Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Defense Advanced Research Projects Agency	DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*	**R-1 ITEM NOMENCLATURE** PE 0603760E: *COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
Total Program Element	253.733	219.809	296.537	-	296.537	266.783	270.941	282.805	287.746	Continuing	Continuing
CCC-01: *COMMAND & CONTROL INFORMATION SYSTEMS*	69.491	69.310	76.800	-	76.800	53.487	39.237	42.632	42.632	Continuing	Continuing
CCC-02: *INFORMATION INTEGRATION SYSTEMS*	104.874	68.876	88.519	-	88.519	84.669	86.083	85.291	85.291	Continuing	Continuing
CCC-04: *SECURE INFORMATION AND NETWORK SYSTEMS*	-	-	15.000	-	15.000	23.000	40.000	40.000	45.000	Continuing	Continuing
CCC-CLS: *CLASSIFIED*	79.368	81.623	116.218	-	116.218	105.627	105.621	114.882	114.823	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Command, Control and Communications Systems program element is budgeted in the Advanced Technology Development Budget Activity because its purpose is to demonstrate and evaluate advanced information systems research and development concepts.

The goals of the Command and Control Information Systems project are to develop and test innovative, secure architectures and tools to enhance information processing, dissemination and presentation capabilities for the commander. This will give the commander insight into the disposition of enemy and friendly forces, a joint situational awareness picture that will improve planning, decision-making and execution support capability and provide secure multimedia information interfaces and assured software to "on the move" users. Integration of collection management, planning and battlefield awareness programs is an essential element for achieving battlefield dominance through assured information systems.

The goals of the Information Integration Systems project are to take diverse data inputs from a variety of sources, efficiently disseminate the information, and perform distributed and dynamic all-source correlation and fusion to produce an integrated, geo-spatially referenced, battlefield database and knowledge-base. The principal element of this project is assured communications using standard and non-traditional means, on and off the battlefield.

The goals of the Secure Information and Network Systems project are to develop and test emerging computer, communications, and network systems where the impact of the systems and the vulnerabilities of the systems are not kinetically based. Network Security technologies arising from other projects will be further identified, developed, integrated, and tested.

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B. Program Change Summary ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Previous President's Budget	269.198	219.809	202.240	-	202.240
Current President's Budget	253.733	219.809	296.537	-	296.537
Total Adjustments	-15.465	-	94.297	-	94.297
• Congressional General Reductions		-			
• Congressional Directed Reductions		-			
• Congressional Rescissions	-	-			
• Congressional Adds		-			
• Congressional Directed Transfers		-			
• Reprogrammings	-8.324	-			
• SBIR/STTR Transfer	-7.141	-			
• TotalOtherAdjustments	-	-	94.297	-	94.297

Change Summary Explanation

FY 2010: Decrease reflects internal below threshold reprogrammings and SBIR/STTR transfer.

FY 2012: Increase reflects establishment of a new project (CCC-04, Secure Information and Network Systems) for 6.3 cyber security efforts and increases for advanced communications programs, EW/Counter EW technologies, and classified programs offset by reductions for Defense Efficiencies for contractor staff support and classified programs.

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COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
CCC-01: *COMMAND & CONTROL INFORMATION SYSTEMS*	69.491	69.310	76.800	-	76.800	53.487	39.237	42.632	42.632	Continuing	Continuing

A. Mission Description and Budget Item Justification

Military operations since the end of the Cold War show that current theater-level command, control, communications, and intelligence/information systems lack the ability to fully support operations in complex, time-critical environments. Warfighters must be prepared for operations ranging from peacekeeping in urban centers to heavy battle actions in remote areas. Current capabilities do not provide the commander with real-time, secure, situational awareness or the ability to orchestrate high-tempo planning, rehearsal, and execution. The programs in this project are developing and testing innovative, secure architectures and tools to enhance information processing, dissemination, and presentation capabilities. These will provide the commander with insight into the disposition of enemy and friendly forces, a joint situational awareness picture that will improve planning, decision-making, and execution, secure multimedia information interfaces, and software assurance to the warfighter "on the move." Integration of collection management, planning, and battlefield awareness are essential elements for achieving battlefield dominance through assured information systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: ZETA	25.586	29.000	32.000
Description: The ZETA program is exploring the unclassified aspects of novel physical devices, concepts, and techniques that leverage quantum physics for information technology. Research in this area has the ultimate goal of demonstrating information technology components with radical improvements in power efficiency and/or computational power relevant to military applications and opportunities. The program will transition via industrial performers. ***FY 2010 Accomplishments:*** - Continued validation of key physical device assumptions. ***FY 2011 Plans:*** - Continue validation of key physical device assumptions. - Initial planning for small-scale demonstration of key physical devices. ***FY 2012 Plans:*** - Perform preliminary small-scale demonstration of key physical devices.			
Title: Resilient Command and Control (RC2)*	10.800	17.760	23.600
Description: *Previously part of Advanced Tactical Battle Manager.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
The Resilient Command and Control (RC2) program is developing a general framework and set of critical mission assurance capabilities to enable Commanders and their staffs to manage the array of C2 systems and architectures (sensor, communications, and information processing) used to conduct operations. These adaptive, resilient C2 resource planning and re-planning capabilities will ensure mission success in the face of C2 system outages. Specific technologies being developed under RC2 include advanced analysis, visualization, and planning tools to provide Commanders and their staffs with a dashboard that enables the following operational and corresponding analytical capabilities: (1) attain and maintain situation awareness of the C2 architectures; (2) understand mission impact of outages; and (3) dynamically realign the C2 systems to ensure the Commander's intent. The tools and technologies that result from RC2 will enable operators to detect anomalous behavior via intuitive information displays; assess business function impact, including 2nd and 3rd-order effects; and dynamically re-plan how the system can be used to achieve organizational goals and priorities. Transition is planned to U.S. Pacific Fleet (USPACFLT). ***FY 2010 Accomplishments:*** - Defined program concept and developed performance metrics. - Conceptualized visualizations that support enhanced C2 situation awareness and understanding. - Participated in USPACFLT Terminal Fury exercise. ***FY 2011 Plans:*** - Provide predictive and diagnostic estimation of C2 system health and status in terms of the ability of those systems to support operational missions. - Prosecute anomalies in context of operational mission priorities. - Conduct experiments with users at USPACFLT. - Conduct an operational demonstration at a single node in the context of a major military exercise. ***FY 2012 Plans:*** - Automatically determine the impact of multiple correlated anomalies on operational activities. - Develop dynamic approaches to allocating critical C2 functions, relations, and information flows over space and time. - Adapt C2 plan to support mission needs. - Develop active visualizations to support C2 system situation awareness and understanding. - Conduct experiments with users at USPACFLT and Commander 7th Fleet. - Conduct an operational demonstration at two nodes in the context of a major military exercise.			
Title: Deep Green ***Description:*** Deep Green is a next-generation, battle command and decision support technology that combines anticipatory planning with adaptive execution to help the commander think ahead, identify when a plan is going awry, and prepare options	15.776	13.727	4.200

