Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Office of Secretary Of Defense											DATE: April 2013	
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*					R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/Science and Technology*							
COST ($ in Millions)	**All Prior Years**	**FY 2012**	**FY 2013#**	**FY 2014 Base**	**FY 2014 OCO ##**	**FY 2014 Total**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**Cost To Complete**	**Total Cost**
Total Program Element	-	96.622	92.602	92.508	-	92.508	94.264	97.003	98.585	100.499	Continuing	Continuing
1: *High Speed Systems Test*	-	23.016	18.177	25.716	-	25.716	20.050	17.664	16.689	17.038	Continuing	Continuing
2: *Spectrum Efficient Technology*	-	9.742	8.696	8.783	-	8.783	7.313	8.705	9.991	10.197	Continuing	Continuing
3: *Electronic Warfare Test*	-	19.127	20.596	14.076	-	14.076	12.553	15.026	14.938	15.212	Continuing	Continuing
4: *Advanced Instrumentation Systems Technology*	-	10.025	9.177	8.989	-	8.989	11.205	12.627	12.630	12.877	Continuing	Continuing
5: *Directed Energy Test*	-	11.235	8.867	6.268	-	6.268	6.492	6.543	5.197	5.307	Continuing	Continuing
6: *Netcentric Systems Test*	-	20.072	18.090	16.063	-	16.063	14.960	10.679	10.922	11.167	Continuing	Continuing
7: *Unmanned and Autonomous System Test*	-	3.159	5.711	6.716	-	6.716	11.479	12.843	14.072	14.312	Continuing	Continuing
8: *Cyberspace Test*	-	0.246	3.288	5.897	-	5.897	10.212	12.916	14.146	14.389	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

The Test and Evaluation/Science and Technology (T&E/S&T) Program seeks out and develops test technologies to stay in pace with evolving weapons technologies. This program is critical to ensure that the Department of Defense (DoD) has the ability to adequately test the advanced systems that will be fielded in the future. To meet this objective, the T&E/S&T Program performs the following activities:

- Exploits new technologies and processes to meet important test and evaluation (T&E) requirements.
- Expedites the transition of new technologies from the laboratory environment to the T&E community.
- Leverages industry advances in equipment, modeling and simulation, and networking to support T&E.

Additionally, the T&E/S&T Program examines emerging T&E requirements resulting from Joint Service initiatives to identify T&E technology needs and to develop a long-range roadmap for technology insertion. The program leverages and employs applicable applied research efforts from the highly developed technology base in DoD laboratories and test centers, other government agencies, industry, and academia to accelerate development of new test capabilities. This program provides travel funds for T&E/S&T program oversight, special studies, analyses, and strategic planning related to test capabilities and infrastructure.

The DoD established seven strategic science and technology (S&T) investment priorities: 1) Data to Decisions, 2) Engineered Resilient Systems, 3) Cyber Science and Technology, 4) Electronic Warfare/ Electronic Protection, 5) Counter Weapons of Mass Destruction, 6) Autonomy, and 7) Human Systems. The T&E/S&T Program has been aligned and prioritized to prepare the T&E community to test warfighting capabilities that emerge from these S&T priority investments.

The T&E/S&T Program is funded within the Advanced Technology Development Budget Activity because it develops and demonstrates high payoff technologies for current and future DoD test capabilities.

Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Office of Secretary Of Defense	DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/Science and Technology*

B. Program Change Summary ($ in Millions)	FY 2012	FY 2013	FY 2014 Base	FY 2014 OCO	FY 2014 Total
Previous President's Budget	96.622	92.602	94.041	-	94.041
Current President's Budget	96.622	92.602	92.508	-	92.508
Total Adjustments	0.000	0.000	-1.533	-	-1.533
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Efficiency Savings: Realignment of Test Technology Development with Testing Requirements	-	-	-1.533	-	-1.533

Change Summary Explanation

- Efficiency Savings: Fiscal Guidance of baseline program adjusted to realign funds for higher priorities within DOD.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 1: *High Speed Systems Test*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
1: *High Speed Systems Test*	-	23.016	18.177	25.716	-	25.716	20.050	17.664	16.689	17.038	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

High-speed/hypersonic weapons are being developed to ensure the continued military superiority and strike capability of the United States including freedom of movement and freedom of action in areas protected by anti-access/area denial defenses. Current weapon system demonstrations and technology development programs include high-speed and hypersonic air-breathing missiles, maneuvering reentry and boost-glide weapons, hypersonic gun-launched projectiles, and air-breathing space access vehicles. These systems require development of conventional and high-speed turbine, ramjet, scramjet, and combined cycle engines; high temperature materials; thermal protection systems (TPS); and thermal management systems.

The High Speed Systems Test (HSST) project addresses test technology needs including propulsion, aerodynamic and aerothermal testing, so the test community has the technology to support the required test scenarios for concepts under development in the science and technology (S&T) community. The technology developments within the HSST project align with the Department of Defense (DoD) S&T priority investments. As such, the HSST project is developing, validating and transitioning advanced test and evaluation (T&E) technologies for ground test, open-air range flight test, and advanced computational tools, along with instrumentation and diagnostics systems for use in both ground tests and flight tests of high speed systems.

The HSST project develops technologies to enable robust, accurate, and timely T&E of these future weapon systems. DoD acquisition regulations require weapon systems to undergo a thorough T&E process to detect deficiencies early and to ensure system suitability and survivability. However, the extreme environments in which these weapons operate preclude accurate determination of their performance and operability with today's T&E assets. Current national test capabilities have deficiencies in data accuracy, flight condition replication and simulation, test methods, productivity, modeling and simulation (M&S) fidelity, and range safety.

The HSST mission is to address these national test capability gaps by providing test technology solutions that will enable high-speed and hypersonic weapon systems to be successfully developed through accurate, robust, and efficient T&E.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: High Speed Systems Test	23.016	18.177	25.716

FY 2012 Accomplishments:

The HSST project made significant advancements in ground and flight test technologies, techniques and instrumentation for both air-breathing propulsion and boost/glide weapons, and developed innovative M&S tools.

