



## System for Contributing and Discovering Derived Mission and Science Data

A system was developed to provide a new mechanism for members of the mission community to create and contribute new science data to the rest of the community. Mission tools have allowed members of the mission community to share first order data (data that is created by the mission's process in command and control of the spacecraft or the data that is captured by the craft itself, like images, science results, etc.). However, second and higher order data (data that is created after the fact by scientists and other members of the mission) was previously not widely disseminated, nor did it make its way into the mission planning process.

This software allows members of the mission community to create and contribute second and higher order data into the set of mission data for use in planning and operations of a mission. This kind of data is indexed and treated in the same way as first order data. The data is discoverable by other users and can be part of the planning process. The system improves the ability to share results, make discoveries, and aid in the operations of a mission. At the time of this reporting, this capability was not available in other software.

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*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-48217.*

## Remote Viewer for Maritime Robotics Software

This software is a viewer program for maritime robotics software that provides a 3D visualization of the boat pose, its position history, ENC (Electrical Nautical Chart) information, camera images, map overlay, and detected tracks.

It is usually very difficult to understand the internal states of onboard robotics software. One common approach is text-based printouts on a terminal, but

it is very difficult to interpret large amounts of data printed out on the screen. Another challenge is that the network connection to the robot might not be reliable, where constantly monitoring the data at high bandwidth is impossible.

This software provides a Qt-based viewer that is intended to be used with onboard robotics software to visualize its internal states and the situational awareness of the robot. OpenGL is used to render vehicle/objects/ENC data, etc. in 3D. It uses UDP (User Datagram Protocol) communication to talk to the onboard software, so each side of the robot and the viewer program can be stopped and started at any time, and the performance degrades gracefully over lossy wireless communications links. It can also save a log of the viewer messages and replay at various speeds, so that it can reconstruct and analyze what happens in the field trials. Other features include QuickTime-based movie creation, overlay of maps, and display of ENC objects.

This software is easily adopted by other robotics projects. It serves as an engineering display for software debugging/monitoring, and also a tool to explain to sponsors/customers what the onboard navigation/perception/control algorithms are doing.

*This work was done by Yoshiaki Kuwata, Michael Wolf, Terrance L. Huntsberger, and Andrew B. Howard of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48126*

## Stackfile Database

This software provides storage retrieval and analysis functionality for managing satellite altimetry data. It improves the efficiency and analysis capabilities of existing database software with improved flexibility and documentation. It offers flexibility in the type of data that can be stored. There is efficient retrieval either across the spatial domain or the time domain. Built-in analysis tools are provided for frequently performed altimetry tasks.

This software package is used for storing and manipulating satellite measurement data. It was developed with a focus on handling the requirements of repeat-track altimetry missions such as Topex

and Jason. It was, however, designed to work with a wide variety of satellite measurement data [e.g., Gravity Recovery And Climate Experiment — GRACE). The software consists of several command-line tools for importing, retrieving, and analyzing satellite measurement data.

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## Reachability Maps for In Situ Operations

This work covers two programs that accomplish the same goal: creation of a “reachability map” from stereo imagery that tells where operators of a robotic arm can reach or touch the surface, and with which instruments. The programs are “marsreach” (for MER) and “phxreach.” These programs make use of the planetary image geometry (PIG) library. However, unlike the other programs, they are not multi-mission. Because of the complexity of arm kinematics, the programs are specific to each mission.

In each case, the input consists of XYZ and surface normal data. The output is a multiband image, co-registered to the input image. Each band represents a predefined combination of arm instrument and arm configuration (e.g., elbow up, elbow down), and the value indicates whether or not the instrument can observe (see or touch) the surface at the corresponding pixel.

This software models the arm precisely, using the same algorithms as the flight software. It is thus uniquely suited to determining reachability and safety of robot arm operations. The MER RAT instrument provides additional information beyond just a flag — it supplies a “preload” value, which indicates how much force the arm can apply at that spot. The MER reachability program considers collisions of the arm with terrain in determining reachability; the PHX program does not.

These programs provide this reachability information in an easy-to-use format by combining the surface position and orientation, arm kinematics, instrument mounting, and instrument approach angles. This software is also integrated into the ground data system and the automated processing pipelines. It understands the EDR and RDR file formats and metadata, and products tailored for in situ surface operations.

