Exhibit R-2, PB 2010 Defense Advanced Research Projects Agency RDT&E Budget Item Justification									DATE: May 2009	
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 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	242.540	328.073	293.476						Continuing	Continuing
CCC-01: COMMAND & CONTROL INFORMATION SYSTEMS	64.899	41.887	61.630						Continuing	Continuing
CCC-02: INFORMATION INTEGRATION SYSTEMS	95.411	139.966	91.301						Continuing	Continuing
CCC-CLS: CLASSIFIED	82.230	146.220	140.545						Continuing	Continuing

A. Mission Description and Budget Item Justification

(U) 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.

(U) 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.

(U) 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.

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B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	255.235	338.964	283.277	
Current BES/President's Budget	242.540	328.073	293.476	
Total Adjustments	-12.695	-10.891	10.199	
Congressional Program Reductions	0.000	-10.891		
Congressional Rescissions	0.000	0.000		
Total Congressional Increases	0.000	0.000		
Total Reprogrammings	-5.707	0.000		
SBIR/STTR Transfer	-6.988	0.000		
TotalOtherAdjustments			10.199	

Change Summary Explanation

FY 2008
Decrease reflects the AFRICOM reprogramming and the SBIR/STTR transfer.

FY 2009
Decrease reflects the reductions for Section 8101 Economic Assumptions and execution delays.

FY 2010
Increase reflects additional funds in the Classified Project; offset by completion of situational awareness and communications efforts in Projects CCC-01 and CCC-02.

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COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
CCC-01: COMMAND & CONTROL INFORMATION SYSTEMS	64.899	41.887	61.630						Continuing	Continuing

A. Mission Description and Budget Item Justification

(U) Military operations since the end of the Cold War illustrate 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 conflict and 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. The programs provide the commander 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 Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Heterogeneous Airborne Reconnaissance Team (HART)*	5.000	4.000	7.901	
*Formerly Heterogeneous Urban Reconnaissance Team (HURT).				
(U) 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/				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**

platform assignments 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 2008 Accomplishments:
- Expanded capability to include taskable (gimbaled) sensors on manned aircraft.
- Added infrared sensor and georegistration capabilities that were demonstrated during live flight testing at Ft. Hunter Liggett.
- Developed, tested and deployed new georegistration algorithms for a specific large format mapping electro-optical sensor that has improved resolution for wide area missions, and reduced processing timelines while simultaneously doubling area coverage.
- Integrated with the Army's Tactical Airspace Integration System (TAIS) and Collection Management Tool (CMT) to assist with airspace integration, automatically identify seams, and fill gaps in sensor coverage.

FY 2009 Plans:
- Support user training operations at Ft. Bliss/Ft. Hood.
- Train and field test with the Army Evaluation Task Force (AETF) to identify other capabilities ready for rapid transition.
- Extend operational area via unmanned aerial vehicle (UAV) communications relay with a 99% assured tactical downlink.
- Add moving target indicator (MTI) for target tracking.
- Provide dynamic overwatch to mobile warfighters by adapting flight paths, sensor and communications footprints, and by planning for UAV handoffs.
- Demonstrate cooperative planning and handoff between multiple HART control centers.
- Demonstrate HART interoperability with service airspace management and imagery dissemination systems.
- Expand HART capability to Warrior and additional rotorcraft (FireScout and micro air vehicle (MAV)).

