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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Defense Advanced Research Projects Agency **Date:** February 2015

Appropriation/Budget Activity 0400: <i>Research, Development, Test & Evaluation, Defense-Wide / BA 3: Advanced Technology Development (ATD)</i>					R-1 Program Element (Number/Name) PE 0603767E / <i>SENSOR TECHNOLOGY</i>							
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	-	268.754	302.821	257.127	-	257.127	275.921	240.658	198.129	203.195	-	-
SEN-01: <i>SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY</i>	-	43.317	34.563	19.901	-	19.901	15.554	9.734	8.798	13.672	-	-
SEN-02: <i>SENSORS AND PROCESSING SYSTEMS</i>	-	110.248	115.004	114.396	-	114.396	160.697	157.194	153.098	170.387	-	-
SEN-03: <i>EXPLOITATION SYSTEMS</i>	-	36.910	58.464	28.664	-	28.664	40.323	40.696	30.136	19.136	-	-
SEN-06: <i>SENSOR TECHNOLOGY</i>	-	78.279	94.790	94.166	-	94.166	59.347	33.034	6.097	-	-	-

A. Mission Description and Budget Item Justification

The Sensor Technology program element is budgeted in the Advanced Technology Development Budget Activity because it funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability and battle damage assessment.

The Surveillance and Countermeasures Technology project will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability, and battle damage assessment. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a clandestine manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing, and low-cost microelectronics to develop advanced surveillance and targeting systems. In addition, this project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats.

The Sensors and Processing Systems project develops and demonstrates the advanced sensor processing technologies and systems necessary for intelligence surveillance and reconnaissance (ISR) missions. The project is primarily driven by four needs: 1) providing day-night ISR capabilities against the entire range of potential targets; 2) countering camouflage, concealment, and deception of mobile ground targets; 3) detecting and identifying objects of interest/targets across wide geographic areas in near-real-time; and 4) enabling reliable identification, precision fire control tracking, timely engagement, and accurate battle damage assessment of ground targets.

The Exploitation Systems project develops algorithms, software, and information processing systems to extract information from massive intelligence, surveillance, and reconnaissance (ISR) datasets. In particular, it develops new technologies for detection and discrimination of targets from clutter, classification and fingerprinting of high value targets, localization and tracking over wide areas, and threat network identification and analysis.

UNCLASSIFIED

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B. Program Change Summary (\$ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	276.364	312.821	279.927	-	279.927
Current President's Budget	268.754	302.821	257.127	-	257.127
Total Adjustments	-7.610	-10.000	-22.800	-	-22.800
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-10.000			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.560	-			
• SBIR/STTR Transfer	-8.170	-			
• TotalOtherAdjustments	-	-	-22.800	-	-22.800

Change Summary Explanation

FY 2014: Decrease reflects the SBIR/STTR transfer offset by reprogrammings.

FY 2015: Decrease reflects congressional reduction.

FY 2016: Decrease reflects completion of Adaptable Navigation Systems (ANS), Adaptable, Low Cost Sensors (ADAPT), and Behavioral Learning for Adaptive Electronic Warfare (BLADE) programs.

UNCLASSIFIED

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Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603767E / SENSOR TECHNOLOGY				Project (Number/Name) SEN-01 / SURVEILLANCE AND COUNTERMEASURES 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
SEN-01: SURVEILLANCE AND COUNTERMEASURES TECHNOLOGY	-	43.317	34.563	19.901	-	19.901	15.554	9.734	8.798	13.672	-	-
A. Mission Description and Budget Item Justification												
This project funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability, and battle damage assessment. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a clandestine manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing, and low-cost microelectronics to develop advanced surveillance and targeting systems. In addition, this project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2014	FY 2015	FY 2016	
Title: Multi-Function Optical Sensing									20.000	19.060	19.901	
Description: The proliferation of radio frequency (RF)-based countermeasures, such as digital radio frequency memory (DRFM), has presented challenges to the effectiveness of data sensors. The Multi-Function Optical Sensing (MOS) program will enable an alternative approach to detecting, tracking, and performing non-cooperative target identification, as well as providing fire control for fighter class and long-range strike aircraft. This program leverages emerging high-sensitivity focal plane array (FPA) and compact, multiband laser systems technology in the near/mid/long-wave infrared bands to enable the development of a multi-function optical system. Technical challenges include the demonstration of inexpensive, multiband, large-format, photon-counting, high-bandwidth receivers and their integration into a multi-optical sensor suite compatible with airborne assets. The MOS program seeks to advance the state of the art of components and technology to support an all-optical airborne system that can detect, geolocate, and identify targets at standoff ranges. Technologies from this program will transition to the Services.												
FY 2014 Accomplishments:												
- Completed design of prototype sensor through critical design review.												
- Initiated development of a first-generation prototype sensor.												
- Incorporated results of concept of operations and algorithm performance on simulated data to refine objective system performance requirements.												
- Initiated investigation of communications protocols for the multi-optical sensor to interact with other systems and platforms.												
- Continued development of sensor data-processing algorithms to improve target tracking and identification.												
- Initiated advanced system signal-processing methodologies for real-time performance and integration into the second-generation sensor system.												

