Test and Evaluation Resources

Public law requires DOT&E to assess the adequacy of operational and live fire testing conducted for programs under oversight, and to include comments and recommendations on resources and facilities available for operational testing and evaluation (OT&E) and on levels of funding made available for OT&E activities. DOT&E monitors and reviews DoD and Service-level strategic plans, investment programs, and resource management decisions to ensure capabilities necessary for realistic operational tests are supported. This report highlights general areas of concern in testing current systems and discusses significant issues, DOT&E recommendations, and testing and evaluation (T&E) resource and infrastructure needs to support operational and live fire testing. FY13 focus areas included:

- General Test Infrastructure
- Operational Test Agency (OTA) Capabilities and Resources
- Continuing Radio Frequency Spectrum Concerns
- Advanced Electronic Warfare (EW) Test Resources
- Aegis-Capable Self-Defense Test Ship (SDTS)
- Aegis Probability of Raid Annihilation (PRA) Test Bed
- Warrior Injury Assessment Manikin (WIAMan)
- Cyber Warfare
- Fifth-Generation Aerial Target
- Real-Time Casualty Assessment (RTCA)
- Additional EW Simulator Units for Surface EW Improvement Program (SEWIP) Operational Testing
- Anti-Ship Cruise Missile (ASCM) Seekers for GQM-163A Supersonic Target
- Modification of GQM-163A Coyote Target to Represent another ASCM Threat
- Long-term Improvement in Fidelity of ASCM Seeker/Autopilot Simulators for EW Testing
- Torpedo Surrogates for Operational Testing of Anti-Submarine Warfare (ASW) Platforms and Systems

General Test Infrastructure

The Budget Control Act of 2011 and the continuing impasse on federal funding present significant challenges for DoD planning and budget formulation. Limitations on test infrastructure funding and related impacts are uncertain, but potentially significant. For example, the Major Range and Test Facility Base (MRTFB) faces negative impacts due to potential loss of funding needed to maintain and enhance capabilities; this funding comes from both institutional sources and customers (whose own funding losses cause schedule delays or cancellations). In turn, unavailable MRTFB assets and capabilities may delay testing for acquisition programs. Specific FY13 impacts due to sequestration alone include:

- One-month delay for the F-35 Joint Strike Fighter (JSF) test program due to limited availability of the 412th Test Wing and the 96th Test Wing in Air Force Materiel Command
- Reduction of flying operations at both the Eglin and Edwards open-air ranges to a four-day-per-week schedule resulting from civilian furloughs and contractor workforce layoffs
- Air Force Space Command ceasing operations of several MRTFB test infrastructure assets (e.g., tracking and imaging radars, telemetry, and imaging optics) for the remainder of FY13.

The test infrastructure continues to face technological and policy challenges and risks in maintaining capabilities to test and evaluate the effectiveness, suitability, survivability, and lethality of current and future defense systems. For example, ensuring the availability of sufficient Radio Frequency spectrum for operational testing of many current weapons systems (such as the JSF) requires policy solutions, technology innovations, and significant funding to maintain existing capabilities. Radio Frequency spectrum concerns are described in greater detail below.

The rapid growth in renewable energy projects across the United States has the potential to adversely affect test capabilities on ranges for current and future systems. Renewable energy proponents have proposed construction of projects in close proximity to and within critical T&E ranges. The abundance of these projects causes a significant concern for DoD test ranges, emphasizing the need for resolution of competing policy objectives for alternative energy and national defense needs.

The 2012 Strategic Plan for DoD T&E Resources identifies some near-term test infrastructure needs:

- Addressing near-term maintenance, sustainment, and modernization needs of T&E facilities across the Services due to obsolescence and equipment deterioration
- Managing the current workforce while shaping future workforce requirements to meet the sophisticated T&E and acquisition challenges brought about by emerging technology
- Developing an investment and operational strategy to produce test capability for unmanned and autonomous systems in the air, land, and maritime domains
- Continuing initial efforts to develop a cyberspace test infrastructure capability that provides friendly force, opposing force, and background environments with representative threats to offer both defensive and offensive cyber operations

The remainder of this section focuses on test infrastructure specific to OT&E. The test infrastructure provides critical support for operational and live fire testing, and DOT&E engages in the DoD budget and review process to address continuing problems related to T&E resources and infrastructure.

Operational Test Agency (OTA) Capabilities and Resources

OT&E is performed by independent OTAs, which each Service is required to maintain. OTA capabilities and resources reside principally in a technically competent and available workforce to plan, execute, and evaluate operational test results. Table 1 provides a census of OTA personnel every two years from FY04-FY12. The data indicate military staffing for both the Navy and United States Marine Corps (USMC) OTAs was fairly constant, while the number of military billets in Army and Air Force OTAs decreased. The Air Force decrease is quite significant, at approximately 36 percent. For civilian personnel, the most significant change is the Marine Corps Operational Test and Evaluation Activity (MCOTEA) increase from FY10-FY12 that reflects policy decisions to insource support for inherited government duties with government civilians and enhance scientific and technical competencies at MCOTEA.

