Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force											Date: February 2020	
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 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	-	65.727	80.525	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
632181: *Spacecraft Payloads*	-	19.287	23.176	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
633834: *Integrated Space Technology Demonstrations*	-	17.543	18.856	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
634400: *Space Systems Protection*	-	9.078	7.708	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
635021: *Space Systems Survivability*	-	1.646	1.581	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
63682J: *Spacecraft Vehicles*	-	18.173	29.204	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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, 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 Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.

In the FY 2021, the Air Force is consolidating its existing thirteen Advanced Technology Development (ATD), Research Development Test and Evaluation (RDT&E), Budget Activity 03 (BA 03) PEs into five new capability focused RDT&E BA 03 PEs to better align with the Air Force Science and Technology (S&T) Strategy signed by the SECAF in April 2019. This consolidation will improve and accelerate delivery of integrated transformational, multidisciplinary, collaborative technology solutions necessary to enable new Air Force warfighting capabilities that support of the National Defense Strategy. This new structure will provide the Air Force and Congress with a clearer understanding and increased transparency of integrated technology solutions and demonstrations key to enabling the Air Force future force design.

In FY 2021, Project 633834, Integrated Space Technology Demonstrations, non-Vanguard efforts and activities will be transferred from PE 0603401F, Advanced Spacecraft Technology to PE 0603033F, Next Gen Platform Dev/Demo. Navigation Technology Satellite-3 (NTS-3) Vanguard activities under this Project will be consolidated and transferred in FY 2021 from PE 0603401F, Advanced Spacecraft Technology to the PE 0603032F, Future AF Integrated Technology Demos, Project 630320, Air Force Vanguards.

In FY 2021, the entirety of Project 63682J, Spacecraft Vehicles, will be transferred from PE 0603401F, Advanced Spacecraft Technology, to PE 0603033F, Next Gen Platform Dev/Demo.

For FY 2021 and future years, efforts and activities under Project 632181, Spacecraft Payloads; Project 634400, Space Systems Protection; and Project 635021, Space Systems Survivability, have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
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*

All these transfers detailed above are part of the Air Force RDT&E BA 03 PE consolidation in order to realign technology areas that better support the National Defense Strategy, Air Force Future Operating Concept and Air Force Science and Technology Strategy, April 2019. This is an administrative realignment and not a new start. This work will continued to be executed by the Air Force Research Laboratory Space Vehicles Technology Directorate located in Kirtland Air Force Base, New Mexico.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 0602298F, and 1206601SF.

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.

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	70.734	70.525	80.358	0.000	80.358
Current President's Budget	65.727	80.525	0.000	0.000	0.000
Total Adjustments	-5.007	10.000	-80.358	0.000	-80.358
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	10.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-2.309	0.000			
• Other Adjustments	-2.698	0.000	-80.358	0.000	-80.358

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: 632181: *Spacecraft Payloads*		
Congressional Add: *Congressional Add: Program increase - radiation hardened memory*	0.000	10.000
Congressional Add: *Program increase - radiation hardened microelectronic processors*	5.805	0.000
Congressional Add Subtotals for Project: 632181	5.805	10.000
Project: 63682J: *Spacecraft Vehicles*		
Congressional Add: *Program increase - space laser communications systems*	9.674	0.000
Congressional Add Subtotals for Project: 63682J	9.674	0.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
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*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Congressional Add Totals for all Projects	15.479	10.000

Change Summary Explanation

Decrease in FY 2019 of $2.698 million is due to realignment of funds to PE 0602212F to support Research and Development Projects, 10 U.S.C. Section 2363, an amendment to PL 110-417, 10 U.S.C. Section 2358 and 10 U.S.C. 2805(d)(1)(B).

Decrease in FY 2021 of $80.356 million is due to:

1) Postponement/curtailment of efforts and activities under Project 632181, Spacecraft Payloads; Project 634400, Space Systems Protection; and Project 635021, Space Systems Survivability, to higher Air Force, Space Force, and Department of Defense priorities.

2) Entirety of Project 63682J, Spacecraft Vehicles, transferring to PE 0603033F, Next Gen Platform Dev/Demo

3) Project 633834, Integrated Space Technology Demonstrations, non-Vanguard efforts and activities transferring to PE 0603033F, Next Gen Platform Dev/Demo.

