# Department of Defense

# FY96
# ELECTRONIC WARFARE
# PLAN

**April 1995**

**Prepared Under Direction of the Office of the Under Secretary of Defense for Acquisition and Technology [OUSD (A&T)]**

# Table of Contents

Page

EXECUTIVE SUMMARY ........ ES-1

Chapter 1
ELECTRONIC COMBAT ACQUISITION POLICY GUIDANCE
1.1 INTRODUCTION ........ 1-1
1.2 SCIENCE AND TECHNOLOGY (S&T) PROGRAMS ........ 1-1
1.3 ACQUISITION PROGRAMS ........ 1-2
1.4 EW ACQUISITION PROGRAM MANGEMENT ........ 1-4
1.5 ELECTRONIC PROTECTION ........ 1-5

Chapter 2
THREAT OVERVIEW
2.1 INTRODUCTION ........ 2-1
2.2 WEAPONS TECHNOLOGY PROLIFERATION ........ 2-1
2.3 C2, DETECTION, AND ACQUISITION SYSTEMS ........ 2-2
2.4 THREAT TO AIR PLATFORMS ........ 2-5
2.5 THREAT TO MARITIME PLATFORMS, ANTISHIP CRUISE MISSILES (ASCMs) ........ 2-9
2.6 THREAT TO LAND FORCES ........ 2-9
2.7 ELECTRONIC WARFARE THREAT ........ 2-12
2.8 DIRECTED ENERGY WEAPONS (DEW) ........ 2-13

Chapter 3
EW TECHNOLOGY PROGRAMS
3.1 INTRODUCTION ........ 3-1
3.2 TRI-SERVICE S&T RELIANCE ........ 3-1
3.3 OVERVIEW OF EW TECHNOLOGY ........ 3-3
3.4 PROGRAMMATIC EMPHASIS IN EW TECHNOLOGY PROGRAMS ........ 3-4
3.5 SERVICE PROGRAM ELEMENTS ........ 3-6
3.6 THREAT WARNING TECHNOLOGY OVERVIEW ........ 3-6
3.7 SELF-PROTECTION TECHNOLOGY OVERVIEW ........ 3-11
3.8 MISSION SUPPORT TECHNOLOGY OVERVIEW ........ 3-18
3.9 EW-RELATED TECHNOLOGY (HPM, LASER, TST) OVERVIEWS ........ 3-26

Chapter 4
THREAT WARNING RESEARCH AND DEVELOPMENT PROGRAMS
4.1 INTRODUCTION ........ 4-1
4.2 FIXED-WING TACTICAL RADAR WARNING RECEIVERS (RWRs) ........ 4-1
4.3 HELICOPTER AND FIXED-WING SUPPORT AIRCRAFT RWRs ........ 4-2
4.4 AIRBORNE ES SYSTEMS ........ 4-4
4.5 MISSILE APPROACH WARNING SYSTEMS ........ 4-5
4.6 SUBMARINE ES SYSTEMS ........ 4-7

Page

Chapter 5
SELF-PROTECTION RESEARCH AND DEVELOPMENT PROGRAMS
5.1 INTRODUCTION ........ 5-1
5.2 FIXED-WING TACTICAL DEFENSIVE JAMMERS ........ 5-1
5.3 AIRBORNE INTEGRATED DEFENSIVE SYSTEMS ........ 5-2
5.4 HELICOPTER AND FIXED-WING IR JAMMERS ........ 5-6
5.5 HELICOPTER DEFENSIVE JAMMERS ........ 5-6
5.6 AIRBORNE IR EXPENDABLES ........ 5-7
5.7 AIRBORNE ACTIVE RF DECOYS ........ 5-7
5.8 SURFACE TACTICAL EW SYSTEMS ........ 5-9
5.9 GROUND VEHICULAR IR SACLOS JAMMERS ........ 5-9

Chapter 6
MISSION SUPPORT RESEARCH AND DEVELOPMENT PROGRAMS
6.1 INTRODUCTION ........ 6-1
6.2 AIRBORNE TACTICAL SIGINT SYSTEMS ........ 6-1
6.3 AIRBORNE ARM TARGETING SYSTEMS ........ 6-3
6.4 COMMUNICATIONS EA SYSTEMS ........ 6-3
6.5 GROUND TACTICAL SIGINT SYSTEMS ........ 6-3
6.6 RF PROXIMITY FUZE JAMMER ........ 6-4
6.7 MULTIDISCIPLINED, MULTIFUNCTIONAL PLATFORMS AND SYSTEMS ........ 6-4

Chapter 7
CONSOLIDATED PROGRESS REPORT ON THE TEST AND EVALUATION PROCESS FOR EW SYSTEMS
7.1 BACKGROUND ........ 7-1
7.2 PROCESS IMPLEMENTATION ........ 7-2
7.3 STATUS ........ 7-2
7.4 ANNUAL REPORT ........ 7-3
7.5 PROGRESS ........ 7-3

## Appendixes

Appendix
A - INDEX ........ A-1
B - REFERENCES ........ B-1
C - GLOSSARY ........ C-1

# EXECUTIVE SUMMARY

## Overview

*A.* The FY96 Department of Defense Electronic Warfare (EW) Plan is prepared by the Joint Command and Control Warfare Center, the Services, Defense Intelligence Agency (DIA), National Security Agency (NSA), and the Joint Staff (JS) under the direction of the Under Secretary of Defense for Acquisition and Technology. The Plan compiles EW, defense cryptologic, and tactical signals intelligence (SIGINT) technology FY95-FY01 research, development, test, and evaluation (RDT&E) and production programs in the President's FY96 budget submitted to the Congress. Special Access Required programs are included in Annex A, released under separate cover. Not addressed are the majority of Service testing and simulator programs and EW systems in the Services' inventory not undergoing product improvements during FY96 and beyond. Terminology and definitions used in this Plan are from the Chairman of the Joint Chiefs of Staff Memorandums of Policy, **Electronic Warfare** (MOP 6), and **Command and Control Warfare** (MOP 30).

*B.* Three specific mission areas are addressed in the Plan. They are referred to in terms of EW technology and EW engineering and manufacturing development (EMD). The mission areas are as follows:

- ***Threat Warning.*** EW and tactical SIGINT systems which are integrated or carried on a host platform and provide platform threat warning or targeting support through reception of electromagnetic energy.

- ***Self-Protection.*** EW systems which are integrated or carried on a host platform and provide platform self-protection through active transmission or reflection of electromagnetic energy or destruction of enemy command and control (C2) systems.

- ***Mission Support.*** Dedicated EW and tactical SIGINT platforms and systems which provide reconnaissance, surveillance, countersurveillance and threat warning, destruction, or disruption, of enemy C2 systems in support of other platforms.

Engineering and manufacturing development programs are further categorized by platform family.

## Threat Overview

*A.* Once again, this year's Plan concentrates on the threat posed by new and emerging weapons technology worldwide. The threat chapter is broken down by threat system type; that is, threat to aircraft, ships, etc. Each section is headed by a chart containing key technology pertinent to that section and discusses the technology and countries active in developing it.

*B.* The primary threat lies not so much with any one country, as it does with the proliferation of high technology. Operation DESERT STORM demonstrated the effectiveness of sophisticated weapon systems. Buyers around the world will use that performance as a yardstick for acquisition decisions. Current United Nations' actions around the world are exposing new deficiencies in system capabilities; industries worldwide are developing or incorporating new technology to solve them. The trend continues toward smaller armed forces with increased weapon system capabilities.

*C.* Since arms exports are, or can be, a major source of foreign currency for several countries, they are attempting to sell a wide variety of weapon systems, including advanced systems. Competition between sellers is keen and the best way to outsell one's competitors is to offer the highest technology at the lowest prices. Another popular alternative provided by many of these countries is the refit of older systems, especially former Soviet equipment, with state-of-the-art system upgrades. This is especially attractive to many third-world countries which cannot afford to replace complete weapon systems. Finally, to further edge out competition, some of these countries are offering to sell both the technology and the manufacturing capability outright to selected clients. This in itself could cause the rapid spread of advanced technology worldwide.

*D.* A serious threat to US forces is precision-guided munitions; that is, smart weapons - antiship cruise missiles, antitank weapons, antiradiation missiles, tactical air-to-surface missiles, and air-to-air and surface-to-air missiles. Concurrently, defensive systems are incorporating new technology to counter currently fielded "smart" systems as well as the threat posed by electronic warfare.

## Technology Overview

*A.* ***FY95-FY01 EW Technology Programs.*** During FY95-FY01, DOD has programmed EW technology tasks totaling $942.9M. These programs are responding to requirements to develop technology to upgrade current EW systems and to Service and commander in chief (CINC) future requirements. EW technology programs are described in terms of supporting threat warning, self-protection, mission support system requirements, and electronic protection (EP). An additional category, EW employment, includes technology programs developing EW simulation and analysis.

*1.* ***Threat Warning.*** Advanced technologies will be applied to improve the Services' capability to obtain warning in dense, multispectral threat environments. Technology examples are fiber optic networks, very high speed integrated circuits, monolithic microwave integrated circuits, artificial intelligence, and advanced antennas (including those using high-temperature, superconducting components). The Navy and Air Force are working on active approaches to enhance capabilities of passive missile warning systems. The Services will develop laser receiver technologies capable of detecting and characterizing laser beamrider threats. This effort is coordinated between the Army, Navy, and Air Force.

*2.* ***Self-Protection.*** Proliferation of precision-guided weapons will continue to make self-protection a difficult task. The Service laboratories will develop a number of advanced countermeasure (CM) techniques to increase the options available for countering weapons in the end game. The frequency requirements are broad. The Radio Frequency Countermeasures Committee of the Joint Directors of Laboratories Technology Panel for Electronic Warfare (JDL-TPEW) has instituted a tri-Service plan to develop a modular, microwave power module (MPM)-based jamming transmitter subsystem. This subsystem will be capable of being scaled up for high effective radiated power (ERP) missions (support jamming), and scaled down for tactical air self-protection applications. The Advanced Research Projects Agency (ARPA) has initiated a program to develop solid-state, diode pumped lasers for infrared countermeasures (IRCM) applications.

*3.* ***Mission Support.*** There are several significant projects that will develop, demonstrate, and evaluate technologies aimed at fusing and correlating information sources to provide improved situational awareness in the battle area, particularly with the Army Common Ground Station. These efforts are driven by technology thrusts in data fusion algorithms and data base architectures. Electronic attack of an enemy's communications will include projects coordinated among the Services.

*4.* ***Electronic Protection.*** Threat EA enhancements are forcing additional EP hardening of radars, C2 and intelligence, and smart weapon guidance systems. Hardening of optics and electro-optic (EO) devices against jamming and spoofing by in-band lasers is ongoing.

*5.* ***EW Employment.*** The Services will continue to develop EW system employment simulations. The Army will develop a Survivability Integration Laboratory, which is a research, development, and evaluation facility for aircraft and ground vehicle survivability equipment. The Naval simulations are developing techniques for handling extremely dense, computation-intensive EW ship defense scenarios; and, at a more detailed level of analysis, effectiveness of specific EW equipment against advanced antiship missiles. EW decision aids are also being developed for Naval Commanders. The Air Force is working on digital simulation laboratories needed to support product center development of programs such as the tri-Service Joint Modeling and Simulation System. In addition, the Air Force will develop the Integrated Defensive Avionics Laboratory as a hardware/software testbed for emulating the various components required for a multispectral integrated electronic combat system.

***B.*** ***FY95-FY01 EW-Related Technology Programs.*** In FY95-FY01, $386.6M is programmed for EW-related technologies. This area covers high-power microwave, laser sources, and tactical SIGINT technologies. Efforts on these technologies are not funded within EW program elements.

## Systems Overview

*A.* *Navy:*

*1.* ***Airborne Systems.*** Force downsizing, the "new world threat," and limited availability of funds have resulted in major changes in Naval Airborne EW programs. A new program, Integrated Defensive Electronic Countermeasures (IDECM) has been added to this year's Plan. The Navy has completed developmental testing of the APR-39A(XE-2) and began operational testing in 2QFY95. In self-protection systems, the Airborne Self-Protection Jammer (ASPJ) has been approved for test on the F-14D with no further systems to be produced beyond those already produced under low-rate initial production (LRIP). Other airborne EW programs remain unchanged.

*2.* ***Maritime Systems.*** With the change in US maritime strategy placing a strong emphasis on littoral warfare, ship self-defense will receive increased emphasis during current and future budget planning cycles. The Advanced Integrated Electronic Warfare System (AIEWS) has received its milestone zero decision from the Assistant Secretary of Navy for Research and Development and Acquisition. The SLQ-32 improvement program will continue at least through phase E which has an IOC of 1996 and has thus far passed operational testing; it now awaits the development of the R-17 software program. NULKA, an active RF antiship missile decoy, has successfully passed operational evaluation and is being considered for full production.

*3.* ***Undersea Systems.*** There is no significant change to undersea system programs at present. Both are proceeding as scheduled. With the downsizing of the submarine fleet, fewer systems will be procured.

*4.* ***Mission Support Programs.*** A major change has been made with the cancellation of the EA-6B Advanced Capability (ADVCAP) program. Other airborne and shipborne EW programs remain unchanged.

***B.*** ***Air Force:***

*1.* The Air Force has adopted a two-phased approach to continue High Speed Antiradiation Missile (HARM) targeting capability after the programmed retirement of the F-4G/APR-47. The Air Force has fielded a podded HARM targeting system (HTS) on the F-16 block 50D aircraft to provide an initial HARM targeting capability.

*2.* The ASTE program will develop technologies for expendable IR countermeasures to provide spectral output, rise times, burn times, and aerodynamic capabilities required for combat, mobility, and special operations aircraft. The technologies showing the best maturity and capability to meet user requirements will be pursued in a competitive EMD program with an EMD contract award planned for late FY95.

*3.* The Common Missile Warning System (CMWS) is a main thrust for DOD EW. CMWS is an Army led joint program with the Navy and Air Force. The CMWS program will provide a missile approach warning capability for installation on current generation tactical aircraft. This system will be configured for internal installation on the F-16, F-15, F-14, F/A-18, AV-8B, and selected Army helicopters. External installation is planned for the A/OA-10. The CMWS is one component of the Army ATIRCM system.

*4.* The EC-130H Compass Call standoff communications jamming aircraft is being upgraded to counter the current and developing threat. This P3I effort includes user configurable bands, and integration of the Tactical Intelligence Broadcast System (TIBS). Additional efforts include increasing the ERP, increasing the reliability and maintainability of preserved subsystems, and a capability for onboard operator training.

*C. Army:*

*1.* The Advanced Integration Aircraft Survivability Equipment (AIASE) program to integrate sensor systems for advanced Army aircraft has been merged with other advanced development program efforts. Army efforts relating to the integration of system's sensors will be conducted within the Advanced Threat IR Countermeasures (ATIRCM) and Suite of Integrated RF Countermeasures (SIRFC) programs. The Advanced Threat Radar Jammer (ATRJ) program is incorporated into the SIRFC program. Situational awareness algorithms and interface data links with Army digitization standards will be developed. The SIRFC program will be used to prove sensor fusion and situational awareness elements.

*2.* The Artillery Delivered Expendable Jammer (AD/EXJAM) is an Army expendable jammer developed to be delivered from a 155mm Howitzer artillery carrier round. In September 1994, AD/EXJAM with upgrades (positive on/off control developed with FY92 funds) was demonstrated and dropped from a MITEK UAV.

***D. Marines:***

*1.* Current programs include one ground EW system, two ground SIGINT collection systems, a SIGINT processing system, a SIGINT broadcast and receiving system, and an special intelligence communications terminal. Acquisition trends reflect changes in priorities driven by downsizing and restructuring of manpower. No new programs are being fielded. There are continuing efforts to analyze and correct shortfalls identified in Southwest Asia.

*2.* The emphasis in the Marines is providing refinements and enhancements to existing capabilities. This includes attempts to extend service life of existing equipment.

*3.* A new functional category (multidisciplined, multifunctional platforms and systems) has been added to chapter 6 to better reflect the near-term generation of capabilities being fielded by the Services. Mobile Electronic Warfare Support System (MEWSS) (AN/MLQ-36) P3I has been moved to this new functional category.

*E. Special Operations Command:*

*1.* US Special Operations Command (USSOCOM) currently has one research and development program under the title Directional Infrared Countermeasures (DIRCM). This is a program to provide an active countermeasures capability for the Special Operations Force (SOF) C-130 fleet.

*2.* USSOCOM's emphasis in EW is on threat identification and avoidance and end game countermeasures in an attempt to increase the survivability of SOF assets. USSOCOM is developing the Electronic Warfare Avionics Integrated Systems Facility to generate and test software enhancements as future threats are identified and countermeasures are fielded.

**Consolidated Progress Report on the Test and Evaluation Process for Electronic Warfare Systems**

In response to Congressional direction, OSD, JS, and the Services developed a structured test and evaluation process for EW acquisition programs. This process is documented in the publication ***DOD Test and Evaluation Process for Electronic Warfare Systems - A Description***. In compliance with Public Law 103-160, 30 November 1993, the report on progress toward implementing the process is included in this DOD EW Plan. This report consolidated the input of the DOD components. A total of 14 EW programs were identified in a DOD Memorandum entitled "Designation of Programs for OSD Test and Evaluation (T&E) Oversight" to use the process and report. This DOD EW Plan provides status descriptions of designated programs in the EW T&E process.

# Chapter 1

# ELECTRONIC COMBAT ACQUISITION POLICY GUIDANCE

## *1.1 INTRODUCTION:*

The Defense Planning Guidance provides the following direction for Defense Acquisition:

"We have adopted a new approach to defense acquisition in light of the changes in projected threats and OSD's acquisition strategy. The expected pronounced slowdown or even halt in Russian modernization programs profoundly alter US modernization requirements. For the new defense strategy, investment must reflect the different nature and sophistication of regional threats, and resulting changes in priority among defense missions, as well as the enduring strategic requirement for technological superiority. Reflecting this refocused approach, the Defense components will:

- Aggressively pursue advanced technologies for potential application in current and future EW systems, to preserve our science and technology base and our forces technological advantage, and to reduce systems life-cycle costs and lengthen service lives.

- Use advanced technology demonstrations and prototypes to demonstrate and validate technologies' and systems' operational performance, producibility, usability, and associated doctrine.

- Incorporate advanced technology into existing or new systems only when: (1) the technology and subsystems are thoroughly proven; (2) technical, production and operational risks are minimized; (3) the production program is cost-effective; and (4) the system is absolutely needed.

The Defense components will also reduce concurrency among the acquisition stages; improve R&D contracting as necessary to support the technology base; and more effectively and efficiently evaluate technologies, systems, and subsystems using such tools as modeling and simulation to augment system field testing."

This guidance applies to all electronic warfare (EW) systems acquisition. The Joint Chiefs of Staff in CJCS MOP 6 have defined EW as: "Any military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy. The three major subdivisions within EW are electronic attack (EA), electronic protection (EP), and electronic warfare support (ES)."

## *1.2 SCIENCE AND TECHNOLOGY (S&T) PROGRAMS:*

Defense Planning Guidance provides the following direction for S&T programs, which applies to EW:

"The changing world situation and the demands of the nation's economic security require that we maintain our technological superiority but also make our technology more affordable. Where possible, those technologies should be developed in a way that sustains the strongest possible S&T base and aids the economic revitalization of the nation. A vigorous S&T program remains a strategic imperative to ensure continued qualitative superiority both in actual technology in the future Base Force and in potential technology for further future (including possible reconstituted) forces. Also, S&T is a much more important factor in the overall acquisition process doing more than before to 'prove out' new technology and components before programs enter the formal acquisition process. Not all S&T successes will enter the acquisition process. Only those meeting the strict criteria mentioned above will proceed."

*A.* ***General Guidance.*** The Defense Planning Guidance requires that we balance the EW S&T programs (research and development categories 6.1, 6.2, and 6.3A) between a core of broad sustaining programs, and the following specific DOD Technology Thrusts:

- Global surveillance and communications, focused upon a theater of operations with sufficient fusion and planning assets.
- All-weather air superiority and defense against low-observable cruise missiles, ballistic missiles, and aircraft.
- Sea control and undersea superiority needed to maintain overseas presence, conduct forcible entry and naval interdiction operations, and operate in littoral zones against submarines, stealthy cruise missiles, and undersea mine threats.
- Rapidly deployable, all-weather, day/night, survivable, mobile, and lethal ground combat capability.
- Technology for Training and Readiness, including embedded training, distributed simulation, and virtual environment depiction.
- Application of advanced technology to reduce life-cycle costs.

*B.* ***Management Guidance.*** EW S&T programs will be coordinated across the Services, aggregating programmatic and budget information in a comprehensive data base. The Joint Directors of Laboratories Technology Panel for Electronic Warfare (JDL-TPEW) will be used as the management focus for EW technology programs.

*C.* ***Specific Guidance:***

- Emphasize the application of directed energy weapons technology to solve EW problems, specifically, the use of laser-based IR countermeasure systems against advanced IR missile seekers, as well as the use of high-powered microwave (HPM) devices for generic self-protection jamming and command and control warfare (C2W) systems.
- Develop next-generation data fusion subsystems for on-platform use.
- Employ artificial intelligence techniques, and parallel and neural architectures to produce understandable situation descriptions without human intervention in the process.

***1.3 ACQUISITION PROGRAMS.*** The Defense Planning Guidance provides the following direction for systems acquisition, which applies to EW systems:

*A.* ***Systems Acquisition.*** The new approach to defense acquisition recognizes that weapon systems no longer must progress from research and development (R&D) to the field at the pace or in the numbers they previously have. Strategic and fiscal changes, and sound management under this approach, will permit funds only for systems acquisitions that are absolutely warranted; that is, when (1) the technologies have been demonstrated and shown to be producible; (2) there is a clear military need for the new EW system or upgrade because an existing system is unacceptably aging or deficient against a specific emerging threat, or there is an unusually promising opportunity for capability improvement and/or cost reduction; and (3) the new EW system or upgrade is cost effective. Exceptions to meet extremely urgent threats will require approval on a case-by-case basis. We will use newly available simulation technologies continuously through the EW system acquisition process to evaluate how system prototypes meet these criteria and contribute across warfare areas.

*1.* Our production and fielding of new EW systems will reflect this new approach. Use EW system upgrades through technology insertions, and service life extension programs (SLEPs), whenever needs can be met in this manner. Develop and procure new start EW systems only if upgrades and SLEPs are unacceptable due to the age and condition of existing EW systems, or because upgrades could not accommodate the evolution of a specific threat or technology, or if a new start promises reduced total costs of ownership.

*2.* Operation DESERT STORM showed that limited numbers of advanced EW systems can significantly enhance the warfighting capability of the overall force disproportionate to their numbers (for example, F-4G, EA-6B, and EH-60). In fielding equipment, apply the "first to fight, first to equip" principle, based on respective units' peacetime roles, and most demanding contingency deployment/employment times.

*3.* Ensure the future ability of the defense industrial base to equip the Base Force, to support contingency-related needs, to contribute needed capability to meet an emerging reconstitution threat, and to do these things efficiently and cost effectively.

***B.*** ***General.*** EW acquisition programs must adhere strictly to the provisions of DOD Directive 5000.1, DOD Instructions 5000.2, and 5200.2-M. The following paragraphs discuss the major considerations that apply in particular to EW system acquisition in the acquisition phases defined in the DOD regulations. The key features of EW systems of the future should include:

*1.* ***Fully-Integrated Architectures.*** EW should be designed into platforms "from the wheels up," avoiding the separate system/black box approaches of the past.

*2.* ***Commonality.*** Systems responding to the same or similar mission requirements, in the same or similar operational environment, should be composed of common modules. Ideally, EW systems will be general purpose enough to satisfy a range of requirements, furthering progress toward the long standing goal of common systems. The Services shall maximize the use of intra- and inter-Service EW systems, subsystems, or modules, including platform hardware, training, test and evaluation, and supportability assets.

*3.* ***General-Purpose Threat Response.*** Systems should be designed to be general purpose with reprogramming capabilities able to counter a wide range of threats.

*4.* ***Modularity.*** Systems should be modular in design to facilitate applications to more than one platform. This modularity shall accommodate both the digital processing and analog components, including the sensors.

***C.*** ***Phase 0, Concept Exploration and Definition:***

*1.* Mission need documentation for EW systems must include validated threat assessments with enough detail so that requirements can be well defined. The Operational Requirements Documents developed in this phase must identify the expected capability to operate in the specified threat environment, including the reprogramming capability required.

*2.* To meet the mission need, application or modification of existing systems (from the same or other Services) must be explored during the concept definition. The goal of system commonality, especially when the threats are similar, must be part of the concept exploration, and be reflected in cost, schedule and performance tradeoffs. Joint approaches to the satisfaction of common EW requirements will be used. When common requirements exist and acquisition efficiencies can be realized, the Office of the Secretary of Defense (OSD) and Services will commit to Joint EW design and acquisitions. Modification of existing systems is an alternative that has to be considered before a new program start is recommended. The ability to rapidly reprogram systems to meet new threats must be a feature of future systems.

*3.* The alternatives proposed should provide for a modular design, so that future requirements can be met by modification or replacement of modules, and that modules can be reused in other EW programs.

*4.* The electronic warfare vulnerability assessment (EWVA) and electronic protection (EP) capability shall be identified for each concept.

*5.* The capability to survive and/or operate in the presence of electromagnetic effects should be considered in the design and procurement of electronic warfare systems and associated support equipment.

*D. Phase 1, Demonstration and Validation:*

*1.* Cost, schedule, and performance tradeoffs must be clearly examined. The costs of new starts versus modifications of existing systems must be especially scrutinized.

*2.* Analyses, modeling, and testing must reflect the actual anticipated, operating and threat environment, and to the extent feasible should reflect force-on-force engagements as well as one-on-one.

*E. Phase 2, Engineering and Manufacturing Development:*

*1.* Reliability and availability must be as high as possible, consistent with cost and performance. System maintenance and repair must be capable of being rapidly done with the minimum of special tools or test equipment.

*2.* Tests results must reflect a realistic portrait of performance under operational conditions. Comparative testing with the presently operational systems must be conducted in the same threat environment.

*3.* Analyses and modeling should be used to the maximum in evaluating various alternatives, due to the lack of EW test and evaluation resources.

*4.* The advantages gained by, and the risks associated with, concurrent developments and production should be carefully weighed and reflected in the proposal acquisition strategy.

*1.4 EW ACQUISITION PROGRAM MANGEMENT.* The following guidance, particular to EW program management, is provided.

- A Quick Reaction Capability (QRC) to develop EW systems will only be used with the approval of the OUSD (A&T). QRC programs will be described in the annual DOD EW Plan.

- Special Access programs will be coordinated through the OUSD (A&T), Joint Staff, and Services before program execution.

- The Future Years Defense Program (FYDP) of the Service concerned must support the proposed EW system acquisition presented to the Defense Acquisition Board (DAB). If it does not, the DOD component head must submit, for the OUSD (A&T)'s information, the funding reductions to other programs in that component that the component head plans to pursue in the planning, programming, and budgeting system to make available funds for the program the DAB has reviewed.

- The Services shall develop a strategy for testing the next-generation, multispectral integrated EW systems. This strategy should include the funding required to upgrade or develop new facilities. Defense Planning Guidance provides the following direction for test and evaluation:

"Reduce operating and maintenance costs for new T&E assets significantly when compared to similar existing facilities. Reduce or eliminate duplication or overlap in test capabilities and efforts. Duplication of test support in such areas as electronic warfare, fixed-wing aircraft, and missile testing will be reduced. For fiscal years 1995 through 1999, program an average savings of 15 percent for each reliance area (3 percent per year)."

- Integration of EW systems with platform and the platform systems may require the EW equipment to be provided as government furnished equipment (GFE) to the platform prime contractor. This will require the EW community to develop a close relationship with the platform prime contractor to enable EW requirements to be addressed properly during the integrated platform development.

*1.5 ELECTRONIC PROTECTION.* All combat systems that rely on the electromagnetic spectrum for their operation, whether dedicated to the EW mission or not, must be able to operate in an environment in which EW is being carried out, beginning with analyses in Phase 0, and continuing with actual field assessments in the later phases, to determine the ability of the system to operate and survive under EW conditions. Requirement and threat documents should support the assessments by clearly stating the EW environment in which the system is expected to operate.

# Chapter 2

# THREAT OVERVIEW

## *2.1 INTRODUCTION:*

*A.* The next two decades will be characterized by redefinition of strategic and security relationships between major powers and evolving powers. Over the next 20 years, US strategic interests will be increasingly affected by fundamentally different concerns in the former Soviet Union to include: regional instability, ethnic and religious rivalries, refugee flows, economic duress, and ecological deterioration. In addition, events in other regions of the world will increasingly affect US security interests. Other nations will be equipped with a wide-ranging mixture of old weapons and electronics, often side-by-side with new and modernized weapons and electronics purchased from worldwide suppliers. Transregional cooperation on technology transfer, through sale or provision of high-technology weaponry, will become particularly acute problems.

*B.* The advance and proliferation of technology will present an array of new and more sophisticated security challenges: regional powers deploying state-of-the-art air defense and antitank weapons, tactical ballistic missiles, and weapons of mass destruction--and the will to use them; and terrorists armed with more advanced surveillance, targeting, and explosive materials. Any counterterrorist/counternarcotics activity could expose US forces to an assortment of weapons that will include: powerful conventional explosives, surface-to-air missiles (SAMs), guided missiles, and electronic attack (EA). In addition, the proliferation of modern communications technologies such as spread spectrum, frequency hopping, high-speed data transmission, and encryption, will challenge the capabilities of the US. Accordingly, each military environment will present a unique set of challenges to US forces.

*C.* This chapter presents threat technology trends and developmental/projected weapons through the year 2015. The overview is organized by weapon category to focus on weapons technology advances which impact US electronic warfare. The emphasis is on the future threat. The chapter begins with a summary of weapons technology proliferation. This is followed by the sensors and systems used for detection, acquisition, and engagement, and their associated modern communications techniques. The chapter is further organized into sections covering the threat to air and maritime platforms and to land forces. Additional sections cover the EW and directed-energy weapons threat.

## *2.2 WEAPONS TECHNOLOGY PROLIFERATION:*

*A.* ***Introduction.*** Proliferation of existing and advanced conventional weapons in the next 5 years will raise the threat to US forces, and may make reaching military objectives more difficult. In the long term (10 to 20 years), the sale of certain advanced weapon components and technologies will shorten development times and increase the capabilities of foreign weapons and the threat that they pose to US forces and interests. In most cases, applying such technologies effectively requires both a defense-industrial infrastructure and the capability to integrate new technologies into weapon development programs, and in the long term, several countries will obtain these infrastructures and capabilities.

### *B.* ***Demand for High-Technology Weapons:***

*1.* Arms sales are big business. Over 40 armament expositions are being held each year throughout the world. However, the current market is flat due to stagnated economies. Arm sales will increase as nations become more prosperous or are able to engage in bartering arms for other goods. One driving factor is the demonstrated effectiveness of advanced conventional weapon systems deployed in DESERT STORM. To sell, especially in the future, the merchants must demonstrate that their systems can counter modern and sophisticated weapon systems.

*2.* Grants and credits from the Former Soviet Union (FSU) fueled the military buildup before 1986.

*3.* Naturally, arms flow more heavily into regions in conflict or having a potential for conflict in the near-term. The advanced conventional weapons and technology that are the big sellers are advanced SAMs, antiship cruise missiles, air-to-air missiles, high-performance aircraft, and precision-guided munitions. Also, subsystems such as laser rangefinders, explosive reactive armor, radar absorbing materials, night vision and thermal imaging devices, and EA are best sellers.

*C. Technology Proliferation to Potentially Hostile Nations:*

*1.* Within high technology base countries that do have export controls, there are companies willing to falsify paperwork or ship the equipment to another company in a country that is acting as a middleman for the true end user. Countries that are often used as middlemen for illegal transactions include Switzerland, Singapore, Hong Kong, Indonesia, and Malta. Although these countries have export laws, they are enforced unevenly; middleman (or cutout) companies are aware there is little risk of detection of buying a high-technology or proliferation item from one country and selling to a proscribed country such as Libya or Iran. These methods are the primary means by which countries of concern obtain high-technology goods from Western countries.

*2.* Some countries acquire technology through co-production or licensing mechanisms.

***D. Technologies Exploitation.*** A few countries with well-developed defense industries will benefit substantially from acquisition of advanced technology to produce more sophisticated weapons than would otherwise have been the case, and in less time. Although their integration may take from 5 to 20 years, technologies are most likely to be transferred. Exploitation of these technologies offers the greatest potential to raise the long-term threat to US forces and fundamentally alter regional military balances.

## *2.3 C2, DETECTION, AND ACQUISITION SYSTEMS:*

### *A. C2 Systems:*

#### *1. C2 Associated Key Technologies Overview:*

- Increased Resistance to Exploitation and EA:
  - Use of fiber optic links
  - Spread spectrum links
  - Use of laser point-to-point communications
  - Fast frequency hopping techniques
  - Increased use of SATCOM
  - Increased use of MMW communications (to 300 GHz)
  - Imbedded decoy signals
  - Increased signal directionality
  - Encryption at all levels
  - Use of cellular networks
- Increased Data Handling Capability:
  - Software-driven systems
    - -- Eases upgrades to systems
    - -- Increase in speed

- Development of intelligent neural networks for sensor management, data fusion, assimilation, and production of a situation assessment.
- Artificial intelligence automatic target recognition algorithms
- Integration of commercially available advanced parallel processingcomputers.

- Network Redundancy:
  - Integrated Systems Digital Networks (ISDN)
  - Multifrequency/multisystem type parallel data transmission
  - Full integration of civilian communications systems including telecommunications and IMARSAT-type systems
- Rapid Net Regeneration:
  - Mobile terminals/relay systems
- Development of "Generic" Systems Which Can Interface with Most Radar and Radio Models.

**NOTE:** Most of the above technologies are available to nearly all countries through dual-use technology programs such as automated air traffic tracking and control systems or secure business communications/data exchange systems.

*2.* A key factor in any country's capability to conduct offensive or defensive operations will be its ability to communicate intelligence and commands between all echelons at near instantaneous speeds, without error. C3 systems must meet multiple requirements: (a) provide decision makers with real-time data on the threat; (b) provide each commander with the current status of his own forces; and (c) instantly and accurately relay his decisions to his subordinate forces. In order to achieve this, a high degree of automation will have to be incorporated into the system. Another factor to consider is the fact that an opponent will try to disrupt this C3 network, thus a high degree of redundancy and network security will have to be built in. Outside of the established nuclear powers, air defense will continue to be the primary reason to develop or buy a complex, redundant, advanced C3 system. Ground forces communication systems are increasing in complexity with demands for higher data rates, greater security, and increased mobility.

*3.* The future of C3 will be dominated by efforts to shorten the decision cycle; and to improve the reliability. The following trends can be seen in future C3 systems:

*a.* A wide range of applications will be software driven for improved reliability and speed.

*b.* Opto-electronics, which includes lasers and fiber optics, will revolutionize communications (very high-speed networks) and have numerous applications for all types of sensors. Fiber-optic links can support a greater amount of signal traffic than wire-based, due to its greater bandwidth capability. Additionally, it is lighter, cheaper, and experiences reduced attenuation compared to standard wire-based systems.

*4.* ***Producers:*** Most countries will design custom C2 systems based around common core computers to fit their customers needs and radar systems. A key point is that most of the technology can be sold or acquired as commercial vice military. This is of great use to countries which are restricted on the armaments market.

*B. Detection/Acquisition Sensors*:

*1. Detection/Acquisition Systems Key Technologies Overview:*

- Land-based/Shipborne Radars:
  - Most all conventional radars will be multifunction, 3D, phased array systems fully compatible with most current or future IADS.
  - Increasing use of MMW
  - Networked radars
  - Increased target handling capability (>300 targets)
    - -- TDMF systems
    - -- Multibeam phased array systems
  - Advanced EP features
    - -- Frequency hopping
    - -- Spread spectrum
    - -- Integrated ARM detection plus automatic counter ARM modes/decoys
    - --Integrated EO systems for passive track (that is, FLIRs, IRSTs, and LLLTV).
  - Mobile systems
  - Features to detect low flying targets
    - -- Pulse Doppler techniques
    - -- Mast-mounted radars
    - -- Aerostat-mounted radars
    - -- Increased clutter reduction techniques
  - Counter LO/Stealth technologies
    - -- Heavy use of HF/VHF bands
    - -- Increased sensitivity
    - -- AO processors to process valid targets in high clutter environments
  - Development of advanced technology radars
    - -- Imaging and holographic radars
    - -- Bistatic and multistatic radar
- Nonradar Systems:
  - IRSTs
  - FLIRs
  - Passive UV trackers
  - Ladars
  - Acoustical systems

*2. Early Warning Systems*:

*a.* Air surveillance is a key component of any air defense system (ADS). Surveillance systems can be divided into three functional categories of early warning, acquisition (ACQ), and ground control intercept (GCI). The purpose of air surveillance is to develop and maintain a situation picture for a given piece of air space. This basic situational awareness is critical to all levels in all air defense systems. In developing the air picture, the surveillance component must detect, identify, correlate, and track a target. Although many types of sensors (both active and passive) can be used, radar remains the primary sensor in all air defense systems.

