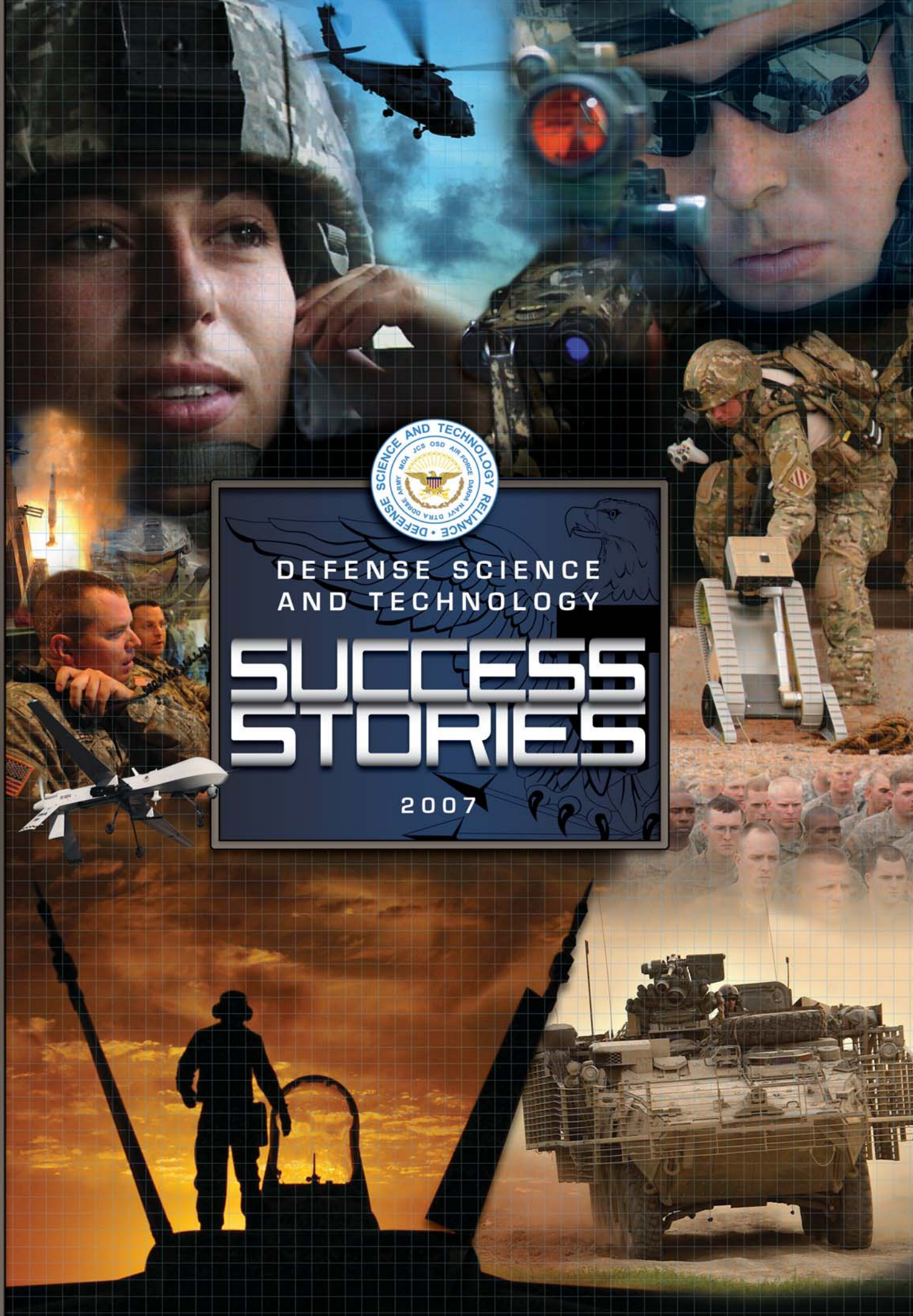

DEFENSE SCIENCE AND TECHNOLOGY RELIANCE • DEFENSE SCIENCE AND TECHNOLOGY
ARMY MDA JCS OSD AIR FORCE DARPA NAVY DTRA DSB&E
DEFENSE SCIENCE
AND TECHNOLOGY
SUCCESS
STORIES
2007

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2007		**00-00-2007 to 00-00-2007**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Defense Science and Technology Success Stories	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Defense Research & Engineering,3030 Defense Pentagon,Washington,DC,20301-3030**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

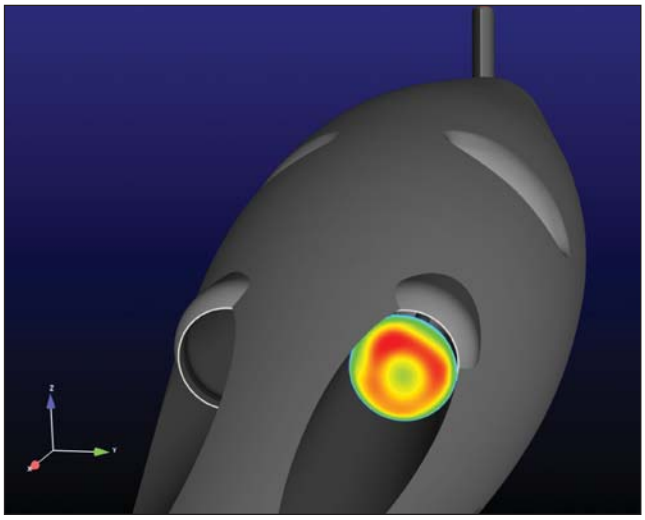
13. SUPPLEMENTARY NOTES

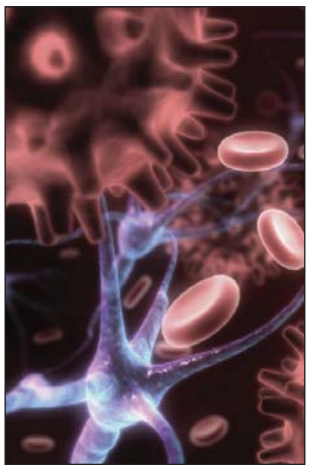
14. ABSTRACT

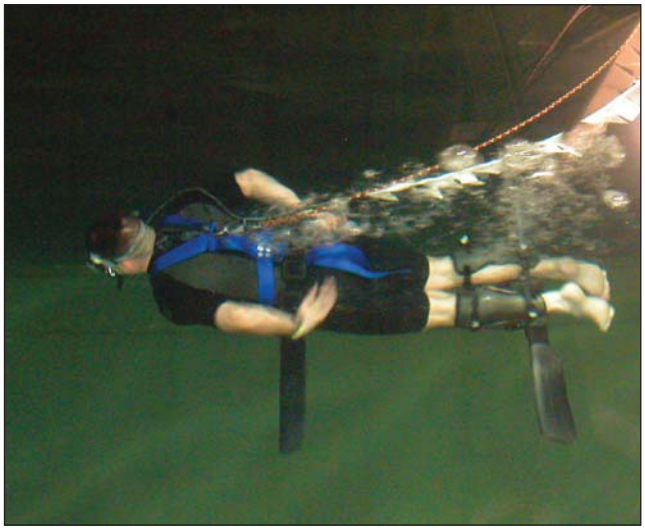
15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**154**	

TABLE OF CONTENTS







Force Application

Force Protection

Ground and Sea Vehicles

Human Systems

Information Systems Tehcnology

Materials and Processes

Net Centric

Sensors, Electronics and Electronic Warfare

Space Programs

Weapons

The Department of Defense (DoD) Science & Technology (S&T) Program seeks to ensure that United States' warfighters have superior and affordable technology to support their missions. To meet this end, DoD implemented Defense Reliance to foster and facilitate collaboration between the Defense Services and Agencies. The overall goal of Reliance has been to provide a forum for Defense S&T Executives to coordinate their individual strategies into one overall Defense S&T Strategy. This process allows the Defense S&T Executives to invest, divest, or collaborate in research, based on the priorities of the other Components, in order to provide the most complete, cost-effective solutions for the warfighter.

Technological superiority has been and continues to be a cornerstone of our national military strategy. The Defense S&T Strategy enables the development and transition of capabilities across the full spectrum of challenges inherent in an uncertain future. Several areas play a particularly pivotal role in executing the QDR strategy, and the Department has accepted some risk in countering traditional challenges, while shifting emphasis on enhancing capabilities to combat irregular, catastrophic, and disruptive threats.

Providing the warfighter with the tools needed to accomplish the mission is the number one priority of Defense S&T. Continued technology development is fundamental to enabling the warfighter to dominate in the face of a continuously changing world and environment. The DoD S&T successes of today will continue to strengthen the capabilities for the warfighters of tomorrow.

This document, the 2007 Defense Science and Technology Success Stories, demonstrates how the Defense Services and Agencies have continued to achieve many goals, such as increasing the efficiency and capability of existing technologies, developing systems that do more with less, and developing stronger and affordable methods of achieving mission success.

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
3030 Defense Pentagon
Washington, D.C. 20301-3030

The 2006 Quadrennial Defense Review (QDR) stated, "The United States is a nation engaged in what will be a long war." The Department of Defense's strong investment in Research and Engineering (R&E) enables the future capabilities necessary for success in this war - the Global War on Terror. The QDR establishes a strategy whereby the Department is prepared to accept some risk in countering traditional challenges, while shifting emphasis on enhancing capabilities to combat irregular, catastrophic and disruptive threats.

The DoD R&E program's mission is to create, demonstrate, prototype, and apply science and technology that enables affordable and decisive military superiority to defeat any adversary on any battlefield. The Department is committed to maintaining technological superiority through the discovery of new technologies that produce revolutionary capabilities and hedge against future uncertainty. Tomorrow's military capabilities depend on today's investments in enabling technologies.

The 2006 Defense Science & Technology Success Stories book highlights activities achieving this mission and clearly provides examples of how the DoD R&E Program is addressing the QDR shift in emphasis. This book presents technologies that have transitioned or have achieved notable successes in the past year. I hope you enjoy reviewing the successes and find the information useful.

John J. Young, Jr.

BATTLESPACE AWARENESS

Man-Portable Threat Warning System

Background: DoD man-portable threat-warning capabilities are limited, stove-piped, and heavy. Small units and individuals have limited tools for real-time signals intelligence (SIGINT) threat detection, warning analysis, and geolocation. A threat-warning communications capability is needed to bridge the gap between forces and their networks. During operations, an improved ability is needed to identify, locate, and categorize threats, and to rapidly adapt to evolving threat signal environments.

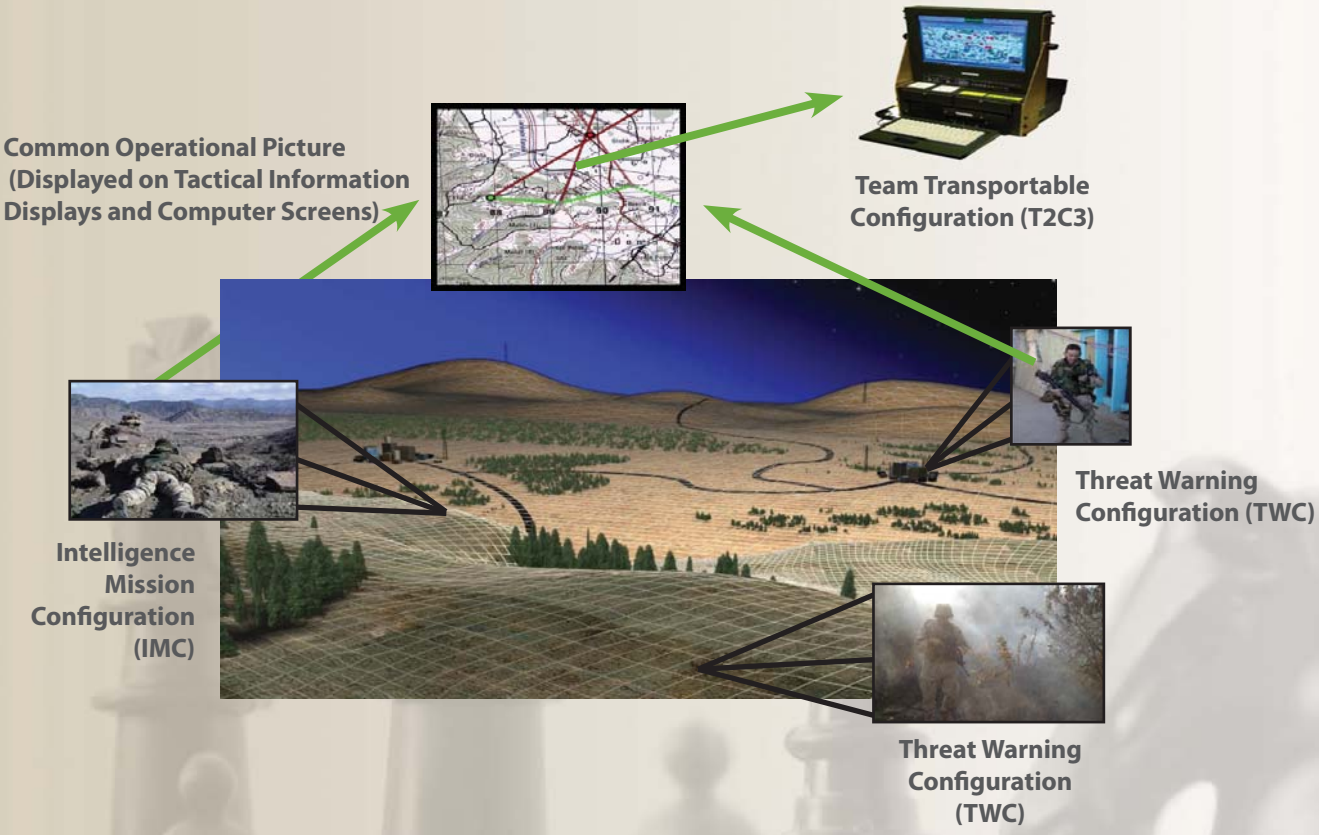
Success: The Man-Portable Threat Warning System (MANPACK) ACTD demonstrated a small, lightweight, modular threat-warning and tactical SIGINT collection system that is rapidly scaleable to operational requirements. The body-worn system displays threat and friendly force data, automated data analysis to permit hands-free operation, and reach back capabilities.

Current Status: USSOCOM is transitioning MANPACK technologies to the Joint Threat Warning System program of record.

Program POC: Ms. Lana Atwell, ODUSD (AS&C), 703-695-9873, lana.atwell@osd.mil

Year Completed: FY 2006

User Sponsor: U.S. Special Operations Command (USSOCOM)


Common Operational Picture
(Displayed on Tactical Information
Displays and Computer Screens)
Team Transportable
Configuration (T2C3)
Threat Warning
Configuration (TWC)
Intelligence
Mission
Configuration
(IMC)
Threat Warning
Configuration
(TWC)

Network-Centric Collaborative Targeting

Background: The warfighter requires actionable targeting information on time-critical targets to support rapid engagement. The purpose of the Network-Centric Collaborative Targeting (NCCT) Advanced Concept Technology Demonstration (ACTD) was to network operational intelligence, surveillance, and reconnaissance (ISR) sensors in order to significantly improve detection, identification, and location of time-critical targets within their cycle times. The ISR sensor platforms included: RC-135 Rivet Joint (RJ), RC-12 Guardrail, E-8 Joint Surveillance Targeting Attack Radar System (JSTARS), United Kingdom E-3 Airborne Warning and Control System (UK AWACS), U-2 Dragon Lady, the R1 Nimrod, and the Navy's Cooperative Engagement Capability (CEC).

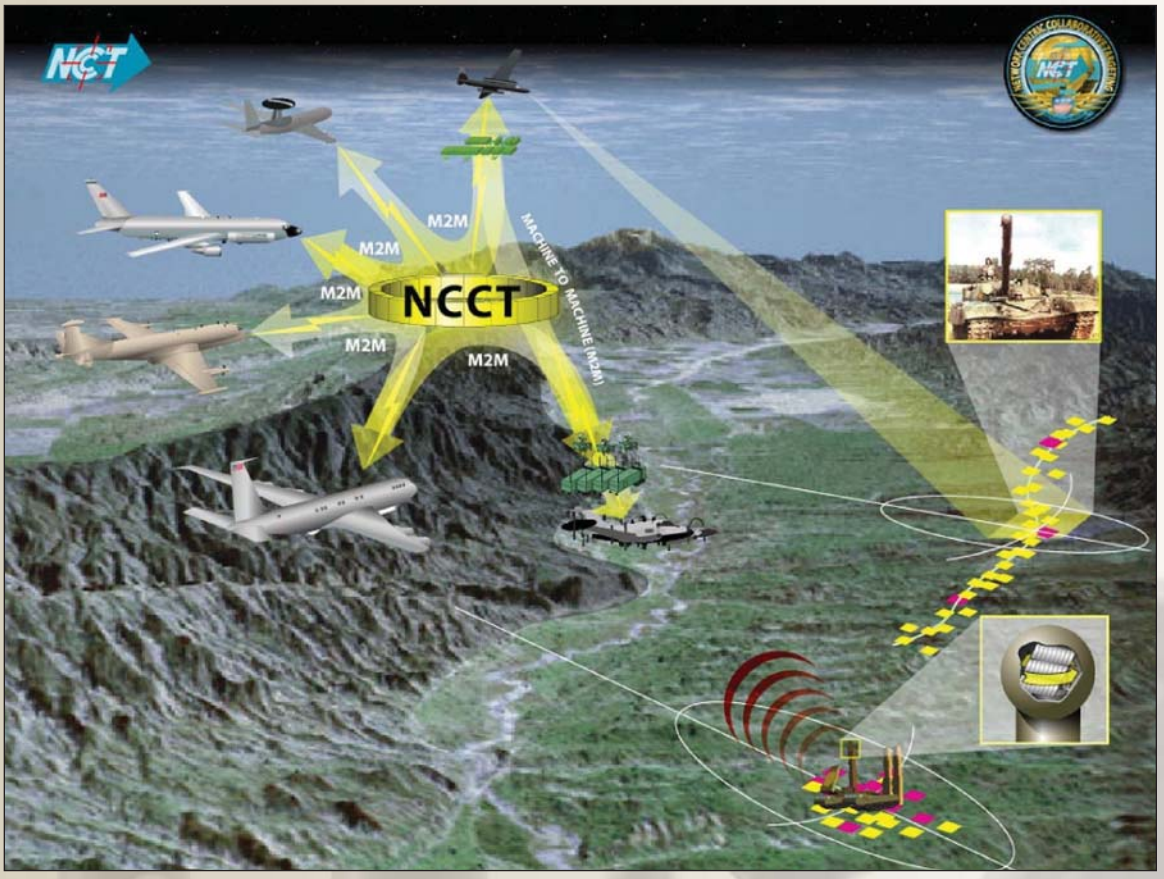
Success: The NCCT ACTD demonstrated the value of multi-INT, multi-security level, and multi-platform collaborative operations to shorten the TST timeline, improve the quality and identification confidence of tracks, and to generate tracks that may have previously not been reported. The U.S. Army's RC-12 Guardrail and U.S. Air Force's RC-135 Rivet Joint rapidly exchanged data machine-to-machine (M2M), enabling action against emitting targets such as surface-to-air missiles and tactical communications systems. A NCCT-equipped RC-12 Guardrail aircraft working with a modified RC-135 Rivet Joint aircraft will allow rapid generation of Army targeting solutions. When a modified E-8 JSTARS aircraft is part of a network, geo-location accuracy improves through the correlation of signal intelligence (SIGINT) to ground moving target indicator (GMTI) tracks supporting the employment of GPS-guided weapons.

Current Status: The U.S. Air Force transitioned the ACTD to an Air Force program of record in FY 2006. Transition is funded for the: RC-135 Rivet Joint; RC-130 Senior Scout; SIGINT components of the Distributed Common Ground System (DCGS) including the U-2; the Falconer Combined Air Operations Center (CAOC); and related Airborne Overheard Interoperability Office (AOIO) elements. Initial NCCT operations are slated for mid-2008. The U.S. Navy has funded engineering development of an automated M2M interface between NCCT and the Navy's CEC. The U.S. Navy is also assessing potential FY 2009 transition activities for specific NCCT integration on Navy systems. Based on their participation in the Trident Warrior 2005 demonstration, the United Kingdom has established a program across their air, land, and sea ISR systems called Project Listener with an initial operational capability (IOC) expected in 2010.

Program POC: Mr. John Wilcox, ODUSD (AS&C), (703) 697 5558, john.wilcox@osd.mil

Year: FY 2006

User Sponsor: U.S. Central Command (USCENTCOM)



NCCT Concept of Operations

Pathfinder

Background: The warfighter requires a real-time urban reconnaissance and surveillance capability for the Special Operations Forces (SOF) unit and small teams in hostile, high-threat urban environments. The Pathfinder ACTD assessed the demands of real-world concepts of operations by providing "on command" battlefield sensor monitoring for small-unit leaders using unattended sensors, unmanned systems (air and ground), and networked communications. Following the development, testing, and integration of Pathfinder components, the ACTD conducted a successful Military Utility Assessment with the 75th Ranger Regiment.

Success: The Pathfinder ACTD designed, developed, tested, trained users for, and fielded the Raven Small Unmanned Aerial System (SUAS). This system is successfully enhancing unit capabilities in reconnaissance, surveillance, force protection, convoy security, and intelligence gathering. The Pathfinder ACTD has delivered Ravens to U.S. forces in Afghanistan, with subsequent purchases and deliveries to U.S. Army and SOF in Iraq.

Current Status: In 2006, the Raven B was selected as the material solution for the combined U.S. Army and USSOCOM SUAS Program of Record with a planned acquisition of more than 700 systems.

Program POC: Andrew J. Mawn, Technology Manager, Andrew.Mawn@us.army.mil

Year: FY 2006

User Sponsor: U.S. Special Operations Command (USSOCOM)

BATTLESPACE AWARENESS

Targeting/Weaponeering Assistance Cell Analysis Support

Background: In support of Operation Iraqi Freedom, DTRA created the Targeting/Weaponeering Assistance Cell (TWAC) as a reachback organization to conduct defeat planning for hard and deeply buried targets (HDBTs). The targeting cell assisted U.S. Air Force, U.S. Central Command (USCENTAF) theater air campaign planners, U.S. Central Command (USCENTCOM) hard target defeat planners, and the Hard Target Research and Analysis Center in target planning against specific HDBTs. Primary TWAC products included Response Surface Maps (RSMs), Integrated Munitions Effects Assessment (IMEA) deterministic attack solutions, and overall weapon, fuze, and attack recommendations for the warfighter.

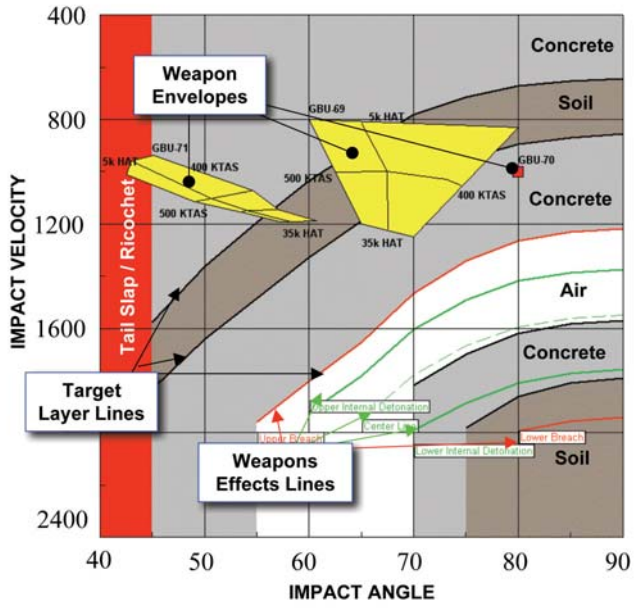
Success: The TWAC, part of Plan and Attack Technologies (DTO JC.34), has developed the Bunker RSM tool, incorporating it into the IMEA 6.0 mission planning software used for hard target defeat (HTD) planning. The RSM tool assists the warfighter in quickly determining whether or not a warhead has the potential to penetrate a bunker target, eliminating the guesswork previously required to develop a viable weaponeering solution. The TWAC has also designed the Warfighter Wizard (WFW) to assist warfighters in HTD planning for tunnel targets. The WFW develops possible viable solutions based on commander's intent and the missions of the tunnel facility, and ranks the solutions based on probability of success. The warfighter concentrates on attack recommendations that have a greater probability of success and avoids the tedium of checking all solutions. The WFW has been incorporated into IMEA 7.0.

