Exhibit R-2, RDT&E Budget Item Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense-Wide, BA 03			R-1 Item Nomenclature: Test and Evaluation/Science and Technology (T&E/S&T), PE 0603941D8Z				
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total PE Cost	38.759	62.344	94.672	96.358	97.883	99.428	100.964
High Speed/Hypersonic Test	9.063	16.647	17.714	18.853	19.060	19.038	19.183
Spectrum Efficient Technology	3.303	0.446	6.124	6.108	11.054	10.810	10.458
Multi-Spectral Test	5.496	9.256	11.294	12.659	12.648	12.549	12.600
Non-Intrusive Instrumentation	4.856	6.941	6.538	4.831	6.607	8.522	9.685
Directed Energy Test	8.944	15.585	17.713	18.852	19.061	19.037	19.183
Netcentric Systems Test	5.093	9.304	12.884	16.035	17.893	17.852	17.940
Unmanned and Autonomous System Test	2.004	4.165	5.056	5.801	6.118	6.087	6.130
Common Range Integrated Instrumentation System	0.000	0.000	15.000	10.250	0.000	0.000	0.000
Multi-Level Security	0.000	0.000	2.349	2.969	5.442	5.533	5.785

Exhibit R-2, RDT&E Budget Item Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03	R-1 Item Nomenclature Test and Evaluation/Science and Technology (T&E/S&T), PE 0603941D8Z

A. (U) 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 pace evolving weapons technology. The 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 Test and Evaluation (T&E) requirements.
- Expedites the transition of new technologies from the laboratory environment to the T&E community.
- Leverages commercial equipment, modeling and simulation, and networking innovations to support T&E.

Additionally, the T&E/S&T program examines emerging T&E requirements derived from joint service initiatives to identify needed technology areas and develop a long-range roadmap for technology insertion. The program leverages and employs applicable 6.2 applied researches from the highly developed technology base in the DoD laboratories and test centers, other government agencies, industry, and academia to accelerate the development of new test capabilities. This PE also provides travel funds for T&E/S&T program oversight, special studies, analyses, and strategic planning related to test capabilities and infrastructure.

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	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03	R-1 Item Nomenclature Test and Evaluation/Science and Technology (T&E/S&T), PE 0603941D8Z

B. (U) PROGRAM CHANGE SUMMARY

	FY 2007	FY 2008	FY 2009
Previous President's Budget:	39.710	62.889	94.855
Current President's Budget:	38.759	62.344	94.672
Total Adjustments:			
Congressional Program Reductions:		(0.545)	
Congressional Rescissions:			
Congressional Increases:			
Other Program Adjustments:	(0.951)		(0.183)

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.

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z			High Speed/Hypersonic Test				
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
High Speed/Hypersonic Test	9.063	16.647	17.714	18.853	19.060	19.038	19.183

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

DoD is developing air-breathing weapons, advanced aircraft and access to space platforms to operate in the high speed (Mach 3-5) and hypersonic speed (Mach 5 and above) regimes. High speed/hypersonic systems to be developed by DoD will require T&E capabilities in numerous areas ranging from ground testing [e.g. wind tunnels, sled tracks, installed-system test facilities, and modeling and simulation (including computational fluid dynamics)] to flight testing. At high and hypersonic speeds, flight testing will challenge existing ground instrumentation systems (e.g., tracking system slew rate limitations, telemetry dropouts due to ionization, etc.) and range safety decision making. High speed/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 of which requires supporting T&E capabilities to determine performance, effectiveness, suitability, survivability, and responsiveness to Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance systems. Service improvement and modernization programs are addressing some basic test facility upgrades using off-the-shelf technologies; however, T&E of high speed/hypersonic systems will require technologies as yet undeveloped or unavailable for T&E purposes. DoD must have adequate T&E capabilities in place in time to meet current development and, ultimately, acquisition program schedules. The purpose of the T&E/S&T High Speed/Hypersonic Test focus area is to address these T&E technology issues.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2007	FY 2008	FY 2009
High Speed/Hypersonic Test	9.063	16.647	17.714

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	High Speed/Hypersonic Test	

FY 2007 Accomplishments:

Continued the efforts initiated in prior years.

- Completed 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. The technology will provide the ability to determine temperature, gas species, and concentration of combustion products in the flow field.
- Completed High Heat Flux Sensor efforts to develop and demonstrate sensors that can provide accurate heat flux measurements in the extreme temperature environment of hypersonic aeropropulsion test facilities. The High Heat Flux Sensor project extended the developments of the Heat Flux Sensor project to enable the sensors to survive at higher temperatures (1500 degrees Fahrenheit vs. 700 degrees Fahrenheit). The high heat flux sensors will allow sensor measurements both in hypersonic propulsion systems and in vitiated test environments.
- Completed Microelectromechanical System Shear Stress Sensor efforts to develop and demonstrate a Silicon Carbide-based Microelectromechanical System sensor capable of measuring two-dimensional shear stress of hypersonic vehicle surfaces.
- Completed Plug Nozzle Study efforts to assess the feasibility of using an axisymmetric plug nozzle to create variable Mach number test conditions in the Arnold Engineering Development Center (AEDC) Aeropropulsion Test Unit facility to determine uniformity of flow conditions downstream of the plug center body in the nozzle to support variable Mach number high speed/hypersonic testing.
- Completed In-Situ Pressure Measurement efforts to develop a proven pressure-sensing approach for evaluating hypersonic engine performance.
- Continued In-Flight Combustion Gas Analysis efforts to fabricate and ground-test a non-intrusive laser spectroscopy diagnostic sensor suitable for in-flight T&E of hypersonic propulsion systems. The sensor will provide improved capability to evaluate the performance of hypersonic combustors in true flight conditions and will support the validation of computational modeling codes.
- Continued Hypersonic Clean Air Heater Test Technology efforts to fabricate and test a sub-scale clean air heater system. The technology will provide the basis for development of a full-scale heater system for use in hypersonic aeropropulsion testing.
- Continued the Test Media Effects efforts modeling effects of vitiates on hypersonic combustion engines to allow prediction of engine performance in clean air flight conditions.

- Continued Regenerative Storage Heater efforts to conduct comprehensive material testing for selecting core brick

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	High Speed/Hypersonic Test	

structural material for storage heater.

- Continued with Hypersonic Engine-Facility Interaction efforts to test a scramjet engine in test facilities and to conduct scramjet engine computational modeling in air, hydrogen, and hydrocarbon vitiation conditions.
- Continued Modeling and Simulation (M&S) for Hypersonic T&E efforts to improve and demonstrate accuracy of US Wind Code for scramjet and ramjet engine test. Efforts continued to improve combustion modeling to include capabilities such as liquid phase chemical kinetics for hydrocarbon-air combustion model, and multiphase spray models for liquid injection model and turbulent heat and mass transfer model.
- Continued High Pressure Arc Heater efforts to develop an arc heater characteristics monitoring system that will determine heater configuration effects on arc behavior in order to develop an analysis tool for determining the propensity of arcing to or between segments. The efforts will provide knowledge to reduce the arcing events, which cause severe damage to facilities.

Initiated new research efforts to address T&E technology challenges in this focus area:

- Variable Mach Number Nozzle.
- Variable Mach Number Test capability using energy addition downstream of the plenum.
- Arc Heater Aerothermal T&E.
- Micro Fiber Optical Sensors.

Initiated Broad Agency Announcement (BAA) in FY 2007 to select efforts for FY 2008 award.

