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Overview of Very Small Aperture Terminal for Television Transmission

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ABSTRACT : *This paper provides an overview of very small aperture terminal (VSAT) network systems for television transmission. In this context, "broadband" means that the application requires a data transfer rate greater than 100 kbps and should allow broadcast, multi and unicast, and interactive bi-directional services to fixed locations. The systems examined include digital broadcasting (e.g., DVB) with IP encapsulation, and bi-directional VSAT star networks. Detailed comparisons of various transmission parameters and standards are provided to help evaluate currently available satellite and ground equipment capabilities.*
In recent times, file transfer application requires support of file broadcast or IP multicast. Typical applications include audio and video broadcast. A VSAT network is inherently broadcast in nature. Thus VSAT networks naturally and efficiently support these new broadcast applications.

KEYWORDS*: VSAT, DVB, TDMA, FDMA, IRD, QPSK.*

I. INTRODUCTION

The acronym VSAT which stands for Very Small Aperture Terminal is the earth station antenna used at the VSAT earth stations. In VSAT the earth station antenna size is typically less than 2.4m in diameter and the trend is towards even smaller dishes not more than 1.8 m in diameter. According to European Telecommunication standard Institute, VSAT is referred as satellite transmit – receive system that has an aperture size smaller than 2.8m. VSATs provide cost effective solutions for the growing telecommunication needs throughout the world. The architecture of the networks is of two types. One is star topology and the other is mesh topology.The star topology is the traditional VSAT network topology, here the communication link are between the hub and the remote terminal. This topology is well suited for data broadcasting or data collection. The access techniques used in a star network can be both frequency domain multiple access (FDMA) and time domain multiple access (TDMA).

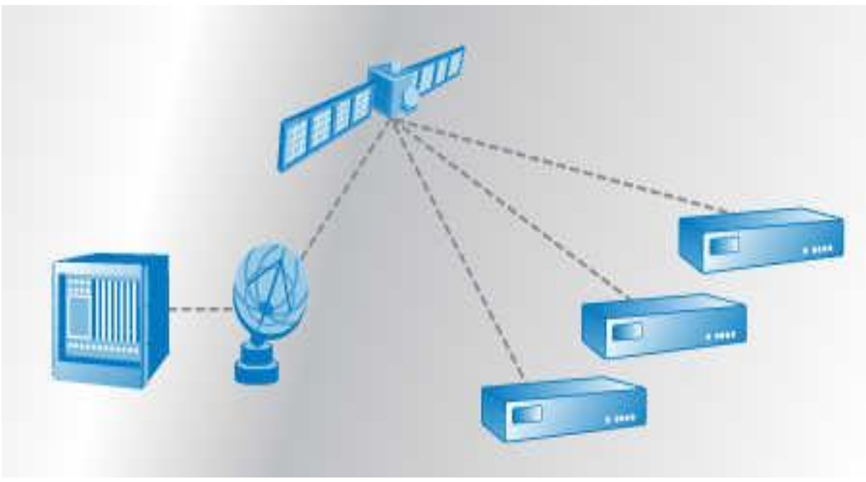

Figure 1.0: A typical VSAT star topology

In mesh topology there is a direct communication between the remote VSAT terminals. This minimizes the time delay which is concerned with speech services. The access method used in a mesh network is FDMA. The links from the hub to the VSAT are called outbound links. The links from the VSAT to the hub are called inbound links. Both inbound and outbound links consist of two parts, uplink and downlink as shown below[1].

