Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Air Force											Date: February 2018	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603788F / *Battlespace Knowledge Development and Demonstration*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	52.274	49.011	51.064	0.000	51.064	56.961	58.628	61.775	63.025	Continuing	Continuing
635319: *Anticipatory OPS Intent and Response*	-	4.000	3.602	6.099	0.000	6.099	6.221	6.344	6.473	6.603	Continuing	Continuing
635320: *Assured Worldwide Connectivity*	-	15.649	12.813	12.658	0.000	12.658	12.278	14.190	14.165	14.454	Continuing	Continuing
635321: *Global Battlespace Awareness*	-	9.600	11.017	11.242	0.000	11.242	14.507	14.156	15.096	15.401	Continuing	Continuing
635322: *Knowledge Management and Computing*	-	4.405	3.369	3.782	0.000	3.782	3.649	2.054	2.093	2.136	Continuing	Continuing
635329: *Cyber Battlespace Dev & Demo*	-	18.620	18.210	17.283	0.000	17.283	20.306	21.884	23.948	24.431	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 Air Force Future Operating Concept established a science and technology challenge 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 by 2035. 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 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.

This program has been coordinated through the Department of Defense Science and Technology 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 program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602601F, 0602602F, 0602605F, 0602788F, 1206601F, and 0602298F.

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 prototypes fro field experiments and/or tests in a simulated environment.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	58.110	49.011	52.995	0.000	52.995
Current President's Budget	52.274	49.011	51.064	0.000	51.064
Total Adjustments	-5.836	0.000	-1.931	0.000	-1.931
• 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	-3.900	0.000			
• SBIR/STTR Transfer	-1.936	0.000			
• Other Adjustments	0.000	0.000	-1.931	0.000	-1.931

Change Summary Explanation

Decrease in FY 2017 due to reprogramming for Hypersonics Science and Technology activities. Decrease in FY 2019 due realignment of funds to focus on Directed Energy Game Changer efforts.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603788F / *Battlespace Knowledge Development and Demonstration*	Project (Number/Name) 635319 / *Anticipatory OPS Intent and Response*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
635319: *Anticipatory OPS Intent and Response*	-	4.000	3.602	6.099	0.000	6.099	6.221	6.344	6.473	6.603	Continuing	Continuing

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 Air Force Future Operating Concept established a science and technology challenge 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 by 2035. 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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Adaptive Planning and Decision Tools	2.366	2.520	1.739
Description: Develop and demonstrate the integration of planning tools and information-based intelligent agents for adaptive replanning and decision support tools. ***FY 2018 Plans:*** Continue to execute experiments, based on operational scenarios, which demonstrate technologies that allow operators at tactical nodes to have the ability to conduct combat planning and tactical assessments of operations during periods of reduced communications with operational level nodes. ***FY 2019 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. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.781 million. Justification for this decrease is described in the plans above.			
Title: Next Generation Planning and Assessment Tools	1.634	1.082	4.360

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635319 / *Anticipatory OPS Intent and Response*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
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. ***FY 2018 Plans:*** Continue to develop software capabilities that employ cyber, directed energy, and electronic warfare weaponry. Refine previously developed models that will give operators and analysts an increased understanding of the second and third order effects of a set of targeting actions. ***FY 2019 Plans:*** 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. Identify and implement state of the art learning models. Develop data-efficient learning. Integrate within the StreamlinedML framework. Develop end-to-end baseline learning capability. Develop model recommendation & user workflow capabilities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $3.278 million. Justification for the increase is due to added emphasis in artificial intelligence and machine learning research to assist assessment and decision making in multiple domains.			
Accomplishments/Planned Programs Subtotals	4.000	3.602	6.099

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603788F / *Battlespace Knowledge Development and Demonstration*	Project (Number/Name) 635320 / *Assured Worldwide Connectivity*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
635320: *Assured Worldwide Connectivity*	-	15.649	12.813	12.658	0.000	12.658	12.278	14.190	14.165	14.454	Continuing	Continuing

