

**UNCLASSIFIED**

PE NUMBER: 0603401F

PE TITLE: Advanced Spacecraft Technology

**Exhibit R-2, RDT&E Budget Item Justification**

DATE

**February 2007**

BUDGET ACTIVITY

**03 Advanced Technology Development (ATD)**

PE NUMBER AND TITLE

**0603401F Advanced Spacecraft Technology**

Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	86.327	101.115	78.704	85.838	99.947	100.531	94.156	95.707	Continuing	TBD
2181 Spacecraft Payloads	30.434	30.389	22.801	27.423	29.265	29.277	23.072	23.611	Continuing	TBD
3834 Integrated Space Technology Demonstrations	27.241	27.461	28.929	32.147	41.825	41.475	38.916	39.376	Continuing	TBD
4400 Space Systems Protection	3.369	3.439	4.958	6.039	6.798	6.867	7.744	7.907	Continuing	TBD
5021 Space Systems Survivability	4.428	4.806	4.866	5.292	5.489	5.571	5.684	5.808	Continuing	TBD
5083 Ballistic Missiles Technology	3.488	3.901	5.847	6.197	6.472	6.625	6.611	6.607	Continuing	TBD
682J Spacecraft Vehicles	17.367	31.119	11.303	8.740	10.098	10.716	12.129	12.398	Continuing	TBD

Note: Funds for the FY 2007 Congressionally-directed Massively Parallel Optical Interconnects in the amount of \$1.1 million were moved from this PE to PE 0603789F, C3I Advanced Development, Project 634216, for execution. Also, funds for the FY 2007 Congressionally-directed Advanced Satellite Thermal Control Program were moved from PE 0603211F, Aerospace Technology Development and Demonstration, Project 63486U, to this PE, for execution.

**(U) A. Mission Description and Budget Item Justification**

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, spacecraft protection, spacecraft and launch vehicles, ballistic missiles, space systems survivability, and development of advanced laser communications technologies to support next generation satellite communication systems. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Note: In FY 2007, Congress added \$2.9 million for Precision Integrated Navigation and Position-Intelligent Networking Technology; \$1.6 million for Space Situational Awareness/Star Tracking System; \$1.0 million for Information Sciences Institute Microsatellite Serial Manufacturing Demonstration Program; \$1.1 million for Small Low-Cost Reconnaissance Spacecraft; \$1.0 million for Photovoltaic Module Development for Lighter Than Air Vehicles; \$1.0 million for Radically Segmented Launch Vehicle (RSLV) Risk Reduction; \$1.0 million for Micromachined Switches for Next-Generation Modular Satellites; \$1.0 million for Large Automated Production of Expendable Launch Structures (LAPELS); \$2.0 million for Microsatellite Serial Manufacturing; \$2.8 million for Systemic Hierarchical Approach to Radiation Hardened Electronics; \$1.0 million for COTS Technology for Situational Awareness; \$1.0 million for Integrated Passive Microelectronic Components; \$1.3 million for Integrated Spacecraft Engineering Tool; \$1.4 million for Intelligent Free Space Optical Satellite Communications Node; \$1.1 million for Massively Parallel Optical Interconnects; and \$10.4 million for Thin Film Amorphous Solar Arrays. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing space system upgrades and/or new space system developments that have military utility and address warfighter needs.

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(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	85.564	68.026	79.897	85.435
(U) Current PBR/President's Budget	86.327	101.115	78.704	85.838
(U) Total Adjustments	0.763			
(U) Congressional Program Reductions		-0.028		
Congressional Rescissions	-0.002	-0.383		
Congressional Increases		33.200		
Reprogrammings	2.280	0.300		
SBIR/STTR Transfer	-1.515			

(U) **Significant Program Changes:**

Changes to this PE since the previous President's Budget are due to higher Air Force priorities.

C. Performance Metrics

(U) Under Development.

## Exhibit R-2a, RDT&amp;E Project Justification

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BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>				PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>			PROJECT NUMBER AND TITLE <b>2181 Spacecraft Payloads</b>			
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2181 Spacecraft Payloads	30.434	30.389	22.801	27.423	29.265	29.277	23.072	23.611	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project funds the development, demonstration, and evaluation of radiation-hardened space electronic hardware, satellite control hardware and software for advanced satellite surveillance operations, and development of advanced laser communications technologies to support next generation satellite communications systems. Improved space-qualifiable electronics and software for data and signal processing will be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., radiation-hardening) commercial data and signal processor technologies for use in Air Force space systems. For mid-term applications, the Improved Space Computer Program will merge advanced, radiation-hardened space processor, memory, and interconnect technologies with commercially-derived, open system architectures to develop and demonstrate robust, on-board processing capabilities for 21st century Department of Defense satellites. In the long-term, this project area focuses on developing low-cost, easily modifiable software and hardware architectures for fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop spacecraft microelectronic devices, including radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems (MEMS) components and applications.	10.110	11.068	11.662	13.417
(U) In FY 2006: Developed and validated the building blocks for a general-purpose processor at 500 million instructions per second. Provided the set of design tools for integrating hardening by design into commercial design tools. Fabricated a 16 megabyte chalcogenide-based nonvolatile memory. Designed initial hardened structured application specific integrated circuit (ASIC) to implement increased ASIC performance on low cost devices. Designed and fabricated the initial test vehicle to demonstrate the miniaturized military Global Positioning System (GPS) receiver performance on low-cost devices.				
(U) In FY 2007: Complete engineering model of the high performance 500 million instruction per second general-purpose processor. Fabricate a high performance design hardened analog-to-digital converter (ADC) for use in space and design a very low-power ADC using advanced design cells and design hardening. Fabricate the miniaturized military GPS receiver for use on terrestrial, aero, and space platforms. Fabricate the building blocks for a very high performance ten million-gate design hardened field programmable gate array.				
(U) In FY 2008: Initiate capabilities to the current Satellite Design Automation software to evolve a logical sequence to form a "push-button toolflow" satellite builder. Initiate radiation-harden space sensor				

