

**COMMUNICATION SATELLITE DEVELOPMENT IN NIGERIA:  
APPLICATIONS, CHALLENGES, AND TECHNOLOGY TRANSFER**

By

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*Insert Salutation here*

## **INTRODUCTION**

Satellite is generically defined as either a man-made or natural object which orbits another object. However, the satellite of concern is man-made satellite, also known as artificial satellite.

Artificial satellite is a spacecraft carrying electronics payloads, antennas, power, control, and other ancillary sub-systems placed in space to orbit the earth. Hence, artificial satellite is very similar to an outside broadcasting vehicle used for terrestrial television/radio broadcasting.

There are three commonly used orbits for placement of satellites, namely, low earth orbit, LEO; medium earth orbit, MEO; and geostationary earth orbit, GEO. Also there are three popular satellite types namely earth observation satellites, navigation satellites, and communications satellites.

A LEO satellite has an altitude between 500 and 1000 km above the earth surface. Satellite operating in this orbit revisits the same point about every 2 hours and stays visible for about 15 to 20 minutes. Hence, it is necessary to have 60 or more collaborating satellites for real time communications. NigeriaSat-1 is an example of LEO observation satellite.

MEO satellites operate at higher orbit of about 1000 and 2000 km with longer visibility period of few hours and larger coverage area than LEO. This orbit is presently occupied by navigation satellites such as global position system, GPS.

The GEO satellites are placed at orbit with a synchronous speed with earth rotation, hence object at this orbit looks stationary relative to the earth. This orbit is popularly used by communication satellite. The focus of this presentation is communication satellites which are deployed primarily for telecommunication services.

Satellite broadcasting is based on the same principle and has the same goal as that of a terrestrial television broadcasting. The only major difference between satellite and terrestrial television broadcasting network is the placement and the required number

of repeaters. In satellite broadcasting, just one repeater placed at a distance of 35768 km directly above the equator subtends a solid angle of about  $17.4^\circ$  with the earth. This translates to about 11000 km of land span.

Therefore, a single satellite has a visibility of 11000 km of the earth which is about 27% of the earth's circumference. Hence, only four satellites or repeaters are needed to cover the whole world. However, three satellites suffice to cover the entire world considering the fact that a vast amount of the earth is covered by un-inhabited seas.

This fewer number of repeaters, in comparison to corresponding thousands of repeaters in terrestrial broadcasting, to cover the world accounts for the numerous advantages and extensive applications of satellite broadcasting over the terrestrial broadcasting. [1]

ITU has divided the world into three regions, namely, region 1, region 2, and region 3. Region 1 covers Europe, Africa, and Middle East with longitudes ranging from  $40^\circ\text{W}$  to  $45^\circ\text{E}$ . The region 2 consists of North, Central, and South America having longitudes  $40^\circ\text{W}$  to  $160^\circ\text{W}$ . And region 3 covers India, Asia, and the Pacific at longitudes of  $160^\circ\text{W}$  to  $45^\circ\text{E}$ . [2].

Services offered by communications satellites are broadly categorised into three, namely, Fixed Service Satellites, FSS; Broadcasting Service Satellites, BSS; and Mobile Service Satellites, MSS. The FSS geostationary communications satellites offer point-to-point communication such as broadcast feeds, telephony, and data communication. BSS, also known as Direct Broadcasting Service, DBS; or Direct-to-Home, DTH satellites are used for providing satellite television and radio services directly to homes.

The MSS repeaters can be placed in GEO, MEO, or LEO orbit provided there are enough number of satellites in the network, or there are properly spaced around the globe. MSS satellites are used for mobile and portable wireless telephones, and television.

## COMMUNICATION SATELLITE IN NIGERIA

Nigeria is a large and populous nation covering an area of 923,768 sq meters made up of 910,768 sq meters of land area, and 13,000 sq meters of water area. It is located and encompassed by a geographic window with the lower left geographic coordinates of  $(2^{\circ} 43.207'' E, 4^{\circ} 17.825'' N)$  and upper right geographic coordinates of  $(14^{\circ} 54.685'' E, 13^{\circ} 52.837'' N)$  as shown in Fig 1.