The TWAC is also the premier program for conventional hard target technology transfer to the warfighter. The TWAC has taken the above tools to operational units in USCENTCOM, U.S. Forces Korea, U.S. Strategy Command (USSTRATCOM), U.S. Pacific Command (USPACOM), U.S. Southern Command (USSOUTHCOM), and U.S. Joint Forces Command (USJFCOM), as well as several stateside operational support squadrons for F-15E, F-16, F-117, B-52, and B-2 aircraft. The TWAC has shown how to apply the lessons learned from 15 years of DTRA HTD testing to targets of interest to the units with the above software. The TWAC has also been invited to the USAF Weapons School at Nellis Air Force Base (AFB), the Combat Targeting Course at Goodfellow AFB, and the Joint Targeting School at Dam Neck, VA to present the HTD lessons learned and incorporate those lessons into the curricula of these schools. Target recommendations from operational units are beginning to show the direct application of the technology and lessons learned, and many units are requesting from DTRA the software and HDBT defeat academics.

Program POC: Mr. Nicholas Leon, 703-767-4120, DTRA/RD-CXSS, nicholas.leon@dtra.mil

Year: FY 2006

Bunker Response Surface Map (RSM) (U)



(U) Weapon Envelopes (in Yellow)

- Points from weapon release envelope and their expected impact conditions
- Envelopes have constant delivery airspeed and altitude "lines"
- Red dot is a JDAM point solution

Bunker Cross Section

(U) Abbreviations: Height Above Target (HAT)
Knots True Airspeed (KTAS)
Milliseconds (msec)
Degrees (deg)
Center of gravity (CG)

The Bunker RSM quickly identifies which inventory penetrator weapons can hold a bunker target at risk. The graphic includes penetrator performance for all impact conditions and weapons effects, all as a function of fuze setting.

SPARTAN Scout Unmanned Surface Vehicle

Background: Recent attacks by nonconventional and terrorist forces have shown there is a need to address force protection issues of naval assets and shore-based facilities. SPARTAN Military Utility Assessments (MUAs) were conducted in FY 2006 for the Intelligence, Surveillance, Reconnaissance (ISR)/ Force Protection (FP) and littoral Mine Warfare (MIW) mission modules, and with ACTD partner, Republic of France, for the Antisubmarine Warfare (ASW) mission module. The MUAs evaluated several overarching SPARTAN Scout ACTD goals, including: extending surface and subsurface detection ranges; establishing defensive barriers; reducing risk to personnel and capital assets; serving as a force multiplier/leveler; allowing warfighters to focus limited resources on the application of combat power; and providing the capability to maintain high combat operational tempo.

Success: The SPARTAN ACTD demonstrated the military utility of unmanned surface vehicles (USVs) as extended sensor and weapons platforms conducting ISR, FP, MIW, and ASW missions in support of naval operations. The open-architecture command and control (C2) element of the Core System will serve as the baseline control system for USVs of all types on the LCS. U.S. Navy LCS Program of Record (POR) will incorporate USV technology developed and matured in the SPARTAN ACTD in the form of specific, self-contained mission packages. These are based on 11-meter USVs to conduct focused mission execution in MW, ASW, and surveillance/force protection. Additionally, documentation developed by the SPARTAN team, including performance specifications, concepts of operation, interface design, training, and maintenance, will serve as the initial baseline for future USV development in both the U.S. Navy and U.S. Army.

Current Status: The SPARTAN USV Core System and C2 technology was identified by U.S. Navy Program Executive Office Littoral and Mine Warfare, PMS-420 for transition into the LCS POR.

Program POC: Mr. M.K. Tribbie, ODUSD AS&C, 703-601-2124, m.tribbie.ctr@osd.mil

Year Completed: FY 2006

User Sponsor: U.S. Pacific Command


BATTLESPACE
ENVIRONMENT

Battlefield Renewable Integrated Tactical Energy System

Background: Former Secretary of the Air Force James Roche challenged AFRL to reduce the weight of the equipment that special operations soldiers were required to carry. Battery weight is the largest single weight component, and AFRL laid out a plan to reduce that weight by 50% over three development spirals.

Success: The Battlefield Renewable Integrated Tactical Energy System (BRITES) Spiral 1 system provides battlefield airmen with a portable power system that is 25% lighter than carrying single-use batteries normally carried for special operations missions. This power system reduces the soldier's load by 8 lb for 1- to 3-day missions. The system provides power to all equipment carried, eliminating the need to carry spare batteries for each different device. In addition, the power system offers the capability to harvest and store energy from various power sources as they are encountered, which extends mission lengths between resupply. The system architecture is flexible, allowing the system to be scaled to fit the needs of changing missions. Because a rechargeable battery is employed that can be recharged overnight, units no longer need to waste single-use batteries on training missions, providing up to $700 per man/per day savings to the unit. Estimated savings for battlefield airmen units could exceed $2M a year.

AFRL provided the technical expertise to the Battlefield Airmen Program Office to demonstrate that the systems met the needed technical objections before fielding. This close cooperation between AFRL and the Program Office slashed development time and allowed the system to transition from AFRL directly to a Milestone C approval decision with the Program Office. This system is now under production contract with the Program Office.

Program POC: Lt Josh Johnson, AFRL/PRPS, 937-255-0654

Year: FY 2006

Lightweight BRITES components

Cooperative Operations in Urban Terrain

Background: The Cooperative Operations in Urban Terrain (COUNTER) program developed a system whereby a single operator has the necessary technology to use multiple unmanned aerial vehicles (UAVs) to collect detailed video intelligence of cluttered urban environments. A flight test demonstration culminated 2 years of work.

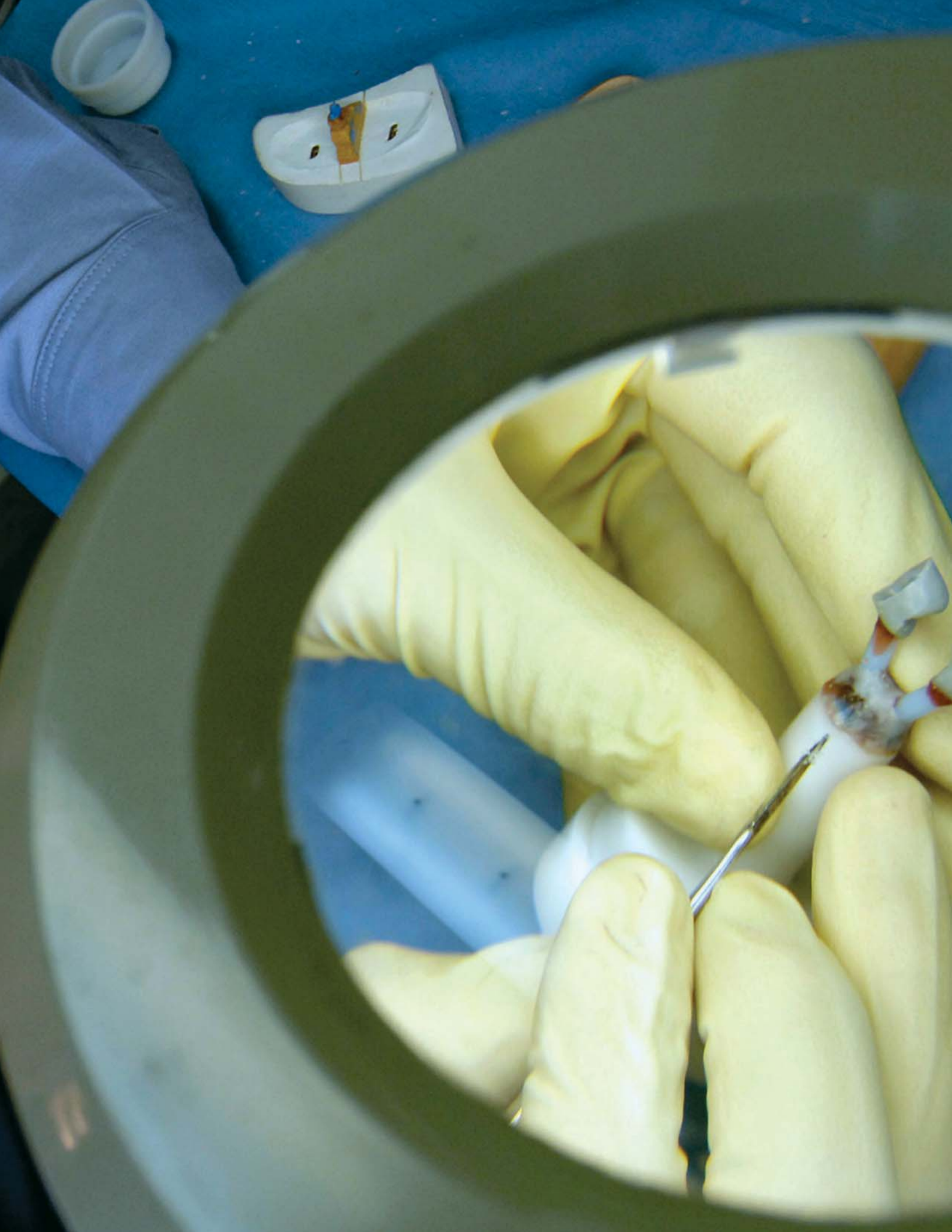
Success: AFRL engineers used UAVs to conduct flight tests, which will provide special operations forces with greatly improved situational awareness in urban environments. Originating with basic research, the COUNTER program developed cooperative control software algorithms and integrated them with a multi-UAV control station. AFRL developed and demonstrated a flight test system in which three UAVs flew in cooperation over an urban area. Each UAV was autonomously tasked with visiting specific targets in order to maximize the allowable flight time and capability of each vehicle. All targets within the urban environment were successfully surveilled by the UAVs. The next technical objective is to control the flight of five coordinated UAVs in FY 2007. The technology has been selected for participation in an upcoming Pacific Command Talisman Saber 07 combined US–AUS exercise.

Program POC: Capt. Nidal Jodeh, AFRL/VACA, DSN 785-8495

Year: FY 2006

As part of the COUNTER project, AFRL scientists used UAVs


BIOMEDICAL



Hemorrhage Control

Background: Uncontrolled hemorrhage remains the leading cause of death on the battlefield, and extremity wounds remain the predominant injuries. Despite advanced capabilities in body armor and combat tactics, a significant proportion of those wounded still bleed to death.

Success: The Marine Corps has adopted QuikClot, made from zeolite, for individual carry by every Marine because it was the most effective agent tested for external use. However, the heat generated by this product, when exposed to large volumes of blood, prevents its use as a first-line agent. Thus, it is reserved only for use when all other attempts to control hemorrhage have failed. Recent research has produced modified zeolites, which are cooler, highly effective, and can deliver additional pro-coagulant agents and antibiotics. Four new products have resulted from this research. The focus of Navy hemostatic research efforts has now shifted to controlling internal bleeding, and several technologies, including nanotechnology to develop effective clotting agents, are being evaluated. Navy-sponsored research has previously developed freeze-dried platelets, which have a long shelf-life and are easily reconstituted, to answer the critical demand for platelets in the battlefield. This platelet product has been licensed to industry (Entegrion) and will be entering clinical trials testing hemorrhage control in 2007. Navy-sponsored research has also demonstrated the effectiveness of using salmon fibrinogen in dressings as a substitute for human fibrinogen, and is investigating ways to more effectively employ fibrinogen and rFVIIa for the control of internal bleeding. The Navy has evaluated using abdominal insufflation as a means to control internal hemorrhage; completed evaluation of arterial shunts (time to occlusion) in a model of vascular injury; and sponsored a study evaluating tourniquets under conditions unique to naval forces. These efforts have saved the Marine Corps over $5M.

Program POC: Dr. Michael B. Given, Casualty Care and Management, ONR, 703-696-4055, givenm@onr.navy.mil

Year: FY 2006

QUICKCLOT HEMOSTATIC AGENT

Fluid Resuscitation and Prolonged Life Sustainment on the Battlefield

Background: The objective of this research was to identify pharmacologic agents (drugs) that reduce mortality due to hemorrhagic shock. The net result of these studies will be effective resuscitation of battlefield casualties through the administration of a drug and with minimal use of fluids. Technical challenges are many and varied because the body's response to trauma, hemorrhage, and resuscitation is very complex. Not only does hemorrhage induce unique patho-physiology, but the use of resuscitation fluids to treat the casualty can have undesirable effects.

Success: The results of this research have demonstrated that vasopressin can reverse hemorrhagic shock when the casualty is refractory to other pressor agents and fluids. Further, it has been demonstrated that a single subcutaneous injection of androstenetriol, or AET, reduces mortality from hemorrhagic shock by 25%, and KATP-channel inhibitors improve outcome by 50% after 72 hours without fluid resuscitation. Trans-sodium crocetinate, or TSC, is a drug that has been shown to reduce mortality in hemorrhagic shock by reducing ischemic injury in tissues. All three drugs mentioned have been licensed to pharmaceutical companies for advanced development. The research has also demonstrated that manipulation of gene transcription by FDA-approved drugs reduces mortality resulting from hemorrhagic shock. The payoff to the warfighter is that pharmacologic resuscitation has the potential to significantly increase the survival rate of combat casualties with a simple injection that mitigates cellular and organ damage resulting from hemorrhagic shock. The use of drugs for resuscitation, in the absence of fluids or with reduced fluid need, will decrease the incidence of coagulopathy induced by resuscitation fluids and will reduce death due to hemorrhage. The use of drugs and low-volume fluids to resuscitate casualties will also reduce the logistical burden related to transportation and storage of bulky fluids, as well as the burden on combat corpsmen/medics who have to carry these fluids in the field.

Program POC: Dr. Michael B. Given, Casualty Care & Management, ONR, 703-696-4055, givenm@onr.navy.mil

Year: FY 2006

Surviving Blood Loss (SBL)

Background: The objective of the Surviving Blood Loss program is to delay the onset of hemorrhagic shock due to blood loss by reducing cellular oxygen demand. This will require developing a fundamental understanding of the mechanisms of oxygen use in cells, as well as the degradation mechanisms caused by lack of oxygen and how to reduce them.

Success: Several Surviving Blood Loss (SBL) program researchers advanced ahead of schedule.

Blood loss and its associated complications account for approximately 50% of battlefield fatalities. The Surviving Blood Loss (SBL) program aims to delay the onset of irreversible shock following hemorrhage by developing low-volume therapies to maintain the warfighter for hours when resuscitation is not available. Two teams have advanced ahead of schedule using metabolic rate reduction with hydrogen sulfide and hormone-induced resistance to shock.

Previous efforts to reduce blood loss and its associated complications have focused heavily on the development of resuscitative fluid products as replacements of lost blood. This strategy is based on the fact that any significant reduction in the circulating blood volume reduces the body's ability to supply the O2 and metabolites needed for tissue survival. The approach is difficult to implement under battlefield conditions due to the relatively large volumes of fluid needed.

To address this problem, the Defense Sciences Office's Surviving Blood Loss program has challenged the scientific community to develop low-volume therapies that reduce tissue demand for O2 and metabolites when full resuscitation is not available. Two teams have made significant progress toward addressing the program's goal including:

- Metabolic rate reduction using Hydrogen sulfide: Researchers at the Fred Hutchinson Research Center and the University of Washington demonstrated that exposure of hemorrhaging rats to non-toxic levels of H2S (≤ 300 ppm) results in a survival rate greater than 85%. While none of the control group survived, H2S-treated animals resuscitated after the 3-hour period survived indefinitely and displayed no adverse behavioral effects. The treatment is hypothesized to reduce cellular O2 consumption by both reversibly inhibiting the mitochondrial enzyme cytochrome oxidase and by acting as an electron acceptor alternative for oxygen.

- Hormone-induced Resistance: Based on their previous demonstration that mature female rodents are more resistant to trauma-related sepsis compared to mature males, Dr. Irshad Chaudry and colleagues (U. Alabama-Birmingham) are investigating the induction of temporary resistance to hemorrhagic shock provided by the female hormone 17β estradiol (E2). The group has demonstrated a 75% survival rate for E2-stabilized male animals subjected the 60% hemorrhage. The mechanism of action is likely related to suppression of the inflammatory response associated with infection and injury. If found effective in large animals, application for approval for this use in humans will be aided by the fact that Estradiol is already an approved drug for human use.

As a result of the teams' significant progress, they have progressed to the next phase ahead of schedule and will be working on techniques to sustain the warfighter for longer periods of time following hemorrhage.

POC: DARPA External Relations, 703-696-2404

Year: FY 2007

Virtual Autopsy

Background: The Virtual Autopsy program has integrated state-of-the-art multi-detector CT (MDCT) into the forensic investigative process at the Charles C. Carson Center for Mortuary Affairs, Dover Air Force Base, DE where the fallen heroes of Operations Iraqi and Enduring Freedom are processed. Virtual Autopsy began to establish the theoretical, scientific, and medical basis for using advanced imaging as part of autopsy and forensic investigation, and to develop innovative automated approaches to aid the autopsy process.

Success: Virtual Autopsy has provided a new source of forensic information through the analysis of three-dimensional MDCT data sets. Applying MDCT Virtual Autopsy to conventional autopsy has given the Office of the Armed Forces Medical Examiner the unique capability of augmenting the autopsy process with MDCT imaging findings and permanently archiving the anatomic findings at the time of death, thereby providing current and future researchers with a vast library of permanent anatomic records of fatal injuries incurred on the modern battlefield. The goal of the Virtual Autopsy program was to develop a new concept in post-mortem examination to complement current procedures by increasing both the accuracy and speed of performing autopsies as well as making the physical autopsy less invasive. It has also provided information that has lead to a better understanding of wartime injuries and, thus, the development of improved protective equipment.

DARPA's Virtual Autopsy program seeks to create mathematical modeling approaches to develop a computational representation of an individual deceased soldier that can be used to analyze the cause and mechanism of injuries to augment medical care on and off the battlefield. Using Computed Tomography (CT) scans and sophisticated segmentation software, a full 3-D reconstruction and re-association can be made of each human body part.

The Virtual Autopsy program aimed to provide data on wound ballistics and metal fragment distribution in order to enhance the development of superior body armor and personal protection equipment.

DARPA researchers used commercial segmentation software, which automatically reconstructs the individual organs and tissues of the body, to detect fragments and metal for analysis. In over 300 cases, there was accurate matching of the segmented fragments with the actual fragments removed during autopsy. This has resulted in a dramatic reduction in time to perform the autopsy in addition to greatly increased fragment retrieval for forensic purposes.

Due to the success of this program, Virtual Autopsy technology has been adopted internationally by several civilian institutions. The Victorian Institute of Forensic Medicine, located in Melbourne, Australia has installed a MDCT scanner and has been in collaboration with the U.S. VA team for over one year to date. Both The Office of the Chief Medical Examiner of Baltimore MD, and New York OCME are planning on installing MDCT equipment in their facilities in the near future.

POC: DARPA External Relations, 703-696-2404

Year: FY 2006

CHEMICAL & BIOLOGICAL


U.S. AIR FO

Joint Chemical, Biological, and Radiological Agent Water Monitor

Background: The Joint Chemical, Biological, and Radiological Agent Water Monitor (JCBRAWM) will provide the capability to detect, identify, and quantify the presence of chemical, biological, and radiological (CBR) contamination in water. Joint forces need the ability to determine the presence or absence of CBR agents in water sources that the joint forces will use, consume, or contact. The JCBRAWM will detect and identify CBR agents as part of three water-monitoring missions: source site selection, treatment verification, and quality assurance of stored and distributed product water. The program schedule called for evolutionary development with five capability increments.

Success: On 16 October 2006, DTRA delivered Increment 1 of the JCBRAWM from the testing and evaluation phase to the JPEO for the technology acquisition phase. Increment 1 delivers three technology components: (1) a microarray of multiplexed assay, (2) a handheld reader, and (3) a pathogen concentrator.

(1) **Microarray of multiplexed assays:** Lateral flow immunoassay is the base technology used to detect pathogens and toxins. Novel materials were developed to allow multiple immunoassays to be spotted on a single test strip (current industry capability is one assay per test strip). There are four different target threat assays on one strip with two spots per target assay, providing a total of eight tests on a single strip.

(2) **Handheld reader:** The microarrays can be read either visually or electronically. The reader will help reduce errors created by poor lighting, stressful events, and the operator's lack of expertise. The reader will also archive the data in electronic file format.

(3) **Pathogen concentrator:** Pathogen detection is dependent on being able to capture, concentrate, and recover the pathogens due per the requirements to detect trace quantities. A breadboard system has been developed for concentrating pathogens 1000:1 from drinking water. These will allow additional biological agents to be detected.

Benefits to the warfighter include:

- The ability to identify CBRN hazards in food, water, and environmental samples
- Improved awareness/protection
- The ability to warn before contaminated water is consumed.

Program POC: Ngai Wong, Ph.D., DTRA, 703-767-3314, ngai.wong@dtra.mil

Year: FY 2006

Service/Agency: Defense Threat Reduction Agency (DTRA), Joint Program Executive Office for Chemical-Biological Defense (JPEO-CBD)

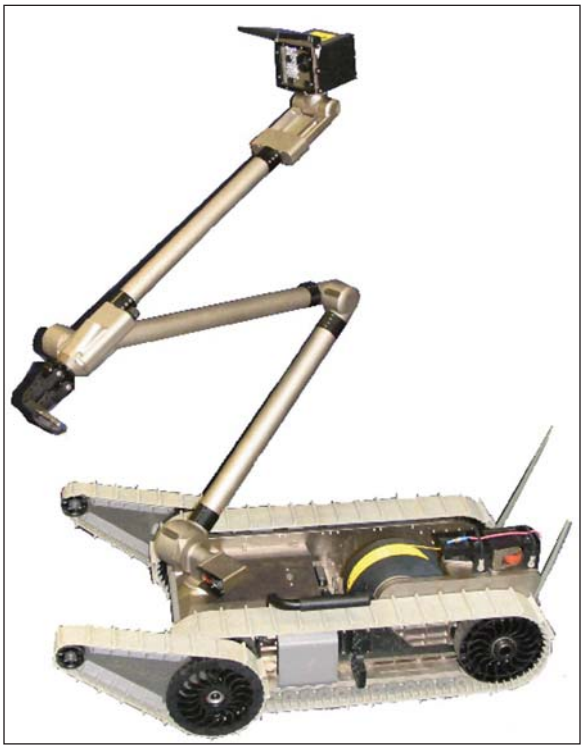
Water storage bladders

Reverse osmosis equipment

Ship in port replenishing water supply

Chemical, Biological, Radiological, and Nuclear Unmanned Ground Reconnaissance ACTD

Background: The purpose of the Chemical, Biological, Radiological, and Nuclear Unmanned Ground Reconnaissance (CUGR) ACTD is twofold: to develop an advanced sensor capability for near-real-time chemical detection and identification for manned platforms; and to demonstrate the military utility of unmanned platforms for chemical, biological, radiological, and nuclear (CBRN) reconnaissance. These enhancements will provide the combatant commander with continuous and critical CBRN situational awareness while reducing the risk to maneuvering and supporting forces.



CBRN Unmanned Ground Vehicle

The objective of the first technology thrust area is to improve the speed and capability of manned NBC reconnaissance vehicles by replacing the current double-wheel sampler system with the Joint Contaminated Surface Detector (JCSD). The JCSD employs laser technology to detect and identify liquid and solid chemical contamination on the ground. Target surfaces are interrogated by laser, and contaminants in the field of view are identified through analysis of their signal against a wide library of spectra. The speed of the laser technology will permit current and future CBRN reconnaissance assets to keep pace with maneuver forces, which is an improvement over existing technology.

In the second technological thrust, the objective is to expand NBC reconnaissance capability in restricted terrain through the use of the CBRN Unmanned Ground

Vehicle (CUGV), a small, short-range reconnaissance robot. Sensors integrated on the robot will allow it to detect and immediately report contamination, as well as collect aerosol samples for further analysis. Survey teams will be able to remotely operate the CUGV from a vehicle or from a protected position. This will eliminate the requirement for the warfighter to manually perform reconnaissance operations in potentially hazardous environments and will minimize exposure to contamination.

Success: The CUGR ACTD completed the technology integration and technical demonstration phase for the JCSD and CUGV in May 2006, and completed an operational demonstration in September 2006. The ACTD Residual Phase for the CUGV began in FY 2007, with the demonstration unit receiving two systems along with sustainment support through FY 2008. Although the JCSD technology and science were proven, there were too many hardware and software issues to support a positive Military Utility Assessment or Residual and Transition decisions. The JCSD will undergo additional integration and technical demonstration activities prior to being issued to the demonstration unit. Additionally, lessons learned, improved concepts of operation, tactics, techniques and procedures, and training support packages developed during the ACTD will be incorporated into joint and service training and doctrinal publications.

