

**UNCLASSIFIED**

PE NUMBER: 0602702F

PE TITLE: Command Control and Communications

<b>Exhibit R-2, RDT&amp;E Budget Item Justification</b>	DATE <b>February 2007</b>
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<b>BUDGET ACTIVITY</b> <b>02 Applied Research</b>	<b>PE NUMBER AND TITLE</b> <b>0602702F Command Control and Communications</b>
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Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	95.676	128.680	116.705	105.496	128.069	111.838	115.121	119.628	Continuing	TBD
4519 Communications Technology	23.987	29.273	27.458	27.126	35.448	24.788	29.305	31.385	Continuing	TBD
4594 Information Technology	26.879	33.581	32.154	31.691	33.502	31.544	33.735	34.979	Continuing	TBD
5581 Command and Control (C2) Technology	44.810	49.696	39.876	35.584	49.132	45.263	42.076	43.071	Continuing	TBD
66SP Space Optical Network Tech	0.000	16.130	17.217	11.095	9.987	10.243	10.005	10.193	Continuing	TBD

Note: In FY 2007, Project 6266SP, Space Optical Network Technology, efforts were transferred from PE 0602500F, Multidisciplinary Space Technology, Project 5082, Optical Networking Technology, in order to more effectively manage and provide oversight of the efforts.

**(U) A. Mission Description and Budget Item Justification**

This program develops technology for Air Force Command, Control, and Communications (C3). Advances in C3 are required to increase warfighter readiness and effectiveness by providing the right information, at the right time, in the right format, anytime, anywhere in the world. The program has four projects. The Communication Technology project develops assured and secure communications technology, and the capability to attack and exploit adversarial information and information systems. The Information Technology project develops improved and automated capabilities to generate, process, fuse, exploit, interpret, and disseminate timely and accurate information. The Command and Control Technology project investigates and develops planning, assessment, and knowledge base technologies to allow the warfighter to plan, assess, execute, monitor, and re-plan on the complex, compressed time scales required for tomorrow's conflicts. The Space Optical Networking Technology project develops the technology base for the next generation of ultra-wide- bandwidth, multi-channeled, air and space-based communications networks on and between platforms. Note: In FY 2007, Congress added \$2.5 million for Adaptive Optics for Lasercom System, \$1.0 million for Advanced Collaboration Platform for Net Centric Command and Control (C2), \$1.5 million for MASINT Visualization Tools, \$1.1 million for Massively Parallel Optical Interconnects, \$2.2 million for Space Qualified Command Data Link, and \$1.6 million for Digital Free Space Optical Laser Transmitter Modems. This program is Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

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(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	96.714	119.267	118.562	116.126
(U) Current PBR/President's Budget	95.676	128.680	116.705	105.496
(U) Total Adjustments	-1.038			
(U) Congressional Program Reductions				
Congressional Rescissions	-0.003	-0.487		
Congressional Increases		4.100		
Reprogrammings	-0.409	5.800		
SBIR/STTR Transfer	-0.626			
(U) <u>Significant Program Changes:</u>				
Not Applicable.				

## C. Performance Metrics

(U) Under Development.

**Exhibit R-2a, RDT&E Project Justification**

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Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4519 Communications Technology	23.987	29.273	27.458	27.126	35.448	24.788	29.305	31.385	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

**(U) A. Mission Description and Budget Item Justification**

The Air Force requires technologies that enable assured, worldwide/theater, high capacity, communications and networking for Air Force Task Forces. These communication and networking technologies will provide capabilities for en route and deployed distributed collaborative command, control, surveillance, reconnaissance and exploitation. A rapidly deployed force requires assured connectivity with reliable, responsive, affordable information exchange via all available communications media. This project provides the technologies for: multi-level, secure, seamless networks; advanced communications processors; anti-jam and low probability of intercept techniques; lightweight, phased array antennas; and modular, programmable, low-cost software radios. It includes technologies for advanced processors and devices, advanced network protocols and services, intelligent communications management and control, advanced communications algorithms, and enabling communication signal processing techniques.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop assured and survivable information and networking technologies enabling worldwide command, control, surveillance, reconnaissance and exploitation operations for the Air Force.	9.763	12.072	9.749	9.073
(U) In FY 2006: Completed development of technologies to improve quality of service and survivability for globally distributed information systems (e.g., JBI). Completed development of programmable networking algorithms that enable wide area dynamic creation of advanced information delivery services, independent of the underlying physical infrastructure devices. Developed capabilities for self-organizing, self-healing, autonomous networking. Developed policy-based network management technologies for real-time network response to changes in information condition (INFOCON) levels. Developed communications/resource network management schemas and sensor exploitation technologies enabling the dynamic integration of communications and sensor management functions for more effective moving target exploitation and fusion. Developed content-based delivery networking (CBDN) technologies for intelligent network delivery and management of end user information.				
(U) In FY 2007: Complete development of capabilities for self-organizing, self-healing, autonomous networking. Continue development of policy-based network management technologies for real-time network response to changes in INFOCON levels. Continue development and test of communications/resource network management schemas and sensor exploitation technologies enabling the dynamic integration of communications and sensor management functions for more effective moving target exploitation and fusion. Continue development of airborne CBDN, synergistic with the Joint				

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- |  | <u>FY 2006</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
|--|----------------|----------------|----------------|----------------|
| <p>(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b></p> <p>Tactical Radio System Wideband Networking Waveform's Network Service Layer, and apply to extremely dynamic infrastructure and network/platform mobility dictated by tactical aircraft.</p> <p>(U) In FY 2008: Continue development of policy-based network management technologies for real-time network response to changes in INFOCON levels. Continue development of airborne CBDN, synergistic with the Joint Tactical Radio System Wideband Networking Waveform's Network Service Layer, and apply to extremely dynamic airborne nets. Continue design and development of airborne network modeling and simulation technology. Initiate design and development of cognitive networking technology that senses operating environment, learns application requirements, and intelligently adapts network protocols. Initiate design and development of network operations and security capability to provide policy-based, mission-based, cross-domain, heterogeneous network quality of performance, security, configuration and fault management in a net-centric environment. Develop and complete intelligent network management agents designed to monitor the airborne domain's handling of the flow of information from platform to platform through various interconnected communication nodes and links. Initiate development of a resilient and self-regenerating information Network Centric Warfare enterprise that dynamically recognizes, characterizes and understands novel cyber attacks and service anomalies, aids in the creation of synthetically diverse, functionally equivalent software, and continuously monitors, reconfigures, and self optimizes the mission critical enterprise to resist new attacks.</p> <p>(U) In FY 2009: Complete development of airborne CBDN, synergistic with the Joint Tactical Radio System Wideband Networking Waveform's Network Service Layer, and apply to extremely dynamic airborne nets. Continue design and development of airborne network modeling and simulation technology. Continue design and development of cognitive networking technology that senses operating environment, learns application requirements and adapts network protocols. Complete development of policy-based network management technologies for real-time network response to changes in INFOCON levels. Continue design and development of network operations and security capability to provide policy based, mission based, cross domain, heterogeneous network quality of performance, security, configuration and fault management. Initiate development of small hand-held multi-data rate , IP compatible, covert network radios. Continue development of a resilient and self-regenerating information Network Centric Warfare enterprise that Dynamically recognizes, characterizes and understands novel cyber attacks and service anomalies, aids in the creation of synthetically diverse, functionally equivalent software, and Continuously monitors, reconfigures, and self optimizes the</p> |                |                |                |                |

