Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force											Date: April 2022	
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 2021**	**FY 2022**	**FY 2023 Base**	**FY 2023 OCO**	**FY 2023 Total**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Cost To Complete**	**Total Cost**
Total Program Element	-	221.779	255.918	192.733	0.000	192.733	197.998	201.322	195.226	192.094	Continuing	Continuing
622002: *Electronic Component Technology*	-	55.230	91.176	41.159	0.000	41.159	42.510	43.587	34.150	27.518	Continuing	Continuing
622003: *EO Sensors & Countermeasures Tech*	-	34.638	24.725	28.120	0.000	28.120	28.768	28.787	29.396	30.036	Continuing	Continuing
622005: *Cyber Technology*	-	16.625	6.934	8.466	0.000	8.466	9.215	9.514	9.713	9.925	Continuing	Continuing
624920: *Electronic Warfare Technology*	-	44.749	45.347	45.410	0.000	45.410	46.085	46.803	47.796	48.835	Continuing	Continuing
626095: *Sensor Fusion Technology*	-	35.716	35.984	33.577	0.000	33.577	34.323	35.234	35.979	36.763	Continuing	Continuing
627622: *RF Sensors and Countermeasures Tech*	-	34.821	51.752	36.001	0.000	36.001	37.097	37.397	38.192	39.017	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 development of agile and resilient mission systems. This program has been coordinated through the Department of Defense Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.

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

This program element may include necessary civilian pay expenses required to manage, execute, and deliver science and technology capabilities. The use of program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602020F, 0602102F, 0602201F, 0602202F, 0602203F, 0602602F, 0602605F, 0602788F, 1206601SF, and 0602298F.

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force	Date: April 2022
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*

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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	232.876	193.514	0.000	0.000	0.000
Current President's Budget	221.779	255.918	192.733	0.000	192.733
Total Adjustments	-11.097	62.404	192.733	0.000	192.733
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	57.000			
• Congressional Directed Transfers	0.000	5.404			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-2.645	0.000			
• Other Adjustments	-8.452	0.000	192.733	0.000	192.733

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Project: 622002: *Electronic Component Technology*		
Congressional Add: *Program increase - exploitation detection for flexible combat avionics*	4.943	5.000
Congressional Add: *Program increase: enhanced security sensors to detect threats in near and far field emissions*	0.000	5.000
Congressional Add: *Program increase: hardware-based oversight system for microelectronics endpoints*	0.000	6.000
Congressional Add: *Program increase: low cost sensors for UAVs*	0.000	5.000
Congressional Add: *Program increase: Zero-trust environment for semiconductor technology*	0.000	10.000
Congressional Add: *Program increase: Extreme wideband RF sensor*	0.000	19.000
Congressional Add Subtotals for Project: 622002	4.943	50.000
Project: 622003: *EO Sensors & Countermeasures Tech*		
Congressional Add: *Low cost sensors for small unmanned vehicles*	4.943	0.000
Congressional Add: *Additive manufacturing for electronics*	5.931	0.000
Congressional Add Subtotals for Project: 622003	10.874	0.000
Project: 622005: *Cyber Technology*		

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force	Date: April 2022
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Congressional Add: *Cyber assurance and assessment of electronic hardware systems*	5.931	0.000
Congressional Add Subtotals for Project: 622005	5.931	0.000
Project: 626095: *Sensor Fusion Technology*		
Congressional Add: *Program increase: Reliability of combat cloud communications systems*	0.000	7.000
Congressional Add Subtotals for Project: 626095	0.000	7.000
Congressional Add Totals for all Projects	21.748	57.000

Change Summary Explanation

Decrease in FY 2021 reflects adjustments to support Research and Development Projects, 10 U.S.C. Section 2363, an amendment to PL 110-417, 10 U.S.C. Section 2358 and 10 U.S.C. 2805(d)(1)(B).

The FY 2022 President's Budget submittal did not reflect FY 2023 through FY 2026 funding. Therefore, an explanation of the change between the two budget positions for FY2023 cannot be made in a relevant manner.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
622002: *Electronic Component Technology*	-	55.230	91.176	41.159	0.000	41.159	42.510	43.587	34.150	27.518	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 demonstrates 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 2021	FY 2022	FY 2023
Title: Sensor Subsystems	9.055	7.912	7.475
Description: Develop, analyze, demonstrate, and perform engineering trade studies for technologies for compact, affordable, multi-function subsystems for aerospace sensors. ***FY 2022 Plans:*** Complete low cost electro-optical/infrared sensor subsystem development. Continue research into autonomous low size, weight and power sensor processing. Continue research into digital at every element technology for multifunction microwave and millimeter wave arrays. Initiate development of low size weight and power wideband multifunction RF sensor subsystem suitable for Group 4 unmanned aircraft system operation. ***FY 2023 Plans:*** Continue research into autonomous low size, weight and power sensor processing. Continue research into digital at every element technology for multifunction microwave and millimeter wave arrays. Continue development of low size weight and power wideband multifunction radio frequency sensor subsystem suitable for Group 4 unmanned aircraft system operation. Initiate millimeter wave digital array demonstrations. Initiate wideband phased array emulation utilizing digital beamforming demonstrator. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $0.437 million. Justification for this decrease is described in plans above.			
Title: Electronic Devices	8.765	6.793	6.762

