Missile Defense Agency (MDA) Exhibit R-2 RDT&E Budget Item Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

COST ($ in Thousands)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total PE Cost	183,849	108,423	118,718	115,234	120,152	127,012	130,358
0502 Advanced Technology Development	176,169	0	0	0	0	0	0
WX25 Advanced Technology Development	0	102,917	113,119	109,205	114,455	120,630	123,976
0602 Program-Wide Support	7,680	0	0	0	0	0	0
ZX40 Program-Wide Support	0	5,506	5,599	6,029	5,697	6,382	6,382

The content previously planned in Project 0502 for FY08-FY13 is now captured in Project WX25 in accordance with the Missile Defense Agency Revised Block Structure.

In FY08, the continuation of NFIRE program funding is captured in the Space Program Element 0603895C, Project WX16, in accordance with the Missile Defense Agency revised Block Structure.

In FY08, the HAA program was canceled. Therefore, FY07 planned activities were modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

In FY08, the Micro Satellite program was canceled. Therefore, FY07 planned activities were modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

A. Mission Description and Budget Item Justification

A.1 System Element Description

As the United States develops and deploys increasing capabilities within the BMDS, our potential adversaries continue to develop more advanced missile technologies. The Advanced Technology Program Element develops tomorrow's technologies for potential integration into the BMDS to out-pace this evolving ballistic missile threat. The technology investment priorities balance the pursuit of the promising next generation technology with near-term, high-payoff, technology solutions that may enhance existing BMDS capabilities. The technology development activities include four focused areas that develop and mature promising concepts and technologies and a dedicated experiment focused on collecting data to support development of future boost phase intercept systems (Near Field Infrared Experiment (NFIRE)). The four focus areas are Sensors; Weapons; Innovation; and Advanced Command, Control, Battle Management, and Communications (C2BMC) Technology.

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A.2 System Element Budget Justification and Contribution to the Ballistic Missile Defense System (BMDS)

This Program Element supports the development of next generation technologies across the entire BMDS as well as the mid-term needs associated with individual elements. The technology efforts selected are intended to lead to: enhanced performance of a specific BMDS component/subsystem; benefit a common component that can be used by multiple elements; or add a new capability to the BMDS. Technologies planned for transition include: the Strategic Illuminator Laser (SILL) for ABL; Next Generation Transmit/Receive Integrated Microwave Module (TRIMM) for THAAD; Improved Chemical Oxygen Iodine Laser (COIL) technology for ABL weight reduction and power output needs; and Quantum Well Infrared Photodetector (QWIP) focal plane arrays (FPAs) for STSS and ABL. The transition of the Multiple Kill Vehicle (MKV) technology into a dedicated acquisition program is one example of a successful breakthrough technology development effort for a subsystem as well as a component that may be used by multiple elements. Additional examples of innovative technology development efforts leading to new capabilities for the BMDS include: Scalable Panels for Efficient Affordable Radar (SPEAR) for advanced sensors; Early Launch Detection and Tracking (ELDT) technologies for Boost Phase sensing; Air Launched Hit-to-Kill (ALHTK) for asymmetric threats and rapid deployment needs; and Coherent Distributed Aperture (CDA) technology for BMDS sensors.

A.3 Major System Element Goals

The three major goals for Advanced Technology are:

- Identify innovative concepts and technologies that can be applied across the BMDS to out pace the threat, improve system performance, and lower life cycle costs
- Maintain a balanced portfolio of high promising technologies with a risk level commensurate with the pay-off, and realize large returns on investment to complement the BMDS
- Develop key promising technologies and transition them into new development programs or as upgrades to improve the capability of the existing BMDS

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B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008 PB)	193,307	118,569	109,540
Current President's Budget (FY 2009 PB)	183,849	108,423	118,718
Total Adjustments	-9,458	-10,146	9,178
Congressional Specific Program Adjustments	0	-9,400	0
Congressional Undistributed Adjustments	0	-746	0
Reprogrammings	-6,540	0	0
SBIR/STTR Transfer	-2,918	0	0
Adjustments to Budget Years	0	0	9,178

FY07 decrease of $9.458 million includes SBIR/STTR transfer and MDA reprogrammings.

FY08 decrease of $10.146 million includes a Congressionally specific program decrease of $9.4 million and a portion of the MDA Congressional undistributed reduction.

FY09 increase of $9.178 million reflects MDA programmatic changes to support program requirements.

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COST ($ in Thousands)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
0502 Advanced Technology Development	176,169	0	0	0	0	0	0
RDT&E Articles Qty	0	0	0	0	0	0	0

Note: In accordance with the Missile Defense Agency revised block structure, the content previously planned in Project 0502 for FY08-FY13 is now captured in Project WX25.

NFIRE Funding: FY06 funding for NFIRE was directed by Congressional action to move from the BMDS Interceptors program element (PE 0603886C) to the BMD Technology program element (PE 0603175C). In FY07, NFIRE content is located in BMD Technology PE 0603175C, Proj 0502 and STSS PE 0603893C, Proj 0812. In FY 2008, content for NFIRE in FY08-13 is captured in the BMDS Space Program PE 0603895C, Proj WX16 in accordance with the MDA revised Block Structure.

In FY08, the HAA program was canceled. Therefore, FY07 planned activities were modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

In FY08, the Micro Satellite program was canceled. Therefore, FY07 planned activities were modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

A. Mission Description and Budget Item Justification

As the United States develops and deploys increasing capabilities within the BMDS, our potential adversaries continue to develop more advanced missile technology. The Advanced Technology Program Element develops tomorrow's technologies for potential integration into the BMDS to out-pace this evolving ballistic missile threat. The technology investment priorities balance the pursuit of the promising next generation technology with near-term, high-payoff, technology solutions that may enhance existing BMDS capabilities. The technology development activities include four focused areas that develop and mature promising concepts and technologies and a dedicated experiment focused on collecting data to support development of future boost phase intercept systems (i.e., Near Field Infrared Experiment (NFIRE) – in FY07 only; in FY08 and beyond, this effort is transferred to the BMDS Space Systems PE and described therein). The four focus areas are Sensors; Weapons; Innovation; and Advanced Command, Control, Battle Management, and Communications (C2BMC) Technology.

The Sensors technology area focuses on developing new technologies to enable threat detection, threat identification, launch-to-destruction threat tracking, and discrimination in all phases of flight. Promising technologies in this area include active electro-optical (EO), passive electro-optical and infrared (EO/IR), and passive radio frequency (RF) sensors for detection and identification; radar system technologies; concepts for Early Launch

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Detection and Tracking (ELDT); spectral sensing for kill assessment; micro satellites for distributed sensing; a High Altitude Airship (HAA) as a near-space platform for persistent surveillance and/or communications missions; and other BMDS applications.

- The EO/IR Passive Sensors task improves IR sensor technologies and components for near term BMDS needs and develops IR materials and focal plane arrays for future BMDS capabilities. These passive EO/IR technology initiatives benefit the BMDS by increasing the maximum range for detection of a threat, increasing the field of view of the infrared search and track function, improving discrimination, reducing the size and weight of sensor components, and accelerating the command and control process required to commence missile defense. The current effort improves the performance of Mercury Cadmium Telluride (HgCdTe) at long wave infrared (LWIR) for STSS in 2014; develops type II superlattice and HgCdTe on Si substrate capabilities at very long wavelength and multicolor for future transition to STSS and MKV in 2015; develops very large format and multicolor Quantum Well Infrared Photodetector arrays for future transition to ABL in the 2012-2014 timeframe. In order to facilitate the transition, the task also includes several laboratory, hardware-in-the-loop, and seeker level test activities to validate and increase the technology readiness level (TRL) of the sensors delivered.
- The Radar Systems Technology (RST) program integrates and tests next-generation transmitters, receivers, antennas, amplifiers, signal processors, and algorithms/software to demonstrate technologies for insertion in future block BMDS radars, as well as to enable and exploit new concepts in radar. RST focuses on revolutionary technology associated with low-power density radar systems with the benefits of higher performance and lower cost, compared to existing systems. The low power density development activities will result in the delivery of a scalable, panel-based array for integration into a government designed Radar Demonstration System. A field demonstration will be conducted in FY11/12 against representative targets at White Sands Missile Range. RST also develops technologies to improve current, BMDS radar systems. The focus in this area is a collaborative MDA, DARPA, Navy and OSD effort to develop and prepare Gallium Nitride power amplifier technologies for insertion into BMDS radars.
- The Early Launch Detection and Tracking (ELDT) program is developing and demonstrating hardware, software and algorithm technologies to provide robust, early launch detection and tracking of ballistic missile launches at a breadboard or prototype level in the relevant environment. Early detection, tracking and typing of the target will enable earlier engagement in boost, ascent, or midcourse. For a forward-based or theater-class missile defense system the time line is a critical component. This technology effort expects to increase battlespace by reducing the time required to detect a boosting missile compared to current baseline overhead and land/sea based assets. For ascent phase intercepts, ELDT improvements will enable targeting and interception of theater-class threats. The technology programs under ELDT include two "see-through-clouds" passive boost detect sensor technologies, as well as a multi-static HF radar (SkyLOS) detect and track effort being pursued with Australia.
- Spectral Sensing for Kill Assessment (SSKA) is investigating phenomenology characteristic of hyper-velocity impacts and developing sensors that can be used for Kill Assessment (determining if the lethal object was hit and destroyed) and Warhead typing (determining the payload or warhead of the threat vehicle from the impact spectrum and debris). The sensors will provide timely information to the Battle Manager to support

shoot-look-shoot engagements, consequence mitigation actions, and follow-on Command response decisions. Limited Kill Assessment capability is planned for 2010 with sensors capable of providing full global coverage of the ICBM threat space by 2014.

- As reported in PB08, we cancelled the Micro Satellite and High Altitude Airship (HAA) programs after FY07 because of budgetary constraints. FY0-7 Accomplishments and close-out activities are reported in Section B of this R-2A Exhibit.

The Weapons technology area focuses on developing technologies and new concepts which enable the successful destruction of any ballistic threat, in any phase of flight, via kinetic energy interceptors or directed energy systems. Focus areas include improved high power laser systems; improved laser components for target discrimination, tracking, and aimpoint selection; technologies that enable advanced kill vehicles to defeat countermeasures and maneuvering targets; and new concepts for integrating existing interceptors and electro-optical sensors onto fighter aircraft to address theater gaps and asymmetric homeland threats. Promising new laser technologies are developed within the Laser Technology Program (LTP) and promising technologies for hit-to-kill interceptors are being developed within the Interceptor Technologies Program (ITP).