*b.* Lessons learned in DESERT STORM have defined the criteria which will be used by purchasing countries. Future radars will have design features that will make them more capable. One new radar can take the place of several older systems. New technology and tactics have generated a number of challenges that future radar designs must overcome.

*3. Tracking and Engagement Sensors:*

*a. Technology Trends.* Once a target has been detected, acquired, and identified, a final step of weapons employment will remain. Target engagement sensors will be used in order to achieve final targeting and weapons employment. Traditionally, these sensors have been primarily radars but newer technology systems exist. These systems include active and passive EO systems and laser detection and ranging (ladars). Along with improvements in radar, these systems will create engagement systems highly resistant to most forms of countermeasures and will increase the probability of a kill.

*b. Electro-Optic Sensor Technology.* Many countries are manufacturing both active and passive EO sensors.

*c. Night Vision Devices.* The Gulf War demonstrated the considerable advantage troops and weapons systems equipped with night vision devices held over those equipped with conventional sighting systems.

*d. Laser Detection and Ranging (LADAR)/Light Detection and Ranging (LIDAR):*

*(1)* LIDAR systems represent a significant dual use technology. Unlike radar research, technological advances in the critical components of LIDAR systems are driven more by commercial/civilian applications than by military requirements. However, LIDAR offers a unique potential for a number of diverse military applications.

*(2)* Significant LIDAR research and development is underway in 13 foreign countries; however, tactical rangefinders are the only military LIDAR systems in routine production.

## *2.4 THREAT TO AIR PLATFORMS:*

### *A. Aircraft Key Technologies Overview:*

- New generation sensors will allow aircraft to conduct antiair or air-to-surface missions.
    - Pulse Doppler, multifunction phased array systems
    - ISAR modes
    - Integrated LRFs, FLIRs and IRSTs
- New generation radars increase target tracking and engagement capability of fighters.
    - Active phased array antennas
    - Advanced processors and TWS techniques will allow greater numbers targets to be tracked and engaged.
    - NCTR techniques
- Increased EP features of radars.
    - Wideband spread spectrum techniques
    - Frequency hopping
    - Polarity diversity
- Tail-mounted, aft scanning radars will allow over-the-shoulder AAM engagements and increased threat warning.
- Fighters will incorporate advanced self-protection features.
    - RCS and IR reduction
    - Improved RWRS
        - -- Conformal phased array antennas

-- DRFM
-- Expanded frequencies (includes MMW to 96 GHz)
- MWRs
-- Active MMW systems
-- Staring arrays
-- UV plume detectors
-- IR detectors
- Smart countermeasures dispensers
-- MMW chaff
-- Optical chaff
- Advanced IR decoys - kinematic or activated metal
- Advanced integrated self-protection systems will incorporate a combination MWR, LWR, RWR, and special C3 signal processors.
- Integrated jammers
-- DRFM-based processors
-- Towed jamming antennas

NOTE: Many of the above technologies are available for retrofit on older generation aircraft giving them an increased capability.

*1.* ***Introduction***. Fighters are an essential part of any country's offensive and defensive capability. They afford the greatest degree of flexibility and mobility. They are the only system which can be used for either offensive or defensive actions. The major draw back for many countries is their complexity and cost. This means most countries can only afford a limited number of these assets and definitely cannot afford to lose them to hostile fire. In the current world market, competition between aircraft manufacturers is intense. All of them are incorporating technology features to make their aircraft attractive to most potential buyers.

*2.* ***Airborne Intercept Radars***. Newer radars can be retrofitted to older existing airframes thus enhancing their capabilities.

*3.* ***RWRs***. It is highly probable that the new class of RWRs will retain the more advanced features of earlier RWR systems. One such feature that will probably be retained and expanded is the capability to automatically dispense chaff on warning of radar track.

*4.* ***Missile Warning Devices***. Most tactical aircraft will likely have an IR missile warning (MW) sensor. This warning system will consist of a lower, aft-mounted, downward and backward-looking sensor. This device will warn of approaching aircraft, air or ground-launched missiles. Integrating the RWR, MW, and other sensors will require a processor that can handle all the inputs from multiple sensors as well as a memory to compare these inputs with a lookup table of threats. When a threat match is found the computer will present a mode of action for the pilot's approval. The pilot's intervention is required for approval for actions such as maneuver, or EA during normal missions. Automatic flare and chaff ejection based on MW could be an exception.

*5.* ***Laser Warning Devices***. The initial devices are simple indicators giving only warning that the platform has been illuminated by a laser with a crude bearing to threat. Later advanced systems will give accurate bearings and possibly indicate threat type. The most advanced systems will automatically dispense countermeasures through an integrated "smart" dispenser.

***B. Air-to-Air Missiles (AAM) - Related Technologies Overview:***

- Improved Guidance Techniques:
  - Multispectral seekers

- IIR and staring arrays
- Air-to-air ARM guidance
- Command inertial midcourse guidance with active terminal homing (CIMGAH)
- MMW seekers
- IR systems to include long wave IR band and two or three color seekers
- Interchangeable seekers

• Wider Engagement Envelopes:
- Wide FOV IR seekers (>50 degrees off boresight)
- Integrated helmet-mounted sights
- Maneuverability increase through incorporation of thrust vectoring and lattice fins
- Longer range systems

• Development of "Anti-AWACS" Missiles:

• Improved Resistance to Countermeasures:
- Advanced flare discrimination and rejection
- Improved resistance to RF jamming with automatic home-on-jam

C. *Surface-to-Air Missiles (SAMs)*:

1. *SAM Related Key Technologies*:

• More Sophisticated Guidance Schemes:
- Multispectral seekers
- Multimode guidance
- Active radar terminal homing
- Imaging IR
- MMW
- Fiber optic guidance
- Two and three color IR
- Laser beam riding and semiactive laser homing
- Antiradar homing

• Capability To "Silent Launch":
- Use of integrated EO systems to provide guidance to missile
- Development of "lock after launch" systems

• EO/IR systems, especially manpads, will get enhanced night engagement capability.
- FLIRs, IRSTs and low light systems will be added on
- Manpad integration into IADS structure
- MMW or LRF Systems to be added

• Increased Mobility.

• Increased Range.

• Increased Lethality:
- Multiple sub missiles
- Advanced directional warheads

• Increased Resistance to Countermeasures:
- Improved IR decoy discrimination
- Increased resistance to RF jamming

2. *Former Soviet Union Trends.* Specific technologies that will address the requirements for RF SAMs are passive and active phased array antennas with digital beam-forming techniques. Missiles are expected to have dual-mode and terminal mode seekers, as well as imaging seekers.

Transmitters will be broader band with low phase noise for better performance in clutter and against low RCS. Antenna arrays will continue to be elevated to produce better low-altitude performance. Coherent digital signal processing will continue with analog-to-digital (A/D) converters at higher intermediate frequencies as A/D technology improves. Target identification will be performed by comparing target signal spectrum with trajectory data from integrated sensors. This information will be supplied to digital computer algorithms for electronic protection. Directional and smart warheads and adaptive fuzes will improve kill probabilities. Long-range missiles are expected to incorporate multiple sub missiles to counter group targets at extended ranges.

*3. Rest-of-the-World (ROW) SAMs:*

*a.* Although many countries appear interested in upgrading their current air defense systems, most are faced with the dilemma that they must balance their requirements for weapons acquisitions with funding constraints. In addition, training, maintenance, command and control, and logistics support are all factors in the acquisition process. SAM producers, on the other hand, are also faced with a highly competitive international weapons market. They must demonstrate to the potential customer that in today's highly technical environment, their systems are as capable as those of their rivals.

*b.* To cope with customers' requirements and generate export sales, SAMs are incorporating nontraditional guidance technologies. Due to their ease of operation and mobility, MANPADS systems are exhibiting increased sales worldwide and are strongly desired by terrorist groups. Though short ranged, these systems still pose a significant threat worldwide. Most future advanced MANPADS will incorporate many of the above technology features.

*D. Antiaircraft Artillery (AAA):*

*1. AAA Associated Technologies Overview:*

- Improved Acquisition/Tracking (especially at night):
  - Multisensor/multitrack systems
  - Use of MMW
  - FLIRs
  - Laser rangefinders
  - Low light TV systems
  - Able to be integrated into or receive data from an IADS
- Increased Lethality:
  - Guided projectiles
    - -- Correctable rounds
    - -- Semiactive laser guided rounds
  - Higher rates of fire
    - -- Liquid propellants
    - -- Gas propellants
    - -- Electromagnetic rail guns
  - New systems will integrate MANPADS-type missiles in addition to guns and use either simultaneously.

*2.* Multisensor platforms for AAA systems will become one of the most significant developments in air defense of third-world or ROW countries. DESERT STORM again proved AAA is still a lethal threat to low flying aircraft. AAA is more widely deployed and heavily used than any other type of air defense weapon system. Moreover, for third-world countries, it is easier to afford than SAMs or fighters.

*3.* Hardware and software improvements in the capabilities of small-caliber close-in weapon systems (CIWS) will also continue. These weapons, with their associated radars and fire control systems, are frequently built with components from a variety of countries.

### *2.5 THREAT TO MARITIME PLATFORMS, ANTISHIP CRUISE MISSILES (ASCMs):*

***A. Antiship Cruise Missile Key Technologies Overview:***

- Guidance Improvements:
    - Increased resistance to countermeasures
    - Fully autonomous capability
    - Increased accuracy from better sensor technology and integration
- Increased Range:
    - Propulsion improvements
- Increased Survivability
- Ability to be carried and launched from a wide variety of platforms (that is, airborne, land, ship, or submarine) through use of smaller, lighter airframes.
- Increased Lethality

***B. Introduction***. ASCMs can be launched from air, surface, and subsurface platforms, and can be also launched from land-based launchers (both mobile and fixed site). Of course it is important to remember the owning country may modify ASCMs giving them new capabilities. Faced with the fact the threat from ASCMs can come from virtually any quadrant, planners will have to be prepared at all times.

***C. The Trend:***

*1.* The trend in future worldwide ASCM technologies will be to build a versatile, autonomous, extremely survivable missile, one that will guarantee a hit. Nearly all producers are active in the export market with the goal of eclipsing their competition through production of "the best system for the price." This means in order to remain competitive all producers will have to incorporate the latest technologies into the missile systems.

*2.* With the concept of ASCMs being proven in the Falklands and Indo/Pakistani wars, a number of countries outside of the US and Russia embarked on their own ASCM development programs. Many of these systems were designed from the outset with the intent of being competitive on the export market. A key factor has always been to incorporate the latest available technology in these systems in order to remain competitive.

### *2.6 THREAT TO LAND FORCES*:

***A. Antitank-Guided Missiles (ATGM):***

***1. Antitank Systems Key Technologies Overview:***

- Improvements in Guidance:
    - Development of jam resistant links for SACLOS/ACLOS systems
        - -- Laser
        - -- MMW
        - -- Fiber optic
    - Fielding of laser-guided systems
        - -- Laser beamriders

-- Semiactive laser homing
- Development of active and passive terminally guided systems
-- Active/passive MMW seekers
-- IR/two-color IR
-- IIR
-- MMW
-- Dual mode seekers - IR/MMW, TV/IIR
- Improvements in Acquisition and Tracking:
  - Addition of night vision systems
  - Automatic target trackers for addition of MMW radar
    -- TV including LLLTV
    -- IIR
    -- Automatic target recognizer
  - Integrated countermeasures hardening at all levels
- Increased Lethality:
  - Tandem warheads
  - Flight profile modifications will allow missile to attack more vulnerable portions of the AFV; that is, top or engine.

*2. Introduction:*

*a.* An environment exists in which ATGM systems and technologies are readily available to virtually anyone with money or goods for barter. Most current and future conflicts will be regional in scope and will involve all types of ground combat and guerrilla engagements. As such, ATGMS should remain viable weapons for use in all types of conflicts and environments.

*b.* At least 100 countries and political factions, worldwide, have ATGMs in their inventories. The number of different operational systems and system variants are quickly approaching 47, and at least 25 new systems are expected to be fielded by the year 2000.

*3. Technology Trends:*

*a.* A majority of the current ATGM systems use semiautomatic, command-to-line-of-sight (SACLOS) guidance. A significant number of manual, command-to-line-of-sight (MCLOS) guided systems are still available, primarily due to the large numbers of these systems which have been produced. Many of the older MCLOS and SACLOS systems are being modified .

*b.* Another feature of many current and future systems is the transition into multifunction roles. ATGMs are no longer restricted to antiarmor applications only.

*B. Precision Guided Munitions (PGM):*

*1. PGM-Related Key Technologies Overview:*

- Development of autonomous long-range airborne systems:
  - Advanced seekers
- Development of autonomous terminal seekers for artillery delivered systems
- UAVs will be able to conduct a variety of missions
  - Missions can be autonomous or in a "tethered mode"
  - Many will have interchangeable mission packages

2. *Introduction.* Precision guided munitions are experiencing explosive development and export sales. In numbers, they are the top military sales item worldwide. The family of PGMs consist of TASMs, guided bombs, ADHPMs, and smart submunitions. These systems can give the most modest military a destructive advantage, if properly used. A key advantage of these systems is that they normally do not require modification of the delivery system. Future systems will be increasingly "smarter" approaching the level of "brilliant" systems.

3. *Tactical Air-to-Surface Missiles (TASMs) and Guided Bombs*:

a. *Introduction*. TASMs and guided bombs pose one of the greatest airborne threats to US ground and air defense forces; they also can pose a serious threat to naval forces. Operation DESERT STORM graphically illustrated the effectiveness of current TASMs resulting in dramatic sales of these systems. Nearly every country with tactical aircraft has a demand for a variety of these systems. In light of this, many countries manufacture TASMs which greatly compounds the proliferation problem.

b. *TASMs*. TASMs can be broken into three categories: ARMs, direct-attack systems, and submunitions carriers. Current direct-attack TASM guidance can be IR, semiactive laser, beamrider, command, or TV.

c. *Guided Bombs*. Though not as long ranged or versatile as TASMs, guided bombs are another popular air deliverable system. The recent Gulf War demonstrated the worth of "smart" versus "dumb". The market for such weapons is excellent. The chief advantage of these systems is that they have greater penetration capability, larger explosive fills, and are cheaper than most TASMs. The data links associated with these systems will be hardened to prevent jamming or interference. Another development will be the fielding of bombs capable of autonomously acquiring and guiding to a target.

4. *Advanced Capability Munitions (ACMs)*. Currently, a majority of worldwide ACM systems are guided artillery shells. These systems are artillery rounds which use semiactive laser guidance to guide to their targets. A drawback to these systems is that they require some form of laser designation. A solution to this problem is the use of UAVs to designate targets. This has spurred a large effort to design and export UAVs with laser designation packages. However, an increasingly popular system enjoying massive development efforts is the area dispenser system and associated submunitions. These systems attack an opponent's forces over a wide area, giving the attacker a substantial "force multiplier." Coupled with this technology will be the development of smart or brilliant submunitions which will allow each submunition to target and attack specific targets over a wide area. Many of these will incorporate MMW or IR seekers. The dispenser systems for these munitions can be deployed in a number of ways: artillery, multiple-rocket launchers, surface-to-surface missiles, cruise missiles, airborne autonomous or captive-carry dispensers, and UAVs. Several countries have developmental munitions programs using multiple sensors, usually MMW and IR, but also "two-color" or "three-color," which means the sensor "sees" more than one range wavelength; for example, the wavelengths for IR seekers are separated into three bands: near IR (1-3 μm), mid IR (3-5 μm), and far IR (8-12 μm). These systems would be resistant to most conventional countermeasures.

C. *Unmanned Aerial Vehicles (UAVs)*. Development and export of UAVs are expanding worldwide. Relatively inexpensive (some are marketed at less than $100,000 each), UAVs can perform many of the missions normally conducted by manned aircraft. This makes them appealing to those countries which cannot afford to buy and operate large quantities of manned aircraft. These systems also have an enhanced utility in high-threat environments. In light of the increasing appeal of these UAVs, it can be expected that more countries may develop similar systems.

## 2.7 *ELECTRONIC WARFARE THREAT*:

### A. *Electronic Warfare Support (ES) System:*

#### 1. *ES Related Technologies Overview*:

- Communications Intercept:
  - Improved capability to process and DF advanced signals
  - Increases in sensitivity and processing capability with significant reduction in weight allowing carriage on a wide variety of platforms - vehicles, manpack, aircraft, submarines, ships, and UAVs
- Noncommunications Intercept:
  - Increasing capability to analyze and process signals in high signal density environments.
  - Capability to intercept advanced signals
  - Improved DF accuracy

2. *Introduction*. ES systems have become increasingly prevalent throughout the world including a number of hostile, third-world nations. These systems can be deployed on mobile ground, sea, sub-sea, air, and space platforms, in addition to fixed-ground sites and manpack systems. Even though ES systems are not destructive on their own, they can be used to target for disruption or destruction assets. ES systems can provide a wealth of intelligence information to a user including: intentions, disposition of forces, defensive posture, and capabilities. Unless an attacker is totally emissions-controlled, ES systems can provide initial indications of potential offensive operations. ES systems can provide passive tracking of targets thus protecting valuable radar assets from ARM attack.

### B. *Electronic Attack*:

#### 1. *EA Related Technologies Overview*:

- Communications Signals
- Noncommunications Signals
- Both Communications and Noncommunication Signals

2. *Technology Trends*. The majority of free-world industrialized countries produce EW equipment. The production ranges from RWR to integrated EW suites. The current equipment is generally modular and designed for use on a variety of platforms. The level of sophistication of the equipment depends on the intended design purpose.

*a. Noncommunications EA*. All future jammers will have a fully automated mode for centralized control/coordination of jamming assets.

*b. Airborne EA*. Advancements in miniaturization will allow more sophisticated EA systems to be packaged for use in all types of aircraft. There will be a number of times when EA equipment will be included with an airframe sale.

3. *Rest of the World*. Until the 1980s, the production of EW equipment was predominately limited to the super powers and Europe. In the last decade, third-world nations such as Chile have proven to be technically capable and successful in the manufacture of advanced EW equipment. Production offers Chile an alternative solution to costly foreign systems and technology transfer barriers, as well as added income generated from export marketing.

## *2.8 DIRECTED ENERGY WEAPONS (DEW)*:

*A.* ***Introduction***. The term "directed energy weapon" refers to three advanced weapons concepts: 1) laser weapons, which employ an intense beam of coherent electromagnetic radiation at IR, optical, ultraviolet, or x-ray frequencies; 2) RF weapons, which employ an intense beam of electromagnetic radiation (narrowband, wideband, or ultra-wideband) at microwave or MMW frequencies; and 3) particle beam weapons (PBW), which employ an intense beam of charged or neutral particles such as electrons, protons, or hydrogen atoms. All three DEWs are LOS, firing energy at or near the speed of light. Target damage could result in "soft kill" (sensor degradation/ upset), "subtle kill" (target destruction through means other than structural damage), or to "hard kill" (structural failure/damage).

*B.* ***Low-Energy Laser (LEL) Threats***:

*1.* Thirty countries are involved in the military use of lasers, including laser rangefinders and target designators. All of these countries have laser research programs, either in the form of a domestic development program or through the acquisition and application of commercially available technologies. Note that export controls may restrict the availability of some technologies.

*2.* Many LELs, which on average have output powers of about 10 watts, are readily available on the commercial market. Commonly available, visible and near-IR lasers can be adapted for military applications. Most of these devices are suited to providing ranging and target designation information to weapons systems, and present a danger to the unaided human eye and EO sensors at ranges out to 3 nm. LELs can damage eyes and sensors, disrupt a pilot's attention from flight instruments and obscure the scene outside the cockpit, and degrade weapon system sensors. Iran, Iraq, Libya, North Korea, and Syria are believed to have genuine interest in converting commercial-grade lasers into antihuman/EO sensor weapons.

*C.* ***High-Power Microwave***. Although the technologies are available to build RF devices, there are demanding engineering problems and many tradeoffs to contend with. Fratricide must be considered if an RF weapon is deployed into the forward area. Fundamental development problems such as antenna design and protection of friendly forces make it hard to make long-range projections.

# Chapter 3

# EW TECHNOLOGY PROGRAMS

*3.1 INTRODUCTION.* The Science and Technology (S&T) program for electronic warfare (EW) is responsible for developing systems to intercept and disrupt complex threat sensors and weapons and otherwise exploit the entire electromagnetic spectrum for US military advantage. The program focuses on developments in the radio frequency (RF), infrared (IR), electro-optic (EO), and ultraviolet (UV) spectra, and on multispectral/multimode designs. The technology plan presented in this chapter is a summary of individual Service EW technology projects as well as a listing of Service cooperative efforts in the exploratory development (6.2) and advanced development (6.3) funding categories. The following key elements of EW technology are especially prominent: 1) the Department of Defense (DOD) must continue to develop and provide EW technology which keeps pace with the advancing worldwide threat; 2) the EW Technology Program must achieve an overall balance between risk and reward within its technical content; 3) the Services must assure continual coordination between EW technology programs and the EW acquisition community to facilitate transition of the technology; and 4) in an effort to maximize the use of available funds, the Services must continue to use a systematic process of inter-Service cooperation.

## *3.2 TRI-SERVICE S&T RELIANCE:*

*A. Description.* Tri-Service Science and Technology Reliance is a set of formal agreements among, and implemented by, the Military Departments for joint planning, collocated in-house work, or lead Service assignment. These agreements cover the bulk of non-Service-unique portions of the Service 6.1, 6.2, and 6.3 programs. Joint planning performed under tri-Service S&T Reliance encompasses both in-house and related contract research and development in the Services. Reliance also is a formal process, authorized by each Service Acquisition Executive and approved by the Deputy Secretary of Defense, which helps streamline the S&T programs of the Military Departments and which better positions the National Defense S&T investment to respond to the challenges of the future.

*B. Responsibility.* Management of the Reliance implementation process was assigned to the Joint Directors of Laboratories (JDL). Specifically, the JDL assumed the responsibility to:

- Define and approve areas for overseeing and planning Reliance cooperative programs.
- Establish cooperative programs through Technology Panels in designated areas.
- Provide oversight for Services carrying out Reliance recommendations.

*C. Goals.* The goals of tri-Service S&T Reliance are to:

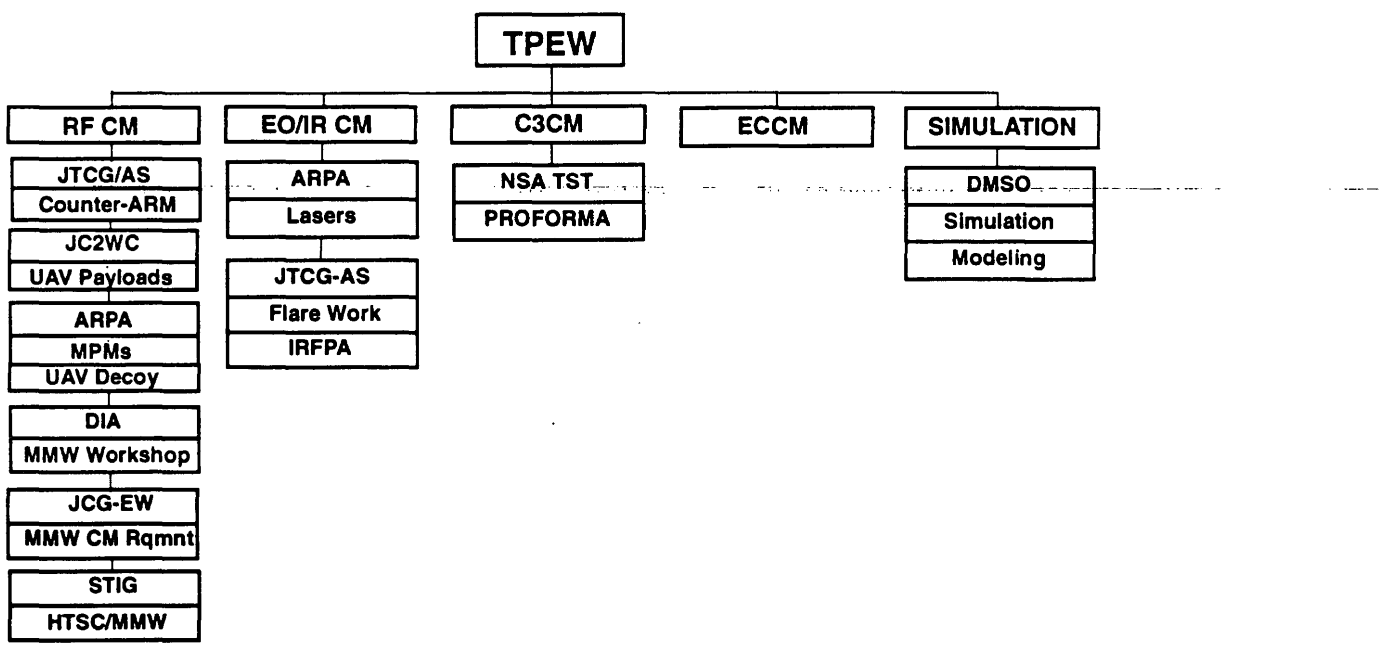
- Enhance the quality of Defense S&T activities.
- Ensure the existence of a critical mass of resources that will develop "world class" products.
- Reduce redundant S&T capabilities and eliminate unwarranted duplication.
- Gain productivity efficiency through collocation and consolidation of in-house S&T work, when appropriate.

- Preserve the vital mission-essential capabilities of the Services throughout the process.

*D. JDL-TPEW:*

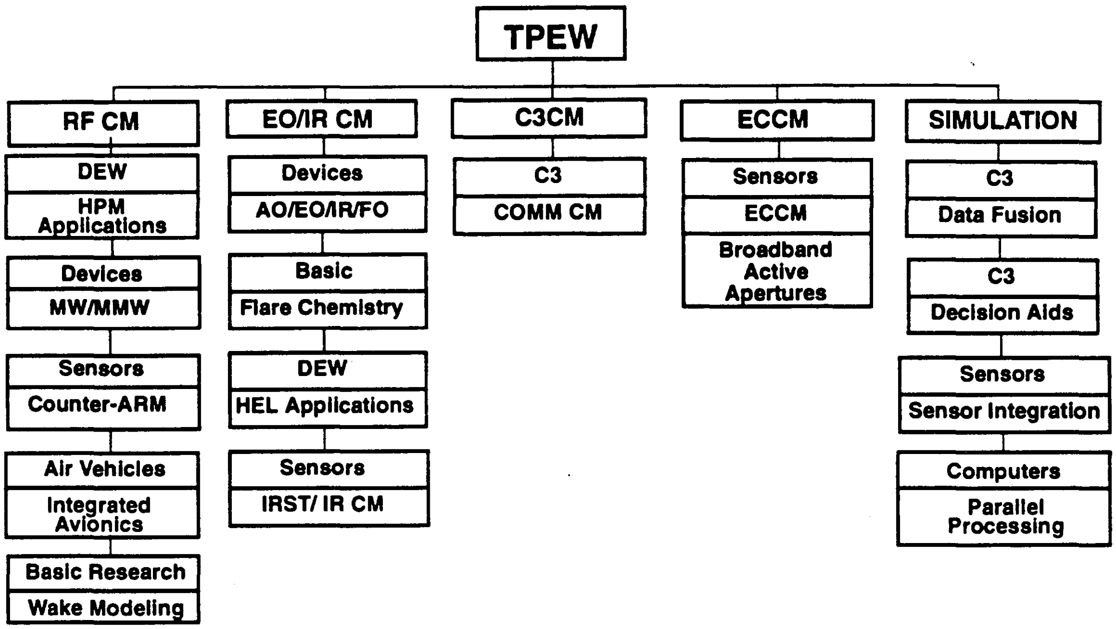
*1. EW Technology Panel.* The Joint Directors of Laboratories Technology Panel for Electronic Warfare (JDL-TPEW) is a part of the formal mechanism established by the JDL to implement Tri-Service Reliance and to provide technical assistance to the JDL on issues concerning EW joint S&T resources and programs. The JDL-TPEW guides technology programs of multi-Service interest and utility and ensures the use of laboratory resources optimally. The JDL-TPEW reviews Service needs and resources, and works toward developing the maximum, reasonable, inter-Service collaboration on each project. As a result, the majority of EW Technology programs are joint or consolidated efforts thus reducing redundance and enhancing reliance between Service EW programs.

*2. Coordination of Projects.* The coordination process is based upon continuous joint Service management of individual projects as they are executed. The single-Service projects within the program have been carefully examined by the JDL-TPEW and validated as unique to the performing Service. In addition, the JDL-TPEW serves as an interface with other DOD organizations, including the Joint Technical Coordinating Group for Aircraft Survivability (JTCG/AS), and other JDL panels such as the Technology Panel for Directed Energy Weapons (JDL-TPDEW) and the Basic Research Panel. Coordinated technology development issues and the relationships between the TPEW committees, other DOD organizations, and other JDL technology panels, are depicted in figures 3-1 and 3-2 respectively.




KEY: JTCG/AS = Joint Technical Coordinating Group for Aircraft Survivability; MMW = millimeter wave; JCG-EW = Joint Coordinating Group for Electronic Warfare; ARM = antiradiation missile; MMW = millimeter wave; HTSC = high-temperature super conductor; ARPA = Advanced Research Project Agency; IRFPA = infrared focal plane array; NT = National Security Agency Tactical SIGINT Technology; STIG = Space Technology Information Group; DMSO = Defense Modeling and Simulation Office. JC2WC = Joint Command and Control Warfare Center; UAV = unmanned aerial vehicle.

**Figure 3-1. Relationship Between TPEW and Other Organizations**




KEY: DEW = directed energy weapons; HPM = high-power microwave; MW/MMW = microwave/ millimeter wave; AO/EO/IR/FO = acoustic-optical/electro-optical/ infrared/fiber optics; HEL = high-energy laser; IRST = infrared search and track

**Figure 3-2. Relationship Between TPEW and Other JDL Panels**

*3.3 OVERVIEW OF EW TECHNOLOGY.* Electronic warfare technology development is responsive to the needs of the Services and directly supports the Top Five Future Joint Warfighting Capabilities of the Joint Chiefs of Staff. Flexible, robust sensor systems have significantly increased the overall US warfighting capability and, in the face of reduced force levels, have become a true force multiplier. During Operation DESERT STORM, for example, advanced targeting systems, precision-guided munitions, suppression of enemy air defenses (SEAD), and self-protection countermeasures (CM) were, to a large degree, responsible for the Coalition Forces' ability to destroy hardened targets and heavily defended positions with minimal risk to aircrews.

*A.* As threat system complexity increases, battlefield surveillance and survivability depend to an even greater extent on the development of advanced radar warning receiver (RWR), electronic warfare support (ES), and electronic attack (EA) systems that can respond to the changing RF environment. With advances in microelectronic and RF device technology, smaller, higher performance, and more affordable receiver systems can be designed for use in numerous ground, air, and naval applications.

*B.* The military forces also look to EW technology for systems that will enable them to recognize and process complex waveforms and provide effective jamming. Knowledge-based systems using artificial intelligence and adaptive parallel distributed processing can provide "smart" software control to maximize operation in a dense, complex signal environment. Specific emitter identification (SEI), microwave monolithic integrated circuits (MMIC), and unintentional modulation on pulse (UMOP) processing are EW technologies which significantly improve EW system capability. MMIC technology, for example, will allow the production of advanced analog receiver systems whose weight and cost will be reduced by a factor of 20. Further, EW technology will demonstrate future, integrated, multifunctional roles (that is, both offensive and defensive) including real-time situational awareness for self-protection and threat targeting and combat identification [identification of friend or foe (IFF)]. This project will combine/integrate technologies being developed within the JDL sensors panel. Critical software and antenna hardware techniques will passively enhance precision angle-of-arrival indicators by at least a factor of 10 and will provide 360 degrees of warning against both missile and aircraft - capabilities not in operation today.

*C.* Surface-to-air missiles (SAMs) using IR guidance have accounted for more than 90 percent of recent US military aircraft losses. Also, antiship cruise missiles now being developed have pseudo-imaging and imaging seekers that are immune to the current US inventory of flares and self-protection jammers. IR countermeasures (IRCM) to protect ships, aircraft, and land combat vehicles must be improved. Land combat vehicles are currently vulnerable to top-attack munitions guided by IR sensors.

*D.* To counter these threats, the EW S&T program has initiated a comprehensive, coordinated and methodical series of system technology developments that will give the military the ability to jam imaging and pseudo-imaging seekers in advanced IR missiles; to detect, identify, and jam modern RF and millimeter wave sensors and weapons; and to develop efficient tools, modeling, and simulations to conduct EA effectiveness assessments. Expendables technology is producing new flares that are more effective against modern IR missile seekers with discrimination logic and other infrared counter countermeasures (IRCCM). Progress in digital RF memory (DRFM) technology (known as DRFM on a chip) is paving the way for light weight, advanced, low-cost, channelized-jammer waveform generators. Furthermore, in the near term, the military forces need improved recognition techniques, IR jamming systems, and decoy devices for tactical, transport, and VIP aircraft, and within the next decade, will need robust laser-based jammers. The electronic warfare S&T program is committed to meeting those needs.

*E.* Although dual-use opportunities are limited within the EW area, a number of promising applications are under development. EW receiver technology contributes to the design of small, lightweight, low-cost analog and digital receivers for general purpose, home entertainment/ satellite use. Infrared fiber optics has the potential for use in medical and industrial diagnostics such as thermography inside engines and machines; remote spectroscopy for industrial control and organic reaction monitoring; and laser beam delivery for surgical and industrial cutting. The wideband IR fiber optic cable used in laser-based countermeasure can also be used for medical/ surgical applications, and the brushless, electronically controlled direct-current motors used in decoys can be widely used in home appliances and automotive devices. Mid-infrared laser sources developed for IRCMs can also be used for materials processing and cutting; chemical identification and detection in drug enforcement and air pollution control; windshear and vortex surveillance at airports; and airborne optical air data and turbulence sensing.

*3.4 PROGRAMMATIC EMPHASIS IN EW TECHNOLOGY PROGRAMS.* From the threat weapon advances identified in chapter 2, and the additional roles being placed on the military in a peacetime environment (for example, identifying and tracking drug and blockade runners), the following thrust areas have been identified for priority attention within EW Technology Programs. (Consistent with the remainder of this Plan, the thrusts are organized into the mission areas of threat warning, self-protection, and mission support.)

*A.* ***Threat Warning - Active RF.*** Active RF threat warning (for example, a radar), either self-contained or cued by other sensors, is required to detect approaching aircraft or missiles.

*B.* ***Self-Protection:***

*1.* *RF.* Required RF capabilities are:

*a.* Decoys for self-protection and deception of sensors.

*b.* Augmentation and expansion of the total inventory of EW devices and techniques available for use in LO vehicles.

*2.* *IR.* Required IR capabilities are flare materials which will not interfere with RF systems to produce an IR/RF expendable capable of defeating multimode or monomode threats.

*3.* *EO.* Required EO capabilities are:

*a.* Reduced size, cost, and weight of active CM systems, while also having increased output power, and detection/discrimination capabilities. Laser devices must be improved in frequency agility, efficiency, reliability, and mechanical strength.

*b.* A system capable of deceiving or disrupting laser designators and rangefinders, thereby preventing or delaying weapon launch. Additional work on jamming algorithms and testing against seekers/receivers also needs to be done.

*c.* Improved camouflage schemes which are required to reduce vehicle visual and EO signatures.

*C.* ***Mission Support:***

*1.* ***RF:***

*a.* Rather than individual components, every element of the enemy command and control (C2) network must be attacked. Destruction, degradation, and deception are all part of the total requirement.

