Exhibit R-2, PB 2010 Air Force RDT&E Budget Item Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602601F Space Technology					
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	124.910	138.980	104.148						Continuing	Continuing
621010: Space Survivability & Surveillance	48.447	49.377	48.207						Continuing	Continuing
624846: Spacecraft Payload Technologies	23.610	27.986	15.063						Continuing	Continuing
625018: Spacecraft Protection Technology	2.787	7.036	8.026						Continuing	Continuing
628809: Spacecraft Vehicle Technologies	50.066	54.581	32.852						Continuing	Continuing

Note

Note: Funds for the FY 2009 Congressionally-directed Center for Solar Electricity and Hydrogen in the amount of $3.6 million were moved from PE 0602201F, Aerospace Vehicle Technologies to this PE for execution.

A. Mission Description and Budget Item Justification

This PE focuses on four major areas. First, space environmental protection develops technologies to understand, mitigate, and exploit effects of weather and geophysics environments on the design and operation of Air Force systems. Second, spacecraft payload technologies improve satellite payload operations by investigating advanced component and subsystem capabilities. Third, spacecraft protection develops technologies for protecting U.S. space assets in potential hostile settings. The last major area, spacecraft vehicles, focuses on spacecraft platform, payload, and control technologies, and their interactions. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary space technologies.

Exhibit R-2, PB 2010 Air Force RDT&E Budget Item Justification	DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	**R-1 ITEM NOMENCLATURE** PE 0602601F Space Technology

B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	128.397	117.519	104.647	
Current BES/President's Budget	124.910	138.980	104.148	
Total Adjustments	-3.487	21.461	0.000	
Congressional Program Reductions	0.000	-0.042		
Congressional Rescissions	0.000	-0.377		
Total Congressional Increases	0.000	18.280		
Total Reprogrammings	-1.431	3.600		
SBIR/STTR Transfer	-2.056	0.000		

Change Summary Explanation

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

Note: In FY 2009, Congress added $2.4 million for Advanced Modular Avionics for Operationally Responsive Space Use, $0.8 million for the Center of Responsive Space Systems, $2.88 million for Multicontinuum Technology for Space Structures, $1.6 million for Radiation Hardened Non-Volatile Memory Technology, $0.8 million for Defensive Counterspace Testbed, $3.0 million for Field Programmable Gate Arrays Mission Assurance Center, $0.8 million for Lightweight, High-Efficient Solar Cells for Spacecraft, $1.6 million for Massively Parallel Optical Interconnects for MicroSatellite Applications, $2.0 million for Nuclear Test Seismic Research, $2.0 million for Reconfigurable Electronics and Non-Volatile Memory Research, and $0.4 million for Shielding Rocket Payloads.

C. Performance Metrics
(U) Under Development.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602601F Space Technology					PROJECT NUMBER 621010	
COST ($ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
621010: Space Survivability & Surveillance	48.447	49.377	48.207						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops the technologies to exploit the space environment for warfighter's future capabilities. The project focuses on characterizing and forecasting the battlespace environment for realistic space system design, modeling, and simulation, as well as the battlespace environment's effect on space systems' performance. It includes technologies to specify and forecast the environment from "mud to sun" for planning operations and ensuring uninterrupted system performance, optimize space-based surveillance operations, and allow the opportunity to mitigate or exploit the space environment for both offensive and defensive operations. Finally, this project includes the seismic research program that supports national requirements for monitoring nuclear explosions.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop technologies for specifying, monitoring, predicting, and controlling space environmental conditions hazardous to Department of Defense (DoD) operational space systems in order to improve performance, reduce cost, and increase operational lifetimes. In FY 2008: Completed detailed analysis of Solar Mass Ejection Imager. Compiled specifications and guidance for operational heliospheric imager. Initiated measurement of interplanetary magnetic fields using wide-field radio array. Commenced development of magnetic reconnection model to study solar flare initiation and energy storage. Initiated program to test and evaluate empirical flare prediction models based on synoptic data from Air Force and national observatory assets. Completed development of energetic electron data assimilation models for real-time situational awareness by coupling to dynamic radiation belt model to provide data-driven specification and forecast capability. Coupled radiation belt model to global geospace environment models to increase accuracy and lead time. Validated models for ionospheric penetration by very low frequency (VLF) electromagnetic waves and their injection into the magnetosphere. In FY 2009: Provide scientific and technical support for both optical and radio parts of solar environmental observing network replacement program. Continue exploring techniques for measuring coronal and interplanetary magnetic fields using new wide-field radio arrays. Continue test and evaluation of empirical	6.773	8.865	8.109	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009	
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology		PROJECT NUMBER 621010

