Presented by:

Barde Jatau, fnis
(Director Geodesy and Special Surveys)
Office of the Surveyor General of the Federation, Abuja Nigeria

During

The International Seminar on Geodetic Reference Frame and Location based Services, Nanning, China on 24\textsuperscript{th} November 2015.
November, 2015

ABSTRACT

The Federal Republic of Nigeria through the Office of the Surveyor General of the Federation (OSGoF), has embraced the GNSS Technology (especially its application in Surveying and Mapping). The Nigerian Global Navigation Satellite Systems Reference Network (NIGNET), came to realization in 2009 and currently fifteen Continuously Operating Reference Stations (CORS) have been installed so far. The network provides free RINEX data online, to the teeming surveying communities. This paper present an overview of some activities carried out in the implementation and management of the network and the current status of the network as well as outlines the details of each station locations and installations. Some of the data posted on-line from the NIGNET website: www.nignet.net was verified by comparing result computed using NIGNET data and some acclaimed centres such as Canadian Precise Point Positioning (PPP) techniques. The result shows an appreciable stability of the network indicating that the stations are moving uniformly along with the African (Nubian) Plate. Furthermore, present challenges were examined and the ways forward were highlighted. In addition, several concerted efforts in the area of capacity building for continuity and sustainability of the NIGNET project by (OSGoF) was reported.
INTRODUCTION

This paper reports the work carried out since 2009 in the implementation of Nigerian GNSS Reference Network (NIGNET) in pursuant of the African Geodetic reference Frame (AFREF) project by the Office of the Surveyor General of the Federation (OSGoF), which is the National Mapping Agency of Nigeria. The project was initiated in 2008 with the goal of establishing a permanent geodetic reference network of GNSS stations to be distributed within the entire Nigerian territory. This paper highlights some of the activities of NIGNET network, current status and some future prospect and challenges. It covers the installation, maintenance and management of the NIGNET.

The Federal Government of Nigeria through OSGoF initiated the project in 2008, but the implementation started in September 2009. The first phase of installation, which included 9 sites, ended by February 2010; however, two more stations were installed in the second phase in March 2011. The third phase was the installation of four stations by the Presidential Technical Committee on Land Reform in conjunction with OSGoF in 2012. The geographic locations of these stations are as shown in Figure 1. The first phase, shown in green, was installed in 2009 and 2010, and the second phase, shown in yellow, was installed in March 2011. The stations in purple represent the one installed in the framework of the Land Reform project. In addition, the station in red represents the one donated by Leica incorporations. Installed and manage by RECTAS in July 2007.
2.0 AIMS AND OBJECTIVES

The main aims and objectives of this presentation are to appraise the status of the NIGNET COR Station project in Nigeria since inception and to present some of the efforts OSGoF made in sustenance of the project and some of the challenges faced. Furthermore, let me digress a bit to seek for collaboration and support from the International Community in the area of capacity building and development of the network to meet current challenges in the dissemination of geospatial information for sustainable development.

3.0 MINNA DATUM (CLARKE 1880 SPHEROID) AS INITIAL REFERENCE

The Clarke 1880 ellipsoid was adopted as the reference ellipsoid for the Nigerian Geodetic Datum to meet the requirements for Surveying, Mapping and Engineering projects. In the Nigerian geodetic network, the Clarke 1880 ellipsoid was adopted as the horizontal geodetic datum, where as the Lagos datum close to the East mole, was adopted as the vertical datum. Nigeria is covered with first-order triangulation chains and traverse control networks. These networks were computed on the Nigerian geodetic datum which was established by Astro-Geodetic method with its origin located at triangulation station L40 (the northern terminal of the Minna base of the Nigerian Primary triangulation network). Hence the datum is a local geodetic datum called “Minna B” datum (the Minna datum applied in the west of the Republic of Cameroun is called “Minna A”). The Minna B datum is based on the Clarke 1880 ellipsoid (Semi-major axis, a = 6378249.145m; Polar Flattening, f = 1/293.465). The L40 origin has the
following adopted geodetic co-ordinates: Latitude $\varphi = 09^\circ 38' 09''$ N Longitude $\lambda = 06^\circ 30' 59''$ E Height $H = 279.6$m above the geoid.

