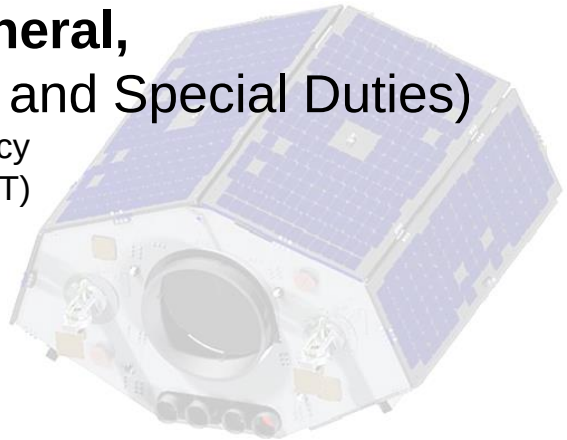
EXPLORING SPACE TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

By

Jonathan Angulu, **Ag. Director General,**
Halidu Ibrahim, PhD, Director(Space Regulations and Special Duties)
National Space Research and Development Agency
Federal Ministry of Science and Technology (FMST)



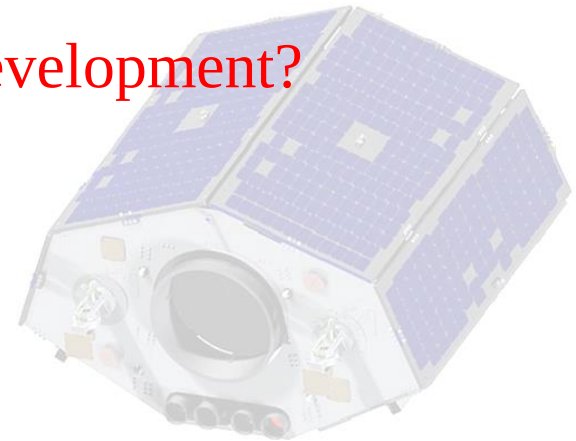
OUTLINE

- *Introduction*
- *Space Technology (ST) and Economic Impacts*
- *Space Technology Segments*
- *ST and the Sustainable Development Goals*
- *The Nigeria Space Programme*
- *The Need and Investment*
- *Recommendations and Conclusion*

Introduction

- Space technology (ST) involves that technology for developing and deploying spacecraft, satellites and space stations into orbits.
- ST also includes the development and use of the ground support infrastructure, equipment and procedures

Can space technology be a tool for national development?



Introduction…

Active space-fairing nations drive their national development with space-based technology, and their deployed space programmes, missions and the space spin-offs have remained sources of revenue generation and sustainable technological growth for such leading nations over the years.

Introduction …

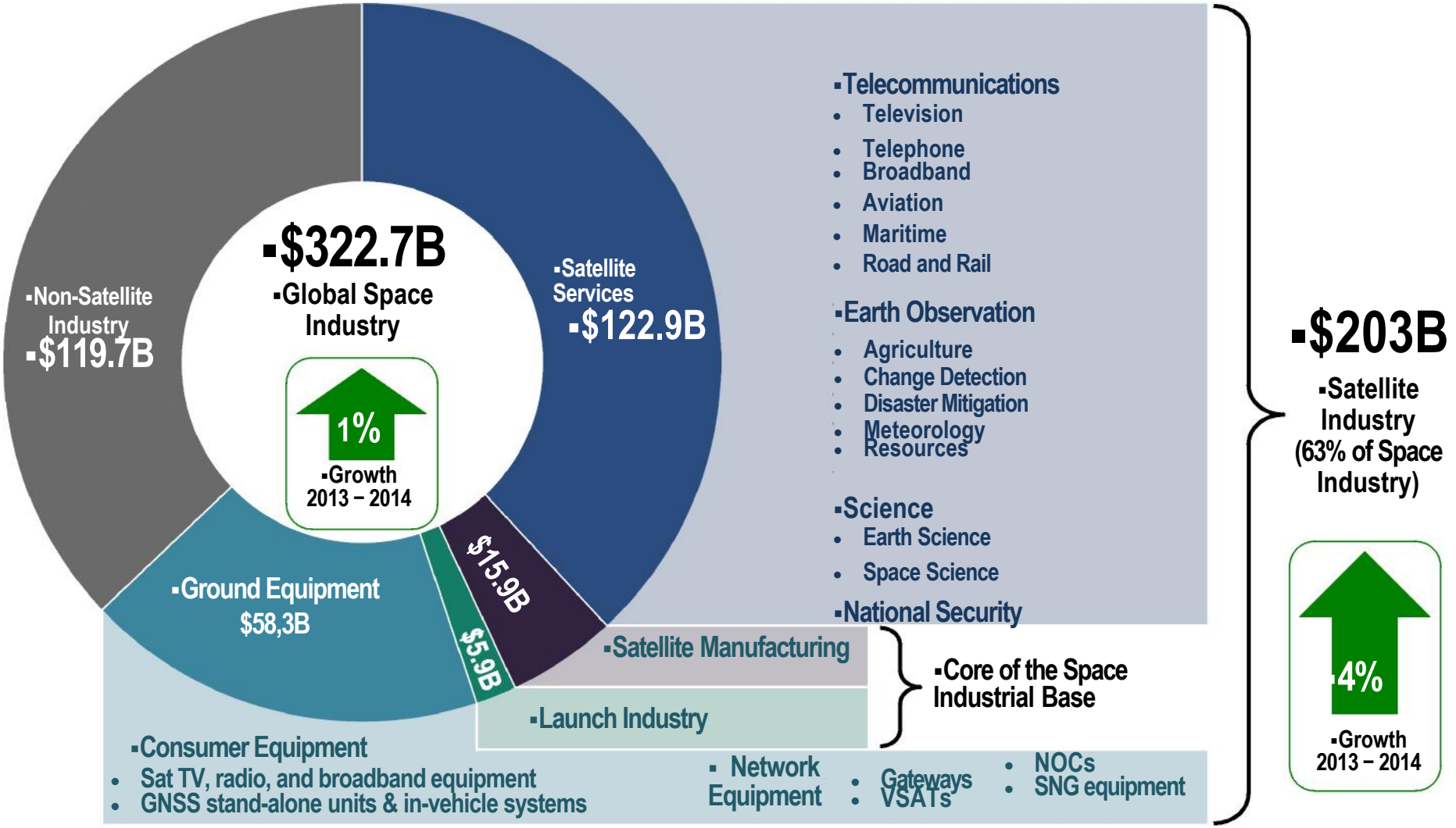
Space technology is a fulcrum for most of the identified Sustainable Development Goals (SDGs), and developing nations are encourage to utilized such existing technology for actualizing the SDGs.

Investing in ST as a technological development vehicle is not cheap but its benefits and turn-around effects are tremendous and enviable when adopted