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Project 2181

Exhibit R-2a (PE 0603401F)

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<b>03 Advanced Technology Development (ATD)</b>	<b>0603401F Advanced Spacecraft Technology</b>	<b>2181 Spacecraft Payloads</b>			
<b>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators.					
(U) In FY 2009: Complete capabilities to the current Satellite Design Automation software to evolve a logical sequence to form a "push-button toolflow" satellite builder. Demonstrate radiation-harden space sensor interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators.					
(U) MAJOR THRUST: Develop intelligent satellite system technologies for responsive spacecraft operations and for satellite control, precision navigation, formation flying, and proximity operations technologies for spacecraft constellations.	3.219	2.523	2.699	2.775	
(U) In FY 2006: Validated command and control capabilities and guidance, navigation, and control algorithms for proximity operations with flight experiment data. Refined command, control, guidance, and navigational capabilities for space superiority to apply to space situational awareness and offensive/defensive operations. Completed command and telemetry simulation development for mission ops center testing. Completed integration of hardware-in-the-loop engineering development unit into testbed, interface with spacecraft command and telemetry simulations, and conducted mission ops center testing. Built unique distributed aperture sensor simulation modules for engineering level, mission/engagement and campaign level analysis tool.					
(U) In FY 2007: Continue to refine command, control, guidance, and navigational capabilities for counterspace to apply to space situational awareness and offensive/defensive operations. Begin to integrate autonomous flight software technologies with command, control, guidance, and navigation technologies to support responsive space systems. Extend hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops center to development and testing of responsive and tactical space systems. Integrate modules and complete distributed aperture sensor analysis tool for engineering level, mission/engagement and campaign level analyses.					
(U) In FY 2008: Further refine command, control, guidance, and navigational capabilities for space superiority. Continue to integrate autonomous flight software technologies with command, control, guidance, and navigation technologies. Continue to extend hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops centers. Begin to model command, control, and communications systems, conduct engineering trades, and perform military utility analysis.					
(U) In FY 2009: Complete command, control, guidance, and navigational capabilities for space superiority.					

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(U) <b>B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Complete integration of autonomous flight software technologies with command, control, guidance, and navigation technologies. Complete extension of hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops centers. Continue to model command, control, and communications systems, conduct engineering trades, and perform military utility analysis.					
(U) MAJOR THRUST: Develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems, space capability protection technologies, access/mobility technologies, and flight experiments.		0.625	1.227	0.718	0.738
(U) In FY 2006: Expanded development of models of surveillance systems for military utility to include tactical surveillance and electro-optical technologies. Developed model responsive and reconfigurable technologies. Refined development of physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis for flight experiments in tactical and responsive satellites.					
(U) In FY 2007: Complete development of models of surveillance systems for military utility to include tactical surveillance and electro-optical technologies. Continue to develop models of responsive and reconfigurable technologies. Apply physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.					
(U) In FY 2008: Begin development of space-based communications models for blue force situational awareness, communications on the move, and data exfiltration. Complete development of models of responsive or reconfigurable technologies. Continue to apply physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.					
(U) In FY 2009: Continue to develop space-based communications models for blue force situational awareness, communications on the move, and data exfiltration. Apply additional physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.					
(U) MAJOR THRUST: Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as "cold body" targets such as decoys, satellites, and midcourse warheads. Note: In FY 2008, increase in funding is due to		2.557	2.657	6.458	9.397

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<b>(U) B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
increased emphasis on hardened focal planes for the next generation satellite.					
(U) In FY 2006: Assessed large format Read Out Integrated Circuits (ROICs), designed through radiation hardened-by-design (RHBD), and fabricated on existing foundries. Investigated the readout and greater focal plane array performance enhancements needed for emerging detector array technologies.					
(U) In FY 2007: Initiate studies for detectors and readouts needed for laser-based surveillance. Continue investigation into readouts fabricated on existing foundries and radiation hard design principles.					
(U) In FY 2008: Continue studies for detectors and readouts needed for exquisite imaging. Increase size/speed of RHBD ROICs. Fold radiation hardness improvement of visible sensor with RHBD ROIC into full focal plane array.					
(U) In FY 2009: Begin full focal plane array for exquisite imaging. Develop visible sensor for potential transition.					
(U) MAJOR THRUST: Develop technologies for multi-access laser communications space terminals with reduced weight, power, and cost for transformational communications.		2.102	1.343	1.064	0.887
(U) In FY 2006: Developed components toward space-qualification and brassboard integration. Developed multi-access laser communications terminal brassboard. Tested components/system in relevant environment.					
(U) In FY 2007: Finalize brassboard integration.					
(U) In FY 2008: Begin multi-access laser communications terminal form-fit-function development. Continue environmental testing of multi-access laser communications terminal components and subsystems in relevant environment.					
(U) In FY 2009: Complete multi-access laser communications terminal form-fit-function demonstration. Complete testing of multi-access laser communications terminal components and subsystems in relevant environment. Initiate multi-access laser communications terminal system level testing in relevant environment.					
(U) MAJOR THRUST: Develop spectral/polarimetric sensing and data exploitation demonstrations for military imaging and remote sensing applications. Note: In FY 2006, advanced and accelerated efforts from PE 0602601F, Space Technology.		1.847	0.214	0.200	0.209
(U) In FY 2006: Completed polarimetric focal plane array (FPA) test article and validate performance. Integrated FPA into laboratory camera and collect high quality data in the laboratory of relevant					

