Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force											Date: April 2022	
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 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
Total Program Element	-	209.256	286.505	243.737	0.000	243.737	257.886	202.880	202.129	205.297	Continuing	Continuing
621010: *Space Survivability & Surveillance*	-	41.807	37.956	61.734	0.000	61.734	74.375	67.819	64.142	64.645	Continuing	Continuing
624846: *Spacecraft Payload Technologies*	-	29.796	29.850	83.122	0.000	83.122	83.583	32.111	32.818	33.469	Continuing	Continuing
624847: *Rocket Propulsion Technology*	-	0.000	22.446	14.221	0.000	14.221	14.418	15.567	15.896	16.206	Continuing	Continuing
624866: *Lasers & Imaging Technology*	-	0.000	16.124	16.527	0.000	16.527	16.999	16.950	17.326	17.664	Continuing	Continuing
625018: *Spacecraft Protection Technology*	-	11.639	53.327	12.180	0.000	12.180	13.672	14.051	14.356	14.643	Continuing	Continuing
628809: *Spacecraft Vehicle Technologies*	-	126.014	126.802	55.953	0.000	55.953	54.839	56.382	57.591	58.670	Continuing	Continuing

Note

Due to FY 2022 funds being applied to the incorrect line item in enactment, $5.0M will be realigned to PE 1206601SF/Space Technology from PE 0602203F/Aerospace Propulsion through an internal reprogramming. This change will be recorded in next year's Justification Documentation.

A. Mission Description and Budget Item Justification

This program focuses on six 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 Department of Air Force systems. Second, the spacecraft payload technologies area improves satellite payload operations by developing advanced component and subsystem capabilities. Third, the rocket propulsion technology area develops rocket propulsion technologies for space access, space maneuver, and the sustainment of strategic systems. Fourth, the lasers & imaging technology area conducts research supporting ground-based optical space domain awareness. Fifth, 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 such program funds would be in addition to civilian pay expenses budgeted in program element 1206616SF.

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force	Date: April 2022
Appropriation/Budget Activity 3620F: *Research, Development, Test & Evaluation, Space Force I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 1206601SF *I 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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	216.874	175.796	0.000	0.000	0.000
Current President's Budget	209.256	286.505	243.737	0.000	243.737
Total Adjustments	-7.618	110.709	243.737	0.000	243.737
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	-7.500			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	118.200			
• Congressional Directed Transfers	0.000	0.009			
• Reprogrammings	-5.235	0.000			
• SBIR/STTR Transfer	-2.383	0.000			
• Other Adjustments	0.000	0.000	243.737	0.000	243.737

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Project: 624847: *Rocket Propulsion Technology*		
Congressional Add: *Congressional Add: Program increase - non-toxic fuels*	-	3.000
Congressional Add: *Congressional Add: Program increase - adaptive medium-lift engine architecture*	-	5.000
Congressional Add Subtotals for Project: 624847	-	8.000
Project: 625018: *Spacecraft Protection Technology*		
Congressional Add: *Congressional Add: Program increase - autonomy in space*	-	10.000
Congressional Add: *Congressional Add: Program increase - ground-based interferometry*	-	6.000
Congressional Add: *Congressional Add: Program increase - open architecture payloads*	-	10.000
Congressional Add: *Congressional Add: Program increase - architecture for space domain awareness beyond GEO*	-	15.400
Congressional Add Subtotals for Project: 625018	-	41.400
Project: 628809: *Spacecraft Vehicle Technologies*		
Congressional Add: *Congressional Add: Program increase - operational cryogenic upper stage augmentation Kit*	6.923	-
Congressional Add: *Congressional Add: Program increase - thin-film photovoltaic energy*	6.923	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force	Date: April 2022
Appropriation/Budget Activity 3620F: *Research, Development, Test & Evaluation, Space Force I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 1206601SF *I Space Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2021**	**FY 2022**
Congressional Add: *Congressional Add: Program increase - hybrid space architecture*	9.890	-
Congressional Add: *Congressional Add: Program increase - resilient solar power*	2.967	-
Congressional Add: *Congressional Add: Program increase - ultra-lightweight solar arrays*	14.835	-
Congressional Add: *Congressional Add: Program increase - link-16 space experiment*	8.901	-
Congressional Add: *Congressional Add: Program increase - advanced space power systems*	6.923	-
Congressional Add: *Congressional Add: Program increase - digital engineering for future space systems*	4.945	-
Congressional Add: *Congressional Add: Program increase - laser communications*	11.868	-
Congressional Add: *Congressional Add: Program increase - lithium-sulfur battery development*	4.945	-
Congressional Add: *Congressional Add: Program increase - small satellite mission control facility*	5.934	-
Congressional Add: *Congressional Add: Program increase - radiation hardened microprocessor*	-	8.900
Congressional Add: *Congressional Add: Program increase - lithium sulfur battery development*	-	4.000
Congressional Add: *Congressional Add: Program increase - thin-film photovoltaic energy*	-	3.000
Congressional Add: *Congressional Add: Program increase - multi-mission distributed antenna technology*	-	10.000
Congressional Add: *Congressional Add: Program increase - hybrid space architecture*	-	5.000
Congressional Add: *Congressional Add: Program increase - ultra-lightweight space solar arrays*	-	5.000
Congressional Add: *Congressional Add: Program increase - university consortia for space technology*	-	10.000
Congressional Add: *Congressional Add: Program increase - advanced multi-physics thermal management*	-	5.000
Congressional Add: *Congressional Add: Program increase - fundamental research*	-	15.000
Congressional Add: *Congressional Add: Program increase - space solar power inc demonstration*	-	2.900
Congressional Add Subtotals for Project: 628809	85.054	68.800
Congressional Add Totals for all Projects	85.054	118.200