Program POC: LTC Tony Bullock, DTRA CBX, 703-767-3440, Tony.Bullock@dtra.mil

Year: 2006

User Sponsor: U.S. Pacific Command

Participating Services/Agencies: The Defense Threat Reduction Agency (DTRA), in conjunction with the Office of the Deputy Under Secretary of Defense for Advanced Systems and Concepts (ODUSD(AS&C)), manages the Chemical, Biological, Radiological, and Nuclear Unmanned Ground Reconnaissance (CUGR) program as the executing agent. The U.S. Army is the lead service, and U.S. Pacific Command is the sponsoring combatant command. The U.S. Army Edgewood Chemical Biological Center is the ACTD technical manager, the Joint Project Manager NBC Contamination Avoidance is the transition manager, and the U.S. Army Pacific is the operational manager. The U.S. Army Pacific designated the 95th Chemical Company, Ft. Richardson, AK, from U.S. Army Alaska as the demonstration unit.


COMMAND &
CONTROL

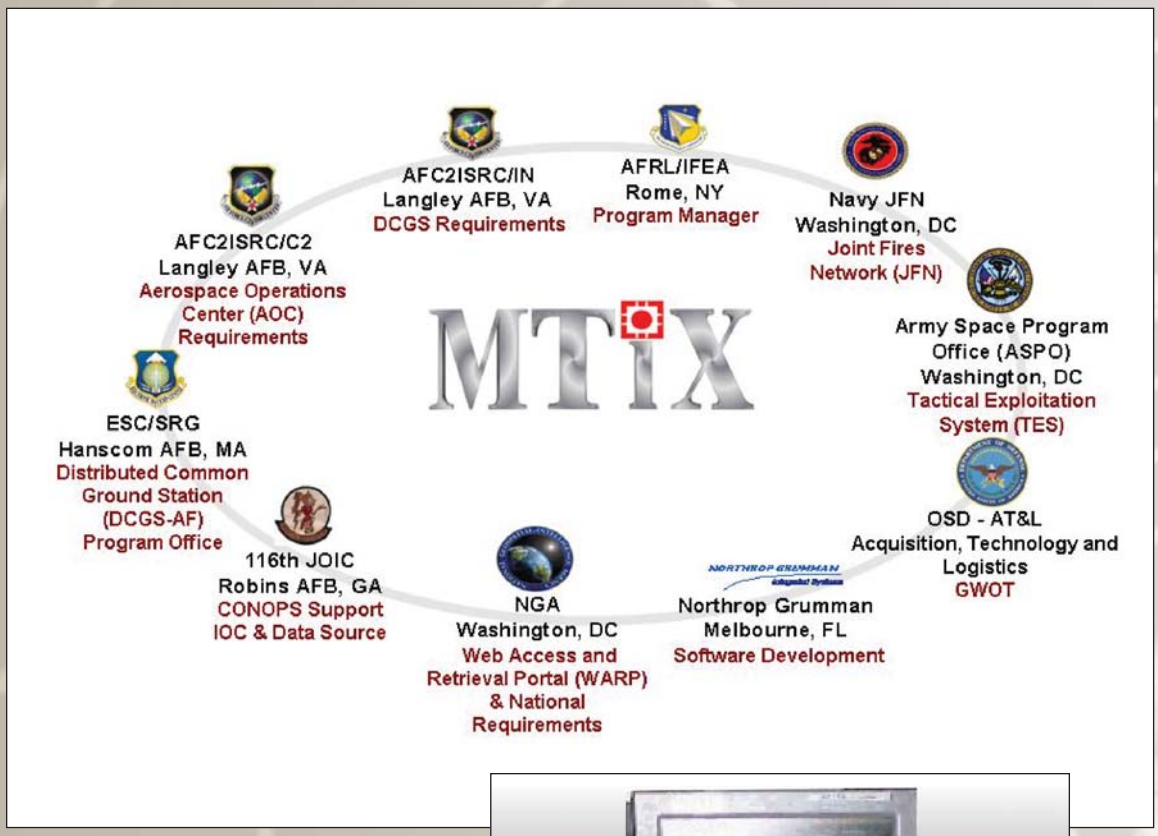
Moving Target Information Exploitation

Background: Moving Target Information Exploitation (MTIX) provides a Web-based access and retrieval system for dissemination of moving target information from Joint Surveillance and Target Attack Radar System (STARS). This capability supports multinational forces and various intelligence agencies of the U.S. MTIX provides an enhanced operational capability to automatically exploit moving-target-indicator (MTI) data in order to locate, identify, and track high-value moving ground targets.

Success: AFRL scientists supported MTIX development, which provides a Web-based access and retrieval for dissemination of moving target information from Joint STARS. The capability reduces time to analyze data to find improvised explosive devices (IEDs) and increases the capability to find, fix, track, apprehend, and kill high-value targets. AFRL scientists processed data from Iraq, fused the data with significant activity events, added it to the database, and disseminated the results. This support was used by multinational forces to task analysts that led to IED event location.

Program POC: Jon Jones, AFRL/IFEA, DSN: 587-3037

Year: FY 2006



Many organizations make MTIX work

MTIX console

Digital Planning Tools for Joint Ground Warfare

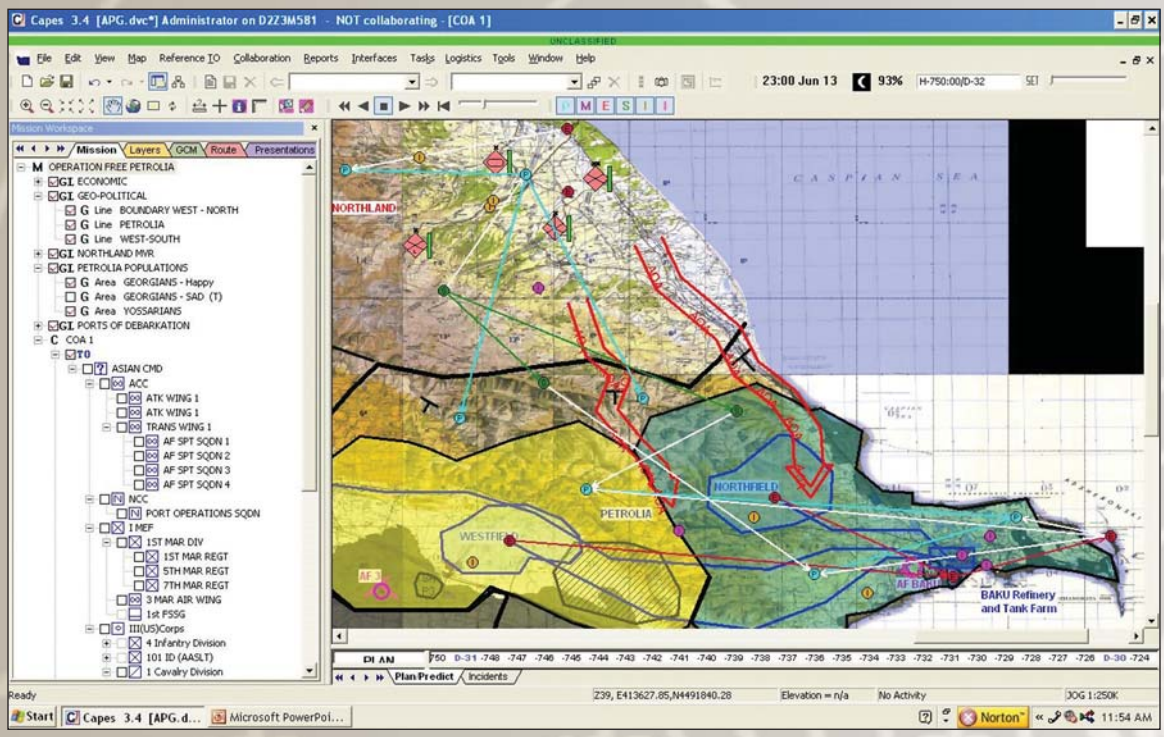
Background: The Agile Commander ATD successfully built digital planning solutions for the U.S. Army that are being used throughout the Service. The primary product was the Combined Arms Planning and Execution System (CAPES). The goal of this Technology Transition Initiative (TTI) project was to use proven planning and decision support solutions from Agile Commander and CAPES to create a Stability and Support Operations (SASO) and Military Operations on Urbanized Terrain (MOUT) operations planning capability for Joint forces via the Joint Common Tactical Workstation (JCTW).

Success: This TTI project successfully added an asymmetrical warfare planning capability to JCTW. Planning software tools that support determination of the most effective combination of tasks across the Diplomatic, Information, Military, and Economic (DIME) spectrum were transitioned to operational use. Mission planners are able to use resultant digital planning tools to execute MOUT and SASO tasks in their planning activities. Both I Marine Expeditionary Force (IMEF) and 101st AAD took early versions of this capability to Iraq during their Operation Iraqi Freedom rotations in FY 2006. In-theater support was provided to IMEF in FY 2007. Additionally, Joint Forces Command has included this effort as part of their PMESII Center of Excellence, and is exploring integration with other asymmetrical warfare models in support of Operation Enduring Freedom.

Current Status: This capability is transitioning to U.S. Army (PM Maneuver Control System) and U.S. Marine Corps (Command and Control Personal Computer) program offices, with the first software release for each program in 2007.

Program POCs: Mr. Stephen Kostek, PEO IEW&S, 732-427-1866, stephen.kostek@us.army.mil; Mr. John Soos, Army RDECOM CERDEC, 732-427-3723, john.soos1@us.army.mil

Year: FY 2006



Screenshot from CAPES


FOCUSED
LOGISTICS

Fiber Grating Sensor for Damage Assessment

Background: Originally developed for monitoring the strength of solid rocket motor casings, the fiber-optic grating systems can also be used to monitor the structure of aircraft, buildings, bridges, roadways, and hydrogen fuel tanks for future hybrid vehicles.

Success: Fiber grating sensors are possible based on the observation that when a part in a fiber-optic sensor grid undergoes strain or deformation, the light transmitted through the fiber is altered, thereby signaling a potential problem. Fiber-optic sensors can be readily embedded in a structure or applied on the surface of a part. Multiple fiber-optic sensors can be distributed throughout a material and their functions can be monitored and recorded by simple signal transducers or computers. The data they provide can be analyzed to determine the location and the severity of the damage on either a continuous basis or in a periodical query of the system.

In commercial applications, these fiber grating sensor systems have been tested in two bridge locations in Oregon where the sensors were able to detect the presence of people merely standing on the bridge surfaces, and to assess traffic types. In other applications, such as in the wing of an airplane, the potential sensitivity of these systems enables them to determine the location, severity, and type of strain (or damage) in the medium in which they are embedded, providing technicians with critical information on the status of aircraft parts. In manufacturing applications, the sensors can be used to determine the rate and cure of composite materials, helping to ensure the integrity of the manufactured part. General applications are in aerospace, civil and government engineering concerns (roadways, bridges, buildings), composite structures that bear load, environmental sensing systems (temperature, humidity), oil and gas industry, naval industry, and hybrid vehicle hydrogen fuel tanks.

MDA funded a Phase II SBIR that concluded in 2006 for a very specific subset of applications (solid rocket motor casings for missiles), and is credited with providing a source of cascading refinements to this technology. The U.S. Army is continuing follow-on efforts with its "Embedded Sensor Technology for Solid Rocket Motor Health Monitoring" program.

POC: Mr. Paul Koskey, MDA/DVI, 703-882-6154

Year: FY 2006/2007

Fiber-optic strain gauges can be used to assess the integrity of railroad trestles.

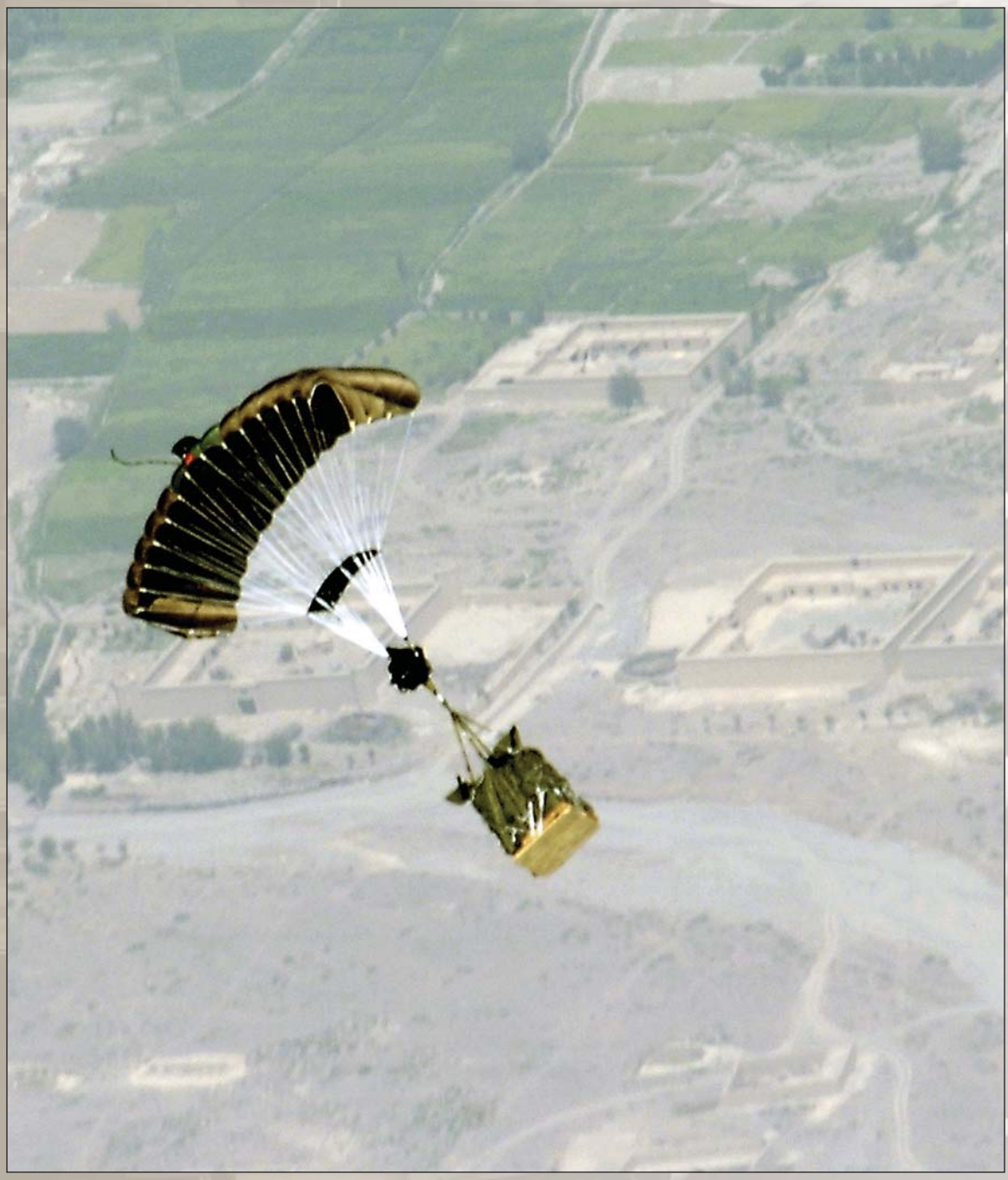
Joint Precision Air Drop System

Background: The dilemma for airdropping supplies has been a stark one, high-altitude airdrops often go badly astray, while low-level drops create significant dangers from enemy fire and reduce range. By using Global Positioning System (GPS) and electro-mechanical steering actuators, the Joint Precision Air Drop System (JPADS) allows air-dropped cargo to self-steer to precise drop zones.

Success: AFOSR joined with the U.S. Army to improve precision air delivery capability. AFOSR provided seed money for mission planning software and associated hardware, then coordinated the basic research and resulting development of critical technologies for wind calculation, on-board computational, and release point determination algorithms. JPADS provides a high-tech, high-altitude precision airdrop cargo delivery capability that has been transitioned through rapid combat fielding to the warfighter and is being used in Afghanistan and isolated locations throughout the world. This provides a just-in-time resupply capability to remote locations not accessible by convoys and in some cases helicopters. It also increases survivability of critical supplies compared to current high-altitude systems due to a lower rate of descent at impact. JPADS is an affordable, reliable, and safe means to achieve GPS-accurate airdrop delivery using existing Army cargo parachutes.

Program POC: Dr. Thomas Kim, AFRL/AFOSR, DSN: 426-1141

Year: FY 2006



A new Global Positioning System-guided Joint Precision Air Drop System bundle, known as Screamer 2K, floats to the ground after being dropped from the back of a C-130 Hercules

Unattended Sea-Bed Power for In-Water Operations (BUG)

Background: Networks comprised of thousands of low-power consuming (ca. up to 1 W) unattended sensors distributed in coastal waters are envisioned to play a central role in the Navy of the future. A key issue confronting implementation of these networks will be power. While batteries are presently the power supply of choice for individual sensors, their finite energy capacity, which limits sensor duration, will make networks of many sensors logistically unfeasible. This effort was directed at determining practical feasibility of harvesting useful electrical power to persistently operate sensors from oxidation of sedimentary organic matter with oxygen in overlying water.

Success: The Unattended, Sea-Bed Power for In-Water Operations program successfully demonstrated a meteorological data buoy in the Potomac River and off the coast of New Jersey. It was solely powered by a Benthic Unattended Generator (BUG) configured in a practical and cost-effective form. The BUG-powered buoy (presently operating in the Great Bay Estuary in NJ) transmits real-time meteorological data every 5 minutes via an RF link. BUGs are fuel cells consisting of graphite anodes embedded in marine sediment connected through an electrical circuit (i.e., the buoy electronics package) to graphite cathodes positioned in overlying water. The cathode is similar to those used in galvanic seawater batteries, which are well known to effect reduction of oxygen. At the anode, a microbial biofilm spontaneously forms, which is enriched by two types of sedimentary microorganisms. The first couples oxidation of sedimentary acetate with reduction of insoluble mineral oxidants. These microorganisms recognize the anode as an inexhaustible oxidant owing to its electrical connection to the cathode, proliferate on the anode, and utilize their ability to reduce insoluble oxidants to directly transfer electrons without reliance on electron-transfer mediator. The second oxidizes elemental sulfur to sulfate; the former generated at the anode by oxidation of sedimentary sulfide. By oxidizing sulfur, these microorganisms remove a potentially fouling precipitate from the anode. Collective activity of the biofilm and continuous flux of fuel by diffusion through sediment ensure indefinite operation of BUG. Present activity is focused on configuring a BUG to power an oceanographic conductivity temperature depth mooring, and initiating applications to persistently power sensors for antisubmarine warfare applications.

Program POC: Leonard M. Tender, Ph.D., Center for Bio/Molecular Science and Engineering, Naval Research Laboratory Code 6900, Washington, DC 20375, 202-404-6029, Tender@nrl.navy.mil.

Year: FY 2006

Naval Research Laboratory marine bio-fuel cells

Automated Storage and Retrieval System

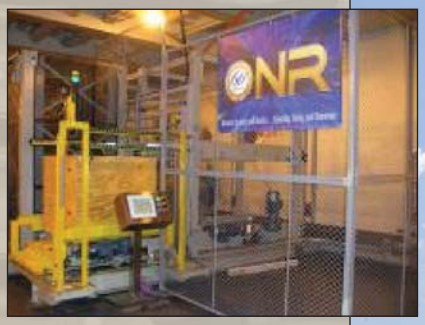
Background: The Automated Storage and Retrieval System (ASRS) designed, developed, and demonstrated automated warehouse technologies specifically tailored to the storage holds on the new T-AKE Class dry cargo/ammunition ship. The ASRS handles all standard Navy pallets and Joint Modular Intermodal Containers (JMICs) while restraining loads at all times. The key challenge was designing the system to be compatible with the shipboard environment, including accommodation of ship motion and shock requirements and providing full load restraint of the stowed loads. Another key design objective was to increase the throughput and selectivity capability to achieve higher efficiencies while maximizing packing density.

Success: A full-scale partial segment of the ASRS design was successfully built and tested in a land-based demonstration (July 2006) with palletized loads and JMICs. In September/October 2006, the land-based demonstrator was successfully operated and tested at sea aboard the USNS Red Cloud. Operational Logistics (OpLog) Integration Program, PMS-325, and industry are all funding follow-on research and development (R&D) efforts. OpLog and PMS-325 have agreed on a larger scale R&D test article for installation on a T-AKE in the first quarter of FY 2008, and industry is using Internal Research and Development funds to perform accelerated wear analysis. Target platforms for this effort are PMS 325 seabasing support vessels.*

Program POC: Tracy Frost, ONR, 703-696-3196, frostt@onr.navy.mil

Year: FY 2007

* The full-scale partial segment of the ASRS design was demonstrated aboard the USNS Red Cloud during the PMS 325 MPF(F) R&D FY 2006 At-Sea Test, Aug/Sept 2006 for concept evaluation only and should not be construed as Navy or PMS 325 support for continued development of the system or as intent to procure the system.



ASRS Demonstrator onboard the USNS Red Cloud for sea-based testing

ASRS Demonstrator on 3.5° pitch / 8°roll platform for land-based testing

FORCE APPLICATION

Thermobaric Weapon ACTD

Background: The Thermobaric Weapon ACTD focused on leveraging emerging explosive, guidance, and warhead concepts to design, weaponize, demonstrate, and deliver an enhanced air-to-ground weapon that will significantly improve the warfighter's capability to defeat military activities protected in tunnels. The three key focus areas of the design for the system are: (1) a new warhead case (designated BLU-121A/B) that balances explosive volume with warhead survivability for the employment method, (2) an explosive fill with improved airblast capabilities to maximize effects for defeating tunnel targets, and (3) an EGBU-15 guidance kit with software modifications designed to optimize attacking tunnel targets. After completing the design process and subsystem testing for the weapon system, the program conducted full-scale static tests at the White Sands Missile Range (WSMR) Capitol Peak tunnel complex. This static testing established both the baseline and BLU-121A/B weapon's capabilities, aided in the planning tools development, and provided data for a Military Utility Assessment. The ACTD then conducted four operational flight demonstrations at WSMR. Each flight test consisted of a weapon being released from an F-15E aircraft, operated by the 422 Test and Evaluation Squadron, and using the concepts of operation, planning tools, delivery tactics, and procedures developed by the program to verify the operational effectiveness of the weapon for functionally defeating underground tunnel facilities.

EGBU-15

Success: The Thermobaric Weapon was successfully developed and the subsystem tested during FY 2003/2004. During FY 2005, the program completed warhead qualification and insensitive munition testing, and conducted full-scale performance testing. The tests met all program objectives in warhead performance and suitability. In FY 2006, the Air Force Operational Test and Evaluation Center and the U.S. Forces–Korea both conducted independent evaluations of the weapons performance. Both evaluations were positive and supported fielding the weapon system in the Air Force inventory. The Air Force has delivered an initial capability to the theater. The Air Force and Department of Defense are evaluating additional procurement requirements as part of the FY 2008 Defense budget.

Program POC: Mr. Tony Pang, 703-767-4878, DTRA/RD-CXSH, Anthony.pang@dtra.mil

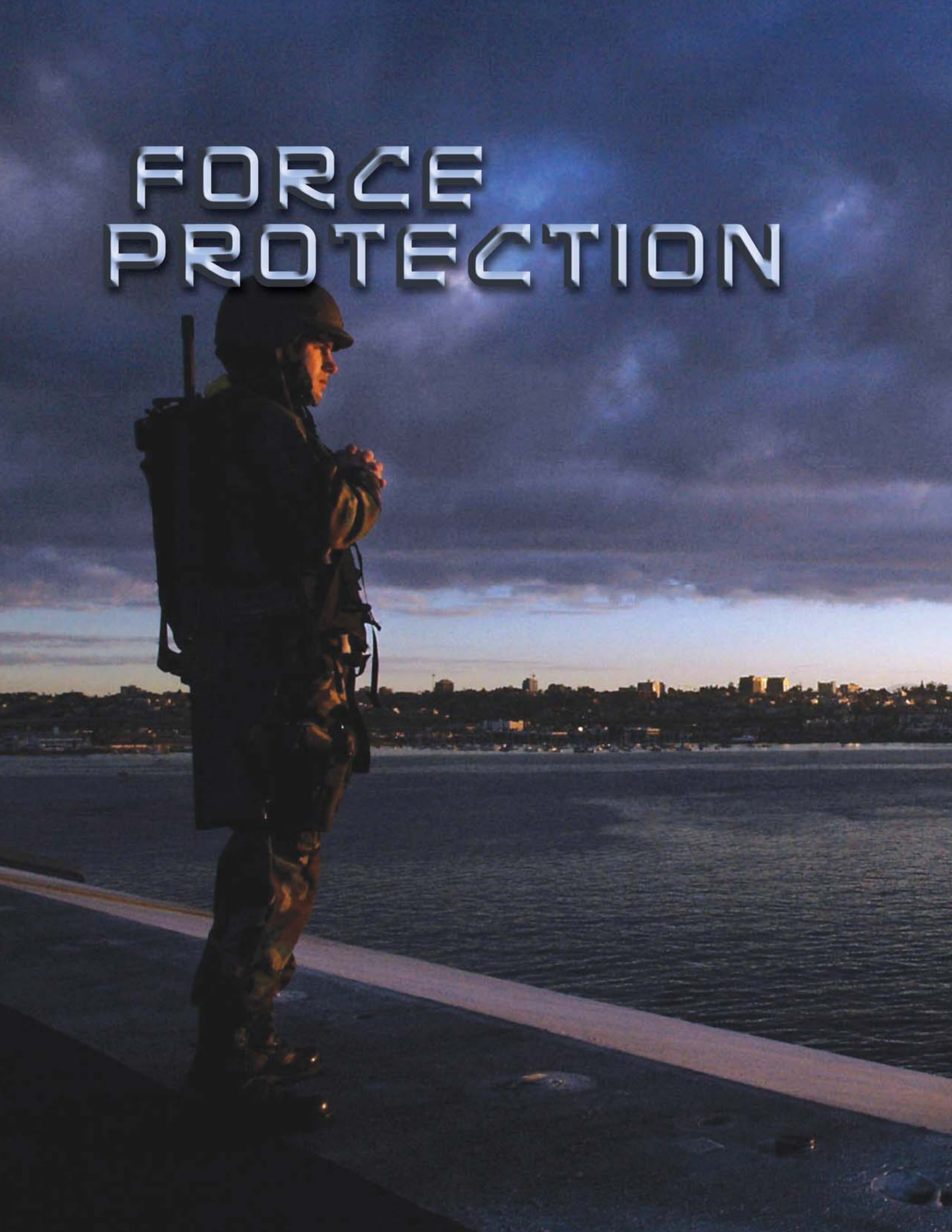
Year: FY 2006

User Sponsor: U.S. Pacific Command

Participating Services/Agencies: Defense Threat Reduction Agency, Naval Surface Warfare Center, Indian Head, U.S. Air Force Air Armament Center, U.S. Pacific Command/U.S. Forces–Korea

The precision guided munitions shop poses for a picture behind an EGBU-15 2,000-pound bomb.