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<u><b>B. Accomplishments/Planned Program (\$ in Millions)</b></u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) materials.					
(U) In FY 2007: Conduct field collection with polarimetric focal plane camera. Demonstrate feasibility of hardware design for transition to acquisition system.					
(U) In FY 2008: Collect laboratory data of satellites using spectral/polarimetric sensing and demonstrate applicability of techniques for space situational awareness.					
(U) In FY 2009: Compare measurements of satellites to predictive models and determine the feasibility of model based exploitation for space situational awareness.					
(U)					
(U) CONGRESSIONAL ADD: Alternating Current (AC) Coupled Interconnect.	1.452	0.000	0.000	0.000	
(U) In FY 2006: Conducted Congressionally-directed effort for AC Coupled Interconnect.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Magnetoresistive Random Access Memory (MRAM) Innovative Communications Materials/Magnetic Random-Access Memory Communications Materials.	0.968	0.000	0.000	0.000	
(U) In FY 2006: Conducted Congressionally-directed effort for Magnetic Random-Access Memory Communications Materials.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Radiation Hardened Microelectronics.	1.162	0.000	0.000	0.000	
(U) In FY 2006: Conducted Congressionally-directed effort for Radiation Hardened Microelectronics.					
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Systemic Hierarchical Approach to Radiation Hardened Electronics.	2.324	2.790	0.000	0.000	
(U) In FY 2006: Conducted Congressionally-directed effort for System Approach to Radiation Hardened Electronics.					

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<b>(U) B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Conduct Congressionally-directed effort for Systemic Hierarchical Approach to Radiation Hardened Electronics.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADDS: Intelligent Free Space Optical Satellite Communications Node.		2.906	1.395	0.000	0.000
(U) In FY 2006: Conducted Congressionally-directed effort for Intelligent Free Space Optical Satellite Communications Node.					
(U) In FY 2007: Conduct Congressionally-directed effort for Intelligent Free Space Optical Satellite Communications Node.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: Precision Integrated Navigation and Position-Intelligent Networking Technology.		1.162	2.889	0.000	0.000
(U) In FY 2006: Conducted Congressionally-directed effort for Precision Integrated Navigation and Position-Intelligent Networking Technology.					
(U) In FY 2007: Conduct Congressionally-directed effort for Precision Integrated Navigation and Position-Intelligent Networking Technology.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: COTS Technology for Situational Space Awareness.		0.000	0.996	0.000	0.000
(U) In FY 2006: Not Applicable.					
(U) In FY 2007: Conduct Congressionally-directed effort for COTS Technology for Situational Space Awareness.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: Integrated Passive Microelectronic Components.		0.000	0.996	0.000	0.000
(U) In FY 2006: Not Applicable.					

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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)		PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology		PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads							
(U) <b>B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>						
(U) In FY 2007: Conduct Congressionally-directed effort for Integrated Passive Microelectronic Components.											
(U) In FY 2008: Not Applicable.											
(U) In FY 2009: Not Applicable.											
(U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool. Note: This Add has been previously executed in Project 633834.		0.000	1.295	0.000	0.000						
(U) In FY 2006: Not Applicable.											
(U) In FY 2007: Conduct Congressionally-directed effort for Integrated Spacecraft Engineering Tool.											
(U) In FY 2008: Not Applicable.											
(U) In FY 2009: Not Applicable.											
(U) CONGRESSIONAL ADD: Micromachined Switches for Next-Generation Modular Satellites.		0.000	0.996	0.000	0.000						
(U) In FY 2006: Not Applicable.											
(U) In FY 2007: Conduct Congressionally-directed effort for Micromachined Switches for Next-Generation Modular Satellites.											
(U) In FY 2008: Not Applicable.											
(U) In FY 2009: Not Applicable.											
(U) Total Cost		30.434	30.389	22.801	27.423						
(U) <b>C. Other Program Funding Summary (\$ in Millions)</b>											
		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:											
(U) PE 0303601F, MILSTAR Satellite Communications System.											
(U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).											
(U) PE 0602601F, Spacecraft Technology.											

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**2181 Spacecraft Payloads****(U) C. Other Program Funding Summary (\$ in Millions)**

- (U) PE 0603311F, Ballistic Missile Technology.
- (U) PE 0603215C, Limited Defense System.
- (U) PE 0603218C, Research and Support.
- (U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
- (U) PE 0604609F, Reliability and Maintainability Technology Insertion Program (RAMTIP).
- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.
- (U) **D. Acquisition Strategy**  
Not Applicable.