TABLE 1. OTA WORKFORCE FY02-FY12 TREND (NUMBER OF PERSONNEL)

MILITARY	FY04	FY06	FY08	FY10	FY12
Army (ATEC-OT)	350	322	306	277	307
Air Force (AFOTEC)	577	548	456	378	369
Navy (COTF)[1]	223	240	221	217	224
USMC (MCOTEA)	26	28	25	28	28
Total Military	**1,176**	**1,138**	**1,008**	**900**	**928**
CIVILIAN	**FY04**	**FY06**	**FY08**	**FY10**	**FY12**
Army (ATEC-OT)	650	729	756	715	627
Air Force (AFOTEC)	195	199	166	191	221
Navy (COTF)[1]	73	76	71	74	73
USMC (MCOTEA)	18	20	24	26	56
Total Civilian	**936**	**1,024**	**1,017**	**1,006**	**977**
TOTAL	**2,112**	**2,162**	**2,025**	**1,906**	**1,905**

ATEC-OT – Army Test & Evaluation Command – Operational Test
COTF – Commander, Operational Test & Evaluation Force
AFOTEC – Air Force Operational Test & Evaluation Command
MCOTEA – Marine Corps Operational Test & Evaluation Activity

[1] COTF totals exclude VX squadrons and Marine Corps Air Detachments.

Degrees in science, technology, engineering, and mathematics provide a strong understanding of the scientific method and the analytical skills important to rigorous T&E. Additionally, degrees in statistics, operations research, and systems engineering are especially useful when constructing designed experiments and analyzing data from tests. Table 2 displays the numbers of these targeted degree fields that focus on test design and analysis. Of note is the lack of civilian personnel with degrees in mathematics/statistics in the Navy.

TABLE 2. NUMBER OF CIVILIAN PERSONNEL WITH DEGREES IN FIELDS SUITED TO TEST DESIGN AND ANALYSIS

DEGREE AREA	ATEC	AFOTEC	COTF	MCOTEA
Mathematics/Statistics	53	5	0	4
Computer & Information Science	71	13	8	1
Engineering	242	37	9	0
Engineering Technology	23	7	1	0
Biological Sciences	13	1	1	0
Physical Sciences	20	6	3	1
TOTAL (Percent of non-admin personnel)	**422/531 (79%)**	**69/89 (76%)**	**22/27 (81%)**	**6/41 (15%)**

ATEC– Army Test & Evaluation Command – Operational Test
COTF – Commander, Operational Test & Evaluation Force
AFOTEC – Air Force Operational Test & Evaluation Command
MCOTEA – Marine Corps Operational Test & Evaluation Activity

Commander, Operational Test and Evaluation Force (COTF) not only has the lowest number of civilian personnel among all the service OTAs but also only 27 T&E civilians with technical backgrounds. In an October 30, 2013 briefing to DOT&E, COTF recognized the need for increasing civilian staffing to improve scientific, technical, engineering, and mathematical/statistical competencies to effectively meet OT&E needs and proffered his plan to improve his workforce's technical competency within the Navy's constraints on the number of civilian billets authorized. DOT&E supports enhancing COTF's civilian workforce and recommends improving both the size and composition of the workforce to improve operational and live fire test planning, execution, and analysis of Navy systems. Furthermore, COTF (as well as the other OTAs) would benefit from having a senior technical advisor to the Commander who is well versed in the science of experimental design and data analysis and is responsible for ensuring technical rigor across the entire Command.

Continuing Radio Frequency Spectrum Concerns

T&E spectrum needs, like those of the rest of DoD, are growing. Bandwidths required by systems under test are expanding as the new system capability expands. Additionally, the number of test conditions and monitored conditions requiring telemetry data has been rising. Test activities are constrained by overlapping signal footprints, so that test schedules of nearby ranges must be interleaved.

In June 2010, the White House directed the Secretary of Commerce, working through the National Telecommunications and Information Administration (NTIA) to collaborate with the Federal Communications Commission (FCC) to make available a total of 500 Megahertz (MHz) of federal and non-federal spectrum over 10 years, suitable for both mobile and fixed wireless broadband use. The spectrum must be available to be licensed by the FCC for exclusive use or made available for shared access by commercial and government users to enable deployment of wireless broadband technologies.

