Autonomous Mission Manager for Rendezvous, Inspection and Mating

To meet cost and safety objectives, space missions that involve proximity operations between two vehicles require a high level of autonomy to successfully complete their missions. The need for autonomy is primarily driven by the need to conduct complex operations outside of communication windows, and the communication time delays inherent in space missions. Autonomy also supports the goals of both NASA and the DOD to make space operations more routine, and lower operational costs by reducing the requirement for ground personnel.

NASA and the DoD have several programs underway that require a much higher level of autonomy for space vehicles. NASA's Space Launch Initiative (SLI) program has ambitious goals of reducing costs by a factor or 10 and improving safety by a factor of 100. DARPA has recently begun its Orbital Express to demonstrate key technologies to make satellite servicing routine. The Air Force's XSS-11 program is developing a proto-flight demonstration of an autonomous satellite inspector. A common element in space operations for many NASA and DOD missions is the ability to rendezvous, inspect and/or dock with another spacecraft. For DARPA, this is required to service or refuel military satellites. For the Air Force, this is required to inspect un-cooperative resident space objects. For NASA, this is needed to meet the primary SLI design reference mission of International Space Station re-supply.

A common aspect for each of these programs is an Autonomous Mission Manager that provides highly autonomous planning, execution and monitoring of the rendezvous, inspection and docking operations. This paper provides an overview of the Autonomous Mission Manager (AMM) design being incorporated into many of these technology programs. This AMM provides a highly scalable level of autonomous operations, ranging from automatic execution of ground-derived plans to highly autonomous on-board planning to meet ground developed mission goals. The AMM provides the capability to automatically execute the plans and monitor the system performance. In the event of system dispersions or failures the AMM can modify plans or abort to assure overall system safety.

This paper describes the design and functionality of Draper's AMM framework, presents concept of operations associated with the use of the AMM, and outlines the relevant features of the flight demonstrations.