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B. Accomplishments/Planned Programs (\$ in Millions)			FY 2014	FY 2015	FY 2016
<ul style="list-style-type: none"> - Investigated alternative approaches for an active cueing system. <p>FY 2015 Plans:</p> <ul style="list-style-type: none"> - Complete the development of the first-generation prototype system. - Incorporate advanced data-processing and target tracking algorithms into the sensor processing chain. - Initiate packaging activity for the incorporation of the developed active focal plane arrays and variable-waveform lasers into the second-generation architecture. - Develop a hardware traceability strategy for the second-generation prototype sensor, which will be part of a roadmap for the development of a fully operational system. <p>FY 2016 Plans:</p> <ul style="list-style-type: none"> - Perform air-to-air demonstrations with the first-generation prototype system. - Initiate the development of a second-generation prototype sensor, which will demonstrate the full capability out to operational ranges. - Commence the development of the second-generation prototype sensor. 					
<p>Title: Adaptable Navigation Systems (ANS)</p> <p>Description: The Adaptable Navigation Systems (ANS) program will provide the U.S. warfighter with the ability to effectively navigate all environments including when Global Positioning System (GPS) is unavailable due to hostile action (jamming) or blockage by structures, foliage, or other environmental obstacles. The ANS approach relies on three major technology innovations. The first is development of a new type of inertial measurement unit (IMU) that requires fewer GPS position fixes. Using cold atom technology, this IMU exceeds the performance of strategic-grade IMUs, with comparable size, weight, and power (SWaP). The second innovation uses Signals of Opportunity (SoOp) from a variety of ground-, air-, and space-based sources, as well as natural SoOps to reduce dependency on GPS position fixes. These will be received on the Services' forthcoming software-defined radios and will use specially tailored algorithms to determine position. The third technology innovation allows SoOp-based position information to be combined with inertial and other sensors to enable flexible navigation systems that can be reconfigured in the field to support any platform or environment. This capability will enhance new advanced component technology for positioning, navigation, and timing (PNT) emerging from other programs in the form of Micro Electro-Mechanical System devices, clocks, and new aiding sensors. Recent advances in mathematics, data abstraction, and network architectures will build upon these capabilities by enabling "plug-and-play" integration of both existing and future navigation components and processing to allow real-time reconfiguration of navigation systems. If successful, major improvements in navigation accuracy and system cost could also be realized. Early transition partners would include all Services, with emphasis on platforms and users that must operate in multiple environments, such as Naval forces.</p> <p>FY 2014 Accomplishments:</p>			14.571	9.779	-

UNCLASSIFIED

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015
<ul style="list-style-type: none"> - Completed development of candidate filter, sensor, and architecture design for plug-and-play system. - Demonstrated flexible, real-time operation of ANS systems on sea-, air-, and land-based platforms using relevant sensor suites. - Transitioned novel navigation measurement technologies, via new sensors, algorithms, or measurement enhancements, into ANS demonstration systems. - Evaluated options for size, weight, power, and cost (SWaP-C)-constrained reference stations that enable full SoOp-based navigation. - Completed design of second-generation 6-degree-of-freedom cold atom IMU. - Evaluated candidate approaches for a wireless time transfer and positioning system that provides GPS-level performance globally with minimal infrastructure, and a compact, jam-proof PNT sensor that provides better than GPS-level performance. <p>FY 2015 Plans:</p> <ul style="list-style-type: none"> - Test and evaluate first-generation 6-degree-of-freedom cold atom-based IMU. - Demonstrate inertial navigation performance of a second-generation cold atom-based IMU on a submarine platform. - Demonstrate the navigation performance, independent of GPS, of the integrated ANS system, comprised of various sensors, including IMUs and SoOp receivers, and a sensor fusion processor, on multiple sea-, air-, and land-based platforms to effect transition to the Services. 			
<p>Title: Adaptable, Low Cost Sensors (ADAPT)</p> <p>Description: The objective of the Adaptable, Low Cost Sensors (ADAPT) program is to leverage commercial technology and manufacturing techniques to improve the development time and significantly reduce the cost of sensors and sensor systems. Currently, military sensors are designed and developed with unique, mission-specific hardware and software capability requirements in a single, fully integrated device. This approach significantly increases both the cost and difficulty of meeting continuously changing requirements and upgrades. Commercial processes, such as those used in the smart phone industry, create reference designs for common system functions and features to accelerate system development time. This makes changing requirements and completing upgrades far simpler. Adopting these commercial processes enables a mission-independent, designed-to-cost "commercial smart core" that can be combined with an appliqué of mission-specific hardware to provide low cost, independently upgradable, and previously infeasible sensor system distribution capabilities. The Smart Munitions effort plans to use ADAPT's sensing, processing, communications, and location capabilities to provide positive identification and man-in-the-loop control of distributed, unattended ground sensor systems. It also seeks to develop a reference design to demonstrate capability and develop tactics for unattended sensors. This program will transition to the Services.</p> <p>FY 2014 Accomplishments:</p> <ul style="list-style-type: none"> - Developed additional reference designs, including Quad-rotor UAV, Fixed Wing UAV, Unmanned Undersea Vessel (UUV), and Software-Defined Radio. - Configured hardware for heterogeneous distributed sensor mission. 		8.746	5.724
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UNCLASSIFIED

