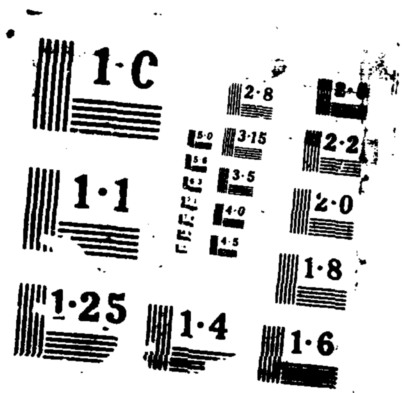
AD-A193 110 AIR FORCE TECHNICAL OBJECTIVE DOCUMENT FY89(U) AIR FORCE WRIGHT AERONAUTICAL LABS WRIGHT-PATTERSON AFB OH APR 88 AFWAL-TR-88-1000 1/1

UNCLASSIFIED F/G 1/3 NL


1·1
1·25
1·4
1·6
1·8
2·0
2·8
3·15
3·5
4·0
4·5

AFWAL-TR-88-1000
(SUPERSEDES AFWAL-TR-86-1000)

AIR FORCE
TECHNICAL OBJECTIVE DOCUMENT
FY 89

April 1988

AVIONICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for Public Release; Distribution Unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFWAL-TR-88-1000	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION AFWAL Avionics Laboratory 6b. OFFICE SYMBOL (If applicable) AFWAL/AAOR	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code) WPAFB, OH 45433	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
62204F	9991	35	LX

11. TITLE (Include Security Classification)
FY89 Technical Objective Document (U)

12. PERSONAL AUTHOR(S)
Multiple Authors

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Technical Report	FROM FY89 TO 92	~~1 Feb~~ 88 Apr	

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB. GR.

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Technical Areas; Technical Objectives; Technology Planning Objectives; Investment Strategy; Technical Thrusts; Navigation; Surveillance; Reconnaissance; Electromagnetic Warfare;

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Technical Objective Documents (TODs) are prepared by the Air Force Laboratories for distribution by DTIC to provide industry with Air Force objectives critical to maintaining aerospace superiority. This TOD, was prepared by the AFWAL Avionics Laboratory Plans Office, ~~and~~ describes the technology required to meet future avionics operational needs. The Avionics Laboratory Investment Strategy is described. The technology program is described in terms of four Technical Areas which correspond to the groupings of the eight Laboratory Technology Planning Objectives (TPOs). The technology approaches are discussed together with related applications to Air Force needs and requirements. Information from the FY87 Technical Investment Plans is included. Points of contact in the Laboratory are identified for each Laboratory TPO. If areas of interest are discovered, industry or academic organizations are encouraged to discuss the objectives further with the Laboratory contact identified to maximize contributions to military technology.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL ROBERT L. REMM	22b. TELEPHONE NUMBER (Include Area Code) (513) 255-4415 22c. OFFICE SYMBOL AFWAL/AAOR

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

18. (Continued) Fire Control; Weapon Delivery; Communications; System Architecture; Information Processing and Control; Subsystem Integration; Artificial Intelligence; Electronic/Electromagnetic Device R&D; Radar Technology; Electro-Optical Technology; Microelectronics Technology; Integrated Communications, Navigation, Identification Technology; System Integration Technology; Software Technology; Electronic Warfare Systems Technology; Digital Avionics; Airborne Electronics and Support Electronics.

TABLE OF CONTENTS

INTRODUCTION

The Air Force Technical Objective Document (TOD) program is an integral part of the process by which the Air Force plans and formulates a detailed technology program to support the development and acquisition of Air Force weapon systems. Each Air Force Laboratory annually prepares a Research and Technology (R&T) Plan in response to available guidance based on USAF requirements, the identification of scientific and technological opportunities, and the needs of present and projected systems. These plans include proposed efforts to achieve desired capabilities, to resolve known technical problems, and to capitalize on new technical opportunities. The proposed efforts undergo a lengthy program formulation and review process. Generally, the criteria applied during the formulation and review are responsiveness to stated objectives and known requirements, scientific content and merit, program balance, developmental and life cycle costs, and consideration of payoff versus risk.

It is fully recognized that the development and accomplishment of the Air Force Technical Program is a product of the teamwork on the part of the Air Force Laboratories and the industrial and academic research and development community. The TOD program is designed to provide to industry and the academic community, necessary information on the Air Force Laboratories' planned technology programs. Each laboratory's TOD is extracted from its Technology Area Plan.

Specific objectives are:

a. To provide planning information for independent research and development programs.

b. To improve the quality of the unsolicited proposals and R&D procurements.

c. To encourage face-to-face discussions between non-Government scientists and engineers and their Air Force counterparts.

One or more TODs have been prepared by each Air Force Laboratory that has responsibility for a portion of the Air Force Technical Programs. All TODs are available from the Defense Technical Information Center (DTIC) to registered DTIC users. Unclassified/unlimited TODs are also available from the National Technical Information Service (NTIS).

As you read through the pages that follow, you may see a field of endeavor where your organization can contribute to the achievement of a specific technical goal. If such is the case, you are invited to discuss the objective further with the scientist or engineer identified with that objective (See page 34). Further, you may have completely new ideas not considered in this document which, if brought to the attention of the proper organization, can make a significant contribution to our military technology. We will always maintain an open mind in evaluating any new concepts which, when successfully pursued, would improve our future operational capability.

On behalf of the United States Air Force, you are invited to study the objectives listed in this document and to discuss them with the responsible Air Force personnel. Your ideas and proposals, whether in response to the TODs or not, are most welcome.

HOW TO USE THIS DOCUMENT

Unsolicited proposals to conduct programs leading to the attainment of any of the objectives presented in this document may be submitted directly to an Air Force Laboratory. However, before submitting a formal proposal, we encourage you to discuss your approach with the Laboratory point of contact. After your discussion or correspondence with the Laboratory personnel, you will be better prepared to write your proposal.

As stated in the "AFSC Guide for Unsolicited Proposals" (copies of this informative guide on unsolicited proposals are available by writing to Air Force Systems Command/PMPD, Andrews Air Force Base, Washington, DC 20334), elaborate brochures or presentations are definitely not desired. It is essential that your letter be prepared to encourage its reading, to facilitate its understanding, and to impart an appreciation of the ideas you desire to convey. Specifically, your letter should include the following:

1. Name and address of your organization.

2. Type of Organization (Profit, Nonprofit).

3. Concise title and abstract of the proposed research and the statement indicating that the submission is an unsolicited proposal.

4. An outline and discussion of the purpose of the research, the method of attack upon the problem, and the nature of the expected results.

5. Name and research experience of the principal investigator.

6. A suggestion as to the proposed starting and completion dates.

7. An outline of the proposed budget, including information on equipment, facility, and personnel requirements.

8. Names of any other Federal agencies receiving the proposal (this is extremely important).

9. Brief description of your facilities, particularly those which would be used in your proposed research effort.

10. Brief outline of your previous work and experiences in the field.

11. If available, you should include a description brochure and a financial statement.

MANAGEMENT OVERVIEW

BACKGROUND

Our primary national security objective is to preserve the United States as a free nation with its fundamental institutions and values intact. The United States Air Force is the primary aerospace arm of our Nation's Armed Forces. The fundamental role of the Air Force is to prepare aerospace forces to accomplish these missions: Strategic Aerospace Offense, Strategic Aerospace Defense, Counter Air, Air Interdiction, Close Air Support, Special Operations, Airlift, Aerospace Surveillance and Reconnaissance, and Aerospace Maritime Operations. Congress has given the Department of the Air Force primary responsibility for equipping aerospace forces in peacetime for the effective prosecution of war. To fulfill this responsibility, the Air Force researches, develops, analyzes, tests, and acquires combat and service systems designed to engage and defeat any enemy in the aerospace.

LABORATORY MISSION

The Avionics Laboratory is part of the Air Force Wright Aeronautical Laboratories (AFWAL), a federation of four laboratories located at Wright Patterson AFB, Ohio, which reports to the Aeronautical Systems Division. The Avionics Laboratory plans and executes the USAF exploratory development, advanced development and assigned basic research programs for aerospace vehicle avionics and associated support electronics.

Avionics is defined as all of the electronics on board an aerospace vehicle. Therefore, any weapon platform (aircraft, missile, spacecraft) must have a complement of avionics to carry out its mission. In fact, the effectiveness of a modern aerospace weapon system to perform an assigned mission is determined to a major extent by the performance of its avionics equipment. This mission of the Laboratory is broad and includes the primary areas of navigation, surveillance, reconnaissance, electromagnetic warfare, fire control, weapon delivery, communications, system architecture, information and signal processing and control, subsystem integration and supporting electronics, software and electromagnetic device research and development.

The Laboratory serves a dual role of providing mission capability and maintaining a strong technology leadership to avoid technology gaps and surprises. Therefore, the Laboratory's technical programs emphasize the application of avionics technology to Air Force needs and the transition of these applications into operational systems in order to improve the Air Force capability to perform its assigned military role. It is equally important that the technical programs generate promising areas of applied technology (technological opportunities) and develop them to the stage where they can be exploited to provide new or improved Air Force capabilities.

AVIONICS TECHNOLOGY AREA

The Avionics Technology Area is divided into four sub-areas: Electronic Devices, Offensive Avionics, Defensive Avionics, and System Avionics. There is a tremendous amount of interdependency between these major technical areas, especially if the weapon system capability being sought is based on a totally integrated avionic system. Each sub-area will be discussed separately in the Technology Area Objectives Section.