In January 2011, the NTIA focused on the 1755–1850 MHz spectrum. On March 20, 2013, the FCC issued formal notice to the NTIA that the lower portion of the band (1755–1780 MHz) would be auctioned for wireless broadband as early as September 2014. In July 2013, the White House directed DoD to vacate that portion of the band, which is extensively used by major DoD systems, including:

- Small Unmanned Aerial Systems
- Tactical Targeting Network Technology
- Tactical Radio Relay
- High Resolution Video
- Precision Guided Munitions
- Point-to-Point Microwave Links
- DoD Video Surveillance/Robotics
- Satellite Operations
- Electronic Warfare
- Air Combat Training System
- Joint Tactical Radio System (JTRS)
- Aeronautical Mobile Telemetry

DoD capabilities in the 1755–1850 MHz band, such as the Air Combat Training System, JTRS, and T&E operations using Aeronautical Mobile Telemetry, will be compressed into the upper portion of the band (1780–1850 MHz). The DoD Chief Information Officer (CIO) has proposed the 2025–2110 MHz band (currently used by television broadcasters and video producers) as a possible alternative band for some of the dislocated systems. However, a July 17, 2013 DoD CIO proposal to NTIA is not consistent with prior DoD findings identified in "Spectrum Reallocation Feasibility Study 1755–1850 MHz Band" issued on September 8, 2011, and from revision 1 of this study issued on March 20, 2012.

In a July 17, 2013 letter to NTIA, the DoD CIO proposed shared usage of 1755–1780 MHz for a limited but unspecified time. The proposal would establish protection zones applicable to JTRS radios only around Forts Irwin, Polk, Bliss, Bragg, and Hood; White Sands Missile Range; and Yuma Proving Ground based on the propagation within the 1755–1780 MHz spectrum using an antenna height of 5 to 10 feet. Once JTRS radios are decommissioned, DoD's shared usage of 1755–1780 MHz would end.

If this spectrum-sharing plan was implemented, it would significantly impede JTRS operation and use for test and training in the United States. For example, brigade-level training activities at Forts Drum, Campbell, Stewart, Lewis, Riley, Benning, and Sill, and numerous other sites in Alaska and Hawaii plan to use JTRS. Army Reserve and Army National Guard units plan to operate JTRS at sites throughout the United States. The proposed protection zones do not account for radio propagation placement of JTRS radios on air platforms (i.e., helicopters or unmanned aircraft systems such as those used by Combat Aviation Brigades). Additionally, Fort Huachuca Electronic Proving Ground provides JTRS test operations, including the Unmanned Aerial System training center. DoD needs a thoughtful transition plan that adequately supports programs such as JTRS and other critical test and training capabilities.

DOT&E anticipates funding for the engineering and equipment acquisitions necessary to vacate the 1755–1780 MHz band will come from the Spectrum Relocation Fund provided for under law to support this change. The DoD CIO estimates the cost to move all operations out of the currently available spectrum at about $3.5 Billion. This estimate assumes only $100 Million will adequately cover the transition costs for only 4 of the 10 systems: Aeronautical Mobile Telemetry, Air Combat Training Systems, JTRS, and Satellite Operations/Electronic Warfare. The DoD "Spectrum Reallocation Feasibility Study 1755–1850 MHz Band," issued September 8, 2011, determined that reallocation cost to Aeronautical Mobile Telemetry alone would be at least $3.10 Billion, and it would take at least 15 years to make the transition. In 2012, the Test Resource Management Center (TRMC) estimated the cost to retain the current capacity of the ranges (i.e., the number of test operations) to be on the order of $400 Million over 5 years due to continued growth of data transmission rates, the associated costs of developing the

technologies needed to support these data transmission rates, and continuing constraints on the spectrum needed for testing.

Advanced EW Test Resources

In February 2012, DOT&E identified shortfalls in EW test resources that prevent development, testing, and timely fielding of U.S. systems capable of operating successfully against threats that currently exist, are proliferating, and are undergoing an accelerating pace of significant upgrades. FY13-18 funding was identified to address these shortfalls and assure the needed test resources would be available in time to support developmental and operational testing of systems, including the JSF. DOT&E recommendations include:

- Developing a combination of open- and closed-loop threat simulators in the numbers required for operationally realistic open-air range testing of JSF and other systems beginning in 2018
- Upgrading the government anechoic chambers with adequate numbers of signal generators for realistic threat density
- Upgrading the JSF mission data file reprogramming lab to include realistic threats in realistic numbers
- Providing Integrated Evaluation and Analysis of Multiple Sources intelligence products needed to guide threat simulations
- Accelerating the Next Generation Electronic Warfare Environment Generator (NEWEG) program's production of high-fidelity signal generators

Capabilities under development in JSF, F-22 Increment 3.2 A/B, B-2 Defensive Management System, Long-Range Strike Bomber, Next Generation Jammer for the EA-18G, Integrated Defensive Electronic Countermeasures upgrades, as well as several other programs, require the combination of improved government-owned anechoic chambers and new open-air range test assets. These test resources are necessary for development and adequate, realistic testing of the systems noted above. Unfortunately, progress in initiating this critical program during the past year has lagged expectations considerably.

