| Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force | | | | | | | | | | | Date: February 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appropriation/Budget Activity<br>3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research* | | | | | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | | | | | | | |
| **COST ($ in Millions)** | **Prior Years** | **FY 2019** | **FY 2020** | **FY 2021 Base** | **FY 2021 OCO** | **FY 2021 Total** | **FY 2022** | **FY 2023** | **FY 2024** | **FY 2025** | **Cost To Complete** | **Total Cost** |
| Total Program Element | - | 168.897 | 219.912 | 211.301 | 0.000 | 211.301 | 205.495 | 200.423 | 205.424 | 208.882 | Continuing | Continuing |
| 622002: *Electronic Component Technology* | - | 43.018 | 52.667 | 50.752 | 0.000 | 50.752 | 49.009 | 47.906 | 49.227 | 50.435 | Continuing | Continuing |
| 622003: *EO Sensors & Countermeasures Tech* | - | 28.416 | 30.934 | 34.638 | 0.000 | 34.638 | 33.716 | 32.449 | 33.143 | 33.260 | Continuing | Continuing |
| 622005: *Cyber Technology* | - | 6.109 | 9.387 | 10.625 | 0.000 | 10.625 | 8.445 | 8.808 | 9.539 | 9.836 | Continuing | Continuing |
| 624920: *Electronic Warfare Technology* | - | 0.000 | 34.795 | 44.749 | 0.000 | 44.749 | 45.296 | 44.589 | 45.242 | 45.937 | Continuing | Continuing |
| 626095: *Sensor Fusion Technology* | - | 31.826 | 32.063 | 35.716 | 0.000 | 35.716 | 34.875 | 33.462 | 34.154 | 35.052 | Continuing | Continuing |
| 627622: *RF Sensors and Countermeasures Tech* | - | 59.528 | 60.066 | 34.821 | 0.000 | 34.821 | 34.154 | 33.209 | 34.119 | 34.362 | 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.

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

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

| Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| Appropriation/Budget Activity<br>3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research* | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | |

| B. Program Change Summary ($ in Millions) | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total |
|---|---|---|---|---|---|
| Previous President's Budget | 171.307 | 202.912 | 209.631 | 0.000 | 209.631 |
| Current President's Budget | 168.897 | 219.912 | 211.301 | 0.000 | 211.301 |
| Total Adjustments | -2.410 | 17.000 | 1.670 | 0.000 | 1.670 |
| • Congressional General Reductions | 0.000 | 0.000 | | | |
| • Congressional Directed Reductions | 0.000 | 0.000 | | | |
| • Congressional Rescissions | 0.000 | 0.000 | | | |
| • Congressional Adds | 0.000 | 17.000 | | | |
| • Congressional Directed Transfers | 0.000 | 0.000 | | | |
| • Reprogrammings | 0.000 | 0.000 | | | |
| • SBIR/STTR Transfer | -2.410 | 0.000 | | | |
| • Other Adjustments | 0.000 | 0.000 | 1.670 | 0.000 | 1.670 |

| Congressional Add Details ($ in Millions, and Includes General Reductions) | FY 2019 | FY 2020 |
|---|---|---|
| **Project:** 622002: *Electronic Component Technology* | | |
| Congressional Add: *Program increase - exploitation detection* | 0.000 | 9.000 |
| Congressional Add Subtotals for Project: 622002 | 0.000 | 9.000 |
| **Project:** 627622: *RF Sensors and Countermeasures Tech* | | |
| Congressional Add: *Program increase - Air Force Minority Leaders Program* | 4.930 | 0.000 |
| Congressional Add: *Program increase - RF spectrum situational awareness* | 0.000 | 8.000 |
| Congressional Add Subtotals for Project: 627622 | 4.930 | 8.000 |
| Congressional Add Totals for all Projects | 4.930 | 17.000 |

**Change Summary Explanation**

Increase in FY 2021 of $1.670 million is due to civilian pay reprice adjustments.

