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Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force **Date:** May 2021

Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>
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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	-	210.940	232.876	193.514	0.000	193.514	-	-	-	-	-	-
622002: <i>Electronic Component Technology</i>	-	52.667	55.327	35.772	0.000	35.772	-	-	-	-	-	-
622003: <i>EO Sensors & Countermeasures Tech</i>	-	30.934	45.638	24.725	0.000	24.725	-	-	-	-	-	-
622005: <i>Cyber Technology</i>	-	9.387	16.625	6.934	0.000	6.934	-	-	-	-	-	-
624920: <i>Electronic Warfare Technology</i>	-	34.795	44.749	45.347	0.000	45.347	-	-	-	-	-	-
626095: <i>Sensor Fusion Technology</i>	-	27.577	35.716	28.984	0.000	28.984	-	-	-	-	-	-
627622: <i>RF Sensors and Countermeasures Tech</i>	-	55.580	34.821	51.752	0.000	51.752	-	-	-	-	-	-

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 PE 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 & technology capabilities. The use of program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 0602298F, and 1206601S.

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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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	219.912	211.301	205.495	0.000	205.495
Current President's Budget	210.940	232.876	193.514	0.000	193.514
Total Adjustments	-8.972	21.575	-11.981	0.000	-11.981
• Congressional General Reductions	0.000	-0.425			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	22.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.625	0.000			
• SBIR/STTR Transfer	-2.495	0.000			
• Other Adjustments	-7.102	0.000	-11.981	0.000	-11.981

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 622002: *Electronic Component Technology*

Congressional Add: *Program increase - exploitation detection*

Congressional Add Subtotals for Project: 622002

Project: 622003: *EO Sensors & Countermeasures Tech*

Congressional Add: *Low cost sensors for small unmanned vehicles*

Congressional Add: *Additive manufacturing for electronics*

Congressional Add Subtotals for Project: 622003

Project: 622005: *Cyber Technology*

Congressional Add: *Cyber assurance and assessment of electronic hardware systems*

Congressional Add Subtotals for Project: 622005

Project: 627622: *RF Sensors and Countermeasures Tech*

Congressional Add: *Program increase - RF spectrum situational awareness*

	FY 2020	FY 2021
Congressional Add Subtotals for Project: 622002	8.898	5.000
Congressional Add Subtotals for Project: 622003	0.000	5.000
	0.000	6.000
Congressional Add Subtotals for Project: 622005	0.000	6.000
Congressional Add Subtotals for Project: 627622	7.909	0.000

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Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
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Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>
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Congressional Add Details (\$ in Millions, and Includes General Reductions)

	FY 2020	FY 2021
Congressional Add Subtotals for Project: 627622	7.909	0.000
Congressional Add Totals for all Projects	16.807	22.000

Change Summary Explanation

FY 2020 Other Adjustments: Decrease of 7.102 million due to Air Force reprogramming.
 FY 2022: Decrease of \$11.981 million due to DAF higher priorities.

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force										Date: May 2021		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602204F / Aerospace Sensors				Project (Number/Name) 622002 / Electronic Component Technology			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
622002: <i>Electronic Component Technology</i>	-	52.667	55.327	35.772	0.000	35.772	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Sensor Subsystems	8.108	9.060	7.012
Description: Develop, analyze, demonstrate, and perform engineering trade studies for technologies for compact, affordable, multi-function subsystems for aerospace sensors.			
FY 2021 Plans: Complete development of direction finding subsystem prototypes for attritable systems. Complete research for highly miniaturized and power-efficient on-board sensor processing. Continue low cost electro-optical/infrared sensor subsystem development. Initiate research into autonomous low size, weight and power sensor processing. Initiate research into digital at every element technology for multifunction microwave and millimeter wave arrays.			
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 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by \$2.048 million. Decrease is due to decreased emphasis in sensor subsystems.			
Title: Electronic Devices	7.185	8.769	5.893

