Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Office of the Secretary Of Defense	Date: February 2016
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*

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	-	8.844	8.807	8.420	-	8.420	9.343	10.120	10.260	10.462	Continuing	Continuing
P278: *Software Engineering Institute (SEI) Applied Research*	-	8.844	8.807	8.420	-	8.420	9.343	10.120	10.260	10.462	Continuing	Continuing

A. Mission Description and Budget Item Justification

Software is a key to meeting the Department of Defense's (DoD) increasing demand for high-quality, affordable, and timely national defense systems. With growing global parity in software engineering, the DoD must maintain leadership to avoid strategic surprise. To assist the DoD in retaining a long-term differential advantage over potential adversaries, the Software Engineering Institute (SEI) Applied Research program element (PE) develops and evaluates the feasibility and practicality of software and computer science concepts, with the potential to improve future DoD systems. The SEI's program of work coordinates across the DoD through Reliance 21, the overarching framework of the DoD's Science & Technology (S&T) joint planning and coordination process. This PE benefits every Community of Interest (COI) due to the ubiquitous nature of software, but directly benefits: Command, Control, Communications, Computers, and Intelligence (C4I); Autonomy; Cyber; and Engineered Resilient Systems. This PE also leverages expertise in government, industry, and academia to enable the development of joint-Service capabilities.

This PE represents a pivot toward more fundamental research that enables the DoD to address longer-term challenges in software technology and engineering. The SEI Applied Research PE funds the SEI Federally Funded Research and Development Center (FFRDC), as the leading DoD center for addressing these longer term challenges. The SEI Applied Research PE bolsters the organic research at the SEI FFRDC, enables stronger collaborations between the SEI FFRDC and academia, attracts top researchers to the SEI, gives the DoD access to top experts in information science, and generally enhances the DoD's ability to benefit from the military applications of research in software and computer science.

B. Program Change Summary ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	9.143	8.824	8.961	-	8.961
Current President's Budget	8.844	8.807	8.420	-	8.420
Total Adjustments	-0.299	-0.017	-0.541	-	-0.541
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.296	-			
• Realignment for Higher Priority Programs	-	-	-0.476	-	-0.476
• FY15 Reprog. for Cancelled Account	-0.003	-	-	-	-
• FFRDC Reduction	-	-0.017	-	-	-

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• Economic Assumptions	-	-	-0.065	-	-0.065

Change Summary Explanation

FY 2017 internal realignment reflects funding for higher Departmental priorities and requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2017 Office of the Secretary Of Defense			Date: February 2016
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	Project (Number/Name) P278 / *Software Engineering Institute (SEI) Applied Research*	

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
P278: *Software Engineering Institute (SEI) Applied Research*	-	8.844	8.807	8.420	-	8.420	9.343	10.120	10.260	10.462	Continuing	Continuing

A. Mission Description and Budget Item Justification

Software is a key to meeting the Department of Defense's (DoD's) increasing demand for high-quality, affordable, and timely national defense systems. With growing global parity in software engineering, the DoD must maintain leadership to avoid strategic surprise. To assist the DoD in retaining a long-term differential advantage over potential adversaries, the Software Engineering Institute (SEI) Applied Research PE seeks to establish a program of applied research that will develop and evaluate the feasibility and practicality of software and computer science concepts with the potential to improve future DoD systems.

The SEI Applied Research PE has four main research thrusts: (1) modern software tools, integrated development environments, and software engineering processes for capturing large data sets about development activities and performance; (2) model-based engineering for the design, verification, and validation of software-intensive cyber-physical systems; (3) software production and code analysis techniques that improve the ability to predict how complex software systems will behave; and (4) Successful use of software-reliant systems involving a human element. These thrusts have known military applications and can be associated with active areas of basic research. The SEI Applied Research PE seeks to translate this promising basic research into solutions for broadly defined military needs. This PE will leverage the expertise of the SEI FFRDC in advanced technology development and technology transition to design, develop, and improve tools, prototypes, and new processes that meet general requirements for software-intensive DoD systems.

The SEI Applied Research PE will conduct research in multicore computing, architecture-led iterative incremental development (Agile at scale); and emerging software and computer science areas that can act as catalysts for acquiring DoD systems with improved performance.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Software Engineering Institute Applied Research	8.844	8.807	8.420
Description: Research projects at the SEI FFRDC will be awarded under this PE on a competitive basis across the SEI. Funding levels in each thrust area may vary from year to year. Research will address the goal of assisting the DoD in retaining a long-term differential advantage over potential adversaries in the area of software-intensive systems and cybersecurity by enhancing assurance, exploiting automation, and understanding human-computer interaction. The four main thrust areas are: 1) Modern software tools, integrated development environments, and software engineering processes have captured large data sets about development activities and performance. This thrust seeks to study the metrics, measurement methodologies, and data analytics required to better understand cost, schedule, security, and performance drivers of software projects based on real-world observation and experimentation for the purposes of assessing fragility and technical debt, improving resiliency and scalability, and supporting cost/performance tradeoffs.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017

2) Model-based engineering for the design, verification, and validation of software-intensive cyber-physical systems (e.g., DoD platforms, Internet of Things (IoT)). This thrust brings automated tools to the problems of requirements engineering, architectural design, and testing. The intention is to dramatically improve assurance and confidence in software-reliant systems through techniques and tools such as model checking and constraint solvers. These tools build upon evidence produced at each step of the acquisition and development lifecycles and which may be applied to running systems in support of mission assurance objectives.

