Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force												Date: May 2021
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602788F / *Dominant Information Sciences and Methods*							
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	-	214.376	215.275	169.110	0.000	169.110	-	-	-	-	-	-
625315: *C4I Dominance Technology*	-	132.669	91.165	93.030	0.000	93.030	-	-	-	-	-	-
625319: *Cyberspace Dominance Technology*	-	60.281	63.926	52.234	0.000	52.234	-	-	-	-	-	-
62OMMS: *Research Site Support*	-	21.426	60.184	23.846	0.000	23.846	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This program develops enterprise-centric information technology for the Department of the Air Force. Advances in enterprise-centric information technologies are required to increase warfighter readiness and effectiveness by providing the right information, at the right time, in the right format, anytime, anywhere in the world. The Connectivity and Protection Tech project provides the technologies for multi-level, secure, seamless networks; advanced communications processors; anti-jam and low probability of intercept techniques, as well as technologies that deter any adversary from attacking computer systems while allowing access to, presence on, manipulation of, and operational effects on adversary computer systems. This project also develops the technology base for the next generation of ultra-wide-bandwidth, multi-channeled, air- and space-based communications networks. The Information Management and Computational Tech project provides advances in information management and dissemination technologies to ensure the delivery of high-quality, timely, secure information to the warfighter, and develop technologies to produce both advanced on demand computational processing and computer architectures with greater capacity and sophistication for addressing dynamic mission objectives under constraints imposed by Department of the Air Force systems. The Information Decision Making Tech project develops the technology to support the commander and staff's ability to command all viable options to achieve desired effects across the full spectrum of operations. The Operational Awareness Tech project develops technologies that improve their capability to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information. The Research Site Support project provides the Rome Research Site infrastructure at Rome, New York and provides for the continued operations of all Rome Research Site properties, buildings, and services necessary for the research mission. Efforts in this program have been coordinated through the Department of Defense (DoD) Science and Technology (S&T) Executive Committee process to harmonize efforts and eliminate duplication.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of such program funds would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0622041F, 0602605F, 1206601SF, and 0602298F.

Funds in this PE may be used to investigate specified technology advancements in air, space and/or cyber domains.

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	216.062	178.668	174.121	0.000	174.121
Current President's Budget	214.376	215.275	169.110	0.000	169.110
Total Adjustments	-1.686	36.607	-5.011	0.000	-5.011
• Congressional General Reductions	0.000	-0.393			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	37.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.607	0.000			
• SBIR/STTR Transfer	-2.293	0.000			
• Other Adjustments	0.000	0.000	-5.011	0.000	-5.011

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 625315: *C4I Dominance Technology*		
Congressional Add: *Program Increase- Artificial Intelligence/Machine Learning Accelerator*	8.000	0.000
Congressional Add: *Program Increase- Combat Cloud Technology*	2.500	0.000
Congressional Add: *Program Increase- Quantum Communications*	4.000	0.000
Congressional Add: *Program Increase- Quantum Cryptography*	7.000	0.000
Congressional Add: *Program Increase*	5.000	0.000
Congressional Add: *Program Increase- Quantum Network Testbed*	0.000	0.000
Congressional Add: *Program Increase- Quantum Information Science Innovation Center*	8.000	0.000
Congressional Add Subtotals for Project: 625315	34.500	0.000
Project: 625319: *Cyberspace Dominance Technology*		
Congressional Add: *Program Increase- Trusted UAS Traffic Management and c-SUAS Testbed*	0.000	0.000
Congressional Add Subtotals for Project: 625319	0.000	0.000
Project: 62OMMS: *Research Site Support*		
Congressional Add: *Program Increase- Quantum Cryptography*	0.000	7.000
Congressional Add: *Program Increase- Quantum Network Testebed*	0.000	10.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *Program Increase- Quantum Information Science Innovation Center*	0.000	10.000
Congressional Add: *Program Increase- trusted UAS traffic management and c-SUAS testbed*	0.000	10.000
Congressional Add Subtotals for Project: 62OMMS	0.000	37.000
Congressional Add Totals for all Projects	34.500	37.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602788F / *Dominant Information Sciences and Methods*	Project (Number/Name) 625315 / *C4I Dominance Technology*	

