Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Air Force											Date: May 2017	
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 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	62.278	61.593	58.910	0.000	58.910	57.237	58.424	60.614	62.681	Continuing	Continuing
632181: *Spacecraft Payloads*	-	15.555	15.936	15.767	0.000	15.767	16.600	16.807	16.353	17.514	Continuing	Continuing
633834: *Integrated Space Technology Demonstrations*	-	21.204	22.416	21.424	0.000	21.424	13.113	13.846	17.430	17.796	Continuing	Continuing
634400: *Space Systems Protection*	-	10.191	8.091	7.964	0.000	7.964	9.921	9.872	9.420	9.625	Continuing	Continuing
635021: *Space Systems Survivability*	-	2.202	1.849	1.820	0.000	1.820	1.942	1.940	1.796	1.836	Continuing	Continuing
635083: *Ballistic Missiles Technology*	-	3.913	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.913
63682J: *Spacecraft Vehicles*	-	9.213	13.301	11.935	0.000	11.935	15.661	15.959	15.615	15.910	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: FY 2018 Air Force	Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	61.813	61.593	60.243	0.000	60.243
Current President's Budget	62.278	61.593	58.910	0.000	58.910
Total Adjustments	0.465	0.000	-1.333	0.000	-1.333
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	2.153	0.000			
• SBIR/STTR Transfer	-1.688	0.000			
• Other Adjustments	0.000	0.000	-1.333	0.000	-1.333

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: 633834: *Integrated Space Technology Demonstrations*		
Congressional Add: *Program Increase*	3.000	-
Congressional Add Subtotals for Project: 633834	3.000	-
Project: 634400: *Space Systems Protection*		
Congressional Add: *Program Increase*	4.000	-
Congressional Add Subtotals for Project: 634400	4.000	-
Congressional Add Totals for all Projects	7.000	-

Change Summary Explanation

Decrease in FY 2016 reflects reprogramming to support Research and Development Projects, 10 U.S.C. Section 2358.

Funding realigned in FY 2018 to support higher DoD priorities for Autonomy and Laser Weapon.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
632181: *Spacecraft Payloads*	-	15.555	15.936	15.767	0.000	15.767	16.600	16.807	16.353	17.514	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 2016	FY 2017	FY 2018
Title: Advanced Space Electronics	4.111	4.834	4.156
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 2016 Accomplishments:*** Began development of advanced electronic circuit components to achieve increased memory density with greater resiliency to the space environment. Continued development of mission-enabling advanced processors, memory, analog to digital/digital to analog converters, field programmable gate arrays (FPGAs), and electron-beam lithography tool. ***FY 2017 Plans:*** Continue development of advanced electronic circuit components producing first pass component. Complete first pass of split-fabrication and begin verification. Complete commercialization development of programmable analog array. Continue technical lead for electron-beam transition and trusted FPGA development. Complete development of high density non-volatile memory technologies. Continue development of high-efficiency power conversion devices. ***FY 2018 Plans:*** Continue development of advanced electronic circuit components. Verify split-fabrication as trusted method. Complete first stage of electron-beam lithography transition and begin productization. Continue as lead for FPGA development. Oversee qualification of processing and memory technology developments. Continue development of high-efficiency power conversion devices. Begin development of analog to digital and digital to analog technologies.			
Title: Advanced Space Modeling and Simulation Tools	1.262	1.149	1.192

