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Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force **Date:** February 2020

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|---|---|
| Appropriation/Budget Activity 3600: Research, Development, Test & Evaluation, Air Force I BA 3: Advanced Technology Development (ATD) | R-1 Program Element (Number/Name) PE 0603788F I Battlespace Knowledge Development and Demonstration |
|---|---|

| COST (\$ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|--|-------------|---------|---------|--------------|-------------|---------------|---------|---------|---------|---------|------------------|------------|
| Total Program Element | - | 58.369 | 56.414 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |
| 635319: Anticipatory OPS Intent and Response | - | 7.978 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 7.978 |
| 635320: Assured Worldwide Connectivity | - | 24.308 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 24.308 |
| 635321: C4I Battlespace Dev and Demo | - | 7.395 | 36.303 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |
| 635322: Knowledge Management and Computing | - | 3.479 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.479 |
| 635329: Cyber Battlespace Dev & Demo | - | 15.209 | 20.111 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |

A. Mission Description and Budget Item Justification

This program develops and demonstrates Air Force enterprise-centric information technologies for the warfighter. The Anticipatory Operations Intent and Response project develops the technologies for dynamic planning and execution with the accuracy, fidelity, and timeliness needed to dominate the battlespace. The Assured Worldwide Connectivity project provides advanced net-enabled architectures and communications technologies in support of global military operations, including a secure information grid for worldwide information exchange of near-real-time multimedia (i.e., voice, data, video, and imagery) information. In addition, this project develops and demonstrates advanced optical networking and communications for Air Force air and space-based information exchange on and between platforms. These optical networks will be rapidly deployable, mobile, interoperable, and seamless between Air and Space Operations Centers (AOCs) and air and space-based platforms either en route or in theater. This project also provides tools and applications leading to the development and integration of cyber deterrence technologies resulting in a strategic capability of cyber dominance within the secure information grid. The Global Battlespace Awareness project develops, integrates, and demonstrates advanced technologies to achieve comprehensive net-centric operations and total battlespace awareness by using and exploiting information from all sources. The Knowledge Management and Computing project develops the technology applications that will provide for a secure, tailored, seamless exchange of information among producers, consumers, and managers of information relevant to a particular community of interest (COI). The project also provides the development of interactive and real-time computing technologies that greatly improve the usability of high-performance computing for the exchange, utilization, and management of information in the enterprise. The Cyber Battlespace Development and Demonstration project develops the ability to deliver sovereign options in cyberspace through the development and integration of cyber attack, cyber defense, and cyber support technologies for a strategic capability of cyber dominance.

The National Defense Strategy and Air Force Future Operating Concept established science and technology challenges to enable operational agility (the ability to rapidly generate and shift among multiple solutions for a given challenge) as a way to adapt swiftly to any situation or enemy action. Operational agility will require flexibility (manifested as multi-domain operations), speed (manifested as superior decision speed), coordination (manifested as dynamic command and control), balance (manifested as presenting a balanced capability mix), and strength (manifested as performance-optimized teams). In order to enable operational agility, this program will

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| Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 3: Advanced Technology Development (ATD)</i> | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | |
| <p>begin to shape future research and development (R&D) to focus on technologies in support of operational agility through multi-domain command and control (MDC2) capabilities.</p> <p>This program has been coordinated through the Department of Defense Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.</p> <p>In FY 2020, Project 635319, Anticipatory OPS Intent and Response; Project 635320, Assured Worldwide Connectivity; and Project 635322, Knowledge Management and Computing efforts were transferred to Project 635321, C4I Battlespace Dev and Demo, in order to realign planning and decision support, intelligent networking transport and management, and information management advanced technology development.</p> <p>In the FY 2021, the Air Force is consolidating its existing thirteen Advanced Technology Development (ATD), Research Development Test and Evaluation (RDT&E), Budget Activity 03 (BA 03) PEs into five new capability focused RDT&E BA 03 PEs to better align with the Air Force Science and Technology (S&T) Strategy signed by the SECAF in April 2019. This consolidation will improve and accelerate delivery of integrated transformational, multidisciplinary, collaborative technology solutions necessary to enable new Air Force warfighting capabilities that support of the National Defense Strategy. This new structure will provide the Air Force and Congress with a clearer understanding and increased transparency of integrated technology solutions and demonstrations key to enabling the Air Force future force design.</p> <p>In FY 2021, the entirety of Project 635321, C4I Battlespace Dev and Demo, will be transferred from PE 0603788F, Battlespace Knowledge Development and Demonstration, to PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech.</p> <p>In FY 2021, the entirety of Project 635329, Cyber Battlespace Dev & Demo, will be transferred from PE 0603788F, Battlespace Knowledge Development and Demonstration, to PE 0603035F, Next Gen Effects Dev/Demos.</p> <p>All these transfers detailed above are part of the Air Force RDT&E BA 03 PE consolidation in order to realign technology areas to better support the National Defense Strategy, Air Force Future Operating Concept and Air Force S&T Strategy, April 2019. This is an administrative realignment for consolidation, and not a new start. The Projects and associated efforts will continue to be executed by the Air Force Research Laboratory Information Technology Directorate located in Rome, New York.</p> <p>This program element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 1206601SF, and 0602298F.</p> <p>This program is in Budget Activity 3, Advanced Technology Development because this budget activity includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.</p> | | |