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
625315: *C4I Dominance Technology*	-	132.669	91.165	93.030	0.000	93.030	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The Department of the Air Force requires advanced technologies which support the Department of the Air Force five core missions and enable the Department of the Air Force to achieve Global Vigilance, Global Reach, and Global Power in support of national security objectives. The technologies developed under this project enable the National Defense Strategy and Department of the Air Force future operating concepts which require operational agility (the ability to rapidly generate—and shift among—multiple solutions for a given challenge), creating combinations of air, space, and cyberspace capabilities to achieve desired effects in the battlespace.

This project provides the technologies for secure, self-configuring, self-healing, seamless networks; advanced communications processors; anti-jam and low probability of intercept communications techniques; agile and dynamic policy-based network management capabilities; and modular, programmable, low-cost software radios. In addition, it develops both the technology base for ultra-wide bandwidth and multi-channeled communications networks (both air and space based) on and between platforms.

This project provides the technologies which enable the ability to globally share, discover, and access information across organizational, functional, and coalition boundaries and between and among domains, the timely delivery of information to tactical assets, the tailoring and prioritization of information based on mission needs and importance, and the scaling, robustness, and collaboration features required of the Department of the Air Force net-centric information management environment.

This project advances technologies enabling the effective execution of military objectives that will vastly improve the ability to support the commander and staff's ability to command all viable options to achieve desired effects 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. This project provides technologies for anticipatory decision support; course of action development, planning, scheduling, and assessment; and the real-time effective portrayal of complex data sets.

This project improves and automates the capability to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information. This project provides not only a network-centric, collaborative intelligence analysis capability that enables the fusion of multi-intelligence and sensor sources to provide timely situational awareness, understanding, and anticipation of the threats in the battlespace, but also the advanced, novel exploitation technologies needed to intercept, collect, locate, and process both covert and overt raw data from intelligence and sensor sources.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Assured Communications & Networks	23.182	24.492	25.462
Description: Develop communications, networking, and signal processing technologies with improved survivability and capacity to provide secure, adaptive, covert, anti-jam, and assured global battlespace connectivity tailored to anti-access and area-denial			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625315 / *C4I Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
environments and contested operations. Includes the research and development to advance existing nuclear capable forces to ensure command, control, and connectivity for the President without constraints. ***FY 2021 Plans:*** Continue the research and development of technologies for robust, adaptive, and mission aware airborne networks. Continue the investigation of high frequency pathways (for example, the V and W band of the electromagnetic spectrum) to support aerial and space-based beyond line of sight communications. Continue the research and development of dynamic map-to-mission for secure message exchange operations continuity and agile info management. Continue development of a waveform testbed and flight test a new multi-waveform radio. Continue research and development to measure propagation at millimeter wave frequencies to validate previously developed models and enable future definition of military satellite communications systems. Continue ionospheric research, propagation modeling and simulation. Develop an ultra-wide band protocol stack to enable future ultra wide-band communications. Develop a directional radio prototype, with optimized user discovery and network interference control interface. ***FY 2022 Plans:*** Continue the research and development of technologies for robust, adaptive, and mission aware airborne networks. Maintain the research and development of large-scale hardware-in-the-loop verification of developed directional networking protocols. Advance the research and development of propagation models. Initiate the development of a network stack suitable for high-bandwidth terahertz links. Launch the development, verification, and validation of advanced, airborne high-frequency antenna/ionospheric structure. Initiate the development, verification, and test of advanced waveforms. Establish the development, verification, and test of software-defined radio prototypes. Continue development of enhanced assurance and filtration offloading. Extend the development of advanced, airborne high-frequency antenna/ionospheric structures. Continue to develop, verify, and validate software-defined radio prototypes. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.970 million. Justification for the increase is described in the plans above.			
Title: Data to Decisions ***Description:*** Investigate and develop technologies for decision quality information dissemination services via publish, subscribe, and query across the Global Information Grid to enterprise and tactical assets and coalition partners. ***FY 2021 Plans:*** Continue the research and development of data analytics and strategic indications and warnings technologies (including large data alignment, indexing and search on textual data, large-scale and disparate data sources, both structured and unstructured data, and employment of various ontologies and machine learning techniques). Continue to advance research and development	12.993	14.210	15.199

