Department of Defense
Fiscal Year (FY) 2025 Budget Estimates

March 2024

Defense Advanced Research Projects Agency

Defense-Wide Justification Book Volume 1 of 5

Research, Development, Test & Evaluation, Defense-Wide

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Department of Defense
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

Appropriation	FY 2023 Actuals	FY 2024 PB Request with CR Adjustments*	FY 2025 Request
Research, Development, Test and Evaluation, Defense-Wide	4,036,274	4,388,382	4,369,913
Total Research, Development, Test, & Evaluation	**4,036,274**	**4,388,382**	**4,369,913**

*A full-year FY 2024 appropriation for this account was not enacted at the time the budget was prepared; account is operating under the Further Additional Continuing Appropriations and Other Extensions Act, 2024 (Public Law 118-35). The amounts included for FY 2024 reflect the annualized level provided by the continuing resolution.

Department of Defense
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

	FY 2023 Actuals	FY 2024 PB Request with CR Adjustments*	FY 2025 Request
Summary Recap of Budget Activities			
Basic Research	450,333	361,961	402,878
Applied Research	1,538,602	1,626,307	1,595,436
Advanced Technology Development	1,808,842	2,286,191	2,244,015
Management Support	238,497	113,923	127,584
Total Research, Development, Test, & Evaluation	**4,036,274**	**4,388,382**	**4,369,913**
Summary Recap of FYDP Programs			
Research and Development	4,036,274	4,388,382	4,369,913
Total Research, Development, Test, & Evaluation	**4,036,274**	**4,388,382**	**4,369,913**

*A full-year FY 2024 appropriation for this account was not enacted at the time the budget was prepared; account is operating under the Further Additional Continuing Appropriations and Other Extensions Act, 2024 (Public Law 118-35). The amounts included for FY 2024 reflect the annualized level provided by the continuing resolution.

Defense-Wide
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

	FY 2023 Actuals	FY 2024 PB Request with CR Adjustments*	FY 2025 Request
Summary Recap of Budget Activities			
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Defense-Wide
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

Appropriation	FY 2023 Actuals	FY 2024 PB Request with CR Adjustments*	FY 2025 Request
Defense Advanced Research Projects Agency	4,036,274	4,388,382	4,369,913
Total Research, Development, Test and Evaluation, Defense-Wide	**4,036,274**	**4,388,382**	**4,369,913**

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Defense-Wide
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

Appropriation: 0400D Research, Development, Test and Evaluation, Defense-Wide

Line No	Program Element Number	Item	Act	Sec	FY 2023 Actuals	FY 2024 PB Request with CR Adjustments*	FY 2025 Request
2	0601101E	Defense Research Sciences	01	U	376,978	311,531	303,830
5	0601117E	Basic Operational Medical Research Science	01	U	73,355	50,430	99,048
	Basic Research				**450,333**	**361,961**	**402,878**
10	0602115E	Biomedical Technology	02	U	104,150	141,081	169,198
15	0602303E	Information & Communications Technology	02	U	365,033	333,029	397,266
16	0602383E	Biological Warfare Defense	02	U	21,717		
21	0602702E	Tactical Technology	02	U	203,644	234,549	117,935
22	0602715E	Materials and Biological Technology	02	U	316,176	344,986	337,772
23	0602716E	Electronics Technology	02	U	527,882	572,662	573,265
	Applied Research				**1,538,602**	**1,626,307**	**1,595,436**
42	0603286E	Advanced Aerospace Systems	03	U	242,369	331,753	269,700
43	0603287E	Space Programs and Technology	03	U	76,900	134,809	225,457
61	0603739E	Advanced Electronics Technologies	03	U	243,110	254,033	257,844
62	0603760E	Command, Control and Communications Systems	03	U	291,580	321,591	336,542
63	0603766E	Network-Centric Warfare Technology	03	U	662,126	885,425	886,511
64	0603767E	Sensor Technology	03	U	292,757	358,580	267,961
	Advanced Technology Development				**1,808,842**	**2,286,191**	**2,244,015**
161	0605001E	Mission Support	06	U	96,637	99,090	113,007
175	0605502E	Small Business Innovative Research	06	U	126,852		

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Defense-Wide
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

Appropriation: 0400D Research, Development, Test and Evaluation, Defense-Wide

Line No	Program Element Number	Item	Act	Sec	FY 2023 Actuals	FY 2024 PB Request with CR Adjustments*	FY 2025 Request
184	0605898E	Management HQ - R&D	06	U	15,008	14,833	14,577
	Management Support				**238,497**	**113,923**	**127,584**
Total Research, Development, Test and Evaluation, Defense-Wide					**4,036,274**	**4,388,382**	**4,369,913**

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Defense Advanced Research Projects Agency
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

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Defense Advanced Research Projects Agency
FY 2025 President's Budget
Exhibit R-1 FY 2025 President's Budget
Total Obligational Authority
(Dollars in Thousands)

Mar 2024

Appropriation: 0400D Research, Development, Test and Evaluation, Defense-Wide

Line No	Program Element Number	Item	Act	Sec	FY 2023 Actuals	FY 2024 PB Request with CR Adjustments*	FY 2025 Request
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Total Defense Advanced Research Projects Agency					**4,036,274**	**4,388,382**	**4,369,913**

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Program Element Table of Contents (by Budget Activity then Line Item Number)

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Appropriation 0400: Research, Development, Test & Evaluation, Defense-Wide

Program Element Table of Contents (Alphabetically by Program Element Title)

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Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	376.978	311.531	303.830	-	303.830	332.425	373.016	393.308	403.331	-	-
CCS-02: *MATH AND COMPUTER SCIENCES*	-	214.936	179.433	188.187	-	188.187	214.925	241.874	255.727	264.831	-	-
ES-01: *ELECTRONIC SCIENCES*	-	4.696	12.854	4.768	-	4.768	5.445	6.128	6.479	6.710	-	-
ES-02: *BEYOND SCALING SCIENCES*	-	68.868	52.004	55.350	-	55.350	48.641	53.649	55.649	53.651	-	-
MS-01: *MATERIALS SCIENCES*	-	60.474	62.934	55.525	-	55.525	63.414	71.365	75.453	78.139	-	-
TRS-01: *TRANSFORMATIVE SCIENCES*	-	28.004	4.306	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Basic Research associated with the Defense Research Sciences Program that provides the technical foundation for long-term National Security enhancement through the discovery of new phenomena and the exploration of the potential of such phenomena for Defense applications. This PE supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information, electronic, mathematical, computer, and materials sciences. This PE also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA funded technologies take root in the U.S. and provide new capabilities for national defense.

The Math and Computer Sciences project supports scientific study and experimentation on new mathematical and computational algorithms, models, and mechanisms in support of long-term national security objectives. Modern analytic and information technologies enable important new military capabilities and drive the productivity gains essential to U.S. economic competitiveness. Conversely, new classes of threats, in particular threats that operate in or through the cyber and information domain, put military systems, critical infrastructure, and the civilian economy at risk. This project aims to magnify these opportunities and mitigate these threats by leveraging emerging mathematical and computational capabilities including artificial intelligence (AI), computational social science, machine learning and reasoning, data science, quantum science, complex systems modeling and simulation, and theories of computation and programming. The basic research conducted under the Math and Computer Sciences project will produce breakthroughs that enable new capabilities for national and homeland security.

The Electronic Sciences project is for basic exploration of electronic and optoelectronic devices, circuits, and processing concepts to meet the military's need for near real-time information gathering, transmission, and processing. In seeking to continue the phenomenal advancement in microelectronics innovation that has characterized the last few decades, the project will provide DoD with new, improved, or potentially revolutionary device options for accomplishing these critical functions. The resulting technologies will help maintain knowledge of the enemy, communicate decisions based on that knowledge, and substantially improve the cost and performance of military systems. Research areas include analog, mixed signal, and photonic circuitry for communications and other applications; alternative computer architectures;

and magnetic components to reduce the size of Electromagnetic (EM) and sensing systems. Other research could support field-portable electronics with reduced power requirements, and new approaches to nanometer-scale structures, molecules, and devices.

The Beyond Scaling Sciences project supports investigations into materials, devices, and architectures to provide disruptive improvements in electronics performance that can be realized by techniques other than transistor scaling. Examples include circuit specialization, non-volatile memory devices that combine computation and memory, and new automated design tools using machine learning. Additionally, new design and manufacturing advances for three-dimensional microelectronics integration will underpin continued performance improvements as silicon transistor scaling plateaus.

The Materials Sciences project provides the fundamental research that underpins the design, development, assembly, and optimization of advanced materials, devices, and systems for DoD applications in areas such as robust diagnostics and therapeutics, novel energetic materials, and complex hybrid systems.

The Transformative Sciences project supports research and analysis that leverages converging technological forces and transformational trends in information-intensive subareas of life sciences, data sciences, and manufacturing. Innovative technologies developed in this project will address multiple DoD challenges such as identification of and adaptation to emerging threats, access to DoD relevant critical materials for manufacturing and warfighter readiness. Successful programs in this project will integrate diverse disciplines and engineer complex biological systems to detect novel threat agents, accelerate warfighter injury recover, accelerate recovery of DoD natural resources following natural disaster, and develop new platform materials and manufacturing processes.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	404.370	311.531	358.978	-	358.978
Current President's Budget	376.978	311.531	303.830	-	303.830
Total Adjustments	-27.392	0.000	-55.148	-	-55.148
• 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	-4.000	0.000			
• Reprogrammings	-9.831	0.000			
• SBIR/STTR Transfer	-13.561	0.000			
• TotalOtherAdjustments	-	-	-55.148	-	-55.148

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2023	FY 2024
Project: CCS-02: *MATH AND COMPUTER SCIENCES*		
Congressional Add: *University Partnerships for AI Development - Congressional Add*	9.000	-
Congressional Add Subtotals for Project: CCS-02	9.000	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2023	FY 2024
Congressional Add Totals for all Projects	9.000	-

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer, transfer of the 'Advanced Predictive Analytics for Supply Chain Risk Management' Congressional Add to the Air Force and reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects completion of several basic research programs in FY 2024 including Alternative Computing, Artificial Social Intelligence for Successful Teams (ASIST), Guaranteeing AI Robustness against Deception (GARD), Human Social Systems, Machine Common Sense (MCS) and Pipelined Reasoning of Verifiers Enabling Robust Systems (PROVERS), Atomic-Photonic Integration (A-PhI) and Rapid Healing for Warfighter Injuries as well as a shift from component development and integration to system demonstration and refinement in the Fundamental Limits program.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 1	R-1 Program Element (Number/Name) PE 0601101E / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) CCS-02 / *MATH AND COMPUTER SCIENCES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
CCS-02: *MATH AND COMPUTER SCIENCES*	-	214.936	179.433	188.187	-	188.187	214.925	241.874	255.727	264.831	-	-

A. Mission Description and Budget Item Justification

The Math and Computer Sciences project supports scientific study and experimentation on new mathematical and computational algorithms, models, and mechanisms in support of long-term national security objectives. Modern analytic and information technologies enable important new military capabilities and drive the productivity gains essential to U.S. economic competitiveness. Conversely, new classes of threats, in particular threats that operate in or through the cyber and information domain, put military systems, critical infrastructure, and the civilian economy at risk. This project aims to magnify these opportunities and mitigate these threats by leveraging emerging mathematical and computational capabilities, including artificial intelligence (AI), computational social science, machine learning and reasoning, data science, quantum science, complex systems modeling and simulation, and theories of computation and programming. The basic research conducted under the Math and Computer Sciences project will produce breakthroughs that enable new capabilities for national and homeland security.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Foundational Artificial Intelligence (AI) Science	40.400	43.771	46.370
Description: The Foundational Artificial Intelligence (AI) Science thrust is developing a fundamental scientific basis for understanding and quantifying performance expectations and limits of AI technologies. Current AI technologies are challenged in handling uncertainty and incompleteness of training protocols and data. This has prevented the successful integration of AI technology into many transformative DoD applications. To address these limitations, the Foundational AI Science thrust focuses on the development of new learning architectures that enhance AI systems' ability to handle uncertainty, reduce vulnerabilities, and improve robustness for Department of Defense AI systems. One focus area of this thrust is the ability to detect and accommodate novelty - i.e., violations of implicit or explicit assumptions - in AI applications. Another focus area is the development of a model framework for quantifying performance expectations and limits of AI systems as trusted human partners and collaborators. A third focus area is the development of new tools and methodologies that enable AI approaches for accelerated scientific discovery. The technology advances achieved under the Foundational AI Science thrust will ultimately remove technical barriers to exploiting AI technologies for scientific discovery, human-AI collaboration, accommodating novelty, and other DoD relevant applications.			
FY 2024 Plans: - Build baseline algorithmic decision makers that are able to be aligned with decision-making attributes of a reference group of human decision makers and computational approaches for quantifying the alignment of the algorithmic decision maker with the human reference group.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop techniques to evaluate algorithmic decision maker's ability to align with a reference group of human decision makers and validate baseline computational approaches for quantifying the measurement of alignment and the impact of alignment on trust of algorithmic decision makers. - Evaluate the performance of machine learning algorithms in combination with a variety of new data modalities to predict mental states self-reported by users. - Investigate technologies and methodologies to partially automate knowledge curation in a human / machine collaboration. - Formulate AI architectures, learning, and reasoning strategies for an autonomous scientist that can use scientific reasoning to acquire knowledge, develop creative hypotheses, and make decisions with its own knowledge in order to enable scientific discovery at speed and scale. - Explore methods to increase accountability and avoid over-trust through human-AI dialogue-based friction that reveals implicit assumptions and reflective reasoning that prompts critical analysis. - Continue to develop foundational AI science, advance the state of the art in AI engineering, and create human-machine teaming approaches that support trustworthy AI for mission- and safety-critical domains. ***FY 2025 Plans:*** - Evaluate algorithmic decision maker's ability to align with a reference group of human decision makers. - Validate baseline computational approaches for quantifying the measurement of alignment, and measure impact of alignment on trust of algorithmic decision makers. - Design baseline computational approaches for quantifying the alignment of an algorithmic decision maker with a single human decision maker. - Develop and demonstrate a rudimentary autonomous AI-based scientist that is simultaneously creative in its generation of scientific hypotheses and skeptical in its examination of scientific hypotheses. - Demonstrate accountability gains through the use of dialogue-based friction between AI-systems and humans, and evaluate the technique on DoD workflows associated with strategic planning and intelligence analysis. - Continue to develop foundational AI science, advance the state of the art in AI engineering, and create human-machine teaming approaches that support trustworthy AI for mission- and safety-critical domains. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from technique development to algorithm validation and verification.			
Title: Young Faculty Award (YFA) ***Description:*** The goal of the Young Faculty Award (YFA) program is to encourage junior faculty at universities and their equivalent at non-profit science and technology research institutions to participate in sponsored research programs that will augment capabilities for future defense systems. This program focuses on cutting-edge technologies for greatly enhancing microsystems technologies, biological technologies, and defense sciences. The long-term goal for this program is to develop the next generation of scientists, engineers, and mathematicians in key disciplines who will focus a significant portion of their careers	17.000	17.000	17.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
on DoD and national security issues. The aim is for YFA recipients to receive deep interactions with DARPA program managers, programs, performers, and the user community. Current activities include research in fifteen topic areas spanning from Machine Learning and Many Body Physics, to Wideband Transmitter-Antenna Interfaces and Multi-Scale Models of Infectious Disease Dynamics. A key aspect of the YFA program is DARPA-sponsored military visits; all YFA Principal Investigators are expected to participate in one or more military site visits to help them better understand DoD needs. ***FY 2024 Plans:*** - Award FY 2024 grants for new two-year research efforts across YFA topic areas, establishing a new set of scientific approaches to solve current DoD challenges. - Continue FY 2023 research on new concepts for microsystem, biological, strategic, and tactical technologies; information innovation; and defense sciences by exercising second year funding and by providing continued mentorship by program managers. - Award Director's Fellowships for top FY 2022 participants to refine technology further and align to DoD needs. ***FY 2025 Plans:*** - Award FY 2025 grants for new two-year research efforts across YFA topic areas, establishing a new set of scientific approaches to solve current DoD challenges. - Continue FY 2024 research on new concepts for microsystem, biological, strategic, and tactical technologies; information innovation; and defense sciences by exercising second year funding and by providing continued mentorship by program managers. - Award Director's Fellowships for top FY 2023 participants to refine technology further and align to DoD needs.			
Title: Perceptually-Enabled Task Guidance (PTG) ***Description:*** The Perceptually-Enabled Task Guidance (PTG) program is developing artificial intelligence (AI) technology that guides users in the performance of a wide range of cognitively challenging physical tasks. PTG leverages recent advances in machine perception, automated reasoning, and augmented reality. The program connects perception to reasoning and reasoning to augmented reality (AR) so as to create personalized, real-time feedback and contextualized assistance. To connect perception and reasoning, PTG develops AI technologies for (1) perceptual grounding, to create a shared vocabulary for perception and reasoning, and (2) perceptual attention, to select important information from large volumes of perceptual data. To connect reasoning with AR, PTG develops AI technologies for (3) knowledge transfer, to derive task models from instructions intended for humans, and (4) user modeling, to determine if, when, and how to best convey task information to the user. Together, PTG technologies will lay the foundation for perceptually-enabled guidance and a qualitatively new type of AI device that enables mechanics, medics, and other military specialists to perform physical tasks within and beyond their skillsets with greater accuracy and efficiency.	18.092	18.500	15.817

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2024 Plans: - Integrate perceptual, reasoning, and augmented reality technology with technologies for knowledge transfer, perceptual grounding, and perceptual attention and develop interactive demonstration scenarios involving answering questions for users performing tasks. - Develop user modeling technologies applicable to individuals performing tasks in multiple military use cases. - Perform assessments of task completion and user acceptance of the integrated technologies in the completion of tasks from application domains defined in collaboration with military stakeholders. ***FY 2025 Plans:*** - Develop and demonstrate capability for systems to answer questions and engage in task-related dialog while monitoring task progress and providing active guidance. - Test ability of systems to follow task steps, identify objects, and track actions while actively guiding military users through multiple tasks simultaneously. - Evaluate integrated system performance against military use case-related tasks in terms of speed of task completion, accuracy, and user acceptance. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects ramping down of development and integration of perceptually enabled intelligent agents, and emphasis shifting to demonstration and assessment of the technology on military task use cases.			
Title: Knowledge Management at Scale	17.300	17.000	5.000
Description: The Knowledge Management at Scale thrust is focused on the development of knowledge management tools that can efficiently capture, analyze and reason with expertise, experience and data. The technology development under this thrust will help address a critical need for assimilating and preserving critical national security knowledge and expertise that is currently being lost due to attrition and other factors. Specific objectives include the following: 1) effective, trustworthy, and easily accepted approaches for domain agnostic knowledge acquisition at scale; 2) capabilities to identify correlations or hidden factors relating to knowledge acquired from different sources; and 3) techniques for incorporating domain models and other data sources for more extensive reasoning-based applications. Example approaches towards achieving these objectives include identifying and demonstrating robust knowledge acquisition tools, exploiting Artificial Intelligence (AI) techniques to establish a framework for knowledge analysis and causal reasoning, and developing automation tools that effectively elicit and impart acquired knowledge via user friendly interfaces. ***FY 2024 Plans:*** - Evaluate novel AI knowledge management tools for use in domains of potential military interest. - Incorporate personal sensor input modality into novel AI tools.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Extend novel AI knowledge management tools to scale to individuals in organizations. - Explore use of large pre-trained models for organizational knowledge management. ***FY 2025 Plans:*** - Compare novel knowledge management tools to large pre-trained models through real-world experimentation in domains of potential military interest. - Transition novel knowledge management tools to military organizations and measure operational effectiveness in stakeholder defined experiments. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from technology development to final testing and transition activities.			
Title: Environment-driven Conceptual Learning (ECOLE) ***Description:*** The Environment-driven Conceptual Learning (ECOLE) program is creating AI agents capable of continually learning from linguistic and visual input to enable human-machine collaborative analysis of image, video, and multimedia documents during time-sensitive, mission-critical DoD analytic tasks, where reliability and robustness are essential. ECOLE aims to transform current machine learning approaches by developing algorithms that can identify, represent, and ground the attributes that form the symbolic and contextual model for a particular object or activity through interactive learning with a human analyst. Knowledge of attributes and affordances, learned dynamically from data encountered within an analytic workflow, will enable joint reasoning with a human partner. This acquired knowledge will also enable the machine to recognize when an observed object or activity is novel, rather than misclassifying the newly observed object or action as a member of a previously-learned class, and to readily learn a new symbolic representation through interaction with its human partner. ***FY 2024 Plans:*** - Formulate AI agents capable of continually learning from language and vision to enable human-machine collaborative analysis of image, video, and multimedia documents. - Develop algorithms that identify, represent, and ground novel attributes that form the symbolic and contextual model for a particular object or activity through interactive learning with a human analyst. - Initiate development of a suite of collaborative human-machine image analysis challenge problems based on inputs from potential transition partners in the defense and intelligence communities. ***FY 2025 Plans:*** - Refine algorithms that identify, represent, and ground novel attributes that form the symbolic and contextual model for a particular object or activity through interactive learning with a human analyst using increasingly expansive, realistic curricula. - Utilize the AI agents' capabilities of continually learning from language and vision to enable human-machine collaborative analysis of image, video, and multimedia documents.	10.000	15.500	21.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Perform initial assessments of collaborative human-machine image and language analysis capabilities on challenge problems of interest to potential transition partners in the defense and intelligence communities. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects ramping up of efforts to create techniques for human-machine collaborative analysis and initiation of work to assess capabilities on a suite of analytic challenge problems of interest to the defense and intelligence communities.			
Title: Alternative Computing ***Description:*** The Alternative Computing thrust is exploring and developing new computational primitives for modeling and simulating complex systems. Despite decades of rapid advancement in electronic computing, there remain important national security relevant challenge problems that do not lend themselves to achieving tractable solutions under size, weight, and power (SWaP) constrained conditions. For example, simulation of complex nonlinear phenomena such as turbulence, fluid flow, and plasma dynamics can be challenging even using currently available high-power computing resources. Building on technologies developed under the Advanced Tools for Modeling and Simulation thrust, also in this PE/Project, the goal of the Alternative Computing thrust is to develop novel architectural and algorithmic approaches to enable fast and accurate simulations for problems that are practically intractable using electronic computers. Approaches considered under this thrust include the following: (1) analog computing substrates for efficiently simulating systems governed by complex non-linear phenomena; (2) multi-functional spin-based devices for scalable, efficient neuromorphic computing; (3) computing approaches that exploit the capacity of nonlinear systems to simulate nonlinear dynamical systems; and (4) quantum enabled optimization of complex systems. ***FY 2024 Plans:*** - Create predictive and scalable benchmarks for quantifying the utility of quantum computers. - Calculate the hardware resources necessary to achieve key utility thresholds using quantum computers to solve transformational problems. - Perform benchmarking of quantum optimization algorithms against the best classical method to demonstrate and quantify quantum advantage. ***FY 2025 Plans:*** - Investigate mathematical approaches for transforming complex systems into solvable representations. - Initiate the development of methods to simplify computation.	18.020	9.000	9.000
Title: Intrinsic Cognitive Security (ICS) ***Description:*** The Intrinsic Cognitive Security (ICS) program, building on technologies developed in the Pipelined Reasoning of Verifiers Enabling Robust Systems (PROVERS) program (PE 0601101E, Project CCS-02), will extend computational formal	-	5.000	14.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
methods with cognitive guarantees and models to protect mixed reality users from cognitive attack. Mixed reality (MR) integrates virtual and real worlds in real time and will be ubiquitous in future military missions, including missions involving dismounted soldiers. Currently, users of MR systems are vulnerable to a wide variety of adversary attacks that exploit the intimate connection between users and MR equipment. Formal methods are rigorous, mathematics-based approaches to provide guarantees about computer-based systems, for example, to guarantee the absence of exploitable weaknesses. Cognitive models represent aspects of human perception, action, memory, and reasoning. The ICS program will extend formal methods by explicitly creating and analyzing cognitive models as part of MR system development to protect the user from adversary attacks. To accomplish this task, ICS will create cognitive guarantees that address mixed reality vulnerabilities and are expressed in languages suitable for proofs from models; build cognitive models for reasoning about users of mixed reality systems with sufficient fidelity relative to human behaviors; and evaluate model, proof, and guarantee validity using automated reasoning tools and prototype implementations of proved guarantees. The cognitive protections to be developed under ICS are needed to prevent exploitation of MR systems by adversaries. ***FY 2024 Plans:*** - Formulate approaches for combining computational formal methods with cognitive guarantees and models to protect mixed reality (MR) users from cognitive attack. ***FY 2025 Plans:*** - Create cognitive guarantees that address mixed reality vulnerabilities and are expressed in languages suitable for proofs from models. - Build cognitive models for reasoning about users of mixed reality systems with sufficient fidelity relative to human behaviors. - Evaluate model, proof, and guarantee validity using automated reasoning tools and initial prototype implementations of proved guarantees. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects ramping up of development and evaluation of techniques to combine computational formal methods with cognitive guarantees and models to protect mixed reality (MR) users from cognitive attack.			
Title: Enhanced SBOM for Optimized Software Sustainment (E-BOSS)	-	5.000	11.000
Description: The Enhanced SBOM for Optimized Software Sustainment (E-BOSS) program is creating enhanced software bill of materials (eSBOM) technologies with new types of rich metadata and developing cyber reasoning algorithms and tools that leverage eSBOMs to defend against potential flaws during the software development process, as well as to triage and remediate flaws found in operation. The global impacts of flawed software deployed at scale (such as the Log4Shell vulnerability found in Log4j cloud and web app deployments, where mitigations took from one week to months, and are not yet completed for a large percentage of systems) motivated the new SBOM requirements in Executive Order 14028. However, SBOMs alone			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
cannot enable identification and mitigation of the flow of hostile data to the flaws in the code. E-BOSS will develop software technologies integrated with modern software build chains to enable rapid triage and remediation of vulnerabilities at the scale of national computing infrastructure. The enhanced metadata incorporated in the eSBOMs will enable trace back of discovered flaw evidence, starting from a crash and walking back through complex inter-component interactions, transfers, and transformations to derive the vulnerability triggers. If successful, E-BOSS technologies will enable cyber-reasoning for improved remediation and sustainment of large-scale software systems. The E-BOSS program is funded in PE 0601101E, Project CCS-02 and PE 0602303E, Project IT-03. ***FY 2024 Plans:*** - Develop enhanced software bill of materials (eSBOM) formats that incorporate new types of rich metadata and initiate development of cyber reasoning algorithms and tools that leverage eSBOMs to defend against potential flaws during software development. - Conceptualize approaches for trace back of discovered flaws, starting from a crash and walking back through complex inter-component interactions, transfers, and transformations to derive the triggers and to identify how and where to apply fixes. ***FY 2025 Plans:*** - Develop enhanced SBOM (eSBOM) with new types of metadata that provides fine-grained data about control and data flows and inter-component interactions. - Develop algorithms in modern build chains and compiler extensions for unifying program analysis techniques and cyber reasoning tools to enable rapid remediation of vulnerabilities at scale. - Establish a concept of operations (CONOPS) and design use cases that are relevant to both open-source communities as well as to DoD software factories and initiate development of a test and evaluation range architecture extensible to millions of simulated nodes. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects ramping up of development of enhanced SBOM technologies and of use cases and a test range to demonstrate and evaluate security and sustainment benefits on large scale software systems.			
Title: Scientific Feasibility (SciFy) ***Description:*** The Scientific Feasibility (SciFy) program, addressing challenges encountered in the Advanced Tools for Modeling and Simulation program (PE 0601101E, Project CCS-02), will develop computational methods to measure the feasibility of claims to enable accurate assessments of scientific content. Automated scientific content generation, via rapidly improving large pre-trained models, has the potential to disrupt the U.S. technology base in times of crisis and to distort the global race for technological dominance in key areas. Similarly, false capability claims can have significant negative implications for national security and international relations. To address these threats, SciFy will focus on methods for assessing the scientific feasibility	-	3.000	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
of claims using automated reasoning to decompose claims into constituent, verifiable parts. Assessing each component will involve referencing existing technological advancements, foundational scientific principles, data, software, models, simulation results, and industry standards or benchmarks. SciFy will create methods that go beyond automated fact-checking by also addressing complex component interactions and operational constraints, and evaluating logical consistency, system integration, and compatibility considerations. If successful, SciFy will enable the U.S. to reliably determine whether claimed scientific and technological capabilities, even when theoretically possible in parts, are practical and realistic when considered as a whole. ***FY 2024 Plans:*** - Formulate approaches to automatically reason, verify, and evaluate scientific, technological, and capability claims, especially in sensitive areas surrounding national security and defense. ***FY 2025 Plans:*** - Develop methods to decompose scientific, technological, and capability claims into constituent, verifiable parts amenable to automated feasibility assessment. - Develop techniques for automatically assessing component feasibility by referencing existing technological advancements, foundational scientific principles, data, software, models, simulation results, and industry standards or benchmarks. - Extend and integrate approaches to address high priority scientific feasibility assessment use cases in collaboration with potential transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects shift from initial analysis activities to development of methods and techniques.			
Title: Emerging Opportunities in Math and Computer Sciences	-	-	39.000
Description: The grounds for strategic surprise are often realized through the discovery of unifying principles, novel fundamental limits, and unexpected connections between nominally disparate fields. This thrust explores emergent capabilities and universal themes at the interface of quantum science, mathematics, nanoscience, and materials science to develop novel approaches to critical national security needs. Emerging opportunities in this thrust will explore and analyze new scientific and technological ideas, seeking answers to high-risk/high-reward what if? questions, and assess the impact of further investment on problems of importance to national security. Understanding the complex interplay between DoD systems and their environment is critical in developing new platforms and in determining the limitations of current platforms. Current mathematical tools cannot capture the nonlinear, multiscale, high dimensional dynamics of the coupled/multiscale physics that describe these complex physical systems. ***FY 2025 Plans:*** - Investigate the potential of AI language processing to enable abstract reasoning. - Initiate the development of capabilities for generalizable knowledge representation and reasoning.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Initiate development of techniques to enable transparent and logical communications between humans and AI models. - Use machine learning algorithms to discover unknown transformations that are difficult to write down and/or discover. - Begin exploring methods for tracking the evolution of large-scale machine learning models. - Initiate efforts to expand data science techniques for socioeconomic systems. - Start to explore the fundamental questions surrounding quantum technologies, sensing, measurement, computation and/or processing. - Explore fundamental questions surrounding math and computer science. - Explore methods for personalized instruction. - Formulate programming languages for optical computing. - Explore formal methods for high-quality software. - Explore techniques for information integrity assessment. - Formulate guided compilers for heterogeneous systems. - Initiate approaches for grounding LPTMs to physical tasks for which training data may be sparse and/or costly. - Adapt techniques from data-driven neural networks to classical optimization problems where there is no training data. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Artificial Social Intelligence for Successful Teams (ASIST) ***Description:*** The Artificial Social Intelligence for Successful Teams (ASIST) program is developing intelligent software agents that can create shared mental models to enable effective teaming with humans. Theory of mind and the ability to create shared mental models are key elements of human social intelligence. Together these capabilities enable human collaboration and teamwork at all scales, whether the setting is a playing field or a military mission. The ASIST program aims to develop technologies to enable machines to exhibit similar capabilities for collaboration and teamwork with humans, capabilities which can be termed artificial social intelligence. These include the capability to infer the goals and situational knowledge of human partners, to predict what human partners will need, and to formulate context-aware actions having high value to team outcomes. ASIST aims to provide the basis for machines that can participate effectively with humans on tasks where teamwork is required. ***FY 2024 Plans:*** - Demonstrate socially intelligent agents capable of partnering with complex teams comprising individuals with specialized skills in support of a selected use case. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	12.800	4.162	-
Title: Guaranteeing AI Robustness against Deception (GARD)	18.000	10.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The Guaranteeing AI Robustness against Deception (GARD) program is developing techniques to defend against deception and other adversarial attacks on machine learning (ML) and artificial intelligence (AI) systems. GARD addresses the need to defend against deception attacks, whereby an adversary inputs engineered data into an ML system intending to cause the system to produce erroneous results. Deception attacks can enable adversaries to take control of autonomous systems, alter conclusions of ML-based decision support applications, and compromise tools and systems that rely on ML and AI technologies. Current techniques for defending ML and AI have proven brittle due to a focus on individual attack methods and weak methods for testing and evaluation. The GARD program is developing techniques that address the current limitations of defenses and produce ML and AI systems suitable for use in adversarial environments. The GARD program is also developing theory regarding potential fundamental limits on achievable ML robustness. ***FY 2024 Plans:*** - Extend adversarial AI techniques to federated learning systems. - Explore the potential of physically realizable attacks in domains relevant to DoD and U.S. Government transition partners. - Demonstrate and transition AI/ML defense technology to DoD and U.S. Government transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Human Social Systems ***Description:*** The social and behavioral sciences provide essential theories and models that can enable deeper understanding of human social/behavioral systems relevant to national security such as mental health, humanitarian aid, disaster relief, and stability support missions, as well as tactical, operational, strategic, and policy-level decision-making across the DoD. However, current limitations to the speed, scalability, and reproducibility of empirical social science research continue to hamper its practical use by the DoD. Additionally, current social behavioral models often fail to accurately interpret social behaviors because they do not sufficiently capture diversity of context. The Human Social Systems thrust will address these limitations by focusing on the following technical challenges: (1) developing and validating new methods, models and tools to perform rigorous, reproducible experimental research at scales necessary to understand emergent properties of human social/behavioral systems; (2) identifying methods to better characterize and quantify properties, dynamics, and behaviors of different social/behavioral systems to enable better and more confident forecasting of changes in such systems, particularly when under stress; (3) developing an understanding of the complex effect of context and incorporating these effects into models; and (4) developing strategic forecasting and operational decision aiding capabilities that account for local contextual and cultural factors to assess the likely effectiveness of and/or responses to actions within an Area of Operations. This research thrust will provide DoD with new, reliable strategies to better understand and respond to social/behavioral system issues at multiple scales (from small group to cities and/or regions) and will significantly improve DoD stabilization, deterrence, and/or gray zone mission outcomes.	11.000	7.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2024 Plans: - Test the accuracy of causal models of regional socioeconomic systems derived from collective local understandings for predicting event outcomes compared to the current state of practice in new locations to test generalizability of methods. - Evaluate the efficiency of methodologies for developing causal models of regional socioeconomic systems derived from collective local understanding compared to the current state of practice in new locations to test generalizability of methods. - Continue to demonstrate that mechanisms developed for engaging local populations are compatible with local infrastructure and generate sufficient quality data to generate predictive causal models in new locations to test generalizability of methods. - Design mechanistic models for targeting brain stimulation to enhance rapid eye movement (REM) sleep and improve sleep-deprived stress and trauma adaptation. - Develop hardware for the targeted modulation of REM sleep mechanisms. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Machine Common Sense (MCS) ***Description:*** The Machine Common Sense (MCS) program is exploring approaches to enable common-sense reasoning by machines. Recent advances in machine learning have resulted in new artificial intelligence (AI) capabilities in areas such as image recognition, task-focused natural language processing, and strategy games such as Chess, Go, and Poker. In all of these application domains, the machine reasoning is narrow and highly specialized, and the machine must be carefully trained or programmed for every situation. This program addresses the challenge of general machine reasoning on par with common sense human cognition. MCS develops computational models that mimic core systems of human cognitive development that are grounded in perceptual, motor, and memory modalities; a simulated interaction and learning environment to support machine manipulation of grounded concept models; and common-sense knowledge repositories to support AI system development. AI systems that are capable of human-like reasoning will be able to behave more appropriately in unforeseen situations and to learn with reduced requirements for training data. ***FY 2024 Plans:*** - Use the simulation environment to assess machine common sense capabilities on benchmark common sense challenge problem suites in environments exhibiting high complexity, noise, and novelty. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	18.000	5.000	-
Title: Pipelined Reasoning of Verifiers Enabling Robust Systems (PROVERS)	8.000	19.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The Pipelined Reasoning of Verifiers Enabling Robust Systems (PROVERS) program is creating the science and technology needed for continuous reasoning about complex systems that can support software development pipelines. These mathematically based techniques, or formal methods, enable rigorous modeling, reasoning, and proving diverse properties of software code or design models, for example, the absence of a specific type of defect or security vulnerability. PROVERS integrates formal methods into a modern incremental and iterative development process by running tools at each code commit and delivering results to developers when they can most effectively remediate discovered issues. To achieve this, PROVERS is focusing on creating and sustaining a body of evidence that can co-evolve with the system under change to support continuous assessment and ensure that the system remains free of identified categories of defects and security vulnerabilities through its lifetime. Key PROVERS objectives include enabling proof maintenance and repair capabilities at a cost that is proportionate to code change; integration of formal methods with code, properties, and proofs in a single workflow that reduces human involvement; providing improved explanations to facilitate proof repair; and automating formal methods-based software analysis to support software developers that are not formal methods experts. PROVERS science and technology will facilitate the agile development and continuous improvement of mission-critical software systems that meet the high security and quality standards required by the DoD. Beginning in FY 2025, this program is funded in PE 0602303E, Project IT-03. ***FY 2024 Plans:*** - Develop and demonstrate formal methods approaches, tools, and data management techniques integrated in pipelined software development processes and quantify the costs related to adding formal methods-based assurances in development workflows. - Implement mathematical approaches for proof engineering at scale and demonstrate efficiency and quality of outputs within existing and modified workflows. - Collaborate with DoD stakeholders on controlled formal-methods-based experiments on selected mission-critical software systems to quantify the improvements in development productivity and system security. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects focus shifting from basic research to applied research with FY 2025 funding provided in PE 0602303E, Project IT-03.			
Title: Advanced Tools for Modeling and Simulation	3.000	-	-
Description: The Advanced Tools for Modeling and Simulation thrust developed foundational mathematical, computational, and multi-physics theories, approaches, and tools to better represent, quantify, and model complex DoD systems from multimodal data analysis through part/system design and fabrication. One focus area of this thrust was developing a unified mathematical framework to enable better visualization and analysis of massive, complex data sets. Rigorous mathematical theories were also developed to address uncertainty in the modeling and design of complex multi-scale physical and engineering systems, incorporating capabilities to handle noisy data and model uncertainty that were well beyond the scope of capabilities that existed			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
at the time. Other work in this thrust focused on developing the mathematical and computational tools required to generate and better manage the enormous complexity of design, ultimately allowing designers to more easily discover non-intuitive (yet realizable) designs that fully leverage new materials and advanced manufacturing approaches now available. Outcomes from this thrust improved the speed and accuracy of modeling and simulation, as well as enabled management of complexity across DoD devices, parts, and systems. Another focus area of this thrust was multi-physics models for predicting behavior and non-intuitive failure pathways for complex, dynamic physical systems.			
Title: Safe Documents (SafeDocs) ***Description:*** The Safe Documents (SafeDocs) program developed software technologies that constrain syntactic complexity in data exchange formats and improve the capability to reject invalid and maliciously crafted data in electronic documents and streaming data. The high complexity and unmanaged evolution of electronic document formats and streaming data protocols greatly increase the computational attack surface. The SafeDocs program rationalized existing data exchange formats significant to the defense mission with attention to compatibility, and advanced the state of the art in the security of document and data format parsers. SafeDocs advances enable automated code verification, assure that the conditions of data validity are enforced, and secure documents and streaming data.	8.000	-	-
Title: Learning with Less Labeling (LwLL) ***Description:*** The Learning with Less Labeling (LwLL) program developed technology to greatly reduce the amount of labeled data required to train machine learning (ML) systems. In supervised ML, a system learns through the use of labeled training examples to recognize and categorize attributes of images, text, or speech. Humans provide these training-data examples to ML systems and, with enough labeled data, it is generally possible to build useful models. Obtaining large amounts of labeled data can be costly, particularly for national security applications. LwLL addressed this problem by creating ML algorithms that learn and adapt more efficiently than current ML approaches, formally deriving the limits of machine learning and adaptation, and training with a combination of labeled and unlabeled data. LwLL created ML systems that are easier to train for use in variable, unpredictable, real-world environments where training data is costly or sparse.	6.324	-	-
Accomplishments/Planned Programs Subtotals	205.936	179.433	188.187

	FY 2023	FY 2024
Congressional Add: University Partnerships for AI Development - Congressional Add	9.000	-
FY 2023 Accomplishments: - Initiated University Partnerships for AI Development.		
Congressional Adds Subtotals	9.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** CCS-02 / *MATH AND COMPUTER SCIENCES*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 1	R-1 Program Element (Number/Name) PE 0601101E / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) ES-01 / *ELECTRONIC SCIENCES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
ES-01: *ELECTRONIC SCIENCES*	-	4.696	12.854	4.768	-	4.768	5.445	6.128	6.479	6.710	-	-

A. Mission Description and Budget Item Justification

The Electronic Sciences project is for basic exploration of electronic and optoelectronic devices, circuits, and processing concepts to meet the military's need for near real-time information gathering, transmission, and processing. In seeking to continue the phenomenal advancement in microelectronics innovation that has characterized the last few decades, the project will provide DoD with new, improved, or potentially revolutionary device options for accomplishing these critical functions. The resulting technologies will help maintain knowledge of the adversary, communicate decisions based on that knowledge, and substantially improve the cost and performance of military systems. Research areas include analog, mixed signal, and photonic circuitry for communications and other applications; alternative computer architectures; and magnetic components to reduce the size of Electromagnetic (EM) and sensing systems. Other research could support field-portable electronics with reduced power requirements, and new approaches to nanometer-scale structures, molecules, and devices.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Emerging Opportunities in Electronic Sciences	-	-	4.768
Description: Studies conducted under this thrust will examine and evaluate emerging opportunities in electronic sciences that could lead to dramatic advances for the DoD and domestic industry. This includes novel technologies in electronic materials, devices, and circuits, as well as associated software algorithms to optimize electronic system performance. Topics include: materials growth and characterization, device architecture and scaling, circuit design and simulation, and algorithm development and integration. ***FY 2025 Plans:*** - Investigate new approaches to decrease time from ideation to realization of new materials and devices. - Investigate approaches to increase yield of new capability during design phase. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Atomic-Photonic Integration (A-PhI)	4.696	12.854	-
Description: The Atomic-Photonic Integration (A-PhI) program is reducing the size, weight, and power of atomic clocks and gyroscopes for position, navigation, and timing (PNT) applications through the development of integrated photonics. Specifically, A-PhI will demonstrate that a compact photonic integrated chip can replace the optical assembly for trapped atomic gyroscopes and clocks without degrading the performance of the device. PNT is a critical resource for all DoD missions such as communications, navigation, reconnaissance, and electronic warfare. While PNT needs usually are met by using the global positioning system (GPS), GPS signals are vulnerable to disruption and a fallback from GPS is essential. In the absence of GPS,			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** ES-01 / *ELECTRONIC SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
tactical-grade clocks and tactical/navigation grade inertial measurement units (IMUs) currently can provide GPS-like accuracy only for the short term, and longer-term GPS-independent strategies are highly desirable. A-PhI will enable long-term GPS independence and enable better-than-GPS PNT accuracy for short durations. ***FY 2024 Plans:*** - Test first highly-accurate transportable optical atomic clock by referencing to civilian and military time standards. - Demonstrate a trapped atom gyroscope with single measurement angle rate resolution and scale factor exceeding commercial gyroscopes. - Demonstrate stability and dynamic control over trapped atoms, including separating them at resolutions smaller than the wavelength of the trapping light. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Accomplishments/Planned Programs Subtotals	4.696	12.854	4.768

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 1	R-1 Program Element (Number/Name) PE 0601101E / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) ES-02 / *BEYOND SCALING SCIENCES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
ES-02: *BEYOND SCALING SCIENCES*	-	68.868	52.004	55.350	-	55.350	48.641	53.649	55.649	53.651	-	-

A. Mission Description and Budget Item Justification

The Beyond Scaling Sciences project supports investigations into materials, devices, and architectures to provide disruptive improvements in electronics performance that can be realized by techniques other than transistor scaling. Examples include circuit specialization, non-volatile memory devices that combine computation and memory, and new automated design tools using machine learning. Additionally, new design and manufacturing advances for three-dimensional microelectronics integration will underpin continued performance improvements as silicon transistor scaling plateaus.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Joint University Microelectronics Program 2.0 (JUMP 2.0)	26.000	26.000	26.000
Description: The Joint University Microelectronics Program 2.0 (JUMP 2.0) program is developing and demonstrating innovative next-generation microelectronics technologies through a public-private consortium with universities, the defense industrial base, and the semiconductor industry. The JUMP 2.0 program addresses the grand technical challenges of our increasingly connected world that must be overcome including: the need for innovation in analog hardware, increasing demand for more memory and data storage, the imbalance between data generation and communication capacity, the emerging security vulnerabilities in highly-interconnected Artificial Intelligence systems, and the unsustainable growth in energy demands for computing. Therefore, the JUMP 2.0 program sponsors academic research teams focused on related key technology areas that will not only impact future defense and national security capabilities but also strengthen U.S. leadership in information and communication technology. The JUMP 2.0 program will push fundamental technology research themes in cognition, communications, sensing to action, computing and processing, memory and storage, integration and packaging, and high-performance energy efficient devices to enable key disruptive advances in microelectronic technology.			
FY 2024 Plans: - Develop emerging materials, devices, and integration and packaging technologies for future microsystems. - Establish concepts for next-generation artificial intelligence, efficient communication, intelligent storage, novel sensing-to-action, and distributed computing architectures.			
FY 2025 Plans: - Benchmark newly-developed materials, devices, and integration and packaging technologies. - Demonstrate components for building next-generation artificial intelligence, efficient communication, intelligent storage, novel sensing-to-action, and distributed computing architectures prototypes.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** ES-02 / *BEYOND SCALING SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Identify new research directions and amend new projects to the JUMP 2.0 university research portfolio.			
Title: Low Temperature Logic Technology (LTLT) ***Description:*** The Low Temperature Logic Technology (LTLT) program will exploit the unique device and material performance characteristics of state-of-the-art silicon transistors at cryogenic temperatures. Current silicon transistors are performance and power limited when operating at room temperature or higher. This program removes these limitations through modifying the design of existing silicon transistors to optimize their performance at cryogenic temperatures. These devices will be compatible with current complementary metal-oxide-semiconductor (CMOS) fabrication process flows and will offer significant increases in performance and power efficiency over room temperature devices. This program has applied research efforts funded in PE 0602716E, Project ELT-02. ***FY 2024 Plans:*** - Fabricate optimized transistors and generate compact device models. - Demonstrate compact, low power memory cells and experimentally show their performance at low temperature. ***FY 2025 Plans:*** - Optimize high speed, low power switching devices and experimentally verify their performance advantage at low temperature. - Optimize compact, high speed, low power static memory cells and experimentally verify their performance advantages at low temperature. - Demonstrate 45X improvement in performance relative to power of low temperature central processing compared to processing at room temperature. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from initial design to demonstration of low power memory cells.	13.188	7.004	3.500
Title: Compartmentalization and Privilege Management (CPM) ***Description:*** The Compartmentalization and Privilege Management (CPM) program is developing new system frameworks, architectures, and tooling to provide fine grained, least privileged, compartmentalization that enables prevention and containment of cyber attacks. Today's information systems are structured around a monolithic core (the kernel) that operates within a single protection domain at a single high privilege level. This monolithic kernel contains many separate components, but because there are no protection boundaries between these components, a single compromise anywhere in the system allows attackers effectively unlimited access through an extended sequence of exploits and steps of privilege escalation and lateral motion. CPM is developing technologies and tools to automatically compartmentalize large legacy software systems and designing processor architectures and system software to enforce a compartment and privilege-level regime. CPM tools and architectures will prevent initial penetrations from propagating into successful cyber attacks.	-	10.000	16.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** ES-02 / *BEYOND SCALING SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2024 Plans: - Formulate approaches and initiate development of a suite of tools to automatically compartmentalize legacy code and manage privilege levels. - Initiate development of processor architectures and system software to enforce a compartment and privilege-level regime with low overhead. - Initiate development of a library of attack campaign test cases for quantifying compartmentalization effectiveness and overhead, and select DoD systems on which to demonstrate attack containment. ***FY 2025 Plans:*** - Produce initial processor designs and refined processor performance models for compartmentalized codes. - Incorporate refined processor performance models in initial implementations of compartmentalization and privilege management tools. - Develop attack campaign test cases for operating systems and legacy applications and conduct initial experiments to measure effectiveness and overhead of compartmentalization and privilege management techniques. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects continued development of techniques, tools processor architectures, and system software to automatically compartmentalize legacy code and manage privilege levels, and initiation of efforts to measure the effectiveness of the technology.			
Title: Emerging Opportunities in Electronic Sciences ***Description:*** The Emerging Opportunities in Electronic Sciences thrust is investing in fundamental technologies to take advantage of novel microscale phenomena. This includes on-chip photonics and optics for high bandwidth interconnects, improved materials for high power and high efficiency devices, advanced computing architectures, novel fabrication and packaging techniques, innovative magnetics, and energy efficient, high performance computing. This thrust aims to set the foundation for future programs by taking on the risk associated with fundamental technologies and ultimately enabling disruptive capabilities for the warfighter. ***FY 2025 Plans:*** - Perform initial exploration of advanced material fabrication techniques for photonic, optical, and magnetic applications. - Develop novel architectures for efficient, high performance computing of complex datasets. - Investigate new materials and devices for high power and high efficiency devices and circuits. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	9.850
Title: Next Generation Microelectronics - Advanced Manufacturing Science	18.680	9.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** ES-02 / *BEYOND SCALING SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: Next Generation Microelectronics - Advanced Manufacturing Science addresses the fundamental science of advanced design, fabrication, packaging, assembly, and testing for complex microsystems. This area also addresses leveraging the underlying device physics of novel material systems to enable electronics that operate in extreme environments, such as environments with high voltage, high current, high temperature, low temperature, and radiation exposure. This effort will build upon a fundamental understanding of the materials, interconnects, and device technologies to enable the design, assembly, testing, and digital emulation of three-dimensional heterogeneous integration (3DHI) in microsystems, and their use in both standard and extreme environments. The physics of interfaces between similar and dissimilar materials and the ability to characterize and reduce defect densities will be critical to the future of 3DHI approaches. In addition, the physics of electron transport, photon transport, and heat dissipation are key areas of study. Materials advances and metrology that improve the reliability of heterogeneously integrated microsystems will be addressed, including those that enable high current density for power delivery. Applied research related to this effort is funded within PE 0602716E, Project ELT-02. ***FY 2024 Plans:*** - Evaluate candidate electrical characterization techniques and metrology for representative three-dimensionally interconnected microsystems and thermally-hardened microsystems. - Perform initial experiments to create precisely aligned, high-density interconnects for digital components. - Characterize candidate novel materials and material systems to extend temperature operation range and to improve thermal interfaces, leveraging artificial intelligence (AI) and additive manufacturing. - Evaluate advanced additive manufacturing techniques including aerosol ink jet printing, nano-composite materials, and selective etching for use in 3DHI electronics. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Guaranteed Architectures for Physical Security (GAPS) ***Description:*** The Guaranteed Architectures for Physical Security (GAPS) program developed hardware security and software architectures with provable security interfaces. These interfaces physically isolate high-risk transactions during both system design and system build, and will ensure that such protections are enforced at run-time. GAPS reduced the inherent complexity through the development of hardware and software that is open, extendible, and compatible with size, weight, and power-constrained environments to enable security across DoD and commercial systems. The program substantially lowered the barrier to safely enabling high-risk transactions, thus allowing for fast computer-to-computer transactions, physical spatial isolation reducing the need for unreliable software partitioning solutions, and more complex missions without putting sensitive data at risk. This program has applied research efforts funded in PE 0602716E, Project ELT-02.	11.000	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** ES-02 / *BEYOND SCALING SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Accomplishments/Planned Programs Subtotals	68.868	52.004	55.350