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2010 Plans: - Test and demonstrate cooperative interaction with TAIS to achieve permissive airspace management for manned and unmanned platforms and indirect fires. - Support operational evaluation and certification of capabilities and limitations. - Collaborate with Future Combat Systems (FCS)/Command and Control of Robotic Entities (C2ORE)/ Future Force Integration Directorate (FFID) to integrate and transition full capabilities into the U.S. Army. - Ruggedize and miniaturize hardware suite. - Ensure scalability appropriate to anticipated areas of employment. - Support operational transition of technology in Program Execution Office Aviation Programs of Record.				
Deep Green* *Previously this was part of Advanced Tactical Battle Manager. (U) Deep Green is a next-generation battle command and decision support technology that interleaves anticipatory planning with adaptive execution to help the commander think ahead, identify when a plan is going awry, and prepare options 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 will save lives and reduce costs. Deep Green will automatically induce a plan and commander's intent from the commander's hand-drawn sketches with accompanying speech 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.	14.785	16.887	19.282	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2008 Accomplishments: - Developed initial Deep Green subsystems/components including Crystal Ball, which assembles a diverse set of candidate plans and provides an integrated probabilistic overlay for all. - Developed initial Commander's Associate, which induces the commander's intended plan from multi-modal man-machine dialog. - Developed initial SimPath, a fast multi-resolution combat model that enables high quality playoffs across the portfolio of planning options. *FY 2009 Plans:* - Extend technologies to monitor an ongoing operation and update the likelihoods that the possible futures being generated by Deep Green will actually occur. - Integrate major components to produce an initial prototype Deep Green system that enables proactive (vice reactive) battle management. - Extend the Deep Green system to support both mid-intensity conflict and counter-insurgency operations. - Extend the Deep Green system to support additional battlefield functional areas, such as air defense, intelligence, and military engineering. *FY 2010 Plans:* - Extend Deep Green to support multi-echelon operations, including Deep Green systems at brigade and battalion levels coordinating among themselves. - Demonstrate functional battle command technology in force-on-force exercises against a live, intelligent enemy. - Begin the process of transitioning Deep Green technologies to fielded battle command systems.				
Urban Leader Tactical Response, Awareness and Visualization (ULTRA-Vis)* *Previously this was part of Urban Commander. (U) The Urban Leader Tactical Response, Awareness and Visualization (ULTRA-Vis) program will develop an integrated soldier-worn situational awareness system that allows the small unit leader to generate	5.033	9.000	13.750	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
iconic representations of hand/arm signals and transmit the iconic commands to a networked squad. 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 hand-off actionable information and direct alerts to the squad/fire teams for real-time collaboration without overload. ULTRA-Vis will develop the key technologies that allow small unit leaders and members to selectively transmit critical combat information in the form of icons using existing, low-bandwidth soldier voice and data radios to covertly relay standard phrases and visual annotations. 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 at the completion of the program in FY 2012. *FY 2008 Accomplishments:* - Initiated system engineering studies and design of ULTRA-Vis subsystems and interfaces. *FY 2009 Plans:* - Develop see-thru display conformal visor using holographic waveguide. - Develop optically-assisted navigation for continuous geo-location and pose estimation. - Develop interface to actuate non-verbal commands and post icons onto a shared urban landscape. *FY 2010 Plans:* - Develop the capability to recognize standard hand and arm signals as used by small unit leaders in close range combat operations. - Develop 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. - Develop a non-occluding, head-mounted see-through visor for viewing iconic overlay on the battlespace.				
Collision Avoidance & Dynamic Airspace Control (CADAC)	4.000	0.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
(U) The goal of the Collision Avoidance and Dynamic Airspace Control (CADAC) program is to maximize airspace utilization through dynamic military airspace management. Today's labor-intensive human centric airspace management processes result in an inefficient use of airspace, limit the density and responsiveness of airborne systems, and have a large forward footprint. Further, the introduction of unmanned aircraft has increasingly complicated the challenge, leading to operating constraints and a realized growing potential for mishaps related to the different characteristics of manned and unmanned systems. This program will evaluate and develop technologies for automated and distributed systems that efficiently manage all objects in the airspace to include munitions, manned and unmanned aircraft. Specifically focused on the needs of the military, the program will deliver provable levels of safety while ensuring military freedom of maneuver. The automated system will be developed as a replacement for current management systems and processes, and may also be employed locally to augment existing systems in complex mixed civil / military environments. It will seek to enable highly automated integration of multi-source information and control to support tightly coupled air/ground/surface operations centered on small-unit unconventional forces. Challenges to be addressed include trusted algorithms, networked information exchange with uncertainty, and integration of legacy, degraded and intentionally disruptive aircraft. The program will also explore novel concepts of operation enabled by radically enhanced airspace utilization. The capabilities developed by this program will benefit all of the Services. *FY 2008 Accomplishments:* - Conducted multiple technology and feasibility analyses. - Developed and simulated candidate system architecture models. - Demonstrated the small Unmanned Aircraft System (UAS) cooperative CADAC component concept.					