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625315 / *C4I Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
for cloud-based data and information sharing environment for optimized processing and automated association capability. Continue to focus signals intelligence characterization on audio and other electronic signals. Continue research and development in exploitation technologies using audio processing for language modeling and deep learning techniques. Continue research on enhanced emitter feature extraction capabilities and development of automated electronics intelligence analysis toolsets. Develop network dynamics algorithms. ***FY 2022 Plans:*** Continue the research and development of data analytics and strategic indications and warnings technologies (including large data alignment, indexing and search on textual data, large-scale and disparate data sources, both structured and unstructured data, and employment of various ontologies and machine learning techniques). Maintain the development of a user customizable entity, event, and relation text extraction capability with automatic performance estimates of the user-customized extractors on new documents and mission areas. Initiate research and development of a Request for Information (RFI) dialog system that can help answer Requests for Information (RFI) for single service applications across 10 essential Intelligence enterprise identified RFIs. Develop a Multi-Int Intelligence, Surveillance, and Reconnaissance ontology connecting Air Force analytics, Application Programming Interfaces, and services. Research and develop an initial integrated threat detection system based on vetted events from PAI fused and corroborated with ISR sources. Continue the research and development of autonomous, heterogeneous, distributed multi-sensor management and upstream data fusion for improved target detection, tracking and classification. Sustain the development of counter Small Unmanned Air systems (C-SUAS) detection and identification, via acoustics, and algorithm work. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.989 million. Justification for the increase is described in the plans above.			
Title: Processing Technologies	0.000	6.481	7.463
Description: Develop automatic and dynamically reconfigurable, scalable, affordable distributed peta-flop processing technologies for real-time global information systems. Starting in FY 2021, the remaining non-cyber work that was performed under Project 625319, Cyberspace Dominance Technology, in the Processing Technologies effort within this PE will now be performed within this effort. ***FY 2021 Plans:*** Develop the application of novel neuromorphic systems for robust machine learning. Continue to advance research and development of the neuromorphic processor and validate capabilities for dynamic learning on mobile and power-constrained platforms. ***FY 2022 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625315 / *C4I Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Advance the application of novel neuromorphic systems for robust machine learning. Continue to advance research and development of the neuromorphic processor and validate capabilities for dynamic learning on mobile and power-constrained platforms. Initiate the development of a prototype integrated with existing embedded high performance computing systems. Commence the development and delivery of a Neuromorphic High-Performance-Computing (Brain-in-the-Box). ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.982 million. Justification for the increase is described in the plans above.			
Title: Multi-Domain Command & Control (MDC2) ***Description:*** Develop advanced monitoring, planning, and assessment technologies enabling aerospace commanders to develop effects-based campaigns. Investigate, analyze, and develop technologies for planning, execution, and automatic rapid reconfiguration of distributed intelligent and integrated command and control information systems to achieve the commander's intent throughout varying crisis levels. ***FY 2021 Plans:*** Continue research for applying machine learning techniques to enhance and optimize space operations. Develop a system for distributed command and control, enabling cyber operators viable options for decision making in the multi-domain arena. Leverage prior efforts in developing a series of experiments in the area of multi-domain command and control. ***FY 2022 Plans:*** Continue research for applying machine learning techniques to enhance and optimize space operations. Advance research and development to refine the mathematical framework and provide a method for evaluating and presenting multi-domain courses of action to maximize operational effects for decisive advantage. Maintain the development of tools, technology, and a framework for execution management of operational center process workflows and applications. Sustain the research and development of a novel composable planning paradigm to overcome the serial and time-intensive nature of existing planning techniques. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.949 million. Justification for the increase is described in the plans above.	17.577	18.782	19.731
Title: Artificial Intelligence/Autonomy/Machine Learning ***Description:*** Perform research and development (R&D) to harness the speed and scale of computers and machines to address problems of complexity. ***FY 2021 Plans:*** Research and develop machine learning approaches for supporting and performing operations in complex adversarial environments. Conduct research to understand operations needs of machine learning algorithms and systems with the multi-	14.496	15.700	16.699

