| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | | | | | | | | DATE February 1999 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| APPROPRIATION/BUDGET ACTIVITY<br>RDT&E, Defense-wide<br>BA3 Advanced Technology Development | | | | | R-1 ITEM NOMENCLATURE<br>Command, Control and Communications Systems<br>PE 0603760E, R-1 #48 | | | | | |
| COST *(In Millions)* | FY 1998 | FY 1999 | FY 2000 | FY 2001 | FY 2002 | FY 2003 | FY 2004 | FY 2005 | Cost To Complete | Total Cost |
| Total Program Element (PE) Cost | 147.525 | 177.492 | 222.888 | 213.380 | 210.483 | 199.480 | 219.046 | 218.671 | Continuing | Continuing |
| Command Control Information Systems CCC-01 | 65.219 | 86.596 | 109.933 | 109.834 | 94.734 | 93.734 | 104.034 | 104.834 | Continuing | Continuing |
| Information Integration Systems CCC-02 | 82.306 | 90.896 | 112.955 | 103.546 | 115.749 | 105.746 | 115.012 | 113.837 | 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 Information Assurance program, the Advanced ISR Management 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 Dynamic Multi-User Information Fusion (DMIF) program terminating in FY 1998, the Dynamic Database (DDB) program, the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD), the Airborne Communications Node (ACN) program, the Command Post of the Future program, and Course of Action Analysis program.

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

| | FY1998 | FY 1999 | FY 2000 | FY 2001 |
|---|---|---|---|---|
| Previous President's Budget | 150.010 | 200.100 | 187.369 | 206.234 |
| Current Budget | 147.525 | 177.492 | 222.888 | 213.380 |

**(U)** **Change Summary Explanation:**

| | |
|---|---|
| FY 1998 | Decrease reflects rephasing of the BADD ACTD and SBIR reprogramming adjustments. |
| FY 1999 | Decrease reflects congressional reductions to the Joint Forces Air Component Command System (JFACC) and Dynamic Database (DDB) programs; termination of the Dynamic-Multi-User Information Fusion (DMIF) program. |
| FY 2000-01 | Increases reflect transition of Project Genoa from PE 0602702E, Tactical Technology, Project TT-03; increases to the Airborne Communications Node (ACN) program for completion of payload integration and bench tests; and the Information Assurance program. |

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| COST *(In Millions)* | FY 1998 | 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 | 65.219 | 86.596 | 109.933 | 109.834 | 94.734 | 93.734 | 104.034 | 104.834 | Continuing | Continuing |

**(U) Mission Description:**

(U) Recent military operations, e.g., Desert Storm and Haiti, demonstrated that current theater command, control, communications, intelligence/information systems, planning and rehearsal systems; and non-lethal weapon's capabilities lack the ability to support effective operations in diverse new arenas and scenarios ranging from desert heavy battle actions to urban areas with large civilian populations. Current capabilities do not provide real-time situational awareness, decentralized battle planning, rehearsal and execution capability, flexible interfaces or critical interoperable wide-area communications. The goals of the programs in this project are to build on an innovative architecture and infrastructure to enhance information processing, dissemination and presentation capabilities for the Commander by inclusion of information pertaining to enemy and friendly forces, providing a joint situational awareness picture and improving planning, decision-making and execution support capability and providing multimedia information interfaces and 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 information systems.

(U) The Joint Forces Air Component Commander (JFACC) Project seeks to revolutionize command and control (C2) of joint and coalition air forces through the incremental development, integration, evaluation, demonstration and transition to the Warfighter of advanced information technologies and software components which will enable new operational C2 concepts and capabilities that will significantly improve the responsiveness, efficiency, effectiveness, and flexibility of air operations. Key aspects of the program are: continuous near-real-time planning, execution, and assessment with all tasks tied to a central strategy and embodied in a common plan representation; collaboration among distributed elements to achieve a high degree of integration through the echelons and across operations, intelligence and logistics; and stable and agile control of theater-wide operations. Software modules will be developed with advanced capabilities for campaign and detailed planning, execution management, resource and adversary analysis, process control, and information/knowledge management. Key technologies include automated and mixed-initiative reasoning, intelligent resource allocation and scheduling, dynamic workflow management, system dynamics modeling and control, information mediation and fusion, knowledge representation and acquisition, and decision-centered information presentation. These technologies will be applied to needs that include: continuous processes that quickly anticipate and react to changes in guidance, threat situation, resource availability and synchronization; full integration of intelligence, logistics and operational activities to support integrated and prioritized operational tasks; empowerment of cross functional teams to quickly respond to battlespace changes; and continuous decision-space awareness to support rapid

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option assessment and decisions at multiple echelons. JFACC technologies, that support operational level decision making and information processing, will be interoperable with related DARPA programs (e.g., Advanced Logistics Project (ALP), Advanced ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM), and Agile Information Control Environment (AICE) ). Program execution features a multi-phased, develop-experiment-transition approach, including close coordination with the Air Force and Navy Battlelabs and other service C2 organizations.

