Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force											Date: February 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	157.078	171.307	202.912	0.000	202.912	209.631	211.243	200.426	205.529	Continuing	Continuing
622002: *Electronic Component Technology*	-	41.902	43.633	43.667	0.000	43.667	46.948	48.328	50.983	52.048	Continuing	Continuing
622003: *EO Sensors & Countermeasures Tech*	-	24.473	28.820	30.934	0.000	30.934	31.497	32.147	33.290	33.989	Continuing	Continuing
622005: *Cyber Technology*	-	6.428	6.196	9.387	0.000	9.387	9.480	8.324	9.253	9.995	Continuing	Continuing
624920: *Electronic Warfare Technology*	-	0.000	0.000	34.795	0.000	34.795	37.176	34.580	34.900	35.582	Continuing	Continuing
626095: *Sensor Fusion Technology*	-	31.370	32.281	32.063	0.000	32.063	32.685	34.498	35.578	36.819	Continuing	Continuing
627622: *RF Sensors and Countermeasures Tech*	-	52.905	60.377	52.066	0.000	52.066	51.845	53.366	36.422	37.096	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) radio frequency antennas and associated electronics for airborne and space surveillance, together with active and passive electro-optical/infrared 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 radio frequency 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 such program funds would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0602602F, 0602605F, 0602788F, 1206601F, and 0602298F.

Project 624920, Electronic Warfare, is new for FY 2020. Starting FY 2020, some Electronic Warfare activities will be transferred from PE 0602204F, Aerospace Sensors, Project 627622, RF Sensors and Countermeasures Tech, and PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, and

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force	Date: February 2019
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*

Project 63691X, EO/IR Warning & Countermeasures Tech, in order to rebalance the mix of Applied Research and Advanced Technology Development. This is an administrative realignment only and not a new start.

As directed in the FY 2018 NDAA, Sec 825, amendment to PL 114-92 FY 2016 NDAA, Sec 828 Penalty for Cost Overruns, the FY 2018 Air Force penalty total is $14.373M. The calculated percentage reduction to each research, development, test and evaluation and procurement account will be allocated proportionally from all programs, projects, or activities under such account.

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.

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	152.782	166.534	174.632	0.000	174.632
Current President's Budget	157.078	171.307	202.912	0.000	202.912
Total Adjustments	4.296	4.773	28.280	0.000	28.280
• Congressional General Reductions	-0.142	-0.227			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	6.500	5.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-0.023	0.000			
• SBIR/STTR Transfer	-2.039	0.000			
• Other Adjustments	0.000	0.000	28.280	0.000	28.280

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: 622002: *Electronic Component Technology*		
Congressional Add: *Program Increase*	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 - research by minority leaders program*	2.468	0.000
Congressional Add: *Program increase - Air Force Minority Leaders Program*	0.000	5.000
Congressional Add Subtotals for Project: 627622	2.468	5.000
Congressional Add Totals for all Projects	6.417	5.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force	Date: February 2019
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*

Change Summary Explanation

Increase in FY 2020 due to civilian pay repricing adjustment; realignment of electronic warfare science and technology (S&T) funding from PE 0603270F, Electronic Combat Technology, to PE 0602204F, Aerospace Sensors; and the realignment and consolidation of Air Force Applied Research S&T funding for Future Air Force Capabilities Applied Research efforts.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622002: *Electronic Component Technology*	-	41.902	43.633	43.667	0.000	43.667	46.948	48.328	50.983	52.048	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, electronic warfare, 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, electronic warfare, positioning, navigation, timing, and smart weapons.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Sensor Subsystems	6.891	10.033	8.425	0.000	8.425
Description: Develop, analyze, demonstrate, and perform engineering trade studies for technologies for compact, affordable, multi-function subsystems for aerospace sensors. ***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 2020 Base Plans:*** Complete wideband multifunction array technology development. Continue development of direction finding subsystem prototypes for attritable systems. Continue research for highly miniaturized and power-efficient on-board sensor processing. Initiate low cost electro-optical/infrared sensor subsystem development. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2020 decreased compared to FY 2019 by $1.608 million. Funding decreased due to completion of joint effort with the Defense Advanced Research Projects Agency developing a wideband, multifunction radio frequency array.					
Title: Electronic Devices ***Description:*** Assess, research, develop, demonstrate and transition revolutionary and evolutionary electronic devices and their associate technologies. ***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. Continue commercialization of Air Force foundry process to industry. Initiate high-voltage L and S-Band power amplifier demonstration. ***FY 2020 Base Plans:*** Complete commercialization of Air Force foundry process to industry. Complete millimeter-wave gallium nitride transistor development. Continue wide-bandgap device technology development for power generation and management. Initiate advanced wide band-gap model development for multi-use applications. Initiate novel wide-band gap switch integration with millimeter-wave transistor development. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $0.271 million. Justification for this decrease is described in plans.	7.914	7.738	7.467	0.000	7.467
Title: Electro-Optical/Infrared (EO/IR) Components ***Description:*** Research, develop, demonstrate and transition electro-optical/infrared (EO/IR) components for next generation intelligence, surveillance, reconnaissance (ISR) and countermeasures. ***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	9.950	9.271	8.725	0.000	8.725

