Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army	Date: April 2022
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603461A *I High Performance Computing Modernization Program*

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	-	221.161	229.123	251.964	-	251.964	254.647	258.284	259.412	260.402	0.000	1,734.993
DS7: *High Performance Computing Modernization Program*	-	181.161	189.123	251.964	-	251.964	254.647	258.284	259.412	260.402	0.000	1,654.993
DW5: *HIGH PERF COMP MODERN (HPCM) (CA)*	-	40.000	40.000	-	-	-	-	-	-	-	0.000	80.000

A. Mission Description and Budget Item Justification

The High Performance Computing Modernization Program (HPCMP) addresses the supercomputing requirements of Department of Defense (DoD) scientists and engineers by: (1) demonstrating and maturing the most advanced, leading-edge computational architectures while exploiting the resulting systems by employing complementary specialized expertise; (2) demonstrating and maturing the Defense Research and Engineering Network (DREN), which investigates, demonstrates, and matures leading-edge digital networking and security technologies to securely deliver computational capabilities to the distributed DoD Research, Development, Test, and Evaluation (RDTE) community; and (3) leveraging specialized expertise from DoD, other federal departments and agencies, industry, and academia to demonstrate and mature leading-edge software application codes. DoD Supercomputing Resource Centers (DSRCs) provide extensive computational capabilities to demonstrate and mature emerging technologies that address the supercomputing requirements of the DoD RDTE community in the areas of hardware, software, and programming environments. All HPCMP sites are interconnected to each other, the DoD High Performance Computing (HPC) RDTE community, and other major defense sites via the DREN, a research network which investigates, demonstrates, and matures (a) state-of-the-art digital networking technologies to ensure a robust distributed environment and (b) the most advanced digital security capabilities to protect the intellectual property of the DoD and its contract entities as they employ HPCMP capabilities. The HPCMP's software application effort (a) optimizes, enhances, demonstrates, and matures critical DoD physics-based and engineering software to allow scientists and engineers to execute calculations with precision and efficiency on leading-edge supercomputers, (b) demonstrates and matures immersive collaborative programming environments to improve science and engineering workflows, and (c) demonstrates and matures leading-edge computational technology from academia and industry. These synergistic activities collectively demonstrate and mature horizontal technologies that are exploited across the DoD RDTE community, ensuring the DoD maintains the most advanced research and development ecosystem in computationally-intensive modeling and design.

The research cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Army	Date: April 2022
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603461A *I High Performance Computing Modernization Program*

B. Program Change Summary ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	221.161	189.123	0.000	-	0.000
Current President's Budget	221.161	229.123	251.964	-	251.964
Total Adjustments	0.000	40.000	251.964	-	251.964
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	40.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	251.964	-	251.964

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Project: DW5: *HIGH PERF COMP MODERN (HPCM) (CA)*		
Congressional Add: *Program increase*	40.000	40.000
Congressional Add Subtotals for Project: DW5	40.000	40.000
Congressional Add Totals for all Projects	40.000	40.000

