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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)									DATE February 1999	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research					R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology PE 0602301E, R-1 #12					
COST (<i>In Millions</i>)	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	296.646	323.959	322.874	331.023	348.231	385.374	391.948	388.277	Continuing	Continuing
JASON ST-01	1.289	1.190	1.200	1.200	1.200	1.200	1.200	1.200	Continuing	Continuing
Intelligent Systems and Software ST-11	88.691	84.853	79.718	78.341	62.094	69.536	74.393	68.034	Continuing	Continuing
High Performance and Global Scale Systems ST-19	149.965	163.110	162.900	161.922	169.887	196.265	198.125	200.972	Continuing	Continuing
Software Engineering Technology ST-22	16.609	16.941	17.227	18.100	18.700	19.300	19.300	19.300	Continuing	Continuing
Information Survivability ST-24	40.092	57.865	61.829	71.460	96.350	99.073	98.930	98.771	Continuing	Continuing

(U) Mission Description:

(U) This program element is budgeted in the Applied Research Budget Activity because it funds projects directed toward the application of advanced, innovative computing systems and communications technologies.

(U) The JASON Group supports studies for the national security community.

(U) The efforts funded in the Intelligent Systems and Software project focus on the development of new information processing technology concepts that lead to fundamentally new software and intelligent system capabilities. This will enable advanced information systems to more effectively accomplish decision-making tasks in stressful, time sensitive situations and create efficient software intensive defense systems.

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(U) The High Performance and Global Scale Systems project develops the computing, networking, and associated software technology base underlying the solutions to computational and information-intensive applications for future defense and federal needs. These technologies will lead to successive generations of more secure, higher performance, and more cost-effective microsystems, associated software technologies, advanced mobile information technology and prototype experimental applications critical to defense operations.

(U) The Software Engineering Technology project supports the Software Engineering Institute (SEI) whose mission is to transition state-of-the-art technology, and best practices to improve the acquisition, engineering, fielding, and evolution of software-intensive DoD systems.

(U) The Information Survivability project develops the technology base underlying the solutions to protecting DoD's mission-critical information systems against attack upon or through the supporting infrastructure. These technologies lead to generations of stronger protection, higher performance, and more cost-effective security solutions scalable to several thousand sites and to high-performance computing technologies.

(U)	<u>Program Change Summary:</u> <i>(In Millions)</i>	<u>FY1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
	Previous President's Budget	309.037	417.723	368.779	412.248
	Current Budget	296.646	323.959	322.874	331.023

(U) Change Summary Explanation:

FY 1998	Decrease reflected accelerated completion of the Human Computer Interaction effort stand-alone program and integration of the related technologies into other intelligent systems programs, and SBIR reprogramming.
FY 1999	Decrease reflects the net effect of congressional program and undistributed reductions. Congress eliminated funding for the Joint Infrastructure Protection program and the Hands-Free Interface program as well as halved the funding for the networking effort.
FY 2000-2001	Decrease reflects discontinuance of Adaptive Computing and Software Composition programs, and program restructuring and reprioritization in Defense Technology Integration and Data Intensive Systems and Software programs.

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COST (<i>In Millions</i>)	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
JASON ST-01	1.289	1.190	1.200	1.200	1.200	1.200	1.200	1.200	Continuing	Continuing

(U) Mission Description:

(U) This project supports the JASONS, an independent group of distinguished scientists and technical researchers that provides analysis of critical national security issues. JASON membership is carefully balanced to provide a wide spectrum of scientific expertise and technical analysis in theoretical and experimental physics, materials, information sciences, and other allied disciplines. The JASON process ensures senior government leaders have the full range of U.S. academic expertise available on issues critical to national security involving classified and unclassified information.

(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Continued studies in: counter proliferation of chemical and biological weapons; advanced sensors to support small unit operations; high bandwidth urban communications; characterization of underground facilities; novel energetic materials; small scale propulsion; and land mine detection. (\$ 1.289 Million)

(U) FY 1999 Plans:

- Continue studies of interest to DoD in multiple disciplines such as: counter proliferation of chemical and biological weapons; advanced sensor technologies; advanced computing; land mine detection; battlefield information systems; battlefield planning and control; small unit operations; military communications; and novel materials. (\$ 1.190 Million)

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(U) **FY 2000 Plans:**

- Continue studies of interest to DoD in multiple disciplines such as: counter proliferation of chemical and biological weapons; space based radar; small payload space launch systems; advanced computing; multi-layered infrastructure defense; advanced sensor technologies including increased radar noise floor and deep buried target characterization; dispersed land forces technology; battlefield information systems and military communications; ultra low power electronics; fiber lasers; and self monitoring materials. (\$ 1.200 Million)

(U) **FY 2001 Plans:**

- Continue studies of interest to DoD. (\$ 1.200 Million)

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

- Not Applicable.

(U) **Schedule Profile:**

- Not Applicable.

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COST (<i>In Millions</i>)	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Intelligent Systems and Software ST-11	88.691	84.853	79.718	78.341	62.094	69.536	74.393	68.034	Continuing	Continuing

(U) Mission Description:

(U) This project develops new information processing technology concepts that will lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems to more effectively accomplish decision-making tasks in stressful, time sensitive situations and create efficient software-intensive defense systems.