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## JPL Space Telecommunications Radio System Operating Environment

A flight-qualified implementation of a Software Defined Radio (SDR) Operating Environment for the JPL-SDR built for the CoNNeCT Project has been developed. It is compliant with the NASA Space Telecommunications Radio System (STRS) Architecture Standard, and provides the software infrastructure for STRS compliant waveform applications. This software provides a standards-compliant abstracted view of the JPL-SDR hardware platform. It uses industry standard POSIX interfaces for most functions, as well as exposing the STRS API (Application Programming Interface) required by the standard. This software includes a standardized interface for IP components instantiated within a Xilinx FPGA (Field Programmable Gate Array).

The software provides a standardized abstracted interface to platform resources such as data converters, file system, etc., which can be used by STRS standards conformant waveform applications. It provides a generic SDR operating environment with a much smaller resource footprint than similar products such as SCA (Software Communications Architecture) compliant implementations, or the DoD Joint Tactical Radio Systems (JTRS).

*This work was done by James P. Lux, Minh Lang, Kenneth J. Peters, Gregory H. Taylor, Courtney B. Duncan, David S. Orozco, Ryan A. Stern, Earl R. Ahten, and Mike Girard 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 Daniel Broderick of the California Institute of Technology at [danielb@caltech.edu](mailto:danielb@caltech.edu). Refer to NPO-47766.*

## RFI-SIM: RFI Simulation Package

RFI-SIM simulates the RFI environment to estimate the interference from terrestrial emitters into spacecraft, or vice versa. A high-fidelity simulation of the RFI environment has been developed by employing all antenna-related and radar system-related parameters of multiple emitters, as well as that of the desired spacecraft.

In the simulation, the real-time analysis of the interference and its effects on error budgets of a desired radar system is taken into account. This provides a reliable tool for radar system design to deal with RFI issues and to evaluate the sensitivity of various parts of a radar system including antenna pattern, RF front-end and digital processing to RFI signals.

The simulator is capable of a high-fidelity, complex, and real-time simulation of RFI environment. It is flexible enough to be employed for various scenarios and for several NASA missions. RFI-SIM can perform the following in support of radar system design and performance analyses:

- Error budget analyses due to RFI on a space-borne radar system;
- Sensitivity analysis of the various radar parameters, as well as hardware specs, in the presence of RFI;
- Verification of the radar system design at several stages of RF and digital components in order to evaluate their robustness against RFI;
- Assistance in algorithm development for RFI detection and removal approach;
- Based on the available database, the RFI environment over North America at L-band has been reliably and successfully simulated and validated so it can be used for L-band space-borne radars in the RFI environment; and
- Estimation of the interference from space-borne radars into terrestrial FAA radars regarding FAA compatibility issues.

*This work was done by Hiram Ghaemi and Curtis W. Chen 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 Daniel Broderick of the California Institute of Technology at [danielb@caltech.edu](mailto:danielb@caltech.edu). Refer to NPO-48565.*

## ION Configuration Editor

The configuration of ION (Interplanetary Overlay Network) network nodes is a manual task that is complex, time-consuming, and error-prone. This program seeks to accelerate this job and produce reliable configurations.

The ION Configuration Editor is a model-based smart editor based on Eclipse Modeling Framework technology. An ION network designer uses this Eclipse-based GUI to construct a data model of the complete target network and then generate configurations. The data model is captured in an XML file. Intrinsic editor features aid in achieving model correctness, such as field fill-in, type-checking, lists of valid values, and suitable default values. Additionally, an explicit "validation" feature executes custom rules to catch more subtle model errors. A "survey" feature provides a set of reports providing an overview of the entire network, enabling a quick assessment of the model's completeness and correctness. The "configuration" feature produces the main final result, a complete set of ION configuration files (eight distinct file types) for each ION node in the network.

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## Dtest Testing Software

This software runs a suite of arbitrary software tests spanning various software languages and types of tests (unit level, system level, or file comparison tests). The dtest utility can be set to automate periodic testing of large suites of software, as well as running individual tests. It supports distributing multiple tests over multiple CPU cores, if available.

The dtest tool is a utility program (written in Python) that scans through a directory (and its subdirectories) and finds all directories that match a certain pattern (directory name starts with "test\_" or "test-") and then executes any tests in that directory as described in simple configuration files. The tests are completely arbitrary and are not tied to any specific programming language. A variety of tests is available to support comparing test output files