With the evolution of space technology, a geocentric datum, which is used all over the world, is also in use in Nigerian geodetic network With the advent of the Navy Navigational Satellite System (NNSS) (Doppler), and later Global Positioning System (GPS) as tools for geodetic positioning, there is often the need to transform coordinates on the geocentric systems to coordinates on the local systems, and vice versa.

### 3.1 TRANSFORMATION PARAMETERS

The connection between global and local datums is usually established by transformation parameters. To determine these transformation parameters, points whose coordinates are known on both datums are usually chosen. Several attempts have been made to determine transformation parameters for the Nigerian Geodetic Datum, using either Doppler or WGS 84 coordinates or Clarke 1880 coordinates. Efforts have been made by both Nigerians and Foreign agencies to determine transformation parameters for the Nigerian Geodetic Datum. There are various methods by which the transformations can be executed. No conclusion has been reached as to which of them is the preferred approach at the moment.

### 3.2 PROBLEMS ASSOCIATED WITH THE OLD CLARKE 1880 SYSTEM

Historically, different ellipsoids have been chosen by different countries of the world in order to simplify surveying and mapping in their region and as such these ellipsoids are not necessarily geocentric. In Nigeria, the regional (local) coordinate system is the Minna Datum based on Clarke 1880 ellipsoid. The geocentric system of Nigeria is the WGS84 ellipsoid. Because of the inherent problems with the local systems, there is bound to be so many inadequacies since each country have its local origin, especially at international borders. Projects don’t really match. Hence the need for embracing the new reference system on which the Continuously Operating Reference System CORS is based (WGS 84). This is a Geocentric system and at Harmony with all other countries of the World. The African Geodetic Reference Frame (AFREF) is geared towards the harmonization of Reference in Africa, based on the International Terrestrial Reference Frame. (ITRF). The way forward will therefore means moving away from the old system (Minna Datum on L40) to geocentric system (WGS84) since data acquisition is best compatible to other modern data types. There is for sure a gradual move towards this direction as it can be seen in the embracement of CORS. But it is evident that this move will require major changes to all maps and other GIS products in Nigeria.
4.0 SITE SELECTION CRITERION

Information guiding the requirements and recommendations for the establishment and operation of Global Navigation Satellite Systems (GNSS) Stations were duly consulted and the criteria were adhered to during the installation. Although, it is generally known that most sites cannot meet up with the full requirements therefore, NIGNET is not an exemption. In view of this, in some stations minimum requirements were considered during site selections. Some of the criteria considered are as follows:

- Monument: Station Mount and Marking of Antenna Reference Point are verified.
- Stability of the ground or platform.
- Clear sky visibility and locations free from interferences due to Radio Frequency (RF) or from other sources.
- Ground based mounting were executed in accordance to the specifications for a ground–based mounting
- For the roof-based monument, all the stations were built on buildings that are at least 5 years old.
- The antennas were rightly oriented to the True North
- Specifications for site cabling were duly followed, where each antenna was made to be closer to the receiver to avoid signal lost due to attenuation.
- For the NIGNET equipment, CORS equipment specifications were considered.
- All our stations are powered by Solar systems due to epileptic nature of power supply from the national electricity grids.

5.0 NIGNET Site Information

The individual site details of some of the NIGNET stations are as follows:

1. ULAG STATION

This station was installed on top of a three-storey building (dormitory) because it was the only available location free from any unforeseen interferences known to the committee during site selection. The station performs relatively well for years until recently when we started experiencing difficulty in data streaming due to communications issues.
2. OSGF STATION

This station was installed on the roof top of OSGoF headquarters, Abuja; unlike other stations, it does not require remote communications. The receiver was installed and hoard in the NIGNET Control/Monitoring rack inside the NIGNET Control room close to the server as shown below. The system (Control/Monitoring Centre) consist of the receiver, router, internet facilities, uninterrupted power using solar panels and their accessories, the monitor and server that houses all the data from the other NIGNET remote station. Data are streamed from all these stations into the control/monitoring centre through File Transfer Protocol (FTP).