(U) Major areas of technical emphasis are: (a) sensor data processing that leverages software-based intelligent processing to acquire sensory information, including advanced airborne video data; (b) situation analysis that provides for the intelligent integration of information from heterogeneous sources, including advanced airborne video data; interactive problem solving, planning, scheduling and decision analysis; and rapid development of large knowledge bases; (c) situation presentation technologies that provide intelligent interfaces to the resultant information streams, including the integration and application of emerging language understanding and translation to address both C4I and intelligence community needs; and (d) information interoperability technologies to support enhanced effectiveness of multi-national missions.

(U) As this program matures, it will have a reduced emphasis on software composition, i.e., the methodology and tools used to compose intelligent software. Beginning in FY 2000, there will be an increased emphasis on the development of intelligent applications that leverage the composition tools developed in the earlier phase of the project. Specific domains of interest are situation analysis, situation presentation, and the processing of sensor-derived information.

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

(U) **FY 1998 Accomplishments:**

- Software Composition. (\$ 30.052 Million)
 - Integrated selected Rapid Design Exploration and Optimization (RaDEO) designed computation tools that demonstrate robust multi-disciplinary design. Demonstrated a 5X reduction in early design trade-off time by combining qualitative & quantitative models.
 - Released design of Formal Language for Expressing Assumptions.
 - Released Version 2 of core architectural description interchange language (ACME) and demonstrated use of ACME to represent multiple domain-specific software models.
 - Released real-time dynamic language system for use by Integrated Feasibility Demonstration teams.
 - Completed Computer Aided Education and Training Instruction (CAETI) effort to enhance training environments.
- Active Sensors. (\$ 22.258 Million)
 - Developed, demonstrated, and evaluated image understanding technologies for image exploitation, automatic population of geospatial database, video surveillance and monitoring, and automatic target recognition to enhance battlefield awareness.
 - Developed concept of operations for Airborne Video Surveillance (AVS) system in cooperation with government video surveillance users. Developed AVS detailed system design and multi-year technology build/evaluate plan. Collected ground truthed data of events and moving targets at the Fort A.P. Hill experimental site and used this data for late FY 1998 laboratory demonstrations of precision video registration (PVR), activity monitoring (AM), and moving target surveillance (MTS) technology.
 - Supported software initiatives at the National Applied Software Engineering Center (NASEC); Johnstown, PA.
- Situation Analysis. (\$ 36.381 Million)
 - Developed initial prototypes for multi-language text extraction and audio transcription where performance is baselined against that of human operators.
 - Continued development of modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding.

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- Integrated human-in-the-loop, automated planning, and decision aids techniques for managing military command and control processes in quickly-changing operational settings; demonstrated capabilities to generate, assess, and select among multiple alternative plans in the same amount of time currently required to generate one plan.
- Used unified ontologies in tools for focused knowledge acquisition; extended learning methods; and added new high-performance, problem-solving methods to the High Performance Knowledge Base library for battlefield awareness, crisis management, and military command and control.
- Developed, in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information fusion, aggregation, and summarization software to filter, access, and integrate information from hundreds of disparate, heterogeneous, distributed data sources.
- Executed congressionally mandated Reuse Technology Adoption Program (RTAP).

(U) **FY 1999 Plans:**

- Software Composition. (\$ 23.134 Million)
 - Conduct Instrumented Feasibility Demonstration (IFDs) of evolutionary design technologies; IFD participants include USTRANSCOM, Joint STARS, and B2 software maintenance.
 - Investigate active approaches to software composition, with emphasis on aspect-oriented programming; on-the-fly component generation and interconnection; and module self-evaluation and configuration.
 - Demonstrate a 2X reduction in detailed design by integrating Design Web and Computational Tools made for multi-disciplinary optimization.
 - Demonstrate web-based toolkit of representation, analysis and generation tools.
- Active Sensors. (\$ 26.993 Million)
 - Integrate the most successful new image understanding and automatic target recognition technologies into feasibility demonstrations for video image exploitation, synthetic environments, and video surveillance; demonstrate and evaluate impact of embedded image understanding technologies on battlefield awareness.

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- Integrate, demonstrate and evaluate laboratory and airborne systems in a simulated cantonment area monitoring scenario, with these technology goals: Activity Monitoring - detect soldier incursion and removal of restricted vehicles from a small area or point; Moving Target Surveillance - maintain track on the removed vehicles, with reliable target re-acquisition as the sensor is multiplexed and tracks are occluded by trees; Precision Video Registration - geolocate moving and stationary vehicles in 80% of the video sequences within 5-10 meters of ground truth.
- Initiate Image Understanding for Force Protection program to demonstrate application of sensor technologies to the difficult task of automated perimeter security.
- Situation Analysis and Presentation. (\$ 34.726 Million)
 - Develop language comprehension technology to provide extraction of content and production of summary information focused on information access, manipulation and creation tasks in order to demonstrate improved readiness for military planning and situation awareness.
 - Develop and demonstrate fully automatic algorithms to determine the structure of radio and TV news broadcasts in several languages allowing military planners and intelligence analysts to detect and track emerging topics.
 - Develop and demonstrate a large, integrated situation assessment knowledge base through reuse of knowledge base components from heterogeneous sources.
 - Define a million axiom knowledge base construction problem and competency test for a military challenge problem requiring technical, military strategy and tactics, and geopolitical knowledge.
 - Demonstrate the utility of man-machine planning and execution control against an aggressive adversary in a realistic simulation of an operational environment and transition to applications and systems programs.
 - Demonstrate and transition Intelligent Integration of Information tools and techniques to enable the rapid construction of large-scale information associates to filter, access, and integrate information from 100s of disparate, heterogenous data sources.
 - Execute Congressionally mandated Asset Source for Software Engineering Technology (ASSET) program.
 - Execute Congressionally mandated program in multi-spectral imaging.
 - Execute Congressionally mandated Reuse Technology Adoption Program (RTAP).