*b.* A miniature RF receiver system (0.5 MHz to 100 GHz) that integrates the functions of sensor, analyzer, and threat locator, would serve as a stand-alone intelligence system, providing the commander with much of the electronic intelligence (ELINT) information needed to fight the battle.

*2.* *EP.* Current and planned US military systems require protection against threat EA enhancements. This portion of the EW Science and Technology Program develops necessary technology to perform vulnerability assessments to assure that US weapon and C3 and intelligence (C3I) systems have adequate and cost-effective hardening. This includes signature reduction programs. Much of the EP hardening is integrated with weapon and C3I system development and funding is included in system program elements not addressed in this plan.

*a.* *RF.* EP improvements are required to assure seeker, weapon, and airborne radar operation in a severe EA and directed energy weapon (DEW) environment, and to protect C3I from jamming, intercept, or weapons targeting.

*b.* *IR.* Vulnerability analyses are used to identify systems vulnerabilities and fixes with emphasis on protecting missile and smart weapon guidance systems. This work also includes out-of-band RF jamming.

*3.* ***EW Employment.*** In order to ensure the maximum installed performance and cost effectiveness for EW technology programs when they are deployed to operational systems, it is necessary to look at potential problems through system modeling and simulation.

*a.* EW simulation capabilities to support detailed engineering analyses of both specific EW equipment and technologies, and computer-intensive higher order simulations are necessary to analyze all levels from one-on-one to force-on-force scenarios. Simulation visualization technologies are also needed to allow immediate, man-in-the-loop evaluation and interaction with EW scenarios.

*b.* EW system integration is required to equip platforms with a multisensor threat warning, correlation, and softkill countermeasures/hardkill response capability.

*c.* EW performance assessment must be performed in real-time to support softkill/hardkill integration.

*D. EW-Related Technology - Laser Sources.* Compact, multiwavelength tunable lasers with increased power and efficiency are required for countermeasures applications.

*3.5 SERVICE PROGRAM ELEMENTS:*

*A. Joint and Consolidated Efforts.* Approximately 95 percent of the projects in EW Technology Programs are tri-Service efforts. Every project in the Technology Program has been reviewed by the JDL-TPEW to determine if potential exists for a cooperative effort. The Reliance process formally defines categories of inter-Service cooperation. The JDL-TPEW efforts are categorized as either joint efforts (common/linked objectives, joint plans, separate funds, multiple sites) or consolidation (lead Service funded). Only a few are categorized as Service unique (funded by affected Service). Funding summaries for these projects are included as tables 3-1 through 3-3.

*B. Service Technology Projects.* Service technology projects in threat warning, self-protection, and mission support are outlined in paragraphs 3-6 through 3-8. The objective is to show the content of major projects and Service-funded functional areas in EW technology. Tasks funded under $100K are not shown. EW-related technologies (that is, HPM, laser sources, and tactical SIGINT) are described in paragraph 3-9. Work in these technologies is not funded under EW program elements (PEs). An overview of DOD special access required/special access project (SAR/SAP) EW programs is included in Annex A which is released under separate cover. Each Service has reviewed pertinent special-access projects using knowledgeable management and technical personnel to certify the absence of duplication.

*C. Key Technology Road Maps.* A review of the EW Technology Program was conducted to show key technologies supporting the war fighters through the engineering and manufacturing development programs in chapters 4, 5, and 6. In each of the functional areas of these chapters, the EW Technology Program was surveyed to determine the key technologies and timelines for development. This information is shown in figures throughout chapters 4, 5, and 6.

*3.6 THREAT WARNING TECHNOLOGY OVERVIEW.* The purpose of this technology effort is to improve the ability of threat warning receivers to sort signals in a dense electromagnetic environment, and to improve receiver sensitivity, allowing detection of signals of shorter duration, higher frequency, and lower power. Some of this technology also applies to laser weapon systems.

*A. RF Threat Warning Technology:*

*1. Receivers/Processors:*

*a. Army:*

*(1) RWR Antenna Technology.* The thrust is to develop a high-accuracy direction finding system featuring an amplitude-only, direction finding concept with accuracy less

than 5 degrees root mean square (RMS), upgradeable to an amplitude and phase direction finding system with an accuracy of less than 1 degree RMS. Neural network algorithms will be developed for enhanced direction finding using coordinated beamforming and nulling techniques to be demonstrated in FY95. System improvements are expected in the areas of high sensitivity and high-accuracy direction finding. Lower cost, smaller size ELINT systems will be based on cryogenically cooled front ends using high-performance antenna and microstrip technology. In addition, this project is investigating use of fiber optic technology to transmit down converted microwave through millimeter wave signals from antennas to remote receivers. The second phase will test a fiber optic distribution network as the front end of an existing system. (PE 62270A, Project A442, Tactical EW Technology)

*(2) Multispectral Warning Sensor.* This FY97 new start will develop a multispectral warning sensor for air and ground vehicles that combines RF, laser, and EW sensors in a single module. Transition to the Integrated Situational Awareness and Countermeasures ATD is planned for FY00. (PE 62270A, Project A442, Tactical EW Technology)

*(3) Electronic Warfare Support (ES).* Several subsystems are being developed which will be evaluated on the Army's ES test bed. The major subsystems are:

- Surface acoustic wave (SAW) channelizer which will resolve the pulse-on-pulse problem and increase receiver sensitivity by 10 decibels (dB).

- Very high-speed integrated circuit (VHSIC) processor and VHSIC modular adaptive signal sorter (VMASS) which will increase the throughput by a factor of 6 to improve operation in a dense environment while reducing the size of the unit by a factor of 5.

- VHSIC threat association module (VTAM) to identify modern parameter-agile radars.

- Low-cost ceramic, phase shifter for electronically steerable, high-gain, broadband apertures in both the microwave and MMW bands. These will provide increased flexibility and reliability as well as accurate direction finding, with a gain of 20 dB.

- New class of antennas called ceramic antennas which provide solid-state beam steering from a simple radiating aperture. In FY95, the ES subsystems will be packaged and demonstrated for application to the Project Manager, Signals Warfare, Intelligence and Electronic Warfare Common Sensor Systems. (PE 62270A, Project A442, Tactical EW Technology)

*b. Navy:*

*(1) MMIC Technology.* A monolithic microwave integrated circuit (MMIC) EW receiver is being developed using special EW/MMIC chips, that effectively reduces by orders of magnitude, the size (3 cubic inches), weight (3 ounces), power (14 watts), and cost ($10,000) of a fully characterized (0.5 to 18.0 GHz) superheterodyne EW receiver. The receiver as described (Phase II) was completed at the start of FY95, with further integration and miniaturization (Phase III) continuing through FY96 and FY97. The cost in production quantities will be $5,000. (PE 62270N, Project RW70W10, RF threat Warning)

*(2) Digital Receiver.* A wideband, digital receiver has been developed using inphase and quadrature (I&Q) architecture to detect and preserve characteristics of complex waveform signals that would be lost in conventional EW receivers. It will transition to 6.3A projects such as AEWT, AEWS, ESM/ATD, and SEI starting in FY96. (PE 62270N, Project RW70W10, RF threat Warning)

# Table 3-1. Army EW Technology Funding ($M)

| PROJECT | FY95 | FY96 | FY97 | FY98 | FY99 | FY00 | FY01 |
|---|---|---|---|---|---|---|---|
| **PE 62270A EW Technology** | | | | | | | |
| A906 Tactical EW Techniques | 7.8 | 6.0 | 6.1 | 6.2 | 6.5 | 7.0 | 7.2 |
| A442 Tactical EW Technology | 10.0 | 9.3 | 8.9 | 9.4 | 9.6 | 10.3 | 10.6 |
| **PE 63270A EW Technology** | | | | | | | |
| DK15 Advanced Comm EA Demo | 2.9 | 3.0 | 3.5 | 4.5 | 7.2 | 10.0 | 10.0 |
| DK16 Noncomm EA Technology Demo | 3.7 | 1.1 | 3.0 | 4.8 | 9.6 | 10.3 | 10.6 |
| **PE 63772A Advanced Tactical Computer S&T** | | | | | | | |
| D243 Common Ground Station | 1.9 | --- | --- | --- | --- | --- | --- |
| Subtotals | 26.3 | 19.4 | 21.5 | 24.9 | 32.9 | 37.6 | 38.4 |
| **PE 62120A Electronics Survivability & Fuzing Technology** | | | | | | | |
| A140 High-Power Microwave | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Subtotals | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| **PE 62624A Pyrotechnics Technology** | | | | | | | |
| AH28 Weapons Systems | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Subtotals | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| **PE 6560A Survivability Lethality Analysis** | | | | | | | |
| D181 ARM Counter-Countermeasures* | 0.5 | | | | | | |
| D190 Integrated Analysis* | 4.7 | | | | | | |
| D234 Close Combat/Fire support Survivability/ Lethality* | 1.6 | | | | | | |
| D235 Missile CCM Technology* | 0.6 | | | | | | |
| D267 Air Defense/Missile Defense Survivability/ Lethality* | 3.8 | | | | | | |
| D626 C41 Survivability* | 3.4 | | | | | | |
| DC10 Technology Assessment* | 2.2 | | | | | | |
| D670 Emerging Technology Systems | | 2.6 | 2.6 | 2.6 | 2.6 | 2.5 | 2.5 |
| D671 Air Defense/Missile Defense Systems | | 4.1 | 4.1 | 4.2 | 4.3 | 4.2 | 4.2 |
| D672 Aviation Systems | | 2.6 | 2.3 | 2.3 | 2.2 | 2.3 | 2.3 |
| D675 C4I/IEW Systems | | 3.1 | 3.2 | 3.2 | 3.1 | 3.0 | 3.0 |
| D677 Ground Combat Systems | | 3.6 | 3.7 | 3.7 | 3.6 | 3.6 | 3.6 |
| D678 Munitions Systems | | 4.2 | 4.3 | 4.2 | 4.2 | 4.1 | 4.1 |
| D679 Soldier Systems | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Subtotals | 16.8 | 20.6 | 20.6 | 20.5 | 20.4 | 20.1 | 20.1 |

**NOTE: Work and funding redistributed to projects listed below starting in FY96; see paragraphs 3.8.B.2-11. This PE has no project terminations or new starts.**

## Table 3-2. Navy EW Technology Funding ($M)

| PROJECT | FY95 | FY96 | FY97 | FY98 | FY99 | FY00 | FY01 |
|---|---|---|---|---|---|---|---|
| **PE 62270N EW Technology** | | | | | | | |
| RE70W10 RF Threat Warning | 2.1 | 2.2 | 2.5 | 2.7 | 2.8 | 2.9 | 3.0 |
| RE70W11 EO/IR Threat Warning | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.2 | 1.3 |
| RE70P10 RF Self-Protection | 5.2 | 5.3 | 6.0 | 6.5 | 6.6 | 6.7 | 6.8 |
| RE70P11 EO/IR Self-Protection | 3.9 | 4.0 | 4.4 | 4.7 | 4.8 | 4.9 | 5.0 |
| RE70S10 EW Employment | 5.0 | 5.2 | 6.0 | 6.3 | 6.4 | 6.5 | 6.6 |
| RE70S11 RF Mission Support | 0.4 | 0.9 | 1.1 | 1.2 | 1.2 | 1.4 | 1.5 |
| Subtotals | 17.2 | 18.3 | 20.8 | 22.4 | 22.9 | 23.6 | 24.2 |
| **PE 62232N EW C3 Technology** | | | | | | | |
| RC32C10 Counter-Communications | 0.8 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Totals | 18.0 | 19.3 | 21.8 | 23.4 | 23.9 | 24.6 | 25.2 |
| **PE 63270N Advanced SEW Technology** | | | | | | | |
| W2194 EWAT | 7.7 | 7.9 | 9.1 | 9.4 | 9.6 | 9.6 | 10.2 |
| U2090 Advanced EW Technology (Functional Recognition) | 6.6 | 6.8 | 7.2 | 7.4 | 7.5 | 7.5 | 8.7 |
| **PE 63792N Advanced Technology Demo** | | | | | | | |
| R1889 MATES | 0.2 | --- | --- | --- | --- | --- | --- |
| R1889 EAGER | 3.5 | 4.0 | 4.5 | | --- | --- | --- |
| R1889 SAR/ISAR CM | 1.5 | --- | --- | --- | --- | --- | --- |
| R1889 Adv ECM Xmtr for Ship Def | --- | 4.5 | 5.5 | 4.0 | --- | --- | --- |
| R1889 Airborne IRCM Demo | --- | 5.0 | 5.4 | --- | --- | --- | --- |
| Totals | 19.5 | 28.2 | 31.7 | 20.8 | 17.1 | 17.1 | 18.9 |
| **PE 63217N Air Systems and Weapons Advanced Technology Development** | | | | | | | |
| R0447 Weapons Advanced Technology | 3.9 | 2.8* | 3.2 | 3.4 | 3.6 | 3.8 | 3.9 |

**NOTE: Funding for passive RF targeting system is TBD and is not included in the funding line for FY96 and beyond.**

## Table 3-3. Air Force EW Technology Funding ($M)

| PROJECT | FY95 | FY96 | FY97 | FY98 | FY99 | FY00 | FY01 |
|---|---|---|---|---|---|---|---|
| **PE 62204F Aerospace Avionics (1)** | | | | | | | |
| 2000 Active EA | 2.1 | 5.1 | 5.2 | 5.3 | 5.6 | 5.8 | 6.0 |
| 7633 Passive EA | 2.9 | 4.4 | 4.5 | 4.6 | 4.8 | 5.0 | 5.2 |
| Totals | 5.0 | 9.5 | 9.7 | 9.9 | 10.4 | 10.8 | 11.2 |
| **PE 63270F Electronic Combat Technology** | | | | | | | |
| 2754 Suppression of Enemy Defenses | 2.4 | 4.0 | 5.1 | 9.0 | 10.1 | 6.7 | 2.4 |
| 691X On-Board CM (2) | 1.0 | 3.2 | 8.8 | 9.8 | 12.0 | 10.4 | 15.7 |
| 2432 Defensive System Fusion | 6.6 | 13.3 | 7.7 | 4.0 | 1.1 | 0 | 0 |
| 431G Threat Alert | 4.0 | 2.3 | 0.4 | 1.6 | 1.5 | 4.6 | 7.5 |
| 2222 Expendable CM | 3.8 | 2.3 | 3.0 | 3.8 | 4.3 | 7.3 | 4.2 |
| Totals | 17.8 | 25.1 | 25.0 | 28.2 | 29.0 | 29.0 | 29.8 |
| **PE 63203F Offensive Avionics EP Technology** | | | | | | | |
| 665A Airborne Sensor Technology (3) | 3.3 | 1.4 | 1.3 | 2.1 | 1.8 | 1.7 | 1.7 |

**NOTES: 1) PE 62204F manpower/salary accounting shifted directly into its projects beginning in FY96. 2) SAC/ Congressional mark against PE 63270F, Project 691X (IRCM) of $9.4M in FY95. 3) Funds shown are EP support technology portion of project.**

*c. Air Force:*

*(1) **Advanced Receiver/Processor Technology.*** The Wright Laboratory (WL) will proceed with plans to use advanced VHSIC and MMIC technology in maturing the all-digital receiver concept, and with the demonstration of critical subsystems. Key to such demonstration is the Advanced Research Projects Agency (ARPA) Technology Reinvestment Program (TRP) effort (FY94-FY97) known as "Millenium"--conceived and managed by WL--which will develop the next generation of high-speed signal conversion circuitry and components critical to the digital concept (for example, analog-to-digital conversion, multiplexing/demultiplexing).

*(2) **EW Receiver Technology Development.*** The first demonstration of the all-digital EW receiver front end will occur in FY96, after FY95 integration work involving the aforementioned Navy I/Q approach, the WL sub-Nyquist technique breadboard and the Army's VTAM processor. (PE 62204F, Project 7633, Passive EA)

*(3) **Software Algorithms.*** Multiple software algorithms will be integrated to perform real-time threat identification and location. Multisensor integration will be done using expert systems and AI techniques. These will be evaluated for application to future RWR and ES systems. Several precision location and identification (PLAID) techniques will be optimized and hosted in a low-cost "super-computer" RTSMP architecture (inclusive of the Navy's interferometric pod technique) and demonstrated in FY97 as an affordable ($150K) Group B enhancement to multiple, operational RWR systems. (PE 62204F, Project 7633, Passive EA; PE 63270F, Project 431G, Threat Alert)

*(4) **RWR Antenna Technology.*** The baseline single aperture brassboard will be evaluated in FY95, both in a low-noise chamber and through customer flight testing. A necessary digital beamforming/feed structure is planned for development beginning in FY96-FY97. (PE 63270F, Project 431G, Threat Alert)

*B. IR Threat Warning Technology:*

*1. Navy: IR Active Detection Techniques.* Active laser sources are used to enhance detection and identification of IR threat missile seekers and IR tracking sensors. Optically augmented (OA) returns from missile optics are measured to look for footprints based upon unique temporal, spatial, spectral, and polarization characteristics. (PE 62270N, Project RE70W11, EO/IR Threat Warning)

*2. Air Force:*

*a. IR Subsystem Development.* This project concentrates on developing a time-to-intercept capability for passive IR missile warning subsystems using active approaches such as a MMW or laser radar in order to optimize the dispensing of decoys. The active subsystem will be cued by an IR missile warning system. A proof of concept demonstration is scheduled for FY95. (PE 63270F, Project 431G, Threat Alert)

*b. Missile Signature Model Validation.* This project involves the acquisition of high-altitude, AAM plume IR signatures through flight test measurements. This data will be used to validate sophisticated IR plume signature models and is required for the definition of IR warning system requirements. The majority of missile signature data collections were completed in FY94; the validation of missile models in accordance with the data will occur in FY95. (PE 63270F, Project 431G, Threat Alert)

*c. Detection In Clutter Enhancements (DICE).* This program concentrates on developing techniques/algorithms for increasing the missile warning performance of staring IR systems. The goal is to detect missile signatures below clutter levels; that is, subclutter visibility in an IR missile warning sensor. Demonstrations will be completed in FY97. (PE 63270F, Project 431G, Threat Alert)

*C. EO Threat Warning Technology - Laser Warning Receiver (Navy).* The technical challenge is to develop a laser warning system which can be used on high-performance tactical aircraft to provide warning over the entire threat spectral range. The work involves the development of an EO laser warning receiver (LWR) based upon a fiber optic integration design. The assessment of the Fiber Optically Coupled Laser Warning System (FOLWS) hardware to provide detection and accurate angle-of-arrival of CW lasers was completed. The FOLWS will be modified to detect laser beamriders and then lab tested. The coordinated tactics model will be used to determine the optimum design for integrating the EO LWR into the platform. (PE 62270N, Project RE70W11, EO Threat Warning)

*3.7 SELF-PROTECTION TECHNOLOGY OVERVIEW.* Improvements in US EW technology are needed to ensure survivability of friendly platforms under attack.

*A. RF Self-Protection Technology:*

*1. Millimeter Wave Countermeasures.* This task will develop onboard and offboard EW systems to defeat or degrade the performance of enemy weapons systems operating in the MMW band. This project includes the development of MMW receiver/transmitter systems, expendables (STRAP), improved Towed Decoy with expanded frequency coverage, broadband MMW chaff, and the methodology for an integrated and coordinated MMW countermeasures response using both on-board and off-board systems and concepts. Work has begun on the design of a low-cost, high-efficiency, modular MMW power module suitable for an electronically steerable array, for both airborne and shipborne applications. The JDL-TPEW RF CM Committee is conducting a series of workshops to plan a comprehensive 5-year MMW EA (active/passive) development plan (4th Quarter FY95) to field a MMW EW capability for initial tri-Service execution in FY96. The

Services will adapt subsequent baseline technologies as necessary. Army is funding to the tri-Service development of a millimeter wave variant of the Microwave Power Module. The program will consist of the design, fabrication, and testing of brassboard units. Upon completion of the brassboard testing, the MMPM modules will be inserted into an existing ECM system for pre-planned product improvement testing in FY97. Demonstrations of receiver and transmitter modules will continue through FY96 and FY97. (PE 62270A, Project A442, Tactical EW Technology; PE 62270N, Project RE70P10, RF Self-Protection; PE 63270F, Project 691X, Onboard CM, and Project 2222, Expendable CM; PE 62204F, Project 2000, Active EA)

2. *LO Countermeasures: LO Ship Countermeasures (Navy).* A modeling task will develop a digital model to generate high-fidelity target signatures of the DDG-51/53 in the cruise missiles EW simulation program. A prototype model has been completed and used in a DDG-53 assessment study. Future work will focus on achieving higher speed and employing new modeling strategies, using smooth contoured surfaces. (PE 62270N, Project RE70S10, EW Employment, and Project RE70P10, RF Self-Protection)

3. *RF Decoys - Air Force:*

a. *Active RF Decoys.* An exploratory development effort will investigate techniques and develop new technologies for the critical subsystems of a distributed architecture decoy. Emphasis will be placed on developing a towed decoy transmitter aerobody and electronics.

b. *Multispectral Decoys.* Candidate expendables will take full advantage of existing countermeasure dispensing systems; that is, ALE-40, ALE-45, ALE-47. As user needs develop, an advanced development effort will be initiated. (PE 62204F, Project 2000, RF Self-Protection; PE 63270F, Project 2222, Expendable CM; PE 62270N, Project RE70P11, IR Self-Protection)

4. *RF Jamming:*

a. *Army:*

(1) *Advanced Airborne Deception.* The goal of this multi-Service program is to develop prototype advanced deception and jamming techniques for aircraft protection. Ground-based prototypes are available for further development and technique enhancement as well as eventual aerial platform technology demonstrations. Field testing will be conducted in FY96. The program will be transitioned into the Army's Advanced Threat Radar Jammer (ATRJ) and Support Jamming Program sponsored by PM/AEC. (PE 62270A, Project A442, Tactical EW Technology)

(2) *Advanced Top Attack Countermeasures.* The goal of this program is development of hardware and countermeasure techniques to protect ground vehicles against terminally guided weapons and munitions. This technology also applies to rotary wing aircraft. (PE 62270A, Project A442, Tactical EW Technology)

b. *Navy:*

(1) *Airborne HRR/ISAR CM.* Transition to the IDECM 6.3 effort is planned for FY97 and transition potential to F/A-18, F-14, and EA-6B aircraft will be evaluated. (PE 62270N, Project RE70P10, RF Self-Protection)

(2) *Advanced Multimode Active EA.* An advanced shipboard EA transmitter must counter modern, multimode, antiship missile threats from the surveillance/targeting stages, through missile seeker acquisition, until fly-by of the missile. The main objectives of this task are to: a) define special functional requirements for the active onboard EA portion of an advanced

system; b) identify advanced technology required; and c) resolve high-risk areas with analysis, test, and evaluation. The results of this work applies to small ship jammers, airborne jammers, and to new systems such as the Advanced Integrated EW System (AIEWS). Baseline requirements have been established, the jammer subsystem has been finalized, and a test bed linear array antenna has been characterized. A brassboard demonstration is scheduled for FY96. (PE 62270N, Project RE70P10, RF Self-Protection)

*(3) Small Ship Jammer.* A brassboard has been fabricated and tested in a simulator facility. After further land-based and shipboard testing, the system will be ready to transition to small ships in FY97. (PE 62270N, Project RE70P10, RF Self-Protection)

*(4) RF Polarization Effects.* This task is developing non cooperative target recognition techniques which exploit the polarization characteristics of the target's radar antenna mainlobe and sidelobes. Two sets of data characterization tests were performed with a frequency-domain polarimeter. Improvements to correlation algorithms were made and joint tests with the Air Force (San Francisco Bay and White Sands) were completed. After additional chamber tests and field tests, the system will be ready to transition for applications to ECM technique optimization through polarization diversity. (PE 62270N, Project RE70P10, RF Self-Protection)

*c. Air Force:*

*(1) MMIC Technologies.* The plan will commence in FY95, with initial designs/subsystem demonstrations occurring in FY96-FY97.

*(2) CM Technologies.* A digital jammer concept, demonstrating significant improvements in size, weight, and cost, will be fabricated.

*(3) Monopulse CM.* Several Air Force pod jamming systems are identified by the EC program office as needing upgrade/retrofit with modern techniques to combat the complex threat and to achieve reliability and maintainability improvements. FY96-FY98 effort will address affordable and modular subsystems employing DRFM, MMIC, MPM and array technologies, compatible with TACAIR requirements and will include parametric analyses of the Army's ATRJ EMD system to capitalize on its architecture/capabilities. Additional technique testing via cooperation under TTCP Subgroup Q will continue. (PE 63270F, Project 691X, Onboard CM.)

*5. ARM Countermeasures:*

*a. Navy.* New simulation, modeling, and analysis tools are being developed to test and evaluate (T&E) ARM countermeasures techniques. Ongoing work includes development of a unique ARM test pod, and a plan for a comprehensive measurements program and radar data base. (PE 62270N, Project RE70P10, RF Self-Protection)

*b. Air Force.* The Air Force is designing an integrated ARM CM concept which will be tested in FY96-FY97 and is a tri-Service project through the Joint Technical Coordinating Group for Aircraft Survivability (JTCG/AS). It will address the air-to-air ARM threat, from a coordinated EA/EP approach. Testing will be performed on the Integrated Defensive Avionics Laboratory (IDAL) ARM simulator at Wright-Patterson Air Force Base. (PE 62204F, Project 2000, Active EA)

*6. Advanced Systems Developments (Navy) - Advanced ECM Transmitter for Ship Defense.* The objective of this ATD is to perform the initial development and demonstration of an ECM transmitter that can successfully engage the modern weapon threat from the surveillance/targeting phases through the terminal run-in phase of an antiship missile. This ATD will develop a brassboard ECM transmitter consisting of a planar array of dual polarized flared notch elements, a power amplification network, a switching and distribution network and a beam forming network. The planar array design features a modular, platform adaptable approach with separate apertures per quadrant that can be driven independently for simultaneous beams or combined for high power beams. (PE 63792N, Advanced Technology Demonstration)

*B. IR Self-Protection Technology:*

*1. IR Decoys:*

*a. Army.* The Army has assumed the lead for IRCM expendables for low-and-slow aircraft applications with funding provided by PM-AEC, JTCG/AS, and EW technology under A442. The Army program will develop improved IR decoys to protect low IR signature helicopters from advanced threats with flare rejection capabilities. Simulation of the missile/target/ flare engagement will be used to define flare and dispenser requirements for aircraft flying nap of the earth mission profiles. Transition will occur through insertion into the Advanced Technology Infrared Countermeasures (ATIRCM) program and retrofit into existing dispensers. In FY95 computer simulations of imaging seekers will be run to determine performance parameters for an imaging seeker decoy for low and slow aircraft. Conceptual designs of imaging seeker decoys will be fabricated and static and wind stream testing will be conducted in FY96-FY97. This program is coordinated with the Navy and Air Force imaging seeker expendable effort. (PE 62270A, Project A442, Tactical EW Technology; PE 62624A, Project AH28, IR Decoys)

*b. Navy.* The purpose of the IR Decoys Task is to develop new IR materials and deployment techniques for both ships and aircraft to defeat the increasingly capable IR threat.

*c. Air Force:*

*(1) IR Sources.* Difficulties in obtaining sufficient rise time from sources has stretched the materials development phase of the program through FY95. Flight tests will occur in FY98. (PE 63270F, Project 2222, Expendable CM)

*(2) Mixed Expendables.* This program will join with the Navy in developing a spectrally balanced, two-color flare design for tactical aircraft needs. This effort will build on the lessons learned from the Advanced Strategic and Tactical Expendables (ASTE) program as well as results from the Tailored Flare, Cooperative IRCM, and Color Balanced Emission programs. Experimental evaluation of this advanced flare will be conducted in FY96/FY97, with flight testing to conclude in FY98. (PE 63270F, Project 2222, Expendable CM; and PE 62270N, Project RE70P11, EO/IR Self-Protection)

*(3) UV Concepts Demo.* Proof-of-concept tests will represent typical tactical aircraft conditions. (PE 62204F, Project 2000, Active EA)

*(4) Multispectral Countermeasures.* This work is a follow-on to the jointly sponsored Innovative Countermeasure Expendable program. The RF subsystem will undergo risk reduction beginning in FY97, leading to an advanced technology demonstration program in FY01-FY03. Navy and Army interaction is continuous. (PE 63270F, Project 2222, Expendable CM; PE 62270N, Project RE70P11, EO/IR Self-Protection)

*(5) Imaging Seeker Expendable.* Work will be conducted jointly with the Naval Surface Warfare Center, Crane Division, to develop an IR expendable capable of decoying an imaging seeker. Development will be based on results from the joint Air Force/Navy (WL/NRL) work in the area of imaging seeker countermeasures technique development. Specifications for spectral, kinematic, temporal, and spatial parameters will be tested under both static and

simulated windstream conditions. The work is being coordinated with the Army. (PE 62204F, Project 2000, Active EA; and PE 62270N, Project RE70P11, EO/IR Self-Protection)

2. *IR Countermeasures:*

a. *Army:*

*(1) Laser Pulse Jamming Techniques.* Work was initiated in FY94 to evaluate the effects of laser jammers on IR surface to air missiles. These measurements will provide the first data using closed loop simulations; that is, actual missile seekers including optics and computer simulated fly-out on flight tables. Simulation work will be completed in FY96 for use in ATIRCM and other laser jammer programs. Developed techniques will be used in field test in accordance with the tri-Service IRCM Plan. (PE 62270A, Project A442, Tactical EW Technology)

*(2) Imaging Seeker CM.* Construction of an imaging seeker breadboard was initiated in FY94 using a 64 x 64 focal plane array. The optics and electronic signal processing will be completed in FY96. Follow-on activities will use the breadboard to develop CM techniques against this class of seeker. This work is part of a tri-Service coordinated program ranging from component and digital simulation to actual hardware surrogates. (PE 62270A, Project A442, Tactical EW Technology)

*(3) Laser Coupling.* Joint work with the Navy will continue in FY96 on low loss IR fibers for both the 3 to 5 and 8 to 12 micron region. Fibers are required to couple laser sources to beam pointing devices in IR jammer applications. (PE 62270A, Project A442, Tactical EW Technology)

b. *Navy:*

*(1)* Work on the integration of IRCM and decoys is under way. Imaging seeker IRCM work will be a Service-coordinated effort. The Air Force will perform hardware testing with the Army developing IRCM techniques. (PE 62270N, Project RE70P11, EO/IR Self-Protection)

*(2) Short Pulse Effectiveness.* The jamming effectiveness of high peak power short laser pulses will be studied using the existing missile evaluation facility at NRL. Initial efforts will concentrate on advanced pseudo-imaging and imaging missiles that are resistant to flare countermeasures. Threat missile hardware available for testing include the Orlon Fiber, Symptom Ares, and Have Factor systems. In addition to the experimental evaluation, a simulation modeling the effects on both component and system level will be used. This work is a cooperatively funded effort with JTCG/AS and the Army PM/AEC. Activity addressed susceptibility of Stinger and Have Factor. (PE 62270N, Project RE70P11, EO/IR Self-Protection)

*(3) Air IRCM/Decoy Integration.* Cooperative techniques using flare decoys with on-board IR jammer sources are investigated to counter advanced SAMs and AAMs with CCM. A lab test facility was built to simulate target, decoy, and jammer signals. Lab tests will be conducted on various missile types. (PE 62270N, Project RE70P11, EO/IR Self-Protection)

*(4) IRST CM Techniques.* Passive infrared sensors, infrared search and track (IRST) and forward looking infrared (FLIR), are used by aircraft interceptors and ground weapon systems to acquire and track aircraft before weapons launch. Active techniques will be investigated to detect and jam IR passive sensors. Lab measurement and simulation equipment tests will be conducted on IR sensors to determine optical cross sections and susceptibility to active jamming. (PE 62270N, Project RE70P11, EO/IR Self-Protection)

*(5) Imaging IRCM.* The evolution of the infrared missile threat to aircraft is progressing toward the use of imaging seekers. The imaging IRCM effort at NRL is part of a tri-Service effort including the Air Force Wright Laboratory and the Army CCNVEOL to investigate techniques to defeat a wide variety of imaging IR seekers. The program uses digital and hybrid simulations and actual component and system hardware. Techniques investigated include expendables, high-power jamming, sensor damage, and cooperative techniques combining some or all of these. The program includes laboratory measurements of component level susceptibility and contract efforts to evaluate IRCCM and to evaluate foreign threats. (PE 62270N, Project RE70P11, EO/IR Self-Protection)

*c. Air Force:*

*(1) Advanced Laser IRCM.* Field testing at White Sands Missile Range is scheduled for FY97-99. This technology will be available for transition to Advanced Technology Transition Demonstrators (ATTD) in FY95-FY97. (PE 62204F, Project 2000, Active EA; PE 63270F, Project 691X, Onboard Countermeasures)

*(2) Imaging Sensor Countermeasures.* The use of signature control concepts to defeat imaging IR sensors will be investigated. The initial phase defined countermeasures concepts which produce effects to disable the imaging seeker track capability. The second phase (FY94-95) will implement the concepts by producing the materials, coatings, etc. that exhibit the desired effects and evaluate their performance. (PE 62204F, Project 2000, Active EA)

*d. ARPA:*

*(1) Compact Lasers.* The goal is to develop technology for efficient, compact, and affordable diode-pumped, solid-state lasers with wavelength diversity in the UV, visible and mid-IR spectral regions. The program follows two main paths: a) laser and nonlinear materials for wavelength conversion, new generation of diode pump arrays, microlaser arrays, phase conjugation and adaptive pointing/tracking concepts, and b) demonstrate diode-pumped, solid-state lasers with output wavelength at 1 and 2 μm with output powers at tens of watts to kilowatt average power. The program is coordinated through the JDL-TPEW to address laser technology critical needs of the Services' EW programs. Funding profile: $5.0M (FY95), $7.0M (FY96), $6.9M (FY97), $4.0M (FY98), and $4.0M (FY99).

*(2) ARPA/Tri-Service Laser.* ARPA has initiated a two-phase program to develop a solid-state, diode pumped laser for IRCM applications. Phase I, which began in FY94 will develop 2-watt, 10-20 kHz multiband lasers for open loop and limited closed loop applications. Two lasers will be delivered for use in Service programs in FY96. Phase II, which will begin in FY96 will develop 20-watt, 10-20 kHz multiband lasers for full closed loop applications. Lasers will be delivered in FY98. The program is coordinated through the JDL-TPEW. (Funding: 4 years, $10M Total)

*3. Advanced System Development:*

*a. Army:*

*(1) **Enhanced Survivability for Ground Vehicles.*** This program is to develop an approach to passively detect and electronically counter top attack/smart munitions used against ground vehicles. Several 6.2 sensor and countermeasure projects will be integrated during this program; specifically, advanced threat signature measurements of top attack and direct fire munitions, multispectral missile/laser warning, and countermeasure development to top attack weapons. Formulation and integration of a self-protection warning and countermeasure suite will result from this program. The integrated suite will transition to the Advanced Land Combat Hit Avoidance ATD. (PE 63270A, Project DK16, Noncommunications Technology Demonstration)

*(2) **Multispectral IRCM Demo.*** This program will conduct live fire, cable car tests of fiber optic coupled, multiline lasers (from ARPA) against advanced imaging IR missiles. ATIRCM will serve as the core hardware and be upgraded with laser sources for risk reduction demonstrations. In addition, passive detection and geolocation of surrounding aircraft for situational awareness and counter reconnaissance will be demonstrated. Associated hardware integration activities will begin in FY97. Cable car field tests will be conducted in FY99. (PE 63270A, Project DK16, Noncommunications Technology Demonstration)

***b. Navy - Tactical Aircraft IRCM Demonstration.*** The Navy has approved an Advanced Technology Demonstration, starting in FY96, of a directed infrared countermeasure system (DIRCM), for Navy tactical aircraft. The goal is to defeat all operational infrared guided missile threats as well as the advanced reticle missile threats in development. The DIRCM system uses an infrared staring array sensor system to detect and locate the threat missile, and hands over to a system that both tracks the missile and provides an optical path for projecting a laser beam at the incoming missile. The laser beam delivers a high jam to signal (J/S) irradiance in all mid IR missile operating bands and is provided by a single solid state laser. The program will use the hardware developed and acquired under the Balanced Technology Initiative (BTI) program. The system will be integrated into a P-3 aircraft to perform end-to-end countermeasure demonstrations against strapped down missiles, missiles on the SNORT track at NWC, and against captive missile seekers in an air-to-air geometry. The program will demonstrate the operation of all the subsystems as well as the effectiveness of the integrated system. Plans to merge the Navy ATD with the Air Force LIFE program are in progress. (PE 63792N, Advanced Technology Demonstration)

***C. EO Self-Protection Technology:***

***1. EO Countermeasures (Army). Barrage Emission Decoy.*** The Army initiated development of a breadboard EO jammer against laser guided weapons. The effort adapts fiber optic laser warning approaches developed by the Air Force and Army as well as a fiber optic transmitter to move the weapon aimpoint off of the target. Hardware will be completed in FY96 and tested against representative laser guided threats in FY97. (PE 62270A, Project A442, EO Countermeasures)

***2. Integrated EOCM Techniques (Navy).*** Electro-optical (EO) techniques to integrate laser-based warning sensors are investigated. Optical technologies will include EO, magneto-optical, acousto-optical, micro lens and fiber optics to derive compact means to steer laser beams on target without the use of stabilized gimbals and to provide for a common receive/transmit aperture. (PE 62270N, Project RE70P11, EO/IR Self-Protection)

*3. EO Countermeasures (Air Force):*

*a.* Countermeasures applications will be investigated to negate the pointing and tracking subsystems forecast for use on enemy laser weapon systems. Countermeasures candidates will be identified and demonstrated in tradeoff studies and laboratory tests. Countermeasures effectiveness tests are scheduled for FY95. If successful, a field test effort to demonstrate the countermeasures effectiveness in a dynamic environment will be initiated. (PE 62204F, Project 2000, Active EA; PE 65132D, JTCG/AS)

*b.* Both tests are jointly sponsored by the Air Force, JTCG/AS, and the Army. Results of this work is being monitored by the Navy. (PE 63270F, Project 691X, On Board CM; PE 65132D, JTCG/AS)

*4. EO Decoys (Joint).* Field testing is planned for FY95. (PE 63270F, Project 2222, Expendable CM)

*3.8 MISSION SUPPORT TECHNOLOGY OVERVIEW.* Electronic warfare conducted in support of military operations requires a mix of systems, including threat warning, self-protection, and mission support. A single EW system will not provide the protection required to successfully accomplish combat missions. Requirements dictate development and employment of mission support systems which attack all elements of an enemy's use of the electromagnetic spectrum. Protection of US systems with EP based on an EW vulnerability assessment is also a significant part of the mission support technology.