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| B. Program Change Summary (\$ in Millions) | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total |
|---|----------------|----------------|---------------------|--------------------|----------------------|
| Previous President's Budget | 60.017 | 56.414 | 56.746 | 0.000 | 56.746 |
| Current President's Budget | 58.369 | 56.414 | 0.000 | 0.000 | 0.000 |
| Total Adjustments | -1.648 | 0.000 | -56.746 | 0.000 | -56.746 |
| • Congressional General Reductions | 0.000 | 0.000 | | | |
| • Congressional Directed Reductions | 0.000 | 0.000 | | | |
| • Congressional Rescissions | 0.000 | 0.000 | | | |
| • Congressional Adds | 0.000 | 0.000 | | | |
| • Congressional Directed Transfers | 0.000 | 0.000 | | | |
| • Reprogrammings | 0.000 | 0.000 | | | |
| • SBIR/STTR Transfer | -1.648 | 0.000 | | | |
| • Other Adjustments | 0.000 | 0.000 | -56.746 | 0.000 | -56.746 |

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 635320: *Assured Worldwide Connectivity*

Congressional Add: *Program Increase - Assured Worldwide Connectivity*

Congressional Add Subtotals for Project: 635320

Congressional Add Totals for all Projects

| | FY 2019 | FY 2020 |
|--|----------------|----------------|
| | 8.753 | 0.000 |
| | 8.753 | 0.000 |
| | 8.753 | 0.000 |

Change Summary Explanation

Decrease in FY 2021 of \$56.746 million is due to the entirety of PE 0603788F, Battlespace Knowledge Development and Demonstration, and associated Projects being transferred to PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech and PE 0603035F, Next Gen Effects Dev/Demos, as part of the Air Force RDT&E BA 03 PE consolidation to realign technology areas to better support the National Defense Strategy, Air Force Future Operating Concept, and the Air Force S&T Strategy, April 2019.

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| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | | | | | | | | Date: February 2020 | | |
| Appropriation/Budget Activity 3600 / 3 | | | | | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | | | | Project (Number/Name) 635319 / <i>Anticipatory OPS Intent and Response</i> | | | |
| COST (\$ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
| 635319: <i>Anticipatory OPS Intent and Response</i> | - | 7.978 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 7.978 |

A. Mission Description and Budget Item Justification

In order to achieve information dominance, the Air Force must be able to monitor, assess, plan, and execute missions rapidly across the full spectrum of operations (air, space, and cyberspace) at all levels of war (strategic, operational, and tactical) and during all phases of conflict (pre-conflict, conflict through stability operations). This project develops and integrates decision support technologies that will enhance the commander's ability to anticipate and dominate the future battlespace by more effectively forecasting the evolution of the battlespace and by more rapidly generating options to "virtually checkmate" the adversary. It develops the decision aid technologies and processes to plan the use of various assets and assess their effects in the battlespace. It provides a tailorable information environment to effectively portray complex data sets accurately in real-time.

The National Defense Strategy and Air Force Future Operating Concept established science and technology challenges to enable operational agility (the ability to rapidly generate and shift among multiple solutions for a given challenge) as a way to adapt swiftly to any situation or enemy action. In order to enable multi-domain operations, this project will begin to shape future research and development to focus on technologies in support of multi-domain command and control.

