Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Office of Secretary Of Defense										DATE: February 2011	
APPROPRIATION/BUDGET ACTIVITY 0400: *Research, Development, Test & Evaluation, Defense-Wide* BA 3: *Advanced Technology Development (ATD)*				R-1 ITEM NOMENCLATURE PE 0603662D8Z: *Networked Communications Capability*							
COST ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012 Base**	**FY 2012 OCO**	**FY 2012 Total**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**Cost To Complete**	**Total Cost**
Total Program Element	27.323	30.035	23.890	-	23.890	28.900	34.221	39.672	41.006	Continuing	Continuing
P662: *Airborne Network Gateway*	5.830	-	-	-	-	-	-	-	-	Continuing	Continuing
P663: *Network Communications Analysis*	21.493	30.035	23.890	-	23.890	28.900	34.221	39.672	41.006	Continuing	Continuing

A. Mission Description and Budget Item Justification

Warfighter's today rely more and more on communications networks to support and enable actions from targeting and shooting weapons to video-conferencing. Though military basic infrastructure capabilities follow the mainstream commercial internet, for many reasons (security, mobility, robustness), commercial telecommunications especially commercial wireless (tactical edge) communications are not well-matched with the requirements of today's warfighter. These trends will continue as the military data load becomes more diverse and heavy. The National Research Council's Network Science Report (2005) and Army Mobile Ad-hoc Network (MANET) JASONS Report (January 2006) state that the type of networking projected to meet military tactical requirements are not supported by network theory, network design nor analysis tools. These tactical edge technology challenges cut across all warfare domains (space, air, ground, sea). In response to recognized technical problems today, as well as anticipated problems in the future, this research will focus on two key problems in networked technologies: the need for expanded wireless reach where no communications infrastructure exists, and the need to create ways to manage diverse wireless communications load and heterogeneous network types. Airborne Network Gateway will expand the wireless communications and networking reach for the tactical force in the form of an airborne network gateway capability. Network Communications Analysis will establish the scientific foundations for military tactical mobile networking with a specific emphasis on the integrated network management of tactical networks. This research will provide the technical basis to standardize the implementation of military network communications capabilities in the areas of airborne network gateways and network communications analysis across the military services, joint staff, OSD and defense agencies.

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B. Program Change Summary ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Previous President's Budget	28.212	30.035	35.287	-	35.287
Current President's Budget	27.323	30.035	23.890	-	23.890
Total Adjustments	-0.889	-	-11.397	-	-11.397
• Congressional General Reductions		-			
• Congressional Directed Reductions		-			
• Congressional Rescissions	-	-			
• Congressional Adds		-			
• Congressional Directed Transfers		-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.619	-			
• Other Program Adjustments	-0.270	-	-	-	-
• Defense Efficiency - Baseline Review	-	-	-9.000	-	-9.000
• Defense Efficiency - Reports, Studies, Boards, and Commissions	-	-	-1.660	-	-1.660
• Defense Efficiency - Contractor Staff Support	-	-	-0.701	-	-0.701
• Economic Assumptions	-	-	-0.036	-	-0.036

Change Summary Explanation

Defense Efficiency – Baseline Review. As part of the Department of Defense reform agenda, implements a zero-based review of the organization to align resources to the most critical priorities and eliminate lower priority functions.

Defense Efficiency – Report, Studies, Boards and Commissions. As part of the Department of Defense reform agenda, reflects a reduction in the number and cost of reports, studies, DoD Boards and DoD Commissions below the aggregate level reported in the previous budget submission.

Defense Efficiency – Contractor Staff Support. As part of the Department of Defense reform agenda, reduces funds below the aggregate level reported in the previous budget submission for contracts that augment staff functions.

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COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
P662: *Airborne Network Gateway*	5.830	-	-	-	-	-	-	-	-	Continuing	Continuing

Note

Project P662 (Airborne Network Gateway) was completed at the end of FY 2010 and there will be no future funding for this project in out years

A. Mission Description and Budget Item Justification

Airborne Tactical Relay - An airborne tactical relay capability enables Beyond Line of Sight (BLOS) range extension for tactical mobile communications. Within the current deployed forces there is no airborne network tier to support locally distributed ground and naval forces at lower tactical levels. The need to increase the capability to support tactical forces at lower levels is highlighted in the 2006 Naval Research Advisory Committee (NRAC) Distributed Operations Study. The lack of an airborne tactical relay limits BLOS tactical communications to available satellite communications. This research will develop, integrate and demonstrate airborne tactical relay technology to support locally distributed tactical forces and achieve improved near-term networked communications capability. Focus will be placed on the transition from research to accelerated fielding. Several candidate payloads and platforms will be investigated to meet the needs of the tactical military user at the lower tactical network tiers, for example, small unit relay. Upon the selection of candidates, the technologies will be integrated, matured and demonstrated to support transition. Research and development will include the development and integration of the payload to include Single Channel Ground and Airborne Radio System (SINCGARS), Enhanced Position Location and Reporting (EPLRS), and Soldier Radio Waveform (SRW) for example; the payload to platform integration to support demonstration; and the development of a small unit Concept of Operations (CONOPS) to demonstrate operations supported by the range extension for tactical units. Demonstrations will be used to support technology maturation and verify technology transition criteria.

Gateway Interoperability - Gateway functions on the ground and in the air are becoming common across the tactical battlefield to integrate disparate networks. Gateways as a general term include relays (range extension), bridges (connect across networks), message translation (connect across data links), and guards/cross domain security (connect across security domains). This research will define, develop, integrate, demonstrate, and assess technology that provides standards to perform gateway functions from the tactical edge to the core Global Information Grid network (GIG). Many technologies and components exist to perform the variety of gateway functions discussed. These would be assessed to identify desirable aspects to be leveraged as the foundation for providing improved interoperability. Emphasis will be placed on demonstrating capabilities to support airborne tactical relays and airborne network gateways. The research will be expanded to provide the technical basis for standards and policies that can be applied across DoD, specifically in support of the GIG.

Airborne Network Gateway Open Call – A percentage of the Airborne Network Gateway funding will be dedicated to supporting new research initiatives in this technical area. Each fiscal year, a RFP will be sent out with specific technical focus area and evaluation criteria for each project. The proposals will be graded by a peer review team who score each proposal in each of predetermined criteria. Proposals are then selected based on total score.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Airborne Tactical Relay	3.465	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Description: Current program plan calls for the development and maturation of an airborne communications relay suitable for flight on a UAV. The relay was demonstrated in an operational environment at the end of 2009 and transitioned in 2010. The first year's effort was executed by the Marine Corps (Office of Naval Research) and the second year's effort was executed by the Marine Corps (Office of Naval Research) and Army (Communications-Electronics Research, Development, and Engineering Center). Plans called for a common, joint airborne relay supporting tactical small units developed jointly by the Marine Corps and Army, to include development of the payloads and concepts of operation and transition directly to the Services. Research efforts include BLOS Tactical Communications Relay (BTCR) and Advanced Tactical Data Link (ATDL). Overall goal: Increase the understanding of airborne tactical relays. Demonstrate the network communication technology required to support small unit distributed operations. Establish the concept of operations for how these technologies will be operationally used and supported. ***FY 2010 Accomplishments:*** - Navy initiated research effort to create models for advanced tactical network scenarios. Documented enabling technologies for Advanced Tactical Data Links. NRL report published September 2010. Brought in and incorporated models of existing systems and manipulated scenarios based on proposed Navy ConOps. Established baseline and capability improvements based on proposed prototypical systems. Formed ATDL Tiger Team. Began to explore extending emulation testbed capabilities (eMANE) to include ADTL. - Continued development for follow on assessment and technology maturation. Completed demonstration of operational relay capability (Camp Roberts, CA). Completed build of software payload for Bogue Field, NC. Incorporated integration of legacy waveforms in new platforms. Converted On-The-move (OTM) tracking system command and control (C2) link to OCONUS supported frequency. Completed BTCR project and transitioned to Marine, Army and CENTCOM partners.			
Title: Gateway Interoperability ***Description:*** Initiated this project in 2009 as a joint all service effort to increase understanding of gateways, a complex area of networking within DoD. Overall Goal: Establish the technical basis for DoD policy and standards for the Global Information Grid (GiG), specifically in the areas of the tactical edge attachment and interoperability to the GiG core networks. ***FY 2010 Accomplishments:***	1.188	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Completed Phase I of the Joint Aerial Layer Network (JALN) Management Study that was used to provide future operations concepts, gap analysis, task analysis, task analysis, and programs and technology review. Held JALN Network Management Summit. - Conducted directional antenna radios and HNR lab & field Demonstrations (BoldQuest Nov 09 and C4ISR OTM July 10). Demonstrated HNR operating extended communications at the CABLE JCTD. NRL and Harris Corp. documented an interface to utilize an NRL developed Programmable Embeddable INFOSEC Product with the HNW radio. Defined interface spec for Type-1 extension to HNW. - Conducted research and create publications in the following areas: UHF waveforms, application coding, spectrum reuse, and antenna technology. Produced detailed reports on each technique. Transitioned intellectual property forming the basis for future airborne C2 links. - Transitioned Enhanced Performance for HNW including Net Entry at Extended Range, AFC2IC Airborne Network Management Analysis, and Advanced Waveform Support to P663 under the Tactical Networking Evolution and Expansion Project.			
Title: Airborne Network Gateway Open Call ***Description:*** A percentage of the Airborne Network Gateway funding will be dedicated to supporting new research initiatives in this technical area. Each fiscal year, a RFP will be sent out with specific technical focus area and evaluation criteria for each project. The proposals will be graded by a peer review team who score each proposal in each of predetermined criteria. Proposals are then selected based on total score. Overall goal: To add innovative research projects in the area of airborne networking to the program. ***FY 2010 Accomplishments:*** - Distributed RFP. Created Peer Review Team. Evaluated and selected FY10 Proposals. Selected the following projects (in combination with proposals from P663 money): Directional Ad-Hoc Networking Technology (DANTE-2), Dynamic Policy Management, Link Scheduling to MAX Aggregate Throughput in TDMA Networks, Channel Modeling for Software Defined Radios in Real Atmospheric Environments, and mlabCUNE: An Emulation Environment for the AFRL Joint Airborne Testbed.	1.177	-	-
Accomplishments/Planned Programs Subtotals	5.830	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

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E. Performance Metrics

Strategic Goals Supported: Net-Centric Warfare/Joint Interoperable Communication

Existing Baseline: Prototype relays and gateways; initial federated, laboratory test beds; prototype joint network management tools

Planned Performance Improvement / Requirement Goal: Link expansion in prototype relays and gateways; continued integration in federated test beds; demonstration of prototypes and software tools

Actual Performance Improvement: Prototype and transition able relays and gateways; usage federated test beds; demonstration of prototypes and software tools

Planned Performance Metric / Methods of Measurement : Utilization of federated test beds; demonstration of prototypes and software tools

Actual Performance Metric / Methods of Measurement : Progress on testbed development; prototype software demonstrated; prototype architectures developed

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COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
P663: *Network Communications Analysis*	21.493	30.035	23.890	-	23.890	28.900	34.221	39.672	41.006	Continuing	Continuing

A. Mission Description and Budget Item Justification

Tactical Mobile Networking - As studies have suggested, for instance, the National Research Council's Network Science Report (2005) and Army Mobile Ad-hoc Network (MANET) JASONS Report (January 2006), the type of networking projected to meet military tactical requirements are not supported by network theory, network design and analysis tools. This research will define those technical parameters important to military tactical mobile networking environments, investigate the status of network design and analysis tools, and evaluate how modeling and simulation is conducted to support tactical mobile networking environments. The role of network experimentation with respect to network modeling will be explored. Further development and analysis will be conducted to improve the awareness of the condition of tactical mobile networking technologies. Design tools, architectures and technical approaches will be recommended to acquisition programs as a result of this research.

Network Management Tools and Analysis - Network management in the commercial world is a highly organized, synchronized activity that has excellent tools to monitor activity and repair disrupted networks as needed. These same tools are ill-matched for management in the wireless world, and specifically for military tactical mobile networking. In addition, the military tactical mobile networking environment lacks the infrastructure (connectivity) and support (helpdesk) because resources (spectrum, people, and equipment) are scarce (not in harm's way). As the complexity of networking grows and as network capabilities are introduced, improved network management is required. For military operations, assured delivery may be needed for specific information and operations. This requires management tools to be in place to ensure continued secure and robust operations, which is not achieved with commercial wireless technologies. This research will assess network management tools in place for the military tactical mobile networking environment; develop technology and tools to address shortfalls with the goal to transition technology to operational systems.

Spectrum Management Tools and Analysis - For wireless, tactical mobile networking, the management of the use of spectrum effects network operations. The demand for spectrum is increasing due to the expanded use of sensors, imagery and voice. This demand increases the pressure on the limited shared radio frequency (RF) spectrum for military tactical networking. The current DoD frequency planning and management infrastructure will have a limited ability to cope with this demand through operational planning, Coalition Joint Spectrum Management Planning Tool (CJSMPT) Joint Capability Technology Demonstration (JCTD) and the Global Electromagnetic Spectrum Information System (GEMSIS). Advanced spectrum management concepts such as sense and adapt, spectrum sharing, and dynamic reallocation are under investigation but not yet mature support operations. This research will evaluate opportunities for more efficient and effective use of the frequency spectrum within DoD. Technology advances are expected to advance the concept of cognitive radio and cognitive antenna devices to sense and adapt operations based on spectrum policy and usage, the management of multi-band and multifunction apertures, and the use of spectrum efficient waveforms for use in military environments. This research will develop the models and tools to demonstrate capabilities for operational planning and monitoring of spectrum as these technologies are introduced.

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Integrated Network Management Capability - Network management becomes more complex as more and different types of networking capability become available. Integrated network management across heterogeneous systems, especially wireless systems, requires definition, design and development. Operationally, network management assumes all functions required to share networking resources and ensure proper operation for participants. This research will define integrated network operations tools for all aspects of network resource management and to prioritize across operational spectrum management, security management, network management, and information management. This research will also develop testbeds specially to validate models and simulations used to develop and test network management tools, and conduct experimentation on approaches developed.

Networked Communications Analysis Open Call – A percentage of the Networked Communications Analysis funding will be dedicated to supporting new research initiatives in this technical area. Each fiscal year, a RFP will be sent out with specific technical focus area and evaluation criteria for each project. The proposals will be graded by a peer review team who score each proposal in each of predetermined criteria. Proposals are then selected based on total score.

Tactical Networking Evolution and Expansion – Fielded and about-to-be-fielded tactical networks can be vastly expanded and evolved from their current capabilities by developing and applying new techniques (or existing techniques developed in basic research) to the existing systems, providing modern capability to the warfighter without the large expense to the DoD of developing new systems. This research will focus on developing and applying new DoD specific techniques to create leap-ahead approaches to Anti-Jam resistance of tactical networks, larger, more fully exploited networks, and expanded capabilities for signal/data processing and data compression in radios and across the networks. This research will take advantage of new software defined radios about to be fielded by the Department, as well as focus on the existing legacy systems, using the successful approach we developed when fielding the Netted Iridium capability.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Tactical Mobile Networking	4.356	5.608	5.336
Description: This project is for the development of new applications and standards that can be used on existing tactical networks to improve data retrieval and discovery by the tactical warfighter. In addition, research is being conducted into tactical communications architectures to develop models useful for optimizing and exploiting tactical networks. New applications and architectures will be tested in a joint federated experimental emulation test bed being developed within this program. Project collaboratively executed by the Navy and Air Force. Results planned for transition to programs of record as maturity of models allow. Research efforts include Wireless Computational Networking Architecture, Heterogeneous Intelligent Filtering Extensions (HIF), Cooperative Heterogeneous Comms, Inter-domain Routing, Tactical Edge Group Wise Networking, SATCOM and Tactical NetOps, Tactical Edge Protocol Evaluation and Experimentation, Channel Modeling for Software Defined Radios in Real Atmospheric Environments, and Communications for Autonomous Systems. Overall goal: Increase understanding of the condition of tactical mobile networking technologies. Improve specification of technical standards and policy for tactical mobile networking. Refine fidelity modeling and simulation to support operations analysis and the articulation of operational requirements and performance parameters. ***FY 2010 Accomplishments:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Used transport protocols to develop a software infrastructure that supports application development. Completed UAV flight tests with reliable data transport with a high throughput. Created two, 40+ node cloud-computing lab testbeds supporting research in wireless ad-hoc cloud computing. Explored TCP routing and AHFS using the developed spectral clustering method. Performed additional indoor and outdoor field tests. - Began development of more detailed filtering capabilities. Began test in conjunction with Army JINX effort to filter network management traffic. Created a policy management interface for HIF tool. Developed multiple HIF gateways. Integrated HIF into the Army VAN testbed. Conducted final demonstration to conclude this program. Presented a paper at MILCOM 2010. - Invented a series of protocols that proactively use heterogeneous (i.e. SatCom and line-of-sight) links cooperatively to yield network performance that exceeds the sum of the performance achievable over the individual links. Documented findings in multiple conference and journal papers in addition to a series of technical memorandum. Implemented protocols in a common simulation package to enable easy evaluation and transfer. Worked to improve network communications protocol. Conducted research using the MIT Lincoln Lab emulation facilities. Synchronized performance visualization and created a description video. - Defined study scenario and approaches using Lincoln Labs network emulation testbed. Obtained study results using Lincoln Labs emulation testbed. Extended research into other network communications capability testbeds (Navy eMANE, Army VAN testbed). - Initiated development of CORE group-oriented networking protocols. Presented technical results on group-based, self-organization algorithms at IEEE MILCOM 2009. Completed initial prototype of the XMPP Overlay (XO), supporting server-less chat, multi-echelon gatewaying and interoperability with enterprise chat systems. Demonstrated interoperability of XO during CERDEC VAN demo. Created advance metrics and analytics to study dynamic group structures. Created and transitioned emulation scenarios to be used in evaluations. Progressed technology that provides both improved group and reliable networking delivery for Disruptive Tolerant Networking (DTN) technology. Submitted three MILCOM 2010 papers. - Began to automate the computation of PE propagation angles. Determined bandwidth limitations of the model for current implementation of PE algorithm. Proposed a spatial phase shift solution to alleviate current restrictions on bandwidth. Identified potential test sites, hardware, spectrum, and MET team for field test. Developed an interface to the signal generator to produce pseudo-random noise and multi-tone signals required for channel soundings.			
FY 2011 Plans: - Continue work in reliable UAV data transport and technology transition. Develop UAV-based cloud computing architecture to provide assured computing capacity on demand at the tactical edge. Improve performance consistency of TCP connections over UAV wireless channels by exploiting channel diversity and developing performance models. - End work on HIF. - Expand suite of protocols to include the ability to handle multiple flows simultaneously and multicast traffic. Work to improve network coding protocol.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Analyze common approaches to determine if certain configurations result in poor or undesirable performance. Use the results and use the performance as feedback to modify protocols. Release protocol results as open source software. Update scenarios ad enhance protocols. - Continue the research fundamental applied science issues in group-based structures in self-organizing networks. Research and development of extensions to XO and group-based reliable messaging will be further addressed. XO-based reliable server-less group XMPP chat will be part of coalition operations experiments (French and German militaries) at Ft. Dix in Oct 2010. Continue DTN research into group-based extensions and approaches. - Complete a study on SATCOM and Tactical NetOps control architectures and interactions, including a draft common architecture approach. Campaign plan for joint strategic and tactical concept of operations for integrated NetOps and recommendations for future work. - Complete experimental evaluation of current state of the art protocols. Provide support for flight evaluation of select tactical edge protocols and technologies. Complete research and experimentation of enhanced cutting edge protocols with autonomy enhancements and hybrid approaches. - Perform a suitable validation and analysis of the channel model. - Investigate approaches to improve simultaneous communications and suppression capabilities by investigating algorithms and technologies that jointly optimize both missions. Create architecture and emulation/simulation description.			
FY 2012 Plans: - Create wireless 'MapReduce' implementation for UAV-based airborne cloud computing to support fast decision-making at the edge of an enterprise. Prototype wireless compute clouds to support transport and processing of large-scale sensor data based on advanced compression techniques. - Share Cooperative Heterogeneous Comms information with programs of record including JTRS and WIN-T. Implement a prototype version on Lincoln Labs mobile vehicle testbed. Prepare a software package (to enable proactively exploiting the redundancy in heterogeneous networks) for release and transition to Programs of record. - Document Inter-domain Routing lessons learned and distribute to DoD operators. Publish definitions of the impact of routing policy configurations on the interoperation and performance of connection disparate networks. - Continue to work Internet standards in self-organizing mobile ad hoc networks. Publish and document experiments and related design and make available to the community. Develop reliable messaging prototype to include algorithm options for distributed long-term consistency vs. adaptive real-time delivery in mobile and disrupted network environment models. Summarize DTN findings in group-based communications. Identify transition opportunities for XO capability. - Submit a MILCOM paper on SATCOM and tactical networks project. - Conduct flight testing for tactical edge protocol project.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Develop end-to-end system simulation capability for the channel model. Generate performance curves to characterize atmospheric impact on systems of interest to the military. Document project results and publish a journal article. - Demonstrate and define the communications requirements needed to support the growth and evolution of unmanned and autonomous systems (ex. UAV, ground robotics).			
Title: Network Management Tools and Analysis ***Description:*** This project is for the development of joint standards and tools for policy-based and measurement-based tactical network management. New standards and applications will be tested in a joint federated experimental emulation test bed being developed within this program. Project jointly executed by the Navy, Air Force and Army, with technology transition agreements being pursued with programs of record. Research efforts include Network Agent Technology for Management (NATM), Joint Integrated Network Management System Exchange (JINX), Small Form Factor Cross Domain Solution (SFF CDS), Cyber Security Metrics Trust Model, Explicit Congestion Network (ECN) Message Based Admission Control (MBAC), Tactical Resource Management and Control, Network End-to-End Monitoring (NEEMO), High Performance Information Assurance for Wireless Applications, Optimal Scheduling in Time Division Multiple Access (TDMA) Networks, and Dynamic Policy Management (DPM). Overall goal: Increased understanding of the complexity of the tactical network management. Determination of the support required for tactical network operations. Evaluation of technology to support transition and fielding to operational capability. ***FY 2010 Accomplishments:*** - Added policy-based network management enhancements to NATM. Extended NTAM framework to address network security. Developed adaptive management plane. Incorporated security policy management. Completed July 10 demonstration. - Began to test JINX in Army Virtual ad-hoc Networking (VAN) testbed and produced final whitepaper. Completed Prototype JINX framework with plug-ins (SCOM, What's Up Gold, OpenNMS, SNMPc) for joint demonstration (Feasibility demonstration for representative Army and Marine NMS text chat systems). - Began development of a government-of-the-shelf tactical SFF CDS in conjunction with the NRL. Created a remote management/situational awareness architecture. Concluded work on SSF CDS in the Networks Program. - Submitted three Cyber Security Metrics whitepapers to MILCOM 2010. Created security metrics assessment tool and computer network defense and attack models. Created additional computer network defense and attack models for testing cyber security metrics. Concluded work on the Cyber Security Metrics Trust Model in the Networks Program. - Began work on ECN MBAC Phase 2 prototype and conducted test in the Army network-in-the-loop testbed. Concluded work on ECN MBAC in the Networks Program. - Created a tactical resource management architecture description. Created design for emulating research management and conducted test in MIT-LL testbed.	5.209	6.167	4.810

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Began restructuring NEEMO architecture to better support data flow and reduce overhead. Added features to support NEEMO to include automatic correlation of flow records from multiple sources, on-way delay measurements, export of alerts and alarms to other management systems, development of control channel for remote filtering/control options, integration of NORM delivery service, and time synchronization. - Completed architecture and dynamic algorithm channel concept for information assurance for wireless applications. E-modeled tactical edge crypto device based on PEIP. Finalized COMSEC red and black interfaces needed for tactical systems. Prototyped Crypto Module and Crypto Host Board providing. Architected Crypto Module to provide higher speed cryptographic processes. Began work with Harris to architect & demo a design for integrating the PEIP-based Ethernet Host with HNR and WIN-T based HDT. - Implemented TDMA scheduler on SSC-PAC HPC Network. Compared the TDMA scheduler performance with Boeing WNW Confidence Tests. Researched current dual-space approaches to the Multicommodity Flow problem. Outlined a Dual-LP solver for the TDMA Multi-commodity Flow problem. - Began development of DPM use cases and algorithms. Demonstrated algorithm against use cases. Completed Phase 1 report and conference publication.			
FY 2011 Plans: Incorporate additional NetOps/Situational Awareness components by specifically integrating security management and IA; develop data mining techniques to offer automated network troubleshooting recommendations; continue work on topology detection; continue research into flow-based analysis; work on synchronization techniques to allow for timing differences at remote nodes; integrate IA techniques to detect unauthorized activity and research integration of multi-layer analysis. Work with appropriate Joint demonstration projects including a potential JCTD focused on NetOps. - Expand Adaptable Information Distribution (AID) work with Disruption Tolerant Distribution and enhanced Multi-Topology Routing Distribution for NATM. - Continue field testing of JINX tool and transition tool to joint environment. Create software that produces live network COP from Visio diagrams. Begin development on visualization of JINX on multi-touch table device. Create Android OS implementation of NRL server-less chat using 802.11 for JINX. - Continue performing emulating research management test in Lincoln Labs emulation testbed. Create semantic network descriptions & policy language design. Produce final report on test results. - Installation of NEEMO on Network Emulator to further research scalability issues and integrate network management into eMANE. Develop data mining techniques to offer automated network troubleshooting recommendations. Research/ implementation of network topology discovery. Continue research into flow-based analysis. Integrate IA techniques to detect unauthorized activity.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Extend the developed architecture and Crypto Host ICD to: 1) Support separate Ethernet data ports for multiple waveforms / applications at different classification levels, needing Type 1 cryptography (using PEIP technology), 2) Allocate channel usage within the Crypto for multi-level security (MLS) and the different application needs, and 3) Support secure remote C2 to dynamically establish crypto channels, load black keys, mission task orders, control the red/black processor cards, etc. - Create prioritization and multicast for the WNW target. Write reports for throughput comparison and algorithm investigation. Complete, code, and test the Dual-LP scheme. - Begin initial network manager integration of DPM in tactical communications lab. ***FY 2012 Plans:*** Continue to incorporate additional NetOps/Situational Awareness components by specifically integrating security management and IA; implement multi-layer analysis capabilities; integration into NetOps architectures and continue transition effort to programs of record. Continue research into flow-based analysis; research methods for automated intrusion detection and resolution and continue work with appropriate Joint demonstration projects. - Continue work on Disruption Tolerant Distribution and enhanced Multi-Topology Routing Distribution for NATM. Conduct additional demonstrations and deliver software. - Mature ID&M software for JINX by incorporating server-less tactical chat interoperable with existing systems, SCOM enhanced with JINX-based Management Packs, and network visualization tools. Create Network scan software to capture existing network organization. - Based on previous demonstrations of the tactical resource management and control project, provide a software package that can be used to illustrate the benefits of longer time-scale more-granular network management function that coordinates and brokers resources across a number of disparate network management systems that are organic to tactical communications systems. - Focus on transition of NEEMO. Continue to expand capability to interact with external network management products. Support the Joint Warfighting Integrated NetOps (JWIN) Joint Concept Technology Demonstration (JCTD). - Apply crypto architecture to the Software Reprogrammable Payload (SRP). - Develop plans for a Joint Demonstration of the optimal scheduling in TDMA Networks capability. Submit MILCOM papers on the topic. - Optimize DPM algorithm. Conduct small scale lab demonstration.			
Title: Spectrum Management Tools and Analysis ***Description:*** This project is for the development of measurement-based spectrum management tools. Applications will be developed and tested in a laboratory environment. Project executed by the Army with results available to the Navy and Air Force through the Joint NETOPS Integrated Collaborative Working Group. Transition planned for the GEMSIS program in 2010-2011 as maturity allows, and to other existing tactical network programs as appropriate. Research efforts include Dynamic Spectrum	3.185	4.817	3.857

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Allocation (DSA) Spectrum Analysis Software, Cognitive Networking Radio Platform (CNRP) and Cognitive Networking Radio Algorithmic Fusion (CNRAF), SIGINT-assisted Spectrum Management, Cognitive Radio Architecture Research, Networking for Spectrum Aware Cognitive Radios, Directional Ad-hoc Networking Technology (DANTE-2), DSA Enhancements, Spectrum Analysis and Experimentation in Dynamic Operational Environments, and Integrating Comm and Electronic Attack. Overall goal: Develop the technical basis to support changes regarding the operational use of spectrum both within the military and among spectrum regulatory bodies. ***FY 2010 Accomplishments:*** - Created a software library for DSA policy generation. Generated propagation models for DSA policy software analysis. Created a DSA policy dissemination mechanism. Created software library for DSA policy generation and created electronic warfare (EW) coexistence policy. Reported on DSA Policy dissemination mechanism. - Developed spectrum sensing and GPS interfaces for the cognitive radio. Began development of a prototype cognitive radio framework for CNRP. Began testbed instrumentation. Began to create interface for CNRP test site up, operations, and data collection. Ported cognitive radio (CR) Framework to GNU Radio. - Developed modeling package to evaluate spectrum planning Created a policy and interoperability report for SIGINT spectrum management. Explored alternative concepts (distributive spectrum sensing and alternate SIGNT modalities). Presented recommendations for specific experiments to connect the SIGINT and spectrum management communities. - Began creating performance metrics definition for the cognitive radio architecture. Conducted experiment in the VAN testbed. Created testbed for multiple DSA radios and multiple DSA networks w/ RF and Data planes testing capabilities. Completed initial study of DSA vulnerability in Electronic Attacks. Setup six node GNU radio/USRP/USRP2 testbed & CR/DSA algorithm development environment. - Began to study resource allocation and optimization in cognitive radio networks. Began developing algorithms that improve node cooperation via the use of relay nodes. Studied the impact of heterogeneity in the available spectrum at different locations of the network. Submitted papers to MILCOM, INFOCOMm and IEEE. - Invented and developed a new class of low-cost, light-weight electronically steered high gain antennas (15 GHz DANTE antenna, beam steering system, and LNA (Rx) and PA(Tx) amplifiers. - Started in-depth testing of new DSA core software and classifier for DSA Enhancements project. Preliminary design completed for frequency selection algorithm. Software in place to support channel quality algorithm. Completed warm start (discovery) design and documentation – More rapid rendezvous. Improved link maintenance to sustain connectivity. Improved channel coordination. ***FY 2011 Plans:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Integrate next generation Spectrum Management tool set in existing operational environments (i.e. Spectrum management centers). Develop algorithms that improve node cooperation via the use of relay nodes. Study the impact of heterogeneity in the available spectrum at different locations of the network. - Create ad-hoc negotiation schema, subnet fragmentation algorithms, subnet reconstitution algorithms, and multi-hop policy requirements for DSA. - Begin creating integrated radio network test bed that enables the development, evaluation, and demonstration of technologies that enable the operation of a Cognitive Radio Network. This will be accomplished by integrating CRNP with the VAN testbed. - Design low-cost sensor for SIGINT assisted spectrum management. Present year-end report. - Conduct electromagnetic environment survey, modeling, manipulation, simulation and emulation. Extend current cognitive radio testbed for more complex testing configurations and parameters. Continue to study capabilities of Cognitive Radio (CR) for EW as well as a counter to implementation of CR. - Continue research on stable throughput of cognitive radio networks and developing capacity scaling laws for cognitive radio networks. - Perform DANTE subsystems tests. Integrate the 15 GHz DANTE subsystems into a monolithic system. - Begin tackling DSA security issues. Study RF man-made noise effects on DSA. - Demonstrate a wireless, airborne and ground based spectrum sensing network. Create software visualization tools to convey real-time sensed spectrum space. - Research reactive electronic attack (EA) radios that can search for potential threats and study the benefits of EA radios cooperation with comm. radios. Investigate cooperation techniques and research key cooperative technologies.			
FY 2012 Plans: Demonstrate the integrated next generation Spectrum Management tool set in existing operational environments (i.e. Spectrum management centers): will extend policy-based reasoning to encompass Comms-EW coexistence requirement; expand policy capabilities to incorporate cooperative collaboration with EW systems and adaptive algorithms for real time cognitive control with special optimization technique to minimize interference for DSA/EW compatibility. - Create comms/EW interaction schema, active jammer algorithms, reactive jammer algorithms, and multi-hop policy solutions for DSA. - Perform an interoperability demonstration of CRNP in the VAN testbed. - Define an interface for connecting and fusing SIGINT data as inputs to spectrum management systems. - Continue cognitive radio testbed research and produce reports and documentation on findings. - Research Multi-hop cognitive radio networks by developing methodologies that maximize resource allocation for a set of end-to-end communication sessions while considering node heterogeneity with respect to available spectrum bands and bandwidth exchange as a means of cooperation.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Perform DANTE 15 GHz integrated hardware extension to other frequencies (antenna) and conduct field demonstrations. - Refine DSA security design to make it more comprehensive. - Refine spectrum software visualization tools. Submit data sets into the DoD Wireless Networking Library. - Build on the functional decomposition and sharing strategy developed in the previous year that recommends approaches for simultaneously operating communications and electronic attack transmitters. Demonstrate the ability to share functions across the two missions and illustrate the benefit to each mission in doing so.			
Title: Integrated Network Management Capability	7.568	7.360	6.998
Description: This project is for the development of joint integrated network management tools, and three federated experimental test beds for the development and evaluation of integrated tactical network management and spectrum management. Project executed jointly by the Navy, Army and Air Force. Plans also establish a Joint Network Operations (NETOPS) Integrated Collaborative Working Group for the establishments of standards and joint development in support of all projects in this program. Membership includes the research community from the Navy, Marine Corps, Army and Air Force as well as developers from acquisition programs such as Warfighter Information Network-Tactical (WIN-T) and Joint Tactical Radio System (JTRS). Future plans call for further joint infrastructure test bed development to include DoD PlanetLab as well as joint networking tools in support of NETOPS. The results of this research will transition to future increments of JTRS and WINT, and if successful, to the field through a joint integrated tactical NETOPS program. Research efforts include Joint Network Management Interoperability, Wireless Networking Library (WNL), Network Emulation and Experimentation, Tactical Edge Wireless Experimentation, Edge Network Visualization and Emulation (ENVE), and Tactical Edge Network Integration and Operational Environment Testbed. Overall goal: Common integrating framework to support interoperability among various aspect of developmental network operations and management to include: spectrum management, network management, security management and information management. Reduce the cost to develop, procure and support networks through the integration across networks and functions within networks. ***FY 2010 Accomplishments:*** - Completed VAN testbed demonstration (July 2010). JCR (formerly known as FBCB2) blue-force tracking production software is being evaluated using the VAN testbed to research potential future enhancements. Integrated Army VAN testbed with the Navy's eMANE by creating an eMANE to VAN adaptor. Completed L-Band Waveform development over EMANE for VAN/eMANE integration. - Published documentation of WNL. Worked to increase participation (submission and usage) of network management data library through advertising events (promotional materials and MILCOM 2010 booth).			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Prepared and disseminated briefing on network emulation experiences and capabilities. Improved network emulations ability to scale to 100s of nodes. Released open source software tools to support network emulation efforts. Created interconnected emulation capability with CERDEC and NRL and conducting joint experiments. - Conducted Mobile Networking Modeling Workshop in Feb 2010. Updated releases of the Extendible Mobile Ad-hoc Emulator (EMANE) framework. Launched NRL 200+ node eMANE facility. Modified eMANE to add HNR/SRW models for directional antenna support. Created eMANE developer training. Added high performance optimizations to eMANE. Created detection and jamming models. NRL “Max-EMANE” Testbed Facility Established. Continued EMANE, CORE & Tools Software Development. - Designed architecture and preliminary experimental evaluation paper for mlabCUNE. Developed hybrid link-emulation models for eMANE. ***FY 2011 Plans:*** Perform a joint Service lab inter-connection specifically using a “chat” capability to validate experimentation. Initiate selection and evaluation of next generation integrated network management software tools. Integrate next generation integrated network management software tools in existing operational environments (i.e. TNOCs, JTF-GNO). - Improve ease of use (through GUI enhancements, etc.) and accessibility of VAN testbed. Develop the capability for the VAN testbed to act as a cloud service on the DREN (Defense Research and Engineering Network) to allow authorized users to test software via remote connections. Perform scalability and application testing. - Continue to administer WNL (including updating software and security patches) and increase usage. - Complete emulation infrastructure expansion. - Implement models of additional DoD command and control tactical edge networking waveforms including legacy and anticipated waveform technologies in eMANE. Incorporate initial simulation-in-the-loop capabilities provided by other mobile network modeling tools and RF propagation prediction models into EMANE framework. Validate EMANE emulated network performance against known data sets collected from field experimentation. Begin advanced tactical data link modeling. Experiment to validate EMANE emulated network performance against known data sets collected from field experimentation. Conduct third DoD Mobile Network Modeling Workshop. - Complete paper of findings/results associated with protocol development for MlabCUNE. Complete final technical report. Transition findings to ENVE project. - Conduct experimental evaluation of current state of the art tactical edge protocols. ***FY 2012 Plans:*** - Develop a virtual network configuration and management toolset. Create user test network instrumentation and technical support capability. Create a testing and debugging software toolkit for distributed software applications. - Continue to recruit and manage the data sets in the WNL.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
- Perform upgrades to improve ability to better manage simultaneous experiments, better collect consistent data collection formats, and enhance performance visualization tools in the MIT-LL testbed. Conduct research on large-scale network emulation experiments and share network visualization and instrumentation software through open source channels. - Develop tactical data link models, radio module interfaces, and automated experiment test-control 'harness' for EMANE. - Conduct flight testing of selected tactical edge protocols and technologies.			
Title: Networked Communications Analysis Open Call ***Description:*** A percentage of the Networked Communications Analysis funding will be dedicated to supporting new research initiatives in this technical area. Each fiscal year, a RFP will be sent out with specific technical focus area and evaluation criteria for each project. The proposals will be graded by a peer review team who score each proposal in each of predetermined criteria. Proposals are then selected based on total score. Overall goal: To add innovative research projects in the area of networked communications to the program. ***FY 2010 Accomplishments:*** - Distributed RFP. Created Peer Review Team. Evaluated and selected FY10 Proposals. Announced proposal awards. Selected the following projects (in combination with proposals from P662 money): Directional Ad-Hoc Networking Technology (DANTE-2), Dynamic Policy Management, Link Scheduling to MAX Aggregate Throughput in TDMA Networks, Channel Modeling for Software Defined Radios in Real Atmospheric Environments, and mlabCUNE: An Emulation Environment for the AFRL Joint Airborne Testbed. ***FY 2011 Plans:*** - Create and distribute FY11 RFP. Conduct a Peer Review Conference where proposal candidates will present their work to the Peer Review teams. ***FY 2012 Plans:*** - No Open Call in FY12	1.175	2.071	-
Title: Tactical Networking Evolution and Expansion ***Description:*** This project is for the development of new applications and approaches that can be used on existing tactical networks to improve the physical- and networking layers for the tactical warfighter. It will explore new ways to build architectures, antennas, signal and data processing or exploit waveforms to improve Anti-Jam resistance, network throughput and scale, or network packet routing to improve these metrics, at low cost and without sacrificing interoperability. Enhanced Performance	-	4.012	2.889

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
for HNW including Net Entry at Extended Range, AFC2IC Airborne Network Management Analysis, and Advanced Waveform Support projects transferred from P662 starting in FY11. Beyond-Link16 project will begin in FY11. Overall goal: Next generation tactical networking in the fielded tactical systems, with vastly increased capabilities, at the lowest cost possible to the DoD. ***FY 2011 Plans:*** Enhanced Performance for HNW including Net Entry at Extended Range, AFC2IC Airborne Network Management Analysis, and Advanced Waveform Support projects transferred from P662 starting in FY11. Beyond-Link16 project will begin in FY11. Begin development of early prototypes for Anti-Jam improvements field testing. Identify transition opportunities. Goal is to demonstrate capabilities in FY2012. Begin planning for additional improvements to increase throughput, scale and IP-networking capability. Identify other candidate improvements. Evaluate operational impact of potential improvements. Transfer Enhanced Performance for HNW including Net Entry at Extended Range, AFC2IC Airborne Network Management Analysis, and Advanced Waveform Support projects from P662. Begin Beyond-Link16 project. - Demonstrate the range advantage of a single tone waveform. Integrate active beam and phase-locked loop steering based on signal levels. Conduct preliminary waveform performance evaluation. - Complete Phase II of the JALN Management Study. Create formal joint concept of JALN control. - Integrate individual advanced waveform approaches into a single waveform design. ***FY 2012 Plans:*** - Develop more efficient Multicast routing schemes for directional antenna mobile routing networks. Refine the cross-layer radio-to-router interface and examine advanced routing load balancing over mixed media networks. Compare long range theoretical link performance with measured results using ONR funded apertures with HNW to further extend the range/throughput performance. Complete Geodesic Cone field test report. - Support JALN Network Management Assessment of Alternatives. Support JALN DOTMLPF Change Requests. Assist with Validation of JALN Network Management Requirements. - Perform feasibility assessment by implementing advanced waveform on hardware appropriate for air applications. Create the definition of a future airborne C2 capability that can co-exist with and augment current Link-16 capabilites.			
Accomplishments/Planned Programs Subtotals	21.493	30.035	23.890

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C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

The Netted Iridium (NI) capability will be transitioned directly to production and sustainment to the DTCS-Army program by the Army for use in the CENTCOM AOR. Other program capabilities will be transitioned to acquisition programs as successful and appropriate.

E. Performance Metrics

Strategic Goals Supported: Net-Centric Warfare/Joint Interoperable Communication. Meet current needs of tactical warfighter

Existing Baseline: Prototype relays and gateways; initial federated, laboratory test beds; prototype joint network management tools

Planned Performance Improvement / Requirement Goal: Link expansion in prototype relays and gateways; Continued integration in federated test beds; demonstration of prototypes and software tools

Actual Performance Improvement: Prototype and transition able relays and gateways; Usage federated test beds; demonstration of prototypes and software tools

Planned Performance Metric / Methods of Measurement: Utilization of federated test beds; demonstration of prototypes and software tools

Actual Performance Metric / Methods of Measurement: Progress on test bed development; prototype software demonstrated; prototype architectures developed