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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 #44					
COST *(In Millions)*	FY 1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	Cost To Complete	Total Cost
Total Program Element (PE) Cost	171.370	185.926	128.863	130.688	136.480	144.046	153.071	Continuing	Continuing
Command & Control Information Systems CCC-01	82.299	100.583	79.209	92.557	104.234	109.534	117.234	Continuing	Continuing
Information Integration Systems CCC-02	89.071	85.343	49.654	38.131	32.246	34.512	35.837	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 Command and Control Information Systems project is developing the technologies necessary to facilitate joint campaign planning and control throughout the battlespace. The primary program in this project is the Joint Forces Air Component Command System (JFACC), which will revolutionize command and control of joint and coalition air forces through the incremental development, integration, evaluation, demonstration, and transition of technology and systems. Other programs addressed in this project include: the Dynamic Command and Control Systems program; the Information Assurance Science and Engineering Tools; the Advanced Intelligence, Surveillance and Reconnaissance (ISR) Management (AIM) program; the Agent-Based Systems program; Project Genoa; and the Active Templates program.

(U) The Information Integration Systems project will develop the technologies necessary to ensure that the enhanced information required by battlefield combatants is available on a near real time basis. Programs addressed in this project include: the Agile Information Control Environment (AICE) program; the Dynamic Database (DDB) program; the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD); the Airborne Communications Node (ACN) program; and the Command Post of the Future program.

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

	FY1999	**FY 2000**	**FY 2001**
Previous President's Budget	177.492	222.888	213.380
Current Budget	171.370	185.926	128.863

(U) **Change Summary Explanation:**

FY 1999	Decrease reflects restructuring of the Joint Forces Air Component Command System (JFACC) and Dynamic Database (DDB) programs; termination of the Dynamic-Multi-User Information Fusion (DMIF) program and SBIR reprogramming.
FY 2000	Decrease reflects congressional reductions, a government wide rescission, inflation reductions and minor program repricing.
FY 2001	Decrease reflects the restructuring of JFACC and DDB programs and accelerated completion of the AICE program. In addition, the decrease is due to consolidation of portions of the Information Assurance programs in PE0602301E, project ST-24, with application-oriented developments remaining in project CCC-01.

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COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Command Control Information Systems CCC-01	82.299	100.583	79.209	92.557	104.234	109.534	117.234	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 diverse new environments and scenarios. These range from conflict and peacekeeping in urban areas with large civilian populations to heavy battle actions in remote areas. Current capabilities do not provide the Commander with real time, secure, situational awareness, nor the ability to conduct decentralized planning, rehearsal and execution. Additionally, the present systems do not provide flexible interfaces or critical interoperable assured communications. The goals of the programs in this project are to build on an innovative architecture and secure infrastructure to enhance information processing, dissemination and presentation capabilities for the Commander. This will be done by including information pertaining to the disposition of enemy and friendly forces, providing a joint situational awareness picture, and improving planning, decision-making and execution support capability, and providing 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 of our strategy for achieving battlefield dominance through assured information systems.

(U) The Joint Force Air Component Commander (JFACC) Project seeks to catalyze a revolution in military command and control (C2), specifically joint and coalition air operations. The objective of the program is to develop innovative technologies that will enable agile and stable control of distributed military operations conducted in an uncertain and rapidly changing environment, dramatically enhancing the effectiveness and efficiency of the Joint Force Air Component Commander. Based on lessons learned from earlier efforts within the program, it was noted that as observation, orientation, decision, and execution times are driven toward progressively shorter timelines, the control of dynamic phenomena within real-time operations becomes the key challenge to practical implementation of any new generation of C2 systems. The emphasis for this program has therefore shifted toward the entire air operations enterprise, expanding and understanding the theories, models, technologies, architectures and concepts that can manage the dynamic effects of large scale, highly agile command and control systems. JFACC will develop and validate new C2 architectural concepts and appropriate control strategies with the ability to: (1) rapidly and efficiently respond to varying objectives and guidance, time constraints, changeable resources, erratic hostile responses, asymmetric threats and unpredictable anomalies (Agility); (2) proactively manage destabilizing events, such as time critical targets, while simultaneously avoiding undesirable long-and short-term effects, to include disruptive and

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inefficient impacts on downstream plans and operations (Stability); (3) adapt to the wide spectrum of military conflicts and activities (Flexibility); (4) provide feedback with reliable performance assessments at the level of abstraction and integration that allows decision makers to make effective decisions (Visibility); and (5) drastically reduce the required number of personnel and physical facility footprints for each C2 node (Cost and Vulnerability). This extension and application of theoretical techniques and tools for the analysis, synthesis, and execution of real-time dynamic control includes these unique technical challenges: (1) a hybrid of symbolic and continuous control and feedback signals (representation of operations); (2) control of nested, dynamically changing execution elements (structural and spatial changes in engaged and supporting forces); (3) predictive, reflexive, and generative state estimation with input and feedback signal ambiguities (decisions and assessments with uncertain and incomplete information); (4) hybrid and distributed control system architectures (centralized, de-centralized, self-organizing, etc.); (5) system control with dynamic counteracting disturbance signals (an active adversary); and (6) complementary human and machine control signals (mixed human/machine decisions).

