# Technological Innovations


Tactical high energy laser beam director.

TRW, Inc.

# The ACTD Program

*By* SUE C. PAYTON

In the 1950s and 1960s, many business firms assumed that they had optimized production. Consequently they removed production from the competition equation. In the two ensuing decades foreign competitors outproduced them. Manufacturing faced a hard choice: change or die.

Now it is the turn of the defense sector, which followed the same approach for a long time. But the competition moved ahead, ranging from aggressor states to terrorists who use technologies that previous enemies never had, thus posing new challenges. The attacks on September 11 magnified the need for rapid change. Innovation within the Armed Forces is coming from the advanced concept technology demonstration (ACTD)

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Line-of-sight anti-tank propulsion system.

Lockheed Martin

program, but such developments alone cannot ensure automatic preeminence or defeat terrorism. Technology as well as advanced concepts, tactics, techniques, and procedures must be applied to competitive areas defined in the Quadrennial Defense Review.

## Enabling Preeminence

Military transformation is a major DOD focus. But what does it mean? It is about ensuring preeminence in competition to deter and defeat all enemies. Just as manufacturing bounced back in the 1980s and 1990s, the Federal government, defense industrial base, and nontraditional suppliers must respond decisively and continually to a changing marketplace. The response must maintain predominance in areas where the homeland and the security of allies are being challenged. It must be quick and continuous because of "disproportionate and discontinuous changes in the security environment," as emphasized by the Quadrennial Defense Review in 2001.

**ACTDs are creating shifts that are more than linear extrapolations of the present day**

In addition, that report listed six transformational areas in which defense must ensure preeminence:

- protecting bases of operations and defeating nuclear, biological, and chemical (NBC) weapons and their means of delivery
- projecting and sustaining U.S. forces in anti-access or area denial environments
- denying enemies sanctuary by persistent surveillance and rapid precision strike
- leveraging information technology and concepts to develop a joint command, control, communications, computers, intelligence, surveillance, and reconnaissance ($C^4ISR$) architecture
- assuring information systems that face attack and conducting information operations
- enhancing the capability and survivability of space systems.

How transformation is achieved is just as important as the key areas. It requires what the Secretary of Defense calls new approaches—the essence of ACTD procedure. This program identifies needs and ways to meet them. A warfighter-developed concept of operations, underpinned by innovative technology and demonstrated by the warfighter for the warfighter, defines success or failure.

Since 1994 this program has rapidly and continually fielded technologies. In its first thirty-six months it resulted in the Predator unmanned aerial vehicle that monitored the accords in Bosnia. By 1999 some 20 percent of ACTD products were supporting Operation Allied Force in Kosovo, By 2001 thirty products were deployed for Operation Enduring Freedom in Afghanistan as well as Operation Noble Eagle at home.

The program enables military transformation in ways not commonly recognized. To date, 97 demonstrations have been initiated. Significant improvements in joint capabilities have occurred when innovative technology was inserted at little cost. Across the joint community, ACTDs are creating paradigm shifts that are more than linear extrapolations of the present day. Moreover, they are focused on the areas where the United States must ensure preeminence.

## Protecting Bases and Defeating WMD

Geography once secured our most important base: the homeland. But today the Nation is not only vulnerable to attack from threats such as cruise and ballistic missiles, but to a terrorist who wears explosive-filled tennis shoes and flies into the country from abroad.

New approaches to early warning are needed. The *Area Cruise Missile Defense ACTD* is giving a more complete national air picture. Mobile units have filled gaps that previously existed in coastal radar coverage and are tied into radar as well as other land-, sea-, and air-based sensors. This demonstration also integrates air pictures. Prior to September 11, North American Aerospace Defense Command tracked aircraft approaching the United States but not domestic traffic, which was monitored by the Federal Aviation Administration. The two pictures have been fused.

Future attacks on the homeland are inevitable. This was anticipated in the *Consequence Management ACTD*, which supports domestic efforts by detecting and identifying biological agents within an hour. Another product assists firefighters, police officers, and rescue workers who were previously unable to communicate on the

same frequency. The *Homeland Security Command and Control ACTD* has software facilitating radio contact among first responders. It permits networks to share data, enabling situational awareness.

An attack on a port or air base could impede deployment. One demonstration developed sensor networks for known points of debarkation in Kuwait and Korea to detect eight biological agents in 15 minutes. Another product has deployable sensors for seaports of debarkation and several others will protect forward forces. The most transformational are directed energy ACTDs. The tactical high energy laser, which was demonstrated in three years, rapidly detects, tracks, and destroys multiple incoming rockets and complements other weapons in an air defense architecture. The challenge is making the system mobile. The active denial system will be the first non-lethal directed energy weapon. It projects millimeter wave energy to heat the skin of targeted individuals, and thus repel hostile crowds like those that threatened allied forces in Somalia and Kosovo. This system could be mounted on ground vehicles, transport aircraft, ships, and other platforms.

