on-board and off-board information sources. Achieving this capability will result in Real-Time Information in the Cockpit (RTIC) presenting a real time, near perfect picture of the battle space to the aircraft operator.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
Aug 1995

3. REPORT TYPE AND DATES COVERED
FINAL

4. TITLE AND SUBTITLE
FY96 AVIONICS TECHNOLOGY AREA PLAN (TAP)

5. FUNDING NUMBERS
PR 9993
TA 00
WU 00

6. AUTHOR(S)
PERSONAL AUTHOR: WADE T. HUNT
CORPORATE AUTHOR: WRIGHT LAB, WPAFB OH

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AVIONICS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7409

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AVIONICS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7409

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
WL-TR-96-1000

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approval for Public Release: Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The Avionics Technical Area Plan is the largest in the twelve Air Force Science and Technology programs. It describes the Avionics and Electronics exploratory and advanced development programs supporting all Air Force mission areas. The plan is divided into four thrust areas. The first thrust covers the area of Targeting and Attack Avionics which includes Radar and E-O Sensors, Automatic Target Recognition, and Fire Control. Thrust two covers Electronic Warfare, including Radar, C3, E-O and IR Countermeasures, Situation Awareness and Threat Alert, Multispectral Expendables, and Support Countermeasures. Thrust three covers System Avionics and includes Airborne Communications and Navigation, Signal and Data Processing, Embedded Software, Integrated Avionics, and Information Fusion. Thrust four, Electron Devices, covers Microelectronics, Microwaves, and Electro-Optics.

14. SUBJECT TERMS
Data Processing, Software, Electronic Warfare, Countermeasures, Avionics Architecture, Automatic Target Recognition, Microelectronics, Microwave, Electro-Optics, Sensor Fusion.

15. NUMBER OF PAGES
38

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to ***stay within the lines*** to meet ***optical scanning requirements***.

Block 1. Agency Use Only *(Leave blank)*.

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C -	Contract	**PR** -	Project
G -	Grant	**TA** -	Task
PE -	Program Element	**WU** -	Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

- **DOD** - See DoDD 5230.24, "Distribution Statements on Technical Documents."
- **DOE** - See authorities.
- **NASA** - See Handbook NHB 2200.2.
- **NTIS** - Leave blank.

Block 12b. Distribution Code.

- **DOD** - Leave blank.
- **DOE** - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
- **NASA** - Leave blank.
- **NTIS** - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

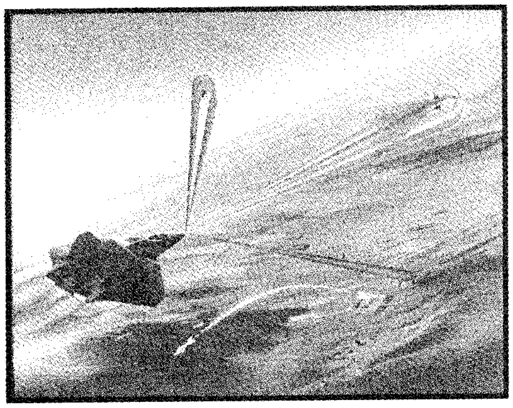
Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only)*.

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

AVIONICS



VISIONS AND OPPORTUNITIES

Future avionics will support military action with unambiguous situation awareness providing a near real-time, near perfect picture of the combat theater achieved through "information management."

The entire world is in the middle of a technology revolution that is framing the future of how wars are fought and won. Future wars will be dominated by stealth, precision weapons, sophisticated intelligence, communication, high speed processing, and the integration/fusing of technologies, strategies, and tactics.

Weapon systems of the future will be information intensive. Future military success lies in acquiring, managing, and controlling this information. Important aspects of this are gathering as much data as possible from on-board/off-board multiple sources, and processing and utilizing it for prosecuting the functions required in a military mission (e.g. air interdiction, air superiority, defense suppression, or electronic warfare). Effective use of large amounts of information, within the physical constraints of an aircraft, lies in maximizing the avionics tools available to the warfighter.

The affordable achievement of our vision of a combat edge for the war fighter is built upon the technologies of sensing, communicating, processing, deceiving, information fusion, and open architecture integrated avionics--components of a superior integrated offensive/defensive response.

Military success also depends on our ability to:

- recognize and quantify the threat
- plan the operation
- mobilize the forces
- transit to the theater rapidly and safely
- project lethal force precisely and affordably against a sophisticated enemy with affordable systems
- deliver all weather precision weapons against critical mobile and fixed targets

The Scientific Advisory Board (SAB), Core Avionics Panel, 1994 Summer Study states that "National defense policy has been to maintain superiority through technology rather than force size." Worldwide, "electronics is the fastest moving technology available to all potential adversaries", so we must ***"emphasize avionics to stay ahead."*** Due to "disparity and uncertainty of future threats", flexibility in avionics is required. Developing common, modular integrated avionics can achieve the necessary flexibility for system integration and cross-platform interoperability. In response to these needs, Information Warfare is an emerging thrust, within the Wright Laboratory Avionics and Solid State Electronics Directorates.

The current Avionics Directorate Mission is "to Provide Air Force Leadership for Avionics Technology for Research and Development and Support to Operational Forces." This Avionics Technology Area Plan (TAP) supports the vision and mission by describing a broad-based technology program that will lead to advanced avionics meeting our customers' needs of performance, supportability, and affordability.

OUR GOALS

Becoming Masters of Information

- Sensing and Precisely Locating the "Impossible" Target
- Leveraging Offboard Information--Open the Pilot's World to Information/Close it to Clutter
- Unambiguous Situation Awareness
- Managing Integrated Offensive/Defensive Response

Sustaining Mission Critical Performance

- Affordable, Maintainable, Mission Supportable

Meeting Customer Needs with Affordable Solutions

- Survivable Aircraft with Weapons on Target
- Real-time Configurable, Adaptive, and Flexible Aircraft
- Increased Longevity and Operational Capability of our Existing Aircraft

To meet these goals, our focus is to develop technologies to:

1) provide a new generation of electronic devices to serve as the building blocks for improved avionics capabilities
2) advance radar, electro-optical sensor technology, target recognition and fire control technologies to detect, recognize, identify, and strike noncooperative targets at long ranges, in all weather, day or night
3) advance jammers, expendables, radar, laser and missile warning, IRCM, technologies to provide multi-mission protection and survivability of aerospace vehicles against advanced electronic combat threats
4) enable totally integrated avionics suites which are both cost and mission effective in supportability and performance.

The Avionics and Solid State Electronics Directorates have a long and proud legacy of technology transition and aerospace excellence that will be leveraged for developing technologies.

- The Electronically Agile Radar provided the basic multifunction aperture radar technology which is incorporated into the B-1B radar.
- The Integrated Electronic Warfare System (INEWS) is the baseline for use in the Air Force's premier fighter, the F-22, as is the Pave Pillar system architecture and the Integrated Communications/Navigation/ Identification Avionics.
- Ultra Reliable Radar demonstrated solid state phased array radar and common signal processor technologies compatible with the F-22's integrated avionics.
- Nearly three decades of investments in synthetic aperture radar technology have fielded an extensive all weather reconnaissance and targeting infrastructure on such platforms as U-2R, B-1B, B-2, F-15E, Joint STARS, and others.
- Fire control algorithms and radar improvements have gone into the F-15 and F-16; monopulse electronic countermeasures into the B-1B and B-52; and signature reduction technology into a number of platforms including the F-117.
- Fundamental electronic building blocks such as VHSIC are being used in every type of modern military and commercial electronic system.
- Monolithic microwave circuits have found their way into radio frequency sensor applications; third generation solid-state phased array radars; and strategic, tactical, and space systems.

THE BOTTOM LINE:
Providing the unchallenged combat edge through avionics.

At the heart of any future avionics system R&D is the integration of offensive and defensive functions with the ability and the facilities to evaluate the suite at all levels. The avionics system will employ common functional modules and reconfigurable software. Smart sensors will detect, locate, identify, prioritize, and track potential threats and targets, both land-based and airborne. This sensor information can be used directly or fused with information from other sources. The results will be presented on a highly flexible multifunction responsive display system, with the pilot as system manager. Avionics technologies will continue to provide the decisive capabilities for Air Force weapon systems. Acquiring, distributing, and applying information in a timely, cost effective manner is the critical key to success.

The future is Avionics, the Air Force's most pivotal, pervasive technology, spanning the entire spectrum of aerospace vehicles and missions.

This plan has been reviewed by all Air Force Laboratory Commanders/Directors and reflects integrated Air Force Technology Planning. We request Air Force Acquisition Executive approval of this plan.

RICHARD R. PAUL
Brigadier General, USAF
Technology Executive Officer

DAVID A. HERRELKO, Colonel, USAF
Commander
Wright Laboratory

CONTENTS

INTRODUCTION

BACKGROUND

The Avionics Technology Area, highlighted in Figure 1, is that part of the Air Force Science and Technology (S&T) Program charged with providing avionics and electronics to support all Air Force mission areas. The avionics program promotes the development of alternatives for future mission requirements and near-term weapon system upgrades to current assets. It emphasizes a balance between performance, availability, and affordability. It develops the basic microelectronics, microwave, and electro-optics devices and components, as well as the offensive and defensive avionics system and subsystem and avionics architecture technologies for aerospace vehicles.

Avionics accounts for 10.8 percent of the Air Force FY96 S&T budget as shown in Figure 2.

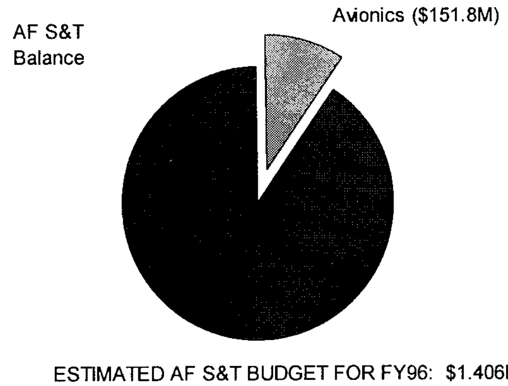


Figure 2: Avionics S&T vs. AF S&T

Funding reflects the President's Budget Request and may change based on possible congressional action.

The total FY96 funding for this area is estimated at $315M with S&T funds amounting to

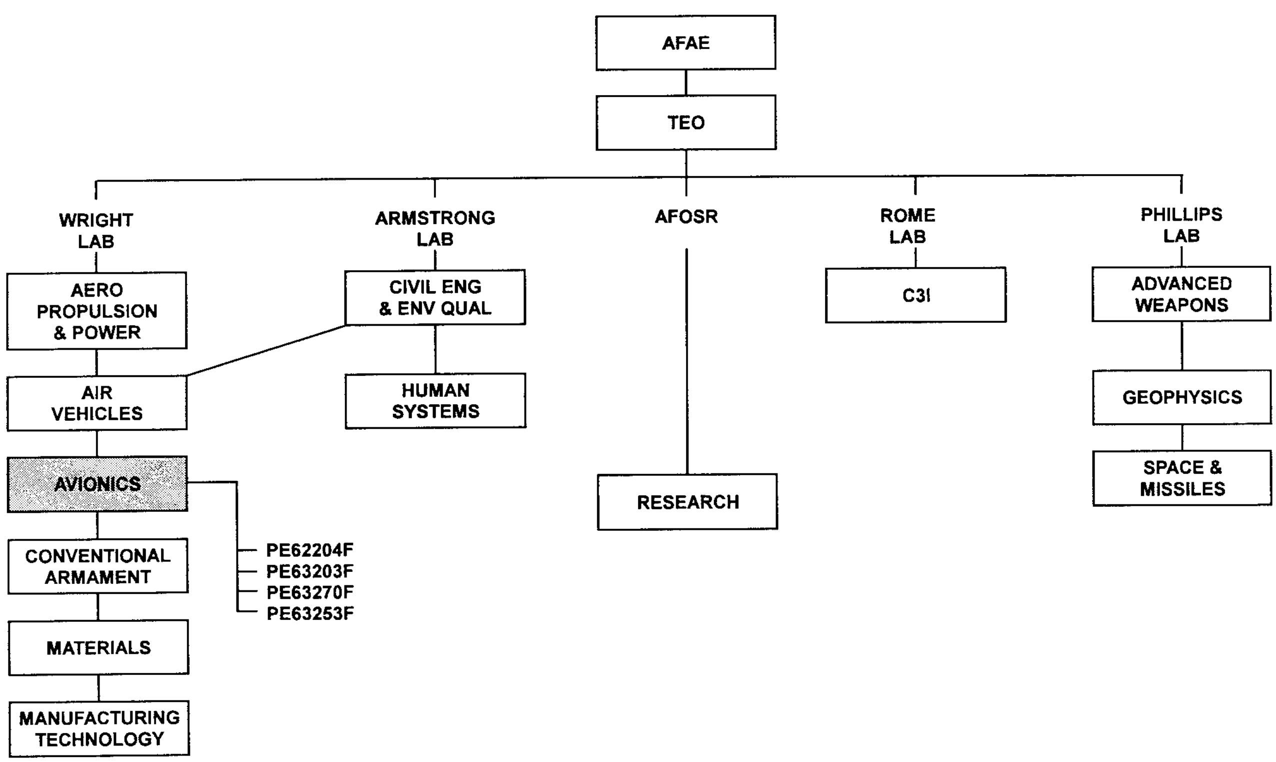


Figure 1: Air Force S&T Program Structure

about 48 percent of this total. ARPA provides the largest single source of non-AF S&T funding (about 17 percent) primarily in the areas of High Temperature Superconductivity, Computer Aided Design and Rapid Prototyping, High Density Microwave Packaging, and Information Processing. About 4 percent of the funds come from the 6.3B Air Combat Command (ACC) sponsored Combat Identification Technology Program Element (PE) for work on non-cooperative target identification.

