| Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army | | | | | | | | | | | Date: May 2021 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appropriation/Budget Activity<br>2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research* | | | | | R-1 Program Element (Number/Name)<br>PE 0602180A *I Artificial Intelligence and Machine Learning Technologies* | | | | | | | |
| **COST ($ in Millions)** | **Prior Years** | **FY 2020** | **FY 2021** | **FY 2022 Base** | **FY 2022 OCO** | **FY 2022 Total** | **FY 2023** | **FY 2024** | **FY 2025** | **FY 2026** | **Cost To Complete** | **Total Cost** |
| Total Program Element | - | - | - | 15.034 | - | 15.034 | - | - | - | - | - | - |
| CL2: *AI Enhanced Intel Operations Technologies* | - | - | - | 3.725 | - | 3.725 | - | - | - | - | - | - |
| CL7: *ATR Using Multiple Cooperative Sensors App Tech* | - | - | - | 7.645 | - | 7.645 | - | - | - | - | - | - |
| CN7: *Predictive Maintenance Applied Research* | - | - | - | 3.664 | - | 3.664 | - | - | - | - | - | - |

**Note**

In Fiscal Year (FY) 2022, this Program Element (PE) is created to focus on applied research efforts in the Army portfolio pertaining to Artificial Intelligence (AI) and Machine Learning (ML) coordinated by the Army's Artificial Intelligence Task Force (AITF); with funding realigned from:

PE 0602143A Soldier Lethality Technology
BD6 Soldier Sys Interfaces/Integration-Sensor Tech

PE 0602144A Ground Technology
CA9 Predictive Maintenance

PE 0602145A Next Generation Combat Vehicle Technology
BF6 Crew Augmentation and Optimization Tech
BF8 Artificial Intelligence & Machine Learning Tech
BF9 Sensors for Autonomous Operations and Surv Tech

0602146A (Network C3I Technology)
AN7 COE - Every Receiver is a Sensor Technology

PE 0603118A Soldier Lethality Advanced Technology
BD7 Soldier Sys Interfaces/Integration-Sensor AdvTech

PE 0603462A Next Generation Combat Vehicle Advanced Technology
BK1 Autonomous Mobility Adv Tech

| Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army | Date: May 2021 |
|---|---|
| **Appropriation/Budget Activity**<br>2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research* | **R-1 Program Element (Number/Name)**<br>PE 0602180A *I Artificial Intelligence and Machine Learning Technologies* |

PE 0603465A Future Vertical Lift Advanced Technology
AL7 Full Spectrum Targeting Advanced Technology

This was a part of the Program Evaluation Groups (PEG) efficiency drill.

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

This PE executes applied research in artificial intelligence (AI) and machine learning (ML) to support an AI-enabled Multi-Domain Operations (MDO) Force. This PE will investigate and further develop technologies in the use of artificial intelligence (AI) and machine learning (ML) to improve target recognition/detection using Multiple Cooperative Autonomous Sensors (MCAS), leader decision-making, replication of tactical behaviors to enable autonomous capabilities for maneuver, predictive maintenance, and Intel support for Operations (specifically in support of long range precision fires). The Army's Artificial Intelligence Task Force (AITF) will provide strategic guidance and coordination of these applied research efforts in AI/ML across the Army Modernization enterprise.

Work in this PE contributes to the Army Science and Technology (S&T) portfolio and is fully coordinated with efforts in PE 0601601A Artificial Intelligence and Machine Learning Basic Research and PE 0603040A Artificial Intelligence Advanced Technologies.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering S&T focus areas, the Army Modernization Strategy and the Joint Artificial Intelligence Center (JAIC).