In FY 2020, Project 635319, Anticipatory OPS Intent and Response, efforts transferred to Project 635321, C4I Battlespace Dev and Demo, in order to realign technology areas that better support both the Air Force Future Operating Concept and National Defense Strategy.

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

| | FY 2019 | FY 2020 | FY 2021 |
|---|----------------|----------------|----------------|
| <p>Title: Adaptive Planning and Decision Tools</p> <p>Description: Develop and demonstrate the integration of planning tools and information-based intelligent agents for adaptive replanning and decision support tools.</p> <p>FY 2020 Plans: Starting in FY 2020, this work is performed under the Multi-Domain Command and Control effort within Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2021 Plans: Not Applicable</p> | 3.618 | 0.000 | 0.000 |
| <p>Title: Next Generation Planning and Assessment Tools</p> <p>Description: Develop and demonstrate an effects-based approach for the next generation of planning and assessment techniques that enable decision makers to determine operational effects.</p> | 4.360 | 0.000 | 0.000 |

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| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635319 / <i>Anticipatory OPS Intent and Response</i> | | |
| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| <p>FY 2020 Plans: Starting in FY 2020, this work is performed under both Multi-Domain Command and Control and Artificial Intelligence/Autonomy/ Machine Learning efforts within Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2021 Plans: Not Applicable</p> | | | | |
| Accomplishments/Planned Programs Subtotals | | 7.978 | 0.000 | 0.000 |
| C. Other Program Funding Summary (\$ in Millions) | | | | |
| N/A | | | | |
| Remarks | | | | |
| D. Acquisition Strategy | | | | |
| N/A | | | | |

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| Appropriation/Budget Activity 3600 / 3 | | | | | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | | | | Project (Number/Name) 635320 / <i>Assured Worldwide Connectivity</i> | | | |
| COST (\$ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
| 635320: <i>Assured Worldwide Connectivity</i> | - | 24.308 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 24.308 |

A. Mission Description and Budget Item Justification

The Air Force requires advanced, net-enabled architectures and communications technologies in support of global kinetic and non-kinetic military operations, including a secure information grid for worldwide information delivery and exchange of near-real-time information including voice, data, video, and imagery. This secure environment will be rapidly deployable, mobile, interoperable, and seamless between the Air Operations Center and aircraft, either en route or in theater. This project provides secure information transmission capabilities for a persistent, global, survivable communications backbone network accessible for warfighters operating in all domains. It provides self-healing, self-configuration, anti-jam communication networking capabilities, and provides enterprise networking capabilities for agile, policy-based network management. In addition, this project develops and demonstrates flight ready systems consisting of high capacity radio frequency (RF) and optical components and architectures for next generation communications.

The National Defense Strategy and Air Force Future Operating Concept established science and technology challenges to enable operational agility (the ability to rapidly generate and shift among multiple solutions for a given challenge) as a way to adapt swiftly to any situation or enemy action. In order to enable multi-domain operations, the Air Force requires world-wide connectivity that is resilient and self-healing in the face of enemy attacks on communication and information assurance, able to withstand breaks in connectivity while still allowing users to collaborate with other connected operators to maintain localized situational awareness. The network balances the respective strengths of both forward-deployed forces and rear-based nodes.

In FY 2020, Project 635320, Assured Worldwide Connectivity, efforts transferred to Project 635321, C4I Battlespace Dev and Demo, in order to realign technology areas that better support both the Air Force Future Operating Concept and National Defense Strategy.

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

| | FY 2019 | FY 2020 | FY 2021 |
|---|----------------|----------------|----------------|
| Title: Connectivity Technologies | 15.555 | 0.000 | 0.000 |
| Description: Develop and demonstrate intelligent networking transport and management technology to provide assured, seamless, battlespace connectivity to the Air Force tailored to anti-access/area denial environments and contested operations. | | | |
| FY 2020 Plans: Starting in FY 2020, this work is performed under both Assured Communications & Networks and Nuclear C3 Modernization efforts within Project 635321, C4I Battlespace Dev and Demo. | | | |
| FY 2021 Plans: Not Applicable | | | |
| Accomplishments/Planned Programs Subtotals | 15.555 | 0.000 | 0.000 |