*A. RF Mission Support Technology:*

*1. Data Fusion:*

*a. Army:*

***(1) IEW Data Fusion Techniques.*** This effort will advance battlefield EW processing capabilities by developing the mature, transferrable software products to integrate diverse IEW source inputs at a single point. These products will be transitioned to Common Ground Station (ATD) and ASAS. (PE 62270A, Project A906, Tactical EW Techniques)

***(2) SIGINT/MTI Correlation.*** This effort will transition to CGS and ASAS in FY95. Enhanced versions of this capability will transition to PM ASAS in FY97 and PM SW in FY99. This task has been coordinated with the tri-Service JDL Data Fusion Subpanel. (PE 63270A, Project DK15, Advanced Communication EA Demonstration)

***(3) Common Ground Station (CGS) ATD.*** This project will develop and demonstrate a prototype for the CGS upgrade of the JSTARS ground station in 1995. The CGS ATD consists of an Army Common Operating Environment computing platform and various communications and interface equipment, mounted in a Standardized Integrated Command Post System shelter, and transported by a HMMWV. The CGS ATD technology will collect, correlate, and disseminate near-real-time multisource data to the All Source Analysis System (ASAS), the Brigade and Below Command and Control (B2C2) system, the Battle Command Decision Support System, the Initial Fire Support Automated System and the Advanced Field Artillery Tactical Data System. Intelligence data is provided by interfaces to a short-range UAV ground station, which supplies both telemetry and RS-170 video; a JSTARS Surveillance and Control Data Link port, which supplies MTI and SAR data; a Secondary Imagery Dissemination System, which provides National Imagery Transmission Format System imagery; a Commander's Tactical Terminal, which supplies TIBS, TRAP, TADIXS-B and TRIXS SIGINT messages; and to ETRAC, which supplies ASARS data. The CGS ATD will operate while collocated with primary sources, in a stationary position, or on the move via advanced SATCOM gateway antenna technology. Capabilities include NRT multimedia processing, correlation, and targeting; a wireless distributed multimedia database; synchronized UAV video and telemetry; interactive mulimedia intelligence summaries; and terrain reasoning. Participation is planned for Theater Missile Defense 95, one of the Army Warfighting Experiments (AWEs) in 1995, and Brigade 96. (PE 63772A, Project D243, Common Ground Station).

*b. Air Force:*

*(1) **Fusion Task Objective.*** The objective of this task is to develop, demonstrate, and evaluate technologies aimed at fusing and correlating information sources on airborne platforms to provide improved situational awareness for aircrews. Classical and advanced data fusion algorithms will be implemented to determine optimal performance for various missions, airborne platforms, and sensor/information suites. Tradeoff issues that affect the design/ real-time performance will be identified and resolved. This task has been coordinated with the tri-Service JDL Data Fusion Subpanel. (PE 63270F, Project 2432, Defensive System Fusion)

*(2) **Fusion Demonstrations.*** The objective of the demonstrations is to evaluate the performance of the developed techniques and algorithms and to determine additional utility for operational airborne systems. Demonstrations will include both field/ground demonstrations for risk reduction (FY96) and flight demonstrations (FY97-FY98). Flight demonstration emphasis will include fusing beyond visual/sensor range information sources with onboard sensor information to provide improved aircrew situational awareness for use in targeting, self-protection and combat identification. (PE 63270F, Project 2432, Defensive System Fusion)

*2. Communications Jamming:*

*a. Army:*

*(1) **New Signals EW.*** This effort develops electronic attack techniques and strategies for jamming systems to optimize their effectiveness against modern, jam resistant communications signals. The development of techniques for jamming communications systems with minimum knowledge of signal parameters is included.

*(2) **ORION ES/EA UAV.*** The ES/EA UAV will be preprogrammed to seek the signal profile of a known high-value target, operate semiautonomously until it detects a matching profile, provide target location and signal data to the Common Ground Station (CGS) or IEWCS asset and exercise precision strike jamming of that target altering its communication traffic if tasked. Demonstration of the ORION ES/EA ATD is planned for FY00. (PE 62270A, Project A906, Tactical EW Techniques; PE 63270A, Project DK15, Adv Comm EA Demos)

*b. Navy:*

*(1) **CNI Countermeasures.*** The work is coordinated with ongoing Air Force and Army projects. (PE 62270N, Project RE70S11, RF Mission Support)

*(2) **Counter Communications.*** The objective is to develop improved technology for attacking C3 systems either directly through jamming or by deception. (PE 62232N, Project RC32C10, Counter Communications)

*c. Air Force - C2 Warfare (C2W).* Advanced EA techniques and technology will be developed to counter C2 threat signals. An ATD for Modern Network C2W (MNC2W) is planned for an FY02 start.

*3. Component Technology (Army).* Supported systems include: Integrated Jammer System, Advanced QUICKFIX, and UAV EW packages. Component technology programs include the following work:

*a. The Adaptive Jammer Power-Amplifier (AJPA)* employs multimode power amplifiers to produce a wide variety of signals in the HF and VHF ranges. The power amplifiers operate in computer-controlled modes to maximize output power, efficiency, or spectral purity.

*b. The Integrated Antenna/Amplifier System (IAAS)* integrates the power amplifier, antenna, and matching network to achieve as much or more radiated power than does the conventional approach while allowing rapid frequency changes.

*c. Characterization and Design of High-Power Field Effect Transistors (FETs)* investigates the use of a high-power nonlinear characterization method for determining the nonlinear two-port parameters of a high-power device. The objective of this project is to design a complimentary power device for high-efficiency switched mode amplifiers using this characterization method.

*d. The Adaptable Jammer Large-Scale Integration (LSI)* program developed a waveform generator for the Army's family of IEW common modules. The frequency range for this unit is 1 to 150 MHz. The adaptable jammer's synthesizer/exciter is programmable for maximum flexibility in ECM systems.

*e. The Chemical Vapor Deposition (CVD) Diamond Heat Tracts for Cooling of High-Power Electronic Devices* project is to demonstrate that diamond layers with high conductivity deposited on silicon substrates can be used to transport heat rapidly.

*f. The High Temperature Superconductivity HF Antenna* project objectives are to reduce the physical size of the antenna structure for tactical mobility purposes and to improve overall transmission efficiency. HF jamming transmission will be enhanced by providing instantaneous matching between the amplifier and the antenna. This is a joint program with ARPA.

*g. EW HF Antenna Size Reduction* research is investigating possible methods and technologies related to ferrite and dielectric materials.

*h. The Power Multiplexing Program* allows the reception of signals in the presence of intentional and unintentional interference. Multiple signals may be passed in the same information bandwidth requiring only a difference in power levels. This allows voice and data to be transmitted simultaneously.

*i. Common Sensor Antenna Program* technical analysis will address critical IEWCS antenna performance by system level modeling and simulation of the IEWCS platforms. (PE 62270A, Project A906, Tactical EW Technology)

*4. Advanced Systems Development (Army).* The Radar Deception and Jamming (RD&J) Advanced Technology Demonstrator (ATD) will evaluate flyable hardware and software in an integrated system configuration. The system provides survivability equipment integration, situational awareness, noncooperative target recognition, precision direction finding/location, power management of countermeasures, and target cueing of weapon systems. The critical design review was completed in FY94 and flight testing is ongoing during FY95. The system will be integrated into the System Integration Laboratory at Fort Monmouth during FY96. The software developed under this program will be inserted directly into the Army's Advanced Threat Radar Jammer (ATRJ) program currently in Engineering and Manufacturing Development. This program is complementary to the Advanced Defensive Avionics Response Strategy (ADARS) and the Expanded Situation Awareness Insertion (EASI) and the Quiet Knight Programs conducted by the Air Force. (PE 63270A, Project DK16, Noncommunications Technology Demonstration)

*B. EP Technology:*

*1. Radar EA Vulnerability Assessment (Air Force):*

*a. Hardware Testing and Analysis.* This effort evaluates radar performance in EW environments through ground, tower, laboratory, and data analysis. EP techniques developed and evaluated through laboratory and ground tests undergo evaluation using a task order contract for tri-Service electronic protection. This is an FY95 new start at the request of the JDL-TPEW. This effort will be a quick reaction task type contract for the independent vulnerability assessment and technique development of tri-Service radar systems. The hardware testing is supported by digital modeling of radars (two detailed radar models, air-to-air and air-to-ground) and in-house hardware air-to-air simulation. This effort will also develop low cost radar designs. This effort is coordinated through the JDL-TPEW EP committee. (PE 63203F, Project 2334, EP Support Technology)

*b. EP Assessment/Analysis.* The Avionics Directorate of the Wright Laboratory sponsors EP analysis to provide core studies in support of radar EP. Efforts include Electronic Protection Techniques Development - which will address system specific EA vulnerabilities (both near and far term threats) and develop EP techniques to eliminate the vulnerabilities. Both the Army and the Navy participate in the program by performing vulnerability assessments. It is coordinated through the JDL-TPEW EP committee. (PE 63203F, Project 2334, EP Support Technology)

*2. Antiradiation Missile Counter-Countermeasures (ARM-CCM) (Army).* The ARM-CCM project objectives are to understand the capabilities of threat ARMs and how they work. The projects provide simulation and hardware tools for both proposed and fielded ARM countermeasures as well as techniques and methodologies which support ARM-CCM investigations. EW vulnerability analyses of ARM threats to US and Allied systems will be conducted in FY95 to support the Army ARM Counter-Warfare Program. Simulation support will be provided to ARM-CCM projects and hardware, tools, techniques, and methodologies will be developed. This project has been coordinated with the Air Force Wright Laboratory/AARM and Army MICOM RDEC. [PE 65604A, Project D181, Antiradiation Missile Counter-Countermeasures (ARM-CCM) (Project zeroed in FY96; work and funding redistributed to Projects D670, D671, D672, D675, and D678 within this PE.)]

*3. Integrated Analysis (Army).* This project provides supporting technology and data for the Army's integrated survivability analysis program to conduct survivability/lethality/ vulnerability (SLV) analysis on Army systems and funds the investigation of the lethality/ vulnerability of smart munitions to the full spectrum of battlefield threats. The analysis is integrated across all battlefield threats; that is, conventional ballistic, electronic warfare, directed energy, nuclear weapons effects, and nuclear and chemical/biological contamination effects. This project supports development of the Army initiative to reduce systems' susceptibility to out-of-band RF countermeasure effects. This project also includes the Army EW signature measurement program and the assessment of laser countermeasure effects on Army optical/electro-optical systems. This project also supports investigations of new technologies/methodologies required for SLV analyses. The thrust of this project is to manage the US Army survivability/lethality integrated analysis programs (Air Defense, Aviation Systems, C4I/IEW, Ground Systems, Munitions, and Integrated Soldier System) for 38 systems under development or in improvement cycles and participate in the ARL FOCUS programs, Battle Labs and ATD initiatives, and special projects for ARL, AMC, and HQDA. [PE 65604A, Project D190, Integrated Analysis (Project zeroed in FY96; work and funding redistributed to Projects D670, D671, D672, D675, D677, D678, and D679 within this PE.)

4. *Emerging Technology Systems (Army).* This project performs integrated Survivability/Lethality/Analysis (SLA) for a category of systems which includes Horizontal Technology Integration systems, Advanced Technology Demonstrator initiatives, and Anti-Radiation Missile (ARM) Counter-ARM systems. Survivability deficiencies are identified and recommendations are made to Program Executive Officer (PEO)/Project Manager (PM) to provide hardening fixes early on in program development. This work is accomplished through theoretical and engineering analyses, signature measurements, modeling, simulations, laboratory experiments, and field investigations. Horizontal Technology Integration systems include Second Generation FLIR (2D GEN FLIR), Battlefield Combat identification System (BCIS), Global Positioning System (GPS), and Enhanced Position Location Reporting System (EPLRS). Advanced Technology Demonstrator initiatives include Active Protection Systems (APS), Missile Countermeasures Devices (MCD), and Advanced Laser Protection Program (ALPP). ARM Counter-Arm efforts assess threat technologies against Theater Missile Defense (TMD), PATRIOT, JSTARS, Corps SAM, and FAAD-C2I ground-based sensors. [PE 65604A, Project D670, Emerging Technology Systems (portions of work and funding from D181, D190, D234, D267, and D626)]

5. *Air Defense/Missile Defense Systems (Army).* Provides the survivability/lethality analysis of US Army air defense and missile defense systems to the full spectrum of battlefield threats and recommends fixes to improve their battlefield survivability. The results are used by each PEO/PM to direct weapon system development efforts, structure product improvement programs by the user to develop doctrine and tactics, and by decision makers in formulating program/production decisions. Recently evaluated systems are: the PATRIOT, Corps SAM, Stinger-RMP, Avenger, GBS, TMD-GBR, MRSR, THAAD, and ERINT. [PE 65604A, Project D671, Air Defense/Missile Defense Systems (Project D267, Air Defense/Missile Defense Survivability/Lethality in FY95)]

6. *Aviation Systems (Army).* Project investigates the SLV of Army aviation systems to the full spectrum of battlefield threats. Aircraft SLV deficiencies are identified and hardening fixes identified as appropriate. SLV analysis directly supports major decision milestone reviews, acquisition documentation, test and evaluation master plans, and cost/operational effectiveness analyses. In FY96, provides for assessment of acoustic technology which might be developed to exploit potential susceptibilities of helicopters. The EWVA investigations under this project include the RAH-66 Comanche, AH-64D Longbow Apache, MH-60K and MH-47E Special Operations Aircraft, Short-Range UAV, OH-58D Kiowa Warrior, CH-47D Chinook, and UH-60Q Dustoff. [PE 65604A, Project D672 Aviation Systems (Project DC10, Technology Assessment in FY95)]

7. *C4I/IEW Systems (Army).* Supports survivability analysis of Army communications and electronic equipment against the full spectrum of friendly and enemy threats. Provides field threat environment support for EWVA. Analyzes vulnerabilities of foreign threat weapons and command, control, communications, computers and intelligence (C4I) and intelligence electronic warfare (IEW) systems to US Army EW systems. Provides threat weapon electronic design data to countermeasure developers and technical capability information to the intelligence community. Supports Army initiatives in vulnerability reduction of C4I/IEW systems against the full spectrum of battlefield threats. EW vulnerability investigations conducted under this project include Maneuver Control System, Common Hardware Software, Standard Integrated Command Post Shelter, Advanced Field Artillery Tactical Data System, FAAD-C21, Combat Service Support

Control System, Mobile Subscriber Equipment, SINCGARS, GPS, Single- Channel Antijam Man-Portable radio, Secure Mobile Antijam Reliable Tactical Terminal, and Enhanced manpack UHF Terminal. [PE 65604A, Project D675, C4I/IEW Systems (Project D626, C4I Survivability in FY95)

*8. Ground Combat Systems (Army).* This project investigates the survivability and vulnerability of Army ground combat systems to the full spectrum of battlefield threats. Analysis will support weapon requirements, test and evaluation master plans, cost/operational effectiveness analysis, and major decision milestones. Recently evaluated systems are: AFAS/FARV, Armored Gun System, Bradley A3, Command and Control Vehicle, ABRAMS M1A2, Breacher, and Heavy Assault Bridge. [PE 65604A, Project D677 Ground Combat Systems, (Project D234, Close Combat/Fire Support Survivability/Lethality in FY95)]

*9. Munitions Systems (Army).* This project funds the investigation of the lethality/ vulnerability of Army fire support weapons to the full spectrum of battlefield threats. The analysis is integrated across all battlefield threats; that is, conventional ballistic, electronic warfare, directed energy, nuclear weapons effects, and nuclear and chemical/biological contamination effects. This work is done through theoretical and engineering analyses, signature measurements, modeling, simulations, laboratory experiments, and field investigations. Systems evaluated include: BAT/BATP3I, Hellfire Longbow Missile, STAFF, Wide Area Mine, and Javelin. [PE 65604A, Project D678 Ground Combat Systems, (Project D234, Close Combat/Fire Support Survivability/Lethality in FY95)]

*10. Soldier Systems (Army).* This project provides the Soldier Survivability Assessments (SSvA) required for the MANPRINT Soldier Survivability Domain. EW vulnerability/ survivability investigations of US Army Land Warrior System include the Computer and Communications System, Protective clothing and Individual Equipment, Chem/Bio Mask, Integrated Headgear, and Weapon System. Integrated survivability/lethality analyses will support scheduled soldier systems program decision milestones in FY96. [PE 65604A, Project D679 Soldier Systems (Project D190, Integrated Analysis in FY95)]

*11. Missile CCM Technology (Army).* This project supports Program Management Offices by development of CM/CCM hardening techniques that missile systems use against laser, RF, and directed energy threats. It supports: a) modeling to investigate vulnerabilities of systems to air defense systems, b) investigations of missile signatures and exploitability, and c) investigations of technology to harden optical windows against lasers, RF, and directed energy threats. This EP project has been coordinated with the Air Force Wright Laboratory/AARM, Navy NAVAIR-546TI, NAWCADWAR, NAWCWDCL, and NAWCWDPM. [PE 65604A, D235, Missile CMM Technology]

*12. Broadband Active Aperture Technology Insertion in EP Systems (ARPA).* ARPA has awarded 3 contracts worth $26.2M to develop interconnected, very thin radar/EW modules under the High Density Microwave Packaging Program. Based on this ARPA effort, key goals for EP programs, such as the Air Force EMR, Navy ERASE/EP, and Army CCM Technology, will readily satisfy by reducing the cost, weight, and volume of radar/EW electronic systems, while achieving the improved EP performance required in hostile EW environments produced by a mix of FSU, European, and US weapon systems. This project is planned for a FY95 start. Multi-Service coordination and planning was conducted in by the Air Force Wright Laboratory/AARM, Navy NAVAIR-546TI, NRL, NAWCADWAR, NAWCWDCL, NAWCWDPM, Army MICOM RDEC/ AMSMJ, and ARL/SLAD/EW Division. The insertion demonstration for EMR and ERASE is planned for FY97.

## C. *EW Employment:*

### 1. *EW Performance Assessment:*

*a. Navy.* Effective use of EW in ship defense requires integration and coordination of a diversity of techniques. This points to the need for decision aids which analyze complex tactical situations, evaluate available options, plan actions, and control their execution. These capabilities are limited on present platforms. Work on a real-time EW Effectiveness Monitor and an Optimal Resource Allocation algorithm will allow the Space and EW commander to evaluate his warfighting capabilities by assessing the effectiveness of EW techniques, and allocating the limited resources available for a ship's defense against missiles in an optimal manner. Sensor integration work will provide the coordination necessary to merge the inputs of several of the ship's sensors. An effort on real-time EW control is continuing. Results of this work are being provided to the Naval Command Control and Ocean Surveillance Center (NCCOSC), lead lab for Naval Tactical Command System-Afloat (NTCS-A). (PE 62270N, Project RE70S10, EW Employment)

*b. Air Force.* The Wright Laboratory is continually examining new concepts and techniques for improving electronic warfare state-of-the-art. A comprehensive program, with a network of in-house research and contractor support, is aimed at analyzing new concepts, identifying potential military needs, and evaluating the military worth of new development products. Digital simulation laboratories (Electronic Combat Simulation Research Laboratory) are the cornerstone of the in-house work and the facilities and expertise needed to support product center development of programs like the tri-Service Joint Modeling and Simulation System. (PE 63270F, Project 691X, On Board Countermeasures, Project 431G, Threat Alert)

### 2. *EW Simulation:*

*a. Army:*

*(1) Survivability Integration Laboratory (SIL).* The thrust of this project is to develop a research, development, and evaluation facility for aircraft and ground vehicle survivability equipment. The SIL currently has the capability to test electronic warfare systems through free space radiation or direct wire input with a wide range of RF and laser stimuli. The SIL will be used to explore system integration techniques as well as subsystem evaluations. The SIL will offer the capability to interface with avionics or vehicle integration development facilities located within the Research, Development, and Engineering Center. The SIL consists of environment generators, simulated (digital and hardware) threat systems, and anechoic chamber. The thrusts for FY96 include: a) upgrading the RF and laser capability of the Multispectral Environment Generator to support the Hit Avoidance ATD and integrated aircraft survivability equipment research, b) integrating the CEESIM with software simulation packages such as SUPPRESSOR and ESAMS to evaluate force level or individual level capabilities, and c) completing development of generic, two-channel scan with compensation target tracking simulators for noncoherent and coherent radars. (PE 62270A, Project A442, Tactical EW Technology)

*(2) Interactive Survivability Simulation (ISS).* Advanced Situational Awareness using the Radar Deception and Jamming Advanced Technology Demonstration hardware and software techniques will be demonstrated with the ISS linked to the Aviation Warfighting Center. In particular, Advanced Situational Awareness techniques will be evaluated in a simulated AH-64 Apache Longbow or an RAH-66 Comanche. (PE 62270A, Project A442, Tactical EW Technology)

(3) ***EW Models for Distributed Interactive Simulation.*** This project will integrate EW sensor models to generate intelligence for Distributed Interactive Simulation (DIS) exercises. The models will emulate COMINT, ELINT and MTI sensors. These models will be attached to separate moving platforms within the simulation. The goal is to provide a gross simulation of the collection capabilities of GUARDRAIL and Joint STARS systems. The collected intelligence data will be displayed using the Common Ground Station ATD. FY95: Develop COMINT, ELINT and MTI models. Participate in exercise conducted by Joint Precision Strike Force Demonstration. Initiate development of EO sensor model. FY96: Improve fidelity of sensor models to reflect expected errors of associated collection systems. Validate models using available test data from intelligence systems. (PE 62270A, Project A906, Tactical EW Techniques)

(4) ***Simulation to Support ORION STO.*** This task will evaluate the value added to extending the range of existing COMINT ground based targets using a UAV. A dynamic force-on-force scenario will be used to support evaluation. The evaluation will analyze differences in field of view and targets sets. All efforts will be completed in FY95. (PE 62270A, Project A906, Tactical EW Techniques)

*b. Navy:*

(1) ***Antiship Missile Countermeasures Simulation.*** This effort addresses the radar, IR, or EO controlled weapon system threat to surface ships either from an ASM or from some platform that controls targeting of the ASM. The work complements overall EW R&D objectives by providing a high-level interface to an integrated environment for EW simulation. This project is supported by the Integrated Data System for data control and access operating in a multilevel, secure environment supporting a mix of data bases. (PE 62270N, Project RE70S10, EW Employment)

(2) ***IR Ship Signature Model.*** An IR missile simulation employing a scan by scan representation of the SS-N-2D, MODTRAN, and imported IR signature data from measurements has been completed. This simulation, building upon the CRUISE Missiles modeling framework, employs a scene editor which allows target signature manipulation to support low observable studies. A workshop was held to investigate the state of IR modeling of ship, halo, water, and sky to determine which approaches have the greatest likelihood of producing acceptable results and to assess the effort required to achieve working code. Experiments have begun to integrate through the IR scene editor computer generated ship IR images from the signature code IRENE. (PE 62270N, Project RE70S10, EW Employment; PE 62121N, Outlaw Rogue)

*c.* ***Integrated Defensive Avionics Laboratory (IDAL) (Air Force).*** This effort is being developed to provide support for research, development, and evaluation of electronic combat subsystems and system integration techniques. The IDAL will use standardized data bases and models to provide stimulus and post analysis for developing and demonstrating real-time, multispectral EC integration capabilities. The intent is to provide a capability so that: 1) contractor- and Government-developed techniques and equipment may be evaluated for effectiveness in an integrated system, 2) techniques and architectural approaches for EC integration may be developed, and 3) in-house EW system integration experience may be developed. The IDAL is to be implemented as a hardware/software testbed for emulating the various components required for an integrated EC system. It will also be used to establish the performance requirements for multispectral countermeasures systems, techniques, mission training/rehearsal, and components as the basis for future upgrades to the F-15, F-16, SOF, and other aircraft. Two operational system testbeds are available for use. Two additional systems (ALQ-135 and ALR-56C) will be integrated in FY95 to support development of the Joint Service Electronic Combat Systems Tester (JSECST). A real-time reconfigurable radar warning receiver function will be incorporated in FY97 through an SBIR effort. The IDAL will offer the capability to interface with the other avionics development facilities located within Wright Laboratory. IDAL can currently interface with the Integrated Test Bed (Avionics System Emulations) and the Communication System Evaluation Laboratory. Direct interface with offensive system facilities will be possible after the Avionics Directorate consolidation in Building 620 in FY98. (PE 63270F, Project 2432, Defensive Systems Fusion)

*D. Counter-WARM (Navy).* Transitions to systems PMs and PEOs began in FY94 and will continue through FY99.

*1. **Functional Recognition.*** Work on the ALR-66, ALR-67, and ALR-76 is complete, and is continuing on the SLQ-32, AIEWS, ALQ-99, and ALQ-126B. (PE 63270N, Project U2090-FR, Functional Recognition)

*2. **Generic Response.*** Hardware development and demonstrations are continuing through FY98. (PE 63270N, Project U2090GR, Generic Response)

*E. Electronic Warfare Advanced Technology (EWAT) (Navy).* The functional areas to be addressed initially by the EWAT program are missile approach warning and end game countermeasures. EWAT will develop a high-resolution ultraviolet (UV) sensor and associated interfacing and processing hardware required for an advanced UV modular missile approach warning system (MAWS). The MAWS will be demonstrated using a QF-4 drone/test aircraft. Concurrently, a miniature laser warning sensor (LWS) will be developed to provide laser energy detection. Additional software will be developed for the ALE-47 countermeasures dispenser system to exploit the information provided by the MAWS and LWS. End game countermeasures will be limited in the near term to advanced versions of conventional expendables such as thrusted flares. (PE 63270N, Project W2194, EWAT)

*F. Advanced Antiradiation Missile Guidance Demonstration (AAGD) and Passive RF Targeting System Overview.* AAGD and Passive RF Targeting are the Navy's principal source of defense suppression technology against lethal, radar-directed threat systems and associated threat emitters. Formerly part of the Electromagnetic Radiating Source Elimination (ERASE) Project which was disestablished in FY95, these subprojects and their predecessors have provided the technology for every US anti-radiation guided missile including Standard ARM, HARM, sideARM and others. AAGD and Passive RF targeting are currently focusing on advanced ARM missile seekers and advanced emitter location/targeting technologies which will ultimately increase aircraft survivability. This work is fully coordinated with the JDL-TPEW to define tri-Service programs in counter-ARM technologies per direction of JDL and OUSD(AT&T)/R&E. (PE 63217N, Project R0447, Weapons Advanced Technology)

*3.9 EW-RELATED TECHNOLOGY (HPM, LASER, TST) OVERVIEWS.* This section provides information on high-power microwave, laser sources , and tactical SIGINT technology (TST) coordinated with the JDL-TPEW. Efforts on these programs are not funded under EW program elements.

*A. **High-Power Microwave Technology.*** Service HPM programs are coordinated through the Joint Directors of Laboratories, Technology Panel for Directed Energy Weapons (JDL-TPDEW) Sub-Panel on HPM Technology. The following paragraphs provide descriptions of HPM technologies which are related to EW projects.

*1. Funding ($M): (Army, Navy, Air Force, DNA)*

| | FY95 | FY96 | FY97 | FY98 | FY99 | FY00 | FY01 |
|---|---|---|---|---|---|---|---|
| HPM Component Technology | 15.0 | 14.4 | 14.0 | 15.2 | 15.5 | 15.1 | 14.6 |
| HPM Effects Susceptibility | 19.9 | 9.5 | 11.7 | 8.9 | 9.3 | 9.3 | 9.8 |
| HPM Hardening Technology | 2.7 | 1.9 | 3.1 | 4.5 | 4.4 | 4.7 | 4.8 |
| HPM Demonstration Programs | 7.1 | 6.0 | 8.7 | 12.8 | 12.8 | 13.3 | 14.4 |
| Totals | 44.7 | 31.8 | 37.5 | 41.4 | 42.0 | 42.4 | 43.6 |

*2. HPM Component Technology:*

*a. HPM Narrowband Component Technology:*

*(1) Objectives.* The specific objectives of the narrowband component technology effort are to: a) increase source output energies by one to two orders of magnitude; b) increase PRF and average power by one to two orders of magnitude; c) develop high-power, frequency-agile sources/amplifiers; d) reduce the size and weight of sources and attendant power supplies to be compatible with military vehicles (for example, airplane, UAV, truck, armored vehicle); e) increase efficiency to tens of percent; f) increase power handling capability of antennas and antenna feeds by two orders of magnitude; and g) increase sidelobe suppression and address fratricide issue.

*(2) Microwave Sources.* A wide variety of classical and newly developed microwave sources is in use and under development. Common to all these devices is a pulsed intense relativistic electron beam which is modulated or bunched and which subsequently interacts with an electromagnetic wave, converting modulated kinetic energy to HPM radiation. Many designs of such tubes are able to produce 100 joules (J) of microwave energy in pulses generally below 1 μs in length. Prominent among these is the split cavity oscillator (SCO) and its variants. High tube efficiency and an ability to phase sources together have been achieved.

*(3) Army.* Difficulties in handling high peak power are pushing the program toward more modularity and the source development program is evolving toward high-power amplifier modules that can be combined to create arbitrarily large radiated powers through phased arrays. The split cavity oscillator (SCO) source that resulted from a joint Army, Air Force, Sandia National laboratories effort, is being ruggedized to increase its continued usefulness on field tests.

*(4) Navy.* The ability to generate 1 kJ has been demonstrated in Ballistic Missile Defense Organization (BMDO)-funded research at the NRL using a relativistic klystron amplifier. Thus, arrays of such vacuum microwave tubes can produce output energy in the multi-kJ range.

*(5) Air Force.* Under active development at Phillips Laboratory are the Annular Beam Amplifier, plasma-filled MILO, and a gyrotron backward wave oscillator. Previous research on the SCO has been completed, and efforts are underway to adapt the SCO technology for various applications and transition it to users. Other narrowband source development efforts are underway to adapt high-average power commercially available sources to Air Force missions. These devices span the frequency regime from below 1 GHz up to 100 GHz. New technology is being sought for kW-class devices in the 100-GHz range.

*b. HPM Wideband Component Technology:*

*(1) Navy.* The Navy is supporting development of photoconductive switches which can be used to construct compact, wideband sources. Air Force, Navy, and contractor laboratories have developed and tested several types of photoconductive switches. The Bulk Optically controlled Semiconductor Switch (BOSS) under development at Naval Surface Warfare Center (NSWC)/DL is based on copper-compensated, bulk GaAs material that can be switched on and off with the application of two short laser pulses. This allows the frequency and bandwidth of the waveform to be controlled. The 4-year BOSS development program will culminate in FY94 with a demonstration to be conducted jointly with Phillips Laboratory. In an alternative approach to wideband systems, the hydrogen spark gap switch offers the ability to switch high-peak powers with fast, pulse rise times and operate at high PRFs with improved reliability over air and oil-filled spark gap switches. The major technical challenge is to investigate the hydrogen switch rise-time performance with a goal of 10 to 100 ps. The BOSS demonstration and hydrogen switch work has joint funding/participation from the Air Force.

*(2) Air Force.* The two types of ultrawide band (UWB) sources under development at Phillips Laboratory are gas switched and solid-state switched. Gas-switched sources are characterized by moderate rep-rates and extremely high-peak powers, while solid-state switched sources employ bulk solid-state semiconductors and operate at high rep-rate with modest output powers. A follow-on to the current H-3 gas-switched device is expected to produce 100 GW peak output power at <2 kHz. GaAs solid-state switched devices provide up to 25 MW with pulse voltages up to 20 kV in a single unit. A multiple-unit system to be delivered in FY94 will provide 1 GW. Technology is also being pursued for antennas and for devices in which the RF source and antenna comprise an inseparable hybrid system.

*3. **HPM Effects/Susceptibility Assessments.*** The objectives of this portion of the DOD HPM program are to: a) develop a data base of HPM effects on US and foreign military systems, b) develop test facilities and measurement techniques to support HPM effects experiments, and c) develop the capability to predict HPM effects through models and analytical methods.

*a. Army.* HPM susceptibility investigations are performed on critical Army systems to determine the RF fluence required to cause mission failure. The systems to be investigated will be based on the Army's priority list for survivability and tested following the Tri-Service Methodology. Specific methods include:

*(1)* Develop a broadband RF field diagnostics probe for HPM narrowband and wideband environments

*(2)* Investigate tools, techniques, and methodologies for analysis of HPM effects phenomena.

*(3)* Increase accuracy and efficiency of HPM field environments.

*b. Air Force.* Air Force concentration in the effects and assessment area has been on support to applications of HPM associated with tactical air warfare and, more recently, space control. In an effort to provide optimal lethality parameters to make HPM technology feasible for these applications, experiments are being performed on aircraft, missile, radar, radio, C3, and ground systems using both narrowband and wideband sources. In an effort to minimize HPM-induced fratricide or suicide for these applications, the models are being extended to US systems and to very high HPM radiation fluences and near-field antenna conditions.

*4. HPM Hardening Technology:*

*a. **Army**.* The Army produced the HPM hardening design guide. In FY94 and FY95, the design guide will be updated to include technological voids such as VHSIC and MMIC technology, ultra-wideband effects and hardening techniques, new methodologies, environmental upgrades, and user responses. The Army is developing and implementing hardening devices and techniques (for both narrowband and wideband) into systems/subsystems that are identified as being susceptible to electromagnetic effects. Hardening measures will concentrate on disturbances and burnout of semiconductors used in particular systems such as MMIC and VHSIC technologies.

*b. **Air Force.*** The Phillips Laboratory 6.4 effort develops and demonstrates conventional engineering technology necessary to evaluate the survivability of existing Air Force and DOD systems to survive the hazardous effects of advanced technology weapons and other high-power sources. These include electromagnetic effects, HPM, and nuclear electromagnetic pulse. Hardening technology, assessment and verification methods, specifications and standards, and hardness maintenance surveillance techniques are developed and transitioned to the product divisions, operating commands, and test and evaluation organizations for use on military as well as civilian systems, especially commercial aircraft. This program draws upon the 6.2 and 6.3 research within the electromagnetic effects group and transitions it to operational and maintenance organizations in the field.