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(U) **FY 2000 Plans:**

- Intelligent Sensor Processing. (\$ 20.482 Million)
 - Develop fully automated video sentries detecting and tracking a skilled infantry squad attempting ingress to a built up site from wooded, grassy, and open terrain over a 24 hour period using an array of cooperating visual and thermal sensors.
 - Specify challenge scenarios, metrics and measurement techniques for competitive evaluation of multi-modal acquisition technologies.
 - Continue development of the Image Understanding for Force Protection (IUFP) program.

- Situation Analysis. (\$ 26.736 Million)
 - Demonstrate statistically based semantic analysis capabilities across four repositories, at least one of which supports access controls.
 - Develop component theory building technologies enabling direct knowledge entry by artificial intelligence novices.

- Situation Presentation and Interaction. (\$ 20.000 Million)
 - Specify network-based service architecture Application Program Interface's (API's) for key components of dialogue architecture; using metrics-based evaluation, demonstrate usability of dialogue interaction with confirming sub-dialogue to reduce task completion time by 80 percent.
 - Demonstrate language and diagram interface, analogic reasoners, and theory explanation capabilities, as well as, develop 10-20 core theories (5K-10K axioms each).

- Intelligent Software for Multi-lingual and Coalition Environments. (\$ 12.500 Million)
 - Demonstrate translanguag document clustering for representative European and Asian languages.
 - Field demonstration of automated translation of briefing documents during U.S. exercises in Republic of Korea.

(U) **FY 2001 Plans:**

- Intelligent Sensor Processing. (\$ 14.000 Million)

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- Demonstrate, via the IUFP program, real-time detection of anomalous behavior in streets and indoor scenes by a cooperating sensor array to be followed by tracking targeted subjects with high resolution sensors for automated comparison with a catalog of known subjects. Detection and tracking performed regardless of weather or illumination; identified intruders are tracked and reported using site model plan and 3D displays.
 - Situation Analysis. (\$ 29.200 Million)
 - Deploy scalable prototype analysis environment in defense application with cross-repository information analysis functionality (semantic retrieval, indexing, value filtering, user defined alerting, and categorizing).
 - Demonstrate direct knowledge entry by a novice (2K axioms/month) for a military problem.
 - Situation Presentation and Interaction. (\$ 20.000 Million)
 - Engineering integration of key components of dialogue architecture.
 - Demonstrate and evaluate dialogue performance for Project Marine; complete a complex travel task requiring negotiation twice as fast with automated service support as with the best human assistance.
 - Alpha level prototype of modality coordinator for speech, gestures and mouse interactions.
 - Intelligent Software for Multi-lingual and Coalition Environments. (\$ 15.141 Million)
 - Extract, translate, and correlate named entities from unstructured documents in multiple languages.
 - Prototype implementation of coalition intelligence integration capability demonstrating synthesis of feedback-based approach to query processing with machine translation.
- (U) **Other Program Funding Summary Cost:**
- Not Applicable.
- (U) **Schedule Profile:**
- Not Applicable.

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COST (<i>In Millions</i>)	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
High Performance and Global Scale Systems ST-19	149.965	163.110	162.900	161.922	169.887	196.265	198.125	200.972	Continuing	Continuing

(U) Mission Description:

(U) This project develops the computing, networking, and associated software technology base underlying the solutions to computational and information-intensive applications for future defense and federal needs. These technologies will lead to successive generations of more secure, higher performance, and more cost-effective microsystems, associated software technologies, advanced mobile information technology and prototype experimental applications critical to defense operations. The project is comprised of the following components:

- The Global Mobile Information Systems effort will enable mobile users to access and utilize the full range of services available in the Defense Information Infrastructure. To achieve this goal, it will develop nomadic technologies and techniques at the applications, networking, and wireless link/node levels.
- The Networking component develops active networking technologies and associated network management capabilities to support deeply networked systems. Research is coordinated with DoD, NASA, DoE, NSF, and other federal agencies.
- The Data Intensive Systems and Software component develops software and hardware technologies for data-starved applications. This component will develop a new approach to computer memory organization that will eliminate severe bottlenecks in present designs.
- The Adaptive Architectures component develops new approaches to the design of computer hardware that incorporates dynamic configuration capabilities. The resultant devices will allow DoD to develop a wide variety of specialized systems by reusing a relatively small set of hardware designs, each of which can be affordably produced in high volumes.
- The Systems Environments component develops scalable software which is tailored toward easing the use of systems by application programmers. This includes run-time services, resource allocation, and experimental applications.

