Exhibit R-2, **RDT&E Budget Item Justification:** PB 2011 Defense Advanced Research Projects Agency	**DATE:** February 2010
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	**R-1 ITEM NOMENCLATURE** PE 0603287E: *SPACE PROGRAMS AND TECHNOLOGY*

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
Total Program Element	226.369	183.477	98.130	0.000	98.130	97.395	129.704	164.360	164.186	Continuing	Continuing
SPC-01: *SPACE PROGRAMS AND TECHNOLOGY*	226.369	183.477	98.130	0.000	98.130	97.395	129.704	164.360	164.186	Continuing	Continuing

A. Mission Description and Budget Item Justification

(U) The Space Programs and Technology program element is budgeted in the Advanced Technology Development budget activity because it addresses high payoff opportunities to dramatically reduce costs associated with advanced space systems and provides revolutionary new system capabilities for satisfying current and projected military missions.

(U) A space force structure that is robust against attack represents a stabilizing deterrent against adversary attacks on space assets. The keys to a secure space environment are situational awareness to detect and characterize potential attacks, a proliferation of assets to provide robustness against attack, ready access to space, the ability to neutralize man-made space environments, and a flexible infrastructure for maintaining the capabilities of on-orbit assets. Ready access to space allows the delivery of defensive systems and replenishment supplies to orbit. An infrastructure to service the mission spacecraft allows defensive actions to be taken without limiting mission lifetime. In addition, developing space access and spacecraft servicing technologies will lead to reduced ownership costs of space systems and new opportunities for introducing technologies for the exploitation of space.

(U) Systems development is also required to increase the interactivity of space systems, space-derived information and services with terrestrial users. Studies under this project include technologies and systems that will enable satellites and microsatellites to operate more effectively by increasing maneuverability, survivability, and situational awareness; enabling concepts include solar thermal propulsion, novel ion-thruster applications, payload isolation and pointing systems.

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B. Program Change Summary ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Previous President's Budget	226.394	200.612	0.000	0.000	0.000
Current President's Budget	226.369	183.477	98.130	0.000	98.130
Total Adjustments	-0.025	-17.135	98.130	0.000	98.130
• Congressional General Reductions		-3.435			
• Congressional Directed Reductions		-11.300			
• Congressional Rescissions	-1.144	0.000			
• Congressional Adds		1.600			
• Congressional Directed Transfers		0.000			
• Reprogrammings	7.480	0.000			
• SBIR/STTR Transfer	-6.361	0.000			
• Congressional Restoration for New Starts	0.000	-4.000	0.000	0.000	0.000
• TotalOtherAdjustments	0.000	0.000	98.130	0.000	98.130

Congressional Add Details ($ in Millions, and Includes General Reductions)

	FY 2009	FY 2010
Project: SPC-01: *SPACE PROGRAMS AND TECHNOLOGY*		
Congressional Add: *Mosaic Camera Technology Transition*	0.000	1.600
Congressional Add Subtotals for Project: SPC-01	0.000	1.600
Congressional Add Totals for all Projects	0.000	1.600

Change Summary Explanation

FY 2009

Decrease reflects Section 8042 rescission of the FY 2010 Appropriations Act, SBIR/STTR transfer offset by the internal below threshold reprogramming.

FY 2010

Decrease reflects reductions for the Section 8097 Economic Assumption, execution delays and FY 2010 new starts and internal below threshold reprogrammings offset by congressional adds (as identified above).