The Laser Technology Program is developing next generation state-of-the art laser technologies. This program will develop higher power, lower weight and more reliable lasers; more sensitive detectors for laser radar (LADAR) target acquisition, discrimination, and precision aim point selection; and advanced optical beam stabilization and pointing technology. The promising technologies under development include:

- Strategic Illuminator Laser- A multi-kilowatt, brassboard illuminator system that significantly advances the state-of-the-art in power, beam quality, reliability, and packaging for the Airborne Laser and other laser platforms. The program validates the physical architecture of the laser head and the achievement of difficult weight and packaging goals for the power, structural, and cooling systems.
- Small Laser Amplifier for Ladar - A powerful small laser transmitter (hundreds of watts) suitable for insertion on a missile defense platform with tight weight and volume constraints. After a successful competition between two companies developing competing/alternative prototypes, the final brassboard construction was awarded.
- Advanced Inertial Reference Unit - A device for highly accurate laser pointing and tracking. The increased accuracy provided by this technology will enhance performance of laser tracking, discrimination and engagement systems such as Airborne Laser. The task includes development of a breadboard prototype device used for telescope pointing and local-loop jitter suppression.
- Angle-Angle Range Doppler Imager - Combine the capabilities angle-angle range and coherent Doppler LADAR to achieve both direct detection and coherent detection to enhance discrimination and aimpoint selection. MIT/LL began work on this project in January 2004 for application on kinetic kill vehicles (KKVs). This effort enables a LADAR system to provide highly accurate range and direction information as well as determining the shape and movement of the target.

- COIL Improvements - Four technology areas are being explored to improve efficiency while reducing weight and volume. These areas are: Deuterated Fuels; Advanced Generators; Supersonic Iodine Injectors; and Advanced Diagnostics for the chemical processes. As these mature, they are anticipated to spawn future investments in line upgrades to the Airborne Laser.
- Ultra-Sensitive Detectors - Follow-on sensor effort to further increase sensitivity to the single photon level by reducing background noise. The combination of High bandwidth, high frame rate and low noise enables the sensor to resolve returns at lower signal levels permitting tracking at longer ranges more accurately for LADAR and KKV sensor applications. Two competing concept development contracts were awarded and on contractor down-selected for the fabrication effort.
- Advanced Track Illuminator Laser (ATILL) - A cryogenically cooled, high efficiency Yb:YAG laser capable of improving beam quality and output power, while reducing weight to support implementation on multiple platforms as a next generation long-range tracking illuminator. The project plan encompasses several noteworthy elements: 1. Relies on FFRDC-developed technology to produce actual hardware; 2. Promotes a cooperative environment among the contractors to share ideas; and 3. Reduces risk by selecting from multiple contractor approaches.
- High Brightness / High Efficiency Lasers - Investigates two promising technologies: Diode Pumped Alkali Laser (DPAL), dielectric gas lasers pumped by diode laser arrays; and Tailored Aperture Ceramic Laser (TACL), ceramic materials with diode pumping on the edges. Projects offer alternative pathways to high average power with exceptional beam quality and efficiency while simultaneously reducing complexity and volumetric footprint--particularly important for reducing device size, power consumption and logistics support to permit long shelf life.
- Optically Triggered Q-Switch / High Average Power Pump Arrays - FY08 new starts jointly funded with Air Force to use Vertical-Cavity Surface-Emitting Lasers (VCSELs) to: 1. Use small VCSEL arrays to provide high power, short pulses with precise timing to initiate Q-switching required for higher energy density in lasers; and 2. Refine VCSEL arrays to pump solid state lasers at higher power levels than laser diode arrays for ladar with fewer failures, simplified optics and lower system weight.
- Fiber Laser Beam Combining - as the telecommunications industry has matured fiber laser technology, it will soon be possible to produce a kilowatt from a single fiber. Combining the output of many fibers could be a method of producing a multi-kilowatt beam for illumination and weaponization while reducing weight and volume and simplifying thermal control systems. MIT/LL will develop beam combining technology to enable scaling of high-efficiency fiber laser arrays.

The Interceptor Technologies Program (ITP) is structured to identify, develop, and transition advanced capabilities for future BMDS weapon systems. Infusion of ITP products will provide new capabilities for Boost, Midcourse, and Terminal Defense to counter new and evolving threats and countermeasures. These technologies provide miniaturized components to enable next generation small and lightweight kill vehicles and space products. They provide robust intercept capabilities in the absence of a priori target information, enhanced target detection and tracking by the kill vehicle, and improved lethality in the presence of endgame countermeasures. The ITP seeks to deliver advanced components and subsystem technologies to enable next generation interceptors and discrimination approaches as well as upgrade and enhance existing kill vehicles to allow them

to keep pace with the evolving threat. In addition, the ITP develops new system concepts that defeat evolving threats and countermeasures. The ITP addresses critical needs identified by Systems Engineering studies and STRATCOM's Prioritized Capabilities List, and risks identified by the MDA acquisition elements. The ITP also leverages the SBIR technology base and industry/FFRDC/university IRAD programs.

During FY 2007, the ITP continued FY 2006 development activities, conducting trade studies, soliciting inputs from industry, assessing technology shortfalls, and planning development projects. Initial investments in promising technologies were made in the following projects:

- Agile Kill Vehicle Technologies - Component, subsystem, and algorithm development to address maneuvering threats.
  - Interceptor propulsion (lightweight solid- and liquid-divert with high thrust and attitude control systems).
  - Lightweight, high strength structures and materials with integral radiation hardening.
  - Advanced kill vehicle guidance, navigation, and control algorithms.
  - Advanced interceptor communications (novel kill vehicle communications approaches and components, low latency in-flight target updates).
- Kill Vehicle Seekers - Concepts, hardware, software, and laboratory prototype development of small, lightweight components and multimode seekers capable of withstanding high stresses from fast accelerating boosters/divert.
  - Advanced active/passive seekers for target object mapping and target identification.
  - Distributed aperture target acquisition methodologies for small kill vehicles.
- Air-Launched Concepts - New concepts and prototype hardware modification and/or development.
  - Air launched weapons concept development and preliminary designs, based on integrating existing PAC-3, THAAD-derived, or new interceptors based on existing air-to-air missile components; and modifying existing EO/IR sensors for employment on aircraft.
  - Advanced air-based weapons employment simulations and concept of operations development utilizing advanced Operator-in-the-Loop simulations.
- Novel Discrimination Concepts - System concept development, trade studies, and component development.
  - Seeker/sensor technologies that offer improved ability to identify threats from among the non-lethal objects during intercept.
  - New and innovative methods to improve the Ballistic Missile Defense System (BMDS) discrimination against future threats.

Based on the success of this initial investment, the ITP will select a limited number of these technology projects initiated in FY 2007 for continued development in FY 2008.

The Innovation area seeks out promising new missile defense concepts and technology solutions and matures them to a level where they can be evaluated for transition directly to the BMDS or alternately to the Sensors, Weapons, or Hercules technology areas for continued development. The search for these technologies includes targeted technology outreach efforts and open solicitations that seek proposals for consideration from domestic

and foreign industry, universities/colleges, researchers, and other agencies. The Innovation activity is organized into three distinct outreach efforts. The first area includes the Advanced Technology Broad Agency Announcement (BAA) and the Missile Defense, Science, Technology and Research (MSTAR) program, both supported by the Advanced Technology Innovation Cell (ATIC). The second area is comprised of statutory programs, and consists of the Technology Applications program and technical oversight of the Historically Black Colleges and Universities/ Minority Institutions (HBCU/MI), the Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programs. The third area is congressionally directed programs which are managed with a goal of maximizing utility for the BMDS.

- The Advanced Technology BAA invites proposals from foreign and domestic businesses, universities, researchers and agencies. This BAA funds domestic and international technologies which are the foundation of the future MDA technology portfolio. The BAA seeks new technologies and innovative concepts for components of the BMDS, and for technological improvements and/or cost reductions in the boost, midcourse, and terminal phases of missile defense. Specific research areas for each missile defense phase encompass Surveillance, Acquisition and Tracking, Discrimination, Communications, Engagement Planning, Threat Engagement, and Kill Assessment. New concepts are sought in the following seven technology areas: Radar Systems, Lasers and Electro-Optical Systems, Integrated Active/Passive IR Sensor Systems, Computer Science, Signal and Data Processing, Physics, Chemistry, and Materials, Mechanical and Aerospace Engineering, and Battle Management/Command and Control. The Innovation activity established an Advanced Technology Innovation Cell (ATIC) to assess, evaluate and recommend investment for new and innovative technologies among proposals from all sources, both domestic and international. The ATIC uses a pool of recognized subject matter experts (SMEs) for the reviews and recommendations. This team of experts (government, industry, and academic) evaluates new ballistic missile defense concepts and technologies determining their technical feasibility, potential value added to the BMDS, initial capability, and maintains cognizance over leading edge concepts. The ATIC performs this function for all solicitations under the cognizance of the Innovation area (Advanced Technology BAA, MSTAR, SBIR/STTR, and HBCU/MI).
- The MSTAR program is an open BAA used to seek out breakthrough revolutionary technology from domestic, accredited universities. It leverages innovative research within academia in seven topic areas having potentially high payoff within the BMDS and provides an opportunity for our brightest young scientists and engineers to contribute to missile defense. MSTAR awards are three-year efforts with a maximum funding level of $600K ($200K/year).
- The Innovation activity conducts the congressionally mandated, Office of Secretary Defense directed Technology Applications (TA) program. This technology transfer (T2) program is approved by DDR&E as an alternative to the usual T2 compliant Cooperative Research and Development Agreements (CRADA) conducted by the Services and Agencies which operate and maintain laboratories and test facilities. The MDA T2 provides education, advice, and access to a business network and publicity for MDA-funded technologists at small and large businesses, universities, and federally funded laboratories. The TA program seeks to reduce the cost of technology development through commercial investment and accelerate maturation of technologies developed by MDA by introducing them into the high volume commercial marketplace.

The innovation activity provides representation to the Federal Laboratory Consortium which overseas and facilitates T2 as directed by the Office of the Secretary of Defense

- The Innovation activity manages and executes the congressionally mandated HBCU/MI program. The Innovation team conducts this program by issuing a BAA soliciting HBCU/MI proposals for research focused on contributing to key MDA technology needs. Contract funding is provided by MDA Small Business office, but Innovation funds the management activities. Innovation researches topics and selects BMDS relevant proposals from Historically Black Colleges and Universities/Minority Institutions (HBCU/MI). Innovation also provides technical and management oversight for the selected proposals.
- The Innovation activity provides technical direction for the congressionally mandated (15 U.S.C. 638(j)(3)) Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) program. Contract funding is provided by MDA Small Business office, but Innovation funds the technical oversight activities for topic selection and evaluation. The effort oversees topic development, evaluates and selects the best proposals from small businesses, and manages the resulting contracts. Advanced Technology SBIR managers conduct the MDA SBIR research, evaluation and debriefing process for all MDA Phase I & II proposals.
- The Innovation activity provides technical and management oversight for congressional interest technology programs.