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
Description: Assess, research, develop, demonstrate and transition revolutionary and evolutionary electronic devices and their associate technologies. ***FY 2022 Plans:*** Complete advanced wide band-gap model development for multi-use applications. Complete initial demonstration of novel wide-band gap switch integration with millimeter-wave transistor development. Continue development of integrated chip-level radio frequency device and power conversion modeling. Continue development of wide bandgap device and power conversion integration technologies. Initiate prototype demonstration of high efficiency microwave power modules with integrated high speed power conversion switching. ***FY 2023 Plans:*** Complete initial demonstration of wide bandgap device and power conversion integration. Continue development of integrated chip-level radio frequency device and power conversion modeling. Continue development of wide bandgap device and power conversion integration technologies. Continue demonstration of high efficiency microwave power modules with integrated high speed power conversion switching. Initiate next generation predictive analysis using higher order harmonics. Initiate wide bandgap W-band device and circuit optimization. Initiate evaluation of next generation wide bandgap radio frequency materials. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $0.031 million. Justification for this decrease is described in plans above.			
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 2022 Plans:*** Complete advanced avalanche photo-diode based focal plane array development. Continue photonic and quantum substructure technology development. Continue research into non-linear devices for tunablity and power scaling. Initiate development of high power, narrow line width lasers sources for advanced sensing and countermeasure applications. ***FY 2023 Plans:*** Continue photonic and quantum substructure technology development. Continue research into non-linear devices for tunablity and power scaling. Continue development of high power, narrow line width lasers sources for advanced sensing and countermeasure applications. Initiate laser component packaging for laser detection and ranging. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $0.319 million. Justification for this decrease is described in plans above.	8.925	6.969	7.288
Title: Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Mission Systems	15.553	7.946	8.886

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
Description: Investigate and develop designs of trusted electronic and optoelectronic systems when integrating commercially available solutions 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 2022 Plans:*** Mature trust in design and trust in fabrication. Continue studies of modeling and simulation capability to improve predictive capability of mission assurance for highly integrated microsystems, devices, and materials. Advance development of prototype trustworthiness assessment capability. Continue reliability assessments of advanced heterogeneously integrated microsystems. Continue the development of processes and techniques for trust through design. Continue verification and validation of security techniques and methodologies for integrated circuit designs. ***FY 2023 Plans:*** Complete initial investigation of trust in design and trust in fabrication methodologies. Complete studies of modeling and simulation capability to improve predictive capability of mission assurance for highly integrated microsystems, devices, and materials. Complete the initial development of processes and techniques for trust through design. Continue development of prototype trustworthiness assessment capability. Continue reliability assessments of advanced heterogeneously integrated microsystems. Continue verification and validation of security techniques and methodologies for integrated circuit designs. Initiate disaggregated multi chip System in Package demonstration using fine pitch for assurance. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $0.940 million. Justification for this increase is described in plans above.			
Title: Advanced Highly Integrated Microsystems for Intelligence, Surveillance, Reconnaissance and Electronic Warfare	7.989	6.492	6.218
Description: Perform research and development of electronic and photonic circuit and microsystem technologies focused on miniaturization, power reduction, reconfigurability and reduced cost. ***FY 2022 Plans:*** Complete development of photonically enabled electronic intelligence subsystem. Complete development of photonic antenna remoting concept. Complete development of integrated and adaptable transceiver microsystems. Continue development of next generation reconfigurable transceiver prototype. Continue development of microsystem integration solutions that integrate advanced components and thermal management technologies for cost, size, weight and power constrained microwave and millimeter wave applications. Initiate development of chip-scale photonic/electronic wideband transceiver components. ***FY 2023 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
Continue development of next generation reconfigurable transceiver prototype. Continue development of microsystem integration solutions that integrate advanced components and thermal management technologies for cost, size, weight and power constrained microwave and millimeter wave applications. Continue development of chip-scale photonic/electronic wideband transceiver components. Initiate development of high-Q passive components for heterogeneous integration. Initiate identification of application areas and development of heterogeneous integration concepts. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $0.274 million. Justification for this decrease is described in plans above.			
Title: Microelectronics & Embedded System Assurance ***Description:*** Investigate and develop microelectronics security technologies to impede unwanted technology transfer and enable timely adoption of commercial and government-off-the-shelf microelectronic technologies that enable revolutionary capabilities for the Air Force. ***FY 2022 Plans:*** Investigate trust technologies and techniques in sensors and sensor systems to deter reverse engineering and exploitation of critical hardware and software technology and impede unwanted technology transfer, alteration of system capability, and prevent the development of countermeasures to our systems. ***FY 2023 Plans:*** Complete investigation of trust technologies and techniques in sensors and sensor systems. Continue development of techniques to deter reverse engineering and exploitation of critical program information. Initiate advanced exploitation tool development to assess modern threat capability. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $0.534 million. Justification for this decrease is described in plans above.	0.000	5.064	4.530
Accomplishments/Planned Programs Subtotals	50.287	41.176	41.159

