VSAT Network Overview

Khalid Abdalrazig Ibrahim Hassan[1] Dr. Amin Babiker A/Nabi Mustafa[2]

Department of Communications, Faculty of Engineering, Al-Neelain University Khartoum, Sudan
Department of Communications, Faculty of Engineering, Al-Neelain University Dean of
Faculty Khartoum, Sudan

Abstract: *VSAT technology is a telecommunication system based on wireless satellite technology . the term vsat stands for "small aperture terminal". As the definition itself dictates , vsat technology of small satellite earth station , this paper shows vsat network technology .*
***Keywords:*** *vsat ,outdoor unit, indoor unit ,hub ,security, earth station.*

I. Introduction

VSAT (Very Small Aperture Terminal) describes a small terminal that can be used for two-way communications via satellite. VSAT networks offer value-added satellite-based services capable of supporting the Internet, data, video, LAN, voice/fax communications, and can provide powerful private and public network communication solutions. They are becoming increasingly popular, as VSATs are a single, flexible communications platform that can be installed quickly and cost efficiently to provide telecoms solutions for consumers, governments and corporations.

The benefits of VSAT technology are being realized in many sectors, both private and public. From banks to administrations, schools, hospitals and rural telecommunications, VSATs are being seized upon to elevate economic, educational, and health standards.

VSATs have been in use for more than 20 years and, with already millions installed all over the world, VSATs are a mature and proven technology. [7]

VSAT comprises of two modules viz. an outdoor unit and an indoor unit. Outdoor unit mainly houses Antenna, feed horn,RF Transceiver,LNA,Power amplifier. The antenna size is typically 1.8 or 2.4 meter in diameter, although smaller antennas are also in use. The indoor unit functions as mux-demux, modem and interfaces with the end user equipments like PCs, LANs, Telephones or an EPABX. Following diagram describes typical schematic consisting various VSAT subsystems. [1]
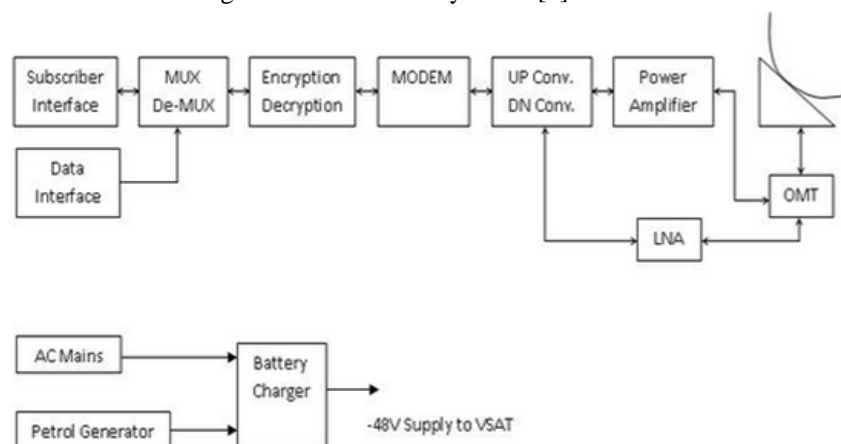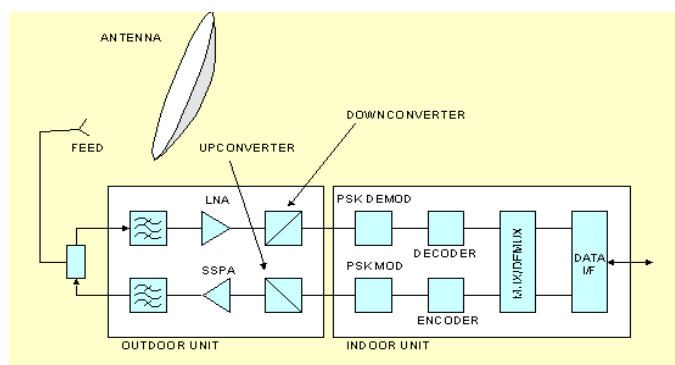

1.1Vsat outdoor unit

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).

1.2 vsat indoor unit

The IDU consists of MUX/DEMUX, EDU (Encryption Decryption Unit), modem (modulator-demodulator). MUX will interface with end user equipments 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 equipments. 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.[4]

Figure (1): components of outdoor and indoor units.

