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The Tracking Data Acquired By the Mobile Radar System Shall Be Transferred To SHAR Using the VSAT Link

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Abstract – MOTR (Multi Object Tracking Radar) is designed to track different stages of the launch vehicle during nominal and non-nominal missions and also to provide data regarding close approach of space debris in LEO. The Mobile MOTR is located at required positions away from the launch vehicle. The Tracking data required to be transferred to remote terminal at SDSC-SHAR. Hence to provide voice and data transfer between different mobile terminals and a fixed terminal at SDSC-SHAR VSAT terminal is to be designed. In this project VSAT terminal is being designed in a cost effective, efficient way and the overall link and system performance is being analyzed.

Index Terms – VSAT Terminal, Configuration, MOTR, Specifications.

1. INTRODUCTION

A very small aperture terminal (VSAT) is a two-way satellite ground station or a stabilized maritime VSAT antenna with a dish antenna that is smaller than 3 meters. The majority of VSAT antennas range from 75 cm to 1.2 m. Data rates range from 4 k bit/s up to 4 M bit/s; some upgraded modules can even reach a max downlink of up to 16 M bit/s. VSATs access satellites in geosynchronous orbit to relay data from small remote earth stations (terminals) to other terminals (in mesh topology) or master earth station "hubs" (in star topology).

VSATs are used to transmit narrowband data (e.g., point-of-sale transactions using credit cards, polling or RFID data, or SCADA), or broadband data (for the provision of satellite Internet access to remote locations, VoIP or video). VSATs are also used for transportable, on-the-move (utilising phased array antennas) or mobile maritime communications.

The Satish Dhawan Space Centre is the launch centre for the Indian Space Research Organization (ISRO). It is located in Shrihari kota, Andhra Pradesh, 80 km north of Chennai. Originally called Shrihari kota High Altitude Range (SHAR, an acronym ISRO have retained to the present day) and then Shrihari kota Launching Range, the centre was renamed in 2002 after the death of ISRO's former chairman Satish Dhawan. SDSC SHAR, with two launch pads is the main launch Centre of ISRO.

SDSC SHAR has the necessary infrastructure for launching satellite into low earth orbit, polar orbit and geostationary transfer orbit. The launch complexes provide complete support for vehicle assembly, fuelling, checkout and launch operations. Apart from these; it has facilities for launching sounding rockets meant for studying the earth's atmosphere.

2. SCOPE

Design, Fabrication, Supply, Integration, Testing and Commissioning of Ku band
VSAT system on turnkey basis as per the specifications.
The VSAT system consists of:

1) 2.4m Ku mobile antenna with all electronics
2) 4.8m Ku fixed terminal with all electronics at Sriharikota.

3. PURPOSE

The 2.4m Ku mobile terminal is collocated on the MOTR mobile system and intended to transfer the tracking data parameters to the fixed terminal at Sriharikota. The required band width for the operation is suitably provided through a GSAT transponder.

3.1. VSAT System Overview

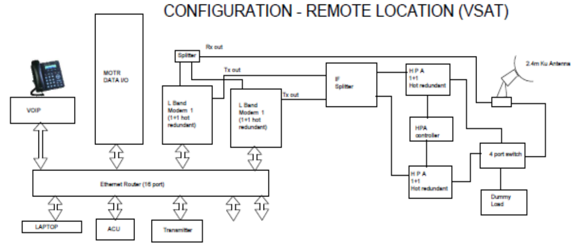


Figure1: Functional block schematics of VSAT

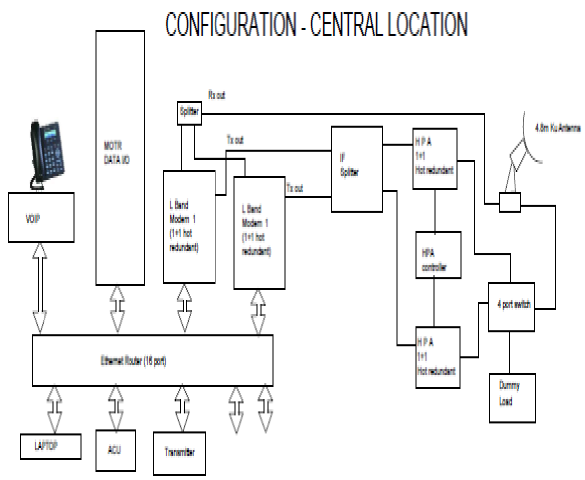


Figure2: Functional block schematic of fixed terminal

3.2. VSAT subsystems

3.2.1. RF transceiver

RF Transceiver is basically a frequency converter. It consists of two parts frequency up converter and frequency down converter. Up converter converts modulator frequency usually in either 70/140 MHz to satellite frequency bands (C,Ku,Ka) as per satellite in use for particular location/application. Down converter does reverse of the up converter. In addition to frequency conversion both provide gain to the signal as per VSAT link budget and the same need to be adjusted as per need of the link using attenuation settings available in RF transceiver in both up/down link.

