Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Defense Advanced Research Projects Agency	**Date:** February 2015
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*

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	-	92.001	92.246	79.021	-	79.021	87.381	115.033	148.689	169.859	-	-
MT-12: *MEMS AND INTEGRATED MICROSYSTEMS TECHNOLOGY*	-	32.632	14.264	-	-	-	-	-	-	-	-	-
MT-15: *MIXED TECHNOLOGY INTEGRATION*	-	59.369	77.982	79.021	-	79.021	87.381	115.033	148.689	169.859	-	-

A. Mission Description and Budget Item Justification

The Advanced Electronics Technologies program element is budgeted in the Advanced Technology Development Budget Activity because it seeks to design and demonstrate state-of-the-art manufacturing and processing technologies for the production of various electronics and microelectronic devices, sensor systems, actuators and gear drives that have military applications and potential commercial utility. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements.

The MicroElectroMechanical Systems (MEMS) and Integrated Microsystems Technology project is a broad, cross-disciplinary initiative to merge computation and power generation with sensing and actuation to realize a new technology for both perceiving and controlling weapons systems and battlefield environments. MEMS applies the advantages of miniaturization, multiple components and integrated microelectronics to the design and construction of integrated electromechanical and electro-chemical-mechanical systems to address issues ranging from the scaling of devices and physical forces to new organization and control strategies for distributed, high-density arrays of sensor and actuator elements. The project will also address thermal management, navigation and positioning technology challenges.

The Mixed Technology Integration project funds advanced development and demonstrations of selected basic and applied electronics research programs. Examples of activities funded in this project include, but are not limited to: (1) component programs that integrate mixed signal (analog and digital; photonic and electronic) or mixed substrate (Gallium Nitride, Gallium Arsenide, Indium Phosphide, or Silicon Germanium with CMOS) technology that will substantially improve the capability of existing components and/or reduce size, weight and power requirements to a level compatible with future warfighter requirements; (2) development and demonstration of brassboard system applications in such areas as laser weaponry or precision navigation and timing to address mid-term battlefield enhancements; and (3) novel technological combinations (i.e. photonics, magnetics, frequency attenuators) that could yield substantial improvement over current systems.

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Defense Advanced Research Projects Agency	**Date:** February 2015
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	107.080	92.246	83.198	-	83.198
Current President's Budget	92.001	92.246	79.021	-	79.021
Total Adjustments	-15.079	-	-4.177	-	-4.177
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-11.913	-			
• SBIR/STTR Transfer	-3.166	-			
• TotalOtherAdjustments	-	-	-4.177	-	-4.177

Change Summary Explanation

FY 2014: Decrease reflects below threshold and omnibus reprogrammings and the SBIR/STTR transfer.

FY 2016: Decrease reflects completion of the MEMS and Integrated Microsystems Technology Project (MT-12).

