RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2)						February 2006	
RDT&E, DEFENSE-WIDE (0400) BUDGET ACTIVITY THREE	TEST AND EVALUATION/SCIENCE AND TECHNOLOGY (T&E/S&T) PROGRAM ELEMENT (PE) 0603941D8Z						
$ in Millions	FY 2005*	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
PE 0603941D8Z	0.000	27.371	39.939	64.988	97.456	99.293	101.533
Hypersonic Test	0.000	4.613	9.676	16.540	26.602	25.024	23.539
Spectrum Efficient Technology	0.000	3.522	4.453	5.189	5.438	5.783	5.908
Multi-Spectral Test	0.000	4.212	5.518	8.549	12.209	12.256	12.518
Embedded Instrumentation	0.000	3.881	5.233	8.289	11.171	11.211	11.433
Directed Energy Test	0.000	5.131	9.068	14.998	23.608	24.124	23.492
Netcentric Systems Test	0.000	1.812	3.986	6.274	6.351	7.165	8.367
Advanced Unmanned Vehicle System Development	0.000	4.200	0.000	0.000	0.000	0.000	0.000
Software Test	0.000	0.000	2.005	5.149	6.018	6.722	8.035
Modeling and Simulation	0.000	0.000	0.000	0.000	3.363	3.780	4.452
Test Range/Facility Technology Improvements	0.000	0.000	0.000	0.000	2.668	3.228	3.789

*Language in the National Defense Authorization Act of 2003 directed the establishment of the Test Resource Management Center (TRMC). The Act also requires the TRMC to administer the Test and Evaluation/Science and Technology (T&E/S&T) program effective Fiscal Year 2006.

Beginning with FY 2006, program element 0603941D8Z (T&E/S&T) transferred from the Operational Test and Evaluation, Defense (OT&E, D) appropriation (0460) to the Defense-wide RDT&E (0400) appropriation. FY 2005 Accomplishments are noted in the OT&E appropriation.

A. **(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION**

The T&E/S&T program seeks out and develops test technologies to pace evolving weapons technology. This program is critical to ensuring that the Department of Defense (DoD) has the capability to adequately test the advanced systems that will be fielded in the future. To meet this objective, the T&E/S&T program:

- Exploits new technologies and processes to meet important T&E requirements.
- Expedites the transition of new technologies from the laboratory environment to the T&E community.
- Leverages commercial equipment and networking innovations to support T&E.

Additionally, the program examines emerging test requirements derived from transformation initiatives to identify needed technology areas and develop a long-range roadmap for technology insertion. This program leverages and employs applicable 6.2 applied research from the highly-developed technology base in the DoD laboratories and test centers, industry, and academia to accelerate the development of new test capabilities. This PE also provides funds to perform travel to carry out oversight of the T&E/S&T program.

This Research Category 6.3, Advanced Technology Development PE, develops and demonstrates high payoff technologies for current and future DoD test capabilities.

B. (U) PROGRAM CHANGE SUMMARY

	FY 2005	FY 2006	FY 2007
Previous President's Budget:	0.000	28.614	44.240
Current President's Budget:	0.000	27.371	39.939
Total Adjustments:		(1.243)	(4.301)
Congressional Program Adjustments:		(0.966)	
Congressional Rescissions:		(0.277)	
Congressional Increases:			
Other Program Adjustments:			(4.301)

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

E. (U) PERFORMANCE METRICS

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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			HYPERSONIC TEST				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Hypersonic Test	0.000	4.613	9.676	16.540	26.602	25.024	23.539

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

The National Aerospace Initiative (NAI) will develop air-breathing weapons, advanced aircraft, and access to space platforms to operate in the hypersonic speed regimes Mach 5 and higher. Hypersonic systems to be developed under the NAI require T&E capabilities in numerous areas ranging from ground testing (wind tunnels, sled tracks, installed-system test facilities, and modeling and simulation (including computational fluid dynamics)) through flight testing. At hypersonic speeds, flight testing will challenge existing ground instrumentation systems (e.g., tracking system slew rate limitations, telemetry dropouts due to ionization) and range safety decision making. Hypersonic weapon systems will depend on several new technological thrusts in areas such as propulsion and engines, structures and materials, guidance and control, seekers and sensors, warheads and payloads, and weapons delivery techniques and end-game dynamics - each requiring supporting T&E capabilities to determine performance, effectiveness, suitability, survivability, and responsiveness to Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems. Service improvement and modernization programs are addressing some basic test facility upgrades using off-the-shelf technologies. However, T&E of hypersonic systems will require technologies not yet developed or available for T&E purposes. The Department must have adequate T&E capabilities in place in time to meet current development, and ultimately, acquisition program schedules. The purpose of this T&E/S&T focus area is to address these T&E technology issues.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2005	FY 2006	FY 2007
Hypersonic Test	0.000	4.613	9.676

FY 2005 Accomplishments: **See OT&E, D (0460) appropriation.**

FY 2006 Plans:

Continue efforts initiated in prior fiscal years. Highlights of the efforts include:

- Complete In-Situ Pressure Measurements for Hypersonic Vehicles efforts to develop an advanced prototype pressure sensor. This embedded sensor will complete long duration testing in a flight representative hypersonic combustor. These sensors will allow for improved accuracy pressure measurements during long-duration flight and ground testing.
- Complete Pulsed Electron Beam Spectroscopy efforts to develop and demonstrate a non-intrusive sensor technology for temperature and gas concentration measurements in the flow field of hypersonic ground test facilities. This will provide the ability to determine temperature, gas species and concentration of combustion products in the flow field.
- Continue Test Media Effects development and demonstration of diagnostic tools to simultaneously measure chemical species, temperature and velocities in hypersonic flows. Efforts will continue in the development of improved Computational Fluid Dynamics (CFD) algorithms to model the effects of vitiates in hypersonic vehicle propulsion systems. These tools will enable the measurement and prediction of vitiate effects to support hypersonic engine test and evaluation.

Initiate efforts selected as a result of the FY 2006 Broad Agency Announcement (BAA). Efforts include:

- Advanced heater technologies to provide realistic clean-air ground test environments to adequately simulate flight conditions for hypersonic weapon systems and target interaction.
- Enhanced CFD models for performance characterization of Mach 7 + hypersonic combustion systems and weapon systems concepts.

Initiate a BAA to select efforts for FY 2007 award.

FY 2007 Plans:

Continue efforts initiated in prior years. These efforts include:

- Complete In-Flight Combustion Gas Analysis efforts to fabricate and ground test a non-intrusive laser spectroscopy diagnostic sensor that is suitable for in-flight test and evaluation of hypersonic propulsion systems. This diagnostic will provide an improved capability to evaluate the performance of hypersonic combustors in true flight conditions, and support the validation of CFD codes.
- Complete Microelectromechanical System (MEMS) Shear Stress Sensors efforts to develop and demonstrate a Silicon Carbide based MEMS sensor that is capable of measuring two-dimensional shear stress environment on the surface of hypersonic vehicles.
- Complete Hypersonic Clean Air Heater Test Technology efforts to fabricate and test of a sub-scale clean air heater

system. This will provide the basis for the development of a full-scale heater system for use in a hypersonic aeropropulsion testing.

- Complete High Heat Flux Sensor efforts to develop and demonstrate high heat flux sensors that can provide accurate heat flux measurements in the extreme temperature environment of hypersonic aeropropulsion test facilities. The High Heat Flux Sensor project extends the developments of the Heat Flux Sensor project to make these sensors survive at higher temperatures (1500 degrees Fahrenheit vs. 700 degrees Fahrenheit). These high heat flux sensors will allow sensor measurements in hypersonic propulsion systems and in vitiated test environments.
- Continue Test Media Effects efforts to model the effects of vitiates on hypersonic combustion engines to allow prediction of engine performance in clean air flight conditions.

Initiate future investigations to address T&E technology challenges in this focus area for:

- Survivable command destruct package to allow safe and reliable termination of hypersonic flight tests.
- Technology to transmit effects and dynamics of Mach 7 + engagements to support weapon system performance evaluation.
- High speed stores separation measurement technology for accurate store/vehicle separation data in hypersonic flight conditions.
- Advanced distributed simulation capabilities for Mach 7 + engagements to allow analysis of hypersonic system performance between test centers and system developers
- Continuous and survivable instrumentation and communications to provide system performance (including time-space position and attitude information) and allow test system command and control throughout the hypersonic test regime.

Initiate a BAA to select efforts for FY 2008 award.

C. **(U) <u>OTHER PROGRAM FUNDING SUMMARY</u>** NA

D. **(U) <u>ACQUISITION STRATEGY</u>** NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			SPECTRUM EFFICIENT TECHNOLOGY				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Spectrum Efficient Technology	0.000	3.522	4.453	5.189	5.438	5.783	5.908

A. **(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION**

Increased commercial use of the radio frequency (RF) spectrum and DoD's higher demands for bandwidth and test data are impacting the capability to test current weapon systems. Realistic testing of modern military systems, and follow-on training at the completion of a defense system's development phase, rely heavily on the use of the RF spectrum, especially in the "L" and "S" microwave bands. Signal propagation, supportable data rates, and other related characteristics make these bands ideally suited for test telemetry and training applications. However, these are the same characteristics that make these bands highly coveted by the wireless communications industry. The growth in the demand for consumer communication services has resulted in reallocation of RF spectrum from government to non-government use. The reallocation of this spectrum, coupled with the increase in activities that use it, has raised concerns regarding the availability of adequate spectrum to support test and training. Each new generation of military system typically generates ten times more data and information than the system it is replacing, resulting in a 20-year trend of exceptional growth in the demand for test and training related spectrum. The next generation of systems will generate proportionately greater data rates that will exceed the capability of our current test infrastructure. Technological advances in the spectrum efficiency focus area are required to ensure that programs will not have to compromise T&E by reducing the number or quality of tests.