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 1	R-1 Program Element (Number/Name) PE 0601101E / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) MS-01 / *MATERIALS SCIENCES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
MS-01: *MATERIALS SCIENCES*	-	60.474	62.934	55.525	-	55.525	63.414	71.365	75.453	78.139	-	-

A. Mission Description and Budget Item Justification

The Materials Sciences project provides the fundamental research that underpins the design, development, assembly, and optimization of advanced materials, devices, and systems for DoD applications in areas such as robust diagnostics and therapeutics, novel energetic materials, and complex hybrid systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Fundamental Limits	30.773	38.140	14.134
Description: Understanding the Fundamental Limits (i.e., achievable boundaries) of scientific principles, processes and technologies is critical to better anticipate technological surprise for our adversaries and ourselves. This thrust explores boundaries across fields such as physics, chemistry, mathematics, biology, and engineering to address critical questions for national security, addressing foundational theory and approaches that include, for example, the fundamental limitations of optical technologies, potential implications for basic biology on national security, and the ability for modeling and simulation to provide a better understanding of complex systems.			
FY 2024 Plans: - Initial demonstration of compact, highly-sensitive atomic vapor-based electric and magnetic field sensor devices. - Initial demonstration of compact vapor-based quantum device with high atom-photon interaction strength and quantum coherence. - Perform an engineering analysis of atomic vapor benchtop devices to provide a blueprint for future fieldable systems tailored to DoD applications. - Complete initial modeling of high energy particle accelerator structures and particle source targets; continue evaluation of laser driver technical approaches for accelerator structures. - Define system requirements for compact and directional particle sources. - Develop the theoretical framework for transport of spin polarized electrons. - Initiate efforts to develop techniques to control chemical reaction pathways for the synthesis and separation of chiral molecules. - Perform experiments to characterize and demonstrate persistence and transport of spin-polarized electrons in chiral and achiral molecules. - Demonstrate yield improvements for synthesis and separation of chiral and achiral molecules. - Investigate the fundamental properties that inhibit and enable adhesion in aqueous environments. - Develop methodologies for forming fuels efficiently from readily-available sources directly at the point of need - Develop models and device designs for correlated multiphoton sources for sensing, communication, and imaging. - Design and simulate cavity-enhanced quantum control and readout schemes for atomic and molecular qubits.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** MS-01 / *MATERIALS SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Validate novel approaches to the scalable creation, autonomous error correction, and control of entangled and topologically protected qubits to enable new capabilities in quantum information processing. - Initiate exploration of novel sensor architectures to simultaneously levitate a heavy mass with high confinement bandwidth in a compact form factor. ***FY 2025 Plans:*** - Complete initial studies of two technical approaches for laser driver and particle accelerator concepts; procure long-lead equipment. - Demonstrate and characterize compact, highly-sensitive atomic vapor-based electric and magnetic field sensor devices. - Demonstrate and characterize compact vapor-based quantum device with high atom-photon interaction strength and quantum coherence. - Perform experiments to characterize and demonstrate persistence and transport of spin-polarized electrons in chiral and achiral molecules. - Demonstrate yield improvements for synthesis and separation of chiral and achiral molecules. - Demonstrate and characterize correlated multiphoton sources for sensing, communication, and imaging. - Continue exploration of novel sensor architectures to simultaneously levitate a heavy mass with high confinement bandwidth in a compact form factor. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from component development and integration to system demonstration and refinement.			
Title: Molecular Systems and Materials Assembly	29.701	24.794	25.359
Description: The Molecular Systems and Materials Assembly thrust is exploring new approaches for the synthesis, assembly, characterization and application of molecules and materials for a variety of DoD applications from the atomic to the product scale. Ultimately, materials and methods developed in this thrust will support a wide range of DoD applications that will leverage novel materials to extend the range, duration, and capabilities of DoD systems and the warfighter. Through control of the arrangement, interactions, and assembly of atoms and molecules, new materials and manufacturing processes are being developed to address long-standing challenges in supply chains, logistics, and sustainment while simultaneously enhancing the warfighter's capabilities on the battlefield. Efforts in this thrust range from fundamental science to better understand the chemistry and physics related to each application, to developing means to utilize such capabilities in future test systems and prototype devices. ***FY 2024 Plans:*** - Predict evolution of morphology and local gradients in electrochemical interfaces. - Demonstrate persistence improvements in solid-state laboratory scale battery test samples due to solid/solid morphogenic interfaces.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** MS-01 / *MATERIALS SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate higher fatigue strength of test samples with morphogenic solid/liquid and solid/vapor interfaces in a corrosive environment. - Achieve simultaneous production of four human macronutrients in microbial food and initiate efforts to produce macro- and micro- nutrients in desired ratios. - Demonstrate in a laboratory environment each of the essential processes required to produce microbial food in the field and initiate efforts to reduce system size, weight, and power (SWaP). - Demonstrate ability to flavor microbial food and initiate efforts to produce multiple flavors and formats. - Leverage data-driven approaches to material discovery to identify candidate tunable optical materials that can lead to disruptive DoD technologies. - Initiate design of CO2 reduction reactors and CO2 capture and release materials. - Model fundamental boundary layer flows to optimize drag reducing geometries in water. ***FY 2025 Plans:*** - Demonstrate regulation of morphology and local gradients in electrochemical interfaces. - Fabricate solid-state battery test samples to demonstrate the utility of persistence in solid/solid morphogenic interfaces. - Fabricate tensile test samples to demonstrate morphogenic solid/liquid and solid/vapor interfaces in a corrosive environment. - Produce microbial foodstuffs that meet the DoD Nutritional Standards for Restricted Rations in accepted food formats, and initiate research to meet the DoD Nutritional Standards for Operational Rations. - Demonstrate a system capable of producing sufficient foodstuffs for multiple people over a two-week period while excluding food-borne pathogens. - Begin growing material candidates to understand their physical and optical properties, multi-state operation and failure mechanisms. - Initiate development of carbon dioxide reactors to address mass and energy transport-based rate limitations in CO2 reduction. - Initiate synthesis and characterization of hybrid reactive/adsorptive materials for evaluating the presence of possible synergistic effects between reaction energy and stability. - Demonstrate drag reduction on surfaces with complex curvatures. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects minor program repricing.			
Title: Emerging Opportunities in Materials Sciences	-	-	16.032
Description: The grounds for strategic surprise are often realized through the discovery of unifying principles, novel fundamental limits, and unexpected connections between nominally disparate fields. Examples include new fundamental limits of sensing and information gathering capabilities enabled by multimodal sensor networks and new avenues to high performance information processing by encoding information within dynamical physical or biological systems. This thrust explores emergent capabilities			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** MS-01 / *MATERIALS SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
and universal themes at the interface of quantum science, mathematics, nanoscience, and materials science to develop novel approaches to critical national security needs. Focus areas include harnessing the universal principles of turbulence from new forms of simulation for high complexity physical systems; systemic discovery of materials with desired properties; the analysis of new scientific and technological ideas of importance to national security. ***FY 2025 Plans:*** - Develop predictive models of broad classes of turbulent dynamics. - Explore quantum simulations for modelling complex physical systems. - Develop adaptive discovery methods for the discovery of new optical materials. - Leverage high-throughput computational and experimental screening methods for thin film materials to rapidly build data sets that drive discovery. - Explore fundamental questions surrounding novel materials and structures. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Accomplishments/Planned Programs Subtotals	60.474	62.934	55.525

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 1	R-1 Program Element (Number/Name) PE 0601101E / *DEFENSE RESEARCH SCIENCES*	Project (Number/Name) TRS-01 / *TRANSFORMATIVE SCIENCES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
TRS-01: *TRANSFORMATIVE SCIENCES*	-	28.004	4.306	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

The Transformative Sciences project focuses on research and analysis that leverages converging technological forces and transformational trends in information-intensive subareas of life sciences, data sciences, and manufacturing. Innovative technologies developed in this project will address multiple DoD challenges such as identification of and adaptation to emerging threats, access to DoD relevant critical materials for manufacturing, and warfighter readiness. Successful programs in this project will integrate diverse disciplines and engineer complex biological systems to detect novel threat agents, accelerate warfighter injury recovery, accelerate recovery of DoD natural resources following natural disaster, and develop new platform materials and manufacturing processes.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Rapid Healing for Warfighter Injuries	19.421	2.970	-
Description: The Rapid Healing for Warfighter Injuries effort is addressing the DoD need for improving warfighter recovery from injury by developing technologies that can accelerate the restoration and repair of complex wounds. This program is developing approaches that combine high-resolution biosensors to track the healing process in real-time with bioactuators to stimulate restoration where and when needed. The primary challenge to achieving this is the lack of a closed-loop interface that can manipulate highly complex signaling pathways in wounds and the developmental interdependencies that scale from cell to tissue. The program will develop new methods to convert dense multi-modal information into the body's native repair processes, and will leverage artificial intelligence to guide the delivery of the signals necessary for healing. Advances from this program will produce bioactuators that can release diverse stimuli with high spatial and temporal resolution, and biosensors that provide the requisite in situ measurement to guide the healing process. ***FY 2024 Plans:*** - Integrate sensors and actuators for all required physiological processes into a single platform. - Demonstrate that the integrated system can fully heal wounds in half the time relative to current state of art or reduce deleterious effects of normal healing in vivo. - Demonstrate that the algorithmic model predicts the wound stage with at least 90% accuracy. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Engineering Functional Materials with Biology	4.309	1.336	-
Description: The Engineering Functional Materials with Biology program is pursuing new approaches to engineer complex biological systems for enhanced capabilities and functional materials to improve military infrastructure design and logistics,			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** TRS-01 / *TRANSFORMATIVE SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
sensors, and platforms. Complex biological materials and systems have unique properties (e.g., controlled porosity, high strength-to-weight ratios, tunable magnetic and optical properties, etc.) not only because of the inherent biological components but also because of how those components are assembled together from microscopic to macroscopic scales. Engineering biology tools and techniques are now at a stage to improve the production, organization, and function of biomaterial systems for a variety of expanded capabilities, including those that can help DoD address supply chain challenges. This program is conducting research to enable information-driven assembly of hierarchical biological systems for materials as well as alternate approaches for the production of critical molecules and materials. Advances in this program will impact: next-generation material design for optical and electronic applications; military approaches to infrastructure design in austere environments; and established methods for the manufacture and maintenance of military platforms. ***FY 2024 Plans:*** - Characterize biological manufacturing approaches for increased performance of microbes in austere environments. - Refine models to predict the feasibility, logistics, and economics of biomanufacturing in austere environments based on experimental biological data. - Develop reproducible high-throughput methods to hypothesize and verify biological mode of action and gene function. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Biology for Security (BIOSEC) ***Description:*** The Biology for Security (BIOSEC) program investigated novel approaches to address the DoD need for rapid detection of unknown and/or emerging biological threats. This program investigated approaches for identifying pathogens based on specific behaviors, or phenotypes, such as niche finding or cell toxicity. Unlike current methods, which rely on a priori knowledge of the pathogen and cannot detect or otherwise analyze unknown threats, this approach handles scenarios involving engineered or undiscovered bacterial pathogens that do not have known hallmarks. Advances in this area have produced completely new capabilities to assess the emergence of pathogens and to detect pathogens that evade detection by traditional methods. Resulting systems can now be used to alert deployed military personnel operating around the world to new biothreats, or in response to a U.S.-based discovery, outbreak, or pandemic.	4.274	-	-
Accomplishments/Planned Programs Subtotals	28.004	4.306	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601101E / *DEFENSE RESEARCH SCIENCES*	**Project (Number/Name)** TRS-01 / *TRANSFORMATIVE SCIENCES*

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601117E / *BASIC OPERATIONAL MEDICAL SCIENCE*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	73.355	50.430	99.048	-	99.048	113.121	127.305	134.596	139.388	-	-
MED-01: *BASIC OPERATIONAL MEDICAL SCIENCE*	-	73.355	50.430	99.048	-	99.048	113.121	127.305	134.596	139.388	-	-

A. Mission Description and Budget Item Justification

The Basic Operational Medical Science Program Element (PE) will explore and develop basic research in medical-related information and technology leading to fundamental discoveries, tools, and applications critical to overcoming DoD challenges. This PE will address the Department's identified warfighter medical care related to prevention and treatment of infectious disease, real-time healthcare interventions of acute and chronic illness and injury, and interventions for improved warfighter resilience and performance against operational stressors. This PE also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA-funded technologies take root in the U.S. and provide new capabilities for national defense.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	76.874	50.430	58.058	-	58.058
Current President's Budget	73.355	50.430	99.048	-	99.048
Total Adjustments	-3.519	0.000	40.990	-	40.990
• 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	-0.734	0.000			
• SBIR/STTR Transfer	-2.785	0.000			
• TotalOtherAdjustments	-	-	40.990	-	40.990

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer and reprogrammings.

FY 2024: N/A

FY 2025: Increase reflects initiation of the Modernized Field Anesthesia program, Accelerated Training and Readiness Assessment program and the Emerging Opportunities in Basic Operational Medical Science thrust as well as the scaling up of efforts in the Preventing Blood Stream Infections in Warfighters After Trauma and Assessing Immune Memory (AIM) programs.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Physiological Overmatch	16.695	12.575	9.131

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601117E / *BASIC OPERATIONAL MEDICAL SCIENCE*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: Warfighters operate under extreme physiological conditions, sometimes with limited resources and manpower, and must acclimate quickly to changing operational needs. The Physiological Overmatch program is investigating innovative approaches to allow the warfighter to adapt rapidly to operational challenges during deployment by developing novel detection and treatment systems. The program will initiate work in aiding the deployed soldier's ability to defend against biological pathogens, resist fatigue, combat sleep deprivation, and maintain a high capacity for teaming and operational synchronization. This program will seek to develop technology devices for in vivo release of therapies as needed by the warfighter, to understand the biological mechanisms of fatigue, and to evaluate teaming all of which will enable improvements to warfighter health and operational performance. This approach represents a significant enhancement to warfighter performance by providing protection from impacts to operational readiness and provides information related to fatigue states and the ability to operate in optimal teaming constructs. ***FY 2024 Plans:*** - Confirm that the therapy delivery device remains active and localized for at least 60 days in vivo. - Develop secure software to signal therapy activation in vivo. - Demonstrate decontamination of bacterial pathogens in vivo. - Obtain physiological measures across sleep deprived, sleep recovery, and non-sleep deprived states. - Begin biospecimen collection to assess the contribution of gut-derived biomolecules and metabolites in regulating sleep and arousal states. ***FY 2025 Plans:*** - Analyze biospecimens to identify gut-derived biomolecules and metabolites in regulating sleep and arousal states. - Identify potential molecular pathways or mechanisms of host interactions with the gut microbiome that are associated with the restorative effect of sleep on cognitive performance in an animal model. - Demonstrate decontamination of pathogens in a large animal model when released from a fully integrated device. - Demonstrate release of therapy from a fully integrated device to regulate circadian rhythm in a large animal model. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects finalization of development activities to focus on final device evaluations.			
Title: Combatting Anti-Microbial Resistant Pathogens	12.875	8.423	5.923
Description: The Combatting Anti-Microbial Resistant Pathogens program is investigating fundamental methods for using preexisting host machinery as a technology to create medical countermeasures that degrade or deactivate pathogen targets. The DoD has long recognized the warfighter's outsized risk of exposure to biological threat agents and to infectious disease, including the increasing prevalence of antimicrobial-resistant (AMR) organisms that are ranked as a Tier 1 threat to the U.S. military. Similarly, the danger posed by bacterial biothreats persists with few countermeasures available. Key advances expected from this			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601117E / *BASIC OPERATIONAL MEDICAL SCIENCE*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
research include identifying methods to discover and develop new classes of chimeric therapeutics for AMR bacteria, bacterial biothreats, and other DoD-relevant diseases and threats. These approaches represent a significant departure from conventional therapeutics, which typically rely on a limited number of small molecules with a narrow set of targets and mechanism of action. Advances in this area may be applied to the mitigation of known, new, and emerging diseases that impact military readiness and pose a global health threat. ***FY 2024 Plans:*** - Demonstrate in vivo safety and specificity of chimeric-molecule-based medical countermeasures against selected pathogens. - Demonstrate chimeric molecules with greater efficacy of state-of-the-art treatment against selected pathogens. - Demonstrate rapidly formulated and assembled chimeric molecules with increased efficacy over the state-of-the-art treatment against pathogens. - Develop up to four novel chimeric countermeasures for full optimization and potential Investigational New Drug (IND) application submission. ***FY 2025 Plans:*** - Develop Good Manufacturing Practices (GMP) grade versions of chimeric medical countermeasures and production pathways to develop GMP-grade therapeutics for pre-IND testing. - Initiate IND applications on chimeric-molecule-based medical countermeasures. - Establish Good-Laboratory Practice (GLP) compliant in vivo models for pre-IND safety, genotoxicity, pharmacology, and toxicity assessments. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the refinement of novel chimeric medical countermeasures for IND submission.			
Title: Assessing Immune Memory (AIM)	11.757	11.624	18.200
Description: Warfighter defense against pathogens is reliant on multiple vaccinations administered repeatedly to maintain effective protection. The Assessing Immune Memory (AIM) program will seek to increase the longevity of infectious disease protection in warfighters by establishing tools that can be employed in new prophylactic development pipelines. Specifically, this program will develop a research and evaluation (R&E) tool to predict vaccine duration through the understanding of critical host factors and immune responses. Further, the tool will evaluate prophylaxis candidates and leverage effective modalities for delivery against emerging, re-emerging, or entirely unknown pathogens. Advances in this program will enable the DoD to increase the number of effective and long-lasting vaccines for warfighters, ensuring broader and consistent immunity in field-forward environments. ***FY 2024 Plans:***			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Collect molecular profiles at early and late timepoints following vaccine challenge in relevant biological models. - Define cell and molecular features that correlate with vaccines that provide observably long immune protection. - Perform single cell molecular analyses to categorize cell-type identifiers that contribute to immune memory. - Begin to integrate data to develop a roadmap for immune memory. ***FY 2025 Plans:*** - Quantify single-cell molecular features from immune cell populations captured following vaccination. - Demonstrate immune cell features correlate with immune memory in the chosen model system. - Test mechanistic generalizability across multiple variations of vaccination. - Identify biologically relevant pathways that lead to immune memory cell formation. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift in focus to evaluating a broad range of vaccine models to determine generalizability of critical factors that correlate with immune responses.			
Title: Preventing Blood Stream Infections in Warfighters After Trauma	-	5.500	18.498
Description: Bloodstream infections (BSI) are a significant source of morbidity in service members that sustain combat-related injuries. Trauma temporarily degrades the efficacy of the host immune system thereby increasing the risk of life-threating opportunistic infections from fungi and bacteria that enter into the blood. If unchecked, bloodborne fungi and bacteria lead to debilitating conditions such as invasive fungal infections (IFI), sepsis, and shock. The Preventing Blood Stream Infections in Warfighters After Trauma program will develop a systems-level approach to prevent BSI in warfighters that suffer trauma from blast. Prophylactic systems circulating in the blood will be developed to bind infectious particles in the blood early and label pathogens for clearance and deliver drugs to destroy pathogens and/or restore healthy physiology. Ultimately this program will develop novel technologies that will protect service members from morbidity and mortality associated with BSI. ***FY 2024 Plans:*** - Initiate development of delivery molecules that can circulate in the bloodstream for an extended period of time. - Evaluate the binding affinity of pathogen-agnostic recognition sequences to different types of fungi and bacteria. - Begin to measure the ability for newly designed prophylactic to bind or neutralize target pathogens. ***FY 2025 Plans:*** - Demonstrate developed prophylaxis is non-toxic and non-immunogenic in the host. - Demonstrate prophylactic prevents growth of a single fungal and bacterial pathogen in blood. - Demonstrate developed prophylaxes increase survival in single fungal and bacterial pathogen in blood.			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate prophylaxes can be produced at scale. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects enhancements in the in vivo trauma care conditions that include burn and blast scenarios.			
Title: Modernized Field Anesthesia* ***Description:*** *Previously part of Improved Interventions The Modernized Field Anesthesia program will aim to produce safe, battlefield-ready anesthetics to reduce the trauma associated with injury and improve combat casualty outcomes. Current therapeutics that enable life-saving interventions and wound stabilization must be used in hospitals or highly-monitored settings due to their lack of safety. Prolonged peer or near-peer conflict could severely impact medical evacuation (MEDIVAC) times, resulting in extended time before patients reach a hospital. The Modernized Field Anesthesia program will seek to uncover mechanisms of anesthesia at multiple biological levels ranging from the molecular to the organismal. Novel treatments developed under the program will exhibit the desirable properties of anesthetics, including calming effects and loss of sensation and consciousness but will have vastly improved safety profiles, making them usable in the field by warfighters with minimal medical training. ***FY 2024 Plans:*** - Develop appropriate biological models for evaluating anesthetic endpoints. - Establish methods to evaluate the biological mechanisms underlying the desired state of anesthesia. ***FY 2025 Plans:*** - Develop appropriate biological models and implement systems and profiling techniques for interrogating multiple model systems of anesthesia. - Initiate studies for anesthetic target discovery associated with analgesia, loss of consciousness, and immobility. - Develop the computational infrastructure required for analysis and prioritization of cellular/molecular target space. - Define target profile effects that are associated with current anesthetic interventions. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a widening of experimental focus to include multiple length-scales in the development and improvement of biological models of anesthesia.	-	3.000	18.282
Title: Accelerated Training and Readiness Assessment* ***Description:*** *Previously part of Physiological Overmatch	-	3.000	15.419

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The Accelerated Training and Readiness Assessment program will seek to advance technologies to drive efficiency and efficacy of military operator preparation and expertise building. This program will seek to understand fundamental biological processes to support real-time physiological assessment, performance diagnostics, and objective prediction of warfighter and team proficiency, with the ultimate goal of improved DoD mission readiness and execution. Advances in this program will result in a significant enhancement to warfighter team performance by providing methods to determine teaming potential and actionable paths to optimal teaming. ***FY 2024 Plans:*** - Develop custom metrics for assessment of team performance and initiate capture of ground truth data across real-world team training sessions. - Create testbed to identify and validate biobehavioral signatures of team coordination. ***FY 2025 Plans:*** - Collect data and identify candidate biobehavioral signatures of warfighter and team performance. - Demonstrate ability to measure and characterize identified signatures rapidly, reliably, and accurately during team training sessions. - Initiate development of predictive models for biobehavioral signature validation. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects shift from initial discovery of candidate biobehavioral signatures to characterization work across various team training scenarios.			
Title: Emerging Opportunities in Modeling Basic Operational Medical Science	-	-	13.595
Description: The DoD will accelerate discovery and development by leveraging recent advances in computational methods to identify new capabilities and address evolving stressors encountered by warfighters. The Emerging Opportunities in Modeling Basic Operational Medical Science thrust seeks to advance machine learning and artificial intelligence to create physics-based simulation of biological function with undetermined or broad military utility. This thrust will seek to understand fundamental biological processes to accurately simulate, and thus predict biological functions, identify emergent properties, predict antibiotic resistance, and help accelerate biology research. Accurate, extensible, and interpretable physics-based simulations of microbial cell behavior will help maintain domestic competitiveness in biomedical research, increase the resiliency of supply chains, serve as a tool for public health and to ensure biosecurity. Technologies in this effort will be developed to create high-fidelity simulations of fundamental biological processes. ***FY 2025 Plans:*** - Initiate automated experimentation and data collection to create high-quality data sets of biological processes.			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Initiate development of initial computational simulation of biological processes. - Create application-specific computational learning models to support the accurate and reliable simulation of biological behavior. - Evaluate initial computational models to assess the ability to simulate, predict, and forecast microbial behavior in DoD-relevant settings. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects thrust initiation.			
Title: Improved Interventions ***Description:*** The Improved Interventions program seeks to develop novel pharmacological interventions to quickly and holistically optimize the performance of the healthy warfighter and improve treatment of the injured warfighter. The status quo for pharmacological intervention is one drug, one target, which often has many undesirable side effects. This program will create a platform to develop pharmacological interventions capable of modulating multiple targets within biological systems of the body, which will reduce side effects and promote safety. Research will focus on the integration of novel bioinformatics approaches, and new chemical synthesis methods to treat the system in order to achieve desired physiological effects. This program will lead to new pharmacological discovery and design principles that will lead to pharmacological interventions that can be used to safely treat and support battlefield causalities. ***FY 2024 Plans:*** - Demonstrate that the optimized novel multi-target drug has greater efficacy than standard of care. - Determine therapeutic index (i.e., ratio of toxic dose/effective dose) of the novel multi-target drug. - Characterize pharmacokinetic properties of the novel multi-target drugs. - Begin Investigational New Drug (IND)-enabling preclinical studies for pharmacology and toxicology. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	13.893	6.308	-
Title: Outpacing Infectious Disease ***Description:*** Military readiness and national security depend on the health and well-being of military service members. Unfortunately, today's antivirals and vaccines are often circumvented by fast-mutating viruses that evolve to develop drug resistance. Military service members often deploy to areas with such diseases that require new protective measures to maintain readiness. The Outpacing Infectious Disease program investigated fundamental methods for using biology as a technology to create adaptive therapeutic response mechanisms to outpace viral diseases such as enabling co-evolution and co-transmission of newly developed therapeutics to ultimately outcompete the pathogen. Key advances expected from this research included identifying methods to discover and develop new classes of dynamic therapeutics for fast-mutating viruses. This approach	2.501	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
represents a significant departure from conventional antiviral therapies, which typically rely on static solutions and continuous re-formulation and re-development in attempt to keep pace with emerging strains and disease variants. Advances in this area may be applied to the mitigation of known, new, or emerging diseases that impact military readiness and pose a national security risk as a potential pandemic.			
Title: Preventing the Emergence of Disease (PED) ***Description:*** Many emerging infectious disease outbreaks have origins in animal reservoirs and occur in areas where DoD personnel are deployed, putting them at high risk of endemic and emerging diseases. The Preventing the Emergence of Disease (PED) program investigated how animal pathogens are transmitted to humans and exploring novel approaches to prevent these events. Tools such as detailed molecular analysis and bioinformatics were leveraged. Researchers developed models to quantify the probability of pathogen disease transmission from animals to humans. Promising intervention approaches were developed to prevent viral species jumps from animal reservoirs to humans. Predicting such jumps is a key capability to mitigating outbreaks originating in animal reservoirs.	2.716	-	-
Title: Early Battlefield Interventions (EBI) ***Description:*** The Early Battlefield Interventions (EBI) program explored new methods to slow and limit damage caused by acute trauma, injury, and bloodstream infection often suffered by warfighters under far forward conditions. Research efforts applied advances in molecular and cellular biology, cell signaling, and biomaterials to develop new tools to alter the time course of pathological processes and prevent bloodstream infections in warfighters that suffer trauma. This tactic is a departure from traditional therapeutic approaches that seek to control symptoms associated with active infections or innate physiological responses to tissue trauma. Therapeutics were developed to rapidly detect infections following trauma and deliver therapeutics to restore healthy physiology. Advances in this area may be applied to the development of both prophylactic and therapeutic medical countermeasures to forward-deployed service members.	12.918	-	-
Accomplishments/Planned Programs Subtotals	73.355	50.430	99.048

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602115E / *BIOMEDICAL TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	104.150	141.081	169.198	-	169.198	193.238	217.467	229.923	238.108	-	-
BT-01: *BIOMEDICAL TECHNOLOGY*	-	104.150	141.081	169.198	-	169.198	193.238	217.467	229.923	238.108	-	-

A. Mission Description and Budget Item Justification

This Biomedical Technology Program Element (PE) focuses on applied research for medical related technologies that will maintain warfighter health and performance before, during, or after operations. Successful technologies within this Program Element will maintain warfighter health against emerging threats through novel biothreat detection, rapid medical countermeasure identification and development, and distributed production of effective therapeutics. In-theater, warfighter health will be maintained through the development of field-relevant technologies such as reliable and accessible critical medical resources, novel detection and protection capabilities for traumatic brain injury, and rapid, effective triage of battlefield injuries. Technologies are also being developed to provide new capabilities for warfighter recovery from sustained injury including, but not limited to spinal cord injury. Additionally, this PE will improve warfighter readiness by characterizing and assaying physical and cognitive performance to drive data-driven awareness. This PE also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA-funded technologies take root in the U.S. and provide new capabilities for national defense.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	126.958	141.081	167.205	-	167.205
Current President's Budget	104.150	141.081	169.198	-	169.198
Total Adjustments	-22.808	0.000	1.993	-	1.993
• 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	-20.000	0.000			
• Reprogrammings	0.292	0.000			
• SBIR/STTR Transfer	-3.100	0.000			
• TotalOtherAdjustments	-	-	1.993	-	1.993

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer and transfer of the 'Prophylactic Medical Countermeasure for Acute Radiation Syndrome' Congressional Add to the Army offset by reprogrammings.

FY 2024: N/A

FY 2025: Increase reflects minor program repricing.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Improved Personnel Placement (IPP)	14.163	15.629	8.031
Description: The Improved Personnel Placement (IPP) program aims to improve force lethality and overmatch by identifying candidates for specialized military roles and developing assays to determine physical/cognitive states in order to maximize performance and resilience, while minimizing attrition. IPP will identify and measure biomarkers for unique physical, cognitive, and behavioral traits associated with a broad spectrum of military specialties. The program will link these phenotypic traits and biomarkers to underlying biological gene expression circuits driving performance. This knowledge will help individualize training and provide novel measures of physical/cognitive states for specialized roles, while providing training cadres greater precision for identifying the candidates without bias. Measuring an individual's biological system will ensure that they achieve their maximum potential while facilitating readiness and resilience for the DoD. ***FY 2024 Plans:*** - Generate a preliminary list of published molecular biomarkers indicative of readiness as targets for molecular sensor development. - Begin sensor development for molecular biomarkers associated with physical task readiness. - Initiate evaluation of preliminary models for predicting physical task readiness. - Begin preparations for a demonstration of sensor outputs within a militarily relevant cohort. ***FY 2025 Plans:*** - Complete non-integrated benchtop sensor procedures for molecular biomarkers. - Execute a demonstration of sensor outputs within a militarily relevant cohort. - Begin sensor development for molecular biomarkers associated with cognitive task readiness. - Initiate evaluation of preliminary models for predicting cognitive task readiness. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects reduction of training samples and refinement of models for end of phase demonstration.			
Title: Deployable Medical Countermeasures for Warfighter Readiness	20.133	27.007	25.508
Description: Maintaining robust protection and treatment against infectious disease threats during stabilization operations (e.g., Humanitarian and Disaster Relief [HADR]) requires rapid drug discovery and reducing manufacturing and supply chain burdens. A major limitation of our current response to emerging biological and chemical threats is the lack of immediate availability of ideal medical countermeasures (MCMs) for rapid response, which includes high quality nucleic acid templates for MCM manufacturing. These nucleic acids are also critical for R&D applications ranging from synthetic biology to the testing and development of medical countermeasures. Current DNA production capabilities are limited to less than a handful of U.S.-based manufacturers; it takes weeks to months to produce adequate quality and quantity of DNA at these manufacturing sites and ship them to downstream partners. The Deployable Medical Countermeasures for Warfighter Readiness program aims to develop an on-			

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
demand deployable platform to manufacture nucleic acid drugs safely at scale, in short timeframes. The platform will be comprised of a fully contained system capable of selectively manufacturing relevant doses of current Good Manufacturing Process (cGMP) grade nucleic acid therapeutics at or near the point of care. This effort will also develop high quality gene-length DNA for research and development. This on-demand platform will enable countermeasures capable of combating novel threats, allowing a small force to prevent regional outbreaks from becoming global emergencies. ***FY 2024 Plans:*** - Demonstrate an evolved, integrated, and automated process for production and formulation of messenger RNA (mRNA). - Demonstrate integrated automation of mRNA quality analytical methods. - Demonstrate high-throughput de novo enzymatic synthesis of oligonucleotides to support parallel synthesis and assembly of multiple DNA targets. - Develop schematics for integration of modules for nucleic acid synthesis, purification, and analysis into an alpha prototype system for DNA medical countermeasures. - Initiate method development for parallel synthesis and assembly of multiple DNA targets at research and development (R&D) scale. - Conduct cybersecurity resilience of nucleic acid synthesis systems. ***FY 2025 Plans:*** - Demonstrate integrated upstream workflow for parallel synthesis of multiple DNA targets at R&D scale. - Develop functionally integrated alpha prototype system for DNA medical countermeasures, including modules for automated DNA synthesis, purification, and analysis. - Initiate development of alpha prototype system for R&D grade DNA, including modules for parallel DNA synthesis, purification, and analysis. - Demonstrate suitability of product produced through end-to-end automated processes using animal studies, showing identical safety and efficacy compared to traditionally-developed MCMs. - Integrate cybersecurity software and hardware into nucleic acid synthesis systems. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the completion of DNA synthesis method development and the shift to automation of the methods.			
Title: Bridging the Gap after Spinal Cord Injury ***Description:*** The Bridging the Gap after Spinal Cord Injury program is developing and integrating technologies to heal and restore function associated with spinal cord injuries. This program will significantly advance treatment technologies by developing implantable, adaptive devices to address different stages of spinal cord injury. For early phases of injury, this program will develop technologies for real-time biomarker tracking and delivery of therapies to stabilize or rebuild nerve connections at the injury site.	12.016	17.815	10.155

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602115E / *BIOMEDICAL TECHNOLOGY*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
For final phase of injury, the Bridging the Gap after Spinal Cord Injury program will develop and integrate a network of devices deployed across the body to effectively create a synthetic nervous system and "bridge the gap" of the spinal cord injury to restore function and sensory feedback. The Bridging the Gap after Spinal Cord Injury program will dramatically improve the quality of life for wounded warfighters and veterans suffering from spinal cord injuries. ***FY 2024 Plans:*** - Evaluate safety of devices, subsystems, and algorithms in vivo. - Assess efficacy of the injury mitigation systems in vivo. - Initiate experiments to establish implanted device longevity and compatibility with imaging systems. - Improve risk mitigation strategies for the complete system and initiate regulatory body engagement. ***FY 2025 Plans:*** - Initiate efficacy assessment for the early injury mitigation systems in animal models. - Initiate regulatory approval procedures for early injury mitigation systems. - Evaluate efficacy of long-term multi-function restoration in preclinical models. - Submit long-term function recovery systems for regulatory approval. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects completion of initial prototyping and development activities and shift to focus on final testing and transition.			
Title: Distributed Access to Critical Biotherapeutics for Warfighters	10.020	14.520	14.001
Description: The goal of the Distributed Access to Critical Biotherapeutics for Warfighters program is to ensure DoD access to critical medical countermeasures (MCMs) by establishing the foundational technologies needed for fully distributable, on-demand manufacturing of protein-based MCMs and critical reagents. To achieve this, investments will be made in technologies that enable immediate, high-yield synthesis of bioactive protein MCMs. This technology will allow the DoD to rapidly secure access to therapeutic proteins and to enzymes needed for nucleic-acid based MCM synthesis without reliance on complex supply chains or slow development cycles. ***FY 2024 Plans:*** - Identify effectors that increase protein expression yields. - Develop methods to decrease lead-time to protein production in cell free systems. - Demonstrate the addition of modifications to proteins produced in a cell free system.			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct a capability demonstration to validate the production of a protein of interest at a yield relevant to operational timeframes. ***FY 2025 Plans:*** - Utilize identified effectors and improved reaction conditions in combination to increase protein expression yields. - Demonstrate initiation of protein production in cell free systems. - Demonstrate the addition of different protein modifications to proteins produced in cell free systems. - Demonstrate production of proteins at relevant yields with correct protein modification added. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects minor program repricing.			
Title: Next-Generation Combat Casualty Care ***Description:*** The Next-Generation Combat Casualty Care program is developing advances in critical efforts to preserve warfighter life and well-being in the battlefields of the future. This research will directly address a leading cause of potentially preventable battlefield casualties by investigating new approaches for developing whole blood substitutes for traumatic injury that can be deployed on the battlefield in far forward settings. Additional potential uses apply to disaster relief, mass casualty events, and stabilization missions. Advances within this program will ensure that the U.S. remains able to care for service members in peer and near-peer conflict by addressing gaps in combat casualty care. ***FY 2024 Plans:*** - Initiate efficacy and safety assessments of therapeutic formulations against hemorrhage using animal models. - Test stability over operationally important temperature ranges using in vitro models. - Provide initial proof-of-concept for scaled-up manufacturing of products. - Prepare for in vivo studies to demonstrate efficacy in complex trauma models. ***FY 2025 Plans:*** - Initiate efficacy and safety assessments of therapeutic formulations against hemorrhage in complex trauma using animal models. - Test stability over operationally important temperature ranges and storage durations exceeding current limits for whole blood using in vitro models. - Provide initial proof-of-concept for scaled-up manufacturing of products with near-cost parity with whole blood. - Prepare for in vivo studies to demonstrate efficacy of stabilized products. ***FY 2024 to FY 2025 Increase/Decrease Statement:***	10.733	14.431	11.167

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects the completion of initial blood substitute development and the initiation of optimization for complex trauma applications.			
Title: Rapid Battlefield Triage	8.907	20.111	24.173
Description: The Rapid Battlefield Triage program is advancing capabilities to quickly triage warfighters requiring urgent life-saving medical intervention and enable medical resources to provide an appropriate response in current and future battlefields. Today, triage at point-of-injury is limited by subjective assessments, tools that are manually intensive, and physiological signatures with little diagnostic and prognostic value. This program will build on recent biomarker discoveries and innovations in sensing platforms to develop field-portable technologies that support triage in the most challenging operational environments. By optimizing allocation of scarce medical resources and scaling to multiple casualties, these devices will help far-forward units maximize their fighting strength against adversaries that inflict large numbers of casualties and constrain evacuation to advanced medical facilities. ***FY 2024 Plans:*** - Build database of trauma signatures with additional sensor modalities. - Evaluate novel physiological signatures of injury type and severity. - Begin to evaluate approaches for stand-off capture of injury signature by semi-autonomous systems. - Begin to evaluate field-portable triage solutions in challenge competitions. - Conduct initial baseline design, development, and integration of triage solutions in initial integration exercise and large-scale field experimentation. ***FY 2025 Plans:*** - Expand database of trauma signatures with additional sensor modalities. - Continue development of virtual testbed for training and testing of virtual autonomous solutions. - Evaluate approaches for stand-off capture of injury signature by semi-autonomous systems in a virtual environment. - Evaluate field-portable triage solutions. - Evaluate approaches for stand-off capture of injury signature by semi-autonomous systems in a real-world (physical) simulation. - Conduct second baseline design, development, and integration of triage solutions in an integration exercise and second large-scale field experimentation. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects shift from analysis and development of a trauma signatures database to large-scale medical triage challenge demonstrations.			
Title: Neurological Assessment and Protection from Brain Injury	9.761	17.609	24.052

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602115E / *BIOMEDICAL TECHNOLOGY*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: Building upon technologies discovered under the Restoring Cognitive Capability program (budgeted in PE 0602715E, Project MBT-02), the Neurological Assessment and Protection from Brain Injury program is transforming our current detection and protection strategies against traumatic brain injury (TBI), such as injury from blast exposure. This program is developing prophylactic countermeasures to prevent severe brain injury. Current available tools in far forward operating environments for these injuries are lacking especially those that effectively discriminate between mild- and medium-level trauma. These novel technologies will change the paradigm for treatment of TBI by preventing injury rather than attempting to reverse or repair it. ***FY 2024 Plans:*** - Define the biological events immediately following TBI. - Initiate investigations of approaches to deliver countermeasures. - Identify candidate molecular pathways to develop countermeasures. - Initiate platform design for protective or immediate treatment countermeasures. ***FY 2025 Plans:*** - Link the first biological events to downstream cellular or molecular cascades known to result in cognitive, psychological, or behavioral symptoms of TBI in vivo. - Develop delivery mechanisms that demonstrate high temporal and spatial resolution in small animal models. - Develop first-in-class countermeasures identified with feasibility data supporting mechanism of action and safety. - Evaluate proof-of-principle payload delivery specificity demonstrations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the completion of druggable target identification and the initiation of development and testing of putative interventions that act on these targets to abridge head trauma-induced pathology.			
Title: Warfighting Performance in Biomedical Technology	-	-	17.231
Description: The DoD ensures force health protection by advancing technologies that sustain the operational reliability and effectiveness of the warfighter. The Warfighting Performance in Biomedical Technology thrust will seek to develop new classes of medical care technologies that prevent and treat injuries that impact warfighter health and performance. This thrust will advance platforms to protect overall force health against the multitude of biothreats and physiological stressors. Technologies that allow autonomous care of patients and greatly improve trauma survivability will also be developed. ***FY 2025 Plans:*** - Evaluate the feasibility of modulating target mechanism(s) for improving emotional health outcome. - Evaluate feasibility of producing heath care sensors capable of autonomous care monitoring in compact form factors.			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602115E / *BIOMEDICAL TECHNOLOGY*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Initiate method development for assessing injury care effectiveness and patient monitoring in austere environments. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects thrust initiation.			
Title: Controlled Genome Protection ***Description:*** The Controlled Genome Protection program will develop advanced capabilities to control and tune the activity of gene editing technologies. This research leverages previous investment in Genome Protection Technologies-developed laboratory tools to prevent or limit unintended genome editing or engineering. Advances in synthetic and environmental biology have significantly expanded the suite of genome editors and modulators available. Many of the new genome editors have been identified from rare, slow-growing microorganisms with unique metabolic capabilities. New tools, both highly specific as well as broadly acting across these new classes of genome editors, are required to advance our understanding of, our control of, and ultimately our leverage of gene editing technologies across all domains of life. Advances within this program will ensure that the U.S. leads innovation in this widespread, advancing field that poses potential national security threats due to the large-scale democratization of gene editing technologies. ***FY 2025 Plans:*** - Initiate discovery of efficient and broadly acting inhibitors of novel genome editors. - Develop assays for demonstrating inhibition of genome editing in vitro. - Initiate characterization of novel genome editors and their associated inhibitors. - Develop computational tools for identifying inhibitors of genome editors. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	15.440
Title: Novel Delivery Technology for Medical Countermeasures ***Description:*** The DoD requires rapid development of medical countermeasures (MCM) to ensure force health protection and improve our ability to respond to emerging and novel biological threats. Despite recent advancements in development of new MCMs, challenges with delivery limits their current therapeutic potential. While emerging targeted delivery systems such as polymer/lipid nanoparticles and viral vectors have enabled the delivery of large, complex MCM molecules, they are still plagued by lack of widespread availability and effectiveness. Investing in efficient, adaptable delivery technology is crucial for strengthening biosecurity preparedness, and will enable rapid response to the evolving biological threat landscape, whether the threat is natural or manmade. The Novel Delivery Technology for Medical Countermeasures program will develop minimally invasive MCM delivery systems, in which any therapeutic can be quickly formulated and administered to treat or prevent any disease. Developing novel delivery platforms will maintain warfighter health and readiness and enable rapid response to existing and novel biothreats.	-	-	19.440

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602115E / *BIOMEDICAL TECHNOLOGY*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2025 Plans: - Identify candidate delivery chassis and formulation strategies capable of delivering protein or nucleic acid-based countermeasures. - Establish assays/methodologies to monitor expression and availability of countermeasures in vitro and in vivo. - Initiate assessment of delivery chassis in two or more cell types in vitro. - Initiate assessment of delivery chassis for multiple medical countermeasure modalities. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Neural Signal Interfaces and Applications (NSIA) ***Description:*** As part of their daily duties, many military personnel must handle large volumes of data and interact with complex systems. These tasks could be made less difficult with advanced neurotechnology platforms, but all such devices currently require invasive surgery to implement. The Neural Signal Interfaces and Applications (NSIA) program is developing non-invasive neurotechnologies that are able to interface with the nervous system with high resolution and precision without surgery. NSIA is utilizing recent advances to transduce neural signals through tissue. Current neurotechnology platforms also have clinical applications, and resulting NSIA technologies will likewise provide clinical treatment opportunities for wounded warriors through non-invasive means. ***FY 2024 Plans:*** - Evaluate impact of environmental factors (e.g., location, ambient noise) on system performance. - Assess performance when using multiple brain regions to generate outputs. - Assess performance when sending multiple channels of information to multiple brain regions. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	9.716	9.231	-
Title: Forensic Indicators of Threat Exposure (FITE) ***Description:*** The DoD responds to a variety of chemical, biological, and radiological threats around the globe that require protective medical countermeasures to ensure force health protection and warfighter readiness. The Forensic Indicators of Threat Exposure (FITE) program is developing a field-deployable resource to reveal an individual's exposure history to chemical, biological, and radiological threats by characterizing epigenetic signatures in an individual's genome and other biological responses. The program is creating the framework for modular technology capable of performing forensic or diagnostic analysis using epigenetic information to provide high specificity of the type of exposure and when it occurred. This novel capability could	4.251	4.728	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602115E / *BIOMEDICAL TECHNOLOGY*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
serve as a field-forward forensic tool for use by the DoD to assist in Chemical, Biological, Radiological, and Nuclear (CBRN) threat detection and response. ***FY 2024 Plans:*** - Characterize identified biomarkers relevant to DoD need. - Finalize analytical methods to increase sensitivity and specificity for validated human exposure signatures. - Initiate assessment of medical countermeasure delivery modalities and their biological responses. - Initiate assessment of CBRN threats and potential inhibitors. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Pandemic Prevention ***Description:*** Military personnel are deployed all over the world for traditional operations that can involve exposure to endemic infectious disease, and are often specifically called upon in response to emerging or re-emerging disease outbreaks with pandemic potential (e.g., Ebola). In both instances, the DoD needs effective countermeasures to protect its deployed forces and maintain warfighter readiness. The Pandemic Prevention program focused on novel methods to accelerate countermeasure discovery, pre-clinical testing, and manufacturing. This program sought to advance and integrate newly developed approaches including bioinformatics assessment of genetic sequencing and nucleic acid-based vaccines and to address technology bottlenecks associated with each stage of medical countermeasure development. Additional research investigated new methods improving the manufacturability, distribution, and delivery of novel therapeutics. Pandemic Prevention enabled an integrated therapeutic development platform that leverages state-of-the-art technologies to prevent disease outbreaks.	4.450	-	-
Accomplishments/Planned Programs Subtotals	104.150	141.081	169.198

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	365.033	333.029	397.266	-	397.266	453.711	510.600	539.845	559.063	-	-
IT-02: *HIGH PRODUCTIVITY, HIGH-PERFORMANCE RESPONSIVE ARCHITECTURES*	-	12.770	15.000	46.805	-	46.805	53.455	60.158	63.603	65.868	-	-
IT-03: *CYBER SECURITY*	-	220.380	167.459	185.714	-	185.714	212.101	238.695	252.367	261.351	-	-
IT-04: *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*	-	131.883	150.570	164.747	-	164.747	188.155	211.747	223.875	231.844	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Applied Research associated with the Information and Communications Technology Program that is directed toward the application of advanced, innovative computing systems and communications technologies. This PE also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA funded technologies take root in the U.S. and provide new capabilities for national defense.

The High Productivity, High-Performance Responsive Architectures project focuses on developing the computer hardware and associated software technologies required for future computationally- and data-intensive national security applications. Powerful new approaches are needed to manage the rapid growth in available sensor data, to leverage advances in machine learning, artificial intelligence, and quantum computing, and to maintain the security of DoD information systems. The project therefore aims not only to create new computing platforms to include quantum technology, but also to efficiently extract information out of large and chaotic data sets with embedded and low-size, weight, and power systems. Advances in these areas will allow for DoD electronic systems to collaboratively manage scarce resources, such as the electromagnetic spectrum, and to adapt to new requirements and situations. Further, the resulting technologies, by being accessible to a wide range of application developers, will support new, sustainable computing systems for a broad spectrum of scientific and engineering applications.

