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**Exhibit R-2, RDT&E Budget Item Justification:** PB 2023 Office of the Secretary Of Defense **Date:** April 2022

<b>Appropriation/Budget Activity</b> 0400: <i>Research, Development, Test &amp; Evaluation, Defense-Wide I BA 3: Advanced Technology Development (ATD)</i>	<b>R-1 Program Element (Number/Name)</b> PE 0603781D8Z I <i>Software Engineering Institute (SEI)</i>
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COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	-	12.128	14.631	13.417	-	13.417	16.993	17.427	17.829	18.186	Continuing	Continuing
781: <i>Software Engineering Institute (SEI)</i>	-	12.128	14.631	13.417	-	13.417	16.993	17.427	17.829	18.186	Continuing	Continuing

**Note**

New Start (Y/N): No

This Software Engineering Institute (SEI) Advanced Technology Development Program Element (PE) applies the software and computer science concepts developed under the 0602751D8Z PE to research, develop, and rapidly transition state-of-the-art software technology, tools, development environments, and best practices to improve the engineering, management, fielding, evolution, acquisition, and sustainment of software-intensive Department of Defense (DoD) systems.

**A. Mission Description and Budget Item Justification**

This program supports the Departments initiatives to Build a Sustainable and Long-Term Advantage, and Build a Resilient Joint Force and Defense Ecosystem.

Software is more pervasive than ever, and computer programs are growing in size and complexity. Designing, managing, and securing integrated, complex, and large-scale mission-critical systems are abilities that the Department of Defense (DoD) and the Defense Industrial Base (DIB) have not yet mastered. Reliance on software-intensive mobile and net-based products and systems has increased (e.g., Joint Tactical Radio System, USS ZUMWALT (DDG-1000), Joint Strike Fighter, F-22, and Army Modernization). As stated in the February 2018 Defense Science Board Report, "Design and Acquisition of Software for Defense Systems," software is a crucial and growing part of weapons systems and the national security mission, and the DoD must address its ability to build and sustain software continuously and indefinitely. With growing global parity in software engineering, the DoD must maintain leadership to ensure a competitive advantage.

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.

The SEI Program Element (PE) addresses the critical need to research, develop, and rapidly transition state-of-the-art software technology, tools, development environments, and best practices to improve the engineering, management, fielding, evolution, acquisition, and sustainment of software-intensive DoD systems. The

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research conducted by this PE directly benefits the technical domains, such as Command, Control, Communications, Computers, and Intelligence (C4I), Autonomy and Artificial Intelligence (AI), Cyber, and Engineered Resilient Systems.

<b>B. Program Change Summary (\$ in Millions)</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023 Base</b>	<b>FY 2023 OCO</b>	<b>FY 2023 Total</b>
Previous President's Budget	12.590	14.677	0.000	-	0.000
Current President's Budget	12.128	14.631	13.417	-	13.417
Total Adjustments	-0.462	-0.046	13.417	-	13.417
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.460	-			
• Other Reprogramming	-0.002	-	-	-	-
• FFRDC	-	-0.046	-	-	-
• Adjustments to Budget Year	-	-	12.954	-	12.954
• Economic Assumption	-	-	0.463	-	0.463

**Change Summary Explanation**

FY 2023 funding increase reflects the fact that the FY 2022 President's Budget request did not include out-year funding.

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<b>Appropriation/Budget Activity</b> 0400 / 3					<b>R-1 Program Element (Number/Name)</b> PE 0603781D8Z / Software Engineering Ins titute (SEI)				<b>Project (Number/Name)</b> 781 / Software Engineering Institute (SEI)			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023 Base</b>	<b>FY 2023 OCO</b>	<b>FY 2023 Total</b>	<b>FY 2024</b>	<b>FY 2025</b>	<b>FY 2026</b>	<b>FY 2027</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
781: Software Engineering Institute (SEI)	-	12.128	14.631	13.417	-	13.417	16.993	17.427	17.829	18.186	Continuing	Continuing
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

**A. Mission Description and Budget Item Justification**

This project focuses on 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.

SEI research focuses on the most significant and pervasive software challenges within the DoD, such as the scalability and reliability of software assurance, supply chain risk management, validation of and trust in autonomous systems, human-computer and human-technology teaming and interaction, computing and communication at the tactical edge, and efficiency and performance of acquisition strategies and software development appropriate for a contested cyber environment.