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- The Signal Processing component is developing software and component level technologies for use in embedded systems that leverage novel signal processing technologies.
- The Defense Technology Integration component is demonstrating new system capabilities that emerge through the integration of selected technologies developed within this program element.
- Each of the above components of this program will integrate capabilities developed under the Information Survivability initiative (Project ST-24) to satisfy defense requirements for secure systems.

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

(U) **FY 1998 Accomplishments:**

- Global Mobile Information Systems. (\$ 14.833 Million)
 - Demonstrated middleware services for adapting applications to changing infrastructure resources.
 - Developed advanced algorithms and components for waveform processing at untethered nodes.
 - Developed software modules for reconfigurable radios.
 - Conducted integrated technology demonstrations.
- Networking. (\$ 20.548 Million)
 - Implemented prototypes of Enhanced Networking Services utilizing composable modules.
 - Completed prototype implementation of active node execution environment; of fast compiler for SmartPacket Methods; and of basic management functions.
 - Initiated operation of wide area Active Network on prototype platforms.

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- Scalable Systems and Software. (\$ 30.916 Million)
 - Scalable Computing.
 - ◆ Demonstrated highly efficient, parallel nodes; auto-parallelization of file input/output (I/O) for scalable systems; first node-level performance of ultra-low-power systems; and distributed, shared-memory support for a commodity processor.
 - Ultrascale Computing.
 - ◆ Assessed quantum-to-Si hardware and software interface; and language for expressing amorphous algorithmic computations.
 - Scalable Software.
 - ◆ Demonstrated fault-tolerant allocation of 100K-entity synthetic force simulation on 1,300 nodes spanning 13 machines at 9 sites.

- Microsystems. (\$ 28.193 Million)
 - Demonstrated formal methods for microprocessor verification.
 - Demonstrated integrated environment for design of advanced microcomponents.
 - Developed novel subsystem designs that use configurable component technology.
 - Demonstrated adaptive template matching concept through software prototype capable of automated runtime remapping.

- Embeddable Computing. (\$ 14.607 Million)
 - Completed prototype suitable for demonstration of embeddable computing technology in unmanned undersea vehicle (UUV) real-time testbeds.
 - Proof of concept demonstration of Microelectromechanical Systems (MEMS) based thermal dissipation device for use in high-density Digital Signal Processing (DSP) packaging capable of achieving 1 TFlop/cu. ft.
 - Released initial versions of space-time adaptive processing (STAP) algorithm tools and libraries.
 - Developed domain-specific development tools with visualization capability and MatLab compatible system generator.

- Systems Environments. (\$ 15.873 Million)
 - Demonstrated experimental versions of new iterative solvers for radar cross-section modeling; languages and runtime services supporting parallel applications such as Advanced Distributed Simulation; and HPC++ languages and runtime services supporting both task and data parallelism.

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- Defense Technology Integration and Infrastructure. (\$ 24.995 Million)
 - Information Management.
 - ◆ Developed algorithms to effectively search collections of documents for words used only in restricted senses; and design query and preference languages incorporating similarity and value filtering.
 - ◆ Investigated statistical co-occurrence techniques for texture classification of images.
 - Intelligent Collaboration and Visualization.
 - ◆ Developed initial library of collaboration middleware for data sharing, coupling and coordination.
 - ◆ Demonstrated real-time capability to discover at least 60% of relevant collaborators using graph-matching algorithms.
 - ◆ Demonstrated initial capability for teams to control shared, time-varying visualization models.
 - ◆ Demonstrated initial capability for semantic access to timed event streams and multimedia archives.

(U) **FY 1999 Plans:**

- Global Mobile Information Systems. (\$ 18.354 Million)
 - Demonstrate application support for distributed computing in mobile environments and continuous multi-tier networking across wireless domains.
 - Prototype implementation of integrated high data-rate untethered node.
- Networking. (\$ 15.172 Million)
 - Extend operation of Active Network testbed to traverse ~10 sites of ~10 switches; each using SmartPackets and composite protocols.
 - Demonstrate active node execution environment supporting resource security, and survivability functions.
- Scalable Systems and Software. (\$ 37.158 Million)
 - Scalable Software.
 - ◆ Release scalable versions of defense-critical engineering software.

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- Data Intensive Computing Systems.
 - ◆ Demonstrate multiprocessor reduced instruction set computer (RISC) chip (16 issue, 1.6 gigaoperations (GOP), 5-cycle message latency).
 - ◆ Investigate instruction set extensions and storage components to allow defense applications to specify whether operations are executed in the central processor or in logic circuits embedded in the memory hierarchy.
- Ultrascale Computing.
 - ◆ Conduct system-level design and simulation study of a computation model-based on large amorphous arrays.
 - ◆ Establish role of Nuclear Magnetic Resonance (NMR) technologies in development of ultrascale computing.
- Adaptive Computing Architectures. (\$ 25.169 Million)
 - Debug and validate novel, configurable component technologies and architectures; demonstrate use of adaptive building blocks in wireless radio applications.
 - Demonstrate 100x user-level software performance improvement over commodity microprocessors on challenge problems; release new algorithm design software environment optimized to leverage adaptive technology.
- Systems Environments. (\$ 14.740 Million)
 - Performance-Driven Compiler and Library Technologies.
 - ◆ Demonstrate experimental scalable structural dynamics application using DARPA sparse matrix library.
 - Load Adaptive Run-time Environments.
 - ◆ Demonstrate microfeedback technologies for adaptive services.
 - ◆ Release prototype subsystem supporting adaptive resource allocation and consumption in response to changing workload and resource availability.
- Signal Processing. (\$ 21.467 Million)
 - Electronic Signal Processing.
 - ◆ Publish benchmarks for embedded signal processing.