The Cyber Security project is developing the computing, networking, and cyber security technologies required to protect DoD, U.S. Government, and U.S. civilian information, information infrastructure, cyber-physical and embedded systems, critical infrastructure, and other computation-intensive mission-critical systems. Information technologies enable important existing and new military capabilities, and drive the productivity gains essential to U.S. industry. Meanwhile, cyber threats grow in sophistication and number, and put sensitive data, classified computer programs, mission-critical information systems, and U.S. economic competitiveness at risk. The technologies developed in this project will enhance the resilience of information systems to current and emerging cyber threats, enable broad situational awareness of the cyber domain, and provide the basis for accurate, calibrated, and safe cyber response.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*

The Artificial Intelligence and Human-Machine Symbiosis project develops technologies to enable machines to function not only as tools that facilitate human action, but also as trustworthy partners to human operators. Of particular interest are systems that can understand human language, extract information, and reliably categorize content contained in diverse media; answer questions, reach conclusions, and propose explanations; and learn, reason, and apply knowledge gained through experience to respond intelligently to new and unforeseen events. Enabling computing systems with such human-like intelligence is now of critical importance because the tempo of military operations in emerging domains exceeds that at which unaided humans can orient, understand, and act. The technologies developed in this project will enable warfighters to make better decisions in complex, time-critical, battlefield environments; intelligence analysts to make sense of massive, incomplete, and contradictory information; software developers and certifiers to design, implement, evaluate, and accredit cyber-physical systems and other complex software-reliant systems with greater efficiency and confidence; and unmanned systems and semi-autonomous agents to perform critical missions in contested physical and virtual environments safely and reliably.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	383.270	333.029	399.233	-	399.233
Current President's Budget	365.033	333.029	397.266	-	397.266
Total Adjustments	-18.237	0.000	-1.967	-	-1.967
• 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	-4.968	0.000			
• SBIR/STTR Transfer	-13.269	0.000			
• TotalOtherAdjustments	-	-	-1.967	-	-1.967

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer and reprogrammings.
FY 2024: N/A
FY 2025: Decrease reflects minor program repricing.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-02 / *HIGH PRODUCTIVITY, HIGH-PERFORMANCE RESPONSIVE ARCHITECTURES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
IT-02: *HIGH PRODUCTIVITY, HIGH-PERFORMANCE RESPONSIVE ARCHITECTURES*	-	12.770	15.000	46.805	-	46.805	53.455	60.158	63.603	65.868	-	-

A. Mission Description and Budget Item Justification

The High Productivity, High-Performance Responsive Architectures project focuses on developing the computer hardware and associated software technologies required for future computationally- and data-intensive national security applications. Powerful new approaches are needed to manage the rapid growth in available sensor data, to leverage advances in machine learning, artificial intelligence, and quantum computing, and to maintain the security of DoD information systems. The project therefore aims not only to create new computing platforms to include quantum technology, but also to efficiently extract information out of large and chaotic data sets with embedded and low-size, weight, and power systems. Advances in these areas will allow for DoD electronic systems to collaboratively manage scarce resources, such as the electromagnetic spectrum, and to adapt to new requirements and situations. Further, the resulting technologies, by being accessible to a wide range of application developers, will support new, sustainable computing systems for a broad spectrum of scientific and engineering applications.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Underexplored Systems for Utility-Scale Quantum Computing (US2QC)	12.770	15.000	46.805
Description: It has been credibly hypothesized - but not proven - that a fault-tolerant quantum computer of sufficient size would revolutionize multiple commercial industries and scientific disciplines. Quantum computers are shown to have transformative potential for critical problems facing the United States, it is in the Government's interest to foster and accelerate commercial progress towards a truly useful, "utility-scale" quantum computer. Initiated under Alternative Computing to both reduce strategic risk and realize transformative opportunity, the US2QC thrust will (1) evaluate disruptive designs for utility-scale, fault-tolerant quantum computers, specifically, systems that can be constructed in less than 10 years; (2) demonstrate each of the enabling sub-systems and components for these designs; and (3) construct a prototype fault-tolerant quantum computer that demonstrates that utility-scale design is viable. ***FY 2024 Plans:*** - Implement initial test and evaluation plans designed to verify and validate component and sub-systems required to achieve utility-scale quantum computing within a near-term timeframe. - Implement initial test and evaluation plans to verify and validate the quantum architecture underpinning a fault-tolerant quantum computer.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-02 / *HIGH PRODUCTIVITY, HIGH-PERFORMANCE RESPONSIVE ARCHITECTURES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Explore strategies for expanding the number of underexplored approaches to fault tolerant quantum computing that can be effectively evaluated by this effort. ***FY 2025 Plans:*** - Begin experimental verification and validation of components and sub-systems required to achieve utility-scale quantum computers within a near-term timeframe. - Begin evaluation of a scalable and fabricable design for a fault-tolerant prototype of a utility-scale quantum computer. - Develop key system performance metrics for prototype designs and initial specification targets for all components and subsystems. - Identify and procure long-lead hardware items needed to perform prototype research and development. - Evaluate an additional system engineering point design for building a fault-tolerant quantum computer. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from initial test plan implementation to full system evaluation.			
Accomplishments/Planned Programs Subtotals	12.770	15.000	46.805

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	Project (Number/Name) IT-03 / *CYBER SECURITY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
IT-03: *CYBER SECURITY*	-	220.380	167.459	185.714	-	185.714	212.101	238.695	252.367	261.351	-	-

A. Mission Description and Budget Item Justification

The Cyber Security project is developing the computing, networking, and cyber security technologies required to protect DoD, U.S. Government, and U.S. civilian information, information infrastructure, cyber-physical and embedded systems, critical infrastructure, and other computation-intensive mission-critical systems. Information technologies enable important existing and new military capabilities, and drive the productivity gains essential to U.S. industry. Meanwhile, cyber threats grow in sophistication and number, and put sensitive data, classified computer programs, mission-critical information systems, and U.S. economic competitiveness at risk. The technologies developed in this project will enhance the resilience of information systems to current and emerging cyber threats, enable broad situational awareness of the cyber domain, and provide the basis for accurate, calibrated, and safe cyber response.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Constellation	31.418	28.000	43.000
Description: The Constellation program is developing technologies, capabilities, and prototype systems to enable full spectrum military cyberspace operations to deter, disrupt, and defeat adversary cyber actors and to defend the U.S. Technologies of interest include but are not limited to artificial intelligence (AI), machine learning (ML), and data science (DS); resilient software, networking, and computing systems; data and information assurance; and cyber threat intelligence. The work achieves high relevance through close coordination with U.S. cyber operators and the use of development, security, and operations (DevSecOps) and other collaborative development processes. The work achieves high velocity through streamlined acquisition, assessment, approval, and deployment processes. Constellation development and deployment pipelines enable the rapid and continuous delivery of cyber technologies, capabilities, and prototype systems into operational use for the DoD. The Constellation program is funded in PE 0602303E, Project IT-03 and PE 0603760E, Project CCC-05 to facilitate rapid transition of cyber technologies and laboratory prototypes from applied research to operational prototypes.			
FY 2024 Plans: - Establish a working group with cyber operators from Commands and Services to prioritize cyber technologies and capabilities and initiate technology adaptation and maturation, and collaborative development of operational prototypes. - Coordinate with systems owners to understand the advantages of pipeline and continuous/incremental integration/delivery development models as a means to achieve rapid deployment to operations. - Develop a continuous integration/continuous development pipeline to achieve rapid deployment to operations through continuous authority to operate (cATO).			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct operational test, evaluation, and readiness assessments for operational prototypes in coordination with product owners and approval authorities. ***FY 2025 Plans:*** - Coordinate with cyber operators from Commands and Services to understand evolving needs, prioritize cyber technologies and capabilities, and accelerate technology adaptation and maturation, and collaborative development of operational prototypes. - Assess development pipeline and continuous/incremental integration/delivery processes as a means to achieve rapid deployment to operations. - Assess and refine the continuous integration/continuous development pipeline as a means to achieve rapid deployment to operations through continuous authority to operate (cATO). - Conduct operational test, evaluation, and readiness assessments for operational prototypes in coordination with product owners and approval authorities. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the expansion of efforts to mature, integrate, assess, and transition cyber technologies and laboratory prototypes from applied research to operational prototypes.			
Title: Cyber Agents for Security Testing and Learning Environments (CASTLE)	8.954	16.000	18.000
Description: The Cyber Agents for Security Testing and Learning Environments (CASTLE) program is developing an Artificial Intelligence (AI) toolkit to instantiate realistic network environments and train AI cyber agents to enable resilient network operations against advanced persistent threats (APTs). CASTLE formulates network hardening as a reinforcement learning (RL) problem and teaches RL agents to operate through the post-breach behavior of widely available penetration testing tools. Over progressive rounds of attack and defense, agents explore defensive actions to proactively stop on-going attacks while maintaining operationally relevant workflows. Environments execute agents inside instrumented subnets that are deployed to live networks and will simulate defensive actions that counter APT tools. Agent execution will produce calibrated datasets for progressively improving simulations. The defensive AI cyber agents developed under CASTLE will provide the DoD with continual security assessments of critical networks and real-time response to cyber attacks. ***FY 2024 Plans:*** - Develop approaches for AI cyber agents to devise defensive measures against cyber attacks. - Develop a simulation and execution environment for evaluating cyber agent decision-making and performance. - Develop a library of APT test cases for quantifying cyber agent learning rates, effectiveness, and overhead in realistic DoD network environments. ***FY 2025 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop techniques for the automated instantiation of multiple cyber agent training environments for evaluating cyber agent decision-making and performance. - Perform an integrated demonstration of multiple agents defending a realistic network environment. - Extend library of APT test cases and include additional post-breach behaviors as observed in the real-world. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects continued development of reinforcement learning based defensive cyber agents and additional efforts to evaluate their performance.			
Title: Signature Management using Operational Knowledge and Environments (SMOKE) ***Description:*** The Signature Management using Operational Knowledge and Environments (SMOKE) program is developing signature management technologies that generate evasive cyber infrastructure which minimizes signatures as a source of attribution. SMOKE technologies incorporate counter-attribution techniques into the design process; quantitatively measure attribution risk in real-time; and maintain evasiveness after infrastructure changes. SMOKE data-driven tools will automate the planning and execution of threat emulated cyber infrastructure needed for network security assessments by red teams. SMOKE data-driven tools will automate the discovery of cyber threat infrastructure signatures. If successful, SMOKE prototypes will enable red teams to plan, build, and deploy cyber infrastructure that is informed by machine-readable signatures of sophisticated cyber threats. ***FY 2024 Plans:*** - Extend cyber planning and generation tools to recommend and execute red team cyber operations plans with contingencies based on real-time attribution risk assessments. - Develop techniques for collecting red team cyber infrastructure emissions and generating attribution risk assessments. - Evaluate red team cyber operations planning and generation capabilities in collaboration with potential transition partners. - Perform integrated demonstrations and initial evaluations of red team capabilities in collaboration with potential transition partners. ***FY 2025 Plans:*** - Develop a fully integrated cyber planning, provisioning, and risk management system that can automatically generate risk-informed cyber infrastructure through real-time, continual attribution assessments. - Integrate cyber planning, generation, and risk management tools with DoD's cyber warfighting architecture and programs of record. - Conduct live demonstrations during DoD cyber exercises to evaluate cyber planning, generation, and risk management tools in collaboration with transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:***	21.060	22.000	14.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects emphasis shifting from development of signature management technologies to demonstration and performance evaluation in collaboration with transition partners.			
Title: Hardening Development Toolchains Against Emergent Execution Engines (HARDEN)	15.986	15.500	13.000
Description: The Hardening Development Toolchains Against Emergent Execution Engines (HARDEN) program is developing techniques and tools to anticipate, isolate, and mitigate emergent system behaviors and thereby improve security of complex integrated software. Today's software development toolchains and testing methodologies provide very limited means for reasoning about adversarial reuse of code as written and designed. This limitation results in unwitting creation of stable, reliable patterns of emergent behaviors within systems that adversaries can reuse in attacks. The HARDEN approach to preventing adversarial code reuse is to create techniques, tools, metadata, and instrumentation for reasoning about emergent execution at all stages of the software development life cycle (SDLC), and for flagging code segments and design patterns where there is high potential for adversarial reuse and emergent execution. To assess their utility, HARDEN technologies will be applied to critical system elements such as bootloaders and to integrated software systems. If successful, the technologies developed by HARDEN will facilitate efficient mitigation of complex code-reuse and emergent-execution vulnerabilities at early SDLC stages, and provide the stronger roots-of-trust required by zero-trust architectures and high-assurance integrated military software systems. ***FY 2024 Plans:*** - Refine tools involving formal methods and hardware inference engines for reasoning about emergent behaviors and mitigating against exploit programming to scale from component-level analysis to subsystems. - Formalize description languages to construct models of emergent execution including operational exploits and to facilitate usage by coders who are not formal modeling experts. - Establish an initial development, security, and operations-enabled infrastructure and associated workflow to enable integration and facilitate flow from modeling to tooling. - Perform initial evaluation of the effectiveness and accuracy of tools, employing methods such as white-box testing and reverse engineering. ***FY 2025 Plans:*** - Automate reasoning over models of emergent execution and evaluate their composability at various data granularities for both source code and binaries. - Integrate emergent computation discovery with standard build chains and integrated development environments to provide developer feedback. - Assess the scalability of tools to capture emergent properties and behaviors in complex interactions between multiple layers of abstraction within a subsystem.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate the reliability and evaluate the effectiveness of mitigations against unintended system behaviors to reduce military mission risk. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects ramping down of development of tools and continued efforts to demonstrate and evaluate the effectiveness of the tools in mitigating emergent-execution vulnerabilities.			
Title: Verified Security and Performance Enhancement of Large Legacy Software (V-SPELLS)	19.703	15.400	11.000
Description: The Verified Security and Performance Enhancement of Large Legacy Software (V-SPELLS) program is creating methods and tools to recover succinct models of domain data abstractions and logic from source code, add enhancements to the models, and convert them to performant new component implementations verified to be compatible and secure. DoD has a critical need for replacing or reworking components of existing software with more secure and more performant code, including cases where a key performance or security benefit comes from moving parts of the software to new hardware, such as utilizing hardware accelerators, isolation enclaves, offload processors, and distributed computation. However, at present, enhancing legacy software components faces high risk that the new software will not be fully compatible with the existing larger environment. Moreover, verified software is currently written from scratch, starting with a formal specification, rather than incrementally added to a system as provably compatible enhancements. V-SPELLS will address these problems by combining novel concepts in verified programming with recent developments in domain specific languages (DSLs) and systems architecture. V-SPELLS aims to enable piecewise, compatible-by-construction improvement of software components in legacy DoD systems, providing incremental software (re)engineering the benefits of formal software verification currently available only to clean-slate development efforts. ***FY 2024 Plans:*** - Extend user interface to enable understanding of specifications most relevant to component domains and most useful for verification goals. - Develop additional analysis and synthesis tools to increase the percentage of legacy code that can be enhanced. - Develop connections between component interface models and architectural modeling tools to facilitate adoption by developers. - Demonstrate the enhancement of software components for a legacy platform representative of DoD needs. ***FY 2025 Plans:*** - Produce a tool for automated hardware interface exploration of large distributed systems. - Complete development of all analysis and synthesis tools to achieve full coverage of legacy code and demonstrate complete component replacement in a large distributed system. - Integrate tools into a military transition partner platform. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects ramping down of development of technologies and tools for updating legacy code and focus shifting to demonstration and transition of tools to a military partner.			
Title: Business Process Logic (BPL)	-	10.000	19.700
Description: The Business Process Logic (BPL) program, addressing issues identified in the Resilient Supply-and-Demand Networks program (budgeted in PE 0602702E, Project TT-13), will develop techniques to characterize and resolve vulnerabilities in business logic systems to protect and assure defense-critical workflows for government and business. Automated workflows written in business logic (BL) control much of the world's enterprises, from administration and operation of seaports to the assembly of weapons systems. Losses due to BL faults and vulnerabilities can range from annoyances to business-threatening outcomes, and so it is important to identify and correct potentially problematic logic issues such as one-way actions or lost resources as early as possible. The BPL program will develop tools to extract workflow representations from BL and use those representations to automatically identify, characterize, and mitigate faults and vulnerabilities in BL scripts and templates. The technologies developed by BPL will enable increased assurance for manufacturing and assembly and greater efficiency for logistics and supply chain management. ***FY 2024 Plans:*** - Formulate machine-processable representations for BL systems that can be generated by ingest of design artifacts and associated documentation. - Explore automated approaches for reasoning across BL representations to characterize faults, trace faults across component interdependencies, and provide mitigations that do not introduce new faults. - Initiate development of a test environment for evaluating the performance of techniques developed for BL representation, analysis, and assurance on representative Defense Industrial Base (DIB) workflows and major BL platforms. ***FY 2025 Plans:*** - Implement machine-processable representations for BL systems and ingest design artifacts and associated documentation. - Demonstrate automated reasoning using BL representations that identifies and characterizes BL faults, traces faults across component interdependencies, and provides mitigations. - Evaluate the performance of techniques developed for BL representation, analysis, and assurance on representative DIB workflows and major BL platforms. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects continued work to develop techniques and tools to characterize and resolve vulnerabilities in business logic systems and additional efforts to evaluate performance of techniques on workflows of importance to the DoD.			
Title: Intelligent Generation of Tools for Security (INGOTS)*	-	9.000	15.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: *Formerly Automated Assessment of Vulnerabilities (AAV) The Intelligent Generation of Tools for Security (INGOTS) program will develop techniques to identify and triage chainable vulnerabilities within widely used secure computing platforms and assess exploitability. Today, sophisticated cyber attacks link multiple vulnerabilities together into exploit chains that bypass software and hardware security measures to compromise critical, high-value systems. Accurately understanding risk is critical for both developers and defenders within cyberspace, but the metrics currently in use do not account for the multiple factors which differentiate an innocuous software flaw from a chainable vulnerability. INGOTS will develop semi-automated tools and techniques to characterize and measure the interdependent exploitability of vulnerabilities and will pioneer a new vulnerability severity metrology that characterizes and measures interdependent exploitability for the next generation of security vulnerabilities. INGOTS will also develop datasets capturing artifacts and features of vulnerabilities and exploits to further drive program analysis and artificial intelligence (AI) approaches for rapid risk assessment. With the INGOTS vulnerability measurement pipeline, developers and defenders will improve software and hardware resiliency of pervasive commercial systems by rapidly identifying and prioritizing their most dangerous flaws. The INGOTS program is also funded in PE 0602716E, Project ELT-02. ***FY 2024 Plans:*** - Formulate approaches to characterize and measure the interdependent exploitability of vulnerabilities as the basis for a new vulnerability severity metrology. - Develop techniques to accurately quantify the severity of a vulnerability chain in software systems that have state-of-the-art defenses. - Explore and prioritize demonstrations of severity analysis on vulnerabilities of interest to transition partners. ***FY 2025 Plans:*** - Develop and demonstrate techniques to characterize and measure the interdependent exploitability of vulnerabilities in complex software systems. - Quantify the accuracy of vulnerability severity assessment for complex software systems that have state-of-the-art defenses. - Demonstrate the capability to identify and prioritize vulnerabilities in software of interest to transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects ramping up of development of techniques to identify and triage chainable vulnerabilities and initial demonstrations of the chainable vulnerability discovery capability.			
Title: Enhanced SBOM for Optimized Software Sustainment (E-BOSS)*	-	6.000	8.014
Description: *Formerly Securing the Software Supply Chain			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The Enhanced SBOM for Optimized Software Sustainment (E-BOSS) program will create enhanced software bill of materials (eSBOM) technologies with new types of rich metadata and develop cyber reasoning algorithms and tools that leverage eSBOMs to defend against potential flaws during the software development process, as well as to triage and remediate flaws found in operation. The global impacts of flawed software deployed at scale (such as the Log4Shell vulnerability found in Log4j cloud and web app deployments, where mitigations took from one week to months, and are not yet completed for a large percentage of systems) motivated the new SBOM requirements in Executive Order 14028. However, standard SBOMs alone cannot enable identification and mitigation of the flow of hostile data to the flaws in the code. E-BOSS will develop software technologies integrated with modern software build chains to enable rapid triage and remediation of vulnerabilities at the scale of national computing infrastructure. The enhanced metadata incorporated in the enhanced eSBOMs will enable trace back of discovered flaw evidence, starting from a crash and walking back through complex inter-component interactions, transfers, and transformations to derive the vulnerability triggers. If successful, E-BOSS technologies will enable cyber-reasoning for improved remediation and sustainment of large scale software systems. The E-BOSS program is funded in PE 0602303E, Project IT-03 and PE 0601101E, Project CCS-02. ***FY 2024 Plans:*** - Formulate enhanced software bill of materials (eSBOM) formats that incorporate new types of rich metadata and initiate development of cyber reasoning algorithms that utilize the information in eSBOMs. - Conceptualize approaches for trace back of discovered flaws, starting from a crash and walking back through complex inter-component interactions, transfers, and transformations to derive the triggers and to identify what and where to apply fixes. ***FY 2025 Plans:*** - Develop eSBOMs with new types of metadata that provide fine-grained data about control and data flows and inter-component interactions and cyber reasoning algorithms and tools that leverage eSBOMs to defend against potential flaws during software development. - Develop algorithms in modern build chains and compiler extensions for unifying program analysis techniques and cyber reasoning tools to enable rapid remediation of vulnerabilities at scale and greater efficiency in software sustainment. - Establish a concept of operations (CONOPS) and design use cases that are relevant to both open source communities as well as to DoD software factories and initiate development of a test and evaluation range architecture extensible to millions of simulated nodes. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects ramping up of development of enhanced SBOM technologies and of use cases and a test range to demonstrate and evaluate security and sustainment benefits on large scale software systems.			
Title: Making and Maintaining in Cyber Security	-	-	24.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: Studies conducted under this thrust aim to create and sustain material and cyber capabilities to secure the defense and civilian digital ecosystems. Mathematically based software development techniques, commonly referred to as formal methods, will be created to enable the development and sustainment of provably secure software for civilian and military information systems, cyber-physical and embedded systems, critical infrastructure, and other computation-intensive mission-critical systems. There is a strong interest in tech refresh of legacy software systems through the use of domain-specific and memory-safe languages. Artificial intelligence (AI) and machine learning (ML) will be developed and applied to enhance cyber security and achieve greater operational resilience through cyber monitors and agents that can detect and characterize cyber threats, engage cyber adversaries, prioritize operationally important workflows, maintain essential services, and complete critical missions. ***FY 2025 Plans:*** - Initiate large language model (LLM)-based techniques to automatically rewrite C/C++ code to memory-safe Rust. - Initiate cyber defense techniques for use internal to clouds, including zero-trust techniques to limit damage by adversaries. - Initiate modular development platforms for rapid prototyping and experimentation of integrated hardware-software devices. - Initiate techniques for computer system components to collectively monitor peer components for infection. - Initiate innovative contracting and business processes to enable rapid transition of capabilities. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Pipelined Reasoning of Verifiers Enabling Robust Systems (PROVERS)	-	-	20.000
Description: The Pipelined Reasoning of Verifiers Enabling Robust Systems (PROVERS) program will create scalable mathematically based technologies, tools, and practices to achieve continuous reasoning about complex systems that can support software development pipelines. These mathematically based techniques, or formal methods, enable rigorous modeling, reasoning, and proving diverse properties of software code or design models, for example, the absence of a specific type of defect or security vulnerability. PROVERS integrates formal methods into a modern incremental and iterative development process by running tools at each code commit and delivering results to developers when they can most effectively remediate discovered issues. To achieve this, PROVERS will focus on creating and sustaining a body of evidence that can co-evolve with the system under change to support continuous assessment and ensure that the system remains free of identified categories of defects and security vulnerabilities through its lifetime. Key PROVERS objectives include enabling proof maintenance and repair capabilities at a cost that is proportionate to code change; integration of formal methods with code, properties, and proofs in a single workflow that reduces human involvement; providing improved explanations to facilitate proof repair; and automating formal methods-based software analysis to support software developers that are not formal methods experts. PROVERS technologies will facilitate the agile development and continuous improvement of mission-critical software systems that meet the high security and quality standards required by the DoD. Basic research for this program is funded in PE 0601101E, Project CCS-02.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2025 Plans: - Create advanced techniques for proof engineering, including knowledge, methods, and tools, that are readily accessible to software engineers. - Design proof-friendly software development systems that facilitate the formal verification of a broad range of system properties in a single workflow that reduces human involvement. - Formulate quantitative models to establish that proof maintenance and repair capabilities are provided at a cost that is proportionate to code change. - Perform security assessments of developed codes for high-assurance systems. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the initiation of applied research to develop, demonstrate, and evaluate scalable techniques and formal methods to enable continuous reasoning about complex systems that can support software development pipelines.			
Title: Open, Programmable, Secure 5G (OPS-5G)	20.791	18.500	-
Description: The Open, Programmable, Secure 5G (OPS-5G) program is developing open source, 5G network software that ensures security and stimulates innovation in mobile wireless hardware. Current trends in mobile wireless technology development are unfavorable in that the U.S. and allies are increasingly dependent on proprietary technologies offered by foreign suppliers. OPS-5G will develop standards-compliant software for 5G mobile wireless networks that is open source, programmable, and secure by design. The availability of open-source software for 5G will have the additional benefit of opening the mobile wireless hardware market to new participants, stimulating innovation and competition. The OPS-5G program aims to move the mobile wireless market off its current model of opaque, proprietary, and vertically-integrated technology provided by a small number of dominant vendors to a more robust model with increased transparency and open-source technology created by a diverse ecosystem of academic and commercial software and hardware developers. OPS-5G is coordinating with existing open-source 5G efforts and U.S. Government, DoD, and industry stakeholders. ***FY 2024 Plans:*** - Extend security architectures capable of defending Internet of Things (IoT)-class devices while minimizing power requirements. - Incorporate formally verified code in programmable switches to augment the security of network defenses. - Develop an operationally relevant network stack and demonstrate secure 5G core networking at DoD installations for multiple use cases. - Deploy technologies in commercially available user equipment and a U.S. mobile network operator. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects program completion.			
Title: Program Analysis for Capability Excellence (PACE)	17.465	8.500	-
Description: The Program Analysis for Capability Excellence (PACE) program is developing tools and techniques to autonomously identify adversary compromise of software, mitigate negative effects of adversary capabilities, and restore the integrity of compromised software. PACE enables rapid, autonomous response to cyber attacks without using source code or requiring recompilation. ***FY 2024 Plans:*** - Demonstrate the versatility of the system by increasing the complexity of the software under attack and the sophistication of the simulated attacker and assess system performance against both automated adversaries and human experts. - Collaborate with transition partners to improve and further develop systems to identify and mitigate software compromise. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Assured Micropatching (AMP)	19.910	7.500	-
Description: The Assured Micropatching (AMP) program is developing technologies to enable the rapid production of targeted micropatches to repair legacy program binaries with strong guarantees. At present, the emergency patching of legacy software, even if all relevant information is available, creates too much uncertainty and takes far too long to validate, leaving critical systems with known flaws vulnerable to adversary attack. AMP is creating capabilities to analyze, modify, and fix legacy software in binary form even when the original source code and/or build process is not fully available. The AMP technical approach involves automatic discovery of known vulnerable components, goal-driven decompilation to isolate and analyze the vulnerable binary components, and minimal-change patching and recompilation to rebuild affected binaries with strong guarantees that the patch will not impair the functions of the system. The technologies developed by AMP aim to enable cyber defenders to quickly and accurately patch legacy binaries in the deployed software systems upon which the DoD depends. ***FY 2024 Plans:*** - Update micropatch positioning and verifiability adjustments for challenge platforms and patch types. - Demonstrate the automatic patching of vulnerabilities for additional use cases of interest to the DoD. - Conduct a challenge event of a networked system of electronic control modules interoperating over a standard data bus used in commercial vehicles, with appropriate test cases for the whole-system evaluation. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects program completion.			
Title: Fast Network Interface Cards (FastNICs) ***Description:*** The Fast Network Interface Cards (FastNICs) program is creating new networking technologies to accelerate the computation of distributed applications. Today's network and computing subsystems are badly out of balance with each other, a result of incremental technology advances in networking and computing market silos. This has produced a bottleneck at the network interface used to connect a machine to an external network, severely limiting the input/output capability. FastNICs will develop new input/output technologies based on more realistic models of complex multiprocessor compute, interconnect, and memory subsystems. FastNICs aims to enable a dramatic increase in computational throughput for distributed applications such as training of machine learning systems. ***FY 2024 Plans:*** - Extend machine learning algorithms to increase hardware utilization and reduce power consumption. - Demonstrate hybrid optical-electrical network interface and computation hardware to support machine learning. - Augment machine learning applications to operate over DoD and commercially available network topologies. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	12.187	5.999	-
Title: Securing Information for Encrypted Verification and Evaluation (SIEVE) ***Description:*** The Securing Information for Encrypted Verification and Evaluation (SIEVE) program is developing technology to enable the creation of mathematically verifiable public statements derived from sensitive information that remains hidden. To accomplish this, SIEVE will produce advances in a cryptographic technique known as zero knowledge (ZK) proofs, which simultaneously enable mathematical verification of public statements while provably hiding the sensitive information from which the statement is derived. The advances produced by SIEVE will make it possible and operationally feasible to verify statements substantially more complex than the current ZK state of the art supports, for example, statements about a software vulnerability that do not reveal details of how the vulnerability can be exploited. ***FY 2024 Plans:*** - Optimize ZK proof techniques and quantify the functionality, information leakage, and robustness to attack of ZK proof technology in collaboration with potential transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	19.902	5.060	-
Title: Resilient Anonymous Communication for Everyone (RACE)	8.800	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The Resilient Anonymous Communication for Everyone (RACE) program developed cryptographic and communication obfuscation technologies to enable anonymous, attack-resilient, mobile communications within a network environment. RACE developed a mobile communication application and distributed systems that provide a secure message-passing service by combining advances in distributed system tasking with communication protocol encapsulation methods. The RACE system maintained confidentiality, integrity, and availability of messaging while preventing large-scale compromise of the system. RACE security was based on rigorous security arguments or statistical arguments based on realistic simulations, and not on ad hoc estimates of security.			
Title: Memory Optimization (MemOp) ***Description:*** The Memory Optimization (MemOp) program developed technology to optimize memory transactions in large scale computing systems. The demand for computing services is growing within both the U.S. Government and commercial industry. In response, new technical approaches were developed to provide massive computation efficiently and cost effectively. In particular, distributed data centers with high-speed interconnects and customizable hardware, including graphics processing units (GPU) and field programmable gate arrays (FPGAs), are being used by service providers to achieve greater efficiency and improved processing performance. MemOp explored new memory architectures that more fully leverage emerging customizable hardware to deliver computing services reliably and at reduced cost. The more promising MemOp memory architectures were implemented and evaluated in hardware and software. The technologies developed in MemOp provide enhanced efficiency and improved performance for large scale computing systems.	7.007	-	-
Title: Cyber-Hunting at Scale (CHASE) ***Description:*** The Cyber-Hunting at Scale (CHASE) program developed data-driven tools for real-time cyber threat detection, characterization, and protection within enterprise-scale networks. U.S. computer networks are continually under attack, but at present there are few capabilities to efficiently extract and analyze the right data from the right device at the right time for DoD-scale information networks. For example, analysis of an in-memory exploit requires detailed data from a few devices, while analysis of a global botnet attack requires summary data from a great many devices. CHASE developed novel algorithms and analysis tools to dynamically collect data from across the network, actively hunt for advanced threats that evade routine security measures, and automatically disseminate protective measures that bolster the collective cyber defense posture.	6.450	-	-
Title: Searchlight ***Description:*** The Searchlight program developed technologies to ensure that quality-of-service (QoS) guarantees are met for distributed applications operating across the Internet. The increasing use of Internet-based distributed applications creates risks as surges in network use can result in resource shortfalls. Searchlight developed novel approaches for allocating inherently limited network resources to optimize the performance of distributed applications. Searchlight techniques and systems enabled	5.747	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-03 / *CYBER SECURITY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
organizations to adapt the QoS for their low-priority traffic resulting in improved QoS for their high-priority traffic without affecting traffic from other Internet users. Searchlight technologies will become increasingly important as 5G systems provide advanced capabilities for organizations to adapt their QoS guarantees.			
Title: Computers and Humans Exploring Software Security (CHESS) ***Description:*** The Computers and Humans Exploring Software Security (CHESS) program developed technologies to enable computers and humans to reason collaboratively over software artifacts, such as source code and compiled binaries, with the goal of finding vulnerabilities more rapidly and accurately than unaided human operators. CHESS envisioned a future in which high-intensity cyber operations are conducted by computer-human teams. CHESS capabilities were designed for use by humans of varying skill levels, even those with minimal previous cyber experience or relevant domain knowledge. Achieving the necessary scale and timelines in vulnerability discovery required innovative combinations of automated program analysis techniques with support for mixed-initiative computer-human collaboration. CHESS aimed to enable U.S. operational cyber superiority by combining human-generated insight into the vulnerability discovery process with the speed and scale of computational analysis.	5.000	-	-
Accomplishments/Planned Programs Subtotals	220.380	167.459	185.714

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	Project (Number/Name) IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
IT-04: *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*	-	131.883	150.570	164.747	-	164.747	188.155	211.747	223.875	231.844	-	-

A. Mission Description and Budget Item Justification

The Artificial Intelligence and Human-Machine Symbiosis project develops technologies to enable machines to function not only as tools that facilitate human action but also as trustworthy partners to human operators. Of particular interest are systems that can understand human language, extract information, and reliably categorize content contained in diverse media; answer questions, reach conclusions, and propose explanations; and learn, reason, and apply knowledge gained through experience to respond intelligently to new and unforeseen events. Enabling computing systems with such human-like intelligence is now of critical importance because the tempo of military operations in emerging domains exceeds that at which unaided humans can orient, understand, and act. The technologies developed in this project will enable warfighters to make better decisions in complex, time-critical, battlefield environments; intelligence analysts to make sense of massive, incomplete, and contradictory information; software developers and certifiers to design, implement, evaluate, and accredit cyber-physical systems and other complex software-reliant systems with greater efficiency and confidence; and unmanned systems and semi-autonomous agents to perform critical missions in contested physical and virtual environments safely and reliably.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Assured Neuro Symbolic Learning and Reasoning (ANSR)	9.620	14.000	16.500
Description: The Assured Neuro Symbolic Learning and Reasoning (ANSR) program is developing new hybrid artificial intelligence (AI) algorithms that deeply integrate symbolic reasoning with data driven learning to create trustworthy AI-based systems. Here, an AI based system is considered trustworthy if it is: (a) robust to domain informed and adversarial perturbations, (b) supported by an assurance framework that creates and analyzes heterogenous evidence towards safety and risk assessments, and (c) predictable with respect to some specification and model of fitness. ANSR develops hybrid AI algorithms for which it is possible to develop evidence-based techniques that support confident assurance judgments. The key idea is to interleave symbolic and neural representations in hybrid AI algorithms that are capable of acquiring symbolic knowledge through learning and performing symbolic reasoning at scale to deliver robust inference, generalize to new situations, and provide evidence for assurance and trust. ANSR technologies will be demonstrated and evaluated on DoD use cases such as autonomy where trustworthiness is essential. ***FY 2024 Plans:*** - Develop and model new hybrid AI algorithms and architectures that deeply integrate symbolic reasoning with data driven machine learning. - Develop an assurance framework and methods for deriving and integrating evidence of correctness and adversarial scenarios for assessing the robustness of hybrid AI algorithms.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop initial use cases and an architecture for engineering and demonstrating mission relevant applications of hybrid AI algorithms. ***FY 2025 Plans:*** - Develop hybrid AI approaches that iteratively reason over symbolic and neural representations for perception, planning, and control to enable enhanced situational understanding, activity recognition, and safety in maneuvering. - Develop an assurance test harness with adversarial AI and evaluate the new hybrid algorithms and architectures. - Perform initial demonstration and evaluation of hybrid AI technologies and their composition in use cases of interest to the DoD. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects ramping up of development of techniques that integrate symbolic reasoning with data-driven machine learning and initiation of demonstration and evaluation on high priority use cases of interest to the DoD.			
Title: Accelerating Artificial Intelligence (AAI)	30.101	30.365	13.250
Description: The Accelerating Artificial Intelligence (AAI) program seeks to go beyond commercially-driven advances in artificial intelligence (AI) and to address important national security challenge applications. Trustworthy AI, which is AI that is safe, reliable, accurate, explainable, and resilient to attacks, is a major focus. Technical challenges include robustness of AI systems in novel, uncertain, and/or unanticipated situations; efficiency and timeliness of AI development, test, evaluation, approval, and certification processes; and identification of tasks or sub-tasks for which greater automation through the use of artificial intelligence/machine learning (AI/ML) is appropriate. Approaches to addressing these challenges will leverage recent advances in transfer learning, causal reasoning, reinforcement learning, generative AI, and large pre-trained models (LPTMs) and large language models (LLMs). If successful, AAI will significantly accelerate AI innovation in many important DoD domains while also reducing the time and cost needed to transition and deploy new AI technologies. ***FY 2024 Plans:*** - Refine methods for converting interview questions into stimuli that evoke preconscious neural and physiological responses. - Develop strategies to mitigate variables that confound the data collection process necessary for aggregating an individual's preconscious response to stimuli. - Develop digital twins representing diverse sets of human teammates for scalable modeling and quantitative assessment of human-AI interaction in realistic settings. - Establish and construct AI technologies, advance the state of the art in AI engineering, and create human-machine teaming approaches that support trustworthy AI for mission- and safety-critical domains. ***FY 2025 Plans:*** - Assemble data acquisition systems that synchronize physiological monitoring of both peripheral sensing (e.g., pupil, cardiac monitoring) and neural sensors (e.g., electroencephalogram).			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct initial real-time tests of machine learning/AI algorithm architectures for analyzing preconscious information evoked by behavioral health related stimuli. - Evaluate potential of using open-source, deidentified, health-related databases to reduce the need for personalized calibration data when training machine learning architectures for analyzing preconscious information evoked by behavioral health related stimuli. - Demonstrate AI technologies, engineering, and human-machine teaming approaches that enable trustworthy AI for mission- and safety-critical domains. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from heavy development of techniques and testing environments to demonstration and test execution.			
Title: Learning Introspective Control (LINC)	8.510	23.000	9.497
Description: The Learning Introspective Control (LINC) program is developing machine introspection and learning technologies to characterize a modified or damaged military platform from its behavior and update the control law to maintain stability and control. The current approach to handling platform modification or damage places the burden of recovery and control on the operator, whether the operator is human or an autonomous controller. In contrast, a platform equipped with LINC technology would continually compare the real-time behavior of the platform as measured by on-board sensors with a learned model, determine if the current observed behavior of the platform differs from that model in ways that might compromise stability and control, and implement an updated control law when required. The LINC capability would aid operators in maintaining effective control of military platforms that suffer damage in battle or have been modified in the field to address emergent requirements identified during operations. ***FY 2024 Plans:*** - Demonstrate computational efficiency of control reconstitution algorithms and establish suitability for integration in DoD systems that have limited spare computational resources. - Integrate machine introspection and learning algorithms on the testbed and make performance measurements to establish the feasibility of automated recovery and control of military platforms that suffer damage in battle or are modified in the field. - Using representative platforms, perform experiments that demonstrate recovery and control of cyber-physical systems for high-priority use cases in collaboration with transition partners. ***FY 2025 Plans:*** - Extend system modeling and control techniques to additional platform types. - Collect performance measurements from platform experiments and demonstrate the ability to maintain functionality in the presence of damage or malfunction, without pre-training or prior modeling.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct field experiments involving recovery and control of cyber-physical systems for high-priority use cases in collaboration with transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects shift from development and implementation of learning introspective control techniques to experimentation involving high-priority use cases in collaboration with transition partners.			
Title: Artificial Intelligence Cyber Challenge (AIxCC)	-	25.000	39.000
Description: The Artificial Intelligence Cyber Challenge (AIxCC) program, addressing issues encountered in the Program Analysis for Capability Excellence (PACE) program (budgeted in PE 0602303E, Project IT-03), seeks to develop and demonstrate techniques for automated discovery and remediation of software vulnerabilities at speed and at scale to secure widely used, critical code. Current automated vulnerability discovery and remediation tools are based on techniques such as fuzzing, logical reasoning, and genetic algorithms, but are limited in terms of effectiveness and user support. AIxCC will leverage recent dramatic advances in artificial intelligence (AI) and machine learning, such as large pre-trained models (LPTMs) and neurosymbolic AI, as the basis for new automated cyber security technologies and tools. AIxCC will use a contest model where teams will use their automation and tooling to complete vulnerability discovery and remediation challenges. Performer teams will be selected for the AIxCC competition based on their capability to leverage advances in AI to create usable, automated tools for vulnerability discovery and remediation, with a focus on tools suitable for broad deployment and applicable to critical infrastructure sectors. AIxCC competitors will train and develop their systems to find and fix vulnerabilities in widely-used open source software, focusing on software used in critical infrastructure. Each competitor system will be evaluated on real-world critical infrastructure software suites and will be scored based on their results both in terms of absolute performance and performance relative to other competitor systems. Winning teams will receive cash awards. If successful, AIxCC will create novel AI-enabled cyber vulnerability remediation technology and tools for securing code at the scale and speed needed to defend U.S. critical infrastructure from cyber attacks. ***FY 2024 Plans:*** - Formulate cyber competitions involving vulnerability discovery and remediation for open source software used in critical infrastructure. - Construct a distributed platform for conducting cyber competitions. - Devise scoring schemes that accurately reflect the effectiveness of automated AI-based vulnerability discovery and remediation systems when applied to the software used in critical infrastructure. - Conduct an initial AI-based vulnerability discovery and remediation cyber challenge focused on critical infrastructure software. ***FY 2025 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop more advanced cyber competitions involving AI-based vulnerability discovery and remediation for software used in critical infrastructure. - Expand the platform for conducting cyber competitions. - Refine scoring schemes to more accurately reflect the effectiveness of automated AI-based vulnerability discovery and remediation systems when applied to the software used in critical infrastructure. - Conduct a final AI-based vulnerability discovery and remediation cyber competition focused on critical infrastructure software. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects continued development of automated AI-based vulnerability discovery and remediation techniques and increased efforts to evaluate the technology on critical infrastructure software.			
Title: Open Price Exploration for National security (OPEN)	-	16.000	30.000
Description: The Open Price Exploration for National security (OPEN) program aims to increase supply chain resilience and enable more efficient critical mineral markets by leveraging advances in artificial intelligence (AI) prediction and forecasting to increase price, supply, and demand transparency. Based on concepts developed in the LogX Program (budgeted in PE 0603760E, Project CCC-02), OPEN will construct structural price predictions from fundamental and observable critical mineral input costs and increase the accuracy and precision of supply and demand forecasts by leveraging this structural price in conjunction with advances in AI and economic modeling. Today, critical mineral markets and supply chains are vulnerable. International supply shocks can lead to large and rapid critical mineral price spikes with immediate economic ramifications, and commodities purchase transactions (e.g., offtake agreements) are negotiated leveraging a mix of opaque and flawed pricing data. OPEN will leverage a decomposition of a critical mineral price into four components (input costs, supply/demand shocks, distortions due to noncompetitive behavior, and stochastic fluctuation) to construct transparent estimations of an approximate marginal cost for critical minerals indexed by time and geographic location, and will estimate supply and demand forecasts for critical minerals that take into account geopolitical factors, energy fluctuations, and technological innovations in recycling and supply chain management. Technology developed under this program will transition to the Services and commercial partners. ***FY 2024 Plans:*** - Develop data engineering framework for acquisition, aggregation, fusion, and provision of data. - Select initial critical minerals. - Construct structural price prediction models. - Construct supply and demand forecasting models. ***FY 2025 Plans:*** - Expand scope of critical minerals. - Evaluate models to assess operational relevance to transition partners.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Update and improve performance of structural price prediction models. - Update and improve performance of supply and demand forecasting models. - Explore extension of model architecture to additional classes of materials. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from initial development to testing and updating models.			
Title: Transfer from Imprecise and Abstract Models to Autonomous Technologies (TIAMAT)*	-	10.000	17.000
Description: *Formerly Learning Autonomy in Synthetic Environments (LASE) The Transfer from Imprecise and Abstract Models to Autonomous Technologies (TIAMAT) program will develop techniques to robustly transfer learned autonomy from fast abstract simulations to autonomous platforms in real-world environments. The autonomy levels of unmanned systems of today are limited because the modeling and simulation (M&S) training environments do not account for the data domain shift common when translating M&S outcomes to the real world - this phenomenon is sometimes referred to as the sim2real gap. The TIAMAT approach will integrate symbolic structures with neural structures to more realistically and robustly transfer learned autonomy. TIAMAT will enable the use of fast abstract simulations by anchoring the learning and transfer of autonomy on semantically consistent components shared across simulations and real environments, so-called "semantic anchors". For TIAMAT, semantic anchors of particular importance include those militarily-relevant phenomena that remain consistent in the source and target environments, for example, mission objectives, special instructions, subject matter expert guidance, rules of engagement, and the laws of physics. Autonomy transfer using semantic anchors will reduce the complexity of the autonomy learning and transfer problems to the comparatively simpler points of reference in the anchored representation. If successful, TIAMAT transfer of M&S-based learning will enable more rapid and robust training and deployment of autonomous systems at higher levels of autonomy. ***FY 2024 Plans:*** - Identify universal features of neural perception and symbolic reasoning for sequential decision-making tasks in reinforcement learning. - Formulate approaches for integrating symbolic and neural structures for autonomous systems with higher levels of autonomy. - Develop use cases and a testbed architecture for evaluating performance of transfer learning of autonomy using semantic anchors. ***FY 2025 Plans:*** - Develop a framework for assessing the robustness to the sim2real gap of autonomy transfer from fast, abstract simulations that are available or can be quickly or automatically developed for a given use case. - Develop techniques to leverage semantic anchors for use in a rapid, robust, autonomy transfer learning system.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate an initial capability to transfer autonomy from readily available or quickly developed abstract simulations to live platforms for scenarios of interest to military operators and potential transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects ramping up of development of techniques to robustly transfer learned autonomy from fast abstract simulations to autonomous platforms for scenarios of interest to military operators and potential transition partners.			
Title: Access in AI and Human-Machine Symbiosis ***Description:*** Studies conducted under this thrust aim to advance core artificial intelligence (AI), human-machine symbiosis (HMS), and machine learning (ML) technologies that ensure physical or virtual presence where and when necessary to provide knowledge and/or achieve desired effects. Primary considerations include the safety, trustworthiness, and security of AI/HMS/ML as an adjunct to human operators and analysts. The potential for AI/HMS/ML systems to leak sensitive/classified training data is of concern, particularly for large language models and large pre-trained models (LPTMs). Another focus involves the human-AI interaction, including techniques to ensure that the human correctly understands the output from the AI/HMS/ML system. This thrust addresses the current limitations of AI/HMS/ML-based technologies to enable implementation in mission-critical information systems suitable for military use. ***FY 2025 Plans:*** - Initiate development of chatbots capable of realistic and positive dialog. - Initiate designs for LPTMs supplemented with legal sources to propose legal actions to deter adversaries. - Initiate exploration of mechanisms to enable rapid transition of intelligence capabilities. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	13.000
Title: Making and Maintaining in AI and Human-Machine Symbiosis ***Description:*** Studies conducted under this thrust aim to develop artificial intelligence (AI), human-machine symbiosis (HMS), and machine learning (ML) technologies to facilitate the creation and sustainment of physical and cyber capabilities. AI/HMS/ML-based abstractions, patterns, architectures, assurance techniques, and iterative processes are developed to facilitate the creation and sustainment of complex systems that must rely on AI-based components and associated training data. The capability to engineer AI/HMS/ML systems that meet the safety, trustworthiness, integrity, and security requirements for mission-critical applications will provide great benefit to the DoD and commercial industry. ***FY 2025 Plans:*** - Initiate exploration of approaches for assuring the integrity of large language models and large pre-trained models (LPTMs). - Initiate development of user protection layers to enable safe and secure mixed reality systems.	-	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Initiate development of negotiation chatbots to enable rapid, iterative, and comprehensive wargaming of complex scenarios. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** FY 2025 increase reflects program initiation.			
Title: Awareness in AI and Human-Machine Symbiosis ***Description:*** The changing landscape of R&D development with renewed great power competition and increased commercial investment means that the DoD must maintain awareness of rapidly changing technology areas in fundamentally different ways. Artificial intelligence (AI) enabled systems permeate everyday life, and commercial AI development is advancing rapidly. Therefore, DoD must maintain awareness of the implications and opportunities of these technologies for defense and National Security applications, broadly defined to include how societal changes may affect adversary approaches to competition. DoD must also understand which unique defense and military needs will not be well supported by commercial AI development. For instance, the novelty and unique contextual situations military systems are required to operate in are not well represented in current commercial training data sets, making it highly unlikely that the way industry is approaching the problem will result in AI that adequately addresses defense applications. Focus areas include new approaches for empowering AI and AI-enabled systems to adapt to varied environments, and for enabling AI reasoning. ***FY 2025 Plans:*** - Investigate the potential of AI language processing to enable abstract reasoning. - Initiate the development of capabilities for generalizable knowledge representation and reasoning. - Initiate development of techniques to enable transparent and logical communications between humans and AI models. - Initiate development of methods for computing attitudes of foreign populations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	9.500
Title: Warfighting Performance in AI and Human-Machine Symbiosis ***Description:*** Studies conducted under this thrust aim to ensure the operational reliability and effectiveness of human, physical, and cyber systems that incorporate artificial intelligence (AI), human-machine symbiosis (HMS), and machine learning (ML) technologies and capabilities. Future advances in AI/HMS/ML will require hybrid designs and learning processes that are influenced both by training data and by key concepts and features proposed by experts in the intended application domains. Such hybrid approaches provide robustness against adversarial attack and improve human alignment. AI/HMS/ML evaluation and assurance is an on-going challenge, and so new techniques, tools, and practices are developed for verifying and validating AI/HMS/ML-based systems that are capable, safe, secure, trustworthy, affordable, and timely, especially for large language models and large pre-trained models (LPTMs).	-	-	7.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2025 Plans: - Initiate multi-level security architectures, technologies, and concepts of operations (CONOPS) for LPTMs. - Initiate AI algorithms and LPTM architectures that can resist security challenges and mitigate attack consequences. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** FY 2025 increase reflects program initiation.			
Title: Automating Scientific Knowledge Extraction and Modeling (ASKEM)	13.130	19.000	-
Description: The Automating Scientific Knowledge Extraction and Modeling (ASKEM) program is developing technologies and tools for the agile creation, sustainment, and enhancement of complex models and simulators to enable knowledge extraction and data-informed decision making in diverse scientific domains and military missions. Current modeling and simulation pipelines do not maintain the relevant inputs, assumptions, and modeling choices made during development, while rapidly changing knowledge, semantically-opaque models, and black-box simulators make pipelined development nearly impossible. ASKEM enables a new paradigm for scientific modeling analogous to the transition in software development from the lengthy waterfall model to agile, continual Development and Operations (DevOps). ASKEM modeling automation tools 1) extract model components from documents and code while abstracting implementation details like math framework, language, and platform; 2) compose distinct model and simulator components; and 3) integrate all elements and processes in an extensible workbench that addresses the entire modeling and simulation lifecycle. ASKEM tools enable experts to maintain, reuse, and adapt large collections of heterogeneous data, knowledge, and models with traceability across knowledge sources, model assumptions, and model fitness and thereby bring agile, pipelined development to modeling and simulation. ASKEM technologies will be applied to multiple use cases to drive scalability and generality. ***FY 2024 Plans:*** - Establish baselines and measure technical component performance for accuracy, timeliness, maintainability, and scalability in selected evaluation domains. - Implement and test interfaces and components, develop human-machine interface, integrate workbench prototype, and validate technical component integration on papers-to-prediction tasks. - Evaluate utility of the integrated system by comparing performance of modelers working with and without the tools on multiple tasks. - Evaluate the workbench against diverse use cases across the modeling and simulation lifecycle in collaboration with transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects program completion.			
Title: Automated Rapid Certification Of Software (ARCOS)	17.930	8.200	-
Description: The Automated Rapid Certification Of Software (ARCOS) program is developing technologies that automate the capture and evaluation of software assurance evidence to enable certifiers to assess system risks earlier in the process and to commit to engineering decisions more rapidly and safely. Current software certification practices do not scale with the extent, complexity, and interconnection of software being developed by the DoD, so certification is becoming a bottleneck to new system deployment. ARCOS technologies address DoD software system certification time and cost. ARCOS technology will automatically and interactively generate strong assurance arguments that incorporate supporting evidence for certification criteria. ARCOS will also develop techniques to compose assurance arguments for pre-evaluated components into consolidated assurance arguments for new systems incorporating those components. ***FY 2024 Plans:*** - Demonstrate automated assurance case generation and composition to enable simultaneous evaluation of assurance criteria in multiple domains such as safety and security. - Demonstrate assurance-driven software development for a representative complex military system that requires high confidence software assurance. - Integrate and harden technologies for automated generation of assurance arguments for use by potential transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Assured Autonomy	5.150	5.005	-
Description: The Assured Autonomy program is developing rigorous design and analysis technologies for continual assurance of learning-enabled autonomous systems to enhance system safety in uncertain environments. Currently, the state of the art for test, evaluation, verification, and validation is only applicable to non-learning systems operating in well-characterized environments. As a result, autonomous systems enabled by machine learning (e.g., deep neural nets for perception, reinforcement learning for control policies, and online model learning) lack rigorous safety assurance. Assured Autonomy is developing new techniques for modeling and system design, formal verification, simulation-based testing, and safety-assured learning to provide continual assurance of learning-enabled autonomous systems. The technologies being developed in Assured Autonomy will enable the DoD to more rapidly and efficiently deploy learning-enabled autonomous systems that can be trusted to operate safely in uncertain environments. ***FY 2024 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Transition integrated toolchain and assurance tools to DoD partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Knowledge-directed Artificial Intelligence Reasoning Over Schemas (KAIROS) ***Description:*** The Knowledge-directed Artificial Intelligence (AI) Reasoning Over Schemas (KAIROS) program developed AI and machine learning technologies to aid a human operator in understanding complex sequences of events in the world. For the purposes of KAIROS, an event is an occurrence that results in an observable and recognizable change in either the physical world or human activity. Events of particular interest to KAIROS are those that create changes that have significant impact on national or homeland security. The KAIROS program developed automated systems that codify existing event-representation schemas and, when needed, create and codify new schemas to bring structure to complex event sequences and present these structured representations to operators. Given multimedia inputs, operators will use KAIROS technologies to identify subsidiary event elements, determine their temporal order, recognize complex event sequences, and link disparate events. KAIROS technologies aim to enable analysts and warfighters to understand unfolding events rapidly and accurately.	24.511	-	-
Title: Symbiotic Design ***Description:*** The Symbiotic Design program developed artificial intelligence-based approaches to augment human teams in the design of cyber-physical systems (CPS), and thereby significantly reduce time to deployment and improve the quality of deployed systems. The current generation of DoD systems and platforms integrate cyber and physical subsystems, but the capability of the engineering teams has not scaled with the enormous complexity of modern CPS. Engineering organizations require large teams of engineers that collectively possess the necessary domain knowledge (of component technologies, theories, and tools), but the prolonged timelines of the development process for modern CPS hinders DoD's ability to counter emerging threats. The Symbiotic Design program addressed this challenge by transforming the human-focused, model-based design flows used today into a symbiotic process of collaborative analysis by humans and continuously-learning artificial intelligence (AI)-based co-designers. The program created technologies essential for AI co-design: design space construction, design composition, and design space exploration. The program demonstrated the approach at realistic scales by a sequence of CPS design challenges of increasing complexity, and quantified the results with respect to development time, system performance, quality, and innovation metrics.	22.931	-	-
Accomplishments/Planned Programs Subtotals	131.883	150.570	164.747

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602303E / *INFORMATION & COMMUNICATIONS TECHNOLOGY*	**Project (Number/Name)** IT-04 / *ARTIFICIAL INTELLIGENCE AND HUMAN-MACHINE SYMBIOSIS*

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602383E / *BIOLOGICAL WARFARE DEFENSE*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	21.717	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
BW-01: *BIOLOGICAL WARFARE DEFENSE*	-	21.717	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

The Biological Warfare Defense project, budgeted in the Applied Research budget activity, focused on the underlying technologies associated with the detection, prevention, treatment and remediation of biological, chemical, and radionuclide threats.