Change Summary Explanation

Fiscal Year 2023 (FY23) funding increase reflects the fact that the FY22 President's Budget request did not include out-year funding.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army			Date: April 2022
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603461A / *High Performance Computing Modernization Program*	Project (Number/Name) DS7 / *High Performance Computing Modernization Program*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
DS7: *High Performance Computing Modernization Program*	-	181.161	189.123	251.964	-	251.964	254.647	258.284	259.412	260.402	0.000	1,654.993
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The High Performance Computing Modernization Program (HPCMP) addresses the supercomputing requirements of Department of Defense (DoD) scientists and engineers by (1) demonstrating and maturing the most advanced, leading-edge computational architectures and exploiting the resulting systems by employing complementary specialized expertise; (2) demonstrating and maturing the Defense Research and Engineering Network (DREN) which investigates, demonstrates, and matures leading-edge digital networking and security technologies to securely deliver computational capabilities to the distributed DoD Research, Development, Test, and Evaluation (RDTE) and acquisition engineering communities; and (3) leveraging specialized expertise from DoD, other federal departments/agencies, industry, and academia to demonstrate and mature leading-edge software application codes. DoD Supercomputing Resource Centers (DSRCs) provide extensive computational capabilities and demonstrate and mature emerging technologies that address the supercomputing requirements of the DoD RDTE and acquisition engineering communities in the areas of hardware, software, and programming environments. HPCMP sites are interconnected to each other, the DoD High Performance Computing (HPC) RDTE community, and other major defense sites via DREN, a research network which investigates, demonstrates, and matures (a) state-of-the-art digital networking technologies to ensure a robust distributed environment and (b) the most advanced digital security capabilities to effectively protect the intellectual property of the DoD and its contract entities as they employ HPCMP advanced capabilities. The HPCMP's software application effort (a) optimizes, enhances, demonstrates, and matures critical DoD physics-based and engineering software to allow scientists and engineers to execute calculations with precision and efficiency on leading-edge supercomputers, (b) demonstrates and matures immersive collaborative programming environments to improve science and engineering workflows, and (c) demonstrates and matures leading-edge computational technology from academia and industry. These synergistic activities collectively demonstrate and mature horizontal technologies that are exploited throughout the DoD RDTE and acquisition engineering communities, ensuring the DoD maintains the most advanced research ecosystem in the areas of computationally-intensive modeling and design.