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
generation reconfigurable focal plane array. Continue to develop a semiconductor optomechanical oscillator. Initiate demonstration of high pulse power midwave infrared laser source. ***FY 2020 Base Plans:*** Complete neutron/radiation detector demonstration. Complete wavelength conversion demonstration. Complete preliminary narrow line width laser demonstration. Continue to explore and evaluate innovative materials and devices for tunability, increased bandwidth and multi-wavelength operation. Continue compact, tunable, laser source prototype. Initiate advanced avalanche photo-diode based focal plane array development. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $0.546 million. Justification for this decrease is described in plans.					
Title: Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Systems	7.557	9.797	12.157	0.000	12.157
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. ***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 2020 Base Plans:*** Continue investigations and demonstration of trust in design and trust in fabrication. Advance modeling and simulation capability to improve predictive capability of mission assurance for highly integrated microsystems, devices, and materials. Continue development of prototype trustworthiness assessment capability. Continue reliability assessments of advanced heterogeneously integrated microsystems. Investigate application of trust into sensors and sensor systems to deter reverse engineering and exploitation of critical hardware and					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
software technology and impede unwanted technology transfer, alteration of system capability, and prevent the development of countermeasures to our systems. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $2.360 million. Funding increased due to realignment from multiple efforts within Project 627622, RF Sensors and Countermeasures Tech.					
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. ***FY 2019 Plans:*** Complete demonstration of highly-reconfigurable microsystem prototype. Complete baseline demonstration of militarily relevant integrated photonic circuit prototype. Continue assessment of microsystem fabrication techniques to militarily-relevant electronics and optoelectronics. Initiate development and demonstration of integrated wideband and adaptable transceiver microsystem. ***FY 2020 Base Plans:*** Complete initial demonstration of integrated wideband and adaptable transceiver microsystem. Initiate development of photonically enabled electronic intelligence subsystem. Initiate development of photonic antenna remoting concept. Initiate development of integrated and adaptable transceiver microsystems. Continue development of military relevant heterogeneous integration technologies. Continue development of additive techniques for advanced electronic subsystems. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $0.099 million. Justification for this increase is described in plans.	5.641	6.794	6.893	0.000	6.893
Accomplishments/Planned Programs Subtotals	37.953	43.633	43.667	0.000	43.667

	FY 2018	FY 2019
Congressional Add: Program Increase	3.949	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

	FY 2018	FY 2019
FY 2018 Accomplishments: Conducted congressionally directed effort. ***FY 2019 Plans:*** Not applicable		
Congressional Adds Subtotals	3.949	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.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622003: *EO Sensors & Countermeasures Tech*	-	24.473	28.820	30.934	0.000	30.934	31.497	32.147	33.290	33.989	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced electro-optical 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 electro-optical 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 electro-optical threat warning and countermeasures.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Passive Electro-Optical/Infrared Sensing in Contested Environments	8.157	13.674	15.126	0.000	15.126
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 2019 Plans:*** 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					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
relevant missions using broad capability computer simulations, including engagement level and campaign level simulations. ***FY 2020 Base Plans:*** Continue infrared search and track simulation and modeling to support detection and tracking algorithm development and sensor performance assessment. Complete design and development of focal plane array and the associated read-out integrated circuit. Continue evaluation of compact hyperspectral imaging sensor performance through low altitude flight testing on a surrogate platform. Conduct a flight test of a breadboard active hyperspectral imaging system on a lab-class aircraft. Evaluate a novel atmospheric characterization technique through continued data collections coincident with truth sensors. Perform studies to leverage dual-band sensor concepts for improved turbulence mitigation to improve the useful range beyond the current state of the art. Initiate studies into improving standoff high-resolution imaging by leveraging new machine learning algorithms. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $1.452 million. Funding increased due to increased emphasis in passive electro-optical/infrared sensing technologies including indications and warnings and targeting support against airborne threats.					
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 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.	16.316	15.146	15.808	0.000	15.808

