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**Exhibit R-2, RDT&E Budget Item Justification:** PB 2020 Army **Date:** March 2019

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| <b>Appropriation/Budget Activity</b><br>2040: <i>Research, Development, Test &amp; Evaluation, Army / BA 2: Applied Research</i> | <b>R-1 Program Element (Number/Name)</b><br>PE 0602783A / <i>Computer and Software Technology</i> |
|--|---|

| 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              | -           | 13.707  | 14.948  | 0.000        | -           | 0.000         | 0.000   | 0.000   | 0.000   | 0.000   | 0.000            | 28.655     |
| Y10: <i>Computer/Info Sci Tech</i> | -           | 13.707  | 14.948  | 0.000        | -           | 0.000         | 0.000   | 0.000   | 0.000   | 0.000   | 0.000            | 28.655     |

## Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to the following:

\* PE 0602145A Next Generation Combat Vehicle Technology

\* PE 0602146A Network C3I Technology

## A. Mission Description and Budget Item Justification

This PE develops and characterizes information and communications processing software that automates the delivery of information used in planning, rehearsal, and execution by ground commanders. Efforts develop communication/network architectures, software, and the information fusion software necessary to simplify the understanding and interactions from humans to humans, humans to computers, and computers to humans. Research enables enhanced understanding of many information sources and accelerates the decision cycle time for commanders and leaders operating in the mobile, dispersed, highly networked environment envisioned for the future force.

Work in this PE is fully coordinated with PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), and PE 0603794A (Command, Control and Communications Advanced Technology).

This PE supports Army Science and Technology efforts in the Command, Control, Communications, and Intelligence portfolio.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

All FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

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| Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army   |         |   |              | Date: March 2019 |               |
| Appropriation/Budget Activity<br>2040: Research, Development, Test & Evaluation, Army I BA 2: Applied Research |         | R-1 Program Element (Number/Name)<br>PE 0602783A I Computer and Software Technology |              |                  |               |
| B. Program Change Summary (\$ in Millions)   | FY 2018 | FY 2019   | FY 2020 Base | FY 2020 OCO      | FY 2020 Total |
| Previous President's Budget  | 14.041  | 14.958  | 15.235       | -                | 15.235        |
| Current President's Budget   | 13.707  | 14.948  | 0.000        | -                | 0.000         |
| Total Adjustments  | -0.334  | -0.010  | -15.235      | -                | -15.235       |
| • Congressional General Reductions   | -0.007  | -0.010  |              |                  |               |
| • Congressional Directed Reductions  | -       | -   |              |                  |               |
| • Congressional Rescissions  | -       | -   |              |                  |               |
| • Congressional Adds   | -       | -   |              |                  |               |
| • Congressional Directed Transfers   | -       | -   |              |                  |               |
| • Reprogrammings   | -       | -   |              |                  |               |
| • SBIR/STTR Transfer   | -0.327  | -   |              |                  |               |
| • Adjustments to Budget Years  | -       | -   | -15.235      | -                | -15.235       |
| Change Summary Explanation   |         |   |              |                  |               |
| FY20 decrease related to science and technology financial restructuring..                                      |         |   |              |                  |               |

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| Exhibit R-2A, RDT&E Project Justification: PB 2020 Army |             |         |         |              |   |               |         |         |   | Date: March 2019 |                  |            |
| Appropriation/Budget Activity<br>2040 / 2               |             |         |         |              | R-1 Program Element (Number/Name)<br>PE 0602783A / Computer and Software Technology |               |         |         | Project (Number/Name)<br>Y10 / Computer/Info Sci Tech |                  |                  |            |
| 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 |
| Y10: Computer/Info Sci Tech                             | -           | 13.707  | 14.948  | 0.000        | -   | 0.000         | 0.000   | 0.000   | 0.000   | 0.000            | 0.000            | 28.655     |

## Note

In Fiscal Year (FY) 2020 this Project is being realigned to:  
Program Element (PE) 0602145A Next Generation Combat Vehicle  
\* BF8 Artificial Intelligence & Machine Learning Tech  
PE 0602146A Network C3I Technology  
\* AP3 Information Assurance and Network Resiliency Techn  
\* AR1 Robust, Resilient and Intelligent C3I Technology

## A. Mission Description and Budget Item Justification

This Project develops and characterizes information and communications processing software to automate the delivery of information for planning, rehearsal, and execution by ground commanders. Efforts develop communication/network architectures, software, and the information fusion software necessary to simplify the understanding and interactions from humans to humans, humans to computers, and computers to humans. Research enables enhanced understanding of many information sources and accelerates the decision cycle time for commanders and leaders operating in the mobile, dispersed, highly networked environment envisioned for the future force.