The Avionics and Solid State Electronics Directorate are committed to the implementation of higher performance, producibility, affordability, and supportability in future avionics. During the past year, two major reliability enhancements were transitioned for implementation in the F-22 Engineering Manufacturing Development (EMD) program. These included the design, development, and manufacturing of a militarized and ruggedized optical card-edge connector using a commercial design. This was necessary because all available connectors failed the minimum requirements needed for the F-22 environment. The design, development, and manufacturing of advanced cooling technologies resulted in a Standard Electronic Module (SEM-E) liquid flow-through module that can dissipate more than 200 watts of power. The F-22 program adopted the liquid flow-through Dmodule for the Central Integrated Processor (CIP) to provide the required cooling capacity.

The Avionics Technology programs are developed from a comprehensive investigation of future Air Force capability needs and the need to continue to enhance our technical superiority at an affordable cost. The challenge is to focus avionics resources into areas that can achieve the greatest increase in combat capability along with providing corresponding improvements in affordability, reliability, and maintainability. Engineers and scientists work closely with HQ AFMC, AFMC Product Center Development Planning communities, and SPOs to identify Major Command (MAJCOM) needs.

Inputs considered in preparing this integrated plan are the Technology Needs and User Reviews. The Air Force Acquisition Executive (AFAE) provides annual guidance, and the Air Force Scientific Advisory Board (SAB) provides yearly technical guidance. Inputs from industry, academia, and Air Force/Service/Agency Laboratories were also considered in developing the plan.

Cooperation with the user is being further enhanced by a teaming process that formalizes and improves the documentation of users' present and projected future capability deficiencies and their plans for rectifying those deficiencies in Mission Area Plans (MAPs).

The Technical Planning Integrated Product Teams (TPIPTs), which include MAJCOMs, all AF Laboratories and Product Centers (including SPOs and XRs), and Development Planning members, are currently developing a process to link the users' deficiencies with the Laboratory programs to resolve the deficiencies.

Project Reliance resulted in a significant increase in inter-AF laboratory and interservice coordination. Many joint-service programs have been established, and more are anticipated as a result of the increase in communication and leveraging power of the three services' funds. An example would be the interdependent development of key elements of a fully integrated sensor system by the Integrated Sensor System Technology Program and the Navy's Advanced Shared Aperture Program.

The Avionics TAP encompasses four main business areas as listed in Table 1.

Table 1: Major Avionics Technology Thrusts

1. Targeting and Attack Avionics
2. Electronic Warfare Technology
3. System Avionics
4. Electron Devices

The relative emphasis of these thrusts is shown by the distribution of the Air Force S&T funds in Figure 3.

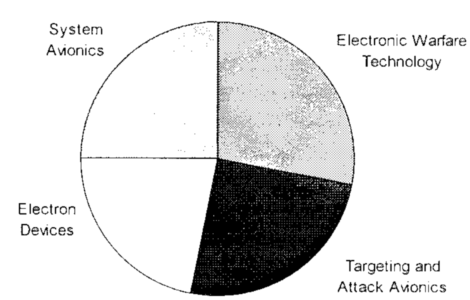


Figure 3: Major Technology Thrusts

The ultimate vision for military avionics is an integrated avionics suite, supporting offensive and defensive functions, which is easily adapted for the specifics of the mission to be performed. This implies avionics for a "reconfigurable" weapon system having superior employment flexibility and supportability at affordable cost.

RELATIONSHIP TO OTHER TECHNOLOGY PROGRAMS

Industrial Programs - Wright Laboratory actively leverages avionics technology from the Independent Research & Development (IR&D) Program. About $1.3B of IR&D funds are spent in avionics related areas (eight times the AF S&T Avionics budget). There is a large amount of IR&D in the Electron Devices area because of extensive commercial markets. There is a relatively low amount of EW-related IR&D funding because of its limited commercial market; however, there are still almost twice the IR&D dollars as S&T funds even in this area. In addition, avionics thrusts are annually briefed to industry by Avionics Directorate personnel. Proposed new Air Force sponsored efforts are identified, as well as additional areas of needed R&D which probably will not have Air Force funding. These briefings help industry plan their IR&D investments and improve the focus on real Air Force needs.

The Avionics Technology area participates in the Small Business Innovation Research (SBIR) program. This program is a valuable source of new ideas and approaches. This year, 25 Phase I efforts and 13 Phase II efforts have been awarded. In support of the Federal Technology Transfer Act, Wright Laboratory's Office of Research and Technology Applications (ORTA) facilitates the transfer of technology between government and industry. Each year, this office coordinates 175 or more requests for technology transfer information for Wright Laboratory, many of which concern avionics, electronics, and Cooperative R&D Agreements (CRDAs). This past year, the Avionics Directorate took an active role in working with industry, academia, and the Wright Technology Center (WTC) in seeking commercial applications of military technology. For example, we are "agents" for several ARPA Technology Reinvestment Project (TRP) effort. These efforts include the use of fiber optics for video distribution aboard commercial aircraft and the use of high speed digital signal processing for military intercept receivers and commercial telecommunications. We are also agents for several TRP SBIR programs and helped form a consortium to apply automatic target recognition technologies to medical imaging and surgery.

International Programs - The Avionics Directorate benefits from Data Exchange Agreements (DEAs) and Memorandums of Understanding (MOUs) with foreign countries. There are 14 agreements for information exchange and cooperative research between the Air Force and other nations. In the System Avionics area, Nunn Amendment monies and foreign source monies have been used for Allied Standard Avionics Architecture activities.

Relationship to Other AF TAPS - The Avionics Technology area relates to many of the other S&T Technology Areas.

The Avionics TAP interfaces closely with Air Vehicle Flight Control, Flight Dynamics Integration, and Crewstation Integration thrusts. Joint programs are being pursued between Targeting and Attack and Conventional Armament Advanced Guidance thrusts. Memorandums of Agreement (MOAs) have been established detailing these cooperative agreements. Avionics interfaces with Rome Laboratory on the Real-Time Information in the Cockpit (RTIC) program.

The Electron Devices thrust is coordinated with the Material Technology Areas of Non-linear Optics and Electromagnetic Sciences and Technology. Close coordination and joint activities exist in all Communications, Command, Control and Intelligence (C^3I) thrust areas. The relationships to these C^3I areas are addressed in a number of MOAs covering the areas of radar/Electro-Optical Infrared (EO-IR) detection and tracking; Communications, Command, and Control (C^3) counter-measures; electronic technology; and artificial intelligence. Agreements have been reached between Wright Laboratory and Phillips Laboratory for specific efforts to be performed to support future advanced development in the Space and Missile area.

A main interface, of the Targeting and Attack Avionics Thrust with the Geophysics area, is the development of Tactical Decision Aids and the Ballistic Winds program. Avionics efforts interface with the Advanced Weapons activities in High Power Microwaves, Lasers, and Global Positioning System (GPS) for precision guidance. AFOSR provides research support from their Life Sciences area to Avionics in neural networks and vision. Support is also provided from the Electronic and Materials Sciences areas to the semiconductor research efforts under the Electron Devices thrust.

Coordination with the Space Technology Interdependency Group (STIG) is accomplished within committee meetings between the Solid State Electronics Directorate, other DoD agencies, and NASA personnel. The STIG Microwave and Millimeter Wave Electronics Subcommittee has identified packaging and interconnect technology as a new area of interdependency, with a present focus on packaging of multichip modules for phased array antenna applications.

This STIG Subcommittee includes members from Wright Laboratory, Rome Laboratory, Army Research Laboratory, Naval Research Laboratory, and NASA in solid-state and vacuum electronics.

CHANGES FROM LAST YEAR

There have been considerable changes in avionics programs as a result of budget reductions, DoD and Air Force downsizing, changes in Air Force priorities, international changes in threats, lessons learned from Desert Storm, and sharply focused investment planning as described on page 2. The recently established Air Force Modernization Planning Process (MPP) and Technology Master Process (TMP) have intensified planning with MAJCOMS, SPOs, and industry. Advanced development efforts in the Avionics TAP continue to be highly rated by the MAJCOMs and Product Center users for relevancy and by the SAB for technical quality. This indicates that we are attaining a good balance of supporting the users while maintaining technical excellence. MAJCOMs are demonstrating interest and commitment by budgeting early for transition of our key programs.

There is increased focus on integrated RF sensor modular architecture due to significant potential cost, weight, and volume savings for future aircraft and retrofit applications. There is also an increased focus on the area of functional integration, with a goal of making avionics more affordable by integrating offensive, defensive, and Communications, Navigation and Identification (CNI) function, databases, and off-board information sources.

In order to improve avionics systems integration research and testing capabilities, the Avionics Directorate is focusing on linking three of our major research laboratories together. The three-laboratory complex is made up of the Integrated Test Bed (ITB), the Integrated Electromagnetic System Simulator (IESS), and the Integrated Defensive Avionics Laboratory (IDAL). The overall concept for developing this complex is called the "Avionics Wind Tunnel," and the first of four planned demonstrations is nearing completion. Additionally, a Distributed Interactive Simulation (DIS) node is being integrated with this inter-lab simulation complex to provide a gateway to other national simulation and testing resources.

The emphasis on design, modeling, and simulation will be increased in three key areas. The focus will shift from developing design automation technology oriented to new systems to developing new tools and approaches that will support the AF's number one design problem -- retrofitting and reengineering the electronics of legacy systems. A second effort will assure that simulation models most needed for Air Force systems, including those for commercial off-the-shelf (COTS) parts, will be readily available for system designers. A third focus on macro-function generator technology, will make available more choices for different speeds, sizes, and power factors available to the application specific circuit designer.

Information Fusion was added as a new subthrust under the System Avionics thrust.

THRUST #1: TARGETING AND ATTACK AVIONICS

USER NEEDS

The Targeting and Attack Avionics Thrust develops technologies critical to resolving deficiencies within the following user developed Mission Area Plans (MAPs): Strategic Attack/ Interdiction, Counter Air, Theater Missile Defense, Electronic Combat, Surveillance/Recce, and Special OPS Combat Support.

Based upon the deficiencies within these MAPs, the needs relative to targeting and attack are:

Targeting and recognizing ground-based mobile and fixed hard targets.

- Stand-off capability
- Delivery of multiple weapons on a single pass
- Accurate medium and high altitude weapon release
- Quick reaction capability against short dwell surface missiles
- Adverse weather detection, targeting, identification capability
- Improved situational awareness

Increased detection/targeting range of airborne targets.

- Counter-countermeasures
- Weapon kinematics, maneuverability
- Ability to deploy and support weapons without entering the lethal range of the threat
- Survivability by providing first look, first shot, first kill before the enemy's weapon system
- Improved situational awareness
- Hostile target identification capability
- Detection and targeting of low observable threats

GOALS

The objective of the Targeting and Attack Avionics Thrust is to develop and transition, into operational combat systems, superior avionics technology to find, identify, and destroy enemy targets--anywhere, anytime, and in any weather. Specific goals are identified below for three principal areas of technology investment: Counter Air, Air-to-Surface, and Visionary Capabilities.

Counter Air

Unambiguous situational awareness

- Beyond visual range air target detection and identification
- Detection and targeting of low observable threats
- Sustained sensor performance in jamming/ clutter environments

Enhanced weapon system effectiveness

- Improved targeting accuracy
- Cooperative engagement

Air-to-Surface

Precise targeting of surface threats

- Deny adverse weather "sanctuary"
- Defeat concealment (camouflage & foliage)
- Discriminate decoys

Enhanced weapon system effectiveness

- Precise weapon aiming
- Maneuvering targeting and weapon release for increased survivability
- Multiple kills in a single pass
- Real-time assessment of target damage mission success
- Increased stand-off ranges
- Mid to high altitude weapon employment
- Sustained sensor performance in jamming/ clutter environments

Visionary Capabilities

Mission-adaptive weapon systems

- Multifunction shared apertures
- Integrated offensive/defensive sensors
- Threat-adaptive target detection
- Model-based vision (MBV) "smart sensing"

Enhanced weapon system affordability.

