RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development			R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E				
COST (In Millions)	FY 2005	FY2006	FY2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	213.971	213.316	232.489	238.395	245.796	248.154	253.154
Command & Control Information Systems CCC-01	54.978	55.485	56.935	56.530	56.900	56.900	55.900
Information Integration Systems CCC-02	93.645	108.384	93.903	93.560	96.795	98.795	103.795
Classified CCC-CLS	65.348	49.447	81.651	88.305	92.101	92.459	93.459

(U) Mission Description:

(U) This 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E

(U) **Program Change Summary:** *(In Millions)*

	FY 2005	FY 2006	FY 2007
Previous President's Budget	219.765	216.408	220.918
Current Budget	213.971	213.316	232.489
Total Adjustments	-5.794	-3.092	11.571
Congressional program reductions	-0.169	-3.092	
Congressional increases	0.000		
Reprogrammings	0.000		
SBIR/STTR Transfer	-5.625		

(U) **Change Summary Explanation:**

FY 2005	Decrease reflects DOE transfer for P.L. 108-447 and SBIR/STTR Transfer.
FY 2006	Decrease reflects undistributed reductions for Section 8125 and the 1% reduction for Section 3801: Government-wide rescission.
FY 2007	Increase reflects emphasis on classified programs in the Command, Control and Communications Systems Program Element.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2006
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE: Command, Control and Communications Systems; PE 0603760E, Project CCC-01

COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Command & Control Information Systems CCC-01	54.978	55.485	56.935	56.530	56.900	56.900	55.900

(U) Mission Description:

(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 support capability, as well as 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.

(U) Warfighter dependence on information systems is growing. DoD systems must deliver and protect information and assure the availability of associated services – particularly in a stressed environment. Included in this project are Joint Air/Ground Operations: Unified Adaptive Replanning (JAGUAR), Advanced Ground Tactical Battle Manager, Predictive Battlespace Awareness, Comprehensive Force Protection, Urban Commander, Heterogeneous Urban Reconnaissance Team (HURT), Tactical Group Decision Analysis Support System, Dynamic Airspace Allocation, Predictive Analysis for Naval Deployment Activities (PANDA), and Organically Assured and Survivable Information Systems (OASIS).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Joint Air/Ground Operations: Unified, Adaptive Replanning (JAGUAR)	10.936	10.178	10.356

(U) The Joint Air/Ground Operations: Unified, Adaptive Replanning (JAGUAR) program will improve 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. The technology provides pilots and commanders the option to choose conventional tactics or conceive unconventional operations. In the latter case, the system captures the innovation and retains the strategic maneuver for future mission plans. JAGUAR monitors actual plan execution against expected results and alerts commanders to significant differences. The technology captures statistical descriptions of small differences to help assess the robustness of future plans. There is a Memorandum of Understanding in place with the U.S. Air Force and technology transition is planned to occur by FY 2008.

(U) Program Plans:

- Equip a training facility with software tools and human observers to capture plans as constructed, executed, and modified.
- Conduct exercises and capture a large set (several hundred) of mission plans as example cases.
- Decompose each plan into plan fragments.
- Assemble groups of related plan fragments into plan templates.
- Develop a large-scale integration algorithm to assemble plan fragments into a synchronized operational plan.
- Build optimization tools to tailor routes, schedule events, and deconflict airspace and radio frequencies.
- Compile standard mission plan products from the optimized operational plan.
- Demonstrate tools to correlate actual field events to planned events.
- Evaluate these techniques in periodic training events

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

	FY 2005	FY 2006	FY 2007
Advanced Ground Tactical Battle Manager	11.070	9.220	6.133

(U) The Advanced Ground Tactical Battle Manager program is developing automated decision support tools for Army and Marine tactical commanders at the battalion level and below. The program also provides support for combined operations employing dismounted soldiers, manned platforms, and autonomous vehicles. The tool will elicit skeletal courses of action through a graphical interface with unit commanders and extend plans by applying adversarial reasoning techniques to identify vulnerabilities and opportunities in the predicted enemy course of action. Finally, modifications or counteractions will be developed to reduce vulnerabilities. A variant of the program would issue plans to subordinate unit commanders and human controllers and possibly integrate necessary elements to automated platforms or automated battle managers. The technology is planned for transition to the Army.

(U) Program Plans:

- Predict enemy movements 30 minutes into the future.
- Identify aggressive and timid enemy behaviors.
- Identify potentially deceptive behaviors.
- Extend prediction horizon further into the future.
- Include concealment and deception behaviors in predictions.
- Build interfaces to existing and future Army intelligence and command and control systems.
- Continue to conduct experiments to ascertain the value of the tools.

	FY 2005	FY 2006	FY 2007
Predictive Battlespace Awareness	4.034	4.046	2.258

(U) The Predictive Battlespace Awareness program develops technology to predict the range of an opponent's future actions. The program will enable commanders to pre-position sensors, weapons, and information to counter the opponent's actions. The program will develop model-

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

and knowledge-based techniques to predict areas of operation and tactical objectives. The technology will support 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. Techniques to be developed include variable-fidelity prediction, such as the ability to determine both target locations over minutes and force zones of influence over hours. 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 empowers commanders to avoid canned responses and supports rapid incorporation of insights about new enemy strategies, capabilities, and tactics from peacetime to the heat of battle. The program will significantly enhance today's mostly manual, slow planning, and analysis processes. Technologies are planned to be transitioned to the Air Force Distributed Common Ground Station.

(U) Program Plans:

- Survey recent military operations to identify cases where opponent's actions could have been anticipated.
- Define a set of realistic challenge problems, including scenarios and a simulation facility to illustrate the context and value of predictive battlespace awareness.
- Develop approaches to prediction that combine physics-based modeling (e.g., for mobility and observability) with knowledge-based techniques (e.g., plan generation or recognition).
- Evaluate alternative approaches against the challenge problems.
- Define a system architecture that combines the best approaches into a consistent, mutually supporting toolkit.
- Integrate selected technologies into the toolkit.

