Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Air Force											Date: February 2015	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	125.989	118.321	147.291	-	147.291	173.838	176.303	181.739	185.455	Continuing	Continuing
622002: *Electronic Component Technology*	-	35.246	27.169	38.261	-	38.261	42.539	43.193	43.339	44.186	Continuing	Continuing
622003: *EO Sensors & Countermeasures Tech*	-	22.795	27.958	26.832	-	26.832	28.246	30.225	33.272	34.006	Continuing	Continuing
626095: *Sensor Fusion Technology*	-	25.688	23.486	27.382	-	27.382	31.822	34.671	32.600	33.290	Continuing	Continuing
627622: *RF Sensors and Countermeasures Tech*	-	42.260	39.708	54.816	-	54.816	71.231	68.214	72.528	73.973	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 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) aerospace sensor technologies for a variety of offensive and defensive uses; 3) RF antennas and associated electronics for airborne and space surveillance, together with active and passive EO sensors; 4) technologies to manage and fuse on-board sensor information for timely, comprehensive situational awareness; and 5) technology for reliable, all-weather surveillance, reconnaissance, and precision strike RF sensors and electronic combat systems. This program has been coordinated through the Department of Defense (DoD) Science and Technology (S&T) Executive Committee process to harmonize efforts and eliminate duplication.

This program is in Budget Activity 2, Applied Research because this budget activity includes scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs.

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Air Force					Date: February 2015
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*		
B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	127.419	118.343	145.655	-	145.655
Current President's Budget	125.989	118.321	147.291	-	147.291
Total Adjustments	-1.430	-0.022	1.636	-	1.636
• Congressional General Reductions	-	-0.022			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.010	-			
• SBIR/STTR Transfer	-1.420	-			
• Other Adjustments	-	-	1.636	-	1.636

Change Summary Explanation

Increase in FY 2016 to prioritize Automatic Target Recognition Technologies.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
622002: *Electronic Component Technology*	-	35.246	27.169	38.261	-	38.261	42.539	43.193	43.339	44.186	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on generating, controlling, receiving, and processing electronic signals for RF sensor aerospace applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance (ISR), electronic warfare, battlespace access, and precision engagement capabilities. The technologies developed include exploratory device concepts; solid state power devices and amplifiers; low noise and signal control components; photonic components; high-temperature electronics; signal control and distribution; signal processing; multi-function monolithic integrated circuits; high-speed analog-to-digital and digital-to-analog mixed mode integrated circuits; reconfigurable electronics; power distribution; multi-chip modules; and high density packaging and interconnect technologies. This project also designs, develops, fabricates, and evaluates techniques for integrating combinations of these electronic component technologies. The project aims to demonstrate significantly improved military sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. The device and component 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, navigation, and smart weapons.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Multifunction Sensor Subsystems	11.681	8.120	9.222
Description: Develop, analyze, demonstrate, and perform engineering trade studies for technologies for compact, affordable, multi-function subsystems for aerospace sensors. ***FY 2014 Accomplishments:*** Developed and demonstrated a capability to predict performance versus lifetime in military relevant environments for a large variety of emerging electronic devices. Initiated engineering trade analysis, and developed optimized sensor system technology. Developed initial trade space models for advanced sensing, and electronic warfare front-ends. ***FY 2015 Plans:*** Continue to develop, refine and demonstrate advanced trade space and prediction tools for emerging devices. Complete engineering trade analysis for baseline sensing system technologies. Continue development of trade space models for advanced system of systems sensing and electronic warfare simulations. ***FY 2016 Plans:*** Complete baseline trade space models for use in advanced system of systems simulations. Complete advanced trade space tools for emerging technologies. Continue development of advanced prediction tools. Initiate next level of fidelity models for advanced future multifunction subsystem concepts. Initiate prototype multi-function demonstrations of concepts determined through analysis and design tools.			
Title: Microelectronic/Optoelectronic Technologies	12.680	9.036	10.172