FY 2011

Not Applicable

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Space Surveillance Telescope (SST) (U) The Space Surveillance Telescope (SST) program will develop and demonstrate an advanced ground-based optical system to enable detection and tracking of faint objects in space, while providing rapid, wide-area search capability. A major goal of the SST program is to develop the technology for large curved focal surface array sensors to enable an innovative telescope design combining high detection sensitivity, short focal length, wide field of view, and rapid step-and-settle to provide orders of magnitude improvements in space surveillance. This capability will enable ground-based detection of un-cued objects in deep space for purposes such as asteroid detection and space defense missions. The Air Force will participate in the DARPA funded developmental testing of SST and then take over operation of SST as a sensor in the Air Force Space Surveillance Network. A Memorandum of Agreement (MOA) has been established with Air Force Space Command for transition. (U) In addition, the program will investigate multi-aperture SST (MASST) alternatives. It will evaluate technologies and techniques to achieve the detection/tracking sensitivity and high search rate of the SST with a more affordable and manufacturable approach, to include the combined use of multiple small telescopes to achieve the same resolution as one large one. MASST alternatives will leverage advances in complex field sensing to combine the fields from multiple small telescopes to produce high resolution images. It will determine how the complex field sensing should be performed at each sub-aperture (telescope), as well as design and develop the appropriate adaptive optics correctors, the compensation algorithms for phase differences between telescopes, and the timing and optimization algorithms needed to generate high resolution imagery in real time. The program will develop and design one or more technology demonstrators to prove the benefit and feasibility of the concepts identified. This approach will enable wider deployment of systems which can detect and track small deep space objects.	3.134	14.960	10.840	0.000	10.840

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2009 Accomplishments: - Constructed and tested sensor subsystem. - Developed, validated, and tested software for autonomous telescope operations and data reporting. - Completed construction of telescope enclosure. *FY 2010 Plans:* - Complete processing of primary and secondary telescope mirrors. - Integrate telescope elements on site. - Initiate a survey and trade studies to assess scope of candidate MASST alternative technologies. - Perform parametric trades to define candidate architectures. - Develop algorithms for complex field reconstruction from sensor data. - Conduct experiments to determine image resolution capabilities of system prototype for near-horizontal 149km propagation. *FY 2011 Base Plans:* - Validate SST system performance and demonstrate surveillance operations. - Utilize National Security Space Office (NSSO) Space Situational Awareness (SSA) architecture to evaluate MASST alternative concepts and technologies identified against the observation gaps and needs. - Complete targeted MASST alternative trade studies and more detailed concept evaluations. - Initiate MASST alternative proof of concept technology demonstrations. - Measure selected targets over a range of atmospheric propagation paths (up to 150 km) with an array of six 0.9 m telescopes. - Develop compensation and timing algorithms for maximum resolution improvement and near-real-time processing.					
Falcon	33.000	24.170	0.000	0.000	0.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
(U) The Falcon program objectives are to develop and demonstrate hypersonic technologies that will enable prompt global reach missions. The technologies include high lift-to-drag techniques, high temperature materials, precision navigation, guidance and control, communications through plasma, and an autonomous flight safety system. Leveraging technology developed under the Hypersonic Flight (HyFly) program, Falcon will address the implications of hypersonic flight and reusability using a series of hypersonic technology vehicles (HTVs) to incrementally demonstrate these required technologies in flight. The HTV-2 program will demonstrate enabling hypersonic technologies for future operational systems through rocket-boosted hypersonic flights with sufficient cross-range and downrange performance to evaluate thermal protection systems, aerodynamic shapes, maneuverability, and long-range communication for hypersonic cruise and re-entry vehicle applications. The Falcon program addresses many high priority mission areas and applications such as global presence and space lift. DARPA established a Memorandum of Agreement (MOA) with the Air Force for the HTV-2 program in May 2003 and with NASA in October 2004. Since 2008, the effort has been jointly funded with the Office of Secretary of Defense Global Strike program office. Falcon capabilities are planned for transition to the Air Force in FY 2011. *FY 2009 Accomplishments:* - Completed and successfully load-tested prototype aeroshell. - Completed first flight vehicle aeroshell. - Completed subsystem testing of first Minotaur IV Lite launch vehicle. *FY 2010 Plans:* - Complete Assembly, Integration and Testing (AI&T) of first HTV-2 vehicle. - Complete second flight vehicle aeroshell. - Complete AI&T of second HTV-2 vehicle. - Complete first Minotaur IV Lite Launch Vehicle. - Complete second Minotaur IV Lite Launch Vehicle. - Conduct flight test of first HTV-2 vehicle incorporating next generation hypersonic technologies.					

