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STRATEGIES FOR ENHANCING GLOBAL ACCESSIBILITY OF TELEVISION SATELLITE BROADCASTING AND MULTIMEDIA DATA TRANSMISSION

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ABSTRACT

Broadcast Television has been and still is the basic and the most popular means of television entertainment in Nigeria. In Nigeria today, there is an increasing number of television networks, e.g: AIT, NTA, Channels, BCOS, e.t.c, however, because of the frequencies allotted to these networks, the signals can only be received in a limited geographical area corresponding to the transmitting strength of their antennas. People living in remote locations solve these reception problems by putting antennas in high places and running cables to their houses. The need to overcome this limitation (i.e. short broadcast range) of the broadcast television led to the discovery and development of the Digital Satellite Television (DSTV). This paper reviews the concept of Digital Satellite Television and its mode of operations. We also attempt to showcase the advantages of DSTV and how it can possibly alleviate the problem of limited reach inherent in the broadcast television station.

Keywords: Broadcast TV, Satellite Technology, Wireless Transmission, Uplink, Geosynchronous orbit.

I. INTRODUCTION

Conceptually, satellite television is analogous to Broadcast Television. It can be defined as a wireless system of delivering television programs directly to viewers' homes. Both Broadcast Television and Satellite Television transmit programs through radio signal [1].

Satellite Television transmits broadcast signals from satellites orbiting the earth. Since these satellites are high in the sky (36000 feet above sea level), it is capable of accommodating many customers on the line of site. Satellite TV systems transmit and receive signals using specialized antennas called **Satellite Dishes** [9].

Many steps are involved between the signal programming sources and the television sets. Satellite television solves the problem of range and distortion by transmitting broadcast signals from satellites orbiting the earth. The rest of the paper is organized as follows: section II presents inherent problems in the broadcast TV. In section III, we give an overview of satellite communication and applications. Section IV presents the operational mode of digital satellite television, while section V depicts the importance of satellite communication. We conclude in section VI with recommendation for the adoption of digital TV as a form of multimedia message transmission.

II. THE BROADCAST TV PROBLEM

The Broadcast Television has remained the most popular means of television entertainment in Nigeria. Broadcast stations make use of powerful antennas to transmit radio waves to the surrounding area; viewers pick up this signal with a much smaller antenna compared to the size of a dish. The major limitation of the broadcast TV is range. The radio signal used in broadcasting shoots out from the broadcast antenna in a straight line. In order to receive these signals, receivers must be in direct line of sight of the antenna [6]. This explains why an antenna fixed at an angle gets a very good reception for certain stations and bad reception for others. Also, signals from the broadcast antenna are affected by obstacles among which are trees and buildings. However, bigger obstacles such as the earth reflect the broadcast radio waves. The curvature of the earth breaks the signal's line of sight thus affecting the transmitted radio wave and distorting the signal. In order to get a perfectly clear signal, receiver must be close to the broadcast antenna without too many obstructions in the way [7].

III. GENERAL SATELLITE CONCEPTS

A communication satellite is a microwave relay station between two or more earth stations. The oldest of all satellite is the moon, but the idea of communication satellites stemmed from Sir Arthur C. Clark in 1945 [1]. The basic concept underlying satellite broadcasting entails straight forward signals beamed into space by an **uplink** dish and received by an orbiting satellite, electronically processed, rebroadcast or **down-linked** to earth before being detected by a dish.

Nearly all satellites designated for commercial use are positioned in the Clarke Belt usually referred to as the **geosynchronous orbit,** meaning that they stay in one place in the sky relative to the earth. Each satellite is launched into space at about 7000mph, reaching approximately

22,300 miles above the earth. At this speed and altitude, the satellite will revolve around the planet once every 24 hours – the same period it takes the earth to make one full rotation. This way, the receiving dish only needs to be directed to the satellite once and from then it picks up the signal without adjustment [7].

The transmission of extremely low power microwaves, representing a form of radio waves underlies the operation of radio, conventional television, satellite broadcasting and other man made communication devices. They constitute part of more general phenomena known as electromagnetic waves that travel at the speed of light equal to 186,000 miles per second. At this rate a signal travels from the uplink to a satellite and back to earth in about 4/10th of a second [9].

III.1 Applications of Satellite Technology

Satellites have become essential for modern life. Among the important applications of satellite technology are video, voice, IP data, radio, earth and space monitoring, global resource monitoring, military, positioning (GPS), micro-gravity science and many others. From direct-to- home distribution to the hubble telescope. Video is about the most successful commercial application for satellites, and direct-to-home or office is the most promising application for the technology at this instance.