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Develop and assess new microelectronic/optoelectronic material, device and fabrication technologies for next generation imaging, precision strike, and battlespace access across all Air Force domains. ***FY 2014 Accomplishments:*** Developed optimized device concepts for multi-use cyber, sensing, warfare and communication applications. Identified and evaluated concepts for compact, high-performance electro-optic and electronic devices and components. Synthesized test articles, characterized behavior, and optimized fabrication methods for enhanced devices and components. Developed tools and methods for analysis and efficient design of game-changing components. ***FY 2015 Plans:*** Complete device concept baseline for multi-use (sense environments and counter threat) applications. Continue to identify and evaluate concepts for compact, high-performance devices and components. Demonstrate projected gains through characterization of test articles in relevant environments. Continue to develop tools and methods to design and analyze game-changing components. ***FY 2016 Plans:*** Complete identification and evaluation of innovative concepts for generation after next compact, high performance devices and components. Demonstrate prototype of a highly integrated microsystem. Continue to refine tools and methods to design, build and analyze game changing component technologies. Initiate evaluation of emerging component technologies against device concept baseline for multi-use applications.			
Title: Antennas ***Description:*** Design and develop antennas for airborne and space-based surveillance. Develop novel and advanced antennas for lightweight, conformal arrays. ***FY 2014 Accomplishments:*** Initiated development of optimized antenna concepts for multi-use sensing, electronic warfare and communication applications. Fabricated and characterized innovative electronic device concepts for wideband, reconfigurable and tunable, and trusted applications. Demonstrated prototype hardware for agile/affordable advanced detector arrays with emphasis on combined spectro-polarimetric filtering. Designed and fabricated high-brightness and agile waveform sources for integration into components and subsystems. ***FY 2015 Plans:*** Continue to fabricate and characterize innovative devices to extend bandwidth, reconfigurability, tunability and trustworthiness. Continue demonstrations of multi-wavelength, agile and affordable advanced detectors and arrays with emphasis on integrated	6.305	4.763	5.417

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
filtering. Continue the design and fabrication of high-brightness and agile waveform sources to integrate into microsystems and subsystems. ***FY 2016 Plans:*** Complete characterization and evaluation of novel high-brightness and agile waveform source. Continue to explore and evaluate innovative devices for increase bandwidth and tunability. Continue demonstrations of multi-wavelength, agile and affordable advanced detectors and arrays.			
Title: Trusted Systems for ISR and Avionics Systems ***Description:*** Investigate and develop designs of trusted electronic and optoelectronic systems when integrating commercially available solutions (commercial-off-the-shelf (COTS)) with emerging government-off-the-shelf (GOTS) advanced technologies. Areas of development include: multi-function RF and EO subsystems, metamaterials, data compression, high-frequency power modules, EO/IR sources, EO/IR detectors, beam control and waveguides, and trusted and reliable electronics. ***FY 2014 Accomplishments:*** Initiated development of optimized device concepts for multi-use cyber, sensing, warfare and communication applications. Fabricated and characterized innovative electronic device concepts for wideband, reconfigurable and tunable, and trusted applications. Demonstrated prototype hardware for agile/affordable advanced detector arrays with emphasis on combined spectropolarimetric filtering. Designed and fabricated high-brightness and agile waveform sources for integration into components and subsystems. ***FY 2015 Plans:*** Continue to identify COTS and GOTS technologies nearly ready or ready for integration into microsystem and subsystem demonstration. Develop, mature and demonstrate solutions utilizing COTs/GOTs technology that enable cyber-hardness, rad-hardness and resistance to tampering. ***FY 2016 Plans:*** Demonstrate trusted sensing and electronic warfare subsystem technologies utilizing the integration of low-cost commercially available electronics with exquisite emerging military electronics. Initiate vulnerability model and simulation capability to assess cost and liability of trust in electronics.	4.580	5.250	6.190
Title: Advanced Components for Electronic Warfare ***Description:*** Develop, mature, and demonstrate critical electronic technologies to enable revolutionary electronic warfare substems. ***FY 2014 Accomplishments:***	-	-	7.260

