BRIEF OVERVIEW
OF
NIGERIAN SATELLITE AUGMENTATION SYSTEM; AFRICA'S REGIONAL SATELLITE-BASED AUGMENTATION SYSTEM

presented @

THE JOINT AFRICAN/ASIA-PACIFIC UN-REGIONAL CENTRES AND BEIHANG UNIVERSITY INTERNATIONAL TRAINING WORKSHOP ON GLOBAL NAVIGATION SATELLITE SYSTEMS(GNSS) 8-13 AUGUST, 2016, ILE-IFE-NIGERIA.

Outline

- About NIGCOMSAT Ltd
- NigComSat – 1R Hybrid COMSAT and Coverage
- Introduction to Global Navigation Satellite System (GNSS)
- Needs Assessment for Augmentation Systems
- Regional Satellite Based Augmentation System (SBAS) across the world (Operational and Planned).
- Illustration of Regional Satellite Based Augmentation System
- NIGCOMSAT-1R NAVIGATION PAYLOAD: Africa's Contribution to SBAS and Global Navigation Satellite System (GNSS).
- Relevance, Envisaged NigComSat-1R L-Band Applications & Economic Importance

NIGCOMSAT

AFRICAN ROOTED GLOBALLY POSITIONED

About NIGCOMSAT Ltd

- The Nigerian Communications Satellite (NIGCOMSAT) LTD is a Government owned Enterprise under Federal Ministry of Communications.

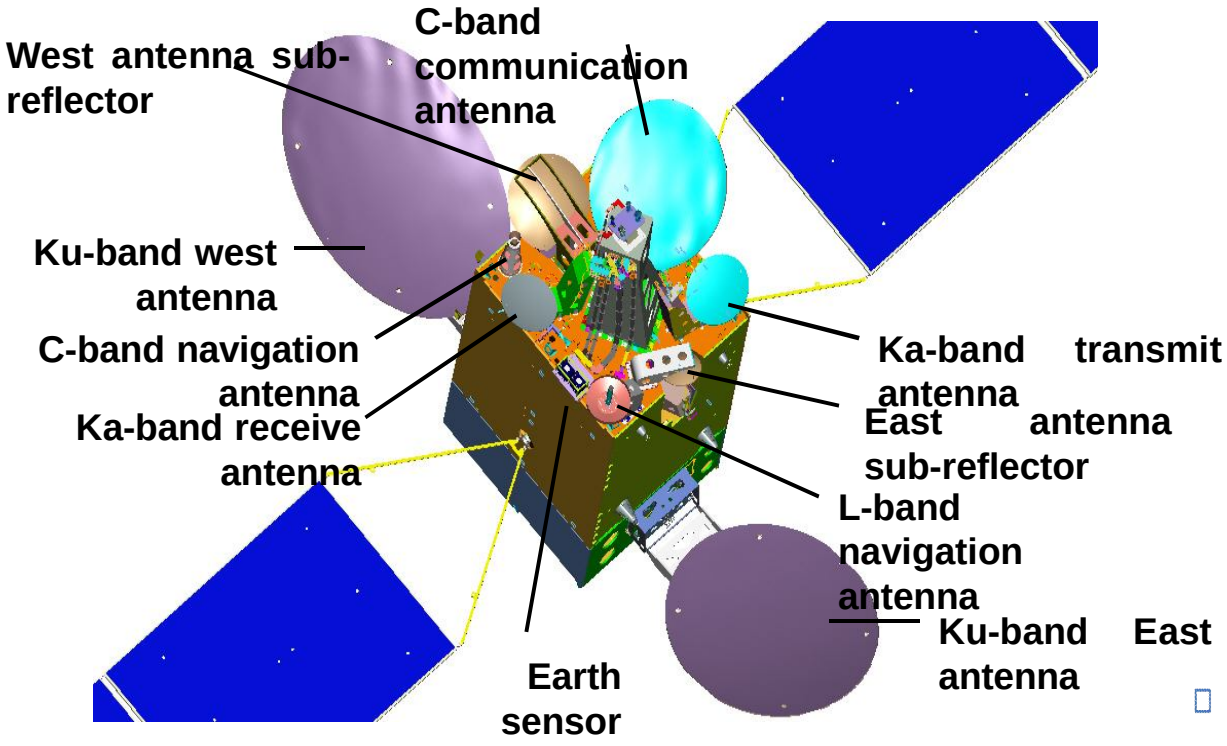
About NIGCOMSAT Ltd

- The company operates and manages geostationary communications satellite; **NigComSat-1, NigComSat-1R**.
- Our mission is “to provide ubiquitous connectivity and communication satellite solutions through innovation”
- Our vision is “to be the leading communications satellite solution provider in Nigeria and indeed Africa”.