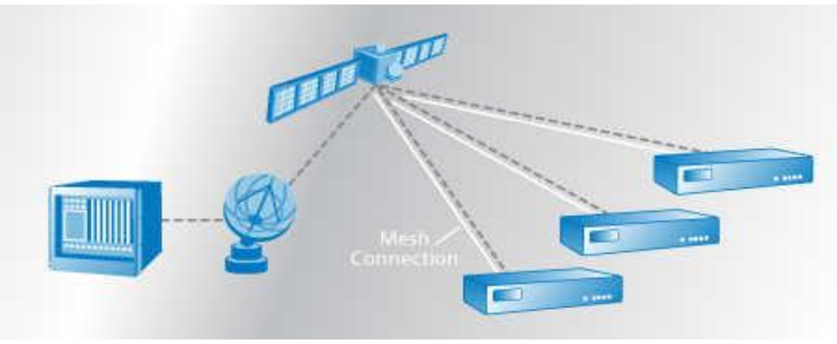

Figure 1.1: A typical VSAT mesh topology

Since the invention of television in the 1920s [2], various analogue television standards have been developed which include Phase Alternating Line (PAL), SéquentielCouleur à MémoireSysteme(SECAM) and National Television Systems Committee (NTSC). These standards are basically spectrum sharing techniques which have their inherent flaws prominent among which are cross-colour, cross luminance and "relatively poor chrominance definition" [3]. The move towards digital transmission of video signals has not been a sudden switch; auxiliary digital services employed to improve image quality have been developed all along. In the 1970s, Vertical Insertion Test signals (VITs) were employed while Video Programmes System (VPS), Multiple Subsampling Encoding system (MUSE), Multiplexed Analogue Components (MAC), D2MAC and High Definition-MAC (HD-MAC) were developed in the 1980s [4]. These efforts in the digital direction had the advantages of less susceptibility to degradation in quality, unique visual effect and ease of television interoperability [5]. Digital video broadcasting (DVB) holds much promise especially in areas of spectrum utilization, high definition content delivery, mobile television integration, high user television interactivity and internet incorporation. The Digital Video Broadcasting (DVB) Project; an organization made of over 260 countries [6], was set up originally to develop technologies for digital video broadcasting via the three traditional broadcasting distribution media; Cable network, satellite systems and terrestrial networks leading to three earlier standards viz DVB-C, DVB-S and DVB-T respectively and its standards have enjoyed wider deployment around the world [7].

II. PROPOSED METHOD

The Internet itself is the last and probably most important interface in the context of data communications. Organizations in the private and public sector have either converted their data communications over to the Internet Protocol, or are in the process of doing so. The interface that is growing to dominate the data world is the simple RJ-45 modular jack associated with the Ethernet standards, 10baseT and 100baseT. Higher rates than 100Mbps demand Gigabit Ethernet or the optical speeds of the Synchronous Digital Hierarchy (e.g., OC-3, OC-48). Such speeds are presently beyond a practical HSA service from currently operating C and Ku band GEO satellites [8]. This could be the domain of the coming generation of broadband satellites employing Ka band spot beams and on-board processing as shown in figure 2.0 below.

Figure 2.0: Ka Band Antenna

A. Broadcast, Multicast and Unicast : Terrestrial networks, including the Internet, are effective for point-to-point transfer of digital media and content. Multicast service over the Internet must employ several point-to-point links to emulate a broadcast system, and therefore has difficulty assuring timely delivery of content to all receivers. A broadcasting station from a local television tower or GEO satellite affords timely delivery of content with a consistent bandwidth. Guaranteeing delivery is usually less of a problem because receivers are designed to directly play the content (a local recording device can allow later playback, if desired).Included in the DVB standard is a data transfer capability called Internet Protocol Encapsulation (IPE). This allows a single broadcast carrier to transfer both television programming and Internet content on the same transport stream. At the subscriber end, the carrier is detected by an integrated receiver decoder (IRD) that extracts the data and delivers it to a local PC or LAN as shown in figure 2.1 below.

Figure 2.1: Scopus IRD 2900 Professional Receiver Decoder [23]

This vehicle allows satellite broadcasters to introduce broadband data into their multiplexed transmissions. The data that rides the MPEG stream may be encrypted along with the digital video and audio, or can be processed with its own unique encryption system. To this may be added a terrestrial return channel for bi-directional service to the desktop or other computational device. Many applications can be supported in this asymmetrical manner since the greater demand is for megabit per second transfer over the satellite in the outbound direction. One must not neglect the potential of this mode for reaching locations that cannot transmit directly over the satellite [9].