3. ABUZ
This station was installed on top of a three-storey building (Department of Survey) since the campus environment is also covered by many high-rise buildings as the only available option at our disposal. This station is adjudged as one of the most reliable stations in the network.

**Zaria**

<table>
<thead>
<tr>
<th>Station</th>
<th>ABUZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Ahmadu Bello University, Zaria</td>
</tr>
<tr>
<td>Date of Installation</td>
<td>24-01-2010</td>
</tr>
</tbody>
</table>

Figure 4: shows ABUZ CORS

4. **BKFP STATION**

This station was installed at one of the corners of the concrete pillar attached to a small building specifically built by the school authority to house the equipment. The station is one of the most reliable stations in the network; however we only transmit 30sec data from this site due to non-availability of 3G services (although we equally log 1sec data for reference and analysis which can be provided on request)

**Birnin Kebbi**

<table>
<thead>
<tr>
<th>Station</th>
<th>BKFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Birnin Kebbi Federal Polytechnic</td>
</tr>
<tr>
<td>Date of Installation</td>
<td>25-01-2010</td>
</tr>
</tbody>
</table>
5. **UNEC STATION**

This station was installed on the top of the two-storey Library building at the University Enugu campus. The station is one of the most reliable and dependable stations in the network. It only has some few problems in communications during the initial week of installation before the router firmware upgrades. The station developed L2 failure about some months ago and efforts is on to correct the anomaly as soon as fund is made available.

<table>
<thead>
<tr>
<th>Location</th>
<th>University of Nigeria Enugu Campus, Enugu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Installation</td>
<td>03-02-2010</td>
</tr>
</tbody>
</table>

6. **CGGT STATION**

This station was installed at the Centre for Geodesy and Geodynamics, Toro (CGGT) of National Space Research Agency (NASRDA) under the auspices of Federal Ministry of Science and Technology; adjudged to be the most stable platform in the country by the national scientific advisory group. The station is suitably located on exposed bedrock with no obstruction and a very good sky visibility. The station was co-located with NASA IGS(CGGN) Toro, observatory station with a two ways splitter transmitting data to two receivers from a single antenna. Unfortunately, the antenna and the splitters developed some faults. They are replaced and functioning perfectly while Osgof is yet to perfect the protocol for data transmission to the server.
Figure 7: shows CGGT CORS

7. **FUTY STATION**

This station was installed on the top of a two-storey building on the campus. At the point of installation, the signal from the ISP around the area was not very strong resulting in some initial hiccups as regards data communications between the server and the station.

These problems were resolved after several attempts on the router firmware modernization and data streaming continues with hitches.

Figure 8: shows FUTY CORS
8. **GEMBU STATION**

This station was installed on a concrete pillar attached to the building where the equipment is housed. The construction of the pillar was done previously before the actual installation of the equipment. The remote location of this station without any reliable communications necessitated the use of satellite link to enable data streaming. The data from the station cannot be assessed at the moment due to satellite re-direction by Junisat and we hope to re-establish communication between the station and the server as soon as this is achieved.

<table>
<thead>
<tr>
<th>Station</th>
<th>GEMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>High Altitude Training Facility, Gembu</td>
</tr>
<tr>
<td>Date of Installation</td>
<td>08-02-2010</td>
</tr>
</tbody>
</table>

Figure 9: shows GEMB CORS

9. **FUTA STATION**

This station was installed at the Federal University of technology, Akure campus. The project was financed by the Presidential Technical Committee on Land Reform in conjunction with OSGoF as technical partner. It is a ground based installation on a rock as shown in the figure below. The issue with the station as to do with data streaming to the server. Several attempts were made to resolve the problem but futile, in fact there was a time when 18 months data was copied out of the system. A lot needs be done to resolve the impasse between the system and the server via the ISP.
10. HUKP

This station was installed at the Hassan Usman Katsina Polytechnic campus. The project again was financed by the Presidential Technical Committee on Land Reform in conjunction with OSGoF as technical partner. It is a ground based installation on a bare ground as shown in the figure below. The issue with the station equally has to do with data streaming to the server. An epileptic services that cannot guarantee uninterrupted data stream at least for 24 hrs.

