Joint Warfighting Science and Technology Plan

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OFFICE OF THE SECRETARY OF DEFENSE

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The Armed Forces of the United States fight as a joint force. This requires advanced technology and concepts to allow our forces to fight effectively as a joint force, not simply as a combination of air, land and naval forces. It is the responsibility of the defense acquisition community to ensure that our future forces have the combat edge provided by superior technology. Our country has relied upon this combat edge in the past for swift, decisive and low casualty victories. A focused, high quality, aggressive science and technology vision, strategy, plan and program responsive to our customers is essential to maintain this edge.

This inaugural edition of the *Joint Warfighting Science and Technology Plan* highlights our technology investment strategy for developing twelve warfighting capabilities critical to our future joint forces. It takes a horizontal perspective across the technology development and Advanced Concept Technology Demonstration programs of the military services and defense agencies, showing how they contribute to achieving the Chairman of the Joint Chiefs of Staff's *Joint Vision 2010*.

This plan is the joint product of my staff, the Joint Staff, the Military Services and Defense Agencies. It has been briefed to the Joint Requirements Oversight Council. I support it.

Paul G. Kaminski
Under Secretary of Defense
(Acquisition and Technology)

JOINT WARFIGHTING
SCIENCE AND TECHNOLOGY PLAN

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I. INTRODUCTION

Since the Korean War, having the technological advantage has been a cornerstone of our national military strategy. Technologies like radar, jet engines, night vision, Global Positioning System (GPS), smart weapons, and stealth have changed warfare dramatically. Maintaining this technological edge has become even more important as the size of U.S. forces decreases and high technology weapons become readily available on the world market. In this new environment, it is imperative that U.S. forces possess technological superiority to ensure success and minimize casualties across the broad spectrum of engagements. The technological advantage enjoyed by the United States in Operation Desert Storm, and still enjoyed today, is a legacy of decades of wise investments in Science and Technology (S&T). Similarly, our warfighting capabilities 10 to 15 years from now will be substantially determined by today's investment in S&T.

The *Defense S&T Strategy* (Reference 1) with its supporting *Basic Research Plan* (Reference 2), *Defense Technology Area Plan* (Reference 3), and this *Joint Warfighting S&T Plan* present the Defense Department's science and technology vision, strategy, plan, and objectives for the planners, programmers, and performers of defense S&T. Revised annually, these documents are a collaborative product of the Office of the Secretary of Defense (OSD), the Joint Staff, the Military Services, and the Defense Agencies. The strategy and plans are fully responsive to the Chairman of the Joint Chiefs of Staff's *Joint Vision 2010* (Reference 4) and the National Science and Technology Council's (NSTC) *National Security Science and Technology Strategy* (Reference 5) as shown in Figure I.1. These documents and the supporting individual S&T master plans of the Military Services and Defense Agencies guide the annual preparation of the DoD budget and Program Objective Memoranda (POMs). The strategy and plans are made available to the United States Government, defense contractors, and U.S. allies with the goals of better focusing collective efforts on superior joint warfare capabilities and improving interoperability between the United States and its allies.

The *Basic Research Plan* (BRP) presents the DoD objectives and investment strategy for DoD-sponsored research performed by universities, industry, and Service laboratories. In addition to presenting the planned investment in 12 broad research areas, this year's plan highlights six strategic research objectives holding great promise for enabling breakthrough technologies for revolutionary 21st century military capabilities.

The *Defense Technology Area Plan* (DTAP) presents the DoD objectives and investment strategy for 10 technology areas critical to DoD acquisition. It takes a horizontal perspective across Service and Agency efforts, thereby charting the total DoD-wide investment for each technology area.

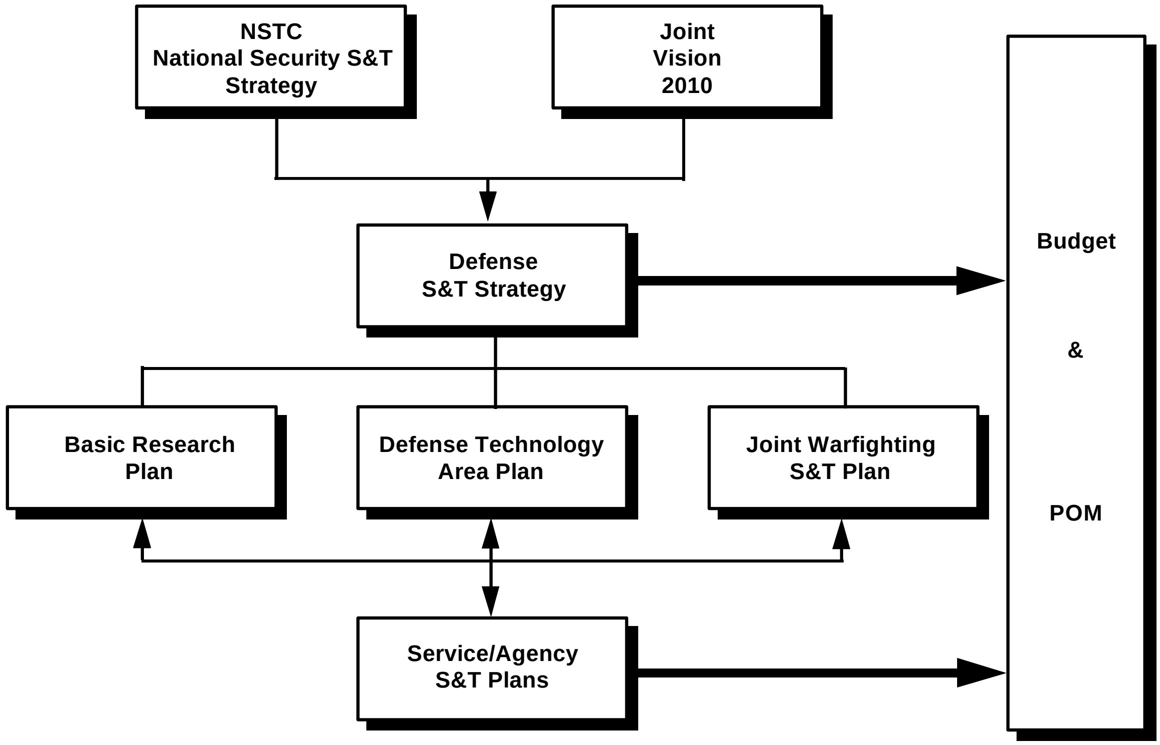

Figure I.1. Science and Technology (S&T) Strategic Planning

This *Joint Warfighting S&T Plan* (JWSTP) also takes a joint perspective, looking horizontally across the Services and Agencies, but for a different purpose. Its objective is to ensure that the S&T program supports priority future joint warfighting capabilities. The Joint Requirements Oversight Council (JROC) has endorsed the JWSTP planning process and methodology and the initial twelve Joint Warfighting Capability Objectives (JWCOs) used in the development of this first JWSTP. The JWCOs are not all inclusive; there are other important joint and Service-unique warfighting capabilities that need strong S&T support; but they provide an important focus for the S&T program.

The JWSTP and DTAP together ensure that the near-, mid-, and far-term needs of the joint warfighter are properly balanced and supported in the S&T planning, programming, budgeting, and assessment activities of DoD. This is the first edition of the *Joint Warfighting S&T Plan*. It will be issued annually as defense guidance. Advanced concepts and technologies identified as enhancing high priority joint warfighting capabilities, along with prerequisite research, will receive funding priority in the President's Budget and accompanying Future Years Defense Plan (FYDP).

Defense Technology Objectives (DTOs) are planning objectives for achieving specific functional and operational capabilities as elements of the JWCOs. Collectively the twelve JWCOs and the supporting DTOs from the *Defense Technology Area Plan* will receive 25 percent of the 6.2 and 6.3 budget in fiscal year 1997 (FY97). Figures I.2 and I.3 show the funding allocation to the DTOs cited in this plan, those cited in the *Defense Technology Area Plan*, and the remainder of the 6.2 and 6.3-funded program. Not every needed technology program is captured in a DTO. If the entire DoD S&T

program were to be defined by DTOs in the *Defense S&T Strategy* and plans, the Services and Agencies would lack the flexibility to seize local opportunities. A balanced, innovative program requires that some flexibility be retained at the Service, Agency, and local laboratory levels.

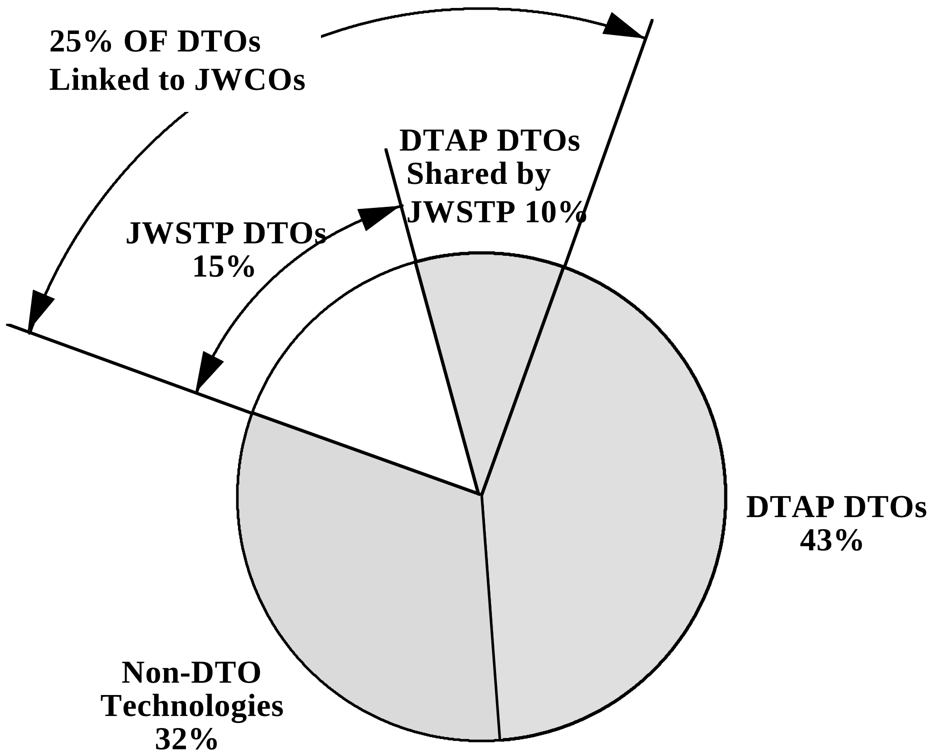

Figure I.2. Joint Warfighting Capability Objectives Funding, Fiscal Year 1997

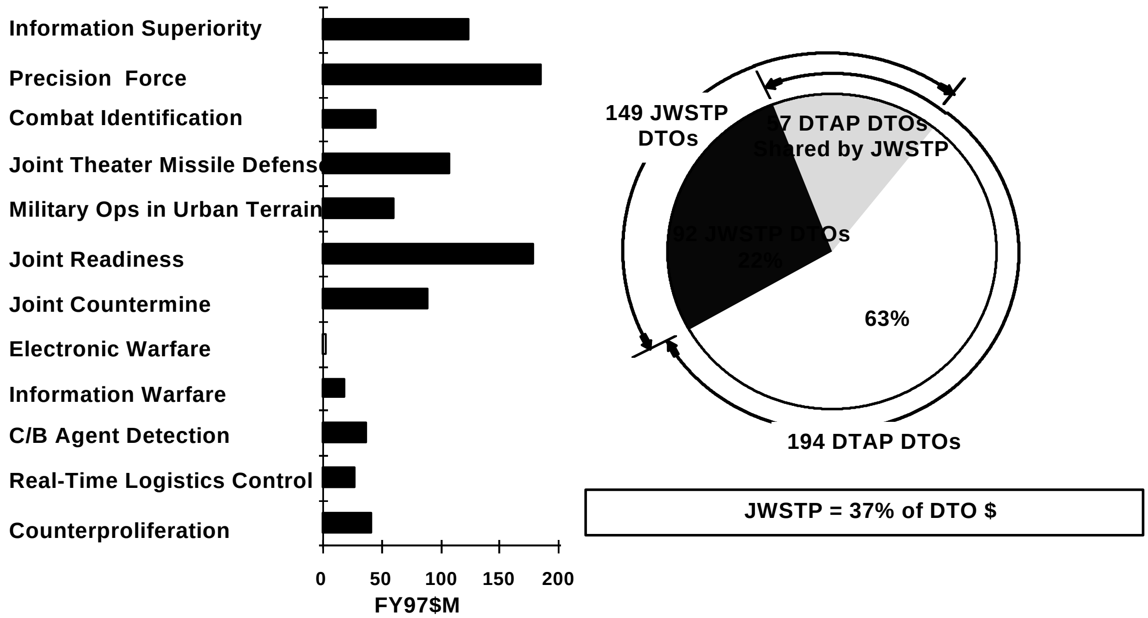

Figure I.3. DTO Share of Defense 6.2 and 6.3 Investment

II. VISION AND STRATEGY

A. JOINT VISION 2010

Joint Vision 2010 is the conceptual template that provides a common direction to help the Military Services develop their unique capabilities within a joint framework of doctrine and programs. This vision of the Chairman of the Joint Chiefs of Staff builds upon the enduring foundation of high quality people and innovative leadership. The traditional concepts of maneuver, strike, protection, and logistics are leveraged with *technological advances* and *information superiority* to produce improvements which are potentially so powerful that they become, in effect, new operational concepts. As shown in Figure II.1, these leveraged concepts emerge as:

- **Dominant Maneuver**: The multi-dimensional application of information and maneuver capabilities to provide coherent operations of air, land, sea, and space forces throughout the breadth, depth, and height of the battlespace to seize the initiative and control the tempo of the operation to a decisive conclusion.
- **Precision Engagement**: The capability to accurately locate the enemy, command and control friendly forces, precisely attack key enemy forces or capabilities, and accurately assess the level of success.
- **Full Dimensional Protection**: The ability to protect our forces at all levels and obtain freedom of action while they deploy, maneuver, and engage an adversary.
- **Focused Logistics**: The capability to respond rapidly to crises, shift warfighting assets between geographic regions, monitor critical resources enroute, and directly deliver tailored logistics at the required level of operations.

These new operational concepts interact to create the powerful, synergistic effect of *full spectrum dominance*, the capability to dominate an adversary across the full range of military operations. *Full spectrum dominance* emerges as a key characteristic of U.S. Armed Forces for the 21st century.

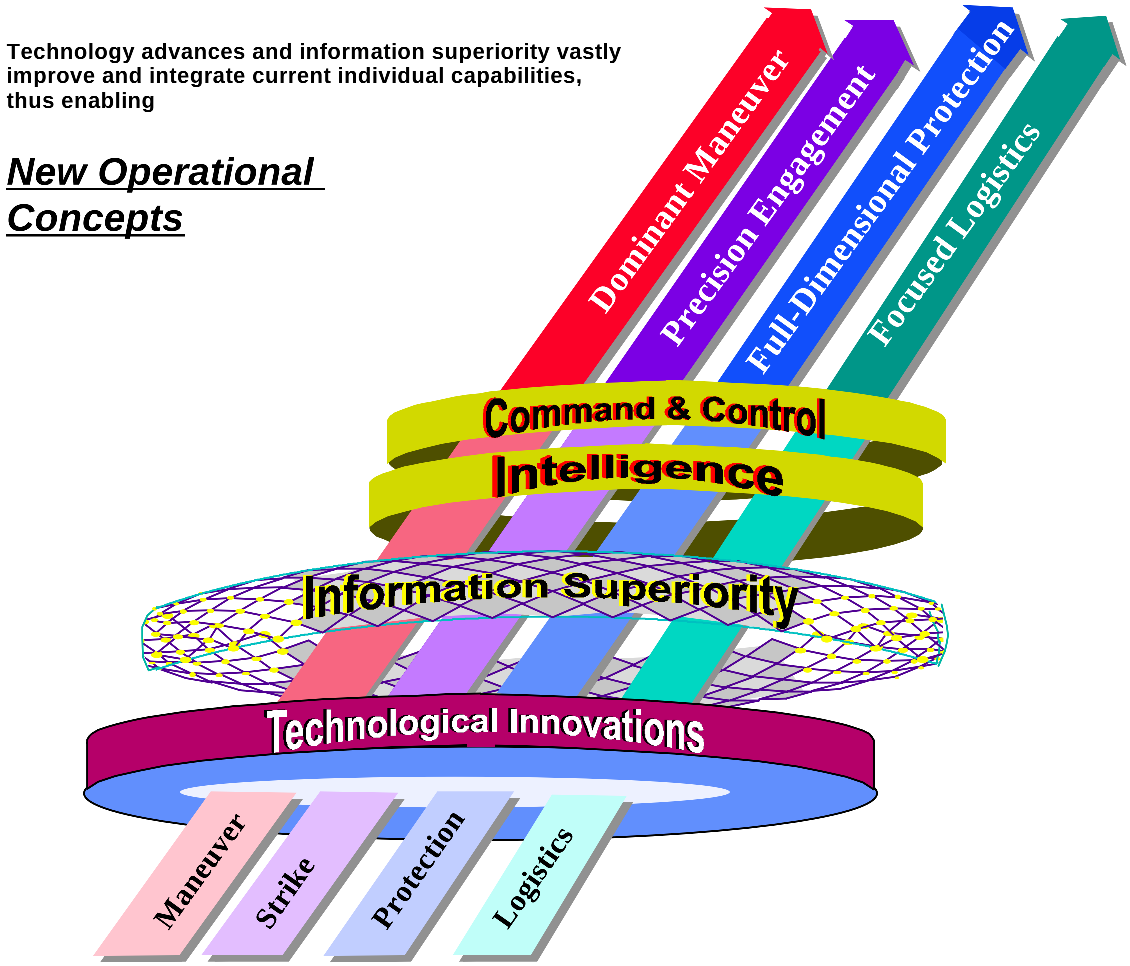

Figure II.1. The Concept of Joint Vision 2010

B. JOINT WARFIGHTING CAPABILITY OBJECTIVE

Achieving *Joint Vision 2010* will, in large measure, depend on the ability to achieve and exploit the twelve joint warfighting capability objectives described below. These twelve objectives, developed by the Joint Staff in collaboration with OSD and the Service science and technology executives, represent some of the most critical capabilities for maintaining the warfighting advantage of U.S. forces. Each is discussed in detail in Chapter IV. The twelve joint warfighting capability objectives defined below support the four leveraged elements of *full spectrum dominance*, as shown in Figure II.2.

Joint Warfighting Capability Objectives \ Joint Vision 2010 Operational Concepts	Dominant Maneuver	Precision Engagement	Full Dimensional Protection	Focused Logistics
A. Information Superiority	●	●	○	○
B. Precision Force	○	●	○	
C. Combat Identification	○	●	●	
D. Joint Theater Missile Defense		●	●	
E. Military Operations in Urban Terrain	●	○	●	
F. Joint Readiness	●	○	○	●
G. Joint Countermine	●		●	
H. Electronic Warfare	●	●	○	
I. Information Warfare	●	○	○	
J. Chemical/Biological Agent Detection	●	○	●	○
K. Real-Time Logistics Control	○			●
L. Counterproliferation		●	●	

● Strong support ○ Moderate support

Figure II.2. Joint Warfighting Support of Joint Vision 2010

- **Information Superiority.** Combines the capabilities of intelligence, surveillance, and reconnaissance (ISR) and command, control, communications, computers, and intelligence (C4I) to acquire and assimilate information needed to dominate and neutralize adversary forces and effectively employ friendly forces. Includes the capability for near-real-time awareness of the location and activity of friendly, adversary, and neutral forces throughout the battlefield area. Also includes a seamless, robust C4 network linking all friendly forces to provide common awareness of the current situation throughout the battlefield area.

- **Precision Force.** Capability to destroy selected targets with precision while limiting collateral damage. Includes precision guided munitions, surveillance, targeting capabilities, and the "sensor-to-shooter" C4I capabilities necessary for responsive, timely force application.
- **Combat Identification.** Capability to differentiate potential targets as friend, foe, or neutral in sufficient time, with high confidence, and at the requisite range to support weapons release and engagement decisions.
- **Joint Theater Missile Defense.** Capability to use the assets of multiple Services and Agencies to detect, track, acquire, and destroy enemy theater ballistic missiles and cruise missiles. Includes the seamless flow of information on missile launches by specialized surveillance capabilities, through tracking by sensors from multiple Services and agencies, to missile negation or destruction.
- **Military Operations in Urban Terrain.** Capability to operate and conduct military operations in built-up areas and to achieve military objectives with minimum casualties and collateral damage. Includes precise weapons, surveillance, navigation, and communications effective in urban areas.
- **Joint Readiness.** Capability to enhance readiness for joint and combined operations, including capabilities for enhanced simulation for training.
- **Joint Countermine.** Capability for assured, rapid surveillance, reconnaissance, detection, and neutralization of mines to enable forced entry by expeditionary forces. Included is the capability to control the sea and to conduct amphibious and ground force operational maneuvers against hostile defensive forces employing sea, littoral, and land mines. For land forces, dominance means the ability to conduct instride tempo operations in the face of severe land mine threats.
- **Electronic Warfare.** Capability to disrupt or degrade an enemy's defenses throughout the area and time required to permit the deployment and employment of U.S. and allied combat systems. Includes capabilities to deceive, disrupt, and destroy the surveillance and command and control systems as well as the weapons of an enemy's integrated air defense network.

Also includes capabilities for recognizing attempts by hostile systems to track or engage.

- **Information Warfare.** Capability to achieve information superiority by affecting adversary information, information-based processes, information systems, and computer-based networks while defending one's own information, information-based processes, information systems, and computer-based networks.
- **Chemical/Biological Agent Detection.** Capability for standoff detection of biological agents is our single most pressing need. Capabilities in both point and standoff detection of chemical and biological agents, combined with the ability to assess and disseminate threat information in a timely manner, are critical to protecting fielded forces.
- **Real-Time Logistics Control.** Capability for near-real-time visibility of people, units, equipment, and supplies which are in storage, in process, in transit, or in theater, and the ability to act on this information.
- **Counterproliferation.** Capability to 1) detect and evaluate the existence of a manufacturing capability for weapons of mass destruction (WMD), and 2) identify and assess the weapon capability of alert and launched WMDs on the battlefield to permit the proper level of counterforce to be exerted promptly. Includes counterforce against hardened WMD storage and production facilities.

C. JOINT WARFIGHTING CAPABILITY ASSESSMENTS

The Joint Warfighting Capabilities Assessment (JWCA) process, supported by the Unified Commanders-in-Chief, Services, and Defense Agencies, identifies opportunities for improving warfighting effectiveness. This continuous process provides insights into issues involving joint warfighting requirements, readiness, plans for recapitalization, and support for joint requirements and resource recommendations. The Joint Requirements Oversight Council (JROC), comprised of the Vice Chiefs of Staff of the four Services and chaired by the Vice Chairman of the Joint Chiefs of Staff, oversees the JWCA process.

The relationship between the Joint Warfighting Capability Assessment areas and the twelve Joint Warfighting Capability Objectives is depicted in Figure II.3.

D. DEFENSE SCIENCE AND TECHNOLOGY STRATEGIC PLANNING AND ASSESSMENT

The Director of Defense Research and Engineering (DDRE) has strengthened the strategic planning and assessment processes critical to improving the Science and Technology (S&T) community's responsiveness to their warfighting and acquisition customers. This has been a team effort involving the Office of the Secretary of Defense (OSD), Joint Staff, Military Services and Defense Agencies. The following is a brief summary of these innovations.

The DDRE has established the Defense S&T Advisory Group (DSTAG) to advise her on the strategic planning, programming, budgeting, review and assessment of the DoD S&T program spanning research, technology development, demonstration and transition. Chaired by the DDRE and meeting bi-weekly, the DSTAG members include the Service S&T Executives, J8, DUSD(AT), Service requirements general/flag officers and the

Joint Warfighting Capability Objectives \ JWCA AREAS	STRIKE	LAND & LITTORAL WARFARE	STRATEGIC MOBILITY AND SUSTAINABILITY	SEA, AIR, AND SPACE SUPERIORITY	DETERRENCE/COUNTER PROLIFERATION OF WEAPONS OF MASS DESTRUCTION	COMMAND AND CONTROL	INFORMATION WARFARE	INTELLIGENCE, SURVEILLANCE & RECONNAISSANCE	JOINT READINESS	REGIONAL ENGAGEMENT/ PRESENCE
A. INFORMATION SUPERIORITY	●				●	●	●	●		
B. PRECISION FORCE	●	●		●	●	○		●		
C. COMBAT IDENTIFICATION	●	●		●		○		○		
D. JOINT THEATER MISSILE DEFENSE	○			●	●	●		●		
E. MILITARY OPERATIONS IN URBAN TERRAIN		●				○		○		
F. JOINT READINESS			○		○	○	○		●	○
G. JOINT COUNTERMINE		●								
H. ELECTRONIC WARFARE	●			●		●		●		
I. INFORMATION WARFARE	○					○	●	○	○	
J. CHEMICAL/ BIOLOGICAL AGENT DETECTION					●			●		
K. REAL-TIME LOGISTICS CONTROL			●		○	○			○	○
L. COUNTERPROLIFERATION	●				●	○	○	●		

● STRONG RELATIONSHIP   ○ MODERATE RELATIONSHIP

Figure II.3. Relationship Between Joint Warfighting Capability Assessment (JWCA) Areas and Joint Warfighting Capability Objectives

Directors of DARPA, DNA and BMDO (see Figure II.4). This participative approach to overseeing the DoD S&T program will greatly improve the focus, quality, timeliness and customer satisfaction of the $7 billion/year DoD S&T investment. Two major tasks of the DSTAG are to guide the development of the annual Defense S&T strategic plans and review the results of the annual Technology Area Review and Assessments (TARA).

- Director, Defense Research and Engineering (Chair)
- Deputy Under Secretary of Defense (Advanced Technology)
- Deputy Assistant Secretary of the Army (Research and Technology)
- Chief of Naval Research
- Deputy Assistant Secretary of the Air Force (Science, Technology and Engineering)
- Director, Ballistic Missile Defense Organization
- Director, Defense Advanced Research Projects Agency
- Director, Defense Nuclear Agency
- Deputy Director, Force Structure, Resources and Assessments, J-8
- Assistant Deputy Chief of Staff for Operations and Plans, Force Development, USA
- Director, Test and Evaluation and Technology Requirements, USN
- Director of Operational Requirements, USAF

Figure II.4. Defense Science and Technology Advisory Group (DSTAG) Members

In addition to building upon the individual S&T strategic plans of the Services and Defense Agencies, this year the *Defense S&T Strategy* is revised to be responsive to the White House *National Security S&T Strategy* (see Figure II.5) and the Chairman of the Joint Chiefs of Staff's *Joint Vision 2010*.

- Pillars
  - The readiness and capabilities of our military forces
  - Our engagement with other nations to prevent conflict from occurring
  - The strength of our economy
- Investment
  - Provide technical solutions to achieve the future joint warfighting capabilities
  - Maintain technological superiority in warfighting equipment
  - Balance basic research and applied technology in pursuring technological advances
  - Incorporate affordability as a design parameter

Figure II.5. National Security Science and Technology Strategy

Achieving Joint Vision 2010 concepts will, in large measure, depend on our ability to achieve and exploit the twelve Joint Warfighting Capability Objectives of Section B above. These objectives, developed by the Joint Staff in collaboration with OSD and the Service S&T executives, represent some of the most critical capabilities for maintaining our warfighting advantage. They do not include all of the future Joint Warfighter's needs derived from the Joint Warfighting Capability Assessment.

The *Defense S&T Strategy* therefore addresses the S&T needs of the future warfighting CINCs and Military Services, while leveraging the S&T efforts of other Federal and private sector S&T as highlighted in the *National Security S&T Strategy*.

As shown in Figure II.6, the JWSTP, DTAP and BRP are published by March in time to be cited in the Defense Planning Guidance to guide Defense Agency and Service preparation of their S&T budget and Program Objective Memorandum (POM). These plans build upon and do not duplicate the Service/Agency S&T plans. They also consider recent technology forecasts such as the Office of the Secretary of Defense's Revolution in Military Affairs, the Air Force's *New Vistas*, the Army's *Force XXI*, and the Marine's *Sea Dragon* efforts.

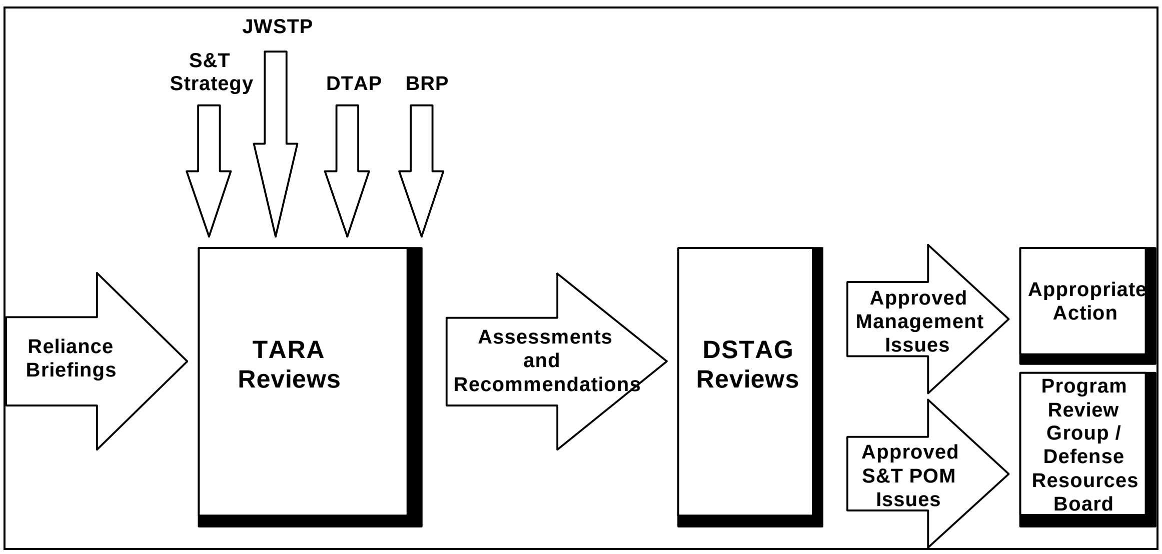

Figure II.6. Technology Area Review and Assessment (TARA) Process in Context

These plans ensure that the near-, mid-, and far-term needs of the joint warfighter are properly balanced and supported in the S&T planning, programming, budgeting, and assessment activities of the DoD. Advanced concepts and technology identified as enhancing high priority joint warfighting capabilities, along with prerequisite research, will receive funding priority in the President's Budget and accompanying Future Years Defense Plan (FYDP). These plans are made available to the United States Government, Defense contractors, and our allies with the goal of better focusing our collective efforts on superior joint warfare capabilities and improving interoperability between the United States and our allies.

In May, Technology Area Review and Assessments are held for each of the 10 DTAP technology areas and basic research. Each of the 11 Panels have at least 2/3 of the members from outside DoD. Most of the TARA members are national leaders from the

National Academy of Sciences, National Academy of Engineering, Institute of Medicine, Defense Science Board or from the Services' Scientific Advisory Boards. The TARA Panel is co-chaired by a senior executive from the Office of the DDRE. The appropriate representative from the Defense S&T Reliance Executive Committee (see Figure II.7) briefs the DoD program as compared to the planning guidance. Special S&T issues identified by the DDRE are also reviewed.

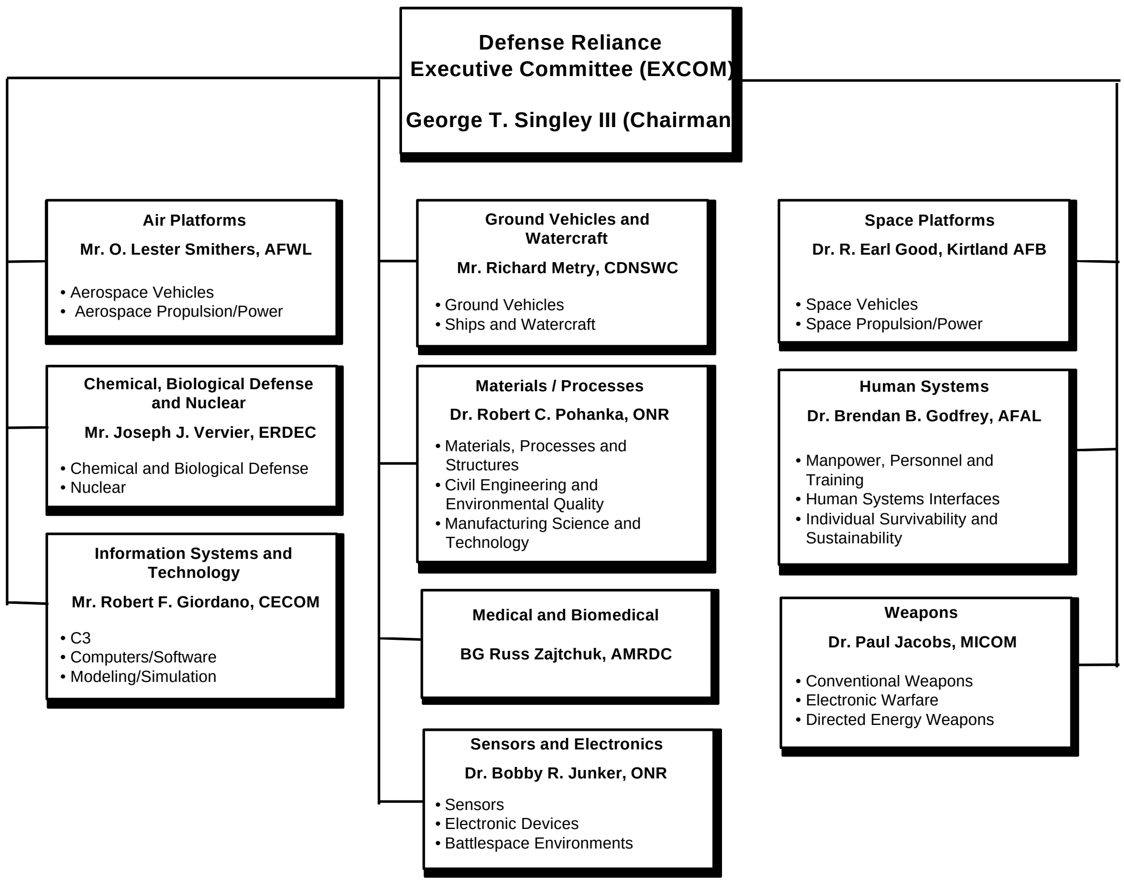

Figure II.7. Defense Technology Area Plan (DTAP) Chapter Chairmen

Following each one week TARA, the DoD co-chair of the TARA briefs the findings and recommendations to the DDRE chaired DSTAG. Included in this brief is the co-chair's program recommendations for termination, adjustment and enhancement to better align the S&T program to comply with guidance. Following the DSTAG briefings, issues are briefed by the DDRE to the Program Review Group and Program Decision Memoranda are issued as needed. Following the POM cycle, revision of *the Defense S&T Strategy* and three supporting plans begins again in time to be published as guidance for the next budget cycle.

III. TRANSITIONING TECHNOLOGY TO THE JOINT WARFIGHTER

The Cold War acquisition process produced the world's best military equipment. That process, however, is too expensive, and the time from concept to fielding is too long for the post-Cold War budgetary and geo-political environment. This *Joint Warfighting Science and Technology Plan* describes the following important mechanisms for transitioning innovative concepts and superior technology to the warfighter and acquisition customer both faster and less expensively than the traditional mechanisms.

A. ADVANCED TECHNOLOGY DEMONSTRATIONS (ATDs)

Service and Agency ATDs seek to demonstrate the maturity and potential of advanced technologies for enhanced military operational capability and/or cost effectiveness. The DTO Volume for the JWSTP and the DTAP presents summary descriptions of the ATDs cited in this plan. ATDs are characterized by the following parameters:

- large scale, both in resources and complexity;
- have operator/user involvement from planning to final documentation;
- provide specific cost, schedule, and performance metrics; and
- have a clearly defined transition target.

B. ADVANCED CONCEPT TECHNOLOGY DEMONSTRATIONS (ACTDs)

ACTDs are designed to transfer technology rapidly from the developers to the users. They are user-oriented and represent an integrated effort to assemble and demonstrate a significant, new or improved military capability that is based on mature advanced technologies. They also are on a scale large enough to demonstrate operational utility and end-to-end system integrity. A demonstration is jointly developed and implemented by the operational user and materiel development communities as key participants. ACTDs allow the warfighter to:

- Evaluate a technology's military utility before committing to a major acquisition effort;
- Develop concepts of operation for employing the new technology; and
- Retain a low-cost residual operational capability if the commander desires.

Upon the conclusion of an ACTD, one of the following three choices will be made based on the results of the exercises:

- Transition the demonstrated technology directly to the warfighter. In this case, only minor, or perhaps no modifications to the existing equipment will be required. This transition approach is particularly appropriate where only small quantities of the new equipment are required.
- Based upon lessons learned during the ACTD, enter the formal acquisition process at some advanced milestone.
- Terminate the efforts or restructure them based on the evolved concept of operations and lessons learned during the ACTD.

The ACTD Master Plan (Reference 6) details the ACTD implementation process and discusses the current status of existing ACTDs. The DTO Volume for the JWSTP and the DTAP presents summary descriptions for all ACTDs cited in this plan.

C. JOINT WARFIGHTING EXPERIMENTS (JWEs)

Joint Warfighting Experiments (JWEs) are conducted as part of joint warfighting exercises. A JWE is a snapshot in time when prototypes and technologies from ACTDs, ATDs, development and techhnology base programs are integrated to permit the warfighter potential and gain insight into future advanced Joint Warfighting Concepts. Sometimes there is a need for additional funding for the integration and synchronization effort across these technologies and for unprogrammed, promising joint warfighting technological solutions. This additional funding is programmed in the Joint Warfighting Integration Program (JWIP). JWEs are DoD-wide efforts to support the horizontal integration and synchronization of advanced technologies from ACTDs, ATDs, and advanced distributed simulation products for experimentation in joint warfighting exercises, such as the recent Roving Sands Theater Missile Defense joint warfighting experiments sponsored by the Commander in Chief, U.S. Central Command.

IV. ACHIEVING JOINT WARFIGHTING CAPABILITY OBJECTIVES

The sections in this chapter describe the significant near-, mid-, and far-term technology efforts supporting each of the twelve Joint Warfighting Capability Objectives listed in Chapter II. Chapter IV, the heart of this plan, is divided into twelve (12) sections. Each section describes the plan for achieving one Joint Warfighting Capability Objective (JWCO).

A. INFORMATION SUPERIORITY

1. Definition

Information Superiority combines the capabilities of intelligence, surveillance, reconnaissance (ISR) and command, control, communications, computers, and intelligence (C4I) to acquire and assimilate information needed to effectively employ our own forces to dominate and neutralize adversary forces. It includes the capability for near-real-time awareness of the location and activity of friendly, adversary, and neutral forces throughout the battlespace; and a seamless, robust C4I network linking all friendly forces that provides common awareness of the current situation. The JCS's vision of future warfighting demands both the development of Information Superiority (IS), and its pervasive and effective use. This section addresses, in addition to IS, the technologies and capabilities for effective employment identified for the Advanced Battlespace Information System (ABIS),[1] and sensors for the acquisition of information leading to information superiority.

Information Superiority is essential to achieving virtually all other Joint Warfighting capabilities. Tactical sensor data and command and decision information derived from these and other capabilities enhances the development of information superiority. U.S. information superiority depends on the development and effective integration of Information Warfare capabilities to protect the information collection, processing, and dissemination capabilities of the U.S. and its coalition partners, and to degrade those of its adversaries.

2. Operational Capability Elements

Warfighters of the future must be able to respond rapidly and effectively, with little or no tactical warning, to a wide range of uncertain threats. These threats include conventional forces and weapons of mass destruction of increasing technological sophistication. There is a decreasing likelihood of forward-based U.S. forces in the theater. An effective response is likely to require interoperating and sharing resources with other coalition forces in the face of these threats. The JCS's vision calls for the rapid deployment of forces that are able to fight on arrival, and are able to sustain operations with a minimal logistics tail in the area of operations.

All this demands significant advances in our ability to develop superior knowledge of the battlespace in real-time, and to employ that knowledge effectively in planning and executing operations. The goal, as illustrated in Figure IV.A.1, is to enable the development of new concepts of operation that will assure operational dominance of the battlespace supported by Information Superiority. This is done by blending three broad capabilities – battlespace awareness, effective force employment, and a grid of assured services – into a system-of-systems.

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[1] Advanced Battlespace Information System, Task Force Final Report, March 1996.

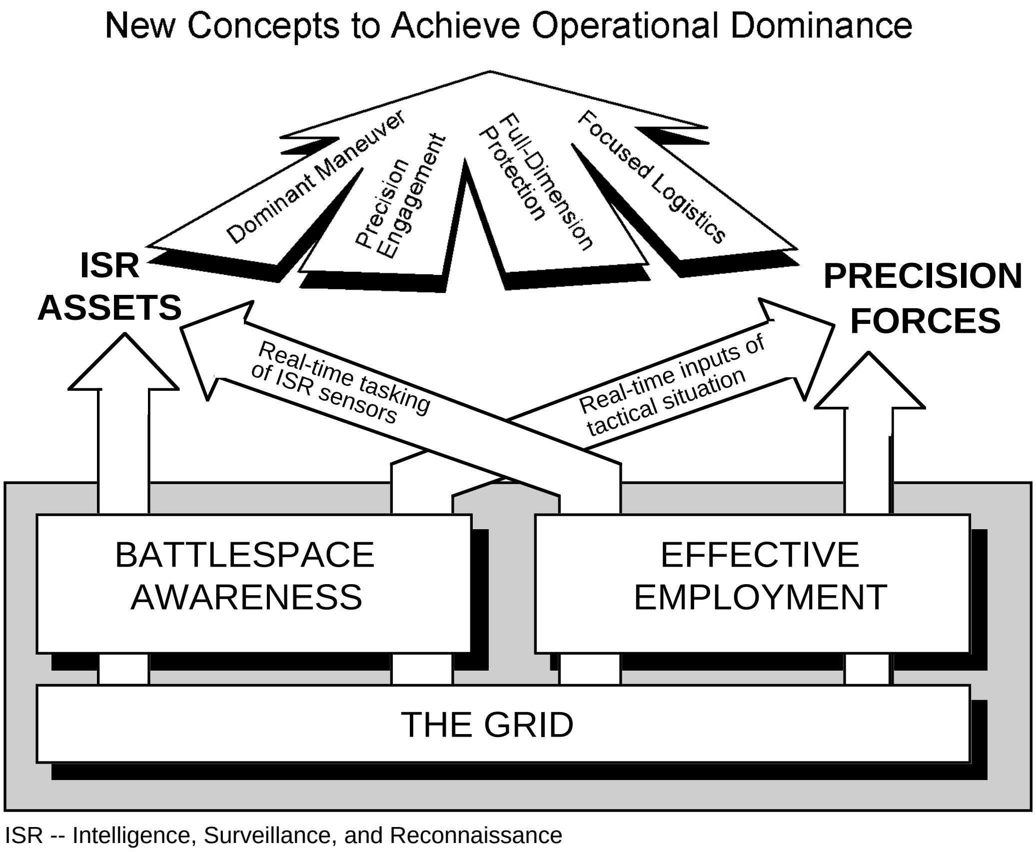


Figure IV.A.1. Information Superiority Concept

Within these three broad capabilities, the Advanced Battlespace Information Systems (ABIS) study (Ref. 7) defined nine operational capabilities. These will provide future warfighters with an overall capability to: (1) control and shape the pace of the battle by providing the commander with a broader perspective and better intuitive feel of the battlespace, including the environmental conditions and operational situation; (2) plan and execute operations to achieve an overwhelming effect at precise places and times; (3) adapt rapidly to changing situations and environmental conditions to attack high priority targets throughout the battlespace. Information Superiority will empower lower echelon force elements by distributing the commander's intent and the information needed for timely and effective execution. Because these capabilities will inevitably degrade in the course of battle, a key objective of Information Superiority is to enable commanders to plan for this eventuality, to identify and protect essential capabilities and to reconfigure command and control structures to meet changing needs.

Effective Employment of Forces. With Information Superiority, commanders will be able to exploit their superior understanding of the battlespace to shape and control the conflict. They will be able to do this by dynamically directing and integrating tactical and supporting ISR resources for mission planning and rehearsal, targeting, and weapon assignment; and by battle damage assessments; and combat assessments to ensure optimum application of precision weapons and forces. Specific operational capability elements are:

1. *Predictive planning and preemption.* The ability to be proactive in the planning process to avoid direct confrontation (by employing alternative means); to be prepared to react and exploit opportunities when direct confrontation must occur, and to shape the expected actions to stay within an enemy's decision cycle and keep him out of ours.
2. *Integrated force management.* The capabilities to achieve the dynamic synchronization of missions and resources from components and coalition forces.
3. *Execution of time-critical missions*. The ability to provide processing language, interface characteristics and linkages which enable rapid target search and acquisition, battle coordination and target selection, hand-off, and engagement for the prosecution of time-critical targets.

Quantitative objectives for effective employment include automated recognition of thousands of targets per hour, and weapon-target pairing and sensor support for effective engagement and real-time battle damage assessment of hundreds of targets per hour. Other objectives include the capabilities to support major force reconstitution within 15 minutes of a mission casualty assessment, 90 percent reprogrammability of threat response options and techniques, and the ability to update national force databases within one hour.

Battlespace Awareness. Battlespace awareness includes the operational capability to acquire information about the position and movement of friendly, adversary, and neutral forces, and about the geospatial situation (e.g., terrain, weather, bathymetric conditions) in which they are deployed. It includes the capabilities to provide a common view and understanding of the situation across tactical and supporting forces, from joint force commanders to individual shooters. The effective integration of battlespace awareness within a system-of-systems will provide the warfighter with an extended view of the battlespace and of current and projected operational conditions, and an enhanced ability to identify and localize features of the battlespace in the face of degraded environmental conditions, and hostile countermeasures. This extended view will support and enhance the warfighters' intuitive feel for situations and command options.

The specific capabilities necessary to achieve battlespace awareness are:

1. *Information acquisition*. The sufficient, timely, high-quality surveillance, reporting, target designation, and assessment information on enemy, friendly, and U.S. units, events, activities, status, capabilities, plans and intentions to ensure that Joint or Coalition Commanders have dominant battlespace knowledge.
2. *Precision information direction*. The capability to dynamically direct and integrate both tactical and supporting C4 and ISR resources for targeting, weaponeering, mission preview, battle damage assessment and combat

assessment to maintain the ability for the on-scene commander to exploit and shape the battle space.

3. *Consistent battlespace understanding.* The capabilities to elevate the level and speed of cognitive understanding of enemy, friendly, and geospatial situations, and maintain consistency in that view across tactical and supporting forces.

Quantitative objectives for these operational capabilities include the capability to broadcast maps and feature data video mosaics at 30 m resolution across the theater of operations within tens of minutes for planning, and at 10 m resolution for real-time tactical targeting and battle damage assessment. Objective capabilities should provide 98 percent awareness of movers over a 4,000 square km area, with the capability to provide estimates of enemy and friendly courses of action within 1-5 minutes for designated targets, 20 minutes-to-one hour for movers, and 6-24 hours for major forces. Improvements should reduce by 50 percent the time required to understand the battlefield situation. Finally, the system should be able to provide a releasable situational picture to coalition forces within 1 minute.

The Grid. The grid will support global connectivity with flexible, rapidly configurable network services, automated assistance to facilitate universal user access to information, and assured services in stressful environments. These services will also provide flexible command structures and support for time-critical, short duration mission tasks such as “sensor-to-shooter” integration and support. The services of the grid are separate from command structures, disseminating battlespace awareness to users when they need it and in the form that they need it to facilitate the collaborative planning and execution of joint and coalition operations. The connectivity and flexibility will also allow the creation of “virtual staffs” that expand and augment the capabilities of in-theater forces with collaborative services, reach-back capabilities, and reduced local footprint.

The critical operational capabilities of the grid are:

1. *Universal transaction services.* The capability to provide warfighters and their systems the ability to exchange and understand information, unimpeded by differences in connectivity.

2. *Distributed environment support*. The mechanisms and services required to allow the warfighters to craft their C4I information environments from the full set of assets connected through the grid, including the ability to establish distributed virtual staffs and task teams.

3. *Assurance of services*. High-quality services that warfighters must have when needed, to meet dynamically changing demands, and defended against physical and information warfare threats.

Quantitative objectives identified for grid operational capabilities include the establishment of reliable and robust operating networks within 10 minutes and tactical communications channels and networks within 10 seconds to one minute; multidomain database search and retrieval within 3 minutes (30 minutes for search and retrieval from distributed assets across the entire grid); broadcast of up to 2,000 target updates/hour, with automatic weaponeering and combat assessment for 500 targets per hour; the dissemination of critical situation changes in less than one minute, with updating of specific target, threat, and force disposition information to users in a 200 square mile theater of operations within 10 seconds.

3. Functional Capabilities

Achieving the Information Superiority operational capability elements described will require significant advances in the functional capabilities to manage the acquisition, simultaneous processing, and parallel dissemination of information in an assured and secure manner, and to effectively integrate mission planning functions. Figure IV.A.2 shows important functional capabilities as they relate to the nine operational capability elements for Information Superiority.

4. Current Capabilities, Deficiencies, and Barriers

Currently fielded information systems do not support the kind of robust, assured, and timely flow of accurate and relevant information needed to meet future joint warfighting needs. Operational practices limit flexibility and effective employment. The structure for C4I remains divided along organizational and functional lines and is strongly tied to the hierarchical command structure, due in large part to inadequate capabilities for the automation of multi-level security. Users must know the secure network addresses all of the nodes with which they want to communicate, a daunting requirement in the heat of battle. Even when information can be provided, it may be in a form that has been tailored and optimized for some other mission. These divisions, tied to a rigid framework of battlefield geometry, limit the commander's ability to assign sensors to priority targets and to dynamically retask high value assets across missions and services in response to changing situations and opportunities. Furthermore, communications bandwidths and connectivity are inadequate to support the flow of data under conditions of peak demand.

"Stovepiping" – the operational fragmentation and end-to-end segregation of information flow by type, command structure, and mission – makes it difficult to acquire, process, and disseminate essential information across joint forces, and makes it virtually impossible to develop a common picture of the battlespace. There currently is only a limited ability to detect and monitor targets and events concealed in foliage, in structures, underground, or in adverse weather or countermeasure environments. Rigid ISR, and lack of visibility of independent tactical sensor tasking and coverage, further limit abilities to manage and coordinate sensor assets for real-time operations.

Operational Capability Elements / Functional Capabilities	Effective Employment			Battlespace Awareness			The Grid		
	Predictive Planning and Preemption	Integrated Force Management	Execution of Time - Critical Missions	Information Acquisition	Precision Information Direction	Consistent Battlespace Understanding	Universal Transaction Services	Distributed Environment Support	Assurance of Services
1. Intelligence Processing and Broadcast	●	●	○	●		●	*The Grid provides supporting and enabling services for all of these critical functional capabiltiies identified*		
2. Intelligent, Distributed MC&G	○	○	○	●	○	●			
3. Collaborative Situation Assessment and BDA		○	○		○	●			
4. Collection and Distribution of Weather and Environ-mental Conditions	●			○		●			
5. Common Understanding & Representation of the Battlespace	●	○	○			●			
6. Situation Projection	●	○				●			
7. IW & Spectrum Dominance	*Related Capability from Information Warfare (Section IV.I)*								
8. Mission Rehearsal and Embedded Training	*Related Capability from Joint Readiness (Section IV.G)*								
9. Command Projection	●	●							
10. Support Simultaneous, Coordinated Operation		●							
11. Repair and Consumeables Management	*Related Capability from Real-time Logistics Control (Section IV.K)*								
12. Joint Force Automated Battle Doctrine		●	○						
13. Theater Intelligence Processing and Broadcast	○	○	○	●	●	●			
14. Shared, Distributed Collaborative Planning	●	●	●	○	○				
15. Rapid, Accurate Battle Damage Assessment	○	○	●		●	○			
16. ISR and C3 System Management	○	●	●	●	○	○			

● Strong support ○ Moderate Support

Figure IV.A.2. Functional Capabilities Needed for Information Superiority

Operational Capability Elements / Functional Capabilities	Effective Employment			Battlespace Awareness			The Grid		
	Predictive Planning and Preemption	Integrated Force Management	Execution of Time - Critical Missions	Information Acquisition	Precision Information Direction	Consistent Battlespace Understanding	Universal Transaction Services	Distributed Environment Support	Assurance of Services
17. Force Status and Execution Management	○	○	●	○	○	○			
18. Parallel Dissemination of Intelligence/BDA	○	○	●			○			
19. Rapid Accurate Automated Targeting	○	●	●		●	●			
20. Automated Mission & Weapon to Target Pairing			●		○				
21. Seamless Connectivity	*The Grid provides supporting and enabling services for all of the critical operational capabilities in these columns*						●	○	○
22. Automatic Adaptive Information Conditioning							●		
23. Location Independent Addressing							●		
24. Flexible, Adaptive Access Control							●		
25. Support Heterogeneous Users and Interfaces								●	
26. Knowledge-based Access and Retrieval								●	
27. Distributed, Collaborative Processing								●	
28. Massive, Distributed Information Management								●	
29. Automated Intelligent Grid System Management							○	○	●
30. Service Extention									●
31. Defensive IW and Information Protection	*Related Capability from Information Warfare (Section IV.I)*								

● Strong support ○ Moderate Support

Figure IV.A.2. Functional Capabilities Needed For Information Superiority (cont'd)

There are a number of technological, organizational, operational, and programmatic barriers to overcoming these current limitations. While commercial information systems technology will continue to advance rapidly, it must be modified to meet military needs and demonstrated under realistic operational conditions. Some of the problems to be overcome in terms of security and battle damage survivability are uniquely military, as are the specific advances required in sensors to support the acquisition of battlespace awareness. Traditional concepts of operation and rigid C4I structures will need to change if the warfighter is to realize the benefits of advancing technology. Battlespace awareness transcends individual Service and organizational divisions, and will require the effective integration of, and sustained commitment to, individual Services and joint programs.

Figure IV.A.3 provides a summary of the nine Information Superiority operational capability elements, functional capabilities limitations, and technology advances needed. Note that the functional capabilities listed include, in addition to those items corresponding directly to the abbreviated titles shown in Figure IV.A.2, essential capabilities shared with other joint warfighting areas. (Note that entries with only a number are defined earlier in the chart.)

5. Technology Plan

Achieving Information Superiority and its seamless integration into warfighting operations will require both advances in technology and the development of new operational concepts to exploit them. Figure IV.A.4. maps selected ACTD's and ATD's for Information Superiority against operational capability elements. The complete list of DTO's shown in Figure IV.A.5 represent a mix of ongoing and funded ACTD's and approved candidates for FY97, and ABIS-proposed ACTDs and long-term DTOs for which specific ATD's and ACTD's are still being defined. Figure IV.A.6 shows how these ACTDs, ATDs and related DTOs support operational capabilities. The volume on Defense Technology Objectives provides further information on demonstrations and DTOs. Figure IV.A.7 provides an integrated roadmap of selected key demonstrations and JWSTP DTOs. Again, because of the pervasive nature of information superiority, not all critical efforts listed in Figures IV.A.5 and IV.A.6 can be displayed.

The near-term program (through FY 2000) includes the ABIS-proposed ACTDs. It should provide the basis for immediate improvements in battlespace awareness and in the integration of improved knowledge into mission planning and execution. These demonstrations will support new concepts of C4I operation and improvements in the warfighter's ability to use ISR assets. This will demonstrate the value of Information Superiority to the operational forces and provide a strong foundation upon which to build an effective long-term program to achieve the JCS's future warfighting vision. New C4I capabilities and concepts will begin immediately to affect capabilities and concepts of operation in all other warfighting areas.

Near-term demonstrations will provide a basis for further improving tactical integration, real-time management of ISR, and dynamic retasking of forces, and for the better integration of concurrent planning and execution in the 2000-2005 time frame. The prototype grid capabilities demonstrated in the near-term should begin to evolve into the type of massive, distributed, and responsive environment envisioned in the long-term ABIS objectives.

Further advances and demonstrations will be required within the 2000-2005 timeframe and beyond to assure the availability of Information Superiority and the secure, and effective services that the warfighters will need in future conflicts. Figure IV.A.7 includes a number of long-term DTOs that will demonstrate Information Superiority capabilities in support of new operational concepts to achieve overwhelming effect across the full spectrum of dominant maneuver, precision engagement, full-dimension protection, and focused logistics capabilities envisioned by the ABIS study.

6. Summary

The planned and funded technology and advanced concept programs will demonstrate and evaluate a wide range of potential Information Superiority improvements in three to five years. Realizing the incremental improvements that lead to the JCS's revolutionary vision of overwhelming dominance in the battlespace (as illustrated in Figure IV.A.8) will require a continuing long-term commitment. These efforts, coupled with the projected continued doubling, every two years, of the performance of the underlying information system hardware, should result in significant incremental improvements in the warfighters' visibility and command of the battlespace, as well as in the availability of accurate, detailed sensor-to-shooter information.

Between now and the year 2000, improvements in force employment will largely be based on better target recognition and timely attack; improved C2 early in the campaign; the beginnings of a defensive IW capability; and an improved information environment for collaborative work. Battlespace Awareness is to be improved by providing a consistent situational picture and an ability for the integrated tasking of SIGINT and IMINT capabilities. Improved awareness will support tactical needs and provide real-time sensor information directly to shooters. Grid capabilities will be improved to support the rapid configuration of tactical networks (including nodes for mobile users) with enhanced abilities to integrate and distribute information securely in a broadly heterogeneous environment.

In the longer term (2000-2010), the continued evolution of operational concepts and the availability of new technologies will provide a basis the for full development of ABIS concepts. Further improvements in force employment will be possible through the wider dissemination of each commander's intent. Improved automated tools for local decision-making, coupled with better status information and an ability to forecast likely future options and contingencies would enhance the ability of commanders at all levels to reason from ambiguous information, and to tailor force and mission packages to meet the needs of an on-going conflict. Battlespace Awareness will be enhanced by continuously projecting friendly and enemy moves and their likely outcomes, by adaptively supporting cognitive functions of diverse users, and by providing tailored information for mission execution when and where it is needed. Grid capabilities will be made more robust by advances in IW, and by providing end-users with an ability to tailor and adapt their information environment and access to information.

Even with the continued advance of commercial information systems, it will be a great challenge to meet the demand for greater bandwidth, processing throughput, and faster response time. There will be unique technology required only by the military. Integration of commercial advances will also be used to meet essential military needs. Out year ACTD's will be needed to demonstrate and validate these advances. The emphasis in the out-year program is on development and demonstration of essential intelligent, adaptable capabilities to ensure availability and security of services at all echelons and to support dominance in all types of conflict.