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
flare prediction models based on synoptic data from Air Force and national observatory assets. Complete coupling of radiation belt model to global geospace environment models to increase accuracy and lead time. Utilize three-dimensional global radiation belt diffusion models to simulate ultimate global effect of wave-particle interactions from VLF electromagnetic wave power injected in narrow altitude slices of radiation belts. Validate models for virtual VLF electromagnetic wave generation in the ionosphere and global transport and power distribution. In FY 2010: Complete trade studies for measuring coronal and interplanetary magnetic fields using new wide-field radio arrays. Assimilate solar vector magnetic field data into solar wind forecast models. Complete development of empirical flare prediction models and start development of physics-based flare forecast models. Analyze energetic particle measurements by recently launched sensors to understand the dynamics of the radiation belts and improve accuracy of space environment specification and forecast models. Begin investigation of new technologies for simulation and mitigation of hazards due to spacecraft electrostatic charging and discharging. Develop the reentry radar profile simulation by collecting data from re-entry vehicle test programs. Upgrade plasma effects simulation upgrade by validating code with flight data.				
MAJOR THRUST: Develop spectral signature libraries, target detection techniques, and decision aids for application to space-based surveillance, laser weapons, and countermeasure systems, including detection of low-observable targets, and targets and space-based resident space object characterization. In FY 2008: Finalized real-time hypertemporal (HT) processing algorithms with optimal parameters for space-based missile launch detection. Developed development third-generation brassboard HT sensor for space-based missile launch detection. Initiated feasibility study of HT applications for technical intelligence from ground, air, and space-based platforms. Used satellite tracking test bed and Air Force Maui Optical and Supercomputing tracking telescopes to demonstrate Space Situational Awareness (SSA) capability of HT sensors and validate the utility of this technique to obtain operational and health status of resident space objects. Other advanced sensors of spectral, polarimetric and temporal capabilities are considered in the down selection phase and tested with ground systems as needed. Completed analysis of space data on real world detections of resident space objects with multiple band thermal infrared, visible, and ultraviolet and	13.457	14.451	15.197	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 621010	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
develop models of sensor performance to evaluate capability of space-based sensors. Utilized planned space demonstrations to validate spectral theater surveillance and area search missions and supporting models. Transitioned spectral image processing and exploitation algorithms and related signature databases to government users. Investigated spectral applications for material identification in support of military chemical/ biological weapons detection and identification in the thermal infrared and other bands. In FY 2009: Finalize brassboard HT sensor for space-based missile launch detection. Incorporate latest real-time HT processing algorithms into sensor platform. Transition brassboard sensor and algorithms to customer for space-based missile launch detection. Test feasibility of HT applications for technical intelligence from ground, air, and space-based platforms. Define the requirements and the optimum configuration of a space-based HT sensor. Develop end-to-end simulation capability, based on the sensor performance models, to assist acquisition community and space operator community in trade space analyses of sensors or sensor suites. The emphasis is on the capabilities to derive information and intelligence about space objects with signals in all bands and all temporal regimes. Continue investigation of spectral applications for material identification in support of military chemical/biological weapons detection and identification in the thermal infrared and other bands. Complete transition of spectral image processing and exploitation algorithms and related signature databases to government users. Complete analysis and documentation of military utility of planned space demonstrations of spectral theater surveillance and area search missions. Complete validation of hyperspectral models. In FY 2010: Demonstrate aircraft-based detection of large booster missile launch through optically thick sunlit clouds using existing HT image processing. Start focused effort on thermal atmospheric model validation and inversion. Initiate the development of sensor system to characterize space object orbital maneuver based on propulsion signatures. With trade space analyses, down select and develop technical specification of space-based multi-phenomenology SSA sensor payload. Document final results from space experiments in reflective spectral tests. Initiate thermal infrared (IR) imaging spectrometer feasibility for space missions. Employ and refine existing spectral radiative transfer models to evaluate requirements of space-based thermal IR imaging spectrometer to meet anticipated mission needs.				

