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 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603203F / *Advanced 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	-	31.968	34.334	42.183	-	42.183	40.945	40.516	38.793	39.565	Continuing	Continuing
63665A: *Advanced Aerospace Sensors Technology*	-	19.822	14.745	17.521	-	17.521	16.547	15.650	15.575	15.884	Continuing	Continuing
6369DF: *Target Attack and Recognition Technology*	-	12.146	19.589	24.662	-	24.662	24.398	24.866	23.218	23.681	Continuing	Continuing

A. Mission Description and Budget Item Justification

Divided into two broad project areas, Advanced Aerospace Sensors develops technologies to enable the continued superiority of sensors from aerospace platforms. The first project area develops and demonstrates advanced technologies for electro-optical sensors, radar sensors and electronic counter-countermeasures, and components and algorithms. The second project area develops and demonstrates radio frequency (RF) and electro-optical (EO) sensors for detecting, locating, and targeting airborne, fixed, and time-critical mobile ground targets obscured by natural or man-made means. Together, the projects in this program develop the means to find, fix, target, track, and engage air and ground targets anytime, anywhere, and in any weather. 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 3, Advanced Technology Development because this budget activity includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.

B. Program Change Summary ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	30.546	34.420	39.901	-	39.901
Current President's Budget	31.968	34.334	42.183	-	42.183
Total Adjustments	1.422	-0.086	2.282	-	2.282
• Congressional General Reductions	-	-0.086			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	2.000	-			
• SBIR/STTR Transfer	-0.578	-			
• Other Adjustments	-	-	2.282	-	2.282

Change Summary Explanation

Increase in FY14 to support Live Virtual Constructive technology effort.

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 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603203F / *Advanced Aerospace Sensors*	

Increase in FY16 due to higher DoD priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force			Date: February 2015
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603203F / *Advanced Aerospace Sensors*	Project (Number/Name) 63665A / *Advanced Aerospace Sensors 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
63665A: *Advanced Aerospace Sensors Technology*	-	19.822	14.745	17.521	-	17.521	16.547	15.650	15.575	15.884	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project area develops and demonstrates aerospace sensor and processing technologies for intelligence, surveillance, reconnaissance (ISR), target, and attack radar applications in both manned and unmanned platforms, including electro-optical sensors and electronic counter-countermeasures for radars. It provides aerospace platforms with the capability to precisely detect, track, and target both airborne (conventional and low radar cross-section) and ground-based, high-value, time-critical targets in adverse clutter and jamming environments. Project activities include developing multi-function radio-frequency systems including radar and electronic warfare technology. Desired warfighting capabilities include the ability to detect concealed targets in difficult background conditions.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Integrated Navigation Technologies	4.483	4.910	4.484

Description: Develop and demonstrate technologies to provide precision position and timing information to enable distributed, layered sensing on air and space vehicles in Global Positioning System (GPS) degraded/denied environments. Develop technologies to maximize positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. Simulate, develop, and demonstrate integrated navigation warfare technologies, to establish and maintain a military advantage in satellite-based navigation.

FY 2014 Accomplishments:
Developed technologies to preserve position, navigation, and timing (PNT) availability, including augmentation technologies for GPS in the event of outage, and advanced technologies that do not rely on GPS. Explored integration of GPS with precise inertial measurement units (IMUs) and augmentation using geo-referenced imagery. Collaborated with the Air Force Research Laboratory's Space Vehicles Directorate to develop advanced, low-drift IMUs involving novel measurement techniques.

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:
Demonstrate GPS augmentation technologies which include use of GNSS signals with functionality to minimize point source interference while maintaining robust PNT. Continue to develop and mature technologies to incorporate GNSS capability in user

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603203F / *Advanced Aerospace Sensors*	**Project (Number/Name)** 63665A / *Advanced Aerospace Sensors Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
equipment to include GPS Modernized Signals. Develop technologies to minimize the hardware and software overhead required on user equipment to process GNSS signals with precision.			
Title: Persistent Sensing in Contested Environment Technologies ***Description:*** Develop active radio frequency (RF) sensor solutions to use against difficult-to-detect targets in challenging environments, and advanced RF architectures for open and reconfigurable systems. Enable persistent intelligence, surveillance, and reconnaissance (ISR) over wide areas, and detect advanced air and ground targets. ***FY 2014 Accomplishments:*** Completed modular RF backend demonstration for combined radar and signal intelligence (SIGINT). Researched and developed a wide area staring radar, and began development of a staring radar RF testbed. Initiated research and development in next generation active RF sensing for contested spectrum environments, including investigation of the limits of active RF sensing with an emphasis on contested and denied environments. ***FY 2015 Plans:*** Continue research and development of high performance conformal array antenna technology, novel waveforms, Multiple-Input Multiple-Output (MIMO) signal processing techniques, and cooperative RF sensing from multiple platforms in contested environments. Characterize, measure, model, simulate, and improve system performance of active and passive RF sensing systems in terms of RF sensing geometry, environmental phenomenology, clutter, and interference. ***FY 2016 Plans:*** Develop wideband apertures, beamforming networks, signal processing and receiver technology to support passive Electronic Support and Passive Radar modes. Continue research and development of high performance conformal array antenna technology, novel waveforms, Multiple-Input Multiple-Output (MIMO) signal processing techniques, and cooperative RF sensing from multiple platforms in contested environments. Characterize, measure, model, simulate, and improve system performance of active and passive RF sensing systems in terms of RF sensing geometry, environmental phenomenology, clutter, and interference.	5.200	3.000	3.419
Title: Passive Radio Frequency (RF) Sensing Technologies ***Description:*** Develop advanced techniques and prototype passive RF sensors to intercept, collect, locate and track enemy RF sensor systems for intelligence, reconnaissance and surveillance (ISR) of air and ground targets. ***FY 2014 Accomplishments:*** Initiated research for creating passive RF sensing testbed for use in indoor and outdoor range laboratories. Initiated advanced exploration and investigation of the limits of passive RF sensing with an emphasis on innovative passive techniques for operations in contested and denied environments. Developed advanced techniques for the exploitation of active RF emitters utilizing passive	4.149	3.884	6.411