	FY 2021	FY 2022
Congressional Add: Program increase - exploitation detection for flexible combat avionics ***FY 2021 Accomplishments:*** Conducted Congressional directed efforts ***FY 2022 Plans:*** Conduct Congressional directed efforts	4.943	5.000
Congressional Add: Program increase: enhanced security sensors to detect threats in near and far field emissions	0.000	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

	FY 2021	FY 2022
FY 2021 Accomplishments: Not applicable ***FY 2022 Plans:*** Conduct Congressional directed efforts		
Congressional Add: Program increase: hardware-based oversight system for microelectronics endpoints ***FY 2021 Accomplishments:*** Not applicable ***FY 2022 Plans:*** Conduct Congressional directed efforts	0.000	6.000
Congressional Add: Program increase: low cost sensors for UAVs ***FY 2021 Accomplishments:*** Not applicable ***FY 2022 Plans:*** Conduct Congressional directed efforts	0.000	5.000
Congressional Add: Program increase: Zero-trust environment for semiconductor technology ***FY 2021 Accomplishments:*** Not applicable ***FY 2022 Plans:*** Conduct Congressional directed efforts	0.000	10.000
Congressional Add: Program increase: Extreme wideband RF sensor ***FY 2021 Accomplishments:*** Not applicable ***FY 2022 Plans:*** Conduct Congressional directed efforts	0.000	19.000
Congressional Adds Subtotals	4.943	50.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
622003: *EO Sensors & Countermeasures Tech*	-	34.638	24.725	28.120	0.000	28.120	28.768	28.787	29.396	30.036	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 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 2021	FY 2022	FY 2023
Title: Passive Electro-Optical/Infrared Sensing in Contested Environments	12.291	12.411	13.765
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 2022 Plans: Conduct flight test evaluation of the staring infrared search and track system against military relevant targets. Complete flight testing of compact, low-cost, low volume, real-time hyperspectral sensor for attritable platforms in preparation for operational demonstration. Continue development of low-earth orbit sensing systems for critical Air Force needs, including event-based sensors and passive interferometry.			
FY 2023 Plans: Continue refinement of advanced processing algorithms for hyperspectral imaging. Conduct demonstration of low-cost, compact hyperspectral imaging sensor with on-board, near real time processing software that utilizes advanced processing algorithms under development. Perform testing of new multi-spectral cameras and filters that allow more compact designs. Continue development of low-earth orbit sensing systems for critical Air Force needs, including event-based sensors and passive interferometry. Perform a field demonstration and evaluation of an event based/neuromorphic sensing system. Finalize development of large format, long wave infrared detector array for infrared search and track in preparation for future testing.			
FY 2022 to FY 2023 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
FY 2023 increased compared to FY 2022 by $1.354 million. Increase is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors.			
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. ***FY 2022 Plans:*** Continue refinement/improvement of laser radar model to improve performance predictions of ability to meet operational demands. Collect additional data from an airborne laser vibrometry system to feed artificial intelligence algorithms for positive target identification. Build small-scale demonstration to show feasibility of new small size, weight and power digital holography system. Complete evaluation of new detector technology for coherent laser radar. Conduct feasibility analysis for space base laser radar concept. ***FY 2023 Plans:*** Refine design of multi-mode laser radar system for attritable platforms. Using data collected from other airborne laser radar programs, benchmark performance of modeling and simulation software. Complete initial development of processing software for multi-mode laser radar collecting vibration and synthetic aperture data. Investigate feasibility of multi-static laser radar concepts. After demonstration of a large aperture laser radar for high-resolution imaging needs, continue refinement of designs to improve performance while working with customers to investigate transition potential of existing designs. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $2.041 million. Increase is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors.	11.473	12.314	14.355
Accomplishments/Planned Programs Subtotals	23.764	24.725	28.120

	FY 2021	FY 2022
Congressional Add: Low cost sensors for small unmanned vehicles ***FY 2021 Accomplishments:*** Conduct congressional directed efforts ***FY 2022 Plans:*** Not applicable	4.943	0.000
Congressional Add: Additive manufacturing for electronics	5.931	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622003 / *EO Sensors & Countermeasures Tech*