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 621010

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop artificial intelligence techniques, forecasting tools, and sensors for improved ionospheric specification and forecasting, including communications/navigation outage forecasting (C/NOFS), space-based geolocation demonstrations, and determination and prediction of radar degradation. In FY 2008: Expanded high-latitude data collection to initiate a high-latitude scintillation warning system. Investigated the impact of convection of scintillations to higher latitudes on Ultra High Frequency communication and Global Positioning System (GPS) navigation systems. Investigated HF induced artificial scintillation generation using HAARP. Developed portable ionospheric sensor suite for measuring total electron content and communications/navigation scintillation. Initiated space radar data collection for ionosphere compensation study. Developed scintillation mitigation technology by using metal-oxide space cloud. Developed techniques of analyzing GPS radio occultation data acquired by C/NOFS and Constellation Observing System for Meteorology, Ionosphere and Climate satellites. Incorporated Kalman filter ionospheric model into forecast models and ionospheric warfighter impact products. Conducted statistical analysis of neutral density to improve accuracy of empirical neutral density models for specifying and forecasting neutral density during geomagnetic storms. Implemented algorithm to assess impacts of penetration electric fields on generation of equatorial irregularities. In FY 2009: Investigate solar activity on enhancement of L-band scintillations to assess the support of the scintillation database and tools to military communication and navigation systems. Measure total electron content and scintillations over the African subcontinent for better defining the equatorial scintillation and GPS error environment in the middle-eastern region. Deliver ionospheric compensation technique with wide-band radio-frequency waves. Improve modeling techniques for specifying high temporal resolution of neutral density and satellite drag to achieve predictive space situation awareness. Improve empirical and neutral density model based on Atmospheric Density Specification experiment data and develop physics-based model of the neutral composition, wind, and density. Continue development of physics-based 3-D model of equatorial plasma bubbles into warfighter products and incorporation of ionospheric Kalman filter operational models into equatorial models. In FY 2010: Develop more capable, less costly ground sensors for ionospheric electron density and scintillation parameters utilizing software digital radio technology and newly available satellite signals. Validate C/NOFS instruments and products for operational uses and define follow-on operational mission configuration.	6.981	7.492	9.652	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 621010	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Implement semi-empirical high-latitude model to couple solar storm effects to the low latitude ionosphere to improve scintillation forecasts. Assess ionospheric effects on the performance of lower frequency space-radar applications such as synthetic aperture radar imagery and coherent-change detection during solar maximum conditions. Quantify the requirements for coupled models. Document improved methods for tailoring the propagation environment (scintillation, scattering, etc.) using the HAARP facilities. Validate scintillation and electron density profiles from radio occultation techniques for operational algorithm development. Expand ground-based sensor network to remote areas supporting research goals and tactical operations. Begin development of space situation awareness testbed.					
MAJOR THRUST: Develop High-frequency Active Auroral Research Program site transmitting and diagnostic instrument infrastructure. In FY 2008: Conducted experimental research with the 3.6 megawatt transmitting array to develop techniques to increase the efficiency of extremely low frequency/very low frequency (ELF/VLF) wave generated in space and initiate research to characterize their interactions with charged particles in the earth's radiation belts. In FY 2009: Continue research to characterize wave-particle interactions and wave amplification effects in space and their potential application to mitigate charged particle effects on space systems and operations. In FY 2010: Enhance wave-particle interactions and amplification research their application to mitigate charged particle effects on space systems and operations with coordinated Demonstration and Science Experiment satellite studies and feedback from physical models.		9.020	9.811	9.259	
MAJOR THRUST: Develop basic seismic technologies to support national requirements for monitoring nuclear explosions with special focus on regional distances less than 2,000 kilometers from the sensors. In FY 2008: Tested and incorporated new research methods for automated processing of increasing numbers of seismic events. Developed long-period regional seismic discrimination, while examining challenges in high-		6.740	6.763	5.990	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 621010