(U) Current military command and control (C2) systems, concepts, and architectures employ a decision cycle (e.g. observe, orient, decide, and act) which is analogous to closed loop feedback Control Theory. Recent experimental discoveries in the DARPA Joint Force Air Component Commander (JFACC) program have verified the efficacy of using the mathematics and science of Control Theory in a dynamic military C2 architecture. The Dynamic Command and Control (DC2) program will produce selected prototype tools that will validate the application of these recent discoveries and advances in Control Theory within a representative military operational environment. The DC2 program will develop an option-rich decision environment with a greater understanding and representation of the predicted outcomes and potential rolldown effects - making for a more responsive and agile C2 system. The DC2 program will support change management to ensure that fluctuations are appropriately minimized and uncertainty is treated as an explicit decision variable - making for a more robust and stable military operation. The DC2 program will enable faster-than-human response to a wide variety of situations, to include time-critical targets, feedback synthesis, change recognition, and other potentially automated military actions - complementing human decision-makers. The DC2 Program will provide the warfighter with the technological catalyst for a revolution in military command and control.

(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 assure the availability of associated services -- particularly in a stressed environment. Information Assurance (IA) technologies will be integrated into future versions of the Defense Information Infrastructure (DII) to provide a robust architecture across a wide range of DoD information systems. The development and fielding of secure information systems will be a continuing process of development and upgrading of existing systems and capabilities. The program is developing and refining information security technology into DII architectures and testbeds. As part of the program, the IA project is beginning to build a science and engineering discipline base for information assurance. One hypothesis to be tested is whether it is possible to create trustworthy systems from innovative

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integration of relatively untrustworthy mechanisms. The resulting security framework will reduce information vulnerability, allow increased interoperability and functionality, and provide the operational commander greater assurance that he will have the information he needs when he needs it. The initial investment provides near term applications to provide a modest level of protection, and a mechanism to test advanced secure information development in an end-to-end environment.

(U) A new 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 ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM) program will expand on efforts begun under the Joint Force Air Component Commander (JFACC) program and provide the technical foundation for ISR support to Joint Vision 2010 and beyond through the development of Information Needs Generation, Collection Strategy Development, and Multi-Asset Synchronization capabilities to dynamically optimize/synchronize, schedule, and request spaceborne, as well as task organically controlled airborne and ground based collection, processing, exploitation and dissemination architecture. The AIM program will optimize ISR support to precision engagement and dominant maneuver 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's Information Needs Generator effort will ensure near-real-time (NRT) information support to component commanders and the Joint Task Force (JTF) 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 simulations in support of trade-off decisions; and the ability to conduct real-time multi-echelon coordination and shared decision making. AIM's Collection Strategy Development effort will interoperate with future automated operational plan representations to continuously interpret ISR requirements contained in the plan and decompose these requirements into discrete sensor, information retrieval, and exploitation tasks. AIM's Multi-Asset Synchronization effort will simultaneously plan and integrate platform routes and schedules that maximize the total information value from the ISR confederation in support of the operational plan. The AIM program will develop or advance technologies in the following areas: multi-node collaboration, semi-automated reasoning, mathematical programming, and cognitive representations. Resulting AIM capabilities will transition to DoD automated planning and C4ISR migration systems as appropriate. Developed capabilities from the AIM project will be installed and operated at the United States Southern Command to ensure the utility of the technologies.

(U) The Control of Agent-Based Systems program will develop scaleable control strategies that enable intelligent software assistants for warfighters allowing them to delegate tasks such as information gathering, logistics supply, and operations planning that can be automated, but currently overload military personnel. Unlike other software, agents reduce the user's workload by operating autonomously and using available information to make intelligent decisions on behalf of the user. Agents are cost-effective; adaptive to new users, tasks, and computing

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environments; and collaborate with other agents on the network to solve problems. Agents also support a new lightweight approach for connecting dissimilar applications that don't speak the same language, but could be dramatically more powerful by sharing data and algorithms. The Control of Agent-Based Systems program will develop control strategies and an interoperability tool to ensure heterogeneous agent systems work correctly and predictably in the evolving Defense Information Infrastructure. This tool will be employed as a basis for agentization of military legacy systems.