B. Digital Video Broadcasting – Return Channel Satellite (DVB-RCS) Network : A DVB-RCS VSAT network is a satellite-based communications system that provide interconnection between users who are exchanging real time (and non-real time) applications based on several data types (e.g. text, voice, images, video etc.). There are two transmission paths, the Forward Channel from a centralized Hub location to the remote location and a Return Channel from the remote location to the central Hub. The DVB-RCS VSAT system underwent final standardization by the European Telecommunications Standards Institute (ETSI) in 2000. The standard calls for a forward link based on a DVB/MPEG-2 data format and a return link using Multi-Frequency – Time Division Multiple Access (MF-TDMA) scheme, allowing a two-way exchange of data. The DVB/MPEG-2 format carries from 1 Mbps up to 45 Mbit/s in the forward link and the MF-TDMA scheme allows from 64 kbps up to 4 Mbps per carrier.

A recent revision of the DVB-RCS standard added support for the new DVB-S2 transmission standard, including adaptive coding and modulation features. The network consists of a central earth station Hub station, the communication satellite and VSAT at the remote sites. Forward traffic to the users at the remote stations (VSATs) is multiplexed into a conventional DVB/MPEG-2 broadcast stream at the Hub and broadcast via the satellite to the VSATs. This broadcast stream is transmitted using QPSK modulation and concatenated convolutional and Reed-Solomon coding (providing a maximum forward data rate of approximately 45 Mbit/s in a 36 MHz transponder) in each transponder used. The return link uses the highly efficient and fast MF-TDMA satellite access scheme together with turbo-coding in order to provide seamless internetworking with other networks. Industry standards are used for carrying data from the VSATs to the Hub Station, in particular Internet Protocol (IP) and Asynchronous Transfer Mode (ATM), or MPEG.

C. Hardware-Implementation : To implement this kind of communication, a user will require a device called a "SIT", ("Satellite Interactive Terminal", "astromodem" or Satellite modem). A suitable satellite-dish is also required. Some systems are supplied as a pre-built combination. The user receives multimedia stream transmissions via the downlink-signals from the satellite. The user sends requests for service signals via the "SIT" and the uplink channel to the satellite. Upon receipt of the command from the user the satellite sends the user request data to the service provider.

D. This takes about 0.5 seconds to connect each way with the satellite. (1 second total for satellite up and downlinks, and another second to the service provider and back, a total of 2 seconds Round-trip delay time).
The protocol used for the SIT portion of the journey is Multiple Frequency Time Division Multiple Access (MF-TDMA). Using this protocol, the user receives data in packets (bursts) that may not be a continuous stream, but when stored and rearranged will generate a virtual 2-dimensional data array. A scheduler is used to maintain these bursts and eliminate duplicates. This protocol is implemented in such a way that different users will receive varying amounts of packet bursts, this helps to regulate the data stream from the satellite-link according to user demands. The forward path (hub to remotes) of the system is based on the relevant ETSI/DVB standards that are shared with the current direct-to-home (DTH) delivery of broadcast television and radio. Thus, both data and video services can be paired (or multiplexed) together to take advantage of existing infrastructure and space segment capacity.

The VSAT employs a scheduled MF-TDMA scheme to access the network and participate in bi-directional communications. MF-TDMA allows a group of VSATs to communicate with a Hub using a set of carrier frequencies, each of which is divided into time-slots. The Hub allocates to each active VSAT a series of bursts; each defined by a frequency, bandwidth, start time and duration. This collection of carrier frequencies and time-slots is referred to as a frame. Each time/frequency slot contains exactly one packet (the packet content being either portions of IP packets or concatenated ATM cells). Frequency-agile VSATs access a pattern of time/frequency slots within these frames. Having established knowledge of the MF-TDMA structure via forward link tables, the VSAT accesses the network using a slotted ALOHA burst. Thereafter, traffic capacity is allocated dynamically, allowing the VSAT to operate in a contention-less mode. A VSAT can only transmit once the VSAT has forward channel reception. Moreover the VSAT must have synchronized itself to the forward link, logged in and have been allocated capacity (in terms of MF-TDMA slots).

Bandwidth and Power Efficiency : Since bits/Hz drive data transmission costs over satellite, and today's satellite bandwidth costs can represent over 20% of direct costs for service to end users, it is in this area that service providers and satellite operators often first focus their evaluation of a DVB-RCS system versus that of other access systems. Most DVB-RCS solution provides for highly-efficient bits/Hz on the forward channel – utilizing 45 Mbps in a 36 MHz transponder as well as taking advantage of every iota of satellite power available rather than wasting it as can happen in a system that is non-capable of saturating a satellite transponder.

