


GLOBAL NAVIGATIONAL SATELLITE SYSTEM (GNSS): A UTILITY FOR SUSTAINABLE DEVELOPMENT IN AFRICA

Dr., Ing. Collins Fosu, FGhIS
KNUST Kumasi Ghana

Yaw Poku-Gyamfi
Building and Road Research Institute, Kumasi Ghana

Prof. Dr.-Ing. Günter Wolfgang Hein
University FAF Munich Germany


Dr. Ing Collins Fosu




OVERVIEW

- ❖ Introduction
- ❖ Africa's Geographic Position and SBAS
- ❖ Infrastructure Needs
- ❖ Some Potential Applications
- ❖ Implementation of GNSS in Ghana
- ❖ Conclusion



Dr. Ing Collins Fosu

INTRODUCTION

- ❖ Rapid spread of modern Information and Communication Technologies (ICT) is dependent on the unprecedented increase in Spatial Information
- ❖ Spatial information provides knowledge about the Earth to unlock the intrinsic value of land for socio-economic development and management of the environment
- ❖ For Africa to be in tune with the current trends in ICT, spatial information and methods to acquire them should be our priority
- ❖ GNSS is therefore the obvious choice—This technology has great potential to contribute to the management of the environment, natural disasters, provide food security, emergency response
- ❖ Improve the efficiency in surveying and mapping, land, water and air navigation



Dr. Ing Collins Fosu

INTRODUCTION cont'd

- ❖ GNSS is a key component of the Information Infrastructure
- ❖ This World Wide Information Utility consists of
 - Two operational space satellite systems, American GPS and Russian GLONASS as well as the in-coming GALILEO (2008)
 - Regional Augmentation System
 - Satellite-Based Augmentation Systems (SBAS)- WAAS of USA, MSAS of Japan, EGNOS of EU
- ❖ The SBAS improve the accuracy, availability, and continuity of service of the signals from satellites
- ❖ Need to acquire the necessary infrastructure to utilize the SBAS.

Dr. Ing Collins Fosu

AFRICA'S POSITION AND SBAS

- ❖ With its position as almost at the centre of the Earth that is latitude 0° and longitude 0°, Ghana in particular and Africa in general is covered by the footprints of two of the most prominent SBAS, WAAS and EGNOS

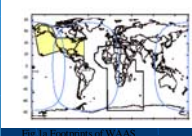


Fig. 1a Footprints of WAAS

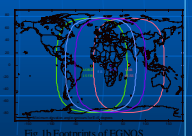




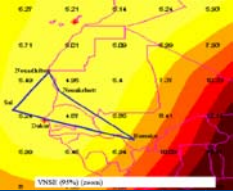
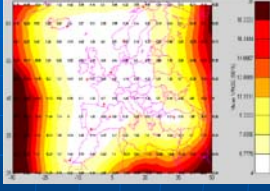
Fig. 1b Footprints of EGNOS

Fig 1a Footprints of WAAS Fig 1b Footprints of EGNOS

Dr. Ing Collins Fosu





AFRICA'S POSITION AND SBAS cont'd

- ❖ **Figure 2a** **Figure 2b**
- ❖ Installation of RIMS during the EGNOS test in July 2002 in Dakar, Senegal and some areas in North-Western corner of Ghana achieved Vertical Navigation System Error (VNSE) comparable to what pertains in Europe 5 to 10 metres

Dr. Ing Collins Fosu




INFRASTRUCTURE NEEDS

To exploit the enormous and ever increasing potential of GNSS African countries need to install some basic infrastructure and provide some facilities

- ❖ National datum and transformation parameters – linking GNSS co-ordinates to local mapping system an, compliment AFREF and WAFREF to establish a common continental and regional reference frames for Afirca
- ❖ Digital maps –Required for Ghana to benefit from GNSS and its applications.
- ❖ Augmentation systems – DGPS and RIMS of EGNOS and WAAS are installed to augment the GNSS signals. This will enable Africa to receive coverage of wide area differential service and satellite navigation precision will increase. Such installations should be viewed in the general plan augmentation system for Africa


Dr. Ing Collins Fosu



INFRASTRUCTURE NEEDS cont'd


- ❖ For Ghana and other African countries to get the best out of GNSS Network of Reference Stations or functional continuously operating reference stations (CORS). CORS are an important enhancement to GPS surveying activities they support and give impetus to additional GPS applications. CORS basically consists of GPS receiver, computer, power supply and mechanism to communicate to outside world.
- ❖ Communication- There should be telemetry component that can that can send signals to and from a control station, CORS usually through wireless broadcasting, for it to link a roving receiver