(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. The earlier a crisis situation is discovered, identified and understood at the National Command Authority level, the easier it is to arrive at preemptive or mitigating strategies. The objectives are to: (1) decrease decision cycle time from days to hours by reducing the time it takes to go from detection of a problem to completion of a thorough briefing with actionable options for the decision maker; (2) increase number of situations that can be managed simultaneously by an order of magnitude because with the increasing number of potential crisis situations and reduced resources we must make analysts more efficient, cover more situations and provide more diverse options; and (3) reduce number of military deployments. The key enabling technologies are: knowledge discovery of critical information from unstructured multimedia sources; structured argumentation to capture and present reasoning from evidence to conclusion; and a comprehensive corporate memory which will enable comparison of critical information across situation, time, and organization. Genoa will use technologies from other DARPA programs such as Information Assurance as well as commercial technologies. The current clients for components of the prototype system are Commander in Chief Pacific (CINCPAC) and Defense Intelligence Agency (DIA).

(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. Active Templates 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 (6 times), improved plan quality (8 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.

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(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Joint Force Air Component Commander (JFACC). ($ 27.403 Million)
  - Evaluated JFACC program results to date and lessons learned. Identified the critical need for new enterprise control techniques to provide system agility, stability, and responsiveness required for dynamic, real-time military operations.
  - Restructured the program focusing on the agile and stable control of military operations. Established a new JFACC Team of performers in line with program restructuring.
  - Established an experimentation laboratory.
  - Developed object-based semantics for distributed operations and demonstrated its utility via a set of interoperability experiments.
  - Transitioned several JFACC-developed technologies into Service weapons systems and commercial markets.

- Information Assurance. ($ 20.818 Million)
  - Demonstrated automated capabilities to limit system access, protect data, manage replication and recovery, provided advanced detection and response to intrusions, anti-flooding techniques, and reconstituted/reconfigured information services to reflect dynamic operational priorities.
  - Demonstrated capability to do integrated monitoring of network service data, detected intrusion status and configuration/ reconfiguration; managed allocation of components and resources dynamically to reconstitute critical functions that have been degraded.

- Advanced ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM). ($ 9.550 Million)
  - Developed AIM tools for information management, strategy development, and multi-asset synchronization.
  - Conducted data collections at Special Project '99 to support technology development.
  - Evaluated ISR, logistics, and operations planning in an integrated experimental demonstration with the JFACC and ALP programs.

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- Control of Agent-Based Systems. ($ 13.365 Million)
  - Developed a framework to facilitate the integration, interoperability, and collaboration of heterogeneous systems between agents, object-based services and applications, and devices to assist information gathering and enhance military planning capabilities.

- Project Genoa. ($ 11.163 Million)
  - Project Genoa began user evaluation of selected components to establish performance metrics relevant to crisis situations. These experiments included initial knowledge discovery, structured argumentation, and argument presentation tools.
  - Components of the prototype system were installed at the DARPA test site for remote access by CINCPAC, DIA and other national security components for these user experiments and evaluations.
  - Developed engineering infrastructure to access user process data and conducted time and motion studies to identify baseline performance for special operations command and control activities.

(U) **FY 2000 Plans:**

- Joint Force Air Component Commander (JFACC). ($ 21.569 Million)
  - Develop a reconfigurable model that simulates the dynamic phenomena within the military air operations enterprise. Using the enterprise model, identify the dynamic behaviors within military air operations, which must be stabilized by the application of innovative control strategies.
  - Experimentally investigate the stability effects of new control technologies and C2 architectures incorporated within the air operations enterprise model.
  - Validate the feasibility of a 10-fold reduction in the time to initiate a required change in operations, with accurate understanding of side and downstream effects.

- Information Assurance. ($ 36.569 Million)
  - Demonstrate automated capabilities that enable dynamic, secure collaboration between enclaves including data and invocation flow rules.

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- Demonstrate real-time, finer-grained advanced attack detection and response at the application layer, operating system, and network infrastructure. Couple advanced attack detection capabilities with automated system security and administration tools to enhance integrated monitoring and control of network services, detected attack status, and system configuration.
- Dynamically and automatically manage allocation of components and resources to reconstitute critical functions that have been degraded.
- Demonstrate security policy interoperability between enclaves. Explore knowledge base approach to adaptive systems management. Improve assurance measurement and risk analysis by establishing value functions for user data.
- Enhance object assurance granularity by augmenting Common Object Request Broker Architecture Security (CORBASEC).
- Complete selection of basic Information Assurance Science and Engineering Tools (IASET) architecture for incorporation into an integrated design environment.
- Conduct initial IASET experiments with information assurance design methodologies emphasizing the application of science-based metrics in assessment activities.

• Advanced ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM). ($ 7.254 Million)
- Demonstrate dynamic replanning capabilities within an integrated collection management demonstration.
- Develop collection, exploitation, and dissemination synchronization techniques to link all phases of ISR management in support of the warfighter.
- Transition initial automated collection strategy tools to the Integrated Collection Management efforts in the Defense Intelligence Agency and the Joint Staff.