Goal	Functional Capabilities	Limitations	Needed Technologies
EFFECTIVE EMPLOYMENT			
Operational Capability Element: Predictive Planning and Preemption			
Dynamic Integration of force operations by collaborative execution monitoring, repair, and retasking of shared assets across echelons, missions, components and coalition forces (control of "coherent" joint/simultaneous operations to optimize dynamics use of resources without pre-empting 'intuitive').	1. Intelligent processing and broadcast 4. Collection and provision of weather and environmental conditions 5. Common understanding and representation of the battlespace 6. Situation projection 9. Command projection 14. Shared, distributed collaborative planning	1. Automated planning systems not dynamic 2. Wargaming not effectively integrated in C4I and cannot be used for on-line planning evaluation 3. Sensor tasking and countermeasures are 'reactive' to emergent Information Warfare (IW) rather than anticipatory 4. IW not integrated with hard kill as a part of tactical options 5. Information search and retrieval can choke at times of peak demand 6. Lack of distributed, consistent data at all levels	1. Auto target & infrastructure identification, recognition, behavior and change detection & BDA 2. Continuous sliding Collaborative planning across Battlespace 3. Just in time mission package construction & delivery 4. Object Oriented Distributed, Automated, Dynamic Planning/Scheduling/ Target Handoff 5. Automated Nodal Analysis and Weaponeering 6. Automated Target/Weapon Pairing & Update 7. Real Time M&S for Assessment and Red/Blue COA analysis 8. Embedded Fault Tolerant, Distributed, M&S for Mission Preview, Rehearsal and Training 9. M&S for Spectrum Dominance Planning 10. M&S for IW Execution Effectiveness Evaluation, IW Surveillance and Planning 11. Easily deployable, Evolvable, Scaleable, Plug & Play Architecture 12. Cross Functional Virtual teams

Figure IV.A.3. Goals, Limitations, and Technologies for Information Superiority

Goal	Functional Capabilities	Limitations	Needed Technologies
Operational Capability Element: Integrated Force Management			
Maintain the ability of the on-scene commander to exploit and shape the battlespace by dynamically directing, and integrating (in accordance with operation, battle and mission priorities) both tactical and supporting ISR resources for targeting weaponeering, mission preview, BDA & combat assessment.	1. 9. 10. Support simultaneous, coordinated operations 12. Joint force automated battle doctrine 14. 16. ISR and C3 system management 17. Force status and execution management 19. Rapid accurate automated targeting *Supporting functions from other warfighting areas:* 7. IW and Spectrum Dominance Planning, Monitoring & Execution 8. Mission Rehearsal/ Embedded Training	7. Present coordination via rigid framework of battlefield geometry 8. Limited ability to apply all assets to formulate and support coherent defensive situation 9. Limited understanding of what needs to be done (strategy, cmdr's intent) and relationship of individual tasks to overall campaign objectives 10. Development of plan to support simultaneous operations is manually intensive 11. Limited realtime insight into conduct of plan 12. No responsive way to dynamically retask high-value assets across missions and services in response to changing situations, opportunities	3. Distributed, Collaborative, and Virtual Situation Awareness 7. 8. 9. 10. 13. Dynamic shared war plan that deals with uncertainty 14. Dynamic Allocation of Shared Resources in Realtime 15. Decision Support to Assess & Replan Consumables
Operational Capability Element: Execution of Time Critical Missions			
Provide a real time fused battlespace picture with integrated decision aid tools which assures coordinated dynamic planning and execution of a broad spectrum of missions from time phased attack of fixed targets to reconnaissance of battle areas and prosecution of time critical targets by integrated hunter-controller-killer assets Provide processing and linkages which enable the rapid target search and acquisition, battle coordination and target selection, handoff and engagement for prosecution of time critical targets.	1. 3. Collaborative Situation Assessment and BDA 14. 15. Rapid, Accurate Battle Damage Assessment 16. 17. 18. Parallel Dissemination of Intelligence/BDA 19. 20. Automated Mission & Weapon to Target Pairing	13. Slow decision and resource allocation process with respect to target cycle times 14. Poor detection of fleeting target entities in crowded battlespace 15. Slow fusion process 16. Best sensor infor not incorporated 17. Human-intensive BDA 18. Targets appear after force package commitments, pop-up targets, movement cycles 19. Execution status unknown 20. Cannot counteract target reaction to threat and engagement 21. Simultaneous pulls on sensors 22. Insufficient connectivity 23. Sensor management not tied to commander's intent	16. Wideband communications and interconnectivity 17. Real-time, cognition aiding displays 18. Automated planning/decision support tools 19. Data interoperability/synchronization 20. Automated IPB Process 21. Fusion and integrated target tracking 22. Automatic target recognition 23. Advanced adaptive, multilevel security 24. ISR management and integration tools

Figure IV.A.3. Goals, Limitations, and Technologies for Information Superiority (cont'd)

Goal	Functional Capabilities	Limitations	Needed Technologies
BATTLESPACE AWARENESS			
Operational Capability Element: Information Acquisition			
Provide sufficient timely high quality surveillance, reporting, target designation & assessment info on enemy, friendly, US units, events, activities, status, capabilities, plans/intentions to ensure that Joint/Coalition Commanders have Dominant Battlespace Knowledge.	1. 2. Intelligent, distributed MC&G 13. Theater intelligence processing and broadcast 16. 19. - Mobile targets - Counter CCD	24. Coverage extent, quality, and continuity-currency 25. "Stove-pipe" nature of systems/ information by type, acquirer/ dissemination 26. Few systems have near-real-time capabilities for responding to tasking & providing direct-continuing support to forces 27. Limited capability to detect-ID-monitor targets/events in foliage, buildings underground 28. Many capabilities can be denied by weather & countermeasures 29. Manpower intensive - little automation of integration/fusion, target detection-ID-BDA capabilities	25. Small volume/weight very high speed-capacity processors and storage devices, plus application software that can be embedded with sensors/platforms 26. Software applications for automated selection & following of coverage areas/targets 27. Software applications for use of multiple data sources (including reference/ databases) to enhance target detection-tracking-designation e.g., detecting changes 28. Foliage penetration MTI/SAR 29. (Near-) simultaneous multi-spectral coverage 30. Passive/multi-static MTI/SAR 31. Small volume/weight multi-spectral rapidly deployable "smart" surface sensors 32. Direct integration of GPS with sensor outputs where appropriate 33. Transfer/translation applications and storage devices/communications for NRT tactical aircraft sensors
Operational Capability Element: Consistent Battlespace Understanding			
Elevate the level of our cognitive understanding of the enemy, friendly and geospatial situation; and maintain consistency in that view across tactical and supporting forces.	1. - From CONUS - Fused NRT SIGINT and imagery - Increased/fused sensor data in NRT 2. 3.	30. No common operational picture 31. Inadequate information support for Cmdr's decision needs 32. Presently too much info w/out quality thresholds, not scaleable	34. Common Integrated Situation Display w/Selectable Detail and Resolution 35. High Rate Broadcast 36. Joint Multi-sensor Fusion & Info Fusion and Sensor Cross Cueing

Figure IV.A.3. Goals, Limitations, and Technologies for Information Superiority (cont'd)

Goal	Functional Capabilities	Limitations	Needed Technologies
	4. 5. 6. 13. 19.	33. Text message intensive with no automated machine understanding 34. Inadequate dissemination of understanding 35. IPB of battlespace degrades when battle begins	37. Auto Target & Infrastructure Id. Recognition, Behavior and Change Detection & BDA 38. Auto Data Validation and Data Validity Tags 39. Tailored Search & Retrieval of Information 40. Intelligent Agent for Knowledge Retrieval, Filtering, Sanitization & Deconfliction 41. Improved Data & Uncertainty Visualization Mgmt 42. Real Time M&S for Assessment and Red/Blue COA analysis 43. Automated Language Translation & Test Understanding 44. Automated Protocol Translation 45. Multilevel Infosec & Information Assurance 46. Distributed, Synchronized, Large Data Base 47. Mass Storage of Information 48. Intelligent Products to Support Decision Making
Operational Capability Element: Precision Information Direction			
Lean forward in the planning process to avoid direct confrontation (by employing alternatives), to be prepared to react and exploit opportunities when direct confrontation must occur, and to shape the expected actions to stay within the enemy's decision cycle and keep him out of ours.	6. 7. 8. 9 14. 15. 19.	36. Limited response to battlespace changes; rigid ISR, lack of visibility into sensor tasking and coverage 37. Sortie impact limitations; Poor/slow BDA 38. Limited comprehensive sensor tasking to support mission 39. No just in time retargetting capability	4. 8. 9. 10. 37. 48. Integrated Cross Sensor Tracking w/Unique Target ID and Real Time Updates 49. Joint multi-sensor & info fusion and sensor cross cueing 50. Distribute, Collaborative, Virtual Planning in real time 51. Rapid M&S for Sensor Coverage Analysis

Figure IV.A.3. Goals, Limitations, and Technologies for Information Superiority (cont'd)

Goal	Functional Capabilities	Limitations	Needed Technologies
THE GRID			
Operational Capability Element: Universal Transaction Services			
Provide warfighters and their systems the ability to exchange and understand information, unimpeded by differences in connectivity, processing, language, or interface characteristics.	21. Seamless Connectivity - Integration across communications media: automatic Multi-Lingual, Multi-Mode, Adaptive Interfaces, Protocols, Standards 22. Automatic, Adaptive Information Conditioning - Automatic, Adaptive Information Conditioning - Automatic Compression/Coding, Automatic "Brokering" of Quality vs Timeliness 23. Location Independent, Personal and Group addressing - Including on the Move 24. Flexible, adaptive access control	40. Information transport generally tied to C2 hierarchy 41. Lack of interoperability 42. Unacceptable limitations on connectivity to tactical users 43. Lack of adaptive conditioning of information to optimize services 44. Users burdened with requirement to know network addresses 45. Limited ability to support multilevel security, especially in coalition operations	22. 52. Universal information transaction mechanisms 53. Automated language, syntax, protocol translation 54. Adaptable Tactical/Mobile Networking 55. Rapidly deployable tactical fiber extensions 56. Tactically extensible, high rate and asymmetric mobile communications 57. Advanced compression, coding abstracting for conditioning of information
Operational Capability Element: Distributed Environment Support			
Provide all mechanics and services required to allow the warfighters to craft their C4I information environments from the full set of assets connected through the grid, including ability to establish distributed virtual staffs, to share a common consistent perception of the battlespace and to construct distributed task teams among sensors, shooters, movers, and command posts.	25. Support for sessions with heterogeneous users and interface modes 26. Knowledge-based access, retrieval, and integration of information management 27. Support for distributed, collaborative processes 28. Massive, heterogeneous, distributed information management	46. Limited ability to integrate processes across heterogeneous system domains 47. Inadequate knowledge navigation and retrieval for massive, distributed, heterogeneous systems 48. Minimal capability for exploiting information within the network to provide users with knowledge and advisory cues 49. Minimal capability to manage distributed information, especially in asymmetric and broadcast communication environments 50. Limited flexibility and adaptability of information security for coalition operations	39. 58. Multi-mode, multi-lingual interface services 59. Heterogeneous multimedia conferencing 60. Automated language and syntax translation 61. Automated mediators and DBMS Tools 62. Massive data storage and management 63. Flexible information security for information exchange, access, and conferencing

Figure IV.A.3. Goals, Limitations, and Technologies for Information Superiority (cont'd)

Goal	Functional Capabilities	Limitations	Needed Technologies
Operational Capability Element: Assurance of Services			
Provide high quality services that the warfighters can be assured will be available whenever and wherever needed, that can be adapted, scaled, and projected to meet dynamically changing demands, and that can be defended against physical and Information Warfare threats.	29. Grid system Management - Automated, Intelligent Management based on User's Status and Plans, Tools to advise of Status and Capabilities of Grid 30. Service extension - Modular plug-and-play, projectability and scalability 31. Defensive IW and Information Protection - Detect and Characterize Intrusion and Attacks, MLS, Anti-Jam Integration of Defensive IW, Grid Management, and Combat	51. Lack of modular plug-and-play to allow adaptation of services and to project information-intensive support globally 52. Lack of confidence that nonorganic assets will be there when needed 53. Lack of predictive/anticipatory network management capabilities 54. Lack of IW sensors and processors for grid self defense 55. Limited ability for supporting multi level security 56. Limited ability to provide both capability and "hardness"	64. Anticipatory services management tools 65. Tools for projecting and visualizing grid capabilities in terms of projected operational needs 66. Multilevel, adaptive information security 67. IW surveillance and defense tools

Figure IV.A.3. Goals, Limitations, and Technologies for Information Superiority (cont'd)

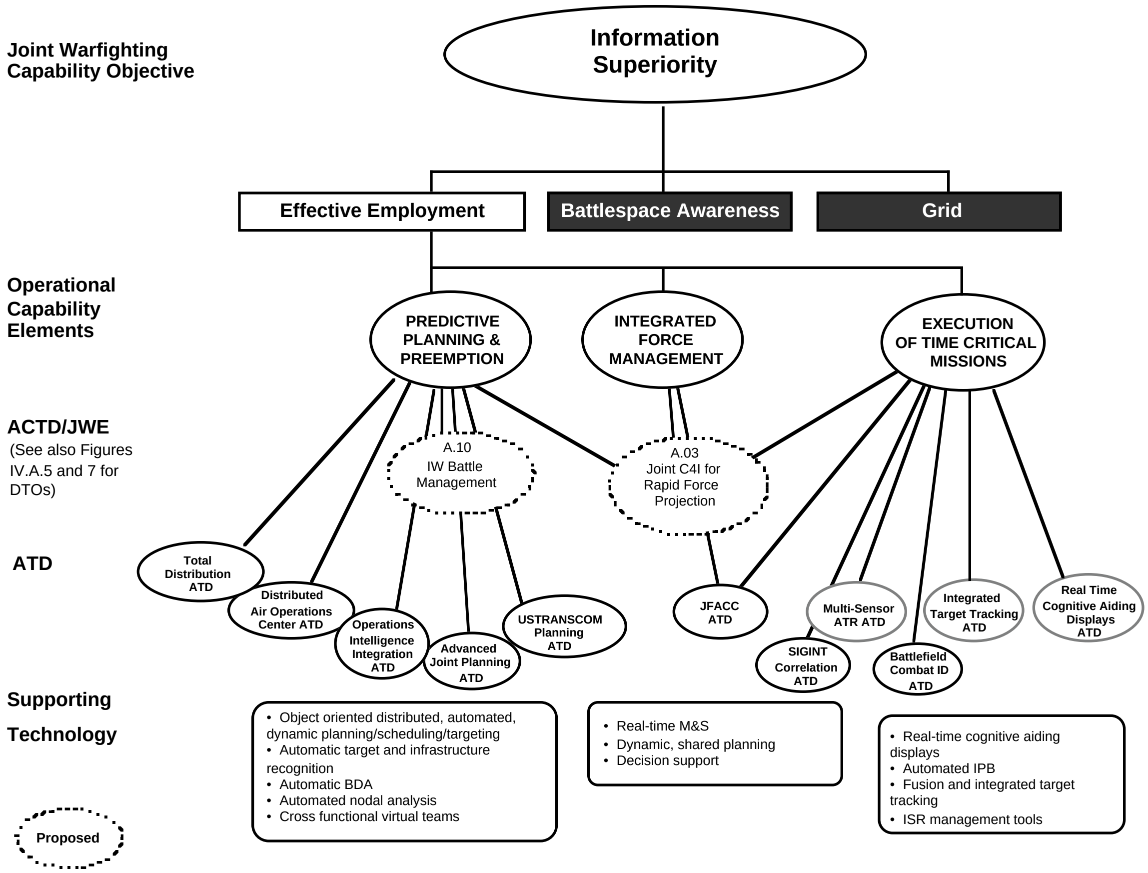


Figure IV.A.4. Technology to Capability – Information Superiority

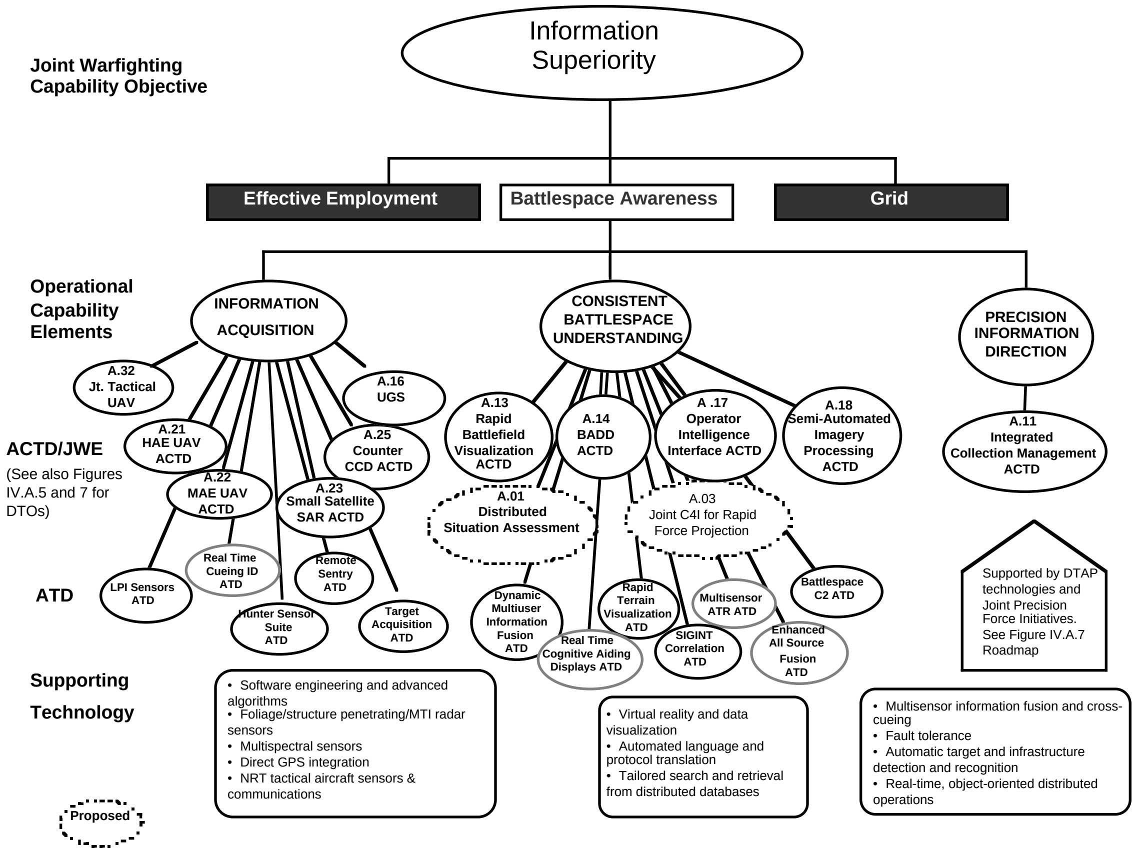


Figure IV.A.4. Technology to Capability – Information Superiority (cont'd)

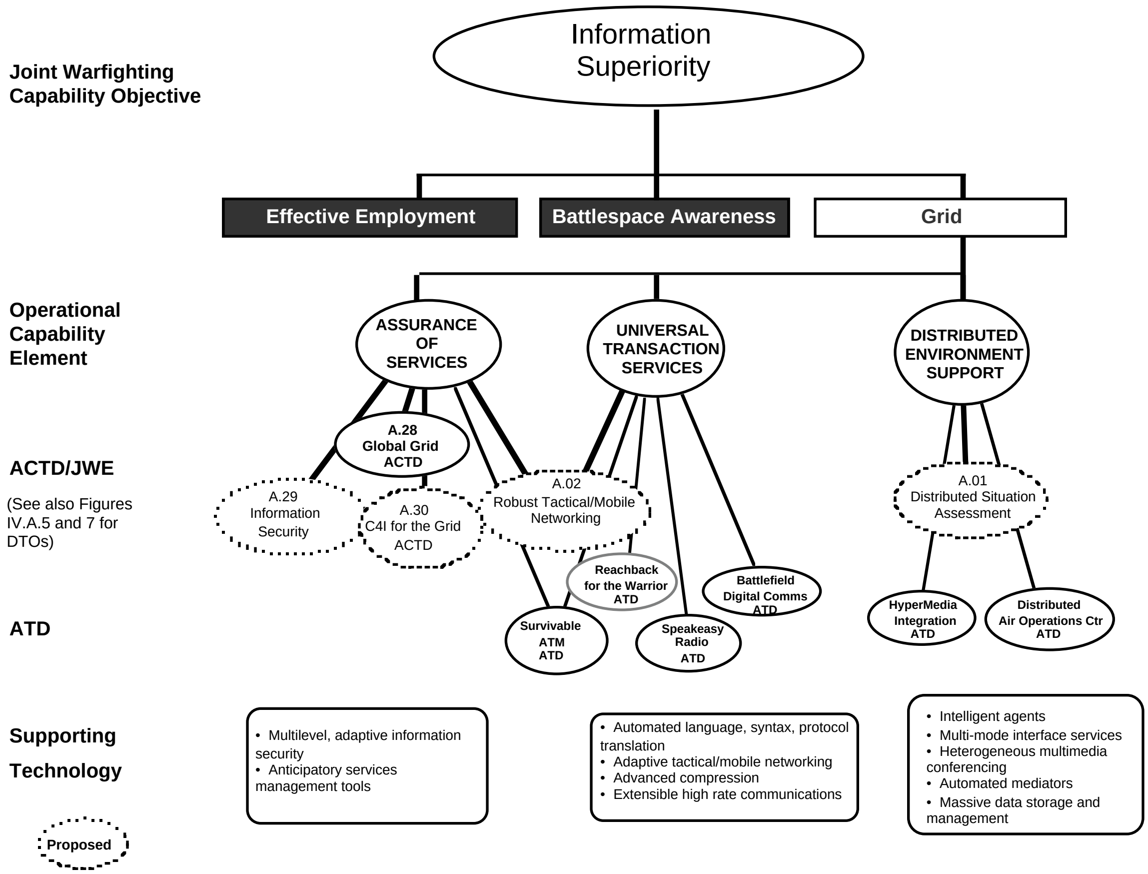


Figure IV.A.4. Technology to Capability – Information Superiority (cont'd)

DTO #	TITLE
A.01	Distributed Situation Assessment ACTD
A.02	Robust Tactical/Mobile Networking ACTD
A.03	Joint C4I for Rapid Force Projection ACTD
A.04	Intelligent, Joint Force Automated Battle Doctrine
A.05	Retasking and Rehearsal for Coordinated Operations On-the-Move
A.06	Distributed Empowerment
A.07	Adaptive Force Package Tailoring
A.08	Theater Joint Information and Spectrum Dominance
A.09	Distributed Battlespace Opportunity Planning
A.10	IW Battle Management ACTD
A.11	Integrated Collection Management ACTD
A.12	End-to-End, Task Synchronized, Mission Support to the Warfighter
A.13	Rapid Battlefield Visualization ACTD
A.14	Battlefield Awareness and Data Dissemination ACTD
A.15	GEODSS Upgrade ACTD
A.16	Unattended Ground Sensor ACTD
A.17	Operator Intelligence Interface ACTD
A.18	Semi-Automated Imagery Processing ACTD
A.19	Knowledge Based Information Presentation
A.20	Cognitive Mission Support to the Warfighter
A.21	High Altitude Endurance UAV ACTD
A.22	Medium Altitude Endurance UAV ACTD
A.23	Small Satellite SAR ACTD
A.24	Wide Area Tracking System ACTD
A.25	Counter Camouflage, Concealment, and Deception ACTD
A.26	Universal Transaction Services
A.27	Distributed Environment Support
A.28	Global Grid Tactical Fiber ACTD
A.29	Information Security
A.30	C4I for the Grid ACTD
A.31	Assurance of Services
A.32	Joint Tactical UAV ACTD
B.01	Precision Strike Counter MRL ACTD
B.02	Rapid Force Projection Initiative ACTD
D.06	Phase II Detect, Cruise Missile Defense

Figure IV.A.5. Defense Technology Objectives – Information Superiority

DTO #	TITLE
F.01	Synthetic Theater of War ACTD
F.02	Advanced Joint Planning
K.01	Total Distribution
K.02	Joint Logistics
HS.04.01.FN	Cognitive Engineering for Information Dominance
IS.01.01.AFNE	Consistent Battlespace Understanding (Joint Battlespace Awareness)
IS.02.02.AFNE	Forecasting, Planning, and Resource Allocation
IS.03.01.AFNE	Integrated Force Management
IS.15.01.NF	Global C4 Information System Infrastructure
IS.16.02.E	Portable Command and Control for the Joint Task Force
IS.17.02.NFE	Defensive Information Warfare
IS.18.02.F	Survivable Information Systems
IS.19.01.AF	Context-Based Information Distribution
IS.20.01.AFNC	Universal Transaction Communications
IS.22.01.AFN	Network Management
IS.23.01.AFNC	Digital Warfighter Communications
IS.24.01.AF	Multiband, Multimode Information System
IS.28.02.FE	Intelligent Information Technology
SE.01.01.ANF	Multi Mission UAV Sensor ATD
SE.03.02.N	High Frequency Surface Wave Radar (HFSWR) ATD
SE.04.01.ANF	Penetrating/Identification Radar
SE.17.02.ANFEC	ATR Dominant Target ID
SE.31.01.A	Digital Terrain Data Generation, Manipulation, and Standardization
SE.32.01.N	Warfare Support in the Littoral Battlespace
SE.33.01.ANF	Combat Weather Support
SE.36.01.ANF	Specification of the C3I Battlespace Environment

Figure IV.A.5. Defense Technology Objectives – Information Superiority (cont'd)

Demonstration Title	Effective Employment: Predictive Planning & Preemption	Effective Employment: Integrated Force Management	Effective Employment: Execution of Time Critical Missions	Battlespace Knowledge: Information Acquisition	Battlespace Knowledge: Consistent Battlespace Understanding	Battlespace Knowledge: Precision Information Direction	Grid: Universal Transaction Services	Grid: Distributed Environment Support	Grid: Assurance of Services	Service Agency	Demonstration is a: DTO	ACTD	ATD
Distributed Situation Assessment					●			●		*	A.01	X	
Robust Tactical/Mobile Networking							●		●	*	A.02	X	
Joint C4I for Rapid Force Projection			●		●					*	A.03	X	
Intelligent, Joint Force Automated Battle Doctrine			●							*	A.04		
Retasking and Rehearsal for Coordinated Operations On-the-Move		●								*	A.05		
Distributed Empowerment		●								*	A.06		
Adaptive Force Package Tailoring	●									*	A.07		
Theater Joint Information and Spectrum Dominance	●									*	A.08		
Distributed Battlespace Opportunity Planning	●									*	A.09		
IW Battle Management	●								○	*	A.10		
Integrated Sensor Tasking ACTD						●				*	A.11		
End-to-End, Task Synchronized, Mission Support to the Warfighter						●				*	A.12		
Rapid Battlefield Visualization ACTD					●					Army	A.13		
Battlefield Awareness and Data Dissemination ACTD					●					Joint	A.14		
GEODSS Upgrade ACTD				●						Air Force	A.15		

* ABIS DTO - Lead activity to be determined. ● Strong Support ○ Moderate Support

Figure IV.A.6. Demonstration Support – Information Superiority

Demonstration Title \ Operational Capability Elements	Operational Capability Elements: Effective Employment			Battlespace Knowledge			Grid			Service Agency	Demonstration is a:		
	Predictive Planning & Preemption	Integrated Force Management	Execution of Time Critical Missions	Information Acquisition	Consistent Battlespace Understanding	Precision Information Direction	Universal Transaction Services	Distributed Environment Support	Assurance of Services		DTO	ACTD	ATD
Unattended Ground Sensor ACTD				●	●					DoD	A.17	X	
Operator Intelligence Interface ACTD					●					TBD	A.17	X	
Semi-Automated Imagery Processing ACTD	○		○		●					DARPA	A.18	X	
Knowledge-Based Information Presentation					●					*	A.19		
Cognitive Mission Support to the Warfighter					●					*	A.20		
High Altitude Endurance UAV ACTD				●						Joint	A.21	X	
Medium Altitude Endurance UAV ACTD				●						Joint	A.22	X	
Small Satellite SAR ACTD				●						Air Force	A.23	X	
Wide Area Tracking System ACTD				●						DOE/Air Force	A.24	X	
Counter Camouflage, Concealment, and Deception ACTD				●						DARPA	A.25	X	
Universal Transaction Services							●			*	A.26		
Distributed Environment Support								●		*	A.27	X	
Global Grid Tactical Fiber ACTD									●	Joint			
Information Security									●	*			
C4I for the Grid ACTD									●	*			
Assurance of Services									●	*			
Joint Tactical UAV ACTD				●						Navy			
Precision Strike Counter MRL ACTD			●			○					B.01	X	

* ABIS DTO - Lead activity to be determined.

● Strong Support ○ Moderate Support

Figure IV.A.6. Demonstration Support – Information Superiority (cont'd)

Demonstration Title	Operational Capability Elements: Effective Employment			Battlespace Knowledge			Grid			Service Agency	Demonstration is a:		
	Predictive Planning & Preemption	Integrated Force Management	Execution of Time Critical Missions	Information Acquisition	Consistent Battlespace Understanding	Precision Information Direction	Universal Transaction Services	Distributed Environment Support	Assurance of Services		DTO	ACTD	ATD
Rapid Force Projection Initiative ACTD		○	●			○					B.02		
Phase II Detect, Cruise Missile Defense ACTD			●			○					D.06		
Synthetic Theater of War ACTD											F.01		
Advanced Joint Planning ACTD	●										F.02		
Total Distribution ACTD	○	○			○						K.01		
Joint Logistics ACTD	○	○			○						K.02		
Cognitive Engineering for Information Dominance					●					Joint	HS.04.01.FN		
Consistent Battlespace Understanding (Joint Battlespace Awareness)					●					Joint	IS.01.01.AFNE		
Forecasting, Planning, and Resource Allocation	●									Joint	IS.02.02.AFNE		
Integrated Force Management		●								Joint	IS.03.01.AFNE		
Global C4 Information System Infrastructure							●			Joint	IS.15.01.NF		
Portable Command and Control for the Joint Task Force		●	●							DARPA	IS.16.02.E		
Defensive Information Warfare									●	Joint	IS.17.02.FNE		
Survivable Information Systems									●	Air Force	IS.18.02.F		
Context-Based Information Distribution					●			●		Joint	IS.19.01.AF		
Universal Transaction Communications							●			Joint	IS.20.01.AFNC		

● Strong Support ○ Moderate Support

Figure IV.A.6. Demonstration Support – Information Superiority (cont'd)

Demonstration Title	Operational Capability Elements									Service Agency	Demonstration is a:		
	Effective Employment			Battlespace Knowledge			Grid						
	Predictive Planning & Preemption	Integrated Force Management	Execution of Time Critical Missions	Information Acquisition	Consistent Battlespace Understanding	Precision Information Direction	Universal Transaction Services	Distributed Environment Support	Assurance of Services		DTO	ACTD	ATD
Network Management						○	●	○	○	Joint	IS.22.01.AFN		
Digital Warfighter Communications			○			○			○	Joint	IS.23.01.AFNC		
Multiband, Multimode Information System							●			Joint	IS.24.01.AF		
Intelligent Information Technology						●				Joint	IS.28.02.FE		
Multi Mission UAV Sensor ATD					●					Joint	SE.01.01.ANF		
High Frequency Surface Wave Radar (HFSWR) ATD					●								
Penetrating/Identification Radar					●					DARPA	SE.04.01.ANF		
ATR Dominant Target ID						●				Joint	SE.17.02.ANFEC		
Digital Terrain Data Generation, Manipulation, and Standardization	○					●				Army	SE.31.01.A		
Warfare Support in the Littoral Battlespace			●							Navy	SE.32.02.N		
Combat Weather Support										Joint	SE.33.01.ANF		
Specification of the C3I Battlespace Environment	○				●					Joint	SE.36.01.ANF		

● Strong Support ○ Moderate Support

Figure IV.A.6. Demonstration Support – Information Superiority (cont'd)

Demonstration Title \ Operational Capability Elements	Effective Employment: Predictive Planning & Preemption	Effective Employment: Integrated Force Management	Effective Employment: Execution of Time Critical Missions	Battlespace Knowledge: Information Acquisition	Battlespace Knowledge: Consistent Battlespace Understanding	Battlespace Knowledge: Precision Information Direction	Grid: Universal Transaction Services	Grid: Distributed Environment Support	Grid: Assurance of Services	Service Agency	Demonstration is a: DTO	Demonstration is a: ACTD	Demonstration is a: ATD
Joint Force Air Component Commander (JFACC)	●	●	●							DARPA			X
Dynamic Multiuser Information Fusion					●					DARPA			X
Littoral Warfare RT EM Interference Management	○									Navy			X
Remote Sentry				●						Army			X
Hunter Sensor Suite				●						Army			X
Target Acquisition				●						Navy			X
Low Probability of Intercept (LPI) Sensors				●						Air Force			X
Expanded Situation Awareness Insertion					○					Army			X
Rapid Terrain Visualization					●					Army			X
Battlespace C2			○		●					Army			X
Battlefield Combat Identification			●	○	○					Air Force			X
Distributed Air Operations Center	●								●	Air Force			X
Operations/Intelligence Intergration	●									Air Force			X

● Strong Support ○ Moderate Support

Figure IV.A.6. Demonstration Support – Information Superiority (cont'd)

Demonstration Title \ Operational Capability Elements	Operational Capability Elements: Effective Employment		Battlespace Knowledge			Grid			Service Agency	Demonstration is a:		
	Predictive Planning & Preemption	Integrated Force Management	Execution of Time Critical Missions	Information Acquisition	Consistent Battlespace Understanding	Precision Information Direction	Universal Transaction Services	Distributed Environment Support	Assurance of Services		DTO	ACTD	ATD
Survivable ATM							●		●	Air Force			X
USTRANSCOM Planning	●									Air Force			X
Hypermedia Integration								●		Air Force			X
SIGINT Correlation			●		●					Air Force			X
Multi-sensor Automatic Target Recognition (ATR)			●		●					*			X
Integrated Target Tracking			●		○					*			X
Real-Time Cognition Aiding Displays			●		●					Navy			X
Enhanced All Source Fusion					●					Air Force			X
Real-Time Cueing Identification				●						Air Force			X
Information for the Warrior									●	Air Force			X

* ABIS DTO - Lead activity to be determined.

● Strong Support ○ Moderate Support

Figure IV.A.6. Demonstration Support – Information Superiority (cont'd)

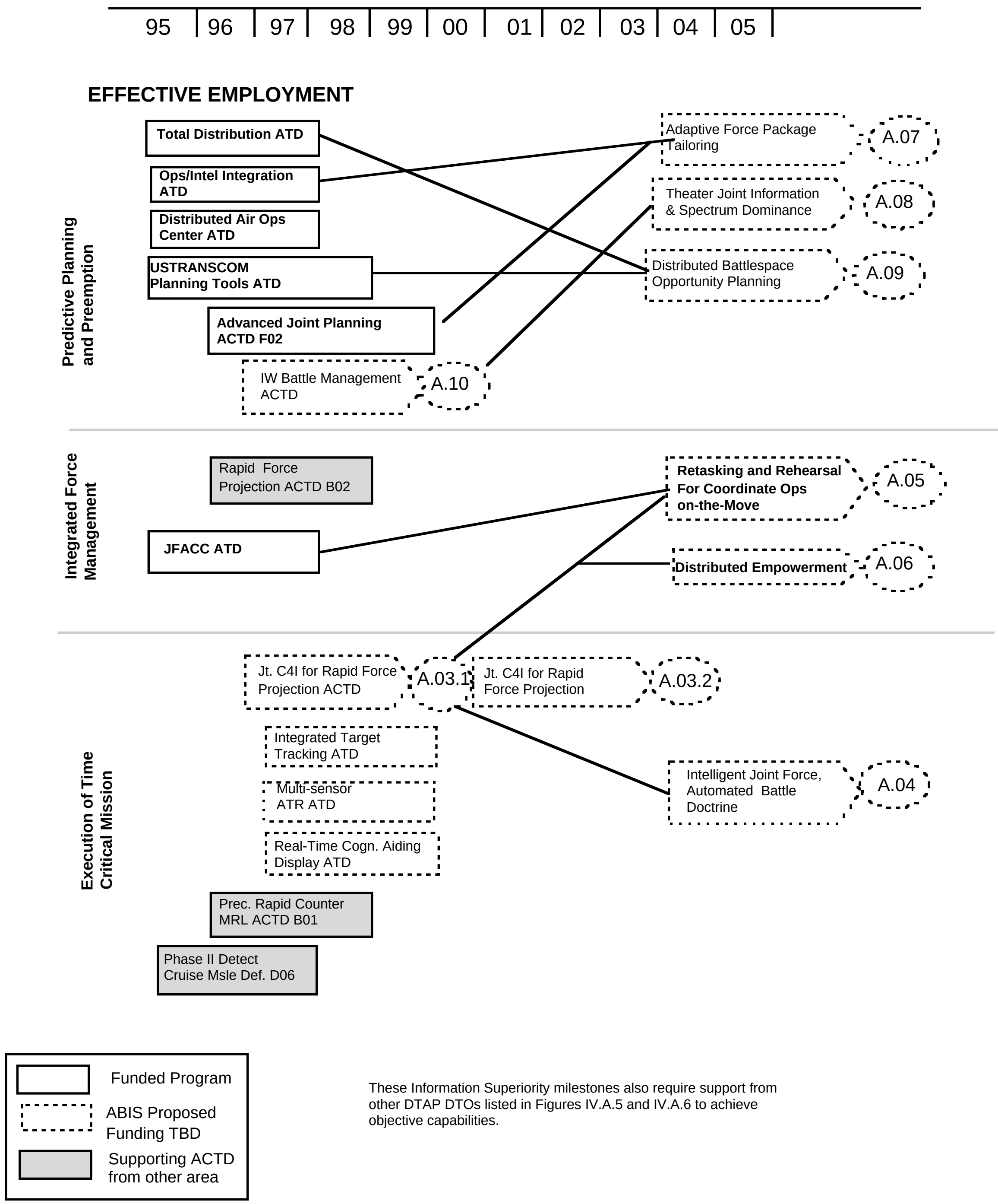


Figure IV.A.7. Roadmap – Information Superiority

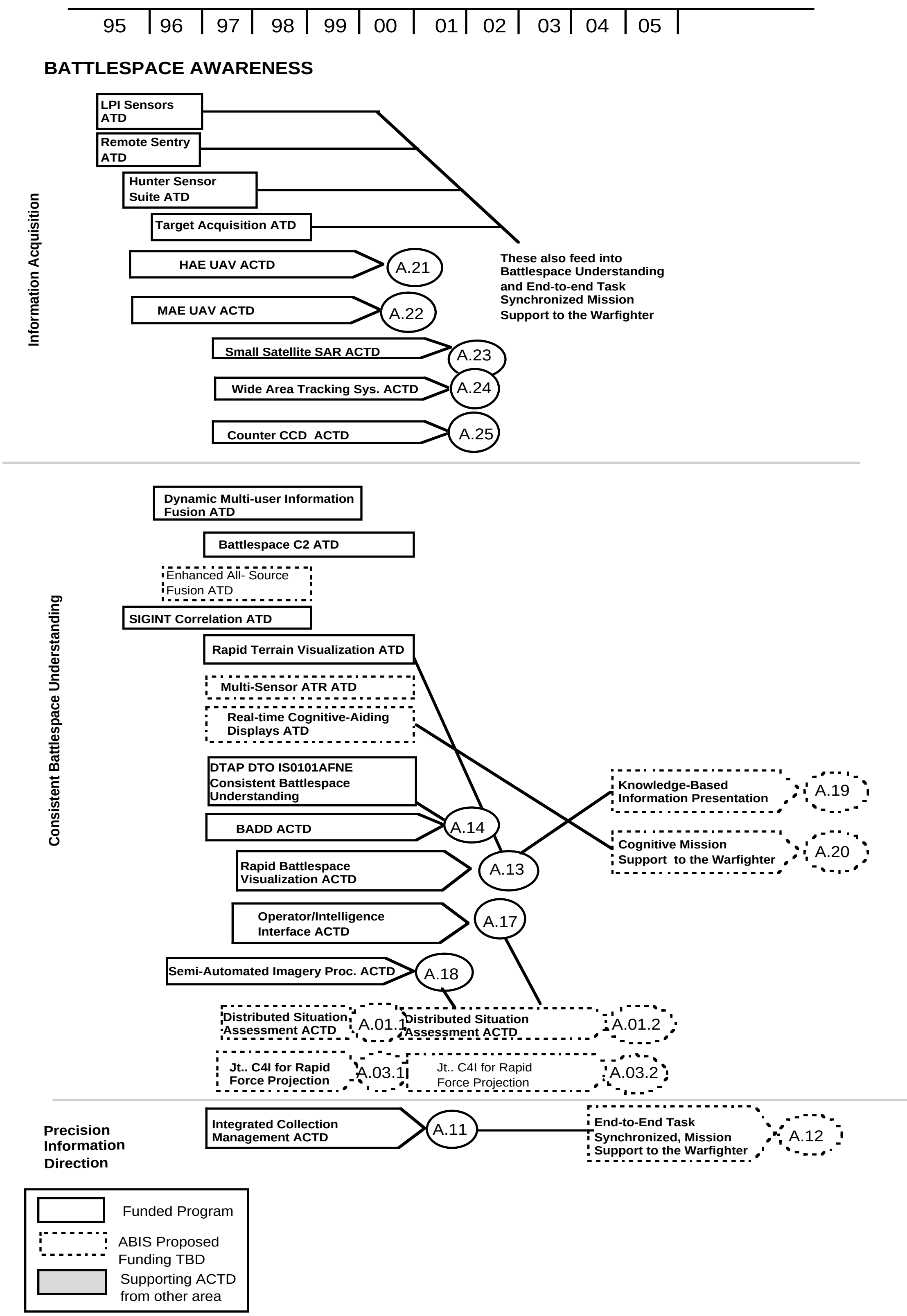


Figure IV.A.7. Roadmap – Information Superiority (continued)

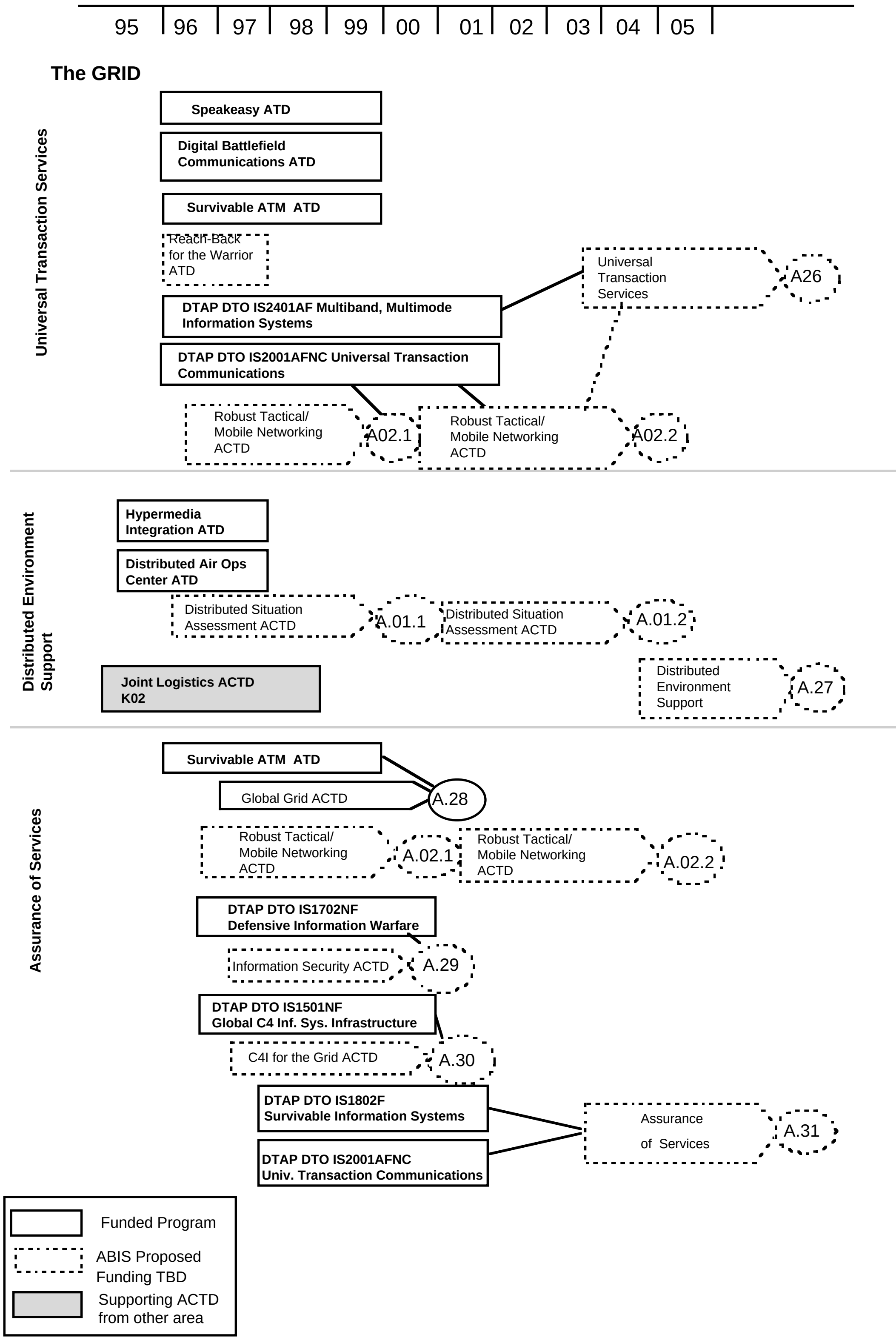
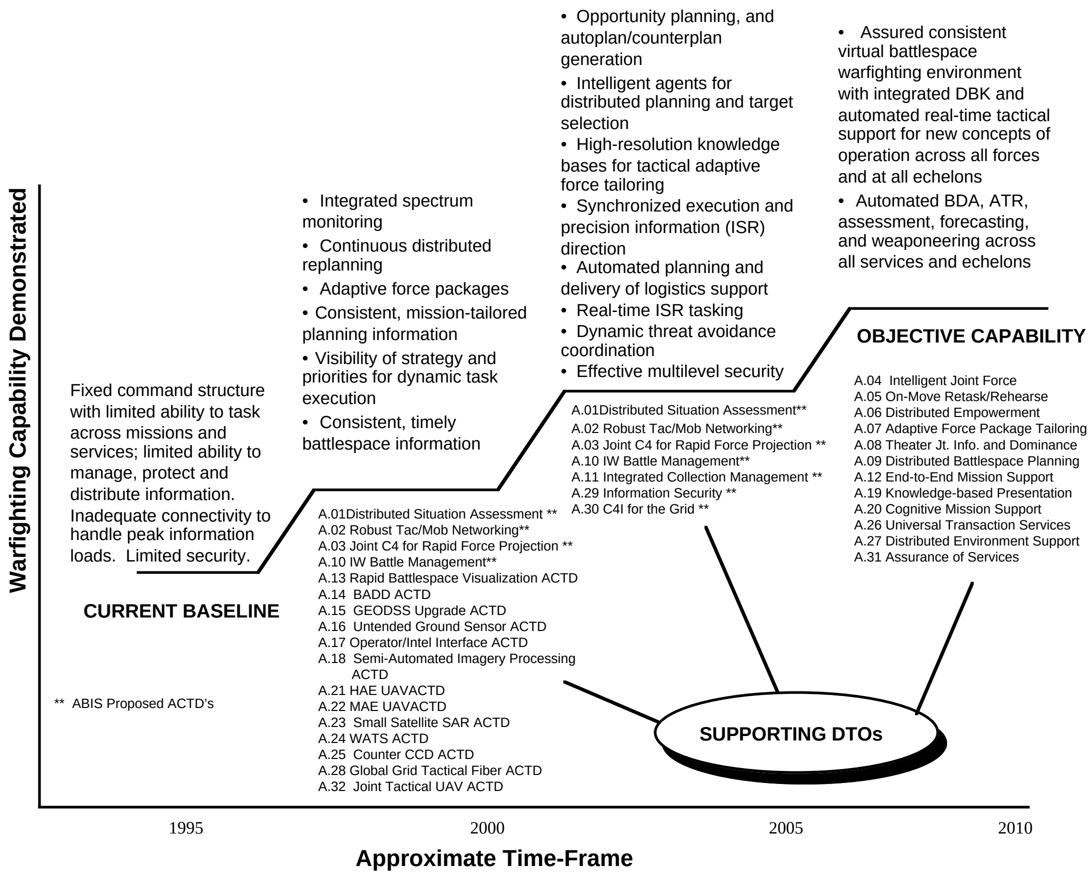


Figure IV.A.7. Roadmap – Information Superiority (cont'd)



Because of space constraints, DTAP DTOs listed as critical to obtaining the interim and objective capabilities are not displayed here. For further information, Figure IV.A.6 shows which of the nine Information Superiority operational capabilities the DTAP DTOs support; the DTAP describes objective capabilities for these demonstrations in more specific terms.

Figure IV.A.8. Progress – Information Superiority

B. PRECISION FORCE

1. Definition

Precision Force is the capability to destroy selected high-value and time-critical targets or inflict damage with precision while limiting collateral damage. This capability includes precision-guided munitions, surveillance, and targeting capabilities. It requires advances in sensors, C2 interoperability, battle management, and lethality. It also requires precision-guided munition enhancements for increased range, accuracy, and weapon effectiveness. Additionally, "sensor-to-shooter" C4I enhancements are necessary for responsive, timely force application. The C4I enhancements are included in the previous section on Information Superiority. Figure IV.B.1 shows a typical concept of Precision Force. Additional components include land- and sea-launched fighter and bomber aircraft, Tomahawk Land Attack Missile (TLAM), and naval gunfire.

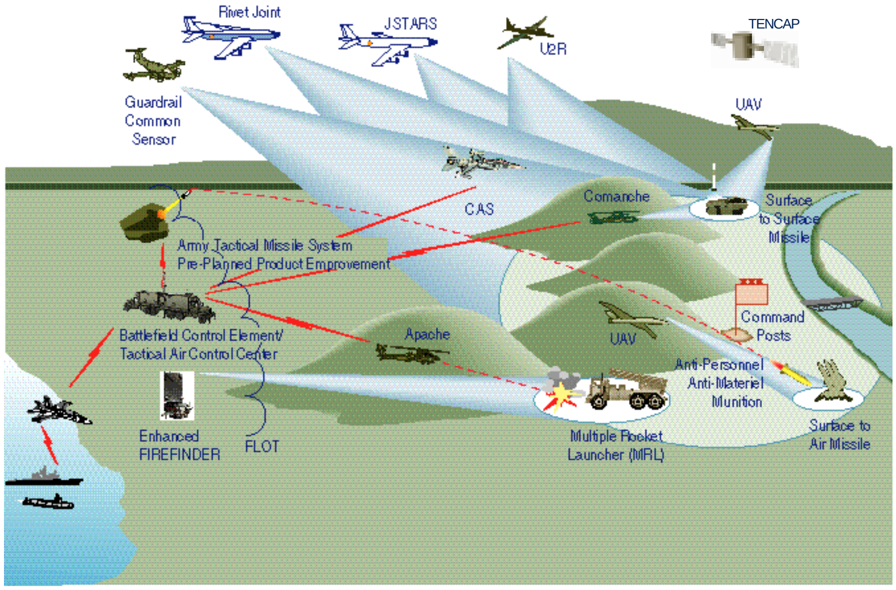


Figure IV.B.1. Precision Force Concept

2. Operational Capability Elements

Mission space is no longer linear or sequential. Whenever possible, the commander seeks to attack and neutralize enemy forces and capabilities throughout the breadth and depth of the mission space to break the coherence and continuity of the enemy's operations.

Precision Force requires operational capability elements for mission planning, weapons employment, combat assessment, and C4I. Sub-elements exist within each of these operational capability elements and must be considered when identifying critical capabilities for Precision Force. Similarly, target acquisition, weapon system employment, and survivability sub-elements must be considered when addressing weapons employment.

3. Functional Capabilities

Precision Force operational capability elements are made possible by a number of functional capabilities. Figure IV.B.2 displays the linkages between operational and functional capabilities. These linkages enable the identification of the critical capabilities essential for employing Precision Force. As an example, the Precision Force Mission Planning Operational Capability Element is strongly dependent on, but not limited to, battlespace management, target prioritization, long-range sensors, and timely intelligence dissemination to the user. Weapon employment is strongly dependent on, but not limited to, weapon resource allocation, target prioritization, and precision weapon lethality.

Combat assessment, which is vital for gauging attack effectiveness, planning follow-up strikes, and assessing the enemy's ability to continue is strongly dependent on, but not limited to, 24-hour, all-weather sensors, responsive targeting and planning products, and counter-camouflage, concealment and deception penetration.

C4I data must be netted to the battlespace grid and into supporting segments of the grid. This is strongly dependent on, but not limited to, battlespace management, intelligence preparation of the battlefield, and the effective correlation and fusion of sensor data.

4. Current Capabilities, Deficiencies, and Barriers

Operational capability elements and current associated limitations are presented in Figure IV.B.3. Major deficiencies confronting the area of mission planning are the timely combat decision and resource allocation processes in relation to target cycle time, the detection of highly mobile targets in crowded mission space, slow processes for fusing various Service automated mission planning systems for target information, and time consuming and incomplete battle damage information and assessments.

Functional Capabilities \ Operational Capability Elements	Mission Planning		Weapon Employment			Combat Assessment	C4I
	Planning	Surveillance & Reconnaissance	Target Acquisition	Weapon System Employment	Survivability	Combat Assessment	C4I
1. Scheme of Operations	●	●	●	●	●	●	●
2. Battlespace Management	●	●	○	○	○	○	●
3 . Intelligence Preparation of the Battlefield	●	●	●	○	○	●	●
4. Target Priorities	●	●	●	●	○	○	○
5. Weapons (resource) Allocation	●	○	○	●	●	○	○
6. Target Data Base	●	●	○	●	●	○	○
7. Round-the-Clock, Day/Night, All-Weather Coverage (Sensors)	●	●	●	●	○	●	○
8. Counter CC&D Penetration	○	●	●	●	○	●	○
9. Responsive Targeting/Planning Products	●	●	●	●	○	●	●
10. Long Range Sensors (Deep Look)	●	●	○	○	○	●	●
11. Survivable	●	●					
12. Area Coverage	●	●	○	○	○	●	○
13. Correlation/Fusion	●	●	●			●	●
14. Timely Intelligence Dissemination to User (planner and shooter, RTIC)	●	●	●	○	●	●	●
15. Timely Sensor Re-Tasking			●			●	●
16. Timely and Accurate Location or Track Data		○	●				
17. Combat ID			●			●	●
18. Automatic Target Recognition		○	●			●	●
19. All-Weather, Day/Night Capable	○	●	○	●		○	
20. Responsive				●		○	

● Strong Support ○ Moderate Support

Figure IV.B.2. Functional Capabilities Needed for Precision Force

Functional Capabilities \ Operational Capability Elements	Mission Planning		Weapon Employment			Combat Assessment	C4I
	Planning	Surveillance & Reconnaissance	Target Acquisition	Weapon System Employment	Survivability	Combat Assessment	C4I
21. Long Range							
22. Flexible Weapon Platform (precision)	○			●			
23. Lethal (precision)		○		●			
24. Discriminate/Combat Identification			○	●	○		
25. Base Defense/Force Protection					●		
26. Air Superiority			○	○	●		
27. SEAD	○			○	●	○	
28. Timely Product	○	○				●	●
29. Retaskable Sensor	○					●	
30. Accurate						●	
31. Updates to Targeting Database	○					●	
32. Secure, Interoperable C4 Structure (communications, data bases, protocols, etc.)	●	●	○	○	○	○	●
33. Dynamic Database	●	●	○	○		●	
34. Proactive Architecture ("pull" right information at the right time system)	●		●	●	●	●	
35. Geopositioning	●	●	●	●	●	●	●
36. Joint Battlefield Architecture	●	●	○			○	●

● Strong Support ○ Moderate Support

Figure IV.B.2. Functional Capabilities Needed for Precision Force (cont'd)

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Mission Planning			
Provide a real-time, fused, battlespace picture with integrated decision aid tools. This will assure coordinated and dynamic planning and execution of a broad spectrum of missions from time-phased attack of targets to reconnaissance of battle areas and prosecution of time critical targets by integrated hunter-killer-controller assets.	Planning 1. Scheme of operations 2. Battlespace management 3. Intelligence preparation of the battlefield 4. Target priorities 5. Weapons (resource) allocation 6. Target data base C4I 7. Round-the-clock, day/night, all-weather coverage (sensors) 8. Counter CC&D penetration 9. Responsive targeting/planning product/timely dissemination 10. Long range sensors (deep look) 11. Survivable 12. Area coverage 13. Correlation/fusion	1. Very large 2. Costly 3. Training required 4. Timeliness 5. Integration with aircraft is limited - may have to type in data after doing planning 6. Can't do mission planning/replanning in aircraft 7. Services use different systems 8. Mission rehearsal 9. Inaccurate aircraft weapons data and algorithms	1. Integrated Target Track 2. Multi-Sensor ATR 3. Real-Time Cognizant Aiding Display 4. Hunter Sensor Suite 5. Remote Sentry 6. Strike Weapon Adaptable Video and Communi-cations Tech-nology (podless video and data links) 7. Battlefield Awareness and Data Collection 8. Real-time temp-late/weapons retargeting 9. Helmet mounted display
Operational Capability Element: Weapons Employment			
Provide processing and linkages that enable rapid target search and acquisition, battle coordination and target selection, as well as hand-off and engagement for prosecution of time critical targets.	Target Acquisition 14. Timely intelligence dissemination to user (planner and shooter) 15. Timely sensor re-tasking 16. Timely and accurate location or track data 17. Combat ID-cooperative and non-cooperative systems 18. Automatic target recognition Survivability 25. Base Defense/Force Protection 26. Air superiority 27. SEAD	10. Mobile target engagement 11. GPS jamming 12. Affordability 13. BDA 14. All-weather 3m CEP weapon 15. Low collateral hard target weapon 16. Hypersonic weapons 17. IFF 18. High off-boresight high angle of attack 19. Nonlethal weapons	3. 4. 5. 8. 10. Miniaturized munitions technology guided flight test 11. Advanced unitary penetrator 12. Anti-jam GPS technology flight test 13. Hammerhead (SAR guidance) 14. Hard target smart fuze 15. Smart soft target munitions demo 16. Intelligent minefield

Figure IV.B.3. Goals, Limitations, and Technologies for Precision Force

	Weapon System Employment 19. All weather, day/night capable 20. Responsive 21. Sufficient range 22. Flexible weapon platform (precision)-retargetable 23. Lethal (precision) 24. Discriminate/Combat ID		17. Precision guided munitions 18. EFOG 19. Crewman's association 20. Precision strike guide navigator 21. Concurrent design ball-joint gimbal 22. Countermine 23. Rapid force projection 24. Shallow water torpedo G&C 25. Highly responsive missile control system 26. Smart skins array 27. Advanced missile airframe 28. Multimode warhead
Operational Capability Element: Combat Assessment			
Provide ability to determine near real-time physical effect of force application to targets and quickly assess impact on in-theater operations.	Combat Assessment 19. 28. Timely product 29. Retaskable sensor 30. Accurate 31. Interoperable updates to targeting database	20. Tasking 4. 21. Limited tactical assets F14 (TARPS) + UAV 7. 13. 22. Counter CCD	6. 23. 29. Joint Precision Strike 13.
Operational Capability Element: C4I			
Provide joint core mission planner, with fully automated "virtual battlefield view" (100% consistent across echelons, with aggregation), which results in direct sensor/shooter tasking in <1 minute with predictive delivery of electronic mission support.	C4I 11. 32. Secure, interoperable C4 structure (communications, data bases, protocols, etc.) 33. Dynamic database 34. Proactive architecture (pull right information at the right time system) 35. Geopositioning 36. Joint battlefield architecture	4. 7. 23. Too much or too little data 24. No/limited fusion of data, i.e., same track from multiple sources or sensors 25. UHF limited to line-of-sight	6. 8. 25. 30. Digital Battlefield Communications 31. Battlespace Command and Control 32. Precision SIGINT Target 33. LPI Communication System 34. LPI Sensors 35. Tactical UAV

Figure IV.B.3. Goals, Limitations, and Technologies for Precision Force (cont'd)

Deficiencies affecting the area of weapons employment are the inability to satisfy the simultaneous need for sensor information, the limited ability of some sensors to acquire and track multiple targets; inadequate coordination of sensor information among battle managers, lack of an all-weather/day-night precision (3m CEP) weapon capability, sortie efficiency for attacks against hard, buried, and strategic targets, GPS jamming, and more affordable precision-guided munitions.