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<b>(U) B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
mission critical enterprise to resist new attacks Initiate development of secure data sharing to prevent the disclosure of sensitive information to untrustworthy users					
(U) MAJOR THRUST: Develop improved, higher bandwidth communications and signal processing technologies to provide secure, adaptive, covert, anti-jam, and assured global battlespace connectivity to highly mobile aerospace forces, while reducing the equipment footprint.		4.484	4.705	4.359	3.731
(U) In FY 2006: Developed information assurance technologies that improve the robustness of the Global Information Grid in both wireline and wireless networks for air, space, ground, and joint/coalition environments to preclude information systems attacks such as distributed denial of service and degradation of device quality. Developed higher performance, adaptively combined multi-dimensional (space, time, frequency, coding, polarization) transmission techniques that enable high bandwidth information transmission and exploitation capabilities over wireless channels which support command and control, and intelligence, surveillance, and reconnaissance missions, and the use of intelligent munitions. Completed development of higher performance video compression and modulation techniques that enable critical objectives for high bandwidth information transmission and exploitation capabilities over wireless channels. Designed and developed a multi-mode, multi-function, sense-and-adapt air-mobile communications capability to dynamically alter communications methods to support, under fast-changing environments, higher-throughput, anti-jam, low probability of intercept, and/or robust [assured] voice, data, and video communications. Performed such design and development within the framework of the Joint Tactical Radio System or compatible software defined radios. Explored/exploited feasible applications of quantum key distribution and cryptography to effect ultra-secure communications for wireline and wireless networks.					
(U) In FY 2007: Complete first phase development of information assurance technologies that improve the robustness of the Global Information Grid in both wireline and wireless networks for air, space, ground, and joint/coalition environments to preclude information systems attacks. Demonstrate promising higher performance, adaptively combined multi-dimensional (space, time, frequency, coding, polarization) transmission techniques that enable high bandwidth information transmission and exploitation capabilities amongst airborne command and control, and intelligence, surveillance, and reconnaissance platforms and various weapon delivery systems with their smart munitions. Test and demonstrate a multi-mode, multi-function, sense-and-adapt air-mobile communications capability to dynamically alter communications methods under fast-changing environment within the framework of					

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(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2006FY 2007FY 2008FY 2009

the Joint Tactical Radio System or compatible software defined radios. Develop and test promising quantum key distribution and cryptography technologies to effect ultra-secure communications for wired and wireless networks. Perform transition planning.

- (U) In FY 2008: Complete demonstration of adaptively combined multi-dimensional (space, time, frequency, coding, polarization) transmission techniques that enable high bandwidth information transmission and exploitation capabilities. Complete demonstration of multi-mode, multi-function, sense-and-adapt air-mobile communications capability to dynamically alter communications methods under fast-changing environment. Continue development of quantum key distribution and cryptography technologies to effect ultra-secure communications for wired and wireless networks. Initiate design and demonstration of assure access, anti jam communications capability that combines multi-dimensional (space, time, frequency, coding, polarization) transmission techniques, multi frequency, multi wavelength, multi path techniques and spectrum sense and adapt techniques. Initiate investigation to provide assured access (anti-jam) covert high capacity spectrum dominance for global networking while denying the adversary the same. Initiate development of scaleable video compression schemes which dynamically trade-off bandwidth and quality based upon the priority of the required information. Initiate the development of advanced, automated, network and bandwidth management technologies to move, manage, and process information in real-time for the warfighter.

- (U) In FY 2009: Complete development of quantum key distribution and cryptography technologies to effect ultra-secure communications for wired and wireless networks. Continue design and demonstration of assure access, anti jam communications capability that combines multi-dimensional (space, time, frequency, coding, polarization) transmission techniques, multi-frequency, multi-wavelength, multi-path techniques, and spectrum sense and adapt techniques. Continue the development of advanced, automated, network and bandwidth management technologies to move, manage, and process information in real-time for the warfighter.

- (U) MAJOR THRUST: Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems' C2, intelligence, surveillance, and reconnaissance data/information.

1.796

2.130

1.500

1.000

- (U) In FY 2006: Explored techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses. Developed, tested, and assessed exploratory radio frequency and optical information transfer technologies.

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Project 4519

Exhibit R-2a (PE 0602702F)

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<b>(U) B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Continue to explore multiple technologies/techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses. Continue development, test, and assessment of exploratory radio frequency and optical information transfer technologies.					
(U) In FY 2008: Complete development, test, and assessment of exploratory radio frequency and optical information transfer technologies. Continue to explore multiple technologies/techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses applicable to battlefield network operations.					
(U) In FY 2009: Continue to explore multiple technologies/techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses applicable to battlefield network operations.					
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop cyber operations technologies for enabling worldwide command, control, communications and intelligence. This effort includes Congressional Add funding of \$1.0 million in FY 2006. Note: Increase in funding in FY 2008 and FY 2009 is due to emphasis on offensive cyber operations.		7.944	7.866	11.850	13.322
(U) In FY 2006: Developed intrusion detection techniques for wireless networks. Developed automated capabilities for damage assessment and recovery. Developed techniques for defining defensive courses-of-action to counter adversary information warfare attacks. Developed defensive techniques for wireless, mobile and embedded systems. Developed detection and eradication techniques for malicious code. Developed of active response and computer network attack (CNA) technologies. Developed advanced correlation fusion techniques for defensive course of action analysis. Initiated work addressing self-healing systems. Conducted Congressionally directed efforts for Cyber Situational Awareness.					
(U) In FY 2007: Complete development of intrusion detection techniques for wireless networks. Continue to develop automated capabilities for damage assessment and recovery. Continue to develop techniques for defining defensive courses-of-action to counter adversary information warfare attacks. Continue to develop defensive techniques for wireless, mobile and embedded systems. Continue to develop detection and eradication techniques for malicious code. Continue development of active response and CNA technologies. Continue development of advanced correlation fusion techniques for defensive course of action analysis. Continue efforts in self-healing systems.					