The best protection against weapons of mass destruction is destroying them before they are used. The *Counterproliferation ACTD* yielded air-delivered munitions for attacking hardened sites and the *Agent Defeat Warhead ACTD* produces an air-delivered penetrating munition to neutralize bunkered chemical and biological weapons while minimizing collateral effects.

## Projecting and Sustaining

To defend against terrorism and other threats, the Armed Forces must take the fight to the enemy. This means possibly projecting power on short notice and in unexpected locations. Power projection requires preplanning to match deploying units to transport assets. This was tedious and was hampered by interoperability in the past. Moreover, emerging demands resulted in constantly changing plans. The *Agile Transportation 21st Century ACTD* optimizes strategic assets for troop and equipment deployment.

Airborne laser module.

TRW, Inc.

Power projection faces greater anti-access and area denial resistance. Air defense is getting tougher. During Allied Force, Serb operators illuminated attacking aircraft, launched missiles, and then shut down radars before NATO high-speed antiradiation missiles could lock on. The *Quick Bolt ACTD* is integrating global positioning system (GPS) receivers and millimeter wave radar into these missiles to counter threat emitter shutdown. This enables the missiles to find the last location of threat emitters and the millimeter wave radar to detect targets in the terminal homing phase.

**finding and hitting an enemy is the essence of war, and speed counts**

Today an enemy may acquire advanced air defense systems on the international market that can be countered by the *Loitering Electronic Warfare Killer ACTD* with air-delivered MK83 bomb, which turns into an inflatable wing unmanned aerial vehicle with a radar jammer. This remotely controlled system is designed to remain in a target area for seven hours, detect air defenses, and degrade them by employing active countermeasures.

Small early entry forces must quickly dominate, even when confronting heavier forces. In this regard two products are helpful. The rapid force projection initiative demonstrated a sensor system for detecting distant enemy armor and weapons to engage it. The sensors have been fielded and the weapons are being produced. The second is the *Line of Sight Anti-Tank ACTD*, which is integrated into a high mobility multipurpose wheeled vehicle to rapidly engage multiple tanks.

Transformed forces require efficient logistic systems. The *Joint Logistics ACTD* provides decisionmaking tools to effectively plan, execute, and replan mission support. The tools are being incorporated into the global combat support system. The *Joint Theater Logistics ACTD* illustrates the utility of a near-real time, collaborative logistic planning system that can react to changes in operational plans, providing a truly integrated capability.

Better maintenance both ensures reliability and reduces footprints. Many corporations have adopted condition-based maintenance, using sensors to monitor equipment. Sensors also transmit to area networks and remotely collect data. The *Joint Advanced Health and Usage Monitoring System ACTD* indicates the benefit of providing real-time critical system information to flight and ground crews of Army and Navy helicopters. This open architecture system reduces maintenance and life threatening mishaps.

## Rapid Precision Strike

Finding and hitting an enemy is the essence of war, and speed counts. Stopping the terror in Kosovo meant finding and hitting Serbian forces faster than they could act. In Afghanistan, the use of rapid precision strike prevented protracted warfare.

Several ACTDs can find enemy forces. Unattended ground sensors from a 1998 product have been available recently. Unmanned aerial vehicle demonstrations are better known. Predator provides an eye in the sky for

commanders. In Kosovo and Afghanistan it watched, targeted, and assessed. It observed noncombatants to prevent casualties and, armed with Hellfire missiles for Enduring Freedom, acted as remote controlled sensor and shooter. Global Hawk offered 24-hour station time over Afghanistan and hit numerous time-sensitive targets.

ACTDs launched in 2002 are focused on unmanned aerial vehicles (UAVs). The Defense Advanced Research Projects Agency will demonstrate a 6 to 9 inch, low-cost reconnaissance and surveillance micro air vehicle for ground forces to see beyond their positions. Unlike other small vehicles, it hovers, perches, and stares for extended periods without user interaction, unless alerted by a changing situation. A larger expendable UAV makes longer flights and carries more sensors.

Enemies know that if they are detected, they can be hit. Extensive surveillance caused Serb forces to use camouflage and concealment in Kosovo. The *Hyperspectral Collection and Analysis System ACTD* overcomes this problem by integrating hyperspectral sensors into platforms. These sensors combine two radar frequencies to track targets through foliage. This demonstration shares sensor data across intelligence networks.