The research cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Department of Defense Supercomputing Resource Centers	95.975	96.537	144.207
Description: The effort investigates, demonstrates, and matures general and special-purpose supercomputing environments that incorporate the most advanced, leading-edge computational architectures, distributed mass storage technologies, and data analysis methodologies; employs complementary specialized expertise to mature and exploit these environments; enables the DoD RDTE and acquisition engineering communities to effectively and efficiently investigate, demonstrate, and mature a broad range of technologies through advanced computational methods.			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603461A / *High Performance Computing Modernization Program*	**Project (Number/Name)** DS7 / *High Performance Computing Modernization Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
FY 2022 Plans: Complete integration of commercial cloud computing, making it broadly available to the entire HPCMP user community. Integrate data-centric center methodologies into our supercomputing centers. Continue to accelerate technology capabilities with a suite of supercomputers and high-end computing services to address DoD priorities that satisfy the diverse needs of DoD stakeholders including security, workload, and architecture requirements. Continue to demonstrate the potential benefits of multiple architectures (scientific, analytics, machine learning, etc.) that incorporate leading-edge processors, accelerators, memory, data input/output (I/O), interconnect, and operating system (OS) capabilities. Continue to demonstrate new mechanisms to access and reduce barriers to supercomputers. Continue to leverage data-intensive supercomputing architectures for DoD use cases in machine learning, artificial intelligence, and data sciences. Implement new capabilities for secure shared highly-classified supercomputing, transportable data-intensive computing at the tactical edge, and persistent data services. ***FY 2023 Plans:*** Will accelerate the integration of commercial cloud computing, with the goal of making it broadly available to the entire HPCMP user community. Will continue to integrate data-centric center methodologies into our supercomputing centers to improve the ability to rapidly extract information from complex computations. Will continue to accelerate technology capabilities with a suite of supercomputers and high-end computing services to address DoD priorities that satisfy the diverse needs of DoD stakeholders including security, workload, and architecture requirements. Will continue to demonstrate the potential benefits of emerging High End Computing technologies including multiple architectures (scientific, analytics, machine learning, etc.) that incorporate leading-edge processors, accelerators, memory, data I/0, interconnect, and OS capabilities. Will continue to demonstrate new mechanisms to access and reduce barriers to supercomputers for non-traditional users and establish mechanisms for establishing hybrid cloud connectivity for HEC workflows. Will continue to leverage data-intensive supercomputing architectures for DoD use cases in machine learning, artificial intelligence, and data sciences. Will implement new capabilities for secure shared highly-classified supercomputing, transportable data-intensive computing at the tactical edge, and persistent data services. Will add additional capacity and capability in HPC through strategic retention of HPC assets and conduct pilot projects for burst to commercial cloud computing. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase ensures continued operations at DSRCs to include improved HPC simulation to close gaps in hypersonic development.			
Title: Defense Research and Engineering Network	31.770	31.955	54.675
Description: The DREN effort investigates, demonstrates, and matures state-of-the-art digital networking technologies to ensure a robust distributed environment among HPCMP sites, the DoD HPC RDTE and acquisition engineering communities, and other major defense sites; investigates, demonstrates, and matures the most advanced digital security capabilities to effectively			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603461A / *High Performance Computing Modernization Program*	**Project (Number/Name)** DS7 / *High Performance Computing Modernization Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
protect the intellectual property of the DoD and its contract entities as they employ HPCMP advanced capabilities; employs complementary specialized expertise to mature and exploit this environment. ***FY 2022 Plans:*** Continue to refine and exploit DREN (an advanced digital DoD wide area research network and part of the DoD Information Network backbone) which provides robust, high-bandwidth, low-latency, low-jitter, and full-service network connectivity among the HPCMP and DoD RDTE/AE communities with specific efforts targeted at the unique requirements of the test and evaluation (T&E) and AE communities. Complete source selection activities for DREN 4, initiated in Fiscal Year 2021 (FY21), leading to a contract award for commercial wide area network services. DREN 4 is the follow-on contract to DREN III, and will provide next-generation technical capabilities and significantly increased bandwidths to support the HPCMP and DoD RDTE/AE communities. Continue to enhance and refine the protection of all external DREN boundaries to enhance the HPCMP's DISA-accredited Tier 2 cybersecurity service provider capability to effectively protect the intellectual property of the DoD and its contract entities as they utilize HPCMP advanced capabilities. Establish and enhance network transport to the commercial cloud for those HPCMP and DoD RDTE/AE communities moving computation, data storage, and other requirements to the cloud environment. Continue to mature the advanced network technologies and complex cybersecurity mechanisms required to implement logically-separated networked COIs (communities of interest) at multiple classification levels. ***FY 2023 Plans:*** Will continue to refine and exploit DREN (an advanced digital DoD wide area research network and part of the DoDIN backbone) which provides robust, high-bandwidth, low-latency, low-jitter, and full-service network connectivity among the HPCMP and DoD RDTE/Acquisition Engineering (AE) communities with specific efforts targeted at the unique requirements of the T&E and AE communities. Will complete transisiton activities for DREN 4. DREN 4 is the follow-on contract to DREN III, and will provide next-generation technical capabilities and significantly increased bandwidths to support the HPCMP and DoD RDTE/AE communities. Will continue to enhance and refine the protection of all external DREN boundaries to enhance the HPCMP's DISA-accredited Tier 2 cybersecurity service provider capability to effectively protect the intellectual property of the DoD and its contract entities as they utilize HPCMP advanced capabilities. Will continue to establish and enhance network transport to the commercial cloud for those HPCMP and DoD RDTE/AE communities moving computation, data storage, and other requirements to the cloud environment. Will continue to mature the advanced network technologies and complex cybersecurity mechanisms required to implement logically-separated networked COIs at multiple classification levels. Removal of DREN under-provisioning. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increase reflects adjustments to align with projected allocations supporting the DREN to support enhancements within the network to include evolving cybersecurity requirements.			
Title: Software Applications	53.416	53.728	53.082