6.0. PROGRESSION IN TRAINING AND CAPACITY BUILDING

The office of the surveyor General of the Federation (OSGoF) made several efforts in training its staff in the area of GNSS applications in Surveying and Mapping and other relevant uses. The following trainings/workshops were supported by OSGOF:

i. GNSS Base Station installation and data processing at Regional Centre for Mapping of Resources for Development (RCMRD) in Nairobi, Kenya.
ii. GNSS, practical sessions on Trimble Business Centre software, Seven par software and Nigeria Geodetic Reference Network (NIGNET) at the Office of the Surveyor General of the Federation, Abuja by Space Earth Geometric Analysis laboratory (SEGAL), Portugal.

iii. Practical sessions on GNSS Navigation and Related applications at the Space Earth Geometric Analysis laboratory (SEGAL), Portugal


In addition, some members of staff of the Office were sent for Masters Programme in relevant fields to enhance the management of the NIGNET Network. The following are some of the Programmes attended by the officers:

i. UN-ITALY, Masters in Navigation and Related applications at Politecnico di Torino, Italy

ii. Masters in Computer Science and Engineering, at the University of Beira Interior Covilha, Portugal.

6.1 PROJECTS AND RESEARCH WORKS USING NIGNET NETWORK

Since the installation of the NIGNET station, there have been several developmental projects and research works carried out using the data from the NIGNET station such as:

- The establishment of the National Geodetic Controls for the determination of transformation parameter
- Establishment of Control Network for the Cross River State Geographic Information System.
- Establishment of Control Network for the Plateau State Geographic Information System
- Ongoing research work on the determination of Nigerian Geocentric Datum
- Ongoing research work on the analysis of the stability of the NIGNET using Precise Point Positioning technique.

6.1.1 The Establishment of Nigerian Geodetic Controls.

The Office of the Surveyor General of the Federation in collaboration with the Federal Ministry of Mines and Steel Development embarked on a GNSS campaign project which saw the addition and observation of 68 control points. This was aimed at obtaining the coordinates of all the trigonometric stations in ITRF 2008 coordinates system. The project was successfully executed and it helped the country in mapping the mining cadastre and all other land resources. The
The project was financed by United Nation and 84 control points were coordinated using ITRF 2008. These observed control points are as shown in figure 12.

<table>
<thead>
<tr>
<th>SOFTWARE</th>
<th>CORS</th>
<th>GCP</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
<th>ELLIPS Ht (m)</th>
<th>Horz RMS (m)</th>
<th>Vert RMS (m)</th>
</tr>
</thead>
</table>