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	**FY 2010**	**FY 2011 Base**	**FY 2011 OCO**	**FY 2011 Total**
- Conduct flight test of second HTV-2 vehicle demonstrating increased thermal environment and cross-range capability.					
Microsatellite Demonstration Science and Technology Experiment Program (MiDSTEP)	3.750	3.312	0.000	0.000	0.000
(U) The Microsatellite Demonstration Science and Technology Experiment Program (MiDSTEP) will develop advanced technologies, capabilities, and space environment characterization required to demonstrate a suite of advanced lightweight microsatellite technologies integrated into high performance microsatellites across the continuum from low earth orbit (LEO) to deep space super geosynchronous orbit (GEO) environments. The program will integrate a variety of advanced technologies, which have not been previously flight-tested, and may include: lightweight optical space surveillance/situational awareness sensors, lightweight power, chemical and electric propulsion systems, advanced lightweight structures, advanced miniature RF technology including micro crosslink and use of COTS approaches, active RF sensor technology, COTS processor and software environments, miniature navigation technologies, including the use of starfields for deep space navigation, and autonomous operations. The developed capabilities will include high thrust, high efficiency solar thermal propulsion systems that can enable responsive orbit transfer as well as provide radiation resistant high-density electrical power. The program will also explore ultra-stable payload isolation and pointing systems and components to enable advanced miniature communication systems. In addition, the program will also consider affordable, responsive fabrication and integration approaches and the possibility of networking microsatellites/modules to create a flexible architecture of assets responsive to multiple missions and threats. The anticipated transition partner is the Air Force.					
FY 2009 Accomplishments: - Conducted system design trades of appropriate technologies. - Performed mission utility assessments and feasibility studies and developed concepts of operation.					
FY 2010 Plans: - Design and develop microsatellite system concepts and integrate selected technologies.					

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Perform component and subsystem ground tests. - Conduct laboratory demonstrations of microsatellite technologies.					
System F6 (U) The objective of the System F6 program is to demonstrate the feasibility and benefits of a satellite architecture wherein the functionality of a traditional “monolithic” spacecraft is replaced by a cluster of wirelessly-interconnected spacecraft modules. Each such “fractionated” module would contribute a unique capability, e.g., computation and data handling, communications relay, guidance and navigation, payload sensing, etc., or it can replicate the capability of another module. The fractionated modules would fly in a loose, proximate cluster orbit or potentially self-assemble into an aggregate system. Critical to this architecture is a robust, system-level approach to ensuring security, integrity, and availability, while implementing authentication and non-repudiation. While delivering a comparable mission capability to a monolithic spacecraft, System F6 significantly enhances functional and programmatic flexibility and robustness, reducing risk through the mission life and spacecraft development cycle, and enabling incremental deployment of the system. The System F6 architecture provides valuable options to decision makers throughout the life cycle development of future space systems that are absent in present-day monolithic architectures. (U) The F6 program will culminate in an on-orbit demonstration of a multi-module space system incorporating the F6 Technology Package—a suite of technologies, components, and algorithms which enables autonomous multi-body orbital rendezvous and proximity operations (RPO) and real-time distributed spacecraft avionics. The F6 Technology Package will be designed such that it can be integrated with most off-the-shelf spacecraft buses to enable them to cooperatively perform a mission or missions. The on-orbit demonstration will be capable of accommodating one or more spacecraft payload modules supplied by a third-party stakeholder. Residual capability to support future payloads with the existing on-orbit infrastructure will also remain, and the infrastructure can be upgraded for an on-orbit resource capability. The utility of the F6 architecture in low earth orbit (LEO) is significantly enabled by persistent broadband connectivity to the ground which allows resource sharing between	44.675	79.000	40.000	0.000	40.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
space-based modules and terrestrial network nodes. A solution to enable high-availability, low-latency, persistent, high-bandwidth communications with LEO spacecraft will be developed in the course of the F6 program. The anticipated transition partner is the Air Force, though the architecture will have the ability to simultaneously accommodate payloads from multiple other partners including the Army and Navy. *FY 2009 Accomplishments:* - Developed a preliminary design of the on-orbit demonstration system. - Performed component and subsystem ground tests. - Conducted hardware integration laboratory (HIL) demonstrations of successively greater capability simulating 1) wireless network operating environment for fractionated satellite systems, 2) orbit propagation with real world dynamics, 3) guidance, navigation and control schemes, 4) cluster flying algorithms, and 5) distributed resource management. - Refined system design to include a detailed description of spacecraft and ground modules, subsystem-level allocation of mass, power and reliability, trade space definition for each technology, and risk analysis with mitigation schemes. *FY 2010 Plans:* - Continue refinement of the design of the on-orbit demonstration system, leading to a critical design. - Continue to perform component and subsystem ground tests. - Continue conducting HIL demonstrations, with increased fidelity provided by integration of actual flight and/or prototype hardware into the testbed. - Perform a full six-degree-of-freedom (6-DOF) long-duration, multi-body simulation with a high-fidelity disturbance model of autonomous stationkeeping and rendezvous and proximity operations (RPO) for the System F6 demonstration cluster. - Conduct a launch vehicle planning review and an information assurance design review. - Develop F6 Developer's Kit, which defines open hardware, software, and operating standards to enable third parties to interface with System F6 at the component, module, and cluster level.					