About NIGCOMSAT-1(R)

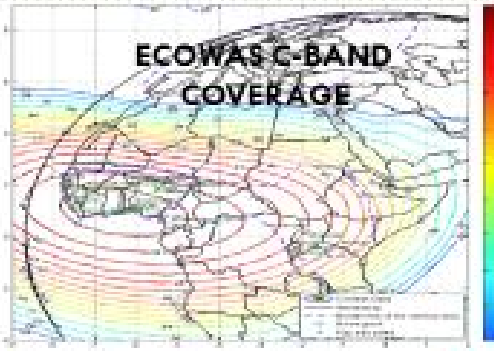
- Nigeria's first communication satellite (NIGCOMSAT-1), a quad-band high powered satellite with navigational capability and capacity launched on 14th May, 2007.
- NIGCOMSAT-1 was Africa's first contribution to the Global Navigation Satellite System as regional Satellite-based Augmentation System (SBAS).
- It was however de-orbited on the 10th of November, 2008 due to an irreparable single point of failure on-board the satellite.
- All broadcast, telecommunication services being offered by the satellite including strategic navigational plans and objectives were disrupted.
- The **NIGCOMSAT-1R**, is the replacement for NIGCOMSAT-1 satellite launched on 19th December, 2011.

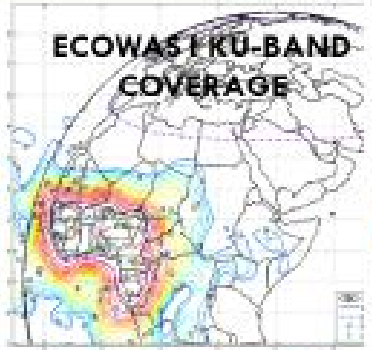
NigComSat-1R

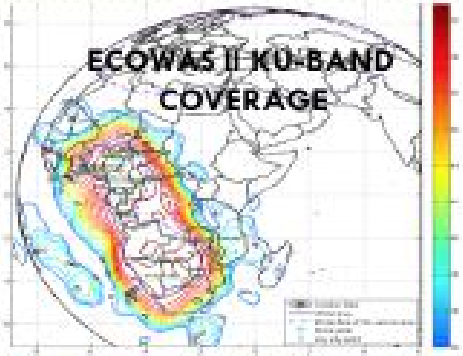


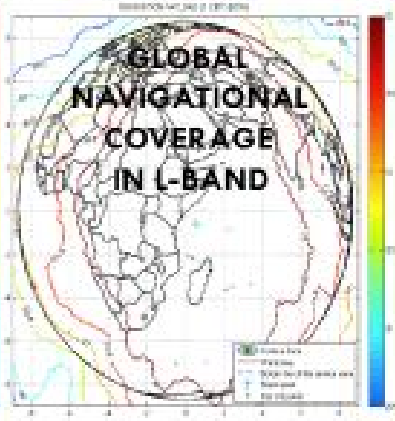
- The satellite is located at 42.5 degree

NIGCOMSAT-1R FOOTPRINTS AND COVERAGE









GROUND INFRASTRUCTURES

- **SATELLITE CONTROL & OPERATIONS**
- **SATELLITE APPLICATIONS**

Satellite Control & Ops (Satellite control)

- Uninterrupted tracking satellite
- Receiving, processing, monitoring and store real time telemetry
- Processing and sending tele-command
- Monitoring satellite status on real time
- Managing satellite platform

  - Satellite attitude control
  - Satellite special management during eclipse season
  - Inhibition protection to the sensors and detectors
  - Managing EPS subsystem
  - Managing TCS subsystem
  - Satellite health check

Satellite Control & Ops (Network Operations)

- Transponders TWTA output power monitoring
- Transponders integral power monitoring
- Transponders noise floor analysis
- Transponders spectrum overall check

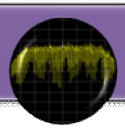
Transponders State Monitoring

- User's integral power monitoring
- The management of the user's band
- Radio and television programs monitoring

Users' Operations Monitoring

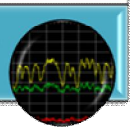
- Spectrum monitoring
- Eb/No monitoring
- Power level monitoring