The Electronic Devices sub-area provides advanced devices and component developments which support the other three avionics sub-areas. A major emphasis is to maintain a strong device technology base to mitigate against technological surprise. Major areas of concentration are electro-optical, microwave, and microelectronics.

The Offensive Avionics sub-area develops the sensors, and their associated processing mechanizations, that are used for the aerospace vehicle mission-functions of surveillance, reconnaissance, and strike. This includes the operations of search, detection, acquisition, tracking, identification, and designation of targets for fire control or weapon delivery.

The Defensive Avionics sub-area develops the radio frequency (RF), electro-optical (EO), and infrared (IR) active and passive countermeasure concepts, techniques, and equipments that are used to increase survivability of aerospace vehicles operating in hostile environments.

The System Avionics sub-area develops the systems for effectively accomplishing the aerospace vehicle functions of communication, navigation, and cooperative identification as well as the core system technologies for information processing (hardware and software), crew system avionics (pilot vehicle interface), integrated avionic system concepts, and avionic software support systems.

GUIDANCE

Guidance for the Avionics Technology area comes from many directions. The Avionics Technology investment strategy basically follows the guidance provided in the AFSC booklet entitled the Air Force Science, Technology and Development Planning Program. Also, many of the programs identified in the Avionics Technology roadmaps support the technical needs identified in the Air Force Science, Technology and Development Planning Program. There are additional programs that address classified deficiencies. In recent years a number of programs such as Pave Pillar, VHSIC Common Signal Processor, VHSIC 1750A Computer, Fiber Optic High Speed Data Bus, ICNIA, Ultra Reliable Radar, and Integrated Electronic Warfare Systems (INEWS) have been redirected to ensure that they are responsive to the Advanced Tactical Fighter requirements. To ensure that avionics programs are responsive to the user community many avionics programs have gone through the formal Technology Transition Plan (TTP) process at ASD. Figure 1 identifies those programs which have signed TTPs with the customer identified.

TECHNOLOGY TRANSITION PLANS

AVIONICS SUB-AREA	TITLE	ASD CUSTOMERS (1)
ELECTRONIC DEVICES	MAGNETIC BUBBLE DEVICES	EN
OFFENSIVE AVIONICS	INFRARED SEARCH/TRACK SYSTEM	RW
	RADAR WARNING RECEIVER/FIRE CONTROL INTERFACE SOFTWARE	TA
	ADVANCED TARGET ACQUISITION SENSOR/IMAGING SENSOR AUTOPROCESSOR	B1B SPO
	JTIDS/PASSIVE ID SIMULATION	ATF SPO
	ULTRA HIGH RANGE RESOLUTION	ATF SPO
	AUTO RADAR TARGET ID (ARTI)	ATF SPO
	ADVANCED AIRBORNE RADAR ECCM	ATF SPO
	A-A ATTACK MANAGEMENT	ATF SPO
	ULTRA RELIABLE RADAR	ATF SPO
DEFENSIVE AVIONICS	DETECTION OF LASER, RADAR AND AND MILLIMETER (DOLRAM)	ATF SPO
	RF RECEIVER FRONT END	RW
	INTRAPULSE PROCESSOR	RW
	MONOPULSE COUNTERMEASURES	RW
	TACTICAL C^3 JAMMER	RW
	CORONET PRINCE	RW
	SILENT ATTACK WRN SYS	RW
	SPECIAL RADOME	EN
	HYBRID IC MMW RECEIVER	EN
	LASER RANGING CM	EN
	ADV AERODYNAMIC FLARE	EN
	FREQUENCY SYNTHESIS R&M	EN
	MAC EW ADV DEVEL	AF
	STRAT LINK JAMMER	AF
	POWER SUPPLY REL IMPROV	EN
	TRAV WAVE TUBE IMPROV	EN
	EXPENDABLE LASER JAMMER	EN
	HIGH PERFORMANCE IR DECOY	EN
	C^3CM ADV MINI-DRONE PAYLOAD	EN
	LOW BAND C^3CM PROG	EN
	ADVANCED IRCM (HAVE GLANCE)	EN
	WIDE BAND C^3CM	EN
	INTERNAL EHF CM	EN
	LOW BAND ADV TRANSMITTER	EN
	C^3CM TRANSMITTER MODULES	EN
	ADV LASER WARNING	RW

Fig. 1

TECHNOLOGY TRANSITION PLANS

AVIONICS SUB-AREA	TITLE	ASD CUSTOMERS (1)
SYSTEMS AVIONICS	PAVE PILLAR	ATF SPO
	VHSIC 1750 COMPUTER	ATF SPO
	VHSIC COMMON SIGNAL PROCESSOR	ATF SPO
	ICNIA	ATF SPO
	AIRBORNE IMAGERY TRANSMISSION	RW
	LOW PROBABILITY OF INTERCEPT COMM	EN
	HIGH SPEED DATA BUS	ATF SPO
	INT TERRAIN ACCESS/RETRIEVAL SYST	EN
	HIGH ACCURACY RLG	EN
	INTERACTIVE ADA WORKSTATION	EN

Fig. 1 (Continued)

Note: (1) EN - ASD Deputy for Engineering
RW - ASD Deputy for Reconnaissance, Strike and Electronic Warfare
AF - ASD Deputy for Airlift and Trainer Systems
TA - ASD Deputy for Tactical Systems

Avionics also provides new technologies that show promise of revolutionizing the nature of warfare. Shown in Figure 2 is the relationship of the Avionics Technology areas to the Project Forecast II technologies. Well over 50% of the avionics program already directly or indirectly supports these technologies. Major efforts are planned for PTs such as PT-10 Wafer-Level Union of Devices, PT-11 Photonics, PT-12 Full-Spectrum, Ultra Resolution Sensors, PT-13 Fail-Soft, Fault Tolerant Electronics, PT-16 Smart Skins, PT-26 Brilliant Guidance, PT-36 Knowledge-Based Systems, PT-41 Distributed Information Processing, and PT-43 Ultra High Software Quality and Productivity. In addition, avionics applies broadly to 29 of the 31 Project Forecast Systems.

Lastly, the Avionics Technology area supports the goal of providing a broad technology base that has sufficient depth to ensure against technological surprise by any potential adversary. To do this we maintain a strong in-house as well as contractual program in basic research, exploratory development and advanced technology development.

THREAT ASSESSMENT

Avionics Technology responds to the severe present and postulated threats for the Strategic Offense, Strategic Defense, Tactical Warfare/War Reserve Material, Command and Control, Tactical Reconnaissance/Intelligence, Space, Mobility, Electronic Combat, and Special Operations mission areas.

The Electronic Device sub-area provides the technology base needed to support the other avionics sub-areas which directly address the capabilities to survive in the postulated combat environment of the future. This sub-area also addresses the need to overcome the threat of technological obsolescence and to maintain a viable technology base in spite of world-wide competition. Efforts in areas such as VHSIC, MIMIC, and GaAs specifically address this need to maintain U.S. technological superiority.

The Offensive Avionics sub-area provides the technology base to allow AF assets to operate and survive in high threat environments. For example, it develops bistatic radar technology with remotely located radiating elements for covert penetration. It develops sensor counter countermeasures, to operate in the presence of enemy microwave jammers, flares, smoke, camouflage, and decoys. It evaluates the ECCM capabilities of airborne radar systems. It supports efforts to detect, track, identify and destroy strategically relocatable targets and low observable air vehicles. It also supports the SDI with efforts in the area of spacebased kenetic energy fire control.

AVIONICS TECHNOLOGIES \ PROJECT FORECAST TECHNOLOGIES	PT-6	PT-7	PT-9	PT-10	PT-11	PT-12	PT-13	PT-14	PT-15	PT-16	PT-18	PT-20	PT-26	PT-28	PT-32	PT-33	PT-36	PT-40	PT-41	PT-43	PT-44	PT-45	PT-48
ELECTRONIC DEVICES																							
Microelectronics			X	X			X					X	X		X	X			X				X
Microwaves				X		X	X		X	X		X	X										
Electro-optics				X	X	X																X	
SYSTEM AVIONICS																							
Avionics Integration						X	X			X			X		X	X	X		X	X			X
Crew System Avionics		X															X	X					
Machine Intelligence						X	X						X				X						
Navigation Sensors/Sys										X		X	X				X						
Comm Systems					X			X		X						X	X						
OFFENSIVE AVIONICS																							
Radar Target Sensors						X	X										X						
E-O Target Sensors					X	X							X										
Target Recognizers						X							X				X						
Targeting & Strike						X	X	X		X							X		X		X		
DEFENSIVE AVIONICS																							
Adv Sensor CM										X	X						X						
C^3CM	X		X																				
Adv Support Jammers														X									
IRCM					X						X											X	
EOCM					X						X			X								X	
Multi Spectral Expend			X																				
Integrated EW			X				X			X	X						X						

Fig. 2

The Defensive Avionics sub-area directly addresses the electronic warfare technologies necessary to allow aerospace vehicles to survive in a hostile environment. Technologies developed cover the entire electromagnetic spectrum and includes active and passive countermeasures such as jammers, warning receivers and processors, expendables, and cross section reduction. Electronic warfare technologies are highly threat sensitive and require close coordination with the intelligence and the using tactical/strategic/airlift communities.

