

of control activities, such as monitoring and control of the electric grid, chemical, or nuclear plant processes, air traffic control, and the like.

*This program was written by Hasan Rahman of Lockheed Martin for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24337-1*

## Update on PISCES

An updated version of the Platform Independent Software Components for the Exploration of Space (PISCES) software library is available. A previous version was reported in “Library for Developing Spacecraft-Mission-Planning Software” (MSC-22983), *NASA Tech Briefs*, Vol. 25, No. 7 (July 2001), page 52. To recapitulate: This software provides for Web-based, collaborative development of computer programs for planning trajectories and trajectory-related aspects of spacecraft-mission design. The library was built using state-of-the-art object-oriented concepts and software-development methodologies. The components of PISCES include Java-language application programs arranged in a hierarchy of classes that facilitates the reuse of the components.

As its full name suggests, the PISCES library affords platform-independence: The Java language makes it possible to use the classes and application programs with a Java virtual machine, which is available in most Web-browser programs. Another advantage is expandability: Object orientation facilitates expansion of the library through creation of a new class. Improvements in the library since the previous version include development of orbital-maneuver-planning and rendezvous-launch-window application programs, enhancement of capabilities for propagation of orbits, and development of a “desktop” user interface.

*This program was written by Don Pearson, Dustin Hamm, Brian Kubena, and Jonathan K. Weaver of Johnson Space Center. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809. MSC-23633-1*

## Ground and Space Radar Volume Matching and Comparison Software

This software enables easy comparison of ground- and space-based radar observations. The software was initially designed to compare ground radar reflectivity from operational, ground based S-

and C-band meteorological radars with comparable measurements from the Tropical Rainfall Measuring Mission (TRMM) satellite’s Precipitation Radar (PR) instrument. The software is also applicable to other ground-based and space-based radars. The ground and space radar volume matching and comparison software was developed in response to requirements defined by the Ground Validation System (GVS) of Goddard’s Global Precipitation Mission (GPM) project.

This software innovation is specifically concerned with simplifying the comparison of ground- and space-based radar measurements for the purpose of GPM algorithm and data product validation. This software is unique in that it provides an operational environment to routinely create comparison products, and uses a direct geometric approach to derive common volumes of space- and ground-based radar data. In this approach, spatially coincident volumes are defined by the intersection of individual space-based Precipitation Radar rays with the each of the conical elevation sweeps of the ground radar. Thus, the resampled volume elements of the space and ground radar reflectivity can be directly compared to one another.

*This work was done by Kenneth Morris and Mathew Schwaller of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). Additional information can also be found on the GPM GVS web site: <http://gpm.gsfc.nasa.gov/groundvalidation.html>. GSC-15738-1*

## Web-Based Interface for Command and Control of Network Sensors

This software allows for the visualization and control of a network of sensors through a Web browser interface. It is currently being deployed for a network of sensors monitoring Mt. Saint Helen’s volcano; however, this innovation is generic enough that it can be deployed for any type of sensor Web. From this interface, the user is able to fully control and monitor the sensor Web. This includes, but is not limited to, sending “test” commands to individual sensors in the network, monitoring for real-world events, and reacting to those events.

*This work was done by Michael N. Wallick, Joshua R. Doubleday, and Khawaja S. Shams of Caltech for NASA’s Jet Propulsion*

*Laboratory. For more information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov).*

*This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at [danielb@caltech.edu](mailto:danielb@caltech.edu). Refer to NPO-47110.*

## Orbit Determination Toolbox

The Orbit Determination Toolbox is an orbit determination (OD) analysis tool based on MATLAB and Java that provides a flexible way to do early mission analysis. The toolbox is primarily intended for advanced mission analysis such as might be performed in concept exploration, proposal, early design phase, or rapid design center environments. The emphasis is on flexibility, but it has enough fidelity to produce credible results. Insight into all flight dynamics source code is provided.

MATLAB is the primary user interface and is used for piecing together measurement and dynamic models. The Java Astrodynamics Toolbox is used as an engine for things that might be slow or inefficient in MATLAB, such as high-fidelity trajectory propagation, lunar and planetary ephemeris look-ups, precession, nutation, polar motion calculations, ephemeris file parsing, and the like. The primary analysis functions are sequential filter/smoothing and batch least-squares commands that incorporate Monte-Carlo data simulation, linear covariance analysis, measurement processing, and plotting capabilities at the generic level.