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603461A / *High Performance Computing Modernization Program*	**Project (Number/Name)** DS7 / *High Performance Computing Modernization Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Description: This effort optimizes, enhances, demonstrates, and matures software applications to provide for the adaptation of widely used applications and algorithms to address RDTE and acquisition engineering communities requirements. The Computational Research Engineering Acquisition Tools and Environments (CREATE) initiative demonstrates and matures advanced application codes to allow scientists and engineers to use supercomputers to design and analyze virtual prototypes of DoD ships, fixed-wing aircraft, rotorcraft, ground vehicles, and radio frequency (RF) antennas; HPCMP Institutes demonstrate and mature advanced supercomputing application codes to address critical high-impact DoD challenges (e.g. blast protection for platforms and personnel, high-power microwaves and lasers, munition sensitivities, and mobile network designs/prototypes); High Performance Computing Applications Software Initiative (HASI) projects address the need to mature and refine critical DoD software that can take advantage of new and emerging hardware advances; the Frontier initiative represents and supports the DoD's highest-priority, highest-impact, most demanding computational work, both from a technical and mission-relevance standpoint; the Productivity, Enhancement, Technology Transfer, and Training (PETTT) initiative (1) optimizes and enhances critical DoD physics based and engineering software to allow scientists and engineers to execute scientific calculations with precision and efficiency on leading-edge supercomputers, (2) demonstrates and matures immersive collaborative programming environments to improve science and engineering workflows, and (3) demonstrates and matures leading-edge computational technology from academia and industry.			
FY 2022 Plans: Continue to mature and enhance multi-disciplinary software technology in support of current and future defense programs, establishing a foundation for powerful decision support applications synthesized using machine learning methodologies. Multi-disciplinary technology for aeronautical systems of all types (i.e., fixed and rotary-wing aircraft, munitions, missiles, rockets, etc.), this endeavor matures model-centric conceptual design software technology to support Pre-Milestone-A Defense acquisition processes, enabling application of physics-based analysis of alternatives, technology trade-space exploration, and analysis of cost implications. Continue to mature software improvements necessary to deploy production quality physics-based design analysis tools for future hypersonic weapon systems (High Speed Strike, Tactical Boost-Glide, and Manned/Unmanned Conventional Prompt Global Strike). For fixed-wing aircraft, a) continue incorporating new generation of high order accuracy solvers; b) continue implementing hypersonic terminal maneuvers; and c) continue incorporating hypersonic long-duration/heat soak algorithms. For rotorcraft, continue aeromechanics analysis associated with maneuvers, airframe propulsion system integration, and weapons carriage and release, as well as infrared suppression analysis, chaff trajectory prediction, debris ingestion analysis, and loads prediction capability necessary for structural airworthiness assessments. RF antenna design and analysis continue to mature computational electromagnetics capabilities to assist in design and evaluation of next generation radar for aircraft, ships, and ground-based platforms; continue demonstrating capability for assessment of electromagnetic hazards on ordnance and optimizing computational methods for electronic warfare assessments and evaluation of multiple antenna systems on a single platform. Continue to include efforts in aircraft radar signature prediction capabilities that effectively include propulsion system			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603461A / *High Performance Computing Modernization Program*	**Project (Number/Name)** DS7 / *High Performance Computing Modernization Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
inlet and exhaust. Continue efforts to incorporate high-resolution (XBand frequencies) virtual test and analysis capabilities for fighter-scale aircraft. For Naval Ships (surface and submarine), continue incorporation of; a) hullform optimization; b) multi-hull seakeeping capabilities; and c) virtual ship powering algorithms. Continue to incorporate 6-degree of freedom (6-DOF) submarine maneuvering. Continue development of ship shock virtual test and analysis capabilities. For Ground Vehicles continue to expand autonomy capabilities associated with ground mobility test requirements. Execute fact finding investigations to more fully understand how physics-informed machine learning can impact DoD priorities and effectively support decision makers throughout weapon system development, deployment, and operation life-cycle.			
FY 2023 Plans: Will continue to mature and advance multi-disciplinary software technology in support of current and future defense programs, building a foundation for powerful decision support applications synthesized using advanced machine learning methodologies. Multi-disciplinary technology for aeronautical systems of all types (i.e., fixed and rotary-wing aircraft, munitions, missiles, rockets, etc.), this endeavor will continue to mature model-centric conceptual design software technology to support high-fidelity digital simulations of weapons and weapon support systems across the product lifecycle. This application of physics-based analysis of alternatives, technology trade-space exploration, and analysis of cost implications will improve application. Will continue mature software improvements necessary to deploy production quality physics-based design analysis tools for future hypersonic weapon systems (High Speed Strike, Tactical Boost-Glide, and Manned/Unmanned Conventional Prompt Global Strike). For fixed-wing aircraft, a) will continue incorporating new generation of high order accuracy solvers; b) will continue implementing hypersonic terminal maneuvers; and c) will continue incorporating hypersonic long-duration/heat soak algorithms. For rotorcraft, will continue aeromechanics analysis associated with maneuvers, airframe propulsion system integration, and weapons carriage and release, as well as infrared suppression analysis, chaff trajectory prediction, debris ingestion analysis, and loads prediction capability necessary for structural airworthiness assessments. RF antenna design and analysis will continue to mature computational electromagnetics capabilities to assist in design and evaluation of next generation radar for aircraft, ships, and ground-based platforms; will continue demonstrating capability for assessment of electromagnetic hazards on ordnance and optimizing computational methods for electronic warfare assessments and evaluation of multiple antenna systems on a single platform a specific area of focus will be the application of antenna evaluation software on naval platforms. Will continue to include efforts in aircraft radar signature prediction capabilities that effectively include propulsion system inlet and exhaust critical to design and evaluation of 6th generation fighter/attack aircraft. Will continue efforts to incorporate high-resolution (XBand frequencies) virtual test and analysis capabilities for fighter-scale aircraft. For Naval Ships (surface and submarine), will continue incorporation of; a) hullform optimization; b) multi-hull seakeeping capabilities; and c) virtual ship powering algorithms. Will continue to incorporate 6-D0F submarine maneuvering. Will continue development of ship shock virtual test and analysis capabilities incorporating the results of recent CVN-78 shock trials in preparation for establishing alternatives for future ship classes including FFG-62. For Ground Vehicles will continue to expand autonomy capabilities associated with ground mobility test requirements. Will execute fact finding investigations to understand how physics-informed machine learning more fully can impact DoD priorities and			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army		Date: April 2022
Appropriation/Budget Activity 2040 / 3	**R-1 Program Element (Number/Name)** PE 0603461A / *High Performance Computing Modernization Program*	**Project (Number/Name)** DS7 / *High Performance Computing Modernization Program*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
effectively support decision makers throughout weapon system development, deployment, and operation life-cycle. Reintroduction of in-situ HEC subject matter experts to improve S&T efforts directly supporting technology transfer into programs of record and prototype efforts. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding decrease reflects adjustments to align with projected allocations supporting software applications. The level of effort within software applications have been reduced to facilitate the availability of funding to support enhanced DREN requirements.			
Title: FY 2022 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	6.903	-
Accomplishments/Planned Programs Subtotals	181.161	189.123	251.964

