Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Defense Advanced Research Projects Agency	DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	R-1 ITEM NOMENCLATURE PE 0603739E: *ADVANCED ELECTRONICS TECHNOLOGIES*

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
Total Program Element	-	144.047	111.008	117.080	-	117.080	159.229	168.112	170.163	175.601	Continuing	Continuing
MT-12: *MEMS AND INTEGRATED MICROSYSTEMS TECHNOLOGY*	-	55.380	41.466	30.225	-	30.225	29.386	23.642	22.095	20.095	Continuing	Continuing
MT-15: *MIXED TECHNOLOGY INTEGRATION*	-	88.667	69.542	86.855	-	86.855	129.843	144.470	148.068	155.506	Continuing	Continuing

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

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

A. Mission Description and Budget Item Justification

The Advanced Electronics Technology 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 goal of the Mixed Technology Integration project is to leverage advanced microelectronics manufacturing infrastructure and DARPA component technologies developed in other projects to produce mixed-technology microsystems. These 'wristwatch size', low-cost, lightweight and low power microsystems will improve the battlefield awareness and security of the warfighter and the operational performance of military platforms. The chip assembly and packaging processes currently in use produce a high cost, high power, large volume and lower performance system. This program is focused on the monolithic integration of mixed technologies to form batch-fabricated, mixed technology microsystems 'on-a-single-chip' or an integrated and interconnected 'stack-of-chips'. The ability to integrate mixed technologies onto a single substrate will increase performance and reliability, while driving down size, weight, volume and cost.

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B. Program Change Summary ($ in Millions)	FY 2012	FY 2013	FY 2014 Base	FY 2014 OCO	FY 2014 Total
Previous President's Budget	150.286	111.008	104.665	-	104.665
Current President's Budget	144.047	111.008	117.080	-	117.080
Total Adjustments	-6.239	0.000	12.415	-	12.415
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-2.143	0.000			
• SBIR/STTR Transfer	-4.096	0.000			
• TotalOtherAdjustments	-	-	12.415	-	12.415

Change Summary Explanation

FY 2012: Decrease reflects reductions for internal below threshold reprogrammings and the SBIR/STTR transfer.

FY 2014: Increase reflects expansion of laser and maskless lithography work in Project MT-15.

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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
MT-12: *MEMS AND INTEGRATED MICROSYSTEMS TECHNOLOGY*	-	55.380	41.466	30.225	-	30.225	29.386	23.642	22.095	20.095	Continuing	Continuing

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

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

A. Mission Description and Budget Item Justification

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. The microfluidic molecular systems effort will develop automated microsystems that integrate biochemical fluid handling capability along with electronics, optoelectronics and chip-based reaction and detection modules for tailored sequence analysis to monitor environmental conditions, health hazards and physiological states. Thermal management technologies will develop heat resistant thermal layers to provide efficient operation for cooling electronic devices. Another 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.

The major technical focus areas of the MEMS and Integrated Microsystems programs contained in this project are: 1) inertial measurement; 2) fluid sensing and control; 3) electromagnetic and optical beam steering; 4) chemical reactions on chip; 5) electromechanical signal processing; 6) analytical instruments; 7) thermal management; and 8) navigation and positioning technologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Micro-Technology for Positioning, Navigation, and Timing (Micro PN&T)	41.989	41.466	30.225
Description: The Micro-Technology for Positioning, Navigation, and Timing (Micro PN&T) program is developing technology for self-contained chip-scale inertial navigation and precision guidance. This technology promises to effectively mitigate dependence on Global Positioning System (GPS) or any other external signals, and enable uncompromised navigation and guidance capabilities. The program will enable positioning, navigation and timing functions without the need for external information updates by employing on-chip calibration, thereby overcoming vulnerabilities which arise in environments where external updates are not available such as caves, tunnels, or dense urban locations. The technologies developed will enable small, low-power, micro-gyroscopes capable of operating in both moderate and challenging dynamic environments; chip-scale primary atomic clock			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014

standards; and on-chip calibration systems for error correction. Advanced micro-fabrication techniques allow a single package containing all the necessary devices (clocks, accelerometers, gyroscopes, and calibration mechanisms) to be incorporated into a volume the size of a sugar cube. The small size, weight and power (SWaP) of these technologies and their integration into a single package responds to the needs of guided munitions, unmanned aerial vehicles (UAVs) and individual soldiers. The Micro PN&T program is an aggregation of Integrated Primary Atomic Clock, Navigation Grade Integrated Micromachined Gyroscopes, Micro Inertial Navigation Technology, Information Tethered Microscale Autonomous Rotary Stages, Micromachined Rate Integrating Gyroscopes, Single-Chip Timing and Inertial Measurement Unit, Primary and Secondary Calibration on Active Layer, and Chip-Scale Combinatorial Atomic Navigator. The technology is expected to transition through industry and existing DoD transition partnerships with the Services.

