Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Air Force											DATE: April 2013	
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*					R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*							
COST ($ in Millions)	**All Prior Years**	**FY 2012**	**FY 2013#**	**FY 2014 Base**	**FY 2014 OCO ##**	**FY 2014 Total**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**Cost To Complete**	**Total Cost**
Total Program Element	-	136.327	127.637	127.539	-	127.539	130.587	130.131	141.846	148.080	Continuing	Continuing
622002: *Electronic Component Technology*	-	35.757	31.683	36.220	-	36.220	39.807	40.141	40.684	41.602	Continuing	Continuing
622003: *EO Sensors & Countermeasures Tech*	-	30.491	23.744	23.078	-	23.078	23.717	20.141	21.844	22.283	Continuing	Continuing
626095: *Sensor Fusion Technology*	-	25.724	28.672	25.458	-	25.458	24.400	24.714	28.243	28.808	Continuing	Continuing
627622: *RF Sensors & Countermeasures Tech*	-	44.355	43.538	42.783	-	42.783	42.663	45.135	51.075	55.387	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

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, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary sensor, electronics, and electronic combat technologies.

Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Air Force					DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*			R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*		
B. Program Change Summary ($ in Millions)	**FY 2012**	**FY 2013**	**FY 2014 Base**	**FY 2014 OCO**	**FY 2014 Total**
Previous President's Budget	134.632	127.637	128.591	-	128.591
Current President's Budget	136.327	127.637	127.539	-	127.539
Total Adjustments	1.695	0.000	-1.052	-	-1.052
• Congressional General Reductions	-	0.000			
• Congressional Directed Reductions	-	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	-	0.000			
• Congressional Directed Transfers	-	0.000			
• Reprogrammings	3.351	0.000			
• SBIR/STTR Transfer	-1.656	0.000			
• Other Adjustments	0.000	0.000	-1.052	-	-1.052

Change Summary Explanation

Decrease in FY 2014 is due to higher DoD priorities.

Reprogrammed for specific projects in accordance with Section 219 of the Duncan Hunter National Defense Authorization Act for Fiscal Year (FY) 2009, as amended by Section 2801 of the National Defense Authorization Act for FY 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622002: *Electronic Component Technology*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
622002: *Electronic Component Technology*	-	35.757	31.683	36.220	-	36.220	39.807	40.141	40.684	41.602	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