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
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 2020 Base Plans:*** Flight test near real time image formation algorithms for new 3-dimension sensing mode using focal planes built the previous year. Continue development of image formation algorithms for synthetic aperture lidar with advanced waveforms. Continue development of advanced focal planes for coherent lidar sensing; including completing design and build of integrated dewar cooler assembly. Develop approach for real-time determination of volumetric turbulence using a holographic sensor. 3-dimension shape sensing efforts will focus on real-time delivery of processed products with an emphasis on overcoming high sensor data rates. Enhance existing aided target recognition algorithms with a focus on segmenting target from its background. Continue to enhance state of the art lidar simulations to support requirements definition, engagement modeling, enhanced processing development, and synthetic data generation for aided target recognition efforts. Investigate use of photon counting arrays for coherent sensing. Investigate the use of polarization gratings as a low cost / low size weight and power method of steering lidar system. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $0.662 million. Justification for this increase is described in the plans above.					
Accomplishments/Planned Programs Subtotals	24.473	28.820	30.934	0.000	30.934

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622003 / *EO Sensors & Countermeasures Tech*

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 2020 Air Force			Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622005: *Cyber Technology*	-	6.428	6.196	9.387	0.000	9.387	9.480	8.324	9.253	9.995	Continuing	Continuing

A. Mission Description and Budget Item Justification

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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Vulnerability Mitigation	2.806	2.704	4.096	0.000	4.096
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 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 2020 Base Plans:*** Continue development of automated tools for performing cyber test and assessment of weapon systems. As more mature capabilities are transitioned, assess community capability gaps and develop/enhance tools as needed. Continue research and development of vulnerability mitigation technologies for legacy platforms and to support the maturation of next generation avionics architectures. Baseline technologies and capabilities will be available this year and will need continued investigation into their secure use. Increase focus on cyber test/assessment/situational-awareness of next-generation architectures. Investigate cyber assessment					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
methodologies and open system architecture standards and approaches to reduce susceptibility of legacy and next-generation avionics architectures. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $1.392 million. Funding increased due to realignment from PE 0603270F, Electronic Combat Technology, Project 634335, Cyber Concepts, Avionics Cyber Vulnerabilities effort.					
Title: Adaptive Cyber Protections ***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 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 2020 Base Plans:*** Mature malware detection, diagnostics, and attack inferencing capabilities for avionics and mission systems. Research and develop real-time response mechanisms for cyber-attacks. Perform research and development in software, firmware and hardware diversity to enable resilient cyber defense systems. Research and develop real-time instruction-level malware detection capabilities to enable early warning and response to cyber threats. Develop automated test generation tools to expose malware embedded within mission critical software and firmware. Investigate evolutionary/co-evolutionary algorithms as a means to develop test samples for the above detection algorithms and to investigate adaptive countermeasures to malware and cyber-attacks. Research and develop cyber resilient immune systems for avionics and mission systems. Investigate cyber protection methodologies and open system architecture standards and approaches to improve cyber resiliency of legacy and next-generation avionics architectures. ***FY 2020 OCO Plans:***	3.622	3.492	5.291	0.000	5.291

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $1.799 million. Funding increased due to realignment from PE 0603270F, Electronic Combat Technology, Project 634335, Cyber Concepts, Avionics Cyber Protections effort.					
Accomplishments/Planned Programs Subtotals	6.428	6.196	9.387	0.000	9.387

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 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 624920 / *Electronic Warfare Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
624920: *Electronic Warfare Technology*	-	0.000	0.000	34.795	0.000	34.795	37.176	34.580	34.900	35.582	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable all weather radio frequency 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. 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 positioning, navigation and timing integrity, accuracy, and resiliency as well as on aircraft mission assurance - the protection of airborne platforms, manned and unmanned, in contested environments. The ultimate goal of the project is to ensure unrestricted access to the airspace and the electromagnetic spectrum in contested and congested environments.