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Begin development of a persistent broadband terrestrial connectivity solution for low-earth-orbit fractionated clusters. *FY 2011 Base Plans:* - Initiate integration, assembly, and testing of flight demonstration system. - Conduct a full ground demonstration of end-to-end system capability to include: networks, wireless communication, ground command and control, and mission support. - Initiate space and launch environment testing. - Commence assembly, training and preparation for ground operations center.					
Front-end Robotics Enabling Near-term Demonstration (FREND) (U) The goal of the Front-end Robotics Enabling Near-term Demonstration (FREND) program is to develop, demonstrate, and fly robotic manipulator technologies designed to allow interaction with geosynchronous orbit (GEO)-based military and commercial spacecraft, extending their service lives and permitting satellite repositioning or retirement. Existing GEO spacecraft are outfitted with sufficient propellant to provide for needed station keeping, repositioning, and retirement maneuvers, which in many cases defines their useful mission durations. Once this propellant is expended, the vehicle is retired and, in many cases, replaced. FREND technologies can enable significant service extension to these spacecraft through re-boosting near end-of-life. (U) Recent events have significantly increased the number of objects/debris in low earth orbit (LEO), particularly in orbital planes of most interest to DoD users, causing an increased threat to safe space operations. FREND combines detailed photogrammetric and laser imaging with robotic multi-degree-of-freedom manipulators to autonomously grapple space objects not outfitted with custom interfaces. A FREND-based servicing spacecraft offers the potential for spacecraft salvage, repair, rescue, reposition, de-orbit and retirement, and debris removal. The program will examine possible solutions for all classes of LEO debris to determine the most economical technical solution set to mitigating the problem. In addition, FREND will investigate neurorobotics as a potential replacement for the baseline	10.806	19.000	11.000	0.000	11.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
suite of algorithms (e.g., arm trajectory planning, vehicle pose estimation, grapple feature identification, or compliance control) required to dock multiple robotic arms with a client spacecraft. The anticipated transition partner is the Air Force. (U) The Catcher's Mitt program is an extension of work performed under the FREND program and will address the increasing on-orbit debris collision problem faced by all U.S. space assets. Recent events have caused a dramatic increase in orbital debris. These events are part of a continuing trend that raises the probability of debris strikes with valuable U.S. space assets, possibly causing critical failures. Catcher's Mitt seeks to reduce the risk of catastrophic collision for on-orbit U.S. space assets, develop new methods for rapidly clearing important orbits after an event generates a large debris field, and develop a new method for long term clearing of debris in the most cost-effective manner. The Catcher's Mitt program will identify critical operational areas at risk as well as new solution concepts to address those risks. Solutions may include development of technologies enabling improved debris detection and tracking, improved collision prediction techniques, improved spacecraft and rocket body de-orbit/retirement capabilities, urgent response orbit clearing, long term orbit clearing, and other novel orbital debris mitigation solutions. The program will culminate in an on-orbit demonstration of selected orbital debris remediation technologies. The anticipated transition partner is the Air Force. *FY 2009 Accomplishments:* - Developed demonstration mission. - Conducted Conceptual Design Review of FREND-based servicing spacecraft with potential mission partners. - Conducted analysis of LEO debris. *FY 2010 Plans:* - Demonstrate application of neurorobotic technology to FREND payload in "earth's gravity" environment. - Initiate a preliminary design of the FREND based servicing spacecraft.					