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015
<ul style="list-style-type: none"> - Field tested Smart Munitions with multiple sensor modalities. <p><i>FY 2015 Plans:</i></p> <ul style="list-style-type: none"> - Field test and demonstrate mobile coordinated device operation using ADAPT reference designs (Smart Munitions and UAVs). - Investigate alternative low cost sensor designs for other small form factor unmanned military platforms. - Transition reference designs to Services. 			
Accomplishments/Planned Programs Subtotals		43.317	34.563
C. Other Program Funding Summary (\$ in Millions)			
N/A			
Remarks			
D. Acquisition Strategy			
N/A			
E. Performance Metrics			
Specific programmatic performance metrics are listed above in the program accomplishments and plans section.			

UNCLASSIFIED

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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
SEN-02: <i>SENSORS AND PROCESSING SYSTEMS</i>	-	110.248	115.004	114.396	-	114.396	160.697	157.194	153.098	170.387	-	-

A. Mission Description and Budget Item Justification

The Sensors and Processing Systems project develops and demonstrates the advanced sensor and processing technologies and systems necessary for intelligence, surveillance, and reconnaissance (ISR) missions. Future battlefields will continue to be populated with targets that use mobility and concealment as key survival tactics, and high-value targets will range from specific individual insurgents and vehicles to groups of individuals and large platforms such as mobile missile launchers and artillery. The Sensors and Processing Systems Project is primarily driven by four needs: (a) providing day-night ISR capabilities against the entire range of potential targets; (b) countering camouflage, concealment, and deception of mobile ground targets; (c) detecting and identifying objects of interest/targets across wide geographic areas in near-real-time; and (d) enabling reliable identification, precision fire control tracking, timely engagement, and accurate battle damage assessment of ground targets. The Sensors and Processing Systems Project develops and demonstrates technologies and system concepts that combine novel approaches to sensing with emerging sensor technologies and advanced sensor and image processing algorithms, software, and hardware to enable comprehensive knowledge of the battlespace and detection, identification, tracking, engagement, and battle damage assessment for high-value targets in all weather conditions and combat environments.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2014	FY 2015	FY 2016
Title: Adaptive Radar Countermeasures (ARC)	19.221	27.975	19.500
Description: The goal of the Adaptive Radar Countermeasures (ARC) program is to provide effective electronic countermeasure (ECM) techniques against new or unknown threat radars. Current airborne electronic warfare (EW) systems rely on the ability to uniquely identify a threat radar system to apply an appropriate preprogrammed countermeasure technique which can take many months to develop. Countering radar systems is increasingly challenging as digitally programmed radars exhibit novel behaviors and agile waveform characteristics. ARC will develop new processing techniques and algorithms that adapt in real-time to generate suitable countermeasures. Using techniques such as state modeling, machine learning, and system probing, ARC will learn the behavior of the threat system, then choose and implement an appropriate countermeasure strategy. The program is planned for transition to the Joint Program Office.			
FY 2014 Accomplishments: <ul style="list-style-type: none"> - Completed detailed system architecture design and validated software interfaces. - Conducted offline testing to demonstrate signal analysis and characterization of unanticipated or ambiguous radar signals. - Assessed countermeasure effectiveness from over-the-air observable changes in the threat radar signals. - Developed methodologies for closed-loop system testing against adaptive radar threats. - Obtained commitments from transition partners to provide baseline hardware and software for integration and testing of algorithms in a laboratory environment. 			

UNCLASSIFIED

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015	FY 2016
<div>- Developed enhanced security structure for transitioning ARC technology to Joint Program Office transition.</div> <div>FY 2015 Plans:<div>- Refine and integrate component algorithms for end-to-end system testing in a hardware-in-the-loop laboratory environment.</div><div>- Begin porting software algorithms onto transition partner provided baseline EW systems to demonstrate enhanced performance against unknown or ambiguous threat radars.</div><div>- Develop detailed flight test plans in concert with relevant programs of record and Service partners.</div></div> <div>FY 2016 Plans:<div>- Complete real-time software and firmware implementation of all major algorithm modules on transition partner provided baseline EW systems.</div><div>- Develop adaptive radar threat models for use in testing which emulate future adversary radar capabilities that are expected to challenge current baseline EW systems.</div><div>- Demonstrate real-time prototype systems by effectively operating against unanticipated or ambiguous radar signals in a hardware-in-the-loop laboratory environment.</div></div>				
<div>Title: Multifunction RF</div> <div>Description: The Multifunction RF (MFRF) program goal is to enable U.S. rotary wing aircraft forces to fight effectively in all forms of severely Degraded Visual Environments (DVE) when our adversaries cannot. The program goes beyond landing aids in DVE to address all elements of combat to include landing, takeoff, hover/taxi, enroute, navigation, lethality, and survivability. Building on previous RF sensors advancements, the program will seek to eliminate many redundant RF elements of current independently developed situational and combat support systems to provide multifunction capability with flexibility of adding new mission functions. This will reduce the overall size, weight, power, and cost (SWaP-C) of subsystems and protrusive exterior antennas on military aircraft, enabling greater mission capability with reduced vehicle system integration burden. The program approach includes; 1) Development of synthetic vision for pilots that fuses sensor data with high-resolution terrain databases, 2) Development of Advanced Rotary Multifunction Sensor (ARMS), utilizing silicon-based tile arrays, for agile electronically scanning technology at low SWAP-C, 3) Implementation of software development kit to re-define modes as required by mission or platform needs; ease of adding new modes via software without hardware modifications. The program is planned for transition to the Army and Marines.</div> <div>FY 2014 Accomplishments:<div>- Finalized tile array and array backplane technology selection for sub-array builds.</div><div>- Began fabrications of sub-arrays for ARMS laboratory demo.</div><div>- Demonstrated integration of silicon-based tile sub-array and digital receiver/exciter backplane.</div></div>		23.954	16.575	9.385

