FRAMEWORK FOR THE ESTABLISHMENT OF A NATIONWIDE GNSS REFERENCE STATIONS

A COST EFFECTIVE TOOL FOR LAND DEVELOPMENT IN GHANA

GNSS AND GHANA -Introduction

- **Definition of GNSS**
  - **GPS, GLONASS, GALILEO, QZSS and Augmentation systems**
- **GNSS is Classified into three user levels,**
  - **Owners of the Satellite Vehicles USA, Russia and the European Union**
  - **Countries developing various Space and Ground Based Augmentation Systems including Japan, Australia, India and others**
  - **The rest of the world that with little or no infrastructure in GNSS including Ghana**
- **Perspective of Ghanaian Professionals**
  - **Ghanaian professionals are yet to fully embrace and utilize this space technology**

GNSS AND GHANA -Introduction

- **Current applications in Ghana**
  - **Cadastral**
  - **GIS**
  - **Engineering Survey**
- **Potential application**
  - **Geodetic Control survey**
  - **Hydrographic**
  - **Meteorology**
  - **Earthquake and deformation studies**
  - **Navigation**
    - **Traffic and transportation**
    - **Precision farming**

MAPPING IN GHANA

- Ghana's Geodetic Reference System
  - Ghana's Geodetic Reference network dates back more than a century ago initiated by Gov. Guggisberg using star observation and telegraphic signals exchange with Cape town SA
  - The coordinates were computed using the Transverse Mercator Projection and aneroid barometer for the heights
  - Based on War Office 1924 ellipsoid
  - A second datum based on Clarke 1880 runs alongside known as the Legon Datum
- Some limitations
  - Inaccuracies
  - Does not support precise Scientific Investigation
  - Difficulties in the determination of Transformation parameters
- Geocentric Reference Frame
  - The need to adapt ITRF as a national reference frame
    - Identical with the WGS-84 and the future GTRF
    - Satisfies international requirements like ICAO, IHO, AFREF and others

NETWORK OF REFERENCE STATIONS-DRIVERS

- To remove the distortions in the current mapping system
- Encourage the use of GNSS throughout the country
- Provide differential corrections within reasonable base-length
- Speed up the land delivery system in the country
- Reduce the cost of Surveying and Mapping in the Country
- Simplify the management of spatial data
- Monitor the deformation of civil structures
- Enhance the investigations in the Earthquake activities in Ghana
- Form the basis for the development of RTK products in the country
- Utilize the network for the acquisition of Meteorological data

NETWORK OF REFERENCE STATIONS

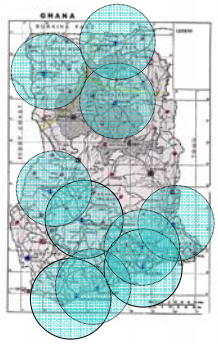
- THIS SHOULD BE MADE OF
  - FUNDAMENTAL STATION
  - REGIONAL REFERENCE STATIONS
    - 10 REGIONAL STATIONS
    - 5 HUB STATIONS
  - PASSIVE REFERENCE STATIONS
    - IN ACCORDANCE WITH THE USER DEMANDS

NETWORK OF REFERENCE STATIONS-IMPLEMENTATION

- Fundamental Point
  - Accurately positioned geocentric station
  - Geodetically tied to IGS and ITRF
  - Should be far away from seismically active zone
  - Kumasi is proposed for the FS

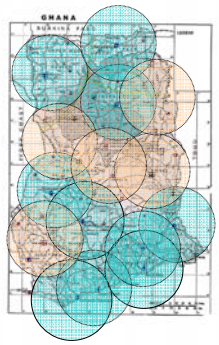
Regional Network

•100km coverage using the existing ten Regional offices of the Survey Department of Ghana
•About 70% of the nation is covered
•Block-edged circles show coverage of the Ghana's Golden Triangle Accra-Kumasi-Takoradi



Nationwide Network

Additional five hub-stations provides coverage for the whole country with 100km or better
Hub stations located at Wiawso (WR), Kete Krachi (VR), Yendi (NR), Bamboi (NR), Atebubu (BAR)



NATIONAL GNSS REFERENCE STATION NETWORK-EQUIPMENT REQUIREMENTS

- GNSS Receivers
  - Dual frequency minimum
  - Capable of recording at 1 sec rate
  - Should be able to track many satellites
  - Should be able to use both internal and external power supply
- Antennas
  - Capable of tracking at least L1 and L2 signals
  - Designed to mitigate multipath degradation
- Computer System
- Telemetry
  - Radio modems
  - FM, SW, MW and other radio sub-carrier
  - GSM
  - Internet

NATIONAL GNSS REFERENCE STATION NETWORK-ACCOMMODATION AND POWER REQUIREMENTS

- REGIONAL OFFICES OF Survey Department
- DISTRICT ASSEMBLIES (hub stations)
- POWER
  - ELECTRICITY
  - BATTERIES
  - SOLAR ENERGY

NATIONAL GNSS REFERENCE STATION NETWORK-MONUMENTS

- The IGS standards of Monumentation should be applied for the **FS**
- The **Regional** and **hub** network should have a fixed antenna on its stable monuments
- The **Passive** Network need not have fixed antenna on the monument

NATIONAL GNSS REFERENCE STATION NETWORK-DATA HANDLING AND MANAGEMENT

- FUNDAMENTAL STATION
  - Data at the FS should be linked to the international systems like the IGS, AFREF etc
  - This will be used as a control point for the network
- REGIONAL DATA CENTERS
  - Data should be used to provide differential correction services to the user community.
  - Data should be sent to the National Data Center
- DATA AT THE NATIONAL DATA CENTER
  - Data from the FS and RDS should be analyzed at the National Data Center for the positional accuracy of the entire network
  - Other applications like meteorological data can be analyzed here

NATIONAL GNSS REFERENCE STATION NETWORK-VERTICAL POSITIONING

- GEOID MAP
  - THIS IS REQUIRED FOR DERIVING MAXIMUM BENEFIT FROM GNSS IN VERTICAL POSITIONING

NATIONAL GNSS REFERENCE STATION NETWORK-WAY FORWARD

MANAGEMENT IN GHANA

Several organizations in Ghana have started using GNSS in various applications and pulling their resources together can be a starting point for the country. These institutions include

- **Building and Road Research Institute**
- **Kwame Nkrumah University of Science and Technology**
- **University of Ghana CERSGIS**
- **PRIVATE SECTOR**
- **SURVEY DEPARTMENT of Ghana**

- **GNSS GROUP should be formed to work on research and development of GNSS in the country**
- **Periodic workshops should be organized to update the user community on new developments and sensitize the decision-makers on the benefits of GNSS**

CONCLUSION

- THE establishment of nationwide GNSS Reference station network in Ghana is long overdue and now that the nation is searching for improvement in the land delivery system
- The existing resources can be utilized for the establishment of GNSS reference station network thus saving cost
- Developing GNSS in Ghana will enhance her integration into continental and global mapping systems.
- The development of GNSS will bridge the gap between the Ghana and the developed world by accelerating her development