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>3600 / 2 | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | Project (Number/Name)<br>622002 / *Electronic Component Technology* | |

| COST ($ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 622002: *Electronic Component Technology* | - | 43.018 | 52.667 | 50.752 | 0.000 | 50.752 | 49.009 | 47.906 | 49.227 | 50.435 | 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 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Title:*** Sensor Subsystems | 9.910 | 8.425 | 9.730 |
| ***Description:*** Develop, analyze, demonstrate, and perform engineering trade studies for technologies for compact, affordable, multi-function subsystems for aerospace sensors.<br><br>***FY 2020 Plans:***<br>Complete wideband multifunction array technology development. Continue development of direction finding subsystem prototypes for attritable systems. Continue research for highly miniaturized and power-efficient on-board sensor processing. Initiate low cost electro-optical/infrared sensor subsystem development.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $1.305 million. Funding increased due to initiating digital at every element technology for multifunction microwave and millimeter wave arrays and civilian pay reprice adjustments. | | | |
| ***Title:*** Electronic Devices | 7.615 | 7.467 | 8.751 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622002 / *Electronic Component Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Description:*** Assess, research, develop, demonstrate and transition revolutionary and evolutionary electronic devices and their associate technologies.<br><br>***FY 2020 Plans:***<br>Complete commercialization of Air Force foundry process to industry. Complete millimeter-wave gallium nitride transistor development. Continue wide-bandgap device technology development for power generation and management. Initiate advanced wide band-gap model development for multi-use applications. Initiate novel wide-band gap switch integration with millimeter-wave transistor development.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $1.284 million. Funding increased due to additional emphasis on development of integrated chip-level radio frequency devices, power conversion modeling wide bandgap device, power conversion integration technologies, and civilian reprice adjustments. | | | |
| ***Title:*** Electro-Optical/Infrared (EO/IR) Components<br><br>***Description:*** Research, develop, demonstrate and transition electro-optical/infrared (EO/IR) components for next generation intelligence, surveillance, reconnaissance (ISR) and countermeasures.<br><br>***FY 2020 Plans:***<br>Complete neutron/radiation detector demonstration. Complete wavelength conversion demonstration. Complete preliminary narrow line width laser demonstration. Continue to explore and evaluate innovative materials and devices for tunability, increased bandwidth and multi-wavelength operation. Continue compact, tunable, laser source prototype. Initiate advanced avalanche photo-diode based focal plane array development.<br><br>***FY 2021 Plans:***<br>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 tunablity and power scaling.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:*** | 9.148 | 8.725 | 10.246 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622002 / *Electronic Component Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| FY 2021 increased compared to FY 2020 by $1.521 million. Funding increased due to additional emphasis on research into non-linear devices for tunablity, power scaling, and civilian pay reprice adjustments. | | | |
| ***Title:*** Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Mission Systems | 9.674 | 12.157 | 13.692 |
| ***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.<br><br>In FY 2021, this effort is renamed from Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Systems to Trusted Electronics for Intelligence, Surveillance, Reconnaissance and Avionics Mission Systems.<br><br>***FY 2020 Plans:***<br>Continue investigations and demonstration of trust in design and trust in fabrication. Advance modeling and simulation capability to improve predictive capability of mission assurance for highly integrated microsystems, devices, and materials. Continue development of prototype trustworthiness assessment capability. Continue reliability assessments of advanced heterogeneously integrated microsystems. Investigate application of trust into sensors and sensor systems to deter reverse engineering and exploitation of critical hardware and software technology and impede unwanted technology transfer, alteration of system capability, and prevent the development of countermeasures to our systems.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $1.535 million. Funding increased due to additional emphasis on development of processes and techniques for trust through design and civilian pay reprice adjustments. | | | |
| ***Title:*** Advanced Highly Integrated Microsystems for Intelligence, Surveillance, Reconnaissance and Electronic Warfare | 6.671 | 6.893 | 8.333 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622002 / *Electronic Component Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Description:*** Develop, mature, and demonstrate critical electronic technologies to enable revolutionary electronic warfare subsystems.<br><br>***FY 2020 Plans:***<br>Complete initial demonstration of integrated wideband and adaptable transceiver microsystem. Initiate development of photonically enabled electronic intelligence subsystem. Initiate development of photonic antenna remoting concept. Initiate development of integrated and adaptable transceiver microsystems. Continue development of military relevant heterogeneous integration technologies. Continue development of additive techniques for advanced electronic subsystems.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $1.440 million. Funding increased due to additional emphasis on 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. | | | |
| **Accomplishments/Planned Programs Subtotals** | 43.018 | 43.667 | 50.752 |