Advanced Tactical Battle Manager (U) The Advanced Tactical Battle Manager program develops automated decision support tools for Army and Marine Corps tactical commanders at the division level and below. The program also provides support for combined operations employing dismounted soldiers, manned platforms, and autonomous vehicles through a graphical interface with unit commanders and extends plans by applying adversarial reasoning techniques to identify vulnerabilities and opportunities in the predicted enemy course of action.		2.000	3.000	6.500	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Finally, it examines modifications or counteractions to reduce vulnerabilities. Products will transition to the Services. (U) The Know What Is to Know Subsystem (KWIKS) develops a support tool that autonomously and continuously, during the execution of a military operation, tracks the state of what is known about the environment, and the forms and priorities of additional collection needs. This tool will provide automated assistance to the process of collections planning, which currently includes manual steps such as analysis of external context, enemy and neutral goals and capabilities, and assessment of known threats. It will support real-time planning of intelligence, surveillance and reconnaissance (ISR) assets, leveraging outputs of automated exploitation capabilities. The overall benefit is more effective, rapid, complete identification of the enemy's state and responsive planning of limited collection assets, resulting in achieving mission objectives with fewer friendly casualties and lower collateral damage. (U) The Cognitive Design and Management for Agile C2 (CODe-MAC2) will develop integrated, in-theater tools for organizational design, cognitive resource configuration, and adaptive management of complex, often unconventional command and control (C2) structures. These tools will enable the U.S. military in real time to modify the responsibilities, relations, tasks, priorities, and information sharing to meet rapidly changing needs of the command across multiple units, echelons, and organizations, while shaping the choices of countries at strategic crossroads. U.S. forces increasingly encounter complex C2 structures that include Coalition forces (manned and unmanned), civilian agency resources, indigenous formal and informal powers, and non-governmental organizations. In response to the resulting challenges, the DoD has identified C2 as one of the areas where new, unconventional structures are needed to meet the new realities of today's operations and missions, and the U.S. Army Training and Doctrine Command has identified a critical gap in the technologies for agile configuration and analysis of C2 structures. *FY 2008 Accomplishments:* KWIKS - Identified emerging computational techniques for analysis of information state under conditions of adversarial concealment and deception and partial observability.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Identified a series of realistic wargame-based experiments to enhance and validate the capabilities of the system. *FY 2009 Plans:* KWIKS - Identify integration environment and develop system capabilities to match transition needs. - Explore initial algorithmic approaches to translating commander's information needs to tangible targeting decks. *FY 2010 Plans:* KWIKS - Develop and evaluate via simulation KWIKS system solutions. - Conduct laboratory tests and obtain user feedback. CODe-MAC2 - Provide predictive and diagnostic estimation of C2 performance for alternative resource, relation, task, and information structures.				
Increased Command and Control Effectiveness (ICE) (U) The Increased Command and Control Effectiveness (ICE) program develops and integrates 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. This capability enables commanders to more rapidly adapt to evolving situations and priorities, and accelerates the incorporation of new personnel into command operations. This program funds portions of the technologies developed in the Personalized Assistant that Learns (PAL) program (funded in PE 0602304E, Project COG-02) that are ready for application to command and control and situational awareness systems.	5.000	7.000	14.197	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
(U) Efforts to integrate PAL technology into a number of operational systems are underway. The very positive initial results obtained with these important command and control systems suggest that nearly all command and control systems can benefit from an infusion of cognitive technology if the software integration effort itself is made simple. A PAL software framework will provide a basic PAL application that can be customized by an application developer in a relatively straightforward fashion. *FY 2008 Accomplishments:* - Developed initial prototypes of cognitively-enhanced versions of operational systems suitable (e.g., certifiable) for use on military networks. - Created an initial PAL Learning Services Framework – a library of basic learning algorithms, structured learning ensembles, and ready-to-go learning applications – that can be used by 3rd party application developers to insert PAL learning technology into existing or developing software applications. *FY 2009 Plans:* - Develop and refine advanced operational prototypes of cognitively-enhanced versions of operational systems that would provide users with advanced information and task-management capabilities such as learning to anticipate users' information needs, pre-fetching needed information, learning users' interests, alerting users about the occurrence of events of interest, managing message traffic, and learning routine procedures and when to execute them. - Demonstrate, test, and evaluate PAL-enhanced information systems in military exercises to validate that the PAL technologies are robust to the dynamics and uncertainties of the battlefield and dramatically compensate for end-user "cognitive overload". - Harden and release the PAL Learning Services Framework. *FY 2010 Plans:* - Extend PAL analyst support capabilities based on test and evaluation in exercises along with end-user feedback. - Integrate PAL-based prototypes with operational C2I information systems and data sources at end user facilities as integral subsystems. Deploy a hardened capability for evaluation in an Army military readiness exercise.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Evolve and improve the PAL Learning Services Framework based on developer feedback.					