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 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-12 / *MEMS AND INTEGRATED MICROSYSTEMS 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
MT-12: *MEMS AND INTEGRATED MICROSYSTEMS TECHNOLOGY*	-	32.632	14.264	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The MicroElectroMechanical Systems (MEMS) and Integrated Microsystems Technology program is a broad, cross-disciplinary initiative to merge computation and power generation with sensing and actuation to realize a new technology for both perceiving and controlling weapons systems and battlefield environments. Using fabrication processes and materials similar to those used to make microelectronic devices, MEMS applies the advantages of miniaturization, multiple components and integrated microelectronics to the design and construction of integrated electromechanical and electro-chemical-mechanical systems. The MEMS program addresses issues ranging from the scaling of devices and physical forces to new organization and control strategies for distributed, high-density arrays of sensor and actuator elements. These issues include microscale power and actuation systems as well as microscale components that survive harsh environments. Thermal management technologies will develop heat resistant thermal layers to provide efficient operation for cooling electronic devices. The current focus in micro technologies is to improve navigation, position and timing capabilities for uncompromised navigation and positioning in today's dynamic military field of operations.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Micro-Technology for Positioning, Navigation, and Timing (Micro PN&T)	28.259	14.264	-
Description: The Micro-Technology for Positioning, Navigation, and Timing (Micro-PNT) program is developing low-Cost, Size, Weight, and Power (CSWaP) inertial sensors and timing sources for navigation in GPS degraded environments, primarily focusing on the development of miniature solid state and atomic gyroscopes and clocks. Both classes of sensors are currently unsuitable for small platform or dismount soldier applications. Micro Electro-Mechanical Systems (MEMS) sensors have limited performance but excellent CSWaP, while atomic sensors are capable of excellent performance but are limited to laboratory experiments due to complexity and high CSWaP. Micro-PNT is advancing both technology approaches by improving the performance of MEMS inertial sensors and by miniaturizing atomic devices. Ultimately, low-CSWaP inertial sensors and clocks will enable ubiquitous guidance and navigation on all platforms, including guided munitions, unmanned aerial vehicles (micro-UAVs), and mounted and dismounted soldiers. Successful realization of Micro-PNT requires the development of new microfabrication processes and novel material systems for fundamentally different sensing modalities, understanding of the error sources at the micro-scale, and development of miniature inertial sensors based on atomic physics. Innovative microfabrication techniques under development will allow co-fabrication of dissimilar devices on a single chip, such that clocks, gyroscopes, accelerometers, and calibration stages can be integrated into a small, low power architecture. The program is developing miniature inertial sensors based on atomic interferometry and nuclear magnetic resonance. Ancillary research efforts for this program are funded within PE 0602716E, Project ELT-01.			

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 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-12 / *MEMS AND INTEGRATED MICROSYSTEMS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
FY 2014 Accomplishments: - Demonstrated basic functionality of miniature atomic physics-based inertial sensors. - Demonstrated functionality of MEMS gyro and co-fabricated calibration stage. - Demonstrated integration of atomic interferometry inertial sensor with high-bandwidth co-sensor. - Demonstrated miniaturized trapped ion clock, with roadmap to self-contained, portable operation. - Demonstrated electronic gyroscope self-calibration with long-term scale factor and bias of <10 ppm of full range. - Demonstrated personal navigation for 4-hour long test with tight integration of MEMS and foot-to-foot ranging. ***FY 2015 Plans:*** - Demonstrate a miniature, self-contained atomic gyroscope with Angle Random Walk (ARW) < 0.05 degrees/sqrt(hr) and bias stability < 0.01 degrees/hr. - Demonstrate self-calibrating MEMS gyroscope with long-term scale factor and bias of <1 ppm of full range.			
Title: Blast Exposure Accelerated Sensor Transfer (BEAST) ***Description:*** The Blast Exposure Accelerated Sensor Transition (BEAST) program built on progress made through the Blast Gauge program and enabled a better understanding of blast-related injuries such as Traumatic Brain Injury (TBI) and Post-Traumatic Stress Disorder (PTSD). During a blast event, the Blast Gauge device captures environmental data and available operational information in order to develop a 3D recreation of the event. The BEAST program provided additional tools for the military community, conducted cognitive testing in high risk service members, and expanded the current knowledge base of the impact of blast exposure by correlating physiological and behavioral changes with direct measures of blast-exposure. Ultimately, these results contributed to the TBI and PTSD knowledge base for improved treatment, developed enhanced understanding of blast events to mitigate exposure and improved training procedures, and aided in completing the transition of the Blast Gauge device to military service sustainment. ***FY 2014 Accomplishments:*** - Supported medical studies using Blast Gauge devices. - Completed development of a web-based tool to store, organize, analyze, and visualize Blast Gauge recordings. - Issued 5th generation Blast Gauge devices to groups of Service members. - Concluded verification and validation blast testing event with Army Testing Center at Aberdeen Proving Grounds. - Finalized approvals to commence clinical studies on physiological and behavioral measures correlated to blast exposure. - Established data collection plan for cognitive testing in clinical participants.	4.373	-	-
Accomplishments/Planned Programs Subtotals	32.632	14.264	-

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 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-12 / *MEMS AND INTEGRATED MICROSYSTEMS TECHNOLOGY*

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.