| | FY 2019 | FY 2020 |
|---|---|---|
| ***Congressional Add:*** Program increase - exploitation detection | 0.000 | 9.000 |
| ***FY 2019 Accomplishments:*** Not applicable | | |
| ***FY 2020 Plans:*** Conduct Congressional directed efforts | | |
| **Congressional Adds Subtotals** | 0.000 | 9.000 |

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

N/A

**Remarks**

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622002 / *Electronic Component Technology* |

**D. Acquisition Strategy**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>3600 / 2 | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | Project (Number/Name)<br>622003 / *EO Sensors & Countermeasures Tech* | |

| COST ($ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 622003: *EO Sensors & Countermeasures Tech* | - | 28.416 | 30.934 | 34.638 | 0.000 | 34.638 | 33.716 | 32.449 | 33.143 | 33.260 | 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 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Title:*** Passive Electro-Optical/Infrared Sensing in Contested Environments | 13.472 | 15.126 | 16.452 |
| ***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 2020 Plans:***<br>Continue infrared search and track simulation and modeling to support detection and tracking algorithm development and sensor performance assessment. Complete design and development of focal plane array and the associated read-out integrated circuit. Continue evaluation of compact hyperspectral imaging sensor performance through low altitude flight testing on a surrogate platform. Conduct a flight test of a breadboard active hyperspectral imaging system on a lab-class aircraft. Evaluate a novel atmospheric characterization technique through continued data collections coincident with truth sensors. Perform studies to leverage dual-band sensor concepts for improved turbulence mitigation to improve the useful range beyond the current state of the art. Initiate studies into improving standoff high-resolution imaging by leveraging new machine learning algorithms. | | | |
| ***FY 2021 Plans:***<br>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 attritable 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. | | | |
| ***FY 2020 to FY 2021 Increase/Decrease Statement:*** | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622003 / *EO Sensors & Countermeasures Tech* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| FY 2021 increased compared to FY 2020 by $1.326 million. Funding increased due to additional emphasis of developing low-earth orbit sensing systems and civilian pay reprice adjustments. | | | |
| ***Title:*** Laser Radar Sensing in Contested Environments<br><br>***Description:*** Develop innovative laser sensing technology for non-cooperative identification of airborne and ground-based targets in contested environments. Develop optical spectrum transmitters, detectors and agile aperture technologies capable of sensing multiple target characteristics for robust non-cooperative target identification and future infrared countermeasure systems.<br><br>***FY 2020 Plans:***<br>Flight test near real time image formation algorithms for new 3-dimension sensing mode using focal planes built the previous year. Continue development of image formation algorithms for synthetic aperture lidar with advanced waveforms. Continue development of advanced focal planes for coherent lidar sensing; including completing design and build of integrated dewar cooler assembly. Develop approach for real-time determination of volumetric turbulence using a holographic sensor. 3-dimension shape sensing efforts will focus on real-time delivery of processed products with an emphasis on overcoming high sensor data rates. Enhance existing aided target recognition algorithms with a focus on segmenting target from its background. Continue to enhance state of the art lidar simulations to support requirements definition, engagement modeling, enhanced processing development, and synthetic data generation for aided target recognition efforts. Investigate use of photon counting arrays for coherent sensing. Investigate the use of polarization gratings as a low cost, low size weight and power method of steering lidar system.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $2.378 million. Funding increased due to additional emphasis on synthetic aperture lidar, vibration sensing, and 3-dimension sensing research and civilian pay reprice adjustments. | 14.944 | 15.808 | 18.186 |
| **Accomplishments/Planned Programs Subtotals** | 28.416 | 30.934 | 34.638 |