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|--|--|--|

| | FY 2019 | FY 2020 |
|---|---------|---------|
| Congressional Add: Program Increase - Assured Worldwide Connectivity | 8.753 | 0.000 |
| FY 2019 Accomplishments: Conducted Congressionally directed efforts. | | |
| FY 2020 Plans: Not Applicable | | |
| Congressional Adds Subtotals | 8.753 | 0.000 |

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

N/A

Remarks

D. Acquisition Strategy

N/A

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| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635321 / <i>C4I Battlespace Dev and Demo</i> |
|--|--|--|

| COST (\$ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|-------------|---------|---------|--------------|-------------|---------------|---------|---------|---------|---------|------------------|------------|
| 635321: <i>C4I Battlespace Dev and Demo</i> | - | 7.395 | 36.303 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |

A. Mission Description and Budget Item Justification

The National Defense Strategy and Air Force Future Operating Concept established science and technology challenges to enable operational agility (the ability to rapidly generate and shift among multiple solutions for a given challenge) as a way to adapt swiftly to any situation or enemy action. In order to enable multi-domain operations, this project will begin to shape future research and development to focus on technologies in support of multi-domain command and control.

In order to achieve operational agility, the Air Force must be able (a) to monitor, assess, plan, and execute missions rapidly across the full spectrum of operations at all levels of war and during all phases of conflict; (b) to field advanced, secure, net-enabled architectures and communications/network technologies in support of persistent, global, and survivable kinetic and non-kinetic military operations; (c) to process and exploit data and information from a variety of sources and domains to create a common operating picture of the battlespace; and (d) to provide the decision maker and staff with seamless access to tailored information within a mobile, dynamic, and scalable, globally distributed Air Operations Center, as well as among other producers, consumers, and managers of information relevant to other particular Communities of Interest (COI).

In FY 2020, Project 635319, Anticipatory OPS Intent and Response; Project 635320, Assured Worldwide Connectivity; and Project 635322, Knowledge Management and Computing efforts transferred to Project 635321, C4I Battlespace Dev and Demo, in order to realign technology areas that better support the National Defense Strategy and Air Force Future Operating Concept.

In FY 2021, the entirety of Project 635321, C4I Battlespace Dev and Demo, will be transferred to PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo, in order to realign technology areas that better support the National Defense Strategy, Air Force Future Operating Concept and Air Force Science and Technology Strategy, April 2019. The Project and associated efforts will continue to be executed by the Air Force Research Laboratory Information Technology Directorate located in Rome, New York. This is an administrative realignment for consolidation, and not a new start.

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

| | FY 2019 | FY 2020 | FY 2021 |
|---|---------|---------|---------|
| Title: Advanced Signal and Data Exploitation Technologies | 1.321 | 0.000 | 0.000 |
| Description: Demonstrate advanced signal and data exploitation technologies for detection, tracking, identification, and targeting of time-critical targets, and information extraction. | | | |
| FY 2020 Plans: In FY 2020, this work is performed within this Project, under the Data to Decisions effort. | | | |
| FY 2021 Plans: | | | |

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| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| Not Applicable | | | | |
| <p>Title: Advanced Data Handling, Visualization and Distributed Data Fusion</p> <p>Description: Develop and demonstrate advanced data handling, event visualization technologies, and distributed data fusion to enable a more effective utilization of data available.</p> <p>FY 2020 Plans: In FY 2020, this work is performed within this Project, under the Data to Decisions effort.</p> <p>FY 2021 Plans: Not Applicable</p> | | 4.363 | 0.000 | 0.000 |
| <p>Title: Adversary Courses of Action</p> <p>Description: Develop models to provide detailed understanding of the adversary's probable intent and future strategy to identify adversary courses of action, the most likely course of action, and the course of action most dangerous to friendly forces and mission accomplishment.</p> <p>FY 2020 Plans: In FY 2020, this work is performed within this Project, under the Multi-Domain Command and Control effort.</p> <p>FY 2021 Plans: Not Applicable</p> | | 1.711 | 0.000 | 0.000 |
| <p>Title: Multi-Domain Command and Control</p> <p>Description: Perform research and development (R&D) that will advance existing, or discover new, command and control capabilities to support multi-domain operations (MDO) for air, space, cyberspace, land, sea, and undersea.</p> <p>For FY 2019 and prior years, Adversary Courses of Action activities were performed within this Project under the Adversary Courses of Action effort.</p> <p>For FY 2019 and prior years, Adaptive Planning and Decision Tools and the Next Generation Planning and Assessment Tools activities were performed within Project 635319, Anticipatory OPS Intent and Response under the Adaptive Planning and Decision Tools and Next Generation Planning and Assessment Tools efforts.</p> | | 0.000 | 8.418 | 0.000 |

