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 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*							
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	-	160.339	152.782	166.534	0.000	166.534	174.632	180.724	185.126	177.980	Continuing	Continuing
622002: *Electronic Component Technology*	-	44.522	38.522	43.633	0.000	43.633	44.486	47.742	48.991	47.749	Continuing	Continuing
622003: *EO Sensors & Countermeasures Tech*	-	21.451	24.473	28.820	0.000	28.820	31.600	32.175	32.737	31.275	Continuing	Continuing
622005: *Cyber Technology*	-	10.120	6.428	6.196	0.000	6.196	6.394	6.497	6.605	6.218	Continuing	Continuing
626095: *Sensor Fusion Technology*	-	34.807	32.370	32.281	0.000	32.281	33.824	34.400	37.290	35.289	Continuing	Continuing
627622: *RF Sensors and Countermeasures Tech*	-	49.439	50.989	55.604	0.000	55.604	58.328	59.910	59.503	57.449	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops the technology base for Air Force aerospace sensors and electronic combat. Advances in aerospace sensors are required to increase combat effectiveness by providing anytime, anywhere surveillance, reconnaissance, precision targeting, and electronic warfare (EW) capabilities. To achieve this progress, this program pursues simultaneous advances in: 1) generating, controlling, receiving, and processing electronic and photonic signals for radio frequency (RF) sensor aerospace applications; 2) electro-optical (EO) and infrared (IR) aerospace sensor technologies for a variety of offensive and defensive uses; 3) RF antennas and associated electronics for airborne and space surveillance, together with active and passive EO/IR sensors; 4) technologies to manage and fuse on-board sensor information for timely, comprehensive situational awareness; 5) technology for affordable, trusted, and reliable, all-weather surveillance, reconnaissance, and precision strike RF sensors and electronic combat systems; and 6) technologies that aid in the discovery and mitigation of cyber vulnerabilities in avionics systems. 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, 0602601F, 0602602F, 0602605F, 0602788F, 1206601F and 0602298F.

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 2019 Air Force	Date: February 2018
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	155.174	152.782	151.000	0.000	151.000
Current President's Budget	160.339	152.782	166.534	0.000	166.534
Total Adjustments	5.165	0.000	15.534	0.000	15.534
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	7.500	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-0.647	0.000			
• SBIR/STTR Transfer	-1.688	0.000			
• Other Adjustments	0.000	0.000	15.534	0.000	15.534

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 622002: *Electronic Component Technology*		
Congressional Add: *Program Increase - electronic component technology*	3.949	0.000
Congressional Add Subtotals for Project: 622002	3.949	0.000
Project: 627622: *RF Sensors and Countermeasures Tech*		
Congressional Add: *Program Increase - Spectrum Monitoring*	3.455	0.000
Congressional Add Subtotals for Project: 627622	3.455	0.000
Congressional Add Totals for all Projects	7.404	0.000

Change Summary Explanation

Increase in FY 2019 due to Department of Defense civilian pay repricing adjustment and realignment of Sensors Science and Technology (S&T) Advanced Technology Development activities to Sensors S&T Applied Research.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 622002 / *Electronic Component Technology*	

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
622002: *Electronic Component Technology*	-	44.522	38.522	43.633	0.000	43.633	44.486	47.742	48.991	47.749	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on electronics and optoelectronics technologies that generate, control, receive, and process electromagnetic spectrum for aerospace sensor and electronic warfare (EW) applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance, EW, battlespace access, and precision engagement capabilities. The technologies developed include exploratory electronic and optoelectronic devices, components, microsystems and subsystems.