Predictive Analysis for Naval Deployment Activities (PANDA) (U) Predictive Analysis for Naval Deployment Activities (PANDA) developed technologies to automatically learn normal activity models of motion and emission for maritime surface vessels, automatically detect anomalous behavior, provide context modeling to resolve known categories of anomalies (e.g., due to weather and business rule changes), and alert processing. The resulting technologies can be extended and applied to a wide range of applications including ground vehicles, troop movements, and individual targets of interest as the methods of tracking those targets improves. *FY 2008 Accomplishments:* - Demonstrated that individual and class-of-vessel motion-based activity patterns can be learned automatically from long-duration tracks. - Used learned patterns to predict future behavior and detect deviations from normal behavior. - Automatically processed deviation reports against a case base of known business behavior and prior deviations to filter out those that occur for good business reasons and alert on those that may pose a threat. - Demonstrated ability to drill down into historical patterns and supporting context information to support analysis of vessel behavior. - Installed initial system capability at operating naval site. - Participated in Trident Warrior 2008 at sea exercise.		11.050	0.000	0.000	
Joint Air/Ground Operations: Unified, Adaptive Replanning (JAGUAR) (U) The Joint Air/Ground Operations: Unified, Adaptive Replanning (JAGUAR) program improves battle management for complex air campaigns that employ new air platforms featuring precision sensors, weapons and communications relays. The JAGUAR system is driven by: 1) targeting information, both for sensor targets and strikes, expressed as point and area targets (i.e., search, combat air patrol); 2) rules of engagement and procedural constraints, such as airspace restrictions; and 3) availability of platforms, weapons, sensors, and communications equipment. From this information, JAGUAR produces ingress routes, flight schedules and patrol zones, while assuring airspace and electronic deconfliction. There is a		8.531	1.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Memorandum of Understanding in place with the U.S. Air Force and technology demonstration is planned to occur in late FY 2009. *FY 2008 Accomplishments:* - Developed a large-scale integration algorithm to assemble plan fragments into a synchronized operational plan. - Built optimization tools to tailor routes, schedule events, and deconflict airspace. - Tested software at the Air Force Distributed Mission Operations Center. - Modified software so it adheres to the Air Force Service-Oriented-Architecture. - Created algorithms that enable distributed JAGUAR clients to inject plans and plan changes. *FY 2009 Plans:* - Interface JAGUAR with existing Air Force databases and information systems.				
Urban Commander (U) The Urban Commander program develops automated tools to help ground commanders construct detailed, realistic operational plans, particularly in nontraditional and urban environments. Partial plans are represented in hierarchical task networks and visualized through synchronization matrices, icon overlays, or tactical sketch animations. Commanders and staff modify, refine, and extend a plan through voice, sketching, and semi-structured input. The system links fragments constructed at different sites, transfers information among related parts, and discovers and recommends solutions for inconsistencies. The system continuously compiles a set of plan cases and employs analogical matching to propose extensions to current plans suggested by past experience. Plan elements are communicated through an integrated set of protocols from the unit commander down to dismount commanders equipped with advanced displays and sensors. Finally, the program continuously assesses progress against the operational plan and alerts users to significant deviations. (U) The Multi-spectral Adaptive Networked Tactical Imaging System (MANTIS) effort develops, integrates, and demonstrates an advanced night vision visualization system. Prototype systems are being built. The system consists of a multispectral sensor suite with a high-resolution display and a high performance	4.500	1.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
vision processor, along with a power supply and radio. The prototypes will provide the soldier with digitally fused, multispectral video imagery in real-time from the Visible/Near Infrared (VNIR), the Short Wave Infrared (SWIR) and the Long Wave Infrared (LWIR) sensors via the high-resolution display. The processor adaptively fuses the digital imagery from the multispectral sensors providing the highest context, best nighttime imagery in real-time under varying battlefield conditions. There is a Memorandum of Agreement in place with the Program Executive Office-Soldier and Night Vision and Electronics Sensor Directorate for transition at the conclusion of Phase III in the first quarter of FY 2010. *FY 2008 Accomplishments:* - Assembled and tested prototype sensor subsystems. - Fabricated the MANTIS high-speed vision processor. *FY 2009 Plans:* - Complete test and integration of the MANTIS vision processor. - Fabricate and test prototypes. - Transition MANTIS prototypes to the U.S. Army (PEO Soldier).				
Predictive Battlespace Awareness (U) The Predictive Battlespace Awareness program developed tools to interactively draw upon a distributed network of human experts, allowing them to collaboratively anticipate an opponent's future actions. The program has enabled commanders to pre-position sensors, weapons, and information to counter the opponent's actions. The program developed model and knowledge-based techniques to predict areas of operation and tactical objectives. The technology supports the modeling of courses of action ranging over time horizons from hours to days. Program techniques permit "on-the-fly" tailoring of models and contextual knowledge, and leverage knowledge of sensor effectiveness, mobility factors, tactical templates, and target characteristics. The tools anticipate enemy operations in time to thwart them with effects-based targeting, enabling use of sensors and other resources in proactive modes. The program has significantly enhanced today's mostly manual, slow planning, and analysis processes.	3.000	0.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2008 Accomplishments: - Downselected algorithms for match-making, negotiation, monitoring and assimilation. - Defined system architecture. - Integrated selected technologies and conduct collaboration demonstrations.				
Tactical Group Decision Analysis Support System (U) The Tactical Group Decision Analysis Support System program developed distributed group decision analysis and network management tools. These tools increase the tempo of the tactical commander's observe-orient-decide-act loop, the quality of decisions, the contribution of data point input across the organization, and the necessary communications capabilities needed to support this decision structure. The tools apply to crisis management situations for tactical commanders and could be transitioned to existing emergency response command and control systems as well as emerging tactical command and control systems. The technologies developed under this program are transitioning to the U.S. Army. *FY 2008 Accomplishments:* - Performed scaling and laboratory-based experimentation.	2.000	0.000	0.000	