II.   VSAT Features

VSAT networks uses very small dish antennas therefore, in order to employ the 6/4 –GHz frequency band it has to utilize the spread spectrum also called CDMA code division multiple access) technique to reduce the signal power spectral density. This is due to the interference produced for using the same band as terrestrial microwave transmission does. Alternatively the 14/12 GHz frequency band may be utilized (if available) which provide satellite capacity with much more efficiency although as we know, with the rain as old enemy. Star VSAT network at 2-Mbps are now available using Single Channel Per Carrier (SCPC) access which is provided by most of the vendors however, occasionally , TDMA (Time division multiple access) technique is also used. VSAT are connected by radio frequency link via satellite. Those links are radio frequency link with a so-called uplink from the station to the satellite and so-called downlink from station to station, sometime called hop consists of an uplink and downlink.

2.1 Uplink

A radio frequency link is modulated carrier conveying information. Basically the satellite receives the uplink carriers from the transmitting earth station within the field of view of its receiving antenna.

2.2 Downlink

Within the field of view Transponder amplifies those carriers, translates their frequency to a lower band in order to avoid possible output/input interference, and transmits the amplified carrier to the station located of its transmitting antenna. [1]

2.3 Vsat frequency band

VSATs operate in the Ku band and C band frequencies. As a rule of thumb C- band (which suffers less from rain attenuation but requires larger antennas) is used in Asia, Africa and Latin America. Ku-band (which can use smaller antennas but suffers from rain fade in monsoon like downpour) is used in Europe and North

America. Interactive antenna sizes range from 75 centimetres to 1.8 meters for Ku-band and C-band from 1.8 meters to 2.4 meters. One way systems can use antennas as small as 45 centimetres. [3]

2.4 Vsat traransmission band
VSATs are most commonly used to transmit:
- narrowband data (a channel in which the bandwidth of the message does not significantly exceed the channel's coherence bandwidth), typical applications are the transmission of payment transaction from point of sales, or transmission of data from/to SCADA systems.
- broadband data (a channel with wide bandwidth characteristics of a transmission medium and the ability to transport multiple signals and traffic types simultaneously), typical applications are the provision of satellite Internet access to remote locations, VoIP or video data transmissions.[6]

III. VSAT Network

A VSAT network consists of three components:
- A central hub
- A satellite
- A virtually unlimited number of VSAT user terminals.

How vsat network work :
     The user's devie is connected to the satellite dish . This transmitter mounted on the satellite dish sends and receives digital signals to a satellite at the same time. When a client requests data from the Internet, the client's VSAT dish transmits a signal to the satellite, which in turn retransmits the signal to a central hub earth station, which in turn is connected, to the Internet. Data from the Internet to the VSAT dish follows the reverse path. The hub or earth station manages, controls and monitors the network.VSAT is capable of providing Broadband services.

     The satellite is located in a fixed-point 36,000kms above the surface of the earth. This position is known as the geostationary orbit. Satellites located at this height orbit the earth at the same speed as the earth rotates on its own axis. This allows the VSAT earth station equipment to be positioned at the satellite and avoids the need for the VSAT earth satellite dish to be repositioned once the initial installation has been completed.

     The VSAT earth stations are usually made up of an outside mounted satellite dish(approximately 1m in diameter) and a coaxial wire connection to specially installed electronic boards mounted inside the master computer. These boards allow signals to be transmitted and received from the satellite dish. Transmissions between the earth station and the satellite station generally operate in the 12 and 14 Ghz frequency bands. Because of the high frequencies used high levels of rainfall can attenuate the signals. The design of the installation is generally engineered to allow for the reductions in the radio signal paths during periods of intense rainfall. The design of the satellite link is generally to guarantee communications for 99.999% time, which is equivalent to a loss of signal for about 4 minutes per year. During this trial no outages were recorded as a result of rainfall. The central satellite hub station allows communications to and from the satellite to connect to the Internet. The central hub station can be located anywhere within the satellite footprint area. For some of the larger satellite operators a number of central hub stations are operated at different locations to ensure alternative telecommunications paths in the event of a failure ofone of the hubs.[2]


Figure (2): VSAT dish .