This project also assesses designs, develops, fabricates, and demonstrates the associated technologies for integrating combinations of these component technologies. The project aims to demonstrate significantly smaller size, lower weight, lower cost, lower power dissipation, higher reliability, trustworthiness and improved performance. The device and subsystem technology developments under this project are military unique; they are based on Air Force and other Department of Defense weapon systems requirements in the areas of radar, communications, EW, navigation, and smart weapons.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Sensor Subsystems	9.779	9.284	10.033
Description: Develop, analyze, demonstrate, and perform engineering trade studies for technologies for compact, affordable, multi-function subsystems for aerospace sensors. This effort is being renamed from Multifunction Sensor Subsystems to better align project and thrusts with funding in functional areas. ***FY 2018 Plans:*** Complete first demonstration of affordable, miniature multifunction prototype. Continue to refine models and simulations through updated technology and microsystem/subsystem performance and cost models. Initiate digital beamforming demonstration using Arrays at Commercial Timescales modules. Initiate development of subsystem prototypes for attritable platforms. ***FY 2019 Plans:*** Complete demonstration of models and simulations for low-cost, multi-function radio frequency subsystems. Complete digital beamforming demonstration. Continue the development of subsystem prototypes for attritable platforms. Initiate demonstration of low-cost on-board sensor processing subsystem. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.749 million. Justification for this increase is described in plans above.			
Title: Electronic Devices	10.778	10.242	7.738

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Assess, research, develop, demonstrate and transition revolutionary and evolutionary electronic devices and their associate technologies. This effort is being renamed from Microelectronic/Optoelectronic Technologies to better align project and thrusts with funding in functional areas. ***FY 2018 Plans:*** Continue to refine tools and methods to design, build, and analyze game changing component technologies. Continue evaluation of emerging component technologies against device concept baseline for multi-use applications. Initiate development of prototypes from identified emerging device concepts. Continue wide-bandgap device technology development for power generation and management. Continue demonstration of models for high-performance, high-frequency, millimeter-wave device technologies for power amplification. Continue commercialization of Air Force foundry process to industry. Continue wide-bandgap device technology development for power generation and management. ***FY 2019 Plans:*** Continue to refine tools and methods to design, build, and analyze game changing component technologies. Continue evaluation of emerging component technologies against device concept baseline for multi-use applications and continue development of prototypes from identified emerging device concepts. Continue wide-bandgap device technology development for power generation and management. Complete demonstration of models for high-performance, high-frequency, millimeter-wave device technologies for power amplification. Complete commercialization of Air Force foundry process to industry. Continue wide-bandgap device technology development for power generation and management. Initiate high-voltage L and S-Band power amplifier demonstration. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $2.504 million. Decrease is due to the renaming/realignment of the thrusts in Project 622002, Electronic Component Technology.			
Title: Electro-Optical/Infrared (EO/IR) Components	5.750	5.454	9.271
Description: Research, develop, demonstrate and transition EO/IR components for next generation intelligence, surveillance, reconnaissance (ISR) and countermeasures. This effort is being renamed from Apertures to better align project and thrusts with funding in functional areas. ***FY 2018 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Complete gimbal-less beamsteering prototype. Continue to explore and evaluate innovative materials and devices for tunability, increased bandwidth and multi-wavelength operation. Initiate compact, tunable, laser source prototype. ***FY 2019 Plans:*** Continue to explore and evaluate innovative materials and devices for tunability, increased bandwidth and multi-wavelength operation. Continue compact, tunable, laser source prototype. Complete demonstration of first generation reconfigurable focal plane array. Continue to develop a semiconductor optomechanical oscillator. Initiate demonstration of high pulse power midwave IR laser source. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $3.817 million. Increase is due to the renaming/realignment of the thrusts in Project 622002, Electronic Component Technology as well as the realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors S&T Applied Research.			
Title: Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Systems	6.569	6.232	9.797
Description: Investigate and develop designs of trusted electronic and optoelectronic systems when integrating commercially available solutions commercial-off-the-shelf with emerging government-off-the-shelf advanced technologies. Areas of development include: multi-function radio frequency and electro-optical subsystems, advanced electronic and optoelectronic materials, on-board sensor processing, high-frequency power modules, electro-optical/infrared sources, electro-optical/infrared detectors, beam control and waveguides, and trusted and reliable electronics. This effort is being renamed from Trusted Systems for intelligence, surveillance, reconnaissance to better align project and thrusts with funding in functional areas. ***FY 2018 Plans:*** Continue to refine demonstration of trust in design and trust in fabrication. Continue modeling and simulation architecture development to inform and predict mission assurance for highly integrated microsystems, devices and materials. Initiate development of prototype trustworthiness assessment capability. ***FY 2019 Plans:*** Complete initial demonstration of trust in design and trust in fabrication. Complete baseline modeling and simulation architecture development to inform and predict mission assurance for highly integrated microsystems, devices and materials. Continue development of prototype trustworthiness assessment capability. Initiate reliability assessments of advanced heterogeneously integrated microsystems. ***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 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2019 increased compared to FY 2018 by $3.565 million. Increase is due to the renaming/realignment of the thrusts in Project 622002, Electronic Component Technology as well as the realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors S&T Applied Research.			
Title: Advanced Highly Integrated Microsystems for Intelligence, Surveillance, Reconnaissance and Electronic Warfare ***Description:*** Develop, mature, and demonstrate critical electronic technologies to enable revolutionary electronic warfare subsystems. This effort is being renamed from Advanced Components for Electronic Warfare to better align project and thrusts with funding in functional areas. ***FY 2018 Plans:*** Complete reconfigurable and agile radio frequency front end prototype. Continue development of highly-reconfigurable microsystem prototype. Continue investigation and development of integrated photonic circuit prototype. Initiate assessment of commercial microsystem fabrication techniques to militarily-relevant electronics and optoelectronics. ***FY 2019 Plans:*** Complete demonstration of highly-reconfigurable microsystem prototype. Complete baseline demonstration of militarily relevant integrated photonic circuit prototype. Complete assessment of microsystem fabrication techniques to militarily-relevant electronics and optoelectronics. Initiate development and demonstration of integrated wideband and adaptable transceiver microsystem. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.516 million. Justification for this decrease is described in plans above.	7.697	7.310	6.794
Accomplishments/Planned Programs Subtotals	40.573	38.522	43.633