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
before they are needed. Deep Green will radically reduce the time needed to plan and execute military operations and will reduce the number of staff officers needed in an operations center. Through rapid mission planning and execution and reduced staff overhead, Deep Green's goal is to save lives and reduce costs. Deep Green will automatically infer the commander's intent and output a plan from the commander's hand-drawn sketches to facilitate rapid option creation. Deep Green generates a broad set of possible futures from those options for all sides in an operation and predicts the likelihood of each future. It supports anticipatory planning by using information about the ongoing operation to nominate future states that are no longer feasible and probable future states upon which the commander should focus additional planning efforts. By anticipating decision points early and allowing the commander to explore the future option space, Deep Green supports commander's visualization and adaptive execution, enabling correct, timely decisions by the commander. Deep Green technology will transition to the U.S. Army. ***FY 2010 Accomplishments:*** - Extended technologies to monitor an ongoing operation and update the likelihoods that the possible future states being generated by Deep Green will actually occur. - Integrated major components to produce an initial prototype Deep Green system that enables proactive (vice reactive) battle management. - Extended the Deep Green system to support additional battlefield functional areas, such as air defense, intelligence, and military engineering. - Conducted system evaluation exercises in military simulation environments with military operators. ***FY 2011 Plans:*** - Extend Deep Green to support multi-echelon operations, including Deep Green systems at brigade and battalion levels coordinating among themselves. - Demonstrate fully-functional, multi-echelon, full-spectrum battle command technology. - Extend the Deep Green system to support both mid-intensity conflict and counter-insurgency operations. - Conduct virtual and live field exercises with Deep Green at military training facilities. ***FY 2012 Plans:*** - Integrate Deep Green technology into fielded battle command systems. - Demonstrate functional battle command technology in force-on-force exercises against a live, intelligent enemy. - Transition Deep Green technology to U.S. Army.			
Title: Adaptive Collaborative Environment (ACE) ***Description:*** The Adaptive Collaborative Environment (ACE) is a comprehensive set of technologies designed to establish information flow through the Joint, Intergovernmental, Interagency, and Multinational (JIIM) communities as they respond to	-	-	17.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
operations in infrastructure denied environments. These denied environments may be caused by massive natural disasters, such as massive earthquakes or tsunamis, or in areas where our communications are actively being denied or subverted by an adversary. The goal of this program is to create an architecture that will allow full, meaningful collaboration to begin across the JIIM community in 48-96 hours after an event. ***FY 2012 Plans:*** - Collect and synthesize information pertaining to prior disasters and relief missions, and challenges to effective mission collaboration. - Develop a framework for translating mission needs into technology and architecture needs. - Develop tools and techniques for rapid data discovery and integration of ad-hoc information systems. - Create a prototype collaborative decision support interface. - Develop and test initial ACE technologies set.			
Title: Heterogeneous Airborne Reconnaissance Team (HART) ***Description:*** The Heterogeneous Airborne Reconnaissance Team (HART) program develops integrated tactical planning and sensor management systems for heterogeneous collections of manned and unmanned platforms operating in urban environments. HART employs a model-based control architecture with dynamic teaming and platform-independent command and control. The system registers new platforms with the battle manager (kinematics, maneuverability, endurance, payloads, and communications links) to facilitate platform-independent tasking. HART provides a commander's interface that allows collaborative tasking of the platforms in the form of operational missions, such as search, track, identify, or engage, rather than routes and events. Additionally, it supplies computationally intensive decision aids, such as advanced 4-D airspace and groundspace deconfliction tools, route planners, and task/platform assignment algorithms. The technology presents mission status and future courses of action to commanders for collaborative adjudication. HART enables augmentation of low-footprint, rapidly deployable, easily sustainable human command structures with teams of machines operating together. There is a Memorandum of Agreement in place with the U.S. Army for technology transition. ***FY 2010 Accomplishments:*** - Tested and demonstrated cooperative interaction with Tactical Airspace Integration System to achieve permissive airspace management for manned and unmanned platforms and indirect fires. - Supported operational evaluation and certification of capabilities and limitations. - Collaborated with Program Manager, Unmanned Aircraft Systems and Army G-2 Intelligence, Surveillance, Reconnaissance Task Force lead to integrate and transition selected capabilities to the U.S. Army. - Ruggedized and miniaturized hardware suite.	7.290	2.000	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Ensured scalability appropriate to anticipated areas of employment. - Supported operational transition of technology to Program Executive Office Aviation Programs of Record. ***FY 2011 Plans:*** - Formulate and assess geo-registration algorithms suitable for highly variable terrain. - Develop new collection management methods that account for terrain-induced routing constraints, ground field of view mapping, and sensor visibility constraints.			
Title: Urban Leader Tactical Response, Awareness and Visualization (ULTRA-Vis) ***Description:*** The Urban Leader Tactical Response, Awareness and Visualization (ULTRA-Vis) program is developing an integrated, soldier-worn situational awareness system that allows the small unit leader to display iconic representations of blue force locations, tactically relevant targets, and coordinated actions and effects The icons are geo-registered on the battlefield and viewed from each warfighter's perspective using a see-through, head-mounted display. The system will enable the small unit leader to conduct non-line-of-sight combat operations using hands-free, iconic command and control while on the move. Information management protocols will support the dissemination of tactical information to allow the squad leader to direct weapons platforms for real-time collaboration without overload. ULTRA-Vis technologies will allow small unit leaders and members to selectively receive and visualize critical combat information using existing, low-bandwidth soldier voice and data radios. ULTRA-Vis empowers the small unit leader with a clear tactical advantage through inter/intra-squad collaboration, heightened situational awareness and the ability to take decisive action while on-the-move. The ULTRA-Vis prototype units are planned for transition to the U.S. Army, Air Force Special Operations Command (AFSOC), and U.S. Marine Corps. ***FY 2010 Accomplishments:*** - Developed the capability to recognize standard hand and arm signals used by small unit leaders in close range combat operations. - Developed the capability to create geo-registered icons and affix the icons with high placement accuracy to the shared urban landscape for display from each warfighter's perspective. - Developed a non-occluding, head-mounted see-through optic for viewing iconic overlay on the battlespace. ***FY 2011 Plans:*** - Create Cursor on Target (CoT) XML formatted data displays and information management for inter-squad collaboration. - Continue refinement and improvements in function and performance of all sub-components. - Integrate multi-mode testbeds to evaluate system functionality and capabilities.	8.033	6.823	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Conduct service relevant simulated operational exercises and demonstrations using ULTRA-Vis in current Concept of Operations (CONOPS).			
Title: Increased Command and Control Effectiveness (ICE) ***Description:*** The Increased Command and Control Effectiveness (ICE) program developed and integrated cognitive systems technology into operational Command, Control, and Intelligence (C2I) systems. DARPA's Cognitive Systems programs have been developing the machine learning, reasoning, and human-machine dialogue technologies necessary to create cognitive assistants. This new technology promises to enable information systems to adapt automatically, during deployment and in real time, to the changing conditions that military commanders confront. It enables commanders to more rapidly adapt to evolving situations and priorities, and accelerates the incorporation of new personnel into command operations. This program funded portions of the technologies developed in PE 0602304E, Project COG-02 that were ready for application to command and control and situational awareness systems. ***FY 2010 Accomplishments:*** - Extended Personalized Assistant that Learns (PAL) analyst support capabilities based on test and evaluation in exercises along with end-user feedback. - Integrated PAL-based prototypes with an operational Army C2 system and participated in an Army military readiness exercise at the National Training Center in Fort Irwin. - Evolved and improved the PAL Learning Services Framework based on developer feedback and released for general use.	2.006	-	-
Accomplishments/Planned Programs Subtotals	69.491	69.310	76.800