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 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-15 / *MIXED TECHNOLOGY INTEGRATION*

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
MT-15: *MIXED TECHNOLOGY INTEGRATION*	-	59.369	77.982	79.021	-	79.021	87.381	115.033	148.689	169.859	-	-

A. Mission Description and Budget Item Justification

The Mixed Technology Integration project funds advanced development and demonstrations of selected basic and applied electronics research programs. Examples of activities funded in this project include, but are not limited to: (1) component programs that integrate mixed signal (analog and digital; photonic and electronic) or mixed substrate (Gallium Nitride, Gallium Arsenide, Indium Phosphide, or Silicon Germanium with CMOS) technology that will substantially improve the capability of existing components and/or reduce size, weight and power requirements to a level compatible with future warfighter requirements; (2) development and demonstration of brassboard system applications in such areas as laser weaponry or precision navigation and timing to address mid-term battlefield enhancements; and (3) novel technological combinations (i.e. photonics, magnetics, frequency attenuators) that could yield substantial improvement over current systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Endurance	17.859	37.669	23.473
Description: The Endurance program will develop technology for pod-mounted lasers to protect a variety of airborne platforms from emerging and legacy electro-optical IR guided surface-to-air missiles. The focus of the Endurance effort will be to develop and test ancillary subsystems, such as a command subsystem, a threat missile warning subsystem, a mechanical support framework, subsystem interfaces, and the design, integration, and testing of a form/fit/function brass-board laser countermeasure. This program is an early application of technology developed in the Excalibur program and will transition via industry. Applied research for this program is budgeted in PE 0602702E, project TT-06. ***FY 2014 Accomplishments:*** - Developed critical design of ancillary subsystems (power supply, thermal management, processing and control, mechanical support framework). - Developed preliminary design for subsystem integration including optical and electrical interconnections and their layouts. ***FY 2015 Plans:*** - Acquire threat devices and/or surrogates in preparation for live fire testing. - Complete the critical design for subsystem integration. - Integrate, assemble and bench-test the brassboard system. ***FY 2016 Plans:*** - Test the brassboard laser weapon system at an outdoor test range against a representative set of dynamic-threat targets. - Assess brassboard system performance in live-fire testing.			

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 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-15 / *MIXED TECHNOLOGY INTEGRATION*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
- Develop a preliminary engineering design for a flight-prototype of a pod-mounted laser weapon system.			
Title: Diverse & Accessible Heterogeneous Integration (DAHI)	13.910	20.300	12.754

Description: Prior DARPA efforts have demonstrated the ability to monolithically integrate different semiconductor types to achieve near-ideal "mix-and-match" capability for DoD circuit designers. Specifically, one such program was the Compound Semiconductor Materials On Silicon (COSMOS) program, in which transistors of Indium Phosphide (InP) could be freely mixed with silicon complementary metal-oxide semiconductor (CMOS) circuits to obtain the benefits of both technologies (very high speed and very high circuit complexity/density, respectively). The Diverse & Accessible Heterogeneous Integration (DAHI) effort will take this capability to the next level, ultimately offering the seamless co-integration of a variety of semiconductor devices (for example, Gallium Nitride (GaN), InP, Gallium Arsenide, Antimonide Based Compound Semiconductors), microelectromechanical (MEMS) sensors and actuators, photonic devices (e.g., lasers, photo-detectors) and thermal management structures. This capability will revolutionize our ability to build true "systems on a chip" (SoC) and allow dramatic size, weight and volume reductions for a wide array of system applications.

