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Department of Defense
Fiscal Year (FY) 2013 President's Budget Submission

February 2012

Defense Advanced Research Projects Agency

Justification Book Volume 1

Research, Development, Test & Evaluation, Defense-Wide

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Exhibit R-2A, RDT&E Project Justification: PB 2013 Defense Advanced Research Projects Agency		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601101E: *DEFENSE RESEARCH SCIENCES*	PROJECT BLS-01: *BIO/INFO/MICRO SCIENCES*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Investigated novel forms of prior knowledge in order to improve sparse signal sampling. ***FY 2012 Plans:*** - Develop detailed mathematical prior-knowledge representations and associated models for imaging and radar applications. - Exploit the new theoretical measurement framework together with novel forms of prior knowledge in order to minimize resource requirements and maximize information gathering, from sparse sampling. - Demonstrate the utility of new compressive measurement theory via improvements in imaging and radar applications. ***FY 2013 Plans:*** - Identify fundamental bounds on performance and cost associated with linear and nonlinear signal priors. - Demonstrate novel reconstruction algorithms that incorporate both signal and task priors to enable improved reconstruction quality and/or reduced measurement resources. - Demonstrate visible imaging using 10x fewer measurements than reconstructed pixels. - Demonstrate RADAR imaging using 10x less bandwidth than a conventional non-compressive system. - Exploit the benefit of adaptation in order to achieve additional reductions in performance and/or measurement resources. - Exploit the benefit of information-optimal measurements within a signals intelligence application.			
Title: Physics in Biology ***Description:*** Understanding the fundamental physical phenomena that underlie biological processes and functions will provide new insight and unique opportunities for understanding biological properties and exploiting such phenomena. Physics in biology will explore the role and impact of quantum effects in biological processes and systems. This includes exploiting manifestly quantum mechanical effects that exist in biological systems at room temperature to develop a revolutionary new class of robust, compact, high sensitivity and high selectivity sensors. Investigation into quantitative neurophysics will examine new modalities for biological injury which could yield a new class of non-invasive medical imagers. ***FY 2011 Accomplishments:*** - Developed a quantum theory for the transport of excitons in photosynthetic systems and for magnetoreception in birds based on a radical pair mechanism. - Experimentally demonstrated coherent transport in a photosynthetic system at 277 K (ambient temperature). - Experimentally demonstrated that fruit flies can distinguish isotopic modification of odorant at room temperature, which is consistent with the predicted vibrational olfaction mechanism. - Developed new quantum process tomography technique for room temperature analysis of photosynthetic systems that is 1000x faster than current techniques.	9.000	11.000	7.678