U.S. Air Force Senior Airman Paul Kaehler (left) and USAF Staff Sergeant Barry Mueller, weapons loaders from the Weapons Standardization Section, 48th Operations Group, 48th Fighter Wing, Royal Air Force Lakenheath, United Kingdom, prepare to load an advanced EGBU-15, a guided air-to-surface weapon on an F-15E Strike Eagle aircraft.


FORCE
PROTECTION

Active Denial

Background: The Active Denial Technology (ADT) "Repel" program is a breakthrough nonlethal technology that uses shorter wavelength millimeter wave energy to rapidly stop, deter, and turn back adversaries from a long range. It will save countless lives by protecting U.S. forces without inflicting injuries on potential adversaries.

Success: ADT produces millimeter waves at a frequency of 95 GHz and uses an antenna to direct a collimated invisible beam toward a designated subject. Traveling at the speed of light, the energy strikes the subject and reaches a skin depth of about 1/64 of an inch. It produces a heat sensation that within seconds becomes intolerable and forces the targeted individual to instinctively flee. There is minimal risk of injury from the beam because of the shallow penetration depth of energy at this short wavelength, the safety features designed into the system, and normal human instinctive reactions. In this program, AFRL scientists and contractors developed technologies required to produce a system that was integrated onto a ground platform and underwent Military Utility Assessment (MUA) in an ACTD. The ACTD has completed its joint, three-phase MUAs with over 3,500 shots on personnel with great success. The program has been the first to operate under an exception to the exposure standards, and has firm documentation of legal review, treaty compliance, policy, and DDR&E support. The program is now starting spiral technology development to address key risk areas, and developing key technologies to enable the capability to be used on future airborne platforms along with small/lighter/cheaper new technologies. This integrating concept supports the precision engagement core competency and provides the critical future capability for creating precise effects rapidly against large target sets.

Program POC: Dr. Diana L. Loree, AFRL/DEHA, DSN 246-5261

Year: FY 2006

Active Denial System

Contamination Avoidance at Seaports of Debarkation

Background: The purpose of the Contamination Avoidance at Seaports of Debarkation (CASPOD) ACTD was to determine the capabilities that could be used prior to, during, and after an attack to mitigate the effects of chemical or biological (CB) agents, and toxic industrial chemicals/materials during the initial stages of power projection operations at seaports with limited U.S. presence. Mitigation is assumed to be on a 24/7 basis and includes workers on and off duty.

Success: The CASPOD ACTD developed the essential concepts of operation (CONOPS) and tactics, techniques, and procedures (TTPs) for deployment, employment, and redeployment worldwide. The ACTD's military utility was assessed using warfighting personnel in realistic scenarios. Off-the shelf, prototype, and developing equipment were identified and procured for operational units to use during and after the Extended User Evaluation. The CASPOD ACTD demonstrated an integrated-sensor picture to the Commander of the Port through a radio frequency network.

Current Status: Thirteen different pieces of equipment were procured, including a command and control suite (PortWarn) for use before, during, and after a CB attack. Portions of PortWarn are now part of the Air Force's Restoration of Operations Information Management System. An extensive suite of protection equipment was purchased and pre-positioned in the area of responsibility. Applicators are available on the General Services Administration schedule. CONOPS, TTPs, and training packets have been prepared for USCENTCOM and U.S. Pacific Command. Non-material solutions and recommendations to policy and host-nation agreements were also developed. The Theater Chemical and Biological Response Package is deployed in Bahrain.

Program POC: Mr. John Wilcox, ODUSD (AS&C), 703-697-5558, john.wilcox@osd.mil

Year: FY 2006

User Sponsor: U.S. Central Command (USCENTCOM)

Seaport at Charleston, SC

Personnel Recovery Extraction Survivability aided by Smart Sensors

Background: Warfighters today have insufficient situational awareness and capability to locate, identify, and communicate with isolated personnel in the battlespace.

In 2006, USJFCOM provided a positive Joint Military Utility Assessment (JMUA) of the Personnel Recovery Extraction Survivability aided by Smart Sensors (PRESS) ACTD Global Personnel Recovery System (GPRS) capability and architecture. GPRS is a two-way, secure over-the-horizon burst, L/S band radio capability to identify, locate, track, and communicate with an isolated person. It includes a GPRS Network Interface Card (GNIC) that fits into current survival radios, portable computers, laptop computers used by isolated persons, rescue aircraft/forces, and command and control (C2) centers.

Success: USJFCOM recommended that the GPRS capability be integrated into the military force structure and that GPRS technology enter the acquisition system at an advanced milestone. There is broad support for the GPRS capability from Combatant Commanders, Services, and agencies, to include the U.S. Border Patrol, U.S. Customs, and U.S. Coast Guard. Coalition interest comes principally from the United Kingdom, which has supported the development of the capability. To date, user requirement surveys have indicated a need for some 300,000 GNICs. The PRESS ACTD developed 15 GNICs that are integrated into a number of systems available for immediate use: PRC-112G survival radios; Air Force Special Operations Command GPRS Radio Module attachment to Sony VAIO palmtop computer; and GNIC integrated into laptop computer for personnel recovery/Blue Forces tracking support onboard rescue aircraft or in C2 centers.

Current Status: Defense Production Act, Title III is funding a GNIC production variant with a first run of 1,000–1,500 GNIC by FY 2008. U.S. Army's Program Executive Office–Soldier is further assessing PRESS technologies for use in the Movement Tracking System Program, as is Special Operations Command for integration of the capability into the Multi-Band Inter-/Intra-Team Radio.

Program POC: Mr. MK Tribbie, ODUSD (AS&C), 703-601-2124, m.tribbie.ctr@osd.mil

Year Completed: FY 2006

User Sponsor: U.S. Joint Forces Command (USJFCOM)

PRESS System Components

Unmanned Surface Vehicle Minesweeping System

Background: The Unmanned Surface Vehicle (USV) Minesweeping System was a Future Naval Capabilities project to develop and demonstrate a new naval capability to enable minesweeping from a safe stand-off distance from sea mines. It will be organic to the expeditionary force and is included as one of the primary mine warfare mission modules on the new Littoral Combat Ship (LCS) class combatant. It enables naval forces to perform day/night, rapid, long-endurance acoustic and magnetic influence minesweeping from an unmanned surface platform in shallow water and very shallow water. This capability minimizes the exposure of service personnel to minefields while allowing amphibious landing forces to maintain an unencumbered operational tempo 'from the sea' and 'to the land' objectives.

Success: This project successfully demonstrated a range of capabilities including: non-propulsive power required to deploy, energize, and retrieve the sweep system; modular component hardware configured for an LCS unmanned surface vessel 11-m Rigid Hull Inflatable Boat; and remote control for unmanned operations. Due to the use of numerous commercial off-the-shelf technologies and relative simplicity of the modular design, the total ownership costs and logistics requirements will be greatly reduced.

Program POC: Mr. Brian Almquist, ONR 321OE, 703-696-3351, almquib@onr.navy.mil

Year: FY 2006

Unmanned Surface Vehicle Sweep System

Shallow Water/Very Shallow Water/Surf Zone Minehunting

Background: This is one of a series of spiral development and demonstration projects involving mine warfare unmanned underwater vehicles (UUVs) being pursued in Navy S&T that will provide an autonomous, organic minehunting capability to naval forces. It provides an early capability that addresses the naval requirements of removing Naval Special Warfare and explosives ordnance disposal (EOD) forces from the minefield and speeding the tactical timeline. It allows early, clandestine battlespace preparation prior to an amphibious assault by Naval Expeditionary Forces as well as port and harbor protection.

Success: In September 2006, a successful multiple UUV demonstration was conducted that confirmed the capability to perform minehunting operations with multiple cooperating autonomous underwater vehicles (AUVs). Key demonstrated functions were in the areas of sensor performance, data processing, navigation, communications, automated identification, and multiplatform tactics. The demonstration included 23 individual missions encompassing 47 hours of unmanned vehicle runtime. Autonomous underwater systems are now augmenting diver/mammal teams in wartime minehunting operations (e.g., operations in the Port of Um Qasr, Iraq). The role of naval AUVs is expanding and in the future may eliminate the need for manned reconnaissance operations.

Program POC: Mr. Brian Almquist, ONR 321OE, 703-696-3351, amlquib@onr.navy.mil

Year: FY 2006

REMUS UUV

Joint Direct Attack Munition Assault Breaching System

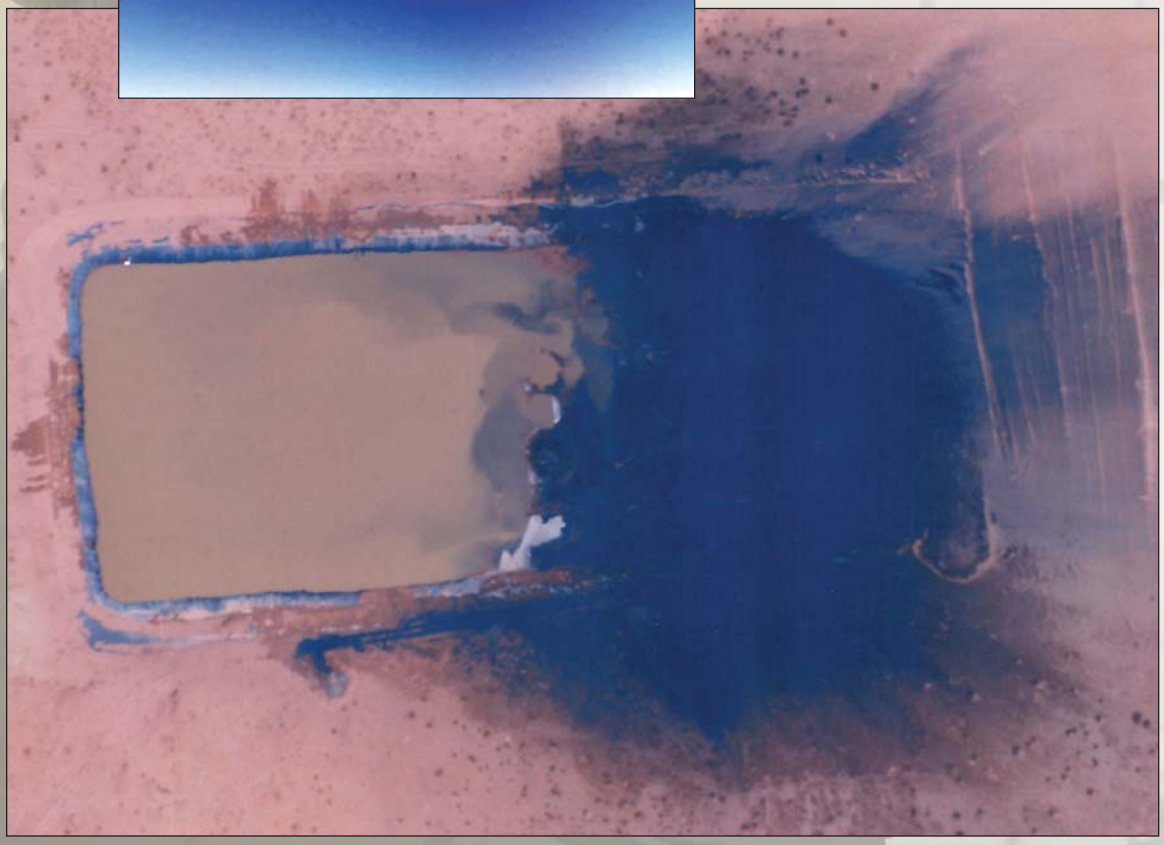
Background: The Joint Direct Attack Munition Assault Breaching System (JABS) project set out to quickly demonstrate a capability to breach surface laid mines and obstacles in the surf zone (SZ) and beach zone (BZ) areas. The JABS is a MK-84 2000-lb general purpose bomb configured with a Joint Direct Attack Munition (JDAM) tail-kit for precision guidance. The tail-kit allows precise delivery of the weapon from Naval TACAIR and USAF bombers. The project completed two key demonstrations within 18 months. In the first demonstration, a single USAF B-52 dropped 10 weapons onto a mine and obstacle field representing a tactical BZ threat. In the second demonstration a flight of four B-52s dropped 42 weapons onto a mine and obstacle field representing a tactical combined SZ/BZ threat. The demonstrations were highly successful meeting or exceeding the threshold requirements.

Success: JABS moved quickly into operational status. It is the first weapon system capable of rapidly breaching surface laid mines and obstacles in the surf and beach zone areas in advance of amphibious landing forces. The Navy and Air Force have signed a Memorandum of Agreement that coordinates operational planning across the two services. The program transitioned to the NAVSEA Acquisition Office (PMS-495), and the Joint Requirements Oversight Council signed a Doctrine, Organization, Training, Material, Leadership and Education, Personnel, and Facilities Change Recommendation on 1 May 2006.

Program POC: Mr. Brian Almquist, ONR 321OE, 703-696-3351, almquib@onr.navy.mil

Year: FY 2006

Inflight B-52 releasing a single MK-84 JABS Weapon



"After" scene at a SZ/BZ test area at China Lake subsequent to 42-MK 84 weapon drops

Countermeasures Protection System

Background: The objective of the Countermeasures Protection System (CMPS) Technology Transition Initiative (TTI) project was to produce a single system capable of improving force protection against radio-controlled improvised explosive devices (RCIEDs). A single system is needed to cover all types of currently known RCIED threat devices simultaneously. The current family of RCIED countermeasures systems does not have a system that fulfills this requirement. Systems variants in the current family are broken up into two categories, each countering a different range of threat devices.

Success: CMPS uses a new architecture optimized to defeat both types of RCIED threats, includes multiple upgrades, and is field-programmable. The programming feature provides the warfighter the crucial capability to tailor countermeasures as required during the mission. It is also available in a vehicle-mounted configuration. CMPS was the first system fielded that contained an integrated solution to low- and high-power threats.

Current Status: CMPS is now called "Warlock DUKE" and is on contract and being produced at a rate of 1,000 per month, with 17,000 systems scheduled to be fielded.

Program POCs: Mr. Stephen Kostek, PEO IEW&S, 732-427-1866, stephen.kostek@us.army.mil; Mr. Steve Abbott, U.S. Army RDECOM, CERDEC, Intelligence and Information Warfare Directorate (I2WD), 732-427-3671, steve.abbott@us.army.mil

Year: FY 2006

Warlock DUKE (CMPS)


GROUND &
SEA VEHICLES


1627

Bar Armor

Background: Because the enemy can suddenly emerge at close-quarters and fire on our forces, the Bar Armor program is providing advanced, lightweight Bar Armor to the Marine Corps to protect our troops, HMMWVs, and trucks from rocket-propelled grenade attacks. Bar Armor vehicle kits have been sent to the Marines in Iraq, and Army Buffalo kits are in production.

Success The Bar Armor system, a lightweight defense against rocket propelled grenades, has successfully transitioned to the U.S. Army and will be issued as a standard accessory for all new mine resistant Buffalo vehicles.

The Bar Armor rapid reaction effort was designed to quickly develop and demonstrate a lightweight, low-cost means of defeating rocket propelled grenades (RPGs). Bar Armor's purpose is to enhance force protection for warfighters serving in Operation Iraqi Freedom (OIF). A simple bar mechanism is effective in defeating a RPG's shaped charge by preventing it from properly initiating and forming an explosive jet. However, previously-fielded systems have been heavy and cumbersome.

Bar Armor is an aluminum bar matrix mounted to specially designed brackets that bolt directly to the doors of a HMMWV. The half-inch aluminum bars spaced several inches apart defeat an RPG by deforming its metal nose and short-circuiting the electrical fuze system. This prevents the proper ignition of the shaped charge and the formation of an explosive jet. To mitigate the effects of secondary explosions caused by the impact of a deflagrated RPG warhead, one inch thick blast attenuation panels have been added to the kit. If damaged, both the bars and the blast attenuation panels are easily replaced in the field. The entire four door package weighs only 150 pounds. The bars, when extended, allow the vehicle's windows to open to about two-thirds of their full range.

In 2005, DARPA, working in conjunction with the Marine Corps Warfighting Laboratory and BAE Systems, designed and fabricated 50 HMMWV Bar Armor systems and delivered them to units serving in OIF. The U.S. Army also ordered 45 units for use with Buffalo vehicles. All 95 Bar Armor units have been delivered to Theater and are installed.

Program POC: DARPA External Relations, 703-969-2404

Year: FY 2006

Buffalo with DARPA Bar Armor

Modeling and Simulation of Multiple Bodies in Close Proximity

Background: Seabasing requires new approaches to cargo transfer between ships in a seaway through Sea State 4. This involves mooring of two or more vessels in close proximity for the purpose of off-loading military equipment and personnel. Numerical simulation of the motions of the seabase in a range of seaways, ship speeds, and headings is a prudent way to determine the maximum seaway that the seabase could safely endure. ONR sponsored the initial development of a high-fidelity simulator to predict the dynamic performance of multiple vessels maneuvering in close proximity and transferring cargo in a seaway. The simulator enables the evaluation of developmental cargo transfer (lift-on/lift-off and roll-on/roll-off), mooring, and fendering systems in support of the seabasing concept, and associated approach, station-keeping, and departure operations.

Success: Under this program Computer Sciences Corporation (CSC) developed a simulator, the Multi Vessel Simulator (MVS), that enables evaluation of developmental cargo transfer, mooring, and fendering systems in support of High-Capacity Alongside Seabase Sustainment, Seabasing, Connected Replenishment, and more traditional Joint Logistics Over The Shore concepts, together with their associated approach, stationkeeping, and departure operations. The MVS computes the six-degree-of-freedom motions of two interacting vessels subject to wind, waves, currents, and maneuvering effectors at zero and nonzero speeds. Any specified number of fenders and mooring lines can act between the vessels.

Model tests jointly funded by ONR and Program Manager–Ships (PMS) 325 were conducted at Maritime Research Institute Netherlands test facility to quantify the hydrodynamic forces and moments experienced by two ships in close proximity while advancing in waves. These model test data were used to validate MVS.

PMS325 has recently used the MVS during Maritime Prepositioning Force (Future) (MPF(F)) sea trials to evaluate the effectiveness of mooring/fendering systems in support of the evolving seabasing concept, as well as the expected motions of coupled vessels. These evaluations support design and operational recommendations and decisions required for various at-sea demonstrations. PMS325 has funded follow-on developmental efforts in with CSC to extend and tailor MVS to support MPF(F), including dynamic positioning. PMS325 plans to continue use of the tool to support the MPF(F) program.

Program POC: Dr. Paul Hess, 703-696-9776, hessp@onr.navy.mil

Year: FY 2006

Two Vessel Operations, U.S. Navy at-sea Technology Demo, 2006

Distributed Shaftless Propulsion Powering Performance Prediction Tool

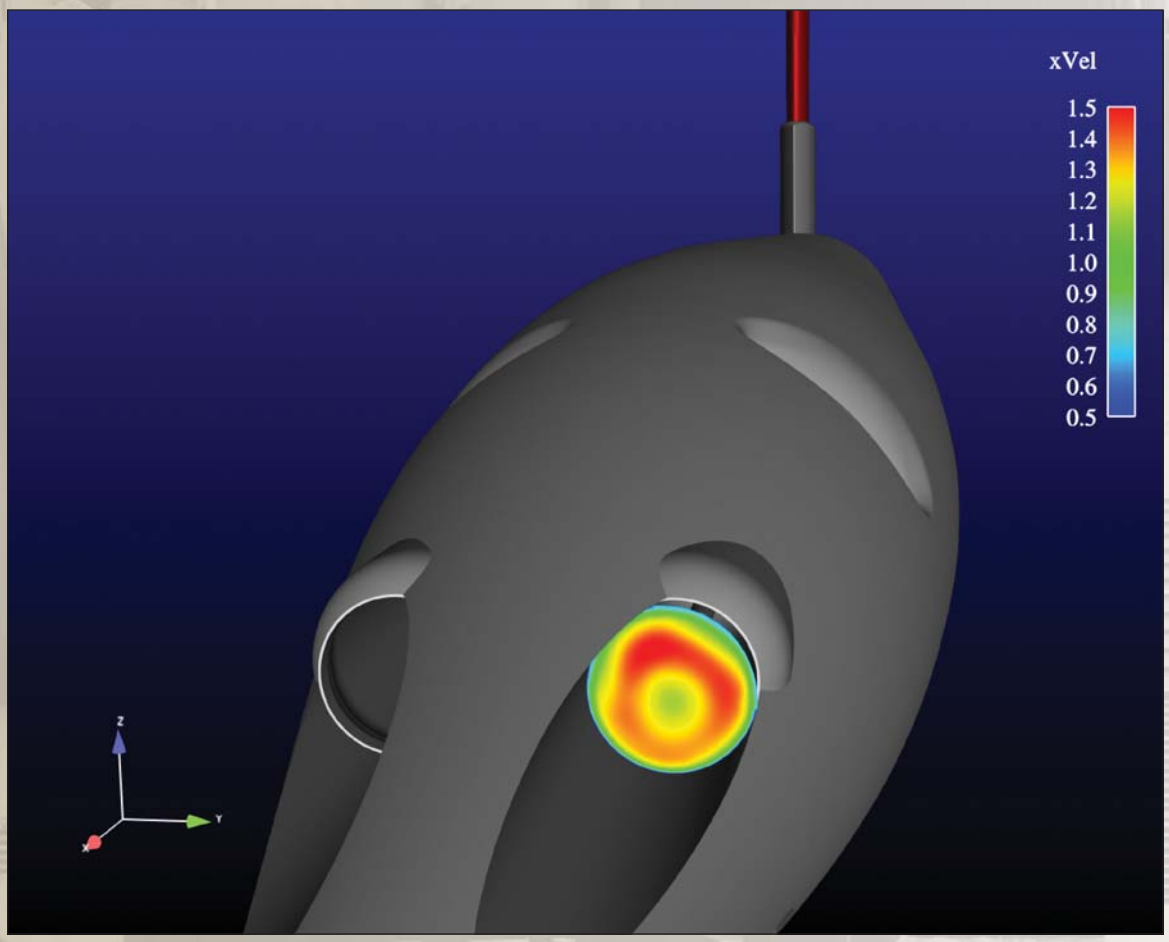
Background: New submarine concepts development requires numerous design spirals that include costly and time-consuming model testing of many different configurations. Validated computational tools would expedite the design spirals by reducing design cycle time and the number of models required for testing. DARPA is currently investing in the development of next-generation submarine concepts with a shaftless propulsion system that would allow design flexibility and reduced cost.

Success: The Office of Naval Research (ONR) developed a predictive capability of powering performance of submarines having distributed shaftless propulsion through use of state-of-the-art computational fluid dynamics (CFD) codes. A model-scale submarine with four internal distributed pumps has been designed and tested in the tow tank at the NSWC Carderock Division. The computational tool was validated using the experimental data. The predicted powering efficiency was within 3% accuracy of measurements. The codes were transitioned to the team(s) involved in the development of the new submarine concepts with shaftless propulsion under the DARPA sponsorship.