The System Avionics sub-area supports efforts to improve the pilot's situational awareness and to reduce pilot workload in order to allow survivable penetration and attack. It also develops fault tolerant system architectures that can automatically reconfigure themselves around internal and subsystem failures providing graceful degradation, resulting in improved system reliability, maintainability, and availability. It also supports efforts in providing secure, antijam, low probability of intercept, survivable communication links.

TECHNOLOGICAL DEFICIENCIES

Electronic Devices - Major deficiencies and improvements being addressed include: frequency agile lasers; optical data processing concepts; high temperature, broad wavelength detectors; very high speed, high density integrated circuits; and, high frequency (millimeter wave) devices and circuits.

Offensive Avionics - Major deficiencies and improvements being addressed include: day/night adverse weather air-to-ground operation; detection and tracking of low RCS aerial targets; identification, tracking and destruction of relocatable targets; beyond visual range air-to-air target identification; effective air-to-air missile launch envelope computation and display; improved sensors (increased range and resolution) for aircraft, missile and spacecraft applications; and reduced cost, size and weight, with increased reliability and maintainability.

Defensive Avionics - Major deficiencies and improvements being addressed include: robust ECCM resistant countermeasure techniques especially against monopulse radars and command and control nets, effective counters to EO controlled weapons, low false alarm missile launch detection, warning and power management system operation in very dense threat environments and orders of magnitude increase in jamming power density. Extensive integration with offensive avionics will reduce cost and weight and enhance overall weapon system performance.

System Avionics - Major improvements being addressed include: reduced software complexity; improved survivability; survivable penetration and attack capabilities; higher sortie generation rates; adaptability to new threats; high equipment availability; avionics for next generation heavy lift launch vehicles; and multiple user applications and interoperability.

TECHNICAL OPPORTUNITIES ASSESSMENT

Electronic Devices - Capabilities being sought for the 1988-1998 decade include: tunable lasers; focal plane arrays; optical circuits; advanced millimeter wave devices; reliable, long life active array elements; sub-micron, very high speed integrated circuits (VHSIC); and, monolithic microwave integrated circuits (MMIC).

Offensive Avionics - Capabilities being sought for the 1988-1998 decade include: high reliability and ultra-high resolution radars; covert and/or low probability of intercept (LPI) radars; doubling of range for forward looking infrared (FLIR) sensors; multifunctional CO_2 laser; automatic cueing and classification; and, beyond visual range air-to-air target classification.

Defensive Avionics - Capabilities being sought for the 1988-1998 decade include: multisensor integrated threat warning; multimegawatt stand-off jammers; a family of new, broadband, active decoy expendables; ECM subsystems and EW suites for Military Airlift Command vehicles; solid state, phased array, self-protection jammers; automatic counters to IR guided weapons; wide-band millimeter wave countermeasures; automatic power management for multiple threats on a priority basis; EW for low observable vehicles; application of Artificial Intelligence to EW signal processing; comprehensive vehicle signature reduction; and, non-adaptive techniques against semi-active RF missiles.

System Avionics - Capabilities being sought for the 1988-1998 decade include: strapdown inertial navigation systems with increased accuracy and smaller size; integrated communication, navigation, identification (CNI) systems with increased availability and reduced size; digital maps to enable threat avoidance and passive, in-weather operation; advanced multiplex buses with plug-in accomodation; standardized processors (data and signal) to provide increased throughput and expandable memory; fault-tolerant integrated avionics system architectures which will enable significant improvements in availability, cost of ownership and mission effectiveness; terrain data based systems that will improve weapons system survivability during low level penetration and that will provide a totally integrated terrain follow/terrain avoidance/threat avoidance capability; and, artificial intelligence, expert systems techniques that will accomplish the task of being the pilot's associate.

POTENTIAL OPERATIONAL UTILITY

Concentrated efforts are made in the Avionics Technology area to ensure that the technologies developed are focused on the needs and requirements of the using commands and the AFLC. Evidence of this close association is the large number of ROCs/SONs and Logistic Needs supported and the large number of signed Technology Transition Plans (TTPs). There are numerous examples of this close association with the user community that could be referenced but space permits only a few to be mentioned. In support of SAC needs there are programs such as the Silent Attack Warning

System (SAWS), Have Law, Cruise Missile Advanced Guidance (CMAG), and the Strategic Relocatable Target programs. There are numerous programs in support of TAC such as Pave Pillar, ICNIA, VHSIC CSP and 1750A, Air-to-Air Attack Management, A-A Covert Sensor Technology, Automatic Target Recognition efforts, ECCM radar efforts, Coronet Prince, Have Glance, INEWS, Dilution Drone, and many others. Many of the avionics technologies that are developed for tactical and strategic applications may also satisfy MAC needs. In addition, the Defensive Avionics sub-area has established a program directed specifically to MAC EW needs.

The Avionics Laboratory is the principal Air Force organization charged with the responsibility for avionics R&D. However, there are many other Government organizations who are investing resources in avionics development. As a consequence, the Laboratory must assure that it invests its resources in the technologies which keep the Air Force on the frontier of knowledge while avoiding duplication. One way of doing this is by participation with other military services, Air Force Product Divisions, Major Commands, and Federal agencies on programs of mutual benefit. An effective means of coordinating programs is via the Joint Directors of Laboratories (JDL) technology panels. For instance, the Technology Panel for EW jointly plans, coordinates, and manages EW programs. As a result of these interactions 85% of our EW programs are now joint or cooperative programs. To ensure applicability, EW programs are briefed yearly to the operating commands at the EW Users Review. As a result of this review the EW program plans are adjusted to take into account the users needs and priorities. The Systems Avionics sub-area has a major program with AFLC resources entitled "Embedded Computer Resources Support Improvement Program." This program will develop advanced extendable integration support facilities for Air Logistic Centers which incorporate rapid software turnaround tools and software readiness concepts. The Avionics Laboratory also participates with DARPA in the conduct of the Strategic Computing program in the Pilot's Associate demonstration program and in the area of automatic target recognition.

Maintaining the viability of the avionics industrial base and incorporating new technologies into weapon systems have become significant challenges to the Air Force. Each generation of Air Force weapons systems has become increasingly dependent on avionics to accomplish the required missions of the weapon systems. The reliance on higher technology avionics has led to increased reliance on electronic devices. The ability of the electronics industry to produce these devices for the combined military and commercial avionics requirements during peacetime, surge, and mobilization conditions is a matter of concern to the DOD. The VHSIC and MIMIC programs are addressing these concerns.

Another means of improving the transition of technology to operational use is via improved communications with industry. The Avionics Laboratory yearly conducts indepth technical reviews of company IR&D technology reports and participates in numerous on-site contractor IR&D reviews. In addition, it sponsors a Briefing to Industry which informs the contractors of our planned investments and encourages feedback.

TECHNOLOGY AREA OBJECTIVES

1. ELECTRONIC DEVICES

a. Microelectronics Technology Objectives

Microelectronics, as exemplified by integrated circuits, is the heart of modern electronic subsystems which, in turn, are vital to the operation of today's and tomorrow's military systems. The objective of the Avionics Laboratory program in this area is to develop and maintain a technologically advanced microelectronics base in support of advanced military system requirements. Emphasis is placed upon advancement of the technology base rather than development of specific devices for use in near term applications. Specifically, the current emphases are upon silicon (Si) and gallium arsenide (GaAs) solid state devices including VHSIC, memory technology, design technology, and advanced interconnect technology.

(1) Silicon IC Technology

Expand the silicon solid state device and integrated circuit technology bases to provide improved performance, reliability, radiation hardness, and cost for advanced airborne and spaceborne systems. Investigate new devices, circuits and fabrication techniques; develop device modeling; develop design methodology; and investigate integration techniques. Considerations include development of: the technology for high density optical interconnect structures; materials and processing techniques for epitaxial heterostructures; three dimensional integrated circuit technology; design methodology for wideband linear integrated circuits using advanced large scale integration (LSI) fabrication techniques; high density, high performance integrated circuits (ICs) for advanced signal processing systems; and low power, radiation hard ICs for high performance aerospace systems.

(2) GaAs Technology

Develop a comprehensive GaAs material, device, and integrated circuit technology base which will meet the broad spectrum of advanced airborne and spaceborne systems requirements in the areas of radar processing, electronic warfare, and communication. These advanced requirements dictate the need for 1-10 GHz digital logic capability. This technical area will address all facets of the GaAs technology to meet these systems requirements. Investigate basic material parameters, growth techniques, and detailed device understanding; explore and develop advanced device and circuit concepts; develop LSI/VLSI technology and concept demonstrations; and expand in-house high speed device design and characterization capability. Expand the III-V semiconductor IC technology data base. Investigate LSI logic circuits with clock rates in excess of 10 GHz. Develop heterostructure devices, ultra high speed heterojunction transistors, and the technology for the selective growth of GaAs structures on silicon substrates leading to the development of advanced heterostructure IC's. Develop the technologies (e.g., high electron mobility transistors and monolithic integrated circuits) needed for submicron, heterostructure transistor LSI and device technology.

