Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
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 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	215.462	182.331	183.322	-	183.322	186.329	190.046	193.929	197.808	0.000	1,349.227
DS7: *High Performance Computing Modernization Program*	-	170.462	182.331	183.322	-	183.322	186.329	190.046	193.929	197.808	0.000	1,304.227
DW5: *HIGH PERF COMP MODERN (HPCM) CONGR ADDS (CAS)*	-	45.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	45.000

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.

Work in this Program Element (PE) supports the Army Science and Technology Environment and Terrain Portfolio.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	177.190	182.331	183.322	-	183.322
Current President's Budget	215.462	182.331	183.322	-	183.322
Total Adjustments	38.272	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	45.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-6.643	-			
• FFRDC	-0.085	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: DW5: *HIGH PERF COMP MODERN (HPCM) CONGR ADDS (CAS)*		
Congressional Add: *Program increase*	45.000	-
Congressional Add Subtotals for Project: DW5	45.000	-
Congressional Add Totals for all Projects	45.000	-

Change Summary Explanation

Congressional increase in project DW5 for High Performance Computing Modernization

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
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 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
DS7: *High Performance Computing Modernization Program*	-	170.462	182.331	183.322	-	183.322	186.329	190.046	193.929	197.808	0.000	1,304.227

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) community; 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 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 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 community, ensuring the DoD maintains the most advanced research ecosystem in the areas of computationally-intensive modeling and design.