The two most significant technology shortfalls in current hypersonic aero propulsion ground test capabilities were clean air heat addition (i.e. non-vitiated air) and variable Mach number test capability. Current production ground test facilities could only create the high temperature inlet conditions necessary for scramjet engine tests by burning fuel in the airflow prior to entering the engine. As demonstrated by an HSST FY 2011 test, the resulting "vitiated air" had different gas properties than clean air and was not representative of what the vehicle would experience during flight. This significantly affected the engine's performance

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
and operability in the test environment resulting in erroneous flight performance predictions. Variable mach number capability was required to “fly the mission” and determine the critical transient operability effects throughout the flight envelope. Component technologies, previously developed by the T&E/S&T program, began incorporation into a small-scale, clean air, true enthalpy, variable Mach number 5-8 aero propulsion test facility. The completed facility would advance the component development to Technology Readiness Level (TRL) 6, provide an on-going test asset to the DoD, and provide risk reduction for construction of a full-scale facility. Significant progress was made this year in Phase I of the development including fabrication, installation, and integrated checkout of the advanced high-temperature refractory bricks, controls, and support systems for the Regenerative Storage Heater. Design efforts for subsequent phases were initiated. These efforts included critical design of the air delivery system and preliminary design of a variable Mach number nozzle. Innovative test techniques were developed to assess the viability of accurately testing large scramjet engines in existing size-limited national test facilities. One effort evaluated a means of truncating the long inlet section of an engine while still accurately replicating the performance of a larger baseline inlet. Another effort evaluated how to quantify and improve the accuracy of direct connect and semi-free jet test techniques by comparing them to a benchmark free jet test configuration. Engine operability and performance test results for each of the test facility configurations werequantified and compared to establish the first known database of engine/test facility configuration scale effects on engine operation. The aforementioned technology developments aimed to permit weapons system developers to maximize the use of existing infrastructure and better understand test results, thereby reducing flight test and acquisition risks. Scramjet engine tests were completed to determine the facility effects of test duration, test media, and freejet versus direct-connect test methodology upon scramjet engine performance and operability. Testing utilized scramjet engine flowpaths of the same design tested in impulse and blowdown ground test facilities. This study culminates in the most extensive examination of hypersonic aero propulsion test methods yet accomplished and will enable significant improvements in the quality of data provided to weapon system developers and computational fluid dynamics tool developers. Accurately predicting the ablation characteristics of a TPS was critical for developing maneuvering reentry and boost-glide vehicles. A major aerothermal T&E capability gap existed in the mid-altitude/mid-pressure flight regime which was representative of the flight corridor for these hypersonic vehicles. Improved arc heater electrodes were developed and tested this year which allowed for longer duration, higher enthalpy testing, and more realistic environments for hypersonic TPS testing. Key flight test technologies were developed for flight termination and flight maneuver optimization. Hardware-in-the-loop testing and final design of a flight rated, autonomous flight termination system were completed. An autonomous flight safety system was designed to assure destruction of an errant hypersonic vehicle under test if it leaves its designated safety corridor, thereby maximizing safety while reducing flight test costs. The current phase of this effort was to complete maturation and transition of autonomous flight safety technology to TRL 6 and pave the way for a direct transition to operational use. Prototype units were being designed and built for use by the Operationally Responsive Space office. Transition coordination was also underway to include other developmental hypersonic vehicle systems. Advanced parameter identification maneuvers were developed and			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
programmed into the flight computer of the third X-51 flight. These optimized test maneuvers were designed to collect far more stability and control data per flight than possible using traditional methods, thus reducing the number of flight tests and costs. Progress was also made in advanced high speed systems test instrumentation. A flight-weight, laser-based, non-intrusive measurement system was flown on a Hypersonic International Flight Research Experimentation (HIFiRE) flight test, resulting in the first-ever in-flight scramjet combustion efficiency measurement. An advanced system utilizing lasers operating in the mid-infrared spectrum and which significantly lowers gas property measurement uncertainty was transitioned to a DoD ground test center and a DoD research laboratory. A miniaturized, temperature-compensated wind tunnel balance for supersonic store separation testing was constructed. Design, fabrication and demonstration of non-intrusive laser hygrometer and optical mass flow measurement systems were completed. Testing of a fiber optic heat flux gauge and a high temperature shear stress sensor were also successfully completed. Advances were achieved in the development of a state-of-the-art validated computational fluid dynamics tool. Improved M&S tools were transitioned to the hypersonic community. These tools could simulate the complex flows within scramjet engines and include physical modeling for turbulence, fuel-air combustion, and heat transfer. The code was successfully used to model combustion phenomenon in a scramjet engine. A technology demonstration was performed to evaluate a technique for testing propulsion systems beyond Mach 8 using magnetohydrodynamics to accelerate flow ionized by electron beams.			
FY 2013 Plans: New test technology efforts will be initiated addressing: test technologies, techniques, and methodologies to determine full-scale propulsion system performance and operability from subscale tests; technology for improved TPS ablation and weather effects characterization; further development of M&S codes for accurate prediction of flow fields, boundary layer transition, and heat transfer in high-speed flow; new and more accurate instrumentation systems; and application of advanced test technologies to other needs such as gas turbine engines, and electromagnetic rail guns. Activities for the clean-air, variable Mach number demonstration facility will continue to develop and demonstrate air delivery system technology to deliver uniform flow with variable pressure and temperature from multiple air sources through a fixed nozzle up to Mach 8 conditions. Scramjet ground tests in semi-free jet, and direct connect test modes will be concluded and compared to free-jet test results to quantify their respective accuracies and identify optimal test methods for larger, next generation scramjet engines. Vitiation effects data will be collected to increase the high speed systems community's knowledge base. Sub-scale ceramic morphing components for high speed ground test facilities will be designed and fabricated to maintain well-conditioned flow while continuously varying the flight Mach number and reducing cooling requirements. Testing of improved arc jet facility electrodes will be completed enabling improved T&E of maneuvering reentry and boost/glide vehicles.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 1: *High Speed Systems Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Verification and improvement of computational fluid dynamics codes will continue, making use of the unique data sets obtained from the HSST scramjet engines tests described above. A boundary layer transition prediction tool for 2-dimensional and axisymmetric bodies will be enhanced allowing for application to complex, 3-dimensional boost-glide vehicle geometries. ***FY 2014 Plans:*** FY 2014 will see continued efforts to improve hypersonic ground and flight test capabilities to levels required for acquisition programs. Efforts will include demonstration of new flight test techniques, improvements in instrumentation, and continued validation and improvement of computational fluid dynamics codes. Progress will continue toward final integration and operation of the clean-air, variable Mach number aeropropulsion facility, including completion of the variable Mach number nozzle design and preparations to demonstrate the capability to simultaneously vary stagnation pressure, temperature and Mach number from 5-8. Design, manufacture, and delivery of a full scale ceramic morphing device for use in a DoD high speed ground test facility will be completed.			
Accomplishments/Planned Programs Subtotals	23.016	18.177	25.716

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 2: *Spectrum Efficient Technology*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
2: *Spectrum Efficient Technology*	-	9.742	8.696	8.783	-	8.783	7.313	8.705	9.991	10.197	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

Weapon systems have become increasingly complex in recent years, resulting in the need for significantly more data to be passed among these systems, and between the systems and our test infrastructure. A vast amount of data must be collected, transmitted, and analyzed, which requires a large amount of radio frequency (RF) spectrum resources. However, the amount of RF spectrum designated to support test and evaluation (T&E) is decreasing, most notably due to reallocation of spectrum for commercial use. The combination of decreasing RF spectrum and increasing data requirements results in an urgent need to create test technologies that maximize the use of spectrum resources for Department of Defense (DoD) T&E operations.