(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 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) project will expand on efforts begun under the JFACC program and provide the technical foundation for ISR support to Joint Vision 2010 and beyond through the development of Information Management, Collection Strategy Development, and Multi-asset Synchronization capabilities to dynamically optimize/synchronize, schedule, and task the spaceborne, airborne and ground based collection, processing, exploitation and dissemination architecture. The AIM project 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 Management effort will insure near-real-time (NRT) information support to 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

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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 project will develop or advance technologies in the following areas: workflow management, multi-node collaboration, social computation, automated reasoning, mathematical programming, and cognitive representations. Resulting AIM capabilities will transition to DoD automated planning and C4ISR migration systems as appropriate.

(U) The Control of Agent-Based Systems Program will develop 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 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. Commercial industry is rapidly adopting intelligent agent technology because it potentially lowers software development costs and automates user tasks. However, being autonomous, agents can misinterpret user requests, go out of control, consume system resources, destroy user confidence, and eliminate any advantage to developers. Systems of agents produced by different developers can interact in complex ways. The Control of Agent-Based Systems Program will complement commercial investment by developing control strategies to ensure heterogeneous agent systems work correctly and predictably in the evolving Defense Information Infrastructure.

(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 Authority 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

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other DARPA projects 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 Director Defense Intelligence Agency (DIA). This project was initiated and budgeted in PE 0602702E, Tactical Technology, Project TT-03, but as it has evolved, it transitioned to CCC-01 in FY 1999.

(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 (6X), improved plan quality (8X more options considered), 60% 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.

**(U) Program Accomplishments and Plans:**

**(U) FY 1998 Accomplishments:**

- Demonstrated and evaluated at the Air Force C2 Battlelab the basic JFACC Project technology/application building blocks and system architecture. Also, demonstrated initial interoperability of selected JFACC component prototypes with several other DARPA projects. ($ 30.237 Million)

- Developed concept of operations for Integrated Battlespace Management Program. ($ 2.954 Million)

- Demonstrated Information Assurance (IA) automated capabilities to limit system access, and prevent system attacks by layering privacy security service over enclave-to-enclave protection and filtering out active code that is dangerous to enclave systems. Demonstrated gross responses for disabling attacks by shutting down outside connection and system-wide recovery. Demonstrated mechanism interoperability with negotiation protocols and good system administration tools to manage security mechanisms in DII Leading Edge Services (LES). Integrated a basic Public Key Infrastructure certificate management system to support basic security services. ($ 19.657 Million)

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- Awarded AIM development contracts for initial Measures of Military Utility, trade studies and trade-off analysis, and designed tools for information management, strategy development, and multi-asset synchronization. Conducted a Concept Validation demonstration of emerging multi-asset synchronization algorithms. Conducted AIM Technology Symposium to demonstrate high-risk / high-payoff technology development areas for collection strategy optimization, predictive analysis for battlefield awareness, automated information needs development, and dynamic replanning for multi-asset synchronization. Transitioned asset allocation algorithms to the Discoverer II program office for use in architecture analysis and trade studies. ($ 7.638 Million)

- Completed the transition and provide one year of maintenance support to the operational Advanced Joint Planning ACTD to USACOM. Conducted a formal assessment of the ACTD's functionality. Completed transition of selected components. ($ 1.813 Million)

- Developed testbed environment to support the simulation, testing, and evaluation of large-scale agent systems, including agent control strategies and agent architecture. ($ 2.920 Million)

**(U)** **FY 1999 Plans:**

- Incorporate preliminary JFACC project results and lessons learned into system constructive models of both the JFACC proper, as well as subordinate wings and squadrons. Perform stability experiments to understand the end-to-end system stability issues across a spectrum of JFACC planning cycle times. Begin development of JFACC planning, assessment and control system modules. Begin development of interoperability technologies required to support operation of JFACC system components across heterogeneous operating environments. Perform cross program integration experiments with other advanced planning programs, specifically, logistics, intelligence, and operations with focus on semantic interoperability issues. ($ 27.750 Million)

- Demonstrate automated capabilities to limit system access, protect data, manage replication and recovery, provide advanced detection and response to intrusions, anti-flooding techniques, and reconstitute/ reconfigure information services to reflect dynamic operational priorities. Demonstrate capability to do integrated monitoring of network service data, detected intrusion status and configuration/reconfiguration; manage allocation of components and resources dynamically to reconstitute critical functions that have been degraded. ($ 24.490 Million)