Aegis-Capable Self-Defense Test Ship (SDTS)

The close-in ship self-defense battle space is complex and presents a number of challenges for OT&E. For example, this environment requires:

- Weapon scheduling with very little time for engagement
- Air and Missile Defense Radar (AMDR) and Close-In Weapons System (CIWS) (to deal with debris fields due to previous successful engagements of individual ASCMs within a multi-ASCM raid)
- Rapid multi-salvo kill assessments for multiple targets
- Transitions from Evolved Sea-Sparrow Missile (ESSM) Command Midcourse Guidance mode to Home-All-theWay guidance mode
- Conducting ballistic missile defense and area air defense missions (i.e., integrated air and missile defense) while simultaneously conducting ship self-defense
- Contending with stream raids of multiple ASCMs attacking along the same bearing, in which directors illuminate multiple targets (especially true for maneuvering threats)
- Designating targets for destruction very close-in by CIWS

Multiple hard-kill weapons systems operate close-in, including the Standard Missile 2 (SM-2), the ESSM, and the CIWS. Soft-kill systems such as the Nulka Mk-53 decoy launching system also operate close-in. The short timelines required to conduct successful ship self-defense place great stress on combat system (CS) logic, CS Element (CSE) synchronization, CSE integration, and end-to-end performance.

Navy range safety restrictions prohibit close-in testing on a manned ship because the targets and debris from successful intercepts will pose an unacceptable risk to the ship and personnel at the ranges where these self-defense engagements take place. These restrictions were imposed following a February 1983 incident on the USS *Antrim* (FFG 20), which was struck with a BQM-74 aerial target during a test of its self-defense weapon systems, killing a civilian instructor. The first unmanned, remotely-controlled SDTS (the Ex-Stoddard) was put into service that same year. A similar incident occurred in November 2013, where two sailors were injured when the same type of aerial target struck the USS *Chancellorsville* (CG-62) during what was considered to be a low-risk test of its combat system. This latest incident underscores the inherent dangers of testing in the close-in battlespace. While it is expected the investigation into the *Chancellorsville* incident may cause the Navy to rethink how they will employ these subsonic targets neared manned ships, the Navy has always considered supersonic ASCM targets a high risk to safety, and will not permit flying them directly at a manned ship.

The Navy has invested in a current at-sea, unmanned, remotely-controlled test asset (the SDTS) and is using it to overcome these safety restrictions. The Navy is accrediting a high-fidelity modeling and simulation (M&S) capability utilizing data from the SDTS, as well as data from manned ship testing, so that a full assessment of ship self-defense capabilities of non-Aegis ships can be completely and affordably conducted. While the Navy recognizes the capability as integral to the test programs for certain weapons systems (the Ship Self-Defense System, Rolling Airframe Missile Block 2, and ESSM Block 1) and ship classes (LPD-17, LHA-6, Littoral Combat Ship, DDG 100, and CVN-78), the Navy has not made a similar investment in an Aegis-capable SDTS for adequate operational testing of the DDG 51 Flight III Destroyer (with Aegis Advanced Capability Build "Next" Combat System and AMDR) capabilities. The current SDTS lacks the appropriate sensors and other combat system elements to test these capabilities.

Although the Navy is investigating an improved flight termination system that would permit closer approach of the current GQM-163A supersonic target to manned Aegis ships, it will only permit cross-range offset reduction from the ship to 1 nautical mile (from the current 2.5 nautical miles for the

GQM-163A). That is the same cross-range offset that existed for the GQM-163A predecessor, the MQM-8G (EER) from 1998 to 2005, and Aegis was not able to conduct self-defense scenarios at that time because of the hazard posed by the proximity of the predecessor supersonic target to a manned ship. The November 2013 incident on USS *Chancellorsville* (CG-62) underscores the inherent dangers of testing in the close-in battlespace. This leaves no safe alternative but to use an SDTS for complete, end-to-end ship self-defense testing. Moreover, the cross-range offsets imposed under the closer approach concept would still result in unacceptable lack of realism in threat presentations for purposes of operational testing.