	FY 2017	FY 2018
Congressional Add: Program Increase - electronic component technology ***FY 2017 Accomplishments:*** Conducted congressionally directed effort. ***FY 2018 Plans:*** Not Applicable	3.949	0.000
Congressional Adds Subtotals	3.949	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

C. Other Program Funding Summary ($ in Millions)

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 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 622003 / *EO Sensors & Countermeasures Tech*	

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
622003: *EO Sensors & Countermeasures Tech*	-	21.451	24.473	28.820	0.000	28.820	31.600	32.175	32.737	31.275	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced electro-optical (EO) aerospace sensor technologies for a variety of offensive and defensive uses. The sensor technologies under development range from the ultraviolet through the infrared portion of the spectrum. Related efforts include improvements in avionics integration, digital processing, analysis tools, and sensor architectures. One of the project's main goals is to improve EO and related technologies for the detection, tracking, and identification of non-cooperative and difficult targets, such as those obscured by camouflage or acquired at great range. This project also develops the passive and active imaging sensors and algorithms needed to enable precision targeting in severe weather. These technologies are critical to future aerospace surveillance and targeting. Other project goals include advanced EO threat warning and countermeasures.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Passive Electro-Optical/Infrared Sensing in Contested Environments	7.150	8.157	13.674
Description: Develop innovative passive optical sensing technology to support surveillance and reconnaissance in contested environments. Develop high performance focal planes, aperture technologies, sensing architectures, and imaging techniques capable of long range target detection and characterization for intelligence, surveillance, reconnaissance and air-to-air sensing.			
FY 2018 Plans: Continue to evaluate, via component and subsystem laboratory testing, innovative sensor concepts to increase long range image quality for high altitude passive electro-optical and infrared reconnaissance sensors. Continue and advance demonstrations of the effectiveness of computational image restoration and noise reduction. Assess non-traditional sensor architectures for improving image quality and the operational range of passive imagers for potential prototyping and laboratory test. Demonstrate technologies and components supporting longwave infrared hyperspectral imaging. Select promising technology options for hyperspectral imaging on small unmanned aircraft systems and advance their technology readiness level. Continue next generation infrared search and track architecture and component development to improve system performance in clutter. Test these component prototypes in a laboratory environment. Improve passive sensing models to support infrared search and track technology trade analyses. Examine potential new capabilities resulting from a systems engineering strategy on cross domain electro-optical sensing for Air Force relevant missions. Initiate incorporation of sensor-specific modeling and simulation results into larger engagement level and campaign level simulations to explore new concepts.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622003 / *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Develop an enhanced midwave infrared imaging upgrade to a fielded reconnaissance sensor. Show performance improvements using appropriate sensor and component technology models. Fabricate and test in a laboratory environment, an electro-optical sensor fore-optic based on novel concepts in optical engineering. Develop and implement the necessary optical metrology capability to support laboratory testing of the novel optics. Continue development of novel computational techniques for image restoration and noise reduction. Demonstrate the most promising candidates in a virtual environment. Complete and test in a laboratory environment, a pathfinder for small size, weight and power hyperspectral imaging for a small unmanned aircraft system. Generate appropriate sensor models to adequately explore performance in a virtual environment. Explore and develop signal processing and data processing algorithms needed to enhance the capabilities of the novel sensor hardware. Refine passive sensing computer models to support infrared search and track technology trade analyses. Generate models for new sensor architectures and examine potential new capabilities resulting from a systems engineering strategy on cross domain electro-optical sensing for Air Force relevant missions using broad capability computer simulations, including engagement level and campaign level simulations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $5.517 million. Increase is due to realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.			