Program POC: Dr. Ki-Han Kim, ONR 331, 703-696-4305, kimk@onr.navy.mil

Year: FY 2005

Notional submarine with distributed shaftless propulsion



Computation of velocity distribution inside the pump using CFD

Unmanned Ground Combat Vehicle (UGCV)—Perception for Off-Road Robotics (PerceptOR) Integration (UPI)

Background: The Unmanned Ground Combat Vehicle (UGCV)—Perception for Off-Road Robotics (PerceptOR) Integration (UPI) program will integrate autonomous navigation algorithms with the Spinner platform to yield an unmanned ground vehicle (UGV) that operates reliably in obstacle-rich terrain. The vehicles will be used to test methods for perception techniques to optimize autonomous performance. This natural mating of the best-of-class sensors and algorithms on a vehicle of Spinner's class represents a leap forward in UGV capability. Autonomous mobility will be further enhanced by the use of terrain data for path planning.

Crusher vehicle with payloads: a stabilized remote weapons station and an extended RSTA mast.

Success: The UPI program and its Crusher autonomous Unmanned Ground Combat Vehicle (UGCV) completed a two-week experiment to test autonomous navigation at Ft. Bliss, Texas, the emerging post for Future Combat Systems experiments and evaluation. Over 250 km of autonomous navigation was completed, including two 20 km autonomous runs without operator intervention that had average speeds over 3.5 m/sec.

The UPI program is a joint effort between DARPA and the U.S. Army, managed by DARPA TTO. The program is assisting the development of UGV science and technology in large part to assist the Future Combat Systems program.

DETAILED REPORT

The UPI program and its Crusher autonomous Unmanned Ground Combat Vehicle (UGCV) completed a two-week experiment to test autonomous navigation at Fort Bliss, Texas, the emerging post for Future Combat Systems experiments and evaluation. Over 250 km of autonomous navigation was completed, including two 20 km autonomous runs without operator intervention that had average speeds over 3.5 m/sec. These runs set speed and distance records for unrehearsed, intervention-free autonomous navigation for vehicles in this size class in terrain that included a majority of the Ft. Bliss terrain types. Regions of the 20 km course included difficult areas of combined slope, washes, vegetation, and soft soils that highlighted the unique mobility abilities of the Crusher platform and tested the integrated perception to allow Crusher to negotiate such terrain autonomously.

Crusher represents a new class of Unmanned Ground Combat Vehicle developed by DARPA. Crusher is a highly mobile vehicle designed from the outset to be unmanned. It is equipped with state-of-the-art perception capabilities, and is used to validate the key technologies necessary to perform military missions autonomously. Crusher is a 7 ton, six-wheeled, all-wheel drive, hybrid electric, skid-steered, unmanned ground vehicle.

Crusher vehicle autonomously navigating through a dry wash at Ft. Bliss, Texas

Since Crusher does not have to accommodate human crews, its novel designs offer unequaled ruggedness, mobility and payload-carrying capacity compared to manned vehicles in its weight class. Its unique suspension enables it to move smoothly over extremely rough terrain and overcome obstacles such as large ditches, man-made barriers or piles of boulders. Other features include a light, strong frame made of aluminum and titanium, a small turbocharged diesel genset, and a suspension system with adjustable ride height that allows the vehicle to either rest on its underside skid plate (0 inches of ground clearance) or at maximum suspension height (30 inches of ground clearance), allowing for greater ease in clearing obstacles. The UPI program has constructed two Crusher platforms for experimental use, allowing continual testing in varying configurations. For example, at this recent Fort Bliss experiment, the Crusher Green vehicle was configured with representative UGV payloads (an area weapon-based remote weapons station and mast-mounted RSTA sensor) and tested at a weight of 8.5 tons, and was tested autonomously at this weight. Crusher Tan was tested at two weights of 7 tons (unloaded base weight with perception) and also ballasted and autonomously tested at a weight of 9.5 tons, the current expected weight of larger FCS UGV classes.

In the recently completed Ft. Bliss tests, the UPI perception system was augmented by modules that use various automatic learning methods to improve the quality of off-road route selection. These methods allow extension of obstacle detection to beyond 70 meters and thus aiding the vehicle in longer range planning at speed and avoiding cul-de-sacs, both of which allow higher average autonomous speeds.

Perception methods including fused laser and optical stereo ranging were used to identify, classify, and plan through obstacles up to 50–75 meters ahead using vegetation detection and adaptive color matching to laser range points. Some of the adaptive methods incorporated from the DARPA IPTO LAGR program have doubled the effective sensing range of the UPI perception system on Crusher, allowing higher speeds.

The Crusher platform and its perception systems/algorithms continue to provide technology transition to the FCS UGV SDD efforts. The UPI program will continue to feed its technology to these programs, validated by performance in continuing experiments through 2007.

FUTURE PLANS

The next DARPA UPI experiment is scheduled for the spring of 2007 tentatively at Ft. Carson, Colorado. The program will culminate in early 2008 with Army users operating Crusher vehicles during representative missions in natural terrain.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2008


HUMAN
SYSTEMS

Powerswim

Background: The Powerswim program is using the highly efficient way sea animals swim to design a new swimming device. Ordinary swim fins push through the water, like oars push a boat, and are about 10 percent efficient. The Powerswim program is developing a device that uses fin lift for propulsion—it basically "flies" through the water—with an efficiency of 80 percent. This could double the speed and range of U.S. Navy SEALS, allowing them to arrive on-shore much faster and much less fatigued.

Success: DARPA's Powerswim funded engineers completed a series of tests comparing fins and Oscillating Foil Devices (OFD) at Carderock Naval Surface Warfare Center on February 2006. The results of the test showed a 40% decrease in energy expenditure for the OFD's when swimming at the target operational speed of 1 knot. The divers were also able to obtain individual speed increases ranging from 33–66% with the OFD's as compared to fins. This is a significant step toward reducing the metabolic cost of swimming and allowing combat swimmers to travel farther faster.

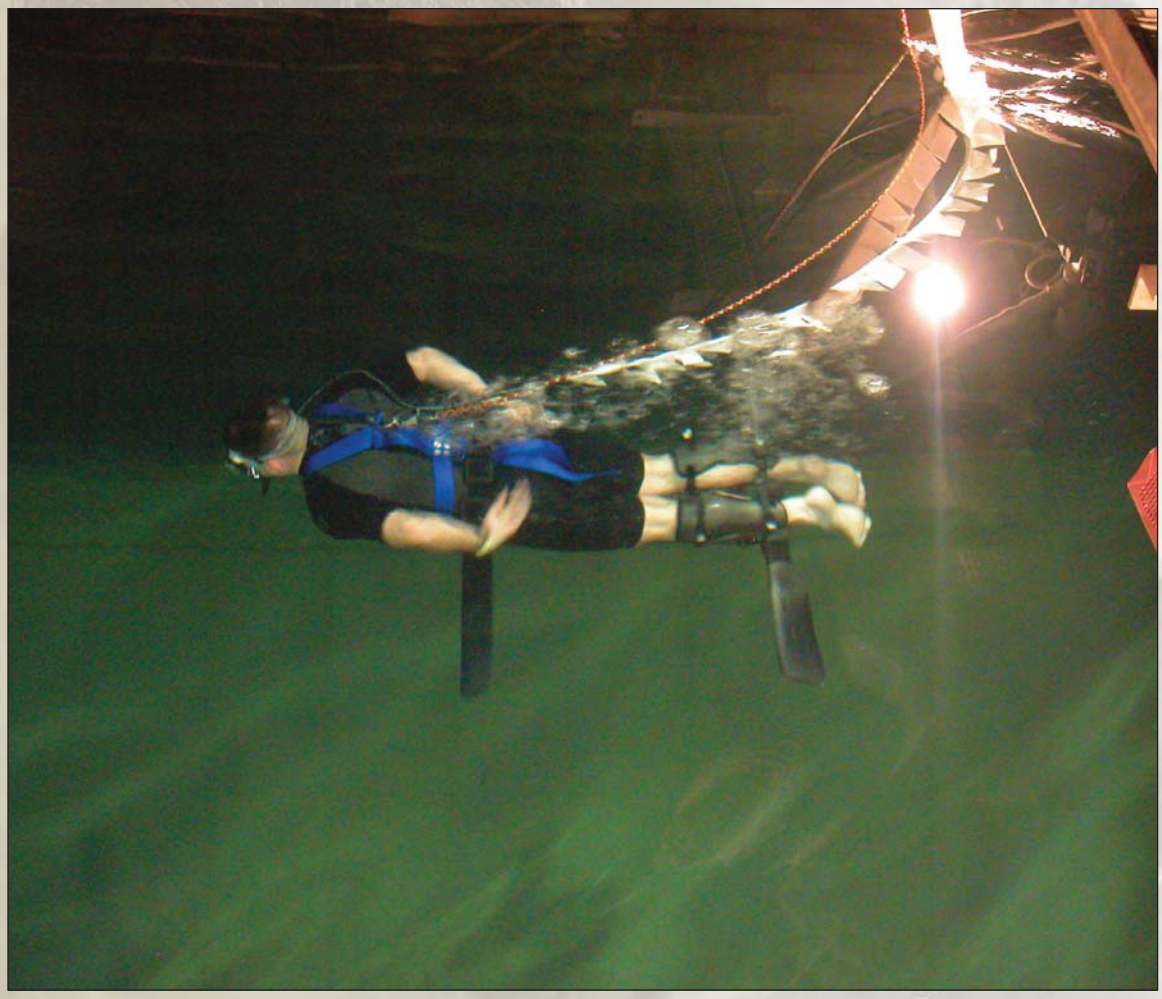
DARPA's Powerswim program seeks to develop a device that reduces the metabolic cost of underwater swimming while remaining compatible with combat swimmer gear and tactics for use in special operation and reconnaissance missions. As a result, swimmers will be able to travel long distances under their own power at dramatically reduced metabolic cost.

The Powerswim concept uses lift-based propulsion to enable a significant increase in swimming efficiency. As a result, combat swimmers will reach the beach with much more "gas in the tank" to perform their missions. Powerswim-funded engineers have collaborated with the Naval Health Research Center and the Carderock Naval Surface Warfare Center to compare fins and Oscillating Foil Devices (OFD's). U.S. Marine and Navy divers swam with both conventional fins and OFD's along a 0.5 mile track. The energy expended using each swimming method was determined through measurement of the diver oxygen consumption. The test results showed a decrease in energy expenditure in excess of 40% for the OFD's as compared to the fin standard when swimming at the target operational speed of 1 knot. The divers were also able to maintain much higher sustained swimming speeds with the OFD's as compared to fins with individual speed increases ranging from 33–60%.

The next step will be to create a system suitable for operational environments and situations by making the system lightweight, compact, and neutrally buoyant.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2007



A Powerswim Diver at Carderock David Taylor Model Basin

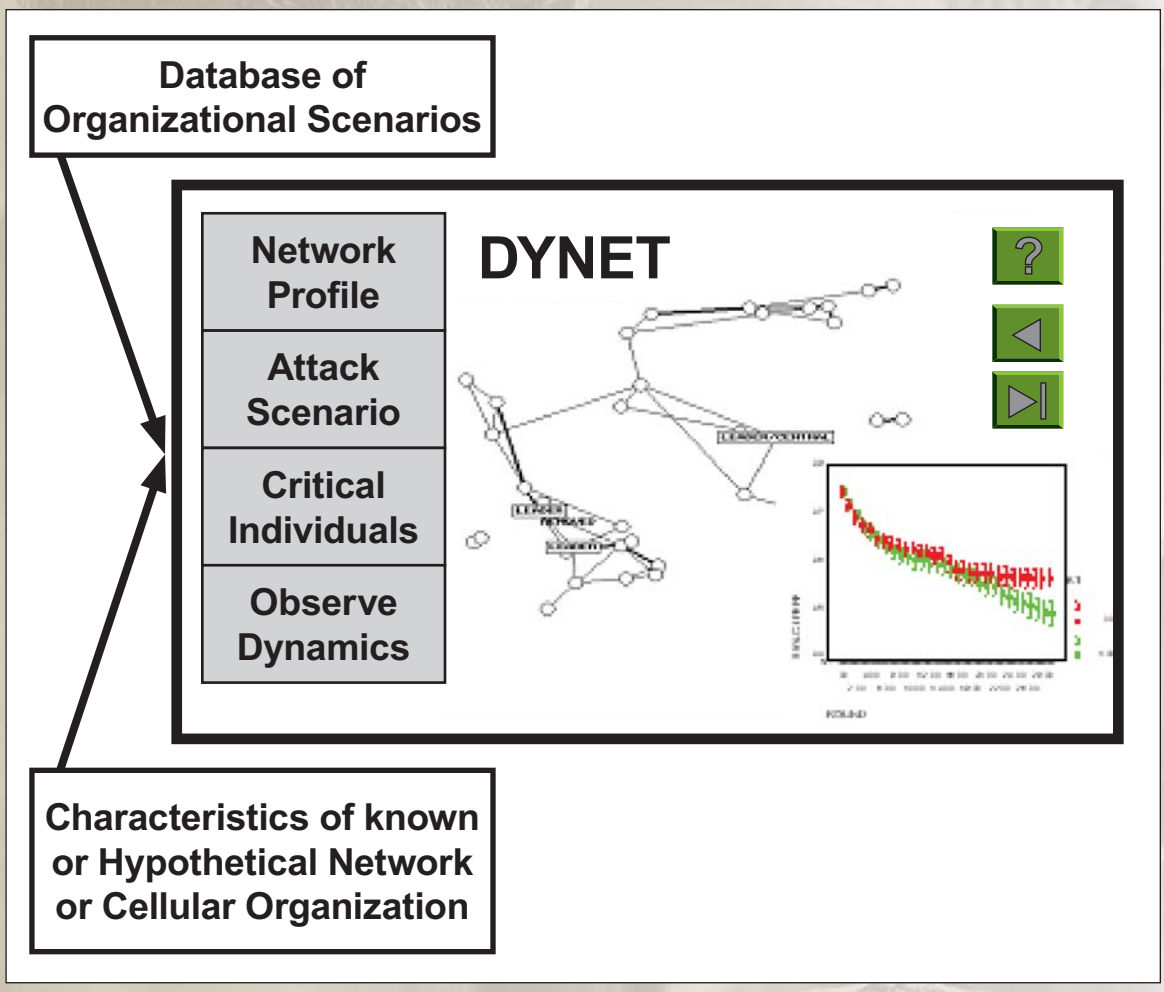
Social Network Analysis: The DYNET Tool Suite

Background: Intelligence analysis has discovered the utility of single-mode social network analysis tools that show the relationship of individuals to each other. The DYNET Tool Suite goes beyond simple people-to-people analysis, to show complex relationships. This tool suite provides plain English reports to explain important social metrics, such as locating key players, "boundary spanners" (people who connect groups), resource holders, and individuals with access to resources. It also provides "what if" analysis that evolves an organization forward in time, when selected individuals are taken out of the social network.

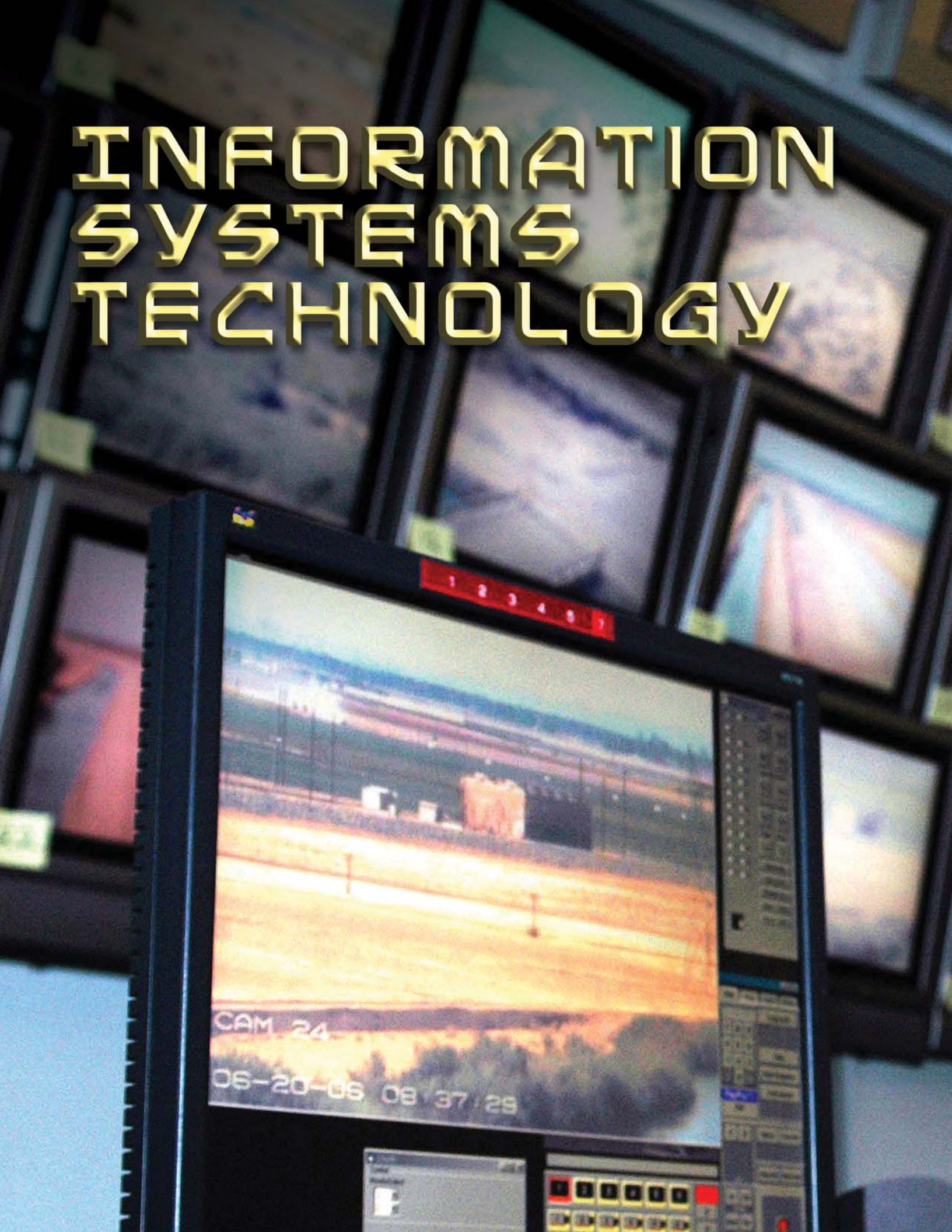
Success: This toolset has been installed at PACOM'S Joint Intelligence Center to analyze terrorist networks in the Pacific Rim. It has also been installed at JFCOM to analyze the results of experiments. The Office of National Drug Control Policy is developing a Memorandum of Understanding to use the tool suite for analyzing drug networks. It is currently being modified for use at the CIA. New modules of this program for analyzing maritime traffic are being developed with a technical demonstration scheduled for March 2007. The maritime domain intelligence modules are being considered for adoption by the Maritime Domain Awareness ACTD and for maritime intelligence by the Office of Naval Intelligence.

Program POC: Dr. Rebecca Goolsby, ONR, 703-588-0558

Year: FY 2007



Analytic Tool for Dynamic Networked and Cellular Organizations


INFORMATION
SYSTEMS
TECHNOLOGY
CAM 24
06-20-06 08 37 29

Advanced Soldier Sensor Information Systems and Technology (ASSIST)

Background: The **Advanced Soldier Sensor Information System and Technology (ASSIST)** program will develop an integrated information system that exploits soldier-worn sensors to augment the soldier's ability to capture, report, and share information in the field—capabilities that are vital for enhanced situational understanding and overall effectiveness in urban combat and post-conflict stability operations. The system will create knowledge-based representations as an input to an array of products, including augmented maps, situational analysis tools, and query and answer capabilities.

Success: The DARPA **Advanced Soldier Sensor Information System and Technology (ASSIST)** Program has developed a system that allows drawings on printed maps to be captured and transmitted over tactical networks via digital pen. Describing locations is often a key task for our warfighters, and doing this via radio with words alone can be a daunting task. For example, "The third house on the left after the alley behind the tall building with a water heater on the roof," could be easily interpreted as one of many areas in a complex urban setting; whereas, the clarity and precision of a thick yellow arrow drawn directly to the target on a satellite map, will more likely be correctly understood. The CAPTURE system allows drawings on printed maps to be captured and transmitted over tactical networks, through the use of a digital pen. The digital pen reads the special patterns inlayed on the map imagery to geo-reference the drawings. The resulting digital ink is then compressed for network transmission. As a result, sketches and other annotations on maps and imagery can be distributed in real-time for mission coordination.

The CAPTURE system capability was tested for ease-of-use and robustness in an exercise at Fort Dix, NJ. In one case, participants, all Operation Iraqi Freedom and Operation Enduring Freedom veterans, used the digital pen to report during their mission. The squad leader briefed his squad on an ambush maneuver and then shared it with the other fire team leaders at other locations. He made detailed sketches on a 1:50,000 standard military map as well as on a printout of a satellite imagery of the target house, and included different line colors and thicknesses to indicate artillery and fields of fire, fire control measures, operational boundaries, opposing force and blue force movements and target areas. The users noted that the tool freed squad leaders to focus on maneuvering the squad, not on trying to communicate the information in a manner that will be correctly received on the other end, which consumes critical time. The result was transmitted over the tactical wireless network to be remotely displayed and shared with the other fire team leaders.

Screenshot of squad leader maneuver annotations

The system's ease-of-use with existing DoD applications has also been demonstrated. The CAPTURE system was loaded on an existing soldier-worn computing system (commercial off the shelf Panasonic Toughbook computer) using a thumb-drive attached to a USB port. With no prior exposure to the soldier-worn system (which uses Falconview imagery as part of its mapping platform), the CAPTURE software was downloaded and installed in less than 10 minutes, and the CAPTURE system was able to transfer its data over the existing Falconview maps into the system, displaying the pen annotations on remote screens embedded in the Soldiers' goggles.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2007

Mounted Battle Command On The Move–HMMWV Variant

Background: Mounted Battle Command On The Move (MBCOTM) provides the commander a suite of communications equipment and battle command software to enable him to effectively execute battle command tasks while displaced from the command post. The current system integrates Army Battle Command System applications into a command and control (C2) system, which provides near-real-time battlefield information focused on intelligence, effects, and maneuver while maintaining both voice and data connectivity on the move. CERDEC's C2 Directorate designed, fabricated, and integrated 10 Block 0+ HMMWV systems, which incorporated advanced Ku-band SATCOM on-the-move communications systems with composite ballistic armor protection. Six of these units have been fielded to operational forces.

Success: These systems were designed, fabricated, integrated, and equipped for fielding within an 8-month period in an effort to support the warfighter in Operation Iraqi Freedom (OIF). The rapid response in the development of this program has provided a unique Ku-band SATCOM on-the-move C2 system to the Army.

Program POC: Rodney Young, RDECOM CERDEC C2D, DSN 987-5763, Rodney.young2@us.army.mil; Thomas Bowers, RDECOM CERDEC C2D, DSN 987-2249, Thomas.bowers1@us.army.mil

Year: FY 2006

MBCOTM PP1 HMMWV variant, rear view of the C4ISR mission equipment showing the dual 4 slice Multi-Processing Unit, communications and networking equipment

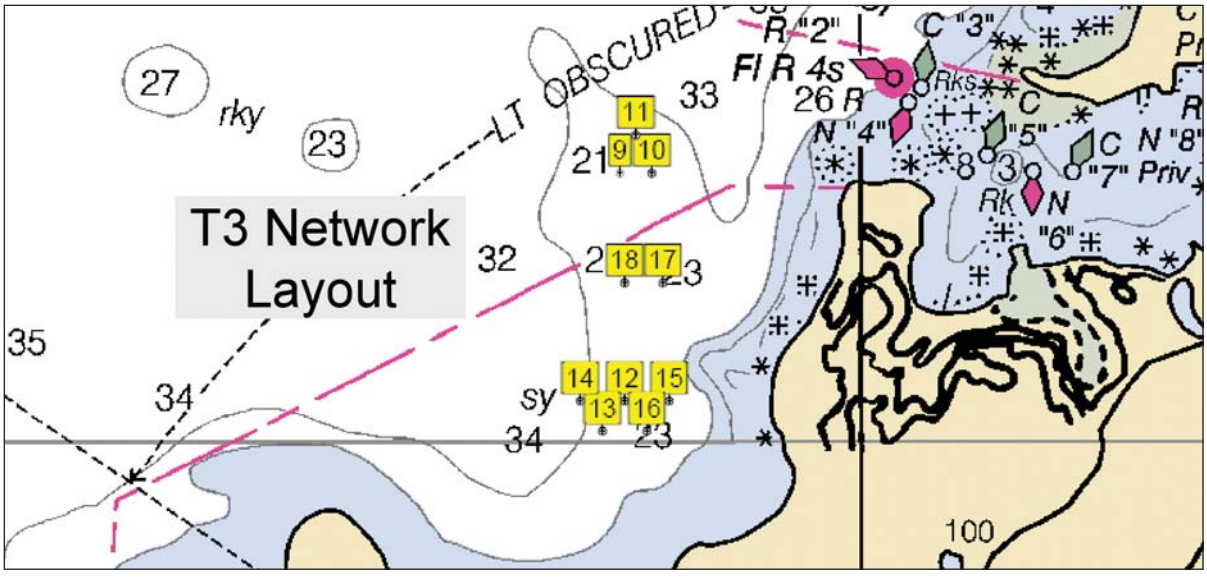
MBCOTM PP1 HMMWV variant, external view with the KU-Band on the Move antenna system

Collaborative Networked Autonomous Vehicles (CNAV)

Background: The Collaborative Networked Autonomous Vehicles (CNAV) (formerly Mission Driven Control of Autonomous Robotic Systems) program is developing autonomous control methods to cause distributed platforms to self-organize and distribute tasks through judicious transactions conveyed over a shared communications network.