(3) <u>Concepts and Technology Applications</u>

Capture very large scale integration (VLSI) designs and architectures, simulate and validate systems performance and operation through computer aided design (CAD) techniques, exploit IC technologies by developing low cost, highly reliable circuits, and transition circuits and system concepts into a broad spectrum of advanced avionics and space applications. Establish and maintain a strong in-house CAD capability utilizing a broad spectrum of design aids, graphical layout concepts and approaches to testability and built-in-test. Develop gigabit system integration techniques, packaging, and design aids. Establish an environment for the design and implementation of artificial intelligence concepts. Expand graphics capability to manage VHSIC designs and micron and submicron structures. Maintain an in-house capability to experimentally assess new devices, processing architectures and define development needs. Investigate and refine power supply technology to meet next generation processor needs. This includes components for high speed switching and VHSIC 0.5 micron requirements. Develop wide-bandwidth silicon and GaAs analog to digital converters (ADCs) for electronic warfare (EW) application. Optimize heterojunction bi-polar transistor device structure through numerical simulation. Evaluate the feasibility of system level integration for front end signal processing.

b. <u>Microwave Technology Objectives</u>

The objective of this area is to develop the technology required to produce, control and apply microwave and millimeter wave power. The scope of efforts includes theory, techniques, devices, and concepts. Application areas generally considered include weapon delivery, communication, navigation, guidance, countermeasures, reconnaissance, surveillance, and data transfer. However, major emphasis is for electronic countermeasures (ECM), radar, and communication systems. Generally, improvements such as higher power, lower cost, better efficiency, broader bandwidths and increased reliability are sought. Technical activities are confined to frequencies below 300 GHz. Four areas are being stressed: solid state sources and amplifiers, thermionic devices, power sensing and control techniques, and phased array/antenna/radome system techniques.

(1) <u>Transistors</u>

Develop efficient, high power, cost effective solid state sources of microwave and millimeter wave power for use in aerospace and avionics systems. Major areas of development include high power Si and GaAs power transistors, materials and processing technologies, and circuits to achieve high power. Feasibility model oscillator and amplifier circuits are designed and fabricated to demonstrate the device technology. Solid state device work will principally be concerned with UHF/microwave silicon power devices/amplifiers for space applications, and GaAs high peak power 30-40 percent duty cycle FETs for radar applications.

(2) Advanced Devices

Demonstrate and develop novel microwave and millimeter wave solid state devices with improved performance, reproducibility and reliability for next generation avionics systems applications. Work will build upon two and three terminal gallium arsenide device technology and extend into advanced III-V compound and other semiconductor materials. Devices and structures developed will be planar and form the technology base for advanced hybrid and monolithic integrated circuits.

(3) Microwave TWTs

Develop microwave tube technology and selected thermionic power sources and amplifiers for ECM, communications and other avionics applications. Concentration is on airborne tube applications with frequencies of interest from 1 to 20 GHz. Improved design reliability and multiple application of tube technology are stressed. Improve Traveling Wave Tube (TWT) reliability by instrumenting a TWT with sensors and non-volatile memory to determine actual field use history. Develop high power, wideband isolators to protect EW tubes in the same manner as radar tubes are protected. Investigate technology for non-invasively assessing tube vacuum integrity. Develop compact high power microwave generator technology.

(4) Millimeter TWTs

Develop millimeter wave tube technology and selected thermionic power sources and amplifiers for ECM, communications and other avionics applications. Concentration is on airborne tube applications with frequencies of interest from 20-100 GHz. Demonstrate the feasibility of high power broad bandwidth tubes from 20-40, 40-55 and 80-100 GHz. Develop helix designs to 40 GHz and coupled cavity approaches to 60 GHz. Demonstrate broadband, high power fast wave devices in the 90 GHz frequency range.

(5) Monolithic ICs

Develop solid state integrated circuit and component technology for transmission, reception and control of microwave and millimeter wave signals for advanced airborne radar, electronic warfare, communications and terminal guidance applications. Develop improved design and fabrication techniques for gallium arsenide monolithic microwave integrated circuits (MMICs). Develop GaAs MMICs for transmit/receive (T/R) modules. Develop T/R modules for spaceborne radar applications. Develop a Q-Band (GaAs) FET power amplifier. Develop single chip MMICs that have both microwave analog and digital circuit functions. Design, fabricate, and test in-house, microwave/millimeter wave devices, circuits and monolithic ICs. Develop computer aided design techniques for non-linear/large signal microwave ICs. Develop broadband low noise and power amplifiers using the HEMT technology.

(6) Power/Control Components

Develop active and passive control components for signal reception, transmission and control in the 1-300 GHz frequency range for advanced avionics applications. Develop power and control components for ECM and communications. Control components include development of: broadband mixers; ferrite materials and components (60-140 GHz): microwave/optical ICs to demonstrate T/R functions; and 94 GHz multipliers. Power combining programs are for the development of a 60 GHz Impact Avalanche Transit Time (IMPATT) diode amplifier for space communications applications and a 150 watt 20 dB gain X-band FET amplifier.

(7) Antennas/Radomes

Develop fundamental microwave antenna and radome technology for advanced radar, electronic warfare and other airborne applications. Investigate multiple beam feed networks with combinations of analog, digital and integrated optics. Implement and evaluate an integrated optical multiple beam array feed network.

(8) Solid State Apertures

Develop and demonstrate fundamental microwave system techniques and solid state phased array technology. Applications include aircraft, missile, and spacecraft systems for radar. ECM, guidance/control, and communication functions. Develop solid state phased arrays wherein the transmitter, receiver, and antenna functions are integrated into modules located at each array element to provide major reliability and performance improvements.

c. Electro-Optics Technology Objectives

The major objective of this area is to develop EO components which will improve performance, reliability, maintainability and reduce the cost of EO equipment used for optical search, countermeasures, surveillance, reconnaissance, identification, fire control, weapon delivery, optical radar, navigation and data storage and transfer. The area encompasses device development, concept demonstration and theoretical analysis and verification. Major emphasis is being given three areas: EO Sources, Optical Control Devices, and EO Detectors.

(1) Lasers

Develop and demonstrate high performance laser sources for future avionics applications such as target search and track, countermeasures, IFF, weapon delivery, reconnaissance, navigation, optical processing, as well as for semiconductor circuit processing. Efforts include tunable laser development in the visible and near to mid infrared, exploitation of non-linear wavelength conversion techniques, and related excitation sources. Emphasis is placed on technology which can be applied in a tactical airborne environment, so efficiency, weight, volume, maintainability, and absence of effluents are all prime considerations.

(2) Optical Control Techniques

Develop and demonstrate devices and techniques for the modulation and control of light, including beam steering, optical signal processing, information and data transmission. Technology developments include bulk, integrated and planar optical devices and circuits, and the integration of optical, digital, and other analog functions on a single substrate. Approaches range from device architecture, design and fabrication, through materials selection and development, to demonstration of functional optical circuits. Fiber optic component development is also included, primarily in conjunction with project Forecast II objectives.

2. OFFENSIVE AVIONICS

a. Microwave Sensor Technology Objectives

Develop and demonstrate the feasibility of microwave radar sensor target acquisition technologies to support in-weather, aerospaceborne targeting and fire control in severe electronic countermeasures (ECM) environments for Air Force reconnaissance and strike mission applications. Near or mid-term (transitionable to engineering development in the FY88-91 timeframe) developments are focused toward the requirements of the ATF and upgrades for the F-15, F-16, and B-1B. Longer term techniques are directed toward the requirements of the next generation of strike/reconnaissance weapon systems which will require large increases in survivability, covertness, and availability as well as advances in functional target acquisition capability. Specific objectives include:

(1) Radar Acquisition of Surface Targets

Develop advanced techniques to enhance the strike aircraft compatibility of ultra-high resolution synthetic aperture radar (UHR SAR) for the acquisition of small difficult tactical, or strategic relocatable surface targets. Effort in the FY88-90 timeframe will be focused toward the development of a calibrated, coherent, polarimetric SAR data base to support automatic target classification research efforts, the demonstration of LPI waveforms compatible with UHR SAR, and the development of SAR autofocus techniques to compensate for the severe maneuvers of strike aircraft. Longer term goals (mid-90s) include the development of a reliable capability for detecting relocatable targets concealed by foliage and the demonstration of passive or bistatic UHR SAR techniques to enhance the covertness and survivability of a penetrating attack aircraft.

(2) Radar Acquisition of Aerospace Targets

Develop the Ultra-Reliable Radar (URR) to demonstrate the feasibility of using emerging technologies such as the solid state phased array (SSPA) and the Common Signal Processor (CSP) with the context of an integrated avionics architecture to improve the reliability, maintainability, and availability of airborne recce/attack radars by an order of magnitude. This effort is specifically focused toward technology transition to the Advanced Tactical Fighter with phased demonstration milestones in the FY88-91 timeframe to support ATF FSED decisions. Longer term air-to-air radar development objectives include the development of improved capability for detecting low cross-section aircraft targets and for determining the content of attacking aircraft formations.

(3) Radar ECCM Techniques

Develop and transition techniques to permit airborne radars to operate properly in a dense, sophisticated and dynamically changing ECM environment. Near term goals (FY88-91) involve the demonstration of the effectiveness of ECCM techniques now being investigated which solve known deficiencies of current airborne pulsed doppler radar in the current threat environment. Mid and far term goals are focused around an integrated approach to decrease the ECM susceptibility of future airborne radars by approaches which make the radar more flexible and adaptable. The long term approaches (mid 90s and beyond) also include an "offensive ECCM" concept which will make the enemy ECM job significantly more difficult. Long term goals also include "shared aperture" approaches for future compatibility with concepts such as the Forecast II "Smart Skins" initiative. The ECCM objectives also include the development and maintenance of a continuing analysis, simulation, and data collection effort to permit responsive vulnerability assessments as new threats arise in order to support our ECCM research programs. A significant portion of the analysis/simulation effort is in-house.

b. Target Recognition Technology

The overall objective is to develop and demonstrate the avionics technology required to provide unambiguous recognition of air and surface targets thereby enhancing both survivability and lethality of our combat aerospace vehicles. The principal challenge is to provide this positive, high confidence, non-cooperative identification, in the presence of significant enemy camouflage, concealment, and deception (CC&D), at ranges compatible with our advanced tactical and strategic weapon systems.

