ACTIVE SENSORS IN SUPPORT OF THE JOINT WARFIGHTING SCIENCE AND TECHNOLOGY PLAN

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1.0 Introduction

The *Joint Warfighting Science and Technology Plan (JWSTP)* is produced annually by the Office of the Secretary of Defense to provide defense guidance for the planners, programmers, and performers of defense S&T. It is one of four documents that presents the DoD's S&T vision, strategy, plan and objectives. The other documents are the *Defense Science and Technology Strategy*, the *Basic Research Plan*, and the *Defense Technology Plan*. The *Joint Warfighting Science and Technology Plan* serves to focus a portion of the DoD science and technology program on supporting future joint warfighting requirements. The plan supports achievement of the operational concepts cited in *Joint Vision 2010* and addresses a variety of new threats present in the national security environment.

The JWSTP represents a joint perspective taken horizontally across the applied research (6.2) and advanced technology development (6.3) plans of the services and defense agencies. The plan presents joint warfighting objectives, which identifies some of the most critical capabilities needed for maintaining the warfighting advantage of U.S. forces. In response to these objectives advanced concepts and technologies must be sought out and pursued to ensure that the U.S. maintains its technological superiority to operate across the broad spectrum of conflict decisively and with relatively low casualties. Advanced Concept Technology Demonstrations (ACTDs) exploit maturing technologies to solve important military problems.

Form SF298 Citation Data

Report Date *("DD MON YYYY")* 00001999	**Report Type** N/A	**Dates Covered (from... to)** *("DD MON YYYY")*

Title and Subtitle Active Sensors in Support of the Joint Warfighting Science and Technology Plan	**Contract or Grant Number**
	Program Element Number
Authors	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Deputy Undersecretary of Defense Advanced Systems and Concepts	**Performing Organization Number(s)**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Monitoring Agency Acronym**
	Monitoring Agency Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract	
Subject Terms	
Document Classification unclassified	**Classification of SF298** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** unlimited
Number of Pages 11	

2.0 ACTDs

A. Mission

A declining budget, significant changes in threats, and an accelerated pace of technology development have challenged our ability to adequately respond to rapidly evolving military needs. In addition, the global proliferation of military technologies, resulting in relatively easy access to these technologies by potential adversaries, has further increased the need to rapidly transition new capabilities from the developer to the user.

In early 1994, the DOD initiated a new program designed to help expedite the transition of maturing technologies from the developers to the users. The Advanced Concept Technology Demonstration (ACTD) program was to help the DOD acquisition process adapt to today's economic and threat environments. ACTDs emphasize technology assessment and integration rather than technology development; the goal is to provide a prototype capability to the warfighter and to support him in the evaluation of that capability. The warfighters evaluate these capabilities in real military exercises and at a scale sufficient to fully assess the full military utility. At the conclusion of the ACTD operational demonstration, there are three potential outcomes. The user sponsor may recommend acquisition of the technology and fielding of the residual to provide an interim and limited operational capability. If the capability or system does not demonstrate military utility, the project is terminated or returned to the technology base. A third possibility is that the military utility assessment can be used to develop a concept of operations (CONOPS) for future or similar technologies. This insight can be utilized to define Operational requirements or acquisition system requirements.

B. Warfighting Need and Role of Active Sensors

U.S. forces today face a set of threats that require rapid and accurate responses if casualties are to be kept to an absolute minimum. These threats arise from the need for U.S. forces to operate in the congested, contentious littoral areas of potential hostile countries, in urban areas where minimizing collateral damage is paramount, and in areas where the use of chemical/biological weapons is a reality. The challenges presented by these requirements necessitate an architecture that blends a variety of solutions. No single system or program, in and of itself, will satisfy all the requirements. However, active sensors have been shown to provide great promise in the detection, classification and localization of potential threats. Active sensors come in many forms; electro-optic, electromagnetic and acoustic. They offer the capability for covert, day/night identification of non-cooperative targets. They provide the warfighter with the ability to locate and identify contaminants, and other potentially harmful gases. When used in conjunction with surveillance and queing sensors they can pinpoint targets for accurate weapon launch. This office is currently sponsoring a series of