Title: Laser Radar Sensing in Contested Environments ***Description:*** Develop innovative laser sensing technology for non-cooperative identification of airborne and ground-based targets in contested environments. Develop optical spectrum transmitters, detectors and agile aperture technologies capable of sensing multiple target characteristics for robust non-cooperative target identification and future infrared countermeasure systems. ***FY 2018 Plans:*** Complete testing of next generation long range holographic aperture laser radar imaging testbed focused on progression to platform compatible configurations. Complete laboratory testing of initial foundry runs of focal planes optimized for holographic imaging. Continue research on components needed for improving synthetic aperture laser radar system capabilities to provide target identification at standoff. Test in laboratory integrated direct detection ladar prototype and advance its technology readiness level. Conduct laboratory tests of candidate holographic aperture ladar techniques for enhancing spatial resolution beyond the diffraction limit of conventional optics while promoting platform-compatible architectures in a laboratory environment. Continue tests of prototype remote laser vibrometry and range-Doppler sensing technology to aid in target identification. Enhance emphasis of vibrometry signal processing refinement and on the development of automated signal recognition. Initiate investigation of advanced system architectures and evaluate candidates. This additional emphasis will involve both direction	14.301	16.316	15.146

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622003 / *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and synthetic aperture ladar approaches. Continue assessment of technology options for laser radar based three-dimensional imaging on small unmanned aircraft system for Air Force relevant missions. ***FY 2019 Plans:*** Test, in a laboratory environment, a distributed aperture laser radar system for imaging at long ranges, beyond the diffraction limit of the available individual apertures. Assess the architecture's limitations and its potential for implementation on current Air Force sensor pods and aircraft internal integration. Demonstrate the use of a holographic laser radar sensor for wavefront sensing and examine its potential for applications where wavefront sensing is a limitation. Continue development of a reduced size, weight and power laser amplifier suitable for laser radar applications such as synthetic aperture ladar and unmanned aircraft systems based active sensing. Enhance efforts to develop an end-to-end laser system computer model. Integrate the software with other system-level models. Continue component development for low cost, low size, weight and power laser radar suited for implementation on an unmanned aircraft system. Analyze potential system improvements brought about by enhanced components through computer modeling and laboratory test. Continue tests of prototype remote laser vibrometry and range-Doppler sensing technology to aid in target identification. Examine utility of candidate automated signal recognition software. Continue investigation of advanced system architectures and evaluate candidates. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $1.170 million. Decrease is due to realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.			
Accomplishments/Planned Programs Subtotals	21.451	24.473	28.820

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 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 622005 / *Cyber Technology*	

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
622005: *Cyber Technology*	-	10.120	6.428	6.196	0.000	6.196	6.394	6.497	6.605	6.218	Continuing	Continuing

A. Mission Description and Budget Item Justification

Work from this effort was previously performed under Project 627622, RF Sensors and Countermeasures Tech.