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622002 / *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
N/A ***FY 2015 Plans:*** N/A ***FY 2016 Plans:*** In FY16 research in this effort has been transferred from efforts in project 622003, "EO Sensors and Countermeasures Tech," in this program to better coordinate and align research. Develop, mature and demonstrate critical electronics technologies to enable highly agile, closed-loop sense, learn and adapt revolutionary electronic warfare subsystems. Demonstrate advancements in real time hardware configurability and the integration at the microsystem level of electrons and photons.			
Accomplishments/Planned Programs Subtotals	35.246	27.169	38.261

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 622003 / *EO Sensors & Countermeasures Tech*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
622003: *EO Sensors & Countermeasures Tech*	-	22.795	27.958	26.832	-	26.832	28.246	30.225	33.272	34.006	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced electro-optical aerospace sensor technologies for a variety of offensive and defensive uses. The sensor technologies under development range from the ultraviolet through the infrared portion of the spectrum. Related efforts include improvements in avionics integration, digital processing, analysis tools, and sensor architectures. One of the project's main goals is to improve electro-optical and related technologies for the detection, tracking, and identification of non-cooperative and difficult targets, such as those obscured by camouflage. 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 2014	FY 2015	FY 2016
Title: Non-cooperative Detection and Identification Technologies	11.076	12.435	-
Description: Develop innovative optical sensing technology for non-cooperative detection and identification of airborne and ground-based targets. ***FY 2014 Accomplishments:*** Developed innovative sensor concepts to increase long range image quality for passive electro-optical and infrared reconnaissance sensors for high altitude platforms. Assessed fundamental geometrical environmental and atmospheric limitations to system performance. Developed approaches for image restoration. Conducted long wave infrared hyperspectral phenomenology and change detection research. ***FY 2015 Plans:*** Evaluate, via modeling and simulation, innovative sensor concepts to increase long range image quality for passive electro-optical and infrared reconnaissance sensors for high altitude platforms. Mature longwave infrared hyperspectral imaging to achieve operationally useful radiometric sensitivity and area coverage rate with a sensor system that is practical and affordable. ***FY 2016 Plans:*** In FY 2016 this effort moves to "Passive EO/IR Sensing in Contested Environments" in this project to better align efforts.			
Title: EO/IR Sensors and Threat Countermeasure Technologies	5.958	7.791	-
Description: Develop optical and infrared sensors for airborne and space situational awareness and threat warning. Develop countermeasure technologies for use against infrared and electro-optical guided missile threats.			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622003 / *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Refined modeling and simulations for multiple ladar modes. Conducted laboratory testing of initial foundry runs of focal planes optimized for three dimensional and holographic imaging. Developed optical materials and devices for improved reliability and performance of mid-infrared lasers operating in harsh environments. Began test of prototype Silicon Gallium (SiGa) detectors. Started design and fabrication of SiGa focal plane array. ***FY 2015 Plans:*** Initiate synthetic aperture ladar (SAL) techniques based on modeling and simulation previously conducted to enhance spatial resolution beyond the diffraction limit of conventional optics through the coherent collection and processing of laser-illuminated scene radiance. Research the problem of improving system capabilities to provide high confidence target identification at standoff ranges for both reconnaissance and targeting platforms. Continue evaluation of prototype Silicon Gallium (SiGa) detectors. Continue design and fabrication of SiGa focal plane array. ***FY 2016 Plans:*** In FY 2016 this effort moves to "Laser Radar Sensing in Contested Environments" in this project to better align efforts.			
Title: Optical Technologies ***Description:*** Develop optical spectrum transmitter, detector and agile aperture technologies capable of sensing multiple target characteristics for robust non-cooperative target identification and future infrared countermeasure systems. ***FY 2014 Accomplishments:*** Refined and demonstrated candidate component technologies for image stabilization and restoration. Determined the utility of non-traditional sensor architectures in improving image quality, and the operational range of passive imagers. Initiated prototyping of a flexible, next generation long wave infrared hyperspectral imaging spectrometer. ***FY 2015 Plans:*** Initiate research in the use of vibrometry and range-Doppler sensing technology to aid in target identification and decoy discrimination at ranges at which the imaging performance is insufficient. Research will also supports phenomenology understanding, signature collection, sensor product visualization, and automatic target recognition in collaboration with other AFRL directorates. Continue prototyping of a flexible, next generation long wave infrared hyperspectral imaging spectrometer. ***FY 2016 Plans:*** In FY 2016 this effort moves to "Passive EO/IR Sensing in Contested Environments" in this project to better align efforts.	5.761	7.732	-
Title: Passive EO/IR Sensing in Contested Environments	-	-	8.944

