Missile Defense Agency (MDA) Exhibit R-2 RDT&E Budget Item Justification	Date: February 2006
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

COST ($ in Thousands)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Total PE Cost	224,016	149,305	206,676	183,414	214,062	222,934	228,247
0502 Advanced Technology Development	221,875	144,847	199,137	177,810	205,247	214,512	221,775
0602 Program-Wide Support	2,141	4,458	7,539	5,604	8,815	8,422	6,472

Note: In FY06, the Multiple Kill Vehicles program funding moved from Project 0502 (Engagement Systems area) to a new Program Element (0603894C) in Project 0515, Multiple Kill Vehicles.

Beginning in FY06, funding for the Near Field Infrared Experiment (NFIRE) was moved to Advanced Technology from PE 0306886C per Congressional direction.

A. Mission Description and Budget Item Justification

The Advanced Technology Program Element develops the next generation technology capabilities for the Ballistic Missile Defense System (BMDS) to counter the current and evolving BMD threat. The technology investment priorities balance the pursuit of next generation technology with promising high payoff near-term technology solutions to increase the current BMDS capability. The technology development activities include six focused areas that develop and mature promising concepts and technologies. The six areas are Innovation and Analysis, Sensing Systems Technology, Engagement Systems Technology, the High Altitude Airship (HAA), Advanced Command and Control and Battle Management and Communications (C2BMC) Technology, and the Near Field Infrared Experiment (NFIRE).

A.1 System Element Description

The Advanced Technology development program develops technology and future capabilities to counter current and evolving threat ballistic missiles. The technology initiatives are transitioned to current BMDS weapons, sensors, and command and control, battle management, and communications (C2BMC) components to improve the capability of the BMDS.

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

This Program Element supports the development of technologies for the entire BMDS. This PE considers BMDS technology needs associated with individual elements as well as unique requirements to realize the next generation BMDS. The technology efforts selected for development may lead to enhanced performance of a specific BMDS component/subsystem, may benefit a common component that can be used by multiple elements, or develop a new technology that adds a new capability to the BMDS. As technologies are matured in this PE, opportunities to integrate them into BMDS components/subsystems are structured to support two-year block upgrades. Examples of planned transitions into the BMDS include the Photonic Time Delay Unit (PTDU) for the THAAD radar; the Strategic Illuminator Laser (SILL) for the Airborne Laser (ABL); the Multiple Kill

Vehicles (MKV) for the Ground Based Interceptor (GBI), Kinetic Energy Interceptor (KI) and future interceptor programs; and quantum well infrared photo detector cameras (QWIPs) for ABL.

A.3 Major System Element Goals

The three major goals for Advanced Technology are:

- Identify new system concepts and next generation technology for the BMDS
- Select and invest in high pay-off technology with a risk level commensurate with the pay-off, and seek large returns on investment to complement the BMDS
- Mature key promising technologies to support two-year BMDS block upgrades and long-term BMDS evolution

B. Program Change Summary	FY 2005	FY 2006	FY 2007
Previous President's Budget (FY 2006 PB)	231,145	136,241	184,877
Current President's Budget (FY 2007 PB)	224,016	149,305	206,676
Total Adjustments	-7,129	13,064	21,799
Congressional Specific Program Adjustments	0	26,056	0
Congressional Undistributed Adjustments	0	-12,992	0
Reprogrammings	-3,326	0	0
SBIR/STTR Transfer	-3,803	0	0
Adjustments to Budget Years	0	0	21,799

FY05 reduction of $7.129 million includes MDA reprogrammings and the SBIR/STTR transfer.

FY06 increase of $13.064 million includes Congressional specific program adjustments (most notably transfer in of the Near Field Infrared Experiment (NFIRE) and NetCentric Airborne Defense Element (NCADE); and transfer out of the High Altitude Airship (HAA)) and a portion of the MDA Congressional undistributed adjustment.

FY07 increase of $21.799 million follows through with the Congressionally directed transfers and includes overhead/infrastructure reductions.

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RDT&E Articles Qty	0	0	0	0	0	0	0

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A. Mission Description and Budget Item Justification

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The Innovation and Analysis (I&A) area seeks out new concepts and technology solutions through a series of programs enabling proposals from domestic and foreign industry, universities/colleges, researchers, and other agencies. The I & A activity matures this new and innovative technology to a level where it can be transitioned directly to the BMDS or selected as a promising technology for future maturation in one of the six technology areas. This area includes the technical direction and programmatic oversight focusing congressionally mandated technology activities towards providing technology improvements for the BMDS. The series of programs conducted in the Innovation and Analysis area include:

- The Advanced Technology Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) program 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.
- One I & A activity researches topics and selects BMDS relevant proposals from Historically Black Colleges and Universities/Minority Institutions (HBCU/MI). I & A provides technical and management oversight for the selected proposals.
- International Science and Technology collaboration proposals are managed by the I&A team. This team ensures that proposals from allied governments, individuals, businesses or universities are processed through full objective evaluation, recommendation and selection processes.