The Advanced Command, Control, Battle Management, and Communications (C2BMC) and Network Technology effort focuses on developing the next generation command and control and battle management concepts and the enabling technologies required to implement them among the BMDS. These activities will develop, integrate, and demonstrate advanced C2BMC concepts and enabling technologies for improving BMDS performance across all mission areas to include defense of friends and allies. Advanced BMDS integration concepts and techniques are demonstrated and evaluated in system-wide flight tests to facilitate the transition to the operational C2MBC. The key concepts under development include:

- Early BMDS subsystem integration, risk reduction, technology maturation, and confidence building. This activity uses simulation, Human-Machine Interface (HMI), mock-ups, early connectivity and prototype interfacing, to enable early information integration at the BMDS level for Command and Control, Battle Management, and Networking capabilities.
- Pathfinder command and control capabilities, including situational awareness, collaborative planning, post-intercept debris and consequence mitigation/management.
- Advanced sensor netting, including techniques to coordinate sensor resources for advanced tracking and discrimination capabilities.
- Advanced battle management and integrated fire control concepts, including techniques to coordinate weapon system engagements to achieve optimal shot doctrine and manage sensor resources against coordinated threat attacks.
- Advanced networking technology, to include migration to distributed architectures for providing distributed, fault tolerant, and gracefully degradable core C2MBC capabilities.

- Advanced concepts and risk reduction efforts associated with BMDS coalition and allied partner integration. Specific areas include situational awareness, post-intercept debris and consequence mitigation/management, and collaborative defense planning.

The Near Field Infrared Experiment (NFIRE) technology effort will collect high and low resolution images of a boosting rocket to improve our understanding of exhaust plume phenomenology and plume-to-rocket body discrimination. We will use this data to validate the models and simulations that are fundamental to developing the guidance and endgame homing algorithms for boost phase interceptors. A secondary objective of the experiment is to collect hyper-temporal short wave infrared and visible data for assessing early launch detection and tracking capability. The experiment will include three plume signature mission types: targets of opportunity, dedicated fly-bys, and ground observations. Targets of opportunity may include aircraft flights, space launches and missile tests at a viewing distance of 100 to 1000 kilometers. Dedicated fly-bys are high resolution observations of a dedicated target vehicle at a range of less than 10 kilometers. Ground observations may include bright burning events such as forest fires, volcanoes, and static tests of rocket engines. In addition to the plume data collections, NFIRE will carry a Laser Communication Terminal, to conduct communication experiments with the German Terra SAR-X satellite. These experiments will test low earth orbit satellite-to-ground and satellite-to-satellite capabilities of the terminal for potential incorporation into the Ballistic Missile Defense System. The laser communication experiments will be conducted on a non-interference basis with the other MDA missions.

The NFIRE satellite will be operated from the Missile Defense Space Experimentation Center (MDSEC) by the MDA Space Applications Center of Excellence. Data products will be utilized by multiple programs to improve missile engagement performance.

NFIRE Goals:

- Launch the Near Field Infrared Experiment satellite
- Conduct multiple data collection missions from the MDSEC against ground, air, space and ballistic missile targets
- Conduct low earth orbit satellite-to-satellite and satellite-to-ground laser communication experiments
- Provide data to validate the models and simulations that are fundamental to developing the navigation, guidance and control, and endgame homing algorithms, as well as laser communication proof of concept

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B. Accomplishments/Planned Program

	FY 2007	FY 2008	FY 2009
Statutory and Mandated	1,800	0	0
RDT&E Articles (Quantity)	0	0	0

FY07 Accomplishments

Technology Applications Program:

- The Technology Applications program conducted Technology Applications Reviews and Business Focus Workshops. Continued to accelerate technology maturation techniques such as commercialization assistance by expert reviews and advice, out reach publications and web site, consultation and training of technology developers, and application of standard metrics to validate technology maturation claims.

HBCU/MI:

- Continued to fund HBCU/MI to support BMDS technology needs as they arise. Complied with DFARS 226-7000 which implements HBCU and MI provisions of 10 U.S.C. 2323 and sets a DoD goal of 5% for each fiscal year to award contract and subcontract dollars to small disadvantaged business concerns and HBCUs and MIs.
- Transitioned successful HBCU/MI programs to the BMDS or Sensors, Weapons, and Hercules technology areas.

SBIR/STTR:

- Continued technical oversight of the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) program.

	FY 2007	FY 2008	FY 2009
Congressional Action	24,643	0	0
RDT&E Articles (Quantity)	0	0	0

FY07 Accomplishments:

Provided programmatic oversight and technical influence for the following congressionally directed technology programs.

- Advanced Processing Architecture
- Massively Parallel Optical Interconnects
- Center for Optical Logic Devices (COLD)
- Advanced RF Technology Development
- Multiple-Target-Tracking Sensor-Array Technology (MOST)

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- Photoconductor on Active Pixel Sensor (POAP)
- SIC Thick Film Mirror Coatings
- Conformal Embedded Rectennas for Areal Platforms

	FY 2007	FY 2008	FY 2009
Weapons Technology	38,542	0	0
RDT&E Articles (Quantity)	0	0	0

FY07 Accomplishments:

- Laser Technology Program
  - Strategic Illuminator Laser - Finished brassboard fabrication and conducted verification testing. The SILL brassboard has achieved full output power with excellent beam quality (less than 1.5 x DL). The Northrop Grumman team is continuing to optimize the output power prior to delivery. Weight and volume requirements were achieved through a combination of a composite optical bench and other innovations.
  - Small Laser Amplifier for Ladar (SLAL) - The contractor (LMCT) completed fabrication of the brassboard prototype and demonstrated fulfillment of all specifications. Delivered completed device to the government and successfully incorporated SLAL into Long Range Ladar.
  - Advanced Inertial Reference Unit - Contractor performed system testing prior to transfer to Naval Postgraduate School for government verification tests.
  - Angle-Angle-Range Resolved Doppler Imager - Having demonstrated that system performance on full-scale targets met or exceeded all requirements, produced final report and documentation. This proven technology will likely be the basis for an Advanced Ranging System for the Airborne Laser.
  - COIL Improvements - Deuterated Fuels: Tested various formulations of advanced fuels leading to deuterated material; Injectors - work deferred due to insufficient funds, Advanced Iodine Generators - work deferred due to insufficient funds; Advanced Diagnostics - concluded contract, integration complete - improved testbed essential to fine tuning of singlet delta oxygen production for greater COIL power.
  - Ultra-Sensitive Detectors - Selected contractor, Raytheon Vision Systems, continued fabrication and integration of detector and multiplexer based on approved design.
  - Advanced Track Illuminator Laser (ATILL) - Requested proposals, conducted source selection and initiated three contracts for concept development phase based on research conducted at MIT/LL.
  - High Brightness / High Efficiency Lasers - Lawrence Livermore National Laboratory operated under limited funding to build a 10 W demonstrator DPAL using pump diodes, a pump delivery system, vapor cell and cooling components from the design effort. TACL efforts will focus on ceramic material selection and laser model development followed by initial lasing experiments.

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- Interceptor Technologies Program:
  - Continued optimal guidance algorithm development for interceptors versus maneuvering threats.
  - Initiated development of component technologies to counter maneuvering threats:
    - Lightweight divert and attitude control system (DACS) thrusters and pressurization components;
    - Lightweight, integrated materials characterization (coupon testing);
    - Miniaturized communications components;
    - Released RFI to industry for Agile Kill Vehicle Technologies.
  - Initiated development of the next generation kill vehicle seekers:
    - Advanced active/passive seeker test bed breadboard telescope laboratory characterization;
    - Distributed aperture seekers algorithm development.
  - Air-Launched Concepts:
    - Continued concept development of air-launched weapons concept and initiated preliminary design of an external weapons bay compatible with PAC-3 and THAAD interceptors, with an integral EO/IR sensor for tactical fighter aircraft;
    - Initiated Operator-in-the-Loop simulations to identify optimal performance characteristics of air-launched weapons and sensors at Boeing's Virtual Warfare Center;
    - Continued advanced air-launched weapons concept of operations development;
    - Developed IR scene generation capability to support HWIL evaluations of IR seekers and IR search and tracking systems;
    - Initiated machine aided configuration options evaluation program to optimize interceptor component and supporting sensor requirements.
  - Conducted characterization tests of reactive materials in novel configurations to enhance kill vehicle lethality.
  - Initiated review of industry responses to the Request for Information on Novel Discrimination Concepts.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2007	FY 2008	FY 2009
Innovative Technology and Analysis	5,231	0	0
RDT&E Articles (Quantity)	0	0	0

FY07 Accomplishments:

Technology Outreach and Advanced Technology BAA:

- Continued to seek innovative and breakthrough technologies from domestic and international sources via the DV-BAA process.
- Continued the Project Arrangement (PA) for a UK scientist to work on the Hercules program, on-site at MDA. Following this PA, continuation of this exchange effort will be realized through the establishment of an MDA working cell in the UK.
- Opened discussions with Germany and Japan for development of the High Altitude Airship (HAA) program.
- Established a Memorandum of Understanding (MOU) with France for BMDS relevant science and technology.
- Initiated discussions with Denmark industry to submit a proposal against MDA's existing BAA.
- Enhanced DV's MDA Web Portal with Web based corporate knowledge capture and collaboration tools process.
- Continued to seek collaboration opportunities with MDA and other Government, Industry, and International efforts.

MSTAR:

- This year six of the MSTAR proposals received are of extremely high quality and addressed a variety of missile defense technology areas required to address technology needed to counter evolving ballistic missile threats to the US and its allies. Research areas targeted under the scope of the MSTARS Program includes Radar Systems; Laser and Electro-Optical Systems; Integrated Active/Passive IR Sensor Systems; Computer Science, Signal and Data Processing; Mathematics, Probability, and Decision Theory; Physics, Chemistry and Materials; Mechanical and Aerospace Engineering; Battle Management and Command and Control Systems. The number of contracts to be award for 2007 is pending a budget determination for 2008. Awards under this program are for three years ($600k), funds are transferred at a rate of $200k per year. Since these awards result in a three year commitment for each university the cumulative value of the program is three times the value of the award. In anticipation of the 2008 budget reductions the impact on the Basic Research will likely be significant.
- Currently, the JHU/APL MSTAR Program (described above) is closest to insertion within the MDA Kill Assessment Program.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2007	FY 2008	FY 2009
Sensing Systems	83,744	0	0
RDT&E Articles (Quantity)	0	0	0

DOLLARS ABOVE INCLUDE HAA in FY07.

FY07 Accomplishments:
Passive EO/IR Technology:

- Demonstrated for the first time a 10 um cutoff, p-on-n superlattice 320x256 IR FPA with performance comparable to HgCdTe. The substrate is completely taken off and passivated. This is a major breakthrough in this new IR material and has significant impact on future IR sensor development. Further development of low background and multicolor capabilities will continue for potential application in STSS and MKV spirals.
- Conducted data analysis on the field test results by Boeing and ABL on two quantum well infrared photodetector (QWIP) cameras at the White Sands Missile Rang in Aug 06. The report from the analysis shows that QWIP has a great potential as a candidate for ABL's future IRST and ARS sensors. Further sensor development and testing are needed to improve the TRL level.
- Experienced a breakthrough in demonstrating (HgCdTe) on Si substrate technology at long wavelength with a 10.5 um cutoff camera that has a NEDT operability of 96.8%. Further development of low background and multicolor capabilities will continue for potential application in STSS and MKV spirals.