Nigeria with longitudes ranging from  $2^{\circ} 43.207''$  and  $14^{\circ} 54.685''$  falls in ITU region 1. Hence, can receive directly and effectively signals from satellites in region 1. Table I tabulates the 51 communications satellites in geostationary orbit as at March 2011 designated as region 1 by ITU. It is required that there should be a minimum of  $2^{\circ}$  spacing between satellites. However, the present 51 satellites occupying  $85^{\circ}$  result in an average spacing of  $1.7^{\circ}$ . [1,3]

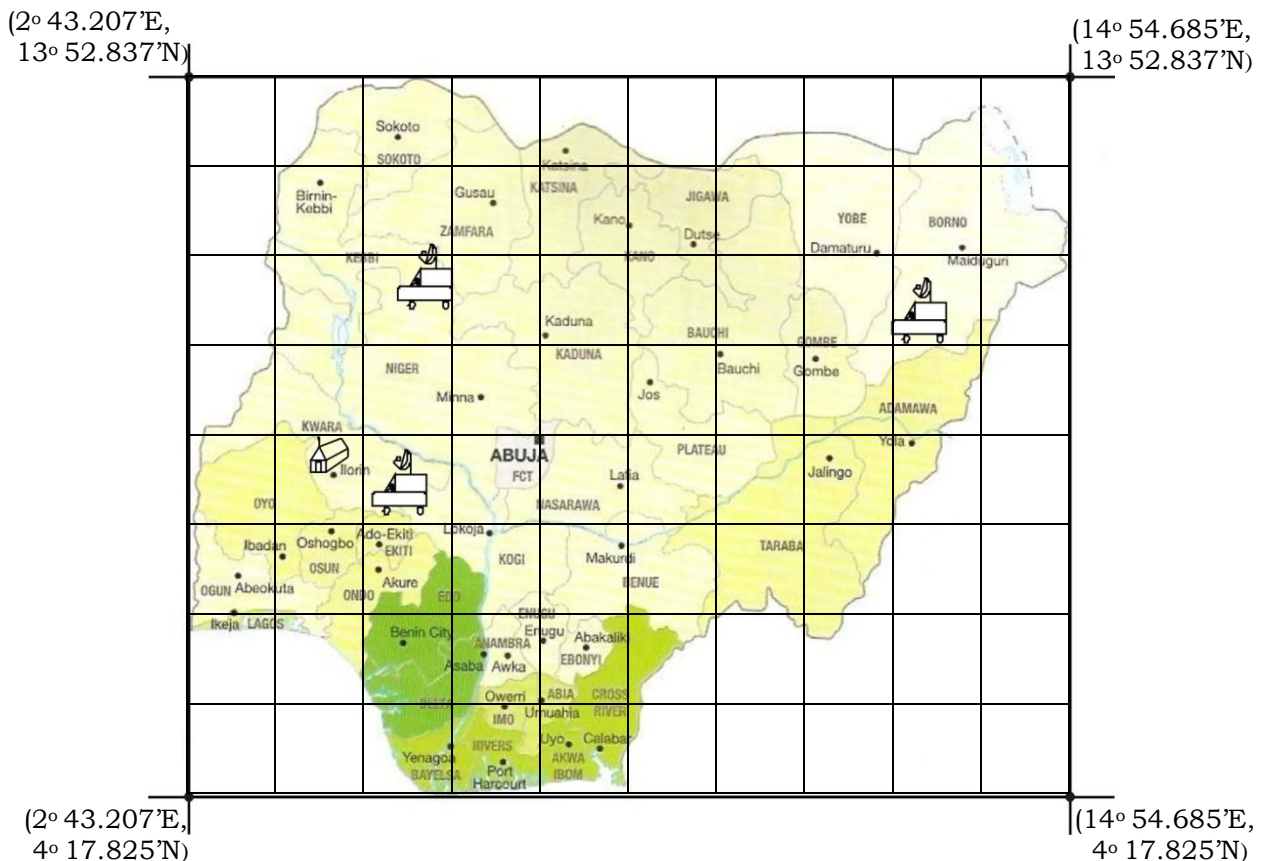


Fig. 1: Nigeria Geographic Location bounded by Rectangle with bottom left corner coordinate  $(2^{\circ} 43.207'E, 4^{\circ} 17.825'N)$  and top right corner coordinate of  $(14^{\circ} 54.685'E, 13^{\circ} 52.837'N)$

**Table I: ITU Region 1 Satellite ( Europe, Africa, Middle East : 40°W – 45°E)**

No. of Satellite as at March 2011: 51 ; Average Satellite Spacing: 1.7°

s/n	Sat. long.	Name of Satellite(s)	Services	s/n	Sat. long.	Name of Satellite(s)	Services
1.	40.5°w	NSS 806	C, Ku	26.	2.8°E	Rascom QAF 1R	C
2.	37.5°w	NSS 10, Telstar 11N	C, Ku	27.	4°E	Eurobird 4A	Ku
3.	34.5°w	Intelsat 903	C, Ku	28.	4.8°E	Astra 4A/1E (incl. 0.7°)	Ku
4.	33.5°w	Hylas 1	L,S,Ka	29.	7°E	Eutelsat W3A	Ku
5.	31.5°w	Intelsat 25	L,S,Ka	30.	9°E	Eurobird 9A	C,Ku