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<b>(U) B. Accomplishments/Planned Program (\$ in Millions)</b>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Complete development of techniques for defining rapid defensive courses-of-action (COA) to counter adversary information warfare attacks. Continue to develop defensive techniques for wireless, mobile and embedded systems. Demonstrate detection and eradication techniques for malicious code. Complete development of advanced correlation fusion techniques for defensive course of action analysis. Complete efforts in self-healing systems. Initiate assured end-to-end Quality of Service (QoS) and Quality of Assurance (QoA) integration to the informaton system enterprise during malicious and non-malicious faults. Develop a prototype that will be able to model the unique aspects of an IP-based airborne network (e.g., aircraft communications, antennas, and networking components) against a variety of cyber threats with the end-goal of improving the overall defenses of the airborne network. Initiate development of access techniques allowing "cyber paths" to protected adversary information systems through a multiplicity of attack vectors. Initiate development of stealth and persistence technologies enabling continued operation within the adversary information network. Initiate programs to provide the capability to exfiltrate any and all types of information from compromised information systems enabling cyber intelligence gathering to achieve cyber awareness and understanding. Initiate technology programs to deliver D5 (deny, degrade, destroy, disrupt, and deceive) effects to the adversary information systems enabling integrated and synchronized cyber and traditional kinetic operations.					
(U) In FY 2009: Initiate work in Cyber Command and Control for defensive cyber operations to achieve cyber awareness and understanding. Continue to develop defensive techniques for wireless, mobile and embedded systems. Continue assured end-to-end Quality of Service (QoS) and Quality of Assurance (QoA) integration to the informaiton system enterprise dueing malicious and non-malicious faults. Initiate work in autonomic defensive response to rapidly recover from adversary cyber attacks. Continue development of information system access methods. Initiate efforts to propagate through adversary networks. Continue cyber intelligence gathering efforts to achieve cyber situational awareness and understanding. Continue cyber and traditional kinetic weapon integration technology development and initiate efforts for cyber delivery to influence operations effects.					
(U) CONGRESSIONAL ADD: Adaptive Optics Lasercom System		0.000	2.500	0.000	0.000
(U) In FY2006: Not Applicable					
(U) In FY2007: Develop and demonstrate reliable bi-directional ground and/or airborne lasercom communications link that automatically acquires and maintains itself in a seamless operation.					

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(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY2008: Not Applicable				
(U) In FY2009: Not Applicable				
(U)				
(U) Total Cost	23.987	29.273	27.458	27.126

(U) <b><u>C. Other Program Funding Summary (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>						
(U) Related Activities:									
(U) PE 0603789F, C3I Advanced Development.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <b><u>D. Acquisition Strategy</u></b> Not Applicable.									

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Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4594 Information Technology	26.879	33.581	32.154	31.691	33.502	31.544	33.735	34.979	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

**(U) A. Mission Description and Budget Item Justification**

The Air Force requires technologies that improve and automate their capability to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information. This project improves global awareness at all levels, enabling warfighters to understand relevant military situations on a consistent basis with the timeliness and precision needed to accomplish their missions. Global awareness is achieved by exploiting information provided by the Air Force, other government agencies, and open source information. The information is fused to support the dynamic planning, assessment and execution cycles via the global information enterprise. Knowledge, information, and data are all archived in the global information base for continued use and historical analysis. The information technologies required to achieve this capability are developed under this project in an affordable manner and include appropriate access mechanisms for our coalition partners. This project develops high-payoff embedded information systems technologies for the next generation of distributed information integration architectures to enable global information dominance and air and space superiority. The embedded information systems technologies provide affordable, innovative, secure, net-enabled embedded information systems to the warfighter.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop innovative multi-sensor collaborative fusion technologies in a fully distributed air and space environment.	6.270	7.646	7.062	6.386
(U) In FY 2006: Developed and evaluated fusion techniques for optimal fusion management. Tested and analyzed vehicle motion models for variable state multiple algorithm to associate the current location of vehicle with a future state. Enhanced multi-source fusion techniques for probabilistic identification and continuous tracking of military significant threats in the battlespace. Evaluated evidence accrual and data mining techniques for improved fusion performance. Developed new measures of performance for higher levels of fusion in analyzing situational assessment and process refinement.				
(U) In FY 2007: Evaluate fusion management and advance the state-of-the-art in track-to-track fusion techniques. Continue the process of probabilistic identification through the use of multi-source fusion. Increase probabilistic confidence through the inclusion of higher-level fusion techniques in the situational assessment and process refinement area. Develop techniques to dynamically update advanced reasoning fusion engines to adapt to changing threat conditions. Develop intelligence, surveillance, and reconnaissance management techniques that optimize the fusion process for identification and continuous tracking of military significant threats. Evaluate network centric approaches to provide distributed fusion techniques to the warfighter.				
(U) In FY 2008: Evaluate fusion management and advance the state-of-the-art in track-to-track fusion				

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<u>(U) B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>techniques. Continue the process of probabilistic identification though the use of multi-source fusion. Continue to increase probabilistic confidence through the inclusion of higher-level fusion techniques in the situational assessment and process refinement area. Continue to develop techniques to dynamically update advanced reasoning fusion engines to adapt to changing threat conditions. Continue to develop intelligence, surveillance, and reconnaissance management techniques that optimize the fusion process for identification and continuous tracking of military significant threats. Evaluate network centric approaches to provide distributed fusion techniques to the warfighter. Develop new track algorithms that combine traditional kinematic associations with multi-INT reasoning to improve the identification and track life times of ground moving targets; taking into account the limitations of gap times, dense target environments and large sensor data inaccuracies. Develop a set of algorithms that can automatically develop, reason, dynamically update various sub-sets of the existing intelligence preparation of the battlespace products (e.g., named areas, target areas, COA, units, infrastructure areas, lines of communication). Initiate development of fused air, ground, and space information through machine-to-machine automatic fusion and dynamic re-tasking processes resulting in a single network centric operational picture. Processes to be examined include machine-to-machine automated multi-INT fusion, long term automated tracking and ID of nominated targets, and automated/adaptive pattern recognition. Initiate investigation of Fusion of CybINT (Cyber Intelligence) with traditional INTs.</p> <p>(U) In FY 2009: Evaluate fusion management and advance the state-of-the-art in track-to-track fusion techniques. Complete the process of probabilistic identification though the use of multi-source fusion. Continue to increase probabilistic confidence through the inclusion of higher-level fusion techniques in the situational assessment and process refinement area. Complete the development of techniques to dynamically update advanced reasoning fusion engines to adapt to changing threat conditions. Complete the development and assessment of intelligence, surveillance, and reconnaissance management techniques that optimize the fusion process for identification and continuous tracking of military significant threats. Complete the development and assessment of network centric approaches to provide distributed fusion techniques to the warfighter. Continue the development of new track algorithms that combine traditional kinematic associations with multi-INT reasoning to improve the identification and track life times of ground moving targets; taking into account the limitations of gap times, dense target environments and large sensor data inaccuracies. Complete the development of a set of algorithms that can automatically develop, reason, dynamically update various sub-sets of the existing intelligence preparation of the battlespace products (e.g., named areas, target areas, COA, units,</p>				

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infrastructure areas, lines of communication). Continue development of fused air, ground, and space information through machine-to-machine automatic fusion and dynamic re-tasking processes resulting in a single network centric operational picture. Processes to be examined include machine-to-machine automated multi-INT fusion, long term automated tracking and ID of nominated targets, and automated/adaptive pattern recognition. Continue investigation of Fusion of CybINT with traditional INTs.

(U)

(U) MAJOR THRUST: Develop higher-level fusion and the enabling information/knowledge base technologies to achieve situational awareness and understanding at all command levels for the dynamic planning, assessment and execution processes.

5.503

6.745

7.319

8.668

(U) In FY 2006: Completed development of intermediate information extraction techniques to decrease analysis time for decision-making and enabling the ability to populate knowledge base systems. Completed development of techniques addressing key entity extraction technology gaps, to improve the accuracy of Air Force and joint systems that exploit information from unstructured text for situation analysis. Developed interactive contextual reasoning with inference techniques for self-organizing data repositories, and content-based extraction to support identification of potential events in the world. Enhanced web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational understanding. Developed inferencing techniques for reasoning about the situation and predict enemy intent and threat possibility.