C. Other Program Funding Summary ($ in Millions)

N/A

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)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
CCC-02: *INFORMATION INTEGRATION SYSTEMS*	104.874	68.876	88.519	-	88.519	84.669	86.083	85.291	85.291	Continuing	Continuing

A. Mission Description and Budget Item Justification

The success of military operations depends on timely, reliable, secure, and synchronized dissemination of command and control and relevant situational awareness information to every military echelon. While wired communications and networks are fairly well developed, providing assured high-bandwidth mobile wireless capabilities that match or exceed commercial wired infrastructure is needed to meet the demands of military users. The goal of the Information Integration Systems project is to develop and demonstrate technologies that will provide effective communications to U.S. forces. Approaches to this goal include developing technologies that increase network capacity and scaling, enhance spectrum efficiency in congested spectrum, tolerate network degradation, provide man-made and natural electromagnetic interference mitigation, defeat network reconnaissance and surveillance, counter denial of service and other threats, and autonomously move relevant information from the cloud to the edge.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Optical & RF Combined Link Experiment (ORCLE)	31.496	19.070	3.951

Description: The Optical & RF Combined Link Experiment (ORCLE) program seeks to develop combined radio frequency (RF) and free space optical (FSO) communications as well as networking technologies that exploit the benefits of complementary path diversity. This effort encompasses the extension of research into the FSO/RF Internet Protocol-based Network system, called Optical RF Communications Adjunct (ORCA). Using optical and RF communication techniques, ORCLE will demonstrate improved battlespace communications using a hybrid RF and FSO link in air-to-air-to-ground environments. The central challenge is to enable optical communications bandwidth without giving up RF reliability, regardless of the weather. ORCLE will develop RF and FSO propagation channel analysis, coding techniques, and modeling to include weather, atmospherics, and aero-optics to provide the joint force commander assured high-data rate communications. The technical objective is to prototype and flight demonstrate hybrid FSO/RF air-to-air-to-ground links that combine the best attributes of both technologies and simulate hybrid network performance. The ORCLE technology is planned for transition to the Air Force.

FY 2010 Accomplishments:
- Executed design reviews that provided information to build prototype system.
- Integrated improved adaptive optics, e.g., lighter deformable mirror, and faster steering mirrors, into an airborne optical link system that will be incorporated into future systems to provide gigabits of data over long ranges with high reliability and quality.
- Completed design and build of a router for integration into future prototypes.
- Validated adaptive optics approaches and control methods during ground checkout.

