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Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army **Date:** February 2016

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 3: Advanced Technology Development (ATD)	R-1 Program Element (Number/Name) PE 0603461A / High Performance Computing Modernization Program
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COST (\$ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	214.614	222.159	177.190	-	177.190	182.338	183.339	186.373	190.100	-	-
DS7: High Performance Computing Modernization Program	-	174.614	177.159	177.190	-	177.190	182.338	183.339	186.373	190.100	-	-
DW5: HIGH PERF COMP MODERN (HPCM) CONGR ADDS (CAS)	-	40.000	45.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

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 (RDT&E) 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 RDT&E community in the areas of hardware, software, and programming environments. All HPCMP sites are interconnected to each other, the DoD High Performance Computing (HPC) RDT&E 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 RDT&E 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 Innovation Enablers 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.

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B. Program Change Summary (\$ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	221.518	177.159	177.190	-	177.190
Current President's Budget	214.614	222.159	177.190	-	177.190
Total Adjustments	-6.904	45.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	45.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-6.904	-			

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: DW5: *HIGH PERF COMP MODERN (HPCM) CONGR ADDS (CAS)*

Congressional Add: *Congressional Increase*

	FY 2015	FY 2016
Congressional Add Subtotals for Project: DW5	40.000	45.000
Congressional Add Totals for all Projects	40.000	45.000

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Exhibit R-2A, RDT&E Project Justification: PB 2017 Army										Date: February 2016		
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
DS7: High Performance Computing Modernization Program	-	174.614	177.159	177.190	-	177.190	182.338	183.339	186.373	190.100	-	-

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 Innovation Enablers 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 2015	FY 2016	FY 2017
Title: Department of Defense (DoD) Supercomputing Resource Centers (DSRCs)	93.242	94.538	94.555
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			

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016	FY 2017
<p>DoD RDTE community to effectively and efficiently investigate, demonstrate, and mature a broad range of technologies through advanced computational methods.</p> <p><i>FY 2015 Accomplishments:</i> Refined and exploited the advanced capabilities of 14 previously demonstrated supercomputers (culminating in the ability to complete 7,900 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/image processing, (8) forces modeling and simulation, (9) electronics, networking, and systems, (10) environmental quality, and (11) integrated modeling and test environments; demonstrated the viability of several large, tightly-integrated supercomputers containing leading-edge (i.e. 2015) processor, memory, disk input/output (I/O), interconnect, and operating system (OS) capabilities (culminating in the ability to complete 9,000 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; matured the ability to interactively apply portions of supercomputers to complex, geographically distributed, near-real-time use cases (e.g. Army weather forecasts for geographically distributed test ranges); matured the ability to interactively prepare and analyze extraordinarily large input and output data sets (e.g. 10 trillion bytes in size) from a remote location (e.g. thousands of miles away); matured software and hardware-based methods for sharing memory across computational nodes to provide scientists and engineers large blocks of contiguous memory (e.g. trillions of bytes) for use cases that require large matrices; demonstrated graphical user interface (GUI) access to supercomputers without requiring software to be added to the client machine to allow scientists and engineers located at sites with prohibitive security practices to apply supercomputing to DoD use cases; demonstrated 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; investigated the energy required to address representative DoD use cases through experimentation and a sophisticated modeling of supercomputer hardware and application software to determine the benefits of 64-bit Acorn RISC Machine (ARM) processors for DoD supercomputing workloads (NOTE: Europe's long-term supercomputing roadmap depends heavily on ARM processors.); investigated (in collaboration with Lawrence Livermore National Laboratory) the power consumption, performance, and reliability of supercomputers relative to environmental parameters within a supercomputing facility.</p> <p><i>FY 2016 Plans:</i> Refining and exploiting the advanced capabilities of 20 (or more) previously demonstrated supercomputers (culminating in the ability to complete 16,900 trillion floating point operations per second) to conduct complex, tightly-coupled, large-scale, scientific calculations to address DoD challenges in the following 11 computational technology areas (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/image processing, (8) forces modeling and simulation, (9) electronics,</p>				