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| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| <p>For FY 2019 and prior years, Advanced Information Management activities were performed within Project 635322, Knowledge Management and Computing under the Advanced Information Management effort.</p> <p>FY 2020 Plans: Continue to execute experiments, based on operational scenarios, which incorporate process management execution into the extensible Space command and control framework, and which integrate disparate data and applications, providing a pedigree for proposed tasking options to decision makers. Continue to develop software capabilities that employ cyber, directed energy, and electronic warfare weaponry. Provide on-the-fly valuable quantitative evaluations of cyber assets to cyber operators, enabling them to present viable cyber options to commanders in multi-domain settings.</p> <p>FY 2021 Plans: In FY 2021, this work is performed under the Multi-Domain Command and Control effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: FY 2021 decreased compared to FY 2020 by \$8.418 million. Funding decreased due to the transfer and realignment of this work to the Multi-Domain Command and Control effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo as part of the Air Force RDT&E BA 03 PE consolidation.</p> | | | | |
| <p>Title: Nuclear C3 Modernization</p> <p>Description: Develop and demonstrate the advancement of existing nuclear capable forces to ensure command, control, and connectivity for the President without constraints.</p> <p>For FY 2019 and prior years, Connectivity Technologies activities were performed within Project 635320, Assured Worldwide Connectivity under the Connectivity Technologies effort.</p> <p>FY 2020 Plans: Continue to perform real-time monitoring of ionospheric conditions over the Continental United States (CONUS). Continue testing of very-low-frequency (VLF) stub antenna for reachback. Continue testing of prototype compact high-frequency (HF) antennas.</p> <p>FY 2021 Plans: In FY 2021, this work is performed under the Nuclear C3 Modernization effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement:</p> | | 0.000 | 4.804 | 0.000 |

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| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| FY 2021 decreased compared to FY 2020 by \$4.804 million. Funding decreased due to the transfer and realignment of this work to the Nuclear C3 Modernization effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo as part of the Air Force RDT&E BA 03 PE consolidation. | | | | |
| <p>Title: Artificial Intelligence/Autonomy/Machine Learning</p> <p>Description: Develop and demonstrate to harness the speed and scale of computers and machines to address problems of complexity.</p> <p>For FY 2019 and prior years, Next Generation Planning and Assessment Tools activities were performed within Project 635319, Anticipatory OPS Intent and Response under the Next Generation Planning and Assessment Tools effort.</p> <p>FY 2020 Plans: Continue to identify and implement state of the art learning models. Continue development of data-efficient learning. Continue to integrate within the StreamlinedML framework. Continue development of end-to-end baseline learning capability. Continue development of model recommendation & user workflow capabilities. Continue investigations of real-time deep learning algorithms.</p> <p>FY 2021 Plans: In FY 2021, this work is performed under the Artificial Intelligence/Autonomy/Machine Learning effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: FY 2021 decreased compared to FY 2020 by \$5.295 million. Funding decreased due to the transfer and realignment of this work to the Artificial Intelligence/Autonomy/Machine Learning effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo as part of the Air Force RDT&E BA 03 PE consolidation.</p> | | 0.000 | 5.295 | 0.000 |
| <p>Title: Data to Decisions</p> <p>Description: Develop and demonstrate the collection, management, analysis, and exploitation of complex data for availability to Air Force and other stakeholders.</p> <p>For FY 2019 and prior years, the Advanced Signal and Data Exploitation Technologies and Advanced Data Handling, Visualization and Distributed Data Fusion activities were performed within this Project under Advanced Signal and Data Exploitation Technologies and the Advanced Data Handling, Visualization and Distributed Data Fusion efforts.</p> <p>FY 2020 Plans:</p> | | 0.000 | 7.254 | 0.000 |