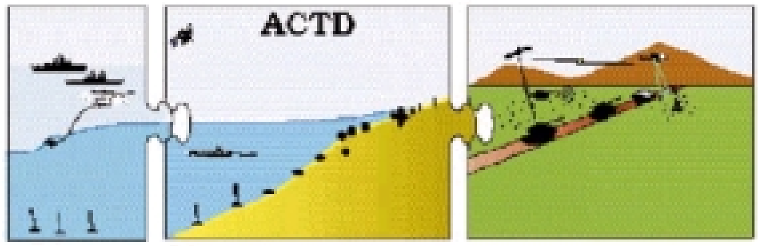
ACTDs that will demonstrate the utility of active sensors in various warfighting situations. These will now be described in the mission context within which they occur.

C. Joint Countermine

The Joint Countermine (JCM) ACTD will evaluate the capability to conduct seamless Countermine operations with an emphasis on clandestine reconnaissance and surveillance. The JCM ACTD is the first of the Class III ACTDs. As such, it takes on an added level of difficulty by integrating a total of eleven novel systems, a JCM tailored digital architecture, a tactical software application which provides a JCM Common Operational Picture, and a JCM Operational Simulation (JCOS) capability.

These Novel demonstration systems are further integrated with previously fielded (or legacy) Army, Navy, and Marine Corps C4ISR and Countermine (CM) capabilities to develop an overall JCM “system-of-systems”. The ultimate goal is to evaluate emerging CM technologies, operational concepts, and doctrine in support of amphibious and other operations that involve Operational Maneuver From the Sea (OMFTS) and follow-on land operations in a mined environment. Both shipboard and airborne lidar systems are strong candidates for detecting and classifying mines. Numerous experiments have shown the utility of lidar to find mines in the shallow water environments. The airborne systems can also be used in the land phase of operations to locate hard targets, thus ensuring a seamless transition form sea to land operations.

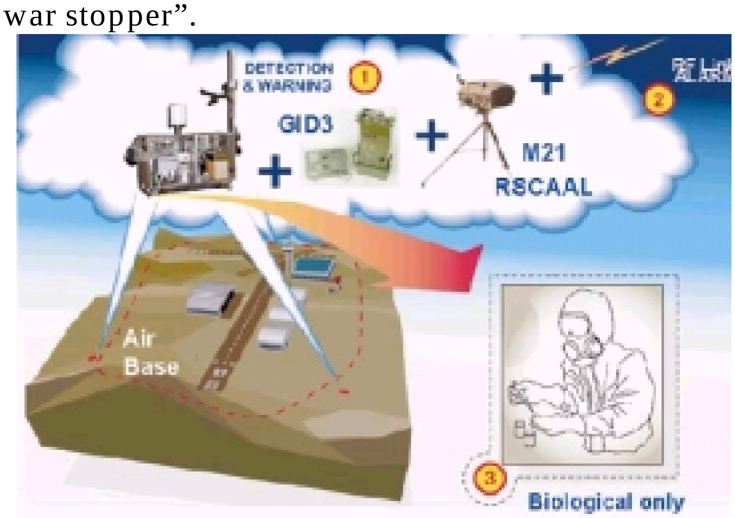
Vision: Seamless Transition of Countermine Capabilities from Sea to Land Operations



Deep Water MCM   SW/USW/S2 MCM   Land Combat MCM

D. Air Base/Port Biological Detection

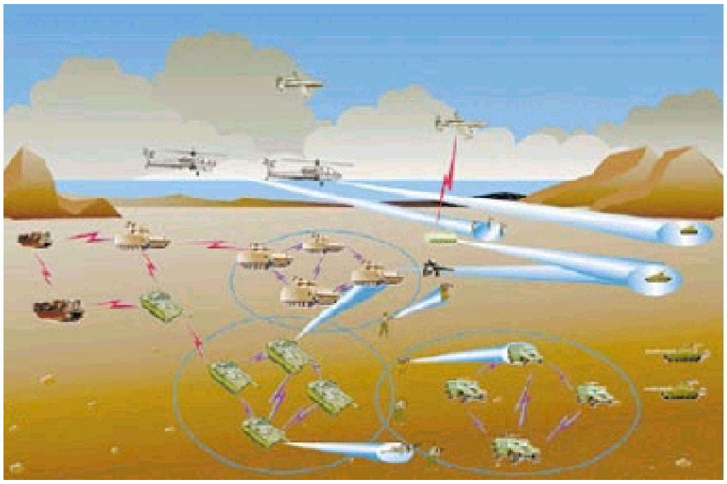
The primary objective of this ACTD is to evaluate the military utility of an Air Base/Port Biological Detection capability and to develop operational procedures for that capability. An additional objective is to provide an interim capability to detect, alarm/warn/dewarn, and presumptively identify against a Biological Warfare (BW) attack on an air base or port facility. This capability can potentially reduce casualties and maintain operational tempo at the facility. Currently, there is no fielded biological detection system to provide warning of BW attacks to critical Air/Sea Ports of Debarkation (APOD/SPOD). An undetected BW attack on APOD/SPODs during early entry could be a "war stopper".



