

systems and computers having 16 GB or more RAM). The advantage of the hard-drive-based analysis is one can work with essentially unlimited-sized data sets.

Separate windows are spawned for the unwrapped/re-sliced data view and any image processing interactive capability. Individual unwrapped images and un-

wrapped image series can be saved in common image formats.

More information is available at http://www.grc.nasa.gov/WWW/OptInstr/NDE_CT_CylinderUnwrapper.html.

This work was done by Don J. Roth of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18808-1.

⑤ Discrete Data Qualification System and Method Comprising Noise Series Fault Detection

Noise fault detector detects an unreasonably high or low variance or standard deviation.

John H. Glenn Research Center, Cleveland, Ohio

A Sensor Data Qualification (SDQ) function has been developed that allows the onboard flight computers on NASA's launch vehicles to determine the validity of sensor data to ensure that critical safety and operational decisions are not based on faulty sensor data. This SDQ function includes a novel noise series fault detection algorithm for qualification of the output data from LO₂ and LH₂ low-level liquid sensors. These sensors are positioned in a launch vehicle's propellant tanks in order to detect propellant depletion during a rocket engine's boost operating phase. This detection capability can prevent the catastrophic situation where the engine operates without propellant. The output

from each LO₂ and LH₂ low-level liquid sensor is a discrete valued signal that is expected to be in either of two states, depending on whether the sensor is immersed (wet) or exposed (dry). Conventional methods for sensor data qualification, such as threshold limit checking, are not effective for this type of signal due to its discrete binary-state nature.

To address this data qualification challenge, a noise computation and evaluation method, also known as a noise fault detector, was developed to detect unreasonable statistical characteristics in the discrete data stream. The method operates on a time series of discrete data observations over a moving window of data points and performs a continuous exam-

ination of the resulting observation stream to identify the presence of anomalous characteristics. If the method determines the existence of anomalous results, the data from the sensor is disqualified for use by other monitoring or control functions.

This work was done by Christopher Fulton, Edmond Wong, and Kevin Melcher of Glenn Research Center; and Randall Bickford of Expert Microsystems, Inc. For more information, contact kimberly.a.dalgleish@nasa.gov.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18694-1.

⑥ Simple Laser Communications Terminal for Downlink From Earth Orbit at Rates Exceeding 10 Gb/s

Implementation of this technology will surpass the spectrum-allocation and bandwidth limitations of current RF systems.

NASA's Jet Propulsion Laboratory, Pasadena, California

A compact, low-cost laser communications transceiver was prototyped for downlinking data at 10 Gb/s from Earth-orbiting spacecraft. The design can be implemented using flight-grade parts. With emphasis on simplicity, compactness, and light weight of the flight transceiver, the reduced-complexity design and development approach involves:

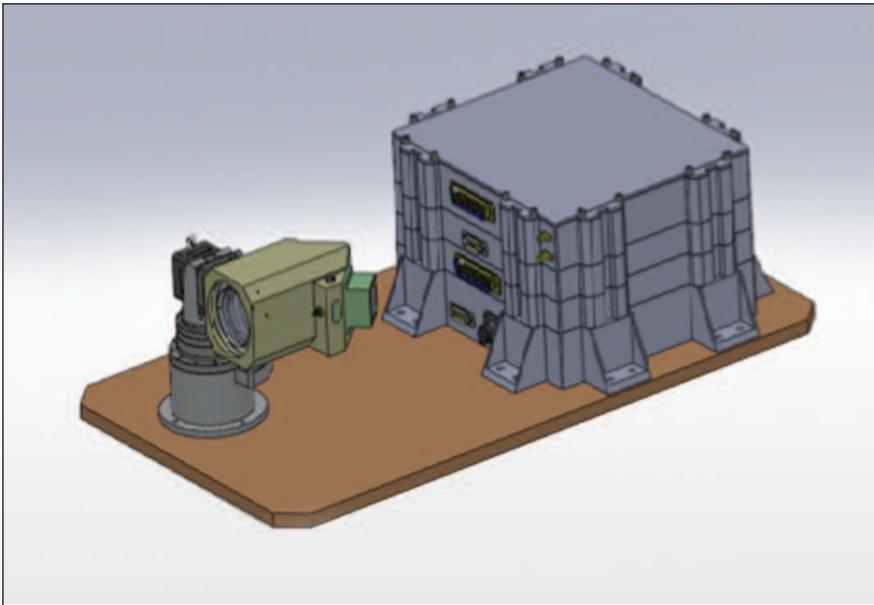
1. A high-bandwidth coarse wavelength division multiplexed (CWDM) (4×2.5 or 10-Gb/s data-rate) downlink transmitter. To simplify the system, emphasis is on the downlink. Optical uplink

data rate is modest (due to existing and adequate RF uplink capability).