FY 2008 Plans:

Continue efforts initiated in prior years.

- Complete Test Media Effects efforts, incorporating the effects of vitiates into computational fluid dynamics codes to predict flame holding within hypersonic vehicle combustors used in hypersonic combustion engine testing.
  The effort will result in the ability to characterize the performance of a hypersonic vehicle in a wind tunnel using vitiated air, and use the results to predict the vehicle's flight performance. The effort will also advance state-of-the-art in-ground test instrumentation to characterize the test environment.
- Complete High Pressure Arc Heater efforts to extend the operating regime for arc heater facilities to the Mach 8–12 regimes. Efforts will provide true air operating conditions to support testing of thermal protection systems and hypersonic combustion systems.
- 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.

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	High Speed/Hypersonic Test

- Complete Combustion Gas Analysis efforts to fabricate and ground-test a non-intrusive laser spectroscopy diagnostic sensor suitable for in-flight T&E of hypersonic propulsion systems.
- Continue Arc Heater Aerothermal efforts to improve aerothermal test capabilities for ground testing of ballistic reentry vehicles.
- Continue Hypersonic Engine-Facility Interaction effort to resolve ground-test issues related to vitiate effects at various test facilities using different combustion heater fuels. Efforts will provide an empirical understanding of the effects of vitiated air on hypersonic scramjet engines and support analysis of ground-test performance at different test facilities.
- Continue Regenerative Storage Heater efforts to finalize pilot heater system design.
- Continue M&S for Hypersonic T&E effort to improve mode transition modeling, including capabilities to conduct numerical simulation of time independent mode transition and simulation of ram to scram mode transition.
- Continue Clean Air Heater Test Technology efforts to design and fabricate a high-pressure elevated temperature air flow system and heater control elements required for testing of heater elements in a flow field.
- Continue Micro Fiber Optical Sensor efforts to develop advanced instrumentation for hypersonic flight test of hot structures, using micro heat transfer sensor for leading edges and pressure sensors for laminar-turbulent transition detection.
- Continue Variable Mach Number Nozzle efforts to develop a high Mach number capability – including variable Mach numbers – for propulsion ground testing.
- Continue Variable Mach Number Test Capability efforts to develop variable Mach 5 to Mach 7 test capability using energy addition downstream of the plenum.

Initiate new research efforts to address T&E technology challenges in this focus area.

- Hypersonic Impulse Facility Analysis to compare the hypersonic propulsion data at Mach 5 and 8 generated by impulse and short duration facilities, and analyze related runtime and vitiation affects.
- Improved Endothermic Fuel System to develop modular hypersonic fuel conditioning system for hypersonic test needs.
- Hypersonic Nozzle Cooling to design tools for wind tunnel nozzles that take condensation, combustion and real gas effects into account.
- Wavelength Multiplexed Tunable Diode Laser Spectroscopy for in-flight, non-intrusive measurement of scramjet thrust using velocity, density and combustion species.

Initiate BAA in FY 2008 to select efforts for FY 2009 award.

FY 2009 Plans:

Continue efforts initiated in prior years.

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	High Speed/Hypersonic Test

- Complete Arc Heater Aerothermal effort to improve aerothermal test capabilities for ground testing of ballistic reentry vehicles.
- Complete Regenerative Storage Heater efforts to develop a brick storage heater based on novel cored brick materials. Efforts will provide a technique to produce non-vitiated air for ground testing hypersonic propulsion systems in a true flight environment.
- Complete M&S for high speed/hypersonic T&E efforts to develop enhanced M&S tools in support of integrated test article and facility effects modeling. The tools will allow detailed analysis of hypersonic system testing prior to physical testing in order to reduce risk and cost of ground test events.
- Complete Clean Air Heater efforts to develop and demonstrate a sub-scale resistive element clean air heater system. The technology will support development of a full-scale wind-tunnel heater system that can provide continuous clean air flow for use in hypersonic aeropropulsion testing.
- Complete Variable Mach Number Nozzle efforts to develop a high Mach number capability – including variable Mach numbers – for propulsion ground testing.
- Complete Variable Mach Number Test Capability efforts to develop variable Mach 5 to Mach 7 test capability using energy addition downstream of the plenum.
- Continue Hypersonic Engine-Facility Interaction efforts that will permit comparison predictions between research and operational engine, and between test facilities as well as the influence of vitiate species on overall system performance.
- Continue Hypersonic Impulse Facility Analysis efforts to compare the hypersonic propulsion data at Mach 5 and 8 generated by impulse and short duration facilities, and analyze related runtime and vitiation affects.
- Continue Improved Endothermic Fuel System efforts to develop modular hypersonic fuel conditioning system for hypersonic test needs.
- Continue Hypersonic Nozzle Cooling efforts to design tools for wind tunnel nozzles that take condensation, combustion or real gas effects into account.
- Continue Wavelength Multiplexed Tunable Diode Laser Spectroscopy efforts for in-flight, non-intrusive measurement of scramjet thrust using velocity, density and combustion species.
- Initiate future investigations to address T&E technology challenges in this focus area.
- Flight vehicle static structural testing to support ground testing of integrated hypersonic vehicles prior to flight testing
- Jet interaction and flow separation control methodologies to ensure high Mach number testing accurately represents in-flight test conditions.
- Methods for electron-beam energy addition to create high temperature flows required to emulate flight conditions of

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	High Speed/Hypersonic Test	

Mach 8 and higher.

- Transient modeling techniques to simulate in-flight transients (e.g. boundary layer effects) in support of "fly the mission" ground tests.

Initiate BAA in FY 2009 to select efforts for FY 2010 award.

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z			Spectrum Efficient Technology				
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Spectrum Efficient Technology	3.303	0.446	6.124	6.108	11.054	10.810	10.458

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

The Spectrum Efficient Technology (SET) program enables T&E of technologies for more efficient use of legacy telemetry bands and expansion into non-traditional areas of the radio frequency spectrum and the optical spectrum. The Test Resource Management Center has realigned the SET program to perform risk reduction and advanced technology development for Central Test and Evaluation Investment Program (CTEIP) projects. Accordingly, the SET Focus Area is structured to provide advanced technology developments needed by the CTEIP integrated Network Enhanced Telemetry (iNET) project. The iNET project has developed an architectural concept for a Telemetry Network System (TmNS) that addresses the needs of the T&E and training communities. However, as the iNET architecture is not sufficiently defined yet to guide the selection and funding of SET projects, SET will not fund any FY 2008 projects. It will stand up again in FY 2009 when iNET is better defined. SET completed nine of its current, ongoing projects in FY 2007, and will complete the remaining six in FY 2008.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2007	FY 2008	FY 2009
Spectrum Efficient Technology	3.303	0.446	6.124

FY 2007 Accomplishments:

Continued efforts initiated in prior fiscal years.

