ate mathematical models of payloads. These models will be used in the SMS to train flight controllers and flight crews on payload operations.

- The Mission Operations Tool provides a streamlined and simplified way to collect the payload-operations data to support the development of mission-operations documentation.
- The Command and Data Tool is a client-server database application program to be used to collect command and telemetry data for the Cargo PC.

Space-Shuttle Emulator Software

Lyndon B. Johnson Space Center, Houston, Texas

A package of software has been developed to execute a raw binary image of the space shuttle flight software for simulation of the computational effects of operation of space shuttle avionics. This software can be run on inexpensive computer workstations. Heretofore, it was necessary to use real flight computers to perform such tests and simulations.

The package includes a program that emulates the space shuttle orbiter general-purpose computer (see figure) [consisting of a central processing unit (CPU), input/output processor (IOP), master sequence controller, and bus-control elements]; an emulator of the orbiter display electronics unit and models of the associated cathode-ray tubes, keyboards, and switch controls; computational models of the data-bus network; computational models of the multiplexer-demultiplexer components; an emulation of the pulse-code modulation master unit; an emulation of the payload data interleaver; a model of the master timing unit; a model of the mass memory unit; and a software component that ensures compatibility of telemetry and command services between the simulated space shuttle
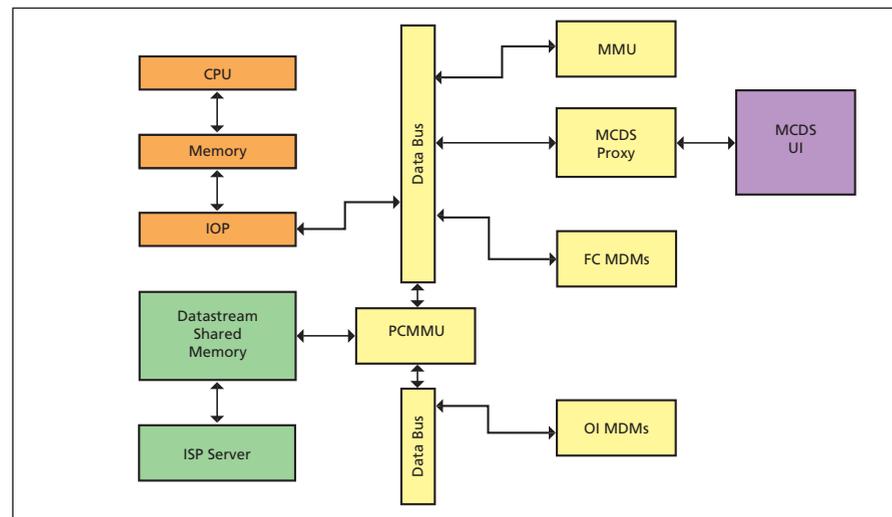
A **High-Level Schematic** indicates the arrangement. (Note: CPU = central processing unit, IOP = input/output processor, ISP= information sharing protocol, PCMMU = pulse code modulation master unit, MCDS = multifunction CRT display system, MDMs = multiplexer/demultiplexers, FC = flight critical, OC = operational instrumentation, and UI = user interface.)

avionics and a mission control center. The software package is portable to several host platforms.

Soft Real-Time PID Control on a VME Computer

NASA's Jet Propulsion Laboratory, Pasadena, California

microPID (µPID) is a computer program for real-time proportional + integral + derivative (PID) control of a translation stage in a Fourier-transform ultraviolet spectrometer. µPID implements a PID control loop over a position profile at sampling rate of 8 kHz (sampling period

125 µs). The software runs in a stripped-down Linux operating system on a VersaModule Eurocard (VME) computer operating in real-time priority queue using an embedded controller, a 16-bit digital-to-analog converter (D/A) board, and a laser-positioning board (LPB).

µPID consists of three main parts: (1) VME device-driver routines, (2) software that administers a custom protocol for serial communication with a control computer, and (3) a loop section that obtains the current position from an LPB-driver routine, calculates

the ideal position from the profile, and calculates a new voltage command by use of an embedded PID routine — all within each sampling period. The voltage command is sent to the D/A board to control the stage. µPID uses special kernel headers to obtain microsecond timing resolution. Inasmuch as µPID implements a single-threaded process and all other processes are disabled, the Linux operating system acts as a soft real-time system.

This program was written by Vahag Karayan, Stanley Sander, and Richard Cageao of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-41107.

∿ Analyzing Radio-Frequency Coverage for the ISS

*Lyndon B. Johnson Space Center, Houston, Texas*

The Interactive Coverage Analysis Tool (iCAT) is an interactive desktop-computer program serving to (1) support planning of coverage, and management of usage of frequencies, of current and proposed radio communication systems on and near the International Space Station (ISS) and (2) enable definition of requirements for development of future such systems. The iCAT can also be used in design trade studies for other (both outer-space and terrestrial) communication systems.

A user can enter the parameters of a communication-system link budget in a table in a worksheet. The nominal (on-axis) link values for the bit-to-noise-energy ratio, received isotropic power (RIP), carrier-to-noise ratio (C/N), power flux density (PFD), and link margin (see figure) of the system are calculated and displayed in the table. Plots of field gradients for the RIP, C/N, PFD, and link margin are constructed in an ISS coordinate system, at a specified link range, for both the forward and return link parameters, and are displayed in worksheets. The forward and reverse link antenna gain patterns are also constructed and displayed. Line-of-sight (LOS) obstructions can be both incorporated into the gradient plots and displayed on separate plots.

This program was written by Steven M. Bolen and Catherine C. Sham of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-23536
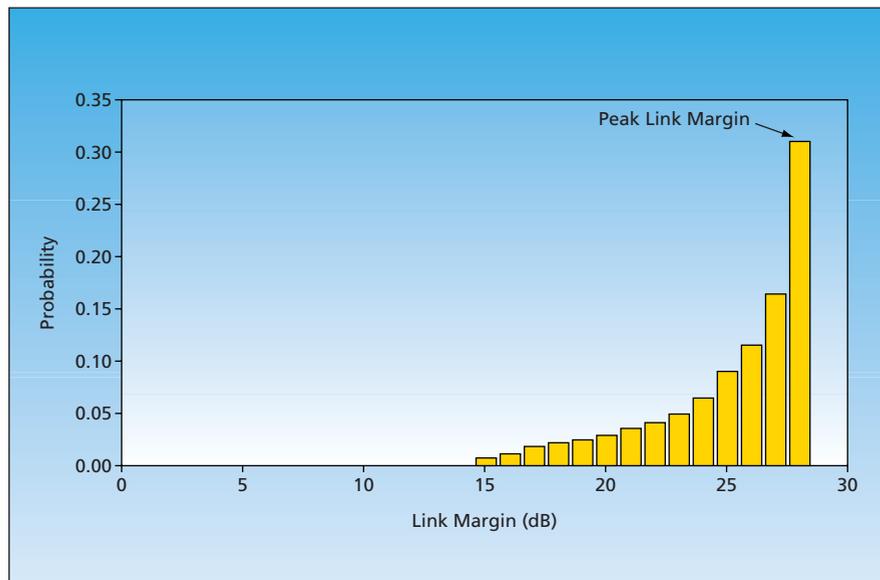
This is the type of **Statistical Analysis** that can be made from the output of iCAT.