Work in this PE is performed by the United States Army Futures Command (AFC).

| B. Program Change Summary ($ in Millions) | FY 2020 | FY 2021 | FY 2022 Base | FY 2022 OCO | FY 2022 Total |
|---|---|---|---|---|---|
| Previous President's Budget | 0.000 | 0.000 | 0.000 | - | 0.000 |
| Current President's Budget | 0.000 | 0.000 | 15.034 | - | 15.034 |
| Total Adjustments | 0.000 | 0.000 | 15.034 | - | 15.034 |
| • Congressional General Reductions | - | - | | | |
| • Congressional Directed Reductions | - | - | | | |
| • Congressional Rescissions | - | - | | | |
| • Congressional Adds | - | - | | | |
| • Congressional Directed Transfers | - | - | | | |
| • Reprogrammings | - | - | | | |
| • SBIR/STTR Transfer | - | - | | | |
| • Adjustments to Budget Years | - | - | 15.034 | - | 15.034 |

**Change Summary Explanation**

In FY2022, this is a new PE with three new FY22 Project funded by realignments from Program Element (PE) 0602143A Soldier Lethality Technology, 0602144A Ground Technology, 0602145A Next Generation Combat Vehicle Technology, 0602146A (Network C3I Technology), 0603118A Soldier Lethality Advanced

| Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army | Date: May 2021 |
|---|---|
| **Appropriation/Budget Activity**<br>2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research* | **R-1 Program Element (Number/Name)**<br>PE 0602180A *I Artificial Intelligence and Machine Learning Technologies* |

Technology, PE 0603462A Next Generation Combat Vehicle Advanced Technology, and PE 0603465A Future Vertical Lift Advanced Technology as a part of the Program Evaluation Group (PEG) efficiency drill.

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | | Date: May 2021 |
|---|---|---|---|
| Appropriation/Budget Activity<br>2040 / 2 | R-1 Program Element (Number/Name)<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | Project (Number/Name)<br>CL2 / *AI Enhanced Intel Operations Technologies* | |

| COST ($ in Millions) | Prior Years | FY 2020 | FY 2021 | FY 2022 Base | FY 2022 OCO | FY 2022 Total | FY 2023 | FY 2024 | FY 2025 | FY 2026 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CL2: *AI Enhanced Intel Operations Technologies* | - | - | - | 3.725 | - | 3.725 | - | - | - | - | - | - |

**Note**

In Fiscal Year (FY) 2022, this project was realigned from the following:
0602145A (Next Generation Combat Vehicle Technology) Project BF9 (Sensors for Autonomous Operations and Surv Tech)
0602145A (Next Generation Combat Vehicle Technology) Project BF8 (Artificial Intelligence & Machine Learning Tech)
0602146A (Network C3I Technology) Project AN7 (COE - Every Receiver is a Sensor Technology)

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

This project will develop various technologies to augment human analysts through AI-enabled decision support and recommendation tools to fundamentally change the way the Army fights and modernize how the Intelligence Warfighting Function supports Multi-Domain Operations and Joint All Domain Command and Control (JADC2). Ultimately, this project will help bridge the research and technology gap within intelligence support to operations and the sensor to shooter thread.

The Capstone Concept for Joint Operations: Joint Force 2020 and the Force 2025 and Beyond (F2025B) strategy calls for the integration of terrestrial sensing and exploitation capabilities to accelerate the data to decision cycle across the Range of Military Operations (ROMO). The Army Operating Concept and the Army Functional Concepts identifies the need for interoperable intelligence organizations capable of conducting synchronized proactive intelligence operations that optimize individual efficiencies and team performance. These concepts are driven by a threat that has studied US advancements during the Global War on Terror and taken notes.

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

This work is supported and coordinated with the Army Intel Community, Army Futures Command, and the Army ISR Task Force.