This program has basic research efforts funded in PE 0601101E, Project ES-01 and applied research efforts funded in PE 0602716E, Project ELT-01. The Advanced Technology Development part of this program will leverage these complementary efforts to focus on the establishment of an accessible, manufacturable technology for device-level heterogeneous integration of a wide array of materials and devices (including, for example, multiple electronics and MEMS technologies) with complex silicon-enabled (e.g. CMOS) architectures on a common silicon substrate platform. This part of the program is expected to culminate in accessible foundry processes of DAHI technology and demonstrations of advanced microsystems with innovative architectures and designs that leverage heterogeneous integration. By the end of the program, this effort seeks to establish a technologically mature, sustainable DAHI foundry service to be made available (with appropriate computer-aided design support) to a wide variety of DoD laboratory, Federally Funded Research and Development Center (FFRDC), academic and industrial designers.

FY 2014 Accomplishments:
- Developed a high-yield, high-reliability accessible manufacturing process flow which will be transitioned to a self-sustaining foundry activity providing heterogeneously integrated circuits with four materials/device technologies (Silicon (Si) CMOS, InP Heterojunction Bipolar Transistor (HBTs), GaN High-electron-mobility transistor (HEMTs), and high-Q passive devices).
- Developed three-technology chiplet-based heterogeneous integration process for use in initial heterogeneous integration multi-project wafer foundry fabrication run.
- Developed process for integration of third-party device technologies in heterogeneous integration foundry.
- Established heterogeneous integration design/simulation tool flows necessary to realize the full potential of heterogeneous microsystems integration.
- Developed thermal simulation tools and process design kit for heterogeneous integration process.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
- Demonstrated capability for supporting multi-project wafer runs using the heterogeneous foundry service under development. - Demonstrated design support capabilities and mask aggregation for initial heterogeneous integration foundry run. - Accelerated development of circuit design techniques and methodologies that enable revolutionary heterogeneously integrated circuit architectures. - Developed example circuits and circuit design block library for use by circuit design teams in initial heterogeneous integration foundry run. ***FY 2015 Plans:*** - Continue to develop a high-yield, high-reliability accessible manufacturing process flow which will be transitioned to a self-sustaining foundry activity providing heterogeneously integrated circuits with four materials/device technologies (Si CMOS, InP HBTs, GaN HEMTs, and high-Q passive devices). - Continue to demonstrate capability for supporting multi-project wafer runs using the heterogeneous foundry service under development. ***FY 2016 Plans:*** - Complete development of a high-yield, high-reliability accessible manufacturing process flow which will be transitioned to a self-sustaining foundry activity providing heterogeneously integrated circuits with four materials/device technologies (Si CMOS, InP HBTs, GaN HEMTs, and high-Q passive devices). - Complete demonstration of capability for supporting multi-project wafer runs using the heterogeneous foundry service under development.			
Title: FLASH - Scaling Fiber Arrays at Near Perfect Beam Quality ***Description:*** The goal of the FLASH program is to demonstrate a transportable, packaged laser system whose output is derived from coherently combining the outputs of an array of ultra-lightweight, flight-worthy high power fiber lasers. The packaged FLASH laser system will project a >30-kW-class beam with near perfect beam quality and very high electrical-to-optical efficiency. The size, weight, and power (SWaP) will be consistent with weight and volume densities needed to support the integration of laser weapons on a broad range of Military platforms. To accomplish these ends, FLASH will (1) greatly reduce the overall size and weight of packaged coherently-combinable high-power fiber laser amplifiers while greatly simplifying the demands they make on support systems such as cabling, cooling lines and support structures while increasing their efficiency and resistance to shock, vibration and acoustics and (2) fabricate an array of these ultralight fiber-laser amplifiers and integrate them with advanced battery power, thermal management and coherent-beam combination sub-systems into a transportable, fully packaged laser system. ***FY 2014 Accomplishments:*** - Demonstrated a benchtop array of 1.3 kW fiber-lasers combined to produce a >30 kW near-diffraction-limited output at >25% electrical-to-optical efficiency.	11.600	18.013	14.100