UNCLASSIFIED

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015
<ul style="list-style-type: none"> - Demonstrated radar software development kit suitable for redefining system functions of integrated system. <p>FY 2015 Plans:</p> <ul style="list-style-type: none"> - Demonstrate utility of software development kit through third-party programming. - Complete laboratory testing of ARMS for flight testing. - Conduct laboratory demo with integrated ARMS, synthetic vision backbone, and multifunction software development kit. - Investigate alternative imaging radar architectures to further reduce size, weight, power, and cost. <p>FY 2016 Plans:</p> <ul style="list-style-type: none"> - Demonstrate DVE landing, takeoff, Ground Moving Target Indicator (GMTI), and Synthetic Aperture Radar (SAR) modes of operation. - Conduct flight tests of ARMS integrated with synthetic vision system on a UH-60 Black Hawk helicopter. 			
<p>Title: Video-rate Synthetic Aperture Radar (ViSAR)</p> <p>Description: Recent conflicts have demonstrated the need for close air support by precision attack platforms such as the AC-130J aircraft in support of ground forces. Under clear conditions, targets are easily identified and engaged quite effectively, but in degraded environments the atmosphere can inhibit traditional optical sensors. The AC-130J must fly above cloud decks in order to avoid anti-aircraft fire, negating optical targeting sensors. Similarly, rotary/wing blades in urban operations generate copious amounts of dust that prevent circling assets from supplying cover fire for ground forces. The Video-rate Synthetic Aperture Radar (ViSAR) program seeks to develop a real-time spotlight synthetic aperture radar (SAR) imaging sensor that will provide imagery of a region to allow high-resolution fire direction in conditions where optical sensors do not function. Technology from this program is planned to transition to Air Force Special Operations Command (AFSOC).</p> <p>FY 2014 Accomplishments:</p> <ul style="list-style-type: none"> - Completed development of transmitter and receiver components for sensor demonstration. - Initiated hardware design and development of ViSAR system. - Demonstrated performance of laboratory quality objective transmitter amplifier. - Completed phenomenology models to support system simulations. <p>FY 2015 Plans:</p> <ul style="list-style-type: none"> - Complete development of flight-worthy high power amplifier. - Demonstrate the integration of low power transmitter and receiver components into sensor. - Integrate phenomenology data into scene simulator and generate data for demonstration of algorithm performance. <p>FY 2016 Plans:</p> <ul style="list-style-type: none"> - Integrate hardware into a sensor control system (gimbal) and demonstrate performance in a laboratory scenario. 		19.250	17.990
			15.250

UNCLASSIFIED

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B. Accomplishments/Planned Programs (\$ in Millions)			FY 2014	FY 2015	FY 2016
<ul style="list-style-type: none">- Integrate hardware and gimbal on a surrogate aircraft.- Conduct flight tests to demonstrate ViSAR performance in comparison to Electro-Optic sensors.					
<p>Title: Military Imaging and Surveillance Technology (MIST)</p> <p>Description: The Military Imaging and Surveillance Technology (MIST) program is developing a fundamentally new optical Intelligence, Surveillance, and Reconnaissance (ISR) capability that can provide high-resolution 3-D images to locate and identify a target at much longer ranges than is possible with existing optical systems. Several prototype optical surveillance and observation systems are being developed that: (1) demonstrate probabilities of recognition and identification at distances sufficient to allow stand-off engagement; (2) overcome atmospheric turbulence, which now limits the ability of high-resolution optics; and (3) increase target identification confidence to reduce fratricide and/or collateral damage. The program will develop and integrate the necessary component technologies including high-energy pulsed lasers, receiver telescopes that have a field of view and depth of field that obviates the need for steering or focusing the optical system, computational imaging algorithms to improve system resolution, and data exploitation and analysis tools. Advances in laser systems, digital imagers, and novel image processing algorithms will be leveraged to reduce the overall size, weight, and power (SWaP) of imaging systems to allow for soldier portable and Unmanned Aerial Vehicle (UAV) platform integration. The MIST program will transition the optical ISR technology to the Air Force and SOCOM.</p> <p>FY 2014 Accomplishments:</p> <ul style="list-style-type: none">- Completed packaging of the high-power pulsed laser required for the MIST long-range prototypes.- Commenced long-range 3-D imaging prototype design and development.- Developed most promising crosswind sensor technologies.- Developed, tested, and transitioned near-hypervelocity rounds for snipers.- Investigated alternate uses of crosswind sensor technology. <p>FY 2015 Plans:</p> <ul style="list-style-type: none">- Complete and transition the short-range 3-D imaging prototypes and technology to the Services.- Complete brassboard and ground demonstrations of the long-range 3-D imaging systems, including testing and demonstration of critical subsystem components.- Complete and test prototypes of the long-range 3-D imaging systems through airborne demonstrations.- Complete packaging and testing of the flight qualified MIST laser. <p>FY 2016 Plans:</p> <ul style="list-style-type: none">- Conduct mountain-to-ground demonstration out to operationally relevant ranges.- Transition the long-range MIST systems to the Air Force.			29.723	23.964	4.761
Title: Spatial, Temporal and Orientation Information for Contested Environments (STOIC)			-	12.500	22.500