- Advanced Technology ensures MDA compliance with Technology Transfer mandates through conducting the MDA Technology Applications (TA) program. This program assists qualified participants by helping them to commercialize products developed from MDA funded technology. The TA program seeks to offset some of the cost and time of technology development by accelerating the maturation of technologies from MDA Contract recipients (BAA, SBIR, STTR, etc.) through the marketplace where private investment and broad application of the products accelerate technology reliability and reduce cost through rate production.
- The I & A activity provides technical and management oversight for congressional interest technology programs.
- The Advanced Technology Innovation Cell (ATIC) identifies, assesses, evaluates and recommends investment for new and innovative technologies among proposals from all sources, both domestic and international. The primary tool used by the ATIC to draw candidates is the Advanced Technology Broad Area Announcement (BAA) which invites proposals from foreign and domestic businesses, universities, researchers and agencies. Additionally, Advanced Technology manages the MDA Science Technology and Research (MSTAR) program which is a BAA open to domestic accredited universities.

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

The EO/IR Active Sensors task, under the Discriminating Sensor Technology (DST) program, is developing advanced laser radar (LADAR) technology. LADAR technology, coupled with passive sensors, can provide improved system discrimination performance by providing target features currently unavailable.

The EO/IR Passive Sensors task develops basic technology in components and materials focused on enhancing the capabilities of the BMDS. Examples include:

- Multi-color, low noise, focal plane arrays and multi-band IR/UV/Visual spectrum cameras
- Silicon substrates for Mercury-Cadmium-Telluride (HgCdTe) infrared sensors
- Very long wave infrared (VLWIR) sensors
- Advanced Infrared Search and Track technologies
- Deployable Large-Aperture Optical Collectors

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These technology initiatives benefit the BMDS by increasing the maximum range for detection of a threat, reducing uncertainty associated with a threat or threat cluster, by enabling a more accurate assessment of threat characteristics (to deduce the type warhead, trajectory, and predicted impact point), and by accelerating the command and control process required to commence missile defense

The Radar Systems Technology (RST) program integrates and tests next-generation transmitters, receivers, antennas, amplifiers, signal processors, and algorithms/software to demonstrate technologies to insert in BMDS radars in future blocks, as well as to enable and exploit new concepts in radar. RST focuses on technologies to improve traditional, high-power density radar systems such as existing Sea-Based X-Band (SBX) Radar and Forward Based X-Band (FBX-T) Radar systems. RST also focuses on revolutionary technology associated with low-power density radar systems with associated benefits of high performance and lower cost, compared to existing systems.

The Early Launch Detection and Tracking (ELDT) effort is developing and demonstrating early detection, all-weather surveillance and fire control technologies for transition to Boost Defense Segment systems. For a forward-based or theater-class missile defense system the time line is a critical component. This technology effort is expected to reduce the time required to detect a boosting missile compared to current baseline overhead and land/sea based assets. For ascent phase intercepts, the increase will be greater.

The Micro Satellite task is investigating small satellite concepts, payloads, and applications for future Ballistic Missile Defense System applications. The micro satellite concept is developing lighter, lower cost satellites that allow for tailoring of payloads and coverage for specific missions including persistent surveillance and on-demand operations against a specific threat region. The following three Micro Satellite experiments will demonstrate detection and tracking, communication, and propulsion concepts to enable future space-related BMD capabilities:

- The Distributed Sensing Experiment will demonstrate the ability of a network of two or three micro satellites to track targets in space and provide three-dimensional tracking information to ground stations.
- The Propulsion Experiment will demonstrate the ability of axial and divert propulsion systems to guide micro satellites, constrained by mass and volume, to fixed points in space. One micro satellite will be tested approximately 30 days after launch and a second micro satellite will be tested after one year in orbit to determine the survivability of the system propellant after it has been dormant for a year.
- Target Risk Reduction Experiment will demonstrate the ability of micro satellites to serve as cooperative targets for the ballistic missile defense system.

The Engagement Systems Technology area focuses on developing technologies enabling engagement of multiple threats in all phases of flight via hit-to-kill interceptors or directed energy. The activities in this area include technologies that increase the likelihood of successfully destroying an incoming ballistic missile by improving the kill vehicle or laser, as well as improving the target tracking and aim point selection using advanced laser

technologies. Promising new laser technologies are developed under the Laser Technology Program (LTP) and multiple promising technologies for hit-to-kill interceptors are being developed under the Multiple Kill Vehicle (MKV) program.

Note: In FY06, the Multiple Kill Vehicles program funding moved from Project 0502 (Engagement Systems area) to a new Program Element (0603894C) in Project 0515, Multiple Kill Vehicles. Additional technologies (beyond MKV) enabling the next generation hit-to-kill interceptors will be developed in this area.

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 which significantly advances the state-of-the-art in power, beam quality, reliability, and packaging for the Airborne Laser and other long-range laser platforms. The program validates both 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 (SLAL) - A powerful small laser transmitter (hundreds of watts) suitable for insertion on a missile defense platform with strict weight and volume constraints. Two contacts were awarded in May 2003 to Northrop Grumman and Coherent Technologies Inc. to develop competing/alternative prototype.
- 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 ABL. Contract was awarded in April 2003 to Applied Technology Associates to develop a breadboard prototype device used for telescope pointing and local-loop jitter suppression.
- Advanced Detectors - Improved detectors for laser radars, with increased sensitivity and bandwidth. Two contractors - SAIC and Sensors Unlimited, will fabricate camera systems for 3-D target tracking and wave front sensing (adaptive optics) for delivery to government facilities and subsequent checkout.
- Angle-Angle Range Doppler Imager (AARDI) - Combine the capabilities angle-angle range and coherent Doppler ladar to achieve both direct detection and coherent detection to enhance discrimination and aim point selection. MIT/LL began work on this project in January 2004.
- Advanced Chemical Oxygen-Iodine Laser (COIL) Technology - Development and experimental characterization of a high performance singlet delta oxygen generator based on a flat jet hydrogen peroxide ejectors that improve chemical yield and device manufacturability COIL technology may provide enhanced engagement performance while reducing the production risks. Contract awarded to Directed Energy Solutions in May 2004.
- Air (Oxygen) Laser - Develop and demonstrate a diode pumped liquid oxygen laser that reduces the weight and complexity of high energy laser weapons sources. The Phase I activity conducted using DARPA funding will develop and demonstrate a single KW device and design a scale-up