4) Navigation Technology Satellite-3 (NTS-3) Vanguard activities under Project 633834, Integrated Space Technology Demonstrations, transferring to the PE 0603032F, Future AF Integrated Technology Demos, Project 630320, Air Force Vanguards.

These transfers in FY 2021 are part of the Air Force RDT&E BA 03 PE consolidation in order to realign technology areas to better support the National Defense Strategy, Air Force Future Operating Concept, and the Air Force S&T Strategy, April 2019.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
632181: *Spacecraft Payloads*	-	19.287	23.176	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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 (for example, 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 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.

In FY 2021 and future years, the efforts and activities under Project 632181, Spacecraft Payloads, have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Space Electronics	3.000	3.197	0.000
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 2020 Plans: Complete the productization stage of electron-beam lithography manufacturing capability. Continue leading trusted Field-Programmable Gate Array development and begin space qualification planning. Continue development of next generation memory technologies for space. Oversee qualification of next generation space processor development and planning memory technology development qualification planning. Continue assessments of tolerance of advanced electronic circuit components to space radiation environmental conditions. Continue development of novel payload processor technologies and architectures, and the electronic memory necessary to support them. Begin development of heterogeneous processing payload architecture for future on-orbit experiment.			
FY 2021 Plans: In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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 2019	FY 2020	FY 2021
FY 2021 decreased compared to FY 2020 by $3.197 million. Funding decreased due to postponement/curtailment of Advanced Space Electronics activities based on higher Air Force, Space Force, and Department of Defense priorities.			
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 2020 Plans:*** Begin leveraging multiple domain analyses across space and terrestrial missions with model-test-model in support of multi-mission geosynchronous space flight demonstrations. Initiate simultaneous trade studies using utility analyses for concept maturation of emergent space technologies for space flight experiments and applications in commercial space. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $0.749 million. Funding decreased due to postponement/curtailment of Advanced Space Modeling and Simulation Tools activities based on higher Air Force, Space Force, and Department of Defense priorities.	0.800	0.749	0.000
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 2020 Plans:*** Continue to develop III-V alternative infrared detector materials for space environments. Continue development of scanning and staring focal plane arrays for missile warning capability demonstrations during laser impingement. Continue performance characterization of visible through infrared focal plane arrays in representative space environments, including natural and man-made radiation, i.e. focused photons, to identify and resolve any shortfalls impeding the technology transition. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	2.000	2.070	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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 2019	FY 2020	FY 2021
FY 2021 decreased compared to FY 2020 by $2.070 million. Funding decreased due to postponement/curtailment of Advanced Space Sensors activities based on higher Air Force, Space Force, and Department of Defense priorities.			
Title: Positioning, Navigation, and Timing Space Payload Technologies	7.682	7.160	0.000
Description: Develop, validate, and transition technologies that: enable new, or enhance existing, United States positioning, navigation, and timing 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 positioning, navigation, and timing space payload technology needs. ***FY 2020 Plans:*** Complete developing advanced positioning, navigation, and timing signals for experimentation on the Navigation Technology Satellite-3 flight experiment. Conduct preliminary assessments of broadband components for use in satellite payloads for Precision Navigation and Timing. Test reprogrammability aspects of on-orbit reprogrammable digital waveform generator and explore use cases for enterprise reprogrammability. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $7.160 million. Funding decreased due to postponement/curtailment of Positioning, Navigation, and Timing Space Payload Technologies activities based on higher Air Force, Space Force, and Department of Defense priorities.			
Accomplishments/Planned Programs Subtotals	13.482	13.176	0.000

	FY 2019	FY 2020
Congressional Add: Congressional Add: Program increase - radiation hardened memory ***FY 2019 Accomplishments:*** Not applicable ***FY 2020 Plans:*** Conduct Congressionally directed effort	0.000	10.000
Congressional Add: Program increase - radiation hardened microelectronic processors	5.805	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 632181 / *Spacecraft Payloads*

	FY 2019	FY 2020
FY 2019 Accomplishments: Conducted Congressionally directed effort ***FY 2020 Plans:*** Not applicable.		
Congressional Adds Subtotals	5.805	10.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
633834: *Integrated Space Technology Demonstrations*	-	17.543	18.856	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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 United States 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.