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Developed broadband cavity-enhanced absorption spectroscopy technique for measurement of the response of the putative magnetoreceptor protein (cryptochrome) in the low-field (10 microT) regime. ***FY 2012 Plans:*** - Establish that magnetoreception is transduced through a biological quantum effect. - Develop concepts and designs for sensors inspired by biological quantum effects. - Experimentally probe the limits of biological sensors' exploitation of the quantum effects. - Demonstrate the biological and evolutionary advantage of quantum effects in photosynthetic systems. - Verify that molecular vibrations, and thus quantum effects, are essential to describing olfaction. ***FY 2013 Plans:*** - Model the performance of synthetic sensors that utilize quantum effects. - Demonstrate the improved performance of synthetic sensors that exploit biologically inspired quantum effects. - Demonstrate the ability to control quantum effects in biological systems by reorienting magnetoreception through the radical pair mechanism using radio frequency fields. - Develop a theory of olfaction that combines quantum and non-quantum effects.			
Title: Human Assisted Neural Devices - Medical ***Description:*** The Human Assisted Neural Devices program is developing the scientific foundation for understanding the language of the brain for application to a variety of emerging DoD challenges, including improving performance on the battlefield and returning active duty military to their units after injury. This requires an understanding of neuroscience, significant computational efforts, and new material design and implementation. Key advances expected from this research include determining the nature and means through which short-term memory is encoded, and discovering the mechanisms and dynamics underlying neural computation and reorganization. These advances will enable memory restoration through the use of devices programmed to bridge gaps in the injured brain. Further, modeling of the brain progresses to an unprecedented level with this novel approach. The programs funded under the Human Assisted Neural Devices are continued in Budget Activity 6.1 Medical Program Element 0601117E, in FY 2012 and subsequent years. ***FY 2011 Accomplishments:*** - Demonstrated improvement of memory retrieval accuracy and speed through use of patterned neural stimulation in animal studies. - Identified homogeneity of neural codes involving long-term memory in different animal models conducting similar memory tasks. - Modeled dynamic functional motor and sensory networks and developed methods for characterizing brain-wide sensory/motor tasks.	18.650	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
FY 2011 Accomplishments: - Conceptualized an approach to automating crowd-sourcing through social compilation. - Created an approach to software engineering and system development that provides end-to-end semantic modeling of a component-based system. - Developed a computing architecture that accepts sensor data as input and outputs human-level concepts such as object class, object features, and activity patterns. - Developed a model-driven development framework for semantically rich control, planning and cognitive systems. ***FY 2012 Plans:*** - Demonstrate how statistical and quasi-experimental analyses of existing data sets can be used to derive answers to key tactical military questions. - Demonstrate approaches for reactive, adaptable, and agile wide-area networks and computing systems.			
Title: Bits to Behavior via Brains (B3) ***Description:*** The Bits to Behavior via Brains (B3) program extends recent work indicating avatar activity in virtual worlds can result in measurable differences in real-world behavior on the part of users. One example of this observation is an increase in physical exercise undertaken by humans when their virtual avatar begins an exercise regimen. Understanding the neural mechanisms that govern the transfer of virtual behavior into actual behavior will enable optimization of virtual resources to train and educate soldiers, and could lead to therapeutic and preventative capabilities. B3 will examine how virtual world interactions influence neural mechanisms of learning (both one-shot and traditional) and executive function (especially judgment). This will be used to enable designers of virtual worlds to determine the methods and themes that will result in the most effective avatar-based virtual environment for military training and decision making. ***FY 2013 Plans:*** - Confirm and extend foundational work on characteristics of avatars to understand real-world decision making processes. - Explore neural mechanisms responsible for decision making processes; confirm avatar-mediated modulation of neurobiological operations as a transferrable tool for optimal learning and decision making. - Begin testing for individual and population-level behavioral differences in response to virtual training environments.	-	-	6.500
Title: Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT) ***Description:*** *Formerly part of Synthetic Biology The Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT) program develops technologies to rapidly respond to a disease or threat, and improve individual readiness and total force health protection. This program utilizes synthetic genetic	8.578	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
circuits to control cellular machinery and includes research to optimize orthogonality and modularity of genetic control elements, identify methods to increase sensitivity and specificity, and demonstrate methods to control cellular machinery in response to changes in physiological status. ADEPT enables the production of RNA-based vaccines, potentially eliminating the time and labor required for traditional manufacture of a vaccine while improving efficacy and safety. ADEPT also develops methodologies for measuring health-specific biomarkers from a collected biospecimen to enable diagnostics at the point-of-need (similar to home-use settings) or in resource-limited clinical facilities (i.e., point-of-care), in-garrison or deployed. The ADEPT program continues in FY 2012 in PE 0601117E, Project MED-01. Applied research for this program is funded in PE 0602115E, Project BT-01. ***FY 2011 Accomplishments:*** - Initiated the creation of synthetic biological elements that operate in mammalian cells. - Investigated the behavior of combining biological elements and determined their functional outcomes. - Initiated development of RNA-based vaccines. - Initiated the development of new concepts and techniques for compact, deployable diagnostics. - Investigated methods for biospecimen stabilization at room temperature.			
Title: Production of Knowledge Bases to Bridge Cultural Divides ***Description:*** The Production of Knowledge Bases to Bridge Cultural Divides program developed tools, techniques, and frameworks for the automated interpretation and quantitative analysis of social networks using emerging methods for edge finding and cluster analysis. These systems have important applications in tactical contexts to aid analysts and operators in connecting the dots amid complex, conflicting, and incomplete data sets. They also establish a foundation for cultural intelligence -- understanding the stability, governance, and economic indicators of a region. These technologies have transitioned into the Nexus 7 program in PE 0602702E, Project TT-13. ***FY 2011 Accomplishments:*** - Developed mathematical and algorithmic modeling and analysis tools. - Established baseline performance and demonstration of enhanced analysis using the tools. - Demonstrated automated and semi-automated processes for exploitation of data collected via experimental analyst assistant. - Deployed initial analytic results to commanders in Afghanistan.	1.360	-	-
Accomplishments/Planned Programs Subtotals	21.809	37.954	47.269

