Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Air Force											Date: February 2015	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	57.787	68.907	54.897	-	54.897	61.693	60.343	59.210	60.346	Continuing	Continuing
632181: *Spacecraft Payloads*	-	14.683	12.664	15.573	-	15.573	15.989	15.908	16.672	16.853	Continuing	Continuing
633834: *Integrated Space Technology Demonstrations*	-	9.565	18.346	17.766	-	17.766	22.416	23.454	15.994	15.692	Continuing	Continuing
634400: *Space Systems Protection*	-	9.691	3.874	6.197	-	6.197	8.091	7.607	8.644	9.057	Continuing	Continuing
634950: *Space Demonstration*	-	10.114	11.737	-	-	-	-	-	-	-	-	21.851
635021: *Space Systems Survivability*	-	2.313	3.076	2.207	-	2.207	1.949	1.946	2.042	2.040	Continuing	Continuing
635083: *Ballistic Missiles Technology*	-	3.280	7.733	3.924	-	3.924	1.687	1.339	0.993	-	Continuing	Continuing
63682J: *Spacecraft Vehicles*	-	8.141	11.477	9.230	-	9.230	11.561	10.089	14.865	16.704	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, spacecraft protection, spacecraft vehicles, ballistic missiles, and space systems survivability. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Efforts in this program have been coordinated through the Department of Defense (DoD) Science and Technology (S&T) Executive Committee process to harmonize efforts and eliminate duplication.

This program is in Budget Activity 3, Advanced Technology Development because this budget activity includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Air Force					Date: February 2015
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 3: *Advanced Technology Development (ATD)*			R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*		
B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	67.894	69.026	60.110	-	60.110
Current President's Budget	57.787	68.907	54.897	-	54.897
Total Adjustments	-10.107	-0.119	-5.213	-	-5.213
• Congressional General Reductions	-	-0.119			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-8.271	-			
• SBIR/STTR Transfer	-1.836	-			
• Other Adjustments	-	-	-5.213	-	-5.213

Change Summary Explanation

FY2014 funding of $8.271 million reprogrammed to support high priority science and technology effort.

FY2016 decrease due to realignment of research efforts.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*	Project (Number/Name) 632181 / *Spacecraft Payloads*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
632181: *Spacecraft Payloads*	-	14.683	12.664	15.573	-	15.573	15.989	15.908	16.672	16.853	Continuing	Continuing

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. Future 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, this project merges 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 (DoD) 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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Advanced Space Electronics	4.933	4.344	4.116
Description: Develop microelectronic devices, including radiation-hardened data processors and high-density hardened memories, advanced packaging technologies, and micro-electro-mechanical system components and applications. ***FY 2014 Accomplishments:*** Focused development of multiprocessor components to reduce power required for on-orbit processing capability. Developed volatile memory for satellite high-density data storage capability. Began to develop analog structured application specific integrated circuits for affordable space electronic support logic. ***FY 2015 Plans:*** Continue development of multi-processor components to provide extremely-high-performance, low-power on-orbit processing capability. Continue to develop high-density volatile memory devices. Continue structured application specific circuits development to include development of reconfigurable or structured analog array integrated circuits to meet growing need for mixed-signal space electronics. Continue development of E-Beam lithography tool. Investigate development of on-shore advanced field programmable gate array (FPGA). ***FY 2016 Plans:*** Begin development of Memristor components to achieve increased memory density with greater resiliency to the space environment. Continue development of mission-enabling advanced processors, memory, analog to digital/digital to analog converters, FPGAs, and E-Beam lithography tool.			
Title: Spacecraft Design Tools	0.190	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 632181 / *Spacecraft Payloads*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Develop satellite system technologies for spacecraft operations and for satellite control, precision navigation, formation flying, and proximity operations technologies. ***FY 2014 Accomplishments:*** Completed development, refinement and use of modular space component ground testbed. Matured plug-and-play standards and structure. Finished supporting Air Force development of a plug-and-play based space vehicle. ***FY 2015 Plans:*** Effort completed in FY 2014. ***FY 2016 Plans:*** N/A			
Title: Advanced Space Modeling and Simulation Tools ***Description:*** Develop modeling, simulation, and analysis tools for space-based surveillance systems, space capability protection technologies, access/mobility technologies, and flight experiments. ***FY 2014 Accomplishments:*** Validated system to mission-level modeling and simulation tools for flight program mission planning. Finalized data requirements fro upcoming flight programs to gather critical validation data on orbit to enhance previously developed modeling and simulations tools. Evaluated the military and technical utility of emerging space vehicle technologies and associated software algorithms. ***FY 2015 Plans:*** Update modeling and simulation tools for flight programs using data sets from recent missions. Continue evaluating the military and technical utility of emerging space vehicle technologies and associated software algorithms. ***FY 2016 Plans:*** Update modeling and simulation tools for flight programs using data sets from recent missions. Continue evaluating the military and technical utility of emerging space vehicle technologies and associated software algorithms.	1.977	0.897	1.263
Title: Advanced Space Sensors ***Description:*** Develop space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as "cold body" objects. ***FY 2014 Accomplishments:***	2.190	2.592	1.806