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- Develop AIM tools for information management, strategy development, and multi-asset synchronization. Conduct data collections at Special Project '99 to support technology development. Evaluation of ISR, logistics, and operations planning in an integrated experimental demonstration with the JFACC and ALP projects. ($ 9.550 Million)

- Develop and test cooperative, federated, and market-based control strategies for Agent-Based Systems to assist information gathering and enhance military planning capabilities. ($ 13.644 Million)

- Project GENOA will begin user evaluation of selected components to establish performance metrics relevant to crisis situations. These experiments will include initial knowledge discovery, structured argumentation, and argument presentation tools. Components of the prototype system will be deployed to CINCPAC, DIA, and the DARPA test site for these user experiments and evaluations. Develop parameterized problem-solving algorithms, a simple representation languages, and a symbolic spreadsheet interface for building, tailoring, and using templates for real-time distributed planning and execution. ($ 11.162 Million)

**(U)** **FY 2000 Plans:**

- Continue the development of JFACC system modules. Select the most promising components for software implementation. Using those components, conduct JFACC planning experiments to quantify planning time and staff reductions that can be achieved using JFACC technology. Experimentally evaluate JFACC prototype modules at the Service Battlelabs to assess individual module military utility and to explore Concept of Operations. Complete the development of strategy-to-task planning capabilities and conduct operational experiments to assess the operational utility of this capability. Begin development of inter-module process controller. Continue cross-program integration experiments. ($ 34.005 Million)

- Demonstrate automated capabilities that enable dynamic, secure collaboration between enclaves including data and invocation flow rules. 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

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and risk analysis by establishing value functions for user data. Enhance object assurance granularity by augmenting Common Object Request Broker Architecture Security (CORBASEC). ($ 30.654 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. ($ 9.799 Million)

- Develop an enhanced agent communication language, an agent programming methodology and component libraries. Identify standard, protective agent services. Integrate compatible models of agent behavior. Demonstrate and stress-test in a military exercise 5-fold speed-up to plan and execute a time-critical operation. For commanders critical information items, demonstrate automated tracking and notification with 95% reliability with less than 5% false alarm rate. ($ 15.877 Million)

- In Project Genoa under knowledge discovery develop and implement information extraction from text and extensive use of intelligent agents, in structured argumentation refine crisis models 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 at CINCPAC test site. ($ 11.759 Million)

- Develop and encode templates of standard operating procedure which integrates causal model capability to show how constraints, event triggering, inference, and uncertain reasoning can be utilized for fast crisis planning and execution. ($ 7.839 Million)

**(U)** **FY 2001 Plans:**

- Continue the development of JFACC system modules. Integrate JFACC modules into an end-to-end working prototype including process control. Conduct high-fidelity stability experiments to complete dynamic characterization of the JFACC process. Conduct robustness experiments by testing the JFACC prototype across a broad range of operational scenarios. Establish multi-echelon control gains required to achieve global stability while minimizing planning and execution time. Continue operational experiments in conjunction with Service battlelabs for military utility assessment and concept of operations development. Begin experiment of system scalability issues. ($ 35.034 Million)

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- Develop automated cyber immune response capability utilizing advanced attack detection indications and warning systems integrated with adaptive system monitoring and control. Apply artificial diversity to the adaptive systems. Develop security enabling technologies for autonomous software agents that allow agents to function safely across enclaves. Enhance object assurance granularity by augmenting DCOM and JAVA Remote Method Invocation (RMI). Develop automatic security policy discovery and negotiation capability among enclaves. Advance assurance measurement capabilities by developing IW attack countermeasure cost/benefit tools. Develop information warfare indications and warning (I&W) tools, utilizing data fusion techniques, to provide Defense Information Infrastructure (DII) wide I&W capability. ($ 35.000 Million)

- Conduct operational evaluation of AIM automated collection strategy development and multi-asset synchronization technologies at Special Project 2001. Incorporate predictive Indications and Warnings technologies into the automated collection strategy development tools. Transition multi-asset synchronization and automated collection strategy development tools to the Discoverer II program office and classified ISR management systems. ($ 10.000 Million)

- Scale-up reliable agent systems. Develop and test methods for understanding large-system autonomous behavior. Demonstrate proof-of-concept prototype for self-configuring software applications comprised of network services and quantify utility for highly complex, dynamic command and control problems. ($ 12.800 Million)

- Project Genoa: Implement products from Information Assurance project to permit operations in a multi-level security environment. Incorporate changes resulting from client evaluation in real world environment. ($ 7.000 Million)

- Integration and demonstration of multiple template merging by users to update information, add dependencies, and attach problem-solvers ($ 10.000 Million)

**(U)** **Other Program Funding Summary Cost:**

- Not Applicable.

