Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Office of the Secretary Of Defense	Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	8.614	9.279	9.580	-	9.580	9.662	9.760	9.811	10.019	Continuing	Continuing
278: *Software Engineering Institute (SEI) Applied Research*	-	8.614	8.279	8.580	-	8.580	8.662	8.760	8.811	9.019	Continuing	Continuing
817: *Cyber Security, Applied Research*	-	0.000	1.000	1.000	-	1.000	1.000	1.000	1.000	1.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Software Engineering Institute (SEI) Federally Funded Research and Development Center (FFRDC) was established in 1984 as an integral part of the DoD's initiative to identify, evaluate, and transition software engineering technologies and practices. The mission of the SEI is to provide the DoD with technical leadership and innovation through research and development to advance the practice of software engineering and technology. The SEI works across government, industry, and academia to improve the state of software engineering from the technical, acquisition, and management perspectives. The SEI engages in research and development of critical software technologies and tools and collaborates with the larger software engineering research community. It facilitates rapid transition of software engineering technologies into practice and evaluates emerging software engineering technologies to determine their potential for improving software-intensive DoD systems. Since its inception, the SEI has helped to transform the fields of software engineering and acquisition, network security, real-time systems, software architectures, and software-engineering process management.

Software is critical to meeting the Department of Defense's (DoD) increasing demand for national defense systems that are high-quality, affordable, and deployed in a timely way. With growing global parity in software engineering, the DoD must maintain leadership in all aspects of software-based system development, operation, defense, and evolution 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 research conducted by this PE directly benefits the technical domains such as Command, Control, Communications, Computers, and Intelligence (C4I), Autonomous Systems and Artificial Intelligence (AI), Cyber, and Engineered Resilient Systems.

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B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	8.955	9.300	9.608	-	9.608
Current President's Budget	8.614	9.279	9.580	-	9.580
Total Adjustments	-0.341	-0.021	-0.028	-	-0.028
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.324	-			
• FFRDC Reduction	-0.017	-0.021	-	-	-
• Other Program Adjustments	-	-	-0.028	-	-0.028

Exhibit R-2A, RDT&E Project Justification: PB 2020 Office of the Secretary Of Defense			Date: February 2019
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	Project (Number/Name) 278 / *Software Engineering Institute (SEI) Applied Research*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
278: *Software Engineering Institute (SEI) Applied Research*	-	8.614	8.279	8.580	-	8.580	8.662	8.760	8.811	9.019	Continuing	Continuing

A. Mission Description and Budget Item Justification

Work conducted under this PE will enable resilient mission assurance in heterogeneous and contested environments through the verification and validation of system performance and architecture. The program will also assist the DoD in retaining a long-term advantage in the areas of software-intensive systems and cyber security by enhancing assurance, exploiting automation and AI, and understanding human-computer interaction.

The SEI Applied Research PE has two main research thrusts with known military applications: (1) Software Engineering, Systems Verification and Validation, and Mission Assurance (formerly Mission Assurance); and (2) Information Assurance.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: SEI Applied Research in the Area of Software Engineering, Systems Verification and Validation, and Mission Assurance (formerly Mission Assurance)	6.811	6.002	6.006
Description: Increasingly numerous lines of code will require a commensurate increase in sophistication of verification and validation mechanisms. This thrust seeks to develop verification techniques for requirements identification, systems of systems architectures, and virtual integration of components. Additionally, research in this area will enable requirements verification for software assurance, analysis and control of unverified code, and automated repair of damaged code. Software production and code analysis methods developed through this program will also improve the accuracy of behavior prediction of complex software system in untested environments.			
FY 2019 Plans: • Create and build benchmarks and datasets, using emerging machine learning computing technologies, for evaluating and improving the effectiveness of machine learning (ML) and computing resource optimization for DoD Systems. • Design and train machine learning algorithms to maximize human-machine teaming effectiveness. • Develop causal modeling tools for system software cost to identify causal factors for software cost that will provide a basis for controlling program costs.			
FY 2020 Plans: • Create tools to automatically assure untrusted external software components to enable rapid software composition for DoD systems.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
• Devise techniques to automatically recover the deployment baseline (artifacts, design rules, security) for cloud-based infrastructure to enable true Infrastructure as Code. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY2019 adjustments are reflective of high priority DoD requirements.			
Title: SEI Applied Research in the areas of Information Assurance (IA) ***Description:*** To gain full advantage from data and information generated by software for use in missions, DoD needs to assure its software is free of vulnerabilities. In its complex systems, DoD uses software developed from an unknown supply chain may include intentionally or unintentionally introduced vulnerabilities. This thrust seeks to develop scalable automated methods to locate, understand, and mitigate the effects of these vulnerabilities. Automated solutions developed through this thrust will be used to discover vulnerabilities in system software source code and to generate proofs of correctness or fault. Additionally, they will be used to model and simulate operational environments to support software and cyber tactics, techniques, and procedures testing. ***FY 2019 Plans:*** • Develop advanced analytics and machine learning technologies to enable self-adaptive cyber defenses. • Develop and test tools that provide rapid certifiable trust for autonomous, cyber-physical platforms. ***FY 2020 Plans:*** • Develop predictive models to find security vulnerabilities introduced through architectural flaws. • Devise practical formal methods which can be utilized to produce trustworthy and assured software on more complex systems; and the emerging technologies of interest to the DoD. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The increase in budget from FY 2019 to FY 2020 reflects additional resources required for technology maturation efforts.	1.803	2.277	2.574
Accomplishments/Planned Programs Subtotals	8.614	8.279	8.580