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625315 / *C4I Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
domain command and control connect. Demonstrate analytical and simulation framework for large-scale swarms that considers potential constraints on communications, on-board processing, sensors, and flight systems. ***FY 2022 Plans:*** Advance the research and development of machine learning approaches for supporting and performing operations in complex adversarial environments. Maintain the research to understand operational needs of machine learning algorithms and systems with the multi-domain command and control connect. Continue to research the application of Interactive Learning techniques to the auto-planning problem and develop an IL based planning capability to augment existing auto-planning tools. Sustain the research and development of machine learning approaches for supporting and performing operations in complex adversarial environments. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.999 million. Justification for the increase is described in the plans above.			
Title: Nuclear C3 Modernization ***Description:*** Perform research and development (R&D) to advance existing nuclear capable forces to ensure command, control, and connectivity for the President without constraints. ***FY 2021 Plans:*** Develop advanced, airborne high-frequency antenna/ionospheric structure. Test advanced waveforms. Develop, verify, and validate software-defined radio prototypes. ***FY 2022 Plans:*** Starting in FY 2022, this work will be performed in PE 0602788F, Dominant Information Sciences and Methods, Project 625315, C4I Dominance Technology, Assured Communications & Networks effort. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $4.010 million. Starting in FY 2022, this work will be performed in PE 0602788F, Dominant Information Sciences and Methods, Project 625315, C4I Dominance Technology, Assured Communications & Networks effort.	3.811	4.010	0.000
Title: Quantum Information Science ***Description:*** Perform research and development (R&D) that will utilize quantum physics for the storage, transmission, manipulation, computing, or measurement of information in ways that offer advantages to classical capabilities. ***FY 2021 Plans:***	6.443	7.490	8.476

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625315 / *C4I Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Continue research and development in the area of supreme and quantum computing information sciences. Demonstrate entangling gates within a trapped ion based network node and perform remote entangling operations between independent network nodes. Conduct performance of interface using trapped ion, superconducting, and photon-based qubit. Develop compact memory-and photon-based network components to be used in future field demonstrations. ***FY 2022 Plans:*** Continue research and development in the area of supreme and quantum computing information sciences. Maintain development of further reducing SWaP of network node demonstrations. Initiate demonstration of quantum information processing on a single chip by using developed quantum photonics processor with photon sources. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.986 million. Justification for the increase is described in the plans above.			
Title: Future AF Capabilities Applied Research ***Description:*** Investigate, design, and develop science and technologies supporting future Department of the Air Force capabilities to provide compelling advantage to the warfighter. To the greatest extent practical, research efforts will utilize modeling and simulation and cross-discipline systems integration (For example: air and space vehicles, avionics, propulsion, materials, human performance, cybersecurity, command, control, communications, computer and intelligence, sensors, electronic warfare, and conventional/unconventional weapons). The National Defense Strategy and the Department of the Air Force Science and Technology 2030 Strategy will inform investments over the FYDP. ***FY 2021 Plans:*** Starting in FY 2021, the Dominant Information Science and Methods portion of this work is performed in PE 0602020F, Future AF Capabilities Applied Research, Project 620200, Enterprise Transformational Applied Research, Transformational Capability Incubator effort. ***FY 2022 Plans:*** Not applicable. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable	19.667	0.000	0.000
Accomplishments/Planned Programs Subtotals	98.169	91.165	93.030

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625315 / *C4I Dominance Technology*