Figure 12: Map of Nigeria showing CORS locations and Ground control points

6.1.2 Investigation on the Accuracy of the Rover Positions Determined from the NIGNET CORS Network

The NIGNET CORS establishment in Nigeria had his own challenges when the data posted on the net was challenged by some M.Sc. and PhD students as regard its accuracy and stability. The Office of the Surveyor General of the Federation decided to set up a team to verify the claims and the team observed on the same points used by the researching students. GNSS observations were carried out on three of the Ground Control Points (GCP) and the results compared with the coordinates generated with some online Precise Point Positioning (PPP) services and (AUSPOS). The outcome of the investigation and analysis of EC03, EC05 and GSE006 GCP's are as shown in tables 1 to 3 and figures 1 to 3 respectively.
<table>
<thead>
<tr>
<th>Software</th>
<th>CORS</th>
<th>Rover</th>
<th>Discrepancy_Lat.01(sec)</th>
<th>Discrepancy_Long.01(sec)</th>
<th>Discrepancy_Ht.01(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUSPUS EC03</td>
<td>6°25'36.10668&quot;N</td>
<td>7°30'17.51519&quot;E</td>
<td>231.372</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPS</td>
<td>6°25'36.11000&quot;N</td>
<td>7°30'17.52000&quot;E</td>
<td>231.4397</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top-con Tools ABUZ</td>
<td>6°25'36.10575&quot;N</td>
<td>7°30'17.51399&quot;E</td>
<td>231.441</td>
<td>0.052</td>
<td>0.095</td>
</tr>
<tr>
<td>BKFP</td>
<td>6°25'36.10637&quot;N</td>
<td>7°30'17.51712&quot;E</td>
<td>231.640</td>
<td>0.129</td>
<td>0.061</td>
</tr>
<tr>
<td>CLBR</td>
<td>6°25'36.10586&quot;N</td>
<td>7°30'17.51336&quot;E</td>
<td>231.150</td>
<td>0.067</td>
<td>0.037</td>
</tr>
<tr>
<td>OSGF</td>
<td>6°25'36.10527&quot;N</td>
<td>7°30'17.51412&quot;E</td>
<td>231.392</td>
<td>0.075</td>
<td>0.032</td>
</tr>
<tr>
<td>UNEC</td>
<td>6°25'36.10536&quot;N</td>
<td>7°30'17.51352&quot;E</td>
<td>231.402</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>AUSPUS EC05</td>
<td>6°25'41.63368&quot;N</td>
<td>7°30'21.81081&quot;E</td>
<td>225.715</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPS</td>
<td>6°25'41.64000&quot;N</td>
<td>7°30'21.81000&quot;E</td>
<td>225.8357</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top-con Tools ABUZ</td>
<td>6°25'41.63281&quot;N</td>
<td>7°30'21.80863&quot;E</td>
<td>225.786</td>
<td>0.090</td>
<td>0.062</td>
</tr>
<tr>
<td>BKFP</td>
<td>6°25'41.63397&quot;N</td>
<td>7°30'21.80757&quot;E</td>
<td>225.989</td>
<td>0.111</td>
<td>0.073</td>
</tr>
<tr>
<td>CLBR</td>
<td>6°25'41.63263&quot;N</td>
<td>7°30'21.81143&quot;E</td>
<td>225.609</td>
<td>0.054</td>
<td>0.040</td>
</tr>
<tr>
<td>OSGF</td>
<td>6°25'41.63228&quot;N</td>
<td>7°30'21.80892&quot;E</td>
<td>225.739</td>
<td>0.068</td>
<td>0.045</td>
</tr>
<tr>
<td>UNEC</td>
<td>6°25'41.63273&quot;N</td>
<td>7°30'21.80935&quot;E</td>
<td>225.688</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>AUSPUS GSE 06</td>
<td>6°25'39.52649&quot;N</td>
<td>7°30'26.58369&quot;E</td>
<td>226.626</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPS</td>
<td>6°25'39.53000&quot;N</td>
<td>7°30'26.58000&quot;E</td>
<td>226.7203</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top-con Tools ABUZ</td>
<td>6°25'39.52352&quot;N</td>
<td>7°30'26.58560&quot;E</td>
<td>226.970</td>
<td>0.056</td>
<td>0.094</td>
</tr>
<tr>
<td>BKFP</td>
<td>6°25'39.52487&quot;N</td>
<td>7°30'26.57474&quot;E</td>
<td>227.036</td>
<td>0.070</td>
<td>0.112</td>
</tr>
<tr>
<td>CLBR</td>
<td>6°25'39.52658&quot;N</td>
<td>7°30'26.58346&quot;E</td>
<td>226.536</td>
<td>0.055</td>
<td>0.035</td>
</tr>
<tr>
<td>OSGF</td>
<td>6°25'39.52466&quot;N</td>
<td>7°30'26.58422&quot;E</td>
<td>226.672</td>
<td>0.069</td>
<td>0.043</td>
</tr>
<tr>
<td>UNEC</td>
<td>6°25'39.52543&quot;N</td>
<td>7°30'26.58258&quot;E</td>
<td>226.598</td>
<td>0.001</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Table 1: Comparism of On-line processing with NIGNET processing results.