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.

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COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
CCC-02: INFORMATION INTEGRATION SYSTEMS	95.411	139.966	91.301						Continuing	Continuing

A. Mission Description and Budget Item Justification

(U) 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. Through the use of wideband dissemination and integrated sensor management, the project will also facilitate multi-site, real-time, collaborative situation assessment and course-of-action evaluations to enable true network centric warfare concepts.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Optical & RF Combined Link Experiment (ORCLE)	33.479	53.067	31.496	

(U) 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 Gateway Network system for tactical reach-back applications called the 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 Special Operations Forces and the Air Force.

FY 2008 Accomplishments:

- Planned range and flight demonstrations of air-to-air-to-ground hybrid FSO/RF links with high availability and gigabit data flows.
- Designed and engineered a prototype hybrid FSO/RF high-capacity network system.

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Investigated the optical channel obscuration mitigation using ultra-short pulse lasers and partially coherent beams. - Began activities for airborne and ground experiments that will operate in direct interface to the Global Information Grid (GIG) and the tactical network gateway. *FY 2009 Plans:* - Construct and field test a brassboard system incorporating the FSO/RF components and dynamic network communication and interface system. - Perform range and flight demonstrations of hybrid FSO/RF links in operational representative environment. - Integrate and test the ORCLE terminals to verify performance and readiness for field experiments and demonstrations. - Develop, design, and build hardware and software of a prototype system for integration into military air and ground platforms. - Coordinate field demonstrations of ORCA networking that supports multiple airborne platforms, a ground node with direct interface to the GIG, and a ground node with an interface to a tactical gateway supporting Internet Protocol (IP)-addressable nodes. *FY 2010 Plans:* - Demonstrate high availability and gigabit data flow network performance with air-to-air-to-ground using multiple FSO/RF nodes in military aircraft and locations. - Demonstrate network instantiation and user interfaces to command and control at multiple levels. - Commence transition of the technology to military utility.				
Disruption Tolerant Networking (DTN) (U) The Disruption Tolerant Networking (DTN) program is developing 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, etc. The program is developing a single model for bundling information and ensuring its delivery, through a series of episodic communications links, from generator	7.205	7.625	1.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
to user. Mechanisms and protocols that reduce bandwidth consumption, reduce latency, and improve reliability of information delivered to tactical deployments will be explored. The program is also exploring a new security model which protects information held in portable devices. To maximize the applicability and commercial viability of these protocols, and develop the basic software in an open source mode, the military, commercial and Internet communities have been engaged. These protocols will be implemented in a typical military system to verify both the performance of the protocol and to validate the utility. The DTN technology is planned for transition to the Army and Marines. *FY 2008 Accomplishments:* - Demonstrated proof of concept of the distributed in-network caching and indexing services in DTN system. - Demonstrated proof of concept of the information binding on demand from a network cache in DTN system. - Demonstrated policy cognitive operation choosing best delivery options. - Integrated DTN into U.S. Marine Corps (USMC) Control On-the-Move Network Digital Over-the-Horizon Relay (USMC CONDOR) systems. *FY 2009 Plans:* - Integrate DTN into USMC military tactics, techniques, and procedures. - Deploy prototype DTN system tactical networks. *FY 2010 Plans:* - Transition DTN to USMC.				
Retro-directive Ultra-Fast Acquisition Sensor (RUFAS) (U) The Retro-directive Ultra-Fast Acquisition Sensor (RUFAS) effort will design, construct, and demonstrate an X-band noise correlating radar with a retro-directive antenna. This effort will research and develop 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 re-radiation of the correlated noise. Combining and tailoring noise correlating interferometry and retro-	1.530	2.787	1.265	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
directive antenna arrays into retro-directive noise-correlating (RNC) radar will allow the radar to operate in omni-directional search mode. The result of this project will be a new type of search-mode radar having promising performance in terms of short acquisition time and low probability-of-intercept. The RUFAS technology is planned for transition to the Army and Marines. *FY 2008 Accomplishments:* - Developed and implemented Doppler filters and tracking algorithms. - Demonstrated 3-dimensional tracking (range, azimuth, and elevation) of small caliber bullets, and Rocket Propelled Grenades (RPGs), and mortars during range live-fire experiments. - Designed and demonstrated ultra-fast radar using retro-directive antenna arrays that show a significant reduction in probability-of-intercept compared to traditional search radars based on coherent transmitters. - Initiated production manufacturability study. *FY 2009 Plans:* - Conduct cost trade study and determine system design limitations to finalize RUFAS design capabilities. - Initiate limited full-scale prototype production to support U.S. Army and U.S. Marine Corps (USMC) platform integration requirement and field evaluations. *FY 2010 Plans:* - Develop and conduct field experiments in support of USMC initial end-user field evaluations. - Complete transition to Army and/or Marines.				
Network Enabled by WDM-Highly Integrated Photonics (NEW-HIP)*	2.500	5.845	5.100	
*Formerly Fiber-Optical Network for Aerospace Platforms. (U) 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				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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, such as the Joint Strike Fighter (JSF). 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 transition to the Services. *FY 2008 Accomplishments:* - Developed the target performance specification for NEW-HIP circuits to satisfy the generalized avionic networking requirements. - Conducted a successful proof-of-concept demonstration of high fidelity wideband analog signal transmission for the AN/ALQ-217 Electronic Support Measures (ESM) system using a WDM optical link in place of expensive precisely tuned coaxial copper cables. *FY 2009 Plans:* - Develop the architecture of the avionics optical network that satisfies the aforementioned requirements. - Develop the target performance specification for NEW-HIP circuits to satisfy the environmental requirements of the Joint Strike Fighter (JSF) program. - Design and prototype the following key optoelectronic components: tunable digital and analog transmitters, tunable digital and analog receivers, multi-channel digital and analog receivers and passive wavelength broadcasting and routing components with focus on digital performance metrics.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
FY 2010 Plans: - Complete the development and prototyping of the key optoelectronic components, adding analog signal capabilities. - Conduct end-to-end performance testing of the digital and analog networking systems.					
