IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Governmental Human Spaceflight Programmes (Overview) (1)

Author: Mr. ANURAG VERMA
Indian Space Research Organization (ISRO), India

Mr. RAJESH KUMAR SINGH
Indian Space Research Organization (ISRO), India
Mr. Nilesh Desai
Space Applications Centre (ISRO), India
Mr. Adarsh Jain
Space Applications Centre (ISRO), India

CREW COMMUNICATION SYSTEM FOR GAGANYAAN

Abstract

The human space flight programme (Gaganyaan) is one of the most ambitious and complex projects, being undertaken by Indian Space Research Organization (ISRO). Communication requirements for the manned mission are unique and more challenging compared to traditional unmanned space flights. The visibility of orbital module with ground control station plays a key role in providing reliable communication link. The research work presented in this paper describes the analysis done for providing coverage to orbital module using data relay satellites and ground stations along with the theoretical and analytical basis of another important challenge viz. the mitigation of communication blackout during re-entry phase of India's Gaganyaan.

Gaganyaan mission proposes to send upto 3 Indian astronauts in Low Earth orbit (LEO) at an altitude of about 400 km and returning them safely to pre-determined destination in India. Its major mission requirements are (i) Continuous visibility of orbital module from the ground stations. (ii) Two-way voice communication between the crew members and ground stations. (iii) Two-way video communication link for crew monitoring, video conferencing and monitoring of critical activities like separation events.

For this mission, visibility analysis of orbital module is carried out considering ground/ship borne stations and data relay satellites. It shows that 90 percent visibility in orbital phase can be achieved through approximately 55 ground/ship borne stations. Two data relay satellites, placed in optimized geostationary orbit slots provide more than 90 percent coverage to the orbital vehicle in orbital phase and 100 percent visibility in ascent and descent phases including dual satellites coverage.

An analysis is also presented to study communication blackout considering a typical blunt shaped re-entry mission, 2.2GHz communication link frequency and uniform plasma sheath thickness of 0.5 inches. The maximum plasma frequency is 18GHz, which results in 28 dB attenuation at 2.2GHz. The attenuation is very high and cannot be compensated by system margins. Hence, suitable technique for mitigation of communication blackout is required during re-entry phase. It is proposed to use static magnetic field method to reduce signal attenuation to negligible levels and ensure the communication link throughout the re-entry path.

Considering above aspects, following communication system architectures are proposed to provide continuous communication link support to orbital module (i) Communication link between ground station and orbital module via two data relay satellites in orbit. (ii) A direct communication link between ground station and orbital module using ground stations during visibility period of orbital module.