Table 2: EC03 Discrepancies in Lat., Long. (sec) and Height (m) wrt. AUSPOS
Fig.13 Shows the discrepancies in Lat., Long. (sec) and Height (m) wrt. AUSPOS in EC03 station

Table 3: EC05 Discrepancies in Lat., Long. (sec) and Height (m) wrt. AUSPOS

<table>
<thead>
<tr>
<th>Software</th>
<th>CORS</th>
<th>Rover</th>
<th>Discrepancy_Lat.01(sec)</th>
<th>Discrepancy_Long.01(sec)</th>
<th>Discrepancy_Ht.01(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONLINE</td>
<td>AUSPOS</td>
<td>EC05</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>TBC</td>
<td>ABUZ</td>
<td>EC05</td>
<td>0.001970</td>
<td>0.000140</td>
<td>-0.017000</td>
</tr>
<tr>
<td>TBC</td>
<td>BKFP</td>
<td>EC05</td>
<td>0.003420</td>
<td>0.000670</td>
<td>-0.065000</td>
</tr>
<tr>
<td>TBC</td>
<td>CLBR</td>
<td>EC05</td>
<td>0.001670</td>
<td>0.001220</td>
<td>-0.039000</td>
</tr>
<tr>
<td>TBC</td>
<td>UNEC</td>
<td>EC05</td>
<td>0.002540</td>
<td>-0.000070</td>
<td>-0.051000</td>
</tr>
</tbody>
</table>

![EC03 Discrepancies in Lat., Long. (sec) and Height (m) wrt. AUSPOS](image-url)
Fig. 14 Shows the discrepancies in Lat., Long. (sec) and Height (m) wrt. AUSPOS in EC05 station

Table 4: GSE006 Discrepancies in Lat., Long. (sec) and Height (m) wrt. AUSPOS

<table>
<thead>
<tr>
<th>Software</th>
<th>CORS</th>
<th>Rover</th>
<th>Discrepancy_Lat.01(sec)</th>
<th>Discrepancy_Long.01(sec)</th>
<th>Discrepancy_Ht.01(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONLINE</td>
<td>AUSPOS</td>
<td>GSE006</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>TBC</td>
<td>ABUZ</td>
<td>GSE006</td>
<td>0.002490</td>
<td>0.000630</td>
<td>0.032000</td>
</tr>
<tr>
<td>TBC</td>
<td>BKFP</td>
<td>GSE006</td>
<td>0.003400</td>
<td>0.001160</td>
<td>-0.015000</td>
</tr>
<tr>
<td>TBC</td>
<td>CLBR</td>
<td>GSE006</td>
<td>0.001650</td>
<td>0.001720</td>
<td>0.010000</td>
</tr>
<tr>
<td>TBC</td>
<td>UNEC</td>
<td>GSE006</td>
<td>0.002520</td>
<td>0.004440</td>
<td>-0.003000</td>
</tr>
</tbody>
</table>

Fig. 15 Shows the Discrepancies in Lat., Long. (sec) and Height (m) wrt. AUSPOS in GSE006 station
From the comparison of the results obtained using NIGNET data and AUSPOS on-line processing services, the differences/discrepancies obtained is negligible. In the same vain, there are negligible differences from the comparison of the results obtained using Nignet data from different CORS stations. The results show that rover positions determined from data obtained from NIGNET CORS are consistent with negligible discrepancies with one another and the on-line processing results.