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016	FY 2017
<p>networking, and systems, (10) environmental quality, and (11) integrated modeling and test environments; demonstrating the viability of two (or more) large, tightly-integrated supercomputers containing leading-edge (i.e. 2016) processor, memory, disk input/output (I/O), interconnect, and operating system (OS) capabilities (culminating in the ability to complete 10,000 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; maturing graphical user interface (GUI) access to supercomputers without requiring software to be added to the client machine to allow scientists and engineers located at sites with prohibitive security practices to apply supercomputing to DoD use cases; maturing 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; investigating 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.</p> <p>FY 2017 Plans: Will refine and exploit the advanced capabilities of 23 (or more) previously demonstrated supercomputers (culminating in the ability to complete 36,400 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. 2017) processor, memory, disk I/O, interconnect, and OS capabilities (culminating in the ability to complete 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 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 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; will 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.</p>				
Title: Defense Research and Engineering Network (DREN)		30.247	30.397	30.402
Description: This 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 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				

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016	FY 2017
<p>and its contract entities as they employ HPCMP advanced capabilities; employs complementary specialized expertise to mature and exploit this environment.</p> <p><i>FY 2015 Accomplishments:</i> Refined and exploited 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; refined and exploited the HPCMP's Defense Information System Agency (DISA)-accredited Level 3 computer network defense capability to effectively protect the intellectual property of the DoD and its contract entities, when employing HPCMP advanced capabilities; demonstrated the advanced network technologies and complex information assurance mechanisms required to implement logically-separated (as opposed to physically-separated) networking communities-of-interest (COIs); matured the ability to acquire a robust set of performance data for DREN III (i.e. bandwidth, latency, jitter, and configuration information) to ensure the network attributes are suitable for complex DoD RDTE use cases; matured the ability to observe the security profile of DREN III using a cloud of over 100 sensors to support the HPCMP's DISA-accredited Level 3 computer network defense capability; investigated hardware architecture and software stack enhancements for network sensors to simultaneously allow (1) active support for the HPCMP's DISA-accredited Level 3 computer network defense capability and (2) active experimentation for novel, adaptive, cyber-security detection and intervention methods; investigated (in coordination with White House, Office of Science and Technology Policy [OSTP], the National Science Foundation [NSF], and the Army Research Laboratory [ARL]) the viability of software-defined networks (SDNs) to allow traditional Internet protocol (IP) and experimental protocol networks to coexist within a common DoD networking infrastructure; demonstrated (in collaboration with the DoD CIO's Office, U.S. Cyber Command, the National Security Agency [NSA], the DISA, and ARL DoD enterprise information system continuous monitoring (ISCM) capability to ingest robust, diverse host-based and network-based near-real-time information to provide a persistent situational awareness (SA); demonstrated (in collaboration with Lawrence Livermore National Laboratory) novel parallel discrete event simulation (PDES) methods to facilitate large-scale networking and cybersecurity research using supercomputers.</p> <p><i>FY 2016 Plans:</i> Refining and exploiting 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; refining and exploiting the HPCMP's DISA-accredited Level 3 computer network defense capability to effectively protect the intellectual property of the DoD and its contract entities, when employing HPCMP advanced capabilities; maturing the advanced network technologies and complex information assurance mechanisms required to implement logically-separated (as opposed to physically-separated) networking communities-of-interest (COIs); demonstrating hardware architecture and software stack enhancements for network sensors to simultaneously allow (1) active support for the HPCMP's DISA-accredited Level 3 computer network defense capability and (2) active experimentation for novel, adaptive, cyber-security detection and intervention methods; demonstrating (in coordination with White House, OSTP, the NSF, and ARL) the ability to employ SDNs to allow traditional Internet protocol (IP) and experimental protocol networks to coexist</p>				