Success: CNAV Completes Final Steps Before Integrated Testing

Executive Summary:
In the fall of 2006, the Collaborative Networked Autonomous Vehicles (CNAV) Program successfully performed the last of its subsystem tests prior to full node integration and field testing to begin early 2007. In October 2006, the last of the spiral experiments in the development of the acoustic underwater ad hoc network subsystem was conducted at the Woods Hole Oceanographic Institution in Cape Cod, MA. The experiment successfully tested the multicast, local broadcast, and global broadcast modes, maintaining a robust, reliable 6-node network. Link level acknowledgements also worked as designed. A separate Single-Cluster test verified that the node-to-node network metrics met design specifications. In November, a Multi-Cluster test in a 10-node network configuration verified that field level performance metrics had been achieved. In these tests, buoys were used as surrogates for CNAV vehicles.



Integrated testing of the CNAV sensor subsystem and the acoustic underwater ad hoc network subsystem was performed in early December 2006 at Keyport, WA. The tests confirmed the operation of the CNAV sensors onboard a node submerged at design depth, and confirmed that the sensor subsystem performed as designed. This was also the first test in which the network operated on actual CNAV vehicles (nodes). The network performed as designed, reliably communicating between nodes for field health monitoring and network maintenance. Test commands were also sent to individual nodes via the network to change test configurations.

Full field integration testing of the CNAV system is scheduled to begin in February 2007.

Detailed Description:
The goal of the CNAV Program is to provide an Intelligence, Surveillance, and Reconnaissance capability in littoral waters. CNAV will accomplish this by creating a field of dozens or hundreds of networked Unmanned Undersea Vehicles (UUVs), through wireless communications and working collaboratively and autonomously to sense objects near the field. The field will be self-organizing and self-healing and will have a reach-back capability to allow reporting of field health and enable high-level orders and control functions to be provided to the field.

The CNAV program UUVs will be capable of collaborative, autonomous behavior for deployment and operation in a littoral environment. When deployed, each UUV will navigate independently to the areas of interest; establish communications for self-localization and for creation of an ad hoc mobile network to support collaboration with other UUVs in the field. Two other significant CNAV roles will allow for reachback communications and for geo-location of the field UUVs. The UUVs will self-organize to support missions and to achieve CNAV sensor performance and endurance goals. UUVs will reconfigure the field as needed to exploit changing environmental conditions, and to replace equipment failures.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2009

Heterogeneous Urban RSTA Team (HURT)

Background: The Heterogeneous Urban RSTA Team (HURT) initiative is developing integrated tactical planning and battle management systems for heterogeneous collections of unmanned platforms operating in urban environments. HURT will enable augmentation of low-footprint, rapidly deployable, easily sustainable human command structures with teams of machines operating together, and will define suitable roles for human command staffs charged with controlling squads of automated forces.

Success: During a September 2006 field experiment at the Marine Corps Air Ground Combat Center California, DARPA autonomously flew multiple small unmanned aircraft systems, such as the WASP, in support of a simulated urban mission. The experiment debuted a new automated control system that conducted area searches to detect and track military personnel posing as infiltrators. The system called Heterogeneous Urban RSTA (Reconnaissance, Surveillance, Tracking and Acquisition) Team (HURT) is a multi vehicle controller that plans and autonomously coordinates aircraft without any changes to the platforms or their ground stations. It allows warfighters to focus on the fight, rather than piloting platforms and sensors, while providing live video from the synchronized aerial collections. During the two week experiment, WASPs flew 30 sorties and logged over 25 hours of flight time.

Autonomous Control of Unmanned Aircraft Systems demonstrated. During the experiment, operators handed control of four unmanned aircraft (WASPs and Ravens) to an autonomous HURT controller that commanded them to execute detailed search patterns in the assigned areas. Unlike its human counterparts HURT always flew the vehicles inside the designated flight zones and within the specified altitude parameters. Freed from joysticks, operators were able to spend more time searching the imagery for targets, and less time worrying about flight restrictions. They also liked the stabilized mosaics that provided wider area views and better overall situation awareness. The operations center received live imagery from the vehicles over a mesh network. In the future, the network will provide a means of connecting unmanned aircraft to larger airspace management systems for dynamically instantiating No Fly Zones that allow unmanned reconnaissance aircraft to operate safely in airspace also used by helicopters, fixed-wing fighters or Medevacs.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2007

Spoken Language Communication and Translation System for Tactical Use (TRANSTAC)

Background: The Spoken Language Communication and Translation System for Tactical Use (TRANSTAC) program will develop technologies that enable robust, spontaneous two-way tactical speech communications between our warfighters and native speakers. TRANSTAC addresses the issues surrounding the rapid deployment of devices for translating new languages, especially languages and dialects with few translators. The program will develop a two-way translation capability and will support Arabic dialects spoken in Iraq.

Success: DARPA has successfully deployed speech-to-speech technology to Iraq as a field trial, in support of the Joint Forces Command. The goal of this technology is to enable units operating in areas where human interpreters are scarce to communicate effectively with speakers of different languages in tactical situations. The feedback from the field trials is crucial to defining the Army translation system requirements and to assess performance in the field.

DARPA speech-to-speech translation systems deployed to Iraq in field trials. Systems under development for the Spoken Language Communication and Translation System for Tactical Use (TRANSTAC) program have been successfully deployed to Iraq for field trials in support of the Multinational Force Security Transition Command-Iraq (MNSTC-I). The speech-to-speech translation technology under development in DARPA's TRANSTAC program has been embraced by U.S. Joint Forces Command (USJFCOM) to help offset the short supply of military linguists. The goal is to enable units operating in areas where human interpreters are scarce to communicate effectively with speakers of different languages in tactical situations. The feedback from the field trial is crucial to defining the Army translation system requirements and to assess performance in the field.

Currently, commercially available systems translate only from English to foreign languages and work with pre-programmed fixed phrases. The goal of TRANSTAC technology is to offer users the ability to have a free-form conversation without having to memorize any pre-determined phrases. During operation, the user speaks into a microphone that is integrated with the TRANSTAC unit. The technology recognizes and translates the speech, which is then vocalized in the target language. The foreign language speaker can then speak into the microphone, and the speech translation process is reversed for the soldier. The current prototypes can recognize and translate Baghdadi Arabic, a dialect spoken by the majority of the population living in central Iraq.

Two systems are currently undergoing limited experimental fielding in Iraq. The first fielding consisted of 30 units of a developmental system, IraqComm, from SRI International. The latest fielding will be 35 Multilingual Automatic Speech-to-Speech Translator (MASTOR) units from IBM. Military users will test the MASTOR units' ability to facilitate conversations with the members of the Iraqi security forces and interactions with Iraqi citizens seeking medical assistance. Because of the current state of system performance, the initial use will be limited to tests by cooperating parties in relatively quiet locations. The TRANSTAC program is aggressively pursuing improvements both in the performance and the usability of the systems so that future systems can be employed in a hands-free, eyes-free manner, with robustness appropriate for outdoor tactical use.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2009

MATERIALS & PROCESSES

B-52 on Fischer-Tropsch Fuel

Background: In order to reduce the Air Force's dependence on foreign oil, which is largely produced in politically unstable regions, the Secretary of the Air Force (SecAF) challenged his staff to develop a plan to fly a B-52 on fuel derived from unconventional sources by the end of 2006. The Air Force consumes over 50% of the U.S. government's fuel purchased, and aviation fuel is approximately 80% of that amount. This project demonstrated the capability to reduce Air Force dependence on foreign oil by 50%.

Success: AFRL provided significant technical support to the successful B-52 flight demonstration with a team effort lead by HQ AFMC and SAF/AQ. In addition to AFRL, Air Combat Command (supplied the B-52H aircraft), Oklahoma City Air Logistics Center (technical responsibility for the B-52 and responsible for the TF-33 engine), Air Force Petroleum office (Fischer-Tropsch (F-T) fuel logistics and specification testing), Arnold Engineering Development Center (engine ground test), and the AF Flight Test center at Edwards AFB (flight test) were active participants. Both the Propulsion and Materials Directorates of AFRL participated in the initiative. AFRL/PRTG was responsible for acquisition of 100,000 gallons of synthetic jet fuel product; developing the blending strategy that concluded that a 50/50 blend with conventional JP-8 would meet the current JP-8 fuel specification; and serving as the F-T fuel technical experts. AFRL/MLSA was responsible for conducting an extensive materials compatibility evaluation with the F-T and blended fuel to ensure that there were no adverse interactions with either the B-52 or any of the ground handling systems coming in contact with the fuel.

In September 2006, the B-52 aircraft successfully completed the planned 10-hour flight test employing two engines using the JP-8/F-T blend and the remaining six engines on JP-8, meeting the SecAF's schedule under budget and with a large amount of synthetic fuel remaining. This allowed the program to follow with eight successful flight tests in December 2006, and will conclude with a series of cold weather engine starts at Minot AFB in late January 2007. Continued program success will lead to certification of the B-52 to operate on a 50/50 blend by summer 2007. This will be followed by the eventual certification of all AF systems to operate on up to a 50/50 synthetic fuel blend (SecAF goal to accomplish by 2010) and the eventual replacement of half of the AF CONUS jet fuel supply with synthetic product (SecAF goal to accomplish by 2016).

Program POC: John Datko, AFRL/PRTG, DSN 785-6918, john.datko@wpafb.af.mil

Year: FY 2006

A B-52H aircraft successfully demonstrated an eight engine flight test with a Fischer-Tropsch and JP-8 Blended fuel mixture.

Morphing Aircraft Structures (MAS)

Background: The Morphing Aircraft Structures program will create adaptive aerospace structural systems that will enable an air vehicle to change shape ("morph") in flight much the same way that birds change their body configuration to match their flight profile. These adaptive structures will enable a single, autonomous military air vehicle to perform missions with a multitude of diverse, conflicting roles, such as dwelling over a target for long periods and then morphing into a maneuverable, high-speed attack configuration to destroy ground targets it identifies, or engaging air threats for self-protection.

Success: Morphing aircraft are multi-role aircraft that change their external shape substantially to adapt to a changing mission environment during flight. This creates superior system capabilities that are not possible without shape configuration changes. The objective of DARPA's Morphing Aircraft Structures (MAS) program is to demonstrate the value of aircraft with wings that are designed to change shape and thereby achieve improved performance in different flight regimes, compared to conventional aircraft. In January 2003 DARPA began a two-and-a-half-year program whose objective was to design and build active, variable-geometry, wing structures with the ability to change wing shape and wing area substantially. The primary technical goal was to develop active wing structures that change shape to provide a wide range of aerodynamic performance and flight control not possible with conventional wings.

On August 1, 2006, DARPA performers successfully flight-tested the MFX-1, a jet-powered, Remotely Piloted Vehicle with a shape-changing, morphing wing. The MFX-1 wing features several technical innovations including unique flexible wing skins designs that stretch substantially as the wing changes shape, and a light-weight, kinematic, moving wing substructure that moves from one shape to another, powered by electro-actuators. Utilizing the MFX-1 wing features, the in-flight area changed 40%, with a span change of 30% and wing sweep varying from 15 degrees to 35 degrees.

The flight testing was carried out at the Camp Roberts, California military flight test range by NextGen Aeronautics, with its partner, the Boeing Phantom Works. The primary purposes of the test were to demonstrate, at sub-scale, the in-flight operation, stability and control of a morphing wing design and, to test new flight test procedures including communications and pilot skills for the next generation MAS airplane. The design had been tested previously in the NASA Transonic Dynamics Wind Tunnel. The flight successfully conducted morphing tests at altitudes ranging between 400 and 600 feet with the pilot flying the airplane around a race track pattern, at speeds ranging from 100 to 120 knots. In-flight data was recorded onboard and included global positioning system location and altitude; three video cameras, mounted on the twin tails

of the aircraft and in the nose, provided pictures of the flight to be downloaded after landing.

NextGen Aeronautics MFX-1 Flight Test at Camp Roberts, 1 August 2006

In MAS Phase III, the program aims to demonstrate the potential operational value of morphing by comparing the performance of the aircraft in morphed and unmorphed configurations while executing controlled maneuvers. The 12-month program goals are to demonstrate the ability to change shape radically in flight while maintaining full flight control and to show the value of maneuvering flight performance capabilities resulting from morphing shape changes. Maneuver flight performance will be assessed against the ability to change climb rate by 50% at low speeds and to reduce turning radius at low speeds by at least a factor of 2 when flying at constant thrust and normal axis 'g' level.

Two contractor teams, with different approaches to wing shape changing, will conduct flight tests during the period March through June 2007. Lockheed Martin Advanced Development Programs, Palmdale CA will conduct tests on an out-of-plane wing morphing configuration and NextGen Aeronautics CA on an in-plane wing morphing design. The Lockheed Martin aircraft is a tailless configuration with retractable gear, rigid upper and lower wing surfaces and a "twin-knuckle" folding wing. The NextGen aircraft is a conventional wing-body-tail aircraft with fixed undercarriage and two-degrees-of-freedom control of wing area and sweep with flexible upper and lower wing skins connected to an articulating "umbrella-like" sub-structure.

A successful demonstration will pave the way for future consideration of morphing adaptive multi-point design aircraft that are capable of achieving optimized performance across a broad mission set and perhaps be capable of unique maneuvers in flight.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2009

Reversible Barriers (ReBar)

Background: The **Reversible Barriers (ReBar)** program will develop personnel and vehicle barrier technology that is extremely lightweight and compact when not deployed, easy and quick to erect, virtually impenetrable, and rapidly removed. Such technology would free up many personnel currently assigned to guard a variety of high valued, access-denied areas (e.g., weapons caches, fuel depots). An example ReBAR system might consist of a rapidly expandable foam that cures within minutes and rapidly dissolves when exposed to an agent controlled by U.S. forces.

Success: DARPA's Reversible Barriers (REBAR) program aims to develop light-weight, robust barriers that can be rapidly emplaced and reversed to allow US forces freedom of movement while denying access to enemy combatants. DARPA researchers have created a novel modular system that consists of two portions: a "tire trap" and a multi-log, inflatable foam-composite wall to create a barrier that is both strong and reversible.

In order to create REBAR barriers that are resistant to various types of chemical, fire, and tool attacks, quick and easy to install, and rapidly reversible for US and allied personnel, the REBAR system was designed to be chemically based. The system consists of specific structures for indoor and outdoor barriers. The outdoor barrier design has aimed for a compact system able to stop a 4000lb vehicle traveling at 30km hour.

DARPA REBAR performers at Los Alamos National Laboratories (LANL), have developed a radical design approach to the outdoor barrier system. The LANL team has created a modular system that consists of a "tire trap" portion coupled with a multi-log, inflatable foam-composite wall portion. Both portions of the system, which operate individually or in combination to stop an approaching vehicle, rely on the vehicle's weight to provide the drag to stop the vehicle's mass.

The tire trap halts the rotation of the tires and entangles it, stopping the vehicle. The tire trap alone will stop a vehicle. The second portion, which consists of multi-log

inflatable foam cylinders, forms a visible barrier. The multi-log wall provides the friction drag adhesion necessary to stop the vehicle. This additional portion can be angled to turn a vehicle over, change the direction of a vehicle and reduce the force of impact. The inflatable foam cylinders are also reinforced with fabric resulting in an additional layer to strengthen the wall from collapse and penetration that may result from projectiles.

DARPA performers at LANL are currently working on a laboratory-scale prototype testing of system components scheduled to complete in May 2007.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2008


NET
CENTRIC

Interim Capability for Airborne Networking

Background: Interim Capability for Airborne Networking (ICAN) provides the capability to conduct near-real-time secure information exchange (e.g., chat, email) between warfighters, using existing disparate communications and network capabilities.

ICAN is the transition of AFRL's Information for Global Reach (IFGR) Advanced Technology Demonstration that provides secure and assured information sharing, improves the timeline and process of collaboration, enables cross-cueing ability, provides migration path to true platform net-centric capabilities, enables a seamless extension of Global Information Grid (GIG) to weapons and ISR platforms, improves mission effectiveness, and results in a shorter kill chain.

Success: ICAN creates an extension of the GIG to weapons and intelligence, surveillance, and reconnaissance (ISR) platforms, providing net-centric capabilities. These capabilities enable improved mission effectiveness by increasing information sharing capabilities and minimizing operator workload. ICAN is a cost-effective solution using existing resources. ICAN technology transitioned successfully and quickly to Joint Surveillance and Target Attack Radar System as an immediate Internet Protocol enabling tool. By extending SIPRNet to the airborne platforms, ICAN is jumpstarting the implementation of early airborne networking.

ICAN technology has enabled crew members to conduct direct communication with Army and Marine ground units through the chat rooms in the Combined Air Operations Center (CAOC). E-8 crews are contributing to improvised explosive device location detection, mortar and rocket backtracking, and immediate re-tasking with the CAOC. Comments from theater indicate that the communications capability ICAN enables substantially improves mission effectiveness (2 hour improvement in information sharing, and doubling the effectiveness of the platform).

Follow on work at AFRL is extending ICAN capabilities, addressing key technical challenges in implementing a joint capability for airborne networking (JCAN). The JCAN program is leveraging the achievements of ICAN, and developing improved

Interim Capability for Airborne Networking (ICAN)

technologies to address routing, diverse communications resources, improved management capabilities and disruption tolerant protocols. These capabilities improve performance, and enable networking in a dynamic airborne environment. This includes providing a smoother Joint Tactical Radio System transition; and providing routing schemes to incorporate Navy airborne assets.

Program POC: Dan Hague, AFRL/IFGC, 315-330-1885 (DSN 587)

Year: FY 2006

Language and Speech Exploitation Resources ACTD

Background. The Language and Speech Exploitation Resources (LASER) ACTD demonstrated and assessed technologies, concepts, and architecture paths to reduce language barriers experienced both by operating forces and the Intelligence Community (IC). Since automated language translation is a very broad area, the ACTD approached the challenge with Integrated Product Teams (IPTs) focused on machine translation for speech-to-speech, text-to-text, and the general area of automated tools for language translation training. The ACTD successfully partnered with and leveraged development efforts already underway throughout DoD and the IC. The U.S. Pacific Command sponsored the ACTD and assessed language translation tools in a variety of venues and military exercises; the specific tool capabilities were deemed ready for user assessment. The ACTD began in FY 2002 and was completed in FY 2006.

Success. The Speech-to-Speech IPT assessed several handheld machine translation devices and assisted in deploying 'best of breed' to Operations Enduring Freedom and Iraqi Freedom. Working with the Defense Advanced Research Projects Agency's automated language translation programs, LASER played a role in advancing two-way speech to speech translation; however, challenges remain in producing a system that will seamlessly handle free–flowing, unconstrained conversations. Phrase-based machine translation achieved the greatest success. Phrase-based translators can be tailored to specific languages and topic domains, which greatly improves the quality of translation. Several of the LASER-assessed phrase-based translators proved so successful that users in Operation Iraqi Freedom requested fielding of these assessed products directly to the theater.

The Text-to-Text IPT successfully fielded five Document Exploitation (DOCEX) suites worldwide, including one suite in support of Operation Iraqi Freedom. The DOCEX is a complete document management system that can scan foreign language documents and perform an initial triage of the document in preparation of key documents for complete translation by human translators. As the LASER assessment confirmed, automated translation of handwritten documents is extremely difficult, whereas automated translation of typed documents has some degree of success. The DOCEX suite was transitioned to the National Ground Intelligence Center for program

management. A multilingual text chat capability was also refined, integrated, and assessed by LASER ACTD and fielded to coalition operations in several theaters of operations.

The major accomplishment of the Training IPT was the creation of a Website hosted by a Special Operations Foreign Language Office server, where computer-based language training tools were available for non-linguists to improve their language skills even while in deployed locations. This Web-enabled access successfully leveraged development work executed by the Language Technology Office at the U.S. Army Intelligence Center.

In addition to all the language translation tools that the LASER ACTD helped to prepare for the warfighters, the ACTD brought DoD and IC community efforts together into a coordinated action for the first time. LASER also helped to establish the first-ever machine foreign language translation program office to focus future efforts in this area.

POC: Mr. Larry Goodell, ODUSD(AS&C), 703-697-1120, larry.goodell@osd.mil

Year: FY 2006

SENSORS, ELECTRONICS & ELECTRONIC WARFARE

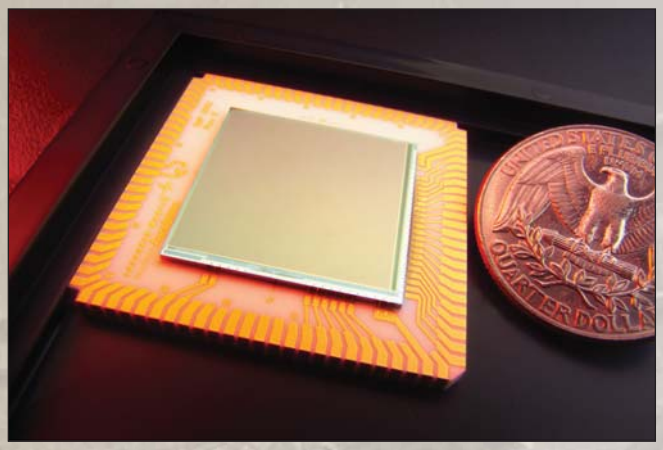
HgCdTe Long-Wave Infrared Focal Plane Array

Background: The Missile Defense Agency (MDA), in conjunction with the Night Vision and Electronic Sensors Directorate (NVESD) and the Army Research Laboratory (ARL), is developing Mercury Cadmium Telluride (also known as either MCT or HgCdTe) on Silicon (Si) focal plane arrays (FPA) for use in long-wave infrared (LWIR) sensors. These sensors will serve as the "eyes" for future ballistic missile weapon systems to find and track the heat of targets. Larger sensor sizes, more sensitive detectors, price reductions, reliability enhancements, and improvements in manufacturing are sought in FPA programs.

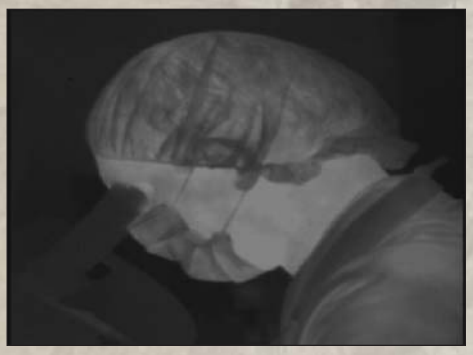
Of the varying technologies available for constructing FPAs, HgCdTe is currently the highest performing material. However, it is costly and only allows small sensors to be constructed. Developing the technology to put HgCdTe on Silicon will allow production costs to be decreased by a factor of four while increasing overall reliability by a factor of two. Additionally, larger FPAs can be constructed to meet the future needs of other systems such as the Space Tracking and Surveillance System (STSS).