Deficiencies confronting the area of combat assessment revolve around timeliness (either real-time or near-real-time rather than the current capability of several hours) and accuracy. A major challenge is to counter an adversary's camouflage, concealment, and deception techniques to obtain accurate battle damage assessments and to measure weapons effectiveness.

Deficiencies in the C4I area focus on two trends. First is the need to handle ever-increasing amounts of information more quickly than ever before. Second is the steady integration of C4I functions into a modular "system-of-systems" architecture that maximizes information availability and aids the planners and warfighters in making the most effective use of that information. The ability to conduct rapid, accurate target study and selection requires substantial development, as does the ability to follow up attacks with comprehensive combat assessments. Technology that will facilitate the completion of real-time, collaborative planning both in the area of operations and at distributed staff locations must be a priority. To support planning improvements, staffs and commanders need to be able to track force status and execution. Rapid, precise strike planning will be improved by the development of a capability to quickly pair mission requirements, target locations, and physical characteristics to weapons delivery systems. The capability to better manage and integrate intelligence, surveillance, and reconnaissance analysis will enhance the development of Precision Force development.

5. Technology Plan

The science and technology program to correct the deficiencies discussed in the previous section is shown in Figure IV.B.4. The Defense Technology Objectives (DTOs) that will provide the new capabilities are listed in Figure IV.B.5. The demonstrations of new capabilities are shown with the related operational capability elements in Figure IV.B.6, and the schedule for achieving the DTOs is shown in Figure IV.B.7.

The four ACTDs that address the deficiencies in the four Precision Force operational capability elements are Precision SIGINT Targeting (PSTS), Rapid Force Projection Initiative (RFPI), Precision Rapid Counter Multiple Rocket Launcher (PRCMRL) and Survivable Armed Reconnaissance on the Digital Battlefield (SARDB). When the last of these ACTDs are completed and the operational capability element goals are achieved, a precision force cooperative engagement capability will have been demonstrated.

The PSTS and SARDB ACTDs address the C4I operational capability elements. By FY 1998, the PSTS ACTD will have demonstrated its objectives of worldwide capability for precision target location, rapid dissemination of data, and the integration of multiple data sources. The results of this ACTD will be used by the SARDB ACTD to meet its objectives. Both of these ACTDs will rely on the results of the Digital Battlefield

Communications ATD, as well as a variety of key 6.2 and 6.3 supporting technologies, to meet their objectives.

The RFPI and PRCMRL ACTDs address the mission planning operational capability deficiencies. The RFPI ACTD will demonstrate increased lethality and survivability for light forces, precision munitions delivery beyond line of sight, and expanded mission space and faster operations tempo via modeling, simulation, and wargaming exercises. The PRCMRL ACTD will do the same for a Korean scenario. This will result in technologies and techniques to provide a real-time, fused, mission space picture to be developed and demonstrated by FY 2001. The Hunter Sensor Suite and EFOG-M are among the ATDs that support these ACTDs.

The weapons employment operational capability deficiencies are addressed primarily by the PRCMRL ACTD. A variety of weapons and platforms will be modeled and operations simulated as part of the Korean scenario, along with the associated ISR techniques. This will provide processing and linkages that enable rapid target search and acquisition, battle coordination and target selection, and handoff and engagement for the prosecution of time-critical targets.

The ATDs and supporting key technology efforts are advancing work on data fusion and combining automatic target recognition technologies with precision location so that weapons can find the types of target specified, or even the particular target, and guide a weapon to hit the target within a few feet of a designated impact point. The Air Force's hyperspectral sensor program is one approach; the use of three dimensional information from a laser radar is proving to be successful. A Navy initiative to destroy time-critical targets will demonstrate the capability to redirect missiles and attack aircraft while on a mission so as to exploit real-time retargeting.

A major focus is demonstrating Global Positioning System (GPS) applications to existing weapons, including the Tomahawk cruise missile and extended range-guided MLRS. GPS applications for new weapons are also being developed. Examples include a Navy effort to demonstrate an inexpensive cruise missile and an Air Force effort to develop small smart bomb technology. The Air Force Miniaturized Munition Technology guided flight test will demonstrate the use of GPS guidance on a small penetrator munition. This new capability will dramatically improve the sortie efficiency for attacks against all but the very hardest fixed targets. Another flight demonstration by the Air Force, called Anti-jam GPS Technology Flight Test (AGTFT), will demonstrate an affordable solution for protecting against an enemy jamming a GPS guided munition. This technology will be demonstrated on a JDAM vehicle in FY 1998.

The Army Guided MLRS program will increase the accuracy of the Extended Range MLRS rocket to a 3 mil system. The BAT Preplanned Product Improved (BAT P3I) will be delivered by Army TACMS Block II, the extended range Block IIa missiles, and MLRS rockets. BAT P3I utilizes acoustics, millimeter wave, and imaging infrared seekers while expanding the BAT target set to include cold, stationary armor, moving armor, SSMs, and MRLs. It includes a selectable warhead that will be switched to hard or soft target mode prior to impact. The BAT P3I is currently in the Dem Val Phase with two competing seeker concepts. The Air Force and Army are jointly pursuing another antimateriel munition called LOCAAS. LOCAAS uses a laser radar (LADAR) seeker to search, identify, and track ground mobile targets and attacks with a multimode warhead.

LOCAAS is being designed for delivery in MLRS and from Air Force fighter and bomber aircraft.

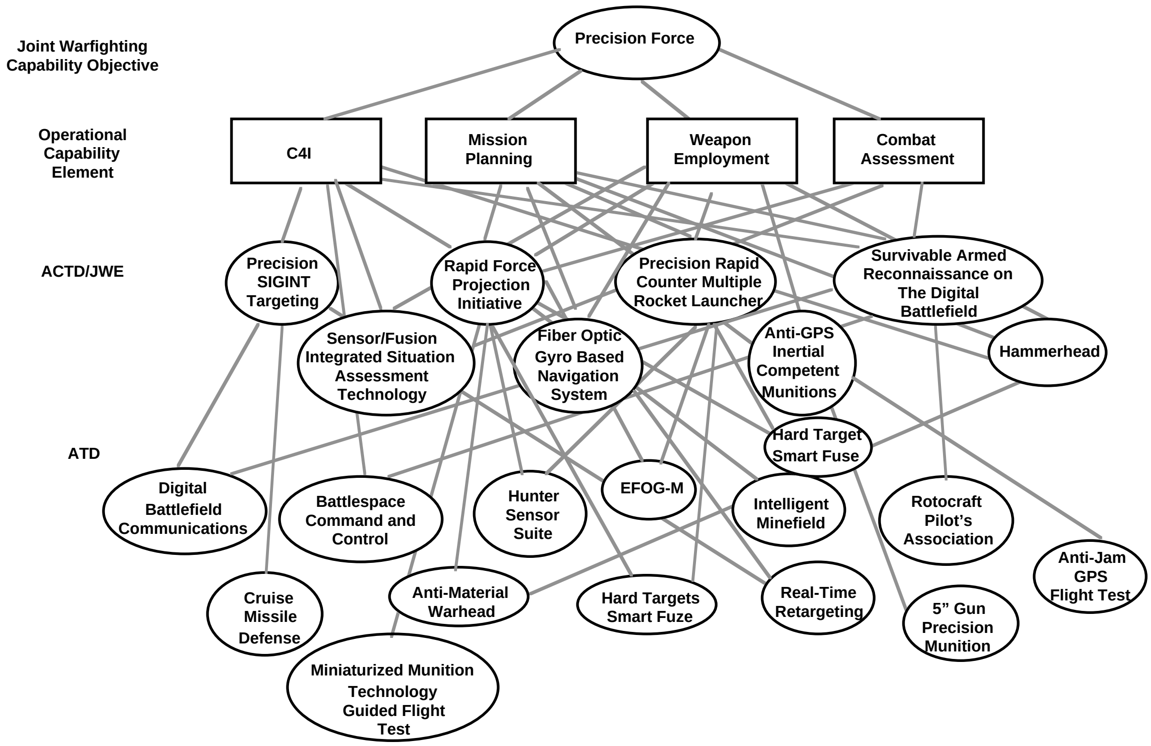
The Air Force is also developing an expanded, more capable air command and control network based on the air operations center, but distributed to Airborne Command and Control Centers, the Airborne Warning and Control System, and the Joint Surveillance Target Attack Radar System. These systems receive tactical information from their own sensors and from other intelligence platforms and processing systems, and can, in turn, rapidly direct combat elements to air superiority, ground attack, or interdiction missions.

In addition to addressing the deficiencies in two other operational capabilities, the SARDB ACTD also addresses the deficiencies in Combat Assessment. By linking the RAH-66 and UAV tactics, the issues of enroute threat updating and dynamic retasking will be addressed. This will provide the ability to determine near-real-time physical effects of force application to targets and quickly assess the impact on in-theater operations.

The Joint Precision Strike Demonstration includes the Integration and Evaluation Center (IEC), a simulation facility providing real, virtual, and constructive elements. It can use prerecorded and scripted events on a virtual battlefield. The IEC has a special capability to collect and record data during a demonstration, compute and display user-defined Measures of Effectiveness (MOE) in real time, and to provide for assessment and evaluation of critical Precision Strike parameters.

6. Summary

The integration of DTOs such as Sensor Fusion/Integrated Situation Assessment Technology, PRCMRL, Hammerhead, and RFPI will, over the period of time covered by the Future Years Defense Plan (FYDP), provide a greater ability to accurately locate, identify, and destroy nearly all classes of targets. By FY 2003, a Precision Force cooperative engagement capability will be demonstrated. Figure IV.B.8 shows the progressive introduction of each DTO to provide the desired capability by the end of the FYDP.



Supporting Key Technologies:
- Multi-sensor ATR
- Digital Battlefield Communications
- Warheads for armor defeat
- Integrated high payoff rocket propulsion technology
- Energetic materials/warheads
- Low cost competent munitions
- Strike weapon video and communication technology
- Tactical UAVs
- Hard target smart fuze
- The Army's combined arms weapons system
- Joint communication technology
- LOCAAS
- Precision Guidance

Figure IV.B.4. Technology to Capability – Precision Force

DTO#	Title
B.01	Precision Rapid Counter Multiple Rocket Launcher ACTD
B.02	Rapid Force Projection Initiative (RFPI) ACTD
B.03	Precision SIGINT Targeting System (PSTS) ACTD
B.04	Survivable Armed Reconnaissance on the Digital Battlefield (SARDB) ACTD
WE.24.08.ANF	Sensor Fusion/Integrated Situation Assessment Technology
WE.21.02.NE	Fiber Optic Gyro Based Navigation Systems
WE.17.02.F	Hammerhead
WE.12.02.ANFH	Anti-Jam GPS Inertial Competent Munitions
WE.05.02.AF	Anti-Material Warhead Flight Test
WE.08.02.F	Miniaturized Munition Technology (MMT) Guided Flight Test
HS.14.05.A	Rotorcraft Pilot Associate

Figure IV.B.5. Defense Technology Objectives – Precision Force

Demonstration Title	Operational Capability Element: Mission Planning	Operational Capability Element: C4I	Operational Capability Element: Weapons Employment	Operational Capability Element: Combat Assessment	Service Agency	Demonstration is a: DTO	Demonstration is a: ACTD	Demonstration is a: ATD
Intelligent Minefield	●		●		Army			X
Hunter Sensor Suite	●		●		Army			X
Precision Rapid Counter Multiple Rocket Launcher	●		●		Joint	B.01	X	
Precision Guided Motor Munition	●		●		Army			X
Rapid Force Projection Initiative	●				Joint	B.02	X	
EFOG-M	●		●		Army			X
Guided MLRS	●		●		Army			X
Precision SIGINT Targeting System		●			Joint	B.03	X	
Rotocraft Pilot Associate				●	Army	HS.14.05.A		X
Battlefield Combat ID		●		●	Army	C.01		X
Survivable Armed Reconnaissance on the Digital Battlefield	●	●		●	Joint	B.04	X	
Sensor Fusion/Integrated Situation Assessment Technology	●	●	○	●	Joint	WE.24.08.ANF		X
Fiber Optic Gyro Based Navigation Systems	●		●		DARPA	WE.21.02.NE		X
Hammerhead	●	●	●		Air Force	WE.17.02.F		X
Anti-Jam GPS Inertial Competent Munitions	●		●		Joint	WE.12.02.ANFH		X

● Strong Support ○ Moderate Support

Figure IV.B.6. Demonstration Support – Precision Force

Demonstration Title	Operational Capability Element				Service Agency	Demonstration is a:		
	Mission Planning	C4I	Weapons Employment	Combat Assessment		DTO	ACTD	ATD
Antimaterial Warhead Flight Test	○		●		Air Force	WE.05.02.AF		X
Anti-jam GPS Technology Flight Test	○		●		Air Force			X
Hard Target Smart Fuze			●	○	Air Force			X
5" Gun Precision Munition			●		Navy			X
Cruise Missile Defense	○	○	●	○	Navy			X
Real-Time Retargeting	●	●	●	○	Navy			X
Precision Strike Navigator	○	○	●		Navy			X
Miniaturized Munition Technology Guided Flight Test	○		●		Air Force	WE.08.02.F		X

● Strong Support ○ Moderate Support

Figure IV.B.6. Demonstration Support – Precision Force (cont'd)

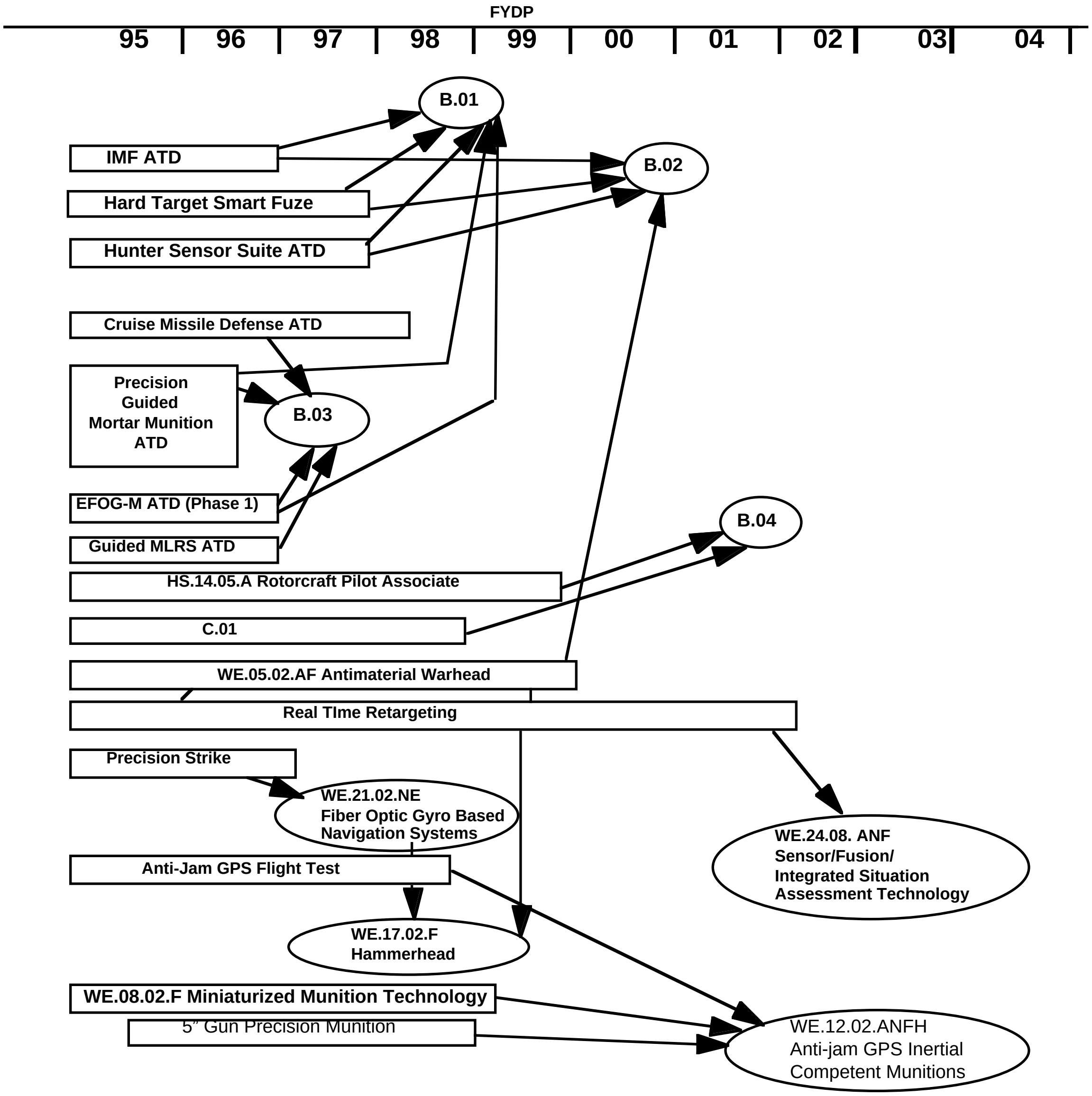


Figure IV.B.7. Roadmap – Precision Force

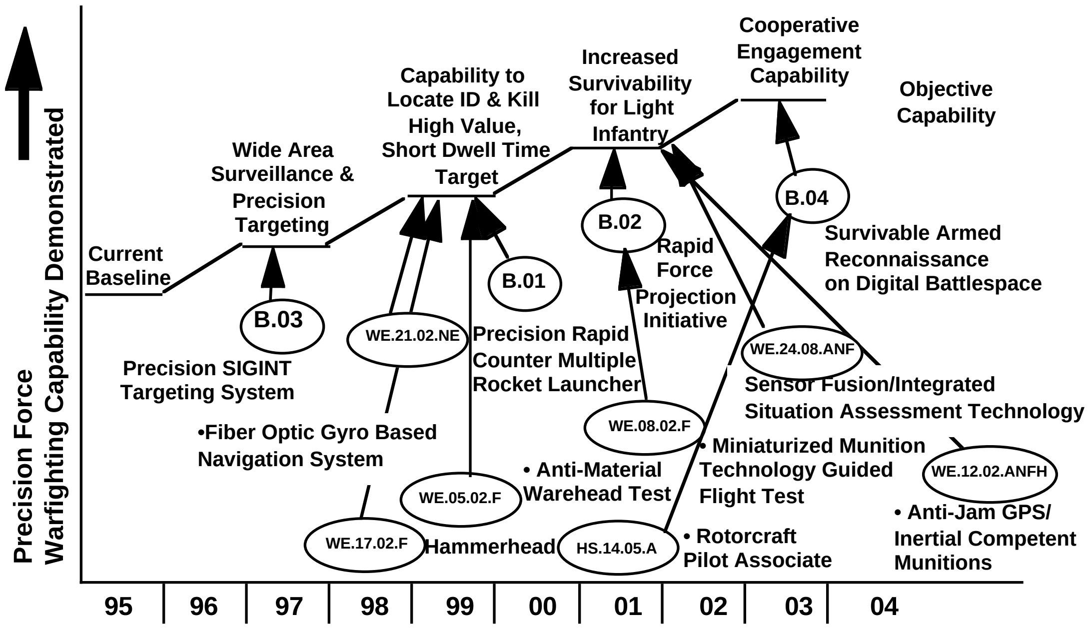


Figure IV.B.8. Progress – Precision Force

C. COMBAT IDENTIFICATION

1. Definition

Combat Identification is the ability to differentiate friend, foe, or neutral, in sufficient time, with high confidence, and at the requisite range to support engagement and weapons release decisions.

2. Operational Capability Elements

Combat Identification (CID) is a capability, not a single system. It is the result of a process that accurately characterizes entities in the combatant's area of responsibility. CID information is a required element in making sound battlefield decisions; i.e., enabling the real-time, efficient application of combatant resources. CID information is needed in all mission areas and for all types of targets, air and surface, as illustrated in Figure IV.C.1.

Most of the time, an identification characterization must at least distinguish between friendly, neutral, and adversary forces fast enough and with high enough confidence to support weapon employment decisions. At other times, the only identification information that may be needed is a class identification (e.g., cruise missile) or target recognition (e.g., tank vs. decoy) so that the correct defensive or offensive tactical resources can be brought to bear. Yet in still other cases, identification characterization down to very specific parameters, such as the platform type (e.g., MiG-29 vs. MiG-21) and intent (e.g., an active interceptor vs. a defector) is required for the efficient application of force. The goal for CID is to provide the necessary identification information for making correct weapon

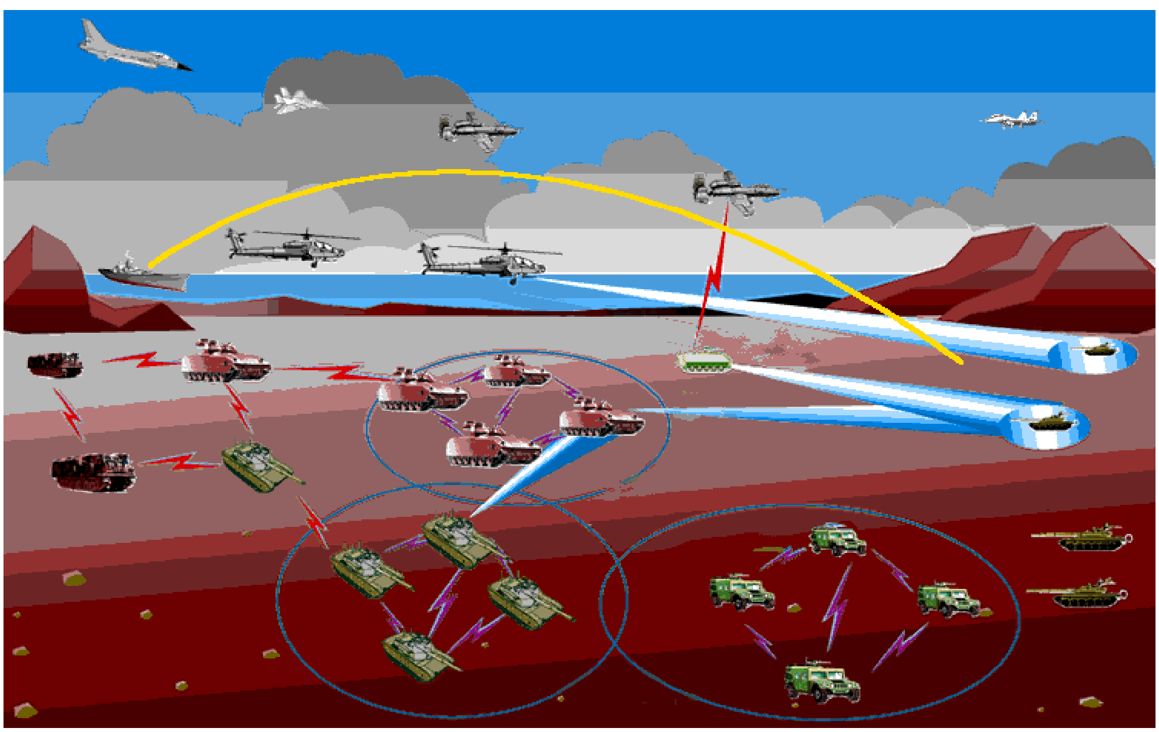


Figure IV.C.1. Combat Identification Concept

decisions. This CID approach supports the efficient attainment of the military objectives (winning the conflict with the fewest losses) while minimizing the chances of fratricide.

Providing an accurate CID capability when and where it is needed requires an integrated architecture that includes non-cooperative identification, cooperative identification, and improved situational awareness. The systems which provide these capabilities must work synergistically within this architecture to provide the required CID information. The "single system" approach to CID is not considered to be technically feasible or affordable. The best and most affordable solution uses the combination of systems and technologies that are ideally suited to each problem and the environment at hand. The additional requirements for CID to be interoperable across the services, non-exploitable by the enemy, secure, supportable, and affordable also apply for obvious reasons. Allied interoperability is desired.

The primary objective requirement for CID is to unambiguously correlate and assign a foe, friend, or neutral identification label to a "target." The assigning of the identification label can be done at any time from initial detection of the potential target into the theater (knowing where all friends, adversaries, and neutrals are all the time) to weapons employment. In order to be useful for a direct fire engagement, the correct target label must be correlated to a sensor return that is in a "weapon sight" (e.g., radar or thermal sight). Indirect fire weapons or supporting fire weapons may not necessarily have to correlate an identification label with a weapon sight if the identification is made unambiguously and sent to the weapon by the fire requester or a surveillance/ reconnaissance platform.

There are two approaches to determining target identification: 1) point a sensor system at the "target" and develop a label either non-cooperatively (e.g., jet engine modulation) or cooperatively (e.g., MK XII Identification Friend or Foe (IFF) system or Battlefield Combat Identification System (BCIS)); or 2) have the potential target declare (either periodically or when queried) its identification and position in a reference frame that the "shooter" can correlate with its own weapon and sensor system (e.g., Joint Tactical Information Distribution System, JTIDS). Both approaches have their strengths and limitations. If the identification is determined by an off-board sensor, there is the added necessity to pass and correlate the required information in a timely fashion. This requirement to correlate an identification label with a sensor return in the "weapon sight" is a key discriminator and a source of significant cost for the systems.

The vision is a fielded CID capability such that all combatant platforms will have available the required identification information in a timely fashion which is commensurate with the range and lethality of the platforms' weapons and sensors. The approach toward realizing this vision is through an integrated CID architecture which combines non-cooperative and cooperative identification sensors and systems with situational awareness capabilities. The required operational capability will then be achieved by combining onboard data from multiple sensors and systems with indirectly-supplied off-board information.

The operational capability elements can be aggregated into two categories: air target platforms and ground target platforms. This is due to the fundamental differences of the operating environments of the different platform categories. Ground platforms are closely spaced, move slowly, and are engaged at close ranges with imaging sensors. Air platforms are more dispersed, move at much higher speeds and are engaged at relatively long ranges with non-imaging sensors.

In general, the current CID capability against all platforms must be improved. The current CID capability in many cases does not allow for maximum use of weapons' range and engagement of targets in highly mixed, fast moving environments. The result is that combat effectiveness is often restricted by confining rules of engagement and procedures.

For ground targets (air-to-ground and ground-to-ground mission areas), the current capability is extremely limited. The objective is to have an initial level of high confidence CID capability fielded for all early-deploying, first line combatant platforms within ten years. The CID capability must provide the required identification information with very high confidence (>98 percent) by FY 2004.

For air targets (surface and ground-to-air and air-to-air mission areas), CID needs improvement in selected areas. In some cases, effective systems have been developed that could fill some of the needs but are not widely fielded. In other cases, very effective systems have been allowed to deteriorate over the years. The objective is to provide the required identification information nearly perfectly (>99.9 percent) by FY 2004.

3. Functional Capabilities

The functional capabilities for CID include foe identification (including platform type, class, and intent information), friend identification, neutral identification, and situational awareness. The functional capabilities required to meet the CID operational capability elements and the strength of their support are shown in Figure IV.C.2. The relative importance of these functional capabilities to the operational capability elements varies due to the fundamental differences in the missions and the operating environments of the potential targets.

Non-cooperative identification sensors and systems have the advantage of potentially identifying foes, friends, and neutrals and only require installation on weapon platforms or platforms which direct target engagement. Cooperative identification systems, which only identify friends, have the advantage of less technical challenge; although they require all friendly potential targets to be equipped with identification equipment. Situational awareness information can be made available from multiple sources (e.g., position and navigation equipment, sensors, and command, control and communications systems) although its usefulness for combat identification is dependent upon the accuracy and timeliness of the data, and the ability to correlate the information with the weapon sights or sensors. The advantage of situational awareness is that it makes use of equipment required for other purposes. All of these functional capabilities working together are needed to provide a robust, high confidence CID capability.

Functional Capabilities	Operational Capability Elements			
1. Foe Identification	●	○	●	●
2. Friend Identification	●	●	●	●
3. Neutral Identification	○	○	●	●
4. Situational Awareness	●	●	●	●

● Strong Support ○ Moderate Support

Figure IV.C.2. Functional Capabilities Needed for Combat Identification

4. Current Capabilities, Deficiencies, and Barriers

The U.S. baseline varies according to operational capability element mission area. Some technological capabilities have not been fielded while others have only been fielded to a small segment of the force.

The current air-to-surface/ground capability may be summarized as follows:

Foe Identification

- Use reconnaissance/surveillance aircraft to exploit electronic signals that may be emitted from a limited set of targets (Electronic Support Measures (ESM)).
- Recognize classes of ships using inverse synthetic aperture radar.

Friend Identification

- Employ marking schemes that can be seen with electro-optic sensors.
- Query ships with a cooperative system (MK XII mode 4).

Neutral Identification

- Visual identification only.

Situational Awareness

- Communicate general target locations situation via voice radio from Forward Air Controllers (FACs) to Close Air Support (CAS) aircraft.

The current ground-to-ground capability may be summarized as follows:

Foe Identification

- Visual identification only.

Friend Identification

- Query potential targets with a cooperative system (Battlefield Combat Identification System - not yet funded for production).
- Employ marking schemes that can be seen with electro-optic sensors.

Neutral Identification

- Visual identification only.

Situational Awareness

- Know general location of friendly battle participants based on tactical radios and the Enhanced Position Location and Reporting System.

The current surface/ground-to-air capability may be summarized as follows:

Foe Identification

- Classify the platform type via detailed analysis of the radar return (e.g., Jet Engine Modulation).
- Exploit electronic signals that may be emitted by the target (Electronic Support Measures (ESM)).

Friend Identification

- Query potential targets with a cooperative system (MK XII mode 4).

Neutral Identification

- Classify the platform type via detailed analysis of the radar return (e.g., Jet Engine Modulation).
- Exploit electronic signals that may be emitted by the target (Electronic Support Measures (ESM)).

Situational Awareness

- Shared "big picture" of the battlefield (JTIDS not fully fielded).

The current air-to-air capability may be summarized as follows:

Foe Identification

- Classify the platform type via detailed analysis of the radar return (e.g., Jet Engine Modulation).
- Exploit electronic signals that may be emitted by the target (Electronic Support Measures (ESM)).

Friend Identification

- Query potential targets with a cooperative system (MK XII mode 4).
- Classify the platform type via detailed analysis of the radar return (e.g., Jet Engine Modulation).

Neutral Identification

- Classify the platform type via detailed analysis of the radar return (e.g., Jet Engine Modulation).
- Exploit electronic signals that may be emitted by the target (Electronic Support Measures (ESM)).

Situational Awareness

- Shared “big picture” of the battlefield (JTIDS - not fully fielded).

For both air and ground weapons, tactics, techniques and procedures play a significant role in sorting friend from adversary or neutral in the battlespace.

The Joint Requirements Oversight Council has reviewed the CID joint warfighting needs by mission areas and has ranked the mission areas in terms of CID capability from the most deficient to the least deficient as follows:

- Air-to-surface/ground;
- Ground-to-ground;
- Surface/ground-to-air; and
- Air-to-Air.

The JROC noted that many U.S. platforms are currently deficient in CID systems and data links. No ground combatants have a long range identification capability, and many front line air superiority fighters have only limited CID suites.

There are two principle barriers to having universal CID capability on all air and ground platforms. The first barrier is affordability; the second is signature exploitability. The cost of CID (both cooperative and non-cooperative) suites that are properly integrated with the weapon sight are usually prohibitive if the only benefit that the system brings is a CID improvement. Additional functionality in the form of communications, situational awareness and/or sensing is helpful in making CID more affordable. The affordability of a system will also vary significantly depending on the environment in which it is considered. Aviation systems are generally more expensive than ground based (automotive) systems. As a result, solutions that are “affordable” for aircraft are often prohibitively expensive for combat vehicles. Technology that eases the integration overhead of a CID-related system and/or reduces its component cost is required.

Signature exploitability is the second barrier. Non-cooperative techniques of identification are most attractive to warfighters due to their ability to generate labels for foe, friendly, and neutral contacts, and because they can provide additional ID information on adversaries (e.g., platform type, class). For air targets, the current capabilities of these systems are limited in range, aspect, and timeliness of reporting. The result is that the indications from this class of system are frequently in the “unknown” or “not available” state. Improvements in sensors and target data bases that expand the envelope of performance for these systems are necessary. For combat vehicles, the signal environment is such that reliable identification at maximum weapons range remains a significant technical challenge. Limitations in sensor resolution coupled with the variation in target aspect, state, countermeasures, and the battlespace signal propagation environment complicate the job of target labeling. Technology improvements for improved sensors and automatic target recognition that can interpret imaging and non-imaging sensor data to reliably identify the platform type are necessary. The key technologies for reaching the Combat Identification Joint Warfighting Capabilities are shown in Figure IV.C.3

5. Technology Plan

The roadmap for developing and demonstrating these technologies has two main elements: ground target identification and air target identification. Each element addresses both the affordability and signature exploitability barriers. An overview of the relationship of the CID operational capability elements, functional capabilities, demonstrations and supporting technologies is shown in Figure IV.C.4.

The ground target identification element first addresses an integrated air-to-ground and ground-to-ground combat identification capability through the Battlefield Combat Identification ATD, the Position Location and Identification ATD, and the Combat Identification ACTD. These demonstrations combine primarily friend identification and limited foe identification with improved battlefield situational awareness resulting from the Army’s Force XXI initiative. The North Finding Module demonstration addresses a key technology needed for affordable correlation of identification labels within the weapon sight on ground platforms.

The next several steps focus on foe identification using non-cooperative techniques. A number of ATDs are critical to this effort, including Target Acquisition, Dominant Targeting and Identification, Air/Land Enhanced Reconnaissance and Targeting, Enhanced Recognition and Sensing LADAR, and MSTAR Model Driven Automatic Target Recognition. Improving the ease of integration will allow for the CID solutions that are evolving or extant to be hosted within the architecture with a minimal expenditure of time or money. This element addresses both the integration of multiple functions within a CID suite to reduce costs and improvements in the case of physical and functional integration onto combat platforms to achieve more rapidly deployable and affordable CID solutions.

The air target identification element represents a more information-rich approach. This element includes both fusion and non-cooperative target identification techniques as typified by several of the Air Force’s HAVE programs. ATDs such as Advanced Identification, Enhanced Recognition and Sensing LADAR, Air Target Algorithm Development, Specific Emitter Identification, and Dominant Targeting and Identification address the signal exploitation issues associated with the non-cooperative air target identification challenge. These efforts are multi-dimensional and proceed in parallel. They each include their own data collection efforts. These signature exploitability efforts are crucial to advancing the capability in non-cooperative sensing to support all target identification. It is the intent of this path in the roadmap to have a wide variety of experiments to examine the issues of signature presence, discrimination, and reliability over a broad range of engagement scenarios and battlespace environmental conditions. Each of the integrated CID suite approaches would be used to demonstrate improved operations (enhanced effectiveness and reduced fratricide) in field exercises with both joint and combined forces.

The primary Defense Technology Objectives and the demonstrations which address the CID operational capabilities are shown in Figures IV.C.5 and IV.C.6.

All CID techniques have a limited period of operational effectiveness before they are degraded or compromised by enemy countermeasures. It is therefore necessary to have an ongoing process for developing new technologies for CID, demonstrating new capabilities in appropriate operational environments, and deploying new or upgraded CID appliqués in order to maintain a superior operational CID capability. The CID roadmap is shown in Figure IV.C.7.

6. Summary

Providing an accurate CID capability when and where it is needed requires an integrated architecture that includes non-cooperative identification, cooperative identification, and improved situational awareness. Improvements in joint warfighting operational capabilities will be demonstrated utilizing suites of these capabilites on various platforms in joint operational environments.

A significant initial improvement is expected for ground target identification with the inception of new cooperative identification techniques combined with improved situational awareness. This will later be augmented with a foe and neutral identification capability for selected weapon systems.

Air target identification improvements will be achieved by increasing the robustness of overall CID capabilities by improving non-cooperative techniques, providing more capable data links, adding data fusion capabilities, and extending the number of platforms equipped. The improvements in demonstrated warfighting capabilities over time are shown in Figure IV.C.8.

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Air-to-Surface/Ground			
• Robust, High Confidence ID Capability at Range and lethality of weapons • Maximize Combatants Military Effectiveness • Minimize Fratricidal Situations • Automated Position Reporting and Correlation for Battlespace (i.e., data link capability) • Interoperable • Secure Operations • Non-exploitable	1. Foe Identification 2. Friend Identification 3. Neutral Identification 4. Situational Awareness	1. Technology limitations (range, ID, accuracy, aspect dependency, timeliness of reporting) 2. CCD technologies 3. Friends/foes/neutrals not clearly defined 4. Lack of standardized data link 5. Affordability 6. Vulnerability	1. EO/IR/Radar imaging 2. EO/IR/Radar Q&A 3. FLIR 4. Laser 5. SAR/ISAR 6. MTI 7. Fusion technology 8. ATR technology 9. Secure data links
Operational Capability Element: Ground-to-Ground			
• Robust, high confidence ID capability at range commensurate with range and lethality of weapons • Maximize combatants military effectiveness • Minimize fratricidal situations • Automated position reporting and correlation for battlespace (i.e., data link capability) • Interoperable • Secure operations • Non-exploitable	1. 2. 3. 4.	1. 2. 3. 4. 5. 6.	8. 9. 10. Low cost North Heading Reference Unit 11. High resolution MMW imaging 12. IR focal plane arrays 13. Data management 14. Signal processing
Operational Capability Element: Air-to-Air			
• Robust, high confidence ID capability at range commensurate with range and lethality of weapons • Maximize combatants military effectiveness • Minimize fratricidal situations • Automated position reporting and correlation for battlespace (i.e., data link capability) • Interoperable • Secure operations • Non-exploitable	1. 2. 3. 4.	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. 5. 6. 7. 8. 9.

Figure IV.C.3. Goals, Limitations, and Technologies for Combat Identification

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Surface-to-Air			
• Robust, high confidence ID capability at range commensurate with range and lethality of weapons • Maximize combatants military effectiveness • Minimize fratricidal situations • Automated position reporting and correlation for battlespace (i.e., data link capability) • Interoperable • Secure operations • Non-exploitable	1. 2. 3. 4.	1. 2. 3. 4. 5. 6.	1. 4. 7. 8. 9. 12. 15. Radar signal exploitation 16. Radar signal modulation

Figure IV.C.3. Goals, Limitations, and Technologies for Combat Identification (cont'd)

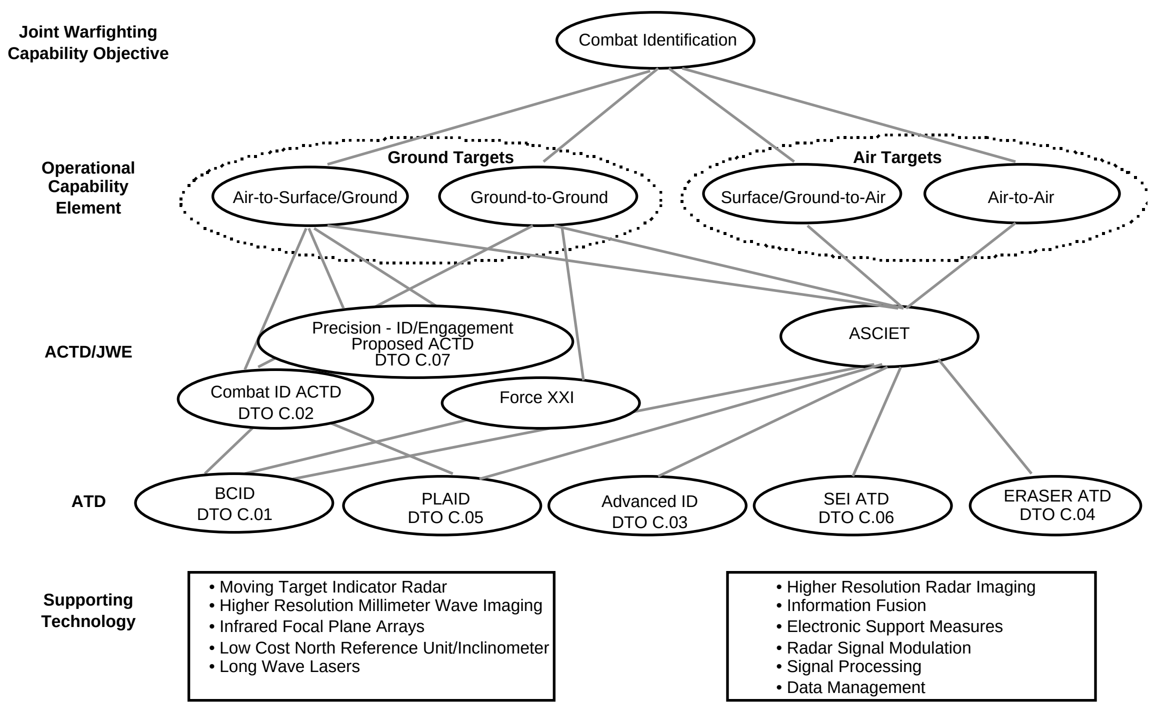


Figure IV.C.4. Technology to Capability – Combat Identification

DTO #	TITLE
C.01	Battlefield Combat Identification ATD
C.02	Combat Identification ACTD
C.03	Advanced Identification ATD
C.04	Enhanced Recognition and Sensing LADAR (ERASER) ATD
C.05	Position Location and Identification (PLAID) ATD
C.06	Specific Emitter Identification ATD
C.07	Precision Identification/Engagement ACTD

Figure IV.C.5. Defense Technology Objectives – Combat Identification

	Operational Capability Element					Demonstration is a:		
Demonstration Title	Air-to-Surface/ Ground	Ground-to- Ground	Surface/Ground- to-Air	Air-to-Air	Service Agency	DTO	ACTD	ATD
Battlefield Combat Identificaiton ATD	●	●			Army	C.01		X
Combat Identification ACTD	●	●			Army	C.02	X	
Advanced Identification ATD			○	○	Air Force	C.03		X
Enhanced Recognition and Sensing LADAR (ERASER)	○	●	●	○	Air Force	C.04		X
Position Location and Identification	●				Air Force	C.05		X
Specific Emitter Identification	●			○	Navy	C.06		X
Precision Target ID/Engagement	●				Navy	C.07	X	

● Strong Support ○ Moderate Support

Figure IV.C.6. Demonstration Support – Combat Identification

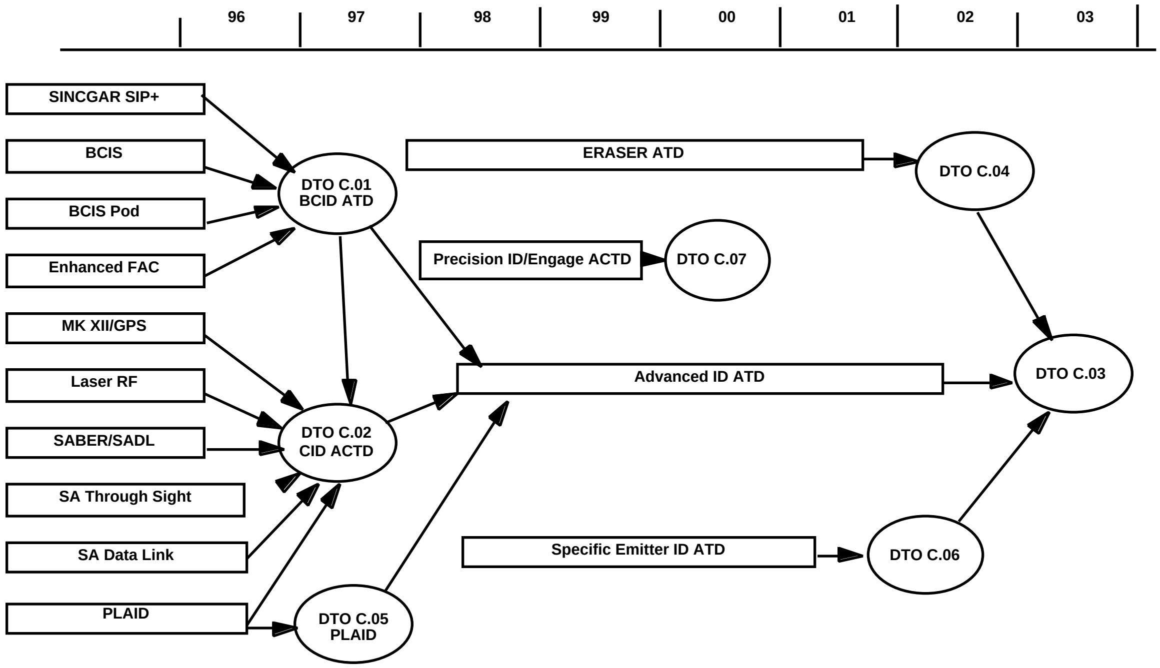


Figure IV.C.7. Roadmap – Combat Identification

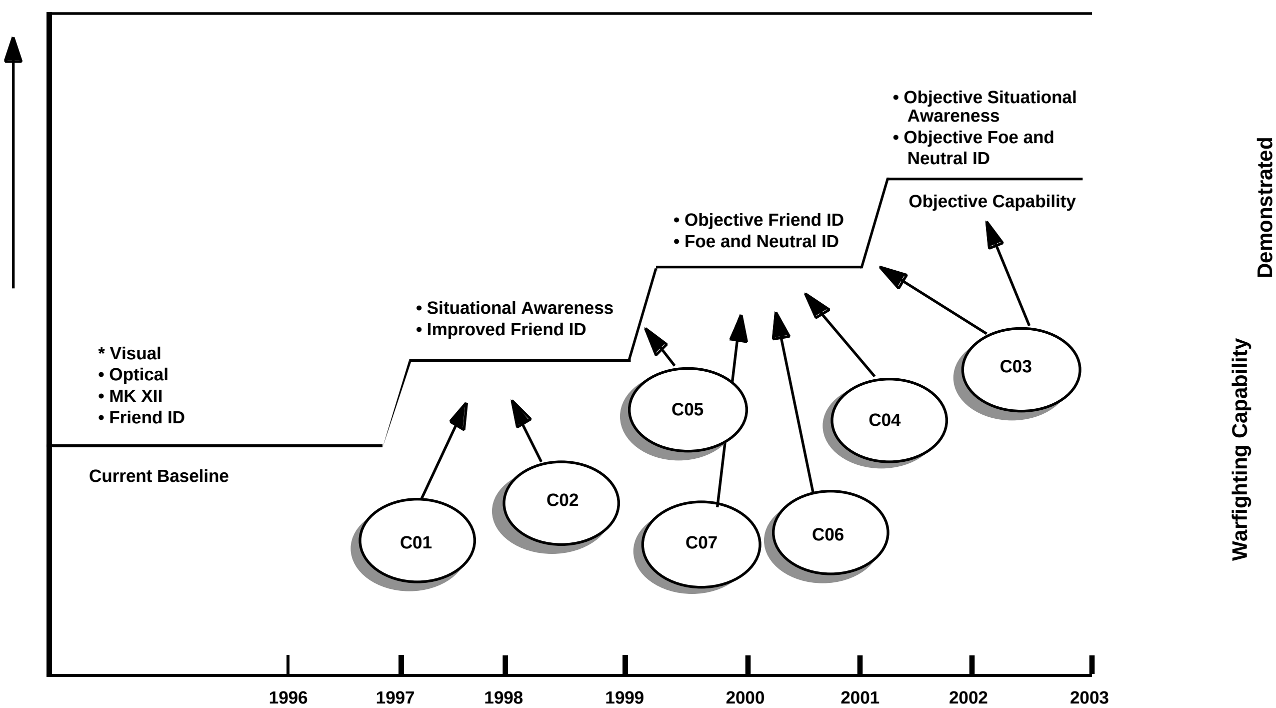


Figure IV.C.8. Progress - Combat Identification

D. JOINT THEATER MISSILE DEFENSE

1. Definition

Joint Theater Missile Defense (JTMD) is the capability to use the assets of multiple Services and Agencies to detect, track, acquire, and destroy enemy theater ballistic missiles and cruise missiles. It includes the seamless flow of information on missile launches by specialized surveillance capabilities, through tracking by sensors from multiple services and Agencies, to missile negation and destruction.

2. Operational Capability Elements

The Theater Missile Defense Mission Need Statement defines the mission of JTMD as "to protect U.S. forces, U.S. allies, and other important countries, including areas of vital interest to the U.S., from theater missile attacks." The JTMD mission includes the protection of population centers, fixed civilian and military assets, and mobile military units. The four operational capability elements, or "pillars," of JTMD are: attack operations, active defense, passive defense, and command, control, communications and intelligence (C3I).

JTMD incorporates a family of systems, currently pursued individually by each service. The Ballistic Missile Defense Organization (BMDO) is responsible for the "family of systems" approach that will ensure timely and cost effective integration into the joint warfighting area. As illustrated in Figure IV.D.1, the three systems comprising the theater missile defense architecture are: (1) land-based interceptors (Patriot Advanced Capability-3, THAAD, Corps SAM) and land-based radars (Patriot and THAAD radars), (2) sea-based interceptors and radar (Navy-Lower Tier or Area Defense and Aegis radar), and (3) space-based sensors, including Space and Missile Tracking System (SMTS). All systems are linked by C3I networks to give joint interoperability.

In addition to the technologies addressed in this section, technologies to support advanced capabilities for attack operations are addressed in the Precision Force and Counterproliferation sections (sections B and L, respectively). The Precision Force section describes support against targets including TMD launchers. (See, for example, Figure IV.B.1.) The Counterproliferation section describes technologies focused on attacking weapons of mass destruction (WMD) and WMD-related facilities (including warhead and theater missile sites). Technologies in Section J, Chemical and Biological Warfare Agent Detection, includes aspects of passive defense related to theater missile defense.

JTMD supports four different Joint Warfighting Capability Assessment (JWCA) areas. It helps assure land, sea, air, and space superiority by negating the theater missile threat in these environments. It provides deterrence against nuclear, biological, and chemical (NBC) weapons by providing a capability to confine enemy missile delivery systems to the enemy's own territory. It enhances the command and control network by linking assets on land, at sea, airborne, and in space together with high data rate communications. Finally, it augments the battlespace intelligence, surveillance, and reconnaissance capability with sensor and radar tracking platforms in all these

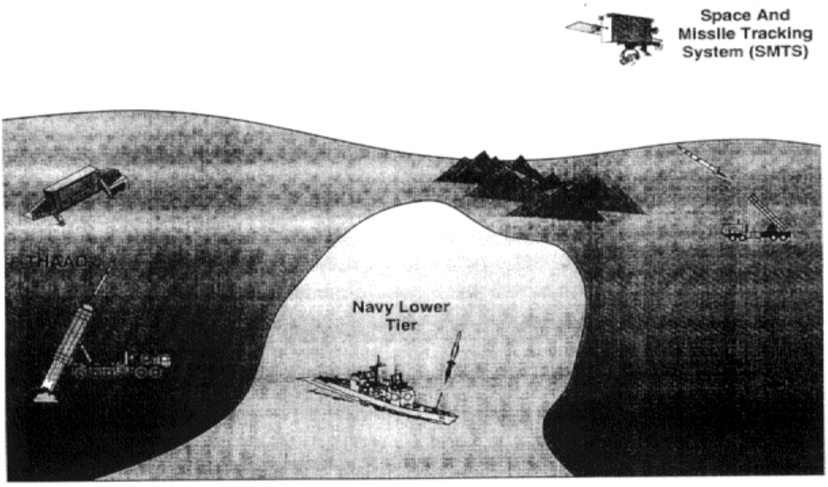


Figure IV.D.1. Joint Theater Missile Defense Concept

environments. Technology programs can be further used to reduce system life-cycle costs by reducing the number of interceptors needed to counter the threat, developing improved manufacturing processes, and assuring system survivability.

The vision is a total Joint Theater Missile Defense architecture which capitalizes on the use of all service assets to combat theater missile threats from land, sea and air, allowing for initial quick response and improved defense capabilities as mobile forces move into a theater.

The characteristics of the cruise missile (CM) threat present special challenges to the JTMD mission. They fly at low altitudes to avoid detection, can maneuver unpredictably to evade intercept, and can be launched from both air and surface carriers, reducing the likelihood of pre-launch suppression.

The current approach to a robust theater missile defense (TMD) capability is to provide a layered defense consisting of 360 degree low altitude coverage for terminal defense systems with extended battlespace into the upper tier to counter long range threats. This will bring the fight into the enemy's own back yard, inducing debris shortfall and countering the threat prior to release of submunitions. The more complex threats demand excellent target acquisition, tracking and discrimination; the ability to counter low observable targets, decoys (both intended and induced), and submunitions, and achieve reliable target kill.

Maneuvering targets pose additional requirements for agile interceptors. Work to reduce interceptor size and weight, and improve solid propellants, contributes significantly to the development and preplanned product improvement of common interceptor components.

Interoperability is greatly improved through work on data compression and data transfer. Innovation in this area must drive the component designs to link all services with common systems. Future experiments are planned to demonstrate coordinated surveillance and attack operations. They will focus on the space-to-ground (or sea) transfer of target object maps and state vectors, sea-land network links to fuse radar data, and distributed simulations using CONUS and theater-based processors linked to command centers. These demonstrations are designed to identify and correct weaknesses in the interoperability of various service assets and correct them.

3. Functional Capabilities

Figure IV.D.2 depicts the functional capabilities required to enable Joint Theater Missile Defense operational capability elements.

Functional Capabilities \ Operational Capability Element	C3 I	Active Defense	Passive Defense	Attack Operations
Acquisition Sensor:				
1. Detection	○	●	●	●
2. Tracking		●	●	●
3. Discrimination		●	○	●
4. Communication	●	●	●	●
5. Structure		●	●	●
Target Intercept:				
6. Lethality		●		
7. Footprint		●		
8. Divert		●		
9. Acquisition		●		
10. Tracking		●		
11. Discrimination		●		
12. Communication	●	●	○	○
13. Structure		●		
14. Directed Energy		●		
C3I:				
15. Data Links	●	●	●	●
16. Waveform	●	●	○	●
17. Data Processing	●	●	●	●
18. Data Fusion	●	●	●	●
19. Structure	●		●	●

● **Strong Support** ○ **Moderate Support**

Figure IV.D.2. Functional Capabilities Needed for Joint Theater Missile Defense

4. Current Capabilities, Deficiencies, and Barriers

The U.S. baseline capability includes the PATRIOT and HAWK Missile defense systems. The fielded PATRIOT technology allows for rapid accurate fire unit emplacement, remote launcher placement up to 12km from the radar, and radar enhancements to improve theater ballistic missile (TBM) detection and increase system survivability. The HAWK technology will yield a low risk, near-term capability for expeditionary forces against short range ballistic missiles through modifications to allow detection, tracking, and engagement of short range TBMs. These baseline capabilities are low altitude terminal systems, lacking the ability to reach out and negate the threat in the enemy's territory. There is currently no capability to engage threats in the upper tier, ascent, or boost phase of flight. The Air Force's Airborne Laser (ABL) program will address this capability.

The CINCs' JTMD assessment program and user interface efforts enable the ultimate user of the systems to redefine and articulate their JTMD requirements. The issues of target discrimination, sensor studies, lethality and target hardening, survivability, engineering and integration support, system architecture, and operations interface all benefit from the S&T efforts.

Figure IV.D.3 summarizes some of the current capabilities and limitations. The fundamental barriers include lack of interoperability, affordability, lethality, target signatures, and data fusion. Lack of interoperability stems from systems independently procured at different times or periods by the services and from independent service operational doctrine. Currently, the Capstone Operational Requirements Document (ORD) gives specific requirements for interoperable capabilities. Joint doctrine continues to evolve and bring synergy to the warfighting efforts of the services. Efforts must also be pursued to ensure NATO and allied force capabilities can operate together. Technology efforts will contribute to the commonality required for theater systems to interact and operate together and address issues of massive amounts of data flow and data fusion.

Affordability must be weighed against various priorities. Complete system architectures are high dollar investments, which must be measured against the perceived threats and desired results. Science and technology that improves production methods, contributes to commonality of components, improves reliability and supportability (thus reducing fielded system quantities), reduces size and weight, eases integration overhead, and reduces component and long term costs are worthwhile investments. High cost items such as interceptor seekers, power generation and conditioning systems for the Ground Based Radar (GBR), and lasers for airborne systems can be made smaller, lighter, and less expensive. Technology which improves interceptor probability of kill allows a reduction in interceptor inventory, leading to large cost reductions.

Lethality is a means of measuring a system's combat value. Plagued by many variables, it is, nevertheless, an important factor in evaluating JTMD systems. Crucial areas of concern include accurate kill assessment, accurate targeting, and aimpoint selection. Interceptors must become more agile to counter maneuvering targets. Science and technology has invested in hit-to-kill, blast fragmentation, and directed energy options for missile defense systems.

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Command, Control, Communications, and Intelligence (C3I)			
Coordinated exchange of information among sensors, radars, launch platforms, interceptors, and command centers	**Acquisition Sensor** 4. Communications **Target Intercept** 12. Communications **C3I** 15. Data links 16. Waveform 17. Data Processing 18. Data Fusion 19. Network Structure	1. Network latency 2. Data link capacity	1. Laser communications 2. High-speed optical data links 3. Solid-state non-volatile memory 4. High capacity computer interface
Operational Capability Element: Active Defense			
Acquire and track target and handover/ communicate data to command centers, fighters, and interceptors	**Acquisition Sensor** 1. Detection 2. Tracking 3. Discrimination 4. 5. Structure	1. Full constellation coverage 2. Radar survivability 3. Target recognition 4. Radar power constraints 5. Lack of Airborne TMD Disseminator	5. Advanced lightweight signal processor 6. High-power T/R modules 7. Large format high uniformity LWIR Focal Plane Arrays 8. Lightweight antennas 9. Cryogenic Power 10. Eyesafe Laser Radar
Negate the threat	**Target Intercept** 6. Lethality 7. Footprint 8. Divert 9. Acquisition 10. Tracking 11. Discrimination 12. 13. Structure 14. Directed Energy	1. Discrimination of sophisticated threat 2. Tracking of maneuvering vehicles 3. Capability for boost phase intercept	11. Solid DACS propellant 12. On-board sensor signal processor 13. Lightweight laser radar 14. High sensitivity Multi-spectral IR sensor 15. Fast framing seeker 16. Sensor Data Fusion 17. Target discrimination algorithms 18. Lightweight chemical laser 19. Adaptive optics and beam control 20. Atmospheric compensation and tracking
Receive, process and transfer data	**C3I** 15. 16. 17. 18.	1.	21. Omni-EHF antenna 22. Advanced fusion algorithm

Figure IV.D.3. Goals, Limitations, and Technologies for Joint Theater Missile Defense

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Passive Defense			
Early, long range, and accurate threat acquisition, tracking, and data distribution	**Acquisition Sensor** 1. Detection 2. Tracking 3. Discrimination 4. Communications **C3I** 15. Data links 16. Waveform 17. Data processing 18. Data fusion	1. Delayed detection of launch 2. Slow impact point projection 3. Detection of early release submunitions	1. 23. Satellite electric propulsion 24. High-efficiency photovoltaics 25. LWIR GaAs sensor 26. Active pixel visible sensor
Operational Capability Element: Attack Operations			
Coordinate cooperative acquisition, tracking, decision making, and kill assessment	**Acquisition Sensor** 1. 2. 3. 4. C3I 15. 16. 17. 18.	1. Non-interoperable communications links 2. Inaccurate kill assessment of chem/bio threats	2. High speed data links 17. 27. CDMA spread-spectrum communications modem

Figure IV.D.3. Goals, Limitations, and Technologies for Joint Theater Missile Defense (cont'd)

Successful TMD detections and intercepts, particularly hit-to-kill intercepts, require accurate and reliable target signatures. Threat signatures drive both the detection and tracking radars and the seeker hardware selections. They also establish requirements for the supporting detection, discrimination, aim point selection, and kill assessment algorithms. The barrier to obtaining accurate signatures is generally a lack of access to real threats operating in their deployed environment. In order to compensate for this, BMDO supports a robust threat and signatures flight and phenomenology program where both simulated threats and acquired threats are flown and measured.

