

VSAT

As we know, VSAT (**V**ery **S**mall **A**perture **T**erminal) refers to receiving and transmitting terminals installed at distant sites connected to a central hub via satellite using small diameter antenna dishes. It is an earth station connected to the geo-synchronous satellite suitable for supporting a variety of two-way telecommunication and information services like voice, data and video.

Essentially there exist two kinds of VSAT networks. These technologies make use of mesh or star configurations but could use the best features of both and implement a hybrid network topology to suit their requirements.

Mesh Configuration:

The VSATs communicate directly with each other without involving any central hub. This usually finds use in Single Channel Per Carrier (SCPC), Demand Assigned Multiple Access (DAMA), satellite access technology.

Few other characteristics of mesh configuration are lower propagation delays (250 ms), lower investment in the central hub but high cost of the VSAT terminals and large size of the antenna, it is ideally suited for data traffic.

The DAMA terminals are more expensive than the TDM/TDMA types, as the electronics associated with its hub are partly included into the individual terminal for direct transmission and reception from the satellite without the actual involvement of the hub.

Star Configuration:

It makes use of the central hub earth station, which provides both point-to-point and Point-to-multipoint communication with the VSAT stations. This configuration requires a high investment on the central hub, small VSAT antenna size and lower cost of VSAT. This Setup is mostly used by TDM/TDMA technologies and ideally suits interactive data applications. The actual communication between remote sites is through hub and happens in two steps because, of which

there is a time delay of approximately 0.5 seconds and makes the technology highly synchronized. However, the actual practice is to use a Hybrid network topology to cater the various requirements, i.e. a part of the network operates in Mesh and the other in Star topology.

The 3 basic components, which make a VSAT terminal, are:

Antenna:

VSATs generally use *offset feed prime focus* antennas, these are generally 0.9 to 2.4 meter in aperture size with two port, linear polarization Tx/Rx feed.

Out Door Unit:

It is built in with the RF electronics and is mounted on the antenna itself. At the main focus of the antenna, a small feed-horn is placed to receive signals and to direct transmit signals. The

feed-horn diverts these receive/transmit signals to a frequency converter. The frequency converter contains Up-Converter and Solid State Power Amplifier for the conversion of Intermediate Frequency to Radio Frequency and its amplification in the transmit path. For the receiving path, it holds Low Noise Block and Low Noise Amplifier for blocking interference and amplifying the weak receive signals and a Down-Converter for conversion of RF to IF.

In Door Unit:

This holds the modulators and demodulators (modems). Modulators convert information being transmitted into an IF signal, suitable for frequency up-conversion and transmission. Demodulators receive IF signals and convert them back into the information format suitable for the users. The number of modems required depends upon the configuration of the terminals. In star configuration, because the terminals communicate through the hub, only one modem is required; but, in the mesh configuration, as the terminals communicate directly, the number of modems depend upon the number of carriers. If the

number of modems is more than one, a Combiner and splitter are required in addition to the normal hardware. The indoor unit communicates with the end user equipment like standalone PCs, LANs, Telephones or an EPABX. The **ODU** is connected through a low loss coaxial cable to the **IDU**. The typical limit of this **Inter Facility Link** cable is about 300 feet.

Hub is the heart of an entire VSAT network, Within the hub is a *Network Management System*, which controls the entire network. The three main elements, which make the hub, are

- ⌘ *Radio Frequency Terminal (RFT),*
- ⌘ *Base Band Unit, and*
- ⌘ *The User Interface Unit.*

The antenna of the hub is large sized, usually 4 to 11 -meters in aperture. Generally the VSAT service provider can install and operate the hub earth station to cater about 200 plus terminals.

The hub takes care of necessary switching which includes allocation of the channels available, decisions on bandwidth required, data rate from the possible range, coding, Informing VSATs- by

receiving and transmitting the given frequencies, configuring, monitoring, troubleshooting etc.

The three basic methods of two-way VSAT communications:

1. **TDMA** (time-division multiple access),
2. **DAMA** (demand-assigned multiple access)
3. **SCPC** (single channel per carrier).

1. TDMA

In a TDMA network all VSATs share satellite resources on a time slot basis. Remote VSATs use TDMA channels or in-routes associated with one out-route. Several VSATs share one in-route and thereby sharing the bandwidth. Typical in-routes operate at 64 or 128 Kbps.

Generally systems with star topology use a TDM/TDMA transmission technique. To all TDMA patterns the function of clock synchronization is important, which is performed by the TDMA hub or Master Earth Station.

