

Satellite Communication in Nigeria: Prospects and Challenges

B.I. Bakare¹, E.V. Odu² and T. Ngeri³

^{1,3}(Electrical and Computer Engineering, Rivers State University of Science & Technology, Nigeria)

²(Electrical and Electronics Engineering Technology, Port Harcourt Polytechnic, Port Harcourt, Nigeria)

ABSTRACT: Satellite communication is a wireless means of transmission of intelligible signals which when properly utilized will bring about great and positive development on the economic growth of any nation. The Federal Government of Nigeria made a giant step in the communication sector by launching five satellites into orbit, NigeriaSat-1, NigComSat- 1, NigeriaSat-2r, NigeriaSat-X and NigComSat-1R. Though faced with challenges, Nigeria and her citizens are utilizing the benefits of satellite communication in several ways such as Speedy internet facility, distance learning, improved security, GPS services, GSM communication, TV and Radio Broadcasting. For Nigeria to make any headway in its quest to bridge the technology gap through communication satellite, increase in penetration of broadband services and adequate funding is needed urgently.

Keywords: Communication, Internet, orbit, Satellite, Wireless

I. INTRODUCTION

A communication satellite is a device that amplifies Radio Frequency signal via a transponder (an integrated receiver and transmitter of radio signals). It creates a communication channel between a source transmitter and a receiver at different locations on Earth. The purpose of communications satellites is to relay the received signal around the curve of the Earth allowing communication between widely separated points [1]. This is simply done by reflecting the radio wave sent to the satellite from the sender back to the receiver at a distance and for this purpose, the satellite is launched into a great distance above the earth surface.

Russia launched the first satellite into orbit called the Sputnik 1 in 1957 while the United State of America (USA) launched two experimental satellite called Echo 1 and Echo 2 in 1960 thereby setting the pace for development in the area of satellite communication. There are over 2000 communication satellites in the world today, each launched into orbit above the earth's surface by different organization to operate at a given range or bands of frequencies in order to eliminate interferences of radio signals. Figure 1 shows a typical communication Satellite in an orbit above the earth.



Figure 1: A typical Communication Satellite

When a satellite is launched, its design enables it to float along a certain distance from earth in an imaginary circle called the orbit. The satellite orbit is a distant path around the earth where satellites are meant to operate and allowing them to virtually see every part of the earth (some part for a single satellite). Satellites are launched into three different orbits categorized by their mode of operation and distance in altitude around the earth. They are:

- **Low Earth Orbit (LEO):** is at a distance of about 160km to 2,000km above the earth's surface. They are less expensive to launch and are only visible from sub-satellite point. Since signal loss depends on distance travelled, the LEO satellites do not require high signal strength and gives back a better signal when compared with the other satellite orbits. They are non-stationary as they are free to move about in their orbits changing their position relative to ground at a very high speed hence require more ground stations and satellite to keep track of it and maintain an uninterrupted connectivity. [1]
- **Medium Earth Orbit (MEO):** is at a distance of about 2,000km to 35,786km above the earth's surface. They are not much expensive to launch and are visible much longer time than the LEO of about 2 to 8 hours with a larger coverage area. Due to it distances results in delay and signal loss producing weaker signals than LEO. They are non-stationary like LEO as they are free to move about in their orbits changing their position relative to ground at a very high speed hence requires also more ground stations and satellite to keep track of it and maintain an uninterrupted connectivity.
- **Geostationary Orbit (GEO):** is at a distance of about 35,786km above the earth's surface. They are expensive to launch and are seen to be stationary (at a standstill position) form an earth observer. It offers a larger coverage area than LEO and MEO. Due to it distances results in delay and signal loss producing weaker signals than LEO and MEO hence require great signal strength for its operation. They are seen to be stationary because they have a movement relative to the earth's rotation (revolving around the earth at 360° every 24 hours). The major advantage of GEO over LEO and MEO is that ground antennas can be aimed at it without having to track the satellite's motion. [1]