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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 2016	FY 2017	FY 2018
Description: Develop modeling, simulation, and analysis tools for space-based surveillance systems, space capability protection technologies, access/mobility technologies, and flight experiments. ***FY 2016 Accomplishments:*** Updated modeling and simulation tools for flight programs using data sets from recent missions. Continued evaluating the military and technical utility of emerging space vehicle technologies and associated software algorithms. ***FY 2017 Plans:*** Begin development of models for cross-platform modeling, simulation, and analysis support of multi-mission geosynchronous space flight demonstration. Support trade studies and utility analysis for concept development of emerging space technologies and associated software algorithms, including advanced positioning, navigation, and timing technologies. ***FY 2018 Plans:*** Apply and analyze models for cross-platform modeling, simulation, and analysis support of multi-mission geosynchronous space flight demonstration. Continue trade studies and utility analysis for concept development of emerging space technologies, future space flight experiments and associated software algorithms, including advanced positioning, navigation, and timing technologies.			
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 2016 Accomplishments:*** Continued 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. Initiated development of long wavelength infrared detector options to enable future satellite characterization and threat warning & assessment capabilities. Continued support to device radiation performance characterization and evaluation. ***FY 2017 Plans:*** Characterize the material damage caused by both surface charging and displacement damage in alternative detector materials and compare results to model developed. Perform experiments as needed to align model predictions with the degradation observed. Investigate potential detector materials for long wavelength infrared detection. ***FY 2018 Plans:***	1.804	2.367	2.316

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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 2016	FY 2017	FY 2018
Deliver a scanning focal plane array (FPA) for missile warning capability demonstration during laser impingement. Characterize performance of scanning FPA in representative space environment to include natural and man-made radiation including focused photons.			
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 2016 Accomplishments:*** Completed initial reviews of the on-orbit reprogrammable digital waveform generator for PNT/Global Positioning System (GPS). Completed advanced technology space qualifiable L-band radio frequency amplifier(s) for PNT/GPS. ***FY 2017 Plans:*** Finalize design and begin brass-board performance evaluation of on-orbit reprogrammable digital waveform generator for PNT/GPS. Initiate critical design activity. Establish hardware feasibility of advanced phased-array elements for future GPS satellites and begin engineering development unit design. ***FY 2018 Plans:*** Complete designs of on-orbit reprogrammable digital waveform generator for PNT/GPS and deliver engineering development units. Initiate development of broadband amplifier for GPS application.	8.378	7.586	8.103
Accomplishments/Planned Programs Subtotals	15.555	15.936	15.767

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: FY 2018 Air Force			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
633834: *Integrated Space Technology Demonstrations*	-	21.204	22.416	21.424	0.000	21.424	13.113	13.846	17.430	17.796	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 2016	FY 2017	FY 2018
Title: Integrated Satellite Demonstrations	18.204	22.416	21.424

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

FY 2016 Accomplishments:

Continued payload integration for geosynchronous spaceflight demonstration. Demonstration payloads include hyper temporal 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). Developed space and ground segment concepts for integrated demonstration of an advanced GPS payload for contested environments. Determined military utility and defined specific goals, scope, technical objectives, and concepts of operation. Began design engineering trade studies for space flight demonstration with target launch of FY2021-2023.

FY 2017 Plans:

Complete payload integration and begin launch vehicle integration of geosynchronous spaceflight demonstration targeted for early FY2018 launch. Demonstration payloads include 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 EELV. Design and build space segment of space based integrated demonstration of

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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 2016	FY 2017	FY 2018
an advanced GPS payload for contested environments with a target launch of FY2021-2023. Refine experiment plans and ground segment concept for experimental operations. ***FY 2018 Plans:*** Complete launch vehicle integration for geosynchronous spaceflight demonstration. Support launch operations. Begin on-orbit operations; conduct experimental flight operations of HTI sensor, integrated on-board sensing, threat assessment and autonomy payload, and increase autonomy and safety of advanced proximity operations. Continue space and ground segment design and build of advanced space-based integrated GPS demonstration for contested environments -- target launch of FY2021-2023.			
Accomplishments/Planned Programs Subtotals	18.204	22.416	21.424

	FY 2016	FY 2017
Congressional Add: Program Increase	3.000	-
FY 2016 Accomplishments: Conducted Congressionally-Directed effort		
Congressional Adds Subtotals	3.000	-