Radar Systems Technology:

- Executed low power density Scalable Panels for Efficient Affordable Radar (SPEAR) Panel Critical Design review. · Achieved key low power density knowledge point with delivery and successful test of SPEAR Spiral 1 Phase 1 64 element tiles from two vendors.
- Completed independent government laboratory performance and electromagnetic interference test and evaluation of SPEAR Spiral 1 Phase 1 hardware.
- Completed design iterations for key components of Next Generation Transmit/Receive Integrated Microwave Module (NGT), including the low noise amplifier, limiter and multi-function monolithic microwave integrated circuits (MMICs); DC-DC converter and transmit-receive module. Initiated transmit/receive integrated microwave module design.
- Achieved Coherent Distributed Aperture knowledge point with successful demonstration of predicted performance against exo-atmospheric targets and an airborne electronic countermeasures platform.
- Fully characterized SPEAR risk reduction Silicon Germanium (SiGe) Transmit/Receive (T/R) Chip components.

- Completed development and demonstrated performance of the SPEAR risk reduction radiator.

Early Launch Detection and Tracking Technology:

- Successfully performed multi-site (3), single channel SkyLOS RX data collection in Florida and Georgia using Sky wave ROTHR illumination and targets of opportunity from KSC and Cape Canaveral.
- Coordinated joint ONIR data collect for Cape Canaveral launch and began analysis of fusion of HF Radar and ONIR data for improved tracking and typing
- Developed advanced detection and tracking algorithms and tested against SkyLOS measurements.
- Demonstrated improved OTHR clutter reduction algorithms using Australian operational assets
- Conducted successful HyperTemporal Imaging (HTI) ground tests in multiple wavelengths through sunlit clouds from the top of Mt Washington, NH
- Successfully demonstrated advanced signal processing for robust HTI performance in jitter environment
- Conducted successful test of AC-coupled radiometer demonstrating suppression of clutter of solar background(Jun/Aug 07)
- Conducted successful FAC plume signature data collection of targets of opportunity from KSC and Cape Canaveral.

Spectral Sensing for Kill Assessment:

- Completed design of high speed spectrometer instrument package for support of data collection during intercept flight tests.
- Continued with BMDS hyper/multi-spectral sensor prototype design, development, and testing.
- Performed ground based experiments to verify exploitable impact features derived from modeling and small scale tests.

Micro Satellites:

- Micro Satellite DSE program
- Completed all design updates for the structural bus based upon lessons learned from the pathfinder.
- Initiated assembly of Satellite 1 structural components (decks, solar panels, closures, stringers)
- Redesigned electronic boxes for the SCC and PDU based on initial vibe testing.
- Completed initial round of PDU Thermal Vac testing
- Completed spacecraft wiring & harnessing of WoodSat mock up
- S-band transceiver and duplexer ordered, expect pre-environmental test unit available late Sep 07.

- Passed a major technical milestone in the program confirming that visible images are completing the path from camera though the processor and to the computer from the prototype instrument.
- The DSE Payload team fabricated the first flight unit components.
- Completing the prototype instrument and the housing of the first flight unit.
- Software developed and tested is in the Build 3 phase with continuing advancements in the detection and tracking algorithms.

Micro Satellite Target System (MTS) program
- Finalized telecom subsystem design
- Procured the flight components
- Completed the power subsystem design
- Final integration and functional test of the core bus

Current budgetary guidance to cancel the Microsat program at the end of FY07 will negate FY08 and subsequent effort. Therefore, FY07 planned activities will be modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

High Altitude Airship:
- Initiated construction of the HAA prototype.
- Continued to develop the power generation, energy storage, and hull mass reduction technologies required for the operational HAA, through our Technology Improvement Project.

Current budgetary guidance to cancel the High Altitude Airship program at the end of FY07 will negate FY08 and subsequent effort. Therefore, FY07 planned activities will be modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2007	FY 2008	FY 2009
Advanced Communications Technology	11,997	0	0
RDT&E Articles (Quantity)	0	0	0

FY07 Accomplishments:

- Continued activities to enable the integration of advanced C2BMC capabilities into BMDS subsystems:
  - Defined and demonstrate the Kinetic Energy Interceptor (KEI) to C2MBC messages associated with enabling C2BMC connectivity, rules of engagement (ROE), machine acknowledgements, sharing of KEI generated boost-phase tracking information, and interceptor seeker imagery.
  - Defined and demonstrated the Surveillance and Tracking Space System (STSS) to C2BMC interface. This includes defining and demonstrating tactical data links (TADIL-J) interfaces in a lab environment and planning for future interfaces. Examine multi-level security issues for overhead non-imaging infrared (ONIR) to C2MBC interfaces.
  - Demonstrated and evaluated advanced C2BMC capabilities in live-flight test events using the C2MBC X-Lab. Assess each capability's performance, maturity level, and readiness for transition into the BMDS.
  - Designed a transportable C2MBC mockup to enable war fighter to define crew positions and develop concept of operations (CONOPS) in the areas of boost phase tracking and classification, sensor resource management, weapons resource management, post-intercept debris information flow, and communication with allies.
- Developed and demonstrated next generation command and control capabilities:
  - Demonstrated sensor registration and health and status monitoring capabilities to eliminate sensor bias, achieve covariance consistency, and synchronize the timing of sensors across the BMDS.
  - Conducted pilot efforts to create a service oriented architecture (SOA) compliant version of the BMDS command and control (C2) capabilities to enable integration with the global command and control system-joint (GCCS-J) and net-enabled command capability (NECC) systems.
  - Developed consequence mitigation/management capabilities; post-intercept debris fallout prediction and warning capabilities; and lethality modeling improvements to enable large raid size debris predictions in real time.
- Developed and demonstrated next generation sensor netting and sensor resource management techniques.
  - Conducted sensor netting experiments associated with BMDS registration, bias mitigation techniques, sensor tracking (local), network tracking, discrimination, sensor resource tasking, system level target object map (TOM), and communications/bandwidth constraints.
  - Assessed distributed track processing techniques for integrated air and missile defense (IAMD) sensor netting concepts, including the use of the Tactical Component Network (TCN).

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

  - Demonstrated and increased maturity of sensor interface definitions using a research and development version of the C2MBC network interface processors (CNIP).
- Developed and demonstrated advanced battle management (BM) and integrated fire control capabilities.
  - Demonstrated and assessed global integrated fire control functionality in the C2BMC X-Lab.
  - Conducted a pathfinder effort to develop an integrated capability for initial system level hit assessment, kill assessment, and weapons typing.
  - Demonstrated initial distributed battle management constructs, including advanced battlefield learning techniques, sensor/shooter asset management, and operations/planning options such as reallocation of assets.
- Demonstrated and transitioned advanced networking technologies.
  - Assessed initial distributed track processing capabilities for IAMD integration, including the use of TCN to enable effective C2 and BM/fire control capabilities under conditions of limited communications bandwidth.
  - Demonstrated and start transitioning flexible theater C2BMC services, including distributed correlation / discrimination and flexible satellite communications.
- Developed tools and techniques to facilitate technology maturation and transition to operations.
  - Developed the analytic and experimentation infrastructure to enable concept simulation. Develop the collaborative environments to enable demonstration of C2BMC capabilities during live flight events using the C2BMC X-Lab.

	FY 2007	FY 2008	FY 2009
NFIRE	10,212	0	0
RDT&E Articles (Quantity)	0	0	0

FY07 Accomplishments:

- Received Laser Communications Terminal (LCT) payload for payload integration
- Completed and certified Ground Segment Mission Operations Center to ensure the system is ready to support mission operations
- Conducted Mission Training to ensure the mission operators are prepared to execute
- Conducted Mission Rehearsals to test the interactions between the ground system, space system, and personnel prior to a mission
- Completed delivery and acceptance of Launch Vehicle to support launch of the spacecraft
- Launched the NFIRE Satellite to insert the spacecraft into orbit
- Conducted Initial On-Orbit Operations to ensure the functionality and performance of the TSP prior to executing a mission
- Accepted delivery of Multi-stage Boost Target
- Conducted Target of Opportunity Missions to collect low resolution plume data and validate the tracking performance of the TSP

- Conducted Near Field Boosting Target Fly-by mission to collect high resolution plume data (Mission 2A)
- Conducted Hyper-Temporal Experiment to assess early launch detect and tracking capability

C. Other Program Funding Summary

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	Total Cost
PE 0207998C BRAC	0	103,219	159,938	61,931	8,724	0	0	333,812
PE 0603881C Ballistic Missile Defense Terminal Defense Segment	1,082,454	1,045,276	1,019,073	795,659	719,847	548,283	439,752	5,650,344
PE 0603882C Ballistic Missile Defense Midcourse Defense Segment	2,985,140	2,243,213	2,209,262	2,276,848	1,385,258	946,437	1,103,532	13,149,690
PE 0603883C Ballistic Missile Defense Boost Defense Segment	622,218	510,241	421,229	423,927	652,642	799,792	991,839	4,421,888
PE 0603884C Ballistic Missile Defense Sensors	514,989	586,121	1,221,143	1,184,280	1,099,649	1,077,632	823,583	6,507,397
PE 0603886C Ballistic Missile Defense System Interceptors	341,358	340,107	386,817	500,966	708,803	815,433	553,136	3,646,620
PE 0603888C Ballistic Missile Defense Test and Targets	584,615	621,861	673,691	672,976	690,938	708,991	719,209	4,672,281
PE 0603890C Ballistic Missile Defense System Core	425,889	413,934	432,262	482,947	605,219	561,947	571,498	3,493,696
PE 0603891C Special Programs - MDA	347,377	196,892	288,315	304,234	538,050	818,136	786,349	3,279,353
PE 0603892C Ballistic Missile Defense Aegis	1,125,426	1,126,337	1,157,783	1,234,220	1,078,539	1,066,712	1,102,542	7,891,559
PE 0603893C Space Tracking & Surveillance System	311,402	231,528	242,441	266,509	560,130	735,727	938,191	3,285,928
PE 0603894C Multiple Kill Vehicle	133,615	229,943	354,455	488,294	649,632	708,582	879,385	3,443,906
PE 0603895C BMD System Space Program	0	16,552	29,771	41,638	56,199	133,915	157,548	435,623
PE 0603896C BMD C2BMC	249,179	447,616	289,277	287,194	270,762	256,767	259,159	2,059,954
PE 0603897C BMD Hercules	46,268	52,462	55,955	55,289	56,400	51,902	52,784	371,060
PE 0603898C BMD Joint Warfighter Support	49,833	49,394	69,982	73,997	77,205	80,168	81,948	482,527
PE 0603904C Missile Defense Integration & Operations Center	104,389	78,557	96,404	100,437	100,366	101,512	102,840	684,505
PE 0603905C BMD Concurrent Test and Operations	21,870	0	0	0	0	0	0	21,870
PE 0603906C Regarding Trench	0	1,986	2,978	4,964	4,963	8,933	8,933	32,757
PE 0603907C Sea Based X-Band Radar (SBX)	0	165,243	0	0	0	0	0	165,243
PE 0605502C Small Business Innovative Research - MDA	142,510	0	0	0	0	0	0	142,510

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	Total Cost
PE 0901585C Pentagon Reservation	15,527	6,019	19,734	5,040	5,284	5,370	5,456	62,430
PE 0901598C Management Headquarters - MDA	93,350	80,392	86,453	70,355	69,855	69,855	69,855	540,115

D. Acquisition Strategy

BMD Technology does not have any major performers that qualify for this category based on the Financial Management Regulations.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

COST ($ in Thousands)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
WX25 Advanced Technology Development	0	102,917	113,119	109,205	114,455	120,630	123,976
RDT&E Articles Qty	0	0	0	0	0	0	0

Note: The content in Project WX25 is a continuation of the efforts reported in Project 0502 and was explained in that project in PB 08.