(U) In FY 2007: Enhance techniques for interactive contextual reasoning with inference techniques for self-organizing data repositories and content-based extraction to support identification of potential events in the world. Continue enhancement of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational understanding. Continue developing inferencing techniques for reasoning about the situation and for predicting enemy intent and threat possibility.

(U) In FY 2008: Complete enhancement of techniques for interactive contextual reasoning with inference techniques for self-organizing data repositories and content-based extraction to support identification of potential events in the world. Continue enhancement of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational awareness and understanding. Continue

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<b>(U) B. Accomplishments/Planned Program (\$ in Millions)</b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>developing inferencing techniques for reasoning about the situation and for predicting adversarial intent and threat possibility. Develop a dynamic real-time information management capability with the objective of decreasing the execution speeds of embedded HPC and enterprise infospheres by 100X. Initiate development of multi-source and automated recognition techniques to support analysis of current situations. Initiate development of technology demonstration plans for cyber situational awareness and understanding using an autonomous set of cooperative agents under positive control to defend mission critical Air force (AF) assets. Initiate development of technology demonstration plans for active intelligence, surveillance and reconnaissance (ISR) defense on wired networks to perform an adaptive response to multiple, coordinated, sustained attacks. Initiate research to forecast actionable futures to support a decision maker's ability to appraise and plan the "best" blue course of action for Rapid, Decide, Act and Adapt. Initiate research to achieve the capability to analyze multiple courses of action (COA) having cascading effects in near real-time. The capability will be able to mix kinetic and non-kinetic options, continuously forecast the direct and indirect effects of each COA, and play COAs forward in time to identify key plan dependencies, decision points, and the foreclosure of options.</p> <p>(U) In FY 2009: Complete enhancement of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational awareness and understanding. Continue developing inferencing techniques for reasoning about the situation and for predicting enemy intent and threat possibility. Continue development of multi-source and automated recognition techniques to support analysis of current situations. Continue development of technology demonstration plans for cyber situational awareness and understanding using an autonomous set of cooperative agents under positive control to defend mission critical AF assets. Initiate development of technology demonstration plans for active ISR defense on wired networks to perform an adaptive response to multiple, coordinated, sustained attacks. Continue research to achieve the capability to analyze multiple courses of action (COA) having cascading effects in near real-time. The capability will be able to mix kinetic and non-kinetic options, continuously forecast the direct and indirect effects of each COA, and play COAs forward in time to identify key plan dependencies, decision points, and the foreclosure of options. Continue research to forecast actionable futures to support a decision maker's ability to appraise and plan the "best" blue course of action for Rapid, Decide, Act and Adapt.</p>				
<p>(U) MAJOR THRUST: Develop automatic and dynamically reconfigurable, affordable, scalable, distributed</p>	4.041	4.770	6.273	7.068

<b>Exhibit R-2a, RDT&amp;E Project Justification</b>	DATE <b>February 2007</b>
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<b>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
petaflop processing technologies for real-time C2 global information systems.				
<b>(U)</b> In FY 2006: Completed architecture for support of real-time requirements for dominant battlespace awareness. Completed study results of next generation information technologies for C2 systems. Evaluated architectural features for cognitive information processing. Initiated algorithm development for next generation information technologies for C2 systems. Initiated architectural development for cognitive information processing. Developed and characterized high performance computers for quantum computing applications.				
<b>(U)</b> In FY 2007: Complete evaluation of architectural features for cognitive information processing. Continue algorithm development for next generation information technologies for C2 systems. Continue architectural development for cognitive information processing. Continue development and characterization of high performance computers for quantum computing applications. Initiate development and characterization of the next generation of high performance computers.				
<b>(U)</b> In FY 2008: Initiate implementation of architectural features for cognitive information processing. Continue algorithm development for next generation information technologies for C2 systems. Continue development and characterization of high performance computers for quantum computing applications. Continue development and characterization of the next generation of high performance computers. Develop a prototype chip that contains a hybrid architecture design; which will provide an emulation capability for large scale cognitive architecture evaluations. Initiate the development of the tools, techniques, standards and technologies required to build highly complex software-intensive systems.				
<b>(U)</b> In FY 2009: Continue implementation of architectural features for cognitive information processing. Complete algorithm development for next generation information technologies for C2 systems. Complete architectural development for cognitive information processing. Complete development and characterization of high performance computers for quantum computing applications. Continue development and characterization of the next generation of high performance computers. Complete the development of a prototype chip that contains a hybrid architecture design; which will provide an emulation capability for large scale cognitive architecture evaluations. Continue the development of the tools, techniques, standards and technologies required to build highly complex software-intensive systems. Initiate development of high capacity processing on demand which will reduce the ever increasing amounts of raw data to actionable information. Provide hardware and system/support software that enables complex software to be readily composed.				
<b>(U)</b>				

**UNCLASSIFIED**

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(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) MAJOR THRUST: Develop modeling and simulation technologies for the next generation of planning, assessment, and execution environments.	2.426	2.776	2.793	2.579	
(U) In FY 2006: Developed advanced modeling and simulation technologies to support next generation planning execution and assessment environments. Developed adversarial behavior models and modeling techniques for dynamic course of action assessment and prediction. Initiated investigation of techniques for integrated interaction and assessment of friendly versus enemy courses of action. Developed simulation techniques for dynamic situation assessment and prediction.					
(U) In FY 2007: Demonstrate advanced modeling and simulation technologies to support next generation planning execution and assessment environments. Demonstrate adversarial behavior models and modeling techniques for course of action assessment and prediction. Conduct concept demonstrations of integrated interaction and assessment of friendly versus enemy courses of action. Demonstrate a prototypical dynamic situation assessment and prediction system. Investigate advanced concepts to provide approaches for a modeling toolset that enables the warfighter to build composable simulations.					
(U) In FY 2008: Complete demonstrations of advanced modeling and simulation technologies to support next generation planning, assessment and execution environments. Continue to demonstrate adversarial behavior models and modeling techniques for courses of action (COA) assessment and prediction. Continue to conduct concept demonstrations of integrated interaction and assessment of friendly versus adversary courses of action. Continue to demonstrate a prototypical dynamic situation assessment and prediction system. Continue to investigate advanced concepts to provide approaches for a modeling toolset that enables the warfighter to build composable simulations. Initiate investigation of ability to forecast potential adversaries and events based on indications of known evidence and projected known and/or anticipated threat(s).					
(U) In FY 2009: Complete demonstrations of adversarial behavior models and modeling techniques for courses of action assessment and prediction. Continue to conduct concept demonstrations of integrated interaction and assessment of friendly versus adversary courses of action. Complete demonstration of a prototypical dynamic situation assessment and prediction system. Continue to investigate advanced concepts to provide approaches for a modeling toolset that enables the warfighter to build composable simulations. Continue investigation of ability to forecast potential adversaries and events based on indications of known evidence and projected known and/or anticipated threat(s).					
(U) MAJOR THRUST: Develop real-time embedded information system technologies for complex,	1.978	2.210	2.700	1.962	

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time-critical, embedded systems to enable affordable design and development of state-of-the-art hardware and software, innovatively incorporate new capabilities, reactively adapt to multiple missions and changing environments, verify, validate, and assure functionality and integrity, and facilitate rapid insertion to support real-time, collaborative operations within a net-centric enterprise.