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015	FY 2016
<p>Description: *Formerly Precision Timing Enabling Cooperative Effects</p> <p>Building on technologies developed in the Adaptable Navigation Systems program, budgeted in PE 0603767E, Project SEN-01, the Spatial, Temporal and Orientation Information for Contested Environments (STOIC) program will enable precision cooperative effects by developing global time transfer and synchronization systems independent of GPS. As a corollary to time synchronization, this program will also enable GPS independent positioning to maintain precise time synchronization between collaborating mobile users. Key attributes of this program are global availability; minimal and low cost infrastructure; anti-jamming capability; and performance equal to or better than GPS through recent advances in cold atom-based clocks and optical time transfer. Other recent advances show that navigation systems using non-traditional sensors can be rapidly configured to provide accurate positioning, navigation, and timing (PNT) capabilities. This program will build on these and other PNT technologies, and extend this level of performance to include the underwater environment in addition to surface, indoor, and airborne environments. Demonstrations on relevant platforms in relevant environments will be used to validate the technology. This program will transition to the Services, emphasizing platforms that operate in GPS-denied environments.</p> <p>FY 2015 Plans:</p> <ul style="list-style-type: none">- Begin developing a compact optical clock that maintains GPS-level time for over a year.- Begin developing a wireless precision time transfer system that provides better than GPS-level performance using multifunctional systems (e.g. radars, imagers, communications).- Begin developing jam-proof PNT systems that provide better than GPS-level performance in contested environments. <p>FY 2016 Plans:</p> <ul style="list-style-type: none">- Complete prototype components of optical clocks.- Complete detailed design and begin development of compact optical clocks.- Prototype components and systems for enabling precision time transfer independent of GPS.- Complete detailed design and begin development of GPS-independent precision time transfer systems.- Prototype jam-proof PNT system components (signal transmit and receive) for achieving GPS-level positioning performance in contested environments.- Complete detailed design and begin development of jam-proof PNT system.				
<p>Title: Automatic Target Recognition (ATR) Technology</p> <p>Description: Automatic target recognition (ATR) systems provide the capability to detect, identify, and track high value targets from collected sensor data. Current ATRs are typically designed for specific sensors and static due to pre-programmed target lists and operating mode, limiting mission execution capabilities. Extending ATR technology to accommodate sensor upgrades or include new emerging targets can be costly and time consuming. The objective of the ATR Technology program is to develop</p>		-	11.000	17.000

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / <i>SENSOR TECHNOLOGY</i>	Project (Number/Name) SEN-02 / <i>SENSORS AND PROCESSING SYSTEMS</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015
<p>technologies that reduce operation limitations while also providing significant performance improvements, dramatically reduced development times, and reduced life cycle maintenance costs. Recent breakthroughs in deep learning, sparse representations, manifold learning, and embedded systems offer promise for dramatic improvements in ATR. Three core areas the program will focus on are: development of on-line adaptive algorithms that enable performance-driven sensing and ATR; recognition technology that enables rapid incorporation of new targets; and technologies that dramatically reduce required data rates, processing times, and the overall hardware and software footprint of ATR systems. ATR technology developed under the program is planned for transition to the Services.</p> <p>FY 2015 Plans:</p> <ul style="list-style-type: none"> - Develop a modeling and simulation framework for testing and evaluating performance-driven ATR systems. - Establish baseline performance for existing radar ATR algorithms against challenge problem data sets. - Design and execute a data collection experiment to provide additional data for algorithm development and testing. - Initiate development of advanced algorithms that support signature generalization and reduced signature database complexity. <p>FY 2016 Plans:</p> <ul style="list-style-type: none"> - Initiate design of an embedded real-time, low-cost radar ATR processor that incorporates advanced ATR algorithms and uses commercial mobile embedded computing platforms. - Design and execute additional data collection experiments for continued algorithm development and testing. - Continue to improve ATR algorithm performance, including decoy rejection and false target rejection. 			
<p>Title: Advanced Scanning Technology for Imaging Radars (ASTIR)</p> <p>Description: The Advanced Scanning Technology for Imaging Radars (ASTIR) program will provide immediate benefit to applications that are constrained by power, weight, and the complexity limits of production. The goal of this program, building on technologies developed under the Multifunction RF (MFRF) program which is budgeted in this PE/project, is to demonstrate a new imaging radar architecture using an electronically scanned sub-reflector to produce a more readily available, cost-effective sensor solution that does not require platform or target motion. Key system attributes will: 1) provide high-resolution 3D imaging for enhanced identification and targeting, independent of platform or target motion; 2) produce video frame rates to provide well-focused images even when there is platform or target motion; 3) beam steer with a single transmit/receive chain to reduce system complexity resulting in lower cost, power, and weight; 4) integrate millimeter-wave (mmW)/terahertz (THz) electronic component advancements from other DARPA programs for transmit and receive functions. The completion of this program will result in a more readily available, cost-effective imaging radar technology that will work in concert with a wide area surveillance system to provide target identification at video frame rates in all conditions where existing sensors will not work. Applications evaluated to date have identified transition opportunities with Special Operations Command and the Navy in force protection.</p> <p>FY 2016 Plans:</p>		-	10.000