• Control of Agent-based Systems. ($ 15.730 Million)
- Develop and demonstrate a flexible information infrastructure and an interoperability tool called the Agent Grid, which will support the dynamic deployment of complex applications for dynamic domains such as military command and control.
- Demonstrate access to shared protocols and ontologies, mechanisms for describing agents' capabilities and needs, and services that support interoperability among agents at flexible levels of semantics distributed across a network infrastructure.

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- Project Genoa. ($ 11.692 Million)
  - Knowledge Discovery: develop and implement information extraction from text and extensive use of innovative visualization of complex information relationships.
  - Structured Argumentation: refine crisis models, develop tools for scenario based, alternative futures reasoning, and develop collaborative option generation, continue work on meeting transcription and develop ability to navigate and play back corporate memory.
  - Implement products from Information Assurance project so that a multi-intranet system may operate at mixed security levels. Continue evaluation by users from the national security community.

- Active Templates. ($ 7.769 Million)
  - Develop and encode templates of standard operating procedure, which integrate causal model capability to show how constraints, event triggering, inference, and uncertain reasoning can be utilized for fast crisis planning and execution.
  - Create a flexible networked architecture that supports template linking, dynamic connections, consistency management, and dynamic information sharing and characterize performance in terms of connection speed, message throughput, and consistency maintenance.

(U) FY 2001 Plans:

- Joint Force Air Component Commander (JFACC). ($ 5.000 Million)
  - Validate the feasibility of a 10-fold reduction in the disruptive side effects and downstream effects due to a required operational change (in addition to previous reductions in decision cycle time) through further development of dynamic control technologies and C2 architectures, and experimentation using the air operations enterprise model.
  - Initiate development of selected component prototypes to experimentally validate the viability of the new concepts and strategies.

- Dynamic Command & Control Systems. ($ 13.251 Million)
  - Construct a dynamic, multi-faceted architectural design for military command and control systems, which provides agility and stability to military operations.
  - Design system and selected component specifications based on the control theory discoveries which enable robustness and flexibility.
  - Develop an extensive library of operational "plant" models which can support a wide range of theoretical to operational experiments.
  - Experimentally validate the command and control architectures and design concepts produced during this phase.

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- Continue to explore new and innovative theories, techniques, and tools for agile and stable military operations.

- Information Assurance Science and Engineering Tools. ($ 21.696 Million)
  - Develop science-based security-enabling technologies, methods, and tools that will allow for the design of measurable and useful Information Assurance systems.
  - Conduct a series of mini-experiments to foster the initial incorporation of developments in Information Assurance sciences, mathematics, metrics, and science-based methods into a set of design and assessment tools.
  - Use experiment results to strengthen the development of the basic architecture into an integrated environment for the design and assessment of Information Assurance.

- Advanced ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM). ($ 9.514 Million)
  - Explore new ISR system architectures and technologies to increase effectiveness and reduce manloading.
  - Conduct operational evaluation of AIM automated collection strategy development and multi-asset synchronization technologies with US Southern Command and in coordination with Joint Forces Command.
  - Transition multi-asset synchronization and automated collection strategy development tools to Army, Air Force, and Intel C^4ISR systems.

- Control of Agent-based Systems (CoABS). ($ 12.800 Million)
  - Demonstrate agent technologies and tools in a military scenario that enables the run-time integration and interoperability of software components such as legacy applications, objects, and agents – into applications customized to target present and future command and control problems.
  - Commence transitioning of CoABS developed technologies and tools for specific integration into Agent Markup Language and Taskable Agent Software Kit programs.

- Active Templates. ($ 10.000 Million)
  - Integrate and demonstrate multiple template merging by users to update information, add dependencies, and attach problem-solvers.

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- Project Genoa. ($ 6.948 Million)
  - Develop and validate emerging concepts from collective reasoning applied to the asymmetric threat. Investigate the use of intelligent agents to automate functions where possible.
  - Demonstrate products that will permit operations in a multi-level security environment. Incorporate changes resulting from client evaluation in real world asymmetric environment.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Mar 00	Framework for the JFACC air operations enterprise model established as the baseline for experimentation and evaluation of new control technologies and C2 architectural concepts.
Jun 00	Demonstrate collaboration in multi-agent systems developed without hard-coded interfaces.
Jun 00	Based on initial JFACC experiments using the air operations enterprise model, assess the contribution of theoretical techniques and tools toward control of air operations, including response times and level of understanding of enterprise dynamics.
Jul 00	Demonstrate modular combined arms execution toolkit and small unit synchronizing toolkit.
Jul 00	Demonstrate Knowledge Base approach to systems management.
Jul 00	Demonstrate user data value functions.
Jul 00	Demonstrate rapid knowledge discovery and structured argumentation in crisis management.
Sep 00	Demonstrate AIM automated collection strategy development and multi-asset planning at JEFX '00.
Sep 00	Demonstrate augmented CORBASEC. Demonstrate composable trust systems.
Sep 00	Demonstrate secure enclave-to-enclave collaboration. Demonstrate advanced intrusion detection and response capability integrated with dynamic system monitoring, control, and restoration.