laser. Phase II, under joint MDA-DARPA funding, will demonstrate the scale-up, tens-of-kW, device. The goal of this effort is to produce high output power laser in a small, lightweight package for a future tactical directed energy weapon, the ABL Strategic Illuminator, or a discriminating LADAR.

- 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 Ejectors; and Advanced Diagnostics. Air Force Research Laboratory is pursuing the first three areas, while Los Gatos Research was competitively contracted for Advanced Diagnostics (February 2005). As these mature, they are anticipated to enable future performance enhancements through line upgrades to ABL.
- Ultra-Sensitive Detectors - Follow-on to Advanced Detectors, further increasing sensitivity to the single photon level by reducing background noise. Contracts were awarded in April 2005 to Raytheon Vision Systems and VOXTEL, for eventual down-select to one team.
- Advanced Track Illuminator Laser (ATILL) - FY06 new start for 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 illuminator.

The High Altitude Airship (HAA) area focuses on developing a stable, geostationary platform to support communications, sensor, or weapons requirements. The HAA concept demonstrates the technical feasibility and military utility of an unmanned, un-tethered, gas filled, solar powered airship that can fly for up to a month at 60,000 feet while carrying a 500 pound payload. The prototype is intended as a developmental step, and functions as a test bed for testing other MDA technologies, toward building an operational High Altitude Airship that can self-deploy from the continental United States to worldwide locations and operate autonomously for long-endurance operations (1 year or more). An operational HAA will be an autonomous, high-altitude, long-endurance platform that will enable continuous over-the-horizon communications, wide-area surveillance, and protection to support theater operations without interruption, or the cost / risk of employing a manned aircraft.

The Advanced Command and Control and 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. This activity will include participation in missile flight event and technology demonstrations to evaluate and assess these advanced concepts and technologies. The key concepts under development include:

- Early BMDS subsystem integration. This activity uses simulation, mock-ups, and testing activities to identify and resolve issues associated with integrating advanced capabilities and new subsystems into the BMDS in support of transition to operations.
- Advanced battle management and global integrated fire control concepts.
- Advanced command & control concepts and enabling network technology.
- Advanced mobile command & control concepts and enabling technology.

- BMDS coalition and allied partner integration (Situational Awareness, Post-Intercept Debris and Consequence Mitigation/Management, and Defense Planning) concepts and enabling technology primarily with UK, NATO and Japan.

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 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.

The Missile Defense Agency was approached by the German government to add a Laser Communications Terminal (LCT) to the satellite for performing communications experiments. These experiments will test satellite-ground and satellite-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.

MDA will benefit significantly from the large amounts of data transmitted directly from a sensor satellite via the LCT. Likewise, the BMDS will benefit as the NFIRE program will provide sensor data to the Missile Defense Space Experimentation Center (MDSEC), the ground operations for NFIRE, STSS and the Space Test Bed, under the auspices of the MDA Space Applications Center of Excellence, where the data will be utilized by multiple programs to improve missile engagement performance. In FY07, the NFIRE program will join the MDSEC in the new program element established in FY06 for the Space Test Bed (PE 0306895C) as one of two core program elements within the MDA Space Applications Center of Excellence.

NFIRE Goals:

- Launch the Near Field Infrared Experiment satellite in the 4th quarter of FY06
- Conduct multiple missions in FY07 to collect data
- Use the data to validate the models and simulations that are fundamental to developing the navigation, guidance and control and endgame homing algorithms

- If feasible, initiate planning for a second NFIRE mission in response to Congressional encouragement in the FY06 Appropriations Bill to complete development of the Kill Vehicle.

B. Accomplishments/Planned Program

	FY 2005	FY 2006	FY 2007
Statutory and Mandated	3,400	1,800	1,305
RDT&E Articles (Quantity)	0	0	0

Note: The SBIR/STTR, Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) and Technology Applications projects are all covered within the BMD Technology PE Statutory and Mandated program.

FY 05 Accomplishments:

- Continued to fund the HBCU/MI programs through contracts for innovative technologies such as advanced electro-optics, MEMS technology, and advanced signal processing.
- Continued providing technology maturation techniques, such as commercialization reviews and outreach, which help leverage outside resources and provide a strong foundation essential for scaling up MDA-funded technology to address system capabilities.
- Continued program support for the administration of the SBIR/STTR Program.
- Established investment strategy for continued advanced research in innovative technologies that can feed into identified technology shortfalls, such as advanced power supplies and lightweight cooling systems.

FY 06 Planned Program:

- Continue to fund HBCU/MI programs to capitalize on successes from past year work.
- Continue to accelerate technology maturation through 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.
- Continue program support for SBIR/STTR through development of topics that will attract innovative technology development proposals that can help achieve BMDS evolution and push the creativity of university and private technologists to help MDA meet technology goals.