	FY 2005	FY 2006	FY 2007
Comprehensive Force Protection	4.224	4.943	3.763

(U) The Comprehensive Force Protection program is developing a rapidly deployable system to provide assured protection of permanent or temporary U.S. base camps in hostile territory. The system includes wide-area sensors and platforms to maintain continuous surveillance of the camp area. The sensors detect potential intruders and weapon launches. The program also includes a suite of airborne sensor platforms that can be tasked rapidly to investigate potential threats or "lock on" to personnel or weapons involved in an attack. Data collected from sensors is

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

automatically analyzed, correlated, and provided to commanders to confirm threats and authorize precision weapons to engage. The system maintains continuous perimeter surveillance, allows rapid investigation, and, when authorized, attacks threats. Technologies are planned to transition to the U.S. Army.

(U) Program Plans:

- Review past and forecasted threat analyses to characterize intrusions, events, activities and signatures.
- Select a test area in which data on intrusions can be collected.
- Place a variety of sensors, both extant and developmental, into the test site along with a communications network back to a data analysis and command station.
- Collect data on realistic intrusions in a variety of weather conditions.
- Characterize the performance of candidate signal processing, target recognition and localization, and environment monitoring algorithms on the test data.
- Select a set of algorithms for a baseline system build.
- Construct and calibrate a system performance model for the selected algorithms.
- Exercise the baseline system in the testbed and compare results against the performance model.
- Selectively improve algorithmic components that contribute the most to performance gaps.
- Demonstrate the final system in continuous operation at a CONUS base.

	FY 2005	FY 2006	FY 2007
Urban Commander	14.795	14.025	11.727

(U) The Urban Commander thrust 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

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 heads-up displays and helmet-worn sensors. Finally, the program continuously assesses progress against the operational plan and alerts users to significant deviations.

- The Multi-spectral Adaptive Networked Tactical Imaging System (MANTIS) program develops, integrates, and demonstrates a soldier-worn visualization system. Both helmet-mounted and handheld versions will be built during Phase 3 of the program. The system consists of five elements: 1) multi-spectral sensor suite; 2) high resolution digital display; 3) inertial measurement unit (IMU); 4) high-speed processor; and 5) power supply. MANTIS provides the warfighter with digitally-fused imagery in real time from the multi-spectral sensor suite, exploiting three distinct spectral bands: 1) the Visible/Near Infrared (VNIR, .4 - .9 microns); 2) the Short Wave Infrared (SWIR, 1 - 2 microns); and 3) the Long Wave Infrared (LWIR, 8 - 12 microns). The fused imagery is shown on two displays; one has a wide field-of view and the other a narrow field-of-view. When viewed together the system furnishes a larger field-of-view image with simultaneous high resolution and stereo capability. The system also allows the warfighters to record and "play back" the video while on the battlefield. The record/playback feature includes: electronic zoom, scroll, pan and panoramic image stitching. MANTIS provides a vision-aided inertial navigation system (INS) and will interface with the future soldier's global positioning system (GPS). When combined with precise pose estimation from the helmet-mounted IMU, MANTIS allows battlefield information to be overlaid on the display to provide increased situational awareness. MANTIS interfaces with the future soldier's advanced communications and networking systems, allowing the warfighter to send/receive video images and position information with fellow soldiers and commanders in real time. The coupling of the imaging system with INS/GPS will provide the individual warfighter a "point-click-kill" capability for real-time target hand-off capability to networked smart weapons fired from remote locations, thereby significantly increasing the lethality of the individual warfighter. The MANTIS technology is planned for transition to the Army at the conclusion of Phase III anticipated to be completed early in FY 2008.

- An urban warfare environment presents the warfighter with limited sightlines and mobility with insufficient knowledge of the disposition of enemy combatants, civilians, and occupied structures. As a result, the warfighter requires situational awareness information, presented in a manner that accounts for current operational context and personal strengths, limitations, and preferences. The Urban Commander program develops planning and control tools tailored to dismounted operations in complex urban environments. "On-the-ground" warfighters do not have time to constantly check an information rich visual display. Cognitive Impedance Matching (CIM) technology will develop a prototype system for presenting the information at the correct time and format to the affected individual. The system will

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

ensure that situational awareness will be obtained and maintained across a range of echelons and battlefield conditions. Urban Commander forms a command and control substrate that enables ground forces, including vehicles and dismounts, to rapidly coordinate actions as the situation and commanders knowledge of the situation change. The program includes: 1) spatial analysis to determine lines of sight and fields of fire; 2) planning aids to assist in sensor placement and route planning; 3) visualization tools to allow commanders and soldiers to rapidly apprehend and address a situation; and 4) analysis tools to suggest locations and types of potential threats. Urban Commander technologies are planned to transition to the Army Program Executive Office Command, Control, and Communications Tactical (PEO C3T).

(U) Program Plans:

– Multi-spectral Adaptive Networked Tactical Imaging System (MANTIS)
  -- Delivered Short Wave Infrared (SWIR) sensor assemblies for evaluation.
  -- Completed independent laboratory characterization/field tests on SWIR sensors.
  -- Completed system design analyses.
  -- Developed fully functional MANTIS testbed (helmet-mounted sensor suite and off-board processor).
  -- Evaluate/demonstrate multi-sensor imagery and processing capability via MANTIS testbed.
  -- Complete functional prototype design.
  -- Fabricate three MANTIS functional prototypes (two helmet-mounted, one handheld) for evaluation.
  -- Conduct independent laboratory/field tests of MANTIS prototypes.
  -- Transition to the US Army (PEO Soldier).