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Connectivity Technologies	15.649	12.813	12.658
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 2018 Plans: Continue development and demonstration of a componentized building-block approach for a modular upgradable design for rapid waveform development of multi-mission radio frequency capability. Continue the development and demonstration of a large area multiple-input and multiple-output antenna capabilities.			
FY 2019 Plans: Continue development and demonstration for rapid waveform development of multi-mission radio frequency capability. Continue Wideband high frequency waveform development and testing. Investigate ionospheric research, propagation modeling and simulation. Perform beacon data collection on both the V and W frequency bands along with waveform development and simulation. Perform airborne testing of very low frequency software defined radio. Develop test platform for Common Very Low Frequency Receiver Increment Two. Demonstrate directional networking prototype. Demonstrate the Variable Rate - multiple-input and multiple-output clustered delay line technology and a targeting and force protection operational demonstration of integrated and field tested tactical-to-enterprise information management services.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635320 / *Assured Worldwide Connectivity*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2019 decreased compared to FY 2018 by $0.155 million. Justification for this decrease is described in the plans above.			
Accomplishments/Planned Programs Subtotals	15.649	12.813	12.658

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603788F / *Battlespace Knowledge Development and Demonstration*	Project (Number/Name) 635321 / *Global Battlespace Awareness*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
635321: *Global Battlespace Awareness*	-	9.600	11.017	11.242	0.000	11.242	14.507	14.156	15.096	15.401	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Air Force must be able to process and exploit data and information from a variety of sources and domains to create a common operating picture of the battlespace to allow commanders to maintain information dominance. This project develops, integrates, and demonstrates advanced technologies to achieve comprehensive net-centric operations and Predictive Battlespace Awareness using information from all sources. Technology development includes: tasking information collectors, such as intelligence, surveillance, and reconnaissance (ISR) platforms, national intelligence sources, etc; correlating and geo-registering the collected data; exploiting the data to extract information of military significance; fusing information from multiple sources to create a digital-and-dimensional representation of the battlespace; assessing the situation; predicting adversary courses of action (COA); and archiving the results for ready use by decision-makers. This is a dynamic, complex process that involves technologies for information exploitation, fusion, processing, storage, and retrieval, as well as technologies for machine reasoning, pattern recognition, and timeline analysis.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Signal and Data Exploitation Technologies	3.424	1.049	5.168
Description: Demonstrate advanced signal and data exploitation technologies for detection, tracking, identification, and targeting of time-critical targets, and information extraction. ***FY 2018 Plans:*** Continue to refine and test technologies for ultra-wideband electronics intelligence signal detection and prosecution. Continue to develop and implement speaker similarity tagging to improve model generation, cohort detection methods, and prioritization methods based on acoustics, radio traffic, keywords, and metadata. ***FY 2019 Plans:*** Continue to refine and test technologies for ultra-wideband electronics intelligence signal detection and prosecution. Demonstrate enhanced emitter feature extraction capabilities. Demonstrate automated electronics intelligence analysis tool sets. Complete development, integrate, and demonstrate cyber-physical measurement and signature intelligence capabilities with the Twenty-Fifth Air Force and United States Special Operations Command as transition partners. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $4.119 million. Justification for the increase is due to additional work required for demonstration of capability in operational setting to Twenty-Fifth Air Force and Special Operations Command.			
Title: Advanced Data Handling, Visualization and Distributed Data Fusion	3.525	6.829	4.363

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635321 / *Global Battlespace Awareness*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Develop and demonstrate advanced data handling, event visualization technologies, and distributed data fusion to enable a more effective utilization of data available. ***FY 2018 Plans:*** Continue development and demonstration of Activity Based Intelligence analysis capabilities from multiple intelligence sources for both near-real time and post mission. Continue to develop near-real time data mining and analysis capabilities by incorporating automated knowledge discovery, pattern learning, modeling and reasoning, and data fusion, exploitation, and processing. Continue to demonstrate the distributed multi-node multi-source intelligence processing, exploitation, and dissemination software framework capabilities compared to current methods for multi-source intelligence data mining, correlation, and fusion analytics. Initiate the automation of collected audio data for enhanced exploitation. ***FY 2019 Plans:*** 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. Demonstrate Seeded Language Modeling demonstration. Advance investigations of real-time deep learning algorithms. Perform service-based capability development. Complete cloud based data and information sharing environment. Continue with Object Based Production optimized processing and automated-association capability. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $2.466 million. Justification for the decrease is due to additional investment required within Advanced Signal and Data Exploitation demonstration.			
Title: Autonomous Text Exploitation	1.428	1.982	0.000
Description: Develop and demonstrate capabilities for reasoning and learning, text understanding, link and group discovery, and advanced analysis for situational awareness and understanding. ***FY 2018 Plans:*** Continue the development and demonstration of capabilities that enable automated text data extraction and exploitation. Continue development and demonstration of software tools and techniques that will fuse textual and non-textual information sources to increase semantic understanding. Continue research and development social media analytics tools and techniques for increased text understanding, as well as large scale, time dependent, network based analytics. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635321 / *Global Battlespace Awareness*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
For FY 2019 and beyond, work accomplished under this effort will be reported in Project 635321, Global Battlespace Awareness, under the Thrust "Advanced Signal and Data Exploitation Technologies". ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $1.982 million. Justification for the decrease is due to additional investment required within Advanced Signal and Data Exploitation demonstration.			
Title: Adversary Courses of Action ***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. ***FY 2018 Plans:*** Continue to develop and demonstrate kinetic and non-kinetic, full-spectrum targeting software tools that will semi-automatically extract and visualize relationships within target system; automatically prioritize/rank targets based on identified relationships; and semi-automatically update understanding of the target system analysis when new batches of reports arrive. ***FY 2019 Plans:*** Continue development and demonstration of full-spectrum targeting and intelligence software tools. Perform operational testing and experimentation on developed semantic capabilities and provide a cross-organization work-flow within intelligence and targeting software. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.554 million. Justification for this increase is described in the plans above.	1.223	1.157	1.711
Accomplishments/Planned Programs Subtotals	9.600	11.017	11.242

