Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Defense Advanced Research Projects Agency	**Date:** May 2021
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603287E / *SPACE PROGRAMS AND TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	-	173.839	151.439	101.524	-	101.524	-	-	-	-	-	-
SPC-01: *SPACE PROGRAMS AND TECHNOLOGY*	-	173.839	151.439	101.524	-	101.524	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Space Programs and Technology program element is budgeted in the Advanced Technology Development budget activity because it addresses high payoff opportunities to dramatically reduce costs associated with advanced space systems and provides revolutionary new system capabilities for satisfying current and projected military missions.

A space force structure that is robust against attack represents a stabilizing deterrent against adversary attacks on space assets. This program element will examine concepts and architectures that move the U.S. away from a dependence on monolithic, ultra-capable, vulnerable, and unsustainably costly assets; replacing them with disaggregated assets that are agile, affordable, and easily replaced/maintained. Ready access to space requires the delivery of capabilities, replenishment of supplies into orbit, and rapid manufacturing of affordable space capabilities. Development of smaller, simpler, and more agile launch vehicles and infrastructure will be pursued. In addition, developing space access and spacecraft servicing technologies will lead to reduced ownership costs of space systems and new opportunities for introducing technologies for the exploitation of space.

Systems development is also required to increase the interactivity and functionality of space systems, space-derived information, and services with terrestrial users. Studies under this program element include technologies and systems that will enable satellites and microsatellites to operate more effectively by increasing maneuverability, survivability, and situational awareness, and precision control of multi-payload systems. Studies will actively seek to take advantage of new commercial developments which may enable both rapid constitution/reconstitution of assets, and agility/functionality not previously available for military systems.

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B. Program Change Summary ($ in Millions)

	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	190.306	158.439	108.126	-	108.126
Current President's Budget	173.839	151.439	101.524	-	101.524
Total Adjustments	-16.467	-7.000	-6.602	-	-6.602
• Congressional General Reductions	0.000	-7.000			
• 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	-9.954	0.000			
• SBIR/STTR Transfer	-6.513	0.000			
• TotalOtherAdjustments	-	-	-6.602	-	-6.602

Change Summary Explanation

FY 2020: Decrease reflects the SBIR/STTR transfer and reprogrammings.
FY 2021: Decrease reflects congressional adjustments.
FY 2022: Decrease reflects completion of the Robotic Servicing of Geosynchronous Satellites (RSGS) systems builds, and transition to early operations of the Blackjack program.

C. Accomplishments/Planned Programs ($ in Millions)

	FY 2020	FY 2021	FY 2022
Title: Robotic Servicing of Geosynchronous Satellites (RSGS)	51.580	46.329	19.005
Description: A large number of national security and commercial space systems operate at geosynchronous earth orbit (GEO), providing persistence and enabling ground station antennas to point in a fixed direction. Technologies for servicing of GEO spacecraft would involve a mix of highly automated and remotely operated (from Earth) robotic systems. The Robotic Servicing of Geosynchronous Satellites (RSGS) program seeks to establish the capability to provide robotic services in GEO suitable for a variety of potential servicing tasks, in full collaboration and cooperation with existing satellite owners and national security space operators, and with sufficient propellant for several years of follow-on capability. Key RSGS challenges include robotic tool/end effector requirements, efficient orbital maneuvering of a servicing vehicle, robotic arm systems, automation of certain spacecraft operations, and development of the infrastructure for coordinated control between the servicer and client spacecraft operations teams. The anticipated transition is to a commercial partner who will provide the satellite to carry the robotic payload and who will operate the robotic servicer. To support the development of a broadly accepted satellite servicing capability, DARPA is using the Consortium for Execution of Rendezvous and Servicing operations (CONFERS) approach to bring together experts from the private sector and Government to research, develop and publish nonbinding, consensus-based standards for safe operational approaches to on-orbit servicing.			