- (U) In FY 2006: Developed dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Developed adaptive embedded computing technologies to support enhanced interoperability and information exchange between tactical C2 platforms to support network centric operations, based on Real-Time Java and reconfigurable computing. Developed processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems. Developed algorithms, methods, and processes to support real-time, adaptive resource management of system resources across multiple tactical platforms. Developed multi-level secure middleware for real-time embedded system architectures. Developed methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Initiated development of power-aware, polymorphic aerospace systems for mission-aware computing.

- (U) In FY 2007: Continue development of dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Complete program to develop adaptive embedded computing technologies to support enhanced interoperability and information exchange between tactical C2 platforms to support network centric operations, based on Real-Time Java and reconfigurable computing. Continue to develop processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems. Continue to develop algorithms, methods, and processes to support real-time, adaptive resource management of system resources across multiple tactical platforms. Continue to develop multi-level secure middleware for real-time embedded system architectures. Continue development of methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Continue development of power-aware, polymorphic aerospace systems for mission-aware computing.

- (U) In FY 2008: Continue development of dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Continue development of affordable, high assurance architecture components for real-time embedded systems supporting Multi-Level Security/Multiple Single Levels of Security (MLS/MSLS) and mixed criticality. Continue

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(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2006FY 2007FY 2008FY 2009

development of methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Initiate development of power-aware, polymorphic aerospace systems for mission-aware computing.

- (U) In FY 2009: Continue development of dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Continue development of affordable, high assurance components for real-time embedded systems supporting Multi-Level Security/Multiple Single Levels of Security (MLS/MSLS) and mixed criticality. Continue development of methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Continue development of power-aware, polymorphic aerospace systems for mission-aware computing.

(U)

- (U) MAJOR THRUST/CONGRESSIONAL ADD: Develop digital information exploitation technologies for electronic communications and special signals intelligence, imagery, and measurement signatures to increase accuracy, correlation, and timeliness of the information value to the decision maker. Note: This effort includes Congressional Add funding of \$1.5 million in FY 2007.

6.661

9.434

6.007

5.028

- (U) In FY 2006: Developed tools to increase the production capability of the intelligence analyst. Develop techniques in steganography, steganalysis, watermarking, and digital data forensics for imagery, video, and speech information protection and authentication, intelligence exploitation, and analysts' tool aids. Developed tools to detect, track, and analyze document and file tampering through the use of steganography, steganalysis, and digital watermarking.

- (U) In FY 2007: Complete first phase development of techniques in steganography, steganalysis, watermarking, and digital data forensics for imagery, video, and speech information protection and authentication, and intelligence exploitation. Continue the development of the multi- intelligence toolsets for the processing, exploitation and dissemination of actionable intelligence, including the development of MASINT capability which integrates inputs from various sensors and visually display the critical MASINT information. Conduct Congressionally directed effort for MASINT visualization tools.

- (U) In FY 2008: Continue the development of the multi- intelligence toolsets for the processing, exploitation and dissemination of actionable intelligence. Develop more effective multi-sensor signature exploitation algorithms to enhance detection (by 50%), identification (by 25%), and assessment (10X reduction in analyst time) of difficult targets; taking into account the complementary signature features

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(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(e.g., geo-physical, materials) that can be derived from multiple MASINT sensors. Develop algorithms to automatically detect and identify audio protection and channelization effects in modern modulated personal communications systems (PCS) with the goal of providing analysts the capability to automatically detect speech privacy and identify methods and means used.				
(U) In FY 2009: Continue the development of the multi- intelligence the processing, exploitation and dissemination of actionable intelligence. Complete the development of more effective multi-sensor signature exploitation algorithms to enhance detection (by 50%), identification (by 25%), and assessment (10X reduction in analyst time) of difficult targets; taking into account the complementary signature features (e.g., geo-physical, materials) that can be derived from multiple MASINT sensors. Complete the development to automatically detect and identify audio protection and channelization effects in modern modulated personal communications systems with the goal of providing analysts the capability to automatically detect speech privacy and identify methods and means used. Initiate development of methods and mechanisms to achieve robust/tamper-proof self-authenticating, self-regenerating code/data and detection and eradication systems for polymorphic malware. Research will include the detection and prevention of embedded malicious software (malware), system self-optimization / diagnosis / recovery, and the development of self-correcting watermarked code and data for trusted and optimized computing.				
(U) Total Cost	26.879	33.581	32.154	31.691

(U) <b><u>C. Other Program Funding Summary (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) Related Activities:										
(U) PE 0603789F, C3I Advanced Development.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										

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(U) D. Acquisition Strategy

Not Applicable.

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Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5581 Command and Control (C2) Technology	44.810	49.696	39.876	35.584	49.132	45.263	42.076	43.071	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

**(U) A. Mission Description and Budget Item Justification**

The Air Force requires C2 technologies that will provide the next generation of weapon systems with improved processing and presentation of information for real-time, distributed battle management and control. Technologies in this project must be capable of taking advantage of future net-centric environments including new structured and ad hoc processes in response to rapidly changing warfare challenges. Technologies being developed will increase capability, quality, and information interoperability, while reducing the cost of C2 systems and infrastructure. Technology development in this project focuses on planning and assessing techniques knowledge bases, distributed information systems, and information management and distribution services. Advances in planning and assessment technologies will vastly improve the military decision making process within C2 systems. Advances in the ability to rapidly detect, classify, identify, and continuously track objects and events will improve the awareness and understanding and prediction of adversarial intentions, allowing the development of various courses of action to counter their intentions. Advances in the development of very large comprehensive knowledge bases to rapidly formulate and create new knowledge are needed by the Expeditionary Aerospace Force. Advances in distributed intelligent information systems will allow automatic rapid reconfiguration of C2 centers to respond to varying crisis levels, as required, by a Net-Centric Aerospace Force. Advances in robust information management and dissemination technologies will ensure the delivery of high-quality, timely, secure information to the warfighter.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems.	6.816	7.730	6.499	5.501
(U) In FY 2006: Demonstrated tools that will automate the intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Developed technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Initiated development of foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real world requiring intelligence. Initiated development of cognitive architectures for self-aware, learning agents.				
(U) In FY 2007: Complete development of technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Continue to develop foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real world requiring intelligence. Investigate and develop specialized cognitive architectures using self-aware, learning agents that can generate well-focused				

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<b>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
knowledge bases for automated intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities.				
(U) In FY 2008: Continue to develop foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real-world requiring intelligence. Continue to investigate and develop specialized cognitive architectures using self-aware, learning agents that can generate well-focused knowledge bases for automated intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Develop a prototype that will have the capability, given commander's policies and Rules of Engagement, to apply context-aware access control to rapidly detect significant events and initiate reprioritization as required using operational databases and an available information management infrastructure. Initiate development of automated capture and self-organization of knowledge in globally distributed repositories.				
(U) In FY 2009: Continue to develop foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real-world requiring intelligence. Continue to investigate and develop specialized cognitive architectures using self-aware, learning agents that can generate well-focused knowledge bases for automated intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Continue development of automated capture and self-organization of knowledge in globally distributed repositories.				
(U) MAJOR THRUST: Investigate, analyze, and develop technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by the Expeditionary Aerospace Force.	12.293	13.622	10.241	9.320
(U) In FY 2006: Developed dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing AOC C2 process. Developed advanced interactive displays suitable for deployment in harsh environments with C2 applications and command centers. Developed advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Developed technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies. Initiated development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in the				

