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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Command, Control and Communications Systems PE 0603760E, R-1 #48					
COST *(In Millions)*	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost To Complete	Total Cost
Total Program Element (PE) Cost	129.162	115.149	130.101	182.889	225.085	276.986	313.089	Continuing	Continuing
Command & Control Information Systems CCC-01	73.126	65.029	76.601	109.336	149.726	195.838	209.384	Continuing	Continuing
Information Integration Systems CCC-02	56.036	50.120	53.500	73.553	75.359	81.148	103.705	Continuing	Continuing

(U) Mission Description:

(U) This program element is budgeted in the Advanced Technology Development Budget Activity because its purpose is to demonstrate and evaluate advanced information systems research and development concepts.

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

(U) The goals of the Information Integration Systems project are to take diverse data inputs from a variety of sources, efficiently disseminate the information, and perform distributed and dynamic all-source correlation and fusion to produce an integrated, geo-spatially referenced, battlefield database and knowledge-base. Through the use of wideband dissemination and integrated sensor management, the project will also facilitate multi-site, real-time, collaborative situation assessment and course-of-action evaluations. These goals are being addressed by the Dynamic Database (DDB) program, the Airborne Communications Node (ACN) program, the Command Post of the Future (CPOF) program, the Symbiotic Communications effort, the next Generation (XG) program and the Advanced Speech Encoding (Vocoder) program.

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

	FY2001	FY 2002	FY 2003
FY02 Amended President's Budget	128.778	117.451	104.480
Current Budget	129.162	115.149	130.101

(U) **Change Summary Explanation:**

FY 2001 Increase reflects minor program repricing.
FY 2002 Decrease reflects minor program repricing.
FY 2003 Increase reflects the expansion of Network Surveillance and Attack Efforts, Project Genoa II and the Total Information Awareness program in project CCC-01.

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COST *(In Millions)*	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost to Complete	Total Cost
Command & Control Information Systems CCC-01	73.126	65.029	76.601	109.336	149.726	195.838	209.384	Continuing	Continuing

(U) Mission Description:

(U) Military operations that have taken place since the end of the cold war have demonstrated that current theater command, control, communications, intelligence/information systems, and planning and rehearsal systems lack the ability to fully support operations in complex, time-critical environments. These operations range from conflict and peacekeeping in urban centers to heavy battle actions in remote areas. Current capabilities do not provide the commander with real time, secure, situational awareness nor the ability to orchestrate high-tempo planning, rehearsal and execution. The goals of the programs in this project are to develop and test innovative, secure architectures and tools to enhance information processing, dissemination and presentation capabilities for the commander. This will give the commander insight into the disposition of enemy and friendly forces, a joint situational awareness picture that will improve planning, decision-making and execution support capability, and provide secure multimedia information interfaces and assured software to "on the move users". Integration of collection management, planning and battlefield awareness programs is an essential element for achieving battlefield dominance through assured information systems.

(U) With the growing dependence on information systems and the pressing need to be able to get the right information to the right person at the right time, it becomes critical to deliver and protect information and assures the availability of associated services – particularly in a stressed environment. Ongoing information security programs funded in this project include the Information Assurance Science and Engineering Tools (IASET) program that is addressing the assurance problem by investigating the underlying science that would allow a formal understanding of the problem at hand, and the Organically Assured and Survivable Information Systems (OASIS) program. Two new efforts in this area are the Advanced Network Surveillance and Cyber Attack Data Correlation. Lastly, the Partners in Experimentation program that was previously funded in the Computing Systems and Communications Technology program element (PE 0602301E, project ST-24) transitions to this project in FY 2003.

(U) The Organically Assured and Survivable Information Systems (OASIS) program seeks to provide defense capabilities against sophisticated adversaries to allow sustained operation of mission critical functions in the face of known and future cyber attacks against DoD information systems. The technology development goals are to conceive, design, develop, implement, demonstrate and validate architectures, tools and techniques that would allow fielding of organically survivable systems. The hardest part of the problem is to provide a real-time capability to make trade-offs between security, performance and functionality of systems depending on the current situation. The approach of the program is to

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use a hierarchy of techniques that provide a layered defense. The program is researching intrusion tolerance techniques in three areas: Real-time execution monitors; error detection and tolerance triggers; and error compensation/response and recovery. Techniques are chosen for their security protection and balanced against the cost incurred in performance, functionality and affordability. OASIS is addressing techniques aimed at hardening servers, clients, and all their software against intrusions. Another major task the program is undertaking is to validate the effectiveness of the techniques and mechanisms developed. The challenge is to characterize the cost and benefits of the techniques sufficiently well to enable a rigorous systems engineering approach to the system design. The OASIS program will transition technologies that allow systems to continue to operate correctly in the face of successful intrusions and attacks through tolerance and self healing properties.

(U) The Advanced Network Surveillance program will develop technologies for monitoring activity on computer systems for signs of cyber attack, using a carefully designed mesh of detection methods and sources of data expanded significantly beyond operating system audits and network protocol logs. More comprehensive and accurate detection technologies will be developed as a result of systematic analysis of where manifestations of important classes of cyber attack can occur, development of sensors that use explicit knowledge of system functional behavior, and combining partial indications from different system layers. This area is critical in order to discover cyber attacks early enough and reliably enough to enable effective defensive actions to be taken before extensive damage is done to computerized systems and networks.

(U) The Cyber Attack Data Correlation program will develop technologies for dynamic deployment, coordination, protection, and correlation of cyber attack sensors to improve security of large networks against coordinated or strategic cyber attacks. Dynamic and distributed sensor techniques are critical to overcoming present and worsening problems with attacks that bypass static monitored network chokepoints, attacks that target the sensors themselves, and adapting sensors to increasing complexity and rates of change in the defended networks.