FY07 Planned Program:

- Continue to fund HBCU/MI to support BMDS technology needs as they arise.

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- 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.
- Continue program support for SBIR and STTR through development of topics that will attract innovative technology development proposals that can help achieve BMDS evolution and push the creativity of university and private technologists to help MDA meet technology goals.

	FY 2005	FY 2006	FY 2007
Congressional Action	39,543	29,850	0
RDT&E Articles (Quantity)	0	0	0

FY05 Accomplishments:

- Provided Congressionally-mandated funding for research into these areas with an emphasis for the program to fill BMDS gaps and explore technology solutions for the net generation BMDS.
  - Advanced Processing Architecture
  - Next-Again-Generation Radiation Hard CMOS (Complementary Metal Oxide Silicon)
  - Ultra-Thin Integrated Electronics Miniaturization Trusted Foundry
  - Massively Parallel Optical Interconnects for Micro satellites
  - Center for Optical Logic Devices
  - Silicon Carbide Wide Bandgap Research
  - Multiple Target Tracking Optical Sensor Array Technology (MOST)
  - Advanced RF Technology Development
  - SiC Thick Film Mirror Coatings
  - Porous Silicon
  - Tulane Missile Defense

FY06 Planned Program:

- Provide Congressionally-mandated funding for these identified research focus areas, as a minimum, to explore technology solutions for the next generation BMDS.
  - Center for Optical Logic Devices
  - Massively Parallel Optical Interconnects for Micro Satellite Applications
  - Advanced RF Technology Development

- Multiple Target Tracking Optical Sensor Array Technology (MOST)
- Porous Silicon
- SiC Thick Film Mirror Coatings
- Advanced Processing Architecture
- Aluminum Nitride Substrates for Wide Bandgap Devices
- High Density Power Supplies using Silicon Carbide
- Day and Night Vision Sensor
- NetCentric Airborne Defense Element (NCADE)

	FY 2005	FY 2006	FY 2007
Innovative Technology and Analysis	7,467	10,118	13,519
RDT&E Articles (Quantity)	0	0	0

Note: The Advanced Technology Innovative Cell (ATIC) is the focal point of all internally and externally generated new ideas submitted to MDA. This team of experts (government, industry, and academic) evaluates new ballistic missile defense concepts and technologies determining their technical feasibility, initial capability, and maintains cognizance over leading edge concepts. The team seeks new and innovative concepts via a Federal Business Opportunities Broad Agency Announcement (BAA) for integrated systems and for technical improvement in boost, midcourse, and terminal phases of missile defense.

The Missile Defense Science, Technology and Research (MSTAR) program is MDA's University Research Program. It seeks to incorporate innovative research at the University level into ballistic missile defense, as well as to provide training for future missile defense scientists and engineers. MSTAR seeks new and innovative concepts via a Federal Business Opportunities Broad Agency Announcement (BAA) for research and for technical improvements in boost, midcourse, and terminal phases of missile defense.

FY05 Accomplishments:

- Solicited, received, and reviewed innovative ideas from industry, private individual and international sources. Selected promising ideas for further research through contracting actions.
- Funded proposals in electro-optics, lasers, advanced power systems, miniaturization of electronics, and other innovative technology.
- Released the MSTAR BAA to solicit proposals from academic institution.
- Awarded contracts under the MSTAR program to a number of institutions focusing on new technology areas evolving from university research. Areas included electro-optical systems, advanced signal processing, laser systems, and microelectronics.

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FY06 Planned Program:

- Continue to seek innovative and Breakthrough technologies and international sources.

FY07 Planned Program:

- Continue to seek innovative and breakthrough technologies from domestic and international sources.

	FY 2005	FY 2006	FY 2007
Sensing Systems	69,701	57,203	79,720
RDT&E Articles (Quantity)	0	0	0

FY05 Accomplishments:

- Discriminating Sensor Technology:
  - Tested upgraded range-resolved Doppler imaging LADAR breadboard at full power.
  - Integrated LADAR with passive sensors and beam pointing system.
  - Tested fully functional active/passive discriminating sensor with breadboard-level fidelity (Technology Readiness Level (TRL) 4) at the AMOR range.
  - Commenced design of a flyable brassboard discriminating sensor based on this technology.
- Passive EO/IR Technology:
  - Established executing agents and initiated efforts for Mercury-Cadmium-Telluride on Silicon, type II strained layer superlattice, high quantum efficiency quantum well infrared photo detectors, and Lead salt materials for focal plane arrays. These advanced IR detector materials improve the sensitivity and cost effectiveness of EO/IR sensors.
  - Developed figures of Merit that quantified goals for each effort.
  - Began growing materials and devices to build focal plan arrays. Material and devices met or exceeded planned quantified milestones.
  - Delivered two prototype quantum well infrared photo detector cameras to Boeing for joint field testing with the Airborne Laser System Program Office. These will support significant performance improvement in EO/IR sensors.
  - Continued development of 10K cryocooler and characterization and qualification of previously developed cryocoolers.
  - Conducted independent testing of previously developed focal plane arrays at the Air Force Infrared Radiation Effects Laboratory.
  - Upgraded focal plane array and cameral field test equipment at the Army Research Laboratory.
- Radar System Technology:
  - Continued development of next-generation transmitters, receivers, antennas, signal processors, and software for improvements in Ballistic Missile Defense System radars.