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- |  | <u>FY 2006</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
|--|----------------|----------------|----------------|----------------|
| (U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b><br>battlespace.  |                |                |                |                |
| (U) In FY 2007: Continue to develop dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing AOC C2 process. Continue to develop advanced interactive displays suitable for rapid deployment in harsh environments with C2 applications and command centers. Continue development of advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Continue to develop technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies. Continue development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in the battlespace.  |                |                |                |                |
| (U) In FY 2008: Complete the development of dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing AOC C2 process. Continue to develop advanced interactive displays suitable for rapid deployment in harsh environments with C2 applications and command centers. Continue development of advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Continue to develop technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies. Continue development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in and around the battlespace. Develop an advanced mission planning process that will provide a self-healing, secure, rule-based automatic scheduling process that resembles an auction style planning capability. Initiate development of capabilities to be more agile within a net centric enabled environment. Develop timely option generation selection and coordination capabilities that account for uncertainty and missing and erroneous information, and supports intuitive decision making process between man and machine collaborating on complex, dynamic problems exploiting the respective strengths of machines (process lots of data) and human (analytical reasoning). Develop dynamic workflow and workload management capabilities to manage the command and control constellation of resources. |                |                |                |                |
| (U) In FY 2009: Continue to develop advanced interactive displays suitable for rapid deployment in harsh environments with C2 applications and command centers. Continue development of advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Continue to develop technologies to improve the fidelity, accuracy,  |                |                |                |                |

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	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b></p> <p>and interconnection of computer-based wargames used to prepare contingency plans and response strategies. Continue development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in the battlespace. Continue development of capabilities to be more agile within a net centric enabled environment. Continue the development of timely option generation selection and coordination capabilities that account for uncertainty and missing and erroneous information, and supports intuitive decision making process between man and machine collaborating on complex, dynamic problems exploiting the respective strengths of machines (process lots of data) and human (analytical reasoning). Continue the development of dynamic workflow and workload management capabilities to manage the command and control constellation of resources.</p>				
<p>(U) MAJOR THRUST: Investigate and develop technologies to securely share information via publish, subscribe, and query with coalition partners as part of the overall Global Information Grid approach. Sharing of information is in part a function of secure sharing, but is also a function of the managing of the information in assessing the trustworthiness of the information and its markup.</p>	6.446	9.349	7.758	6.361
<p>(U) In FY 2006: Completed investigation of technologies to dynamically filter and fuse information and produce customized coalition information products. Developed technology approaches to rapidly assimilate appropriate coalition partners into appropriate COI Infospheres. Extended cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources such as firewalls/guards/routers, application servers, intrusion detection systems, etc. Investigated the ability to perform and enforce role-based access control to these COI Infospheres. Focused research on multi-domain event correlation from a centralized perspective (e.g., guarding services enabled, multi-level security repository) in order to establish a composite picture of resource status with the ability to centrally react to that status. Developed techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Initiated development of publish/subscribe technologies for application to a CBDN system for intelligent network management of user information.</p>				
<p>(U) In FY 2007: Complete development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Complete development of technology approaches to rapidly assimilate appropriate coalition partners into appropriate COI Infospheres. Complete investigation on performing and enforcing role-based access control to these COI Infospheres. Continue cross-domain information sharing research and development to include</p>				

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<b>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>collaborative monitoring and management of multi-national enterprise resources. Continue development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Investigate technologies, which can determine the pedigree of information in a coalition environment and assess the trustworthiness of the marked up information to be shared throughout the coalition. Investigate and prototype the application of information fusion and information management technologies such as fuselets to extend composite views of events across a multi-domain enterprise into fused events. Continue development of publish/subscribe technologies for application to a CBDN system for intelligent network management of user information.</p> <p>(U) In FY 2008: Continue cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources. Continue development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Continue to investigate and prototype the application of information fusion and information management technologies such as fuselets to extend composite views of events across a multi-domain enterprise into fused events. Continue development of publish/subscribe/query technologies for application to a content-based delivery networking (CBDN) system for intelligent network management of user information. Initiate development of technologies to systematically integrate information sources across COI's.</p> <p>(U) In FY 2009: Complete cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources. Continue development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Continue to investigate technologies, which can determine the pedigree of information in a coalition environment and assess the trustworthiness of the marked up information to be shared throughout the coalition. Continue to investigate and prototype the application of information fusion and information management technologies such as fuselets to extend composite views of events across a multi-domain enterprise into fused events. Continue development of publish/subscribe/query technologies for application to a content-based delivery networking (CBDN) system for intelligent network management of user information. Investigate technologies, which can determine the pedigree of information in a coalition environment and assess the trustworthiness of the marked up information to be shared throughout the coalition. Initiate techniques in characterization for an integration of pedigrees across organizational entities.</p> <p>(U)</p>				

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Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2006FY 2007FY 2008FY 2009

(U) MAJOR THRUST: Develop next generation monitoring, planning, execution, and assessment technologies and tools enabling distributed aerospace commanders to efficiently and collaboratively develop effects based campaigns.

9.516

9.909

7.924

6.951

(U) In FY 2006: Developed technologies to dynamically and rapidly assess the battlespace with a special emphasis on effects based assessment. Investigated application of decision support sciences to C2 activities within a Coalition AOC. Extended Course of Action analysis capability to allow collaboration between geographically remote locations. Developed intelligent information systems capable of supporting joint/coalition C2 for various missions. Developed and applied semantic ontology technologies for use in C2 applications, such as effects-based planning and dynamic tasking. Developed tools to increase situational awareness through intelligent information push and pull in dynamic environments. Investigated intelligent information processing techniques to enhance the C2 decision-making process, such as family of web service concepts; secure, shareable object spaces; legacy bridges; component-based architectures; information presentation components; and incorporation of Network Centric Warfare Service concepts. Prototyped these techniques and demonstrated feasibility and usefulness. Explored the application of system of systems and federation of systems engineering principles to enable joint C2 capabilities.

(U) In FY 2007: Complete development of next generation of monitoring, planning, execution, and assessment technologies and tools enabling aerospace commanders to efficiently and collaboratively develop effects-based campaigns. Complete development of technologies to dynamically and rapidly assess the battlespace, and provide near-real-time command of manned and unmanned forces to execute the required missions. Complete the incorporation of decision support science into C2 tools. Complete Course of Action analysis capability to allow collaboration between geographically remote locations. Continue to investigate application of decision support sciences and advanced decision-making concepts to C2 activities within a Coalition AOC. Continue to develop intelligent information systems capable of supporting joint/coalition C2 for various missions in a dynamically changing environment. Continue to develop tools to increase situational awareness through intelligent information processing. Continue the application of system of systems and federation of systems engineering in the creation of joint C2 capabilities. Explore the application of intelligent software agents as virtual battle staff members to enhance various C2 processes. Develop and demonstrate an effects-based dynamic tasking process enabled by dynamically accessible data and information services.

