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Installation of the First SATCOM Link Between Maitri, Antarctica and India

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ABSTRACT

Space Applications Centre, Ahmedabad has installed and commissioned a 3m C-Band Earth Station at Maitri. The commissioning of SATCOM link between Maitri, Antarctica and mainland India sets a new landmark in ISRO's SATCOM programme. With the commissioning of the counter-part Earth Station at NCAOR, Goa; the Indian Antarctic Station, Maitri is now connected to the World Wide Web.

Keywords: Antarctica, Maitri, Earth Station, Link, Goa India.

1.0 INTRODUCTION

Space Applications Centre, Ahmedabad has installed and commissioned a 3m C-Band Earth station at Maitri, Antarctica (71deg S, 11 deg E) to provide a two way Communication Link between Maitri at Antarctica and mainland India. At the time of installation and commissioning, this Earth Station was characterized and tested using 13m antenna system at MCF, Hassan. Later on, a 7.2m C- Band Station was installed and commissioned at National Centre for Antarctic & Ocean Research (NCAOR), Goa to establish a dedicated communication link for round-the-clock operations. This link has been designed to operate at a very low elevation angle for the video conferencing, video streaming and internet browsing applications. The link operates at a data rate of around 1 Mbps between Maitri and Goa.

The selection of materials for the antenna and its foundation and the design of electronic-subsystems were carried out keeping in mind the weather of the cold and windy Antarctic conditions. The system was configured with full redundancy, considering the extreme isolation of the place, disconnected from the rest of the world. All the Earth Station materials were transported from NCAOR, Goa to Antarctica ice-shelf coast by ship. It was a real test of men and machine to shift the heavy and odd shaped antenna materials from ice-shelf to Maitri station by helicopter.

It took two helicopters, making 8-10 sorties per day, for about 10 days, to transport the Earth Station material from shift to Maitri.

2.0 NETWORK DESCRIPTION

The communication network has been planned with geostationary satellite and Earth Stations at Maitri, Antarctica and mainland India. The C-band has been chosen for the communication, because of its inherent advantages of lesser propagation loss at low elevation angles, negligible rain attenuation and availability of satellites having a wider beam width of Antarctica and main land India coverage. The network configuration has been planned with INTELSAT IS-1002 satellite, as Maitri station does not come within the beam coverage of Indian National Satellite (INSAT).

As it was difficult to transport heavy materials to Antarctica and also expensive to provide radome protection to a bigger size antenna, the communication network has been configured with Earth Station of 3m antenna at Maitri and 7.2 m antenna at NCAOR, Goa. PAMA (Pre-Assigned Multiple Access) is the access technique for these Earth Stations, as the communication link has been planned with two fixed nodes for round the clock operations.

The project was initiated with installation of Antarctic Earth Station. The communication link was tested with MCF Hassan for establishing the feasibility of the link. The Earth Station antenna look-angles at Maitri and MCF, Hassan for IS-1002 satellites are 345.5°E azimuth, 10.0° Elevation and 195° E azimuth, 3.5° Elevation.

3.0 SATELLITE PARAMETERS

The major specifications of the INTELSAT-IS 1002 located at 359 deg E longitude are as follows:

Sr. No.	Parameters	Specification
1.	Total transponders	C-band : up to 70 (in eqiv. 36 MHz units) Ku-band : up to 32 (in eqiv. 36 MHz units)
2.	Uplink frequency	5850 to 6425 MHz 13.75 to 14.50 GHz
3.	Downlink frequency	3625 to 4200 MHz 10.95 to 12.75 GHz
4.	Polarization	C-band : Circular – Right or Left Hand Ku-band : Linear – Horizontal or Vertical

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5.	EIRP (Beam edge to beam peak)	Global : 32.0 up to 36.0 dBW Hemi : 37.0 up to 44.1 dBW Zone : 37.0 up to 46.4 dBW
6.	G/T (Beam edge to beam peak)	Global : -10.7 up to -7.7 dB/K Hemi : -6.5 up to +2.4 dB/K Zone : -4.6 up to +3.0 dB/K
7.	SFD range (Beam edge)	C-band : -89.0 to -67.0 dBW /m^2 Ku-band : -87.0 to -69.0 dBW /m^2

4.0 SATCOM TERMINAL SPECIFICATIONS AT MAITRI, ANTARCTICA

The Earth Station at Maitri, Antarctica consists of a 3m antenna system, Radome, transmit and receive chains consisting of 1:1 redundant LNA/ TWTAs, Block Up/Down Converters, Modems, and Base band units. The base band part comprises of Video Conferencing Unit. Additionally, this station is also capable of providing internet connectivity and video streaming reception from NCAOR, Goa.