- Electronically scanned sensors
- Low cost adaptive architectures
- "Reusable" software for sensor management and target recognition
- Automated scene/target rendering for mission planning and rehearsal
- All solid-state electro-optical (EO) sensors

TARGETING AND ATTACK AVIONICS THRUST

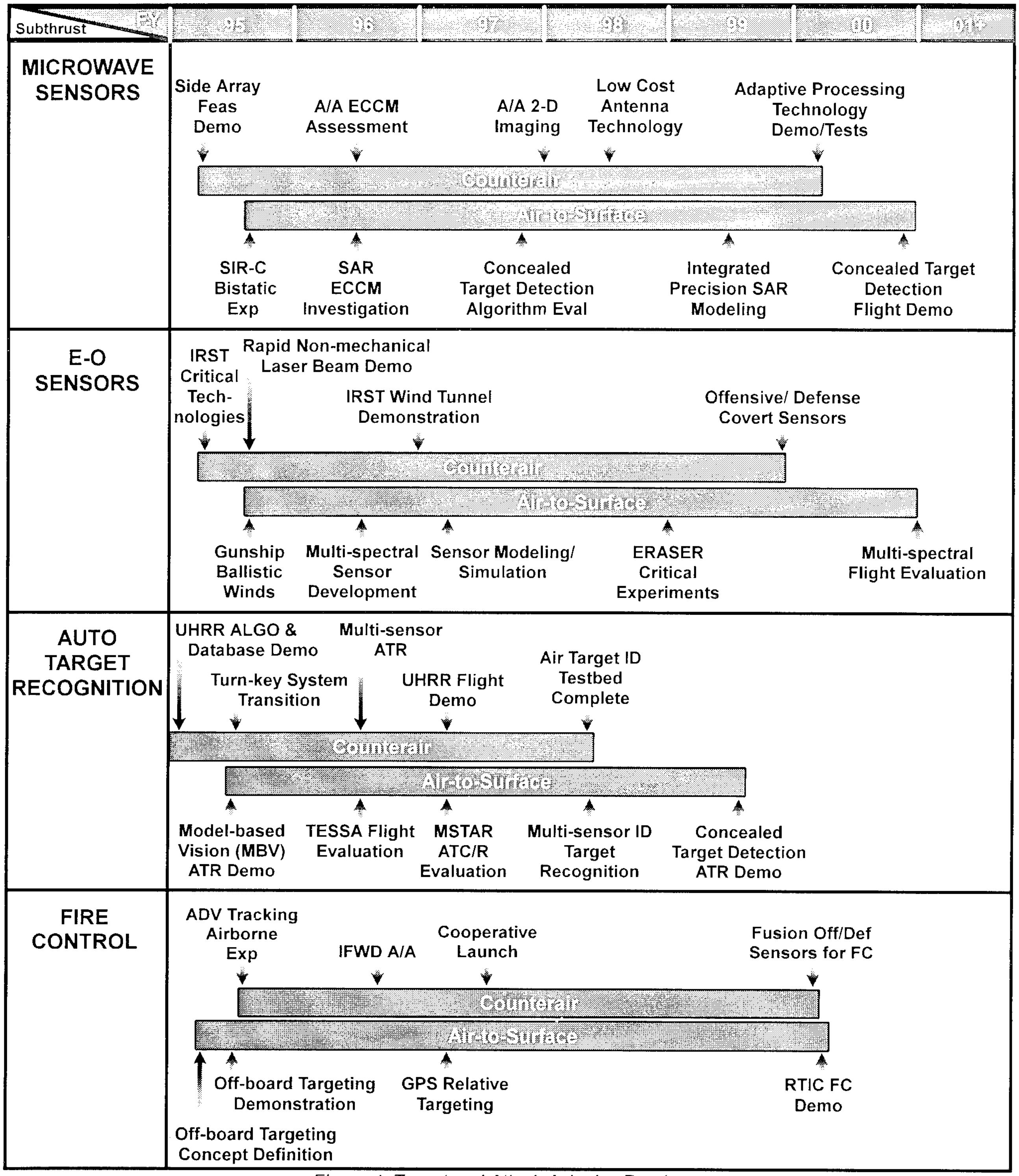


Figure 4. Target and Attack Avionics Roadmap

MAJOR ACCOMPLISHMENTS

Major accomplishments made toward meeting user needs are shown below. They are organized (as is the rest of the thrust) by the four subthrusts for investment: 1) microwave sensors, 2) electro-optical sensors, 3) auto target recognition, and 4) fire control.

Microwave Sensors: The feasibility of utilizing adaptive processing techniques to perform detection of conventional and low cross-section threats was demonstrated in a dynamic electromagnetic interference environment. A six degree of freedom solution for all-aspect waveforms with a 10-12dB cancellation improvement was completed. This technology is essential to ensuring that operational and future systems can detect and target airborne threats.

Improvements in detection of ground based threat targets buried in trees or in the open were demonstrated through the use of three-dimensional interferomic synthetic aperture radar (IFSAR). Collection of airborne, real-time ultra-high resolution radar imaging (UHR) data of moving targets was also completed.

Another area of increased interest and investiment is the development of low cost radar technologies for both aging and new aircraft platforms. A study was completed that identified radar architectures providing the required performance and improved reliability and maintainability while reducing overall system cost.

Electro-Optical Sensors: The Ballistic Winds effort accomplished preliminary measurements that show the feasibility of using laser radar to improve the first shot accuracy of Air Force Special Operations Command (AFSOC) gunships. The same wind sensing technology promises improved accuracy for cargo drops, high altitude bombing, and wind shear detection by commercial aircraft. This technology will transition to Warner Robins ALC in FY96.

Fabrication was completed of full-scale, coated panels for an infrared (IR) window capable of operation in a sustained supersonic environment. The window will complete wind tunnel evaluation to characterize window performance and durability. This window is the highest risk technology involved in the insertion of advanced IR search and track sensors into airborne weapon systems.

Auto Target Recognition: Target recognition technology for long range, all aspect non-cooperative identification of air targets is being transitioned to an Air Combat Command (ACC) 6.4-funded flight demonstration. Most critical to the combat utility of this capability was the achievement of a technology breakthrough for rapid rendering of synthetic target signatures. This technology has been adopted by the intelligence community to support the target recognition efforts of other services, as well as threat definition/validation activities. A "turn-key" system to produce synthetic signatures will transition to the intelligence community in FY96.

Fire Control: Real-time targeting information in the cockpit is a revolutionary concept exploiting the benefits of utilizing information from off-board sensors for precision air-to-surface attack. Technologies being developed will provide the warfighter the targeting solution required to deploy weapons against both stationary and moving ground based targets while minimizing the need to employ on-board sensors and increase platform observability. A preliminary evaluation using simulation and airborne data has been completed in support of HQ AF to establish the operational feasibility and utility of off-board targeting concepts. An evaluation has been completed in support of the HQ AF study to develop a targeting scheme using off-board information using laboratory and airborne data.

CHANGES FROM LAST YEAR

FY95 represented a year of change for the Targeting and Attack Avionics Thrust. In FY95, a Congressionally-directed cut of nearly 50 percent of the investments in target recognition and fire control caused the delay and termination of programs in support of critical user deficiencies.

In contrast, Congress directed the Targeting and Attack Avionics Thrust to invest $1.5M in the Navy Advanced Anti-Radiation Guided Missile Program (AARGM). In FY95, the Targeting and Attack Thrust began utilizing the users MAPs as a primary input to developing the investment strategy. Through in-depth involvement with the Technology Process Integrated Planning Teams (TPIPT), this thrust has been able to develop programs that satisfy the deficiencies of the users in the timeframe required. This process has also help ensure the users are establishing the necessary 6.4 programs to ensure technology is transitioned to the operational systems. The impacted efforts are described below.

Microwave Sensors

- Termination of technology development and evaluation of advanced electronic counter-countermeasure (ECCM) techniques needed to maintain air combat viability of airborne radars against emerging threat countermeasure systems.

Electro-Optical Sensors

- Downward redirection of the Advanced Infrared Search and Track (AIRST) program to develop a passive air target detection sensor for sustained supersonic operation. This program, critical to reducing sensor cost and weight while maintaining performance, was reduced to a wind tunnel evaluation of the highest risk subsystem, the window.

Auto Target Recognition

- A 48-percent reduction of USAF Science and Technology funds for the joint service, ARPA, university, and industry effort to develop reliable, automatic target recognition and attack technologies critically needed for wide area search, positive identification of targets before weapon release, cooperative engagement of off-board targeting, and flexible weapon deployment.

Fire Control

- Termination of the Advanced Target Attack (ATACK) program to complete development of software upgrades that provide multiple target kill per single pass over the target area.
- Addition of the Congressionally-directed AARGM program. AARGM will develop a dual mode (anti-radiation homing and active millimeter wave) seeker for a high-speed anti-radiation missile (HARM) application. This program will also evaluate potential payoffs for ACC through the incorporation of the AARGM technology in the mission area of preemptive destruction.

It is also important to note that the Targeting and Attack Avionics Thrust suffered a reduction of $31M across FY96-98 in the FY96 POM. This reduction will cause long term impacts in the ability of this thrust to provide affordable technology solutions to find, identify, and attack enemy threats at anytime, in any weather.

On a positive note, the Avionics Directorate and ARPA will be working together toward furthering MBV technology development and supporting infrastructure. Rapidly evolving plans represent an acknowledgment by the Joint Service automatic target recognition (ATR) community (including recce/intel customers) that the MBV discipline, pioneered within the Targeting and Attack Avionics Thrust, provides the best long-term approach to fielding critically needed ATR capabilities that are reliable and supportable.

MILESTONES

Four investment areas are used to outline plans and significant milestones within the Targeting and Attack Avionics Thrust: (1) microwave sensors, (2) electro-optical sensors, (3) target recognition, and (4) fire control.

Microwave Sensors

Development of microwave sensor technology focuses on beyond-visual-range detection and identification of conventional and low observable air targets operating in severe jamming and ground clutter environments. It also focuses wide area search, detection, and recognition of ground targets under adverse weather conditions and concealment by camouflage and foliage.

Using target and background clutter data and mission analysis accomplished in preceding efforts, the Concealed Target Detection program, jointly conducted with ARPA, will complete critical design of algorithms for wide area detection and classification of targets concealed by camouflage and foliage. In FY96, this effort will perform data collections to validate algorithm performance. This will lead to the development of a sensor specification for a flyable brassboard sensor to verify detection performance in FY98. Success criteria includes detection of more than 80 percent of concealed targets with near-zero false alarms.

Continued development of radar electronic protection (EP) techniques is critical to assure the warfighter sustained radar performance within expected dynamic electromagnetic interference environments of the future. The strategy for this investment is to concentrate on low cost, software-based solutions for quick upgrade of operational systems. During FY96, synthetic aperture radar (SAR) ECCM techniques will complete development and undergo data collection against the target electronic warfare (EW) threat. Success will be evaluated through the ability of the radar system to maintain detection and track capabilities in the presence of the EW threat.

In support of the visionary capability, low cost radar technologies, sensor architectures, and apertures are being explored. Specific emphasis is being given to development of adaptive processing techniques to accommodate difficult ground clutter conditions, enemy barrage noise jamming, low radar cross-section (RCS) targets, and unique radar installations within our own low observable aircraft.

Electro-Optical Sensors

While unable to perform within adverse weather environments, EO sensor technologies offer the unchallenged advantages of stealth and precision for pilotage, target identification, weapon aiming, obstacle detection, and short range environmental sensing. An additional advantage relates to human factors--rate of sensing and relative ease of image interpretation. During FY96, EO investments will exploit these advantages for covert pilotage with simultaneous target search, target/decoy discrimination, identification, and wind-corrected delivery of weapons and cargo.

The focus of the redirected AIRST program is to complete fabrication and laboratory evaluation (FY96) of full-scale panels for a low RCS IR window for sustained supersonic speeds; conduct cost/performance design trade-offs; and develop end-to-end simulation and modeling tools.

Successful experiments (FY95) in wind profiling using laser radar provide the technical confidence for follow-on demonstration with AFSOC and Air Mobility Command (AMC). Specifically, the ability to provide three-dimensional wind corrections to the Gunship AC-130 fire control solution for an increase in lethality while operating at higher altitudes and at longer stand-off ranges will be tested during FY95. Also in FY95-96, improvements in high altitude cargo delivery wind profiling will be developed and demonstrated. Wind profiling technology for gunship platforms will transition to Warner Robins, ALC in FY96.

Affordable Sensor Technology for Aerial Targeting (ASTAT) will address issues directly affecting the development and transition of IR sensor technology to operational systems--cost, size, weight, and complexity are excessive for a single-function sensor in fighter applications. This effort will explore concepts for expanding the IR Search and Track System (IRST) capability to include threat warning and air-to-surface targeting. Sensor technology will be developed and evaluated to reduce acquisition and life cycle cost.

The Joint Multi-Spectral Sensor Program (JMSP) will develop the technology required to perform passive, wide area search, detection, cueing, and targeting while defeating camouflage, concealment and deception. This technology may also support the warfighter's need for a bomb damage assessment capability. In FY96, JMSP will collect multi-spectral data and evaluate targeting algorithm performance.

Laboratory experiments and concept studies will build the foundation for improved visionary EO sensors for unambiguous situational awareness including detection and identification of targets and decoys. Multispectral sensing, integrated active/passive sensors, multifunction sensing architectures, and more affordable/reliable EO sensor systems will be explored.

Auto Target Recognition

Noncooperative identification of air targets and recognition of surface targets requiring wide area search and decoy discrimination including threats buried in foliage or concealed, are the principal challenges for this investment area. The rapidly evolving discipline of MBV invokes the tools and processes of target, background, and environment modeling, smart sensing, and hypothesis testing. Frequently misunderstood to be an ATR "algorithm" alternative, MBV provides a scientific framework for synthesis, application, evaluation, and mission support for all ATR algorithms. This approach, pioneered by the Wright Laboratory Mission Avionics Division, is now widely accepted and being pursued cooperatively with members of other services, industry, other Government laboratories, universities, ARPA, and the intelligence community.

All aspect angle, long range noncooperative identification of air targets will be a near-term success for the MBV process. Target recognition algorithms and supporting target signature databases have been developed in accordance with the MBV discipline. The algorithms will complete performance validation during FY95 and transition to operational testing under ACC 6.4 funding. Synthetic target signature generation capability will follow in the FY96-98 time frame. The success of the transition will be judged by the ability of the 6.4 program to integrate the algorithms and signature database into an operational radar system, and to perform long range, high confidence identification with low false alarm rates.

Other MBV successes relate to the problem of recognizing stationary and mobile surface targets. Using the same MBV principles and target signature prediction tools cited above for air target identification, synthetic signatures of surface targets can be predicted for high resolution SAR imagery. Already usable, to a limited extent, by the intelligence community for threat definition/validation, the same signatures provide reference models for maturing ATRs. Groundbased experiments will be conducted during FY96 to quantify performance of existing algorithms to support automated target cueing within U-2R, Moving and Stationary Target Acquisition and Recognition (MSTAR), and Theater Missile Defense (TMD) applications.