Change Summary Explanation

FY 2022: -$7.5M congressional reduction for inadequate justification

The FY 2022 President's Budget submittal did not reflect FY 2023 through FY 2026 funding. Therefore, an explanation of the change between the two budget positions for FY 2023 cannot be made in a relevant manner.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
621010: *Space Survivability & Surveillance*	-	41.807	37.956	61.734	0.000	61.734	74.375	67.819	64.142	64.645	Continuing	Continuing

A. Mission Description and Budget Item Justification

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Space Environment Research	20.235	11.031	16.474
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 2022 Plans:*** Complete exploitation of radiation aged materials to enhance predictive models. Continue developing generation-beyond-next trapped and untrapped particle specification model development efforts. Complete demonstrations of space environment sensor and anomaly attribution tool. Continue developing technologies to exploit and mitigate space environment effects. Continue to prototype and demonstrate new ground-based and space-based sensors for monitoring and specifying the state of the space environment for military applications, and continue to develop modelling capabilities to better enable accurate forecasting of the state of the space environment. Continue research into the physics and dynamics of the sun to better specify and forecast solar events and better understand how those events impact the near-earth space environment. Continue to 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 with emphasis on developing an end-to-end modeling Suite for re-entry systems. Initiate development of capabilities using environmental interactions such as radio frequency interference, material aging, and plume luminescence to enable coupled local and enterprise space domain awareness. Initiate integration with local multi-agent autonomous threat sensing and characterization to accurately sense and specify the space environmental impacts on military radio-frequency systems. Initiate demonstration of controlled radio-frequency propagation effects across relevant frequency ranges for operations. Initiate improvement in efficiency of plasma generation systems to enable practical applications, and validate plasma cloud formation models and evolution for engineered solutions. ***FY 2023 Plans:*** Continue advancement of regional space environment specification and modeling to enable tactical applications. Complete development of next generation ionospheric observing systems. Continue development of controlled-radio frequency propagation			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
effects across relevant frequency ranges for operations. Continue improvements in efficiency of plasma generation systems to enable practical applications. Complete plasma cloud formation models and evolution for engineered solutions. Complete next generation system for specifying and predicting space environment impacts on radio frequency services at relevant frequencies. Continue developing and enhancing 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. Initiate advanced research into beyond-geosynchronous space environment impacts to national systems. Continue applied research of space environment interactions and effects for space domain awareness. Initiate transition of basic research in solar and space environment physics to applied research efforts. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $5.443 million. Funding increased due to new requirements to expand space environment research into beyond-geosynchronous and artic impacts to national systems.			
Title: Surveillance Technologies ***Description:*** Develop advanced target detection techniques, spectral signature libraries, and decision aids for space-based sensors and surveillance systems. ***FY 2022 Plans:*** Complete development of capability metrics for new satellite constellation architectures, advanced data analytics, and satellite demonstration concepts. Continue development of advanced surveillance and detection technologies, including innovative data analytics and sensor concepts, to track targets that pose new challenges for missile warning systems and an expanded range of tactical threat warning systems. Complete study and transition findings for decreasing satellite bandwidth for down-link of missile warning data to Missile Warning System Program Office. Transition findings of hyper-temporal imaging demonstration of new early missile warning concept to Missile Warning System Program Office and Other Government Agencies. Continue development of automated data analytics for data processing on-board satellites, and initiate development for cloud platforms, to meet tactical mission timelines. Continue study of tactical surveillance technologies for target detection by autonomous sensing grids operating across multiple-domains. ***FY 2023 Plans:*** Continue development of novel sensing technologies, including innovative data analytics and sensor concepts, to track targets that pose new challenges for missile warning systems and an expanded range of tactical threat warning systems. Continue development of automated data analytics for data processing on-board satellites, and cloud platforms, to meet tactical mission timelines. Continue study of tactical surveillance technologies for target detection by autonomous sensing grids operating across multiple-domains to meet the information timeliness, track custody and data access requirements necessary to detect, track and target emerging hypersonic missile threats. ***FY 2022 to FY 2023 Increase/Decrease Statement:***	5.864	8.300	9.508