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
- Estimated the capability of a 21-element optical-phased array system to compensate for atmospheric turbulence under various atmospheric conditions. - Demonstrated target-in-the-loop phase-locking on a stationary target at a 7 km distance. ***FY 2015 Plans:*** - Develop and test a packaged, flight-worthy, coherently-combinable, fiber laser amplifier with an output power, beam-quality, size and weight consistent with system integration on tactical aircraft. - Develop a preliminary design for a >30 kW, transportable, packaged laser system including fiber lasers, thermal management, power systems, and beam combination. ***FY 2016 Plans:*** - Develop a critical design for a >30 kW transportable, packaged laser system. - Fabricate and /or procure parts and hardware for the >30 kW, transportable, packaged laser system. - Assemble and test key subsystems for the >30 kW, transportable, packaged laser system. - Begin the integration of key subsystems for a >30 kW, transportable, packaged laser system.			
Title: Direct SAMpling Digital ReceivER (DISARMER) ***Description:*** The goal of the Direct SAMpling Digital ReceivER (DISARMER) program is to produce a hybrid photonic-electronic analog-to-digital converter (ADC) capable of coherently sampling the entire X-band (8-12 GigaHertz (GHz)). Conventional electronic wideband receivers are limited in dynamic range by both the electronic mixer and the back-end digitizers. By employing an ultra-stable optical clock, the DISARMER program will allow for mixer-less digitization and thereby improve the dynamic range 100x over the state of the art. Such a wide-bandwidth, high-fidelity receiver will have applications in electronic warfare and signals intelligence systems with the potential to drastically reduce the cost, size and weight of these systems. The DISARMER program will design, fabricate, and test a hybrid photonic-electronic ADC packaged in a standard form factor. This involves the integration of electronic and photonic circuits, packaging of a mode-locked laser with ultralow jitter, and delivering a field programmable gate array with the necessary firmware to process the sampled data. This program has applied research efforts funded in PE 0602716E, Project ELT-01. ***FY 2014 Accomplishments:*** - Defined system architecture and flow-down metrics for individual components. - Designed and fabricated a novel, single channel optical receiver chip capable of receiving electrical pulses that are < 2 ps wide. - Designed remote sampling head and sourced components to incorporate electronic RF frontend, electro-optic modulator, and 4 GHz-wide filter. ***FY 2015 Plans:***	2.000	2.000	2.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
- Design, fabricate and test the second generation optical receiver chip with 8 channels and optimized optical response to minimize the parasitic capacitance of the circuit. - Complete system engineering of field programmable gate array capable of continuous streaming of digital data. - Demonstrate direct sampling of a 2 GHz-wide bandwidth signal at 9 effective bits of fidelity. ***FY 2016 Plans:*** - Demonstrate direct sampling of a 4 GHz-wide bandwidth signal at 10 effective bits of fidelity.			
Title: Photonic Radio ***Description:*** The rapid pace of wireless technology development has created a commercial technology base with accessible components that span the radio spectrum up to 100 GHz. When faced with agile or unknown threats across decades of bandwidth, conventional radio frequency (RF) systems perform poorly. Massively channelized receivers spanning just tens of GHz also have unacceptable size and power envelopes for very large defense platforms. Recent developments in integrated photonics have demonstrated the potential to channelize, filter and down-convert RF signals in the photonic domain with significantly improved performance and greatly reduced size. The Photonic Radio program will build on this foundation to deliver a chip-scale photonic channelized receiver spanning 20 to 50 GHz in 200 MHz-wide channels. The program will design and build a complete and compact solution with intimate integration of electronics with high performance photonic devices, such as very high Q filters and on-chip high-power lasers. The program will also package the prototype system and conduct field tests for insertion into advanced weapons systems. ***FY 2016 Plans:*** - Design and simulate the complete channelized receiver and generate flow down specifications to component technologies. - Fabricate and test integrated photonic down-converter and high-Q filters with more than 55 decibels of dynamic range.	-	-	9.890
Title: Fast and Big Mixed-Signal Designs (FAB) ***Description:*** Developing capabilities to intermix and tightly integrate silicon processes which are currently supported at different scaling nodes and by different vendors is critical to increasing the capabilities of high-performance military microelectronics. For example, Silicon-Germanium (SiGe) Bipolar Complementary Metal-oxide Semiconductor (BiCMOS) processes allow CMOS logic to be integrated with radio frequency (RF) heterojunction bipolar transistors (HBTs), which enables mixed-signal circuits having RF analog capabilities tightly coupled to digital processing. However, the SiGe process flow was developed to integrate to a single CMOS technology node and significant design and engineering effort is required to retarget the flow for a new node. Thus, BiCMOS processes tend to lag behind commercial CMOS by several generations. This program will investigate the potential for a truly process-agnostic integration technology, i.e. one that is inclusive of any current or future circuit fabrication technology such as Gallium Arsenide (GaAs), Gallium Nitride (GaN) and SiGe with a standardized interconnect topology. Such a technology platform will enable the design of individual circuit Intellectual Property (IP) blocks, such as low-noise amplifiers and	-	-	7.200