(1) Surface Target Recognition

Provide a capability for unambiguous recognition of ground targets from an attack aircraft. A suite of multispectral model-based target recognition algorithms will be developed and demonstrated to permit long range recognition of tactical armor, airbase, air defense and other mobile targets. The algorithms will exploit understanding of target phenomenology and environmental effects to optimize attack performance in the presence of countermeasures including decoys, netting, smokes, etc.

(2) Aerospace Target Recognition

Provide a capability for Beyond-Visual-Range (BVR) non-cooperative identification of aircraft. This capability would significantly enhance both survivability and lethality of our combat aircraft by permitting earlier, longer range engagements against both traditional and reduced observable hostile aircraft. Radar and electro-optical/infrared target signature phenomena will be exploited to provide a basis for development of a multispectral target identification capability.

(3) Technology Base

Develop a technology base to support surface target recognition and aerospace target recognition. This technology base includes the development of phenomenological models to understand the target discriminants for target recognition and the development of advanced algorithm approaches and tools to exploit these discriminants. It also includes the development of algorithmic approaches to utilize contextual and operational tactics knowledge to aid the target recognition process.

c. Electro-Optical Sensor Technology Objectives

Develops and demonstrates electro-optical sensor technology for tactical and strategic reconnaissance and air-to-air and air-to-ground strike systems for severe countermeasure environments. Accomplishes exploratory and advanced development of these electro-optical systems, including: long range targeting laser radars; second generation, full spectrum, forward looking infrared (FLIR) systems; passive and active electro-optical synethetic aperture systems; countermeasure hardening of multifunctional cruise missile guidance and navigation systems and all other electro-optical systems. Maintains the capability and establishes techniques for the characterization of the atmosphere at all altitudes.

(1) EO Acquisition of Surface Targets

Develops and demonstrates the feasibility of EO sensors capable of detecting and tracking surface targets for reconnaissance and strike missions. Effort in the FY88-90 timeframe includes the development of dual band focal plane arrays, the demonstration of synthetic aperture FLIR technology, the development of phased array laser radar, and the flight demonstration/data collection of a CO_2 laser radar with a passive channel. Early FY90's goals include development of an advanced dual band FLIR, development of a tool set required for advanced EO sensor modeling/design, continued in-house testing/evaluation of EO sensors, the design/development of synthetic aperture laser radar technology, and the development of a sensor suite to demonstrate the utility of 3-D information for tactical reconnaissance. Efforts targeted for the mid FY90s include flight demonstration of a full spectrum FLIR, the definition of system requirements, and design of a high resolution EO sensor capable of performaning reconnaissance and targeting functions from an endoatmospheric hypersonic platform, the development and flight demonstration/data collection of a synthetic aperture laser radar, the advanced development and flight test of a strategic targeting laser radar, and investigation of the synergistic effects of combining advanced FLIRs with CO_2 laser radars.

(2) EO Acquisition of Aerospaceborne Targets

Develops and demonstrates the feasibility of EO sensors capable of detecting and tracking aerospaceborne targets in severe ECM environments. Near term efforts (FY88-90) will be to examine multi-spectral techniques for clutter reduction and target acquisition. The mid term effort (early FY90s) will be to develop advanced technology and assess sensor subsystem design issues for an advanced multi-functional, multi-spectral, integrated covert sensor.

(3) EO CCM Techniques

Develops and demonstrates the feasibility of EO sensors capable of operating in a severe countermeasure environment to support all air-to-ground and air-to-air strike and reconnaissance missions. The near term goals (FY88-90) involve the feasibility demonstration of the effectiveness of electro-optical counter-countermeasure techniques for forward looking infrared sensors, carbon dioxide laser radar sensors and automatic target recognizers. Mid term goals (early FY90s) are focused on developing these feasible electro-optical counter-countermeasure techniques, and integrating them into their respective brassboard sensors for future testing. Also includes techniques to exploit unusual target/background phenomenology characteristics for the detection and targeting applications. In the far term (mid FY90s and beyond) the countermeasure hardened sensors and target recognizers will be flight tested, demonstrating their effectiveness in the real world. This demonstration will also lead to combined sensor hardening.

d. Fire Control/Weapons Delivery Technology

The overall objective of this area is to develop and demonstrate advanced, effective, low cost avionics technologies for intelligence acquisition and for targeting and striking air and ground targets under day/night and all-weather conditions for both tactical and strategic missions.

(1) Strategic Targeting and Strike

Define, develop and demonstrate targeting and strike technologies for current and future strategic air vehicles which will permit the attack of high value, fixed, mobile and air targets. Efforts include active and passive cruise missile guidance system development and test, mission planning and reference preparation. Other efforts address application of this technology to multifunction, autonomous air vehicle to attack surface-to-surface weapons and tanks. A further application is to a semi-autonomous bomber scout to extend the bomber's targeting ability and range. Other applications include avionics concepts for hypervelocity environments.

(2) Tactical Targeting and Strike

Demonstrate air combat and recce/strike targeting and fire control technology for low observable applications and demonstrate multi-mode targeting and fire control technology for multimission applications to attack ground or air targets. Efforts include concept definition for covert recce/strike, covert air combat, internetted fire control for manned/unmanned missions, and expert techniques for multimode fire control.

e. Offensive Avionics Applications

The objective of this area is the identify, develop and transition multi-technology applications to acquire, identify, and strike air/ground/space targets applications include ADI, SDI, strategic relocatable target capability, autonomous operations, and air operations.

3. DEFENSIVE AVIONICS

a. Advanced Sensor Countermeasures Objectives

Develop and demonstrate in flight tests with live missile firings, the effectiveness of non-adaptive, simple, inexpensive cross polarization jamming against advanced monopulse missile seekers.

(1) Techniques

Develop and demonstrate in laboratory and flight test evaluations improved robust missile countermeasures concepts and modulations against advanced missile seeker sensors. Efforts include non-adaptive missile CM, modulated cross polarization CM, air-to-air CM and novel MW/MMW jammer development. Emphasis is on tactical airborne environment where volume, weight and reliability are prime considerations.

(2) Systems

Develop and demonstrate in flight test evaluation improved robust radar countermeasures subsystems against advanced threat sensors where the human operator is the primary ECCM concern. Sophisticated, closed-loop (receiver augmented), automatic, robust techniques are required that are not easily negated in effectiveness. Efforts include MAC EW Suite development, advanced system evaluation development and flight test for the B-1B, millimeter wave CM, EW subsystem reliability improvements and solid state amplifier jammer developments.

b. Command, Control and Communications (C3) Countermeasures Objectives

Continue laboratory brassboard testing and develop flyable spread spectrum jammer for strategic and tactical aircraft survivability enhancement.

(1) Tactical

Develop and demonstrate spread spectrum, low frequency C^3CM and amplifier concepts to defeat advanced C^3 nets. Efforts include wideband jammer, lowband C^3CM, spectrally pure C^3CM and advanced amplifier developments. Efforts are related to Advanced DECEPTION PFII technology thrust.

(2) Strategic

Develop and demonstrate active and passive, overt and covert ECM systems and concepts to defeat airborne and ground-based C^3 links with emphasis on the SUAWACS-directed environment. Efforts include strategic link jammer, LEAD jammer and digital shift key jammer. Efforts are related to Advanced DECEPTION PFII technology thrust.

(3) Space Based

Develop and demonstrate countermeasures against tactical communications satellites. Efforts include communication navigation link CM and satellite link CM.

c. Support Jammers Objectives

Continue testing of improved stand-off jamming modulations and system risk reduction developments. Initiate high power countermeasures system development for TAC. Conduct high power microwave susceptibility testing and ECM system field testing.

(1) Stand-Off Jamming (Conventional)

Develop and demonstrate techniques, transmitters and systems to enhance and augment existing support jamming. Efforts are associated with the EF-111A/EA-6B, ALQ-99 and Navy SLQ-32. Technology developments are in sidelobe suppression CM, solid state amplifier jammers and high power countermeasures.

(2) High Power Microwaves

Derive, develop and demonstrate concepts, devices and subsystems to categorize susceptibility of avionics systems to high power microwaves and fabricate ECM systems to defeat similar threat systems. Efforts and technology thrusts include nonstandard effects and MIOELNIR - a field test CM demonstration.

d. Infrared Countermeasures Objectives

Continue development and flight test evaluation of passive scanning infrared missile warning developments. Initiate advanced infrared countermeasures system development and flight test.

(1) Warning Receivers

Develop and demonstrate in laboratory, ground and flight test, improved passive warning receiver subsystems capable of providing threat warning and situation awareness for both missiles and aircraft. Sophisticated processing techniques and algorithms are required that are capable of handling and processing the extremely high data rates. Higher sensitivity detector arrays are needed for both scanning and staring systems to achieve significantly improved range capability with low false alarm rates. Efforts include scanning systems for both forward and rear aspect and data processing techniques.

(2) Jammers

Develop and demonstrate in laboratory and flight test, robust and generic countermeasures against advanced threat sensors including missiles, IRSTs and ground-based surface-to-air IR acquisition and tracking subsystems. Sophisticated automatic, robust techniques are required that are not easily negated in effectiveness. Efforts include the Closed Loop IR Countermeasures (CLIRCM) and IRST CM techniques developments and the Have Glance system evaluation.