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| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635321 / <i>C4I Battlespace Dev and Demo</i> | | |
| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| <p>Continue to refine and test technologies for ultra-wideband electronics intelligence signal detection and prosecution. Continue development and demonstration of intelligence analysis capabilities from multiple intelligence sources for both near-real time and post mission. Continue research and development in data analytics and strategic indications and warnings. Perform service-based capability development. Continue with object based production optimized processing and automated-association capability.</p> <p>FY 2021 Plans: In FY 2021, this work is performed under the Data to Decisions effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: FY 2021 decreased compared to FY 2020 by \$7.254 million. Funding decreased due to the transfer and realignment of this work to the Data to Decisions effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo.</p> | | | | |
| <p>Title: Assured Communications & Networks</p> <p>Description: Develop and demonstrate secure and reliable communications to ensure the delivery of timely, reliable, and actionable information to warfighters and systems.</p> <p>For FY 2019 and prior years, Connectivity Technologies activities were performed within Project 635320, Assured Worldwide Connectivity under the Connectivity Technologies effort.</p> <p>FY 2020 Plans: Continue development and demonstration for rapid waveform development of multi-mission software defined radio frequency capability. Continue Wideband high frequency waveform development and testing. Investigate ionospheric research, propagation modeling and simulation. Continue beacon data collection on both the V and W frequency bands along with waveform development and simulation. Continue development of test platform for Common Very Low Frequency Receiver Increment Two.</p> <p>FY 2021 Plans: In FY 2021, this work is performed under the Assured Communications & Networks effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: FY 2021 decreased compared to FY 2020 by \$10.532 million. Funding decreased due to the transfer and realignment of this work to the Assured Communications & Networks effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo as part of the Air Force RDT&E BA 03 PE consolidation.</p> | | 0.000 | 10.532 | 0.000 |
| Accomplishments/Planned Programs Subtotals | | 7.395 | 36.303 | 0.000 |

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| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635321 / <i>C4I Battlespace Dev and Demo</i> |

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

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force **Date:** February 2020

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| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635322 / <i>Knowledge Management and Computing</i> |
|--|--|--|

| COST (\$ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|-------------|---------|---------|--------------|-------------|---------------|---------|---------|---------|---------|------------------|------------|
| 635322: <i>Knowledge Management and Computing</i> | - | 3.479 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.479 |

A. Mission Description and Budget Item Justification

The Air Force requires technologies that will provide the decision maker and staff with seamless access to tailored information within a mobile, dynamic, and scalable, globally distributed Air Operations Center, as well as among other producers, consumers, and managers of information relevant to other particular Communities of Interest (COI). This project demonstrates the enterprise management capabilities needed for the rapid distribution of actionable information, as well as the needed advances in high performance computing to ensure this complex capability. This project develops an agile information environment that focuses on quality of service, transformation and brokering, a federated information environment focusing the relationship among the members of the environment, a secure cross-domain information sharing capability that focuses on the security layer and inter-COI information exchange in different security domains, and a collaboration environment focusing on the information workflow layer of the enterprise.

The National Defense Strategy and Air Force Future Operating Concept established science and technology challenges to enable operational agility (the ability to rapidly generate and shift among multiple solutions for a given challenge) as a way to adapt swiftly to any situation or enemy action. In order to enable multi-domain operations, this project will begin to shape future research and development to focus on technologies in support of multi-domain command and control.

In FY 2020, Project 635322, Knowledge Management and Computing, efforts transferred to Project 635321, C4I Battlespace Dev and Demo, in order to realign technology areas that better support the National Defense Strategy and Air Force Future Operating Concept.