A key sensor in the detection of biological contaminants is a differential absorption lidar (DIAL) detector. This system examines the absorption spectrum of the atmosphere to determine presence of foreign molecules. The ACTD will also leverage advanced detection and identification technologies from the DoD counterproliferation initiative and technology base community. Co-sponsors for the ACTD are Commander In Chiefs (CINCs) of the Pacific and Central Commands who will provide the crews for operation of the sensor network that will be deployed to those theaters. Dugway Proving Ground (DPG) will provide the test range for tests and demonstrations. In addition to the detection and presumptive identification system, several other interim capabilities will be provided by this ACTD: (1) sensor decontamination equipment, (2) low cost contamination detection sampling kits, (3) C4I connectivity and interface with the air base or port warning and reporting system, (4) unmasking procedures, and (5) tested concept of operations (CONOPS).

E. Combat Identification

Combat Identification is a critical requirement for the battlefield of the future. It is recognized that the highest payoff is achieved through positive hostile identification. If this cannot be achieved to the required degree of performance under all battlefield conditions, it will be necessary, at least, to ensure that friendly forces are not engaged. Additionally, the engagement of neutrals should be minimized. Therefore, a combination of non-cooperative systems, cooperative systems, and improved use of Situational Awareness (SA) would be employed simultaneously on the future battlefield in a variety of implementations depending on weapon system requirements and economic constraints.



Battlefield of the Future

The joint Combat Identification (CID) Advanced Concept Technology Demonstration (ACTD) provides a mechanism to improve the most deficient CID mission areas: Air-to-Surface (A-S) and Surface-to-Surface (S-S). The Joint CID ACTD will assess twelve CID system alternatives, each having the potential to provide an operationally effective, affordable A-S and S-S CID capability that is jointly interoperable with existing CID/C4I systems. This initiative builds upon the architecture developed by a DOD Combat ID Task Force established in 1994, under the auspices of the office of the Assistant Secretary of Defense, Command, Control, Communications, and Intelligence (C3I). The twelve technologies selected for assessment in the CID ACTD are described below. The combat identification problem requires a solution or implementation that is cost affordable. To the furthest extent possible existing technologies or systems are being experimented with to evaluate their potential for utility. Laser range finders are one of the most proliferated active sensors, and may potentially play a key role in target identification prior to weapons release. The assessment includes interim capability systems that will provide an operational combat capability, as well as the assessment of non-interim capability systems that employ alternative technologies.