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
FY 2023 increased compared to FY 2022 by $1.208 million. Funding increased due to increased emphasis in automated data analytics and sensing technologies to meet tactical mission timelines.			
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 2022 Plans:*** N/A ***FY 2023 Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** N/A	1.744	0.000	0.000
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 2022 Plans:*** N/A ***FY 2023 Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** N/A	5.660	0.000	0.000
Title: Alternative Navigation Technologies ***Description:*** Develop new technologies based on cold atom physics and photonics that provide autonomous jam-proof precision inertial navigation to augment Global Positioning System in case of Global Positioning System-denial. Develop atomic clocks and methods to disseminate time based on new technologies to replace legacy Global Positioning System atomic clocks and networks. ***FY 2022 Plans:*** Complete transition of advanced atomic clocks to industry. Continue testing of cold atom 3-axis accelerometers for improved Internal Navigation Systems in Global Position System-denied environments. Initiate development of advanced photonic systems	8.304	18.625	13.752

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
for high-performance time transfer. Initiate development of advanced components for quantum systems such as very low noise amplifiers, power efficient narrow-bandwidth lasers, and optical frequency comb technology. Initiate development of quantum timing systems for advanced communication applications. Initiate demonstration of 3-axis accelerometer outside of laboratory environment. ***FY 2023 Plans:*** Continue testing of cold atom 3-axis accelerometers for improved Internal Navigation Systems in Global Position System-denied environments. Continue development of advanced photonic systems for high performance time transfer. Continue development of advanced components for quantum systems such as very low noise amplifiers, power efficient narrow-bandwidth lasers, and optical frequency comb technology. Continue development of quantum timing systems for advanced communication applications. Initiate preparation for second demonstration of 3-axis accelerometer outside of laboratory environment. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $4.873 million. Funding decreased due to a decreased emphasis on optical frequency technology development.			
Title: Strategic Radiation Hardened Electronics ***Description:*** Develop, produce, and acquire strategic radiation hardened non-volatile memory for strategic missiles, missile defense, and military space systems. ***FY 2022 Plans:*** N/A ***FY 2023 Plans:*** Initiate identification of electrical and radiation performance requirements and specification development for strategic radiation hardened non-volatile memory. Initiate design, fabrication, test and evaluation of test articles to support technical development. Initiate space qualification of the strategic radiation hardened non-volatile memory family and supporting design support kit. Initiate efforts to ensure durability of a domestic source of readout integrated circuits and focal plane array technologies. Initiate efforts to enable maturation of large format high-dynamic range focal plane arrays. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $22.000 million. Funding increased due to the initiation of this effort to increase emphasis on strategic radiation hardened electronics technology development.	0.000	0.000	22.000
Accomplishments/Planned Programs Subtotals	41.807	37.956	61.734

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
624846: *Spacecraft Payload Technologies*	-	29.796	29.850	83.122	0.000	83.122	83.583	32.111	32.818	33.469	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops advanced technologies that enhance spacecraft payload operations by improving component and subsystem capabilities. The project focuses on 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 2021	FY 2022	FY 2023
Title: Space-Based Detector Technologies	6.149	6.325	6.216
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 2022 Plans:*** Continue design, development, and assessment of low-cost, high-volume infrared detectors and focal plane arrays for proliferated space architecture layers. Continue development of focal plane array optical data outputs for higher speed and data throughput and continue radiation tolerance characterization of photonic devices. Continue development of alternative infrared focal plane array materials and device architectures. Complete development of resilient scanning and staring digital focal plane arrays. Initiate development and assessment of event based sensing concepts and hardware. Initiate development of high dynamic range, laser hardened 8192 x 8192 pixels, 10 micron pixel pitch focal plane arrays. ***FY 2023 Plans:*** Complete design, development, and assessment of low-cost, high-volume infrared detectors and focal plane arrays for proliferated space architecture layers. Continue development of focal plane array optical data outputs for higher speed and data throughput and continue radiation tolerance characterization of photonic devices. Continue development and refinement of alternative infrared focal plane array materials and device architectures. Continue development and assessment of event based sensing concepts and hardware and initiate partnerships with other Government agencies to explore potential transition paths. Continue development of high dynamic range, laser hardened 8192 x 8192 pixels, 10 micron pixel pitch focal plane arrays to provide resilience against emerging threats. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $0.109 million. Justification for this decrease is described in the plans above.			
Title: Space Elecronics Research	6.928	4.675	8.761