	FY 2021	FY 2022
FY 2021 Accomplishments: Conduct Congressional directed efforts ***FY 2022 Plans:*** Not applicable		
Congressional Adds Subtotals	10.874	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
622005: *Cyber Technology*	-	16.625	6.934	8.466	0.000	8.466	9.215	9.514	9.713	9.925	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on technologies for enabling agile and resilient Air Force mission systems. This project improves our understanding of cyber vulnerabilities of mission systems by investigating the fundamental nature of those 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. This project develops 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. This project investigates open architecture concepts and technologies to deliver capability flexibility to Air Force mission systems. These technologies are matured via integrated capability demonstrations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Vulnerability Mitigation ***Description:*** Apply knowledge from computer vulnerability discovery and computer security to investigate capabilities for identifying and mitigating vulnerabilities in United States mission 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 2022 Plans:*** Starting in FY 2022, this work is performed under Project 622005, Cyber Technology, Flexible and Secure Avionics effort. ***FY 2023 Plans:*** Not applicable	4.324	0.000	0.000
Title: Flexible and Secure Avionics ***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. Support test, maintenance, and acquisition communities with cyber subject matter expertise and techniques through consultation and technical interchange. Support other Services with cyber resiliency capabilities for air, ground and sea platforms and develop Open Mission Systems architectures incorporating cyber protections and resilience technologies. ***FY 2022 Plans:*** Perform flight test and demonstrations in operationally relevant capabilities for malware detection, diagnostics, and attack inferencing for mission systems. Continue research and develop real-time response mechanisms for cyber-attacks and software, firmware, and hardware diversity techniques to enable resilient cyber defense systems. Mature laboratory demonstrations	6.370	6.934	8.466

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
of automated test generation tools to expose malware embedded within mission critical software and firmware. Continue to investigate protection methodologies and open system architecture standards and approaches to improve agility and resiliency of legacy and next-generation mission systems architectures. Perform laboratory and flight demonstrations on flight worthy hardware. Share expertise with other Services and Test, Maintenance, and Acquisition communities. In FY 2022 this effort was renamed from Agile Mission Systems Protections to Flexible and Secure Avionics. ***FY 2023 Plans:*** Continue investigation and development of techniques to enable resilient cyber protections for avionics systems. Continue laboratory and flight demonstrations on flight worthy hardware. Share expertise with other Services and Test, Maintenance, and Acquisition communities. Initiate investigating protection technologies applied to open system architectures to enable resilience in next-generation mission systems and facilitate agility in mission system capability. Initiate development of advanced modular architecture for agile avionics. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $1.532 million. Increase is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors.			
Accomplishments/Planned Programs Subtotals	10.694	6.934	8.466

	FY 2021	FY 2022
Congressional Add: Cyber assurance and assessment of electronic hardware systems	5.931	0.000
FY 2021 Accomplishments: Conduct Congressional directed efforts		
FY 2022 Plans: Not applicable		
Congressional Adds Subtotals	5.931	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
624920: *Electronic Warfare Technology*	-	44.749	45.347	45.410	0.000	45.410	46.085	46.803	47.796	48.835	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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Positioning, Navigation and Timing in Contested/Denied Environments	12.446	14.415	13.778
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 2022 Plans: Continue the exploration of position, navigation and timing alternatives to satellite navigation, such as RF signals of opportunity, magnetic, and vision aiding of inertial navigation systems. Prototype technologies to support airborne precise time, frequency, velocity and position as well as transfer between platforms to enable coherent sensing (intelligence, surveillance, reconnaissance) and effects (electromagnetic warfare). Demonstrate prototype trust techniques to enable military use of foreign satellite navigation signals. Develop software defined antenna electronics to complement software defined navigation receiver efforts, and explore advanced algorithms for software defined navigation. Begin to develop the requirements for a prototype communications receiver to provide a connected solution for time, frequency, velocity and position data transfer.			
FY 2023 Plans: Continue research and prototype demonstrations of integrated position, navigation and timing alternatives to satellite navigation, such as radio frequency signals of opportunity, magnetic, and vision aiding of inertial navigation systems. Demonstrate technologies to support airborne precise time, frequency, velocity and position as well as transfer between platforms to enable coherent sensing (intelligence, surveillance, reconnaissance) and effects (electromagnetic warfare). Continue to develop and demonstrate prototype trust techniques to enable military use of foreign satellite navigation signals. Continue to develop software defined antenna electronics to complement software defined navigation receiver efforts, and explore advanced algorithms for			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
software defined navigation. Mature the requirements for a prototype communications receiver to provide a connected solution for time, frequency, velocity and position data transfer. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $0.637 million. Justification for this decrease is described in plans above.			
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. This project 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 2022 Plans:*** Continue research to develop 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 the demonstration of robust modeling, simulation, and assessment capability to determine the efficiency versus effectiveness of emerging electronic support and electronic attack technologies, in complex electromagnetic spectrum background environments with hardware in the loop. Continue to develop and demonstrate distributed electronic warfare techniques to defeat integrated air defense systems. Continue integration of electro-optical and radio frequency engagement model development and experimentation to develop strategies to counter multispectrum threats to airborne platforms. ***FY 2023 Plans:*** Continue research to develop electromagnetic warfare technologies that operate in a contested electromagnetic environment to reason about complex threat capabilities/intentions. Technologies must understand the electromagnetic environment to synthesize an optimized response in a time frame to support aircraft survivability against adaptive and agile threats. Continue integration of electro-optical and radio frequency engagement model development and experimentation to develop strategies to counter multi-spectral threats to airborne platforms. Expand robust modeling, simulation, and assessment capability to include multi-spectral components to determine the efficiency versus effectiveness of emerging electronic support and electronic attack technologies. Continue to enhance hardware in the loop assessment capabilities to keep pace with complex electromagnetic spectrum background environments and emerging threats. Continue to develop and demonstrate distributed electronic warfare techniques to defeat integrated air defense systems. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $3.909 million. Increase is due to realignment of personnel between this effort and the Electro-Optical/Infrared Threat Warning and Countermeasures Technologies effort.	22.759	20.741	24.650
Title: Electro-Optical/Infrared Threat Warning and Countermeasures Technologies	9.544	10.191	6.982