3.1 Vsat network Architectures
Any telecommunication services there are three basic implementations services: one-way, split-two-way (referred to as split-IP sometimes, when referring to internet traffic) and two-way implementation. Further division of two-way implementation are star and mesh network architectures.
 There are two Architectures;

▪ Star: In Star network architecture, all traffic is routed via the main hub station. If a VSAT want to communicate with another VSAT, they have to go through the hub station. This makes double hop link via the satellite.[4]

　　Star is The most common VSAT configuration os the TDM/TDMA. These have a high bit rate outbound carrier (Time Division Multiplexed) from the hub to the remote earth stations, and one or more low or medium bit rate (Time Division Multiple Access) inbound carriers. In a typical VSAT network, remote users have a number of personal computers or dumb terminals that are connected to the VSAT terminal that in turn is connected to a centralised host computer either at individual sites or at a data processing centre. Data sent to the VSAT terminal from the data terminal equipment (DTEs) is buffered and transmitted to the hub in packets.[5]
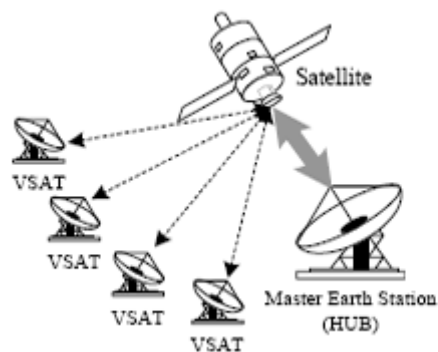
Figure(3): star vesat tepology..[6]

▪ Mesh: Meshed VSAT networks provide a way to set up a switched point to point data network that can have the capability for high data rates of up to 2Mb/s. Links are set up directly between remote terminals usually on a call by call basis. These networks are usually configured to operate without a large central earth station and carry a mix of data traffic and telephony traffic or only data traffic. These networks generally will have a network control station, which controls the allocation of resources across the network. This control centre is only involved in the signalling for the call setup/teardown and in monitoring the operation of the network.[5]
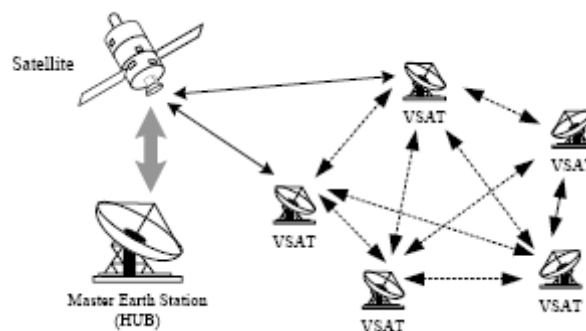
Figure (4) : mesh vsat topology.[6]

There are three factors that's shows wich architectures sutable than others one:
■ The structure of information flow within the network.
■ The requested link quality and capacity.
■ The transmission delay.

Structure of Information Flow
　　VSAT network can support different type of application and each has an optimum network configuration.

Broadcasting: A central site distributes information to many remote sites with no back flow of information. Hence a start shaped one-way network supports the service at the lowest cost.

Corporate Network: Most often companies have a centralized structure with administration and management performed at a central site, and manufacturing or sales performed at site scattered over a geographical area information from the remote sites needs to be gathered at the central site has to be distributed to the remote ones, such as task sharing. Such an information flow can be partially supported by a start one-way VSAT Network.

Interactivity Between Distributed Sites: Other companies or organization with decentralised structure are more likely to compromise many interacting one with a meshed VSAT network using direct single hop connections from VSAT to VSAT is hence mostly desirable.

Link Quality and Capacity

The link considered here is the link from the transmitting to the receiving one. Such a link may comprise several parts. For instance a single hop link would comprise an uplink and downlink; a double hop link would comprise two single hop links, one being inbound and outbound. Fig 1.3 indicates the general trend which relates EIRP to G/T in a VSAR network, considering a given baseband signal quality in term of constant BER. EIRP designates the equivalent isotropic radiated power of the transmitting equipment and G/T is the figure of merit of the receiving equipment.

Transmission Delay

With a single hop link from VSAT in a humbles network, the propagation delay is about 0.25s. With a double hop from VSAT to VSAT via the hub, the propagation delay is twice as much, i.e. about 0.5s.
Double hop may be a problem for voice communication. However, it is not a severe problem for video or data transmission. Table 1.2 summarizes the above discussion given the EIRP and G/T values for a VSAT, the designer can decide for both a large delay from VSAT to VSAT and a large capacity or a small delay and a lower capacity, by implementing either a start network, or mesh one.