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
frequency regional discrimination. Researched efforts on seismic calibration; seismic detection, location, and discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Conducted comprehensive studies to transition the program to meet emerging local seismic monitoring requirements. Designed and conducted theoretical, laboratory, and field studies to support local monitoring. In FY 2009: Develop different techniques for automated processing of increasing numbers of seismic events. Conduct detailed research on causes of challenges in high-frequency regional discrimination. Further continue efforts on seismic calibration; seismic detection, location, and discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Continue to conduct detailed studies of particular challenge areas in local seismic monitoring. Refine design and conduct theoretical, laboratory, and field studies to support local monitoring. In FY 2010: Refine and expand the applicability of different techniques for automated processing of increasing numbers of seismic events. Continue to conduct detailed research on causes of challenges in high-frequency regional discrimination. Integrate results of seismic calibration and observational studies of seismic wave propagation, including propagation in Eurasia, into a unified model. Continue to conduct detailed studies of particular challenge areas in local seismic monitoring. Refine design and conduct theoretical, laboratory, and field studies to support local monitoring of new targets. Continue to study improvements in seismic detection, location, and discrimination.				
CONGRESSIONAL ADD: High-frequency Active Auroral Research Program. In FY 2008: Conducted Congressionally-directed effort for HAARP. In FY 2009: Not Applicable. In FY 2010: Not Applicable.	3.129	0.000	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 621010

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
CONGRESSIONAL ADD: Nuclear Test Seismic Research. In FY 2008: Conducted Congressionally-directed effort for Nuclear Test Seismic Research. In FY 2009: Conduct Congressionally-directed effort for Nuclear Test Seismic Research. In FY 2010: Not Applicable.	2.347	1.995	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 621010

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0305111F/ Weather Systems.	0.000	0.000							Continuing	Continuing
PE 0305160F/ Defense Meteorological Satellite Program.	0.000	0.000							Continuing	Continuing
PE 0601102F/ Defense Research Sciences.	0.000	0.000							Continuing	Continuing
PE 0602204F/ Aerospace Sensors.	0.000	0.000							Continuing	Continuing
PE 0603401F/ Advanced Spacecraft Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602601F Space Technology					PROJECT NUMBER 624846	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
624846: Spacecraft Payload Technologies	23.610	27.986	15.063						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops advanced technologies that enhance spacecraft payload operations by improving component and subsystem capabilities. The project focuses on four primary areas: (1) development of advanced, space-qualified, survivable electronics, and electronics packaging technologies; (2) development of advanced space data generation and exploitation technologies, including infrared, Fourier Transform hyperspectral imaging, polarimetric sensing, and satellite antenna subsystem technologies; (3) development of high-fidelity space simulation models that support space-based surveillance and space asset protection research and development for the warfighter; and (4) development of advanced networking, radio frequency, and laser communications technologies to support next generation satellite communication systems.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop advanced infrared device technologies for space applications that enable hardened space detector arrays with improved detection, to perform acquisition, tracking, and discrimination of space objects such as decoys, satellites, and warheads throughout their trajectory. Note: In FY 2009: Increase in funding is due to emphasis on SSA technologies. In FY 2008: Investigated spectral agility. Explored field-enhancement technologies. Demonstrated a three-layer single pixel polarimeter. Pursued long-wave infrared (LWIR) superlattice defect reduction and passivation optimization. In FY 2009: Continue investigating spectral agility. Demonstrate tuning from 8 to 12 microns in 1 micron increments. Continue investigating field enhancement technologies. Demonstrate optical amplification using quantum interference and demonstrate enhancement using plasmons. Continue investigating the single pixel polarimeter. Demonstrate improved LWIR superlattice detector and assess very long-wave infrared feasibility. In FY 2010: Expand investigation of spectral agility to longer wavelengths. Expand investigation of field enhancement technologies. Complete final demonstration of optical amplification using quantum interference.	3.647	5.242	3.157	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 624846