Work in this Project is fully coordinated with PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), and PE 0603794A (C3 Adv Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

FY20 realignments are due to financial restructuring in support of Army Modernization Priorities.

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

|   | <b>FY 2018</b> | <b>FY 2019</b> | <b>FY 2020</b> |
|---|----------------|----------------|----------------|
| <b>Title:</b> Multi-Media Information Processing and Exploration  | 1.554          | 1.863          | -              |
| <b>Description:</b> This effort develops and characterizes fusion software to improve the completeness and timeliness of decision-making for Mission Command. The goal of this effort is to develop software applicable to the Distributed Common Ground Station ? Army (DCGS-A) architecture (an integrated architecture of all ground/surface systems) and for next generation analytic capabilities. |                |                |                |
| <b>FY 2019 Plans:</b>   |                |                |                |

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| <b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2020 Army  |   | <b>Date:</b> March 2019   |                |                |
| <b>Appropriation/Budget Activity</b><br>2040 / 2  | <b>R-1 Program Element (Number/Name)</b><br>PE 0602783A / <i>Computer and Software Technology</i> | <b>Project (Number/Name)</b><br>Y10 / <i>Computer/Info Sci Tech</i> |                |                |
| <b>B. Accomplishments/Planned Programs (\$ in Millions)</b>   |   | <b>FY 2018</b>  | <b>FY 2019</b> | <b>FY 2020</b> |
| Investigate theoretically grounded approaches for uncertainty quantification and propagation in multi-scale, multi-source data and models; develop methods for computational learning and reasoning that operate on shorter time scales and/or where there may be few or no guarantees of convergence and are amenable to adaptive learning and optimization; and develop self-organizing, self-managing, self-adapting, self-maintaining, self-protecting properties in heterogeneous complex-systems that facilitate interoperability, just-in-time human interactions, and the implementation of local-adaptation functionality in self-organizing, complex human and agent systems.   |   |   |                |                |
| <b>FY 2019 to FY 2020 Increase/Decrease Statement:</b><br>This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AR1 (Robust, Resilient, and Intelligent C3I) Technology) in FY20 as part of the financial restructuring.   |   |   |                |                |
| <b>Title:</b> Cyber Security & Information Assurance<br><br><b>Description:</b> This effort designs and characterizes software for the protection of information and networks in wireless tactical environments. The goal is to develop software algorithms that detect and defeat malicious activities of adversaries in bandwidth-constrained tactical networks.<br><br><b>FY 2019 Plans:</b><br>Explore and implement network and physical layer based approaches for evolving network behavior to improve network resilience in the presence of adversarial disruption based on mission and information requirements; will investigate methods for machine learning (ML) with incomplete information and ambiguous guidance and applications to detect and thwart adversarial ML; investigate generation after next applications for intrusion detection and active defense; investigate applications in threat intelligence as well as attribution of malicious code; investigate identification of malicious activity via network sessions attributes; and will investigate techniques to secure cyber physical systems that do not have integrated security built-in.<br><br><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b><br>This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AP3 (Information Assurance and Network Resiliency Techn) in FY20 as part of the financial restructuring. |   | 4.050   | 4.814          | -              |
| <b>Title:</b> Context-Based Information Exchange<br><br><b>Description:</b> This effort investigates techniques that integrate local and external information sources, and it applies text and video analytic approaches to support automated intelligence analysis and decision making.<br><br><b>FY 2019 Plans:</b><br>Develop approaches for adversarial learning that is resilient to continuous learning threats and maximizes Soldier and agent situational awareness; will develop methods and models for complex event processing, with compact representations, efficient pattern evaluation, and mission-centric focus to accelerate reasoning and decision making; and will conduct experiments to   |   | 2.334   | 2.289          | -              |

