Test and Evaluation Resources

By title 10 USC, DOT&E is to assess the adequacy of test and evaluation (T&E) resources and facilities for operational and live fire testing and evaluation. DOT&E monitors and reviews DOD- and Service-level strategic plans, investment programs, and resource management decisions that affect realistic operational and live fire tests. This section discusses areas of concern in T&E infrastructure needed for adequate operational and live fire testing of current and future systems, the associated challenges, and makes recommendations. Specific areas include:

- Modernizing T&E Infrastructure for National Defense Strategy (NDS) Technologies
- T&E Workforce for the NDS
- Chemical, Biological, Radiological, and Nuclear Survivability Test and Evaluation Capability
- Open-Air Range Modernization
- Threat Representation for OT&E of Space Systems
- Missile Defense – Pacific Collector and Pacific Tracker Ship Replacement
- Advanced Satellite Navigation Receiver (ASNR)
- Fifth-Generation Aerial Target (5GAT)
- Navy Aerial Targets and Payloads
- Navy Surface Warfare (SUW) Targets
- Naval Test Infrastructure Upgrades
- Submarine Target and Countermeasure Surrogates for Torpedo Testing
- Army Manning and Test Technologies for OT&E
- Electronic Warfare (EW) and Navigation Warfare (NAVWAR) for Land Combat
- Tactical Engagement Simulation with Real Time Casualty Assessment (TES/RTCA)
- Threat Modeling and Simulation (M&S) for T&E
- Foreign Materiel Acquisition Support for T&E
- Allied Nations Partnerships for T&E
- Earthquake Damage to T&E Infrastructure
- 5G and Radio Frequency (RF) Spectrum for T&E
- Range Capabilities and Sustainment

Modernizing T&E Infrastructure for NDS Technologies

The 2019 DOD Appropriations Act authorized $150 Million to DOT&E for modernizing DOD T&E infrastructure in areas such as hypersonics, directed energy, artificial intelligence, machine learning, robotics, and cyberspace. In FY19, DOT&E partnered with the Test Resources Management Center (TRMC) in the Office of the Under Secretary of Defense for Research and Engineering [OUSD(R&E)] and the Services to align T&E infrastructure investments with advanced technology roadmaps. DOT&E and the TRMC developed an investment strategy and managed T&E infrastructure modernization program implementation. In FY20, this investment supported T&E infrastructure capabilities in the following NDS advanced technology areas and will be transitioned to test ranges, the Services, and TRMC for sustainment as they are completed:

- Hypersonics ($55 Million). Telemetry and optics instrumentation for unmanned aerial, atmospheric measurement capabilities, and capability supporting end-game scoring and weapons effects.
- Directed Energy ($57 Million). High-Energy Laser (HEL) instrumentation and atmospheric characterization, HEL target and scoring boards, high-power microwave (HPM) diagnostics.
- Big Data Analytics ($28 Million). Analytics to evaluate next generation aircraft.
- Autonomy / Cyberspace ($10 Million). Autonomous cyber threat emulation (“Red Team”) tools.

TRMC proposed a $10 Million investment in artificial intelligence (AI)/machine learning test tools to stress AI data-fusion algorithms in FY19. Based on limited options for developing effective test tools, this funding was reallocated to directed energy and big data analytics projects in FY20.

T&E Workforce for the NDS

The NDS and USD(R&E) modernization priorities focus on development of capabilities based on advanced technology areas such as hypersonics, directed energy, autonomy, artificial intelligence, and technological innovations to computation, communications, navigation, and sensor capabilities based on quantum physics. Development and testing of systems using these technologies requires an adequately trained and qualified workforce in adequate numbers to develop and implement test strategies and provide the infrastructure to characterize their performance. For example, autonomous systems that rely on AI and machine learning are being developed to provide new capabilities that span warfighting functions from intelligence analysis and mission sustainment to force protection and medical treatment of casualties. Autonomous systems are expected to team with human users and/or other autonomous systems, may learn and evolve over time, and potentially exhibit emergent behavior. Understanding the operational performance of autonomous capabilities will require a knowledgeable and multi-disciplinary T&E workforce. Testing autonomous

systems requires development of testing methods, evaluation frameworks, and architectures, to include development of autonomy countermeasures, test beds, M&S capabilities, and test ranges to observe and analyze performance. The following are recommended to improve access to the highly skilled and talented human capital needed to test and evaluate advanced technology weapon systems:

- Incentivize development of the civilian T&E workforce through establishment of a T&E career path that includes education and training opportunities and rotational assignments.
- Provide professional pay for hiring civilians with special knowledge and skills in high demand.
- Establish/expand scholarships, internships, and fellowship programs to attract new talent to the defense T&E community.
- Expand use of expertise at Federally Funded Research and Development Centers, National Laboratories, University-Affiliated Research Centers (UARCs), and universities.
- Establish federated UARCs in specific technology areas to enable DOD access to world-class expertise.