Dr. Ing Collins Fosu





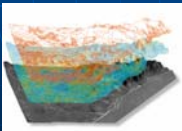
SOME POTENTIAL APPLICATIONS

Dr. Ing Collins Fosu




Surveying/Mapping/GIS

- Sub-centimeter accuracy
- 100%-300% savings in time, cost, & labor
- Rural electrification
- Telecom tower placement
- Pipelines
- Oil, gas, and mineral exploration
- Flood plain mapping







Dr. Ing Collins Fosu




Precision Agriculture

- Maximize use of resources
 - Optimized plowing of crop rows
 - Tailored applications of seeds, fertilizer, water, pesticides
 - Improved management of land, machinery, personnel, time
 - Greater crop yields
- Minimize environmental impacts
 - Localized identification and treatment of distressed crops reduces chemical use
 - Precise leveling of fields prevents fluid runoff


This grain combine can be outfitted with a GPS receiver, yield monitor, and electronic sensors to track crop production based on location. These data can be transferred to a geographic information system to create a yield map and subsequently used to analyze the field and make site-specific management decisions.

Dr. Ing Collins Fosu



Environmental Management


- Forestry
- Wetlands management
- Natural resource management
- Fisheries boundary enforcement
- Endangered species and habitat preservation
- Hazardous material cleanup
 - Oil spills, toxic waste





With the help of GPS data, Leoko has a timber harvesting program that is good for the country's economy and environment.


Dr. Ing Collins Fosu



Public Services




A GPS-based automated toll system keeps traffic on Germany's increasingly crowded highways.




- City planning
- Transportation infrastructure
 - Road Billing Network (ROBIN)
 - Snowplows
- Emergency response
 - Law enforcement
 - Fire fighting
 - Search and rescue
 - Paramedics
 - Disaster relief

Dr. Ing Collins Fosu

Maritime Navigation



GPS-based navigation guides mariners along Iceland's fog shrouded coastline.





- GPS-based vessel tracking and traffic management maximizes effectiveness of waterways
- Improved safety increases maritime commerce
- Maritime DGPS service for enhanced accuracy and safety available in 34 countries

Dr. Ing Collins Fosu

Aviation

- GPS approved for en-route navigation
- More efficient flight routing leads to fuel savings
- Better tracking of aircraft enhances safety
- Closer spacing of planes increases airspace capacity

Dr. Ing Collins Fosu

Car Navigation




GPS-based tracking systems allow police to answer 10 times more calls than radio-based systems.

- On-board navigation
- Fleet management
- Roadside assistance
- Stolen vehicle recovery
- Enhanced services

Dr. Ing Collins Fosu

Consumer/Recreational

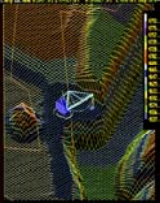
- Portable receivers for fishermen, hunters, hikers, cyclists, etc.
- Recreational facilities -- golf courses, ski resorts
- Integration of GPS into cellular phones






Dr. Ing Collins Fosu

Open Pit Mining



- Enhanced management of assets, equipment
- Progress tracked in real-time, remotely
- Improved machine control saves time, lowers maintenance and fuel consumption, prevents accidents
- Rapid surveying for drilling blast holes
- Smaller, more empowered workforce

Dr. Ing Collins Fosu

Timing

- GPS offers an inexpensive alternative to costly, high maintenance timing equipment
- Telecommunications network synchronization & management
 - Phones, pagers, wireless systems
 - LANs, WANs, Internet
- Financial transactions
- Electrical power grid management & fault location
- Digital signatures for e-commerce



Dr. Ing Collins Fosu



IMPLEMENTATION OF GNSS IN AFRICA

Successful introduction of GNSS depends on the following

- ❖ Formation of GNSS group of experts at the national level to work towards its introduction.
- ❖ Education and sensitization of the public especially decision makers
- ❖ Capacity building especially human resources
- ❖ Marketing strategies to explore areas in the economy where the technology can support and how it can support
- ❖ Develop and establish a system that will be demand driven
- ❖ Collaboration with International organizations and other countries
- ❖ Funding should be from state budget, public private partnerships, donor agencies, multinational companies like the mines who are direct beneficiaries. Also users should access it at a cost.

Dr. Ing Collins Fosu



Conclusion

It is obvious from the above sections that GNSS has enormous and ever increasing potential which can be exploited for national development and poverty alleviation in a sustainable manner, especially with the improved services of GPS which is undergoing modernization, GLONASS which is increasing its orbiting satellites and the introduction of fully civilian GALILEO by the year 2010. Improved GNSS is becoming more accessible around the globe.

With the proposed expansion of the Satellite Based Augmentation Systems, EGNOS to Africa and the improved receiver technology at affordable costs, it is imperative for African countries to take the necessary steps to join in the search for the benefits of this space technology for the betterment of our people and be competitive in the global economy.

Dr. Ing Collins Fosu