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**(U) Schedule Profile:**

| Plan | Milestones |
|---|---|
| Jun 99 | Demonstrate computer network resource protection for pathogenic agent systems. |
| Sep 99 | Integrate a basic Public Key Infrastructure certificate management system to support basic security services. Demonstrate basic replication techniques and anti-flooding techniques (port filtering). |
| Sep 99 | Demonstrate integrated ISR and operations planning in an integration experiment with JFACC, ALP and AIM at the Technology Integration Center. |
| Sep 99 | Release initial Active Template toolbox with symbolic spreadsheet interface and parameterized problem-solvers. |
| Jun 00 | Demonstrate collaboration in multi-agent systems developed without hard-coded interfaces. |
| Jun 00 | Demonstrate AIM automated collection strategy development and continuous multi-asset planning within an integrated collection management demonstration. |
| 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. |
| Jul 00 | Demonstrate and experimentally assess individual JFACC module/component prototypes for campaign and detailed planning, execution management, resource and adversary analysis, process control, and information/knowledge management. Evaluate JFACC system capabilities for cross-functional strategy-to-task linkage, and distributed and dynamic process management. |
| Sep 00 | Demonstrate augmented CORBASEC. |
| Sep 00 | Demonstrate secure enclave-to-enclave collaboration. Demonstrate advanced intrusion detection and response capability integrated with dynamic system monitoring, control, and restoration. |
| Sep 00 | Demonstrate semi-automated templates handling incomplete data amidst 100 execution changes in a military exercise. |
| Dec 00 | Demonstrate tools for analysis of IW attack costs. |
| Dec 00 | Demonstrate system recognition of malicious code. |
| 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 |

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| | |
|---|---|
| | synchronizing toolkit. |
| Jul 01 | Demonstrate operational prototype crisis management system functionality. |
| Jul 01 | Demonstrate and experimentally assess integrated JFACC module/component implementations for campaign and detailed planning, execution management, resource and adversary analysis, process control, and information/knowledge management. Evaluate JFACC system level timing and stablity within the context of continuous and interleaved planning, execution, and assessment. |
| Sep 01 | Demonstrate prototype adaptive security system and prototype DII I&W system. |
| Sep 01 | Conduct operational evaluation of AIM's automated collection strategy development and dynamic multi-asset synchronization tools. Initial demonstration of AIM's predictive indications and warnings technologies. |
| Sep 01 | Demonstrate augmented DCOM and JAVA RMI. |
| 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. |
| Jul 02 | Complete Project Genoa by turning over transition to customers. |
| Aug 02 | Operational evaluation of integrated AIM capabilities for dynamic and proactive information needs generation, optimized collection strategy development, multi-asset synchronization for execution of the selected collection strategy, and continuous collaboration between operations and ISR. |
| 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 1998 | FY 1999 | FY 2000 | FY 2001 | FY 2002 | FY 2003 | FY 2004 | FY 2005 | Cost to Complete | Total Cost |
| Information Integration Systems CCC-02 | 82.306 | 90.896 | 112.955 | 103.546 | 115.749 | 105.746 | 115.012 | 113.837 | 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 PE 0603762E 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 Multi-User Information Fusion (DMIF) program, the Dynamic Database (DDB) program, the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD), the Airborne Communications Node (ACN) program, the Command Post of the Future (CPoF) program, and Course of Action Analysis program.

(U) The Dynamic Multi-User Information Fusion (DMIF) program was an advanced technology development program for the defense and intelligence communities, including next-generation automated capabilities to support the operational service fusion systems: All Source Analysis System (ASAS), Theater Battle Management Core System (TBMCS), and Global Command and Control System (GCCS). The DMIF-created situation picture would reduce information overload and overcome barriers to interoperability among sensor exploitation sites, intel processing sites, and operators' decision nodes. The DMIF program was terminated in December 1998.

(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 Dynamic Situation Model (DSM) that integrates geo-registered sensor history data with terrain, 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 DSM 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

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multi-sensor observables. Significant situation changes will be shared throughout the battlespace within a scaleable "DDB enterprise" of distributed DSM 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 DSM nodes, and support queries and searches of distributed databases.