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Defense Advanced Research Projects Agency	DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601117E: *BASIC OPERATIONAL MEDICAL SCIENCE*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Demonstrate the ability of non-human primates to perform a dexterous sensorimotor task through the use of a neural interface, without the use of neural spike recordings.			
Title: Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT)*	-	17.500	24.500
Description: *Previously funded in Synthetic Biology in PE 0601101E, Project TRS-01 The Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT) program will develop the underlying technologies to rapidly respond to a disease or threat, and improve individual readiness and total force health protection by providing centralized laboratory capabilities at non-tertiary care and individual settings. ADEPT will develop and exploit synthetic biology for the in vivo creation of nucleic acid circuits that continuously and autonomously sense and respond to changes in physiologic state and for novel methods to target delivery, enhance immunogenicity, or control activity of vaccines, potentially eliminating the time to manufacture a vaccine ex vivo. ADEPT advancements to control cellular machinery include research to optimize orthogonality and modularity of genetic control elements; identify methods to increase sensitivity and specificity; and demonstrate methods to control cellular machinery in response to changes in physiological status. ADEPT will develop methodologies for measuring health-specific biomarkers from a collected biospecimen to enable diagnostics at the point-of-need or resource limited clinical facilities (point-of-care), in-garrison or deployed. Additionally, ADEPT will initiate techniques to characterize natural signal transduction pathways, such as electrical and mechanical, that are not conventionally used to guide diagnosis, or as a therapeutic measure. The signals will be studied in detail and their physiological function validated for measurement and modulation to determine diagnostic and therapeutic benefit. Applied research efforts are budgeted in PE 0602115E, Project BT-01. ***FY 2012 Plans:*** - Initiate development of modular and orthogonal nucleic acid-based elements for application within a sense-and-respond circuit that operates within context of a mammalian cell. - Investigate controlled expression in mammalian cells of synthetic circuit that responds to physiological biomarkers associated with health status. - Develop novel concepts and molecular approaches to enable deployable diagnostics. - Develop novel reagents and materials for stabilizing self-collected biospecimens at room temperature for simple shipment and storage. - Develop methods for sample preparation that require no operator manipulation and are consistent with point-of-need and point-of-care settings. - Develop new methods for signal amplification amenable to deployable diagnostics. ***FY 2013 Plans:*** - Demonstrate development of modular and orthogonal nucleic acid-based elements for application within a sense-and-respond circuit that operates within context of a mammalian cell.			