B. **(U) ACCOMPLISHMENTS/PLANNED PROGRAM**

	FY 2005	FY 2006	FY 2007
Spectrum Efficient Technology	0.000	3.522	4.453

FY 2005 Accomplishments: **See OT&E, D (0460) appropriation.**

FY 2006 Plans:

Continue efforts initiated in prior fiscal years. Highlights for the projects include:

- Complete Super High Frequency (SHF) Channel Modeling and Implementation efforts to incorporate effects of sea interference in the SHF bands into the channel model. This channel model supports development of advanced robust modulation techniques required for telemetry in the SHF band.
- Complete Steerable Beam, Directional Antenna Concepts ground and flight demonstration of a prototype steerable beam system. This will provide a closed loop capability to steer telemetry signals to reduce data dropouts and minimize the effects of antenna to antenna interference.
- Complete X-band Tracking demonstration of X-band telemetry tracking of a rocket in flight. This effort will demonstrate the technology necessary to modify existing telemetry assets to support operation in the SHF band.

Initiate projects identified by the FY 2006 BAA process:

- Novel networked telemetry technologies that support remotely tunable datalink transceivers to provide increased data security, improve range safety, and allow for inter-range operation coordination and other future range applications.
- Optical communications brassboard to demonstrate optical telemetry to augment the existing and planned RF telemetry spectrum for systems-of-systems testing.
- Development of adaptive antenna arrays for unobtrusive and non-interfering operations for system under test, and variable beamwidth directional antennas for frequency sharing during system-of-systems tests.
- Algorithms that support ultra-high data rate pre-processing, compression, storage, and bandwidth- efficient modulation schemes for transmission of T&E data in dynamic test environments.

Initiate a BAA to select efforts for FY 2007 award.

FY 2007 Plans:

Continue efforts initiated in prior fiscal years. The efforts include:

- Complete Spectrally Efficient High Data Rate Telemetry System for SHF fabrication and flight demonstration of a real-time data encoder integrated into an Advanced Orthogonal Frequency Division Multiplexing (AOFDM) transmitter and receiver.
- Complete RF Microelectromechanical System (MEMS) Antenna fabrication and flight testing of a MEMS software-defined antenna system that will allow dynamic reconfiguration of the antenna transmit frequency and polarity to support adaptive use of the telemetry spectrum during test events.
- Complete Phased Array Antenna demonstrations of an autonomous neural network and antenna algorithms that will

provide improved tracking accuracy for ground-based receive antennas. This will allow improved tracking accuracy during dynamic testing and reduce signal fading during high dynamic maneuvers.

- Complete Beamformer Antenna ground demonstration of a wrap around phased array antenna system that can support over-the-horizon test capabilities. This system will support the evaluation of space-based telemetry applications.

Initiate additional investigations as a result of the BAA process to address critical T&E technology issues such as:

- Techniques for overcoming transmission losses during ionization periods of hypersonic systems testing.
- Methods to increase efficiency and reliability of future telemetry, command and control, and datalink communications for T&E.
- Methods to improve transmission efficiency by compensating for Doppler shift in coherent telemetry receivers.

Initiate a BAA in FY 2007 to select efforts for FY 2008 award.

C. (U) **OTHER PROGRAM FUNDING SUMMARY** NA

D. (U) **ACQUISITION STRATEGY** NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			MULTI-SPECTRAL TEST				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Multi-Spectral Test	0.000	4.212	5.518	8.549	12.209	12.256	12.518

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

DoD S&T programs are developing new technologies for use in multi-spectral and hyperspectral sensors, seekers, and detectors for weapon systems and intelligence, surveillance, and reconnaissance systems. T&E of new multi-spectral and hyperspectral sensors to be used in these future weapon systems will require new T&E technologies. Current methods for testing multi-spectral and hyperspectral sensors rely heavily on expensive field test programs. While these field tests provide realistic data for sensor testing, they leave several critical gaps. For example, test conditions are not repeatable because environments observed one day will be different the next day. Imagery can be collected and stored to partially mitigate this deficiency, but this process is expensive and cannot cover the full spectrum of environments required for complete test article evaluation and performance analysis. The T&E community needs the ability to test these advanced seekers and sensors in a repeatable, objective fashion before and after integrating them into warfighting systems. This T&E/S&T focus area is addressing these needs through research efforts in scene generation, injection and projection to create test technologies that can be combined into integrated multi-spectral and hyperspectral test capabilities. Without these new T&E technologies, DoD will not be able to adequately test and evaluate the multi-spectral and hyperspectral weapon systems of the future.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2005	FY 2006	FY 2007
Multi-Spectral Test	0.000	4.212	5.518

FY 2005 Accomplishments: **See OT&E, D (0460) appropriation.**

FY 2006 Plans:

Continue efforts initiated in prior fiscal years. Highlights for the projects include:

- Complete UV LEDs for T&E characterization of the LEDs and conducted tests to determine the feasibility of using these LEDs to evaluate the performance of MWSs. This technology will support the development of advanced stimulators for MWS T&E.
- Complete Hyperspectral Testbed Design efforts to design the testbed and fabricate the subsystem of the prototype LWIR hyperspectral testbed.
- Complete Multi-Spectral Stimulator Injection Test Method fabrication of the prototype hardware system and initiated preliminary closed loop testing. The prototype system incorporates real-time Radio Frequency (RF) output with clutter, correlated with the Infrared (IR) output to support hardware-in-the-loop testing of multi-spectral weapon systems in the Mid-Wave IR (MWIR), LWIR and millimeter wave (MMW) frequencies.
- Complete Hyperspectral Sensor Evaluation – Minimum Resolvable Temperature (MRT) efforts to identify a test methodology for evaluation of undersampled imagers. The test methodology measures optical parameters from the sensor and uses these measurements in an MRT simulation to determine predicted field performance

Initiate projects identified by the FY 2006 Broad Agency Announcement (BAA) process:

- Stand-alone UV through LWIR Scene Projector technologies well advanced beyond current emissive array projectors. These technologies were being developed for use in DOD T&E facilities and by DOD sensor and system developers.
- Innovative multi-spectral & hyperspectral data mining techniques to support evaluation of multi-spectral and hyperspectral imaging systems.
- Modeling & Simulation to generate multi-spectral sensor scenes to stimulate multi-spectral and hyper-spectral UV to LWIR, as well as MMW, acoustical, seismic & magnetic sensor systems.
- Spectrally structured MWIR-LWIR emitter arrays to produce very high radiometric apparent temperature

Initiate a BAA to select efforts for FY 2007 award.

FY 2007 Plans:

Continue efforts initiated in prior fiscal years. The efforts include:

- Complete Dynamic Hyperspectral Thermal Signature Model final development of the signature model. The final release open-source software package will be capable of generating multi-spectral and hyperspectral imagery for use in testing of advanced weapon systems, such as Future Combat Systems.

- Complete Hyperspectral Testbed Design integration and demonstration of the prototype hyperspectral image projection system. This testbed will allow repeatable closed loop testing of advanced hyperspectral imagers under controlled, user defined test conditions that can not be efficiently achieved in field testing.
- Complete Multi-Spectral Stimulator Injection Test Method closed-loop demonstration of the prototype hardware system. This demonstration will include stimulation of a RF/IR sensor fusion algorithm. This system will provide realistic direct injection testing of multi-spectral sensor systems.

Initiate projects identified by the FY 2007 BAA process. Efforts are planned in the following areas:

- Technologies to support the generation and projection of polarized visible and near-IR imagery for T&E of advanced weapon systems.
- T&E field tools for data collection related to radiance, spectral precision, dynamic range, frame rate, ground system signatures, and missile signatures.

Initiate a BAA to select efforts for FY 2008 award.

C. **(U) OTHER PROGRAM FUNDING SUMMARY** NA

D. **(U) ACQUISITION STRATEGY** NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			EMBEDDED INSTRUMENTATION				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Embedded Instrumentation	0.000	3.881	5.233	8.289	11.171	11.211	11.433

A. **(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION**

Instrumentation requirements for systems-under-test, hardware-in-the-loop testing, and training are increasing exponentially for new weapon systems. Onboard or personnel-borne instrumentation and equipment are required for sensing and collecting critical performance data; determining accurate time, space, position, and attitude information; interfacing with command and control data links; monitoring and reporting system-wide communications; reporting human operator performance; and storing and transmitting data. These requirements drive the need for enabling technologies for miniaturized, non-intrusive instrumentation suites with increased survivability in harsh environments.

There is minimal space available for adding instrumentation to new weapon systems subsequent to their development. Additional weight and power draw can adversely affect the weapon system's signature and performance. Instrumentation for humans-in-the-loop, such as a dismounted soldier, should not detrimentally affect the soldier's performance or operational burden. New technologies can be exploited to integrate small non-intrusive embedded instrumentation (EI) into new platforms during design and development, and, in some cases, into existing platforms. This EI can provide the required data for T&E, training, and logistics throughout the system's lifecycle, and provide the ability to collect critical system performance data during combat missions.

The use of embedded instrumentation for T&E, training, and logistics has the potential for significantly reducing the total ownership costs of new weapon systems while enhancing force readiness. Accordingly, the Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01D states that acquisition programs should include embedded instrumentation as part of system trade-off studies and design analyses. The EI focus area will advance T&E technologies needed to facilitate compliance with CJCSI 3170.01D.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2005	FY 2006	FY 2007
Embedded Instrumentation	0.000	3.881	5.233

FY 2005 Accomplishments: **See OT&E, D (0460) appropriation.**

FY 2006 Plans:

Continue efforts initiated in prior fiscal years. Highlights for the projects include:

- Complete Compact Holographic Data Storage fabrication and test of a brassboard high density storage device. The storage device will be suitable for embedding in Systems Under Test (SUTs) for storage of test data. The holographic storage device has no moving parts and is capable of storing a minimum of 750 gigabytes (0.75 terabytes) of data.
- Complete Advanced Munitions Flight Test Instrumentation development, fabrication and flight test of a MEMS-based instrumentation module on a munition. This embedded instrumentation package will provide time, space, and position information (TSPI) to improve munition evaluation without adversely impacting the munition design or function.
- Complete Gas Turbine Engine Probe design and fabrication of a gas extraction probe capable of being embedded within a combustor and housing the CO Emissions Sensor for Gas Turbine Engines.
- Complete Software Architecture for EI design and demonstration of an extensible, platform-independent reusable software architecture. This architecture will support integration of embedded instrumentation onto multiple weapon systems.