(U) The objective of the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) is to deliver, install and evaluate an operational prototype system that delivers to warfighters a consistent operational picture of the joint/coalition battlefield, allows commanders to design/tailor their own information environment, and provides access to key transmission mechanisms and worldwide data repositories. The description of the battlespace provided to the warfighters under this ACTD will be tailored to their mission needs by intelligent selection of information to be broadcast, intelligent processing of user requests (pull) and filtering at the warfighter workstation so that needed information is available. BADD will be evaluated through participation in a series of collaborative assessments, demonstrations, and a military utility assessment. BADD is also operating under a Memorandum of Agreement with the Global Broadcast Service Program Office to provide advanced information management capabilities and new applications for this system as part of the overall transition plan of BADD developments to operations after test and evaluation in the ACTD. 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).

(U) To avoid confusion, the Phase III (Technology Improvement) phase of BADD will henceforth be renamed Agile Information Control Environment (AICE). AICE will focus on 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. To successfully demonstrate the operational payoff of these capabilities, AICE will develop a prototype MetaNet that provides end-to-end quality of service across multiple tactical and commercial-based networks. AICE will also develop an Adaptive Information Controller that optimally allocates the resources of shared information infrastructure (networks, servers, guards, etc.) based upon overall operational concerns. AICE will develop Information Policy Management Tools that enable a commander of a large military enterprise to create, establish and maintain an enterprise wide specification of information flow priorities. AICE will also develop a unifying theoretical basis for characterizing and measuring the performance of Adaptive Information Control components. Performance Analysis and Integration experiments will be conducted to integrate and measure the performance of AICE components via a series of experiments that utilize the theoretical basis developed.

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(U) The Airborne Communications Node (ACN) program will provide a multifunction payload deployable on an airborne platform that demonstrates for the first time that a single communications node 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 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. A prototype payload is being developed to be supportable on a Global Hawk High Altitude Endurance unmanned airborne vehicle, but 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. The Airborne Communications Node program will integrate Warfighter Internet functionality to provide Internet-like communication services across multiple airborne nodes. The program will conclude with field demonstrations in FY 2002.

(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 required to do so. 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.

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(U) The Course of Action Analysis (COAA) program is focused on advanced technology development in the area of Course of Action Analysis. The program is developing a set of tools for performing COAA that can be demonstrated to determine the ability of these tools to support large-scale combat events.

(U) Real-Time Infrastructure Capabilities Assessment (RICA) will develop new technology for improving the military's capability to perform real-time effects-based targeting and re-targeting of infrastructure systems. The current technology supports the capability to perform sophisticated analyses of an enemy's infrastructure and select targets based on causal models of the effects of the targeted components on overall system performance. The current limitation of this technology is that the development, maintenance, and operation of these analytic models is manpower intensive and time consuming – preventing the use of effects-based targeting in real-time course of action generation. This project effort will evaluate the current processes used to accomplish effects-based targeting and develop new sensor exploitation and information exploitation technologies to enable the real-time generation of courses of actions based on the high-precision target analyses.

(U) The purpose of the SkyLink program is to provide mobile tactical users with multimedia $C^2I$ (voice, data and video) using broadband commercial satellites. SkyLink will help enable the Next Generation Command and Control vision by providing the data bandwidths that support real-time video conferencing, distributed collaboration, image transfer, multi-media database access and interactive visualization to distributed, mobile operations personnel as well as to isolated mobile forces. It is projected that burst data rates on the order of hundreds of megabits per second to mounted forces and tens of megabits per second to dismounted forces can be achieved.

(U) The Asymmetric Threat component will develop information technology to provide improved awareness of asymmetric threats. New techniques will be developed: to automatically monitor and extract facts about people, places and activities from speech and textual data sources; to automatically discover network links and relationships from a large collection of facts about a terrorist network; to model and reason about a terrorist's groups capabilities and intentions; to derive a set of potential sites and activities to watch for based on a terrorist's group's capabilities and intentions; and to manage the exploitation and fusion of heterogeneous sensors to automatically monitor for those activities.

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**(U) Program Accomplishments and Plans:**

**(U) FY 1998 Accomplishments:**

- DMIF: Continued development of the DMIF system to implement strategically controlled fusion, that is, real-time context-sensitive tasking of multiple fusion engines. This tasking adapts to the characteristics of available or incoming information, the performance of the available information processing applications (such as ASAS, CIS, or GCCS), and the specific tactical situation (as represented by the commander's critical intelligence requirements or via automated planning systems). By selecting fusion engines and tuning their parameters based on the real-time context, strategic control of multiple fusion engines ensures that users get peak performance over a much broader range of conditions than any single fusion engine could provide. Systems include fusion engines from the Army, Air Force, Navy, national agencies, and R&D systems. Demonstrated functionality at integrated operations/intelligence demonstrations with the JFACC program, the DARPA-DISA Joint Program Office, and transitioned components into ASAS. ($ 11.689 Million)