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016	FY 2017
<p>within a common DoD networking infrastructure; maturing (in collaboration with the DoD CIO's Office, U.S. Cyber Command, the NSA, DISA, and ARL) a DoD enterprise ISCM capability to ingest robust, diverse host-based and network-based near-real-time information to provide a persistent SA.</p> <p>FY 2017 Plans: Will further 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 T&E community; will initiate strategic technical planning for DREN IV, a follow-on to DREN III, with next-generation technical capabilities and significantly increased bandwidths to support the HPCMP and DoD RDT&E communities; will further refine and exploit the HPCMP's DISA-accredited Level 3 computer network defense capability to effectively protect the intellectual property of the DoD and its contract entities as they utilize HPCMP advanced capabilities; will mature the advanced network technologies and complex cybersecurity mechanisms required to implement logically-separated networked communities-of-interest (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 Level 3 computer network defense capabilities and (2) active experimentation for novel, adaptive cybersecurity detection and intervention methods; will continue to demonstrate the ability to employ software-defined networks (SDNs) to allow traditional Internet protocol (IP) and experimental protocol networks to coexist within a common DoD networking infrastructure; will mature an information system continuous monitoring (ISCM) capability to ingest robust, diverse, host-based and network-based near-real-time information to provide a persistent situational awareness (SA); will improve cybersecurity methods to aid in the detection of insider threats.</p>				
<p>Title: Software Applications</p> <p>Description: This effort optimizes, enhances, demonstrates, and matures software applications to provide for the adaptation of widely used applications and algorithms to address (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)</p>		51.125	52.224	52.233

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B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2015	FY 2016	FY 2017
<p>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.</p> <p>FY 2015 Accomplishments: Matured jet engine propulsion portion of fixed-wing aircraft model to account for engine dynamics under cruise flight conditions; matured rotorcraft model to address the complex multi-physics (i.e. fluid dynamics and structural mechanics) required to analyze the Joint Multi-Role (JMR) Helicopter (an anticipated replacement for over 4,000 medium-lift helicopters); investigated coupled-physics model for conducting analyses of alternatives (AoAs) for fixed-wing aircraft concept designs; matured RF electromagnetics (EM) model to increase dynamic range of features sizes (i.e. minute details on a large platform) to determine the optimal placement of antennas on a heavily armed ground-attack aircraft variant of the C-130 (i.e. the AC-130 Specter); matured structural ship model to assess naval vessels under various (a) sea-states (i.e. ocean conditions), (b) complex maneuvers, and (c) degrees of stability (e.g. intact and damaged); matured model for conducting analyses of alternatives (AoAs) for concept ship designs to support further Small Surface Combatant (SSC) studies under the direction of the Secretary of the Navy; demonstrated suite of computational models which couple (a) the high-fidelity dynamics of multi-bodies (i.e. interconnected rigid/flexible parts of an unpowered vehicle), (b) a model of a vehicle powertrain (i.e. components necessary to generate power and deliver that power to the road/surface), and (c) a physics-based model of the surrounding environment to virtually test vehicle mobility across a wide range of scenarios; further matured model for examining personnel/platform blast protection (e.g. determining blast effects on (a) wheeled armored personnel carriers (APCs) and (b) vehicle occupants in support of Occupant Centric Platform (OCP) and Warrior Injury Assessment Manikin (WIAMAN) blast experiments); investigated, demonstrated, and matured computational models via PETTT to address critical DoD HPC RDT&E needs.</p> <p>FY 2016 Plans: Maturing jet engine propulsion portion of fixed-wing aircraft model to account for engine dynamics under transient flight conditions (i.e. complex maneuvers); maturing rotorcraft model to address the intricate maneuvers required to analyze the JMR Helicopter (an anticipated replacement for over 4,000 medium-lift helicopters); maturing coupled-physics model for conducting AoA for fixed-wing aircraft concept designs to investigate (a) next generation cargo aircraft (i.e. potential future replacements for the C-130 and C-17) and (b) advanced precision-guided Army parachutes for deployment of equipment and supplies to ground troops; maturing RF EM model to assess the ability to shrink antennas for F-22s and F-35s using advanced materials (e.g. meta-materials – artificial substances engineered to have properties not found in nature); maturing multi-physics ship model to allow refined ship/shock analysis for underwater/surface explosions, capturing the effects of moderate and severe structural damage; maturing multi-physics ship model to allow detailed propeller analysis, capturing the effects of cavitation [i.e. the creation of voids/bubbles]; maturing model for conducting AoAs for concept ship designs by incorporating cost as a design variable; maturing suite of computational models which couple (a) high-fidelity multi-body dynamics simulations for wheeled and tracked vehicles, (b) vehicle powertrain model (i.e. components necessary to generate power and deliver that power to the road/surface), (c)</p>			