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Demonstrate controlled expression in mammalian cells of synthetic circuit that responds to physiological biomarkers associated with health status. - Quantify performance of developed molecular approaches designed for deployable diagnostics. - Quantify performance of biostabilization reagents/materials. - Quantify performance of methods for room temperature analyses and reagent stabilization. - Quantify detection limits achieved with signal amplification methods. - Demonstrate performance of new sample preparation methods suitable for simple and multiplexed analysis off of biospecimens that are either self-collected under low-resource settings or collected by trained professionals at the physician-office settings. - Design integration of developed diagnostic methodologies. - Investigate bioelectric signatures and signaling patterns related to biological responses, such as baseline status and regenerative tissue conditions. - Characterize bio-electric signaling from multiple cell types/biological environments.			
Title: Dialysis-Like Therapeutics ***Description:*** Sepsis, a bacterial infection of the blood stream, is a significant cause of injury and death among combat-injured soldiers. The goal of this program is to develop a portable device capable of controlling relevant components in the blood volume on clinically relevant time scales. Reaching this goal is expected to require significant advances in sensing in complex biologic fluids, complex fluid manipulation, separation of components from these fluids, and mathematical descriptions capable of providing predictive control over the closed loop process. The envisioned device would save the lives of thousands of military patients each year by effectively treating sepsis and associated complications. Initial basic research will develop the component technologies that will ultimately make up the integrated device. Included in this effort will be the development of non-fouling, continuous sensors for complex biological fluids; design of high-flow microfluidic structures that do not require the use of anticoagulation; development of intrinsic separation technologies that do not require pathogen specific molecular labels or binding chemistries; and predictive modeling and control (mathematical formalism) with sufficient fidelity to enable agile adaptive closed-loop therapy. Applied research efforts are budgeted in PE 0602115E, Project BT-01. ***FY 2012 Plans:*** - Achieve intermittent sensing technologies for the detection of pathogens and biomolecules in flowing blood, blood components, and wound fluid at least every 45 minutes with more than 2 hours of continuous operation. - Attain microfluidic architectures and coatings for 100 mL/hr microfluidic system blood flow for at least 2 hours without platelet activation or clotting.	-	5.000	5.000

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Accomplish 50% removal of pathogens and select bioagents from blood or blood components via label free separation technologies. - Demonstrate a clinically relevant sepsis predictive model and training algorithm based on data sets from published literature. ***FY 2013 Plans:*** - Improve intermittent sensing technologies for the continuous detection of pathogens and biomolecules in flowing blood, blood components, and wound fluid. - Refine microfluidic architectures and coatings for continuous blood flow without platelet activation or clotting. - Enhance label-free separation technologies to successfully remove pathogens and select bioagents from blood or blood components. - Validate the sepsis predictive modeling using larger anonymous clinical datasets.			
Accomplishments/Planned Programs Subtotals	-	37.870	39.676

D. Other Program Funding Summary ($ in Millions)

N/A

E. Acquisition Strategy

N/A

F. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Defense Advanced Research Projects Agency	DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602115E: *BIOMEDICAL TECHNOLOGY*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
FY 2012 Plans: - Develop a platform to reproducibly demonstrate the evolutionary pathway of a virus under multiple selective pressures. - Validate predictive algorithms against selected experimental pressures on viral evolutionary pathways. - Use algorithm to investigate virus mitigation and frequency globally to predict the timing and geographic location of reassortment events. - Model processes to accurately predict the drift and shift of virus in pre-human, animal reservoirs. - Develop first-ever system for anticipating evolution of clinical drug resistance through the use of an in vitro viral-evolution reactor. - Demonstrate novel sequencing technologies to reduce error rate. - Demonstrate evolution in microdroplet cell-viral infection systems. ***FY 2013 Plans:*** - Predict timing of antiviral failure in chronically infected viral host (animal) model. - Predict location(s) of genetic mutation responsible for antiviral failure in a chronically infected viral host (animal) model. - Predict number of viral generations necessary to achieve antiviral resistance in a chronically infected viral host (animal) model. - Predict location of genetic mutation(s) responsible for resistance to subunit vaccine (such as hemagglutinin or recombinant protective antigen.) - Correlate influenza vaccine failure in syngeneic/specific pathogen-free poultry with pathogen evolution in the natural ecologies of Asia. - Use in vitro evolution reactors to predict emergence of novel, variant influenza strains from within-reservoir species. - Use in vitro evolution reactors to predict emergence of dengue virus mutations in a region where dengue has recently appeared. - Use in vitro evolution reactors to predict host resistance to candidate pathogens.			
Title: Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT)*	-	10.508	15.500
Description: *Previously funded in Synthetic Biology in PE 0601101E, Project TRS-01 The overarching goal of the Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT) program is to increase our ability to rapidly respond to a disease or threat and improve individual readiness and total force health protection by providing centralized laboratory capabilities at non-tertiary care settings. ADEPT will focus on the development of Ribonucleic Acid (RNA)-based vaccines, potentially eliminating the time and labor required for traditional manufacture of a vaccine while at the same time improving efficacy. ADEPT will also focus on advanced development of key elements for simple-to-operate diagnostic devices. A companion basic research effort is budgeted in PE 0601117E, Project MED-01. ***FY 2012 Plans:***			