Chemical, Biological, Radiological, and Nuclear Survivability Test and Evaluation Capability

The Chemical, Biological, Radiological, and Nuclear (CBRN) Survivability Oversight Group, established by the CBRN Survivability Policy, has identified several T&E infrastructure shortfalls that should be addressed to enable adequate assessment of the U.S. nuclear deterrent posture. To enable adequate testing and evaluation of several ongoing nuclear modernization programs, the DOD should:

- Continue to improve T&E infrastructure and M&S tools to adequately evaluate the effects of nuclear blast-generated cold and warm X-ray environments on DOD systems. This is a critical T&E shortfall for the Ground Based Strategic Deterrent (GBSD) program, and the CBRN Survivability Oversight Group – Nuclear estimates funding requirements of $51 Million in the near-term (1-2 years) and $79 Million for the life of the program to establish this T&E capability.
- Continue establishment of an in-house capability to evaluate nuclear blast-generated pulsed neutron environment effects. The DOD is currently relying on Department of Energy facilities that are not readily available and can only handle small, coupon-sized items. This shortfall limits our ability to evaluate GBSD survivability in appropriate fusion flux. The CBRN Survivability Oversight Group – Nuclear estimates that $28 Million is needed for this capability.
- Upgrade existing test facilities and wind tunnels to evaluate the durability of our systems in lofted radioactive dust and debris after a nuclear blast. The combined abrasive and chemical effects of such an environment can cause damage to optical sensor windows, leading surface edges, hot engine components, and other key systems and sub-systems. CBRN Survivability Oversight Group – Nuclear estimates $8 Million for the cost of this capability.
- Continue to improve T&E infrastructure to enable the assessment of combined effects in a nuclear environment. The combined nuclear effects can disrupt electronic, propulsion, sensor, and other systems, as well as degrade weapon's flight and other surfaces in ways that are difficult to predict. For example, combined effects of neutron exposure and electromagnetic pulse could potentially affect GBSD systems, and these combined effects would only be identified by testing systems in an environment with combined phenomena.

CBRN T&E infrastructure must be adequately resourced and maintained to handle multiple types of current and emerging CBRN threats and to test the CBRN capabilities that enable our ability to operate in hostile CBRN environments.

Open-Air Range Modernization

Existing laboratories and range systems do not reflect current or future threat laydowns, and must be upgraded for both flight test and training missions. Improvements include but are not limited to the following:

- Connecting U.S. test and training ranges via secure networks.
- Acquisition of additional high fidelity, rapidly reprogrammable, open-air threat emulation systems.
- Upgrades to current high fidelity systems in order to provide greater flexibility to the ranges in support of the warfighter.

Full funding is required to provide the necessary test and training capabilities that enable real-time battle-shaping of open-air missions. Collection of critical, open-air mission data is also necessary for verification, validation, and accreditation of associated M&S capabilities.

Threat Representation for OT&E of Space Systems

U.S. warfighting capabilities rely heavily on space-based systems for situational awareness, communications, and precision targeting. In recent years, Russia, China and other potential adversaries have worked to diminish U.S. warfighting advantages by developing capabilities designed to degrade our space systems. The DOD currently lacks the T&E infrastructure to adequately represent many space threats, including attacks using cyber, electronic warfare, kinetic weapons, nuclear detonations, and directed energy. While some limited threat-representative capabilities do exist, they are not widely known nor utilized within the DOD T&E community.

In 2019 and 2020, the U.S. Air Force began an initial buildup of space systems T&E infrastructure to address known T&E capability gaps, primarily focusing on foundational infrastructure elements that are cross-cutting, enduring, and usable across multiple space systems. Despite these initial investments, the current and planned level of resources is insufficient to enable adequate threat testing of the many space programs currently under development. DOT&E estimates $100 Million per year across the Future Year Defense Program (FYDP) is required

to adequately test existing space programs against validated threats, and that investment will need to continue beyond the FYDP to address emerging threats. To help address this resource mismatch, TRMC in conjunction with DOT&E and the Services, is developing a space test capabilities investment roadmap to document all significant gaps to ensure the development of a National Space Test and Training Range capable of representing realistic threats to space systems.