- Completed Super High Frequency Channel Modeling flight test data reduction.
- Completed Spectrally Efficient High Data Rate Telemetry System for super-high frequency flight-testing of real-time capability.
- Completed Laser Telemetry effort to demonstrate a Free Space Optical telemetry system during flight test.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Spectrum Efficient Technology	

- Completed Smart Modulating Retroreflector modulator fabrication and systems analysis, characterized link stability and throughput, performed dynamic testing, and data reduction.
- Completed Optical Communications and Advanced Telemetry Study and delivered results of analysis.
- Completed Steerable Beam Directional Antenna Concept effort to develop a flight-qualified phase shift controlling device to steer the pattern of combined antennas in real-time.
- Completed Radio Frequency Microelectromechanical Systems effort to develop a phased array antenna package that will allow better usage of spectrum resources without interference.
- Completed Beamformer Antenna effort to develop antennas that are low cost and can support over-the-horizon testing.
- Completed Phased Array Antenna dynamic pointing test, flight test planning, and analysis.
- Continued Broadband Telemetry Antenna fabrication, integration, testing, and delivery of antennas 1 and 2.
- Continued Aeronautical Network Telemetry, coordinated layer-2 & layer-3 Quality of Service approach, confirmed transport layer interoperability, completed final architecture refinement.
- Continued Improved Linear Power Amplifier effort to reduce linear transmitter power supply, heat sink requirements, weight, size, and cost by 30 percent.
- Continued Medium Access Control planning, scripting, and analysis; optimized and upgraded model, repeated simulation, and delivered initial report; developed high-fidelity model; and conducted high-fidelity simulation.
- Continued Enhanced Forward Error Correction (EFEC) by extending results from phase 1 to characterize the performance of the test suite of EFEC codes on the second and third of the three common telemetry modulation schemes. Developed simplified coherent and non-coherent decoders for pulse code modulation/frequency modulation and advanced range telemetry continuous phase modulation schemes.
- Continued Space-Time Coding effort to develop a verified space-time code data encoding and processing technique and prototype receiver designed to improve link reliability.

FY 2008 Plans:

Continue efforts initiated in prior fiscal years. Efforts will provide risk mitigation and advanced technologies to support the CTEIP iNET project.

- Complete Broadband Telemetry Antenna fabrication, integration, testing, and delivery of antennas 1 and 2.
- Complete Aeronautical Network Telemetry, coordinated layer-2 & layer-3 Quality of Service approach, confirmed transport layer interoperability, completed final architecture refinement.
- Complete Medium Access Control high fidelity simulations.

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Spectrum Efficient Technology

- Complete Enhanced Forward Error Correction (EFEC) effort to finalize the coherent and non-coherent decoders and deliver detailed design of decoders with performance table identifying the best combinations of EFEC codes and decoders.
- Complete Improved Linear Power Amplifier effort to reduce linear transmitter power supply, heat sink requirements, weight, size, and cost by 30 percent.
- Complete Space-Time Code effort to develop a verified space-time code data encoding and processing technique and prototype receiver designed to improve link reliability.

Determine future investigations to address T&E technology challenges in this focus area by developing a roadmap in conjunction with the iNET effort.
Initiate BAA in FY 2008 to select efforts for FY 2009 award.

FY 2009 Plans:

Reactivate the SET focus area to provide risk mitigation and advanced technologies to support the CTEIP iNET project.
Initiate BAA in FY 2009 to select efforts for FY 2010 award. Begin development of an advanced waveform to work in the SHF band.

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z		Multi-Spectral Test					
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Multi-Spectral Test	5.496	9.256	11.294	12.659	12.648	12.549	12.600

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

The Multi-Spectral Test (MST) focus area develops technologies to test multi-spectral (MS) and hyper-spectral (HS) sensors, seekers, and detectors for weapon systems and intelligence, surveillance, and reconnaissance systems. T&E of new MS and HS sensors to be used in these future weapon systems will require new T&E technologies. Current methods for testing MS and HS 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. Without these new T&E technologies, DoD will not be able to adequately test and evaluate the MS and HS weapon systems of the future.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2007	FY 2008	FY 2009
Multi-Spectral Test	5.496	9.256	11.294

FY 2007 Accomplishments:

Continued efforts initiated in prior fiscal years.

- Completed Dynamic HS Thermal Signature Model efforts including scene builder, graphical user interface, and scenario editor. Provided software, run-time analysis, and final report along with user manuals and support documentation.
- Completed Multi-Spectral Stimulator Injection Test Method efforts by providing results of hardware-in-the-loop demonstration and engineering drawings; delivered user manuals, final report, and prototype system.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Multi-Spectral Test	

- Completed HS Testbed demonstration, completed and provided software, and delivered user manuals and final report.
- Continued Super-lattice Light-Emitting Diode test and delivered Mid-Wave Infrared (MWIR) array; began design, fabrication, and testing of Long-Wave Infrared (LWIR) array; and began development of MS processing protocols.

Initiated new research efforts to address T&E technology challenges in this focus area.

- Multi-Spectral Passive long-wave infrared Polarization Signature Model.
- Ultraviolet (UV)-MWIR Micro-Plasma Projector.
- MS & HS Polarized Scene Projector with Bandwidth Control.
- Next Generation Read-in Integrated Circuits for IR Scene Projection.

Initiated a BAA to select efforts for FY 2008 award.

FY 2008 Plans:

Continue efforts initiated in prior fiscal years.

- Continue Super-lattice Light-Emitting Diode (SLED) efforts by delivering 64x64 MWIR and LWIR arrays, and optimize 512x512 MWIR and LWIR SLEDs and couple the two to form a monolithic, two-color infrared emitter for delivery; and deliver scalability study for 1024x1024 or larger arrays. Deliver final report.
- Continue Multi-Spectral Passive long-wave infrared Polarization effort to provide capability for a spatial/spectral resolution radiometric predictive VIS/SWIR background model. Technology also incorporates validated threat signatures for sensor/seeker T&E.
- Continue Micro-Plasma Projector effort to provide capability to accurately represent high temperature and flexible spectral emitters for representing threat weapon signatures in hardware in the loop multi -wavelength sensors & seekers T&E systems.
- Continue Multi-spectral Polarized Scene Projector effort to provide capability to precisely control parameters required to test and evaluate polarized sensors. Develop ability to generate polarized returns for T&E of illuminated scenes projected to polarized sensors.
- Continue Read-In Integrated Circuit effort to provide capability to provide a high drive current source for development of missile defense end-game scenarios that include high-intensity target signatures in cold backgrounds for scene projectors used in seeker and sensor T&E.

Initiate new research efforts to address T&E technology challenges in this focus area.

- Hyperspectral Test Suite efforts to fabricate, integrate and demonstrate integrated and real-time Mid-Wave Infrared and Long-Wave Infrared scene projection.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Multi-Spectral Test	

- Hyperspectral Imaging Projector (HIP) efforts to fabricate chalcogenide fiber optics and HIP prototype unit with Multi-Spectrum/Hyper-Spectral sensors.
- Cell-based Hyperspectral Atmospheric Radiation Model (CHARM) efforts to develop and demonstrate the CHARM engine performance with large complex scenes and real-time scene generators.

Initiate a BAA in FY 2008 to select efforts for FY 2009 award.

FY 2009 Plans:

Continue efforts initiated in prior fiscal years.

- Complete Super-lattice Light-Emitting Diode (SLED) by delivering 64x64 MWIR and LWIR arrays, and optimize 512x512 MWIR and LWIR SLEDs and couple the two to form a monolithic, two-color infrared emitter for delivery; and deliver scalability study for 1024x1024 or larger arrays. Deliver final report.
- Continue Multi-Spectral Passive long-wave infrared Polarization effort to provide capability for a spatial/spectral resolution radiometric predictive VIS/SWIR background model. This technology also incorporates validated threat signatures for sensor/seeker T&E.
- Continue Micro-Plasma Projector effort to provide capability to accurately represent high temperature and flexible spectral emitters for representing threat weapon signatures in hardware in the loop T&E.
- Continue Multi-spectral Polarized Scene Projector effort to provide capability to precisely control parameters required to test and evaluate polarized sensors.
- Continue Read-In Integrated Circuit effort to provide capability to provide a high drive current source for development of missile defense end-game scenarios that include high-intensity target signatures in cold environments.