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Conduct technology and utility trade studies to model the problem, identify significant risks to operational assets, and determine possible technological solutions. *FY 2011 Base Plans:* - Develop debris remediation conceptual designs.					
Fast Access Spacecraft Testbed (FAST) (U) The goal of the Fast Access Spacecraft Testbed (FAST) program is to demonstrate a suite of critical technologies including high efficiency solar cells, sunlight concentrating arrays, large deployable structures, and ultra light weight solar arrays. These technologies enable light-weight, high efficiency, and high-power satellites of 20kW scalable to 80kW or more. The specific power goal is 130 W/Kg yielding an ultra light-weight power system of approximately 230 Kg for a 30 kW array. Combined with electric propulsion, FAST enables fast-transfer roaming satellites with nearly five times the fuel efficiency of conventional chemical propulsion. For example, FAST will permit on-demand access to any point on the geosynchronous ring or within the high-altitude, super synchronous “graveyard” (where derelict systems are regularly repositioned in order to free up orbital slots within the ring), greatly improving our ability to rapidly deploy and reposition satellites, as well as monitor the geosynchronous environment. Alternatively, FAST will permit responsive launch capabilities including deployment of small geosynchronous satellites on small launch vehicles. Scaled up systems will nearly double the effective satellite mass launched to high altitude orbits today, significantly downsizing the need for large launch vehicles. The anticipated transition partner is the Air Force. *FY 2009 Accomplishments:* - Performed detailed design, development, and ground testing of the FAST spacecraft high-power generation subsystem. - Demonstrated mechanical deployment of full-scale solar concentrator and heat rejection system in 1G environment. - Initiated design and development of the FAST demonstrator spacecraft.	11.849	13.347	3.290	0.000	3.290