This technology will also provide the ACC TMD program with the ability to locate, identify, and attack massed armor, theater missile launchers and supporting infrastructure. In FY96, this effort will complete demonstration of an integrated radar and Forward Looking IR (FLIR) equipped with an automatic target cuer/recognizer for precision target detection and cueing.

Future investments will explore the use of MBV principles as a framework for automation of "situation determination." Preliminary (but superficial) assessments of this vision indicate MBV methods of evidence accrual and hypothesis formulation are directly usable for reduction of crew-member workload and decision timelines.

Fire Control

This investment area serves to integrate the products and capabilities of this thrust's "target finding" technologies, off-board targeting sources, and weapons to complete the function of "target engagement." Improved probability of kill, longer range/first shot engagement of air targets, cooperative attack, multiple kills per pass, workload reduction, and enhanced survivability are the primary mission drivers for this area.

Advanced "track before detect" technologies are being developed to extend the detection range of airborne targets. Algorithms completed in FY94 will be evaluated using flight data in FY95, and rooftop tested in FY96. Success will be measured in terms of significant increases in the detection range of both conventional and low-observable targets.

Concepts for improved accuracy of missile targeting and cooperative launch are being explored to enhance weapon system employment flexibility. Being sought is the ability to release air-to-air missiles at maximum range and to support weapons in flight for a first shot/kill capability without entering into the lethal range of the threat aircraft. Concepts conceived during FY95 will undergo engineering analysis in FY96-97. Metrics for success are the ability to cooperatively launch and support air-to-air missiles and improvements in weapon system accuracy.

Cooperative attack fire control continues to be an area of significant payoff in terms of fire control effectiveness for reduced weapon system cost and number of weapons needed to destroy a target. Fire control concepts for upgrade of air-to-air and air-to-surface subsystems through the use of all available targeting information are being evaluated. These concepts are in the early stages of formulation with the potential technology validation experiments in FY00.

Off-board targeting experiments are being pursued to include evaluations using F-15 test aircraft. This technology will support mission area plan requirements for TMD and Strategic Attack/Interdiction.

THRUST #2: ELECTRONIC WARFARE TECHNOLOGY

USER NEEDS

The Electronic Warfare Thrust develops technologies critical to resolving penetration and survival deficiencies within the following user-developed Mission Area Plans (MAPS): Electronic Combat, Surveillance/Reconnaissance, Counter Air, Strategic Attack/Air Interdiction, Space-based Navigation, Airlift, Air Refueling, and Special Operations - Weapon Systems.

Deficiencies in the area of Electronic Warfare are classified; however, general user needs fall into the following categories:

- Threat warning against laser and radar emitters that control air defense weapon systems
- Accurate threat identification in all portions of the frequency spectrum in order to aid situation awareness
- Warning of missile threats, whether guided by infrared, semi-active radar or active radar seekers
- Counter of autonomous and netted ground-based and airborne threat elements
- Defeat of infrared guided missiles by on-board or off-board countermeasure (CM) concepts
- Denial of effectiveness of lethal radar controlled weapons through use of on-board or off-board CM concepts
- Improvement of support CMs through CM payload improvements of both manned and unmanned air vehicles (UAV)
- Denial of effectiveness of threat command and control networks through advanced CM concepts

GOALS

The mission of this thrust is to develop and transition into operational combat systems, effective and affordable electronic warfare technology that will assure aircraft survivability during mission accomplishment. This will require technologies to provide aircrew alert and effective CMs against current and evolving threat weapon systems in a wide variety of mission scenarios. Specific goals have been identified in six major areas of technology investment. These goals are summarized as follows:

Radar/Missile ECM

- Develop effective, robust, radar CMs to Keep Missile on the Rail (KMOR)
- Develop advanced techniques to counter radio frequency (RF) missiles in the end game.
- Evaluate electronic countermeasures (ECM) against exploited foreign threats
- Develop advanced technology to assure affordable and reliable solutions

Missile Warning

- Develop affordable Infrared (IR) missile warning
- Develop laser warning
- Improve detection of low and suppressed IR signature threats
- Develop combined functions with targeting sensors

Situation Awareness/Threat Alert

- Improve detection, identification and location of high priority threat signals
- Develop data fusion of on-board and off-board data to enhance situation awareness
- Provide real-time intelligence information to the cockpit
- Exploit advanced technology to assure affordability of situational awareness capabilities

Infrared Countermeasures

- Develop deceptive jamming IR countermeasures (IRCM) to assure future survivability against advanced IR missiles
- Develop CM techniques for electro-optical (EO) and laser threats
- Conduct seeker exploitation to assure technique effectiveness against counter-countermeasure (CCM) circuits

Multispectral Expendables

- Develop active and passive RF decoy technologies which effectively deny effectiveness to threat missiles
- Develop IR decoy technology
- Develop dual mode IR/RF decoys to effectively degrade missile seekers using either or both portions of the spectrum

ELECTRONIC WARFARE TECHNOLOGY

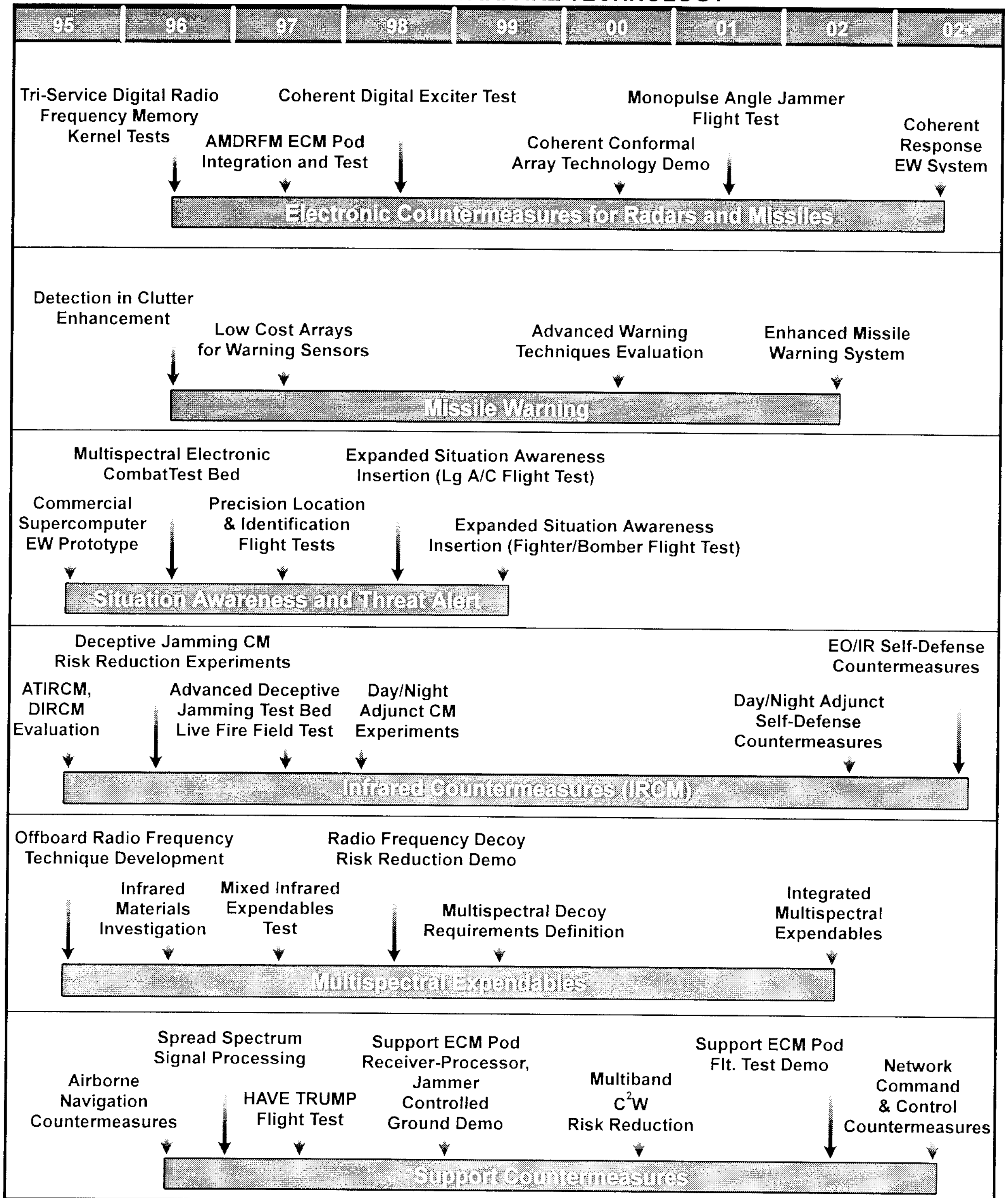


Figure 5. Electronic Warfare Technology Roadmap

Support Countermeasures

- Detect, exploit, and counter command and control networks, including radar sensors
- Develop means to stimulate threat radar network via electronic payloads on UAVs
- Develop electronic attack of threat airborne navigation and identification signals
- Develop jamming technology to degrade early warning and ground control intercept radars

The ultimate vision of this thrust is to continuously provide timely, prioritized, and effective solutions to the operational electronic warfare user's needs. This requires continuing baseline research into new concepts against evolving threats to assure the enemy cannot benefit through "surprise" threat technology. This baseline technology will be translated into solutions for real needs through a timely, highly focused program of work.

MAJOR ACCOMPLISHMENTS

Radar/Missile ECM: A new CM concept and its potential for being directly integrated into an operational jamming system was successfully tested against an advanced threat missile seeker. The concept, termed Terminal Threat Technique Optimization (T3O), was conceived and implemented solely through in-house analysis and evaluations.

Situation Awareness/Threat Alert: Improved situation awareness and optimized CM responses were demonstrated with applicability to a variety of aircraft and missions. The demonstration highlighted advanced software algorithms that used mission planning, on-board and off-board data sources to perform multi-source situational threat assessment, sensor management, and a situation dependent threat environment optimized response strategy. This technology, developed under the Advanced Defensive Avionics Response Strategy (ADARS), is being implemented in the Integrated Defensive Avionics Laboratory (IDAL) for the Multi-Spectral Electronic Combat Test Bed in support of the Enhanced Situation Awareness Insertion (ESAI) program.

Infrared Countermeasures: A methodology has been developed for performing parallel IR missile seeker exploitation and digital model development using graphical program tools. This methodology produces quality exploitation reports and detailed threat models in 12-14 months.

Extensive open-loop and closed-loop CM algorithm data runs were accomplished against semi-active laser guided weapons. Joint AF/Army live-fire field tests were successfully conducted at Redstone Arsenal utilizing TOW2 missiles to simulate laser beamrider missiles. In these field tests, CM power levels were determined.

The "HIGH GEAR" effort, investigating optimized IR paints for Air Mobility Command (AMC) aircraft including threat analysis performed by in-house and confirmed by field tests, was completed.

Multispectral Expendables: An exploitation of an advanced IR seeker with complex IR counter-countermeasure (IRCCM) processing was completed. Understanding of this threat system will aid the development of advanced IR decoy technology as well as upcoming AF/Navy field and captive carry testing.

Next generation distributed (a combination of on-board and off-board) decoy architecture concepts were defined including considerations such as aerobodies, amplifiers, and digital architectures.

Support Countermeasures: A new laboratory In-house capability was demonstrated that provides a capability to generate and test command and control warfare (C2W) techniques against a wide variety of current and future threats.

CHANGES FROM LAST YEAR

The major change from last year's plan was due to a large budget cut in the area of IRCM. Any effort related to "laser-based" IRCM was cut from the program due to perceived duplication with both a 6.4 Army and a Special Operations Command (SOCOM) program. The cut, however, did not allow for research into the continuing problem of advanced threats such as imaging seekers which are not a consideration in the other programs. In order to assure vitally needed research continues, thus maintaining an adequate technology base for countering advanced IR threats, an extensive revision of the plan was initiated. The revision includes inputs from other laboratories, the user, and other services. The goal is still to ensure that multiple advanced threats can be effectively and affordably countered using closed-loop IRCM concepts; however, effort has been delayed and restructured to more closely build upon and take advantage of the Army and SOCOM programs. This restructured effort is being accomplished with Army and Navy participation.

MILESTONES

Radar/Missile ECM

The first row of the roadmap describes milestones related to Radar/Missile ECM.

- 3Q96 - Strive to reduce the cost and size of Digital RF Memory (DRFM), a technology vital to the effectiveness of modern CM systems. The goal is to produce a single architecture that meets the jamming needs of all three services.
- 3Q97 - Integrate and test the advanced monolithic DRFM (AMDRFM) in an operational jamming system. The test will be conducted in a simulated threat environment such as IDAL.
- 3Q98 - Evaluate the coherent digital exciter (CoDE), the fundamental building block to be used in all future jammers to generate jamming signals against coherent monopulse radars.
- 3Q99 - Incorporate several new CM technologies into a single program in which various combinations will be tested. This will include DRFMs, microwave power modules (MPMs) and/or monolithic microwave integrated circuit (MMIC) technology.
- 3Q00 - Demonstrate the coherent conformal array technology to provide advanced ECM antennas that maintain low observability.
- 3Q01 - Demonstrate, through the Monopulse Angle Jammer Demonstration program an advanced jamming system that integrates all the coherent on-board technology with an advanced off-board jammer. The ultimate objective is KMOR; but if that fails, an engagement end game ECM will be provided.

Missile Warning

The second row on the roadmap lists three major milestones leading to an out year enhanced missile warning system.