Sensor data fusion is a technique in which multiple sensors provide individual data sets on targets and backgrounds, which are then processed into a single merged set of data. The fused data present a much more accurate picture of the battlespace to the field commanders than the sum of the individual data sets. The data fusion process occurs in different ways: (1) the fusion of data from several sensors on the same platform, e.g., a thermal imaging sensor and laser radar onboard an interceptor or a space surveillance satellite; (2) the transfer or handover of data from one sensor platform to another, e.g., target object map data handover from one surveillance sensor to an interceptor; or (3) the merging of track files recorded and processed from two or more geographically separated sensors, e.g., ground radar and space surveillance sensor data track files. These represent difficult technical problems for theater missile defense, since this fusion of data must take place in real time in order to be useful.

5. Technology Plan

Some of the key technologies needed to breach the limitations to achieving the functional capabilities and enabling the operational capability elements are shown in Figure IV.D.4. These technologies contribute to the seven Defense Technology Objectives (DTOs) which, together with the technologies cited in Section B (Precision Force) and Section L (Counter-Proliferation) for attack operations and Section J (Chemical and Biological Warfare Agent Detection), lead to four JTMD operational capability elements. These operational capability elements and the JWCO will be enabled by successfully attaining each of the DTOs, which are listed in Figure IV.D.5.

The DTOs are designed to demonstrate an ever-increasing capability with time, as advances in technology increase sub-system performance.

D.01 - The Navy Upper Tier or Theater-Wide Defense Interceptor requires an integration of newly emerging technologies such as a solid propellant for divert and attitude control systems (DACS). The objective is to demonstrate this capability with the launch of a hit-to-kill interceptor from a ship.

D.02 - The Integrated Sensor/Data Fusion Demonstration is a series of experiments performed on the ground and on an aircraft, focusing on integrating a suite of novel optoelectronic sensors with a lightweight laser radar. These experiments utilize a state-of-the-art neural network image processor to perform high-speed sensor signal processing, and perform multi-sensor on-board sensor data fusion in real time, simulating a space or UAV based sensor platform with enhanced tracking and surveillance capability.

D.03 - The Advanced Discriminating Interceptor objective requires the integration of a passive sensor and active laser radar coupled to advanced data fusion algorithms and next generation propulsion and processing to perform reliable intercepts of complex, sophisticated target threat clouds.

D.04 - The Advanced X-Band Radar Demonstration will incorporate technology advances in GaAs MIMIC transmit/receive modules producing more than 20 watts of power, wide bandgap electronics for low frequency high power conditioning, and cryo-power for efficient power production. The goal is to decrease antenna and support vehicle footprint by half, while maintaining or improving the power/aperture product.

D.05 - The Advanced Space Surveillance objective exploits gains made in laser communications, advanced multi-band sensors, image data fusion algorithms, processors, satellite propulsion and solar power generation to demonstrate capabilities to detect and track complex threats, employing stealth and sophisticated decoys, from space.

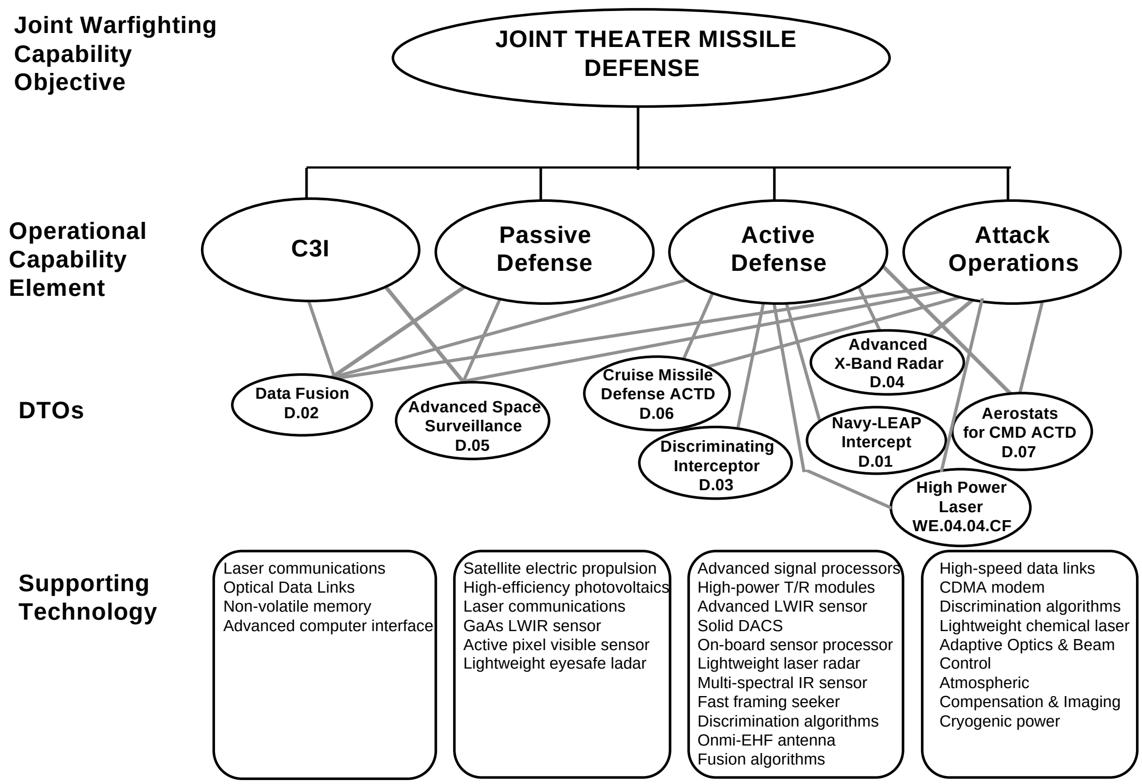


Figure IV.D.4 Technology to Capability - Joint Theater Missile Defense

DTO #	TITLE
D.01	Navy Upper Tier LEAP Interceptor
D.02	Integrated Sensor/Data Fusion Demonstration
D.03	Advanced Discriminating Interceptor
D.04	Advanced X-Band Radar Demonstration
D.05	Advanced Space Surveillance
D.06	Cruise Missile Defense (CMD) Phase II ACTD
D.07	Aerostats for Cruise Missile Defense ACTD
WE.04	High Power Lasers for TMD

Figure IV.D.5. Defense Technology Objectives – Joint Theater Missile Defense

D.06 and D.07 - Cruise Missile Defense Phase II and Aerostats for Cruise Missile Defense ACTDs, together with the (completed) Phase I/Mountain Top ACTD, address advanced airborne surveillance and track to provide precision cueing for fighters. Both fixed-wing and aerostat platforms will provide the capability.

WE.04 - The High Power Lasers for TMD DTO achieves laser beam propagation over long turbulent atmospheric paths using advanced tracking and compensation technology. It further reduces chemical oxygen-iodine laser mass for aircraft installation.

Beam stability and atmospheric compensation is demonstrated using advanced algorithms and adaptive optics.

Each DTO is further defined in the DTO Volume for the JWSTP and the DTAP, Section II-D. As the DTOs are achieved, they are demonstrated with participation by warfighters. The demonstrations are listed in Figure IV.D.6. The schedule for technology development and achievement of DTOs is shown by the roadmap in Figure IV.D.7, along with the key technologies. Effective joint theater missile defense requires several systems to function together as an integrated unit: ground-based radar, ground- or sea-based interceptors, a space-based sensor, and a battle management architecture tying them all together. Thus, the roadmap for developing and demonstrating the technologies to make this possible is quite complex. Moreover, since the theater missile threat is an evolving one, the system of defenses must aspire to increasing levels of competence as it matures, calling on ever more advanced and highly capable technology, as is depicted in Figure IV.D.7.

Much of the technology for a first-generation theater missile defense system is already at hand and is at the testing and evaluation stage. Nevertheless, a defense technology objective program is in place to help manage the risk of the first deployments.

6. Summary

Figure IV.D.8 summarizes the build-up of capability to provide a full theater architecture for defense against ballistic and cruise missiles. Together with the THAAD system for high endoatmospheric intercepts of TBMs, the technology demonstrations provide additional capabilities to address intercepts above the atmosphere and precision targeting of CMs. Navy Area Defense is further enhanced by providing the capability for earlier, over-the-horizon targeting and tracking of TBM launches as well as an added superior discrimination ability on exoatmospheric interceptors. The objective system for JTMD, with a space-based detection and tracking system in place, is backed-up with technologies supporting advanced surveillance platforms and sensing.

Demonstration Title	Operational Capability Element: Attack Operations	Active Defense	Passive Defense	C3I	Service Agency	Demonstration is a: DTO IV.D	ACTD	ATD
Navy-LEAP Intercept	○	●			BMDO, Navy	D.01		
Integrated Sensor/Data Fusion Demo	●	●	○	●	BMDO,Army, Air Force, Navy	D.02		
Discriminating Interceptor	○	●		○	BMDO,Army, Air Force, Navy	D.03		
Advanced X-Band Radar	●	●	●	●	BMDO, Army	D.04		
Advanced Space Surveillance	●	●	○	●	BMDO, Air Force	D.05		
Cruise Missile Defense Phase II ACTD	○	●	○	○	Navy, Army	D.06	X	
Aerostats for Cruise Missile Defense	○	●	○	○	Navy, Army	D.07	X	
High Power Laser	●	●	○	●	Air Force	WE.04		

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Figure IV.D.6. Demonstration Support – Joint Theater Missile Defense

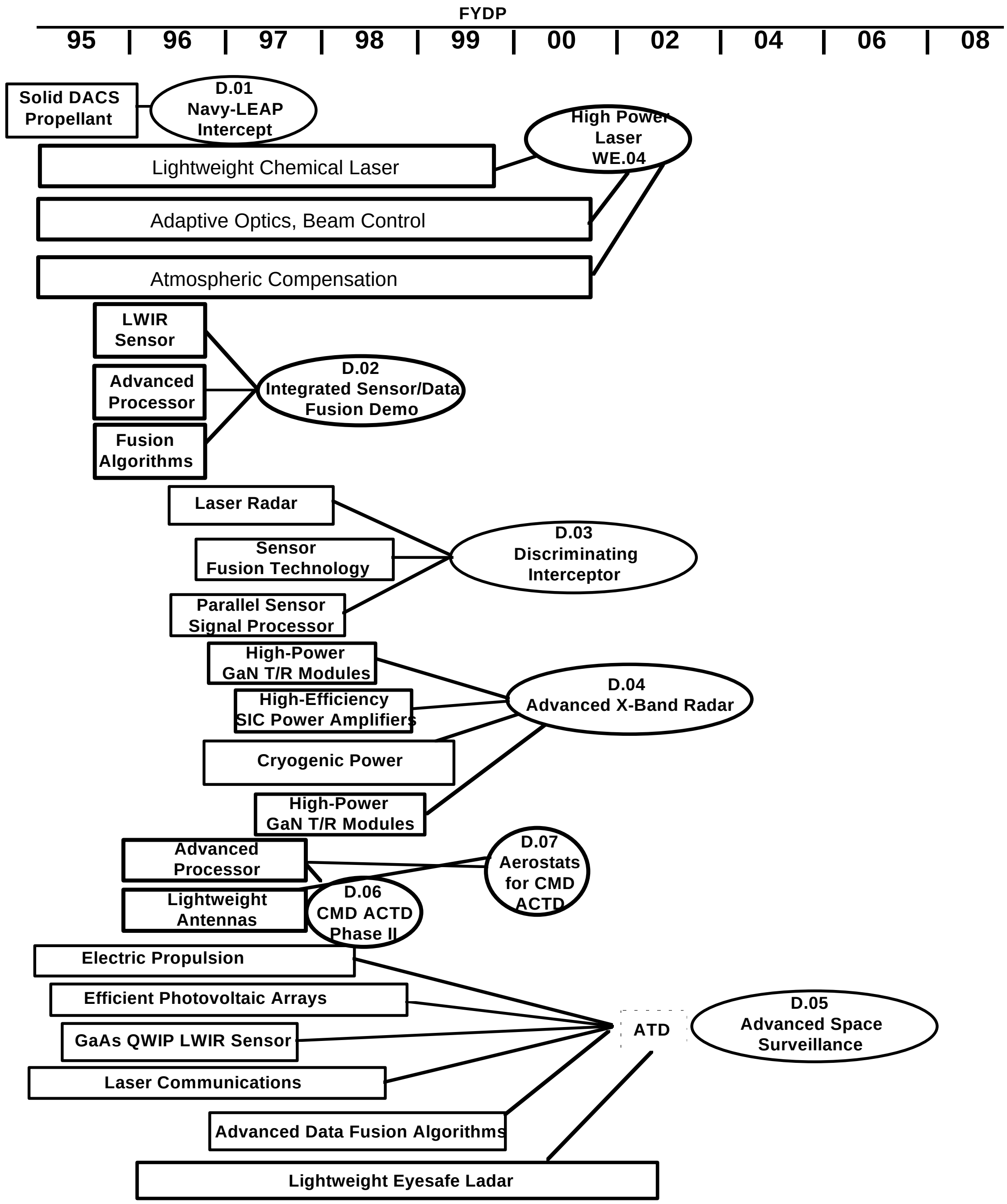


Figure IV.D.7. Roadmap—Joint Theater Missile Defense

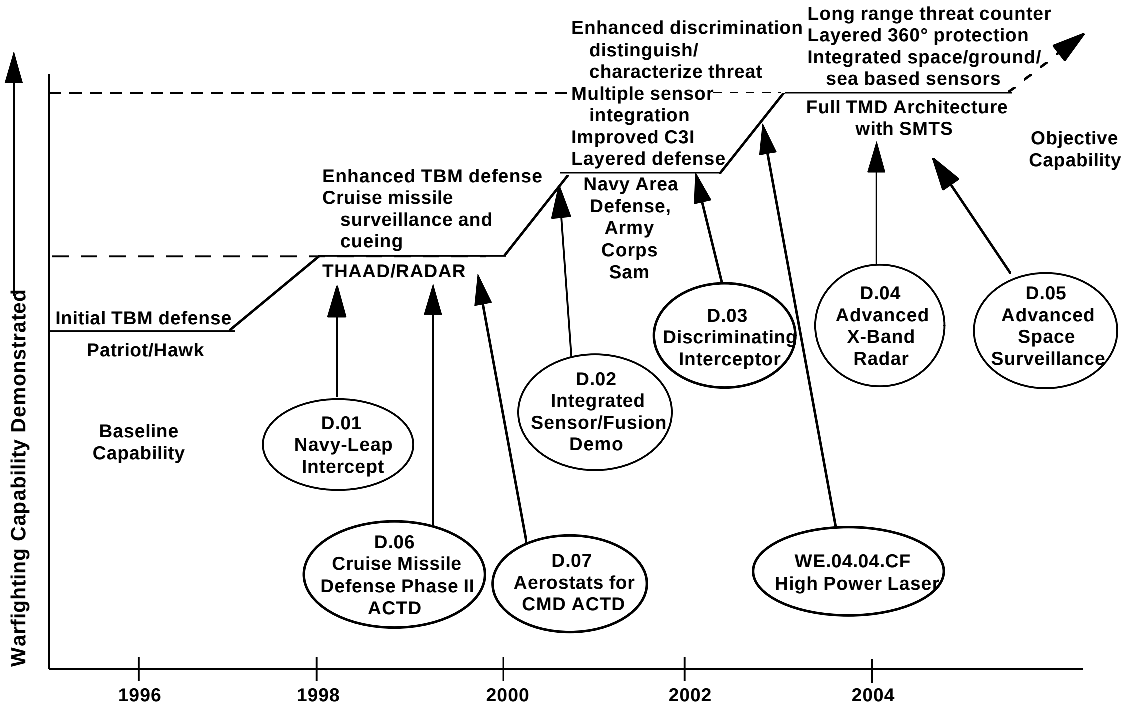


Figure IV.D.8. Progress – Joint Theater Missile Defense

E. MILITARY OPERATIONS IN URBAN TERRAIN (MOUT)

1. Definition

Military Operations in Urban Terrain (MOUT) is the capability to operate and conduct military operations in built-up areas and achieve military objectives with minimum casualties and minimum collateral damage. MOUT requires precise weapons, surveillance, sensing, target detection, and situational awareness enhancements.

2. Operational Capability Elements

Urban centers increasingly are the sites of conflict throughout the world. MOUT is, and will continue to be, a major area of concern for U.S. forces. MOUT includes all military actions that are planned and conducted in an environment where man-made construction affects the tactical options available to the commander. Urban operations involve closer ranges and visibility obstructions. Actions involve small units, and the potential for producing casualties is high. MOUT requires extensive use of Army and Marine light forces whose mission success tends to focus more on the operational effectiveness at lower echelons (e.g., battalion and below) than larger scale conflicts. The U.S. operational advantage, typically associated with long-range, high technology weapons platforms that use mass and mobility, is significantly reduced in urban environments.

At the highest level, warfighting success depends upon expansion of the battlespace to gain an advantage over opposing forces. To expand the battlespace for dismounted warriors in a MOUT environment, operational capability elements available to warfighters, leaders and commanders must be synchronized according to tactics developed specifically for MOUT scenarios. These key operational capability elements are:

MOUT Command, Control, Communications, Computers, and Intelligence (C4I). Both horizontal and vertical command and control (C2) capabilities in near-real-time, notwithstanding surrounding buildings, from battalion down to individual combatants, will allow commanders to maneuver forces and operate at a faster tempo than an adversary. Individuals and small units must be afforded the capability to maintain comprehensive situational awareness. Near-real-time sensor-to-shooter linkages are needed to facilitate the ability to process and rapidly disseminate data and extend the battlespace from improved multi-spectral sensors and optics, combat identification systems, topographical systems, counter-sniper systems, unmanned ground and aerial vehicles (UGV, UAVs), and other emerging systems.

MOUT Survivability. Warfighters must be able to survive and accomplish their missions in the midst of various threats and environments typically found in MOUT, including small arms fire, snipers, booby traps, mines, sensor detection, respiratory protection, flames and fires, and friendly fire. Survivability systems must enhance situational awareness and maneuverability via intelligence, sensory inputs, and other means.

MOUT Engagement. Overmatching lethality is required in terms of direct and indirect firepower tailored to defeat targets commonly encountered in MOUT, using smart and precision-guided munitions. MOUT lethality capabilities must effectively defeat enemy targets, while at the same time minimizing collateral damage. Less than lethal capabilities are required to exercise control over non-combatants in conflict situations. Man-portable target acquisition capabilities are needed to allow forces to collect, analyze, process, and disseminate timely intelligence and targeting data for both direct and indirect fires.

MOUT Maneuverability. Geolocation and navigation technologies capable of operating reliably in built-up areas are required to enhance the warfighter's and small unit's ability to navigate and maneuver in urban environments even when global positioning system (GPS) signals are not available. Digital urban terrain databases coupled with mapping software will further enhance the accuracy and efficiency of maneuver within an urban environment. The ability to insert airborne combat forces directly into the urban terrain with precision and in a survivable, covert manner will amplify U.S. forces' ability to expand and dominate the urban battlespace.

Improving operational capabilities for MOUT will not be achieved by the development of a single technology. A MOUT system-of-systems (see Figure IV.E.1) will most effectively provide the complement of functional capabilities necessary for successful MOUT missions, whether they are combat or non-combat military operations. Commanders must have the ability to plan and equip their troops depending on the specific MOUT mission. This requires the capability to select and tailor equipment from the entire system-of-systems available for MOUT.

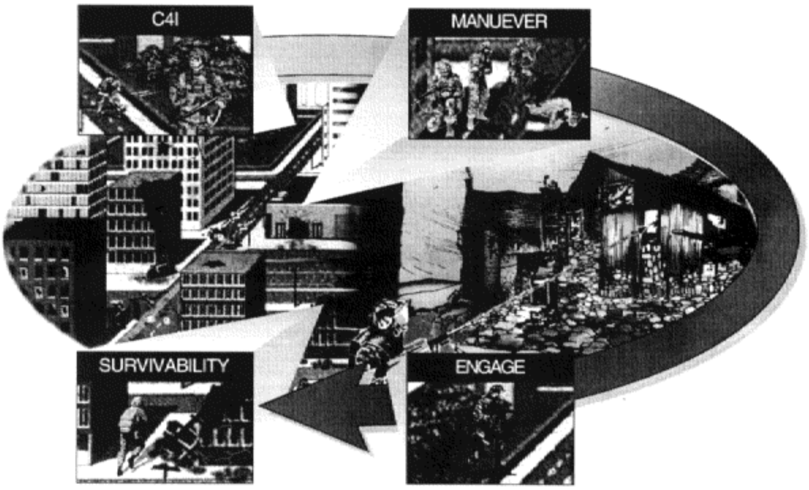


Figure IV.E.1. Military Operations in Urbain Terrain – Concept

3. Functional Capabilities

To achieve the needed operational capability elements, and to create a greater U.S. military advantage, MOUT requires, at a minimum, the functional capabilities described below and shown in Figure IV.E.2.

MOUT Command, Control, Communications, Computers and Intelligence (C4I). Near-real time vertical and horizontal C2 from the battalion down to the individual combatant will enhance situational awareness at all levels. This will be accomplished through hands-free robust communications with packet relay protocol, high data rate communications for rapid voice, data, and video transmissions, and video capture. Fusing, filtering, and dissemination technologies will ensure that essential information is distributed to the appropriate small units. Functional capabilities include high resolution helmet mounted displays for viewing weapon and night vision sensor data, and linking the two for rapid target acquisition capability, through-wall sensors, and sensor-to-shooter linkages. (See Defense Technology Objective (DTO) E.01.)

MOUT Survivability. Improved small arms protective vests will stop 7.62mm armor piercing rounds. Multi-spectral signature reducing materials and techniques will reduce detection by enemy sensors. Lightweight multi-functional protective materials will allow survival in flame and fires and other environmental threats and hazards. Combat identification, indirect viewing/unexposed firing, mine detection, counter-sniper systems, and personnel status monitoring will also enhance survivability, as will overall improvements in situational awareness, particularly when digitally linked. (See DTO E.02.)

MOUT Engagement. Improved individual and crew-served weapons with full-solution fire control, coupled with improved bunker-defeating weapon systems, will enhance target engagement capabilities against fortified, dug-in, or defilade targets. Multi-spectral sensors will provide enhanced target acquisition under all operational conditions. In addition, the sensor-to-shooter linkages will provide effective target handover to supporting stand-off precision weapons systems. Foams, irritants, barriers, obscurants, and incapacitants will provide less-than-lethal capabilities to augment crowd control and deal effectively with the non-combatant population. (See DTO E.03.)

MOUT Maneuverability. Self-contained navigation technologies capable of better than 3 meter accuracy for GPS augmentation, urban databases and digital mapping (better than 1 meter resolution) and simulations fed by the rapid generation of terrain, feature, and building data, will provide increased command tempo, control, intelligence, and mission planning and rehearsal, while enhancing maneuverability of individuals and the force. Precision covert personnel aerial delivery technologies capable of providing 25 meter circular error probable accuracy will heighten soldier mobility and survivability. (Maneuverability capabilities are reflected in DTO E.01.)

Functional Capabilities \ Operational Capability Elements	MOUT C4I	MOUT Maneuverability	MOUT Engagement	MOUT Survivability
1. GPS + self-contained navigation	●	●		
2. Interoperability of the stand-alone and embedded soldier-to-soldier ID capabilities	O			●
3. Hands-free individual communication with packet relay	●			
4. Near-real-time awareness, targeting, terrain independent location capability	●			O
5. Wireless communications providing voice, data, video, and graphics	●		O	
6. Detection of sniper, mortar, and artillery projectiles	●			●
7. Precision sensor self location		●		●
8. Simulation of imperfect intra-squad communications	O			●
9. Use of virtual environments (e.g., man-in-the-loop) simulators	●	●	●	●
10. Assessment of weapons effectiveness in urban environments			O	●
11. Assessments of thermal characteristics impacting sensor effectiveness				●
12. Near real-time vertical and horizontal C2	●	O	O	O
13. Improve short, mid, and long range communication capabilities	●	O	O	O
14. Hand over high priority targets	●		O	
15. Indirect viewing/unexposed firing	●			●
16. Identification-through-wall sensors	O		●	
17. High resolution helmet mounted displays	●		O	
18. Video capture	●		O	O
19. Sensor-to-shooter linkages	●		●	
20. Urban databases and mapping	●	●		
21. Head mounted vision systems that are impervious to urban lighting		●		
22. Capability to display situation data or weapon sight imagery	●			
23. Sensors for unmanned ground and aerial vehicle surveillance	●			
24. Detection/location of mines and explosive ordnance	●			●
25. Neutralize snipers				●
26. Mark cleared rooms, buildings, and mine fields	●			
27. Observe areas indirectly	●			

● Strong Support O Moderate Support

Figure IV.E.2. Functional Capabilities Needed For Military Operations in Urban Terrain

Functional Capabilities \ Operational Capability Elements	MOUT C4I	MOUT Maneuverability	MOUT Engagement	MOUT Survivability
28. Remote sensors manning check points	●			
29. Survivable covert insertion of airborne combat forces		●		●
30. Precision delivery of personnel		●		
31. Increased individual maneuverability (negotiate obstacles)		●		
32. Stealthier breaching		●	○	
33. Multi-functional weapon system capable of firing air-bursting munitions and kinetic energy projectiles			●	
34. Integrated full solution fire control			●	
35. Modular fire control, mission adaptable and adaptable to other weapons			●	
36. Defeat targets in defilade, around corners			●	
37. Automated target detection tracking	○		●	
38. Non-line of sight firing			●	
39. Remote firing capability			●	
40. Bunker-defeating mechanism			●	
41. Provide non-lethal force options for point and crowd targets while retaining lethal fire capability	○		●	○
42. Provide direct fire blunt impact munitions capability			●	
43. Non-lethal stand-off and alternatives to weather and wind dependent riot control agents	○		●	
44. Immobilize moving vehicles without injury to occupants	○		●	
45. Light weight protection from small arms			●	
46. Reduced visual, IR and thermal detectability				●
47. Electronic reporting of medical status of individual in real-time	○			●
48. 99 percent probability of identifying friendly equipped soldiers in all battlefield environments	○			●

● Strong Support   O Moderate Support

Figure IV.E.2. Functional Capabilities Needed For Military Operations in Urban Terrain (cont'd)

4. Current Capabilities, Deficiencies, and Barriers

As captured in the Defense Science Board 1994 Summary Study on Military Operations in Built-up Areas (Reference 8), the current U.S. military capability was developed largely to conduct large scale, rural war in central Europe. Many current systems are not fully suited to the MOUT mission and environment. Heretofore, the U.S. military strategy and doctrine called for avoiding urban areas (and controlling them from without) due to the difficult challenges this environment presents to fighting forces. Contributing factors include the lack of detailed pre-conflict intelligence for urban centers; intensive manpower requirements; the slowed tempo of maneuvering forces due to urban obstacles; the desire to minimize non-combatant casualties and damage to population centers; uncertainties regarding the behaviors of indigenous populations; the impact of conflict upon the political, ethnic, religious, and economic elements; and the ability to control an urban center without entering it.

The terrain is complex. Combatants must deal with a wide range of environments from cities with high rise structures to small villages with more primitive dwellings. The urban infrastructure includes power grids, sewer systems, transportation networks, telephone and communications systems, and the news media. To minimize non-combatant casualties and collateral damage, U.S. forces are likely to be constrained to operate under different rules of engagement, and some conventional weapons may not be authorized for use. Most urban populations are fundamentally heterogeneous, and an enemy can deliberately use civilians to mask its own actions. With national and international news media concentrated in urban areas, every action undertaken by military forces will be susceptible to immediate scrutiny. The media can inadvertently pass vital intelligence to an enemy, and at the same time have the ability to influence public opinion and support.

There are several barriers to substantially improving the operational capabilities and providing the key functional capabilities for U.S. forces in MOUT, as detailed in Figure IV.E.3.

MOUT Command, Control, Communications, Computers and Intelligence (C4I). Key concerns include the limiting effects of urban environments on small unit communications reliability and range; the communication network to provide near-real-time vertical and horizontal C2 from the battalion down to the individual combatant, enhancing rather than overwhelming the warfighter's capabilities and tempo; and the life cycle costs for expanding digital linkage down to the individual.

MOUT Survivability. Key concerns include cost and maturity of low observable technologies for the individual warfighter; minimizing weight for enhanced individual protection from direct and indirect fires, and from other threats such as flame and fires; the cost of and radio frequency (RF) interference susceptibility; weapon sensor wireless link to helmet display for acquiring and engaging targets from unexposed positions; and the cost of anti-sniper technology for man-portable applications.

MOUT Engagement. Key concerns include ease of use; cost and reliability of man-portable fire control systems for defeating enemies in defilade within and around man-made structures, while minimizing collateral damage; logistics issues associated with the availability of lethal versus less-than-lethal weapons based on quickly changing scenarios; the reliability and accuracy required for indirect fire weapons to support forward warfighters in urban environments; rapid identification and tracking of potential adversaries within an urban area; the use of enhanced vision and target acquisition sensors in areas with varied and changing light levels; and the size, weight, and power of new weapon systems.

Goal	Functional Capabilities	Limitations	Key Technolgies
Operational Capability Element: MOUT Integration Efforts			
21st Century Land Warrior/Small Unit Operations • Integration of risk mitigating technology upgrades to the dismounted Force XXI Warfighter System • Comprehensive awareness, robust communications, and an integrated grid of the battlespace • Internetted and arrayed tactical sensors which extend the warfighter's tactical awareness	1. GPS + Self-contained navigation 2. Warfighter-to-warfighter combat ID 3. Communications relay 4. Near real time awareness, targeting, terrain-independent location capability 5. Wireless communications providing voice, data, video, and graphics 6. Sniper/mortar/artillery 7. Precision sensor self location	1. Ability to maintain accurate position coordinates over time 2. Reliability, interference, jamming 3. Manportable solutions 4. Millimeter wave technology too heavy 5. Limited link margin and range in MOUT 6. Helmet weight 7. Bore sighting weapon mounted sensors	1. Multi-channel RF links 2. Wireless networking 3. Data compression technologies 4. Real-time video 5. Lightweight power technologies 6. Electronics packaging 7. Low power electronics 8. Micro electro-mechanical systems (MEMS)
Operational Capability Element: MOUT Modeling and Simulation			
• Evaluate contributions of novel MOUT capabilities to the light force • Enhance MOUT training and mission rehearsal • Develop a force-on-force, mobile test bed	8. Simulation of imperfect intra-squad communications 9. Virtual environments(e.g. man-in-the-loop) simulators 10. Assessment of weapons effectiveness in urban environments 11. Assessment of thermal characteristics impacting sensor effectiveness	8. Accurate simulation of the suppression effects of novel weapon systems 9. Synthetic environments that are acceptable reproductions of real combat environments 10. Appropriate fidelity of digital terrain databases	9. Fuzzy logic decision rules to represent dismounted infantry behavior 10. Advanced image generation technologies
Operational Capability Element: MOUT C4I			
C4I • Demonstrate robust C4 capabilities to provide commanders and warfighters with seamless, non-hierarchical, adaptive networks for multimedia communications in a highly mobile MOUT environment • Enhanced situational awareness • Reliable wireless communications in an urban environment • Improved tactical intelligence collection	1. 3. 12. Near real-time vertical and horizontal C2 13. Improved short, mid, and long range communication capabilities 14. Hand-over of high priority targets 15. Indirect viewing/unexposed firing 16. Identification-through-wall sensors 17. High resolution helmet mounted displays 18. Video capture 19. Sensor to shooter linkages 20. Urban databases and mapping	11. Timely intelligence, reconnaissance, information, and country profiles 12. Limiting effects of urban environments on communications reliability range 13. Inability to maintain constant GPS signal in the urban environment 14. Cost, weight, and power for individual combatant acquisition, data processing, display, and weapons systems 15. EMI and RF interfer-ence problems asso-ciated with tightly packaged combatant sensor, communi-cation, and weapons systems	11. Enhanced communications technologies 12. Enhanced navigation technologies 13. Advanced man/machine interfaces 14. Automated artificial intelligence assisted sensor/data fusion 15. Systems miniaturization technologies

Figure IV.E.3. Goals, Limitations, and Technologies For Military Operations in Urban Terrain

Goal	Functional Capabilities	Limitations	Key Technolgies
Advanced Sensors • Improve warfighter vision • Highly mobile system to detect and locate sniper, mortar, artillery fire • Overhead, non-line of sight surveillance • Unmanned ground vehicle surveillance (UGV) and mine detection systems	6. 21. Head mounted vision systems that are impervious to urban lighting 22. Capability to display situation data or weapon sight imagery 23. Surveillance sensors for ground vehicle and unmanned aerial surveillance 24. Detection/location of mines and explosive ordnance 25. Neutralize snipers 26. Mark cleared rooms, buildings, and mine fields 27. Observe areas indirectly 28. Remote sensors manning check points	16. See-thru flat panel displays have limited resolution 17. Uncooled thermal sensors have limited resolution 18. Current sensors have insufficient sensitivity and resolution to detect or track small arms projectiles 19. No available shared aperture IR/radar sensor 20. No available "smart ground station" processing capability 21. Current sensor technology requires full time MITL teleoperation of UGVs 22. Current sensor technology not size/weight/cost optimized for UGV applications 23. Automated mine detection capabilities limited	16. High resolution displays 17. Advanced, lightweight multi-spectral sensors 18. Low cost millimeter wave radar 19. Projectile detection / tracking algorithms processing 20. High bandwidth data links 21. Smart remote/ground station processing with ATR
Operational Capability Element: MOUT Maneuverability			
Self-Contained Navigation • Demonstrate seamless augmentation to GPS navigation capabilities	1. 20.	11. 12. 13. 14. 15.	8. 12. 15.
Precision Personnel Insertion • Precision covert insertion of airborne combat forces	29. Survivable covert insertion of airborne combat forces 30. Precision delivery of personnel in the expanded battlefield	24. Accurate characterization of decelerator aerodynamic coefficients of performance 25. Maneuvering around urban obstacles at night 26. Gliding characteristics of parafoil	22. Computational fluid dynamics applications for decelerator characterizations
Individual Maneuverability Enhancements • Mechanical enhancements for the urban warrior for navigating and breaching obstacles	31. Increased individual maneuverability 32. Stealthier breaching	27. Inability to capture and effectively use 100% of the body's energy expenditure	23. Advanced materials 24. Miniaturized propulsion 25. Biomechanics and robotics

Figure IV.E.3. Goals, Limitations, and Technologies For Military Operations in Urban Terrain (cont'd)

Goal	Functional Capabilities	Limitations	Key Technolgies
Operational Capability Element: MOUT Engagement			
Advanced Individual Combat Weapons • Ability to effectively acquire, engage, and incapacitate personnel targets in all operational scenarios, at extended ranges and in defilade, with an affordable weapon system	33. Multi-functional weapon system with air-bursting munitions and kinetic energy projectiles 34. Integrated full solution fire control 35. Modular fire control, mission adaptable and to other weapons 36. Defeat targets in defilade, around corners 37. Automated target detection & tracking 22. 38. Non-line of sight firing 39. Remote firing 40. Bunker defeating mechanism	28. System weight, power 29. Portability 30. Uniform fragmentation distribution 31. Stability of light weight machine gun platforms 32. Accurate laser range finding in all environments	6. 7. 23. 26. Efficient recoil mitigation 27. Accurate all-environment laser ranging techniques 28. Lightweight optoelectronics 29. Directed air-burst mechanisms 30. Lightweight, down-range wind sensing
Non-Lethal Weapons/Munitions • Provide anti-personnel and anti-materiel non-lethal devices to increase mission effectiveness and reduce collateral damage	41. Non-lethal force options for point and crowd targets, while retaining lethal fire capability 42. Direct fire blunt impact munitions capability 43. Greater non lethal stand-off and alternatives to weather and wind dependent riot control agents 44. Immobilize moving vehicles without injury to occupants	33. No tunable (lethality selectable) non lethal weapons/munitions exist 34. Limited bio-effects database on personnel effects of non lethal technologies 35. No approved policy statement, mission need statement, or operational concept	31. Integrated range feedback with selectable lethality (non-lethal to lethal) munitions on a singe weapons platform 32. Variable velocity weapon mechanisms 33. Proximity fuzing for anti-personnel use
Operational Capability Element: MOUT Survivability			
Ballistic Protection • Advanced armor material systems providing lightweight, highly effective small arms and fragmentation protection • Reduced casualties	31. 45. Lightweight protection from small arms projectiles	36. Lack of affordable lightweight, flexible small arms materials 37. Limited understanding of fundamental penetration mechanisms 38. Independent component approach - not integrated	13. 23. 34. Enhanced numerical modeling to understand fundamental penetration 35. Increased strength, and low density materials 36. Improved specific toughness, high modulus polymers

Figure IV.E.3. Goals, Limitations, and Technologies For Military Operations in Urban Terrain (cont'd)

Goal	Functional Capabilities	Limitations	Key Technolgies
Individual Signature Reduction • Low cost lightweight multi-spectral camouflage for the individual combatant	46. Reduced visual, IR, and thermal detectability	39. The integration of thermal camouflage technology into a textile material 40. Site specific camouflage	37. Lightweight, flexible multi-spectral textile materials
Advanced Medical Technology • Personal status monitoring • Early detection/prevention of casualty • Quick aid response • Casualty extraction • Far forward care	47. Electronic reporting of medical status of individual in real time	41. Electronics miniaturization and integration 42. Lack of dissemination of combat information 43. Lack of personal medical sensors 44. No automatic transmission of medical information	6. 7. 14. 38. Accurate medical sensors on individual
Combat Identification • Stand alone warfighter-to-warfighter combat ID capability to prevent fratricide	2. 48. 99% probability of identifying friendly equipped warfighters in all battlefield environments	28.	6. 7. 18. 39. Laser propagation 40. RF antenna design/construction 41. RF spread spectrum signal transmission and processing

Figure IV.E.3. Goals, Limitations, and Technologies For Military Operations in Urban Terrain (concluded)

MOUT Maneuverability. Key concerns include the consistent inability to receive and maintain reliable GPS signals due to urban infrastructure; insufficient geolocation accuracy; lack of digital urban terrain databases; the cost to generate and rapidly disseminate high resolution urban databases and digital maps; and accurate characterization of decelerator aerodynamic coefficients of performance and the logistics issues associated with the providing and carrying of improved mobility tools not normally carried by dismounted forces but required in MOUT.

5. Technology Plan

The technology developments supporting the operational needs are shown in Figure IV.E.4. Figure IV.E.5 lists the DTOs for MOUT, and Figure IV.E.6 shows the demonstrations supporting this technology development.

The U.S. warfighter currently has basic capabilities for conducting the full spectrum of operational missions in most environments; however, there are significant deficiencies. The intent of the MOUT technology plan is to provide a path for resolving those deficiencies and advancing critical technologies needed for MOUT. The group of required capabilities identified here must be developed to ensure that the U.S. can overmatch any adversary in a conflict set in urban terrain. The roadmap for the development and demonstration of the MOUT system-of-systems is shown below in Figure IV.E.7.

The technologies required to achieve the functional and operational capability elements that are critical for MOUT are at varying levels of maturity, and will be demonstrated at the component and subsystem level primarily through the completion of the Defense Technology Area Plan (DTAP) Defense Technology Objectives (DTOs). (See Figure IV.E.5). The full suite of products and functionality that evolves from these technologies is required for seamless operation in a MOUT environment. To maximize our warfighting edge, these technologies must be integrated into a MOUT system-of-systems, including modular systems for C4I, survivability, engagement, and maneuverability.

One of the greatest technical challenges for MOUT is the integration of a wide range of equipment, with all the associated technical barriers, which will operate effectively and reliably given the particular challenges of the urban environment. In addition, integration of much of this equipment onto the human platform, with all its peculiarities, variations, and individual preferences, is critical, given that most MOUT operations focus on small units. Experience has shown that a systems approach must be aggressively pursued, as opposed to a "stove-pipe" development of each technology component.

As seen on the roadmap in Figure IV.E.7, various projects feed into these objective areas. Service and Defense Advanced Research Projects Agency (DARPA) ATDs and technology demonstrations (TDs) will develop the new technologies, and most of the efforts provide for demonstration of those technologies. The component programs link in and provide products along the way for the integration of interim operational capability elements (as delineated in DTOs E.01 - E.04) to be followed by integration into the larger MOUT system-of-systems. The primary focus of a few key programs (e.g., DARPA Small Unit Operations (SUO), Army/Marine Corps 21st Century Land Warrior (21CLW)) is on integrating subsystems, systems, and functionality for the warfighter. These programs are the "glue" that will form the cornerstone of the MOUT system-of-systems.

The primary areas encompassed in the MOUT technology plan are C4I, survivability, engagement, and maneuverability. While not an operational capability element per se, modeling and simulation (M&S) will contribute to the assessment of advanced technologies as well as contributing to MOUT training and mission rehearsal. M&S will complement hardware and system development via an instrumented MOUT testbed. Coupled with upgraded models and simulations, this capability will be used to assess and evaluate hardware and software performance. M&S will also augment the development and assessment of advanced operational concepts and tactics, techniques, and procedures for MOUT operations, in addition to providing a mission rehearsal capability. In aggregate, the M&S effort will allow full operational exploitation of the technological advances. (See DTO E.04.)

Each component will be ready for demonstration at a different point along the roadmap. This technology plan includes a proposed Advanced Concept Technology Demonstration (ACTD) for MOUT. The proposed ACTD will provide the first opportunity to demonstrate a MOUT system-of-systems in the FY 1999-2000 timeframe.

This initiative cuts across the Services and will capture the efforts of the Army, DARPA, Marine Corps, and U.S. Special Operations Command (USSOCOM). It will focus primarily on the integration, linkage, and interoperability of MOUT system components, and will include demonstrations in joint field exercises. (See DTO E.05.)

6. Summary

The accomplishment of the objectives delineated in each of the MOUT DTOs reflects the integration of capabilities within a given operational area (e.g., C4I). These DTOs are, in effect, waypoints on the path to achieving a full-spectrum of enhanced operational capability elements in MOUT. Each DTO represents a complement of interim capabilities within that specific area. The proposed MOUT ACTD will complete the integration, interoperability, and linkage across the operational areas to achieve the full-spectrum, seamless MOUT capability as illustrated in Figure IV.E.8. The successful implementation of this technology plan will result in substantial improvements in U.S. forces' ability to effectively and efficiently accomplish missions including general war, contingency operations, counterinsurgency, and peace and humanitarian operations in built-up areas.

Measures of success will serve as quantitative goals for the proposed MOUT ACTD. While not defined for all potential technologies, the overall measures of success (see MOUT ACTD, the DTO Volume for the JWSTP and the DTAP Section IV-E) are defined in terms of percent improvement over the base case (i.e., current Army/Marine Corps/SOF MOUT capabilities), as defined in the 1994 Defense Science Board Summary Study on Military Operations in Built-up Areas (Reference 8), and applicable doctrinal and technical publications. Specific measures of effectiveness (MOE) for technology components will be developed and refined using the model-test-model methodology. The base case will be modeled using CASTFOREM, incorporating the anticipated field experiment, terrain, and scenario. Based on runs of the base case and the ACTD case, specific data on MOEs and performance can be predicted with defensible analytical underpinnings.

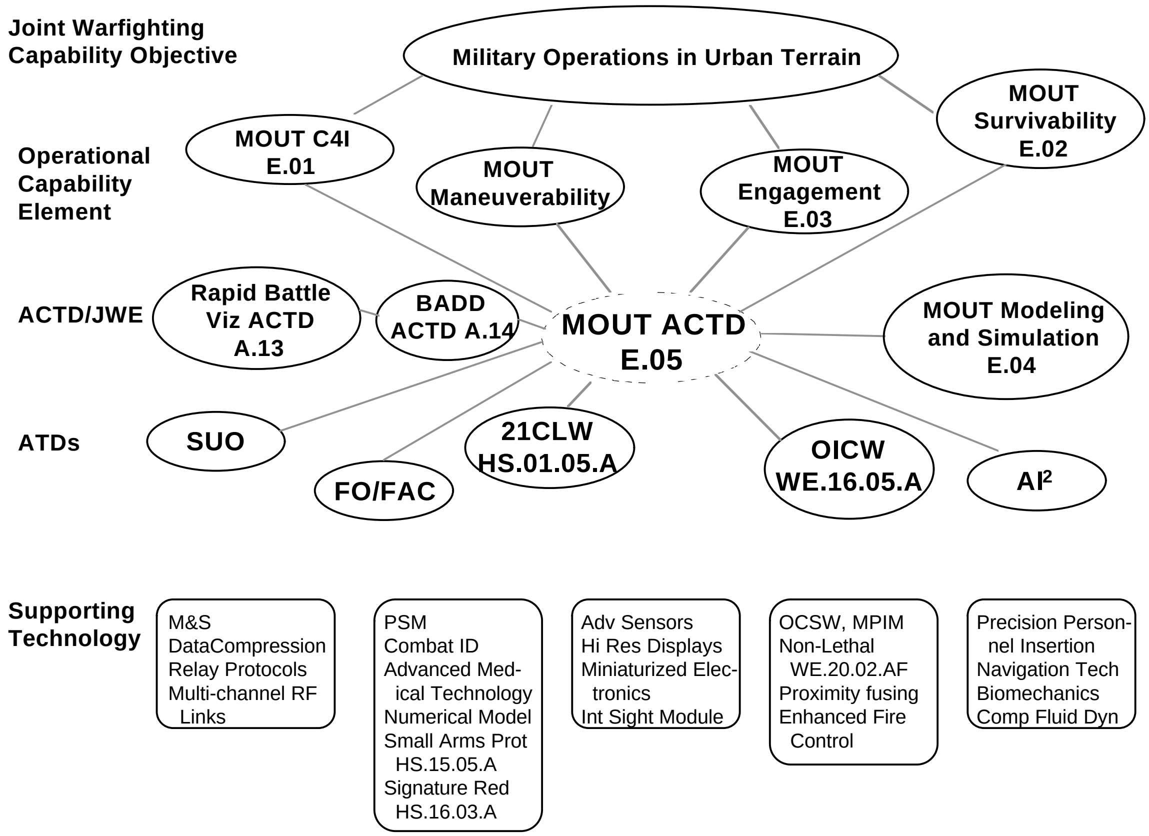


Figure IV.E.4. Technology to Capability – Military Operations in Urban Terrain

DTO	TITLE
E.01 A.13 A.14 HS.01.05.A	**MOUT C4I** Rapid Battlefield Visualization ACTD Battlefield Awareness and Data Dissemination (BADD) ACTD 21st Century Land Warrior
E.02 HS.15.05.A HS.16.03.A	**MOUT Survivability** Small Arms Protection for the Individual Combatant Thermal Signature Reduction for the Individual Combatant
E.03 WE.16.05.A WE.20.02.AF	**MOUT Engagement** Objective Individual Combat Weapon Non-Lethal Technologies
E.04	**MOUT Modeling and Simulation**
E.05	**MOUT ACTD (proposed)**

Figure IV.E.5. Defense Technology Objectives – Military Operations in Urban Terrain

Demonstration Title	Operational Capability Element: MOUT C4I	MOUT Maneuverability	MOUT Engagement	MOUT Survivability	Service Agency	Demonstration is a: DTO	ACTD	ATD
MOUT C4I: Rapid Battlefield Visualization ACTD	●		○	○	Joint	E.01 A.13	X	
Battlefield Awareness and Data Dissemination ACTD	●			○	DARPA	A.14	X	
21st Century Land Warrior (21CLW)	●	○	○	●	Army Marine Corps	HS.01.05.A		X
Advanced Image Intensifier ATD	●	○		○	Army	E.01		X
Small Unit Operations (SUO)	●	○	○	○	DARPA	E.01		
MOUT Survivability: Counter Sniper				●	DARPA, Army	E.02 E.02		
Small Arms Protection for Individual Combatant				●	Army	HS.15.05.A		
Combat Identification	○		○	●	Army	C.01		
Thermal Signature Reduction for Individual Combatant				●	Army	HS.16.03.A		
Advanced Medical Technologies				●	DARPA, Army	E.02		
MOUT Engagement: Objective Individual Combat Weapon ATD			●		Joint	E.03 WE.16.05.A		X
Foward Observer/Forward Air Controller ATD	●		●		Marine Corps	E.03		X
Non-Lethal Weapons			●		Army, DARPA	WE.20.02.AF		
MOUT Modeling and Simulation	●	○	○	●	Marine Corps, Army, DARPA	E.04		
MOUT ACTD (proposed)	●	●	●	●	Joint	E.05	X	

● Strong Support ○ Moderate Support

Figure IV.E.6. Demonstration Support – Military Operations in Urban Terrain

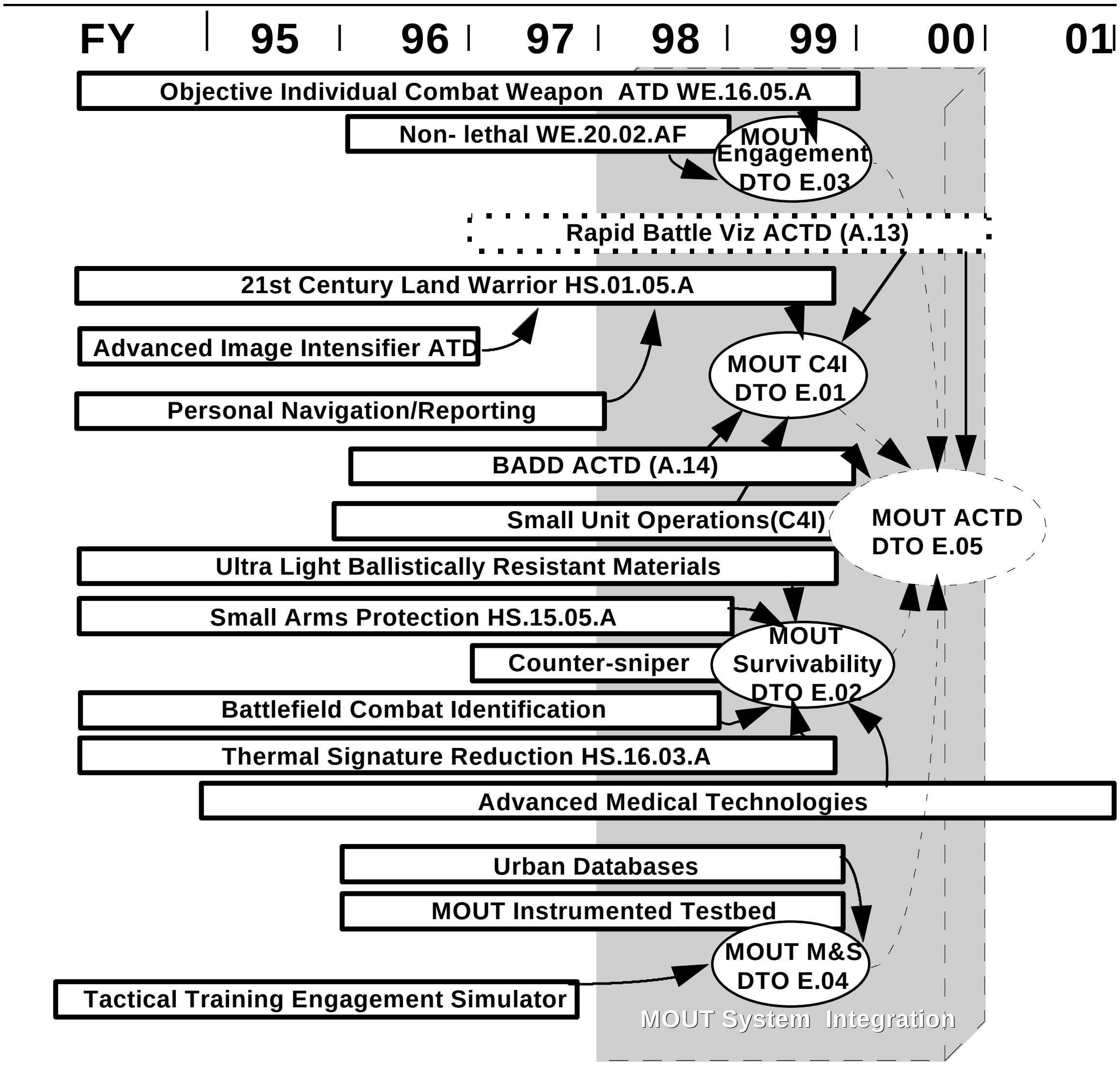


Figure IV.E.7. Roadmap – Military Operations in Urban Terrain

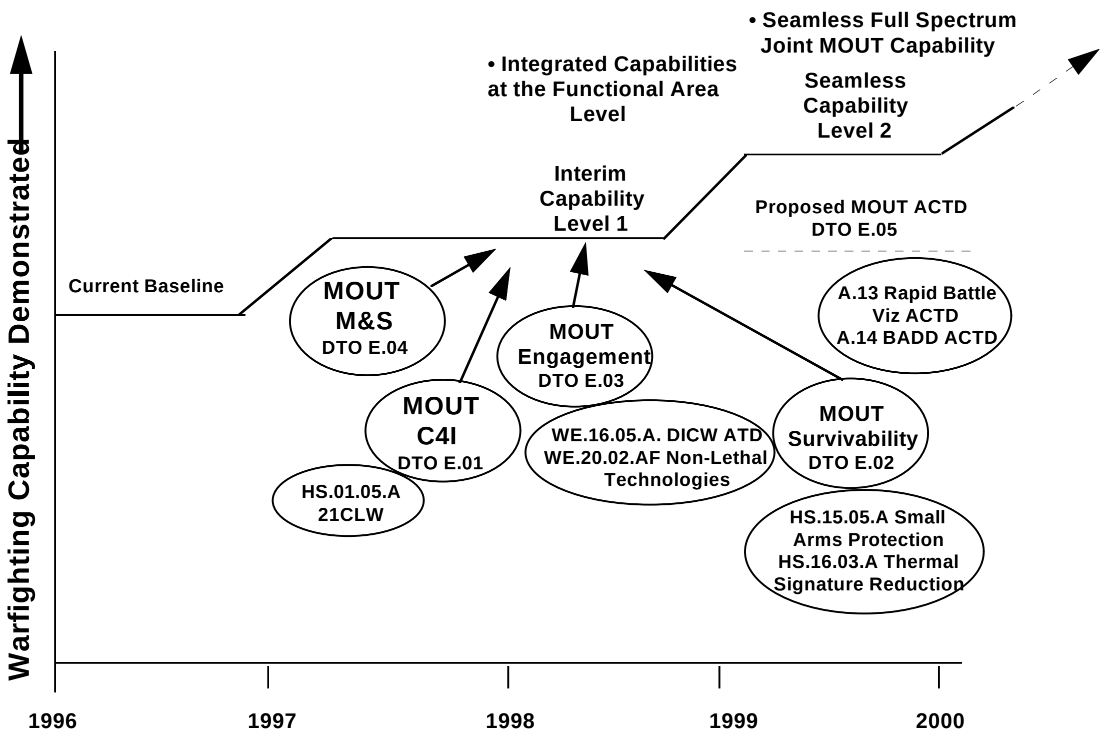


Figure IV.E.8. Progress – Military Operations in Urban Terrain

F. JOINT READINESS

1. Definition

Joint Readiness is defined as a CINC's ability to integrate and synchronize forces to execute assigned missions. The CJCS-approved Universal Joint Task List (UJTL) identifies the tasks that must be accomplished within the Joint Warfighting arena. The UJTL is broken down into operational and functional capabilities that are the CINC's domain. If a Combatant Command has the means to accomplish all of the joint mission essential tasks derived from the UJTL, then by definition the assigned forces have achieved a high state of readiness.

Figure IV.F.1 depicts the technology areas within which advances will lead to increased functional capabilities. These enhancements will result in improved performance in the operational capabilities that define Joint Readiness. The Joint Warfighting Capability Objectives (JWCOs) discussed in this plan contain near-, mid-, and long-term technology objectives. The majority of the operational capability elements affecting joint readiness are discussed in technology objectives contained in the other 11 JWCOs of this plan. To avoid duplication, this section narrows its focus to capabilities not covered in the other JWCOs, namely the broad areas of training, planning, and assessment.

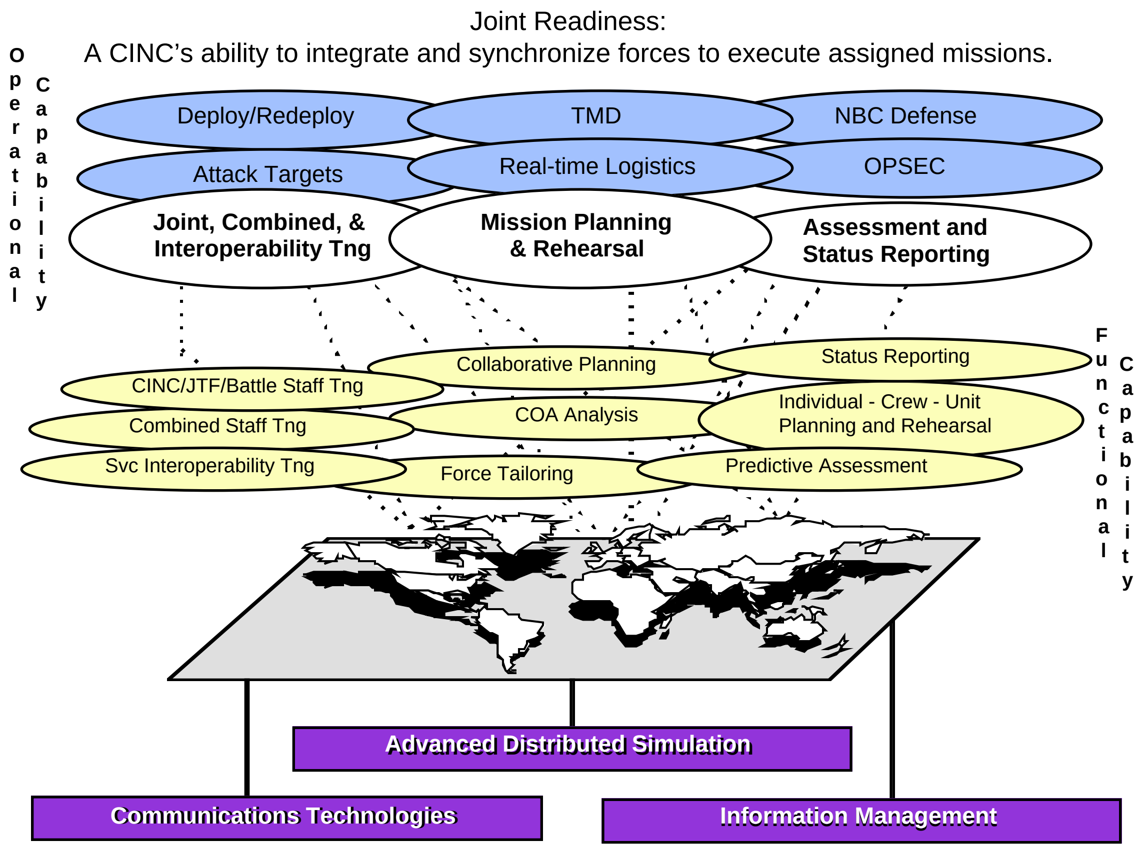


Figure IV.F.1. Joint Readiness Concept

2. Operational Capbility Elements

This section discusses only technology objectives affecting the operational capabilities of joint, combined and interoperability training (Train); mission planning and rehearsal (Plan); and readiness assessment and status reporting (Assess). These operational capabilities deal primarily with the ability of CINC and Commander Joint Task Force (CJTF) to train their respective staffs, assess the readiness of assigned forces from both active and reserve components stationed in CONUS and deployed abroad, and evaluate possible courses of action.

3. Functional Capabilities

Figure IV.F.2. shows the relationship of the functional capabilities to the operational capability elements listed above. As portrayed in Figure IV.F.1., enhanced Joint Readiness operational capability elements will come from improving the following functional capabilities: (1) CINC/CJTF/Battle staff training, combined staff training, and interoperability of forces; (2) individual/crew/unit planning and rehearsal of missions, and courses of action (COA) development; and (3) status reporting, assessments and force tailoring.