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
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 2022 Plans:*** Continue threat characterization and development of countermeasures techniques to defeat emerging advanced electro-optical/infrared guided threats to airborne platforms. Continue the development of advanced threat surrogates and conduct infrared countermeasure testing at test ranges. Continue to investigate long-range missile warning and laser warning technology concepts. Continue development of an advanced framework for modeling and simulation and hardware in the loop assessment with scene generation of engagements and techniques to defeat electro-optical and infrared guided threats to airborne platforms. Validate results using data collected in live fire tests. ***FY 2023 Plans:*** Continue threat characterization and development of countermeasures techniques to defeat emerging advanced electro-optical/infrared guided threats to airborne platforms. Continue to investigate long-range missile warning and develop laser warning technology concepts to improve aircraft and aircrew survivability. Continue development of advanced threat surrogates and conduct infrared countermeasure testing at test ranges. Continue development of an advanced framework for modeling and simulation and hardware in the loop assessment with scene generation of engagements and techniques to defeat electro-optical and infrared guided threats to airborne platforms. Continue to validate results using data collected in live fire tests. Continue development of electro-optical/infrared models and scenes to transition to multi-spectral threat assessment. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $3.209 million. Decrease is due to realignment of personnel between this effort and the Radio Frequency Electronic Warfare Technologies effort.			
Accomplishments/Planned Programs Subtotals	44.749	45.347	45.410