This project focuses on technologies for cyber security and resilience of Air Force weapon systems. First, this project improves our understanding of avionics cyber vulnerabilities by investigating the fundamental nature of avionics vulnerabilities including: how they come about, how they can be discovered, how they can be quantified and categorized, how they can be exploited, and how they can be removed or mitigated to secure the system. Second, this project aims to develop adaptable and resilient hardware/software for real-time avionics cyber-attack pattern recognition and develop a protection system with the capability for autonomous learning, adaptation, and self-protection. Lastly, this project investigates open architecture concepts and technologies to deliver capability flexibility to Air Force avionics and weapon systems. These technologies are matured via integrated capability demonstrations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Vulnerability Mitigation	4.418	2.806	2.704
Description: Apply knowledge from computer vulnerability discovery and computer security to investigate capabilities for identifying and mitigating vulnerabilities in United States avionics systems resulting from software and/or hardware deficiencies. Develop automated and cost effective processes, techniques and technologies to assist in the identification of potential vulnerabilities.			
FY 2018 Plans: Based on classes of vulnerabilities identified in FY 2017 efforts and the characterized hardware: Investigate means to automate and make scalable vulnerability assessment tools and techniques. Investigate systematic methodologies to achieve repeatable and reliable cyber test to expand our understanding of root causes of avionics vulnerabilities. Investigate and apply our insights to evaluate feasibility of new capability concepts on next generation avionics architectures designed from a secure foundation.			
FY 2019 Plans: Continue to investigate means to automate and make scalable vulnerability assessment tools and techniques. Continue to investigate systematic methodologies to achieve repeatable and reliable cyber test to expand our understanding of root causes of avionics vulnerabilities. Investigate and apply our insights to evaluate feasibility of new capability concepts on next generation avionics architectures designed from a secure foundation. Begin transition from hands-on legacy platform assessment and tool development to developing guidelines, methodologies, and technologies for cyber hardening and resilience.			
FY 2018 to FY 2019 Increase/Decrease Statement: FY 2019 decreased compared to FY 2018 by $0.102 million. Justification for this decrease is described in plans above.			
Title: Adaptive Cyber Protections	5.702	3.622	3.492

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622005 / *Cyber Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Develop avionics protection tools and capabilities to enable manned and unmanned aircraft, avionics, and related support equipment to automatically adapt to and withstand cyber attacks. Research and develop tools, methodologies and architecture guidelines that enable the design of avionics systems with sense, learn and adapt capabilities. ***FY 2018 Plans:*** Continue avionics protections research into real-time software/hardware monitoring tools. Apply these techniques to next-generation intelligence, surveillance and reconnaissance and avionics system architectures to investigate avionics malware detection and response protection system. ***FY 2019 Plans:*** Continue investigations into platform-independent malware feature selection capability. Investigate automation and optimization of malware detection and classification work using machine learning techniques. Investigate adaptable cyber protections and technologies to achieve cyber resilience in avionics systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.130 million. Justification for this decrease is described in plans above.			
Accomplishments/Planned Programs Subtotals	10.120	6.428	6.196

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 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 626095 / *Sensor Fusion Technology*	