Here are some revenue extracts …

Space Technology and Economic Impacts

The 2014 Global Space Economy

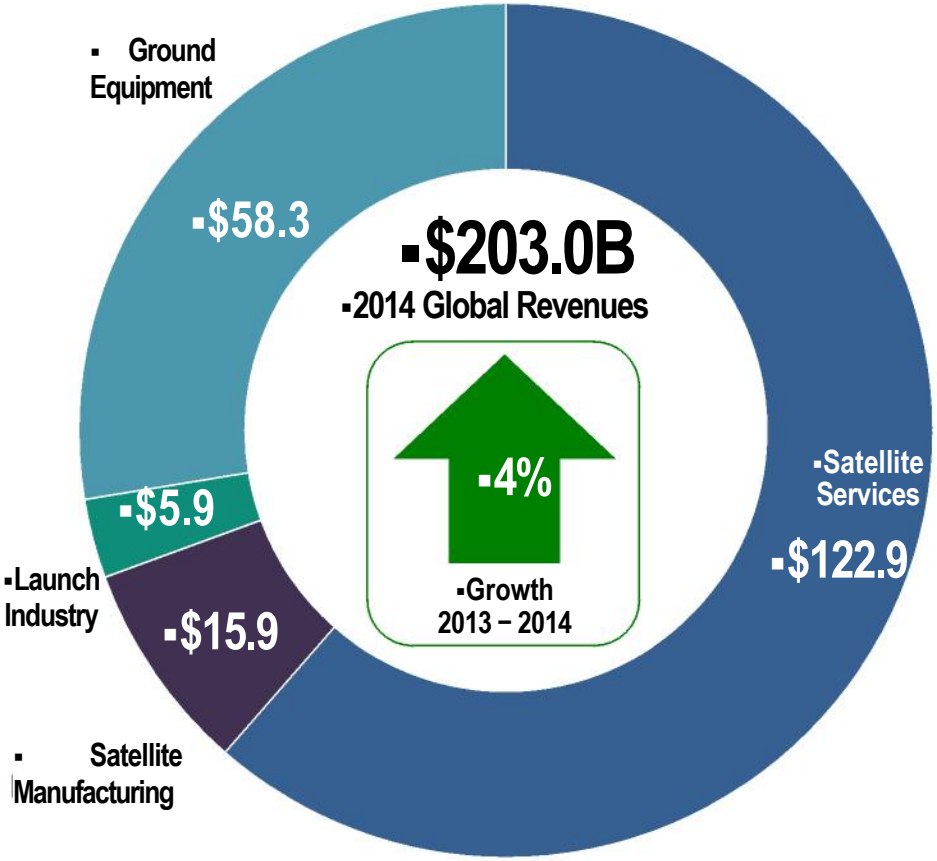


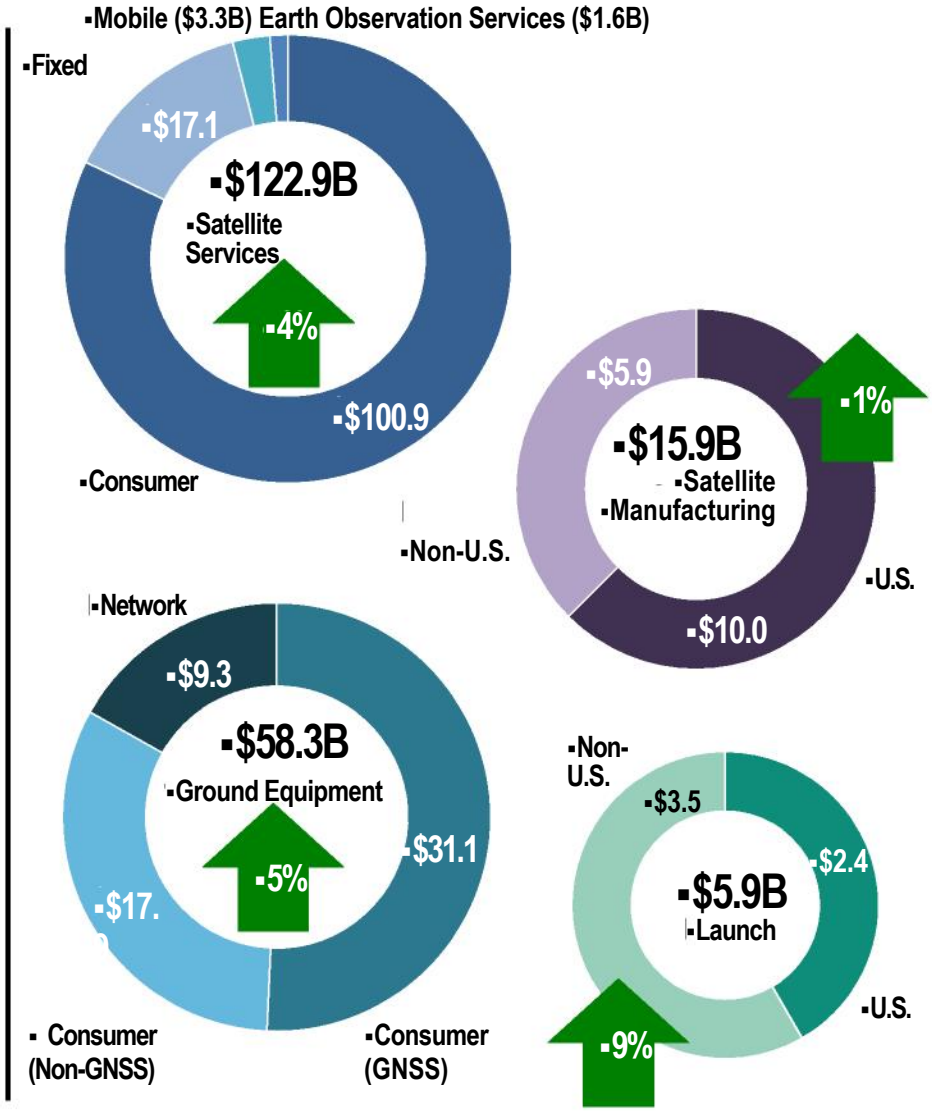
It is a multi-billion dollar industry with various investment opportunities and huge revenue

Extracted from www.sia.org/wp-content/uploads/2015

Satellite Industry - 2014 Case Study

The global satellite industry alone yielded $203B in revenue

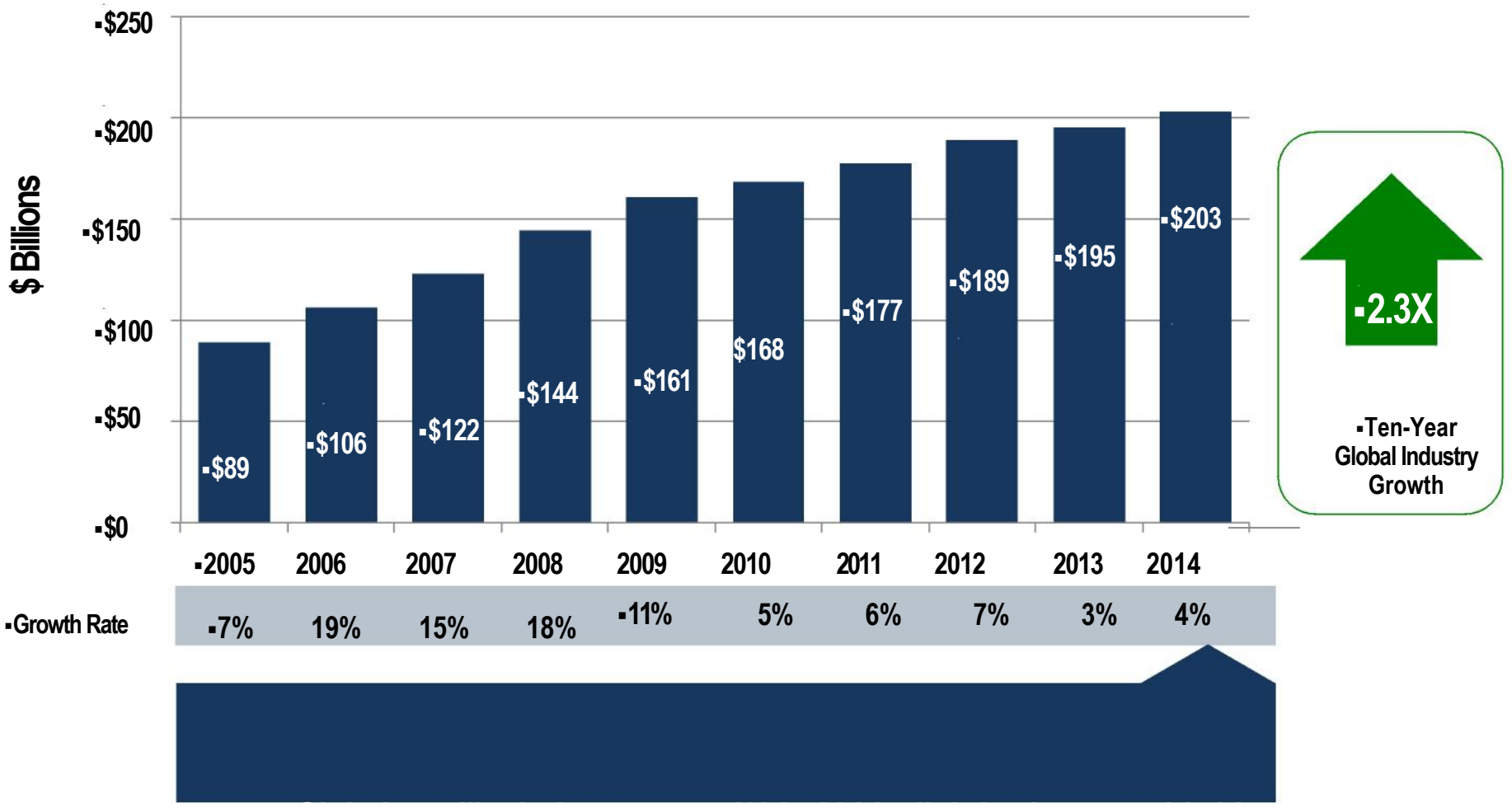




Extracted from www.sia.org/wp-content/uploads/2015

Yearly Global Satellite Industry Revenues

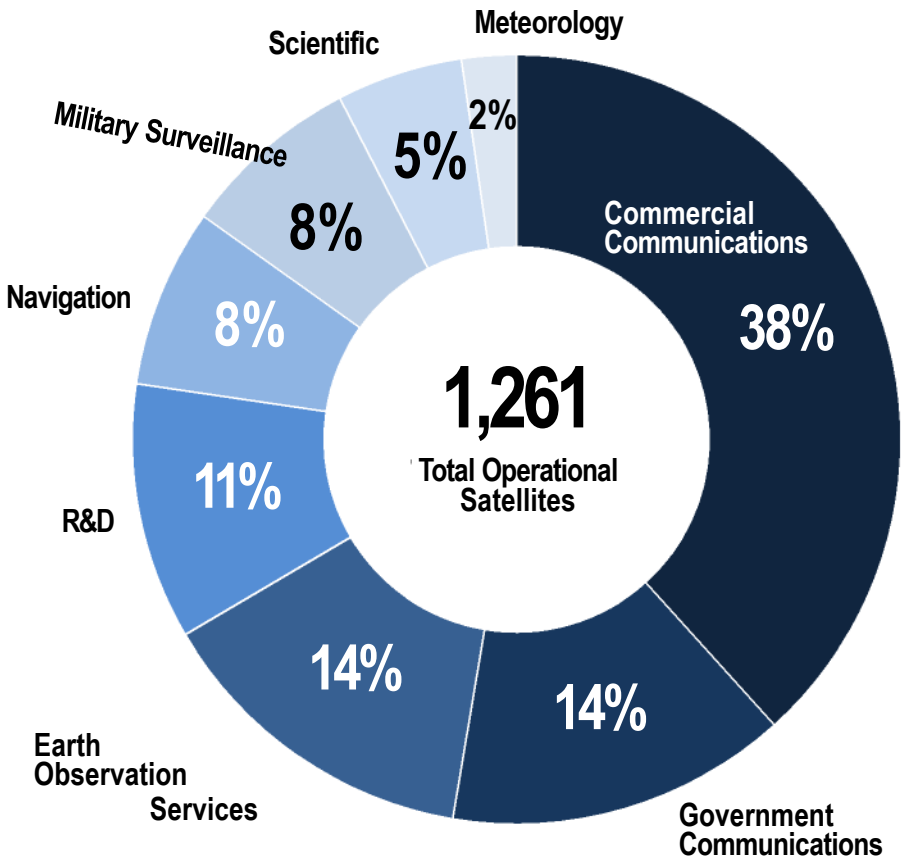
These revenues include the capital flights from Nigeria and other consuming Africa nations



Extracted from www.sia.org/wp-content/uploads/2015

Operational Satellites

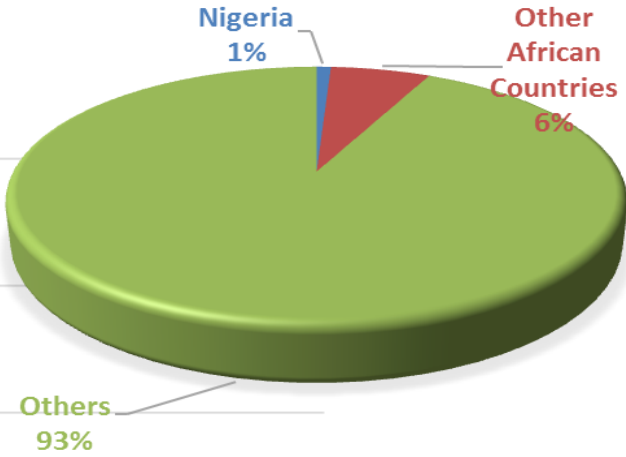
Operational satellites by function as at 2014



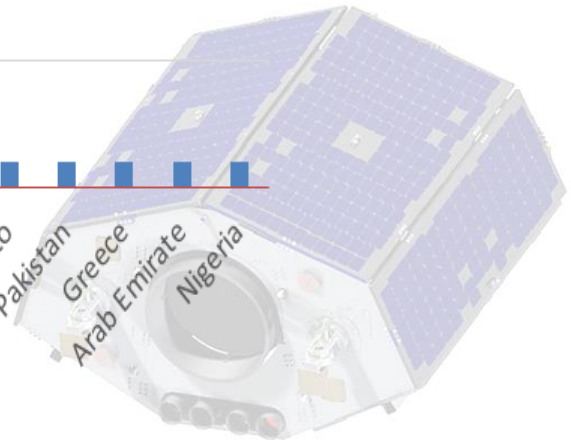
Extracted from www.sia.org/wp-content/uploads/2015