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- ◆ Demonstrate enabling technologies including: Discrete Fourier Transform (DFT) chips based on clockless logic, Single Instruction Multiple Datastream (SIMD) and multi-Digital Signal Processing (DSP) board designs, Myricom 2.5 Gbps high speed configurable interconnect.
- ◆ Develop compiler and code generators to permit retargeting of commercial signal processing tools to suit tactical signal processing environments.
- Bio-Digital Signal Processing.
 - ◆ Evaluate alternative mechanisms for embedded logic & communications subsystems that incorporate biological materials.
 - ◆ Investigate techniques, which transduce electrical/optical/magnetic signals to/from chemical and/or biological processes.
- Defense Technology Integration. (\$ 31.050 Million)
 - Information Management.
 - ◆ Develop framework for federation of text, image and relational databases.
 - ◆ Demonstrate presentation aids for military type documents in English, Korean and a European language.
 - ◆ Validate design of secure repository architecture for digital objects up to 100 megabytes in size.
 - Intelligent Collaboration.
 - ◆ Integrate application-specific and generic collaboration middleware.
 - ◆ Develop Session Management middleware, leveraging multicasting technology that adjusts to variations in bandwidth and connectivity.
 - ◆ Develop tools that enable teams and individuals to retrieve situation and task relevant information from static and dynamic archives containing a record of experiences from multi-sensory sources; and adjust team dynamics in real-time in response to changes in mission and situation.

(U) FY 2000 Plans:

- Global Mobile Information Systems. (\$ 18.600 Million)
 - Beta-level prototype of high data-rate untethered node incorporating miniature codec.
 - Prototype implementation of mobile wireless Asynchronous Transfer Mode (ATM) networks.
 - Integrate GloMo simulation models and conduct scenario simulations for 100+ node network.

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- Networking. (\$ 23.815 Million)
 - Demonstrate use of active network approach to achieve live protocol updates within two roundtrip times.
 - Release of prototype active network toolkits for end-user stations and network elements including performance measurement capabilities.
 - Engineering analysis of active network performance.
 - Initiate transfer of global scale networking technologies into distributed operational testbeds.
 - Prototype demonstration based on use of X-Bone technology to operate multiple virtual internetworks with appropriate compartmentalization of user communities.

- Data Intensive Systems and Software. (\$ 28.665 Million)
 - Design processor in memory very large scale integration (VLSI) components that support in situ processing of application data.
 - Implement compiler that generates code compatible with processor in memory architecture.
 - Simulate data-intensive systems, demonstrating 10-fold performance improvement on critical DoD applications.
 - Develop architectural framework for use of data intensive technologies in embedded applications; investigate alternative approaches to package level integration of data intensive technologies with high bandwidth sensor interfaces.

- Adaptive Computing Architectures. (\$ 29.739 Million)
 - Prototype implementation and runtime libraries supporting adaptive performance monitoring and analysis.
 - Demonstrate automated, model-based synthesis of heterogenous Digital Signal Processing (DSP), Application Specific Integrated Circuit/Field Programmable Gate Array (ASIC/FPGA), General Purpose (GP) system designs for large-scale systems.
 - Investigate novel approaches to in-situ logic placement and routing based on techniques such as amorphous computing.

- Systems Environments. (\$ 16.200 Million)
 - Release reference implementation of mission-critical Quality of Service (QoS) architecture.
 - Release prototype operating system with partitioned resource management for strict QoS guarantees.

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- Specify common services for scalable active software; develop technologies for just-in-time compilation and dynamic loading to support nomadic coding and the migration of continuously operating processes.
- Develop latency management framework that incorporates techniques such as optimistic processing, caching and approximation to decrease the apparent access time to remotely hosted datasets.
- Signal Processing. (\$ 20.881 Million)
 - Electronic Signal Processing.
 - ◆ Implement prototype multiprocessor event collection and analysis system and automated stress test generator for signal processing applications; demonstrate use of high performance signal processing for weapon systems applications.
 - ◆ Establish challenge problem testbed for experimental development of 1 cubic foot Synthetic Aperture Radar (SAR)/Automatic Target Recognition (ATR) system.
 - ◆ Adapt infrared radar /ATR algorithms for use with adaptive computing systems (ACS) technology and processing of second generation forward looking infrared radar image data; enable 10Hz frame rate and perform joint demonstration with Night Vision Electronics Sensors Directorate.
 - Bio-Digital Signal Processing.
 - ◆ Develop minimally invasive imaging tools for monitoring the state of ongoing biological experiments.
- Defense Technology Integration. (\$ 25.000 Million)
 - Joint demonstration of Quality of Service (QoS) management software with AdCon-21; employ Command, Control, Computations, Communications Intelligence Surveillance Reconnaissance (C4ISR) sensor data for targeting with total reallocation latency of less than 5 seconds.
 - Alpha level prototype demonstrating integration of information management tools with high capacity storage subsystems to mask impact of limited and/or sporadic network connectivity.
 - Joint field experiment (with CECOM) to characterize preference of protocols developed for use in Global Mobile Information Systems; demonstrate Multiple Beyond Line-of-Sight Communications (MUBLCOM) including voice and data.
 - Develop application framework for global asset instrumentation.