Although precision targeting depends on precise knowledge of the terrain, timely collection of data and missile programming pose problems. The *Rapid Terrain Visualization ACTD* shortens this process. Two sensors mounted on aircraft rapidly generate high-resolution topographic data and highly precise digital terrain elevation data to target GPS weapons. The system reduces target-location error from eleven meters to one.

One significant problem is that enemy forces are going underground. In both Kosovo and Afghanistan opponents hid in tunnels, caves, and hardened facilities. New products are aimed at such targets. The *2002 Thermobaric ACTD* defeats tunnels and improves capabilities and concepts relative to munitions used in Afghanistan. In addition, a 2001 demonstration put Navy penetrators on Army missiles, providing forces in Korea with a critical capability.

Quick reaction launch vehicle.

1st Combat Camera Squadron (Garrett D. Rosler)

Targeting is often complex. In Afghanistan it was managed with software from the *Theater Precision Strike Operations ACTD*, which provides a blueprint for attacking targets. This software can establish priorities, maximize the opportunities to engage time-sensitive targets, and deconflict targeting throughout the battlespace.

## Joint C4ISR Architecture

As Bill Gates has observed: "Changes will occur because of a disarmingly simple idea: the flow of digital information." This flow greatly depends on the digital network in an organization. A joint C4ISR digital network poses a challenge for DOD because of the number of incompatible systems to be linked. One demonstration breaking interoperability barriers is Link 16. Previously, two key networks were incompatible, the Link 16 tactical data link network, used by the Navy and Air Force, and the joint variable message format network, used by the Army and Marine Corps. This product provides a translator and fuses air and ground pictures and allowed commanders in Afghanistan to see E–8 joint surveillance and target attack radar system (JSTARS) ground targets and air targets in one precise and accurate picture.

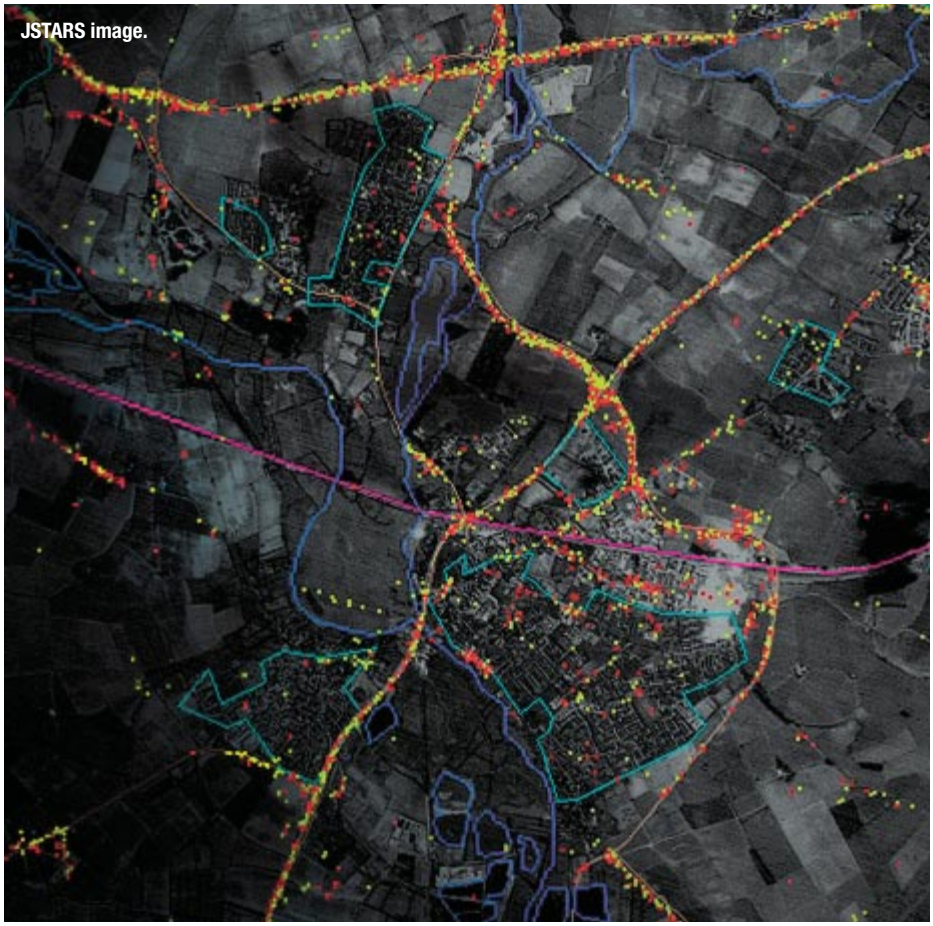
Sensor fusion—meshing sensor data into one picture—is one way to reduce targeting time as well as errors. Tactical sensors and reconnaissance are integrated under the *Joint Intelligence, Surveillance, and Reconnaissance ACTD*, which demonstrates two-way links between firefinder radars, millimeter wave radars on Apache helicopters, and remote battlefield sensors. Moreover, the *Network Centric Collaborative Targeting ACTD* seeks to link sensors with machine-to-machine front-end processing on the RC–135 Rivet Joint, E–8 JSTARS, E–3 airborne warning and control system, Global Hawk, Predator, U–2, and EP–3. Fusing multiple intelligence sources will enable time-sensitive designation of mobile targets. Its purpose is reducing target location error on mobile threat emitters to 10 meters and providing warfighters with a targeting solution.