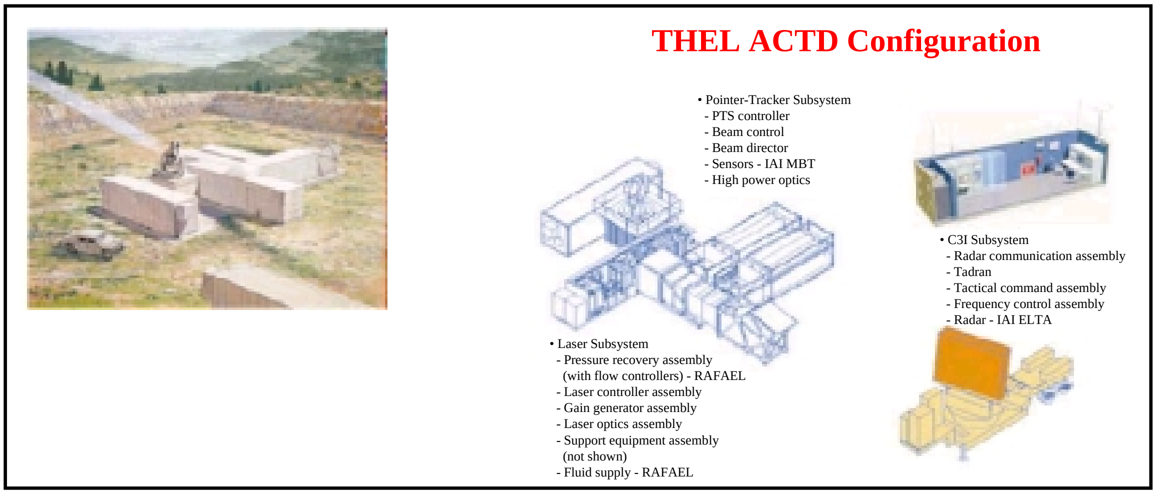
These systems are as follows:

Interim Capability Systems
- Battlefield Combat Identification System (BCIS)
- Enhanced BCIS Forward Air Controller (E FAC)
- Situational Awareness Data Link Forward Air Controller (SADL FAC)
- Air-to-Surface BCIS (Fixed Wing)
- Air-to-Surface BCIS (Rotary Wing)
- Single Channel Ground and Airborne Radio System, System Improvement Program Plus (SINCGARS SIP(+))
- SINCGARS SIP (+) F/O FAC
- Situational Awareness Data Link (SADL)
- Situational Awareness Beacon with Reply (SABER)

"Non-Interim Capability" Systems
- Mark XII/Global Positioning System (MK XII/GPS)
- Laser/Radio Frequency (LRF) Designator
- Situational Awareness Through the Sight (SATTS)
- Radar-coupled Emitter Passive Location and Identification (REPLI)

F. Tactical High Energy Laser (THEL)

The THEL ACTD will evaluate the effectiveness of a THEL to negate the threat posed by Katyusha and other short-range artillery rockets to populated areas in northern Israel. On 18 Jul 96, a Memorandum of Agreement (MOA) between the U.S. and the State of Israel was signed for the cooperative THEL ACTD. The MOA provides for development and functional testing of a THEL demonstrator, consisting of a laser; pointer/tracker; and command, control, and communication subsystems. The MOA also contains an option for field testing the demonstrator at the High Energy Laser Systems Test Facility (HELSTF) on White Sands Missile Range (WSMR).



The three primary subsystems of the THEL demonstrator are: the laser subsystem (LS), the pointer tracker subsystem (PTS), and C3I system. The LS is a deuterium fluoride chemical laser which consists of the fluid supply, the gain generator, controller, and pressure recovery assemblies. The PTS is made up of the beam path from the laser to the outside world which includes an internal optical train and a large gimbaled telescope made up of a primary and secondary mirror fed by a coude' path. The C3I subsystem consists of a remote acquisition radar, and a trailer which houses computer equipment and a commander and gunner's console. The U.S. has invested in numerous Department of Defense high energy laser development programs over the last 20 years that have demonstrated and proven the beam generation and beam pointing technologies that support the THEL concept. Now, for the first time, the THEL ACTD is utilizing these mature technologies to develop a THEL demonstrator with limited operational capability. An emphasis of the THEL ACTD is the development of fire control and command, control, communication and intelligence (FC/C3I) techniques to take advantage of the laser's rapid response capability for close-in engagements where time lines are very short. The THEL concept has potential for Naval applications when combined with passive/active trackers for ship self-defense.

G. Mobile Operations in Urban Terrain (MOUT)

The objective of the joint Army/Marine Corps MOUT ACTD is to improve the operational effectiveness of soldiers and Marines operating in MOUT. The objective of the MOUT ACTD has been developed into a three-part mission as delineated below. This objective is in response to the National Military Strategy requirement that the U.S. possess a decisive force capability which is highly lethal, survivable and highly deployable. Urban centers have increasingly become the sites of conflict throughout the world, and will remain so as we move into the 21st century. The nature and complexity of the urban environment mandates manpower intensive operations due to line-of-sight restrictions, inherent fortifications, limited intelligence, densely constructed areas, the presence of non-combatants and associated restrictive rules of engagement. These manpower intensive operations have a much higher potential for casualties and collateral damage than operations in other environments. The 1996 Joint Warfighting Science and Technology Plan cites MOUT as one of the Joint Chiefs of Staff ten Joint Warfighting Capability Objectives.