– Urban Commander
  -- Identify a set of urban combat scenarios ranging from peacekeeping to aggressive assault and document sets of mission tasks from which tactical plans may be constructed.
  -- Define a common plan representation, based on service training material, for combined arms operations and construct an initial collection of operational plans, for many scenarios and force structures.
  -- Develop multi-modal presentation of situation awareness data, utilizing visual, auditory, haptics, and other presentation modes.
  -- Develop new interfaces for presenting content rich information in a compact format and operational languages.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

-- Construct protocols to propagate changes generated at one location to affected locations, in accordance with defined policy and build flexible algorithms to match changes received from remote locations to the aspects of a plan retained locally.
-- Demonstrate detection of plan inconsistencies and recommend corrections and conduct a series of laboratory evaluations with Army and Marine commanders to assess the quality and utility of program products.
-- Develop an architecture based on the concept of a tactical global information grid (T-GIG), a service-oriented architecture that provides adaptive user filtering at the GIG side (not the user side) for information delivery, fault tolerant mechanisms, and controlled filter propagation.
-- Develop a context aware system, incorporating sensors and software to detect the warfighter's operational conditions and current cognitive state, and to detect if the warfighter has incorporated the situation awareness data that has been presented.
-- Incorporate additional tools for presenting and understanding situation awareness, including mapping and line of fire tools.

	FY 2005	FY 2006	FY 2007
Heterogenous Urban Reconnaissance Team (HURT)	9.100	10.220	5.782

(U) The Heterogeneous Urban Reconnaissance Team (HURT) initiative develops integrated tactical planning and sensor management systems for heterogeneous collections of unmanned platforms operating in urban environments. HURT 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. HURT 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 4D airspace and groundspace deconfliction tools, route planners, and task/platform assignments algorithms. The technology presents mission status and future courses of action to commanders for collaborative adjudication. HURT enables augmentation of low-footprint, rapidly deployable, easily sustainable human command structures with teams of machines operating together. HURT technology is planned for transition to the United States Marine Corps, U.S. Special Operations Command, and Air Force Special Operations Command at the conclusion of Phase II anticipated to be completed by FY 2007.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

(U) Program Plans:
- Select a baseline planning/control algorithm.
- Develop a centralized information management server.
- Define multi-user reconnaissance missions.
- Assess the ability of the planning/control algorithms to effectively use each platform.
- Conduct field tests at an urban warfare training facility.

	FY 2005	FY 2006	FY 2007
Tactical Group Decision Analysis Support System	0.000	2.853	4.591

(U) The Tactical Group Decision Analysis Support Systems program will develop distributed group decision analysis tools. These tools will increase the tempo of the tactical commander's observe-orient-decide-act (OODA) loop, the quality of decisions, and contribution of data point input across the organization with an emphasis on maximizing input on decisions breadth, decision content, problem attributes considered, and events/actions considered. The developed tools will be applied in 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 planned for transition to the Services in FY 2008.

(U) Program Plans:
- Develop novel data structures and algorithms to exploit as many individual contributions as possible to a group decision problem in order to provide a comprehensive and well-founded automated decision.
- Create distributed infrastructure and user interface mechanisms to support real-time group decision analysis without the need for expert facilitators/participants to be in the same place at the same time.
- Provide a capability for continuous tracking of real-world events as well as stakeholder revisions related to the decision, to alert the tactical commander when the decision that was made is no longer optimal.
- Develop prototype decision analysis systems and validate that these systems lead to more effective decision making.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

	FY 2005	FY 2006	FY 2007
Dynamic Airspace Allocation	0.000	0.000	2.500

(U) The goal of the Dynamic Airspace Allocation program is to maximize airspace utilization supporting global operations of military and civilian aircraft through dynamic airspace allocation. The labor-intensive human centric process will be replaced by an automated system that addresses all objects in the airspace to include munitions, manned aircraft, and unmanned air vehicles. The automated system will be developed to be compliant with Federal Aviation Administration (FAA) and International Civil Aviation Organization (ICAO) regulations to allow utilization of the system in peace time and war. Challenges to be addressed include maintaining real-time kinematic information for all objects in the airspace and the development of algorithms to dynamically reallocate airspace without human involvement.

(U) Program Plans:
- Develop and simulate potential system architectures.
- Develop a preliminary design for the system.
- Demonstrate critical technologies.
- Develop and test a prototype system.

	FY 2005	FY 2006	FY 2007
Predictive Analysis for Naval Deployment Activities (PANDA)	0.000	0.000	9.825

(U) Predictive Analysis for Naval Deployment Activities (PANDA) develops technology to automatically learn normal activity models (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 technology can be extended and applied to a wide range of applications including ground vehicles, troop movements, and individual targets of interest (e.g., suspected insurgents), as the methods of tracking those targets improves. The initial application will be anomaly detection in the maritime domain. PANDA technologies are planned to transition to the Office of Naval Intelligence and the Fleet Commanders.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

(U) Program Plans:
- Develop new technologies and system architectures to support distributed learning of activity pattern models from complex spatio-temporal, all-source data.
- Demonstrate that individual and class-of-vessel motion-based activity patterns can be learned and used to detect anomalies.
- Use patterns to predict movements and classify (groups of) vessels as potentially (non) hostile with a low incidence of false alarms.
- Learn and detect multi-ship correlated activities.
- Incorporate context models.
- Leverage detection/tracking capabilities to include large and small (harbor) vessels.

