Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force											Date: February 2020	
Appropriation/Budget Activity 3620F: *Research, Development, Test & Evaluation, Space Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 1206601SF / *Space 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	-	0.000	0.000	130.874	0.000	130.874	128.708	125.315	128.077	130.666	Continuing	Continuing
621010: *Space Survivability & Surveillance*	-	0.000	0.000	41.807	0.000	41.807	43.141	42.160	46.013	46.836	Continuing	Continuing
624846: *Spacecraft Payload Technologies*	-	0.000	0.000	29.796	0.000	29.796	31.276	30.031	31.374	31.495	Continuing	Continuing
625018: *Spacecraft Protection Technology*	-	0.000	0.000	11.639	0.000	11.639	12.421	11.957	13.406	13.765	Continuing	Continuing
628809: *Spacecraft Vehicle Technologies*	-	0.000	0.000	47.632	0.000	47.632	41.870	41.167	37.284	38.570	Continuing	Continuing

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity (BA) 02 due to the creation of a new Appropriation for Space Force.

This program focuses on four major areas. First, the space survivability and surveillance area develops technologies to understand space weather and the geophysics environment for mitigation and exploitation of these effects to Space Force systems. Second, the spacecraft payload technologies area improves satellite payload operations by developing advanced component and subsystem capabilities. Third, the spacecraft protection area develops technologies for protecting United States space assets in potential hostile settings. The last major area, spacecraft vehicles, focuses on spacecraft platform and control technologies, and their interactions. Efforts in this program have been coordinated through the Department of Defense Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.

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, 0602298F, 0602601F, 0602602F, 0602605F, and 0602788F.

This work will still be executed by the Air Force Research Laboratory Space Vehicles (AFRL/RV) Technology Directorate located at Kirtland Air Force Base, New Mexico. This is an administrative realignment and not a New Start.

As directed in the FY 2018 NDAA, Sec 825, amendment to PL 114-92 FY 2016 NDAA, Sec 828 Penalty for Cost Overruns, the FY 2019 Air Force penalty total is $50.0M. The calculated percentage reduction to each research, development, test and evaluation and procurement account will be allocated proportionally from all programs, projects, or activities under such account.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3620F: *Research, Development, Test & Evaluation, Space Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	0.000	0.000	0.000	0.000
Current President's Budget	0.000	0.000	130.874	0.000	130.874
Total Adjustments	0.000	0.000	130.874	0.000	130.874
• 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	0.000	0.000			
• SBIR/STTR Transfer	0.000	0.000			
• Other Adjustments	0.000	0.000	130.874	0.000	130.874

Change Summary Explanation

+$130.874 million; funds starting in FY 2021 were transferred from RDT&E, Air Force to RDT&E, Space Force; this total includes a $10.000 million increase for classified space applied research activities.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
Appropriation/Budget Activity 3620F / 2	R-1 Program Element (Number/Name) PE 1206601SF / *Space Technology*	Project (Number/Name) 621010 / *Space Survivability & Surveillance*	

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
621010: *Space Survivability & Surveillance*	-	0.000	0.000	41.807	0.000	41.807	43.141	42.160	46.013	46.836	Continuing	Continuing

(+) The sum of all Prior Years is $0.000 million less than the represented total due to several projects ending

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity (BA) 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