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Sep 00	Demonstrate semi-automated templates handling incomplete data amidst 100 execution changes in a military exercise.
Sep 00	Demonstrate Advanced ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM) automated collection strategy development and multi-asset planning Joint Expeditionary Force Exercise (JEFX) '00.
Dec 00	Demonstrate tools for analysis of IW attack costs.
Dec 00	Demonstrate system recognition of malicious code.
Feb 01	Experimentally evaluate JFACC-developed theoretical control techniques and tools completed, incorporating them into the final enterprise model. Validate the reduction in both time and disruptive effects to the air operations enterprise. Identify most promising C2 architecutural concepts, control strategies, and components for further validation.
Mar 01	Initiate development of selected components from new JFACC C2 architectural concepts and control strategies.
Mar 01	Demonstrate dynamic policy adjustment.
Jun 01	Demonstrate agents that dynamically create software interfaces; define scalability limitations.
Jul 01	Demonstrate CINC to tactical level integrated combined arms execution command and control with small unit synchronizing toolkit.
Sep 01	Demonstrate prototype adaptive security system and prototype DII I&W system.
Sep 01	Conduct evaluation of AIM's automated collection strategy development and dynamic multi-asset synchronization tools at Special Project '01.
Sep 01	Demonstrate that users can tailor their own templates, update information, add dependencies, and attach problem-solvers. Show that active template technology is scalable in that 50 templates have been built. Show that planning speed doubles and plan quality improves.
Jun 02	Demonstrate agent-based software technology for creating "super-applications" at run time.
Dec 02	Operationally evaluate integrated AIM capabilities for dynamic and proactive optimized collection strategy development, multi-asset synchronization for execution of the selected collection strategy, and continuous collaboration between operations and ISR.
Jan 02	Experimentally validate DC2 architectures and component design concepts.
Sep 02	Show six-fold increase in execution replanning using Active Templates attached to live data feeds from battlefield sensors.

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COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Information Integration Systems CCC-02	89.071	85.343	49.654	38.131	32.246	34.512	35.837	Continuing	Continuing

(U) Mission Description:

(U) The goals of the Information Integration Systems project are to take diverse inputs, including those planned as outputs, from the PE0603762E Sensors and Exploitation Systems project (SGT-04), and perform distributed and dynamic all-source correlation and fusion to produce an integrated, geo-spatially referenced, battlefield database and knowledge-base, and through the use of wideband dissemination and integrated sensor management allow multi-site, real-time, collaborative situation assessment and course-of-action evaluations. These goals are being addressed by the Dynamic Database (DDB) program, the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD), the Airborne Communications Node (ACN) program, and the Command Post of the Future (CPOF) program.

(U) The overarching goal of the Dynamic Database (DDB) program is to continuously produce significant battlespace information from immense quantities of multi-sensor data in a manner responsive to a diverse user community. More specifically, the DDB program will design, build, and demonstrate a system that (1) provides ready access to all battlespace sensor observations collected over time, (2) uses the resulting sensor history to identify and focus users' attention on tactically significant battlespace events, and (3) shares and synchronizes local situation changes across the distributed battlespace. Dynamic Database contents will be maintained and shared through a Sensor History Database (SHDB) that integrates geo-registered sensor history data with terrain, and potentially environmental, and force information to yield a logically consistent, multi-level view of the battlespace. Single and multi-sensor data fusion approaches will be developed that efficiently update the SHDB by filtering tactically significant changes from the Dynamic Database sensor history. This objective includes the development of theory and techniques for incorporating mission and situation context into low-level processing algorithms, and advanced phenomenology models for translating expected conditions and behaviors into multi-sensor observables. Significant situation changes will be shared throughout the battlespace within a scaleable Dynamic Database (DDB) enterprise of distributed Sensor History Database (SHDB) nodes, computing applications, processors, and information repositories. DDB enterprise technologies will be developed to monitor database conditions for change, trigger external processes when conditions meet posted criteria, propagate changes across DDB nodes, and support queries and searches of distributed databases.