(3) Transmitters

Develop and demonstrate in the laboratory advanced laser transmitters that provide higher efficiency and output, frequency agility/diversity, lighter and smaller devices with improved reliability, maintainability and supportability. Efforts include Advanced Source and IR Source.

e. Electro-Optical Countermeasures Objectives

Continue development of TV countermeasures system and flight test evaluation. Initiate advanced EO CM system development against ECCM hardened sensors.

(1) Visual

Develop and demonstrate in flight test, robust and generic countermeasures against visual and electro-optically directed threat systems. Develop advanced laser transmitters with higher efficiency output and frequency agility/diversity and improved detector subsystems. Efforts include air-to-ground and air-to-air demonstration systems, and laser and receiver subsystem development programs. Emphasis will be placed upon volume and weight reduction and improvements in reliability and maintainability.

(2) Laser

Develop and demonstrate in flight evaluation, techniques and subsystems capable of providing warning of laser-aided and laser weapon threat systems and providing robust countermeasures. Efforts include adaptive pointing techniques, laser beamrider CM, and laser receiver systems.

(3) Directed Energy

Develop and demonstrate in field tests a jammer against particle beam weapons.

f. Multi-Spectral Expendable Jammers Objectives

Continue development of IR chaff, millimeter wave expendables and doppler decoys for tactical, strategic and space-based applications. Develop a family of electronic combat payloads for RPVs.

(1) Subsonic

Develop and demonstrate expendable laser, infrared, millimeter wave and radio frequency packages. Key issues are dispenser cartridge compatibility, cost, signature matching characteristics and all altitude operation. Decoy separation characteristics are additional factors.

(2) Supersonic

Develop and demonstrate multi-spectral decoys with emphasis on flare technology due to the benign operating environment of IR sensors at cooler, high altitudes where supersonic performance is prevalent. Efforts include supersonic flare, optimum flare and dual IR/RF decoy. Materials work has preceded these flare developments.

(3) Precursor

Develop and demonstrate RPV and area/threat system dilution concepts with emphasis on electronic combat payload optimization. Work in small platform payloads, mini-drones and concept exploration is involved. Efforts include RASP (analog RF memory), dilution drone analysis and development, and C^3/Radar jamming payload optimzations. Drivers are cost, size, weight, prime power and long shelf life.

(4) Space Expendables

Design, develop and test in simulated environments a family of space expendables for satellite protection and SDI applications.

g. Integrated EW and Power Management Systems Objectives

Conduct advanced software developments utilizing artificial intelligence for electronic warfare. Continue in-house multi-spectral system experiments with integrated EW subsystems.

(1) Software

Develop and laboratory test advanced higher order languages and artificial intelligence/neural network logic concepts for EW subsystems. Candidate language is Ada. Efforts include higher order language EW software analysis and demonstration and AI-driven EW systems.

(2) Receivers

Develop and test IFM, Acousto-optic, channelized, microscan and superheterodyne receivers for EC applications. Efforts are focused toward simulataneous signal reception in agile dense signal environments.

(3) Processors

Develop and demonstrate signal and data processors to pre and post process EW signal environments in the tens of millions of pulses per second. Key technologies are VHSIC, high speed signal processing, intrapulse processing, angle-of-arrival determination and sensor data fusion algorithms. Efforts include programmable signal preprocessor, VHSIC EW processor and SMART SKINS PF-II experimental panel concept design and development.

(4) System Integration

Develop and conduct simulations of multi-spectral threat environments to stimulate integrated EW systems. Efforts include frequency synthesizer, integrated EW analysis/modeling and the EW in-house simulation facility development.

4. SYSTEM AVIONICS

a. Machine Intelligence Objectives

Develop, evaluate, and demonstrate the utility of machine intelligence technologies to provide for new processing architectures, to provide for recognition and understanding of sensor data, and to serve as a pilot aid for improved mission effectiveness.

(1) Neural Learning Theory and Applications

Research and develop learning mechanisms, learning systems, and learning theory for massively parallel adaptive network architectures. Investigate alternative architectures to that of the conventional digital computer, with an emphasis on neurobiology, animal learning theory, and radically different engineering approaches to machine intelligence that are not considered standard artificial intelligences methodology. Applications will include adaptive control, image understanding, speech recognition, and computer-aided decision making.

(2) Machine Perception and Image Understanding

Develop an intelligent vision system capable of sensing and interpreting three dimensional objects. Develop the software and hardware tools to interpret the information from sensors and identify objects, targets, and scenes. This effort will apply learning mechanisms such as Dr Klopf's Drive-Reinforcement Neural Learning Mechanism, the Adaptive Resonance Theory, and the Genetic Classification Algorithm to image understanding and image algebra. Also develop integration tools for synthesizing global descriptions from local features. Primary applications will be in the field of scene analysis and image identification for automatic target recognizers.

(3) Intelligent Avionics

Apply and demonstrate adaptive techniques, neural and evolutionary, and artificial intelligence to avionics applications to develop smart systems that reduce the workload of the aircraft crew, assist the decision making process under complex and rapidly changing environments, and where acceptable allow autonomous operation. Addresses the real-time issues of applying machine intelligent techniques to avionics systems and subsystems. Applications include electronic warfare signal identification, ECM or ECCM resource management, reconstruction of communication waveforms and coding, and overall avionics system resource management.

b. Avionics Integration Technology Objectives

Develop and validate advanced avionics integration technologies to improve the reliability, maintainability, supportability, and mission effectiveness of next generation avionic systems.

(1) System Design/Avionics Architecture

Define, develop, and demonstrate the PAVE PACE next generation Avionics Integration Architecture for AF vehicles of the 21st century. Upward compatibility with the existing PAVE PILLAR architecture will be maintained. Investigate expert systems, parallel processing networks, hybrid opto-electronic computing, advanced packaging and cooling technologies, and advanced software support environments. Experimentally evaluate conformal electronics packaging and cooling to include surface cooling of electronic wafers, optical backplanes, composite materials, and environmental sealing. Establish system control procedures to utilize tremendous speed and data flow of parallel and opto-electronic processors with fault tolerant artificial intelligence systems. Develop and demonstrate next-generation signal processing functions which take full advantage of the high speed capabilities of Gallium Arsenide (GaAs) integrated circuit technology. Develop data processor technology which exploits new architectural concepts such as the Reduced Instruction Set Computer (RISC), VHSIC circuitry, and Ada language to implement real-time avionics data and Artificial Intelligence (AI) processors. Provide airframe quality system avionics availability through: reliability and fault tolerance; 1000 times faster processing; and 100 times improvement in programmer productivity. Enable advanced AI applications in real-time such as pilot decision aiding and automatic target classification. Focus on Forecast II goals for 21st century vehicles and avionic technology transition to both advanced aircraft such as ATF, ATB, and C17, and retrofit to current systems, (F15, F16, F18, etc).

(2) Mission Critical Software

Requirements for mission critical embedded software have far outstripped our ability to produce that software. To aid in this dilemma, high-technology remedies are needed that will develop the tools required for higher software productivity. The tools will be in three classes: hardware/software integration; software/Ada development; and artificial intelligence for software engineering. Develop techniques to integrate these technologies. Rapid Turnaround (RT) and adaptive reconfiguration technologies and methodologies are being developed to enhance USAF's responsiveness to requests for modification of mission critical embedded computer systems. Methodologies will identify the test, analysis, and other support software to provide for and validate the required RT capability. Concepts will be explored and developed to ensure rapid reprogramming of current and next-generation avionics systems including radar and communication-electronics. Additionally, Fire-Control and other systems will be evaluated for ECM response requirements and other rapid reprogramming and adaptive reconfiguration concerns. RT and adaptive reconfiguration technologies should be available for next generation avionic systems as they enter the inventory.

c. Crew Systems Avionics Technology Objectives

Provide fully integrated displays and crew station which provide revolutionary improvements in pilot/crew situation awareness and ability to effectively manage the weapon and aircraft system.

(1) Controls and Displays

Develop and demonstrate large area, full color, sunlight readable, reliable, and high yield and producible flat panel displays. This includes developing the image generator technology to produce the airborne pictorial scenes that will be shown on flat panel displays and Super Cockpits. Initial investigations are being done in the 3-D holographic technology area to meet the requirement of three dimensional display capabilities.

(2) Rapidly Reconfigurable Cockpit

Develop Ada graphics software for airborne operations. Develop interactive editors that enable an engineer or pilot to design a pictorial display for presentation in a cockpit. Develop software tool sets to support Ada graphics software which is machine independent.

(3) Pilot Aiding

Develop information control and pilot interaction with intelligent avionics for improved situation awareness and improved pilot decisions under intense threat conditions. Develop an AI processor to execute the expert systems and AI software for airborne systems.

(4) PAVE CAP

Integrate large area full color displays, helmet mounted sights and displays, 3-D holographic displays, automatic speech recognition systems, real-time graphics processors, pilot aiding systems, and AI processors into a functional crew system. This requires developing a crew system avionics architecture that will integrate these technologies and address future technologies as they mature.

d. Navigation Sensors and Systems Technology Objectives

Develop navigation sensors/systems technology that will improve performance, operational flexibility, and cost effectiveness of future tactical/strategic aircraft and cruise missiles.