This project develops technologies to understand and control the space environment for warfighter's future capabilities. The focus is on characterizing and forecasting the battlespace environment for more realistic space system design, modeling, and simulation, as well as the battlespace environment's effect on space systems' performance. This includes technologies to specify and forecast the space environment for planning operations, ensure uninterrupted system performance, optimize space-based surveillance operations, and provide capability to mitigate or exploit the space environment for both offensive and defensive operations. Finally, this project includes the seismic research program that supports national requirements for monitoring nuclear explosions.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Space Environment Research	0.000	0.000	20.235
Description: Develop techniques, forecasting tools, sensors, and technologies for specifying, monitoring, predicting, and controlling space environmental conditions hazardous to Department of Defense operational space and radar systems.			
FY 2020 Plans: For 2020 and prior, this work is performed under the Space Environment Research effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance.			
FY 2021 Plans: Continue exploitation and data collection of radiation aged materials for electrical and optical property changes to enhance predictive models. Identify and initiate generation-beyond-next trapped and untrapped particle specification model development efforts. Continue space environment sensor and anomaly attribution tool demonstrations to identify key model development requirements and transition roadblocks. Research and develop technologies to exploit and mitigate space environment effects to the Department of Defense's advantage. Prototype and demonstrate new ground-based and space-based sensors for monitoring and specifying the state of the space environment for military applications. Continue to develop and enhance space environment modelling capabilities to better enable accurate specification and forecasting of the state of the space environment, and the resulting impacts to Department of Defense and national systems. Advance research into the physics and dynamics of the sun			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
to better specify and forecast solar events and better understand how those events impact the near-earth space environment. Explore fundamental radio frequency and chemical interactions in the near-earth space environment to inform potential utility for military applications. Continue work on hybrid supersonic solver code development and validation, expanding the solver to include accurate Global Positioning System performance. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable			
Title: Surveillance Technologies ***Description:*** Develop advanced target detection techniques, spectral signature libraries, and decision aids for space-based sensors and surveillance systems. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Surveillance Technologies effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2021 Plans:*** Initiate development of capability metrics for new satellite constellation architectures, advanced data analytics, and satellite demonstration concepts. Continue study of advanced surveillance and detection technologies for tracking emerging and evolving targets, including ballistic and non-ballistic targets that pose new challenges for missile warning systems. Document findings of innovative computational methods for missile warning System Program Office to significantly decrease satellite down-link bandwidth while maintaining high fidelity of missile warning data. Document findings of analysis tasks associated with on-orbit experiments that demonstrated advanced sensor and analytic methods of innovative hypertemporal imaging early missile warning concept, including the collection and analysis of missile and missile like data. Continue investigation of on-board processing capabilities and limitations for large datasets. Continue investigation of advanced surveillance and detection technologies for an expanded range of mission applications. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable	0.000	0.000	5.864
Title: Radiation Remediation Research ***Description:*** Conduct Radiation Belt Remediation research through development and validation of analytical performance models for remediation of Earth radiation belts following high altitude nuclear detonation. ***FY 2020 Plans:***	0.000	0.000	1.744

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
For 2020 and prior, this work is performed under the Radiation Remediation Research effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2021 Plans:*** Conduct FY 2019 efforts, moved to FY 2020 due to slip in space experiment launch date: Complete space experiment operations, and reduction and exploitation of data sets to finalize end-to-end model validation. Conduct assessment of feasibility and system requirements for space-based and combined ground and space-based remediation systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable			
Title: Seismic Technologies ***Description:*** Develop seismic technologies to support national requirements for monitoring nuclear explosions with special focus on regional distances less than 2,000 kilometers from the sensors. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Seismic Technologies effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2021 Plans:*** Test new algorithms on high performance computing capabilities with special focus on improving earth structure models and the resulting automation of the discrimination of seismic events. Exercise earth models in use in high-performance computing modeling and simulation codes for operational expert analysis of difficult-to-discriminate earthquakes and explosions. Continue to test specific algorithms for application of big data heuristics to more quickly characterize seismic events. Further develop new statistical approaches to the behavior of discriminants for local (less than 200 kilometers) and regional (less than 2,000 kilometers) seismic events. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable	0.000	0.000	5.660
Title: Alternative Navigation Technologies ***Description:*** Develop new technologies based on cold atom physics that provide autonomous jam-proof precision inertial navigation to augment Global Positioning System in case of Global Positioning System-denial. Develop atomic clocks based on new technologies to replace legacy Global Positioning System atomic clocks. ***FY 2020 Plans:***	0.000	0.000	8.304