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
Description: Develop technologies for space-based payload components such as radiation-hardened electronic devices, microelectro-mechanical system devices, and advanced electronics packaging. ***FY 2022 Plans:*** Continue leadership role in Deputy Assistant Secretary of Defense Systems Engineering trusted and assured microelectronics strategy efforts to develop trusted manufacturing techniques that reduce risk to National Security Space systems. Continue adapting bench-marking capabilities on new electronics using the latest spacecraft algorithms and transitioning bench-marking capabilities and results to the acquisition community to enable data-informed payload architecture design decisions. Complete space qualification planning for next generation space processor. Complete development of alternative memory approaches. Continue research and development of ultra-low power and neuromorphic/cortical processing architectures and advanced transistor research to enable game-changing capabilities in future National Security Space systems. Initiate small satellite, high-performance processing to enable on-orbit autonomy, data fusion, and machine learning. ***FY 2023 Plans:*** Continue leadership role in Deputy Assistant Secretary of Defense Systems Engineering trusted and assured microelectronics strategy efforts to develop trusted manufacturing techniques that reduce risk to National Security Space systems. Continue adapting bench-marking capabilities on new electronics using the latest spacecraft algorithms and transitioning bench-marking capabilities and results to the acquisition community to enable data-informed payload architecture design decisions. Initiate prototype memory manufacturing, testing and design improvements. Complete research and development of ultra-low power and neuromorphic/cortical processing architectures and advanced transistor research to enable game-changing capabilities in future National Security Space systems. Continue research and development of high-performance processing for small satellites to enable revolutionary on-orbit edge processing, autonomy, data fusion, and machine learning. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $4.086 million. Funding increased due to increased emphasis on memory manufacturing and testing, along with small satellite high-performance processing.			
Title: Modeling and Simulation Tools for Space Applications ***Description:*** Provide modeling, simulation, and analysis for technology evolution in space-based terrestrial surveillance systems, precision navigation and timing, space domain awareness, satellite communications, space environment monitoring, and space control payloads. ***FY 2022 Plans:*** Initiate next generation mission-level military utility analyses of technology and associated architectures and employment concepts across multi-domain mission applications. Continue refining guidelines and checkpoints for concept maturation evaluations in context of emerging space technologies. Complete development of models and mission simulations of the National Space	8.789	5.682	5.784

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
Defense Center's capabilities. Initiate model-based systems engineering into technology decision-making and flight experiment design. ***FY 2023 Plans:*** Continue mission-level military utility analyses of technology and associated architectures and employment concepts across multi-domain mission areas. Continue refining guidelines and checkpoints for concept maturation evaluations in context of emerging space technologies. Continue to evolve processes for applying model-based systems engineering into technology decision-making and flight experiment design. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $0.102 million. Justification for this increase is described in the plans above.			
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 2022 Plans:*** Complete transition of advanced precision navigation, and timing waveforms via publication of interface control document and continue to examine the interaction of signals between the space, ground, and user equipment segments. Continue development of new technologies for positioning, navigation, and timing payloads that will improve performance and affordability. Continue development of technologies for multi-layer space-based positioning, navigation, and timing architecture in order to improve resiliency of the space architecture and reduce burden on the user. Continue development of modeling and simulations of next generation space architecture and the impact of developing technologies. Initiate laboratory and field testing capabilities of new signals and architecture concepts. ***FY 2023 Plans:*** Initiate flight experiments to examine the interaction of signals between the space, ground, and user equipment segments in contested environments and exercise potential CONOPs. Continue development of technologies for multi-layer space-based positioning, navigation, and timing architecture in order to improve resiliency of the space architecture, affordability, and reduce burden on the user. Continue development of physics level modeling and simulations of next generation space architecture and the impact of developing technologies. Continue laboratory and field testing capabilities of new signals and architecture concepts. ***FY 2022 to FY 2023 Increase/Decrease Statement:***	7.930	13.168	11.361

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
FY 2023 decreased compared to FY 2022 by $1.807 million. Funding decreased due to a decreased emphasis on field testing of new signals.			
Title: Resilient Positioning, Navigation, and Timing Solutions ***Description:*** Develop technology solutions providing diversity of signal and orbit to increase resilience of space-based positioning, navigation, and timing. ***FY 2022 Plans:*** N/A ***FY 2023 Plans:*** Initiate development of technologies for frequency and waveform agility that can use alternate signal sources for positioning, navigation, and timing solutions in jammed environments. Initiate development of technologies for path diversity and alternate signal processing with the ability to provide solutions to modifiable software defined user equipment. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $51.000 million. Funding increased due to the initiation of this effort to increase emphasis in resilient positioning, navigation, and timing technology development.	0.000	0.000	51.000
Accomplishments/Planned Programs Subtotals	29.796	29.850	83.122