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

	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023</b>
<b>Title:</b> SEI Advanced Technology Development in the Area of Software Engineering, Systems Verification and Validation, and Mission Assurance	10.356	10.844	9.620
<b>Description:</b> This research seeks to mature and rapidly prototype techniques to verify methods for identifying requirements, systems of systems architectures, and virtual integration of components. Furthermore, research in this area will pursue rapid prototyping and transitioning of capabilities that verify requirements for software assurance, analysis/control of unverified code and automated repair of damaged code. Software production and code analysis methods developed through this program will also improve the ability to predict how complex software systems, including AI-enabled systems, will behave in untested environments. Increasingly, large numbers of lines of code and the addition of machine-learning techniques will require a commensurate increase in sophisticated verification and validation mechanisms.			
<b>FY 2022 Plans:</b>			
<ul style="list-style-type: none"> <li>• Incorporate uncertainty modeling and methods to improve machine-learning models used by DoD/IC organizations to increase their ability to reason about machine learning model inferences and to reduce the time to retrain to achieve an acceptable level of accuracy and/or certainty.</li> <li>• Verify and extend model checking for design properties of for DoD systems and software, demonstrating a reduction in the mean time required to detect design defects from months to hours.</li> <li>• Prototype an AI risk analysis approach that enables developers to elicit requirements and conduct an independent verification of the security properties of the machine learning components through unit, integration, and uncertainty tests.</li> </ul>			
<b>FY 2023 Plans:</b>			

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023</b>
<ul style="list-style-type: none"> <li>Develop new techniques to allow feedback between deployed software, software modeled through model-based systems engineering, and deployed systems. This approach can be automated using machine learning methods that enable comparison of online information systems performance with modeled systems performance in a variety of mission and application contexts. The intent of this approach in the applied areas is to implement as an information service for DoD platforms to utilize.</li> </ul> <p><b>FY 2022 to FY 2023 Increase/Decrease Statement:</b> Changes reflect minor budget fluctuations.</p>				
<p><b>Title:</b> SEI Advanced Technology Development in the Area of Information Assurance</p> <p><b>Description:</b> Powerful machine learning algorithms can be subverted by malicious manipulation or falsification of data collected through normal channels. Algorithms must be trusted and effective in the presence of adversaries. This thrust seeks to defend against and minimize the impacts of information falsification attacks.</p> <p><b>FY 2022 Plans:</b></p> <ul style="list-style-type: none"> <li>Implement new capabilities in model software and system engineering to a) map models to micro-service performance b) use of an external micro-service analysis tool to simulate the propagation of faults and the system reconfiguration.</li> <li>Utilize artificial intelligence (AI) test harness to verify security properties of neural network components through unit, integration, and uncertainty tests.</li> </ul> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>Enable verification and validation of systems at the embedded level through graph based models of embedded systems performance and integration of large collections of such embedded systems on complex command and control applications. The intent of this approach in the applied areas is to implement as an information service for DoD platforms to utilize.</li> </ul> <p><b>FY 2022 to FY 2023 Increase/Decrease Statement:</b> There was no significant change between FY 2022 and FY 2023.</p>		1.772	1.787	1.797
<p><b>Title:</b> Artificial Intelligence Engineering Initiatives</p> <p><b>Description:</b> Artificial Intelligence (AI) engineering is an emergent discipline focused on developing tools, systems, and processes to enable the application of AI in real-world contexts. The rise in availability of computing power and massive datasets have led to the creation of new AI, models, and algorithms encompassing thousands of variables and capable of making rapid and impactful decisions. Too often, though, these capabilities work only in controlled environments and are difficult to replicate, verify, and validate in the real world. The need for an engineering discipline to guide the development and deployment of AI capabilities is urgent. AI engineering aims to provide a framework and tools to proactively design AI systems to function in environments characterized by high degrees of complexity, ambiguity, and dynamism; and aims to equip practitioners to develop systems</p>		-	2.000	2.000

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023</b>
across the enterprise-to-edge spectrum, to anticipate requirements in changing operational environments and conditions, and to ensure human needs are translated into understandable, ethical, and thus trustworthy AI.			
<b><i>FY 2022 Plans:</i></b> • Develop an AI Engineering Book of Knowledge, creating a Department standard specifying a guide to the generally accepted AI engineering approach.			
<b><i>FY 2023 Plans:</i></b> • Enable the ability for a wide variety of researchers from DoD Research Laboratories to Federally Funded Research and Development Centers to access methods in distributed cloud and High Performance Computing Environments that enable risk analysis in machine learning and distributed computing infrastructure.			
<b><i>FY 2022 to FY 2023 Increase/Decrease Statement:</i></b> There was no significant change between FY 2022 and FY 2023.			
<b>Accomplishments/Planned Programs Subtotals</b>	12.128	14.631	13.417

<b>C. Other Program Funding Summary (\$ in Millions)</b>											
<b>Line Item</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023 Base</b>	<b>FY 2023 OCO</b>	<b>FY 2023 Total</b>	<b>FY 2024</b>	<b>FY 2025</b>	<b>FY 2026</b>	<b>FY 2027</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
• BA 2, RDT&E, PE # 0602751D8Z: <i>Software Engineering Institute Applied Research</i>	9.216	9.571	11.030	-	11.030	11.365	11.607	11.867	12.105	-	-

**Remarks**

**D. Acquisition Strategy**

N/A