2. Highly simplified and compact 5-cm-diameter clear aperture optics assembly is configured to single transmit and receive aperture laser signals. About 2 W of 4-channel multiplexed (1,540 to 1,555 nm) optically amplified laser power is coupled to the optical assembly through a fiber optic cable. It contains a highly compact, precision-pointing capability two-axis gimbal assembly to coarse point the optics assembly. A fast steering mirror, built into the optical path of the

optical assembly, is used to remove residual pointing disturbances from the gimbal. Acquisition, pointing, and tracking are assisted by a beacon laser transmitted from the ground and received by the optical assembly, which will allow transmission of a laser beam.

3. Shifting the link burden to the ground by relying on direct detection optical receivers retrofitted to 1-m-diameter ground telescopes.
4. Favored mass and volume reduction over power-consumption reduction. The two major variables that are avail-



A Laser Communications Terminal consists of the optical head on a 2-axis gimbal (left), and an electronics/laser box (right).

able include laser transmit power at either end of the link, and telescope aperture diameter at each end of the link. Increased laser power is traded for smaller-aperture diameters.

5. Use of commercially available space-qualified or qualifiable components

with traceability to flight qualification (i.e., a flight-qualified version is commercially available). An example is use of Telecordia-qualified fiber optic communication components including active components (lasers, amplifiers, photodetectors) that, ex-

cept for vacuum and radiation, meet most of the qualifications required for space.

6. Use of CWDM technique at the flight transmitter for operation at four channels (each at 2.5 Gb/s or a total of 10 Gb/s data rate). Applying this technique allows utilization of larger active area photodetectors at the ground station. This minimizes atmospheric scintillation/turbulence induced losses on the received beam at the ground terminal.
7. Use of forward-error-correction and deep-interleaver codes to minimize atmospheric turbulence effects on the downlink beam.

Target mass and power consumption for the flight data transmitter system is less than 10 kg and approximately 60 W for the 400-km orbit (900-km slant range), and 12 kg and 120 W for the 2,000-km orbit (6,000-km slant range). The higher mass and power for the latter are the result of employing a higher-power laser only.

This work was done by Joseph M. Kovalik, Hamid Hemmati, Abhijit Biswas, and William T. Roberts of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48413

Application Program Interface for the Orion Aerodynamics Database

Lyndon B. Johnson Space Center, Houston, Texas

The Application Programming Interface (API) for the Crew Exploration Vehicle (CEV) Aerodynamic Database has been developed to provide the developers of software an easily implemented, fully self-contained method of accessing the CEV Aerodynamic Database for use in their analysis and simulation tools. The API is programmed in C and provides a series of functions to interact with the database, such as initialization, selecting various options, and calculating the aerodynamic data. No special functions (file read/write, table lookup) are required on the host system other than those included with a standard ANSI C installation. It reads one or more files of aero data tables.

Previous releases of aerodynamic databases for space vehicles have only included data tables and a document of the algorithm and equations to combine them for the total aerodynamic

forces and moments. This process required each software tool to have a unique implementation of the database code. Errors or omissions in the documentation, or errors in the implementation, led to a lengthy and burdensome process of having to debug each instance of the code. Additionally, input file formats differ for each space vehicle simulation tool, requiring the aero database tables to be reformatted to meet the tool's input file structure requirements. Finally, the capabilities for built-in table lookup routines vary for each simulation tool. Implementation of a new database may require an update to and verification of the table lookup routines. This may be required if the number of dimensions of a data table exceeds the capability of the simulation tool's built-in lookup routines.

A single software solution was created to provide an aerodynamics soft-

ware model that could be integrated into other simulation and analysis tools. The highly complex Orion aerodynamics model can then be quickly included in a wide variety of tools. The API code is written in ANSI C for ease of portability to a wide variety of systems. The input data files are in standard formatted ASCII, also for improved portability.

The API contains its own implementation of multidimensional table reading and lookup routines. The same aerodynamics input file can be used without modification on all implementations. The turnaround time from aerodynamics model release to a working implementation is significantly reduced.

This work was done by Philip E. Robinson and James Thompson of Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24819-1