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 2012	FY 2013	FY 2014
Title: Multifunction Sensor Subsystems	10.396	12.238	11.681
Description: Develop, analyze, demonstrate, and perform engineering trade studies for technologies for compact, affordable, multi-function subsystems for aerospace sensors.			
FY 2012 Accomplishments: Completed first demonstrations of higher performance, with reduced size and weight, of advanced sensor front-ends. Developed initial trade space models for advanced sensing and electronic warfare front-ends. Developed compact and lightweight high-frequency antennas.			
FY 2013 Plans: Complete second round of demonstrations. Using engineering trade analysis, start development of optimized sensor system technology previously demonstrated.			
FY 2014 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622002: *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Develop and demonstrate a capability to predict performance versus lifetime in military relevant environments for a large variety of emerging electronic devices. Initiate engineering trade analysis, start development of optimized sensor system technology. Develop initial trade space models for advanced sensing and electronic warfare front-ends.			
Title: Microelectronic/Optoelectronic Technologies ***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 2012 Accomplishments:*** Fabricated and characterized innovative electronic device concepts for wideband, reconfigurable and tunable applications. Demonstrated prototype hardware for agile/affordable advanced detector arrays with emphasis on combined spectro-polarimetric filtering. Conducted application development of high-brightness and agile waveform sources for integration into components and subsystems. Investigated and performed analysis for materials/device/circuit trades. ***FY 2013 Plans:*** Develop optimized device concepts for multi-use cyber, sensing, warfare and communication applications. Continue to develop and demonstrate a capability to predict performance versus lifetime in military relevant environments for a large variety of emerging electronic devices. Identify key failure mechanisms for electronic device technologies and their corresponding accelerants and chemistry. ***FY 2014 Plans:*** Continued the development of optimized device concepts for Multi-use cyber, sensing, warfare and communication applications. Identify and evaluate concepts for compact, high-performance electro-optic and electronic devices and components. Synthesize test articles, characterize behavior, and optimize fabrication methods for enhanced devices and components. Develop tools and methods for analysis and efficient design of game-changing components.	9.556	9.150	13.654
Title: Power Consumption ***Description:*** Develop, fabricate, and test electronic and optoelectronic devices and techniques to reduce power loss and power consumption for future imaging, electronic warfare, and ISR sensors. ***FY 2012 Accomplishments:*** Refined and transitioned solutions for multi-function electronic and optoelectronic components for imaging and electronic warfare applications. Investigated and analyzed mixed electronic and optoelectronic functions. ***FY 2013 Plans:***	6.629	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622002: *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
N/A. Effort terminated due to higher DoD priorities. ***FY 2014 Plans:*** N/A			
Title: Mixed-Signal Component Technologies ***Description:*** Develop integrated design, modeling and simulation tools, and integration techniques for complex mixed-signal component development in advanced electronic component technologies. ***FY 2012 Accomplishments:*** Developed and demonstrated prototypes of complex mixed-technology (digital, RF, microwave, optical, and mechanical) components using both advanced and emerging electronic component technologies. ***FY 2013 Plans:*** Continue demonstration of microsystem prototypes. Refine trade analysis. ***FY 2014 Plans:*** N/A. Effort terminated due to higher DoD priorities.	4.526	4.576	0.000
Title: Antennas ***Description:*** Design and develop antennas for airborne and space-based surveillance. Develop novel and advanced antennas for lightweight, conformal arrays. ***FY 2012 Accomplishments:*** Integrated new detection algorithm with low-cost seeker hardware. Demonstrated integration and test of new conformal digital beamforming phased array antennas on airborne radar platforms. Developed new hardware to exploit emerging metamaterials for compact radiating sensor applications including conformal array antennas and electronics based upon complex media. Assessed the viability of obtaining novel material properties consistent with the demonstration of highly integrated subsystems based upon RF integrated circuit applications to enable small, highly directional antenna element device drivers. ***FY 2013 Plans:*** Develop novel antenna concepts for wideband applications. Integrate and demonstrate lightweight conformal phased array aperture. ***FY 2014 Plans:*** Initiate development of optimized antenna concepts for multi-use sensing, electronic warfare and communication applications. Fabricate and characterize innovative electronic device concepts for wideband, reconfigurable and tunable, and trusted	4.650	5.719	6.305

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622002: *Electronic Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
applications. Demonstrate prototype hardware for agile/affordable advanced detector arrays with emphasis on combined spectro-polarimetric filtering. Design and fabricate high-brightness and agile waveform sources for integration into components and subsystems.			
Title: Trusted Systems for ISR and Avionics Systems ***Description:*** Investigate and develop designs of trusted electronic and optoelectronic systems when integrating commercially available solutions (COTS) with emerging 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 2012 Accomplishments:*** N/A ***FY 2013 Plans:*** N/A ***FY 2014 Plans:*** Initiate development of optimized device concepts for multi-use cyber, sensing, warfare and communication applications. Fabricate and characterize innovative electronic device concepts for wideband, reconfigurable and tunable, and trusted applications. Demonstrate prototype hardware for agile/affordable advanced detector arrays with emphasis on combined spectropolarimetric filtering. Design and fabricate high-brightness and agile waveform sources for integration into components and subsystems.	0.000	0.000	4.580
Accomplishments/Planned Programs Subtotals	35.757	31.683	36.220

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 2014 Air Force			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622003: *EO Sensors & Countermeasures Tech*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
622003: *EO Sensors & Countermeasures Tech*	-	30.491	23.744	23.078	-	23.078	23.717	20.141	21.844	22.283	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