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

- VIS/Near Infrared (NIR) HS Polarized Signature Model.
- HS NIR/SWIR Projector.
- MS/HS Ground Targets.
- MS/HS Field Characterization System.
- MS/HS Data Fusion T&E.
- HS MWIR Background Signature Model.
- MS Whole Sky Imager T&E.

Initiate a BAA in FY 2009 to select efforts for FY 2010 award.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Multi-Spectral Test	

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z			Non-Intrusive Instrumentation				
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Non-Intrusive Instrumentation	4.856	6.941	6.538	4.831	6.607	8.522	9.685

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

This focus area was established to address the T&E challenges discussed below; however, the TRMC has determined that requirements and transition partners must be better understood. Accordingly, this focus area will not initiate any FY 2008 new starts, but will develop a Non-intrusive Instrumentation (NII) T&E technology road map to determine the way forward. Ongoing projects will continue to completion. Based on road mapping efforts, this focus area will fund new starts in FY 2010.

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, NII suites with increased survivability in harsh environments, which the NII Focus Area addresses.

Minimal space is available for adding instrumentation to new weapon systems subsequent to their development. Moreover, 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 NII into new platforms during design and development, and, in some cases, into existing platforms. NII 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 NII 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 NII focus area will also advance T&E technologies needed to facilitate compliance with CJCSI 3170.01D.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Non-Intrusive Instrumentation

	FY 2007	FY 2008	FY 2009
Non-Intrusive Instrumentation	4.856	6.941	6.538

FY 2007 Accomplishments:

Continued efforts initiated in prior fiscal years:

- Completed On-Board Wireless Data Communications efforts to develop and demonstrate a prototype wireless data bus for use with smart sensors on a system under test. This will enable integration of NII into test articles with minimal impact to the SUT. A demonstration was conducted at Aberdeen Test Center.
- Continued Holographic Memory Cube Upgrade for terabyte data storage and retrieval.
- Continued Advanced Munitions Flight Test Instrumentation efforts to develop, fabricate, and flight test a Microelectromechanical System (MEMS)-based instrumentation module in an artillery shell. This embedded instrumentation package will improve weapon evaluation without adversely impacting the weapon design or function.
- Continued High Speed and Temperature Diagnostics efforts to develop and demonstrate 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. The probes will support both ground and flight-testing of hypersonic vehicles.
- Continued MEMS Fiber Optic Sensors efforts to design, fabricate, and demonstrate optical pressure, temperature, and shear stress sensors integrated into a single sensor head. The sensors will be embedded into a test article to demonstrate practical application in an operationally relevant environment.
- Continued Digital Communications Test Data Bus efforts to develop and demonstrate a prototype miniaturized, self-calibrating embedded instrumentation system that consists of smart sensors, a subsystem controller, and a processor. The 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.
- Continued Open Modular Embedded Instrumentation Architecture efforts to design and develop an embedded system architecture that is open, modular, and scalable. The architecture has been demonstrated in tests of the Multi-Megawatt Electric Power System being developed for directed energy weapons applications.

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Non-Intrusive Instrumentation

- Continued Self Powered Chip efforts to design power mixer-supply system integrated circuit, sensor system integrated circuit, and fuel cell-lithium ion brassboard. Efforts continue to test, evaluate, and optimize wireless telemetry and common, off-the-shelf sensor technologies.
- Continued Wide Band Location Positioning System efforts to develop acquisition waveform and algorithm to test acquisition and tracking software and to design and test receiver and transmitter reference frequency. Efforts will provide Time Space Positioning Information (TSPI) in Global Positioning Systems (GPS)-denied environments such as buildings.
- Continued Harsh Environment D-Fiber Sensors efforts to enhance D-Fiber sensor in ways such as improving spectral response, reducing fiber brittleness, and improving sensor packaging. Efforts continue to enhance the fiber sensor integrated monitoring to develop high speed monitoring and wavelength sweeping source, which are survivable in extreme environments.

Initiated new research efforts to address T&E technology challenges in this focus area.

- Multi-Species Gas Sensor Arrays
- MEMS Optical Pressure Sensors
- Ultra High Dynamics GPS.

FY 2008 Plans:

Continue efforts initiated in prior fiscal years:

- Complete Holographic Memory Cube Upgrade system for terabyte data storage and retrieval.
- Complete Advanced Munitions Flight Test Instrumentation efforts to develop, fabricate, and flight test a Microelectromechanical System (MEMS)-based instrumentation module on an artillery shell. This embedded instrumentation package will improve weapon evaluation without adversely impacting the weapon design or function.
- Complete High Speed and Temperature Diagnostics efforts to develop and demonstrate 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. The probes will support both ground and flight testing of hypersonic vehicles.
- Complete MEMS Fiber Optic Sensors efforts to design, fabricate, and demonstrate optical pressure, temperature, and shear stress sensors integrated into a single sensor head. The sensors will be embedded into a test article to demonstrate practical application in an operationally relevant environment.

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Non-Intrusive Instrumentation

- Complete Digital Communications Test Data Bus efforts to develop and demonstrate a prototype miniaturized, self-calibrating embedded instrumentation system that consists of smart sensors, a subsystem controller, and a processor. The 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 Open Modular Embedded Architecture efforts to demonstrate an NII architecture that can be configured for incorporation into any system under test. The architecture will support incorporation of smart sensors and synthetic instruments, and provide a standardized interface protocol for development of advanced, non-intrusive sensors.
- Complete Harsh Environment D-Fiber Sensors efforts to integrate robust D-fiber sensors with an integrated monitoring system to create a fiber optic sensor suite. The NII package will be usable as either embedded instrumentation or as NII for integration into existing platforms.
- Continue Self Powered Chip efforts to fabricate and test mixer-supply system integrated circuit, sensor system integrated circuit, and fuel cell-lithium ion brass board. Efforts continue to design an integration package for the system.
- Continue Wideband Location Positioning System to design and test miniature receiver prototype and to design and fabricate four portable transmitter prototypes.
- Continue Multi-Species Gas Sensor Array efforts to design improvements in sensor sensitivity and survivability in the presence of interfering gas species. Efforts continue to quantify composition of critical constituents in turbine engine exhaust products and to improve accuracy in measuring exhaust products to help develop better engine fuel mixtures and engine components.
- Continue MEMS Optical Pressure Sensor efforts to miniaturize data acquisition and analysis test hardware with very small MEMS sensors and wireless transmitters to describe flow patterns and behavior in machinery.
- Continue Ultra High Dynamic GPS efforts to improve accuracy associated with TSPI of warfighting assets.

Develop an NII roadmap to guide future efforts.

FY 2009 Plans:

Continue efforts initiated in prior fiscal years.

- Complete Self Powered Chip efforts to design, integrate, and demonstrate a self contained MEMS sensor package that integrates a sensor and power supply into a package that is a few cubic centimeters in size. The integrated sensor design will support the incorporation of different sensors into non-intrusive sensor packages.
- Complete Wideband Location Positioning System efforts to develop and demonstrate a location positioning system using

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Non-Intrusive Instrumentation

wide band radio frequency transmissions to provide position information in GPS-denied environments. Efforts will support T&E of systems in urban environments.