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
For 2020 and prior, this work is performed under the Alternative Navigation Technologies effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2021 Plans:*** Complete rad-hard component development for advanced compact atomic clocks with improved accuracy and stability to replace legacy atomic clocks. Deliver system for integration onto experimental satellite system. Continue transition of advanced atomic clocks to industry with potential on ramp onto future satellites. Continue testing of cold atom 3-axis accelerometers for improved Internal Navigation Systems in Global Position System denied environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable			
Accomplishments/Planned Programs Subtotals	0.000	0.000	41.807

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 3620F / 2	R-1 Program Element (Number/Name) PE 1206601SF / *Space Technology*	Project (Number/Name) 624846 / *Spacecraft Payload Technologies*	

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
624846: *Spacecraft Payload Technologies*	-	0.000	0.000	29.796	0.000	29.796	31.276	30.031	31.374	31.495	Continuing	Continuing

(+) The sum of all Prior Years is $0.000 million less than the represented total due to several projects ending

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity (BA) 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

This project develops advanced technologies that enhance spacecraft payload operations by improving component and subsystem capabilities. The project focuses on development of advanced, space-qualified, survivable electronics, and electronics packaging technologies; development of advanced space data generation and exploitation technologies, including infrared sensors; and development of high-fidelity space simulation models that support space-based surveillance and space asset protection research and development for the warfighter.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Space-Based Detector Technologies	0.000	0.000	6.149
Description: Develop advanced infrared device technologies that enable hardened space detector arrays with improved detection to perform acquisition, tracking, and discrimination of space objects and missile warning.			
FY 2020 Plans: For 2020 and prior, this work is performed under the Space-Based Detector Technologies effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies.			
FY 2021 Plans: Begin design, development, and assessment of low-cost, high-volume infrared detectors and focal plane arrays for proliferated space architecture layers. Begin development of focal plane array optical data outputs for higher speed and data throughput and begin radiation tolerance characterization of photonic devices. Begin development of alternative infrared focal plane array materials and device architectures. Continue development of resilient scanning and staring digital focal plane arrays. Complete development of 8192 x 8192 pixels, 10 micron pixel pitch focal plane arrays hardened to the natural space environment and focused photons to enable whole-earth staring for Launch Detection and Missile Warning missions.			
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 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 624846 / *Spacecraft Payload Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Not applicable			
Title: Space Electronics Research ***Description:*** Develop technologies for space-based payload components such as radiation-hardened electronic devices, microelectro-mechanical system devices, and advanced electronics packaging. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Space Electronics Research effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2021 Plans:*** Continue leadership role in Deputy Assistant Secretary of Defense Systems Engineering trusted and assured microelectronics strategy efforts by development of trusted manufacturing techniques that reduce risk to National Security Space systems. Improving benchmarking capabilities on state-of-the-art electronics using latest spacecraft algorithms and transitioning results to acquisition community to enable data-informed payload architecture design decisions. Initiating complete space qualification planning for next generation space processor and begin implementing plan. Continue development of alternative memory approaches for high density memory needed for next-generation space systems. Continue research and development of ultra-low power and neuromorphic/cortical processing architectures to enable game-changing capabilities in future National Security Space systems. Continue advanced transistor research and development, and transitioning techniques to mainstream manufacturing. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable	0.000	0.000	6.928
Title: Modeling and Simulation Tools for Space Applications ***Description:*** Develop modeling and simulation tools for space-based ground surveillance systems, rendezvous and proximity operations, imaging of space systems, disaggregated satellite architecture, and space control payloads. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Modeling and Simulation Tools for Space Applications effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2021 Plans:*** Complete mission-level military utility analyses of architecture approaches across multi-domain mission areas. Continue refining guidelines and checkpoints for concept maturation evaluations in context of emerging space technologies. Continue development of models and mission simulations of the National Space Defense Center's new space and space enterprise capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	0.000	0.000	8.789