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 2012	FY 2013	FY 2014
Title: Non-cooperative Detection and Identification Technologies	5.936	10.377	11.102
Description: Develop innovative optical sensing technology for non-cooperative detection and identification of airborne and ground-based targets.			
FY 2012 Accomplishments: Conducted sensor concept demonstrations for long-range target identification using passive and active techniques, including multispectral/polarimetric imaging, vibrometry, 3-D, sparse aperture and synthetic aperture laser radar. Extended signature collection experiments and demonstrated techniques for long-range object reconstruction/ shape extraction based on multi-aspect multispectral and polarimetric images and coherent laser radar data. Initiated study of advanced sensing methods for overcoming atmospheric limitations to extended recognition range. Performed field experiments, quantify utility, and develop concepts for airborne experiments of synthetic aperture imaging in the presence of atmospheric turbulence. Developed model-based algorithms for longwave hyperspectral change detection.			
FY 2013 Plans: Continue sensor concept demonstrations for long-range target identification using innovative passive and active techniques. Perform longwave hyperspectral change detection experiments to assess model-based algorithms. Continue laboratory and begin field demonstrations of agile multifunction waveforms for long-range, combined temporal synthetic aperture and remote vibrometry			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622003: *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
waveforms. Begin buildup of linear frequency modulation testbed to support long range performance quantification. Continue development of signal processing and automated signature recognition algorithms for remote vibrometry. ***FY 2014 Plans:*** Develop innovative sensor concepts to increase long range image quality for passive electro-optical and infrared reconnaissance sensors for high altitude platforms. Assess fundamental geometrical environmental and atmospheric limitations to system performance. Develop approaches for image restoration. Continue longwave infrared hyperspectral phenomenology and change detection research.			
Title: Inovative Optical Sensing Technologies ***Description:*** Develop innovative optical sensing technology to support military operations in dynamic and urban environments. ***FY 2012 Accomplishments:*** Performed hyperspectral phenomenology experiments and initiated trade studies for spectral-aided tracking and relocation of targets. Conducted laboratory experiments and began field demonstrations of holographic aperture imaging for high resolution 2-D and 3-D imaging. Conducted demonstrations of multi-aperture transceivers with wavelength and transmitter location diversity. Developed signal processing and automated signature recognition algorithms for remote vibrometry. Developed 3-D imaging technologies for urban applications including scaled sensor designs, modeling and simulation and flight test of prototype sensors. Initiated development of wide area and targeting specific processing algorithms. ***FY 2013 Plans:*** Develop processing methods and sensor requirements for spectral-aided tracking and relocation of targets. Conduct tower demonstrations of multi-aperture transceivers with wavelength and transmitter location diversity. Continue development of signal processing and automated signature recognition algorithms for remote vibrometry. ***FY 2014 Plans:*** This effort moves to Thrust 3 - EO/IR Sensors and Threat Countermeasures in this project to better align efforts.	3.057	0.672	0.000
Title: EO/IR Sensors and Threat Countermeasure Technologies ***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. ***FY 2012 Accomplishments:*** Conducted the assessment of advanced infrared missiles and infrared acquisition sensors. Developed simulation and hardware-in-the-loop test capability to characterize hardware and evaluate/test countermeasure concepts. Conducted development and integration of advanced laser threat detection sensors to demonstrate situational awareness and countermeasure hand-	7.819	2.758	6.215

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622003: *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
off capabilities. Developed simulation and hardware-in-the-loop test capability to characterize hardware and evaluate/test threat warning and countermeasure concepts. Developed performance requirements for advanced electro-optical and infrared countermeasure concepts across mission concepts of employment. ***FY 2013 Plans:*** Continue the assessment of advanced infrared missiles and infrared acquisition sensors. Develop system requirements for Proactive Infrared Countermeasures (PIRCM) to defeat advance infrared (IR) guided missile and IR acquisition and tracking sensor operating in the near to mid-IR bands. Continue development and integration of advanced missile warning sensors to demonstrate situational awareness and countermeasure hand-off capabilities. Continue developing simulation and hardware-in-the-loop test capability to characterize hardware and evaluate/test threat warning and countermeasure concepts. Perform technology development of laser IRCM hardware suitable in size, weight and performance for fighter and mobility aircraft. ***FY 2014 Plans:*** Refine modeling and simulations for multiple ladar modes. Conduct laboratory testing of initial foundry runs of focal planes optimized for three dimensional and holographic imaging. Continue development of optical materials and devices for improved reliability and performance of mid-infrared lasers operating in harsh environments. Begin test of prototype Silicon Gallium (SiGa) detectors. Start design and fabrication of SiGa focal plane array.			
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 2012 Accomplishments:*** Developed beamsteering technology for sparse aperture and compact 3-D laser radar systems. Performed characterization of competing beamsteering component technology concepts. Initiated proof of concept experiments for an agile aperture assembly. Developed design concepts for wideband optical detector arrays suitable for coherent laser radar systems. Defined and implemented optimized waveforms for laser-based sensing. Conducted active and passive sensor phenomenology experiments and model development. Demonstrated initial mid-infrared lasing and frequency conversion in waveguide and fiber media to reduce use of coupling optics for improved reliability and reduced cost of laser sources operating in harsh environments. ***FY 2013 Plans:*** Demonstrate high speed and random access optical phased array scanning with photon counting arrays. Demonstrate increased mid-infrared power and efficiency in waveguide and fiber media to reduce use of coupling optics for improved reliability and reduced cost of laser sources operating in harsh environments. ***FY 2014 Plans:***	5.506	5.271	5.761