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
626095: *Sensor Fusion Technology*	-	35.716	35.984	33.577	0.000	33.577	34.323	35.234	35.979	36.763	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops foundational and applied 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 air and ground based targets engaged in multitudes of behaviors in a broad range of operational environments. This project conducts exploratory and applied 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 which leverage data fusion, adaptive signal processing, sensor and platform orchestration, leveraging artificial intelligence / machine learning research communities. This project develops concepts and algorithms for efficient processing at the edge, parallel processing, distributed processing, and high-performance computing in sensor data processing and synthetic data generation.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Battlespace Awareness Sensing Fusion	14.450	11.738	15.883
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 and platforms. 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 2022 Plans: Continue to generate knowledge through fusion of multiple spatial and temporal sensors to provide solutions for contested environments wherein data is extremely limited. Continue to apply deep and machine learning techniques to the detection/ tracking/targeting and recognition of stationary and moving objects and systems, and for pattern of life understanding in a broad set of sensing operating conditions. Advance the development in decision/feature and/or signal-level fusion capabilities that will be applied to new multi-sensor exploitation for autonomy efforts to include demonstration of four-dimensional change detection for intelligence, surveillance and reconnaissance applications. Continue to investigate fusion of hard and soft information sources for military relevant applications. Design and evaluate neural network training techniques, to include blended measured-synthetic training, for deep and machine learning classifiers to produce timely and autonomous intelligence, surveillance and reconnaissance, enhanced situational awareness and improved battlespace awareness with decision timelines inside the adversary's observe, orient, decide, act loop.			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
In FY 2022 this effort was renamed from Synthesis for Understanding to Battlespace Awareness Sensing Fusion. ***FY 2023 Plans:*** Continue to generate knowledge through fusion of multiple spatial and temporal sensors, improving the state of the art in fusion exploitation. Continue to provide solutions for contested environments wherein data is extremely limited. Continue to apply deep and machine learning techniques to the detection/ tracking/targeting, recognition of stationary and moving objects and ground-based systems, pattern of life understanding, applying advanced information understanding tools and emerging techniques, over a broad set of sensing operating conditions. Start research applying techniques learned in air/space to ground application, applying those techniques, where applicable to the air/space to air problem. Continue to investigate fusion of hard and soft information sources for military relevant applications. Continue to invest in integration capabilities which reduce the time between development and demonstration such as a development, secure, operations and algorithm containerization. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $4.145 million. Increase is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors and realignment of funding from Project 626095, Sensor Fusion Technology, Multi-Domain Sensing Effects and Analysis effort.			
Title: Multi-Domain Sensing Effects and Analysis	7.763	6.046	3.436
Description: This effort 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 represent current and next generation sensing platforms to include air, space, and cyber to include fusion of information, battlespace understanding, and the ability to simulate sensor and platform performance at the mission level, engagement level, and physics level, to understand performance and trade space amongst these domains. ***FY 2022 Plans:*** Develop new autonomy performance evaluation techniques adapted to specific artificial intelligence and machine learning challenges. Continue to perform empirical performance estimation for intelligence, surveillance, and reconnaissance automated sensing exploitation of military-critical targets with limited training data. Continue to mature sensor data as-a-service research environment by extending into classified networks and pursuing integration with other data science and research cloud environments further enabling sensing autonomy developers and warfighting analysts. Develop defense applications for new data tagging and automated availability architecture; assist transitions of this capability service-wide and to intelligence community partners. Transition test and evaluation harness software to department-wide performance analysis community; continue to standardize test metrics and performance understanding. ***FY 2023 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
Continue development of autonomy performance evaluation techniques adapted to specific artificial intelligence and machine learning challenges. Continue to perform empirical performance estimation for intelligence, surveillance, and reconnaissance automated sensing exploitation of military-critical targets with limited training data. Employ data as-a-service research environment by extending from unclassified to classified networks, leveraging research cloud environments, further enabling sensing autonomy developers and warfighting analysts. Transition to defense applications the ability to perform new data tagging and automated data availability architecture to a service-wide application along with our intelligence community partners. Continue the transition of test and evaluation harness software to department-wide performance analysis community, leveraging standardize test metrics and performance measurement understanding. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $2.610 million. Funding decrease is a result of realignment of funding to Project 626095, Sensor Fusion Technology, Battlespace Awareness Sensing Fusion effort.			
Title: Knowledge and Execution 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 to include sensor and platform optimization and control, providing environment characterization consistent with the needs of automated and autonomous systems. This research and development investment allows for the automation of closed-loop intelligence, surveillance and reconnaissance. ***FY 2022 Plans:*** Improve and integrate onboard mission resource management techniques for distributed sensing/effects capabilities via open autonomy architectures and continue experimentation via simulation, live, and blended sim/live testing (multiple aircraft & sensors). Continue improving representational and computational efficiency of on-board reasoning about ground targets and target groupings, and target behaviors. Continue development of foundational knowledge management algorithms for situation awareness incorporating interacting ground targets, environments, and operationally representative contingencies. Embrace new forms of reasoning and continue to evolve forms of representations and combined representations and reasoning approaches like self-querying synergistic knowledge graph / machine learning world models, more diverse state representations in reinforcement learning, and spiking neural network reinforcement learning. In FY 2022 this effort was renamed from Multisource Knowledge Representation and Management to Knowledge and Execution Management. ***FY 2023 Plans:*** Continue to improve and integrate onboard mission resource management techniques for distributed sensing/effects capabilities via open autonomy architectures and continue experimentation. Continue to accomplish performance understanding through	13.503	6.900	11.216