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
FY 2021 Plans: - Complete flight software for integration. - Complete build and test of robotic arms and tool changers. - Complete build and test of robotic tools and tool holders. - Complete payload structures fabrication. - Continue integration of robotic payload. - Publication of CONFERS Standard Operational Principles and Practices by International Standards Organization. ***FY 2022 Plans:*** - Test and complete space qualification of integrated robotic payload. - Deliver integrated and tested robotic payload for integration to spacecraft. - Initiate partner training and detailed demonstration planning. - Convene CONFERS fourth general assembly and Global Satellite Servicing Forum. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects completion of system builds.			
Title: Blackjack ***Description:*** The Blackjack program is developing space technologies demonstrating a proliferated smallsat constellation capability in Low Earth Orbit (LEO). Capabilities demonstrated will provide constant custody of very large numbers of concurrent targets; target identification, tracking, and characterization; tactical communications; architectural resilience via massive proliferation; and rapid on-orbit technology refresh and experimentation. Blackjack will leverage commercial industry plans to build constellations in LEO to provide global commercial broadband internet service. Key efforts include low size, weight, power, and cost (SWaP-C) multi-modality smallsat sensor payloads, algorithms for autonomous payload and architecture command and control, algorithms for satellite on-board processing and data fusion, and advanced manufacturing for military payload mass production. A MOA documents the partnership with U.S. Space Force and Air Force. The anticipated transition partners are the U.S. Space Force, Air Force and Space Development Agency. Blackjack will progress through design and build of 2 satellites with missile warning/defense payloads, then an additional 2 satellites with tactical communications and Intelligence, Surveillance, and Reconnaissance (ISR) payloads, and then build and launch 2 additional missile warning/defense and 8 additional tactical communications/ISR satellites for the full Blackjack demonstration of a proliferated LEO constellation. ***FY 2021 Plans:*** - Complete Critical Design Review (CDR) for commoditized satellite bus. - Complete CDR for sensor payloads. - Complete CDR for autonomous control element.	79.762	68.610	42.019

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Initiate autonomous control element manufacturing. - Complete CDR for satellite integrator. - Procure missile tracking payload sensor for in-space experiments. - Procure tactical communications and ISR payloads for in-space experiments. - Initiate assembly, integration, and testing for initial two satellites. - Initiate full demonstration spacecraft bus manufacturing. - Initiate full demonstration sensor payload manufacturing. ***FY 2022 Plans:*** - Conduct operations of first demonstration satellites. - Complete assembly, integration, and testing of full demonstration satellites. - Launch full demonstration satellites to support autonomous constellation control. - Initiate procurement of two additional OPIR (Overhead Persistent Infrared) missile warning/defense payloads. - Launch and conduct check-out and early operations of first two ISR/Radio Frequency (RF) satellites. - Launch and conduct check-out and early operations of first two OPIR satellites. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 decrease reflects a shift from spacecraft procurement to assembly integration and testing and early operations.			
Title: Demonstration Rocket for Agile Cislunar Operations (DRACO) ***Description:*** Maintaining U.S. interests in cislunar space will require leap-ahead propulsion technology. Current space propulsion includes electric (high efficiency but low thrust) and chemical (high thrust but low efficiency). The Demonstration Rocket for Agile Cislunar Operations (DRACO) program seeks to develop and demonstrate a High-Assay Low-Enriched Uranium (HALEU) nuclear thermal propulsion (NTP) system on orbit by 2025. The NTP technology demonstrated by DRACO can achieve thrust similar to chemical systems, but with 2-5 times the efficiency. The enhanced performance afforded by NTP will allow the U.S. to lead operations in the cislunar volume, a volume that is in danger of being defined by the adversary. The anticipated transition partner is the Air Force. ***FY 2021 Plans:*** - Initiate preliminary design of an NTP demonstration reactor. - Initiate conceptual design of demonstration system (DS) and operational system (OS) NTP spacecraft. - Complete system requirements review for OS spacecraft concept. - Complete subsystem requirements review for NTP demonstration reactor. - Demonstrate designs of NTP fuel elements in representative test environments. - Complete system requirements review for DS spacecraft concept.	10.000	33.000	37.000