Advancements in the key technology areas of advanced distributed simulation (e.g., common technical framework, authoritative environmental representations, and human systems interfaces) will lead to more effective joint, combined, and interoperability training. Modeling and simulation (M&S) improvements, advances in communications technologies (e.g., bandwidth management techniques and multi-level security), and information management (e.g., rapid database preparation, high performance computing, and data standardization) will yield faster collaborative planning, dynamic re-tasking, and more realistic mission rehearsal. Additional research is needed in the area of performance assessment at the individual and collective levels. Specifically, measures of performance must be developed and incorporated into models and simulations, and methodologies must be developed to support automated assessment and reporting.

4. Current Capabilities, Deficiencies, and Barriers

The current capability to conduct distributed joint, combined and interoperability training is limited. Most often, this requires forces to be brought to a single location to use dedicated computer models and simulators or to conduct live exercises. Both methods involve high travel costs and, in the case of dedicated computer models, the added detraction of training with artificial systems instead of real world C4I and weapons systems controls. Computer simulations, as they exist today, are often time and labor intensive to plan, set up, and run, and frequently require large support staffs. The principal barriers to more effective joint and combined staff training include the lack of interoperability among service and allied training simulations and models and the lack of tools and methods for assessment and feedback. Another barrier is the absence of an embedded training capability in C4I and weapons systems. A common technical framework for M&S based on a high level architecture, data standardization and a common understanding of actions and interactions will help overcome the interoperability shortfalls and allow for seamless

Functional Capabilities \ Operational Capability Elements	Train: Joint	Train: Combined	Train: Interoperability	Plan: Mission Planning	Plan: Mission Rehearsal	Assess: Status Reporting	Assess: Predictive Assessment
1. Joint/Combined Interoperability	●	●	●		○		
2. Combined Staff Training		●	●				
3. CINC /CJTF/Battle Staff Training	●	○					
4. Individual/Crew/Unit Planning & Rehearsal	○	○	○	●	●		
5. Collaborative Planning & Rehearsal			○	●	●		
6. COA (Staff) Development			○	●			○
7. Status Reports						●	○
8. Assessments (In Theater)						○	●
9. Force Tailoring						○	●

● Strong Support ○ Moderate Support

Figure IV.F.2. Functional Capabilities Needed for Joint Readiness

distributed simulation. Planning for interoperating with simulations from the requirements definition stage of new weapons and C4I systems acquisition will allow for more realistic training.

Collaborative mission planning is currently limited to the passing of independently generated portions of mission plans from one Service or unit to another. There are no real-time collaborative planning tools currently fielded that enable disparate mission planning systems to share information. Mission rehearsal tools are limited to selected weapons systems, mission preview systems, and simulators, virtually all of which are in the aviation community. Realism, or human immersion, in the simulators is limited by the lack of effective and accurate representations of other systems, human behaviors, and the natural environment. Deficiencies and barriers to mission planning and mission rehearsal include disparate architectures among current planning systems which preclude interoperability, a lack of shared standards and protocols, and non-standard databases.

Readiness assessment and status reporting is currently limited to manual recording, relatively simple mathematical formulations, and educated guess work. The Status of Resources and Training (SORTS) system provides an estimate of current unit or force readiness based on a compilation of readiness evaluations from its component units. There is no effective means of determining future readiness based on current operations and resource decisions. For instance, a CINC can only guess what effects there will be on his ability to successfully execute an OPLAN tasking in a Major Regional Conflict (MRC) if assigned forces are currently conducting a peacekeeping mission and cannot train for combat missions. Advances in performance assessment methods and the development of predictive tools will lead to more robust and objective assessments of readiness from individual units to joint force levels. Additional work is needed in providing performance feedback to trainers and trainees and in aggregating and synthesizing readiness data for high-level reporting needs.

Figure IV.F.3 identifies performance goals within each functional capability, current limitations to achieving those goals, and the technologies required to overcome those limitations. Figure IV.F.4 illustrates how technology developments support overall joint readiness. Note that several DTO's from other sections (most notably Information Superiority, Section IV.A) are crucial to achieving Joint Readiness. Figure IV.F.5 lists currently programmed DTOs supporting Joint Readiness, while Figure IV.F.6 shows the enhanced capabilities resulting from those technological advancements.

5. Technology Plan

Figure IV.F.7 is the roadmap for developing and demonstrating the technologies required to support the advancements in functional and operational capabilities which affect joint readiness. This roadmap shows how advances in advanced distributed simulation, communication technologies, and information management will provide significant improvements in the ability to conduct distributed joint, combined, interoperability, and staff training of various scales.

Technology advances are needed to effectively link live, virtual and constructive simulations. The Synthetic Theater of War (STOW) ACTD is intended to develop and demonstrate M&S technology which can then be used by major simulation development programs such as the Joint Simulation System (JSIMS). JSIMS is the next generation training tool for the Combatant Command, Commander Joint Task Force and Joint Task Force Component Commanders and their staffs. It will be the first training capability to fully utilize the technology advances envisioned in this plan. The Advanced Distributed Simulation (ADS) DTO will demonstrate the use of a common technical framework which enables unprecedented interoperability among simulation systems. The framework will be utilized by STOW, JSIMS and all other simulation developments. The collective goal of these efforts is to reduce exercise planning and set-up time by 70 percent, reduce the exercise support cadre by 50 percent, and reduce travel in support of command post and computer aided exercises by 60 percent. The DoD Modeling & Simulation Master Plan (DoD 5000.59.P) (Reference 10) provides a more detailed discussion of planning in this area.

Technological advances, such as those pursued under the Rapid Battlefield Visualization ACTD (DTO A.13), are necessary to merge digital imagery with terrain data to rapidly develop databases which provide realistic depiction of areas of operation for training and real-world contingencies. The databases produced must be at the accuracy required for the specific application (e.g., high resolution with features for Special Operations or precision guided munitions mission planning and rehearsal, or lower resolution for JTF-level constructive wargames). The Special Operations community has a stated need for the delivery of terrain databases for mission planning and rehearsal within 96 hours. Overall reductions in terrain database developmental time should be in excess of 75 percent. The MOUT ACTD (DTO E.05) will begin to address individual and small unit performance in complex urban environments with a goal of increasing situational awareness at all levels by 50 percent and increasing force survivability by 20 percent.

Advances in M&S technology, particularly the development of a common technical framework and seamless interfaces with real-world C4ISR systems, will make not only automated mission planning and rehearsal across all Services and mission areas a reality, but real-time dynamic collaborative planning as well. The Advanced Joint Planning ACTD will leverage advances in distributed M&S and, in particular, the Advanced Distributed Simulation DTO to demonstrate C4I systems integration for distributed collaborative planning capability and common perception of the battlespace. This will result in a 80 percent reduction in CINC planning cycles for emerging crisis response and a 60 percent reduction in planning time for major deployments. This aspect of joint readiness is also supported by the DARPA Advanced Logistics Program (DTO K.03) which is targeted at the full range of advanced logistics support. Vital to these capabilities is a marked improvement in networking, multi-level security, and communication technologies, such as those pursued by the Assurance of Services DTO (DTO A.31) and Information Security ACTD (DTO A.29). These capabilities will be magnified when commanders can design their own information systems that deliver an accurate, timely, and consistent picture of the joint/coalition battlefield as provided by the Battlefield Awareness and Data Distribution (BADD) ACTD (DTO A.14).

The Joint Training Readiness (JTR) DTO will demonstrate feedback tools for training and joint force assessment methodologies. As a result, this DTO will leverage investments in synthetic environments and distributed simulation, as well as provide tools for linking performance in joint exercises to estimates of joint training readiness. The JTR DTO will also demonstrate the use of performance and assessment data in cost-effectiveness evaluations and trade-off decisions to guide joint training policy and resources. The DTO will result in a 30 percent reduction in time required to achieve training readiness and a 50 percent increase in the number of warfighting tasks demonstrated effectively during exercises. Although not the immediate domain of the CINC, work in this area promises to yield technologies that can be used to assess and predict long-term impacts (greater than 2 years) on readiness as a result of current operations and resourcing decisions made at the national level.

One or more Joint Warfighting Experiments (JWE), held in conjunction with a planned joint exercise, will provide opportunities to employ all of these emerging technologies to enhance training, planning and assessment capabilities for the CINC and his component units. The results of the JWEs will help shape future joint training, planning, assessment, and associated acquisition decisions.

6. Summary

Joint readiness is directly affected by many of the other 11 JWCOs in this plan, but the operational capabilities of training, planning, and assessing are essential elements that must be specifically addressed. Developments in technology promise advancements in these capabilities in the near-, mid- and long-term, as illustrated in Figure IV.F.8.

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Joint, Combined and Interoperability Training			
• Provide home station, real-world equipment training for distributed forces (active and reserve) • Ensure cross-simulation validity of representations and interactions	1. Joint/Combined/ Interoperability 2. Combined staff training 3. CINC/CJTF Battle staff training	1. Limited interoperability of simulations at different levels of resolution 2. Incompatible protocols and interfaces between and among deployment, redeployment, personnel, logistics, C4I, M&S, information, and instrumentation systems 3. Incompatible data formats for automated data processing 4. Lack of interactive dynamic environmental effects models 5. Bandwidth limitations of present communications nets (limited support for large block data transfers or simultaneous flow of data, voice, graphics, and video) 6. Multi-level security cannot interactively support a mix of classified and unclassified information 7. Long lead time for development of environmental databases 8. Lack of cross platform commonality of terrain databases	1. Easily deployable, evolvable, scaleable, interoperable, plug and play architecture for C4, intelligence, and M&S systems for "train as we fight" capability 2. Virtually resident database capable of self update and automatic reconstruction and redistribution 3. Advanced M&S tools 4. Multi-level security 5. Secure, high rate, high bandwidth communications 6. Information fusion 7. Tailored, natural language, information search and retrieval capability 8. Embedded, deployable, distributed fault tolerant M&S for mission planning, rehearsal and training 9. Distributed, synchronized databases 10. Object oriented, distributed automated, dynamic scenario generation and exercise planning
Operational Capability Element: Mission Planning and Rehearsal			
• Provide rapid response to planning and rehearsal requirements for contingency operations • Real-time mission planning • Dynamic mission retasking	4. Individual/crew planning and rehearsal 5. Collaborative planning and rehearsal 6. Course of action development	1. 2. 3. 4. 5. 6. 7. 8.	1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. Advanced collaboration planning capability
Operational Capability Element: Assessment and Status Reporting			
• Provide near-real-time information on unit readiness, e.g., relevant details on each person (education, training, health, etc.) and equipment (numbers, condition, status) for assigned forces • Tailor force packages based on near real-time readiness status update to modifying or reconfiguring forces due to changes in situation, mission, or combat capability • Provide the capability to predict near- and mid-term impacts of operational and resource decisions on unit and joint readiness	7. Status reporting 8. Force tailoring 9. Predictive assessment	1. 2. 3. 4. 9. Delay in data reporting 10. No common metrics for operational picture/readiness reporting, especially coalition readiness 11. Lack of accredited algorithms to forecast readiness impacts 12. Lack of performance measures embedded in models and simulations 13. Lack of tools to assess collective and joint readiness and provide feed back to trainers, trainees, and commnders 14. Lack of tools and capabilities to synthesize and report readiness	3. 5. 6. 12. Intelligent agents to retrieve, filter, sterilize, sanitize, and deconflict information and data 13. Object oriented, distributed, automated, dynamic planning tools 14. Effective methods for embedding performance measures in M&S systems 15. Capabilities to synthesize and report readiness data 16. After action review tools 17. Unit performance measures in readiness reporting

Figure IV.F.3. Goals, Limitations, and Technologies for Joint Readiness

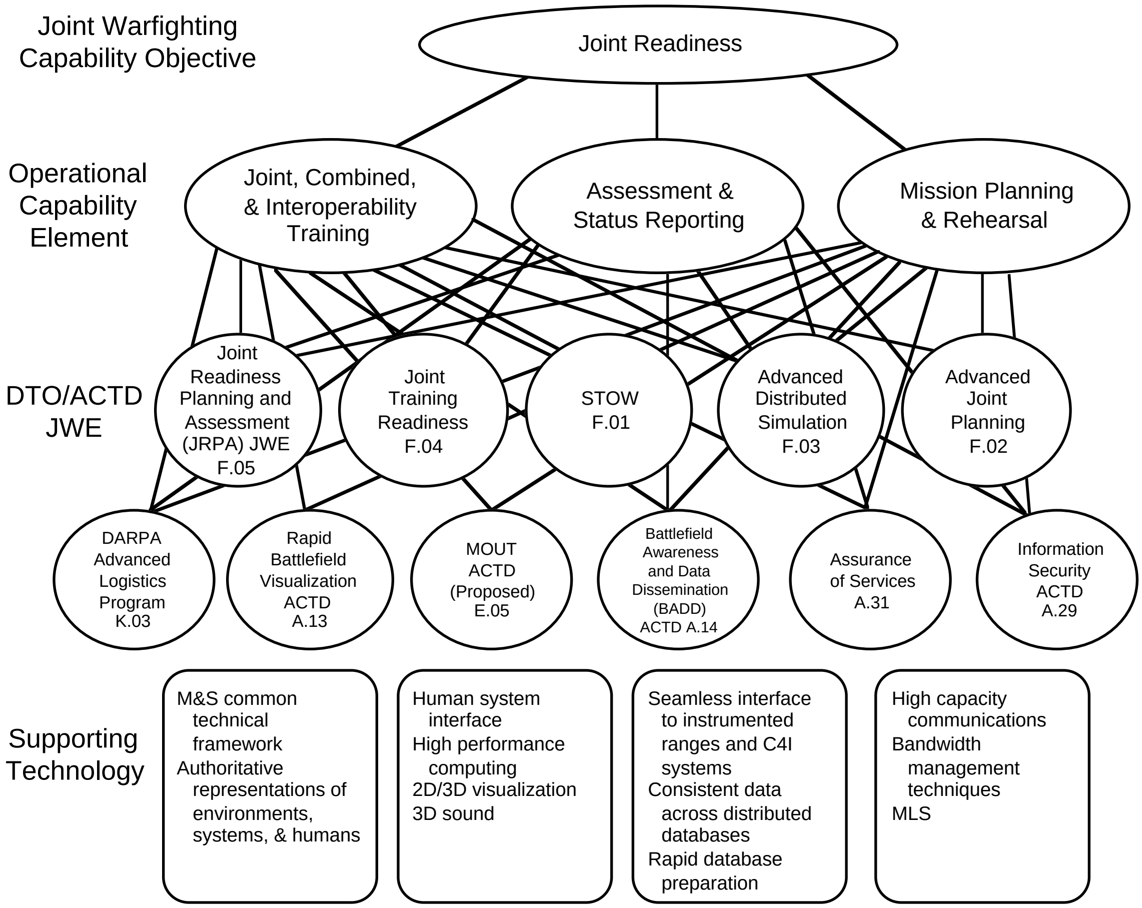


Figure IV.F.4. Technology to Capability – Joint Readiness

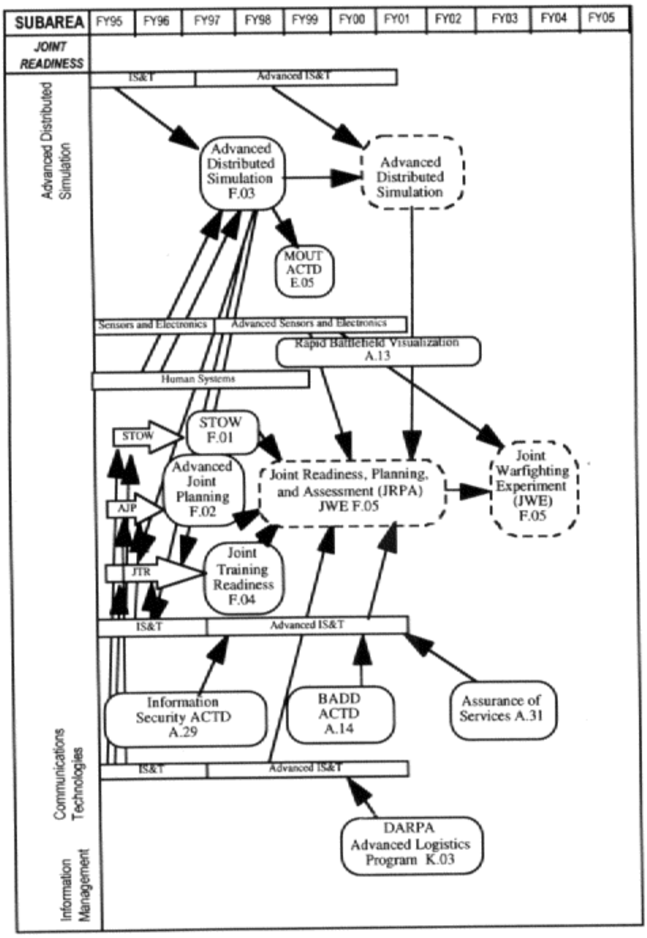
DTO #	TITLE
F.01	Synthetic Theater of War (STOW) ACTD
F.02	Advanced Joint Planning (AJP) ACTD
F.03	Advanced Distributed Simulation
F.04	Joint Training Readiness
F.05	Joint Readiness, Planning and Assessment (JRPA) JWE
A.13	Rapid Battlefield Visualization ACTD
A.14	Battlefield Awareness and Data Dissemination (BADD) ACTD
A.29	Information Security ACTD
A.31	Assurance of Services
E.05	MOUT ACTD (Proposed)
K.03	DARPA Advanced Logistics Program

Figure IV.F.5. Defense Technology Objectives – Joint Readiness

Demonstration	Train			Plan		Assess		Operational Capability			
	Joint	Combined	Interoperability	Mission Planning	Mission Rehearsal	Status Reporting	Predictive Assessment	Service/ Agency	DTO	ACTD	ATD
Synthetic Theater of War (STOW)	●	●	●					ARPA	F.01	X	
Advanced Joint Planning (AJP)	○	○	○	●	○			ARPA	F.02	X	
Advanced Distributed Simulation	●	●	●	●	●	●	●	DMSO	F.03		
Joint Training Readiness	○	○	○	○		●	●	DUSD (R), Services	F.04		
Joint Warfighting Exercise (JRPA) JWE	●	○	●	●	●	●	●	Joint Staff	F.05		
Rapid Battlefield Visualization ACTD	●	○	●	●	●			Army	A.13	X	
Battlefield Awareness and Data Dissemination (BADD) ACTD	●	○	●	●	●	●	○	DARPA	A.14	X	
Information Security ACTD	●	○	●	●	●	○	○	DARPA	A.29	X	
Assurance of Services	●	●	●	●	●	●	●	DARPA	A.31		
MOUT ACTD (Proposed)	●	●	●	●	●		○	DARPA	E.05	X	
DARPA Advanced Logistics Program	●	●	●	●	●	●	●	DARPA	K.03	X	

● **Strong Support** ○ **Moderate Support**

Figure IV.F.6. Demonstration Support – Joint Readiness



IS&T = Information Systems and Technology

Figure IV.F.7. Roadmap – Joint Readiness

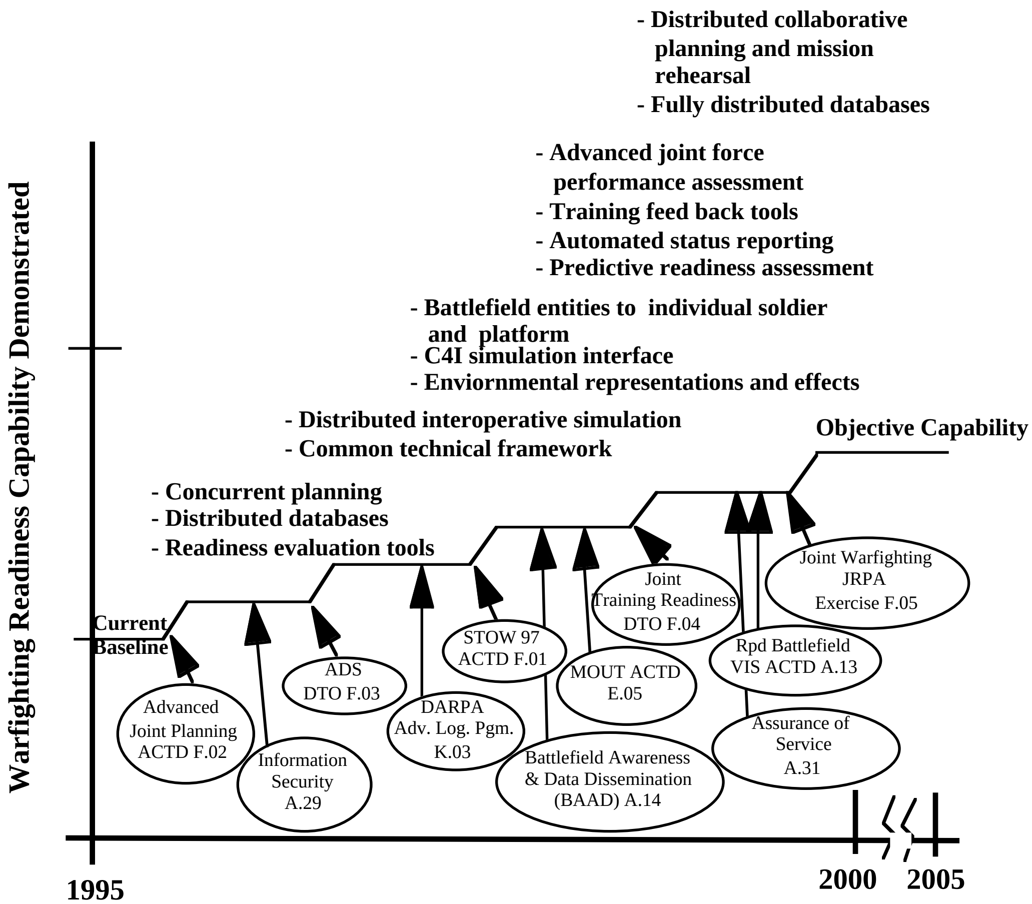


Figure IV.F.8. Progress – Joint Readiness

G. JOINT COUNTERMINE (JCM)

1. Definition

Joint Countermine provides the capability for the assured, rapid detection and neutralization of mines to enable forced littoral entry by expeditionary forces. Included is the capability to conduct amphibious and ground force operational maneuvers against hostile defensive forces employing mines. This requires enhancements to detect and neutralize mines in selected corridors on land, beach, shallow water areas, and at sea at rates adequate to minimize exposure of friendly forces to hostile fire.

2. Operational Capability Elements

For all U.S. forces, the threats of sea and land mines pose significant challenges to shaping and maintaining dominance of the battlespace. U.S. forces, forward deployed and operating in the littorals, must possess the ability to establish dominance of the battlespace. For naval forces this means control of the sea to allow unencumbered maneuver through sea lanes of communication to operating areas where instride amphibious assaults are executed. For land based forces this means control of the land to include both maneuver for tempo operations and peacekeeping missions.

Joint Countermine addresses the complex countermine problem through a "system-of-system" approach. Countermine operations, both at sea and on land, have historically been considered in terms of a number of elements, individually and separately applied to the various tasks involved in detecting and neutralizing mines and minefields. The Joint Countermine Objective is to integrate all equipment and operations into a seamless capability to conduct expeditionary naval, amphibious and/or land/airborne missions into hostile territory with minimal disruption and losses due to enemy minefields. A spin-off capability is the ability to remotely locate, survey, register, and clear mines in roadbeds and off roads during operations other than war (OOTW). As Bosnia, Somalia, and Operation Desert Storm have shown, this is a critically needed capability to achieve force protection and to support peacekeeping.

The diverse service countermine elements will be integrated through a linked architecture which provides the commanders full visibility, status, and control of countermine operations. A comprehensive simulation system, the Joint Countermine Operational System (JCOS), will permit realistic training, mission rehearsal, and, ultimately, operational support at all operational unit echelons.

U.S. forces must be able to "engage regional forces promptly in decisive combat on a global basis." In the post-Cold-War era, U.S. forces and those of our coalition partners must be able to bring the battle to the enemy in expeditionary operations. Mines (sea, coastal, and land) offer hostile third world countries a low cost means to hold our forces at bay – particularly in a climate of very low tolerance for combat losses – and to disrupt operations other than war. The best way to counter mines is to detect the presence of mines and minefields and avoid them in the first place. Even with "perfect real-time intelligence" this "ideal" solution may not be feasible, since mining operations are generally employed to channel forces into directions the enemy desires. For tactical reasons it may be necessary to breach rather than bypass the minefield. In any event, the decision as to where, how, and when to enter a combat area must be made with the maximum confidence in one's knowledge of the location and nature of defensive minefields.

Thus, the first essential step in the joint countermine Joint Warfighting Capability Objective is broad, covert surveillance utilizing all available sources, including National Technical Means (NTM), UAVs, and HUMINT, to characterize the littoral areas and terrain and to narrow entry options. The initial surveillance phase is followed by tactical clandestine reconnaissance during which potential avenues of approach are investigated in detail for mines, obstacles, and other defenses. The commander selects the actual assault path based on the latest intelligence and, once overt operations commence, seeks to establish a beach head or lodgment within two to six hours after the commitment of forces. Even in areas deemed to contain few or no mines, some breaching operations must be anticipated, since mines could be laid at the last minute and/or scattered into the area by missiles or artillery.

Figure IV.G.1, the Joint Countermine Concept, shows an integrated, operational concept which provides high confidence in the surveillance, reconnaissance, detection, characterization, and breaching or clearing of potential minefields which could otherwise deter or prevent operational missions into hostile areas. The emphasis is on high confidence, since command decisions must be made with a reliable assessment of the likelihood of success and potential losses. The objective of countermine S&T programs is to have, within five years (by 2001), an initial limited capability for integrated countermine operations which substantially remedies the most serious current deficiencies, followed within five more years by an operational capability that addresses all current known threats.

The initial five year capability will be achieved through a combination of countermine systems integrated into an appropriate command and control structure. Individual elements of the S&T program are developing systems for the remote and airborne detection of minefields on land and at sea as well as on the beach and in the surf zones. In addition, NTM data from overhead sensors will be made available in near real time to the tactical commanders. By FY 1997, greater than 95 percent detection with acceptable false alarm rates of buried, roadbed individual mines including plastic mines will be demonstrated using ultra-sensitive magnetic sensors, multi-spectral and infrared imaging sensors, and ground penetrating radar. Breaching and clearing of beach and land areas will be accomplished by advanced mechanical and explosive systems currently in development.

Longer term (ten year) capabilities depend upon advanced technologies now emerging from basic and applied research. These will form the basis for joint countermine forces to keep pace with the expected expansion of the sea and land mine threat well into the 21st century. Promising longer term technologies being pursued include directed energy for detection and destruction, undersea acoustic local area networks, and advanced differential synthetic aperture radar for clandestine reconnaissance. Developments also include hypersonic, water-piercing projectiles for

Vision: Seamless Countermine Operational Capability Element for Surveillance, Reconnaissance, Detection, Characterization, Breaching and Clearing of Mines and Minefields

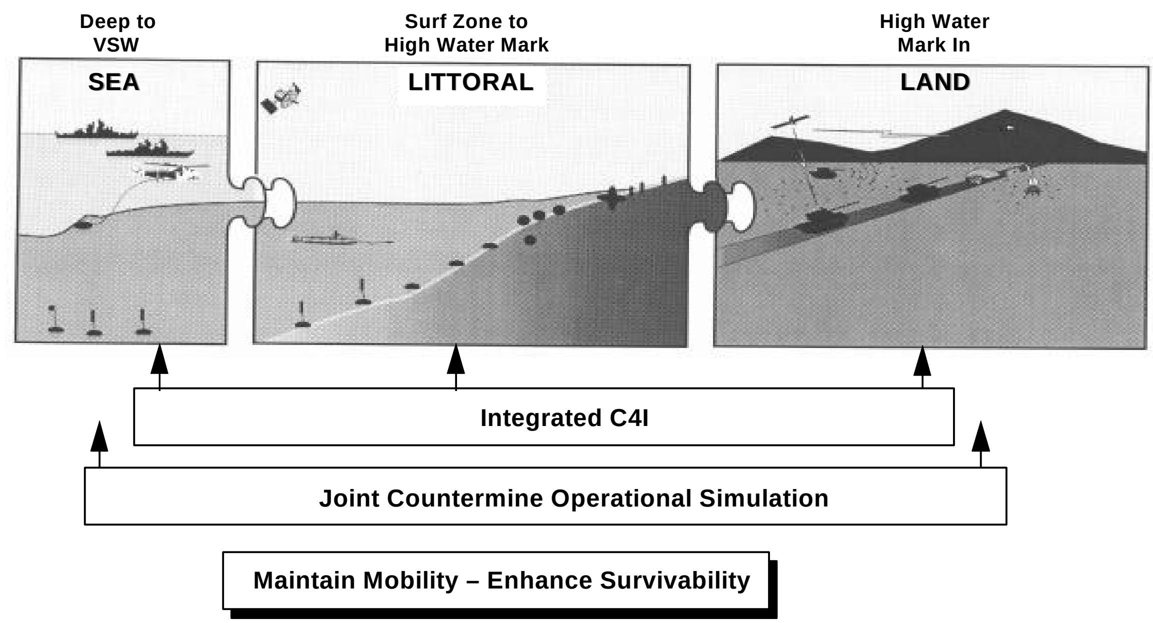


Figure IV.G.1. Joint Countermine Concept

stand-off mine clearance. The 1996 DoD Multi Disciplinary University Research Initiative (MURI) Broad Announcement has increased significantly the funding of this nation's leading university researchers to develop advanced mine detection and neutralization technologies. The Army's Night Vision Electronic Sensors Directorate has an active demonstration program open for evaluation to all promising contractor technologies.

3. Functional Capabilities

Figure IV.G.2 illustrates the Joint Countermine functions required to produce the operational capability elements.

4. Current Capabilities, Deficiencies, and Barriers

Figure IV.G.3 presents the technologies needed to breach the limitations to achieving the Joint Countermine objective.

Current operational countermine surveillance capabilities rely upon human and other intelligence sources. Overhead assets may be tasked to support the surveillance of minefield laying operations and to survey minefields, but as yet are not integrated into near-real-time capabilities in the field. This deficiency was recognized during the Gulf War; its remedy is one of the primary objectives of ongoing development efforts.

Functional Capabilities \ Operational Capability Elements	Surveillance, Reconnaissance & Detection						Breaching & Neutralization					Battlespace Management			
	Standoff Mine/Minefield Detection	Close-In Mine Detection	Continuous Surveillance	Precision Targeting	Precise Minefield Location	High Search-Rate Reconnaissance	Stand-Off Breaching	In-Stride Breaching and Clearance	Route Clearance	ID of Mines	Explosive Neutralization	Marking	Reporting	Recording	Dissemination
1. Detect mines outside kill radius	●	●			○								○	○	
2. Positive mine identification	○	●		○						●					
3. Determine presence of explosive material		●					○	○							
4. Differentiate mines from background clutter	○	●	○		○	○									
5. Combine multiple sensor findings	●	●			●	●							○	○	
6. Neutralize mines regardless of fuse type							●	●	●		●				
7. Low logistics burden, all-weather, mine neutralization							●	●	●		●				
8. Unmanned platforms for detection and neutralization	○	○	○			○	○	●	●		○				
9. Remote marking and minefield location dissemination												●	●	○	○
10. All-weather mine detection and neutralization	○	○	○	●	●	○				●			○		
11. Underwater power generating sources			●									○	●	○	
12. Remote environmental data gathering			●										●	●	
13. Access to NTM data	○		●	○	○	●				○		○	●	●	○
14. Automated situational awareness			○	○	○	○						○	●	●	●
15. High resolution underwater imaging			●	●	●	○				○		●	○	○	
16. Undersea positioning and sensor networks			●	○	●					○		○	○	○	
17. Hypervelocity/kinetic energy projectiles				●			●	●	●		●				
18. Influence sweeping signal sources								●				○	●	○	
19. Theater DGPS for SEAL teams					●	○				○		●	●	○	○

● Strong Support O Moderate Support

Figure IV.G.2. Functional Capabilities Needed for Joint Countermine

GOAL	FUNCTIONAL CAPABILITIES	LIMITATIONS	KEY TECHNOLOGIES
Operational Capability Element: Countermine Battlespace Management			
Demonstrate ability to conduct seamless countermine in support of Joint Operations.	9. Remote marking and minefield location dissemination 11. Underwater power generating sources 13. Access to NTM data 14. Automated situation awareness 15. High resolution underwater imaging 18. Influence sweeping signal sources 19. Theater DPGS for SEAL teams	1. No common countermine operational picture 2. No coordinated efforts in joint countermine 3. Limited ability to conduct in stride breaching for maneuver forces 4. Limited ability to detect and neutralize mines in the surf zone	1. Multi-spectral sensors and sensor fusion for all-weather all day detection 2. Robotics 3. Signature duplication and reduction 4. Automatic target pattern recognition 5. Integration of data into joint situation display
Operational Capability Element: Stand-off and Close-in Mine/Minefield Detection, Marking, Recording			
To provide Maneuver Commanders and individual soldiers the capability to detect 95% of land mines from a safe distance at maneuver speeds of 30 kph for vehicles, 3 kph for soldiers.	1. Detect mines ouside kill radius 2. Positive mine identification. 3. Determine presence of expolosive material 4. Differentiate mines from background clutter 5. Combine multiple sensor findings 10. All weather mine detection & neutralization	5. Excessive false alarm rate and low detection in high clutter background 6. Environmental limitations of sensors 7. No ability for automated marking and recording of mines/minefields data to the situation display	4. 6. Multi-sensor data fusion 7. Ground penetrating radar 8. Enhanced IR sensitivity/resolution 9. Forward looking radar/IR 10. Hyperspectral imaging 11. Integrated countermine marking and recording data into the battlefield management and data base
Operational Capability Element: Stand-off and In-Stride Breaching and Route Clearance			
To provide Maneuver Commanders the ability to eliminate up to 95% of mines during Military Operations	2. 6. Neutralize mines regardless of fuse type 7. Low logistics burden, all weather, mine neutralization 8. Unmanned platforms for detection & neutralization 17. Hypervelocity/kinetic energy projectiles. 18.	8. Dynamics of mine/fuse threat forces, a systems of systems 9. Neutralization is slow and labor intensive 10. Need to obtain high confidence level for clearance missions 11. Excessive human interaction in neutralization techniques	2. 12. Kinetic energy neutralization 13. RF signal neutralization 14. Chemical neutralization 15. Sensor fusion for integrated and automatic detection, classification and neutralization 16. Enhanced area explosives and energetic materials 17. Integration of countermine neutralization data into the battlefield management
Operational Capability Element: High Search Rate Reconnaissance, Precise Minefield Location and Targeting, and Continuous Surveillance			
Capability to collect, correlate and report pre-hostility MIW operations to determine the extent of minefields and mines in the amphibious operations area, the precise location of mines, and key environmental factors	5. 10. 12. Remote environmental data gathering 13. 15. 16. Undersea positioning and sensor networks 17. 19.	12. Inefficient use of dedicated platforms in theater 13. Inadequate access to intelligence data bases at the tactical level 14. Ability to fuse data from multiple platforms and to characterize environmental factors 15. No ability to provide continuous surveillance 16. Very limited capability to identify mines in shallow water 17 Limited capability to rapidly sweep, remove, or destroy mines in shallow water	1. 7. 10. 13. 16. 18. Synthetic aperture radar 19. Sensor and data fusion 20. Underwater power generation 21. Influence sweeping signal sources 22 Magnetic sensors

Figure IV-G.3. Goals, Limitations, and Technologies for Joint Countermine

GOAL	FUNCTIONAL CAPABILITIES	LIMITATIONS	KEY TECHNOLOGIES
Operational Capability Element: ID of Mines and Neutralization of Sea Mines			
From the sea - identify and dispose of mines and obstacles in very shallow water through the back beach with minimal casualties to men and equipment	2. 6. 7. 10. 17.	18. Very limited capability to identify mines in very shallow water, in the surf zone 19. Limited capability to rapidly sweep, remove, or destroy mines in very shallow water, the surf zone, or on the beach 12. 13. 17. 20. Limited ability to characterize environmental factors 21. Limited clandestine undersea sensor for very shallow water and surf zone 22. Techniques limited by high clutter, background	10. 16. 18. 19. 21. 23. Hypervelocity projectiles 24. Theater differential GPS navigation for SEALS 25. High repetition rate lasers, imaging sonars, and high-speed cameras 26. High fsrequency acoustic specification of the environment 27. Precise underwater positioning 28. Exploitation of national technical means sensors

Figure IV-G.3. Goals, Limitations, and Technologies for Joint Countermine (con't)

Mine detection in deep and shallow water has been focused on the limited role of port breakout, and has received renewed interest since the Gulf War. The need is to provide a capability to maintain control of sea lanes of communication. Today's deep and shallow water capability, while not perfect, is tractable using advanced sonar systems, trained marine mammals, magnetic signature suppression, and influence sweeping systems. On the other hand, the only current clandestine capability for very shallow water and surf/beach zone mines and obstacles are the Navy SEALs, who must conduct a very dangerous mission, usually under darkness. These same forces also use explosive charges to clear lanes in the shallow waters and onto the beach when necessary.

Land forces must also rely on fragmentary intelligence sources for the location and extent of minefields, and send out scouts and patrols to conduct reconnaissance missions. The detection of mines by land forces is still done substantially the same way as during WWII, namely by hand-held magnetic detectors, probes, or inadvertent detection. Breaching is done using tank-mounted mine plows and tank-mounted rollers for proofing. Line charges can also be used to clear a narrow lane through pressure sensitive mines. Mines are cleared using hand-held detectors and individually placed explosive charges.

There are many deficiencies in our current baseline countermine capabilities, as is evident from the above discussion. Probably the most severe is in the area of detection, surveillance, and reconnaissance. There is no operational system which can detect non- or very low metallic mines. Today, the only means for detecting mines in shallow or surf zone waters is by a human agent, visually or by touch. Even when located and cleared, the marking of lanes through shifting coastal waters is inaccurate and unreliable. There is no current means for rapidly clearing the mines in shallow waters, surf zone, and beach. Finally, mine detection and clearing operations are not normally conducted during training exercises. Realistic countermine training exercises generally cannot be held due to the extensive time it currently takes to breach.

A second significant barrier is technology. Mines come in a daunting variety of designs, typically at very low (relative) cost. Many are unreliable, adding added risk to clearing operations. The mine weapons designer has a significant advantage over his countermine colleague in that he always has the first move, and the countermine community is always forced to react. One of the fundamental truths about countermine technology is that there is no one technology which offers a single solution (i.e., silver bullet) to the problem of detecting, neutralizing, or clearing mines or minefields. Rather, a range of technologies – ground penetrating radar, acoustic, optical and infrared, magnetic, etc. – must be fused to approach the problem. One advantage which is likely in dealing with third world forces, since they are very likely to have obtained their inventory of low cost mines in the (unfortunately burgeoning) world market, is a reasonably reliable understanding of the threat systems, although their deployment may be unconventional and their performance unreliable.

5. Technology Plan

Figure IV.G.4 presents the technologies needed to breach the limitations to functional capabilities required to achieve Joint Countermine objectives. These technologies offer the potential for a significant increase in today's capability and their need is underscored by experience in Operation Desert Storm, Somalia, and Bosnia.

Figure IV.G.5 identifies the Joint Warfare Countermine Defense Technology Objectives (DTOs). Definitions, points of contact, and funding profiles for the Joint Countermine JWCO are provided in Appendix A.

Figure IV.G.6 shows the DTOs which, when attained, will enable the operational capability elements. Each DTO is defined in Appendix A and plotted in the Technology Roadmap of Figure IV.G.7.

The roadmap for developing and demonstrating the technologies required to support the JCM JWCO is shown in Figure IV.G.7. This roadmap represents the demonstrations which result from three serial processes: (1) phenomenology, (2) technology, and (3) integration. Phenomenology addresses the understanding of the physical effects which influence mine detection and negation. These include better understanding of hydrographic phenomena in shallow and littoral waters and the surf zone, acoustic and electromagnetic mine and minefield signatures, and the reaction of explosives to chemical and energetic perturbation (pressure, directed energy, etc.). Technology enables the design and manufacturing of various sensors and neutralization systems. It also includes algorithms for the detection and identification of mines and minefields, taking advantage of all available data, both sensor as well as intelligence and threat data bases. Integration represents the effort required to put technologies on a militarily significant platform for demonstration. Integration also addresses the critical need to provide a comprehensive C4I capability which includes high confidence situation awareness in real time of the mine threat, and all friendly assets and their capabilities, and to coordinate among the services and coalition forces an optimized, seamless countermine operation.

The technology efforts include several projects in the Army, Navy, and Marine Corps S&T program. Below is a list of the efforts, by DTO:

G.01 The Off-Route Smart Mine Clearance (ORSMC) provides a capability to neutralize off-route smart mines. It utilizes a remotely controlled vehicle with survivability enhancements to emulate tank or other vehicle signatures, thereby triggering impotent activation.

G.02 Close-in Man Portable Mine Detector (CIMMD) will provide a man portable non-metallic and metallic detection capability for dismounted forces.

G.02 The Vehicle Mounted Mine Detector (VMMD) integrates a number of technologies with a remotely operated vehicle to detect and mark on-route mines at a vehicle class pace.

G.03 The Mine Hunter/Killer Program integrates robotics, detection, and destruction technologies to provide an affordable capability neutralize mines on an individual basis.

G.03 Mobile Intelligent Targeting Elements (MITES) are small, swarming, disposable, robotic devices to neutralize mines in and near the surf zone.

G.04 The Coastal Battlefield Reconnaissance and Analysis (COBRA) system provides a UAV mounted capability to detect minefields in beach and surf zones, utilizing multi-spectral imaging sensor with a data fusing algorithm.

G.04 Littoral Remote Sensing I (LRS I) will provide clandestine surveillance and reconnaissance of an amphibious operations area (beach defenses, beach topography, broached off-shore mines, bathymetry) by exploiting National Technical Means sensors.

G.05 The Joint Amphibious Mine Countermeasures (JAMC) is a telerobotic operated bulldozer mounted with various devices to provide a capability to clear mines and light obstacles from large areas of the beach zone, thereby allowing for rapid deployment of amphibious assault forces.

G.05 The Explosive Neutralization (EN) systems include various explosive net and shaped charges designed to neutralize minefields extending from very shallow water up to the high water mark on the beach.

G.06 Mine Countermeasures Integration and Automation (MCMIA) uses small, low cost robotic systems to conduct minefield and obstacle breaching and large area clearance to decrease the resources and time needed to perform minefield breaching and clearance.

G.06 Autonomous Surveillance/Recce Networks (ASRN) are fixed and mobile acoustic local area networks for clandestine surveillance and reconnaissance. They use moored and autonomous underwater vehicle based sensors.

G.07 Advanced Sensors technology is a group of undersea vehicle-deployed sensors which provide high detection and classification capabilities for deep water and shallow water volume and bottom mines.

G.08 The Advanced, Light-weight Influence Sweep System (ALISS) utilizes acoustic and superconducting magnetic technologies to extend wide area mine-sweeping into very shallow waters.

G.08 The Dyad minesweeper is a new influence mine sweeping technology using craft of opportunity which are lighter weight. It is based on an Australian dipole magnet technology sweep system.

G.09 Navy Tactical Missile System/Mine Countermeasures (NTACMS/MCM) is a concept for the delivery of surf zone to craft landing zone explosive neutralization using tightly dispersed APAM bomblets from the Navy Tactical Missile System (NTACMS deployed from a ship).

G.09 Advanced Minehunting and Mapping Technologies (AMMT) is the integration of advanced sensor technology into autonomous underwater vehicles.

G.10 LRS II will include collection parameters and limiting physics for shallowly submerged and buried sea and land mines and obstacles, as well as greater capabilities to fuse data.

G.10 Remote Airborne Mine Clearance System (RAMICS) is a hypervelocity, supercavitating round fired at a submerged sea mine. The round will penetrate the ocean surface, ride a cavitation bubble to the target, penetrate the target, and explode.

The primary mechanism for integration is the Joint Countermine Advanced Concept Technology Demonstration (ACTD) (DTO 1), sponsored and executed by USACOM and developed and managed by a joint Navy/Marine Corps/Army project office. The two key integration activities in this ACTD are the C4I effort and the Joint Countermine Operational Simulation (JCOS) project. Under the C4I effort, the Joint Task Force Commander will be provided a complete, up-to-date situation awareness of countermine intelligence and status (injected into the Common Operational Picture–COP), along with direct connectivity to all maneuver units via existing or planned communication links. The JCOS links existing modeling and simulation tools along with representations of all CM entities and units in a distributed interactive simulation (DIS) framework consistent with the JCM/C4I net to provide a comprehensive planning, training, rehearsal, and operational evaluation tool for joint countermine operations

Related work with potential to help countermine efforts include the recently completed technology demonstrations sponsored by the Army Environmental Center for range clean-up at the Jefferson Proving Ground. Results of this two phase program are under study for applications to the tactical countermine problem.

6. Summary

The collective capability demonstrated for each DTO scheduled between 1997 and 2004 shows a stepped improvement in operational capability over the previous demonstration. The capabilities and their schedule of availability are depicted in Figure IV.G.8. Intermediate DTOs follow Service operational mission lines (i.e., the Navy has responsibility for at-sea mine detection and neutralization, the Army and Marine Corps for on-land). The overall Countermine Objective is to provide a seamless mine and minefield detection and neutralization capability in a force projection that comes from the sea and terminates at an inland target.

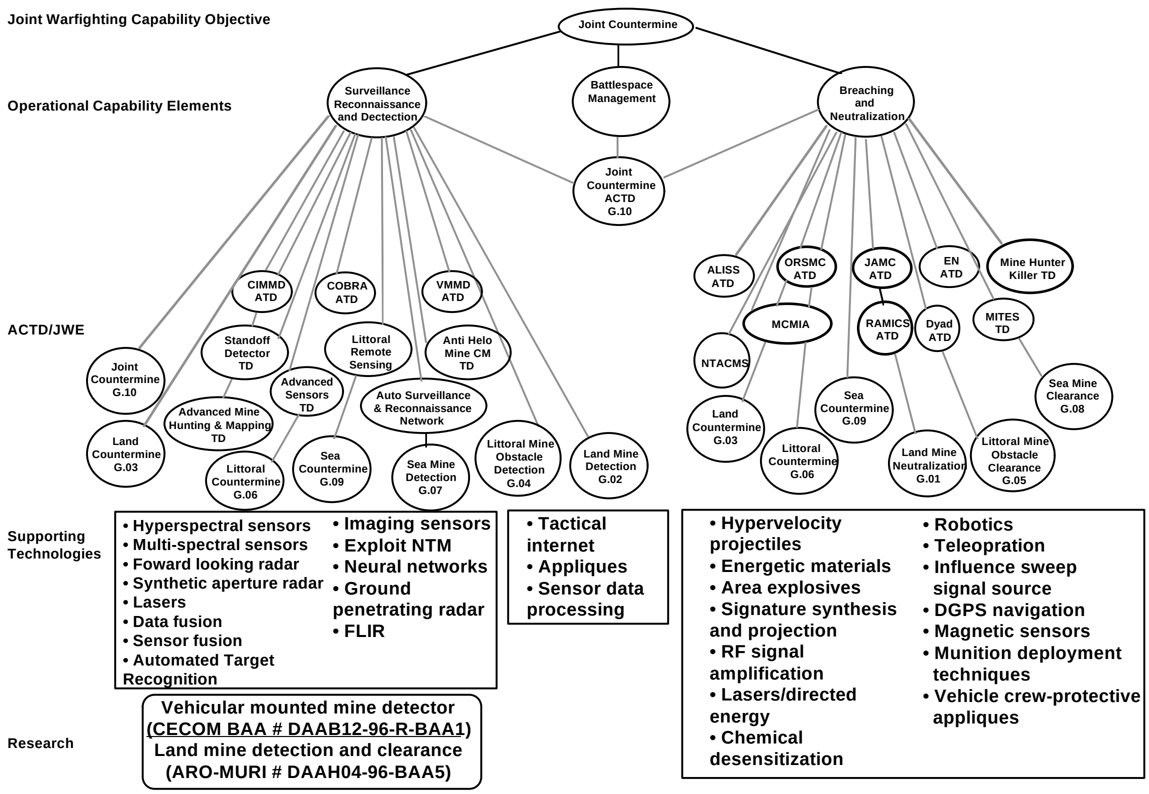


Figure IV.G.4. Technology to Capability – Joint Countermine

DTO #	TITLE
G.01	Land Mine Neutralization
G.02	Land Mine Detection
G.03	Land Countermine
G.04	Littoral Mine Obstacle Detection
G.05	Littoral Mine Obstacle Clearance
G.06	Littoral Countermine
G.07	Sea Mine Detection
G.08	Sea Mine Clearance
G.09	Sea Countermine
G.10	Joint Countermine ACTD
SE.10.02.ANFEC	EO Sensor, Fusion, and Targeting
SE.17.02.ANFEC	ATR Dominant Target ID
IS.01.01.AFNE	Consistent Battlespace Understanding (Joint Battlespace Awareness)
SE.15.01.ANE	Sensor Signal Processing (Acoustic, Magnetic, Seismic)

Figure IV.G.5. Defense Technology Objectives – Joint Countermine

Demonstration Title	Operational Capability Elements: Surveillance, Reconnaissance and Detection: Stand-off Mine/Minefield Detection	Close-in Mine Detection	Continuous Surveillance	Precision Targeting	Precise Minefield Location	High Search Rate Reconnaissance	Breaching and Neutralization: Stand-off Breaching	In-Stride Breaching and Clearance	Rate Clearance	ID of Mines	Explosive Neutralizatin	Battlespace Management: Marking	Reporting	Recording	Dissemination	Demonstration is a: Service Agency	DTO	ACTD	ATD
Joint Countermine ACTD	●	●	●	○	●	○	●	●	○	○	●	●	●	●	●	A/N	G.10	X	
Remote ABN Mine Clearance System ATD										●	●		○			N	G.10		X
Stealth Swath					●					●		○	○	○		N	G.10		X
Mine Hunter Killer ATD	●	●						●	●					○		A	G.03		
Auto Surveillance and Reconnaissance Network			●	○	●								○	○	○	N	G.06		X
Explosive Neutralization ATD							●	●			●	○				N	G.05 G.08		X
Advanced Sensors TD				●	●								○	○		N	G.07		X
CIMMD ATD	●	○														A	G.02		X
VMMD ATD	●	●										○		○		A	G.02		X
ORSMC ATD							●	●	●					○		A/N	G.01		X
MITES TD							●	●								D	G.01		X
COBRA ATD	●												○	○	○	N	G.04		X
Littoral Remote Sensing	●		●		●								○	○	○	N	G.04 G.07		X
JAMC ATD								●						○		N	G.05		X
MCMIA	●	●		○				●	○			○				N	G.06		X
Navy Tactical Missile System MCM											●					N	G.09		X
Advanced Mine Hunting and Mapping TD					●	○				○		○	○	○		N	G.09		X
Dyad ATD								●					○			N	G.08		X
ALISS ATD								●					○			N	G.08		X

A - Army, N - Navy, D - ARPA

● Strong Support ○ Moderate Support

Figure IV.G.6. Demonstration Support – Joint Countermine

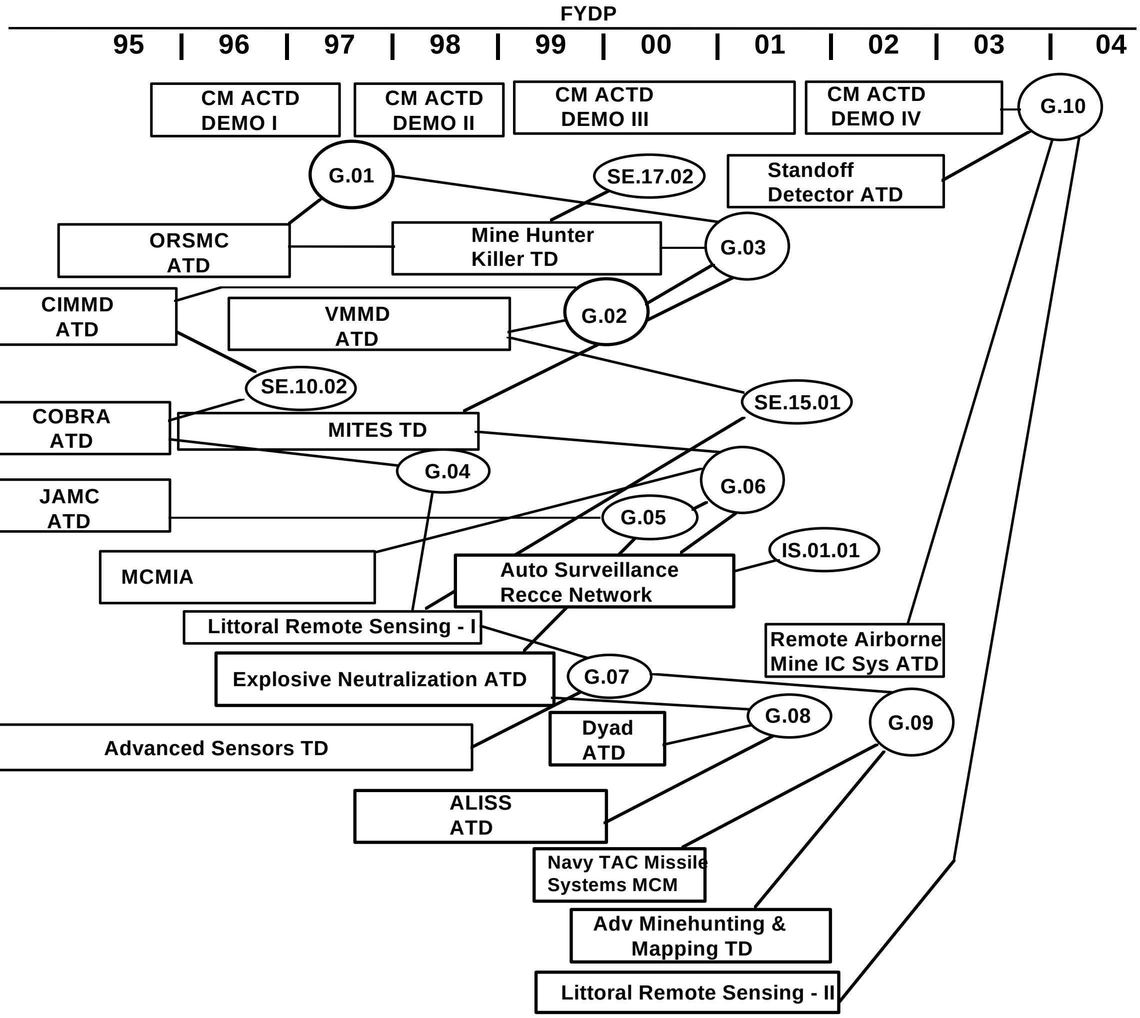


Figure IV.G.7. Roadmap – Joint Countermine

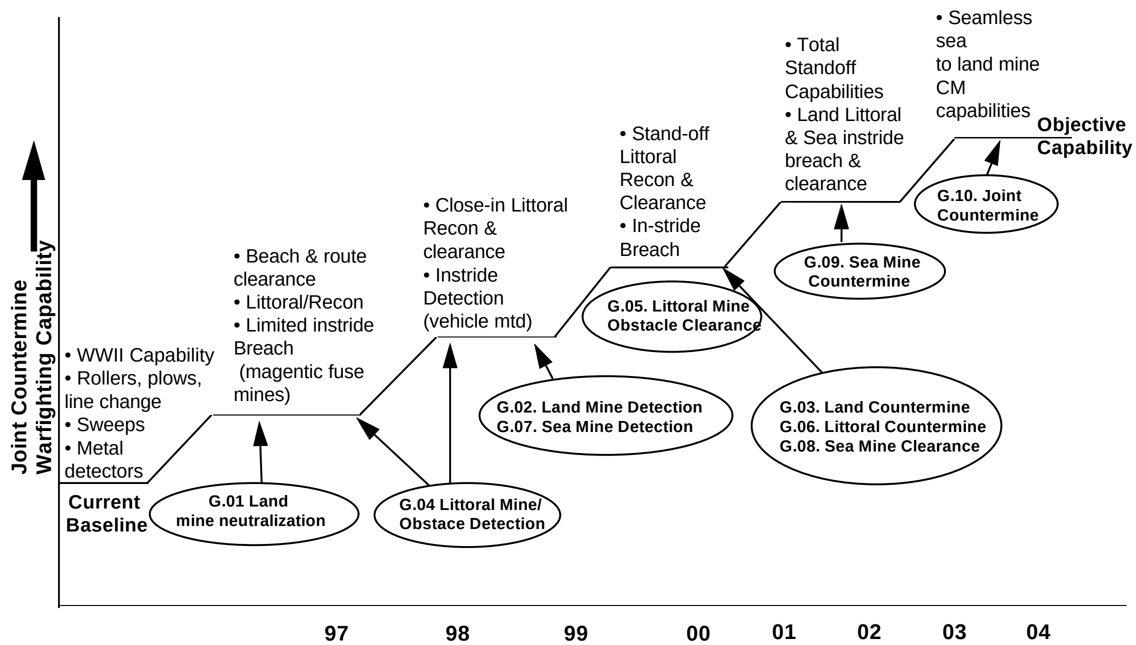


Figure IV.G.8. Progress – Joint Countermine

H. ELECTRONIC WARFARE

1. Definition

Electronic Warfare (EW) encompasses the capability to degrade or neutralize the effectiveness of enemy defenses over the areas and times required to permit the deployment and employment of U.S. and allied combat systems. EW includes capabilities for denying, degrading, deceiving, disrupting, and destroying enemy command and control, reconnaissance and surveillance, target acquisition, and integrated air defense systems, including associated weapon systems. It includes the critical capabilities for recognizing tracking or engagement attempts by hostile systems, and automatically initiating the appropriate countermeasures and response.

2. Operational Capability Elements

The strategic goal of electronic warfare (EW) is to control and exploit the electromagnetic spectrum for the maximum effectiveness of U.S. military operations, i.e., to deny, disrupt, degrade, deceive and/or exploit the enemy use of the spectrum while ensuring its use by friendly or joint forces. EW has three components: electronic attack (EA), electronic protection (EP) and electronic warfare support (ES). Each component provides a range of benefits to participants in joint organizations and operations. Figure IV.H.1 depicts these principal components as they contribute to joint operations.

Electronic attack (EA) involves the defensive and/or offensive protection of U.S. forces and platforms against hostile sensors and C3 systems. In its traditional form ("self-protection"), it consists of a warning receiver to warn of impending weapon attack, expendable countermeasures, and a jamming system working together to prevent sensor guided weapons from hitting their target. More recent technology further expands the assets for electronic attack by engaging sophisticated, long range target acquisition sensors such as airborne and space-based radar, and the communications supporting all phases of the enemy attack and/or defense – thereby becoming a key, integral element of battlespace dominance.

One critical aspect of electronic attack is the ability to deny an opponent his use of command, control, communications, computers and intelligence, surveillance, and reconnaissance (C4ISR) systems, enabling U.S. platforms and forces to operate freely throughout the battlespace with minimal loss to hostile weapons. This is an enabling capability for operations requiring penetration of hostile territory, e.g., suppression of enemy air defenses (SEAD), close air support, counter-C3, and precision attack on any fixed or mobile target.

Electronic protection (EP) supports the development of design features and employment techniques that allow U.S. forces to enjoy the benefits of accurate electronic sensors and systems–despite an environment that includes hostile jamming, deception activity, and enemy weapons targeting that depends upon detection, recognition, and position determining of U.S. emitters. Electronic protection allows operational users to initiate and prosecute a mission without degradation from opposing electronic warfare or from conventional or directed energy weapons cued or targeted by hostile sensors.