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021		
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622002 / <i>Electronic Component Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>Description: Assess, research, develop, demonstrate and transition revolutionary and evolutionary electronic devices and their associate technologies.</p> <p>FY 2021 Plans: Complete wide-bandgap device technology proof of concept for power generation and management. Continue advanced wide band-gap model development for multi-use applications. Continue novel wide-band gap switch integration with millimeter-wave transistor development. Initiate development of integrated chip-level radio frequency devices and power conversion modeling and wide bandgap device and power conversion integration technologies.</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by 2.876 million. Decrease is due to decreased emphasis in electronic devices.</p>				
<p>Title: Electro-Optical/Infrared (EO/IR) Components</p> <p>Description: Research, develop, demonstrate and transition electro-optical/infrared (EO/IR) components for next generation intelligence, surveillance, reconnaissance (ISR) and countermeasures.</p> <p>FY 2021 Plans: Complete initial evaluation of innovative materials and devices for tunability, increased bandwidth and multi-wavelength operation. Complete compact, tunable, laser source prototype. Continue advanced avalanche photo-diode based focal plane array development. Initiate photonic and quantum substructure technology development. Initiate research into non-linear devices for tunability and power scaling.</p> <p>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 tunability and power scaling. Initiate development of high power, narrow line width lasers sources for advanced sensing and countermeasure applications.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement:</p>		8.395	8.930	6.069

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622002 / <i>Electronic Component Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
FY 2022 decreased compared to FY 2021 by \$2.861 million. Decrease is due to realignment of funding to Project 622002, Electronic Component Technology, Microelectronics & Embedded System Assurance effort.				
<p>Title: Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Mission Systems</p> <p>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.</p> <p>FY 2021 Plans: Complete initial investigations of 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. Continue development of prototype trustworthiness assessment capability. Continue reliability assessments of advanced heterogeneously integrated microsystems. Continue investigations of 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. Initiate the development of processes and techniques for trust through design. Initiate investigations of security verification techniques and methodologies for integrated circuit designs.</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by \$8.529 million. Decrease is due to realignment of funding to Project 622002, Electronic Component Technology, Microelectronics & Embedded System Assurance effort.</p>		13.449	15.575	7.046
<p>Title: Advanced Highly Integrated Microsystems for Intelligence, Surveillance, Reconnaissance and Electronic Warfare</p> <p>Description: Perform research and development of electronic and photonic circuit and microsystem technologies focused on miniaturization, power reduction, reconfigurability and reduced cost.</p> <p>FY 2021 Plans:</p>		6.632	7.993	5.592

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622002 / <i>Electronic Component Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>Complete assessment of military relevant heterogeneous integration technologies. Complete development of additive techniques for advanced electronic subsystems. Initiate development of next generation reconfigurable transceiver prototype. Continue development of photonically enabled electronic intelligence subsystem. Continue development of photonic antenna remoting concept. Continue development of integrated and adaptable transceiver microsystems. Initiate 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.</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by 2.401 million. Decrease is due to decreased emphasis in microsystems.</p>				
<p>Title: Microelectronics & Embedded System Assurance</p> <p>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.</p> <p>FY 2021 Plans: Not applicable</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 increased compared to FY 2021 by \$4.160 million. Increase is a result of realignment of funding from Project 622002, Electronic Component Technology, Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Mission Systems effort.</p>		0.000	0.000	4.160
Accomplishments/Planned Programs Subtotals		43.769	50.327	35.772

