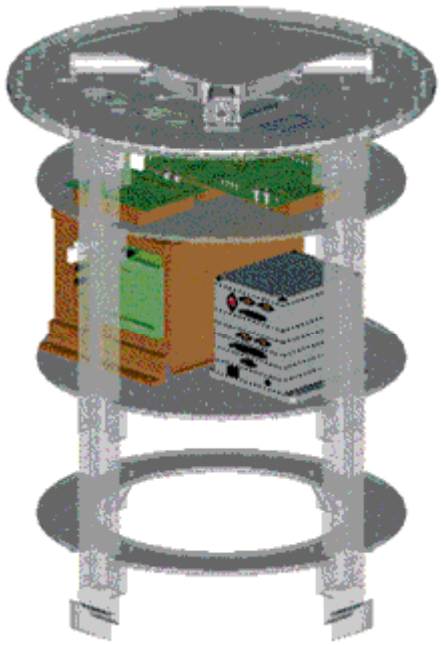
Feasibility Activities Completed for the Direct Data Distribution (D^3) Experiment

The Direct Data Distribution (D^3) project being designed at the NASA Glenn Research Center at Lewis Field will demonstrate a high-performance communications system that transmits information at up to 1.2 gigabits per second (Gbps) from an advanced technology payload carried by the space shuttles in low Earth orbit to small (0.9-m) autonomously tracking terminals on the Earth. The flight communications package features a solid-state, phased-array antenna operating in the commercial K-band frequency that electronically steers two independently controlled downlink beams toward low-cost tracking ground terminals. The array enables agile, vibration-free beam steering at reduced size and weight with increased reliability over traditional mechanically steered reflectors. The flight experiment will also demonstrate efficient digital modulation technology that allows transmission of substantially increased amounts of latency-tolerant data (up to 72 Gb of data per minute of contact time) with very high quality (10^{-11} bit error rate). D^3 enables transmission from low-Earth-orbit science spacecraft, the shuttles, or the International Space Station directly to NASA field centers and principle investigator sites, or directly into the commercial terrestrial telecommunications network for remote distribution and archive. The ground terminal features a cryocooled receiver for ultralow noise and a reduced antenna aperture as well as open-loop tracking for unattended operations. The D^3 technology validation and service demonstration will help to facilitate NASA's transition from using Government-owned communications assets to using commercially provided services.

The hardware for D^3 will incorporate advanced technology components developed under the High Rate Data Delivery Thrust Area of the NASA Cross-Enterprise Technology Development Program (CETDP) in Glenn's Communications Technology Division. Components for the flight segment will include the electrically steerable phased-array antenna being built by the Raytheon Systems Corporation, which uses monolithic microwave integrated circuit (MMIC) technology operating at 19.05-gigahertz (GHz), and the digital encoder-modulator chipset, which uses four-channel orthogonal frequency division multiplexing (OFDM). The encoder-modulator will use a chipset developed by SICOM, Inc., which is both bandwidth and power efficient. Components for the ground segment will include a low-cost, open-loop tracking ground terminal incorporating a cryoreceiver to minimize terminal size without compromising receiver capability. The D^3 project team is currently negotiating the final arrangements for the experiment's shuttle flight, which is tentatively planned for the fourth quarter of calendar year 2002. D^3 is a work area under the Advanced Communications campaign within the Space Operations Technology Project of the Space Operations Management Office at the NASA Johnson Space Center.

In fiscal year 1999, the D^3 team, composed of both civil servants and Dynacs Engineering Company, Inc., personnel, completed several feasibility activities. The initial thermal and structural designs of the flight payload were developed for the NASA Goddard Space

Flight Center Hitchhiker-G carrier. The preliminary structural layout is shown in the illustration. In addition, the team has been working on mechanical, electrical, and safety integration issues with Raytheon, the developer of the array. The results of the tracking feasibility study indicated the requirements for the size of the ground terminal antenna, desirable locations, and contact times. The initial design for the orthogonal frequency division multiplexing modulator board was completed, and a local vendor was contracted to fabricate and populate the breadboard version of the board.



Preliminary layout of the Direct Data Distribution experiment in a NASA Goddard Space Flight Center Hitchhiker-G canister.

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