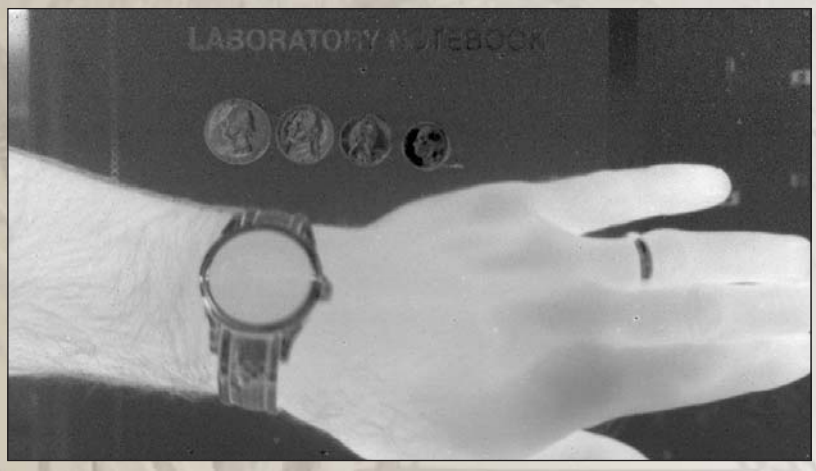
Success: In 2006, NVESD transferred its technique to industry that enables the large scale deposit of the buffer layer and HgCdTe on a chip. NVESD also received several 256x256 HgCdTe on Silicon FPAs from several industry sources for testing. Follow-on testing of these FPAs has shown that manufacturing improvements allowing an operability greater than 98% are possible.

Program POC: Dr. Meimei Tidrow, MDA/DVS, 703-882-6188



LWIR FPA





Various thermal images

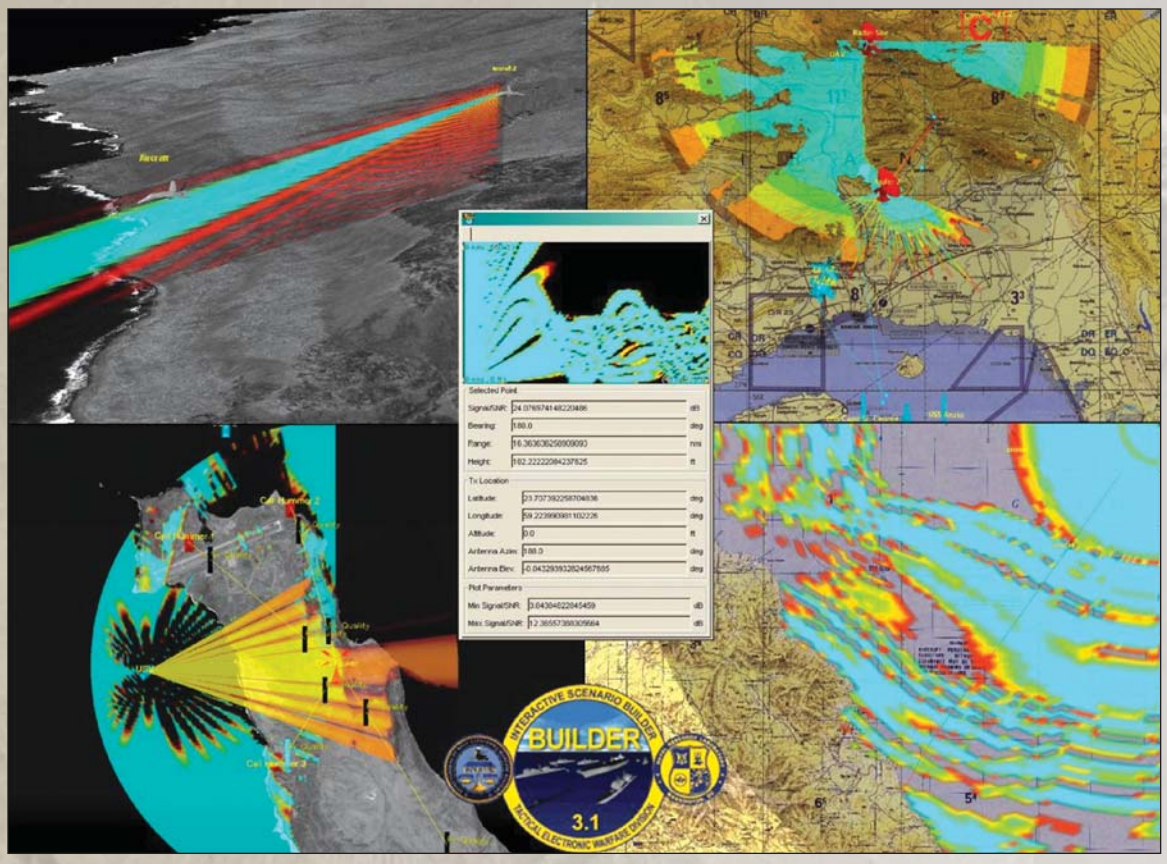
Interactive Scenario Builder (Builder)

Background: The objective of this effort was to develop a physics-based radio frequency (RF) propagation modeling and simulation tool. Builder provides a tool for analysts and planners to interactively ask and answer "what if" questions in order to gain better understanding of the predicted RF environment for communication, electronic warfare (EW) and radar devices in two, three, and four (time) dimensions. Better understanding of the complex and highly dynamic RF environment enables optimal use of limited RF resources and EW systems for defense of single ship and multi-ship strike groups. With Builder, mission planners can predict surface ship RF and EW systems performance against targeted RF transceivers. The intuitive interface and open architecture design have since been adopted in both the air and ground communities.

Success: The successful development and implementation of Builder enables users to bring together large volumes of disparate data in an intuitive and timely manner to produce graphical representations of complex RF propagation environments. Direct interfaces to Fleet Numerical Meteorological and Oceanography Center servers enable downloading of global and regional meteorological datasets, greatly increasing the precision of the propagation predictions. Interfaces to Navy Emitter Reference File and Combat Support Database facilitated generation of multiplatform scenarios with numerous communications, radar, and EW/RF systems. Builder was selected as the RF modeling and simulation component of the Joint Information Operations Planning Capability. Naval Explosive Ordnance Disposal, the lead agency for Counter Remote Control Improvised Explosive Device Electronic Warfare (CREW) systems, selected Builder as the core of their modeling and simulation effort to define CREW system requirements, analytically compare different system capabilities, and produce a pre-mission planning tool. Over 330 users from across the U.S. DoD have registered at the Builder Website for use of this technology.

Program POC: Mr. Brian Sjoberg, Naval Research Laboratory, Code 5774, 202-404-7616

Year: FY 2006



Examples of RF propagation predictions from top-left, running clockwise:

1) **Air-to-air radar,**
2) **Ground-to-air radar,**
3) **RF transmitter propagation prediction using meteorological forecast (center image displays a single vertical slice of this data), and (4) comms network propagation with jamming effects.**

Camouflaged Long Endurance Nano-Sensors (CLENS)

Background: The Camouflaged Long Endurance Nano-Sensors (CLENS) initiative is developing low-cost, lightweight micro-sensors for area reconnaissance and perimeter monitoring to support warfighter operations in difficult environments. CLENS will have broad application in support of comprehensive intelligence, surveillance, and reconnaissance for situational awareness, and will enable persistent sensing of dismounted combatants in the toughest of environments, such as forests.

Success:
Efforts on the Camouflaged Long Endurance Nano-Sensors (CLENS) program have culminated in the demonstration of the world's first low-power, integrated Radio Frequency sensor and communications network. The CLENS program successfully conducted a series of field assessments in November 2006 that showcased the operation of a real-time 25-node CLENS network and its ability to self-organize, robustly classify and track ground targets and relay actionable target intelligence for display at remote command sites.

Final CLENS Device

The development of the final CLENS device (seen above) has begun, which has been designed to provide at least 180 days of endurance at a mass of less than 150 grams and a volume slightly under 4 cubic inches.

Camouflaged Long Endurance Nano-Sensors (CLENS) successfully completes real-time field assessments, kicks-off Final Phase to build 150-gram, 6-month device. The primary objective for the CLENS program is to develop and demonstrate a lightweight, long endurance sensor network for providing persistent reconnaissance and surveillance of ground targets in difficult sensing environments. The CLENS System utilizes a network of ultra-wideband Radio Frequency nodes that jointly support radar-based sensing and communications. The network can operate stand-alone or as an addition to existing unattended ground sensors, and is an obvious sensing choice when robust detection and low false alarm performance is required in

urban, riverine, subterranean (within caves), forested, and similarly challenging environments. Besides providing substantially improved target detection, CLENS can provide reliable head-count, target geolocation and tracking, target ground speed, and projected target lengths, all supporting classification and threat assessments. The ultra-wideband communications that are indigenous to the design can support the exfiltration of data from the network's interior to long-haul communications at its periphery.

The final node has been designed to fit easily into the warfighter's backpack and robustly operate at node separations exceeding 30 m. These characteristics of the system will provide the ability to cover large areas of interest with a quantity of nodes that can be easily transported and deployed by a small unit of action.

Program POC: DARPA External Relations, 703-696-2404.

Year: FY 2007

Multispectral Adaptive Networked Tactical Imaging System (MANTIS)

Background: The **Multispectral Adaptive Networked Tactical Imaging System (MANTIS)** program is developing, integrating, and demonstrating a soldierworn visualization system that will provide the warfighter with digitally fused, multi-spectral video imagery in real-time (from helmet-mounted sensors) displayed on a helmet-mounted visor. MANTIS will enable the warfighter to see where the enemy cannot, giving the warfighter the advantage in operations at night and in smoke and fog, and it will provide the warfighter with augmented reality and increased situational awareness.

Success: The DARPA Multispectral, Adaptive, Networked, Tactical Imaging System (MANTIS) program has demonstrated new, multispectral image fusion ***to regain the night*** and real-time, video image sharing over a low-bandwidth, soldier radio network ***to exploit the net***. MANTIS paves the way for both helmet-mounted (Urban Fire Teams) and hand-held (Scout) applications that will augment or replace the current Night Vision Goggles (NVGs)—currently available to friend and foe.

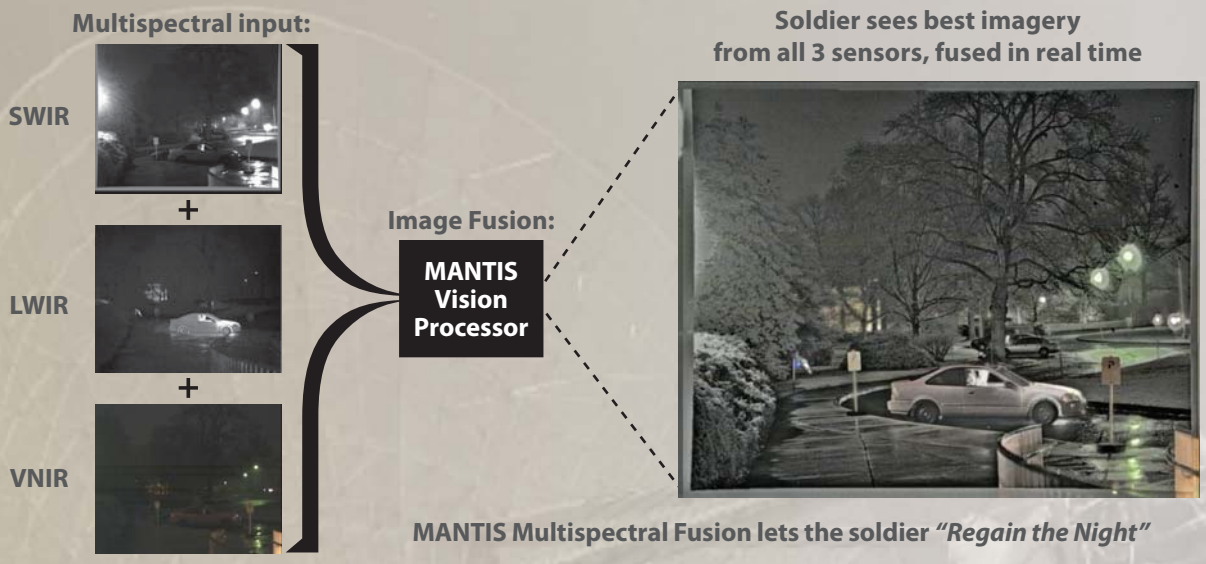
First, MANTIS has added an all-new spectral region—the Short Wave Infrared (SWIR)—allowing the soldier to "see" at night from natural sky-glow (*even without moonlight*), where current NVGs (image intensification in the Visible/Near Infrared spectrum) have limitations under moonless conditions.

Current Night Vision Goggles

MANTIS

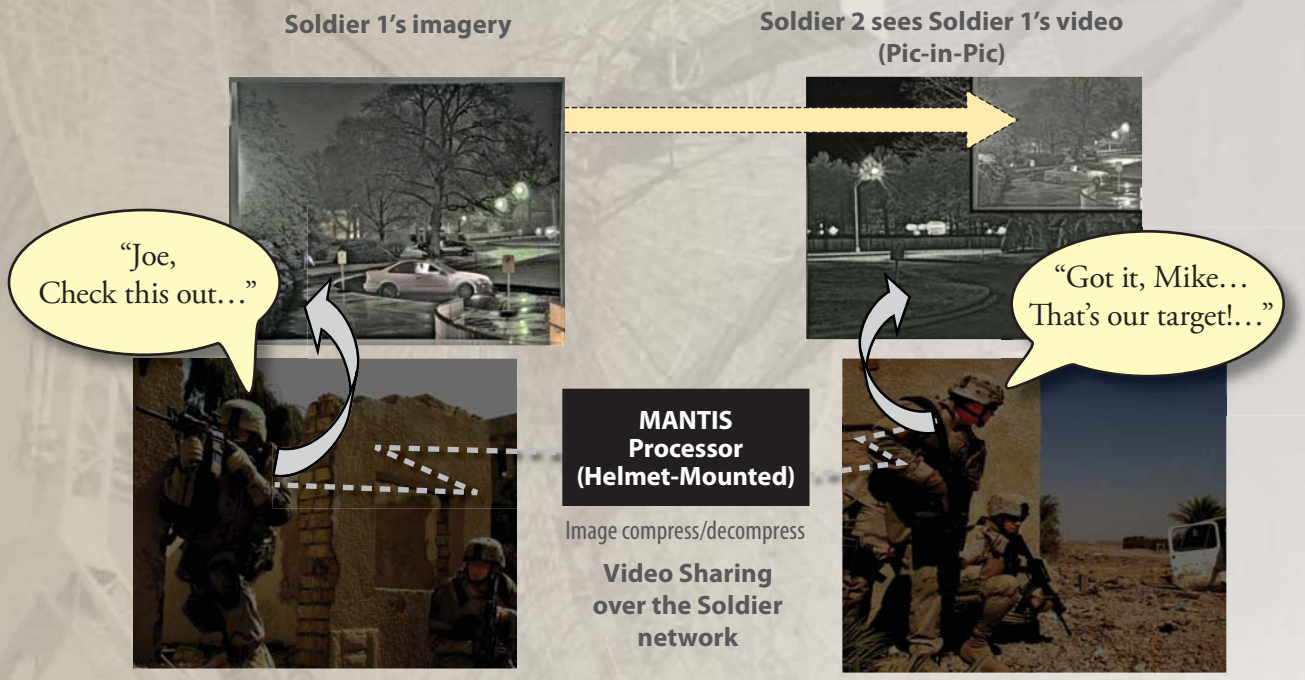
Side-by-side Imagery Comparison — Moonless Night: the *"SWIR Advantage"*

Second, using a helmet-mounted testbed, the MANTIS program has completed preliminary testing of new, multispectral image fusion algorithms that work *simultaneously in 3 spectral bands*—the short-wave infrared (SWIR), the long-wave infrared (LWIR) and the visible/near-infrared (VNIR). The high-speed MANTIS Vision Processor fuses digital imagery adaptively in real time so *the soldier always sees the best imagery* in his helmet-mounted display.



MANTIS Multispectral Fusion lets the soldier *"Regain the Night"*

Finally, the MANTIS testbed was also used to demonstrate the capability for image sharing of video between two soldiers over a wireless network *in real time*. Network analysis has recently confirmed that the MANTIS processor can compress and transmit video imagery *over existing, low-bandwidth soldier radios* being tested by the Army.



MANTIS lets the soldier *"Exploit the Net"*

The MANTIS high performance vision processor is a versatile system-on-a-chip (SOC) that accepts multiple input formats for up to 3 sensors. The high speed processor is based on a modular design and is fully programmable for use in a variety of tactical imaging applications (e.g., UAVs, UGVs, air/ground platforms).

MANTIS will not only allow the soldier to regain the night, but will also exploit network-centric warfare *at the tactical level*. These capabilities are being implemented in the MANTIS Phase III prototypes for transition to the US Army in FY 2008.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2008

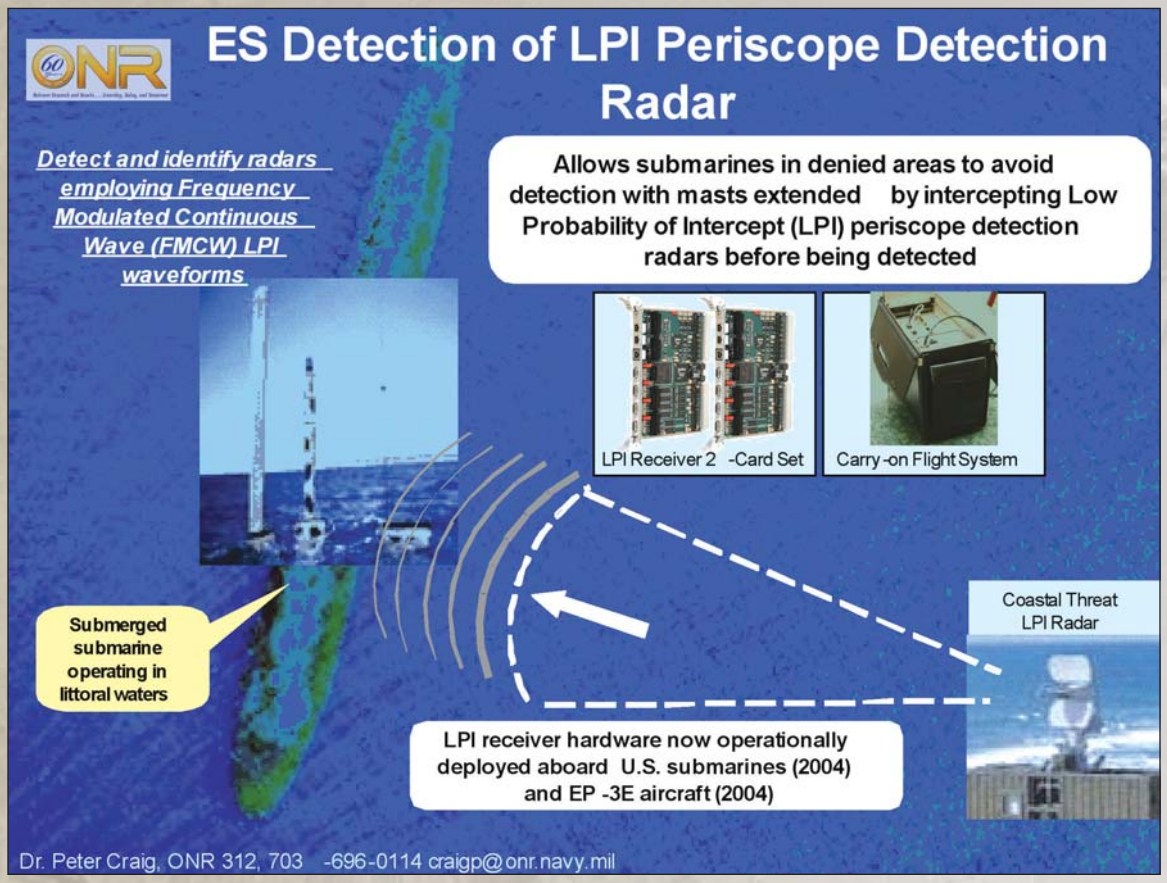
Detection and Identification of LPI and Advanced-Waveform Radio Frequency Emitters

Background: The objective of this DTO was to develop and demonstrate receiver and signal processing techniques suitable for detection and identification of low probability of intercept (LPI) and advanced-waveform radio frequency (RF) signals used in modern RF emitters such as radars and communication systems. This Electronic Support Measure (ESM) RF signal detection capability will enhance threat warning and situational awareness, particularly for the survivability of submarines in hostile threat environments. Two specific classes of LPI radar signals addressed were the frequency-modulated continuous wave (FMCW) and advanced phase-coded classes. The proliferation of LPI radars poses a significant threat to a submarine's ability to operate undetected, especially in the littorals. LPI radars manage their radiated power using techniques such as ultra-wide bandwidth and frequency modulation to improve resolution and deny detection by ESM systems. Existing ESM systems designed to operate against narrowband emitters with high peak power levels have limited capability against LPI emitters. Development of digital receiver and digital processing techniques was emphasized to optimize detection within a low-signal-to-noise-ratio, high-clutter environment.

Success: Over-water testing of an LPI detection system verified that the ES detection range exceeded the radar detection range significantly. Technology development provided ES receivers the capability to detect low-power, swept-frequency radars to which they were previously insensitive. In 2005, the LPI hardware was integrated with a submarine AN/BLQ-10 ES system and successfully tested against an FMCW radar. The Naval Research Laboratory LPI Team developed, tested, and deployed this new capability that provides detection and classification of LPI radar signals. This capability uses commercial off-the-shelf hardware and is easily incorporated into the existing submarine EW system using software that runs on almost any ESM processor. The result was the integration into the existing submarine ESM system with minimal impact and cost. The success of these LPI-developed detection subsystems for ES receivers has led to great interest for deployment on other platforms by the Air Force and the Army.

Program POC: Dr. Ted Roberts, Naval Research Laboratory, Code 5722, 202-767-3074

Year: FY 2006



Detection of LPI Radars beyond the radar's detection range

Subterranean Communications for First Responders and the Military

Background: Both military and commercial operations have a need for underground communications. Through a Small Business Innovation Research Program, CERDEC has developed a stand-alone, networked radio system that communicates 'through-the-media.' This system can be used in caves, tunnels, and mine shafts as well as basements, multi-story buildings, and subway and utility tunnels. The device will provide a 'through-the-earth' networked communications system for users underground and on the surface.

Success: In Phase I, the system concept was validated by showing successful voice, data, and image transfer in caves and abandoned mines through approximately 800 feet of earth. Consequently, the program progressed into Phase II. After the mining disasters in January 2006 motivated testing in a West Virginia coal mine, the concept system exceeded expectations and outperformed other systems tested. The visibility of the success of these underground coal mine tests bolstered confidence in the system and attracted NIOSH to invest in the project for Phase II Plus. This should ensure commercialization of the product.

Program POCs: Philip Ciorciari, 732-427-2028 / Kristopher Glover, 732-427-8075 CERDEC STCD, AMSRD-CER-ST-WL-NS, Ft. Monmouth, NJ 07703

Year: FY 2007

Participating Services/Agencies: U.S. Army, Communications–Electronics Research, Development, and Engineering Center (CERDEC), National Institute of Occupational Safety and Health (NIOSH)

Standoff Intelligence Detection Deploying to Iraq

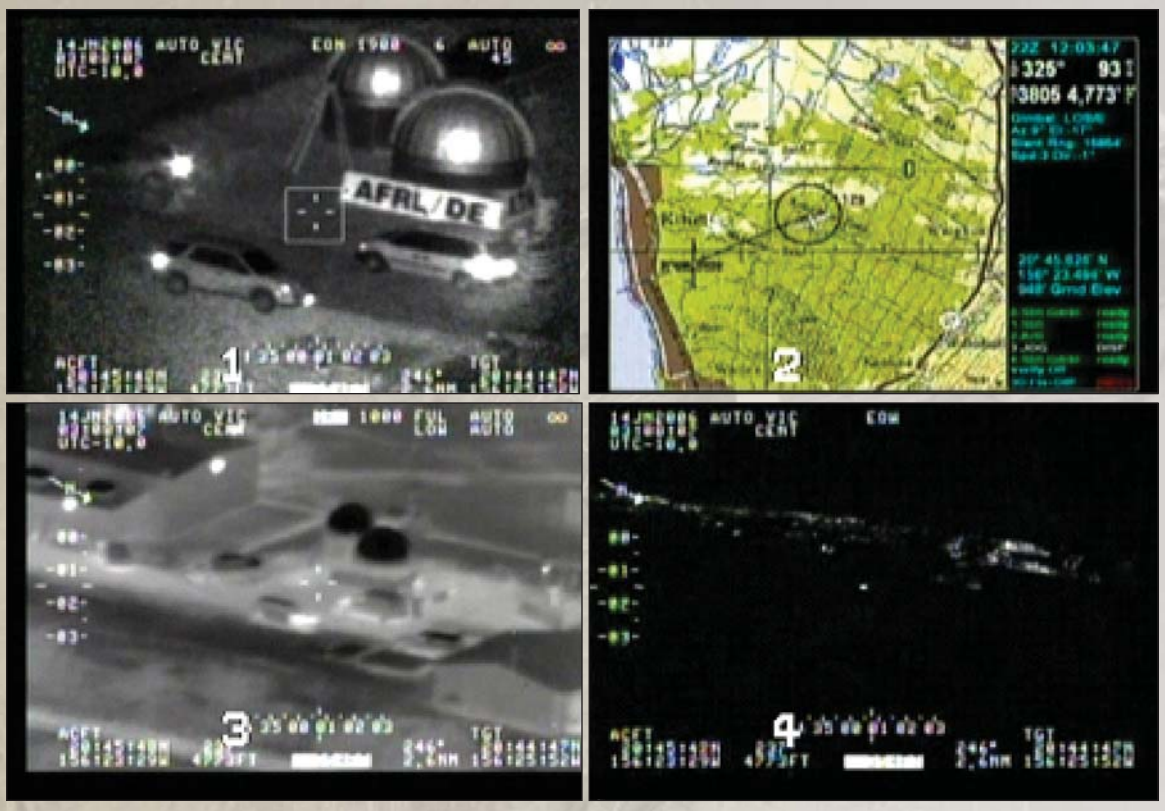
Background: The U.S. armed forces have been striving to dominate the night through use of night-time sensors, usually image intensifiers or infrared sensors. While the U.S. maintains a distinct advantage in this area over its adversaries, we still do not see as well at night as in day. Infrared sensors have worse resolution than visible sensors, and they detect contrast in temperature, not contrast in reflectivity, which is not how human operators are used to observing. A night-time sensor that is just as good as a day-time camera would be a tremendous benefit.