6.1.3 The Analysis of the Stability of the NIGNET using Precise Point Positioning Technique.

In order to ascertain and reassure the end users in terms of the stability of the stations, there has been periodic analysis of the stability of the NIGNET stations. The results of the analysis carried on some of the NIGNET stations in 2014 is as shown in Figure 16

![Figure 16: Map Showing Vector Resolution of the Displacement at each Station (From 2011-2014).](image_url)

From the analysis, the following deductions were made:

i. There is stability in the vertical movement.

ii. There is movement in both North and East components: - The movements as it can be seen from the figure above, being represented by a vector resolution as in Figure 16
above are of the magnitude of 7cm, in both directions (Eastings and Northings). Though not exactly 7cm, but considering errors emanating from receivers noise, we can affirm that the movements stands at 7cm.

iii. The Displacements of 7cm is in same direction for all the stations and at 45 degrees, which is positive for all, and indicates movements of the plates.

iv. From the uniform directional movement so far, it can also be deduced that there is no any anomaly with any of the stations in terms of displacement.

v. From the results it means there is a plate movement of around 2cm per year, which seems to be in harmony with the Information obtained from: https://en.wikipedia.org/wiki/African_Plate “The African Plate's speed is estimated at around 2.15 cm (0.85 in) per year. It has been moving over the past 100 million years or so in a general northeast direction”.

7.0 Challenges Emanating from the Current NIGNET Status.

The Federal Government has made some efforts in establishing the NIGNET Network however, the following challenges exist:

i. The present numbers of CORS are highly insufficient for implementation of several GNSS applications within the country.

ii. Data streaming from the remote stations to the data control centre has been a serious challenge due to non availability of stable Internet Communication Services.

iii. The technical support will need to be more than it is at the moment looking at the prospects in the near future.

iv. Human capacity development needs to be enhanced for the sustenance of the GNSS infrastructure and application in the country.

8.0 NIGNET Future Road map

In order to meet up with the current challenges in terms of Geospatial data needs and applications and sustenance of the mantle of some UN polices for sustainable developmental projects in developing countries, the office of the Surveyor General of the Federation is poised to come up with some urgent programme to support future enhancement of the NIGNET stations:

i. Developing a policy that mandates unification of Reference Frame based on NIGNET Network for the entire country.

ii. Installation of at least four (4) CORS Station per state (subject to budgetary support).

iii. Implementation of Networked Transport of RTCM via Internet Protocol (NTRIP) for Real Time Kinematics (RTK) Services.

iv. Seek for collaboration and technical support from other Stakeholders within and outside the country in terms of capacity building, for efficient utilization maintenance of the NIGNET CORS network.
v. Creation of awareness for end users especially within the Surveying and Mapping community and other stakeholders.

9.0 CONCLUSION

The Federal Government of Nigeria has embraced the GNSS Technology (especially its application in Surveying and Mapping). The Office of the Surveyor General of the Federation is capitalizing on the political will being enjoyed to fast tract the development of the new reference frame for Nigeria which will be consistent with the African Geodetic Reference Frame (AFREF) and the International Terrestrial Reference Frame (ITRF).

We are open to any meaningful collaboration with the international community that can assist to accelerate the realization of our mission.
About the Author

Barde Jatau is currently the director of Geodesy and Special survey in the Office of the Surveyor General of the Federation of Nigeria. He holds a B.Sc. (Hons) Degree in Land surveying from Ahmadu Bello University, Zaria, Nigeria. He later gained Post Graduate Diploma in Land Information System (with Urban Applications) and M.Sc. in Geographic Information System (Urban Applications) from International Institute of Aerospace Surveys and Earth Sciences (ITC), Enschede, The Netherlands in 1988 and 1991 respectively. He is a fellow of the Nigerian Institution of Surveyors and is Registered with Surveyors Council of Nigeria (SURCON). He was the Survey Coordinator of the Abuja Master-plan implementation management team from 1982 to 2006. He pioneered the establishment of the Abuja Geographic information System (AGIS) in 2004.
Reference


A.I.EL-Hahab, 2014: Assessment of PPP for establishment of CORS Network for Municipal Surveying in the Middle East.

Ghoddousi-Fard 2005, Online GPS Processing Services, an Initial Study Department of Geodesy and Geomatics Engineering, Geodetic Research Laboratory University of New Brunswick, Canada.


R.Ebner, W.E. Featherstone, 2008, How well can online GPS PPP Post-processing Services be used to Establish Geodetic Survey Control Network.