To achieve the low SWaP necessary for guided munitions, UAVs, and personal navigation applications, the technologies in the MicroPN&T program will have to push the limitations of integration and performance in current MicroElectroMechanical systems (MEMS) technologies. Unprecedented levels of precision will be required to meet the stringent demands of the military environment. New architectures for devices will be developed that will leverage advances in fabrication techniques in order to increase stability and performance of a MEMS structure. Applied research for this program is funded within PE 0602716E, Project ELT-01.

FY 2012 Accomplishments:

- Fabricated, for the first time, millimeter-sized 3D structures - spheres, toroids, and "wineglasses" - the structures to enable low-cost, small size rate integrating gyroscopes; the design paradigm to provide direct measurement of orientation and angular velocity.
- Identified fabrication method to co-fabricate clocks and inertial sensors into a ten cubic millimeter package for navigation microsystems through multi-layer packaging of inertial sensors, clocks and environmental isolation.
- Demonstrated three-dimensional microfabrication techniques of non-traditional MEMS materials (e.g. diamond, fused silica, bulk metallic glass) for rate integrating gyroscopes that are compatible with large-scale manufacturing.
- Demonstrated small primary atomic/ion clocks with time losses of only 17 ns after one day of operation.
- Completed independent government evaluation of micro inertial navigation technology in a closed-loop (700 m x 800 m), military/residential neighborhood. Demonstrated boot-mounted inertial sensors with 16 m accumulated error after 4 hours of testing.
- Demonstrated a fabrication technique that allows for the integration of timing and inertial measurement unit into a small package.

FY 2013 Plans:

- Demonstrate a microsystem rate-integrating gyroscope to provide directly measured orientation angle and angular velocity.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Demonstrate a fabrication technique to manufacture microsystem rate-integrating gyroscopes, and trimming techniques to increase the level of performance by a factor of ten. - Demonstrate a microsystem that combines a functional timing and inertial measurement unit in a ten cubic millimeter package. - Demonstrate the co-fabrication of an inertial sensor and a calibration stage to enable integration of error correction technologies on the same stage. - Model internal and external sources of error, scale-factor, and bias drift for inertial devices. - Identify self-calibration techniques to compensate for long-term drift. - Demonstrate small primary atomic/ion clocks with time losses of only 1.6 micro-second after one month of operation. ***FY 2014 Plans:*** - Demonstrate a microsystem rate-integrating gyroscope with performance near or at navigation-grade. - Demonstrate a microsystem that combines a functional timing and inertial measurement unit with performance values for time loss of 1 ns/min and Circular Error Probable CEP < 10 m. - Use models for internal and external sources of error to develop on-chip calibration algorithms. - Develop architecture for chip-scale combinatorial atomic navigator. - Demonstrate combinatorial physics for compact systems with a startup time less than a minute using high-accuracy atomic physics-based inertial devices.			
Title: Thermal Management Technologies (TMT) ***Description:*** The goal of the Thermal Management Technologies (TMT) program was to explore and optimize new nanostructured materials and other recent advances for use in thermal management systems. The overall goal of the program was to insert breakthrough materials and structures at all layers of DoD systems, and enable higher power densities, increased performance, and improved efficiency. Modern, high-performance heat spreaders, which use two-phase cooling, were developed to replace the copper alloy spreaders in conventional systems. Enhancing air-cooled exchangers by reducing the thermal resistance through the heat sink to the ambient, increasing convection through the system, improving heat sink fin thermal conductivity, optimizing and/or redesigning the complementary heat sink blower, and increasing the overall system (heat sink and blower) coefficient of performance was another thrust of this program. Another element of this effort focused on novel materials and structures that can provide significant reductions in the thermal resistance of the thermal interface layer between the backside of an electronic device and the next layer of the package, which might be a spreader or a heat sink. Technology will be inserted through DoD industrial firms into future DoD systems. ***FY 2012 Accomplishments:*** - Inserted Thermal Ground Plane substrates to demonstrate improvements in Gallium Nitride power amplifiers, high-power transmit/receive modules, high-density electronic systems, avionics modules, and other opportunities enabled by lightweight, flexible, highly-conductive heat spreaders.	13.391	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Completed multiple insertion demonstrations for enhanced heat exchangers, and initiated transitions to platforms. - Demonstrated 10x improvements over state of the art for re-workable thermal interface materials. - Demonstrated high heat density active cooling modules for efficient operation of cooled electronic devices. - Initiated development of near junction thermal transport techniques including high thermal conductivity diamond and microfluidic cooling.			
Accomplishments/Planned Programs Subtotals	55.380	41.466	30.225