FY 2011 Plans:

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Test airborne and ground-based FSO communications terminals that use adaptive optics (AO) to increase the coupling efficiency of received laser light, while reducing overall received power variations. - Develop and test an optical modem and forward error correction (FEC) system that, combined with the Optical Automatic Gain Control (OAGC), demonstrate greatly improved receiver sensitivities. - Incorporate a multifunction hybrid router capable of providing node discovery, Mobile Ad Hoc Network (MANET) formation, differentiation of services, and retransmission of lost packets. - Assemble prototype nodes and install on a minimum of three aircraft networked to ground terminals for data distribution as well as battlefield command and control experiments. ***FY 2012 Plans:*** - Execute final testing of a 4 node network (3 air nodes and one ground node) to demonstrate hybrid high data rate FSO/RF and advanced network capabilities that provide information rates sufficient for current military needs and mission requirements. - Validate the ability to provide the warfighter low latency information for command and control as well as Intelligence, Surveillance and Reconnaissance (ISR) requirements. - Demonstrate network instantiation and user interfaces to command and control at multiple levels. - Complete transition of the technology.			
Title: Military Networking Protocol (MNP) ***Description:*** The Military Networking Protocol (MNP) program will create architectures, protocols and network controllers to enhance security and operation of military networks. MNP technologies will enforce military user authentication, manage military network traffic and automatically configure military networks. By enforcing military user authentication, military network protocols will provide full attribution of every military device and track each device's network flows to provide full attribution down to the individual source of bad/erroneous data or malicious activity. MNP prioritization schemes will be controlled by the military commanders at various echelons to address changing mission requirements. MNP technologies will transition to DISA and/or the military Services. ***FY 2010 Accomplishments:*** - Developed and initiated formal testing of military networking architectures, protocols and network controllers. - Developed and tested a 200-node military networking testbed. ***FY 2011 Plans:*** - Complete initial testing and down-select to a single MNP architecture, protocol and network controller design set. - Coordinate with DISA and the Services to foster program participation and to develop a transition plan for MNP technologies.	13.385	9.750	21.268

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Initiate the continued design of the selected MNP architecture and protocols and build prototype network controllers. ***FY 2012 Plans:*** - Conduct interim system test and verification of the MNP architecture and protocols. - Continue the refinement and design of the selected MNP architecture, protocols and network controllers. - Increase the scale of the MNP test-bed for the final test and demonstration. - Coordinate with DISA and the Services to continue program participation and to finalize a transition plan and/or memorandum of agreement for MNP technology.			
Title: Wireless Network after Next (WNaN) and Advanced Wireless Networks for the Soldier (AWNS) ***Description:*** The Wireless Network after Next (WNaN) and Advanced Wireless Networks for the Soldier (AWNS) program goals are to develop and demonstrate technologies and system concepts that will enable densely deployed radio networks to compensate for limitations of the physical layer of a low-cost wireless node. WNaN/AWNS networks will manage node configurations and the topology of the network to reduce the demands on the physical and link layers of the network. The technology created by the WNaN/AWNS effort will provide reliable and available battlefield communications at low system cost. This program will also improve the hardware, firmware, and software to allow the integration of the Joint Tactical Radio System (JTRS) Soldier Radio Waveform (SRW) for backward interoperability to legacy communication systems. An ancillary initiative is investigating the integration of Multi-User Detection (MUD) and Multiple-Input Multiple Output (MIMO) technology into the WNaN radio platform. The objective of this effort is to perform MUD and MIMO algorithm development and system trade studies analysis that position these technologies for transition into the WNaN radio node. In addition, this effort will investigate Wireless Distributive Computing (WDC), Content Base Access (CBA), and smart antenna technology to enhance the network and node ability to understand the operating environment, mission concept of operations, and node responsibilities to assist in data processing, information dissemination, and accomplishment of the military objectives. In addition, this program will develop a low-cost handheld/body wearable wireless node that can be used to form high-density ad-hoc networks and gateways to the Global Information Grid. This program will also develop robust networking architecture(s) and network technologies/processes that will exploit high-density node configurations. Coordination between DARPA and the Army will culminate in network demonstrations using the multichannel nodes to establish viability for the Army to transition to programs of record and procure WNaN/AWNS devices and technology. Transition to the Army is planned to begin in 2011 and complete in 2013 following culmination of experiments and demonstrations. ***FY 2010 Accomplishments:*** - Conducted field experiments and demonstrations of prototypes of more than 100 radio nodes operating in a mobile ad hoc network.	18.602	10.923	18.300

