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OVERVIEW OF THE MARS LASER COMMUNICATIONS DEMONSTRATION PROJECT

Bernard L. Edwards[1], Stephen A. Townes[2], Roy S. Bondurant[3], Don M. Boroson[3], Ben A. Parvin[2], Abhijit Biswas[2], Joseph J. Scozzafava[3], Richard J. Fitzgerald[1], Samuel H. Zingales[2], and Ramon DePaula[4]
[1]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA
[2]Jet Propulsion Laboratory, Pasadena, CA 91109, USA
[3]MIT Lincoln Laboratory, Lexington, MA 02420, USA
[4]NASA Headquarters, Washington, DC 20546, USA

E-mail address: Bernard.L.Edwards@nasa.gov

ABSTRACT

This paper provides an overview of the Mars Laser Communications Demonstration Project, a joint project between NASA's Goddard Space Flight Center (GSFC), the Jet Propulsion Laboratory, California Institute of Technology (JPL), and the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL). It reviews the strawman designs for the flight and ground segments, the critical technologies required, and the concept of operations. It reports preliminary conclusions from the Mars Lasercom Study conducted at MIT/LL and on additional work done at JPL and GSFC. The lasercom flight terminal will be flown on the Mars Telesat Orbiter (MTO) to be launched by NASA in 2009, and will demonstrate a technology which has the potential of vastly improving NASA's ability to communicate throughout the solar system.

INTRODUCTION

In the near future the National Aeronautics and Space Administration anticipates a significant increase in demand for long-haul communications services from deep space to Earth. Distances will range from 0.1 to 40 AU, with data rate requirements in the 1's to 1000's of Mbits/second. The near term demand is driven by NASA's Space Science Enterprise which wishes to deploy more capable instruments onboard spacecraft and increase the number of deep space missions. The long term demand is driven by missions with extreme communications challenges such as very high data rates from the outer planets, supporting sub-surface exploration, or supporting NASA's Human Exploration and Development of Space Enterprise beyond Earth orbit.

NASA's Goddard Space Flight Center, the Jet Propulsion Laboratory, and MIT's Lincoln Laboratory are working together to demonstrate optical communications on the 2009 Mars Telesat Orbiter. The Mars Laser Communications (Lasercom) Demonstration Project will demonstrate one possible solution in meeting NASA's future long-haul communication needs. Lasercom sends information using beams of light and optical elements, such as telescopes and optical amplifiers, rather than RF signals, amplifiers, and antennas. Near-Earth lasercom systems have been demonstrated (GeoLITE and GOLD in the U.S. and SILEX in Europe), and the technology has the potential to revolutionize deep space communications.

NASA sponsored a study at MIT/LL this past year to develop the demonstration concept and some strawman designs. The demonstration flight terminal is being designed to provide a continuous data link of between 1 and 100 Mbits/second from Mars to Earth, depending on the instantaneous distance and atmospheric conditions. The 100 Mbits/second data rate will be a significant performance increase over today's RF systems and will be largely due to the use of efficient signaling, detection architectures, and high performance error-correcting codes that operate 0.5-0.75 dB from capacity. The demonstration is planning to use ground terminals capable of receiving the encoded laser beam and transmitting an uplink beacon laser to the flight terminal, for active tracking and pointing control of the narrow laser beam. Critical technologies for receiving the deep space signal include low-cost large collection apertures and low-noise photon-counting detectors. The project is investigating using existing astronomical telescopes as well as building one high performing terminal to allow operations close to the sun.

Lasercom will enable bandwidth-hungry instruments, such as hyper-spectral imagers, synthetic aperture radar (SAR) and instruments with high definition in spectral, spatial or temporal modes to be used in deep space exploration. The Mars Laser Communications Demonstration Project will provide much needed engineering insight by the end of this decade.

CONCLUSION

The Mars Laser Communications Demonstration...

ACKNOWLEDGEMENTS

(Delete?) The authors wish to acknowledge the contributions of Roy S. Bondurant, Don M. Boroson, and Joe Scozzafava of MIT Lincoln Laboratory who contributed material and figures for this paper.

The work described in this paper was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA and through NASA sponsorship at Lincoln Laboratory, Massachusetts Institute of Technology, under contract with the Air Force.