# U.S. Automated Rendezvous and Capture Capabilities Review

**Category 3 - Integrated Systems**

**Abstract Title:** An Integrated Autonomous Rendezvous and Docking System Architecture Using Centaur Modern Avionics.

**Author:** Kurt Nelson

**Affiliation:** General Dynamics, Space Systems Division
**Phone:** 619 496-7386
**Fax:** 619 496-7676

**Technical Details:**

The avionics system for the Centaur upper stage is in the process of being modernized with the current state-of-the-art in strapdown inertial guidance equipment. This equipment includes an integrated flight control processor with a ring laser gyro based inertial guidance system. This inertial navigation unit (INU) uses two MIL-STD-1750A processors and communicates over the MIL-STD-1553B data bus. Commands are translated into load activation through a Remote Control Unit (RCU) which incorporates the use of solid state relays. Also, a programmable data acquisition system replaces separate multiplexer and signal conditioning units. This modern avionics suite is currently being enhanced through independent research and development programs to provide autonomous rendezvous and docking capability using advanced cruise missile image processing technology and integrated GPS navigational aids. A system concept has been developed to combine these technologies in order to achieve a fully autonomous rendezvous, docking and autoland capability. This paper will discuss the current system architecture and the evolution of this architecture using advanced modular avionics concepts being pursued for the National Launch System.

**Historical Background:**

The Centaur avionics suite has undergone a dramatic modernization over the last four years. Current state-of-the-art in strapdown inertial sensors and processor technology has been incorporated into the new Inertial Navigation Unit (INU). In addition to the Centaur avionics modernization program, substantial investment has been made in technologies focused at enhancing the capabilities of the Centaur avionics suite. These technologies include fault tolerance & redundancy management, and the integration of GPS and image processing sensors. The combination of these technologies integrated into an avionics suite can provide a very viable solution for an Autonomous Rendezvous & Docking system.

An advanced avionics architecture is also being developed by General Dynamics under the Multi-Path Redundant Avionics Suite (MPRAS) Advanced Development Program for the Advanced Launch System (ALS). This technology provides the architecture for the next generation launch vehicle systems. As this technology matures, the Centaur modern avionics architecture can be evolved to incorporate these advanced technologies.

**Technology Maturity:**

The technologies being utilized for the demonstrated autonomous rendezvous capability currently exist and are being flown on launch vehicles and military systems today. The advanced MPRAS architecture is in the development stage and is targeted to support the NLS vehicles. A technology evolution plan has been developed to transition from Centaur modern avionics to the advanced MPRAS architecture as it matures.

**Test Experience:**

The autonomous rendezvous and docking proof of concept has been demonstrated in a closed loop dynamic simulation using the image processing hardware, a representative flight control processor system, and a high fidelity vehicle model. A successful space station docking simulation has been developed and demonstrated.

The integration of the GPS position and velocity data into the inertial navigation unit is in progress and is scheduled for completion by the end of this year.

**Sponsorship and funding:**

Currently, the development of the integrated rendezvous and docking system is being pursued on IR&D funding. General Dynamics is working with Johnson Space Center, Marshall Space Flight Center, and Langley Research Center in a cooperative effort to combine the expertise and laboratory capabilities of each center to organize a multi-center test and demonstration program of this system.