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: FY 2018 Air Force			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
634400: *Space Systems Protection*	-	10.191	8.091	7.964	0.000	7.964	9.921	9.872	9.420	9.625	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 2016	FY 2017	FY 2018
Title: Space Situational Awareness (SSA) Capability Development	1.370	1.778	1.846
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 2016 Accomplishments: Transitioned space-based imaging concepts to system development community for further maturation. Began development of integrated tracking filter incorporating physics-based neutral density drag models for improved SSA.			
FY 2017 Plans: Continue development of integrated tracking filter incorporating physics-based neutral density drag models for improved SSA. Initiate testing of sensors with reduced solar exclusion angle constraints to provide improved coverage for SSA sensors. Initiate second level testing of ground-based RF sensing package and continue end-to-end processing chain to demonstrate SSA utility of in-house algorithm development.			
FY 2018 Plans: Complete all on-orbital-regime integrated tracking filter and transition to operational community. Continue maturing sensors with reduced solar exclusion angle for improved SSA. Continue maturation of RF sensing modalities. Complete processing chain showing end-to-end tracking and characterization capabilities incorporating real data.			
Title: Space Indicators and Warning Research	1.697	2.268	2.014
Description: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites.			
FY 2016 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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 2016	FY 2017	FY 2018
Reviewed 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. Identified and reviewed holistic, resilient spacecraft concept technologies. Identified and developed integration paths for key resilient spacecraft technology discoveries. ***FY 2017 Plans:*** Identify enabling rapid space-based threat identification and attribution capabilities. Assess, refine, and begin developing best candidate resilient spacecraft concept technologies. Continue to identify and develop integration paths for resiliency enabling technology discoveries. ***FY 2018 Plans:*** Integrate space cyber resilience concepts into ground and flight experiments. Conduct experiments to evaluate integration of resilience technologies and concepts into programs of record and high value assets; document and disseminate best practices and lessons learned. Continue maturing resilient spacecraft concepts. Conduct evaluation of on-orbit data from geosynchronous spaceflight demonstration and other flight experiment and operational test opportunities.			
Title: Spacecraft Threat Detection ***Description:*** Develop active satellite local space awareness technologies and exploitation tools for satellite systems. ***FY 2016 Accomplishments:*** Refined capabilities to perform on-board course of action mission planning which involved tasking of satellite subsystems as well as other space system entities; matured technology through ground and flight demonstration opportunities, including delivery of hardware for flight experiment. Selected cross-queuing concepts and identified specific candidate technologies to integrate and increase cross-coordination between space and ground sensor assets. ***FY 2017 Plans:*** Continue to advance technology for on-board threat detection and course-of-action generation and response using live satellite data. Complete demonstration of closed loop tasking and sensor cross-queuing utilizing on-orbit and ground assets. Initiate development of enterprise-level situation monitoring and command and control. ***FY 2018 Plans:*** Continue to advance technology in on-board threat detection and course-of-action generation and response using live satellite data. Continue advanced technology development for enterprise-level situation monitoring and demonstrate concepts of space battle management command and control through experimentation with ground stations and flight experiments.	3.124	4.045	4.104
Accomplishments/Planned Programs Subtotals	6.191	8.091	7.964

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 634400 / *Space Systems Protection*

	FY 2016	FY 2017
Congressional Add: Program Increase ***FY 2016 Accomplishments:*** Conducted Congressionally-Directed effort.	4.000	-
Congressional Adds Subtotals	4.000	-

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: FY 2018 Air Force			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
635021: *Space Systems Survivability*	-	2.202	1.849	1.820	0.000	1.820	1.942	1.940	1.796	1.836	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 2016	FY 2017	FY 2018
Title: Spacecraft Survivability/Reliability	2.202	1.849	1.820
Description: Develop technologies to provide improved space radiation and ionospheric hazard specification and forecasting. ***FY 2016 Accomplishments:*** Enhanced computational performance of standard radiation belt model for satellite design while continuing to add new on-orbit data. Transitioned spiral one of anomaly attribution tool to operational demonstration. Began upgrading design of compact energetic particle sensor to meet requirements for use in contested space. Completed specification and forecasting of solar radio-frequency interference affecting Air Force communications and satellite systems. ***FY 2017 Plans:*** Support spiral one anomaly attribution tool demonstration and transition to operational use with common ground system. Initiate spiral two development for anomaly attribution tool to include additional information for operators and incorporate limited space environment forecast demonstrations. Begin detailed design, assembly, and calibration of energetic particle sensor for use in contested space. Begin development of automated exploitation tool for on-orbit data for rapid detection and characterization of space environment impacts. Investigate and improve forecasting of solar radio events that impact Air Force operational systems. ***FY 2018 Plans:*** Continue spiral one anomaly attribution tool demonstration and transition to operational use with common ground system. Continue spiral two development for anomaly attribution tool and begin transition to operational demonstration. Complete assembly and calibration of energetic particle sensor for use in contested space. Continue development of automated exploitation tool for on-orbit data for rapid detection and characterization of space environment impacts. Begin exploiting data from on-orbit radiation remediation mission for inclusion in standard radiation belt model for satellite design. Continue investigation and improvement of the forecasting of solar radio events that impact Air Force operational systems.			
Accomplishments/Planned Programs Subtotals	2.202	1.849	1.820