In FY08, funding for NFIRE is moving from this PE (as well as PE 0603893C) to the Space Program Element 0603895C.

In FY08, the HAA program was canceled. Therefore, FY07 planned activities were modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

In FY08, the Micro Satellite program was canceled. Therefore, FY07 planned activities were modified to consolidate and finalize technical efforts in a manner which will enable efficient reactivation, if that is determined to be of value in the future.

A. Mission Description and Budget Item Justification

As the United States develops and deploys increasing capabilities within the BMDS, our potential adversaries continue to develop more advanced missile technology. The Advanced Technology Program Element develops tomorrow's technologies for potential integration into the BMDS to out-pace this evolving ballistic missile threat. The technology investment priorities balance the pursuit of the promising next generation technology with near-term, high-payoff, technology solutions that may enhance existing BMDS capabilities. The four focus areas are Sensors; Weapons; Innovation; and Advanced Command, Control, Battle Management, and Communications (C2BMC) Technology.

The Sensors technology area focuses on developing new technologies to enable threat detection, threat identification, launch-to-destruction threat tracking, and discrimination in all phases of flight. Promising technologies in this area include active electro-optical (EO), passive electro-optical and infrared (EO/IR), and passive radio frequency (RF) sensors for detection and identification; radar systems technologies; concepts for Early Launch Detection and Tracking (ELDT); spectral sensing for kill assessment; micro satellites for distributed sensing; and other BMDS applications.

- The EO/IR Passive Sensors task improves IR sensor technologies and components for near term BMDS needs and develops IR materials and focal plane arrays for future BMDS capabilities. These passive EO/IR technology initiatives benefit the BMDS by increasing the maximum range for detection of a threat, increasing the field of view of the infrared search and track function, improving discrimination, reducing the size and weight of sensor components, and accelerating the command and control process required to commence missile defense. The current effort improves the performance of Mercury Cadmium Telluride (HgCdTe) at long wave infrared (LWIR) for STSS in 2014; develops type II superlattice and HgCdTe on Si substrate capabilities at very long wavelength and multicolor for future transition to STSS and MKV in 2015;

develops very large format and multicolor Quantum Well Infrared Photodetector arrays for future transition to ABL in the 2012-2014 timeframe. In order to facilitate the transition, the task also includes several laboratory, hardware-in-the-loop, and seeker level test activities to validate and increase the technology readiness level (TRL) of the sensors delivered.

- The Radar Systems Technology (RST) program integrates and tests next-generation transmitters, receivers, antennas, amplifiers, signal processors, and algorithms/software to demonstrate technologies for insertion in future block BMDS radars, as well as to enable and exploit new concepts in radar. RST focuses on revolutionary technology associated with low-power density radar systems with the benefits of higher performance and lower cost, compared to existing systems. The low power density development activities will result in the delivery of a scalable, panel-based array for integration into a government designed Radar Demonstration System. A field demonstration will be conducted in FY11/12 against representative targets at White Sands Missile Range. RST also develops technologies to improve current, BMDS radar systems. The focus in this area is a collaborative MDA, DARPA, Navy and OSD effort to develop and prepare Gallium Nitride power amplifier technologies for insertion into BMDS radars.
- The Early Launch Detection and Tracking (ELDT) program is developing and demonstrating hardware, software and algorithm technologies to provide robust, early launch detection and tracking of ballistic missile launches at a breadboard or prototype level in the relevant environment. Early detection, tracking and typing of the target will enable earlier engagement in boost, ascent, or midcourse. For a forward-based or theater-class missile defense system the time line is a critical component. This technology effort expects to increase battle space by reducing the time required to detect a boosting missile compared to current baseline overhead and land/sea based assets. For ascent phase intercepts, ELDT improvements will enable targeting and interception of theater-class threats. The technology programs under ELDT include two "see-through-clouds " passive boost detect sensor technologies, as well as a multi-static HF radar (SkyLOS) detect and track effort being pursued with Australia.
- Spectral Sensing for Kill Assessment (SSKA) is investigating phenomenology characteristic of hyper-velocity impacts and developing sensors that can be used for Kill Assessment (determining if the lethal object was hit and destroyed) and Warhead typing (determining the payload or warhead of the threat vehicle from the impact spectrum and debris). The sensors will provide timely information to the Battle Manager to support shoot-look-shoot engagements, consequence mitigation actions, and follow-on Command response decisions. Limited Kill Assessment capability is planned for 2010 with sensors capable of providing full global coverage of the ICBM threat space by 2014.

The Weapons technology area focuses on developing technologies and new concepts which enable the successful destruction of any ballistic threat, in any phase of flight, via kinetic energy interceptors or directed energy systems. Focus areas include improved high power laser systems; improved laser components for target discrimination, tracking, and aimpoint selection; technologies that enable advanced kill vehicles to defeat countermeasures and maneuvering targets; and new concepts for integrating existing interceptors and electro-optical sensors onto fighter aircraft to

address theater gaps and asymmetric homeland threats. Promising new laser technologies are developed within the Laser Technology Program (LTP) and promising technologies for hit-to-kill interceptors are being developed within the Interceptor Technologies Program (ITP).

The Laser Technology Program is developing next generation state-of-the art laser technologies. This program will develop higher power, lower weight and more reliable lasers; more sensitive detectors for laser radar (LADAR) target acquisition, discrimination, and precision aim point selection; and advanced optical beam stabilization and pointing technology. The promising technologies under development include:

- Strategic Illuminator Laser- A multi-kilowatt, brassboard illuminator system that significantly advances the state-of-the-art in power, beam quality, reliability, and packaging for the Airborne Laser and other laser platforms. The program validates the physical architecture of the laser head and the achievement of difficult weight and packaging goals for the power, structural, and cooling systems.
- Small Laser Amplifier for Ladar - A powerful small laser transmitter (hundreds of watts) suitable for insertion on a missile defense platform with tight weight and volume constraints. After a successful competition between two companies developing competing/alternative prototypes, the final brassboard construction was awarded.
- Advanced Inertial Reference Unit - A device for highly accurate laser pointing and tracking. The increased accuracy provided by this technology will enhance performance of laser tracking, discrimination and engagement systems such as Airborne Laser. The task includes development of a breadboard prototype device used for telescope pointing and local-loop jitter suppression.
- Angle-Angle Range Doppler Imager - Combine the capabilities angle-angle range and coherent Doppler LADAR to achieve both direct detection and coherent detection to enhance discrimination and aimpoint selection. MIT/LL began work on this project in January 2004 for application on kinetic kill vehicles (KKVs). This effort enables a LADAR system to provide highly accurate range and direction information as well as determining the shape and movement of the target.
- COIL Improvements - Four technology areas are being explored to improve efficiency while reducing weight and volume. These areas are: Deuterated Fuels; Advanced Generators; Supersonic Iodine Injectors; and Advanced Diagnostics for the chemical processes. As these mature, they are anticipated to spawn future investments in line upgrades to the Airborne Laser.
- Ultra-Sensitive Detectors - Follow-on sensor effort to further increase sensitivity to the single photon level by reducing background noise. The combination of High bandwidth, high frame rate and low noise enables the sensor to resolve returns at lower signal levels permitting tracking at longer ranges more accurately for LADAR and KKV sensor applications. Two competing concept development contracts were awarded and on contractor down-selected for the fabrication effort.
- Advanced Track Illuminator Laser (ATILL) - A cryogenically cooled, high efficiency Yb:YAG laser capable of improving beam quality and output power, while reducing weight to support implementation on multiple platforms as a next generation long-range tracking illuminator. The project plan encompasses several noteworthy elements: 1. Relies on FFRDC-developed technology to produce actual hardware; 2. Promotes a cooperative environment among the contractors to share ideas; and 3. Reduces risk by selecting from multiple contractor approaches.

- High Brightness / High Efficiency Lasers - Investigates two promising technologies: Diode Pumped Alkali Laser (DPAL), dielectric gas lasers pumped by diode laser arrays; and Tailored Aperture Ceramic Laser (TACL), ceramic materials with diode pumping on the edges. Projects offer alternative pathways to high average power with exceptional beam quality and efficiency while simultaneously reducing complexity and volumetric footprint--particularly important for reducing device size, power consumption and logistics support to permit long shelf life.
- Optically Triggered Q-Switch / High Average Power Pump Arrays FY08 new starts jointly funded with Air Force to use Vertical-Cavity Surface-Emitting Lasers (VCSELs) to: 1. Use small VCSEL arrays to provide high power, short pulses with precise timing to initiate Q-switching required for higher energy density in lasers; and 2. Refine VCSEL arrays to pump solid state lasers at higher power levels than laser diode arrays for ladar with fewer failures, simplified optics and lower system weight.
- Fiber Laser Beam Combining - as the telecommunications industry has matured fiber laser technology, it will soon be possible to produce a kilowatt from a single fiber. Combining the output of many fibers could be a method of producing a multi-kilowatt beam for illumination and weaponization while reducing weight and volume and simplifying thermal control systems. MIT/LL will develop beam combining technology to enable scaling of high-efficiency fiber laser arrays.

The Interceptor Technologies Program (ITP) is structured to identify, develop, and transition advanced capabilities for future BMDS weapon systems. Infusion of ITP products will provide new capabilities for Boost, Midcourse, and Terminal Defense to counter new and evolving threats and countermeasures. These technologies provide miniaturized components to enable next generation small and lightweight kill vehicles and space products. They provide robust intercept capabilities in the absence of a priori target information, enhanced target detection and tracking by the kill vehicle, and improved lethality in the presence of endgame countermeasures. The ITP seeks to deliver advanced components and subsystem technologies to enable next generation interceptors and discrimination approaches as well as upgrade and enhance existing kill vehicles to allow them to keep pace with the evolving threat. In addition, the ITP develops new system concepts that defeat evolving threats and countermeasures. The ITP addresses critical needs identified by Systems Engineering studies and STRATCOM's Prioritized Capabilities List, and risks identified by the MDA acquisition elements. The ITP also leverages the SBIR technology base and industry/FFRDC/university IRAD programs.