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

| | FY 2019 | FY 2020 | FY 2021 |
|--|---------|---------|---------|
| Title: Advanced Information Management | 3.479 | 0.000 | 0.000 |
| Description: Demonstrate how a publish, subscribe, and query information management paradigm can enable vertical and horizontal integration of Air Force information systems. | | | |
| FY 2020 Plans: Starting in FY 2020, this work is performed under the Multi-Domain Command and Control effort within Project 635321, C4I Battlespace Dev and Demo. | | | |
| FY 2021 Plans: Not Applicable | | | |
| Accomplishments/Planned Programs Subtotals | 3.479 | 0.000 | 0.000 |

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| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635322 / <i>Knowledge Management and Computing</i> |
| C. Other Program Funding Summary (\$ in Millions) N/A | | |
| Remarks | | |
| D. Acquisition Strategy N/A | | |

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| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | | | | | | | | Date: February 2020 | | |
| Appropriation/Budget Activity 3600 / 3 | | | | | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | | | | Project (Number/Name) 635329 / <i>Cyber Battlespace Dev & Demo</i> | | | |
| COST (\$ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
| 635329: <i>Cyber Battlespace Dev & Demo</i> | - | 15.209 | 20.111 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |

A. Mission Description and Budget Item Justification

The Air Force requires the ability to deliver sovereign options in cyberspace through the development and integration of cyber-attack, cyber defense, and cyber support technologies for a strategic capability of cyber dominance. This project develops the ability to deliver cyber-attack capabilities (access, stealth, persistence, intelligence, and weapons delivery), cyber defense capabilities (attack detection, attack attribution, and response automation) and cyber support capabilities (situation awareness and war gaming). This project will also develop 1) a science and engineering capability demonstrating new models of computation, 2) novel approaches for high performance, interactive, net-centric, distributed and embedded computing systems, and 3) the technological tools enabling affordable, large-scale, and complex software-intensive systems.

The National Defense Strategy and Air Force Future Operating Concept established science and technology challenges to enable operational agility (the ability to rapidly generate and shift among multiple solutions for a given challenge) as a way to adapt swiftly to any situation or enemy action. In order to enable multi-domain operations, this project will begin to shape future research and development to focus on cyber technologies in support of multi-domain command and control.

In FY 2021, the entirety of Project 635329, Cyber Battlespace Dev & Demo, will be transferred to Program Element 0603035F, Next Gen Effects Dev/Demos, Project 635329, Cyber Battlespace Dev & Demo, as part of the Air Force Research Development Test and Evaluation (RDT&E), Budget Activity 03 (BA 03) PE consolidation in order to realign technology areas to better support the National Defense Strategy, Air Force Future Operating Concept and Air Force Science and Technology Strategy, April 2019. The Project and associated efforts will continue to be executed by the Air Force Research Laboratory Information Technology Directorate located in Rome, New York. This is an administrative realignment for consolidation, and not a new start.

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

| | FY 2019 | FY 2020 | FY 2021 |
|--|----------------|----------------|----------------|
| Title: Cyber Offense | 3.881 | 0.000 | 0.000 |
| Description: Develop and demonstrate offensive cyber operations capabilities in a series of experimental technology demonstrations. | | | |
| FY 2020 Plans: Starting in FY 2020, this work is performed within this Project, under the Cyber Power Projection effort. | | | |
| FY 2021 Plans: Not Applicable | | | |
| Title: Resiliency | 5.437 | 7.339 | 0.000 |

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| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 | | |
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| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| <p>Description: Integrate and demonstrate a resilient and self-generating information enterprise that dynamically recognizes, characterizes, and understands novel cyber attacks, and then reconfigures and self-optimizes itself to resist new attacks.</p> <p>FY 2020 Plans: Continue to develop and evolve of software capabilities and Concept of Operations for active guidance and automated processes addressing cyber resiliency and survivability. Continue to advance capability migration to form factors which more readily align with operational systems. Continue to demonstrate automated cyber survivability using integrated cyber technologies within the operational system laboratory in the context of risk management framework requirements. Continue development of an advanced secure processor hardware capability.</p> <p>FY 2021 Plans: In FY 2021, this work is performed under the Resiliency effort in PE 0603035F, Next Gen Effects Dev/Demo, Project 635329, Cyber Battlespace Dev & Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: FY 2021 decreased compared to FY 2020 by \$7.339 million. Funding decreased due to the transfer and realignment of this work to the Resiliency effort in PE 0603035F, Next Gen Effects Dev/Demo, Project 635329, Cyber Battlespace Dev & Demo as part of the Air Force RDT&E BA 03 PE consolidation.</p> | | | | |
| <p>Title: Game Changing Computing Power</p> <p>Description: Develop and demonstrate computer architectures with greater capacity and sophistication to enable game-changing computing power to the warfighter anywhere, anytime.</p> <p>FY 2020 Plans: Continue and complete work to improve software specifications using evolutionary approaches to optimize computer processing. Extend Robust AI/Autonomy/Machine Learning upgrades and development. Complete the research and development to demonstrate a trusted and resilient embedded system (e.g. autonomous vehicle) that is capable of identifying, localizing and automatically repairing previously unknown or unintended vulnerabilities in the software</p> <p>FY 2021 Plans: In FY 2021, the cyber component of this work is completed and the non-cyber component of this work is performed under the Game Changing Computing Power effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement:</p> | | 4.779 | 4.962 | 0.000 |