3.2.2. RF power amplifier

RF Power amplifier is the unit which provide power amplification without any frequency change before signal is transmitted to the antenna and consecutively to the air.

3.2.3. RF LNA

RF LNA is the low noise amplifier used in VSAT. As the signal is received by antenna is composed of noise as well as useful information signal part. In addition it is very low in the power level. LNA's job is to boost this low level of signal to the sufficient level considering less amplification of noise part, so that adequate C/N is maintained.

3.2.4. Satellite Modem

Satellite modem provides two major functionalities in the VSAT. The first one is it makes link reliable by adding forward error correction functionality using various techniques such as convolution coding/turbo coding and so on. The second one is that it does task of modulation and demodulation. There are various modulation techniques used in modem, the most popular among them are QPSK/8PSK.

3.2.5. Antenna

Antenna is basically an electro-magnetic frequency transducer. It sends and receives EM waves of various frequency bands. Antenna diameter and aperture vary band to band. Hence C band antenna design is different than Ku band. The signal to be transmitted will be provided to antenna by Power Amplifier.

3.3. VSAT Outdoor Unit

The Outdoor unit is usually mounted near the antenna systems outside hence the name. It consists of RF frequency converters (Up/Down converter), Power Amplifier, Low Noise Amplifier (LNA), OMT and Antenna system.

The Up/Down converters convert frequencies IF to RF frequencies and vice versa. For example, Up converter converts 70MHz to 6175 MHz and Down converter converts 3950MHz to 70MHz for C band application. Power Amplifier will amplify the signal before transmitting to the feed horn of the Antenna system. LNAs are designed to amplify the noise added received signal received from the satellite. It is designed such that it will amplify the signal and not the noise. Noise temperature defines LNA performance.

Antenna system houses reflector, feed horn, mount and cables. VSAT antenna usually varies from 1.8 meters to 2.4 or 3.8 meters. Feed horn is mounted at focal point of the antenna. The feed horn guides transmitted power towards the antenna dish and will go to the medium consecutively. It also collects the received power from dish and will enter into the LNA. Feed horn is made of array of microwave passive components. The outdoor unit is connected through coaxial cable to the indoor unit, which is situated inside the room/building. Length of the cable is usually about 300 foot (approx. 90 meter).

3.4. VSAT Indoor Unit

The IDU consists of MUX/DEMUX, EDU (Encryption Decryption Unit), modem (modulator-demodulator).MUX will interface with end user equipment viz. telephone, computers and sometime with EPABX and LAN or router, if it has to carry more information. MUX will multiplex all the channels connected with it using TDM. On receiver side DEMUX is used to de-multiplex the channels and passed on to respective end user equipment. EDU is basically the Encryption-Decryption unit which provides security by modifying the information to be transmitted. On receiver side encryption technique will be conveyed so that the information can be retrieved back again. MODEM is basically performs modulator-demodulator functionality on transmit and receive side respectively. Modulator inserts information on intermediate frequency (IF), usually called carrier. This is done based on modulation scheme set. Usually

QPSK scheme is used in satellite communication and Forward Error Correction is also employed in modem which enhances the BER for the same transmitter power usually used in non-FEC systems. In order to communicate between VSAT 1 and VSAT 2, modulator frequency of VSAT 1 and demodulator frequency of VSAT 2 need to be same and vice versa to complete full duplex communication channel. Based on frequency assignments as per FDMA various modem and RF frequency converters are set.

3.5. VSAT Network Architecture

VSAT network architecture is the way Hub station and/or VSATs are interfaced with satellite to provide the service. There are five main topologies exist, viz. broadcast, point to point, point to multipoint (star), mesh, hybrid. Let us understand each of this VSAT topology. In Broadcast type, there is a single broadcasting station interfaced with satellite and satellite will relay signals to all the VSATs. Here broadcasting station-satellite-all VSATs link exist. In point to point type of topology, two VSATs communicate via satellite using dedicated assigned channel. So here VSAT1-Satellite-VSAT2 dedicated link exist. In Star topology, there are three entities hub station (usually with larger antenna), VSATs and Satellite. All the communications between VSATs happen through Hub station. Hence here if VSAT1 and VSAT2 need to communicate then, link is VSAT1-satellite-Hub-Satellite-VSAT2.