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(U) The objective of the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) is to integrate and demonstrate information management and battlefield awareness technologies that allow operational users to easily access and exploit an expanded, massive information flow, and for commanders to manage it. This operational prototype service will allow commanders to design/ tailor their own information environment, and provides access to key transmission mechanisms and worldwide data repositories. BADD will supply the warfighter with a description of the battlespace tailored to their mission needs by intelligent selection of information to be broadcast/delivered (e.g. Global Broadcast Service (GBS), broadband DISN and selected tactical networks), as well as intelligent processing of user requests (pull) and filtering at the warfighter workstation so that relevant/needed information is available. Selected applications and dissemination services will be transitioned to the Defense Information Systems Agency (DISA) for incorporation into the Defense Information Infrastructure Common Operating Environment (DII/COE). The Phase III (Technology Improvement) phase of BADD, renamed the Agile Information Control Environment (AICE), is developing and demonstrating breakthrough information management technologies that provide 10 times improvement in the efficient and timely delivery of information; that extend current information management services to support time critical and real-time information flows (e.g., sensor to shooter); and that optimize information flows based upon maximizing the value of information delivered vs. today's practice of maximizing the volume of data delivered.

(U) The Airborne Communications Node (ACN) program is developing a multifunction payload deployable on an airborne platform that can interconnect, much beyond current radio range (beyond line of sight and horizon), more than 70 different channels and 17 waveforms. This capability will provide tactical units with direct access to over-the-horizon communications capability and continuous broad area communications coverage over the battlefield, with cross-system connectivity amongst on-the-move warfighters – to include Joint and Coalition forces - significantly improving rapid force projection, synchronization and synergy. To connect isolated and rapidly maneuvering forces via high data rate communications, provide reach-back connectivity to CONUS from forward elements, allow gateway connectivity among dissimilar radios and support secure channel-based dynamic configuration control requires the development of a system capable of providing reliable service in a severe electromagnetic interference (EMI) and jamming environment. This is achieved through the development of a highly flexible, software reprogrammable radio communication system that incorporates a complex cosite mitigation approach. The system is designed to be flexible and scalable to any airborne platform, including tactical UAVs and manned platforms, for rapid deployment, thus enhancing the existing legacy communications capability, providing new commercially-derived services (i.e., cellular) and enabling support for the small unit operations and mobile command centers of the future.

(U) 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

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required to do so. Three important command functions will be addressed in order 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 approach is to provide a very intuitive, well integrated, decision-centered, information environment in which the commander and a few staff members can quickly understand the changing battlefield situation, select the best course of action (COA), communicate that COA to the implementing units, and monitor the execution. The key technologies to be developed are: (1) an integrated visualization environment where the commander and his staff can view immediately understandable presentations of the changing battlefield situation, presentations which are tailored to the situation and the command decisions of interest; (2) a powerful and comprehensive human-computer interaction capability (through speech and gesture understanding, language understanding, dialog management, and visual collaboration) so that the commander and his staff can successfully understand and explore the information environment, without requiring dozens of staff members to operate and integrate multiple information systems; (3) a command post dialog manager which would automatically track current activities and tasks in the command post to tailor the information presentations to topics of interest; (4) an integrated suite of knowledge bases, intelligent agents, plan sentinels, information processing assistants which would 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 hardware and software components that can be quickly configured and tailored to various command environments (stationary and mobile), at different echelons of command.

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Dynamic Database (DDB). ($ 23.598 Million)
  - Completed the initial DDB architecture design. Developed and conducted experiments of single-sensor entity phenomenology models.
  - Developed prototype multi-sensor target phenomenology models. Incorporated situation context into single and multi-sensor anomaly detection algorithms.
  - Demonstrated a prototype update service for the entity layer of the Dynamic Database.

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- Integrated technology products in the Dynamic Database (DDB) System Integration Laboratory (SIL) and demonstrated an initial DDB system capability that ingests raw multi-sensor data, aligns, and mosaics the data within a common 2-D spatio-temporal reference frame and provides the user ready access to sensor history data.
- Conducted a multi-sensor data collection at the National Training Center in conjunction with the XVIII Airborne Corps 525th Military Intelligence (MI) Brigade. Sensor types included Synthetic Radar (SAR), Electro-optic (EO), Infrared (IR), Ground Moving Target Indicator (GMTI) Radar, and Signals Intelligence (SIGINT) from a mix of currently fielded and advanced technology sensors platforms. Data from this collection was used to develop fusion algorithms and assess robustness of DDB technology.

- BADD ACTD. ($ 11.457 Million)
  - Deployed Battlefield Awareness and Data Dissemination (BADD) software to PACOM and began the operational utility assessment.
  - Integrated the BADD software with the DISA Information Dissemination Manager (IDM) COTS/GOTS products in preparation for fielding to selected CINCS in 3d Qtr FY 00.
  - Initiated formal segmentation of the BADD/DISA products for integration into the Defense Information Infrastructure (DII) Common Operating Environment (COE) and the Global Command and Control System (GCCS).
  - Delivered the battlefield Awareness video archiving tools to the Joint Staff Service Center (JSSC) for installation and CINC utilization.
  - Conducted four collaborative assessments with operational users at multiple agencies/distributed service sites (Army, Navy, Air Force, Special Operations Force (SOF) and Joint).
  - Began the two-year ACTD sustainment phase.
  - Conducted pilot services at SPAWAR San Diego, Hurlburt AFB, FT Gordon, ACOM, Joint C4SIR Battle Center (JBC) and CECOM.