MOUT ACTD Mission

1. Determine the military utility of advanced technologies and new operational concepts to achieve dominance in MOUT go to war operations.

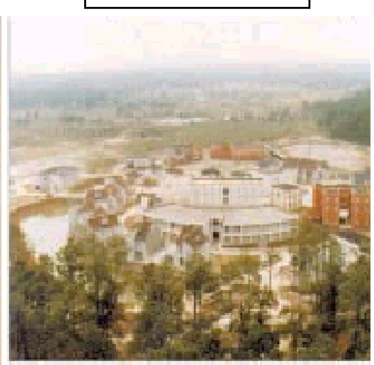
2. Provide interim operational capabilities to the MOUT ACTD experimental unit(s) with associated Tactics, Techniques and Procedures (TTPs).

3. Set the stage for rapid acquisition of the successful ACTD products. Each site, pictured below, is undergoing phased instrumentation in support of the ACTD.

Capabilities of the MOUT Instrumentation System (IS) include: visual day/night cameras (McKenna only); two-way and tactical communication audio coverage; time tagging of all recorded events in real time; soldier/Marine ID; soldier/ Marine location (x, y, z coordinates); OPFOR location; target location; weapons effects (what fired, when, what effects); OPFOR/Target shootback results; fratricide recording; and the ability to visually represent and electronically replicate collected data for post experiment analysis. Supporting IS sensors include acoustic, IR, laser, seismic, GPS and video.

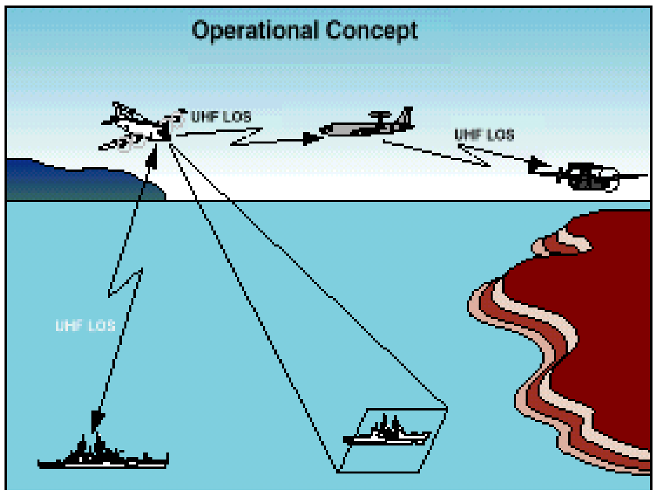
Army Test Site

USMC Test Site



H. Precision Targeting & Identification (PTI)

The Precision Targeting Identification (PTI) ACTD will demonstrate the military worth of an advanced, cost-effective, surveillance and target identification technology in an operational environment. The PTI ACTD will employ an advanced, third generation, infrared sensor, SIGINT laser radar (LADAR) and C4ISR sensor systems. The PTI system will provide a day/night target detection, classification, and dissemination capability at stand-off ranges that cannot be achieved with conventional detection and monitoring systems. PTI's initial operational deployment will set the stage for the rapid transition into EMD and acquisition for surveillance and tactical platforms.



Modern U.S. military operations are conducted in congested littoral and overland areas where friendly, hostile, and multi-national forces are operating. Presently, operational theater commanders and on-scene warfighters must place their personnel ships, and aircraft in harm's way for positive target identification - usually relying on layered sensors or visual means for positive ID. Should weapons release become necessary, the warfighter's fire control solution is complicated due to his inability to discriminate quickly and accurately among friendlies, neutrals, and hostiles. Incidents such as the accidental downing of an Iranian commercial air-liner, friendly fire casualties during Operation Desert Storm, and an accidental shoot-down of a U.S. helicopter during Operation Southern Watch have led to Operational Requirements Documents (ORD) for new Combat Identification (CI) and targeting technologies.