Another challenge is getting the right information to the tactical level. This was achieved by the *Extending the Littoral Battlespace ACTD*, with a three-tiered wide area network. Lightweight computers—which transmit text, images, and voice wirelessly—replaced radios. The system also distributed a common picture of the battlespace. This demonstration is transitioning to an effort known as the JTF wide area network to enable secure, reconfigurable tactical level interoperability throughout a theater. Although this network is not yet operational, a former commander of U.S. Pacific Command outlined its potential as follows: "special operators in Afghanistan would have had the same picture as 15th Marine Expeditionary Unit in Camp Rhino. . . . The same picture would have been in the F–15, F–18, and B–52 cockpits." He also indicated that it would have been in JTF and JFACC headquarters.

Information must also flow to coalition partners. The air tasking order for Afghanistan was electronically transferred between American and British systems by products resulting from the *C4I for Coalition Warfare ACTD*. This also speeded coordination among national air staffs. Coalition operations will benefit from the *Language*

*and Speech Exploitation ACTD*, an automatic translation tool. At present, personnel must translate operations plans and documents for coalition partners, a time-consuming process.

Information superiority is not enough. It must lead to decision superiority. In Afghanistan operations were aided by visualization tools within unified and subordinate commands. These new tools automatically compile data and display it on knowledge walls, providing situation awareness at a glance. The information can also be distributed, enabling a broad understanding of ground truth. These tools were from the *Commander in Chief for the 21st Century ACTD*.


JSTARS image.

Northrop Grumman

## Cyber Threats

Information superiority is relative to enemy capabilities. Some will try to deny any friendly advantage by degrading networks. Iraq and other nations are reportedly developing the capability to mount cyber attack. Protecting networks is thus key to maintaining information superiority.

Recent exercises have tested our ability to detect and counter cyber attacks, a major challenge. Cyber radar was developed in the *Information Assurance Automated Intrusion Detection Environment ACTD*. The first tier of this architecture collects information on local environments using intrusions sensors. The next tier fuses the information into a big picture, and the top tier provides analysis to identify threats and determine responses. Several defense sites have been instrumented with this technology.

**recent exercises have tested our ability to detect and counter cyber attacks**

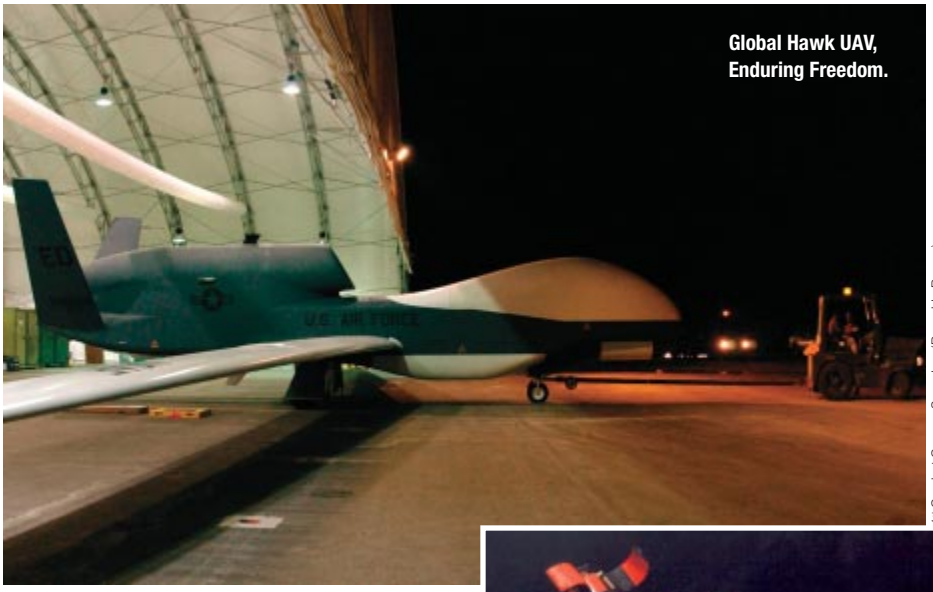
The capability to respond to network intrusions is manifest in the *Active Network Intrusion Defense ACTD*, which changes network components such as routers and firewalls to automatically block hackers. Network protection includes multilevel security, giving access to users cleared for classified data while denying entry to unauthorized users. Such protection is especially needed for coalition and interagency operations. A proof of concept for multilevel network security is featured in the *Content-Based Information Security ACTD*, which allows authorized users to access secret information on a tactical-level coalition network and also operate on disadvantaged networks and those interfacing with public networks.