Missile Defense – Pacific Collector and Pacific Tracker Ship Replacement

Missile defense testing is conducted over the broad ocean area due to the expansive area required for safe missile flight. The Missile Defense Agency requires extensive instrumentation to conduct flight test operations, which to date has been provided by two highly instrumented ships:

- The Pacific Collector is the host to the Transportable Telemetry System-1 (TTS-1) and serves to collect full-trajectory telemetry truth data beyond existing test ranges and land-based instrumentations sites. Further, it integrates a range safety system with the TTS-1 and Satellite Communications to maintain positive control over a missile flight termination system during powered flight.
- The Pacific Tracker is host to the TTS-2 and the dual S/X-band Transportable Radar. It provides midcourse telemetry and the capability to characterize target complex phenomena from deployment to intercept well beyond the limitations of traditional test ranges and other land-based instrumentation.

Both ships are homeported in Portland, Oregon, and the vessels are owned, operated, and maintained by the U.S. Department of Transportation's Maritime Administration in support of Missile Defense Agency testing. They were both constructed in 1966 and are rapidly approaching their end of service life. The optimal schedule for ship and instrumentation replacement would be FY28 for Pacific Collector and FY32 for Pacific Tracker. Replacement funding needs to be programmed not later than FY23 to achieve this schedule.

Advanced Satellite Navigation Receiver (ASNR)

The DOT&E Test and Evaluation Threat Resource Activity (TETRA) project for the ASNR is intended to improve the accuracy of the Time Space Position Information (TSPI) instrumentation used to collect threat missile dynamics and performance data during flight tests. Accurate TSPI information is needed to support threat model design, and the development/improvement of U.S. countermeasure capabilities. Current TSPI instrumentation cannot capture all required data for system assessment, flight data analyses, intelligence model design, and will start becoming obsolete within the next 2 years. The ASNR task needs continued funding for completion in order to provide the Intelligence Community (IC) and test community with the required TSPI accuracy, and to mitigate obsolescence of a critical capability.

Fifth-Generation Aerial Target (5GAT)

The 5GAT team completed the fully government-owned design, delivered the first demonstration prototype aircraft, and successfully completed Air Force-led low-speed and high-speed taxi testing at Dugway Proving Grounds, Utah, in September 2020. On October 23, 2020, the first prototype experienced an in-flight mishap that resulted in the loss of the aircraft. A safety investigation is underway to determine the cause of the mishap. The prototyping effort will provide cost-informed alternative design and manufacturing approaches for future air vehicle acquisition programs. The program will also provide verified cost data for all-composite aircraft design/development and alternative tooling approaches. Early production work for the second prototype aircraft is currently underway. The DOD has requested $32.7 Million in FY21 to continue development and testing of the second 5GAT prototype aircraft. DOT&E recommends full funding for the continuation of this prototyping effort to meet the urgent need for a full-scale fifth generation aerial target that can adequately represent current and future threat aircraft characteristics. TRMC will begin managing the 5GAT program in FY21.

Navy Aerial Targets and Payloads

Improved aerial target capabilities are needed to emulate the threats for testing current and upcoming surface Navy combat systems, defensive missiles, and radars, including those of CVN 78 and DDG 51 Flight III ships.

- The BQM-74 and BQM-177 subsonic aerial target radar seeker payloads are not able to emulate some important features of anti-ship missile radars. The Navy plans an initial operational capability for a new BQM-177 emitter in 2QFY21. The BQM-74 is no longer in production and will sunset in early FY22.
- The GQM-163 supersonic aerial target does not have a payload to emulate the radar systems of modern supersonic anti-ship missiles. The Navy is developing such a program through TRMC but the current program does not provide for such a capability on high-diving GQM-163s. The Navy should continue with the current program and develop a follow-on program to provide for the diving capability.
- The GQM-163 needs kinematic improvements to allow for higher G maneuvers in the sea-skimming flight profile, and for steeper dives in the high-diver profile, such that they support testing of shipboard defensive capabilities against modern anti-ship cruise missile (ASCM) threats. If the GQM-163 cannot be sufficiently modified, the Navy will need to initiate a new supersonic aerial target program.
- Aerial targets need a responsive cruise missile seeker emulator to test integrated hard kill and soft kill air defense systems on Navy ships. Current and future operational testing of shipboard active electronic attack or decoy ("soft kill") systems, such as Surface Electronic Warfare Improvement

Program (SEWIP) Block 3, Nulka, and Advanced Off-Board Electronic Warfare, are unable to assess the effectiveness of these systems. The threat surrogates currently employed cannot emulate the threat missiles' responses, including their autopilot logic, kinematic responses, and electronic protection capabilities. They also do not fly at threat-representative speeds, altitudes, or maneuvers. The development of a programmable responsive cruise missile surrogate (RCMS) would allow for adequate effectiveness assessments of these systems, as well as the combat systems that employ them. Such an aerial target would also allow for the assessment of the host combat system's abilities to coordinate soft-kill and hard-kill (missile) systems. An RCMS would be utilized for all current and upcoming surface Navy combat system test programs that utilize soft-kill systems.