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BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>					PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>			PROJECT NUMBER AND TITLE <b>3834 Integrated Space Technology Demonstrations</b>		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3834 Integrated Space Technology Demonstrations	27.241	27.461	28.929	32.147	41.825	41.475	38.916	39.376	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

**(U) A. Mission Description and Budget Item Justification**

This project is a series of advanced technology demonstrations designed to address mission needs by applying emerging technologies from the Air Force Research Laboratory, other Government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in an relevant environment.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop microsatellite (10-100Kg) technologies for integrated, robust, flexible, microsatellite demonstrations building on previous work and leveraging investments by other organizations. Applications include space-based space situational awareness and/or tactical satellite concepts.	23.948	26.465	28.929	32.147
(U) In FY 2006: Completed autonomous flight demonstration. Completed next in series of satellite designs. Procured initial bus and payload hardware. Fabricated payload and bus.				
(U) In FY 2007: Complete payload and bus fabrication. Perform functional and environmental tests of payload and bus. Complete system level integration of payload and microsatellite and complete functional and environmental tests of integrated system. Begin integration with launch vehicle. Integrate ground control system and satellite software simulations. Perform simulated mission operations for missions operations training.				
(U) In FY 2008: Complete system level integration of payload and microsatellite and complete functional and environmental tests of integrated system. Begin integration with launch vehicle. Integrate ground control system and satellite software simulations. Perform simulated mission operations for missions operations training.				
(U) In FY 2009: Complete autonomous flight demonstration. Perform de-orbit maneuver. Complete next in the series of satellite design(s). Initiate procurement of bus and payload hardware.				
(U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). Note: In FY 2007, this Add has been moved to Project 632181, for execution.	0.969	0.000	0.000	0.000
(U) In FY 2006: Conducted Congressionally-directed effort for Integrated Spacecraft Engineering Tool (ISET).				

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(U)	<b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>				<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>			
(U)	In FY 2007: Not Applicable.										
(U)	In FY 2008: Not Applicable.										
(U)	In FY 2009: Not Applicable.										
(U)											
(U)	CONGRESSIONAL ADD: Microsatellite Serial Manufacturing Process. Note: In FY 2007, this Add has been moved to Project 63682J, for execution.				1.355	0.000	0.000	0.000			
(U)	In FY 2006: Conducted Congressionally-directed effort for Microsatellite Serial Manufacturing Process.										
(U)	In FY 2007: Not Applicable.										
(U)	In FY 2008: Not Applicable.										
(U)	In FY 2009: Not Applicable.										
(U)											
(U)	CONGRESSIONAL ADD: Radially Segmented Launch Vehicle (RSLV) Risk Reduction.				0.969	0.996	0.000	0.000			
(U)	In FY 2006: Conducted Congressionally-directed effort for Radially Segmented Launch Vehicle Risk Reduction.										
(U)	In FY 2007: Conduct Congressionally-directed effort for Radially Segmented Launch Vehicle (RSLV) Risk Reduction.										
(U)	In FY 2008: Not Applicable.										
(U)	In FY 2009: Not Applicable.										
(U)	Total Cost				27.241	27.461	28.929	32.147			
(U)	<b><u>C. Other Program Funding Summary (\$ in Millions)</u></b>										
		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U)	Related Activities:										
(U)	PE 0602601F, Spacecraft Technology.										
(U)	PE 0603605F, Advanced Weapons Technology.										
(U)	This project has been coordinated through the Reliance 21 process to										

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PROJECT NUMBER AND TITLE

**3834 Integrated Space Technology  
Demonstrations****(U) C. Other Program Funding Summary (\$ in Millions)**

harmonize efforts and  
eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**Exhibit R-2a, RDT&E Project Justification**

DATE  
**February 2007**

BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>					PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>			PROJECT NUMBER AND TITLE <b>4400 Space Systems Protection</b>		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4400 Space Systems Protection	3.369	3.439	4.958	6.039	6.798	6.867	7.744	7.907	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

**(U) A. Mission Description and Budget Item Justification**

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in potentially hostile warfighting environments. The project performs assessments of critical components and subsystems, and evaluates susceptibility and vulnerability to radio frequency (RF) and laser threats. This project also develops technologies that mitigate identified vulnerabilities. Technologies are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Use multi-threat assessment tools to assess space-based electro-optical, communication, and other responses to various candidate RF and laser countermeasures and directed energy threats.	0.783	0.825	1.191	1.450
(U) In FY 2006: Performed predicative analysis of laboratory data to validate models being developed for the satellite constellation analysis tool. Modeled mitigation techniques and incorporated into constellation analysis tool.				
(U) In FY 2007: Verify mitigation models against test data and commence predictive analysis of technique effectiveness.				
(U) In FY 2008: Conduct laboratory testing of candidate RF and Laser countermeasures and validate multi-threat assessment tool.				
(U) In FY 2009: Conduct demonstrations illustrating effects and meditation analysis. Identify technology transfer opportunities and report findings to major commands.				
(U) MAJOR THRUST: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites.	1.729	1.823	2.627	3.200
(U) In FY 2006: Selected the most promising defensive technology and began space experiment planning and integration. Identified potential of multiple-use technologies to detect threats and measure environmental phenomenon associated with space flight (weather experiments, analysis debris, assist in navigation, etc.).				
(U) In FY 2007: Conduct defensive technology space demonstration and post flight analysis. Identify technology transfer opportunities.				
(U) In FY 2008: Select the most promising detection and defensive technology and begin integration.				