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: - Integrate FAST high-power generation subsystem with demonstrator spacecraft. - Conduct 30-day ground test of FAST subsystems in thermal vacuum chamber including heat rejection capability. - Demonstrate mechanical deployment of full scale solar concentrator system in 1G. *FY 2011 Base Plans:* - Conduct system level testing of FAST technology to support future orbital demonstrations.					
Space Situational Awareness (SSA) & Counterspace Operations Response Environment (SCORE) (U) The goal of the Space Situational Awareness (SSA) & Counterspace Operations Response Environment (SCORE) program is to develop and demonstrate an operational framework and responsive defense application to enhance the availability of vulnerable commercial space-based communications resources. SCORE will correlate a wide range of operational support and space system ground user data to rapidly identify threat activities, propose mitigating countermeasures, and verify the effectiveness of selected responses. Critical technologies include accessing disparate sources of relevant data, model-based situational awareness, and candidate response generation and evaluation. Particular emphasis will be placed on the ability to continuously adapt to changes in defended system components and usage patterns as well as validation of SCORE system integrity. The potential transition customer is the Air Force. *FY 2009 Accomplishments:* - Conducted system trades and validated critical components. - Performed analysis of system parameters and operational procedures. *FY 2010 Plans:* - Develop algorithms and software required to integrate disparate information into a single framework.	4.800	4.400	0.000	0.000	0.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Integrate software environment into a suite of visualization products that provide situational awareness and decision making tools. - Conduct operational scenario testing of system, and refine algorithms and software.					
MEO Synthetic Aperture Radar (MEOSAR) (U) Synthetic Aperture Radar (SAR) integration time is currently limited by the amount of ground vehicle motion encountered during the synthetic aperture collection time. For space radar systems, this has traditionally meant that SAR had to be accomplished at low earth orbit (LEO) trajectories where the collection time would be much shorter given the high speeds of a LEO satellite. Although the specifics depend heavily on geometric considerations, medium earth orbit (MEO) SAR imaging intervals can be a factor of approximately eight times longer, compared to a LEO alternative. The longer integration times required at MEO can have a major impact on the quality of the otherwise equivalent SAR image due to the presence of internal motion within the image scene. To achieve equivalent quality imagery, the contribution of the moving targets within the image must be excised. The MEO Synthetic Aperture Radar (MEOSAR) program will develop techniques to identify moving targets and extract them from the data prior to imaging to avoid the streaking caused by their motions. The program will develop reliable automated detection of moving targets within SAR imagery using a double thresholding process in interferometric phase and amplitude. This moving target detection technique can be readily reversed to excise the moving targets from the clutter (image) background. Temporal sub-array processing will demonstrate early detection and rejection of moving targets in sub-array images. The program will develop improved motion detection and removal algorithms, demonstrate their performance on simulated and airborne data, and develop an architectural concept for a MEOSAR system. The developed technology will be transitioned to the Air Force. *FY 2009 Accomplishments:* - Performed compact test range demonstration validating system concept and algorithms. - Completed design for a potential flight demonstration system.	1.750	4.000	0.000	0.000	0.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: - Initiate final design plans for the flight demonstration system. - Complete subsystem technologies analysis.					
Multi-Aperture Geosynchronous (GEO) Imager (MAGI)* *Formerly Bi-Static Shield. (U) The goal of the Multi-Aperture Geosynchronous (GEO) Imager (MAGI) program is to demonstrate a segment of a world-wide millimeter wave (MMW) surveillance capability by combining radar and radio astronomy technologies and techniques. By merging interferometric receiving and correlation techniques, used by radio astronomers for decades, with high power narrow-band radar transmitter technologies, MAGI hopes to prove the capability to obtain an order of magnitude improvement in imaging resolution of GEO and near-GEO satellites. A low cost demonstration using the NASA Goldstone X-Band radar and existing radio astronomy assets (the National Radio Astronomy Organization's Very Long Baseline Array) will be conducted to prove the concept at X-band. Based upon resolution requirements, the follow-on prototype demonstration will be at MMW (~90GHz), and will, to the greatest extent practicable, utilize COTS MMW antennas and high power (HP) narrow-band transmitters. The anticipated transition partner is the Air Force. *FY 2009 Accomplishments:* - Conducted first principles analyses of scattered signatures. - Conducted initial imaging campaign against selected GEO and near-GEO satellites. - Developed techniques to accurately recover the complex correlation functions measured during the imaging campaign and transform them into images. *FY 2010 Plans:* - Conduct additional measurement campaigns on candidate deep space objects. - Refine algorithms as required.	3.500	8.688	10.000	0.000	10.000

C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Develop requirements and system concept for a prototype MAGI system. *FY 2011 Base Plans:* - Survey current state of the art and developmental MMW technologies to provide a development plan for HP sources that could be used for the Prototype Demonstration. - Initiate design of a prototype MAGI demonstration system.					
Responsive, Reliable Access to Space Program (R2A2 Space) (U) The goal of the Responsive, Reliable Access to Space Program (R2A2 Space) is to mature and demonstrate the technologies for low cost, routine and reliable access to space. Enabling technologies include composite or light weight structures, integral load bearing propellant tanks, thermal management systems, high energy density propulsion systems, advanced guidance and controls, rocket back maneuvering for a reusable first stage, and advanced upper stages. The program will validate critical technologies on the ground and, where practical, demonstrate them in flight. Where feasible, flight testing will leverage the substantial ongoing entrepreneurial private sector investments. The key program goal is demonstrating aircraft-like operability including low flight costs of less than $1M with rapid turnaround times of less than 24 hrs. *FY 2011 Base Plans:* - Conduct technology survey and selection. - Develop reusable vehicle demonstration concept(s), which may include leveraging of commercial sector investments.	0.000	0.000	7.000	0.000	7.000
Advanced Nano/Micro-Satellite Technology for Tactical Applications (U) The goal of the Advanced Nano/Micro-Satellite Technology for Tactical Applications program is to demonstrate critically needed technologies enabling a very small (nano- and micro-) satellite constellation that provides persistent tactical military applications. The U.S. Army, U.S. Air Force, intelligence community, and other potential users have identified such small satellites as a potential	0.000	0.000	4.000	0.000	4.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
technical approach for delivering affordable persistence for the tactical warfighter. By deploying large numbers of very low cost nano-satellites in distributed constellations a persistent effect can be provided to terrestrial forces. Today's technology limits the ability to do this and advances in key areas are needed to make this vision a reality. Specifically, nanosatellites lack sufficient power, communications, propulsion and imaging capacity to address many tactical needs. Key technologies include: deployable communications antennas, crosslink communications, interferometric technologies, small imaging systems, attitude control subsystems, efficient solar electric arrays, efficient maneuver capability, efficient upper stages, etc. *FY 2011 Base Plans:* - Conduct trade study of available technologies and investment opportunities. - Initiate concept design.					
XTIM (U) Leveraging technology developed in the MiDSTEP program, XTIM is an autonomous system of determining timing and positioning of space assets using X-ray pulsars and then broadcasting this information for navigation and time uses independent of, and supplemental to, GPS. XTIM autonomously calculates its position and absolute time from celestial sources. XTIM then broadcasts this information to users either on the ground or in space as a method to enhance their navigation solutions. In addition, XTIM reference data can be used to update the GPS constellation ephemerides and timing with limited or no ground support. XTIM also provides an alternative timing source that can be used as a checksum for GPS receivers to insure detection of spoofing or sophisticated jamming attacks. XTIM leverages previous work by DARPA which analytically demonstrated that X-ray pulsars could be used for navigation of space assets. XTIM will create a truly autonomous and universal time reference for military navigation and communication needs. The anticipated transition partner is the Air Force.	0.000	6.000	7.000	0.000	7.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Defense Advanced Research Projects Agency	DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	**R-1 ITEM NOMENCLATURE** PE 0603287E: *SPACE PROGRAMS AND TECHNOLOGY*