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

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622003 / *EO Sensors & Countermeasures Tech* |

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

**Remarks**

**D. Acquisition Strategy**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>3600 / 2 | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | Project (Number/Name)<br>622005 / *Cyber Technology* | |

| COST ($ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 622005: *Cyber Technology* | - | 6.109 | 9.387 | 10.625 | 0.000 | 10.625 | 8.445 | 8.808 | 9.539 | 9.836 | 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 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Title:*** Vulnerability Mitigation | 2.661 | 4.096 | 4.709 |
| ***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 2020 Plans:***<br>Continue development of automated tools for performing cyber test and assessment of weapon systems. As more mature capabilities are transitioned, assess community capability gaps and develop/enhance tools as needed. Continue research and development of vulnerability mitigation technologies for legacy platforms and to support the maturation of next generation avionics architectures. Baseline technologies and capabilities will be available this year and will need continued investigation into their secure use. Increase focus on cyber test/assessment/situational-awareness of next-generation architectures. Investigate cyber assessment methodologies and open system architecture standards and approaches to reduce susceptibility of legacy and next-generation avionics architectures. | | | |
| ***FY 2021 Plans:***<br>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. | | | |
| ***FY 2020 to FY 2021 Increase/Decrease Statement:*** | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622005 / *Cyber Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| FY 2021 increased compared to FY 2020 by $0.613 million due to civilian pay reprice adjustments. | | | |
| ***Title:*** Agile Mission Systems Protections<br><br>***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.<br><br>In FY 2021, this effort is renamed from Adaptive Cyber Protections to Agile Mission Systems Protections.<br><br>***FY 2020 Plans:***<br>Mature malware detection, diagnostics, and attack inferencing capabilities for avionics and mission systems. Research and develop real-time response mechanisms for cyber-attacks. Perform research and development in software, firmware and hardware diversity to enable resilient cyber defense systems. Research and develop real-time instruction-level malware detection capabilities to enable early warning and response to cyber threats. Develop automated test generation tools to expose malware embedded within mission critical software and firmware. Investigate evolutionary/co-evolutionary algorithms as a means to develop test samples for the above detection algorithms and to investigate adaptive countermeasures to malware and cyber-attacks. Research and develop cyber resilient immune systems for avionics and mission systems. Investigate cyber protection methodologies and open system architecture standards and approaches to improve cyber resiliency of legacy and next-generation avionics architectures.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $0.625 million due to civilian pay reprice adjustments. | 3.448 | 5.291 | 5.916 |
| **Accomplishments/Planned Programs Subtotals** | 6.109 | 9.387 | 10.625 |

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

N/A

**Remarks**

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>622005 / *Cyber Technology* |

**D. Acquisition Strategy**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>3600 / 2 | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | Project (Number/Name)<br>624920 / *Electronic Warfare Technology* | |

| COST ($ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 624920: *Electronic Warfare Technology* | - | 0.000 | 34.795 | 44.749 | 0.000 | 44.749 | 45.296 | 44.589 | 45.242 | 45.937 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

This project develops and assesses affordable, reliable, all weather radio frequency countermeasure concepts for aerospace applications covering the range of radio frequency sensors including communications, navigation, intelligence, surveillance and reconnaissance (ISR), and radar, both active and passive, across the air, land, sea, space and cyber domains. It develops and evaluates technology for electronic warfare, integrated radar and electronic warfare systems, and electro-optical/ infrared seeker defeat. This project develops the radio frequency warning and countermeasure technology for advanced electronic warfare and information operations applications. The project also explores technologies to maintain a military advantage in positioning, navigation and timing integrity, accuracy, and resiliency as well as on aircraft mission assurance - the protection of airborne platforms, manned and unmanned, in contested environments. The ultimate goal of the project is to ensure unrestricted access to the airspace and the electromagnetic spectrum in contested and congested environments.