(U) The Partners in Experimentation program will conduct security technology experimentation with operational military and coalition partners. Operational experimentation will provide valuable feedback to the security technology research and development process which will demonstrate to operational personnel the benefits of advanced technology, and accelerate technology transition.

(U) The coming generation of collection systems will provide dramatically increased volumes of higher fidelity data to the operational decision-maker. The challenge will be to dynamically manage and synchronize this advanced collection architecture with the next-generation processing, exploitation and dissemination capabilities to provide the critical information to the decision maker in the constantly changing operational situation. The Advanced Intelligence, Surveillance and Reconnaissance Management (AIM) program will develop Collection Strategies and Multi-asset Synchronization components to dynamically optimize/synchronize, schedule, and task the spaceborne, airborne and ground based collection, processing, exploitation and dissemination architecture. The AIM program will optimize Intelligence, Surveillance and Reconnaissance

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(ISR) support to precision engagement and tactical operations by providing proactive information support to the warfighter, continuous integration of operations and ISR, responsive ISR timelines, optimal ISR confederation management, and synchronization of ISR asset and exploitation tasking. AIM will ensure near-real-time information support to commanders and the Joint Task Force by providing all echelons with: a common view of the collection environment; current status of collection, processing, exploitation and dissemination operations; faster than real-time modeling and simulation in support of trade-off decisions; and the ability to conduct real-time multi-echelon coordination and shared decision making. In addition, three new initiatives: Advanced Sensor/Strike Battle Manager, Advanced Ground Tactical Battle Manager, and Network Effects-based Targeting With Adversarial Reasoning (NETWAR) are funded in FY 2003.

(U) The objective of the new Advanced Sensor/Strike Battle Manager initiative is to assist warfighters planning complex campaigns with new air platforms that contain both precision sensors and precision weapons. It will combine symbolic reasoning about tactics and engagement options with numerical tools to optimize waypoints, schedule tasks, and dynamically synchronize multi-platform engagements.

(U) The objective of the new Advanced Ground Tactical Battle Manager initiative is to automatically extend operational plans sketched by commanders of robotic forces into commands for each tactical vehicle, taking into account terrain, restrictive rules of engagement, weather, and opponents' capabilities. It will construct contingency plans to anticipate uncertainties in opponents' location and capability, and dynamically replan operations as new information arrives.

(U) The objective of the new Network Effects-based Targeting With Adversarial Reasoning (NETWAR) initiative is to nominate critical targets in opponents' networks that achieve desired effects with minimal risk of collateral damage. It will model dependencies within and across networks, identify critical nodes, calculate potential work-around within and among networks to mitigate damage to those nodes, and recommend targets for precision engagement.

(U) The Control of Agent-Based Systems (CoABS) program is developing the ability to rapidly assemble a set of disparate information systems into a coherently interoperating whole. This is being done without redesigning legacy systems and includes interoperation with non-DOD governmental systems and open-sourced systems not built to a pre-existing government standard. The development and implementation of mobile agents and agent-communication languages will help both in the facilitation of multi-systems integration and in controlling the information flow to alleviate bandwidth saturation and degraded quality of service. The CoABS program will demonstrate and deploy a middleware-based approach, and toolkits for rapid creation of capability to support the interoperation of heterogeneous systems in contingency and coalition operations, and thus will enable the interaction of military and non-military resources in these critical operations.

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(U) Project Genoa is developing tools and a prototype infrastructure for collaborative crisis understanding and management for the national security community ranging from the National Command Authorities to Commanders of the Unified Commands. The growing transnational threats increase the need for early crisis discovery and mitigation. To develop timely preemptive or mitigating strategies, Project Genoa's objectives are to: (1) decrease the decision cycle time from days to hours by reducing the time it takes to go from problem detection to providing the decision maker with actionable options; (2) increase the number of situations that can be managed simultaneously by an order of magnitude; (3) decrease the reaction time when new information is received; and (4) reduce number of military deployments. The current clients for components of the prototype system are Joint Chiefs of Staff and Defense Intelligence Agency, National Security Agency, Office of Assistant Secretary of Defense (International Security Affairs), Joint Counter-intelligence Assessment Group, Commander-in-Chief Pacific (J3), and Commander Joint Forces Command (J9).

(U) Project Genoa II, part of the DARPA Total Information Awareness Program, will focus on the information technology support needed by teams of intelligence analysts and operations and policy personnel as they attempt to anticipate and preempt asymmetric threats to U.S. interests. Needed are faster systems of humans and machines, ways to overcome the biases and limitations of the human cognitive system, "cognitive amplifiers" that help teams of people rapidly and deeply understand complicated and uncertain situations, and methods to more effectively distribute data residing in break existing stovepiped information repositories. Genoa II will provide technologies to make the teams faster, smarter, and more collaborative. The project will apply automation to team processes so that more can be accomplished sooner. It will develop and deploy cognitive aids that allow humans and machines to think together about complicated problems, and it will override the barriers inherent in today's information stovepipes by creating a dynamic, adaptable, peer-to-peer collaborative environment that supports the necessary co-existence of hierarchical and network organizations. Genoa II's products will be deployed to the Information Awareness Center at U.S. Army INSCOM.