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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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
MT-15: *MIXED TECHNOLOGY INTEGRATION*	-	88.667	69.542	86.855	-	86.855	129.843	144.470	148.068	155.506	Continuing	Continuing

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

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

A. Mission Description and Budget Item Justification

The goal of the Mixed Technology Integration project is to leverage advanced microelectronics manufacturing infrastructure and DARPA component technologies developed in other projects to produce mixed-technology microsystems. These 'wristwatch size', low-cost, lightweight and low power microsystems will improve the battlefield awareness, security of the warfighter and the operational performance of military platforms. At the present time, systems are fabricated by assembling a number of mixed-technology components: microelectromechanical systems (MEMS), microphotonics, microfluidics and millimeterwave/microwave. Each technology usually requires a different level of integration, occupies a separate silicon chip and requires off-chip wiring, and requires fastening and packaging to form a module. The chip assembly and packaging processes produce a high cost, high power, large volume and lower performance system. This program is focused on the monolithic integration of mixed technologies to form batch-fabricated, mixed technology microsystems 'on-a-single-chip' or an integrated and interconnected 'stack-of-chips'.

The field of microelectronics incorporates micrometer/nanometer scale integration and is the most highly integrated, low-cost and high-impact technology to date. Microelectronics technology has produced the microcomputer-chip that enabled or supported the revolutions in computers, networking and communication. This program extends the microelectronics paradigm to include the integration of heterogeneous or mixed technologies. This new paradigm will create a new class of 'matchbook-size', highly integrated device and microsystem architectures. Examples of component-microsystems include low-power, small-volume, lightweight, microsensors, microrobots and microcommunication systems that will improve and expand the performance of the warfighter, military platforms, munitions and Unmanned Air Vehicles (UAVs).

The program includes the integration of mixed materials on generic substrates including glass, polymers and silicon. The program is design and process intensive, using 'standard' processes and developing new semiconductor-like processes and technologies that support the integration of mixed-technologies at the micrometer/ nanometer scale. The program includes the development of micrometer/nanometer scale isolation, contacts, interconnects and 'multiple-chip-scale' packaging for electronic, mechanical, fluidic, photonic and rf/mmwave/microwave technologies. For example, a mixed-technology microsystem using integrated microfluidics, MEMS, microphotonics, microelectronics and microwave components could provide a highly integrated, portable analytical instrument to monitor the battlefield environment, the physical condition of a warfighter, the identity of warfighters (friend or foe) or the combat readiness of equipment. The ability to integrate mixed technologies onto a single substrate will drive down the size, weight, volume, and cost of weapon systems while increasing their performance and reliability.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Low Cost Thermal Imager - Manufacturing (LCTI-M)	21.300	20.509	19.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014

Description: The Low Cost Thermal Imager - Manufacturing (LCTI-M) effort builds upon previous manufacturing and imaging work and will develop a pocket-sized, manufacturable, and practical thermal imager at a price point that allows them to be provided to large numbers of warfighters. Availability of very low cost and small form-factor infrared (IR) cameras will facilitate new techniques and applications that could provide the decisive edge needed in modern battlefields. These cameras will 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 will be integrated with a handheld device such as a cell phone with network capability for tactical intelligence, surveillance and reconnaissance. In order to achieve this goal, breakthroughs will be required in low-cost thermal imagers manufactured using wafer scale integration, vacuum packaging, low cost optics and low-power signal processing. By the end of the program, the imager chips will be fully integrated with a low-cost processor and optics. The camera will have 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 will be the transition partners.

