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REAL-TIME SIMULATIONS FOR AUTOMATED RENDEZVOUS AND CAPTURE

JOHN A. CUSEO (303-971-9302)
SPACE OPERATIONS SIMULATION LABORATORY
MARTIN MARIETTA ASTRONAUTICS GROUP

Although the individual technologies for automated rendezvous and capture (AR&C) exist, they have not yet been integrated to produce a working system in the United States. Thus, real-time integrated systems simulations are critical to the development and pre-flight demonstration of an AR&C capability. Real-time simulations require a level of development more typical of a flight system compared to purely analytical methods, thus providing confidence in derived design concepts. This presentation will describe Martin Marietta's Space Operations Simulation (SOS) Laboratory, a state-of-the-art real-time simulation facility for AR&C, along with an implementation for the Satellite Servicer System (SSS) Program.

The SOS Laboratory simulations use a combination of hardware and software to provide a high-fidelity testbed for development and analysis of AR&C systems including autonomous control algorithms, sensor subsystems, propulsion systems and docking mechanisms. The SOS Laboratory simulations also provide man-in-the-loop control (i.e., teleoperation) in addition to autonomous control for evaluation of supervised AR&C systems.

A major component of the simulation architecture is the moving base carriage (MBC). The MBC provides six degrees-of-freedom to simulate the rotational and translational state of the chase vehicle (i.e., CTV/STV), and its AR&C sensors, with respect to the target vehicle (i.e., SSF, STS, etc.). The MBC has a maneuvering volume of over 14,000 cubic feet to simulate approaches from 60 feet full scale. Simulation scales up to 100:1 are used to simulate approaches from 6000 feet. The target vehicles used in the simulations can be mounted on a single-axis or three-axis servo-driven gimbal system to increase the degrees-of-freedom available to facilitate simulation of maneuvers such as 360 degree fly-arounds or tumbling satellite retrieval. The MBC and target gimbals are controlled by an Encore 32/9750 simulation controller which also executes the software that models the spacecraft systems and orbital environment. This includes models of the chase and target vehicles GN&C system, propulsion subsystem, inertial measurement systems and mass properties. Other key components of the simulation architecture include the on-orbit and ground control supervisory control consoles. These consoles are integrated into the real-time simulation and provide all the functions required to teleoperate a free-flying spacecraft and/or supervise the operations of an autonomous system during rendezvous and capture.

The elements of the SOS Laboratory described above have been integrated to provide a real-time integrated systems end-to-end simulation for the Satellite Servicer System program. The simulation includes all elements of the SSS Flight Demonstration

program: autonomous rendezvous and capture, supervised autonomous orbital replacement unit (ORU) replacement, supervised autonomous fluid resupply and proximity operations. The end-to-end simulation of the flight demonstration involves deployment of the satellite servicer system and target vehicle from STS, separation and subsequent autonomous rendezvous and capture, supervised autonomous ORU replacement and fluid resupply, and ending with retrieval of the satellite servicer system and target vehicle by STS.

A six minute videotape titled "Satellite Servicer System End-to-End Simulation" will also be presented which highlights the SOS Laboratory's capabilities with respect to autonomous rendezvous and capture.