(1) Inertial Systems/Sensors

Develop inertial systems/sensors to improve performance, operational flexibility, and cost effectiveness of future tactical/strategic aircraft and cruise missiles. Design, fabricate, and flight test a high accuracy ring laser gyro strapdown inertial navigation system (Performance goal is 0.1 nautical miles per hour). Develop a strapdown non-dithered laser gyro that meets the needs of a broad range of weapon systems. Emphasis will be placed on environmental capability and reduced size, weight, power, and complexity. System performance goal will be for 0.5 nm/hr. Design and develop a multi-axis laser gyro in a single block of optical material for application in tactical, hypervelocity, and kinetic energy weapons. Design will be for a totally hardmounted, non-dithered navigator. Develop an inertial grade fiber optic gyro with capability of surviving high g's, temperature, and radiation environments for application in strategic systems and weapons.

(2) Integrated Navigation

Develop, test, and validate intelligent, robust integrated reference system technology to support a broad range of mission requirements for tactical and strategic aircraft of the 1990s and beyond. Develop a distributed Kalman filter architecture that contains fault detection, isolation, and reconfiguration features.

Develop and evaluate, via extensive computer simulation, an adaptive tactical navigation system. Continuously reconfigure the navigation algorithm and hardware based on the threat, accuracy requirements, and availability of resources, using stored terrain map information and extensive use of artificial intelligence/expert system technology. Develop an intelligent, robust integrated reference system to demonstrate and validate improved fault detection and isolation concepts for a broad range of 1990-2000's reference system suites. Goals include enhanced reconfiguration and autonomous mission mode capabilities utilizing artificial intelligence technology, system compatibility with advanced information distribution architectures of the future (such as PAVE PILLAR), and full utilization of VHSIC technology and parallel processing techniques for improved real-time performance. This technology capability will be validated and demonstrated through extensive computer simulation, ground based hot bench evaluation, and critical element flight testing.

(3) Radio Navigation

Develop radio navigation systems/sensors technologies to improve performance, operational flexibility, and cost effectiveness of future tactical/strategic aircraft and cruise missiles. Establish a design for a multifunction, integrated, conformal antenna system addressing 2 MHz to 2 GHz RF functions needed by ICNIA and INEWS terminals in future tactical fighters. Develop a multifunction CNI antenna embedded within the airframe composite materials utilizing micro strip array, special purpose radome and antenna feed techniques. Develop and demonstrate GPS receiver architecture technology for enhanced jam resistance performance capability. Design emphasis will include total system electronic counter-countermeasure techniques, Design, develop, and demonstrate an integrated stellar inertial system for current and advanced strategic applications based on solid state focal plane imaging devices. Emphasis will be placed on significant reductions in cost, weight, and size and improved sensitivity over current systems.

(4) Hypervelocity Vehicle Navigation Technology

Develop navigation component and systems technology for a broad range of Hypervelocity Vehicle (HVV) applications. Develop the core avionic technologies to meet the full range of mission requirements of endoatmospheric and exoatmospheric vehicles such as National Aerospace Plane (NASP), Hypersonic Glide Vehicle (HVG), and National Space Transportation System (NSTS). Develop areas to emphasize advanced reference components, intelligent adaptive navigation system architectures, communication antenna technology, and highly integrated fault tolerant system architectures which optimize system application performance, survivability, and reliability. This effort builds on 6.2 work that identifies core avionic technologies required for hypervelocity aerospace vehicles where environmental survivability, decreased size, power, weight, and fault tolerance capability are of utmost concern.

c. Communication Systems Technology Objectives

Design, develop, and transition jam resistant (JR), Low Probability of Intercept (LPI) transmission/reception systems for strategic and tactical communications to reduce the physical vulverability of the airborne platform.

(1) Integrated Communication

Design, develop, and demonstrate a reliable, reconfigurable, multimode, multiband, integrated communication, navigation, and identification avionics (ICNIA) system. This advanced communication system emphasizes the following technologies: Very High Speed Integrated Circuits (VHSIC), Monolithic Microwave Integrated Circuits (MMIC), ADA, Adaptive Signal Processing, Optical Processors, Millimeter Wave, and Laser Communication. A new multimode low probability of intercept (LPI), low probability of detection (LPD), low probability of exploitation (LPE), anti-jam (AJ), secure airborne communication capability is being developed through integration of the following signal processing techniques: adaptive transmit power control, adaptive beam pointing, bandwidth compression, spread spectrum modulation, adaptive null steering antenna, adaptive interference suppression, and adaptive signal masking. Feasibility modeling is being performed at both RF and optical frequencies for application to both strategic and tactical aerospace vehicles (i.e., Advanced Tactical Fighter (ATF), Advanced Technology Bomber (ATB), Hypervelocity Vehicle (HVV), F15, F16). These new communication systems will reduce not only the size, weight, and cost of future avionics, but also reduce the physical and electromagnetic vulnerability of the aerospace vehicle and increase its survivability and mission effectiveness.

(2) Data Links

Design, develop, and demonstrate a modular, wideband, multiple-sensor AJ/LPI data link for real-time beyond line-of-sight air-to-air transmission/reception of tactical/strategic reconnaissance imagery and/or wideband digital data from manned or unmanned platforms. A low probability of detection (LPD), jam-resistant (JR) intra-flight data link network is also being developed to share multi-sensor data between multiple airborne platforms for situational awareness. Technologies being emphasized include: high gain antenna system; acquisition and tracking; wideband spread spectrum, concatenated coding, millimeter wave and low observable antenna arrays. SATCOM flight test and analysis support is being provided to Electronic Systems Division (ESD), Space Division (SD), and the Navy.