Project 624920, Electronic Warfare, is new for FY 2020. In FY 2019 and prior, this work is reported under PE 0602204F, Aerospace Sensors, Project 627622, RF Sensors and Countermeasures Tech, and PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, and Project 63691X, EO/IR Warning & Countermeasures Tech. This is administrative realignment only and not a new start.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Positioning, Navigation and Timing in Contested/Denied Environments	0.000	0.000	9.663	0.000	9.663
Description: 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 navigation and timing threats. ***FY 2019 Plans:*** For FY 2019 and prior, this work is performed under Project 627622, RF Sensors and Countermeasures Tech, Hybrid Sensor Technologies effort and under PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, Position, Navigation and Timing for Contested/Denied Environments effort. ***FY 2020 Base Plans:*** Expand research on navigation sensor integration, modeling, and simulation to incorporate open architecture attributes. Continue alternative navigation, bandwidth efficient communications for navigation, and timing technologies research. Continue exploring technologies to support precise time and time transfer with airborne platforms to enable coherent sensing (intelligence, surveillance, reconnaissance) and effects (electronic					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 624920 / *Electronic Warfare Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
warfare). Start development of trust techniques to enable military use of global navigation satellite systems. Continue modeling and simulation studies to address the multispectrum threat to satellite navigation systems. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $9.663 million. Funding increased due to the realignment from Project 627622, RF Sensors and Countermeasures Tech, Hybrid Sensor Technologies effort, and PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, Position, Navigation and Timing for Contested/Denied Environments effort.					
Title: Radio Frequency Electronic Warfare 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 2019 Plans:*** For FY 2019 and prior, this work is performed under Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Countermeasures Technologies effort. ***FY 2020 Base Plans:*** Continue 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. Continue to extend research to address dynamic planning for collaborative autonomous electronic warfare systems. Continue the demonstration of robust modeling, simulation, and assessment capability to study the efficiency versus effectiveness of electronic support and electronic attack capabilities, including distributed electronic warfare assets and cognitive/autonomous technologies, against complex threat emitters in integrated air defense systems and in complex electromagnetic spectrum background environments. Continue research into effective management of electronic warfare assets in operational environments focusing on a multi-ship strike package employment. Start incorporation of electro-optical and radio frequency integrated engagement model development to meet multispectrum threats. ***FY 2020 OCO Plans:***	0.000	0.000	17.631	0.000	17.631

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 624920 / *Electronic Warfare Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $17.631 million. Funding increased due to realignment from Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Countermeasures Technologies effort.					
Title: Electro-Optical/Infrared Threat Warning and Countermeasures Technologies ***Description:*** Develop electro-optical/infrared sensor countermeasure technologies. Explore novel concepts to enable electro-optical/infrared threat seeker exploitation and surrogate modeling. Conduct fundamental research in countermeasures to defeat electro-optical/infrared threat seekers. Conduct fundamental research on integrated electro-optical/infrared threat warning systems. ***FY 2019 Plans:*** For FY 2019 and prior, this work is performed under Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Countermeasures Technologies effort, and PE 0603270F, Electronic Combat Technology, Project 63691X, EO/IR Warning & Countermeasures Tech, Advanced Electro-Optical/Infrared Warning and Countermeasures effort. ***FY 2020 Base Plans:*** Continue threat characterization and countermeasures development of new threats to include new jam codes and countermeasure techniques. Continue development of low-cost missile warning capabilities. Investigate long-range missile and laser warning technology concepts. Start incorporation of electro-optical and radio frequency integrated engagement model development to meet multispectrum threats. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $7.501 million. Funding increased due to realignment from Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Countermeasures Technologies effort, and PE 0603270F, Electronic Combat Technology, Project 63691X, EO/IR Warning & Countermeasures Tech, Advanced Electro-Optical/Infrared Warning and Countermeasures effort.	0.000	0.000	7.501	0.000	7.501
Accomplishments/Planned Programs Subtotals	0.000	0.000	34.795	0.000	34.795