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Increase stability of RNA-based vaccines. - Demonstrate efficacy of RNA-based vaccines in a small animal model. - Develop advanced instrumentation approaches for sample preparation for diagnostics. - Develop advanced instrumentation approaches for detector elements of autonomous diagnostics devices. ***FY 2013 Plans:*** - Demonstrate increased humoral and cellular responses with RNA-based vaccines as compared to benchmark vaccines in vivo. - Demonstrate increased efficacy of RNA-based vaccines in vivo in small and large animal models. - Demonstrate quantitative performance metrics for developed instrumentation approaches for diagnostic sample preparation. - Demonstrate quantitative performance metrics for developed instrumentation approaches for detector elements of autonomous diagnostic devices.			
Title: Tactical Biomedical Technologies*	-	16.676	18.500
Description: *Previously funded in PE 0602715E, Project MBT-02 The Tactical Biomedical Technologies thrust will develop new approaches to deliver life-saving medical care on the battlefield. Uncontrolled blood loss is the leading cause of preventable death for soldiers on the battlefield. While immediate control of hemorrhage is the most effective strategy for treating combat casualties and saving lives, currently no method other than surgical intervention can effectively treat intracavitary bleeding. A focus in this thrust is the co-development of a materials-based agent(s) and delivery mechanism capable of damaged tissue-targeted hemostasis and wound control. This system will effectively treat compressible and non-compressible wounds regardless of geometry or location. Additionally, rapid response to emerging biological threats on the battlefield is impacted by logistical delays of delivering the necessary therapeutics. Creating a "pharmacy on demand" will enable far-forward medical providers to manufacture and produce small molecule drugs and biologics in order to ensure that the therapeutics are available when they need them. This project will also develop new algorithms, protocols, and methods to allow registration and comparison of disparate sources of data in biology (across species, experimental systems, hierarchies and populations). ***FY 2012 Plans:*** - Demonstrate hemostasis agent stability consistent with operational requirements. - Demonstrate hemostasis in less than four minutes on a non-compressible injury model. - Demonstrate that hemostatic material does not induce intracavitary fibrosis within 28 days when left at the wound site. - Design scale-up for large-volume hemostasis agent synthesis. - Initiate discussions for wound stasis system FDA approval.			

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Develop peripheral nerve recording interfaces and control algorithms that capture motor intent signals from the residual nerves in amputees. - Develop sophisticated real-time classification algorithms designed to operate dextrous control of an upper limb neuroprosthetic using electroencephalogram and other signals captured entirely from non-invasive, non-penetrating, sources. - Develop biotic/abiotic neural interface technology to overcome known failure mechanisms. - Replace linear and low-order, non-linear decoding techniques with sophisticated statistical and non-linear algorithms. - Develop a novel neural interface that will be implanted via a minimally invasive intravascular approach. - Enlist commercial neural interface manufacturers to develop tools to allow users to evaluate probe reliability in situ, helping them to pinpoint the source of failure should it be due to flaws in the probe design or manufacture. - Develop techniques and standards to evaluate the long-term biocompatibility of advanced neural interface materials. Collaborate with FDA and American National Standards Institute (ANSI) to adapt biocompatibility safety standards for neural interfaces. ***FY 2013 Plans:*** - Demonstrate a tactor-array system capable of driving neural plasticity and sensory percept reorganization through remapping of fingertip touch percepts to amputee residual limbs. - Demonstrate wearable bioelectric sensor array with 32 active differential channels capable of controlling a standard myoelectric prosthetic hand. Extend sophisticated electromyography (EMG)-decoding algorithms to adapt to real-world artifacts and to infer user intent. - Develop clinically viable self-contained implantable EMG-recording sensors that would have a direct and immediate impact on traditional myoelectric prostheses and transplanted muscle re-innervation patients by substantially increasing the number of controllable independent degrees of freedom. - Demonstrate the biological stability, durability, and reliability of a peripheral nerve interface through motor, sensory, and closed-loop behavioral activities in a freely moving animal model. - Initiate clinical trials for peripheral nerve recording interfaces that capture motor control signals from the endogenous residual nerves. - Demonstrate an electroencephalogram-based fully non-invasive, non-penetrating, neural-interface system capable of providing prosthetic limb control for human users. - Demonstrate the improved reliability of newly developed neural probe technologies designed specifically to overcome known failure mechanisms. - Demonstrate use of best-of-breed statistical and non-linear decoding algorithms and quantify the improvements in accuracy and reliability.			
Title: Dialysis-Like Therapeutics	-	5.000	11.500