(U) The Total Information Awareness (TIA) program will focus on developing and implementing information technologies into a prototype system to aid in countering terrorism through prevention. The TIA program will predict and hence enable preemption of terrorist activity. TIA will: develop architectures for a large-scale counter-terrorism database, for system elements associated with database population, and for integrating algorithms and mixed-initiative analytical tools; develop novel methods for populating the database from existing sources, create innovative new sources, and invent new algorithms for mining, combining, and refining information for subsequent inclusion into the database; and, develop revolutionary new models, algorithms, methods, tools, and techniques for analyzing and correlating information in the database to derive actionable intelligence. DARPA will work in close collaboration with one or more U.S. intelligence agencies that will provide operational guidance and evaluation, and act as a technology maturation and transition partner(s). The TIA focus is on developing usable tools, rather than conducting demonstrations. That is, creating fully functional, leave-behind prototypes that are reliable, easy to install, and packaged with documentation and source code (though not necessarily complete in terms of desired features), that will enable the intelligence community to evaluate new technology

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through experimentation, and rapidly transition it to operational use, as appropriate. The primary goal of TIA is the assured transition of a system-level prototype that integrates technology and components developed in other DARPA programs including Genoa and Genoa II described above; TIDES (PE 0602301E, ST-11); Genisys, EELD, WAE, HID, and Bio-Surveillance described in PE 0602301E, ST-28.

(U) The Active Templates (AcT) program will produce a robust, lightweight software technology for aiding in the automation of detailed planning and execution for military operations using a plan spreadsheet metaphor. Active Templates are distributed data structures whose variables will be linked to live data feeds or problem-solving methods. AcT will assist with automated planning and execution by capturing, improving and updating critical information such as current state, goals, constraints, alternative actions, standard defaults, decisions in context and rationale. Active Templates will be designed to be user-tailorable, networked, noise-tolerant, user-supported, scalable, and widely adopted. As a result, the technology to be fielded will provide faster plan generation (six times), improved plan quality (eight times more options considered), 60 percent reduction in staff-hours required to track and coordinate missions, enhanced ability to capture lessons learned, and improved national capability to respond in a crisis. Early prototypes of AcT technologies have been adopted by Special Operations Command where they have been shown to accelerate temporal planning by a factor of four and reduce the number of personnel required for battle tracking by a factor of six. DARPA is working closely with the Joint Special Operations Command to add spatial planning capabilities and simple forms-based coordination tools that may be defined dynamically by ordinary users in less than a day. Experiments (e.g., time-and-motion studies) with these technologies show improvements in the range indicated above.

(U) The Tera Hertz Operational Reachback (THOR) program will mature required technologies and credibly demonstrate a system able to provide a high data rate (internet-like) backbone to the tactical user whether airborne, terrestrial, or maritime. By focusing on the militarily unique need for a truly mobile and deployable high-data-rate infrastructure that extends access to existing commercial and military terrestrial fiber infrastructures, the Department's vision of a "Global Grid" will be enabled by creating the high-data-rate nexus among the terrestrial, space, and air grids. This is expected to be accomplished by leveraging the commercial global optical fiber network, multi-quantum well retro-reflectors, and advances in optical phased array technology that have been motivated by directed energy applications. Together, these technologies enable the creation of a hybrid fiber-free space optical network extension. Gigabit-per-second connectivity and long-haul reachback to and between airborne assets, as well as multi megabit-per-second connectivity and reachback to and from terrestrial and maritime forces will be demonstrated in the final year of the program.

(U) The Joint Force Air Component Commander (JFACC) program has addressed critical issues in military command and control (C2), specifically joint and coalition air operations by developing and validating new C2 architectural concepts and appropriate control strategies. Final demonstrations and evaluations complete in FY 2001.

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(U) Building upon the results of previous C2 efforts, the Man and Machine Command and Control (M2C2) program developed the theory, algorithms, software, modeling and simulation capabilities to coordinate multi-level planning, assessment and control of distributed semi-autonomous forces with collective objectives through the hierarchical application of systems and control theoretic methods.

(U) Program Accomplishments and Plans:

(U) FY 2001 Accomplishments:

- Man and Machine Command and Control (M2C2). ($10.458 Million)
  - Developed theories for resource allocation and task negotiation.
  - Cultivated control technologies for optimal route planning to fixed/mobile targets.
  - Developed estimation techniques to reconstruct decision information in the presence of measurable feedback.
  - Created designs for hierarchical decision-making tools within a dynamic, closed-loop architecture.

- Joint Forces Air Component Commander (JFACC). ($7.000 Million)
  - Completed experimentation and evaluated effectiveness of C2 architectures incorporated, via simulation, into air operations systems.

- Information Assurance Science and Engineering Tools (IASET). ($20.209 Million)
  - Developed initial science-based security enabling disciplines, methods, and preliminary tools that will allow for the design of measurable and useful Information Assurance systems. These deliverables will be provided to the ULTRA*LOG, OASIS, FTN and Cyber Panel programs.
  - Demonstrated real-time execution monitoring techniques and tools to mitigate malicious mobile code.
  - Demonstrated integrity mark technology for protection of sensitive imagery.
  - Investigated new approaches to intrusion tolerance based on data, spatial, temporal and analytical redundancy and resource allocation; identified relevant challenge problems.
  - Demonstrated self-protecting mobile agent prototype.
  - Developed architecture for building intrusion tolerant systems from potentially vulnerable components by applying existing fault-tolerant approaches to intrusion tolerance and that support layered defenses and provide resilience to attacks.