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Demonstrated enhanced networking technology to include Disruption Tolerant Networking (DTN) and Dynamic Spectrum Access (DSA) capability with the spectrum policy reasoning engine. - Simulated mobile ad-hoc wireless network performance for networks of >250 nodes. - Demonstrated a communication system where the network layers can mitigate shortfalls in the radio physical layer. - Initiated development/implementation of Type 2 security architecture within the WNaN radio/network. - Conducted demonstrations of pre-production radios in field tests that form a highly adaptive, dynamic, self-forming, self-healing WNaN military tactical network. ***FY 2011 Plans:*** - Demonstrate spectrum efficiency and utilization in experimentation and simulation. - Complete and integrate initial installation of Type 2 security architecture. - Complete simulations of mobile ad hoc wireless network performance in networks of 1,000 nodes. - Integrate Mobile Networked MIMO (MNM), Multi-User Detection (MUD) and Soldier Radio Waveform (SRW) within radio nodes. - Integrate smart antenna capabilities into radio nodes. - Integrate Wireless Distributed Computing (WDC), Content Based Access (CBA) and any required networking functions to support transformative application functionality. - Initiate transition to U.S. Army. - Explore ability of radio node to perform multi-purpose applications and alternative platform applications. ***FY 2012 Plans:*** - Identify functions, perform implementation, and integrate WDC and CBA into the WNaN system. - Integrate MUD and MIMO into the system so all waveform types are available for various communication conditions to improve network performance. - Perform experiments utilizing transformational applications within the WNaN node.			
Title: Communications Under Extreme RF Spectrum Conditions (CommEx)* ***Description:*** *Formerly Next Generation Communications The Communications Under Extreme RF Spectrum Conditions (CommEx) program will develop signal detection and reasoning technology that will allow radios to recognize jamming attacks and then adapt to maintain communications, even in the presence of cognitive jammer attacks and dynamic interference of multiple cognitive network interactions. The program will develop models of adversary, commercial, and friendly cognitive radios and implement those models in a "reasoner" that assesses, in real time, the current and future dynamics of the communications network. Core technologies for operation in highly dynamic and/or high jamming to signal environments will be developed to include: automated jamming waveform forensics; RF Environment	-	6.500	25.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
assessment (time, space, frequency, polarization); technologies for addressing known attack strategies and interference properties; and antenna, RF, signal processing, modulation, and network optimization technology. Based on predictions of the level of communication success compared to mission communication requirements, the "reasoner" within the cognitive radio will choose waveform selections/configurations that best achieve mission objectives. The "reasoner" will include the capability to analyze and select optimum waveform configurations during all aspects of a mission, to include initial alert, ingress, mission, and infiltration. The design effort will lead to new radio communication architectures, more robust radio communication networking, and better understanding of selection amongst interference avoidance and interference suppression strategies. This program also seeks to enable communication between dispersed and distributed emitters and receivers to provide a multiplier in capacity for both locating emitters and assessing effectiveness of an electronic attack. In addition to protecting communications from jamming, an analysis of methods to prevent geolocation of communication signals is also planned. The CommEx technology is planned for transition to the U.S. Army. ***FY 2011 Plans:*** - Develop and demonstrate algorithms to measure cognitive radio jammers and communication network behaviors that sufficiently characterize state space and behavior. - Establish baseline sensor performance requirements. - Develop efficient model structures of communication links, interference networks, essential metrics, and transforms. - Define what resources are available to handheld, vehicular, airborne, or shipboard communication platforms to determine what level of performance would be able to be achieved for each platform. - Develop efficient distributed algorithms and implement hardware prototypes for carrier frequency offset and frame synchronization. - Develop efficient algorithms for channel estimation, computation and distribution of network information; design the associated protocols. ***FY 2012 Plans:*** - Integrate live hardware into the detailed experiments to assure that dynamic range, realistic multipath and clutter, and implementation specific simulations are analyzed with sufficient rigor to assure performance in live hardware. - Perform experiments and simulations that model legacy waveforms and interference sources not previously seen by the system. - Develop hardware, firmware and software using CommEx technologies, and corresponding application programming interfaces and drivers in the radio to understand and control system performance. - Investigate counter geolocation techniques.			
Title: Cloud to the Edge	-	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2012 Defense Advanced Research Projects Agency		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Description: The goal of this program is to provide tactical warfighters operating at the edge with interactive, on-demand access to relevant information and a greater ability for real-time sharing of new operational content. This content can include images, video, maps, and database access along with tools for visualization of information, and reach back search capabilities. Ubiquitous access to relevant situational awareness and command and control information throughout the battle space is a key objective. Advances in key enabling technologies in Optical RF Communications Adjunct (ORCA), MAINGATE, and WNaN (all budgeted in this PE), and programs in PE 0602716E, Project ELT-01, are enabling high-capacity communications to the edge. However, the current centralized or regional storage and dissemination of information presents security, reliability, and capacity challenges in identifying and getting relevant information to users at the edge. Commercial industry has developed approaches to the autonomous dissemination of high demand information by using distributed servers and advanced networking and information database technologies, combined with highly-reliable fixed networking infrastructure with embedded complex information exploitation tools. This program will leverage commercial capabilities to develop and demonstrate the technologies and prototype systems in networking, servers, and information dissemination techniques to enable efficient, robust information dissemination using dynamic, mobile, ad hoc military networks. These technologies and system concepts will autonomously seek out relevant information and move it to where it is needed in a timely and assured manner. Capabilities from this effort will transition to the DoD. ***FY 2012 Plans:*** - Conduct studies and analyses for information flow patterns through the regional and localized networks. - Develop software architectures for distributed data dissemination and technologies for dynamic networks. - Begin development of key enabling technologies.			
Title: Mobile Hot Spots ***Description:*** Military users operating at the edge are facing huge challenges with regard to reporting a whole host of tactical activities to include voice reports, accurate and timely position location information (PLI), texting options for unique missions, and imagery and video requirements for high value targets and site exploitation. This large increase in responsibilities at the Battalion, Company, Platoon, Squad, Team, and Special Operations levels requires improved communications capabilities. All requirements grow exponentially due to the proliferation of high-data rate sensors (video, etc), UAVs, and the emergence of the Soldier/Marine as both an operator and a sensor. Thus, the development of tactical tools exploiting these data sources demands new ways of providing this level and sophistication of high bandwidth communications support. This data growth has created a 100-1000x mismatch of data needs and available network capacity. Mobile Hot Spots will provide an analog to the commercial wired solution to exploding high bandwidth requirements that relies on a hierarchical approach using core networks, regional/neighborhood distribution networks, and finally distributed access points. This program will develop the high data rate mobile communications technologies that are required to close the bandwidth gap and create high-capacity and secure wireless	-	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2012 Defense Advanced Research Projects Agency		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