- As at 2014 more than 1200 satellites were in orbit:
  - >50% are ComSats
  - >38% are commercial ComSats
- Only 57 countries operate/own at least one (even as regional consortia)
- The satellites generate huge incomes for the nations

Communication Satellite Ownership in Around Africa region (42.5^{0}W - 42.5^{0}E)



- **Insignificant revenues for Africa**
- **huge capital flight from Africa**



Space Technology and Economic Impacts

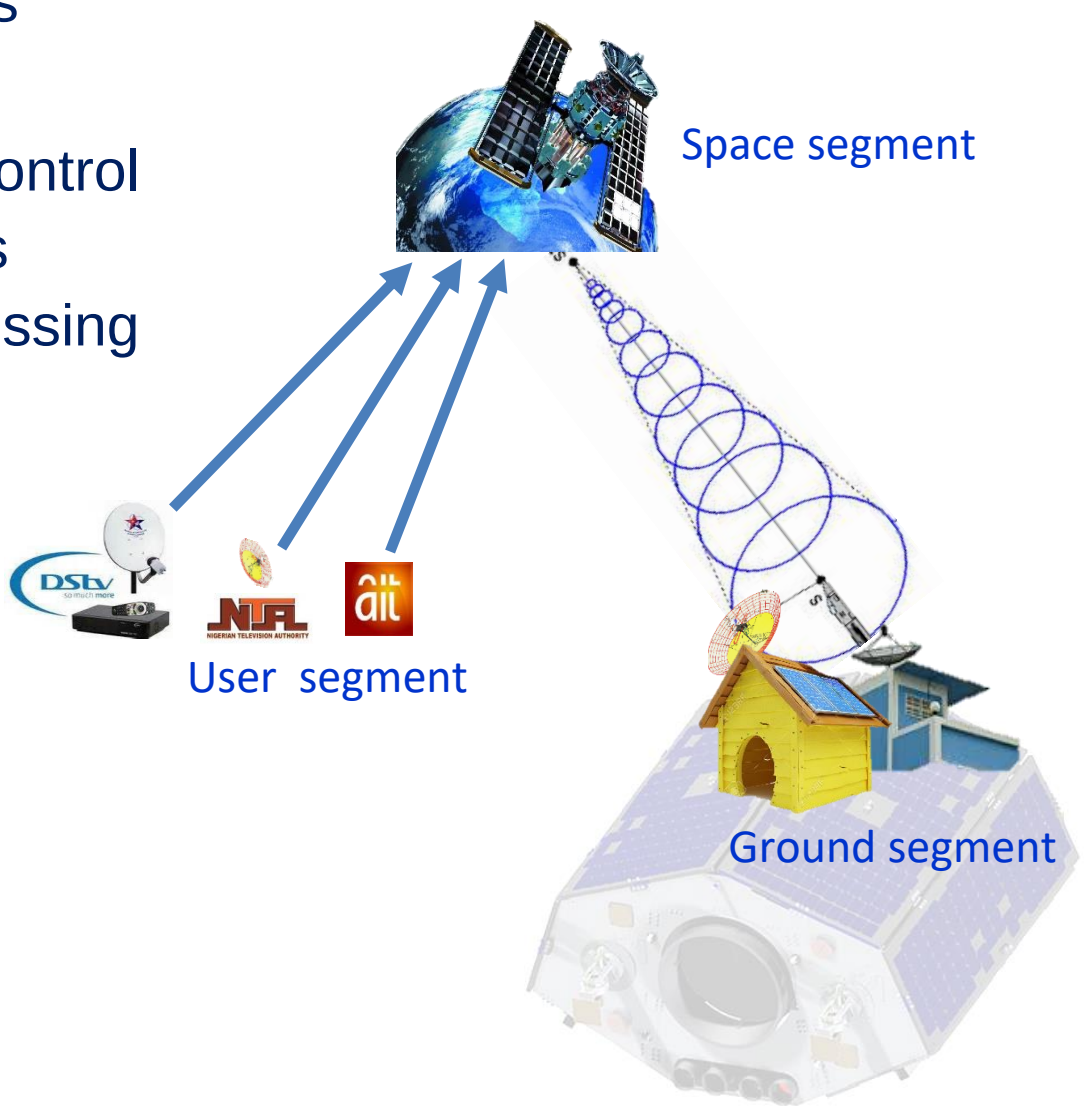
- Space Technology:
  - transforms nations economically, putting them on a pedestal of irreversible economic development and benefits, e.g. USA, Canada, UK, Russia, China, etc.
- It covers commercial, civil, and national security of a nation.
- It enables high-level research, creates employment and remains source of revenue. E.g. Canadian Space Industry supports
  - about 200 private companies
  - Space program based research institutions and universities
  - Generated about US$3.3billion in 2012
- Many African countries have not had similar progress as they have hardly accepted space technology as a tool for economic development.

ST and Impacts…

- Today the US and Europe capture the large part of commercial space market
- The UK space industry contributes over £9b to her economy and employs over 29,000 workers (www.gov.uk)
- Today, more nations are increasingly embracing space technology for their development and growth (e.g. Indian, China, Brazil, etc.)
- As at 2015, 19 countries have or are developing/planning to host spaceports for orbital or sub-orbital launches
- Man's daily live is continously being affected and dependent on ST, hence growth in the satellite industry – increase demand for comSats and EoS
- Uses and applications of ST are immense and with much benefits, resulting in increase in global demand for space data and more investments in ST
- Nigeria needs more investment in ST for her increasing growth, development and economic diversification.

What Constitute Space Technology?

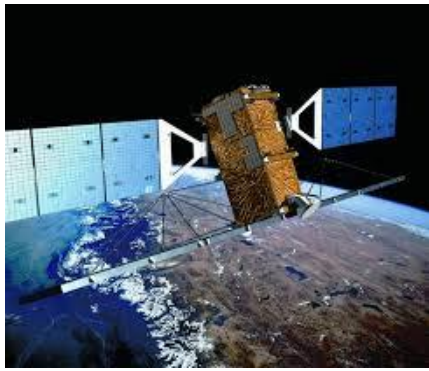
- Space Segment
  - Satellites and spacecrafts
- Ground segment
  - Antennas and system control
  - Communication networks
  - Data archiving and processing
- User segment
  - User receivers
  - Mobile devices
  - Space spin-offs
- Space services
  - Launch programmes
  - Space insurance
  - etc



Space Segment

This includes :

- Development of spacecraft and satellites
- Spacecraft control and space communications



➢Earth Observation Satellites.
➢Communication Satellites.
➢Navigational Satellites.
➢Meteorological Satellites
➢Other spacecraft such as the International Space Station.

GPS constellation

Ground Segment

The use of ST on the ground segment includes:

- Network Equipment
  - » Gateways
  - » Control stations
  - » Very Small Aperture Terminals (VSATs)
- Consumer Equipment
  - » Satellite TV dishes
  - » Satellite radio equipment
  - » Satellite broadband dishes
  - » Satellite phones and mobile satellite terminals
  - » Satellite navigation stand-alone hardware

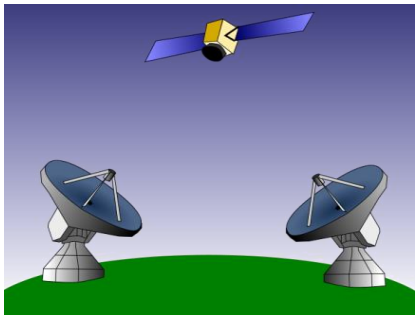
User Segment

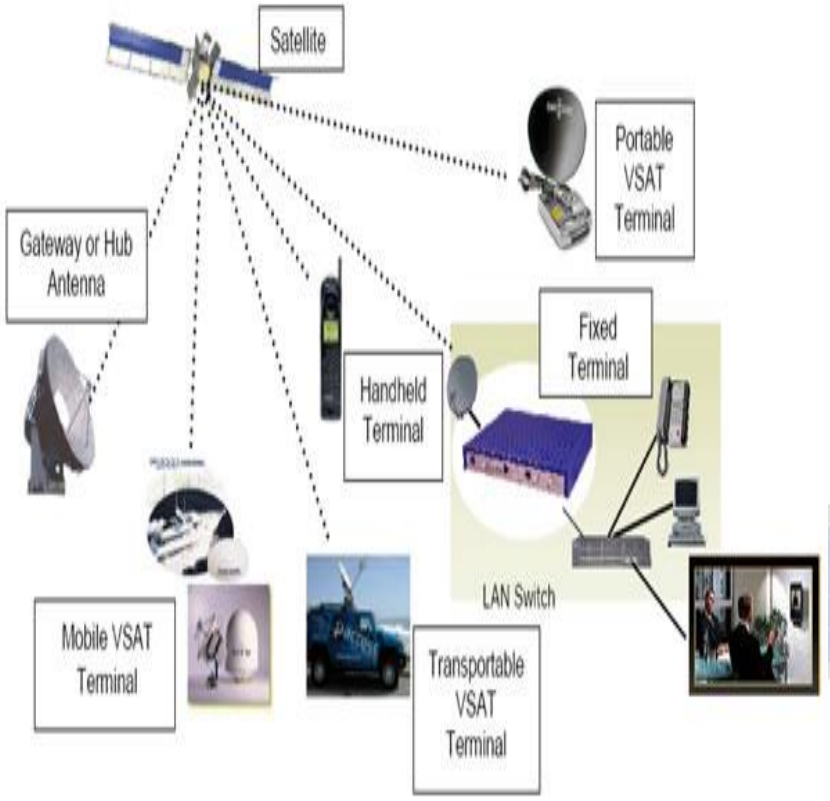
The use of ST for the user segment includes:

- Development and use of different receivers – handheld and mobile
- Use, development and application of space-based software
- ST spin-off technologies applicable in medicine, agriculture, etc.

Communication Satellites

- A communication satellite is in orbit for purpose of telecommunication, enabled by its transponder
- Enables wider reach and global coverage
- Used for fixed, and mobile communications involving ships, planes, vehicles, hand-held terminals, television and radio broadcasting



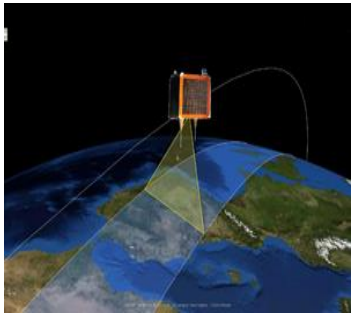


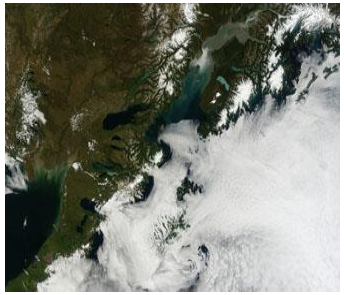
Communication Satellites

- Provides access to high-speed internet and broadband service to remote areas
- They are major parts of the commercial space market
- Lease of communication satellite transponders generated US $15billion in 2009.
- Satellite TV broadcasting generated US$72 billion in 2009.