The L and S frequency bands are the traditional spectrum allotted for military use. The explosive need for spectrum in the commercial sector has resulted in reallocation of portions of these bands to industry. To compensate, DoD is now authorized to use the C-Band spectrum which offers numerous benefits, including a three-fold increase in available bandwidth, but C-Band comes with technical challenges. Most notably, our current test infrastructure for telemetry is not designed to accommodate C-Band. Technologies are required to implement innovative techniques that efficiently facilitate our use of C-Band without a major overhaul to our national test infrastructure. For instance, commercial telemetry transmitters operate in C-Band but do not have the form factor (size and weight) or rugged packaging to survive airborne test applications.

Traditional telemetry applications employ streaming telemetry where data is moved one-way from the instrumented system under test to our test infrastructure. Modern network based telemetry capabilities, like those being developed by the Central Test and Evaluation Investment Program (CTEIP) integrated Network Enhanced Telemetry (iNET) effort, enable more robust, efficient bidirectional transfer of data. DoD's strategy is to create technologies for streaming telemetry capability in C-Band while opening up legacy L- and S-Bands for networked telemetry.

The Spectrum Efficient Technology (SET) project is developing test technologies that enable more efficient use of legacy telemetry bands and expansion into non-traditional areas of the RF and optical spectra at DoD test ranges. The technology development efforts within the SET project have been prioritized to align with Department of Defense guidance on science and technology priority investments. As such, the SET project is focusing on growing data requirements of warfighting systems and the limited availability of spectrum for testing. The SET project is structured to develop test technologies to advance range communications, networked telemetry capabilities, and enhanced management of spectrum at DoD test ranges.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Spectrum Efficient Technology	9.742	8.696	8.783
FY 2012 Accomplishments: The SET project developed technologies to meet networked telemetry requirements and performed risk reduction for CTEIP. Technology enabling the dynamic reconfiguration of transmitted test data over a telemetry network was further matured. The SET project continued development of a networked data recorder to provide risk reduction in support of the CTEIP iNET development.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 2: *Spectrum Efficient Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
The research and development of advanced data protocols for test data transmission across the iNET network continued. A networked telemetry transceiver using an advanced waveform was developed and tested as a risk reduction effort for iNET development. The SET project matured and demonstrated radio network technology to rapidly change operating frequencies in the presence of non-cooperative interference, thus maintaining connectivity with no perceivable impact on telemetry network performance. Spectrum and network management technology development continued, with a focus on capabilities that allowed for dynamic distribution of spectrum resources among test participants. Technologies matured by SET provided risk reduction in support of spectrum management which was challenged by spectrum sell-off activities. Development continued on advanced technologies to increase RF bandwidth efficiency. A wideband power amplifier capable of efficiently operating with advanced waveforms within the traditional telemetry bands was matured and demonstrated. The prototype amplifier increased overall efficiency in spectrum utilization. Research continued to determine the ideal coding scheme for advanced waveforms such as Shaped Offset Quadrature Phase Shift Keying, a more spectrally efficient data transmission scheme for aeronautical telemetry. Forward error correction schemes for use in aeronautical telemetry to increase data reliability in dynamic test environments were completed and demonstrated. These forward error correction schemes were adopted by the Range Commanders Council Telemetry Group for inclusion in Inter-Range Instrumentation Group telemetry standards. The SET project continued the development of a three dimensional channel model tool for modeling and simulation of telemetry channels in various environments. This tool provided higher fidelity simulations for use in researching the effects of terrain and other factors on telemetry channels. The SET project investigated techniques to expand telemetry operations into non-traditional spectrum bands by characterizing multipath effects in multiple range environments. Additionally, SET compared the data link performance of legacy RF spectrum allocations to the recently allocated C-Band spectrum. The results of this investigation were published and transitioned to the DoD test ranges. SET continued efforts to develop airborne phased array antenna technology that would enable flexible scheduling of the T&E spectrum by incorporating both the traditional L/S bands and recently permitted C-Band frequencies. Some of these technologies would reduce the technical risk associated with beam steering in the C-Band frequencies, reduce the amount of infrastructure modifications needed to implement a C-Band telemetry capability, and provide over-the-horizon data connectivity to test large-footprint weapons, such as long range missiles.			
FY 2013 Plans: The SET project will further advance development of technologies required for network telemetry. Efforts to develop policy-based network management tools will be completed, demonstrated, and transitioned to support CTEIP developments. Spectrum and network management systems, including a suite of network protocols, will be demonstrated and transitioned to the test ranges. Technologies to develop advanced waveforms designed to increase bandwidth efficiency will be matured. The development of advanced waveforms will enable the telemetry network to support multiple high data rate test assets and increase efficiency in spectrum utilization. Development of a networked data recorder in support of iNET will be completed, demonstrated, and transitioned to support the deployment of a networked telemetry system. Technologies to develop a three dimensional channel model tool used in modeling and simulation of telemetry channels in various environments will be matured.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 2: *Spectrum Efficient Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Phased array antenna technology utilizing both the traditional and C-Band frequencies will continue to be matured to enable flexible spectrum scheduling and alleviate technical risk associated with tracking and beam steering in the C-Band. The SET project will initiate efforts to develop an airborne multiband transceiver to support networked telemetry, increase spectrum scheduling efficiency, improve efficiency in ground telemetry and antenna systems, and support data transmission in both traditional L/S and C-bands. ***FY 2014 Plans:*** The SET project will initiate development of radio technology that can utilize alternate spectrum in the upper frequency bands. These efforts will determine the feasibility of some of the upper bands for use in telemetry. Additional efforts on alternate data link technologies in the optical realm will be investigated. If efforts in this area are successful, these technologies can provide augmentation to the RF telemetry bands. The SET project will continue efforts to mature phased array technology for use on the ground as well as in airborne applications. The high directionality of phased array antenna technologies on aircraft will enable the ability to leverage spectrum spatial reuse techniques for more effective spectrum scheduling. The SET project will begin investigation of technologies that will provide autonomous self-forming telemetry networks to provide connectivity in flight line and other areas that currently suffer from limitations in communications coverage caused by buildings and terrain. Efforts will complete in the development of a three dimensional channel model tool used in modeling and simulation of telemetry channels in various environments. Additionally, the SET project will complete work to mature technologies in optimization and management of the telemetry networks through spectrum management tools designed to optimize spectrum utilization.			
Accomplishments/Planned Programs Subtotals	9.742	8.696	8.783