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 632181 / *Spacecraft Payloads*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Continued developing wide field of view large focal plane array for theater missile warning, missile detection, and battlespace awareness. Initiated radiation hardened visible scanning effort to improve sensor capabilities for comprehensive Space Situational Awareness (SSA). ***FY 2015 Plans:*** Investigate material system alternative to mercury cadmium telluride for use in wide field of view applications in support of classic intelligence, surveillance, and reconnaissance missile warning applications. Continue to mature radiation hardened visible starrers and/or scanners as well as long wavelength infrared detection in support of SSA missions. ***FY 2016 Plans:*** Continue to investigate and develop alternative sensor systems that provide wide field of view capabilities to enable advanced missile warning, space-based reconnaissance, space situational awareness and threat warning and assessment applications. Initiate development of long wavelength infrared detector options to enable future satellite characterization and threat warning & assessment capabilities. Continue support to device radiation performance characterization and evaluation.			
Title: Positioning, Navigation, and Timing (PNT) Space Payload Technologies ***Description:*** Develop, validate, and transition technologies that: enable new, or enhance existing, U.S. PNT satellite capabilities by increasing resiliency and availability of accuracy; and/or increase the affordability of providing current capabilities. Develop validate, and transition technologies to meet identified Air Force Space Command/Space and Missile Systems Center PNT space payload technology needs. ***FY 2014 Accomplishments:*** Initiated acquisition of advanced on-orbit reprogrammable digital waveform generator technology for application to future satellites in the Global Positioning System (GPS) system to enable after-launch modification of the GPS signals or the implementation of new signals and signal combining/synthesis techniques over the on-orbit life of the satellite. Enabled increased flexibility and resiliency of the GPS system. Conduct system engineering and initiate designs of advanced technology space qualifiable L-band radio frequency (RF) amplifier(s) for PNT/GPS. ***FY 2015 Plans:*** Finalize design and begin performance evaluation of advanced technology space qualifiable L-band RF amplifier(s) for PNT/GPS. ***FY 2016 Plans:*** Finalize design and begin performance evaluation of on-orbit reprogrammable digital waveform generator for PNT/GPS. Take delivery of advanced technology space qualifiable L-band radio frequency amplifier(s) for PNT/GPS.	5.393	4.831	8.388
Accomplishments/Planned Programs Subtotals	14.683	12.664	15.573

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 632181 / *Spacecraft Payloads*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*	Project (Number/Name) 633834 / *Integrated Space Technology Demonstrations*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
633834: *Integrated Space Technology Demonstrations*	-	9.565	18.346	17.766	-	17.766	22.416	23.454	15.994	15.692	Continuing	Continuing

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 U.S. government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in a relevant environment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Integrated Satellite Demonstrations	9.565	18.346	17.766

Description: Develop satellite technologies for integrated, robust, flexible, satellite demonstrations building on previous work and leveraging investments by other organizations.