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| Appropriation/Budget Activity<br>2040 / 2   | R-1 Program Element (Number/Name)<br>PE 0602783A / Computer and Software Technology | Project (Number/Name)<br>Y10 / Computer/Info Sci Tech |         |         |
| B. Accomplishments/Planned Programs (\$ in Millions)  |   | FY 2018   | FY 2019 | FY 2020 |
| determine methods that support diverse, nonlinear, and emergent system behaviors or tractable optimization strategies in non-stationary systems.  |   |   |         |         |
| FY 2019 to FY 2020 Increase/Decrease Statement:<br>This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) in FY20 as part of the financial restructuring.  |   |   |         |         |
| Title: Multi-Lingual Computing<br>Description: This effort develops and assesses computational multilingual algorithms and software frameworks to enable commanders and troops to bridge language barriers in order to counter adversaries and collaborate with allies. In FY19, funds from this effort are realigned to support the Army science and technology (S&T) Modernization priorities.  |   | 2.597   | -       | -       |
| Title: Network Theories and Models<br>Description: This effort investigates and designs theory based software models to characterize and validate emerging network protocols and structures. The goal of this effort is to develop software algorithms that maintain effective communications in networks in spite of disruptive effects such as task reorganization, mobility of friendly forces, and adversarial attacks on friendly networks.  |   | 1.453   | -       | -       |
| Title: Heterogeneous Computing and Computational Sciences<br>Description: This effort researches and develops software algorithms to allow information processing across different computing hardware platforms. The goal of this research is to provide high performance computing (HPC) / processing capabilities to the Soldier on the battlefield.<br><br>FY 2019 Plans:<br>Investigate computational capabilities and new enabling applications for domain-specific, coupled, and heterogeneous architectures; advance computing capabilities amid fundamental limitations in exponential growth of Moore's law via algorithmic innovations; and develop methods to address planning, reasoning, and uncertainty at the tactical edge enhanced with heterogeneous computing resources.<br><br>FY 2019 to FY 2020 Increase/Decrease Statement:<br>This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) in FY20 as part of the financial restructuring. |   | 1.719   | 1.689   | -       |
| Title: Machine Learning with Constrained Resources  |   | -   | 3.967   | -       |

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| <b>Appropriation/Budget Activity</b><br>2040 / 2   | <b>R-1 Program Element (Number/Name)</b><br>PE 0602783A / <i>Computer and Software Technology</i> | <b>Project (Number/Name)</b><br>Y10 / <i>Computer/Info Sci Tech</i> |                |
| <b>B. Accomplishments/Planned Programs (\$ in Millions)</b>  |   | <b>FY 2018</b>  | <b>FY 2019</b> |
| <p><b>Description:</b> This effort will research new machine learning data sets and reinforcement learning methods to address issues of statistically mismatched and incomplete information which must be annotated, collected, classified and used for rapid decisions by autonomous intelligent agent (IA) and joint IA-Human teams. In addition, multi-modal communication approaches will be investigated to ensure effective communications and understanding of intent. The goal of this research is enable joint human-intelligent agent decision making, optimizing the strengths of each in the decision process and creating an adaptive, agile team.</p> <p><b>FY 2019 Plans:</b><br/>Develop methods for system-self-awareness of space, time and power characteristics and their relation to requirements of active/pending system missions, with additional ability to degrade or self-destruct gracefully; design approaches that balance the trade-off between accuracy of computation required to answer queries of users, security concerns and mission criticality/relevance; investigate the use of reinforcement learning to develop resilient behaviors and learn effective strategies for accomplishing Soldier relevant mission tasks in complex environments; and develop approaches that learn from human input develop a scalable technique for performing machine learning online, in complex Army environments, and at operational tempo.</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b><br/>This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence &amp; Machine Learning Tech) in FY20 as part of the financial restructuring.</p> |   |   |                |
| <p><b>Title:</b> FY 2019 SBIR / STTR Transfer</p> <p><b>Description:</b> FY 2019 SBIR / STTR Transfer</p> <p><b>FY 2019 Plans:</b><br/>FY 2019 SBIR / STTR Transfer</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b><br/>FY 2019 SBIR / STTR Transfer</p>   |   | -   | 0.326          |
| <b>Accomplishments/Planned Programs Subtotals</b>  |   | 13.707  | 14.948         |
| <b>C. Other Program Funding Summary (\$ in Millions)</b>   |   |   |                |
| N/A  |   |   |                |
| <b>Remarks</b>   |   |   |                |
| <b>D. Acquisition Strategy</b>   |   |   |                |
| N/A  |   |   |                |

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| Exhibit R-2A, RDT&E Project Justification: PB 2020 Army |   | Date: March 2019                                      |
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| E. Performance Metrics<br>N/A                           |   |   |