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
3: *Electronic Warfare Test*	-	19.127	20.596	14.076	-	14.076	12.553	15.026	14.938	15.212	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

Readily available, infrared (IR) seeking, man-portable air defense systems (MANPADS) are difficult to detect and pose an imminent and lethal threat to military aircraft of all types. Our ability to counter such threats is essential to owning the airspace in theater. Therefore, the ability to test missile warning systems (MWS), hostile fire indicators, IR countermeasures (IRCM), and advanced threat sensors is critical to our national defense. Additionally, a new generation of enemy radio frequency (RF) missile seekers is both currently fielded and in further development, requiring a correspondingly new generation of test technologies to test the latest countermeasures. The test and evaluation (T&E) community is required to test IRCM and RF countermeasure systems in a repeatable manner with ground-truth data before and after integration into warfighting systems. Without new test technologies, the Department of Defense (DoD) will be unable to perform adequate T&E of advanced warning and countermeasure systems.

The technology development efforts within the EWT project have been prioritized to align with DoD guidance on science and technology priority investments. As such, the EWT project is focusing on the test needs in both the electro-optic (EO), including IR, and the RF threat domains. Additionally, development of core test technologies in this area can be leveraged to meet other EO and RF test requirements, such as in fire control systems, reconnaissance sensors, and missile seeker subsystems.

The EWT project develops test technologies to stimulate IRCM and RF system sensors through the high-fidelity simulation of scenes viewed by the sensors. Stimulation can be as simple as testing to see if a system under test responds to an image or as complex as simulating complex battle space phenomena to measure the response of a system under test in a more relevant, cluttered scenario. Simulations and stimulations are used at open air ranges and in installed system test facilities (ISTF), and in hardware-in-the-loop (HWIL) test beds.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Electronic Warfare Test	19.127	20.596	14.076
FY 2012 Accomplishments: The EWT project continued developing the technology for the high-temperature scene emitter for the Central Test and Evaluation Investment Program (CTEIP) Joint Distributed IRCM Ground-Test System (JDIGS) development, which was improving DoD test capabilities for directional IR countermeasures (DIRCM) systems. The EWT risk reduction effort for JDIGS entered the final stages of testing a new superlattice light-emitting diode source that could provide two-color, high-temperature scenes with a frame rate fast enough to test new IRCM and MWS. The EWT project completed development of read-in integrated circuit technology, which supplies electrical energy to emitters that generate images in ISTF and HWIL test facilities. This technology completed final testing and was integrated with scene			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 3: *Electronic Warfare Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
projection cameras. The EWT project made significant progress in the development of a hyperspectral imaging projector, which allowed characterization and testing of hyperspectral imaging cameras used for intelligence, surveillance and reconnaissance. The EWT project initiated an effort to develop a breadboard technology to produce high-fidelity electronic counter-countermeasures (ECCM) radar signal processing techniques that employ sophisticated waveforms with algorithms, such as adaptive filtering. This test technology development was to address a need, identified by the Navy-led, CTEIP-sponsored Tri-Service Electronic Warfare Test Capabilities Study, to improve testing against modern surface-to-air missile threats. ***FY 2013 Plans:*** Risk reduction activities for CTEIP in testing MWS in integrated ISTF and HWIL will continue. The EWT project will concentrate on addressing new test technology needs identified in the update to the IRCM Test Resource Requirements Roadmap. Furthermore, EWT technology developments will focus on stimulating synthetic aperture radars with RF injection, including realistic background clutter. Research will be conducted for testing wide area emitters. Efforts to develop surrogate missiles for testing of MWS and IRCM systems will continue. To address the testing of systems operating in the mid-wave IR band, the EWT project will develop technologies to enable the full testing of mid-wave IR sensor/seekers by adding clutter models and scene generators to real-time stimulation technologies. Furthermore, efforts to develop technology to test against ECCM techniques of modern surface-to-air missiles will continue. ***FY 2014 Plans:*** The EWT project will invest in new technologies related to improving the electronic warfare T&E infrastructure. These new technologies will be identified by the Tri-Service EWT Working Group formed in FY 2011, and further address test needs identified in the IRCM Test Resource Requirements Roadmap and the Tri-Service Electronic Warfare Test Capabilities Study.			
Accomplishments/Planned Programs Subtotals	19.127	20.596	14.076

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 4: *Advanced Instrumentation Systems Technology*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
4: *Advanced Instrumentation Systems Technology*	-	10.025	9.177	8.989	-	8.989	11.205	12.627	12.630	12.877	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

The Advanced Instrumentation Systems Technology (AIST) project addresses the test technology gaps resulting from emerging weapon systems that need to be tested at Department of Defense (DoD) open air ranges, undersea ranges, installed systems test facilities, hardware-in-the-loop laboratories, and measurement test facilities. Instrumentation requirements for systems under test are increasing exponentially for new weapons systems. Vehicle on-board and warfighter wearable instrumentation packages are required. This instrumentation is for sensing and collecting critical performance data; determining accurate time, space, position information (TSPI)and attitude information; interfacing with command and control data links; monitoring and reporting system-wide communications; recording human operator performance; and storing and transmitting data.