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| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 | | |
| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635329 / <i>Cyber Battlespace Dev & Demo</i> | | |
| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| FY 2021 decreased compared to FY 2020 by \$4.962 million. Funding decreased due to the transfer and realignment of this work to the Game Changing Computing Power effort in PE 0603034F, Persistent Knowledge, Awareness, & C2 Tech, Project 635321, C4I Battlespace Dev and Demo as part of the Air Force RDT&E BA 03 PE consolidation. | | | | |
| <p>Title: Autonomous, Multi-level Access and Transfer</p> <p>Description: Develop autonomous, secure information access and sharing capabilities required by the Air Force net-centric information enterprise.</p> <p>FY 2020 Plans: Extend development and integration of polyglot file identification filter to mitigate data exfiltration risk. Sustain development of a modularized filter store to maximize filter re-usability and increase the agility of cross-domain solutions to support new file types.</p> <p>FY 2021 Plans: For FY 2021, this work is performed under the Autonomous, Multi-level Access and Transfer effort in PE 0603035F, Next Gen Effects Dev/Demo, Project 635329, Cyber Battlespace Dev & Demo.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: FY 2021 decreased compared to FY 2020 by \$1.422 million. Funding decreased due to the transfer and realignment of this work to the Autonomous, Multi-level Access and Transfer effort in PE 0603035F, Next Gen Effects Dev/Demo, Project 635329, Cyber Battlespace Dev & Demo as part of the Air Force RDT&E BA 03 PE consolidation.</p> | | 1.112 | 1.422 | 0.000 |
| <p>Title: Cyber Power Projection</p> <p>Description: Develop and demonstrate offensive cyber capabilities in contested environments through a series of experiments and exercises.</p> <p>For FY 2019 and prior years, Cyber offense activities were performed under the Cyber Offense effort within this project.</p> <p>FY 2020 Plans: Extend development of systems to identify items of interest associated with the Internet of Things. Advance the development of a counter small unmanned aerial system open architecture specification to enable interoperability between disparate protection systems. Continue to integrate and transition multiple Air Force Research Laboratory and Air Force Lifecycle Management Center counter small unmanned aerial system capabilities. Provide capability to enable the warfighter access into congested environments as directed by warfighter requirements.</p> <p>FY 2021 Plans:</p> | | 0.000 | 6.388 | 0.000 |

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| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 | | |
| Appropriation/Budget Activity 3600 / 3 | R-1 Program Element (Number/Name) PE 0603788F / <i>Battlespace Knowledge Development and Demonstration</i> | Project (Number/Name) 635329 / <i>Cyber Battlespace Dev & Demo</i> | | |
| B. Accomplishments/Planned Programs (\$ in Millions) | | FY 2019 | FY 2020 | FY 2021 |
| In FY 2021, this work is performed under the Cyber Power Projection effort in PE 0603035F, Next Gen Effects Dev/Demo, Project 635329, Cyber Battlespace Dev & Demo. | | | | |
| <i>FY 2020 to FY 2021 Increase/Decrease Statement:</i> FY 2021 decreased compared to FY 2020 by \$6.388 million. Funding decreased due to the transfer and realignment of this work to the Cyber Power Projection effort in PE 0603035F, Next Gen Effects Dev/Demo, Project 635329, Cyber Battlespace Dev & Demo, as part of the Air Force RDT&E BA 03 PE consolidation. | | | | |
| Accomplishments/Planned Programs Subtotals | | 15.209 | 20.111 | 0.000 |
| C. Other Program Funding Summary (\$ in Millions) N/A | | | | |
| Remarks | | | | |
| D. Acquisition Strategy N/A | | | | |