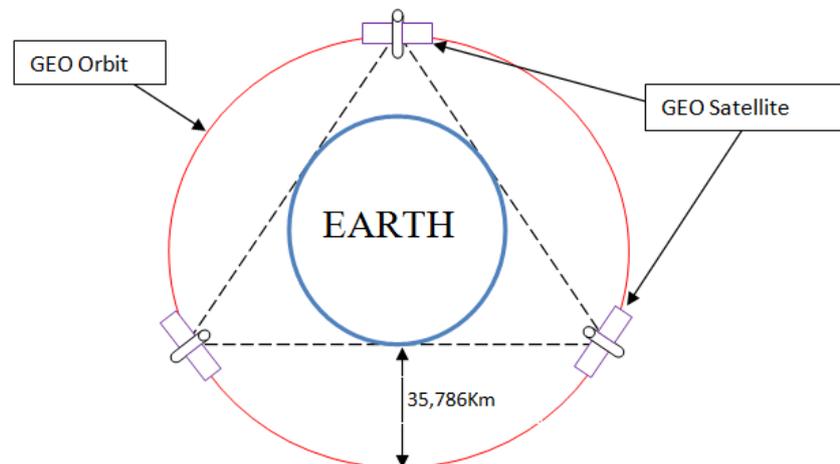


Figure 2: Three GEO Communication Satellite Covering the Earth

In contrast, it takes 3 GEO satellite to cover the earth as shown in figure 2 above while it takes LEO 20 or more satellites to cover the entire earth and 10 or more in MEO. In addition, communicating with satellites in LEO and MEO requires tracking antennas on the ground to ensure seamless connection between satellites. [2] Group of Satellites working together is referred to as a Satellite Constellation which relay their information between one another and ground stations.

II. SATELLITE COMMUNICATION OPERATION

Allocation of frequencies (microwave bandwidth) to satellite services is a complicated process therefore requires international coordination and planning. This is done as by the International Telecommunication Union (ITU). The government runs auctions that worth billions for an organization that tend to obtain part of the regulated bandwidth or frequency range. Satellite operators apply years in advance just to get a launch support, tracking, telemetry and operation.

In order to effectively implement this frequency planning, the earth is divided into three regions:

- **Region 1:** consist of Europe, Africa and Mongolia
- **Region 2:** consist of North and South America and Greenland
- **Region 3:** consist of Asia (excluding region 1 areas), Australia and south-west Pacific.

Satellite communication consists of two parts: The Ground component (either fixed or mobile is made up of transmitter, receivers, and ancillary equipment basically on earth), and the Space component (an area in the outer space consisting mainly of the satellite) as shown in figure 3 below [2].

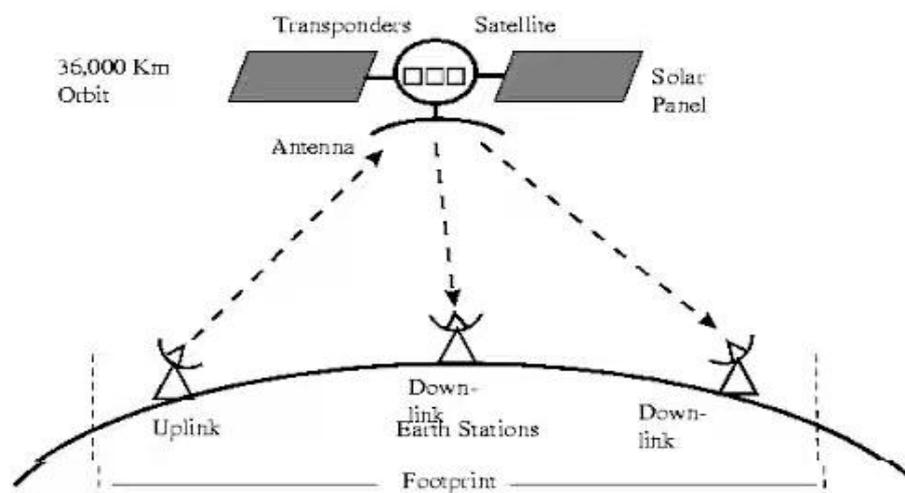


Figure 3: A Typical Satellite Communication Operation

When electromagnetic signal is sent from earth, it is received by the satellite with the help of a transponder; the signal is then amplified and sent back to earth. The sending of signals can be done immediately or stored to be sent later when the satellite properly faces the earth. Some active satellites are also designed to carry programming and recording features meaning they could easily be played back [3].