Exhibit R-2a, RDT&E Project Justification

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BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>	PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>	PROJECT NUMBER AND TITLE <b>4400 Space Systems Protection</b>
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(U) <b>B. Accomplishments/Planned Program (\$ in Millions)</b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Conduct demonstrations of systems integration and performance.				
(U) In FY 2009: Conduct mitigation technology space demonstration and post flight analysis.				
(U) MAJOR THRUST: Develop visible and near-infrared laser protection technologies.	0.857	0.791	1.140	1.389
(U) In FY 2006: Demonstrated visible and near-infrared laser protection technologies. Conducted ground test of optical sensor subsystem incorporating selective mitigation approaches. Developed selected protection techniques and evaluate effectiveness as a laser mitigation technique of optical sensor subsystems. Coordinated space simulation testing of prospective protection technology.				
(U) In FY 2007: Coordinate space demonstration of protective technology. Identify technology transfer opportunities and report findings to major commands.				
(U) In FY 2008: Develop selected protection techniques and coordinate space simulation testing of prospective protection technology. Qualify technology for application on space experiment for orbital demonstration.				
(U) In FY 2009: Nominate "space qualified" technology and provide test unit to experimental satellite for integration.				
(U) Total Cost	3.369	3.439	4.958	6.039

(U) <b>C. Other Program Funding Summary (\$ in Millions)</b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) Related Activities:										
(U) PE 0602102F, Materials.										
(U) PE 0602601F, Spacecraft Technology.										
(U) PE 0603605F, Advanced Weapons Technology.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										

Exhibit R-2a, RDT&E Project Justification

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BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603401F Advanced Spacecraft  
Technology

PROJECT NUMBER AND TITLE

4400 Space Systems Protection

(U) D. Acquisition Strategy

Not Applicable.

**Exhibit R-2a, RDT&E Project Justification**

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BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>					PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>			PROJECT NUMBER AND TITLE <b>5021 Space Systems Survivability</b>		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5021 Space Systems Survivability	4.428	4.806	4.866	5.292	5.489	5.571	5.684	5.808	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

**(U) A. Mission Description and Budget Item Justification**

This project develops and demonstrates technologies to improve space system survivability and reliability of current and future Department of Defense space systems that must continue operation despite natural space hazards. It develops and demonstrates cost-effective solutions to mitigate hazardous space environmental interactions including electrical charge buildup and electronics failures due to both single radiation events and long-term radiation doses.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop sensors to specify and forecast conditions in the space environment that degrade the operation of satellite, communication, navigation, and surveillance systems. Support integration, launch, validation, and operation of instrumentation to provide improved space radiation and ionospheric hazard specification and forecasting.	3.043	3.671	3.683	4.066
(U) In FY 2006: Completed concept design for joint-agency space-based coronagraph and heliospheric imager for next-generation solar hazard detection system. Designed concept micro- and nano-technology sensors for energetic particle, neutral density, low-energy plasma space weather characterization.				
(U) In FY 2007: Identify space test opportunity and begin construction of joint agency coronagraph and heliospheric imager for solar hazard detection. Complete concept design of next-generation miniaturized space weather sensors and begin development of engineering models.				
(U) In FY 2008: Continue construction of joint agency coronagraph and heliospheric imager for solar hazard detection. Continue development of miniaturized space weather sensor engineering models. Initiate program to test and evaluate empirical flare prediction models based on synoptic data from Air Force and national observatory assets.				
(U) In FY 2009: Continue construction of joint agency coronagraph and heliospheric imager for solar hazard detection. Complete development of miniaturized space weather sensor engineering models. Identify space test opportunity for miniaturized solar hazard sensors. Continue program to test and evaluate empirical flare prediction models based on synoptic data from Air Force and national observatory assets.				
(U) MAJOR THRUST: Conduct collaborative space and laboratory experiments and develop hardware and software tools to improve the survivability of spacecraft power, communications, navigation, and	0.375	0.370	0.382	0.389

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Exhibit R-2a, RDT&E Project Justification		DATE <b>February 2007</b>			
BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>	PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>	PROJECT NUMBER AND TITLE <b>5021 Space Systems Survivability</b>			
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) surveillance systems.					
(U) In FY 2006: Developed space plasma control experiment plan combining satellite charge control and tether propulsion and particle remediation concepts. Integrated dynamic space particle climatology and radiation belt forecast models into spacecraft environment effect tool suite. Fabricated payload to demonstrate radiation belt remediation technologies using electromagnetic wave technologies.					
(U) In FY 2007: Construct space plasma control experiment payload and establish joint-agency collaboration for spaceflight. Continue expansion of spacecraft environment effect tool suite to include dynamic space particle climatologies and forecast models. Complete radiation belt remediation payload and begin calibration and integration onto Air Force test satellite.					
(U) In FY 2008: Complete space plasma control experiment payload and begin calibration and integration onto Air Force test satellite. Complete spacecraft environment effect tool suite to include dynamic space particle climatologies and forecast models. Release tool suite to DoD community. Complete radiation belt remediation payload calibration and complete integration onto Air Force test satellite.					
(U) In FY 2009: Launch space plasma control experiment payload on Air Force test satellite into orbit. Begin on-orbit checkout and in-flight calibration. Begin development of new medium earth orbit radiation belt model. Launch radiation belt remediation payload on Air Force test satellite into orbit. Begin on-orbit checkout and in-flight calibration.					
(U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems.	1.010	0.765	0.801	0.837	
(U) In FY 2006: Developed filter-based optimization algorithms to determine full particle energy spectra utilizing complete inputs available from compact environment anomaly sensor. Determined impact sensor design and finalize requirements and conceptual design of radiation, plasma, chemical, and impact effect distributed anomaly resolution and spacecraft effects sensor suite. Completed construction of compact environment anomaly sensor to diagnose severe radiation environments expected during active wave radiation belt remediation experiment.					
(U) In FY 2007: Employ full energy spectra algorithms to convert entire compact environment anomaly sensor data bases into dynamic climatological model for anomaly resolution and space system design. Commence construction of hardware for space demonstration of the distributed anomaly resolution sensor. Calibrate and integrate compact environment anomaly sensor for diagnosing severe radiation					