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 624846 / *Spacecraft Payload Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Not applicable			
Title: Alternative Positioning, Navigation, and Timing Technology ***Description:*** Identify and develop technologies that enable new, or enhance existing, United States positioning, navigation, and timing satellite capabilities by increasing resiliency and availability of accuracy, and/or increasing the affordability of providing current capabilities. Develop technologies to meet identified Air Force Space Command/Space and Missile Systems Center positioning, navigation, and timing space payload technology needs. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Alternative Positioning, Navigation, and Timing Technology effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2021 Plans:*** Develop advanced Precision Navigation and Timing waveforms and begin to examine the interaction of signals between the space, ground, and user equipment segments. Explore new technologies for positioning, navigation, and timing payloads that will improve performance and affordability. Continue studies that explore technologies for multi-layer space-based positioning, navigation, and timing architecture in order to improve resiliency of the space architecture. Work to develop modeling and simulation results of next generation space architecture and the impact of developing technologies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable	0.000	0.000	7.930
Accomplishments/Planned Programs Subtotals	0.000	0.000	29.796

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 3620F / 2	R-1 Program Element (Number/Name) PE 1206601SF / *Space Technology*	Project (Number/Name) 625018 / *Spacecraft Protection 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
625018: *Spacecraft Protection Technology*	-	0.000	0.000	11.639	0.000	11.639	12.421	11.957	13.406	13.765	Continuing	Continuing

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity (BA) 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Threat Warning Research	0.000	0.000	11.639
Description: Develop satellite threat warning technologies and tools for space defense. Exploit on-board inherent satellite resources, satellite-as-a-sensor, and self-aware satellite technologies. Develop technologies to detect, assess, and respond to threats and anomalies.			
FY 2020 Plans: For 2020 and prior, this work is performed under the Threat Warning Research effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 625018, Spacecraft Protection Technology.			
FY 2021 Plans: Continue to develop techniques to detect, track, identify, and characterize satellites using multi-phenomenology to address gaps in knowledge for space situational awareness and consider the tasking, collection, processing, exploitation and dissemination needs. Assess timeliness and persistence of space situational awareness capability and develop techniques to mitigate the growing population of objects that need to be monitored, from newly launched objects to debris. Conduct cooperative development utilizing commercial and international space situational awareness sources. Initiate research and development on an integrated ground and space indications and warnings experiment. Utilize space resiliency testbed to integrate technology solutions, and evaluate effectiveness against notional threats to our space architectures. Develop cyber hardening technologies, and integrate space and cyber operations capabilities. Conduct end-to-end evaluations and hardware-in-the-loop experiments for threat warning and response capabilities for protection of high value space assets. Conduct experiments, integrating commercial space C2 capabilities into Department of Defense ground architectures. These capabilities include real-time mission			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 625018 / *Spacecraft Protection Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
planning, utilization of non-traditional Intel sources (i.e. social media), multi-path communications architectures, etc. Develop and demonstrate autonomous technologies using net-centric space command and control architectures for multi-domain command and control across the full scope of the ground and space-based enterprise. Continue development and demonstration of advanced algorithms for sensor data fusion and satellite threat detection, assessment, and response. Investigate, implement, and demonstrate integrated command and control systems at the tactical, operational, and strategic levels. Continue assessment and development of commercial capability in order to either augment or replace traditional methods for space related command and control. Continue engagements with commercial space data providers for testing new enabling technologies on commercial satellites. Continue to develop on-board autonomous satellite technologies and plan for next generation flight experiments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable			
Accomplishments/Planned Programs Subtotals	0.000	0.000	11.639

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 3620F / 2	R-1 Program Element (Number/Name) PE 1206601SF / *Space Technology*	Project (Number/Name) 628809 / *Spacecraft Vehicle Technologies*	

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
628809: *Spacecraft Vehicle Technologies*	-	0.000	0.000	47.632	0.000	47.632	41.870	41.167	37.284	38.570	Continuing	Continuing

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity (BA) 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