Work in this Project supports the Army Science and Technology Environment and Terrain Portfolio.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Department of Defense Supercomputing Resource Centers	92.313	97.298	97.121
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			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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 2017	FY 2018	FY 2019
DoD Research, Development, Test and Evaluation (RDTE) community to effectively and efficiently investigate, demonstrate, and mature a broad range of technologies through advanced computational methods. ***FY 2018 Plans:*** Refine and exploit the advanced capabilities of previously demonstrated supercomputers (utilizing the existing capability complete 31,000 trillion floating point operations per second) to conduct complex, tightly-coupled, large-scale, scientific calculations to address Department of Defense (DoD) challenges in the following 11 CTAs: (1) space and astrophysical sciences, (2) structural mechanics, (3) fluid dynamics, (4) chemistry and materials science, (5) electromagnetics and acoustics, (6) climate/weather/ocean modeling and simulation, (7) signal and image processing, (8) forces modeling and simulation, (9) electronics, networking, and systems, (10) environmental quality, and (11) integrated modeling and test environments. Demonstrate the viability of two (or more) large, tightly-integrated supercomputers containing leading-edge (i.e. 2018) processor, memory, disk I/O, interconnect, and OS capabilities (adding an additional capability of 11,000 trillion floating point operations per second) to conduct complex, tightly-coupled, large-scale, scientific calculations to address DoD challenges in the 11 CTAs cited above; further mature GUI access to supercomputers without requiring software to be added to the client machine to allow scientists and engineers at sites with prohibitive security practices to apply supercomputing to DoD use cases; further mature the ability to use both general purpose and accelerated processors collectively in a single supercomputer (i.e. a hybrid supercomputer) to expand the breadth of DoD use cases that can be addressed by supercomputing; mature data-intensive supercomputing architectures for DoD use cases in which it is more economical to move (in real-time) the executable code to the data (as opposed to the standard approach of moving the data to the executable code) to expand the breadth of DoD use cases that can be addressed by supercomputing; mature shared above secret capabilities to address critical DoD mission requirements. ***FY 2019 Plans:*** Will continue to refine and exploit the advanced capabilities of previously demonstrated supercomputers (utilizing the existing capability complete 31,000 trillion floating point operations per second) to conduct complex, tightly-coupled, large-scale, scientific calculations to address DoD challenges in the following 11 CTAs: (1) space and astrophysical sciences, (2) structural mechanics, (3) fluid dynamics, (4) chemistry and materials science, (5) electromagnetics and acoustics, (6) climate/weather/ocean modeling and simulation, (7) signal and image processing, (8) forces modeling and simulation, (9) electronics, networking, and systems, (10) environmental quality, and (11) integrated modeling and test environments. Will demonstrate the viability of two (or more) large, tightly-integrated supercomputers containing leading-edge (i.e. 2019) processor, memory, disk I/O, interconnect, and OS capabilities (adding an additional capability of 11,000 trillion floating point operations per second) to conduct complex, tightly coupled, large-scale, scientific calculations to address DoD challenges in the 11 CTAs cited above; will continue to further mature GUI access to supercomputers without requiring software to be added to the client machine to allow scientists and engineers at sites with prohibitive security practices to apply supercomputing to DoD use cases; will continue to further mature the ability to use both general purpose and accelerated processors collectively in a single supercomputer (i.e. a hybrid supercomputer)			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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 2017	FY 2018	FY 2019
to expand the breadth of DoD use cases that can be addressed by supercomputing; will continue to mature data-intensive supercomputing architectures for DoD use cases in which it is more economical to move (in real-time) the executable code to the data (as opposed to the standard approach of moving the data to the executable code) to expand the breadth of DoD use cases that can be addressed by supercomputing; will continue to mature shared above secret capabilities to address critical DoD mission requirements. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Planned program decrease.			
Title: Defense Research and Engineering Network ***Description:*** This effort investigates, demonstrates, and matures state-of-the-art digital networking technologies to ensure a robust distributed environment among High Performance Computing Modernization Program (HPCMP) sites, the DoD High Performance Computing (HPC) Research, Development, Test and Evaluation (RDTE) community, and other major defense sites; investigates, demonstrates, and matures 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; employs complementary specialized expertise to mature and exploit this environment. ***FY 2018 Plans:*** Refine and exploit Defense Research and Engineering Network (DREN) III (an advanced digital DoD research network) which provides robust, high-bandwidth, low-latency, low-jitter connectivity among the HPCMP and DoD RDTE communities with specific efforts targeted at the unique requirements of the Test & Evaluation (T&E) and Acquisition Engineering communities; continue strategic technical planning and acquisition strategy development for DREN IV, a follow-on to DREN III, with next-generation technical capabilities and significantly increased bandwidths to support the HPCMP and DoD RDTE communities; continue to refine and exploit 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; continue to mature the advanced network technologies and complex cybersecurity mechanisms required to implement logically-separated networked COIs at multiple classification levels; continue to demonstrate hardware architecture and software stack enhancements for network sensors to simultaneously allow (1) active support for the HPCMP's Defense Information Systems Agency (DISA)-accredited Tier 2 cybersecurity service provider capabilities and (2) active experimentation for novel, adaptive cybersecurity detection and intervention methods; continue to demonstrate the ability to employ SDNs to allow traditional IP and experimental protocol networks to coexist within a common DoD networking infrastructure; continue to mature an ISCM and cyber situational awareness capability to ingest robust, diverse, host-based and network-based near-real-time information by harnessing HPC resources for advanced mission essential task elements; improve cybersecurity methods to aid in the detection of insider threats. ***FY 2019 Plans:***	28.159	31.284	32.150

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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 2017	FY 2018	FY 2019
Will continue to refine and exploit DREN III (an advanced digital DoD research network) which provides robust, high-bandwidth, low-latency, low-jitter connectivity among the HPCMP and DoD RDTE communities with specific efforts targeted at the unique requirements of the Test & Evaluation (T&E) and Acquisition Engineering communities; will continue strategic technical planning and acquisition strategy development for DREN IV, a follow-on to DREN III, with next-generation technical capabilities and significantly increased bandwidths to support the HPCMP and DoD RDTE communities; will continue to refine and exploit 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 mature the advanced network technologies and complex cybersecurity mechanisms required to implement logically-separated networked COIs at multiple classification levels; will continue to demonstrate hardware architecture and software stack enhancements for network sensors to simultaneously allow (1) active support for the HPCMP's DISA-accredited Tier 2 cybersecurity service provider capabilities and (2) active experimentation for novel, adaptive cybersecurity detection and intervention methods; will continue to demonstrate the ability to employ SDNs to allow traditional IP and experimental protocol networks to coexist within a common DoD networking infrastructure; will continue to mature an ISCM and cyber situational awareness capability to ingest robust, diverse, host-based and network-based near-real-time information by harnessing HPC resources for advanced mission essential task elements; improve cybersecurity methods to aid in the detection of insider threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Adjustment due to inflation.			
Title: Software Applications	49.990	53.749	54.051
Description: This effort optimizes, enhances, demonstrates, and matures software applications to provide for the adaptation of widely used applications and algorithms to address Research, Development, Test and Evaluation (RDTE) 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 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			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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 2017	FY 2018	FY 2019

science and engineering workflows, and (3) demonstrates and matures leading-edge computational technology from academia and industry.