- The Navy should augment current and planned aerial target emitter systems with improved data collection regarding the details of the transmitted radio frequency emissions. These data will improve the Navy's ability to determine if ship combat systems are receiving and processing threat radar seeker information correctly.
- The increased tempo of Navy testing have exceeded the throughput capability of the GQM-163 target preparation and storage facilities. The Navy funded MILCON P-586 in FY19 which will provide an 8 bay Missile Assembly Building in FY22.
- In order to test new Navy radars, modern electronic attack test assets must be procured in sufficient quantities to support multiple concurrent ship IOT&Es. The more advanced jamming assets also need to be integrated with unmanned aerial vehicles (UAVs).
- The lack of a threat-representative multi-stage supersonic target limits the ability to assess the combat effectiveness of ship self-defense capabilities.
- A hypersonic threat missile surrogate is needed to assess combat system, radar, and missile self-defense performance against hypersonic threats and to validate M&S.

Navy Surface Warfare (SUW) Targets

The Navy actively manages surface targets, such as the high-speed maneuverable surface target (HSMST), which are used by both test and training communities. Several factors determine the availability of surface targets during the fiscal year, such as appropriated funding for new targets, the existing target inventory, the attrition rate of the targets used for test and training, and the availability of facilities for outfitting of the targets with instrumentation for operation on ranges. Adequate numbers of SUW targets are required to support T&E. For example, the Littoral Combat Ship Independence variant with SUW Mission Package Increment 3 was unable to perform operational testing in accordance with the approved test plan due to unavailablility of needed HSMST targets. The Navy requires full funding for SUW targets, such as the HSMST, to ensure that sufficient quantities are available to support test and training missions.

At present, there is limited availability of SUW targets that can exceed 45 knots. The HSMSTs can only reach speeds of about 40 knots in very flat sea states. Without adequate numbers of high-speed SUW targets, the Navy will be unable to characterize the capabilities of the weapon systems designated for defending against small boat swarms that a likely adversary might employ. Options to address this shortfall include procurement of commercial fast boats or potential use of fast boats confiscated by counterdrug authorities. An example of a commercial small boat that could serve as an SUW target is the British-produced Bladerunner, which comes in a variety of models. A Model 51 Bladerunner can reach speeds of 63 knots and costs approximately $100,000. The Navy should explore options for acquisition of high-speed SUW targets and procurement of adequate quantities of these targets for testing ship self-defense capabilities against these threats.

Naval Test Infrastructure Upgrades

Self -Defense Test Ship for Testing Shipboard Air Defense Systems

Safety constraints preclude realistic operational testing of short-range air defense systems against ASCM threats on manned ships. In order to satisfy the statutory requirement to demonstrate end-to-end performance capabilities during OT&E, this testing requires an unmanned, sea-going test platform such as the existing Self-Defense Test Ship (SDTS). In addition to providing a realistic, low-risk venue to conduct end-to-end live testing, testing on the SDTS generates critical validation data for M&S capabilities used for supplemental analysis. To ensure a capability is available to support upcoming ship class and combat systems testing, the Navy must fully fund the needed repairs to the existing SDTS for continued use, or begin procuring a replacement unmanned test asset that will support LHA 8, LPD 17 Flight II, CVN 79, and FFG 62 testing, which also encompasses operational testing of the new Enterprise Air Surveillance Radar. Urgent action is needed to address this potential shortfall given the time necessary to repair or replace the SDTS and current Navy plans to use the SDTS to support testing LHA 8 in FY24. The Navy's strategy for assessing the self-defense capability of DDG 51 Flight III relies critically on testing ESSM Block 2 on the existing SDTS. If an SDTS is not available to support this testing, the DDG 51 Flight III test strategy is no longer executable as planned.