Work in this Project supports the Army Science and Technology Ground Portfolio and the Joint Artificial Intelligence Center (JAIC)

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

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| ***Title:*** Synthetics and Low Level Detection | - | - | 0.850 |
| ***Description:*** This effort will develop technology in low level object detection and recognition. Low level object detection and recognition is a key machine learning challenge because objects presented in such problems have a lot of variation and limited amounts of training data. This makes it difficult to build high performing AI models to address these challenges. | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | Date: May 2021 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | **Project (Number/Name)**<br>CL2 / *AI Enhanced Intel Operations Technologies* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| ***FY 2022 Plans:***<br>This effort will leverage feature invariance from multi-class classification using data that is readily available to develop an AI network to predict class representatives from the samples themselves. Using such a model, we can then predict representation for novel object classes from very few novel class samples, improving AI algorithm learning and reducing the need for manual data input.<br>In a separate approach to low level detection, we propose to enable the few-shot detector to learn novel objects from both the visual information and using semantic relations. This will promote knowledge propagation from base classes to novel classes, speeding up the time it takes to train AI algorithms.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>In Fiscal Year (FY) 2022, this effort is a new start. | | | |
| ***Title:*** AI Enhancements for Prometheus<br>***Description:*** Prometheus is an umbrella of capabilities to support sensor to shooter automation for the strategic, operational, and tactical levels. This work will develop AI capabilities for support of Long Range Precision Fires, Mission Command, and Maneuver Commanders by leveraging Intelligence Community enterprise investments in sensing, data transport, and Machine Learning / AI frameworks.<br>***FY 2022 Plans:***<br>This effort will augment Military Intelligence and Operations (Intel/Ops) with computer vision and deep learning capabilities to automatically triage data collection and automate AI-driven indications and warning (I&W) to support targeting. This effort will also develop better AI collection management and tasking capability to allow Military Intelligence soldiers to automate AI workflows. Lastly, we will document repeatable process for deploying AI capabilities to meet Army needs.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>In Fiscal Year (FY) 2022, this effort is a new start. | - | - | 1.255 |
| ***Title:*** AI-Enabled Intelligence Decision Support<br>***Description:*** This effort will augment Military Intelligence and Operations (Intel/Ops) with machine intelligence capabilities to leverage Mission, Enemy, Terrain and Weather, Troops, Time Available, and Civilian Considerations (METT-TC) information available to Commanders in support of Intelligence Preparation of the Battlefield (IPB) and the Military Decision Making Process (MDMP). The work will assist in visualizing and animating threat models to support automated AI-enabled enemy courses of action analysis.<br>***FY 2022 Plans:*** | - | - | 1.100 |

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | Date: May 2021 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | **Project (Number/Name)**<br>CL2 / *AI Enhanced Intel Operations Technologies* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| Develop AI agents to employ Mission, Enemy, Terrain and Weather, Troops, Time Available, and Civilian Considerations (METT-TC) information available to Commanders to generate courses of action for threat formations as well as conduct AI-war gaming in support of Intelligence Preparation of the Battlefield and the Military Decision Making Process. Smart ?agents? will enable automated, machine intelligence-enabled course of action analysis integrated with the broader mission command enterprise. Given these knowns about the operational environment, the effort will conduct automated real-time strategy war gaming between synthetic agents representing friendly and adversary forces at the Division echelon.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>In Fiscal Year (FY) 2022, this effort is a new start. | | | |
| ***Title:*** Foundation for AI Intelligence Support to Operations (ARCANE SERIES)<br>***Description:*** Develop an AI infrastructure/pipeline for training, integrating, and sustaining computer vision algorithms into production grade systems enterprises and edge systems for the Army Military Intelligence and Operations (Intel/Ops) community.<br>***FY 2022 Plans:***<br>Will develop an algorithm development kit with standardized deep learning model architectures that simplify training and deploying computer vision-based AI models; will create a machine learning model library with registered models, training datasets, and near real-time diagnostics from deployed models, that can be used for monitoring, alerting, and accelerating transfer learning and recalibration; will develop containerized packaging for the algorithm development kit and machine learning model library, reducing the digital scope of these assets so they can more easily be deployed on edge applications and cloud-accessible servers; will deploy the development kit and library on various edge devices and cloud-accessible servers.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>In Fiscal Year (FY) 2022, this effort is a new start. | - | - | 0.520 |
| **Accomplishments/Planned Programs Subtotals** | - | - | 3.725 |