technologies by exploiting advances in high-frequency and new security paradigms using RF, millimeter wave (MMW) and/or optical transmission. This work will leverage advances in critical system technologies in Optical, MMW, RF Combined Link Experiment (ORCLE), and SMART (both budgeted in this PE), and programs in PE 0602716E, Project ELT-01. This effort will also leverage commercial off the shelf short range, high speed communications access portals and scalable high data rate networking technologies. Trade-offs between scaling capacity, high data rate, communications overhead, system overhead (size, weight, and power), and mobility will be addressed. The Mobile Hot Spots program is targeted to transition to the Army, Marine Corps Expeditionary Forces. ***FY 2012 Plans:*** - Develop hardware and networking architectures for regional and local reliable, high capacity / high speed networks. - Develop possible physical layer, data layer, and network layer security solutions. - Initiate baseline technologies for short range, high data rate networks. - Explore hardware, software, and waveform options to include unmanned aerial systems, soldiers, and mobile platforms connected into network topologies. - Develop methods to support high density spectrum / high capacity activity in the communication networks. - Develop Hot Spot service interfaces to high demand applications subsystems. - Initiate security solution technology development.			
Title: Network Enabled by WDM-Highly Integrated Photonics (NEW-HIP) ***Description:*** The Network Enabled by WDM-Highly Integrated Photonics (NEW-HIP) program will facilitate building or upgrading military aircraft and other aerospace platforms with a wavelength division multiplexed (WDM) single-mode fiber-optic networking infrastructure. This will have many capabilities that are well beyond those of currently used copper- and multi-mode-fiber-based technologies. Originally, the program focused on specific technologies for application on the Navy's EA-6B Prowler aircraft; however, the program has been broadened to focus on technologies that will provide advanced capabilities to a multitude of military aircraft. The NEW-HIP technologies and associated architecture will provide: scalability in the bandwidth and the number of connected devices; immunity to electromagnetic interference (EMI) and cable cross-talk; reduced cable and overall system weight and volume; increased reliability without an associated weight or volume penalty; ease of integration and future upgradeability; and the ability to carry mixed analog and digital signal formats. This will be accomplished by taking full advantage of single-mode fiber-optic WDM technology and leveraging optoelectronic and photonic integration techniques developed in DARPA photonics components program. To reduce the size, weight, and power and to increase the reliability and the flexibility of interconnecting arbitrarily placed client devices with various signal formats, the NEW-HIP program will use passive, transparent, and wavelength-routing technology at the core of the network, and tunable optical transmitters and receivers (transceivers) to inter-connect the client devices at the edge of the network. The technologies developed under this program are planned for	6.100	3.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Defense Advanced Research Projects Agency		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
transition to the Services for eventual incorporation into military aircraft, including tactical aircraft, UAVs, wide-bodied aircraft and rotorcraft. ***FY 2010 Accomplishments:*** - Developed the final architectures of the avionics optical network that satisfies the requirements for networking digital signals and developed preliminary architectures for analog signals. - Developed the final performance specification for NEW-HIP circuits to satisfy the performance and environmental requirements of military aircraft. - Continued the development and prototyping of the digital optoelectronic components. - Began development of analog optoelectronic components. - Conducted performance analysis of the digital links using prototype network component performance data. - Began investigation of the application of NEW-HIP technology to military rotary aircraft. ***FY 2011 Plans:*** - Continue development of the key optoelectronic digital and analog networking components with respect to performance, size, weight, power and environmental requirements. - Conduct packaging and environmental testing of the key optoelectronic digital networking components.			
Title: Analog Logic ***Description:*** The Analog Logic program will develop and demonstrate architectures, designs, and development tools for implementing probability computational functions in analog circuitry to overcome performance limitations inherent in digital designs. This program will apply the technologies to signal processing functions typically performed in digital form, which experience design complexity, high power consumption, thermal loads, limits to computational speeds, loss in dynamic range, and susceptibility to manufacturing variances. The Analog Logic program will build and demonstrate an analog-only signal processing capability with no local oscillator, down conversion, or analog-to-digital conversion. The Analog Logic program will also develop the algorithm libraries and automated development tools needed for developing algorithms in a low-cost fashion similar to Very-High-Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL). The Analog Logic program has the potential to reduce complexity and power requirements for signal processing functions while improving performance relative to digital implementations in field programmable gate arrays (FPGA), digital signal processors (DSP), and general purpose processors (GPP). The result is a significant reduction in system cost, increase in battery life, and higher system reliability and performance for critical wireless military communications system components. As a consequence of this effort, there will be a great saving in cost, power, and volume to many modern military systems implementing wideband	6.486	7.650	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
signal spreading, spectrum utilization, multiple input multiple output channels and radar applications. This program is planned for transition to the Army. ***FY 2010 Accomplishments:*** - Completed design for 1024 Point fast fourier transform (FFT) engine with 8 bits equivalent dynamic range, and with 10 times reduction in gate count. - Demonstrated software implementation of FFT-based convolution engine with programmable coefficients. - Completed designs for linear and short-term memory devices cell designs. - Developed description programming language for both analog logic algorithms and constraint sets. - Completed design study of microprocessors based on analog logic archetypes. - Initiated fabrication of analog logic FFT engine with programmable weights using silicon complimentary metal-oxide-semiconductor (CMOS) technology. ***FY 2011 Plans:*** - Complete fabrication of analog logic 1024 Point FFT engine with 8 bits equivalent dynamic range, and with 10 times reduction in gate count. - Demonstrate automated circuit design synthesis from factor graph description. - Demonstrate direct RF processing for a sub-3 GHz receiver (decoded signal, with no (U) conventional local oscillator, down-conversion, or analog-to-digital conversion). - Demonstrate automated generation of the analog logic cells and synthesis of the constraint sets. - Demonstrate proof-of-concept analog logic processor. - Complete technology transition planning of the analog logic capability for DoD applications.			