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APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 622003: *EO Sensors & Countermeasures Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Refine and demonstrate candidate component technologies for image stabilization and restoration. Determine the utility of non-traditional sensor architectures in improving image quality and the operational range of passive imagers. Initiate prototyping of a flexible, next generation long wave infrared hyperspectral imaging spectrometer.			
Title: Next Generation EO Sensor Technologies ***Description:*** Develop and fabricate new semiconductor components, materials and techniques with capability to identify military and urban threats, to provide threat warning, and precisely engage targets in cluttered environments. Develop emerging optoelectronic materials, devices and circuits for next generation EO sensors exploiting advanced operational modes such as plasmonics, metamaterials, non-linear optics and quantum optics. ***FY 2012 Accomplishments:*** Capitalized on performance enhancements by integrating new materials with advanced plasmonic device technology at the macro, micro and nano scales. Applications included: non-cooperative target identification, automatic target recognition (ATR), ultraviolet to infrared threat warning, countermeasures, communications, computing and urban surveillance. ***FY 2013 Plans:*** Develop new semiconductor materials and devices for military-specific applications such as biological agent detection and covert communications, as well as phase-only correlation techniques for ATR. ***FY 2014 Plans:*** This effort moves to Thrust 3 - EO/IR Sensors and Threat Countermeasure Technologies in this Project to better align efforts.	8.173	4.666	0.000
Accomplishments/Planned Programs Subtotals	30.491	23.744	23.078

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 2014 Air Force			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 626095: *Sensor Fusion Technology*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
626095: *Sensor Fusion Technology*	-	25.724	28.672	25.458	-	25.458	24.400	24.714	28.243	28.808	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

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 2012	FY 2013	FY 2014
Title: Automatic Target Recognition Technologies	1.808	10.560	9.625
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 2012 Accomplishments:*** Enhanced and assessed physics-based techniques to meet the target detection and identification requirements for ISR and combat identification applications. Conducted development and evaluation of automated battle space behavior analysis. Conducted development and assessment of technology that will fuse precision time, position, attitude, and velocity sensor data to enable improved geo-location capabilities for future distributed time and distributed platform sensing. Enhanced multi-sensor, pixel level registration techniques as necessary to support requirements. Assessed and developed capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Conducted research of bio-inspired automatic target recognition technologies and assessed and evaluated these techniques for			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
all missions with emphasis on urban applications. Conducted assessment of automatic target recognition, sensor management, and sensor fusion algorithms for urban ISR from small remotely piloted aircraft (RPA). ***FY 2013 Plans:*** Enhance and assess physics-based techniques to meet the autonomous target detection and identification requirements for ISR applications. Enhance multisensor, pixel level registration techniques as necessary to support requirements. Continue to assess and develop capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy and autonomous sensor, processor, and bandwidth management. Continue research of bio-inspired automatic target recognition technologies and continue to assess and evaluate these techniques for all missions with emphasis on urban applications. Continue assessment in Planning & Direction, Collection, Processing and Exploitation, Analysis and Production, and Dissemination and Experimentation (PCPAD-X) integrative and virtual environments of automatic target recognition, sensor management, and sensor fusion algorithms for urban ISR. ***FY 2014 Plans:*** 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 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. Continue research of bio-inspired automatic target recognition technologies.			
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 2012 Accomplishments:*** Matured target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence sensors emphasizing one target model for application to all parts of the spectrum. Developed signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology automatic target recognition of ground targets. Developed signatures, algorithms, target modeling, and phenomenological modeling of other phenomenological features not previously exploited. Generated synthetic air and ground target signatures with sufficient fidelity to support development and assessment of automatic recognition of targets in operationally realistic mission environments. Investigated model-driven spectral signal processing and exploitation techniques. Developed automatic target recognition algorithm-driven RF sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high-diversity data. Initiated measurements and prediction technology to analyze space object signatures in support of space situational awareness. ***FY 2013 Plans:***	4.449	4.845	4.180