FY 2012 Accomplishments:
- Developed and reviewed camera design and overall architecture compatible with cell phone platform.
- Co-located DoD's prime microbolometer fabrication capability in a commercial 200 mm MEMS Fab line, in order to leverage low-cost manufacturing infrastructure.
- Demonstrated small pixel microbolometer producibility and performance. Preliminary results indicated detector performance goal is achievable.
- Initiated wafer level vacuum packaging development by establishing technical approach and material selection criteria. First seal tests showed good metal ring formation with good binding strength.
- Demonstrated feasibility of wafer scale optics producibility.
- Built prototype wafer scale optics for 320x240, 17 micrometer pixel array. Characterization and testing of prototypes are being performed.

FY 2013 Plans:
- Establish interim small form-factor camera integration.
- Demonstrate and deliver interim 640x480 LCTI-M camera.
- Finalize design of low cost IR optics for LCTI-M.
- Conduct 2nd LCTI-M program review and plan technology transition.
- Demonstrate an integrated smart phone and first prototype thermal camera.

FY 2014 Plans:
- Fabricate low cost wafer scale optics for LCTI-M camera.
- Demonstrate small form factor camera integration employing 3-D assembly techniques.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Deliver final 640x480 LCTI-M cameras with test results and 1280X1024 camera engines.			
Title: Maskless Direct-Write Nanolithography for Defense Applications	10.834	15.000	0.000
Description: The Maskless Direct-Write Nanolithography for Defense Applications program will develop a maskless, direct-write lithography tool that will address both DoDs needs for affordable, high performance, Integrated Circuits (ICs) in small lots and the commercial market's need for highly customized, application-specific ICs. In addition, this program will provide a cost effective manufacturing technology for low volume nanoelectromechanical system (NEMS) and nanophotonic devices within the DoD. Transition will be achieved by maskless lithography tools, installed in the Trusted Foundry and in commercial foundries, which will enable affordable incorporation of state-of-the-art semiconductor devices in new military systems, and allow for the cost-effective upgrade of legacy military systems. ***FY 2012 Accomplishments:*** - Finalized system and subsystem requirements for the lithography demonstrations at 14 nanometer feature sizes. - Designed an optical system which will exhibit patterning performance to the 14 nm node at 11 wafer-level--per-hour-per-column. - Successfully integrated the 3rd generation electron beam column with a Rotary Stage Demonstrator Platform. - Demonstrated a dynamic pattern generator with electron reflection efficiency in excess of 50%. - Demonstrated complex pattern printing in photo sensitive material using a fully programmable dynamic pattern generator, achieving a resolution of 75 nm with a wafer-plane current of 200 nano amps. - Developed a new process to fabricate the electron-focusing lenslets and CMOS shift registers in concert at one location, which will eliminate several failure mechanisms and greatly increase the reliability of dynamic pattern generator fabrication. - Qualified a chemically-amplified resist for patterning with the 3rd generation electron beam column down to the 32 nm node. ***FY 2013 Plans:*** - Design and build a 4th generation electron-beam column capable of 14 nm node lithography. - Demonstrate system-level lithography for at least 3 relevant patterns obtained from an industry partner achieving resolution, critical dimension uniformity, line edge roughness, and layer-to-layer overlay tolerance compatible with the 14 nm node (metal layer geometry half pitch of ~ 32 nm). Throughput will be 1 wafer-level-per-hour-per-column with a wafer-plane current ranging from 0.7-4.2 microamps.			
Title: RESOLVE	0.000	0.000	15.000
Description: The goal of RESOLVE is to extend the capability of the Maskless Nanowriter program by developing an e-beam direct-write lithography tool capable of affordable fabrication of custom ASICS down to nodes required by the DoD in the Trusted Foundry. In addition, this program will provide a manufacturing technology for nanoelectromechanical systems (NEMS) and nanophotonics initiatives within the DoD. It is expected that this tool will provide a cost-effective alternative to extreme ultra-violet			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
lithography for fabrication of deep-sub-micron complementary metal-oxide semiconductor (CMOS) processes and is projected to also meet the objectives required in the commercial sector for high-volume manufacturing. ***FY 2014 Plans:*** - Ship a pre-alpha reflection e-beam lithography tool (developed under the Maskless Nanowriter program) to the Trusted Foundry for evaluation and process development. - Demonstration at the Trusted Foundry of all patterning specifications for advanced nodes derived by an industry partner. - Develop new compact electron-beam column for integration into 6-column cluster designed for ultimate use in a production-level tool.			