Efforts to counter existing and emerging biological, chemical and radiological threats included countermeasures to stop the pathophysiologic processes that occur as a consequence of an attack, collection of environmental trace constituents to support chemical mapping, tactical and strategic biological, chemical, and radiological sensors, and integrated defense systems.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	23.059	0.000	0.000	-	0.000
Current President's Budget	21.717	0.000	0.000	-	0.000
Total Adjustments	-1.342	0.000	0.000	-	0.000
• 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	-0.742	0.000			
• SBIR/STTR Transfer	-0.600	0.000			

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer and reprogrammings.
FY 2024: N/A
FY 2025: N/A

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Defense Against Mass Terror Threats	21.717	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602383E / *BIOLOGICAL WARFARE DEFENSE*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The objective of the Defense Against Mass Terror Threats program was to identify and develop technologies that have the potential to significantly improve the United States' ability to reduce the risk of mass casualties in the wake of a Weapons of Mass Terror (WMT) attack. Challenges in reducing U.S. vulnerability to these attacks included developing new sensors and systems that afford early warning and opportunities to interdict these threats before they can be employed in urban areas and other population centers. A major goal of this program was to develop new sensors and sensing networks that can economically and reliably provide these wide-area monitoring capabilities for WMT threat signatures.			
Accomplishments/Planned Programs Subtotals	21.717	-	-

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	203.644	234.549	117.935	-	117.935	134.691	151.579	160.262	165.967	-	-
TT-03: *NAVAL WARFARE TECHNOLOGY*	-	31.957	7.759	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
TT-04: *ADVANCED LAND SYSTEMS TECHNOLOGY*	-	36.666	60.481	3.251	-	3.251	3.713	4.178	4.418	4.575	-	-
TT-07: *AERONAUTICS AND SPACE TECHNOLOGY*	-	57.602	74.675	71.996	-	71.996	82.225	92.535	97.835	101.318	-	-
TT-13: *INFORMATION ANALYTICS TECHNOLOGY*	-	77.419	91.634	42.688	-	42.688	48.753	54.866	58.009	60.074	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Applied Research associated with the Tactical Technology Program that supports the advancement of concepts and technologies to enhance the next generation of tactical systems. This PE funds a number of projects in the areas of Naval Warfare, Advanced Land Systems, Aeronautics and Space Technology and Information Analytics Technology. This PE also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA-funded technologies take root in the U.S. and provide new capabilities for national defense.

The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. Enabling and novel technologies include concepts for expanding the envelope of operational naval capabilities to include the entire sea column such as improved situational awareness over large maritime environments, ship self-defense techniques, novel underwater propulsion modalities, high speed underwater vessels, improved techniques for underwater object detection and discrimination, long endurance unmanned surface vehicles, methods and techniques for servicing assets throughout the sea column, and high bandwidth communications. This project will also examine methods and architectures for distributing maritime operations to enable a more agile, survivable, and cost-effective fleet.

The Advanced Land Systems Technology project is developing technologies for enhancing U.S. military effectiveness and survivability in operations ranging from traditional threats to military operations against irregular forces that can employ disruptive or catastrophic capabilities, or disrupt stabilization operations, including competing in underground spaces. Programs in this project will break the relative symmetry of land combat to give U.S. forces a decided advantage in the current and future ground battlefield. The emphasis is on developing affordable technologies that reduce reliance on consolidated forward-operating bases and required lines of communication, and provide small units and individual warfighters with hyper-mobility and hyper-lethality. This project will develop methods and technologies to expand the maneuver trade space to include the vertical dimension, including subterranean environments, as well as underground spaces. It will leverage advances in artificial intelligence to enable integrated manned-unmanned operations and decrease warfighter exposure through the use of autonomous agents.

Aeronautics and Space Technology efforts will address high payoff opportunities that dramatically reduce costs associated with advanced aeronautical and space systems and/or provide revolutionary new system capabilities for satisfying current and projected military mission requirements. This includes advanced technology

studies of revolutionary propulsion, vehicle, and launch concepts, sophisticated fabrication methods, and examination of novel materials and enabling technologies for aeronautics and space system applications. Studies that also fundamentally change the calculus of battle including consideration of a mix of assets, platforms that are potentially disposable or with limited lifespans, and autonomous integration of space and air platforms in the tactical battlespace are included.

The Information Analytics Technology project develops technology for analyzing data and information arising from: 1) intelligence networks; 2) open sources, social and broadcast media, and other external sources; 3) sensors and signal/image processors; and 4) collection platforms and weapon systems. Technical challenges include processing huge volumes of diverse, incomplete, and uncertain data in tactically-relevant timeframes, and countering the information operations of sophisticated adversaries who seek to deceive, degrade, deny, and disrupt the U.S. information enterprise. Benefits sought include a deeper understanding of the evolving operational environment tailored to the needs of commanders at every echelon; an enhanced capability to plan, monitor, and control diverse military operations ranging from stabilization and information operations to combat engagements; and increased efficiency of core military functions such as national and homeland security, warfighter health and readiness, and defense support of law enforcement and civil authorities.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	206.883	234.549	181.779	-	181.779
Current President's Budget	203.644	234.549	117.935	-	117.935
Total Adjustments	-3.239	0.000	-63.844	-	-63.844
• 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	3.681	0.000			
• SBIR/STTR Transfer	-6.920	0.000			
• TotalOtherAdjustments	-	-	-63.844	-	-63.844

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer offset by reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects completion of the Semantic Forensics (SemaFor) and Computational Cultural Understanding (CCU) programs, and a shift from field experimentation to final documentation in the Robotic Autonomy in Complex Environments with Resiliency (RACER) program.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-03 / *NAVAL WARFARE TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
TT-03: *NAVAL WARFARE TECHNOLOGY*	-	31.957	7.759	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. Enabling and novel technologies include concepts for expanding the envelope of operational naval capabilities to include the entire sea column such as improved situational awareness over large maritime environments, ship self-defense techniques, novel underwater propulsion modalities, high speed underwater vessels, improved techniques for underwater object detection and discrimination, long endurance unmanned surface vehicles, methods and techniques for servicing assets throughout the sea column, and high bandwidth communications. This project will also examine methods and architectures for distributing maritime operations to enable a more agile, survivable, and cost-effective fleet.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Advanced Maritime Defense Technologies Concepts	24.437	7.759	-
Description: The Advanced Maritime Defense Technologies Concepts program will explore novel technologies and concepts of operations to mature capabilities that extend freedom of access, operations, and homeland defense in all parts of the maritime domain, including waterways, arctic areas, and the seabed. The program will investigate and mature technologies necessary for unmanned underwater vehicle (UUV) and unmanned surface vessel (USV) concepts for autonomous operation and domain specific warfare. Enabling technologies for advanced undersea systems, including a revolutionary propulsion concept, and novel approaches for maritime platform and fixed location self-defense will be investigated. Novel technologies and concepts required for arctic and seabed operations, such as distributed sensing, navigation, and communications architectures, as well as including new technologies to enable long duration maritime platforms will also be investigated. Finally, future concepts, approaches, and techniques will be identified to enable contested environment operations utilizing unmanned maritime platforms. ***FY 2024 Plans:*** - Finalize conceptual evaluation of APEX for underwater vehicles. - Complete a conceptual study in cross-domain transitions for vehicles and weapon systems. - Complete development of an architecture to inform conceptual evaluation of defensive systems and sensors for fixed locations. - Conduct a conceptual study on USV autonomy evaluation planned to enable long duration emission-controlled operations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES)	7.520	-	-
Description: The Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES) program developed technologies for a point defense system against today's most stressing threats by developing a highly maneuverable, medium			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-03 / *NAVAL WARFARE TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
caliber, guided projectile, and fire sequencing and control system capable of neutralizing large threat raids of high speed, highly maneuverable targets. Leveraging recent advancements in gun hardening, miniaturization of guided munition components, and long-range sensors, MAD-FIRES advanced fire control technologies, medium caliber gun technologies, and guided projectile technologies enabling the multiple, simultaneous target, kinetic engagement mission at greatly reduced costs. MAD-FIRES achieved lethality overmatch through accuracy rather than size, thus expanding the role of smaller combat platforms into missions where they have been traditionally outgunned. MAD-FIRES, sized as a medium caliber system, enhanced flexibility for installment as a new ship self-defense system. This program is also funded in PE 0603766E, Project NET-02.			
Accomplishments/Planned Programs Subtotals	31.957	7.759	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
TT-04: *ADVANCED LAND SYSTEMS TECHNOLOGY*	-	36.666	60.481	3.251	-	3.251	3.713	4.178	4.418	4.575	-	-

A. Mission Description and Budget Item Justification

The Advanced Land Systems Technology project is developing technologies for enhancing U.S. military effectiveness and survivability in operations ranging from traditional threats to military operations against irregular forces that can employ disruptive or catastrophic capabilities, or disrupt stabilization operations, including competing in underground spaces. Programs in this project will break the relative symmetry of land combat to give U.S. forces a decided advantage in the current and future ground battlefield. The emphasis is on developing affordable technologies that reduce reliance on consolidated forward-operating bases and required lines of communication, and provide small units and individual warfighters with hyper-mobility and hyper-lethality. This project will develop methods and technologies to expand the maneuver trade space to include the vertical dimension, including subterranean environments, as well as underground spaces. It will leverage advances in artificial intelligence to enable integrated manned-unmanned operations and decrease warfighter exposure through the use of autonomous agents.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Robotic Autonomy in Complex Environments with Resiliency (RACER)	24.843	55.000	3.251
Description: Multi-domain operations (MDO) present complex and challenging environments to ground combat platforms. Ground combat platforms must operate in a more distributed manner in these environments to gain a sustained tactical advantage and enhance warfighter survivability. The Army intends to deploy autonomous robotic combat vehicles and optionally manned fighting vehicles to accomplish this objective. In order to meet the demands of an MDO environment, significant advances in perception, planning, and control algorithms are required to autonomously maneuver faster and more resiliently in complex and novel off-road situations. Maneuver environments are characterized by three-dimensional surfaces of highly compliant soils and vegetation, hundreds of positive and negative obstacle classes, no defined road networks or driving rules, and where use of terrain for survivability is critical. In order to achieve operationally relevant speeds and resilience to novel situations on the battlefield, while simultaneously reducing the soldier's cognitive and communications burden and increasing battle space awareness, Robotic Autonomy in Complex Environments with Resiliency (RACER) will develop and demonstrate game-changing autonomous ground combat vehicle mobility using a combination of simulation and advanced platforms. RACER will deliver autonomy algorithms using the latest in Artificial Intelligence (AI) and machine-learning techniques, a code repository, an off-road simulation environment tailored for military off-road autonomy development, tactical route planning methods, and field-demonstrated off-road autonomous capabilities. The culmination of the RACER program will demonstrate fully autonomous maneuver on a military Unmanned Ground Vehicle (UGV) in a variety of militarily relevant environments.			
FY 2024 Plans: - Continue Government-hosted field experiments in increasingly complex terrain and obstacle classes with combat vehicle scale autonomous system.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct alternative simulation environments resiliency testing of autonomy development. - Test tactically relevant route planner against simulated adversary force. - Curate autonomy data sets for use by service stakeholders. - Complete build of a large-scale demonstration platform fleet for demonstration with multiple teams. ***FY 2025 Plans:*** - Conduct final capstone Government-hosted field experiments with large-scale platform (combat vehicle scale) in environments that contain relevant complexity and obstacle classes. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the completion of experimentation and final documentation.			
Title: Advanced Ground Technologies Concepts ***Description:*** The Advanced Ground Technologies Concepts program aims to surmount key challenges associated with redefining access and timely delivery of effects to the ground domain by using targeted investments that explore the feasibility of novel technical solutions, force capabilities, innovations in logistics and manufacturing. In particular, program investments encompass technologies that promise breakthroughs in enabling actionable situational awareness across diverse environments, missionized autonomy for integration of manned-unmanned ground and air vehicle force; intelligent ground mobility systems; advanced military robotic systems; technologies expanding the effective ranges of surface-to-surface precision fires and in situ manufacturing of tactical munitions in mass to enable rapid response to quick developing conflicts while avoiding limitations of extended logistics chains. ***FY 2024 Plans:*** - Identify concepts and technologies to enable in situ digital manufacturing of tactical grade munitions. - Identify concepts and technologies that enable contested environments operations utilizing advanced ground autonomy, perception and decision making to enable single operators to command multiple platforms. - Mature framework for human-machine embodied decision making for enhanced situational awareness across environments. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	10.790	5.481	-
Title: Urban Reconnaissance through Supervised Autonomy (URSA) ***Description:*** The Urban Reconnaissance through Supervised Autonomy (URSA) program developed and demonstrated new autonomous agents and techniques that support a Blue Force Commander in managing the complexity and ambiguity of urban spaces by rapidly identifying and discriminating among potential threats during missions ranging from minutes to hours. The program used perception-enabled autonomous vehicles to manage complexity and interactions with populations to drive down	1.033	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
the ambiguity between peaceful civilians and threats. The program created a system of autonomous ground and air platforms operating in conjunction with U.S. ground forces that monitor an area overtly to detect hostile forces and establish Positive Identification (PID) before any U.S. troops come into contact. Military units follow strict rules of engagement (ROEs) that prescribe an escalation of force appropriate with the level of hostilities and confidence that an individual is engaged in nefarious behavior. This program established a Legal, Moral, Ethical (LME) working group comprising multiple experts (technologists, military, university professors, ethicists, legal experts) to engage in development of an ethical operations process (DevEthOps) to engineer Responsible Artificial Intelligence (RAI) principles into this supervised autonomous system. URSA explored scenarios and probed behaviors to enable identifying innocent civilians and individuals who pose a threat to U.S. Forces, allies, or non-combat civilians. This mission requires the integration and maturation of novel sensors, and unmanned ground and air vehicles which leverage current techniques in perspective and reactive autonomy to navigate cluttered urban environments. URSA developed new search and engagement behaviors to disambiguate human actions and serve as evidence that a potential target is a threat. It implemented new dimensions of evidence such as the human reactions to these engagements to improve confidence of operators in determining with high precision and low false positives who may pose a threat and who does not. While developed for Urban environments, other applications may include managing large populations of any kind to include supporting Military Police and detainee operations.			
Accomplishments/Planned Programs Subtotals	36.666	60.481	3.251

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-07 / *AERONAUTICS AND SPACE TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
TT-07: *AERONAUTICS AND SPACE TECHNOLOGY*	-	57.602	74.675	71.996	-	71.996	82.225	92.535	97.835	101.318	-	-

A. Mission Description and Budget Item Justification

Aeronautics and Space Technology efforts will address high payoff opportunities that dramatically reduce costs associated with advanced aeronautical and space systems and/or provide revolutionary new system capabilities for satisfying current and projected military mission requirements. This includes advanced technology studies of revolutionary propulsion, vehicle, and launch concepts, sophisticated fabrication methods, and examination of novel materials and enabling technologies for aeronautics and space system applications. Studies that also fundamentally change the calculus of battle including consideration of a mix of assets, platforms that are potentially disposable or with limited lifespans, and autonomous integration of space and air platforms in the tactical battlespace are included.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Oversight	23.800	30.500	28.618

Description: Oversight will develop and demonstrate a suite of autonomy technologies to provide constant custody of targets as a service for tactical operations in contested environments. Existing and emerging space systems will be evaluated. Proliferated Low Earth Orbit (p-LEO) satellite constellations and payloads will be leveraged due to their high-bandwidth, processing-on-the-edge capabilities in support of tactical, efficient, integrated missions at scale. Oversight will develop autonomous technology to enable advanced collaboration among constellations of satellites for target custody in contested environments where the numbers of targets is far greater than the number of satellites and sensors over the operating area. The Oversight program will culminate with a demonstration using existing on-orbit p-LEO assets combined with live, virtual and constructive terrestrial assets.

FY 2024 Plans:

- Continue development of necessary constant custody algorithms for software applications and services.
- Incorporate target scenarios, satellite constellation resources and ground resources into the government-owned modeling and simulation framework.
- Demonstrate capability of applications and services in a performer-provided laboratory environment.
- Evolve the applications from the modeling and simulation framework to incorporate target scenarios, satellite constellations resources and ground resources.
- Conduct demonstration of performer-developed suite of software applications and services running in the loop on representative space hardware in the government modeling and simulation environment to assess performance of constant custody of 100 targets.

FY 2025 Plans:

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-07 / *AERONAUTICS AND SPACE TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Deliver performer-developed suite of applications and services that will run in the government-owned modeling and simulation environment. - Demonstrate performer-developed software in the modeling and simulation environment. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from software development to delivery and demonstrations in the modeling and simulation environment.			
Title: Advanced Aeronautics and Space Technologies ***Description:*** The Advanced Aeronautics and Space Technologies program examines and evaluates aeronautical and space technologies and concepts through applied research. These may include feasibility studies of novel or emergent materials, sensors and tactics for air and space platforms, launch vehicles, satellites, manufacturing and implementation approaches, and hardware demonstrations of key enabling technologies. The areas of interest range from propulsion and power, guidance and control, concepts to enable novel air platforms, to innovative technologies and platform concepts to enable new missions and resilient operations for space systems, from low earth orbit to cislunar space. Aeronautics interest areas include hybrid electric/ combustion propulsion concepts, small-scale air mobility solutions, and networking of both piloted and unpiloted air vehicles. Space interest areas include advanced or novel power and propulsion systems, novel sensors, advanced lightweight structures, advanced miniature radio frequency (RF) technology, precision navigation and timing technologies, ground and space-based space domain awareness, avionics, structures, and novel approaches to support terrestrial operations. These studies may lead to the development of new programs, components or subsystems to enhance future aerospace platforms, or improvement of existing systems. ***FY 2024 Plans:*** - Identify concepts and technologies to provide improved resilience, survivability, and lethality in contested environments. - Perform laboratory demonstrations of novel technologies for early risk reduction and concept validation. ***FY 2025 Plans:*** - Explore updated and new architectures for aerospace vehicle concepts. - Improve ability of piloted and unpiloted vehicles to cooperate to enhance mission effectiveness.	33.802	10.000	10.000
Title: Persistent Optical Wireless Energy Relay (POWER) ***Description:*** The Persistent Optical Wireless Energy Relay (POWER) program will design, build, and demonstrate effective optical energy relays. These relays will enable a ground-based laser to efficiently transmit energy over 100s of kilometers leveraging a high-altitude transmission layer which minimizes atmospheric absorption and scattering. The high-altitude energy relay nodes will redirect, correct, and selectively harvest energy from the optical energy source and then beam that energy	-	29.175	33.378

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-07 / *AERONAUTICS AND SPACE TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
back down to the surface for conversion to electricity. These relays are the core building blocks to construct a flexible, resilient, reconfigurable, persistent, and distributed energy network. POWER will also produce conceptual designs for new platform capabilities realized by offboarding power storage and generation. These platforms will have range, endurance, and payload power performance that is no longer tied to platform size enabling a new class of small but high-performance platforms. ***FY 2024 Plans:*** - Complete airborne relay Conceptual Design Review (CoDR). - Initiate design and development of low power relays able to demonstrate beam redirect, wavefront correction, and energy harvesting to support risk reduction of high-power relay. - Validate propagation modeling based on low power relay testing. ***FY 2025 Plans:*** - Conduct Laboratory Demonstrations of key risk technologies. - Initiate manufacturing of relay system components. - Initiate detailed design of hardware and software systems, including both relay and aircraft interfaces. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from design, development and modeling activities to hardware procurement and component manufacturing.			
Title: Gambit ***Description:*** The Gambit program will study a Rotating Detonation Engine (RDE) propulsion system design that enables standoff strike of time-critical targets from 4th generation fighters at campaign scale. This will help pave a path to a flight test of a prototype system in a future program. ***FY 2024 Plans:*** - Conduct a study that explores the technology that may lead to the development of a design of an operational system. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	-	5.000	-
Accomplishments/Planned Programs Subtotals	57.602	74.675	71.996

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-07 / *AERONAUTICS AND SPACE TECHNOLOGY*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
TT-13: *INFORMATION ANALYTICS TECHNOLOGY*	-	77.419	91.634	42.688	-	42.688	48.753	54.866	58.009	60.074	-	-

A. Mission Description and Budget Item Justification

The Information Analytics Technology project develops technology for analyzing data and information arising from: 1) intelligence networks; 2) open sources, social and broadcast media, and other external sources; 3) sensors and signal/image processors; and 4) collection platforms and weapon systems. Technical challenges include processing huge volumes of diverse, incomplete, and uncertain data in tactically-relevant timeframes, and countering the information operations of sophisticated adversaries who seek to deceive, degrade, deny, and disrupt the U.S. information enterprise. Benefits sought include a deeper understanding of the evolving operational environment tailored to the needs of commanders at every echelon; an enhanced capability to plan, monitor, and control diverse military operations ranging from stabilization and information operations to combat engagements; and increased efficiency of core military functions such as national and homeland security, warfighter health and readiness, and defense support of law enforcement and civil authorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Influence Campaign Awareness and Sensemaking (INCAS)	15.000	20.600	11.688

Description: The Influence Campaign Awareness and Sensemaking (INCAS) program is developing analyst-guided techniques, tools, and platforms for the DoD to detect and understand geopolitical influence campaigns in a rigorous, quantitative manner. Increasingly, competitors and adversaries are using influence operations to project soft power. Competitor and adversary influence campaigns can be overt in the form of anti-U.S. messaging, or they can be disguised in the form of complex narratives that seek to advance agendas harmful to U.S. interests. The U.S. Government and DoD need the capability to rapidly detect and understand competitor and adversary messaging campaigns and narratives within the context of the populations and groups for whom they are intended. To accomplish this, the program will develop and operationalize natural language processing, social network analysis, psychographics, and behavioral science-based technologies, and integrate these into a unified influence campaign modeling framework and sensemaking platform. INCAS aims to produce a suite of automated digital tools to enable analysts to better understand how information is being used by competitors and adversaries, and to quantitatively assess in real time and at scale the effects of influence campaigns across time and over multiple platforms.

FY 2024 Plans:

- Extend multimedia analytics to discover influence indicators in video and other media and associate these indicators with population attributes.
- Develop analytics for assessing the threat, similarity, and confidence level of adversary influence campaigns based on multiple social media platforms.
- Extend datasets, human-machine interfaces, and workflows to quantify the effectiveness of influence campaign sensemaking and potential response strategies.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Provide technology to potential transition partners to enable military users to assess utility against adversary influence campaigns. ***FY 2025 Plans:*** - Refine multimedia analytics for influence indicator discovery and quantify the association with population attributes. - Expand variety and scope of influence indicators to include detection of coordinated messaging across platforms. - Refine system utility by increasing the accuracy of influence messaging detection and improving the interactive capabilities of the user interface. - Enhance technology in response to transition partner feedback and facilitate evaluation by military users against adversary influence campaigns. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects ramping down development of techniques to detect and characterize influence campaigns and focus shifting to evaluation and transition the techniques.			
Title: Beyond Linear Signal Processing (BLiP)	4.000	15.000	11.000
Description: The Beyond Linear Signal Processing (BLiP) program is performing a fundamental redevelopment of the radar signal processing chain with the intent that smaller radar apertures will operate with the performance of much larger, more expensive radar systems. Building upon earlier technology efforts, including the Arrays at Commercial Timescales (ACT) program (previously budgeted in PE 0602716E/Project ELT-01), which focused on hardware-based limitations such as bandwidth and dynamic range, BLiP is focusing on the software and signal processing to fundamentally enhance all radars. Multiple recent developments show that non-linear and iterative estimation algorithms can out-perform our current linear radar signal processing algorithms. BLiP is developing and maturing the algorithms for specific radar mission areas through rapid development, integration, real-time processing, and field testing. ***FY 2024 Plans:*** - Conduct a series of field data collections with well-characterized radar targets. - Develop signal processing baseline and BLiP system performance models for a specific mission area. - Commence development of the end-to-end processing algorithms and techniques for real-time radar data acquisition and analysis. - Acquire and install radar processing with a high-performance graphical processing unit (GPU) into an existing radar facility. ***FY 2025 Plans:*** - Conduct independent verification and validation (IV&V) and integrate the real-time developments into a testbed radar system.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct test exercise for controlled target flight tests. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from performer processing and testing to the transition of BLiP software.			
Title: Resilient Supply-and-Demand Networks (RSDN)	9.400	15.000	10.000
Description: The Resilient Supply-and-Demand Networks (RSDN) program is developing supply-chain risk management analytics to detect systemic vulnerabilities and improve resilience in supply and demand networks. At present, the separation of supply-chain information into confidential silos obscures a system-wide view, inhibiting comprehensive risk-focused analysis of supply and demand networks. RSDN is developing techniques for modeling both the broad level of the supply-chain network and the detailed level of individual procurement agreements. Network analytics and visualizations will reveal emerging fragilities and enable deep situational awareness of systemic vulnerabilities and potential disruptions. Blind spots due to hidden interdependencies can lead to fragility in supply chains. An RSDN stress-testing framework will enable repeatable scenario analysis of strategic vulnerabilities in supply and demand networks, automated analysis and discovery of risk patterns, and evaluation of alternative risk mitigation strategies. ***FY 2024 Plans:*** - Augment the initial datasets with supplemental information about the participants and their relationships to provide a granular view of each supply and demand network. - Expand the initial library of vulnerability analytics and visualizations with new methods and algorithms to illuminate supply and demand network blind spots and identify data gaps. - Demonstrate a stress-testing capability to assess the propagation of shock scenarios through a supply and demand network and to motivate suitable mitigation strategies. - Demonstrate an initial end-to-end system for mapping supply and demand networks, analyzing systemic fragilities, and conducting stress-testing evaluations. ***FY 2025 Plans:*** - Develop privacy-preserving functionality to permit analysis of sensitive data to inform supply and demand network representations, analytics, and stress tests. - Develop techniques to identify contingency features in contracts to support machine learning that highlights patterns of fragility. - Demonstrate a stress-testing capability to model dynamic shock scenarios that incorporate nonlinear behavior of supply and demand networks. - Demonstrate generalizability of the end-to-end system to additional use cases. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects ramping down of development of techniques for analyzing and stress-testing supply and demand networks and focus shifting to demonstration and assessment of the stress-testing capability.			
Title: Defense Applications of Innovative Remote Sensing (DAIRS)	-	8.000	10.000
Description: The Defense Applications of Innovative Remote Sensing (DAIRS) program seeks to enable new approaches for the persistent long-range tracking of maritime and air targets. Specifically, DAIRS will focus on the use of surface wave over-the-horizon radar (SWOTHR) with operation in low latitudes, where spread-Doppler clutter currently limits reliable target track to ranges less than 100km, and the low bandwidth precludes the use of microwave target classification approaches. The program will explore passive remote sensing using endemic noise sources as a highly disruptive method for environmental and target sensing. Space time adaptive processing and polarimetric sensing provide the baseline technologies for clutter rejection and this program will combine those techniques with technologies developed in the Shosty program (budgeted in PE 0603767E, Project SEN-01), which uncovered spatial-temporal correlation that potentially provides suppression of spread-Doppler clutter. The program will develop these methods for various conditions that affect SWOTHR, including the day/night cycle, sea state, forward scatter and backscatter, and bistatic range. Additionally, the program will take a first-principles approach for conducting classification at high frequency wavelengths for total disruption of the field. Technology developed under this program will be transitioned to the Services and the U.S. Coast Guard. ***FY 2024 Plans:*** - Perform data collection to support passive noise radar and classification approach investigations. - Develop and deploy SWOTHR receiver and transmit sites in the relevant low-latitude environment. ***FY 2025 Plans:*** - Collect, characterize, and deliver in-situ data from the relevant low-latitude environment. - Begin algorithmic development on passive noise radar, target classification and spread-Doppler clutter reduction techniques. - Apply techniques and lessons learned to follow-on collection campaigns. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from initial data collection to algorithm development.			
Title: Computational Cultural Understanding (CCU)	18.000	17.000	-
Description: The Computational Cultural Understanding (CCU) program is creating cross-cultural language understanding technologies to improve a DoD operator's situational awareness and interactional effectiveness. CCU natural language processing technologies will recognize, adapt to, and recommend how to operate within emotional, social, and cultural norms that differ across societies, languages, and group affinities. To support diverse and emergent use cases, CCU technologies will be engineered to require minimal to no training data in a local culture, while maximizing operator success during negotiations and			

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
other interactions in the field. CCU will create new component technologies for sociocultural norm discovery, cross-cultural emotion recognition, and communicative change detection. The program will incorporate these component technologies into a prototype platform to assist military users with cross-cultural dialogue. ***FY 2024 Plans:*** - Generalize sociocultural analysis and dialogue assistance techniques to encompass multiple language-culture pairs. - Utilize the integration testbed to evaluate and optimize cross-cultural language understanding and situational awareness technologies. - Implement sociocultural analysis and dialogue assistance capabilities in wearable hardware to facilitate assessment in real-world scenarios. - Demonstrate effectiveness of sociocultural analysis and cross-cultural dialogue assistance within additional negotiation scenarios in collaboration with military stakeholders. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Semantic Forensics (SemaFor)	21.015	16.034	-
Description: The Semantic Forensics (SemaFor) program is developing technologies to defend against multimedia falsification and disinformation campaigns. Statistical detection techniques have been successful, but media generation and manipulation technologies applicable to imagery, voice, video, text, and other modalities are advancing rapidly. Purely statistical detection methods are now insufficient to detect these manipulations, especially when multiple modalities are involved. Existing media generation and manipulation algorithms are data driven and are prone to making semantic errors that provide defenders an opportunity for asymmetric advantage. SemaFor is developing semantic and statistical analysis algorithms that determine if media is generated or manipulated, attribution algorithms that infer if media originates from a particular organization or individual, and characterization algorithms that reason about whether media was falsified (generated or manipulated) for malicious purposes. SemaFor aims to create technologies to identify, deter, and understand adversary media falsification. ***FY 2024 Plans:*** - Refine and demonstrate approaches for reasoning about manipulated media across multimodal types (images, video, audio, or text) of information. - Finalize application programming interfaces including multimodal (images, video, audio, or text) system enhancements based on input from transition partners and other stakeholders.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate media falsification detection, attribution, and characterization capabilities on use cases of interest to transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Adapting Cross-domain Kill-Webs (ACK) ***Description:*** The Adapting Cross-domain Kill-Webs (ACK) program assisted military decision makers with rapidly identifying and selecting options for tasking and re-tasking assets within and across organizational boundaries. ACK assisted users with selecting sensors, effectors, and support elements across military domains (space, air, land, surface, subsurface, and cyber) to form and adapt kill chains to deliver desired effects on targets. Today's Command and Control (C2) organizations and processes cannot support multi-domain warfighting concepts, especially during joint operations. ACK addressed this challenge by utilizing a decentralized approach to allocating resources to tasks and assigning mission orders to assets, motivated by ideas developed in online commerce, sourcing, and supply chain management, such as bid requests and offers. The impact of ACK was to accelerate asset re-allocation and assignment decision timelines to be on the order of minutes, and the output of ACK was automated tools and decision aids to support the selection of the elements of a kill-chain and assignment of roles and responsibilities to each of the elements. Technology developed under this program transitioned to the Services.	6.000	-	-
Title: Data-Driven Discovery of Models (D3M) ***Description:*** The Data-Driven Discovery of Models (D3M) program developed automated model discovery techniques and tools that enable non-expert users to create empirical models of real, complex processes and phenomena. The ability to understand the battlespace is driven increasingly by expert analysis of sensor and open-source data. The DoD and IC communities are fundamentally limited by a shortage of domain-focused subject matter expert data scientists to construct empirical models that predict behaviors and anticipate contingencies during tactical and strategic planning. D3M addressed this need by creating technologies that automate the construction of complex empirical models. D3M technologies include a library of data modeling primitives that are automatically selectable, automated approaches for composition of complex models from modeling primitives, and intuitive mechanisms for human-model interaction that enable curation of models by non-experts. D3M focused on the types of empirical modeling problems commonly encountered by the DoD and IC.	4.004	-	-
Accomplishments/Planned Programs Subtotals	77.419	91.634	42.688

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	316.176	344.986	337.772	-	337.772	385.764	434.132	458.998	475.338	-	-
MBT-01: *MATERIALS PROCESSING TECHNOLOGY*	-	127.121	150.549	177.523	-	177.523	202.746	228.167	241.236	249.824	-	-
MBT-02: *BIOLOGICALLY BASED MATERIALS AND DEVICES*	-	189.055	194.437	160.249	-	160.249	183.018	205.965	217.762	225.514	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Applied Research associated with the Materials and Biological Technology Program that is focused on developing materials and biological technologies that make possible a wide range of new military capabilities. This PE also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA funded technologies take root in the U.S. and provide new capabilities for national defense.

The major goal of the Materials Processing Technology project is to develop novel materials, fabrication and processing techniques, models, devices and components that will lower the cost, increase the performance, and/or enable new missions for military platforms and systems. Included in this project are efforts across a wide range of technology areas including manufacturing, electronics, sensors, optics, and complex and autonomous systems.

The Biologically Based Materials and Devices project will leverage the growing application space of the biological sciences for the development of new DoD capabilities to improve the sustainability of warfighters, and operational platforms in varied environments. This project will develop solutions for critical resource processing, materials development, threat detection and characterization, environmental remediation, and warfighter resilience to infectious disease and environmental stressors. The materials developed through this project will protect and sustain warfighters and operations in austere environments.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	337.726	344.986	349.088	-	349.088
Current President's Budget	316.176	344.986	337.772	-	337.772
Total Adjustments	-21.550	0.000	-11.316	-	-11.316
• 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	-9.900	0.000			
• SBIR/STTR Transfer	-11.650	0.000			
• TotalOtherAdjustments	-	-	-11.316	-	-11.316

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer and reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects minor program repricing.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	Project (Number/Name) MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
MBT-01: *MATERIALS PROCESSING TECHNOLOGY*	-	127.121	150.549	177.523	-	177.523	202.746	228.167	241.236	249.824	-	-

A. Mission Description and Budget Item Justification

The major goal of the Materials Processing Technology project is to develop novel materials, fabrication, and processing techniques, models, devices, and components that will lower the cost, increase the performance, and/or enable new missions for military platforms and systems. Included in this project are efforts across a wide range of technology areas, including manufacturing, electronics, sensors, optics, and complex and autonomous systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Materials for Extreme Environments	51.600	72.640	70.100

Description: The Materials for Extreme Environments thrust is exploring new materials, innovative architectures, and development processes that will significantly enhance the performance and persistence of DoD platforms operating in extremely harsh environments. Materials with superior strength, functionality, and resiliency are critical for enabling DoD platforms, weapons and other components to operate and persist under conditions including, but not limited to, extremely high or low temperatures, turbulence, ionizing radiation, and/or corrosive environments. Recent developments in materials such as high entropy alloys, superconducting materials, and infiltrated carbon fiber composites hold promise for achieving material solutions for improved survivability in a wide range of harsh environmental conditions. Similarly, advancements in material design, processing and manufacturing are enabling novel material architectures that can further enhance performance and resilience in structures such as leading edges, windows and apertures, propulsion systems, and space structures. Exemplar areas of research within the Materials for Extreme Environments thrust include the following: 1) high temperature materials for hypersonic platforms, 2) high temperature window and aperture materials, 3) radiation and/or electromagnetic pulse (EMP) hardened electronics for space platforms, 4) coatings for platform survivability in corrosive environments, 5) active and passive cooling methods for apertures and forward-facing vehicle features, and 6) superconducting and magnetic materials for novel propulsion systems.

FY 2024 Plans:

- Create two additional analytic techniques that leverage physics-based design principles to increase convergence speed while minimizing computational resources.
- Complete validation of system-level models that couple vehicle geometry, materials response, and vehicle trajectory to performance.
- Transition new performance models to defense analysts to use in further research, development, and operational systems design efforts.
- Demonstrate increased precision of the materials and manufacturing system to enable the exemplar application of a >100-meter diameter radio frequency (RF) reflector antenna.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Refine manufacturing and cost models based on fabrication trials of higher precision subcomponents. - Demonstrate ability to meet area built per mass launched metric (10 meters squared per kilogram) in a laboratory setting by testing higher precision subcomponents. - De-risk manufacturing and assembly approaches for future in-orbit demonstrations. - Develop system-level models that project improved seeking capability. - Conduct testing of novel infrared and radio frequency apertures suitable for hypersonic platforms under high-temperature conditions to validate performance models. - Prepare bench top demonstration(s) of novel technology for sustained very low Earth orbit (VLEO) operations. - Determine the feasibility of the novel technologies to enable sustained VLEO operations. - Develop electrode material solutions for magnetohydrodynamic pumps. - Generate material models based on conceptual point designs for undersea magnetohydrodynamic pump prototypes. ***FY 2025 Plans:*** - Demonstrate increased precision of the materials and manufacturing systems to enable the exemplar application of segmented longwave infrared optics. - Demonstrate ability to meet area built per mass launched metric (1 meter squared per kilogram) in a laboratory setting by testing higher precision subcomponents. - Demonstrate suitable designs that support one (1) meter segmented longwave infrared optics. - Initiate flight test readiness review(s) for in-orbit demonstrations of developed technology. - Conclude bench top demonstration(s) and finalize feasibility studies of the novel technologies to enable sustained VLEO operations. - Conduct initial design trades and scalability study of undersea magnetohydrodynamic pump to show traceability to larger application. - Conduct materials testing of electrode design to ensure proposed solution will achieve program metrics. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects minor program repricing.			
Title: Functional Materials and Devices	35.021	45.800	60.023
Description: The Functional Materials and Devices thrust is developing advanced materials, components and systems to improve device performance for DoD structural, sensing, imaging and communication applications. One focus of this thrust involves development of advanced transductional materials that convert one form of energy to another for DoD-relevant applications. While promising transduction materials are known for a variety of applications, integration into devices has not been realized. Another focus area is the development of physics-based models that predict material behavior when illuminated by high peak power electromagnetic interference. A third focus area involves development of new multi-functional materials and device designs			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
that will radically decrease the size, weight and power requirements of high-energy photon sources. Such devices should enable fieldable detection units for sensing, non-destructive evaluation of parts, and detection of DoD-relevant targets. A fourth focus area is developing new liquid-based, large-aperture imaging systems such as telescopes. Such telescopes would break the unfavorable, exponential scaling between aperture size and cost for normal telescopes and enable low-cost imaging platforms for ground- and space-based applications. Another focus area under this thrust involves novel nano-architected materials to enhance device-relevant properties for applications to quantum-enhanced sensors. Finally, novel design optimization approaches will be explored where material composition and microstructure are included as explicit, continuous variables alongside shape optimization. This co-optimization of shape and material together will enable new combinations of structural performance and sustainability for a variety of DoD applications. ***FY 2024 Plans:*** - Finalized system design for a compact and ruggedized electron accelerator system based on demonstrated components. - Complete and test a compact and ruggedized electron accelerator prototype system. - Validate performance of integrated system prototypes at Government lab sites. Begin transition of prototypes to Government entities. - Extend optimized night vision designs to include visual access to an additional infrared spectral band beyond the near-infrared, i.e., the short-, mid-, or long-wave infrared). - Scale-up synthesis of novel obscurant particles suitable for cubic meter-scale pilot demonstrations of passive obscurants and lab-scale demonstrations of active obscurants and demonstrate asymmetric visibility in both cases. - Finalize experimental material test platform designs and continuum material design optimization approach. - Explore design frameworks integrating both shape and material as concurrent degrees of freedom to unlock new optimal design balancing performance, cost, and sustainability metrics. - Conduct proof-of-concept manufacturing demonstrations to produce and test multi-material structural components. - Complete preliminary design review and critical design review of large liquid-mirror telescope. - Begin building lab demo of large liquid-mirror telescope, with plans to double aperture sizes. - Develop preliminary designs, models and synthesis protocols for functionally engineered electronic metamaterials with enhanced quantum properties. - Conduct lab experiments to explore self-neutralized air breathing plasma as a medium to enable novel electronic propulsion techniques capable of using air from the atmosphere as the ionization medium. - Explore hybrid additive manufacturing approaches to enable embedded structural health monitoring for load-bearing metallic components. ***FY 2025 Plans:*** - Demonstrate prototype of previously developed extended optimized night vision designs developed.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate novel material testing techniques to generate design-relevant properties 10x faster than current approaches. - Evaluate novel multimaterial designs to quantify performance, cost, and sustainability benefits. - Conduct out-of-plane liquid mirror hardware demonstration and begin advancing designs from laboratory setting to on-sky demonstrations. - Explore the design space for metamaterial-based nanoelectronic device architectures for applications to quantum sensing, computing, and communications. - Explore and develop device-level fabrication techniques to incorporate functionally engineered quantum materials within nanoelectronic device architectures. - Perform preliminary materials and device characterization of metamaterial-based nanoelectronic devices to validate material-scale and device-scale models of enhanced quantum effects. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from exploration to development and testing.			
Title: Reconfigurable Systems	17.000	17.000	11.000
Description: In the Reconfigurable Systems thrust, new approaches are being developed to enable more rapid and robust adaptation of defense systems and systems-of-systems to changing mission requirements and unpredictable environments. This includes development of capabilities across sensing, perception, planning and control for autonomous, high-speed operation in cluttered environments without Global Positioning System (GPS) information. This also includes development of capabilities to manipulate and control adversary sensory perception and/or situational awareness. Additional work in this thrust focuses on how sensing systems and military systems-of-systems are designed for real-time resilient response to dynamic, unexpected signals and contingencies. Research is developing a more unified view of system behavior that allows better understanding and exploitation of complex interactions among components, including development of formal mathematical approaches to complex adaptive system composition and design. These capabilities will impact autonomous systems and systems-of-systems, including those that involve humans, in a variety of DoD-relevant contexts. ***FY 2024 Plans:*** - Initiate integration of critical components into a high-performance, environmentally-robust portable optical clock device with picosecond timing precision. - Initiate integration of critical components into a high-performance, environmentally-robust transportable optical clock with month-long nanosecond holdover. ***FY 2025 Plans:*** - Conduct integration, environmental testing, and performance characterization of high-performance, environmentally-robust portable optical clock device with picosecond timing precision.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct integration, environmental testing, and performance characterization of high-performance, environmentally-robust transportable optical clock with month-long nanosecond holdover. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a transition from development to integration and testing.			
Title: Chemical Processing for Force Protection ***Description:*** Research in the Chemical Processing for Force Protection thrust is focused on the development of new chemical approaches and technologies across a broad spectrum of DoD needs. One area involves development of innovative approaches for scalable small molecule synthesis coupled with predictive tools for route design, possibly offering a new strategy to discover how to make new molecules such as pharmaceuticals and explosives. A second area includes qualification of new molecules made using agile manufacturing platforms. Another focus leverages advances in automation to develop safe, reproducible experimental approaches for systematic development of energetic materials. In addition, investments in this thrust will advance chemical characterization, information management and analysis, and automation. ***FY 2024 Plans:*** - Integrate semi-automated experimental platforms into cleared, U.S. Government facilities and begin demonstrating system operability through a series of Government-directed demonstrations. - Generate systematized data sets for energetic formulation development. - Initiate efforts to determine if detecting and/or characterizing adverse genetic effects by developing initial indicators consistent with an attack in food systems is a viable approach to early detection and warning. - Prepare and assemble sites and synthesis platforms to support the agile manufacturing and qualification of new molecules. ***FY 2025 Plans:*** - Demonstrate final system operability through a series of Government-directed demonstrations. - Demonstrate synthesis of multiple targets on modular agile manufacturing platforms. - Develop informatics models capable of near real-time qualification of molecules manufactured on agile synthesis platforms. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from system development to final demonstrations and transition.	23.500	15.109	10.400
Title: Making and Maintaining in Materials Processing Technology ***Description:*** The Making and Maintaining thrust is developing technologies that enable the production of molecules, materials, and parts in an expeditionary setting that will untether military forces from supply chains and enable a continuous global presence. Focus areas include making products at the point of need from local feedstock, developing the ability to use non-optimized	-	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
materials in manufacturing; accelerating part qualification; and new approaches to developing room temperature superconductors and efficient thermoelectric materials. ***FY 2025 Plans:*** - Investigate methods for embedded material damage sensing for structural parts. - Develop initial screening of 2D catalytic materials for low temperature solid oxide fuel cell running on complex hydrocarbons. - Investigate new methods for low energy carbon/hydrogen capture from air. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Awareness in Materials Processing Technology ***Description:*** Efforts in the Awareness thrust examine and develop opportunities to increase our understanding of adversarial systems and through improved processing techniques, models, and signals of opportunity that will generate low-cost, actionable solutions for enhanced detection and characterization of events and systems of interest. Focus areas include improved sensing and assessment. ***FY 2025 Plans:*** - Assess feasibility multi-spectral sensing modalities for improved sensing. - Assess operational potential of multi-spectral sensor designs. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase is due to program initiation.	-	-	6.000
Title: Access in Materials Processing Technology ***Description:*** The Access thrust is exploring novel approaches to modeling and controlling physical environments in various conditions for improved vehicle design. Nonlinear flow conditions impact underwater, hypersonic, and space vehicles and represent some of the oldest unsolved challenges in physics. The ability to model high-Reynolds number classical turbulence, for instance, or turbulent cascades in compressible fluids, is extremely limited. Focus areas include new modeling and simulation tools to understand complex physical conditions, and to aid engineers in design, regardless of scale. ***FY 2025 Plans:*** - Develop new sensing to characterize turbulent conditions. - Explore methods to reduce effects of turbulence and pressure fluctuations. - Develop a modeling and simulation tool to improve performance in turbulent conditions. - Test surface solutions improve performance in turbulent conditions.	-	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Initiate the development of modeling and simulation tools to predict electromagnetic field modulation at large distances. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase is due to program initiation.			
Accomplishments/Planned Programs Subtotals	127.121	150.549	177.523

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	Project (Number/Name) MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
MBT-02: *BIOLOGICALLY BASED MATERIALS AND DEVICES*	-	189.055	194.437	160.249	-	160.249	183.018	205.965	217.762	225.514	-	-

