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Author: Mr. Quirin Funke
TU Muenchen, Germany, quirin.funke@esa.int

Mr. Max Roessner
Germany, max.roessner@gmx.de
Prof. Christoph Guenther
Germany, christoph.guenther@dlr.de
Dr. Patrick Henkel
Technical University of Munich, Germany, patrick.henkel@tum.de

SATELLITE CONSTELLATIONS FOR DATA TRANSFER FROM THE MOON

Abstract

For future missions to the moon, especially those including a lander, it is of certain interest to have a communication gateway back to earth. As several missions to the moon are currently in the planning phase, a global lunar communication network providing this service would be very useful. Especially smaller missions would benefit a lot from it, as expensive and power consuming long range transmitters are not necessary anymore and relay satellites are already available.

This paper is a study of orbit constellations for such a satellite communication network at the moon. Three different approaches which lead to three networks with different qualities are optimized and analyzed.

The first approach is based on the assumption that in a communication network for satellites a constant connection is not required. It is sufficient if periodic communication possibilities with an Earth based ground station are provided. The focus of such a constellation is to minimize the number of needed satellites and the delay between the time of a wish to send and the final reception. On the far side of the Moon additional latency is introduced because of the necessity to store the data on the satellite until the Earth is visible again. The result of this study is a new constellation that combines a global low latency with the fewest needed satellites.

The second approach is a further development of the first one to a constellation which provides constant coverage. The number of needed satellites increases significantly, but the value of the network as well. Critical mission phases can be observed without interruptions and significant delays, even on the far side of the Moon if inter satellite links are also implemented.

The third approach includes a rather uncommon orbit, at least at the Moon. It is possible to put a satellite in orbit around the libration point L2, a point of equilibrium of forces behind the moon. Such a satellite would therefore always see Moon's far side. If the orbit height is big enough the satellite also is in visibility of the Earth, thus a constant available relay for Moon's far side. The scope of this paper is a basic mission analysis and study of the advantages of such a constellation.

Such a relay satellite also improves a constellation of the first approach by removing the additional delay on Moon's far side.