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
626095: *Sensor Fusion Technology*	-	34.807	32.370	32.281	0.000	32.281	33.824	34.400	37.290	35.289	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops the technologies required to perform management and fusion of sensor information for timely, comprehensive situational awareness, automatic target recognition, integrated fire control, and bomb damage assessment. This project determines the feasibility of technologies and concepts for fire control that help to precisely locate, identify, and target airborne and surface targets. The project emphasizes finding reduced signature targets and targets of opportunity. It will enable new covert tactics for successful air-to-air and air-to-surface strikes. This project also develops the technologies required to create trusted autonomic, distributed, collaborative, and self-organizing sensor systems that provide anticipatory intelligence, surveillance and reconnaissance, situational awareness, and decision support for multi-layered sensing. This program provides the technologies for: 1) trusted sensors and trusted sensor systems that will deter reverse engineering and exploitation of our critical hardware and software technology and impede unwanted technology transfer, alteration of system capability, and prevent the development of countermeasures to United States systems; 2) collaborative tasking of our own distributed heterogeneous sensor networks across a region and co-opted tasking of both traditional and non-traditional adversary sensors; 3) secure sensor web backbone technologies, sensor web physical topologies, and related protocols to assure reliable trusted sensor interactions; and 4) defining architectures for distributed trusted collaborative heterogeneous sensor systems and semantic sensor networks, developing new methodologies for system of systems sensor engineering and analysis, and new techniques for sensor network situation awareness and predictive analytics.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Target Signature Modeling	4.847	4.508	4.496
Description: Develop, evaluate, and demonstrate target signature models to support sensor exploitation algorithm development and testing for reconnaissance and strike mission applications. ***FY 2018 Plans:*** Develop space-time alignment with synthetic multi-sensor target primitive data. Initiate development of multi-sensor feature level fusion for stationary target identification. ***FY 2019 Plans:*** Continue development and initiate experimentation for multi-sensor feature level fusion for stationary target identification. Demonstrate space-time alignment with measured multi-sensor target primitive data with in-house multi-sensor test bench. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.012 million. Justification for this decrease is described in plans above.			
Title: Sensor Exploitation Technologies	7.395	6.877	6.858
Description: Develop technical methods required for algorithm performance models, performance driven sensing, layered sensing and other sensing and exploitation technologies impacted by automated exploitation capabilities.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 626095 / *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Continue development of adaptive deep learning synthetic aperture radar target identification algorithms with more challenging conditions, including decoy rejection. Develop decision level fusion methodology conditioned on operating conditions and feature dependencies. ***FY 2019 Plans:*** Develop optimized high performance computing-based deep learning synthetic aperture radar and electro-optical/infrared algorithm training process. Continue development of a closed-loop sensor mode controller for adaptive transmit and receive. Initiate development of methodology for feature level fusion within a single modality. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.019 million. Justification for this decrease is described in plans above.			
Title: Sensor Management for Automatic Target Recognition ***Description:*** Develop multi-platform and multi-sensor control strategies to create advantages for survival, autonomous sensing, and autonomous exploitation in contested environments. Incorporate sensing platform kinematics and external operating conditions into analyses of effective multi-sensor control and multiple intelligence data fusion capabilities. Assess advantages of multi-sensor closed loop control techniques for platform survival, command and control, intelligence, surveillance and reconnaissance, and strike missions. Enhance existing automatic target recognition sensor management, and sensor fusion technologies by application of multi-sensor data and distributed data processing. ***FY 2018 Plans:*** Conduct an initial multi-domain intelligence, surveillance and reconnaissance processing, exploitation and dissemination analysis. Conduct live demonstration of decentralized asset management with real and synthetic unmanned aerial vehicles to include target identification, passive geolocation, and context-sensitive target prioritization. Develop modeling and simulation space and remote sensing toolbox. Develop initial adaptive representation algorithm to test in simulation. ***FY 2019 Plans:*** Conduct enhanced multi-domain intelligence, surveillance and reconnaissance processing, exploitation and dissemination analysis. Develop electronic warfare/cyber effects toolbox. Demonstrate in simulation reasoning and replanner selection using multiple replanners and architectures. Initiate development of adaptive representation algorithms for high level information sharing. Initiate development a general framework for joint inference and control with arbitrary sensors. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.046 million. Justification for this decrease is described in plans above.	17.649	16.413	16.367
Title: Distributed Sensing for Automatic Target Recognition	4.916	4.572	4.560

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 626095 / *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Develop techniques and metrics for adaptive, penetrating, distributed radio frequency exploitation in contested environments. ***FY 2018 Plans:*** Continue to develop bi-static phenomenology models. Demonstrate new waveforms to exploit bi-static radio frequency phenomenology. Continue to develop a systems theory for incorporating identification uncertainty in automatic target recognition algorithms. Demonstrate distributed exploitation algorithms on prior data collections. Continue to design a closed-loop sensor mode controller for adaptive transmit and receive. ***FY 2019 Plans:*** Investigate transition opportunities for real-time processing of bistatic air-to-ground moving target indication algorithms. Investigate transition opportunities for algorithms for imaging and identifying moving targets using geometric invariance. Continue to develop alternative algorithms for non-template-based synthetic aperture radar automatic target recognition exploitation. Plan bistatic X-band data collection with a moving receiver to demonstrate algorithms to exploit bistatic synthetic aperture radar data with unknown parameters in non-cooperative environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $0.012 million. Justification for this decrease is described in plans above.			
Accomplishments/Planned Programs Subtotals	34.807	32.370	32.281