Missile and Navy Test Range Telemetry Systems and Infrastructure

Testing of shipboard air defense systems requires that air-defense missiles be equipped with in-flight telemeters that provide missile performance data to testers. These in-flight telemeters need to be designed such that the Navy can collect data in operational tests where a representative number of missiles are fired. DOT&E recommends the following to realize this capability:

- Convert the telemeters for the Standard Missile family of missiles (e.g., SM-6 Block IA) and Evolved Sea Sparrow

Missile Block 2 from S-band to C-band for improved spatial resolution such that missile telemetry may be collected from all missiles in flight during operational tests. Without such conversion it is not possible to determine why missiles succeed or fail in operational tests involving threat representative sized raids of aerial target. The Navy programmed resources in FY22 for this conversion.

- The Navy Pacific Missile Range Facility (PMRF) and the Point Mugu Sea Range (PMSR) need telemetry upgrades to support simultaneous tracking of multiple missiles that are employed during air defense mission testing. These upgrades include installation of Active Electronically Scanned Array telemetry collection antennas and improvements to range facility equipment to support telemetry data processing. The Navy programmed resources in FY22 for these telemetry upgrades.
- A Rolling Airframe Missile (RAM) Block 2 missile telemeter that is compatible with the missile's warhead requires development. The current RAM Block 2 telemeter is incompatible with the warhead forcing operational testers to choose between having missile telemetry or having a warhead. This situation leads to uncertainty in the results of operational tests. The RAM Program Office supports this development, but the Navy has yet to fund it.

Resources Needed to Test Surface Ship Electronic Warfare Systems

The Navy traditionally tested passive electronic surveillance systems using the Shipboard Electronic Systems Evaluation Facility (SESEF), where a pulse generator, known as the Combat Electromagnetic Environment Simulator (CEESIM), an amplifier, and an antenna are used to emulate hostile radars, but such systems will not be adequate for testing active electronic warfare systems. Viable surrogates for threat airborne and surface (e.g., coastal defense) radars are needed to test and evaluate the systems required to thwart these threats. In October 2016, DOT&E identified the needs to develop such threat radar surrogates, but these surrogates are still unavailable. Without such test assets, it is unclear how the Navy will credibly test active electronic attack systems like Surface Electronic Warfare Improvement Program (SEWIP) Block 3.

Submarine Target and Countermeasure Surrogates for Torpedo Testing

The effectiveness of U.S. anti-submarine aircraft, surface combatant ships, and submarines must be evaluated against threat representative surrogates. U.S. nuclear-powered submarines and foreign diesel electric submarines are surrogates for most threats. However, the unavailability of both types of submarine targets for testing has significantly delayed or limited testing of the P-8A's Multi-static Active Coherent (MAC) anti-submarine warfare (ASW) system and upgrades to the U.S. submarine fleet's Acoustic Rapid Commercial-off-the-shelf Insertion (A-RCI) sonar system. Torpedo testing also requires a mobile, set-to-hit submarine target. The Navy completed an evaluation of set-to-hit target options in 2018 and determined the most cost effective and timely solution for a set-to-hit torpedo target is a certified U.S. attack submarine slated for inactivation. The Navy is completing an analysis to determine set-to-hit certification criteria for potential submarine targets. The Navy plans to use a combination of existing surrogates, modified artificial targets, and manned submarines to support torpedo testing. DOT&E remains concerned about capabilitiy shortfalls for ASW testing given the lack of dedicated threat representative surrogates and the Navy's submarine force structure which is not adequate to support both operational and testing demands.

In FY09, DOT&E funded the development of the Submarine Launched Countermeasure Emulator (SLACE) to provide representation of threat countermeasures that have significantly different performance characteristics than U.S. countermeasures. Further enhancement of SLACE is required to provide characteristics of modern torpedo countermeasures. DOT&E supported the use of FY19 funding to include the development of a towed array and its integration into SLACE. This will enable SLACE to emulate modern torpedo countermeasures and better inform the capabilities of lightweight and heavyweight ASW torpedoes.

Army Manning and Test Technologies for OT&E

In FY18, the Army initiated modernization and acquisition reforms through the establishment of eight Cross Functional Teams (CFTs) and the activation of the Army Futures Command (AFC). A primary goal of the AFC and CFTs is to support the rapid acquisition and fielding of new warfighting capabilities to counter advancements made by near-peer adversaries. The Army Test and Evaluation Command (ATEC) is an essential partner in the Army's modernization efforts. Within ATEC, Operational Test Command (OTC) performs a critical role by ensuring these new warfighting systems are tested as they are intended to be integrated into combat formations and thus exercise their operational dependencies (e.g. consumables, command and control, field level maintenance and repair, etc.). The Army's desire to incorporate more soldier feedback early in the development cycle, along with compressed fielding timelines, is expected to created a surge of OTC-supported testing in the FY21-FY24 timeframe. Increased weapon system complexity and rapid test-fix-test cycles requires a T&E workforce that is resourced to keep pace with the CFTs and support shorter decision timelines. Investments in cutting edge weapons technology necessitates a proportional investment in operational test technology. To meet these demands, ATEC has placed T&E professionals within the CFTs, where they willhelp synchronize data collection efforts across the testing continuum and identify test capability and resource issues early. ATEC is leveraging Army and DOD training initiatives to support the continued education of its workforce.