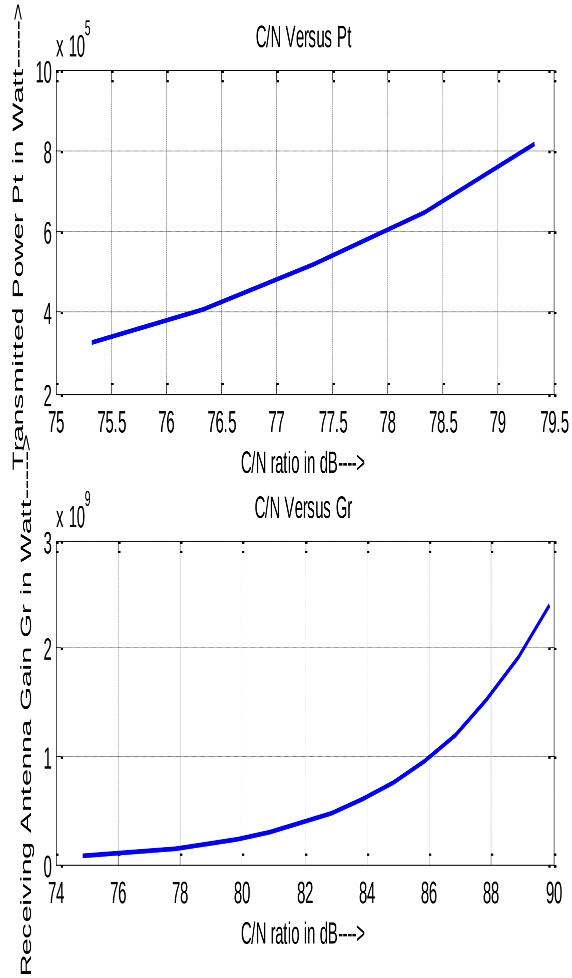
Hence two hop communication is needed to communicate between any two VSATs in the network. In Mesh type of topology, VSATs can communicate with one another directly and no Hub station is needed. But each VSAT need to be complex owing to more functionalities required similar to the Hub station. Also antenna specifications need to be different than star type of topology. In Hybrid type is the combination of both star and mesh type. Here few of the VSATs communicate via Hub and few can communicate directly with one another.

3.5.1. Specifications

Sr. No	**Parameter**	**Modulator Specifications**
1	Type of Modulation	BPSK/QPSK/OQPSK/8-PSK/8QAM
2	Data Rate	1.2 kbps to 5 Mbps, 1bps step size
3	IF Tuning Range	950MHz to 2150 MHz in 1 Hz step size.
4	Error Correction Scheme (FEC)	Viterbi 1/2, 3/4, 7/8 (k=7), and Reed Solomon Selectable N & K LDPC-16K: ½, 2/3, ¾, 14/17, 7/8, 10/11,16/17
5	Tx Output Power	+5 to -35 dBm
6	Output power stability	±0.5 dB over Frequency & Temperture.
7	Transmit ON/OFF ratio	>55 Db
8	Output Spectrum/ Filtering	Roll off factors of 10% ,20%, 25%, 35% (selectable)
9	Spurious	-55 dBc in band
10	Phase Noise	-90 dBc/Hz at 100 Hz -100 dBc/Hz at 1 KHz
11	Data Interface: a)Serial synchronous: b)Ethernet IP Interface:	(EIA-530/RS422/V.35/RS-232) 10/100 Base T, Gigabit Ethernet (4 port bridge interface)
12	Data clock source	Internal /External, Rx recovered.
13	Output impedance and connector	50 Ohms. Ntype Fem
14	BUC Power	24VDC 120W 48V DC 150W 48W DC 200W
	Parameter	**Demodulator Specifications**
15	Demodulation	BPSK/QPSK/OQPSK/8-PSK/8QAM

16	IF Frequency Range	950MHz to 2150 MHz in 1 Hz step size.
17	Input power Range	10log (Symbol rate) -125 min (in dBm) 10log (Symbol rate) -80 max (in dBm)
18	Total Input Power	+10 dBm
19	Acquisition Range	Programmable ±100Hz to ±1.25 MHz
20	Acquisition Time	Better than 100 ms at data rate 64 Kbps QPSK Better than 50 ms at data rate 1 Mbps QPSK
21	BER Performance	Rate ½, BPSK/QPSK $1x10^{-8}$ BER to be met at : EbNo Viterbi: 6.0dB; Vit+RS : 3.2 dB LDPC-16K: 1.7dB
22	FEC Decoder	Viterbi 1/2, 3/4, 7/8 (k=7), and Reed Solomon Selectable N & K LDPC-16K: ½, 2/3, ¾, 14/17, 7/8, 10/11,16/17
23	Temperature	Operating : 0 to 50ºC Storage : -20 to 70ºC
24	Power Supply	100-240V AC 1.2 A Max.
25	Dimensions (WXDXH) And weight	19" (W) x 11" (D) x 1.75" (H) 1RU. Weight <7 lbs
26	LNB Voltage	Selectable: Off, 13 or 18 VDC
27	BUC/LNB Reference	10MHz via Tx center conductor, at -3dBm.

4. RESULTS



5. CONLUSION

The purpose of this project was to design the overall link and system performance of the VSAT. In this work, the introduction, configuration, system overview, subsystems and network architecture of VSAT are explained. In order to provide voice and data transfer between mobile terminals and fixed terminal, RF link is verified. The tracking data acquired by the mobile radar system shall be transferred to SHAR using the VSAT link. The project is being implemented in MOTR, SDSC-SHAR.

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