6.	30°w	Hispasat 1C/1D/1E	Ku, L,S,Ka	31.	10°E	Eutelsat W2A	C,Ku
7.	29.5°w	Intelsat 801 (incl. 2.2°)	L,S,Ka	32.	13°E	Hot Bird 6,7,9	Ku
8.	27.5°w	Intelsat 907	C, Ku	33.	15.8°E	Eutelsat, Sesat 1, W2M, Euro Bird 16	Ku
9.	24.5°w	Intelsat 905	C, Ku	34.	16°E	Turksat 1C (incl. 2.7°)	L, S,Ka
10.	22°w	NSS 7	C, Ku	35.	17°E	Amos 5	L,S,Ka
11.	20°w	NSS 5	C	36.	19.2°E	Astra H, 1KR, 1L, 1M	Ku
12.	18°w	Intelsat 901	C, Ku	37.	20°E	Arabsat 2E	C
13.	15°w	Telstar 901	C,Ku	38.	21.6°E	Eutelsat W6	Ku
14.	14°w	Express A4 (incl. 1.5°)	L,S,Ka	39.	23.5°E	Astra 3A, 3B	Ku
15.	12.5°w	Atlantic Bird 1	Ku	40.	25.5°E	Eurobird 2	Ku
16.	11°w	Express AM 44	C,Ku	41.	26°E	Badr 4,5,6	Ku
17.	8°w	Atlantic Bird 2	Ku	42.	28.2°E	Eurobird, Astra 2A, 2B,2D	Ku
18.	7.8°w	Telecom 2D	L,S,Ka	43.	30.5°E	Arabsat 5A	C,Ku
19.	7°w	Nilesat, Atlantic Bird 4A	Ku	44.	31.5°E	Astra 1G, 2C	Ku, L,S,Ka
20.	5°w	Atlantic Bird3	C,Ku	45.	33°E	Eurobird 3	Ku
21.	4.3°w	Thor 3 (incl. 0.8°)	L,S,Ka	46.	36°E	Eutelsat W4,W7	Ku
22.	4°w	Amos 2,3	Ku	47.	38°E	Paksat1	C,Ku
23.	0.8°w	Thor 5,6 ; Intelsat 10-02	C,Ku	48.	39°E	Hellas Sat 2	Ku
24.	1.8°E	Astra 1D (incl. 3.2°)	Ku	49.	40°E	Express AM 1 (incl. 2.7°)	C,Ku
25.	2°E	Astra 1C (incl. 4.1°)	Ku	50.	42°E	Turksat 2A, 3A	Ku
				51.	45°E	Intelsat 12, Afrisat 2 (moving 0.6°)	Ku, L,S,Ka