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(U) **FY 2001 Plans:**

- Global Mobile Information Systems. (\$ 19.000 Million)
 - Demonstrate secure multicast services over multihop, multimode network.
 - Field demonstration of proxy-enabled distributed computing in mobile environments.
 - Investigate alternative approaches capable of achieving gigabit per speed connectivity in battlefield environments.

- Networking. (\$ 23.662 Million)
 - Investigate alternative approaches to large-scale network engineering including in-situ simulation technology.
 - Demonstrate performance improvements of 100% for large multicast sessions based on active suppression of redundant acknowledgement and retransmission messages.
 - Demonstrate use of active network technology to enhance mobile/nomadic network-based services and protocols.
 - Continue transfer of global scale technologies into distributed operational testbeds.

- Data Intensive Systems and Software. (\$ 28.380 Million)
 - Prototype fabrication of processor in memory very large scale integration (VLSI) components that support in situ processing of application data.
 - Conduct bench experiments to demonstrate that fabricated components achieve performance predicted by simulations.
 - Prototype demonstration of amorphous computing array.

- Adaptive Computing Architectures. (\$ 31.300 Million)
 - Reconfigurable Architectures.
 - ◆ Release beta version of Adaptive Computing Systems (ACS) software including compilers and support for commercial design environments such as MatLab and Khoros; demonstrate 10x improvement in compilation times.
 - ◆ Demonstrate self test diagnosis and reconfiguration to circumvent defective and/or damaged portions of commodity logic components.

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- Reconfigurable Kernels.
 - ◆ Investigate alternative approaches to the interfaces and structure of reconfigurable kernels suitable for use in adaptive computing environments.
- Systems Environments. (\$ 19.500 Million)
 - Release prototype distributed object software with real-time Quality of Service (QoS) management.
 - Demonstrate support for mixed workloads of hard, soft, and non-real-time applications.
 - Demonstrate QoS-driven fault detection and recovery within 500 msec.
 - Demonstrate on-the-fly generation of nomadic code enabling synchronization and rendezvous of multiple mobile components.
- Signal Processing. (\$ 21.080 Million)
 - Electronic Signal Processing.
 - ◆ Specify standard Application Program Integration (API) for data shaping and data mapping of embedded defense applications; develop prototype of visual program compiler and code generator.
 - ◆ Implement prototype system demonstrating integration of deeply networked sensors and tactical signal processing technologies.
 - ◆ Conduct bench experiments to demonstrate in situ processing of model-based automatic target recognition (ATR) data at 100,000 ray-patch intersections per second.
 - ◆ Alpha level prototype of forward-looking sonar towed array with ranging functionality and ability to form 30K independent beams.
 - ◆ Demonstration of flight-capable Synthetic Aperture Radar (SAR)/Automatic Target Recognition (ATR) system recognizing 30 target types in presence of camouflage concealment deception.
 - Bio-Digital Signal Processing.
 - ◆ Demonstrate use of high resolution imaging technology and signal transduction to effect interactive control over simple biological systems.
- Defense Technology Integration. (\$ 19.000 Million)
 - Field demonstration of information management tool tailored for use in environments with limited and/or sporadic network connectivity.

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- Integrate active network capabilities into Run-Time Infrastructure (RTI) for use with high-level architecture (HLA)-compliant simulations; prepare for joint demonstration with DMSO.
- Prototype demonstration of global asset instrumentation.

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

- Not Applicable.

(U) **Schedule Profile:**

- Not Applicable.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research					R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology PE 0602301E, Project ST-22					
COST <i>(In Millions)</i>	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Software Engineering Technology ST-22	16.609	16.941	17.227	18.100	18.700	19.300	19.300	19.300	Continuing	Continuing

(U) Mission Description:

(U) Software is key to meeting DoD's increasing demand for high quality, affordable, and timely national defense systems. There is a critical need to rapidly transition state-of-the-art technology and best practices to improve the acquisition, engineering, fielding, and evolution of software-intensive DoD systems. This project will fund the technology transition activities of the Software Engineering Institute (SEI) at Carnegie Mellon University. The SEI is a Federally Funded Research and Development Center (FFRDC) sponsored by the Office of the Under Secretary of Defense for Acquisition and Technology. It was established in 1984 as an integral part of the DoD's software initiative to identify, evaluate, and transition high leverage technologies and practices, and to foster disciplined software engineering practices by DoD acquisition and life cycle support programs and within the industrial base where the bulk of defense software is produced. The Institute works across government, industry, and academia to: (1) improve current software engineering activities from both management and engineering perspectives; (2) facilitate rapid, value-added transition of technology to practice; and (3) evaluate and calibrate emerging technologies to determine their potential for improving the evolution of software-intensive DoD systems.

(U) The SEI enables the exploitation of emerging software technology by bringing engineering discipline to software acquisition, development, and evolution. The SEI focuses on software technology areas judged to be of the highest payoff in meeting defense needs. FY 1997 and FY 1998 focus areas were: Technical Engineering Practices (including Information Survivability practices, Architecture-centered Software Engineering, and Commercial Off-The-Shelf (COTS)-Based Software Engineering), Enhanced Software Management Capabilities (including Software Process Improvement and Capability Maturity Model Integration (CMMI)), and Accelerating Adoption of High Payoff Software Technologies.