Project 624920, Electronic Warfare, was new for FY 2020. In FY 2019 and prior, these electronic warfare activities were reported under PE 0602204F, Aerospace Sensors, Project 627622, RF Sensors and Countermeasures Tech, and PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, and Project 63691X, EO/IR Warning & Countermeasures Tech.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Title:*** Positioning, Navigation and Timing in Contested/Denied Environments | 0.000 | 9.663 | 13.276 |
| ***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 2020 Plans:***<br>Expand research on navigation sensor integration, modeling, and simulation to incorporate open architecture attributes. Continue alternative navigation, bandwidth efficient communications for navigation, and timing technologies research. Continue exploring technologies to support precise time and time transfer with airborne platforms to enable coherent sensing (intelligence, surveillance, reconnaissance) and effects (electronic warfare). Start development of trust techniques to enable military use of global navigation satellite systems. Continue modeling and simulation studies to address the multispectrum threat to satellite navigation systems. | | | |
| ***FY 2021 Plans:***<br>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, | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>624920 / *Electronic Warfare Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| 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.<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $3.613 million. Funding increased due to realignment of Position, Navigation and Timing for Contested/Denied Environments research from PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, Position, Navigation and Timing for Contested/Denied Environments effort, to this effort. | | | |
| ***Title:*** Radio Frequency Electronic Warfare Technologies | 0.000 | 17.631 | 23.378 |
| ***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.<br>***FY 2020 Plans:***<br>Continue research to demonstrate electronic warfare technologies that can reason about threat capabilities and intentions and the electromagnetic environment to synthesize an optimized response in a time frame to support aircraft survivability against adaptive and agile threats. Continue to extend research to address dynamic planning for collaborative autonomous electronic warfare systems. Continue the demonstration of robust modeling, simulation, and assessment capability to study the efficiency versus effectiveness of electronic support and electronic attack capabilities, including distributed electronic warfare assets and cognitive/ autonomous technologies, against complex threat emitters in integrated air defense systems and in complex electromagnetic spectrum background environments. Continue research into effective management of electronic warfare assets in operational environments focusing on a multi-ship strike package employment. Start incorporation of electro-optical and radio frequency integrated engagement model development to meet multispectrum threats.<br>***FY 2021 Plans:***<br>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 | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>624920 / *Electronic Warfare Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| 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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $5.747 million. Funding increased due to realignment of Radio Frequency Electronic Warfare research from PE 0603270F, Electronic Combat Technology, Project 633720, EW Quick Reaction Capabilities, Radio Frequency Electronic Warfare effort, to this effort. | | | |
| ***Title:*** Electro-Optical/Infrared Threat Warning and Countermeasures Technologies<br><br>***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.<br><br>***FY 2020 Plans:***<br>Continue threat characterization and countermeasures development of new threats to include new jam codes and countermeasure techniques. Continue development of low-cost missile warning capabilities. Investigate long-range missile and laser warning technology concepts. Start incorporation of electro-optical and radio frequency integrated engagement model development to meet multispectrum threats.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $0.594 million due to civilian pay reprice adjustments. | 0.000 | 7.501 | 8.095 |
| **Accomplishments/Planned Programs Subtotals** | 0.000 | 34.795 | 44.749 |

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

N/A

**Remarks**

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>624920 / *Electronic Warfare Technology* |

**D. Acquisition Strategy**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>3600 / 2 | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | Project (Number/Name)<br>626095 / *Sensor Fusion Technology* | |

| COST ($ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 626095: *Sensor Fusion Technology* | - | 31.826 | 32.063 | 35.716 | 0.000 | 35.716 | 34.875 | 33.462 | 34.154 | 35.052 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