Title: Mobile Networked Multiple-Input/Multiple-Output (MIMO) (MNM) ***Description:*** The Mobile Networked Multiple-Input/Multiple-Output (MIMO) (MNM) program will pursue MIMO communication systems, which have the potential to increase data rates by 10-20 times above current systems. MIMO will use multipath to create parallel channels in the same frequency band thereby increasing spectral efficiency. This effort will demonstrate the MNM capability under dynamic urban Non-Line-of-Sight multipath channel conditions where conventional techniques are degraded. This effort will undertake advanced MIMO technology development and perform field demonstrations of mobile ad hoc networks (MANETs). This effort will culminate in the development of a wideband form-factor system for use in tactical edge devices including troops, vehicles, and robotics. The MNM technology is planned for transition to the Army. ***FY 2010 Accomplishments:*** - Designed nodes to be employed in various devices, including robotics, mobile, and/or advantaged devices.	4.000	4.483	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Showed the ability to scale to a large number of network nodes while providing an order of magnitude improvement in reliability over related single-input/single-output systems. - Demonstrated a communication system where the network layer can mitigate shortfalls in the physical layer in a live multi-node demonstration. ***FY 2011 Plans:*** - Design, build, test, and demonstrate MIMO capabilities into a handheld/body wearable multi-channel radio that utilizes high volume, low cost commercial off the shelf RF circuits, narrowband tuning filters and dual-core digital signal processing baseband processing. - Perform a demonstration in an operational environment.			
Title: Mobile Ad Hoc Interoperability Networking GATEway (MAINGATE) ***Description:*** Building upon gateway technology developed under the WNaN and Future Combat Systems (FCS) Communications program, the Mobile Ad hoc Interoperability Networking GATEway (MAINGATE) program seeks to develop the next generation Network Centric Radio System (NCRS) with additional capabilities. MAINGATE will enable heterogeneous groups of radios to be integrated into a heterogeneous network tolerant to high latency and packet loss. The technologies developed for the program will permit affordable, tactical, real-time, high-fidelity video, data, and voice services for deployment in a networked environment, to support tactical operations in maneuvering or dismounted operations for line-of-sight (LOS) and beyond-line-of-sight (BLOS) communications, on the move (OTM) and at the halt (ATH). Two critical technologies for achieving these goals: 1) a backbone radio architecture that enables a versatile internet protocol Mobile Ad hoc Network (MANET) and 2) a radio gateway that enables legacy analog and digital communications systems to be interconnected through a network. The MAINGATE program will use an iterative build-test-build approach that will culminate with limited user testing by U.S. and Allied Experimental Forces evaluating the affect of MAINGATE on new tactics, techniques, and procedures designed for the networked maneuver and dismounted forces. The resulting MAINGATE system and capability is planned for transition to the U.S. Army. ***FY 2010 Accomplishments:*** - Developed and demonstrated Engineering Design Model 2 (EDM2) MAINGATE system units which include a gateway capability for interoperability between all targeted legacy networks and a wireless MANET capability, to create an adaptive internet protocol backbone network among gateways, and for connection to the Global Information Grid (GIG). - Continued integration of Dynamic Spectrum Access (DSA) and Disruption Tolerant Networking (DTN) technologies into the MAINGATE system.	10.000	7.000	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Provided the network backbone and radio interoperability for the U.S. Army Training and Doctrine Command (TRADOC), Advanced Expeditionary Warrior Experiment (AEWE), at the Spiral F large scale premier testing. ***FY 2011 Plans:*** - Enhance the MAINGATE system units by expanding RF spectrum coverage, and increasing aggregate data rate. - Conduct in-theater field evaluation of 40 units performing Intelligence, Surveillance and Reconnaissance / Command and Control (ISR/C2) networking radio interoperability.			
Title: Disruption Tolerant Networking (DTN) ***Description:*** The Disruption Tolerant Networking (DTN) program developed network protocols and interfaces to existing delivery mechanisms ("convergence layers") that provide high reliability information delivery using communications media that are not available at all times, such as low earth satellites, Unmanned Aerial Vehicle (UAV) over-flights, orbital mechanics, or links that experience fading or interference, etc. The program developed a single model for bundling information and ensuring its delivery, through a series of episodic communications links, from generator to user and explored a new security model which protects information held in portable devices. Protocols were implemented in the Software Interoperability Environment (SIE) situational awareness (SA) tool to verify both the performance of the protocol and to validate the utility. DTN technology is transitioning to the U.S Army and U.S. Marine Corps. ***FY 2010 Accomplishments:*** - Tested DTN on USMC operational networks. - Coordinated DTN transition opportunities with U.S. Army and U.S. Marine Corps.	1.000	-	-
Title: Retro-directive Ultra-Fast Acquisition Sensor (RUFAS) ***Description:*** The Retro-directive Ultra-Fast Acquisition Sensor (RUFAS) effort designed, constructed, and demonstrated an X-band noise correlating radar with a retro-directive antenna. This effort researched and developed a new type of radar sensor based on the correlations of the Gaussian noise received by an antenna array from a small object located in the far field of the antennas and the retro-directive reradiation of the correlated noise. Combining and tailoring noise correlating interferometry and retro-directive antenna arrays into a retro-directive noise-correlating (RNC) radar allows the radar to operate in omni-directional search mode. The result of this project is technology supporting a new type of search-mode radar having promising performance in terms of short acquisition time and low probability-of-intercept. ***FY 2010 Accomplishments:*** - Assessed design alternatives to improve performance.	1.265	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Researched feasibility of using RUFAS algorithms to detect Measurements and Signature Intelligence signatures to support Electronic Warfare (EW). - Completed technology maturation and development that will reduce risk for insertion into follow-on efforts.			
Title: Scalable Millimeter-wave (MMW) Architectures for Reconfigurable Transceivers (SMART) ***Description:*** The Scalable Millimeter-wave (MMW) Architectures for Reconfigurable Transceivers (SMART) program developed a new technology for producing very thin millimeterwave array apertures and transceivers. The technology development culminated in the demonstration of a large-sized coherent, active electronically steerable array (AESA) with an output power density of 5W per square cm and a total layer thickness of less than 1cm. The SMART technology approach resulted in a breakthrough in performance over conventional millimeterwave approaches. The 3-D multi-layer assembles developed will greatly reduce AESA packaging complexity and enable very compact, low-cost, millimeterwave, and radio frequency circuit "building blocks" to combine to form arbitrarily large arrays. New capabilities, such as the ability to construct reconfigurable and/or multi-band AESAs and other MMW circuits, will be enabled by this architectural approach. This program is transitioning through industrial producers of MMW radar systems for DoD applications. ***FY 2010 Accomplishments:*** - Completed initial testing of integrated components at high frequencies. - Initiated a large-size integrated transceiver array of 400 active elements with high output power, low losses, and low noise. - Initiated final demonstrations of transceiver technology.	10.540	-	-
Title: Networked Bionic Sensors for Threat Detection ***Description:*** The Networked Bionic Sensors for Threat Detection program developed and demonstrated low power micro-sensor devices and networks for multiple missions including, language/speech detection and recognition processing, and shooter localization. The system used ultra-low power signal conditioning/processing front-end processors with advanced algorithms for distributed sensor network applications. This program provided the ability to discretely monitor buildings, human presence detection/tracking in other sensitive areas, enable force protection, and provide battle damage information. Intelligence, surveillance, and reconnaissance (ISR) capabilities will be enhanced with this technology by allowing detection and tracking of high-value targets with hand emplaced or air deployed sensor networks. The technology developed is transitioning to the U.S. Marine Corps. ***FY 2010 Accomplishments:*** - Evaluated bionic sensor technology in a field experiment conducted at the National Training Center at Fort Irwin.	2.000	-	-
Accomplishments/Planned Programs Subtotals	104.874	68.876	88.519

