

## Intelligent Systems Technology Infrastructure for Integrated Systems

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Significant advances have occurred during the last decade in intelligent systems technologies (a.k.a. knowledge-based systems, KBS) including research, feasibility demonstrations, and technology implementations in operational environments. Evaluation and simulation data obtained to date in real-time operational environments suggest that cost-effective utilization of intelligent systems technologies can be realized for Automated Rendezvous and Capture applications. The successful implementation of these technologies involve a complex system infrastructure integrating the requirements of transportation, vehicle checkout and health management, and communication systems without compromise to systems reliability and performance.

The resources that must be invoked to accomplish these tasks include remote ground operations and control, built-in system fault management and control, and intelligent robotics. To ensure long-term evolution and integration of new validated technologies over the lifetime of the vehicle, system interfaces must also be addressed and integrated into the overall system interface requirements. An approach for defining and evaluating the system infrastructures including the testbed currently being used to support the on-going evaluations for the evolutionary Space Station Freedom Data Management System will be presented and discussed. Intelligent system technologies to be discussed include artificial intelligence (real-time replanning and scheduling), high performance computational elements (parallel processors, photonic processors, and neural networks), real-time fault management and control, and system software development tools for rapid prototyping capabilities. Generic applications of these technologies are focused on distributed, real-time avionics architectures; avionics software capable of autonomous operations for long duration periods; vehicle health management and control (including reconfiguration); and, advanced landing and recovery systems. Examples of each of the on-

going efforts in these technology areas/applications will be discussed with the current application status.

The on-site supporting testbeds have been developed to support the sponsored efforts for Space Station Freedom, OAET (AI, Data Systems, Photonics), OAET/OSF Strategic Avionics Technology Program, and the Defense Advanced Research Projects Agency (DARPA). The Automation Sciences Research Facility (ASRF), a 60,000 laboratory dedicated to the development of intelligent systems technologies, recently became operational in October 1991 and provides the laboratory and research environments for the technology efforts described above. In addition, the ASRF is integrated with the Human Performance Research Laboratory (HPRL) to provide an integrated research environment to address the human's interaction/interface with highly automated systems and the merger of intelligent systems technologies with "conventional" technologies. The configuration/status/capability of the individual technology testbeds as well as the integrated ASRF/HPRL testbed will be described. Specific technology deliverables and system demonstrations conducted in operational environments to demonstrate the cost-effectiveness of the technology implementations will be discussed. Examples of fielded technology demonstrations to be discussed include Constrained-based Scheduling for Space Shuttle, Automated Thermal Control System for Space Station Freedom, and Real-time Fault Management and Control for the F-18. Aerospace contractors such as IBM, Rockwell, Lockheed, and McDonnell Douglas have expressed an interest in using the testbed capabilities resident at Ames when they become operational during early CY-92 for "external" utilization.

Personnel within the Division supporting the above efforts number approximately 120 researchers. The AI research group is among the best in the United States with international recognition and acceptance. The computational sciences research group is rapidly gaining international recognition and has released significant software tools to the NASA, academic, and industrial communities. Significant technology software products have been delivered both to the NASA operational centers and to the aerospace industry for use and evaluation in aerospace mission applications. Typical examples of these deliverables and the cost benefits obtained from each will be described.

Funding to support the current research efforts including the demonstration efforts and the rapid prototyping capabilities are provided by the following sources: OAET, Code RC; OSF, Codes MT and MD; O SSA, Code SE; and, the Defense Advanced Research Projects Agency (DARPA). Annual funding from these sources exceed \$15M per year.