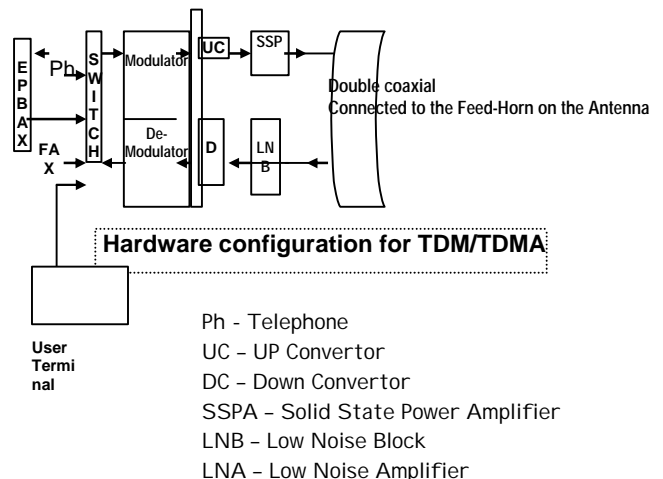
⌘ Fixed Assigned TDMA:

The VSATs may access the in-route on a fixed assigned TDMA mode, where each VSAT is given a specific time slot or slots.

⌘ Slotted ALOHA:

In this case each VSAT can access any slot at any time with the remote sites randomly transmitting messages on the inbound transmission path. Most of the time this allows messages instant access to the in-route data stream making it to be the fastest method of transmitting messages to the hub. But, when two or more sites transmit packets simultaneously a collision occurs and the hub station will not receive any of the affected packets. When a collision occurs, remote sites undergo a random transmission delay and retransmit the packet in another time slot before the transaction is complete. TDMA networks are ideally suited for medium to large networks with medium data rates.

The mode of the VSAT can be switched between a slotted Aloha mode to a Fixed Assigned Mode and the technique is *Dynamic Reservation*, depending on the traffic, this switching is done dynamically and allows maximum usage of satellite resources.



The VSAT network used by *HCL Insys* falls under the TDMA category.

Frequency Division Multiple Access:

In this case all the VSATs share the satellite resource on the frequency area only, typically implemented in a mesh or a single satellite hop topology. There are a few varieties of this technology, SCPC or PAMA and DAMA.

2. SCPC (PAMA)

The term SCPC is often used interchangeably with **PAMA** (Pre Assigned Multiple Access).

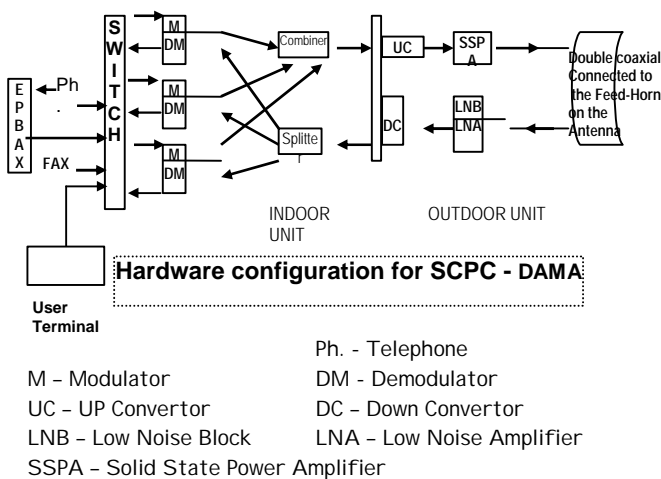
The VSATs are pre-allocated a designated frequency; similar to the terrestrial leased line solutions. In an organization PAMA connects high data traffic, these solutions use the satellite resources constantly for which has no corresponding call up delay which could make them most suitable for interactive data applications or high volumes of traffic. SCPC means the usage of a single satellite carrier for carrying a single channel of user traffic. The frequency is allocated on a pre-assigned basis in case of SCPC VSATs.

SCPC type of VSAT is implemented at *Inter Connect Stock Exchange*.

3. DAMA

In this case, from a pool of satellite channels a pair of available channels are selected, which are kept available for use by any station in that network to establish a call. Once the call is completed the channels are released. Due to this method the DAMA technology is suitable for voice traffic and data traffic in batch mode, this

supports point to point voice, fax, and also video conferencing. *IDBI (Industrial Development Bank of India)* has implemented the DAMA category of VSAT.



CDMA (Code Division Multiple Access):

Trough a centralized network monitoring system multiple VSATs are allowed to transmit at the same time and share a common frequency band by assigning a unique code to each of the VSAT. The

data signal is combined with a high bit rate code signal; this bit rate code is independent of data. Mixing the incoming composite data/code signal with a locally generated and correctly synchronized replica of the code makes reception at the end of the link. Star topology is the default setup, because this network requires that the central NMS co-ordinates code management and clock synchronization of all remote VSATs. There are some practical restrictions in the use of spread spectrum. It is mainly employed for avoiding interference or for security reasons in military systems.