C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: - Design an architecture utilizing XTIM to seamlessly integrate into the current pointing, navigation and timing systems allowing them to utilize the strengths of the autonomous nature of XTIM to defeat current vulnerabilities. *FY 2011 Base Plans:* - Design a geosynchronous orbit demonstration mission to be launched aboard an Evolved Expendable Launch Vehicle Secondary Payload Adaptor (ESPA) class spacecraft and proceed through preliminary design review. - Perform an X-ray beam line test of the brass board design to demonstrate feasibility of X-ray detection. - Perform an electron background rejection measurement of the brass board design to demonstrate feasibility of the geosynchronous background mitigation concept.					
Big Eye (U) Leveraging advanced membrane optics demonstrating photon sieve optics, Big Eye will enable the technology for very large aperture optics for space platforms. Big Eye utilizes the fact that photon sieve optics can achieve diffraction limited images for very large structures where only flatness is the primary concern. Big Eye will demonstrate the manufacturability of large membranes (up to 20 meters), large structures to hold the optics tight and flat, and also demonstrate the secondary optical elements needed to turn a diffraction based optic (such as photon sieve) into a wide bandwidth imaging device. Big Eye will end with a technology demonstration that significantly reduces the risk of these types of optics for flight development. The anticipated transition partner is the Air Force. *FY 2010 Plans:* - Perform system engineering to identify the system requirements which a large (20 m) optic would need to satisfy to obtain near diffraction limited images at geo-synchronous orbit.	0.000	5.000	5.000	0.000	5.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: - Design, construct and test an optic at least 5 m in diameter which shows how the material qualities needed for orbit could be obtained.					
Integrated Sensor is Structure (ISIS) (U) The Integrated Sensor is Structure (ISIS) program is developing a sensor of unprecedented proportions that is fully integrated into a stratospheric airship that will address the nation's need for persistent wide-area surveillance, tracking, and engagement for hundreds of time-critical air and ground targets in urban and rural environments. ISIS is achieving radical sensor improvements by melding the next-generation technologies for enormous lightweight antenna apertures and high-energy density components into a highly-integrated lightweight multi-purpose airship structure - completely erasing the distinction between payload and platform. The ISIS concept includes ninety-nine percent on-station 24/7/365 availability for Simultaneous Airborne Moving Target Indicator (AMTI) (600 kilometers) and Ground-Based Moving Target Indicator (GMTI) (300 kilometers) operation; ten years of autonomous, unmanned flight; hundreds of wideband in-theater covert communications links; responsive reconstitution of failed space assets; plus CONUS-based sensor analysis and operation. Beginning in FY 2010, this program will be budgeted in PE 0603286E, Project AIR-01. The ISIS technology demonstration system transitions to the Air Force in 2013. *FY 2009 Accomplishments:* - Conducted system requirements review of demonstration system. - Developed and demonstrated calibration and compensation subsystem. - Demonstrated large-scale critical integrated subsystems. - Designed radar resource controller for dynamically assigned aperture.	78.400	0.000	0.000	0.000	0.000
Mode Transition (MoTr) Demonstration	10.000	0.000	0.000	0.000	0.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
(U) The Mode Transition (MoTr) Demonstration program, an outgrowth of the Falcon program, seeks to ground test a turbine-based combined-cycle (TBCC) engine using hydrocarbon fuel. The MoTr program will demonstrate transition from turbojet to ramjet/scramjet cycle and is the critical experiment required to enable reusable, air-breathing, hypersonic flight. MoTr leverages previous and on-going advances in air-breathing propulsion technology, including the Falcon Combined-cycle Engine Technology (FaCET) and the Air Force/DARPA High Speed Turbine Engine Technology Demonstration (HiSTED) programs. Beginning in FY 2010, this program will be funded in PE 0603286E, Project AIR-01, Advanced Aerospace Systems. *FY 2009 Accomplishments:* - Completed FaCET freejet testing. - Selected a turbojet from the HiSTED program. - Completed conceptual design of a TBCC engine model. - Completed facility assessment study and selected a primary facility.					
Satellite Program for Instant Depletion of Energetic Radiation (SPIDER)	17.000	0.000	0.000	0.000	0.000
(U) The effects of High Altitude Nuclear Detonations (HAND) are catastrophic to satellites. HAND-generated charged particles are trapped for very long periods of time, possibly for years, oscillating between the earth's north and south magnetic poles. This enhanced radiation environment would immediately degrade low earth orbiting (LEO) spacecraft capability and result in their destruction within a few weeks. The Satellite Program for Instant Depletion of Energetic Radiation (SPIDER) program investigated technologies and techniques to rapidly mitigate the HAND-enhanced trapped radiation within days of a HAND event, before LEO spacecraft capabilities are degraded. *FY 2009 Accomplishments:* - Developed and analyzed trapped radiation mitigation concepts.					
RAD Hard by Design (RHBD)	3.705	0.000	0.000	0.000	0.000