Initiate projects identified by the FY 2006 Broad Agency Announcement (BAA):

- Synthetic instrumentation that combines sensor technology with integrated processing techniques to create multi-functional instruments.
- Techniques to achieve miniaturized, reduced-weight instrumentation packaging.
- Methods to improve instrument survivability in harsh environments, such as at hypersonic speeds.
- Low power instrumentation to reduce on-board power demands.
- Smaller, higher capacity recorders to support passive operation of embedded instrumentation.
- Passive devices for improving ground truth measurements, such as for attitude and miss-distance measurements.

Initiate a BAA to select efforts for FY 2007 award.

FY 2007 Plans:

Continue efforts initiated in prior fiscal years.

- Complete Digital Communications Test Data Bus development and demonstration of a prototype miniaturized, self-calibrating embedded instrumentation system that consists of smart sensors, a subsystem controller and a processor. This instrumentation system will be capable of operating on missile system power in the operational environment and will be able to support continuous life cycle T&E.
- Complete High Speed and Temperature Diagnostics development of a series of probes that can withstand continuous exposure to hypersonic test environments. The effort is developing an optical species probe, total pressure probe, total temperature probe and a Mach/flow angularity probe. These probes will support both ground and flight testing of hypersonic vehicles.
- Complete MEMS Fiber Optic Sensors design, fabrication, and demonstration of optical pressure, temperature, and shear stress sensors integrated into a single sensor head. These sensors will be embedded into a test article to demonstrate practical application in an operationally relevant environment.
- Continue Open Embedded Modular Architecture efforts to design and develop of an open, modular, and scalable embedded system architecture. This architecture will be demonstrated on the Multi-Megawatt Electric Power System being developed for directed energy weapons applications.

Initiate future investigations to address T&E technology challenges in this focus area for:

- Advanced wireless data and communications techniques, including the use of vehicle power lines as a data bus for data transfer and distribution
- Human performance instrumentation to support T&E in Joint Urban Operations environments.
- Non-intrusive network interfaces with critical operational components including the MIL-STD-1553 data bus to support gathering operational data without affecting operational performance.
- Instrumentation command and control techniques to provide remote operation of instrumentation during T&E events.
- High anti-jam signal processing techniques for T&E operations in an electronic warfare and jamming environment.

Initiate a BAA to select efforts for FY 2008 award.

C. (U) **OTHER PROGRAM FUNDING SUMMARY** NA

D. (U) **ACQUISITION STRATEGY** NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			DIRECTED ENERGY TEST				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Directed Energy Test	0.000	5.131	9.068	14.998	23.608	24.124	23.492

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

Directed Energy (DE) technologies are rapidly transitioning into acquisition programs and Advanced Concept Technology Demonstrations (ACTDs). These weapons technologies, which primarily consist of High Energy Laser (HEL) and High Power Microwaves (HPM), are outpacing their supporting test technologies. Advancements in HEL and HPM have created a new class of weapon systems in which energy is placed on a target instantaneously, making traditional test techniques for evaluating conventional munitions (with flight times ranging from seconds to minutes) not applicable to DE systems' T&E. As a result, new technology solutions are needed to ensure adequate developmental, live fire, and operational test capabilities are available when the DE acquisition programs are ready to test.

DE system and component testing requires two principal assessments: how well the weapon is performing and the specific interaction of energy and target. The current ability to assess DE systems performance and interactions is based on effects testing, i.e. determining if and when the target was destroyed. This does not provide the detailed test data required to understand DE system performance. Military utility of these weapons will be dependent on the knowledge acquired through T&E to know how much to trust the technologies under development and how best to use them. This T&E/S&T focus area is developing the needed technologies to quantitatively assess both HEL and HPM performance and target interaction to support thorough testing of DE systems.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2005	FY 2006	FY 2007
Directed Energy Test	0.000	5.131	9.068

FY 2005 Accomplishments: See OT&E, D (0460) appropriation.

FY 2006 Plans:

Continue efforts initiated in prior fiscal years. Highlights for the projects include:

- Complete Directed Energy Data Acquisition Transformation (DEDAT) development, fabrication, and test of a three axis field probe and simultaneous trigger capability. The three axis field probe and simultaneous trigger will be used with the previously developed Compact Remote Data Acquisition (CRDAQ) system for conducting T&E of HPM systems.
- Complete Modulated Retro Target Sensors (MRTS) development and demonatration of a breadboard retroreflector sensor system that is capable of providing on-target measurements of HEL performance during T&E events of dynamic targets. This system uses retroreflectors to transmit the sensor data from the target to an off-board data acquisition system.
- Complete Quantum Well Infrared Photodetector (QWIP) integration of the Hybrid QWIP and Near Infrared (NIR) Indium-Gallium-Arsenide (InGaAs) focal plane array (FPA) with the Computed Tomographic Imaging Spectrometer (CTIS). The prototype QWIP/NIR/CTIS camera system was demonstrated in both lab and field environments. The QWIP/NIR/CTIS camera will allow remote analysis of HEL interaction with targets to characterize laser performance.
- Complete Range Profiles of Turbulence integration and demonstration of a brassboard DIM LIDAR system. The DIM LIDAR data was compared with truth data to verify system performance.
- Complete Microwave Test Diagnostics fabrication and test of a prototype compact self-contained HPM field diagnostic system. This survivable diagnostic sensor will support T&E of HPM systems using mobile targets.