Carriers Monitoring



- Adjacent satellites interference
- Cross Polarization interference
- Intermodulation interference
- Adjacent channel interference
- Electromagnetic environment interference
- Earth station equipment spurious interference
- Sun Outage
- Interfere caused by wrong operations

Interference Analysis and Processing



- Turn on or turn off
- Muting on or muting off)
- Gain step adjustment
- Backup switch

Payload operations

- Create files for Users' carriers
- Regular contacts or visits to customers
- Process of interference appeal
- Notice of sun outage time
- Notice of satellite major operation
- Notice of the best time of pointing to the satellite
- Customer complaint processing

Regular contacts with customers

INTRODUCTION TO GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) : GPS

- After the first world war, the first manifestation of new technology capable of usurping the super accurate mechanical chronometers occurred in 1904 by the United States Navy using radio-time signals as an aid for determination of longitude at sea and thus Greenwich time.
- Global Positioning System (GPS) originated from the Navigation System with timing and Ranging Known as NAVSTAR initiated by JPO of US DOD in 1973.
- Initial Operational Capability (IOC) was reached in 1993 with 24 *satellites* while Full Operational capability (FOC) was declared on July 17th, 1995.
- The primary goals were military but the U.S Congress helped in promoting civil use free of charge which led to final deactivation of the selective availability on 2nd May, 2000 and improvement for civilian users went from 100m to about 20m accuracy.

INTRODUCTION TO GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

Other GNSS are as presented in the table below:

System	No. of Satellites	Nominal Altitude (Km)	Orbit Inclination *i* (°)	Initiation and Current Operational Capability
GPS	30 (5th Feb. 2016)	20,000	55	Initiated 1973 by USA, 1995(FOC)
GLONASS	24 (29th May 2016)	19,000	64.8	Initiated by Russia in 1975, 1996(FOC) 2011 (Restarted Modernization)
GALILEO	Presently 14 satellites (24th May 2016) (30)	24,000	56	Initiated by EU in 2000, 2014(IOC) 2020(FOC) tentatively
BEIDOU (COMPASS)	Presently 23 (13th June, 2016) (30)	30 MEO Satellites (21,500) 5 IGSO Satellites inclined at 55 degrees	55	Initiated by China in 1990s. Regional System declared operational in 2011. 2020 (FOC)

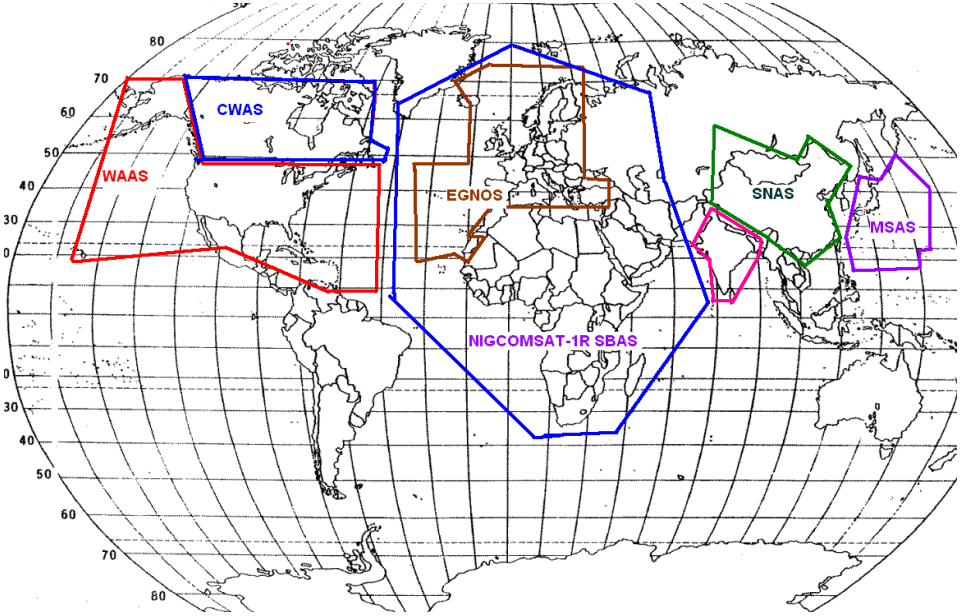
Needs Assessment for Augmentation Systems