Electronic warfare support (ES) is the activity that gathers, consolidates, and employs information from hostile or potentially hostile electronic sensors and C3 systems. This component is critical to developing a comprehensive picture of the battlespace and a reliable indication of hostile force movement and intentions. Electronic support allows force avoidance, efficient engagement, and electronic deception of sensors and communications systems, and is closely related to Information Superiority and Information Warfare. This capability enables a wide range of operational options which contribute to virtually every combat and peace-keeping mission.

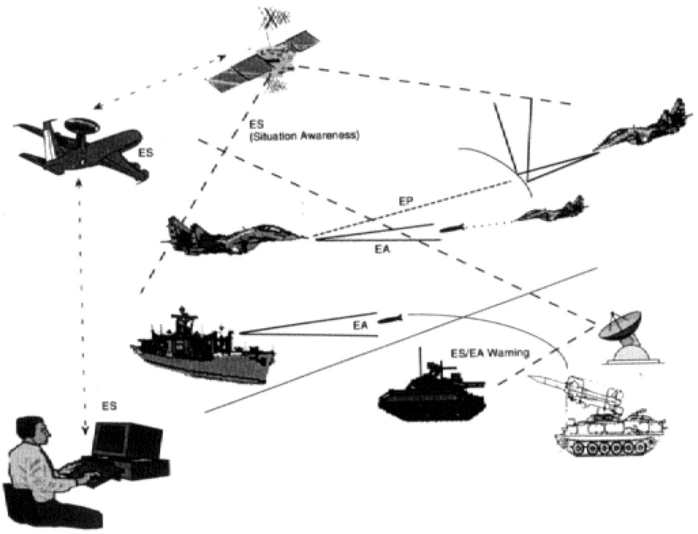


Figure IV.H.1. Electronic Warfare Concept

3. Functional Capabilities

Figure IV.H.2 depicts the relationships between operational capability elements and functional capabilities for the electronic attack and electronic support components of electronic warfare. Because electronic protection capabilities are generally specific to a sensor or C3 system, the electronic protection component is not further addressed in this section.

Functional Capabilities \ Operational Capability Element	Electronic Attack						Electronic Protection	Electronic Support		
	Attack Warning	Aircraft Protection	Ship Protection	Land Combat Vehicle Protection	C2 Attack	Non-lethal SEAD		Signal Collection	Emitter ID/Location	Battlespace Awareness
1. Real-time RF Threat Detection, ID & Geolocation	●	●	●	●	●	○	SPECIFIC TO SENSOR OR C3 SYSTEM–NOT ADDRESSED IN THIS CHAPTER	●	●	●
2. Missile Approach Warning	●	●	●	●	○					
3. Modular, Programmable EW Receiver/Processor	●				●	●		●	●	●
4. Sensor / Data Fusion, Electronic Intelligence	●	●	●	●	○	○		●	●	●
5. Decoy Terminal Threat Weapons		●	●	●		●				
6. UAV EW Employment	○	●	●	●	●	●		●	●	●
7. Robust, Multi-spectral EA of Simultaneous Threats		●	●	●		●				
8. Broadband, Coherent, Surgical RF Countermeasures		●	●	●	●	○				
9. 2nd Generation Directed IRCM		●	●	●						
10. Laser-based IRCM		●	●	●						
11. Counter IADS Surveillance, Acquisition and C2		●	○	○	●	●		○	○	○

● Strong Support ○ Moderate Support

Figure IV.H.2. Functional Capabilities Needed for Electronic Warfare

4. Current Capabilities, Deficiencies, and Barriers

Current electronic warfare capabilities are generally the result of extensive, detailed concentration on the capabilities of the former Soviet Union; a coherent "successor" threat has not yet been established. However, it is clear that there are generic trends in global military technology that allow identification of the most prominent deficiencies and barriers to joint EW operations. Figure IV.H.3 provides a top-level summary of capabilities, limitations, and key technologies to overcome current limitations and to provide those capabilities.

The threat of passively-guided weapons has increased dramatically over the past decade and, today, infrared guided weapons pose a serious and growing threat to U.S. forces and platforms in the air, on land, and at sea. Inexpensive, portable missiles can be launched with ease and effectiveness against all airborne combatants. The threat of longer-range infrared guided anti-ship missiles is equally great, and formidable in both at-sea and littoral scenarios. Land combat vehicles are similarly threatened by frontal and top-attack munitions guided by infrared and multispectral seekers. *Protection against infrared guided weapons is the highest priority need in electronic attack* and is an important deficiency that constrains the efficient execution of joint operations.

The technology barriers to resolution of these EA deficiencies include inadequate detection range and angular resolution on attack warning systems to eject decoys or initiate jamming; insufficient power, low efficiency, and unacceptable size, weight, and cost of laser devices that could be used in countermeasure systems; and insufficient output power and excessive size, weight, and cost of high power microwave systems for self-protection of platforms. Each of these barriers is being addressed with ongoing technology demonstration programs. As a second area of high EA priority, the rapid development and adoption of new communications technology has created deficiencies in the ability of U.S. forces to exploit and selectively disrupt modern signals. Cellular and personal communications systems used by civilians and hostile forces, and high capacity digital, multi-channel networks associated with distributed information systems, pose particularly difficult technical challenges. The ability to detect, analyze, exploit, and disrupt these signals is fundamental to the conduct of joint operations against an opponent with modern communications equipment and sensors. In the context of EA, jamming transmitters and antennas used against C3 signals require improvements in precise modulation selection and modulator control, linearity, efficiency, output power, and directivity.

Electronic protection measures are generally specific to a sensor or C3 system. These measures entail the tailoring of generic protection technology and techniques to satisfy the electronic protection requirements of a specific system in order to ameliorate the effects of hostile jamming, deception, targeting, or directed energy attack. Although included as an element of electronic warfare, these efforts are an integral part of the sensor or C3 development program. As stated previously, further EP details are omitted from this section.

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Electronic Attack – Platform Protection			
• >99% combined probability of no weapon launch, weapon miss and/or malfunction	• Attack warning 1. Real-time RF Threat Detection, ID & Geo-Location 2. Missile Approach Warning 3. Modular, Programmable EW Receiver/Processor 4. Sensor/Data Fusion, Electronic Intelligence • Decoy terminal threat sensors 5. Decoy terminal threat weapons 6. UAV Employment 7. Robust, Multi-Spectral EA of Simultaneous Threats • Effective, coherent jamming of threat sensors 8. Broadband, coherent, surgical RFCM 9. 2nd Generation Directed IRCM 10. Laser-Based IRCM	1. Inaccurate/ambiguous threat identification and bearing 2. Limited probability of intercept in high signal, low noise environment 3. Unmatched spectral content and output profile/signatures 4. Tight packaging constraints 5. High cost of integrating multi-spectral capability(s) 6. Incoherent sources/ radiation 7. High retrofit costs 8. Non-integrated approach to multi-spectral/multi-mode threats	1. Advanced signal detection and ID algorithms 2. COTS parallel multi-processors 3. High sensitivity, multi-band detectors 4. Directional apertures 5. Digital, channelized receivers 6. Enhanced IR flare materials 7. Digital RF memories 8. Kinematic/aerodynamic techniques 9. MMIC/VHSIC/MPM technologies 10. Laser-based IRCM (min. 2W/20kHz, mid IR) 7. 11. Low-noise amplifiers 9. 12. Coherent, false target CM techniques
Operational Capability Element: Electronic Attack--C2W & SEAD			
• Exploit, disrupt, deceive modern integrated defense system/ network	• Complex C2 signal ID 1. 3. 4. • Non-fratricidal C2 jamming 11. Counter JADS Surveillance Acquisition & C2	9. Insufficient low-noise signal intercept and decoding 10. Inability to track/jam in real-time 11. Non-linear power amplification 12. Imprecise coding/ signal demodulation 13. Poor beam/radiation control	13. Negative signal-to-noise, signal ID & code ID/tracking algorithms 14. Parallel signal channel tracking/algorithm techniques 15. High efficiency, linear, solid state amplifiers/C2 MPMs 16. Rapid, near real-time code breaking techniques 17. Efficient antenna designs down through HF (e.g., high temperature super conductivity, arrays) 9.

Figure IV.H.3. Goals, Limitations, and Technologies for Electronic Warfare

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Electronic Attack--C2W & SEAD (cont'd)			
	• Non-lethal SEAD 1. 3. 4. 6. 8. 11.	14. Affordable cost of UAV decoys 15. Affordable, compact SOJ techniques	9. 18. Controlled aperture vs. bandwidth techniques 19. Large-extent phased arrays
Operational Capability Element: Electronic Support			
• > 99% probability of signal intercept, detection, location and ID/ analyze from HF thru millimeter wave RF spectrum	• Highly fidelity signal detection, separation, recognition & tracking 1. 3. 4.	16. Little interoperability between operational/ Service systems 17. Ambiguous overlapping threat parameters 18. Insufficient processing time in dense environment	1. 2. 4. 5. 20. Software-reconfigurable/ "open"-architectures 21. Sub 1 degree DF Aperture systems 22. Rapid, high fidelity analog-to-digital conversion hardware/ processing
	• Consolidate/"fuse" all-source data with archival data 1. 3. 4.	19. Insufficient processing power 20. Inability to deal with missing, incomplete and corrupted data	2. 23. Expert systems and algorithms 24. Knowledge representation/ computer "reasoning" techniques that allow manipulation of sensor, text and archival data in one process
	• Ability to collect signals over hostile territory 6.	21. Vulnerability of conventional manned platforms	25. UAV payloads with compact, channelized, digital receiver architecture 26. Wideband data linking
Operational Capability Element: Electronic Protection			
(Not considered in this document.)			

Figure IV.H.3. Goals, Limitations, and Technologies for Electronic Warfare (cont'd)

Electronic warfare support is the activity that gathers timely information on hostile force composition, status, and intentions by intercepting and analyzing the signals from their electronic systems, and integrating this information with that of our own forces and electronic systems–whether at the Joint Command, at-sea battlegroup, or single-seat cockpit/battlefield soldier level. The composition and characteristics of C3 systems are changing rapidly as low-cost, high-performance digital technology becomes universally available. The proliferation of this technology has also encouraged the widespread availability of cellular and personal communications devices that are highly mobile and resistant to conventional electronic warfare attacks. Optical fiber networks, coupled with rapidly increasing computer performance, constitute the basis for powerful information systems that support sophisticated military C3 functions as easily as civilian applications. These advances in processing and communications technology facilitate and encourage the acquisition of customized, unique C3 systems in the military forces of many small countries. This diversity and unpredictability constitutes a formidable challenge to ES organizations that must support operational users with services and products in any conceivable location and situation.

As advance knowledge of threat system parameters, necessary for attack warning and countermeasure waveform development, becomes more difficult to obtain, electronic warfare receivers on tactical aircraft will have to assume some of the burden formerly assigned to dedicated special signal collection receivers. This will be necessary to accumulate detailed information on classes of, as well as individual, emitters and to support the development of generic system recognition algorithms.

The ability to fuse different forms of information from multiple sources is an important capability in an environment of mixed-media signals. Algorithms that can analyze and consolidate information from different sensors and databases can produce a product that is more complete and informative than the sequential examination of the individual contributions. Algorithms using expert system techniques and artificial intelligence principles can represent and manipulate knowledge faster and more exhaustively than is possible with human analysts in time-critical situations.

The technology deficiencies in electronic warfare include incomplete development of technologies suitable for UAV platforms for signal collection missions; inadequate processing subsystems and algorithms for detection, identification, and analysis of new communications waveforms; unacceptable performance in signal collection against mixed-media networks containing fiber optic and other transmission media; and inadequate performance and excessive cost to acquire and maintain warning and signal collection capabilities in tactical electronic warfare receivers. Finally, current capabilities in the representation of data, automated sensor product analyses, and machine reasoning capabilities are insufficient to perform timely and complete sensor product and data fusion.

Figure IV.H.4 illustrates how technology developments support technical demonstrations that contribute to operational capability elements in Electronic Warfare. Figure IV.H.5 lists planned DTOs for EW, details of which can be found in the DTO Volume for the JWSTP and the DTAP. Figure IV.H.6 correlates the technical demonstrations with the operational capability elements they support.

5. Technology Plan

As emphasized above, a critical, coordinated tri-service plan to address vulnerability to infrared (IR) missiles and weapons has been developed and is being executed. The program includes near-term measures to reduce vulnerability using improved warning capabilities and flares.

Capabilities to attack hostile C3 networks will vastly improve with the development of transmitters with more efficient power amplification; modern, digital, EA modulation formats; and greater angular precision. These enhancements will effectively increase jammer power on victim systems and reduce interference with U.S. and allied systems in the vicinity. A coordinated tri-service effort will develop signal separation, recognition, analysis, and countermeasure techniques against specific waveforms used in C3 applications. These ES capabilities will be consolidated with the jamming improvements developed as an electronic attack measure to produce an improved ability to selectively disrupt hostile communications and weapons control networks.

Similarly, a coordinated development is under way to design and integrate critical digital receiver/processor technologies to yield next-generation electronic warfare receivers. These receivers will be capable of performing warning, signal parameter collection, situation assessment, threat geo-location, and combat ID-assist functions. The ultimate objective of the tri-service efforts is to develop a common, modular EW receiver for use on all platforms and in all Services. Such receivers will integrate the advantages of broadband, channelized monolithic receivers "on-a-chip" with commercial, real-time, parallel digital signal processors to yield an affordable, adaptable, software–reconfigurable capability. This capability will serve to fill a number of operational needs that are now satisfied by more than a dozen individual systems.

To augment the EW "triad" of the future (stand-off communications jamming, SEAD, and stand-off radar jamming), a joint development effort is being initiated to design and develop the next generation stand-off support jammer. A key to the program is the adoption of a reconfigurable pod/UAV concept which will not depend upon a dedicated airframe in the future. Synergies of the technologies involved will also have joint applications to affordable upgrades to jamming systems of all three Services and their respective platforms.

Figure IV.H.7 is a roadmap for developing and demonstrating the technologies required to support the operational advances in Electronic Warfare. This roadmap concentrates on the themes of IRCM (air, land, and sea platforms) and the Information Warfare-related aspects of command and control warfare and support and stand-off jamming.

6. Summary

Figure IV.H.8 portrays how this investment strategy will provide incremental improvements to Electronic Warfare. This section on Electronic Warfare Joint Warfighting Capability Objective describes a well-balanced approach to achieve platform protection and electronic support to all joint combatants. The plan emphasizes solutions to the formidable, world-wide IR missile threats; multi-spectral situation awareness; countering the command and control hierarchies of the hostile force, while preserving, real-time knowledge of the enemy; and in countering the enemy early in the engagement process via the EW triad of command and control warfare, SEAD and support and stand-off jamming. EW has important synergies with the Information Superiority, Information Warfare, Combat Identification and Precision Force JWCOs by assuring survivability to the joint warfighter.

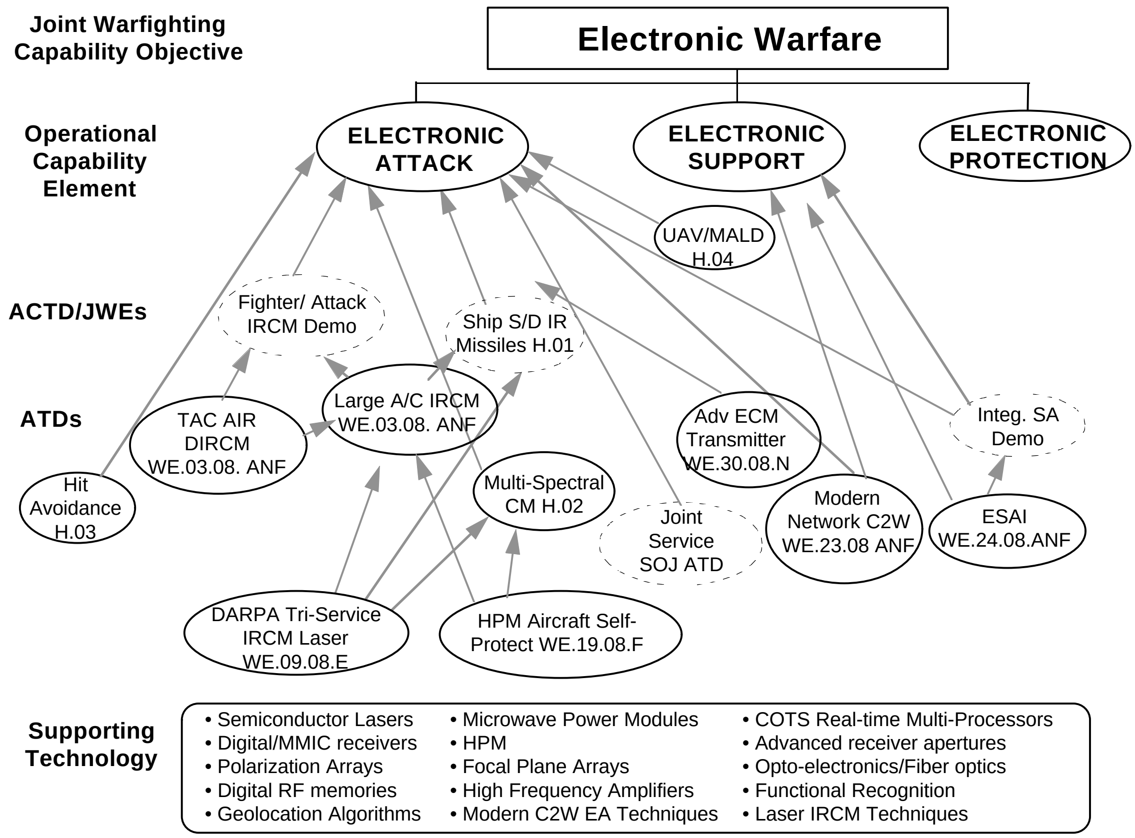


Figure IV.H.4. Technology to Capability – Electronic Warfare

DTO #	TITLE
H.01	Ship Defense Against IR Missiles (MATES)
H.02	Multi-spectral Countermeasures ATD
H.03	Hit Avoidance ATD
H.04	Miniature Air-Launched Decoy ACTD
WE.03.08.ANF	Combat Aircraft IRCM / TACAIR DIRCM
WE.09.08.E	DARPA Tri-Service IRCM Laser Technology
WE.23.08.ANF	Modern Network Command and Control Warfare Technology
WE.24.08.ANF	Sensor Fusion/Integrated Situation Assessment Technology
WE.30.08.N	Advanced ECM Transmitter for Ship Self-Defense
WE.19.08.F	HPM/Laser Aircraft Self-Protect Missile Countermeasures

Figure IV.H.5. Defense Technology Objectives – Electronic Warfare

	Operational Capability Element				Demonstration is a		
Demonstration Title	**EA**	**EP**	**ES**	**Service Agency**	**DTO**	**ACTD**	**ATD**
Precision Threat ID & Location	○	SPECIFIC TO SENSOR OR C3 SYSTEM -- NOT ADDRESSED IN THIS CHAPTER	●	A,N,F	WE.23.08.ANF		
Enhanced Situation Awareness Insertion	○		●	F	WE.23.08.ANF		
Miniature Air-Launched Decoy	●		○	ARPA, F	H.04	●	
Joint Service SOJ	●		○	A,N,F			●
Adv ECM Transmitter	●			N	WE.30.08.N		●
Ship Self-Defense vs. IR Missiles	●			N	H.01		●
Laser IRCM Fly-out Experiments	●		●	F	WE.03.08.ANF		
TACAIR DIRCM	●		●	N	WE.03.08.ANF		●
Multispectral Countermeasures	●		○	A	H.02		●
Hit Avoidance	●		●	A	H.03		●
C2W EA Techniques	●			A,N,F	WE.24.08.ANF		
Modern Network C2W	●		○	A,N,F	WE.23.08.ANF		●
DARPA Tri-Service IRCM Laser	●			ARPA, A,N,F	WE.09.08.E		

Figure IV.H.6. Demonstration Support – Electronic Warfare

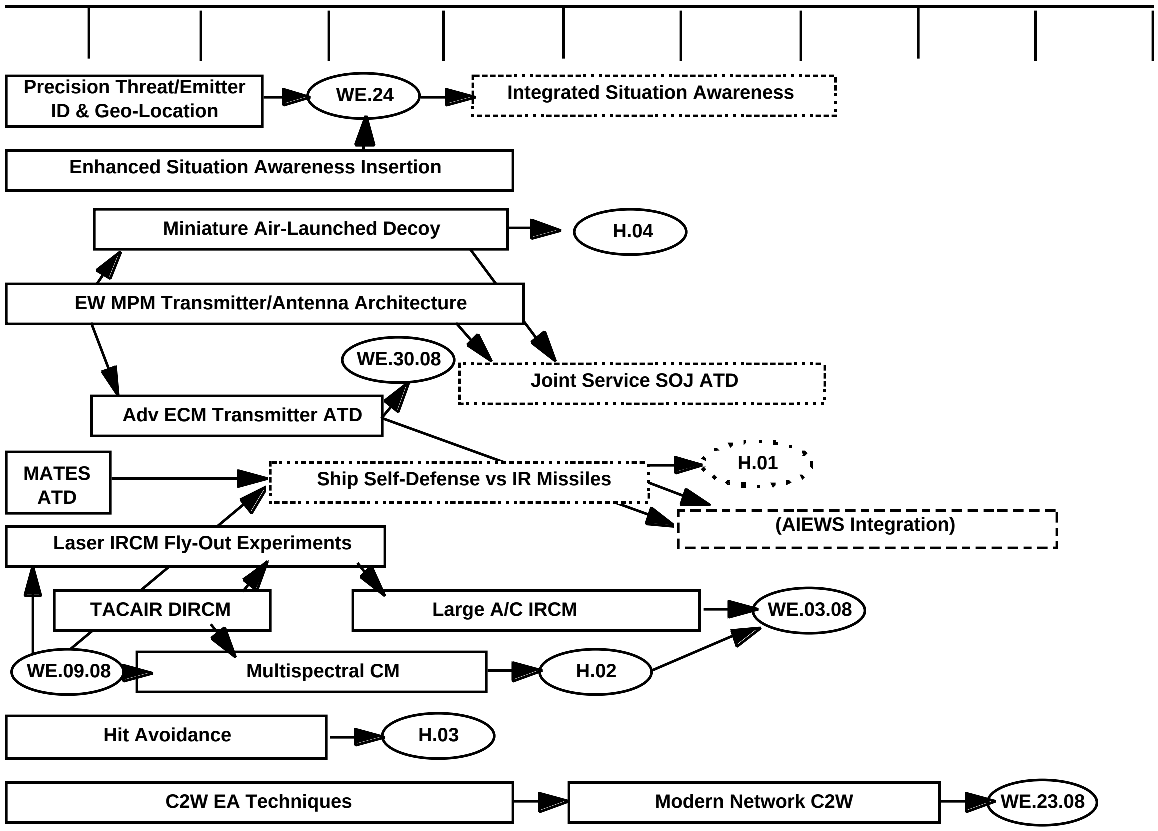


Figure IV.H.7. Roadmap – Electronic Warfare

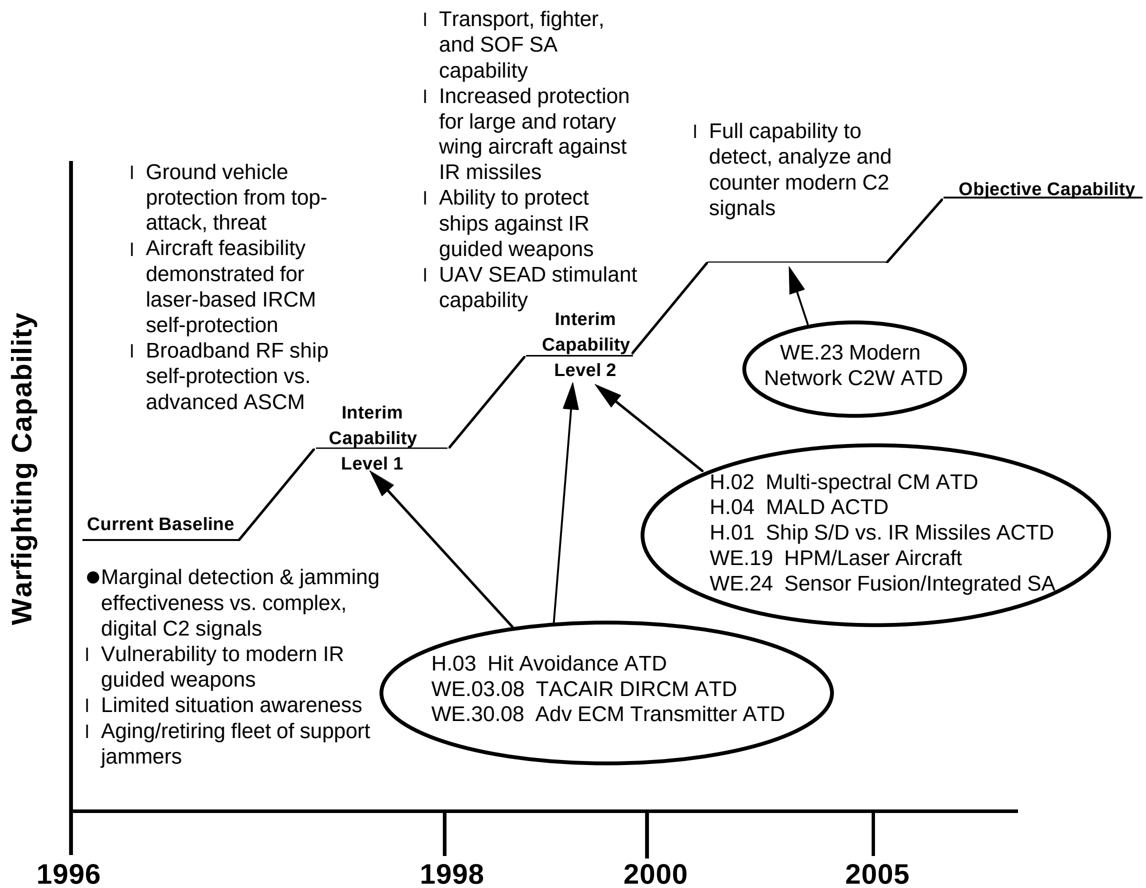


Figure IV.H.8. Progress – Electronic Warfare

I. INFORMATION WARFARE

1. Definition

Information Warfare (IW) encompasses actions taken to achieve information superiority by affecting adversary information, information-based processes, information systems and computer-based networks, while defending one's own information, information-based processes, information systems, and computer-based networks. In this section, the term "information system" includes information, information-based processes, information systems, and computer-based networks either individually or in combination with each other.

This section addresses only the unclassified aspects of IW and the associated science and technology programs which address key joint warfighter IW requirements. It does not address classified IW initiatives. It should be noted that information warfare is a dynamic area. Doctrine, policy, and the taxonomy are as fast moving as the supporting technology. Accordingly, the taxonomy used in this section describes the relevance of key technology initiatives to joint warfighter requirements, but should not be interpreted as being representative of the entire spectrum of warfighter IW roles and missions.

2. Operational Capability Elements

Figure IV.I.1 represents a conceptual view of the information warfare environment. The joint warfighter must have the operational capability to defend information systems from both deliberate and accidental disruptions, as well as the operational capability to attack adversary information systems. These operational capability elements give the joint warfighter a credible deterrent across the full spectrum of conflict. They also ensure information superiority and permit the conduct of operations without effective opposition. This section describes how key, enabling, technologies will be explored through DTOs, ACTDs, and ATDs to provide timely operational capabilities to the joint warfighter.

To achieve information superiority and contribute to dominant battlespace knowledge, the technology base must support joint warfighter requirements in two overlapping areas: defensive information warfare (IW-D) and offensive information warfare (IW-O). There is an overlap between these two areas that represents those technologies and operational capability elements that are common to both. Figure IV.I.2 expands upon these overarching capabilities, identifying subordinate operational capability elements.

Subordinate categories of IW-D are: protect, detect attack, and restore. For the purpose of this plan, information security, operations security, and information integrity are subelements of protect. Information security encompasses confidentiality, integrity, authentication, non-repudiation, and to some extent, availability. Operations security ensures that critical friendly information and activities cannot be easily intercepted or observed by adversary intelligence systems. Information integrity ensures that the information is unimpaired.

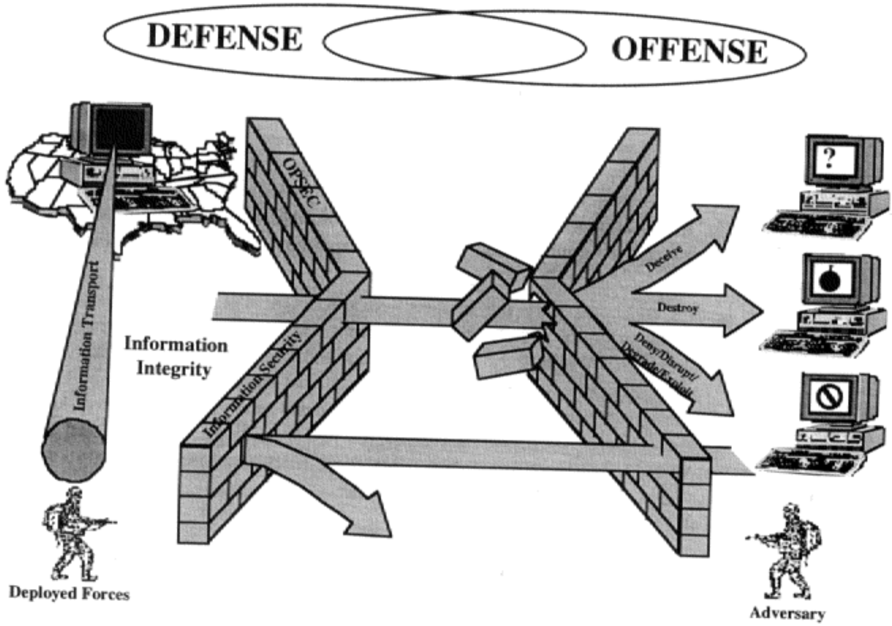


Figure IV.I.1. Information Warfare Concept

For IW-O, the technology base must provide the joint warfighter with a stockpile of new weapons, including several based upon improved conventional electronic warfare technologies. IW-O includes capabilities to deny/disrupt/degrade/exploit, deceive, and destroy adversary information systems. At the intersection of IW-D and IW-O is effective C4I which is critical to both. Other capabilities also can be considered to be "shared" by IW-D and IW-O. For example, deception techniques and supporting technologies, developed under an IW-O initiative can be used (i.e., shared) with IW-D to enhance information security or operations security.

3. Functional Capabilities

The technology base must support a set of functional capabilities which contribute to the achievement of the operational capability elements described in the previous sub-section. A number of these IW functional capabilities are common to IW-D and IW-O. For example, tools that assess vulnerabilities or that "map" the structure of an information system can contribute to both IW-D and IW-O operations. Figure IV.I.2 identifies the following functional capabilities to achieve the IW Operational Capability Elements.

1. *Information consistency* includes the integrity, protection, and authentication of information systems.

2. *Access controls/security services* ensures information security and integrity by limiting access to information systems to authorized personnel only. It includes trusted electronic release, multi-level information security, and policies.

3. *Service availability* ensures that information systems are available when needed, often relying upon communications support for distributed computing.

4. *Network management and control* ensures the use of reconfigurable, robust protocols and control algorithms, self-healing applications and systems capable of managing distributed computing over heterogeneous platforms and networks.

5. *Damage assessment* determines the effectiveness of attacks in both a defensive capacity (e.g., where and how bad) and an offensive capacity (e.g., measure of effectiveness).

6. *Reaction (isolate, correct, act)* responds to a threat, intruder, or network or system disturbance. Intrusions must be characterized and decision-makers must have the capability to isolate, contain, correct, monitor surreptitiously, etc. The ability to correct includes recovery, resource reallocation, and reconstitution.

7. *Vulnerability assessment and planning* is an all-encompassing functional capability that includes the ability to realistically assess the joint warfighter's information system(s) and information processes and those of an adversary. The assessment of warfighter systems facilitates the use of critical protection functions such as risk management and vulnerability analysis. The assessment of an adversary's information system provides the basis for joint warfighter attack planning and operational execution.

8. *Preemptive indication* provides system and subsystem precursors or indications of impending attack.

9. *Intrusion detection/threat warning enables* detection of attempted and successful intrusions (malicious and non-malicious) by both insiders and outsiders.

10. *Corruption of adversary information/systems* can take many diverse forms, ranging from destruction to undetected change or infection of information. There are two subsets of this function: (1) actions taken on information prior to its entry into an information system; and (2) actions taken on information already contained within an information system.

11. *Defeat of adversary protection* includes the defeat of information systems, software and physical information system protection schemes, and hardware.

12. *Penetration of adversary information system* provides the ability to intrude, or inject desired information, into an adversary's information system, network, or repository. The function includes the ability to disguise the penetration – either the fact that the penetration has occurred, or the exact nature of the penetration.

Functional Capabilities \ Operational Capability Elements	Defense						Offense		
	Protect						Respond		
	Information Security	Operations Security	Information Integrity	Detect Attack	Restore	C4I	Deny/Disrupt/Degrade/Exploit	Deceive	Destroy
1. Information Consistency	●	○	●						
2. Access Control/Security Services	●	●	●						
3. Service Availability	○		●		●	●			
4. Network Management and Control	○		●		●	●			
5. Damage Assessment			●	●	●	●	●	●	●
6. Reaction (Isolate, Correct, Act)		●	●		●				
7. Vulnerability Assessment and Planning	●	●	●	●	●	●	●	●	●
8. Pre-emptive Indication	●		●	●					
9. Intrusion Detection/Threat Warning	●	○	●	●					
10. Corruption of Adversary Information/System							●	●	●
11. Defeat of Adversary Protection							●	●	○
12. Penetration of Adversary Information System							●	●	●
13. Physical Destruction of Adversary Information System							●		●
14. Defeat of Adversary Information Transport							●	○	
15. Insertion of False Station/Operator Into Adversary Information System				○			●	●	
16. Disguise of Sources of Attack		○					●	●	

● Strong Support ○ Moderate Support

Figure IV.I.2. Functional Capabilities Needed for Information Warfare

13. *Physical destruction of adversary information system* physically denies an adversary the means to access or use its information systems. Actions include traditional hard-kills as well as actions of a less destructive nature, which cause a physical denial of service.

14. *Defeat of adversary information transport* defeats any means involved in the movement of information either to or within a given information system. It transcends the classical definition of electronic warfare by encompassing all means of information conveyance, rather than just the traditional electrical means.

15. *Insertion of false station/operator into adversary information system* provides the ability to inject a false situation or operator into an adversary's information system.

16. *Disguise of sources of attack* encompasses all actions designed to deny an adversary any knowledge of the source of an information attack or the source of information itself. Disguised sources, which deny the adversary true information sources, often limit the availability of responses, thereby delaying correction or retaliation.

4. Current Capabilities, Deficiencies, and Barriers

Currently, the bulk of the information available to the joint warfighter is provided over legacy, communications-intensive, message-based information distribution systems. While there is a high degree of assurance (i.e., confidence in the integrity, confidentiality, and availability) associated with information received via stove-piped classified systems, there is less assurance associated with information received over other systems. In addition, there is a limited ability to internetwork at varying levels of security.

Although there are deficiencies in current IW operational capabilities that can be attributed to non-technical issues (e.g., operator awareness and training) there are many deficiencies that exist because there remain technological barriers to be overcome. From a technology perspective, much is being done, using existing technology, to meet warfighter requirements. The judicious application of existing technology is rapidly advancing the state-of-the-art, particularly in the area of IW-D. Existing capabilities are being applied in unique ways and are being extended to provide more effective means of network protection. Ranging from advanced access control systems to effective means of encryption of databases and transmitted information, tools are becoming available which help ensure the availability, integrity, and confidentiality of critical information for the joint warfighter.

In spite of these efforts, limitations still exist because many technology barriers have yet to be overcome. Figure IV.I.3 summarizes current capabilities and limitations. Currently, IW-D is limited in the following areas: management of distributed information, multilevel security (MLS), countermeasures that are generally reactive to emergent IW rather than anticipatory, predictive and anticipatory network management capabilities, IW sensors and processing for grid self-defense, and intrusion detection techniques that do not scale or that do not facilitate damage assessment or automated response. IW-O is limited in the following areas: integration of IW with hard kill as a continuum of tactical operations, the ability to automatically and rapidly determine points of vulnerability, and diverse tailorable IW attack tools.

Figure IV.I.3 lists key technologies that are needed to overcome these limitations. Figure IV.I.4 graphically portrays a subset of these key technologies and their respective relationship to ACTDs. As a relatively new area of focus within the DoD, IW has only one currently approved ACTD, Navigation Warfare, with a second proposed ACTD, IW Planning Tools, pending approval.

5. Technology Plan

Meeting the IW needs of the joint warfighter requires the development of new technology as well as the adaptation and insertion of applicable commercial technology. In addition to the two ACTDs previously cited, Figure IV.I.5 provides a list of DTOs (most of which are described in the DTAP) that have direct relevance to achieving the operational capability elements of IW.

The following DTOs address IW-D capabilities:

- *Context-Based Information Distribution (IS.19.I.06.AF)* will provide a robust, adaptive, automated information distribution infrastructure tailored for computer-to-computer interaction in bandwidth-constrained environments to assure the timeliness and integrity of battlefield information.
- *Assured Communications (IS.21.I.07.AF)* will provide Multi-Level Secure (MLS) Asynchronous Transfer Mode (ATM)/FASTLANE cell encryption and B3-level secure guards and firewalls to enable information security. As a result, the joint warfighters will have the ability to be seamlessly and transparently internetworked at multiple security levels.
- *Network Management (IS.22.I.08.AFN)* will provide the capability for continuity and information timeliness through adaptation of the communication network.
- *Defensive Information Warfare (IS.17.02.NFE)* will provide secure COTS-based computing clusters, databases, and tools to support global policy enforcement across platforms.
- *Survivable Information Systems (IS.18.02.F)* will increase information system survivability through dynamic fault avoidance and recovery mechanisms, and through the dynamic reallocation of computing resources.
- *Navigation Warfare ACTD (I.03)* will improve the survivability of GPS information.

The following DTOs address IW-O capabilities:

- *High Power Microwave C2W/IW Technology (WE.22.09.F)* will enable the joint warfighter to disrupt, degrade and destroy electronics in information systems and communications links.

GOALS	FUNCTIONAL CAPABILITIES	LIMITATIONS	KEY TECHNOLOGIES
OPERATIONAL CAPABILITY ELEMENT: INFORMATION SECURITY			
Provide protection from deliberate or inadvertent, unauthorized disclosure, acquisition, manipulation, modification, or loss of sensitive information under various complex security policies, using distributed open systems architectures, and different security attributes.	1. Information Consistency 2. Access Control/ Security Services 7. Vulnerability Assessment and Planning 8. Preemptive Indication 9. Intrusion Detection/Threat Warning	1. Limited MLS capability 2. Countermeasures are generally reactive to emergent IW rather than anticipatory 3. Limited network management and security management capabilities 4. Limited availability of trusted operating systems 5. COTS applications vulnerabilities 6. Inadequate tools for validating system security and robustness 7. Limited authentication and identification capabilities 8. Inadequate automated intrusion detection techniques 9. Inadequate data contamination recovery techniques	1. Secure firewalls and guards (B3 Level) 2. Dynamic reallocation of computing resources 3. Automated intrusion detection and response capabilities 4. MLS secure COTS-based clusters 5. Trusted Operating systems 6. Malicious code detection tools 7. Security analysis tools 8. Security Engineering for Systems
OPERATIONAL CAPABILITY ELEMENT: OPERATIONS SECURITY			
Eliminate, or reduce to an acceptable level, the vulnerabilities that an adversary could exploit by obtaining information about friendly capabilities, limitations, and intentions.	2. 6. Reaction (Isolate, Correct, Act) 7.	3. 7. 10. Limited ability to manage distributed information 11. Limited classification management capability of data objects.	9. Robust, adaptive, automated context-based information distribution infrastructure 10. Advanced high speed protocol/encryption and advanced key management for tactical and strategic networks

Figure IV.I.3. Goals, Limitations, and Technologies for Information Warfare

GOALS	FUNCTIONAL CAPABILITIES	LIMITATIONS	KEY TECHNOLOGIES
OPERATIONAL CAPABILITY ELEMENT: INFORMATION INTEGRITY			
Ensure that information is sound and unimpaired.	1. 2. 3. Service Availability 4. Network Management and Control 5. Damage Assessment 6. 7. 8. 9.	1. 4. 5. 7. 11. 12. Limited scaleable encryption	1. 4. 5. 10.
OPERATIONAL CAPABILITY ELEMENT: DETECT ATTACK			
Provide early warning of potential attacks so as to alert all defensive mechanisms, initiate available, reactive measures and minimize or obviate attack effectiveness.	5. 7. 8. 9.	13. Limited predictive and anticipatory network management capability 14. Limited IW sensors and processing for grid self-defense 15. Intrusion-detection techniques do not scale, do not facilitate damage assessment or automated response	3. 7. 11. Secure Global Positioning System
OPERATIONAL CAPABILITY ELEMENT: RESTORE			
Achieve an ability to continue to operate at some nominally acceptable level through attacks so as to avoid catastrophic failure of the system and endure into the post-attack period for recovery and/or reconstitution.	3. 4. 5. 6. 7.	13. 14. 15. 16. Limited IW damage assessment 17. Current technologies have limited capability to support continued operations during network partition	2. 3. 7. 12. Fault avoidance and recovery mechanisms
OPERATIONAL CAPABILITY ELEMENT: C4I			
Achieve transport of the required information, from anywhere to anywhere, “just in time”.	3. 4. 5. 7.	1. 17.	2. 4. 10. 12.

Figure IV.I.3. Goals, Limitations, and Technologies for Information Warfare (Cont’d)

GOALS	FUNCTIONAL CAPABILITIES	LIMITATIONS	KEY TECHNOLOGIES
OPERATIONAL CAPABILITY ELEMENT: DENY/DISRUPT/DEGRADE/EXPLOIT			
Selectively control an adversary's use of information, information-based processes, and information systems through the application of offensive IW capabilities that deny access to, or use of information, disrupt operations or capabilities, or selectively degrade levels of service	5. 7. 10. Corruption of Adversary Information/System 11. Defeat of Adversary Protection 12. Penetration of Adversary Information System 13. Physical Destruction of Adversary Information System 14. Defeat of Adversary Information Transport 15. Insertion of False Station/Operator into Adversary Information System	16. 18. IW not integrated with hard kill as a continuum of tactical operations 19. Limited ability to automatically and rapidly determine points of vulnerability 20. Lack of arsenal of diverse, tailorable IW attack tools 21. Difficult to keep attack tools current in era of rapid change in information technology 22. Increasing sophistication of advanced protection software and hardware 23. Limited capability to surreptitiously enter a wide range of information systems	7. 13. High Power Microwave Attack Technology 14. Electronic attack against digital information transport systems 15. Information warfare planning and decision aid tools 16.
OPERATIONAL CAPABILITY ELEMENT: DECEIVE			
Provide the Joint Warfighter with the capability to selectively influence an adversary's use of, or confidence in, information, information-based processes, information systems and computer-based networks through the application of offensive deceptive IW capabilities that provide the means to manipulate the information or information sources which support them.	5. 7. 10. 11. 12. 15. 16. Disguise Sources of Attack	19. 20. 21. 22. 23.	7. 14. 15.
OPERATIONAL CAPABILITY ELEMENT: DESTROY			
Provide capability to selectively destroy an adversary's information, information-based processes, information systems and computer-based networks through the application of offensive weapons that destroy the information, or the capability to use, transport, collect or access it.	5. 7. 10. 12. 13.	16. 18. 19. 20. 21. 22. 23.	7. 13. 14. 15. 16.

Figure IV.I.3. Goals, Limitations, and Technologies for Information Warfare (Cont'd)

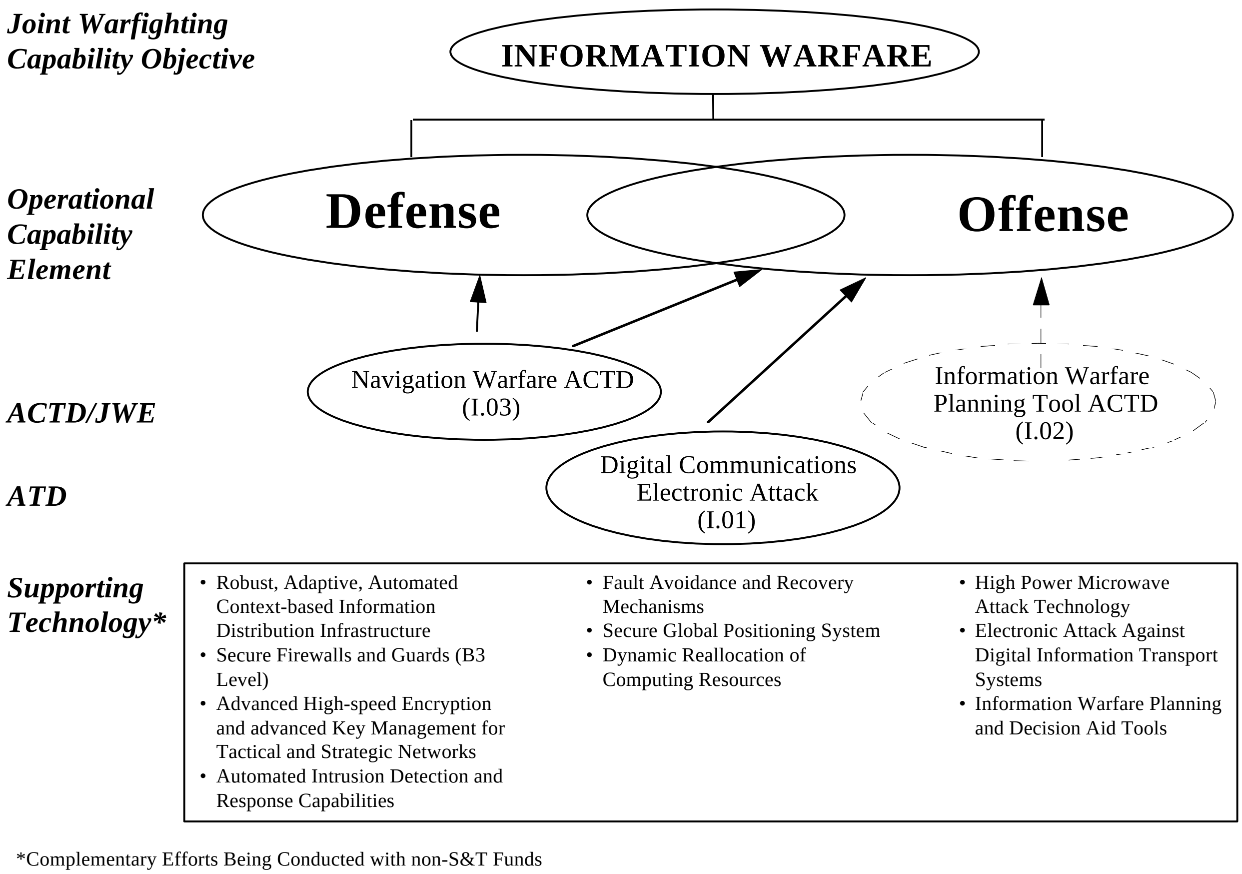


Figure IV.I.4. Technology to Capability – Information Warfare

DTO #	TITLE
I.01	Digital Communications Electronic Attack
I.02	Information Warfare Planning Tool ACTD (Proposed)
I.03	Navigation Warfare ACTD
WE.22.09.F	High Power Microwave C2W/IW Technology
WE.23.08.ANF	Modern Network Command and Control Warfare (C2W) Technology
IS.19.06.AF	Context-Based Information Distribution
IS.21.07.AF	Assured Communications
IS.22.01.AFN	Network Management
IS.17.02.NFE	Defensive Information Warfare
IS.18.02.F	Survivable Information Systems

Figure IV.I.5. Defense Technology Objectives – Information Warfare

- *Modern Network Command and Control Warfare (C2W) Technology (WE.23.08.ANF)* will provide the capability to intercept and attack/counter advanced, global military communications networks from ground and airborne platforms, thereby providing an IW-O capability against information transport systems.
- *Digital Communications Electronic Attack (I.01)* will provide an electronic attack capability against advanced communications in use today, and those that are being further developed as recognizable potential threats in future conflicts.
- *Information Warfare Planning Tool ACTD (I.02)* will provide a set of in theater offensive IW planning aids to enable rapid selection of IW options via modeling and simulation tools.

Figure IV.I.6 provides a list of demonstrations that are currently planned to meet the DTOs. In addition, this figure depicts the relevance of each of these demonstrations to the various IW operational capability elements, and identifies the respective Services and Agencies involved in each.

Figure IV.I.7 provides a graphical depiction of the timelines and relationships of a subset of the key technologies being developed in support of the DTOs cited above. As noted earlier, there currently exists only one approved IW-related ACTD; however, as indicated in this figure, three possible new ACTDs or ATDs (identified in dotted lines) are proposed as logical future extensions of the current planned efforts in this area.

6. Summary

IW is a relatively new joint warfighting area which crosscuts several JWCOs and DTAP technology areas. Figure IV.I.8 reflects the contributions of the DTOs to an incremental improvement in IW capabilities. Near-term capabilities will internetwork warfighters at the tactical level, improve the security and reliability of distributed databases, and provide improved protection techniques. Mid-term capabilities will take advantage of high bandwidth, encrypted links to internetwork warfighters at varying levels of security, and provide a suite of IW-O planning tools and effectiveness models. The capability objective will ensure the availability, confidentiality, and integrity of information by providing the warfighter with a robust, adaptive, automated context-based information infrastructure and suites of tools to protect friendly information systems and attack adversary information systems.

It is important to recognize that the IW threat is real. IW-D and IW-O capabilities, at various levels, are widely available. DoD systems, particularly those that are unclassified, are currently vulnerable. While a concerted, coordinated attack against DoD interests would require considerable resources, significant damage to DoD information systems is possible. The S&T community takes this threat seriously and will continue to focus funding on key technologies that support the joint warfighter IW requirements. IW represents a new tenet in military doctrine. The appropriate investment in the supporting technologies will enable the DoD to achieve military superiority through information superiority.

Demonstration Title	Operational Capability Element: Defense – Protect – Information Security	Defense – Protect – Operations Security	Defense – Protect – Information Integrity	Defense – Detect/Attack	Defense – Restore	Defense – C4I	Offense – Respond – Deny/Disrupt/Degrade/Exploit	Offense – Respond – Deceive	Offense – Respond – Destroy	Service/ Agency	Demonstration is a: DTO	ACTD	ATD
High Power Microwave Target Effectiveness Modeling							●		●	A, AF	WE.22.09.F		
High Power Microwave Sources							●		●	A, AF	WE.22.09.F		
Electronic Attack Strategies to Counter Complex Comm Formats							●	○		A, AF	WE.23.08.ANF		
1000% Improvement in Jam-to-Signal Ratios							●	○		A, AF	WE.23.08.ANF		
Tools/Techniques for Electronic Attack Against Digital Transport							●	●		A	I.01		
Electronic Attack to Disrupt/Deny Information Systems							●	●		A	I.01		
Model-based Robust Recovery			●		●					A, AF	IS.19.01.AF		
Scalability of Context Based Command and Control (CBC2) to Large Systems of Mobile Computers			●		○	●				A, AF	IS.19.01.AF		
B3 Secure Guards and Firewalls	●			○						A,N, AF	IS.21.07.AF		
ATM/FASTLANE Agile Cell Encryption	●									A, N,AF	IS.21.07.AF		
ATM Internet Protocol for Interoperability	○	○	●		●	○				A, N, AF	IS.22.01.AFN		
MLS Secure Internetted Clusters of COTS-based Elements	●	○	○		○					N, AF, D, N	IS.17.02.NFE		
Penetration Detection/Reaction Tools	●	○			○					N, AF, D, N	IS.17.02.NFE		
Dynamic Selection & Application of Fault Avoidance/Recovery	●		○	○	●					AF	IS.18.02.F		
Dynamic Reallocation of Computing Resources	○		○	○	○	○				AF	IS.18.02.F		
Navigation Warfare			●	○	●					J	I.03	X	
Information Warfare Planning Tools							●	●	●	J	I.02	X	

● Strong Support ○ Moderate Support

Figure IV.I.6. Demonstration Support – Information Warfare

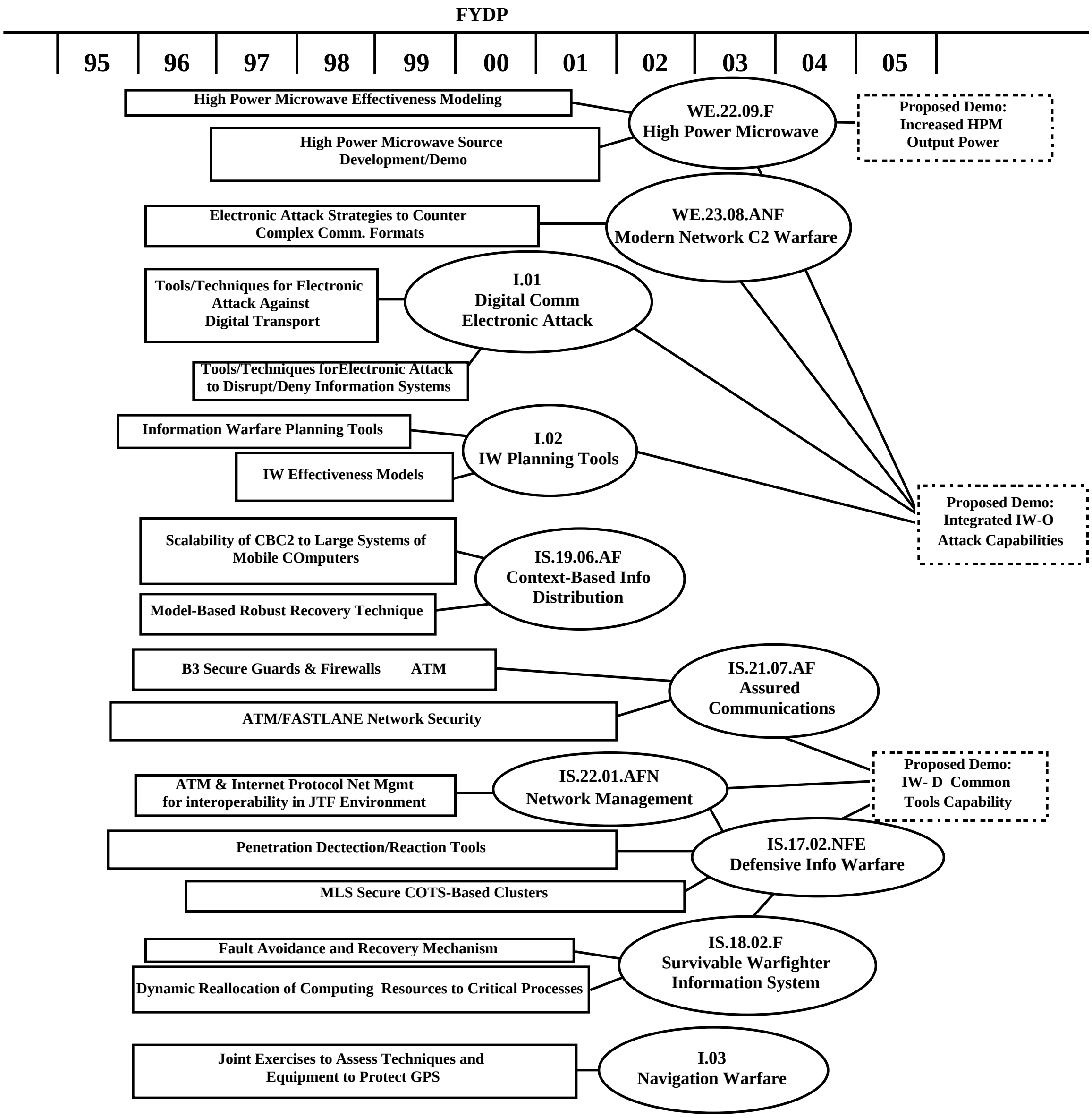


Figure IV.I.7. Roadmap – Information Warfare

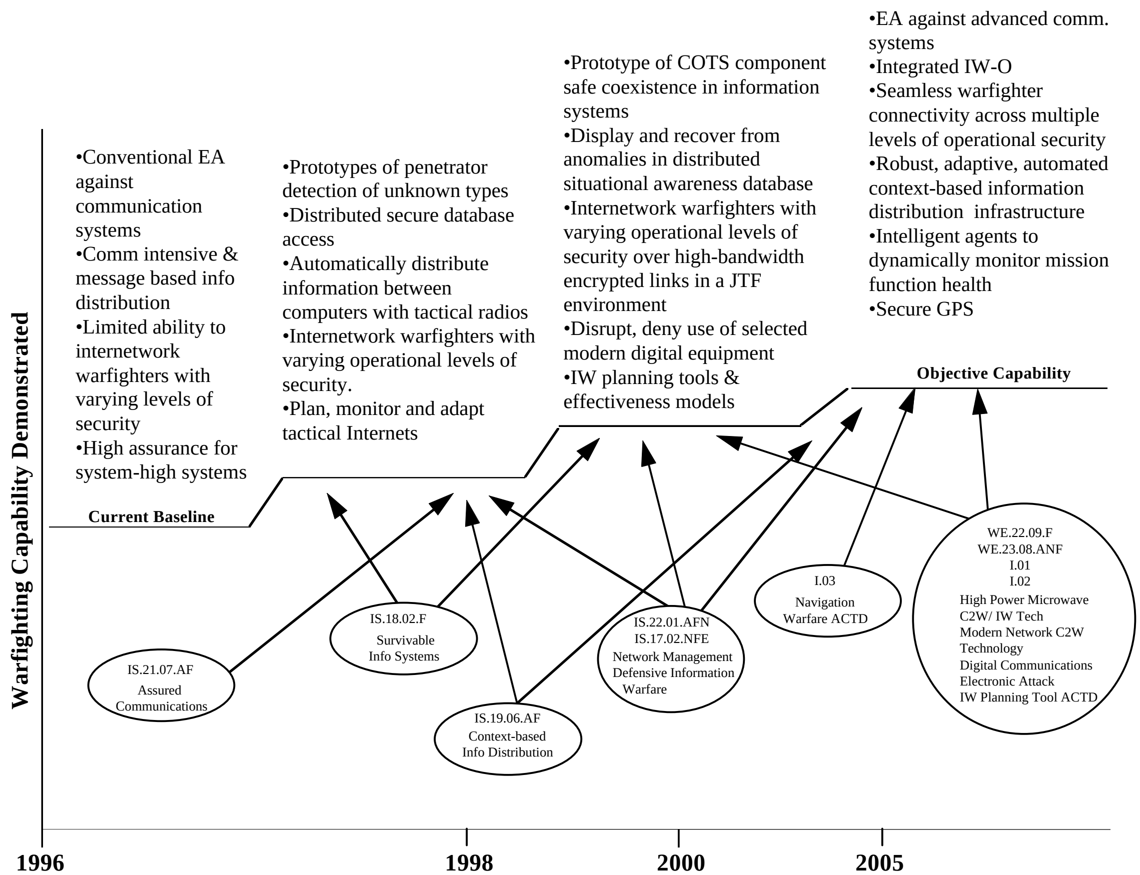


Figure IV.I.8. Progress – Information Warfare

J. CHEMICAL AND BIOLOGICAL AGENT DETECTION

1. Definition

Contamination avoidance is the highest priority of the DoD chemical and biological (C/B) defense program, which also includes force protection (individual, collective, and medical) and decontamination. This taxonomy is defined briefly under the passive defense part of Counterproliferation described in Section IV-L of this report. Contamination avoidance includes the ability to detect, identify, characterize, and warn of a C/B agent attack. Capabilities in point and early warning detection of chemical and biological agents, combined with the ability to assess and disseminate threat and hazard information in a timely manner, are critical to determining the appropriate protective posture for fielded U.S. forces and allowing them to continue their missions in a C/B contaminated environment.