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622003 / *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Develop innovative passive optical sensing technology to support surveillance and reconnaissance in contested environments. Develop high performance focal planes, aperture technologies and imaging techniques capable of long range target detection and characterization for ISR. ***FY 2014 Accomplishments:*** N/A ***FY 2015 Plans:*** N/A ***FY 2016 Plans:*** This effort continues the work realigned from "Optical Technologies," "Non-cooperative Detection and Identification Technologies" efforts in this project. Evaluate, via modeling and simulation, innovative sensor concepts to increase long range image quality for high altitude passive electro-optical and infrared reconnaissance sensors at twice the current operational range. Conduct initial demonstrations of the effectiveness of computational image restoration and noise reduction. Refine and demonstrate candidate component technologies for jitter mitigation and restoration in the presence of deep turbulence. Investigate system-level impacts of image restoration technology using a commercial reconnaissance sensor and platform. Determine the utility of non-traditional sensor architectures in improving image quality and the operational range of passive imagers. Mature longwave infrared hyperspectral imaging to achieve operationally useful radiometric sensitivity, detection performance, and area coverage rates at far off nadir viewing geometries. Continue prototyping of a flexible, next generation long wave infrared hyperspectral imaging spectrometer. Complete evaluations of prototype SiGa long wave infrared detectors at high operating temperatures. Continue investigation of high performance long wave infrared detectors for hyperspectral imaging. Initiate technology developments for next generation infrared search and track (IRST) components and systems focused on performance in clutter using staring focal planes and reduced complexity implementations. Adapt passive sensing models to support IRST technology trade analyses.			
Title: Laser Radar Sensing in Contested Environments ***Description:*** This effort continues the work done in "EO/IR Sensors and Threat Countermeasure Technologies" effort in this project. Develop innovative laser sensing technology for non-cooperative detection and 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.	-	-	17.888

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 622003 / *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: N/A ***FY 2015 Plans:*** N/A ***FY 2016 Plans:*** Develop synthetic aperture ladar (SAL) techniques based on modeling and simulation previously conducted to enhance spatial resolution beyond the diffraction limit of conventional optics. Research the problem of improving system capabilities to provide high confidence target identification at standoff ranges for both reconnaissance and targeting platforms. Continue fabrication and characterization of critical components for a long range SAL demonstration system. Design and fabricate next generation long range holographic aperture ladar imaging testbed focused on progression to platform compatible configurations. Continue research in the use of remote laser vibrometry and range-Doppler sensing technology to aid in target identification and decoy discrimination at ranges at which the imaging performance is insufficient. Research will also support phenomenology understanding, signature collection, sensor product visualization, and automatic target recognition in collaboration with other Air Force Research Laboratory Technology Directorates. Conduct laboratory testing of initial foundry runs of focal planes optimized for three dimensional and holographic imaging. Increase emphasis on applications for long range air-to-air ladar updating modeling and simulation, phenomenology measurement capabilities and to support utility analysis and system design and evaluations.			
Accomplishments/Planned Programs Subtotals	22.795	27.958	26.832