Table1:Characteristics of star and mesh network configuration.[1]

	star-shaped (double hop)	meshed (single hop)
Capacity (given VSAT EIRP and G/T)	large	small
Delay (from VSAT to VSAT)	0.5 s	0.25 s

3.2 Flexibility of vsat network

One of the main advantages of VSAT networks is that network expansion, addition of new terminals and provision of new services can be accommodated without reconfiguring or impacting the operation of the rest of the network.

However, the performance of the network and hence the quality of the service delivered to the user are sensitive to the amount of traffic, which increases as more and more terminals of VSATs are added to the network. It is therefore important to allow spare capacity in the space segment and the hub, typically 20% more traffic and 20% more VSATs than initially expected. Growth beyond initial capacity must be orderly and modular. Considering that frequent acquisitions and corporate restructuring are part of today's business world, it is important that the customer not be constrained on its potential growth in telecommunication needs.

3.3 Vsat network application and types of traffic
3.3.1 Civilian VSAT networks
Types of service

VSAT networks deal with interactive data traffic, where the user terminals are most often personal computers. The most notable exceptions are voice communications and satellite news gathering. Voice communications on a VSAT network means telephony with possibly longer delays than those incurred on terrestrial lines, as a result of the long satellite path. Telephony services imply full connectivity, and delays are typically 0.25 s or 0.50 s depending on the selected network configuration, as mentioned above.

Satellite news gathering (SNG) can be viewed as a temporary network using transportable VSATs, sometimes called 'fly-away' stations, which are transported by car or aircraft and set up at a location where news reporters can transmit video signals to a hub

Types of traffic

Depending on the service, the traffic flow between the hub and theVSATs may have different characteristics and requirements.

Data transfer or broadcasting ,which belongs to the category of oneway services, typically displays file transfers of one to one hundred megabytes of data. This kind of service is not delay sensitive, but requires a high integrity of the data which are transferred. Examples of applications are computer download and distribution of data to remote sites.

Interactive data, is a two-way service corresponding to several transactions per minute and per terminal of single packets 50 to 250 bytes long on both inbound and outbound links. The required response time is typically a few seconds. Examples of applications are bank transactions and electronic funds transfer at point of sale.

Inquiry/responsais a two-way service corresponding to several transactions per minute and terminal. Inbound packets (typically 30–100 bytes) are shorter than outbound packets (typically 500–2000 bytes). The required response time is typically a few seconds.
Examples of applications are airline or hotel reservations and database enquiries.

Supervisory control and data acquisition (SCADA) is a two-way service corresponding to one transaction per second or minute per terminal. Inbound packets (typically 100 bytes) are longer than outbound packets (typically 10 bytes). The required response time ranges from a few seconds to a few minutes. What is most important is the high data security level and the low power consumption of the terminal. Examples of applications are control and monitoring of pipelines, offshore platforms, electric utilities and water resources.

3.3.2 Military VSAT Network

Military forces in the world have adopted VSAT networks indeed the inherent flexibility in the deployment of VSAT s makes them a valuable means to install temporary communication link between small units in the battlefield and headquarters located near the hub. More over the topology of a star shaped network fits well into the natural information flow between field units and command base. Frequency bands are at X-band, with uplinks in the 7.9-8.4 GHz band and downlinks in the 7.25-7.75 GHz bands.[3]

3.4 Vsat network security

VSAT network terminal Susceptible for many haching types that is may Adversely affect or stop work of the network.

Most common hacking:

- Firstly, what we typically see in the field is automated port scans. Where individuals or programs operating in the internet will scan the ports of all IP addresses in certain IP ranges, including VSAT terminals, and depending on the ports, try to log in. With this we see a massive flood of TCP connections and IP ping messages to terminals and any device behind those terminals. Generally, when logging in does not succeed they hop to the next IP address. They just scan the entire internet and when they are not successful, they just move on.

- Secondly, VSAT terminals typically offer more services than pure IP routing, like some HTTP webservers or file sharing services. The next step in hacking a terminal is trying to exploit the vulnerabilities of these services on the terminal. This is typically done by exploiting buffer overruns in the software implementation of these services. When successful, the hacker is typically able to force the device to run any type of malicious software.