<b>Exhibit R-2a, RDT&amp;E Project Justification</b>	DATE <b>February 2007</b>
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<b>BUDGET ACTIVITY</b> <b>03 Advanced Technology Development (ATD)</b>	<b>PE NUMBER AND TITLE</b> <b>0603401F Advanced Spacecraft Technology</b>	<b>PROJECT NUMBER AND TITLE</b> <b>5021 Space Systems Survivability</b>
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<b>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
environment on Air Force test satellite.				
(U) In FY 2008: Analyze data from compact environment anomaly sensor data bases and continue anomaly resolution for space system design. Continue construction of hardware for space demonstration of the distributed anomaly resolution sensor. Integrate compact environment anomaly sensor for diagnosing severe radiation environment on Air Force test satellite.				
(U) In FY 2009: Continue construction of hardware for space demonstration of the distributed anomaly resolution sensor. Perform verification and validation of compact environment anomaly sensor for diagnosing- severe radiation environment.				
(U) Total Cost	4.428	4.806	4.866	5.292

<b>(U) <u>C. Other Program Funding Summary (\$ in Millions)</u></b>									
	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>						
(U) PE 0602601F, Spacecraft Technology.									<u>Total Cost</u>
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <b><u>D. Acquisition Strategy</u></b> Not Applicable.									

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BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>					PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>			PROJECT NUMBER AND TITLE <b>5083 Ballistic Missiles Technology</b>		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5083 Ballistic Missiles Technology	3.488	3.901	5.847	6.197	6.472	6.625	6.611	6.607	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

**(U) A. Mission Description and Budget Item Justification**

This project develops, integrates, and demonstrates advanced technologies for sustainment and modernization of strategic ballistic missiles. The project focuses on developing robust, low maintenance inertial navigation instruments to sustain current ballistic missile systems, as well as provide new, small, low-powered, high precision instrumentation for next generation missile systems.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation instrumentation applied to emerging vehicle designs and other technologies that sustain current strategic missile systems. Provide critical missile technology concepts to support future space force application and strategic systems.	1.744	1.951	2.924	3.099
(U) In FY 2006: Explored laboratory proof-of-concept of the most promising next generation missile navigation instrumentation designs. Fabricated initial navigation instruments and engineering demonstration units. Performed engineering development tests. Evaluated instrument performance and provided improvements to meet established performance goals.				
(U) In FY 2007: Develop and integrate engineering design next generation missile navigation systems and ground test in environments relevant to subsequent flight test conditions. Evaluate system performance and provide improvements to meet established performance goals. Initiate flight test demonstration planning.				
(U) In FY 2008: Continue next generation missile navigation system engineering development, design, and ground test in relevant strategic environments, and evaluate design improvements against established performance goals. Continue flight test demonstration planning. Initiate engineering system design verification and testing.				
(U) In FY 2009: Continue engineering system development design verification and testing to incorporate performance improvements. Conduct flight qualification testing and evaluation of candidate demonstration flight units. Initiate system integration of flight demonstration units with emerging vehicle designs.				
(U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation technologies with new vehicle designs to provide robust, flexible, lower cost solutions for sustaining current strategic missile	1.744	1.950	2.923	3.098

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<b>Exhibit R-2a, RDT&amp;E Project Justification</b>	DATE <b>February 2007</b>
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<b>BUDGET ACTIVITY</b> <b>03 Advanced Technology Development (ATD)</b>	<b>PE NUMBER AND TITLE</b> <b>0603401F Advanced Spacecraft Technology</b>	<b>PROJECT NUMBER AND TITLE</b> <b>5083 Ballistic Missiles Technology</b>
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<b>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
systems.				
(U) In FY 2006: Developed long-term plan for sled testing of high-gravitational force tolerant navigation instrumentation and range safety devices. Characterized instrumentation performance in quiescent environments. Designed system level design interfaces with experimental test bed.				
(U) In FY 2007: Continue long-term planning and initiate long-lead hardware acquisition and coordination with test facilities in preparation for sled testing of high-gravitational force tolerant navigation instrumentation and range safety devices. Measure performance of navigation instrumentation and range safety devices with associated platform hardware, power sources, support software, and communication interfaces in 100 times the gravitational force flight-like vibration environments. Continue system level design interfaces with experimental test bed.				
(U) In FY 2008: Complete test planning, integration, and conduct sled testing of high-gravitational force tolerant navigational instrumentation and range safety devices in preparation for future flight test demonstrations. Continue performance evaluation of navigation instrumentation and range safety devices with associated hardware and software interfaces in relevant dynamic and hostile environments. Validate system design refinements and initiate long-term plan for flight testing advanced navigational instrumentation and range safety devices with new vehicle designs.				
(U) In FY 2009: Measure and evaluate performance of advanced navigation instrumentation and range safety devices from experimental test bed and sled testing. Continue long-term planning and initiate long-lead hardware acquisition for flight testing advanced navigational instrumentation and range safety devices with new vehicle design interfaces. Initiate qualification testing of designs against validated system level interfaces.				
(U) Total Cost	3.488	3.901	5.847	6.197

<b>(U) <u>C. Other Program Funding Summary (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) PE 0601102F, Defense Research Sciences.										
(U) PE 0602601F, Space Technology.										
(U) PE 0603311F, Ballistic Missile Technology.										