- Complete Multi-Species Gas Sensor Array efforts to design, integrate, and demonstrate long-life high-sensitivity sensors to quantify composition of critical constituents in turbine engine exhaust products. The sensor will improve accuracy in measuring exhaust products to produce better engine fuel mixtures and engine components.
- Complete MEMS Optical Pressure Sensor efforts to produce and demonstrate an integrated optical pressure sensor package with plug-and-play capability for on-blade acoustic measurement to describe flow patterns and behavior around rotor blades and difficult locations in turbo machinery.
- Complete Ultra High Dynamic GPS efforts design, and integrate and demonstrate a system that improves accuracy associated with TSPI.

Initiate a BAA in FY 2009 to select efforts for FY 2010 award.

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z		Directed Energy Test					
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Directed Energy Test	8.944	15.585	17.713	18.852	19.061	19.037	19.183

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

Directed Energy (DE) test technologies are rapidly transitioning into acquisition programs and Advanced Concept Technology Demonstrations. These weapon technologies, primarily consisting of High Energy Lasers (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; traditional test techniques for evaluating conventional munitions (with flight times ranging from seconds to minutes) are 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 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 a target was destroyed. Current capabilities do not provide the detailed test data required to understand DE system performance. Military utility of these weapons will be dependent upon the knowledge acquired through T&E to know how much to trust the technologies under development and how best to use them. The T&E/S&T Directed Energy Test 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 2007	FY 2008	FY 2009
Directed Energy Test	8.944	15.585	17.713

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Directed Energy Test	

FY 2007 Accomplishments:

Continued projects initiated in prior years. Efforts provide risk mitigation and advanced technologies to support the Central Test and Evaluation Investment Program (CTEIP) Directed Energy Test and Evaluation Capability (DETEC) program.

- Completed Dielectric Electromagnetic Field Probes efforts to develop and demonstrate dielectric-based field probes based on planar waveguide technology that can measure electric and magnetic fields during HPM T&E events. The dielectric field probes will cause little or no perturbation of the electromagnetic environment during the event.
- Completed Delivered Irradiance Assessment Tool efforts to assess approaches for determining HEL irradiance delivered to the target. The tool will combine data from multi-spectral imagery sensors and sensor-atmospheric propagation models to determine HEL irradiance to the target.
- Completed Laser Irradiance T&E Tool efforts to develop algorithm for in-band and thermal imagery to determine incident irradiance from temperature distributions.
- Continued T&E Adaptive Optics System efforts to integrate and test an adaptive optics system in support of remote measurement of HEL temperature with high spatial and temporal accuracy. The adaptive optics system will be integrated into the Advanced Pointer Tracker at the HEL System Test Facility.
- Continued Quantum Well Infrared Photodetector (QWIP) efforts to test an integrated QWIP, Near Infrared (NIR) Focal Plane Array, and Computed Tomographic Imaging Spectrometer (CTIS). The prototype camera system will be demonstrated in both lab and field environments. The QWIP/NIR/CTIS camera system will allow off-board analysis of HEL beam interaction with a target to characterize the laser weapon performance.
- Continued Reflectance and Data Fusion Model efforts to develop and demonstrate improved bidirectional reflection distribution function models to predict the laser irradiance based on reflected energy measurements from various target material compositions. The effort will develop a dynamic data fusion model that will support projecting two-dimensional HEL imagery onto three-dimensional target representations, allowing more detailed analysis of HEL-target interaction during T&E.
- Continued Holographic Target Board efforts to design, fabricate, and test a small-scale holographic HEL target board using photo-thermo-refractive glass to measure HEL irradiance of an incident laser beam.
- Continued Multiple Wave Temperature Sensor efforts to design a multi-band camera system for target surface temperature measurement.
- Continued Bi-static Optical Imaging Sensor efforts to design and fabricate a prototype ground-based HEL diagnostics sensor and to install and characterize the prototype sensor.
- Continued Dielectric Antenna Electro-Optical Sensor efforts to design and fabricate a prototype device consisting of a

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Directed Energy Test

Dielectric resonance antenna and Electro-Optical (E-O) resonator.

Initiated new research efforts to address T&E technology challenges in this focus area.

- Compact Three Axis Sensor efforts to develop a compact, electro-optical sensor that detects three-axis electric field measurements during HPM irradiation.
- Scanning Target Board efforts to develop an HPM target board that uses an array of compact, multi-layered patch antennas to map the HPM source power spectrum.
- Laser Protected Antenna efforts to develop shielding techniques to protect flight termination system antenna from errant HEL irradiation.
- Probe-based Irradiance Profiler efforts to develop a prototype system using a probe and beam camera to determine irradiance on an HEL target.
- Temperature & Irradiance Sensor Matrix efforts to develop a matrix of conformal, onboard photoconductive detectors to determine target irradiance and temperature profiles.
- Magneto-Optical Field Sensor efforts to develop fiber-coupled optical sensors using the Faraday effect to non-intrusively capture magnetic fields during HPM irradiation.

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

FY 2008 Plans:

Continue efforts initiated in prior years. Efforts will provide risk mitigation and advanced technologies to support the CTEIP DETEC project.

- Complete Bi-static Optical Imaging Sensor efforts to develop, fabricate, and demonstrate a brass board hyper-spectral imager by utilizing a fiber-based field sensor. This effort will develop the technology to use a bi-static hyper-spectral imager to remotely characterize multiple HEL beam wavelengths and power level signatures to support HEL test events.
- Complete T&E Adaptive Optics System efforts to integrate and test an adaptive optics system in support of remote measurement of HEL temperature with high spatial and temporal accuracy. The adaptive optics system will be integrated into the Advanced Pointer Tracker at the HEL System Test Facility.
- Complete Quantum Well Infrared Photodetector (QWIP) efforts to test an integrated QWIP, Near Infrared (NIR) Focal Plane Array, and Computed Tomographic Imaging Spectrometer (CTIS). The prototype camera system will be

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Directed Energy Test

demonstrated in both lab and field environments. The QWIP/NIR/CTIS camera system will allow off-board analysis of HEL beam interaction with a target to characterize the laser weapon performance.

- Complete Reflectance and Data Fusion Model efforts to develop and demonstrate improved bidirectional reflection distribution function models to predict the laser irradiance based on reflected energy measurements from various target material compositions. The effort will develop a dynamic data fusion model that will support projecting two-dimensional HEL imagery onto three-dimensional target representations, allowing more detailed analysis of HEL-target interaction during T&E.
- Complete Dielectric Antenna E-O Sensor efforts to fabricate and test a dielectric antenna with an embedded E-O crystal to measure changes in the electric field during an HPM engagement. The sensor will allow non-intrusive measurement of HPM environments with minimal impact on the fields measured.
- Continue Holographic Target Board efforts to design, fabricate, and test large scale holographics HEL target boards using photo-thermo-refractive glass to measure HEL irradiance of the an incident laser beam.
- Continue Multiple Wave Temperature Sensor efforts to integrate multi-band focal plane array, electronics, and operating software, and to characterize the multiple wave temperature sensor performance.
- Continue Compact Three-Axis Sensor efforts to develop a sensor that measures short, pulsed HPM fields in real-time. Efforts will include design and integrate ultra-wideband capable, fast rise-time, high sensitivity, compact sensors for minimal perturbation of the measured field and three-axis polarizations.
- Continue Scanning Target Board efforts to develop a system with sufficient resolution to derive energy distribution for direct measurement of primary beam shape of HPM systems and sources in complex environments.
- Continue Laser Protected Antenna efforts to develop laser-hard shielding that does not interfere with antenna performance during HEL testing. Assess flight termination system antenna and component vulnerability in relation to laser irradiation and thermal damage, conduct design trades for protection concepts, and conduct radio frequency (RF) verification tests.
- Continue Probe-based Irradiance Profiler efforts to develop non-intrusive methods for measuring HEL irradiance profile remotely using utilizing information from HEL/probe lasers and cameras for ground targets.
- Continue Temperature & Irradiance Sensor Matrix efforts to develop conformal, externally-mounted micro-sensors to resolve location and intensity of airborne HEL laser spots with minimal aerodynamic & thermal signature effects.
- Continue Magneto-Optical Field Sensor efforts to apply the Faraday Effect at microwave bandwidths at remote locations from light source & detector to measure magnetic fields in order to better understand HPM.