(U) In FY 2008: Continue to investigate application of decision support sciences and advanced

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BUDGET ACTIVITY <b>02 Applied Research</b>	PE NUMBER AND TITLE <b>0602702F Command Control and Communications</b>	PROJECT NUMBER AND TITLE <b>5581 Command and Control (C2) Technology</b>
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	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b></p> <p>decision-making concepts to C2 activities within a Coalition AOC. Continue to develop intelligent information systems capable of supporting joint/coalition C2 for various missions in a dynamically changing environment. Continue to develop tools to increase situational awareness and understanding through intelligent information processing. Continue the application of system-of-systems and federation-of-systems engineering in the creation of joint C2 capabilities. Continue to explore the application of intelligent software agents as virtual battle staff members to enhance various C2 processes. Complete the development and demonstration of an effects-based dynamic tasking process enabled by dynamically accessible data and information services. Initiate development of capability for a full-spectrum analysis for effects attainment at all levels of a campaign, linking leading indicators to desired and undesirable effects. The capability will utilize causal reasoning, linking effects to actions to desired end-state, will develop non-deterministic, non-linear causal linkages, and will be capable of reasoning through uncertainty &amp; ambiguity. Initiate research to achieve the ability to predict the current and future impact of an adversary cyber attack on Air Force (AF) information systems. Develop effects-based defense models to help predict the 1st and 2nd order impact of cyber attacks on an information system/mission. Develop Cyber defense containment scenarios that minimize current and future adversary impact to net-centric warfare (NCW) mission.</p> <p>(U) In FY 2009: Continue to investigate application of decision support sciences and advanced decision-making concepts to C2 activities within a Coalition AOC. Continue to develop intelligent information systems capable of supporting joint/coalition C2 for various missions in a dynamically changing environment. Continue to develop tools to increase situational awareness and understanding through intelligent information processing. Continue the application of system-of-systems and federation-of-systems engineering in the creation of joint C2 capabilities. Continue to explore the application of intelligent software agents as virtual battle staff members to enhance various C2 processes. Continue research to achieve the ability to predict the current and future impact of an adversary cyber attack on AF information systems. Continue the development of effects-based defense models to help predict the 1st and 2nd order impact of cyber attacks on an information system/mission. Continue the development of Cyber defense containment scenarios that minimize current and future adversary impact to NCW mission. Continue the development of capability for a full-spectrum analysis for effects attainment at all levels of a campaign, linking leading indicators to desired and undesirable effects. The capability will utilize causal reasoning, linking effects to actions to desired end-state, will develop non-deterministic, non-linear causal linkages, and will be capable of reasoning through</p>				

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BUDGET ACTIVITY <b>02 Applied Research</b>	PE NUMBER AND TITLE <b>0602702F Command Control and Communications</b>	PROJECT NUMBER AND TITLE <b>5581 Command and Control (C2) Technology</b>				
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>		
(U) uncertainty & ambiguity.						
(U) MAJOR THRUST: Investigate and develop technologies to implement flexible, high performance, secure, scalable, and survivable information management and dissemination services to enable a Global Information Grid-based COI Infosphere.	3.968	2.177	2.023	1.901		
(U) In FY 2006: Investigated and developed publish, subscribe, and query technologies enabling a secure infosphere that can support thousands of C2 and intelligence, surveillance, and reconnaissance clients at various levels of security classification, and can operate within a coalition warfighting environment. Completed investigation of new advanced publish, subscribe, and query technologies for the Information Management services, which provide higher levels of performance, security, and scalability to meet Air Force net-centric requirements. Completed investigation of techniques to optimize these publish, subscribe, and query mechanisms to be used within bandwidth-limited environments. Investigated automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Completed investigation of the interoperability of various COI Infospheres (e.g., Combat Support, Intel, Business) with respect to the management and sharing of information across them. Developed high payoff publish, subscribe and query laboratory prototypes which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force Net-centric environment needs. Investigated automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Focused on automated composition of tailoring entities, and runtime environments. Investigated methods and techniques for dynamically evolving the net-centric environment so as to avoid system crashes or latency as new information sources arrive or depart the environment. Focused on representation of real-time performance guarantees and negotiation for various levels of service as would be required in tactical aircraft. Investigated and assessed the use of semantic markup and semantic web languages as part of the COI Infosphere. Initiated the investigation of technology and approaches to prioritizing information in a COI Infosphere so as to effectively utilize communication and computing resources. Develop technology and techniques to monitor, obtain feedback, and assert control over the COI Infosphere.						
(U) In FY 2007: Complete investigation in the use of semantic markup and semantic web languages as part of the COI Infosphere. Complete investigation of technology and approaches to prioritizing information in a COI Infosphere so as to effectively utilize communication and computing resources. Continue to						

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- |  | <u>FY 2006</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
|--|----------------|----------------|----------------|----------------|
| <p>(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b></p> <p>develop high-payoff publish, subscribe, and query laboratory prototypes, which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force net-centric environment needs. Continue to investigate automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Continue to develop technology and techniques to monitor, obtain feedback, and assert control over the COI Infosphere. Investigate the security policy enforcement between COI Infospheres at various levels of security classification. Continue to investigate methods and techniques for dynamically evolving the netcentric environment so as to avoid system crashes or latency as new information sources arrive or depart the environment.</p> <p>(U) In FY 2008: Continue to develop high-payoff publish, subscribe, and query laboratory prototypes, which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force net-centric environment needs. Continue to investigate automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Continue to develop technology and techniques to monitor, obtain feedback, and assert control over the COI Infosphere. Continue to investigate the security policy enforcement between COI Infospheres at various levels of security classification. Continue to investigate methods and techniques for dynamically evolving the net-centric environment so as to avoid system crashes or latency as new information sources arrive or depart the environment. Initiate decentralization and fault tolerant information management services for the tactical environment. Initiate development of information transformation services and adaptive information management services that learn, self-configure, self-manage, and are self-healing. Initiate a study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats.</p> <p>(U) In FY 2009: Continue to develop high-payoff publish, subscribe, and query laboratory prototypes, which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force net-centric environment needs. Develop the security policy enforcement between COI Infospheres at various levels of security classification. Investigate methods and techniques for dynamically evolving the net-centric environment so as to avoid system crashes or latency by exploiting information technologies based on Quality of Service mechanism. Initiate integration of information services across operational boundaries and dissimilar infrastructure based systems. Continue development of information transformation services and adaptive information management</p> |                |                |                |                |