Initiate projects identified by the FY 2006 Broad Agency Announcement (BAA) process:

- Survivable target board technologies to measure and evaluate the total instantaneous output power of continuous wave HEL systems to support static beam/target interaction testing.
- Off-board HEL sensor concepts for airborne and ground targets to measure surface temperatures and thermal effects without interfering with system operation or perturbing test environment.
- Survivable HPM field probes that do not perturb the RF environment and provide a reliable measurement of field strength in an HPM engagement.
- Modeling and Simulation techniques to accurately predict and understand the total beam distribution for HEL weapon systems to address critical safety issues such as ensuring that T&E events do not affect civilian or military infrastructure.

Initiate a BAA to select efforts for FY 2007 award.

FY 2007 Plans:

Continue projects initiated in prior years. Highlights of the projects include:

- Complete Electro-optical Sensor Technology efforts to fabricate and test a HPM field probe based on a novel electro-optical material that changes its optical characteristics when subjected to an HPM environment. This field probe will allow non-intrusive measurement of HPM environments with minimal impact on the fields measured.
- Complete Dielectric Electromagnetic Field Probes efforts to develop and demonstrate dielectric-based field probes that can measure electric and magnetic fields during HPM T&E events. These dielectric field probes will cause little or no perturbation of the electromagnetic environment during the event.
- Complete HEL Off-Target Temperature Sensor efforts to fabricate and demonstrate of an off target imaging system that can measure the surface temperature of HEL beams. The sensor will provide a method to remotely characterize the HEL beam/target interaction during T&E events.
- Complete T&E Adaptive Optics System efforts to integrate and test an adaptive optics system to remotely measure HEL temperature with high spatial and temporal accuracy. The adaptive optics system will be integrated into the Advanced Pointer Tracker at HELSTF.

Initiate future investigations to address T&E technology challenges in this focus area for:

- Wide-spectrum, single substrate imagers to enhance imaging and detection of HEL beams from a variety of systems/sources.
- DE (HEL or HPM) hardened flight termination system/range destruct package to safely and reliably provide for termination of the target, even when high concentrations of DE are present on the target.
- Methods to measure optical transmissivity with a 100 times increase in sampling rates over current measurement techniques at different wavelengths along laser beam paths to support HEL T&E.
- Use of physics-based models incorporated into virtual geographical representations of T&E ranges to provide 3-dimensional, geodetically accurate models of beam propagation, beam spread, lethal range, fluence on target, and atmospheric effects.

Initiate a BAA to select efforts for FY 2008 award.

C. **(U) OTHER PROGRAM FUNDING SUMMARY** NA

D. **(U) ACQUISITION STRATEGY** NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			NETCENTRIC SYSTEMS TEST				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Netcentric Systems Test	0.000	1.812	3.986	6.274	6.351	7.165	8.367

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

The S&T community is developing advanced Netcentric Systems to support DoD's Critical Transformational Capabilities—Conduct Information Operations, Deny Enemy Sanctuary, and Leverage Information Technologies. Advancements in Netcentric Systems will provide commanders and staff with an adaptive, network-centric, configurable operational information visualization environment, which will improve the speed and quality of command decisions. Information assurance and survivability are central to achieving these advancements. These advances will enable a spectrum of operational capabilities ranging from enhanced management and exploitation of intelligence, surveillance, and reconnaissance assets to next-generation tactical radio systems. Successful implementation of these transformational capabilities will necessitate a corresponding transformation in DoD's ability to test and evaluate Netcentric Systems. The Netcentric Systems Test (NST) focus area will address the T&E scenarios, technologies, and analysis tools required to ensure that operational networked systems delivered to the warfighter provide an assured capability to acquire, verify, protect, and assimilate information necessary for battlefield dominance within a complex netcentric environment.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2005	FY 2006	FY 2007
Netcentric Systems Test	0.000	1.812	3.986

FY 2005 Accomplishments: **See OT&E, D (0460) appropriation.**

FY 2006 Plans:

Continue projects initiated in FY 2005. Highlights for the projects include:

- Complete The Tactical-Report Generation Test Bed for C4ISR Systems efforts to develop and demonstrate the Tactical-Report Generation Test-bed (TGT). The TGT generates realistic sensor data and formatted message data streams from user-supplied scenarios to support Joint system tests, evaluations, experiments and programs of C4ISR systems.
- Complete Network Simulation and Analysis Tools (NSAT) for C4ISR development, integration and test of a suite of interoperable software tools, components, and enhancements to the Repeatable Performance Evaluation & Analysis Tool (REPEAT). These tools allow REPEAT to provide a framework to test next generation C4ISR systems based on a service oriented architecture in a Network Centric environment.