In FY 2021, Project 633834, Integrated Space Technologies Demonstrations, non-Vanguard efforts and activities will be transferred from PE 0603401F, Advanced Spacecraft Technology to PE 0603033F, Next Gen Platform Dev/Demo. Navigation Technology Satellite-3 Vanguard activities under this Project will be consolidated and transferred in FY 2021 from PE 0603401F, Advanced Spacecraft Technology, to the PE 0603032F, Future AF Integrated Tech Demos, Project 630320, Air Force Vanguards. These transfers are part of the Air Force RDT&E BA 03 PE Consolidation in order to realign technology areas that better support the National Defense Strategy, Air Force Future Operating Concept, and Air Force Science and Technology Strategy, April 2019. The Project and associated Non-Vanguard efforts and activities will continue to be executed by the Air Force Research Laboratory Space Vehicles Technology Directorate located in Kirtland Air Force Base, New Mexico. This is an administrative realignment for consolidation, and not a new start.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Integrated Satellite Demonstrations	17.543	18.856	0.000
Description: Develop satellite technologies for integrated, robust, and flexible satellite demonstrations building on previous work and leveraging investments by other organizations.			
FY 2020 Plans: Conclude on-orbit operations; complete and close-out experimental flight operations of spacecraft, hypertemporal imaging sensor, integrated on-board sensing, threat assessment and autonomy payload, and advanced proximity operations. Complete final reports for spacecraft, payloads and experiments. Complete transition of spacecraft operations to Air Force Space Command. Continue space segment components and sub-systems development with a focus on breadboard test and verification results for next generation navigation test satellites. Continue payload and user equipment development and complete user equipment and system software compatibility review to support a projected FY 2023 launch. Conduct on-orbit demonstration of a Geosynchronous orbit small satellite extending the maturity of multiple communication technologies and operational concepts for future small satellites. Continue on-orbit demonstrations of multiple formation flying satellites for near autonomous formation control. Leverage opportunities to fly demonstrations and prototypes, where successes can identify quick transition to next generation technology needs. Coordinate a manifest timeline for critical space projects prioritizing Air Force Space Command technical, security, and operational development requirements. Utilize the Long Duration Propulsive Evolved Expendable Launch			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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 2019	FY 2020	FY 2021
Vehicle Secondary Payload Adaptor launch schedule and other prospects to quickly fly demonstrations and prototypes. Mature payloads from concept proposal to leverage commercial Low Earth orbit constellations. Milestones for these efforts are a Systems Requirements Review and a Preliminary Design Review. Deliverables will be a preliminary system design package and a system interface document. ***FY 2021 Plans:*** In FY 2021, non-Vanguard work is performed under the Integrated Satellite Demonstrations effort in PE 0603033F, Next Gen Platform Dev/Demo, Project 633834, Integrated Space Technology Demonstrations. Navigation Technology Satellite-3 Vanguard activities will be performed under the Navigation Technology Satellite-3 effort in PE 0603032F, Future AF Integrated Technology Demos, Project 630320, Air Force Vanguards. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $18.856 million. Funding decreased due to the transfer and realignment of this work to the Integrated Satellite Demonstrations effort in PE 0603033F, Next Gen Platform Dev/Demo, Project 633834, Integrated Space Technology Demonstrations with the exception of the Navigation Technology Satellite-3 Vanguard work which will be transferred to the Navigation Technology Satellite-3 effort in PE 0603032F, Future AF Integrated Technology Demos, Project 630320, Air Force Vanguards, as part the Air Force RDT&E BA 03 PE consolidation.			
Accomplishments/Planned Programs Subtotals	17.543	18.856	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
634400: *Space Systems Protection*	-	9.078	7.708	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of United States space assets in hostile warfighting environments. The project performs assessments of critical components and subsystems, and evaluates susceptibility and vulnerability to radio frequency and laser threats. This project also develops technologies that mitigate identified vulnerabilities. These technologies support balanced satellite protection strategies for detecting and avoiding threats in a hostile space environment.

