Paper ID: 79848
student

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Communication Systems and Services, Part 3 (4)

Author: Ms. Alessia Di Giacomo
Sapienza University of Rome, Italy, ale.digiacomo.a@gmail.com

Mr. Angelo Fabbrizi
Sapienza University of Rome, Italy, fabbrizi.1656661@studenti.uniroma1.it
Dr. antonello binni
Sapienza University of Rome, Italy, antonello.binni@uniroma1.it

CAVE ENVIRONMENT WAVEGUIDE-BASED SYSTEM FOR LUNAR EXPLORATION WIRELESS TELECOMMUNICATION

Abstract

As human space exploration gains more concern and attention, the establishment of human outposts and bases on the Moon and Mars is becoming a realistic goal. From this perspective, lava tubes provide a suitable location for long-duration human settlement and scientific activities as natural shelter from extreme space conditions. Moreover, this underground environment involves different challenges related to the communication systems due to the lack of direct line-of-sight paths, interferences and thickness of the rocks that can attenuate or block electromagnetic signals. Nevertheless, a wireless telecommunication system is needed to guarantee the communication between the ground control center on Earth and the astronauts, in order to realize remote control and real-time monitoring of probe activities, to collect valuable data and to perform various scientific tasks. The Sapienza Space Systems and Space Surveillance Laboratory (S5Lab) at Sapienza University of Rome is currently conducting a feasibility study for the realization of a wireless telecommunication network using the waveguide nature of the cave walls within the analog mission project named GEA. One of the most crucial parts is the examination and identification of the underground analogies between the Lunar lava tubes and relevant testing scenarios in caves on Earth. Through a comparison based on electromagnetic properties, it is possible to find the best terrestrial surrogate for those on Moon and Mars. As a consequence of the cave selection, some in-situ tests are conducted to verify the wireless network's functionality through a system composed of two antennas that can be put at more than 100 meters of distance. The transmitted signal is observed during its propagation along the path from the transmitter to the receiver. Often during the wave propagation in the underground environment, the cave's walls act like a waveguide and they can create an amplification of the received signal, assisting communication by reflecting the incident and rescattered signals. This can be beneficial to the establishment of low-power links in operational environment. This paper will describe the preliminary results of a waveguide-based wireless telecommunication network solution. In the former section, the waveguide electromagnetic model for an irradiated signal inside a cave will be presented. In the consecutive sections, the design of the wireless communication network and the validation results of the system through different in-situ tests in caves are discussed, together with the evolution plan and future implementation of the project.