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BUDGET ACTIVITY

**03 Advanced Technology Development (ATD)**

PE NUMBER AND TITLE

**0603401F Advanced Spacecraft  
Technology**

PROJECT NUMBER AND TITLE

**5083 Ballistic Missiles Technology****(U) C. Other Program Funding Summary (\$ in Millions)**

- (U) PE 0603601F, Conventional Weapons Technology.
- (U) PE 0603851F, Intercontinental Ballistic Missile-Dem/Val.
- (U) PE 0604851F, Intercontinental Ballistic Missile-EMD.
- (U) PE 0605860F, Rocket System Launch Program-Space.
- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.
- (U) **D. Acquisition Strategy**  
Not Applicable.

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BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>					PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>			PROJECT NUMBER AND TITLE <b>682J Spacecraft Vehicles</b>		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
682J Spacecraft Vehicles	17.367	31.119	11.303	8.740	10.098	10.716	12.129	12.398	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: Funds for the FY 2007 Congressionally-directed Massively Parallel Optical Interconnects in the amount of \$1.1 million were moved from this Project to PE 0603789F, C3I Advanced Development, Project 634216, for execution. Also, funds for the FY 2007 Congressionally-directed Advanced Satellite Thermal Control Program were moved from PE 0603211F, Aerospace Technology Development and Demonstration, Project 63486U, to this PE, for execution.

**(U) A. Mission Description and Budget Item Justification**

This project develops and demonstrates compact, low-cost, spacecraft and launch vehicle power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation activities focus on lightweight, low-cost, low-volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen and sodium sulfur spacecraft batteries and flywheel energy storage systems for extended (five to ten year) satellite missions. The project's power distribution efforts focus on producing lightweight, high-efficiency, standardized power busses for use on future space systems.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Developed and evaluated performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules.	1.351	2.103	2.355	2.327
(U) In FY 2006: Completed space environmental testing of thin-film solar cells and modules. Performed radiation testing of lattice mismatch multi-junction solar cells.				
(U) In FY 2007: Perform radiation testing of five to six junction solar cells. Construct flight hardware for thin-film solar array. Demonstrate roll-to-roll production of thin-film solar cells on polymer substrates.				
(U) In FY 2008: Complete fabrication of flight hardware for Thin-Film Radiation Exposure flight experiment. Complete ground portion of on-orbit prediction model for thin-film solar cells. Develop interconnect technologies for advanced multijunction solar cell structures.				
(U) In FY 2009: Demonstrate greater than 14% efficient thin-film solar cells. Begin performance optimization of greater than 40% efficient solar cell concepts.				
(U) MAJOR THRUST: Develop technologies for long life, efficient, low-vibration, lightweight mechanical cryocoolers and integration components for space applications.	0.878	1.482	1.330	1.044
(U) In FY 2006: Completed development of low temperature flight-qualified high capacity cryocooler and demonstrated performance of cryocooler and control electronics integrated with focal plane in a relevant environment. Improved performance of key critical components including compressor, electronics, and				

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE			
<b>03 Advanced Technology Development (ATD)</b>	<b>0603401F Advanced Spacecraft Technology</b>	<b>682J Spacecraft Vehicles</b>			
<b>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
heat exchangers.					
(U) In FY 2007: Assess various advanced technologies such as micro-electro-mechanical, optical cooling, and other concepts to further reduce cryocooler mass and improve performance for space based situational awareness applications. Initiate advanced concept development program to support multi-temperature and large focal plane cooling requirements for space-based space surveillance and other mission applications.					
(U) In FY 2008: Complete design and begin development of a non moving parts compressor using proton biased membrane technology. Complete design and begin development of a low vibration conductance, cross gimbal 35 K cooling loop interface to support space tracking missions. Complete design and begin development of an improved thermal interface material doubling conductive transfer capacity in space cooling applications. Complete comprehensive study and begin technology development of satellite cryogenic interface requirements and improved technologies to support space tracking applications.					
(U) In FY 2009: Continue development of a non moving parts compressor using proton biased membrane technology. Continue development of a low vibration conductance, cross gimbal 35 K cooling loop interface to support space tracking missions. Continue development of an improved thermal interface material doubling conductive transfer capacity in space cooling applications. Continue technology development of satellite cryogenic interface requirements and improved technologies to support space tracking applications					
(U)					
(U) MAJOR THRUST: Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas. Note: In FY 2008, increase in funding is due to acceleration of the thermal management testbed program.		1.659	3.657	5.229	2.965
(U) In FY 2006: Developed ultra-lightweight, high-structural efficiency mirror support structures for space mirrors. Demonstrated qualification-level performance of all-composite payload adapters and fairing structures for Evolved Expendable Launch Vehicles.					
(U) In FY 2007: Demonstrate space qualification-level performance for large diameter launch vehicle fairing. Transition multi-functional structures technology to unmanned aerial vehicle and launch vehicle community. Demonstrate space qualification-level performance for 25-meters long ultralightweight deployable structures.					
(U) In FY 2008: Develop symbiotic structural technologies for large deployable structural sensors and					