The technology development efforts within the AIST project have been prioritized to align with DoD guidance on science and technology (S&T) priority investments, particularly in support of human systems, engineered resilient systems, and counter weapons of mass destruction. The AIST project is focused on supporting technology developments for advanced TSPI instrumentation (especially with limited or no use of the Global Positioning System (GPS)), advanced sensors, advanced energy and power systems for instrumentation, non-intrusive instrumentation, mitigating range encroachment issues, and measuring warfighter cognitive performance. The AIST project addresses requirements for miniaturized, non-intrusive instrumentation suites with increased survivability in harsh environments. Such instrumentation is an urgent need because minimal space is available to add instrumentation to new or existing weapon systems subsequent to their development; furthermore, additional weight and power draw for instrumentation can adversely affect weapon system signature and performance. Instrumentation for humans-in-the-loop, such as dismounted soldiers, must not adversely affect soldier performance, induce artificiality in the test environment, nor create operational burden. New technologies can be exploited to integrate small, non-intrusive instrumentation into emerging platforms during design and development, and, in some cases, into existing platforms. This class of instrumentation will provide critical system performance data during test and continuous assessment throughout a system's lifecycle. Technology developed under AIST can also benefit training and combat missions by enabling a continual feedback loop between the developer, training staff, operators and commanders.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Advanced Instrumentation Systems Technology	10.025	9.177	8.989
FY 2012 Accomplishments: The warfighter must conduct military operations in a diverse array of locations, to include urban, mountainous, and densely forested environments. Consequently, a continued major thrust for FY 2012 included the development of test technologies to support collection of TSPI for soldier systems (manned or unmanned), particularly in GPS-denied or degraded environments, such as in urban areas and tunnels. Efforts to test systems that operate in a GPS-denied environment included technology			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 4: *Advanced Instrumentation Systems Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
that enabled networking of GPS-enabled components within the test environment, and then using the network to integrate GPS and other positional information across the connected nodes. The nodes shared raw observables from GPS and inter-node ranges to locate each network node with high reliability. Final testing resulted in sub-meter position accuracy in environments that may be encountered in urban operations. A related technological approach employed a layered system of sensors leveraging collaborative navigation, existing radio frequency ranging technology, and a Doppler velocimeter to achieve more precise TSPI under GPS-impaired conditions. System components had integrated and planning was underway for preliminary testing in a realistic environment. Also, progress was made on a warfighter inertial tracking system for dismounted warfighters. This technology employed boot-mounted sensors to provide sub-meter geolocation over GPS-denied durations of greater than 2 hours; system performance and system component requirements were verified. To support testing of high-speed, high-acceleration systems, an ultra-high dynamics GPS receiver was developed. The receiver performed significantly better than existing test instrumentation. Position solutions were obtained at velocities up to 10 kilometers/ second with time-to-first-fix under 0.5 seconds, which was important for testing air-to-air missile systems launched from under the wing or from a weapons bay, and for range safety. Requirements were being gathered for future test and evaluation GPS TSPI activities and to guide the architecture for next generation solutions. A holographic optical memory system was designed for on-board test data recording and retrieval, extending the data storage capacity of current state-of-the-art holographic memory up to 16 terabytes. Laboratory testing had demonstrated that an increased capacity beyond 16 terabytes was possible. Attachment technology development continued with investigation of new adhesive formulations that employed an electrically releasing foil patch. This technology allowed attachment of sensors to non-conductive, painted exterior surfaces of aircraft and other combat vehicles, significantly reducing the time to restore the system under test to its operational configuration. Investigations in this area continued with the aim of producing a stable adhesive formulation with an extended shelf life. To improve testing at DoD undersea range complexes, algorithms and methodologies were investigated to automate detection and classification of marine mammal vocalizations from ocean floor range sensors (e.g., hydrophones) with testing planned at the Atlantic Undersea Test and Evaluation Center. This test technology allowed the Navy to conduct critical test and evaluation (T&E) events without adversely impacting marine mammal populations. Efforts continued to assess and leverage microsystems technology under development at universities, the Defense Advanced Research Projects Agency, and government laboratories. These efforts were applicable to T&E of modern war fighting systems; a final report was produced.			
FY 2013 Plans: Numerous warfighting systems are brought to theater by rapid acquisitions. These systems involve operations in extreme conditions, over long distances, for long durations, and often with very small physical footprints (i.e. microsystems). Furnishing adequate energy and power to instrument such systems for testing is a significant technological challenge. Major thrusts for FY 2013 include continuing ongoing efforts in advanced sensors, TSPI instrumentation, and advanced data acquisition and transformation that require little power along with the development of advanced power sources for test instrumentation.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 4: *Advanced Instrumentation Systems Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Additionally, AIST will pursue test technologies to assess warfighter cognition under various workloads. The AIST project will complete its assessment of emerging microsystems technology and develop a roadmap for potentially leveraging microsystems technologies in instrumentation at DoD ranges. The AIST project will complete: the development and testing of classifiers to identify specific sea mammals (e.g., dolphins and whales) found at undersea ranges; the development and testing of magnetic field sensors for the harsh environment of electromagnetic rail gun firings; an attachment technology that is environmentally resistant (e.g., shelf life) and does not require any solvents to restore test articles to operational condition; efforts for collecting TSPI on dismounted soldiers and related soldier systems in GPS-denied or degraded environments such as those found in urban and subterranean operations. The AIST project will also complete application specific integrated circuit architectures with high dynamic, multi-frequency, anti-jamming capability to provide TSPI in GPS-denied and GPS-jammed environments. ***FY 2014 Plans:*** The AIST project will initiate efforts to develop advanced TSPI technologies for non-intrusive applications using wireless systems and optical, infrared, and/or acoustic techniques. TSPI technologies will be further developed to support: data collection in GPS-denied environments, TSPI on high dynamic systems such as missiles and projectiles, TSPI on swimmers and divers, and TSPI on non-cooperative undersea weapon systems. Advanced sensor initiatives for non-intrusive applications will include multimodal transducers, and self-registering/self-calibrating sensors. Sensing applications will include weapon system orientation, body armor blunt trauma evaluation, warfighter body posture and orientation, stores separation, and angle of incidence. Advanced power/energy initiatives will develop technologies for non-intrusive application, particularly energy harvesting devices and load management devices. This will include fuel cells for warfighter wearable instrumentation, military vehicle instrumentation, and embedded sensors for weapon systems. Advanced data transformation initiatives will develop technologies for adaptive computing, self-configuration, and self-calibration of instrumentation. Additional goals include technologies for: virtual/synthetic instrumentation, data compression, wireless on-board data transport and improved data storage density. Other areas of investigation will include data management techniques; decreased size, weight, and power (SWaP); and micro-miniaturization of electronic components for non-intrusive applications. Lastly, AIST will investigate technologies for reducing or eliminating range environmental encroachment issues and warfighter cognitive performance measurement and assessment.			
Accomplishments/Planned Programs Subtotals	10.025	9.177	8.989

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 4: *Advanced Instrumentation Systems Technology*

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 5: *Directed Energy Test*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
5: *Directed Energy Test*	-	11.235	8.867	6.268	-	6.268	6.492	6.543	5.197	5.307	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

The Department of Defense (DoD) is exploring the military utility, safety, and suitability of directed energy weapons. A robust test capability to assess directed energy weapons is essential to understanding their effectiveness and limitations, including determining their effectiveness in performing counter improvised explosive device (C-IED) operations. Such assessments will depend upon knowledge acquired through the test and evaluation (T&E) of directed energy technologies and testing of operational concepts. Directed energy weapon technologies, primarily consisting of high energy lasers (HEL) and high powered microwaves (HPM), are outpacing available test capabilities. Traditional test techniques for evaluating conventional munitions (with flight times ranging from seconds to minutes) are not sufficient for the T&E of directed energy weapons that place energy on target instantaneously. Consequently, new test technology solutions are needed to ensure that adequate developmental, live-fire, and operational test capabilities are available when directed energy programs are ready to test.

Directed energy system and component testing requires three principal assessments: (1) energy or power on target; (2) the effects on the target; and (3) the propagation of the directed energy to the target through the atmosphere. In addition, the vulnerabilities of DoD systems to directed energy threats are required to be characterized in accordance with Military Standard (MIL-STD)-464C. Equally as important, current test capabilities do not provide the detailed data required to understand U.S. directed energy system performance and effects.

The technology development efforts within the Directed Energy Test (DET) project have been prioritized to align with DoD guidance on science and technology priority investments. As such, the DET project is developing the technologies necessary for quantitative assessment of United States HEL and HPM performance, as well as the vulnerability of DoD weapon systems to enemy directed energy threats.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Directed Energy Test	11.235	8.867	6.268
FY 2012 Accomplishments: To assess HEL energy on target, sensor array designs were developed to directly measure irradiance across laser spots on target materials. Additional developments produced alternative sensor array designs to measure the temperature profiles on the back surface of a HEL-irradiated target so that inverse heat conduction algorithms could be applied to estimate the temperature on the front (HEL-heated) surface. In this same HEL T&E area, fabrication began on a hyperspectral sensor technology to remotely measure radiance from an HEL spot on the target. In the area of HEL effects on target, an adaptive optics system was designed and fabrication of a prototype was started. The test technology allowed improved remote imaging of an HEL spot on a remote target. This test technology was designed to be readily adaptable to telescopes at various test facilities. Regarding HEL atmospheric propagation, a multi-light detection and ranging system to measure important atmospheric profiles along a slant path adjacent to the HEL beam propagation path began			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 5: *Directed Energy Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
development. This technology simultaneously measured profiles for three parameters: optical turbulence, water vapor content, and aerosol attenuation. A test technology supporting both HPM energy on target and effects on target was transitioned to the testing community within Air Force Research Laboratory. This technology measured the electric field arriving at eight locations on the target and the temperature rise resulting from those fields. It was used for testing the Counter-electronics High Power Microwave Advanced Munitions Project Joint Concept Technology Demonstration. Also, a family of HPM sensor technologies demonstrated measurement of energy inside large targets during HPM engagements. The sensor technologies could be used singly or in combination to non-intrusively measure electric and magnetic field vectors at the same location within a target system. Early testing of electric field sensors in support of electromagnetic rail gun T&E identified a prime source for indicating rail wear, a key issue for rail gun systems. To better support C-IED testing, the test technology development to measure soil electrical properties built a brass board sensor with three interchangeable heads to cover the required frequencies. The brass board had been used in proving the concept to measure the soil electrical properties for portions of the test site within minutes versus days associated with legacy systems. Results produced measurements similar to those of legacy technologies. This soil properties measurement technology was transitioned to the testing community. The technology to characterize terahertz beam quality in support of testing the proliferating number of Terahertz sensors and detectors, which were used for force protection and characterizing explosives or biological threats, was transitioned to the test community.			
FY 2013 Plans: Within the HEL area, efforts will focus on completing the technology developments for measuring energy on target and characterizing effects on target using onboard sensing. The performance of these matured technologies will direct the focus of future investments to optimize HEL measurement capabilities on test ranges. New efforts will be initiated to address identified test technology shortfalls, including HEL test safety and HEL collateral effects. This includes efforts to improve the understanding of HEL reflection hazards so that testing of HEL systems can be done safely without risk to observers and sensors. In addition, test technologies will focus on the characterization of solid state laser effects on targets in support of weapons systems in development and demonstration by the Army, Navy, and Air Force. Test technologies to support the measurement of laser lethality on rockets, artillery, mortars, and unmanned air vehicle targets will remain a key area of investment. Furthermore, efforts to characterize beam propagation through the atmosphere will center on the maritime environment in support of emerging needs of the Navy. Investment will be placed in laser safety software and hardware to allow testing at multiple test ranges without affecting aircraft and space-based sensors. Initiatives to achieve very small, non-intrusive current and voltage sensors to measure HPM effects inside a target will be completed. These technologies will be transitioned to at least two locations to demonstrate the flexibility of these approaches. A small, minimally intrusive data acquisition device with a wide bandwidth to match that of the non-intrusive electric and magnetic field sensors will be investigated.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 5: *Directed Energy Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
A HPM test risk reduction effort will be performed to determine the best approach to construct a more durable pressurized – radio frequency transmitting dome that does not leak over time for a test capability that emulates wideband threats. A new study will be initiated to investigate technologically-viable alternatives to provide the neutron radiation required for nuclear survivability testing. ***FY 2014 Plans:*** Investments in HEL test technologies will be initiated to assess the changes in HEL effects due to the shift of HELs to shorter wavelengths near 1 micron. Such HELs include solid state, fiber, and free electron laser systems. Tunable over a wide range, free electron lasers present unique testing challenges for open air testing, including measuring laser energy on target, as well as characterizing the beam propagation and thermal blooming effects. As development of electromagnetic rail guns and the free electron lasers advance, investments in test technologies supporting these weapon systems will be initiated. In the HPM area, measuring the actual cause of HPM effects on electronics will be addressed by measurement of electrical currents within the wires and chips of the electronic targets. To better support weapon research and design, a method will be sought to determine the time out of action for targets after an HPM attack. In survivability testing, these sensors will support assessment of susceptibility with different HPM source power levels. Additionally, the DET project will address technology for small, powerful HPM sources to allow testing of the susceptibility of U.S. equipment in a chamber environment.			
Accomplishments/Planned Programs Subtotals	11.235	8.867	6.268

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 6: *Netcentric Systems Test*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
6: *Netcentric Systems Test*	-	20.072	18.090	16.063	-	16.063	14.960	10.679	10.922	11.167	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