- Satellite-Based Augmentation System (SBAS) arose from the need to provide continuity, Availability, Integrity and Accuracy of GPS signals to eliminate errors and compensate for discrepancies associated with GPS signals and other navigation systems.
- An augmentation system can be Ground-Based (GBAS) or Satellite-Based (SBAS) and arises from the need to provide continuity, availability, integrity and accuracy of Global positioning signals to eliminate errors and compensate for discrepancies associated with GPS signals as well as fleet management capability.
- Augmentation is important in applications that involve safety of life, i.e all phases of flight, which requires improved accuracy of the global positioning signals to eliminate errors and compensate for discrepancies through differential corrections associated with GPS signals and other navigation systems in terms of positioning, velocity and timing requirements of aviation, maritime and land-based transport systems.
- The most effective augmentation system, especially for coverage capability, is the Satellite-Based Augmentation System (SBAS), which transmits signals over a wide geographic area for identified primary and secondary users in a mix controlled and free market.

REGIONAL SATELLITE BASED AUGMENTATION SYSTEM (SBAS) ACROSS THE WORLD (OPERATIONAL AND PLANNED).

a. USA: Wide Area Augmentation System (WAAS), expanded to Canada as CWAAS and planned expansion to South America.
b. Europe: European Geostationary Navigation Overlay System (EGNOS) with planned expansion over Africa.
c. China: Chinese Satellite Navigation Augmentation System (SNAS) currently DRAGON: Differential Reference Augmentation Global Overlay Network.
d. Japan: MTSAT Satellite Augmentation System (MSAS).
MTSAT means Multi-functional Transport SATellite.
e. India: GPS-Aided Geo-Augmented Navigation (GAGAN).
f. Russian Federation: System Differential Correction and Monitoring (SDCM).
g. ***AFRICA: Nigerian Satellite Augmentation System (NSAS): First with Nigeria and expansion to African countries including oceans to the extend of our coverage.***

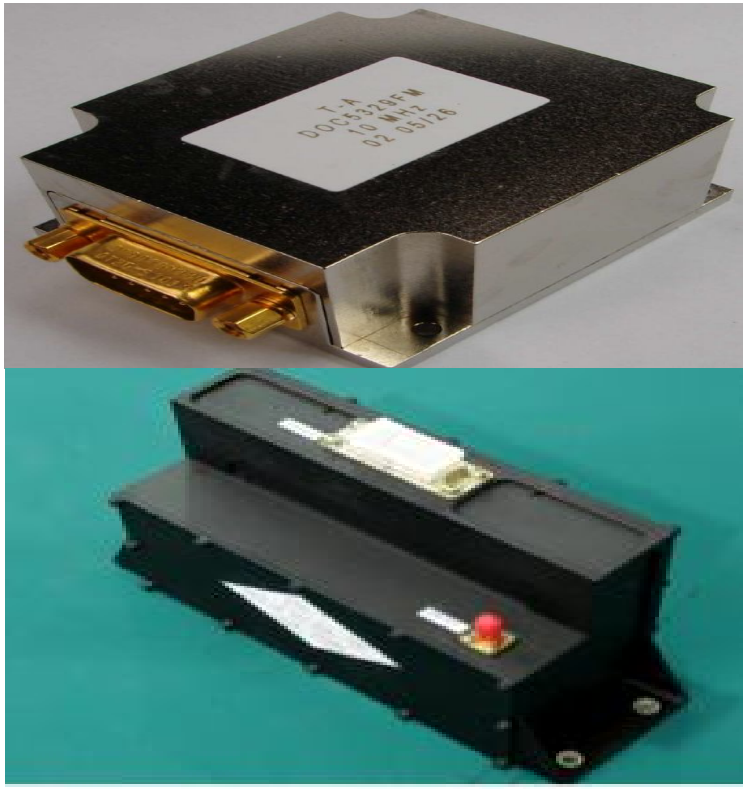
ILLUSTRATION OF REGIONAL SATELLITE BASED AUGMENTATION SYSTEM.