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
analog-to-digital converters, with a goal of re-use of the IP across applications. Re-use will allow the DoD to amortize the upfront design cost of these blocks over several designs instead of leveling the burden on a single program. Furthermore, the IP can be designed in the fabrication process best suited for the performance goals and evolve more quickly than larger, more expensive single chip systems-on-a-chip. Through standardization of the interface, FAB will enable the DoD to leverage the advancements driven by the global semiconductor market rather than relying on a single on-shore foundry provider or on proprietary circuit designs owned by a handful of traditional prime performers. In the Advanced Technology Development part of this program, focus will be placed on the development of rapid development and insertion of microsystems utilizing III-V semiconductors and other microelectronic technologies with advanced Si CMOS. This program has Applied Research efforts funded in PE 0602716E, Project ELT-01. ***FY 2016 Plans:*** - Investigate analog intellectual property (IP) reuse techniques for efficient, rapid fabrication of high-performance RF/microwave circuits. - Develop standardized, high-bandwidth interfaces for chiplet-to-chip interconnection. - Initiate circuit demonstration using intellectual property reuse techniques.			
Title: Precise Robust Inertial Guidance for Munitions (PRIGM) ***Description:*** The Precise Robust Inertial Guidance for Munitions (PRIGM) program will develop low-Cost, Size, Weight, and Power (CSWaP) inertial sensor technology for GPS-free munitions guidance. PRIGM comprises two focus areas: 1) Development of a Navigation-Grade Inertial Measurement Unit (NGIMU) that transitions state-of-the-art MEMS to DoD platforms by 2020; and 2) Research and development of Advanced Inertial MEMS Sensors (AIMS) to achieve gun-hard, high-bandwidth, high dynamic range navigation requirements with the objective of complete autonomy in 2030. At present, DoD suffers a trade-space dichotomy between low-CSWaP tactical-grade IMUs, based on MEMS inertial sensors, and relatively high-CSWaP navigation-grade IMUs, based on ring-laser or interferometric fiber-optic gyroscopes (RLG/iFOG). RLG/iFOG is the technology of choice for high-value platforms. However, for the vast majority of platforms (munitions, dismounts, UAVs), CSWaP necessitates the use of lower-performance MEMS-based IMUs. Under the micro-PNT program, DARPA has developed MEMS gyroscopes with performance rivaling that of navigation-grade interferometric fiber optic gyros (IFOGs), thus exposing a new tradespace for low-CSWaP navigation grade IMUs. The PRIGM program will advance the technology readiness level (TRL) of state-of-the-art MEMS inertial sensors from TRL-3 to TRL-6. The ultimate goal of the program is to develop a complete MEMS-based navigation-grade IMU with an identical mechanical/electronic interface to existing DoD-standard tactical-grade MEMS IMUs, thereby providing a drop-in replacement for existing DoD systems and rapid transition to TRL-7. This program has applied research efforts funded in PE 0602716E, Project ELT-01.	-	-	6.286