- 3Q96 - Develop a technique for detecting passive IR missiles in high clutter environments, which will double the detection-in-clutter range while maintaining a false alarm rate of less than 0.2 per hour.
- 3Q97 - Develop processor algorithms to compensate for the reduced performance of uncooled IR detector arrays. Current focal plane arrays require cryogenic coolers that provide increased performance but have multiple drawbacks. The payoff is very low cost IR focal plane arrays to allow low cost IR missile warning systems.
- 3Q00 - Evaluate several techniques to determine the best performance versus cost trade-offs of the enabling technologies, ultimately leading to the cost-driven Enhanced Missile Warning System, the final milestone. (FY02)

Situation Awareness and Threat Alert

- 3Q95 - Incorporate several advanced commercial processors into standard-size line replaceable unit (LRU) prototypes, demonstrating the feasibility to directly replace existing processor LRUs. Advantages include increased processing speed, reliability, maintainability, and a vast amount of additional processing capability to support other planned improvements.
- 3Q96 - Provide a multispectral electronic combat test bed for the development and evaluation of situation awareness/threat alert technology.
- 3Q97 - Incorporate innovative techniques to fulfill the users' timing, precision location, and emitter identification requirements.
- 3Q98 - Incorporate off-board location and intelligence information and correlate it with the on-board information. This approach is expected to fulfill the increased information accuracy and timeliness needs of the users.
- 3Q99 - Conduct two separate flight test demonstrations of expanded situational awareness to satisfy the differing needs of fighter and bomber aircraft.

Infrared Countermeasures

The issues that must be resolved to incorporate a laser-based CM against IR threats will be investigated.

- 3Q95 - Evaluate first generation IRCM systems ATIRCM and DIRCM, against large aircraft IRCM requirements. Necessary modifications will be identified and programs will be focused to develop appropriate technologies.
- 3Q96 - Conduct deceptive jamming experiments to examine critical areas such as acquisition, pointing and tracking, threat understanding, and CM jam code development and effec-

tiveness.

- 3Q96 - Demonstrate trailing fiber optical cable CM techniques through flight tests against a typical laser designated missile.
- 3Q98 - Validate the concept of using closed-loop/open-loop CM techniques as a robust countermeasure for large aircraft through the advanced IRCM testbed. The testbed will be evaluated during a live fire field test at White Sands Missile Range.
- 3Q02 - Extend and focus the IRCM concepts toward a system demonstration for both day and night operations protecting both large and small aircraft.

Multispectral Expendables

The milestones for this area of the roadmap place primary emphasis on reducing the risk of developing a multispectral (multi-mode) expendable decoy.

- 3Q95 - Investigate and develop robust, novel expendable decoy techniques for RF countermeasures. Technique "merit" is determined by using modeling and simulation tools or hardware-in-the-loop tests.
- 3Q96 - Investigate and test next-generation advanced flare compositions for expendables through the IR Materials Investigation.
- 3Q97 - Integrate and test promising new advances in IR flare techniques and technologies through the Mixed IR Expendables effort. Prototype expendables will be developed and flight tested against advanced IR seekers.
- 3Q98 - Develop and demonstrate a brassboard prototype active RF expendable in the "RF decoy risk reduction" effort.
- 3Q99 - Integrate the results of the above efforts, as well as the current and projected applicable threat intelligence, into modeling and simulation tools to determine multispectral decoy requirements definition. The results of these concentrations will then culminate in a risk reduction effort (the last milestone) to integrate both the RF and IR countermeasure techniques and technologies into a single expendable that will function with existing countermeasures dispenser systems.
- FY02 - Through the integrated multispectral expendable effort provide a single expendable to counter threat seekers that utilize RF, or IR, or combinations of both, providing the aircraft with an increased missile CM capability, as well as significant savings in acquisition and logistics costs.

Support Countermeasures

- 3Q96 - Develop and test a brassboard to surgically deny an adversary's navigation aids without disrupting friendly navigation aids.
- 1Q97 - Develop theory and algorithms for the detection, characterization, and exploitation of spread spectrum waveforms.
- 4Q97 - Develop and flight test a capability to counter specific communication links without affecting other contiguous links.
- 4Q98 - Develop and ground test a brassboard escort jammer in an pod configuration.
- 4Q98 - Demonstrate a capability to jam and deny operation of the radar elements of the Integrated Air Defense System.
- FY00 - Demonstrate a low risk/risk reduction VHF-UHF communications digital jammer.
- FY02 - Flight test a full system brassboard of a support ECM pod to demonstrate ground network degradation.
- FY02+ - Demonstrate a capability to find the correct information network worldwide and surgically apply the correct CM techniques. This would deny a specific hostile force access to information that would help to target lethal weapons against our forces.

THRUST #3: SYSTEM AVIONICS

USER NEEDS

Many user needs have been identified through AFMC's Technology Master Process, and the joint AFMC/ACC Fighter Configuration Plan. These technology needs flow directly down from the operational deficiencies described by the MAJCOM users. In addition, the Scientific Advisory Board Summer Study on Aging Aircraft has identified "Obsolescent Avionics" as one of only two high leverage opportunities for extended life of our operational aircraft. The System Avionics Thrust develops technologies critical to resolving deficiencies in the following mission areas: Air-to-Surface, Counter Air, Special Operations Mobility of Forces in Denied Territory, Surveillance/Recce/Intel, Electronic Combat, Information Warfare, Mobility, Force Enhancement, Strategic Deterrence, & Modeling/Simulation. Further, these deficiencies have been prioritized across the fighter fleet. Deficiencies relative to System Avionics include:

Inadequate Situational Awareness

- Off-board sources
- On-board sources
- Information processing and fusion

Avionics for stealth operations

- Covert penetration
- Passive navigation
- Covert communications

Susceptibility to jamming

- Global Positioning System (GPS)
- Tactical communications

Dissemination of time critical data

- Targeting
- Threat
- Recce/Intel
- Bomb Damage Assessment (BDA)
- Missile Warning

Affordable, flexible, reliable, sustainable, available avionics

- Line Replaceable Unit/Module commonality
- Software design/support
- 2-level maintenance
- Open/hybrid architecture

Avionics for aging aircraft

- Integrated modular avionics across fleet
- Integration technology for legacy systems

GOALS

The objective of the System Avionics Thrust is to develop and transition into operational combat systems superior integrated avionics for full-spectrum offensive, defensive, and Communication, Navigation and Identification (CNI) operations. The technologies pursued in this thrust find pervasive application across the full range of combat missions and operational aircraft. The specific goals, as related to the deficiencies, reflect benefits to be achieved for the most stringent/demanding of requirements. Significant avionics cost, size, and weight savings have been shown for fully-fitted multiple-role aircraft. Benefits to other platforms, aging systems and related mission areas are scaleable.

Inadequate Situational Awareness

- Increase situational awareness - 10 fold
- Incorporation of off-board sources
- No mission impacts due to Operational Flight Program (OFP) anomalies
- Flexible/low-cost/open architecture signal & data processing
- No mission impacts due to run-time failures
- Improve processor speed 20 times without impacting fielded software - Save $1.5B
- Fault-tolerant, commercial off-the-shelf (COTS) based processors - 98 percent fault coverage built-in-self-test
- Improved avionics with machine intelligence

SYSTEM AVIONICS THRUST

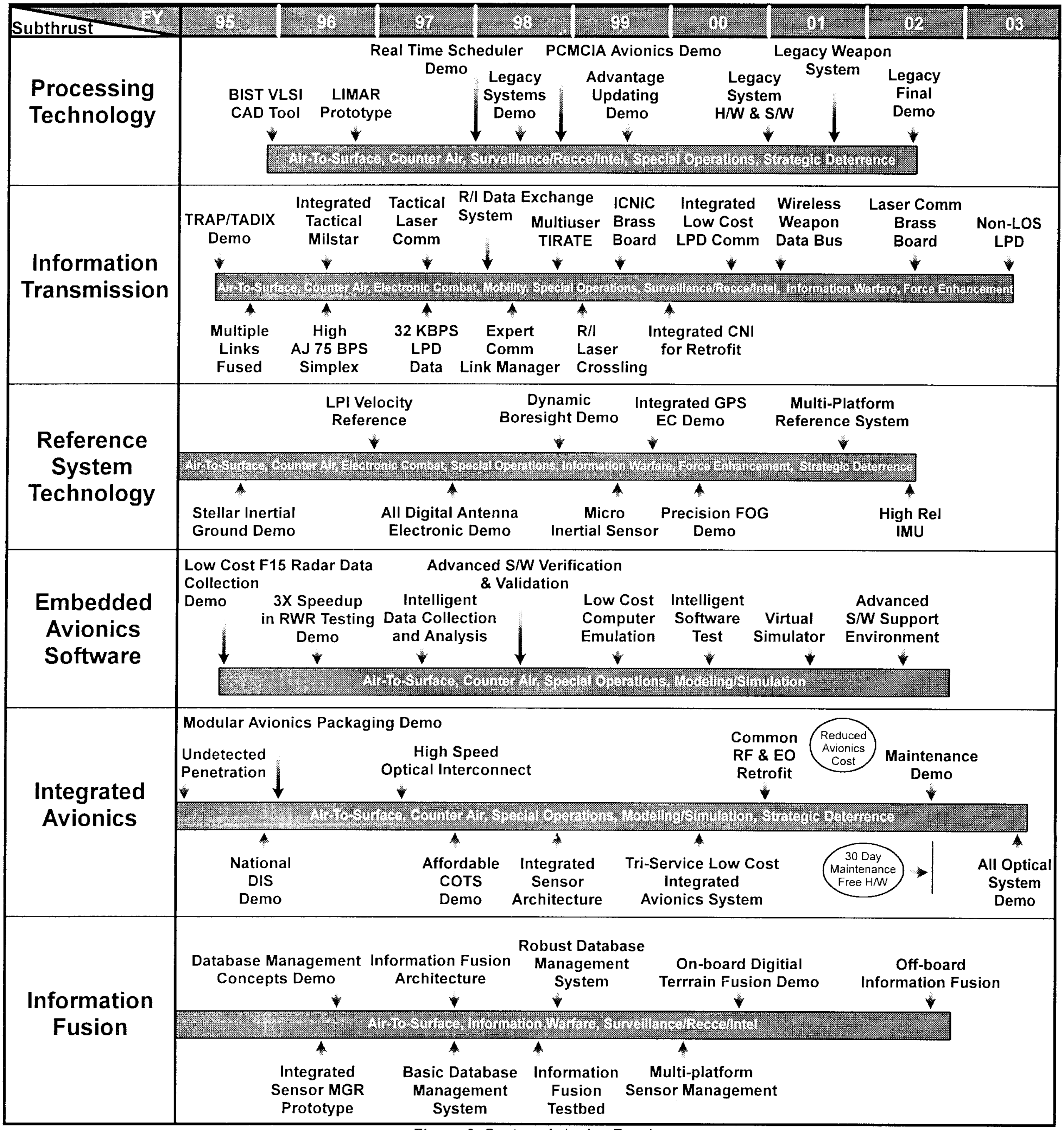


Figure 6. System Avionics Roadmap

Avionics for stealth operations

- Eliminate "comm-out" operations
- Electromagnetic signature - reduce sphere of vulnerability 80 percent
- Passive reference system accuracy - 3 fold increase
- High rate data transfer for covert cooperative engagements
- Low cost, low probability of detection voice & data transfer

Susceptibility to avionics jamming

- Jamming susceptibility of communication & reference systems - Reduce 50%
- Fault tolerant, integrated, nonemitting reference
- Jam-resistant, high accuracy GPS receivers

Dissemination of time critical data

- Target, threat, recce, BDA information dissemination - reduce timelines from days & hours to minutes & seconds
- Sharable database for system-wide exploitation

Affordable, flexible, reliable, sustainable, available avionics

- Emergency changes to Operational Flight Program (OFP) - under 24 hours
- OFP test stations - Reduce cost 50%
- OFP test - 100 times faster and 1/10 labor
- OFP development and maintenance - 10 times productivity
- Improve avionics flexibility & availability with reinforcement learning
- OFP block cycle changes - In budget under 1 year
- Avionics weight - reduce 50%
- Avionics volume - reduce 50%
- Reliability - improve 3 fold
- Flight-line maintenance personnel - reduce 20%
- Guaranteed-predictable processing
- COTS technology and standards to reduce avionics cost

MAJOR ACCOMPLISHMENTS

In order to meet the user needs, this thrust is organized into six subthrusts: 1) Processing Technology, 2) Information Transmission, 3) Reference System Technology, 4) Embedded Avionics Software, 5) Integrated Avionics, and 6) Information Fusion

Processing Technology

- Demonstrated advanced infrared algorithm on the Configurable Hardware Algorithm-Mappable Preprocessor (CHAMP). CHAMP out-performed the Texas Instruments TMSC80 Digital Signal Processor 27 to 1 showing this commercial field programmable logic array based architecture is the highest performing programmable signal processor available.

- Developed Advantage Updating general-purpose, learning controller in-house. In continuous time, this reinforcement learning system controls highly nonlinear systems previously difficult to control. Advantage Updating optimally controlled an aircraft in a missile avoidance simulation. The controller has been assigned AF invention #21153 and patent is pending.

Information Transmission

- Completed Tactical Laser Communications. Breadboard to provide omni-directional, hands-off, highly covert optical communications for Air Force Special Operations Command (AFSOC) helicopters and slow moving platforms during clandestine operations.

- Demonstrated TRAP and TADIXS-B links on Integrated CNI Avionics using Ada. This software will transition to the F-22.

Reference System Technology

- Completed and ground-tested world's first strapped-down, all-solid state, astro-inertial passive reference system. Provides three to five times improvement in cost and reliability and 70% reduction in size and weight.

- Developed and laboratory tested laser velocimeter for Low Probability of Intercept (LPI) velocity aiding of precision reference system for application to long range strategic penetrator aircraft and cruise missiles.