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
Appropriation/Budget Activity 3620F / 2	R-1 Program Element (Number/Name) PE 1206601SF / *Space Technology*	Project (Number/Name) 624847 / *Rocket Propulsion Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
624847: *Rocket Propulsion Technology*	-	0.000	22.446	14.221	0.000	14.221	14.418	15.567	15.896	16.206	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops rocket propulsion technologies for space access and space maneuver. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, and innovative space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Develop technologies to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the sustainment of the space and rocket propulsion industry, providing rocket propulsion technology for the entire Department of Defense (DoD). Technologies under this project enable capabilities of interest to both DoD and National Aeronautics and Space Administration (NASA). Tasks include: modeling and simulation; proof of concept tests of critical components; advanced component development; and ground-based tests. All thrusts are part of the Rocket Propulsion for the 21st Century (RP21) collaboration and are reviewed by a DoD level steering committee yearly for relevance to DoD missions and progress towards RP21 Goals.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Liquid Engine Combustion Technologies	0.000	6.800	6.013
Description: Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. ***FY 2022 Plans:*** Complete evaluation of methane multi-injector designs in hot-fire conditions. Complete hot fire tests in combustion stability rig. Complete combustion stability modeling critical for future hydrocarbon fueled liquid rocket engines. Complete developing understanding of hydrocarbon fuel production, expanding testing into methane fuels and other cryogenic cooling. Continue the employment of new fuel and material operating limitations, manufacturing processes, and launch goals in cycle analysis to identify trade space for future engines. Continue to develop and evaluate advanced material solutions for high temperature components in rocket propulsion. Continue installation of new test facility that will fill the current capability gap and allow for fast, low-cost testing of multi-injector designs and stability strategies at conditions relevant to the demands of both Department of Defense and industry for next-generation engines (including use of liquid oxygen and higher pressures and thrust). Continue development and payoff determination of rotating detonation rocket engine technologies. ***FY 2023 Plans:*** Complete installation of new test facility that will fill the current capability gap and allow for fast, low-cost testing of multi-injector designs and stability strategies at conditions relevant to the demands of both Department of Defense and industry for next-generation engines (including use of liquid oxygen and higher pressures and thrust). Continue the employment of new fuel and material operating limitations, manufacturing processes, and launch goals in cycle analysis to identify trade space for future			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 624847 / *Rocket Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
engines. Continue to develop and evaluate advanced material solutions for high temperature components in rocket propulsion. Continue development and payoff determination of rotating detonation rocket engine technologies. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $0.787 million. Justification for this decrease is described in the plans above.			
Title: Advanced Liquid Engine Technologies ***Description:*** Develop advanced liquid engine technologies for improved performance, while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles. ***FY 2022 Plans:*** Continue sub-scale risk mitigation and technology maturation activities to incorporate into next generation engine concepts. Continue modular component integration and interaction research activities supporting next generation engine concepts. ***FY 2023 Plans:*** Continue sub-scale risk mitigation and technology maturation activities to incorporate into next generation engine concepts. Continue modular component integration and interaction research activities supporting next generation engine concepts. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $0.221 million. Justification for this increase is described in the plans above.	0.000	3.009	3.230
Title: On-Orbit Propulsion Technologies ***Description:*** Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for station-keeping, repositioning, and orbit transfer for satellites and satellite constellations. ***FY 2022 Plans:*** Continue advanced chemical propellants development focusing on flight-weight systems to assist in transition to industry partners. Continue to support the maturation of advanced diagnostics for both chemical and electric propulsion thruster plumes with potential for integrated state-of-health application. Continue to expand the validation and verification programs (both experimental and flight) to quantify accuracy of modeling and simulation tools developed to support thruster-spacecraft integration. Continue transition and support of thruster/ plume modeling framework to spacecraft industry to propulsion community. Continue expanding exploration of advanced integrated electric propulsion and chemical thruster concepts and assess new spacecraft propulsion requirements. ***FY 2023 Plans:*** Continue advanced chemical propellants development focusing on flight-weight systems to assist in transition to industry partners. Continue to support the maturation of advanced diagnostics for both chemical and electric propulsion thruster plumes with potential for integrated state-of-health application. Continue to expand the validation and verification programs (both experimental	0.000	4.637	4.978

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 624847 / *Rocket Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
and flight) to quantify accuracy of modeling and simulation tools developed to support thruster-spacecraft integration. Continue transition and support of thruster/plume modeling framework to spacecraft industry to propulsion community. Continue expanding exploration of advanced integrated electric propulsion and chemical thruster concepts and assess new spacecraft propulsion requirements. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $0.341 million. Justification for this increase is described in the plans above.			
Accomplishments/Planned Programs Subtotals	0.000	14.446	14.221