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
626095: *Sensor Fusion Technology*	-	25.688	23.486	27.382	-	27.382	31.822	34.671	32.600	33.290	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Automatic Target Recognition Technologies	9.599	9.500	-
Description: Develop automatic target recognition (ATR), sensor management, and sensor fusion technologies for target detection, tracking, and identification in ISR, and combat identification applications.			
FY 2014 Accomplishments: Assessed and enhanced physics-based techniques to meet the autonomous target detection and identification, sensor management, and sensor fusion requirements for intelligence, surveillance, and reconnaissance applications, combat identification applications, and Planning & Direction, Collection, Processing & Exploitation, Analysis & Production, and Dissemination - eXperimental (PCPAD-X) in contested and uncontested environments. Assessed and developed capabilities to represent and utilize sensor parameters and errors to improved fused geo-location accuracy. Conducted research of bio-inspired automatic target recognition technologies.			
FY 2015 Plans: Develop advanced object recognition methods which correlate data from multiple sensors from air, space and cyber domains. Continue to assess and enhance physics-based techniques to meet the autonomous target detection and identification, sensor management, and sensor fusion requirements for intelligence, surveillance, and reconnaissance applications, combat			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 626095 / *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
identification applications, and PCPAD-X in contested and uncontested environments. Continue to assess and develop capabilities to represent and utilize sensor parameters and errors to improved fused geo-location accuracy. ***FY 2016 Plans:*** In FY 2016 this effort moves to "Distributed Sensing for ATR" in this project to better align efforts.			
Title: Target Signature Modeling ***Description:*** Develop, evaluate, and demonstrate target signature models to support sensor exploitation algorithm development and testing for reconnaissance and strike mission applications. ***FY 2014 Accomplishments:*** Matured target signature models for signature exploitation of multi-spectral systems and signals intelligence sensors emphasizing one target model for application to all parts of the spectrum. Developed signatures, algorithms, target modeling, and phenomenological modeling of features not previously exploited. Developed automatic target recognition algorithm-driven radio-frequency sensor design. ***FY 2015 Plans:*** Continue development of all-source target models for emerging threat systems in contested environments. Create and assess methods for validating all-source signature models. Continue to mature target signature models for signature exploitation of multi-spectral systems and signals intelligence sensors. Mature promising approaches to develop a single target model for application to all parts of the spectrum. ***FY 2016 Plans:*** Develop ground clutter modeling and reduced feature-set target signature prediction techniques for radio frequency sensors. Initiate controlled data collections and high resolution feature database for emerging sensors. Initiate implementation of advanced theoretical approaches to salient feature extraction from limited sensor data. Continue maturing promising approaches to develop a single target model for application to all parts of the spectrum. Continue development of all-source target models for emerging threat systems in contested environments. Demonstrate maturing methods for validating all-source signature models.	4.180	4.080	3.814
Title: Sensor Exploitation Technologies ***Description:*** Develop technical methods required for algorithm performance models, performance driven sensing, layered sensing and other sensing and exploitation technologies impacted by automated exploitation capabilities. ***FY 2014 Accomplishments:***	7.034	6.500	5.817