FY 2014 Accomplishments:
Began space flight operations of geosynchronous orbit satellite demonstrating advanced autonomy technologies. Continued maintenance and debugging of geosynchronous orbit experimental satellite flight software and orbit analysis tools. Procured long-lead components, the platform, and Air Force payloads for planned demonstration of an augmented Evolved Expendable Launch Vehicle Secondary Payload Adaptor (ESPA) geosynchronous orbit experiment.

FY 2015 Plans:
Continue one year of experimental flight operations. Begin analyzing science and health and status data. Verify maneuverable geosynchronous experimental platform design. Verify spacecraft subsystem and payload hardware and software post component/subsystem delivery in preparation for component/subsystem tests and system integration and test.

FY 2016 Plans:
Continue and complete payload integration for geosynchronous spaceflight demonstration and begin launch vehicle integration targeted for launch in FY17. Demonstration payloads include HyperTemporal Imaging (HTI) sensor to detect missile launches under sun-lit clouds which could enable all weather early missile detection; integrated on-board sensing, assessment, and autonomy technology payload which could enable Air Force space asset resiliency to a specific set of threats; and an experiment to demonstrate increased autonomy and safety in advanced proximity operations which could enable Air Force inspector satellites for high value Air Force assets. The spacecraft will demonstrate a multi-orbit, multi-mission-capable, propulsive secondary payload adapter which could enable increased flexibility and affordability for the Evolved Expendable Launch Vehicle (EELV). Develop concept for next-generation integrated demonstration. Determine military utility and define specific goals, scope,

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 633834 / *Integrated Space Technology Demonstrations*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
technical objectives, and concepts of operation. Begin design engineering trade studies for space flight demonstration with a target launch of FY18-19.			
Accomplishments/Planned Programs Subtotals	9.565	18.346	17.766

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*	Project (Number/Name) 634400 / *Space Systems Protection*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
634400: *Space Systems Protection*	-	9.691	3.874	6.197	-	6.197	8.091	7.607	8.644	9.057	Continuing	Continuing

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 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 and avoiding threats and operating in a hostile space environment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Space Situational Awareness Capability Development	6.481	2.685	1.371
Description: Develop tools and technologies that advance space-based proximity awareness capabilities and enable protection and countermeasure courses of action. Efforts will assess a variety of phenomenologies and concepts in response to multiple threat classes and scenarios. ***FY 2014 Accomplishments:*** Used experimental test results from deep-space imaging experiments, conduct an engineering trade study for a space-based concept. ***FY 2015 Plans:*** Initiate hardware development on space-based imaging concepts that show viability under the feasibility study. Complete data analysis from the joint threat scenario study to quantify technology return-on-investment metrics. Initiate concept development, modeling, and simulations. ***FY 2016 Plans:*** Transition space-based imaging concepts to system development community for further maturation. Begin development of integrated tracking filter incorporating physics-based neutral density drag models for improved SSA.			
Title: Space Indicators and Warning Research	3.017	0.295	1.699
Description: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. ***FY 2014 Accomplishments:***			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 634400 / *Space Systems Protection*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Continued local area sensor for indication and warning engineering unit development. Continued design concept for integrated sensor suite and response system for automated response options. ***FY 2015 Plans:*** Continue updating sensor specifications and evaluating additional sensors to compare attributes (size, weight, power, performance, maturity, etc.) of sensor technologies against case uses/scenarios/missions. ***FY 2016 Plans:*** Review improvements in local environment sensing technologies in support of rapid space-based threat identification and attribution capabilities to enable/improve spacecraft resilient course-of-action options in a threat environment. Identify and review holistic, resilient spacecraft concept technologies. Identify and develop integration paths for key resilient spacecraft technology discoveries.			
Title: Spacecraft Threat Detection ***Description:*** Develop active satellite local space awareness technologies and exploitation tools for satellite systems. ***FY 2014 Accomplishments:*** Expanded satellite autonomy architecture and demonstrate threat/anomaly detection and response with real-time sensor processing and control. ***FY 2015 Plans:*** Develop components to enable on-board detection, assessment, and resolution of spacecraft anomalies to include co-orbital and directed energy threats. Apply efforts towards geosynchronous spaceflight demonstration as well as extensions to demonstrate multi-asset, space and ground, coordination. Employ system levels concepts to enable cross queuing of assets both on-orbit and on the ground. ***FY 2016 Plans:*** Refine capabilities to perform on-board course of action mission planning which will involve tasking of satellite subsystems as well as other space system entities; mature technology through ground and flight demonstration opportunities. Down-select cross queuing concepts and identify specific candidate technologies to integrate and increase cross coordination between space and ground sensor assets.	0.193	0.894	3.127
Accomplishments/Planned Programs Subtotals	9.691	3.874	6.197