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(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Technical Engineering Practices: Defined and documented administrative process and procedures for global incident response coordination. Processed guides for global incident response coordination to be used by collaborating incident response teams. A vulnerability knowledge base used by response teams was enhanced to support the collection, analysis, and sharing of security incident data. Architectural patterns supporting the integration of Commercial Off-The-Shelf (COTS) components have been identified. Attribute-specific survivability patterns for COTS-based architectures and legacy systems were demonstrated. (\$ 9.400 Million)
- Enhanced Software Management Capabilities: Integrated and enhanced models for software processes, process improvement methods, and analytical capabilities to provide a common base for process assessments and improvement analysis. Released software and systems model under the CMMI framework for stakeholder review. Initiated operation of a repository for DoD software measurement data and risk management experience; released software measurement handbook and risk evaluation guidebook. (\$ 5.400 Million)
- Adoption of Software Technologies: Developed guidebook for introducing technology change into organizations. Demonstrated potential utility of collaborative process technology for enhancing cooperation in responding to information warfare attacks. Provided support to establish performance measures for cost and benefits of improved practices. (\$ 1.809 Million)

(U) FY 1999 Plans:

- Software Engineering Technical Practices: Establish/refine guidelines for helping the DoD and DoD contractors migrate legacy systems into product lines. Architecture evaluation guidelines and tradeoff techniques will be demonstrated, and an initial version of a security improvement tool kit will be developed to help system administrators protect their systems against current and emerging threats. Architecture evaluation techniques for COTS-based systems will be offered to reduce costs and risk. Training in the development of COTS-based systems will be made available for executives and program managers. (\$ 11.360 Million)

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- Software Engineering Management Practices: Release of the integrated models (software, systems, and Integrated Product and Process Development (IPPD)) under the CMMI framework for public review and pilot test. Publication of Version 1 of CMMI support products. CMMI will be harmonized with International standards. Initial release of Team Software Process training. (\$ 4.086 Million)
- Adoption of Software Technologies: Upgraded and expanded measurement information repository will be released to define the benefits and costs of technical practices; Development of measurement guidance for tracking performance at organizational and enterprise levels and development of guidance for the application of the Earned Value Management System (EVMS) to the development of software-intensive systems. Provide transition planning and measurement support to SEI maturation and transition activities. (\$ 1.495 Million)

(U) FY 2000 Plans:

- Software Engineering Technical Practices: Define and pilot a method for survivable network technology analysis. Development of security self-evaluation method and training. Version 1 of product line acquisition guidelines and courses will be made available for use by DoD. Courses for training software engineers in the development of COTS-based systems will be available. DoD-based data on the benefits and costs of architecture analysis methods will be available. (\$ 11.340 Million)
- Software Engineering Management Practices: Update and release of CMMI training, assessment and other products based on Government and industry use and feedback. Data available showing the benefits, costs, and appropriate conditions for use of Team Software Process. (\$ 4.687 Million)
- Adoption of Software Technologies: Develop guidebook for introducing technology change into organizations. Additional guidance for use of metrics in software acquisition and development. Continue to provide software measurement support to all initiative work to ensure performance measures are established. Provide transition planning and measurement support to SEI maturation and transition activities. (\$ 1.200 Million)

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(U) **FY 2001 Plans:**

- Software Engineering Technical Practices: Establish techniques for modeling and predicting survivability attributes of systems while they are under development. Exemplar architectures for survivable systems will be in use by DoD and industry. Standard COTS evaluation practices will be defined and in use to support the development of COTS-based systems. (\$ 11.700 Million)
- Software Engineering Management Practices: Support rollout and widespread use of integrated CMM models; extend models to additional disciplines; document benefits and costs of using the integrated models; prepare for revision of models based on actual experience in their use. (\$ 5.100 Million)
- Adoption of Software Technologies: Standard practices for adopting technology are in widespread use. Provide transition planning and measurement support to SEI maturation and transition activities. (\$ 1.300 Million)

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

- Not Applicable.

(U) **Schedule Profile:**

- Not Applicable.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research					R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology PE 0602301E, Project ST-24					
COST (<i>In Millions</i>)	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Information Survivability ST-24	40.092	57.865	61.829	71.460	96.350	99.073	98.930	98.771	Continuing	Continuing

(U) Mission Description:

(U) This project is developing the technology required to protect DoD's mission-critical systems against attack upon or through the supporting information infrastructure. These technologies will enable our critical systems to provide continuous correct operation even when they are subject to attack, and will lead to generations of stronger protection, higher performance, and more cost-effective security and survivability solutions scalable to several thousand sites. Technologies developed under this project will be exploited in High Performance and Global Scale Systems (Project ST-19), Command and Control Information Systems (Project CCC-01), Information Integration Systems (Project CCC-02), and in other programs to satisfy defense requirements for secure and survivable systems.