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Defense Advanced Research Projects Agency		Date: February 2015		
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / SENSOR TECHNOLOGY	Project (Number/Name) SEN-02 / SENSORS AND PROCESSING SYSTEMS		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015	FY 2016
<ul style="list-style-type: none">- Develop sensor design concepts and processing algorithms.- Develop a prototype electronic sub-reflector beam-steering system and conduct tests to characterize performance and validate the approach.- Conduct mission studies and determine the system performance metrics required to support specific military applications.				
Title: Small Satellite Sensors		-	-	8.000
Description: Building upon low cost and small form factor sensor research conducted under DARPA's ADAPT and Multi-Function Optical Sensing programs (budgeted in PE 0603767E, Project SEN-01), the Small Satellite Sensors program will develop and space-qualify electro-optical and infrared (EO/IR) sensor and inter-satellite communications technologies, and establish feasibility that new DoD tactical capabilities can be implemented on small (<100 lb) satellites. Experimental payloads will be flown on small satellites, and data will be collected to validate new operational concepts. Small satellites provide a low-cost and quick-turnaround capability for testing new technologies and experimental payloads. Operationally, small and low-cost satellites enable the deployment of larger constellations which can provide greater coverage, persistence, and survivability compared to a small number of more expensive satellites, as well as the possibility for launch-on-demand. This program seeks to leverage rapid progress being made by the commercial sector on small satellite bus technology, as well as investments being made by DoD and industry on low-cost launch and launch-on-demand capabilities for small satellites. The program will focus on developing, demonstrating, and validating key payload technologies needed by DoD that are not currently being developed for commercial space applications. Technologies developed under this program will transition to the Air Force.				
FY 2016 Plans:				
<ul style="list-style-type: none">- Develop conceptual designs for EO/IR sensor and inter-satellite communications subsystems.- Develop software performance models for candidate sensor systems, and perform laboratory and airborne testing to improve model fidelity and assist in selection of flight hardware.- Begin design of experimental sensor payloads compatible with a small satellite bus, and perform preliminary design review.- Begin development of unique component and subsystem technologies needed to support on-orbit demonstrations.- Investigate alternative low-cost payloads suitable for integration on a small satellite.				
Title: Low Cost Seeker		-	-	8.000
Description: The Low Cost Seeker program will develop novel weapon terminal sensing and guidance technologies and systems, for air-launched and air-delivered weapons, that can (i) find and identify fixed and moving targets with only minimal external support, (ii) achieve high accuracy in a GPS-denied environment, and (iii) have very small size and weight, and potentially low cost. The development objectives are technologies and systems with small size, weight and power (SWaP), low recurring cost, applicability to a wide range of weapons and missions such as small unit operations, suppression of enemy air defenses, precision strike, and time-sensitive targets. The technical approach for the sensing/processing hardware is to use passive EO/IR sensors,				

