SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration (5)

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RC-SIM: RADIOCOMM SIGNALS FOR RETRIEVAL OF PLANETARY GEOPHYSICAL PARAMETERS

Abstract

The RC-SIM project aimed at the analysis of existing and new techniques for the exploitation of radio-communication signals from interplanetary probes for remote sensing of the surface and other geophysical parameters of planetary bodies. It was funded by ESA General Studies Programme lead by GMV, with the collaboration of the Universities of Rome and Bologna. Main objectives of RC-SIM have been:

- Investigate which physical parameters can be obtained from the use, as a remote sensing instrument, of the radio-communication systems on-board interplanetary probes.
- Analyse the added value provided with this approach compared to other instrument types also giving geophysical parameters of planetary surfaces and interiors.
- Develop a prototype simulator generating quantitative results of the different aspects involved in the radio communication link.

After reviewing the previous and foreseen experiments on this field and the state-of-the art of radio-communication systems, three scenarios were considered:

- Titan scenario. Defining an orbiter around Titan and a balloon overflying its surface in different configurations for the realization of radar bi-static experiments (orbiter-Earth; balloon-orbiter; Earth-orbiter; Earth-balloon), in order to assess the capability to retrieve the dielectric constant and the r.m.s. surface slope of Titan.

- Martian lander. Determining the Martian rotational state by using the RF telecommunication signal between a lander and an Earth station. The analysis showed the level at which rotational state parameters could be retrieved using state-of-the-art instrumentation and Ka-band radio-links. Both Doppler and range observables contribute to the determination of the rotational state.

- Moon interferometric mission. It involves a network of 3-4 widely spaced landers on the Moon, aimed to accurate determining (to 0.2 mm) the lunar tides and librations. The radio-communication signals are combined in an interferometric mode, cancelling the Moon orbital motion and the propagation media effect.

The most relevant models needed in the simulation were:

- Accurate Mars and Moon rotational state model.

- Titan surface model of interaction and reflection of RF signal.

- Error models (atmospheric, interplanetary...)

- Retrieval models.

The simulator was developed to assess the potential benefits from the use of telecom links for geophysical investigations and to evaluate the scientific requirements that may come from future planetary missions. The results show that state-of-the-art architecture of radio-communication systems may provide significant improvements in the knowledge of several geophysical parameters. The flexible simulator setup allows analysing different configurations and models, or performing sensitivity analyses in the context of future missions.