- AICE. ($ 19.460 Million)
  - Theoretical Framework and Metrics: Developed comprehensive AICE Functional Architecture baseline. Coordinated, standardized and documented all major interfaces in AICE. Developed performance assessment methodologies and metrics to permit controlled scientific evaluation of AICE technologies.
  - AICE Technology Development: Developed AICE technology components which span the AICE Functional Architecture. Began developing prototype MetaNet consisting of tactical networks (MSE, CEC, and LINK16), DISN networks, and commercial networks. Developed information channel building and instantiation of information channels on commercial ATM and military EHF SATCOM

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networks with mission-driven quality of service. Began development of information flow optimization technologies for global, content-based information utility maximization. Developed formalism for hierarchical resource allocation policy expression and resolution against mission objectives. Developed a generalized specification of the metadata attribute space over which policies are applied. Developed the multi-dimensional vectorspace-based algebra required to achieve other AICE technical goals.

- Performance Assessment and Integration: Developed Performance Assessment Environment and defined experiments to evaluate and spur improvement of AICE technology components. Developments supported AICE component Build 1.

- Airborne Communications Node (ACN). ($ 21.933 Million)
  - Initiated the design, development, and integration the proof-of-concept payloads (three system design teams).
  - Continued ACN technology integration and experimentation, and conducted lab demonstrations to verify mitigation approaches/designs for high-risk areas such as electromagnetic interference (EMI)/cosite and antenna coupling/range.

- Command Post of the Future (CPOF). ($ 12.623 Million)
  - Began development of CPOF technologies, an integration environment, and designed a series of decision experiments to test the effectiveness of the CPOF system to improve command decisions. Technology development in automated visualization, multi-modal interfaces, automated context tracking, and dialog management was begun. Detailed studies of mental models of command decision making were begun and first cut encoding of these models into a functional abstraction hierarchy (FAH) was started. A detailed system integration plan was developed. Detailed experiment planning was begun with extensive interaction between the principal investigators (PIs), representatives from the battle labs (principally, the Marine Corps Warfighting Lab and the Army's Battle Command Battle Lab), and the CPOF senior advisory group made up of retired senior military commanders from all services. Development of the first version of the CPOF integration environment was begun.

(U) FY 2000 Plans:

- BADD ACTD. ($ 7.418 Million)
  - Complete the integration effort with DISA's products. Field BADD/DISA products to selected CINC's six months prior to the end of the ACTD. Continue upgrading capability (based on warfighter input/feedback) to provide a more enhanced version to the CINC's in the latter part of the FY. Provide interfaces that will allow other ACTDs and programs to take advantage of the BADD capabilities. Upgrade the software to be compliant with the DISA next iteration of the DII COE. Transition capability to DISA.

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- AICE. ($ 3.210 Million)
  - Complete closeout of AICE in concert with BADD ACTD transition.

- Dynamic Database (DDB). ($ 25.445 Million)
  - Complete a refined DDB architecture design that prototypes a single node DDB System Integration Laboratory (SIL). Expand the Sensor History Database (SHDB) object schema to include pedigrees that automatically map entity-level situation assessments to multi-sensor source data using data-driven fusion methodologies.
  - Extract and fuse enhanced multisensor data features over time. Include visible Electro-optic (EO) into the stored data-types. Develop and validate multiple-sensor terrain and entity phenomenology models. Validate prototype multi-sensor target phenomenology models.
  - Incorporate situation context into single and multi-sensor anomaly detection algorithms.
  - Demonstrate an interactive prototype update service for the entity layer of the Dynamic Database.
  - Explore alternative concepts for detecting/recognizing significant change and activity from multi-source data.
  - Upgrade technology products in the DDB SIL. Demonstrate an interactive prototype DDB system that ingests raw multi-sensor data, aligns, mosaics, and displays the data within a common 3-D spatio-temporal reference frame, automatically identifies and cues the user to uncorrelated data features, updates the sensor history layer of the SHDB, and provides the user ready access to Synthetic Aperture Radar (SAR), Electro-Optic (EO), Infrared (IR), Ground Moving Target Indicator (GMTI) Radar, and Signals Intelligence (SIGINT) sensor history data registered to a common fiducial and entity-level situation hypotheses.