	FY 2020	FY 2021
Congressional Add: Program Increase- Artificial Intelligence/Machine Learning Accelerator ***FY 2020 Accomplishments:*** Conduct congressionally directed efforts. ***FY 2021 Plans:*** Not applicable.	8.000	0.000
Congressional Add: Program Increase- Combat Cloud Technology ***FY 2020 Accomplishments:*** Conduct congressionally directed efforts. ***FY 2021 Plans:*** Not applicable.	2.500	0.000
Congressional Add: Program Increase- Quantum Communications ***FY 2020 Accomplishments:*** Conduct congressionally directed efforts. ***FY 2021 Plans:*** Not applicable.	4.000	0.000
Congressional Add: Program Increase- Quantum Cryptography ***FY 2020 Accomplishments:*** Conducted congressionally directed efforts. ***FY 2021 Plans:*** Conduct congressionally directed efforts.	7.000	0.000
Congressional Add: Program Increase ***FY 2020 Accomplishments:*** Conduct congressionally directed efforts. ***FY 2021 Plans:*** Not applicable.	5.000	0.000
Congressional Add: Program Increase- Quantum Network Testbed ***FY 2020 Accomplishments:*** Not applicable. ***FY 2021 Plans:*** Conduct congressionally directed efforts.	0.000	0.000
Congressional Add: Program Increase- Quantum Information Science Innovation Center ***FY 2020 Accomplishments:*** Conducted congressionally directed efforts. ***FY 2021 Plans:*** Conduct congressionally directed efforts.	8.000	0.000
Congressional Adds Subtotals	34.500	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625315 / *C4I Dominance Technology*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602788F / *Dominant Information Sciences and Methods*	Project (Number/Name) 625319 / *Cyberspace Dominance Technology*	

