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INTERPLANETARY COMMUNICATION: A REVIEW OF FUTURE REQUIREMENTS

Abstract

A variety of interplanetary mission scenarios has been established by almost all space agencies playing a major role in space exploration. Typical mission scenarios start with exploration missions to the Moon before proceeding to other destinations as Mars or asteroids.

Reliable communication plays a crucial role in particular for efficient science data downlink or video transmission for human missions. Currently, the communication of all planned interplanetary missions relies on RF systems. Any initial plans for optical communications have been limited to technology demonstrations.

We present the results of an ESA funded study about the analysis of communication and navigation requirements of future interplanetary mission scenarios. The objective of this activity was to understand the requirements and challenges of future interplanetary communication and navigation systems. A systematic collection and review of communication requirements for the European Exploration Program has been performed. Other international initiatives have been taken into account as well. The collected requirements for about 73 planned or initiated international interplanetary missions from all major space agencies have been analyzed. This comprises concept studies of future missions (e.g. Mars Sample Return), as well as studies on the medium- and long-term programmatic planning.

The synthesis of the scenarios review has lead to a reduced set of 13 characteristic mission scenarios. This set of representative missions considers five Moon senarios (remote sensing, impactor network, lander rover, sample return, human presence), 5 Mars scenarios (meteorology orbiter, lander rover, lander network, sample return, human presence), an observatory at L2, an asteroid sample return mission and a Jupiter mission including a Europa lander.

These scenarios have been taken as basis for the derivation of dedicated user requirements for communication and navigation. Starting from the projected user requirements such as science data rate or needed navigation performance the system requirements have been derived both for communication and navigation. For this mapping both RF and optical communication have been analysed in detail. In addition, the applicability of new techniques such as Interplanetary Internet or advanced navigation techniques has been investigated.

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