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

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Title:*** Target Signature Modeling | 4.383 | 0.000 | 0.000 |
| ***Description:*** Develop, evaluate, and demonstrate target signature models to support sensor exploitation algorithm development and testing for reconnaissance and strike mission applications.<br><br>***FY 2020 Plans:***<br>Starting in FY 2020, this work is performed under the Multi-Domain Sensing Effect and Analysis effort within Project 626095, Sensor Fusion Technology in this PE.<br><br>***FY 2021 Plans:***<br>Not applicable<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>Not applicable | | | |
| ***Title:*** Sensor Exploitation Technologies | 6.745 | 0.000 | 0.000 |
| ***Description:*** Develop technical methods required for algorithm performance models, performance driven sensing, layered sensing and other sensing and exploitation technologies impacted by automated exploitation capabilities.<br><br>***FY 2020 Plans:*** | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>626095 / *Sensor Fusion Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| Starting in FY 2020, this work is performed under the Multi-Domain Sensing Effect and Analysis and Synthesis for Understanding efforts within Project 626095, Sensor Fusion Technology in this PE.<br>***FY 2021 Plans:***<br>Not applicable<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>Not applicable | | | |
| ***Title:*** Sensor Management for Automatic Target Recognition<br>***Description:*** Develop multi-platform and multi-sensor control strategies to create advantages for survival, autonomous sensing, and autonomous exploitation in contested environments. Incorporate sensing platform kinematics and external operating conditions into analyses of effective multi-sensor control and multiple intelligence data fusion capabilities. Assess advantages of multi-sensor closed loop control techniques for platform survival, command and control, intelligence, surveillance and reconnaissance, and strike missions. Enhance existing automatic target recognition sensor management, and sensor fusion technologies by application of multi-sensor data and distributed data processing.<br>***FY 2020 Plans:***<br>Starting in FY 2020, this work is performed under the Multisource Knowledge Representation and Management effort within Project 626095, Sensor Fusion Technology in this PE.<br>***FY 2021 Plans:***<br>Not applicable<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>Not applicable | 16.254 | 0.000 | 0.000 |
| ***Title:*** Distributed Sensing for Automatic Target Recognition<br>***Description:*** Develop techniques and metrics for adaptive, penetrating, distributed radio frequency exploitation in contested environments.<br>***FY 2020 Plans:***<br>Starting in FY 2020, this work is performed under the Synthesis for Understanding and the Multisource Knowledge Representation and Management efforts within Project 626095, Sensor Fusion Technology in this PE.<br>***FY 2021 Plans:***<br>Not applicable<br>***FY 2020 to FY 2021 Increase/Decrease Statement:*** | 4.444 | 0.000 | 0.000 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>626095 / *Sensor Fusion Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| Not applicable | | | |
| ***Title:*** Synthesis for Understanding | 0.000 | 13.380 | 14.377 |
| ***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.<br><br>***FY 2020 Plans:***<br>Develop capabilities for space-time alignment of multiple hard (physics-based) and soft (human-based) information sources. Model information uncertainty for multiple information sources (hard and soft). Apply deep and machine learning techniques to the detection/tracking/identification of stationary and moving entities, and for pattern of life understanding. Develop decision/feature-level fusion capabilities for physics-based information from multiple sensors/intelligence sources. Investigate fusion of hard and soft information sources for military-relevant applications. Design and evaluate training techniques, for example, blended measured-synthetic training, for deep and machine learning classifiers given limited measured data.<br>***FY 2021 Plans:***<br>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.<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $0.997 million due to civilian pay reprice adjustments. | | | |
| ***Title:*** Multi-Domain Sensing Effects and Analysis | 0.000 | 6.535 | 8.206 |
| ***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.<br><br>***FY 2020 Plans:*** | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>626095 / *Sensor Fusion Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| Key applied research investments will be made in the following: 1) leverage academic partnerships with respect to specific Air Force applications in modeling, simulation and analysis, 2) design and build next generation correct fidelity performance models, 3) develop one or more challenge problems to support Air Force technology investment understanding, 4) perform in-the-field data collections to verify and validate performance using measured sensor data.<br>***FY 2021 Plans:***<br>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.<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $1.671 million. Funding increased due to additional emphasis on collecting, tagging, curating, and retrieving data for advanced sensing development. | | | |
| ***Title:*** Multisource Knowledge Representation and Management<br>***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.<br>***FY 2020 Plans:***<br>Continue to develop mission performance metrics for distributed sensing capabilities in which families of suitable solutions exist. Improve representational and computational efficiency of graph-based information fusion methods. Develop foundational algorithms for sensing management incorporating environment analysis, target tracking and recognition, and operationally representative external factors.<br>***FY 2021 Plans:***<br>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.<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $0.985 million due to civilian pay reprice adjustments. | 0.000 | 12.148 | 13.133 |
| **Accomplishments/Planned Programs Subtotals** | 31.826 | 32.063 | 35.716 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>626095 / *Sensor Fusion Technology* |