*5. HPM Demonstration Program (Air Force):*

*a.* A number of particular applications have been identified and are undergoing development with user commands.

*b.* Source development efforts will culminate in FY96 with a critical experiment to verify source effectiveness and select the preferred technology. Design and fabrication of a prototype will be completed and tested in FY97.

*c.* Source development will culminate in a critical experiment in FY96. Fabrication of the demonstration prototype will be finished in FY98 in time to support a demonstration in the same year.

***B. Laser Source Technology.*** Service laser programs are coordinated through the Joint Directors of Laboratories, Technology Panel for Directed Energy Weapons (JDL-TPDEW) Sub-Panel on Laser Technology. The following paragraphs provide descriptions of laser source technologies which are related to EW projects.

*1. Funding ($M): (Army, Air Force)*

| | FY95 | FY96 | FY97 | FY98 | FY99 | FY00 | FY01 |
|---|---|---|---|---|---|---|---|
| Laser Source Technology | 9.8 | 8.0 | 8.2 | 9.6 | 9.6 | 9.6 | 9.9 |

*2. Laser Source Technology:*

*a. **Army.*** The primary objective of the Army program is to develop more efficient, reliable and compact laser sources for the next generation of military systems, including laser rangefinders, communications, chemical detection, designation, countermeasure systems and laser radars. The program includes development of solid-state dye lasers and diode lasers for both military and potential medical applications. Military applications include wavelength diverse air defense weapons as well as wavelength converters for on-going countermeasure systems such as

STINGRAY. The wavelength diverse characteristics of solid state dye lasers may provide useful radiation sources for medical applications ranging from drug activation to surgery and wound cauterization.

*b.* ***Air Force.*** The High Power Semiconductor Laser Technology (HPSLT) program, formerly the Phased Integrated Laser Optics Technology (PILOT) program, is concerned with the development of high-power, coherent semiconductor diode lasers and diode laser arrays which have high potential for direct use in communications, sensor blinding, active denial, and other tactical applications. Wavelengths are 0.7 to 1.0, 1.33 to 1.55, and 2 to 5 µm. Goals include a 1 cubic foot, 100-pound, 100-watt coherent laser diode array source, including power supply and thermal management system, to be demonstrated in FY98 and a 20-watt source in the 2 to 5 µm band in FY96. As a spinoff of array development and scaling efforts under the HPSLT program, a number of near-term technology transition opportunities for individual laser diodes and medium-power laser diode arrays are also being pursued. Efforts within the past year have successfully transitioned demonstration laser diode and diode array devices to users for field testing in the areas of IR illumination, landing zone marking, portable communication, area denial, aircraft cargo loading, and medical applications. (PE 63605F, Project 3151, PL/LIDA)

*C.* ***Tactical SIGINT Technology.*** A Technology Review panel (TRP) identifies, assesses, and prioritizes technology projects for the TST. The panel membership is comprised of senior research and development personnel from the Military Services laboratories, DIA, and NSA/CSS. This cross program coordination process allows a cross flow of technology information with a very wide set of customers.

*1.* ***DF/Geolocation:***

*a.* The Digital Beamforming Network program will develop digital beamforming and phase measurement techniques for direction finding and digital frequency measurements. Subcarrier sampling techniques will be employed to reduce the requirement for a high sampling speed analog-to-digital converter. Software algorithms will be developed unique to the beamforming and phase measurement application. (Algorithm testing-FY95, Hardware demo-FY96, Project complete-FY97).

*b.* The Multipath Techniques project will enable the ELINT/ESM system to recognize the multipath condition and determine the actual direction to the emitter. (Develop algorithms-FY95, Final report-FY96).

*c.* The DD/TDOA Deconvolution Algorithm Study will develop a new class of software algorithms which will determine simultaneous delay and doppler parameters of the signal for use in precision emitter geolocation. (Final report-FY95).

*d.* The Low Cost Geodesic Cone Antenna will explore the ramifications of using a less expensive phase shifter design to reduce the cost of the seventy two required phase shifters from $600K to under $1K in production quantities. (Lab testing, integration with testbed-FY95, Project complete-FY96).

*e.* The Ultra Wideband Collection System will establish and demonstrate a method for providing scientific and technical analysis, OPELINT and tactical ELINT against future wide bandwidth radars operating up to several GHz in bandwidth. (Final report-FY95)

*f.* The Channelizer/Encoder for RIVET JOINT Receiver will use the Condor Hawk wideband 500 MHz instantaneous IF output. The Condor Hawk receiver is used as a tuner on all service tactical platforms. A ceramic resonator channelizer and MMIC detector log video amplifiers will be used to provide analog inputs to a signal encoder card. The encoder card will be used to form pulse descriptor words and computer aided software engineering tools will be used to add Random Agile Deinterleaving and Unique Threat Identification Method software as analysis tools. (Final report-FY96).

2. *Information Processing and Display.* This project involves development of hardware and software to improve security, provide knowledge-based automated assistance to analysts, improve the display of tactical intelligence and speed the flow of information to tactical commanders. The Tactical Data Fusion System will integrate several algorithms developed under NSA's DCP technology research program to provide innovative, effective, and efficient data fusion and correlation. Multiple signals and multiple sources in the tactical operating environment will be combined to generate a single composite information picture for the war fighter. (Prototype complete-FY95).

3. *Very Wideband Compressive Receiver.* This project will use a high- temperature superconductive (77 degrees Kelvin) delay line previously developed by ARPA which will increase the bandwidth of a compressive receiver from 500 MHz to potentially 3 GHz. (Lab test and integration with IEW ESM test bed-FY95).

4. *Project SPENCE.* Advanced ELINT Receiver is a modularized channelizer/detector log video amplifier using small, modular, lightweight ceramic high-Q inductors in a sixteen channelizer configuration with 100 dB isolation between adjacent channels. This is coupled with a three-stage successive detector log video amplifier which provides 100 dB dynamic range over a fifty MHz operating bandwidth. Intra-channel frequency discriminators have been developed using miniature ceramic filter delay lines instead of bulky coaxial delay lines. A simultaneous RF signal detector was computer modeled, developed and added to the prototype. Detection of coherent signals in noise directly at microwave RF is being modeled and demonstrated. (Integrate total effort-FY95).

5. *ELINT/MMIC RF Receiver.* This project objective is to design, fabricate, and demonstrate a broadband (0.5-18.0 GHz), tunable ELINT receiver using MMIC technology. These receivers will have the same or superior characteristics of conventional built receivers; however, they will be smaller, lighter, require less power, and cost less. (Test & Debug-FY95, System Transition-FY96).

6. *Signal Processing.* This area involves the development of advanced receivers and processing capabilities to deal with the increased proliferation of state-of-the-art emitters.

*a.* The Digital Microscan effort will integrate currently available special purpose digital techniques for computing the received spectrum from digitized samples in real time into an IF digital receiver. Its performance will be similar to an analog microscan or compressive receiver in terms of pulse frequency, and bandwidth measurement. The significantly faster spectral update rate will enable an accurate determination of pulse time-of-arrival, amplitude, modulation, and pulse duration. The result will be an extremely versatile, high sensitivity IF digital receiver. (Lab & Field Testing-FY95).

*b.* The Next-Generation ESM Processor Design Study will result in a specification and set of measures of effectiveness for use in the evaluation of competing processor designs. The requirements for compatibility with existing systems and opportunities for product improvements will also be examined and used in the new specifications. (Final report-FY95).

*c.* The Hybrid IFM/Compressive Receiver Architecture Design Program will enable an ELINT/ESM system to cover very wide instantaneous bandwidths by combining the best attributes of IFM and compressive receiver architectures in one unit resulting in a moderate sensitivity receiver with a very wide bandwidth. The receiver will be used for cuing narrower bandwidth receivers to further analyze detected signals. (Lab test and final report-FY96).

*d.* ESM Algorithm Conversion program will provide a means to collect the state-of-the-art ELINT/ESM algorithms for deinterleaving, pulse train analysis and emitter identification and render them into Computer Aided Software Engineering (CASE) compatible representation. The CASE tools will enable signal processors to be simulated in a high level language and evaluated for the optimum hardware/software configuration. (Final report-FY96).

# Chapter 4

# THREAT WARNING RESEARCH AND DEVELOPMENT PROGRAMS

*4.1 INTRODUCTION.* This chapter describes threat warning systems which are in engineering and manufacturing development (EMD), product improvement, or future unfunded planning initiatives. The chapter is organized by functional categories which are shown in figure 4.1. For several functional categories, there are threat assessments which summarize weapon system technologies which our systems face now or in the future. Developments are driven primarily by operational deficiencies and CINC requirements. Timelines for system development are depicted on roadmaps showing major milestones.

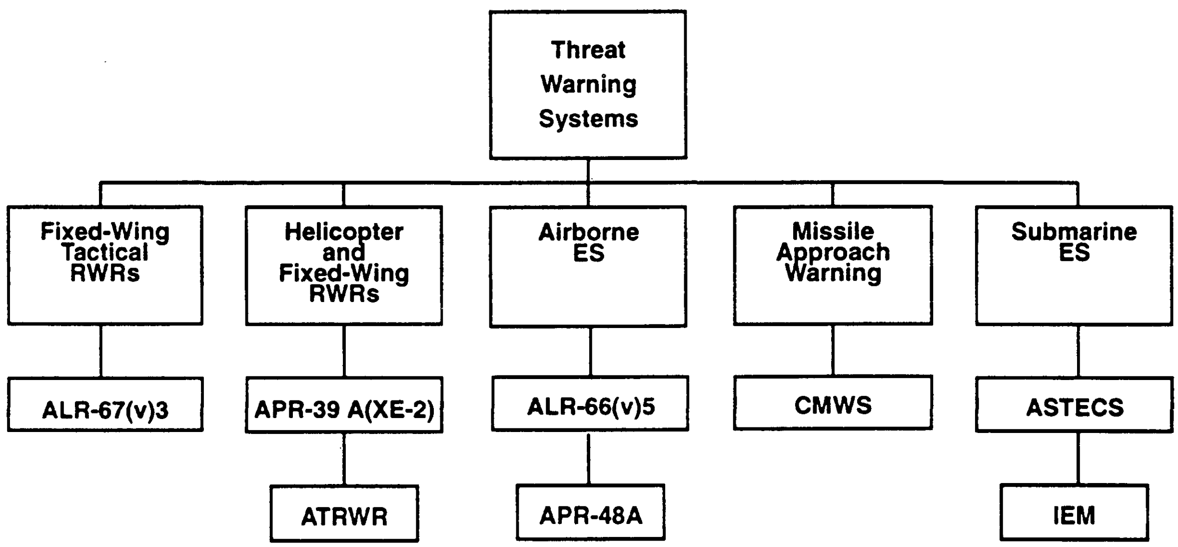



**Figure 4-1. Threat Warning Functional Areas**

## 4.2 *FIXED-WING TACTICAL RADAR WARNING RECEIVERS (RWRs):*

### A. *System Description:*

1. ***ALR-67(V)3***, (USN) (PE Number 0604270N/E2175). The (V)3 is currently in the EMD phase engaged in Navy DT flights and TECHEVAL. The test and evaluation master plan (TEMP) was approved by OSD in December 1994. Subsequently, a contract was let for the procurement of 20 test assets. These units will support OT-IIA testing scheduled for November-December 1995.

2. ***ALR-69 Upgrade*** (USAF) (2002-2007) (unfunded). Upgrades (preferably technology insertions) to the A/AO-10 ALR-69 RWR will be required to provide adequate situational awareness and threat warning for advanced threat radars. This upgrade will add electronic warfare preprocessing equipment (EWPE) and sensor integration technology to the A/OA-10's integrated systems architecture.

*3. ALR-56C/M RAD* (USAF) (F-15 1995-1999, F-16, 1995-2001) (unfunded). Random Agile Deinterleaving (RAD) technology upgrades to the F-15/F-16 ALR-56C/M RWR will allow threat warning capability to keep current with advanced radar threats. RAD adds the ability to measure the new RAD parameter and uniquely identify/sort the multitude of overlapping radar pulses in a dense environment. Addition of dual polarity antennas will enhance capability against polarity diverse/agile systems (1996-1999) (unfunded).

*B. Key Technologies Roadmap:* (figure 4-2)

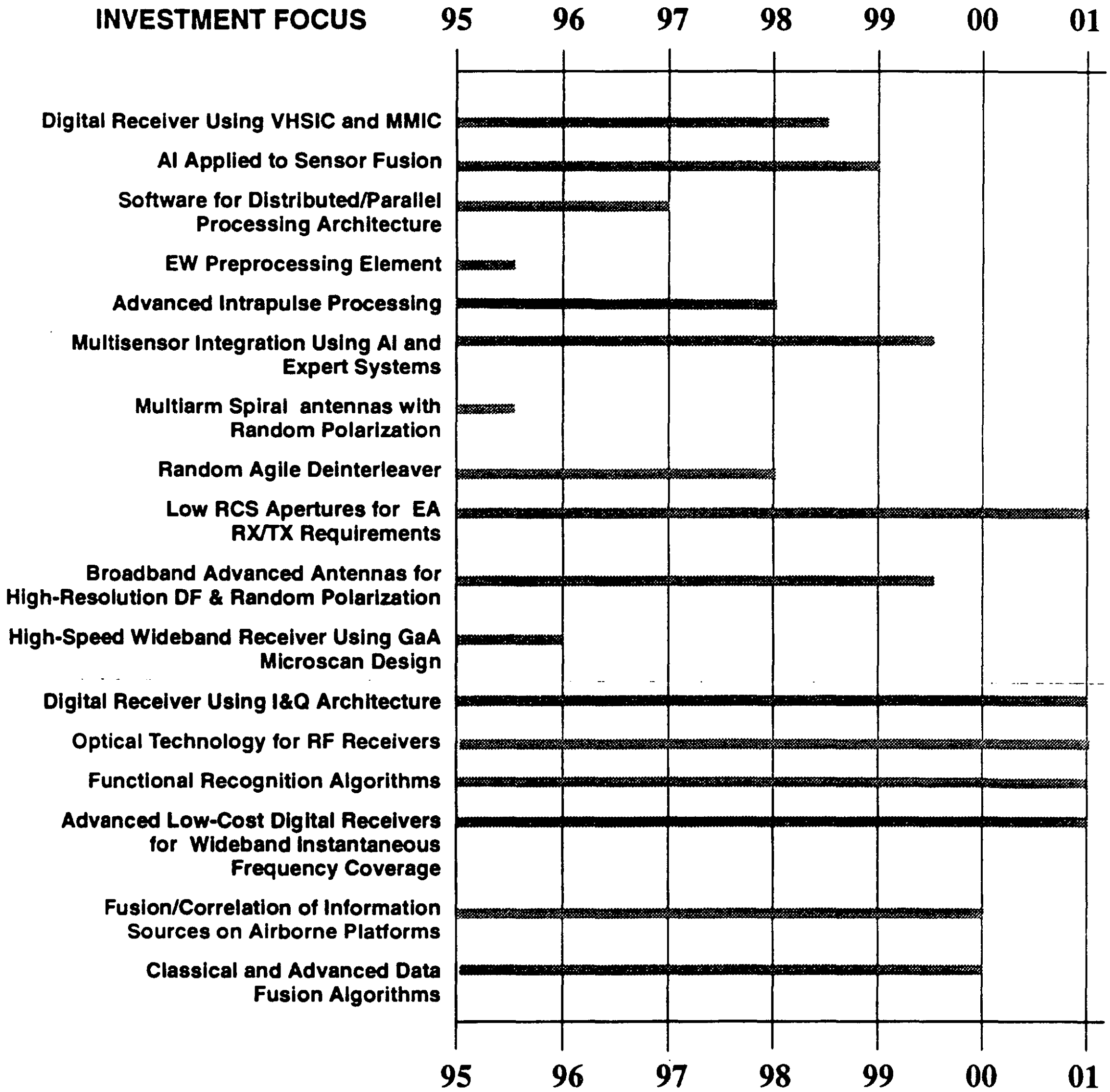



**Figure 4-2. Key Technologies Roadmap Fixed-Wing Tactical RWR**

### *4.3 HELICOPTER AND FIXED-WING SUPPORT AIRCRAFT RWRs:*

*A. Threat Assessment.* Helicopter and fixed-wing support aircraft will be exposed to the same threats as fixed-wing tactical radar warning receivers with particular emphasis on antiaircraft artillery (AAA) fire control radars.

*B. System Description:*

*1. APR-39A(XE-2)* (to be redesignated APR-39A(V)2 upon type classification and production approval), (Joint) (Army PE Number 64270A/D665/ED; Navy PE Number 64270N/E2175). The APR-39A(XE-2) is an Army-led/Navy/Marine Corps common-use, RWR development. It is designed to provide warning of RF surface-to-air and air-to-air threats to Army Special Electronic Mission Aircraft (SEMA), Navy/Marine Corps helicopters, Air Force MH-60G, and slow flying, fixed-wing aircraft. Software problems were encountered during the Army and Navy Operational Testing (OT III) of the APR-39A(XE-2). Developmental testing was completed during 4QFY94. Preliminary results are very promising although procurement funding will not be included in the FYDP until a successful OT report is complete (approximately 4QFY95).

*a.* There are four RWRs in the APR-39 family. The APR-39(V)1 and APR-39A(V)1 were developed for Army scout/attack helicopter missions, which are conducted at treetop level and below, on the enemy side of the forward line of troops (FLOT).

*b.* The APR-39(V)2 was developed for SEMA.

*c.* The APR-39A(XE-2) is the cornerstone of SEMA and USMC helicopter EW suite integration, as it will also display AVR-2 laser warning and AAR-47 missile warning data.

*d.* For the Army, savings in cost and weight and improved performance are realized as a result of tailoring the APR-39 designs to the different mission characteristics. The APR-39A(XE-2) will be installed on USMC V-22, AH-1, UH-1, and CH-53 aircraft; USN CH-53, MH-53, RH-53, HH-60H and USMC KC-130 aircraft.

*2. Advanced Threat Radar Warning Receiver (ATRWR)* (USA) (PE Number 64270A/D665/AD). The ATRWR is one of three components of the Suite of Integrated RF Countermeasure (SIRFC) system (chapter 5). The ATRWR is designed to detect and prioritize pulse, pulse Doppler, and CW radars associated with surface-to-air, air-to-air, and AAA threats and to provide automatic cueing for preemptive, terminal mode countermeasures. The system is intended to be a replacement for the limited capability resident in the APR-39 family of warning receivers.

*C. Key Technologies Roadmap:* (figure 4-3)

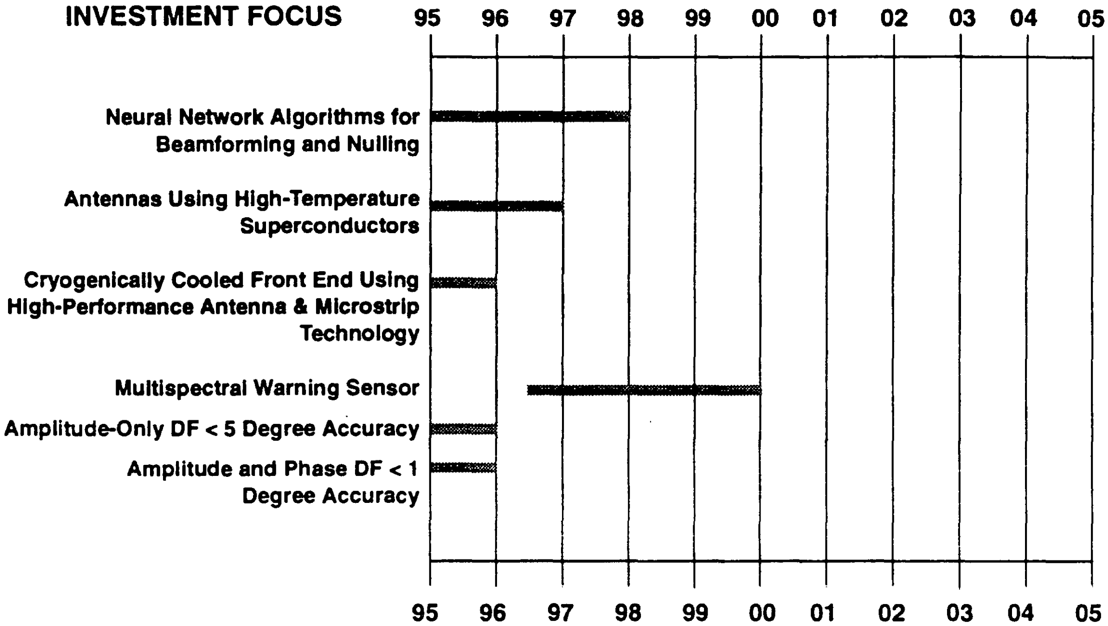



**Figure 4-3. Key Technologies Roadmap Helicopter and Fixed-Wing Support Aircraft RWRs**

## *4.4 AIRBORNE ES SYSTEMS:*

*A. Threat Assessment.* Airborne ES aircraft will be exposed to the same threats as fixed-wing tactical RWRs.

*B. System Description:*

1. *ALR-66(V)5* (USN) (PE Number 64221N/1588):

*a.* The ALR-66(V)5, currently under development as contractor-furnished equipment (CFE), is intended to be part of the Update IV kit to be retrofitted into P-3C aircraft. However, the program is on hold pending a review of maritime patrol aircraft replacements.

*b.* The Update IV Avionics Program for the next generation of maritime patrol aircraft requires improvements in the ES suite. The ALR-66(V)5 was chosen as a replacement for the ALR-77 when the ALR-77 went over budget and exceeded weight restrictions. When in the automatic mode, the ALR-66(V)5 will provide radar warning capabilities through a preflight insertion data-loaded library and the ES management software. The system will use the same wingtip antennas as the Update III aircraft. A separate DF channel will provide refined DF for ES fixing and over-the-horizon targeting (OTH-T) functions.

2. *APR-48A* (USA) (PE Number 64270A/63776A/64816A/D665/ED):

*a.* The APR-48A Radar Frequency Interferometer (RFI) is a previously unavailable precision target locating and backup threat warning device for application to the AH-64D Long Bow Apache and Army ground systems.

*b.* Performance enhancements include a high-frequency extension to 40 GHz, and a built-in test/fault isolation to antenna, receiver, and processor line replaceable units.

*C.* ***Key Technologies Roadmap:*** (figure 4-4)

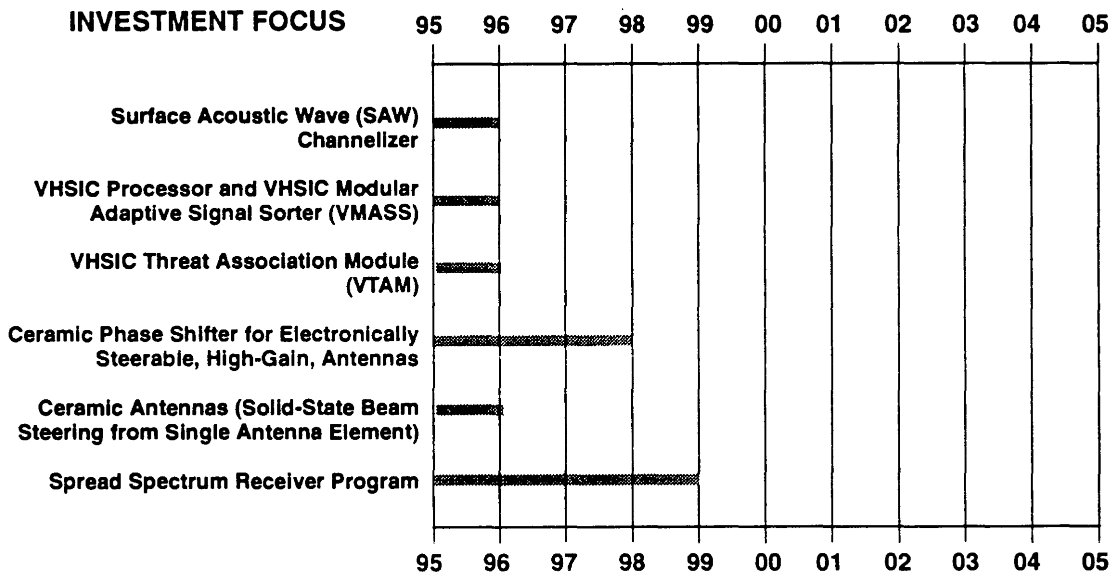



**Figure 4-4. Key Technologies Roadmap Airborne ES Systems**

## *4.5 MISSILE APPROACH WARNING SYSTEMS:*

*A.* ***Operational Capability. Missile Approach Warning Systems***. The goal of these systems is to accurately detect missile launches with sufficient time to deploy countermeasures or to alert the aircrew to take evasive action. The Army's Advanced Threat IR CM System includes the Common Missile Warning System (CMWS) which uses two state-of-the-art sensor (IR and UV) technologies.

*B.* ***Missile Approach Warning Systems Roadmap.*** The CMWS is designed to detect the approach of a threat missile and initiate countermeasures. The CMWS augments RWRs by detecting both RF and non-RF (IR/EO) missiles. In order to promote a common missile warning solution, the Army, Air Force and the Navy have joined together under the CMWS program to develop, with the Army as lead, a common missile warning system for helicopters, airlift and tactical aircraft platforms such as the F-14, F-15, F-16, F-18, and AV-8B. The following program strategies form the baseline for each Service's approach to implementing CMWS.

*1.* ***Army.*** Existing aircraft will use the AAR-47. The Army as executive agent will lead a multi-Service effort with the Air Force and Navy to meld their former missile warning systems into a joint CMWS.

*2.* ***Navy:***

*a.* Existing helicopters will use the AAR-47.

*b.* F-14s, F-18s, and AV-8Bs will use the "Common" MAW system provided by the CMWS program.

3. *Air Force:*

*a.* Fighters, airlift aircraft and SOF helicopters will use the "Common" MAW system provided by the CMWS program.

*b.* SOF fixed-wing aircraft will use the system provided by DIRCM Program.

C. *System Description - Common Missile Warning System (CMWS)* (Joint) (Army PE Number 64270A/D665/AD; Air Force PE Number 64270F). CMWS is an Army-led joint program with the Air Force and Navy. CMWS combines the Army former Advanced Threat Missile Detector (ATMD) and an Electronic Control Unit (ECU), a major subsystem of ATIRCM program, with the Air Force/Navy former Advanced Missile Warning System (AMWS) program. CMWS replaces ATMD as one of the Army's three major components of the ATIRCM program. The goal of the CMWS is to establish a common missile warning system design with fit, function, and interfaces that are interchangeable across all platforms (aircraft and pods). Modernized, demonstrated technologies will be used to meet the operational requirements for missile warning to detect/declare the current missile threats, with particular emphasis on IR SAM threats. ATIRCM/CMWS will be designed so that CMWS can exist as a stand-alone effort. Initial installation of CMWS is planned for the following Service lead platforms: MH-60K, AV-8B, F- 16, and ALQ-131 pod. The follow-on platforms include: OH-58D, ALQ-184 pod, A/OA-10, F-14, F- 15, F/A-18, and USAF airlift aircraft.

D. *Key Technologies Roadmap:* (figure 4-5)

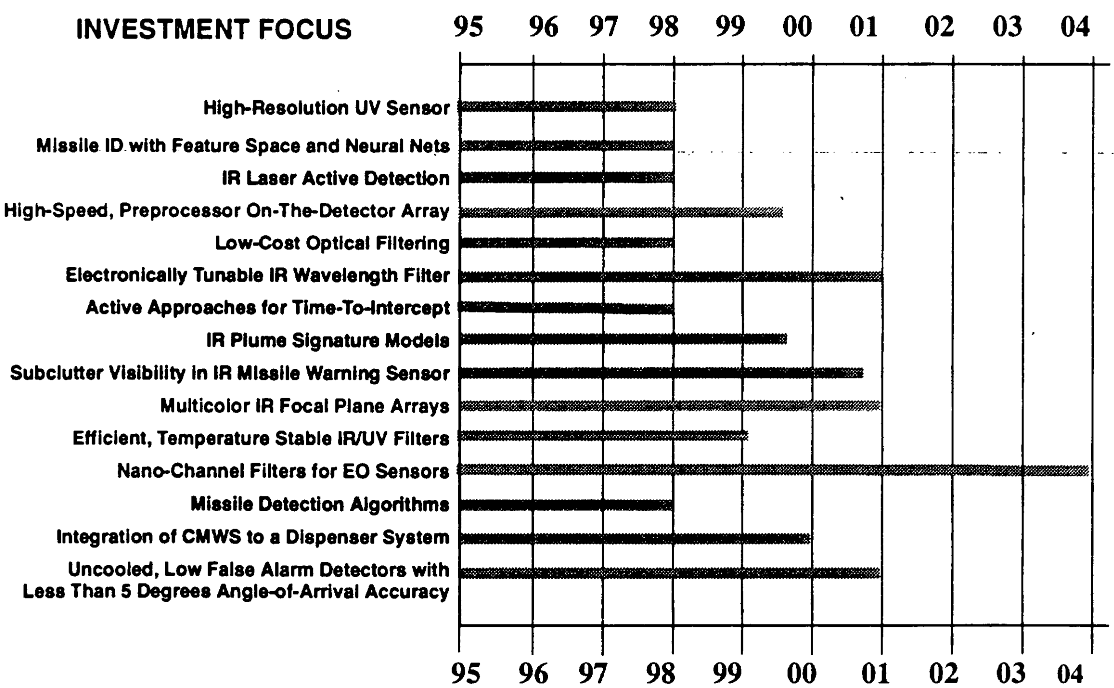



**Figure 4-5. Key Technologies Roadmap Missile Approach Warning Systems**

## *4.6 SUBMARINE ES SYSTEMS:*

*A.* ***Threat Assessment.*** Submarine ES systems face airborne, surface, and sub-surface threats which employ various techniques to avoid or reduce exposure to submarine ES sensors.

***B. Operational Capability - Submarine ES Systems*** (including those with ADF). Submarine ES systems consist of receiver/processors and their associated RDF mast- and periscope-mounted systems. Before the introduction of the WLQ-4(V)/BLA-4/BRD-7 package on SSN-637 class submarines in 1980, submarine ES systems functioned as tactical threat warning receivers.

*C. System Description:*

*1. Advanced Submarine Tactical ESM Combat System (ASTECS)* (USN) (PE Number 64558/F1950). ASTECS is a state-of-the-art tactical ES system proposed for installation on SSN-21 and future class submarines. ASTECS is scheduled to replace the AN/WLQ-4(V)1 on future class submarines.

*2. Integrated ESM Mast (IEM)* (USN) PE Number 64503/F0775). The IEM is a state-of-the-art system that will replace the AN/BLD-1 and AN/BRD-7, the radar and the communications direction finding (DF) systems currently in the fleet. The IEM program has been restructured to make the IEM interface design compatible with ES systems aboard the SSN-688 class submarines and the ASTECS planned for the New Attack Submarine (NAS).

# Chapter 5

# SELF-PROTECTION RESEARCH AND DEVELOPMENT PROGRAMS

*5.1 INTRODUCTION.* This chapter describes self-protection systems which are in engineering and manufacturing development (EMD), product improvement, or future unfunded planning initiatives. The chapter is organized by functional categories which are shown in figure 5-1. For several functional categories, there are threat assessments which summarize weapon system technologies which our systems face now or in the future. Developments are driven primarily by operational deficiencies and CINC requirements.

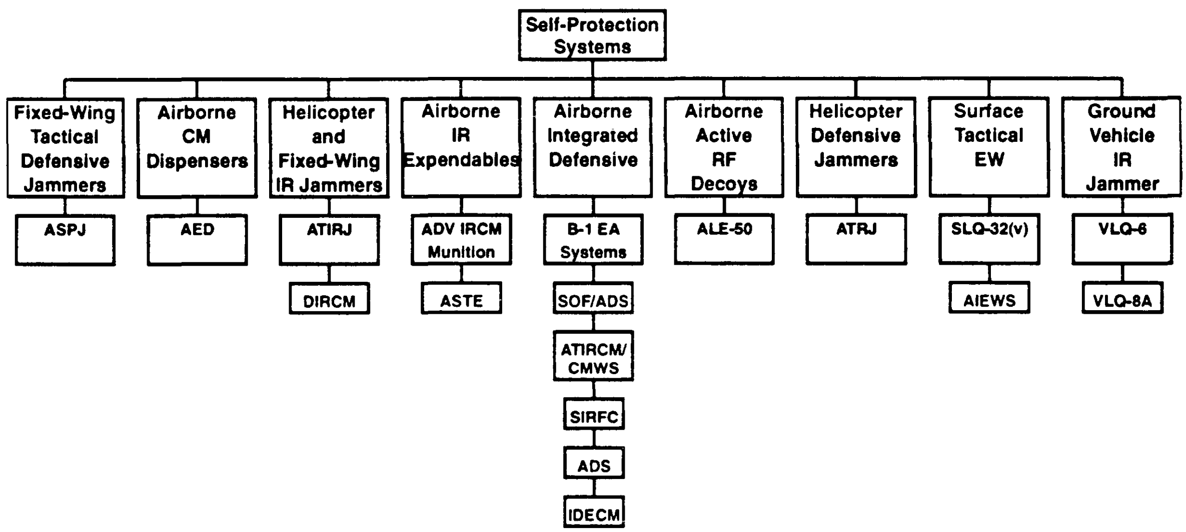



**Figure 5-1. Self-Protection Functional Areas**

## 5.2 *FIXED-WING TACTICAL DEFENSIVE JAMMERS:*

*A.* ***Threat Assessment.*** Fixed-wing tactical radar jamming systems will face a complex signal environment from radars using frequency diversity (both agility and simultaneous multiple frequencies), parameter agility, electronic beam scanning, coded pulses for pulse compression, and advances in digital signal processing brought on by increases in computing power and sampling rates. Advances in monolithic microwave integrated circuit (MMIC) technology have enabled a trend towards active phased array antennas. This enables more flexible beam steering, power management, antenna pattern nulling, and sidelobe level management, all of which improve EP performance. Target tracking radars will increasingly use MMW frequencies for greater tracking accuracy and deception measures. A trend toward lower antenna sidelobes and wide receiver dynamic range both reduce the effectiveness of EA techniques. Newer systems incorporate jamming analyzers which enable dynamic reaction to the jamming threat. Low probability of intercept will become part of the design philosophy in newer systems using wide bandwidth transmission, low peak power, short transmission times and use of the MMW spectrum.

*B.* ***Operational Capability. Fixed-Wing Tactical Defensive Jammers.*** Currently no capability exists against MMW band or LPI emitters.

*C.* ***System Description - F-15E ALQ-135 Band 1.5 Jammer*** (1995-1999) (unfunded). The F-15E will add the advanced technology ALQ-135 Band 1.5 low frequency radar jammer to its self defense suite. Band 1.5 will complement and enhance the current Band 3 jammer with defensive low frequency jamming.