APPENDICES

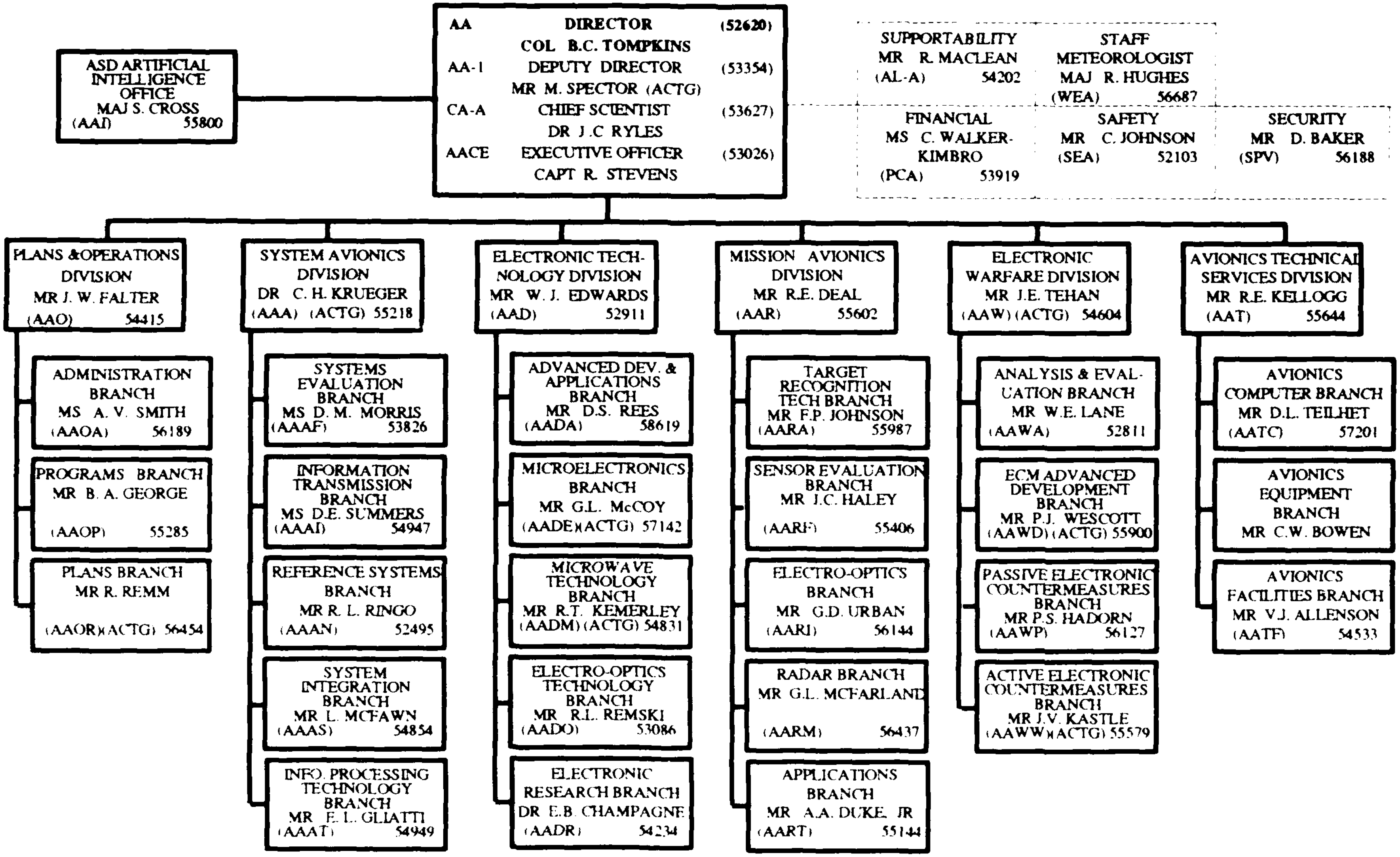
ORGANIZATION CHART

FUNDS

FACILITIES

POINTS OF CONTACT

AVIONICS LABORATORY



AAORG.CHP
1 APRIL 1988

FUNDS

SOURCES

PROGRAM ELEMENT	TITLE	EST FY88	EST FY89	EST FY90	EST FY91
DL PROGRAM					
61101F	In-House Laboratory Independent Research	1.3	1.3	1.3	1.3
62204F	Aerospace Avionics	59.5	66.5	68.0	69.3
63203F	Advanced Avionics for Aircraft	0.9	30.1	37.0	42.4
63253F	Advanced System Integration Demonstration	2.9	14.0	15.2	19.7
63452F	Very High Speed Integrated Circuits (VHSIC)	99.5	44.1	0.0	0.0
63743F	EO Warfare	0.0	0.0	38.8	43.4
64241F	EO Warfare	41.8	47.6		
63109F	INEWS/ICNIA Advanced Development	53.5			
	SUBTOTAL	268.4	203.6	160.3	176.0
OTHER DIRECT PROGRAM					
71112F		4.3	4.5	4.6	4.8
OTHER AFSC		32.6	16.4	16.4	16.4
OTHER AIR FORCE		3.6	.4	.4	.4
OTHER DOD		11.0	15.2	15.2	15.2
NON DOD		.3	1.0	1.0	1.0
SUBTOTAL OTHER		51.8	37.5	37.6	37.8
TOTAL LABORATORY INCOME ($ MILLIONS)		320.2	241.1	197.9	213.8
LABORATORY OPERATIONS					
6.1		1.1	1.1	1.2	1.3
6.2		30.1	30.0	30.0	30.0
6.3/Other		5.7	6.0	6.0	6.0
TOTAL ($ MILLIONS)		36.9	37.1	37.2	37.3

FACILITIES

Examples of Major Existing Facilities

Communications Systems Evaluation Laboratory (CSEL) - Provides the capability to simulate, under computer control, the various portions of communication data links and systems for satellites, aircraft and weapons. It includes UHF, X-band and K-band transmitters, receivers, modems, input-output transducers and test equipment. Included is a ten-foot diameter K-band antenna dish and small antenna for X and K band. Antenna control can be manual, automatic and/or computer controlled.

Avionics System Analysis and Integration Laboratory (AVSAIL) - Provides the capability to accurately simulate the operation of a complete avionics system, including all subsystems interactions, and external environment concerns according to design approaches and mixes that may be varied by the user. AVSAIL is structured around three Harris H800B computers and VAX 11/780. The Harris computers provide a direct access capability to the MILSTD 1553B bus and to various PDP-11 minicomputers providing graphics and cockpit interfaces.

Targeting Systems Characterization Facility (TSCF) - Provides an economical means for exercising and characterizing breadboard or production EO sensors performance over a fully instrumented and calibrated range. The facility includes 8km and 2.5km ranges to target areas where military and synthetic targets are used.

Dynamic Electromagnetic Environment Simulator (DEES) - Simulates 96 RF emitters in the 0.5-18 GHz range that can be used to evaluate radar homing, warning and electronic intelligence receivers. Other capabilities include: three-dimensional transmit and receive antenna pattern modeling with real time polarization mismatch, airborne interceptors, multiple guidance emitters, pseudo random phase modulation, frequency hopping and selective emitter control.

Electronic Defense Evaluator (EDE) - Provides the capability to perform feasibility testing of developmental ECM techniques and concepts. The facility can simulate in real time tactical engagements between ECM equipped aircraft and a pulse radar ground site. The facility has a self contained capability to simulate a given kind of generic threat radar (search, acquisition, track), a given kind of penetrating aircraft, maneuvering or non-maneuvering flight paths and one-way and two-way signal propagating paths. In one principal mode of operation, EDE operates on line with DEES to evaluate the response of automatic ECM systems in high signal environments.

Electronic Warfare Anechoic Chamber (EWAC) - Provides the capability for testing EW techniques against threat radars in a secure, shielded, 39'L x 30'W Anechoic Chamber. Free space simulation is essential for testing monopulse ECM techniques such as cross polarization and wave front distortion. Three monopulse variant radars are available for tests. One is a classic monopulse tracker. Another is a "scan-with-compensation" tracker. The third (SADS-6) represents a semi-active missile seeker. It is tied in with a target angular position system through a digital computer, to provide a complete closed-loop flyout model.

Sensor Quality Analysis Laboratory I & II (SEQAL I & II) - Provides the capability to analyze and evaluate performance of various types of reconnaissance and weapon delivery systems including visual (photographic and electro-optical) IR and radar. Both SEQAL I & II consist of VAX computers that may be operated together through optical links or may be operated independently. The SEQAL facilities operate with both analog and digital imagery in softcopy or hardcopy to reduce and analyze sensed data and image enhancement processes. This unique two facility approach is capable of simultaneous operation at different security classification levels.

RF/EO Foreign Materials Exploitation - Provides the facilities to evaluate the capability and performance of RF and EO devices and equipment. The classified facility is housed in a 25,000 square foot area and can accommodate systems up to 30 feet in length. It can propagate and measure RF signals from 3-20 GHz and EO signals from 0.4 to 10 microns over a range extendable to 120 feet.

Radar Reflectivity Range - Indoor anechoic chamber (60'L x 30'W) instrumented for radar backscatter measurements. This facility is instrumented for operation from 1.2-40 GHz. Target signatures can be measured to -40 dbm with accuracy of 1 db at all frequencies.

Electronic Warfare Simulation Analysis Facility (EWSAF) - Provides an electronic warfare digital simulation capability for evaluating the effectiveness of electronic aircraft penetration against enemy weapon systems. Can use up to 40 distinct digital simulation models. Facility is located in a vaulted RF screen room approved for secret and compartmented intelligence security levels.

Dynamic Analyzer - Provides the capability for evaluating the design integrity and performance of R&D operational avionics sensors/systems under simulated flight conditions. Can accommodate 2000 pounds of equipment, six feet in diameter by ten feet long, in a chamber that can simulate various ranges of altitude, temperature, motion, targets and air flow.

Device Research Facility - Over 4,500 square feet of Class 10 and Class 100 environmentally-controlled cleanroom areas enable the fabrication of integrated circuit devices with features as small as 0.5 micron and smaller. Capabilities include all device processing levels from epitaxial film growth to final device characterization. Photolithography, electron beam lithography and metalization of both gallium arsenide and silicon wafers are among the capabilities provided by this facility.

VHSIC/IDAS Computer-Aided-Engineering (CAE) Laboratory - Provides the tools and resources for Laboratory engineers and scientists to explore several areas within the circuit design arena. These areas include Design Automation (DA) tools for electronic circuits, use and evaluation of the VHSIC Hardware Design Language, databases and database management systems for circuit design data, new concept in Integrated Circuit (IC) design and simulation, and computer graphics for DA applications. It also allows technical contract managers with a test-bed for both hardware and software contract deliverables, VHSIC chip documentation, and CAD/CAM interfaces for IC fabrication, (Resources: Calma Workstation, Apollo Workstations, Symbolics Workstation, and VAX Computer.)

Computer-Aided-Design (CAD) Laboratory. Fulfills the need of the AAD Division for an in-house design capability. It supports the generation of SSI through LSI circuit designs as used in several different projects including MMIC, MESFET, MODFET, and IGFET. This facility also provides the interface to manufacturing that is required for the production of the mask sets used in integrated circuit fabrication. (Resources: Calma Workstation, Apollo Workstations, and VAX Computer.)

Radar Analysis and Signal Processing Laboratory - Provides a capability for development, assessment, and evaluation of advanced radar signal processing algorithms and for analysis/assessment of radar subsystem performance when subjected to a hostile threat environment. The facility includes: general purpose computers; high speed, real-time radar signal processing and analysis hardware; detailed radar, ECM and ECCM models; and peripherals to support modeling, analysis and signal processing efforts. A data base of selected radar and ECCM data is being developed and will be maintained to support both in-house and contracted analysis and development efforts.

New Facilities Required

Addition to Building 620 - This facility, which has been planned for the Military Construction Program (MCP), will ultimately provide 200,000 square feet of Laboratory space. It will be adjacent to Building 620 and will permit 620's full utilization as a Laboratory facility. It will locate 90% of the Laboratory's scientists, engineers and staff within walking distance of each other, enable proper attack on integration activities, and permit release of vacated facilities to other organizations.

AVIONICS LABORATORY
TECHNOLOGY AREA OBJECTIVES
POINTS OF CONTACT

Electronic Devices

- Electro-Optics Technology, Mr Richard Remski, AFWAL/AADO, (513) 255-3086, AV 785-3086

- Microwave Technology, Mr Robert T. Kemerley, AFWAL/AADM, (513) 255-4831, AV 785-4831

- Microelectronics Technology, Mr Gary L. McCoy, AFWAL/AADE, (513) 255-7142, AV 785-7142

Offensive Avionics

- Mission Avionics, Mr Ed Deal, AFWAL/AAR, (513) 255-6502, AV 785-6502

Defensive Avionics

- Electro-Optical (EO) Countermeasures, Bruce Noren, AFWAL/AAWD, (513) 255-6649, AV 785-6649

- Radio-Frequency (RF) Countermeasures, Mr Paul J. Westcott, AFWAL/AAWD, (513) 255-6650, AV 785-6650

System Avionics

- Avionics System Integration Technology, Mr Lester McFawn, AFWAL/AAAS, (513) 255-4854, AV 785-4854

- CNI Systems Technology, Mr Ronald L. Ringo, AFWAL/AAAN, (513) 255-2495, AV 785-2495

U.S. GOVERNMENT PRINTING OFFICE 1988

END
DATE
FILMED
DTIC
JULY 88