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
RF sensing techniques. Conducted research and development of passive RF sensors including phenomenology, modeling and simulation, algorithm development and experimentation. ***FY 2015 Plans:*** Continue research and development of passive multi-mode radar technology, including signal intelligence (SIGINT), airborne moving target indicator (AMTI), ground moving target indicator (GMTI), and synthetic aperture radar (SAR) imaging. Further develop sensor resource management capabilities for sensor time, energy, and waveform management, as well as optimal utilization of non-cooperative signals in the field of regard. Continue development of algorithms and hardware for passive RF sensing applications, with emphasis on both high endurance at long stand-off range, and survivable, covert stand-in RF sensing within contested airspace. ***FY 2016 Plans:*** Research and develop an illumination selection manager to support passive radar functions in an anti-access/area denial (A2/AD) environment. Continue research and development of passive multi-mode radar technology, including SIGINT, AMTI, GMTI, and SAR imaging.			
Title: Long Range Sensing Technologies ***Description:*** Develop radio frequency (RF) and electro-optical (EO) sensor technology to detect, locate, and identify air and ground targets at long ranges, including those that are low-observable, or use deception or camouflage. ***FY 2014 Accomplishments:*** Initiated development of advanced active and passive electro-optical (EO) sensing technologies for surveillance and reconnaissance at standoff ranges in contested environments. Developed long range temporal synthetic aperture radar system. Demonstrated high power, high coherence transmitter and receiver array. Initiated ground and flight test plans for aircraft integration. Developed transceiver hardware for ground based imaging of satellite in geosyncronous orbit. Initiated test and characterization of mercury-cadmium-teluride on silicone focal plane. Initiated design and prototyping of passive infrared imaging system for enhanced range infrared target recognition and full motion video. ***FY 2015 Plans:*** Extend ground moving target indicator (GMTI) and synthetic aperture radar (SAR) techniques developed for detection and tracking of dismounts and high value mobile ground targets from high angle, close-in radio frequency (RF) sensing scenarios to low angle, long stand-off RF sensing geometric scenarios with anti-access/area denial (A2/AD). Revise and extend prior radar systems engineering and develop improved algorithms and multi-static cooperative radar techniques to address the challenges of long stand-off RF sensing in A2/AD airspace. ***FY 2016 Plans:***	5.990	2.951	3.207

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Continue to develop improved algorithms for low grazing angle, long stand-off GMTI and SAR. Collect data for testing of algorithms. Revise and extend prior radar systems engineering and develop improved algorithms and multi-static cooperative radar techniques to address the challenges of long stand-off RF sensing in A2/AD airspace. Develop technology to enable multi-function RF systems. Develop simulation models that combine radio frequency and electro-optical/infrared sensors with a sensor resource manager. Continue to demonstrate open architecture constructs that enable rapid technology refresh in RF systems.			
Accomplishments/Planned Programs Subtotals	19.822	14.745	17.521