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- Advanced ISR (Intelligence, Surveillance and Reconnaissance) Management (AIM). ($6.800 Million)
  - Explored new ISR system architectures and technologies to increase effectiveness and reduce man loading in tactical as well as planning applications.
  - Conducted operational evaluation of AIM automated collection Strategy Developer (SD) and Multi-Asset Synchronizer (MAS) technologies with U.S. Southern Command. Employed MAS as an off-line, real-time, component of operational exercise Unified Endeavor 2001/2003.
  - Expanded SD and MAS capabilities to include tasking of and Signal Intelligence sensors. Characterized performance of AIM components in terms of algorithm timeliness and quantitative collection needs derived from real time processing and exploitation systems such as Dynamic Database (DDB).
  - Evaluated dynamic re-planning capabilities as part of an integrated collection management demonstration linking AIM and Dynamic Database technologies in a novel control paradigm that enables responsive sensor management driven by data exploitation needs.
  - Established a collaborative engineering environment to conduct AIM/DDB experimentation. Knowledge gained in these experiments transitioned to the Dynamic Tactical Targeting (DTT) program in FY 2002.
  - Partnered with the DIA Joint Intelligence Virtual Architecture program to explore use of their Joint Collaborative Environment as an application server for making AIM components more broadly and rapidly accessible to operational users.
  - Experimented with NRO to introduce AIM technologies to their advanced concept development environment.

- Control of Agent-Based Systems (CoABS). ($11.745 Million)
  - Demonstrated a CoABS Grid that was self-healing, operating without human intervention, quickly assembled, supporting 100's of sensors in a heterogeneous environment.
  - Demonstrated mobile agents and tools that are capable of significantly reducing bandwidth demands (>65%); and capable of going anywhere, anytime, autonomously to gather data or perform other functions.
  - Empirically demonstrated efficacy of approach in realistic military domains, such as Fleet Battle Experiments.

- Active Templates. ($9.408 Million)
  - Integrated and demonstrated multiple templates merging by users to update information, add dependencies and attach problem-solvers.

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- Demonstrated initial capability to automatically and continuously compile geophysical information from different databases and other networked information sources.

- Project Genoa. ($7.506 Million)
  - Completed development of corporate memory, future scenario generation tools and tailored presentation tools.
  - Developed and validated emerging concepts from collective reasoning applied to the asymmetric threat.
  - Investigated the use of intelligent agents to automate functions where possible.
  - Incorporated changes resulting from client evaluation in real world asymmetric environment.

(U) FY 2002 Plans:

- Advanced ISR (Intelligence, Surveillance and Reconnaissance) Management (AIM). ($11.110 Million)
  - Evaluate integrated AIM capabilities for optimized ISR collection management to provide continuous dynamic and proactive collaboration between operations and ISR.
  - Develop user interface to include task valuation and prioritization methodologies and associated metrics in combination with quantitative data driven needs, for use in multi-user/multi-mission environments.
  - Complete experimentation/validation of AIM technology in a major military command environment with participation in a command level exercise such as millennium challenge 02 or Joint Expeditionary Force Experiment (JEFX).
  - Conduct final year assessment and evaluation for military utility, and transition of Multi-Asset Synchronizer and Strategy Developer tools to airborne and overhead collection systems including collection management migration systems, IC MAP.
  - Develop “front-end” input through use of AIM Market Oriented Prioritization (AMOP) approach.
  - Utilize “Knowledge Capture” techniques to assess program maturity and define future applications/experimentation and transition opportunities.

- Control of Agent-Based Systems (CoABS). ($11.110 Million)
  - Release Agent-Grid code and components tailored to military user needs, with automated features for rapid (<hours) grid creation.
  - Demonstrate the scalability of the architecture to support > 1,000 agents without conflicts.
  - Evaluate CoABS in military applications including major joint exercises featuring coalition operations and situation.

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- Active Templates. ($11.018 Million)
  - Develop Active Template representation/library capabilities for extending the terms, critical planning parameters for template adaptation and merging.
  - Demonstrate advanced tools for extending term-ontology to avoid duplication and conflicting semantics.

- Project Genoa. ($7.639 Million)
  - Continue testing and experiments in user environments.
  - Modify Genoa infrastructure as needed in user environments.
  - Transition components to user agencies such as Joint Chiefs of Staff, Defense Intelligence Agency, OSD(C3I), OSD(ISA), etc.
  - Deploy and support leave-behind prototypes at critical nodes within the intelligence community for use during Operation Enduring Freedom and the continuing war on terrorism.
  - Create an on-site laboratory at an intelligence agency for rapid prototyping and testing new ideas for follow-on Genoa programs.

- Organically Assured and Survivable Information Systems (OASIS). ($18.152 Million)
  - Develop an experimental intrusion tolerant database from commercial-off-the-shelf (COTS) components.
  - Begin development of a system for automated behavior modeling of programs and information systems.
  - Explore design of intelligent systems that can judge the trustworthiness of their computational environment and make strategy and resource allocation decisions.
  - Design a framework for tolerating intrusions in large-scale, heterogeneous, networked computing enterprises.
  - Develop algorithms that tolerate random, unpredictable (Byzantine) faults resulting from a class of staged, coordinated intrusions.
  - Demonstrate a scalable intrusion-tolerant architecture for distributed services prototype.
  - Explore the best approach to development of a self-healing system.
  - Integrate OASIS technologies to demonstrate a notional intrusion tolerant architecture.
  - Prototype new cyber attack detection techniques that use application, operating system, or network data not captured in operating system audit or network packet logs.

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- Develop taxonomic models of attack methods and manifestations and use them to expose gaps in detection.
- Initiate development of capabilities for deploying, retargeting, and analyzing placement of cyber attack detection sensors in a large network.