- Thirdly, hackers may opt to use low-end routers or terminals as a distributer for viruses. Since these devices are always powered on and people don't distrust their own devices, infected devices can cause a rapid spread of viruses in the local network.

- Fourthly, in case there is a network behind your terminal which is publicly accessible (e.g. a library). Someone can try to hack the VSAT terminal from within this public network with any of the above methods, often just to display their hacking skills.

Once access is gained to the terminal, it can be used for snooping any passing internet traffic, for example stealing credit card data or passwords. Normally no information itself is stored on the VSAT terminal, but it can be intercepted on the terminal.

3.4.1Securing visat terminal

It is possible to protect VSAT terminals by not allowing them direct connectivity to the internet. You can remotely connect to the VSAT terminal, but only if you pass by the VSAT hub, using the hub as an intermediate hop. If you set your network up in this way there is no direct connectivity between the terminal and the internet. Thisprotects against the bulk of the first three types of hacking. Note that blocking connectivity between the terminal and the internet does not in any way impact the client's ability to use the VSAT terminal for bidirectional internet access.

The second and fourth types of hacking consist of exploiting open ports to login typically using Telnet or SSH. The approach taken on our, Newtec's, VSAT terminals is to make sure that none of the terminal's ports are accessible from the internet and alimited set of ports (i.e. HTTP, DNS, DHCP, etc.) can be accessed from the customer premises network. Moreover, the services that are accessible from the customer premises network have limited system access. So even if a service is hacked, there is another barrier to overcome before any data can be accessed and/or intercepted.

You can also protect the devices in the customer premises network by filtering, blocking or detecting that they are undergoing a hacking attempt. Protecting these devices is generally not done by the manufacturer of the VSAT equipment, but it is up to the clients to do so. This is typically done just before the VSAT hub where you can implement some sort of blocking policy.

Finally, it is also important to secure the satellite communication link. Sensitive data could be intercepted between the terminals and the hub, since satellite communication is distributed.

3.4.2 Securing the communication link

Over large geographical areas, meaning that almost anyone can listen in. To prevent this from happening, the approach taken by Newtec (and others) is to encrypt all user data that is flowing via the VSAT link. This is done by separating all user data immediately when it enters the VSAT terminal and isolate the traffic inside an encrypted tunnel.

Another threat to the satellite communication link is a rogue VSAT terminal taking over the satellite link of another VSAT terminal. This would offer a malicious user unauthorised access to the network. To counter this, your VSAT terminal (like theMDM2200 – see picture) can add a X.509 certificate based authentication to its encryption key exchange protocol. This creates a strong tie between the intended VSAT terminal and the satellite link and as such prevents rogue VSAT terminals accessing your network.[8]

IV. Conclusion

Vsat technology it is two way communication via satellite that allows to service providers offers fast and secure transmission. The main advantages of VSAT systems are their flexibility and ease of installation. The established terrestrial network is certain to expand its coverage progressively, and in fixed configurations between large population centres it will provide the most efficient means of communications.

Vsat network can be secure against of the different five types of hacking by securing the vsat terminals and vsat communication link.

Refrences

[1]. Http://Www.Ukessays.Com/Essays/Information-Technology/Overview-Of-Vsat-Networks-Information-Technology-Essay.Php
[2]. Dermot Ahern"Vsat Very Small Aperture Terminal "Minister For Communications, Marine And Natural Resources
[3]. September 2003
[4]. John Wiley & Sons Ltd, :Vsat Network" The Atrium, Southern Gate, Chichester, West Sussex Po19 8sq, England 1995 & 2003
[5]. Http://Samples.Sainsburysebooks.Co.Uk/9780470866856_Sample_383472.Pdf
[6]. Http://Www.Academia.Edu/8591677/Vsat_System_Overview_Covering_Block_Schematic_Installation_And_More
[7]. Http://Services.Eng.Uts.Edu.Au/~Kumbes/Ra/Wireless_Networks/Vsat/Trevs%20page/Vsat.Htm
[8]. Http://Securityaffairs.Co/Wordpress/21049/Hacking/Vsat-Terminals-Opened-Targeted-Cyber-Attacks.Html
        Http://Www.Level421.Com/Index.Php?Id=1730
[9]. Http://Www.Newtec.Eu/Article/Article/Securing-Vsat-Terminals.