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 635021 / *Space Systems Survivability*

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: FY 2018 Air Force			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
635083: *Ballistic Missiles Technology*	-	3.913	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.913

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 2016	FY 2017	FY 2018
Title: Advanced Navigation Instruments	3.913	0.000	0.000
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 2016 Accomplishments:*** Completed weapons hardening of solid-state gyroscope sensor. Completed architecture studies to leverage communications links to provide position and time knowledge, and initiated demonstration of performance on hand held military radios. ***FY 2017 Plans:*** In FY 2017, PE 0603401F, Advanced Spacecraft Technology, Project 635083, Ballistic Missiles Technology efforts were transferred to PE 0603401F, Advanced Spacecraft Technology, Project 63682J, Spacecraft Vehicles, in order to better align advanced navigation technology research and development. ***FY 2018 Plans:*** N/A			
Accomplishments/Planned Programs Subtotals	3.913	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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: FY 2018 Air Force			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
63682J: *Spacecraft Vehicles*	-	9.213	13.301	11.935	0.000	11.935	15.661	15.959	15.615	15.910	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 2016	FY 2017	FY 2018
Title: Space Power Technologies	1.159	0.990	1.110
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 2016 Accomplishments:*** Selected candidate approaches for achieving greater than 35% efficient solar cells and initiated cell performance and radiation optimization for selected method. Continued development of resilient technologies for module/array survivability. Initiated demonstrations of flexible array technology through ground demo and/or flight experiments. ***FY 2017 Plans:*** Continue to optimize 35% efficient solar cell architectures for end-of-life performance. Initiate mitigation approaches for thermal excursion events for resilient array technologies. Complete on-orbit flight experiment demonstration of flexible array technology. ***FY 2018 Plans:*** Complete end-of-life optimization of solar cell architectures approaching 35%. Continue development of mitigation approaches for thermal excursion in resilient arrays. Initiate on-orbit flight experiment of resilient array technologies.			
Title: Spacecraft Thermal Technologies	0.254	0.000	0.000
Description: Develop technologies for long-life, efficient, low-vibration, lightweight mechanical cryocoolers and integration components for space applications. ***FY 2016 Accomplishments:*** Completed validation of high-order models to low-order models to reduce optimization time through quick parametric analysis. In FY2016, Project 63682J, Spacecraft Thermal Technologies, completes. ***FY 2017 Plans:***			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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 2016	FY 2017	FY 2018
N/A ***FY 2018 Plans:*** N/A			
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 2016 Accomplishments:*** Completed contracted efforts and in-house government testing, delivered high-performance heat spreader, compliant thermal interface material, and electronics cooling technologies for spaceflight experiment. Using the International Space Station, tested the micro-gravity deployment of a new passive-strain-energy-deployed, flexible composites solar array expected to improve capability on Air Force spacecraft six-fold. Developed and tested deployment of a lightweight baffle and an affordable deployable radio-frequency aperture for communication and high-gain GPS signals. Initiated spaceflight experiment planning to test structurally-integrated sensing technologies for on-orbit impact detection and situational awareness of potential threats. ***FY 2017 Plans:*** Complete high-performance heat spreader, compliant thermal interface material, electronics cooling technologies, roll-out solar array, and deployable baffle development for potential applications by DoD programs and prime contractors. Continue spaceflight experiment to test structurally-integrated sensing technologies for on-orbit impact detection and situational awareness of potential threats. Initiate flight experiment to test an affordable deployable aperture for denied area communication and high-gain, anti-jam GPS applications. ***FY 2018 Plans:*** Complete spaceflight experiment to test structurally-integrated sensing technologies for on-orbit impact detection and situational awareness of potential threats. Continue flight experiment to test affordable deployable antennas for denied area communication and high-gain, anti-jam GPS applications. Initiate integrated experiment concepts testing structures and thermal technologies for high energy density, full spectrum radio frequency reconfigurabilty, adaptability, and protection.	1.159	0.992	1.109
Title: On-Orbit Satellite Controls ***Description:*** Develop technologies for spacecraft controls and mechanisms for on-orbit applications. ***FY 2016 Accomplishments:***	0.452	0.423	0.433