DOT&E strongly recommends development of an Aegis-capable SDTS to test ship self-defense systems' performance in the final seconds of the close-in battle and to acquire sufficient data to accredit ship self-defense performance M&S. Absent this critical resource, the lives of our Sailors and their success in battle will be placed at unacceptable risk. This is because use of the SDTS during the past decade has demonstrated clearly and repeatedly that shortfalls in combat system self-defense performance cannot be found and fixed without the realistic testing possible only using the SDTS. The estimated cost for development and acquisition of this capability over the Future Years Defense Program is approximately $284 Million. Of that, $228 Million would be recouped after the test program completes by installing the hardware in a future DDG 51 Flight III hull. DOT&E has disapproved the AMDR Test and Evaluation Master Plan (TEMP) because, contrary to its predecessor AMDR Test and Evaluation Strategy, the TEMP did not provide for the resources needed to equip an SDTS. Similarly, DOT&E will disapprove the DDG 51 Flight III TEMP if it omits the resources needed to equip an SDTS.

Aegis Probability of Raid Annihilation (PRA) Test Bed

The Navy has a robust strategy for evaluating the Probability of Raid Annihilation (PRA) for the LHA-6, Littoral Combat Ship 1 and 2, DDG 1000, and CVN-78 ship classes. This strategy, documented in the Air Warfare Ship Self-Defense Enterprise TEMP, is based on a paradigm in which data from lead ship testing are combined with data from testing on the Navy's unmanned SDTS to accredit an end-to-end M&S tool, known as the PRA Test Bed. In addition to providing the accreditation data, SDTS and lead ship testing satisfy the statutory requirements for testing under operationally realistic conditions, and provide for a qualitative and quantitative assessment of the ship class' capability. Once accredited, the PRA Test Bed assesses the numeric PRA requirement. Each phase of testing – lead ship, SDTS, and PRA Test Bed – is needed to assess the ship class' capability.

Starting with Aegis Weapon System's Advanced Capability Build 12, all Aegis platforms must demonstrate that they meet their respective PRA requirements during operational testing. However, the Navy does not have an acceptable strategy for assessing PRA on Aegis Platforms until an Aegis-equipped SDTS is available. The Navy has stated that they will not acquire an Aegis-equipped SDTS. Consequently, the Navy cannot assess PRA for Aegis platforms.

In addition to not having an Aegis-equipped SDTS, the Navy's M&S suite for the Aegis combat system is not nearly as capable as the Navy's PRA Test Bed. The Aegis M&S suite falls short of the PRA Test Bed in three important areas:

- First, the representation of Aegis in the M&S suite uses a specification-based model as opposed to a tactical code model. While specification-based models can be useful, depending on their intended uses, they are generally of lesser fidelity than tactical code models. This is because they are ultimately limited to how accurately the specifications were implemented in the tactical code. Thus, a perfect specification model of the Aegis Weapon System would accurately represent how it is intended to work, while a tactical code model would represent how it actually works. Almost all models in the Navy's PRA Test Bed use tactical code representations of the combat system elements.
- Second, the Navy's Aegis M&S suite does not account for all the elements of the Aegis Combat System's kill-chain in an end-to-end fashion. Although each part of the kill-chain is considered, interactions between the different kill-chain elements are not considered. Live fire test events conducted on the Navy's current SDTS for other combat systems (e.g., the Ship Self-Defense System) have shown that such interactions can have profound effects on the ship's capability. The Navy's PRA Test Bed, via a virtual test range architecture, considers interactions between elements of the kill-chain.
- Third, the Navy's Aegis M&S suite does not adequately account for how ESSM and SM-2's performance might be affected by different ASCM raid types. The Aegis Weapon System's strategy attempts to account for these effects, but the current architecture of the M&S suite does not adequately support their inclusion. Live fire test events conducted on the Navy's current SDTS for other combat systems (e.g., the Ship Self-Defense System) show that these effects can be very important. By comparison, the PRA Test Bed includes these effects via its virtual range.

To account for these shortcomings, the Navy should implement an M&S strategy for Aegis Cruisers and Destroyers that is similar to the PRA Test Bed. In order to accredit such a model for operational testing, the Navy should acquire an Aegis-equipped SDTS. Because of the time and cost associated with acquiring an Aegis-equipped SDTS, it is difficult to see how the Navy can provide such an asset prior to DDG 51 Flight III testing in 2022. The strategy and the timelines for developing such a model and acquiring an SDTS should be documented in the Advanced AMDR, the Aegis Modernization, and the DDG 51 Flight III TEMPs. The Navy should also consider adding the DDG 51 Flight III PRA assessment to the existing Air Warfare Ship Self-Defense Enterprise TEMP to better coordinate the planning and execution of events intended to support the PRA assessment.