3) Software production and code analysis techniques that improve the ability to predict how complex software systems will behave. Software systems today are assembled from components supplied from around the world, often with unknown provenance. Consequently, analysis techniques that indicate the past and potential behavior of code artifacts (e.g., binaries) are important to make assurance claims. This thrust aims to develop techniques to build more secure software given knowledge of risky design patterns and forensics, and to combine this with code analysis techniques (developed in concert with malware analysis) to predict the behavior of software systems comprised of components acquired through a risky or unknown supply chain.

4) Successful use of software-reliant systems involves a human element. This thrust addresses issues including insider threat behavior, user security; trust in automated systems, and cybersecurity threat intelligence. Its aim is to acquire insights into how humans interact with technology (including computers) to understand if functionality provided can be used efficiently in missions, including circumstances where users may be under stress and/or must contemplate cooperation with robotic assistants.

FY 2015 Accomplishments:

- Studied, created, and significantly improved secure coding rules for the C++ Coding Standard, a programming language used in major weapons systems such as the Joint Strike Fighter.
- Researched and developed several static analysis checkers to reduce coding mistakes and vulnerabilities in software for improved security throughout the DoD supply chain.
- Developed tools and techniques to automate the analysis of increasingly complex malware to generate effective, scalable, and rapid responses to cyber threats.
- Studied and produced tools, techniques, and system configurations to identify behavior used by malicious insiders, to prepare the Defense Industrial Base (DIB) to meet new National Industrial Security Program Operating Manual (NISPOM) insider threat regulations effective in 2016.
- Created a comprehensive simulation model for DoD system sustainment programs to conduct analysis of mission demand, technology, and funding to identify and mitigate risks for the sustainment of DoD engineering work.
- Developed and tested initial feasibility of processes to automate tools and techniques for scalable, high-fidelity assessments of individual performance during exercises for cyber mission teams.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
• Developed new formal verification algorithms and automated analysis tools to verify the design and performance of mission-critical cyber-physical, distributed-adaptive, real-time systems. • Produced methods, techniques, and semi-automated tools for assuring the quality and affordability of DoD avionics systems through identification of technical debt and verification of architectural alternatives. • Created a prototype tool, analysis techniques, and measures to detect and identify system defects in DoD aviation acquisition programs prior to critical design review and system integration testing. ***FY 2016 Plans:*** • Evaluate the balance of cyber vs. non-cyber investment for the Software Engineering Institute to reflect information technology gaps in the DoD's mid and long-term plans. • Ensure that the SEI uses and collects information from interactions with such groups as the service communities of interest, the RDA Task Force, the Defense Science Board, and other relevant groups to identify the gaps in the Department of Defense's software and information system strategy. • Create techniques for assisting analysts in determining anomalies and outliers in data analytics processing. • Study and develop techniques and tools for automated reduction of cyber vulnerabilities in existing software. ***FY 2017 Plans:*** • Research and create tools and techniques for automatic detection and semi-automatic mitigation of potential security vulnerabilities introduced by configuration and software development errors. • Develop principles, tools, and techniques for characterizing and performing risk assessments of, and mitigation strategies for, potential collateral damage resulting from electronic warfare and/or cyber operations. • Create new, scalable techniques, algorithms, and tools for understanding the behavior of programs in binary form, including malware and other software of unknown provenance. • Study and develop formal methods, tools, and modeling techniques to design adaptable software that accommodates failures in cyber-physical environments with highly uncertain conditions. • Develop tools and techniques for the automatic generation of intelligible explanations of autonomous/robotic behaviors that will help to establish trust with human operators in critical situations.			
Accomplishments/Planned Programs Subtotals	8.844	8.807	8.420

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• BA 3, PE# 0603781D8Z: *Software Engineering Institute (SEI)*	15.198	15.173	14.264	-	14.264	15.441	15.909	16.130	16.447	Continuing	Continuing

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C. Other Program Funding Summary ($ in Millions)

Line Item	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

Remarks

Together with PE 0603781D8Z, SEI, the SEI Applied Research PE represents a pivot toward more fundamental research that enables the DoD to address longer-term challenges in software technology and engineering. The SEI Applied Research PE will fund the SEI FFRDC as the leading DoD center for addressing these longer term challenges. The SEI Applied Research PE bolsters the organic research at the SEI FFRDC, enables stronger collaborations between the SEI FFRDC and academia, attracts top researchers to the SEI, gives the DoD access to top experts in information science, and generally enhances the DoD's ability to benefit from the military applications of research in software and computer science.

D. Acquisition Strategy

N/A

E. Performance Metrics

- Transition of tools, methods, and practices for use in DoD technology development programs and programs of record.
- Transition of tools, methods, and practices to the DIB to support DoD technology development programs and programs of record.
- Number of citations in peer reviewed journals and reports.
- Number of external research collaborations and interactions with the broader software and computer science community.