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Complete baseline design review for NTP demonstration reactor. - Complete technology maturation plan review for DS spacecraft concept. ***FY 2022 Plans:*** - Begin detailed design of the NTP demonstration reactor. - Begin preliminary design of the demonstration system NTP spacecraft. - Begin fabrication of long lead components for both the NTP demonstration reactor and demonstration system NTP spacecraft. - Complete preliminary design review (PDR) for the demonstration system. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 increase reflects program focus shift from feasibility studies to design and initial demonstration.			
Title: Advanced Space Technology Concepts ***Description:*** Studies conducted under this program will examine and evaluate emerging technologies and concepts with the potential to provide substantial improvement in efficiency and effectiveness of operations in space. This includes the degree and scope of potential impact and improvements to military operations, mission utility, and warfighter capability. Studies are also conducted to analyze emerging threats along with possible methods and technologies for countermeasures. The feasibility of achieving potential improvements, in terms of resources, schedule, and technological risk, is also evaluated. The results from these studies are used, in part, to formulate future programs or refocus ongoing work. Topics of consideration include advanced or novel power and propulsion systems, novel sensors, advanced lightweight structures, advanced miniature radio frequency (RF) technology, navigation technologies, avionics, structures, advanced communications, autonomous constellation operations, and on-orbit software environments. ***FY 2021 Plans:*** - Explore options for high-thrust, high-efficiency propulsion, and autonomous collaboration within satellite constellations. - Examine the use of new technologies to provide responsive, resilient space system capabilities. ***FY 2022 Plans:*** - Initiate studies of new concepts and novel approaches for global navigation and timing systems. - Examine the use of new technologies to enable operation in novel orbital domains.	3.500	3.500	3.500
Title: DARPA Launch Challenge ***Description:*** Advances in technology, including networking and computing, have significantly increased the utility of small (<300kg) spacecraft that would previously have been of limited military value. For the simultaneous purposes of responsiveness and resiliency, these spacecraft are envisioned to be built on dramatically faster timelines (weeks instead of years) than are executed today. The current practice for space launch generally favors large launch vehicles with complex, one-of-a-kind	11.500	-	-

C. Accomplishments/Planned Programs ($ in Millions)	**FY 2020**	**FY 2021**	**FY 2022**
infrastructure. This architecture has been matched to the large, heavy spacecraft, which compose most of DoD's space architecture today. Small spacecraft, which offer large potential value for resiliency and tactical employment, are typically required to rideshare for access to space, which requires programmatic, technical, and schedule entanglement with other programs. The U.S. commercial sector has promising developments for small launch vehicles that are designed for launch on rapid timescales with minimal fixed infrastructure. To incentivize industry to deliver capability that can meet emerging DoD needs for rapid, responsive launch of small payloads, the DARPA Launch Challenge was designed to reward competitors who could demonstrate the ability to launch a payload to orbit with minimal notification time and unknown pre-conditions regarding the payload configuration, required orbit, and launch site.			
Title: Experimental Spaceplane (XSP) ***Description:*** The goal of the Experimental Spaceplane (XSP) program was to design a scalable, responsive, prototype reusable launch system capable of inserting commercially and militarily relevant payloads (greater than 3,000 lbs.) into low earth orbit and suborbital trajectories. There was a $5M/launch cost goal to drive down the expense of space access by an order of magnitude versus traditional expendable launch vehicles. This was to be accomplished by designing for high velocity staging which dramatically reduces the amount of costly expendable hardware. The ability to fly 10 times in 10 days and designing the system to launch a payload into orbit within 24 hours was traceable to the responsiveness necessary in a military system. The system had design goals to fly greater than Mach 6.5 multiple times.	12.497	-	-
Title: Planar Imager ***Description:*** The Planar Imager program evaluated the feasibility of a lightweight, compact, affordable optical payload to be integrated into a ride-share compatible satellite bus with equivalent imaging performance of current commercial conventional optical imaging satellites. This technology has the potential to significantly lower the size, weight, power, and cost (SWaP-C) of high-resolution intelligence, surveillance, and reconnaissance (ISR) satellites enabling persistent coverage by an affordable satellite constellation and enabling a rapid reconstitution ability. To achieve this goal, Planar Imager explored recent developments in materials science and nanofabrication and matured small-scale ultra-thin optics demonstrated in the laboratory to larger sizes. Reducing optical payload SWaP-C enables multiple ISR satellites to be packaged into a single launch vehicle fairing, dramatically reducing launch costs and improving reconstitution rate. A more persistent and pervasive space-based ISR architecture will increase warfighter readiness and lethality. These planar optics also have possible applications in optical imaging systems where SWaP-C is a constraint, impacting all areas of optical remote sensing and imaging as well as any system that requires optical components. The anticipated primary transition partners are the Air Force and Space Force.	5.000	-	-
Accomplishments/Planned Programs Subtotals	173.839	151.439	101.524

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D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A