During FY 2008, the ITP continued FY 2007 development activities, conducting trade studies, soliciting inputs from industry, assessing technology shortfalls, and planning development projects. Initial investments in promising technologies were made in the following projects:

- Agile Kill Vehicle Technologies - Component, subsystem, and algorithm development to address maneuvering threats.
  - Interceptor propulsion (lightweight solid- and liquid-divert with high thrust and attitude control systems).
  - Lightweight, high strength structures and materials with integral radiation hardening.
  - Advanced kill vehicle guidance, navigation, and control algorithms.
  - Advanced interceptor communications (novel kill vehicle communications approaches and components, low latency in-flight target updates).

- Kill Vehicle Seekers - Concepts, hardware, software, and laboratory prototype development of small, lightweight components and multimode seekers capable of withstanding high stresses from fast accelerating boosters/divert.
  - Advanced active/passive seekers for target object mapping and target identification.
  - Distributed aperture target acquisition methodologies for small kill vehicles.
- Air-Launched Concepts - New concepts and prototype hardware modification and/or development.
  - Air launched weapons concept development and preliminary designs, based on integrating existing PAC-3, THAAD-derived, or new interceptors based on existing air-to-air missile components; and modifying existing EO/IR sensors for employment on aircraft.
  - Advanced air-based weapons employment simulations and concept of operations development utilizing advanced Operator-in-the-Loop simulations.
- Novel Discrimination Concepts - System concept development, trade studies, and component development.
  - Seeker/sensor technologies that offer improved ability to identify threats from among the non-lethal objects during intercept.
  - New and innovative methods to improve the Ballistic Missile Defense System (BMDS) discrimination against future threats.

The Innovation area seeks out promising new missile defense concepts and technology solutions from domestic and foreign small business, universities, government laboratories, and individual technologists with the intent to mature them to a level where they can be evaluated for transition directly to the BMDS or alternately to the Sensors, Weapons, or Hercules technology areas for continued development. The search for these technologies includes targeted technology outreach efforts and open solicitations that seek proposals for consideration from domestic and foreign industry, universities/colleges, researchers, and other agencies. The Innovation activity is organized into three distinct outreach efforts. The first area includes the Advanced Technology Broad Agency Announcement (BAA) and the Missile Defense, Science, Technology And Research (MSTAR) program, both supported by the Advanced Technology Innovation Cell (ATIC). The second area is comprised of statutory programs, and consists of the Technology Applications (TA) to comply with Technology Transfers mandates and technical oversight of the Historically Black Colleges and Universities/ Minority Institutions (HBCU/MI), the Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programs. The third area is congressionally directed programs which are managed with a goal of maximizing utility for the BMDS.

- The Advanced Technology BAA invites proposals from foreign and domestic businesses, universities, researchers and agencies. This BAA funds domestic and international technologies which are the foundation of the future MDA technology portfolio . The BAA seeks new technologies and innovative concepts for components of the BMDS, and for technological improvements and/or cost reductions in the boost, midcourse, and terminal phases of missile defense. Specific research areas for each missile defense phase encompass Surveillance, Acquisition and Tracking, Discrimination, Communications, Engagement Planning, Threat Engagement, and Kill Assessment. New concepts are sought in the following seven technology areas: Radar Systems, Lasers and Electro-Optical Systems, Integrated Active/Passive IR Sensor Systems, Computer Science, Signal and Data Processing, Physics, Chemistry, and Materials, Mechanical and Aerospace Engineering, and Battle Management/Command and

Control. The Innovation activity established an Advanced Technology Innovation Cell (ATIC) to assess, evaluate and recommend investment for new and innovative technologies among proposals from all sources, both domestic and international. The ATIC uses a pool of recognized subject matter experts (SMEs) for the reviews and recommendations. This team of experts (government, industry, and academic) evaluates new ballistic missile defense concepts and technologies determining their technical feasibility, potential value added to the BMDS, initial capability, and maintains cognizance over leading edge concepts. The ATIC performs this function for all solicitations under the cognizance of the Innovation area (Advanced Technology BAA, MSTAR, SBIR/STTR, and HBCU/MI).

- The MSTAR program is an open BAA used to seek out breakthrough revolutionary technology from domestic, accredited universities. It leverages innovative research within academia in ten topic areas having potentially high payoff within the BMDS and provides an opportunity for our brightest young scientists and engineers to contribute to missile defense. MSTAR awards are three-year efforts with a maximum funding level of $600K ($200K/year).
- The Innovation activity conducts the congressionally mandated, Office of Secretary Defense directed Technology Applications (TA) program. This technology transfer program provides education, advice, and access to a business network and publicity for MDA-funded technologists at small and large businesses, universities, and federally funded laboratories. The TA program seeks to reduce the cost of technology development through attracting commercial investment and accelerating maturation of technologies developed by MDA by introducing them into the high volume commercial marketplace.
- The Innovation activity manages and executes the FFAR directed congressionally mandated HBCU/MI program. The Innovation team conducts this program by issuing a BAA soliciting HBCU/MI proposals for research focused on contributing to key MDA technology needs. Contract funding is provided by MDA Small Business office, but Innovation funds the management activities. Innovation researches topics and selects BMDS relevant proposals from Historically Black Colleges and Universities/Minority Institutions (HBCU/MI). Innovation also provides technical and management oversight for the selected proposals.
- The Innovation activity provides technical direction for the congressionally mandated (15 U.S.C. 638(j)(3)) Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) program. Contract funding is provided by MDA Small Business office, but Innovation funds the technical oversight activities for topic selection and evaluation. The effort oversees topic development, evaluates and selects the best proposals from small businesses, and manages the resulting contracts. Advanced Technology SBIR managers conduct the MDA SBIR research, evaluation and debriefing process for all MDA Phase I & II proposals.
- The Innovation activity provides technical and management oversight for congressional interest technology programs.

The Advanced Command, Control, Battle Management, and Communications (C2BMC) and Network Technology effort focuses on developing the next generation command and control and battle management concepts and the enabling technologies required to implement them among the BMDS. These activities will develop, integrate, and demonstrate advanced C2BMC concepts and enabling technologies for improving BMDS performance

across all mission areas to include defense of friends and allies. Advanced BMDS integration concepts and techniques are demonstrated and evaluated in system-wide flight tests to facilitate the transition to the operational C2MBC. The key concepts under development include:

- Early BMDS subsystem integration, risk reduction, technology maturation, and confidence building. This activity uses simulation, Human-Machine Interface (HMI), mock-ups, early connectivity and prototype interfacing, to enable early information integration at the BMDS level for Command and Control, Battle Management, and Networking capabilities.
- Pathfinder command and control capabilities, including situational awareness, collaborative planning, post-intercept debris and consequence mitigation/management.
- Advanced sensor netting, including techniques to coordinate sensor resources for advanced tracking and discrimination capabilities.
- Advanced battle management and integrated fire control concepts, including techniques to coordinate weapon system engagements to achieve optimal shot doctrine and manage sensor resources against coordinated threat attacks.
- Advanced networking technology, to include migration to distributed architectures for providing distributed, fault tolerant, and gracefully degradable core C2MBC capabilities.
- Advanced concepts and risk reduction efforts associated with BMDS coalition and allied partner integration. Specific areas include situational awareness, post-intercept debris and consequence mitigation/management, and collaborative defense planning.

B. Accomplishments/Planned Program

	FY 2007	FY 2008	FY 2009
Statutory and Mandated	0	1,589	1,611
RDT&E Articles (Quantity)	0	0	0

FY08 Planned Program:

Technology Applications Program:

- The Technology Applications program will conduct Technology Applications Reviews and Business Focus Workshops. Continue to accelerate technology maturation techniques such as commercialization assistance by expert reviews and advice, out reach publications and web site, consultation and training of technology developers, and application of standard metrics to validate technology maturation claims.

HBCU/MI:

- Continue technical oversight of the HBCU/MI to support BMDS technology needs as they arise. Comply with DFARS 226-7000 which implements HBCU and MI provisions of 10 U.S.C. 2323 and sets a DoD goal of 5% for each fiscal year to award contract and subcontract dollars to small disadvantaged business concerns and HBCUs and MIs.

- Transition successful HBCU/MI programs to the BMDS or Sensors, Weapons, and Hercules technology areas.

SBIR/STTR:
- Continue technical oversight of the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) program.

FY09 Planned Program:
Technology Applications Program:
- The Technology Applications program will conduct Technology Applications Reviews and Business Focus Workshops. Continue to accelerate technology maturation techniques such as commercialization assistance by expert reviews and advice, out reach publications and web site, consultation and training of technology developers, and application of standard metrics to validate technology maturation claims.

HBCU/MI:
- Continue technical oversight of the HBCU/MI to support BMDS technology needs as they arise. Comply with DFARS 226-7000 which implements HBCU and MI provisions of 10 U.S.C. 2323 and sets a DoD goal of 5% for each fiscal year to award contract and subcontract dollars to small disadvantaged business concerns and HBCUs and MIs.
- Transition successful HBCU/MI programs to the BMDS or Sensors, Weapons, and Hercules technology areas.

SBIR/STTR:
- Continue technical oversight of the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) program.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2007	FY 2008	FY 2009
Weapons Technology	0	35,528	43,655
RDT&E Articles (Quantity)	0	0	0

FY08 Planned Program:

- Laser Technology Program
  - Strategic Illuminator Laser - Complete government testing of delivered unit prior to incorporation into Airborne Laser.
  - Advanced Inertial Reference Unit - Deploy to Maui Space Surveillance System and integrate into Active Track Program.
  - COIL Improvements - Deuterated Fuels: Test deuterated reactants and mature fuels work toward full-scale demonstration to determine reactant utility; Injectors - resume fabricating full-scale Iodine nozzles for testing; Iodine Advanced Generators - resume scaling up the selected configuration for thorough testing.
  - Ultra-Sensitive Detectors - Complete Detector system modeling, final design documentation, and delivery of prototype camera system for testing at government location.
  - Advanced Track Illuminator Laser (ATILL) - Complete concept development phase with Concept Design Review and exercise option(s) for breadboard design and fabrication. Contractors to work with MIT/LL to leverage their facilities and expertise
  - High Brightness / High Efficiency Lasers - Build and test the 10 W demonstrator DPAL using pump diodes, a pump delivery system, vapor cell and cooling components from the design effort. TACL efforts will focus on ceramic material selection and laser model development followed by initial lasing experiments. Finalized design and fabricate an 850 W demonstrator DPAL based on lessons learned from 10 W prototype with scaled-up thermal control system. Extensive TACL experiments will refine models and fabricate improved gain media for best beam quality possible.
  - Optically Triggered Q-Switch / High Average Power Pump Arrays - Design and build trigger electronics, assemble trigger modules and test Cr+4 active q-switched unit / Design, fabricate, and package pump array module and test 885nm VCSEL pumped solid state laser.
  - Convene a laser technology working group meeting to examine promising BMDS relevant laser technologies and select one to three technology base projects in FY 2008 for execution in FY 2009. Define knowledge/decision points to measure technical progress for each selected project.
  - Fiber Laser Beam Combining - Survey different approaches, select the most promising approach and complete a detailed design. Conduct supporting experiments with breadboard fiber holder. Begin hardware procurements for FY09 8-element demonstration.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

Interceptor Technologies Program:

- Select a limited number of technology projects executed in FY 2007 for continued development in FY 2008. Candidate technology projects include:
  - Optimal guidance and kill vehicle control algorithms for maneuvering threats;
  - Lightweight, high thrust liquid divert and attitude control system (DACS) thrusters and pressurization concepts (component laboratory demonstrations);
  - Lightweight, high strength structures characterizations with integrated radiation hardening (component laboratory demonstrations);
  - Miniaturized communications components (component laboratory demonstrations);
  - Advanced active/passive seeker breadboard telescope laboratory characterization with active component;
  - Distributed aperture seeker algorithm and hardware-in-the loop demonstrations;
  - Preliminary design of external weapons bay with integrated EO/IR sensor, capable of supporting a flight test with PAC-3 or THAAD derivative interceptors;
  - Advanced air-based weapons employment simulations and concept of operations development;
- Concept studies and analyses for selected novel discrimination concepts.