A. Mission Description and Budget Item Justification

The Biologically Based Materials and Devices project will leverage the growing application space of the biological sciences for the development of new DoD capabilities to improve the sustainability of warfighters and operational platforms in varied environments. This project will develop solutions for critical resource processing, materials development, threat detection and characterization, environmental remediation, and warfighter resilience to infectious disease and environmental stressors. The materials developed through this project will protect and sustain warfighters and operations in austere environments.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Persistent Terrestrial Living Sensors	15.140	14.384	4.118
Description: The Persistent Terrestrial Living Sensors program is developing engineered biological sensor platforms capable of detecting land-based threats (e.g., chemicals, radiation, and biologics) and relaying unique signals to existing DoD assets. Unlike conventional methods that monitor threats and are limited by sensor energy needs, these biological sensors are effectively energy independent, increasing the potential for wide distribution and environmental robustness. Resulting platforms will enable a variety of remote, persistent monitoring and reporting capabilities to address threat scenarios relevant for national security, including passively detecting chemicals, pathogens, and radiation in various environments. These sensors will provide a flexible suite to complement conventional sensor systems within the DoD. ***FY 2024 Plans:*** - Quantify plant phenotype changes in relevant environments to determine and optimize functional molecular characteristics. - Integrate technical approaches for plant molecular responses to environmental stimuli and functional protein production. - Investigate the potential for additional plant phenotypes as an outcome of protein production. ***FY 2025 Plans:*** - Scale technical approaches for increased usability and reliability of plant phenotypes as an outcome of protein production. - Ensure integration of technical approaches does have intended and desirable effects at scale for relevant use cases. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects completion of foundational research on component technologies for final integration and testing.			
Title: Gene Editor Enabled Diagnostics & Biosurveillance	18.931	12.158	4.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The Gene Editor Enabled Diagnostics & Biosurveillance program aims to develop fieldable, low-cost, programmable and reconfigurable diagnostic capabilities for rapid, specific, sensitive, and multiplexed detection and characterization of biological threats in military and public health scenarios. This program is investigating the design rules for high confidence diagnostic biosurveillance as well as develop agnostic pathogen detection and characterization platform technology for overall threat assessment. These design rules will inform advanced computational and machine learning approaches to scan genome data, algorithmically design probes and guides for optimal assay results, and characterize previously unknown organisms or threats. Additional work will develop portable, cold chain-free platforms that can preserve microbe samples to enable field-forward diagnostics and threat assessments either at the point-of-need or in other areas of interest. ***FY 2024 Plans:*** - Complete assay and component integration into ruggedized field-forward devices. - Evaluate program performance through independent verification and validation (IV&V) studies with government partners. - Assess progress towards manufacturing and distribution goals of devices and disposable components. - Evaluate durability of prototype devices in simulated field conditions. - Initiate technology development to support in-field, agnostic detection, preservation, characterization, and threat assessment of potential pathogens. ***FY 2025 Plans:*** - Demonstrate reconfigurability for the device containing multiplexed diagnostic assays. - Finalize respiratory and sepsis panels for Point of Need (PON) devices. - Initiate regulatory approval procedures for PON device. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects completion of research activities and shift to finalizing device integration and transition.			
Title: Unburdening the Warfighter from Chemical/Biological (CB) Defense	17.558	15.748	6.916
Description: The Unburdening the Warfighter from Chemical/Biological (CB) Defense program aims to increase warfighter survivability by developing improved personal protective equipment (PPE) and medical countermeasure (MCM) technologies to protect against CB threats. Current methods of CB protection require significant logistical burdens, including suits that are bulky and hot, which limit operational effectiveness. These burdens increase if additional levels of protection are required. The Unburdening the Warfighter from CB Defense program will investigate and design novel biological and material approaches that provide rapid protection against multiple CB agents for the warfighter. This research will innovate PPE through the discovery of compounds and lightweight, durable systems designed to capture, neutralize, or repel CB agents. This novel approach will provide almost immediate and lasting protection even in austere operational settings.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2024 Plans: - Develop clinically relevant animal models to test safety and efficacy of platform technologies. - Scale up protection requirements while maintaining adherence to safety and burden requirements. - Initiate safety and toxicity testing of system components in tissue-specific experimental models. ***FY 2025 Plans:*** - Investigate the protection breadth (e.g., threat agnostic) and adaptability of platform technologies against multiple chemical and biological agents in animal models. - Test the ability to rapidly reconfigure the protective platform against agents (toxins). - Characterize baseline safety and toxicity of platform technology components in animal models. - Investigate chemical agent neutralization characteristics in barrier protection strategies. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects reduction of research activities to conduct system demonstration.			
Title: Bio-Inspired Coastal Defense	12.002	15.322	17.941
Description: The Bio-Inspired Coastal Defense program is developing self-sustaining, hybrid man-made and biological reef structures to fortify and defend DoD bases in low-lying coastal regions. Military assets in these coastal regions are vulnerable to storm surges, wave action, and sea-level rise that cause erosion, degrade infrastructure, and impede operations. Innovative coastal defense will require major technological advances in (1) design, construction, and placement of manufactured reef primers, (2) accelerated recruitment and/or growth of reef species, and (3) sustained, zero-cost natural maintenance and improvement (e.g., increased durability after challenge) of the defensive reef. The primary benefit of such structures is to attenuate wave height during storm events for both established and under construction coastal facilities. ***FY 2024 Plans:*** - Initiate field tests for ecosystem engineers to achieve improved coral and oyster growth. - Deploy test structure in the field and measure wave attenuation. - Continue to optimize temperature tolerance for corals with field trials. - Optimize oyster growth to achieve disease tolerance in the lab and in the field. ***FY 2025 Plans:*** - Evaluate wave attenuation performance in the field. - Optimize temperature tolerance, growth, and disease resistance in the field. - Test larval attractance and algal inhibitors in the field.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Assess biomarker development for coral and oysters. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from initial laboratory studies to field development and testing for ecosystem engineering technologies.			
Title: Environmental Microbes as a Bioengineering Resource (EMBER) ***Description:*** The Environmental Microbes as a Bioengineering Resource (EMBER) program aims to develop novel, bio-based technologies to overcome key challenges facing domestic supply of Rare Earth Elements (REEs) critical to the U.S. and Department of Defense (DoD). This program will leverage the diversity, specificity, and customizability of environmental microbiology to enable new domestic biomining methods for the separation, purification, and conversion of REEs into manufacturing-ready forms. Advances in this area will deliver capabilities to assure access to DoD-critical materials domestically and in operational settings. ***FY 2024 Plans:*** - Design, build, and test survival and functionality of multiple, engineered environmental microbe strains under biomining-relevant conditions. - Demonstrate the ability to utilize a bio-based approach to bind several individual REEs with high specificity and to recover a single target REE from complex mixtures. - Utilize a biological approach to convert at least two REEs from one chemical form into another at high yield. - Refine bio-based REE purification pipeline to reflect compatibility with domestic source material as well as any containment strategies for living genetically engineered organisms used in the pipeline. ***FY 2025 Plans:*** - Continue to advance engineerable chassis strains that function and grow under the extreme conditions relevant to REE biomining/bioprocessing. - Complete development of assays for REE binding to expand the number of REEs detected and the assay throughput, in support of the REE biomining workflow. - Develop and demonstrate biomining modules for the separation and recovery of multiple individual REEs from mining partner source material. - Continue development of techno-economic analysis and lifecycle analysis that reflects the biomining approach. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the completion of bench scale studies to prepare for pilot scale demonstrations.	9.200	11.879	9.815
Title: Materiel Protection through Biologics	15.188	17.093	17.835

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: Military infrastructure and systems are expected to function years beyond their original intended lifetime but are subject to degradation by environmental factors. For instance, the formation of biofilms is ubiquitous, corroding and biofouling many military systems, such as aircraft, fuel tanks, ships, medical devices, and filtration systems for water and air. In another example, critical defense assets such as missile silos and naval piers rely on aging concrete infrastructure, ultimately costing the DoD billions of dollars annually to repair and maintain. Building upon technologies investigated under the Bio-Inspired Coastal Defense program, the Materiel Protection through Biologics thrust will develop approaches to sustain military infrastructure and systems by developing biological or bio-inspired technologies to imbue beneficial functions into existing systems, resulting in benefits such as, but not limited to, reducing drag, mitigating corrosion, or repairing concrete. These bio-inspired interventions will protect and sustain equipment and infrastructure, reducing operation costs and increasing service lifetime. ***FY 2024 Plans:*** - Adapt accelerated-aging methods and testbeds to assess the long-term performance of self-repairing concrete. - Develop tools to apply and maintain function of self-repairing treatments to concrete prisms and cylinders. - Integrate diagnostic data from non-destructive evaluation and accelerated aging testbeds into material-scale models of crack healing in concrete. - Generate models that predict assembling biofilms in static conditions using high-throughput testbeds. - Engineer communities that are resilient to disturbances while simultaneously generating target function, such as reduction of corrosion. ***FY 2025 Plans:*** - Engineer and validate that microbial communities and/or community members can produce a target function and resist or recover from disturbances such as low-temperature to high-temperature environmental cycling. - Demonstrate the system can run multiple testbeds in parallel and track biofilm function(s) non-destructively. - Identify strategies to evaluate concrete repair technologies at the component scale (e.g., columns, beams, slabs, or mock craters). - Integrate concrete repair technologies with quality control diagnostics for non-destructive evaluation. - Generate models for predicting efficacy of concrete repair technologies. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects minor program repricing.			
Title: Bioremediation of Battlefields	6.150	12.829	13.457
Description: The Bioremediation of Battlefields effort is addressing the DoD need to stabilize and remediate sites impacted by prior military activities, including contaminated combat zones, defense installations, and test ranges. This will ensure the safety of service members and local communities, and minimize the environmental impact of warfare by developing biological tools			

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
that remediate soil contamination. This program will eliminate contaminants, and thus restore habitability, by identifying and optimizing organisms, such as microbes, fungi, and plants, that can detect toxic compounds, mitigate their impact, and report on the state of remediation. Bioremediation of Battlefields will reduce the long-term impacts of military activities and improve the overall environmental health and land use potential for contaminated sites. ***FY 2024 Plans:*** - Characterize biochemically-based approaches to specifically biodegrade soil contaminants. - Establish high-throughput testbeds for studying bioremediation activity in complex soil environments. - Develop and test potential mechanisms for enabling overt signaling of soil contamination state. - Develop potential strategies for ecological containment of the plant and microbial species. ***FY 2025 Plans:*** - Demonstrate integration of the synthetic plant-microbe communities. - Demonstrate bioremediation of the focal soil contaminant(s). - Demonstrate overt signaling to demonstrate remediation of the focal soil contaminant(s). - Demonstrate scalability of the high-throughput plant-microbe testbed platform(s). ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects minor program repricing.			
Title: Biotechnology for Challenging Environments	11.813	14.659	13.270
Description: The Biotechnology for Challenging Environments program is developing novel biological solutions to enable warfighter operations in remote and extreme environmental conditions. As the DoD expands operations into previously inaccessible domains, new and unique logistical constraints imposed by extreme conditions and resource scarcity threaten warfighter and warfighting platform readiness. This program will develop technologies using biological approaches to protect and maintain performance of warfighters and warfighting platforms, such as electronics and infrastructure, from challenging environments. Technology advances developed in this effort will extend mission duration and enhance operational capabilities in emerging domains. ***FY 2024 Plans:*** - Initiate design and engineering of microbes and other biological or bio-inspired components to produce novel materials for capabilities in extreme environments. - Down-select candidate molecules from libraries of biologically sourced or inspired molecules with potential ice modulation activity for DoD applications. - Assess performance of molecules with demonstrated ice modulation properties using a quantitative testbed.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Begin optimizing high performing molecules to enhance material properties and increase performance. ***FY 2025 Plans:*** - Continue molecule engineering activities on best performing molecules to improve activity. - Explore chemical functionalization of molecules for incorporation into different materials and form factors. - Scale-up molecules and materials for prototyping, testing and evaluation. - Initiate safety and toxicity studies of molecules and materials. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects focus on execution of iterative design, build, and test cycles to improve and optimize activity of top performing molecules identified.			
Title: Turning Upcycled Waste into Novel, Sustainable Materials ***Description:*** Currently the DoD relies on critical materials and commodity molecules, such as petroleum-, rubber- and wood-derived products, which are needed to protect and provide mobility to our warfighters in an austere, expeditionary setting. Unfortunately, providing these materials to our warfighters suffers from vulnerabilities such as fragile supply chains, foreign sourcing, or costly shipping to points of need. These critical materials also contribute to DoD waste streams with no further value, while also creating environmental and logistical challenges. To address this, the Turning Upcycled Waste into Novel, Sustainable Materials program will investigate the feasibility of converting abundant DoD waste stream products (e.g., tires, scrap wood, and paper) into durable, and sustainable materials. Approaches will be investigated to develop materials suitable for use in applications ranging from contingency construction materials to commodity molecules. ***FY 2024 Plans:*** - Identify strategies to support programmable culture-based approaches to produce commodity molecules. - Identify experimental approaches to generate datasets for multi-scale, switchable, metabolic models of culture-based biomanufacturing. - Identify approaches to validate and verify biosynthesis optimization. - Initiate research into the pre-processing of wood/paper waste stream feedstocks and synthesis of DoD-relevant materials from those feedstocks. ***FY 2025 Plans:*** - Initiate research on alternative multi-input, multi-output culture-based approaches. - Design testbeds to characterize culture-based production of molecular commodities. - Determine culture types and metabolic pathways required for culture-based commodity production. - Investigate methods to optimize culture-based commodity production, incorporating commercialization and techno-economic analysis.	-	8.332	16.914

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate highly efficient production and scalability of DoD-relevant materials from wood waste feedstocks. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the shift from design to development of multi-input, multi-output commodity chemical production platforms.			
Title: Signal Processing and Communication with Biotechnology ***Description:*** The DoD requires the ability to monitor complex operating environments with sufficient resolution and confidence to inform missions and protect personnel and platforms against various physical and chemical threats. The Signal Processing and Communication with Biotechnology program will develop a new customizable sensing methodology using a novel microbe-based, platform technology capable of detecting a variety of input signals, processing information, and generating multiple output signal types in diverse operational environments. Technology developed in this program will offer insight into signal processing and transmission methodologies with logistical advantages and reliable operability in contested environments. ***FY 2024 Plans:*** - Initiate development of living, microbial sensing devices that respond to multiple input signal types (e.g., chemicals, magnetic fields, light) and produce signals that are detectable by receiver devices. - Assess living microbial sensors for user-defined multi-channel input signal processing, response time, sensitivity, and durability under conditions that mimic operational environments. - Establish speed and accuracy baseline for microbial device design methodology. ***FY 2025 Plans:*** - Initiate pressure-testing of design, build, and test cycle using prescribed parameters and time limitations for additional microbial devices. - Demonstrate increased speed and accuracy of the microbial device design methodology. - Begin to establish theoretical stand-off/remote sensing distances for microbial devices. - Begin testing of methodology and microbial device performance. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift in focus from initial microbial system designs to implementation of pressure tests.	-	9.028	13.348
Title: Strengthening Resilient Emotions and Nimble Cognition Through Engineering Neuroplasticity (STRENGTHEN) ***Description:*** The Strengthening Resilient Emotions and Nimble Cognition Through Engineering Neuroplasticity (STRENGTHEN) program, building upon efforts started under the Human Social Systems program in PE 0601101E, Project CCS-02, aims to overcome the limitations of focusing on descriptions of individual disease effects and suicide risk factors by adopting a transdiagnostic approach that addresses the mechanisms (i.e., predictors or causes) of mental health and wellbeing.	-	10.902	9.500

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
STRENGTHEN will optimize the brain networks essential for Cognitive Flexibility and Emotional Regulation, establishing dose response, time-to-onset, and duration-of-effect curves to quantify the impact of change in Cognitive Flexibility and Emotional Regulation on validated measures of suicidality, behavioral health, and wellbeing within DoD. ***FY 2024 Plans:*** - Develop individualized neurobehavioral response models of Cognitive Flexibility and Emotional Regulation. - Design individualized multimodal multidimensional neuroplastic interventions to optimize Cognitive Flexibility and Emotional Regulation. - Develop suite of interventions to optimize Cognitive Flexibility and Emotional Regulation in populations at low risk, at risk, and at high risk of suicide to maximize well-being and minimize suffering from mental illness, substance abuse, and suicidality. - Commence development of a mechanistic understanding of mental health for transdiagnostic treatment. - Assess and select hybrid interventions designed to increase mental health resiliency. ***FY 2025 Plans:*** - Evaluate impact of hybrid interventions on Cognitive Flexibility and Emotional Regulation. - Refine individualized neurobehavioral response models of Cognitive Flexibility and Emotional Regulation. - Enhance hybrid interventions demonstrated to increase mental health resiliency with additional techniques. - Evaluate impact of enhanced hybrid interventions on Cognitive Flexibility and Emotional Regulation. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from initial design and development to testing and evaluation.			
Title: Field Forward Biothreat Storage Solutions for Force Protection	-	-	11.179
Description: Warfighters are currently deployed to emerging disease hotspots with increasing pathogen spillovers. Biosurveillance groups tasked with force health protection rely on cold chains and transport media to maintain sample viability for characterization in a laboratory setting, but these methods are unreliable, sometimes inaccessible, or limited in their utility. Building upon technologies investigated under the Gene Editor Enabled Diagnostics & Biosurveillance program, the Field Forward Biothreat Storage Solutions for Force Protection program will offer expanded capabilities to microbial threat characterization by developing systems capable of long-term, cold chain-free storage of microbial samples. Systems that are able to reliably store and retrieve viable microbes over long timescales will ensure that collected samples reach the lab for study in a usable state, allowing the DoD to better leverage its field-forward laboratories to perform pathogenicity assessments for countermeasure development. ***FY 2025 Plans:*** - Acquire microbes necessary to begin testing storage and retrieval methods. - Develop generalizable methods for storing and retrieving multiple types of microbes from different sample types.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate ability to store and retrieve multiple microbes without cold chain for at least one week. - Collect relevant samples necessary to inform design specifications for prototype system. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Biological Undersea Energy ***Description:*** The Biological Undersea Energy program will aim to develop emerging technologies that ensure the DoD has the capability to maintain a presence in austere oceanic environments to provide advanced knowledge of resources and conditions and achieve desired mission effects. Approaches will be developed that utilize biological processes and products to provide energy for improved endurance and performance capabilities while reducing the reliance on servicing or resupply. ***FY 2025 Plans:*** - Identify and model key biological processes that will enable autonomous remote energy production in oceanic environments. - Develop modeled biological processes into optimized biological systems with improved performance capabilities in a lab setting. - Complete a capability design that describes all components and processes in a brassboard including engineering diagrams, expected performance metrics, and other design considerations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	14.456
Title: Environmental Dynamics with Biologically Based Materials and Devices ***Description:*** The Environmental Dynamics with Biologically Based Materials and Devices thrust aims to develop technologies to advance understanding of changing environmental dynamics that result from anthropogenic activities. Understanding the dynamics of physical, complex biological environments in the face of human activity, natural disasters, and severe weather events is a key component of DoD missions. Novel approaches will be developed that utilize biological processes to better understand environmental dynamics in order to exploit changing environments for a DoD strategic advantage, provide solutions to mitigate/ negate environmental damage, and restore operational function to damaged DoD installations at tactical and strategic timescales. ***FY 2025 Plans:*** - Initiate comparison of environments to identify key species for improved environmental resilience and recovery. - Characterize key community species in the environment to understand ecosystem succession and recovery processes in response to environmental dynamics. - Begin investigation of natural vegetation response to relevant DoD activities. ***FY 2024 to FY 2025 Increase/Decrease Statement:***	-	-	7.500

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 increase reflects program initiation.			
Title: Expanding Human Resiliency ***Description:*** The Expanding Human Resiliency program aims to maximize warfighter resiliency by leveraging the human microbiome to improve physiology. This program will develop new technologies to control and manipulate the microbiome, expanding on current state-of-the-art approaches to have more precise and on-demand control of microbiomes. Technologies in this effort will be developed to elucidate the complex interactions between the microorganisms and their host as well as the interactions between consortia of adapted and evolved microorganisms. Advances in this area will both develop novel technologies to interrogate complex microbial communities in human systems and discover ways to beneficially harness microbiomes to expand warfighter resiliency. ***FY 2024 Plans:*** - Complete independent verification and validation (IV&V) testing to assess efficacy of engineered skin microbial formulations to reduce landings by mosquitoes using a small animal model. - Conduct studies in large animal models to assess microbiome safety, efficacy, and transience needed for regulatory approvals. - Initiate regulatory approval procedures to test microbiome formulations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	13.621	8.074	-
Title: Persistent Aquatic Living Sensors ***Description:*** The Persistent Aquatic Living Sensors program is developing novel capabilities to achieve strategic objectives in operational environments by leveraging chemical solutions and living organisms present in the environment. This effort focuses on characterizing marine biological behavior in response to targets of interest. This program will enable persistent dominance in contested waters and provide the DoD with a toolbox of materials and methods for achieving strategic objectives. Results from this research will enhance future DoD naval operations. ***FY 2024 Plans:*** - Complete development of current system prototypes. - Develop, refine, and scale-up the new materials and system prototypes. - Complete field testing of the materials and system prototypes under real-world conditions with DoD end-users. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	18.004	6.466	-
Title: Restoring Cognitive Capability	10.860	10.318	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The Restoring Cognitive Capability program is developing novel drugs to provide rapid therapy for neuropsychiatric disorders experienced by warfighters and veterans. Active-duty military personnel face increased risk of acute and chronic neuropsychiatric dysfunction, limiting day-to-day function and return to duty. Current therapeutic approaches for many neuropsychiatric disorders (e.g., Post Traumatic Stress Disorder [PTSD], mood disorders, and substance abuse) rely on individual management with integrated psychiatric therapy and medication. However, most interventions approved for use in these conditions lack long-term efficacy, involve a logistical burden of treatment and/or carry a risk of serious adverse side effects. Novel drugs developed under this program will be designed to functionally interact with neuronal receptor subtypes known to play a role in these neuropsychiatric conditions, with the aim of enabling fast-acting and effective alleviation of neuropsychiatric dysfunction with single or minimal doses. ***FY 2024 Plans:*** - Optimize novel compounds for pharmacological properties (adsorption, distribution, metabolism, and excretion (ADME)) and validate with in vivo models. - Perform full dose-response and time-course studies with candidate compounds in vivo. - Confirm mechanism of action in vivo by verifying gene expression and protein biomarkers. - Demonstrate preclinical therapeutic efficacy and lack of adverse effects in vivo. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Food and Feedstocks on Demand ***Description:*** The Food and Feedstocks on Demand program is developing biological technologies to support the DoD need to strengthen local resource security for the warfighter. Currently, operators in the field are burdened with transport and disposal of single-use materials. This program is using these impure mixed waste materials as inputs to re-form the molecules for nutrition or other strategic applications. Research in this program will provide a versatile system that delivers food and petroleum/oils/lubricants (POLs) so that warfighters can independently produce material support from waste materials to extend mission duration and/or expand operational flexibility in resource-limited environments. ***FY 2024 Plans:*** - Design and engineer deconstruction methods and waste breakdown systems to align with relevant military scenarios and waste types. - Evaluate modular systems for additional military use cases. - Pressure test robustness and system integration between waste deconstruction platforms and bioreactor systems.	17.395	9.480	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Provide preliminary analyses that products are within desired specifications. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Atmospheric Water Extraction (AWE) ***Description:*** The Atmospheric Water Extraction (AWE) program aims to enable water harvesting directly from the atmosphere by leveraging new materials and advanced engineering and manufacturing techniques to alleviate logistical and tactical burdens. Currently, the DoD relies on purification of existing water sources and/or distribution of bottled or treated water to provide the warfighter with sufficient daily hydration. State-of-the-art water-from-air generation systems are not suitable for military applications because the systems do not operate in a range of atmospheric conditions needed by our soldiers, from arid conditions (<40% relative humidity) to extremely humid, and are too energy-intensive (<7 gallons of water output per gallon of fuel). This program will deliver systems with extraordinarily low size, weight, and power (SWaP) characteristics to provide potable water to individual warfighters and expeditionary units and will provide insights into how new materials can help the warfighter overcome existing material challenges. Technologies developed under this program will provide strategic and tactical advantages aligned with the DoD's vision of future combat operations carried out by distributed and self-sustaining forces. ***FY 2024 Plans:*** - Select final scaled sorbent material candidates for integration into device prototype. - Integrate sorbent materials with final components of water extraction device. - Test and evaluate final fabricated components of water extraction device. - Demonstrate final prototype water extraction device under program test conditions. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	13.952	13.257	-
Title: Preemptive Expression of Protective Alleles and Response Elements (PREPARE) ***Description:*** The Preemptive Expression of Protective Alleles and Response Elements (PREPARE) program is creating a transient, near immediate prophylaxis and treatment to protect military personnel and civilians against public health and national security threats. Currently, protection against Chemical, Biological, Radiological, and Nuclear (CBRN) threats relies on physical barrier technology. This program includes research to develop novel transient and reversible gene modulator therapies to bolster intrinsic host defenses. Work within this program will provide novel solutions that extend beyond the DoD's capabilities to respond to re-emerging, newly emerging, or engineered threats. ***FY 2024 Plans:*** - Demonstrate the utility of using programmable gene modulators to combat chemical threats in an animal model.	9.241	4.508	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	**Project (Number/Name)** MBT-02 / *BIOLOGICALLY BASED MATERIALS AND DEVICES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate the use of programmable gene modulators to combat multiple viral threats in small and large animal models of infection. - Finalize formulations to deliver programmable gene modulators to appropriate cells and tissues with high specificity for infectious disease threat exposures in an animal model. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Accomplishments/Planned Programs Subtotals	189.055	194.437	160.249

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	527.882	572.662	573.265	-	573.265	527.916	525.030	558.054	568.074	-	-
ELT-01: *ELECTRONIC TECHNOLOGY*	-	105.209	120.837	88.921	-	88.921	107.331	114.289	120.835	125.136	-	-
ELT-02: *BEYOND SCALING TECHNOLOGY*	-	422.673	451.825	484.344	-	484.344	420.585	410.741	437.219	442.938	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Applied Research associated with the Electronics Technology Program that is directed towards developing electronics that make a wide range of military applications possible. The PE focuses on turning basic advancements into the underpinning technologies required to address critical national security issues and to enable an information-driven warfighter. This PE also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA funded technologies take root in the U.S. and provide new capabilities for national defense.

Advances in microelectronic device technologies continue to significantly benefit improved weapons effectiveness, intelligence capabilities, and information superiority. The Electronic Technology project supports continued advancement in microelectronics, including electronic and optoelectronic devices, Microelectromechanical Systems (MEMS), semiconductor device design and fabrication, and new materials and material structures. Areas of particular emphasis of this work include reducing the barriers to designing and fabricating custom electronics and exploiting improved manufacturing techniques to provide low-cost, high-performance sensors. Programs in this project will also greatly improve the size, weight, power, and performance characteristics of electronic systems; support positioning, navigation, and timing in GPS-denied environments; and develop sensors more sensitive and robust than today's standards. This project has six major focus areas: Electronics, Photonics, Microelectromechanical Systems, Architectures, Algorithms, and other Electronic Technology research.

The Beyond Scaling Technology project pursues electronics performance advancements that exploit new concepts in circuit specialization and three-dimensional heterogeneous integration (3DHI) by the optimization of materials, devices, architectures, and designs to achieve specific circuit function at high performance. Because electronics advancements must simultaneously make progress in performance and secure the foundation on which our microelectronics infrastructure relies, this envisioned specialization will require incorporation of security safeguards and advancing manufacturing tools and process automation. Accordingly, programs within the Beyond Scaling Technology project will reduce barriers to making specialized circuits in today's silicon hardware and 3DHI by improving producibility. This will significantly increase the ease with which DoD can design, deliver, and eventually upgrade critical, customized microelectronics, particularly for operation in extreme environments. Programs also explore alternatives to traditional circuit architectures, for instance by exploiting 3DHI to optimize electronic devices and by incorporating novel materials and new techniques for securing DoD and commercial data and hardware.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	554.155	572.662	595.500	-	595.500
Current President's Budget	527.882	572.662	573.265	-	573.265
Total Adjustments	-26.273	0.000	-22.235	-	-22.235
• 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	-8.431	0.000			
• SBIR/STTR Transfer	-17.842	0.000			
• TotalOtherAdjustments	-	-	-22.235	-	-22.235

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer and reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects minor program repricing.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602716E / *ELECTRONICS TECHNOLOGY*	Project (Number/Name) ELT-01 / *ELECTRONIC TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
ELT-01: *ELECTRONIC TECHNOLOGY*	-	105.209	120.837	88.921	-	88.921	107.331	114.289	120.835	125.136	-	-

A. Mission Description and Budget Item Justification

Advances in microelectronic device technologies continue to significantly benefit improved weapons effectiveness, intelligence capabilities, and information superiority. The Electronic Technology project supports continued advancement in microelectronics, including electronic and optoelectronic devices, Microelectromechanical Systems (MEMS), semiconductor device design and fabrication, and new materials and material structures. Areas of particular emphasis of this work include reducing the barriers to designing and fabricating custom electronics and exploiting improved manufacturing techniques to provide low-cost, high-performance sensors. Programs in this project will also greatly improve the size, weight, power, and performance characteristics of electronic systems; support positioning, navigation, and timing in GPS-denied environments; and develop sensors more sensitive and robust than today's standards. This project has six major focus areas: Electronics, Photonics, Microelectromechanical Systems, Architectures, Algorithms, and other Electronic Technology research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Fast Event-based Neuromorphic Camera and Electronics (FENCE)	19.500	16.037	7.000

Description: The Fast Event-based Neuromorphic Camera and Electronics (FENCE) program will develop and demonstrate a low latency, low power event-based infrared (IR) camera to enable intelligent sensors for tactical DoD applications. Event-based imagers are an emerging class of sensors with major demonstrated advantages relative to traditional cameras. State-of-the-art visible event-based cameras have been shown to produce over two orders of magnitude less data in optimal conditions relative to traditional framing cameras because they transmit data only from pixels that have changed. This leads directly to two orders of magnitude lower data latency and a commensurate reduction in power consumption. Despite their inherent advantages, existing event-based cameras are not compatible with DoD applications because DoD applications regularly face conditions that are not optimal, where issues such as clutter and noise cause a large percentage of the event-based pixels to change simultaneously. When this happens, today's event-based cameras do not perform significantly better than traditional cameras. FENCE will develop an infrared event-based imager consistent with military requirements. FENCE will develop a four-megapixel asynchronous read-out integrated circuit (ROIC), co-designed with a 3D integrated processor that will intelligently remove noise and clutter to maintain low power and latency operation even when faced with all of the pixels firing simultaneously. If successful, this new class of sensors enabled by FENCE will be capable of responding to fast moving targets and discriminating dim targets in noisy conditions.

FY 2024 Plans:
- Measure processing layer power consumption.
- Integrate components into full focal plane array (FPA).

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-01 / *ELECTRONIC TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Measure integrated processor layer power consumption. ***FY 2025 Plans:*** - Conduct ROIC control demonstration. - Perform initial FPA functionality testing. - Test fully integrated camera for final program metrics. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects moving from design and fabrication to integration and testing.			
Title: Waveform Agile Radio-frequency Directed Energy (WARDEN)	15.000	20.000	8.000
Description: The Waveform Agile Radio-frequency Directed Energy (WARDEN) program aims to extend the range and lethality of high-power microwave (HPM) systems by introducing flexible waveform techniques that use combinations of frequency, amplitude, and pulse-width modulations to significantly improve electromagnetic coupling into complex target enclosures and increase the probability of disruption or damage to internal electronic components and circuits. Applications for HPM systems include counter-unmanned aerial systems (C-UAS), vehicle and vessel disruption, electronic strike, and guided missile defense. Current HPM systems use oscillators to produce electromagnetic radiation. These systems are inherently narrowband and lack the frequency agility to support waveforms to maximize electromagnetic coupling and to optimally exploit electronic system vulnerabilities. Lacking the capability to use optimized waveforms, HPM oscillators have been pushed close to the physical limits of peak power generation. To develop a more efficient, lower power, waveform agile approach, the WARDEN program will develop and demonstrate the first broadband HPM amplifier; create new theory and simulation tools to predict electromagnetic coupling into complex enclosures and the effects on electronics; and develop novel agile waveform techniques capable of reducing the susceptibility threshold of targeted electronics systems to HPM attack. ***FY 2024 Plans:*** - Experimentally demonstrate broadband amplifier power, bandwidth, and pulse duration performance at low repetition rates. - Integrate electromagnetic coupling tools that combine deterministic, reduced-model, and statistical approaches into a hybrid framework. - Validate electromagnetic coupling tools and predictive models through comparison with experimental measurements. - Demonstrate disruptive agile waveform techniques on integrated electronics. ***FY 2025 Plans:*** - Experimentally demonstrate broadband amplifier power, bandwidth, and pulse duration performance at full repetition rate using WARDEN developed waveforms. - Demonstrate integrated electromagnetic coupling tools that combine deterministic, reduced-model, and statistical approaches using a hybrid framework.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-01 / *ELECTRONIC TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Validate electromagnetic coupling tools and predictive models through comparison with experimental measurements on relevant targets. - Demonstrate disruptive agile waveform techniques on integrated electronics relevant to the DoD. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the move from development to demonstration and validation.			
Title: Generating RF with Photonics for low Noise (GRYPHON) ***Description:*** The Generating RF with Photonics for low Noise (GRYPHON) program will develop compact sources of microwaves and millimeter waves with extremely low phase noise. Compact signal sources used today, such as crystal oscillators, are too noisy to support advanced military radar and communications functions. Conversely, best-in-class oscillators which use optical techniques to synthesize extremely pure microwaves are too large and expensive to deploy on the airborne systems, munitions, and other size-constrained platforms where the DoD requires high-performance capabilities. The GRYPHON program will draw on recent advances in miniature optical components to replicate best-in-class optical frequency synthesis techniques in microchip form factors. ***FY 2024 Plans:*** - Demonstrate microwave generation with frequency tunability. - Reduce phase noise of components and microwave synthesizers. - Characterize environmental robustness of microwave oscillators. ***FY 2025 Plans:*** - Package microwave synthesizers into compact modules. - Optimize the design of synthesizers with output across multiple frequency bands. - Optimize the design of synthesizers with robustness to environmental stress. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the move from development to design optimization.	16.000	14.000	6.000
Title: Humboldt ***Description:*** The Humboldt program seeks to develop directed energy (DE) devices to produce disruptive effects in electronic systems. The devices have potential for dual-use as sources to characterize the susceptibility of commercial electronics to electromagnetic interference (EMI). ***FY 2024 Plans:*** - Experimentally characterize the operation of the proof-of-concept devices.	9.500	17.000	15.300

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-01 / *ELECTRONIC TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate the effectiveness of the proof-of-concept devices on electronic systems. - Validate the effectiveness of the proof-of-concept devices on electronic systems. ***FY 2025 Plans:*** - Develop integrated devices in final form factor. - Experimentally characterize the operation of the fully-integrated devices. - Validate the effectiveness of the fully-integrated devices. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the move from proof-of-concept to the development of fully-integrated devices.			
Title: Ultra-Wide BandGap Semiconductors (UWBGS)*	-	13.000	22.621
Description: *Formerly Robust Protection for Electronic Systems (ROPES) The Ultra-Wide BandGap Semiconductors (UWBGS) program will develop and optimize ultra-wide bandgap (UWBG) materials and fabrication processes required to enable the next revolution in semiconductor electronics. UWBGS will establish the foundation for the creation of producible and reliable, high performance UWBG devices for a variety of DoD (and commercial) applications. These include, but are not limited to: high power radio frequency (RF) switches; high power density RF amplifiers; high RF power protection device; high voltage switches for power electronics; high temperature electronics and deep ultraviolet light-emitting diodes and lasers. The program will address the key technical challenges that are limiting the performance of UWBG device. These challenges include realizing high quality UWBG materials, ability to tailor electrical characteristics of UWBG materials; ability to create homo- and heterostructures with abrupt junctions and low defect density; and the realization of ultra-low resistance electrical contacts. UWBGS will fabricate device test structures to quantify the improvements in these areas. To be successful, the program will leverage recent advances in UWBG materials. ***FY 2024 Plans:*** - Develop UWBG material synthesis approaches to reduce defect density and improve doping and uniformity required for producing UWBG devices; establish a baseline for material quality by designing, fabricating, and characterizing test structures. - Develop materials and fabrication process to create low resistance electrical contacts to UWBG materials; fabricate and characterize test structures to quantify improvement in contact resistance. ***FY 2025 Plans:*** - Optimize UWBG material synthesis approaches to reduce defect density and improve doping and uniformity; quantify improvements in material quality by designing, fabricating, and characterizing test structures. - Optimize fabrication process to create robust, low resistance electrical contacts to UWBG materials; fabricate and characterize test structures to quantify robustness and improvement in contact resistance.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-01 / *ELECTRONIC TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Evaluate characterization results versus current state-of-the-art to quantify the improvement possible with UWBG devices. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from investigating approaches and processes of interest to materials and device development and optimization.			
Title: Scalable Analog Neural networks (ScAN) ***Description:*** Building upon technologies discovered under the Fast Event-based Neuromorphic Camera and Electronics (FENCE) program, the Scalable Analog Neural networks (ScAN) program will increase neural network (NN) inferencing capabilities at the edge and simultaneously reduce the size, weight, and power (SWaP) needs of edge platforms. Currently, sensor outputs are digitized at the edge, which consumes SWaP and limits capabilities of edge platforms, but are then transmitted for processing at the command center. ScAN aims to skip or delay the digitization step and implement analog inferencing and compression techniques directly on the analog sensor data at the edge. ScAN objectives are to enable 2000-fold reduction in SWaP for processing of sensor data. ScAN will enable intelligence generation at the edge for missions that collect large amounts of sensor data, such as hyper-spectral imaging for unmanned aerial systems. ***FY 2024 Plans:*** - Initiate development of analog feature extraction and classification techniques for analog sensor data. - Initiate development of inferencing and compression algorithms. - Perform initial hardware and algorithm co-design analysis for the system design of representative mission-relevant sensor systems. ***FY 2025 Plans:*** - Demonstrate analog hardware at medium scales. - Extend development of analog feature extraction and classification techniques to larger scales. - Extend development of inferencing and compression algorithms to larger scales. - Extend hardware and algorithm co-design analysis to larger-scale, mission-relevant sensor systems. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from initial design and development to design finalization and initial demonstration.	-	6.800	19.000
Title: Warfighting Performance for Electronic Technology ***Description:*** Studies conducted under this thrust explore electronics and electronic systems have the potential to offer disruptive performance for the warfighter. This includes advancing the underlying electronics and leveraging the gains associated with tightly integrating advanced electronics at the module and system level. The feasibility and impact of these potential improvements is	-	-	7.000

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
also evaluated. Topics include: processing architectures for modern digital arrays, advanced software algorithms for electronic systems, and passive target tracking technologies ***FY 2025 Plans:*** - Evaluate high performance computing and processing architectures and needs in modern digital arrays. - Perform analysis of the current state-of-the-art of array algorithms and identify areas for development. - Identify trade space of active and passive tracking techniques for advanced targeting applications. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects thrust initiation.			
Title: Non-Kinetic Delivery for Electronic Technology ***Description:*** Studies conducted under this thrust examine and evaluate new technologies that employ non-physical means to degrade or deny targeted adversary capabilities. Studies are also being conducted to investigate technologies to protect against intentional and unintentional non-kinetic effects on friendly systems. The feasibility and potential impact of these technologies for the warfighter is also evaluated. Topics include: high power radio frequency (RF) and optical sources, ultrawide bandgap materials, RF filters, rectifiers, and diodes, and advanced modeling and simulation capabilities. ***FY 2025 Plans:*** - Perform trade study for suitability of using non-kinetic effects across a suite of relevant DoD missions. - Evaluate candidate RF and optical materials and architectures for high power sources to be used for non-kinetic effects. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects thrust initiation.	-	-	4.000
Title: Focal Arrays for Curved Infrared Imagers (FOCII) ***Description:*** The Focal Arrays for Curved Infrared Imagers (FOCII) program is developing curved focal plane arrays for broadband infrared (IR) imagers to enhance battlefield detection and discrimination while maintaining situational awareness. FOCII will leverage curving strategies for state-of-the-art focal plane arrays combined with advances in designing and manufacturing stress relief features to demonstrate hardware that simultaneously provides maximum resolution and illumination. This program will develop novel designs for IR imagers that enable minimal size, weight and cost for size-constrained applications. This will enable new applications in passive seeker technology for missiles, overhead persistent infrared imaging, 360-degree situational awareness, infrared search and track, and long-range targeting. ***FY 2024 Plans:*** - Measure radiometric performance of large area focal array curved to final program specified objective radius.	10.000	9.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-01 / *ELECTRONIC TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate thermal cycling of large area focal array curved to final program specified objective radius. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Wideband Adaptive RF Protection (WARP) ***Description:*** The Wideband Adaptive RF Protection (WARP) program is developing radio-frequency (RF) front-end technology that can protect wideband digital radios against external electromagnetic threats and self-interference through tunable filtering, limiting, and/or signal cancellation. The ability to create tunable and reconfigurable band pass and band stop filters at microwave frequencies will be important for implementing transmit/receive modules in next-generation multi-function arrays. Another important area of interference mitigation is self-interference. WARP is developing the signal cancellation technology that will listen to the transmitted interfering signal and subtract it from the input of the receiver so faint signals near the noise floor can still be detected. Program research will provide feedback mechanisms that intelligently correct these problems. Whether for self-induced interference or external interference jamming, WARP is developing intelligent filtering and self-interference cancellation technologies to protect wideband DoD receivers. ***FY 2024 Plans:*** - Scale adaptive wideband adaptive filter designs to provide full-band coverage. - Scale adaptive analog signal canceller designs to full-band coverage of low-band and high-band. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	14.000	14.000	-
Title: Quantum Imaging of Vector Electromagnetic Radiation (QuIVER) ***Description:*** The Quantum Imaging of Vector Electromagnetic Radiation (QuIVER) program is developing full-tensor magnetic field sensors and will demonstrate them in DoD-relevant applications and concept of operations. In addition to being diagnostically relevant, such sensitive magnetometers could enable future human-machine/brain-machine interfaces. The DoD and industry also use magnetometers for magnetic anomaly detection, which may allow for the discovery of mineral/oil deposits, discovery of old wellheads, or the detection of improvised explosive devices. In addition, magnetometers offer the possibility of magnetic navigation, which may operate in GPS-denied environments. Recent advancements have resulted in the potential to develop highly-sensitive vector magnetometers, which would enable the consequent development of sensitive full-tensor gradient sensors. Such tensors offer more degrees of freedom than their scalar or vector counterparts and potentially provide additional information about the source of the magnetic field. ***FY 2024 Plans:*** - Design reduced size, weight, and power (SWaP) tensor magnetometer with sensor fusion and automation.	13.000	11.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-01 / *ELECTRONIC TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Complete construction of reduced-SWaP tensor magnetometer system for field testing and validate sensitivity and functionality. - Perform field test of reduced-SWaP tensor magnetometer system. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Quantum Apertures (QA) ***Description:*** The Quantum Apertures (QA) program will develop novel radio receiver and aperture systems using quantum sensors as the receiving elements. These receiver systems will be portable, programmable over a very large frequency range, and more sensitive than classical systems at similar size and temperature. This will be achieved by exploiting quantum-based receiving elements composed of atomic vapor cells in highly-excited Rydberg states that have programmable sensitivity over a large range of frequencies and amplitudes. The program will require quantum engineering and traditional electro-mechanical systems engineering to overcome technical and application challenges that impede rapid adoption of a quantum aperture receiver by the defense industrial base. The receiver system's enhanced capabilities will be leveraged in this program to develop novel waveforms while also being compatible with constraints imposed by real-world defense applications. The final receiver system will comprise a phase-sensitive array of quantum receiving elements, lasers to program the sensor and read out radio signals, and processing electronics. Beginning in FY 2024, this program is funded in PE 0602716E, Project ELT-02.	8.209	-	-
Accomplishments/Planned Programs Subtotals	105.209	120.837	88.921

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602716E / *ELECTRONICS TECHNOLOGY*	Project (Number/Name) ELT-02 / *BEYOND SCALING TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
ELT-02: *BEYOND SCALING TECHNOLOGY*	-	422.673	451.825	484.344	-	484.344	420.585	410.741	437.219	442.938	-	-