Parts of the microwave spectrum are designated and used as follows (for a detailed

- VHF/UHF 0.1-0.3 GHz - MilSat- amateur radio, "little" LEO
- L Band -1-2 GHz - Mobile Sat/marine, "big" LEO
- S Band 2-4 GHz - Satellite command/control
- C Band 4-8 GHz - Data, voice, video distribution
- X Band 8-12 GHz - Military-EOS
- Ku 12-18 GHz - Direct TV, Data, Voice, SNG, IP services
- K 18-27 GHz -N/A (22.3-H₂O absorption)
- Ka 27-40 GHz - The next wave
- V 40-75 GHz - Released in the future (60 GHz -O₂ absorption) [4]

III. THE TREND OF SATELLITELAUNCHINGIN NIGERIA

The quest to launch a national satellite started in the year 1976 which the then Military Government could not execute. On the 27th day of September, 2003, Nigeria launched its first satellite called the **NigeriaSat-1**. It was built by a United Kingdom based satellite technology company, Surrey Space Technology Limited (SSTL). The satellite was launched aboard the Kosmos-3M rocket from Russian Plesetsk spaceport. Its building and launching was sponsored by the FederalGovernment of Nigerian at a cost of 30 million US dollars. NigeriaSat-1 satellite was designed for Disaster MonitoringConstellation (DMC) having 100 kg mass. It carries an optical imaging payload developed to provide 32 m ground resolution with an exceptionally wide swath width of over 640 km. Images are stored in a 1-gigabyte solid-state data recorder and returned via an 8-Mbit/s S-band downlink. NigeriaSat-1 can image scenes as large as 640 x 560 km, providing unparalleled wide-area, medium-resolution data which is used within Nigeria to monitor pollution, give early warning signals of environmental disaster, help detect and control desertification in the northern part of Nigeria; to assist in demographic planning; establish the relationship between vectors and the environment that breeds malaria, give early warning signals on future outbreaks of meningitis using remote sensing technology; provide the technology needed to bring education to all parts of the country through distant learning; and to aid in conflict resolution and border disputes by mapping out state and International borders [5].

On the 13th day of May, 2007, 16:01 GMT Nigeria lunched its second satellite and Africa's first communication satellite called the **NigComSat-1** (a geostationary satellite). It was built in China in 2004 and launched from Xichang Satellite Launch Centre in China aboard a Chinese Long March 3B rocket [4] at the cost of 32 billion Naira (including launching and ground station). It was designed based on the Chinese DFH-4 satellite bus, and carries a variety of transponders: 4 C-band; 14 Ku-band; 8 Ka-band; and 2 L-band and was made to provide coverage to many parts of Africa, and the Ka-band transponders would also cover Italy. NigComSat-1 provided Nigerians with communications, internet services, health, agriculture, environmental protection and national security. 18 months later, on the 10th of November, 2008, the satellite was reported to have failed in its orbits due to an anomaly in its solar array. It was switched off for analysis and to also avoid

any possible collision with other satellite as it was said to be put into “emergency mode operation in order to effect mitigation and repair” by Nigerian Communication Satellite Limited. The next day (11th of November, 2008) the satellite failed after losing power [5].

Hence on the 19th of December, 2011 China launched a Communication satellite called **NigComSat-1R** to replace the lost NigComSat-1 with no cost to Nigeria. It is also a DFH-4 satellite whose contract was signed by Nigerian Federal Ministry of Science and Technology, NigComSat limited and CCWIC (China Great Industries Corporation) on the 24th of March, 2009. According to the then President Goodluck E. Jonathan, the money for NigComSat-1R was paid by the insurance policy on NigComSat-1.

NigeriaSat-2 and **NigeriaSat-X**, where Nigeria's third and fourth satellites launched in to orbit on the 17th day of August, 2011, by Ukrainian Dnepr rocket from a Yasny military base in Russia built at cost over **£35 million**. They are also designed for DMC having 300 kg mass and were built as a high-resolution earth satellite by SSTL. It has 2.5-metre resolution panchromatic (very high resolution), 5-metre multispectral (high resolution, NIR red, green and red bands), and 32-metre multispectral (medium resolution, NIR red, green and red bands) antennas. They were built to replace NigeriaSat-1. Table 1 below show a brief summary of events on the development of Satellite launching in Nigeria.

Table 1 BriefSummary of Events on the development of Satellite launching in Nigeria.