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop spectral sensing and data exploitation methodologies for military imaging and remote sensing applications. Note: In FY 2009: Increase in funding is due to emphasis on SSA technologies. In FY 2008: Explored the development of a predictive model for advanced imaging concepts. Using the physics-based models, developed an end-to-end capability to predict the performance, benefit, and cost of various sensors for Intelligence, Surveillance, and Reconnaissance (ISR) and SSA applications. In FY 2009: Complete the development and begin the validation of a predictive model for advanced imaging. Validate against laboratory and available field data of ISR and SSA missions. Make improvements to the simulation capability to improve accuracy and usability of the model. Utilize the prediction capability to develop concepts for purpose built sensors for SSA. In FY 2010: Complete validation of advanced imaging technology predictive models for SSA concepts of operation. Continue to advance simulation capability to enhance accuracy and usability of these models.	0.996	3.170	3.828	
MAJOR THRUST: Develop technologies for space-based payload components such as low power, high performance, radiation-hardened electronic devices, micro-electro-mechanical system devices, and advanced electronics packaging for next generation high performance space electronics. Note: In FY 2010, reduction is due to higher Air Force priorities. In FY 2008: Explored 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 interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators. 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	3.244	4.396	3.411	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009	
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology		PROJECT NUMBER 624846

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators. In FY 2010: Initiate study of phase change materials and begin to develop new classes of electronics that enable efficient analog computing. Develop methods of hardening generation after next electronic devices that enable a factor of two increase in computing performance. Investigate the operation of nanoelectronic devices and incorporate those into new classes of detectors and transistors to enable terahertz operation. Initiate the study of thermoelectric cooling based on advanced Peltier effect materials. Initiate development of radiation hardened plug-and-play interface module to support rapid development or reconfiguration of spacecraft hardware.				
MAJOR THRUST: Develop modeling, simulation, and analysis tools for space-based surveillance systems, rendezvous and proximity operations, optical/infrared imaging space systems, distributed satellite architecture, and space control payloads. Design, develop, test, and evaluate advanced, highly capable decision support and resource management tools and techniques that will enable comprehensive space superiority situational awareness. Note: In FY 2008, increase in funding is due to acceleration of the development of engineering and military utility models for space superiority analysis of space situational awareness and defensive space control (DSC) technologies. In FY 2008: Completed support of autonomous and responsive space flight experiments with simulations and data validation. Completed extension of the simulation architecture to feed engineering-level data to mission/ campaign models. Developed engineering and military utility models for space superiority analysis of space situational awareness and defensive space control technologies. In FY 2009: Develop engineering, military utility, and cost models for space superiority analysis of SSA detection capabilities. Develop a simulation repository capability for the distributed architecture simulation lab. Begin development of first generation decision support tools for space superiority. Begin development of confidence metrics and software system testbed to score developed tools.	5.627	4.884	4.214	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification			DATE: May 2009	
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology		PROJECT NUMBER 624846	
B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Complete SSA detection analysis tools and begin developing engineering and military utility models for object identification to support SSA and DSC. Incorporate additional tools from external and external sources. Validate tools and code in the simulation repository. Continue development first generation decision support tools for space superiority. Finalize software system testbed. Begin testing of tools on testbed. Begin development of resource management tools for space superiority.				
MAJOR THRUST: Develop technologies for multi-access laser communications terminals. Assess the maturity of single access terminal components and their applicability to a multi-access terminal design. Note: This effort completed in FY 2008. In FY 2008: Integrated single-access laser communications terminal components into multi-access laser communications terminal. In FY 2009: Not Applicable. In FY 2010: Not Applicable.	6.576	0.000	0.000	
MAJOR THRUST: Develop technologies for next-generation space communications terminals and equipment and methods/techniques to enable future space system operational command and control concepts. Note: In FY 2010, reduction is due to higher Air Force priorities. In FY 2008: Not Applicable. In FY 2009: Initiate study of future communication requirements. Develop subsystems for testing and performance enhancements experiments. In FY 2010: Begin development of engineering model of critical technology to satellite communication and ground terminals.	0.000	3.711	0.453	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 624846	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
CONGRESSIONAL ADD: Field Programmable Gate Arrays/ Field Programmable Gate Arrays Mission Assurance Center. In FY 2008: Conducted Congressionally-directed effort for Field Programmable Gate Arrays. In FY 2009: Conduct Congressionally-directed effort for Field Programmable Gate Arrays Mission Assurance Center. In FY 2010: Not Applicable.		1.564	2.992	0.000	
CONGRESSIONAL ADD: Reconfigurable Electronic and Non-Volatile Memory Research. In FY 2008: Conducted Congressionally-directed effort for Reconfigurable Electronic and Non-Volatile Memory Research. In FY 2009: Conduct Congressionally-directed effort for Reconfigurable Electronic and Non-Volatile Memory Research. In FY 2010: Not Applicable.		1.956	1.995	0.000	
CONGRESSIONAL ADD: Radiation Hardened Non-Volatile Memory Technology. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Radiation Hardened Non-Volatile Memory Technology.		0.000	1.596	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 624846