Beginning in FY14, DOT&E expressed concern about reductions in funding for personnel and test technology at OTC. When adjusted for inflation, there has been a 15 percent decrease in funding for OTC personnel and a 34 percent reduction in funding for OT Test Technology from FY14-FY20. Funding

for operational test technology and infrastructure has not been adequate to sustain legacy data collection instrumentation, command and control networks, and live/virtual/constructive simulation capabilities. Beginning in FY21, these downward trends appear to be flattening, but DOT&E remains concerned that current funding levels will not be sufficient to support the Army's aggressive modernization goals through the FY22 Program Objective Memorandum. DOT&E acknowledges that the Army has made substantial investments in developmental test range infrastructure and test technology in support of modernization efforts, and is now planning to shift focus to OT readiness and near peer threat representation in support of Multi-Domain Operations. DOT&E recommends that ATEC continue working with the CFTs to evaluate the operational test technology needs associated with the Army's modernization priorities and increase funding to match the needs.

Electronic Warfare (EW) and Navigation Warfare (NAVWAR) for Land Combat

Over the past few decades, the Army's dedicated EW capabilities have atrophied while its vulnerabilities have grown due to the expanded dependency on terrestrial and space based networks, and the Global Positioning System (GPS). The Army must fight as a joint force and across all mission domains, the electromagnetic spectrum, and the information environment. With the establishment of the Army's Assured-Positioning, Navigation, and Timing (A-PNT) and Network CFTs, AFC is developing technologies and fielding systems that will counter EW and NAVWAR threats.

Due to the Department-wide focus on operating in contested environments, there is a high demand for intentional GPS interference environments that is stressing the DOD's current capacity to support multiple simultaneous NAVWAR test and training events. To help meet the demand, the Army should accelerate its efforts to get the Threat Systems Management Office certified to conduct advanced threat NAVWAR. Many of the Army's data instrumentation systems are dependent on commercial GPS receivers for PNT information and cannot function properly in a GPS contested environment. The Army should immediately begin to incorporate alternative PNT technologies into its intrumentations systems in order to support this testing.

Providing a realistic threat environment during OT is essential to ensuring that systems are survivable and will support units operating in the contested environments described in the MDO concept and the National Defense Strategy. Threat EW and NAVWAR environments should be considered for all OT, and are critical to the operational testing of future Army network initiatives, Nett Warrior/Leader Radio, Manpack Radio, Mission Command Systems, Electronic Warfare Planning and Management Tool, and A-PNT.

Tactical Engagement Simulation with Real Time Casualty Assessment (TES/RTCA)

Realistic operational environments and a well-equipped opposing forces (OPFOR) intent on winning are fundamental to the adequate operational test of land and expeditionary warfare combat systems. Force-on-force battles between live tactical units is a preferred method of creating a complex and evolving battlefield environment for test and training. Tactical Engagement Simulation with Real Time Casualty Assessment (TES/RTCA) systems integrate live, virtual, and constructive components to enable these force-on-force battles and provide a means for simulated kinetic and non-kinetic engagements to have realistic outcomes. TES/RTCA systems also record the time-space position information, and firing, damage, and casualty data for all players and vehicles in the test event as an integrated part of the test control and data collection architecture.

Current TES/RTCA systems have not kept pace with modern threat capabilities and the threat conditions found in full-spectrum warfare. Many of the new combat systems being developed under the Army's modernization priorities (Long Range Precision Fires, Next Generation Combat Vehicles, Future Vertical Lift, Army Network, Air and Missile Defense Capabilities, and Soldier Lethality) will have advanced technologies that will need to be replicated in a TES system. Without upgrades to TES/RTCA systems, force-on-force testing will not be representative of the full-spectrum warfare as detailed in the Army's MDO 2028 concept and the NDS.