WAAS: US Wide Area Augmentation System EGNOS: European Geostationary Navigation Overlay Service MSAS: Japanese MTSAT Satellite Augmentation SystemSNAS: Chinese Satellite Navigation Augmentation System CWAAS: Canadian Wide Area Augmentation System

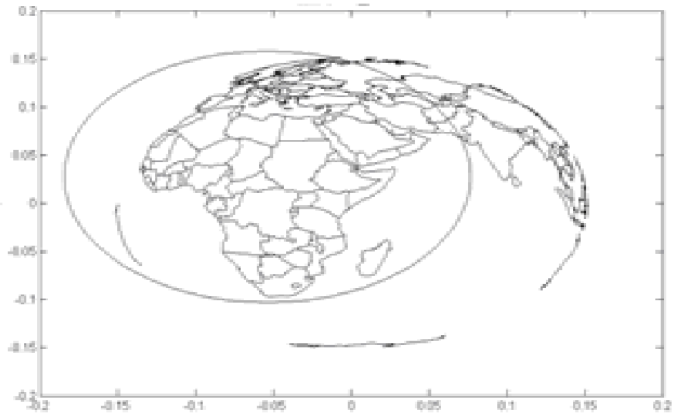
NIGCOMSAT-1R NAVIGATION PAYLOAD: AFRICA'S CONTRIBUTION TO SBAS AND GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS).

- ***10MHz ultra stable crystal oscillator was used for the L-band payload to meet the performance requirements of frequency conversion stability and accuracy***.



10MHz Master Oscillator

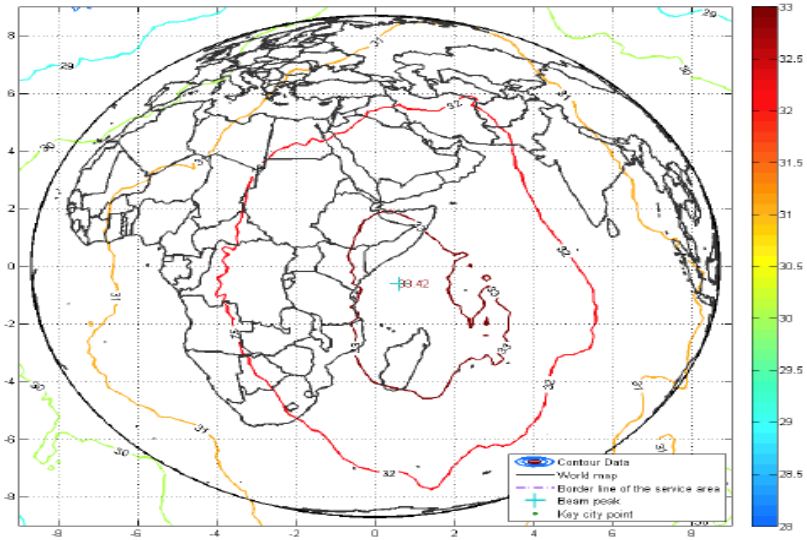
NIGCOMSAT-1R NAVIGATION PAYLOAD: AFRICA'S CONTRIBUTION TO SBAS AND GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS).



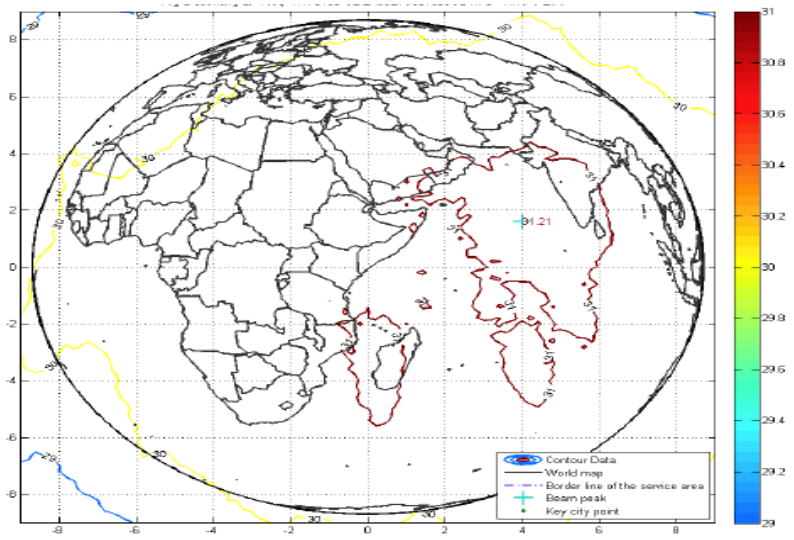
The downlink coverage beam of NIGCOMSAT-1R Geo-Navigation Satellite using L –Band Helix Antenna.

NIGCOMSAT Master Control Station with C-L Band Antenna Systems

NIGCOMSAT-1R NAVIGATION PAYLOAD: AFRICA'S CONTRIBUTION TO SBAS AND GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS).