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C. Other Program Funding Summary ($ in Millions)

N/A

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 2012 Defense Advanced Research Projects Agency			DATE: February 2011
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COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
CCC-04: *SECURE INFORMATION AND NETWORK SYSTEMS*	-	-	15.000	-	15.000	23.000	40.000	40.000	45.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

Computer, networking, and communication technologies have rapidly matured in the last decade and have had a profound effect on DoD weapons systems. In many instances the combination of those technologies has become either the integral piece of many of the emerging traditional land, air, and sea based weapon platforms or have become a stand alone, non-platform based virtual weapon system. In recognition of this fact, the Secure Information and Network Systems project will develop and test emerging computer, communications, and network systems where the impact of the systems and the vulnerabilities of the systems are not kinetically based. The project will identify, further develop and integrate, and test prototypes of promising network security technologies generated in projects such as, but not limited to, those developed in DARPA's Information & Communications program element (PE 0602303E), Cognitive Computing Systems program element (PE 0602304E), and Machine Intelligence program element (PE 0602305E).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Cyber Insider Threat (CINDER)* ***Description:*** *Previously funded in PE 0602303E, Project IT-03 The Cyber Insider Threat (CINDER) program will develop techniques for countering one of the most significant and malicious threats to military networks and systems: the cyber insider threat. Current defenses are based on network and host intrusion detection, and look for "break-ins" and abnormal behavior but do not attempt to characterize a user's mission. The CINDER program will build tools and techniques that characterize user mission in a multi-level security environment. ***FY 2012 Plans:*** - Identify constraints for each class/mission and develop constraint detection concepts. - Quantify probability of detection and probability of false alarms as a function of adversary class and mission for each system. - Design and build scalable prototype systems.	-	-	12.000
Title: Secure Information and Network Systems Experimentation (SINSE) ***Description:*** Protecting the integrity of DoD networks and systems is vitally important, given the constant barrage of attempted intrusions. The Secure Information and Network Systems Experimentation (SINSE) program will leverage promising technologies generated in Project IT-03 (PE 0602303E), Project CCC-02 (PE 0603760E) and other network-based weapons technology projects to build an agile and robust defense for DoD networks and systems. Rapidly changing approaches to malicious attacks on DoD networks cannot be neutralized with one approach. Integrating, testing, and expanding approaches developed across	-	-	3.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
many initiatives gives SINSE a diverse knowledge base to further explore techniques and strategies. Viable technologies will be assessed, tested, and quickly transitioned to DoD networks. SINSE offers the opportunity to integrate multiple technologies to augment and reinforce existing network and system defenses. ***FY 2012 Plans:*** - Identify promising technologies for further study, experimentation, prototyping, and development. - Conduct experiments using DoD network assets to validate technology defense capabilities.			
Accomplishments/Planned Programs Subtotals	-	-	15.000

C. Other Program Funding Summary ($ in Millions)

N/A

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 2012 Defense Advanced Research Projects Agency			DATE: February 2011
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COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
CCC-CLS: *CLASSIFIED*	79.368	81.623	116.218	-	116.218	105.627	105.621	114.882	114.823	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds classified DARPA programs that are reported in accordance with Title 10, United States Code, Section 119(a)(1) in the Special Access Program Annual Report to Congress.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Classified DARPA Program	79.368	81.623	116.218
Description: This project funds Classified DARPA Programs. Details of this submission are classified. ***FY 2010 Accomplishments:*** Details will be provided under separate cover. ***FY 2011 Plans:*** Details will be provided under separate cover. ***FY 2012 Plans:*** Details will be provided under separate cover.			
Accomplishments/Planned Programs Subtotals	79.368	81.623	116.218

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Details will be provided under separate cover.