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE			
<b>03 Advanced Technology Development (ATD)</b>	<b>0603401F Advanced Spacecraft Technology</b>	<b>682J Spacecraft Vehicles</b>			
<b>(U) B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
improved thermal management sensors. Perform flight-qualification tests of novel deployable structure architectures, cryogenic tanks, and launch vehicle structural components. Develop thermal management testbed.					
(U) In FY 2009: Fly elastically-deployed, stored strain energy, deployable structural architectures including shape memory alloy reinforced hinges. Develop and test thermal management hardware.					
(U)					
(U) MAJOR THRUST: Develop technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems.		1.666	2.857	2.389	2.404
(U) In FY 2006: Developed rapid-slew, fast tracking gimbal technology to allow sub-orbital space situational awareness missions. Demonstrated space qualification-level performance for miniaturized vibration isolation systems for optical payloads.					
(U) In FY 2007: Ground demonstrate full multi-axis flywheel attitude control system with integrated energy storage. Demonstrate space qualification-level performance for passive vibro-acoustic damping devices to mitigate launch vehicle acoustic loads. Flight demonstrate on-orbit docking and fluid transfer mechanisms.					
(U) In FY 2008: Implement estimation algorithm for improved local situational awareness using on existing on-orbit asset.					
(U) In FY 2009: Begin implementation of advanced estimation algorithms for improved local situational awareness onto flight hardware prototype under development.					
(U)					
(U) CONGRESSIONAL ADD: Beta Energy Cells (BEC) for Defense and Intelligence Applications.					
(U) In FY 2006: Conducted Congressionally-directed effort for Beta Energy Cells (BEC) for Defense and Intelligence Applications.		4.067	0.000	0.000	0.000
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays.		3.873	10.361	0.000	0.000
(U) In FY 2006: Conducted Congressionally-directed effort for Thin Film Amorphous Solar Arrays.					
(U) In FY 2007: Conduct Congressionally-directed effort for Thin Film Amorphous Solar Arrays.					

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Exhibit R-2a, RDT&E Project Justification		DATE <b>February 2007</b>			
BUDGET ACTIVITY <b>03 Advanced Technology Development (ATD)</b>	PE NUMBER AND TITLE <b>0603401F Advanced Spacecraft Technology</b>	PROJECT NUMBER AND TITLE <b>682J Spacecraft Vehicles</b>			
(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Large Automated Production of Expendable Launch Structure (LAPELS).	3.873	2.590	0.000	0.000	
(U) In FY 2006: Conducted Congressionally-directed effort for LAPELS.					
(U) In FY 2007: Conduct Congressionally-directed effort for LAPELS.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Information Sciences Institute Microsatellite Serial Manufacturing Demonstration Program.	0.000	0.996	0.000	0.000	
(U) In FY 2006: Not Applicable.					
(U) In FY 2007: Conduct Congressionally-directed effort for Information Sciences Institute Microsatellite Serial Manufacturing Demonstration Program.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Microsatellite Serial Manufacturing. Note: This Add has been previously executed in Project 633834.	0.000	1.992	0.000	0.000	
(U) In FY 2006: Not Applicable.					
(U) In FY 2007: Conduct Congressionally-directed effort for Microsatellite Serial Manufacturing.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Photovoltaic Module Development for Lighter than Air Vehicles.	0.000	0.996	0.000	0.000	
(U) In FY 2006: Not Applicable.					
(U) In FY 2007: Conduct Congressionally-directed effort for Photovoltaic Module Development for Lighter than Air Vehicles.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					

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Exhibit R-2a, RDT&E Project Justification				DATE February 2007							
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)		PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology		PROJECT NUMBER AND TITLE 682J Spacecraft Vehicles							
(U)	<b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>						
(U)	CONGRESSIONAL ADD: Small Low-Cost Reconnaissance Spacecraft.	0.000	1.096	0.000	0.000						
(U)	In FY 2006: Not Applicable.										
(U)	In FY 2007: Conduct Congressionally-directed effort for Small Low-Cost Reconnaissance Spacecraft.										
(U)	In FY 2008: Not Applicable.										
(U)	In FY 2009: Not Applicable.										
(U)											
(U)	CONGRESSIONAL ADD: Space Situational Awareness/Star Tracking System.	0.000	1.594	0.000	0.000						
(U)	In FY 2006: Not Applicable.										
(U)	In FY 2007: Conduct Congressionally-directed effort for Space Situational Awareness/Star Tracking System.										
(U)	In FY 2008: Not Applicable.										
(U)	In FY 2009: Not Applicable.										
(U)											
(U)	CONGRESSIONAL ADD: Advanced Satellite Thermal Control Program.	0.000	1.395	0.000	0.000						
(U)	In FY 2006: Not Applicable.										
(U)	In FY 2007: Conduct Congressionally-directed effort for Advanced Satellite Thermal Control Program.										
(U)	In FY 2008: Not Applicable.										
(U)	In FY 2009: Not Applicable.										
(U)	Total Cost	17.367	31.119	11.303	8.740						
(U)	<b><u>C. Other Program Funding Summary (\$ in Millions)</u></b>										
		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U)	Related Activities:										
(U)	PE 0602203F, Aerospace Propulsion.										
(U)	PE 0602601F, Spacecraft Technology.										
(U)	PE 0603218C, Research and Support.										
(U)	PE 0603226E, Experimental Evaluation of Major										

## Exhibit R-2a, RDT&amp;E Project Justification

DATE

February 2007

BUDGET ACTIVITY

**03 Advanced Technology Development (ATD)**

PE NUMBER AND TITLE

**0603401F Advanced Spacecraft  
Technology**

PROJECT NUMBER AND TITLE

**682J Spacecraft Vehicles****(U) C. Other Program Funding Summary (\$ in Millions)**

Innovative Technologies.

**(U) PE 0603500F,**Multi-Disciplinary Advanced  
Development Space  
Technology.**(U)** This project has been  
coordinated through the  
Reliance 21 process to  
harmonize efforts and  
eliminate duplication.**(U) D. Acquisition Strategy**

Not Applicable.