In FY 2021 and future years, the efforts and activities under Project 634400, Space Systems Protection, have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Space Situational Awareness Capability Development	2.227	1.409	0.000
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 2020 Plans:*** Continue to develop and integrate processing techniques into evolved operations centers to autonomously detect, track, identify and characterize satellites to meet timelines needed for implementation of courses of actions mitigating potential gaps for evolving threats. Continue to further develop prototypes utilizing multi-phenomenology based on the observables indicating a potential threat to mitigate knowledge gaps. Continue to conduct an integrated ground and space experiment for space situational awareness with available sensors. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $1.409 million. Funding decreased due to postponement/curtailment of Space Situational Awareness Capability Development activities based on higher Air Force, Space Force, and Department of Defense priorities.			
Title: Space Indicators and Warning Research	2.851	2.182	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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 2019	FY 2020	FY 2021
Description: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. ***FY 2020 Plans:*** Conduct RED-vs-BLUE space-cyber experiment campaign with 50th Space Wing and other government agency partners, utilizing an on-orbit space platform. Evaluate technology solutions, and develop concepts of operation and tactics, techniques, and procedures for satellite operations in a cyber-contested space environment. Utilize space resiliency testbed to integrate and assess technology solutions for a projected FY 2021 on-orbit experiment campaign. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $2.182 million. Funding decreased due to postponement/curtailment of Space Indicators and Warning Research activities based on higher Air Force, Space Force, and Department of Defense priorities.			
Title: Spacecraft Threat Detection ***Description:*** Develop active satellite local space awareness technologies and exploitation tools for satellite systems. ***FY 2020 Plans:*** Continue to develop advanced software related technology for 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. Perform ground based demonstration of multi-domain command and control using space based assets Initiate advanced autonomy demonstrations to prove advanced concepts in multi-domain real-time command and control. Plan for flight demonstration of satellite autonomy technologies with an emphasis on on-board planning systems. Demonstrate and experiment with prototype threat warning and response systems within an integrated multi-domain testbed. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $4.117 million. Funding decreased due to postponement/curtailment of Spacecraft Threat Detection activities based on higher Air Force, Space Force, and Department of Defense priorities.	4.000	4.117	0.000
Accomplishments/Planned Programs Subtotals	9.078	7.708	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
635021: *Space Systems Survivability*	-	1.646	1.581	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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.

In FY 2021 and future years, the efforts and activities under Project 635021, Space Systems Survivability, have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Spacecraft Survivability/Reliability	1.646	1.581	0.000
Description: Develop technologies to provide improved space radiation and ionospheric hazard specification and forecasting. ***FY 2020 Plans:*** Continue updating standard radiation belt model for satellite design and complete transition. Mature next-generation highly-miniaturized energetic charged particle sensor for use in contested space. Continue spiral two demonstration of anomaly attribution tool and incorporate next-generation models for enhanced exploitation of sensor data. Initiate development and demonstration of tools to specify impacts of the ionosphere and near-earth space environment dynamics on Department of Defense systems to support strategic, operational, and tactical users. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $1.581 million. Funding decreased due to postponement/curtailment of Spacecraft Survivability/Reliability activities based on higher Air Force, Space Force, and Department of Defense priorities.			
Accomplishments/Planned Programs Subtotals	1.646	1.581	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
63682J: *Spacecraft Vehicles*	-	18.173	29.204	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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.