Title: Excalibur	15.642	18.420	0.000
Description: The Excalibur program will develop high-power electronically-steerable optical arrays, with each array element powered by a fiber laser amplifier. These fiber-laser arrays will be sufficiently lightweight, compact, and electrically efficient to be fielded on a variety of platforms with minimal impact on the platform's original mission capabilities. Each array element will possess an adaptive-optic capability to minimize beam divergence in the presence of atmospheric turbulence, together with wide-field-of-view beam steering for target tracking. With each Excalibur array element powered by high power fiber laser amplifiers (at up to 3 kilowatts (kW) per amplifier), high power air-to-air and air-to-ground engagements will be enabled that were previously infeasible because of laser system size and weight. In addition, this program will also develop kilowatt-class arrays of diode lasers which will provide an alternate route to efficiently reaching mission-relevant power levels, and they will test the ultimate scalability of the optical phased array architecture. Excalibur arrays will be conformal to aircraft surfaces and scalable in size and power by adding additional elements to the array. Excalibur will provide the technology foundation for defense of next generation airborne platforms, including all aircraft flying at altitudes below 50,000 ft, against proliferated, deployed, and next-generation man-portable air-defense systems (MANPADS) and more capable air-to-air missiles converted for use as ground-to-air missiles. Excalibur will enable these platforms to fly at lower altitude and conduct truly persistent, all-weather ground missions, such as reconnaissance despite low-lying cloud cover. Further capabilities may include multichannel laser communications, target identification, tracking, designation, precision defeat with minimal collateral effects as well as other applications. The Excalibur program will also develop efficient high-power laser amplifier arrays based on coherent or spectral beam-combining. The potential of these arrays to scale to tactical power levels (100 kilowatt class) will be investigated. These laser amplifier arrays will be designed to work in tandem with the core laser components developed under the Excalibur program in PE 0602702E, Project TT-06. In addition a conceptual design and CONOPS development for a High Energy Laser Counter Measure (HELCM) system will be developed to enable a near-term capability for low-altitude self-defense against MANPADS. This technology will transition via industry.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: - Completed the design, fabrication and procurement of the components for a coherently or spectrally combinable array of 21 array elements, each fed by a compact 1-kW fiber laser amplifier. - Achieved a record 1.93 kW coherent laser combining using a diffractive optical element with 79% efficiency and near-perfect beam quality. - Demonstrated phase locking of a 7 element array over a 7 km outdoor range in turbulent conditions. - Coherently combined 7 high-power fiber lasers in an optical phased array with a total output power of 2.5 kW and near-perfect beam quality. - Initiated development of ancillary HELCM open architecture subsystems (command, threat warning/ laser-quality declaration, lightweight pod). ***FY 2013 Plans:*** - Demonstrate beam combining (coherent or spectral) of twenty-one 1-kW fiber laser amplifiers. - Demonstrate coherent combining of a 19-element 2-D optical phased array with a combined power of 21 kW and tip/tilt adaptive optics. - Conduct field measurements to assess the potential of a conceptual proactive search capability for HELCM systems.			
Title: Endurance	0.000	6.500	22.800
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 2013 Plans:*** - Initiate the design of an integrated, miniaturized, form/fit/function brass-board laser countermeasure that incorporates subsystem modularity and open-architecture design principles. - Design ancillary subsystems (power delivery, thermal management, processing and control, mechanical support framework). ***FY 2014 Plans:*** - Complete the design of an integrated, miniaturized, form/fit/function brass-board laser countermeasure that incorporates subsystem modularity and open-architecture design principles. - Initiate preparations for look-down, shoot-down live-fire testing of the brass-board laser countermeasure.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Fabricate, assemble and test ancillary subsystems.			
Title: Diverse & Accessible Heterogeneous Integration (DAHI)	0.000	0.000	17.055