The downlink coverage beam of NIGCOMSAT-1R Geo-Navigation Satellite on L1 Frequency



The downlink coverage beam of NIGCOMSAT-1R Geo-Navigation Satellite on L5 Frequency

Channel	Frequency (MHz)	Polarization	Bandwidth (MHz)
L1-Downlink	1575.42	RHCP	4
L5-Downlink	1176.45	RHCP	20

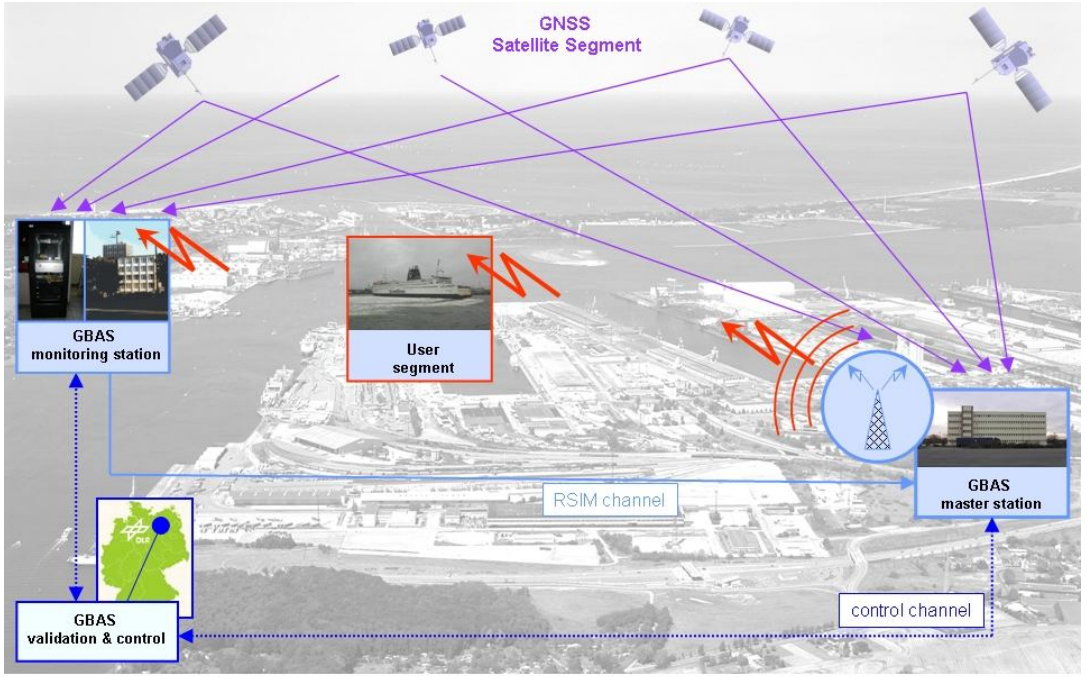
RELEVANCE, ITS ENVISAGED APPLICATIONS AND ECONOMIC IMPORTANCE

Aviation

- Increased Runway Access
- More direct en route flight paths
- New precision approach services
- Reduced and simplified equipment on board aircraft

Maritime

- Ocean navigation
- Port approaches
- Restricted waters guidance
- Auto docking



Train Transportation

- **Automatic tracking and inspections.**
- **The prevention of collisions, derailments, work zone incursions, and rail switch errors.**
- **Automatic speed control / braking**
- **The increasing of capacity and efficiency for all rail users.**
- **Position control, loading and unloading operations**

Civil Engineering/GIS

Land Surveying

GIS Collection

Land Slide

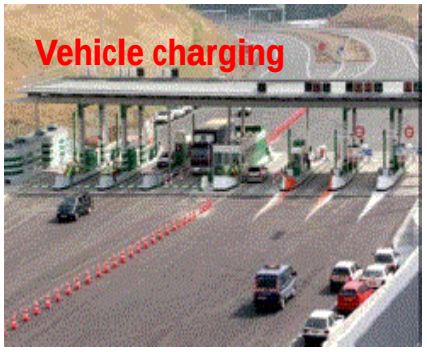
Precision Agriculture

Deformation Monitoring

For the high precision applications, the GNSS/SBAS terminals with sub-meter level position accuracy can be used for land surveying, slide, deformation, etc.