Military Networking Protocol (MNP)* *Formerly Next Generation Routing and Addressing. (U) The Military Networking Protocol (MNP) program seeks to develop networks with full military organizational unit attribution. Current network routing methodologies use internet protocol (IP) address numbers that are distributed in no defined pattern or methodology. As a result, current routing systems spend large amounts of time and computing power updating and maintaining tables that "point" to where different IP addresses are located geographically. The MNP program will resolve this issue with network addressing schemes that will reduce the load on routers as well as greatly simplify router configuration. By clearly identifying network traffic, MNP allows the network infrastructure to provide prioritization levels, reallocate bandwidth between different users or different military units, and automatically make quality of service decisions. MNP traffic will be compatible with existing Internet infrastructure and may allow or deny entry or transit of unauthenticated data and transmit data as fast as (or faster than) existing network protocols. Hardware developed in this program will be self-configuring and will greatly reduce the need for trained network personnel and overall network's maintenance cost. This program is planned for transition to the Services. *FY 2008 Accomplishments:* - Investigated transition opportunities for new network addressing schemes and completed trade study on the impacts on state of the art technology. - Completed military utility analysis to establish program stretch goals. *FY 2009 Plans:* - Develop machine naming schema for data packets that are geographically based and that allow for fine grained control of precedence and improved quality of service capabilities.		1.250	4.550	2.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Develop tactical router replacements that work with existing computers/routers and require no new configuration and enable self-forming networks that will result in at least an order-of-magnitude reduction in training, configuration, and installation time. *FY 2010 Plans:* - Develop changes to Domain Naming Server (DNS) functions to accommodate the forwarding of services to mobile users. - Conduct demonstrations in operationally relevant environments.				
Scalable MMW Architectures for Reconfigurable Transceivers (SMART) (U) The Scalable Millimeter-wave (MMW) Architectures for Reconfigurable Transceivers (SMART) program is developing a new technology for producing very thin millimeterwave array apertures and transceivers. The technology development will culminate 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 will result in a breakthrough in performance over conventional millimeterwave approaches. The 3-dimensional (3-D) multi-layer assembles that are being developed will greatly reduce AESA packaging complexity and will 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 will transition through industrial producers of MMW radar systems for DoD applications. (U) The Analog Logic program will develop and demonstrate architectures, designs, and development tools for implementing 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	8.200	10.540	14.026	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
the algorithm libraries and an automated development tools needed for developing algorithms in a low-cost fashion similar to Very-High-Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL). (U) 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. Furthermore, the technology will enable computational scaling to extend beyond anticipated limitations described by Moore's Law (the number of transitions on integrated circuits has doubled every year since the integrated circuit was invented). As a result of this effort, there will be a great saving in cost, power, and volume to many modern military systems implementing wideband signal spreading, spectrum utilization, multiple input multiple output channels and radar applications. This program is planned for transition to the Army. *FY 2008 Accomplishments:* Scalable Millimeter-wave Architectures for Reconfigurable Transceivers (SMART) - Achieved an integrated, sixteen element (4x4) transmit (only) millimeter-wave AESA with output power greater than 5W/cm^2 and thickness less than 10mm. - Demonstrated in an anechoic chamber the ability to direct the beam. - Initiated development of prototype receiver components. Analog Logic - Developed analog logic designs and prototypes of signal processing components. - Established analog logic hardware description library (HDL) of basic arithmetic operators. *FY 2009 Plans:* Scalable Millimeter-wave Architectures for Reconfigurable Transceivers (SMART) - Incorporate receive capability into the AESA while maintaining the thin dimension. - Demonstrate high isolation between transmit and receive functions. - Conduct evaluations and demonstrations of prototype components.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiate development of design automation algorithms and tools. Analog Logic - Demonstrate initial analog logic signal processing prototypes. - Develop integrated analog logic circuitry for insertion into prototype radio receiver. - Design concepts and tools for integrated design flow of analog logic circuitry. *FY 2010 Plans:* Scalable Millimeter-wave Architectures for Reconfigurable Transceivers (SMART) - Complete initial testing of integrated components at high frequencies. - Demonstration of a large-size integrated transceiver array of 400 active elements with high output power, low losses, and low noise. Analog Logic - Demonstrate end-to-end capability of a receiver prototype using integrated analog logic components. - Develop and demonstrate an initial capability for automated design and synthesis of analog logic circuitry using the HDL. - Produce designs for ultra high-speed analog logic components. - Establish technology transition planning for use of the analog logic capability for DoD applications.				
Wireless Network after Next (WNaN) (U) The Wireless Network after Next (WNaN) program goal is to develop and demonstrate technologies and system concepts enabling densely deployed networks in which distributed and adaptive network operations compensate for limitations of the physical layer of the low-cost wireless nodes that comprise these networks. WNaN networks will manage node configurations and the topology of the network to reduce the demands on the physical and link layers of the nodes. The technology created by the WNaN network effort will provide reliable and highly available battlefield communications at low system cost. (U) The WNaN 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	15.739	22.958	24.414	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
develop robust networking architecture(s) and network technologies/processes that will exploit high-density node configurations. This program will culminate in a large-scale network demonstration using the multi-channel nodes. The results of the initial WNaN technology are planned for transition to the Army. *FY 2008 Accomplishments:* - Designed and built a handheld multi-channel WNaN radio that utilizes high volume, low cost Commercial off-the-shelf (COTS) radio frequency integrated circuits (RFIC), narrowband tuning filters and dual-core Digital Signal Processor (DSP) baseband processing. - Developed, integrated, and tested low risk and enhanced network technologies that exploited diverse paths and frequencies to support the network formation. - Produced prototype WNaN radios and integrated the low risk network technology for initial test and experimentation. *FY 2009 Plans:* - Conduct demonstration of ten prototype WNaN radios with low risk networking technology to include Combat Net Radio through packetized voice, simple IP services through Ethernet connection, and Position Location Information (PLI). - Conduct demonstration of forty prototype WNaN radios with first enhanced networking technology to include Disruption Tolerant Networking (DTN) and spectrum policy reasoning. - Develop, integrate, and test of the second enhanced network technologies that exploit diverse paths and frequencies to support network scalability and network formation of tens of thousands of operational nodes. - Demonstrate a communication system where the network layers can mitigate shortfalls in the radio physical layer. - Develop 100 advanced prototype WNaN radios that matches production form factor. - Develop gateway capabilities for interoperability between networks. - Initiate wireless mobile ad-hoc network (MANET) capability among gateways.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2010 Plans: - Conduct test and demonstration of 100 advanced prototype WNaN radios with the second enhanced network technologies. - Develop, integrate, and test of the full function network technologies that exploit diverse paths and frequencies to support network scalability and network formation of tens of thousands of operational nodes. - Build and test 500-1000 pre-production WNaN radios. - Integrate final version of advanced full function network technologies into the WNaN pre-production prototype radio.				