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 626095 / *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Developed performance models for sensor exploitation technologies, and associated databases and tools. Conducted validation of algorithm performance models to be used in the PCPAD-X integrative and virtual environments. Enhanced development of an integrated, unified automatic target recognition (ATR) methodology. ***FY 2015 Plans:*** Develop novel techniques for analysis of large sensor data sets to discover, characterize, and identify threatening activities in contested environments. Continue development of sensor resource optimization enablers for autonomous sensor employment. Continue development and validation of performance models for sensor exploitation technologies. Demonstrate application of sensor and algorithm performance models in the PCPAD-X integrative and virtual environments. Continue to enhance development of an integrated, unified ATR methodology through industry and university outreach. ***FY 2016 Plans:*** Initiate analysis of sensor data where the transmitter and receiver are from distinct platforms or sensing devices. Develop and assess techniques for near real time extraction, representation, and analysis of multi-dimensional information from image sequences. Continue development of novel techniques for analysis of large sensor data sets to discover, characterize, and identify threatening activities in contested environments. Continue to demonstrate application of sensor and algorithm performance models in PCPAD-X. Continue to enhance development of an integrated, unified ATR methodology through industry and university outreach.			
Title: Trusted Sensing Technologies ***Description:*** Develop, evaluate, and demonstrate methodologies, techniques, and strategies to instill trust in distributed, heterogeneous sensing systems within air, space, and cyber domains. ***FY 2014 Accomplishments:*** Developed advanced trusted sensing services, middleware, and frameworks for multilayered sensing and spectrum warfare. Developed methods, tools, and processes to determine and assess vulnerability and mission assurance for complex system-of-systems for spectrum warfare. Developed autonomic trusted sensor technologies to address self-aware, self-healing, and self-organizing sensor systems. Developed detect and response mechanisms to remedy software and hardware supply chain vulnerabilities. ***FY 2015 Plans:*** Initiate research in trusted exploitation algorithms and tools for PC-PAD, defining and quantifying metrics. Build upon previous work in PCPAD-X to research application of trust metrics in the evaluation of COTs, GOTs, and contractor owned exploitation algorithms and tools to assure the mission. ***FY 2016 Plans:***	4.875	3.406	-

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 626095 / *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
In FY 2016 this effort moves to "Sensor Management for ATR" in this project to better align efforts.			
Title: Sensor Management for ATR ***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 multi-INT data fusion capabilities. Assess advantages of multi-sensor closed loop control techniques for platform survival, command and control, ISR, and strike missions. Enhance existing automatic target recognition (ATR), sensor management, and sensor fusion technologies by application of multi-sensor data and distributed data processing. ***FY 2014 Accomplishments:*** N/A ***FY 2015 Plans:*** N/A ***FY 2016 Plans:*** This effort continues work from "Trusted Sensing Technologies" effort. Develop exploration of multi-sensor inference and control approaches for autonomous operations. Develop metrics for assessing multi-sensor control techniques with regard to assured threat avoidance and optimal sensor positioning. Initiate size-weight-power-constrained processing assessment approaches for future platform on-board processing of multi-sensor data. Define and develop multi-sensor performance assessment approaches for inclusion in PCPAD-X.	-	-	13.884
Title: Distributed Sensing for ATR ***Description:*** Develop techniques and metrics for adaptive, penetrating, distributed RF exploitation in contested environments. ***FY 2014 Accomplishments:*** N/A ***FY 2015 Plans:*** N/A ***FY 2016 Plans:*** This effort continues work accomplished in effort "Automatic Target Recognition Technologies."	-	-	3.867

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 626095 / *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Develop bi-static phenomenology models. Design new waveforms to exploit bi-static RF phenomenology. Develop a systems theory for incorporating ID uncertainty in ATR algorithms. Develop distributed exploitation algorithms. Design a closed loop sensor mode controller for adaptive transmit and receive.			
Accomplishments/Planned Programs Subtotals	25.688	23.486	27.382