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
625319: *Cyberspace Dominance Technology*	-	60.281	63.926	52.234	0.000	52.234	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The Department of the Air Force requires technologies to deliver a full range of options in cyberspace on par with air and space dominance in each of the areas of cyber-attack, cyber defense, and cyber support to achieve the strategic capability of cyber dominance. The Department of the Air Force requires the development of superior, intelligent, on-demand computing to enable information superiority to include advances in secure information sharing across domains and boundaries as well as technologies that successfully deter any adversary from attacking computer systems anytime, anywhere by ensuring the Department of the Air Force's ability to: access, maintain presence on, and deliver effects to adversary systems; detect, defend, and respond to attacks on friendly computer systems and provide forensic analysis concerning those attack attempts; and provide cyber situational awareness to Department of the Air Force Commanders. In addition, the Department of the Air Force requires technology development that produces computing architectures with greater capacity and sophistication for addressing constrained, dynamic mission objectives; game-changing computing power to the warfighter, disruptive computing power at the tactical edge and for federated grid services; and interactive and real-time computing improving the usability of high-performance computing to the Department of the Air Force. It includes technologies in computational sciences and engineering, computer architectures and software intensive systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Cyber Defense Technologies	20.531	21.432	32.225
Description: Develop cyber defense and supporting technologies to detect, defend, and respond to attacks on computer systems as well as provide forensic concerning attacks. ***FY 2021 Plans:*** Continue research in the area of autonomous integrated cyber operations. Continue applied research in the area of biologically resilient cyber technologies. Continue research into mission-specific block-chain capabilities, and the alignment of cyber resilient services and dynamic management tailored towards unmanned aerial systems. Develop radical architectural and infrastructural changes from computational diversity, to deliver a quantifiable improvement to cybersecurity. ***FY 2022 Plans:*** Continue research in the area of autonomous integrated cyber operations. Advance applied research in the area of biologically resilient cyber technologies. Extend research into mission-specific block-chain capabilities, and the alignment of cyber resilient services and dynamic management tailored towards unmanned aerial systems. Maintain the development of radical architectural and infrastructural changes from computational diversity, to deliver a quantifiable improvement to cybersecurity. Continue to sustain research and validation of a cyber-hardened (robust, secure) processor for embedded weapon systems. Continue to maintain applied research to create trusted and resilient embedded systems that are capable of identifying, localizing,			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625319 / *Cyberspace Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
and automatically repairing previously unknown and/or unintended vulnerabilities. Sustain development of software using evolutionary approaches to make embedded systems tolerant to unexpected and unforeseen situations. Continue to investigate research concepts and capabilities for cyber survivability techniques and algorithms for counter-unmanned aerial systems. Extend development of a counter-unmanned aerial systems open architecture to enable interoperability. Maintain evolution of autonomous machine learning functions. Continue the validation and demonstration of automated workflows into defensive cyber operations systems. Sustain development of a model-assisted concolic firmware exploration and threat models based on device behavior. Conduct large scale device analysis and demonstration on AF-relevant system. Create a capability to model, intercept, and synchronize the state of all embedded devices connected on a single bus. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $10.793 million. Starting in FY 2022, the work within this PE, under Project 625319, Cyberspace Dominance Technology, in the Advanced Architectures Technologies effort, Survivability Technologies effort, and Cyber Technology for Spectrum Warfare effort, will all be performed within this PE, under Project 625319, Cyberspace Dominance Technology, Cyber Defense Technologies effort.			
Title: Cyber Offense Technologies	17.037	20.121	20.009
Description: Develop offensive cyber operations technologies to access, maintain presence on, and deliver effects to adversary systems. ***FY 2021 Plans:*** Continue to advance research and development of new, leading-edge technologies that are game changing and employ dominant power for cyber offensive operations. Continue increased activity in capabilities for multi-function, non-kinetic cyber effects against adversarial systems. Continue to demonstrate ground-based and airborne delivery of disrupt, deny, degrade, destroy, or deceive effects that are both cyber and physical/kinetic. Initiate implementation of automated extension of attack model. ***FY 2022 Plans:*** Sustain research and development of new, leading-edge technologies that are game changing and employ dominant power for cyber offensive operations. Continue to increase research and development in capabilities for multi-function, non-kinetic cyber effects against adversarial systems. Continue to demonstrate ground-based and airborne delivery of disrupt, deny, degrade, destroy, or deceive effects that are both cyber and physical/kinetic. Maintain the advancement of research in systems to perform blind data discovery associated with the Internet of Things. Advance the identification of items of interest associated with the Internet of Things. Extend research for specific items of interest within the Internet of Things. Complete the Mission tool framework and automated vulnerability discovery framework. ***FY 2021 to FY 2022 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625319 / *Cyberspace Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