Networked Bionic Sensors for Threat Detection (U) The Networked Bionic Sensors for Threat Detection program will develop and demonstrate low power micro-sensor devices and networks for multiple missions including, language/speech detection and recognition processing, and shooter localization. The system will use ultra-low power signal conditioning/ processing front-end processors with advanced algorithms for distributed sensor network applications. This program will provide 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 planned for transition to the U.S. Marines Corps in FY 2013. *FY 2008 Accomplishments:* - Conducted preliminary test and analysis of Bionic Ear Sensor. *FY 2009 Plans:* - Develop a system architecture to exploit network of low-power micro-sensor devices. - Conduct system design trades of power vs. performance sensitivity and accuracy. - Develop algorithms for acoustic micro-sensor network exploitation for threat detection.	1.500	2.950	2.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
FY 2010 Plans: - Design a brassboard system for field environments. - Build prototype systems for operational evaluation.					
Mobile Networked Multiple-Input/Multiple-Output (MIMO) (MNM) (U) The Mobile Networked Multiple-Input/Multiple-Output (MIMO) (MNM) project 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 (Joint Tactical Radio System (JTRS) cluster 1 size PC card) system. The MNM technology is planned for transition to the Army in FY 2011. *FY 2008 Accomplishments:* - Designed, built, tested, and demonstrated a multi-channel MNM radio that utilizes high volume, low cost COTS RF circuits, narrowband tuning filters and Digital Signal Processor (DSP) baseband processing. - Demonstrated 120 Mbps throughput in laboratory testing for multiple communications modes. - Designed, tested and demonstrated ability of MNM technology to perform in a narrowband interference/ jamming environment using MIMO spatial nulling approaches. - Developed, integrated, and tested low risk network technologies that exploit diverse paths and frequencies to support network scalability and network formation. *FY 2009 Plans:* - Continue development, integration, and test of high risk enhanced network technologies that exploit diverse paths and frequencies to support network scalability and network formation to support thousands of operational nodes. - Continue development, integration, testing and demonstration of MNM wideband interference mitigation technology.		1.500	3.000	4.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2010 Plans: - Demonstrate a communication system where the network layer can mitigate shortfalls in the physical layer in a live eight node demonstration. - Design, build, test, and demonstrate handheld/body wearable multi-channel MNM radio that utilizes high volume, low cost COTS RF circuits, narrowband tuning filters and dual-core DSP baseband processing.				
Mobile Ad Hoc Interoperability Networking GATEway (MAINGATE) (U) Building upon gateway technology developed under the WNaN and Future Combat Systems (FCS) Communications programs, the Mobile Ad hoc Interoperability Networking GATEway (MAINGATE) program seeks to develop the next generation Network Centric Radio System (NCRS) with additional capabilities and an assured affordable unit price to the user. 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 to be deployed in a networked environment to support tactical operations in maneuver or dismounted operations for line-of-site and beyond-line-of-site communications on the move and at the halt. Two critical technologies for achieving these goals: 1) a backbone radio architecture that enables a versatile IP 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 Army and Marine Corps with a focus on Special Operations Forces. *FY 2008 Accomplishments:* - Initiated development of an initial gateway capability for interoperability between selected legacy networks. - Initiated development of an initiation wireless MANET capability to create an adaptive IP backbone network among gateways.	7.000	15.600	3.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2009 Plans: - Complete development and demonstrate the initial, interoperable gateway capability. - Complete development of an initiation wireless MANET capability and demonstrate an adaptive IP backbone network among gateways. - Conduct initial evaluation of gateway and MANET performance in fielded environment. *FY 2010 Plans:* - Develop and demonstrate the final gateway capability for interoperability between all targeted legacy networks. - Develop and demonstrate the final wireless MANET capability to create an adaptive IP backbone network among gateways and for connection to the Global Information Grid (GIG).				
Radio Deception Networks (U) This program will develop software and prototype hardware to enable U.S. forces to easily conduct radio deception operations. For example, the system will make it appear that U.S. forces are not where they appear to be electronically, and vice versa. The radio frequency (RF) footprint for U.S. ground forces has dramatically increased with the proliferation of radios, blue force trackers, GPS, etc. A moderately sophisticated adversary can easily gain insight into our intent by monitoring our forces' RF spectrum usage. This program's objectives will include electronically portraying a mechanized infantry battalion, both stationary and moving; and portraying the same type of unit leaving an area while it actually remains in place. Additionally, there will be metrics that address the number of people required to organize the electronic deception operations. The program is of immediate and long-term use to the U.S. ground forces. This program is planned for transition to the U.S. Army and U.S. Marine Corps. *FY 2010 Plans:* - Conduct a study to identify techniques and methods to steer directional signals using phased array antennas. - Develop algorithms, techniques, and control programs to enable RF signature deception. - Conduct breadboard testing of software solutions.	0.000	0.000	3.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Polarized Rotation Modulation (PZRM) Communications	1.398	1.000	0.000	
(U) The goal of the Polarized Rotation Modulation (PZRM) Communications program is to develop new extremely high data rate, point-to-point, or point-to-multipoint wireless communications waveform using the PZRM/Orthogonal Signal Spectrum Overlay (OSSO) communications concept to exploit the presently unused polarization and rotation dimensions of radiation. The PZRM Communications program will investigate the use of polarization, including OSSO, modulation and the ability for conventional radios to carry all information over the transmitted signal amplitude, phase and frequency. Polarization modulation introduces an additional dimension. A radio with four polarization possibilities would transmit four times the information with all other aspects of the waveform held constant. OSSO enables multiple orthogonal signals to overlay one another in the same radio bandwidth thereby increasing spectral efficiency. Use of the antenna as part of the information processing architecture of a radio has not been previously performed. This technology has the potential to increase the capacity of existing radio channels without increasing spectrum or modem complexity. The program demonstrated as an enhancement to an otherwise state-of-the-art communications system. *FY 2008 Accomplishments:* - Completed first phase of initial research. *FY 2009 Plans:* - Complete final assessment of technology.				
Next Generation (XG)	1.600	1.000	0.000	
(U) The Next Generation (XG) program goals are to develop both the enabling technologies and system concepts to provide dramatic improvements in assured military communications in support of a full range of worldwide deployments through dynamic spectrum access. U.S. Forces face unique spectrum access issues in each country in which they operate due to competing civilian or government users of national spectrum. These constraints must be reflected in all force planning and may preclude operation of critical systems. Coalition and allied operations are even more complex to manage, and may severely limit the U.S. ability to fully exploit its superiority and investment in information technology. The XG program approach is to develop the theoretical underpinnings for dynamic access to the spectrum, the				