- Tera Hertz Operational Reachback (THOR). ($6.000 Million)
  - Initiate development of a high power laser source by phase combining multiple inexpensive lasers used by the telecommunications industry.
  - Demonstrate eight milli-watt fiber laser phasing with an overall output equal to the number of fibers times their individual output power.
  - Initiate development of a passive optical terminal.
  - Demonstrate quantum well modulating corner cube retro reflector operation at 1.55 μm wavelength in the laboratory.
  - Investigate the use of steerable agile beam technology to eliminate the gimbals.

(U) FY 2003 Plans:

- Active Templates. ($5.175 Million)
  - Develop Active Template Planning and Execution Shell including tools for template development such as selecting and tailoring dependencies and problem solving algorithms. These tools will also include advanced problem solvers like generative planning, temporal/uncertain reasoning and triggering for complex events.

- Organically Assured and Survivable Information Systems (OASIS). ($6.812 Million)
  - Demonstrate a comprehensive approach to intrusion tolerance in a commercial-off-the-shelf (COTS) setting.
  - Prototype and evaluate a framework for tolerating intrusions in large-scale, heterogeneous, networked computing enterprises.
  - Build a distributed compositional architecture for the deployment of intrusion tolerance mechanisms implementing an explicitly stated but flexible tolerance policy.
  - Develop an integrity and availability framework that combines passive intrusion tolerance and active intrusion recovery mechanisms.

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- Advanced Network Surveillance. ($7.500 Million)
  - Research the theoretic aspects of dynamic security models and formal assurance modeling necessary to improve the ability to make quantitative assessments of the assurance of information systems and networks.
  - Develop models for the hierarchical diffusion of fault adaptive methods through the physical, component, system, and mission levels of a distributed system architecture.

- Cyber Attack Data Correlation. ($9.000 Million)
  - Develop sensor protection and peer-challenge techniques to discover sensors that have been subverted or lost to attacks.
  - Develop techniques for communicating cyber attack detection data among a dynamic collection of cyber attack detection sensors.
  - Investigate new system enforcement and response mechanisms that can actively aid with cyber attack detection.

- Partners in Experimentation. ($3.044 Million)
  - Demonstrate large-scale hardened client technology and policy implementation in military operational environment.
  - Evaluate performance and scalability of lab proven anomaly detection techniques for intrusion detection in real world high volume environments.

- Tera Hertz Operational Reachback (THOR). ($11.000 Million)
  - Complete system trade studies for a maritime terminal.
  - Extend the advantages of High Data Rate fiber to the mobile expeditionary warfighter whether on land, on the sea, or under the sea.
  - Provide free space optical connectivity from a terrestrial Point of Presence into the theater of operations via air relay.
  - Provide large reductions in size, weight, and prime power consumption over state of the art systems.
  - Provide significant cost reduction in optical links.
  - Demonstrate end-to-end system concept for the warfighter.

- Control of Agent-Based Systems (CoABS). ($2.070 Million)
  - Expand the capability of the Grid and Agent systems to support inclusion of National Sensors and additional data fusion functions.
  - Develop an experimentation project to infuse innovative and transformational concepts and technology for Navy Expeditionary Sensor Grid.

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- Project Genoa II. ($7.000 Million)
  - Design faster systems of humans and machines by assimilating new information technologies to operational agencies to meet asymmetric threats.
  - Develop tools for cognitive amplification by extending the ability of software to model current states, estimate plausible futures, support formal risk analysis, and provide for automated option planning. Supporting technology includes the use of intelligent agents, cognitive machine intelligence, associative memory, neural networks, pattern matching, Bayesian inference networks, and biologically inspired algorithms.
  - Develop tools for cross-agency collaboration designed to operate across existing hierarchical organizations while maintaining control and accountability. Areas under consideration will include: Knowledge Management; corporate memory; context-driven, declarative-policy enforcement; self-aware data; business rules; self-governance; and automated planning.

- Total Information Awareness (TIA). ($10.000 Million)
  - Initiate development of architectures for large-scale counter-terrorism database.
  - Develop novel methods for populating database from existing sources.
  - Develop new models, algorithms, methods, tools and techniques for analyzing and correlating information in the database.

- Advanced Sensor/Strike Battle Manager. ($5.000 Million)
  - Build models, plan authoring tools, and planning algorithms to plan strike missions using air platforms carrying both sensors and strike weapons.
  - Incorporate a capability to manage shoot-look-shoot engagement strategies supported by multiple platforms.

- Advanced Ground Tactical Battle Manager. ($5.000 Million)
  - Build situation estimation, situation assessment, and tactical plan generation tools to generate and update, continuously, plans for tactical ground combat.
  - Incorporate a capability to create and modify new tactics in response to evolving enemy capabilities and differing operational environments.

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- Network Effects-based Targeting With Adversarial Reasoning. ($5.000 Million)
  - Build models, analysis tools, and plan generation tools to identify critical nodes in opponents' networked systems, both military (e.g., logistics) and dual use (e.g., transportation).
  - Incorporate a capability to anticipate opponents' workarounds to U.S. attacks, including repair, reconstitution, or substitution.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Advanced ISR (Intelligence, Surveillance and Reconaissance) Management (AIM):	
Mar 02	Test and evaluate open and closed loop performance of AIM system to coordinate ISR collection assets in a dynamic and responsive multi-user environment.
Jul 02	Conduct experimentation of AIM technology at operational command (e.g. Joint Battle Center (JBC), USSOCOM, CENTCOM).
Sep 02	Transition AIM technology to collection management systems (e.g. IC MAP, DCGS, CICMP).
Control of Agent-Based Systems (CoABS):	
Jul 03	Release product quality Agent Grid code, generalized for broad military users and commercial standards group.