In FY 2021, the entirety of Project 63682J, Spacecraft Vehicles, will be transferred to PE 0603033F, Next Gen Platform Dev/Demo, Project 63682J, Spacecraft Vehicles, as part of the Air Force RDT&E PE BA 03 PE Consolidation in order to realign technology areas to better support the National Defense Strategy, Air Force Future Operating Concept, and Air Force Science and Technology Strategy, April 2019. The Project and associated efforts will continue to be executed by the Air Force Research Laboratory Space Vehicles Technology Directorate located in Kirtland Air Force Base, New Mexico. This is an administrative realignment for consolidation, and not a new start.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Space Power Technologies	1.000	1.065	0.000
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 and arrays. ***FY 2020 Plans:*** Continue on-orbit flight experiment development for advanced solar cells, solar arrays, and batteries. Target integration with small, experimental satellites to leverage system-level developments. Further development of on-orbit directed energy sensing approaches. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $1.065 million. Funding decreased due to postponement/curtailment of Space Power Technologies activities based on higher Air Force, Space Force, and Department of Defense priorities.			
Title: Spacecraft Structures Technologies	1.000	1.415	0.000
Description: Develop, integrate, and demonstrate composite spacecraft structures and thermal technologies for deployable structures, antennas, electronics cooling, and structural sensing.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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 2019	FY 2020	FY 2021
FY 2020 Plans: Complete integrated experiments testing structures and thermal technologies for high energy density, full spectrum radio frequency reconfigurability, adaptability, and protection. Complete integrated ground experiment or flight experiment for extremely thin, multi-mission, radio frequency antennas for ensured capability in highly contested environments. Initiate integrated ground experiment or flight experiment for high-power small satellites technologies. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $1.415 million. Funding decreased due to postponement/curtailment of Spacecraft Structures Technologies activities based on higher Air Force, Space Force, and Department of Defense priorities.			
Title: On-Orbit Satellite Controls ***Description:*** Develop technologies for spacecraft controls and mechanisms for on-orbit applications. ***FY 2020 Plans:*** Complete testing of advanced computer-vision based navigation algorithms and software for precision spacecraft relative motion control missions. Initiate experiments with algorithms using on-orbit data collected from past missions. ***FY 2021 Plans:*** In FY 2021, all activities in this effort have been postponed/curtailed due to higher Air Force, Space Force, and Department of Defense priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $0.416 million. Funding decreased due to postponement/curtailment of On-Orbit Satellite Controls activities based on higher Air Force, Space Force, and Department of Defense priorities.	0.415	0.416	0.000
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 2020 Plans:*** Continue support of planned five-year W/V-band propagation experiment. Support ground terminal operations, maintenance, and re-deployments. Collect and analyze data to statistically characterize atmospheric propagation effects and correlate	2.080	12.001	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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 2019	FY 2020	FY 2021
to meteorological parameters. Continue development of space-qualified V-band high power amplifier technology. Initiate development of W/V-band satellite transponder for on-orbit experiment and demonstration coupled with crosslinks. Continue systems engineering and technology risk-reduction for W/V-band ground terminals. ***FY 2021 Plans:*** In FY 2021, this work will be performed under the Space Communication Technologies effort in PE 0603033, Next Gen Platform Dev/Demo, Project 63682J, Spacecraft Vehicles. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $12.001 million. Funding decreased due to the transfer and realignment of this work to the Space Communication Technologies effort in PE 0603033F, Next Gen Platform Dev/Demo, Project 63682J, Spacecraft Vehicles, as part of the Air Force RDT&E BA 03 PE Consolidation.			
Title: Inertial Sensor Navigation Technologies ***Description:*** Develop and test radiation hardened solid state inertial sesnors. ***FY 2020 Plans:*** Continue design, development and testing of inertial sensor prototypes and radiation hardened electronics and initiate conceptual designs for inertial measurement systems. Continue to mature modelling, simulation and test/validation procedures for inertial sensor systems in relevant strategic environments. ***FY 2021 Plans:*** In FY 2021, this work is performed under the Inertial Sensor Navigation Technologies effort in PE 0603033F, Next Gen Platform Dev/Demo, Project 63682J, Spacecraft Vehicles. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $14.307 million. Funding decreased due to the transfer and realignment of this work to the Inertial Sensor Navigation Technologies effort in PE 0603033F, Next Gen Platform Dev/Demo, Project 63682J, Spacecraft Vehicles, as part of the Air Force RDT&E BA 03 PE Consolidation.	4.004	14.307	0.000
Accomplishments/Planned Programs Subtotals	8.499	29.204	0.000

	FY 2019	FY 2020
Congressional Add: Program increase - space laser communications systems	9.674	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603401F / *Advanced Spacecraft Technology*	**Project (Number/Name)** 63682J / *Spacecraft Vehicles*

	FY 2019	FY 2020
FY 2019 Accomplishments: Conducted Congressionally directed effort ***FY 2020 Plans:*** Not applicable.		
Congressional Adds Subtotals	9.674	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A