IV.DIGITALSATELLITE TELEVISION

DSTV is well matched to the needs of the Nigerian society as it is able to meet the entertainment needs of the society, more importantly, the rural areas beyond the reach of the broadcast TV. One major advantage of the DSTV is its ability to solve the inherent problems of the broadcast TV – **range** and **distortion** since satellite services are available almost everywhere on earth without wires. In this section, we present a vivid description of one of the most promising applications of the satellite technology – the DSTV.

IV.1. Satellite TV Operations

Most satellite TV customers get their TV programs through a **Direct Broadcast Satellite** provider such as Multichoice, FSTV, TITV, e.t.c. the provider selects programs and broadcasts them to subscribers as a set package. Basically, the provider's goal is to bring hundreds of channels to the television sets. Unlike earlier programming, the provider's broadcast is completely digital which provides a better picture and sound quality. Early satellite TV was broadcast on C-band radio (3.4GHz to 7GHz) frequency range. Digital broadcast satellite transmits programs in the KU frequency range (12GHz to 14GHz).

The five major components involved in a direct-to-home satellite system are: The Programming Source, The Broadcast Center, The Satellite, The Digital Satellite Dish and The Receiver or Digital satellite Decoder

The figure below shows the relationship between each of these components, which will be discussed in turn.

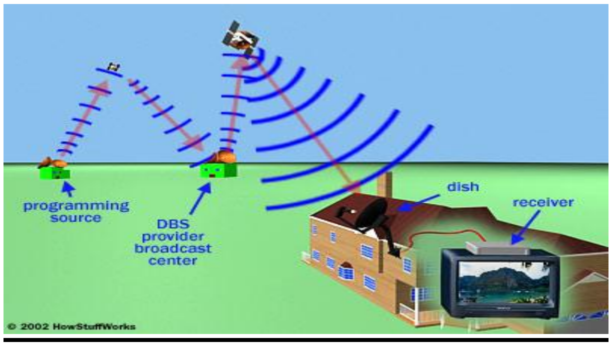

Fig. 1 Relationship between the components of DSTV.

IV.1.1. The Programming Source

The programming sources are simply the channels that provide programming for broadcast. The provider does not create original programming itself, it pays other companies, e.g. ESPN, Super Sport, CNN, e.t.c. for the right to broadcast their contents through satellite. Thus, the provider is more like a middle man between the customer and the actual programming source.

IV.1.2.The Broadcast Centre

The broadcast center is the central hub of the system. At the broadcast center, the DBS provider
receives signals from various programming sources and beams a broadcast signal to satellites in geosynchronous orbits.

IV.1.3. The Satellite

The satellites are responsible for receiving signals from the broadcast station and then broadcasting them to the ground.

IV.1.4. The Digital Satellite Dish

This dish is responsible for picking up the signals from the satellite or multiple satellites as the case may be and passes it on to the Receiver (Digital Satellite Decoder) at the viewer's end.

There are three noteworthy components of a satellite dish. These are the **reflective surface or parabola curvature**, the **feedhorn** and the amplifier section **– Low Noise Block Converter (LNB)**. We will focus on these as they are the major components of a dish. Figure 2 below shows us these components of a dish.

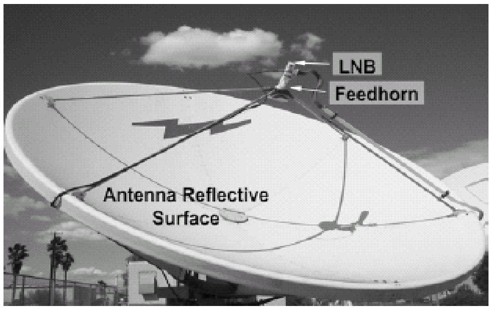

Fig. 2 Components of a Digital Satellite Dish.

The Reflective Surface

The reflective surface is responsible for reflecting the satellite signal to a very sharp focal point. It relies on the geometric properties of its parabolic curve to do this. Although, the focal point is not as perfect as theory would dictate, it still falls within a small radius. Collection of signal is very important at the focal point thus prompting the need for a specially designed feedhorn that matches the antenna's geometry precisely. On most occasions, the dish as well as the feedhorn is usually sold together as a single unit. This type of feed is called a Low Noise Block Converter (LNB).