Beginning in FY20, the Army cut funding for the Integrated Live, Virtual, Constructive, Test, and Training Environment (ILTE) program that was to acquire the TES/RTCA upgrades. Cutting funding to ILTE is counter to the NDS to "build a more lethal Force" and the Army modernization and readiness priorities. The Army has indicated that it will be restarting ILTE funding beginning in FY22 and better synchronizing requirements across Army stakeholders. DOT&E and the TRMC are supporting ILTE upgrades in FY21 by providing Resource Enhancement Program funds. Sustained investment and upgrades in TES/RTCA capabilities are necessary for testing systems such as Next Gen Squad Weapon, Amphibious Combat Vehicle, Bradley and Abrams Upgrades, Armored Multi-Purpose Vehicle, AH-64E Block III, Mobile Protected Firepower, Stryker Upgrades, and Next Generation Combat Vehicle.

Threat Modeling and Simulation (M&S) for T&E

The DOT&E TETRA team leads the Threat M&S Working Group Enterprise in the development of common, Intelligence Community (IC)-endorsed threat models used in T&E. M&S will play an increasing role in T&E efforts, and the U.S. is at risk of a degrading technological advantage without accurate, authoritative M&S capabilities. TETRA promotes threat M&S development based on an enterprise management process that provides

interoperability standards to facilitate data correlation with threat models across the T&E enterprise. Funding has been allocated to develop, validate, and deliver at least 10 RF and 10 infrared high-priority threat models. These threat models encompass a combination of digital models, software-in-the-loop models, high-fidelity hardware-in-the-loop models, flyout models, missile signature models, and high-fidelity missile seeker models. Additional funding will be required to fully develop required near-peer threat models for future battlefield environments. DOT&E recommends continued funding for development of required threat models in collaboration with the IC for systems T&E.

Foreign Materiel Acquisition Support for T&E

Actual foreign materiel and the information gained through the exploitation of foreign materiel is critical to developing and fielding weapons that work. DOT&E and TETRA develop an annual prioritized list of foreign materiel requirements that are submitted to the Joint Foreign Materiel Program Office (JFMPO) to inform whole of government materiel collection priorities. There is a need to identify and develop new sources and opportunities for acquiring foreign materiel. Foreign materiel acquisitions are often lengthy and unpredictable, making it difficult to identify appropriate year funding. DOT&E continues to recommend a no-year or non-expiring funding line for foreign materiel acquisitions, funded at a level of $10 Million per year for Office of the Under Secretary of Defense for Intelligence & Security.

Allied Nation Partnerships for T&E

The DOT&E TETRA Team supports ongoing allied nation partnerships to improve federated T&E capabilities. TETRA represents DOT&E as the Executive Secretary for the NATO Sub-Group 2 Planning Committee and fills several critical leadership positions on the Multinational Test & Evaluation Program (MTEP) and the Air Electronic Warfare Cooperative Test & Evaluation Project Arrangement (Air EW CTE PA). TETRA promotes the development and execution of a multi-year roadmap to improve the M&S tools, capabilities, and architecture for synthetic and live T&E efforts supporting national and collective requirements. DOT&E recommends continued support of the T&E partnerships with allied nations.

Earthquake Damage to T&E Infrastructure

Naval Air Weapons Station, China Lake, California endured magnitude 6.4 and 7.1 earthquakes in July 2019. The China Lake Ranges provide 25 percent of all DOD range capability for the mission areas that they support. Recovery efforts now underway are enabled by a $3 Billion Congressional appropriation for recovery. This funding supports 18 MILCON projects and associated instrumentation and measurement capabilities at South Airfield, Propulsion Laboratory, Main Base, Main Magazine Area and the Range Control Complex. Nine projects have been awarded in 2020 with construction starting in 2021, and the remaining nine projects are expected to award in 2021. VX-31 is back to 70 percent capacity with full capability forecast for the 1QFY24. Range operations have been restored to 75 percent capacity with full capacity expected by summer 2021, when classified temporary test bays are operational. Heavily damaged ordnance T&E facilities associated with insensitive munitions, environmental qualification, and warhead testing were restored to limited capacity, with a return to full capacity on track for completion in 2021. Large and small motor testing and X-ray capabilities are dependent on the award of three MILCON projects scheduled for award in 2021. The key acquisition programs affected include F/A-18 family of systems, Air Force Unmanned Aerial System (UAS) programs, F-35, Trident, Tomahawk, AIM-9X, AV-8B, Army Deliberate Attack, and T&E support to Australian and UK armed forces.

5G and Radio Frequency (RF) Spectrum for T&E

National spectrum policy supports turning over more spectrum resources to commercial users in frequency bands currently used to support our testing and training. This spectrum sell-off is occurring at the same time the Department is expanding network centric systems, increasing our spectrum needs.