The specifications of the SATCOM terminal at Maitri are given below:

Sr. No.	Parameter	Specifications
1	Antenna	3m Solid Parabolic reflector with Cassegrain feed
2	Frequency of Operation	3700 - 4200 MHz Receive 5900 - 6400 MHz Transmit
3	Polarization	Circular (LHCP / RHCP)
4	Antenna gain	43 dB for Tx 40 dB for Rx
5	G/T	18.3 dB / K @ 4 GHz & 5 deg elevation angle
6	EIRP	64.5 dBW
7	Antenna mount	El / Az
8	Radiation Pattern	CCIR recommendation 580-5
9	Antenna Pointing	0.2°
10	Modulation & Data Rate	QPSK ; 640 kbps
11	IF Band	950-1750 MHz

5.0 TEST RESULTS (WITH MCF, HASSAN)

As mentioned, the project was initiated with the installation of Antarctic Earth Station. The communication link was first tested with MCF, Hassan for establishing the feasibility of the link, as the Earth Station at NCAOR, Goa was not ready by then. The test schedule was from 01 Feb to 07 Feb 2008.

Specifications of the MCF Hassan Earth Station are as follows:

Sr. No.	Parameter	Specifications
1	Antenna	13m Solid Parabolic reflector with Cassegrain feed
2	Frequency of Operation	3700 - 4200 MHz Receive 5900 - 6400 MHz Transmit
3	Polarization	Circular (LHCP / RHCP)
4	Antenna gain	53 dB for Rx 55 dB for Tx
5	G/T	32 dB / K @ 4 GHz & 5 deg elevation angle

5.1 Test Results:

Tx Frequency at Maitri: 6300.8075 MHz

Rx Frequency at Maitri: 4113.5425 MHz

Tx Frequency at MCF, Hassan: 6338.5425 MHz

Rx Frequency at MCF, Hassan: 4075.8075 MHz

A. Beacon C/N_0

Satellite: Intelsat IS - 1002 @ 359°E
Beacon Freq: 3952.5 MHz (RHCP)
C/N0: 71 dBHz

B. Loopback C/N_0 (at Maitri)

Maitri EIRP: 59 dBW
Satellite: Intelsat IS - 1002 @ 359°E
C/N0: 58 dBHz

C. Loopback C/N_0 (at MCF)

MCF EIRP: 73 dBW
Satellite: Intelsat IS - 1002 @ 359°E
C/N_0: 81 dBHz

D. C/N_0 of Communication link Carrier (Received at Maitri):

Satellite: Intelsat IS - 1002 @ 359^0E
MCF EIRP: 73 dBW
C/N0: 71 dBHz

E. C/N_0 of Communication link Carrier (Received at MCF):

Satellite: Intelsat IS - 1002 @ 359^0E
Maitri EIRP: 62 dBW
C/N0: 69 dBHz

F. BER, SNR & Audio/Video Quality

Sr. No.	Maitri EIRP (dBW)	SNR @ Maitri (dB)	BER @Maitri	Audio Quality	Video Quality
1	64.4	6.5	2.3×10^{-9}	Ok	Ok
2	63.4	5.9	5.1×10^{-7}	Ok	Ok
3	62.4	5.6	5.7×10^{-7}	Ok	Ok
4	61.4	4.5	4.1×10^{-5}	Ok	Freezing
5	60.4	4.2	4.2×10^{-5}	Ok	frozen
Data Rate : 1024 kbps Video Conferencing @ 512 kbps , Internet Browsing @ 512 kbps					

6.0 CONCLUSION

The commissioning of SATCOM link between Maitri, Antarctica and mainland India sets a new landmark in ISRO's SATCOM programme. The excellent project planning, system engineering & design and fabrication of antenna & its platform have made it possible to transport the Earth Station material from ship to Maitri by helicopter. It was a real challenge to men and machine to shift and install the antenna system and radome at the world's coldest and windiest place. It required good engineering efforts and skills to commission the SATCOM link, at such a low elevation angle, against all odds in a record time.

This SATCOM station is providing the vital round-the-year communication support to the Indian scientific community pursuing their research work at Maitri. With the commissioning of the Earth Station at NCAOR, Goa; the Indian station, Maitri has been brought within the ambit of the World Wide Web.