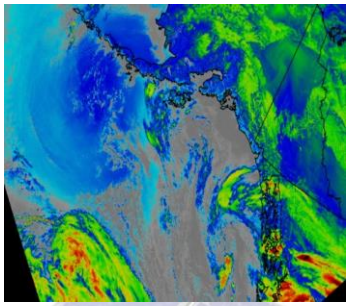
Satellites for Earth and Climate Monitoring

- They are satellites in earth orbit used for observing processes and phenomena of the atmosphere





- Designed for earth observation, and they include environmental and remote sensing satellites.



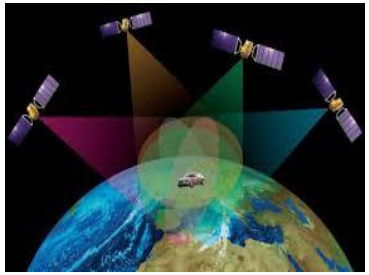
- Provide data and information that help in monitoring and predicting weather and environmental events e.g tornadoes, and forest fires, monitoring of natural resources, landuse and land cover, etc.

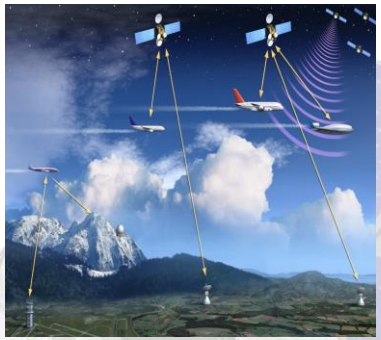
Navigation Satellites

- Hitherto developed for military application – delivery of weapons, location and guidiance, etc.

- Currently supporting different civil applications - traffic management, security, aviation, vehicular navigation, precision agriculture, etc.

- Generated US$ 15billion revenue in 2009, and estimated to be around EUR 50billion in 2013.





Space Activities and Platforms

- Space activities involves satellite manufacturing, research and development, launch capability, and ground segment development

- Include satellite manufacturing, research and development, launch capability, and ground segment development

- Only few nations have the technology, facilities and competence for space launch

- Such countries enjoy huge economic and commercial advantage beyond

A Developing Nation in Space

- India
  - Involved with space technology since the 1960s .
  - developing capabilities and indigenous space-related technologies through the Indian Space Research Organisation (ISRO)
  - 2012 – 2017 space budget is US$7.4billion, about ₦2.7trillion.
  - Objectives include strengthening and expanding
    - communications and navigation operational services;
    - imaging capabilities for natural resource management,
    - weather and climate change studies with space science, and planetary exploratory missions;
    - development of heavy lift launcher and reusable launch vehicles;
    - A human space flight programme.

A Developing Nation in Space …

- India Space Benefits
  - Expanding commercial capability
    - developing GSLV-MKIII for launching commercial communication satellites
  - Tapping into the satellite navigation market
    - Developing navigation satellite system - IRNSS and GAGAN for civil and military navigation beyong the Indian region
  - Space research and prowess
    - Launched Mangalyaan into Mars in 2014
  - Telecommunication services provision for Indians
    - 11 INSAT communication satellite supporting telephoning, DTH TV broadcast, tele-medicine and tele-education
  - Socio-economic impact and Space spin-offs
    - Catering for her defence, agricultural and other needs
    - Transferred >200 technologies to industry, creating employment.

ST and the Sustainable Development Goals

- Sustainable Development is defined as development that satisfies the needs of the present without compromising the ability of future generations to satisfy theirs.

- In order to be sustainable, development must combine three main elements: fairness, protection of the environment, and economic efficiency.

Sustainable Development Goals

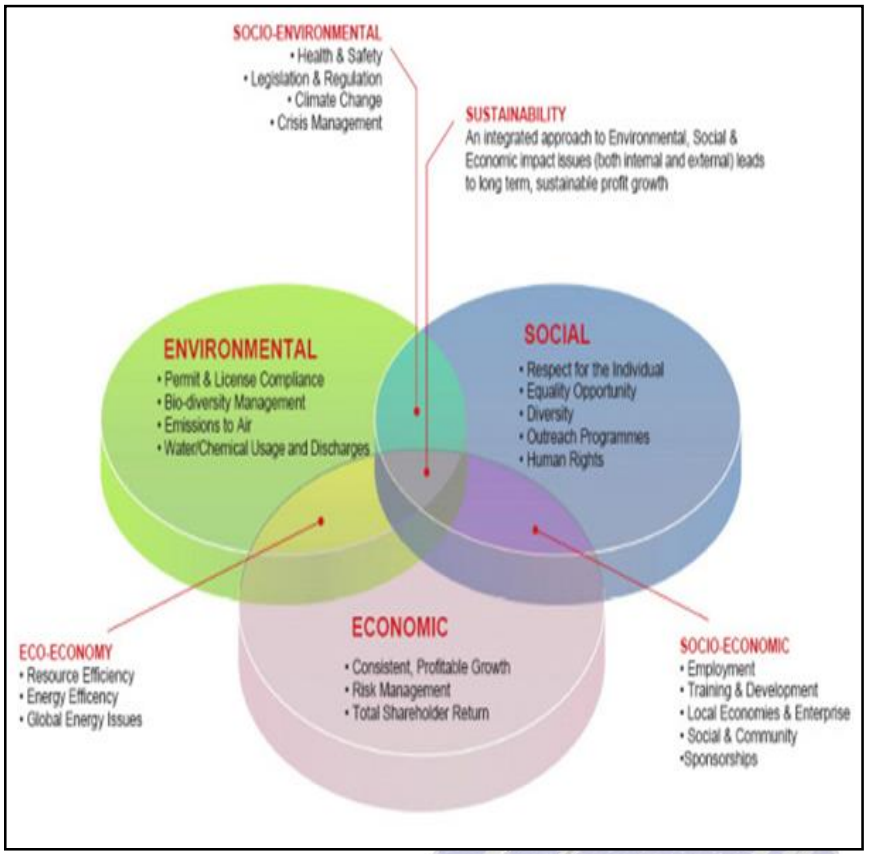
- In June 2012, Heads of State and high-level representatives met at Rio de Janeiro, Brazil, for the United Nation Conference for Sustainable Development (UNCSD) Rio+20.

- The Head of States and Governments and High Representatives, meeting at United Nations Headquarters in New York in September 2015 decided the new global Sustainable Development Goals (SDGs).

- They recognized that scientific knowledge and evidence-based approaches play an integral part in achieving SDGs.

AIMS OF SUSTAINABLE DEVELOPMENT

- A number of 17 SDGs with 169 associated targets that are supported by three pillars of sustainability of human activity exist:
  - 1. Economic development
  - 2. Environmental protection
  - 3. Social equity
- Aims to improve quality of life - easier access to medical care and social services
- The promotion of new forms of renewable energy such as wind, solar, and geothermal power.



- SDG allows the basic needs of present and future generations to be fulfilled with regard to demographic constraints, such as: access to water, education, health, employment, and the fight against hunger .

Space Technology Innovation For Sustainable Development

Involves three key approaches:

- Addressing basic needs through innovation and capacity building including poverty reduction, agriculture, urban planning, resource management and disaster risk reduction;

- Promoting innovation and innovative approaches which will lead to sustainable economic growth and job creation; and

- Promoting global and regional cooperation for better management of global challenges together by finding global pictures and information.

Space Technology Innovation For Sustainable Development

- The use of space science and technology for the attainment of sustainable development and the need to strengthen the outer space legal framework is of utmost importance especially in developing countries.

- Outer space is described as mankind's common heritage, that developing countries must be allowed equal access. The rational and peaceful uses of outer space provides a powerful tool for furthering the well-being of humanity and the earth's environment.

- Space technology and applications are fundamental tools for actualizing sustainable development throughout the world, especially for a developing countries like Nigeria.

17 Key Sustainable Development Goals

Poverty

Food Security

Health

Education

Gender Equality

Water

Energy

Employment

Resilient Infrastructure

Reduce Inequality

Cities

Sustainable Consumption

Climate Change

Marine Resources

Ecosystems and Biodiversity

Justice and Good Governance

Partnerships for Implementation

SDG 1: End poverty in all its forms everywhere

- Space technology is being used to enhance data and information that will help decision makers formulate knowledgeable, timely decision on possible intervention and type of action required for socio-economic growth that meets the basic needs of people, such as food, water, sanitation, health, housing and transportation.

SDG 3: Ensure Healthy Lives and Promote Well-being for all at all Ages

- Role space technology in ensuring healthy lives and well being include;
  - Telemedicine for rural population and medical practitioners in remote locations
  - Disease prediction
  - Satellite help to Assess the risk of epidemics (e.g Ebola outbreak)
  - Environmental monitoring and analysis for health care and hygiene
  - Mapping deadly mosquitoes
- NASRDA is working on project with Malaria Eradication Program of Ministry of Health to produce Malaria map for the area prone to Mosquito breeding



NASRDA Efforts on SDG 3 - Telemedicine Programme

- The mobile unit equipped with basic telemedicine and communications equipment such as auto-tracking Ku antenna, equipment rack with router and modem is fully operational.
- There are eight (8) fixed remote terminals of the Project, including UCH

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

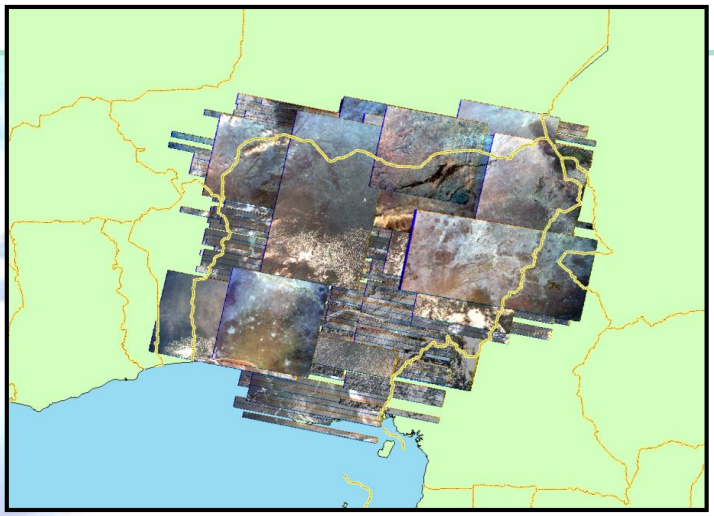
- Space technology are presently being use to enhance satellite data and information exchange for establishing an operational system for tele-education services for e-learning in rural areas.
- Development of multi-media materials for interactive tele-education.
- Tele-learning tools for educators.

NASRDA Efforts on SDG 4 - Supporting Nationwide Research and Learning

- Provision of Laboratories- 21 GIS Labs have been established in 21 Nigerian Universities and polytechnics, building their capacity to use NigeriaSat-2 and NigeriaSat-X satellite images.

- Training of over 1000 Nigerians across MDAs

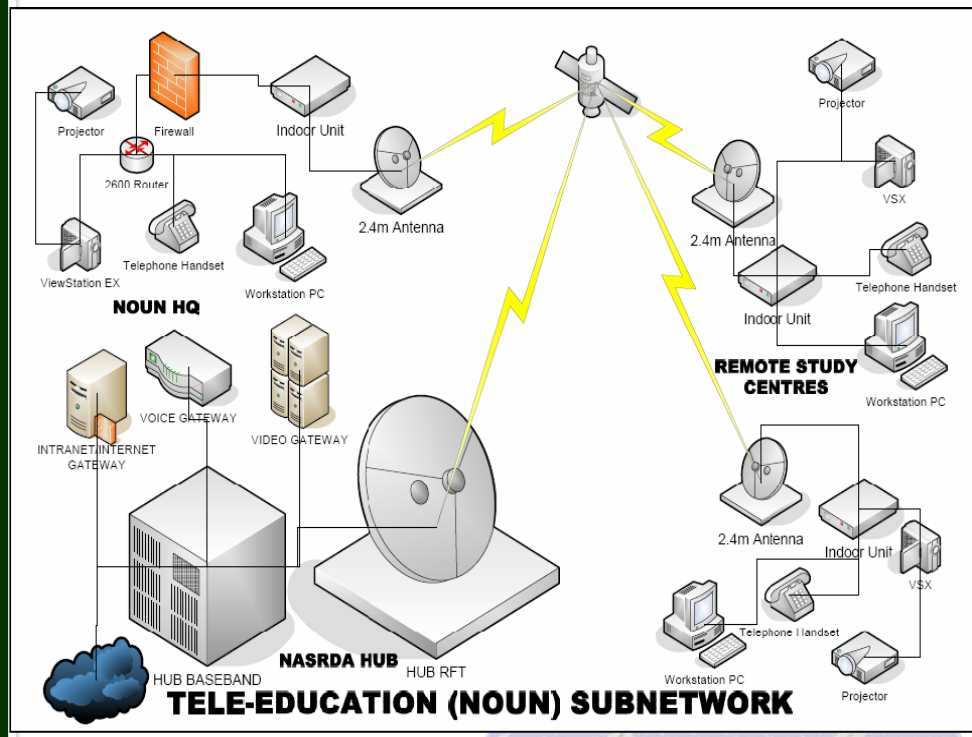
- Donation of Satellite Imageries- The Agency has donated images for research to several Nigeria tertiary institutions worth N3 Billion.



INSITUTION	IMAGE
UNIVERSITIES	NigeriaSat-X, NigeriaSat-2
INEC	NigeriaSat-X
NIGERIA ARMY	NigeriaSat-X, NigeriaSat-2
POLYTECHNICS	NigeriaSat-X, NigeriaSat-2
INTERNATIONAL STUDENTS	NigeriaSat-X, NigeriaSat-2
Great Green Wall	NigeriaSat-X, NigeriaSat-2
UN/WORLD BANK	NigeriaSat-X, NigeriaSat-2

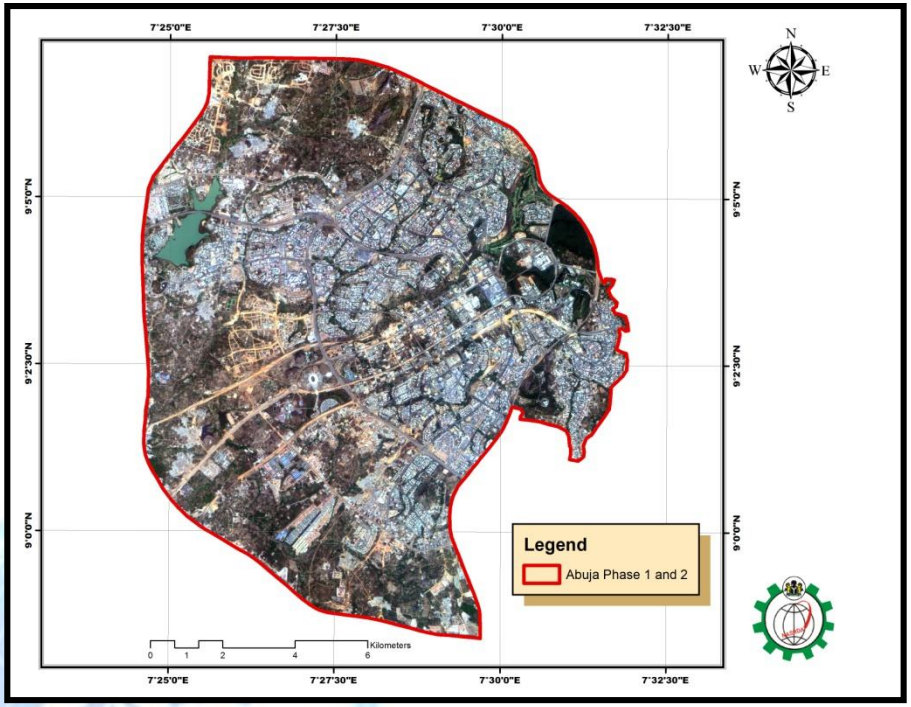
TELE-EDUCATION

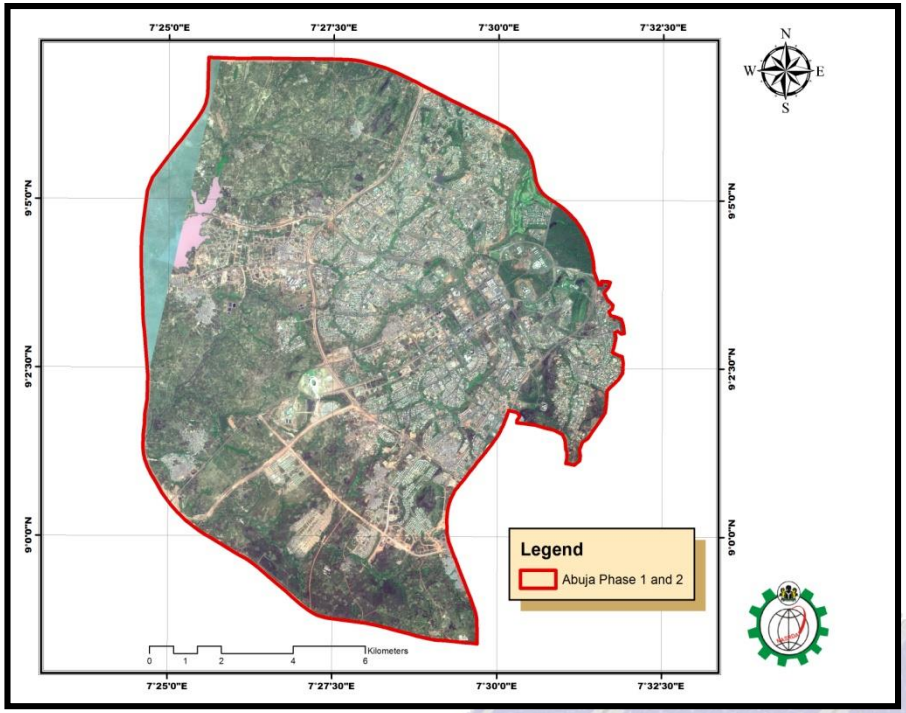
- The project has a pilot scheme of 12 study centres located across the nation with a teaching administrative HUB at the NOUN headquarters in Lagos.
- The network is capable of enhancing the delivery of lectures from the study centres respectively, depending on where the resource persons are located.



NASRDA Effort in Using Space Technology to Achieve SDGs: Mapping and Monitoring of Slum Development in Abuja using NigeriaSat-2

- The dataset used in this study are **NigeriaSat-2** and **Spot 5** high resolution satellite imagery.



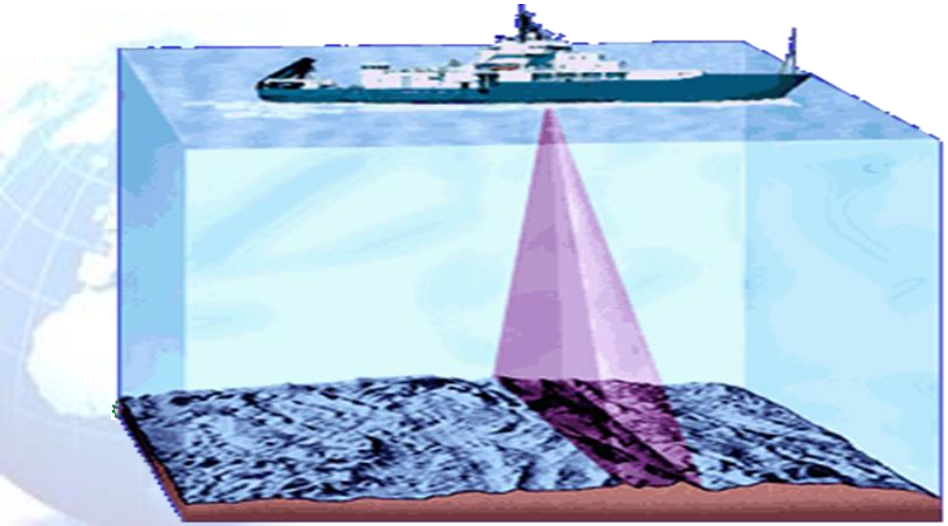


NigerianSat 2 Image, 5m Resolution of 2012

Spots 5 Image, 5m Resolution of 2005

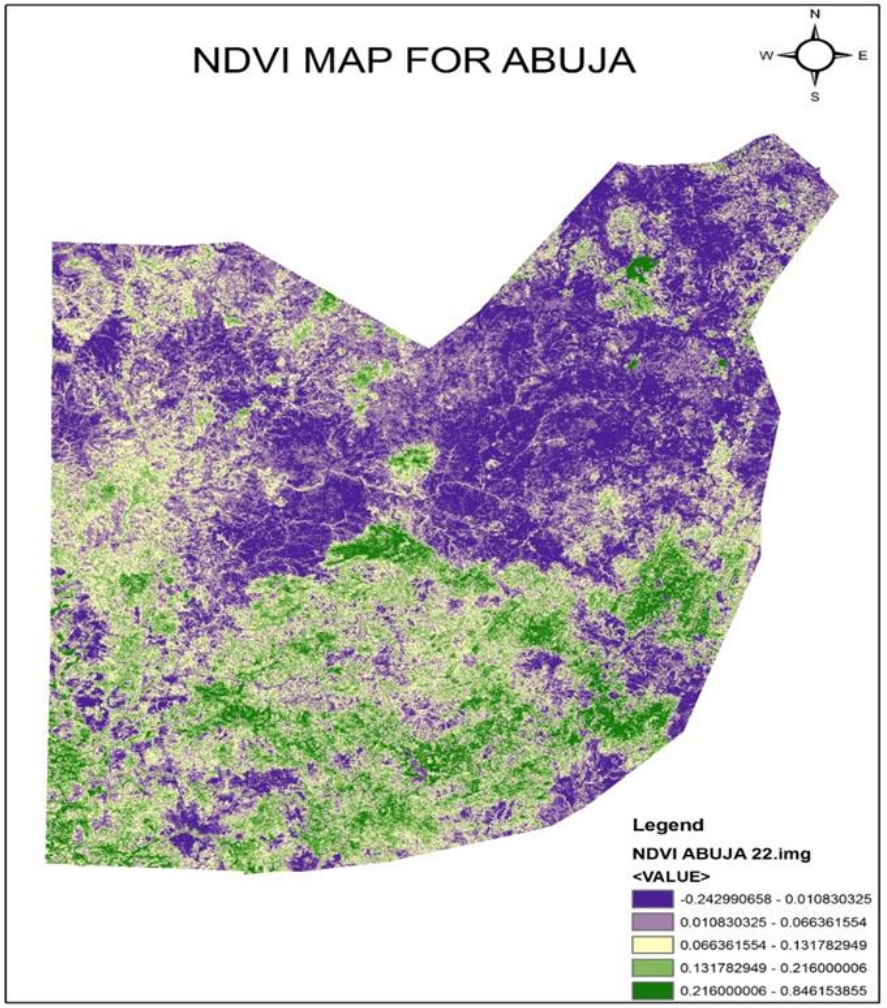
SDG 14; Conserve And Sustainably Use The Oceans, Seas And Marine Resources For Sustainable Development

- Remote sensing technologies and GIS for oceanography greatly help in marine ecosystems management, encouraging nations to take an intelligent approach in managing resources found in their territorial seas.
- Vessel tracking from space is actualize by space technology
- Sea-level rise in seasons and operations with satellites over a wide scale enable controls and monitoring of marine



SDG 15: Protect, Restore and Promote Sustainable use of Terrestrial Ecosystems, Sustainably Manage Forests, Combat Desertification, and Halt and Reverse Land Degradation And Halt Biodiversity Loss.

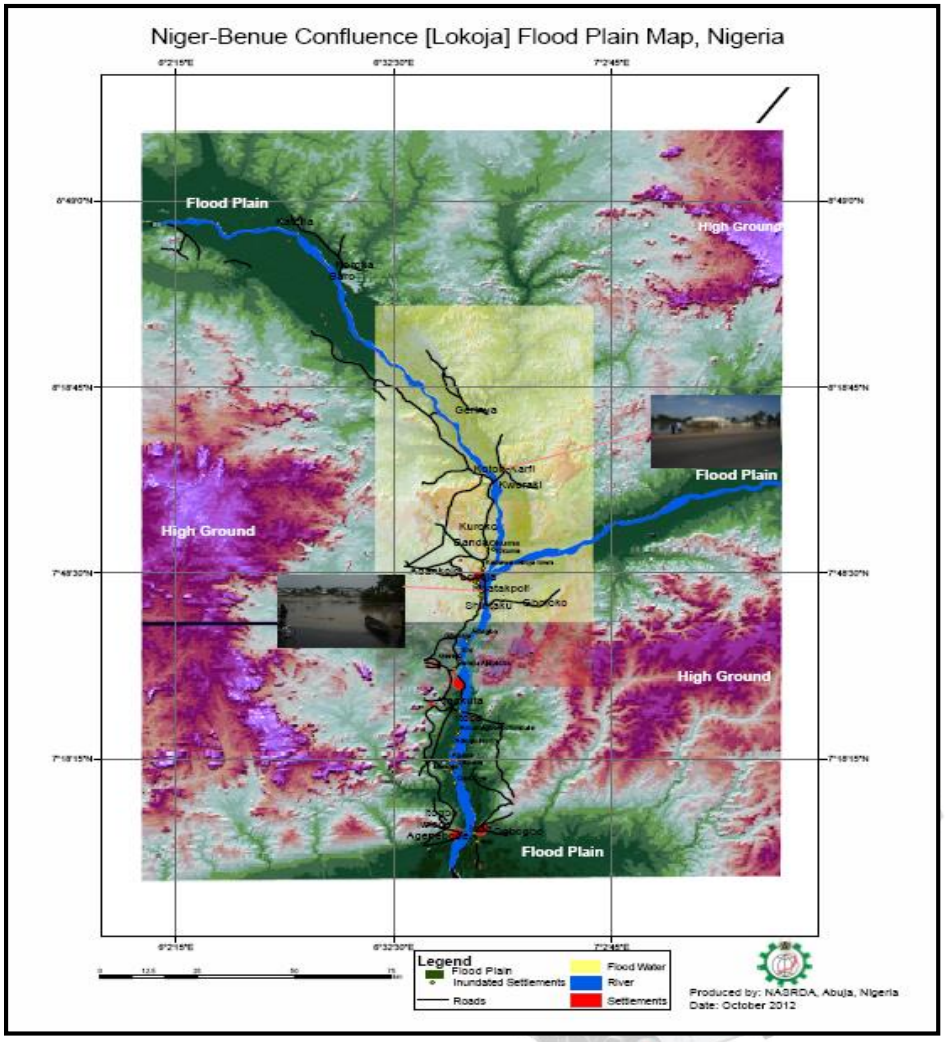
- Space technologies are being used to monitor terrestrial ecosystems by looking at land cover change and keeping track of desertification and wildlife habitat.
- Monitoring forest degradation and deforestation.
- For monitoring forest fires and tracking biodiversity.



NASRDA Effort In Support of Government to Combat Desertification, and Halt and Reverse Land Degradation

FLOOD DISASTER

- Lokoja was one of the flooded areas during the 2012 flood .
- NASRDA visited the flood area and produced a flood plain and vulnerability map for the affected areas.
- The map was used by NEMA to rehabilitate those affected by the flood.
- NASRDA is engaged with lots of other space-based environmental impact projects



SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development

NASRDA'S African Union Activities for Sustainable Development

- NASRDA, on behalf of Nigeria, is a member of the Africa Leadership in Space Conference (ALC), plays major roles in space science and technology and innovation in Africa.
- NASRDA is also a member of the African Resource Monitoring Satellite Constellation (N2 is the first satellite in the constellation).
- NASRDA is instrumental to the development of the African Space Policy.
- NASRDA is currently hosting the Regional Support Office of the United Nation Platform for Space-based Information for Disaster Management and Emergency Response (West and Central Africa).
- ARCSTEE (affiliate of UNOOSA) trains English Speaking African Countries in Space Science and Technology.

Sustaining Development?

How can we enhance and sustain the development of Nigeria?

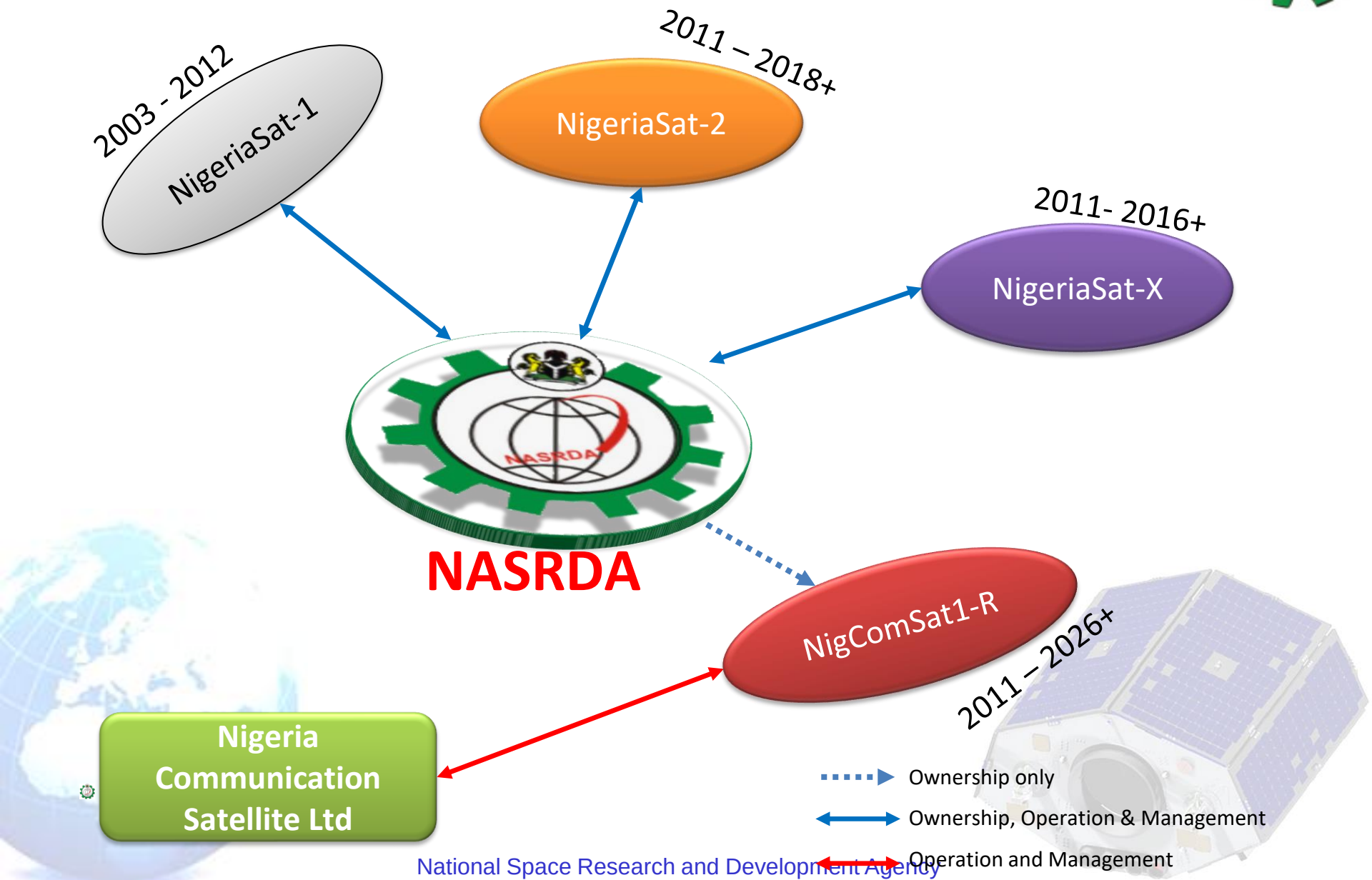
Mr. President, we can use science and technology

YES!! We have NASRDA! we can invest more in space technology and reverse the current huge capital flight, create jobs and spin-off

Honourable Minister, Space technology plays a huge role in that! It added $323B to the global economy in 2014 only.