Network Scale Efficiency : DVB-RCS is fundamentally designed to be scalable to large populations of terminals. MF-TDMA offers a significant efficiency advantage over other access schemes through the "pooling effect" inherent in statistical multiplexing of large terminal populations in not just one, but two dimensions (frequency and time) simultaneously.

Channel Coding : Channel coding effectively sacrifices bandwidth efficiency for improved reliability of transmission. DVB-RCS uses Turbo coding, which offers excellent bandwidth efficiency for given bit-error ratio (and therefore power efficiency).

Modulation Scheme : Most return channel uses QPSK, which is commonly acknowledged as the optimal trade-off between power and bandwidth efficiency in modulation for multiple access IP over satellite applications. An open standard modulation scheme using QPSK which permits use of linear radios that allows the remote VSAT user to use any qualified L-Band BlockUp converter (BUC) manufactured on the market. [10]

III. RESEARCH METHOD

Standards for digital video broadcasting can be viewed or studied from the standpoint of the distribution media or by looking at the technical specifications for each stage of the broadcast process.

A. The Satellite Standard : Designing a system of moving pictures with accompanying audio which employs satellite communication will require considering the drawbacks of this distribution medium. Satellite channels suffer from signal degradation due to the course travelled by the transmitted signal to arrive at the receiver(s) and this in turn decreases carrier-to-noise ratio. This explains the choice of Quadrature Phase Shift Keying (QPSK) as a modulation technique for the DVB-S standard which was developed in 1994.The DVB-S system based on the Moving Picture Experts Group-2(MPEG-2) for source coding is able to provide multi-programming services through Time Division Multiplexing (TDM) [11]. Error correction is achieved by combining convolutional forward error correction (FEC) for inner coding and Reed-Solomon (RS) codes for outer coding to ensure a balance between power efficiency and spectrum utilization.

DVB-S2 essentially builds upon DVB-S and DVB-DSNG (DVB-Digital Satellite News Gathering) adding to them advancement in coding schemes and flexibility to satisfy users' demand for capacity and interactivity [12]. It employs Adaptive Coding and Modulation (ACM) which allows transmission parameters variation instead of the constant coding and modulation(CCM) used in DVB-S. The DVB-S2 standard specifies8PSK, 16APSK and 32APSK modulation schemes in addition to the QPSK in the earlier standards. A combination of Bose-Chaudhuri-Hocquenghem(BCH) for outer coding, Low Density Parity Check(LDPC) for inner coding and bit interleaving provides robust forward error coding suitable for the noise prone satellite channel. Furthermore a backward compatibility feature of DVB-S2 allows for the accommodation of already existing DVB-S equipment while its non-backward compatibility mode ensures full utilization of the digital "dividend" provided by its deployment [13 – 15]. A summary of the differences between DVB-S and DVB-S2 parameters is shown in Table 3.0.

TABLE 3.0
COMPARISON OF DVB-S AND DVB-S2 FEATURES [14]

	DVB-S	**DVB-S2**
Modulation	QPSK	QPSK, 8PSK, 16ASK, 32ASK
Coding Scheme	Viterbi and Reed Solomon	LDPC AND BCH
Coding Rates	½, 2/3, ¾, 5/6, 7/8	¼, 1/3, 2/5, ½, 3/5, 2/3, ¾, 4/5, 5/6, 8/9, 9/10
Adaptive Coding	No(CCM only)	VCM and ACM* (*Requires return channel)
Roll-Off	0.35	0.20, 0.25, 0.35
Spectral Efficiency	1.0 – 1.75 bits/Hz	0.5 – 4.5 bits/Hz

B. The Cable Standard : Similar to the satellite standard, presently there are two generations of the cable standard. Developed in 1994, the DVB-C (DVB-over cable standard) is built upon the Quadrature Amplitude Modulation (QAM) accommodating 16 to 256-QAM constellations with a roll-off factor of 0.15. The cable medium is relatively less noisy since it is shielded and so error protection is based upon a shortened Reed-Solomon (RS) Code while convolutional interleaving ensures protection of the error protected packets against burst errors [16]. With improvement in coding techniques, the specifications for digital broadcasting over cable was expanded to allow for higher order modulation in DVB-C2, adaptable input formats which added to the MPEG transports stream of DVB-C. There is a parallel between the format for error protection in DVB-C2 and DVB-S2; both use FEC encoding which employs BCH outer coding, LDPC inner coding and bit interleaving which allows for cable retransmission of received satellite signals. The higher order QAM mappings are implemented up to the level of 4096QAM [17]. Furthermore in DVB-C2, the single carrier modulation method is replaced by the multi-carrier Orthogonal Frequency Division Multiplexing (OFDM). The performance of DVB-C2 shows low impact of narrow band interference and negligible impact of burst errors and impulsive noise under simulated conditions [18].

