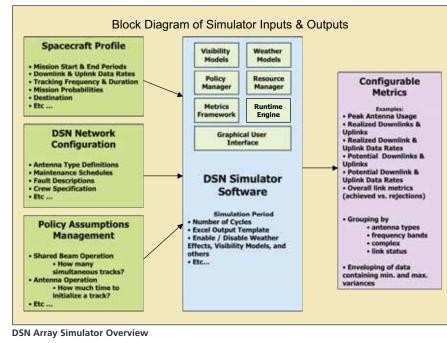# DSN Array Simulator

NASA's Jet Propulsion Laboratory, Pasadena, California

The DSN Array Simulator (wherein "DSN" signifies NASA's Deep Space Network) is an updated version of software previously denoted the DSN Receive Array Technology Assessment Simulation. This software (see figure) is used for computational modeling of a proposed DSN facility comprising user-defined arrays of antennas and transmitting and receiving equipment for microwave communication with spacecraft on interplanetary missions. The simulation includes variations in spacecraft tracked and communication demand changes for up to several decades of future operation. Such modeling is performed to estimate facility performance, evaluate requirements that govern facility design, and evaluate proposed improvements in hardware and/or software.

The updated version of this software affords enhanced capability for characterizing facility performance against user-defined mission sets. The software includes a Monte Carlo simulation component that enables rapid generation of key mission-set metrics (e.g., numbers of links, data rates, and date volumes), and statistical distributions thereof as functions of time. The updated version also offers expanded capability for mixed-asset network modeling — for example, for running scenarios that involve user-definable mixtures of antennas having different diameters (in contradistinction to a fixed number of antennas having the same fixed diameter). The improved version also affords greater simulation fidelity, sufficient for validation by comparison with actual DSN operations and analytically predictable performance metrics.
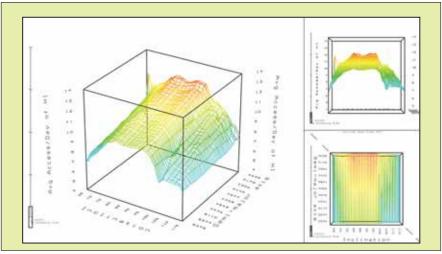
This program was written by Raffi Tikidjian and Ryan Mackey of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-44506.

DSN Array Simulator Overview

Parametric-Studies and Data-Plotting Modules for the SOAP

NASA's Jet Propulsion Laboratory, Pasadena, California

"Parametric Studies" and "Data Table Plot View" are the names of software modules in the Satellite Orbit Analysis Program (SOAP). Parametric Studies enables parameterization of as many as three satellite or ground-station attributes across a range of values and computes the average, minimum, and maximum of a specified metric, the revisit time, or 21 other functions at each point in the parameter space. This computation produces a one-, two-, or three-dimensional table of data representing statistical results across the parameter space. Inasmuch as the output of a parametric study in three dimensions can be a very large data set, visualization is a paramount means of discovering trends in the data (see figure).

Sample Output

Data Table Plot View enables visualization of the data table created by Parametric Studies or by another data source: this module quickly generates a display of the data in the form of a rotatable three-dimensional-appearing plot, making it unnecessary to load the SOAP output data into a separate plotting program. The rotatable three-dimensional-appearing plot makes it easy to determine which points in the parameter space are most desirable. Both modules provide intuitive user interfaces for ease of use.

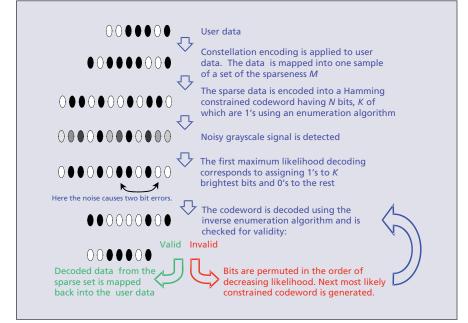# Testing of Error-Correcting Sparse Permutation Channel Codes

NASA's Jet Propulsion Laboratory, Pasadena, California

A computer program performs Monte Carlo direct numerical simulations for testing sparse permutation channel codes, which offer strong error-correction capabilities at high code rates and are considered especially suitable for storage of digital data in holographic and volume memories. A word in a code of this type is characterized by, among other things, a sparseness parameter (M) and a fixed number (K) of 1 or "on" bits in a channel block length of N (see figure).

In a test, random user data words are generated and mapped into code words. Transmission of the words through a noisy channel is simulated by adding simulated white Gaussian noise whose amplitude is determined by the signal-to-noise ratio. Detection of each word is performed via strict Maximum Likelihood detection algorithm starting with the initially detected codeword, which is produced by sorting the resulting bit values and assigning a value of 1 to the highest K of them and 0 to the rest. A newly developed permutation sorting algorithm is further applied to determine the maximum weight valid code word. The maximum likelihood valid sparse codeword is decoded, by means of an inverse of an enumerative scheme used in generating code words, to obtain the original use data. From the results of this simulation, block error rates (BERs) and other statistics that characterize the performance of the code are calculated. Sparse permutation channel codes satisfy the balanced channel coding constraint and, as determined from the direct numerical simulation, also simultaneously provide high error correction with use of BER as low as 10^{-10} and less even for fairly large raw bit error rates. Channel codes of sufficiently large block size ($N > 100$) asymptotically approach the information theoretic limits for communications channel capacity.

An **Outline of the Code** used for numerical simulation of the error-correction performance.

Visual Target Tracking on the Mars Exploration Rovers

NASA's Jet Propulsion Laboratory, Pasadena, California

Visual target tracking (VTT) software has been incorporated into Release 9.2 of the Mars Exploration Rover (MER) flight software, now running aboard the rovers Spirit and Opportunity. In the VTT operation (see figure), the rover is driven in short steps between stops and, at each stop, still images are acquired by actively aimed navigation cameras (navcams) on a mast on the rover (see artistic rendition). The VTT software processes the digitized navcam images so as to track a target reliably and to make it possible to approach the target accurately to within a few centimeters over a 10-m traverse.

The operations on the digitized images include a normalized cross-correlation algorithm along with template-image-magnification and template-image-roll-compensation algorithms.