A. Mission Description and Budget Item Justification

The Beyond Scaling Technology project pursues electronics performance advancements that exploit new concepts in circuit specialization and three-dimensional heterogeneous integration (3DHI) by the optimization of materials, devices, architectures, and designs to achieve specific circuit function at high performance. Because electronics advancements must simultaneously make progress in performance and secure the foundation on which our microelectronics infrastructure relies, this envisioned specialization will require incorporation of security safeguards and advancing manufacturing tools and process automation. Accordingly, programs within the Beyond Scaling Technology project will reduce barriers to making specialized circuits in today's silicon hardware and 3DHI by improving producibility. This will significantly increase the ease with which DoD can design, deliver, and eventually upgrade critical, customized microelectronics, particularly for operation in extreme environments. Programs also explore alternatives to traditional circuit architectures, for instance by exploiting 3DHI to optimize electronic devices and by incorporating novel materials and new techniques for securing DoD and commercial data and hardware.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Low Temperature Logic Technology (LTLT)	22.000	12.985	10.000
Description: The Low Temperature Logic Technology (LTLT) program is exploiting the unique device and material performance characteristics of state-of-the-art silicon transistors at cryogenic temperatures. Current silicon transistors are performance and power limited when operating at room temperature or higher. This program mitigates these limitations through modifying the design of existing silicon transistors to optimize their performance at cryogenic temperatures. These devices will be compatible with current complementary metal-oxide-semiconductor (CMOS) fabrication process flows and will offer significant increases in performance and power efficiency over room temperature devices. Basic research for this program is funded within PE 0601101E, Project ES-02.			
FY 2024 Plans: - Improve low-temperature device characteristics to enhance performance. - Demonstrate the performance/power improvement of the LTLT devices. - Demonstrate the performance/power improvement of a central processing unit with large on-chip static random access memory.			
FY 2025 Plans: - Further improve the performance/power of the LTLT devices. - Demonstrate the performance/power improvement of a larger scale central processing unit operating at low temperature.			
FY 2024 to FY 2025 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 decrease reflects the move from development and demonstration of the devices to optimization.			
Title: COmpact Front-end Filters at the ElEment-level (COFFEE)	14.000	14.000	14.000
Description: The COmpact Front-end Filters at the ElEment-level (COFFEE) program is developing and demonstrating compact, high frequency radio frequency (RF) filter technology without compromising performance, specifically low insertion loss and high-power handling. The new filtering technology will enable interference rejection capability, efficient spectral management, and coexistence with commercial 5G applications. It is projected that COFFEE filter technology will enhance the resilience of military microwave and mm-wave radar and communication systems for DoD spectral dominance into the future. For commercial applications, COFFEE will result in more efficient use of mm-wave frequency allocations for 5G networks. ***FY 2024 Plans:*** - Integrate the resonators into compact, low insertion loss filters demonstrated at microwave frequencies. - Construct filters with high power handling and, as required, integrable tuning. ***FY 2025 Plans:*** - Achieve repeatable manufacturability of high-performance filters with low device-to-device variability. - Integrate the low insertion loss filters into filter tiles with supporting architecture. - Demonstrate capabilities of filter tiles under operationally relevant conditions.			
Title: ELectronics for G-band ARrays (ELGAR)	18.000	19.000	11.000
Description: The ELectronics for G-band ARrays (ELGAR) program is developing the integration technologies needed to create compact, high-performance G-band (220 GHz) array front-end electronics to enable phased array antenna systems for DoD communications and sensing. ELGAR will address the key technical challenges that prevent III-V electronics from realizing high-performance G-band arrays, namely achieving efficient, compact G-band III-V monolithic microwave/millimeter wave integrated circuit power amplifiers (MMIC PAs) with high output power density, and achieving low loss off-chip interconnects between adjacent G-band array components. In particular, ELGAR will develop III-V compatible, silicon-like fabrication and integration approaches to enable compact, high power density, high efficiency G-band MMICs and arrays. The technologies developed will support applications including high data rate communications in size, weight, and power-constrained platforms. ***FY 2024 Plans:*** - Further improve the efficiency and output power of compact G-band III-V MMIC PAs that use the silicon-like multilayer interconnects. - Further reduce the power loss of array-level interconnects for integration of G-band PAs with other array components. - Design and fabricate circularly-polarized, medium-power transmit array test articles.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Design and fabricate circularly-polarized, low-noise receive array test articles. ***FY 2025 Plans:*** - Further improve the efficiency and output power of compact G-band III-V MMIC PAs that use the silicon-like multilayer interconnects. - Further reduce the power loss of array-level interconnects for integration of G-band PAs with other array components. - Characterize circularly-polarized, medium-power transmit array test articles; design circularly-polarized, high-power transmit array test articles. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from initial design to fabrication and characterization of components.			
Title: Quantum Inspired Classical Computing (QuICC) ***Description:*** The Quantum Inspired Classical Computing (QuICC) program will implement quantum-inspired algorithms using classical dynamic systems in novel computing architectures for the efficient solving of complex optimization problems. Currently, too much computational energy is required to solve mission-scale optimization problems leading to sub-optimal solutions and excessive computation times. This program will create frameworks for analyzing the computational advantage provided by quantum-inspired algorithms and perform the hardware and algorithm co-design needed to reduce the required energy to optimally solve mission-scale problems. ***FY 2024 Plans:*** - Initiate development of analog subsystems for quantum-inspired solvers. - Perform initial hardware performance model development. - Demonstrate co-design framework for digital resource estimation. - Develop systematic methodologies for predictive benchmarks. ***FY 2025 Plans:*** - Demonstrate small-scale analog subsystem hardware and validate initial hardware performance models. - Demonstrate digital resource estimation in the co-design framework and initial predictive benchmarking techniques. - Implement and optimize solver algorithms to increase the accuracy of the framework estimates. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from algorithm and hardware design to subsystem development and design.	17.000	15.000	13.000
Title: Massive Cross Correlation (MAX) ***Description:*** The Massive Cross Correlation (MAX) program aims to develop a scalable wideband correlator that can simultaneously achieve the state-of-the-art dynamic range of a digital correlator with the power efficiency enabled by analog	18.000	19.000	13.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
electronics. Correlators are the core signal processing component used in critical DoD applications such as spread spectrum communications, passive coherent location, and synthetic aperture radar. Current correlator implementations use field-programmable gate arrays and general-purpose graphics processing units requiring thousands of watts of power and racks of supporting computer equipment for today's low frequency, low bandwidth applications, which creates challenges for their use in power-constrained platforms and in applications that require high frequency, high bandwidth solutions. The MAX program will leverage advances in analog signal processing and state-of-the-art fin field-effect transistor (FinFET) semiconductor processes to overcome these challenges. ***FY 2024 Plans:*** - Critical design review of analog correlators meeting high efficiency in simulation. - Fabricate initial designs of scalable, wideband analog correlators achieving high efficiency in a laboratory test environment. - Independent verification and validation of correlators meeting program metrics with government-furnished waveforms. ***FY 2025 Plans:*** - Implement proof-of-concept designs showing program efficiency goals at program dynamic range requirements meeting initial bandwidth metrics. - Critical design review of analog correlators meeting intrinsic hardware dynamic range in simulation. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from design completion to the start of device fabrication.			
Title: Robust Electronics for Radiative Environments (RE2)	4.000	7.000	8.000
Description: The Robust Electronics for Radiative Environments (RE2) program is developing advanced radiation-hardened (rad-hard) nonvolatile memories to meet the demands of emerging missions. Current rad-hard memories are many generations behind state-of-the-art commercial electronics and cannot meet the needs of future systems. In order to address these needs, RE2 will work to deliver high-performance memories for space and strategic systems. ***FY 2024 Plans:*** - Initiate design evaluation of candidate rad-hard and rad-tolerant processor and memory architectures. - Evaluate results of trade study and design evaluation to guide approaches to hardening memories to strategic levels while achieving key latency and density goals. - Initiate first cycle of design, fabrication, packaging and assembly, and test. ***FY 2025 Plans:*** - Execute first design review to evaluate architecture and design of first memory arrays. - Complete first cycle of design, fabrication, packaging and assembly, and test.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Collect and analyze first data on radiation response and map the result into anticipated mission profiles. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from initial design to design finalization and fabrication.			
Title: H6 ***Description:*** The H6 program, building on technology developed in the Lasers for Universal Microscale Optical Systems (LUMOS) program (budgeted in this PE and Project), is developing the first tactical-grade clock. Tactical-grade clocks are ultra-small, low power, fieldable and can maintain the timing needed for DoD-relevant applications in challenging environments. Precise timing in a tactical package will decouple operations from GPS dependence, overcoming a significant operational vulnerability for the warfighter. Precise tactical-grade clocks from H6 will enable increased signal assurance and pervasive communications security in high-jamming regions. Additionally, H6 will enable real-time, physical monitoring and tracking of warfighters and special forces and will play a critical role in search and rescue through the ability to maintain precise time over a long mission duration without having to re-establish external communications. ***FY 2024 Plans:*** - Initiate construction of tactical-grade clock components. - Demonstrate temperature-insensitive operation in realistic environments. - Develop clock components towards miniaturization of the final system. ***FY 2025 Plans:*** - Develop hypotheses for long-term clock aging. - Demonstrate preliminary aging reduction techniques. - Initiate construction of miniaturized clock. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from initial design to initiating construction of tactical-grade clock components.	12.000	15.000	9.000
Title: Technologies for Heat Removal in Electronics At the Device Scale (THREADS) ***Description:*** The Technologies for Heat Removal in Electronics At the Device Scale (THREADS) program is developing technologies to overcome transistor thermal limits to realize robust, high power density transistors that operate near their fundamental electronic limit of radio-frequency (RF) output power. DoD's RF transmitters increasingly use high-power gallium nitride (GaN) wide bandgap (WBG) transistors, which provide a 5X improvement in RF power output compared to the legacy gallium arsenide (GaAs) technology. Achieving high RF power output while maintaining a transistor operating temperature below the nominal maximum reliable operation temperature faces two challenges. The first challenge is reducing thermal resistance within the device. This will be achieved by leveraging recent advances epitaxial growth processes and phonon bridges to reduce	14.000	26.000	15.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
semiconductor material thermal resistance. The second challenge is more efficiently moving heat away from the transistor hot spots. This will be achieved through novel transistor topologies and by leveraging recent advances in the integration of 2D and 3D cooling structures and high thermal conductivity materials, such as diamond, into the transistor. THREADS will demonstrate high efficiency X-band transistors and power amplifier (PA) test vehicles with an output power density of 16X higher than production GaN amplifiers. THREADS technology will enable increased range for radar, communications, and electronic warfare systems. ***FY 2024 Plans:*** - Finalize initial concepts for the reduction of transistor thermal resistance. - Fabricate thermal resistance test structures and measure a 2.5X reduction in thermal resistance. - Finalize preliminary concepts for robust RF PAs with increased output power density. - Fabricate transistors and PAs and measure a 5X increase in output power density. ***FY 2025 Plans:*** - Refine concepts for the reduction of transistor thermal resistance. - Design and fabricate thermal resistance test structures with a 5X reduction in thermal resistance. - Refine concepts for robust RF PAs with increased output power density. - Design and fabricate transistors and PAs with a 10X increase in output power density. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from initial development to design and fabrication.			
Title: Minitherms3D ***Description:*** Minitherms3D is developing thermal management solutions for the three-dimensional heterogeneous integration (3DHI) of microelectronics to accelerate the growth of compact, high-performance microsystems. 3DHI microsystems are enabling technologies for phased array systems and dense computing for artificial intelligence and machine learning applications. Minitherms3D will reduce the size, weight and power (SWaP) of high-performance 3DHI microsystems by developing novel methods to remove heat from within the 3D stack, transmit it to the outer boundaries of the stack, and reject it to outside the ambient environment. ***FY 2024 Plans:*** - Develop in-tier heat removal solutions. - Begin development of efficient thermal link to heat rejection components. - Begin development of low-SWaP thermal rejection components. ***FY 2025 Plans:*** - Provide a three-tier test vehicle to demonstrate improved thermal management capabilities.	9.341	18.000	18.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Refine thermal performance of developed solutions for both within stack and outside stack technical challenges. - Begin development of five-tier stack test vehicle to demonstrate improved thermal management capabilities.			
Title: Space Power Conversion Electronics (SPCE) ***Description:*** The Space Power Conversion Electronics (SPCE) program is developing highly-efficient, radiation-tolerant point of load (POL) converters for low-earth-orbit satellites. In today's space power systems, POL converters derate their operating voltage to maintain radiation tolerance, resulting in decreased efficiency and limiting the satellite's available power, capabilities, and battery lifetime. To address this deficiency, SPCE will develop high-performance, radiation-tolerant high voltage switches by exploiting advanced wide-bandgap semiconductor advanced material synthesis, novel device architectures, and 3D heterogeneous integration technology. ***FY 2024 Plans:*** - Complete analysis of candidate wide-bandgap material systems for radiation-tolerant, high-voltage transistors with increased switching performance. - Complete initial simulations of expected switching performance of advanced radiation-tolerant, high-voltage transistors enabled by wide-bandgap materials. - Perform design of high-performance radiation-tolerant, high-voltage switches enabled by wide-bandgap semiconductor transistors. ***FY 2025 Plans:*** - Optimize design and fabrication of radiation-tolerant, high-voltage transistors. - Demonstrate device integration technologies which enables high-efficiency, high-energy-density POL converters. - Perform initial characterization of the integrated, high-efficiency, high-energy-density POL converters.	12.000	18.000	18.000
Title: Faithful Integration Reverse-engineering and Emulation (FIRE) ***Description:*** The Faithful Integration Reverse-engineering and Emulation (FIRE) program will develop tools to find and patch vulnerabilities within cyber-physical systems. A cyber-physical system operates in the physical world using hardware sensors to perceive the analog environment, digital software for processing, and actuators to interact with the environment. Cyber-physical vulnerabilities arise from the composition of hardware, software, and physical components where each component may not be vulnerable in-and-of itself. FIRE will develop novel modeling and simulation techniques to help expedite finding and patching vulnerabilities in cyber-physical systems. ***FY 2024 Plans:*** - Creation of a surrogate cyber-physical test vehicle to demonstrate the tools.	3.000	14.040	24.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Proof-of-concept demonstration of tools on the surrogate cyber-physical test vehicle. ***FY 2025 Plans:*** - Evaluate results of the surrogate cyber-physical test vehicle. - Perform real-world demonstration of the approaches. - Scale the approaches to medium-complexity systems. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from initial development to proof-of-concept of tools.			
Title: NanoWatt Platforms for Sensing, Analysis, and Computation (NaPSAC) ***Description:*** Efficient, high-speed scientific computing architectures are a ubiquitous requirement for applications including modeling of complex physical systems, advanced device designs, and multiscale computations of dynamical phenomena such as climate models or turbulence. Current state-of-the-art computing systems requires prohibitive amounts of energy and time to perform such calculations. The NanoWatt Platforms for Sensing, Analysis, and Computation (NaPSAC) program aims to develop a novel computational architecture for massively parallel, ultralow power "in-memory" computation. NaPSAC-based computing architectures can potentially yield transformative impact by enabling beyond-state-of-the-art computational speed and accuracy. Applications of immediate relevance to the DoD include simulations of turbulent flows, multiscale electromagnetic simulations of plasma dynamics, advanced semiconductor device design, and the modeling of high-performance materials. ***FY 2024 Plans:*** - Develop computational algorithms to enable efficient computations of complex systems including high performance materials and advanced semiconductor devices. - Finalize nanoresonator-based computing architectures to enable massively parallel hyperspectral computations, optimize material parameters for tunability and precision, and initiate device fabrication. ***FY 2025 Plans:*** - Demonstrate preliminary proof-of-concept test articles of novel nanoresonator-based computing engines for high speed, energy efficient scientific computations. - Perform concept validation and preliminary benchmarking of computing accuracy, speed and power efficiency of nanoresonator computing modules. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from algorithmic and architecture design to component development and validation.	5.500	14.000	12.000
Title: Optomechanical Thermal Imaging (OpTIm)	5.000	12.300	16.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: Advanced infrared (IR) detectors and thermal imaging systems underpin a vast DoD application space including biochemical detection; infrared Search-and-Track; and terrestrial and space-based Intelligence, Surveillance, and Reconnaissance. Current IR detectors suffer from numerous limitations including poor sensitivity, poor signal bandwidth, or the need for expensive cryogenic cooling. The Optomechanical Thermal Imaging (OpTIm) program will develop a new modality of low size, weight, and power, room temperature IR detectors capable of quantum-level sensitivity, thereby enabling transformative enhancements to DoD capabilities including, but not limited to, night vision, surveillance, multispectral detection, and remote detection of trace industrial pollutants and greenhouse gases. ***FY 2024 Plans:*** - Investigate technical and fundamental performance limits of this modality of infrared (IR) detection. - Execute device simulations and demonstrations of single-pixel test articles of a new modality of infrared detection. - Demonstrate design, simulation, and fabrication of novel detector surface coatings capable of identifying specific chemical or biological signatures in the infrared spectrum. - Develop integrated device designs of scalable IR detector concepts for IR imaging applications. ***FY 2025 Plans:*** - Demonstrate functionality and characterize performance of novel optomechanical IR detector devices. - Initialize fabrication, integration, and characterization of scalable optomechanical IR detectors. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from component fabrication and demonstration to system integration and demonstration.			
Title: Processor Reconfiguration for Wideband Sensing Systems (PROWESS)	16.732	17.000	16.000
Description: The Processor Reconfiguration for Wideband Sensing Systems (PROWESS) program is developing high-throughput streaming-data processors that change their programming at nanosecond timescales to detect novel radiofrequency (RF) signals. Sensing complex and unanticipated signals across wide RF bandwidths is limited by the computing capacity available at the tactical edge. Today's tactical spectrum sensors rely on field-programmable gate arrays (FPGAs) for low-latency, high-throughput signal processing. Since FPGA reconfiguration time (milliseconds) is much slower than RF signal dynamics (nanoseconds), FPGAs cannot optimize their signal processing in real time as new signals are observed. Recent advances in application-specific processing arrays, real-time task scheduling, and high-bandwidth input/output enable the development of new run-time reconfigurable array (RTRA) processors capable of reprogramming themselves as new signals are received. PROWESS is investigating RTRA processors and receiver integration approaches to enhance the performance of tactical RF sensors in congested spectrum. ***FY 2024 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop preliminary concept designs to integrate RTRA processors into complete spectrum sensing systems. - Finalize concept design for RTRA processor test chips. - Conduct design review of RTRA processor test chips and their integration into systems. ***FY 2025 Plans:*** - Develop concept designs to integrate RTRA processors into spectrum sensing testbeds. - Finalize concept design for RTRA processor test chips. - Develop initial compilers and related RTRA programming tools. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from initial concept designs to finalizing concept designs for the test chips and their integration into systems integration.			
Title: Digital RF Battlespace Emulator (DRBE)	20.000	23.500	14.000
Description: The Digital RF Battlespace Emulator (DRBE) program is developing a large-scale, interactive, emulated radio frequency (RF) environment, providing the DoD with the capability to cost-effectively evaluate adaptive, intelligent, and spatially distributed next-generation RF systems. DRBE is leveraging advances in massively multi-core computing hardware and high-bandwidth digital cross-connects to emulate realistic RF environments accounting for RF platform movement, signal propagation effects and delays, signal interference, and interactions between RF systems. An electronics architecture supporting the power and latency requirements demanded by these emulation environments does not currently exist. DRBE is pursuing three technical thrust areas: architecture, massively multi-core computing, and scenario modeling. The resulting test environment will allow plug-and-play connections for hundreds of RF systems in a battlespace test. Multi-system exercises will then be quickly executed through many different combat scenarios and variations. DRBE is serving to develop concept of operations (CONOPS), inform battle plans, and fine-tune the performance of both individual and large groups of RF systems. Additional development started in 2024 greatly expands the input/output bandwidth of DRBE to support for much larger RF scenarios. ***FY 2024 Plans:*** - Demonstrate real-time RF emulation on computational accelerator chip. - Integrate High-Performance Computer (HPC) with RF interfaces. - Deliver DRBE components to DoD laboratory for integration. ***FY 2025 Plans:*** - Validate real-time HPC performance with a representative DRBE workload. - Develop DRBE HPC prototype with expanded input/output subsystem.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Assemble mechanical prototype to support large-scale integrated photonics. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the move from on-chip emulation to real-time HPC validation.			
Title: Next Generation Microelectronics Manufacturing (NGMM)* ***Description:*** *Formerly Next Generation Microelectronics Prototyping - Designs Next Generation Microelectronics Manufacturing (NGMM) creates new software design tools to enable the development of novel three-dimensional heterogeneous integration (3DHI) microsystems that are test articles with the NGMM program. The design tools developed will be validated through design challenges. These design challenges provide the opportunity to explore approaches that will improve and accelerate the adoption of 3DHI standardized chip-to-chip interfaces and package optimization. Leading-edge chip designs will be fabricated, and subsequently integrated into 3DHI designs in multi-project demonstration runs. Additional research related to this effort is funded within PE 0603739E, Project MT-16. ***FY 2024 Plans:*** - Create initial software components and establish baseline processes for multi-user assembly design kit. - Identify and initiate challenge problems for 3DHI microsystems and establish appropriate metrics. - Determine goals for design challenges for standardized 3D chip-to-chip integration practices. - Establish plan for utilizing leading-edge chips (or chiplets) to develop components for novel 3DHI test article designs. ***FY 2025 Plans:*** - Run two design challenges for 3DHI microsystems standardized chip-to-chip integration practices. - Complete two fabrication runs for leading-edge chips as components for novel 3DHI test article designs. - Assess and validate efficacy of initial assembly design kit based upon novel 3DHI test article designs from challenge runs. - Update goals for the next set of design challenges for standardized chip-to-chip integration practices, based on assessment of assembly design kit and the interface standard.	25.000	25.000	25.000
Title: Next Generation Microelectronics - Advanced Manufacturing Approaches for three-dimensional heterogeneous integration (3DHI) ***Description:*** Next Generation Microelectronics - Advanced Manufacturing Approaches for three-dimensional heterogeneous integration (3DHI) addresses the unique manufacturing requirements for 3DHI microsystems, including design, fabrication, packaging, assembly, and security. New multi-chip, multi-technology assembly and packaging will advance beyond silicon-centric integration to include integration of radio frequency (RF), photonics, and compound semiconductors. In order to enable this diversity of materials and functions, integration technologies will be enabled by improving thermal management, improving inter-	27.000	4.000	-

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
chip power delivery, and improving the diagnostic capability of these complex microstructures. Basic research related to this effort is funded within PE 0601101E, Project ES-02. ***FY 2024 Plans:*** - Continue developing multi-chip, multi-technology assembly and packaging techniques consistent with high density interconnects (less than or equal to one-micron pitch). - Develop requirements for a distributed heterogenous processing architecture. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Optimum Processing Technology Inside Memory Arrays (OPTIMA)* ***Description:*** *Previously part of Next Generation Microelectronics - 3DHI The Optimum Processing Technology Inside Memory Arrays (OPTIMA) program aims to create a fast, small, energy-efficient, and adaptable compute-in-memory (CIM) accelerator using approaches compatible with very large-scale integration (VLSI) fabrication. Traditional accelerators based on von Neumann architecture have limitations in terms of computational power efficiency and speed. By demonstrating Multiply Accumulate Macros (MAMs) consisting of a large number of Multiply Compute Elements (MCE) into CIM architectures, these challenges can be overcome, leading to improved performance. The program goal is to showcase high-performance MAMs with innovative signal processing circuitry and architectures, with a focus on optimizing both space and power efficiency. ***FY 2024 Plans:*** - Develop a low-energy, single-transistor footprint MCE with improved energy efficiency and speed. - Optimize the size and footprint of the MCE to enhance compactness and integration capabilities. ***FY 2025 Plans:*** - Further enhance the energy efficiency and speed of the MCEs for improved performance. - Experimentally demonstrate a compact MAM with a high number of MCEs, showcasing scalability and potential for parallel processing. - Evaluate performance of compact MAM with high number of MCEs. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from development of the initial concept to enhancement and demonstration of an optimized device.	13.000	16.000	17.240
Title: Scalable On-Array Processing (SOAP)*	-	10.000	20.000

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: *Previously part of Next Generation Microelectronics - 3DHI The Scalable On-Array Processing (SOAP) program is designed to achieve scalable algorithms and processing architectures to overcome the inherent digital bottlenecks that severely limit today's wideband operation on arbitrarily large elemental digital phased arrays. SOAP aims to reduce the computational complexity of array processing as a function of element count, from exponential to linear scaling. SOAP also seeks to move the processing from physically separated back-end processors to processors integrated into the array, in order to fully process all the information generated at the element level, with no elemental information loss. To achieve these aims, SOAP will design processors that can be distributed within the array, as close to the elements as possible. These processors should be connected and networked in such a way that the data from any element can be processed by any processor. ***FY 2024 Plans:*** - Development of two data sets for testing and demonstration. - Development of new adaptive array processing algorithms that maintain the performance of traditional algorithms but reduces the number of computational steps and scales more linearly as array size increases. ***FY 2025 Plans:*** - Design of processing elements necessary to move array processing onto the array. - Completion of new adaptive array processing algorithms. - Independent verification and validation of delivered algorithms. - Finalization of design of processing elements necessary to move array processing onto the array. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the program moving from initial design and data set development to design completion and verification.			
Title: Intensity-Squeezed Photonic Integration for Revolutionary Detectors (INSPIRED)*	-	9.000	17.000
Description: *Previously part of Next Generation Microelectronics 3DHI The Intensity-Squeezed Photonic Integration for Revolutionary Detectors (INSPIRED) program will develop compact, ultra-low-noise optical detectors. Low-noise detection is vital to all optical science and technology, but the quantum nature of light imposes a fundamental quantum limit on a conventional optical detectors noise performance. Recent experiments have demonstrated that exotic quantum states called squeezed light can be harnessed to overcome the quantum limit, albeit from bench-scale apparatuses that ultimately restrict the application of squeezed-light-enhanced detectors to esoteric applications such as gravitational-wave astronomy. The INSPIRED program will leverage recent advances in chip-scale quantum optics and materials			

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
to realize optical detector modules operating well below the quantum noise limit in form factors that enable deployment in applications such as biosensing, navigation, and communications. ***FY 2024 Plans:*** - Establish squeezed-light measurement methodology and procedure. - Complete design of chip-scale photonic components that will serve as basis for squeezed light generator. - Complete design of low-loss chip-scale photonic components that will serve as basis for low-loss interferometer circuit. ***FY 2025 Plans:*** - Complete fabrication process development for integrated photonics circuits that can create and manipulate quantum states of light. - Experimentally demonstrate squeezed light generation using chip-scale components. - Experimentally demonstrate components chip-scale low-loss interferometer circuits. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from design completion to fabrication and experimental demonstration.			
Title: Next Generation Microelectronics - Advanced Manufacturing for Extreme Environment Electronics ***Description:*** Next Generation Microelectronics - Advanced Manufacturing for Extreme Environment Electronics addresses the design, fabrication, packaging, assembly, and testing of the next generation of microsystems targeted for use in extreme environments: high voltage, high current, high temperature, low temperature, and radiation exposure. New manufacturing methods will be created, with an emphasis on developing techniques to enable high survivability of these microsystems while operating in the extreme environments. This effort will also develop techniques to significantly improve the performance of these unique microsystems. Basic research related to this effort is funded within PE 0601101E, Project ES-02.	43.000	-	-
Title: Macaroni* ***Description:*** *Previously part of Next Generation Microelectronics - Extreme Environment Electronics Measurement and control of the electromagnetic spectrum is a key area of research for the Department of Defense (DoD). Spectrum dominance requires quick and efficient control of electromagnetic radiation from low frequencies to X-rays. In classical antenna theory, the sensitivity-bandwidth product is fundamentally limited by the physical shape and size of the antenna. This performance degrades significantly as the antenna becomes electrically small, that is, the physical size becomes much smaller than the electromagnetic wavelength of operation. The Macaroni program seeks to develop electrically-small receivers and transmitters with performance that exceeds the current state of the art (SoA). Recent advances in quantum sensors, materials science, electromagnetic shielding, laser technology, resonators, cryogenic systems, and vacuum components have pushed	-	20.000	24.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
the SoA in sensing technologies. For transmitters, new insights in active antenna technology, control schemes, methods of impedance matching, and strategies for volume filling present new opportunities. Furthermore, recent efforts in piezoelectrics, magnetoelectrics, high-index materials, and multiferroic materials may be leveraged. ***FY 2024 Plans:*** - Develop theory of electrically-small receiver and transmitter. - Perform design of concept test vehicle for validation of developed theory of electrically-small receiver and transmitter. - Experimentally validate theory of electrically-small receivers and transmitters. ***FY 2025 Plans:*** - Finalize design of concept test vehicle for validation of developed theory of electrically-small receiver and transmitter. - Demonstrate electrically-small receiver performance meeting program metrics in a laboratory environment. - Demonstrate electrically-small transmitter performance meeting program metrics in a laboratory environment. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from concept validation to demonstration of the electrically-small receiver and transmitter.			
Title: High Operational Temperature Sensors (HOTS)*	-	12.000	22.000
Description: *Previously part of Next Generation Microelectronics - Extreme Environment Electronics The High Operational Temperature Sensors (HOTS) program seeks to develop high-temperature sensor microelectronics that can operate at extreme temperatures (800°C). The program is looking for innovative approaches that enable revolutionary advances in science and technology for integrated sensor module development. The current state of the art in high-temperature sensors is limited by the performance of transducers and signal-conditioning microelectronics. The HOTS program aims to overcome these limitations by developing new transducers and signal-conditioning microelectronics that can operate at high temperatures while still meeting the performance goals. ***FY 2024 Plans:*** - Perform multi-physics simulation and analysis of sensor performance. - Design and fabricate discrete high operational temperature transistors. - Design and fabricate discrete high operational temperature pressure transducers. ***FY 2025 Plans:*** - Verify and validate performance of high operational temperature transistors and transducers. - Design full circuits and simulate performance of the integrated sensor system based on measured component results.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Integrate the discrete transducer and transistors to form high operational temperature sensor modules. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from design and fabrication of the discrete high temperature components to the design and integration of the components into the complex module.			
Title: Advanced Sources for Single-event Effect Radiation Testing (ASSERT)* ***Description:*** *Previously part of Next Generation Microelectronics - Extreme Environment Electronics 3D heterogeneously integrated (3DHI) microelectronics will be a key driver of the next wave in electronics performance. However, the nation's current single-event effect (SEE) radiation testing infrastructure lacks the ability to analyze and qualify emerging 3D devices for operation in high radiation environments. To fill this gap, the Advanced Sources for Single-event Effect Radiation Testing (ASSERT) program will develop new source technologies to create charge tracks with deep penetration depths for SEE qualification of 3DHI topologies and packaging, provide the means to selectively probe device topologies to inform engineering design, and generate data to validate developing models and codes and to provide training sets for optimization. ***FY 2024 Plans:*** - Commence development of radiation source design, verified through 3D simulation. - Develop predictive single-event effect testing methodology. ***FY 2025 Plans:*** - Finalize radiation source designs and initiate fabrication, procurement, and laboratory preparation. - Conduct proof-of-concept experiments to validate the ability of novel sources to reproduce single-event effect responses in representative electronic devices. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from initial concept design and development to design finalization and initiating fabrication of the sources.	-	15.000	17.000
Title: Next Generation Microelectronics - Advanced Manufacturing Tools ***Description:*** Next Generation Microelectronics - Advanced Manufacturing Tools addresses the development of new manufacturing tools for the design, fabrication, packaging, assembly, testing, and digital emulation of the next generation of advanced microsystems. Specifically, these advanced microsystems include three-dimensional heterogeneous integration (3DHI) and designs targeted for use in extreme environments such as high voltage, high current, high temperature, low temperature, and radiation exposure. New tools to improve manufacturing and testing will be designed, built, and characterized. These tools will enable cost-effective on-shoring of automated processes for packaging, assembly, and testing of advanced microsystems.	42.000	16.200	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The software and hardware tools addressed in this program will advance integration techniques beyond current commercial capabilities to support national security needs. Design, verification, and security for 3DHI will be supported by coordinated investments that couple manufacturing and electronic design automation. Basic research related to this effort is funded within PE 0601101E, Project ES-02. ***FY 2024 Plans:*** - Develop tools for design, simulation, testing, and cost-optimization of 3DHI components and packages. - Continue developing multi-domain models for virtual prototyping of 3DHI components and packages. - Implement methodologies for design optimization for multi-chip, multi-technology packaging and assembly techniques consistent with high density interconnects. - Evaluate methods for implementing security features into 3DHI electronics and their associated interconnects. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Quantum Augmented Network (QuANET)* ***Description:*** *Previously part of Next Generation Microelectronics - Advanced Manufacturing Tools The Quantum Augmented Network (QuANET) program is developing quantum-augmented networks that add security and covertness properties inherent in quantum communications to classical, non-quantum, network infrastructures. Today, digital communication paradigms use a network stack that consists of a layered set of software protocols. The higher layers are closer to applications on computers and servers, while the bottom layers are closer to the physical channel implementation. State-of-the-art networks commonly rely on security at the top layers of the stack, assuming that this security also mitigates attacks on lower layers. Unfortunately, advanced persistent threat (APT) attacks are defeating many existing state-of-the-art security capabilities. The QuANET program seeks to augment existing software infrastructure and network protocols with quantum properties to mitigate these attack vectors. QuANET will develop the hardware, protocols, and software tools to enable quantum communications over classical, non-quantum, network infrastructures. QuANET algorithms, protocols, and software infrastructure will facilitate multiplexing quantum photons into classical optical streams, enabling the use of quantum timing and sensing information atop classical information. Integrating quantum photons into classical optical data streams will bring the event detection, node verification, and high-fidelity timing mechanisms of quantum communications into existing classical networks. If successful, QuANET will enable quantum-augmented networking that provides greater security than current classical networks. ***FY 2024 Plans:*** - Design specifications for a quantum network interface card (qNIC) that has the ability to send and receive quantum information, as well as sending and receiving quantum timing and sensing information.	8.000	12.000	19.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop initial algorithms, protocols, and software infrastructure for hybrid quantum-classical optical data streams, enabling the use of quantum timing and sensing information in synchrony with classical information. - Develop algorithms, protocols, and software infrastructure for integrating quantum secure communication links into a classical network infrastructure running Internet protocols. ***FY 2025 Plans:*** - Build a test article for quantum augmented network, utilizing fabricated qNICs and developed quantum communication algorithms, protocols, and software infrastructure. - Demonstrate initial capabilities of a test article for a quantum augmented network to send and receive quantum information. - Test and evaluate initial security capabilities of a test article for a quantum augmented network to detect and mitigate network attacks such as rogue or counterfeit nodes, unwanted listeners, route injections, and timing attacks. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects continued development of techniques to integrate quantum information in classical communication networks and expanded work to assess the capabilities of a test article for a quantum augmented network.			
Title: Continuous-correctness On Opaque Processors (COOP)* ***Description:*** *Previously part of Next Generation Microelectronics - Advanced Manufacturing Tools The Continuous-correctness On Opaque Processors (COOP) program will validate that continuous correctness of software enables adoption of the latest processors with low overhead. Instead of creating new threat-specific signatures to detect the threats, COOP detects the physical manifestations of software errors and continuously corrects the errors with mathematical guarantees. ***FY 2024 Plans:*** - Research hardware/software approaches for creating unique software signatures. - Research hardware/software approaches to detect and understand software signatures. ***FY 2025 Plans:*** - Develop proof-of-concept that errors detected can be corrected within a relevant timeframe. - Develop techniques to minimize overhead during error detection. - Validate proof-of-concept solutions to correlate signatures to software errors within a relevant timeframe. ***FY 2024 to FY 2025 Increase/Decrease Statement:***	-	5.000	20.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 increase reflects the move from researching hardware and software to developing and validating proof-of-concept solutions.			
Title: Additive Manufacturing of MicrosystEms (AMME)* ***Description:*** *Previously part of Next Generation Microelectronics - Advanced Manufacturing Tools The Additive Manufacturing of MicrosystEms (AMME) program will revolutionize microsystem manufacturing by leveraging selective material synthesis and 3D patterning to enable a new class of microsystems. Additive Manufacturing (AM) has enabled complex single-material geometries that were previously impossible to produce via traditional manufacturing methods. However, microsystem manufacturing has not exploited AM due to fundamental limits of material quality, resolution, and print throughput. The AMME program will use selective material synthesis to create high-quality material precursors that permit simultaneous printing of conductors and insulators with high-resolution and high-volume throughput. Additionally, AMME will focus on commercialization of this technology such that the Department of Defense and intelligence community can quickly adopt the productized system to fabricate novel microsystems. ***FY 2024 Plans:*** - Initiate multi-material precursor development. - Initiate 3D synthesis modeling and analysis. ***FY 2025 Plans:*** - Develop 3D synthesis modeling and analysis. - Develop multi-material precursor. - Demonstrate simultaneous multi-material synthesis. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the move from initial development to development and demonstration.	-	13.800	25.000
Title: Quantum Apertures (QA) ***Description:*** The Quantum Apertures (QA) program is developing novel radio receiver and aperture systems using quantum sensors as the receiving elements. These receiver systems will be portable, programmable over a very large frequency range, and more sensitive than classical systems at similar size and temperature. This will be achieved by exploiting quantum-based receiving elements composed of atomic vapor cells in highly-excited Rydberg states that have programmable sensitivity over a large range of frequencies and amplitudes. The program will require quantum engineering and traditional electro-mechanical systems engineering to overcome technical and application challenges that impede rapid adoption of a quantum aperture receiver by the defense industrial base. The receiver system's enhanced capabilities will be leveraged in this program to develop novel	-	12.000	7.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
waveforms while also being compatible with constraints imposed by real-world defense applications. The final receiver system will comprise a phase-sensitive array of quantum receiving elements, lasers to program the sensor and read out radio signals, and processing electronics. Initial funding for this program is funded in PE 0602716E, Project ELT-01. ***FY 2024 Plans:*** - Design an architecture for quantum aperture sensors in multiple-element arrays. - Demonstrate navigational waveform reception by quantum aperture. - Conduct quantum aperture sensor testing within a DoD-cleared facility. ***FY 2025 Plans:*** - Develop a specific test article for quantum apertures according to transition partner needs. - Demonstrate functional arrays of test articles for quantum apertures. - Receive operationally-relevant waveforms using quantum apertures. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from development of a specific architecture and system design to demonstration and testing.			
Title: Intelligent Generation of Tools for Security (INGOTS) ***Description:*** The Intelligent Generation of Tools for Security (INGOTS) program is developing techniques to identify and triage chainable vulnerabilities within widely used secure computing platforms and assess exploitability. Today, sophisticated cyber attacks link multiple vulnerabilities together into exploit chains that bypass software and hardware security measures to compromise critical, high-value systems. Accurately understanding risk is critical for both developers and defenders within cyberspace, but the metrics currently in use do not account for the multiple factors which differentiate an innocuous software flaw from a chainable vulnerability. INGOTS is developing semi-automated tools and techniques to characterize and measure the interdependent exploitability of vulnerabilities and will pioneer a new vulnerability severity metrology that characterizes and measures interdependent exploitability for the next generation of security vulnerabilities. INGOTS will also develop datasets capturing artifacts and features of vulnerabilities and exploits to further drive program analysis and AI approaches for rapid risk assessment. With the INGOTS vulnerability measurement pipeline, developers and defenders will improve software and hardware resiliency of pervasive commercial systems by rapidly identifying and prioritizing their most dangerous flaws. The INGOTS program is also funded in PE 0602303E, Project IT-03. ***FY 2024 Plans:*** - Formulate approaches to characterize and measure the interdependent exploitability of vulnerabilities as the basis for a new vulnerability severity metrology.	-	11.000	29.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop techniques to accurately quantify the severity of a vulnerability chain in software systems that have state-of-the-art defenses. - Explore and prioritize demonstrations of severity analysis on vulnerabilities of interest to transition partners. ***FY 2025 Plans:*** - Develop and demonstrate techniques to characterize and measure the interdependent exploitability of vulnerabilities in complex software systems. - Quantify the accuracy of vulnerability severity assessment for complex software systems that have state-of-the-art defenses. - Demonstrate the capability to identify and prioritize vulnerabilities in software of interest to transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects continued development of techniques to quantify the severity of individual and chained vulnerabilities and expanded work to assess the accuracy and utility of the techniques.			
Title: Supply Chain & Logistics in Electronic Technology ***Description:*** DARPA's Supply Chain and Logistics in Electronic Technology thrust will develop technologies to help ensure a robust and secure domestic supply chain for advanced microsystems. This includes the design, assembly, packaging, and testing technologies for advanced microsystems that exploits and extends beyond commercial activities. It takes advantage of innovations in photonics, optics, materials, and advanced three dimensional heterogeneous integration (3DHI) for the highest performance electronics technology. In doing so, the goal is to revolutionize domestic industry and enable safe and reliable access to disruptive technology. ***FY 2025 Plans:*** - Perform initial studies of automating the design of complex, 3D circuits to include advanced artificial intelligence / machine learning techniques. - Develop methodology for the built-in self-test of devices and circuits within 3DHI microsystems. - Develop novel processes for the heterogeneous integration of diverse materials at the atomic scale. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects thrust initiation.	-	-	20.600
Title: Warfighting Performance in Electronic Technology ***Description:*** DARPA's Warfighting Performance in Electronic Technology thrust seeks to develop technologies that will drive the next generation of electronic systems for the warfighter. This includes developing advanced active and passive sensor systems that will integrate efficient processing with exquisite detection. It also includes adaptive technologies with embedded machine	-	-	10.504

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
learning and cognitive behaviors that are then incorporated into electronic systems. These technologies will enable sensor systems with unprecedented performance and efficiency while minimizing size, weight, and power (SWaP). ***FY 2025 Plans:*** - Perform study of capabilities of current passive sensors and on techniques to improve their performance. - Perform initial design of sensor with integrated processing in an edge-relevant form factor. - Evaluate use of artificial intelligence / machine learning for use in adaptive sensors and systems. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects thrust initiation.			
Title: Automatic Implementation of Secure Silicon (AISS) ***Description:*** The Automatic Implementation of Secure Silicon (AISS) program is enabling a design tool and Intellectual Property (IP) ecosystem where security is pervasive and can be incorporated naturally into chip design with minimal effort and expense. The program will enable rapid evaluation of architectural alternatives in platform integration where security can be optimized relative to the conventional design economic measure of power, area, and speed. The program will advance multi-level provenance and integrity validation techniques for design through improvement of current methods or invention of novel technical approaches, and will demonstrate new capabilities in the context of reduced instruction set computing (RISC) architectures or computer processors. AISS will protect advanced chips from known attack strategies by incorporating security into a highly automated system aimed at reducing design time while maximizing exploration of architectural alternatives. As a result, DoD applications will benefit from more secure chips becoming pervasive whether procured commercially or designed specifically for defense systems. ***FY 2024 Plans:*** - Develop design automation and optimization recommendations as a means to override/interact with defaults. - Simplify automation flow in consideration of third-party security techniques and cryptographic IP. - Develop two forms of documentation; one that will serve as a user guide, and one for the purposes of interfacing to AISS. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	21.700	6.000	-
Title: Lasers for Universal Microscale Optical Systems (LUMOS) ***Description:*** The Lasers for Universal Microscale Optical Systems (LUMOS) program is integrating high-performance light sources into silicon integrated photonics enabling compact, rugged, high-performance systems for positioning, navigation, communications, 3D imaging, and quantum technologies. Silicon photonics today enables microscale integration of complex optical systems, but the platforms lack of optical gain precludes the creation of lasers and amplifiers through foundry processes.	18.000	10.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
LUMOS will deliver the missing capability to provide compact optical sources at wavelengths from the visible to the infrared, and will create a universal manufacturing platform that builds upon the current photonics ecosystem. To drive innovation and maintain DoD access to leading-edge deployable photonic solutions, LUMOS will establish a technology pathway connecting government, academic, commercial, and defense users of integrated photonics, and will provide multi-project wafer runs through an open-access foundry. ***FY 2024 Plans:*** - Incorporate device improvements and higher-complexity external designs in a second laser-enabled foundry run. - Construct system demonstrators utilizing high-power and visible-wavelength integrated platforms. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Data Privacy in Virtual Environments (DPRIVE) ***Description:*** The Data Privacy in Virtual Environments (DPRIVE) program will make secure processing on untrusted hardware feasible through the development of new hardware accelerators that allow the data to remain encrypted at all times, even during processing. The hardware developed under DPRIVE will accelerate several fully homomorphic encryption (FHE) schemes more than three orders of magnitude over commodity processors. The program plans to provide strong privacy protections at the tactical edge with no more than one order of magnitude penalty in computation time, and to enable very strong privacy at the enterprise level with no more than three orders of magnitude penalty compared to the corresponding unencrypted processing on commodity processors. The program will enable the development and deployment of these hardware accelerators to edge computing devices where power and time are a premium, as well as to enterprise computing facilities where the amount and sensitivity of the data requires increased protection. ***FY 2024 Plans:*** - Fabricate mother board to accommodate the homomorphic encryption coprocessor and appropriate interfaces to a central processing unit (CPU). - Submit tape-out of final chip designs to one or more foundries. - Package and test the DPRIVE coprocessor microcircuit for basic operations. - Execute pre-determined workloads and benchmarks to establish performance, speed, and accuracy of the coprocessor's homomorphic encryption capabilities. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	16.000	10.000	-
Title: Guaranteed Architectures for Physical Security (GAPS)	12.000	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602716E / *ELECTRONICS TECHNOLOGY*	**Project (Number/Name)** ELT-02 / *BEYOND SCALING TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The Guaranteed Architectures for Physical Security (GAPS) program developed hardware security and software architectures with provable security interfaces. These interfaces physically isolated high-risk transactions during both system design and system build, and will ensure that such protections are enforced at run-time. GAPS reduced the inherent complexity through the development of hardware and software that is open, extendible, and compatible with size, weight, and power-constrained environments to enable security across DoD and commercial systems. The program substantially lowered the barrier to safely enabling high-risk transactions, thus allowing for fast computer-to-computer transactions, physical spatial isolation reducing the need for unreliable software partitioning solutions, and more complex missions without putting sensitive data at risk. Basic research for this program is funded within PE 0601101E, Project ES-02.			
Title: Structured Array Hardware for Automatically Realized Applications (SAHARA) ***Description:*** The Structured Array Hardware for Automatically Realized Applications (SAHARA) program developed technology for the secure development of custom chips for defense systems. Current DoD systems often employ field-programmable gate array (FPGAs), whose flexibility advantages are offset by lower performance. Structured application specific integrated circuits (ASICs) deliver significantly higher performance and lower power consumption, which makes them an efficient and effective alternative to FPGAs for defense electronic systems. Manually converting FPGAs to structured ASICs, however, is a complex, lengthy, and costly process. SAHARA developed automated technologies to reduce design time, optimize performance, and minimize the power dissipated by the secure, structured ASIC.	6.400	-	-
Accomplishments/Planned Programs Subtotals	422.673	451.825	484.344

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	242.369	331.753	269.700	-	269.700	302.244	346.641	366.495	379.542	-	-
AIR-01: *ADVANCED AEROSPACE SYSTEMS*	-	242.369	331.753	269.700	-	269.700	302.244	346.641	366.495	379.542	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Advanced Aerospace Systems Program that is focused on exploiting high pay-off opportunities to provide revolutionary new system capabilities, as opposed to incremental or evolutionary advancements, in order to achieve undeterrable air presence at dramatically reduced costs. Rapid prototyping and experimentation of integrated system concepts, as well as enabling vehicle subsystems will be conducted. Programs will explore new architectural concepts that employ a mix of weapon technologies that achieve lethality through a combination of overwhelming performance and overwhelming numbers rather than through the use of singular and costly high value assets. Studies conducted under this program element include examination and evaluation of emerging aerospace threats, technologies, concepts, use of autonomy to minimize risk, and applications for missiles, munitions, and vehicle systems.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	241.015	331.753	361.051	-	361.051
Current President's Budget	242.369	331.753	269.700	-	269.700
Total Adjustments	1.354	0.000	-91.351	-	-91.351
• 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	9.114	0.000			
• SBIR/STTR Transfer	-7.760	0.000			
• TotalOtherAdjustments	-	-	-91.351	-	-91.351

Change Summary Explanation

FY 2023: Increase reflects SBIR/STTR transfer offset by reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects completion of the Tactical Boost Glide and MoHAWC programs as well as the shift from aircraft fabrication and ground testing to flight testing in the Control of Revolutionary Aircraft with Novel Effectors (CRANE) program.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: LongShot	36.000	41.038	36.742
Description: The LongShot program is developing and flight demonstrating an air-launched system capable of engaging multiple adversary targets from standoff ranges using existing air-to-air missiles. LongShot will be deployed either externally from existing fighters or internally from existing bombers. This system will capitalize on a slower speed, fuel-efficient air vehicle for ingress, while retaining highly energetic air-to-air missiles for end-game target engagements, which provides several key benefits that increase weapon effectiveness. This program will address the stability and control challenges of launching air-to-air missiles from a relatively small UAV in an operational environment. Potential transition partners include the Navy and Air Force. ***FY 2024 Plans:*** - Complete detailed design of full vehicle including all subsystems, fabrication of initial flight test vehicles and begin integration onto host aircraft. - Conduct subscale wind-tunnel campaign verifying final design aerodynamic parameters. - Conduct subsystem and safety recovery system verification testing. - Conduct weapon integration and ground testing. - Conduct fabrication, integration, testing, and checkout of final flight test vehicles. ***FY 2025 Plans:*** - Conduct full-scale wind-tunnel test to exercise critical mechanisms and subsystems, gather structural dynamics data, gather unsteady aerodynamic data, and derive scaling corrections for transonic aero data. - Conduct captive carry test of flight vehicles on host aircraft. - Conduct a series of flight demonstrations validating air vehicle stability and controls upon separation from host-aircraft and prior to, during, and after separation of an air-to-air missile payload. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from fabrication of final test vehicles to flight testing.			
Title: Glide Breaker	18.250	29.100	38.029
Description: Glide Breaker is developing and demonstrating a propulsion technology to support a lightweight vehicle designed for hit-to-kill engagement of hypersonic threats at very long range. Glide Breaker will first demonstrate a divert and attitude control system (DACS) to enable a kill vehicle capable of intercepting hypersonic threats during glide phase. The program will then quantify jet interaction effects between the DACS plumes and the hypersonic cross flow by conducting wind tunnel and flight tests. Results of these tests will culminate into a divert propelled flight test of a vehicle at conditions relevant to glide-phase intercept of a hypersonic threat. ***FY 2024 Plans:***			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct cold-gas wind tunnel testing of aero bodies with divert jets to develop performance database in a relevant aerodynamic environment. - Conduct hot-gas wind tunnel testing of aero bodies with divert jets to develop a performance database in relevant aerothermal environment. - Complete detailed design of the flight test article. - Initiate procurement of long lead items leading to a demonstration vehicle. ***FY 2025 Plans:*** - Complete wind tunnel testing of aero bodies with divert jets. - Manufacture and instrument a separating aero body to be flown in the flight test. - Integrate ground test data with computational tools for verification and validation of jet interaction effects. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the shift from ground testing and simulation to flight test vehicle build up and integration.			
Title: Advanced Aerospace System Concepts	4.554	3.360	3.500
Description: Studies conducted under this program examine and evaluate emerging aerospace technologies and system concepts for applicability to military use. 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 aerospace threats along with possible methods and technologies to counter them. 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 prototype development programs or refocus ongoing work. Topics include: methods of defeating enemy anti-aircraft attacks; munition technologies to increase precision, range, endurance, and lethality of weapons for a variety of mission sets; novel launch systems; air vehicle control, power, propulsion, materials, and architectures; and payload and cargo handling systems. ***FY 2024 Plans:*** - Examine and refine rocket, airbreathing, and combined air vehicle architectures, concepts of operations, and propulsion and vehicle technology. - Demonstrate integrated cross-domain air dominance solutions. - Develop deeper understanding of hybrid aerodynamics and propulsion concepts to enable future technology demonstrations. ***FY 2025 Plans:*** - Perform laboratory demonstrations of technologies to enable cross-domain air dominance solutions. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 increase reflects minor program repricing.			
Title: Control of Revolutionary Aircraft with Novel Effectors (CRANE) ***Description:*** The Control of Revolutionary Aircraft with Novel Effectors (CRANE) program will develop and demonstrate revolutionary improvements in aircraft controls technology. The program will design, build, and flight test an aircraft able to fly and maneuver at altitude relying on state-of-the-art Active Flow Control (AFC) technology. AFC is a broad term that encompasses a range of technology approaches; it includes a number of control mechanisms which alter the aerodynamic flow field thru ejection or suction of fluid via an orifice on a lifting body. An emphasis of the program is on assessing AFC component technologies, risk reduction and experimentation, integrated testing, fabrication and demonstration of a relevant scale novel and innovative aircraft. Technologies, design tools and models developed and demonstrated under this program will be made available to all Services as well as the civilian aerospace sector for application to future air systems development. ***FY 2024 Plans:*** - Complete the system Critical Design Review (CDR). - Complete fabrication and subsystem integration of a demonstration aircraft. - Complete airworthiness and ground/flight test approvals. - Initiate ground test of the demonstration aircraft. ***FY 2025 Plans:*** - Complete ground testing of the demonstration aircraft. - Initiate and complete flight testing of the demonstration aircraft. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the shift from aircraft fabrication and ground testing to flight testing.	40.565	42.500	29.715
Title: Liberty Lifter ***Description:*** The Liberty Lifter program will design and demonstrate a runway-independent, large-payload, survivable, dual-flight regime aircraft capable of extended on-water operations and flight both in and out of ground effect. Critical to an effective aircraft of this type is a robust sea plane capability to operate in high sea states as well as an innovative manufacturing approach that dramatically reduces vehicle acquisition costs. The vehicle is anticipated to be survivable against peer threats due to the combination of extremely low altitude operations and speeds significantly higher than ships. The ability to deploy amphibious cargo while on the water will minimize exposure time and enable a wide variety of mission capabilities in the maritime domain including rapid contested logistics support, and search and rescue. The Liberty Lifter program is envisioned to deliver a technology demonstrator with potential to transition to military service partners for continued testing and development activities.	31.000	42.310	38.398

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The demonstrator is expected to be approximately 80% size and 50% maximum gross takeoff weight of a future Liberty Lifter objective system. ***FY 2024 Plans:*** - Complete design changes reflecting the program refocus on a technology demonstrator, leading to delta CoDR. - Continue extensive risk reduction analysis, modeling and simulation, and test activities to inform demonstrator preliminary design. - Scope and purchase of initial long-lead items for demonstrator production. ***FY 2025 Plans:*** - Complete platform preliminary design review, manufacturing plan review, and test planning review for demonstrator. - Initiate demonstrator detailed design and analysis activities. - Conduct demonstrator subcomponent testing. - Purchase of remaining long-lead items for demonstrator production. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects shift from demonstrator preliminary design and extensive risk reduction activities to detailed design and demonstrator subcomponent testing.			
Title: SPeed and Runway INdependent Technologies (SPRINT) X-Plane Demonstration Project	-	22.663	36.866
Description: The SPeed and Runway INdependent Technologies (SPRINT) X-Plane Demonstration Project will develop and demonstrate the fundamental technologies needed for combined high speed and vertical take-off and landing (VTOL) capabilities in a single aircraft. This program culminates in the fabrication and flight test of a demonstrator that validates the critical technologies in a representative environment and reduces technical, schedule, and cost risk for a follow-on operational system. High speed VTOL aircraft are highly desired in a variety of military missions such as infiltration/exfiltration, contested personnel recovery, troop transport, logistics support, and armed escort; however, the thresholds for speed and range have evolved with military strategy and mission needs. The SPRINT Demonstrator is envisioned to transition to military services for further risk reduction flight testing. ***FY 2024 Plans:*** - Conduct design and analysis activities leading to Conceptual Design Review (CoDR) for multiple concepts. - Initiate preliminary design and analysis activities. - Initiate simulations, component testing, subsystem testing, manufacturing planning, and flight test planning. ***FY 2025 Plans:*** - Continue simulations, component testing, subsystem testing, manufacturing planning, and flight test planning.			