YEAR	EVENTS
1976	Nigeria began the quest of building and launching a satellite but it was not executed
2003	NigeriaSat-1, Nigerian first Satellite was launched on 27 th of September, 2003
2004	China commence the building of Nigeria's second satellite on 15 th of December, 2004
2007	NigComSat-1, the Nigerian second and Africa's first communication satellite was launched on 13 th of May, 2007
2008	NigComSat-1 was shut down on the 10 th of November, 2008 as it was reported to have developed issues with the solar panel array.
2008	Nigerian NigComSat-1 was lost on the 11 th day of November, 2008 when the satellite lost it power
2009	The Nigerian Federal Government signed a contract based on the insurance policy of NigComSat-1 for its replacement
2011	NigeriaSat-2 and NigeriaSat-X, Nigerian third and fourth satellite was launched on 17 th August, 2011
2011	NigComSat-1R was launched on the 19 th day of December, 2011 as a replacement of the failed NigComSat-1.

IV. THE IMPACT OF COMMUNICATION SATELLITE IN NIGERIA

Satellite communication as an important tool to the growth of science and technology found application in the following areas in Nigeria.

- **Weather Forecasting:** Most satellites are specially designed and assigned to an area of earth (like Nigeria) to monitor its climatic conditions and are able to predict the weather conditions of that region. This is done by taking images of earth from the satellite, transferring them using assigned radio frequency to an earth station. These satellites find their application in the prediction of earth disasters and monitor the changes in the Nigeria's vegetation, sea state etc.
- **Radio and TV Broadcast:** There are dedicated satellites with the responsibility of making 100s of channels across the globe available and are also responsible for broadcasting live matches and news as shown in figure x below



Figure 1: A Typical NigeriaHouse with VSAT Satellite Dish

- **Military Satellites:** These satellites can be used as a military weapon, as communication satellite or for gathering intelligent information for military purposes.
- **Navigation Satellites:** These satellites allow for precise localization world-wide. GPS is used in Nigerian Ships and aircraft as a traditional navigation systems which is also installed in most cars.
- **Global Telephone and Mobile Communication:** The second satellite Nigeria launched was a communication satellite which boosted international telephone and mobile communication as a system of reducing the use of cables and extending the area of coverage.

The advancement in science and technology has today no doubt brought about tremendous enhancement of effective communication process in Nigeria. This positive trend which has brought about the development of satellite as a Space Technology has proved greatly instrumental in laying the foundation for effective communication structure by guaranteeing the availability of speedy access to real-time data and geospatial information which have similarly proved impactful on virtually all human developmental effort [6]. The impact of communication satellite to Nigeria can be discussed as follows:

- ✓ **Communication:** Communication satellites are designed to work the whole day non-stop to keep the entire world connected together. The discovery of communication satellite has brought about an effective and cheaper way of communication to the world including our dear country Nigeria. Its advantage over terrestrial repeaters had made it an exclusive medium used by all telecommunication devices (like TV, Radio service, mobile telephone, etc) to easily transmit or transport data to any part of the world at a very great speed in the real-time process without interruption when doing so.
- ✓ **Education:** Education is a vital component of a nation's economic growth and development. The lack of quality and good education in a country means the fall of that country and its dependence on other developed countries for provision and support. The quality of education for Nigerian can be improved basically with the aid of the internet and effective communication. Internet access is presently today very active in Nigeria due to the communication satellite it uses. Distance learning is being encouraged as student from Nigeria are certified by foreign school form merely taking online courses (study over the internet)
- ✓ **Internet access:** There is a rapid increase in the access of information in Nigeria through fast growth of the internet which in return holds substantial promise for development. Communication and data delivery capabilities of the Internet have helped to develop the knowledge level of individuals and organizations in the nation to a level where both personal and business needs can be met professionally. Satellite communication links stands as a support to the Internet.
- ✓ **Online Health care and Telemedicine:** It is said that "health is wealth", that "A healthy nation is said to be a wealthy one". The number of medical cases needing expert judgment in Nigeria over the years has outgrown the number of experts available in the country. More lives will be saved in cases of emergency if the right diagnosis needed is given in the shortest possible time for the right treatment to be administered. Satellite communication has reduced the needs and flying in of expert form developed nations to handle our medical cases. Video calls over the network (like Skype) can put an expert at a distance place to appear as if he or she is right there in the same room with the person seeking for help.
- ✓ **Distance management:** Satellite telephony has helped to bridge the gap between rural to urban communication accesses. Satellite-based digital networks provide efficient long-distance service to rural communities at lower cost than similar land-based wired networks with satisfactory quality, reaching remote areas where terrestrial facilities are not available.
- ✓ **Tracking/ theft management and crime control:** Geographic Positioning System (GPS) is a vital satellite service for object tracking. GPS satellite service has been widely applied to aid navigation worldwide, which has been of great benefit in monitoring and theft control. It finds its application in recovery of stolen vehicles, fleet management, field service management, asset tracking, field sales and even wildlife tracking, land surveying, commerce, map-making, scientific uses etc. [7]
- ✓ **Economic Development:** Money has always remained a key factor to a nation's economic growth. It is said that the money invested into the satellite business return over 20 times the capital expenditure. The project, according to experts, was expected to help African (users of NigComSat-1) save more than \$900 million spent for telephony trucking and data transport services, \$660 million in phone call charges and broadband access, as well as create more than 150, 000 jobs for Nigerians. [8]