- Continued design and technical analysis of advanced antenna technologies; further demonstrate distributed aperture coherence; completed development of high voltage X-Band power amplifier chips based on GaAs technology.
- Commenced development of transmit/receive modules based on packaging of wide-bandgap materials in conjunction with DARPA.
- Conducted Preliminary Design Reviews for two competitive approaches to the low-power antenna tiles that will comprise the building blocks for the panels and antennae for the Scalable Panels for Efficient, Affordable Radar system development program.

- Early Launch Detection and Tracking Technology:
  - Continue investigation into electro-optical and radio-frequency methods for Early Launch Detection and Tracking (ELDT).
  - Participate in all available flight tests as well as dedicated static tests in order to continue gathering data for proof-of-principle.
  - Commence initial system engineering and design for prototypical ELDT sensors.
- Spectral Sensing for Kill Assessment:
  - Began Phenomenology studies to better understand the spectral environment resulting from a hyper-velocity impact between a kill vehicle and an RV with a nuclear warhead. Began preliminary sensor designs to test and study hyper-velocity impact phenomenology.
- Micro Satellites
  - Completed Distributed Sensing Experiment System Functional Review and initiated Phase 2 Design and Fabrication.
  - Completed Distributed Sensing Experiment preliminary design review.
  - Completed Micro Satellite Propulsion Experiment System Functional Review and initiated Phase 2 Design and Development.
  - Initiated Micro Satellite Propulsion Experiment source selection for the prime integrator. Established Micro Satellite Target System - Risk Reduction Experiment using Small Business Innovative Research approach.

FY06 Planned Program:

- Discriminating Sensor Technology:
  - Continue full-power testing currently underway at the Maui Space Sensor System test complex
- Passive EO/IR Technology:
  - Continue efforts for Mercury-Cadmium-Telluride on Silicon, type II strained layer superlattice, high quantum efficiency quantum well infrared photo detectors, and Lead salt materials for focal plane arrays.
  - Build initial focal plane arrays and conduct independent testing to evaluate performance.
  - Conduct hardware-in-the-loop testing in relevant Exoatmospheric Kill Vehicle and Terminal High Altitude Area Defense system environments at the Massachusetts Institute of Technology Lincoln Laboratory.
  - Conduct Airborne Laser System Program office field test of quantum well infrared photo detector and Mercury-Cadmium-Telluride cameras.
  - Continue 10K cryocooler development.

- Radar Systems Technology:
  - Continue development of next-generation transmitters, receivers, antennae, signal processors, and software for improvements in BMDS radars.
  - Continue design and technical analysis of advanced antenna technologies; begin the integration of tiles to comprise the low-power density antenna arrays.
  - Continue development of transmit/receive modules based on packaging of wide-bandgap materials in conjunction with DARPA.
- Early Launch Detection and Tracking Technology:
  - Continue investigation into electro-optical and radio-frequency methods for Early Launch Detection and Tracking (ELDT).
  - Participate in all available flight tests as well as dedicated static tests in order to continue gathering phenomenology data.
  - Participate in cooperative R&D with Australia to accomplish testing of advanced Over the Horizon radar concepts and algorithms.
  - Complete design and commence fabrication of prototypical ELDT sensors.
- Spectral Sensing for Kill Assessment:
  - Begin development of a high speed spectrometer instrument package for intercept flight tests.
  - Continue modeling effort of hyper-velocity impact and subsequent fireball development and spectral output. Perform ground based experiments to verify modeling efforts and test potential sensor prototypes
- Micro Satellites
  - Continue development of Micro Satellite technologies to enable future BMDS space components and systems. Planned activities will include at a minimum:
    - Complete Distributed Sensing Experiment Critical Design Review and initiate Phase 3 Fabrication, Integration and Test.
    - Select Prime Integrator for Micro Satellite Propulsion Experiment and prepare for Preliminary Design Review.
    - Select and award small business company to begin the Micro Satellite Target System - Risk Reduction Experiment.

FY07 Planned Program:

- Passive EO/IR Technology:
  - Continue efforts for Mercury-Cadmium-Telluride on Silicone, type II strained layer superlattice, high quantum efficiency quantum well infrared photo detectors, and Lead salt materials for focal plane arrays.
  - Build interim focal plane arrays and cameras and conduct independent testing to evaluate performance.

- Radar System Technology:
  - Continue development of next-generation transmitters, receivers, antennae, signal processors, and software for improvements in BMDS radars' detection, acquisition, tracking and discrimination. This effort includes possible development of large aperture passive RF antennae.
  - Continue design and technical analysis of advanced antenna technologies; test and characterize low power density arrays in a radar testbed.
  - Continue development of transmit/receive modules based on packaging of wide-bandgap materials in conjunction with DARPA.
- Early Launch Detection and Tracking Technology:
  - Complete fabrication of prototypical ELDT sensors in both electro-optical and radar frequency bands.
  - Utilize prototypes in all available flight tests.
- 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.
  - Initiate development of advanced, high accuracy Infrared Search and Track (IRST) system.
- Micro Satellites
  - Continue development of Micro Satellite technologies to enable future BMDS space components and systems. Planned activities will include at a minimum:
    - Complete the build of three Distributed Sensing Experiment micro satellites and conduct the Pre-environmental Test Review and Launch Readiness Review.
    - Conduct Micro Satellite Propulsion Experiment Preliminary Design Review.
    - Conduct Micro Satellite Target System - Risk Reduction Experiment Analysis, Design and Development.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2006
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2005	FY 2006	FY 2007
Engagement Systems Technology	81,928	28,345	41,093
RDT&E Articles (Quantity)	0	0	0

Note: In FY06, the Multiple Kill Vehicles program funding moved from Project 0502 (Engagement Systems area) to a new Program Element (0603894C) in Project 0515, Multiple Kill Vehicles. Following resources were moved: FY06 - $82 million, FY07 - $220 million, FY08 - $273 million, FY09 - $306 million, FY10 - $308 million, FY11 - $113 million.