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 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 627622 / *RF Sensors and Countermeasures Tech*	

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
627622: *RF Sensors and Countermeasures Tech*	-	49.439	50.989	55.604	0.000	55.604	58.328	59.910	59.503	57.449	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable all weather radio frequency sensing and countermeasure concepts for aerospace applications covering the range of radio frequency sensors including communications, navigation, intelligence, surveillance and reconnaissance (ISR), and radar, both active and passive, across the air, land, sea, space and cyber domains. This project also develops and evaluates technology for ISR sensors, fire control radars, electronic warfare, integrated radar and electronic warfare systems, and offensive information operations systems. It emphasizes the detection and tracking of surface and airborne targets with radio frequency signatures that are difficult to detect due to reduced radar cross sections, concealment and camouflage measures, severe clutter, or heavy jamming. Techniques exploited include the use of multiple radio frequency phenomenologies, multi-dimensional adaptive processing, advanced waveforms and knowledge-aided processing techniques. This project also develops concepts to counter threats to our aerospace systems. It develops and evaluates technology for electronic warfare, integrated radar and electronic warfare systems, and electro-optical/infrared seeker defeat. This project develops the radio frequency warning and countermeasure technology for advanced electronic warfare and information operations applications. The project also explores technologies to maintain a military advantage in position navigation and timing integrity, accuracy, and resiliency.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Hybrid Sensor Technologies	10.151	11.256	13.069
Description: Develop hybrid sensor solutions to be responsive to needs and detect difficult targets. Develop resilient position, navigation and timing sensors. Explore position, navigation and timing solutions to enable novel distributed radio frequency sensing and countermeasure techniques. Develop technology base to provide solutions addressing threats that exploit multiple sensor phenomenologies.			
FY 2018 Plans: Conduct research to provide optimal frameworks for hybrid navigation sensor integration and modeling and simulation. Continue research regarding alternative navigation and timing technologies. Explore technologies to support precise time and time transfer with airborne platforms. Continue bandwidth efficient communication protocol research to support collaborative state estimation techniques to enable common model referencing for position, navigation and timing in Global Positioning System denied environments. Continue modeling and simulation studies to address the multispectrum threat. Continue integration of passive radar illumination selection manager hardware and software and conduct data collection on a finite number of radio frequency emitters (cooperative/non-cooperative) and assess the utility of correlated multi-mode (for example synthetic aperture radar, moving target indication and signals intelligence) operation.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Continue research to provide optimal frameworks for hybrid navigation sensor integration and modeling and simulation. Continue alternative navigation and timing technologies research. Continue exploring technologies to support precise time and time transfer with airborne platforms. Continue bandwidth efficient communication protocol research to support collaborative state estimation techniques to enable common model referencing for position, navigation and timing in Global Positioning System denied environments. Continue modeling and simulation studies to address the multispectrum threat. Continue passive radar illumination selection manager hardware and software development and assess the utility of correlated multi-mode (for example synthetic aperture radar, moving target indication and signals intelligence) operation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $1.813 million. Increase is due to realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.			
Title: Radio Frequency Sensor Technologies ***Description:*** Conduct applied research and development for the advancement of passive and active radio frequency sensors; including phenomenology, modeling and simulation, algorithm development, and experimentation. Plan, execute, and maintain state-of-the-art radio frequency sensor research and development facilities. Conduct research on sensing, learning, and adapting to enable the countering of emerging adaptive, agile radio frequency threats. ***FY 2018 Plans:*** Develop passive radar illumination selection manager electronic support hardware and electromagnetic environment forensics software. Conduct system engineering analysis to provide test criteria for critical experiment. ***FY 2019 Plans:*** The radio frequency countermeasures technology work performed in fiscal year 2018 in this effort, was moved in fiscal year 2019 to Project 627622, Radio Frequency Sensors and Countermeasures Technology, Radio Frequency Countermeasures Technology effort. Integrate passive radar illumination selection manager hardware and software and conduct data collection on a finite number of radio frequency emitters (cooperative/non-cooperative) and assess the utility of correlated multi-mode (synthetic aperture radar/moving target indicator/signals intelligence) operation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $6.750 million. Decrease is due to realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.	13.419	14.878	8.128
Title: Multi-Band/Multi-Beam Technologies	9.181	10.181	11.315