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
Description: Sepsis, a bacterial infection of the blood stream, is a significant cause of injury and death among combat-injured soldiers. The goal of this program is to develop a portable device capable of controlling relevant components in the blood volume on clinically relevant time scales. Reaching this goal is expected to require significant advances in sensing in complex biologic fluids, complex fluid manipulation, separation of components from these fluids, and mathematical descriptions capable of providing predictive control over the closed loop process. The envisioned device would save the lives of thousands of military patients each year by effectively treating sepsis and associated complications. Applied research under this program further develops and applies existing component technologies and then integrates these to create a complete blood purification system for use in the treatment of sepsis. Included in this effort will be development, integration and demonstration of non-fouling, continuous sensors for complex biological fluids; implementation of high-flow microfluidic structures that do not require the use of anticoagulation; application of intrinsic separation technologies that do not require pathogen specific molecular labels or binding chemistries; and refinement of predictive modeling and control (mathematical formalism) with sufficient fidelity to enable agile adaptive closed-loop therapy. The basic research part of this program is budgeted in PE 0601117E, Project MED-01. ***FY 2012 Plans:*** - Evaluate existing sensing, microfluidic flow, and intrinsic separation component technologies for use in an integrated blood purification system and initiate research plan to achieve significant improvements in line with the overall program goals. - Develop integration plan for component technologies developed in the basic research aspect of this program. - Develop regulatory pathway leading to an approved integrated device. ***FY 2013 Plans:*** - Refine integration strategy, develop a bread-board system, and demonstrate bread-board system in a small animal model. - Confirm regulatory plan and begin regulatory approval process for the integrated device.			
Title: Warrior Web ***Description:*** Warrior Web, previously funded in the Maintaining Combat Performance Thrust in PE 0602715E, Project MBT-02, will develop an adaptive, compliant, nearly transparent, quasi-active joint support system to mitigate acute injuries caused by physically demanding events common to missions such as airborne and air assault insertions. Warrior Web represents an expansion of capability beyond "lightening the load." Warrior Web's capability space is between biomechanics, robotics, physiology, and combat clothing. This program will result in technology that reduces the injuries sustained by soldiers. Allowing soldiers to perform their missions with reduced risk for injuries will have immediate effects on mission readiness, soldier survivability, and mission performance.	-	-	10.250