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
simulation, demonstration, and blended sim/live testing (multiple aircraft & sensors). Continue improving representational and computational efficiency of on-board reasoning about ground targets and target groupings, and target behaviors. Start new research in foundational knowledge of emerging management algorithms for battlespace awareness incorporating interacting air/ground targets, air/air targets, environments, and operationally representative contingencies. Continue the development of emerging algorithms to perform information reasoning and continue to evolve forms of representations and combined representations and reasoning approaches such as self-querying synergistic knowledge graph / machine learning world models, more diverse state representations in reinforcement learning, and spiking neural network reinforcement learning. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 increased compared to FY 2022 by $4.316 million. Increase is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors and realignment of funding from Project 626095, Sensor Fusion Technology, Cyber Physical Sensing effort.			
Title: Cyber Physical Sensing	0.000	4.300	3.042
Description: Cyber Physical Sensing is the opportunity to exploit the internet of things and other non-traditional intelligence, surveillance and reconnaissance sensing systems in a way other that what they were designed to do. This additional source of information closes the gap between current intelligence, surveillance and reconnaissance collection capabilities and the vision of all intelligence, surveillance and reconnaissance, all the time. This technology investment looks at the sensing opportunities which exist at the point where physics meets the cyber domain. This effort focuses on the proliferated sensing devices, extracting information from multi-intelligence sensors and translating that information into detection, tracking and identification by use of multi-intelligence fusion. This effort leverages processing at-the-edge and distributed processing, exploited using new-generation machine learning, artificial intelligence and deep learning techniques. ***FY 2022 Plans:*** Master real-world sensing physics between the adversary and devices uniquely available via the cyber domain. Develop and instrument empirical, multi domain research facilities to collect, demonstrate, and access cyber physical sensing in mission-relevant context. Research, develop, and transition processing and exploitation techniques with edge and core flexibilities on proliferated and distributed cyber physical platforms. Advance deployed warfighters tactics, techniques, and procedures through the use of exploited cyber physical modalities. Create unsolvable dilemmas for our adversaries by persistent, omniscient sensing of their physical state through cyber means. ***FY 2023 Plans:*** Research new non-traditional intelligence, surveillance and reconnaissance collection opportunities, associate new opportunities to intelligence, surveillance and reconnaissance collection capabilities, and invest appropriately in research and development of techniques to improve collection, processing, and dissemination of information, allowing for automation and autonomy in intelligence, surveillance and reconnaissance. Continue research and development in edge to core/cloud information processing			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
and how these capabilities can best be utilized to get within the adversaries observe, orient, decide, act loop. Start research in new novel techniques to exploit unforeseen information from these non-traditional ISR information sources. Continue research which advances tactics, techniques and procedures by way of new exploitation techniques of cyber physical modalities. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $1.258 million. Funding decrease is a result of realignment of funding to Project 626095, Sensor Fusion Technology, Knowledge and Execution Management effort.			
Accomplishments/Planned Programs Subtotals	35.716	28.984	33.577

	FY 2021	FY 2022
Congressional Add: Program increase: Reliability of combat cloud communications systems	0.000	7.000
FY 2021 Accomplishments: Not applicable		
FY 2022 Plans: Conduct Congressional directed efforts		
Congressional Adds Subtotals	0.000	7.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
627622: *RF Sensors and Countermeasures Tech*	-	34.821	51.752	36.001	0.000	36.001	37.097	37.397	38.192	39.017	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 2021	FY 2022	FY 2023
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 2022 Plans:*** Starting in FY 2022, this work is performed under Project 627622, RF Sensors and Countermeasure Tech, Passive Radio Frequency Sensing effort and Distributed Radio Frequency Sensing effort. ***FY 2023 Plans:*** Not applicable	11.935	0.000	0.000
Title: Multiband Multifunction Radio Frequency Sensing ***Description:*** Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks. ***FY 2022 Plans:***	11.022	20.272	14.295