Exhibit R-2a, PB 2010 Defense Advanced Research Projects Agency RDT&E Project Justification		DATE: May 2009
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	PROJECT NUMBER CCC-02

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
technologies and subsystems that enable dynamic access, and the system prototypes to demonstrate applicability to legacy and future DoD radio frequency emitters. The program is investigating methods to leverage the technology base in microelectronics with new waveform and medium access and control protocol technologies to construct an integrated system. The program goals are to develop, integrate, and evaluate the technology to enable equipment to automatically select spectrum and operating modes to both minimize disruption of existing users, and to ensure operation of U.S. systems. The result of the XG program will be to develop and demonstrate a set of standard dynamic spectrum adaptation technologies for legacy and future emitter systems for joint service utility. The XG communications technology is planned to transition to the Army for implementation in a range of current and future communication systems including the Joint Tactical Radio Systems clusters. *FY 2008 Accomplishments:* - Developed and demonstrated large-scale network organization and adaptation. - Integrated software into two military radios. - Conducted medium and large-scale military scenario demonstrations. *FY 2009 Plans:* - Complete technology transition to the Joint Tactical Radio System and current and future communication systems.				
Advanced Speech Encoding (ASE) (U) The Advanced Speech Encoding (ASE) program will achieve an order of magnitude reduction of voice communication bit rates over current state-of-the-art voice encoders (VOCODER) in noisy military environments. Such a reduction will significantly decrease the probability of detection of transmitted signals and will also decrease the required transmit energy, thereby increasing battery lifetime. The program will pursue two novel approaches toward achieving its goal. One approach builds upon multiple noise-immune sensors that have been combined with traditional coding algorithms to achieve significant improvements in intelligibility and quality in harsh noisy environments. This approach will be extended to nontraditional ultra-low-bit-rate coding algorithms. An alternative approach will explore communication without acoustic information achieved by extracting laryngeal and sublingual muscle signals that are	3.992	3.995	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
produced when a person generates sub-vocal speech. This approach will yield a revolutionary capability in situations where stealth is of the utmost importance, or in situations where acoustic signals cannot be used, such as under water. The ASE technology is planned for transition to the Special Operations Command and the Communications and Electronics Command of the U.S. Army after a prototype demonstration scheduled for FY 2009. *FY 2008 Accomplishments:* - Developed a prototype real-time ultra-low-bit-rate communication system integrating the ASE VOCODER technology and a military radio. - Developed techniques to capture and enhance sub-vocal signals to enable stealth communication among warfighter teams. - Explored the nature of sub-vocalic signals (physiological source, speaker dependence, and robustness) and the information content of the signals. *FY 2009 Plans:* - Demonstrate a robust sub-vocalic silent-speech communications system. - Demonstrate the ultra-low-bit-rate communication system in the field. - Transition ASE encoding and decoding device and Government standards to DISA. - Conduct user demonstration of sub-vocalic prototypes.					
Conflict Modeling, Planning, and Outcomes Experimentation (COMPOEX) (U) The Conflict Modeling, Planning, and Outcomes Experimentation (COMPOEX) research effort is developing technologies that will enhance the capability of leaders to plan and conduct complex campaigns. This includes a comprehensive suite of decision support tools that help leaders with: visualizing and understanding the situation and the complex operational environment they must operate in; constructing and managing plans that enable the commander to synchronize and integrate interdependent effects over a long period of time; employing the best sequence of unified actions to produce the desired effects; and generating and exploring options and courses of action to understand the range of outcomes and appreciate the side effects that may occur. Technologies developed in the program are planned to transition to the U.S. Pacific Command (PACOM), which will continue to assist development of more		3.229	1.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
comprehensive capabilities transitioning incrementally by FY 2009. Technologies will also transition to Office of the Secretary of Defense Program Analysis and Evaluation (OSD PA&E). *FY 2008 Accomplishments:* - Developed and demonstrated technologies to support leaders and staffs in authoring courses of action and campaign plans. - Continued on going operational experiment with PACOM using COMPOEX to assist in initial planning. - The Office of the Secretary of Defense Program Analysis and Evaluation (OSD PA&E) used COMPOEX models and tools to support plan evaluation. *FY 2009 Plans:* - Complete final PACOM demonstration. - Complete the transition to OSD PA&E as one of their analytical tools.				
DARPA Interference Multiple Access (DIMA) Communications (U) The DARPA Interference Multiple Access (DIMA) Communications program will develop a networked radio system that supports voice, video and data. The goal of this program is a network that is dynamically controllable using techniques such as reconfiguration, optimum resource allocations based on mission priorities, and dynamic policies, as opposed to relatively passive reactions to changes by the commercial infrastructure. This program will initially develop direct sequence spread spectrum (DSSS) communications technologies as a building block to enable robust, mobile, tactical wireless networks, which are the foundation for network centric warfare concepts. The fundamental technical challenges are scalability, multi-user detection processing, low probability of detection/low probability of interception (LPD/ LPI), robustness and platform size, weight and power (SWAP) requirements. The DIMA Communications program will develop and demonstrate a system based on multi-user detection (MUD) concepts that take advantage of overloaded channels while operating in an environment absent of infrastructure (ad-hoc networked.) The technologies developed under this program are planned for transition to the services. *FY 2008 Accomplishments:* - Completed development of multi-user Parameter Estimation (PE).	5.289	4.049	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Completed development of DIMA Infrastructure Free Waveform/Media Access Control (MAC). - Demonstrated real-time DIMA on a COTS platform. *FY 2009 Plans:* - Reduce complexity of DIMA system. - Develop and demonstrate real-time DIMA in a mobile ad hoc network using a radio handheld platform. - Test the network in scenarios relevant to tactical users. - Transition of DIMA program.				

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, PB 2010 Defense Advanced Research Projects Agency RDT&E Project Justification								DATE: May 2009		
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					PROJECT NUMBER CCC-CLS	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
CCC-CLS: CLASSIFIED	82.230	146.220	140.545						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds Classified DARPA Programs. Details of this submission are classified.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Classified DARPA Program	82.230	146.220	140.545	
This project funds Classified DARPA Programs. Details of this submission are classified. *FY 2008 Accomplishments:* Details will be provided under separate cover. *FY 2009 Plans:* Details will be provided under separate cover. *FY 2010 Plans:* Details will be provided under separate cover.				

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Details will be provided under separate cover.