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>3600 / 2 | R-1 Program Element (Number/Name)<br>PE 0602204F / *Aerospace Sensors* | Project (Number/Name)<br>627622 / *RF Sensors and Countermeasures Tech* | |

| COST ($ in Millions) | Prior Years | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total | FY 2022 | FY 2023 | FY 2024 | FY 2025 | Cost To Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 627622: *RF Sensors and Countermeasures Tech* | - | 59.528 | 60.066 | 34.821 | 0.000 | 34.821 | 34.154 | 33.209 | 34.119 | 34.362 | 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 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***Title:*** Hybrid Sensor Technologies | 12.687 | 0.000 | 0.000 |
| ***Description:*** Develop hybrid sensor solutions to be responsive to needs and detect difficult targets. Develop resilient position, navigation and timing sensors. Explore position, navigation and timing solutions to enable novel distributed radio frequency sensing and countermeasure techniques. Develop technology base to provide solutions addressing threats that exploit multiple sensor phenomenologies.<br><br>***FY 2020 Plans:***<br>Starting in FY 2020, this work is performed under Project 624920, Electronic Warfare Technology, Positioning, Navigation and Timing in Contested/Denied Environments effort within this PE.<br><br>***FY 2021 Plans:***<br>Not applicable<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>Not applicable | | | |
| ***Title:*** Radio Frequency Sensor Technologies | 7.973 | 9.127 | 9.946 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>627622 / *RF Sensors and Countermeasures Tech* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| ***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.<br><br>***FY 2020 Plans:***<br>Analyze passive radar illumination selection manager collected data from the ground-based static testing to establish an experimental technical baseline for a future airborne experiment.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $0.819 million due to civilian on pay reprice adjustments. | | | |
| ***Title:*** Multi-Band/Multi-Beam Technologies<br><br>***Description:*** Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks.<br><br>***FY 2020 Plans:***<br>Continue to employ adaptive, reconfigurable and tunable detection methods and techniques as effective optional countermeasures to developing multi-mission, unmanned sensing blue force platforms such as the Low Cost Attritable Aircraft Technology effort.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:*** | 11.160 | 12.705 | 13.498 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>627622 / *RF Sensors and Countermeasures Tech* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| FY 2021 increased compared to FY 2020 by $0.793 million due to civilian pay reprice adjustments. | | | |
| ***Title:*** Sensor Resource Management<br><br>***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.<br><br>***FY 2020 Plans:***<br>Utilize delivered sensor resource management tools to integrate data collected from the Defense Advanced Research Projects Agency System of Systems Integration Technology and Experimentation gauntlets and begin engineering study for multi-ship/ multi-spectral sensor resource manager.<br><br>***FY 2021 Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 increased compared to FY 2020 by $0.810 million due to civilian pay reprice adjustments. | 9.256 | 10.567 | 11.377 |
| ***Title:*** Radio Frequency Countermeasure Technologies<br><br>***Description:*** This project develops the radio frequency warning and countermeasure technology for advanced electronic warfare and information operations applications. Specifically, it develops techniques and technologies to detect and counter the communications links and sensors of threat integrated air defense systems and hostile command and control networks.<br><br>***FY 2020 Plans:***<br>Starting in FY 2020, this work is performed under Project 624920, Electronic Warfare Technology, Radio Frequency Electronic Warfare Technologies effort within this PE.<br><br>***FY 2021 Plans:***<br>Not applicable<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:*** | 13.522 | 0.000 | 0.000 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>627622 / *RF Sensors and Countermeasures Tech* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 |