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
- Begin construction of a full microplasma electronics based radiation hardened RF system. - Initial testing of a microcavity material for high power microwave protection.			
Title: IntraChip Enhanced Cooling (ICECool) ***Description:*** The IntraChip Enhanced Cooling (ICECool) program is exploring disruptive technologies that will remove thermal barriers to the operation of military electronic systems, while significantly reducing size, weight, and power consumption. These thermal barriers will be removed by integrating thermal management into the chip, substrate, or package technology. Successful completion of this program will close the gap between chip-level heat generation density and system-level heat removal density in RF arrays and embedded computers. Specific areas of focus in this program include overcoming limiting evaporative and diffusive thermal transport mechanisms at the micro/nano scale to provide an order-of-magnitude increase in on-chip heat flux and heat removal density, determining the feasibility of exploiting these mechanisms for intrachip thermal management, characterizing the performance limits and physics-of-failure of high heat density, intrachip cooling technologies, and integrating chip-level thermal management techniques into prototype high power electronics in the form factor of RF arrays and embedded computing systems. ***FY 2013 Plans:*** - Investigate advanced evaporative, thermoelectric, and diffusive technologies for intrachip thermal management in electronic and photonic components. - Determine fundamental limits of advanced thermal technologies and feasibility of implementation into compact defense electronic and photonic systems. - Investigate benefits to system-level performance and size, weight, power, and cost (SWaPC) through the use of intrachip thermal management technologies.	-	-	8.000
Title: In vivo Nanoplatforms (IVN) ***Description:*** The In vivo Nanoplatforms (IVN) program seeks to develop the nanoscale systems necessary for in vivo sensing and physiologic monitoring and delivery vehicles for targeted biological therapeutics. The nanoscale components to be developed will enable continuous in vivo monitoring of both small (e.g. glucose, lactate, and urea) and large molecules (e.g. biological threat agents). A reprogrammable therapeutic platform will enable tailored therapeutic delivery to specific areas of the body (e.g. cells, tissue, compartments) in response to traditional, emergent, and engineered threats. The key challenges to developing these systems include safety, toxicity, biocompatibility, sensitivity, response, and targeted delivery. The IVN program will have diagnostic and therapeutic goals that enable a versatile, rapidly adaptable system to provide operational support to the warfighter in any location.	-	-	5.000

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013
FY 2013 Plans: - Begin development of initial in vivo diagnostic platform for small molecules. - Initiate development of in vivo therapeutic platform for treatment of infectious disease. - Begin technical analysis of safety and efficacy for proposed in vivo platforms.			
Title: Pixel Network (PIXNET) for Dynamic Visualization ***Description:*** The Pixel Network (PIXNET) for Dynamic Visualization program aims to develop infrared imaging components and the necessary application programming interface (API) system to provide real-time and dynamic tactical visualization of battlefield situation awareness and exploitation at individual level and at collective ensemble. The goal is to enable one-to-many and many-to-one real-time intelligence, surveillance and reconnaissance (ISR) data and metadata to maximize mission relevancy and minimize decision time during day/night operations. The program will focus on significant reduction in cost, size, weight and power (SWaP) of infrared sensor components to enable portability and ability to deploy widely to all participants in the theatre. Development of wafer scale IR sensor and coolers for low cost manufacturing will provide a price point that will allow them to be deployed to each warfighter. The emphasis on a small form -factor (<3.5 cm3) will naturally enable new opportunities such as surveillance with micro-UAVs, networked handheld devices with fused imaging capabilities to share tactical information at troop level, and intelligence for rapid decision/action. The phenomenology of different infrared wavelengths will be exploited for targets of interest and only relevant data will be transmitted, thus reducing data burden over the network. Having the capability of PIXNET at the soldier level will increase situational awareness and will enable more effective tactics, techniques and procedures (TTP). PIXNET will take advantage of small computing platforms such as Android cell phones API to integrate and demonstrate digital image data distribution and signal processing via wireless connectivity. The Program Executive Office, Space Sciences Laboratory, PM Optics USMC and industry will be the transition partners. ***FY 2013 Plans:*** - Develop and review IR camera design and overall architecture that will demonstrate digital image data distribution and signal processing via wireless connectivity using a cell phone or PDA platform. - Develop CMOS compatible wafer scale manufacturing of integrated image sensor-cooler for very low SWaP IR camera technology. - Develop wafer scale low-cost and high transmission optics. - Develop strategy to reduce IR image sensor cost by 15 to 50X. - Demonstrate rudimentary operation of networked IR sensors for digital signal processing and image data distribution.	-	-	12.000
Title: Microscale Power Conversion (MPC)	15.000	-	-