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct design and analysis activities leading to Preliminary Design Review (PDR). - Initiate limited detailed design and critical design activities. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the shift from simulations, component testing and subsystem testing to initiation of limited detailed design and critical design activities.			
Title: Artificial Intelligence (AI) Reinforcements (AIR) ***Description:*** AI Reinforcements (AIR) will develop and demonstrate dominant tactical autonomy for multi-ship, beyond visual range, real-world air combat missions. This program is focused on developing highly accurate models that are orders of magnitude faster than the present state-of-the-art and then using those models to unlock novel and robust AI-driven autonomy approaches. An operations-centric development approach will be enabled through the use of human-on-the-loop F-16 testbeds. On piloted platforms, AIR's algorithms will automate tactical control tasks transforming junior pilots from low-level tacticians into high-level mission commanders. For unpiloted platforms, AIR will enable vehicles to perform missions with minimal human oversight. The outcome of this program will be an AI air combat capability that works in dynamic, operationally representative environments. The transition partner is the U.S. Air Force. ***FY 2024 Plans:*** - Evaluate current sensor and aircraft models and the ability to use them in high-speed simulation. - Establish pipelines to incorporate feedback from flight test data into underlying Modeling and Simulation (M&S) tools. - Develop AI algorithms that work on testbed aircraft. - Establish framework for M&S and interfaces with testbed aircraft. - Incorporate F-16 testbeds into the AIR integration and testing pipeline and iterate development through live flight testing. ***FY 2025 Plans:*** - Demonstrate modeling approaches that are significantly faster than baseline references. - Verify performance in Offensive Counter Air (OCA) and Defensive Counter Air (DCA) mission sets. - Introduce non-stationary conditions and incorporate Electronic Warfare capabilities. - Scale the AI-driven autonomy to four-ship operations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects scaling up testing from two to four-ship operations.	-	21.082	41.171
Title: AdvaNced airCraft Infrastructure-Less Launch And RecoverY (ANCILLARY) ***Description:*** The AdvaNced airCraft Infrastructure-Less Launch And RecoverY (ANCILLARY) program will develop and flight demonstrate an X-plane with the critical technologies required for a leap-ahead in long endurance, vertical takeoff and landing	-	13.200	22.886

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
(VTOL) unmanned air system (UAS) performance. The UAS will be able to launch and recover from small ship flight decks and austere land locations in adverse weather without additional infrastructure equipment, thus enabling expeditionary deployments. ***FY 2024 Plans:*** - Conduct design and analysis activities leading to Conceptual Design Review (CoDR) for multiple concepts. - Complete Preliminary Design Reviews (PDRs) for multiple performer X-Plane designs. - Conduct risk reduction activities. ***FY 2025 Plans:*** - Conduct detailed design and analysis activities leading to Critical Design Review (CDR) for multiple concepts. - Conduct manufacturing, assembly, and ground testing of the X-plane vehicle(s). - Conduct VTOL flight testing of the X-plane(s) at Flight Test Event 1. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from design activities to manufacturing, assembly, and testing of the vehicle(s).			
Title: Rapid Experimental Missionized Autonomy (REMA)	-	5.000	13.893
Description: Commercial-quality drones demonstrate surprising usefulness on the modern battlefield. Rapid Experimental Missionized Autonomy (REMA) will enhance commercially available and stock military drones with a subsystem to enable autonomous operation. The program, building on technologies developed under the Oversight program (PE 0602702E / Project TT-07), will focus on delivering autonomy without being tied to a specific drone design. REMA will look to develop these capabilities through rapid spirals of development. New mission functionality will be delivered through development spirals accelerating from three-month duration at program inception to one-month by program completion. Drones are either remotely piloted via radio frequency (RF) tethers or pre-programmed with relatively simple mission profiles relying on GPS waypoints. Both approaches are vulnerable to RF jamming, especially at the terminal phase of the mission. Research and Development (R&D) programs have demonstrated autonomy capabilities for drones, but these have been bespoke solutions, with software spirals of nine months or longer, too slow of a response in a dynamic battlefield. The REMA program addresses specific challenge problems, during which performers will develop, collaborate, and deliver an autonomy subsystem for drones at a rapid pace. ***FY 2024 Plans:*** - Develop software, integrate with other performers, test, refine, and retest REMA solution in each spiral. ***FY 2025 Plans:*** - Continue to develop software, integrate with other performers, test, refine, and retest REMA solution in each spiral.			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Increase the rate of spiral events from 2-month durations to 1-month duration. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from hardware procurement and longer spiral events for software development, testing and integration to 1-month spiral events for software development, testing and integration.			
Title: Making and Maintaining in Advanced Military Systems ***Description:*** Studies conducted under this thrust will examine and evaluate advanced approaches to make military system technologies manufacturable and accessible for the DoD and domestic industry. This includes new methods to design, fabricate, package, and test complex assemblies. Certain DoD applications also need these complex assemblies to be used in extreme environments. The feasibility of achieving potential improvements, in terms of resources, schedule, and technological risk, is also evaluated. Topics include: additive manufacturing at scale, portable methods of manufacturing and maintaining platforms and systems at point-of-need, technological solutions to increase rate of testing while continuing to manage risk, and application of novel materials or processes to reduce cost, time, and infrastructure requirements for production of platforms and systems. ***FY 2025 Plans:*** - Initiate additive manufacturing techniques to mass produce reliable low-cost platforms. - Initiate model-based systems engineering techniques to explore approaches to design that allow rapid scalable production. - Initiate design techniques that increase portability for manufacturing surges at time-of-demand. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	3.500
Title: Kinetic Delivery in Advanced Aerospace Systems ***Description:*** Studies and other initiatives conducted under this thrust examine and evaluate emerging technologies and system concepts that employ physical means to degrade or deny targeted adversary capabilities. The feasibility of achieving potential improvements, in terms of resources, schedule, and technological risk, is also evaluated. The results from these studies and initiatives are used, in part, to formulate future prototype development programs or refocus ongoing work. Topics for this thrust include: methods of defeating enemy anti-aircraft attacks; munition technologies to increase precision, range, endurance, and lethality of weapons for a variety of mission sets; digital design methodologies that are compatible with surged production to deliver large quantities in time of critical need; advanced energetics; and examining novel target defeat mechanisms. ***FY 2025 Plans:*** - Laboratory testing of advanced effector concepts. - Development and testing of novel energetics.	-	-	5.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E / *ADVANCED AEROSPACE SYSTEMS*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Planning for field testing of prototype concepts. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** FY 2025 increase reflects program initiation.			
Title: Tactical Boost Glide (TBG) ***Description:*** The Tactical Boost Glide (TBG) program is a Joint DARPA / Air Force effort developing and demonstrating technologies to enable air-launched tactical range hypersonic boost glide systems, including flight demonstration of a vehicle that is traceable to an operationally relevant weapon that can be launched from current platforms. The program will also consider traceability, compatibility, and integration with the Navy Vertical Launch System (VLS). The metrics associated with this objective include total range, time of flight, payload, accuracy, and impact velocity. The program will address the system and technology issues required to enable development of a hypersonic boost glide system considering (1) vehicle concepts possessing the required aerodynamic and aero-thermal performance, controllability and robustness for a wide operational envelope, (2) the system attributes and subsystems required to be effective in relevant operational environments, and (3) approaches to reducing cost and improving affordability for both the demonstration system and future operational strike systems. TBG capabilities are planned for transition to the Air Force and the Navy. ***FY 2024 Plans:*** - Complete assembly, integration, and test (AI&T) of fourth flight test vehicle. - Conduct test readiness reviews (TRR), conduct flight tests, and complete post-test analysis. - Conduct Navy variant subsystem demonstration testing. - Conduct technology development studies and ground testing to support ability to separate weapons and stores at speeds above the state of the art and supporting next generation strike capabilities. - Conduct propulsion system technology development to support continuous operations for next generation strike platforms. - Conduct technology development studies and testing in the area of design criteria, material attributes and airframe/subsystem development that supports next generation strike platforms. - Complete initial combined heating and mechanical loads test to calibrate analysis models, quantify structural contact loads and thermal transfer functions through representative joints and materials. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	30.000	81.500	-
Title: More Opportunities with HAWC (MoHAWC) ***Description:*** MoHAWC will develop, integrate, and demonstrate technologies to increase effectiveness and producibility of an air-launched hypersonic cruise missile. These technologies include advancing hydrocarbon scramjet-powered propulsion operation,	60.000	30.000	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
shrinking navigation components, upgrading aircraft integration algorithms, and improving manufacturing approaches. Flight tests will expand the operational envelope. This program will collaborate with Navy and Air Force science and technologies efforts to meet future technology insertion dates for service programs of record. This program builds off the demonstrator system design, technology advances and lessons learned under the Hypersonic Airbreathing Weapon Concept (HAWC) and supporting technology maturation programs. ***FY 2024 Plans:*** - Complete subsystem technology risk reduction efforts. - Complete assembly, integration, and ground testing of multiple flight test systems. - Complete multiple flight tests. - Complete flight test data analysis and final program review. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Series Hybrid Electric Propulsion AircRaft Demonstrator (SHEPARD) ***Description:*** The Series Hybrid Electric Propulsion AircRaft Demonstrator (SHEPARD) program designed and developed an efficient Hybrid Electric Propulsion (HEP) system and integrated it into a unique military aircraft application. The innovative aircraft design included essential operational considerations and mission system components. The program employed a rapid development framework that capitalizes on maturing mission-enabling technologies to quickly meet emergent mission needs while overcoming significant system-level technical challenges. The result was a flight-demonstrated system with a minimal viable mission capability that was developed quickly and at relatively low cost.	22.000	-	-
Accomplishments/Planned Programs Subtotals	242.369	331.753	269.700

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	76.900	134.809	225.457	-	225.457	257.490	289.776	306.373	317.280	-	-
SPC-01: *SPACE PROGRAMS AND TECHNOLOGY*	-	76.900	134.809	225.457	-	225.457	257.490	289.776	306.373	317.280	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Space Programs and Technology Program that 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. Ready access to space requires the delivery of capabilities, replenishment of supplies into orbit, and rapid manufacturing of affordable space capabilities. 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.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	74.388	134.809	227.314	-	227.314
Current President's Budget	76.900	134.809	225.457	-	225.457
Total Adjustments	2.512	0.000	-1.857	-	-1.857
• 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	5.197	0.000			
• SBIR/STTR Transfer	-2.685	0.000			
• TotalOtherAdjustments	-	-	-1.857	-	-1.857

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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*

Change Summary Explanation

FY 2023: Increase reflects SBIR/STTR transfer offset by reprogrammings.
FY 2024: N/A
FY 2025: Decrease reflects minor program repricing.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Demonstration Rocket for Agile Cislunar Operations (DRACO)	47.513	81.977	146.352

Description: Maintaining U.S. interests in cislunar space requires significant advances in propulsion technology. Current space propulsion includes electric (high efficiency but low thrust) and chemical (high thrust but low efficiency) systems. The Demonstration Rocket for Agile Cislunar Operations (DRACO) program will develop and demonstrate a High-Assay Low-Enriched Uranium (HALEU) nuclear thermal rocket (NTR) system on orbit by FY 2027. The NTR technology demonstrated by DRACO will achieve thrust similar to chemical rockets, but with 2-5 times the efficiency. The enhanced performance afforded by NTR will allow the U.S. to lead operations in the cislunar volume, in particular for missions that require moving heavy cargo across large distances in a timely manner.

FY 2024 Plans:
- Complete detailed design of the NTR engine (NTRE).
- Complete detailed design of experimental NTR vehicle (XNTRV).
- Continue fabrication of long lead components for the XNTRV.
- Complete build of primary non-nuclear NTRE components such as turbopump and valves.
- Complete assembly of engineering development unit of the NTRE for cold-flow test campaign.
- Conduct cold-flow test campaign for turbopump and the NTRE system.
- Begin making nuclear fuel into fuel elements to the specifications as determined by the detailed design of the NTRE.

FY 2025 Plans:
- Complete acquisition and machining of remaining major NTRE materials and components.
- Complete assembly of major XNTRV subsystems and begin preparations for space environment testing.
- Conduct space environment testing of major XNTRV subsystems.
- Manufacture reactor core fuel, reactor vessel, and beryllium for moderator and reflector.
- Begin assembly of fueled nuclear reactor.
- Complete assembly of cryogenic liquid hydrogen tank.
- Test Cryogenic liquid hydrogen tank to obtain propellant storage performance data.
- Begin full assembly of XNTRV.

FY 2024 to FY 2025 Increase/Decrease Statement:

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 increase is due to the assembly of the bus for the XNTRV, assembly of the tank, conducting cold flow testing of the NTRE, fuel manufacturing for the NTRE reactor core, and the completion of space qualification testing of major subsystems.			
Title: Robotic Servicing of Geosynchronous Satellites (RSGS) ***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 is establishing 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 transition agreement is with 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 (CONFERS) operations 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. ***FY 2024 Plans:*** - Complete functional testing and space qualification of integrated robotic payload. - Deliver integrated and tested robotic payload. - Support combined testing of integrated robotic payload and spacecraft bus. - Develop partner training and detailed demonstration planning. ***FY 2025 Plans:*** - Conduct launch, on-orbit checkout, and calibration of integrated robotic payload. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects minor program repricing.	5.000	4.900	5.200
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, effectiveness, and resilience 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.	3.500	12.500	12.007

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
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 applying artificial intelligence to low earth orbit (LEO) constellation operations to enable collaboration between space, air, maritime, and ground platforms in anti-access/area denial (A2/AD) theaters; robust architectures for precision navigation and timing; enabling operations in Cislunar space; novel approaches to space domain awareness; integration of commercial capabilities into military operations; and on-orbit software environments. ***FY 2024 Plans:*** - Initiate studies of new applications for military and commercial proliferated LEO (p-LEO) constellations. - Initiate studies of innovative approaches to enable dynamic space operations. - Perform laboratory demonstrations of novel technologies for early risk reduction and concept validation. ***FY 2025 Plans:*** - Explore updated and new architectures for space vehicle concepts. - Investigate novel approaches to defend joint forces operating in terrestrial environments. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects minor program repricing.			
Title: Otter ***Description:*** The Otter program will develop and demonstrate air breathing propulsion technologies that enable operations in very low earth orbital domains that are currently inaccessible. Propulsion capabilities demonstrated will provide increased mission duration and ability to maneuver without regret. Key efforts include the development of new propulsion systems, improved ground test capabilities, and analysis tools to support system development. Otter will progress through development of analysis and test tools, design of candidate propulsion systems, ground testing, build of a demonstrator satellite, and culminate in a long duration (> 1 year) spaceflight demonstration. The anticipated transition partner is the U.S. Space Force. ***FY 2024 Plans:*** - Develop analysis tools to support system design. - Upgrade test facilities to support component testing. - Develop and mature propulsion system designs. ***FY 2025 Plans:*** - Refine measurement instrumentation of test facilities to support component testing. - Conduct component testing. - Continue development and maturation of propulsion system designs.	-	25.435	61.898

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
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*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct initial testing of air harvesting inlets. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the shift from concept development and initial design to ground testing of preliminary inlet and thruster designs.			
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 is leveraging 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 Memorandum of Agreement (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, build, and launch of four satellites with tactical communications and Intelligence, Surveillance, and Reconnaissance (ISR) payloads for the full Blackjack demonstration of a proliferated LEO constellation. ***FY 2024 Plans:*** - Conduct and complete on-orbit Blackjack constellation demonstration. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	20.887	9.997	-
Accomplishments/Planned Programs Subtotals	76.900	134.809	225.457

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	243.110	254.033	257.844	-	257.844	268.650	273.822	255.088	261.116	-	-
MT-15: *MIXED TECHNOLOGY INTEGRATION*	-	33.793	47.847	24.643	-	24.643	30.024	31.673	33.487	34.679	-	-
MT-16: *BEYOND SCALING ADVANCED TECHNOLOGIES*	-	209.317	206.186	233.201	-	233.201	238.626	242.149	221.601	226.437	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Advanced Electronics Technologies Program that seeks to design and demonstrate state-of-the-art manufacturing and processing technologies for the production of various electronics and microelectronic devices, sensor systems, integrated photonic-electronic components that have military applications and potential commercial utility. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements.

The Mixed Technology Integration project funds the advanced development and demonstration of selected basic and applied electronics research programs. Examples of technologies with funded development and demonstration activities include, but are not limited to: reducing the size, weight, and power (SWaP) of components for laser weapon systems that will protect airborne platforms from emerging surface-to-air missiles; integrated photonic-electronic components for positioning, navigation and timing in GPS-denied environments; flexible, software-defined cameras that enable real-time image analysis of complex scenes to provide more actionable information; and optical communications systems that rely on no moving parts enabling their use on SWaP-restricted platforms. Funding under this project is intended to advance transitioning novel technologies to use, providing advanced components compatible with mid-term and other future warfighting requirements.

The Beyond Scaling Advanced Technologies Project supports activities to enable and accelerate the transition of disruptive microelectronics advancement, including those developed under the Beyond Scaling Sciences (ES-02) and Beyond Scaling Technology (ELT-02) projects. Funding under this project will include developing new technologies and capabilities in commercial settings, establishing access to these new processes and to commercial state-of-the-art foundries, enabling prototyping, developing manufacturable processes for three-dimensional heterogeneous integration (including integrated photonics), advancing new architectures and integration technologies for advanced field programmable gate arrays (FPGAs), and innovating back end of line technologies for wide bandgap semiconductors.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603739E *I ADVANCED ELECTRONICS TECHNOLOGIES*

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	250.917	254.033	248.628	-	248.628
Current President's Budget	243.110	254.033	257.844	-	257.844
Total Adjustments	-7.807	0.000	9.216	-	9.216
• 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	0.272	0.000			
• SBIR/STTR Transfer	-8.079	0.000			
• TotalOtherAdjustments	-	-	9.216	-	9.216

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer offset by reprogrammings.

FY 2024: N/A

FY 2025: Increase reflects minor program repricing.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	Project (Number/Name) MT-15 / *MIXED TECHNOLOGY INTEGRATION*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
MT-15: *MIXED TECHNOLOGY INTEGRATION*	-	33.793	47.847	24.643	-	24.643	30.024	31.673	33.487	34.679	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Mixed Technology Integration project funds the advanced development and demonstration of selected basic and applied electronics research programs. Examples of technologies with funded development and demonstration activities include, but are not limited to: reducing the size, weight, and power (SWaP) of components for laser weapon systems that will protect airborne platforms from emerging surface-to-air missiles; integrated photonic-electronic components for positioning, navigation and timing in GPS-denied environments; flexible, software-defined cameras that enable real-time image analysis of complex scenes to provide more actionable information; and optical communications systems that rely on no moving parts enabling their use on SWaP-restricted platforms. Funding under this project is intended to advance transitioning novel technologies to use, providing advanced components compatible with mid-term and other future warfighting requirements.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Wideband Secured and Protected Emitter and Receiver (WiSPER)	21.000	25.000	8.643

Description: The Wideband Secured and Protected Emitter and Receiver (WiSPER) program aims to develop an ultra-broadband technology platform to demonstrate a robust, secure, and protected communication link. WiSPER technology provides high signal coding gain to deliver a secured and protected link with significantly enhanced capacity for next generation DoD communications. Current terrestrial tactical radios operate with limited bandwidth at prescribed low frequency bands, which are unable to support high capacity with multiple users and are vulnerable to interference and jamming. WiSPER technology addresses military needs for assured communications, throughput, security, and size, weight, and power limitations of future command, control, communications, computers, intelligence, surveillance and reconnaissance missions. The program will develop an ultra-broadband compact antenna, radio frequency front-end electronics, mixed-signal circuits, and waveform technologies. The WiSPER program will culminate with the integration and demonstration of a secured communication link. Technologies developed under the WiSPER program are planned for transition to the Services.

FY 2024 Plans:

- Begin implementation of second-generation functional test prototype secured radio transceiver doubling accessible bandwidth with increased dynamic range and diversity.
- Optimize the second-generation secured radio transceiver design using modeling and simulation.
- Integrate second-generation functional test prototype of the secured radio transceiver into a transportable unit.

FY 2025 Plans:

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-15 / *MIXED TECHNOLOGY INTEGRATION*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Demonstrate transportable prototype secured radio transceiver operating in clear weather environment, demonstrating spatial coding and second-generation featureless packet generation, transmission, and reception. - Design third-generation functional test prototype of the secured radio transceiver. - Begin implementation of third-generation functional test prototype secured radio transceiver reducing size, weight, and power to tactical levels and adapting for operation in harsh conditions and environments. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the change from extensive development of the transceiver to fine-tuning optimization of the transceiver.			
Title: Modular Efficient Laser Technology (MELT)	12.793	22.847	16.000
Description: The Modular Efficient Laser Technology (MELT) program will demonstrate the first compact, high-power laser tile as the key building block to enable the next generation of scalable high energy laser (HEL) sources for laser weapon systems (LWS). Today's LWS use fiber laser array HEL sources, complex optical benches, and beam directors. These systems are large and heavy, contain large numbers of individual components, and require skilled labor to fabricate and integrate. This makes current LWS difficult and costly to manufacture, limiting their deployment and application. MELT will leverage recent advances in coherent beam combining and photonic integrated circuits (PICs) fabrication techniques to develop tiled arrays integrated with semiconductor-based optical systems, low-loss waveguides, optical interconnects, and application-specific integrated circuits (ASIC) into a compact laser tile that can be integrated with a supporting backplane to provide scalable HEL sources. This will provide the LWS developer a scalable HEL architecture that maintains excellent beam quality and allows LWS deployment on size, weight, and power (SWaP)-constrained platforms. MELT will leverage a mature industrial base for semiconductor manufacturing, as well as recent advances in photonic integrated circuits, coherent beam combining algorithms, semiconductor cooling techniques, and optical lithography to achieve its program goals. Technologies from this program are intended for transition to Army, Air Force, and Navy. ***FY 2024 Plans:*** - Perform design of thermal management system for semiconductor amplifier planar array. - Simulate performance of thermal management system for expected range of electrical-to-optical efficiency. - Hold laser tile design review and deliver design review package to include details of laser tile design, modeling, and simulation. - Demonstrate a planar array of emitters in a laboratory, to include demonstrating coherent beam combination and non-mechanical beam steering, for traceability to a fully integrated laser tile. ***FY 2025 Plans:*** - Fabricate full laser tile array of semiconductor amplifiers with good electrical-to-optical efficiency. - Design fully integrated laser tile with good beam quality.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-15 / *MIXED TECHNOLOGY INTEGRATION*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Hold panelized high energy laser (HEL) design review and deliver design review package to include details of panelized HEL, modeling, and simulation. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from finalizing designs to initiating fabrication and assembly.			
Accomplishments/Planned Programs Subtotals	33.793	47.847	24.643

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	Project (Number/Name) MT-16 / *BEYOND SCALING ADVANCED TECHNOLOGIES*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
MT-16: *BEYOND SCALING ADVANCED TECHNOLOGIES*	-	209.317	206.186	233.201	-	233.201	238.626	242.149	221.601	226.437	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Beyond Scaling Advanced Technologies Project supports activities to enable and accelerate the transition of disruptive microelectronics advancement, including those developed under the Beyond Scaling Sciences (ES-02) and Beyond Scaling Technology (ELT-02) projects. Funding under this project will include developing new technologies and capabilities in commercial settings, establishing access to these new processes and to commercial state-of-the-art foundries, enabling prototyping, developing manufacturable processes for three-dimensional heterogeneous integration (including integrated photonics), advancing new architectures and integration technologies for advanced field programmable gate arrays (FPGAs), and innovating back end of line technologies for wide bandgap semiconductors.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Next Generation Microelectronics Manufacturing (NGMM)	175.000	175.000	203.000

Description: The Next Generation Microelectronics Manufacturing program is creating a domestic capability for next-generation microsystems using three-dimensional heterogeneous integration (3DHI), including design, fabrication, packaging, assembly, and testing. This capability will emphasize design innovations to sustain U.S. leadership in semiconductors and enhance the use of manufacturing automation in the design, assembly, and testing of 3DHI test articles. The baseline capability will allow users from across the country to quickly and efficiently develop working test articles based on early-stage research and development. This will enable a wide range of organizations and stakeholders to accelerate a domestic 3DHI ecosystem, in the same way foundry access enabled fabless design companies and their associated ecosystems to proliferate.
This research service will feature a baseline fabrication capability for research test articles via a stable 3DHI assembly design kit. Users of the research service will have the ability to join multi-project demonstration runs or dedicated taxi runs. This national accelerator will remove a major impediment to the domestic development of next-generation three-dimensional microsystems and will extend research capabilities beyond those currently being developed worldwide. The research services will incorporate the ability to fabricate unique microsystem test articles using a wide range of devices and materials, integrating the most advanced manufacturing and assembly technologies across silicon, compound semiconductors, photonics, MEMS, and other advanced microelectronics technologies. Applied research associated with this effort is funded within PE 0602716E, Project ELT-02.

FY 2024 Plans:
- Establish capability for developing pre-competitive technologies that enable the next generation of manufacturing and accelerate the transfer of innovation from research to prototyping, by enhancing the ability of users to access design, metrology, assembly, and advanced packaging resources.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-16 / *BEYOND SCALING ADVANCED TECHNOLOGIES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Initiate establishing base capabilities for 3DHI prototyping including defined process modules for interconnect vias, bumping, and bonding. - Conduct assessment to reduce cycle-time for die handling in the packaging and assembly processes. - Establish process module validation procedures to include user-based assessments and conduct interim validation assessments. - Create a development plan for automated assembly and advanced packaging toolsets. - Create advisory board and convene biannually to ensure strategic alignment of technical objectives with emerging capabilities. ***FY 2025 Plans:*** - Release first version of assembly design kit for baseline process modules including interconnect vias, bumping, and bonding. - Conduct first round of research collaboration to increase interconnect density and increase bonding material diversity. - Conduct experiments to quantify the baseline to demonstrate reducing the cycle-time for die handling in the package and assembly processes. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects SBIR hold and administrative costs.			
Title: Programmable Logic for Applications In Defense (PLAID)	21.806	31.186	15.000
Description: The Programmable Logic for Applications In Defense (PLAID) program is developing a heterogeneous compute platform that can support processing of large data arrays. Current computing architectures are subject to scaling, bandwidth, and memory limitations, and the large size of today's chips limits the movement of data resulting in a fundamental trade-off between circuit size and data throughput. The PLAID program will break this paradigm with new architecture development and will achieve more than a 10X increase in on-chip bandwidth. In addition to the development of this new device, the PLAID program will expedite deployment into DoD systems by engaging the defense industrial base to map DoD-relevant radio frequency (RF) processing problems onto the new architecture. These RF problems may include element-level digital beamforming, multi-target tracking radar applications, and synthetic aperture radar processing. Once applications are mapped onto the new processor, the implementation will be programmed and tested with the intent that the use of the new device developed by commercial industry will directly transition into an asymmetric advantage for the DoD and will be used by the defense industrial base in emerging applications. ***FY 2024 Plans:*** - Complete detailed device designs and begin device verification. - Complete security design to include cryptography, key management, and secure boot. - Complete DoD application initial mapping of trade-offs between problem size and device resources.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-16 / *BEYOND SCALING ADVANCED TECHNOLOGIES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Initiate design of approaches to make computations verifiable on advanced computational hardware. ***FY 2025 Plans:*** - Complete device verification and tape-out engineering silicon. - Complete validation and characterization plan for engineering silicon. - Initiate pre-release of alpha programming software. - Demonstrate implementations of DoD applications in simulation. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects the end of design activities and the move to fabrication, verification, and demonstration.			
Title: Supply Chain & Logistics in Electronic Technology ***Description:*** DARPA s Supply Chain and Logistics in Electronic Technology program is developing the technologies to help ensure a robust and secure domestic supply chain for advanced microsystems. This includes the design, assembly, packaging, and testing technologies for advanced microsystems that exploits and extends beyond commercial activities. It takes advantage of innovations in photonics, optics, materials, and advanced three-dimensional heterogeneous integration (3DHI) for the highest performance electronics technology. In doing so, the program is working to revolutionize domestic industry and enable safe and reliable access to disruptive technology. ***FY 2025 Plans:*** - Initiate trade study on the areas of biggest need and impact in the domestic supply chain of advanced microsystems. - Perform initial design and development of new techniques in reliability testing of complex microsystems. - Develop techniques for the reliable integration and packaging of electronics integrated with advanced photonic and optical interconnects. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	15.201
Title: Technologies for Mixed-mode Ultra Scaled Integrated Circuits (T-MUSIC) ***Description:*** The Technologies for Mixed-mode Ultra Scaled Integrated Circuits (T-MUSIC) program developed an on-shore semiconductor foundry platform for very wide band radio frequency (RF) mixed-mode integrated circuit analog-to-digital converters for commercial and military systems. Mixed-mode circuits take analog and RF signals and transform them to digital data for processing in computing systems. As defense and commercial wireless applications move to higher frequencies in order to carry more data traffic, integrating the broadband mixed-mode circuitry with high-speed digital processing logic onto one chip becomes imperative to avoid data transfer bottlenecks. T-MUSIC worked to integrate high-speed, high-performance analog and digital electronics together in highly-scaled silicon complementary metal-oxide semiconductor (CMOS) foundries on-shore. This	7.511	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-16 / *BEYOND SCALING ADVANCED TECHNOLOGIES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
process enabled the high levels of integration and performance needed for DoD-relevant and commercial 5G/6G applications. A goal of the T-MUSIC program was to enable very wide bandwidth wireless operations beyond 100 gigahertz (GHz) with low noise and high dynamic range. In addition, T-MUSIC aimed to develop next-generation terahertz (THz) mixed-mode devices based on the advanced digital CMOS fabrication platform. The T-MUSIC program established advanced on-shore foundry capabilities to establish a long-term domestic world-class RF mixed-mode system-on-chip technology for intended transition to DoD and commercial applications.			
Title: Photonics in the Package for Extreme Scalability (PIPES) ***Description:*** The Photonics in the Package for Extreme Scalability (PIPES) program developed optical signaling technologies for digital microelectronics. Distributed and parallel computing architectures are now pervasive across all size scales, from personal-scale multicore processing units to enterprise-scale high performance computing systems, and span application domains from consumer electronics to DoD systems. Increasingly, however, the benefits of parallelism are constrained not by the limits of computation at individual nodes but by the movement of data between nodes. PIPES advanced microelectronics capabilities by intimately integrating photonics with advanced integrated electronics to yield system connectivity with an unprecedented combination of high aggregate bandwidth, power efficiency, channel density, and link reach. Specifically, PIPES developed photonic input/output (I/O) capability for application-specific integrated circuits and field-programmable gate arrays (FPGAs) that are widely used in advanced DoD sensors and radio frequency systems. The goal of the program was improving I/O bandwidth density, efficiency, and reach by more than 100X to enable disruptive DoD system parallelism and performance scaling. As PIPES technologies matured, they proliferated into central processing units, graphical processing units, and emerging tensor-flow processing units that impacted a wide range of dual-use applications including artificial intelligence, machine learning, large scale emulation, and high-performance computing. To further mature the technology and assure domestic manufacturing ecosystem for DoD use, key PIPES technologies transitioned to the OUSD(R&E) program Co-Packaged Analog-Drive High-Bandwidth Optical Input/Output (KANAGAWA).	5.000	-	-
Accomplishments/Planned Programs Subtotals	209.317	206.186	233.201

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	291.580	321.591	336.542	-	336.542	302.926	290.888	259.512	254.401	-	-
CCC-02: *INFORMATION INTEGRATION SYSTEMS*	-	139.262	160.191	75.273	-	75.273	108.852	114.799	110.015	105.930	-	-
CCC-05: *CYBER SYSTEMS*	-	2.000	40.000	108.689	-	108.689	121.883	135.149	143.602	148.471	-	-
CCC-06: *COMMAND, CONTROL AND COMMUNICATION SYSTEMS*	-	150.318	121.400	152.580	-	152.580	72.191	40.940	5.895	0.000	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Command, Control and Communications Systems Program focused on demonstrating and evaluating advanced information systems research and development concepts.

The Information Integration Systems project develops and demonstrates technologies that will provide effective communications to U.S. forces. The success of military operations depends on timely, reliable, secure, and synchronized dissemination of command and control and relevant situational awareness information to every military echelon. While wired communications and networks are fairly well developed, providing assured high-bandwidth mobile wireless capabilities that match or exceed commercial wired infrastructure is needed to meet the demands of military users. Approaches to this goal include developing technologies in these areas:

- High-Capacity Links technologies - enables greater back-haul capability.
- Advanced Networking technologies - supports resilience, adaptability, scalability, and composable systems to enable adaptive effects webs.
- Low Probability of Detection and Anti-Jam (LPD/AJ) technologies - provides assured communications in very high-threat environments.
- Novel Radio Frequency and Spectral Sensing (RF/SS) - supports efficient spectrum management in congested environments and detection of electromagnetic threats.

The Cyber Systems project develops, implements, and demonstrates techniques, tools, and frameworks for the full range of cyber operations. Cyber is now ubiquitous to warfighting. For non-kinetic operations in advance of lethal conflict, cyber can be a powerful enabler of information operations that limit adversary options and deter adversary actions. For kinetic operations during lethal conflict, cyber can be a force multiplier and provide an asymmetric advantage. The Cyber Systems project aims to create operational prototypes based on the cyber technology developed in applied research programs (budgeted in PE 0602303E, Project IT-03), in the private sector, and in academia. The utility of the operational prototypes that are developed in this project will be assessed, and improvements made, based on demonstrations and evaluations conducted in collaboration with warfighters, acquisition programs, and combatant commands.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603760E *I COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	298.050	321.591	242.909	-	242.909
Current President's Budget	291.580	321.591	336.542	-	336.542
Total Adjustments	-6.470	0.000	93.633	-	93.633
• 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	3.127	0.000			
• SBIR/STTR Transfer	-9.597	0.000			
• TotalOtherAdjustments	-	-	93.633	-	93.633

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer offset by reprogrammings.

FY 2024: N/A

FY 2025: Increase reflects initiation of the Access in Information Integration Systems and Access in Cyber Systems thrusts, as well as the ramping up of efforts in the Constellation and classified programs.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	Project (Number/Name) CCC-02 / *INFORMATION INTEGRATION SYSTEMS*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
CCC-02: *INFORMATION INTEGRATION SYSTEMS*	-	139.262	160.191	75.273	-	75.273	108.852	114.799	110.015	105.930	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Information Integration Systems project develops and demonstrates technologies that will provide effective communications to U.S. forces. The success of military operations depends on timely, reliable, secure, and synchronized dissemination of command and control and relevant situational awareness information to every military echelon. While wired communications and networks are fairly well developed, providing assured high-bandwidth mobile wireless capabilities that match or exceed commercial wired infrastructure is needed to meet the demands of military users. Approaches to this goal include developing technologies in these areas:

- High-Capacity Links technologies - enables greater back-haul capability.
- Advanced Networking technologies - supports resilience, adaptability, scalability, and composable systems to enable adaptive effects webs.
- Low Probability of Detection and Anti-Jam (LPD/AJ) technologies - provides assured communications in very high-threat environments.
- Novel Radio Frequency and Spectral Sensing (RF/SS) - supports efficient spectrum management in congested environments and detection of electromagnetic threats.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Space-Based Adaptive Communications Node (Space-BACN)	35.031	32.104	7.175
Description: The Space-Based Adaptive Communications Node (Space-BACN) program seeks to create a reconfigurable intersatellite optical communications terminal that has low size, weight, power, and cost (SWaP-C) and easily integrates onto small satellites, as well as a methodology for cross-constellation command and control (C2). Space-BACN will enable on-orbit communications and data relay between heterogeneous satellite constellations that operate on different optical intersatellite link (OISL) specifications. Today's government and commercial OISL-equipped satellites are unable to communicate with each other due to reliance on single-waveform terminals and a lack of standardization for waveform specifications. Space-BACN will overcome this challenge by developing a modular, reconfigurable optical terminal that is standard-agnostic and able to support most current and future OISL protocols. Space-BACN will also develop a C2 system that controls access and configures connectivity between constellations based on availability and mission requirements. Technology developed under this program will transition to the Services and the Space Development Agency (SDA).			
FY 2024 Plans: - Implement cyber hardening plan for communications terminal electronics, operating system, and C2. - Demonstrate connectivity between optical aperture and reconfigurable modem designs. - Test and evaluate application programming interfaces (APIs) and connectivity plan for different scenarios. - Conduct evaluation of cyber hardening measures.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-02 / *INFORMATION INTEGRATION SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop low SWaP-C, space qualifiable design of optical aperture. - Develop low SWaP-C, space qualifiable design of reconfigurable modem. ***FY 2025 Plans:*** - Conduct full interoperability demonstration. - Collaborate with transition partners to develop cross-constellation surge capacity scenarios. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from design, evaluation, and development activities to full demonstration.			
Title: Mission Integrated Network Control (MINC) ***Description:*** The goal of the Mission Integrated Network Control (MINC) program is to develop networking resource management technology to enable agile, self-healing, heterogeneous communications that adapt autonomously to battlefield situations and information needs. Technology developed by MINC will translate warfighter information needs and mission applications into requests for communication services and will autonomously discover and configure communications nodes and pathways to form and execute adaptive effects chains and move information where it is needed the most. MINC supports applications that will provide up-to-date information to support warfighter situational awareness, a customized common operating picture, and adaptive effects chains across joint all-domain operations in a highly contested environment. Technology from this program will transition to the Services. ***FY 2024 Plans:*** - Demonstrate integration of resource modeling and forecasting into network discovery. - Demonstrate network orchestration across multiple heterogeneous networks and control decisions aligned with mission objectives. - Conduct Government-led code reviews and evaluate cybersecurity of the MINC system. - Collaborate with transition partners to integrate MINC into transition-oriented applications. - Analyze concepts of employment and coordinate with key transition partners to inform operational deployment. - Demonstrate mission-driven networking paradigm to dynamically manage networks aligned with mission objectives. ***FY 2025 Plans:*** - Demonstrate MINC capabilities and value in a relevant field exercise. - Collaborate with operational partners to develop a clear path to accreditation of the MINC solution. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from system integration to capability demonstration.	26.022	25.035	6.238
Title: Generating Communications Channels to Operate (GeCCO)	19.000	16.695	15.010

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-02 / *INFORMATION INTEGRATION SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Description: The Generating Communications Channels to Operate (GeCCO) program will enable secure communications for military operations in contested environments by creating communications paths that assure privacy and availability. This effort will develop advanced and flexible communication architectures that employ new virtual network services. GeCCO will enable communications by leveraging commercial networks. Future distributed operations across the globe will require a small logistical footprint and the flexibility to adapt to the available communication environments (commercial and military). GeCCO will address the secure use of already widespread advanced cellular networks to preserve privacy of communications by preventing pattern-of-life analysis. Technology developed under this program will transition to the Services. ***FY 2024 Plans:*** - Research privacy-preserving techniques aligned with operational requirements. - Initiate pattern-of life analysis of network traffic. - Begin integration of network services with the network architecture through Government-led integration events. - Develop framework to deploy and manage software services. ***FY 2025 Plans:*** - Begin development, security, and operations (DevSecOps) with operational partners. - Test integrated network services and network architecture with transition partners in a controlled field environment. - Use framework to develop and deploy advanced network services. - Conduct experiments with services developed by third parties. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from development and integration to testing and experimentation.			
Title: Strategic Chaos Engine for Planning, Tactics, Experimentation and Resiliency (SCEPTER)	18.000	20.020	12.023
Description: The Strategic Chaos Engine for Planning, Tactics, Experimentation and Resiliency (SCEPTER) program will develop machine-generated strategies for strategic planning. SCEPTER will discover novel and surprising Courses of Action (CoAs) by exploring the high complexity state-action space of military engagements at high machine speeds. High CoA exploration speed is enabled by tailorable abstraction of trusted, expert informed models. A few of the highest performing CoAs will be validated in higher fidelity simulators along with a thorough human review. Initially, SCEPTER will generate synthetic CoAs to identify vulnerabilities in human generated plans. In later stages of the program, SCEPTER will be applied in developing novel plans. Ultimately, SCEPTER will continually evaluate war plans as changes in theater occur (blue and/or red force laydowns, new equipment, etc.) to find new opportunities and weaknesses and help prevent surprise from competitors. Technology developed under this program will transition to the Services. ***FY 2024 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-02 / *INFORMATION INTEGRATION SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop advanced methods of incorporating unscripted goal-oriented agents into CoA generation and evaluation. - Develop advanced methods for managing and controlling the exponential growth of the global state-action space. - Demonstrate advanced performance of machine-derived plans against three or more military scenarios. - Compare machine-derived planning against human-derived planning. ***FY 2025 Plans:*** - Refine performance of machine-derived plans against military scenarios. - Demonstrate advanced performance of updated machine-derived plans against military scenarios. - Transition program to Armed Forces warfighter planning organizations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from development to demonstration and transition.			
Title: Space domain Wide Area Tracking & Characterization (Space-WATCH)	9.500	30.000	22.827
Description: The Space domain Wide Area Tracking & Characterization (Space-WATCH) program will enable real-time persistent tracking of objects in low earth orbit (LEO) and provide actionable intelligence on tactical timescales. Space-WATCH will enable detection and tracking of objects orbiting the Earth on much faster timescales than current ground-based sensors are capable of by combining proliferated, on-orbit sensors with automated data fusion. By working with commercial companies operating in LEO to host low-cost sensors on their space platforms, Space-WATCH will employ thousands of sensors on orbit to continuously gather data. Space-WATCH will utilize automated algorithms to process and fuse all the collected data for anomaly detection and false alarm reduction, making the data useful and actionable to ground-based operators. This comprehensive data set of objects in LEO and real-time information on anomalies will greatly increase the accuracy of the Department of Defense's space situational awareness, as well as enable appropriate responses to anomalies, such as maneuvering space assets out of the way of orbital debris. Technology developed under this program will transition to the U.S. Space Force and Space Development Agency. ***FY 2024 Plans:*** - Develop initial as-a-service market structure. - Develop and build sensors. - Conduct system integration and software testing. - Launch sensors on host platforms. - Develop sensor fusion and anomaly detection algorithms. - Conduct data fusion testing with simulated data. - Instantiate functional marketplace. ***FY 2025 Plans:*** - Collect on-orbit data.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-02 / *INFORMATION INTEGRATION SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct data fusion testing with live data. - Update data fusion algorithms. - Test and evaluate market place with live data. - Update market place incentive structure based on as-a-service feedback. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from building and launching hardware to on-orbit data collections.			
Title: Access in Information Integration Systems ***Description:*** The Access in Information Integration Systems thrust will design and demonstrate advanced communications systems and information systems technology to provide novel concepts and advanced capabilities to access challenging new environments and overcome contested domains. Emphasis will be on concepts and approaches that increase situational awareness, command and control, communications, information infrastructure, cyber operations, information operations, artificial intelligence, and autonomous capabilities at the tactical edge. Technology advancements will support interoperability, security, and resilience. ***FY 2025 Plans:*** - Develop algorithms to allow for secure computation over untrusted hardware. - Develop distributed algorithms to take advantage of new compute capabilities. - Design a testbed and model performance over commercial systems. - Demonstrate edge computing approaches capable of increasing service availability. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.	-	-	12.000
Title: Resilient Networked Distributed Mosaic Communications (RNDMC) ***Description:*** Resilient Networked Distributed Mosaic Communications (RNDMC) aims to provide Beyond-Line-Of-Sight (BLOS) tactical communications for an Anti-Access/Area Denial (A2/AD) environment by developing low-cost expendable transceivers that may be hand carried or hosted on ground platforms, autonomous air vehicles, high altitude platforms, and low-cost/low earth orbit satellites. RNDMC plans to use a combination of synchronized transceivers and tactical radios to enhance desired signals and reject intentional and unintentional interference. RNDMC will design, develop, and demonstrate a distributed field of expendable transceivers, providing a robust, low-cost, BLOS tactical communications system that degrades gracefully as transceiver nodes become unavailable. The RNDMC goal is a demonstration on ground and air platforms and will not be reliant on Global Positioning System (GPS). Technologies from this program will transition to the Services. ***FY 2024 Plans:***	18.762	17.263	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-02 / *INFORMATION INTEGRATION SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Conduct field exercise to validate RNDMC approach in a multi-hop relay and multipoint-to-multipoint configuration. - Determine airborne platform for hosting RNDMC relay nodes. - Integrate RNDMC payload onto unmanned airborne platform to support long-range relay testing. - Transition RNDMC technology to the Office of Naval Research. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Air Space Total Awareness for Rapid Tactical Execution (ASTARTE) ***Description:*** The Air Space Total Awareness for Rapid Tactical Execution (ASTARTE) program will develop and demonstrate innovative approaches to create a joint, regional (covering the span of an Army division) airspace picture and dynamically managing local airspace operations in an Anti-Access/Area Denial (A2/AD) environment without requiring conventional high-power radars or communications. This capability will support airspace dynamic planning and real-time re-planning and deconfliction of a wide array of airborne systems and long-range fires. ASTARTE will identify and deconflict operational missions in a complicated environment filled with ground and airborne threats, friendly fires, precision guided munitions, manned and unmanned aircraft, and civilian aviation. ASTARTE will develop a virtual and live testbed for airspace management systems, a series of algorithms for airspace planning and operations, and a collection of sensors, leveraging existing and novel sensors for real-time spatial and temporal tracking of airborne platforms. ASTARTE will be compatible with legacy command and control (C2) airspace management tools to take advantage of prior investments in technologies, such as human-machine interfaces, and to minimize costs and the impact on training. Technologies from this program will transition to the Army. ***FY 2024 Plans:*** - Conduct additional live experimentation to assess operational use of ASTARTE technology in joint exercises. - Integrate ASTARTE microservices in Army command and control software. - Develop software documentation and package system for technology transition. - Investigate techniques to increase confidence in system output. - Transition ASTARTE capability to the Army. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	12.947	19.074	-
Accomplishments/Planned Programs Subtotals	139.262	160.191	75.273

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-02 / *INFORMATION INTEGRATION SYSTEMS*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	Project (Number/Name) CCC-05 / *CYBER SYSTEMS*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
CCC-05: *CYBER SYSTEMS*	-	2.000	40.000	108.689	-	108.689	121.883	135.149	143.602	148.471	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Cyber Systems project develops, implements, and demonstrates techniques, tools, and frameworks for the full range of cyber operations. Cyber is now ubiquitous to warfighting. For non-kinetic operations in advance of lethal conflict, cyber can be a powerful enabler of information operations that limit adversary options and deter adversary actions. For kinetic operations during lethal conflict, cyber can be a force multiplier and provide an asymmetric advantage. The Cyber Systems project aims to create operational prototypes based on the cyber technology developed in applied research programs (budgeted in PE 0602303E, Project IT-03), in the private sector, and in academia. The utility of the operational prototypes that are developed in this project will be assessed, and improvements made, based on demonstrations and evaluations conducted in collaboration with warfighters, acquisition programs, and combatant commands.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Carcosa	2.000	35.000	41.500
Description: The Carcosa program is developing and demonstrating cyber technologies for use by warfighters during tactical operations. Carcosa cyber technology aims to provide warfighters in the field with enhanced situational awareness of their immediate battlespace. Carcosa technologies are being integrated in prototype tools suitable for use by warfighters with a range of cyber knowledge and skills, including both cyber novices and advanced cyber practitioners.			
FY 2024 Plans: - Collaborate with military stakeholders and explore cyber technology to provide warfighters in the field with enhanced situational awareness of the immediate battlespace. - Collaborate with operational units to develop new tactics, techniques, and procedures (TTPs) enabled by organic cyber capabilities. - Collaborate with potential transition partners to formulate proof-of-concept demonstrations of organic cyber in support of tactical operations.			
FY 2025 Plans: - Iteratively improve user interface to minimize cognitive burden on tactical cyber operators. - Develop improved form factor for optimized integration with existing equipment. - Evaluate and demonstrate technologies to military stakeholders and potential transition partners.			
FY 2024 to FY 2025 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-05 / *CYBER SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 increase reflects continued technology development and ramping up of evaluation and demonstration activities.			
Title: Constellation	-	5.000	27.000
Description: The Constellation program is developing technologies, capabilities, and prototype systems to enable full spectrum military cyberspace operations to deter, disrupt, and defeat adversary cyber actors and to defend the U.S. Technologies of interest include but are not limited to artificial intelligence (AI), machine learning (ML), and data science (DS); resilient software, networking, and computing systems; data and information assurance; and cyber threat intelligence. The work achieves high relevance through close coordination with U.S. cyber operators and the use of development, security, and operations (DevSecOps) and other collaborative development processes. The work achieves high velocity through streamlined acquisition, assessment, approval, and deployment processes. Constellation development and deployment pipelines enable the rapid and continuous delivery of cyber technologies, capabilities, and prototype systems into operational use for the DoD. The Constellation program is funded in PE 0603760E, Project CCC-05 and PE 0602303E, Project IT-03 to facilitate rapid transition of cyber technologies and laboratory prototypes from applied research to operational prototypes. ***FY 2024 Plans:*** - Establish a working group with cyber operators from Commands and Services to prioritize cyber technologies and capabilities and initiate technology adaptation and maturation, and collaborative development of operational prototypes. - Coordinate with systems owners to understand the advantages of pipeline and continuous/incremental integration/delivery development models as a means to achieve rapid deployment to operations. - Develop a continuous integration/continuous development pipeline to achieve rapid deployment to operations through continuous authority to operate (cATO). - Conduct operational test, evaluation, and readiness assessments for operational prototypes in coordination with product owners and approval authorities. ***FY 2025 Plans:*** - Coordinate with cyber operators from Commands and Services to understand evolving needs, prioritize cyber technologies and capabilities, and accelerate technology adaptation and maturation, and collaborative development of operational prototypes. - Assess development pipeline and continuous/incremental integration/delivery processes as a means to achieve rapid deployment to operations. - Assess and refine the continuous integration/continuous development pipeline as a means to achieve rapid deployment to operations through continuous authority to operate (cATO). - Conduct operational test, evaluation, and readiness assessments for operational prototypes in coordination with product owners and approval authorities. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-05 / *CYBER SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 increase reflects the expansion of efforts to mature, integrate, assess, and transition cyber technologies and laboratory prototypes from applied research to operational prototypes.			
Title: Cyber Defense of Critical Infrastructure ***Description:*** Efforts conducted under this thrust feature engagement with strategic partners at Combatant Commands (COCOMs) to identify capability gaps and generate strategic impact in an accelerated timeline. U.S. national security is reliant upon COCOM mission success, which in turn depends on effective collaboration and coordination with partner nations. This thrust will enhance COCOM partnership, presence, and readiness capabilities and position the U.S. and partners to defeat competitor and adversary nations as the need arises. ***FY 2025 Plans:*** - Improve resiliency of critical infrastructure in the digital domain throughout the area of responsibility (AOR). - Ensure persistent and robust communication systems in contested environments. - Improve ability to conduct assured joint operations with partner nations. - Engage directly with U.S. and partner services to identify and address capability gaps. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects initiation of collaborative efforts with partner nations to ensure resilient cyber, robust communication, and assured joint operations capabilities across multiple COCOMs.	-	-	20.189
Title: Access in Cyber Systems ***Description:*** Efforts conducted under this thrust aim to develop, implement, and demonstrate techniques, tools, and frameworks to ensure physical or virtual presence where and when necessary to provide knowledge and/or achieve desired effects. Cyber access is critical to ensure the U.S. can maintain a continuous virtual presence on adversary networks and systems. An at-will cyber access capability will be created to undermine adversary confidence in their combat, information, and weapon systems. ***FY 2025 Plans:*** - Initiate alternative frameworks for cyber access with specified operational characteristics. - Initiate artificial intelligence (AI) and machine learning (ML)-based access techniques. - Initiate access simulation environments having realistic adversary networks and defenses. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** FY 2025 increase reflects program initiation.	-	-	20.000
Accomplishments/Planned Programs Subtotals	2.000	40.000	108.689

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	**Project (Number/Name)** CCC-05 / *CYBER SYSTEMS*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603760E / *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*	Project (Number/Name) CCC-06 / *COMMAND, CONTROL AND COMMUNICATION SYSTEMS*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
CCC-06: *COMMAND, CONTROL AND COMMUNICATION SYSTEMS*	-	150.318	121.400	152.580	-	152.580	72.191	40.940	5.895	0.000	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This project funds classified DARPA programs that are reported in accordance with Title 10, United States Code, Section 119(a)(1) or its successor.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Classified DARPA Program	150.318	121.400	152.580
Description: This project funds Classified DARPA Programs. Details of this submission are classified. ***FY 2024 Plans:*** Details will be provided under separate cover. ***FY 2025 Plans:*** Details will be provided under separate cover. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** Details will be provided under separate cover.			
Accomplishments/Planned Programs Subtotals	150.318	121.400	152.580

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	662.126	885.425	886.511	-	886.511	863.388	440.126	286.821	273.926	-	-
NET-01: *JOINT WARFARE SYSTEMS*	-	48.046	110.335	44.996	-	44.996	126.535	105.577	69.272	63.322	-	-
NET-02: *MARITIME SYSTEMS*	-	116.826	160.050	149.654	-	149.654	154.702	144.603	195.238	210.604	-	-
NET-06: *NETWORK-CENTRIC WARFARE TECHNOLOGY*	-	497.254	615.040	691.861	-	691.861	582.151	189.946	22.311	0.000	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Network-Centric Warfare Technology Program that addresses high payoff opportunities to develop and rapidly mature advanced technologies and systems required for today's network-centric warfare concepts. It is imperative for the future of the U.S. forces to operate flawlessly with each other, regardless of which services and systems are involved in any particular mission. The overarching goal of this PE is to enable technologies at all levels, regardless of service component, to operate as one system.