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 624920 / *Electronic Warfare 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 2020 Air Force			Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
626095: *Sensor Fusion Technology*	-	31.370	32.281	32.063	0.000	32.063	32.685	34.498	35.578	36.819	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops foundational technologies required for closed-loop autonomous sensing employing multiple information domains, diverse sensor phenomena, and multiple platform types to provide intelligence, surveillance, and reconnaissance; target recognition; situational awareness and battlespace visualization; fire control; and battle damage assessment capabilities against a wide variety of targets engaged in multitudes of behaviors in a broad range of operational environments. This project conducts exploratory investigations to determine technology feasibility and estimate operational capability constraints associated with missions in future contested and highly contested operating environments, using cooperative and non-cooperative sensing sources. This project develops techniques to automate multi-sensor exploitation and information processing that leverage the data fusion, adaptive signal processing, and artificial intelligence / machine learning research communities. This project develops concepts and algorithms for efficient parallel processing, distributed processing, and high-performance computing in sensor data processing and synthetic data generation.

In FY 2020, efforts within this project are realigned to better reflect technical areas being emphasized such as autonomy, multi-domain and multi-sensor information processing, leverage of machine learning developments and enterprise-level modeling, simulation and analysis.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Target Signature Modeling	4.370	4.496	0.000	0.000	0.000
Description: Develop, evaluate, and demonstrate target signature models to support sensor exploitation algorithm development and testing for reconnaissance and strike mission applications. ***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 2020 Base Plans:*** Starting in FY 2020, this work will be performed under the Multi-Domain Sensing Effect and Analysis effort within Project 626095, Sensor Fusion Technology. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2020 decreased compared to FY 2019 by $4.496 million. Funding decreased due to realignment to Multi-Domain Sensing Effect and Analysis effort within Project 626095, Sensor Fusion Technology.					
Title: Sensor Exploitation Technologies ***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. ***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 2020 Base Plans:*** Starting in FY 2020, this work will be performed under the Multi-Domain Sensing Effect and Analysis and Synthesis for Understanding efforts within Project 626095, Sensor Fusion Technology. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $6.858 million. Funding decreased due to realignment to Multi-Domain Sensing Effect and Analysis and Synthesis for Understanding efforts within Project 626095, Sensor Fusion Technology.	6.667	6.858	0.000	0.000	0.000
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 2019 Plans:***	15.912	16.367	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
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 2020 Base Plans:*** Starting in FY 2020, this work will be performed under the Multisource Knowledge Representation and Management effort within Project 626095, Sensor Fusion Technology. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $16.367 million. Funding decreased due to realignment to Multisource Knowledge Representation and Management effort within Project 626095, Sensor Fusion Technology.					
Title: Distributed Sensing for Automatic Target Recognition ***Description:*** Develop techniques and metrics for adaptive, penetrating, distributed radio frequency exploitation in contested environments. ***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 2020 Base Plans:*** Starting in FY 2020, this work will be performed under the Synthesis for Understanding and the Multisource Knowledge Representation and Management efforts within Project 626095, Sensor Fusion Technology. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:***	4.421	4.560	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2020 decreased compared to FY 2019 by $4.560 million. Funding decreased due to realignment to Synthesis for Understanding and Multisource Knowledge Representation and Management efforts within Project 626095, Sensor Fusion Technology.					
Title: Synthesis for Understanding ***Description:*** Continue to develop novel techniques for behavioral and physical knowledge generation from multiple sensors, intelligence sources, domains (Air, Space, Cyber) and sources to include algorithm development, assessment, and experiments across multiple distributed, homogeneous and heterogeneous sensors. This effort will focus on technology areas of data association, entity detect/track/identification, information fusion, training with limited data, and data/performance modeling. The application of machine learning techniques to address technical challenges in contested environments is a particular emphasis. ***FY 2019 Plans:*** For FY 2019 and prior, this work is performed under the Sensor Exploitation Technologies effort within Project 626095, Sensor Fusion Technology. ***FY 2020 Base Plans:*** Develop capabilities for space-time alignment of multiple hard (physics-based) and soft (human-based) information sources. Model information uncertainty for multiple information sources (hard and soft). Apply deep and machine learning techniques to the detection/tracking/identification of stationary and moving entities, and for pattern of life understanding. Develop decision/feature-level fusion capabilities for physics-based information from multiple sensors/intelligence sources. Investigate fusion of hard and soft information sources for military-relevant applications. Design and evaluate training techniques, for example, blended measured-synthetic training, for deep and machine learning classifiers given limited measured data. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY2019 by $13.380 million. Funding increased due to realignment from Sensors Exploitation Technologies effort within Project 626095, Sensor Fusion Technology to better reflect technical areas being emphasized such as autonomy, multi-domain and multi-sensor information processing, leverage of machine learning developments and enterprise-level modeling, simulation and analysis.	0.000	0.000	13.380	0.000	13.380
Title: Multi-Domain Sensing Effects and Analysis	0.000	0.000	6.535	0.000	6.535