The PTI C4I system can receive initial off-board cueing. Other on-board sensors can handoff to PTI's electro-optics system. Its IR sensor performs unresolved target detection and handoff to the LADAR for target exploitation. Targets are interrogated to generate classification signatures. The LADAR performs aspect invariant classification of aircraft, ships, or ground targets by exploiting the return signal from the target. The PTI system also generates 3-D state vectors on targets to provide a fire-control quality track for weapons employment and to disseminate target track and secondary imagery.

The current state-of-the-art in small lightweight ladar systems, suitable for operation in aircraft, is a carbon dioxide laser operating in the 8 to 12 micron range. This technology provides excellent transmission characteristics through the atmosphere with identification demonstrated at required stand-off ranges. Future technology developments are focused on developing laser radar systems using a solid state laser transmitter operating at a shorter wavelength, typically 1-2 microns. Solid state offers the potential of lighter weight, lower power and increased efficiency with the same operational performance.

3.0 The Future

> "Weapons of mass destruction--nuclear, biological, and chemical--along with their associated delivery systems, pose a major threat to our security and that of our allies and other friendly nations. Thus, a key part of our strategy is to seek to stem the proliferation of such weapons and to develop an effective capability to deal with these threats.
> —1996 National Security Strategy

The growing military need for a capability to deny, disrupt or destroy nuclear, biological, and chemical (NBC) related facilities while controlling the potential for collateral effects poses a unique set of operational requirements. The ramifications of the release of NBC related materials resulting from attack are potentially so severe that predicting, controlling, and assessing collateral effects are of paramount importance. Such NBC releases could not only endanger our own troops, coalition members, friends and allies, but could also affect civilian populations in a way which undercuts coalition cohesion or our own will to fight. Active sensors that have been developed for chemical/biological, navigation, targeting, mine warfare, and combat identification are now being evaluated for this new technology thrust area. Future efforts are being directed to develop and field sensors and systems to deny, disrupt or defeat a potential adversary's NBC related facilities while minimizing collateral effects and providing more reliable bomb damage assessments. The warfighters' capabilities required to conduct counterforce operations in these areas include:

- Surveillance (Monitoring, tracking, Intelligence)
- Targeting (using battlefield surveillance and other intelligence assets)
- Planning attacks to deny, interdict,
- Conducting strikes and restrikes
- Performing battle damage assessment
- Contamination migration

As future military operations are conducted in Low Intensity Conflicts or in Operations other than War, the rules of engagement will be governed by political as well as military needs. This places severe restrictions on the potential for loss of US Forces to manned surveillance and reconnaissance missions. Future Integrated Surveillance and Reconnaissance (ISR) requirements will drive the need to place some of the previously discussed active sensors into unmanned aerial vehicles (UAVS) or remote vehicles. In order to meet the size and volume constraints on the platforms, a downsizing of the current state of the art for stand-off sensors systems is required.

It is expected that systems can be fielded in the near future for a variety of manned and unmanned platforms. The leading obstacle to transitioning active optical sensor systems is the high unit cost relative to passive sensors. It will continue to be a struggle to insert these technologies on these low cost expendable platforms. As the stand-off range for unmanned platforms is reduced, the size and power of the remote sensor can be reduced. One promising approach is the use of solid state or direct diode laser sources to produce lower powered sensor systems.

4.0 Summary

"U.S. military forces in the 21st century must be prepared to face a wide range of security challenges, including some that cannot now be foreseen but that probably will emerge. The United States must harness advanced technologies.... to enable our future joint forces to achieve the capability to dominate an adversary across a full range of military operations".

William W. Cohen, Secretary of Defense
Response to the Senate Armed Services Committee, January 1997

Active systems play a key role in achieving many of the JWSTP capabilities objectives. They provide the mechanism to achieve many leaps in capability the warfighter desires. Active sensors provide the warfighter the ability for day/night operations in those missions where precision, rapid response and positive identification are paramount. They provide one of the best solutions to the threat environment of today and tomorrow.

ACTDs are an integral part of the acquisition reform process. They are proving to be an important link between the technologist and the warfighter. ACTDs are providing a vital path for new technology, such as active sensors, to move to the battlefield faster than would otherwise be possible, and with a solid understanding of the operational capability that these technologies enable.