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603788F / *Battlespace Knowledge Development and Demonstration*	Project (Number/Name) 635322 / *Knowledge Management and Computing*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
635322: *Knowledge Management and Computing*	-	4.405	3.369	3.782	0.000	3.782	3.649	2.054	2.093	2.136	Continuing	Continuing

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 Air Force Future Operating Concept established a science and technology challenge 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 by 2035. 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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Information Management	4.405	3.369	3.782
Description: Demonstrate how a publish, subscribe, and query information management paradigm can enable vertical and horizontal integration of Air Force information systems.			
FY 2018 Plans: Continue plans to develop, demonstrate and transition information management capabilities that securely bridge the gaps between enterprise and tactical domains for increased shared situational awareness across the theater of war for targeting and force protection operations. Focus will be on vulnerability assessments of the developed software, and, on field testing, technology integration, testing, and maturation. Continue the development, transition and delivery of new technologies in the form of plugins and include security for bulk data at rest to deliver full functionality for Air Force Special Operations Command Special Tactics mission sets so that special tactics operators can have superior situational awareness and communications.			
FY 2019 Plans: Continue plans to develop, demonstrate and transition information management capabilities that securely bridge the gaps between enterprise and tactical domains for increased shared situational awareness across the theater of war for targeting and force protection operations. Continue with capability enhancements and technology hardening based on operational			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635322 / *Knowledge Management and Computing*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
user assessments and collaboration. Execute a Technology Readiness Level 6 targeting and force protection operational demonstration of integrated and field tested tactical-to-enterprise information management services. Improve and update runway survey toolkit plug-in to aid aircraft runway surveys in austere locations. Spearhead geo-location capabilities in Global Positioning System denied environments using elevation, formations, and constellations. Ensure transition and hand-off special tactics plug-ins with Air Force Life Cycle Management Center support to the Battlefield Airman System Program Office. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.413 million. Justification for this increase is described in the plans above.			
Accomplishments/Planned Programs Subtotals	4.405	3.369	3.782

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603788F / *Battlespace Knowledge Development and Demonstration*	Project (Number/Name) 635329 / *Cyber Battlespace Dev & Demo*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
635329: *Cyber Battlespace Dev & Demo*	-	18.620	18.210	17.283	0.000	17.283	20.306	21.884	23.948	24.431	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 Air Force Future Operating Concept established a science and technology challenge 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 by 2035. 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.