- Command Post of the Future (CPOF). ($ 16.662 Million)
  - Produce technology in the areas of automated visualization, multi-modal interaction (speech and gesture recognition) automated context tracking, dialog management, and cognitive modeling.
  - Cognitive visualization principles will be encoded in a knowledge base and the tools for extracting and using these principles will be developed.
  - Tools for recognizing speech and 2D gesture interactions will be developed as well as higher order sketch understanding.
  - Automated context tracking will encode the mental models captured in the functional abstraction hierarchy (FAH) and develop technologies for isolating and tracking cues for indexing the FAH.
  - Continue development and refinement of the command decision making mental models and encode them in the FAH.

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- Complete the first series of limited objective experiments (LOEs) and conduct a comprehensive experiment in conjunction with a major warfighting experiment.
- Phase II experiments will be designed and a number of the phase 2 LOEs will be run.
- The integration environment will be complete and individual technology components will be added.

- Airborne Communications Node (ACN). ($ 32.608 Million)
  - Down select up to two teams for technology enabling payload architecture and development. This architecture will be targeted to operate within the stringent environment of the Global Hawk high altitude endurance unmanned aerial vehicle, thereby stressing the packaging technology required to meet the form, fit and function. The payload architecture will be modular and scalable, which will enable subsets of the full functionality to be transferred to other SWAP-limited platforms like tactical UAVs.
  - Conduct laboratory demonstrations of critical subsystems (e.g., interference mitigation subsystem).

(U) FY 2001 Plans:

- Dynamic Database (DDB). ($ 12.240 Million)
  - Extend database query services to include rapid access to all levels of situation information in response to pre-defined user profile requested content-based index and query capabilities.
  - Continue to upgrade technology products in Dynamic Database (DDB) System Integration Laboratory (SIL). Demonstrate an interactive prototype DDB system that ingests raw multi-sensor data, aligns, mosaics, and displays the data within a common 3-D spatio-temporal reference frame, automatically identifies and cues the user to uncorrelated data features, updates the sensor history layer of the Sensor History Database, and provides the user ready access to Synthetic Aperture Radar (SAR), Electro-optic (EO), Infrared (IR), Ground Moving Target Indicator (GMTI) Radar, and Signals Intelligence (SIGINT) sensor history data registered to a common fiducial and both entity and force level situation hypotheses.
  - Incorporate Dynamic Database (DDB) technology into the XVIII Airborne Corps, 525th Military Intelligence Brigade, and Forward Sensor Enclave testbed.
  - Develop algorithms for multi-modal data fusion from visual systems and related feature recognition in a specific task domain with real-time requirements.
  - Nonlinear techniques for automatic audio recognition and feature extraction in noisy, multi-speaker environments.

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- Build an open plug-and-play architecture where modalities are mixed and matched to best support the target environment.

- Command Post of the Future (CPOF). ($ 24.861 Million)
  - Continue to develop and integrate new CPOF technology into a complete CPOF system to enable commanders to improve the speed and quality of command decisions to stay ahead of the adversary's ability to react.
  - Integrate and test new versions of the technology components in a series of simulation-based decision experiments.
  - Integrate the most effective technology into a complete CPOF system for an end-to-end demonstration of in a simulated joint exercise.
  - Begin preparations for an operational demonstration of the CPOF system in a joint field exercise in FY 2002.

- Airborne Communications Node (ACN). ($ 12.553 Million)
  - Complete development of critical technologies.
  - Verify the critical technologies at the component level.
  - Mature the ACN architecture to a preliminary design.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Dynamic Database:	
Oct 00	Incorporate Dynamic Database DDB technology into XVIII Airborne Corps 525th MI Brigade Forward Sensor Enclace (FSE) Testbed.
Jun 01	Demonstrate an interactive DDB system that ingests raw multi-sensor data, aligns, mosaics and displays the data within a 3-D Spatio-temporal reference frame in the System Integration Laboratory (SIL).
Aug 01	Preliminary architecture for sensor-to-sensor cascaded exploitation and tasking.

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Battlefield Awareness And Data Dissemination:

Apr 00	Field BADD products to selected CINCs.
Sep 00	Complete BADD ACTD transition to DISA and the Services.

Agile Information Control Environment:

Apr 00	Complete AICE theoretical framework.
Sep 00	Demonstrate AICE prototype MetaNet.

Airborne Communications Node:

May 00	Down select to two ACN teams.
Jan 01	Interim review and initial laboratory test data.
Sep 01	System performance review and simulation test results.

Command Post Of The Future:

Aug 00	CPOF Comprehensive Experiment One run in conjunction with Advanced Warfighting Experiment (AWE).
Jul 01	CPOF Comprehensive Experiment Two to run at Fort Hood in warfighting experiment.
Dec 01	Demonstrate Course of Action (COA) level analysis within major Army exercises (e.g., Advanced Warfighter Experiment - AWE).