Amplifier - LNB

The concentrated signal from the reflective surface is channeled to a low noise amplifier that has a very low noise flow. The low noise amplifier is responsible for amplifying the signal to a level that is just above the receiver's threshold. This in turn is detected the block converter, and thereafter converts it to an electrical current, amplifies it and down-converts or lowers its frequency. The down-converted signal is subsequently relayed to the indoor Satellite Receiver of the various TV sets.

Feedhorn

Feedhorns come in several different forms with the most common being the scalar feedhorn. The scalar feedhorn has a large circular plate with a series of circular rings attached to its surface as shown in figure 3. These rings collect the signal at the antenna's focal point and conduct the incoming signal to the waveguide attached between the rings and the LNB the effect of this is to concentrate the signal in an effort to correct

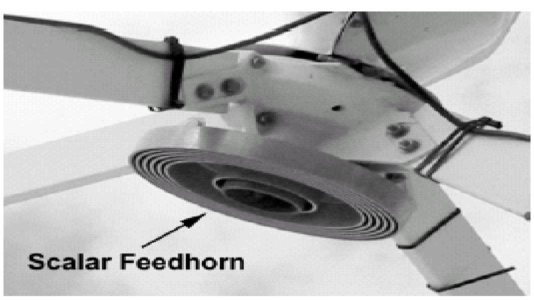

Fig. 3 Scalar Feedhorn.

the imperfections of the parabolic shape of the reflective surface.

IV.1.5. The Receiver

The receiver is responsible for receiving the video and audio signals that are digitized, compressed and modulated, it processes these signals into a form that can be deciphered by the decoder and passes it on to the TV.

IV.2. The Programming

Satellite TV providers get programming from two major sources: **natural turnaround channels** (e.g.: ESPN, CNN, Movie Magic) and various **local channels** (e.g.: AIT, Channels, MBI, NTA).

Turnaround channels usually have a distribution center that beams their programming to a geostationary satellite and thus the broadcast center uses large satellite dishes to pick up these signals from several sources. Most local stations on the other hand do not transmit their programming to satellite so the provider gets it another way. If the provider includes local programming in an area, it will have a small local facility consisting of a few racks of communication equipment. The equipment receives local signals directly from the broadcaster through fiber-optic cable or an antenna and then transmits them to the central broadcast center.

The broadcast center converts all of this programming into a high quality, uncompressed digital stream. At this point, the stream contains a vast quantity of data – about 270 megabits per second (Mbps) for each channel. In order to transmit the signal from there, the broadcast center has to compress it otherwise it will be too big for the satellite to handle. The next section explains how the signal is compressed.

IV.3. Data Signal Compression

The video compression format used by DBS providers is a critical step that has made DBS services a success. This video compression format is the MPEG-2 compressed video format, which is the same format used to store movies on DVD's. With MPEG-2 compression, the provider can reduce the 270-Mbps stream to about 5 or 10 Mbps depending on the type of programming. This allows many high quality video signals to be transmitted on a satellite transponder (frequency band). Digital compression thus enhances satellite transmission up to about 200 channels. However, without digital compression, only about 30 channels transmission is achievable.

At the broadcast center, the high quality digital stream of video goes through an MPEG-2 encoder which converts the programming to MPEG-2 video of the correct size and format for the satellite receiver. The MPEG encoder analyses each frame and decides on how to encode it.

The encoder eliminates redundant or irrelevant data and extrapolates information from other frames to reduce the overall size of the file. Each frame can be encoded in one of three ways:

(a) As an **intraframe**: This method of encoding provides the least compression during which an intraframe completes image data for that frame.

(b) As a **Predicted** frame: a predicted frame contains just enough information to tell the satellite receiver how to display the frame based on the most recently displayed intraframe or predicted frame. This means that the frame contains only the data that relates to how the picture has changed from the previous frame.

(c) As a **Bidirectional** frame: to display a bidirectional frame, the receiver must have the information from the surrounding intraframes or predicted frames. Using data from the closest surrounding frames, the receiver interpolates the position and colour of each pixel.

These processes of encoding occasionally produce articrafts – little glitches in the video image but for the most part, it creates a clear, vivid picture.

The rate of compression depends on the nature of programming. If the encoder is converting a newscast, it can use a lot more predicted frames because most of the scene stays the same from one frame to the next. In other sorts of programming such as action movies and music videos, things change very quickly from one frame to the next, so the encoder has to create more intraframes. As a result, something like a newscast generally compresses into a much smaller size than something like an action movie.