C. The Terrestrial Standard : Terrestrial broadcasting has been the mainstay of local broadcasting especially in the analogue mode. It suffers from less attenuation when compared to satellite broadcasting but its channel is not as secure as the cable channel. It is arguable that terrestrial broadcasting in the analogue mode holds attraction in areas where affording set top boxes and (or) satellite dishes is beyond the financial capacity of locals. Figure 3.1 below is a typical mast housing Silverbird Terrestrial TV antenna transmitting on channel 30 UHF Awka, Nigeria.

Figure 3.0: A 450ft Mast housingSTV UHF-30 Antenna [22]

In the DVB-T system, the RS code is implemented on the MPEG-2 transport stream for outer coding coupled with a punctured Viterbi Convolutional code for inner coding. This combination serves to provide error protection while OFDM transmission provides good multipath performance for the QPSK, 16-QAM, and 64QAM modulated data carriers [19]. Digital Video Broadcasting over terrestrial systems- second generation (DVB-T2) deployed in 2009, nine years after the first generation standard extends the performance of the earlier standard by adding LPDC, BCH and interleaving(bit, cell, time and frequency interleaving) FEC for error protection; constellation rotation; Multiple Physical Layer Pipes; extended interleaving and optional Multiple Input, single Output (MISO) transmission mode. It also adds a higher modulation level of 256-QAM, uses the active constellation and tone detection techniques to reduce the Peak to Average Power Ratio (PAPR) [20]. Comparisons of some features of both generations are shown in Table 3.1.DVB-T2 is not the only standard for Digital Terrestrial Television Broadcasting; in the United States, the Advanced Television Systems Committee (ATSC) has standards which bear its name; in Japan there is the Integrated Services Digital Broadcasting-Terrestrial (ISDB-T) standard and in China the Digital Terrestrial Multimedia Broadcast (DTMB) standard is deployed. Similar among these standards is their progress into the second generation. The progress of the development of the digital television standards has helped free up spectrum for incorporation of internet services on the broadcasting channel creating avenue for interactive services, reception of satellite and cable services on mobile devices leading to specifications for handheld terminals, internet protocol based broadcasting(Internet Protocol Television) and possible convergence of the broadcasting standards. These feats have employed cutting edge technologies for example in DVB-S2 and DVB-C2, the Shannon's limit has been nearly reached raising doubts over a next generation's standard.

	DVB-T	**DVB-T2**
Coding Scheme	Convolutional Coding + Reed Solomon	LDPC and BCH
Coding Rates	½, 2/3, ¾, 5/6, 7/8	¼, 1/3, 2/5, ½, 3/5, 2/3, ¾, 4/5, 5/6, 8/9, 9/10
Modes	QPSK, 16QAM, 64QAM	QPSK, 16QAM, 64QAM, 256QAM
Guard Interval	¼, 1/8, 1/16, 1/32	¼, 19/128, 1/8, 19/256, 1/16, 1/32, 1/128
Fast Fourier Transform(FFT) Size	2k, 8k	1k,2k, 4k, 8k, 32k
Bandwidth	6, 7, 8 MHz	1.7, 5, 6, 7, 8, 10 MHz
Maximum Data Rate(at 20dB C/N)	3.17Mbit/s	45.5Mb/s
Required C/N ratio(at 24Mbit/s)	16.7 dB	10.8 dB

TABLE 3.1 : COMPARISON OF FEATURES OF DVB-T AND DVB-T2 [21]