*D.* *Key Technologies Roadmap:* (figure 5-2)

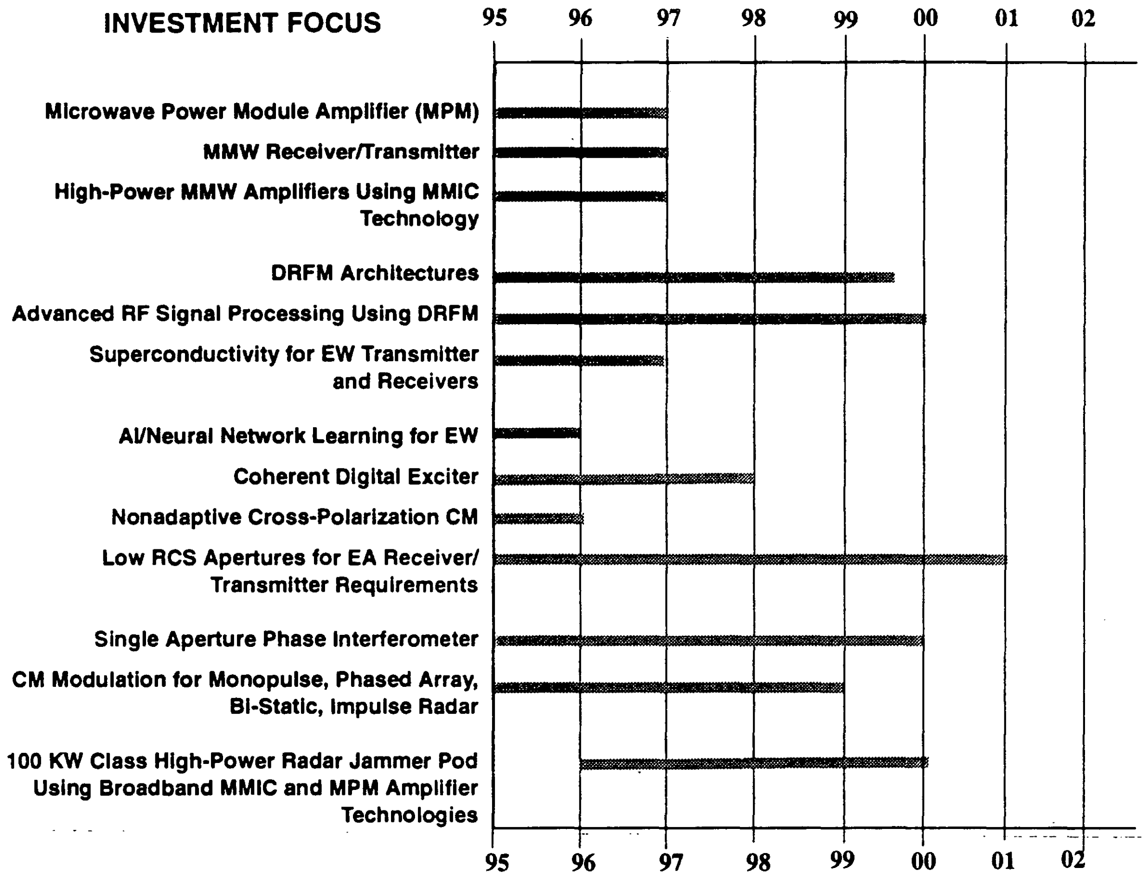



**Figure 5-2. Key Technologies Roadmap Fixed-Wing Tactical Defensive Jammers**

## *5.3 AIRBORNE INTEGRATED DEFENSIVE SYSTEMS:*

*A.* ***Threat Assessment.*** Airborne integrated defensive systems will be exposed to the same threat listed for fixed-wing tactical defensive jammers (paragraph 5.2.A.).

*B.* *System Descriptions:*

*1.* ***B-1 Defensive System Improvements*** (USAF) (PE Number 64226F, Project 1019):

*a.* The current B-1 defensive system includes the ALQ-161A, which is an integrated RFS/EA system, a missile tail warning system, and a chaff and flare dispensing system. The system was best suited for B-1's initial low-altitude nuclear penetration mission. ALQ-161A improvements, emphasizing supportability features, were developed in the late 1980s, completed development testing in 1991, but were not procured.

*b.* In keeping with Strategic Arms' Control Treaties and the Air Force's 1992 Bomber Roadmap, B-1 is being re-roled as the workhorse conventional heavy bomber. Survivability improvements required to support this new conventional tasking are the focus of this project. A broader range of threats must be addressed as projected missions include blue/gray air defenses, high as well as low altitude mission profiles, repeated visits to a given target area, and use in force packages with friendly aircraft. Improvements sought include more capable situational awareness, added jamming capability, and better supportability.

*c.* In 1993, the Air Force hired Rockwell International (RI) as integrating contractor for the B-1 Conventional Mission Upgrade (CMUP) program, to include integration of additional and more capable conventional weapons, as well as a defensive system upgrade. In addition a cost and operational effectiveness analysis (COEA) on the CMUP was started at the Institute for Defense Analysis (IDA). Groundwork was established for wide open competition among defensive system contractors, and a competitive RFP was drafted. In November 1994, Congress prohibited spending FY94 and remaining FY93 RDT&E funds to address deficiencies in B-1 EA systems. Accordingly, all tasks were halted except for support to the B-1 COEA.

*d.* The Air Force is developing an incremental B-1 ECM program to provide enhanced capability against near-term threats. System requirements are being reviewed using current DPG guidance and projected threat base at the turn of the century. Start for this program is planned for FY97 with a Milestone II decision occurring in June 1996. This incremental approach will be fielded in support of JDAM capability enhancing survivability to complement the increased lethality of the B-1.

*e.* Missile warning system (MWS) and IR EA requirements for the B-1 are under review.

*2.* ***B-52 Enhancements - B-52 ALQ-172 High-Altitude Cover*** (1995-2001) (unfunded). Provide for extended ALQ-172 antenna coverage.

*3.* ***Millimeter Wave (MMW) Receive/Jam Capability*** (2003-2011, B-52) (unfunded); (2002-2007, A/OA-10) (unfunded); (2002-2006, F-15) (unfunded); (2000-2004, F-16) (unfunded). Modifications will provide the capability of detecting, avoiding, and jamming advanced MMW threat systems. Currently have no capability against MMW systems.

*4.* ***Special Operations Forces/Airlift Defensive System (SOF/ADS)*** (US Special Operations Command) (PE Number 1160404BB):

*a.* ***Description.*** This program was originally known as "Integrated Defensive Avionics System" and was subsequently changed to "Special Operations Forces/Airlift Defensive Systems (SOF/ADS)." The overarching requirement is threat identification and avoidance. The primary objectives are to develop an advanced infrared countermeasures (IRCM) system for SOF aircraft against recently deployed and projected threats and support the enhancements of existing SOF EW equipment through measurements, studies, and demonstrations.

*b.* ***Requirement Definition.*** This project will identify and develop enhancements for each SOF aircraft that will reduce detection, vulnerability, and threat engagement; thereby increasing the overall survivability of SOF assets. This project will identify and develop enhancements to each platform to meet the projected threat (baseline 1996). Recommendations for equipment modification or replacement will be developed by each System Program Manager (SPM) based upon the results of ongoing engineering assessments and operational requirements. This project also provides systems for SOF-unique portions of the Warner Robins Air Logistics Center, Electronic Warfare Avionics Integrated Systems Facility (EWAISF). The EWAISF directly supports software development and testing. Part of the EWAISF effort is the Systems Integration

Laboratory (SIL) designed to support the incorporation of SOF/ADS modifications into specific SOF platforms. The SOF/ADS project line no longer funds the integration of the disparate defensive systems installed on the SOF aircraft. The project now addresses the upgrade or replacement of existing systems and capabilities. Although defensive system integration remains a long-term goal, it is, and is expected to remain, an unfunded requirement through the FYDP. Subprojects include:

*(1)* A modification of the AN/ALE-40 chaff and flare dispenser system that will enhance the aircraft's self-protection capability against infrared threats.

*(2)* A retrofit to the AN/ALE-47 expendable dispenser system.

*(3)* An improvement program that enhances and provides a direction finding capability to the AN/APR-46 RF panoramic receiver.

*(4)* An upgrade to the AN/AAR-44 missile warning receiver that will provide 360-degree spherical coverage.

*5. **Suite of Integrated RF Countermeasure (SIRFC)*** (USA) (PE Number 64270A/ D665/AD/ED).

*a.* The SIRFC system provides integrated passive and active combat threat identification and target acquisition cueing through exploitation of microwave and millimeter wave emissions. Threat identification and cueing are coupled with fused complementary and coordinated jamming and decoying of threat fire control systems. The SIRFC system provides fully automated operation with a crew override capability. The required threat performance is achieved relative to frequency coverage, sensitivity, environmental pulse density, unambiguous threat identification, and complex EP handling including pulse compression, coherency, and monopulse techniques. Enhanced jamming is achieved by the use of advanced deception/ disruption options. The SIRFC system provides threat location with precision angle of arrival accuracy within a 360-degree sensing and jamming field of regard. The SIRFC system incorporates gate arrays, microwave and millimeter wave integrated circuits, reduced instruction set computer processing, and the DOD standard ADA programming language. The design goal of this combination of technologies is lower operations and sustainment costs by improving reliability, availability, and maintainability features. Added advantages of the SIRFC are reduced space and weight. Enhanced functionality and interoperability are obtained by the use of the digital interface between SIRFC modules and the aircraft's avionics and weapons systems digital architectures. SIRFC functions as a bus controller for other aircraft survivability equipment, incorporates a MIL-STD-1553 serial data bus, and dual RS-232 serial ports to ensure interconnectivity. Further, the capability exists for threat situational handoff to friendly aircraft and the battlefield commander.

*b.* The SIRFC system includes the ability to record the threat environment during combat missions to provide precision long-range reconnaissance and near real-time situation briefings for smart mission planning. Additionally, the SIRFC system will interface with the ATIRCM/CMWS system to achieve multispectral protection. The initial interface of ATRJ and ATIRCM/CMWS will be on the MH-47E for operational testing in 3QFY99 with fielding in FY01. Embedded training features provide the ability to achieve integrated sustainment training. The modular architecture of the SIRFC system's advanced Standard Electronic Modules (SEM) provides an effective sub-module diagnostics capability to give affordable sustainment cost at the aviation unit maintenance (AVUM) level. In addition, the SEM architecture provides a capability for upgrades and expansions for future product improvements by replacing sub-modules rather than complete systems. Some Army applications will only be using the receiving and processing

*5.8 SURFACE TACTICAL EW SYSTEMS - Key Technologies Roadmap:* (figure 5-8)

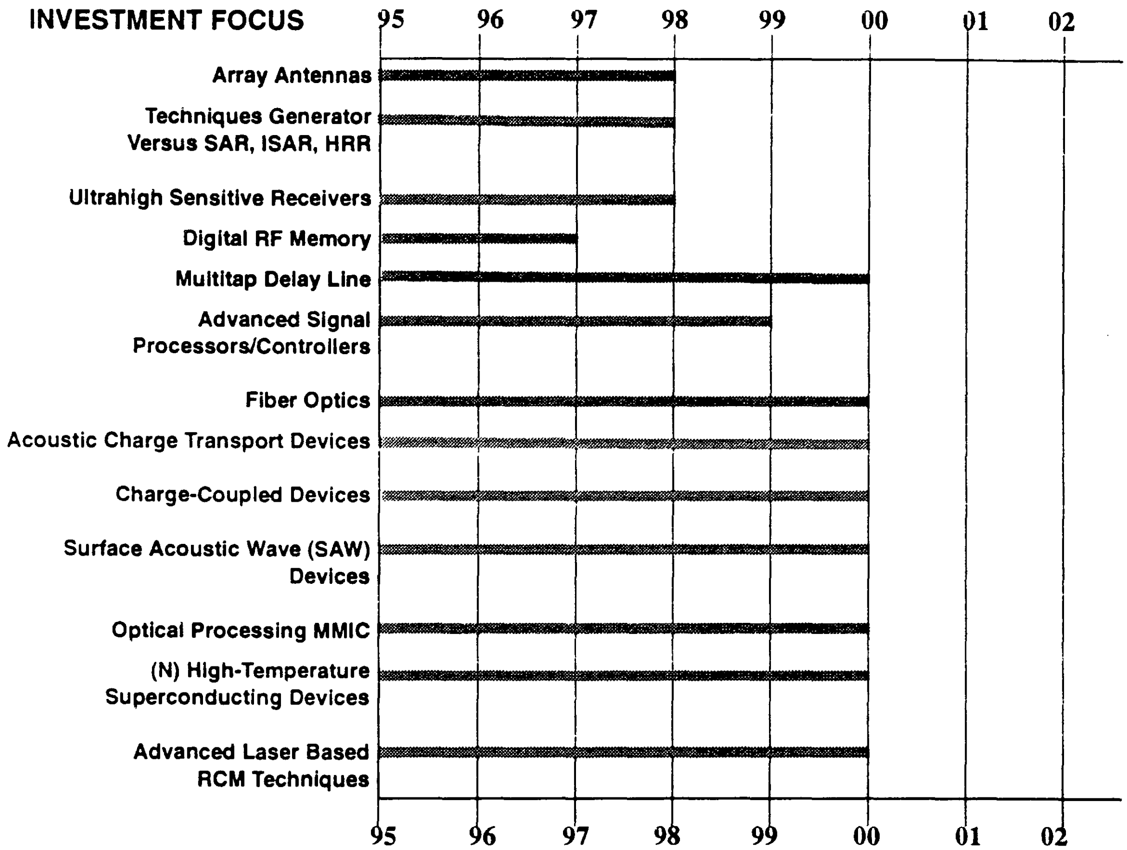



**Figure 5-8. Key Technologies Roadmap Surface Tactical EW Systems**

*5.9 GROUND VEHICULAR IR SACLOS JAMMERS - Systems Description. Missile Countermeasures Device (MCD)* (AN/VLQ-6 and AN/VLQ-8A) (USA). The MCD is an electronic infrared countermeasures device designed to protect ground combat vehicles from SACLOS ATGM threats. It is mounted on the outside of the vehicle and counters the missile threat by emitting IR energy that confuses the ATGMs causing them to miss their intended target. The MCD enhances the survivability of ground combat vehicles by providing protection against the following ATGMs: AT-3, AT-4, AT-5, AT-7, HOT, MILAN, and variants of these ATGMs. The following MCDs have been fielded: US Marine Corps (Abrams 280), US Armor Center, Fort Knox (Abrams 14), US Infantry School, Fort Benning (BFVS 8), Special Contingency to Kuwait (BFVS 54), Pre-Position Afloat (BFVS 154). Based on input from FORSCOM MACOMS, fielding of MCDs will be based on mobilization orders. Materiel release and retype classification from Limited Procurement Urgent (LPU) to standard has been in process at US Army Communications Electronics Command (CECOM).

*C.* *Key Technology Roadmap:* (figure 5-5)

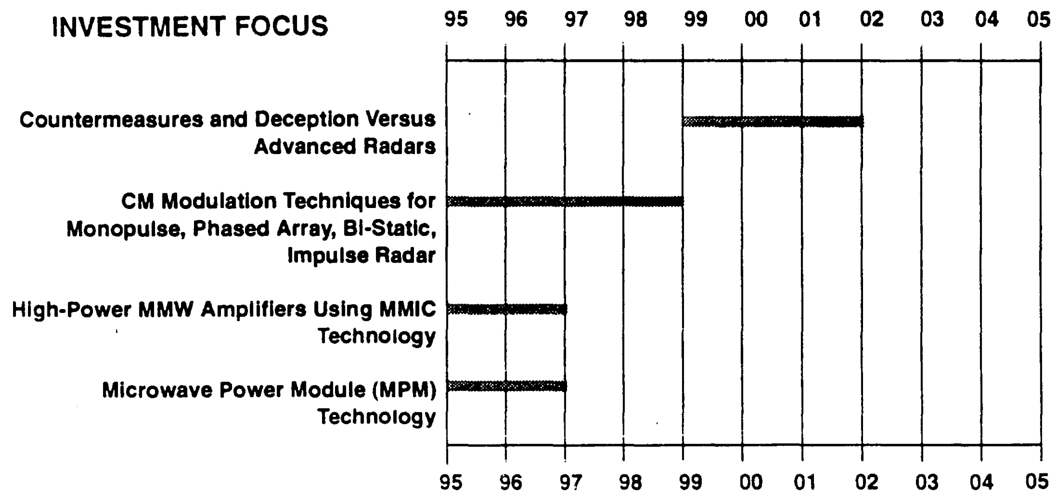



**Figure 5-5. Key Technologies Roadmap Helicopter Defensive Jammers**

*5.6* *AIRBORNE IR EXPENDABLES - Key Technologies Roadmap:* (figure 5-6)

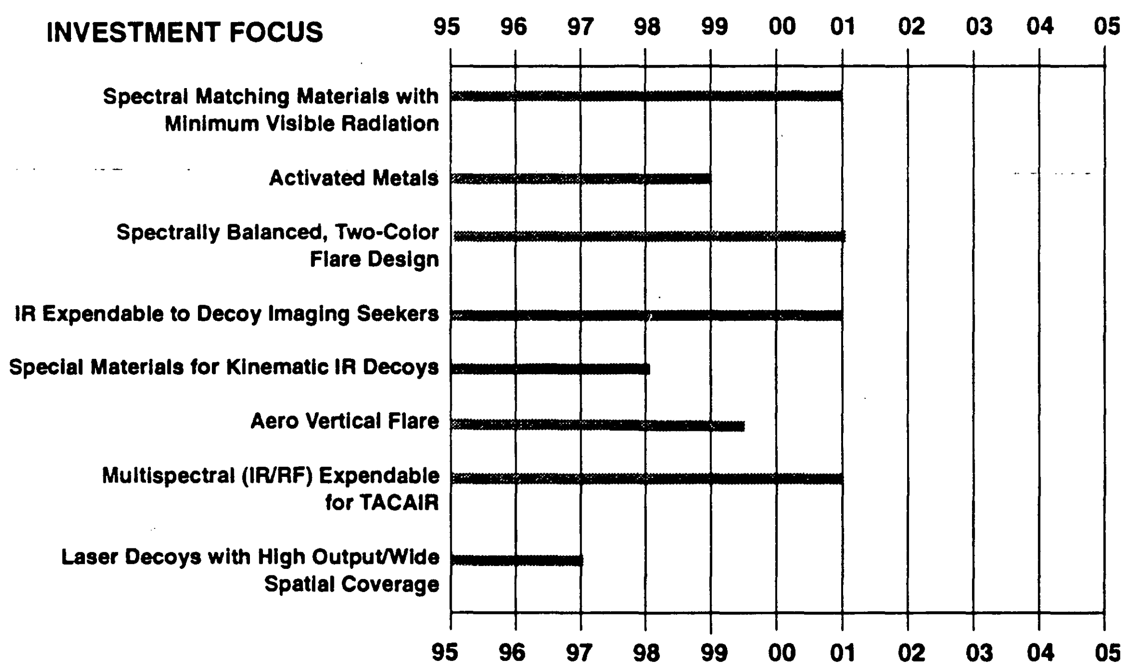



**Figure 5-6. Key Technologies Roadmap Airborne IR Expendables**

*5.7 AIRBORNE ACTIVE RF DECOYS - Key Technologies Roadmap:* (figure 5-7)

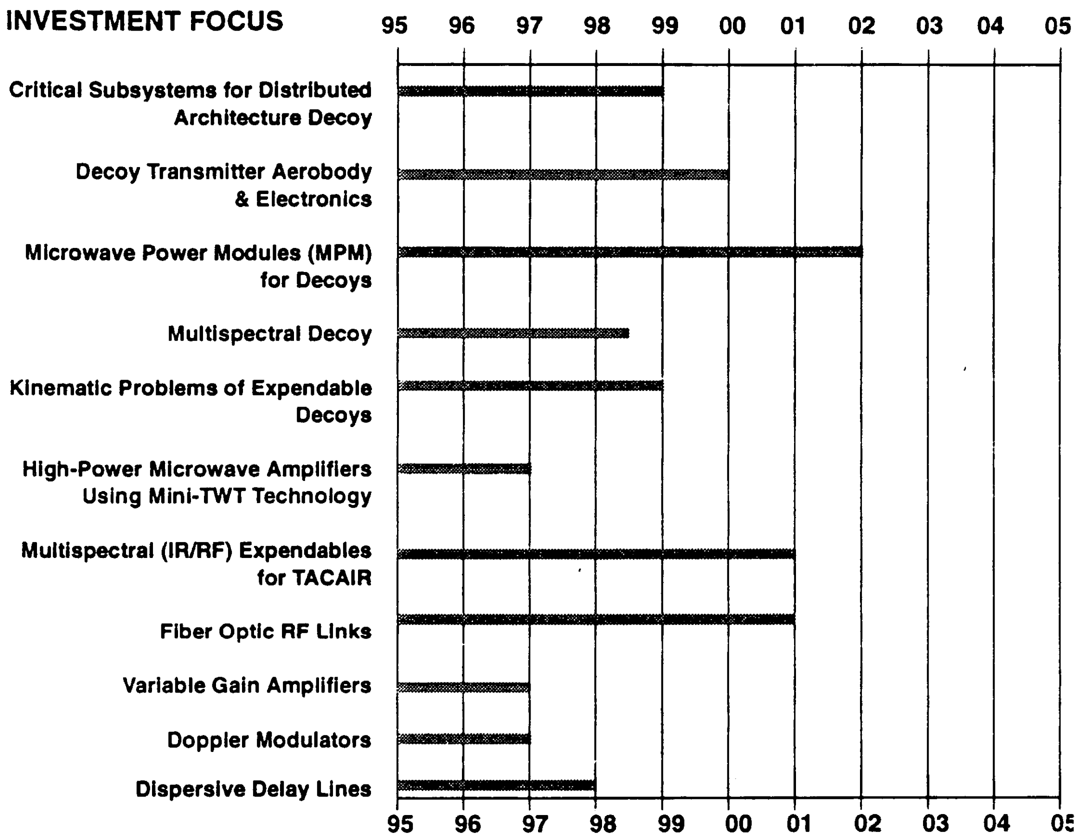



**Figure 5-7. Key Technologies Roadmap Airborne Active RF Decoys**

*5.4 HELICOPTER AND FIXED-WING IR JAMMERS - Key Technology Roadmap:* (figure 5-4)

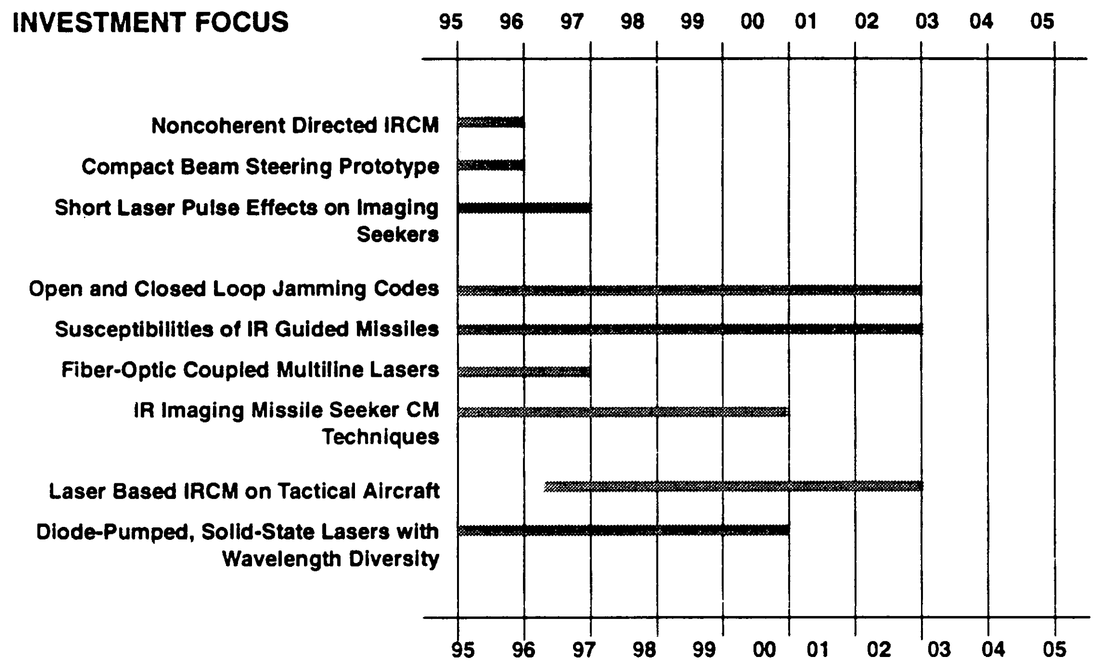



**Figure 5-4. Key Technologies Roadmap Helicopter and Fixed-Wing IR Jammers**

*5.5 HELICOPTER DEFENSIVE JAMMERS:*

*A. Threat Assessment.* Helicopter defensive jammers will be exposed to the same threat listed for fixed-wing tactical defensive jammers (paragraph 5.2.A.).

*B. System Description - Advanced Threat Radar Jammer (ATRJ)* (USA) (PE Number 64270A/D665/AD) is one of the major subsystems of the SIRFC program. ATRJ is designed to simultaneously jam a minimum of four threat radars and will incorporate JIAWG specifications for commonality where applicable/available. This system has potential use on all low and slow flying aircraft.

elements of the system which function stand-alone for situational awareness and handoff to airframe weapon systems.

*6. Airlift Defensive Systems (ADS)* (USAF) (PE Numbers 0604270F for common, and 0604231 for C-17 specific development; 41119F for the C-5; 41118F for the C-141; 41115F for the C-130; and 41130F for the C-17 procurement). The ADS program provides an integrated, common architecture, flight reprogrammable defensive system for self-protection for the C-5/17/130/141 USAF airlift aircraft. This is the only existing program to provide airlift fleet EW protection. There is a requirement to provide protection for these aircraft from the peacetime threat (SA-7A/B, SA-14, Redeye, and Stinger) and wartime threats during tactical and strategic airlift. The defensive suite for all these aircraft will use off-the-shelf AAR-47 missile approach warning receivers and will be initially fielded with the ALE-40. When the ALE-47 becomes available, it will be installed instead of the ALE-40. The FY95 R&D funds will complete software changes to the AAR-47 missile warning system, test efforts for the new ALE-47 countermeasures system on the C-5, and installation engineering for the ALE-47 and AAR-47 on the C-17.

C. *Key Technologies Roadmap:* (figure 5-3)

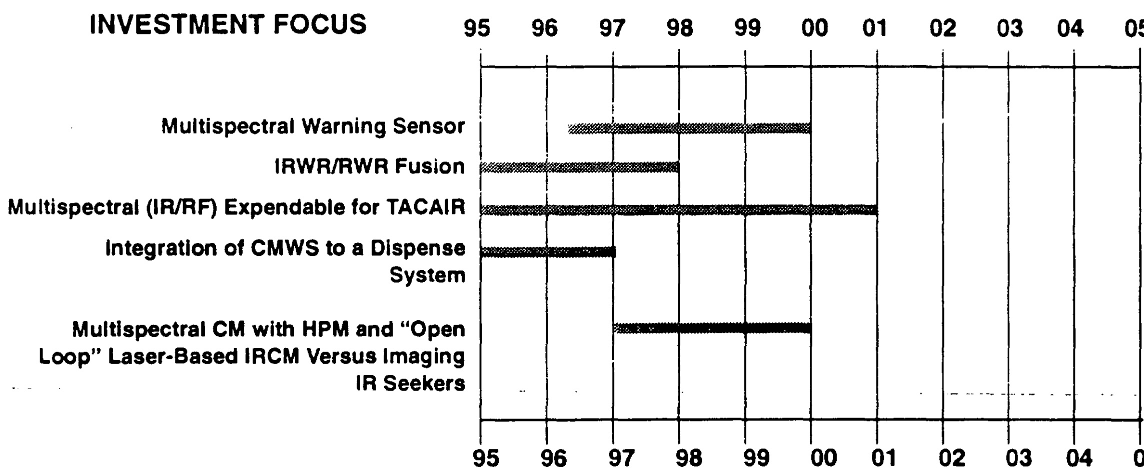



**Figure 5-3. Key Technologies Roadmap Airborne Integrated Defensive Systems**

# Chapter 6

# MISSION SUPPORT RESEARCH AND DEVELOPMENT PROGRAMS

*6.1 INTRODUCTION.* This chapter describes mission support systems which are in engineering and manufacturing development (EMD), product improvement, or future unfunded planning initiatives. The chapter is organized by functional categories which are shown in figure 6.1. Developments are driven primarily by operational deficiencies and CINC requirements.

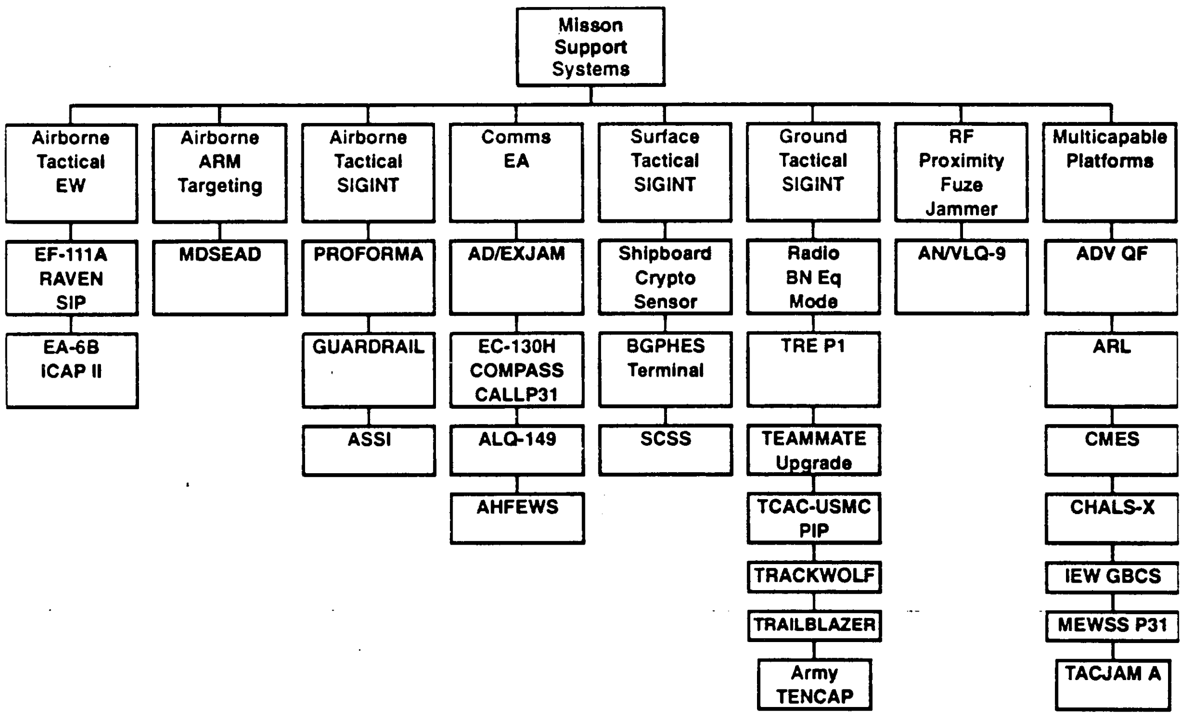



**Figure 6-1. Mission Support Functional Areas**

## *6.2 AIRBORNE TACTICAL EW SYSTEMS:*

### *A. System Description:*

*1.* ***EF-111A Raven System Improvement Program (SIP)*** (USAF/PE Number 27252F/ 64270F). This system is being terminated in FY95.

2. ***EA-6B Investment Strategy*** (USN) (PE Number 0604270N/W0556):

*a.* Before the warfighting capabilities of the EA-6B can be improved, it is crucial to ensure that the platform will be able to sustain its force strength numbers and that it can be flown safely and affordably. Currently, the EA-6B has three distinct configurations (Blocks) of aircraft; seventy Block 82 aircraft, thirty-one Block 86 aircraft, and twenty-six Block 89 aircraft. To remain viable in fleet service, the EA-6B needs safety, structural life, and supportability improvements. Consequently, the priorities for further investment in the EA-6B are as follows:

- ensure that the aircraft remains safe to fly,
- ensure an adequate inventory is maintained,
- minimize the life cycle costs through configuration standardization, and
- improve the warfighting capability by extending the transmit and receive frequency range.

*b.* The first three investment priorities are met by the completion of three on-going EA-6B Operational and Safety Improvement Programs (OSIPs) which will standardize all fleet aircraft to Block 89A configuration and incorporate safety of flight and structural improvements. Currently, the addition of band 2/3 or band 9/10 transmitters are the only warfighting improvements that are affordable. The band 2/3 transmitter is the number one Fleet priority, and when coupled with a suitable new receiver, it enables a significant C2W capability. The band 2/3 transmitter is the only funded war fighting upgrade.

*B. Key Technologies Roadmap:* (figure 6-2)

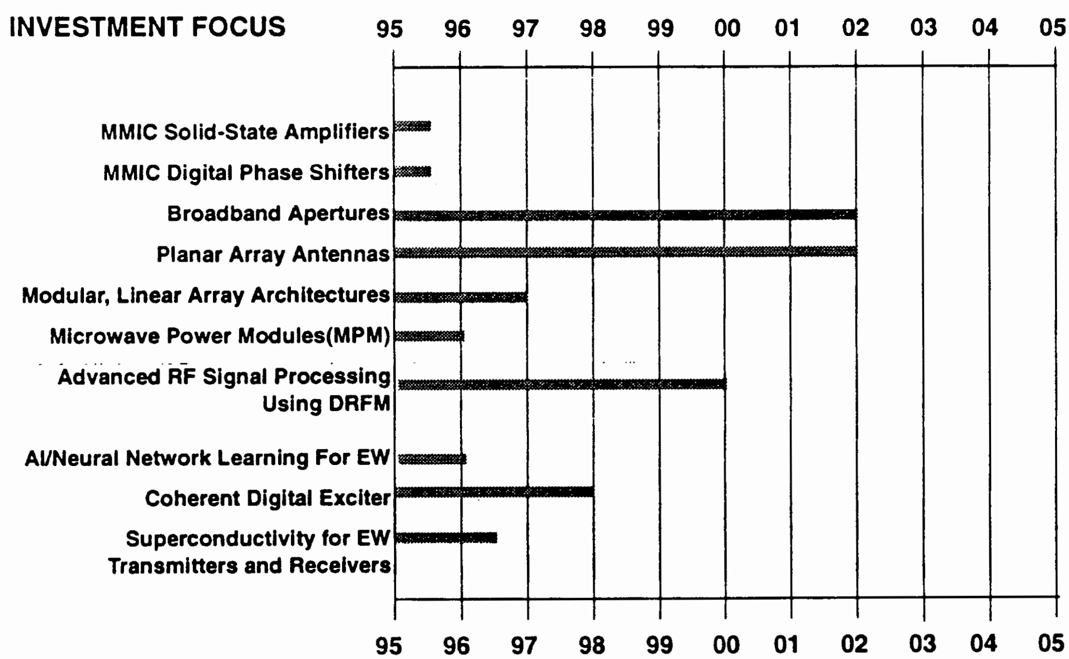



**Figure 6-2. Key Technologies Roadmap Airborne Tactical EW Systems**

*6.3 AIRBORNE ARM TARGETING SYSTEMS - Key Technologies Roadmap:* (figure 6-3)

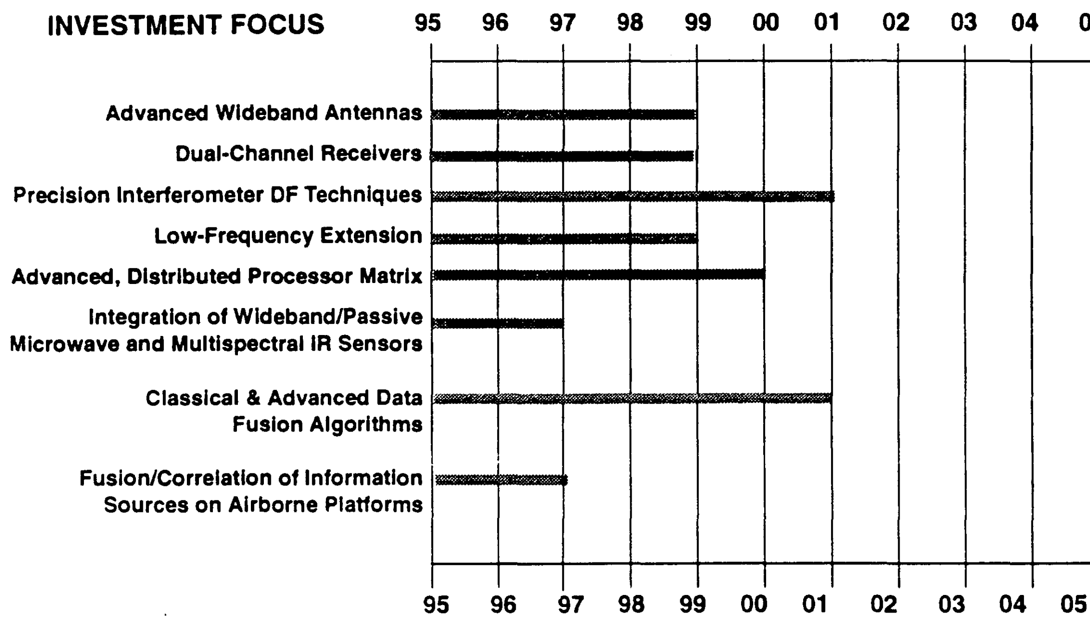



**Figure 6-3. Key Technologies Roadmap Airborne ARM Targeting Systems**

*6.4 COMMUNICATIONS EA SYSTEMS - System Description - Army High Frequency Electronic Warfare System (AHFEWS)* (USA) (PE Number 64812). The AHFEWS is a one-of-a-kind, echelon-above-corps, intelligence and EW system designed to perform both ES (to include locate using AOA) and EA missions in the HF spectrum in support of regional or theater commanders.