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Complete demonstration of electronic support measure/airborne moving target indicator/ground moving target indicator modes in ultra high frequency to S-band ground demonstrator. Continue advanced mode development for multi-beam digital arrays, implementing more complex modes and advanced waveforms. Continue investigation of advanced digital signal processing techniques to demonstrate mode-switching and multi-function capability. Initiate mode development for 2-18 GHz airborne digital array. Perform laboratory demonstration of millimeter wave digital beamforming array for command and control functionality. Continue demonstration of additive manufacturing techniques and use of COTS components to fabricate low-cost, wide bandwidth, scalable, and conformal phased array antennas for integration on unmanned sensing platforms such as the Low Cost Attritable Aircraft Technology XQ-58A experimental platform. Complete study of alternative digital backend technologies. Complete performance assessment of wideband digital arrays embedded on platforms. Initiate full wave analysis of sensor performance on large platforms. In FY 2022 this effort was renamed from Multi-Band/Multi-Beam Technologies to Multiband Multifunction Radio Frequency Sensing. ***FY 2023 Plans:*** Demonstrate integrated electronic support measure/airborne moving target indicator/ground moving target indicator modes for passive multi-mode radar using ultra high frequency to S-band digital array demonstrator. Continue advanced mode development for multi-beam and multi-function digital arrays, implementing more complex modes and advanced waveforms with applications for Advanced Early Warning radar. Begin transition of ground-based modes to airborne digital array demonstrator. Continue integration of additively manufactured antennas and radar backend components to demonstrate low-cost, wide bandwidth, scalable, and conformal phased array antennas for unmanned sensing platforms. Perform bi-static flight data collection using low cost digital beamforming receiver. Continue development of techniques for analysis of complex active electronically scanned arrays on large platforms. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $5.977 million. Decrease is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors.			
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 2022 Plans:***	11.864	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Starting in FY 2022, this work is performed under Project 627622, RF Sensors and Countermeasure Tech, Passive Radio Frequency Sensing effort and Distributed Radio Frequency Sensing effort. ***FY 2023 Plans:*** Not applicable			
Title: Passive Radio Frequency Sensing ***Description:*** Develop a system that performs traditional radar sensing modes through passive means. The research plan is designed to continue the development of the subsystems which make up the passive radar and to follow a spiral development path that involves the integration and testing of various technology instantiations to produce alternate versions of a full passive multi-mode system. Includes the development of low size-weight-and-power radio frequency signal detection and geolocation payloads for small unmanned air systems and the integration of advanced receiver subsystems to meet a particular need of the Air Force. Explore combat identification technologies, modeling and simulation enhancements, and technologies supporting passive radar, electronic support, and signals intelligence. ***FY 2022 Plans:*** Continue development of low cost, size, weight and power direction finding payloads and geolocation techniques. Continue integration onto attritable unmanned air systems to improve radio frequency situational awareness for advanced battle management system applications. Initiate development of advanced processing techniques for onboard signal characterization, geolocation/track, and signals pattern-of-life analysis. Continue integration of bi- and multi-static radar clutter models into high fidelity radar system models for evaluation of advanced passive radar performance in complex environments. Continue analysis of bi-static target/ground scattering phenomenology to improve combat identification of ground targets from bi-static/multi-static radar systems. Continue analysis of bi-static high resolution radar data in conjunction with advanced automated target recognition algorithms to demonstrate improved timeliness for combat identification of complex targets from bi-static radar systems. ***FY 2023 Plans:*** Continue development of small low cost direction finding payloads and advanced processing techniques for onboard signal characterization, geolocation/track, and signals pattern-of-life analysis. Demonstrate distributed multi-ship geolocation aboard small unmanned aircraft systems. Continue development of enhanced radio frequency modeling and simulation tools for evaluation of passive radar performance in complex environments. Complete integration of bi- and multi-static radar clutter models into modeling and simulation tools. Continue to integrate high fidelity modeling and simulation with mission level modeling to demonstrate operational utility of passive radar concepts. Continue analysis of bi-static target/ground scattering phenomenology and bi-static high resolution radar data in conjunction with advanced automated target recognition algorithms to demonstrate	0.000	11.554	9.081

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
improved accuracy and timeliness for combat identification of complex targets. Initiate investigation of advanced processing techniques to enhance passive radar performance. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** FY 2023 decreased compared to FY 2022 by $2.473 million. Decrease is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors.			
Title: Distributed Radio Frequency Sensing ***Description:*** Develop innovative, timely, and affordable target detection, tracking, and characterization (namely imaging/ identification) capabilities that leverage two or more spatially-distributed receivers and transmitters that use cooperative radio frequency transmitters (illuminators), namely those radio frequency sources that have a common objective to the receiver systems being used. ***FY 2022 Plans:*** Continue development of robust multi-static transmit waveforms and receive processing chains for operationally relevant multi-static ground moving target indicator systems. Continue development of clutter mitigation techniques for multi-channel distributed sensor systems to detect slow-moving targets in denied environments. Continue advancement of multi-static synthetic aperture radar algorithms to improve operation in complex environments. Complete study of imaging alternatives for low signal-to-noise environments. Initiate assessments of multi-static synthetic aperture radar algorithms to support combat identification and automatic target recognition requirements on tactical timelines. Initiate implementation and demonstration of multi-static synthetic aperture radar algorithms on low cost, size, weight and power platforms. Continue data collection and analysis to assess performance of distributed radar systems for ground moving target indicator and synthetic aperture radar modes. ***FY 2023 Plans:*** Continue development of robust non-traditional multi-static transmit waveforms and receive processing chains for operationally relevant multi-static ground moving target indicator systems. Initiate investigation of platform constraints and implementation of near real-time processing. Define requirements for capstone flight experiment demonstrating multi-static detection and tracking of ground targets. Continue enhancements of multi-static synthetic aperture radar algorithms to support combat identification and automatic target recognition requirements on tactical timelines. Continue implementation and demonstration of multi-static synthetic aperture radar algorithms on cost and size constrained platforms. Begin to develop/mature distributed 3-dimensional imaging algorithms that are scalable to a multi-domain approach. Continue data collection and analysis to assess performance of distributed radar systems for ground moving target indicator and synthetic aperture radar. Continue to explore multi- and cross-domain applications. ***FY 2022 to FY 2023 Increase/Decrease Statement:***	0.000	19.926	12.625

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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 2021	FY 2022	FY 2023
FY 2023 decreased compared to FY 2022 by $7.301 million. Decrease is the result of rebalancing organizational support costs among the projects in PE 0602204F, Aerospace Sensors.			
Accomplishments/Planned Programs Subtotals	34.821	51.752	36.001

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable