

A Detailed Over-View of Satellites Launched By National Research and Development Agency from 2001-2016

Nsikan Nkordeh, Ibinabo Bob-Manuel, Oluyinka Oni

Abstract- More often than none, space exploration is considered as a Western endeavor and regarded as an ‘elite’ activity, reserved for the world’s superpowers. In recent years however, developing nations such as Nigeria, India, Chile and South Africa, have begun to change this view, by showing that they can play a role in the exploration of the world beyond earth. As Ade Abiodun states: “the Space Age, which began as a competition among scientists in two countries, the Soviet Union and the United States, soon took on a political life of its own”. The desire to explore and utilize the space environment for the benefit of mankind has become almost a universal quest, with each day witnessing the ascent of humankind into space from different corners of the globe’.

In this directed study, an in-depth of satellites associated with the Nigerian Space programme has been undertaken. A well detailed and comprehensive research into these satellites; the specifications and its applications as well as the economic, technological and scientific contribution to the nation’s advancement.

The National Space Research and Development Agency(NASRDA) which is the body in charge of satellite operations in Nigeria and has 5 functioning satellites, each with various centres stationed in different parts of the nation has been in existence over the past ten years. Nigeria was recognised as the first African nation to have launched a fully operating satellite. The main focus of the space programme thus far, has been satellite technology.

NigeriaSat-1, launched in 2003 was Nigeria’s first satellite¹. launched into orbit and still fully functional has been successful in obtaining and retrieving disaster monitoring information². and imagery. Ever since then, Nigeria has launched four more satellites with record of only one failure from the second³. satellite; NigComSat-1 which was later replaced with the⁴. NigComSat-1R. An establishment of six centres dedicated to⁵. advance Nigeria’s space programme through education⁶. research and technology was opened throughout the country. Individually and holistically they hold local, national and international importance as a representation of the beginnings of the Nigerian and African Space Age, and as achievements of technological and scientific advancement.

Index Terms— NASRDA, NigComSat-1 NigeriaSAT, Payload, Satellite

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I. INTRODUCTION

A satellite is a celestial body or man-made device that orbits a planet or a star. For example, Earth is a satellite because it revolves round the Sun and the moon is a satellite which revolves round the Earth [1].

A satellite has a variety of uses, some of which include communication, navigation, atmospheric studies, remote sensing, space exploration, weather, search and rescue all of which depend on the type of satellite in use. Satellites have a highpoint view that allows them to collect more information, faster than instruments on the ground. Satellites serve as a pathway for signals to be sent across distances of varying range in a short amount of time. Satellite comes in various shapes and sizes, all of which have two parts in common which is; the antenna and power source. Satellites are launched into space on rockets. When a satellite is launched into space, they are monitored by agencies on ground.

National Space Research and Development Agency (NASRDA) is an agency in charge of satellites launched by Nigeria and is charged with the mandate to consolidate all Space Science and Technology related activities. The Agency was established in May 5, 1999 with six operational centres [2];

Centre for Satellite Technology Development(CSTD), Abuja

Centre for Space Science and Technology Education(CSSTE), Ile-Ife

Centre for Space transportation and Propulsion(CSTP), Epe

Centre for Basic Space Science(CBSS), Nsukka

Centre for Geodesy and Geodynamics(CGG), Toro

National Centre for Remote Sensing(NCRS), Jos

The Headquarter is located in Abuja. The National Space Research and Development Agency is in pursuit of the development and application of space science application and technology for the socio-economic benefits of the nation. [3]. So far five satellites have been launched by the NASRDA;

1. NigeriaSAT-1 (27th September 2003)
2. NIGCOMSAT-1 (14th May 2007)
3. NIGERIASAT-X (17th August 2011)
4. NIGERIASAT-2 (17th August 2011)
5. NIGCOMSAT-1R (13th December 2011)

This paper therefore aims at the detailed explanation of the satellites that have been launched by the National Space Research and Development Agency(NASRDA) between the years 2001-2016.

II. NIGERIASAT-1

On the 27th of September, 2003 Nigeria launched the Nigeria-Sat-1 micro-satellite into low orbit. Thus becoming the first African nation to own and operate a space borne multispectral remote sensing satellite system. NigeriaSat-1 was designed by a United Kingdom company, Surrey Space Technology Limited and was launched by a Kosmos-3m rocket in Plesetsk, Russia for 30 million dollars. This spacecraft was built as part of a training program by SSTL, joined the Disaster Monitoring Constellation along with spacecraft from five other countries (Algeria, China, Turkey, Spain and UK)[4]. some of the reasons for putting the spacecraft into orbit are;

1. To alert on early warning signals of environmental disaster
2. To detect and control desertification in the northern part of Nigeria
3. To aid in demographic planning

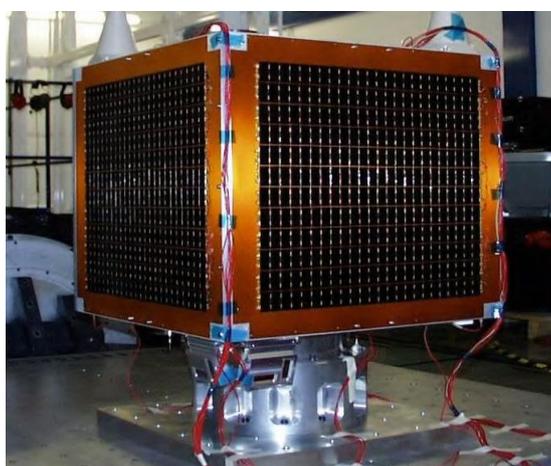


Fig.1 NigeriaSat-1 before launch

NigeriaSat-1 was the 1st satellite to provide a picture of California after the Hurricane Katrina disaster in August, 2005. Ade Abiodun states: “you start small you learn from that experience - and from that you gain a lot of capability” (BBC NEWS 2003:n.p).

The satellite launched became a historical event adding value to the progress of the Nigerian Space Programme. The programme was seen as a relevant feature in Nigeria’s development and into its ‘Space Age’

Nigeria’s first satellite NigeriaSat-1 upholds a particular significance as a sign of Nigeria’s premier and indeed successful travel into space.

The Disaster Monitoring Constellation, the NigeriaSat-1 being a member can be seen as a joint global attempt to survey and study the world from space.

FEATURES of NIGERIASAT-1 [6]

1. launched into a polar sun synchronous orbit of altitude being 686km
2. weight of 98kg with push beam scanning technology
3. life span of 5 years’ minimum
4. swath width of 600km
5. Payload imaging of 3band multispectral imager in the green and red image band

6. ground sampling distance with spatial resolution pf 32 metres
7. Storage capacity of one gigabyte ssdr to support storage activities
8. Forward and store communication system
9. GPS that’s space borne for orbit determination
10. two computers in the satellite for processing data
11. Butane propulsion system for orbit maintenance and station keeping
12. NigeriaSat-1 had a mounted solar cell array for supplying power with NiCad cells for backing up the battery.

Table.1 Disaster Monitoring Constellation 2003[5a]

Country	Designation	Type	Imager	Launch	
	Algeria	Alsat-1	DMC	32m MS	2002
	China	Beijing-1	DMC+4	32m MS / 4m Pan	2005
	Nigeria	NigeriaSat-1	DMC	32m MS	2003
	Turkey	Bilsat-1	Mission Completed 2006		
	UK	UK-DMC	DMC	32m MS	2003
	Spain	Deimos-1	DMC	22m MS	2008
	UK	UK-DMC2	DMC	22m MS	2008

Table.2 Technical Details Of Nigeriasat-1 [5b]

Parameter	Specification
Swath width	600km
Typical revisit cycle (temporal resolution)	3 - 5 days (but 1 day when used in conjunction with other DMC satellites)
Ground Sampling Distance (GSD) i.e. spatial resolution	32m
Maximum image size (Pixels)	20,000 x 16,000 pixels ~ 300,000km ²
Wavebands (spectral resolution)	Channel 1 (Green: 0.52 μm – 0.62 μm) Channel 2 (Red: 0.63 μm – 0.69 μm) Channel 3: (NIR: 0.76 μm – 0.90 μm)
Average orbital altitude	684km (perigee 676, apogee 692)
Orbital period	98.4min
Inclination	98.1°
Weight	98kg
Life span	5 years

III. NIGCOMSAT-1

It was Nigeria’s second satellite and Africa’s first ever geosynchronous communication satellite [8]. It was built by a Chinese company “China Great Wall Industries Cooperation” and was launched aboard a Chinese long march 3B carrier rocket on 13th of May 2007 from the Xichang Satellite Launch Centre [9]. It provided Ku-Band, Ka-Band, L-Band and C-Band. It failed in orbit in November 2008 due to a technical malfunction (power failure due to problem in solar panels). It was worth 311 million, dollars.

It was equipped to improve telephone and internet connections mainly for central Africa: ‘the launch is being portrayed as part of a drive to enhance rural access to technology and the internet and boost Nigeria’s and Africa’s knowledge economy’
 Note: Due to its early demise, CGWIC replaced it with the NigCom1-R



Fig.2 Model of the NigComSat-1 in CSSTE

Specifications Of Nigcomsat-1 [10a]

1. Mass of 5150kg at launch (Includes mass of rocket)
2. 15-year service life
3. positioned at 42.5 degrees east
4. 5 tons’ wet mass was carried at launch 1.1)
5. forty transponders (28 active) in the Ku, C, Ka, and L-bands. The NigComSat-1 provides total

Application Nigcomsat-1 [10b]

1. coverage over the middle east, Europe and of course Africa
2. Pan-African Satellite having coverage over the African continent.

IV. NIGERIASAT-X

It was an observation satellite that provided the Disaster Monitoring Constellation and Nigerian National Space Research and Development Agency and with an imaging capacity of 22mGSD [11a], it was launched into space on the August 17, 2011 in Yasny Lunch site located in the Orenburg region, Russia by DNEPR going 700 km on altitude into the orbit. NigeriaSat-X operated on the SSTL-100

It was developed by a team of twenty-six (26) Nigerian engineers under the super-vision of surrey space technology limited. It was created in 18 months.

Features Of NigeriaSAT-X [12]

1. Sensor detector -eastman Kodak KLI14403 linear CCD sensor
2. Spectral bands – 0.52-0.62 micometre (green)
3. Lens-custom design ,155.9mm focal length lens
4. GSD-22metres
5. Swath per channel -greater than 300 kilometres
6. Total imaging swath – greater than 600 kilometre
7. Data quantization 8/10-bit digitization
8. SNR- greater 100
- 9.

- Applications of NigeriaSAT-X [13b]
1. provide a very high resolution system that helps in mapping the country once in every four months
 2. secure food supply by monitoring the Nigerian plant status
 3. aids in the development of the Nigerian geographical information system
 4. promote human resources nationally to use space applications in Nigerian development
 5. provide data to the NASRDA constantly



Fig.3 Model of NigeriaSAT-X before launch

V. NIGERIASAT-2

The NigeriaSAT-2 is the most sophisticated small satellite on the planet, reaching new standard in earth observation technology. its high resolution data has aided for resource management and mapping of the Nigerian territory.

The Nigeria sat-2 was also designed by Surrey Satellite Technology on the request of the National Space Research and Development Agency. It was launched on August 17, 2011 by a Dnepr launch rocket from Yasny Lunch site located in the Orenburg region, Russia. It was built at a cost of \$35million



Fig. 4 Image of The NigeriaSAT-2 before launch

Specifications of NigeriaSAT-2 [10c]

1. 2.5- meter resolution panchromatic; it makes use of a high resolution imager to capture detailed images across the globe
2. 5m GSD 4-ban multi-spectral imagery; in combination with data provided by the panchromatic instrument, it

helps in adding colour to the imagery and also makes it easy to pan information gotten from the satellite

3. 45-degree roll/pitch off pointing; used to select imaging target and enables access opportunities to any place in the globe (at least one in 2 days)
4. Agility; this allows for a number of physical separate targets to be imaged in the same pass
5. Downlink speeds of 2 x 205 Mbps; allows the satellite to provide high quality data in as little time as possible
6. Life span; it has a life span of 7.4 years

Images are captured for certain areas and application needs. The Nigeriasat-2 provides data that can meet these various requirements

Application of NigeriaSAT-2

1. Urban mapping
2. Oil spillage (2.5m or 5m)
3. Change in land use for both rural and urban areas
4. hydrology that is irrigation, farming projects
5. production of crops and monitoring of forest vegetation
6. security and protection (2.5m panchromatic)
7. protection of pipelines
8. terrain analysis and structure mapping

VI. NIGCOMSAT-1R

It is hybrid geostationary satellite built by the Great China Wall Industries Cooperation at no cost to the Nigeria government as a replacement for the nigcomsat-1 which failed in November, 2008. The nigcomsat-1r is also a DFH-4 like its predecessor but superior to it has latter or newer component.

The launch of the new satellite was on a long march 3b from the Xichang satellite centre in china on December 13, 2011. It has two ground control station. The main station is in Abuja while the back -up station in in kasha, china [13a].

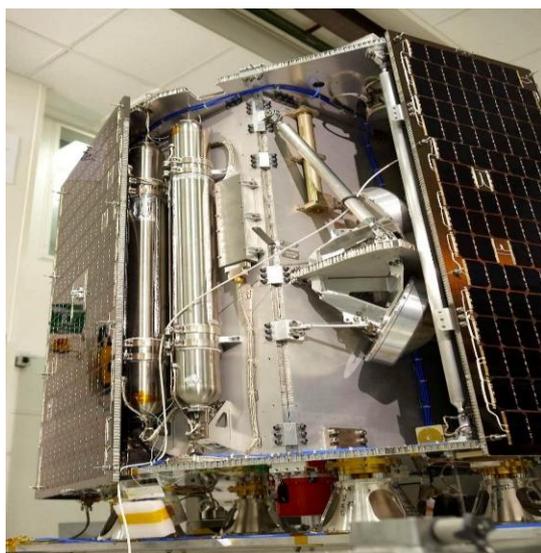


Fig 5. Model of NIGCOMSAT-1R before launch

Table.3 NIGCOMSAT-1R Transponder Information

TRANSPONDER INFORMATION:

PAYLOAD	COVERAGE	BANDWIDTH/TRANSPONDER	POWER
Ku-BAND	WEST, SOUTH AFRICA,& KASHI	31.5MHz	150 Watt TWTA
C-BAND	WEST, EAST AND CENTRAL AFRICA	36 MHz	60 Watt TWTA
Ka-BAND	EUROPE,NIGERIA & SOUTH AFRICA	120 MHz	70 Watt TWTA
L-BAND	GLOBAL	L1 = 4 MHz L5 = 20 MHz	L1 = 62 W SSPA L5 = 45 W SSPA

Features of NIGCOMSAT-1R [13b]

1. It is a super hybrid geostationary satellite
2. It has twenty-eight (28) transponder;
 - a) C-band: 4 active transponders (covers West Africa, east africa and central africa)
 - b) KU-band: 14 active transponders ()
 - c) KA-band: 8 acive transponders
 - d) L-band payload: 2 active transponders (navigational)
3. minimum life span; 15 years
4. max at launch: 5088.2 kg
5. dimension: 2360mm X 2100mm X 3700mm

APPLICATION OF NIGCOMSAT-1R

1. The KU-bands will aid communication link between Nigeria and China
2. NigComSat helped in increasing economic growth in Nigeria by aiding the creation of employment and reducing cost of telephone and internet bill
3. C-band aids communication within Africa
4. Ka- band will be able to reach parts of Europe
5. L-band will help in navigation channels and make for more accurate satellite position in Africa

a.

VII. FUTURE GOALS OF THE AGENCY

1. Development and Building of made in Nigeria Satellite 2018
2. Development of Rocketry/Propulsion system 2025
3. Development of Spin Off of Allied Industries- Electronics, Software 2026
4. Large Scale Commercialization of Space Technology and Know-how 2028

VIII. UNDER-UTILIATION OF SATELITES BY BOTH NIGERIA AND OTHER AFRICAN COUNTRIES

It would be insightful to highlight and take cognizance of some of the area's where the use of African owned satellites has fallen short of its full potentials. The aim of this, is not to belittle the efforts of these African countries. But to aid in improving the services of these satellites to better serve us; **Mapping:** a specific mapping program should be put in place by the government to harness images retrieved from these satellites, to aid in revision of some of our out-of-date medium scale regional maps and the production of new set of maps to keep y with change in the environment.

Conservation of land: data obtained for satellites could aid conservations plans with are designed at preserving existing values. Areas tagged “Green Vegetation” or “Historical Monument” can better be monitored with the aid of satellites. This would help in reduction of cases of vandalism in these sites.

Communications: Communications satellites cover all land masses and there is growing need for both high speed internet and broadcasting. Hence, countries with communication satellites can market a ratio of their serves for income. This will help provide revenue for national development.

IX. SENSITIZATION OF THE AGENCY

The importance of the Nigerian Space Research and Development Agency and the satellites services they provide cannot be over-emphasized. Hence, bringing its existence to the general public is of utmost importance. Below, are ways that can help with this endeavor;

OUTREACH PROGRAMS: conducting outreach programs to universities, secondary schools and other learning centers to educate them on these satellites, functions of the agency and career paths as well as how these satellites aid in the national and African development space and research agency.

SOCIAL MEDIA: Since the turn of the century, social media platforms such as twitter, facebook and other social networking sites has aided in the profusion of information across the globe by providing a platform for interaction. Hence enhancing a social media presence can be a vital tool in developing awareness of the NASRDA.

ADVERTISEMENT USING TRADITIONAL METHODS: While the use of print media may be declining in the face of electronic communications, many consumers still read newspapers and magazines. You may be able to use the declining significance of print publications to your advantage by negotiating a lower advertising rate. Create attention-grabbing advertisements that prominently display the NASRDA and their value.

X. CONCLUSION

As is evident from the above study, the Nigerian Space Programme is a complex and developing programme. Established in 1999, the agency has come a long way and has formed a strong foundation. Largely influenced by political and social motivations, the programme is seen as a stimulus for the failing Nigerian economy, a source for national identity and as a governmental venture to alleviate the country’s widespread poverty and to boost its technological advancement.

NASRDA, has since 1999, launched 5 satellites into orbit, though recorded only one failure but the programme has been seen as a huge success and Nigeria also been the first African nation to launch a satellite has given the country International credit and recognition. These satellites have aided in communication, education, security, agriculture, health facilities as well as monitor and manage occurrence of natural disasters, terrain analysis and structure mapping, and a whole lot more.

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