Warrior Injury Assessment Manikin (WIAMan)

In 2011, DOT&E initiated a research program to improve the Department's understanding of the cause and nature of injuries incurred in combat by underbody blast (UBB) events and to develop appropriate instrumentation to assess such injuries in testing. Critical research needs include adequate medical data to improve injury assessments during live fire testing and the development of instrumentation designed specifically for the UBB environment. The proposal resulted in an Army-led, five-year research and development program, known as the Warrior Injury Assessment Manikin (WIAMan), to improve knowledge of occupant injuries due to UBB events. WIAMan utilizes expertise from both inside and outside the Department to develop and execute a widely-scoped, critical medical research plan, which will provide critical data to the materiel and T&E communities. For example, university research partners specializing in injury biomechanics underpin the WIAMan program. The medical data generated under the WIAMan program will support development of a biofidelic prototype anthropomorphic test device (ATD) designed to capture vertical occupant loading, the primary load axis to which occupants are exposed in a UBB event. The WIAMan ATD is a novel approach for understanding the vulnerability of a vehicle's occupants to the effects of UBB, which supports LFT&E requirements. These advances will better inform users, vehicle designers, testers, and evaluators about the nature and severity of injuries incurred from UBB events.

The WIAMan project also supported fabrication of the Accelerative Loading Fixture (ALF), which is a unique research and test facility for replicating the full-scale UBB environment for mounted Soldiers, at Aberdeen Proving Grounds, Maryland. Experiments conducted in the ALF are already contributing new information and insights on human response to UBB. The WIAMan system will use ALF throughout the life of the program for research and for verification testing.

The WIAMan Program Office at the Army Research Laboratory manages all aspects of WIAMan development. The medical research is ongoing, and research results are transitioning to the ATD developer. A study of options for a suitable data acquisition system is also underway.

In its June 20, 2013 report, 113-44, the Senate Committee on Armed Services recommended a $10 Million increase for WIAMan noting that "…the development of such a test manikin would significantly improve the Department's ability to measure the projected injuries that could be caused by various blast events caused by improvised explosive devices. Such information would lead to improved survivability of ground combat vehicles." If received, this funding will help ensure the program meets its schedule for delivering critical information for ground combat vehicles.

Cyber Warfare

Experimentation, development, testing, training, and mission rehearsal of offensive and defensive cyber-warfighting capabilities require representative cyber environments. Such environments are made up of distributed cyber ranges capable of interacting and interoperating with other DoD ranges, since cyber-warfighting capability is a critical enabler of operations in the air, land, sea, and space domains.

DOT&E proposed enhancements to existing facilities to create the DoD Enterprise Cyber Range Environment (DECRE) comprised of the National Cyber Range (NCR), the DoD Information Assurance Range, the Joint Information Operations Range (JIOR), and the Joint Staff J6's C4 Assessments Division (C4AD).

DECRE will provide for:

- Consistent portrayal of operationally realistic, threat-representative cyber environments
- Expansion of JIOR operations capacity to plan and rigorously execute approximately 100 distinct events per year
- Upgrades to introduce cloud-based Regional Service Delivery Points (RSDPs)
- Incorporation of technologies emerging from the NCR for rapid design, reconfiguration, and sanitization of networks
- Incorporation of various Live, Virtual, and Constructive capabilities
- Range environments where advanced cyber-attacks can be conducted to understand the scope and duration of cyber effects, and where training and tactics, techniques, and procedures (TTPs) development can be performed
- Implementation of archival capabilities to record and play back live events, and blend mixes of live and previously recorded events
- Creation of a stand-alone cyber lab for testing and rehearsal of advanced offensive capabilities

Preliminary work in each of the above areas is underway, but development and delivery of these capabilities will depend on the actual funding levels across the Future Years Defense Program. Of note, the first operational RSDP is expected to be fielded in 3QFY14, and will provide the foundation for greater traffic and realism, hosting of NCR technologies and persistent environments, and an expanded number of simultaneous DECRE events.

With assistance from DOT&E, the C4AD team developed a high-fidelity environment to examine the effects of cyber-attacks on systems that support Combatant Commands' Common Operating Picture. This environment will feature prominently in the assessment of U.S. Northern Command's Vigilant Shield 14 exercise, allowing realistic demonstration of the effects of an advanced cyber-attack. U.S. Pacific and European Commands have also expressed interest in employing this environment in FY14 to confirm and/or improve their abilities to perform their command and control missions in a contested cyber environment. Two other environments are currently under development (Command and Control Battle Management Communications and Aegis weapon systems), and these environments are expected to come online later in FY14. Each of the above environments was motivated by vulnerabilities identified during

DOT&E Information Assurance and Interoperability (IA/IOP) assessments. As funding permits, DOT&E expects to initiate development of several additional environments each year. DOT&E expects that these high-fidelity cyber environments will become essential to IA/IOP assessments, OT&E, and also to the training of the DoD Cyber Mission Force being implemented by U.S. Cyber Command.