FY 2022 decreased compared to FY 2021 by $0.112 million. Justification for the decrease is described in the plans above.			
Title: Advanced Architectural Technologies ***Description:*** Develop the architectural mechanisms that form the basis for predictable software and high assurance systems. ***FY 2021 Plans:*** Continue to sustain research and validation of a cyber-hardened (robust, secure) processor for embedded weapon systems. Continue to maintain applied research to create trusted and resilient embedded systems that are capable of identifying, localizing, and automatically repairing previously unknown and/or unintended vulnerabilities. Continue development of software using evolutionary approaches to make embedded systems tolerant to unexpected and unforeseen situations. ***FY 2022 Plans:*** Starting in FY 2022, this work will be performed within this PE, under Project 625319, Cyberspace Dominance Technology, in the Cyber Defense Technologies effort. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $8.624 million. Starting in FY 2022, this work will be performed within this PE, under Project 625319, Cyberspace Dominance Technology, in the Cyber Defense Technologies effort.	7.689	8.624	0.000
Title: Processing Technologies ***Description:*** Develop automatic and dynamically reconfigurable, scalable, affordable distributed peta-flop processing technologies for real-time global information systems. ***FY 2021 Plans:*** Starting in FY 2021, the non-cyber work will be performed within this PE, under Project 625315, C4I Dominance Technology, in the Processing Technologies effort. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable	4.715	0.000	0.000
Title: Survivability Technologies ***Description:*** Develop methods and technologies for controlled operation of information systems during attacks and fault conditions, minimizing vulnerabilities of cyber attacks, and guaranteeing the accuracy and correctness of data and codes.	3.011	3.989	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625319 / *Cyberspace Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
FY 2021 Plans: Continue to investigate research concepts and capabilities for cyber survivability techniques and algorithms for counter-unmanned aerial systems. Continue development of a counter-unmanned aerial systems open architecture to enable interoperability. Continue with evolution of autonomous machine learning functions. Continue the validation and demonstration of automated workflows into defensive cyber operations systems. ***FY 2022 Plans:*** Starting in FY 2022, this work will be performed within this PE, under Project 625319, Cyberspace Dominance Technology, in the Cyber Defense Technologies effort. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $3.989 million. Starting in FY 2022, this work will be performed within this PE, under Project 625319, Cyberspace Dominance Technology, in the Cyber Defense Technologies effort.			
Title: Cross-Domain Technologies ***Description:*** Develop secure cross-domain discovery services for access to services outside the existing domain. Develop the tools to allow collaboration of workflows required by the Air Force net-centric information management system. ***FY 2021 Plans:*** Continue the research and development in cross-domain solution technologies by developing content filtering, with an emphasis on improving support for rapid inclusion of new data types with minimal requirements for lengthy data type threat assessments and minimal custom coding. Continue research and development for machine to machine interfaces. Continue to extend the development of cross-domain solution command and control capabilities to manage cross-domain solution risks based upon changes in mission and threat for diversified platforms via hardware abstraction, containerization/separation of the operation system (mobile, desktop, server). ***FY 2022 Plans:*** Much of the technology covered under this effort has matured to the level of advanced technology. Starting in FY 2022, the remaining work will be performed within this PE, under Project 625315, C4I Dominance Technologies, in the Assured Communications & Networks effort. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $6.012 million. Starting in FY 2022, this work will be performed within this PE, under Project 625315, C4I Dominance Technologies, in the Assured Communications & Networks effort.	5.944	6.012	0.000
Title: Cyber Technologies for Spectrum Warfare	1.354	3.748	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 625319 / *Cyberspace Dominance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Description: Develop technologies combining electronic warfare, signals intelligence, communications, and cyber technologies that provide synergistic access, exploitation and effects across air and cyber domains in congested and contested environments. ***FY 2021 Plans:*** Continue to advance research in systems to perform blind data discovery associated with the Internet of Things. Continue with identification of items of interest associated with the Internet of Things. Continue research for specific items of interest within the Internet of Things. ***FY 2022 Plans:*** Starting in FY 2022, this work will be performed within this PE, under Project 625319, Cyberspace Dominance Technology, in the Cyber Offense Technologies effort. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $3.748 million. Starting in FY 2022, this work will be performed within this PE, under Project 625319, Cyberspace Dominance Technology, in the Cyber Offense Technologies effort.			
Accomplishments/Planned Programs Subtotals	60.281	63.926	52.234