	FY 2021	FY 2022
Congressional Add: Congressional Add: Program increase - non-toxic fuels ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	3.000
Congressional Add: Congressional Add: Program increase - adaptive medium-lift engine architecture ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	5.000
Congressional Adds Subtotals	-	8.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
Appropriation/Budget Activity 3620F / 2	R-1 Program Element (Number/Name) PE 1206601SF / *Space Technology*	Project (Number/Name) 624866 / *Lasers & Imaging Technology*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
624866: *Lasers & Imaging Technology*	-	0.000	16.124	16.527	0.000	16.527	16.999	16.950	17.326	17.664	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project conducts research supporting ground-based optical space domain awareness.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Optical Space Situational Awareness and Satellite Vulnerability	0.000	16.124	16.527

Description: Develop advanced, long-range, electro-optical technologies that enable ground-based optical Space Domain Awareness (SDA) and quantum-based optical communications. Develop and use technologies to quantitatively assess the vulnerability of blue satellite systems and components to lasers and other directed energy sources. Operate the Starfire Optical Range (SOR) to conduct research meeting internal and customer requirements.

FY 2022 Plans:

Continue research & development of laser-enabled space domain awareness (SDA) focused on full-dark imaging using laser illumination. Continue to mature component technologies for 24/7 real-time optical imaging of near-earth and geosynchronous objects enabling characterization on tactical timelines. Continue investigation through measurement, modeling, and simulation of the susceptibility of satellite components to laser and other directed energy threats to inform practical designs for protective equipment and for employing protection methods on tactically-rapid timelines. Continue to mature daylight detection of satellites allowing custody through daytime hours when satellites cannot normally be detected by ground-based optical systems. Continue development of laser-enabled options for both ranging to and imaging of geosynchronous satellites from apertures smaller than 3 meters. Continue development of long-range secure optical network technology leveraging quantum science, especially for free space lasercom channels during daylight. Continue project to apply machine-learning to automatically identify geosynchronous-orbit objects more accurately and rapidly than current ""hard-wired"" algorithms can. Conduct research into maintaining custody of space craft in 3-body pseudo-orbits, such as in cis-lunar space and Earth-Sun equilibrium zones. Continue to maintain the Starfire Optical Range (SOR) R&D facilities and experimental equipment in a mission-ready state."

FY 2023 Plans:

Continue research & development of laser-enabled space domain awareness (SDA) focused on full-dark imaging using laser illumination. Continue to mature component technologies for 24/7 real-time optical imaging of near-earth and geosynchronous objects enabling characterization on tactical timelines. Continue investigation through measurement, modeling, and simulation of the susceptibility of satellite components to laser and other directed energy threats to inform practical designs for protective equipment and for employing protection methods on tactically-rapid timelines. Continue to mature daylight detection of satellites allowing custody through daytime hours when satellites cannot normally be detected by ground-based optical systems. Continue

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 624866 / *Lasers & Imaging Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
development of laser-enabled options for both ranging to and imaging of geosynchronous satellites from apertures smaller than 3 meters. Continue development of long-range secure optical network technology leveraging quantum science, especially for free space lasercom channels during daylight. Continue project to apply machine-learning to automatically identify geosynchronous-orbit objects more accurately and rapidly than current ""hard-wired"" algorithms. Conduct research into maintaining custody of space craft in 3-body pseudo-orbits, such as in cis-lunar space and Earth-Sun equilibrium zones. Continue to maintain the Starfire Optical Range (SOR) R&D facilities and experimental equipment in a mission-ready state. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $0.403 million. Justification for this increase is described in the plans above.			
Accomplishments/Planned Programs Subtotals	0.000	16.124	16.527

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
625018: *Spacecraft Protection Technology*	-	11.639	53.327	12.180	0.000	12.180	13.672	14.051	14.356	14.643	Continuing	Continuing

A. Mission Description and Budget Item Justification

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 2021	FY 2022	FY 2023
Title: Threat Warning Research	11.639	11.927	12.180
Description: Develop satellite threat warning technologies and tools for space defense with an emphasis on new orbital regimes such as cislunar, speed-of-light threats such as cyber, and many-on-many engagement. ***FY 2022 Plans:*** Continue to develop techniques to detect, track, identify, and characterize satellites using multi-phenomenology techniques with an emphasis on space domain awareness beyond geosynchronous equatorial orbit all the way to the moon. Assessment includes sensors, data integration, and operator tools, to include government, commercial, and allies. Complete research and development on an integrated ground and space indications and warnings experiment. Continue development of on-orbit threat warning sensing and assessment with emphasis on spectrum awareness and inherent, on-board satellite sensors. Continue research on cyber hardening of space assets with laboratory testbeds transitioning regularly to on-orbit experimentation. Continue experimentation and exercises with Department of Defense ground architectures, operations centers, and commercial and international partners. Complete demonstration of advanced sensor data fusion algorithms. 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 2023 Plans:*** Continue to develop techniques to detect, track, identify, and characterize satellites using multi-phenomenology techniques with particular focus on space domain awareness beyond geosynchronous equatorial orbit all the way to the moon; investigate potential flight experiments that will demonstrate utility of cislunar domain awareness for deterring threats from deep space. Continue development of on-orbit threat warning sensing and assessment with emphasis on spectrum awareness and inherent, on-board satellite sensors. Continue research on cyber hardening of space assets with laboratory testbeds and solidify a pipeline for continuously transitioning cyber hardening techniques to on-orbit experiments. Continue experimentation and exercises with Department of Defense ground architectures, operations centers, and commercial and international partners, with an emphasis on employing agile space operations software development techniques. Continue engagements with commercial space data			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
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 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $0.253 million. Justification for this increase is described in the plans above.			
Accomplishments/Planned Programs Subtotals	11.639	11.927	12.180