The Nigeria Space Programme

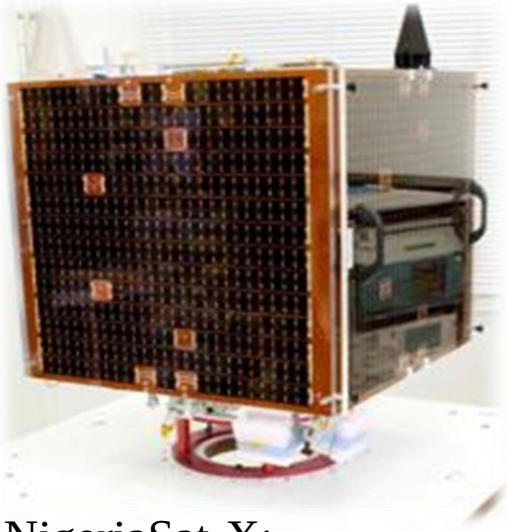
Nigeria Space Programme …



Nigeria Space Assets

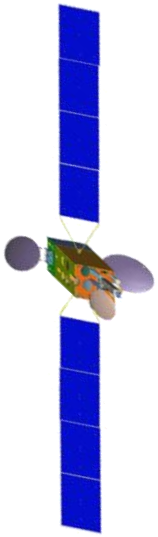
NigeriaSat-1: 32m Multi-Spectral Imager (MSI)
Launch: 27th Sep 2003
Part of DMC
De-Orbited 2012

NigeriaSat-2:
2.5m Pan
5m & 32m MSI
Launch: 17th August 2011



NigeriaSat-X:
22m MSI
Launch: 17th August 2011
Built by Nigerian KHTTs

Nigeria Space Assets



NIGCOMSAT-1:
Launched:
13th May 2007
De-Orbited:
11th Nov 2008

NIGCOMSAT-1R:
Launched: 19th Dec 2011
Bands: C, Ku, Ka, and L
Uses: Tele-medicine, Tele-Education, Telephony, Tele-conferencing, Data Transfer, Television & broadcasting Security & Surveillance

Some Achievements with Our Earth Observation Satellites

NigeriaSat-1

Satellite Atlas of Nigeria

- Scale: 1:100,000
- Saved Nigeria over N2 Billion
- Images used to produce first ever Nigerian Satellite Atlas

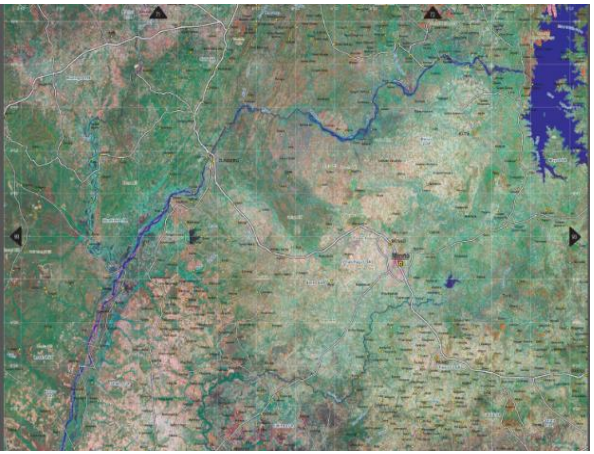
Domestication of GIS technology through Collaboration

- 15 GIS / Remote Sensing laboratories established in Nigerian Universities

Donation of Satellite Imageries to Nigerian Universities

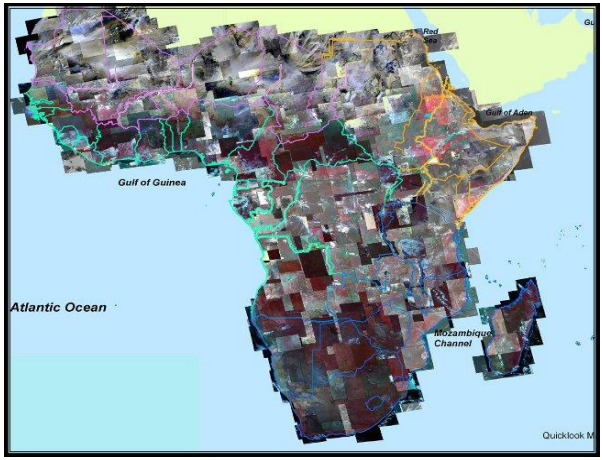
- Over 3000 Images donated
- Worth over N3 Billion Naira

Nigeria Space Programme: Impact and Applications

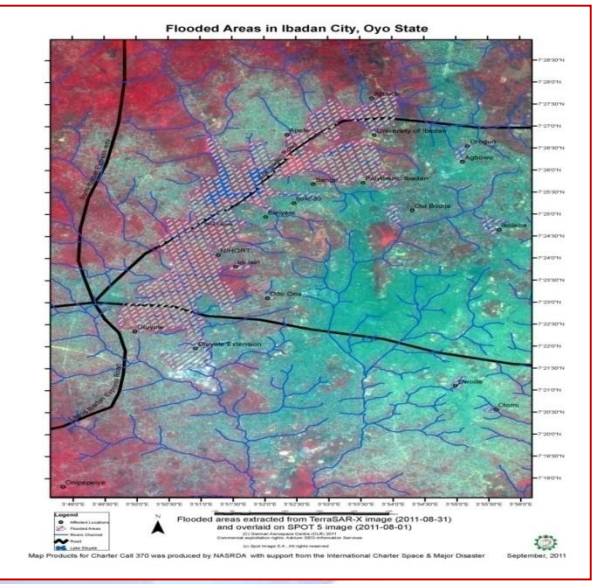


Atlas Image, Nigeria

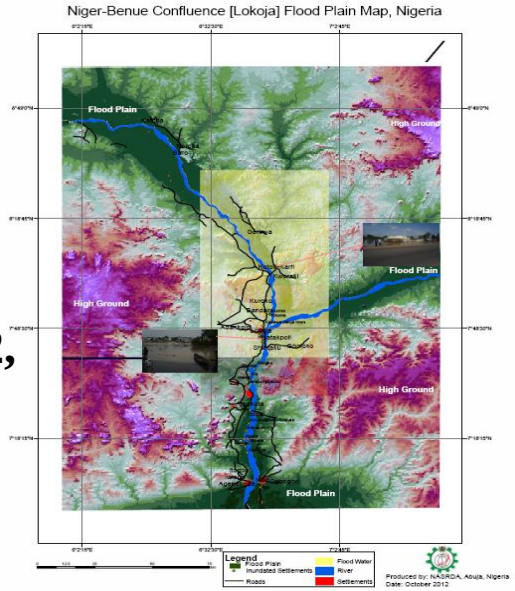
NigeriaSat-2 Imageb by NigeriaSat-2, 30th November 2011



Africa imaged with NigeriaSat-1



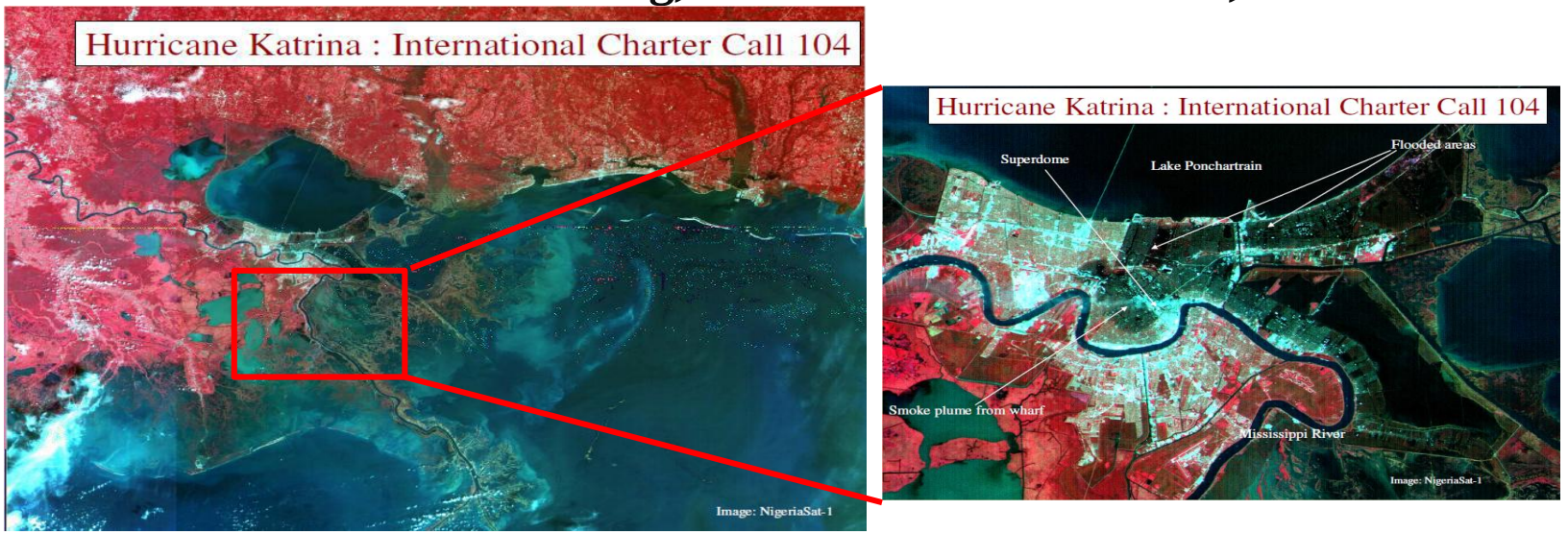
Ibadan Flood 2011



Lokoja Flood 2012

Nigeria Space Programme: Impact and Applications…

International disaster monitoring, Hurricane Katrina 2005,New Orleans



- Generation and provision of satellite images worth over ₦2 billion annually.
- Enabling urban Mapping at a scale of 1:25,000.
- Supporting disaster monitoring and management, (e.g. Goronyo, Ibadan, Lokoja Floods intervention)
- Enabling data revolution in Africa through African Resource Monitoring Satellite Constellation.
- Providing Space-Based Support to the Armed Forces (Supported Operations in North East, Niger, Mali).

Nano Satellite: Nigeria Edusat-1

- The programme consists of 5 CubeSats belonging to:
  - Japan, Nigeria,
  - Ghana, Mongolia and
  - Bangladesh
- Space X Falcon9 Rocket launched the satellites from Kennedy Space Centre in Florida, USA on June 6th 2017

- The Satellite was deployed into lower orbit with:
  - orbital parameter of 460 kilometers and
  - an inclination of 15.6
- Enhanced capacity building
- Designed, built and owned by NASRDA in collaboration with FUTA
- Programme implemented by the Japanese Space Agency through the Kyushu Institute of Technology.