Initiate new research efforts to address T&E technology challenges in this focus area:

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Directed Energy Test	

- Atmospheric Transmission Measurement effort to develop stationary, ground-based measurement of slant path transmission for ranges of ~ 10km.
- Integrated Sensor and Software Model effort to integrate low-cost, high-resolution temperature sensor with an Inverse Heat Conduction model in an instrument that can be used determine heat put on target by an HEL system.
- Initiate Sensor Inverse Temperature Determination effort to determine laser energy deposition onto a composite target.
- Remote Target & Laser Imagery Determination effort to develop "inverse problem" retrieval solution under HEL engagement based on in-band and out-of-band radiance imagery.
- High Power Microwave Attenuator efforts.
- Cine Radiography of Explosive HPM Munitions efforts to develop a compact flash X-ray source.
- Non-intrusive, Internal Target Sensor efforts to develop a non-intrusive, large dynamic range and high bandwidth sensor to measure incident HPM magnetic field amplitude, internal cavity fields and circuit board currents.
- Dual Oscillator Microwave Generation efforts to extend center frequency of spark gap oscillators up from 500MHz to 2.5GHz.

Initiate a BAA in FY 2008 to select efforts for FY 2009 award.

FY 2009 Plans:

Continue projects initiated in prior years.

- Complete Holographic Target Board efforts to fabricate and demonstrate large-scale holographic HEL target board that uses photo-thermo-refractive glass to measure HEL irradiance of an incident laser beam. The reusable system will deliver test data that is both spatially and temporally resolved.
- Complete Multiple Waveband Temperature Sensor efforts to fabricate and demonstrate a remote four-waveband infrared temperature sensor that allows measurement of target surface temperature during HEL field tests.
- Complete Compact Three-Axis Sensor efforts develop a sensor to measure short-pulsed HPM field in real-time, including calibration and demonstration of three-axis E-O sensor. Efforts will allow understanding of HPM effects on fielded systems internal electronics and aid in countermeasure development.
- Complete Probe-based Irradiance Profiler to understand properties of target during irradiation in the presence of HEL beam fluctuations. The effort will produce robust, high-fidelity diagnostics for HEL weapon systems to ensure proper, effective operation in support of warfighters.
- Complete Temperature & Irradiance Sensor Matrix effort to scale-up sensor matrix fabrication to withstand airborne

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Directed Energy Test	

HEL environment with large peak irradiances, high target surface temperatures, and aerodynamic sheer forces. Demonstrate this technology.

- Complete Magneto-Optical Field Sensor effort to develop microwave photonic system using fiber-optic connections, Magneto-Optical sensor, and opto-electronic circuitry to non-intrusively detect magnetic fields and demonstrate technology. Efforts will allow accurate assessment of narrowband HPM threats and provide better opportunity for response and countermeasures.
- Continue Scanning Target Board efforts to develop target board base element, perform base element M&S and optimize sensor designs, and fabricate and test target board. The effort will support development of HPM weapons for the battlefield to allow warfighter understanding of HPM irradiation on targets.
- Continue Laser Protected Antenna efforts to produce laser-resistant Flight Termination components using refractory material while simultaneously maintaining RF reliability during HEL irradiation. Integrate components and demonstrate performance.
- Continue Atmospheric Transmission Measurement effort to develop stationary, ground-based measurement of slant path transmission for ranges of ~ 10km.
- Continue Integrated Sensor and Software Model effort to integrate low-cost, high resolution temperature sensor with Inverse Heat Conduction model in an instrument that can be used determine heat put on target by an HEL system.
- Continue Sensor Inverse Temperature Determination effort to determine laser energy deposition into a composite target.
- Continue Remote Target & Laser Imagery Determination effort to develop “inverse problem” retrieval solution under HEL engagement based on in-band and out-of-band radiance imagery.
- Continue High Power Microwave Attenuator efforts.
- Continue Cine Radiography of Explosive HPM Munitions efforts to develop compact flash X-ray source.
- Continue Non-intrusive, Internal Target Sensor efforts to develop non-intrusive, large dynamic range and high bandwidth sensor to measure incident HPM magnetic field amplitude, internal cavity fields and circuit board currents.
- Continue Dual Oscillator Microwave Generation non-intrusive instrumentation (NII) efforts to extend center frequency of spark gap oscillators up from 500MHz to 2.5GHz.

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

- Advanced physics based M&S tools to predict HEL-target interactions in real time.
- Advanced HEL measurement techniques that do not affect target dynamics or response to laser irradiation.
- Advanced HPM measurement techniques that do not perturb the RF environment and that provide a reliable measurement of field strength in an HPM engagement.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Directed Energy Test	

Initiate a BAA in FY 2009 to select efforts for FY 2010 award.

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Netcentric Systems Test	

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z			Netcentric Systems Test				
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Netcentric Systems Test	5.093	9.304	12.884	16.035	17.893	17.852	17.940

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

The Netcentric Systems Test (NST) focus area measures and assesses the performance of the physical, information and cognitive domains of joint integrated architectures. 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 and control decisions. Information assurance is central to achieving these advancements. 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 the ability of DoD to test and evaluate Netcentric Systems. The NST focus area addresses 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 2007	FY 2008	FY 2009
Netcentric Systems Test	5.093	9.304	12.884

FY 2007 Accomplishments:

The NST Focus Area provided numerous briefs throughout the year to socialize and receive critical input from various subject matter experts in the T&E/S&T field.

The input received has facilitated further tailoring of the NST focus area to better provide risk mitigation and advanced

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Netcentric Systems Test	

technologies in support of the Central Test & Evaluation Investment Program (CTEIP) Joint Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Interoperability T&E Capability (InterTEC) project, as well as numerous other potential transition partners.

Continued projects initiated in prior fiscal years to include the projects listed below.

- Completed Tactical-Report Generation Test Bed for C4ISR Systems to develop a scenario/message generator that records, infuses and seamlessly interleaves multiple information feeds to generate choreographed mission thread sensor data and formatted message data streams to simulate netcentric scenarios.
- Completed Validation for Netcentric Simulations effort to develop a quantitative verification methodology for netcentric simulations based on metrics that adequately characterize system performance and effectiveness.
- Continued Executable Architecture Analysis Modeling effort to develop test technologies to create executable models of netcentric architectures comprised of integrated combat, communications, and process models.
- Continued Middleware Enhancements for Netcentric Simulation Architecture efforts to develop and demonstrate a network coding technology that will enable a gain by a factor of two or more in testing middleware communication throughput over test networks.
- Continued Joint Virtual Network Centric Warfare effort to develop the capability to build, test, evaluate, and optimize large-scale, real-time communication networks integrated with hardware, software, external systems, test ranges, and warfighters.
- Continued Technology and Tools for Joint Testing effort to prototype T&E tools for developing test architectures, assigning test measures, and visualizing and testing Joint command and control systems in a service oriented architecture environment.