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Continue to mature target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence sensors emphasizing one target model for application to all parts of the spectrum. Continue to develop signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology for automated sensor exploitation of ground targets. Continue the development of signatures, target modeling, and phenomenological modeling of other phenomenological features not previously exploited. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support development and assessment of automatic recognition of targets in realistic mission environments. Continue development of automatic target recognition algorithm-driven RF sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high-diversity data. ***FY 2014 Plans:*** Continue to mature 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. Continue the development of signatures, algorithms, target modeling, and phenomenological modeling of features not previously exploited. Continue development of automatic target recognition algorithm-driven radio-frequency sensor design.			
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 2012 Accomplishments:*** Conducted investigations of sensor exploitation techniques. Developed a capability to model the performance of these technologies. Validated algorithm performance models. Developed databases and tools required to support performance modeling and assessment. Enhanced development of an integrated, unified automatic target recognition methodology building upon the modeling and assessment tools developed. ***FY 2013 Plans:*** Continue development of a capability to model the performance of sensor exploitation technologies. Continue validation of algorithm performance models to be used in the PCPAD-X integrative and virtual environments. Continue development of databases and tools required to support performance modeling and assessment. Continue to enhance development of an integrated, unified automatic target recognition methodology building upon the modeling and assessment tools developed. ***FY 2014 Plans:***	5.887	7.564	6.778

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 626095: *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Continue development of performance models for sensor exploitation technologies, and associated databases and tools. Continue validation of algorithm performance models to be used in the PCPAD-X integrative and virtual environments. Continue to enhance development of an integrated, unified ATR methodology.			
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 2012 Accomplishments:*** Completed development of new technologies and methodologies for producing adaptive, assured, and trusted architectures for multilayered sensing. Developed advanced trusted sensing services, methodologies and techniques for acquisition, aggregation, and portrayal of critical data for sensing network situation awareness. Initiated development of methods, tools, and processes to determine and assess vulnerability and mission assurance for complex system-of-systems for spectrum warfare. ***FY 2013 Plans:*** Continue development of advanced trusted sensing services, middleware, and frameworks for multilayered sensing and spectrum warfare. Continue development of methods, tools, and processes to determine and assess vulnerability and mission assurance as a function of system scale in complex system-of-systems. Continue development of methods, tools, and processes to determine and assess vulnerability and mission assurance for complex system-of-systems for spectrum warfare. ***FY 2014 Plans:*** Continue development of advanced trusted sensing services, middleware, and frameworks for multilayered sensing and spectrum warfare. Continue development of methods, tools, and processes to determine and assess vulnerability and mission assurance for complex system-of-systems for spectrum warfare. Continue development of autonomic trusted sensor technologies to address self-aware, self-healing, and self-organizing sensor systems. Continue development of detect and response mechanism to remedy software and hardware supply chain vulnerabilities.	8.786	2.267	4.875
Title: Anti-Tamper Sensing Technologies ***Description:*** Develop technologies that enable autonomic trusted features in sensor systems to deter reverse engineering and exploitation of critical military hardware and software systems. ***FY 2012 Accomplishments:*** Developed integrated software protection and anti-tamper systems for multilayered ISR sensing systems and spectrum warfare applications. Developed key technologies for trusted sensors for multi-layered ISR sensing systems to assure anti-tamper and software protection of key military capabilities. Developed autonomic trusted sensor technologies to address self-aware, self-healing, and self-organizing sensor systems. Assessed and evaluated commercial technologies for application to military trusted	2.684	1.779	0.000