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602204F / *Aerospace Sensors*	Project (Number/Name) 627622 / *RF Sensors and Countermeasures Tech*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
627622: *RF Sensors and Countermeasures Tech*	-	42.260	39.708	54.816	-	54.816	71.231	68.214	72.528	73.973	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable all weather radio frequency (RF) sensing and countermeasure concepts for aerospace applications covering the range of RF sensors including communications, navigation, intelligence, surveillance, reconnaissance (ISR), and radar, both active and passive, across the air, land, sea, space and cyber domains. This project also develops and evaluates technology for ISR sensors, fire control radars, electronic warfare, integrated radar and electronic warfare systems, and offensive information operations systems. It emphasizes the detection and tracking of surface and airborne targets with RF 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 RF phenomenologies, multi-dimensional adaptive processing, advanced waveforms and knowledge-aided processing techniques. This project also develops the RF 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 air defense systems and hostile command and control networks. The project also exploits emerging technologies and components to provide increased capability for offensive and defensive RF sensors, including radar warning, RF electronic warfare, and electronic intelligence applications.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Hybrid Sensor Technologies	7.372	7.939	12.082
Description: Develop hybrid sensor solutions to be responsive to needs and detect difficult targets. Develop jam-resistant time, position, and velocity sensors.			
FY 2014 Accomplishments: Developed strategies to optimize reference technologies for distributed sensing mission. Expanded research of alternatives when GPS is degraded or denied in contested environments. Reduced size, weight, and power of inertial components, while pursuing near navigation grade performance.			
FY 2015 Plans: Mature GPS augmentation technologies that take advantage of distributed platforms relaying Global Navigation Satellite Systems (GNSS) signals and geo-referenced real-time imaging to improve GPS accuracy in GPS sparse or denied environments. Develop technologies that expand the ability to incorporate GNSS signals into GPS user equipment as a means to improve navigation signal reliability and availability.			
FY 2016 Plans: Develop technologies to ensure robust and accurate navigation in GPS contested and denied environments. Mature navigation augmentation and GPS resilience technologies, such as taking advantage of signals of opportunity, as well as environmental			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
sensing, such as vision or magnetic sensors, to improve inertial measurement unit aided navigation accuracy in GPS sparse or denied environments.			
Title: RF Sensor Technologies ***Description:*** Conduct applied research and development for the advancement of passive and active RF sensors; including phenomenology, modeling and simulation, algorithm development, and experimentation. Plan, execute, and maintain state-of-the-art RF sensor research and development facilities. ***FY 2014 Accomplishments:*** Conducted research and development in dismount classification, waveform diversity, multiple inputs-multiple outputs (MIMO) for electronic protection and ATI for GMTI radar. Conducted model development for MIMO and waveform diverse distributed sensing networks, and for airborne multi-static radar, illumination management and bi-static airborne early warning systems. ***FY 2015 Plans:*** Continue research and development of agile waveforms, adaptive spectrum utilization techniques, and electromagnetic forensics sensing of the signal environment for robust adaptive RF sensing in contested spectrums and persistent stand-in RF sensing in denied environments. Continue research and development of RF sensor technology, including: signals intelligence (SIGINT) hardware, algorithms, and techniques, passive radar techniques, and advanced receive array antenna technology with wideband and high dynamic range, for passive multimode radars and efficient combat identification capabilities. ***FY 2016 Plans:*** Initiate research on fully polarimetric bistatic RF ground target and clutter phenomenology and relevant ground vehicle dynamics for RF sensing. Continue research and development of RF sensor technologies, including antennas, electromagnetic structures, propagation in plasma medium, electromagnetic modeling & simulation, and prototype experimentation for efficient combat identification capabilities. Develop agile, spectrally efficient, radar waveforms and robust distributed sensing techniques for dominance in non-traditional RF environments. Initiate development of electromagnetics forensics techniques for passive RF sensing and EW applications.	13.798	11.614	16.055
Title: Optimize RF Sensing Technology ***Description:*** Develop technology to reduce size, weight, and power of RF sensors. Develop technology to enable affordable upgrades and optimally control RF and multi-intelligence sensors. ***FY 2014 Accomplishments:*** Initiated development of distributed and layered EW effects to maintain spectrum dominance for assured operations, and position, navigation, and timing (PNT) in contested environments. Explored and analyzed next generation RF-based threats for potential	5.905	5.195	-