Description: Prior DARPA efforts have demonstrated the ability to monolithically integrate inherently 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, Indium Phosphide, 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 complementary research efforts funded in PE 0601101E, Project ES-01, and in PE 0602716E, Project ELT-01. The Advanced Technology Development part of this program will leverage the 6.1 and 6.2 programs with 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, FFRDC, academic and industrial designers. ***FY 2014 Plans:*** - 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 at least three materials/devices. Establish heterogeneous integration design/simulation tool flows necessary to realize the full potential of heterogeneous microsystems integration. - Demonstrate capability for supporting multi-project wafer runs using the heterogeneous foundry service under development. - Accelerate development of circuit design techniques and methodologies that enable revolutionary heterogeneously integrated circuit architectures.			
Title: FLASH - Scaling Fiber Arrays at Near Perfect Beam Quality	0.000	0.000	13.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: The goal of the FLASH program is to demonstrate a high-efficiency, optical phased array that projects a 100-kW-class beam with near perfect beam quality. To accomplish these ends, it will achieve a 4x reduction in the overall size and weight of high-power laser weapons while increasing robustness to make it suitable for deployment in long-endurance or low-observable aircraft. The completed high-energy laser system will enable long range engagement of air, space, and ground targets. ***FY 2014 Plans:*** - Develop and test a prototype coherently combinable fiber laser with an output power of 1.5 KW capable of being light weighted to the level required for system integration. - Demonstrate coherent combining of 100 laser elements. - Finish a comprehensive system requirement review of the entire laser system including fiber lasers, thermal management, power systems, and beam steering.			
Title: Gratings of Regular Arrays and Trim Exposures (GRATE)	6.208	1.500	0.000
Description: The goal of the Gratings of Regular Arrays and Trim Exposures (GRATE) program is to develop revolutionary circuit design methodologies combined with innovative fabrication techniques to enable cost-effective, low-volume fabrication of application specific integrated circuits (ASICs) for DoD applications. The design methodologies will enable a simplified physical layout implementation of circuits by using extremely regular geometries without sacrificing circuit density or performance. These simplified circuit designs will be implemented using high-resolution grating patterns that can be fabricated at high-throughput using either mask-based or maskless lithography. The methodologies developed in this program are expected to reduce significantly the design costs of high-performance DoD ASICs at the advanced complementary metal-oxide semiconductor (CMOS) technology nodes. ***FY 2012 Accomplishments:*** - Demonstrated grating-based design and fabrication of logic/memory "standard cells" and high-speed RF devices using current photolithography processes. - Fabricated analog devices with > 350 GHz performance. - Created a design targeted at 14 nanometer technology for CMOS using optimized logic and memory cells. ***FY 2013 Plans:*** - Fabricate 1-D digital design at the 14 nm node. - Demonstrate > 300 GHz performance for 1-D Silicon Germanium transistor circuit. - Transition and make the analog 1-D design and fabrication available to the DoD user community via a multi-project wafer run.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Through transition to industry, leverage the knowledge gained from manufactured 14 nm CMOS designs to support design-technology co-optimization at the 10 nm and 7 nm CMOS process nodes.			
Title: Advanced Wide FOV Architectures for Image Reconstruction & Exploitation (AWARE)	16.596	7.613	0.000
Description: The Advanced Wide FOV Architectures for Image Reconstruction & Exploitation (AWARE) program primarily addresses the passive imaging needs for multi-band, wide field of view (FOV) and high-resolution imaging for ground and near ground platforms. The AWARE program aims to solve the technological barriers that will enable wide FOV, high resolution and multi-band camera architectures by focusing on four major tasks: high space-bandwidth product (SBP) camera architecture; small pitch pixel focal plane array architecture; broadband focal plane array architecture; and multi-band focal plane array architecture. The AWARE program will advance integration of technologies that enable wide field of view and high resolution and multi-band cameras, including the technologies demonstrated in the related AWARE program in PE 0602716E, Project ELT-01. AWARE