*6.5 GROUND TACTICAL SIGINT SYSTEMS:*

*A.* ***Threat Assessment.*** Ground tactical SIGINT systems will be exposed to the same threat as surface tactical SIGINT systems.

*B.* ***System Description:***

*1.* ***Radio Battalion Equipment Modifications*** (USMC) (PE Number 0305885G/ 0206496M):

*a.* The Radio Battalion Modifications program will provide enhancements to existing capabilities resident within the SIGINT units of the Marine Corps. The goal of this program is to extend the service life of selected current systems by replacing or upgrading outmoded components and meet the changing threat through a series of product improvements rather than EMD efforts. Functionally, the Radio Battalion Modifications program integrates matured technology and equipment from other Service systems and industry into existing Radio Battalion/ Special Security Communications Teams (SSCTs) systems.

*b.* The AN/MSC-63 Special Security Communications Central (SSCC) provided a slow (75 baud), manual, two-circuit Special Intelligence (SI) communications capability for the processing of SCI message traffic within the Marine Air Ground Task Force (MAGTF). The upgraded AN/MSC-63A SSCC increases capacity to eight 2400-baud circuits and automates message processing functions, thereby enhancing the tactical commander's ability to receive and disseminate time-critical threat information. The upgraded AN/MSC-63A more effectively operates with the other Services.

2. *TEAMMATE Upgrade (AN/TRQ-32(V)2)* (USA) (PE Number 0305885G/ 0208026A). Fielding of the TRQ-32A(V)2 as replacement for the TRQ-32(V) and TRQ-32(V)2 variants began in FY94. The older CUCV-mounted system, which had a limited DF frequency range and limited data-interface system, has now been replaced in all Force Package 1 and some Force Package 2 units. All of these older systems will be withdrawn from the force by the end of FY96. Upgraded systems will only be fielded to divisional and separate brigade/Armored Cavalry Regiment intelligence units. Older variants at Corps-level (Tactical Exploitation Battalion) will be withdrawn and not replaced. The TRQ-32A(V)2 is fielded with the Heavy-HMMWV as prime mover, a Digital Temporary Storage Recorder, a Global Positioning System self-location capability, extended frequency range for DF operations, and significantly improved interfaces to conduct DF operations. The AN/PRD-12 is fielded as a component of the TEAMMATE, providing the HF DF capability. When it is deployed separately from TEAMMATE, the PRD-12 provides intercept and DF from 0.5 to 500 MHz. As well as the interfaces described in paragraph 3.a. above, the TRQ-32A(V)2 passes intelligence by digital data links to TCAC and ASAS processors. TEAMMATE is one of the systems to be replaced by intelligence and electronic warfare (IEW) GBCS. TEAMMATE will remain in the force in active units not receiving IEW GBCS and at reserve Training Centers-Intelligence (RTC-1).

3. *AN/TSQ-152 (TRACKWOLF)* (USA) (PE Number 0208026A). Procurement of an improved TRACKWOLF capability was started in FY94. This system, Enhanced TRACKWOLF, will provide the Commander, 3rd US Army with an organic capability to deploy rapidly, in either man-packed or C-130 transportable vehicle configurations, into hostile theaters of operation and immediately begin to intercept, locate, and exploit opposing force high frequency voice communications. The system provides exploitation of conventional and modern low probability of intercept modulations, and when placed in-theater early in the troop transportation flow, it can provide hostile emitter location, opposing force intent, and critical order of battle data throughout the Commander's entire area of interest prior to the initiation of combat, a vital combat power multiplier.

4. *AN/TSQ-138 (TRAILBLAZER)* (USA) (PE Number 0305885G/ 020802A). TRAILBLAZER is one of the systems to be replaced by the Intelligence and Electronic Warfare (IEW) GBCS. TRAILBLAZER will remain in the force in active units not receiving IEW Ground-Based Common Sensor and at Reserve Training Centers-Intelligence (TRC-1).

*6.6 RF PROXIMITY FUZE JAMMER - Key Technologies Roadmap:* (figure 6-4)

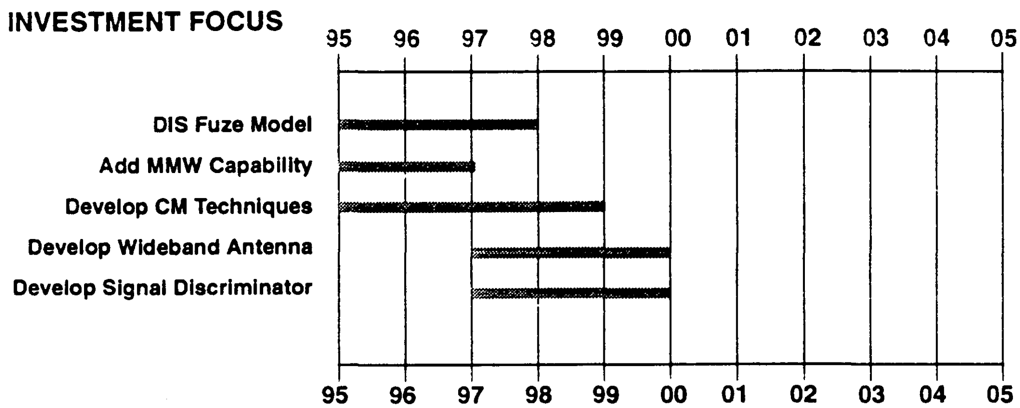



**Figure 6-4. Key Technologies Roadmap RF Proximity Fuze Jammer**

## *6.7 MULTIDISCIPLINED, MULTIFUNCTIONAL PLATFORMS AND SYSTEMS:*

### *A. System Description:*

1. *EH-60A Advanced QUICKFIX (AQF)* (USA) (PE Number 64270-DL12):

*a.* The IEW Advanced QUICKFIX (AQF) program is an evolutionary development which satisfies the Operational Requirements Document (ORD) to conduct airborne ES, EA, EP, targeting, and SIGINT of threat emitters (communications and noncommunications), both conventional and modern spread spectrum in a single multidisciplined platform. AQF is 100 percent interoperable with Army Division Ground Based Common Sensor Heavy and Light (GBCS-H/L) resources and the USMC Mobile Electronic Warfare Support System (MEWSS) for combined operations. AQF replaces the existing QUICKFIX.

*b.* The IEW AQF development strategy calls for the phased development of common replacement modules to upgrade the IEW AQF capabilities as technology advances. The implementation of system enhancements will be carefully synchronized in order to take optimum advantage of technology breakthroughs while minimizing risk. Initial subsystems include TACJAM-A for ES and EA of communications emitters, complemented by the Communications High Accuracy Location System Exploitable (CHALS-X) subsystem for EP and targeting. The noncommunications ES, EP, SIGINT, and targeting is provided by Common Modular ELINT System (CMES). The resulting AQF platform results in an airborne self-contained fully integrated SIGINT, EW, and targeting platform with on-the-move capabilities.

*c.* Basis of issue for the Advanced QUICKFIX is four per division and four per ACR.

2. *Airborne Reconnaissance Low (ARL)* (USA) (PE Number 0305150A):

*a.* A total of three interim systems were fielded to US SOUTHCOM under an Urgent Statement of Need (SON) in support of counter-narcotics operations. Worldwide deployment potential transferred the system to the Army TIARA account in FY94. The three systems fielded are single function systems; two COMINT (ARL-C) and one IMINT (ARL-I) aircraft. System acquisition strategy calls for the deployment of 6 additional Multifunctional aircraft (ARL-M) as well as the retrofit of the single function aircraft to ARL-M status.

*b.* The ARL maintains a suite of Aircraft Survivability Equipment (ASE). Measures include the AN/APR-39 radar detector, AN/AAR-47 Missile Detector, and the AN/M-130 Chaff/ Flare Dispenser, over the top engine exhaust diffusers, and armor floor plating.

*c.* Current fielding schedule to continue development of the ARL-M is two in FY96 one in FY97. Procurement for the 7th through 9th aircraft, as well as the retrofit of the interim, single-function systems are currently unfunded.

*3.* ***Common Modular ELINT System (CMES)*** (USA) (PE Number 64270-DL12):

*a.* The IEW CMES program is an Army NDI integration effort which results in ES, EP, SIGINT, and weapons grade targeting capabilities against conventional and modern spread spectrum noncommunications emitters. CMES provides frequency coverage of the UHF, SHF, and EHF (including MMW) bands. CMES uses enhanced Time Difference of Arrival (TDOA) techniques to provide the user with real-time information and target quality locations. The CMES is currently a 6U Versa Module Eurocard (VME) configuration suitable for tracked, wheeled, airborne (fixed and rotary), and land- and sea-based applications. Product improvements include manpack and UAV applications jointly by the Army, Marines and Navy.

*b.* The CMES subsystem is not fielded as a stand-alone system. CMES currently provides ES, EP, SIGINT, and targeting as a component of the Army's GBCS H/L, AQF and the Marine's MEWSS. The CMES is being considered for ES, SIGINT, and targeting in UAV applications jointly by the Army, Marines, and Navy.

*4.* ***Communications High Accuracy Location System Exploitable (CHALS-X)*** (USA) (PE Number 64270-DL12):

*a.* The CHALS-X program is an Army development effort that provides ES, EP, and weapons grade targeting capabilities against conventional and modern frequency hopping communications emitters. CHALS-X operates in the HF/VHF/UHF/SHF frequency bands. CHALS-X uses enhanced Time Difference of Arrival and Difference Doppler (TDOA/DD) techniques to provide the user with real-time target quality locations. The CHALS-X is currently a single- or dual-channel, 6U VME configuration suitable for tracked, wheeled, airborne (fixed and rotary), and land- and sea-based applications. Product improvements include manpack and UAV applications.

*b.* The CHALS-X subsystem is not fielded as a stand-alone system. CHALS-X currently provides ES, EP, and targeting as a component of the Army's GBCS H/L, AQF, GRCS and Marine's MEWSS. The CHALS-X is being considered for ES and targeting in UAV applications.

*5.* ***Intelligence and Electronic Warfare Ground Based Common Sensor (GBCS)*** (USA) (PE Number 0604270):

*a.* The IEW GBCS program is an evolutionary development which satisfies the Required Operational Capability (ROC), dated October 1990, to conduct ground ES, EA, EP, SIGINT, and targeting of threat emitters (communications and noncommunications) in a single, multifunctional platform. GBCS is 100 percent interoperable with AQF and the Marine's MEWSS.

*b.* The IEW GBCS development strategy calls for the phased development of common replacement modules to upgrade the IEW GBCS capabilities as technology advances. The implementation of system enhancements will be carefully synchronized in order to take optimum advantage of technology breakthroughs while minimizing risk. Initial subsystems include TACJAM-A for ES and EA of communications emitters, complemented by CHALS-X subsystem for EP and targeting. The noncommunications ES, EP, SIGINT, and targeting is provided by CMES. The resulting GBCS platform is a self-contained, fully integrated SIGINT, EW, and targeting platform with on-the-move capabilities.

*c.* GBCS leverages technology that results in the elimination of five unique systems from the battlefield. Modular commonality will result in a decreased number of unique hardware components and systems with military intelligence (MI) units, reducing both logistics and maintenance support requirements. IEW GBCS will simplify IEW logistics support and increase mission tasking and response to the tactical aerial sensors. This development and production will be done by the integration of mature technology into common sensors and carriers. The fielding of IEW GBCS to units will reduce the overall number of vehicles and personnel required, further reducing unit maintenance and logistics requirements. With regard to both the system and carrier, there will be a decrease in prescribed load lists, repair parts, and on-hand stock maintained by unit communications electronics and motor maintenance sections.

*d.* The basis of issue is four GBCS-Light (GBCS-L) per air assault, airborne, light division, and light ACR; and six GBCS-Heavy (GBCS-H) per armored and mechanized infantry division and four GBCS-H in the heavy ACRs.

*6.* ***TACJAM-A*** (USA) (PE Number 64270A/DL12):

*a.* TACJAM-A is an Army development effort that provides ES, EA, and COMINT technological enhancements to currently fielded and future EW, intelligence, and weapons-associated systems. TACJAM-A provides coverage in the HF/VHF/UHF frequency range including capabilities of detection, identification, tracking, location, denial, disruption, and suppression of conventional and modern spread spectrum signals. New features include frequency hopping and burst signal jamming, enhanced signal recognition/classification, and sync jamming of data signals. Methods of EA include noise, deceptive, smart and brilliant. The TACJAM-A program is currently under engineering and manufacturing development with initial limited production in-progress and will produce modular building blocks that can be structured to meet Army, Marine and certain Naval current and future Intelligence and EW mission needs while reducing life-cycle costs. The modules are configurable and adaptable to a variety of platforms and applications where ES, EA, and intelligence capabilities are required. In addition, the current approach will accommodate technology insertion to respond to projected threat requirements. The TACJAM-A program is directed against currently known and emerging threat signal modulations.

*b.* TACJAM-A is not fielded as a stand-alone system. The TACJAM-A subsystem is currently used for combined ES/EA and intelligence missions as a component of the Army's GBCS H/L, AQF, ARL, and the Marine's MEWSS. TACJAM-A is being used in Naval submarine applications for the IEM/ASTECS. A joint interest MNS has been signed with the Navy for the development of the ES/EA capability onboard SH-60 (SEAHAWK) helicopters. Additionally, the Navy is reviewing use of the TACJAM-A for ES purposes aboard surface vessels.

*7.* ***Intelligence and Electronic Warfare Common Sensor (IEWCS)*** (1995-2015) (unfunded). The IEWCS program will provide the US Army tactical commander with a modern set of subsystems. The IEWCS will integrate both communications (radio band) and noncommunications (radar band) detection, collection, precision location, simultaneous EA "smart jamming" and exploitation of enemy communications. The concept is designed to satisfy the situation development, target acquisition, and communications EA requirements of the supported commander.

*a* The IEWCS is a modular set of sensor subsystems scalable and adaptable for integration into wheeled and tracked group-based platforms as well as fixed-wing and rotary-wing aircraft. The system can be interoperable with, and provide input for cross-cueing of, other division and corps IEW assets; for example, GRCS, ARL, AN/PRD-12.

*(1)* The integration of technologically advanced electronic warfare support (ES) permits the employment of extremely rapid detection and collection of both fixed frequency and modern modulation low probability of intercept (LPI) and low probability of detection (LPD) communications and noncommunications.

*(2)* The technologically advanced EA subsystem permits the employment of extremely short duration, "smart jamming" of digital communications which enhances the likelihood of successfully interrupting enemy communications, significantly reduces fratricide of friendly communications, and increases the survivability of the jamming system.

*(3)* The technologically advanced precision location subsystem provides targetable accuracies of high value and high payoff by using ground systems (GBCS) interoperating with at least one aerial/moving platform and time difference of arrival (TDOA) and differential doppler (DD) techniques, or by surrounding the area of interest with GBCS systems using only TDOA techniques.

***b.*** IEWCS is built for change. Rather than using the traditional "new system start" approach, IEWCS uses the "digitization holster" approach. Characteristics of this approach are open architecture and modular design, industry standards (6U VME), nonproprietary, and evolutionary growth/expansion. Advantages are continued leverage of electronics miniaturization, capability stays leading edge, and focuses new development investment. Future changes are already being worked on in Army laboratories with funding provided by the Defense Cryptologic Program.

# Chapter 7

# CONSOLIDATED PROGRESS REPORT ON THE TEST AND EVALUATION PROCESS FOR EW SYSTEMS

*7.1 **BACKGROUND**.* In response to Congressional direction, OSD convened a Task Force comprised of representatives of OSD, JS, and the Services to develop a structured T&E Process for EW acquisition programs. This task force developed and published ***DOD Test and Evaluation Process for Electronic Warfare Systems - A Description***. On 14 June 1994, the Director, Operational Test and Evaluation, and the Director, Test and Evaluation, jointly promulgated the Description and distributed it to the Secretaries of the Military Departments, the Chairman of the Joint Chiefs of Staff, and the Directors of Defense Agencies. The ***DOD T&E Process for EW Systems - A Description*** also contains the procedure for measuring in-Service progress toward implementation of the electronic warfare (EW) test and evaluation (T&E) process. An abbreviated version of this process is shown in figure 7-1. A more detailed explanation is contained in the ***FY95 DOD EW Plan***.

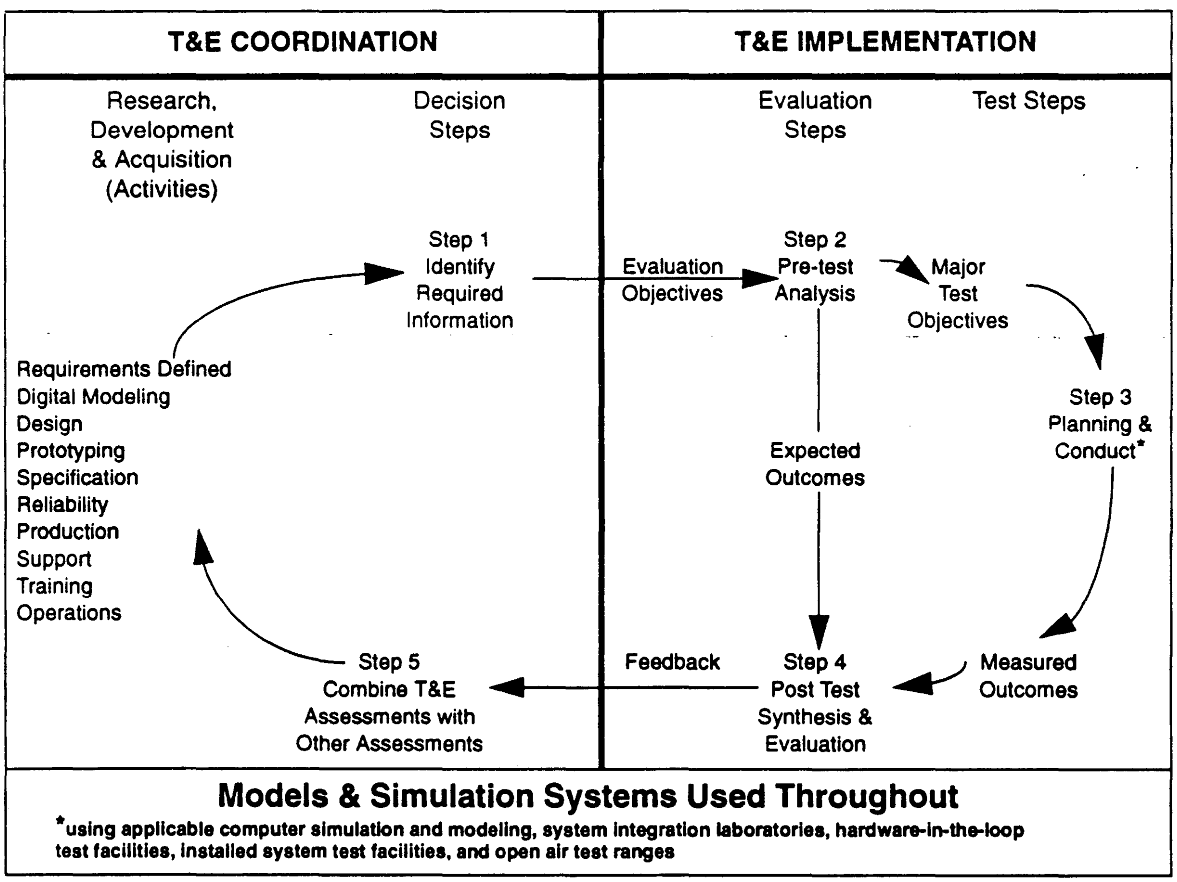



**Figure 7-1. DOD Test and Evaluation Process**

*7.2 PROCESS IMPLEMENTATION.* In compliance with *Public Law 102-160,* 30 November 1993, this chapter reports on progress toward implementing the ***DOD T&E Process for EW Systems***. This report contains progress information on a total of 15 EW programs that were identified in a DOD Memorandum entitled "*Designation of Programs for OSD Test and Evaluation (T&E) Oversight,*" dated 2 September 1994, to use the process and report.

*7.3 STATUS.* The current status of implementation of the EW T&E process for those designated programs is discussed below. The status descriptions contain information such as current milestone, acquisition phase, present step in the EW T&E process, and other information pertinent to the test and evaluation strategy/plan.

*A.* ***AN/APR-39A(XE-2)*** - A joint program with Army lead. It is a milestone II, phase II program at step three in the process. Report reflects Navy/USMC implementation efforts. Software verification TECHEVAL successfully completed. OPEVAL (final operational T&E) started early FY95.

*B.* ***SIIRCM (ATIRCM and ADV IRCM Munition)/Common Missile Warning System (CMWS)*** (formerly MAWS) - A joint program with Army as the lead. SIIRCM is presently at milestone II, phase II, and step three of the EW T&E Process. The CMWS portion is presently at milestone I, phase I and step two in the EW T&E process. The program combines the SIIRCM and CMWS program that consist of an IR countermeasure, and IR countermeasure munition, and a CMWS.

*C.* ***SIRFC/ATRJ*** - An Army program presently at milestone II, phase II and step one of the EW T&E process. EMD T&E will consist of: (1) bench testing, (2) pole testing, (3) avionics integration lab, (4) initial flight checkout (electromagnetic compatibility and airworthiness), (5) anechonic chamber (antenna isolation measurement, antenna patterns, angle of arrival, threat detection, response time), and (6) flight testing.

*D.* ***AIEWS*** - A milestone 0, phase 0 Navy program presently at step one of the EW T&E process.

*E.* ***AN/ALR-67(V)*** - A Navy program at milestone II, phase II, and step three of the EW T&E process. System is presently in TECHEVAL having completed software qualification testing, system performance testing at contractor, system integration testing in lab, initial flight testing (combined DT/OT), and an early operational assessment.

*F.* ***AN/ALQ-165/ASPJ*** - A Service-terminated post-milestone II, phase III Navy program. Existing units will undergo integration testing with the F-14D as part of the overall F-14D survivability testing.

*G.* ***EA-6B*** (all upgrades) - A post milestone III, phase III Navy program for which the advanced capability was terminated. The program remains on OSD T&E oversight, and a new T&E strategy is being developed to reflect the upgrade program.

*H.* ***IDECM*** - A Navy milestone I, phase I program presently at step two of the process.

*I.* ***F-15E includes TWES (ALQ-135 and ALR-56C)*** - An Air Force milestone II, phase II program at step four of the EW T&E process. The phase II, step three DT&E and OT&E efficiently used a variety of test facilities.

*J.* ***EF-111 (SIP)*** - An Air Force milestone II, phase II program at step three of the process. SIP is a complex program consisting of five separate projects. The program has been canceled, but a draft TEMP is in coordination to complete FY95 commitments.

*K.* ***AN/ALQ-131, AN/ALQ-161, AN/ALR-56M, AN/ALR-62I, and AN/ALR-69*** (all versions) - these remaining Air Force programs are all mature post-milestone III, phase III programs that will conduct FOT&E as required.

*7.4* ***ANNUAL REPORT***. In compliance with *Public Law 103-160*, 30 November 1993, OSD must report to Congress on progress toward using the DOD T&E Process for EW systems. For EW acquisition programs under OSD T&E oversight, the Services shall provide input to OSD by completing this report at the end of each fiscal year. Reports should be submitted through the respective Service Acquisition Executive to OUSD (A&T)/DTSE&E to arrive not later than 15 November. Reports contain the following elements:

*A.* Program name, date of report, and reporting period.

*B.* The EW T&E process applied with respect to current milestone, phase, and T&E process steps in progress. For Step 3 of the process, emphasize the test events conducted.

*C.* The overall results of that EW T&E process application toward test methodology, test results, major issues, and potential delays.

*D.* Adequacy of T&E resources.

*E.* Feedback with suggestions for improving the EW T&E process.

*7.5* ***PROGRESS***:

*A.* The DOD EW T&E Process has been implemented by the ***DOD Test and Evaluation Process for Electronic Warfare Systems - A Description***, promulgated on 13 June 1994.

*B.* EW programs to use the EW T&E process have been identified in a DOD Memorandum entitled "*Designation of Programs for OSD Test and Evaluation (T&E) Oversight*," dated 2 September 1994.

*C.* A report format has been developed and distributed for implementation.

# Appendix A

# INDEX


**-A-**

AAA systems 2-8
AAR-44 5-4
AAR-47 4-3, 4-5, 5-5
Active RF Decoys 3-12
ADHPMs 2-11
ADS 5-5
ADV IRCM Munition 7-2
Advance Integrated Electronic Warfare System ES-5
Advanced Airborne Deception 3-12
Advanced Antiradiation Missile Guidance Demonstration (AAGD) 3-26
Advanced Capability Munitions (ACMs) 2-11
Advanced ELINT Receiver 3-31
Advanced Integrated Electronic Warfare System (AIEWS) 7-2
Advanced Integration Aircraft Survivability Equipment ES-6
Advanced Laser IRCM 3-16
Advanced Missile Warning (AMWS) 4-6
Advanced Missile Warning System (AMWS) 4-6
Advanced Multimode Active EA 3-12
Advanced Receiver/Processor Technology 3-10
Advanced Research Projects Agency (ARPA) 3-10
Advanced Strategic and Tactical Expendables (ASTE) 3-14
Advanced Submarine Tactical ESM Combat System (ASTECS) 4-7
advanced technology 1-1
Advanced Threat Infrared Countermeasure (ATIRCM) 5-4
Advanced Threat IR CM system 4-5
Advanced Threat IR Countermeasures ES-6
Advanced Threat Missile Detector (ATMD) 4-6
Advanced Threat Radar Jammer (ATRJ) ES-6, 3-12, 3-21, 5-6
Advanced Threat Radar Warning Receiver (ATRWR) 4-3
Advanced Top Attack Countermeasures 3-12
AH-64D Long Bow Apache 4-4
air defense system 2-4
Air IRCM/Decoy Integration 3-15
Airborne ARM Targeting Systems 6-3
Airborne EA 2-12
Airborne HRR/ISAR CM 3-12
Airborne Integrated Defensive Systems 5-2
Airborne Intercept Radars 2-6
Airborne Reconnaissance Low (ARL) 6-5
Airborne Self-Protection Jammer ES-5
Airborne Self-Protection Jammer (ASPJ) ES-5
Airborne Tactical EW Systems 6-1
Aircraft Survivability Equipment (ASE) 6-5
Airlift Defensive Systems (ADS) 5-5
ALE-40 5-4, 5-5
ALE-47 5-4, 5-5
all-digital receiver 3-10
ALQ-131 7-3
ALQ-135 7-2
ALQ-161 7-3
ALQ-161A 5-2
ALQ-165/ASPJ 7-2
ALR-56C 7-2
ALR-56C/M RAD 4-1
ALR-56M 7-3
ALR-62I 7-3
ALR-66(V)5 4-4
ALR-67(V) 7-2
ALR-67(V)3 4-1
ALR-69 7-3
ALR-69 Upgrade 4-1
ALR-77 4-4
AN/AAR-44 5-4
AN/BLD-1 4-7
AN/BRD-7 4-7
AN/MSC-63 Special Security Communications Central (SSCC) 6-3
AN/MSC-63A 6-4

AN/MSC-63A SSCC 6-3
AN/TSQ-138 (TRAILBLAZER) 6-4
AN/TSQ-152 (TRACKWOLF) 6-4
AN/WLQ-4(V)1 4-7
Annular Beam Amplifier 3-27
Antiradiation Missile Counter-Countermeasures (ARM-CCM) 3-21
Antiship Missile Countermeasures Simulation 3-25
APR-39(V)1 4-3
APR-39A(V)1 4-3
APR-39A(V)2 4-3
APR-39A(XE-2) 4-3, 7-2
APR-46 5-4
APR-48 4-4
APR-48 Radar Frequency Interferometer 4-4
ARL-C 6-5
ARL-I 6-5
ARL-M 6-5
ARM 2-11
ARM Countermeasures 3-13
Army air defense and missile defense 3-22
Army aviation systems 3-22
Army communications and electronic equipment 3-22
Army fire support weapons 3-23
Army ground combat systems 3-23
Army High Frequency Electronic Warfare System (AHFEWS) 6-3
ARPA 3-16
ARPA/Tri-Service Laser 3-16
artificial intelligence 1-2
ASTE ES-6
ASTECS 4-7
ATGM 2-10
ATGMs 2-10
ATIRCM 3-14, 3-15, 7-2
AVR-2 4-3

-B-

B-1 Conventional Mission Upgrade (CMUP) 5-3
B-1 Defensive System Improvements 5-2
B-52 ALQ-172 High-Altitude Cover 5-3
Ballistic Missile Defense Organization 3-27
Barrage Emission Decoy 3-17
Base Force 1-2, 1-3
Basic Research Panel 3-2
BLA-4 4-7
BRD-6/7 4-7
BRD-7 4-7
Broadband Active Aperture Technology Insertion 3-23
Bulk Optically controlled Semiconductor Switch 3-28

-C-

C2 Warfare (C2W) 3-20
C3 Systems 2-3
C3 systems 2-3
ceramic antennas 3-7
Channelizer/Encoder for RIVET JOINT Receiver 3-30
CNI Countermeasures 3-19
Command and Control Warfare (MOP 30) ES-3
Common Ground Station (CGS) 3-18, 3-19
Common Missile Warning System (CMWS) 4-5, 4-6, 7-2
Common Modular ELINT System (CMES) 6-5
Commonality 1-3
Communications EA Systems 6-3
Communications High Accuracy Location System Exploitable (CHALS-X) 6-5
Communications Jamming 3-19
compact laser sources 3-29
Compact Lasers 3-16
Component Technology 3-20
Counter-WARM 3-26

-D-

data fusion 1-2, 3-18, 3-19
DD/TDOA Deconvolution Algorithm Study 3-30
Defense Acquisition Board 1-5
Defense Intelligence Agency ES-3
Defense Planning Guidance 1-1, 1-2, 1-5
Deputy Secretary of Defense 3-1

DESERT STORM ES-3, 1-3, 2-2, 2-4, 2-8, 3-3
Detection In Clutter Enhancements (DICE) 3-11
Digital Beamforming Network 3-30
Digital Microscan 3-31
Digital Receiver 3-7
DIRCM 3-17
directed energy weapons 1-2, 2-13
Directed Infrared Countermeasures Systems (DIRCM) 3-17
DOD Directive 5000.1 1-3
DOD Instructions 5000.2 1-3
DOD T&E Process for EW Systems 7-2
DOD Test and Evaluation Process for Electronic Warfare Systems - A Description 7-1, 7-3

-E-

EA-6B 7-2
EA-6B Advanced Capability ES-6
EA-6B Investment Strategy 6-1
EA-6B/EA-6B ICAP II Improvements 6-1
Early Warning Systems 2-4
EC-130H Compass Call ES-6
EF-111 (SIP) 7-3
EF-111A Raven System Improvement Program (SIP) 6-1
EH-60A Advanced QUICKFIX (AQF) 6-4
Electronic Combat Simulation Research Laboratory 3-24
Electronic Warfare Advanced Technology (EWAT) 3-26
Electronic Warfare Avionics Integrated Systems Facility ES-7, 5-3
electronic warfare preprocessing equipment 4-1
electronic warfare vulnerability assessment 1-4
electronically steerable, high-gain, broadband apertures 3-7
ELINT/MMIC RF Receiver 3-31
Emerging Technology Systems 3-22
Enhanced Survivability for Ground Vehicles 3-17
EO Countermeasures 3-17
EO Decoys 3-18
EP ES-5
ES systems 2-12
ESM Algorithm Conversion 3-32
EW Employment ES-5
EW Performance Assessment 3-24
EW Simulation 3-24

-F-

F-15E ALQ-135 Band 1.5 Jammer 5-2
Fiber Optically Coupled Laser Warning System (FOLWS) 3-11
fiber optics 2-3
Fixed-Wing Tactical Defensive Jammers 5-1
Fully-Integrated Architectures 1-3
Functional Recognition 3-26
Fusion Demonstrations 3-19
Future Years Defense Program 1-5

-G-

Gas-switched sources 3-28
GBCS-Heavy (GBCS-H) 6-6
GBCS-Light (GBCS-L) 6-6
General-Purpose Threat Response 1-3
Generic Response 3-26
ground control intercept 2-4
Ground Tactical SIGINT Systems 6-3
Guided Bombs 2-11
gyrotron backward wave oscillator 3-27

-H-

HAMMERLOCK 3-13
Helicopter Defensive Jammers 5-6
High Power Semiconductor Laser Technology (HPSLT) 3-30
High Speed Antiradiation Missile (HARM) ES-6
High-Power Microwave Technology 3-26
HPM Demonstration Program 3-29
HPM Effects/Susceptibility Assessments 3-28
HPM hardening design guide 3-29
HPM Hardening Technology 3-29
HPM Narrowband 3-27

HPM Wideband Component Technology 3-28
Hybrid IFM/Compressive Receiver Architecture 3-31

**-I-**

IEW Data Fusion Techniques 3-18
IIR 2-9, 2-10
Imaging IRCM 3-16
Imaging Seeker CM 3-15
Imaging Seeker Expendable 3-15
Imaging Sensor Countermeasures 3-16
Information Processing and Display 3-31
integrated ARM CM 3-13
Integrated Defensive Avionics Laboratory (IDAL) 3-25
Integrated Defensive Electronic Countermeasures (IDECM) ES-5, 7-2
Integrated EOCM Techniques 3-17
Integrated ESM Mast 4-7
integrated survivability analysis program 3-21
Intelligence and Electronic Warfare Ground Based Common Sensor (GBCS) 6-6
Interactive Survivability Simulation (ISS) 3-24
IR Active Detection 3-11
IR Countermeasures 3-15
IR Decoys 3-14
IR Ship Signature Model 3-25
IR Subsystem Development 3-11
IRST CM Techniques 3-16

**-J-**

Joint Command and Control Warfare Center ES-3
Joint Directors of Laboratories (JDL) 3-1
Joint Directors of Laboratories Technology Panel for Electronic Warfare (JDL-TPEW) 1-2, 3-2, 3-6
Joint Directors of Laboratories, Technical Panel for Electronic Warfare 1-2
Joint Directors of Laboratories, Technology Panel for Directed Energy Weapons (JDL-TPDEW) 3-26, 3-29
Joint Modeling and Simulation System 3-24
Joint Staff ES-3
Joint Technical Coordinating Group for Aircraft Survivability (JTCG/AS) 3-2, 3-14
JTCG/AS 3-13

**-L-**

LADAR 2-5
Laser Coupling 3-15
Laser Detection and Ranging 2-5
Laser Pulse Jamming Techniques 3-15
Laser Source/Laser Protection Technology 3-29
Laser Warning Devices 2-6
Laser Warning Receiver 3-11
LIDAR 2-5
Light Detection and Ranging 2-5
LO Countermeasures 3-12
LO Ship Countermeasures 3-12
Low Cost Geodesic Cone Antenna 3-30
Low-Energy Laser (LEL) 2-13

**-M-**

MAW 4-5
MCD 5-9
MCLOS 2-10
Memorandums of Policy, Electronic Warfare (MOP 6) ES-3
millimeter wave (MMW) receive/jam capability 5-3
Millimeter Wave Countermeasures 3-11
miniature laser warning sensor (LWS) 3-26
Missile Approach Warning (MAW) systems 4-5
Missile CCM Technology 3-23
Missile Countermeasures Device (MCD) 5-9
Missile Signature Model Validation 3-11
Missile Warning Devices 2-6
Mission Support ES-3, ES-5
MMIC Technology 3-7, 3-13
Mobile Electronic Warfare Support System (MEWSS) 6-4
Modularity 1-3

Monopulse CM 3-13
Multipath Techniques project 3-30
Multisensor integration 3-10
Multispectral Countermeasure 3-14
Multispectral Decoys 3-12
Multispectral IRCM Demo 3-17
Multispectral Warning Sensor 3-7

-N-
National Security Agency ES-3
New Signals EW 3-19
Next-Generation ESM Processor Design 3-31
Night Vision Devices 2-5
Noncommunications EA 2-12
Nulka ES-5

-O-
Office of the Secretary of Defense 1-4
Opto-electronics 2-3
ORION ES/EA UAV 3-19
OSD's acquisition strategy 1-1

-P-
particle beam weapons (PBW) 2-13
photoconductive switches 3-28
plasma-filled MILO 3-27