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622002 / <i>Electronic Component Technology</i>
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	FY 2020	FY 2021
Congressional Add: Program increase - exploitation detection	8.898	5.000
FY 2020 Accomplishments: Conduct Congressional directed efforts		
FY 2021 Plans: Conduct Congressional directed efforts		
Congressional Adds Subtotals	8.898	5.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force										Date: May 2021		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>				Project (Number/Name) 622003 / <i>EO Sensors & Countermeasures Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
622003: <i>EO Sensors & Countermeasures Tech</i>	-	30.934	45.638	24.725	0.000	24.725	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
<p>Title: Passive Electro-Optical/Infrared Sensing in Contested Environments</p> <p>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.</p> <p>FY 2021 Plans: Conduct a flight test evaluation of the staring infrared search and track system against military relevant targets. Start development of a low-cost, low volume, real-time hyperspectral sensor and processor for attributable platforms including advanced machine learning algorithms to improve performance, speed and computational efficiency of hyperspectral detection. Complete analysis of active hyperspectral imaging demonstrations in preparation for transition. Initiate development of low-earth orbit sensing systems for critical Air Force needs.</p> <p>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 attributable 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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by 5.985 million. Decrease is due to decreased emphasis in infrared sensing.</p>	15.529	18.396	12.411
<p>Title: Laser Radar Sensing in Contested Environments</p>	15.405	16.242	12.314

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622003 / <i>EO Sensors & Countermeasures Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
<p>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.</p> <p>FY 2021 Plans: Continue development of data processing algorithms for 3-dimension sensing and synthetic aperture lidar (laser radar). Continue to advance the state of the art in coherent lidar (digital holography) and non-mechanical beam steering for low-cost sensing applications. Continue development of Aided Target Recognition algorithms for 3-dimension laser radar. Investigate use of data from flight collection of the vibration sensor to advance aided target recognition algorithms using artificial intelligence and machine learning. Continue to make improvements on lidar modeling to include engagement level models for evaluating mission effectiveness of various laser radar systems.</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by 3.928 million. Decrease is due to decreased emphasis in laser radar sensing.</p>			
Accomplishments/Planned Programs Subtotals	30.934	34.638	24.725

	FY 2020	FY 2021
<p>Congressional Add: Low cost sensors for small unmanned vehicles</p> <p>FY 2020 Accomplishments: Not applicable</p> <p>FY 2021 Plans: Conduct congressional directed efforts</p>	0.000	5.000
<p>Congressional Add: Additive manufacturing for electronics</p> <p>FY 2020 Accomplishments: Not applicable</p> <p>FY 2021 Plans: Conduct Congressional directed efforts</p>	0.000	6.000
Congressional Adds Subtotals	0.000	11.000

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622003 / <i>EO Sensors & Countermeasures Tech</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force **Date:** May 2021

Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602204F / Aerospace Sensors				Project (Number/Name) 622005 / Cyber Technology			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
622005: <i>Cyber Technology</i>	-	9.387	16.625	6.934	0.000	6.934	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
<p>Title: Vulnerability Mitigation</p> <p>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.</p> <p>FY 2021 Plans: Complete assessing Test, Maintenance, and Acquisition community capability gaps of transitioned automated test tools. Start last round of new tools and technique refinements as required. Continue to work with other Services to demonstrate cyber resiliency capabilities on air, ground and sea platforms. Continue development of next generation mission systems architecture to design in agile and resilient capabilities. Perform initial flight demonstration of integrated Open Mission Systems architecture with next generation mission systems architecture.</p> <p>FY 2022 Plans: Starting in FY 2022, this work is performed under Project 622005, Cyber Technology, Flexible and Secure Avionics effort.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by \$5.185 million. The decrease is due to the realignment of funding to Project 622005, Cyber Technology, Flexible and Secure Avionics effort.</p>	4.324	5.185	0.000
<p>Title: Flexible and Secure Avionics</p> <p>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,</p>	5.063	5.440	6.934

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622005 / <i>Cyber Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
<p>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.</p> <p><i>FY 2021 Plans:</i> Demonstrate initial 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. Demonstrate automated test generation tools that 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.</p> <p><i>FY 2022 Plans:</i> 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 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.</p> <p>In FY 2022 this effort was renamed from Agile Mission Systems Protections to Flexible and Secure Avionics.</p> <p><i>FY 2021 to FY 2022 Increase/Decrease Statement:</i> FY 2022 increased compared to FY 2021 by \$1.494 million. The increase is due to realignment of funding from Project 622005, Cyber Technology, Vulnerability Mitigation effort.</p>			
Accomplishments/Planned Programs Subtotals	9.387	10.625	6.934