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APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 626095: *Sensor Fusion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
systems. Completed development of key technology experiments to demonstrate trusted sensor technologies on military weapon systems. ***FY 2013 Plans:*** Continue development of integrated software protection and anti-tamper systems for multilayered ISR sensing systems and spectrum warfare applications. Continue development of autonomic trusted sensor technologies to address self-aware, self-healing, and self-organizing sensor systems. Initiate development of detect and response mechanism to remedy software and hardware supply chain vulnerabilities. Initiate development of software protection and anti-tamper solutions that integrate universal situational awareness to improve attack monitoring and prediction capabilities. ***FY 2014 Plans:*** Efforts move to Thrust 4 - Trusted Sensing Technologies in this Project to better align efforts.			
Title: Multi-Layered Sensing Technologies ***Description:*** Develop trusted and assured avionics system network and integration technology, physical topologies, and protocols to support multi-layered sensing. ***FY 2012 Accomplishments:*** Developed avionics system vulnerability assessment testbed. Developed and assessed advanced avionics bus technologies for trusted sensing. Conducted analysis to exploit wired and wireless avionics sensor systems and analysis of technologies to protect and defend sensor systems. ***FY 2013 Plans:*** Continue development of avionics system vulnerability testbed. Complete development of advanced avionics bus technologies for trusted sensing. Continue analysis to exploit wired and wireless avionics sensor systems and begin analysis of technologies to protect and defend sensor systems. Initiate assessment of susceptibilities of commercial derivative avionics systems. ***FY 2014 Plans:*** Efforts move to Thrust 4 - Trusted Sensing Technologies in this Project to better align efforts.	2.110	1.657	0.000
Accomplishments/Planned Programs Subtotals	25.724	28.672	25.458

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2014 Air Force		DATE: April 2013
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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 2014 Air Force			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602204F: *Aerospace Sensors*	PROJECT 627622: *RF Sensors & Countermeasures Tech*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
627622: *RF Sensors & Countermeasures Tech*	-	44.355	43.538	42.783	-	42.783	42.663	45.135	51.075	55.387	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable all weather RF sensing and countermeasure concepts for aerospace applications covering the range of RF sensors including communications, navigation, 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 2012	FY 2013	FY 2014
Title: Hybrid Sensor Technologies	2.620	5.524	7.839
Description: Develop hybrid sensor solutions to be responsive to needs and detect difficult targets. Develop jam-resistant time, position, and velocity sensors.			
FY 2012 Accomplishments: Developed strategies to optimize reference technologies for distributed sensing missions. Explored alternatives when GPS is degraded or denied. Reduced size, weight, and power of inertial components. Enhanced precision of GPS and non-GPS reference technologies.			
FY 2013 Plans: Continue to develop strategies to optimize reference technologies for distributed sensing missions. Explore alternatives when GPS is degraded or denied. Continue to reduce size, weight, and power of inertial components, while pursuing near navigation grade performance.			
FY 2014 Plans:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Continue to develop strategies to optimize reference technologies for distributed sensing mission. Expand research of alternatives when GPS is degraded or denied in contested environments. Continue to reduce size, weight, and power of inertial components, while pursuing near navigation grade performance.			
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 2012 Accomplishments:*** Completed Distributed Sensing Test Range. Upgraded Outdoor Range capabilities. Performed RF Sensing experimentation including sidelobe nulling, RF Tomography, and multispectral fusion (RF and EO/IR). Stood up X-Band multi-channel phased array radar capability. Began establishment of Open System Architecture for Outdoor Range operations. ***FY 2013 Plans:*** Continue research and development in dismount detection, sparse arrays, polarization diversity, RF tomography, multiple-inputs and multiple-outputs (MIMO) for EP, and Along Track Interferometry (ATI) for ground moving target indicator(GMTI). Continue outdoor range experimentation for concept verification and validation. Continue Outdoor Range Open System Architecture refinement and implementation. Establish new measurement capabilities at low (UHF) and high (Ku/Ka) frequency bands. ***FY 2014 Plans:*** Continue research and development in dismount classification, waveform diversity, MIMO for electronic protection and ATI for GMTI radar. Continue 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.	18.353	11.282	13.814
Title: Advanced RF Architectures ***Description:*** Develop active RF sensor solutions to use against difficult-to-detect targets in challenging environments, and advanced RF architectures for open and reconfigurable systems. Enable persistent ISR over wide areas, and detect advanced air and ground targets. ***FY 2012 Accomplishments:*** Developed and tested reconfigurable array manifold and initiate integration with multi-channel receiver for system demonstration. Tested reconfigurable architecture against multiple configurations and missions, and utilize active array and manifold in the research of advanced RF waveforms. ***FY 2013 Plans:***	1.158	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
N/A. Effort completed in FY12. ***FY 2014 Plans:*** N/A			
Title: Passive RF Sensor Technologies ***Description:*** Develop advanced techniques and prototype passive RF sensors to intercept, collect, locate and track enemy RF sensor systems for ISR of air and ground targets. ***FY 2012 Accomplishments:*** Developed requirements for passive millimeter wave RF receivers, antennas and signal processors. ***FY 2013 Plans:*** Develop signal obstacle course to verify tunable RF architecture using dynamic RF signals. This program will utilize in-house facilities, and state-of-art RF hardware deliverables from the Defense Advanced Research Projects Agency and Air Force contracts. ***FY 2014 Plans:*** Efforts move to Thrust 2 - RF Sensor Technologies in this Project to better align efforts.	0.222	1.518	0.000
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 2012 Accomplishments:*** Initiated research and modeling of distributed and layered electronic warfare (EW) efforts (i.e., multiple jammers or jamming techniques) for spectrum warfare. Explored and analyzed a future/on-coming RF-based threat for potential counters and perform initial vulnerability assessment. Researched advanced electronic support (ES) concepts. Conducted the research and exploration of an adaptable ES/electronic attack (EA) capability, including the exploration of the synergy of a real-time ES system coupled with tailorable EA techniques. ***FY 2013 Plans:***	8.155	5.821	5.895