(U) Information Survivability focuses on early prototypes of software technologies leading to protection for large-scale, heterogeneous systems usable over a wide range of performance in diverse threat environments. High confidence network-based systems will include security mechanisms and value-added security services for integration into network-based infrastructure as well as inherent protection mechanisms to allow the system to resist, repel and survive attack. High confidence computing systems will be developed that provide modular security services and mechanisms, provide high reliability for distributed computations, and allow geographically separated parts of an organization to interact as if they shared a common security perimeter. This also includes integrity mechanisms to allow damage to be detected rapidly. Assurance and dynamic integration tools will allow security and survivability to be inserted into legacy systems, and will enable critical systems to reconfigure and survive in the face of detected threat and successful attack.

(U) Survivability technologies will be developed to mitigate national and defense computing infrastructure vulnerabilities that could be exploited by an information warfare enemy. Intrusion detection systems will allow attacks on the defense infrastructure to be detected, the damage to be assessed, and appropriate response to be taken. Technologies will be developed to detect national security threats through correlation and analysis of observed/reported activities.

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

(U) **FY 1998 Accomplishments:**

- High Confidence Networking. (\$ 8.458 Million)
 - Demonstrated secure multicast protocol.
 - Demonstrated secure routing protocols with public key certificate infrastructure.

- High-Confidence Computing. (\$ 9.314 Million)
 - Completed middleware for end-to-end fault tolerant realtime services on Local Area Networks (LAN).
 - Demonstrated integrated security support in prototype extensible operating system.

- Assurance and Integration. (\$ 7.856 Million)
 - Implemented an initial set of wrapper components supporting security and fault tolerance.
 - Completed prototype implementation of tools for refinement of secure software architectures.

- Survivability of Large Scale Systems. (\$ 14.464 Million)
 - Demonstrated techniques for detecting previously unknown attacks.
 - Developed specification for a primitive survivable “immune system” for coordinating response to attacks and intrusions.

(U) **FY 1999 Plans:**

- High Confidence Networking. (\$ 16.765 Million)
 - Demonstrate secure middleware supporting distributed applications over mobile and wireless networks.
 - Demonstrate secure, multi-policy, high speed group communication.
 - Execute congressionally mandated program in software security research. (\$ 0.500 Million)
 - Execute congressionally mandated program in computer security. (\$ 1.000 Million)

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- High-Confidence Computing. (\$ 14.838 Million)
 - Demonstrate techniques for general pairwise tradeoffs among realtime operations.
 - Evaluate prototype compiler for certifying proof-carrying code.
 - Release operating system prototype supporting efficient, secure nested virtual machines.
- Assurance and Integration. (\$ 9.773 Million)
 - Complete initial wrapper-generator toolkits.
 - Demonstrate integration of security composition techniques into software engineering tools.
- Survivability of Large Scale Systems. (\$ 16.489 Million)
 - Develop techniques for diagnosing multi-agent, multi-staged attack, through common Intrusion Detection Framework.
 - Demonstrate Adaptive Architecture for Survivable Systems.
 - Conduct red team exercise(s) to assess intrusion detector systems.

(U) **FY 2000 Plans:**

- High Confidence Network-Based Resources. (\$ 18.400 Million)
 - Advanced prototype demonstration of secure agent network nodes.
 - Prototype demonstration of "push-back" techniques for denial-of-service attacks.
- High Confidence Data and Computing. (\$ 15.700 Million)
 - Investigate basic integrity mark technology.
 - Develop tools for inserting integrity checks into mobile code.
 - Identify mechanisms that rapidly distinguish intact and corrupted data through automated verification of code and data integrity.

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- Assurance and Dynamic Integration. (\$ 10.200 Million)
 - Complete enhanced wrapper-generator toolkits.
 - Implement prototype of artificial diversity toolkit.
 - Investigate new approaches to large-scale software composition based on software tolerances and redundancy instead of absolute correctness; identify relevant challenge problems.
- Large Scale Intrusion Assessment and Response. (\$ 17.529 Million)
 - Initial design for hierarchical reporting structure for intrusion detection systems.
 - Develop experimental methods for filtering events of purely local significance.
 - Common framework for linking intrusion assessment and response components.
 - Develop workflow model supporting dynamic response capability.

(U) **FY 2001 Plans:**

- Survivability of Network-Based Resources. (\$ 20.500 Million)
 - Develop techniques to isolate corrupted or malicious network entities.
 - Design active techniques for traceback and automated response.
- High Confidence Data and Program Integrity. (\$ 17.360 Million)
 - Prototype demonstration of integrity mark technology supporting near continuous operation during post-attack audit.
 - Implement alpha prototype toolkit for incorporating integrity techniques into defense software.
- Dynamic Integration of Decentralized Systems. (\$ 13.000 Million)
 - Prototype implementation of dynamic integration technology based on software tolerance concept.
 - Investigate market-based resource allocation mechanisms.
 - Develop methods to capture state information, for use with interrupted or suspended computation leading to experimental evaluation of software tolerance concept; down-select to most promising options for further development and challenge problem demonstrations.

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- Large Scale Intrusion Assessment and Response. (\$ 20.600 Million)
 - Design protocols to allow detectors and sensors to exchange information on their capabilities.
 - Implement initial peer-to-peer protocols allowing detection components to suppress events of purely local significance.
 - Prototype demonstration of integrated assessment and response capability.

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

- Not Applicable.

(U) **Schedule Profile:**

- Not Applicable.

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