The RF spectrum required for 5G includes radio frequencies below 6 gigahertz (GHz), and at or above 24.25 GHz (millimeter-wave frequency). The entire 3.1–3.55 GHz band, also referred to as middle or “mid-band”, is allocated to both federal and non-federal radiolocation services, with federal services currently receiving priority. RF spectrum in this part of the 5G range is a crucial part of DOD’s test and evaluation infrastructure. It enables detectability measurements (e.g., radar cross-section) of warfighting systems; realistic threat representation, such as replicating emissions of adversary systems; electronic warfare system assessments (jammer effectiveness and vulnerability to electromagnetic effects); detection and targeting-radar testing necessary to evaluate hostile-fire identification, counter-UAS, and counter-fire systems; and communications systems testing across multiple geographic locations. The 3 GHz mid-band is also critical to operation of air, land, and sea combat radars.

The Federal Communications Commission (FCC) has formally initiated commercialization of a broad portion of mid-band spectrum where, until now, federal users were given precedence. This policy change, which will auction the 3.45–3.55 GHz range, could significantly affect military radar operations and the aforementioned vital test capabilities, jeopardizing testing and delaying development of some of the Department’s most critical systems. The DOD is forming a transition plan to share this mid-band section with the private sector as co-primary users, yet it remains a requirement for realistic operational test and evaluation and warfighter training. It is imperative that future spectrum sales be carefully structured to ensure no additional loss of capabilities and that adequate spectrum is available to satisfy current and future DOD testing requirements.

Range Capabilities and Sustainment

DOT&E continues to monitor activities with the potential to limit the ability of the Department to fully use test and evaluation infrastructure. The following continue to be areas of particular concern:

Mission Space

Operational testing of hypersonic weapons, directed-energy systems, and autonomous and unmanned vehicles is either now underway or planned in the near future. Adequate operational testing will require long-range corridors that are in excess of currently available air, land, and sea space. The Department is concerned about certain areas of the mid-Atlantic and off the coast of California, which are being considered for wind power development. Our previous concern regarding the eastern Gulf of Mexico statutory moratorium on oil and gas development, which was scheduled to expire in 2022, has been alleviated by the administration recently extending this moratorium through 2032. Federal land withdrawals for the Nevada Test and Training Range were scheduled to expire in 2021; however, Congress is proposing to renew this land withdrawal for 25 years in the FY21 National Defense Authorization Act. The Department is supportive of ongoing efforts to retain this essential space to preserve our current capability to test and train.

If the available range space constrains our ability to accomplish the required open air testing, the Department may need to consider alternative methods that segment operational testing to fit within the available mission space, and/or becoming more dependent on M&S. Both these methods reduce the operational realism of full open-air testing and create other challenges in being able to validate these M&S.

Threats to Range Instrumentation

Some of the current range instrumentation rely on obsolete technology and software, increasing the risk of exploitation of sensitive information generated by weapon system testing. Adequate funding for range instrumentation modernization is required so instrumentation can be upgraded or replaced to standards that incorporate cybersecurity as a key performance parameter.

Persistent Surveillance

Foreign intelligence services are continuously attempting to conduct surveillance of U.S. weapon systems capabilities. One method of conducting this surveillance is through investing in U.S. entities adjacent to our test and training ranges. The Foreign Investment Risk Review Modernization Act (FIRRMA) of 2018 (part of the FY19 National Defense Authroization Act) provided several reforms to the Committee on Foreign Investment in the United States (CFIUS) process. It included a provision to assist in identifying real estate transactions posing a potential threat to national security through persistent surveillance of government activities conducting sensitive operations. Since its enactment, progress has been made working with the Services through the OSD Industrial Policy/Global Markets and Investments Office, the OSD participated in the Department of Treasury's rule making process to promulgate the FIRRMA regulations necessary to identify and mediate the transactions in proximity to sensitive test activities. In addition, the OSD provided a mapping capability shared across the DOD CFIUS process that rapidly mapped and identified potential proximity issues with real estate transactions. Based on the new rules, it is forecasted the case load will increase to approximately 1,000 per year over the next 2 years.

T&E Range Infrastructure Study

The NDS supports weapon systems developments that use a wide-range of new technologies such as directed energy weapons, hypersonic systems, autonomous systems, and artificial intelligence. Operational testing of capabilities that employ these new technologies will require modernizing our ranges, test infrastructure, and test capabilities. To assess current test capabilities and plan for the future, the National Academies of Science, Engineering, and Medicine (NASEM) is enlisting subject matter experts in land, sea, air, space and cyberspace warfighting domains from industry, academia and government, to assess the adequacy of range capabilities in the 2025-2035 time frame. DOT&E is sponsoring this study which is expected to complete in November 2021.