



An **Activity Network With Resource Allocations** constitutes a graphical representation of a flexible activity plan to which the instant algorithm applies. Each activity time interval ( $A_i$ ) is characterized by (1) time variables  $e_{is}$  and  $e_{ie}$  for start and end events, respectively; (2) a non negative flexible activity-duration link (e.g., [2,5] for activity  $A_1$ ); and flexible separation links between events (e.g., [0,4] from  $e_{3e}$  to  $e_{4s}$ ). Associated with each event is a resource-allocation variable (e.g.,  $r_{31}$  with event  $e_{3s}$ ). It is assumed that all events occur after starting time  $T_s$  and before an ending event time  $T_e$  rigidly connected to  $T_s$ . The interval  $[T_s, T_e]$  is denoted the time horizon of the network.

plexity (and thus of cost) of a maximum-flow algorithm applied to an auxiliary flow network of  $2N$  nodes. The algorithm is believed to be efficient in practice; experimental analysis shows the practical cost of maxflow to be as low as  $O(N^{1.5})$ .

The algorithm could be enhanced following at least two approaches. In the first approach, incremental subalgorithms for the computation of the envelope could be developed. By use of tem-

poral scanning of the events in the temporal network, it may be possible to significantly reduce the size of the networks on which it is necessary to run the maximum-flow subalgorithm, thereby significantly reducing the time required for envelope calculation. In the second approach, the practical effectiveness of resource envelopes in the inner loops of search algorithms could be tested for multi-capacity resource scheduling. This

testing would include inner-loop backtracking and termination tests and variable and value-ordering heuristics that exploit the properties of resource envelopes more directly.

*This work was done by Nicola Muscivtola of Ames Research Center and David Rijsman of Mission Critical Technologies Inc. For further information contact the Technology Partnerships Division, Ames Research Center, (650) 604-2954. ARC-14948-1*

## MSLICE Science Activity Planner for the Mars Science Laboratory Mission

NASA's Jet Propulsion Laboratory, Pasadena, California

MSLICE (Mars Science Laboratory InterfaCE) is the tool used by scientists and engineers on the Mars Science Laboratory rover mission to visualize the data returned by the rover and collaboratively plan its activities. It enables users to efficiently and effectively search all mission data to find applicable products (e.g., images, targets, activity plans, sequences, etc.), view and plan the traverse of the rover in HiRISE (High Resolution Imaging Science Experiment) images, visualize data acquired by the rover, and develop, model, and validate the activities the rover will perform. MSLICE enables users to securely contribute to the mission's activity planning process

from their home institutions using off-the-shelf laptop computers.

This software has made use of several plug-ins (software components) developed for previous missions [e.g., Mars Exploration Rover (MER), Phoenix Mars Lander (PHX)] and other technology tasks. It has a simple, intuitive, and powerful search capability. For any given mission, there is a huge amount of data and associated metadata that is generated. To help users sort through this information, MSLICE's search interface is provided in a similar fashion as major Internet search engines.

With regard to the HiRISE visualization of the rover's traverse, this view is a map of the mission that allows scientists

to easily gauge where the rover has been and where it is likely to go. The map also provides the ability to correct or adjust the known position of the rover through the overlaying of images acquired from the rover on top of the HiRISE image. A user can then correct the rover's position by collocating the visible features in the overlays with the same features in the underlying HiRISE image. MSLICE users can also rapidly search all mission data for images that contain a point specified by the user in another image or panoramic mosaic.

MSLICE allows the creation of targets, which provides a way for scientists to collaboratively name features on the surface of Mars. These targets can also be

used to convey instrument-pointing information to the activity plan. The software allows users to develop a plan of what they would like the rover to accomplish for a given time period. When developing the plan, the user can input constraints between activities or groups of activities. MSLICE will enforce said

constraints and ensure that all mission flight rules are satisfied.

*This work was done by Mark W. Powell, Khawaja S. Shams, Michael N. Wallick, Jeffrey S. Norris, Joseph C. Joswig, Thomas M. Crockett, Jason M. Fox, Recaredo J. Torres of Caltech; James A. Kurien, Michael P. McCurdy, and Guy Pyrzak of NASA Ames Re-*

*search Center; and Arash Agheoli and Andrew G. Bachmann of Stinger Ghaffarian Technologies, Inc. for NASA's Jet Propulsion Laboratory.*

*This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45908.*

---

## ▶ Telemetry-Enhancing Scripts

*NASA's Jet Propulsion Laboratory, Pasadena, California*

Scripts Providing a Cool Kit of Telemetry Enhancing Tools (SPACKLE) is a set of software tools that fill gaps in capabilities of other software used in processing downlinked data in the Mars Exploration Rovers' (MER) flight and test-bed operations. SPACKLE tools have helped to accelerate the automatic processing and interpretation of MER mission data, enabling non-experts to understand and/or use MER query and data product command simulation software tools more effectively. SPACKLE has greatly accelerated some operations and provides new capabilities.

The tools of SPACKLE are written, variously, in Perl or the C or C++ language. They perform a variety of search and shortcut functions that include the following:

- Generating text-only, Event Report-annotated, and Web-enhanced views of command sequences;
- Labeling integer enumerations with their symbolic meanings in text messages and engineering channels;
- Systematic detecting of corruption within data products;
- Generating text-only displays of data-product catalogs including downlink status;
- Validating and labeling of commands related to data products;

- Performing of convenient searches of detailed engineering data spanning multiple Martian solar days;
- Generating tables of initial conditions pertaining to engineering, health, and accountability data;
- Simplified construction and simulation of command sequences; and
- Fast time format conversions and sorting.

*This program was written by Mark W. Maimone of Caltech for NASA's Jet Propulsion Laboratory.*

*This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45700.*

---

## ▶ Analog Input Data Acquisition Software

*John F. Kennedy Space Center, Florida*

DAQ Master Software allows users to easily set up a system to monitor up to five analog input channels and save the data after acquisition. This program was written in LabVIEW 8.0, and requires the LabVIEW runtime engine 8.0 (free download from National Instruments; ni.com) to run the executable. A DAQ card must be installed in the computer for this program to work correctly, and it must have

up to five analog input channels. The user can set the channel configuration, and other channel details, from the setup tab after the program has begun.

A Setup tab holds all information for the channels that will be used for data acquisition, and allows the user to save or upload the settings for future use by writing or reading a configuration file. The Data Acquisition tab is where the

commands to acquire, stop, and save data are located, and where the data will be displayed. The user can choose to display scaled or un-scaled data while acquisition is taking place.

*This work was done by Ellen Arens of Kennedy Space Center. For more information, visit [http://www.openchannelsoftware.com/projects/Analog\\_Input\\_Data\\_Acquisition](http://www.openchannelsoftware.com/projects/Analog_Input_Data_Acquisition) for a free download. KSC-13203*

---

## ▶ Relay Sequence Generation Software

*NASA's Jet Propulsion Laboratory, Pasadena, California*

Due to thermal and electromagnetic interactivity between the UHF (ultra-high frequency) radio onboard the Mars Reconnaissance Orbiter (MRO), which performs relay sessions with the Martian landers, and the remainder of the MRO payloads, it is required to integrate and

de-conflict relay sessions with the MRO science plan. The MRO relay SASE/PTF (spacecraft activity sequence file/ payload target file) generation software facilitates this process by generating a PTF that is needed to integrate the periods of time during which MRO supports relay

activities with the rest of the MRO science plans. The software also generates the needed command products that initiate the relay sessions, some features of which are provided by the lander team, some are managed by MRO internally, and some being derived.