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Description: This thrust will focus on two primary areas: (1) Multi domain sensing and effects mission analysis and (2) performance understanding and assessments. It will develop methodologies and modeling, simulation, and analysis tools to enable multi domain analysis and technology development, informing other efforts and projects across the directorate. Investments in modeling, simulation and analysis will represent current and next generation sensing platforms to include air, space, and cyber as well as the fusion of information amongst these three domains. ***FY 2019 Plans:*** For FY 2019 and prior, this work is performed under the Target Signature Modeling and the Sensor Exploitation Technologies efforts within Project 626095, Sensor Fusion Technology. ***FY 2020 Base Plans:*** Key applied research investments will be made in the following: 1) leverage academic partnerships with respect to specific Air Force applications in modeling, simulation and analysis, 2) design and build next generation correct fidelity performance models, 3) develop one or more challenge problems to support Air Force technology investment understanding, 4) perform in-the-field data collections to verify and validate performance using measured sensor data. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $6.535 million. Funding increased due to realignment from Target Signature Modeling and Sensor Exploitation Technology efforts within Project 626095, Sensor Fusion Technology to better reflect technical areas being emphasized such as autonomy, multi-domain and multi-sensor information processing, leverage of machine learning developments and enterprise-level modeling, simulation and analysis.					
Title: Multisource Knowledge Representation and Management ***Description:*** Develop, evaluate, and demonstrate models for sensing and for adversary behavior that support anticipatory asset tasking, characterization of latencies and related uncertainties, and joint inference and control. Develop multisource sensing techniques providing environment characterization consistent with the needs of automated and autonomous systems. ***FY 2019 Plans:***	0.000	0.000	12.148	0.000	12.148

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
For FY 2019 and prior, this work is performed under the Sensor Management for Automatic Target Recognition effort within Project 626095, Sensor Fusion Technology. ***FY 2020 Base Plans:*** Continue to develop mission performance metrics for distributed sensing capabilities in which families of suitable solutions exist. Improve representational and computational efficiency of graph-based information fusion methods. Develop foundational algorithms for sensing management incorporating environment analysis, target tracking and recognition, and operationally representative external factors. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $12.148 million. Funding increased due to realignment from Sensor Management for Automatic Target Recognition effort within Project 626095, Sensor Fusion Technology to better reflect technical areas being emphasized such as autonomy, multi-domain and multi-sensor information processing, leverage of machine learning developments and enterprise-level modeling, simulation and analysis.					
Accomplishments/Planned Programs Subtotals	31.370	32.281	32.063	0.000	32.063

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 2020 Air Force			Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
627622: *RF Sensors and Countermeasures Tech*	-	52.905	60.377	52.066	0.000	52.066	51.845	53.366	36.422	37.096	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 intelligence, surveillance and reconnaissance 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 positioning, navigation and timing integrity, accuracy, and resiliency.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Hybrid Sensor Technologies	11.134	12.842	0.000	0.000	0.000
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 2019 Plans:*** 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					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
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 2020 Base Plans:*** Starting in FY 2020, this work will be performed under Project 624920, Electronic Warfare Technology, Positioning, Navigation and Timing in Contested/Denied Environments effort. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $12.842 million. Funding decreased due to realignment to Project 624920, Electronic Warfare Technology, Positioning, Navigation and Timing in Contested/Denied Environments effort.					
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 2019 Plans:*** 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 2020 Base Plans:*** Analyze passive radar illumination selection manager collected data from the ground-based static testing to establish an experimental technical baseline for a future airborne experiment. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:***	14.717	8.128	9.127	0.000	9.127