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Not Applicable.				

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0603401F/ Advanced Spacecraft Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602601F Space Technology					PROJECT NUMBER 625018	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
625018: Spacecraft Protection Technology	2.787	7.036	8.026						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops the technologies for protecting U.S. space assets in potential hostile environments to assure continued space system operation without performance loss in support of warfighter requirements. The project focuses on identifying and assessing spacecraft system vulnerabilities, developing threat warning technologies, and developing technologies to mitigate the effects of both intentional and unintentional threats.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop key satellite threat warning technologies and tools for high value satellite asset defense. Note: In FY 2009, all thrusts in this Project were combined to better align technology development efforts. In FY 2008: Conducted sensor space flight experiment and analysis. Identified technology transition opportunities and provide associated engineering designs and concepts. In FY 2009: Not Applicable. In FY 2010: Not Applicable.	1.123	0.000	0.000	
MAJOR THRUST: Develop high value space asset defensive capabilities. Note: In FY 2009, all thrusts in this Project were combined to better align technology development efforts. In FY 2008: Developed space experiment using onboard systems or developed proof of concept space experiment to validate concept and multiple use technology. In FY 2009: Not Applicable.	0.951	0.000	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 625018	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
MAJOR THRUST: Develop techniques to exploit existing on-board inherent satellite resources, satellite-as-a-sensor, and self-aware satellite technologies as a first-line threat detection system. Note: In FY 2009, all thrusts in this Project were combined to better align technology development efforts. In FY 2008: Transitioned technology to other compatible space systems for multiple uses. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		0.713	0.000	0.000	
MAJOR THRUST: Develop key satellite threat warning technologies and tools for high value satellite asset defense. Provide high value space asset defensive capabilities through techniques to exploit existing on-board inherent satellite resources, satellite-as-a-sensor, and self-aware satellite technologies. Note: In FY 2009, this thrust was formed by combining previous thrusts to better align technology development efforts. The increases in FY 2009 and out are due to increased Air Force emphasis on defense of space assets. In FY 2008: Not Applicable. In FY 2009: Develop an active and/or passive threat warning sensor for detection of a direct assent or co-orbital vehicle and transition these engineering designs. Identify potential technology options that could provide defensive capability for incorporation into geosynchronous orbit/low earth orbit satellites and complete engineering designs.		0.000	6.238	8.026	

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APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 625018

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Explore capabilities of potential defensive subsystems through laboratory testing. Identify likely transition opportunities and prepare engineering models to assess performance. Develop techniques to exploit existing satellite sensors for dual use defense.				
CONGRESSIONAL ADD: Defensive Counterspace Testbed. In FY 2008: Not Applicable. In FY 2009: Congressionally-directed effort for Defensive Counterspace Testbed. In FY 2010: Not Applicable.	0.000	0.798	0.000	

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
PE 0603401F/ Advanced Spacecraft Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology	PROJECT NUMBER 625018

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602601F Space Technology					PROJECT NUMBER 628809	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
628809: Spacecraft Vehicle Technologies	50.066	54.581	32.852						Continuing	Continuing

Note

Note: Funds for the FY 2008 Congressionally-directed funds for the Center for Solar Electricity and Hydrogen in the amount of $2.4 million were moved from PE 0602203F, Aerospace Propulsion, Project 33SP, to this Project, for execution.