Nigeria Space Programme

25-Year Roadmap to Nigeria's Space Mission (2005-2030)

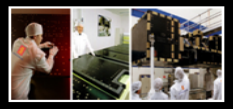
TIME

ROAD MAP TO NIGERIA'S SPACE MISSION

2030

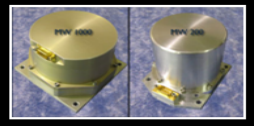
Launch of Nigerian Satellites from Nigerian Launch Pad (2030)

2028



Large Scale Commercialization of Space Technology & Know-how (2028)

2026



Spin-Off of Allied Industries – Electronics, Software etc. (2026)

2025

Development of Rocketry/ Propulsion System (2025)

2018

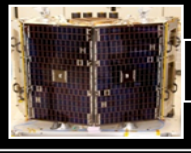
Development and Building of Made in Nigeria Satellites (2018)

2015

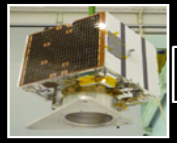
Training of Nigerian Astronauts (2015)

AstroSAR (2015)

2011



NigeriaSat-2 (2011)



NigeriaSat-X (2011)

MILESTONE

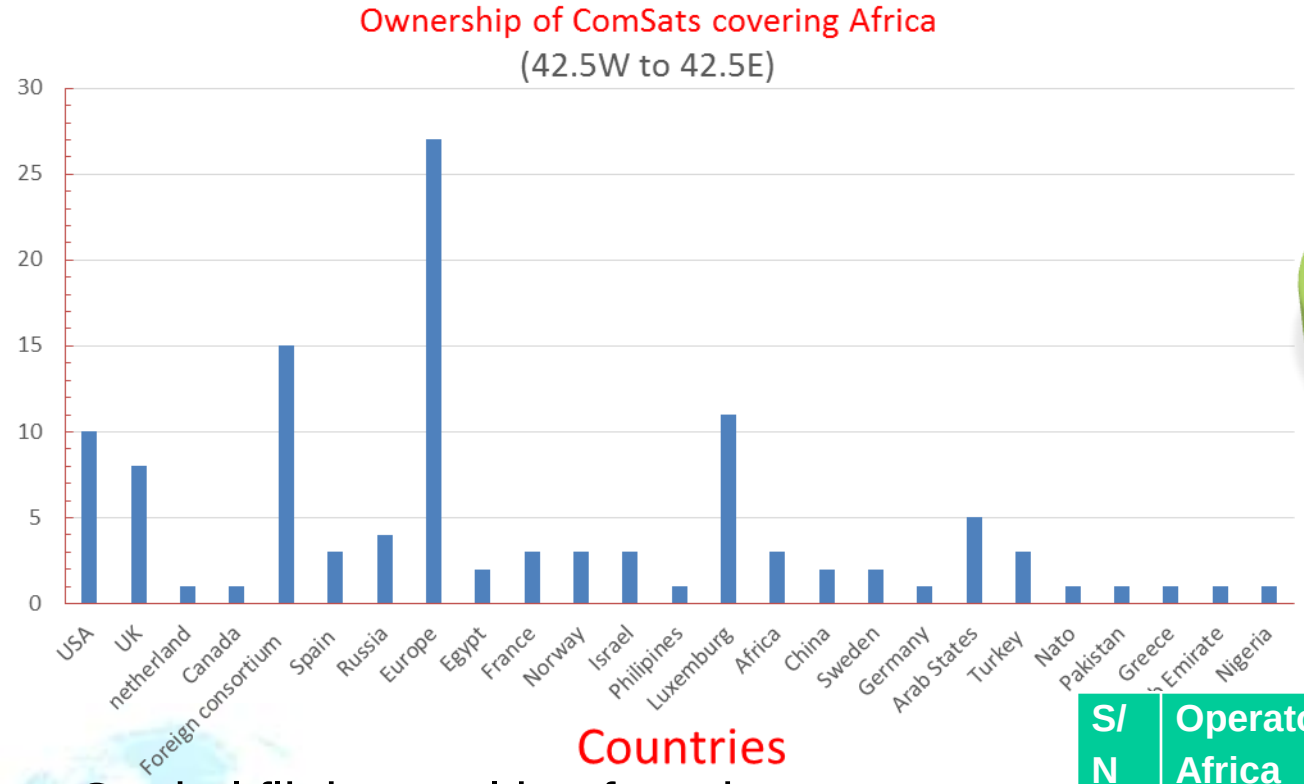
Investment Avenues for Development

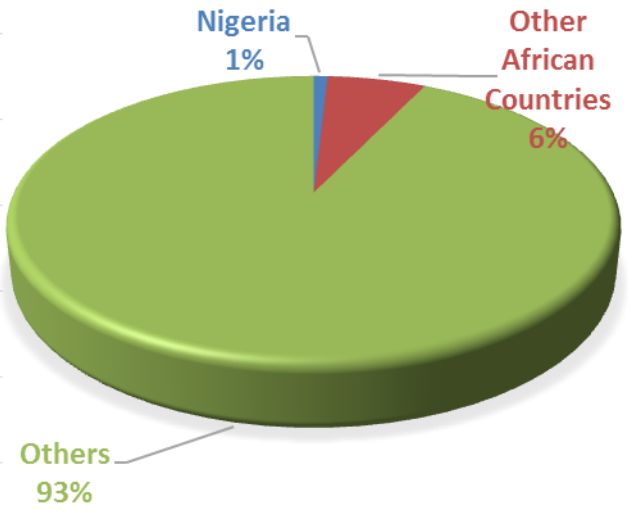
Nigeria space Roadmap requires development of many systems and facilities

- Development and equipping of Satellite Assembly, Integration, Test Design Centre (AITDC)
- Development and launch of sub-metre high resolution satellites
- Development and launch of dual-purpose Communication Satellites
- Development and launch of Synthetic Aperture Radar (SAR) satellite s
- Rocketry and Propulsion System Development
- Space Product and Services commercialis-ation

These and more provide investment opportunities to potential investors

Need of Communication Satellite..





- Capital flight resulting from huge revenues generated by non-Africa (America and European) ComSat owners and operator
- Unfortunately, Nigeria has only one i.e. NigComSat-1R, which is insufficient and not currently optimized

S/N	Operator over Africa	2013 Revenue(US$)
1.	Intelsat	$2,640M
2.	SES	$2,560M
3.	Eutelsat	$1,632M
4.	Telesat	$839M
5.	Nilesat	$180.91M
6.	Arabsat	$360M
7.	NigComSat (Nigeria)	-

Space Technology Contribution to GDP

NASRDA'S CONTRIBUTION GDP

AGRICULTURE
-Increase yield
-cost reduction
-Dev. of new breed

- Precision farming
- Zero Gravity Experiment

COMMUNICATION
IMPROVE DIRECT TO HOME TV & SATELLITE RADIO
IMPROVE COMM SYSTEM FOR SECURITY

Communication Satellite

SECURITY AND DEFENSE
WEAPONS DEVELOPMENT
SURVIALANCE-

- Rocketry Program
- Unmanned Aerial Vehicle
- Earth Observation Satellite

INDUSTRILIZATION
SOFTWARE DEVELOPMENT
ICT
HARDWARE DEV
ARTIFITIAL INTELLIGENCE
AGRIC PROCESSASING
AEROSPACE/AERONAUTICS

Spin-Offs

EDUCATION
CAPITAL FLIGHT REDUCTION
IMPROVE QUALITY EDUCATION/RESEARCH
FOREIGN INCOME GENERATION
IMPROVE QUALITY BASIC EDUCATION

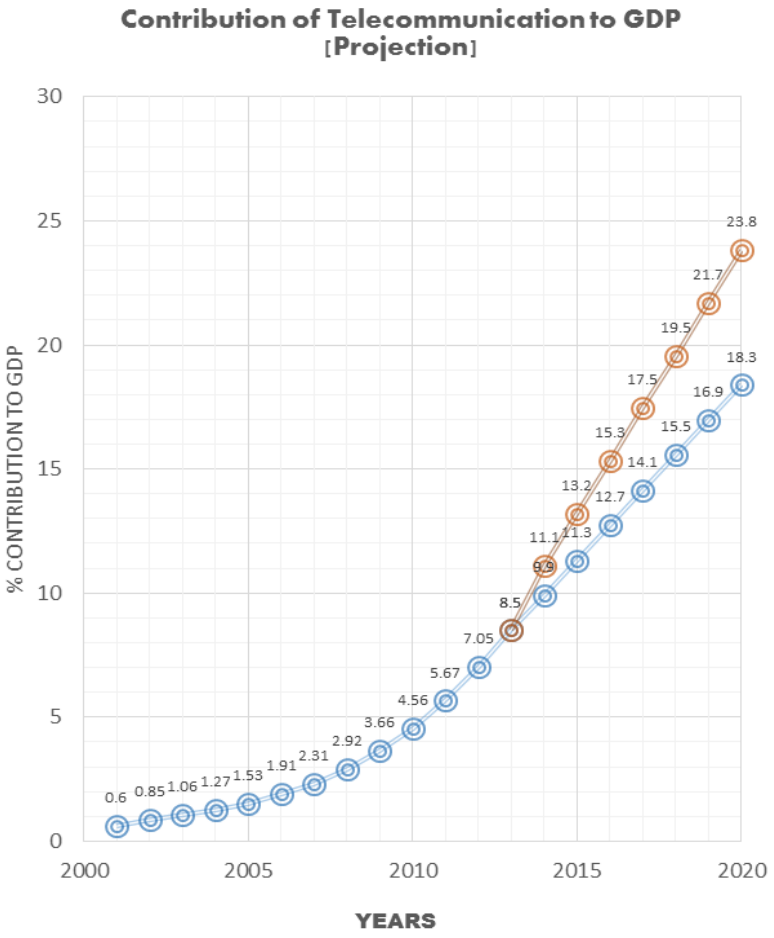
- Tele-Education
- Space Science Education Campaign
- Planetarium and Space Museum

HEALTH
ACCESSIBILITY TO QUALITY HEALTH FACILITY AND PROFESSIONALS
REDUCE CAPITAL FLIGHT

- Mobile Health
- Tele-Medicine

Recommendations & Conclusion

- Space technology (ST) is an economic development tool as evident in economies of active space-fairing nations.
- ST impacts the GDP of a nation, and supports actualization of the SDGs
- Government-only funding cannot sustain ST development: need for private public partnership (PPP)
- Nigeria can accelerate her development and growth through the use of space for actulaizing more than the SDGs



THANK YOU

FOR LISTENING...