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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 2016	FY 2017	FY 2018
Initiated development of advanced computer-vision based navigation algorithms and software for precision spacecraft relative motion control missions. ***FY 2017 Plans:*** Continue development and initiate testing of advanced computer-vision based navigation algorithms and software for precision spacecraft relative motion control missions. ***FY 2018 Plans:*** Continue development and testing of advanced computer-vision based navigation algorithms and software for precision spacecraft relative motion control 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 2016 Accomplishments:*** Supported fabrication and testing of the W and V frequency band space flight instrument and ground receiver unit. Identified a host spacecraft for the flight experiment; launch is anticipated in 2019. Completed fabrication and test of transmit antenna array. Completed analysis of the data from the Compact Laser Terminal flight experiment. ***FY 2017 Plans:*** Complete testing and qualification of the payload for the W and V frequency band satellite communications flight experiment. Initiate testing and evaluation of a software defined radio for a low Earth orbiting cube-satellite experiment operating in S and L frequency bands providing wide-band, high-date-rate satellite telemetry, command, and control. ***FY 2018 Plans:*** Support integration and test of the W and V frequency band flight instrument onto the host spacecraft. Support initial design and breadboard testing of W and V frequency band follow-on project that would demonstrate W and V band satellite communications (bi-directional, modulated signals) and mitigate technology risks in order to facilitate transition to an operational system. Continue to support development of critical space and ground terminal technology, such as multi-beam antenna, high power amplifiers, low noise amplifiers, reconfigurable radios, and wideband modem and signal processing technology.	3.291	2.812	1.905
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. ***FY 2016 Accomplishments:***	2.898	8.084	7.378

Exhibit R-2A, RDT&E Project Justification: FY 2018 Air Force		Date: May 2017
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 2016	FY 2017	FY 2018
Continued efforts to develop atomic clock technology from laboratory experiments into flight experiment payload units to transition to industry. Continued fabrication and development of engineering models of the clocks for testing and integration. ***FY 2017 Plans:*** Finalize efforts to develop atomic clock technology from laboratory experiments into flight experiment payload units to transition to industry. Begin integration and testing of clock engineering models. Begin development of radiation-hardened, ultra-stable laser needed for cold-atom atomic clocks, accelerometers, and gyroscopes operating in space or nuclear environments. Begin development of technology to leverage communications links to provide positioning and time knowledge, and continue second spiral demonstration of performance on handheld military radios to inform technology development activity. In FY 2017, PE 0603401F, Advanced Spacecraft Technology, Project 635083, Ballistic Missiles Technology efforts were transferred to PE 0603401F, Advanced Spacecraft Technology, Project 63682J, Spacecraft Vehicles, in order to better align advanced navigation technology research and development. ***FY 2018 Plans:*** Continue transition of atomic clock technology to industry to build into flight experiment payload units for flight testing. Continue integration and testing of clock engineering models. Continue the development of radiation-hardened, ultra-stable laser needed for cold-atom atomic clocks, accelerometers, and gyroscopes operating in space or nuclear environments. Continue the development of technology to leverage communications links to provide positioning and time knowledge, and continue second spiral demonstration of performance on handheld military radios to inform technology development activity.			
Accomplishments/Planned Programs Subtotals	9.213	13.301	11.935

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.