- Completed radio frequency (RF) wavefront simulator for laboratory testing GPS adaptive antenna electronics. It was integrated into our Communications System Evaluation Lab and Integrated Electromagnetic System Simulator & provides a one-of-a-kind capability to evaluate GPS under realistic jamming scenarios.

- Demonstrated Navigation Test Evaluation Laboratory (NavTEL) is a modular, reconfigurable test system with the flexibility to perform a wide variety of real-time GPS tests at greatly reduced costs. Transitioned NavTEL to test organization at Holloman Air Force Base.

Embedded Avionics Software

- Demonstrated tenfold increase in the number of threats that can be tested for radar warning receivers under the A Digital Avionics Methodology Schema (ADAMS) program. The prototype system was requested by the Special Operations Support Center for ALR-69 testing.

Integrated Avionics

- Transitioned blind-mate connector, high-density monolithic packaging using low temperature co-fired ceramic, receiver protection module, and RF built-in test design circuitry to F-22, F-16 & B-1B without completing test due to related S&T program cancellation and the high impact of these technologies as assessed by program offices and industry.

- Completed National Distributed Interactive Simulation (DIS) demonstration with all DIS modes and software implemented in Ada.

Information Fusion

- Developed sensor management architecture prototype based upon reasoning with uncertainty, prioritization, and scheduling formal methods.

- Developed sensor management demonstration prototype and research tool enabling future research to use the developed architecture and mathematical methods.

CHANGES FROM LAST YEAR

Wright Laboratory initiated integrated modular avionics programs for both near and far-term update of aging avionics. A refocused project in the Advanced Avionics Integration Program Element (PE 63253F), called Integrated Avionics for Aging Aircraft, was formulated to develop and transition common integrated avionics technology across the existing aircraft fleet. This project includes initiatives in integrated CNI, low-cost processor and software upgrade for legacy systems, and application of commercial technology.

A new subthrust, Information Fusion, has been added to this thrust. Information fusion includes information warfare initiatives in fusion architectures, fusion algorithm development, sensor management, and real-time database management.

Real-Time Schedulers for Parallel Processors (RTSPP) was stopped prior to contract award due to FY95 funding cuts. A revised program is planned for FY96 start with focus on scheduling distributed processor resources for aging aircraft.

The Integrated Sensor System (ISS) program was initiated with wide participation from the avionics industry. Industry committed a very talented team with high-level company support because this integration approach shows high potential to impact cost, reliability, and performance of future systems and for modernization of current systems.

MILESTONES

Major milestones in the System Avionics Thrust include the following:

Processing Technology

- FY96 - Demonstrate parallel techniques for VLSI built-in-self-test (BIST) providing high fault coverage, low test times, and minimum performance impact via simulations on realistic-sized commercial and military microcircuit designs.

- FY96 - Develop a non-scanning, eye-safe Laser IMaging And Ranging (LIMAR) receiver providing video rate range to and polarizing state for each pixel of the reflective surface.

- FY97 - Demonstrate capability to achieve guaranteed, predictable run-time performance of hard deadline real-time software for avionics executives on parallel processor architectures.

- FY97 - Demonstrate 100 million pixel per second, avionics form factor cockpit graphics display generator for display of time critical data in an integrated cockpit display.

- FY97 - Complete feasibility study for applying commercial Personal Computer Memory Card International Association (PCMCIA) technology to avionics. Build prototype PCMCIA avionics system and evaluate using COTS components.

- FY98 - Complete methodology for the implementation of dynamic, real-time scheduling algorithms which combine dynamic scheduling techniques with the predictability and analysis techniques of Rate Monotonic Scheduling for avionics applications.

- FY98 - Complete prototype militarized PCMCIA system evaluation and determine retrofit strategies for existing aircraft.

- FY98 - Demonstrate incremental 1750A computer upgrade methods to improve throughput and memory while retaining machine code compatibility with legacy software.

- FY99 - Demonstrate flexibility and performance of Advantage Updating reinforcement learning system in stressing avionics application.

- FY00 - Demonstrate scaleable parallel processor architecture for avionics applications such as automatic target recognition to provide high performance in a scaleable, open architecture.

- FY01 - Transition legacy computer upgrade methods to weapon system computer for aging aircraft.

Information Transmission

- FY96 - Demonstrate integrated CNI off-board intelligence links. Transition Ada software to F-22 for Real-Time Information in the Cockpit (RTIC) capability.

- FY98 - Demonstrate 1.54 Mbps airborne local area network for secondary dissemination of time critical BDA, threat, and targeting information.

- FY98 - Flight demonstrate low-power, lightweight, low-probability-of-detection recce/intel laser crosslink for airborne exchanges of data at rates up to 1.1 Gbps.

- FY99 - Demonstrate low cost covert, voice and data transfer, real-time adaptive techniques to improve Low Probability of Detection/Jam Resistant (LPD/JR) performance and electromagnetic interference/compatibility.

- FY99 - Complete Integrated CNI Subsystem (ICNIS) for aging aircraft based upon F-22 avionics. Demonstrate highly covert voice and data transfer using programmable common modules across the fleet for improved international interoperability, mission reliability, and life cycle costs. Demonstrate an affordable communications system upgrade capability for RTIC, Hostile Target ID, and Theater Missile Defense.

- FY01 - Demonstrate low cost wireless data bus for aircraft-to-weapon data transfer to eliminate rewiring existing aircraft for new weapons.

Reference System Technology

- FY96 - Conduct evaluation of first Precision Fiber Optic Gyroscope for high-accuracy passive navigation.

FY97 - Demonstrate fully-packaged, navigation-grade, micro-machined vibrating beam accelerometer to lower cost and improve reliability of aerospace inertial reference system.

- FY98 - Flight demonstrate an integrated inertial network providing increased accuracies for ACC precision targeting and strike.

- FY98 - Flight demonstrate low-cost, threat emitter locator for tactical aircraft using GPS, radar warning receivers (RWR)s, and short range, air-to-air data link.

- FY02 - Laboratory demonstrate affordable, all-solid state, inertial measurement unit with unprecedented reliability for accurate, available aircraft navigation, guidance, attitude, and flight management.

Embedded Avionics Software

- FY96 - Demonstrate complete ADAMS system to decrease RWR test setup throughput time by a factor of 3:1.

- FY96 - Demonstrate capability to detect, monitor, and record anomalous avionics behavior for rapid analysis and repair.

- FY97 - Demonstrate capability to detect anomalous avionics behavior and record appropriate data for quick analysis and repair on the ground.

- FY98 - Provide greatly enhanced capability for avionics software verification and validation.

- FY99 - Demonstrate low-cost capability to emulate computers with automated reconfiguration to improve manpower and resource utilization and reduce software development and weapon system trainer costs.

- FY00 - Demonstrate enhanced capabilities for automatically testing and analyzing weapon system software.

- FY01 - Demonstrate completely reconfigurable weapon system simulation/test system eliminating the need for expensive, individual simulators.

- FY02 - Demonstrate low cost software techniques for computer upgrade on aging aircraft using COTS hardware and software.

Integrated Avionics

- FY96 - ISS. Perform modeling, simulation and rapid prototyping to validate architectural integrity. Design ISS common RF modules, and initiate embedded control and application software design. Complete demonstration plan, defining signal sources, system control, functionality, operational capabilities, fault injection/recording and post demonstration data capture and analysis.

- FY97 - Fabricate/emulate and test ISS common module types. Code and unit test system control and embedded application software.

- FY99 - Demonstrate low cost in-flight mission training and rehearsal system for Special Operations infil/exfil aircraft.

- FY00 - Demonstrate reconfigurable, geographically distributed simulator environment capable of simultaneous, multiple scenario testing.

- FY00 - Demonstrate low-cost, integrated avionics for an entire avionics suite.

- FY01 - Transition a common RF and EO system approach for aging aircraft.

- FY02 - Demonstrate zero avionics maintenance.

Information Fusion

- FY96 - Demonstrate Integrated Sensor Manager prototype.

- FY96 - Demonstrate the contribution of integrated database management concepts to situational awareness, stealth operations, data dissemination, and reduced software costs.

- FY96 - Develop integrated on-board, real-time avionics database management system components including database definition, application program interface specification, object definition, manipulation and control language specifications, and test scenario definitions.

- FY97 - Demonstrate a baseline information architecture for avionics data fusion.

- FY97 - Demonstrate basic, real-time, object-oriented avionics database management system for common data store and sharing data types (sensor, mission, map, track...) across avionics subsystems to improve accuracy and software reuse while decreasing database and application modification time.

- FY98 - Develop and implement information fusion testbed which will be a Wright Laboratory "Center" for information fusion evaluation competitions and demonstrations.

- FY98 - Complete information fusion testbed development.

- FY00 - Demonstrate prototype, real-time data base management system with stored terrain, obstacle, feature, and "all source" threat data in a multi-level secure environment.

- FY02 - Demonstrate information fusion architecture with seamless processing from off-board data collection through real-time cockpit display.

THRUST #4: ELECTRON DEVICES

USER NEEDS

Over the past three decades electron device technology has provided unprecedented enhancements in the superiority of Air Force weapons systems. New technologies are continually emerging and continued support and exploitation of these technologies is key to satisfying the following future customer needs:

- Reliable radar for all weapons systems
- Real time, low power signal processing and information transfer
- Target recognition/location in adverse weather
- Multi-wavelength infrared (IR) countermeasures
- Electronics affordability (reliability, maintainability and supportability)
- Obsolete parts replacement

These technology needs are referenced in the following three Technical Planning Integrated Product Team Documents (TPIPTs):

- ASC: Air-to-Surface; Counter Air; Electronic Combat
- ESC: Surveillance/Recce
- SMC: Force Enhancement

The Electron Devices Thrust addresses these and other user needs with three functional areas: Microelectronics, Radio Frequency (RF) Components and Electro-Optical (EO) Devices. It resolutely directs its resources toward solutions that cannot be achieved with commercial, off-the-shelf (COTS) technology. We work closely with Rome Laboratory and other DoD organizations in the Electron Devices area.

GOALS

Microelectronics - develops and transitions new device technology to address the need for affordable, higher throughput signal processing devices that must often withstand severe environments. This area is focused primarily on developing:

- New device phenomenon
- Improved packaging and interconnect
- Cost effective design and manufacturing methodology able to accommodate the complexity of future electronic systems
- An approach to survivable, failure free electronics
- Micromachining technology for high performance microsensors
- High temperature device technology for turbine engine control and remote microwave sensors
- Minimally packaged known good die (KGD) for multi-chip assemblies
- Distributed power with near point of load power conversion

The need for shorter design times and lower life cycle costs will be met by developing various automatic design synthesis tools with a library of models for components of interest to the Air Force.

RF Components - research and development is concerned with satisfying the future requirements for airborne and space-based radar, communications, electronic warfare (EW), and smart weapons through the generation, control, propagation, and detection, of microwave and millimeter wave signals. The major emphasis is on developing:

- Solid state power amplifiers for phased array antennas needed in multifunction radar, electronic warfare, and communications systems
- Microwave and millimeter wave power modules for advanced radar and electronic warfare systems
- Affordable, small volume millimeter wave integrated circuits (ICs) for terminal guidance applications
- Affordable vacuum electronics for radar, communications and EW systems
- Multifunction phased arrays for advanced radar/EW/communications systems
- High power, high efficiency microwave/millimeter wave transmitters for airborne and space-based platforms

Another focus is toward demonstrating microwave/digital, mixed-mode electronics for EW and radar applications.

ELECTRON DEVICES THRUST

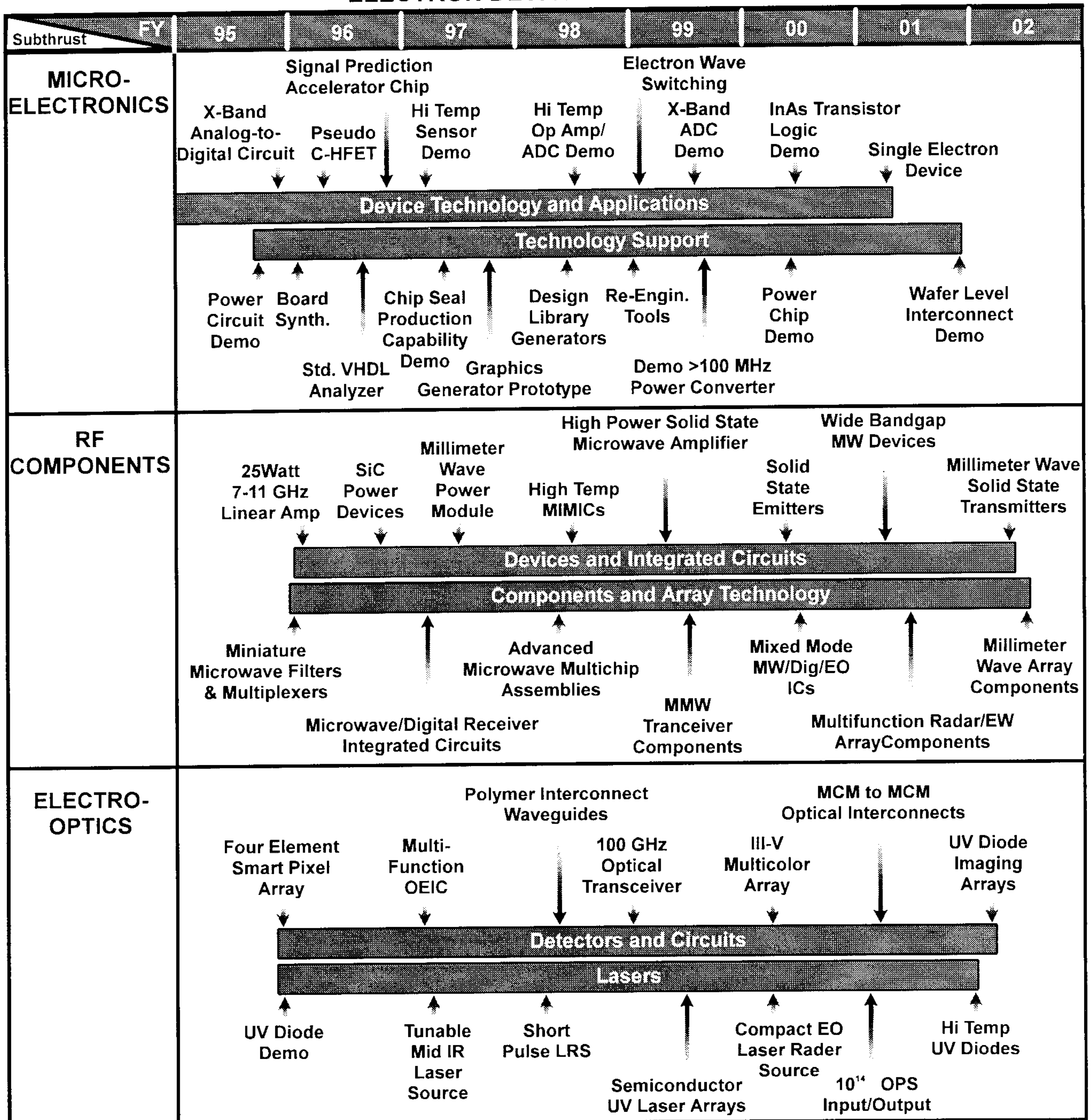


Figure 7. Electron Devices Roadmap.