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | | Date: May 2021 |
|---|---|---|---|
| Appropriation/Budget Activity<br>2040 / 2 | R-1 Program Element (Number/Name)<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | Project (Number/Name)<br>CL7 / *ATR Using Multiple Cooperative Sensors App Tech* | |

| COST ($ in Millions) | Prior Years | FY 2020 | FY 2021 | FY 2022 Base | FY 2022 OCO | FY 2022 Total | FY 2023 | FY 2024 | FY 2025 | FY 2026 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CL7: *ATR Using Multiple Cooperative Sensors App Tech* | - | - | - | 7.645 | - | 7.645 | - | - | - | - | - | - |

**Note**

In Fiscal Year (FY) 2022, funding was realigned from the following:
PE 0602143A (Soldier Lethality Technology) Project BD6 Soldier Sys Interfaces/Integration-Sensor Tech
PE 0602145A (Next Generation Combat Vehicle Technology) Project BF6 Crew Augmentation and Optimization Tech
PE 0602145A (Next Generation Combat Vehicle Technology) Project BF8 Artificial Intelligence & Machine Learning Tech
PE 0603118A (Soldier Lethality Advanced Technology) Project BD7 Soldier Sys Interfaces/Integration-Sensor AdvTech
PE 0603462A (Next Generation Combat Vehicle Advanced Technology) Project BK1 Autonomous Mobility Adv Tech
PE 0603465A (Future Vertical Lift Advanced Technology) Project AL7 Full Spectrum Targeting Advanced Technology

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

This work will develop Artificial Intelligence (AI) and Machine Learning (ML) algorithms that leverage a team of air and ground sensors to autonomously navigate and collaborate through shared perception of the optical, thermal, and electromagnetic spectrums to find, identify, geo-locate, and track targets during reconnaissance missions.

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

Work in this Project supports the Army Science and Technology Lethality Portfolio and the Joint Artificial Intelligence Center (JAIC)

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

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| ***Title:*** Collaborative Target Detection and Tracking | - | - | 5.645 |
| ***Description:*** This effort will develop the ability to automatically detect and track targets using the electro-optical, thermal, and electromagnetic sensors and constrained computing hardware onboard the air and ground vehicles, which process the sensor data using AI/ML algorithms and share threat perception across the unmanned team. | | | |
| ***FY 2022 Plans:*** | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | Date: May 2021 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | **Project (Number/Name)**<br>CL7 / *ATR Using Multiple Cooperative Sensors App Tech* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| Develop the ability for unmanned vehicles to self-identify and geo-locate targets, share target data among the unmanned and manned team for verification, and then serve as autonomous forward observers to auto-correct indirect fire.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>In Fiscal Year (FY) 2022, this effort is a new start. | | | |
| ***Title:*** Autonomous and Collaborative Mobility<br>***Description:*** This effort will develop mobility algorithms using AI/ML techniques to passively perceive the terrain so that air and ground vehicles can self-navigate without active and detectable sensing. Develop collaborative teaming techniques for autonomous air and ground vehicles to work together on reconnaissance missions.<br>***FY 2022 Plans:***<br>Develop AI algorithms that enable autonomous maneuver of air and ground platforms that collaboratively coordinate their movement within an assigned zone and passively sense the terrain and surroundings to avoid obstacles.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>In Fiscal Year (FY) 2022, this effort is a new start. | - | - | 1.000 |
| ***Title:*** Intuitive Mission Command Interfaces<br>***Description:*** Develop ability for warfighters to quickly and intuitively convey reconnaissance guidance, confirm or deny detected targets, and take recommended action through common mission command tools, including Tactical Assault Kit (TAK) and Integrated Visual Augmentation System (IVAS).<br>***FY 2022 Plans:***<br>Develop the intuitive relay of reconnaissance intent to the autonomous team of air and ground vehicles. Develop the ability for rapid validation of targets and activation of recommended effects (e.g., indirect fire) using TAK and IVAS.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>In Fiscal Year (FY) 2022, this effort is a new start. | - | - | 1.000 |
| **Accomplishments/Planned Programs Subtotals** | - | - | 7.645 |