2. Operational Capability Elements

Figure IV.J.1 illustrates how chemical and biological agent detection, identification and warning (DIW) affect all aspects of the battlespace, particularly in supporting the national two major regional conflicts (MRC) global power projection strategy. Technologies for the detection, identification, characterization, and warning of an attack are the cornerstone of defense against C/B warfare. The key operational capability elements, as listed across the top of Figure IV.J.2, are:

- Early warning of a chemical attack;
- Early warning of a biological attack;
- Point detection (or local warning) of a chemical attack;
- Point detection (or local warning) of a biological attack; and
- Warning and reporting of chemical and biological attacks.

Operational capability elements for C/B detection are driven by the Defense Technology Objectives (DTOs) provided in the DTO Volume for the JWSTP and the DTAP. Technologies to support these objectives will be refined through Advanced Concept Technology Demonstrations (ACTDs), Advanced Technology Demonstrations (ATDs), other technology demonstrations, and various technology thrusts.

Early Warning. Early warning of chemical and biological agents is critical to the effective avoidance of and protection against C/B contamination. Early warning of a biological attack is the highest CINC counterproliferation priority. Early warning, which complements point detection, is intended primarily as a means of detecting and tracking chemical and biological agent clouds and providing information to commanders downwind that a chemical or biological attack has begun. Intelligence capabilities provide information of an enemy's chemical or biological warfare capabilities (*e.g.*, the size and nature of an enemy's stockpile). In contrast, early warning provides information as early in an attack as possible (from tens of seconds to tens of minutes before units are exposed to C/B contamination) so that commanders have increased options on operational responses, including which protective posture to assume.

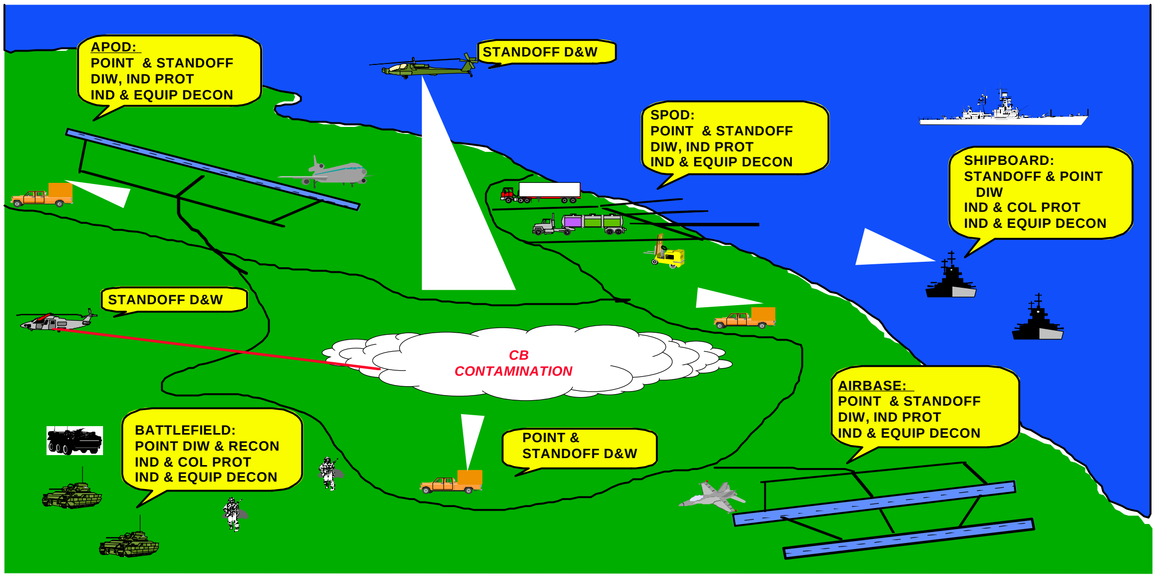


Figure IV.J.1. Chemical and Biological Agent Detection Concept

Functional Capabilities \ Operational Capability Elements	Early Warning: Chemical Detection	Early Warning: Biological Detection	Point Detection: Chemical Detection	Point Detection: Biological Detection	Warning & Reporting
Early Warning Chemical Detection					
1. Low cost lightweight vehicle mounted	●				○
2. Vapor, aerosol and liquid detection for all warfighting applications	●				○
Early Warning Biological Detection					
3. Single system for aircraft, vehicle, ship, and fixed site defense		●			○
Point Chemical Detection					
4. Single system for all warfighting applications			●		○
Point Biological Detection					
5. Single Bio point detonation capability for all warfighting applications				●	○
6. Advanced Bio agent sampling/collection technologies				●	○
Warning and Reporting					
7. Automatic NBC warning and reporting to all forces in theater	●	●	●	●	●

● Strong Support ○ Moderate Support

Figure IV.J.2. Functional Capabilities Needed For Chemical / Biological Warfare Agent Detection

Early warning may be implemented through standoff detection using a variety of laser detector technologies at ranges up to 100 km from the contamination, through point detectors deployed on remotely-controlled platforms (e.g., unmanned aerial vehicles, UAVs), or through the forward placement of point detectors (e.g., airdrops, special operations forces (SOF) emplacement). While a single technology (or technology suite) with combined multi-agent chemical and biological detection is a goal of these efforts, such a solution is not planned for transition out of tech base during the Future Years Defense Plan (FYDP). Current technology thrusts for early warning focus on separate systems for chemical and biological detection.

The most likely near-term approach will continue to rely on complementary detection technologies using the following approach. Especially for biological agents, current and near-term technologies seek first to sense the presence of higher than normal concentrations of aerosols or particulate matter in the atmosphere. If it is present, data are examined to determine whether the aerosol or particulate formation is natural or man-made. Simultaneously, other sensors will seek to detect whether the aerosol or particulate contains biological material. As technologies mature, new systems will be able to detect, identify, and characterize an increasing number of toxic agents, more reliably, and from greater distances. Problems associated with developing these technologies include overcoming attenuation of laser energy by the atmosphere absorbents, and providing algorithms to discriminate between natural aerosols and man-made aerosols with biological warfare agents, miniaturizing and ruggedizing sensors, developing advanced sampling technologies, and integrating systems into warning and reporting networks.

One of the key early warning defense technology objectives–stand-off and remote biological warfare agent detection–recently has been transitioned out of the technology base and is being funded jointly by Joint Program Office for Biological Defense (JPO-BD) and the Counterproliferation Support Program. This program seeks to provide maneuver forces with an early capability against an upwind release of biological agents. Technologies being evaluated include laser stand-off detectors and sensors mounted on UAVs. Concepts of employment of these technologies will be evaluated in an ACTD proposed for an FY 1997 start.

Point Detection. The overall goal of point detection (also referred to as local warning) is to develop point sensor technologies that can rapidly detect the presence of biological warfare agents, uniquely identify biological warfare agents, and to optimize the sensitivity, selectivity, reliability, and size of chemical warfare agent detectors. The program is divided into two parts, biological and chemical. Technologies under consideration in the near- and mid-term cannot address both of these threats using the same technology. However, there are efforts to develop a single suite of sensors to detect all potential C/B threats. Chemical and biological detectors would be incorporated as separate modules and upgraded as newer technologies emerge.

Point detection improves visualization of biological and chemical hazards in a local environment through the exploitation of emerging technologies such as immunoassays, deoxyribonucleic acid and gene probes, various forms of spectroscopy, and other physical and chemical characterization technologies. Technological challenges include (1) the development of sensor technology with sufficient sensitivity and discrimination to detect, identify, and quantify the presence of biological and chemical hazards without false alarm, and (2) the integration and development of C3I technologies to permit rapid, automatic collection, collation, dissemination and display of C/B hazard information to various command levels. Up to now, the primary S&T focus has been in sensor development, but it is evident that new technologies are required to integrate sensor information with other battlefield situation awareness information (e.g., geographical, meteorological) in order to properly design the software and hardware for the digital battlefield of the future.

The strategy for the biological detection technology effort is to develop a series of different technologies in parallel to ensure that a capability in biological detection is achieved. Several technologies currently being pursued are considered to be mature enough for transition to an Advanced Technology Demonstration in FY 1996. The large number of emerging technologies that are in various stages of development led to a decision by the JPO-BD to sponsor a yearly field trial and evaluation of available technologies. The evaluation will provide recommendations to advance the development of mature technologies, return immature technologies back to the laboratory for additional development, or to terminate the development of inadequate technologies.

The chemical detection strategy is similar to that for biological detection. Currently there are fewer technologies being considered – e.g., ion mobility spectroscopy (IMS) and surface acoustic wave (SAW) devices. In addition, mass spectrometry is being examined for its applicability to both the chemical and biological detection problem. An evaluation of the state of development of IMS and SAW technologies in FY 1997 will lead to selection of the most promising technology to pursue for future systems.

Warning and Reporting. Warning and reporting is the critical link between C/B detection and C/B protection. The goal of this effort is to provide sufficient, timely information to commanders at all levels from early and direct warning capabilities so that they may develop options on how to conduct their mission and decide the appropriate protective posture to assume, including dewarning for downgrading protective posture. Warning and reporting is a critical issue in contamination avoidance. The military Services have agreed to expedite the development of an early capability by integrating ongoing hardware and software into a Joint Warning and Reporting Network (JWARN) to be fielded in FY 1999. Technologies will be developed to provide increased management and control functions, as well as to integrate features of the emerging Global Command Control System (GCCS). The long term goal of JWARN is to decrease warning time by eliminating the manual and voice transmission of data, replacing it with digital transmissions, and by providing significantly improved modeling and simulation capabilities to identify and predict the location and nature of C/B hazards on the battlefield.

3. Functional Capabilities

Figure IV.J.2 shows the functional capabilities required to produce the operational capabilities comprising Chemical/Biological Agent Detection. Specific technology programs are listed under each functional capability.

4. Current Capabilities, Deficiencies, and Barriers

Figure IV.J.3 presents current limitations and the key technologies being pursued to overcome these limitations. Overcoming these technology limitations will lead to the

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: *Early Warning Chemical*			
Lightweight on-the-move detection (Field-of-view 360° wide x 60° high). High-value site defense.	1. Low cost, lightweight vehicle capability for contamination avoidance. 2. Vapor, aerosol, and liquid agent detection for ships and air bases.	1. No on-the-move detection capability. 2. Vapor detection only. 3. No miniaturized systems 4. No unattended sensors	1. FTIR with moving background algorithm 2. DISC/DIAL 3. Coherent frequency agile laser 4. Remotely employable technologies
Operational Capability Element: *Early Warning Biological*			
Generic detection and identification. High-value asset defense. Early warning of bio attack. Tracking of threat agent clouds.	3. Single system for aircraft, vehicle, ship, and fixed site defense.	5. Not eye-safe. 6. Aerosol cloud detection only.	5. Eye-safe laser. 6. Wide-band tunable laser for agent identification. 7. Remotely employable technology.
Operational Capability Element: *Point Chemical Detection*			
Small, lightweight, rapid detection and characterization of all threat agents.	4. Single chemical point detector for all warfighting and support applications (e.g., troops, aircraft, ships, vehicles, SOF)	7. No mustard agent detector 8. Detectors are not sufficiently miniaturized	8. Miniature detectors 9. IMS, SAW, and other technologies with agent concentrator
Operational Capability Element: *Point Biological Detection*			
Rapid, all agent detection and characterization	5. Single bio point detection for all warfighting applications 6. Advanced bio agent sampling technologies	9. No portable systems 10. Limited number of agents 11. No rapid detection 12. Inadequate sampling and collection systems	10. Lightweight detector 11. Near-real time detection 12. Advanced collection/sampling technologies
Operational Capability Element: *Warning and Reporting*			
Fully integrated, interoperable, joint service, real-time warning, reporting and mapping of all C/B hazards	7. Automatic warning and reporting to all the force up to the theater command level	13. Manual 14. Voice, radio, and paper reports 15. Not integrated into GCCS	13. Automatic radio relay 14. Automatic NBC report preparation 15. Computer mapping with rapid, near real-time updates

Figure IV.J.3. Goals, Limitations, and Technologies For Chemical / Biological Agent Detection

functional capabilities necessary to enable the chemical/biological agent detection operational capabilities. Following each operational capability is a summary of current limitations that must be overcome to accomplish the various DTOs.

For *early warning*, the technological issues are: (1) discrimination of biological warfare agents from each other and from naturally occurring biological materials in the atmosphere; (2) size, weight, and power of chemical and biological detection systems; (3) aerosol background – naturally occurring biological materials (e.g., pollen) may cause high false alarm rates for biodetection systems; (4) man/machine interface; (5) sensor integration on various platforms (e.g., UAVs); (6) on-the-move stand-off detection of chemical agents; and (7) sensitivity of stand-off detection systems. Meeting these constraints may require trade-offs in range and sensitivity.

For *point detection*, the technological issues are: (1) development of real-time detection of biological materials (current capabilities require 15 or more minutes to detect biological agents and longer to identify agents), (2) unique identification of biological materials (current efforts are focused on generic detection of aerosols and particulates and identification of a limited number of agents), (3) improved sampling and collection technologies for chemical and biological agents, (4) small lightweight chemical detector (current capabilities provide detection for units, but are not useful for use by an individual.), (5) decrease in false alarm rate, and (6) sampling and collection of suspect aerosols.

For *warning and reporting*, the technological issues are: (1) digitization of battlefield sensor information, (2) automation of detection and warning processes, (3) collation and display of relevant information at various command levels, (4) integration of other sensor information such as geolocation, and meteorology, and (5) integration of data into appropriate models for analysis and presentation.

5. Technology Plan

Technology demonstrations and joint field trials provide a means for the rapid field testing of technical options to solve operational needs. Figure IV.J.4 illustrates how these demonstrations support the CB detection joint warfighting capability objective. Figure IV.J.5 lists the DTOs which, when attained, will enable the operational capabilities as shown by Figure IV.J.6. Each JWSTP DTO is described in the DTO Volume for the JWSTP and the DTAP, and their relationships are plotted in the technology roadmap, Figure IV.J.7.

6. Summary

Science and technology efforts in C/B agent detection provide the basis for significant advances in protecting U.S. forces from the C/B threat and supports the number one priority of the CINC/JROC Counterproliferation JWCA. Warning and reporting is key to detection efforts because it integrates detection systems into the digital battlefield and provides commanders with information they need to accurately visualize the battlefield. Figure IV.J.8 provides an indication of how each DTO will contribute to the overall joint warfighting capability objective. Achieving these objectives will ensure that the future warfighter is equipped with state-of-the-art technologies and does not face the same C/B warfare deficiencies encountered during Operation Desert Storm.

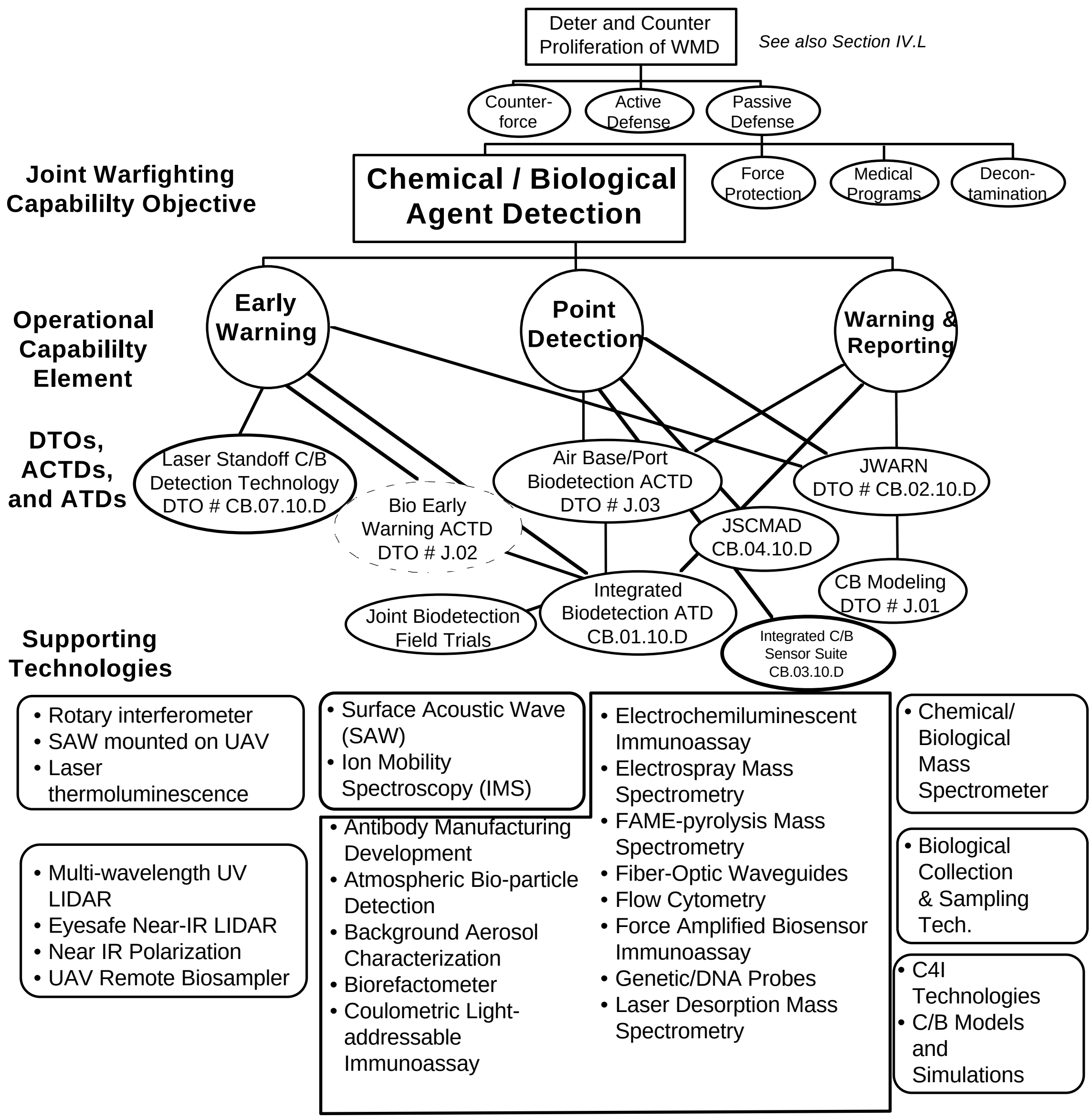


Figure IV.J.4. Technology to Capability Chemical / Biological Agent Detection

DTO #	Title
J.01	Chemical and Biological Modeling
J.02	Biological Early Warning ACTD (Proposed)
J.03	Air Base/Port Biodetection ACTD
CB.07.10.D	Laser Standoff C/B Detection Technology
CB.02.10.D	Joint Warning & Reporting Network (JWARN)
CB.01.10.D	Integrated Biodetection ATD
CB.04.10.D	Joint Service Chemical Miniature Agent Detector (JSCMAD)
CB.03.10.D	Integrated C/B Sensor Suite

Figure IV.J.5. Defense Technology Objectives – Chemical / Biological Agent Detection

Demonstration Title	Operational Capability Element: Early Warning		Point Detection		Warning & Reporting	Service/Agency	DTO	ACTD	ATD
	Biological	Chemical	Biological	Chemical					
Laser Standoff C/B Detection Technology	●	●			○	D	CB.07.10.D		
Biological Early Warning ACTD	●				●	D	J.02	P	
Joint Warning and Reporting Network	●	●	●	●	●	D	CB.02.10.D		
Air Base/Port Biodetection ACTD			●		●	D	J.03	X	
Chemical and Biological (C/B) Modeling	○	○	○	○	●	D	J.01		
Integrated Biodetection ATD			●		●	D	CB.01.10.D		X
JSCMAD				●		D	CB.04.10.D		
Integrated C/B Sensor Suite	●	●	●	●	○	D	CB.03.10.D		

D Joint Service Chem/Bio Defense Program
P Proposed

● Strong Support ○ Moderate Support

Figure IV.J.6. Demonstration Support – Chemical and Biological Agent Detection

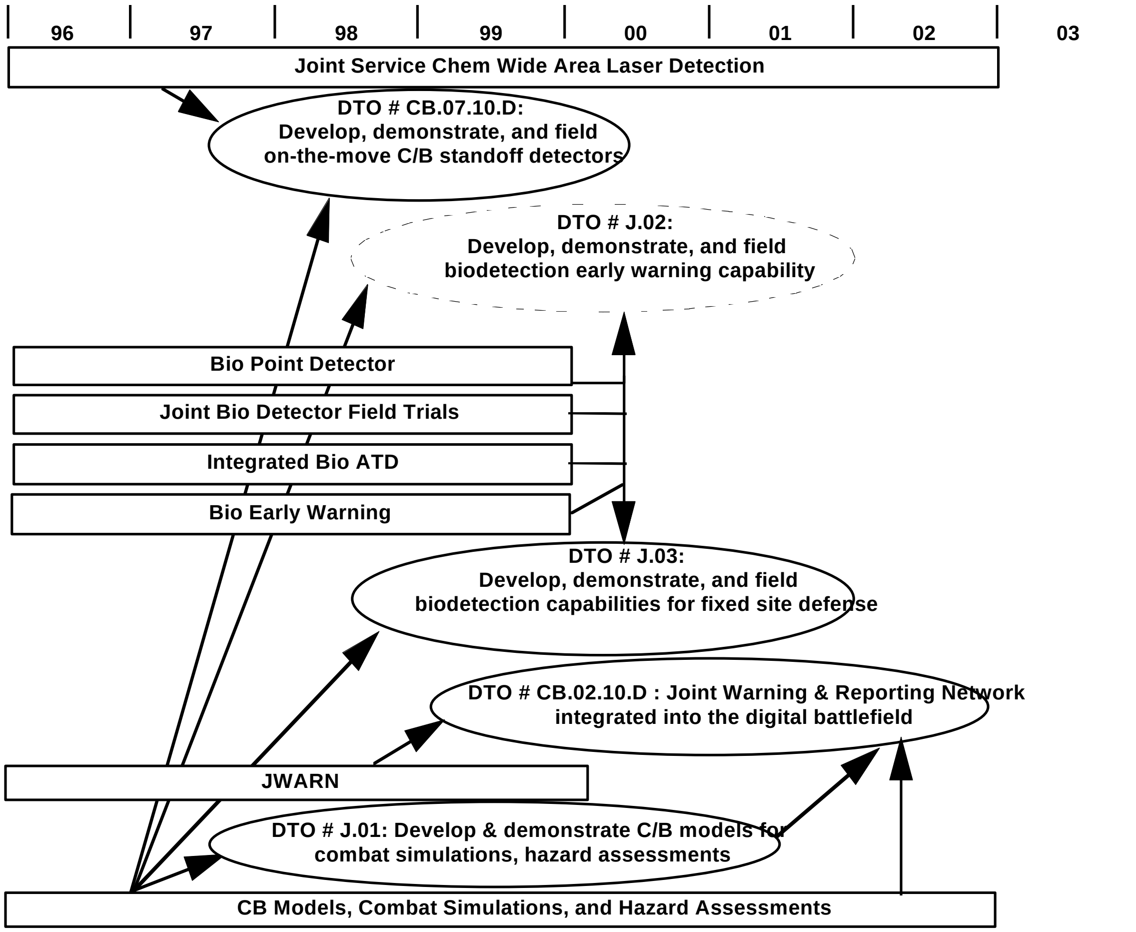


Figure IV.J.7. Roadmap – Chemical / Biological Agent Detection

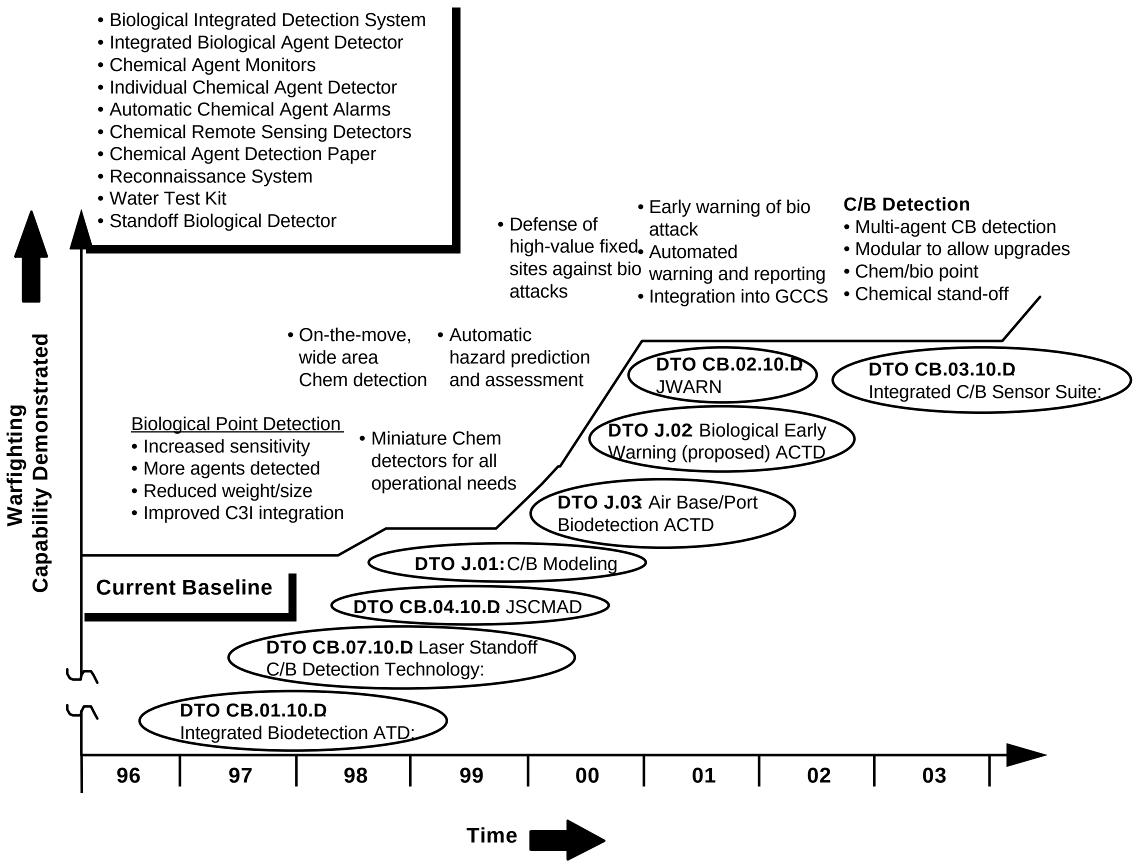


Figure IV.J.8. Progress – Chemical / Biological Agent Detection

K. REAL-TIME LOGISTICS CONTROL

1. Definition

Real-time logistics control is the capability for near real-time visibility of people, units, equipment, and supplies which are in-storage, in-process, in-transit, or in-theater, and the ability to act on this information.

2. Operational Capability Elements

Real-time logistics control is at the heart of future combat power. It is the national capability that delivers and sustains combat operations wherever and whenever needed. The domain of logistics spans the individual disciplines of materiel acquisition, supply and storage, maintenance, transportation and traffic management; it also includes medical evacuation. Real-time logistics control is the welding of these functional disciplines into a seamless interoperable process whereby information processing technologies are applied to create operational capabilities for planning, execution, execution monitoring, and replanning. Logistics planning will be conducted concurrently with the warfighting concept of operation; logistics will influence future decision-making actions on the battlefield.

National military strategy has changed from one of a forward deployed presence to one of CONUS-based forces that must respond rapidly to operations anywhere in the world. As a result, the demands on the logistics systems have increased dramatically. The challenge for the future is to project and sustain combat power sooner without relying on massive inventories and organic lift. The future logistics control system must support a vision of reliable sustained flow to the foxhole, analogous to the "just-in-time" inventory concepts within the private industry. Logistics support costs must be reduced without sacrificing readiness or troop protection.

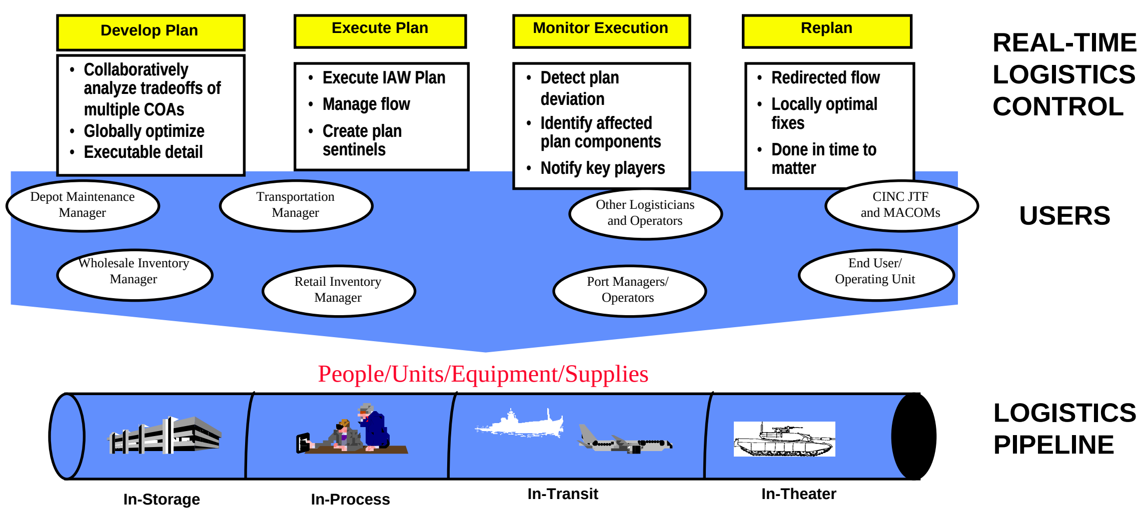
As may be inferred from Figure IV.K.1.a, current logistics systems are compartmentalized stovepipes and have little common data-sharing capability. Efforts are currently under way in the Defense Total Asset Visibility Program (DTAV), under DUSD(L) sponsorship, to link these numerous stovepipe logistics systems in order to provide asset visibility. Improvements in source data capture to provide accurate and timely data, combined with advanced methods to monitor logistics execution, will provide input into a real-time logistics control system to manage the logistics pipeline as shown in Figure IV.K.1.b.

Providing real-time logistics control requires an integrated open architecture that enables data sharing and interactive processing across disparate systems that can be accessed by remote users. The key to success will hinge on the development of advanced information processing technology to support real-time logistics planning, execution, monitoring, and replanning. Logistics systems of the future must exploit the state-of-the-art distributed system architectures, current state measurements from Automated Identification Technologies (AIT) and other technologies, and heterogeneous database access and maintenance techniques. These systems must be supported by reliable, robust logistics communications infrastructure to maintain continuous visibility into the logistics pipeline.

Real-Time Logistics Control					
Defense Total Asset Visibility*					
Army	**Navy**	**Marine Corps**	**Air Force**	**DLA**	**USTC**
GTN	GTN	GTN	GTN	GTN	GTN
TCAIMS II	TCAIMS II	TCAIMS II	TCAIMS II	TCAIMS II	TCAIMS II
DAAS	DAAS	DAAS	DAAS	DAAS	WPS
LIF	SALTS	MAGTF-II	AFEMIS	LIPS	CAPS II
TERMS (WPS)	UICP	MUMMS	CAS-A	LINK	
RF Tech	CAIMS / OMMS	SASSY	SCS	SAMMS	
ATAV	ATAC	DSSC	SBSS	DEPRA	
SARSS-O	VMISR	AMMOLOGS	MASS	DSS	
	SNAP	TMS	REMIS		
		ATLASS	AFLIF		
			CMOS		

*These terms are defined in the Glossary

IV.K.1.a. Asset Visibility Input for Real-Time Logistics Control



IV.K.1.b. Real-Time Logistics Control

Figure IV.K.1. Real-Time Logistics Control Concept

Control of the logistics pipeline demands a radical shift in the way planning and execution are done today. Operations and logistics must be viewed as a tightly coupled closed loop system in which participants work together to create a detailed plan. Operators and logisticians, at all levels, must be brought together in a distributed interactive planning environment to plan, execute, monitor, and rapidly replan.

A key element of this coordinated process will be the ability to plan in sufficient detail to execute directly from the plan. The logistics plan must be developed in consonance with the war plan, and have explicit representations of the assumptions and expectations used to develop the plan. These assumptions are critical to detecting deviations from the plan through the creation of trigger processes or "plan sentinels" that can be placed at key nodes or links in the logistics pipeline to detect deviations. "Plan sentinels" will provide the necessary closed loop feedback to maintain control of the logistics system. Combined with rapid replan capability, sentinels would enable the oversight process required to maintain a continuous loop of planning, execution, monitoring, and replanning.

The future concept of operations is envisioned as an interoperable environment for the operators in J3 and logisticians in J4 to coordinate their activities. A J3 and J4 environment that is tightly linked will enable the impact of logistics to bear directly on the decision making process during the course of action evaluations.

3. Functional Capabilities

Only by building on a foundation of advanced information technology can a fundamental change in logistics planning and operations execution be achieved. Technology must be developed that speeds logistics planning, execution, monitoring, and replanning; ensures accurate, reliable, and timely information; and creates plan monitors that provide early warnings of events that deviate from the plan. Figure IV.K.2 shows the functional capabilities required to produce the operational capability elements comprising the essential elements of real-time logistics control.

Significant changes in the logistics planning and execution paradigm are:

a. Capturing item level detail to be used in plan development;

b. Understanding in advance the impacts of alternative logistics decisions on the battlefield;

c. Automated access into logistics databases by intelligent software agents that can seek out and return with prescribed information;

d. All movements optimized and scheduled for movement from the same platform;

e. Real-time monitoring feed back from not only the transportation movements, but also operational status of the infrastructure that supports the logistics framework;

f. Replanning action triggered by "sentinels" to enable corrective action based on predictive analysis;

Functional Capabilities / Operational Capability Elements	Planning	Execution	Monitoring	Replanning
1. Support Force Sourcing	●		O	●
2. Logistics Requirements Generation	●			●
3. Critical Item Identification	●	●	O	●
4. Commercial Sourcing	●	●	O	●
5. Rapid Negotiation & Ordering	●	●		●
6. Plan Deviation			●	O
7. Optimization	●	●		●
8. Mode/Carrier Allocation	●	●		●
9. Route Allocation	●	●	O	●
10. Cost/Quality Evaluation	●			●
11. Scheduling	O	●	O	●
12. Detailed Load Plan	●	●		●
13. COA Logistics Evalution	●	●	●	●
14. Replan & Reschedule		●	●	●
15. Motion Mitigation – Cargo Offload		●		

● Strong Support O Moderate Support

Figure IV.K.2. Functional Capabilities Needed For Real-Time Logistics Control

g. Tracking supply demands and fills from the factory to the fox hole;

h. Software agents that can seek out requirements from commercial sources and autonomously negotiate the purchase order or contract;

i. Course of action evaluation tools that translate logistics capability into meaningful decision making aids.;

j. Planning time reduced from days to hours and the time allowed for replanning cut from hours to minutes; and

k. Reduce over shipments by 33 percent and misshipments by 90 percent.

4. Current Capabilities, Deficiencies, and Barriers

The current logistics spectrum is compartmentalized into functional disciplines. Supporting logistics systems are unique to their own functional domain and have little or no common data sharing capability. Improvement efforts of the past and present are overly focused on solving the short-range problem and ignore the tougher long-range re-engineering effort that is desperately needed.

Lack of access to data across the disparate databases that make up the logistics world has prevented the full integration of legacy systems that support day to day logistics operations. The application of new object oriented programming languages working in an open reference architecture will make possible the sharing of common data even though the database structures and/or software languages are different. The Joint Logistics ACTD, supported by the Total Distribution ATD, and the Defense Advance Research Projects Agency (DARPA) Advanced Logistics Program will take the first steps to extend this architecture.

Visibility over assets and resources has continued to be a “number one” priority. Over the past several years advances into cargo and asset visibility have begun to provide early solutions. The use of LOGMARS and RF-technology has resulted in significant improvements in asset visibility, but cost, operating ranges, reliability, human interface, size, and power sources all need improvement.

Today’s planning and execution realms remain separated. Logistics plans are developed at a high level and provide only a summary of what the intended movement requirement may look like. Planning is hampered by a serialized process. The warfighting commander delineates the overall mission and concept of operation. The operations staff (J3) outlines the alternative courses of action (COA) and the requirements seen as necessary to fight and win. Only after a lengthy series of actions to “source” the forces and resupply requirements is a plan seemingly finished; however it remains at the summary level. The information usually does not reflect what will eventually move.

When it becomes necessary to deploy forces, the move is almost never executed in the manner in which it was planned. When execution begins, the unit, installation, or depot decides what and how much equipment and materiel will move. Distinctly different logistics systems are used to execute the actual movements and resupply demand actions. There is very little real-time feedback to commanders to tell them whether or not they are deviating from the plan they had built. As unforeseen events begin to affect the actual movement, operators and planners cannot predict the magnitude of breakdowns or their location as a result of the new set of circumstances. The planning and execution processes today suffer greatly from compartmentalized systems that lack the level of detail upon which to make timely and accurate decisions.

Figure IV.K.3 summarizes the limitations and identifies the technologies needed to breach the limitations to achieving the functional capabilities that enable real-time logistics control.

5. Technology Plan

Controlling the logistics pipeline hinges on technologies developed for planning, execution, monitoring, and rapid replanning. These technologies will enable the logistics plan to be developed in consonance with the warfighting plan, the execution to be accomplished based on the details of the logistics plan, and responses to deviations to be made in time to matter.

Accurate and accessible information is the foundation upon which the logistics systems must be built. Technologies must be pursued to support the autonomous connection of heterogeneous and distributed databases, semi autonomous search and retrieval, and intelligent query for information. Successful implementation will allow the operator to know where his supplies are and monitor their condition.

The technologies to enable development of real-time logistics control and the linkage of these to demonstrations and capabilities are shown in Figure IV.K.4.

As shown in Figure IV.K.5, three DTOs must be completed in order to achieve real-time logistics control. The Total Distribution (TD) ATD (K.01), is sponsored by the Army. It continues development of the Logistics Anchor Desk (LAD) and integrates it with logistics data sources. The LAD is a workstation that provides logistics decision support tools. The LAD will transition to the Joint Logistics (JL) ACTD (K.02). The overall goal of the JL ACTD is to link and consolidate relevant logistics data sources, models, and simulations shown in Figure IV.K.1, in order to provide users with situation awareness and the ability to conduct more effective logistics management. In an interconnected, parallel effort the DARPA Advanced Logistics Program (K.03), will demonstrate advanced information technology applications needed to gain control of the logistics pipeline. As the DARPA technology matures, it will be demonstrated and transitioned to the JL ACTD. Accomplishment of these three objectives will provide the DoD with the required operational capabilities of logistics planning, execution, monitoring, and replanning as demonstrated in Figure IV.K.6. A roadmap showing the interrelationship of these objectives over time is shown in Figure IV.K.7.

The U.S. Army Materiel Command (AMC) and the Information Systems Office at DARPA have made many steps toward addressing increased asset visibility, connectivity, and interoperability with the introduction of the LAD initiative. LAD evolved from prototype tools developed under the Army's TD ATD and DARPA's Joint Planning Initiative, to investigate sustainment issues for Force XXI. This joint automation initiative links and consolidates logistics data sources, models, and simulations to provide leaders with situational awareness and the ability to conduct more effective logistics management. The resulting common view of the battlefield provided by LAD can then be fed into models, simulations, and artificial intelligence planning tools to support the development and evaluation of plans and courses of action. LAD displays, in real time, the information needed by logistical commanders and planners at the strategic, operational and tactical levels. With LAD, planners can determine the required equipment and personnel densities, identify support requirements for mission critical units or items, provide projections and summaries of sustainment issues, forecast secondary item densities, monitor the performance of logistical systems and units, and monitor ongoing deployment actions along with the status of critical items. Work done with one LAD can be then communicated to other Anchor Desks by transferring data electronically or by using an integrated virtual conferencing capability. This permits leaders at all levels to conduct distributed collaborative planning across the services and echelons. The LAD provides an integrated view of sustainment to influence the process within the appropriate time to make a difference in military outcomes.

The JL ACTD will build upon planned technology migration from the Advanced Joint Planning ACTD, the Joint Task Force (JTF) ATD and the DTAV program. With the addition of reliable broad band communications provided by the Battlefield Awareness Data Dissemination (BADD) ACTD and the DARPA Advanced Logistics program, the technology will be in hand for the next generation, 21st century logistics systems. JL ACTD leave-behind capabilities will include a network of workstations, interfaces, exercise and operational data, communications, and on-site support within CINCs operations and logistics planning cells. These leave-behind capabilities will use data from the DTAV initiative, complement the operational planning capabilities provided by the Advanced Joint Planning ACTD, and migrate capabilities into the emerging Global Combat Support System (GCSS). The JL ACTD will continue to conduct Joint Warfighting Experiments embedded in CINC-level exercises (e.g., Unified Endeavor, Cobra Gold, Prairie Warrior, Ulchi Focus Lens, JWID, and Bright Star) as JL ACTD Demonstration Exercises. The JWEs will provide a cost-effective basis for the user to make informed operational architecture, requirement and acquisition decisions. The JL ACTD will also use day-to-day operations to refine and expand the operational concept and user requirements.

The DARPA Advanced Logistics Program will develop and demonstrate software tools and protocols needed to gain control of the logistics pipeline and enable the warfighter to project and sustain overwhelming combat power sooner. In summary, the program will produce advanced information technology to put the right materiel in the right place, at the right time, while supporting the need to do so with the reduced reliance on large DoD inventories. The program will develop a shared technology base of information manipulation and planning tools to support planning, execution, monitoring and focused replanning throughout the logistics pipeline. The program will focus on four main areas:

- Transportation tools to track assets and make smarter use of lift.
- Rapid supply services for faster and more flexible acquisition of supplies.
- Force sustainment planning and sourcing.
- Logistics COA feasibility planning that is linked to the war plan.

The Advanced Logistics Program will be demonstrated through a system that tightly couples continuous planning and execution monitoring in an interoperable course of action (COA) and logistics support environment linking CINC Operations (J3) and Logistics (J4) Staff, DLA, and TRANSCOM. As technology matures in the DARPA Advanced Logistics Program, it will be transitioned to the JL ACTD.

The approach to system design and objective (K.03) will build upon advanced software architectures being developed under initiatives such as the Advanced Joint Planning ACTD and JTF ATD. The future system will add logistics extensions and schema to the generic architecture. Since these programs are in the transition path to the GCSS and Defense Information Infrastructure (DII) environments, the logistics system of the future will be compatible and transition appropriately.

The Advanced Logistics Program will take full advantage of operational exercises to demonstrate functional capability. Increasingly complex demonstrations will lead to a full end-to-end logistics system demonstration in FY 2000. The program will exploit Bright Star and Sea Emergency Deployment Readiness Exercises (SEDRE) to show completion of DTO K.03. In addition, specific technology components of the program will be demonstrated during yearly Interim Feasibility Demonstrations (IFD) and Joint Warfare Interoperability Demonstrations (JWID).

6. Summary

Real-time logistics control means getting control over the logistics pipeline. The current logistics environment consists of disparate databases, compartmentalized by functional disciplines. Future operations will demand that logistics planning be conducted concurrently with the warfighting concept of operations. Only by applying and advancing information systems technology can these capabilities be met.

Figure IV.K.8 identifies the Joint Warfighting Capability Objectives necessary to achieve real-time logistics control. The TD ATD (K.01) is the first step to linking databases and providing a suite of distribution planning tools. The JL ACTD (K.02) builds on the technology gained in the TD ATD and other asset visibility programs within the Department of Defense. It expands the planning environment with collaborative tools, analysis tools, and basic monitoring ability. The DARPA Advanced Logistics Program evolves in parallel transitioning technology to the JL ACTD as it matures. Real-time logistics control capability is demonstrated in (K.03) with a system that tightly couples continuous planning, execution, monitoring, and replanning. The warfighter will be linked in an interoperable environment with the logistics support staff to collaborate on the course of action and necessary logistics support requirements.

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Planning			
Develop a plan based on item level detail that can be executed, plan that can collaboratively analyze multiple COA's and can be globally or locally optimized. Reduce the planning cycle from days to hours.	1. Support Force Sourcing 2. Logistics Req'mts Generation 3. Critical Item Identification 4. Commercial Sourcing 5. Rapid Negotiation and Ordering 7. Optimization 8. Mode/Carrier Allocation 9. Route Allocation 10. Cost/Quality Evaluation 11. Scheduling 12. Detailed Load Plan 13. COA Log Evaluation 14. Replan and Reschedule 15. Motion Mitigation/ Cargo Offload	1. No infrastructure investment/alternative planning. 2. Human interaction with creating source data. No automated source data capture. 3. Planning systems only run with summary level data. 4. No aggregation and deaggregation processing available. 5. Logistics and transportation systems are not linked to conduct movement feasibility in the "sourcing" process. 6. No cost evaluation done. 7. No automated access into logistics databases by intelligent software agents. 8. Limited movement optimization or scheduling within same platform. 9. Limited collaboration tools 10. No mapping tools to asses infrastructure in theater	1. Semi-autonomous search and retrieval 2. EDI extensions 3. Advanced optimization 4. Active data bases and data mining 5. Shared ontology 6. Interoperable modeling 7. High fidelity simulations 8. Adaptive work flow 9. Intelligent agent mediator processing 10. Advanced Human Computer Interface 11. Desktop Video Teleconferencing 12. Shared Whiteboards
Operational Capability Element: Execution			
Execute IAW detailed plan with the ability to manage the flow of actions in real time. Within the systems architecture create plan sentinels that can respond to deviations from the plan assumptions and expectations.	3. 4. 5. 7. 8. 9. 11. 12. 13. 14. 15.	11. Details for execution not linked to the plan. 12. Deviation detection during execution not possible. 13. No optimization process in use for asset allocation and scheduling. 14. No access to commercial data bases. 15. Requires "pushed" data. 16. Semantics difficulties. 17. No visible requisition process: no receipt to fill. 18. No autonomous negotiation and purchase	13. Advanced scheduling technology 14. Deviation detection from monitoring systems 15. Motion mitigation control research 16. In-theater measurements monitors 17. Automated Identification Technology (AIT) 18. Infrastructure monitors 19. Object oriented plan representation

Figure IV.K.3. Goals, Limitations, and Technologies For Real-Time Logistics Control

Goal	Functional Capabilities	Limitations	Key Technologies
Operational Capability Element: Monitoring			
Real time monitoring of inventory, both DoD and commercial suppliers, movements, and infrastructure capability. By interacting with "sentinels", detect deviations in the plan, identify the key affected areas and notify players.	1. 3. 4. 6. Plan Deviation 9. 11. 13. 14.	19. No real time feed back on the status of logistics operations. 20. Only nodal reporting within ITV process. 21. No infrastructure capability feed back. 22. No automated source data capture. 23. No real time monitoring feed back from transportation movements, and operational status of the infrastructure that supports the logistics framework. 24. No logistics visualization techniques. 25. No method to detect deviations that occur and signal the need for replanning.	20. Dependency-driven notification of deviation from plan 21. Next generation AIT research 22. Embedded software agents ("sentinels") 10.
Operational Capability Element: Replanning			
The capability to conduct complete or partial replanning actions based on the changing situation as reported from the monitoring elements. Replanning cycle can be accommodated within minutes.	1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14.	26. No rapid replanning capability exists. 27. No method to initiate replanning and scheduling based upon input from monitoring and deviation detection sentinels. 28. No method to automatically notify all players of replan actions. 29. No method to replan with optimization to fix local or global problems. 30. Limited collaboration tools. 31. No mapping tools to asses infrastructure in theater	1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

Figure IV.K.3. Goals, Limitations, and Technologies For Real-Time Logistics Control (cont'd)

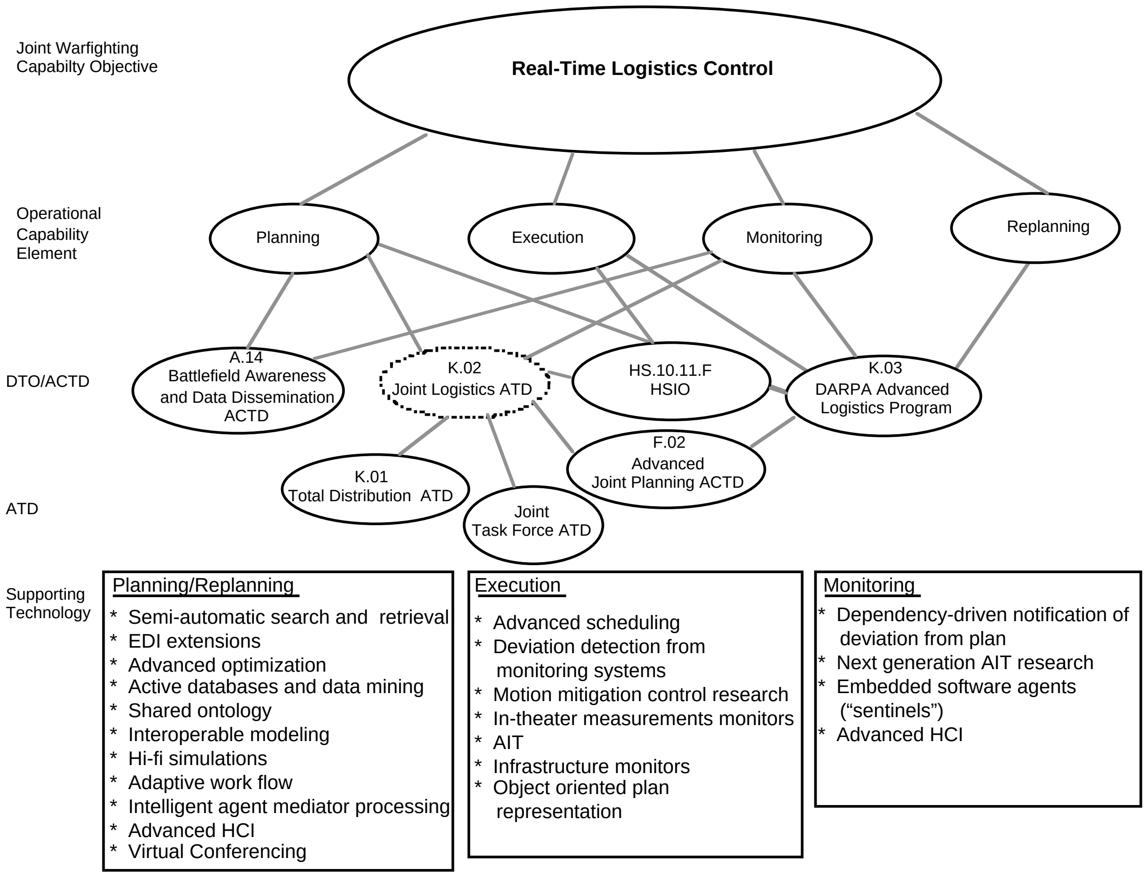


Figure IV.K.4 Technology to Capability – Real-Time Logistics Control

DTO#	TITLE
K.01	Total Distribution ATD
K.02	Joint Logistics ACTD
K.03	DARPA Advanced Logistics Program
F.02	Advanced Joint Planning ACTD
A.14	Battlefield Awareness and Data Dissemination ACTD
HS.10.11.F	Integrated Technical Information to Improve Maintenance Performance and Operations

Figure IV.K.5 Defense Technology Objectives – Real-Time Logistics Control

Demonstration Title	Operational Capability Element				SERVICE AGENCY	Demonstration is a		
	PLANNING	EXECUTION	MONITORING	REPLANNING		DTO	ACTD	ATD
Total Distribution ATD	○		●		Army	K.01		X
Joint Logistics ACTD	●		○		Army	K.02	X	
DARPA Advanced Logistics Program	●	●	●	●	DARPA	K.03		
Advanced Joint Planning ACTD	●	●	●	●	DARPA	F.02	X	
Battlefield Awareness and Data Dissemination ACTD	●		○		DARPA	A.14	X	
Integrated Technical Information to Improve Maintenance Performance and Operation	○	○	●		Air Force	HS.10.11.F		

Figure IV.K.6 Demonstration Support – Real-Time Logistics Control

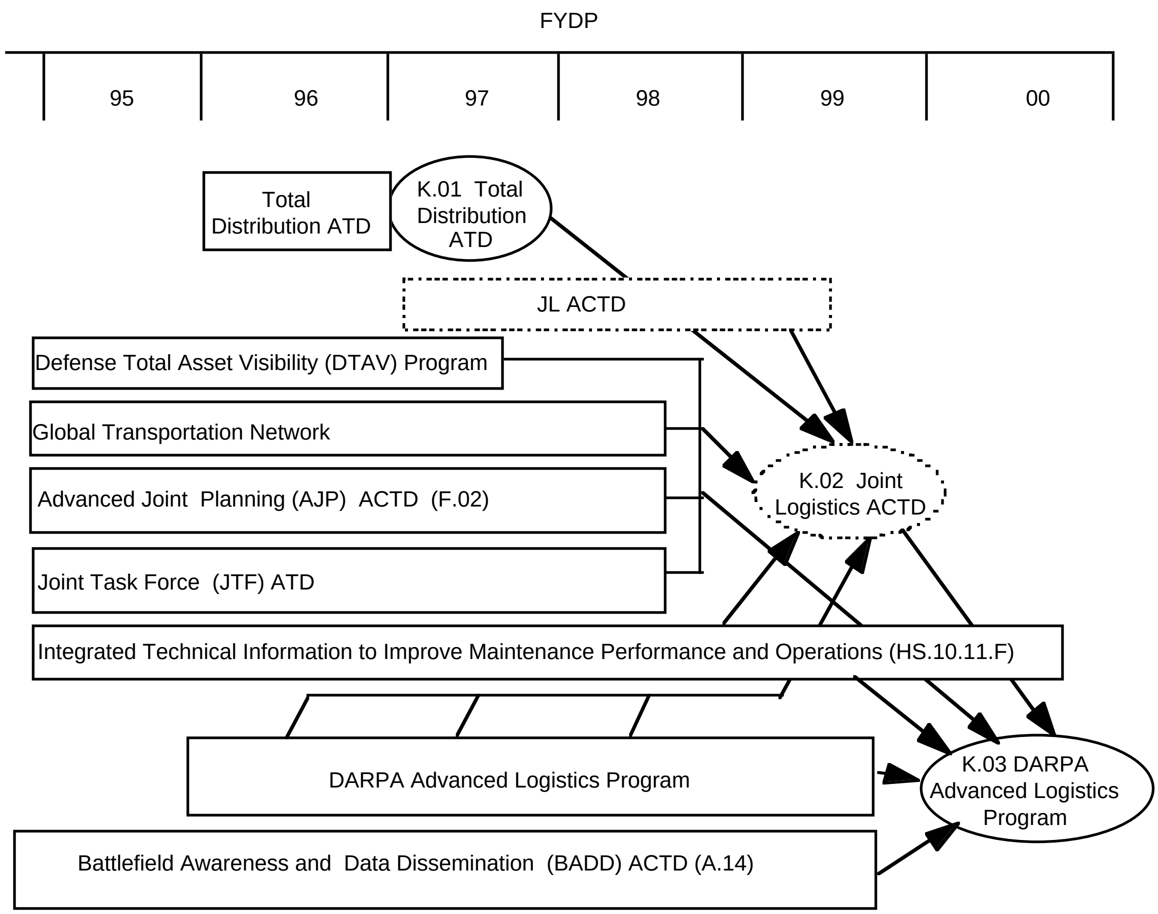


Figure IV.K.7. Roadmap – Real-Time Logistics Control

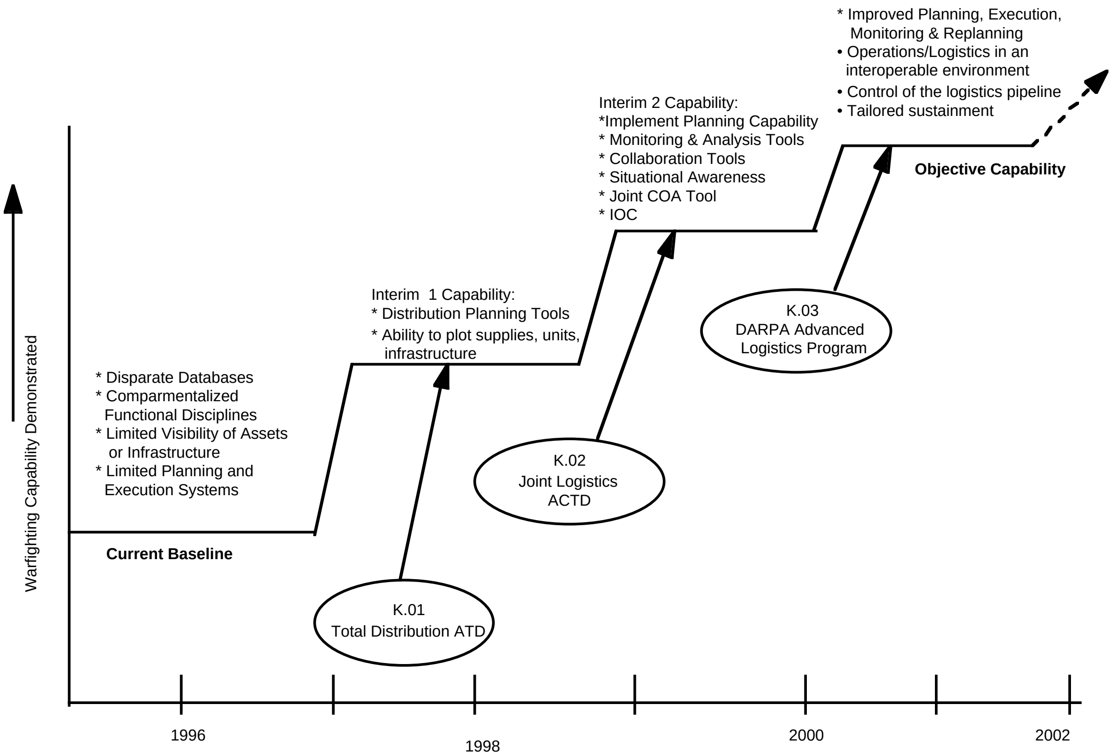


Figure IV.K.8. Progress – Real-Time Logistics Control

L. COUNTERPROLIFERATION

1. Definition

A wide array of political, economic, technological, and military capabilities are necessary to effectively counter the proliferation of weapons of mass destruction (WMDs). The DoD's counterproliferation (CP) capabilities are associated with seven functional areas: (i) prevent proliferation by denying attempts of would-be proliferaters to acquire or expand WMD capabilities–proliferation prevention; (ii) obtain actionable strategic and tactical intelligence on existing or emerging proliferant states or groups–strategic and tactical intelligence; (iii) watch the battlefield to detect, identify, and characterize WMD forces–battlefield surveillance; (iv) target, interdict, and/or destroy hostile nuclear, biological, and chemical (NBC) forces and supporting infrastructure with minimal collateral effects–counterforce; (v) actively defend U.S. forces, other friendly forces, and non-combatants by intercepting ballistic and cruise missiles with NBC warheads–active defense; (vi) passively defend U.S. forces, other friendly forces, and non-combatants through NBC agent detection, individual and collective protection, medical treatment, and decontamination--passive defense; and (vii) find and safely dispose of WMDs that paramilitary groups or terrorists attempt to covertly employ in the U.S. or in a theater of U.S. military operations – counter terrorism.