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks. ***FY 2018 Plans:*** Integrate conformal/planar multi-band (C- and Ka Bands) radio frequency antenna proof-of-concepts with select multi-beam technologies for multi-spectral sensing capability. Employ adaptive, reconfigurable and tunable detection methods and techniques as effective optional countermeasures on sensing blue force platforms. ***FY 2019 Plans:*** Validate through radio frequency range testing simultaneous multibeam, conformal antenna with integrated radar/communication and multi-spectral signal processing functions on representative low-cost, size, weight and power constrained platforms (for example, Miniature Air-Launched Decoy). Continue to employ adaptive, reconfigurable and tunable detection methods and techniques as effective optional countermeasures on sensing blue force platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $1.134 million. Increase is due to realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.			
Title: Sensor Resource Management ***Description:*** Develop technology to enable optimization of sensor resources in contested environments on own-ship and multi-ship in manned, unmanned and manned/unmanned teaming concepts. ***FY 2018 Plans:*** Continue demonstration of robust modeling and simulation capability to study the efficiency versus effectiveness of distributed electronic warfare assets including electronic support and electronic attack capabilities. Continue research into effective management of electronic warfare assets in operational environments focusing on a multi-ship strike package employment. Validate single and multi-ship sensor resource management under high fidelity modeling and simulation conditions, and under the construct of an open mission systems architecture. Continue to develop additional functional disciplines (radar, electro-optical/ infrared, high energy laser) in the service oriented architecture and sensor resource optimization. Continue bandwidth efficient communication protocol research to support collaborative state estimation techniques to enable common model referencing for position, navigation and timing in Global Positioning System denied environments. ***FY 2019 Plans:***	13.233	14.674	9.411

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The radio frequency countermeasures technology work performed in fiscal year 2018 in this effort, was moved in fiscal year 2019 to Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Countermeasures Technology effort. Assess fidelity of sensor resource manager Air Force Simulation models with leveraged flight test data (radar, electro-optical/infrared) collected under Defense Advanced Research Projects Agency's System of Systems Integration Technology and Experimentation Program. Complete single ship sensor resource management effort resulting in radio frequency multi-function/multi-mode use cases for size, weight and power constrained platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decreased compared to FY 2018 by $5.263M. Decrease is due to realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.			
Title: Radio Frequency Countermeasure Technologies ***Description:*** This project develops the radio frequency warning and countermeasure technology for advanced electronic warfare and information operations applications. Specifically, it develops techniques and technologies to detect and counter the communications links and sensors of threat integrated air defense systems and hostile command and control networks. ***FY 2018 Plans:*** For FY 2018, this work is performed in PE 0602204F, Project 627622, RF Sensors and Countermeasures Tech, under the efforts Radio Frequency Sensor Technologies and Sensor Resource Management. ***FY 2019 Plans:*** Conduct research to demonstrate electronic warfare technologies that can reason about threat capabilities and intentions and the electromagnetic environment to synthesize an optimized response in a time frame to support aircraft survivability against adaptive and agile threats. Extend research to address dynamic planning for collaborative autonomous electronic warfare systems. Demonstrate robust modeling and simulation capability to study the efficiency versus effectiveness of distributed electronic warfare assets including electronic support and electronic attack capabilities. Continue research into effective management of electronic warfare assets in operational environments focusing on a multi-ship strike package employment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $13.681 million. Increase is due to the realignment of Radio Frequency Sensor Technologies and Sensor Resource Management efforts within Project 627622, RF Sensors and Countermeasures Tech. Additionally, the increase was impacted by the realignment of Electronic Combat Technology and Advanced Aerospace Sensors Science and Technology (S&T) Advanced Technology Development activities to Aerospace Sensors Applied Research.	-	0.000	13.681
Accomplishments/Planned Programs Subtotals	45.984	50.989	55.604

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

	FY 2017	FY 2018
Congressional Add: Program Increase - Spectrum Monitoring ***FY 2017 Accomplishments:*** Conducted congressionally directed effort. ***FY 2018 Plans:*** N/A.	3.455	0.000
Congressional Adds Subtotals	3.455	0.000

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.