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 634400 / *Space Systems Protection*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

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, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*	Project (Number/Name) 634950 / *Space Demonstration*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
634950: *Space Demonstration*	-	10.114	11.737	-	-	-	-	-	-	-	-	21.851

A. Mission Description and Budget Item Justification

This project will provide mission design and development, payload integration, launch support, operations planning, and one-year of on-orbit operations for a science and technology space-launch mission. The project will provide a launch opportunity in support of the multi-agency "new entrant" certification strategy and the Air Force Launch Services New Entrant Certification Guide.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: S&T Space Launch Integration and Test	10.114	11.737	-
Description: Provide mission design and development, payload integration, launch support, operations planning, and one-year of on-orbit operations for a science and technology space-launch mission while supporting the multi-agency "new entrant" certification strategy. ***FY 2014 Accomplishments:*** Provided mission definition, design, development, and operations planning. Refined satellite and payload manifest. Continued planning and integration of satellites and payloads onto launch vehicle. ***FY 2015 Plans:*** Finalize satellite and payload manifest. Complete payload/satellite/launch vehicle integration. ***FY 2016 Plans:*** Effort completes in FY 2015.			
Accomplishments/Planned Programs Subtotals	10.114	11.737	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*	Project (Number/Name) 635021 / *Space Systems Survivability*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
635021: *Space Systems Survivability*	-	2.313	3.076	2.207	-	2.207	1.949	1.946	2.042	2.040	Continuing	Continuing

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Spacecraft Survivability/Reliability	2.313	3.076	2.207

Description: Develop technologies to provide improved space radiation and ionospheric hazard specification and forecasting.

FY 2014 Accomplishments:

Completed preliminary design review of compact environmental sensor and began assembly of engineering unit. Accepted delivery and began integrating high-energy particle telescopes into compact space environment sensor. Utilized newly available space environment data sets to improve the accuracy of standard radiation belt model for satellite design. Delivered microdosimeter space environment sensor for integration into customer spacecraft. Demonstrated ability to generate tailored space environment hazards for spacecraft.

FY 2015 Plans:

Continue utilizing on-orbit data to generate tailored space environment hazards for operational systems. Expand space environment anomaly attribution tool to new orbital domains. Complete assembly and initiate calibration and test of compact space environment sensor. Update standard radiation belt model with additional new on-orbit data. Begin integrating next-generation solar and interplanetary models with anomaly resolution tool to provide predictions of space environment hazards.

FY 2016 Plans:

Enhance computational performance of standard radiation belt model for satellite design while continuing to add new on-orbit data. Transition spiral one of anomaly attribution tool to operational demonstration. Begin optimizing design of compact space environment sensor. Evaluate performance of solar and interplanetary models to provide anomaly hazard predictions. Continue exploitation of on-orbit data from wider array of sources to improve understating of system specific space environment effects. Complete specification and forecasting of solar radio-frequency interference affecting Air Force communications and satellite systems.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 635021 / *Space Systems Survivability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Begin transition of solar radio emission monitoring specification and forecasting of radio-frequency into updated model, which will enable understanding and assessment of impacts on Air Force assets.			
Accomplishments/Planned Programs Subtotals	2.313	3.076	2.207