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Active Templates:

Sep 02 Show six-fold increase in execution replanning using Active Templates attached to live data feeds from battlefield sensors. Active Templates command and control tools were used for special operations forces contingency planning in support of Operation Enduring Freedom.

Sep 03 Demonstrate capability for distributed battlestaffs to tailor templates, six times faster plann generation, eight times more options, availability of 500 Active Templates and 60 percent reduction in staff-hours required to track/coordinate missions.

Tera Hertz Operational Reachback (THOR):

Apr 02 Technology tasks contract award.

Apr 02 System integrator contract award.

Dec 02 Solicitation for critical subsystem bb/bb prototyping & technology demonstrations.

Feb 03 Critical subsystem contract award..

Organically Assured and Survivable Information systems (OASIS):

Aug 03 Integrated Design and Assessment Environment applied to design effort for new information system.

Oct 03 Conduct empirical validation experiments of mathematical computation models that include code mobility.

Partners in Experimentation:

Sep 03 Complete large scale hardened client and server experiment as well as Perpetually Available and Secure Information Systems (PASIS) and email sandboxing experiments in operational environments.

Advanced Network Surveillance:

Sep 03 Complete first design iteration of fault adaptive distributed system architecture.

Cyber Attack Data Correlation:

Sep 03 Conduct preliminary experiments validating the utility of system enforcement and response mechanism prototypes.

Project Genoa:

Aug 02 Create On-site laboratory for rapid prototyping and testing.

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Project Genoa II:
Sept 03 Develop tools for cognitive amplification and cross-agency collaboration.

Total Information Awareness (TIA):
Sep 03 Develop architectures, new models and tools for analyzing and correlating database information.

Advanced Sensor/Strike Battle Manager:
Mar 03 Complete system functional architecture and baseline technology prototypes for critical functions.

Advanced Ground Tactical Battle Manager:
Sep 03 Conduct initial demonstration in an instrumented experimentation facility.

Network Effects-Based Targeting with Adversarial Reasoning:
Sep 03 Assess baseline technologies on network model simulations with 100-node networks.

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COST *(In Millions)*	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Cost to Complete	Total Cost
Information Integration Systems CCC-02	56.036	50.120	53.500	73.553	75.359	81.148	103.705	Continuing	Continuing

(U) Mission Description:

(U) The goals of the Information Integration Systems project are to take diverse data inputs from a variety of sources, efficiently disseminate the information, and perform distributed and dynamic all-source correlation and fusion to produce an integrated, geo-spatially referenced, battlefield database and knowledge-base. Through the use of wideband dissemination and integrated sensor management, the project will also facilitate multi-site, real-time, collaborative situation assessment and course-of-action evaluations. These goals are being addressed by the Dynamic Database (DDB) program, the Airborne Communications Node (ACN) program, the Command Post of the Future (CPOF) program, the Symbiotic Communications effort, the next Generation (XG) program, and the Advanced Speech Encoding (Vocoder) program.

(U) The overarching goal of the Dynamic Database (DDB) program was to continuously produce significant battlespace information from immense quantities of multi-sensor data in a manner responsive to tactical users at multiple echelons. More specifically, DDB ingests and registers Ground Moving Target Indicator radar, Signals Intelligence and Imagery (Synthetic Aperture Radar, Electro-Optic and Infra-Red) Intelligence raw sensor data to a common fiducial to reference all sensor data to a Common Targeting Grid. DDB components have been integrated with components of the Advanced Intelligence, Surveillance and Reconnaissance Management (AIM) program to develop a control theoretic framework for sensor management and data exploitation. The coupling of these technologies will demonstrate a proof of concept in which additional data required by DDB processes is used to drive sensor collections. The DDB program concluded in 2001 and the technology demonstrated, to include the DDB-AIM experiment, provided the underpinnings of the Dynamic Tactical Targeting (DTT) program that is beginning in FY 2002 (PE 0603762E, Project SGT-04, Sensors and Exploitation Systems).

(U) The Airborne Communications Node (ACN) program will enable an affordable, autonomous communications infrastructure that simultaneously provides assured communications, situational awareness and signals intelligence (SIGINT). It is envisioned that ACN payloads will be integrated on platforms ranging from High Altitude Endurance (HAE) unmanned airborne platforms (e.g., Global Hawk) to tactical platforms (e.g., Predator, Army Tactical UAV). The ACN payload will be scalable such that payloads for various platforms can be constructed from a core module set. The ACN on a HAE will provide wide-area wireless communications and SIGINT services over the theater of operation for joint and multinational forces by establishing an early robust airborne infrastructure for intra-theater line-of-site (LOS) and reachback beyond line-of-site

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(BLOS) without the need for large in-theater assets. ACN will augment and enhance the battlefield communications infrastructure in order to adapt communications, situational awareness and SIGINT services to the flow of battle. Therefore, the ACN system needs to be adaptable, interoperable, robust, secure, and affordable within the size, weight and power constraints of the intended platforms.