The DoD technology base supports each of the above seven CP functional areas. However, in the context of this JWSTP, counterproliferation is the capability for (1) detecting and evaluating the existence of manufacturing capability for weapons of mass destruction (WMD), and (2) battlefield identification and assessment of the damage capability of alert and launched WMDs to permit the proper level of counterforce to be exerted promptly, and (3) passive defense of individuals and forces. It includes improved counterforce against hardened WMD storage and production facilities. It also includes planning tools incorporating collateral damage prediction, specialized surveillance capabilities, advanced weapons, and enhanced battle damage assessment capabilities. This JWSTP focuses on passive defense and counterforce.

a. Passive Defense

In the context of Counterproliferation, passive defense is the capability to avoid or survive a nuclear, biological, or chemical attack and to continue missions in a contaminated environment. Contamination avoidance is the cornerstone of the C/B passive defense program and is detailed in section IV-J of this report. In addition to contamination avoidance, the defense program includes force protection (individual, collective, and medical) and decontamination, as described in this section.

b. Counterforce

Counterproliferation counterforce is the capability to destroy, neutralize, or deny access to above-ground, slightly buried (bermed bunkers and cut-and-cover), and deeply buried targets (including tunnels) containing weapons of mass destruction (WMD) and related facilities and systems, while minimizing collateral effects from the hazardous materials contained in the WMD facility. The potential for catastrophic casualties among both combatants and non-combatants resulting from the release of hazardous WMD materials may require new operational tactics, techniques, and procedures in addition to new technologies. Some time urgent WMD launch systems are mobile; requirements for detection, tracking and defeat of such targets are discussed in section IV.B, Precision Force. Active defense against WMD-carrying theater ballistic missiles is addressed in Section IV.D, Joint Theater Missile Defense.

2. Operational Capability Elements

Figure IV.L.1 illustrates the concept of counterproliferation on the battlefield.

a. Passive Defense

The key operational capability elements in the passive defense area are: (1) detection, identification and warning of C/B attacks (described in Chapter IV-J of this report); (2) individual (non-medical) protection; (3) collective protection; (4) decontamination; and (5) medical protection (including both vaccines and post-exposure therapies).

Operational concepts for passive defense are driven by the Defense Technology Objectives (DTOs) included in the DTO Volume for the JWSTP and the DTAP. Technologies to support these objectives will be refined through ACTDs, ATDs, other technology demonstrations, and various technology development programs.

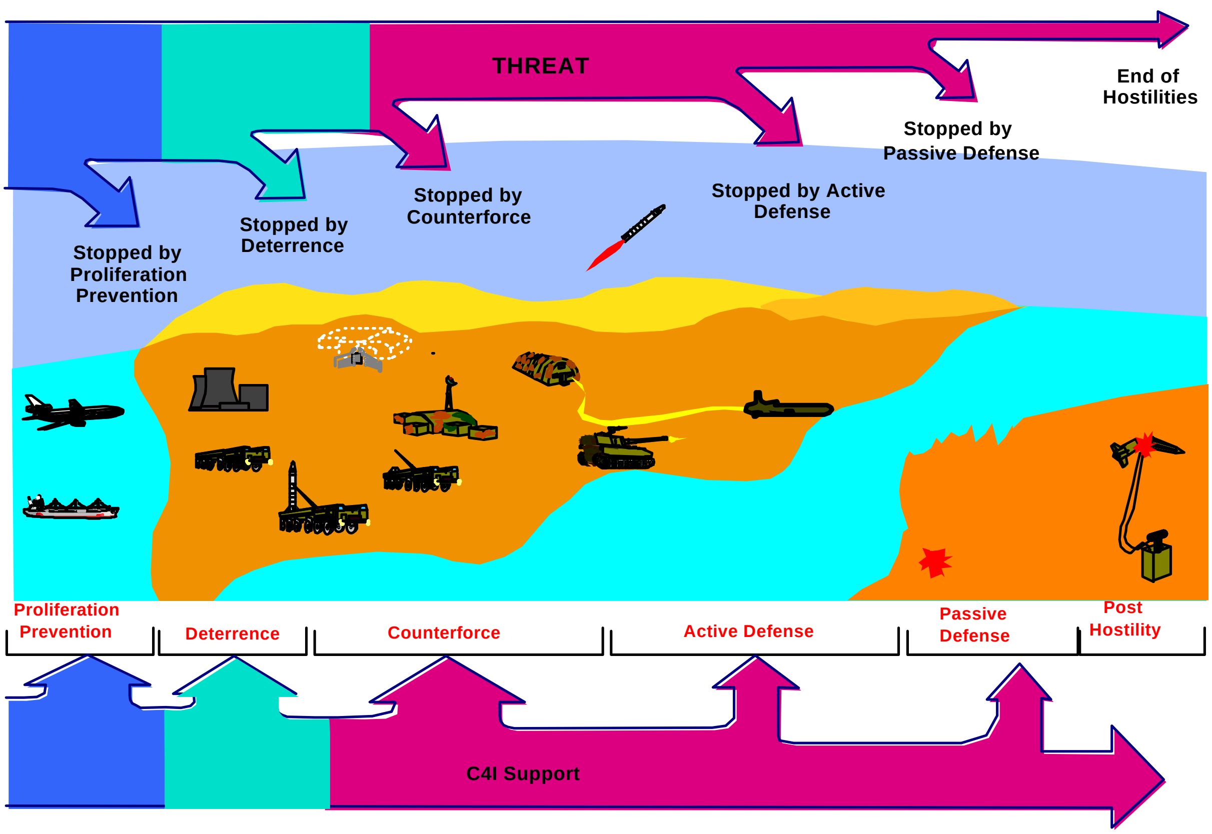


Figure IV.L.1. Counterproliferation Concept

Individual Protection. The goals of individual protection technology efforts are to (1) improve protection against current threats and add protection against future threats, (2) minimize mission degradation by reducing the impact of the use of individual protection on the soldier's performance, and (3) reduce the logistics burden. The key components of individual protection are ocular and respiratory protection and percutaneous protection. Both components support general soldier requirements such as the Army's 21st Century Land Warrior Concept and specialized applications for the Navy and Air Force. Advanced filtration technologies and selectively agent-impermeable membranes will reduce individual performance degradation. Because of the high interest in providing protection against biological agents for both U.S. forces and their supporting civilian infrastructure in global force projection, initiatives will examine the feasibility of using lightweight, disposable biological masks against such hazards. The key to effective individual protection relies on accurate detection, identification, and warning so forces know when to assume the appropriate protective posture.

Collective Protection. The collective protection technology base efforts seek to maintain protection against current threats and add protection against future threats. At the same time, collective protection technology efforts seek to reduce logistical burdens through the development of improved filter materials with longer useable lifetimes. Collective protection efforts focus on: (1) improvements to current reactive-adsorptive materials, (2) advanced non-reactive filtration processes, (3) advanced reactive filtration, (4) regenerable filtration processes for NBC protection of military vehicles, aircraft, ships, shelters, and buildings, and (5) a reduced logistics burden.

Decontamination. Decontamination is defined as the process of removing or neutralizing from a surface the hazard resulting from a chemical or biological agent attack. The objective of decontamination technology efforts is to develop methods which are effective, environmentally safe, react with chemical agents or disinfect biological agents, and do not affect the operational effectiveness of the surface or equipment being decontaminated. Current decontamination materials are caustic and rely heavily on water, and methods for decontamination cannot currently be used to decontaminate large critical areas such as sea or air ports of debarkation or the interiors of sea or air transport vehicles. An effective decontaminant for electronic components is a critical shortfall. Critical studies are needed to define the decontamination technology issues which must be addressed as part of the national global force projection and our ability to deploy to two potentially contaminated MRCs simultaneously.

Medical Protection. Medical protection consists of three primary functions: (1) pre-exposure preventative measures, (2) post-exposure treatment, and (3) diagnostic capabilities. These functions are applied to defense against chemical and against biological threats. Technology efforts will provide a number of medical products for preventing illness or soldier degradation when percutaneous or aerosol chemical agents or biological agents are used on the battlefield. For soldiers exposed to these agents, a number of initiatives will seek to reduce the lethality/incapacitation effects of BW agents and reduce the time requirement to return to duty. Current technologies only provide partial protection against a number of percutaneous or inhaled chemical agents, and only a limited number of vaccines are available against biological agents. In addition, there are some treatments for exposure to a limited number of biological agents.

b. Counterforce

Execution of successful counterforce missions against WMD and WMD-related facilities while minimizing the potential for collateral effects requires improvements in: (1) the identification and characterization of targets, (2) attack planning and execution, including the development of automated planning tools and procedures and all weather attack capability, (3) probability of kill and battle damage assessment (BDA), and (4) assessment and minimization of collateral damage/hazards. While these operational capability elements are not unique to the counterforce mission, their application to WMD-related targets requires specific functional capabilities and the application of specialized technologies.

3. Functional Capabilities

Figure IV.L.2 shows the functional capabilities required to produce the passive defense and counterforce operational capability elements.

4. Current Capabilities, Deficiencies, and Barriers

Figure IV.L.3 presents the key technologies that are needed to overcome limitations and to enable achievement of the requisite functional and operational capability elements in the realm of counterproliferation.

a. Passive Defense

For (non-medical) individual protection, the technological issues are: (1) the development of materials and environmental systems which provide reduced heat and other stress burdens on the soldier, and are more selective in precluding transport of agents across the ensemble barrier, but at the same time pass heat and perspiration, (2) providing clear criteria for dexterity and mobility requirements, and (3) providing masks which can be adapted to a number of specialized aircrew applications.

For collective protection, the technological issues are: (1) the development of longer lifetime filters/filter materials for collective protection shelters, and (2) the development of regenerative filter processes and materials.

For decontamination, the technological issues are: (1) the development of a less corrosive, non-aqueous based decontamination material, (2) the development of technologies for dissemination of decontaminants over large surface areas such as sea and airports, (3) providing technologies for decontamination for sensitive closed areas (such as cargo holds or ship compartments) and sensitive equipment (such as electronics and avionics), and (4) developing reactive materials for self-decontamination.

For medical protection, the technological issues are: (1) the development of vaccines against remaining threat list biological warfare agents, (2) the development of FDA-acceptable testing protocols for vaccines to determine vaccine efficacy using non-human subjects, (3) the development of improved topical skin decontamination material, and (4) the development of prophylaxes against nerve and blood agents.

Functional Capabilities / Operational Capability Elements	Passive Defense: Chemical/Biological Detection (*See also Chapter IV-J*)	Passive Defense: Individual Protection	Passive Defense: Collective Protection	Passive Defense: Decontamination	Passive Defense: Medical Protection	Active Defense: ***See Chapter IV-D Joint Theater Missile Defense***	Counterforce: Timely Target ID & Characterization	Counterforce: Prompt Attack Planning & Execution	Counterforce: Reliable Kill/BDA	Counterforce: Minimal Collateral Effects
Passive Defense										
1. Common IPE design		●								
2. Reduced performance degradation		●								
3. Integration/Compatibility w/equipment		●	●							
4. Regenerable filtration		●	●							
5. Reduced weight, cube, and power req			●							
6. Non-corrosive, non-aqueous decontaminant				●						
7. Sensitive equipment decon				●						
8. Large Area Decon				●						
9. Nerve agent pre-treatment/therapy					●					
10. Ant-seizure therapy					●					
11. Reactive topical skin protectant					●					
12. Nerve agent field diagnosis					●					
13. Cyanide prophylaxes					●					
14. Immunization against aerosol threats					●					
15. Bio-multivalent vaccines					●					
16. Bio vaccines					●					
17. Rapid bio diagnostic kits					●					
Counterforce										
18. ID and Characterization Sensors							●	○	○	●
19. WMD Mission Planning Tools							○	●	●	●
20. Sensor Data Fusion							●	○	○	●
21. WMD Prolif. Path Prediction							○	○		
22. Real-Time Weather Data & Forecasts							●	●		●
23. Collateral Effects Prediction							○	●	○	●
24. Enhanced Penetrating Munitions								●	●	●
25. Enhanced Lethality Warheads								●	●	●
26. Agent Defeat Warheads								●	●	●
27. Hard Target Smart Fuzing								●	●	●
28. All Weather Guidance								●	●	●
29. BDA Sensors									●	

● Strong support ○ Moderate Support

Figure IV.L.2. Functional Capabilities Needed for Counterproliferation

b. Counterforce

The current counterproliferation counterforce capabilities are limited to above-ground and slightly buried (relatively soft) WMD facilities with little capability to minimize collateral effects other than through attempting functional denial while avoiding direct attack against any WMD material. This functional denial capability is very dependent on full characterization of the WMD target complex, which for underground structures is almost impossible unless there are very detailed and highly reliable human intelligence sources. When WMD material is attacked, the resulting collateral effects prediction capabilities are useable with existing hazard prediction codes only under moderate weather conditions and only with a small set of WMD material types and storage conditions.

CINC counterproliferation priorities can be directly linked to enhancements in the four counterproliferation counterforce operational capabilities as listed in this Joint Warfighting S&T Plan. The technology barriers to each counterproliferation counterforce operational capability element, their associated goal(s), functional capability, limitations, and needed technologies are addressed in Figure IV.L.3 and discussed below.

Timely target identification and characterization. WMD development can be masked by commercial chemical and pharmaceutical processes, medical and biological research, and nuclear power generation. In addition, WMD activities can be hidden in underground structures that include hardened facilities. Specialized proliferation path prediction tools, sensors, and sensor data fusion techniques are required to identify and characterize WMD targets sufficiently to allow the selection of appropriate counterforce options.

Prompt attack planning and execution. The efficient planning and execution of attacks against WMD targets requires specialized target planning tools to best address the warfighter's damage criteria while minimizing the associated collateral effects. Accurate estimation of potential collateral effects against both combatants and non-combatants resulting from attacks against WMD targets plays a unique role in the warfighter's decision process of when and how to attack these targets. In addition, the high priority of WMD related targets requires all-weather guidance to meet the warfighter's need to attack whenever he/she chooses.

Reliable kill and BDA. The reliable kill of underground and hardened WMD facilities while minimizing collateral effects requires enhanced penetrating munitions with warheads that have enhanced lethality and agent defeat/neutralization characteristics. Penetrating munitions also require a smart, programmable, hard target fuzing capability to ensure detonation at precise depths, and precision guidance to provide detonation-point accuracy. In addition, physical attacks on underground structures require special BDA sensors that provide confidence in functional damage assessments.

Minimize collateral effects. The minimization of collateral effects and the understanding of the hazards associated with the WMD materials released requires specialized tools that can reliably predict appropriate weather (mainly winds) over actual terrain and accurately predict the transport of WMD materials due to the weather conditions. It also involves the understanding of lethality aspects of the numerous chemical, biological and nuclear hazards.

Goal	Functional Capability	Limitations	Needed Technologies
Detection/Identification of CB Agents (see Figure IV.J.3)			
Operational Capability Elements: Individual (Non-Medical) Protection			
Protect force from C/B contamination and ensure ability to sustain operations and accomplish mission in a C/B contaminated environment	1. Common individual protection equipment (IPE) design and material for Services' applications with modular adaptation for ground, sea, and air. (Same system– different packages.) 2. Reduced performance degradation. 3. Assure integration and compatibility with future equipment	1. Significant improvements in respiratory protection not likely in near future without a material (filter) break-through or using a powered system 2. Ability to satisfy final performance goals may require multiple systems and/or power as in case of thermal degradation 3. Full definition of the 21st Century Land Warrior is needed to satisfy future compatiblity requirements 4. Attempting to use one mask for all joint service missions may result in performance reductions for some missions 5. Mission requirements for weight, protection, and launderability force trade-offs. No single material fulfills all requirements currently 6. Requirements for protection and tactility for gloves force trade-offs 7. Promising materials for percutaneous protection do not meet affordability requirements. Unsuitable for mass production	1. New concepts in respiratory protection: enhanced protection studies. Material and composite technologies 2. Protective system integration and analysis: quantify mission performance; performance testing; performance models for predicting current and future equipment 3. Protective material and test technologies: improve test methodology for protection assessment. Improve aerosol stability. Investigate effects of different aerosol sizes on protection 4. New/improved filtration systems: develop engineered adsorbent – superactivated adsorbents and polymeric adsorbents. New catalytic systems will be developed. Improved particulate filtration technologies 5. Focus on the unique operational aspects of the marine environment, such as firefighting/damage control, flight deck operations, and high-intensity SPECWARS operations 6. Selectively-permeable materials for percutaneous protection 7. Various reactive and non-reactive lightweight materials and membranes for protection against all identified C/B hazards 8. Novel elastomers for overboot protection
Operational Capability Elements: Collective Protection			
Ensure ability to sustain operations and accomplish mission in a C/B contaminated environment	4. Regenerable (catalytic) filtration to reduce logistics burden while increasing protection factor 5. Reduce weight, cube, and power requirements	8. Limited basic research funding to understand link between physical and adsorptive properties of various materials in order to predict and optimize filtration performance 9. No adequate means to measure filter life in the field 10. No clearly defined requirements for collective protection	9. Reactive-adsorptive materials 10. Advanced non-reactive filtration processes 11. Advanced reactive filtration processes for NBC protection of military vehicles, aircraft, ships, shelters, and buildings 12. Regenerative filtration processes (pressure- and temperature-swing adsorption, PSA/TSA) 13. Embedded monitors 14. Plasma technologies 15. Catalytic Oxidation (CATOX)

Figure IV.L.3 Goals, Limitations, and Technologies for Counterproliferation

Goal	Functional Capability	Limitations	Needed Technologies
Operational Capability Elements: Decontamination			
Ensure ability to sustain operations and accomplish mission in a C/B contaminated environment	6. All-agent, non-corrosive less labor-intensive decon capability 7. Decontaminant suitable for aircraft, ship, and vehicle interiors, and sensitive items 8. Determine requirements for large area decon	11. Current decontaminant (DS2) is effective in chemical decontamination, yet has a surface corrosive effect 12. Limited assessments have been made to determine scope of problems associated with large area decontamination (LAD). Consequently, there are no formal requirements for LAD 13. Environmental and safety requirements limit choice of decontaminants 14. Assessment of methods and technologies to decon compartment interiors needed	16. Non-corrosive, non-aqueous decontaminant for field/equipment 17. Environmentally safe decon of electronic and sensitive equipment 18. Sorbent decon 19. Large area decontaminant dissemination techniques and technologies 20. Surface Raman Spectrometer to monitor decon 21. Quaternary Ammonium Complexes 22. Enzymatic decontaminants
Operational Capability Elements: Medical Chemical Defense			
Maintain technological capability to meet present requirements and counter future threats. Provide individual-level prevention and protection to preserve fighting strength. Provide medical management of chemical casualties to enhance survival and expedite and maximize return to duty	9. Nerve agent pretreatment and therapy 10. Antiseizure therapy 11. Advanced development of topical skin protection 12. Advanced development of nerve agent field diagnosis 13. Advanced development of cyanide prophylaxis	15. Need expansion of chemical/biological medical training program 16. Advanced product development and FDA approval process for fielding of chemical products 17. Current downsizing and monetary restrictions 18. Integration of DoD/Triservice needs (better joint coordination and representation	23. Vesicant and respiratory agent therapy 24. Advanced anticonvulsant 25. Multichamber autoinjector 26. Reactive topical skin protectant 27. Topical optical treatment 28. Catalytic scavenger treatment for chemical agents 29. Rapid field diagnostics
Operational Capability Elements: Medical Biological Defense			
Sustain effectiveness of U.S. Armed forces operating in a BW environment • To prevent casualties by use of medical countermeasures • To diagnose disease with forward deployable kits and confirmation assays, and • To threat casualties to prevent lethality, and to maximize return to duty	14. Aerosol immunization against biological threat agents 15. Multivalent vaccine against biological threat agents 16. Pretreatment against biological threat agents 17. Rapid diagnosis kits	19. FDA approval of Bio Agent vaccines using non-human models 20. Rapid stockpiling of vaccines identified by threat priority	30. Anthrax immunization prophylaxis 31. Botulinum toxin immunization 32. Smallpox immunization 33. Use of other commercially available vaccines if necessary, e.g., chlorea, plague, tularemia, Q-fever, encephalitis verus, etc. 34. Field-Deployable Diagnostic kits
Operational Capability Elements: Timely Target Identification and Characterization			
• Find and characterize WMD production, storage or related facilities that are on or below the ground (at shallow or moderate depth) • Find mobile missile launchers in hiding places or in transport • Find and characterize very hard or deeply buried underground WMD facilities to include tunnels	18. ID and characterization sensors 19. WMD mission planning tools 20. Sensor Data Fusion	21. Few sensor capabilities for finding either mobile missile launchers or buried WMD targets 22. Little exploitation of all source information to identify and describe WMD targets 23. Minimal real-time intelligence and targeting information for warfighters	35. Advanced SAR/radar imaging 36. Unattended Ground Sensors (UGS) with seismic, acoustic, electromagnetic, and NBC capabilities 37. Multi-sensor imaging 38. Remote BW/CW sensors 39. Low-cost & man-portable sensors 40. Microsensors 41. Real-time data fusion/integration 42. ATR and automated handling of massive data streams 43. Automated proliferation path analysis for critical node identification

Figure IV.L.3 Goals, Limitations, and Technologies for Counterproliferation (cont'd)

Goal	Functional Capability	Limitations	Needed Technologies
Operational Capability Elements: Prompt Attack and Planning			
• Develop operationally suitable, integrated, computerized force application recommendations with confidence bounds and collateral effects predictions/minimization for WMD targets	18. 19. 20. 21. WMD Prolif. path prediction 22. Real-time weather data & forecast 23. Collateral effects prediction	24. No decision aid to determine where in WMD development, production, and employment process counterforce attacks have highest probability of success and minimum collateral effects 25. No attack planning tools for WMD targets that select aimpoints, fuzing, and weapon types for a broad range of soft and hardened targets and that predict both structural response and collateral effects 26. No attack planning tools that permit optimization to minimize collateral effects for a broad range of WMD targets	44. Targeting calculation capabilities that include the following: - soft, bermed, cut-and-cover, and deeply buried targets - structural response and functional kills of internal equipment - restrike decisions based on BDA - tunnel portal and adit disruption - advanced conventional/ enhanced weapon payloads - optimization to minimize collateral effects - real-time weather data input
Operational Capability Elements: Reliable Kill/BDA			
• Acquire means to defeat WMD targets at times and under circumstances chosen by the U.S.	24. Enhanced penetrating munitions 25. Enhanced lethality warheads 26. Agent defeat warheads 27. Hard-target smart fuzing 28. All-weather guidance 29. BDA sensors	27. No available earth penetrator that can destroy deeply-buried or very hard WMD targets 28. No earth penetrator with payloads for BW/CW agent defeat or neutralization 29. Limited, highly accurate all weather delivery capability 30. No sub-surface BDA 31. No real-time all-source data fusion	45. Advanced penetrating weapons 46. Void-sensing, depth-sensing fuze 47. Highly accurate, all-weather guidance/delivery 48. Weapon-borne sensor to provide penetration/detonation history. 49. High temperature incendiary and BW/CW agent defeat payloads 50. Real-time all-source sensor data fusion
Operational Capability Elements: Minimal Collateral Effects			
• Develop an operationally suitable, integrated all-weather WMD source/transport/effects prediction capability for effects on military forces and civilian populations resulting from 1)accidental release from WMD facility, 2)enemy use of WMD weapon, or 3)US attack on WMD weapon or facility. • Develop means to minimize collateral effects resulting from US attack on WMD facility or weapon	19. 20. 21. 22. 23. 26. 27. 28. 29	32. No integrated, automated and validated NBC hazard prediction tools for wide-ranging WMD targets and U.S. weapons 33. No sensors and tools able to provide detailed equipment, enemy WMD weapons, and WMD facility characterization 34. No special weapons that achieve functional kill while minimizing NBC release	51. Accurate models for expulsion of NBC materials 52. High-resolution in-theater real-time weather data and forecasts 53. Accurate models for terrain effects on transport of NBC models 54. Lethality assessment of dispersed NBC materials 55. Targeting methods and advanced weapons to minimize expulsion of NBC materials 56. Sensors and tools for WMD facility, equipment, and enemy WMD weapon characterization 57. Real-time all-source sensor data fusion

Figure IV.L.3 Goals, Limitations, and Technologies for Counterproliferation (concluded)

5. Technology Plan

Technology demonstrations and joint field trials provide a means for the rapid field testing of technical options to solve operational needs. Figure IV.L.4 illustrates how these demonstrations support the passive defense and counterforce joint warfighting capability. Figure IV.L.5 shows the Defense Technology Objectives (DTOs) which, when attained, will enable the operational capability elements. Figure IV.L.6 shows the demonstration support of operational capability elements. Each DTO is described in Appendix B and their relationships are plotted in the technology roadmap, Figure IV.L.7.

6. Summary

Figure IV.L.8 notionally shows the progress over time as each DTO is achieved.

a. Passive Defense

Science and technology efforts in passive defense provide the basis for significant advances in protecting U.S. forces from C/B threat and support the #1, #6, #7, and #8 priorities of the CINC/JROC Counterproliferation JWCA. Passive defense must integrate all the operational capability elements (C/B detection, force protection, and decontamination) to provide an effective warfighting capability in a contaminated environment. Figure IV.L.8. provides a notional path showing how each DTO will contribute toward the overall joint warfighting capability. Achieving these objectives will ensure that the warfighter is equipped with state-of-the-art technologies and does not face the same deficiencies encountered during Operation Desert Storm when threatened by future adversaries.

b. Counterforce

The Counterproliferation I and II ACTDs are being conducted in multiple phases. This allows planning, execution, and assessment to be accomplished with current capabilities against defeatable WMD targets now and to expand capabilities and potential target sets to finally address all WMD facilities with minimal and predictable collateral damage.

The Counterproliferation I ACTD (DTO L03) consists of the first two phases. Phases III through V are included in the Counterproliferation II ACTD (proposed). These last three phases involve advanced weapons and employment capabilities to minimize collateral effects by avoiding the release of, or neutralizing chemical and biological agents.

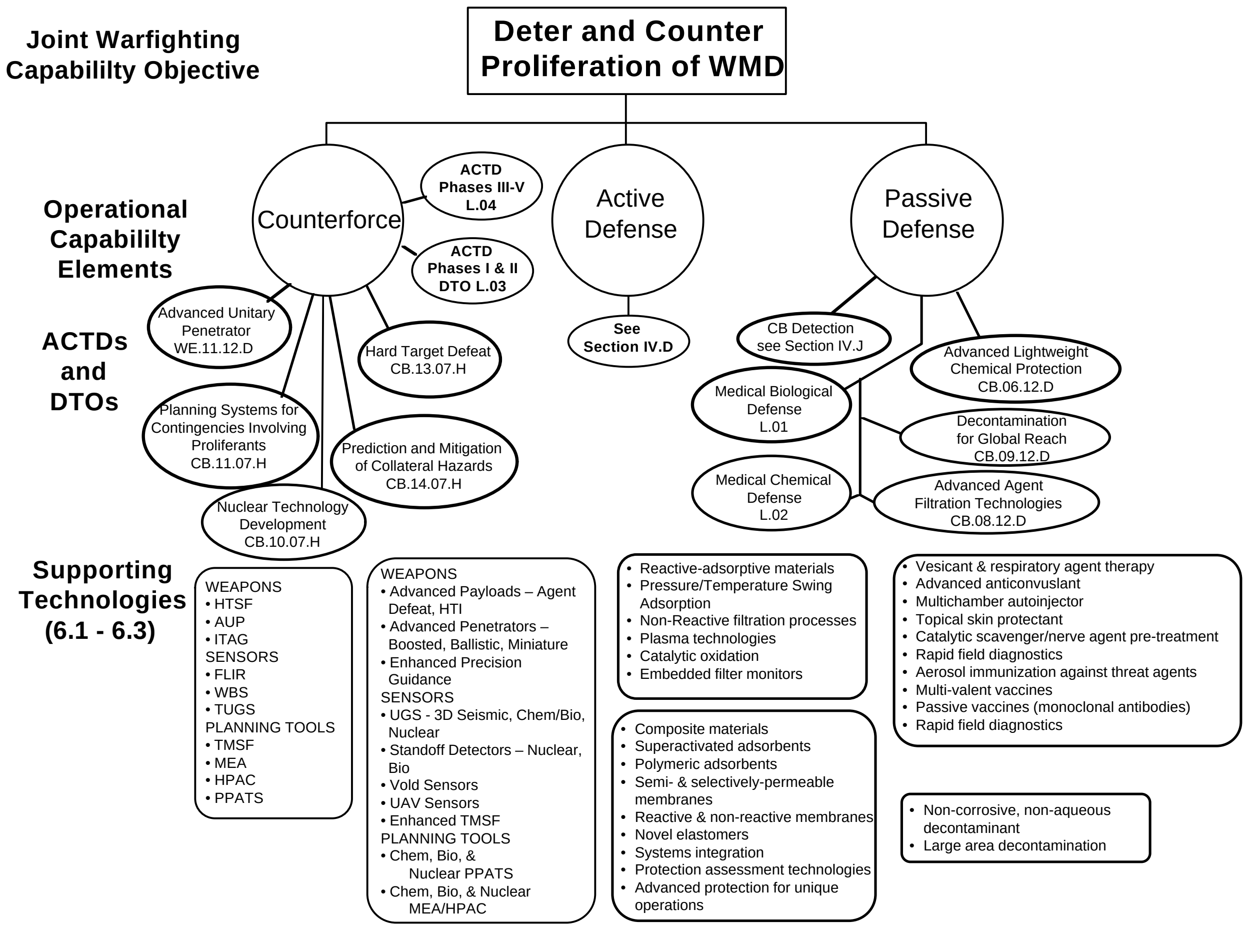


Figure IV.L.4 Technology to Capability -- Counterproliferation

DTO #	Title
L.01	**Passive Defense** Medical Biological Defense
L.02	Medical Chemical Defense
CB.06.12.D	Advanced Lightweight Chemical Protection
CB.08.12.D	Advanced Agent Filtration
CB.09.12.D	Decontamination for Global Reach
L.03	**Counterforce** Counterproliferation I ACTD (Technologies to defeat shallow-buried biological and chemical weapon storage and production facilities)Decontamination for Global Reach
L.04	Counterproliferation II ACTD (Technologies to defeat an expanded WMD target set including surface, mobile, and deeply buried targets)
CB.10.07.H.	Nuclear Technology Development
CB.11.07.H	Planning Systems for Contingencies Involving Proliferants
CB.13.07.H	Hard Target Defeat
CB.14.07.H	Prediction and Mitigation of Collateral Hazards
WE.11.12.D	Advanced Unitary Penetrator (AUP)

Figure IV.L.5. Defense Technology Objectives – Counterproliferation

Demonstration Title	Operational Capability: Passive Defense — CB Detection (See Section IV-J)	Passive Defense — Individual Protection	Passive Defense — Collective Protection	Passive Defense — Decontamination	Passive Defense — Medical Protection	Counterforce — Timely Target ID & Characterization	Counterforce — Prompt Attack Planning & Execution	Counterforce — Reliable Kill/BDA	Counterforce — Minimal Collateral Effects	Active Defense (See Section IV-D Joint Theater Missile Defense)	Service/Agency	Demonstration is a: DTO	ACTD	ATD
Passive Defense Advanced Lightweight Chemical Protection		●									D	CB.06.12.D		
Advanced Agent Filtration		●	●		○						D	CB.08.12.D		
Decontamination for Global Reach				●					○		D	CB.09.10.D		
Medical Biological Defense (ATD equivalent)					●						D	L.01		X
Medical Chemical Defense (ATD equivalent)					●						D	L.02		X
Counterforce ACTD Phases I & II, Target and Defeat Shallow-Buried WMD Facilities						●	●	●	●		DNA	L.03	X	
ACTD Phases III-V, Target and Defeat Surface, Mobile, and Deeply Buried WMD Target						●	●	●	●		DNA	L.04	X	
Nuclear Technology Development						●		●	●		DNA	CB.10.07.H		
Planning System for Contingencies							●				DNA	CB.11.07.H		
Hard Target Defeat						●		●			DNA	CB.13.07.H		
Prediction and Mitigation of Collateral Hazards									●		DNA	CB.14.07.H		
Advanced Unitary Penetrator								●			DNA	WE.11.12.D		

● = Strong Support ○ = Moderate Support

Figure IV.L.6 Demonstration Support—Counterproliferation

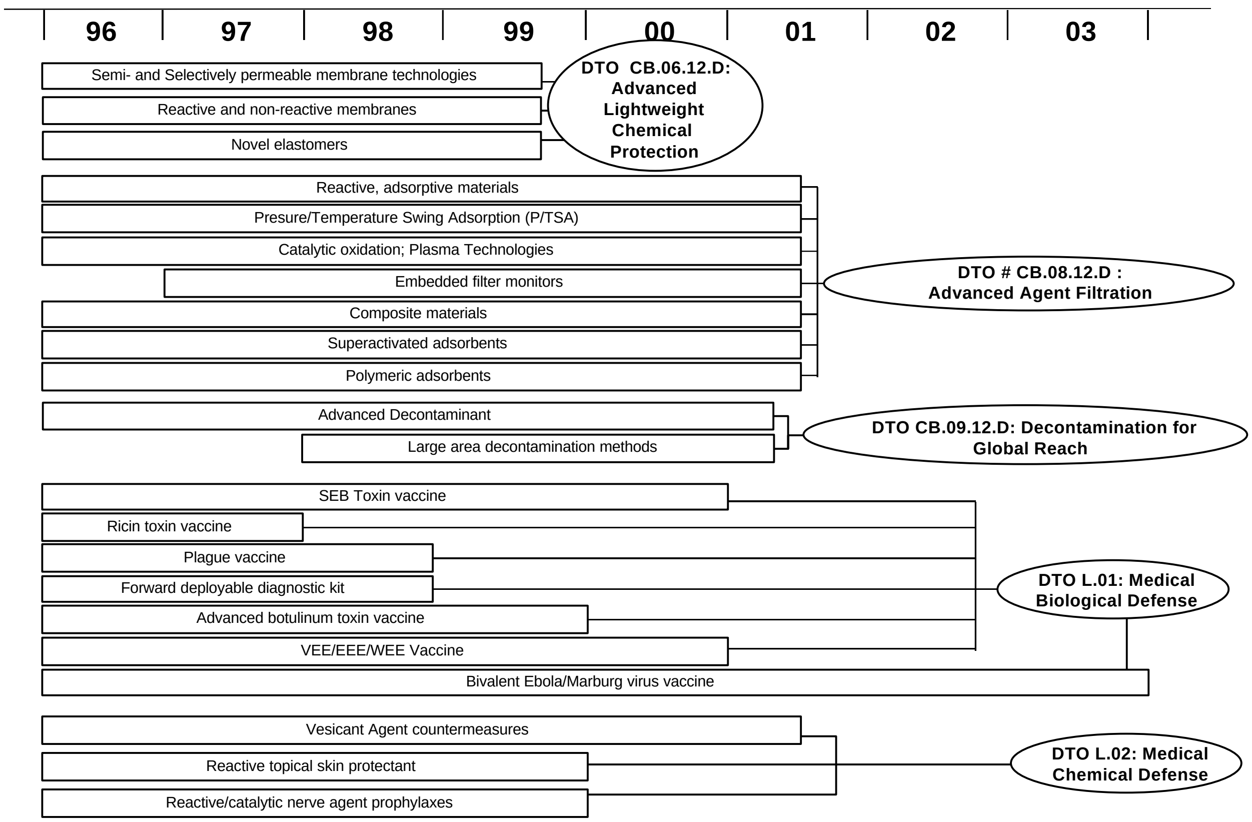


Figure IV.L.7.a. Roadmap-Counterproliferation (Passive Defense)

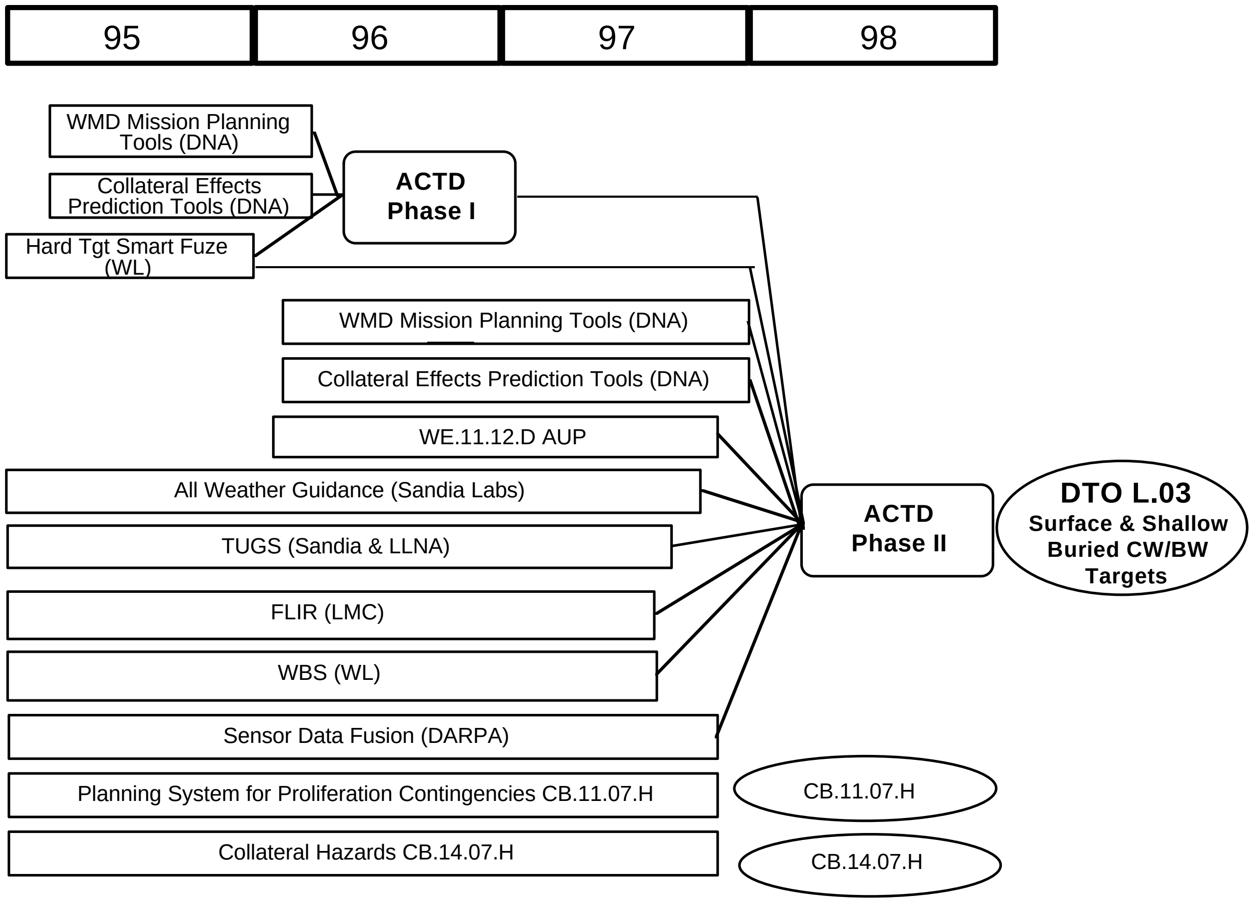


Figure IV.L.7.b. Roadmap Counterproliferation (Counterforce)

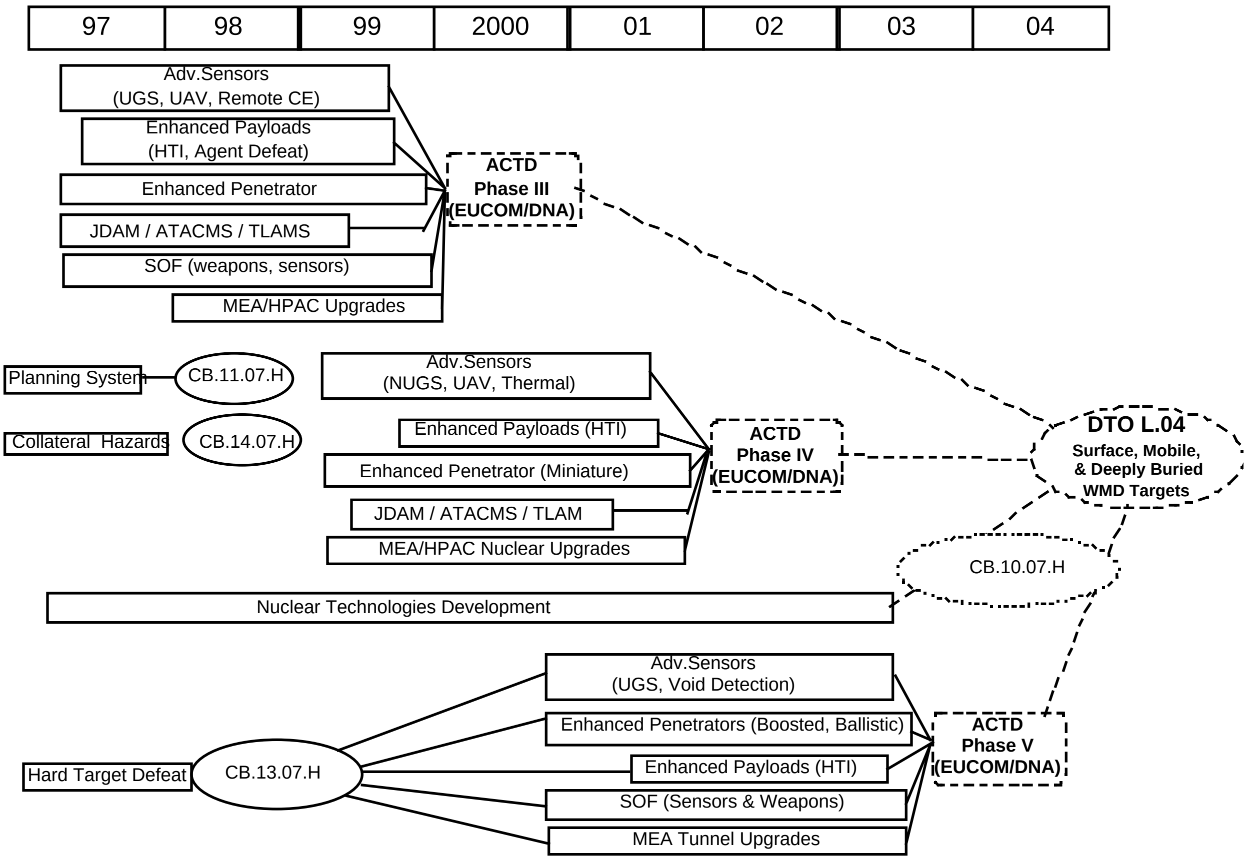


Figure IV.L.7.b. Roadmap Counterproliferation (Counterforce) (cont'd)

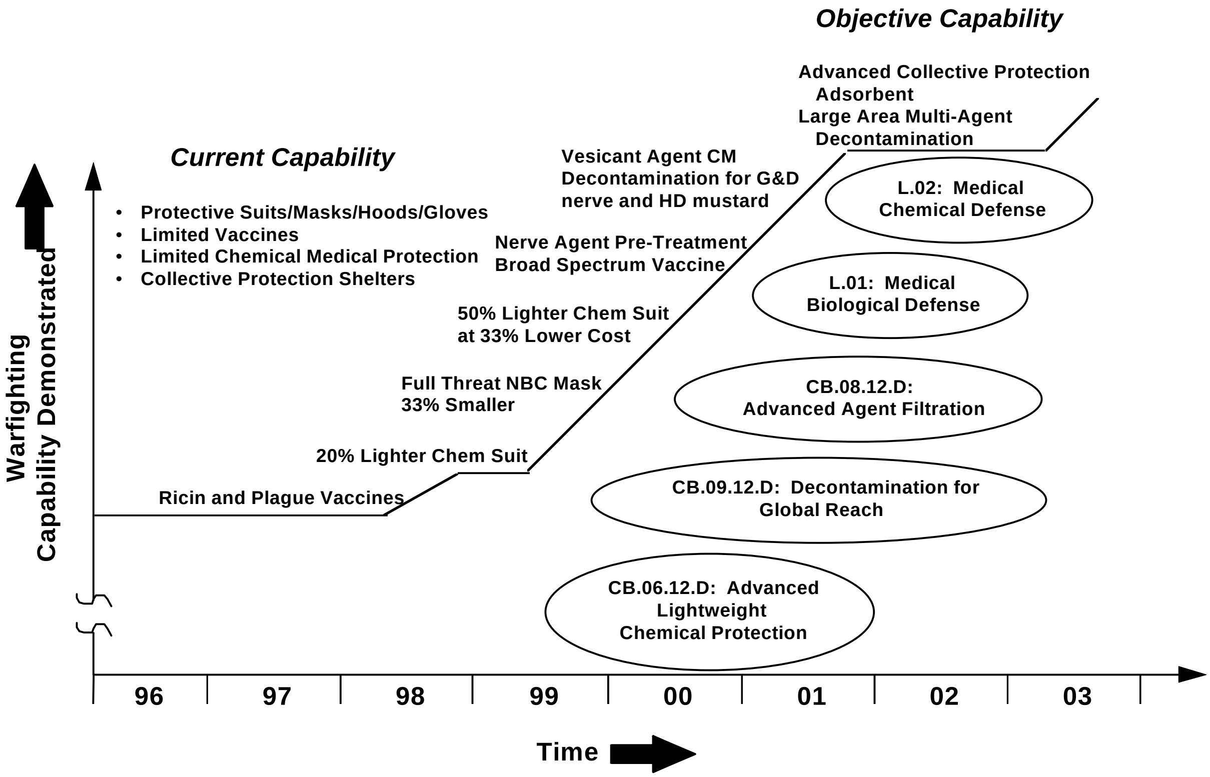


Figure IV.L.8.a. Progress—Counterproliferation (Passive Defense)

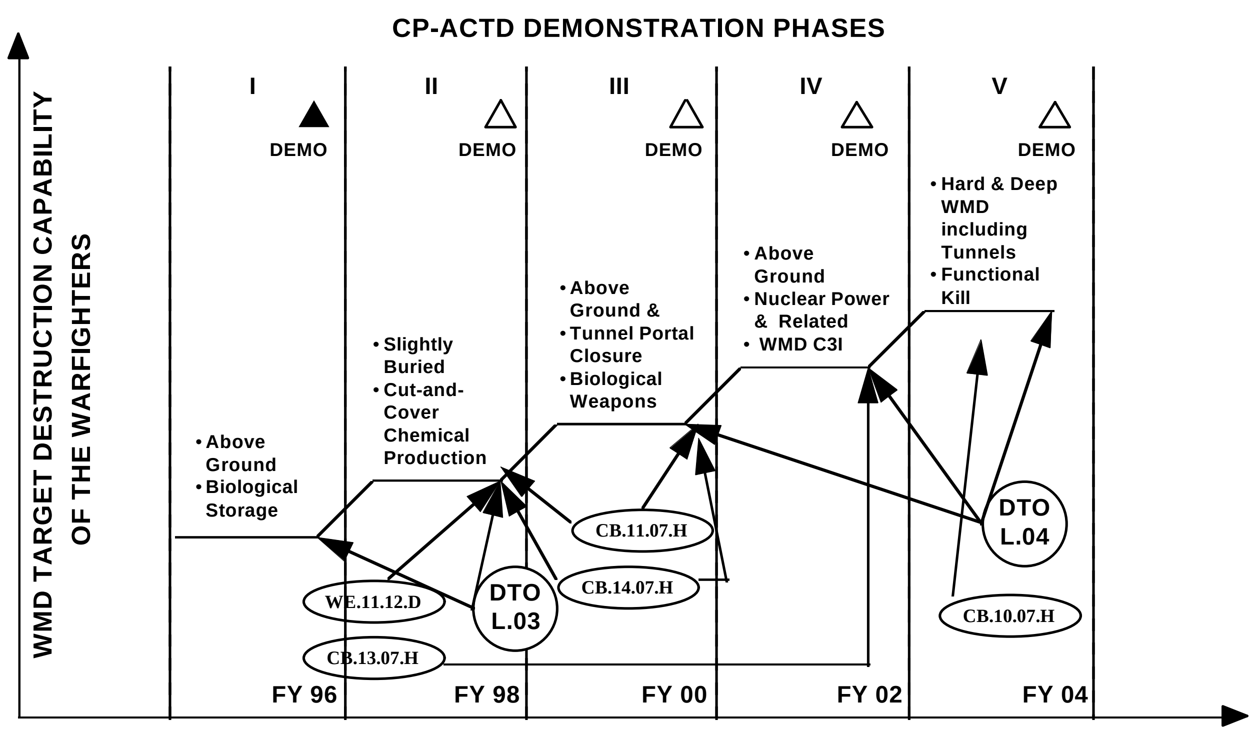


Figure IV.L.8.b. Progress—Counterproliferation (Counterforce)

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GLOSSARY

21CLW	21st Century Land Warrior
3D	Three Dimensional
A/C	Aircraft
ABIS	Advanced Battlespace Information Systems
ABL	Airborne Laser
ACTD	Advanced Concept Technology Demonstration
ADS	Advanced Distributed Simulation
AF	Air Force
AFEMIS	Air Force Equipment Management Information System
AFLIF	Air Force Logistics Information File
AGTFT	Anti-jam GPS Technology Flight Test
AI	Artificial Intelligence
AIT	Automated Identification Technologies
AI2	Advanced Image Intensifier
AJP	Advanced Joint Planning
ALISS	Advanced Light-weight Influence Sweep System
AMC	Army Materiel Command
AMMOLOGS	Ammunition Logistics System
AMMT	Advanced Minehunting and Mapping Technologies
AOC	Air Operations Center
AP	Armor Piercing
ASCIET	All Service Combat Identification Evaluation Team
ASCM	Anti-Ship Cruise Missile
ASD(AE)	Assistant to the Secretary of Defense (Atomic Energy)
ASRN	Autonomous Surveillance/Reconnaissance Networks
ATAC	Advanced Traceability and Control
ATACMS	Advanced Tactical Missile System
ATAV	Army Total Asset Visibility
ATD	Advanced Technology Demonstration
ATLASS	Asset Tracking Logistics and Supply System
ATM	Asynchronous Transfer Mode
ATR	Automatic Targeting Radar; Automatic Target Recognition

AUP	Advanced Unitary Penetrator
B	Biological
BADD	Battlefield Awareness and Data Dissemination
BCIS	Battlefield Combat Identification System
BDA	Battle Damage Assessment
BFV	Bradley Fighting Vehicle
BM	Ballistic Missile
BMDO	Ballistic Missile Defense Organization
BMT	Ballistic Missile Technology
BRP	Basic Research Plan
BW	Biological Weapon
C	Chemical
C&C	Cut and Cover
C/B	Chemical and Biological
C2	Command and Control
C2W	Command and Control Warfare
C3	Command, Control, and Communications
C3I	Command, Control, Communications, and Intelligence
C4	Command, Control, Communications, and Computers
C4I	Command, Control, Communications, Computers, and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAC2	Combined Arms Command and Control
CAIMS/OMMS	Conventional Ammunition Integrated Management System
CAPI	Cryptographic Application Programming Interfaces
CAPS-II	Consolidated Aerial Port System II
CAS	Close Air Support
CAS-A	Combat Ammunition System (Wholesale Level)
CASTFOREM	Combined Arms Support Task Force Evaluation Model
CATOX	Catalytic Oxidation
CBC2	Context-Based Command and Control
CID	Combat Identification
CIMMD	Close-In Man Portable Mine Detector
CINC	Commanders-in-Chief
CJCS	Chairman, Joint Chiefs of Staff
CJTF	Commander, Joint Task Force
CM	Cruise Missile

CMOS	Cargo Movement Operations System
COA	Course of Action
COBRA	Coastal Battlefield Reconnaissance and Analysis
CONOPS	Concept of Operations
COTS	Commercial Off-the-Shelf
CP	Counterproliferation
CW	Chemical Weapon
DAAS	Defense Automated Addressing System
DARPA	Defense Advanced Research Projects Agency
DBK	Dominant Battlespace Knowledge
DDRE	Director of Defense Research and Engineering
DEPRA	Defense Program for Redistribution of Assets
DIAL	Differential Absorption of Light
DIRCM	Directional Infrared Countermeasures
DIS	Distributed Interactive Simulation
DISC	Differential Scattering
DISN	Defense Information Systems Network
DIW	Detection, Identification, and Warning
DLA	Defense Logistics Agency
DMSO	Defense Modeling and Simulation Organization
DNA	Defense Nuclear Agency
DOB	Depth of Burst
DoD	Department of Defense
DSB	Defense Science Board
DSS	Distribution Standard System
DSSC	Direct Support Stock Control
DSTAG	Defense S&T Advisory Group
DTAP	Defense Technology Area Plan
DTAV	Defense Total Asset Visibility Program
DTO	Defense Technology Objective
DUSD(AT)	Deputy Undersecretary of Defense (Advanced Technology)
EA	Electronic Attack
ECM	Electronic Countermeasures
EMI	Electro-Magnetic Interference
EN	Explosive Neutralization
EO	Electro-Optics
EP	Electronic Protection

ES	Electronic Support
ESAI	Enhanced Situation Awareness Insertion
ESM	Electronic Support Measures
EUCOM	European Command
EW	Electronic Warfare
FACs	Forward Air Controllers
FDA	Food and Drug Administration
FLIR	Forward Looking Infrared Radar
FO/FAC	Forward Observer/Forward Area Controller
FTIR	Fourier Transform Infrared
FY	Fiscal Year
FYDP	Future Years Defense Plan
GBS	Global Broadcast System
GPS	Global Positioning System
GTN	Global Transportation Network
HF	High Frequency
HMD	Helmet Mounted Display
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HPAC	Hazard Prediction Analysis Capability
HPM	High Powered Microwave
HTI	High Temperature Incendiary
HTSF	Hard Target Smart Fuze
IADS	Integrated Air Defense System
ID	Identification (Friend or Foe)
IFD	Interim Feasibility Demonstrations
IFF	Identification Friend or Foe
IMINT	Imagery Intelligence
IMS	Ion Mobility Spectroscopy
INFOSEC	Information Systems Security
IOC	Initial Operating Capability
IP	Internet Protocol
IR	Infrared
IRCM	Infrared Countermeasures
IS	Information Superiority
ISR	Intelligence, Surveillance, and Reconnaissance

ITAG	Inertial Terrain-Aided Guidance
IW	Information Warfare
IW BDA	Information Warfare Battle Damage Assessment
IW-D	Defense Information Warfare
IW-O	Offensive Information Warfare
IW-P	Information Warfare-Protect
Javelin	Medium Range Anti-Tank Missile (2 km Dragon replacement)
JAMC	Joint Amphibious Mine Countermeasures
JBPDS	Joint Biological Point Detection System
JBREWS	Joint Biological Remote Early Warning System
JCM	Joint Countermine
JCOS	Joint Countermine Operational System
JCS	Joint Chiefs of Staff
JDAM	Joint Defense Attack Munition
JNBCRS	Joint Service Reconnaissance System
JPO-BD	Joint Program Office for Biological Defense
JROC	Joint Requirements Oversight Council
JSAWM	Joint Service Agent Water Monitor
JSCMAD	Joint Service Chemical Miniature Agent Detector
JSCWILD	Joint Service Chemical Warning and Identification LIDAR Detector
JSIMS	Joint Simulation System
JSLSCAD	Joint Service Lightweight Standoff Chemical Agent Detector
JSSAP	Joint Service Small Arms Program
JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
JTMD	Joint Theater Missile Defense
JTR	Joint Training Readiness
JWARN	Joint Warning and Reporting Network
JWCA	Joint Warfighting Capability Assessment
JWCO	Joint Warfighting Capability Objective
JWDTO	Joint Warfighting Defense Technology Objective
JWE	Joint Warfighting Experiment
JWID	Joint Warfare Interoperability Demonstrations
JWIP	Joint Warfighting Integration Program
JWSTP	Joint Warfighting Science and Technology Plan
kHz	Kilohertz

LAD	Large Area Decontamination
LAD	Logistics Anchor Desk
LADAR	Laser Radar
LAV	Lightly Armored Vehicle
LES	Leading Edge Services
LIDAR	Light (Laser) Detection and Ranging
LIF	Logistics Intelligence File
LIPS	Logistics Information Processing System
LINK	Logistics Information Network
LLNL	Lawrence Livermore National Labs
LRS	Littoral Remote Sensing
LSTAT	Life Support
M&S	Modeling and Simulation
M/S	Multispectral
MALD	Miniature Air Launched Decoy
MAGTF II	Military Assistance Group Task Force - II
MASS	MICAP Asset Sourcing System
MCMIA	Mine Countermeasures Integration and Automation
MEA	Mission Effectiveness Analysis
MITES	Mobile Intelligent Targeting Elements
MITL	Man-in-the-Loop
MLS	Multi-Level Security
MMIC	Monolithic Microwave Integrated Circuit
MOBA	Military Operations in Built-Up Areas
MOE	Military Measures of Effectiveness
MOUT	Military Operations in Urban Terrain
MPIM	Multipurpose Individual Munition
MPM	Microwave Power Module
MRC	Major Regional Conflicts
MRL	Multiple Rocket Launcher
MUMMS	Marine Corps Unified Material Management System
MURI	Multi Disciplinary University Research Initiative
NBC	Nuclear, Chemical, and Biological
NL	Non-Lethal
NRT	Near Real Time
NTM	National Technical Means
NTACMS	Navy Tactical Missile System/Mine Countermeasures

NUGS	Nuclear Unattended Ground Sensors
OCSW	Objective Crew Served Weapon
OICW	Objective Individual Combat Weapon
OOTW	Operations Other Than War
OPLAN	Operations Plan
OPSEC	Operational Security
OS	Operating System
OSD	Office of the Secretary of Defense
PE	Program Element
POM	Program Objective Memorandum
PPATS	Proliferation Path Analysis
PRCMRL	Precision Rapid Counter Multiple Rocket Launcher
PSA/TSA	Pressure- and Temperature-Swing Adsorption
PSM	Personnel Status Monitor
PSTS	Precision SIGINT Targeting
RAAP	Rapid Application of Air Power
RAMICS	Remote Airborne Mine Clearance System
REMIS	Reliability and Maintainability Information System
RF	Radio Frequency
RFPI	Rapid Force Projection Initiative
RFTECH	Radio Frequency Technology
S&T	Science and Technology
S/D	Self Defense
S/W	Software
SA	Situation Assessment/Awareness
SALTS	Streamlined Automated Logistics Transmission System
SAMMS	Standard Automated Material Management System
SARDB	Survivable Armed Reconnaissance on the Digital Battlefield
SARSS-O	Standard Army Retail Supply System-Objective
SASSY	Supported Activity Supply System
SAW	Surface Acoustic Wave
SBSS	Standard Base Supply System (AF)
SCS	Stock Control System
SEAD	Suppression of Enemy Air Defenses
SEDRE	Sea Emergency Deployment Readiness Exercises

SIGINT	Signal Intelligence
SNAP	Ship Non-Tactical ADP Program (Navy)
SOCOM	Special Operations Command
SOF	Special Operations Forces
SOJ	Standoff Jamming/Jammer
SOLIC	Special Operations – Low Intensity Conflict
SORTS	Status of Resources and Training
STOW	Synthetic Theater of War
STRADIS	Simulation and Training Aide for the Dismounted Soldier
STS	Sensor to Shooter
SUO	Small Unit Operations
TACAIR	Tactical Aircraft
TAP	Technology Area Plan
TARA	Technology Area Review and Assessments
TCAIMS	Transportation Coordinator Automated Information Management System
TD	Technology Demonstration
TEED	Tactical End-End Encryption Device
TERMS	Terminal Management System
TFXXI	Task Force XXI
TLAMS	Tactical Land Attack Missile System
TMD	Theater Missile Defense
TMSF	Tactical Multi-Sensor Data Fusion
TMS	Transportation Management System
TUGS	Tactical Unattended Ground Sensors
U.S.	United States
UAV	Unmanned Aerial Vehicle
UGS	Unattended Ground Sensors
UGV	Unmanned Ground Vehicle
UHF	Ultra High Frequency
UICP	Uniform Inventory Control Point
UJTL	Universal Joint Task List
USD(A&T)	Under Secretary of Defense (Acquisition and Technology)
UV	Ultraviolet (radiation)
VHF	Very High Frequency
VHSIC	Very High Speed Integrated Circuit
VIP	Very Important Person

VMISR	Virtual Master Stock Item Record
VMMD	Vehicle Mounted Mine Detector
VV&A	Verification, Validation, and Analysis
W	Watts
W/H	Warhead
WBS	Weapon Borne Sensor
WL	Wright Laboratories, Eglin AFB
WMD	Weapons of Mass Destruction
WPS	Worldwide Port System