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
counters and perform vulnerability assessments. Researched advanced electronic support (ES) concepts. Completed research and exploration of an adaptable ES/electronic attack (EA) capability. ***FY 2015 Plans:*** Conduct Electro-Magnetic/Electronic Warfare Battle Management (EM/EWBM) research to optimize use of EW assets against current and future integrated air defense systems and RF threats. Identify, develop and integrate improved electronics that reduce cost, size, weight and power of current EW systems to facilitate development of distributed EW jammers/sensor systems. Develop new approaches to protection of aircraft avionics systems and on-board data networks. ***FY 2016 Plans:*** Efforts moves to "Sensor Resource Management" thrust in this Project.			
Title: Multi-Band/Multi-Beam Technologies ***Description:*** Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks. ***FY 2014 Accomplishments:*** Developed RF/EO subsystem concept prototype and began its development to validate trade space tools. Initiated trade space analysis for RF/EO subsystem and device concepts. Developed MIMO and waveform-diverse system models for multi-sensor networks operating in contested environments containing complex clutter and multi-path. Developed cognitive and phenomenology-based algorithms. Developed GPS and non-GPS navigation schemes for hypersonic vehicles. ***FY 2015 Plans:*** Identify advanced RF/EO subsystem concepts to refine and update trade space capability. Complete the MIMO and waveform-diverse models for system and system of systems analysis. Initiate highly integrated, mostly digital microsystems for reconfigurable and tunable capabilities. ***FY 2016 Plans:*** Continue research in advanced RF/EO subsystem concepts to support expendable RF systems configurations. Develop and demonstrate concepts to support expendable RF ISR sensors (Radar, SIGINT, Electronic Support, and Combat ID). Develop conformal RF antenna concepts from C-Band to Ka-Band. Develop advanced geo-location algorithms for single and multiple platform operations. Continue research in highly integrated digital microsystems for reconfigurable and tunable capabilities.	5.901	5.616	10.928
Title: Counter RF Threat Technologies ***Description:*** Develop aerospace platform jamming technologies and techniques to counter advanced radio-frequency (RF) threats associated with current and future aerospace weapons systems.	9.284	9.344	-

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Developed technologies that ensure unfettered access to the electromagnetic spectrum while denying the same to adversaries. Conducted long-term research on integrating bio-inspired decision-making and cognitive capabilities into EW and EW battle management systems to improve responses in ambiguous EM environments. ***FY 2015 Plans:*** Develop multi-faceted approaches to countering RF threats. Efforts include development of machine learning, autonomous systems to identify frequency agile and changing waveforms. Develop counter-countermeasures to digital radio frequency memory (DRFM) based jammers. Develop Electromagnetic/Electronic Warfare Battle Management (EM/EWBM) tools, and distributed EW techniques to counter state-of-the-art integrated air defense systems. Develop novel disruptive technologies that leverage cyber, directed energy, and machine learning to counter RF, EO/IR threats. ***FY 2016 Plans:*** In FY 2016 this effort moves to "Sensor Resource Management" in this project.			
Title: Sensor Resource Management ***Description:*** Develop technology to enable optimization of sensor resources in contested environments on own-ship and multi-ship in manned, unmanned and manned/unmanned teaming concepts. ***FY 2014 Accomplishments:*** N/A ***FY 2015 Plans:*** N/A ***FY 2016 Plans:*** This effort continues research from efforts "Optimize RF Sensing Technology" and "Counter RF Threat Technologies". Develop distributed sensor management techniques utilizing an Open Mission Systems (OMS) context and Service Oriented Architecture (SOA) common set of messages and data models. Use Electronic Warfare and Communications as first functional disciplines to initiate SOA constructs. Initiate layered effects analyses on next generation RF based threats, counters and perform vulnerability assessments. Initiate operational architecture and mission services through common mission control center constructs. Continue research of advanced Electronic Support (ES) concepts and exploration of adaptable Electronic Attack (EA) EA/ES capabilities.	-	-	15.751
Accomplishments/Planned Programs Subtotals	42.260	39.708	54.816

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602204F / *Aerospace Sensors*	**Project (Number/Name)** 627622 / *RF Sensors and Countermeasures Tech*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.