(U) In current tactical operations, ground commanders conduct operations with a situational awareness that measures around 27 percent to 50 percent of ground truth. This uncertainty, often called the 'fog of war', slows down and degrades the quality of command decisions. Radical improvements in situational awareness are necessary for effective tactical operations. The objective of the Command Post of the Future (CPOF) program is to improve the speed and quality of command decisions, more effectively disseminate command decisions, and reduce the number of staff members required to process and manage the information systems. Three important command functions will be addressed to achieve this objective: 1) improved speed and quality of situation awareness; 2) improved speed of course of action (COA) development and selection; and 3) improved clarity of COA communication between commander and subordinates. For each of these command functions, CPOF is developing technologies that leverage the expertise of the commander by exploiting and augmenting natural cognitive abilities. The key technologies to be developed are: (1) an integrated visualization environment for the commander and his staff; (2) a powerful and comprehensive human-computer interaction capability; (3) a robust collaborative communication environment for creating shared understanding among commanders and staff through both voice and visual interactions; (4) an integrated suite of systems to automate many of the lower level staff functions and automatically invoke and operate supporting, planning and analysis applications; and (5) a modular, portable suite of software components that can be quickly configured and tailored to various command environments (stationary and mobile), at different echelons of tactical command. The program concludes at the end of FY 2002.

(U) Future combat systems increasingly rely on accurate intelligence preparation of the battlefield. This includes timely and accurate georegistration of all sensed data for precision weaponry on targets (including mobile targets). The single biggest error source that exists in the georegistration process is the lack of accurate knowledge of the terrain. Current national databases provide only coarse Level 1 data and in a few years Level 2 data will become available. This is insufficient to take full benefit of even current generation weapon accuracies and will continue to fall further behind as the weapons navigation and guidance systems improve at a faster pace. In order to overcome this, the Symbiotic Communications program will develop an airborne system that can generate, in real-time, Digital Terrain Elevation Data (DTED) with a precision commensurate with NIMA defined Level 4. This system will operate in all weather and passively. An additional attribute being explored includes automated terrain categorization that can delineate degrees of wetness and discriminate between fields and trees. In addition, exploration of techniques for using multiple frequencies to achieve enhanced spatial resolution leading to a potential DTED Level 5 precision will be conducted.

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(U) The Next Generation (XG) program goals are to develop both the enabling technologies and system concepts to provide dramatic improvements in assured military communications in support of a full range of worldwide deployments through the dynamic redistribution of allocated spectrum along with novel waveforms. U.S. Forces face unique spectrum access issues in each country in which they operate, due to competing civilian or government users of national spectrum. These constraints must be reflected in all force planning and may preclude operation of critical systems. Coalition and allied operations are even more complex to manage, and may severely limit the U.S. ability to fully exploit its superiority and investment in information technology. The XG program approach is to develop the theoretical underpinnings for dynamic control of the spectrum, the technologies and subsystems that enable reallocation of the spectrum, and the system appliqué prototypes to demonstrate applicability to legacy and future DoD radio frequency emitters. The approach plans to investigate methods to leverage the technology base in microelectronics with new waveform and Medium Access and Control protocol technologies to construct an integrated system. The proposed program goals are to develop, integrate, and evaluate the technology to enable equipment to automatically select spectrum and operating modes to both minimize disruption of existing users, and to ensure operation of U.S. Systems. The result of the XG program will be to develop and demonstrate an appliqué for legacy and future emitter systems for joint service utility.

(U) The Advanced Speech Encoding (Vocoder) program will investigate the reduction of voice communication bit rates. The program will compress speech to bit rates between 200 bps and 800 bps while producing speech quality at least as good as that produced by the current standard, and maintaining that quality and bit rate in militarily relevant noisy environments. Reliable authentication of the speaker's identity will also be investigated. This will be accomplished by directly measuring the glottal excitation function, which, when combined with the information contained in the acoustic data, allows direct computation of the physical vocal tract transfer function. Furthermore, since the physical vocal tract transfer function is directly associated with the formation of phonemes, it is possible to recognize the phonemic information in the speech and transmit that thus allowing further data rate reductions. Finally, direct measurement of the vocal excitation waveform potentially provides a unique physiological set of metrics that can be used for speaker authentication.

(U) Program Accomplishments and Plans:

(U) FY 2001 Accomplishments:

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- Dynamic Database (DDB). ($6.340 Million)
  - Completed development of registration algorithms to co-register Ground Moving Target Indicator (GMTI), Signals Intelligence (SIGINT), and Imagery Intelligence (IMINT) data to a standard National Imagery and Mapping Agency (NIMA) terrain product - Common Image Base (CIB).
  - Completed algorithm development to use nonlinear techniques for automatic recognition of speakers and parameter characterization of emitters, derivation of tactical communications networks from communications emissions, recognition of new/different vehicular behavior from GMTI and near real time extraction of military objects from multi-spectral imagery.
  - Completed initial capability for object discovery of large numbers of tactically significant ground targets (moving and stationary) over a brigade size area.
  - Demonstrated an initial capability to derive force relationships among objects using the Force Level Change Detection (FLCD) algorithm.
  - Demonstrated an interactive DDB system-level capability that performs multi-sensor object level fusion using a Kosovo-like data set.
  - Conducted proof of concept experiments integrating components of DDB and AIM technology in a control theoretic framework.

- Command Post of the Future (CPOF). ($17.861 Million)
  - Continued to develop and integrate new CPOF technology into a complete CPOF commander's dialog system to enable commanders to improve the speed and quality of command decisions to stay ahead of the adversary's ability to react.
  - Integrated and tested new versions of the technology components in a series of simulation-based decision experiments.
  - Integrated the most effective technology into a complete CPOF commander's dialog system for an end-to-end demonstration in a simulated joint exercise.
  - Began preparations for an operational demonstration of the CPOF commander's dialog system in a joint field exercise in FY 2002.

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- Airborne Communications Node (ACN). ($31.835 Million)
  - Demonstrated performance of critical technologies (co-site mitigation, antennas, array processing, power amplifiers, multi-band coupler, mobile ad hoc networking).
  - Matured the ACN system architecture and developed point designs for multiple platforms (Global Hawk, Predator, and Shadow 200).
  - Demonstrated feasibility of multi-mission concept (simultaneous support of communications and SIGINT) through detailed system simulation.
  - Initiated a study to examine integration of FCS high band communications, directional networking, and Small Unit Operations/Situational Awareness System (SUO SAS) waveform integration within the ACN architecture.