FY09 Planned Program:

- Laser Technology Program
  - COIL Improvements - Test deuterated fuels in full-scale demonstration and resume full-scale Injector fabrication, Generator performance verification, and development of four Iodine Nozzle technologies.
  - Advanced Track Illuminator Laser (ATILL) - Complete fabrication of breadboard laser and verification testing leading to scale-up of design and production by single contractor.
  - Optically Triggered Q-Switch / High Average Power Pump Arrays - Complete testing of optically triggered Q-switch and scale-up (additional modules) and test pump arrays along with integrated thermal management system.
  - Continue those efforts started in FY 2008 that demonstrate sufficient technical progress towards defined knowledge/decision points.
  - Convene a laser technology working group meeting to examine promising BMDS relevant laser technologies and select one to three technology base projects in FY 2009 for execution in FY 2010. Define knowledge/decision points to measure technical progress for each selected project.
  - Fiber Laser Beam Combining - Complete 8-element prototype and test the resultant beam for power level and quality. Scale up design for 24 elements and begin long lead parts procurement.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

- Interceptor Technologies Program:
  - Continue development of technology projects selected in FY 2008. Candidate technology projects include:
    - Optimal guidance and kill vehicle control algorithm (Hardware-In-the-Loop testing).
    - Lightweight liquid divert and attitude control system (DACS) thrusters and pressurization system hot fire tests (component laboratory demonstrations).
    - Lightweight, high strength prototype structures characterizations.
    - Miniaturized communications components(component laboratory demonstrations).
    - Advanced active/passive seeker breadboard demonstrations with active component.
    - Distributed aperture seeker algorithm and hardware demonstrations.
    - Complete detailed design and prototype of a sensor and external weapons bay for tactical fighter aircraft.
    - Advanced air-launched weapons employment simulations and concept of operations refinement.
  - Concept studies and analyses of novel discrimination concepts.

	FY 2007	FY 2008	FY 2009
Innovative Technology and Analysis	0	6,125	8,575
RDT&E Articles (Quantity)	0	0	0

FY08 Planned Program:
Technology Outreach and Advanced Technology BAA:

- Continue to seek innovative and breakthrough technologies from domestic and international sources via the DV-BAA process.
- Continue to pursue International program and expand Project Arrangements with other countries to attract participating scientist to work at MDA.
- Continue to seek collaboration opportunities with MDA and other Government, Industry, and International efforts.

MSTAR:

- Award several MSTAR contracts in a variety of missile defense technology areas seeking to further acquire technology needed to counter evolving ballistic missile threats to the US and it allies.

FY 09 Planned Program:
Technology Outreach and Advanced Technology BAA:

- Continue to seek innovative and breakthrough technologies from domestic and international sources via the DV-BAA process.
- Continue to pursue International program and expand Project Arrangements with other countries to attract participating scientist to work at MDA.

- Continue to seek collaboration opportunities with MDA and other Government, Industry, and International efforts.

MSTAR:

- Award several MSTAR contracts in a variety of missile defense technology areas seeking to further acquire technology needed to counter evolving ballistic missile threats to the US and it allies.

	FY 2007	FY 2008	FY 2009
Sensing Systems	0	47,075	46,945
RDT&E Articles (Quantity)	0	0	0

FY08 Planned Program:

Passive EO/IR Technology:

- Continue to improve type II super-lattice material quality and passivation. Deliver single-color, long-wavelength, focal plane array for lab testing and hardware in the loop testing. The goal is to demonstrate the technology in single color, then go to very large format, two-color array for MKV and very long wavelength for STSS.
- Continue to reduce the buffer layer dislocation defects of the HgCdTe on Si substrate. Deliver single color long wavelength focal plane array for lab testing. The goal is to be a competitive technology to be demonstrated in single color, then go to very large format two-color for MKV and long wavelength for STSS.
- Continue to develop 2k x 2k two-color quantum well infrared photo-detector arrays for ABL Block upgrades.
- Look into new concepts of infrared technologies, such as dilute III-V material for future potential infrared material to meet BMD needs.

Radar System Technology:

- Complete fabrication, assembly integration and test and delivery of SPEAR Spiral 1 quarter panels.
- Conduct independent government tests of SPEAR Spiral 1 quarter panels.
- Initiate design activities for SPEAR Spiral 2 antenna development.
- Complete SPEAR risk reduction SiGe T/R Chip development with delivery of fully tested SiGe T/R device.
- Demonstrate NGT gallium nitride MMIC 1,000,000 hour mean time to failure, achieving key knowledge point.
- Continue NGT MMIC and transmit receive module development.
- Conduct NGT TRIMM Preliminary and Critical Design Reviews.

- Coordinate, finalize and initiate execution of MDA-DARPA Gallium Nitride (GaN) Power Amplifier Technology Transition Agreement and the associated collaborative technology development and transition to production (TTP) program.

Early Launch Detection and Tracking Technology:

- Development of SkyLOS-C2BMC data interface and test in JNIC X-Lab to investigate message format, data latency, and data fusion.
- Develop CONOP for using SkyLOS in concert with other BMDS elements through X-Lab simulations and test.
- Extend the detection and tracking algorithms being developed for SkyLOS measurements to accommodate Overhead Non-imaging Infra-Red (ONIR) measurements.
- Demonstrate the fusion algorithms using actual data collected during ELDT SkyLOS experiments.
- Development of SkyLOS-C2BMC data interface and test in JNIC X-Lab to investigate message format, data latency, and data fusion.
- Develop CONOP for using SkyLOS in concert with other BMDS elements through X-Lab simulations and test.
- Extend the detection and tracking algorithms being developed for SkyLOS measurements to accommodate Overhead Non-imaging Infra-Red (ONIR) measurements. Demonstrate the fusion algorithms using actual data collected during ELDT SkyLOS experiments.
- Participate in cooperative R&D waveform development testing in Australia that will demonstrate advanced MIMO Over the Horizon radar clutter mitigation using Australian operational assets.
- Develop technical specifications for HTI system to be demonstrated and flown aboard AFRL technology satellite
- Conduct testing of real-time HTI launch detection techniques, to include detection algorithms and advanced sensors
- Demonstrate through cloud detection of developmental HTI sensor
- Develop jitter mitigation techniques for HTI sensor
- Conduct flight and ground tests using FAC sensors

Spectral Sensing for Kill Assessment:

- Complete development of high speed spectrometer instrument package for support of data collection during intercept flight tests.
- Continue with BMDS hyper/multi-spectral sensor prototype design, development, and testing.
- Perform ground based experiments to verify exploitable impact features derived from modeling and small scale tests.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

FY09 Planned Program:

Passive EO/IR Technology:

- Continue to improve type II super-lattice material quality and passivation. Deliver single-color, long-wavelength, focal plane array for lab testing and hardware in the loop testing. The goal is to demonstrate the technology in single color, then go to very large format, two-color array for MKV and very long wavelength for STSS.
- Continue to reduce the buffer layer dislocation defects of the HgCdTe on Si substrate. Deliver single color long wavelength focal plane array for lab testing. The goal is to be a competitive technology to be demonstrated in single color, then go to very large format two-color for MKV and long wavelength for STSS.
- Continue to develop 2k x 2k two-color quantum well infrared photo-detector arrays for ABL Block upgrades.
- Look into new concepts of infrared technologies, such as dilute III-V material for future potential infrared material to meet BMD needs.

Radar System Technology:

- Conduct Preliminary and Critical Design Reviews for the SPEAR Spiral 2 10,000 element array.
- Conduct testing of SPEAR Demonstration System backend using the SPEAR Spiral 1 tiles.
- Complete final design activities for the SPEAR Demonstration System and order long lead items.
- Complete NGT DC/DC converter development and prototype TRIMM fabrication, assembly, integration and test.
- Complete NGT transition-to-production (TTP) plans; put in place MANTECH efforts; fabricate TTP TRIMMs and begin THAAD pilot array testing.

Early Launch Detection and Tracking Technology:

- Perform integrated MIMO, multi-site (4), multi-channel SkyLOS RX data collection at Woomera, AU using LOS TX and cooperative target.
- Demonstrate joint exploitation of SkyLOS + ONIR sensors for early launch detection tracking and target typing.
- Development testing of MIMO transmit waveforms with Australia to demonstrate real time radar clutter mitigation using Australian operational assets.
- Integrate operational HTI prototype on AFRL technology demonstration satellite.
- Conduct flight and ground tests of operational HTI sensor.

Spectral Sensing for Kill Assessment:

- Complete development of high speed spectrometer instrument package for support of data collection during intercept flight tests.
- Continue with BMDS hyper/multi-spectral sensor prototype design, development, and testing.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

- Perform ground based experiments to verify exploitable impact features derived from modeling and small scale tests.

	FY 2007	FY 2008	FY 2009
Congressional Action	0	12,600	0
RDT&E Articles (Quantity)	0	0	0

FY 08 Planned Program:

Provide programmatic oversight and technical influence for the following congressionally directed technology programs:

- Aluminum Nitride for Substance and Devices
- Massively Parallel Optical Interconnects
- Multiple-Target-Tracking Sensor-Array Technology (MOST)
- Net Centric Airborne Defense Element (NCADE)

	FY 2007	FY 2008	FY 2009
Advanced Communications Technology	0	0	12,333
RDT&E Articles (Quantity)	0	0	0

FY09 Planned Program:

- Commence/continue activities to enable the integration of advanced C2BMC capabilities into BMDS subsystems.
  - Demonstrate and evaluate advanced C2BMC capabilities in five live-flight test events using the C2BMC X-Lab.
  - Align war fighter concept of operations (CONOPS) with appropriate engagement sequence group (ESG) in the areas of boost phase tracking and classification, sensor resource management, weapons resource management, post-intercept debris information flow, and communication with allies.
- Develop and demonstrate next generation command and control capabilities.
  - Continue to Develop, demonstrate, and transition a sensor registration and health and status monitoring capability for fixed site sensors.
- Develop and demonstrate next generation sensor netting and sensor resource management techniques.
  - Conduct sensor netting experiments associated with BMDS registration, sensor tracking (local), network tracking, discrimination, sensor resource tasking, system-level TOM, and communications/bandwidth constraints.
  - Conduct assessments of expanded distributed track processing capabilities for the BMDS, to include measurement and track-level sensor information. Assess both tracking and discrimination constructs for adapting TCN to achieve BMDS and IAMD system tracking and discrimination needs.
- Develop and demonstrate advanced battle management (BM) and integrated fire control capabilities.