aggregates the following programs: Lambda Scale (formerly NIRD), Broadband (formerly PT-SQUAD), Multi-Band (formerly DUDE), and Wide Field of View (formerly MOSAIC). The integration of the technologies will demonstrate subsystems such as focal plane arrays (FPAs) and cameras. Such focal plane arrays can also be used to fabricate very large number of pixels for persistent surveillance applications. ***FY 2012 Accomplishments:*** - Demonstrated a fully integrated 1280x720, 5 micrometer (µm) pitch longwave infrared (LWIR) camera performance at 80 and 120 K. - Designed and fabricated 1024x1024, 18 µm Read Out Integrated Circuit (ROIC) on 8" diameter wafers. ROIC wafers completed ambient temperature probe screening tests for short and open circuits. - Designed and fabricated 1024x1024, 18 µm broadband detector arrays with response from 0.5 to 5 µm. Detectors hybridized to fanout circuits demonstrated dark current density of 10^3 A/cm^2 at 200 K and 10^6 A/cm^2 at 150 K. - Expanded lambda scale detector application space to include Midwave IR (MWIR) and LWIR wavebands. Achieved excellent operability (99.97 %) from 1280x720, 5 µm pitch MWIR arrays. Also achieved excellent MWIR NETD (35.5 mK, 35 Hz, @ 110 K with f/1.65 optics) from 1280x720, 5 µm pixel arrays. - Initiated 6 µm Mercury Cadmium Telluride(HgCdTE) and InGaAs nCBn FPA designs for persistent surveillance applications. - Transitioned a 12um MWIR handheld target spotting camera into production. ***FY 2013 Plans:*** - Optimize broadband detector array fabrication and assembly processes to maximize FPA operability. Hybridize 1024x1024, 18 µm detector arrays to 1024x1024, 18 µm ROICs. - Finalize camera integration and demonstrate broadband (0.5 to 5 µm) performance with 1024x1024, 18 µm FPA. - Fabricate and demonstrate 2048x2048, 5 µm LWIR and MWIR FPAs for helicopter landing under brownout conditions.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
- Conduct initial field tests for multi-band rifle scope.			
Title: COmpact Ultra-stable Gyro for Absolute Reference (COUGAR) ***Description:*** The COmpact Ultra-stable Gyro for Absolute Reference (COUGAR) program goal was to realize the fundamental performance potential of the resonant fiber optic gyro in combination with bandgap optical fiber (BGOF), ultra-stable compact lasers, phase conjugate elements, and silicon optical benches: a compact ultra-stable gyro for absolute reference applications. The COUGAR gyro has a practical and typical size (~ 4 inch diameter) featuring bias stability and sensitivity (or angle random walk), that is more than 100 times better than state-of-the-art gyroscopes. This program is transitioning via industry. ***FY 2012 Accomplishments:*** - Developed bandgap optical fiber realizing >300m lengths of bandgap fiber with higher order mode suppression and polarizing characteristics. - Demonstrated low noise laser suitable for use in COUGAR gyro. - Integrated low noise lasers with control electronics to suppress noise and lock lasers together. - Demonstrated an optical bandgap fiber gyro in the laboratory with < 10 udeg/rt-hr angle random walk.	10.087	0.000	0.000
Title: High Frequency Integrated Vacuum Electronic (HiFIVE) ***Description:*** The objective of the High Frequency Integrated Vacuum Electronics (HiFIVE) program was to develop and demonstrate new high-performance and low-cost technologies for implementing high-power millimeter-wave sources and components. This program developed new semiconductor and micro-fabrication technologies to produce vacuum electronic high-power amplifiers for use in high-bandwidth, high-power transmitters. Innovations in design and fabrication were being pursued to enable precision etching, deposition, and pattern transfer techniques to produce resonant cavities, electrodes, and magnetics, and electron emitting cathodes for compact high-performance millimeter wave devices. These new technologies will eliminate the limitations associated with the conventional methods for assembly of high-power sources in this frequency range. This technology is transitioning via industry. ***FY 2012 Accomplishments:*** - Completed final fabrication and initial testing of a high-power amplifier prototype device incorporating HiFIVE micro-fabrication technologies into a compact module form factor. - Performed laboratory measurements of performance and validate RF power levels, including advanced driver amplifiers. - Initiated integration of compact amplifier technology at G-band in a miniaturized tube form factor. - Demonstrated integrated and compact amplifier technology at G-band and the nearby radiolocation bands. - Completed laboratory measurements of performance of miniaturized tube amplifier at 220GHz.	8.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	88.667	69.542	86.855

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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.