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Continue development of distributed and layered EW effects. Continue to explore and analyze future/on-coming RF-based threats for potential counters and perform vulnerability assessments. Continue to research advanced ES concepts. Complete research and exploration of an adaptable ES/EA capability. ***FY 2014 Plans:*** Initiate development of distributed and layered EW effects to maintain spectrum dominance for assured operations and position, navigation, and timing (PNT) in contested environments. Continue to explore and analyze next generation RF-based threats for potential counters and perform vulnerability assessments. Continue to research advanced ES concepts. Complete research and exploration of an adaptable ES/EA capability.			
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 2012 Accomplishments:*** Further developed an electronic chassis framework (toolkit) for applying open architectures to Department of Defense sensing systems. Further developed and demonstrated a W-band solid state power amplifier for wideband satellite communications (SATCOM) applications. ***FY 2013 Plans:*** Develop RF/EO subsystem concept prototype and begin its development to validate trade space tools. Refine trade space analysis. ***FY 2014 Plans:*** Continue to develop RF/EO subsystem concept prototype and begin its development to validate trade space tools. Initiate trade space analysis for RF/EO subsystem and device concepts. Continue the development of MIMO and waveform-diverse system models for multi-sensor networks operating in contested environments containing complex clutter and multi-path. Continue the development of cognitive and phenomenology-based algorithm. Continue development of GPS and non-GPS navigation schemes for hypersonic vehicles.	10.397	7.093	5.891
Title: Complex Clutter Environments ***Description:*** Investigate detection of difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms. ***FY 2012 Accomplishments:***	3.450	2.800	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Developed radar environment models for clutter rejection and multipath mitigation by combining electromagnetic phenomenology, cognitive algorithms and sensor signal processing pertaining to the detection and tracking of small targets in complex clutter and jamming environments for MIMO sensor network configurations. ***FY 2013 Plans:*** Continue the development of models applicable to MIMO and waveform-diverse systems for multi-sensor networks operating in complex clutter and multi-path environments, and further continue the development of cognitive and phenomenology-based algorithm theory for the detection and classification of difficult targets and dismount activities for persistent and ubiquitous coverage using multi-platform configurations. ***FY 2014 Plans:*** Efforts move to Thrust 6 - Multi-Band/Multi-Beam Technologies in this Project to better align efforts.			
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. ***FY 2012 Accomplishments:*** N/A ***FY 2013 Plans:*** Initiate research on distributed and layered EW effects. Explore and analyze RF-based threats for potential counters and perform vulnerability assessments. Initiate research for advanced EW concepts. ***FY 2014 Plans:*** Continue to develop technologies that ensure unfettered access to the electromagnetic spectrum while denying the same to adversaries. Continue long-term research on integrating bio-inspired decision-making and cognitive capabilities to EW and EW battle management systems to improve responses in ambiguous EM environments.	0.000	9.500	9.344
Accomplishments/Planned Programs Subtotals	44.355	43.538	42.783

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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E. Performance Metrics

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