Offense is the best defense against cyber attacks. It also degrades enemy networks to gain warfighting advantages. The *Information Operations Planning Tool ACTD* helps these operations. It consists of linked workstations in combatant command and subordinate headquarters that enable collaborative planning as well as modeling and simulation tools to recommend targets. This asset was installed at U.S. Central Command in 1999.

## Enhancing Space Systems

From directing land forces to pushing real-time intelligence into the cockpit, space systems possess myriad capabilities. The Nation is becoming more dependent on space assets—some think that investments in this sector could approach 10 percent of gross domestic product in this century. But the vulnerability of these capabilities is increasing. Satellites may become attractive targets for an enemy. Moreover, as the number of satellites grows, more systems will be affected by natural hazards and collisions between working satellites and space debris will become more common.

Protecting space assets starts with improved situational awareness. The *Space Surveillance Operations ACTD* uses the first satellite designed to track objects in high Earth orbit. Most satellite observation is done by ground-based systems, which have limited surveillance abilities because of location,



Global Hawk UAV, Enduring Freedom.

1st Combat Camera Squadron (Reynaldo Ramon)

weather, and time of day. This space-based system has found more than 100 lost objects and reduced the number of missing satellites from 63 to 13.

Satellites must be able to diagnose their health and sense threats in the immediate area. But it can be difficult to distinguish between hostile actions and natural phenomena. Such ambiguity could seriously degrade crisis management. The *Compact Environmental Anomaly Sensor ACTD* provides onboard warning and diagnosis. It is deployed on a defense support program satellite to monitor the environment around spacecraft and warn of natural hazards such as electrical charging, single event upsets, and radiation effects, which can harm or kill a satellite.

In addition, natural hazards affect satellite-to-ground links (like ionospheric scintillation) that can disrupt satellite communications and global positioning signals. This can have serious military and economic consequences. The *Communication/Navigation Outage Forecasting System ACTD* provides a capability to forecast scintillation 4 to 6 hours in advance, and possibly for 24 hours, to allow better communications planning.

Some capabilities of the global positioning system are available to potential enemies. The *Navigation Warfare ACTD* prevents such use while enhancing friendly GPS employment. It has developed both GPS jammers and a jam-resistant system.

Brilliant Anti-Armor Submunition.

Northrop Grumman

## The Hardest Step

Technological innovations are clearly possible and warfighters are using them, but they are not enough. Military transformation depends on cultural acceptance—convincing an institution to accept new ways of doing business. Harnessing innovative organizational and cultural changes is a stumbling block in corporate America and even more so within DOD. Sometimes it has required a generation to make improvements, even when they are recognized as being in the best interest of the Armed Forces. Technology advances faster than the ability of the human mind to accept it.

Time lag is a complex problem. There is a great need to get technology to commanders, which must often rapidly bridge a gap between what is already fielded and what is required to be preeminent. While the military departments are resourced to organize, train, and equip, they spend little on rapid acquisition. Forging stronger ties with the services for funding demonstrations and helping commanders to find resources are goals of the Advanced Systems and Concepts Office. Without forceful support from the services, time is lost in searching for funds that could be better spent on technology integration and utility assessments. One example is the demonstration that produced the Predator UAV. Although needed for warfighting, it faced cultural resistance that was described by the President: "Predator had skeptics because it did not fit the old ways."

Technology is advancing at an unprecedented pace and is readily available to anyone, friend and foe alike. Fielding technology faster means solving funding problems. Enhancing the role of unified commanders in the resource allocation process can adapt the defense establishment to the needs of warfighters. "Transformation is simply fostering changes that result in a dramatic improvement over time in the way a combatant commander wages war," according to the Chairman. Although the ACTD program is rapidly transitioning technologies, it is only a partial solution. The challenge of military transformation is more cultural than technological. **JFQ**