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / <i>SENSOR TECHNOLOGY</i>	Project (Number/Name) SEN-02 / <i>SENSORS AND PROCESSING SYSTEMS</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015
<p>which have evolved into very small and inexpensive devices in the commercial market, and the reconfigurable processing architecture developed in DARPA's ADAPT program (budgeted in PE 0603767E, Project SEN-01). The technical approach to target identification will start from "deep learning" algorithms pioneered for facial recognition and the identification of critical image features. Technologies developed under this program will transition to the Services.</p> <p>FY 2016 Plans:</p> <ul style="list-style-type: none"> - Develop small size, weight, and power (SWaP) and cost sensor and processing unit. - Design novel target identification algorithms. - Integrate feature-based navigation (non-GPS) with the small SWaP sensors/processing unit. - Conduct laboratory demonstrations of integrated sensor/processing unit. 			
<p>Title: Behavioral Learning for Adaptive Electronic Warfare (BLADE)</p> <p>Description: The Behavioral Learning for Adaptive Electronic Warfare (BLADE) program will develop the capability to jam adaptive and rapidly evolving radio frequency (RF) threats in tactical environments and at tactically-relevant timescales. This will change the paradigm for responding to evolving threats from lab-based manual development to an adaptive in-the-field systems approach. When an unknown or advanced RF threat appears, BLADE networked nodes will dynamically characterize the emitter, synthesize an effective countering technique, and evaluate jamming effectiveness by iteratively probing, learning, and adapting to the threat. An optimization process will tailor real-time responses to specific threats, producing a countermeasure waveform that maximizes jam effectiveness while minimizing the required jamming resources. Thus BLADE will enable the rapid defeat of new RF threats and provide the warfighter with real-time feedback on jam effectiveness. The program is transitioning to the U.S. Army Communications-Electronic RDT&E Center, Intelligence and Information Warfighter Directorate for further maturation and hardening.</p> <p>FY 2014 Accomplishments:</p> <ul style="list-style-type: none"> - Performed test and evaluation of real-time prototypes in a laboratory environment based on Government provided threat networks that exhibited spectrum agility. - Successfully integrated algorithms into a prototype communication countermeasures system (CCS). - Extended and enhanced algorithms for over-the-air mobile operations involving dynamic battlefield conditions and cluttered RF environments. - Demonstrated accurate real-time electronic warfare battle damage assessment for transition partner defined threat networks. - Conducted open air ground testing at the U.S. Army Electronic Proving Grounds, Ft Huachuca, AZ. - Transitioned BLADE Phase II software algorithms to U.S. Navy Naval Surface Warfare Center Crane Maritime Expeditionary Division for use in the Standalone High Accuracy response Path (SHARP) project. <p>FY 2015 Plans:</p>		18.100	5.000
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Exhibit R-2A, RDT&E Project Justification: PB 2016 Defense Advanced Research Projects Agency		Date: February 2015	
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / <i>SENSOR TECHNOLOGY</i>	Project (Number/Name) SEN-02 / <i>SENSORS AND PROCESSING SYSTEMS</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015
<ul style="list-style-type: none"> - Formally test and evaluate ground-based and airborne prototype systems in an operationally relevant environment featuring agile threat networks. - Quantify the minimum hardware requirements, including processing and memory, necessary to execute the BLADE algorithms on transition platforms. - Transition BLADE components to U.S. Army Communications-Electronic RDT&E Center Intelligence and Information Warfare Directorate. 			
Accomplishments/Planned Programs Subtotals		110.248	115.004
C. Other Program Funding Summary (\$ in Millions)			
N/A			
Remarks			
D. Acquisition Strategy			
N/A			
E. Performance Metrics			
Specific programmatic performance metrics are listed above in the program accomplishments and plans section.			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Defense Advanced Research Projects Agency										Date: February 2015		
Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603767E / SENSOR TECHNOLOGY				Project (Number/Name) SEN-03 / EXPLOITATION SYSTEMS			
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
SEN-03: EXPLOITATION SYSTEMS	-	36.910	58.464	28.664	-	28.664	40.323	40.696	30.136	19.136	-	-