	FY 2005	FY 2006	FY 2007
OASIS	0.819	0.000	0.000

(U) The Organically Assured and Survivable Information Systems (OASIS) program developed technologies for DoD information systems to sustain the operation of mission-critical functions in the face of cyber attacks or accidental faults. These technologies included an intrusion tolerant database architecture using commercial off-the-shelf (COTS) components; a distributed architecture for deploying intrusion-tolerant mechanisms featuring explicitly stated but flexible tolerance policies; a framework for tolerating intrusions in large-scale, heterogeneous, networked computing enterprises; and a system integrity and availability framework that combines passive intrusion tolerance and active intrusion recovery mechanisms. The program used the systems approach to the intrusion problem by integrating prevention, detection, response and tolerance technologies into a military system. The goal was to significantly improve the survivability of the system in the face of a large-scale cyber attack. The OASIS technology is transitioning to the Air Force after completion of red team validations. Specifically, key aspects of the survivable design are planned to be incorporated to the Joint Battlespace Infosphere (JBI) system development.

(U) Program Plans:
- Integrated OASIS and other DARPA and commercial technologies to develop and demonstrate a survivable variant of the Joint Battlespace Infosphere.
- Validated survivability claims of OASIS researchers technologies using recognized methodologies on operational systems.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-01

- Demonstrated the effectiveness of survivable architectures in the face of a determined cyber attack on an exemplar critical military information system.
- Evaluated and applied novel approaches to composing assurance cases for large-scale systems.
- Validated the survivable system with a comprehensive adversarial test scenario.
- Probed the extent of enhanced survivability capabilities with a series of red team experiments.

(U) Other Program Funding Summary Cost:

- Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Information Integration Systems CCC-02	93.645	108.384	93.903	93.560	96.795	98.795	103.795

(U) Mission Description:

(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. This project hosts many of DARPA's most innovative communications and networking systems. Programs funded are: the Secure Adaptive Waveforms (SAW) program, the Connectionless Networking (CN) program, the Next Generation (XG) program, the Advanced Speech Encoding (ASE) program, the Symbiotic Communications (SYCO) program, the Optical & RF Combined Link Experiment (ORCLE) program, the Policy Based Network Management program, the Disruption Tolerant Networking program, the Network Centric Operations/Battle Command program, the Advanced Antenna Concepts program, the Fiber-Optical Network for Aerospace Platforms program (formerly the Navy Photonics Program), the Advanced HF Communications program, the Communications to the Tactical Edge program, the Self-Forming Networks program, the Scalable MMW Architectures for Reconfigurable Transceivers (SMART) (formerly Ideal RF Link) program, the DARPA Interference Multiple Access Communications (formerly Robust, Responsive, Reconfigurable and Invisible (R3I) Network) program, the Terabit Optical Ethernet program, the Multiple-Input/Multiple-Output (MIMO) Satcom program, and the Wireless Network after Next (WNaN) program.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Secure Adaptive Waveforms	6.356	4.013	3.127

(U) The Secure Adaptive Waveforms (SAW) program, and the related Polarized Rotation Modulation (PZRM) Communications program, addressed lessons learned from the Airborne Communication Node (ACN) program concerning the need for secure communications waveforms. The SAW program investigated approaches for an adaptive waveform agile communications system that could change structure (frequency,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

modulation, data rate, hop rate, code, etc.) on a periodic or aperiodic basis to minimize the probability of detection, interception, and exploitation in order to support covert operations.

(U) The goal of the Polarized Rotation Modulation (PZRM) Communications program is to develop new extremely high data rate, point-to-point, and wireless communications using the PZRM communications concept which can be implemented at any wavelength – RF to visible – to exploit the presently unused polarization and rotation dimensions of radiation. The PZRM communications program will investigate the use of polarization 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. Use of the antenna as part of the information processing architecture of a radio has not been previously performed. This technology will greatly increase the capability of existing channels without increase in spectrum or modem complexity. The program will be demonstrated as an enhancement to an otherwise state of the art networking system. The Polarization Modulation technology is planned for transition to Service applications in FY 2008.

(U) Program Plans:

- Secure Adaptive Waveforms
  - -- Initiated system design effort.

- Polarized Rotation Modulation Communications
  - -- Perform simulations to determine bit error rates and the optimum modulation schemes commensurate with the center frequencies and bandwidth permissible.
  - -- Conduct simulations to verify performance predictions and identify component elements.
  - -- Construct a demonstration prototype and undertake laboratory tests to validate PRZM concept.
  - -- Demonstrate at long range under operational conditions.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

	FY 2005	FY 2006	FY 2007
Connectionless Networking (CN)	7.101	5.707	3.580

(U) In order to bring data efficiently from high value, but energy limited sensors (such as unattended ground sensors (UGS)), into system architectures like that of the Airborne Communications Node (ACN), a new fundamental emphasis must be placed on how these kinds of sensor networks communicate. The Connectionless Networking (CN) program will develop technology to allow networks (such as UGS) to send and receive messages without initial link acquisition or previous sharing of routing information. This will improve energy per bit of delivered information by as much as 100 to 1,000 times compared to conventional and near-term deployable communications systems such as currently contemplated by both commercial and military users. Conventional radio link and network designs expend most of the energy on link establishment and maintenance, as well as packet and network overhead. This energy requirement not only limits the lifetime of energy-limited systems, it unnecessarily fills the radio spectrum; limiting available bandwidth; creates unnecessary risks of detection; and increases thermal loads. These impacts are especially severe for communications with proliferated sensors, or remotely operated weapons. Eliminating the requirement to maintain a continuous network link would enable these platforms to provide continuous connectivity without consumption of power, or compromising emanations. The CN program will exploit existing and available signal processing components, intelligent (processing and memory intensive) routing, and availability of situational information to demonstrate a total energy savings of at least 100 times typical connection oriented network applications. The Connectionless Networking technology is planned for transition to the Army, Navy, and Air Force for unattended ground sensors and low duty cycle applications in FY 2007.

(U) Program Plans:

- Investigated specific technology requirements for each of the traditional wireless networks.
- Determined layer specific solutions.
- Investigated layer integrating approaches.
- Modeled acquisition and media access; network and transport design; and aggregate energy cost savings.
- Predicted achievable performance improvement.
- Translate the technology design and simulations into actual hardware and software.
- Design and fabricate prototype CN network node devices, and perform laboratory and field CN demonstrations.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

– Develop and evaluate candidate approaches for implementation complexity, on-board processor and memory capability/power, overhead, scalability and performance.

	FY 2005	FY 2006	FY 2007
Next Generation (XG)	15.571	10.916	2.869

(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 technologies and subsystems that enable dynamic access, and the system prototypes to demonstrate applicability to legacy and future DoD radio frequency emitters. The approach plans to investigate methods to leverage the technology base in microelectronics with new waveform and medium access and control protocol technologies to construct an integrated system. The proposed 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 for transition to the Army in the Joint Tactical Radio Systems clusters in FY 2007.

(U) Program Plans:

– Conducted CONUS and OCONUS spectrum usage analysis.
– Analyzed military bands during force exercises.
– Analyzed civilian band usage in a variety of locales (urban and rural settings).
– Analyzed correlation between distributed nodes.
– Investigated concepts for employment and utility of a dynamic waveform to the warfighter.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

- Conducted lab demo of "sense and adaptation" performance.
- Performed analysis and simulation of multiple control protocols.
- Used military band spectrum analysis to assess subsystem technology development.
- Develop and evaluate candidate approaches for implementation complexity, on-board processor and memory capability/power, overhead, scalability and performance.
- Develop hardware prototypes.
- Demonstrate spectrum agility performance of prototypes in field experiments.

	FY 2005	FY 2006	FY 2007
Advanced Speech Encoding (ASE)	4.782	6.699	5.383

(U) The Advanced Speech Encoding (ASE) program will achieve an order of magnitude reduction of voice communication bit rates in noisy military environments over current state-of-the-art voice encoders (VOCODER). 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 at 2400 bits per second (bps). This approach will be extended to nontraditional ultra-low-bit-rate coding algorithms in order to achieve 300 bps coding capability in harsh military environments. Alternative approaches will also be explored, such as the communication without acoustic information achieved by extracting laryngeal and sublingual muscle signals that are 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 Advanced Speech Encoding technology is planned for transition to the Army by FY 2008.

(U) Program Plans:

- Demonstrated significant improvement of intelligibility and quality voice communications in harsh noisy environments at 2400 bps.
- Demonstrate a voice communication system (sensors plus coder) operating at 1000 bps that is at least as good as today's DoD standard in harsh military noisy environments.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

- Demonstrate a 300 bps VOCODER with intelligibility, quality and aural speaker recognition in harsh military noisy environments that is at least as good as today's DoD standard.
- Demonstrate the capability for ultra-low-rate coding in a field demonstration of a prototype communications system.
- Explore the nature of sub vocalic signals (physiological source, speaker dependence, robustness) and the information content of the signals.

	FY 2005	FY 2006	FY 2007
Symbiotic Communications (SYCO)	12.726	8.738	1.375

(U) The Symbiotic Communications (SYCO) program will develop an airborne passive radar system to enable precision targeting and battlefield situational awareness. SYCO will generate high resolution Synthetic Aperture Radar (SAR) imagery. This system will operate passively and be effective in clear and adverse weather. SYCO has demonstrated a proof-of-concept through ground-based and airborne flight tests. Additionally, a design for a real-time prototype, as well as automated algorithms to enable real-time processing have been developed and tested. To complete this project, the prototype will be developed and packaged to be form/fit/function compatible for transition. The SYCO technology is planned for transition for Service applications in FY 2008.

(U) Program Plans:

- Develop real-time airborne demonstrator system.
- Demonstrate high resolution SAR at national imagery interpretability rating scale level 4.
- Participate in limited user testing.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

	FY 2005	FY 2006	FY 2007
Optical & RF Combined Link Experiment (ORCLE)	23.018	21.041	10.597

(U) The Optical & RF Combined Link Experiment (ORCLE) seeks to develop combined radio frequency (RF) & free space optical (FSO) communications as well as networking technologies that exploit the benefits of complementary path diversity. This effort 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 and "all-weather" performance. 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 in FY 2007.

(U) Program Plans:

- Developed a networking schema for quality of service using RF for latency sensitive assured delivery and FSO for bulk high bandwidth transfers that are less latency sensitive using a dynamic & synergistic dual physical layer.
- Developed compact beam steering using a small form factor and wide field of view.
- Perform range and flight demonstrations of air-to-air-to-ground hybrid FSO/RF links with high availability and gigabit data flows.
- Investigate the optical channel obscuration mitigation using ultra short pulse lasers and partially coherent beams.
- Execute common/combined FSO/RF apertures that enable transition to operational platforms as replacements rather than addition to current systems while maintaining or improving current capabilities.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

	FY 2005	FY 2006	FY 2007
Policy Based Network Management (PBNM)	1.687	4.599	0.000

(U) Drawing upon lessons learned from the Airborne Communications Node/Adaptive Joint C^{4}ISR Node (ACN/AJCN) program and previous DARPA programs in mobile ad-hoc networking, the Policy Based Network Management (PBNM) program seeks to enable reliable and understandable control of non-homogeneous ad-hoc networks and other communications systems that must interact to support the commander's mission objectives. This effort seeks to create a system control methodology that will allow intuitive control over complex communications systems while still preserving the flexibility of the emerging ad-hoc networks. In addition to creating a method for an operator to understand the state of the network, PBNM will allow the network to implement the commander's intent for the operation by dynamically changing function and allocation throughout the duration of a mission. PBNM will control traffic at the application level by making the system aware of what is currently possible, what is currently allowed, and how communications are expected to change over the duration of a mission.

(U) Program Plans:

- Demonstrate, using wireless networked communications, the ability to control information traffic to satisfy commander's intent and mission needs.

	FY 2005	FY 2006	FY 2007
Disruption Tolerant Networking (DTN)	7.042	6.633	8.065

(U) Drawing upon technical challenges identified in specific programs, such as the Airborne Communications Node/Adaptive Joint Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C^{4}ISR) Node (ACN/AJCN) and other non-ground based Mobile Ad-Hoc Network (MANET) programs, the Disruption Tolerant Networking (DTN) program will develop 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, UAV over-flights, orbital mechanics, etc. The program will develop a single model for bundling information and ensuring its delivery, even through a series of episodic communications links, from generator to user. To maximize the applicability and commercial viability of these protocols, and develop the basic software in an open source mode, the military, commercial and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

Internet communities will be engaged. These protocols will be implemented in a typical military system to verify both the performance of the protocol and to validate the utility. These protocols are also applicable to NASA applications, such as deep space communications. The Disruptive Tolerant Networking technology is planned for transition to the Army in FY 2009.

(U) Program Plans:

- Demonstrate that information organized into bundles can be delivered across intermittent networks.
- Commence research to show "fuzzy scheduling" can make network routing decisions in the presence of uncertainty about available or optimal paths.
- Investigate policy cognitive operation by moving intelligence into networks to make the best choices on delivery.
- Enable networks to deliver traffic without the end-to-end address and routing information using deferred, hierarchical address binding techniques.
- Develop mechanisms to allow code-base-independent environmentally-aware selection of routing algorithms.
- Demonstrate trusted delivery of bundles across networks in which access to a PKI is not reliable.

	FY 2005	FY 2006	FY 2007
Network Centric Operations/Battle Command	7.452	9.054	11.584

(U) The DoD is transforming to a more network centric focus for military operations. Network centricity, among other benefits, facilitates the sharing of situation information and access to resources. Shared situation awareness enables collaboration and self synchronization at all operational levels thereby greatly increasing mission effectiveness. Military campaigns in the future will not necessarily be focused solely on major military operations. These campaigns will involve attempts at conflict avoidance, and if this fails, possibly major combat operations with periods of various security, stability, reconstruction, transformation and transition operations. Future campaigns will be characterized by an increased demand for the commander to employ the most appropriate actions (diplomatic, information operations, military, economic, etc.) against the adversary's various political, military (air, land and sea; regular or irregular), economic, social, information distribution, infrastructure, etc. systems. Commanders in the future will use network centricity to access a larger base of knowledge sources and a greater range of resources and actions. Concurrently, the commander will be challenged to exploit these capabilities to achieve a mixture of appropriate effects.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

(U) Until recently, the primary technological emphasis for network centric operations has been on improving command, control, communications and computing, intelligence, surveillance and reconnaissance (C^4ISR) systems to enable better sensor-decider-shooter linkages. While appropriate, there must also be more emphasis on technologies to assist commanders in: 1) understanding the complex operational environment, developing and managing effects-based campaigns that employ all options available to the commander, and synchronizing combat operations, security, stability, reconstruction, transformation and transition operations over the entire time of the campaign; 2) enabling tactical units to self synchronize to exploit targets of opportunity by applying effects using any weapon or effect generator, any sensor system, from any of the services, from the U.S. or its allies, on land, air, maritime or space platforms to immediately create effects against targets on land, in the air or on the sea; and 3) communicating seamlessly across mobile ad hoc networks, data links, fixed and transportable networks as well as commercial systems.

(U) Initial technologies developed in the program are planned to transition to the Army Network Enabled Battle Command program and to the U.S. Joint Forces Command as an initial capability in FY 2006, with more comprehensive capabilities transitioning in FY 2007 and FY 2008.

(U) Program Plans:

- Develop and demonstrate technologies for integrating modeling and visualization techniques into action/effects exploration and campaign planning with an emphasis on modeling an adversarial coalition's various political, social, economic, information dissemination, service infrastructure, etc. systems as well as its military or insurgent capabilities.
- Develop and demonstrate technologies to support humans in authoring courses of action, development and campaign planning; decompose objectives, to effects, to nodes, to actions; capture and model interdependencies between assumptions, activities and intended objectives, and between intended and unintended effects; and assist the human in synchronizing objectives and activities.
- Develop and demonstrate technologies to enable tactical entities to autonomously, dynamically, self synchronize activities in accordance with the commanders guidance in a decentralized, distributed manner and enable commanders to synchronize guidance to ensure harmonious interaction of tactical entities.
- Develop and demonstrate a single, common C^4ISR system architecture and a common technology building block for seamlessly integrating the strategic, operational and tactical levels of warfare.
- Develop interface systems for seamlessly integrating data from self-forming, mobile, ad hoc, tactical networks into high data rate internet-type networks like the Global Information Grid (GIG).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

	FY 2005	FY 2006	FY 2007
Advanced Antenna Concepts	4.152	5.711	6.075

(U) The Adaptive Amplification effort will enable small wireless devices, antennas, and associated components to provide similar effectiveness to larger ones. Current antenna technology limits the ability to miniaturize the physical size of the antenna, resulting in a requirement for large platforms or physical deployments for special operations. Similarly, limited antenna bandwidth limits the ability to fully exploit software-based radios, such as Joint Tactical Radio System (JTRS), since the antennas they utilize are limited in bandwidth. Application of advanced technology offers the ability to fabricate devices that can effectively couple to very non-resonant antennas. The basic technology has been developed for application to small-sized radios with wide bands of operation.

(U) The Ultra-Fast Radar effort will entail the design, construction, and demonstration of 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. The combining and tailoring of noise correlating interferometry and retro-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 Ultra Fast Radar technology is planned for transition to the Army in FY 2007.

(U) Program Plans:

- Adaptive Amplification
  - -- Identified promising technologies.

- Ultra-Fast Radar
  - -- Develop an X-band noise correlating radar with a retro-directive antenna to show an approximately 5-times reduction in acquisition time compared to traditional electronically-steered search-mode radar, and an even greater reduction in comparison to mechanically scanned radar.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

-- Design and demonstrate ultra-fast radar using retro-directive antenna arrays that will show a significant reduction in probability-of-intercept compared to traditional search radars based on coherent transmitters.
-- Determine if the concept offers significantly reduced cost and greater simplicity to radar development and antenna designs than current systems.

	FY 2005	FY 2006	FY 2007
Fiber-Optical Network for Aerospace Platforms (formerly Navy Photonics Program)	3.758	4.000	4.750

(U) The Fiber-Optical Network for Aerospace Platforms program will facilitate building or upgrading military aircraft and other aerospace platforms with a future-proof fiber-optical networking infrastructure with many capabilities that are well beyond those of currently used copper-based technology. Originally, the program focused on specific technologies for application on the Navy's EA-6B Prowler aircraft, however, the program has now been restructured to focus on technologies that will provide advanced capabilities to a multitude of military aircraft and aerospace platforms. These new capabilities include: scalability in bandwidth and 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 fiber-optical wavelength-division-multiplexing (WDM) technology and leveraging optoelectronic and photonic integration techniques developed in DARPA photonics components program. To reduce size, weight and power requirements and to increase the reliability and the flexibility of interconnecting arbitrarily placed client devices with various signal formats, use will be made of passive, transparent, 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 in FY 2010.

(U) Program Plans:
– Compile an extended superset of the requirements for a network to be deployed in various target aerospace platforms.
– Create a suitable architecture for a mostly passive, wavelength-division-multiplexing (WDM) fiber-optical network with high connectivity for increased reliability.
– Develop a wavelength plan for interconnecting arbitrarily placed client devices using tunable optical transceivers.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

- Develop a protocol for rapid restoration from multiple failures through protection switching or by re-tuning the optical transceivers.
- Conduct an analysis to estimate the resulting network reliability and survivability under various failure scenarios.
- Demonstrate the ability to interconnect client devices with a wide range of analog and digital signal formats.
- Demonstrate the ability to integrate the appropriate combinations of optical devices and components to reduce weight and volume.
- Build and flight-test a network test bed that is representative of a network suitable for one or more target aerospace platforms.

	FY 2005	FY 2006	FY 2007
Advanced HF Communications	0.000	1.842	3.300

(U) The goal of the Advanced HF Communications program is to provide always-available, high-rate communications at long ranges for Special Operations Force (SOF) teams using miniaturized equipment. Currently SOF teams rely on satellite communications (Satcom) for long range connectivity. However, Satcom requires line of site access, and channel availability. The Advanced HF Communications will develop antenna and radio technology to provide high-rate communications at long ranges using ground wave and near vertical incidence skywave (NVIS) propagation. A fundamental challenge is reducing the size, weight and power (SWaP) requirements for SOF applicability. Novel miniature HF antenna technologies and channel adaptive radio technologies will be developed and demonstrated in man portable form factors. The technologies developed under this program are planned for transition to Special Forces in FY 2009.

(U) Program Plans:

- Investigate novel antenna designs for miniature form factor and high efficiency.
- Perform propagation experiments to determine atmospheric effects on communications using both ground wave and NVIS electromagnetic propagation modalities.
- Develop improved statistical models of atmospheric effects on communications to implement effective equalization techniques using state of the art digital signal processing components and algorithms.
- Develop a dual mode transceiver prototype in a package that validates the size, weight and power requirements of the SOF user.
- Perform a field demonstration on a prototype transceiver in various environments to validate the concept.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

	FY 2005	FY 2006	FY 2007
Communications to the Tactical Edge	0.000	4.375	7.843

(U) The future DoD communications architecture will provide a multi-tiered capability consisting of: a worldwide, broadband Global Information Grid (GIG); transportable networks like the Army Warfighter Information Network-Tactical (WIN-T); and totally wireless mobile ad hoc tactical networks formed using the next generation Joint Tactical Radio System (JTRS) terminals. This project will provide technology to make networks "user-aware" and oriented toward delivering tailored services to each user by dynamically balancing communications supply and demand. An Information Flow Control Network will be created to act as a dynamic overlay to existing communications networks while simultaneously serving as an underlay to existing service oriented architectures and other middleware. Rather than provide "best effort" with no guarantees, the Information Flow Control Network will provide "best service" with guarantees. The Communications to the Tactical Edge program will transition to the Army in FY 2009.

(U) Program Plans:

- Develop technology to implement a user-transparent service that dynamically monitors the communications supply available and the communications demand desired at each user (or end system) and is aware of the military missions being executed by each user.
- Develop middleware technology to dynamically negotiate and control demands to meet supply by means such as context-preserving content reduction.
- Develop middleware technology to dynamically negotiate and control access to communications services (supply) by methods such as dynamically assigned use of the military multi-level priority and precedence system or other dynamic quality of service parameters.
- Perform trial demonstrations using simulation and emulation over existing backbone networks.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

	FY 2005	FY 2006	FY 2007
Self-Forming Networks	0.000	4.606	1.648

(U) The Self-Forming Networks program seeks to develop networks that use addresses that are distributed topographically (e.g., geographically or by organizational unit). Current network routing methodologies use 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 Self-forming Networks will reduce the load on routers as well as greatly simplify router configuration. These networks will be a paradigm shift in that numbered IP addresses will no longer exist, and changes to the Domain Naming Server (DNS) system will allow for services to mobile users to be incorporated. This program is planned for transition to the Services in FY 2009.

(U) Program 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.
- 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.
- Develop changes to DNS functions to accommodate the forwarding services to mobile users.

	FY 2005	FY 2006	FY 2007
Scalable MMW Architectures for Reconfigurable Transceivers (SMART)	0.000	5.370	7.499

(U) This program, formerly Ideal RF Link, seeks to exploit recent advances in analog transmit and receive technology with progress in ultra-high speed logic to simultaneously reduce the transceiver phase noise and reduce analog device non-linearities with digital correction techniques. In particular, the current performance of Silicon Germanium and Indium Phosphide bipolar device technology is now fast enough, with cut-off frequencies of > 350 GHz, that error correction technique such as predistortion and feed forward correction can be considered for application to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

RF components. The effort will develop new circuit topologies and algorithms along with cross technology integration schemes. This combination will increase the maximum signal data rate (increase the bits/sec/Hz) for DoD RF links.

(U) Program Plans:
- Study fundamental limits to RF communication links and perform system study.
- Define critical technical challenges to increasing link margin by improving component linearity.
- Establish program metrics for optimum RF link demonstration.
- Initiate component development and heterogeneous integration demonstrations.

	FY 2005	FY 2006	FY 2007
DARPA Interference Multiple Access (DIMA) Communications (formerly R^3I Network)	0.000	5.080	7.458

(U) The DARPA Interference Multiple Access (DIMA) Communications program will develop a networked radio system that supports voice 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, covertness, robustness and platform size, weight and power requirements. The DIMA Communications program will develop and demonstrate a DSSS system based on multi-user detection concepts that can operate in an infrastructureless (ad-hoc networked) environment. The technologies developed under this program are planned for transition to the Army and SOCOM in FY 2008.

(U) Program Plans:
- Demonstrate feasibility of concept in a wireless test bed.
- Develop optimized waveform, multi-user detection processing and channel parameter estimation algorithms.
- Demonstrate system performance through a combination of simulation and hardware prototype field demonstrations.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

	FY 2005	FY 2006	FY 2007
Terabit Optical Ethernet	0.000	0.000	2.100

(U) The Terabit Optical Ethernet (TOE) Program will develop and demonstrate tera-bit per second optical routing using a distributed routing concept that will enable a three order of magnitude reduction in size and weight requirements over current routing technology. This technology routes each transmitted packet via a wavelength based on the destination node in a ring architecture. A major technical challenge is obtaining the ability to quickly and precisely tune the laser source. This program will develop Terabit Optical Ethernet Network Interface Cards that will demonstrate the throughput, scaling and weight reduction potential of this technology. Strong interest has been expressed by the user community for the dissemination in real time of the large volume, high value metadata that the next generation of sensors will produce, while at the same time providing on demand access to stored information. This will enable breakthroughs in the rapid exploitation and analysis of critical high-bandwidth sensor data needed to support DoD operations. Technologies developed under this program will transition to Service Applications in FY 2008.

(U) Program Plans:
- Develop the system design for the TOE network interface card.
- Develop a hardware prototype and demonstrate the capabilities.

	FY 2005	FY 2006	FY 2007
Multiple-Input / Multiple-Output (MIMO) Satcom	0.000	0.000	2.950

(U) The MIMO Satcom program will develop a proof of concept system that will enable multiple users access to 100 kilobits per second (kbps) satcom channels using the existing C-band satellite architecture. This new capability becomes possible, in part, by moving away from the existing paradigm regarding usage of these satellites. This new MIMO Satcom paradigm envisions satellites as merely a node or relay for a single user. In communications terminology, the satellite is part of a single-input / single-output (SISO) channel. Instead, this program will consider the multiple satellites simultaneously. Using this approach, a multitude of co-channel users send signals that illuminate a multitude of satellites. Powerful processing algorithms then isolate the individual communication links. Using the constellation in this manner provides signal gain and interference rejection.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

(U) The most important advantage for military missions is the ability to use the existing C-band uplink infrastructure with antenna aperture areas several orders of magnitude smaller than are currently needed. The large size of current C-band ground station antennas is driven by the need to limit adjacent satellite interference rather than the need for additional link margin. Operation with drastically reduced apertures is possible if the requirement to avoid illuminating an adjacent satellite is removed. By relaxing beam size requirements the ground terminal footprint can be reduced. Other satellite constellations with reduced coverage offer greater power and, hence, more capacity.

(U) The increased complexity of the MIMO Satcom communication link demands dynamic and adaptive network protocols to ensure optimal performance is achieved. The technologies developed under this program will transition to the Services' expeditionary forces in FY 2008.

(U) Program Plans:
- Develop the system design requirements.
- Develop the system components.
- Integrate the components and demonstrate the communications capability.
- Demonstrate the fundamental capability enhancement using processed data.

	FY 2005	FY 2006	FY 2007
Wireless Network after Next (WNaN)	0.000	0.000	3.700

(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 effort will provide reliable and highly-available battlefield communications at low system cost.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2006
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, Project CCC-02

(U) The WNaN program will develop a prototype handheld wireless node that can be used to form high-density ad hoc networks and gateways to the Global Information Grid. This program will develop robust networking architecture(s) that will exploit high-density node configurations from related DARPA programs. This program will culminate in a large-scale network demonstration using inexpensive multi-channel nodes. WNaN technology is planned for transition to the Army in 2010.

(U) Program Plans:
- Design and build wireless nodes incorporating 4 channel inexpensive RF circuits.
- Demonstrate a communication system where the network layer can mitigate shortfalls in the physical layer.
- Demonstrate a 500 to 1000 node integrated WNaN system.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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