(U) FY 2002 Plans:

- Airborne Communications Node (ACN). ($16.048 Million)
  - Verify the system design through simulation and end-to-end laboratory demonstration.
  - Mature the architecture to a critical design.
  - Commence transition of system to Services.
  - Continue/complete technology development.
  - Complete study examining integration of FCS high band communications, directional networking, and SUO SAS waveform integration within the ACN architecture.

- Symbiotic Communications. ($21.396 Million)
  - Complete ground experiments for signal and terrain scatter characterization.
  - Complete initial development of range compression algorithms.
  - Complete preliminary system analyses and trade studies.
  - Initiate planning and hardware development for early flight test.
  - Initiate development of data processing architecture and algorithms.
  - Investigate terrain classification using polarization, spatial and spectral diversity.
  - Investigate high-resolution passive imaging of emitters.
  - Investigate potential platforms and begin hardware optimization process.

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- Command Post of the Future (CPOF). ($4.676 Million)
  - Complete the final experiments in cognitive principals of visualization, multi-modal interaction, collaborative planning and command decision-making.
  - Complete technology development of CPOF component technologies of dynamic visualization, multi-modal interfaces and collaborative planning.
  - Integrate final component technologies and knowledge bases into the final prototype commander's mobile interactive display system, the BattleBoard; qualify system capabilities.
  - Participate in an advanced warfighting experiment using the CPOF BattleBoard as the primary command interface of the brigade and battalion level.
  - Transition and integrate the CPOF commander's dialog system into the Army's Agile Commander ATD testbed.

- Next Generation (XG). ($4.000 Million)
  - Initiate CONUS and OCONUS Spectrum Usage Analysis.
    -- Military bands during Force Exercises.
    -- Civilian band usage in a variety of locales (urban and rural settings).
  - Award initial technology and system contracts.
  - Investigate the higher-level functions required for multi-requirement optimization and parameterization of a waveform to include processing load, timing & synchronization.
  - Investigate concepts for employment and utility of a dynamic waveform to the warfighter.

- Advanced Speech Encoding (Vocoder). ($4.000 Million)
  - Begin development of noise suppression algorithms.
  - Begin development of speaker authentication features and algorithms.
  - Begin development of less than one KB per second vocoder.

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(U) FY 2003 Plans:

- Airborne Communications Node (ACN). ($11.500 Million)
  - Mature technology to technology readiness level (TRL) 5 by mid FY 2003.
  - Complete transition of system into Services.
  - Down-select to one contractor team, based on the results of the end-FY02 laboratory demonstration, to go forward into prototype and flight demonstration.
  - Initiate a joint-funded (Service(s) and DARPA) effort to prototype multi-mission ACN payload flight hardware and integrate on a manned aircraft for flight demonstrations and exercise participation.
  - Continue development of technologies to reduce overall size, weight, and power to support eventual integration (post initial flight demonstration) on strategic (Global Hawk) and tactical (Shadow) UAVs.
  - Participate in Joint Forces Command exercise.
  - Continue focused development of antennas to support aircraft integration.

- Symbiotic Communications. ($25.000 Million)
  - Complete development of data processing architecture and algorithms for non-real time system.
  - Conduct flight tests with non-real time system to validate algorithms.
  - Demonstrate Digital Terrain Elevation Data (DTED) 3 with non-real-time processing of flight data.
  - Conduct critical design review for real-time airborne system.
  - Initiate development of real-time airborne system.

- Next Generation (XG). ($10.000 Million)
  - Complete spectrum analysis of military bands usage.
    -- Conduct two to three exercises at 10 plus locations.
    -- Establish baseline for analysis.
  - Conduct Lab Demo of Sense and Adaptation Technology Performance.
    -- Perform analysis and simulation of multiple control protocols.
    -- Use military band spectrum analysis to assess subsystem technology development.

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- Identify attacks of concern against various items, including; software radios, beam-forming antennae, and 3G handsets.
- Quantify differential between linear multistage transforms and linear with one non-linear stage transform.
- Initiate development of testbed for hardware in-the-loop testing of concepts.
- Characterize next generation Electronically Steerable Array antenna, and Rf component technology for inclusion into eventual demonstrator.

- Advanced Speech Encoding (Vocoder). ($7.000 Million)
  - Complete development of noise suppression algorithms.
  - Demonstrate <1 kb/sec vocoder.
  - Begin development of prototype chip combining vocal waveform measurement radar and associated software.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Airborne Communications Node:	
Jan 02	System design review incorporating integration plan and physical architecture allocation.
Sep 02	Critical Design Review and Technology Rediness Level 5 laboratory demonstration.
Symbiotic Communications:	
May 02	Complete terrain scatter studies.
Jun 02	Demonstrate range compression processing.
Apr 03	Complete early flight test.
Jun 03	Demonstrate SAR and digital terrain elevation data level three processing.
Aug 03	Preliminary Design Review for airborne system.

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Next Generation (XG):

Apr 02	Initial system design, sensing, dynamic waveform, sense and adapt technology development contract awards.
Aug 02	Analyze and measure spectrum usage in urban, open and forested environments.

Advanced Speech Encoding (Vocoder):

Mar 02	Performer contract awards.
Sep 02	Complete development of noise suppression algorithms.
Sep 03	Demonstrate less than one kb per second vocoder.