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*	Project (Number/Name) 635083 / *Ballistic Missiles Technology*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
635083: *Ballistic Missiles Technology*	-	3.280	7.733	3.924	-	3.924	1.687	1.339	0.993	-	Continuing	Continuing

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Advanced Navigation Instruments	3.280	7.733	3.924
Description: Develop, integrate, and demonstrate advanced navigation instrumentation applied to emerging vehicle designs and other technologies that support warfighter needs for a safe, secure, and reliable strategic deterrence. ***FY 2014 Accomplishments:*** Continued design and build of fully weapons hardened Advanced Inertial Measurement Unit (AIMU) design to meet Minuteman III requirements. Continued ground testing to include component testing and sled test of prototype AIMU to validate performance. ***FY 2015 Plans:*** Continue weapons hardening of critical technology elements of AIMU system. Build two ground test units with improved design updates for additional testing and integration planning. Investigate and implement multipath mitigation improvements. Incorporate in militarily relevant hardware and conduct field testing. ***FY 2016 Plans:*** Complete weapons hardening of solid-state gyroscope sensor. Complete architecture studies to leverage communications links to provide position and time knowledge, and initiate demonstration of performance on hand held military radios.			
Accomplishments/Planned Programs Subtotals	3.280	7.733	3.924

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 635083 / *Ballistic Missiles Technology*

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, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603401F / *Advanced Spacecraft Technology*	Project (Number/Name) 63682J / *Spacecraft Vehicles*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
63682J: *Spacecraft Vehicles*	-	8.141	11.477	9.230	-	9.230	11.561	10.089	14.865	16.704	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and demonstrates compact, low-cost, spacecraft power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. This project also develops composites for spacecraft structures and technologies for spacecraft control and mechanisms.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Space Power Technologies	2.192	1.705	1.161
Description: Develop power generation space technologies such as multi-junction solar cells, thin-film solar cells, lightweight solar cell arrays, and radiation resistant solar cell modules. ***FY 2014 Accomplishments:*** Completed development of efficient 35% inverted metamorphic (IMM) solar cell. Continued development of 36-37% IMM and quantum dot enhanced IMM solar cells. Completed IMM solar cell interconnection and continue maturation of module technologies. ***FY 2015 Plans:*** Continue development of approaches for greater than 35% efficient solar cells. Mature module/blanket technologies for increased reliability and resiliency. Mature flexible array technologies. ***FY 2016 Plans:*** Down-select candidate approaches for achieving greater than 35% efficient solar cells and initiate cell performance and radiation optimization for selected method. Continue development of resilient technologies for module/array survivability. Initiate demonstrations of flexible array technology through ground demo and/or flight experiments.			
Title: Spacecraft Thermal Technologies	0.784	1.080	0.255
Description: Develop technologies for long-life, efficient, low-vibration, lightweight mechanical cryocoolers and integration components for space applications. ***FY 2014 Accomplishments:*** Using correlated computer modeling results, continued to reduce size, weight, and power requirements, ease integration, and increased reliability of cryocoolers and supporting payload thermal management systems for very large format focal plane arrays for missile warning capability and for industry to significantly improve overall cryocooler design. Further expanded computer			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 63682J / *Spacecraft Vehicles*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
modeling to additional cryocooler components, to include flow straightening effects and other refrigeration cycles (reverse Brayton), and provided correlated results to industry. ***FY 2015 Plans:*** Continue computer simulations to optimize performance of different cryogenic coolers in support of payload thermal management systems for very large format focal plane arrays for missile warning capability and for industry. Increase manufacturability of space-borne cryocoolers through the implementation of commercial, terrestrial cryocooler technologies, combined with space-like designs. ***FY 2016 Plans:*** Complete validation of high-order models to low order models to reduce optimization time through quick parametric analysis			
Title: Spacecraft Structures Technologies ***Description:*** Develop, integrate, and demonstrate composite spacecraft structures and thermal technologies for deployable structures, antennas, electronics cooling, and structural sensing. ***FY 2014 Accomplishments:*** Performed data analysis on variable heat transfer modulation experiment aboard the International Space Station. Produced flight-representative deployable baffle and folded optics for compact star-trackers and wide-field-of-view imagers. ***FY 2015 Plans:*** Develop new thermal technologies for heat dissipation of high energy density spacecraft electronics slated for use on Air Force communications and Global Positioning System (GPS) spacecraft. Initiate in-house testing of these technologies and begin working the technology transition process to Air Force spacecraft prime contractors. Mature technologies for composite spacecraft deployable structures, solar arrays, electro-optical and radio-frequency apertures, and de-orbit mechanisms. Test structurally-integrated sensing technologies on satellite structures to provide an improved option for monitoring spacecraft health and potential threats. ***FY 2016 Plans:*** Complete contracted efforts and in-house government testing, deliver high-performance heat spreader, compliant thermal interface material, and electronics cooling technologies for spaceflight experiment. Using the International Space Station, test the micro-gravity deployment of a new passive-strain-energy-deployed, flexible composites solar array expected to improve capability on Air Force spacecraft by six times. Develop and test deployment of a lightweight baffle and an affordable deployable radio-frequency aperture for communication and high-gain GPS signals. Initiate spaceflight experiment planning to test structurally-integrated sensing technologies for on-orbit impact detection and situational awareness of potential threats.	1.765	2.141	1.161
Title: On-Orbit Satellite Controls	1.106	0.523	0.453