IV.4.Encryption & Transmission

The last section has attempted to explain how video is compressed at the broadcast center. After this video is compressed, the provider needs to encrypt it in order to keep people from accessing it for free. Encryption scrambles the digital data in such a way that it can only be decrypted (i.e. converted back into usable data) if the receiver has the correct decryption algorithm and security keys.

Once the signal is compressed and encrypted, the broadcast center beams it directly to one of its satellites. The satellite picks up the signal with an onboard dish, amplifies the signal and uses another dish to beam the signal to earth; viewers' dishes can then pick it up.

IV.5. Receive Site

At the reception site, a dish serves as a special kind of antenna. The dish reflects and concentrates as much of the very weak signal as possible to its focus where a feed channels the signals into the Low Noise Block Converter (LNB). The LNB amplifies the radio signal bouncing off the dish and filters out the noise (radio signals not carrying programming). Figure 4 depicts how incoming radio wave is focused onto the feedhorn.

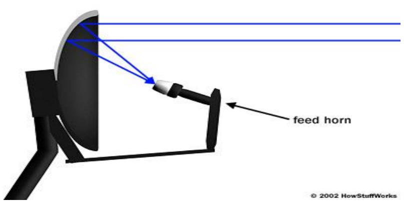

Fig. 4 The curved dish focuses incoming radio waves onto the feed horn.

The amplified, filtered signal is then cabled indoors to the satellite receiver or processed into a form that can be deciphered by a television. The end component in the entire satellite TV system is the receiver. The receiver has four essential jobs:

(i) It de-scrambles the encrypted signal. In order to unlock the signal, the receiver needs the proper decoder chip for that programming package. The provider can then communicate with the chip via the satellite signal to make necessary adjustments to its decoding parameters.

(ii) It takes the digital MPEG-2 signal and converts it into an analog format that a standard television can understand.

(iii) It extracts the individual channels from the larger satellite signal. When you change the channel on the receiver, it sends the signal just for that channel to your TV.

(iv) It keeps track of pay per view programs and periodically phones a computer at the provider's headquarters to communicate billing information.

Receivers have a number of other features as well. They pick up programming schedule from the provider and present this information in an onscreen programming guide. Some receivers have built-in digital video recorders as well which lets you pause live television shows or record it on a hard drive.

V. ACCRUABLE BENEFITS OF SATELLITE SERVICES

Satellite services have tremendous advantages, among which are:

(i) Satellite services are available almost everywhere on earth without wires.

(ii) They cover a very wide range. For example, downlink transmit antennas can target over 40% of the earth's surface with **global** beams. They can also be used to broadcast to selected countries or continents via **zone** beams and can also pinpoint smaller areas with **spot** beams.

(iii) Satellite technology is a mobile technology as it does not require wires thereby enabling mobility. An example of mobile satellite communication technology is the Global System for Mobile Communication (GSM).

Basically, from the advantages listed above, we see that satellite services are the perfect broadcast medium in any society. DSTV is already making use of these advantages of Satellite services to overcome the basic problems of the broadcast TV.
However, the above listed advantages are still not fully realizable due to the huge cost of launching a communication satellite. This operation was hitherto limited to few rich countries of the world with the cost ranging from hundred millions to billions of dollar, albeit, with advances in technology coupled with the above listed benefits, more countries and corporate organization are beginning to launch their individual satellites, while INTELSAT, the world satellite services provider opined that there has been tremendous decrease in the cost to consumers from over $10 per minute to less than $1 per minute thereby making the services avoidable to the general populace.

VI. CONCLUSION AND RECOMMENDATIONS

This paper has expounded the basic concept of Digital Satellite Television (DSTV), highlighting and explaining the functional components of the Digital Satellite Television as well as the operation modules and techniques. We have also been able to depict the advantages of the Digital Satellite Television over broadcast television and how DSTV most especially overcomes the broadcast range limitation which is a major problem of the broadcast transmission.

Although, digital broadcast satellite service is still lacking some of the basic features of conventional cable (the ability to easily split signals between different TV's and VCR's, for example), its high quality picture, varied programming selection and extended service areas makes it a good alternative for some.

Its ability to cover a wide area makes it a better alternative in the most society as it becomes easier to reach the rural areas beyond the reach of the broadcast TV stations, thereby making available important information aimed at averting and monitoring natural disasters like volcanoes, land slides, tsunamis, as well as sensitizing the general public on the major events like election, census and also monitor cum controlling brake out of epidemic and other contagious diseases. From the afore-mentioned, the need for onward transition into digital satellite multimedia transmission is imperative in other to fully harness the huge benefit accruable from its operation.

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