	FY 2021	FY 2022
Congressional Add: Congressional Add: Program increase - autonomy in space ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	10.000
Congressional Add: Congressional Add: Program increase - ground-based interferometry ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	6.000
Congressional Add: Congressional Add: Program increase - open architecture payloads ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	10.000
Congressional Add: Congressional Add: Program increase - architecture for space domain awareness beyond GEO ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	15.400
Congressional Adds Subtotals	-	41.400

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
628809: *Spacecraft Vehicle Technologies*	-	126.014	126.802	55.953	0.000	55.953	54.839	56.382	57.591	58.670	Continuing	Continuing

A. Mission Description and Budget Item Justification

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 2021	FY 2022	FY 2023
Title: Space Power/Thermal Research	3.834	6.184	10.922
Description: Develop technologies for advanced space platform subsystems such as compact, high efficiency solar power cells and arrays, and innovative power generation concepts. ***FY 2022 Plans:*** Continue developing high power arrays and storage capability for small satellites including solar array structures tailored for small missions but scalable to all missions with specific power greater than 100 watts per kilogram. Complete transition of technologies developed for advanced space solar cells, solar array, and energy storage for current heritage space systems, to include solar cells with end of life performance, which depends on the mission, above 28% power conversion efficiency, energy storage chemistries with cell-level specific energy greater than 300 watt-hours per kilogram, and array hardening approaches to provide drop-in replacement panels. Initiate development of power system sensing and protection capabilities across the applicable threat matrix for proliferated low Earth orbit constellations and next generation US Space Force satellite buses. Initiate exploration of alternative power generation sources beyond solar including nuclear. Initiate research to enable high-pulsed power systems including generation, storage, and heat rejection technologies for small satellites. ***FY 2023 Plans:*** Continue development of high power arrays and storage capability for small satellites including solar array structures scalable to all missions with specific power greater than 100 watts per kilogram. Continue development of power system protection capabilities to sense and warn of directed energy threats for proliferated low Earth orbit constellations and next generation US Space Force satellite buses. Continue exploration of alternative power generation sources, such as nuclear to characterize the limitations and challenges underpinning operating space systems in non-traditional orbital regimes. Continue research to enable high-pulsed power systems including generation, storage, and heat rejection technologies for small satellites. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $4.738 million. Funding increased due to increased emphasis on alternative space power generation for non-traditional orbit regimes.			
Title: Space Structures and Controls Research	9.924	12.484	20.504

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
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. ***FY 2022 Plans:*** Complete transition of reactive maneuver strategies for spacecraft resiliency for hardware-in-the-loop testbeds, on-orbit navigation estimation algorithms for traditional orbits, and on-orbit experiment planning for reactive maneuver strategies. Continue research in autonomous spacecraft flight software including verification and validation and techniques for high-fidelity simulations. Continue transition efforts in agile manufacturing, additive manufacturing, and high-performance phased arrays and antennas. Initiate research to enable space logistics concepts including autonomous rendezvous, proximity operations, and docking; refueling and module upgrade; and on-orbit assembly. Initiate research to develop guidance and navigation algorithms for cislunar space including novel orbits. Initiate research efforts in high-performance, resilient small satellite technologies and development efforts in deployable structures, metrology, power and thermal management for tactical intelligence, surveillance, and reconnaissance missions in contested environments. ***FY 2023 Plans:*** Continue research in autonomous spacecraft flight software including verification and validation and techniques for high-fidelity simulations. Complete transition efforts in agile manufacturing, additive manufacturing, and high-performance phased arrays and antennas. Continue research to enable space logistics concepts including autonomous rendezvous, proximity operations, and docking; refueling and module upgrade; and on-orbit assembly. Continue research to develop guidance and navigation algorithms for cislunar space including novel orbits. Continue research efforts in high-performance, resilient small satellite technologies and development efforts in deployable structures, metrology, power and thermal management for tactical intelligence, surveillance, and reconnaissance missions in contested environments. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $8.020 million. Funding increased due to increasing interest in potential operations in cis-lunar space and other novel orbits.			
Title: Space Experiments ***Description:*** Develop flight experiments to improve the capabilities of existing operational space systems and to enable new transformational space capabilities. ***FY 2022 Plans:*** Complete on-orbit demonstration of Link-16 experiment from space and transition mission data experimental findings to Space Development Agency for future architecture proliferation. Complete on-orbit small satellite demonstration capable of measuring radiation in the inner magnetosphere giving insight into the particle radiation space environment. Continue requirements development and preliminary concept feasibility and preliminary designs of follow-on space experiments in areas that include	21.456	26.316	9.357