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Develop technologies for spacecraft controls and mechanisms for on-orbit applications. ***FY 2014 Accomplishments:*** Continued advanced spacecraft guidance, navigation, and control subsystem hardware development efforts. ***FY 2015 Plans:*** Initiate development of advanced low size/weight/power high-precision navigation hardware for geosynchronous SSA missions. ***FY 2016 Plans:*** Continue development of advanced low size/weight/power inertial measurement units and high-precision maneuvering technology for geosynchronous SSA missions.			
Title: Space Communication and Control Technologies ***Description:*** Develop technologies for next-generation space communications terminals and equipment, along with methods/ techniques to enable future space system operational command and control concepts. ***FY 2014 Accomplishments:*** Developed satellite communication flight experiments to support future Air Force satellite systems, particularly reconfigurable/ reprogrammable satellite transceivers, space laser communication terminals, and millimeter wave atmospheric propagation experiments. ***FY 2015 Plans:*** Continue incremental development of satellite communication flight experiments to support future Air Force satellite systems, particularly reconfigurable/reprogrammable satellite transceivers, space laser communication terminals, and millimeter wave atmospheric propagation experiments. Support Space and Missile Systems Center Low-Cost User Terminal initiatives. ***FY 2016 Plans:*** Complete evaluation of small space-based laser communication terminal and verify technology readiness for transition to the satellite development community. Complete risk reduction activities and initiate assembly, integration and testing work for a satellite communication flight experiment to support next-generation Air Force communications needs. Continue to invest in advanced applied research and development projects that address technology gaps identified by Air Force Space Command for future military satellite communication systems.	2.294	4.441	3.297
Title: Advanced Alternative Navigation Technologies ***Description:*** Develop new atomic clock technologies and transition these technologies to industry for potential application to future positioning, navigation, and timing space considerations.	-	1.587	2.903

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: N/A ***FY 2015 Plans:*** Initiate efforts to transition newly-developed atomic clock technology from laboratory experiments to industry for potential space systems application. Design and begin fabricating engineering models of these clocks to meet DoD positioning and timing requirements. ***FY 2016 Plans:*** Continue efforts to develop atomic clock technology from laboratory experiments into prototypes to transition to industry. Continue fabrication and development of engineering models of the clocks for testing and integration.			
Accomplishments/Planned Programs Subtotals	8.141	11.477	9.230

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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.