A. Mission Description and Budget Item Justification

The Exploitation Systems project develops algorithms, software, and information processing systems to extract information from massive intelligence, surveillance, and reconnaissance (ISR) datasets. In particular, it develops new technologies for detection and discrimination of targets from clutter, classification and fingerprinting of high value targets, localization and tracking over wide areas, and threat network identification and analysis. Interest extends to open source information, and also addresses issues such as trustworthiness and provenance of that information. The resulting technology will enable operators to more effectively and efficiently incorporate all sources of information, including sensor, human, and open source data, in intelligence products.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2014	FY 2015	FY 2016
Title: Insight	36.910	43.534	11.664
<p>Description: Insight is developing the next generation multi-intelligence exploitation and resource management system. Insight provides new exploitation capabilities through an integrated, standards-based system that is designed for mission flexibility and cross-theater applicability. Insight will enable detection of threat networks through combination and analysis of information from imaging and non-imaging sensors and other sources. The technical approach emphasizes model-based correlation, adversary behavior modeling, threat network analysis tools, resource management tools, a unified data management and processing environment, novel exploitation algorithms and analysis methodologies, and tools to integrate human and machine processing, including visualization, hypothesis manipulation, on-line learning, and distributed social intelligence. Insight development activities leverage both virtual and physical test bed environments. The virtual test bed enables evaluation of alternative sensor mixes and algorithms under extended operating conditions. The physical test bed enables live testing under realistic operational conditions using current and next generation sensing and processing systems. Insight technology development is coordinated with the following transition sponsors: Army Program Executive Office - Intelligence, Electronic Warfare & Sensors, United States Army Intelligence Center of Excellence, Project Manager Distributed Common Ground System - Army, the Air Force Intelligence, Surveillance, and Reconnaissance Agency, National Air and Space Intelligence Center, and the Air Force Research Laboratory. Insight provides a unified architecture for plug-and-play ISR with extensibility to all Services and Combatant Commands, initially the Central, Special Operations, and Pacific Commands.</p> <p>FY 2014 Accomplishments:</p> <ul style="list-style-type: none"> - Finalized formal transition agreements for transfer of technologies to Army and Air Force. - Demonstrated updated/improved and new analytical capabilities to support offensive, defensive, and stability operations during a live field test and in the context of an Army Brigade training rotation. - Developed new virtual sensor models and developed a complex virtual environment scenario for test, integration and validation prior to live test events. 			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Defense Advanced Research Projects Agency			Date: February 2015		
Appropriation/Budget Activity 0400 / 3		R-1 Program Element (Number/Name) PE 0603767E / <i>SENSOR TECHNOLOGY</i>		Project (Number/Name) SEN-03 / <i>EXPLOITATION SYSTEMS</i>	
B. Accomplishments/Planned Programs (\$ in Millions)			FY 2014	FY 2015	FY 2016
<ul style="list-style-type: none"> - Augmented and demonstrated the reasoning component of the system to process various new and other relevant information sources (simulated and live) in support of contemporary mission profiles and operational environments. - Tested and matured advanced fusion technologies in live and virtual operational environments. - Tailored component and system level capabilities to specific transition partner objectives, software, data and workflows and demonstrated improvements in analytical effectiveness. <p>FY 2015 Plans:</p> <ul style="list-style-type: none"> - Complete the initial software baseline insertion and transfer technologies to Army and Air Force. - Continue to augment, refine and adapt algorithms and software baseline in preparation for second capability insertion to Army and Air Force. - Adapt capabilities to emerging operational environments, to include integration of additional, non-traditional sensors and information sources. - Test and mature advanced analytic and resource management technologies in live and virtual operational environments. - Execute a live field test in coordination with a military training rotation to demonstrate improvements and maturity of system capabilities in a dynamic operational environment. - Develop a new and advanced data model compatible with existing system data models. - Deliver refined, advanced and integrated capabilities that address key performance parameters of transition partner programs of record aligned with their software release cycles. <p>FY 2016 Plans:</p> <ul style="list-style-type: none"> - Test advanced analytic and resource management technologies in coordination with a military training rotation to demonstrate improvements and maturity of system capabilities. - Tailor final component and system level capabilities to specific transition partner objectives. - Deliver final integrated capabilities that address key performance parameters of transition partner programs of record for insertion into software baselines. - Prepare and finalize software packages and documentation for transition to Services. 					
<p>Title: Media Forensics*</p> <p>Description: *Formerly Battlefield Evidence</p> <p>The Media Forensics program will create technologies for analyzing diverse types of content and media to determine their trustworthiness for military and intelligence purposes. Current approaches to media forensics for authentication and verification are manpower intensive and require analysts and investigators to undertake painstaking analyses to establish context and provenance. Media Forensics will develop, integrate, and extend image and video analytics to provide forensic information that can be used by analysts and automated systems. Technologies will transition to operational commands and the intelligence community.</p>			-	14.930	17.000

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603767E / <i>SENSOR TECHNOLOGY</i>	Project (Number/Name) SEN-03 / <i>EXPLOITATION SYSTEMS</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2014	FY 2015
<i>FY 2015 Plans:</i> - Formulate approaches to automatically detect when image and video files have been altered or manipulated. - Develop operator-in-the-loop technologies for analyzing and determining the trustworthiness of open source and collected images and video. - Initiate development of techniques for detection of information sources not consistent with other observations, indicative of possible disinformation efforts. <i>FY 2016 Plans:</i> - Develop advanced techniques for media fingerprinting and the ability to search large repositories for content produced by the same device. - Develop cross media representations of semantic content in image and video sources and techniques to combine information indicating where the sources reinforce or contradict each other. - Develop approaches for countering evolving anti-forensics technologies.			
Accomplishments/Planned Programs Subtotals		36.910	58.464
C. Other Program Funding Summary (\$ in Millions) N/A Remarks D. Acquisition Strategy N/A E. Performance Metrics Specific programmatic performance metrics are listed above in the program accomplishments and plans section.			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2016 Defense Advanced Research Projects Agency										Date: February 2015		
Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603767E / <i>SENSOR TECHNOLOGY</i>				Project (Number/Name) SEN-06 / <i>SENSOR TECHNOLOGY</i>			
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
SEN-06: <i>SENSOR TECHNOLOGY</i>	-	78.279	94.790	94.166	-	94.166	59.347	33.034	6.097	-	-	-
A. Mission Description and Budget Item Justification This project funds classified DARPA programs that are reported in accordance with Title 10, United States Code, Section 119(a)(1) in the Special Access Program Annual Report to Congress.												
B. Accomplishments/Planned Programs (\$ in Millions)										FY 2014	FY 2015	FY 2016
Title: Classified DARPA Program Description: This project funds Classified DARPA Programs. Details of this submission are classified. FY 2014 Accomplishments: Details will be provided under separate cover. FY 2015 Plans: Details will be provided under separate cover. FY 2016 Plans: Details will be provided under separate cover.										78.279	94.790	94.166
Accomplishments/Planned Programs Subtotals										78.279	94.790	94.166
C. Other Program Funding Summary (\$ in Millions) N/A Remarks D. Acquisition Strategy N/A E. Performance Metrics Details will be provided under separate cover.												