Initiated new research efforts in:

- Analyzer for Netcentric Systems Test Confederations.
- Configurable Situational Awareness Displays.
- Dynamic Distributed Networking for Test and Evaluation.
- Flexible Analysis Services.
- Netcentric Systems Test Architecture and Technology Insertion Environment.
- Service Oriented Architecture Toolset.
- Technologies for Tactical Video.
- Validation for Netcentric Simulations.

Initiated a BAA in FY2007 to select efforts for FY 2008 award.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Netcentric Systems Test	

FY 2008 Plans:

Continue projects initiated in prior years. Efforts will provide risk mitigation and advanced technologies to support the CTEIP InterTEC and Joint Information Assurance Test Suite-Web Enabled Test (JIATS-WET) projects and will include the following:

- Complete Dynamic Distributed Networking for Test and Evaluation effort to develop tools to dynamically configure Netcentric Systems Test infrastructure communications networks.
- Complete Flexible Analysis Services effort to develop and demonstrate generic message protocol translation prototypes (initial Link 16 capability) with a parser rule and profile creation user interface and a generic message parser.
- Complete Netcentric Systems Test Architecture and Technology Insertion Environment effort to develop an architecture, tools, and a laboratory to integrate, demonstrate and validate NST technology projects.
- Complete Middleware Enhancements for Netcentric Simulation Architecture efforts to develop and demonstrate a network coding technology that will enable a gain by a factor of two or more in test middleware communication throughput over test networks.
- Complete Configurable Situational Awareness Displays effort; demonstrate and deliver final 3D visualization tool and final report.
- Complete Executable Architecture Analysis Modeling, perform testing, and deliver final technical report and software development plan.
- Continue Analyzer for Netcentric Systems Test Confederations effort to develop and demonstrate web-based technologies to automate Netcentric test planning and scenario development.
- Continue Joint Virtual Network Centric Warfare effort by demonstrating virtual communication link technology enabling visualization of transmit events, link connectivity, terrain cross sections, and line-of-sight visibilities.
- Continue Service-Oriented Architecture T&E Toolset efforts that will provide a web-enabled display and manipulation of test architectures.
- Continue Technology and Tools for Joint Testing effort to develop agile command and control data-mining algorithm prototype and data mining visualization.
- Continue Technologies for Tactical Video and demonstrate a battlespace awareness tool that integrates sensor imagery data with other Joint Mission Effectiveness (JMe) test data projected into the battlespace.

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

- Cognitive Command & Control (C2) Capabilities for Agent Based Model-Enabled Data Farming to develop models capturing the C2 structures and develop bio-inspired and natural algorithms to automatically generate adversarial

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Netcentric Systems Test	

behavioral.

- Cognitive Performance Assessment Test Technologies to develop objective models for real-time measure and analysis of warfighter cognitive performance and situational awareness, and to develop advanced algorithms to fuse multivariate performance data to determine task specific cognitive states.
- Net-Centric Command & Control Test Analysis Algorithms to develop technologies for real-time analysis of joint mission effectiveness in a C2 environment.
- Flexible Analysis Services to develop architecture compatible to the NST infrastructure deciphering dynamically defined communications and intelligent algorithms for NST analysis, visualization, and reporting.
- Effects Based Approach to Operations Support to develop modeling technologies for conventional and unconventional effects of Information Operations actions.
- Multi-Level Security Cross Layer Scheme for Mobile Ad Hoc Network to build multi-level security features into distributed, decentralized, quality of service medium access control while preserving power and bandwidth.
- Rapid Live-Virtual-Constructive (LVC) Reconfiguration to develop advanced artificial intelligence algorithms that enable rapid and automated configuration or reconfiguration of distributed LVC resources.
- Policy-Based Adaptive Network and Security Management to develop a policy based management system for controlling cross-domain multi-level security and automated network Quality of Service controls through recognition of TENA based applications.
- Waveform and Link Manager Risk Mitigation to develop technologies that facilitate protocol implementation handling uncertain radio frequency communication links.

Initiate BAA in FY 2008 to select efforts for FY 2009 award.

FY 2009 Plans:

Continue projects initiated in prior years. Efforts will provide risk mitigation and advanced technologies to support the CTEIP InterTEC and JIATS-WET projects.

- Complete Configurable Situational Awareness Displays efforts; demonstrate and deliver final 3D visualization tool and final report.
- Complete Executable Architecture Analysis Modeling, perform testing, and deliver final technical report and software development plan.
- Complete Joint Virtual Network Centric Warfare efforts by demonstrating virtual communication link technology enabling visualization of transmit events, link connectivity, terrain cross sections, and line-of-sight visibilities.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Netcentric Systems Test	

- Complete Technologies for Tactical Video efforts to demonstrate a battlespace awareness tool that integrates sensor imagery data with other Joint Mission Effectiveness (JMe) test data projected into the battlespace.
- Continue Technology and Tools for Joint Testing efforts to develop agile C2 data-mining algorithm prototype; and conduct data mining advanced visualization.
- Continue Cognitive Command & Control (C2) Capabilities for Agent Based Model-Enabled Data Farming efforts to develop models capturing the C2 structures and develop bio-inspired and natural algorithms to automatically generate adversarial behavioral.
- Continue Cognitive Performance Assessment Test Technologies efforts to develop objective models for real-time measure and analysis of warfighter cognitive performance and situational awareness, and to develop advanced algorithms to fuse multivariate performance data to determine task specific cognitive states.
- Continue Net-Centric Command & Control Test Analysis Algorithms efforts to develop technologies for real-time analysis of joint mission effectiveness in a C2 environment.
- Continue Flexible Analysis Services efforts to develop architecture compatible to the NST infrastructure; deciphering dynamically defined communications and intelligent algorithms for NST analysis, visualization, and reporting.
- Continue Effects Based Approach to Operations Support efforts to develop modeling technologies for conventional and unconventional effects of Information Operations actions, Stability & Security Operations actions, Diplomatic, Information, Military, and Economic actions; and Political, Military, Economical, Social, Information, & Infrastructure.
- Continue Multi-Level Security Cross Layer Scheme for Mobile Ad Hoc Network efforts to build multi-level security features into Distributed, Decentralized, Quality of Service Medium Access Control while preserving power and bandwidth.
- Continue Rapid Live-Virtual-Constructive (LVC) Reconfiguration efforts to develop advanced artificial intelligence algorithms that enable rapid and automated configuration or reconfiguration of distributed LVC resources.
- Continue Policy-Based Adaptive Network & Security Management efforts to develop a policy based management system for controlling cross-domain multi-level security, and develop automated network Quality of Service controls.

- Continue Waveform and Link Manager Risk Mitigation efforts to develop technologies that facilitate protocol implementation handling uncertain radio frequency communication links.

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

- Capabilities to evaluate advances from a “human-out” perspective (i.e., determine what information actually enhances a warfighter’s performance).

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Netcentric Systems Test	

- Technologies to non-intrusively assess low probability of detection and low probability of communications and data link interception.
- Methods to assess the contribution of netcentricity to decision superiority in operational scenarios.

Initiate BAA in FY 2009 to select efforts for FY 2010 award.