Success: Laser illuminators offer a solution by providing an artificial source of light at or near the same wavelengths that humans are accustomed to viewing. The fundamental problem is to get a laser (with enough power) and a detector (with enough sensitivity) together in a package that gives a useful range and can operate in potentially harsh flying conditions.

AFRL has a number of programs using laser illumination for sensing. The Standoff Intelligence Detection (SID) program took the simplest approach in an attempt to build something that was ready for operational use as quickly as possible. SID took an operational surveillance turret, the MX-20, and integrated into it a standard DoD designator laser (with different optics) and a commercial detector that is very sensitive. This package was flight tested extensively in 2005–2006 on a Twin Otter aircraft flying over Maui, HI. In September 2006, the U.S. Army put the SID package on two of the seven tethered aerostats it is purchasing to deploy in Iraq and Afghanistan, and funded AFRL to produce an integrated system. The first SID package will deploy in fall 2007.

Program POC: Maj Laura Durr, AFRL/DES, 505-846-4357

Year: FY 2006



Clockwise from lower left:

1) FLIR image of RME Domes and cars

2) Simultaneous (Bore-sighted) SWIR laser image of FLIR scene

3) GPS/Targeting real-time Mapping (topo 1:24K) display of A/C and target location

4) Color TV at night showing distant lights along the shoreline of Maui, the flight test location

Boomerang

Background: The Boomerang program focused on enhancing the safety of vehicle convoys and increasing situational awareness by rapidly developing and demonstrating affordable and reliable acoustic gun shot detection and localization techniques. Acoustic sensors, mounted in an array at the top of a mast, are used to detect both supersonic shock and sound waves from muzzle blast, and then identify the location of the shooter. Boomerang developed system hardware design and packaging, vehicle integration concepts, user interfaces and signal processing algorithms and software for prototype systems, and continued refinement of algorithms, hardware and software to improve system performance and accuracy. Boomerang systems are being operationally evaluated by warfighters serving in Operation Iraqi Freedom for force protection capabilities for moving vehicles and stationary sites.

Success: The DARPA Boomerang program was a rapid response effort designed to develop and demonstrate acoustic gun shot detection and localization technologies to enhance force protection for warfighters serving in Operation Iraqi Freedom and other hostile areas. Since program inception, DARPA developed over 150 Boomerang systems in various and continually improving configurations. They are being evaluated by the Services in combat operations and adverse localities. Originally built for on-the-move convoy protection, Boomerang units were mounted on the High-Mobility Multipurpose Wheeled Vehicle. Modifications were later made to enable Boomerang to be evaluated in a stationary role, to secure high-value facilities. The systems have received high praise from the Services, which have acquired a number of additional systems on their own. As a result of this positive feedback, the Army has awarded a contract for additional Boomerang units to be used by U.S. Forces.

Boomerang gun shot detection system transitions from DARPA to the Services. The Boomerang system is designed to detect supersonic projectiles fired at close range and provide instant indication of shooter direction, range and elevation. The system is designed for ease of use and installation, and field upgradeability. Over two-thirds of the military units that received Boomerang have been fired at, and in response the system has successfully provided vital real-time shot detection information. Both the U.S. Army and Marine units that received Boomerang units have responded positively for both the stationary and mobile systems.

In support of the Boomerang deployment, DARPA collaborated with the Marine Corps War Fighting Lab (MCWL) and the U.S. Army Rapid Equipping Force (REF). MCWL supported the program since its inception. MCWL participated in: assisting with the deployment of the initial 50 systems within 66 days; gathering of feedback critical to development of the Boomerang II improved systems; and, the eventual shipment of a more robust system to Theater. The REF's assistance was equally vital to the program's success. The REF assisted in the shipment of additional systems, provided in-theater training, and is currently supporting the sustainment effort through the U.S. Army Materiel Command.

In response to queries concerning the feasibility of deploying Boomerang systems for stationary applications where vehicle battery operation is undesirable, DARPA initiated a Boomerang generator effort. This effort was funded via a 2005 DDR&E Quick Reaction Special Projects funding and was based on portable solid oxide fuel cell technology developed under DARPA's Palm Power program. Six prototype propane fueled generators were delivered to the Marines for evaluation and test with Boomerang equipment. Preliminary results suggest the generators work well in a controlled environment. However, the combination of heavy wind and cold weather required frequent restarts of the generator. The performer is aware of these limitations and has a working solution.

DARPA's involvement with the development of Boomerang ended in January 2007. The Services have also expressed significant interest in acquiring an improved Generation III Boomerang, currently under development, which will have enhanced design features, greater accuracy and improved operability. Boomerang was developed by BBN Technologies of Cambridge, MA.

Boomerang In-Theatre

Stationary

Mobile

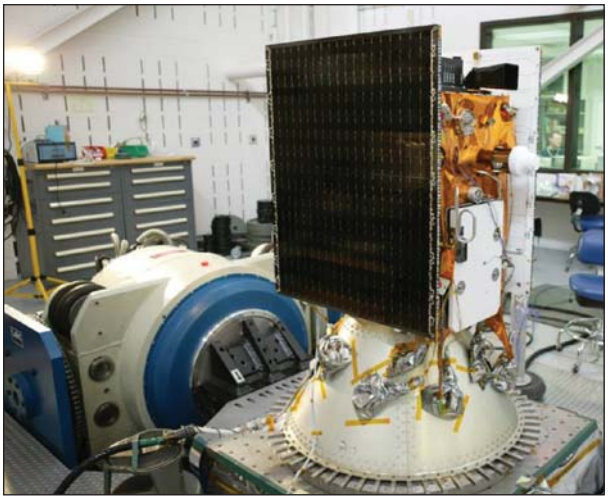
Program POC: DARPA External Relations, 703-696-2404

Year: FY 2006


SPACE
PROGRAMS

Experimental Satellite System (XSS-11)

Background: This effort established a foundation for low-cost, reduced-size satellites with extended capabilities benefiting the warfighter, and provided highest performance computing capability for the harshest space environment.

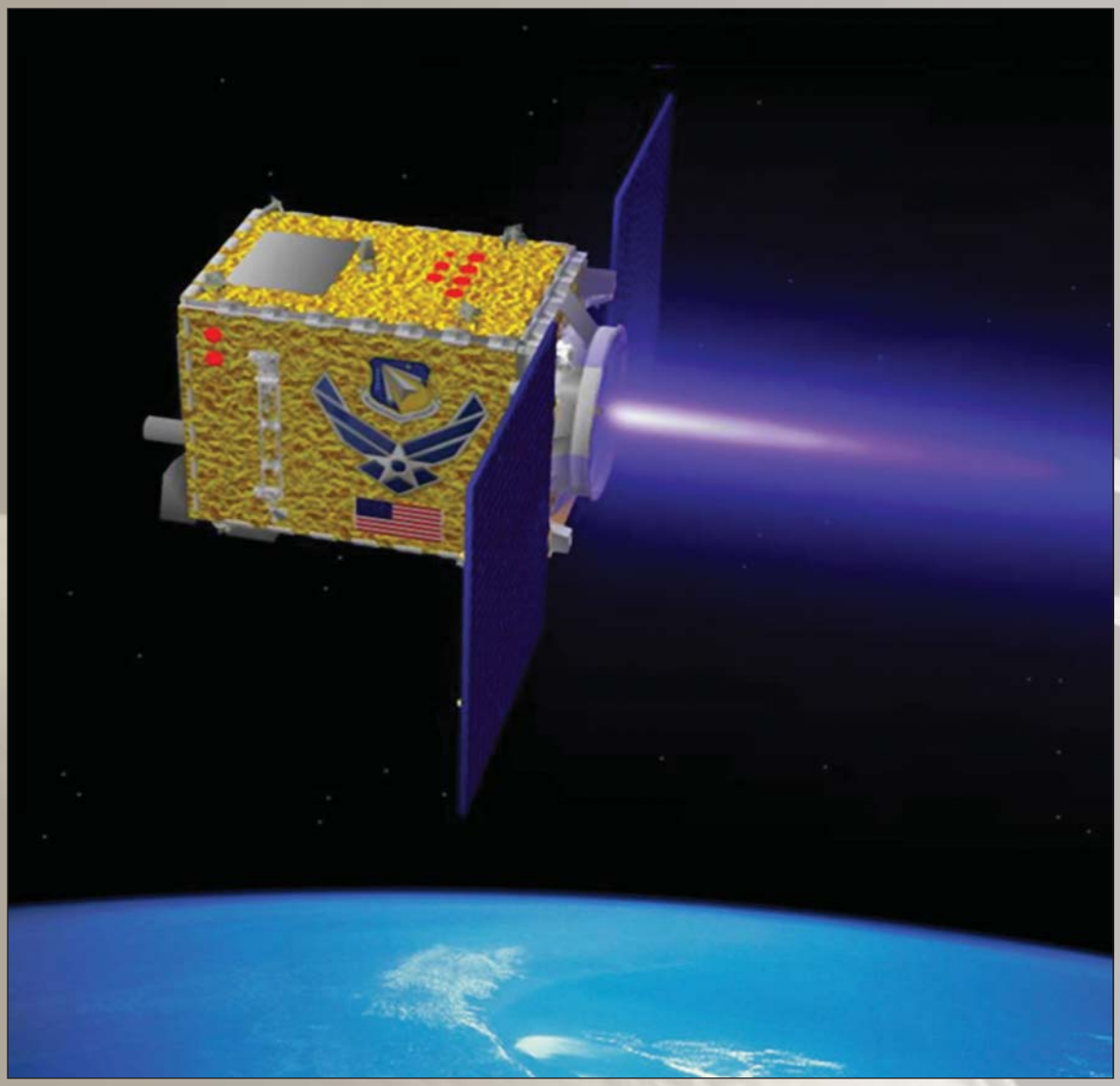


Pre-launch laboratory testing of XSS-11

Success: This program demonstrated ground-breaking rendezvous and proximity operations around two resident space objects (RSOs), including the Minotaur upper stage that took XSS-11 into orbit. Over its year of on-orbit operations, the XSS-11 performed over 50 rendezvous and RSO acquisitions, over 300 natural motion circumnavigations, over 20 stationary station keepings, and several dozen linear translations around and near the RSOs. It was integrated other VS technologies such as the newest space processor the Rad 750, which provides a 10X increase in performance for the XSS-11 main processor, at reduced power consumption. The mission was completed on 15 December 2006; it completed 100% of its original mission objectives.

Program POC: Mr. Harold V. Baker, AFRL/VSEI, 505-853-3349; Mr. Creigh Gordon, AFRL/VSSE, 505-846-6079

Year: FY 2006



XSS-11 conceptual artist drawing

High Frequency Active Auroral Research Project (HAARP)

Background: The High Frequency Active Auroral Research Project (HAARP) developed new experimental research capabilities and conducted research programs to exploit emerging ionosphere and radio science technologies related to advanced defense applications. The FY 1990 Appropriation Act provided funds for the creation of HAARP, jointly managed by the Air Force Research Laboratory and the Office of Naval Research to exploit emerging ionosphere and high power radio technology for new military systems applications. Key to the current effort was the expansion of the experimental research facility that includes a 3.6 MW high-frequency transmitter and a variety of diagnostic instruments, to conduct investigations to characterize the physical processes that can be initiated and controlled in the ionosphere and space, via interactions with high power radio waves. Among these were: (1) the generation of extremely low frequency/very low frequency radio waves for submarine and other subsurface communication, and the reduction of charged particle populations in the radiation belts to ensure safe spacecraft systems operations; (2) the control of electron density gradients and the refractive properties in selected regions of the ionosphere to create radio wave propagation channels; and (3) the generation of optical and infrared emissions in space to calibrate space sensors. To date, the facility has been developed to include a suite of optical and radio diagnostics and an advanced, modern, high frequency transmitting array that has a radiated power of 960 kW, about one-third of the 3.6MW called for in the original concept and plan. The current high frequency transmitting array has proven to be extremely reliable and flexible, and has shown the feasibility of the overall concept. However, results to date have indicated that the advanced applications-related research activities and new military system concept demonstrations envisioned under the program require that the high frequency transmitting capability at the site be increased from the present 960 kW level to the originally planned 3.6 MW level. A study completed by an Air Force/Navy Panel also pointed to additional high-value functions that can potentially be accomplished with the a 3.6 MW capability, in particular, the exploration and refinement of scientific principles that could lead to the development and deployment of a system to provide protection for spacebased assets from emergent asymmetric threats. DARPA established an MOA with the Air Force and Navy for this program in November 2002. The HAARP technology transitioned to the Air Force and Navy in FY 2006.

Success: The High-Frequency Active Auroral Research Program (HAARP) instrument is a ground-based phased array transmitter, located near Gakona, AK. It is used to explore the behavior of the natural and induced near earth environment, and to investigate communications and other high frequency, extremely low and very low frequency applications. The HAARP antenna array and its elevated ground screen are supported by towers mounted on frozen-

in-place thermopiles. The prototype antenna array comprises 48 crossed-dipole elements in a 6x8 rectangular pattern generating 960 kilowatts of average power. This is being expanded to 180 crossed dipoles, in a 12x15 pattern that will generate 3.6 MW of average power. Physical site and infrastructure expansion are complete, and integration and testing of subsystem components and electrical and fiber wiring are nearing completion. System integration and testing are is underway with a 12x12, 2.8 MW subarray. The completed array will be on line in the first half of 2007.

Aerial view of full HAARP array with all transmitter shelters in place

The High-Frequency Active Auroral Research Program (HAARP) instrument is poised for full-scale tests in the first half of 2007. The goal of the joint Air Force—Navy—DARPA HAARP Instrument Completion program is to upgrade the HAARP transmitters to the latest available components and methods, and then have 132 such transmitters produced to augment the 48 already on-site. The modernized control systems of the new transmitters are also being back-fitted to the original units, for compatibility in control and monitoring. The result will be a 14-fold increase in effective radiated power in the ionospherically-directed beam. DARPA's primary role is to fund the updating and production of 132 additional transmitters, sufficient to drive the full 12x15 antenna array at 3,600 kW. All of the transmitters are on-site and installed. All but 6 of the installed transmitters have been integrated into the array and checked out. Engineering testing of the array has begun, with a 12x12 subarray powered up for the first time to exercise the beam shaping and steering software. The full 12x15 array is expected to come on line in March 2007. Engineering shakedown of the full array is expected in March and April, followed Government acceptance testing in May and a "ribbon cutting" event in June 2007.

The upgrade and completion of the HAARP instrument was initiated when it became apparent that the complete array could provide improved and enhanced generation of very low frequency and extremely low frequency (VLF-ELF) waves in the magnetosphere. This would expand HAARP's usefulness in conducting ionospheric and magnetospheric research. It would particularly improve our understanding of the near-earth space environment, which is critical for predicting the behavior and lifetimes of near-earth satellites.

Program POC: DARPA External Relations, 703-696-2404

Year: FY 2006


WEAPONS

Strategic Illuminator Laser (SILL)

Background: The Missile Defense Agency (MDA) has a program dedicated to the development of next-generation target illuminator lasers. The SILL (Strategic Illuminator Laser) project under this program is an effort to provide longer detection ranges while reducing both the weight and the size of airborne laser illuminator systems. The illuminator laser is a critical component of the High Energy Laser (HEL) weapon system. It is used in conjunction with tracking sensors to help point the laser weapon precisely at the target. Other lasers also help to remove atmospheric distortion and distortion from other parts of the weapon's optical system so that the laser can be more tightly focused on a target.

Success: An intermediate brassboard laser was delivered for testing in 2006. The brassboard Light Weight Gain Module achieved "First Light" on March 22, 2007. A flight-qualifiable SILL Laser and Electronics delivery is planned for September 2007. The SILL program is under consideration for transition to the MDA Airborne Laser (ABL) program for enhancing its Boost Phase Intercept (BPI) capabilities.

POC: Mr. Jim Kotora, MDA/DVW, 703-882-6145

Year: FY 2007

Airborne Laser (ABL) Aircraft

Compact Kinetic Energy Missile

Background: The Compact Kinetic Energy Missile (CKEM) program objective was to develop and demonstrate an anti-armor KE missile half the size and weight of the previous generation line-of-sight missile to provide overmatching lethality against current and projected anti-tank advanced armor, explosive reactive armor, and hard point targets, bunkers, and buildings. CKEM provides hit-to-kill, precision lethality in a missile system integrated on a HMMWV package that is less than 60 inches long and weighs less than 100 lb. CKEM provides long-range firings beyond that of tank main guns, and utilizes a novel lethality system.

The AMRDEC began development on the CKEM concept in 2000. The primary pacing technologies were identified and matured to provide a direct-fire, line-of-sight KE missile capability for the Army.

Success: In FY 2002, critical CKEM technologies were demonstrated, including advanced propulsion, lethal mechanisms, high-G guidance, and control. These were demonstrated in full-scale technology flight tests. In FY 2003, the CKEM program demonstrated "overwhelming lethality" against advanced threat targets of interest during full-scale sled testing, and continued demonstration of critical hypervelocity technologies in operational environments. In FY 2004, the program performed risk reduction flight tests, continued critical technology testing, demonstrated short-range lethality performance, performed subsystem integration testing, and validated simulation models. In FY 2006, the CKEM ATD successfully conducted integrated weapon system flight test demonstrations on a modified HMMWV. These flight test demonstrations were conducted with lethal mechanism against representative advanced threat armor vehicles and MOUT targets.

Program POC: Loretta Painter, AMRDEC, RDECOM, 256-876-2520, loretta.painter@us.army.mil

Year: FY 2006

Launch photo from CKEM Lethality Test Flight—Sequential (LTF-Seq) Mission—9 November 2006 at Eglin Air Force Base, Florida

Focused Lethality Munitions

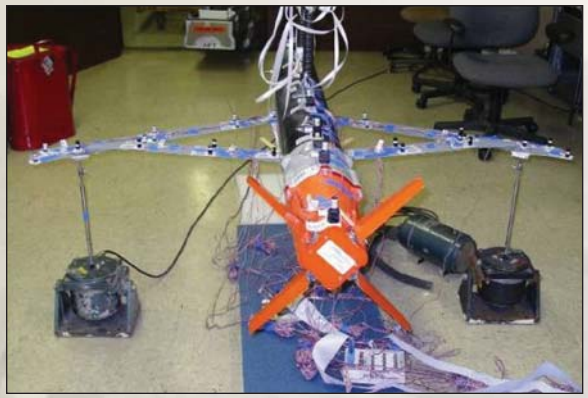
Background: Focused Lethality Munitions (FLM) significantly reduces collateral damage, enabling prosecution of targets in an urban setting that could not be attacked previously due to the proximity of non-combatants. In turn, this allows the urban target prosecution rate to increase, thereby decreasing conflict duration, attrition, and cost.

Static Detonation Arena Tests
- Horizontal, Vertical & Debris Field Mapping
- Lethality/Collateral Damage Assessment Inputs

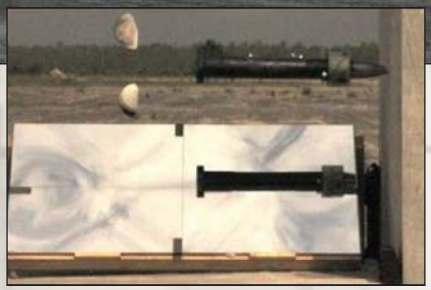
Success: Traditional steel warheads generate fragments that travel well beyond the target area, endangering non-combatants—especially in urban areas. FLM has a composite warhead case that replaces the steel warhead case and disintegrates into nonlethal fibers upon detonation, thus significantly reducing collateral damage. FLM Multiphase Blast Explosive (MBX) produces a high near-field impulse to ensure high blast-only lethality. AFRL scientists collaborated with Lawrence Livermore National Laboratory to develop the composite munitions cases for projectiles, penetrators, and general purpose bombs. AFRL also developed and tested a family of MBX explosive formulations for the various munitions applications.

Program POC: Mr. Cunard, AFRL/MNMW, 850-882-7994, donald.cunard@eglin.af.mil

Year: FY 2006



Design Verification Tests (Structural Tests)
- Evaluate Design Failure Thresholds/Margin
- Ensure Design Meets SDB I Specifications



Gun Penetration Tests
- Sled Test Risk Mitigation
- Offset Sabot Induces Controlled Angle of Attack
- On-board Accelerometer Measures Impact Conditions

Sled Penetration Tests
- Configured with SDB I Common Airframe
- Verifies End-to-End FLM Functionality

Lightweight Dismounted Mortar Weapon

Background: The user demanded a mortar system weight reduction to improve manned portability of the M252 81-mm Mortar Weapon System. The Lightweight Dismounted Mortar Weapon (LWDMW) ATO was a three year (FY 2004–FY 2006) S&T effort to explore the use of new materials and manufacturing processes, seeking to demonstrate a 30–40% targeted weight savings in an 81-mm mortar prototype while meeting or exceeding the current M252 performance requirements.

A soldier adjusts the elevation of the LW 81mm Mortar.

Success: At the same time as the Army ATO, the Office of Naval Research funded an advanced materials effort with very similar objectives for both the 60-mm and 81-mm mortar weapons in support of the USMC. The Army and Navy collaborated to produce prototype components for demonstration and live-fire engineering component tests conducted in FY 2005. The lightweight (LW) tube was made of inconel, a nickel-based alloy used extensively in aerospace applications and manufactured using a flow-forming process, reducing the manufacturing cost by 70% from $23,000 to $7,000. The LW baseplate prototype was a result of extensive modeling and simulation, which resulted in a weight-optimized high-strength aluminum design. The LW bipod prototype design proved to be more portable than the currently fielded bipod and is of similar architecture as the current 60-mm and 120-mm bipods, improving commonality across systems.

The success of the LW component testing, as well as the projected reduction in manufacturing cost, in particular through the use of a flow-formed inconel tube, led PM CAS/PM Mortars to encourage a project refocus concentrating on these technologies that could transition to production without a lengthy system design and development (SDD) program. The technologies developed under the ATO, which resulted in a 30% weight savings (65 vs. 93 lb), are undergoing safety certification and qualification testing on production-representative lightweight prototypes of each component (expected to complete in 4Q07).

Program POC: José Santiago, ARDEC, 973-724-6211, jose.santiago3@us.army.mil

Year: FY 2006

The LW81mm bipod packs up smaller than the currently fielded bipod and is easier to transport.

Wide-Area Search Synthetic Aperture Radar

Background: The Air Force Research Laboratory (AFRL) is developing state-of-the-art weaponry that users can launch into the vicinity of mobile targets to autonomously find and defeat them. This capability provides increased survivability, multiple kills per pass, and minimal pilot workload. Since there is an inherent delay between observing a target and subsequently launching a weapon, users require the capability to rapidly search a large area. Additionally, they need a weapon that can operate day or night and in adverse weather.

Success: Under the Wide-Area Search Synthetic Aperture Radar (WASSAR) program, AFRL and Northrop Grumman Electronic Systems (Baltimore, MD) are using synthetic-aperture radar (SAR) weapons technology, addressing the need to perform wide-area searches for mobile and relocatable targets in adverse weather. The research team transformed a SAR device into a multimode radar seeker, combining SAR technology with ground moving-target indicator and high-range-resolution radar signal processing. Users will employ these modes to perform autonomous target classification to increase probability of kill. The wide-area search capability is a requirement due to the uncertainty of a target's location after its initial detection. Scientists tested the modified system 12 times, with successful results. The effort demonstrated the capability for a weapon-quality radar seeker to search a 50 square km area for stationary and moving targets in less than 2 minutes and under adverse weather conditions.

Program POC: Mr. F. Arredondo, AFRL/MNGS, 850-883-2176, Francisco.arredondo@eglin.af.mil

Year: FY 2006