FY05 Accomplishments:

- Laser Technology Program
  - Continued execution of Strategic Illuminator, Compact Laser Radar Amplifier, Advanced Inertial Reference Unit, Advanced Detectors, and Angle-Angle-Range Doppler Imaging LADAR efforts, from prototype demonstration to termination.
  - Selected one to three technology base projects in FY05 for execution in FY06.
  - Conducted a Concept Design Review for ADI, Block 2008/2010 capability in BMDS.
  - Completed disposition of Capistrano Test Site equipment from the former Spaced Based Laser program in FY05.
  - Strategic Illuminator Laser- Achieved first light using a single gain medium (Nov 2004)and first light at full power (June 2005). A Preliminary Design Review was conducted in May 2005 and the breadboard demonstration was completed in July 2005 leading to the final brassboard design.
  - Small Laser Amplifier for Ladar - Following successful Program Review in November 2004, both contractors entered Phase IIb, breadboard fabrication. Both contractors completed their breadboards and successfully demonstrated more than the required half power in September 2005.
  - Advanced Inertial Reference Unit - Exercised Option 2a following a successful Critical Design Review in December 2004. The program plan was followed and a prototype device was fabricated.
  - Advanced Detectors - Completed Phase 2 of detector batch production and camera integration (detector and read-out) and began Phase III final design documentation, fabrication, testing and delivery. Modeling & simulation of the system conducted.
  - Angle-Angle-Range Resolved Doppler Imager - Completed waveform generator and range-Doppler resolution demonstration. Integrated Northrop-Grumman SLAL amplifier into breadboard for Angle-Angle Doppler capability and demonstrated system operation on indoor, full-scale test range.
  - Advanced Chemical Oxygen-Iodine Laser Technology - Completed preliminary testing of nozzle and scaled-up the design. Built facility to handle more complex testing, conducted successful hot flow test, and produced test report to conclude the project.

- Air (Oxygen) Laser - Following contract award in early FY05, developed device architecture based on requirements analysis, conducted trade-off studies and acquired/fabricated components leading to initial design verification testing.
- COIL Improvements - Deuterated Fuels: Constructed test apparatus and obtained specially formulated fuels to begin testing in October 2005; Subscale Supersonic Iodine Injection: subscale testing completed and design and fabrication for full scale Iodine nozzles underway; Advanced Generators: Centrifugal Spray undergoing testing; Rotating Sparge demo completed, microclimates underway; Advanced Diagnostics: contractor designed, fabricated and installed instrumentation to measure chemical species concentrations being generated for COIL.
- Ultra-Sensitive Detectors - Awarded two contracts and completed detector and multiplexer design.

- Hit-to-Kill Interceptors
  - Identified additional areas (beyond MKV) where new technology development is required to enable the next generation hit-to-kill interceptors.
- Multiple Kill Vehicles
  - Conducted MKV hover test kill vehicle critical design review.
  - Conducted MKV system engineering studies and analyses.
  - Conducted kill vehicle seeker, divert propulsion, and avionics breadboard and brassboard demonstrations.
  - Conducted kill vehicle mission and seeker processor algorithm and software development.

FY06 Planned Program:

- Laser Technology Program
  - Strategic Illuminator Laser - Fabrication of the brassboard version will continue until delivery in the first quarter of FY07.
  - Small Laser Amplifier for Ladar - Conduct Critical Design review and down-select to one contractor for Phase III, breadboard production and delivery.
  - Advanced Inertial Reference Unit - Following assemble and integration, will exercise Option 2b to conduct system performance testing and complete the effort.
  - Advanced Detectors - Complete Phase III testing at a Government facility and submit final report.
  - Angle-Angle-Range Resolved Doppler Imager - Integrate an improved amplifier into the brassboard for Angle-Angle-Doppler capability and package the unit for outdoor range testing to demonstrate system performance with full scale targets.
  - Air (Oxygen) Laser - Achieve first light and continue design verification testing on 4kW device. Success with low power device will lead to scale-up design and fabrication in Phase II.

- COIL Improvements - Deuterated Fuels: continue testing various proportions of deuterated material; Injectors - finish fabricating full scale Iodine nozzles and testing; Iodine Advanced Generators -complete testing various alternatives and select one technique for scale-up; Advanced Diagnostic - conclude contract and receive documentation.
- Ultra-Sensitive Detectors Down-select to one contractor for fabrication of breadboard based on approved design.
- AARDI ladar - Complete program. Test integrated AARDI breadboard at MIT/Lincoln Laboratory.
- Advanced Track Illuminator Laser (ATILL) - Complete fabrication of breadboard laser and verification testing leading to scale-up of design and production by single contractor.
- Identify and select promising technologies for lightweight, high efficiency, high power, and high intensity lasers for boost, ascent and midcourse applications for execution starting in FY07.
- Identify and select promising technologies for stable and long-life laser fuel technologies for chemical lasers and long life power source technologies for execution starting in FY07.
- Identify and select one to three other technology base projects in FY06 for execution in FY07.