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2020 increased compared to FY 2019 by $0.999 million. Justification for this increase is described in plans above.					
Title: Multi-Band/Multi-Beam Technologies ***Description:*** Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks. ***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 2020 Base Plans:*** Continue to employ adaptive, reconfigurable and tunable detection methods and techniques as effective optional countermeasures to developing multi-mission, unmanned sensing blue force platforms such as the Low Cost Attritable Aircraft Technology effort. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $1.390 million. Funding increased due to realignment of civilian pay from Project 626095, Sensor Fusion Technology.	10.071	11.315	12.705	0.000	12.705
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 2019 Plans:*** 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	14.515	9.411	10.567	0.000	10.567

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
effort resulting in radio frequency multi-function/multi-mode use cases for size, weight and power constrained platforms. ***FY 2020 Base Plans:*** Utilize delivered sensor resource management tools to integrate data collected from the Defense Advanced Research Projects Agency System of Systems Integration Technology and Experimentation gauntlets and begin engineering study for multi-ship/multi-spectral sensor resource manager. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $1.156 million. Funding increased due to realignment of civilian pay from Project 626095, Sensor Fusion Technology.					
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 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 2020 Base Plans:*** Starting in FY 2020, this work will be performed under Project 624920, Electronic Warfare Technology, Radio Frequency Electronic Warfare Technologies effort. ***FY 2020 OCO Plans:***	0.000	13.681	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $13.681 million. Funding decreased due to realignment to Project 624920, Electronic Warfare Technology, Radio Frequency Electronic Warfare Technologies effort.					
Title: Future AF Capabilities Applied Research ***Description:*** Investigate, design, and develop science and technologies supporting future Air Force capabilities to provide compelling advantage to the warfighter. To the greatest extent practical, research efforts will utilize modeling and simulation and cross-discipline systems integration (For example: air and space vehicles, avionics, propulsion, materials, human performance, cybersecurity, command, control, communications, computer and intelligence, sensors, electronic warfare, and conventional/unconventional weapons). The National Defense Strategy and Air Force Science and Technology 2030 Strategy will inform investments over the future years defense planning (FYDP). ***FY 2019 Plans:*** In FY 2019, this work is performed under multiple projects and efforts within the following Air Force Science and Technology Programs: 0602102F, Materials; 0602201F, Aerospace Vehicle Technologies; 0602202F, Human Effectiveness Applied Research; 0602203F, Aerospace Propulsion; 0602204F, Aerospace Sensors; 1206601F, Space Technology; 0602602F, Conventional Munitions; 0602605F, Directed Energy Technology; and 0602788F, Dominant Information Science and Methods. ***FY 2020 Base Plans:*** Continue to investigate and mature science and technology that enables future warfighting concepts to provide leap-ahead capabilities. The National Defense Strategy and Air Force Science and Technology 2030 Strategy focus this science and technology toward, but not limited to, the following capabilities: 1) global persistent awareness; 2) resilient information sharing; 3) rapid, effective decision-making; 4) complexity, unpredictability, and mass; and 5) speed and reach of disruption and lethality. ***FY 2020 OCO Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:***	0.000	0.000	19.667	0.000	19.667

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2020 increased compared to FY 2019 by $19.667 million. Funding increased due to the realignment and consolidation of Air Force Applied Research Science and Technology funding for Future Air Force Capabilities Applied Research efforts.					
Accomplishments/Planned Programs Subtotals	50.437	55.377	52.066	0.000	52.066

	FY 2018	FY 2019
Congressional Add: Program increase - research by minority leaders program ***FY 2018 Accomplishments:*** Conducted Congressionally directed efforts ***FY 2019 Plans:*** Not Applicable	2.468	0.000
Congressional Add: Program increase - Air Force Minority Leaders Program ***FY 2018 Accomplishments:*** Not applicable ***FY 2019 Plans:*** Conduct Congressionally directed efforts	0.000	5.000
Congressional Adds Subtotals	2.468	5.000

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.