IV. RESULTS AND DISCUSSIONS

DVB systems distribute data using a variety of approaches, including by satellite (DVB-S, DVB-S2 and DVB-SH; also DVB-SMATV for distribution via SMATV); cable (DVB-C); terrestrial television (DVB-T, DVB-T2) and digital terrestrial television for handhelds (DVB-H,DVB-SH); and via microwave using DTT (DVB-MT), the MMDS (DVB-MC), and/or MVDS standards (DVB-MS). These standards define the physical layer and data link layer of the distribution system. Devices interact with the physical layer via a synchronous parallel interface (SPI), synchronous serial interface (SSI), or asynchronous serial interface (ASI). All data is transmitted in MPEG-2 transport streams with some additional constraints (DVB-MPEG). A standard for temporally-compressed distribution to mobile devices (DVB-H) was published in November 2004.These distribution systems differ mainly in the modulation schemes used and error correcting codes used, due to the different technical constraints. DVB-S (SHF) uses QPSK, 8PSK or 16-QAM. DVB-S2 uses QPSK, 8PSK, 16APSK or 32APSK, at the broadcaster's decision. QPSK and 8PSK are the only versions regularly used. DVB-C (VHF/UHF) uses QAM: 16-QAM, 32-QAM, 64-QAM, 128-QAM or 256-QAM. Lastly, DVB-T (VHF/UHF) uses 16-QAM or 64-QAM (or QPSK) in combination with COFDM and can support hierarchical modulation.

The DVB-T2 specification was approved by the DVB Steering Board in June 2008 and sent to ETSI for adoption as a formal standard. ETSI is expected to publish the standard in July 2009. The DVB-T2 standard will give more-robust TV reception and increase the possible bit-rate by over 30% for single transmitters (as in the UK) and is expected to increase the max bit-rate by over 50% in large single-frequency networks.

A. **Content :** Besides audio and video transmission, DVB also defines data connections (DVB-DATA - EN 301 192) with return channels (DVB-RC) for several media (DECT, GSM, PSTN/ISDN, satellite etc.) and protocols (DVB-IPTV: Internet Protocol; DVB-NPI: network protocol independent).Older technologies such as teletext (DVB-TXT) and vertical blanking interval data (DVB-VBI) are also supported by the standards to ease conversion. However, for many applications more advanced alternatives like DVB-SUB for sub-titling are available.

B. **Return channel :** DVB has standardized a number of return channels that work together with DVB (-S/T/C) to create bi-directional communication. RCS is short for Return Channel Satellite, and specifies return channels in C, Ku and Ka frequency bands with return bandwidth of up to 2 Mbit/s. DVB-RCT is short for Return Channel Terrestrial, specified by ETSI EN 301958.

C. **Technology :** Satellites used for television signals are generally in either naturally highly elliptical (with inclination of +/-63.4 degrees and orbital period of about 12 hours, also known as Molniya orbit) or geostationary orbit 37,000 km (22,300 miles) above the earth's equator as shown in figure 4.1 below. Satellite television, like other communications relayed by satellite, starts with a transmitting antenna located at an uplink facility. Uplink satellite dishes are very large, as much as 9 to 12 meters (30 to 40 feet) in diameter. The increased diameter results in more accurate aiming and increased signal strength at the satellite. The uplink dish is pointed toward a specific satellite and the uplinked signals are transmitted within a specific frequency range, so as to be received by one of the transponders tuned to that frequency range aboard that satellite. The transponder 'retransmits' the signals back to Earth but at a different frequency band (a process known as translation, used to avoid interference with the uplink signal), typically in the band (4–8 GHz) or Ku-band (12–18 GHz) or both. The leg of the signal path from the satellite to the receiving Earth station is called the downlink.

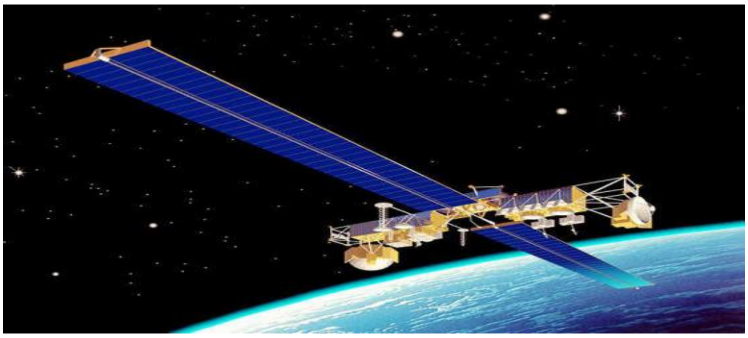

Figure 4.0: Television Satellite in space [23]