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
• BA 3, PE# 0603781D8Z: *Software Engineering Institute (SEI)*	14.468	15.016	15.111	-	15.111	15.239	15.400	15.688	16.020	Continuing	Continuing

Exhibit R-2A, RDT&E Project Justification: PB 2020 Office of the Secretary Of Defense		Date: February 2019
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	**Project (Number/Name)** 278 / *Software Engineering Institute (SEI) Applied Research*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost

Remarks

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 bolsters the organic research at the SEI Federally Funded Research and Development Center (FFRDC), enables stronger collaborations between the SEI FFRDC and academia, attracts top researchers to the SEI, and gives the DoD access to top experts in information science, which 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

Performance metrics for this project include the transition of solutions, methods, and practices for use in DoD technology development programs and programs of record; the transition of solutions, methods, and practices to the Defense Industrial Base to support DoD technology development programs and programs of record, the number of citations in peer reviewed journals and reports, and the number of external research collaborations and interactions with the broader software and computer science community.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Office of the Secretary Of Defense			Date: February 2019
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602751D8Z / *Software Engineering Institute (SEI) Applied Research*	Project (Number/Name) 817 / *Cyber Security, Applied Research*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
817: *Cyber Security, Applied Research*	-	0.000	1.000	1.000	-	1.000	1.000	1.000	1.000	1.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

Work conducted under this project will enable resilient mission assurance in heterogeneous and contested environments through the verification and validation of system performance and architecture. The program will also assist the DoD in retaining a long-term advantage in the area of cybersecurity by enhancing assurance, exploiting automation, and understanding human-computer interaction.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Cyber Security	-	1.000	1.000
Description: Warfighting in the cyber domain often operates at sub-second timescales and across multiple domains of authority. Methods used to accomplish many tasks (e.g., malware analysis, coordinating multiple agents) demand large amounts of time, attention, and special skills and are not scalable. This thrust seeks to develop and increase the use of automation to simplify the completion of these tasks. Example activities include automation of moving target defenses, code artifact reverse engineering, analysis of network flows at enterprise scale, assessing the operating boundaries for Artificial Intelligence (AI) and Machine Learning (ML) algorithms, and development and assessment of workforce skills. ***FY 2019 Plans:*** • Utilize AI/ML techniques to find and classify security vulnerabilities in code, including predicting security flaws in synthetic code. • Develop a reference architecture that automatically adapts to organizations' tooling and codebases to accurately classify and prioritize security alerts, minimizing manual effort by validators. ***FY 2020 Plans:*** • Develop means to assure and verify trustworthiness of AI/ML systems via new techniques to continuously assess the operating boundaries for AI/ML algorithms. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no change in the Cyber investment between FY 2019 and FY 2020. Note: the Cyber effort was funded in PE 0603781D8Z, Project 781 in FY 2018.			
Accomplishments/Planned Programs Subtotals	-	1.000	1.000

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Office of the Secretary Of Defense		Date: February 2019
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C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Metrics for this program include 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 Defense Industrial Base to support DoD technology development programs and programs of record; the number of citations in peer reviewed journals and reports; and the number of external research collaborations and interactions with the broader software and computer science community.