- Dynamic Database (DDB) Program: Completed the Phase I DDB architecture design. Installed the DDB System Integration Laboratory (SIL) to facilitate the exchange and evaluation of ideas and approaches, support distributed experimentation requirements, incubate and integrate evolving DDB technologies, and conduct system and technology proof-of-concept demonstrations. Laid the foundation for future DDB development by integrating existing "backbone" products (such as algorithms, phenomenology models, software, and databases) into the DDB SIL. In conjunction with DMIF, produced an initial object schema for the Dynamic Situation Model. Initiated single and multi-sensor fusion algorithms research and demonstrate a prototype update service for the sensor history layer of the Dynamic Database. Produced initial geo-registration and mosaicing tools for SAR, MTI, IR, and SIGINT sensor and incorporate tools in the Dynamic Database computation services. Developed a limited spatio-temporal database query capability. Produced an application programming interface specification for the Dynamic Database management system. Incorporated the initial Dynamic Situation Model object schema into the Dynamic Database and demonstrate the ability to ingest and process raw sensor data. Collected SAR, MTI, IR, EO, and SIGINT sensor data in preparation for FY 1999 activities. ($ 14.986 Million)

- BADD ACTD: Released the initial version of Phase II software (Release 1) increasing the level of automation previously provided to users and extending information management and dissemination support to the level of individual battalions/ships. BADD stood up six CONUS pilot service sites to include the Army, Air Force, Navy, ACOM and JBC. Completed collaborative assessments at two of the six

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pilot service sites that were evaluated by ACOM, the operational sponsor. Stood up the first digital tactical video server and demonstrated real-time population of that server, as well as automated meta-data generation for a number of tactical video surveillance platforms. ($ 43.820 Million)

- Airborne Communications Node (ACN): Selected multiple teams and initiated competitive ACN system design technology integration efforts. Initiated core technology integration from Warfighter's Internet and GLOMO programs and conducted initial technology investigations of very high bandwidth air-to-air and air-to-ground communications. The Warfighter's Internet Program integration with the ACN Program began. ($ 8.318 Million)

- Command Post of the Future: The program focused on defining operational concepts for the new system and developing a concept demonstration to show operational users for evaluation and feedback. A group of operational advisors was formed from service representatives at the Army Battle Command Battle Lab – Ft. Leavenworth, the Mounted Maneuver Battle Lab at Ft. Knox, and the Marine Corp Warfighting Lab at Quantico. User studies were conducted by visiting operational military units to construct initial concepts of operation for CPOF, focusing on the Joint Land Forces Component Commander (JFLCC) as the target user. A concept demonstration was developed by integrating emerging technology in visualization, speech understanding, human-computer interaction, and decision aids to create an initial demonstration of envisioned CPOF capabilities. ($ 3.493 Million)

**(U)** **FY 1999 Plans:**

- Complete a Phase II DDB architecture design. Develop and validate single-sensor terrain and entity phenomenology models. Develop prototype multi-sensor target phenomenology models. Elicit and incorporate situation context into single and multi-sensor anomaly detection algorithms. Demonstrate a prototype update service for the entity layer of the Dynamic Database. Integrate technology products in the DDB SIL and demonstrate an interactive prototype DDB system that ingests raw multi-sensor data, aligns and mosaics the data within a common 2-D spatio-temporal reference frame, identifies and cues the user to uncorrelated data features, updates the sensor history layer of the Dynamic Situation Model, and provides the user ready access to sensor history data. ($ 23.595 Million)

- BADD ACTD: BADD will provide new information management capabilities to include creation of a 3-D graphical depiction of a consistent operational picture by near-real-time integration of all relevant databases, demonstrate variable information management, control information flows' content and resource allocation based on operational priorities, across constrained servers/networks,

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demonstrate near real time deliver of digital video streams/video products to tactical users. Video data will be filterable based on meta-data tagging (i.e. geographic area, video content) and will be merged into the Battlefield Awareness display. Complete military utility assessment at Roving Sands. Begin the 2-year ACTD sustainment phase. Operate Pilot Services and begin transition of initial CONUS and OCONUS Pilot Services to DISA. Complete the transition of integrated tactical video services to NIMA (video archiving tools) and to DISA/GCCS (video viewers). ($ 14.459 Million)