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

N/A

**Remarks**

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | Date: May 2021 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | **Project (Number/Name)**<br>CL7 / *ATR Using Multiple Cooperative Sensors App Tech* |

**D. Acquisition Strategy**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | | Date: May 2021 |
|---|---|---|---|
| Appropriation/Budget Activity<br>2040 / 2 | R-1 Program Element (Number/Name)<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | Project (Number/Name)<br>CN7 / *Predictive Maintenance Applied Research* | |

| COST ($ in Millions) | Prior Years | FY 2020 | FY 2021 | FY 2022 Base | FY 2022 OCO | FY 2022 Total | FY 2023 | FY 2024 | FY 2025 | FY 2026 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CN7: *Predictive Maintenance Applied Research* | - | - | - | 3.664 | - | 3.664 | - | - | - | - | - | - |

**Note**

In Fiscal Year (FY) 2022, this project was realigned from:
PE 0602144A (Ground Technology) Project CA9 (Predictive Maintenance).

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

This effort develops and characterizes artificial intelligence (AI) and machine learning (ML) tools and capabilities to intelligently predict and analyze maintenance status for emerging and legacy aviation and ground platforms; extracts maintenance data from databases, sensor data and inference of missing data via virtual simulations investigating maintenance concepts that employ AI data capture and integrate AI tools into enterprise resource planning for military aviation and ground vehicles. Platforms of focus are prioritized by cost and value to Army missions and potentially include the UH60, AH64, CH47, Stryker, and Abrams. Each platform will be sequentially evaluated both at the appropriate component (i.e. engine health) and fleet level. This research enables use of predictive maintenance to increase fleet operational readiness through reduced downtime by preventing critical failure during missions, maximizing availability to combatant commands. Findings will be used to construct a robust Army wide predicative maintenance platform that will accelerate the pace of innovation for this problem set. This platform includes data engineering, pipelines, AI development eco-system, and application delivery. All outcomes will be used to inform requirements and technical architectures for modernization efforts of next generation aviation and ground systems both manned and unmanned.

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

Work in this Project supports the Army Science and Technology Ground Portfolio and the Joint Artificial Intelligence Center (JAIC)

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

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| ***Title:*** Predictive Maintenance | - | - | 3.664 |
| ***Description:*** This effort performs research on AI, deep learning, and predictive analytics to forecast major issues on current and future platforms which enables the Army to respond to upcoming failures. Focus will be to identify component failure relationships to principal end items for prediction of critical failure prior to corrective maintenance and reactive supply chain requisitions. Research will increase efficiency, decrease fleet operating and sustainment costs for equipment platforms, and reduce the time and costs associated with repair part requisition, management and transportation. | | | |
| ***FY 2022 Plans:*** | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2022 Army | | Date: May 2021 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602180A / *Artificial Intelligence and Machine Learning Technologies* | **Project (Number/Name)**<br>CN7 / *Predictive Maintenance Applied Research* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| Will investigate and develop new capabilities of a standardized end-to-end pipeline for gathering data from maintenance sensors in ground platforms (both manned and unmanned) and improve performance failure prediction models for critical components.<br>***FY 2021 to FY 2022 Increase/Decrease Statement:***<br>Work in this project was realigned from 0602144A (Ground Technology) Project CA9 (Predictive Maintenance). | | | |
| **Accomplishments/Planned Programs Subtotals** | - | - | 3.664 |

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A