	FY 2020	FY 2021
Congressional Add: Program Increase- Trusted UAS Traffic Management and c-SUAS Testbed ***FY 2020 Accomplishments:*** Not applicable. ***FY 2021 Plans:*** Conduct congressionally directed efforts.	0.000	0.000
Congressional Adds Subtotals	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602788F / *Dominant Information Sciences and Methods*	Project (Number/Name) 62OMMS / *Research Site Support*	

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
62OMMS: *Research Site Support*	-	21.426	60.184	23.846	0.000	23.846	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The Air Force Research Laboratory Information Directorate leads the discovery, development and implementation of information science and technology to drive transformation within the Department of the Air Force and across the Department of Defense. The focus of the work is to provide the warfighter with the required technology-based capabilities to defend the Nation by unleashing the power of innovative information science and technology to anticipate, find, fix, track, target, engage, and assess anything, anytime, anywhere. Since the site is a single-purpose location which is not located on a military installation, the Information Directorate has unique requirements for supporting its science and technology mission. As the host unit, the directorate is responsible to provide the Rome Research Site infrastructure at Rome, New York and provide for the continued operations of all Rome Research Site properties, buildings, and services necessary for the research mission. Operations include: logistics and communication services, utilities, maintenance of facilities and structures, safety and security of the workforce and visiting researchers, and ensures compliance with the laws, regulations, and directives that pertain to site operations. These services are host unit responsibilities and are necessary to provide a safe and effective environment for the Research Site's workforce and mission.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Rome Research Infrastructure	21.426	23.184	23.846
Description: Provide the necessary services and support including, but not limited to: fire inspections, refuse collection, water, electricity, steam, heat, custodial, and grounds maintenance services to the Research Site. Provide the necessary support for the maintenance and repair of Research Site facilities (buildings and other structures), vehicle and equipment lease and security/ safety inspections and services as necessary for compliance and safety/security of personnel and research assets. Provide the Research Site with long haul communications (using the Government Services Administration set of Networx contracts for Continental United States), trunk connectivity and wireless communications. ***FY 2021 Plans:*** Continue to provide civilian payroll and non-pay costs for installation operations in support of the Rome Research Site property and all onsite personnel. Continue to provide facilities, facility operations, facility sustainment, support equipment, contracts, and associated costs to plan, manage and execute the following functions: fire prevention, disaster preparedness, plant operation and purchase of commodity, refuse collection, pavement clearance of snow and ice, grounds maintenance including landscaping, real property special inspections, pest control, and custodial services. Continue to provide Real Property Management and Engineering Services, including: (1) Facility Management and Administration and (2) Installation Engineering Services. Facility Management includes public works management costs, contract management, material procurement, facility data management, furnishings management costs, and real estate management. Installation Engineering Services includes annual inspection of facilities, master planning, overhead of planning and design, overhead of construction management, and non Site Recovery			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 62OMMS / *Research Site Support*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Management service calls. Continue to provide basic installation communication services, including long haul trunk and telecommunications services. Continue to provide site vehicle lease for logistics, security, and mission support under the Government Services Administration. ***FY 2022 Plans:*** Continue to provide civilian payroll and non-pay costs for installation operations in support of the Rome Research Site property and all onsite personnel. Continue to provide facilities, facility operations, facility sustainment, support equipment, contracts, and associated costs to plan, manage and execute the following functions: fire prevention, disaster preparedness, plant operation and purchase of commodity, refuse collection, pavement clearance of snow and ice, grounds maintenance including landscaping, real property special inspections, pest control, and custodial services. Continue to provide Real Property Management and Engineering Services, including: (1) Facility Management and Administration and (2) Installation Engineering Services. Facility Management includes public works management costs, contract management, material procurement, facility data management, furnishings management costs, and real estate management. Installation Engineering Services includes annual inspection of facilities, master planning, overhead of planning and design, overhead of construction management, and non Site Recovery Management service calls. Continue to provide basic installation communication services, including long haul trunk and telecommunications services. Continue to provide site vehicle lease for logistics, security, and mission support under the Government Services Administration. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.662 million. Justification for the increase is due to additional site support costs as described in the plans above.			
Accomplishments/Planned Programs Subtotals	21.426	23.184	23.846

	FY 2020	FY 2021
Congressional Add: Program Increase- Quantum Cryptography ***FY 2020 Accomplishments:*** Not applicable. ***FY 2021 Plans:*** Conduct congressionally directed efforts. To be executed from Project 625315, C4I Dominance Technology.	0.000	7.000
Congressional Add: Program Increase- Quantum Network Testebed	0.000	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602788F / *Dominant Information Sciences and Methods*	**Project (Number/Name)** 62OMMS / *Research Site Support*

	FY 2020	FY 2021
FY 2020 Accomplishments: Not applicable. ***FY 2021 Plans:*** Conduct congressionally directed efforts. To be executed from Project 625315, C4I Dominance Technology.		
Congressional Add: Program Increase- Quantum Information Science Innovation Center ***FY 2020 Accomplishments:*** Not applicable. ***FY 2021 Plans:*** Conduct congressionally directed efforts. To be executed from Project 625315, C4I Dominance Technology.	0.000	10.000
Congressional Add: Program Increase- trusted UAS traffic management and c-SUAS testbed ***FY 2020 Accomplishments:*** Not applicable. ***FY 2021 Plans:*** Conduct congressionally directed efforts. To be executed from Project 625319, Cyberspace Dominance Technology.	0.000	10.000
Congressional Adds Subtotals	0.000	37.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A