V. CHALLENGES FACED WITH SATELLITE COMMUNICATION IN NIGERIA

Nigeria will have to contend with a lot of challenges in Satellite communication sector. Presently, the United States of America has 19 satellite stations while United Kingdom has 5. This alone shows the level and quality of satellite communication when compare to Nigeria that has just 1 station. The challenges are as follows:

- **High cost of broadband:** Ernest Ndukwe, a former executive chairman of Nigerian Communication Commission (NCC) regretted that Nigerians operating companies are paying relatively high bandwidth charges for satellite links in the nation, a development, he argued has discouraged the extensive use of satellite as alternative means for long distance transmission [9].
- **Lack of technological know-how:** One great challenge faced by Nigeria is the high level of technological impotence. Nigeria relied on Russian and Chinese engineers for launching satellite. Dr. Chris Uwaje (the president of ISPON) in *The Nation* (2011, P.43) admitted this challenge: It is, therefore our professional opinion that our nation is faced with monumental challenge on how to structure, configure and reposition Information and Communications Technology and especially software in Nigeria as a prime industry for nation building, economic survival, national security and global competitiveness.
- **External influence:** “Africa is currently being dominated in all spheres militarily, medically and educationally to the control or near complete dominance of the communications technology space” by western powers were the words of Joe Anuga, a lecturer at the University of Jos. Which he therefore feared that if Nigerians don’t take their communication destiny in their own hands, we may not be able to attain the level of independence we require as a nation.
- **Political influence:** Most appointments into sensitive areas in the country are done not on merit but on political considerations. Communication satellite is so sensitive a venture to be politicized
- **Economic challenge:** Communication satellite project is a capital intensive one and needs more funds and adequate time to realize its objectives. This is also a challenge to Nigeria since she is faced with economic challenges especially in take-off and continued sustainability of critical projects.
- **Policy somersaults:** New policies are always made by successive governments in Nigeria just to score political goals. This has also posed a critical challenge for the communication satellite sector. [9]

V. CONCLUSION AND RECOMMENDATION

The Access to a reliable and adequate information has always become a true weapon of mass socio-economic development; and serves as a backbone to the individual’s improved quality of life. Nigeria has taken quit a giant step in her communication satellite developmental efforts but should also try to improve in activities that will boost her standard in this sector.

For Nigeria to make any headway in its quest to bridge the gap through communication satellite, the following recommendations should be taking into consideration: Increase in penetration of broadband services is neededurgently. This can be achieved by cutting down the cost through offering incentives to users, Empowerment of Information Communications and Technology experts in the country through training on international standard: Federal Government should establish a technology convergence center for satellite and other technologies for professionals to acquire international quality standard. Satellite engineers need to be trained and re-trained from time to time to be able to cope with the trends and patterns of new technologies, Increase Funding: Adequate funding is needed for maintenance of hard and soft ware components of the satellite facilities. A robust and effective maintenance culture should be built and sustained by all stakeholders, Partnership: Nigeria should be ready to partner with other African countries like South Africa, Egypt and many others to rob mind together and learn from one another to improve the fortunes of satellite communication in the continent. It is high time for the nation to be able to build its own satellite without the help of others. This will in return boost the economy and reduce the amount of money spent launching a satellite, Nigeria should engage in building satellites with more lifespan and a reduced weight. This will also save cost of production and launching.

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