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2016 Plans: - Initiate efforts to demonstrate MEMS inertial sensors that meet all NGIMU performance requirements with relaxed environmental requirements - Design, fabricate, and characterize gyroscopes with Angle Random Walk (ARW) of 0.0035 deg/rt(hour), turn-on-to-turn-on bias repeatability of 0.001 deg/hr, in-run bias stability of 0.001 deg/hr, and scale factor repeatability of 5 ppm. - Design, fabricate, and characterize accelerometers with Velocity Random Walk (VRW) of 1 mm/sec/rt(hour), turn-on-to-turn-on bias repeatability of 25 micro-g, in-run bias stability of 10 micro-g, and scale factor repeatability of 100 ppm.			
Title: Microwaves and Magnetics (M&M) ***Description:*** Passive magnetic components such as frequency selective limiters (FSL), isolators, circulators, phase shifters and filters are integral to numerous military electronic systems in applications including radar, imaging, communications, and electronic warfare. However, the rate of development and level of integration in microwave and mm-wave magnetic components have severely lagged the corresponding advancements and monolithic integration of semiconductor, microelectromechanical systems (MEMS), and optical active devices. In some cases the magnetic technologies have changed little in the past 20 to 30 years. The Microwaves and Magnetics program will leverage advanced magnetic components leading to disruptive improvements in system performance and novel functionality. A particularly attractive magnetic component for front-end receivers is FSL. An FSL is a device that automatically attenuates high power signals above a certain threshold while allowing low power signals at different frequencies to pass. Use of FSLs will enable receivers to operate in the presence of strong interferers providing wideband protection, enable operation in congested RF environments, and increase effective dynamic range. Corresponding advances in other magnetic components and technologies will dramatically improve the performance, and increase the integration level of transmitters and receivers for Department of Defense (DoD) applications. This program has applied research efforts funded in PE 06020716E, Project ELT-01. ***FY 2016 Plans:*** - Leverage advances in magnetic materials and microwave design and modeling techniques to initiate the design of a FSL with low insertion loss, wide bandwidth, improved transient response, and high power handling capability. - Explore potential opportunities for system integration and develop a test plan that will provide supporting FSL performance data.	-	-	3.318
Title: Low Cost Thermal Imager - Manufacturing (LCTI-M) ***Description:*** The Low Cost Thermal Imager - Manufacturing (LCTI-M) effort built upon previous manufacturing and imaging work and developed a pocket-sized and smartphone-integrated, manufacturable, and practical thermal imager at a price point that allows it to be provided to large numbers of warfighters. Availability of very low cost and small form-factor infrared (IR) cameras facilitates new techniques and applications that could provide the decisive edge needed in modern battlefields. These cameras	14.000	-	-

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 0603739E / *ADVANCED ELECTRONICS TECHNOLOGIES*	**Project (Number/Name)** MT-15 / *MIXED TECHNOLOGY INTEGRATION*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
allow a soldier to have practical thermal imaging capability for locating warm objects (e.g., enemy combatants) in darkness. The small size, weight and power (SWaP) thermal camera can be integrated with a handheld device such as a cell phone with network capability for tactical intelligence, surveillance and reconnaissance. The imager chips were fully integrated with a low-cost processor and optics. The camera has wireless connectivity to integrate video display with cell phones or PDAs. U.S. Army PEO Soldier Sensors and Lasers (SSL), PM Optics USMC, USSOCOM and industry are the transition partners. ***FY 2014 Accomplishments:*** - Completed low-cost wafer-scale optics for LCTI-M camera. - Demonstrated small-form-factor camera integration employing 3-D assembly techniques. - Delivered interim prototype cameras for testing. - Delivered final 640x480 LCTI-M cameras with test results and 1280X1024 camera engines.			
Accomplishments/Planned Programs Subtotals	59.369	77.982	79.021

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.