Although many improvements are in progress, DOT&E expects the demand for high-fidelity cyber environments and range events will exceed the nascent capabilities. For example, U.S. Cyber Command alone estimates that the Cyber Mission Force will require more than 100 training activities each month, a great deal more than the current capability for 100 events per year across all DoD customers. The integration of key U.S. and coalition range nodes and labs for distributed, secure, operationally realistic, and threat-representative cyber environments will further expand the demand. DOT&E will closely monitor and report on the evolution of DECRE during FY14. DOT&E strongly recommends that the currently fragmented management and resourcing of DECRE be consolidated under an Executive Agent.

Fifth-Generation Aerial Target

Current aerial targets, including the QF-16 (in development) and sub-scale drones, do not adequately represent enhanced fifth-generation fighter capabilities, including low observability, low probability of intercept sensors, and embedded electronic attack. Aerial targets with the capacity to represent these characteristics are necessary for the operational test adequacy of U.S. air-to-air and surface-to-air weapons systems. Over the next five years, the feasibility of completing operationally realistic testing will decline significantly without an aerial target solution. The risk to the DoD in assessing the mission effectiveness of surface-to-air and air-to-air missile systems will be unacceptable without a representative fifth-generation aerial target. Over the next decade, the production and proliferation of fifth-generation fighter aircraft will enhance Anti-Access/Area Denial strategies and, without question, will challenge U.S. air superiority in future conflicts. Current weapon system testing is limited to segmented approaches using a combination of captive-carry against the F-22 and live-fire against sub-scale and fourth-generation full-scale targets. The capacity to conduct end-to-end testing, from post-launch acquisition to end-game fusing, against a fifth-generation fighter threat does not exist and constitutes a critical shortfall.

DOT&E initiated studies on the design and fabrication of a dedicated fifth-generation aerial target to evaluate U.S. weapon systems effectiveness. DOT&E requested $40 Million (out of $80 Million total) in the FY14 program review to complete final design, tooling, and prototyping efforts. The Canadian Government informally expressed interest in funding the remaining $40 Million as part of a joint U.S./Canada Defense Development Sharing Agreement. This agreement allows joint research and development efforts funded by DoD and the Canadian Department of Defence Production.

Real Time Casualty Assessment (RTCA)

Simulated force-on-force battles must contain enough realism to cause Soldiers and their units to make tactical decisions and react to the real-time conditions on the battlefield. RTCA systems integrate Live, Virtual, and Constructive (LVC) systems to enable these simulated force-on-force battles. RTCA capability provides a means for simulated engagements to have realistic outcomes based on the lethality and survivability characteristics of both the systems under test and the opposing threat systems; therefore, RTCA systems must exhibit critical attributes of real-world combat engagements such as direct and indirect fires, IEDs and mines, realistic battle damage and casualties, a mix of ground and air vehicles, and a competent and capable threat force. RTCA systems must record the time-space position information and firing, damage, and casualty data for all players in the test event. Playback of these data provides a critical evaluation tool when determining the combat system's capability to support Soldiers as they complete their unit mission.

In recent years, Army Test and Evaluation Command (ATEC) has used a portion of its RTCA capability (a combination of the ATEC Player and Event Tracking System, Multiple Integrated Laser Engagement System, and LVC components) to support tests. For Network Integration Evaluation (NIE) 14.1 (scheduled for 1QFY14), DOT&E requested that ATEC use their full RTCA capability to collect data in support of the AN/PRC-117G radio and Nett Warrior evaluations. Shortfalls found during NIE 14.1 will be captured and used to augment the findings of the ongoing Army RTCA study. The Army initiated this study in FY13 to identify capability gaps based on upcoming operational tests and to provide a recommended course of action for necessary improvements. The results of the study were not available as of this writing. A finalized report is due in 1QFY14. DOT&E expects the report to include near-term plans for improving the existing RTCA system in support of upcoming tests, as well as plans for a long-term sustained capability. In addition to improving the existing system, and due to their common requirements and limited budgets, the Army test and training communities are working together on a future system called the Army – Tactical Engagement Simulation System. DOT&E supports this test and training synergy since the training community can use RTCA instrumentation developed for OT&E once the system is fielded.

RTCA is essential to realistic force-on-force testing of current and future land and expeditionary warfare systems, and DOT&E requires RTCA for systems such as Ground Combat Vehicle, Amphibious Combat Vehicle, Bradley and Abrams Modernization, Armored Multi-purpose Vehicle, Apache Block III, Joint Lightweight Tactical Vehicle, and Stryker upgrades. The estimated cost for improvements to the current ATEC RTCA system is $35 Million over the next five years. The cost to develop the Army – Tactical Engagement Simulation System is not known at this time.

Additional EW Simulator Units for Surface Electronic Warfare Improvement Program (SEWIP) Operational Testing

At present, there exists only one each of the Kappa, Uniform, and Gamma EW simulators to support SEWIP operational testing. These simulators use Lear Jets as platforms to fly against shipboard EW systems. SEWIP Block 2 is the latest EW system under development. More than one of each type of simulator are needed (e.g., one for each Lear Jet) for adequate SEWIP Block 2 testing in FY14 using threat-realistic stream raid profiles. An estimated development/procurement cost is $5 Million.