EO Devices - provides a device and component technology base that transitions basic materials and device research concepts into advanced development approaches for system prototypes. The approach is continually guided by such system needs as active and passive sensors for communications, laser radar, IR countermeasures (IRCM), weapon delivery and target tracking, recognition, and classification. Applications platforms vary from ground equipment through aircraft and missiles to space vehicles. The approach involves the conception, development and initial demonstration of high performance sources (lasers), detectors (arrays), and photonic/fiber optic devices and EO phenomena, with the exploitation of these devices and phenomena for application to tactical and strategic systems. The majority of the programs focus on:

- More complete spectral coverage
- High speed and throughput processing
- Increased optical sensitivity and power

- More accurate, higher resolution sensor capabilities
- Monolithic optoelectronic/digital/microwave circuits to improve system performance and reduce cost
- Low power, 2-5 micrometer tunable laser for laser radar & IRCM
- Optical interconnects for high speed digital processing

The devices, packaging and design tools realized within these three areas will continue to build upon the strong technology base ultimately responsible for high performance, reliable and affordable systems in the Air Force.

MAJOR ACCOMPLISHMENTS

Microelectronics: Accomplishments include advancing from GaAs to InP-based materials, improving existing device structures, such as quantum devices and high density Complementary Heterostructure Field Effect Transistors (C-HFETs) for very large scale integration. The C-HFET technology, developed by the Air Force over the last several years for high speed signal processing application, has been successfully transitioned to one commercial manufacturing pilot line facility and is being transferred to a second commercial pilot line facility.

A micro-machined pressure sensor exhibiting a sensitivity of 4KHz/psi was demonstrated in FY94. As a result of the success with the pressure sensor and the progress on a micro-accelerometer, a complementary Navy funded program was integrated with the Air Force effort to enhance device yield and performance.

The follow-on effort in high temperature electronics was awarded in 4Q94. This joint program between the Solid State Electronics Directorate and the Aero Propulsion and Power Directorate is aimed at engine control applications. This directorate is also working closely with the Materials Directorate to resolve a dopant problem in the epitaxial layer of the silicon carbide material. It is anticipated this materials effort will also include participation from NASA Lewis and the National Institute of Standards and Technology (NIST).

In the area of distributed power, a 50 VDC to 5 VDC, 50 watt power converter module, which switches at 100 Mhz, has been fabricated using high density, interconnect packaging technology and achieved greater than 200 watts per cubic inch power density.

In FY95, Parameterized VHSIC Hardware Description Language (VHDL) Generator Technology was pioneered by a small business for the design of finite impulse response (FIR) filters, that generates near-custom designs of FIR filters in minutes. A Beta-Version of a VHDL Accelerator that executes on multi-processor desktop workstations was demonstrated by a university/small business team. Commercial simulator vendors are expressing interest.

RF Components: Microwave heterojunction bipolar transistor (HBT) Monolithic Microwave Integrated Circuit (MMIC) amplifiers were designed and fabricated that produce 20 watts continuous wave output power, with 40% power-added efficiency over the 7.25-7.75 GHz frequency band. These power amplifiers are used for advanced SHF communications transmitters. They offer more power and efficiency than what is commercially available from foreign sources. In the area of high temperature electronics, microwave silicon carbide field-effect transistors have been designed, fabricated and tested that produce 3.5 watts with 5 dB gain at 6 GHz. The ARPA/Tri-Service MIMIC program, which ends in FY95, has achieved significant results in making Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) chips more affordable for a broad range of military systems. Chip costs have been reduced by a factor of 10, chip fabrication yields have been doubled, and chip area with equivalent or better performance has been reduced by a factor of 3 to 4. MIMIC chips have been inserted into systems, such as F-22 radar/EW, AMRAAM, LANTIRN, and ALQ-135. A new jointly funded program with the Army/ARL was initiated to develop methodologies and approaches to enhance the fabrication yield of MMICs and multi-chip assemblies. It focuses on design for high yield, chip selection, and chip testing/screening techniques.

EO Devices: Passive polymer optical waveguides have matured dramatically. Low loss, and even more critical, high temperature, chemically stable devices were demonstrated along with several architecturally superior techniques for coupling of light into the waveguide itself. This Air Force developed technology has become so promising that Intel Corp. has recognized it as critical to their future high speed systems. ARPA funding has significantly increased the level of effort in this area.

Significant advancements in III-V based IR detectors/arrays Gallium Arsenide (GaAs) were demonstrated in-house where state-of-the-art performance parameters were achieved at higher than normal operating temperatures. This technology is being applied to multi-wavelength (dual) detector concepts both contractually and in-house. Diode like performance was demonstrated in GaAlN based detector arrays. Both contractual and in-house efforts lead to advancement of the technology.

CHANGES FROM LAST YEAR

Microelectronics: Consolidating the contractor's facilities will result in an unavoidable delay in the pseudomorphic C-HFET program. The equipment used to fabricate these devices will be moved to the contractor's facility, which currently houses their commercial production lines. A new FY95 effort will be initiated to optimize a monolithically integrated technology. This effort is intended to expand the state-of-the-art in speed, power, and density by demonstrating complex functions such as logic, memory, and control on the same substrate without incurring the penalty of chip-to-chip interconnects.

The planned demonstration of a micro-accelerometer for navigation systems was delayed approximately six months. This delay allows incorporating process enhancements from a complementary Navy program into the final Air Force fabrication run. The process enhancements are expected to increase both device yield and performance.

The planned FY95 power device development effort was not awarded due to unacceptable risk in all approaches. Device development work will continue, internal to the Air Force and in industry, with a planned resolicitation of this critical area in FY96.

RF Components: In FY95, 6.3A funds were partially restored. The resources are being used to partially fund the AWACS broadband vacuum electronics power amplifier demonstration, continue work on miniature filters for radar/EW arrays, and demonstrate microwave/digital mixed-mode receivers for radar and EW applications.

Work will be initiated to demonstrate high density packaging technology for phased array antenna power distribution systems. Work on the ARPA/Tri-Service Microwave and Analog Front-End Technology (MAFET) program will result in contract awards in mid-FY95. The Solid State Electronics Directorate is the Air Force's lead organization. A joint Technology Reinvestment Project (TRP) was initiated with ARPA this year to address microwave and millimeter wave wireless communications and intelligent vehicle highway systems.

EO Devices: Air Force research and development of low power lasers changed dramatically in the past year. While the areas of research remain basically the same, the relationships among all governmental organizations have remained in a constant flux. ARPA has continued to be a major funding source for lasers for many applications, including optical countermeasures. Jointly coordinated (DoD level) program plans are being developed to meet future DoD requirements in this technology area. The technology base for IRCM devices has also led to development plans for 2 micro-meter sources for laser radar. Emphasis is shifted to shorter pulse lengths and increased frequency stability.

This year, increased emphasis has been placed on ultraviolet (UV) sources (lasers/light emitting diodes) for various applications from communication to integrated circuit patterning. Joint programs are underway with Phillips Laboratory to develop the UV technology needed for space and aircraft applications. New teaming agreements and understanding among the Air Force laboratories are allowing the breadth of the Air Force laser expertise to be efficiently applied to many varieties of laser related research and applications.

MILESTONES

Microelectronics:

FY96-98 emphasizes devices for 10-25 GHz digital clock and analog-to-digital converter (ADC) sampling rates, and for greatly improved processor throughput rates per watt of power dissipation. Device types entail C-HFETs, nanoelectronics and new, higher density techniques for logic implementation and HBTs for direct X-band analog-to-digital conversion.

GSPS, 4-bit ADC chip
• FY95, early FY96 - demonstrate and evaluate the first and second iteration. Provide supporting packaging and interconnect technology and design tools.

Inertial Reference Microsensors
• 2Q95 - demonstrate the microbeam accelerometer.
• Late FY96 - have a fully integrated microsensor design as a result of the new High Performance Sensor program.
• 3Q98 - demonstrate integrated microsensor.

High temperature electronics
• 1Q96 - complete the optimized silicon carbide process.
• 4Q97 - fabricate an advanced operational amplifier in silicon carbide for turbine engine control.
• 2Q98 - fabricate the first high temperature ADC.

Joint analog/digital power distribution effort
• 4Q95 - initiate effort.
• 4Q96 - complete architecture tradeoff studies.

3-D Virtual Reality Multichip Module program (working closely with Rome Laboratory)
• FY96, 97, 98 - stress the latest CAD silicon compiler, built-in-self-test, and multichip module design technologies as well as pioneer and demonstrate a design process for generating very rapid upgrades to new generation IC technologies such as silicon-on-insulator (SOI) and GaAs C-HFET.
• FY96 - complete an application specific synthesis tool and a silicon compiler specifically for the design of custom analog and digital neural network circuits.

RF Components:

FY96-98 focuses on developing microwave and millimeter wave components and ICs for airborne and space-based radar, EW and communications applications.

Transmitters
• FY96-01 develop and demonstrate both solid state and vacuum electronics components.
• 3Q96 - continue work on extending SiC power devices to 10 GHz.
• 3Q96 - research on HBT power amplifiers for phased array radars, at 7-11 GHz.

Millimeter wave power modules
• 3Q97 - demonstrate in the 18-40 GHz frequency range for EW transmitters. In-house design and modeling capabilities will be enhanced to evaluate new IC and multi-chip assembly approaches in terms of performance and affordability.

Mixed-mode microwave/digital components
• 1Q01 - develop highly integrated components to be demonstrated for radar, EW and communications applications.
• 1Q02 - apply the IC and component advances to demonstrate advanced multichip assemblies for future active aperture systems.
• FY96-01 - continue in-house work on MMIC material/device correlation and analysis with the goal of coupling the effort to the ARPA/Tri-Service MAFET program to enhance chip performance and affordability.

Solid state emitters
• FY99-FY02 - develop emitter based on wide bandgap semiconductors (FY01), millimeter wave transceiver components (FY99), mixed mode microwave/ digital/ optoelectronic components (FY00), and multifunction radar/ EW/communications components (FY01).

EO Devices:

Detector arrays made of III-V materials require developing focal plane array (FPA) technology in the full spectral band including UV through far IR.

Multispectral detector arrays in the IR
• FY 98 - develop for applications requiring multisignatures in a single aperture device, emphasizing high performance and reliability through the implementation of GaAs technology. Resulting in a dual band IR device.

Fifteen watt tunable mid-IR flight qualifiable laser
• FY98 - develop, in a joint effort with Phillips Laboratory, for future AF space platforms.

Optical interconnects
• 1Q01 - address critical needs for future high speed signal processors both as back-plane interconnect, as well as between multichip modules

Passive polymer waveguide devices
• FY97 - demonstrate.

High speed optical transceivers
• FY99 - demonstrate.