Initiate projects identified by the FY 2006 Broad Agency Announcement (BAA) process:

- Development of T&E metrics to determine the effectiveness of Information Operations.
- Tools that employ artificial intelligence to support the instrumentation and visualization of netcentric T&E environments.
- Development of non-intrusive instrumentation and T&E communication networks (including networks-of-networks) that do not affect the performance of networked systems under evaluation, especially for humans-in-the-loop network-centric environments.
- Methods to support T&E of decision aids used in network-centric operations.
- Ability to assess information assurance within complex systems-of-systems.
- Methods to evaluate the performance of network-centric operations in a multi-node dynamic environment.

Initiate a BAA to select efforts for FY 2007 award.

FY 2007 Plans:

Continue projects initiated in prior years. The projects include:

- Complete A Test Agent for Testing Command and Control, Decision Support and Intelligent Agents efforts to develop an intelligent agent based test systems that allows the T&E of network systems that use single or multiple embedded intelligent agents. This test tool will provide the ability to automatically evaluate command and control systems used in a Network Centric environment.

Initiate future investigations to address T&E technology challenges in the focus area for:

- Techniques for capturing spatial and temporal registration across large numbers of sensors, multimedia communications, and human-system interface devices.
- Techniques for capturing and evaluating multiple simultaneous collaborative user data links.
- Techniques for capturing and evaluating human physical and cognitive performance.
- Capability to evaluate advances from a "human-out" perspective; i.e., determine what information actually enhances a warfighter's performance.
- Technologies to non-intrusively assess low probability of detection/low probability of intercept communications and data links.
- Methods to assess the contribution of netcentricity to decision superiority in operational scenarios.
- Additional netcentric systems T&E technology issues will be identified, incorporated into the NST roadmap, and addressed in future research plans.

Initiate a BAA to select efforts for FY 2008 award.

C. (U) **OTHER PROGRAM FUNDING SUMMARY** NA

D. (U) **ACQUISITION STRATEGY** NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			ADVANCED UNMANNED VEHICLE SYSTEM DEVELOPMENT				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Advanced Unmanned Vehicle System Development	0.000	4.200	0.000	0.000	0.000	0.000	0.000

A. (U) **MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION**

The DoD is developing a new class of complex autonomous unmanned systems to handle specialized, hazardous operations when appropriate. Early systems, such as soldier-in-the-loop unmanned aerial vehicles, already serve in critical roles in the operational environment. This new class of autonomous vehicle will require innovative methods to test and evaluate the system's performance and its ability to adapt to changes in the operational environment.

This Congressional add project is focused on the development, test, and evaluation of an integrated unmanned protection system in support of transport security missions. This research and development effort will provide the T&E/S&T program with insights into the T&E challenges associated with testing of autonomous systems and will act as a roadmap to guide T&E technology developments in this area.

B. (U) **ACCOMPLISHMENTS/PLANNED PROGRAM**

	FY 2005	FY 2006	FY 2007
Advanced Unmanned Vehicle System Development	0.000	4.200	0.000

FY 2005 Accomplishments: NA

FY 2006 Plans:

Continue projects initiated in FY 2005. Highlights for the projects include:

- Complete The Tactical-Report Generation Test Bed for C4ISR Systems efforts to develop and demonstrate the Tactical-Report Generation Test-bed (TGT). The TGT generates realistic sensor data and formatted message data streams from user-supplied scenarios to support Joint system tests, evaluations, experiments and programs of C4ISR systems.
- Complete Network Simulation and Analysis Tools (NSAT) for C4ISR development, integration and test of a suite of interoperable software tools, components, and enhancements to the Repeatable Performance Evaluation & Analysis Tool (REPEAT). These tools allow REPEAT to provide a framework to test next generation C4ISR systems based on a service oriented architecture in a Network Centric environment.

Initiate projects identified by the FY 2006 Broad Agency Announcement (BAA) process:

- Development of T&E metrics to determine the effectiveness of Information Operations.
- Tools that employ artificial intelligence to support the instrumentation and visualization of netcentric T&E environments.
- Development of non-intrusive instrumentation and T&E communication networks (including networks-of-networks) that do not affect the performance of networked systems under evaluation, especially for humans-in-the-loop network-centric environments.
- Methods to support T&E of decision aids used in network-centric operations.
- Ability to assess information assurance within complex systems-of-systems.
- Methods to evaluate the performance of network-centric operations in a multi-node dynamic environment.

Initiate a BAA to select efforts for FY 2007 award.

FY 2007 Plans:

Continue projects initiated in prior years. The projects include:

- Complete A Test Agent for Testing Command and Control, Decision Support and Intelligent Agents efforts to develop an intelligent agent based test systems that allows the T&E of network systems that use single or multiple embedded intelligent agents. This test tool will provide the ability to automatically evaluate command and control systems used in a Network Centric environment.