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z			Unmanned and Autonomous Systems Test				
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z		Unmanned and Autonomous Systems Test					
Unmanned and Autonomous Systems Test Systems Test	2.004	4.165	5.056	5.801	6.118	6.087	6.130

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

The next generation of unmanned warfighting support systems is in development and will rapidly transition from research efforts into acquisition programs. In addition, on-going research into autonomous and semi-autonomous systems indicates such systems will soon emerge as a new test challenge. The Unmanned and Autonomous Systems Test (UAST) Focus Area is addressing the current and emerging challenges associated with T&E of these important warfighting assets. As the complexity of Unmanned and Autonomous Systems (UAS) increases, the capability to test these systems must also be developed. UAS T&E technology advancements are required to enable testing of the behavior of learning unmanned and autonomous systems. Ranges and installed system test facilities must be able to characterize UAS responses to mission priorities in densely-packed battle spaces and predict from the data how these systems will respond in the future. The Department of Defense must have the capability to test the ability of these systems to interact safely and effectively with large groups of humans and to determine how these systems respond to unscripted scenarios. This capability requires the development of technology to accurately collect and compare situational awareness of autonomous systems to the ground truth situation; test unmanned systems in a net-centric environment; maintain non-line-of-sight tracking; and execute controlled, repetitive, and realistic stimulation of systems under test.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2007	FY 2008	FY 2009
Unmanned and Autonomous Systems Test	2.004	4.165	5.056

FY 2007 Accomplishments:

Completed process using BAA to select efforts for FY 2007 award.

Initiated research efforts to address T&E technology challenges in this focus area:

- Remote Embedded Test Systems effort.
- Flexible Command and Control.
- Reconfigurable Wireless Measurement System.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Unmanned and Autonomous Systems Test	

- Microbeacon tracking of autonomous Systems.
- Integrated Agent Based Framework.
- High Fidelity Communication Modeling and Analysis.

Initiated BAA in FY 2007 to select efforts for FY 2008 award.

FY 2008 Plans:

Continue efforts initiated in prior fiscal years.

- Complete Flexible Command and Control efforts to develop technology that allows operation of multiple UAS platforms within a precisely prescribed environment that can be monitored and controlled locally, or widely distributed, over all battlespaces/test infrastructures.
- Complete Intelligent Agent Based Framework efforts to develop preplanning techniques which properly characterize communications links to support UAS operations in complex environments.
- Continue Remote Embedded Test Systems efforts to develop long duration, lightweight hybrid power/energy system for reliable UAS operation of onboard sensors and data transmission devices.
- Continue Reconfigurable Wireless Measurement System efforts to develop non-intrusive test instrumentation for real time measures at the system and sub-system levels for both truth and perceived truth data.
- Continue Microbeacon tracking efforts to develop non obtrusive instrumentation for time, space, position information.
- Continue High Fidelity Communication Modeling and Analysis efforts to develop modeling and simulation tools to provide controlled, repetitive, and realistic stimulation of systems under test.

Initiate new research efforts to address T&E technology challenges in the focus area.

- Development of a common architecture allowing integration of diverse systems from across the services and enabling distributed live, virtual, and constructive testing of UAS.
- Command and control techniques to safely control multiple lethal unmanned systems in densely packed battlespaces (air, land, and sea, and combinations thereof).
- Techniques to test and control UAS in an unscripted scenario.
- Technologies to conduct Non-Line-of-Sight (NLOS) tracking of UAS during T&E events.
- Creation, manipulation, and reproduction of the full battlespace environment for test of UAS learning algorithms.

Initiate BAA in FY 2008 to select efforts for FY 2009 award.

FY 2009 Plans:

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Unmanned and Autonomous Systems Test

Continue efforts initiated in prior fiscal years.

- Complete Remote Embedded Test Systems efforts to develop long duration, lightweight hybrid power/energy system for reliable UAS operation of onboard sensors and data transmission devices.
- Complete Reconfigurable Wireless Measurement System efforts to develop non-intrusive test instrumentation for real time measures at the system and sub-system levels for both truth and perceived truth data.
- Complete Microbeacon tracking efforts to develop non obtrusive instrumentation for time, space, position information.
- Complete High Fidelity Communication Modeling and Analysis efforts to develop modeling and simulation tools to provide controlled, repetitive, and realistic stimulation of systems under test.

Initiate new research efforts to address T&E technology challenges in the focus area.

- Modeling of semi-autonomous and autonomous systems to facilitate prediction of UAS performance in scenarios to supplement development and operational T&E events.
- Techniques to conduct T&E in deep sea operations (e.g. data rates, telemetry, way points, off-board sensors, etc.) for unmanned undersea vehicles.
- Methods for testing autonomous space systems (e.g. accessibility, latency, safety/health hazards, etc.) in an operationally relevant environment.
- Tools to evaluate the cognitive behavior and predict future performance of learning algorithms in semi-autonomous and autonomous systems.

Initiate a BAA in FY 2009 to select efforts for FY 2010 award.

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z			Common Range Integrated Instrumentation System				
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Common Range Integrated Instrumentation System	0.000	0.000	15.000	10.250	0.000	0.000	0.000

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

The Department of Defense has a critical need for enhanced T&E instrumentation to support advanced aircraft, avionics, and weapons system testing. The Common Range Integrated Instrumentation System (CRIIS) is a tri-service project that provides a family of capabilities to improve time-space-position information (TSPI) accuracy in low- to high-dynamic test environments and data link throughput capabilities using spectrally efficient data links. CRIIS participant packages will be highly miniaturized in both pod-mounted and internally mounted configurations. CRIIS is highly dependent upon advanced technology development in the areas of high-accuracy TSPI and spectrally efficient, high throughput data transmission.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2007	FY 2008	FY 2009
Common Range Integrated Instrumentation System	0.000	0.000	15.000

FY 2009 Plans:

- Initiate risk reduction activities leading to development of an improved data link.
- Initiate technology maturation activities to attain improved TSPI accuracy and increased update rates.

Exhibit R-2a, RDT&E Project Justification	February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Common Range Integrated Instrumentation System

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY N/A

Exhibit R-2a, RDT&E Project Justification						February 2008	
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z		Multi-Level Security					
Cost ($ in millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Multi-Level Security	0.000	0.000	2.349	2.969	5.442	5.533	5.785

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION

Multi-level Security (MLS), a new start project for FY 2009, is essential in future telemetry systems where multiple test articles transmit data at various security levels to testers cleared to different levels in disparate facilities. The MLS effort will provide technology to eliminate the need to run systems with different security levels of data, avoid running the entire computer network at System-High, and allow individuals not cleared to the System-High level to participate in the test. Security requirements extend to include coalition partners participating in cutting edge systems with closely held US components. Moreover, security levels include protection of proprietary information, thereby enabling different contractors to actively participate in testing. The MLS system will have all the essential functions required by security (logging, segregation, etc.) but provide almost transparent operation with minimal latency.

B. (U) ACCOMPLISHMENTS/PLANNED PROGRAM

	FY 2007	FY 2008	FY 2009
Multi-Level Security	0.000	0.000	2.349

FY 2009 Plans:

Initiate risk reduction efforts to accomplish MLS through a common data link.

- Permit access to approved users.
- Prohibit access to unapproved users.
- Identify attempts to intercept and change data.
- Segregate information by security level.
- Permit users at higher levels to view information at lower levels.
- Prohibit applications at lower levels from writing or viewing information at higher levels.
- Maintain minimal latency.

Exhibit R-2a, RDT&E Project Justification		February 2008
Appropriation/Budget Activity RDT&E, Defense Wide, BA 03, PE 0603941D8Z	Multi-Level Security	

C. (U) OTHER PROGRAM FUNDING SUMMARY NA

D. (U) ACQUISITION STRATEGY NA