GLOSSARY

A	
A/C	Aircraft
AARGM	Advanced Anti-Radiation Guided Missile Program
ABIT	Airborne Imagery Transmission
ACC	Air Combat Command
ACP	Associative CoProcessor
ADAMS	A Digital Avionics Methodology Schema
ADARS	Advanced Defensive Avionics Response Strategy
ADC	Analog-to-Digital Converters
ADCOM	Adaptive Communications
ADV	Advanced
AF	Air Force
AFAE	Air Force Acquisition Executive
AFB	Air Force Base
AFIT	Air Force Institute of Technology
AFMC	Air Force Materiel Command
AFOSR	Air Force Office of Scientific Research
AFSOC	Air Force Special Operational Command
AIRST	Advanced Infrared Search and Track
ALC	Air Logistics Center
AMC	Air Mobility Command
AMDRFM	Advanced Monolithic Digital RF Memory
AMRAAM	Advanced Medium Range Air-to-Air Missile
APT	Acquisition, Pointing, and Tracking
APTAS	Automatic Programming Technologies for Avionics Systems
ARPA	Advanced Research Project Agency
ASAAC	Allied Standard Avionics Architecture Council
ASAP	Advanced Shared Aperture Program
ASC	Aeronautical Systems Center
ASIRT	Avionics Systems Integration Research Team
ASTAT	Affordable Sensor Technology for Aerial Targeting
ATACK	Advanced Target Attack
ATARS	Advanced Tactical Air Reconnaissance System
ATC	Automatic Target Cueing
ATD	Advanced Technology Demonstration
ATIRCM	Advanced Threat IRCM
ATR	Automatic Target Recognition
ATTD	Advanced Technology Transition Demonstration
AutoVal	Automated Validation
B	
BDA	Bomb Damage Assessment
BIPS	Billion Instructions Per Second
BIST	Built-In-Self-Test
BTI	Ballistic Technology Initiative
C	
C^2	Command and Control
C^2W	Command and Control Warfare
C^3	Communications, Command, and Control
C^3I	Control, Communications, Command, and Intelligence
CAD	Computer-Aided Design
CARTS	Common Ada Run Time System
CC&D	Camouflage, Concealment, and Deception
CCM	Counter-countermeasure
CHAMP	Configurable Hardware Algorithm-Mappable Preprocessor
C-HFET	Complementary Heterostructure Field Effect Transistor
C-HIGFET	Complementary Hetero-structure Insulated Gate Field Effect Transistor
CIP	Central Integrated Processor

GLOSSARY

CM	Countermeasure
CNI	Communications, Navigation, and Identification
CoDE	Coherent Digital Exciter
COTS	Commercial Off-the-Shelf Technology
CRDA	Cooperative R&D Agreements
CW	Continuous Wave

D

DARPA	Defense Advanced Research Projects Agency
dB	Decibel
dc	Direct Current
DEA	Data Exchange Agreement
DIA	Defense Intelligence Agency
DIRCM	Digital IRCM
DIS	Distributed Interactive Simulation
DKF	Distributed Kalman Filter
DoD	Department of Defense
DRFM	Digital RF Memory

E

ECCM	Electronic Counter-Countermeasures
ECM	Electronic Countermeasures
EL	Solid State Electronics Directorate
EMC	Electromagnetic Compatibility
EMD	Engineering Manufacturing Development
EMI	Electromagnetic Interference
EO	Electro-Optic
EO-IR	Electro-Optic-Infrared
EP	Electronic Protection
ESAI	Enhanced Situation Awareness Insertion Program
ESC	Electronics System Center
EW	Electronic Warfare

F

FIR	Finite Impulse Response
FLASER	FLIR/Laser
FLIR	Forward-Looking Infrared
FPA	Focal Plane Array
FRACTIL	FLIR Automatic Cueing Technology Insertion into LANTRIN
FY	Fiscal Year

G

GaAs	Gallium Arsenide
GATS	GPS-Aided Targeting System
GHz	Gigahertz
GPS	Global Positioning System

H

HADIS	High-Speed Instrumentation System
HARM	High-Speed Anti-Radiation Missile
HBT	Heterojunction Bipolar Transistor
HDMP	High Density Microwave Packaging
HHLR	Hand Held Laser Radios
HIVASP	High Value Asset Self Protection Program
HQ	Headquarters
HTSC	High Temperature Super Conductor
H/W	Hardware

I

IADS	Integrated Air Defense System
IC	Integrated Circuit
ICNIA	Integrated Communications Navigation Identification Avionics
ICNIS	Integrated CNI Subsystem
ID	Identification
IDAL	Integrated Defense Avionics Laboratory
IEEE	Institute for Electrical and Electronics Engineers

GLOSSARY

IESS	Integrated Electromagnetic System Simulator
IF	Intermediate Frequency
IFF	Identification Friend or Foe
IFPS	Intra Formation Positioning System
IFSAR	Interferomic Synthetic Aperture Radar
ILIR	Independent Laboratory Innovative Research
IMU	Inertial Measurement Unit
INEWS	Integrated Electronic Warfare System
InP	Indium Phosphide
INS	Inertial Navigation System
IPT	Integrated Product Team
IR	Infrared
IRCCM	Infrared Counter-Countermeasure
IRCM	Infrared Countermeasures
ISS	Integrated Sensor System
ITB	Integrated Test Bed
IR&D	Independent Research and Development
IRST	Infrared Search and Track

J-K

JIAWG	Joint Integrated Avionics Working Group
JMSP	Joint Multi-Spectral Sensor Program
JR	Jam Resistance
KGD	Known Good Die
Khz	Kilahertz
KMOR	Keep Missile on the Rail

L

LANTIRN	Low Altitude Navigation and Targeting Infrared System for Night
LPD	Low Probability of Detection
LPD/JR	Low Probability of Detection/Jam Resistant
LPI	Low Probability of Intercept
LIFE	Laser Infrared Flyout Experiment
LIMAR	Laser IMaging and Ranging
LRU	Line Replaceable Units
LWIR	Long Wavelength Infrared

M

MAFET	Microwave and Analog Front-End Technology Program
MAJCOM	Major Command
MAP	Mission Area Plan
MBV	Model-Based Vision
MCM	Multichip Module
MHz	Megahertz
MIMIC	Microwave/Millimeter Wave Monolithic Integrated Circuit
MMIC	Monolithic Microwave Integrated Circuit
MMW	Millimeter Wave
MNS	Mission Needs Statement
MOA	Memorandum of Agreement
MOSIAC	Modeling System for Advanced Strategic Tactical Expandable Investigation of Countermeasures
MOU	Memorandum of Understanding
MPM	Microwave Power Module
MPP	Modernization Planning Process
MSTAR	Moving and Stationary Target Acquisition and Recognition

N

NASA	National Aeronautics and Space Administration
NavTEL	Navigational Test Evaluation Laboratory
NIST	National Institute of Standards and Technology

O

OATC	Ohio Advanced Technology Center
OEIC	Opto-Electronic Integrated Circuit
OFP	Operational Flight Program
ORTA	Office of Research and Technology Applications

GLOSSARY

OSD — Office of Secretary of Defense

P

PCMCIA — Personal Computer Memory Card International Association
PE — Program Element
PL — Phillips Laboratory
PRF — Pulse Repetition Frequency

R

RAD — Random Agile Deinterleaver
RAMTIP — Reliability and Maintainability Technology Insertion Program
RCS — Radar Cross-Section
R&D — Research and Development
RF — Radio Frequency
RM&S — Reliability, Maintainability, and Supportability
RTAIS — Real-Time Artificial Intelligence System
RTIC — Real-Time Information in the Cockpit

RTS — Relative Targeting System
RTSPP — Real-Time Schedulers for Parallel Processors
RWR — Radar Warning Receiver

S

S&T — Science and Technology
SAB — Scientific Advisory Board
SAR — Special Access Required
SAR — Synthetic Aperture Radar
SATCOM — Satellite Communications
SBIR — Small Business Innovation Research
SDI — Strategic Defense Initiative
SEM-E — Standard Electronic Module
SHF — Super-High Frequency
SOCOM — Special Operations Command
SOF — Special Operations Forces
SOI — Silicon-on-Insulator
SPO — System Program Offices

STARS — Surveillance Target Attack Radar System
STIG — Space Technology Interdependency Group
S/W — Software

T

T3O — Terminal Threat Technique Optimization
TADIX — Tactical Data Information Exchange System
TAP — Technology Area Plan
TEO — Technology Executive Officer
TIBS — Tactical Information Broadcast Service
TMD — Theater Missile Defense
TMP — Technology Master Process
TPIPT — Technical Planning Integrated Product Team
T/R — Transmit/Receive
TRAP — Tactical Receive Applications
TRP — Technology Reinvestment Project
TTO — Technology Transition Officer

U

UAV — Unmanned Air Vehicle
UHF — Ultra-High Frequency
UHR — Ultra-High Resolution Radar
USAF — United States Air Force
USSOCOM — United States Special Operations Command
UUT — Unit Under Test
UV — Ultraviolet

V-W

VDC — Volts dc
VHDL — VHSIC Hardware Description Language
VHF — Very-High Frequency
VHSIC — Very High Speed Integrated Circuit
VLSI — Very Large Scale Integration
VSIM — Virtual Simulator

WL — Wright Laboratory
WPAFB — Wright-Patterson Air Force Base
WTC — Wright Technology Center

TECHNOLOGY MASTER PROCESS OVERVIEW

USER NEEDS

Part of the Air Force Materiel Command's (AFMC) mission deals with maintaining technological superiority for the United States Air Force by:

- Discovering and developing leading edge technologies
- Transitioning mature technologies to system developers and maintainers
- Inserting fully developed technologies into our weapon systems and supporting infrastructure, and
- Transferring dual-use technologies to improve economic competitiveness

To ensure this mission is effectively accomplished in a disciplined, structured manner, AFMC has implemented the Technology Master Process (TMP). The TMP is AFMC's vehicle for planning and executing an end-to-end technology program on an annual basis.

The TMP has four distinct phases, as shown in Figure 8:

- Phase 1, **Technology Needs Identification** - Collects customer-provided technology needs associated with both weapon systems/product groups (via TPIPTs) and supporting infrastructure (via CTCs), prioritizes those needs, and categorizes them according to the need to develop new technology or apply/insert emerging or existing technology. Weapon system-related needs are derived in a strategies-to-task framework via the user-driven Mission Area Planning process.
- Phase 2, **Program Development** - Formulates a portfolio of dollar constrained projects to meet customer-identified needs from Phase 1. The Technology Executive Officer (TEO), with the laboratories, develops a set of projects for these needs requiring development of new technology, while

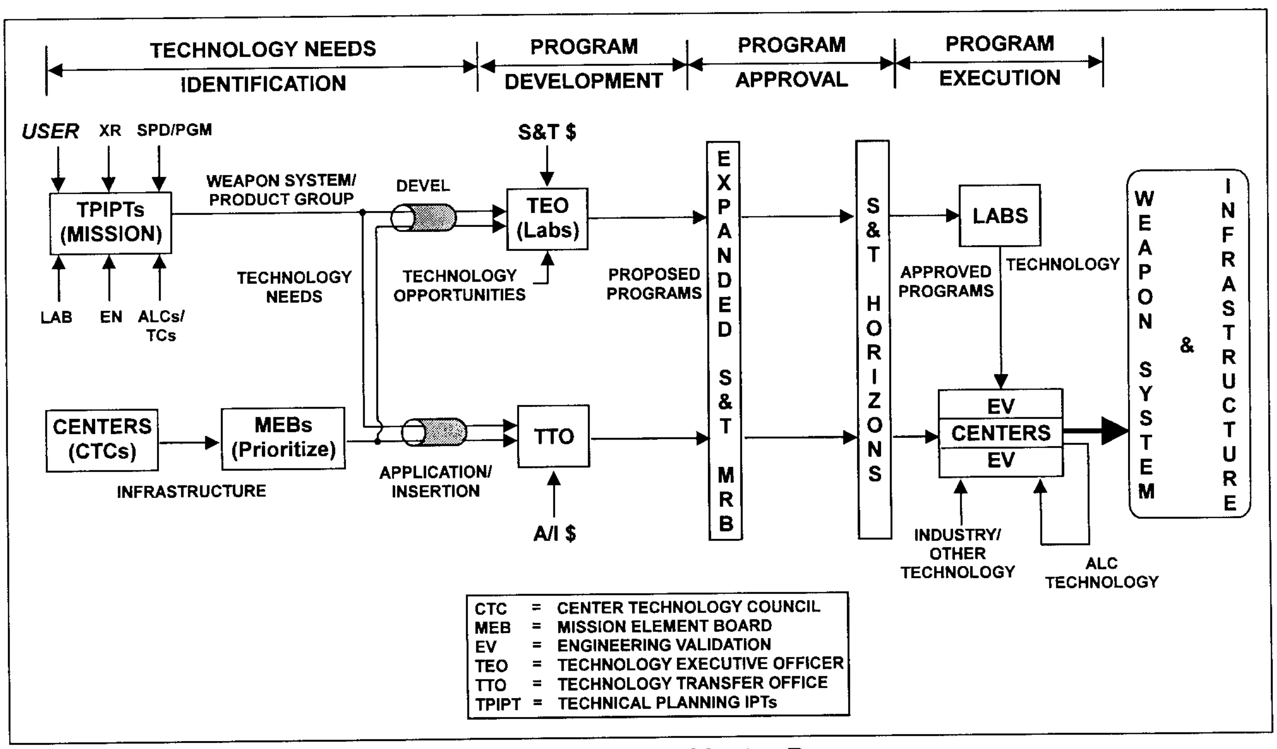


Figure 8: Technology Master Process

the Technology Transition Officer TTO) orchestrates development of a project portfolio for those needs which can be met by the application/insertion of emerging or existing technology.

- Phase 3, **Program Approval** - Reviews the proposed project portfolio with the customer base via an Expanded S&T Mission Element Board and later, the AFMC Corporate Board via S&T HORIZONs. The primary products of Phase 3 are recommended submissions to the POM/BES for S&T budget and for the various technology application/insertion program budgets.

- Phase 4, **Program Execution** - Executes the approved S&T program and technology application/insertion program within the constraints of the Congressional budget and budget direction from higher head-quarters. The products of Phase 4 are validated technologies that satisfy customer weapon system and infrastructure deficien-cies.

TMP IMPLEMENTATION STATUS

The Technology Master Process is in its first full year of implementation. AFMC formally initiated this process at the beginning of FY94 following a detailed process development phase. During the FY96 cycle, AFMC will use the TMP to guide the selection of specific technology projects to be included in the Science and Technology FY99 POM and related President's Budgets.

Additional information on the Technology Master Process is available from HQ AFMC/STP, DSN 787-7850, (513) 257-7850.

INDEX

TAP SUBTHRUSTS