- Conduct architecture assessments of BM functions federated between C2BMC/GIFC and various allied/coalition partners.
- Integrate the CONOPS information and engagement sequence group (ESG) priorities for advanced and emerging BMDS capabilities (such as multiple kill vehicles) into distributed battle management constructs.

- Demonstrate and transition advanced networking technologies.
  - Continue assessment of distributed track processing capabilities for IAMD integration, including the use of TCN to enable effective C2 and BM/fire control capabilities under conditions of limited communications bandwidth.

C. Other Program Funding Summary

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	Total Cost
PE 0207998C BRAC	0	103,219	159,938	61,931	8,724	0	0	333,812
PE 0603881C Ballistic Missile Defense Terminal Defense Segment	1,082,454	1,045,276	1,019,073	795,659	719,847	548,283	439,752	5,650,344
PE 0603882C Ballistic Missile Defense Midcourse Defense Segment	2,985,140	2,243,213	2,209,262	2,276,848	1,385,258	946,437	1,103,532	13,149,690
PE 0603883C Ballistic Missile Defense Boost Defense Segment	622,218	510,241	421,229	423,927	652,642	799,792	991,839	4,421,888
PE 0603884C Ballistic Missile Defense Sensors	514,989	586,121	1,221,143	1,184,280	1,099,649	1,077,632	823,583	6,507,397
PE 0603886C Ballistic Missile Defense System Interceptors	341,358	340,107	386,817	500,966	708,803	815,433	553,136	3,646,620
PE 0603888C Ballistic Missile Defense Test and Targets	584,615	621,861	673,691	672,976	690,938	708,991	719,209	4,672,281
PE 0603890C Ballistic Missile Defense System Core	425,889	413,934	432,262	482,947	605,219	561,947	571,498	3,493,696
PE 0603891C Special Programs - MDA	347,377	196,892	288,315	304,234	538,050	818,136	786,349	3,279,353
PE 0603892C Ballistic Missile Defense Aegis	1,125,426	1,126,337	1,157,783	1,234,220	1,078,539	1,066,712	1,102,542	7,891,559
PE 0603893C Space Tracking & Surveillance System	311,402	231,528	242,441	266,509	560,130	735,727	938,191	3,285,928
PE 0603894C Multiple Kill Vehicle	133,615	229,943	354,455	488,294	649,632	708,582	879,385	3,443,906
PE 0603895C BMD System Space Program	0	16,552	29,771	41,638	56,199	133,915	157,548	435,623
PE 0603896C BMD C2BMC	249,179	447,616	289,277	287,194	270,762	256,767	259,159	2,059,954
PE 0603897C BMD Hercules	46,268	52,462	55,955	55,289	56,400	51,902	52,784	371,060
PE 0603898C BMD Joint Warfighter Support	49,833	49,394	69,982	73,997	77,205	80,168	81,948	482,527
PE 0603904C Missile Defense Integration & Operations Center	104,389	78,557	96,404	100,437	100,366	101,512	102,840	684,505
PE 0603905C BMD Concurrent Test and Operations	21,870	0	0	0	0	0	0	21,870

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	Total Cost
PE 0603906C Regarding Trench	0	1,986	2,978	4,964	4,963	8,933	8,933	32,757
PE 0603907C Sea Based X-Band Radar (SBX)	0	165,243	0	0	0	0	0	165,243
PE 0605502C Small Business Innovative Research - MDA	142,510	0	0	0	0	0	0	142,510
PE 0901585C Pentagon Reservation	15,527	6,019	19,734	5,040	5,284	5,370	5,456	62,430
PE 0901598C Management Headquarters - MDA	93,350	80,392	86,453	70,355	69,855	69,855	69,855	540,115

D. Acquisition Strategy

BMD Technology does not have any major performers that qualify for this category based on the Financial Management Regulations.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

COST ($ in Thousands)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
0602 Program-Wide Support	7,680	0	0	0	0	0	0
RDT&E Articles Qty	0	0	0	0	0	0	0

Note: Efforts within this project continue in FY2008 and out under project ZX40

A. Mission Description and Budget Item Justification

Program-Wide Support provides funding for common non-headquarters support functions across the entire program such as strategic planning, program integration, business management, cost estimating, contracting, and financial management, to include preparation of financial statements, reimbursement of financial services provided by DFAS, internal review and audit, earned-value management, and program assessment. Includes costs for both government civilians performing these functions, as well as outside services and support contractors that augment government staff in these areas. Many of these costs reside within the Missile Defense Agency Executing Agents in the Services: Army Space and Missile Defense Command, Army PEO Space and Missile Defense, Office of Naval Research, and various Air Force laboratory and acquisition activities, although some functions and costs within this program element are performed by MDA employees assigned within the National Capital Region (NCR). Other costs included herein provide facility capabilities for MDA Executing Agent locations, such as physical and technical security, legal services, travel and training, office and equipment leases, utilities and communications, supplies and maintenance, and similar operating expenses. Also includes funding for charges on canceled appropriations in accordance with Public Law 101-510, legal settlements, and foreign currency fluctuation on a limited number of foreign contracts.

B. Accomplishments/Planned Program

	FY 2007	FY 2008	FY 2009
Civilian Salaries and Support	7,680	0	0
RDT&E Articles (Quantity)	0	0	0

See Section A: Mission Description and Budget Item Justification

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

C. Other Program Funding Summary

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PE 0603890C Ballistic Missile Defense System Core	425,889	413,934	432,262	482,947	605,219	561,947	571,498	3,493,696
PE 0603891C Special Programs - MDA	347,377	196,892	288,315	304,234	538,050	818,136	786,349	3,279,353
PE 0603892C Ballistic Missile Defense Aegis	1,125,426	1,126,337	1,157,783	1,234,220	1,078,539	1,066,712	1,102,542	7,891,559
PE 0603893C Space Tracking & Surveillance System	311,402	231,528	242,441	266,509	560,130	735,727	938,191	3,285,928
PE 0603894C Multiple Kill Vehicle	133,615	229,943	354,455	488,294	649,632	708,582	879,385	3,443,906
PE 0603895C BMD System Space Program	0	16,552	29,771	41,638	56,199	133,915	157,548	435,623
PE 0603896C BMD C2BMC	249,179	447,616	289,277	287,194	270,762	256,767	259,159	2,059,954
PE 0603897C BMD Hercules	46,268	52,462	55,955	55,289	56,400	51,902	52,784	371,060
PE 0603898C BMD Joint Warfighter Support	49,833	49,394	69,982	73,997	77,205	80,168	81,948	482,527
PE 0603904C Missile Defense Integration & Operations Center	104,389	78,557	96,404	100,437	100,366	101,512	102,840	684,505
PE 0603905C BMD Concurrent Test and Operations	21,870	0	0	0	0	0	0	21,870
PE 0603906C Regarding Trench	0	1,986	2,978	4,964	4,963	8,933	8,933	32,757
PE 0603907C Sea Based X-Band Radar (SBX)	0	165,243	0	0	0	0	0	165,243
PE 0605502C Small Business Innovative Research - MDA	142,510	0	0	0	0	0	0	142,510
PE 0901585C Pentagon Reservation	15,527	6,019	19,734	5,040	5,284	5,370	5,456	62,430
PE 0901598C Management Headquarters - MDA	93,350	80,392	86,453	70,355	69,855	69,855	69,855	540,115

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

COST ($ in Thousands)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
ZX40 Program-Wide Support	0	5,506	5,599	6,029	5,697	6,382	6,382
RDT&E Articles Qty	0	0	0	0	0	0	0

Note: In accordance with the Missile Defense Agency revised block structure, the content previously planned in Project 0602 for FY08-FY13 is now captured in Project ZX40.

A. Mission Description and Budget Item Justification

Program-Wide Support provides funding for common non-headquarters support functions across the entire program such as strategic planning, program integration, business management, cost estimating, contracting, and financial management, to include preparation of financial statements, reimbursement of financial services provided by DFAS, internal review and audit, earned-value management, and program assessment. Includes costs for both government civilians performing these functions, as well as outside services and support contractors that augment government staff in these areas. Many of these costs reside within the Missile Defense Agency Executing Agents in the Services: Army Space and Missile Defense Command, Army PEO Space and Missile Defense, Office of Naval Research, and various Air Force laboratory and acquisition activities, although some functions and costs within this program element are performed by MDA employees assigned within the National Capital Region (NCR). Other costs included herein provide facility capabilities for MDA Executing Agent locations, such as physical and technical security, legal services, travel and training, office and equipment leases, utilities and communications, supplies and maintenance, and similar operating expenses. Also includes funding for charges on canceled appropriations in accordance with Public Law 101-510, legal settlements, and foreign currency fluctuation on a limited number of foreign contracts.

B. Accomplishments/Planned Program

	FY 2007	FY 2008	FY 2009
Civilian Salaries and Support	0	5,506	5,599
RDT&E Articles (Quantity)	0	0	0

See Section A: Mission Description and Budget Item Justification

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2008
APPROPRIATION/BUDGET ACTIVITY: RDT&E, DW/03 Advanced Technology Development (ATD)	R-1 NOMENCLATURE: 0603175C Ballistic Missile Defense Technology

C. Other Program Funding Summary

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	Total Cost
PE 0207998C BRAC	0	103,219	159,938	61,931	8,724	0	0	333,812
PE 0603881C Ballistic Missile Defense Terminal Defense Segment	1,082,454	1,045,276	1,019,073	795,659	719,847	548,283	439,752	5,650,344
PE 0603882C Ballistic Missile Defense Midcourse Defense Segment	2,985,140	2,243,213	2,209,262	2,276,848	1,385,258	946,437	1,103,532	13,149,690
PE 0603883C Ballistic Missile Defense Boost Defense Segment	622,218	510,241	421,229	423,927	652,642	799,792	991,839	4,421,888
PE 0603884C Ballistic Missile Defense Sensors	514,989	586,121	1,221,143	1,184,280	1,099,649	1,077,632	823,583	6,507,397
PE 0603886C Ballistic Missile Defense System Interceptors	341,358	340,107	386,817	500,966	708,803	815,433	553,136	3,646,620
PE 0603888C Ballistic Missile Defense Test and Targets	584,615	621,861	673,691	672,976	690,938	708,991	719,209	4,672,281
PE 0603890C Ballistic Missile Defense System Core	425,889	413,934	432,262	482,947	605,219	561,947	571,498	3,493,696
PE 0603891C Special Programs - MDA	347,377	196,892	288,315	304,234	538,050	818,136	786,349	3,279,353
PE 0603892C Ballistic Missile Defense Aegis	1,125,426	1,126,337	1,157,783	1,234,220	1,078,539	1,066,712	1,102,542	7,891,559
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Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date **February 2008**
APPROPRIATION/BUDGET ACTIVITY **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE **0603175C Ballistic Missile Defense Technology**

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