	FY 2020	FY 2021
<i>Congressional Add:</i> Cyber assurance and assessment of electronic hardware systems	0.000	6.000
<i>FY 2020 Accomplishments:</i> Not applicable		
<i>FY 2021 Plans:</i> Conduct Congressional directed efforts		
Congressional Adds Subtotals	0.000	6.000

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 622005 / <i>Cyber Technology</i>
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C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force										Date: May 2021		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>				Project (Number/Name) 624920 / <i>Electronic Warfare Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
624920: <i>Electronic Warfare Technology</i>	-	34.795	44.749	45.347	0.000	45.347	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Positioning, Navigation and Timing in Contested/Denied Environments	9.663	12.446	14.415
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 2021 Plans: Continue 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 (electromagnetic warfare). Begin to develop the requirements for a prototype communications receiver to provide a connected solution for time, frequency, velocity and position data transfer. Continue development of trust techniques to enable military use of global navigational satellite systems. Continue modeling and simulation studies to address the multi-spectrum threats to satellite navigation systems.			
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			

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 624920 / <i>Electronic Warfare Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
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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.			
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<p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 increased compared to FY 2021 by 1.969 million. Funding increased due to realignment from PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, Resilient Positioning, Navigation and Timing effort.</p>			
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Title: Radio Frequency Electronic Warfare Technologies	17.631	22.759	20.741
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<p>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.</p>			
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<p>FY 2021 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. Conduct technology maturation demonstrations to showcase improved performance. 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. Start experimentation with low cost and miniaturized electronic attack assets. Conduct demonstration of distributed and robust techniques that are delivered through digital at the aperture jammers. Continue incorporation of electro-optical and radio frequency integrated engagement model development to meet multispectrum threats.</p>			
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<p>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.</p>			
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FY 2021 to FY 2022 Increase/Decrease Statement:			
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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force	Date: May 2021
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 624920 / <i>Electronic Warfare Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
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FY 2022 decreased compared to FY 2021 by \$2.018 million. Decrease is due to realignment of funding to Project 624920, Electronic Warfare Technology, Positioning, Navigation and Timing in Contested/Denied Environments effort and Electro-Optical/Infrared Threat Warning and Countermeasures Technologies effort.			
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Title: Electro-Optical/Infrared Threat Warning and Countermeasures Technologies	7.501	9.544	10.191
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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 2021 Plans:

Continue threat characterization and countermeasures techniques development against new infrared guided threats. Evaluate advanced threat surrogates during infrared countermeasure testing at several test ranges. Begin laboratory and field testing of new low-cost missile warning sensor and evaluate upgrades to Large Aircraft Infrared Counter-Measure program missile warning and countermeasures sensors. Continue to investigate long-range missile and laser warning technology concepts. Continue development of electro-optical and radio frequency integrated engagement models into the Advanced Framework for Simulation, Integration and Modeling environment to meet multispectrum threats. Start test of novel countermeasure techniques against advanced threats.

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 2021 to FY 2022 Increase/Decrease Statement:

FY 2022 increased compared to FY 2021 by 0.647 million. Justification for this increase is described in plans above.

Accomplishments/Planned Programs Subtotals	34.795	44.749	45.347
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C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force **Date:** May 2021

Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 624920 / <i>Electronic Warfare Technology</i>
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D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force **Date:** May 2021

Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602204F / Aerospace Sensors				Project (Number/Name) 626095 / Sensor Fusion Technology			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
626095: <i>Sensor Fusion Technology</i>	-	27.577	35.716	28.984	0.000	28.984	-	-	-	-	-	-