Initiate future investigations to address T&E technology challenges in the focus area for:

- Techniques for capturing spatial and temporal registration across large numbers of sensors, multimedia communications, and human-system interface devices.
- Techniques for capturing and evaluating multiple simultaneous collaborative user data links.
- Techniques for capturing and evaluating human physical and cognitive performance.
- Capability to evaluate advances from a "human-out" perspective; i.e., determine what information actually enhances a warfighter's performance.
- Technologies to non-intrusively assess low probability of detection/low probability of intercept communications and data links.
- Methods to assess the contribution of netcentricity to decision superiority in operational scenarios.
- Additional netcentric systems T&E technology issues will be identified, incorporated into the NST roadmap, and addressed in future research plans.

Initiate a BAA to select efforts for FY 2008 award.

C. **(U) OTHER PROGRAM FUNDING SUMMARY** NA

D. **(U) ACQUISITION STRATEGY** NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)						February 2006	
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			ADVANCED UNMANNED VEHICLE SYSTEM DEVELOPMENT				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Advanced Unmanned Vehicle System Development	0.000	4.200	0.000	0.000	0.000	0.000	0.000

A. (U) **MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION**

The DoD is developing a new class of complex autonomous unmanned systems to handle specialized, hazardous operations when appropriate. Early systems, such as soldier-in-the-loop unmanned aerial vehicles, already serve in critical roles in the operational environment. This new class of autonomous vehicle will require innovative methods to test and evaluate the system's performance and its ability to adapt to changes in the operational environment.

This Congressional add project is focused on the development, test, and evaluation of an integrated unmanned protection system in support of transport security missions. This research and development effort will provide the T&E/S&T program with insights into the T&E challenges associated with testing of autonomous systems and will act as a roadmap to guide T&E technology developments in this area.

B. (U) **ACCOMPLISHMENTS/PLANNED PROGRAM**

	FY 2005	FY 2006	FY 2007
Advanced Unmanned Vehicle System Development	0.000	4.200	0.000

FY 2005 Accomplishments: NA

FY 2006 Plans:

Initiate effort to investigate development of technologies associated with advanced unmanned vehicle systems in response to congressional add. This effort will conduct research to identify technology challenges associated with the development and test and evaluation of unmanned and autonomous systems. Included in this effort are tasks to evaluate and develop perception, behaviors, and interface methods to support use of intelligent unmanned systems in an operational environment. This involves:

- Conducting evaluations on relevant unmanned platforms instead of research systems.
- Performing field experiments to evaluate collaborative unmanned system behaviors and system responses.
- Extending primitive robot behaviors to complex, tactical behaviors for force protection, countermine operations, and remote characterization applications.

This effort also will provide data that will be incorporated into a roadmap to support the T&E/S&T program's evaluation of the technology shortfalls in unmanned vehicle testing that require S&T development.

FY 2007 Plans: NA

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2a)							February 2006
DEFENSE WIDE RDT&E (0400) BUDGET ACTIVITY THREE, PE 0603941D8Z			SOFTWARE TEST				
$ in Millions	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Software Test	0.000	0.000	2.005	5.149	6.018	6.722	8.035

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

Use of complex, high-speed, software-intensive systems is increasing within weapons; Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems; and other automated information processing systems. Most software-intensive systems are developed, tested, and fielded in significantly shorter periods than hardware systems. Software components are generally upgraded more frequently than hardware in systems. Testing systems with software components requires rigorous software configuration control to ensure that reported test results apply to the actual fielded software.

Most current software tests are manpower intensive and require expert knowledge of the system under test. An automated, objective test capability is required to assess the effectiveness and performance of future software systems as well as to determine the appropriate amount of regression testing required when that software is modified. As the use of "learning" software proliferates, testing will be required to identify unacceptable behavior, detect defects in behaviors that have yet to be learned, and to predict the future performance of the learning software. Significant integration and interoperability issues among software systems and large databases must be overcome to enable testing of software-intensive systems. Artificial stimulation will be needed for both load and security testing. Methods to verify software integrity must also be identified. The Software Test focus area will develop the T&E technologies necessary to adequately test software intensive systems as the complexity of these systems increases in the future.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2005	FY 2006	FY 2007
Software Test	0.000	0.000	2.005

FY 2005 Accomplishments: NA

FY 2006 Plans: NA

FY 2007 Plans:

Initiate efforts in the Software Test focus area, including:

- Exploring the capabilities of software centers of excellence to support advanced development efforts.
- Identifying an Executing Agent.
- Forming a working group of qualified T&E and S&T subject matter experts.

Initiate a Broad Agency Announcement to identify initial research projects in this area. The initial emphasis of this focus area will be developing and demonstrating technologies to objectively test software-intensive systems. Potential areas of investigation include:

- Development of metrics to objectively quantify the performance of software-intensive systems and adaptive software systems.
- Automated techniques to assess software system effectiveness and suitability.
- Development of metrics to quantify standards for regression testing of modified software.
- Methods to perform automated regression testing after accepted software has been modified.

Initiate a BAA to identify additional efforts for FY 2008 award.

C. (U) **OTHER PROGRAM FUNDING SUMMARY** NA

D. (U) **ACQUISITION STRATEGY** NA