## BENEFITS AND CHALLENGES

The geographical closeness of Nigeria to the equator suppose to be of immense advantage in communications satellite in term of dish elevation angle. The lower the elevation angle of a dish the more ground noise it picks. Hence, a stipulated minimum elevation angle is imposed. For this reason, it is difficult to receive usable signals

from sites near the arctic region. At the equator where the latitude is  $0^\circ$ , when the longitude of an earth station is the same with that of the satellite, the resulting elevation that the dish makes is  $90^\circ$  while at the arctic the elevation angle will be approaching  $0^\circ$ . Also it is possible to experience low elevation angle when close to the equator if the differential longitude angle between a site and satellite is high. For example, if an earth station at NASRDA, Abuja ( $7.49^\circ\text{E}$ ,  $9.06^\circ\text{N}$ ) is aimed at a communications satellite at  $80^\circ$  longitude results in elevation angle of  $8.6^\circ$  which below the minimum. While the same earth station pointed to NigComSat-1 located at  $42^\circ\text{E}$  would give  $49^\circ$  elevation angle and  $79^\circ$  if pointed to a satellite at  $7.5^\circ\text{E}$ . Another challenge to communication satellite is signal attenuation due to rain, harmattan, and sahel dust. Satellite signals in the Ku and Ka bands suffer degradation from these environmental effects. The heavier the rain fall rate the more the degradation. ITU divided the world into rain zones ranging from A to Q with A being the least and Q the highest rain fall rate. Nigeria is in rain zone P in the south, zone N in the savannah region, and M zone in the far North.[4].

## **COMMUNICATIONS SATELLITE APPLICATIONS**

Communications satellite system consists of earth station transmitter, space segment repeater, and another earth station receiver. The placement in space of the repeater unit at an altitude where only three of such repeaters are needed to cover the entire world in 24/7, i.e. continuously, turns the world into a global village.

Hence, delivery of information signals either in analogue or digital form through this medium is cost-effective. This has rendered delivery of the same services through other means a far distant rival. Therefore, it is not surprising the numerous applications of communication satellites.

These applications include television and radio services, video\_on\_demand, telephony, Internet services, global distribution of data, tele-education, tele-medicine, and electronic commerce.

**Television and Radio Application:**

Terrestrial television and radio service delivery is localised because of the large number of repeaters, with their attendant cost, required to have even a national coverage. For instance in Nigeria where television and radio services are delivered via terrestrial, Nigerians living in states far away from their states have become “information diaspora” in their own country !

Satellite television and radio provide access not only nation-wide but also globally. AIT satellite broadcasting is a typical example of global coverage. Digital technology has further enhanced and widened the applications of television and radio. For instance, the channel bandwidth for one analogue television programme is sufficient for over six digital television programmes.

Also, a digital television programme can be accompanied with multi-lingual audio. Hence, delivering digital television programmes in Nigeria via satellite will eliminate language divide and further enhance our unity.

**Internet Application:**

Communications satellite has been the major vehicle for global availability of Internet services without it Internet is just intranet. The four main Internet services are e-mail, ftp, telnet, and www. E-mail is faster, more secured, reliable, and cheaper than conventional postal system.

The ftp service for transferring files from known websites on the Internet is only cost-effective over communications satellite. Telnet, a real time online resource sharing over Internet is major globally available over communications satellites. The World Wide web, www, is another real time online service popularised by e-commerce, web based simulation, online business and research collaboration and partnership.

It is communications satellite that makes this service available globally and affordable. Internet broadcasting is a new synergy service that offers digital television broadcasting over the Internet.