- AICE: Begin AICE technology development in MetaNet, Adaptive Information Control (AIC) and Information Policy Management (IPM) areas. Begin theoretical framework and metrics development. Begin developing prototype MetaNet consisting of tactical networks (MSE, CEC, LINK16), DISN networks, and commercial networks. Begin development of information flow optimization technologies for dynamic channel building and global, content-based information utility maximization. Generalize the concept of metadata attribute spaces stated in the BADD ACTD, and develop the multi-dimensional vectorspace-based algebra required to achieve other AICE technical goals. Conduct Performance Analysis and Integration experiments to assess and spur improvement of technology components. ($ 19.510 Million)

- Airborne Communications Node (ACN): Continue the execution of the design phase with multiple system design teams and initiate payload design and development for a proof of concept - functional - demo in early FY 2000. Continue ACN technology integration and experimentation and conduct lab demonstrations to verify mitigation approaches/designs for high-risk areas such as EMI/cosite and antenna coupling/range. ($ 22.100 Million)

- Command Post of the Future (CPoF): The program will begin to develop CPoF technology, an integration environment, and begin work to design a series of decision experiments to test the effectiveness of the CPoF system to improve command decisions. Technology development will begin to create a new suite of human-systems interaction technology, the major technology emphasis of the program, to include work in cognitive engineering, displays and workspace design, visualization, multi-modal user interaction, and dialog management and reasoning. System integration will also begin to refine and integrate the individual technologies into a complete CPoF system for testing in simulation-based Command Post exercises. Experiment planning will begin with user representatives from the service battle labs to define operationally meaningful test problems and design a series of simulation-based decision experiments to test the effectiveness of the new technology in improving command decisions. The first version of an integrated CPoF system will be created and tested at the end of FY 1999. ($ 11.232 Million)

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**(U)** **FY 2000 Plans:**

- BADD ACTD: Complete the 2-year ACTD sustainment phase. ($ 7.418 Million)

- AICE: Complete the development of metadata vectorspace-based algebra and use it to develop dynamic and conditional information profiling capabilities. Continue development of advanced information management technologies including Large-Scale Dynamic Channel Building Algorithms, Global Quality-of-Service Optimization, and Information Management Services to moving entities. Demonstrate prototype MetaNet providing end-to-end quality of service across tactical, DoD DISN, and commercial IP networks, as well as DoD tactical networks. Use Performance Assessment Environment to evaluate and select highest payoff technologies for insertion and evaluation within the BADD ACTD architecture. Begin investigation of incorporating ACN as part of the MetaNet. ($ 23.391 Million)

- Complete a Phase III DDB architecture design that prototypes a single node DDB SIL. Expand the Dynamic Situation Model 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 EO into the stored data-types. Develop and validate multiple-sensor terrain and entity phenomenology models. Validate prototype multi-sensor target phenomenology models. Incorporate automatic situation context into single and multi-sensor anomaly detection algorithms. Demonstrate an interactive prototype update service for the entity layer of the Dynamic Database. Upgrade technology products in the DDB SIL and 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 Dynamic Situation Model, and provides the user ready access to sensor history data and entity-level situation hypotheses. Incorporate DDB technology in XVIII Airborne Corps 525th Military Intelligence (MI) Brigade forward sensor enclave (FSE) testbed. ($ 33.308 Million)

- Command Post of the Future (CPoF): The program will produce new technology components, which will enable commanders to improve the speed and quality of command decisions to stay ahead of the adversary's ability to react. Technology will be produced to enable the commander and his staff to easily access information and quickly understand changing battlefield situations by speaking, pointing and naturally interacting with a suite of high-resolution displays in a CPoF environment. Technology will be produced to automatically generate visual presentations of battlefield information, tailored to the individual commander's background, preferences, current situation, task, and topic of interest. Different versions of these technology components will be integrated and tested in a series of simulation-based decision experiments. ($ 17.638 Million)

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- Airborne Communications Node (ACN): Conduct proof of concept manned aircraft demonstrations of competitive ACN system designs and down select to a single team for full function payload design and development. This design will be targeted to operate within the stringent environmental of the Global Hawk high altitude endurance unmanned aerial vehicle, thereby stressing the packaging technology required to meet the form, fit and function. This will enable subsets of the full functionality and design to be easily transferred to other SWAP-limited platforms like tactical UAVs. Complete final system designs and begin system integration. Conduct laboratory demonstrations of critical subsystems. ($ 31.200 Million)

**(U)** **FY 2001 Plans:**

- AICE: Demonstrate the capability to support real-time information flows across the MetaNet. Develop mechanisms for visualizing and understanding the macro structure of information flows supporting a large military operation. Automate the generation of information management policies based upon commander's intent. Assess military utility. Transition into pilot service and/or operational environments ($ 24.693 Million)