Road Transportation

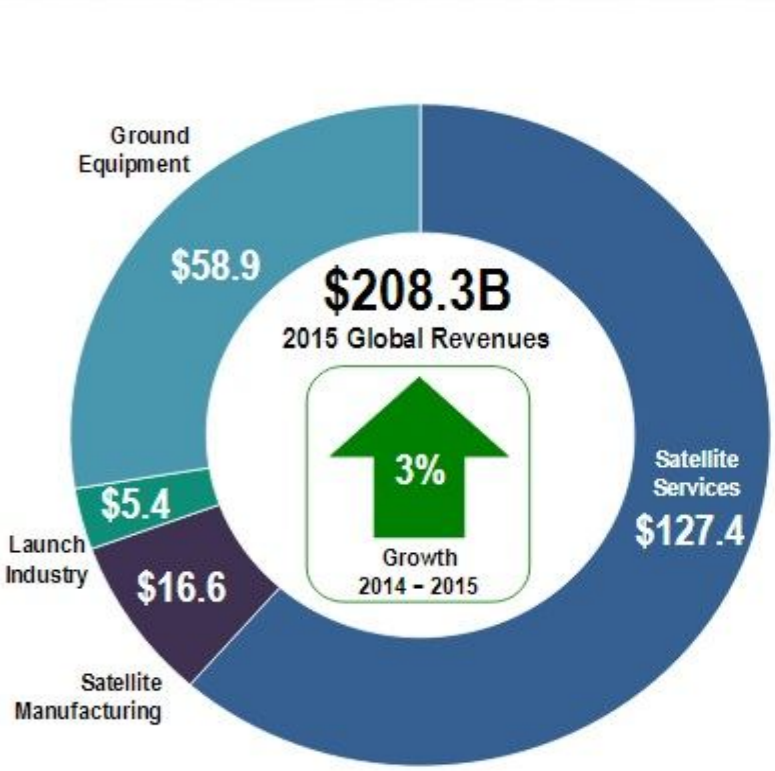
- Vehicle navigation
- Fleet management
- Intelligent parking guidance
- Tracking of events in real time
- Integration with GIS systems
- Demographic Information etc.

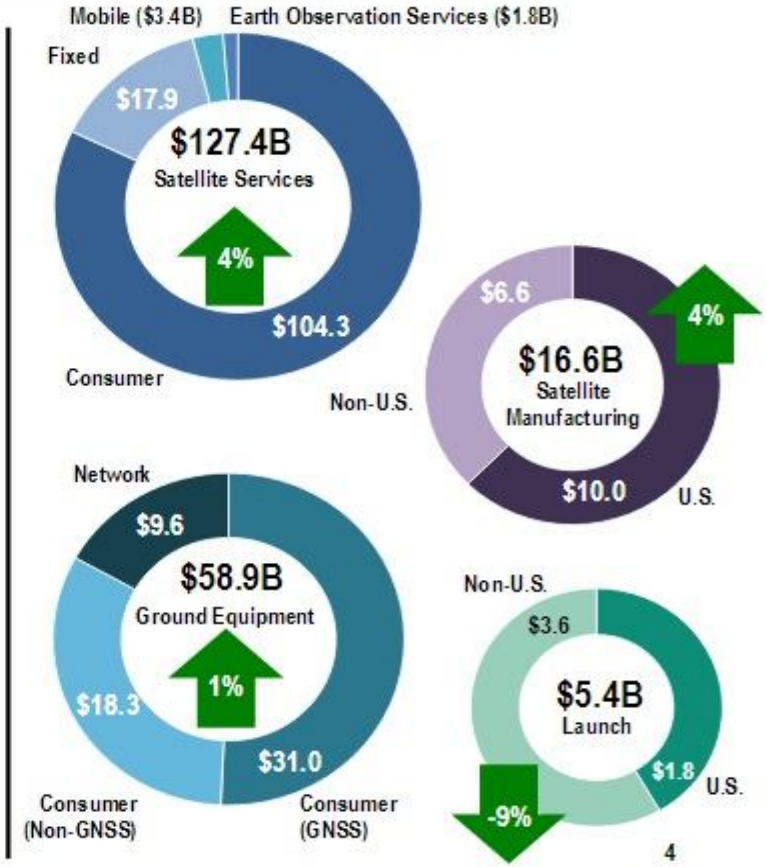


OTHER GNSS/SBASAPPLICATIONS ARE:

- Security of National Infrastructure: Pipelines, Power Lines, Gas Reservoirs, Strategic national Infrastructure.
- Improved Agricultural Practice with high yield.
- Improved Emergency Services, Recovery Services, Search & Rescue: NEMA, Fire Fighters, FRSC etc
- Utility Management: Energy and Communications Company for synchronization.
- Geographic Information System Companies
- Tourism
- Telematic Services i.e Insurance Companies
- Environmental Protection, Characterization and Demography
- Paramilitary Organizations, Security Agencies etc
- Public Safety: Tall Buildings, Bridges etc
- Scientific Research

GLOBAL 2015 SATELLITE INDUSTRY ASSOCIATION (SIA) INDICATOR SUMMARY REPORT



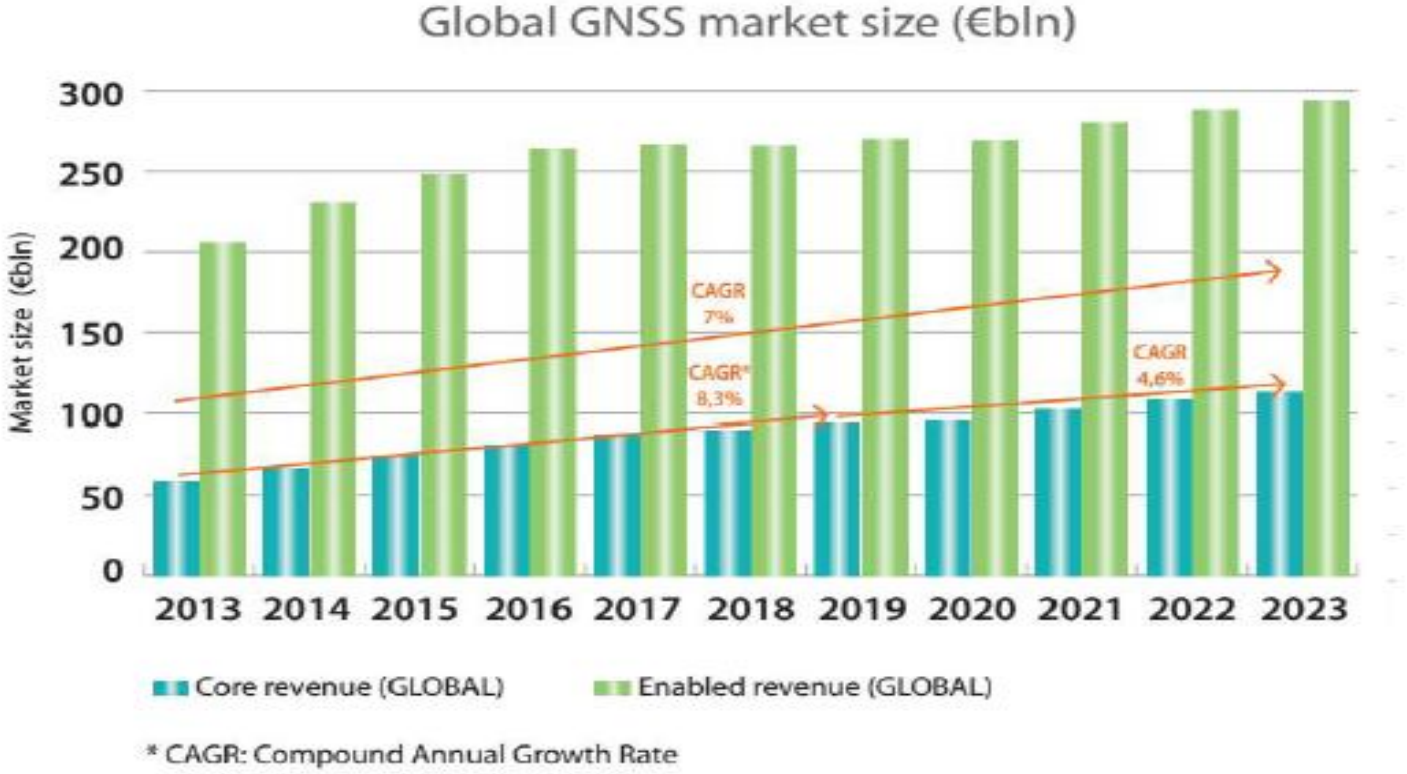


Prepared by:

THE TAURI GROUP

Market for Satellite Navigation

* **Almost 4 billion GNSS devices used worldwide, Africa and Middle East are experiencing the FASTEST GROWTH**



Thank You!