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, 0602601F, 0602602F, 0602605F, 0602788F, 1206601F, and 602298F.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Cyber Offense	5.132	3.241	3.928
Description: Develop and demonstrate offensive cyber operations capabilities in a series of experimental technology demonstrations.			
FY 2018 Plans: Adapt and demonstrate technologies to remain current with new waveforms and signals. Continue development and demonstration of software that holds adversary threats at risk by exploiting the electromagnetic spectrum, and other signals of interest, for access and mission effects. Continue performing cyber vulnerability assessments to strengthen the security of the developed software.			
FY 2019 Plans: Continue to develop systems to identify items of interest associated with the Internet of Things. Facilitate the development of a counter small unmanned aerial system open architecture specification to enable interoperability between disparate protection			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635329 / *Cyber Battlespace Dev & Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
systems. Demonstrate ground-based and airborne delivery of mitigation (disrupt, deny, degrade, destroy, or deceive) effects, both cyber and physical/kinetic. Integrate and transition multiple Air Force Research Laboratory and Air Force Lifecycle Management Center counter small unmanned aerial system capabilities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.687 million. Justification for this increase is described in the plans above.			
Title: Effects-based Cyber Defense ***Description:*** Integrate technology to demonstrate an effects-based strategic approach to cyber defense that focuses on avoiding, deterring, and minimizing the threat, and rendering the adversary ineffective. ***FY 2018 Plans:*** Complete development and demonstration of technologies for the proactive control of cyber defenses that integrate with existing mission assurance framework(s) in a relevant environment. Complete the integration of cyber capabilities with existing intelligence, surveillance, and reconnaissance systems in a relevant environment. Demonstrate these technologies in relevant environments, such as the Cyber Experimentation Environment. This technology thrust completes its capability development in FY 2018. ***FY 2019 Plans:*** This technology thrust will have completed its capability development in FY 2018. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $4.084 million. Justification for the decrease is due to the completion of capability development within this Thrust in FY 2018.	5.029	4.084	0.000
Title: Resiliency ***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. ***FY 2018 Plans:*** Continue to develop and evolve software capabilities and Concept of Operations for active guidance and automated processes addressing cyber resiliency and survivability using a relevant system laboratory. Continue to develop effective red teaming techniques that sufficiently assess detection capabilities for mission-level critical events. Continue to develop and demonstrate ground vehicle protection prototype for automotive cyber-security. Continue development of mission monitoring components, analytics engine, and command and control technology integration. ***FY 2019 Plans:***	3.637	6.997	7.464

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635329 / *Cyber Battlespace Dev & Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Continue to develop and evolve software capabilities and Concept of Operations for active guidance and automated processes addressing cyber resiliency and survivability using a relevant system laboratory. Continue capability migration to form factors which more readily align with operational systems. Demonstrate automated cyber survivability using integrated cyber technologies within the operational system laboratory in the context of risk management framework requirements. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.467 million. Justification for this increase is described in the plans above.			
Title: Game Changing Computing Power ***Description:*** Develop and demonstrate computer architectures with greater capacity and sophistication to enable game-changing computing power to the warfighter anywhere, anytime. ***FY 2018 Plans:*** Develop and demonstrate real-time neuromorphic computing architecture simulation framework. Conduct the first spiral demonstration of the inherently trusted and resilient architectures, mature for integration into a realistic operational environment. Continue development and demonstration of embedded computing pod in the field on a test platform with real-time processing and communication concepts. ***FY 2019 Plans:*** Continue the development of inherently trusted and resilient embedded computing. Improve software specifications using evolutionary approaches and make them inherently tolerant to the unexpected or unforeseen. As part of a trusted and resilient architecture, test and document the secure processor (T-CORE) cyber defenses and other features. Provide support to transition partners and application programmers or the T-CORE specification. Release T-CORE version 2. Continue with Robust Machine Learning upgrades and development. 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 that is used to support the mission and fight through zero day attacks that exploit these vulnerabilities to cause harm and/or failure to the mission. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $2.116 million. Justification for the increase is due to additional development work required for the secure processor release and autonomous vehicle demonstration.	3.225	2.663	4.779
Title: Autonomous, Multi-level Access and Transfer ***Description:*** Develop autonomous, secure information access and sharing capabilities required by the Air Force net-centric information enterprise.	1.597	1.225	1.112

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603788F / *Battlespace Knowledge Development and Demonstration*	**Project (Number/Name)** 635329 / *Cyber Battlespace Dev & Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Continue development and prototype development of advanced cross domain solutions. Refine interfaces and techniques to enforce cross-domain solutions compliance with machine to machine interface specifications to enable cross-domain enablement of machine to machine communications more robust and effective. Demonstrate and prototype multi-level security access solutions, including commercial-off-the-shelf mobile technologies as the basis for secure multi-level collaboration. ***FY 2019 Plans:*** Continue to develop and integrate a polyglot file identification filter to mitigate data exfiltration risk. Continue to develop a modularized filter store to maximize filter re-usability and increase the agility of cross-domain solutions to support new file types. Demonstrate a Commercial Solution for Classified compliant secure mobile solution that can enforce security policies beyond commercial solutions to satisfy unique Air Force requirements. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.113 million. Justification for this decrease is described in the plans above.			
Accomplishments/Planned Programs Subtotals	18.620	18.210	17.283

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.