-Q-
Quick Reaction Capability 1-4

-R-
Radar Deception and Jamming (RD&J) 3-21
Radar EA Vulnerability Assessment 3-21
Radio Battalion Equipment Modifications 6-3
Random Agile Deinterleaving 4-1
relativistic klystron amplifier 3-27
Reliance 3-6
RF Decoys 3-12
RF Polarization Effects 3-13
RF Proximity Fuze Jammer 6-4
RF SAMs 2-7
RWR Antenna Technology 3-6, 3-10
RWRs 2-6

-S-
SA-7A/B, SA-14, Redeye, and Stinger 5-5
SACLOS 2-10
Self-Protection ES-3, ES-4
self-protection systems 5-1
Service Acquisition Executive 3-1
Ship Self Defense ES-5
SIGINT/MTI Correlation 3-18
SIIRCM 7-2
SIRFC 5-4
SIRFC/ATRJ 7-2
SLQ-32 ES-5
Small Ship Jammer 3-13
small-caliber close-in weapon systems (CIWS) 2-9
SOF/ADS 5-3
Soldier Survivability Assessments (SSvA) 3-23
solid-state switched sources 3-28
Special Access programs 1-4
special access required/special access project 3-6
Special Operations Forces/Airlift Defensive System (SOF/ADS) 5-3
split cavity oscillator 3-27
Submarine ES systems 4-7
Suite of Integrated RF Countermeasure (SIRFC) 4-3, 5-4
Suite of Integrated RF Countermeasures ES-6
Surface acoustic wave (SAW) channelizer 3-7
Survivability Integration Laboratory (SIL) 3-24
survivability/lethality analysis 3-22
Systems Overview ES-5

-T-
T&E Process for EW 7-1
TACJAM-A 6-6, 6-7
Tactical Aircraft IRCM Demonstration 3-17
Tactical Air-to-Surface Missiles 2-11
Tactical Air-to-Surface Missiles (TASMs) 2-11
Technology Overview ES-4

Technology Panel for Directed Energy Weapons (JDL-TPDEW) 3-2
Technology Reinvestment Program (TRP) 3-10
test and evaluation 1-5
test and evaluation process ES-7
Threat Overview ES-3
Threat Warning ES-3
threat warning systems 4-1
Tri-Service Science and Technology Reliance 3-1
TWES 7-2
two-color flare 3-14

**-U-**
Ultra Wideband Collection System 3-30
ultraviolet (UV) sensor 3-26
Under Secretary of Defense for Acquisition ES-3
Unmanned Aerial Vehicles (UAVs) 2-11, 2-12
Update IV Avionics Program 4-4
UV Concepts Demo 3-14

**-V-**
Very Wideband Compressive Receiver 3-31
VHSIC modular adaptive signal sorter (VMASS) 3-7
VHSIC processor 3-7
VHSIC threat association module (VTAM) 3-7

**-W-**
WLQ-4(V) 4-7
WLQ-4(V)1 4-7
WLR-1G/H 4-7
WLR-1H 4-7
WLR-8 4-7

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AIASE ........................................ Advanced Integrated Aircraft Survivability Equipment (USA)
AICR........................................... advanced intelligence collection and reporting
AIEWS........................................ Advanced Integrated EW System
AIRCMM.................................... Advanced Infrared Countermeasures Munition
ALCM......................................... air-launched cruise missile
ALWS ......................................... Advanced Laser Warning Receiver System
AM ............................................. amplitude modulation
AMC ........................................... Air Mobility Command (USAF)
................................................... Army Materiel Command (USA)
AMD ........................................... audio manipulation device
AMOP......................................... amplitude modulation on pulse
AMWS ........................................ Advanced Missile Warning System
ANS ............................................ air navigation systems
AO.............................................. acousto optical
AOA............................................ angle of arrival
AOCMS ...................................... Airborne Optical Countermeasure System
APC............................................ armored personnel carrier
AQF ............................................ Advanced QUICKFIX
AQL ............................................ Advanced QUICKLOOK
AR............................................... active radar
ARF............................................ antiradar future
ARH............................................ antiradiation homing
ARL ............................................ Army Research Laboratory
ARM ........................................... antiradiation missile
ARPA.......................................... Advanced Research Project Agency
ARWR ........................................ Advanced Radar Warning Receiver
ASAP .......................................... Airborne Shared Aperture Program
ASAS .......................................... All-Source Analysis System
ASCM......................................... antiship cruise missile
ASE............................................. aircraft survivability equipment (USA)
ASIC ........................................... application specific integrated circuit
ASLC .......................................... adaptive sidelobe cancellation
ASM............................................ air-to-surface missile
ASP ............................................. Advanced Sensor Program
ASMD......................................... antiship missile defense
ASN RD&A................................ Assistant Secretary of the Navy for Research, Development, and Acquisition
ASOM......................................... autonomous standoff missile
ASPJ ........................................... airborne self-protection jammer
ASRAAM ................................... Advanced Short-Range Air-to-Air Missile
ASTE .......................................... advanced strategic and tactical expendable
ASTECS ..................................... Advanced Submarine Tactical Electronic Warfare Support Measures Combat System
ASW ........................................... antisubmarine warfare
AT ............................................... antitank
ATC ............................................ air traffic control
ATCCS ....................................... Army Tactical Command and Control System
ATACMS.................................... Army Tactical Missile System
ATD ............................................ advanced technology demonstration
ATEP .......................................... Advanced Tactical ELINT Processor

# Appendix C

## GLOSSARY

-A-

A .......... Army
AAA.......... antiaircraft artillery
AAED-towed.......... advanced airborne expendable decoy-towed
AAFC.......... antiaircraft gun fire control
AAM .......... air-to-air missile
AAMRL.......... Armstrong Aerospace Medical Research Laboratory
AAW .......... air-to-air warfare
AAWS-H .......... Advanced Antitank Weapons System-Heavy
AAWS-M.......... Advanced Antitank Weapon System-Medium
AAWWS.......... Advanced Adverse Weather Weapon System
ACC.......... Air Combat Command
ACD.......... acoustically coupled devices
ACE .......... airborne self-protection jammer countermeasure enhancement
ACLOS .......... automatic command to line-of-sight
ACM .......... Advanced Capability Munition
ACQ.......... acquisition
ACR.......... armored cavalry regiment
ACT .......... acoustic charge transport
AD .......... air defense
.......... artillery delivered (USA)
.......... analog-to-digital
AD/EXJAM.......... Artillery-Delivered Expendable Jammer
ADF .......... automated direction finding
ADM .......... advanced development model
ADS .......... air/airlift defense system
.......... ATGM Defense System
ADVCAP.......... advanced capability (USN)
AEB .......... active electronic buoy
AEC .......... aviation electronic combat
AED .......... Advanced Expendable Dispenser
AEP.......... adaptive event processing
AEW .......... airborne early warning
AEWIC .......... Army Electronic Warfare Intelligence Committee
AEWS.......... Advanced EW System
AF .......... Air Force
AFAS .......... Advanced Field Artillery System
AFB .......... Air Force Base
AFV .......... armored fighting vehicle
AGC.......... automatic gain control
AGI .......... Intelligence Support Vessel (Naval)
AHFEWS.......... Army High-Frequency Electronic Warfare System
AI .......... airborne intercept
.......... artificial intelligence
AIA .......... Air Intelligence Agency

| | |
|---|---|
| | cooperative countermeasures (USN) |
| CCO | Communications Collection Outstation |
| CCP | Consolidated Cryptologic Program |
| | consolidated command post |
| CCT/H-R | Commanders' Tactical Terminal/Hybrid Receive Only |
| CCWS | Common Cryptologic Workstation |
| CDS | Combat Direction System (USN) |
| CE | concept exploration |
| | critical experiment |
| CECM | communications electronic countermeasures |
| CECOM | Communications Electronics Command (USA) |
| CEP | Concept Evaluation Program |
| CFAR | coherent fire control air-to-air radar |
| | constant false alarm rate |
| CFE | Conventional Forces Europe |
| | contractor furnished equipment |
| CFT | Cryptologic Field Trainer |
| CG | guided missile cruiser |
| CGN | nuclear-guided missile cruiser |
| CGS | common ground station |
| CHALS-X | Communications High Accuracy Location System Exploitable |
| CHAALS | Communications High Accuracy Airborne Location System |
| CILOP | conversion in lieu of procurement (USN) |
| CIMGAH | command inertial midcourse guidance with active terminal homing |
| CINC | commander in chief(s) |
| CIS | Commonwealth of Independent States (formerly USSR) |
| CLOS | command to line-of-sight |
| CM | countermeasures |
| CMAS | Countermeasures Assessment Simulator |
| CMDS | countermeasures dispenser system |
| CMES | Command Module ELINT System |
| CMOS | |
| CMJ | cooperative modulated jamming |
| CMS | countermeasures set |
| CMUP | Conventional Mission Upgrade Program |
| CMWS | Common Missile Warning System |
| CNI | communication, navigation, and identification |
| CNR | combat net radio |
| CO2 | carbon dioxide |
| COEA | cost and operational effectiveness analysis |
| COMJAM | communications jammer(ing) |
| COMINT | communications intelligence |
| CP | circular polarization |
| CPBW | charged partical beam weapon |
| CPS | Combat Protection System |
| CPS for ASM | Combat Protection System for Armored Systems Modernization |
| CSC | Conventional Systems Committee |
| CSAR | counter synthetic aperture radar |
| CSSA | Naval Security Group Cryptologic Shore Support Activity |

ATGM ........................................ antitank guided missile
ATIRCM...................................... Advanced Threat Infrared Countermeasures
ATIRJ ........................................ Advanced Threat Infrared Jammer
ATM .......................................... antitactical missile
ATMD ........................................ Advanced Threat Missile Detector System
ATR ........................................... Automatic Target Recognition
ATRJ.......................................... Advanced Threat Radar Jammer
ATRWR..................................... Advanced Threat Radar Warning Receivers
ATTD......................................... Advanced Technology Transition Demonstrator
ATWA ....................................... Advanced Threat Warning Antenna
AUS .......................................... Australia
AVUM....................................... aviation unit maintenance
AWAC....................................... Airborne Warning and Control
AWACS..................................... Airborne Warning and Control System

-B-

B................................................ billion
BARB ........................................ boosted antiradiation bomb
BCIS ......................................... Battlefield Combat Identification Systems
BDP .......................................... Battlefield Development Plan
BFC........................................... battle force combatant
BFV .......................................... Bradley Fighting Vehicle
BFVS ......................................... Bradley Fighting Vehicle System
BG............................................. Battle Group (USN)
BGPHES.................................... Battle Group Passive Horizon Extension System (USN)
BLK .......................................... block (upgrade)
blue WARM .............................. US/Allied wartime reserve modes
BMDO ....................................... Ballistic Missile Defense Organization
Bn.............................................. Battalion
BOSS ......................................... Bulk Optically controlled Semiconductor Switch
BTI............................................ Balanced Technology Initiative
Bty ............................................ Battery
BWO......................................... backward wave oscillator

-C-

C-Nite ....................................... COBRA night/day sight
C2.............................................. command and control
C2W.......................................... command and control warfare
C2I ............................................ command, control, and intelligence
C3.............................................. command, control, and communications
C3CM ........................................ command, control, and communications countermeasures
C3I ............................................ command, control, communications, and intelligence
CAD.......................................... Counter Antiradiation Missile Decoy
CAS .......................................... Collection Antenna System
.................................................. close air support
CAT .......................................... counter-altimeter techniques
CC&D........................................ camouflage, concealment, and deception
CCD.......................................... charge-coupled devices
CCIRP....................................... Countermeasures Communication Integrated Receiver Processor
CCM ......................................... counter-countermeasures

**-E-**

EA .......... electronic attack (formerly ECM)
EAGER ..........
EC .......... electronic combat (USAF)
ECCM .......... electronic counter-countermeasures (now electronic protection)
ECM .......... electronic countermeasures (now electronic attack)
ECP .......... engineering change proposal
ECU .......... Electronic Control Unit
EDM .......... engineering development model
EEPROM .......... electronically erasable programmable read only memory
EFA .......... European Fighter Aircraft
EHF .......... extremely high frequency
EIP .......... external/internal processor
ELINT .......... electronic intelligence
EM .......... electromagnetic
EMD .......... engineering and manufacturing development
EMI .......... electromagnetic interference
EMR .......... Electronic-Combat Multifunction Radar
EO .......... electro-optics
EOB .......... electronic order of battle
EOCM .......... electro-optics countermeasures
EO/IR .......... electro-optic/infrared
EORSAT .......... ELINT ocean reconnaissance satellite (CIS)
EOSAS .......... Electro-Optical Signature Analysis System
EP .......... electronic protection (formerly ECCM)
EPLRS .......... Enhanced Position Locating Reporting System
EPU .......... enhanced performance update (USN)
ERASE .......... Electromagnetic Radiating Source Elimination
ERP .......... effective radiated power
ES .......... electronic warfare support (formerly ESM)
ESA .......... electronic scanned antenna
ESG .......... executive steering group
ESM .......... electronic warfare support measures (now electronic warfare support)
ESS .......... ELINT Support Systems
ETIBS .......... Enhanced Tactical Information Broadcast Service
EUSA .......... European Security Agency
EW .......... electronic warfare
EWAISF .......... Electronic Warfare Avionics Integrated Systems Facilities
EWAT .......... Electronic Warfare Advanced Technology
EWVA .......... Electronic Warfare Vulnerability Assessment (USA)
EWPE .......... electronic warfare preprocessing element
EXJAM .......... expendable jammer

**-F-**

FAADS .......... Forward Area Air Defense System
FAE .......... fuel-air explosive
FAME .......... frequency adding media (laser)

CSWD........................................ CECOM Signal Warfare Directorate
CTF........................................ Cryptologic Field Trainer
CTOL........................................ conventional takeoff and landing
CTT........................................ Commander's Tactical Terminal
CTT/H........................................ Channel Tactical Terminal/Hybrid
CTT/H-R........................................ Commanders Tactical Terminal/Hybrid-Receive Only
CV........................................ aircraft carrier
CVBG........................................ aircraft carrier battle group
CVN........................................ nuclear aircraft carrier
CW........................................ continuous wave

**-D-**

DAB........................................ Defense Acquisition Board
DART........................................ Doppler Ambiguity Resolution Technique
dB........................................ decibel
dBm........................................ decibels relative to 1 milliwatt
DCP........................................ Defense Cryptologic Program (formerly Tactical Cryptologic Program)
DD........................................ destroyer
DDG........................................ guided missile destroyer
DDI........................................ Deceptive ECM and Decoy Integration
DDDRE........................................ Deputy Director Defense Research and Engineering
DE........................................ directed energy
DECM........................................ defensive electronic countermeasures (USN)
DEM/VAL........................................ demonstration/validation
DEW........................................ directed energy weapons
DF........................................ direction finding
DFM........................................ dogfight missile
DHS........................................ Data Handling System
DIA........................................ Defense Intelligence Agency
DICE........................................ detection-in-clutter enhancements
DIME........................................ Dynamic Infrared Missile Evaluator
DIRCM........................................ directed infrared countermeasures
DIS........................................ distributed interactive simulation
DLS........................................ Decoy Launcher System
DMSO........................................ Defense Modeling and Simulation Office
DOA........................................ direction of arrival
DOD........................................ Department of Defense
DODD........................................ Department of Defense Directive
DRFM........................................ digital radio frequency memory
DSCS........................................ Defense Support Cryptologic System
DS........................................ direct support (USN)
DSC........................................ Direct Satellite Communications
DSPS........................................ differential standard positioning service
DT........................................ developmental test(ing)
DTSR........................................ Digital Temporary Storage Recorder
DUER........................................ Digital Ultrahigh frequency Electronic counter-countermeasure Radio
DUEU........................................ Digital Universal Exciter Upgrade
DVO........................................ direct view optics

HOJ .......... home-on-jam
HPC .......... high-power countermeasure
HPM .......... high-power microwave
HPSLT .......... High Power Semiconductor Laser Technology Program
HQ .......... headquarters
HRR .......... high-range resolution
HTS .......... HARM Targeting System
HTSC .......... high temperature super conductor
HULTEC .......... hull-to-emitter correlation
Hz .......... Hertz (cycles per second)

**-I-**

IAC .......... Intelligence Analysis Center (USMC)
IADS .......... Integrated Air Defense System
IASE .......... Integrated Aircraft Survivability Equipment (USA)
ICADS .......... Integrated Cover and Deception System (USN)
ICAP .......... improved capability (USN)
ICNIA .......... Integrated Communications, Navigation, Identification, and Avionics
ICTT .......... Improved Commanders Tactical Terminal
IDAL .......... Integrated Defensive Avionics Laboratory
IDAP .......... Integrated Defensive Avionics Program (USN)
IDAS .......... Interactive Defensive Avionics System
IDECM .......... Integrated Defensive Electronic Countermeasures (USN)
IDL .......... interoperable data link
IEM .......... Integrated Electronics Mast
IEW .......... intelligence and electronic warfare
IEWCS .......... intelligence electronic warfare common sensor
IFF .......... identification, friend or foe
IFM .......... instantaneous frequency measurement
IGRV .......... Improved GUARDRAIL V
IIR .......... imaging infrared
INEWS .......... Integrated EW System
INS .......... internal navigation system
IOC .......... initial operational capability
IOT&E .......... initial operational test and evaluation
IPB .......... Intelligence Preparation of the Battlefield
IPF .......... Integrated Processing Facility
IQ .......... in-phase and quadrature
IR .......... infrared
IRAM .......... infrared absorbing materials
IRCCD .......... infrared charge coupled device
IRCCM .......... infrared counter-countermeasures
IRCM .......... infrared countermeasures
IRFPA .......... infrared focal plane array
IRST .......... infrared search and track
IRTWS .......... infrared threat warning sensor
ISAR .......... inverse synthetic aperture radar
ISDN .......... integrated systems digital network
I&W .......... indications and warnings

FAR .......... false alarm rate
FAS .......... Fast Acquisition System
FC .......... fire control
FFG .......... guided missile frigate
FFT .......... fast Fourier transform
FH .......... frequency hopping
FLIR .......... forward-looking infrared
FLOT .......... forward line of troops
FLTSATCOM .......... Fleet Satellite Communications
FM .......... frequency modulation
FMOP .......... frequency modulation on pulse
FO .......... follow-on
FOC .......... full operational capability
FOCLWS .......... fiber optically coupled laser warning system
FOG .......... fiber-optic-guided
FOMRAAM .......... follow-on medium-range air-to-air missile
FOT&E .......... follow-on test and evaluation
FOV .......... field of view
FREQ .......... frequency
FSK .......... frequency shift keying
FSU .......... former Soviet Union
FTC .......... fast time constant
FTR .......... fighter
FWE .......... Foreign Weapons Exploitation
FY .......... fiscal year
FYDP .......... Future Years Defense Plan

**-G-**

GBCS .......... ground-based common sensor
GBS .......... ground-based sensor
GCI .......... ground-controlled intercept
GEN-X .......... generic expendable
GFC .......... gunnery fire control
GHz .......... gigaHertz (cycles per second)
GPF .......... Ground Processing Facilities
GPS .......... global positioning system
GRCS .......... GUARDRAIL Common Sensor
GRV .......... GUARDRAIL V

**-H-**

HARM .......... High-speed Antiradiation Missile
HDL .......... Harry Diamond Laboratory
HEJ .......... hand emplaceable jammer
HEL .......... high-energy laser
HEML .......... High-Energy Microwave Laboratory
HERTF .......... High-Energy Research and Technology Facility
HF .......... high frequency
HFDF .......... high frequency direction finding
HIL .......... hardware in the loop
HMMWV .......... High Mobility Multipurpose Wheeled Vehicle

| | |
|---|---|
| LHX | Army Light Helicopter Family |
| LID | Laser Infrared Countermeasures Development |
| LIDAR | light detection and ranging |
| LITE | laser IRCM techniques experiments |
| LLLTV | low light level television |
| LLADS | Laser Light Air Defense System |
| LPD | long pulse device |
| LO | low observable |
| LOAL | lock-on-after-launch |
| LOB | line of bearing |
| LOS | line of sight |
| LOSAT | line of sight antitank |
| LOSR | line-of-sight-rate |
| LP | liquid propellant |
| LPH | amphibious assault ship, helicopter |
| LPI | low probability of intercept |
| LPU | Limited Procurement Urgent |
| LRIP | low-rate initial production |
| LRS | Local Receiver Set |
| LSAH | laser semiactive homing |
| LSI | large-scale integration |
| LWIR | long wavelength infrared |
| LWR | laser warning receiver |
| LWS | laser warning sensor |

-M-

| | |
|---|---|
| M | million |
| m | meter |
| MAGTF | Marine Air-Ground Task Force |
| MANPADS | man-portable-SAM systems |
| MAP | measurement and processor |
| MAS | Mission Avionics System (USN) |
| MASS | Modular Adaptive Signal Sorter |
| MATES | Multiband ASCM Defense Tactical EW System |
| MAWR | missile approach warning receiver |
| MCD | missile countermeasures device |
| MCLOS | manual command to line-of-sight |
| MCR | mobile cellular radio |
| MCS | master control station |
| | master control sets |
| MCRDAC | Marine Corps Research, Development, and Acquisition Command |
| MDSEAD | Manned Destructive Suppression of Enemy Air Defenses |
| MEWSS | Mobile Electronic Warfare Support System (USMC) |
| MFN | Mode Forming Network |
| MG | missile guidance |
| MHz | megaHertz |
| MI | military intelligence |
| MIDL | miniaturized interoperable data link |
| MIIDS | Military Intelligence Information Distribution System |

**-J-**

JACG ........................................ Joint Aeronautical Commanders Group
JASORS .................................... Joint Advanced Radio System
JCG-EW .................................... Joint Coordinating Group for Electronic Warfare
JCS ........................................... Joint Chiefs of Staff
JC2WC ...................................... Joint Command and Control Warfare Center
JDL-TPAM ............................... Joint Directors of Laboratories, Technology Panel for Advanced Materials
JDL-TPEW ............................... Joint Directors of Laboratories, Technology Panel for Electronic Warfare
JDL-TPDEW ............................. Joint Directors of Laboratories, Technology Panel for Directed Energy Weapons
JIAWG ...................................... Joint Integrated Avionics Working Group
JLC ........................................... Joint Logistics Commanders
JPDL ......................................... Joint Potential Designation List
JPO ........................................... Joint Program Office
JROC ........................................ Joint Requirements Oversight Council
JS .............................................. Joint Staff
JSS ............................................ jamming subsystem
JSSAP ....................................... Joint Service Small Arms Program
JSTARS ..................................... Joint Surveillance and Target Acquisition Radar System
JTCG/AS .................................. Joint Technical Coordinating Group for Aircraft Survivability
JTIDS ........................................ Joint Tactical Information Distribution System

**-K-**

K ............................................... thousand
kft .............................................. kilofeet
kHz ............................................ kiloHertz
km ............................................. kilometer
kW ............................................ kiloWatt

**-L-**

LADAR ..................................... laser detection and ranging
LAIR ......................................... lamp augmented infrared
LAN .......................................... local area network
LANTIRN ................................. Low-Altitude Navigation Targeting Infrared System for Night
LARC ........................................ laser ranger countermeasure
LAV .......................................... light armored vehicle
LBR .......................................... laser beam rider
LCC .......................................... life cycle cost
LCS .......................................... laser cross section
.................................................... low cost seeker (high-speed ARM)
LEL .......................................... low energy laser
LF ............................................. low frequency
LFM .......................................... linear frequency modulation
LGB .......................................... laser-guided bomb
LHA .......................................... amphibious assault ship, general purpose
LHD .......................................... amphibious assault ship, multipurpose

ns .......... nanosecond
NSA .......... National Security Agency
NSWC .......... Naval Surface Warfare Center
NTDS .......... Naval Technical Data System
NTWS .......... New Threat Warning System
NVIS .......... near-vertical-incidence-skywave

**-O-**

OA .......... optical augmentation
OASYS .......... Obstacle Avoidance System
OPEVAL .......... operational evaluation
OPL .......... optical power limiter
OPO .......... optical parametric oscillator
OR .......... operationally ready
ORD .......... Operational Requirements Document
ORIPS .......... Observable Reduction by Image Processing System
OSD .......... Office of the Secretary of Defense
OT .......... operational test(ing)
OT&E .......... operational test and evaluation
OTH .......... over the horizon
OTH-DC&T .......... over-the-horizon detection, classification, and targeting
OTHR .......... over-the-horizon radar
OTH-T .......... over-the-horizon targeting
OTU .......... operator terminal update

**-P-**

PBW .......... particle beam weapon
PCN .......... Personal Communications Networks
PD .......... pulse Doppler
PDF .......... precision direction finding
PE .......... program element
PEO .......... Program Executive Officer
PGG .......... guided missile gunboat
PGM .......... precision guided munition
PIP .......... product improvement program
PL .......... Phillips Laboratory
PLRS .......... Position Locating Reporting System
PM-AFAS .......... Project Manager for the Advanced Field Artillery System
PM-AEC .......... Project Manager for Aviation Electronic Combat (USA)
PMO .......... Program Management Office
PMS .......... Pedestal Mounted Stinger
PM-SS .......... Program Manager for System Survivability
PM-SW .......... Program Manager for Signals Warfare
POET .......... primed oscillated expendable transponder
POI .......... probability of intercept
POM .......... Program Objective Memorandum
POMCUS .......... pre-positioned stocks (USA)
PPS .......... pulses per second
.......... Precise Positioning Service
PRF .......... pulse repetition frequency

| | |
|---|---|
| MINLAWS | Miniaturized Laser Warning Sensor |
| MISPE | monopulse-information signal processing |
| MLRS | Multiple Launch Rocket System |
| MLRS-TG | Multiple Launch Rocket System-Terminally Guided Warhead |
| mm | millimeter |
| MLV | memory loader verifier (USN) |
| MMIC | monolithic microwave integrated circuit |
| MMPM | millimeter wave power module |
| MMW | millimeter wave |
| MNS | Mission Needs Statement |
| MOD | modification |
| MOFA | multi-option fuze for artillery |
| MOPA | master oscillator-power amplifier |
| MOU | memorandum of understanding |
| MPM | microwave power module |
| MRD | Motorized Rifle Division (CIS) |
| MRDFS | Man-Transportable Radio Direction Finding System |
| MRL | multiple rocket launcher |
| MRR | Multi-Role Radar |
| MS | mission support |
| MSD | multi-Service decoy |
| MSE | mobile subscriber equipment |
| msec | millisecond |
| MSNAP | multichannel steerable null antenna processor |
| MSTDF | Mobile Systems Technical Data Facility |
| MSW | magnetostatic wave |
| MTI | moving target indicator |
| MW | megaWatt |
| | missile warning |
| | microwave |
| MWR | missile warning receiver |
| MWS | missile warning system |

**-N-**

| | |
|---|---|
| NAWC | Naval Air Warfare Center |
| NATO | North Atlantic Treaty Organization |
| Nav | navigation |
| NAVAIR | Naval Air Systems Command |
| NCAA | Nonnuclear Consumables Annual Analysis (USAF) |
| NCCS | Naval Command and Control System |
| NCCOSC | Naval Command, Control and Ocean Surveillance Center |
| NCTR | noncooperative target recognition |
| NDI | nondevelopmental item |
| NF | no foreign dissemination |
| NGDS | Naval Group Defense Simulations |
| nm | nautical mile |
| NNOR | Nonnuclear Ordnance Requirement (USN) |
| NOFORN | Not Releasable to Foreign Nationals |
| NOCONTRACT | Not Releasable to Contractors |
| NRL | Naval Research Laboratory |

SAM ........................................ surface-to-air missile
SAP ........................................ special access project
SAR ........................................ synthetic aperture radar
........................................ Special Access Required
SAS ........................................ Speaker Authentication System
SATCOM ........................................ satellite communications
SATNAV ........................................ satellite navigation
SAW ........................................ surface acoustic wave
SAWS ........................................ Silent Attack Warning System
SCADS ........................................ Shipboard Cover and Deception System
SCCM ........................................ Shipboard Communication Countermeasures
SCI ........................................ Sensitive Compartmented Information
SCN ........................................ ship construction funding
SCO ........................................ split cavity oscillator
SCORE ........................................ SIGINT Classification of Recognized Emitters
SCSS ........................................ Shore-Based Cryptologic Support System
SDIO ........................................ Strategic Defense Initiative Organization
SEAD ........................................ suppression of enemy air defenses
SEI ........................................ specific emitter identification
SEM ........................................ Standard Electronic Modules
SEMA ........................................ Special Electronic Mission Aircraft (USA)
SEMI ........................................ Special Electromagnetic Interface
SHF ........................................ super high frequency
SHPS ........................................ Survival High-Performance Sensor
SI ........................................ Special Intelligence
SIGINT ........................................ signals intelligence
SIL ........................................ Systems Integration Laboratory
SILO ........................................ signal location (USAF)
SIP ........................................ System Improvement Program
SIRFC ........................................ Suite of Integrated RF Countermeasures
SIT ........................................ static induction transistor
SLAM ........................................ standoff land attack missile
SLEWS ........................................ Shipboard Lightweight EW System
SLEP ........................................ Service Life Extension Program
SLS ........................................ sidelobe suppression
SPM ........................................ System Program Manager
S/N ........................................ signal to noise (ratio)
SOC ........................................ special operations command
SOF ........................................ special operations forces
SOJ ........................................ standoff jamming
SOLL ........................................ Special Operations Low Level (USAF)
SP ........................................ self-protect
SPCL ........................................ single pulse chemical laser
SPEW ........................................ Small Payload EW
SPS ........................................ Standard Positioning Service
SRBM ........................................ short-range ballistic missile
SS ........................................ diesel/electric attack submarine
SSB ........................................ ballistic missile submarine
SSBN ........................................ nuclear ballistic missile submarine
SSCC ........................................ Special Security Communications Central

PRI ........................................... pulse repetition interval
PTECS ....................................... Portable Tactical Electronic Combat System
P3I............................................. preplanned product improvement
ps ............................................... picosecond

**-Q-**

QOT&E ..................................... qualification operational test and evaluation
QRC .......................................... quick reaction capability

**-R-**

R&D.......................................... research and development
RAD.......................................... random agile deinterleaving
RAM ......................................... radar absorbent material
.................................................. rolling airframe missile
RAIDS ...................................... Rapid Antiship Missile Defense Integrated Defense System
RAP .......................................... radar absorbing paint
RCS .......................................... radar cross section
RD&J ........................................ radar deception and jamming
RDT&E..................................... research, development, testing, and evaluation
REC .......................................... Radioelectronic Combat (Russian)
RECI ......................................... radar emitter classification/identification
REL........................................... releasable
REWS ....................................... Radioelectronic Warfare Service (Russian)
RF ............................................. radio frequency
RFED ........................................ Radio Frequency Expendable Decoy (USA)
RFI ............................................ Radar Frequency Interferometer (USA)
.................................................. Radio Frequency Interference
RFP ........................................... request for proposal
RGPO......................................... range gate pulloff
RMP.......................................... reprogrammable microprocessing (USA)
RMS.......................................... root mean square
RO............................................. reduced observable
ROE .......................................... rules of engagement
RORSAT .................................. Radar ocean reconnaissance satellite (Russian)
ROK.......................................... Republic of Korea
ROR.......................................... range-only-radar
ROW ......................................... rest-of-the-world
RPG .......................................... receiver processor group
RPV .......................................... remotely piloted vehicle
RSS ........................................... rosette scan seeker
.................................................. radio spectral search
RTD .......................................... receive transmit dead
RTSMP ..................................... real-time symmetric/scalable multiprocessor
RWR ......................................... radar warning receiver

**-S-**

S&T .......................................... science and technology
SACLOS ................................... semiautomatic command to line-of-sight
SADARM ................................. Sense and Destroy Armor
SADI ......................................... Ship Automated Decoy Integration

TJS .......... Tactical Jamming System
TMD .......... Theater Missile Defense
TOA .......... time of arrival
TOW .......... Tube-launched, Optically-tracked, Wire-guided Missile
TPCS .......... Team Portable COMINT System
T/R .......... transmit/receive
TRAP .......... Tactical broadcast service and Related Applications
TRE .......... tactical receive equipment
TRIXS .......... Tactical Reporting Intelligence Exchange System
TRP .......... Technology Review Panel
.......... Technology Reinvestment Program
TST .......... tactical SIGINT technology
TSGM .......... terminally guided submunitions
TTCP .......... The Technical Cooperation Program
TTR .......... target tracking radar
TV .......... television
TVM .......... track via missile
TW .......... threat warning
TWS .......... track-while-scan
.......... threat warning sensor
TWT .......... traveling wave tube

**-U-**

UAV .......... unmanned aerial vehicle
UDM .......... User Data Module (USA)
UE .......... universal exciter
UEU .......... universal exciter upgrade
UFMOP .......... unintentional frequency modulation on pulse
UHF .......... ultrahigh frequency
UHR .......... ultrahigh resolution
UK .......... United Kingdom
UMOP .......... unintentional modulation on pulse
USA .......... United States Army
USAF .......... United States Air Force
USAICS .......... United States Army Intelligence Center and School
USD .......... Under Secretary of Defense
USD(A&T) .......... Under Secretary of Defense for Acquisition and Technology
USMC .......... United States Marine Corps
USN .......... United States Navy
USS .......... United States Ship
UT&E .......... User Test and Evaluation
UV .......... ultraviolet
UVMMAWS .......... Ultraviolet Modular Missile Approach Warning System
UWB .......... ultrawide band

SSCT........................................ Special Security Communications Team
SSDS........................................ Ship's Self-Defense System
SSEE........................................ Ship's Signal Exploitation Equipment
SSES........................................ Ship's Signal Exploitation Space (USN)
SSG........................................ guided-missile submarine
SSGN........................................ nuclear-guided missile submarine
SSIP........................................ Sensor System Improvement Program
SSM........................................ surface-to-surface missile
SSN........................................ nuclear submarine
ST........................................ Surface Terminal (USN)
STADD........................................ ship-towed acoustic deception device
STAFF........................................ smart target activated fire-and-forget
STIG........................................ Space Technology Information Group
STM........................................ service test model
STRAP........................................ Straight-Through-Repeater Antenna Performance (USN)
SV........................................ space vehicles
SWIP........................................ System Weapons Improvement Program
SWO........................................ standing wave oscillator

**-T-**

T3O........................................ Terminal Threat Technique Optimization
TA........................................ target acquisition
TAAM........................................ tactical antiarmor missile
TACAIR........................................ tactical aircraft
TACAN........................................ tactical air navigation
TACINTEL........................................ tactical intelligence
TADIXS-B........................................ Tactical Data Information Exchange Service Broadcast
TAM........................................ Threat Association Module
TAPS........................................ Top Attack Protection System
TAR........................................ target acquisition radar
TASM........................................ tactical air-to-surface missile
TASS........................................ top-attack sensor submunitions
TBM........................................ tactical ballistic missile
TCAC........................................ Technical Control and Analysis Center
TCAE........................................ Technical Control and Analysis Element
TCP........................................ Tactical Cryptologic Program
TD........................................ tank division (CIS)
TDMF........................................ time division multiplexed function
TDOA........................................ time direction of arrival
TEAA........................................ tactical extended area attack
TEAMS........................................ Tactical EA-6B Mission Planning System
TEFE........................................ tactical emitters feature extraction
TELAR........................................ transporter erector launcher and radar vehicle
TEMP........................................ test and evaluation master plan
TENCAP........................................ Tactical Exploitation of National Capabilities
TEP........................................ Tactical ELINT Processor
TERPES........................................ Tactical Electronic Reconnaissance Processing and Evaluation System
TEWD........................................ Tactical Electronic Warfare Division
TEWS........................................ Tactical Electronic Warfare System (F-15)

**-V-**

VAL .......................................... US Army Vulnerability Assessment Laboratory
VDL .......................................... video data link
VHF .......................................... very high frequency
VHSIC ...................................... very high speed integrated circuit
VHSM ...................................... very high speed microprocessor
VIDS ........................................ Vehicle Integrated Defense System
VLSI ......................................... very large scale integration
VMASS .................................... very high speed integrated circuit modular adaptive signal sorte
VME .........................................
VSTOL ..................................... vertical/short takeoff and landing
VTAM ...................................... very high speed integrated circuit threat association module

**-W-**

WAM ........................................ window addressable memory
WARM ..................................... wartime reserve modes
WL ........................................... Wright Laboratory
WN ........................................... Warning: Intelligence Sources and Methods Involved
WNINTEL ................................ Warning: Intelligence Sources and Methods Involved

**-X-**

X-EYE ...................................... cross-eye
X-POL ...................................... cross-polarization

μm ............................................ micrometer
μs ............................................. microsecond