- DDB: Include video data into the stored data-types. Extract and fuse visible EO to extend multisensor data features over time. Develop and validate EO & video terrain and entity phenomenology models to incorporate streaming video into the mosaic display process. 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 the DDB SIL and 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 Dynamic Situation Model, and provides the user ready access to sensor history data, entity- and force-level situation hypotheses. Incrementally update intelligent DDB services in 525th MI FSE testbed. ($ 10.000 Million)

- Command Post of the Future (CPoF): The program will 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. New versions of the technology components developed in FY 1999 will be integrated and tested in a series of simulation-based decision experiments. The most effective technology will be integrated into a complete CPoF system for an end-to-end demonstration of in a simulated joint exercise. Preparations will begin for an operational demonstration of the CPoF system in a joint field exercise in FY 2002. ($ 22.000 Million)

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- Airborne Communications Node (ACN): Complete full system integration, extend laboratory demonstrations across multiple subsystem components, plan extensive ground interaction and flight demonstrations with joint warfighters, and conduct multi-platform (including Global Hawk) flight demonstrations in Joint Warfighter environments. ($ 11.400 Million)

- Demonstrate the ability to automatically extract facts about potential terrorist activities form open sources data and correlate those facts to accurately model a terrorist network. ($ 20.000 Million)

- Real-time Infrastructure Capabilities Assessment (RICA) will develop a set of workarounds reasoners to speed up the effects-based targeting process by providing the capability to automatically assess an enemy's ability to compensate for a damaged component. RICA will develop an information system to enable real-time re-targeting of infrastructure targets based on damage assessment and real-time observations of the targeted systems performance. ($ 3.000 Million)

- Skylink: The program will identify and define the key components of the effort and a strategy or process for engaging with SATCOM providers and industry. Also, a detailed technical architecture will be developed to support a proof of concept experiment. The effort will focus on augmentation of TCP/IP and ATM technology for mobile tactical use, development of heterogeneous interfaces, augmentation of fixed site signaling and tracking technology for mobile sites, and development of assured service protocols. ($ 12.453 Million)

**(U) Other Program Funding Summary Cost:**

- Not Applicable.

**(U) Schedule Profile:**

| Plan | Milestones |
|---|---|
| Mar 99 | Complete Military Utility Assessment of BADD Release 2. |
| Jun 99 | Complete BADD ACTD Military Utility Assessment at Roving Sands. |
| Jun 99 | Demonstrate single node prototype DDB technologies, to include sensor history database and computation services (registration and mosaicing) for SAR, IR, SIGINT, and MTI. |
| Sep 99 | Test integrated Command Post of the Future system. |

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| Oct 99 | AICE assessment environment operational. |
| Nov 99 | Complete AICE Release 1. |
| Dec 99 | Complete initial ACN System Design Reviews and conduct proof of concept flight demonstrations. |
| Dec 99 | Demonstrate an interactive DDB multi-sensor history database and entity-level situation assessment service (extending the services to include EO). |
| Jan 00 | Downselect to one ACN Team. |
| Mar 00 | Participate in major field test experiment (Ulchi Focus Lens) operating on live and simulated data from multiple sensors. |
| Apr 00 | Complete AICE theoretical framework. |
| Jul 00 | Demonstrate Smart Adversary to Army. |
| Sep 00 | Complete BADD ACTD transition to DISA, GBS Joint Program Office (JPO) and the Services. |
| Sep 00 | Demonstrate AICE prototype MetaNet. |
| Oct 00 | Phase III complete. Incorporate DDB technology into XVIII Airborne Corps 525th MI Brigade FSE Testbed. |
| Nov 00 | Complete AICE Release 2 technology products. |
| Dec 00 | 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 SIL. |
| Jun 01 | Demonstrate a fully interactive dual-node DDB entity- and force-level situation assessment service (extending the services to include video). |
| Jul 01 | Demonstration of Smart Adversary extended to Navy and Air Force. |
| Aug 01 | Complete ACN Payload Integration, laboratory and antenna range tests. |
| Sep 01 | Demonstrate COAA level analysis within major Army exercises (e.g., Advanced Warfighter Experiment -AWE). |
| Sep 01 | Demonstrate real-time flow support, AICE MetaNet. |
| Sep 01 | Complete AICE technology transition into pilot service or operational environments. |
| Oct 01 | Phase IV complete. Incrementally update DDB technology into XVIII Airborne Corps 525th MI Brigade FSE Testbed. Begin preparation to expand DDB into a multi-sensor, multi-node-distributed architecture. |
| Oct 01 | Skylink Proof of Concept experiment. |
| Mar 02 | Complete ACN payload integration and test with Global Hawk. |
| Aug 02 | Complete ACN field demonstrations. |
| Sep 02 | Complete ACN transition. |