A. Mission Description and Budget Item Justification

This project focuses on seven major space technology areas: spacecraft platforms (e.g., structures, controls, power, and thermal management); space-based payloads (e.g., survivable electronics); satellite control (e.g., software for autonomous distributed satellite formation flying, signal processing, and control); modeling and simulation of space-based systems; satellite protection technologies (e.g., space environment effects, debris prediction, and threat warning/attack reporting); microsatellite technologies; and space experiments of maturing technologies for space qualification.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop technologies for advanced space platform subsystems such as cryocoolers, compact, high efficiency solar power cells and arrays, and innovative power generation concepts. In FY 2008: Refine and validated cryocooler component and system models with experimental data. Completed theoretical model of multistage cooler energy flows. Investigated thermodynamic loss mechanisms in regenerative cycle cryocoolers through computational fluid dynamics models. Completed definition and commenced procurement technology development design work for improved short-wavelength infrared/ medium-wavelength infrared (SWIR/MWIR) cryocooler application needs for missile launch detection and technical intelligence missions. Developed advanced concept solar cells traceable to efficiencies greater than 40%. In FY 2009: Further refine and validate cryocooler component and system models with experimental data. Continue to investigate thermodynamic loss mechanisms in regenerative cycle cryocoolers through computational fluid dynamics models. Complete design work for improved SWIR/MWIR cryocooler application	4.354	4.253	4.769	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
for missile launch detection and technical intelligence mission systems. Complete engineering demonstration of advanced array for thin-film solar cells scaleable to greater than 100 kw. In FY 2010: Continue to refine and validate cryocooler component and system models with experimental data. Complete models/validation of pulse tube and start models/validation of inertance tube, regenerator and compressor. Continue to investigate thermodynamic loss mechanisms in regenerative cycle cryocoolers through computational fluid dynamics models, including two stage pulse tube cryocoolers and multistage coolers from 110 Kelvin to 10 Kelvin. Develop subcell technology for thin-film tandem solar cell traceable to greater than 20% efficiency. Continue development of material growth and device structures for solar cells traceable to 40% or higher ultra high efficiency solar cells.				
MAJOR THRUST: Develop technologies for advanced space platform structures such as structural controls for vibration suppression, multi-functional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures. Note: In FY 2009 and out, increase in funding is due to increased emphasis on spacecraft structures. In FY 2008: Completed characterization of thermal protection structural performance. Provided autonomy concepts to support defensive/protection actions by spacecraft. Developed multifunctional structural hardware concepts for space situational awareness, such as structural health monitoring, light occultation by nearby objects, and detection of radio frequency (RF) emissions. Developed system-level architectures for large precision deployable structures. Commenced development of advanced estimation algorithms for better local situational awareness using existing and next-generation hardware, such as star-trackers for object detection, characterization, and tracking. In FY 2009: Continue development of multifunctional structural hardware concepts for space situational awareness, such as structural health monitoring, light occultation by nearby objects, and detection of RF emissions. Continue development of system-level architectures for large precision deployable structures. Continue development of advanced estimation algorithms for better local situational awareness using existing and next-generation hardware, such as star-trackers for object detection, characterization, and tracking.	10.441	14.594	12.635	

