

Did you ever wonder how pictures of Mars get to us?

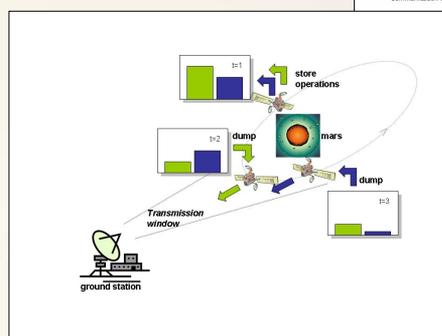
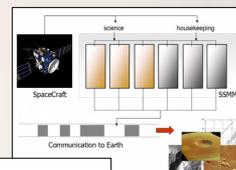
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The Problem

In the complex domain of the Mars Express space mission, this project has addressed the problem of synthesizing the transmission operations for the gathered data (collected from the on-board payload and spacecraft devices) towards Earth, synchronizing transmission depending on Earth visibility time windows. The main goal is to optimize the use of the on-board memory, which is subdivided into a set of packet stores, in order to avoid data loss while assuring reasonable access times for scientific data. This problem has been called Mars Express Memory Dumping Problem (MEX-MDP).



MEXAR2

MEXAR2 is an advanced software tool for continuous support to data dumping activities for MARS EXPRESS. The aim of the MEXAR2 project is to propose a flexible and easily configurable system which allows several tuning mechanisms targeted at improving quality parameters for a dump plan. In addition, the design of the system is object-oriented and is implemented in Java, in order to easily run the system under different operative systems as UNIX, LINUX, Windows or Mac OSX.



Goals of the project

- To select one problem in the Mars-Express mission planning domain (MEX-MDP)
- To study algorithms for its solution by applying AI techniques
- To design an interactive interface to integrate the human operator in the solving process
- To preserve user's responsibility in the solving process

MEXAR2 Problem Solver: it performs the three following steps:

- information acquiring: reads all the input files and the domain parameters file and extracts the necessary pieces of information to initialize internal data structures.
- Solving: generates a solution by applying a specific solving methods based on the use of Max-Flow algorithms.
- Output production: given the results of the previous step, it generates all the output files according to the ESA requirements.

Man Machine Interface: it helps the user to specify the problems and to analyze the solutions found. Twofold objective:

- to reproduce the usual problem solving cycle of real users
- to exploit the domain expert abilities and foster the involvement and contribution to the problem solving.

PSI

Chronology of a history of success

In the period November 2000 - July 2002, the PST at ISTC-CNR, has worked at the ESA study "Efficient Planning Algorithms for an Interplanetary Mission". This study was aimed at demonstrating Artificial Intelligence techniques for Planning and Scheduling applied to a real space mission planning problem for MARS-EXPRESS. The open problem, which has been jointly identified by the PST members and MARS-EXPRESS MPS experts, has been studied and formalized as the Mars Express Memory Dump Problem (MEX-MDP).

In May 2002, the group delivered to ESA-ESOC an advanced prototype of a software system called MEXAR which was able to automate the generation of spacecraft operations for efficient on-board mass memory dumping. A very important limitation plagued the MEXAR project: the unavailability of real data from the spacecraft or even from a realistic simulation of the spacecraft's nominal work. As a consequence, although the study had a very positive outcome, it remained at the level of "nice demo".

In June 2004, contacts with the Mission Planning Team of MARS-EXPRESS were resumed. It clearly emerged that during actual spacecraft operations in the first six months of activities around Mars, the mission planners had in fact faced manpower overload in addressing the Spacecraft Memory Dumping Problem. We proposed to commence a specific study aimed at understanding the problem on the basis of real data analysis. Regular contacts with senior members of the ESOC Mission Planning Team, allowed us to get acquainted with real-world data, as well as to receive direct information on some of the crucial aspects of the problem, and in particular with the decisions taken during on-line operations.

In September 2004 we were able to deliver to ESA increasingly accurate operational versions of a software system able to cope with real problem instances, and manage the same data files used in real-world operations.

February 2005: the new operational tool called MEXAR2 is in continuous use at ESA-ESOC as the main tool for the synthesis of solution of MEX-MDP instances. It is able to synthesize directly the commands to be uploaded on board the spacecraft for returning memory data to Earth.

During the period April - December 2005, in a new study named "MEXAR2: A Software Tool for Continuous Support to Data Dumping Activities for MARS-EXPRESS", we have robustified the tool with a further set of functionalities and a user interface that facilitates its management.

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