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 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 2020	FY 2021	FY 2022
<p>Title: Battlespace Awareness Sensing Fusion</p> <p>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.</p> <p>FY 2021 Plans: Continue to develop capabilities for space-time alignment of multiple domain information sources. Continue to apply deep and machine learning techniques to the detection/tracking/identification of stationary and moving objects and systems, and for pattern of life understanding in a broader set of operating conditions. Start advance development in decision/feature-level fusion capabilities that will be applied to new multi-sensor exploitation for autonomy efforts. Continue to investigate fusion of hard and soft information sources for military relevant applications. Continue to design and evaluate neural network training techniques, to include blended measured-synthetic training, for deep and machine learning classifiers.</p> <p>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</p>	11.260	14.450	11.738

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021		
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 626095 / <i>Sensor Fusion Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>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.</p> <p>In FY 2022 this effort was renamed from Synthesis for Understanding to Battlespace Awareness Sensing Fusion.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by 2.712 million. Decrease is due to decreased emphasis in sensing fusion.</p>				
<p>Title: Multi-Domain Sensing Effects and Analysis</p> <p>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 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.</p> <p>FY 2021 Plans: Continue to leverage academic partnerships with respect to specific Air Force applications in modeling, simulation and analysis. Continue to design and build next generation correct fidelity performance models. Continue to develop operational vignettes to support Air Force technology investment understanding. Continue to support in-the-field data collections to verify and validate performance using measured sensor data. Start research efforts for effectively collecting, tagging, curating, and retrieving data for advanced sensing development. Start the development of representative scenarios for autonomy development.</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement:</p>		5.308	7.763	6.046

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 626095 / <i>Sensor Fusion Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
FY 2022 decreased compared to FY 2021 by 1.717 million. Decrease is due to decreased emphasis in sensing effects.				
<p>Title: Knowledge and Execution Management</p> <p>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.</p> <p>FY 2021 Plans: Continue development of mission resource management techniques for distributed sensing capabilities. Start the development of improving representational and computational efficiency of ground base and on-board reasoning and re-planning methods. Continue development of foundational management algorithms for situation awareness incorporating environment analysis, target detection, tracking and recognition, and operationally representative contingencies.</p> <p>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.</p> <p>In FY 2022 this effort was renamed from Multisource Knowledge Representation and Management to Knowledge and Execution Management.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 decreased compared to FY 2021 by \$6.603 million. Decrease is due to realignment of funding to Project 626095, Sensor Fusion Technology, Cyber Physical Sensing effort.</p>		11.009	13.503	6.900
<p>Title: Cyber Physical Sensing</p> <p>Description: Cyber Physical Sensing is a new sensing opportunity area. 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-INT sensors and translating that information into detection, tracking and identification by use of multi-INT fusion. This effort leverages processing at-the-edge and distributed processing to enable machine learning, artificial intelligence and deep learning techniques.</p>		0.000	0.000	4.300

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force	Date: May 2021
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 626095 / <i>Sensor Fusion Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
<p><i>FY 2021 Plans:</i> Not applicable</p> <p><i>FY 2022 Plans:</i> 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.</p> <p><i>FY 2021 to FY 2022 Increase/Decrease Statement:</i> FY 2022 increased compared to FY 2021 by \$4.300 million. Increase is due to realignment of funding from Project 626095, Sensor Fusion Technology, Knowledge and Execution Management effort.</p>			
Accomplishments/Planned Programs Subtotals	27.577	35.716	28.984

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force										Date: May 2021		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>				Project (Number/Name) 627622 / <i>RF Sensors and Countermeasures Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
627622: <i>RF Sensors and Countermeasures Tech</i>	-	55.580	34.821	51.752	0.000	51.752	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Radio Frequency Sensor Technologies	14.262	9.946	0.000
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 2021 Plans: Complete analysis of ground-based data from passive illumination selection manager and initiate algorithm improvements. Start analysis of bistatic high resolution radar data in conjunction with advanced automated target recognition algorithms to demonstrate improved timeliness for combat identification of complex targets from bistatic radar systems. Initiate system integration and ground testing of low cost bistatic radar system for attritable/expendable platforms. Initiate integration of low cost data collection and signal processing backend to provide real-time processing for future airborne demonstration.			
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 2021 to FY 2022 Increase/Decrease Statement:			