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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 5581 Command and Control (C2) Technology			
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) services that learn, self-configure, self-manage, and are self-healing. Continue study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats.					
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop distributed collaboration technologies, advance collaboration science, virtual environments, and predictive simulation tools to facilitate the development and fielding of next generation operational collaborative decision support systems. This effort includes Congressional Add funding of \$3.8 million in FY 2006 and \$1.0M in FY 2007.		5.771	6.909	5.431	5.550
(U) In FY 2006: Developed advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning, Air Force concepts of operations, and next generation planning, execution, and assessment environments. Developed distributed collaborative environment technology for operations other than war and similar applications. Conducted Congressionally-directed efforts for an Advanced Collaborative Platform for Netcentric Command and Control, and for Decision Support Tools. Conducted Congressionally-directed efforts for an Advanced Collaborative Platform for Net-Centric Command and Control (C2), and for Decision Support Tools.					
(U) In FY 2007: Continue development of advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning and next generation planning, execution, and assessment environments, including data exchange protocols, access privileges and data access. Prototype distributed collaborative environment technologies for advanced decision support for high-profile system concepts, such as the Global Strike Concept of Operations and operations other than war. Conduct Congressionally directed effort for Advanced Collaborative Platform for Net-Centric Command and Control (C2).					
(U) In FY 2008: Continue development of advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning and next generation planning, execution, and assessment environments. Continue to prototype distributed collaborative environment technologies for advanced decision support for high-profile system concepts, such as the Global Strike Concept of Operations and operations other than war. Initiate a study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats. Support context aware collaborative user interfaces and semantic interoperability.					
(U) In FY 2009: Continue development of advanced information technologies for collaborative					

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(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
decision-making and knowledge management in support of capability-based planning and next generation planning, execution, and assessment environments. Continue to prototype distributed collaborative environment technologies for advanced decision support for high-profile system concepts, such as the Global Strike Concept of Operations and operations other than war. Continue study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats. Support context aware collaborative user interfaces and semantic interoperability				
(U)				
(U) Total Cost	44.810	49.696	39.876	35.584

(U) <b><u>C. Other Program Funding Summary (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) Related Activities:										
(U) PE 0603617F, C3 Applications.										
(U) PE 0303401F, Communications-Computer Systems (C-CS) Security RDT&E.										
(U) PE 0603789F, C3I Advanced Development.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										

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02 Applied Research

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0602702F Command Control and  
Communications

PROJECT NUMBER AND TITLE

5581 Command and Control (C2)  
Technology

(U) D. Acquisition Strategy

Not Applicable.

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BUDGET ACTIVITY <b>02 Applied Research</b>					PE NUMBER AND TITLE <b>0602702F Command Control and Communications</b>			PROJECT NUMBER AND TITLE <b>66SP Space Optical Network Tech</b>		
Cost (\$ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
66SP Space Optical Network Tech	0.000	16.130	17.217	11.095	9.987	10.243	10.005	10.193	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, Project 6266SP, Space Optical Network Technology, efforts were transferred from PE 0602500F, Multidisciplinary Space Technology, Project 5082, Optical Networking Technology, in order to more effectively manage and provide oversight of the efforts.

**(U) A. Mission Description and Budget Item Justification**

This project develops the technology base for the next generation of ultra-wide bandwidth, multi-channeled, air and space-based communications networks on and between platforms. As the application of laser-based, point-to-point communications between satellites emerges, air and space-based optical networks, whose communications capacities are thousands of times greater than current communications satellites, become a realistic possibility. This project will assess and adapt the emerging communication and information technologies, for applications in air and space. This project will explore technologies for implementing photonic chip scale optical Code Division Multiple Access (CDMA) and Wavelength Division Multiplexed (WDM) transceivers and prototype networks, built to demonstrate the benefits associated with the advanced fiber optic, wireless, platform, and satellite networks that can be built from them. This project will develop and demonstrate technology to integrate current Radio Frequency (RF) with high data rate Optical Laser communications, along with network management techniques, tools and software to support them. These technologies have potential applications in specific military systems including reliable, high bandwidth, jam-resistant communications at the theater level, and multiplexing of multiple DoD users onto a common networking infrastructure for reduced manning and logistics.

**(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and assess optical network technologies for application in the space environment.	0.000	1.534	1.520	3.030
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Complete demonstration of highly integrated multi-gigabit optical network with 4 x 4 optical data router and optical backbone interface chips. Initiate demonstration of highly integrated multi-gigabit optical network with 16 x 16 optical data router and optical backbone interface chips.				
(U) In FY 2008: Complete demonstration of 16 x 16 optical data router and optical backbone interface chips for integration with on board Integrated Core Processor. Initiate design and development of 40 channel multi-wavelength optical network for on-board air and space applications				
(U) In FY 2009: Continue development of 40 channel multi wavelength optical network for on-board air and space applications				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and assess existing and emerging Optical CDMA and WDM modulation schemes and protocols for use in space-based optical networks. NOTE: This thrust contains \$1.1M in Congressional add funding in FY2007.	0.000	4.110	3.574	1.833

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PROJECT NUMBER AND TITLE

66SP Space Optical Network Tech

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2006FY 2007FY 2008FY 2009

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Continue design and development of optical burst switching and optical label switching protocols for applicability to air and space-based optical networks. Continue flight demonstration of industry standard single mode optical communications bus interface chip for airborne platforms. Develop and demonstrate a compact, highly integrated optical interconnect for space based optical networking through research placing greater emphasis on wavelength division multiplexing (WDM) rather than spatial parallelism. Conduct Congressionally directed effort for Massively Parallel Optical Interconnects.

(U) In FY 2008: Continue design and development of optical burst switching and optical label switching protocols for applicability to air and space-based optical networks. Complete flight demonstration of industry standard single mode optical communications bus interface chip for airborne platforms

(U) In FY 2009: Initiate flight demonstration of multi gigabit multi wavelength optical communications bus interface chip for space and air platforms.

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate heterogeneous, seamless, secure, self-configuring high capacity air/space/surface wireless networks that integrate current RF with high data rate Optical Laser communications. NOTE: This thrust contains \$1.6M in Congressional add funding.

0.000

8.294

12.123

6.232

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Continue design and development of waveform, coding, management, and atmospheric mitigation technologies for a combined RF/laser communications terminal. Demonstrate development of industry standard single mode optical communications bus for airborne platforms and air-to-air or air-to-ground RF and laser networked communication. Develop and demonstrate a tunable chirp managed, directly modulated laser transmitter for extremely high data rates in free space optical communications. Conduct Congressionally directed effort for Digital Free-Space Optical Laser Transmitter Modems.

(U) In FY 2008: Complete the characterization of the combiner RF/laser communications brassboard. Design and develop higher throughput RF waveform data link technology for operation under adverse weather conditions. Conduct flight demonstration of combined RF/laser communications brassboard in cooperation with the demonstration of advanced airborne sensor technologies.

(U) In FY 2009: Complete the development and start the characterization of higher throughput RF

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(U) <b><u>B. Accomplishments/Planned Program (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
waveform data link technology for operation under adverse weather conditions. Initiate the design of an integrated RF/laser communications airborne qualifiable brassboard.				
(U) CONGRESSIONAL ADD: Space Qualified Common Data Link	0.000	2.192	0.000	0.000
(U) In FY2006: Not Applicable				
(U) In FY2007: Develop space qualified Common Data Link hardware, and extend the performance of the hardware to insure the hardware will have an environmental robustness to operate in the space environment				
(U) In FY2008: Not Applicable				
(U) In FY2009: Not Applicable				
(U) Total Cost	0.000	16.130	17.217	11.095

(U) <b><u>C. Other Program Funding Summary (\$ in Millions)</u></b>	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>							
(U) Related Activities:										
(U) PE 0603789F, C3I Advanced Development.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										
(U) <b><u>D. Acquisition Strategy</u></b>										
Not Applicable.										