The objective of the Joint Warfare Systems project is to create enabling technologies for seamless joint operations, from strategic planning to tactical and urban operations. Joint Warfare Systems leverage current and emerging network, robotic, and information technology and provide next generation U.S. forces with greatly increased capability, lethality, and rapid responsiveness. Critical issues facing this project are: (1) U.S. opponents using systems that are flexible, robust, and difficult to neutralize; and (2) U.S. doctrine that limits the use of firepower to lessen the impact of operations on noncombatants. These problems are magnified in urban and semi-urban areas where combatants and civilians are often co-located and in peacekeeping operations where combatants and civilians are often indistinguishable. Meeting these challenges places a heavy burden on joint war planning. Understanding opponent networks is essential so that creative options can be developed to counter their strategies. Synchronization of air and ground operations to apply force only where needed and with specific effects is required. This project supports all levels of the force structure including: (1) the strategic/operational level by generating targeting options against opponents' centers of gravity that have complex networked relationships; (2) the tactical/operational level by managing highly automated forces with tight coupling between air and ground platforms; and (3) the focused tactical level by developing platforms and tools, which acquire targets of opportunity and cue network-based analysis of likely enemy operations thus maximizing the effectiveness of ground forces in stability and support operations.

The Maritime Systems project is identifying, developing and rapidly maturing critical advanced technologies and system concepts for the naval forces' role in today's network-centric warfare concept. Improvements in communications between and among submarines, surface ships and naval aircraft have allowed these forces to operate seamlessly with each other and with other Service's network-centric systems. Naval forces will play an ever-increasing role in network-centric warfare because of their forward deployed nature, their unique capability to operate simultaneously in the air, on the sea and under the sea, and their versatile ability to provide both rapid strike and project sustained force. The technologies developed under this project will capitalize on these attributes, improve them and enable them to operate with other network-centric forces.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603766E *I NETWORK-CENTRIC WARFARE TECHNOLOGY*

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	673.562	885.425	941.270	-	941.270
Current President's Budget	662.126	885.425	886.511	-	886.511
Total Adjustments	-11.436	0.000	-54.759	-	-54.759
• 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	9.208	0.000			
• SBIR/STTR Transfer	-20.644	0.000			
• TotalOtherAdjustments	-	-	-54.759	-	-54.759

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer offset by reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects completion of the DARPA Assault Breaker II (ABII), Autonomous Multi-domain Adaptive Swarms-of-Swarms (AMASS), No Manning Required Ship (NOMARS), Manta Ray, Sea Train and Timely Information for Maritime Engagements (TIMEly) programs, as well as a shift from initial flight testing to technology transition activities in the Air Combat Evolution (ACE) program.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	Project (Number/Name) NET-01 / *JOINT WARFARE SYSTEMS*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
NET-01: *JOINT WARFARE SYSTEMS*	-	48.046	110.335	44.996	-	44.996	126.535	105.577	69.272	63.322	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The objective of the Joint Warfare Systems project is to create enabling technologies for seamless joint operations, from strategic planning to tactical and urban operations. Joint Warfare Systems leverage current and emerging network, robotic, and information technology and provide next generation U.S. forces with greatly increased capability, lethality, and rapid responsiveness. Critical issues facing this project are: (1) U.S. opponents using systems that are flexible, robust, and difficult to neutralize; and (2) U.S. doctrine that limits the use of firepower to lessen the impact of operations on noncombatants. These problems are magnified in urban and semi-urban areas where combatants and civilians are often co-located and in peacekeeping operations where combatants and civilians are often indistinguishable. Meeting these challenges places a heavy burden on joint war planning. Understanding opponent networks is essential so that creative options can be developed to counter their strategies. Synchronization of air and ground operations to apply force only where needed and with specific effects is required. This project supports all levels of the force structure including: (1) the strategic/operational level by generating targeting options against opponents' centers of gravity that have complex networked relationships; (2) the tactical/operational level by managing highly automated forces with tight coupling between air and ground platforms; and (3) the focused tactical level by developing platforms and tools, which acquire targets of opportunity and cue network-based analysis of likely enemy operations thus maximizing the effectiveness of ground forces in stability and support operations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Air Combat Evolution (ACE)	20.070	19.627	7.996
Description: As the Services develop new Joint Multi-Domain Battle warfighting concepts, there is a strong demand for innovative ways to assess architectures, advance technology, and support operators developing advanced multi-domain tactics. The Air Combat Evolution (ACE) program will apply technologies and principles of distributed autonomy and artificial intelligence (AI) to aerial within-visual-range (WVR) maneuvering, colloquially known as a dogfight, in modeling and simulation (M&S), surrogate, and ultimately full-scale vehicles. The program will deliver an initial instantiation of a scalable AI controller enabling aircraft autonomy at levels ranging from an advanced tactical autopilot for dynamic maneuver to a form of multi-domain mosaic battle management controller. Experiments will explore both augmentation of existing manned platforms and enhanced future unmanned systems. ACE will provide an early opportunity to build operator trust in combat autonomy and demonstrate adaptive human-machine teaming tools and architectures. Technology developed by this program will transition to the Services.			
FY 2024 Plans: - Conduct flight test of WVR algorithms on full-scale aircraft with progression to more complex scenarios. - Integrate combat autonomy for more complex campaign scenarios with real world data.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Execute F-16 aircraft modifications to enable combat autonomy. - Conduct full-scale aircraft flight evaluations of combat autonomy. ***FY 2025 Plans:*** - Demonstrate human machine interfaces that support appropriate trust in WVR combat autonomy on full-scale aircraft. - Transition autonomy technologies to Air Force partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from initial flight testing to technology transition.			
Title: Autonomy Standards and Ideals with Military Operational Values (ASIMOV) ***Description:*** The Autonomy Standards and Ideals with Military Operational Values (ASIMOV) program will develop autonomy benchmarks to objectively and quantitatively measure the ethical readiness of future autonomous systems and the ethical difficulty of proposed use-cases in support of military operational values (e.g., international humanitarian law, rules of engagement, etc.) in increasingly complex and changing scenarios. In order to accelerate the development and eventual use of ethical autonomous systems, an implementable measurement and benchmarking framework of military autonomy must be developed. Based on technologies developed in the Urban Reconnaissance through Supervised Autonomy (URSA) program (budgeted in PE 0602702E, Project TT-04), ASIMOV's benchmark will enable future autonomous systems that undergo the intensive testing to be evaluated and scored with autonomy readiness levels (ARL) much like how technology readiness levels (TRL) and manufacturing readiness levels (MRL) are used to describe the maturity of technology and manufacturing processes, respectively. ASIMOV will decompose the five Department of Defense's Responsible Artificial Intelligence (AI) Ethical Principles (Responsibility, Equitability, Reliability, Traceability, and Governability) in a structured, observable, and independently verifiable manner to measure the readiness of specific autonomous systems to perform ethically within those scenarios. Technology developed under ASIMOV will be transitioned to the demonstration and operational testing (DT/OT) community, the Director of Operational Test and Evaluation (DOT&E), and the Services. ***FY 2024 Plans:*** - Develop initial autonomy benchmark through decomposition of quantifiable values for the five Responsible AI Ethical Principles. ***FY 2025 Plans:*** - Develop initial framework for the quantitative benchmark. - Develop ethical and complex scenarios for benchmarking Autonomous Weapon Systems (AWS). - Develop synthetic data in various sensor modalities. - Enhance the generative environment to be capable of rapidly generating synthetic scenes and scenarios. ***FY 2024 to FY 2025 Increase/Decrease Statement:***	-	5.000	22.000

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
The FY 2025 increase reflects a shift from initial benchmark development to development of framework, scenarios, and data.			
Title: Awareness in Joint Warfighting Technology	-	-	15.000
Description: The Awareness in Joint Warfighting Technology thrust will develop and demonstrate advanced technologies to project power and identify and deliver capabilities in deeply denied areas. Future joint warfighting will rely increasingly on autonomy and explore new environments and domains. In deeply denied areas, challenges to conduct collaborative battlefield operations among multiple networked autonomous systems remain. This autonomy will need to overcome an active adversary's ability to adapt while delivering enough awareness to enable trust in achieving the desired goal. In order to project power in novel ways, this area will also develop technologies and toolsets to detect new sets of indicators and actions to impact an adversary's capabilities. Lastly, joint warfighting in denied areas will require forward deployed operators to exploit local resources to support and sustain ongoing operations. This includes the forward-deployed use of resources, leveraging existing infrastructure for sensing and communications and exploring expeditionary advanced manufacturing techniques and live, virtual, and constructive experimentation and technology/system demonstration to support technology transition objectives and provide data that supports transition partners' investment decisions. ***FY 2025 Plans:*** - Initiate studies for logistics and industrial base network dynamics. - Establish collaborative information exchange forums with industry, DoD, and inter-agency logistical partners. - Perform analytics and experimentation to identify potential projects dealing with industry and DoD network performance improvement. - Integrate industrial base analytics with comparable analytic efforts dealing with warfighting operational concepts. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Assault Breaker II (ABII)	26.515	65.097	-
Description: Assault Breaker II (ABII) seeks to change the current warfighting paradigm of reliance on a Service-specific and platform centric force that executes prescribed kill chains to a highly adaptable and capability-based force. This new paradigm operates as a disaggregated kill web able to execute rapidly composable, joint, and all domain kill chains. ABII will exploit both existing and emerging technologies across the Services to address known capability gaps, opportunities, and threats. ABII will conduct mission-centric, multi-Service and multi-domain analyses, modeling & simulation (M&S), and experimentation to inform research and development and program of record recommendations. ABII will build an enduring, multi-service M&S environment to support complex mission level kill web analysis. ABII will also design and develop a Vanguard Force DevOps Environment			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
(VFDE) and battle management enclave with physical nodes that will enable the transition of ABII technologies, concepts and architectures to the Services. ABII is completing development and will be transitioning to the Office of the Secretary of Defense. ***FY 2024 Plans:*** - Design kill web architecture study-based scenarios for M&S and experimentation validation. - Conduct model and simulation execution and analysis. - Complete validation of multi-level security environment. - Re-align experimentation architecture to the Office of the Secretary of Defense and Services. - Transition battle management software capabilities to the Office of the Secretary of Defense. - Re-align M&S system to the Office of the Secretary of Defense and Services. - Complete final recommendations for validated warfighting architectures. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Autonomous Multi-domain Adaptive Swarms-of-Swarms (AMASS)	1.461	20.611	-
Description: Autonomous Multi-domain Adaptive Swarms-of-Swarms (AMASS) builds on the successes of SESU (budgeted in this PE/Project) and on related Service programs to create a scalable, robust, and interoperable system-of-systems, capable of defeating adversary Anti-Access/Area Denial (A2/AD) capabilities at the theatre level. The SESU program leveraged a large number of cost-imposing, autonomous drones with a small footprint in order to degrade, disrupt, deceive, or destroy an adversary's A2/AD capabilities at the operational level. The program focused on command and control (C2) to plan and execute mission level effects (e.g., open corridors for conventional force employment) in contested environments, swarm behaviors, and control of payloads required to sense and effect. The AMASS C2 software and architecture will coordinate the operations of a heterogenous mix of autonomous air, ground, and surface assets, developed by different Services and vendors, running different swarm behavior software, with different payloads, in order to deliver distributed sensing, kinetic and non-kinetic effects, information operations, and other hybrid effects. AMASS planning and execution software will enable disparate autonomous platforms to collaborate and negotiate with each other to complete complex counter-A2/AD missions and to dynamically adapt to changes in the environment such as attrition, targeting errors, and unanticipated adversary actions, as well as changes in missions or target sets. The planned transition partners for the capability are Service Programs of Record. ***FY 2024 Plans:*** - Enhance SESU C2 to support planning and execution of missions leveraging multiple disparate airborne, waterborne (surface), and ground-based drone swarms. - Design and develop C2 software enabling swarms (airborne, waterborne (surface), and ground-based) to negotiate with each other in order to achieve mission objectives.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-01 / *JOINT WARFARE SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Apply AMASS technologies to new threats and geographies in simulation for inclusion in future efforts. - Update C2 architecture based on simulation results to support different swarm (airborne, waterborne (surface), and ground-based) behaviors. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Accomplishments/Planned Programs Subtotals	48.046	110.335	44.996

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	Project (Number/Name) NET-02 / *MARITIME SYSTEMS*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
NET-02: *MARITIME SYSTEMS*	-	116.826	160.050	149.654	-	149.654	154.702	144.603	195.238	210.604	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Maritime Systems project is identifying, developing and rapidly maturing critical advanced technologies and system concepts for the naval forces' role in today's network-centric warfare concept. Improvements in communications between and among submarines, surface ships and naval aircraft have allowed these forces to operate seamlessly with each other and with other Service's network-centric systems. Naval forces will play an ever-increasing role in network centric warfare because of their forward deployed nature, their unique capability to operate simultaneously in the air, on the sea and under the sea, and their versatile ability to provide both rapid strike and project sustained force. The technologies developed under this project will capitalize on these attributes, improve them and enable them to operate with other network-centric forces.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Advanced Propulsor, Experimental (APEX)*	2.000	41.413	83.318

Description: *Formerly Advanced Propulsors, Experimental (APEX)

Current submarine propulsor and propeller designs have reached the technical limits of achieving significant improvements, constrain ship layouts, and maneuvering capabilities. The Advanced Propulsor, Experimental (APEX) program is developing and demonstrating a new generation of submarine propulsor designs enabling revolutionary improvements in submarine design, maneuverability, speed, and quieting that will transform future submarine designs. The APEX program is building upon technologies developed in the Advanced Maritime Defense Technologies Concepts budgeted in PE 0602702E, Project TT-03. The anticipated transition is to the Navy.

FY 2024 Plans:
- Complete mechanical design space exploration (DSE) feasibility studies.
- Design and fabricate 1/20th scale demonstrator.
- Complete Conceptual Design Review (CoDR) for objective system.

FY 2025 Plans:
- Complete Preliminary Design Review (PDR) for demonstrator system.
- Conduct detailed design for the APEX full and quarter scale designs and purchase long-lead items.
- Initiate development of a quarter scale (demonstrator) vehicle and conduct initial testing.
- Conduct subsystem modeling, simulation and analysis activities.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Develop, build, and test the quarter scale vehicle subsystems. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift to detailed design, fabrication, and test activities.			
Title: Willow ***Description:*** The Willow program will develop innovative payloads to conduct Acoustic Warfare (AW) to counter active surface sonars using a unique combination of acoustic hardware and waveforms provided by advanced sonar signal processing algorithms. Willow will provide a robust capability to help the Navy respond to active sonar threats. No current method exists to challenge adversary active sonars. Willow will use advanced hardware-in-the-loop simulations, Independent Verification and Validation (IV&V), and stressing at-sea testing to create this capability. Technology developed under this program will transition to the Navy. ***FY 2024 Plans:*** - Define operational concepts based on selected performer systems. - Develop prototype acoustic projector payload hardware commensurate with operational concepts. - Develop software and waveforms to provide acoustic effects to support counter sonar capabilities. - Conduct end-to-end performer software simulations to provide interim analysis against program metrics. - Conduct IV&V to verify performer simulations, hardware, and waveforms. - Conduct in-water engineering tests of critical hardware components. ***FY 2025 Plans:*** - Conduct Critical Design Review of prototype acoustic projector payloads prior to at-sea testing. - Conduct at-sea test to verify prototype system performance and modeling efficacy. - Conduct in-water node coordination test to verify node-to-node handoff autonomy. - Select prototype payloads for further development based on performance against metrics in at-sea testing. - Conduct IV&V to verify performer updates to simulations, hardware and waveforms based on lessons learned from initial at-sea testing. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the shift from software development and hardware testing to at-sea testing.	5.000	27.002	31.691
Title: Goblin ***Description:*** The undersea domain has significant importance to national security and military operations, but manned missions are restricted in their operational ranges. The Goblin program will enhance U.S. autonomous capabilities in the challenging undersea domain by developing and demonstrating complex underwater systems able to search, locate, and execute mission	22.378	25.838	30.645

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
objectives without the need for human control. Navigation approaches will focus on the use of commercial, low-cost navigation hardware combined with environmental feature-based algorithm approaches to eliminate reliance on the Global Positioning System (GPS) for long-duration missions. Key Goblin technical challenges include sensing techniques that provide high-resolution navigation without GPS, perception and effector strategies for objects with unknown parameters, long-duration autonomy approaches to support mission execution, and autonomy approaches that do not rely on human interaction. The anticipated transition is to the Navy. ***FY 2024 Plans:*** - Conduct testing of new sensor and payload configurations that incorporate lessons learned throughout FY 2023. - Begin development, fabrication, and testing of the vehicle that will support subsequent transition. ***FY 2025 Plans:*** - Complete fabrication and testing of the vehicle to support transition. - Deliver the vehicle to the Navy for further development. - Test the government-owned system in a representative maritime environment. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects transition partnership for continued developmental testing and fielding. The transition partnership required rigorous testing in highly unstructured and dynamic environments.			
Title: Awareness in Maritime Systems	-	-	4.000
Description: The envisioned future fleet of Uncrewed Surface Vehicles (USVs) is not survivable in a contested environment unless it can plan and execute mission maneuvers without the enemy easily detecting, tracking and localizing their positions. Current USV autonomy can't respond and adapt to a changing threat environment, making USVs highly vulnerable. The Awareness in Maritime Systems thrust will develop and demonstrate platform autonomy technologies that can enable operations in emission-controlled environments or when communications have been compromised. Platform awareness of both the external environment and of its own internal health and operating status, and the ability to make decisions based on this awareness, will become an enabling capability for future autonomous systems. Cooperative operation of Uncrewed Air Vehicles (UAVs) will be explored to extend the awareness envelope for maritime platforms, as well as the use compact, plug-in modular autonomy control systems that can rapidly adapt commercial UAVs for military missions. ***FY 2025 Plans:*** - Conduct spiral development of plug-in autonomy controllers. - Develop and laboratory test advanced behaviors for maritime autonomy. ***FY 2024 to FY 2025 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2025 increase reflects program initiation.			
Title: No Manning Required Ship (NOMARS)	28.000	27.548	-
Description: No Manning Required Ship (NOMARS) is developing small, low-cost, disaggregated naval platforms to demonstrate the ability to perform persistent power projection and force application combat missions currently conducted from large, high-value capital ships. The NOMARS program will design a ship that can operate autonomously for long durations at sea, enabling a ship design process that eliminates considerations associated with crew. NOMARS focuses on exploring novel approaches to the design of the sea frame (the ship without mission systems) while accommodating representative payload size, weight, and power. The goal of the program is to demonstrate the feasibility of Unmanned Surface Vessels (USVs) that operate autonomously for months to years without human intervention, in large numbers, with only periodic, depot-based maintenance. This capability will enable disaggregated persistent USVs, allowing the surface fleet to credibly threaten peer adversaries and negate their investments in high-cost weapon systems designed to counter large naval targets such as aircraft carriers. A successful NOMARS program will prove feasibility of a small unmanned ship with significantly improved reliability and functional performance over current USVs providing a pathway to allow a distributed lethality concept to become viable: small ships, in large numbers, each of which is individually low-cost and low-value, but in aggregate presents a significant deterrent. The anticipated transition partner is the Navy. ***FY 2024 Plans:*** - Complete subsystem verification and validation. - Complete build of the demonstrator vessel. - Conduct Test Readiness Reviews. - Perform ship-level verification and validation activities. - Initiate at-sea demonstrations. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Manta Ray	25.069	19.800	-
Description: The Manta Ray program is developing and demonstrating a new class of long-duration, long-range unmanned underwater vehicles (UUVs) at an acquisition and lifecycle cost significantly less than current payload-capable UUVs. This new class of UUV will give the combatant commander an amplification of capacity without disrupting current operations by remaining independent of manned vessels and ports once deployed. The primary goal of the Manta Ray program is to open a design space for future UUVs capable of both long-duration missions and large payload capacity. A secondary goal of the program is to advance key technologies benefiting other naval designs such as low lifecycle cost UUV operations, energy management			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
technologies to enable long-duration operations, biofouling reduction technologies, and long-duration navigational enablers. The anticipated transition partner is the Navy. ***FY 2024 Plans:*** - Complete integration of full-scale vehicle. - Conduct preliminary testing of full-scale vehicle in controlled maritime environments. - Conduct at-sea demonstration of full-scale vehicle performing full range of behaviors and capabilities. - Refurbish and transition full-scale vehicle. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Sea Train ***Description:*** The Sea Train program will support the delivery of masses of Unmanned Surface Vessels (USVs) into theater, without reliance on large, manned capital assets. The Sea Train program is developing and demonstrating approaches to exploit the efficiencies of longer slender hulls, while enabling a distributed fleet of tactical USVs. The Sea Train concept enables vessels that are efficient for transoceanic transport while enabling dispersed operations as individual vessels. The Sea Train program is also developing and demonstrating connectors and approaches to couple the vessels, the control laws required to drive the vessel in open ocean conditions, sensor approaches to understand the wave environment to efficiently navigate the vessel, and the autonomy required to connect and disconnect the vessels without human intervention. The goal of this effort is to improve transport efficiency over what can be achieved with current monohull designs. This allows for the efficient transport of smaller vessels into and out of theater, an operation that is normally accomplished today by carrying smaller vessels on board larger vessels or reliance on at-sea refueling of smaller vessels. The anticipated transition partner is the Navy. ***FY 2024 Plans:*** - Complete demonstration of fleet representative missions with third-scaled demonstrators to include aggregation, disaggregation and operations within complex seaways. - Complete transition of Sea Train demonstration models and sub system technologies to Navy/Marine Corps/Army for follow-on testing and demonstration. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	17.331	15.949	-
Title: Timely Information for Maritime Engagements (TIMEly) ***Description:*** Integration of undersea elements for joint cross-domain operations is critical for developing the most effective distributed kill webs. The Timely Information for Maritime Engagements (TIMEly) program is creating a heterogeneous	4.548	2.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
underwater network architecture that will span the ocean and bridge to other operating domains. TIMEly will provide an adaptive, heterogeneous, scalable communications capability to link undersea and cross-domain assets together into kill webs with minimal operator burden. The program will focus on developing architectures with the capability to transfer the right information to its intended recipient. TIMEly will work within commonly understood limitations, with a focus on protocols, quality of service, and information exchange. The program will leverage developments demonstrating short-range and long-range acoustic communications at higher bandwidth and greater reliability, while minimizing detectability. The program will also leverage recent developments in network interoperability to manage heterogeneous undersea and cross-domain networks. Technology developed by this program will transition to the Navy. ***FY 2024 Plans:*** - Conduct end-to-end demonstration with operational mission partners. - Conduct post-test analysis to evaluate TIMEly operational effectiveness. - Transition TIMEly hardware and software products to the Navy. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES) ***Description:*** The Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES) program developed technologies for a point defense system against today's most stressing threats by developing a highly maneuverable, medium caliber, guided projectile, and fire sequencing and control system capable of neutralizing large threat raids of high speed, highly maneuverable targets. Leveraging recent advancements in gun hardening, miniaturization of guided munition components, and long-range sensors, MAD-FIRES advanced fire control technologies, medium caliber gun technologies, and guided projectile technologies enabling the multiple, simultaneous target, kinetic engagement mission at greatly reduced costs. MAD-FIRES achieved lethality overmatch through accuracy rather than size, thus expanding the role of smaller combat platforms into missions where they have been traditionally outgunned. MAD-FIRES, sized as a medium caliber system, enhanced flexibility for installment as a new ship self-defense system. This program was also funded in PE 0602702E, Project TT-03.	6.500	-	-
Title: Hunter ***Description:*** The Hunter program developed novel concepts for Extra Large Unmanned Undersea Vehicles (XLUUVs) to deliver complex payloads. The program explored efficient encapsulation and buoyancy control concepts to be implemented with advanced fiber handling capabilities for high bandwidth communications in order to create a highly modular and adaptable ocean interface. The interface significantly increased the payload handling ability of the XLUUVs, allowing them to deliver completely new capabilities previously delivered only by manned platforms. The Hunter program established a new capability for integration	6.000	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	**Project (Number/Name)** NET-02 / *MARITIME SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
into maritime system of systems warfare architectures. Technologies developed under the Hunter program transitioned to the Navy.			
Accomplishments/Planned Programs Subtotals	116.826	160.050	149.654

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603766E / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	Project (Number/Name) NET-06 / *NETWORK-CENTRIC WARFARE TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
NET-06: *NETWORK-CENTRIC WARFARE TECHNOLOGY*	-	497.254	615.040	691.861	-	691.861	582.151	189.946	22.311	0.000	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This project funds classified DARPA programs that are reported in accordance with Title 10, United States Code, Section 119(a)(1) or its successor.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Classified DARPA Program	497.254	615.040	691.861
Description: This project funds Classified DARPA Programs. Details of this submission are classified. ***FY 2024 Plans:*** Details will be provided under separate cover. ***FY 2025 Plans:*** Details will be provided under separate cover. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** Details will be provided under separate cover.			
Accomplishments/Planned Programs Subtotals	497.254	615.040	691.861

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	292.757	358.580	267.961	-	267.961	129.658	159.392	159.875	156.808	-	-
SEN-01: *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY*	-	45.681	62.563	66.218	-	66.218	24.812	85.109	89.984	93.187	-	-
SEN-02: *SENSORS AND PROCESSING SYSTEMS*	-	58.258	62.067	45.208	-	45.208	53.516	74.283	69.891	63.621	-	-
SEN-06: *SENSOR TECHNOLOGY*	-	188.818	233.950	156.535	-	156.535	51.330	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Sensor Technology Program focused on sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability and battle damage assessment.

The Surveillance and Countermeasures Technology project funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability, and battle damage assessment. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a clandestine manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing, and low-cost microelectronics to develop advanced surveillance and targeting systems. In addition, this project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats.

The Sensors and Processing Systems project develops and demonstrates the advanced sensor and processing technologies and systems necessary for Intelligence, Surveillance, and Reconnaissance (ISR) missions. Future battlefields will continue to be populated with targets that use mobility and concealment as key survival tactics, and high-value targets will range from specific individual insurgents and vehicles to groups of individuals and large platforms such as mobile missile launchers and artillery. The Sensors and Processing Systems project is primarily driven by four needs: (a) providing day-night ISR capabilities against the entire range of potential targets; (b) countering camouflage, concealment, and deception of mobile ground targets; (c) detecting and identifying objects of interest/targets across wide geographic areas in near-real-time; and (d) enabling reliable identification, precision fire control tracking, timely engagement, and accurate battle damage assessment of ground targets. The Sensors and Processing Systems project develops and demonstrates technologies and system concepts that combine novel approaches to sensing with emerging sensor technologies and advanced sensor and image processing algorithms, software, and hardware to enable comprehensive knowledge of the battlespace and detection, identification, tracking, engagement, and battle damage assessment for high-value targets in all weather conditions and combat environments.

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	308.442	358.580	334.971	-	334.971
Current President's Budget	292.757	358.580	267.961	-	267.961
Total Adjustments	-15.685	0.000	-67.010	-	-67.010
• 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	-7.467	0.000			
• SBIR/STTR Transfer	-8.218	0.000			
• TotalOtherAdjustments	-	-	-67.010	-	-67.010

Change Summary Explanation

FY 2023: Decrease reflects SBIR/STTR transfer and reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects completion of the Fiddler, Moving Target Recognition (MTR) and Thermal Imaging Technology Experiment-Recon (TITE-R) programs, as well as the ramping down of efforts in the Painter and classified programs.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / *SENSOR TECHNOLOGY*	Project (Number/Name) SEN-01 / *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
SEN-01: *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY*	-	45.681	62.563	66.218	-	66.218	24.812	85.109	89.984	93.187	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Surveillance and Countermeasures Technology project funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability, and battle damage assessment. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a clandestine manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing, and low-cost microelectronics to develop advanced surveillance and targeting systems. In addition, this project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Ouija	16.550	23.981	26.924

Description: The goal of the Ouija program is to quantify the High Frequency (HF) noise environment in space and improve the characterization of the ionosphere in support of warfighter capabilities. Ouija intends to make ionospheric measurements of unprecedented granularity using ground equipment and satellites in very low earth orbit (VLEO) to improve ionospheric models and better predict long-range HF propagation. Ouija technology will result in improved performance and characterization of radars and communication systems that operate in the HF band. Technology developed under this program will transition to the Services.

FY 2024 Plans:
- Build and launch Ouija satellite.
- Conduct test and measurement campaign using satellite and ground assets.
- Develop assimilative HF propagation models.
- Validate HF modeling using Ouija data.

FY 2025 Plans:
- Conduct on-orbit operations and test demonstration.
- Incorporate satellite launch and operations lessons learned to build additional satellites.
- Launch additional satellites for further measurement campaigns.
- Conduct scaled test between multiple satellites and ground assets.

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*	**Project (Number/Name)** SEN-01 / *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Validate assimilative HF propagation models using scaled satellite demonstration. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from initial satellite launch to additional launches and data analysis.			
Title: Dynamic Optimization for Defense of Ground bases with Electromagnetic warfare (DODGEball) ***Description:*** The Dynamic Optimization for Defense of Ground bases with Electromagnetic warfare (DODGEball) program will develop algorithms for optimization of non-kinetic countermeasures for efficient and effective resource management in extended campaign warfare. Based on technologies developed in the Strategic Chaos for Planning, Tactics, Experimentation, and Resiliency (SCEPTER) program (budgeted in PE 0603760E, Project CCC-02), DODGEball will optimize heterogeneous applications of electromagnetic warfare for the defense of surface forces and infrastructure for long duration campaigns. Technology developed under this program will transition to the Services. ***FY 2024 Plans:*** - Analyze Government-furnished information on threat characteristics and operational scenarios. - Develop initial multi-objective optimization algorithms for long duration engagements. ***FY 2025 Plans:*** - Develop simulation environment to evaluate optimization, countermeasures, and feedback. - Refine initial optimization algorithms for efficient resource management including countermeasure and feedback parameters. - Evaluate non-kinetic countermeasure effectiveness within Government hardware-in-the-loop laboratory. - Iterate subsystem designs based on laboratory and modeling evaluations. - Develop initial feedback techniques, hardware, and models. - Begin combined evaluation of optimization algorithms integrated with countermeasure and feedback models in a realistic simulation environment. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects a shift from model development to laboratory testing and demonstration.	-	6.000	28.000
Title: Awareness in Surveillance and Countermeasures Technology ***Description:*** The Awareness in Surveillance and Countermeasures Technology thrust will design and demonstrate advanced sensing systems and countermeasure technologies that provide novel capabilities to inform unique future capabilities and expand capabilities into new areas of operation. Efforts will emphasize improvements to size, weight and performance to extend endurance, advance autonomous operations, and reduce costs to maximize system coverage and provide operational capability. Challenges that will be overcome include extended operations without the need for supporting infrastructure, continued operations in harsh physical environments, and extended persistent operations in contested environments.	-	-	11.294

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*	**Project (Number/Name)** SEN-01 / *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2025 Plans: - Conduct a feasibility analysis for affordable, distributed cislunar spacecraft orbital mobility concepts. - Conduct a conceptual design review for an affordable cislunar spacecraft. - Conduct prototype testing of critical sub-systems for an affordable cislunar spacecraft. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects program initiation.			
Title: Fiddler ***Description:*** The Fiddler program seeks to train an artificial intelligence (AI) algorithm to synthesize artificial Synthetic Aperture Radar (SAR) images at any arbitrary look angle, frequency, and polarization based on a few examples of real images. These artificial images will be used to train and improve the performance of Automatic Target Recognition (ATR) algorithms. This capability will allow the government to collect a small amount of SAR imagery on a desired target and then rapidly develop new SAR-based ATR algorithms which are effective at detecting that target. Technology developed under this program will transition to the Services. ***FY 2024 Plans:*** - Demonstrate that the baseline software-generated images can effectively train an ATR algorithm over a wide range of viewing angles. - Demonstrate that the baseline software can meet the specified time requirements for generating new images. - Conduct laboratory testing of the baseline software. - Evaluate the baseline software to demonstrate that it can successfully create synthetic SAR imagery for a wide range of viewing angles. - Implement algorithm improvements to reduce the number of training samples required. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	8.700	17.935	-
Title: Moving Target Recognition (MTR) ***Description:*** The Moving Target Recognition (MTR) program seeks to enable the use of synthetic aperture radar (SAR) sensors to detect, track, image, and automatically recognize moving ground targets within an area of interest. SAR sensors provide the capability to detect and identify high-value targets in all weather conditions but only when the targets are stationary due to limitations in traditional SAR processing. Ground moving target indicator (GMTI) radars are capable of detecting and tracking moving targets, but they cannot form recognizable images of targets. MTR will overcome the limitations of traditional SAR and improves the operational utility of widely deployed SAR sensors on many different types of platforms. The recognition capability	13.372	14.647	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*	**Project (Number/Name)** SEN-01 / *SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
enables new concepts of operation for maintaining persistent custody of high-value targets on the move. Unlike GMTI, which loses custody if the track is broken due to terrain or other factors, MTR-enabled SAR sensors are able to tolerate coverage gaps by reacquiring and reestablishing identification of the moving targets. Technology developed under MTR will transition to the Services. ***FY 2024 Plans:*** - Continue to develop and mature moving target Automatic Target Recognition (ATR) algorithms and characterize their performance using ground-truth data. - Tailor the moving target imaging algorithms to create optimal inputs to the ATR algorithms. - Perform independent verification and validation of ATR algorithm performance. - Transition the MTR software and algorithms to the transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.			
Title: All Source Combat Operations and Targeting (ASCOT) ***Description:*** The All Source Combat Operations and Targeting (ASCOT) program allowed maritime platforms to maintain robust battlespace awareness and survivability by combining data and coordinating operations using all available sensors. The program created methods for optimal balancing of battlespace awareness and survivability by leveraging existing networked sensors and local platform sensors. Key attributes of this program were survivability, information latency, reliability, and endurance. Demonstrations on relevant platforms in relevant environments were used to validate the technology. Technologies from this program transitioned to the Navy.	7.059	-	-
Accomplishments/Planned Programs Subtotals	45.681	62.563	66.218

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / *SENSOR TECHNOLOGY*	Project (Number/Name) SEN-02 / *SENSORS AND PROCESSING SYSTEMS*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
SEN-02: *SENSORS AND PROCESSING SYSTEMS*	-	58.258	62.067	45.208	-	45.208	53.516	74.283	69.891	63.621	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Sensors and Processing Systems project develops and demonstrates the advanced sensor and processing technologies and systems necessary for Intelligence, Surveillance, and Reconnaissance (ISR) missions. Future battlefields will continue to be populated with targets that use mobility and concealment as key survival tactics, and high-value targets will range from specific individual insurgents and vehicles to groups of individuals and large platforms such as mobile missile launchers and artillery. The Sensors and Processing Systems project is primarily driven by four needs: (a) providing day-night ISR capabilities against the entire range of potential targets; (b) countering camouflage, concealment, and deception of mobile ground targets; (c) detecting and identifying objects of interest/targets across wide geographic areas in near-real-time; and (d) enabling reliable identification, precision fire control tracking, timely engagement, and accurate battle damage assessment of ground targets. The Sensors and Processing Systems project develops and demonstrates technologies and system concepts that combine novel approaches to sensing with emerging sensor technologies and advanced sensor and image processing algorithms, software, and hardware to enable comprehensive knowledge of the battlespace and detection, identification, tracking, engagement, and battle damage assessment for high-value targets in all weather conditions and combat environments.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Painter	21.097	25.562	15.524
Description: The Painter program seeks to create revolutionary advancements in laser technologies for future active optical systems. Painter will translate efficiency benefits from critical laser components into compact optical sources. The objective of Painter is to simultaneously increase the power and decrease the size of laser sources compared to state of the art. Aggressive packaging objectives will be met by overcoming the thermal management challenges of state-of-the-art lasers. Painter development is guided and constrained by spectral properties required to support multiple mission applications. Technologies from Painter will transition to the Services.			
FY 2024 Plans: - Conduct critical design review for Painter laser technology. - Complete construction of laboratory-based Painter laser. - Create Painter laser technology breadboard demonstration system. - Evaluate breadboard and rack-mounted Painter hardware in lab and operationally relevant environments.			
FY 2025 Plans: - Conduct critical design review of brassboard Painter demonstration system. - Demonstrate breadboard Painter system performance against operational scenarios in an operationally relevant environment.			

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*	**Project (Number/Name)** SEN-02 / *SENSORS AND PROCESSING SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Build Painter demonstration lasers and conduct field testing. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from component design and construction to system demonstration.			
Title: Distributed Radar Image Formation Technology (DRIFT) ***Description:*** Based on recent developments in small synthetic aperture radar (SAR) satellites in commercial industry, there are new opportunities to experiment with novel SAR-related concepts. The goal of the Distributed Radar Image Formation Technology (DRIFT) program is to demonstrate advanced capabilities enabled by a cluster of SAR satellites flown in formation. DRIFT seeks to acquire data from SAR satellites flown in formation and to demonstrate novel processing algorithms on this data. This will expand the utility of small SAR satellites, including commercial satellites, for military applications. Technology developed under this program will transition to the Services. ***FY 2024 Plans:*** - Perform on-orbit data collection to demonstrate formation flying and joint radar operation. - Test and validate performance of DRIFT algorithms using real data from on-orbit collections. - Begin to optimize algorithms and software to run on tactically relevant timescales. ***FY 2025 Plans:*** - Further optimize algorithms and software using SAR data collected on-orbit. - Finalize tactical-relevant software framework. - Demonstrate tactical use-case scenarios for DoD applications. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects a shift from data collection and initial validation toward tactical demonstrations.	7.054	12.977	7.049
Title: Cancun ***Description:*** The Cancun program will create distributable nodes to measure the radio high frequency (HF) environment for improved war fighter situational awareness. Cancun will enable cost-effective wide-area deployment of low size, weight, power, and cost (SWaP-C) nodes. Cancun will also develop the command and control (C2) network and planning tools required to address the challenge of coordinating large numbers of Cancun nodes deployed over distances of well over 1000 kilometers. The Cancun nodes will measure the state of the ionosphere using a sounding function, as well as record and relay portions of the HF radio band for analysis. The mission planning tool will be developed with war fighter input to optimize functionality. Technologies developed under the Cancun program will transition to the Services. ***FY 2024 Plans:***	6.500	15.447	22.635

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*	**Project (Number/Name)** SEN-02 / *SENSORS AND PROCESSING SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Build and deliver Cancun hardware nodes and functional software. - Integrate the hardware and software for fully functional Cancun nodes. - Design, build, and deliver Cancun C2 software. - Field test integrated Cancun nodes. ***FY 2025 Plans:*** - Integrate field test results to develop initial mission planning tools. - Refine Cancun hardware nodes and software based on field test results. - Refine Cancun command and control software based on field test results. - Develop new algorithms and functionality for mission planning tools. - Purchase hardware and scale node production for follow-on field tests. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects the shift from designing and building to scaling hardware for larger field tests.			
Title: Thermal Imaging Technology Experiment-Recon (TITE-R) ***Description:*** The Thermal Imaging Technology Experiment-Recon (TITE-R) program developing and demonstrating complimentary sensing modalities, advanced processing, and low size, weight, and power which will more closely represent an objective capability. TITE-R is developing sensors and software automation capable of supporting future operations implemented on small (< 250 kg) satellites. TITE-R is also developing mission software to support automated on-board processing and simplified operator tasking. TITE-R aims to rapidly develop and test early-to-space prototype system payloads to be made available to transition partners to integrate with space vehicles and conduct experimentation. Technology developed by this program will transition to the Services and other government agencies. ***FY 2024 Plans:*** - Build, deliver and test payloads. - Complete transition of integrated software and hardware capability to transition partners. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects program completion.	14.190	8.081	-
Title: Coho ***Description:*** The Coho program developed advanced signal processing technologies and techniques for future Radio Frequency (RF) systems. These systems created an asymmetric advantage for tactical operations in anti-access/area-denial environments by extending the real-time operating bandwidth of tactical signal processing, underpinning the ability of U.S. and Allied Forces to accurately orient and beneficially maneuver in the electromagnetic spectrum. Coho provided ultra-wideband RF signal detection	9.417	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency		Date: March 2024
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603767E / *SENSOR TECHNOLOGY*	**Project (Number/Name)** SEN-02 / *SENSORS AND PROCESSING SYSTEMS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
and recognition capabilities in a form factor suitable for tactical platforms. Coho sought to provide capabilities for multiple mission areas. These capabilities included (1) surveillance: combining wide operating bandwidth with noise isolation for background electromagnetic search in the low signal to noise ratio environment, (2) filtering: isolating signals based on modulation features to process signals in the presence of co-channel interference, and (3) localization: supporting low-latency execution of multi-aperture processing for discrimination of signals based on angle of bearing. Technology from Coho transitioned to the Services.			
Accomplishments/Planned Programs Subtotals	58.258	62.067	45.208

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2025 Defense Advanced Research Projects Agency			Date: March 2024
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / *SENSOR TECHNOLOGY*	Project (Number/Name) SEN-06 / *SENSOR TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
SEN-06: *SENSOR TECHNOLOGY*	-	188.818	233.950	156.535	-	156.535	51.330	0.000	0.000	0.000	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This project funds classified DARPA programs that are reported in accordance with Title 10, United States Code, Section 119(a)(1) or its successor.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Classified DARPA Program	188.818	233.950	156.535
Description: This project funds Classified DARPA Programs. Details of this submission are classified.			
FY 2024 Plans: Details will be provided under separate cover.			
FY 2025 Plans: Details will be provided under separate cover.			
FY 2024 to FY 2025 Increase/Decrease Statement: Details will be provided under separate cover.			
Accomplishments/Planned Programs Subtotals	188.818	233.950	156.535

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 6: *RDT&E Management Support*	**R-1 Program Element (Number/Name)** PE 0605001E / *MISSION SUPPORT*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	96.637	99.090	113.007	-	113.007	115.159	117.376	119.012	120.684	-	-
MST-01: *MISSION SUPPORT*	-	96.637	99.090	113.007	-	113.007	115.159	117.376	119.012	120.684	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Mission Support Program Element provides funding for the costs of mission support activities for the Defense Advanced Research Projects Agency. The funds provide personnel compensation for mission support civilians as well as costs for building rent, physical security, travel, supplies and equipment, communications, printing and reproduction.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	86.869	99.090	102.654	-	102.654
Current President's Budget	96.637	99.090	113.007	-	113.007
Total Adjustments	9.768	0.000	10.353	-	10.353
• 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	9.768	0.000			
• SBIR/STTR Transfer	0.000	0.000			
• TotalOtherAdjustments	-	-	10.353	-	10.353

Change Summary Explanation

FY 2023: Increase reflects reprogrammings.

FY 2024: N/A

FY 2025: Increase reflects required mission support civilian personnel costs for Advanced Research Concepts (ARC) Fellows, support personnel, and program managers.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Mission Support	96.637	99.090	113.007
Description: Mission Support			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 6: *RDT&E Management Support*	**R-1 Program Element (Number/Name)** PE 0605001E / *MISSION SUPPORT*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2024 Plans: - Fund mission support civilian salaries and benefits, including additional technical and support civilian personnel costs for increased mission requirements and administrative support costs. - Fund travel, rent and other infrastructure support costs. - Fund security costs to continue access controls, uniformed guards, and building security requirements. ***FY 2025 Plans:*** - Fund mission support civilian salaries and benefits, including additional technical and support civilian personnel costs for increased mission requirements and administrative support costs. - Fund travel, rent and other infrastructure support costs. - Fund security costs to continue access controls, uniformed guards, and building security requirements. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 increase reflects revised civilian personnel costs.			
Accomplishments/Planned Programs Subtotals	96.637	99.090	113.007

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 6: *RDT&E Management Support*	**R-1 Program Element (Number/Name)** PE 0605502E / *SMALL BUSINESS INNOVATION RESEARCH*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	126.852	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
SB-01: *SMALL BUSINESS INNOVATION RESEARCH*	-	126.852	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

In accordance with Public Law No: 116-92 (National Defense Authorization Act 2020) and the Small Business Act (15 U.S.C. 638), the DARPA Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are designed to provide small, high-tech businesses and academic institutions the opportunity to propose radical, innovative, high-risk approaches to address existing and emerging national security threats, thereby supporting DARPA's overall strategy to enable fundamental discoveries and technological breakthroughs that provide new military capabilities.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	126.852	0.000	0.000	-	0.000
Total Adjustments	126.852	0.000	0.000	-	0.000
• 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	126.852	0.000			

Change Summary Explanation

FY 2023: Increase reflects SBIR/STTR transfer.
FY 2024: N/A
FY 2025: N/A

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Small Business Innovation Research	126.852	0.000	0.000
Description: The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 6: *RDT&E Management Support*	**R-1 Program Element (Number/Name)** PE 0605502E / *SMALL BUSINESS INNOVATION RESEARCH*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
designed to provide small, high-tech businesses and academic institutions the opportunity to propose radical, innovative, high-risk approaches to address existing and emerging national security threats; thereby supporting DARPA's overall strategy to enable fundamental discoveries and technological breakthroughs that provide new military capabilities. ***FY 2024 Plans:*** - Will continue to utilize DoD Out of Cycle BAA to release SBIR/STTR topics on a Just-in-Time basis. - Will continue to release an SBIR and/or STTR Open topic in accordance with the 2022 SBIR/STTR Reauthorization Act. Lessons learned from initial FY 2023 release will be identified and implemented for FY 2024. - Will continue its Due Diligence Program Business Assessment Program, taking lessons learned from its implementation in FY 2023 and improving and streamlining them in FY 2024. - Will continue to leverage DARPA SBIR/STTR topics in support of larger DARPA Programs to the highest extent possible to ensure successful transition of SBIR/STTR technologies. - Will continue to utilize various funding pathways available to the SBIR/STTR programs. This includes, Phase I, Phase II, Direct to Phase II, co-funds, cross agency awards, Phase II Enhancements, and SBIR XL Pilot. - Will continue to use DARPA s SBIR XL pilot, which aims to increase opportunities for DARPA funded technology by reimagining SBIRs to transform ideas into successful small businesses that scale. The goals of SBIR XL include: (1) increase relevance of SBIR Program for Technology Development in DARPA; (2) emphasize transition and commercialization as part of evaluation process including establishment of concrete commercialization milestones; (3) raise award ceilings to support efforts for operation-scale deployment, increasing the probability of technology transition and commercialization; (4) decrease award timelines. - Will continue to link wherever possible to the OUSD(R&E) Critical Technology Areas which include: (1) FutureG; (2) Trusted AI and Autonomy; (3) Biotechnology; (4) Advanced Computing and Software; (5) Integrated Sensing and Cyber; (6) Directed Energy); (7) Hypersonics; (8) Microelectronics; (9) Integrated Network Systems-of-Systems; (10) Quantum Science; (11) Space Technology; (12) Renewable Energy Generation and Storage; (13) Advanced Materials; (14) Human-Machine Interfaces. ***FY 2025 Plans:*** - Will continue to utilize DoD Out of Cycle BAA to release SBIR/STTR topics on a Just-in-Time basis. - Will continue to release an SBIR and/or STTR Open topic in accordance with the 2022 SBIR/STTR Reauthorization Act. Lessons learned from the FY 2024 release will be identified and implemented for FY 2025. - Will continue its Due Diligence Program Business Assessment Program, taking lessons learned from FY 2024 and improving and streamlining them in FY 2025. - Will continue to leverage DARPA SBIR/STTR topics in support of larger DARPA Programs to the highest extent possible to ensure successful transition of SBIR/STTR technologies. - Will continue to utilize various funding pathways available to the SBIR/STTR programs. This includes, Phase I, Phase II, Direct to Phase II, co-funds, cross agency awards, Phase II Enhancements, and SBIR XL Pilot.			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 6: *RDT&E Management Support*	**R-1 Program Element (Number/Name)** PE 0605502E / *SMALL BUSINESS INNOVATION RESEARCH*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
- Will continue to use DARPA s SBIR XL pilot, which aims to increase opportunities for DARPA funded technology by reimagining SBIRs to transform ideas into successful small businesses that scale. The goals of SBIR XL include: (1) increase relevance of SBIR Program for Technology Development in DARPA; (2) emphasize transition and commercialization as part of evaluation process including establishment of concrete commercialization milestones; (3) raise award ceilings to support efforts for operation-scale deployment, increasing the probability of technology transition and commercialization; (4) decrease award timelines. - Will continue to link wherever possible to the OUSD(R&E) Critical Technology Areas which include: (1) FutureG; (2) Trusted AI and Autonomy; (3) Biotechnology; (4) Advanced Computing and Software; (5) Integrated Sensing and Cyber; (6) Directed Energy); (7) Hypersonics; (8) Microelectronics; (9) Integrated Network Systems-of-Systems; (10) Quantum Science; (11) Space Technology; (12) Renewable Energy Generation and Storage; (13) Advanced Materials; (14) Human-Machine Interfaces.			
Accomplishments/Planned Programs Subtotals	126.852	0.000	0.000

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 6: *RDT&E Management Support*	**R-1 Program Element (Number/Name)** PE 0605898E / *MANAGEMENT HQ - R&D*

COST ($ in Millions)	Prior Years	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total	FY 2026	FY 2027	FY 2028	FY 2029	Cost To Complete	Total Cost
Total Program Element	-	15.008	14.833	14.577	-	14.577	14.676	14.777	14.881	14.987	-	-
MH-01: *MANAGEMENT HQ - R&D*	-	15.008	14.833	14.577	-	14.577	14.676	14.777	14.881	14.987	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Management HQ - R&D Program Element provides funding for the administrative support costs of the Defense Advanced Research Projects Agency. This project provides funding for DARPA Management Headquarters Activities (MHA). The funds provide personnel compensation for management headquarters civilians as well as associated travel and support contract costs.

B. Program Change Summary ($ in Millions)	FY 2023	FY 2024	FY 2025 Base	FY 2025 OCO	FY 2025 Total
Previous President's Budget	14.636	14.833	14.624	-	14.624
Current President's Budget	15.008	14.833	14.577	-	14.577
Total Adjustments	0.372	0.000	-0.047	-	-0.047
• 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	0.372	0.000			
• SBIR/STTR Transfer	0.000	0.000			
• TotalOtherAdjustments	-	-	-0.047	-	-0.047

Change Summary Explanation

FY 2023: Increase reflects reprogrammings.

FY 2024: N/A

FY 2025: Decrease reflects minor repricing of management headquarters civilian personnel, travel, and support contract costs.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
Title: Management Headquarters	15.008	14.833	14.577
Description: Management Headquarters			

Exhibit R-2, RDT&E Budget Item Justification: PB 2025 Defense Advanced Research Projects Agency	Date: March 2024
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 6: *RDT&E Management Support*	**R-1 Program Element (Number/Name)** PE 0605898E / *MANAGEMENT HQ - R&D*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2023	FY 2024	FY 2025
FY 2024 Plans: - Fund management headquarters civilian salaries, benefits, travel and support contract costs. ***FY 2025 Plans:*** - Fund management headquarters civilian salaries, benefits, travel and support contract costs. ***FY 2024 to FY 2025 Increase/Decrease Statement:*** The FY 2025 decrease reflects minor repricing of management headquarters civilian personnel, travel, and support contract costs.			
Accomplishments/Planned Programs Subtotals	15.008	14.833	14.577

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A