|---|---|---|---|
| Not applicable | | | |
| ***Title:*** Future AF Capabilities Applied Research | 0.000 | 19.667 | 0.000 |
| ***Description:*** Investigate, design, and develop science and technologies supporting future Air Force capabilities to provide compelling advantage to the warfighter. To the greatest extent practical, research efforts will utilize modeling and simulation and cross-discipline systems integration (For example: air and space vehicles, avionics, propulsion, materials, human performance, cybersecurity, command, control, communications, computer and intelligence, sensors, electronic warfare, and conventional/ unconventional weapons).<br><br>The National Defense Strategy and Air Force Science and Technology (S&T) Strategy will inform investments over the FYDP.<br><br>In FY 2019, this work was performed under multiple projects and efforts within the following Air Force S&T Programs: 0602102F, Materials; 0602201F, Aerospace Vehicle Technologies; 0602202F, Human Effectiveness Applied Research; 0602203F, Aerospace Propulsion; 0602204F, Aerospace Sensors; 1206601F, Space Technology; 0602602F, Conventional Munitions; 0602605F, Directed Energy Technology; and 0602788F, Dominant Information Science and Methods.<br><br>***FY 2020 Plans:***<br>Investigate and mature science and technology that enables future warfighting concepts to provide leap-ahead capabilities. The National Defense Strategy and Air Force S&T Strategy focus this science and technology toward, but not limited to, the following capabilities: 1) global persistent awareness; 2) resilient information sharing; 3) rapid, effective decision-making; 4) complexity, unpredictability, and mass; and 5) speed and reach of disruption and lethality.<br><br>***FY 2021 Plans:***<br>Starting in FY 2021, this work is performed in PE 0602020F, Future AF Capabilities Applied Research, Project 620200, Enterprise Transformational Applied Research, Transformational Capability Incubator effort.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2021 decreased compared to FY 2020 by $19.667 million. Funding decreased due to realignment and consolidation of Future AF Capabilities Applied Research effort to PE 0602020F, Future AF Capabilities Applied Research, Project 620200, Enterprise Transformational Applied Research, Transformational Capability Incubator effort, to better align with the Air Force S&T Strategy SECAF April 2019 and provide Congress with increased transparency on transformational Air Force S&T activities. | | | |
| **Accomplishments/Planned Programs Subtotals** | 54.598 | 52.066 | 34.821 |

| | FY 2019 | FY 2020 |
|---|---|---|
| ***Congressional Add:*** Program increase - Air Force Minority Leaders Program | 4.930 | 0.000 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>3600 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602204F / *Aerospace Sensors* | **Project (Number/Name)**<br>627622 / *RF Sensors and Countermeasures Tech* |

| | FY 2019 | FY 2020 |
|---|---|---|
| ***FY 2019 Accomplishments:*** Conducted Congressionally directed efforts<br>***FY 2020 Plans:*** Not applicable | | |
| ***Congressional Add:*** Program increase - RF spectrum situational awareness<br>***FY 2019 Accomplishments:*** Not applicable<br>***FY 2020 Plans:*** Conduct Congressional directed efforts | 0.000 | 8.000 |
| **Congressional Adds Subtotals** | 4.930 | 8.000 |

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

N/A

**Remarks**

**D. Acquisition Strategy**

N/A