A typical satellite has up to 32 transponders for Ku-band and up to 24 for a C-band only satellite, or more for hybrid satellites. Typical transponders each have a bandwidth between 27 MHz and 50 MHz Each geo-stationary C-band satellite needs to be spaced 2 degrees from the next satellite (to avoid interference). For Ku the spacing can be 1 degree. This means that there is an upper limit of 360/2 = 180 geostationary C-band satellites and 360/1 = 360 geostationary Ku-band satellites. C-band transmission is susceptible to terrestrial interference while Ku-band transmission is affected by rain (as water is an excellent absorber of microwaves at this particular frequency). The downlinked satellite signal, quite weak after traveling the great distance (see inverse-square law), is collected by a parabolic receiving dish, which reflects the weak signal to the dish's focal point. Mounted on brackets at the dish's focal point is a device called a feedhorn. This feedhorn is essentially the flared front-end of a section of waveguide that gathers the signals at or near the focal point and 'conducts' them to a probe or pickup connected to a low-noise block downconverter or LNB. The LNB amplifies the relatively weak signals, filters the block of frequencies in which the satellite TV signals are transmitted, and converts the block of frequencies to a lower frequency range in the L-band range. The evolution of LNBs was one of necessity and invention.

The original C-Band satellite TV systems used a Low Noise Amplifier connected to the feedhorn at the focal point of the dish as shown in figure 4.1 below.

Figure 4.1: 1.2M C-Band Satellite Antenna for Outdoor STV Broadcast [22]

The amplified signal was then fed via 50 Ohm impedance coaxial cable to an indoor receiver or in other designs fed to a downconverter (a mixer and a voltage tuned oscillator with some filter circuitry) for downconversion to an intermediate frequency. The channel selection was controlled, typically by a voltage tuned oscillator with the tuning voltage being fed via a separate cable to the headend. But this simple design evolved. Designs for microstrip based converters for Amateur Radio frequencies were adapted for the 4 GHz C-Band. Central to these designs was concept of block downconversion of a range of frequencies to a lower, and technologically more easily handled block of frequencies (intermediate frequency).The advantages of using an LNB are that cheaper cable could be used to connect the indoor receiver with the satellite TV dish and LNB, and that the technology for handling the signal at L-Band and UHF was far cheaper than that for handling the signal at C-Band frequencies. The shift to cheaper technology from the 50 Ohm impedance cable and N-Connectors of the early C-Band systems to the cheaper 75 Ohm technology and F-Connectors allowed the early satellite TV receivers to use, what were in reality, modified UHF TV tuners which selected the satellite television channel for down conversion to another lower intermediate frequency centered on 70 MHz where it was demodulated. This shift allowed the satellite television DTH industry to change from being a largely hobbyist one where receivers were built in low numbers and complete systems were expensive (costing thousands of Dollars) to a far more commercial one of mass production. Direct broadcast satellite dishes are fitted with an LNBF, which integrates the feedhorn with the LNB.

The satellite receiver demodulates and converts the signals to the desired form (outputs for television, audio, data, etc.). Sometimes, the receiver includes the capability to unscramble or decrypt; the receiver is then called an integrated receiver/decoder or IRD. The cable connecting the receiver to the LNBF or LNB must be of the low loss type RG-6, quad shield RG-6 or RG-11, etc. It cannot be standard RG-59 [23].

V. CONCLUSION

Progress in digital video broadcasting standards shows the benefits of digital broadcasting. This offers opportunities for developing countries like Nigeria to explore cooperative efforts to overcome their challenges. Television stations with many remote out-stations can create a private high-speed satellite intranet, which links the main office reliably with all remote VSATs as is the cast of Silverbird Television (STV). These networks, comparable to the corporate or institutional networks of large multinational companies or international institutions, today need high speed, reliable and cost-effective communications. This is especially true when the locations are dispersed over remote regions and barely connectable via a terrestrial network infrastructure as is the case of Silverbird Television whose headquarter is located in Lagos with about six (6) out-stations spread across Nigeria.

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