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
FY 2022 decreased compared to FY 2021 by \$9.946 million. Funding decreased due to realignment to Project 627622, RF Sensors and Countermeasures Tech, Passive Radio Frequency Sensing effort and Distributed Radio Frequency Sensing effort.				
<p>Title: Multiband Multifunction Radio Frequency Sensing</p> <p>Description: Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks.</p> <p>FY 2021 Plans: Continue to employ adaptive, additively manufactured phased array demonstration by laboratory testing and performance validation of single subarray panel. Start fabricating and integrating multiple subarray panels designed for a Low Cost Attritable Aircraft Technology experimental platform. Start advanced mode development for multi-beam digital arrays, implementing more complex modes and advanced waveforms. Start integration of advanced digital signal processing techniques to demonstrate mode-switching and multi-function capability.</p> <p>FY 2022 Plans: 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.</p> <p>In FY 2022 this effort was renamed from Multi-Band/Multi-Beam Technologies to Multiband Multifunction Radio Frequency Sensing.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 increased compared to FY 2021 by \$6.774 million. Increase is a result Department of the Air Force reprogramming.</p>		17.707	13.498	20.272
<p>Title: Sensor Resource Management</p> <p>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.</p>		15.702	11.377	0.000

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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / <i>Aerospace Sensors</i>	Project (Number/Name) 627622 / <i>RF Sensors and Countermeasures Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
<p><i>FY 2021 Plans:</i> Continue development of sensor resource management within Defense Advanced Research Projects Agency Arrays at Commercial Timescales architecture, extending beyond basic array control to real-time implementation including latency effects on mission execution. Initiate implementation of sensor resource management concepts for passive multi-mode radar, providing coordination of system resources between electronic support, illumination selection manager and passive radar subsystems. Continue development of multi-ship sensor resource management techniques for optimizing distributed and multi-spectral sensing resources.</p> <p><i>FY 2022 Plans:</i> 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.</p> <p><i>FY 2021 to FY 2022 Increase/Decrease Statement:</i> FY 2022 decreased compared to FY 2021 by \$11.377 million. Funding decreased due to realignment of funding to Project 627622, RF Sensors and Countermeasures Tech, Passive Radio Frequency Sensing effort and Distributed Radio Frequency Sensing effort.</p>			
<p><i>Title:</i> Passive Radio Frequency Sensing</p> <p><i>Description:</i> 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.</p> <p><i>FY 2021 Plans:</i> For FY 2021 and prior, this work is performed under Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Sensor Technologies effort, Sensor Resource Management effort, and Multiband Multifunction Radio Frequency Sensing effort.</p> <p><i>FY 2022 Plans:</i> 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</p>	0.000	0.000	11.554

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
<p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 increased compared to FY 2021 by \$11.554 million. Funding increased due to realignment of funding from Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Sensor Technologies effort and Sensor Resource Management effort.</p>			
<p>Title: Distributed Radio Frequency Sensing</p> <p>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.</p> <p>FY 2021 Plans: For FY 2021 and prior, this work is performed under Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Sensor Technologies effort, Sensor Resource Management effort, and Multiband Multifunction Radio Frequency Sensing effort.</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 increased compared to FY 2021 by \$19.926 million. Funding increased due to realignment from Project 627622, RF Sensors and Countermeasures Tech, Radio Frequency Sensor Technologies effort and Sensor Resource Management effort.</p>	0.000	0.000	19.926
Accomplishments/Planned Programs Subtotals	47.671	34.821	51.752

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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	FY 2020	FY 2021
Congressional Add: Program increase - RF spectrum situational awareness	7.909	0.000
FY 2020 Accomplishments: Conduct Congressional directed efforts		
FY 2021 Plans: Not applicable		
Congressional Adds Subtotals	7.909	0.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A