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
autonomy, cyber security, and development of small satellite sub-systems to improve performance and military utility. Continue working long lead items such as contracting strategy, parts, frequency allocation, and information assurance strategies. Initiate development and on-orbit experiment of a space-to-air/ground mesh-network concept. ***FY 2023 Plans:*** Continue design and build of satellite experiments demonstrating small satellite systems/sub-systems to prove performance, military utility, and enabling capabilities in autonomy, cyber resiliency and integration of commercial and government space networks for command and control (C2) of a hybrid space architecture. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $16.959 million. Funding decreased due to higher USSF priorities.			
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 2022 Plans:*** Continue to support W/V-band payload operations, telemetry analysis, and health and status monitoring. Initiate deployment of laser communications onto V/W-band test set-ups to show synergy between terminals. Complete development of 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. Complete development and demonstration of novel laser communications technologies such as multi-wave length optical routers. Initiate development of router that supports multi-spacecraft network and network traffic. Initiate developing methods for multi-access laser communications, reconfigurable laser communications, and positioning, navigation, and timing over laser communication links. ***FY 2023 Plans:*** Continue scientific research and technology development for space communications with focus on W/V-band spectrum options, laser communications, and adaptive technologies. Complete demonstration of multi-wavelength optical router. Initiate development of reconfigurable laser communication technology. Initiate demonstration of technology for positioning, navigation, and timing over laser communication links. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $2.152 million. Funding increased due to new requirements for optical and laser communication links development.	5.746	13.018	15.170
Accomplishments/Planned Programs Subtotals	40.960	58.002	55.953

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

	FY 2021	FY 2022
Congressional Add: Congressional Add: Program increase - operational cryogenic upper stage augmentation Kit ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	6.923	-
Congressional Add: Congressional Add: Program increase - thin-film photovoltaic energy ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	6.923	-
Congressional Add: Congressional Add: Program increase - hybrid space architecture ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	9.890	-
Congressional Add: Congressional Add: Program increase - resilient solar power ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	2.967	-
Congressional Add: Congressional Add: Program increase - ultra-lightweight solar arrays ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	14.835	-
Congressional Add: Congressional Add: Program increase - link-16 space experiment ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	8.901	-
Congressional Add: Congressional Add: Program increase - advanced space power systems ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	6.923	-
Congressional Add: Congressional Add: Program increase - digital engineering for future space systems ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort. This effort will be executed in PE 1206601SF, Space Technology, Project 625018, Spacecraft Protection Technology.	4.945	-
Congressional Add: Congressional Add: Program increase - laser communications ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort. This effort will be executed in PE 1206601SF, Space Technology, Project 624846, Spacecraft Payload Technologies.	11.868	-
Congressional Add: Congressional Add: Program increase - lithium-sulfur battery development ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	4.945	-
Congressional Add: Congressional Add: Program increase - small satellite mission control facility ***FY 2021 Accomplishments:*** Conduct Congressionally directed effort.	5.934	-
Congressional Add: Congressional Add: Program increase - radiation hardened microprocessor	-	8.900

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3620F / 2	**R-1 Program Element (Number/Name)** PE 1206601SF / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

	FY 2021	FY 2022
FY 2022 Plans: Conduct Congressionally directed effort.		
Congressional Add: Congressional Add: Program increase - lithium sulfur battery development ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	4.000
Congressional Add: Congressional Add: Program increase - thin-film photovoltaic energy ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	3.000
Congressional Add: Congressional Add: Program increase - multi-mission distributed antenna technology ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	10.000
Congressional Add: Congressional Add: Program increase - hybrid space architecture ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	5.000
Congressional Add: Congressional Add: Program increase - ultra-lightweight space solar arrays ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	5.000
Congressional Add: Congressional Add: Program increase - university consortia for space technology ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	10.000
Congressional Add: Congressional Add: Program increase - advanced multi-physics thermal management ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	5.000
Congressional Add: Congressional Add: Program increase - fundamental research ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	15.000
Congressional Add: Congressional Add: Program increase - space solar power inc demonstration ***FY 2022 Plans:*** Conduct Congressionally directed effort.	-	2.900
Congressional Adds Subtotals	85.054	68.800

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A