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
(U) This program developed, characterized, and demonstrated microelectronic design technologies to enable fabrication of radiation hardened electronic components using leading-edge, commercial fabrication facilities. The current mainstream approach for fabricating radiation-hardened electronics depends on specialized process technologies and dedicated foundries that serve this military market niche. While commercial semiconductor fabrication is not explicitly radiation hardened, recent trends in deeply scaled fabrication such as very thin oxides, trench isolation, and multiple levels of metal are resulting in semiconductor devices that are inherently more tolerant of radiation than older generations. This program pursued development of design-based technologies to enable pure commercial fabrication technologies to attain radiation hardened electronics equivalent to those from the dedicated foundries. The design technology developed under the Radiation Hardening by Design (RHBD) program is planned for transition to the Air Force and to the Defense Threat Reduction Agency (DTRA) at the end of Phase II. Specific design libraries for hardened circuits will transition through the defense electronics design industry, which are being supported largely by DTRA and the Air Force. *FY 2009 Accomplishments:* - Fabricated and tested “final” RHBD demo integrated circuits (ICs) chosen in FY 2008 (90 nm complementary metal oxide semiconductor (CMOS) technology). - Completed investigation of RHBD efficacy in 65 nm CMOS technology. - Completed investigation of RHBD efficacy in silicon on insulator (SOI) technology.					
Accomplishments/Planned Programs Subtotals	226.369	181.877	98.130	0.000	98.130

	FY 2009	FY 2010
Congressional Add: Mosaic Camera Technology Transition *FY 2010 Plans:* - Continue research into the transition of mosaic camera technology.	0.000	1.600

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C. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
Congressional Adds Subtotals	0.000	1.600

D. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• Falcon: *OSD*	11.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
• Space Surveillance Telescope: *USAF*	1.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

E. Acquisition Strategy

N/A

F. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.