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APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 628809	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Continue development of system-level deployable structures for RF frequencies. Initiate development of integrated thermal management subsystems for responsive space class satellites. Finish and transition advanced estimation algorithms for local situational awareness for next-generation systems. Begin development of guidance, navigation and control algorithms for built around rapid integration and test of satellite hardware. Begin development of advanced data association algorithms for space object tracking. Build representative test cases for data association algorithms. Initiate development of modular plug-and-play spacecraft structural panels to address such concerns as rapid assembly, thermal management, and built-in harnesses and electronics.					
MAJOR THRUST: Develop flight experiments to address key scientific and technological problems in order to improve the capabilities of existing operational space systems and to enable new transformational space capabilities. Note: Funding changes are due to launch preparation activities and higher Air Force priorities. In FY 2008: Completed delivery of all spacecraft payloads. Completed spacecraft assembly, integration and test. Trained mission operations team for on-orbit activities. Prepared science teams for on-orbit operations using simulated data to certify the dissemination and analysis process. In FY 2009: Prepare spacecraft for launch. Complete all spacecraft to launch vehicle interface analysis and approval. Launch spacecraft and commence with Mission Operations. In FY 2010: Integrate spacecraft with separation systems. Integrated spacecraft with launch vehicle. Conduct mission operations rehearsals. Conduct critical design review of next generation spacecraft bus. Begin spacecraft hardware procurement. Continue spacecraft software development.		25.054	23.287	15.448	
CONGRESSIONAL ADD: Deployable Structure Systems for Space. In FY 2008: Conducted Congressionally-directed effort for Deployable Structure Systems for Space.		1.564	0.000	0.000	

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APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 628809	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2009: Not Applicable. In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Microsatellite Target System. In FY 2008: Conducted Congressionally-directed effort for Microsatellite Target System. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		1.564	0.000	0.000	
CONGRESSIONAL ADD: Mission Design and Analysis Tool. In FY 2008: Conducted Congressionally-directed effort for Mission Design and Analysis Tool. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		0.489	0.000	0.000	
CONGRESSIONAL ADD: Center for Solar Electricity and Hydrogen. In FY 2008: Conducted Congressionally-directed effort for Center for Solar Electricity and Hydrogen. In FY 2009: Conduct Congressionally-directed effort for Center for Solar Electricity and Hydrogen.		2.347	3.590	0.000	

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APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 628809	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Multicontinuum Technology for Space Structures. In FY 2008: Conducted Congressionally-directed effort for Multicontinuum Technology for Space Structures. In FY 2009: Conduct Congressionally-directed effort for Multicontinuum Technology for Space Structures. In FY 2010: Not Applicable.		1.956	2.872	0.000	
CONGRESSIONAL ADD: Shielding Rocket Payloads. In FY 2008: Conducted Congressionally-directed effort for Shielding Rocket Payloads. In FY 2009: Conduct Congressionally-directed effort for Shielding Rocket Payloads. In FY 2010: Not Applicable.		0.341	0.399	0.000	
CONGRESSIONAL ADD: Advanced Modular Avionics for Operationally Responsive Space Use. In FY 2008: Conducted Congressionally-directed effort for Advanced Modular Avionics for Operationally Responsive Space Use. In FY 2009: Conduct Congressionally-directed effort for Advanced Modular Avionics for Operationally Responsive Space Use.		1.956	2.394	0.000	

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APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602601F Space Technology			PROJECT NUMBER 628809	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Center for Responsive Space Systems. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Center for Responsive Space Systems. In FY 2010: Not Applicable.		0.000	0.798	0.000	
CONGRESSIONAL ADD: Lightweight, High-Efficiency Solar Cells for Spacecraft. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Lightweight, High-Efficiency Solar Cells for Spacecraft. In FY 2010: Not Applicable.		0.000	0.798	0.000	
CONGRESSIONAL ADD: Massively Parallel Optical Interconnects for MicroSatellite Applications. In FY 2008: Not Applicable. In FY 2009: Conduct Congressionally-directed effort for Massively Parallel Optical Interconnects for MicroSatellite Applications.		0.000	1.596	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Not Applicable.				

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602203F/ Aerospace Propulsion.	0.000	0.000							Continuing	Continuing
PE 0602102F/ Materials.	0.000	0.000							Continuing	Continuing
PE 0603311F/ Ballistic Missile Technology.	0.000	0.000							Continuing	Continuing
PE 0603401F/ Advanced Spacecraft Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

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