The Net-Centric Systems Test (NST) project is pursuing test technologies to emulate multi-Service, Joint, and coalition net-centric operations in a system of systems test and evaluation (T&E) environment. Additionally, the NST project develops technologies to analyze and evaluate the increasingly massive amounts of structured and unstructured data generated by complex net-centric tests. The technology to conduct T&E on net-centric systems is challenged by sensor platforms, command and control systems and weapon platforms that support the kill chain in a Joint operation. These systems must be evaluated for their ability to provide an accurate, timely transfer of data (e.g., target tracks, weapons allocation, mission tasking and situational awareness), as the data passes among different systems of Service and coalition participants. The NST technologies advance test automation (test planning, test execution, test control, and analysis) that enable the virtual integration of Department of Defense (DoD) weapon laboratories and open air ranges. Using models and simulations along with hardware-in-the-loop laboratories, the effectiveness of Joint missions can be assessed in terms of system-of-systems interoperability and effectiveness in executing Joint mission operations, including testing of weapons and Command and Control systems accessing and providing information to the Global Information Grid. The technology development efforts within the NST project have been prioritized to align with DoD guidance on science and technology priority investments, particularly in measuring “Data to Decision” techniques and warfighting capabilities. Ultimately, the NST portfolio enables the T&E community to “test like we fight” by replicating net-enabled, Joint mission operations within a T&E environment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Netcentric Systems Test	20.072	18.090	16.063

FY 2012 Accomplishments:

Efforts included technology development for planning a complex, multi-system, mission-level net-centric test in a distributed live-virtual-constructive (LVC) environment and controlling test execution through management of the mission scenario. The NST project developed test planning technologies to address test integration and interoperability issues. Ontologies were developed to formalize concepts pertaining to LVC test resources in a net-centric joint mission environment (JME). The NST project developed knowledge bases that captured subject matter expertise on setup and execution of a test event and characteristics of test resources. Machine reasoning capabilities were extended and integrated to automate test planning tasks. The NST project continued development of a planning and visualization technology to support joint mission thread testing to better correlate test data to the effectiveness of mission operations.

The NST project advanced technologies to support the execution of distributed tests with active network control, enhanced the dynamic management of the test infrastructure, and improved the integration of Service laboratories and test ranges. These

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 6: *Netcentric Systems Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
technologies were transitioned and integrated into the Test and Training Enabling Architecture (TENA) that was used by the Joint Mission Environment Test Capability (JMETC) and at test facilities and training ranges. The NST project continued investigating in technologies to test military systems that employed Service-Oriented Architectures (SOA), including test technologies to help the tester understand what was happening inside and between SOAs during test events. A SOA prototype test tool was developed and successfully demonstrated for the Joint Interoperability Test Command. These test technologies allowed the tester to understand the environment, including but not limited to network hardware and software. The NST project also developed technologies for the next generation of TENA middleware that supported a broad range of networks, including wireless networks, and provided native support for handheld and embedded computing platforms. This technology successfully demonstrated TENA connectivity through wireless networks to several commercially-available smartphone devices. Global Positioning System and accelerometer test data were successfully transmitted over commercial cellular carriers using an encrypted virtual private network. The NST project transitioned test technologies to the Central Test and Evaluation Investment Program (CTEIP) Interoperability Test and Evaluation Capability (InterTEC) to support a planning and visualization web service technology used during the InterTEC Cyber Event. This technology enabled testers to efficiently apply mission threads to test design. In addition, these test technologies also transitioned to the NAVAIR Integrated Warfighting Capability.			
FY 2013 Plans: The NST project will focus on efforts that enable TENA to utilize remote methods of authentication and privilege management to distributed users. This technology will support the DoD's remote authentication T&E needs and next generation Multi-Level Security T&E capabilities. Additionally, the NST project will continue the development of technologies to support the measurement and analysis of the net-centric test environment. The analysis of Joint mission threads in near real-time will be assisted by the development of a test technology that will allow effective replication and characterization of Joint mission threads. The testing of SOA will be emphasized through the research and development of instrumentation and analysis tools utilizing embedded agent-based technologies. Additional test technology development will be conducted in semantic interoperability and defining ontologies that formalize concepts pertaining to distributed test resources in a net-centric JME. The NST project will focus predictive smart dead-reckoning technology to address the challenge to adequately synchronize the distributed test environment. This effort will provide the necessary distributed intelligence to manage time space position information (TSPI) updates in the net-centric test battlespace with a distributed LVC architecture. The NST project will build upon previously developed NST technologies to solve the test challenges of producing accurate TSPI predictions under all network conditions, to include both unpredictable network latency and missing information. Since the predictive smart dead-reckoning technology will be built on top of the policy-enabled agent, it will be able to provide fast response under complex test event conditions.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 6: *Netcentric Systems Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
The NST project will continue developing technology that will automate the planning of test events based on advanced semantic web technology. Development will continue on technologies to support the use of TENA over a broad range of networks and to provide a common interoperability test architecture. Modeling and simulation technologies to support emulation and stimulation of networks for conducting T&E along with simulation fidelity assessments in the T&E context will also be investigated.			
Accomplishments/Planned Programs Subtotals	20.072	18.090	16.063

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 7: *Unmanned and Autonomous System Test*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
7: *Unmanned and Autonomous System Test*	-	3.159	5.711	6.716	-	6.716	11.479	12.843	14.072	14.312	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

Unmanned and Autonomous Systems (UAS) support every domain of warfare. They operate in space, in air, on land, on the sea surface, undersea and in subterranean conditions to support a vast variety of missions. The emergence of unmanned systems brings a host of revolutionary capabilities that will profoundly influence warfare. The Unmanned and Autonomous Systems Test (UAST) project addresses current and emerging challenges associated with the test and evaluation (T&E) of these critical warfighting capabilities. The technology development efforts within the UAST project have been prioritized to align with Department of Defense (DoD) guidance on science and technology priority investments, particularly in assessing autonomy. As such, the UAST project is developing test technologies to simulate, stimulate, instrument, measure, and assess autonomous systems' ability to perceive its environment, process information, adapt to dynamic conditions, make decisions, and effectively act on those decisions in the context of mission execution.