Choosing the Right solution

Parameters	TDMA VSATs	PAMA VSATs	DAMA VSATs
Number of sites	Small to large	Less than 10	Less than 10
Interactive application	Bursty	High Traffic	Call set-up delay
Batch Traffic	Less than 5 Mb	Large	Large
Voice	Supported	Supported	Ideally suited
Data Broadcast	Ideally suited	Not supported	Can be supported
Video conferencing	Not supported	Can be supported	Can be supported

Space Segment

Having talked about the SMALL ONE on the earth, let us look into the BIG ONE over our head.

The space segment of the VSAT communication is available in the satellite, for example the space segment for the Indian Service Providers is the *INSAT 2B* satellite, located at 93.5 degree east.

Transponders:

In the satellite body there are a number of transponders, or repeaters whose functions are:

- ? **Signal Reception:** It receives the signal uplinked by a VSAT and/or hub.
- ? **Frequency Translation:** The frequency of the received signal is translated to a different frequency known as the downlink frequency, this ensures that there is no positive feedback and also avoid interference related issues.
- ? **Amplification:** The transponder also amplifies the downlink signal. The capacity of the

transponders is determined by the capacity of the satellite. The INSAT series of satellites have typically 12/18 transponders in various frequency bands; the bandwidth of each transponder is typically 40Mhz. The Ku-Band is Internationally popular frequency band. This Ku-Band because of its higher frequency can support traffic with smaller antenna sizes in comparison to C/Ext - C band. However it can be affected by rain which makes it unsuitable for use in Southern regions. Presently, Indian service providers hire a space segment only on the INSAT series and operate in Ext - C band only.

Frequency Bands

Freq. Band	Up-Link (GHz) Earth Station to Satellite	Down-Link(GHz) Satellite to Earth Station
C-Band	5.925 to 6.425	3.700 to 4.200
Ext - C Band	6.725 to 7.025	4.500 to 4.800
Ku-Band	14.000 to 14.500	10.950 to 11.700

Indian regulations have recently been made easy and the use of Ku - band VSATs is also allowed. But only after, the DoT (Department of Telecommunications) works out the costing for Ku - band VSATs might turn out to be more than that for Ext C -band currently in use. Ext - C band is available only on the INSAT series of satellites and is not a standard band available internationally.

Link Budgets:

These make sure that the Radio Frequency equipment would justify the requirements of the network topology and satellite modems in use. Equivalent Isotropically Radiated Power is the power transmitted from a transmitting object. The Link Budget estimates the ground station and satellite EIRP required. Satellite EIRP can be defined as the sum of output power from the satellite's amplifier, satellite antenna gain and losses. Apart from the known losses due to various cables and interconnecting devices, it is customary to keep sufficient link margin for various extra noises, which may effect the

performance. It is also important to be safe from signal attenuation due to rain/snow. A satellite provides two resources bandwidth and amplification power; mostly the limiting resource is power rather than bandwidth.

Implementing VSAT - The Pros and Cons

- ✍ Provides an integrated solution for Voice, data and video communication.
- ✍ Better Reach- Installable in difficult terrain, remote areas.
- ✍ Reliability - uptime of upto 99.5 % is achievable in VSAT network compared to leased line (in Indian conditions).
- ✍ Maintenance - A single point contact with the service provider - lesser elements involved and hence easy fault finding.
- ✍ Flexibility
Bandwidth can be increased gradually - from as little as 2.4Kbps to as much as 2Mbps.
Add-on cards facilitate LAN connectivity, Voice connection etc.
- ✍ Better Network Management.

Very high Initial Cost of Implementation.
High Propagation delay.

Frequently Used VSAT related terms

- ACU - Antenna Control Unit
- CA/TDMA - Combined Access / Time division Multiple Access
- C/TDMA - Contention/ TDMA
- C-Band - A portion of electromagnetic spectrum in 4 - 6 GHz range used for Satellite communication.
- DC/TDMA - Demand Controlled / TDMA
- IF - Intermediate Frequency
- INSAT - Indian domestic Satellite System
- INTELSAT - International Telecommunications Satellite Organisation
- ISDN - Integrated Services Digital Network
- PA/TDMA - Permanent Assigned / TDMA
- PSDN - Public Switched Data Network
- PSTN - Public Switched Telephone Network
- RFI - Radio Frequency Interference
- RFT - Radio Frequency Transceiver