• Hit-to-Kill Interceptors
- Identify and select promising technologies to enable the next generation of hit-to-kill interceptors for execution starting in FY07.
- Initiate development of technologies to counter the evolving threat.

FY07 Planned Program:

• Laser Technology Program
- Strategic Illuminator Laser - Finish brassboard fabrication, conduct verification testing, and deliver product.
- Angle-Angle-Range Resolved Doppler Imager - Complete outdoor testing with full-scale targets and targets of opportunity. Conclude with delivery of device and documentation.
- Air (Oxygen) Laser - Proceed with Phase II effort of fabrication of scaled-up (10kW) breadboard
- COIL Improvements - Deuterated Fuels: Mature fuels and work toward full-scale demonstration; Injectors - finish full-scale injector testing; Iodine Advanced Generators: Scale-up selected alternative and complete performance verification; Pursue additional improvement projects.
- Ultra-Sensitive Detectors - Deliver prototype camera system for testing at Government location.
- Advanced Track Illuminator Laser (ATILL) - Complete fabrication of breadboard laser and verification testing leading to scale-up of design and production by single contractor.
- Initiate development of technologies for lightweight, high efficiency, high power, and high intensity lasers for boost, ascent and midcourse applications.
- Initiate development of stable and long-life laser fuel technologies for chemical lasers and long life power source technologies.

- Select three technology base projects in FY07 for execution in FY08.

- Hit to Kill Interceptors
  - Initiate development of the next generation hit-to-kill interceptors.
  - Continue development of technologies to counter the evolving threat.
  -

	FY 2005	FY 2006	FY 2007
High Altitude Airship	19,836	4,036	40,651
RDT&E Articles (Quantity)	0	0	0

The High Altitude Airship program will demonstrate the technical feasibility and military utility of an unmanned, untethered, gas filled, solar powered airship prototype that can fly for up to a month at 60,000 feet while carrying a 500 pound payload. A Technical Improvement Program is to be executed simultaneously to mature critical technologies as key risk reduction activities for the future operational airship. The flight demonstration of the prototype High Altitude Airship is planned for the FY08/09 timeframe.

FY05 Accomplishments:

- Conducted the prototype airship design and risk reduction phase culminated with a Critical Design Review.
- Prime contractor submitted proposal for the next phase of the program, which included the design and build of a prototype HAA, risk reduction activities, and a Technology Improvement Plan for the operational Airship vehicle.
- Reviewed contractor proposals and conducted Alpha contracting in preparation for contract award in 2006.

FY06 Planned Program:

- Conduct Decision Point One to evaluate and assess the program progress in order to determine the ability of the program to meet the Airship objectives to proceed with Airdock Remediation activities.

FY07 Planned Program:

- Continue the design and initiate build of the High Altitude Airship Prototype Vehicle with work in solar-regenerative power, propulsion and hull design.
- Continue Technology Improvement Plan for the High Altitude Airship operational vehicle with work in power generation, energy storage, and hull mass reduction.

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2006
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

	FY 2005	FY 2006	FY 2007
Advanced Communications Technology	0	0	12,049
RDT&E Articles (Quantity)	0	0	0

FY07 Planned Program:

- Commence/continue the activities to enable the integration of the following subsystems into the BMDS:
  - Kinetic Energy Interceptors (KEI)
  - Surveillance and Tracking Space System (STSS)
  - Airborne Laser (ABL)
  - Sea-Based X-Band (SBX) Radar
  - Micro Satellite
  - Overhead Non-Imaging Infrared (ONIR) feature data (moving sensors to space)
  - Other Special/Highly classified program integration activities
- Develop and demonstrate advanced Battle Management and Fire Control technologies to include:
  - Global Integrated Fire Control system
  - Initial Hit, Kill, and Weapons Typing
  - Target Discrimination, decision logic
  - Sensor Netting, Tracking and Fusion
  - Target Object Mapping
  - Sensor Registration Health and Status monitoring
  - Operator C2BMC mockups addressing iterative crew positions, Concepts of Operations, and user interface improvements for advanced BMDS conops development and refinement
- Develop and demonstrate advanced Command & Control and Network Technology to include:
  - Consequence Mitigation, post-intercept debris fallout prediction and warning (both Domestic and International)
  - Support to Lethality Model computational speed improvements to support larger raid size debris predictions in real time
  - Consequence Mitigation coalition concepts of operations with varying tactics/techniques/procedures
  - Network Service Levels for Improved Communications
  - Dynamic Network Performance for B/W efficiency and robustness
  - Improvements in Information Assurance
  - Distributed Track Correlation, Fusion, and Management

- Reduced Network Bandwidth Architectures and Technologies

- Experiment with Advanced Mobile Command and Control for BMDS as mobility adapted
- Experiment with BMDS coalition and Allied Partner integration for cross-domain solutions from a technology standpoint
- Bring integrated experiments into live flight, real time participation in 4 - 6 BMDS live flight missiles events and demonstrations
- Perform Technology Readiness Level Assessments of experiment portfolio quarterly

	FY 2005	FY 2006	FY 2007
NFIRE	0	13,495	10,800
RDT&E Articles (Quantity)	0	0	0

FY06 Planned Program:

- Complete spacecraft bus assembly, integration, and test to prepare for payload integration
- Complete and deliver the Tracking Sensor Payload (TSP) for payload integration
- Receive Laser Communications Terminal (LCT) payload for payload integration
- Perform Space Vehicle integration and acceptance testing to ensure the spacecraft and its payloads are functioning
- Perform Space Vehicle environmental testing to ensure the spacecraft and its payloads can survive launch and space environments
- Complete and certify Ground Segment Mission Operations Center to ensure the system is ready to support mission operations
- Conduct Mission Training to ensure the mission operators are prepared to execute
- Conduct Mission Rehearsals to test the interactions between the ground system, space system, and personnel prior to a mission
- Complete delivery and acceptance of Launch Vehicle to support launch of the spacecraft
- Launch the NFIRE Satellite to insert the spacecraft into orbit

FY07 Planned Program:

- Conduct Initial On-Orbit Operations to ensure the functionality and performance of the TSP prior to executing a mission
- Accept delivery of two Multi-stage Boost Targets
- Conduct Target of Opportunity Missions to collect low resolution plume data and validate the tracking performance of the TSP
- Conduct Near Field Boosting Target Fly-by mission to collect high resolution plume data
- Conduct Hyper-Temporal Experiment to assess early launch detect and tracking capability
- Conduct laser communications experiments to assess the viability of the technology for use by the BMDS and STSS Block 2012 (O)

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2006
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 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Total Cost
PE 0603879C Advanced Concepts, Evaluations and Systems	166,996	0	0	0	0	0	0	166,996
PE 0603881C Ballistic Missile Defense Terminal Defense Segment	914,063	1,198,860	1,037,203	878,540	615,005	731,692	482,362	5,857,725
PE 0603882C Ballistic Missile Defense Midcourse Defense Segment	4,487,253	2,489,257	2,605,567	2,444,109	2,065,344	1,979,612	1,617,059	17,688,201
PE 0603883C Ballistic Missile Defense Boost Defense Segment	472,543	490,863	632,028	567,493	493,842	615,859	988,731	4,261,359
PE 0603884C Ballistic Missile Defense Sensors	567,193	294,283	536,428	554,012	623,089	306,965	217,590	3,099,560
PE 0603886C Ballistic Missile Defense System Interceptors	272,064	215,952	438,287	634,709	1,138,597	1,391,301	1,499,204	5,590,114
PE 0603888C Ballistic Missile Defense Test and Targets	700,570	632,107	692,209	614,174	649,766	668,624	678,105	4,635,555
PE 0603889C Ballistic Missile Defense Products	384,935	394,652	521,640	517,507	534,429	530,893	531,219	3,415,275
PE 0603890C Ballistic Missile Defense System Core	398,852	420,151	558,231	557,880	561,003	548,354	554,731	3,599,202
PE 0603891C Special Programs - MDA	0	324,522	421,303	836,168	1,110,695	1,027,677	1,260,497	4,980,862
PE 0603892C Ballistic Missile Defense Aegis	0	939,066	990,565	857,832	900,265	933,815	816,206	5,437,749
PE 0603893C Space Tracking & Surveillance System	0	239,998	361,515	429,679	640,367	787,008	818,606	3,277,173
PE 0603894C Multiple Kill Vehicle	0	83,000	220,370	273,805	307,566	309,284	115,119	1,309,144
PE 0603895C BMD System Space Program	0	0	0	45,000	150,000	166,000	206,100	567,100
PE 0605502C Small Business Innovative Research - MDA	138,907	0	0	0	0	0	0	138,907
PE 0901585C Pentagon Reservation	11,001	17,386	15,586	6,058	6,376	4,490	4,725	65,622
PE 0901598C Management Headquarters - MDA	110,662	99,327	89,314	86,821	86,244	70,600	70,714	613,682
PE Air Force Military Personnel	0	3,628	7,640	8,332	8,535	8,826	9,129	46,090
PE Air Force Operations and Maintenance	17,600	7,964	11,712	33,830	33,080	34,119	35,398	173,703
PE Air Force Other Procurement	0	2,400	1,453	11,279	386	17,710	25,709	58,937
PE Army Operations and Maintenance	49,597	66,974	68,246	69,809	71,472	73,325	75,230	474,653
PE Army Natl Guard Military Personnel	21,000	17,648	24,432	24,952	25,591	25,591	25,591	164,805
PE Army Natl Guard Operations and Maintenance	0	155	151	150	154	164	167	941
PE Navy Operations and Maintenance	11,300	12,900	24,100	24,400	24,600	23,300	23,700	144,300
PE PAC-3/MEADS Missile Procurement	574,972	581,924	578,579	660,584	616,020	509,032	738,679	4,259,790
PE PAC-3/MEADS RDT&E	344,978	304,973	336,959	465,395	521,791	522,418	502,961	2,999,475

Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification	Date: February 2006
APPROPRIATION/BUDGET ACTIVITY: **RDT&E, DW/03 Advanced Technology Development (ATD)**	R-1 NOMENCLATURE: **0603175C Ballistic Missile Defense Technology**

COST ($ in Thousands)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
0602 Program-Wide Support	2,141	4,458	7,539	5,604	8,815	8,422	6,472
RDT&E Articles Qty	0	0	0	0	0	0	0

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 2005	FY 2006	FY 2007
Civilian Salaries and Support	2,141	4,458	7,539
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 2006
APPROPRIATION/BUDGET ACTIVITY: RDT&E, DW/03 Advanced Technology Development (ATD)	R-1 NOMENCLATURE: 0603175C Ballistic Missile Defense Technology

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