The UAST project will provide the test technologies to effectively measure performance and characterize risk, thereby increasing warfighter trust in autonomous systems. Current DoD test capabilities and methodologies are insufficient to address the testing of increasingly autonomous units and teams of unmanned systems operating in unstructured, dynamic, battlespace environments. Furthermore, advancements are being made in developing collaborating system-of-autonomous-systems, working in concert as a swarm or pack and in close proximity with humans. New test technologies are needed to stress the collective set of autonomous systems under realistic conditions, predict emergent behavior of autonomous systems, emulate the complex environment, and assess mission performance of these highly coupled and intelligent systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Unmanned and Autonomous System Test	3.159	5.711	6.716
FY 2012 Accomplishments: The UAST project focused on predicting and assessing the autonomy functions of unmanned and autonomous systems through the initiation of new technology developments. The complexity of operational unmanned and autonomous systems, with all possible interactions occurring between sensing, perception, reasoning, mapping, decision making and action, resulted in an almost infinite set of potential interactions and correspondingly, an almost infinite set of test conditions. An effort was initiated to employ evolutionary/genetic algorithms in a software-in-the-loop environment to accurately predict the fault conditions of a complex, long-duration autonomous system. Initially supporting testing of the Long Duration – Unmanned Underwater Vehicle, this test technology improved the ability to predict fault conditions and thereby enabled focused test strategies that dramatically improved the efficiency of testing.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 7: *Unmanned and Autonomous System Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
In the area of autonomous system performance assessment, a test technology was developed to enable automated stress testing of UAS software at the interfaces of the core components without requiring source code. The approach was agnostic to the specific component interface. This technology provided the tester with a perspective of system performance and a currently unavailable prediction of behavior. Recent stress-testing of a representative ground-based UAS system identified vulnerability issues at the command interface layer of the system. Additionally, in the area of autonomous system performance assessment, a virtual UAS test bed was designed that used environmental data from external sources (to include imagery from operational areas of interest) and injected that data into simulations of a given UAS to predict the behavior of the system in the operational environment. An initial demonstration of this test technology facilitated efficient testing in an operationally representative environment and allowed for safe operations at “edge of the envelope” performance parameters.			
FY 2013 Plans: Efforts will focus on test technology supporting the near term challenges identified in the 2011 – 2036 DoD Unmanned Systems Integrated Roadmap, such as, integrating DoD unmanned systems within the National Airspace and safely operating unmanned aerial systems within our national ranges. The UAST project will further explore test technologies to meet the challenges of testing autonomy by leveraging advances made in the standardization of UAS architectures, functional components, and interfaces. The test technology to adapt evolutionary algorithms to predict fault conditions will be expanded to address evaluation functions for multiple missions of a long duration UAS. The effort to stress test UAS software will explore technologies to integrate UAS models with software exception databases to allow for sharing of test data across multiple UAS platforms. The UAS virtual test bed effort will complete its architecture and terrain modeling, develop perceptual boosting algorithms based on vehicle sensors, and integrate all sensor and simulation modules into a complete virtual test bed. The complete prototype test bed will be verified through comparison of the outputs from the models inside the virtual proving ground with real data acquired during field tests. The UAST project will deliver a roadmap of potential test technology needs for testing autonomous systems at DoD ranges.			
FY 2014 Plans: The UAST project will deliver the technologies developed in the on-going efforts discussed above. Furthermore, the UAST project will continue to develop test technology that addresses mid-term UAS test challenges associated with autonomy and initiate efforts to explore the far term challenges of testing system intelligence. These efforts will include an examination of test technologies that measure the logical flow of sensing data, to perception, decisions, and action. Additionally, the UAST project will focus on enhancing the test environment to assess unmanned threat systems. The UAST project will develop instrumentation and analysis technologies to enable UAS testing that furnishes data to support the evaluation of overall mission performance in a Joint context. The UAST project will initiate efforts to enable dynamic construction, control, measurement of complex systems-of-autonomous-systems and tactically meaningful counter-unmanned systems analysis. Test requirements will expand to integrate multi-UAS test beds that support a simulation-based methodology to seamlessly integrate constructive simulation, UAS-in-the loop simulation, and live UAS tests. The UAST project will deliver complementary tools to predict UAS behavior by monitoring how			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 7: *Unmanned and Autonomous System Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
autonomous systems process data in response to environmental changes. Simulated systems will replicate multiple platforms for the evaluation of multi-platform behaviors and detailed system/event logging. Modeling and simulation techniques will be expanded to provide high fidelity representations of appropriate environmental complexity in order to stress the UAS and establish confidence in the safety and capabilities of future systems.			
Accomplishments/Planned Programs Subtotals	3.159	5.711	6.716

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 8: *Cyberspace Test*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
8: *Cyberspace Test*	-	0.246	3.288	5.897	-	5.897	10.212	12.916	14.146	14.389	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

The Department of Defense (DoD) ability to use cyberspace for rapid communication and information sharing in support of operations is a critical enabler of DoD military missions. Advancements in utilizing cyberspace are outpacing the technologies needed for test and evaluation (T&E). The Cyberspace Test Technology (CTT) project will develop advanced technologies and methodologies to test and evaluate DoD capabilities and information networks to defend and conduct full-spectrum military operations across cyberspace. Current cyberspace T&E capabilities are insufficient to support the continual experimental, contractor, developmental, operational, and live-fire testing requirements of warfighter systems operating in cyberspace. Many of the test tools and infrastructure items required for systems in cyberspace will need advancement and maturation of various nascent test technologies. The CTT project has been aligned with DoD guidance on science and technology (S&T) priorities, specifically in the area of Cyber S&T. The CTT project will address test technology shortfalls in cyberspace testing, including planning cyberspace tests, creating representative cyberspace threats, and executing cyberspace tests.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Cyberspace Test	0.246	3.288	5.897
FY 2012 Accomplishments: A CTT broad agency announcement (BAA) was issued to solicit CTT proposals from industry, academia, and government laboratories, seeking technology solutions in each of the three CTT domains for cyberspace testing: cyberspace test planning, cyberspace threats, and cyberspace test execution and analysis.			
FY 2013 Plans: The CTT project will focus on test technologies to address the need to provide automated CTT planning, set-up, and configuration. Additionally, the CTT efforts will prototype technologies to meet the need for real-time hardware-in-the-loop capabilities to simulate cyberspace threats. The CTT project will investigate using integrated cross-domain solutions and gateways to create realistic cyberspace tests at multiple levels of security classifications. The CTT project will also focus on threat cyberspace attack technologies required to assess information assurance vulnerabilities and to improve the agility of cyberspace test capabilities. A CTT roadmap, which synchronizes with overall Department cyberspace plans, will be developed.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Office of Secretary Of Defense		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603941D8Z: *Test and Evaluation/ Science and Technology*	PROJECT 8: *Cyberspace Test*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
The CTT project will continue to focus on technologies addressing the need to provide automated cyberspace T&E (design, planning, and configuration), particularly in support of defensive cyber operations testing. The CTT project will also develop test technologies to advance a distributed cyberspace test environment.			
Accomplishments/Planned Programs Subtotals	0.246	3.288	5.897

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Percentage of T&E/S&T projects progressing satisfactorily toward technical, financial, schedule, and risk mitigation goals.