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 / 3	R-1 Program Element (Number/Name) PE 0603203F / *Advanced Aerospace Sensors*	Project (Number/Name) 6369DF / *Target Attack and Recognition 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
6369DF: *Target Attack and Recognition Technology*	-	12.146	19.589	24.662	-	24.662	24.398	24.866	23.218	23.681	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project area develops and demonstrates advanced technologies for attack management, fire control, and target identification and recognition. This includes developing and demonstrating integrated and cooperative fire control techniques to provide for adverse-weather precision air strikes against multiple targets per pass and at maximum weapon launch ranges. Specific fire control technologies under development include attack management, sensor fusion, automated decision aids, advanced tracking for low radar cross section threats, and targeting using both on-board and off-board sensor information. This project area also evaluates targeting techniques to support theater missile defense efforts in surveillance and attack. These fire control technologies will provide force multiplication and reduce warfighter exposure to hostile fire. This project area also develops and demonstrates target identification and recognition technologies for positive, high confidence cueing, recognition, and identification of airborne and ground-based, high-value, time-critical targets at longer ranges than are currently possible. The goal is to apply these technologies to tactical air-to-air and air-to-surface weapon systems so they are able to operate in all weather conditions, during day or night, and in high-threat, multiple target environments. Model-based vision algorithms and target signature development techniques are the key to target identification and recognition. This project is maturing these technologies in partnership with the Defense Advanced Research Projects Agency (DARPA) and evaluating the techniques to support theater missile defense efforts in surveillance and attack. Fire control and recognition technologies developed and demonstrated in this project area are high leverage efforts, providing for significant advancements in operational capabilities largely through software improvements readily transitionable to new and existing weapon systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Integrated Sensor Targeting Technologies	2.700	3.570	4.564
Description: Develop an advanced suite of sensors with automatic target recognition, fusion, and target tracking, all working in concert to provide a high-confidence identification capability.			
FY 2014 Accomplishments: Identified new candidate technologies to improve electro-optical automatic target recognition, synthetic aperture radar automatic target recognition, and the multi-sensor fusion algorithms for both Planning, Collection, Processing, Analysis, and Dissemination (PCPAD) and combat identification applications in contested and denied environments. Enhanced phenomenological modeling, target and scenario databases and exploitation tools necessary to address contested and denied environments. Developed PCPAD capabilities for non-contested environments.			
FY 2015 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Continue assessing integrated sensor targeting technologies for permissive environments which could serve as candidate solutions for PCPAD in contested environments. Create target signature databases from electro-optical, synthetic aperture radar, and multi-source sensor data for targets representing the highest priority threat systems. ***FY 2016 Plans:*** Demonstrate phenomenology-derived feature toolkit for high resolution characterization of salient RF and EO features for select targets; Initiate development and assessment of reduced feature set target models and update target signature database; Demonstrate salient feature extraction for distributed radar and ladar. Initiate challenge problem development for assessment of reduced target feature sets in PCPAD-experimental (PCPAD-X). Continue development of applications to utilize target signature databases from electro-optical, synthetic aperture radar, and multi-source sensor data for targets representing the highest priority threat systems.			
Title: Multi-Sensor Target Recognition ***Description:*** Develop and assess multi-sensor automatic target recognition for intelligence, surveillance, reconnaissance, strike, and weapon systems. ***FY 2014 Accomplishments:*** Assessed technology supporting intelligence, surveillance and reconnaissance systems in contested anti-access/area denial environments. Developed new automatic target recognition fusion research to address technology gaps. Initiated research in development and assessment of multi-sensor automatic target recognition specifically for strike. Initiated spiral development of sensor exploitation algorithms of multi-sensor automatic target recognition systems supporting PCPAD. ***FY 2015 Plans:*** Continue development of target signature formation techniques from single and multiple cooperating sensors, and sensors and signals of opportunity. Create experiments for demonstrating the contributions of promising technologies to address deficiencies in automatic target recognition for select classes of targets in contested environments. ***FY 2016 Plans:*** Initiate development of applications to characterize and suppress clutter in bi-static and passive RF sensors; Initiate development of advanced tracking algorithms for bi-static and passive RF sensors; Continue multi-sensor data collections for RF and EO sensors; Demonstrate and characterize accuracy in uncertainty estimation for vision-aided navigation and geo-registration; Demonstrate onboard image processing on unmanned air systems for insertion into information fusion and decision making systems; Conduct PCPAD-X assessments of multi-sensor tracking and change detection applications for mobile targets in contested environments.	4.716	8.169	10.142
Title: Wide-Angle, Continuously-Staring Technologies	4.730	7.850	9.956

Exhibit R-2A, RDT&E Project Justification: PB 2016 Air Force		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Develop wide angle, continuous staring, multi-sensor/wavelength sensing and automated exploitation technology to detect, track, and identify targets over large areas at low sensor update rates. ***FY 2014 Accomplishments:*** Conducted an assessment of technology supporting intelligence, surveillance and reconnaissance systems in contested anti-access/area denial environments. Developed new automatic target recognition fusion to address technology gaps. Initiated research in development and assessment of multi-sensor automatic target recognition specifically for strike. Initiated spiral development of sensor exploitation algorithms of multi-sensor automatic target recognition systems supporting PCPAD. ***FY 2015 Plans:*** Continue development of stand-off (air and space) and episodic stand-in sensing capabilities for contested and denied environments. Continue development of exploitation algorithms, phenomenological modeling, image formation, and target and scenario databases necessary to support transition of staring sensing capabilities to the warfighter. Continue to integrate, demonstrate and evaluate enhanced wide angle and wide area sensing and exploitation technologies in conditions representative of contested and denied environments. ***FY 2016 Plans:*** Demonstrate tracking, change detection, and image processing capabilities for data representative of contested and denied environments; Collect, process, and catalogue data from advanced wide-angle sensor; Demonstrate reduced SWaP image processing and change detection from large SAR data sets; Demonstrate improved geo-registration and PNT from wide-area EO imagery; Continue development of stand-off (air and space) and episodic stand-in sensing capabilities for contested and denied environments.			
Accomplishments/Planned Programs Subtotals	12.146	19.589	24.662

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.