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016	FY 2017
<p>a physics-based model of the surrounding environment to virtually test vehicle mobility across a wide range of scenarios and analyze (d) mobility performance from a driver perspective. Maturing model for examining personnel/platform blast protection (e.g. determining blast effects on (a) wheeled APCs and (b) vehicle occupants in support of OCP and WIAMAN blast experiments); investigating, demonstrating, and maturing computational models via PTTTT to address critical DoD HPC RDT&E needs by improving the capability and scalability of software to address DoD critical problems in the areas of computational fluid dynamics, computational chemistry and materials, computational structural mechanics, and climate, weather and ocean modeling to optimize utilization of new and emerging hardware configurations.</p> <p>FY 2017 Plans: Will mature multi-disciplinary software technology in support of current and future defense programs. For fixed-wing aircraft, this includes, but is not limited to, 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.) and mission planning for fielded and new systems and associated upgrades. Also, it will support Defense acquisition decisions associated with exploration and design analysis of future manned and unmanned aerial vehicle concepts. 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, and debris ingestion analysis. These capabilities are being deployed in support of the Future Vertical Lift (FVL) Program, as well as for sustainment of existing rotorcraft-based programs and associated upgrades, such as the Improved Turbine Engine Program (ITEP). Will mature capability for automated mesh generation for advanced aircraft and for hydrodynamic (steering and resistance) assessments for advanced submarines. Will mature conceptual and early modeling capabilities in sync with detailed design and analyses representations to realize full-lifecycle management of systems and platforms; 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, will optimize computation methods for electronic warfare assessments and evaluation of multiple antenna systems on a single platform; will further mature multi-physics ship model to allow 1) refined ship and shock analysis for underwater/ surface explosions, capturing the effects of moderate and severe structural damage; 2) detailed propeller analysis, capturing the effects of cavitation, i.e., the creation of voids and bubbles; will further mature model for conducting analyses of alternatives (AoAs) for concept ship designs by incorporating cost as a design variable. Will further optimize suite of computational models which couple (a) high-fidelity multi-body dynamics simulations for wheeled and tracked vehicles, (b) a vehicle powertrain model (i.e. components necessary to generate power and deliver that power to a surface), (c) a physics-based model of the surrounding environment to virtually test vehicle mobility across a wide range of scenarios, and (d) mobility performance analysis from a driver perspective; will further mature model for examining personnel/platform blast protection, e.g. determining blast effects on both wheeled APCs and vehicle occupants in support of OCP and WIAMAN blast experiments. Frontier projects will advance and mature DoD's highest-priority, highest-impact computational efforts, including simulation of hypersonic vehicles, simulation of stratified turbulence to enable predictive modeling of vehicles, sensors, and weapons operating in the ocean and</p>				

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016	FY 2017
atmosphere, simulation and studies to support development of the Navy's electromagnetic railgun launcher technologies, and three-dimensional simulations of complex engine sprays under real engine conditions. The PETTT initiative will optimize and enhance critical DoD physics-based and engineering software to allow scientists and engineers to execute scientific calculations with precision and efficiency on leading-edge supercomputers. New programming languages, algorithms, computational techniques, workflow environments, and data management and analysis techniques will be used to efficiently leverage the power of next generation supercomputers.				
Accomplishments/Planned Programs Subtotals		174.614	177.159	177.190
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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COST (\$ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
DW5: HIGH PERF COMP MODERN (HPCM) CONGR ADDS (CAS)	-	40.000	45.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

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

This project enables the Defense Research, Development, Test and Evaluation (RDTE) 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.

Work in this project supports the Army Science and Technology Innovation Enablers (formerly named Enduring Technologies) 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 2015	FY 2016
Congressional Add: Congressional Increase	40.000	45.000
FY 2015 Accomplishments: Congressional increase for the High Performance Computing Modernization Program.		
FY 2016 Plans: Congressional increase for the High Performance Computing Modernization Program.		
Congressional Adds Subtotals	40.000	45.000

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 3	R-1 Program Element (Number/Name) PE 0603461A / <i>High Performance Computing Modernization Program</i>	Project (Number/Name) DW5 / <i>HIGH PERF COMP MODERN (HPCM) CONGR ADDS (CAS)</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A