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Army											Date: April 2022	
Appropriation/Budget Activity 2040 / 3					R-1 Program Element (Number/Name) PE 0603461A / *High Performance Computing Modernization Program*				Project (Number/Name) DW5 / *HIGH PERF COMP MODERN (HPCM) (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
DW5: *HIGH PERF COMP MODERN (HPCM) (CA)*	-	40.000	40.000	-	-	-	-	-	-	-	0.000	80.000
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This project enables the Defense Research, Development, Test and Evaluation (RDT&E) community to resolve critical scientific and engineering problems more quickly, and with more precision, using advanced, physics-based computer simulation supported by high performance computing (HPC) technology. The computational expertise and resources enable Department of Defense (DoD) personnel to analyze phenomena that are often impossible, not cost effective, too time-consuming, or too dangerous to study any other way. The High Performance Computing Modernization Program (HPCMP) supports the requirements of the DoD's scientists and engineers in three major areas of effort: supercomputing resource centers, the Defense Research and Engineering Network (DREN), and software applications. DoD Supercomputing Resource Centers (DSRCs) provide extensive capabilities and demonstrate new technologies that address user requirements for hardware, software, and programming environments. Efforts of the DSRCs are augmented by dedicated HPC project investments (DHPIs) that address near real-time and real-time HPC requirements. All sites in the HPC Modernization Program are interconnected to one another, the user community, and major defense sites via the DREN, a research network which matures and demonstrates state-of-the-art computer network technologies. The Software Application effort optimizes and improves the performance of critical common DoD applications programs to run efficiently on advanced HPC systems, matures and demonstrates leading-edge computational technology from academic and commercial partners, and provides collaborative programming environments.

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
Congressional Add: Program increase	40.000	40.000
FY 2021 Accomplishments: Program Increase supports advanced research on High Performance Computing.		
FY 2022 Plans: Congressional Interest Item funding provided		
Congressional Adds Subtotals	40.000	40.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A