These functions have a user interface that is based on that of the MATLAB ODE suite. To perform a specific analysis, users write MATLAB functions that implement truth and design system models. The user provides his or her models as inputs to the filter commands. The software provides a capability to publish and subscribe to a software bus that is compliant with the NASA Goddard Mission Services Evolution Center (GMSEC) standards, to exchange data with other flight dynamics tools to simplify the flight dynamics design cycle. Using the publish and subscribe approach allows for analysts in a rapid design center environment to seamlessly incorporate changes in spacecraft and mission design into navigation analysis and vice versa.

*This work was done by James R. Carpenter and Kevin Berry of Goddard Space Flight Center and Kate Gregory, Keith Speckman, Sun Hur-Diaz, Derek Surka, and Dave Gaylor of Emergent Space Technologies, Inc. For*

for further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15728-1

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## Distributed Observer Network

The Distributed Observer network (DON) is a NASA-collaborative environment that leverages game technology to bring three-dimensional simulations to conventional desktop and laptop computers in order to allow teams of engineers working on design and operations, either individually or in groups, to view and collaborate on 3D representations of data generated by authoritative tools such as Delmia Envision, Pro/Engineer, or Maya. The DON takes models and telemetry from these sources and, using commercial game engine technology, displays the simulation results in a 3D visual environment.

DON has been designed to enhance accessibility and user ability to observe and analyze visual simulations in real time. A variety of NASA mission segment simulations [Synergistic Engineering Environment (SEE) data, NASA Enterprise Visualization Analysis (NEVA) ground processing simulations, the DSS simulation for lunar operations, and the Johnson Space Center (JSC) TRICK tool for guidance, navigation, and control analysis] were experimented with. Desired functionalities, [i.e. Tivo-like functions, the capability to communicate textually or via Voice-over-Internet Protocol (VoIP)

among team members, and the ability to write and save notes to be accessed later] were targeted. The resulting DON application was slated for early 2008 release to support simulation use for the Constellation Program and its teams.

Those using the DON connect through a client that runs on their PC or Mac. This enables them to observe and analyze the simulation data as their schedule allows, and to review it as frequently as desired. DON team members can move freely within the virtual world. Preset camera points can be established, enabling team members to jump to specific views. This improves opportunities for shared analysis of options, design reviews, tests, operations, training, and evaluations, and improves prospects for verification of requirements, issues, and approaches among dispersed teams.

*This work was done by Michael Conroy, Rebecca Mazzone, William Little, and Priscilla Elfrey of Kennedy Space Center; David Mann of ASRC Aerospace; and Kevin Mabie, Thomas Cuddy, Mario Loudermon, Stephen Spiker, Don Whiteside, Frank McArthur, Tate Srey, and Dennis Bonilla of Valador Inc. For further information, contact the Kennedy Innovative Partnerships Program Office at (321) 861-7158. KSC-13081*

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## Computer-Automated Evolution of Spacecraft X-Band Antennas

A document discusses the use of computer-aided evolution in arriving at a

design for X-band communication antennas for NASA's three Space Technology 5 (ST5) satellites, which were launched on March 22, 2006. Two evolutionary algorithms, incorporating different representations of the antenna design and different fitness functions, were used to automatically design and optimize an X-band antenna design. A set of antenna designs satisfying initial ST5 mission requirements was evolved by use of these algorithms.

The two best antennas — one from each evolutionary algorithm — were built. During flight-qualification testing of these antennas, the mission requirements were changed. After minimal changes in the evolutionary algorithms — mostly in the fitness functions — new antenna designs satisfying the changed mission requirements were evolved and within one month of this change, two new antennas were designed and prototypes of the antennas were built and tested. One of these newly evolved antennas was approved for deployment on the ST5 mission, and flight-qualified versions of this design were built and installed on the spacecraft. At the time of writing the document, these antennas were the first computer-evolved hardware in outer space.

*This work was done by Jason D. Lohn of Ames Research Center and Gregory S. Hornby of the University of California Santa Cruz and Derek S. Linden of JEM Engineering. Further information is contained in a TSP (see page 1). ARC-15568-1*