# Command and Control of Space Assets Through Internet-Based Technologies Demonstrated

The NASA Glenn Research Center successfully demonstrated a transmission-control-protocol/ Internet-protocol- (TCP/IP) based approach to the command and control of on-orbit assets over a secure network. This is a significant accomplishment because future NASA missions will benefit by using Internet-standards-based protocols. Benefits of this Internet-based space command and control system architecture include reduced mission costs and increased mission efficiency. The demonstration proved that this communications architecture is viable for future NASA missions.

This demonstration was a significant feat involving multiple NASA organizations and industry. Phillip Paulsen, from Glenn's Project Development and Integration Office, served as the overall project lead, and David Foltz, from Glenn's Satellite Networks and Architectures Branch, provided the hybrid networking support for the required Internet connections. The goal was to build a network that would emulate a connection between a space experiment on the International Space Station and a researcher accessing the experiment from anywhere on the Internet, as shown in the figure.
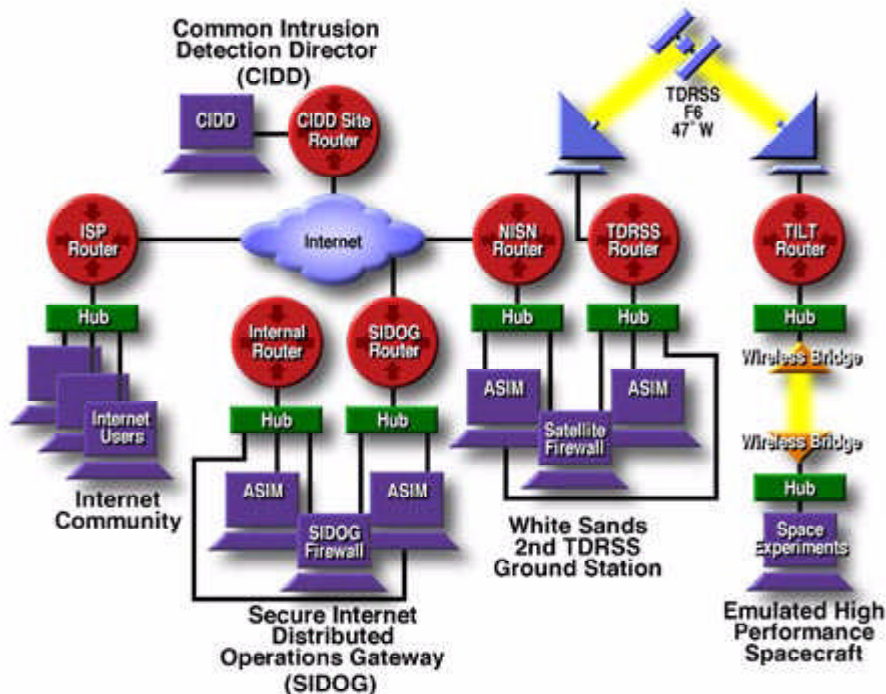
Network architecture used for Inspection 2000.
Long description: Diagram shows how architecture components are connected from Common Intrusion Detection Director (CIDD) to the CIDD site router to the Internet,

which connects to an Internet service provider (ISP) router, an NISN router, and a secure Internet distributed operations gateway (SIDOG).

The experiment was interfaced to a wireless 802.11 network inside the demonstration area. The wireless link provided connectivity to the Tracking and Data Relay Satellite System (TDRSS) Internet Link Terminal (TILT) satellite uplink terminal located 300 ft away in a parking lot on top of a panel van. TILT provided a crucial link in this demonstration. Leslie Ambrose, NASA Goddard Space Flight Center, provided the TILT/TDRSS support. The TILT unit transmitted the signal to TDRS 6 and was received at the White Sands Second TDRSS Ground Station. This station provided the gateway to the Internet. Coordination also took place at the White Sands station to install a Veridian Firewall and automated security incident measurement (ASIM) system to the Second TDRSS Ground Station Internet gateway. The firewall provides a trusted network for the simulated space experiment.

A second Internet connection at the demonstration area was implemented to provide Internet connectivity to a group of workstations to serve as platforms for controlling the simulated space experiment. Installation of this Internet connection was coordinated with an Internet service provider (ISP) and local NASA Johnson Space Center personnel.

Not only did this TCP/IP-based architecture prove that a principal investigator on the Internet can securely command and control on-orbit assets, it also demonstrated that valuable virtual testing of planned on-orbit activities can be conducted over the Internet prior to actual deployment in space.

Glenn contact: David A. Foltz, 216-433-5077, David.A.Foltz@grc.nasa.gov
Author: David A. Foltz
Headquarters program office: OSF (SOMO)
Programs/Projects: Secure mission operations over the Internet, including accessing experiments aboard the shuttles or the International Space Station