The SEWIP Block 3 program needs a Lear Jet-mountable Gamma asset for the FY17 IOT&E to present multiple simulated threats to SEWIP simultaneously. The estimated cost for acquisition of a second asset is $15 Million.

Anti-Ship Cruise Missile (ASCM) Seekers for GQM-163A Supersonic Target

Operationally realistic emissions from the GQM-163A supersonic target require threat-representative ASCM seekers that will stay locked on the target ship. This capability will provide threat-representative stimulation for shipboard EW systems, in addition to ensuring that the ship's combat system has a constant track of the incoming target emissions for launching (and guiding, on those same emissions) Rolling Airframe Missile Block 1 and/or Block 2 missiles as interceptors. This unit would be similar to the seeker used in the BQM-34 Open Loop Seeker subsonic target and the STEERAN unit currently used in the BQM-74E subsonic target. Since the diameters of the GQM and BQM targets differ greatly, the new ASCM seeker requires extensive re-engineering and testing to adapt the BQM unit to fit the GQM without disturbing the GQM kinematics/maneuverability. CVN-78/Rolling Airframe Missile Block 2 requires this capability for adequate operational testing in FY17. Estimated development cost is $10 Million to $20 Million. Estimated unit cost is $500 Thousand.

Modification of GQM-163A Coyote Target to Represent another ASCM Threat

The Navy's GQM-163A Coyote Validation Report of May 2006 identified two threats that the Coyote could fundamentally represent. Thus far, attention has focused mostly on a Coyote representation of one of the two threats. DOT&E recommends an engineering analysis to determine what alterations to the Coyote vehicle should be made to use it as a surrogate for the second threat discussed in the GQM-163A Coyote Validation Report. The results of the engineering analysis will inform the Coyote alteration to provide targets for IOT&E of the Aegis Modernization program in FY17 as well as the Aegis DDG Flight III program in FY23. The estimated cost of the analysis is $3 Million. Estimated cost for alteration of existing Coyotes is $150 Thousand per target for 12 targets, or $1.8 Million total. Four targets (two primary plus two backups) would be for the Aegis Modernization IOT&E, and eight targets (four primary plus four backups) would be for the Aegis DDG Flight III IOT&E.

Long-term Improvement in Fidelity of ASCM Seeker/Autopilot Simulators for EW Testing

Fidelity of ASCM threat representation during electronic warfare testing in operational environments remains an area for improvement due to the continued reliance on manned aircraft for captive carry of the simulators. The aircraft cannot fly at the high speeds and low altitudes needed for a full representation of ASCM threats. Some plausible improvements needing examination and proposed solutions include:

- Recoverable, unmanned aerial vehicles using embedded, miniaturized simulators that are maneuverable at ASCM speeds and altitudes
- Encrypted telemetry to track system responses to electronic attack against these simulators
- Human-controlled override capability

These aerial vehicles would support IOT&E of SEWIP upgrades and FOT&E with new ship classes in the post-FY23 timeframe. Estimated development cost is $120 Million. Estimated unit cost is $15 Million.

Torpedo Surrogates for Operational Testing of Anti-Submarine Warfare (ASW) Platforms and Systems

Operational testing of ASW platforms and related systems includes the ability to detect, evade, counter, and/or destroy an incoming threat torpedo. The determination of system or platform performance is critically dependent on a combination of the logic used for acquisition, the dynamic and noise characteristics, and fusing methods of the incoming torpedo. Due to differences in technological approach and development, U.S. torpedoes are not representative in many of these torpedo characteristics for many highly proliferated torpedoes, particularly those employed in Anti-Surface Warfare (ASuW) by other nations. Operational testing that is limited to U.S. exercise torpedoes will not allow the identification of existing limitations of ASW platforms and related systems against threat torpedoes and will result in uninformed decisions in the employment of these same platforms in wartime. A January 9, 2013 DOT&E memorandum to the Assistant Secretary of the Navy (Research, Development & Acquisition) identifies specific threat torpedo attributes that the threat torpedo surrogate(s) must be evaluated against. The non-availability of threat-representative torpedo surrogates will prevent adequate operational testing for ASW platforms and related systems, as well as adversely affect tactics development and validation of these tactics within the fleet.

DOT&E estimates that DoD will need approximately $500 Thousand to conduct a study of torpedo surrogate development options, including life-cycle and operation cost, quantity and types of torpedo surrogates required, and employment methodology. DOT&E believes that surrogate development and production for threat torpedoes will benefit from an enterprise approach to prevent burdening a single acquisition program.