This project focuses on spacecraft platforms (for example: structures, power, and thermal management); satellite control (signal processing and control); and space experiments of maturing technologies for space qualification.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Space Power/Thermal Research	0.000	0.000	4.458
Description: Develop technologies for advanced space platform subsystems such as cryocoolers, compact, high efficiency solar power cells and arrays, and innovative power generation concepts. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Space Power/Thermal Research effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2021 Plans:*** Continue research into advanced space solar cells, solar array, and energy storage technologies. Focus on support for current heritage space systems, while also pivoting towards support of smaller space vehicles that will be utilized for the Space Warfighting Construct. Solar cells with end of life performance, which depends on the mission, above 28% power conversion efficiency. Solar array structures tailored for small to large missions with specific power greater than 100 watts per kilogram. Energy storage chemistries with cell-level specific energy greater than 300 watt-hours per kilogram. Further development of array hardening approaches to provide drop-in replacement panels. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable			
Title: Space Structures and Controls Research	0.000	0.000	11.540
Description: Develop revolutionary and enabling technologies, including lighter weight, lower cost, high performance structures for space platforms; guidance, navigation, and controls hardware and software for next generation of space superiority systems.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: For 2020 and prior, this work is performed under the Space Structures and Controls Research effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2021 Plans:*** Continue reactive maneuver strategies for spacecraft resiliency in hardware-in-the-loop testbeds. Initiate on-orbit experiment planning for reactive maneuver strategies. Apply research in verification and validation techniques for autonomous spacecraft flight software to high-fidelity simulations and brassboard laboratory experiments. Apply improved estimation algorithms for on-orbit navigation software to experimental data to assess performance and robustness. Complete laboratory and high-fidelity simulations/breadboard implementation for navigation algorithms and assess progress towards flight experiment demonstration. Continue development of integrated proof-of-concept experiments for advanced, agile manufacturing and assembly technologies for satellite production to improve performance and affordability. Continue research in functionalized structures using multi-material additive manufacturing. Transition development of research efforts in high-power small satellite technologies and affordable, high-performance phased arrays and electrically steerable antennas for tactical communication and radar concepts for agile, intelligent targets to advanced development and flight experimentation. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable			
Title: Space Experiments ***Description:*** Develop flight experiments to improve the capabilities of existing operational space systems and to enable new transformational space capabilities. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Space Experiments effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2021 Plans:*** Conduct on-orbit small satellite demonstration of the first ever Link-16 from space to the tactical user enabling a Common Operating Picture for the Warfighter in a contested/degraded environment in support of Multi-Domain Command and Control. On-orbit small satellite demonstration capable of measuring radiation in the inner magnetosphere giving insight into the particle radiation space environment. Conduct a flight selection process and perform trade studies to determine the next flight experiment(s). Develop and mature a reference design, technical objectives, and experiment plan in coordination with Air Force Space Command, Space and Missile Systems Center and/or other mission partners. Begin working long lead items such as contracting strategy, parts, frequency allocation, and information assurance strategies. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	0.000	0.000	24.952

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Not applicable			
Title: Space Communication Technologies ***Description:*** Develop technologies for next-generation space communications terminals and equipment and methods/techniques to enable future space system operational command and control concepts. ***FY 2020 Plans:*** For 2020 and prior, this work is performed under the Space Communication Technologies effort in Appropriation 3600, Budget Activity (BA) 02, PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2021 Plans:*** Support W/V-band payload operations, telemetry analysis, and health and status monitoring. Conduct development and technology demonstrations to address future military satellite communications capability and technology needs, for example, high-gain antenna, high-power amplifiers, low-noise amplifiers, cognitive / resilient networks, reconfigurable satellite radios / transponders, and anti-jam signal processing technologies. Support development and demonstration of novel laser communications technologies such as multi-wave length optical routers. Develop network traffic models, multi-spacecraft network models, and spacecraft network simulation support, along with analysis/visualization tools to aid. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Not applicable	0.000	0.000	6.682
Accomplishments/Planned Programs Subtotals	0.000	0.000	47.632

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A