FY 2018 Plans:

Mature multi-disciplinary software technology in support of current and future defense programs. 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 cost implications. For fixed-wing aircraft, this includes, but will not be limited to, high-fidelity physics-based analysis capabilities for coupled aerodynamics, structural dynamics, propulsion, and flight controls in support of flight certifications (e.g., air worthiness, store carriage and release, etc.), mission planning for fielded and new systems and associated upgrades, and acquisition decisions associated with exploration and design analysis of future manned and unmanned aerial vehicle concepts. Additionally, it includes implementation of foundational software improvements necessary to begin development of physics-based design analysis tools for future hypersonic weapon systems (High Speed Strike, Tactical Boost-Glide, and Manned/Unmanned Conventional Prompt Global Strike). For rotorcraft, exemplars include 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. These capabilities are deployed in support of the FVL Program, as well as for sustainment of existing rotorcraft-based programs and associated upgrades, such as the ITEP. For RF antenna design analysis, further mature computational electromagnetics capabilities to assist in design and evaluation of next generation radar for aircraft, ships, and ground-based platforms; demonstrate capability for assessment of electromagnetic hazards on ordnance and optimize computational methods for electronic warfare assessments and evaluation of multiple antenna systems on a single platform. For Naval Ships (surface and submarine), further mature conceptual and early modeling capabilities in sync with detailed design and analyses, to realize full-lifecycle management of systems and platforms, and for conducting AoAs.

FY 2019 Plans:

Will continue to mature multi-disciplinary software technology in support of current and future defense programs. For aeronautical systems of all types (i.e., fixed and rotary-wing aircraft, munitions, missiles, rockets, etc.), this endeavor will continue maturing 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 cost implications. For fixed-wing aircraft, this will include, but will not be limited to, high-fidelity physics-based analysis capabilities for coupled aerodynamics, structural dynamics, propulsion, and flight controls in support of flight certifications (e.g., air worthiness, store carriage and release, etc.), mission planning for fielded and new systems and associated upgrades, and acquisition decisions associated with exploration and design analysis of future manned and unmanned aerial vehicle concepts. Additionally, it will include implementation of foundational software improvements necessary to begin development of physics-based design analysis tools

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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 2017	FY 2018	FY 2019
for future hypersonic weapon systems (High Speed Strike, Tactical Boost-Glide, and Manned/Unmanned Conventional Prompt Global Strike). For rotorcraft, exemplars will include 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. These capabilities will be deployed in support of the FVL Program, as well as for sustainment of existing rotorcraft-based programs and associated upgrades, such as the ITEP. For RF antenna design analysis, will further mature computational electromagnetics capabilities to assist in design and evaluation of next generation radar for aircraft, ships, and ground-based platforms; will demonstrate capability for assessment of electromagnetic hazards on ordnance and will optimize computational methods for electronic warfare assessments and evaluation of multiple antenna systems on a single platform. For Naval Ships (surface and submarine), will further mature conceptual and early modeling capabilities in sync with detailed design and analyses, to realize full-lifecycle management of systems and platforms, and for conducting AoAs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Adjustment due to inflation.			
Accomplishments/Planned Programs Subtotals	170.462	182.331	183.322

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
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) CONGR ADDS (CAS)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
DW5: *HIGH PERF COMP MODERN (HPCM) CONGR ADDS (CAS)*	-	45.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	45.000

Note

Congressional increase for Program increase

A. Mission Description and Budget Item Justification

This is a Fiscal Year 2017 Congressional increase to the High Performance Computing Modernization Program.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program increase	45.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	45.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A