**Telephony Application:**

Communication satellite provides low cost telephone service to rural areas and also globally in real time. Video phone and video conferencing are possible via communications satellite.

**Data Communication Application:**

Surveillance and monitoring of scenes, and control of electrical appliances from anywhere in the world are becoming popular applications of data communication over satellite. Point-to-point data communication from observation satellite can be made point-to-multipoint via communications satellite.

**Tele-Education Application:**

It is becoming increasingly difficult for both government and private sector to provide adequate access to tertiary education. Distance learning provides access education globally to everybody that so desires. Also distance learning offers second chance for late education and drop-outs.

Remote access to well equipped laboratories and e-libraries located anywhere in the world, processes known as virtual laboratories, and virtual libraries respectively is available via communications satellite. The service of world experts in education is available online and offline over satellite. Researchers all over the world can form virtual collaboration forum.

**Tele-Medicine Application:**

Health care delivery in Nigeria is grossly inadequate both in quantity and quality. Tele-medicine extends and expands health care delivery via communications satellite. Experiences of expert physicians all over the world can be shared over satellite. Medical students can have access to watch remotely surgery and complex health care delivery process over communications satellite.

**E-Commerce Application:**

Business transactions are being conducted globally at a click of a button over the Internet. E-commerce has turned the entire world to one big show room and has removed the side effects of middle men in business.

It offers cheap and global medium for advertisements. Electronic money transfer is gradually turning the world to a cashless society. All these services are effected over communications satellite.

**E-Government Application:**

Information is power, hence, communications satellite provides a venue to empower people through information. Government activities can be communicated to individuals right in their homes in real time. People's opinions can be harnessed via satellite.

**DEVELOPMENT AND TECHNOLOGY TRANSFER IN NIGERIA**

National Space Research and Development Agency, NASRDA, of Nigeria recored the first milestone in satellite development with the development and final launching of NigeriaSat-1 in 2003. The NigeriaSat-1 is a LEO observation micro-satellite used for 32 metre resolution remote sensing.

The Nigeria's NigComSat-1 satellite which was launched into geostationary orbit in 2007 became the first African communications satellite . It was reported failed in 2008. NigComSat-1 had transponders in the C, Ku, and Ka bands with strong footprint in Nigeria, some parts of Africa, and south Europe.

It was developed to provide telecommunication services, Internet and Multimedia services, tele-education and rural telephoning to Nigeria and some parts of Africa [5,6 ].

Federal Government of Nigeria has been making concerted efforts in technology transfer of satellite development for the empowerment of Nigerians. Firstly, Federal Government of Nigeria established NASRDA to carry out this mandate.

Towards the realisation of this mandate, Nigerian Engineers of NASRDA have been participating actively under the supervision of leading world experts and organisations in satellite technology development. For instance, our engineers participated in development of NigeriaSat-1, and NigComSat-1.

In fact, Nigerian Engineers built the NigeriaSat-2 observation satellite to be launched soon; and are actively involved in the development of NigComSat-2 communications satellite yet to be launched. For the sustainability of satellite technology development, the Centre for Satellite Technology Development, CSTD, of NASRDA made a move to collaborate with Nigerian universities through a project code named SPIRE, (Satellite to Promote Instructional and Research Experiment).

However, this project was surprisingly abandoned unaccomplished. The technology transfer of satellite development is a must task that has to be accomplished. Hence, Federal Government of Nigeria needs to intensify efforts in satellite technology development.

## **RECOMMENDATIONS**

It is, therefore, recommended that:

1. Federal Government of Nigeria intensifies efforts by adequately financing satellite technology development and space research ;
2. NASRDA resumes the abandoned SPIRE projects ;
3. NASRDA collaborates with NUC to develop curricula in space science and technology for our tertiary institutions ;

4. NASRDA conducts the Stakeholders' s meeting regularly.

*Thank you for listening.*