Establishment of Continuously Operating Reference Stations for Land Management and Infrastructure Development in Ghana

Presentation By: Surv. Naa Seidu Zakaria Abu FGhIS
Ag. Director of Survey and Mapping Division, Lands Commission, Ghana

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Introduction

A modern and reliable national geodetic reference framework is essential for:

effective land management

infrastructure development

national digital transformation

environmental monitoring

Introduction cont…

Geospatial intelligence forms the backbone of national development

- Supporting land administration
- Engineering
- Urban planning
- Environmental monitoring
- Disaster resilience

To meet the increasing demands of digital governance and smart infrastructure development, Ghana requires a robust geodetic reference framework.

Introduction cont…

Historically, Ghana relied on a network of passive ground monuments—

- Triangulation points
- Traverse stations
- Benchmarks

While these served the country for decades, they are no longer adequate for modern surveying and geospatial applications.

Introduction cont…

This paper presents Ghana's major transition towards a CORS-based geodetic system designed to provide reliable, real-time, and precise positioning services nationwide..

Condition of Ghana's National Geodetic Network

The national geodetic network has faced significant challenges:

- Sparse distribution of remaining ground control points

Loss and destruction of many monuments due to construction, encroachment, erosion, and natural disasters

- Inconsistent positional reliability due to aging coordinates and lack of systematic updates

- Limited accessibility, as many control points are overgrown, damaged, or lost

these challenges have led to survey inconsistencies, inefficiencies, and reduced reliability in land parcel mapping and engineering applications, demonstrating the importance of transitioning to a modern geodetic reference system.

Early CORS Development: LAP I & II

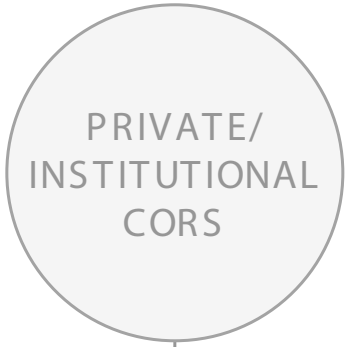
Under the Land Administration Project (LAP I & II), Ghana established five standalone CORS. Although important early steps, these stations faced key limitations:

- Operated independently without networking
- Limited or no internet connectivity
- No centralized data management
- Inadequate geographic coverage

Despite LAP's recommendation for nationwide CORS expansion, funding constraints halted further progress at the end of the project.

Growth of Private and Institutional CORS

To address operational needs, several private survey firms and academic institutions installed their own CORS. However:

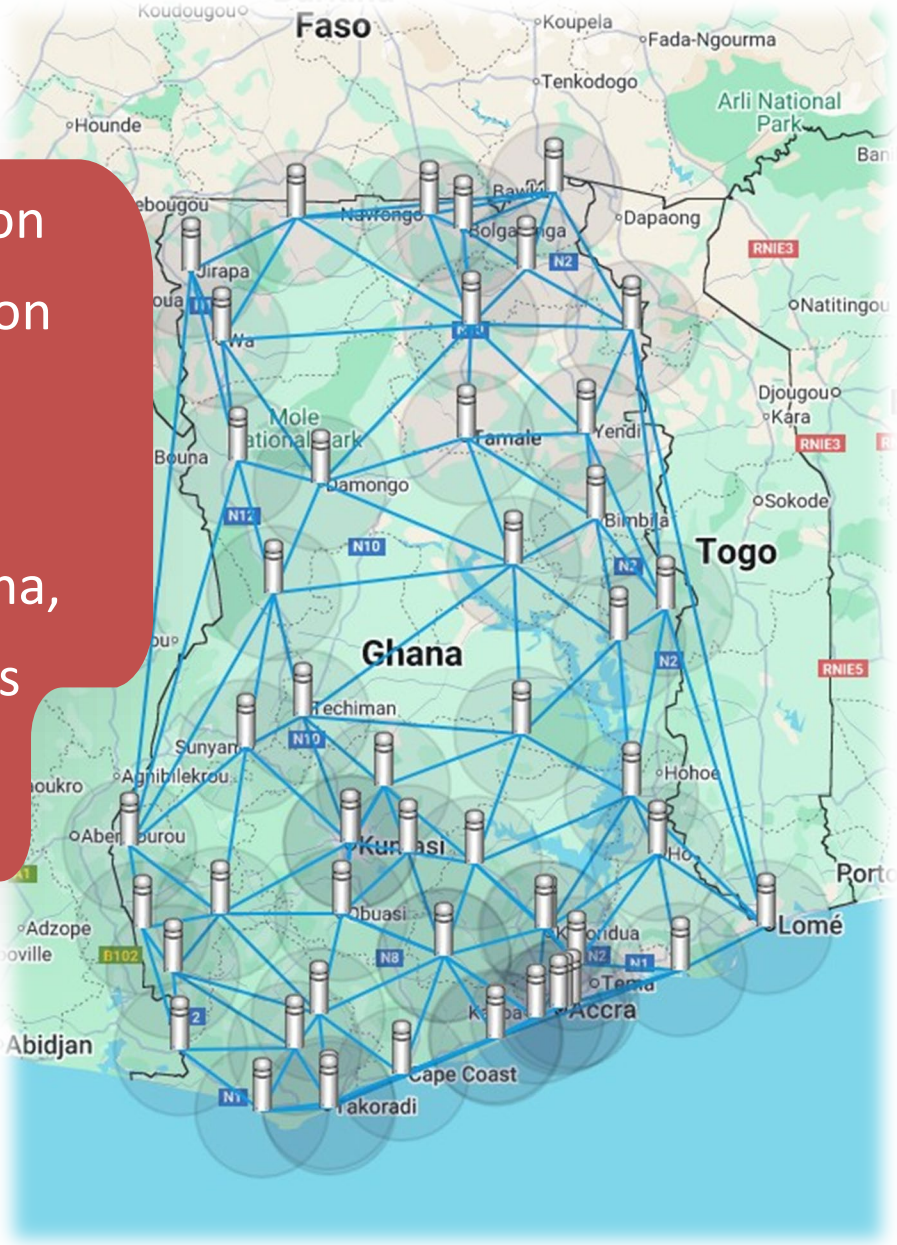


- These were standalone systems
- They operated without interconnectivity
- No unified standards governed their setup
- There was no harmonized national coordinate framework

This fragmented landscape reinforced the need for a unified national CORS network underpinned by common standards and central management.

The New National CORS Initiative

The Lands Commission, in collaboration with the Licensed Surveyors Association of Ghana (LISAG) and GMX Systems Ghana Limited, has embarked on the establishment of 52 CORS across Ghana, with a long-term target of 100 stations to achieve full national coverage.



The New National CORS Initiative cont…

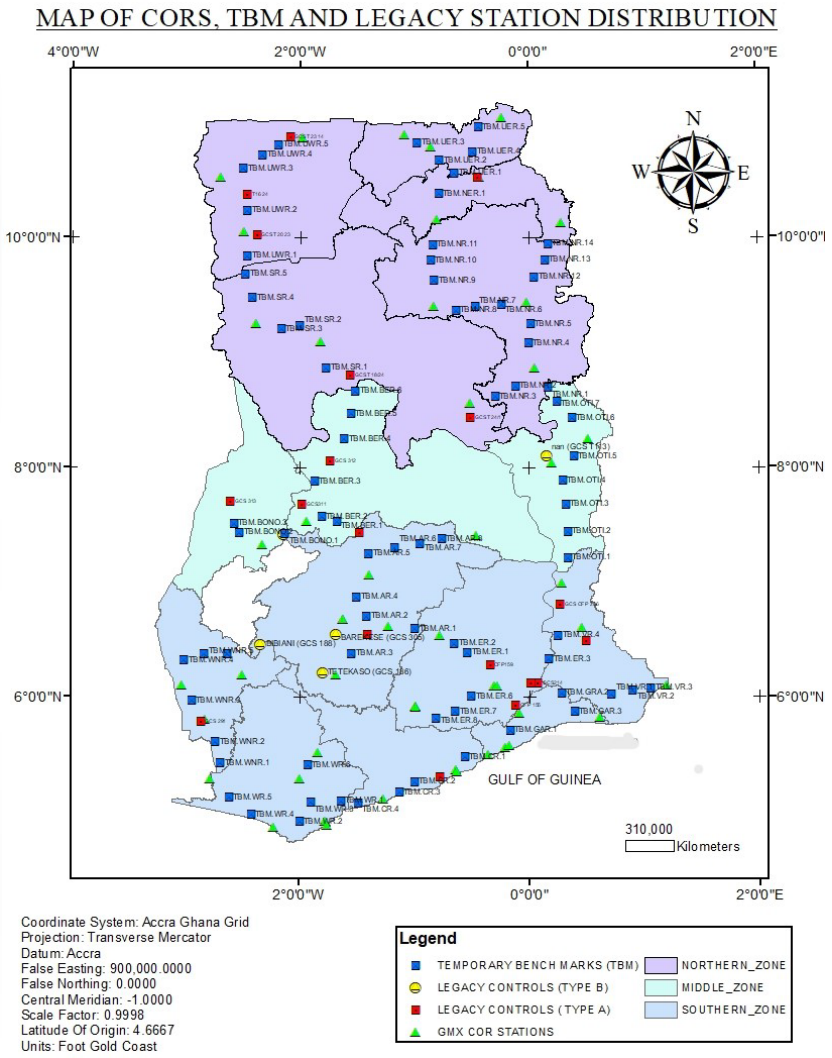
Objectives:

- Provide accurate, real-time GNSS positioning services
- Improve consistency and reliability of land and engineering surveys
- Support digital land administration and e-governance
- Enhance environmental monitoring, infrastructure planning, and disaster resilience
- Integrate Ghana into continental and global geodetic frameworks

National Zoning Approach

To streamline data collection and processing, Ghana was partitioned into three zones:

1. Southern Zone
2. Middle Zone
3. Northern Zone



This zoning enhanced efficient scheduling, coordination, and quality control during the nationwide GNSS observation campaign.

Key Institutional Collaboration: Role of Ghana Water Company Limited

A significant boost to the CORS initiative came from the Ghana Water Company Limited (GWCL)—the first public institution to collaborate with GMX Systems Ghana Ltd.

GWCL has played a pivotal role by:

- Hosting a significant number of CORS installations at its facilities
- Providing secure sites, power, and infrastructure
- Facilitating technical access and maintenance
- Utilizing CORS data for engineering, hydrological planning, and asset management
- Demonstrating strong public-sector leadership in geospatial modernization

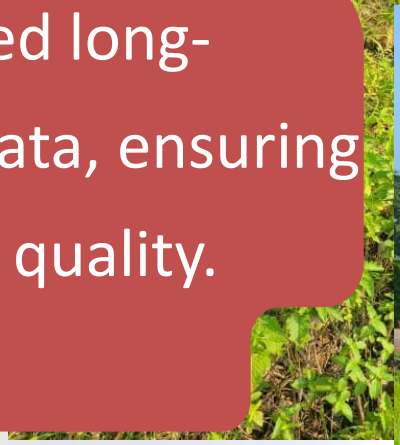
This partnership reduced deployment costs, improved spatial coverage, and set an example for other national agencies.

Nationwide Geodetic Observation Campaign

A comprehensive nationwide GNSS observation campaign was conducted involving:

1. Geodetic control points
2. Temporary Benchmarks (TBMs)
3. LAP existing CORS
4. Private/institutional (LiSAG) CORS
5. Newly established CORS active during the observation

Survey teams collected long-session static GNSS data, ensuring high redundancy and quality.



Data Processing

A technical team of professional surveyors is currently processing the data to:

- Compute accurate coordinates for the new CORS
- Adjust the network into the National Grid Coordinate System (NGCS)
- Validate spatial consistency and geodetic integrity

Alignment with AFREF and ITRF

Upon completion of the national adjustment, the network will be aligned with:

AFREF, the African Reference Frame

ITRF, the International Terrestrial Reference Frame

This will ensure that Ghana's geodetic system is interoperable with global geospatial datasets and regional reference frameworks.

Establishment of a National GNSS Data Centre

To ensure long-term sustainability, the Lands Commission in collaboration with GMX Systems Ltd. and LiSAG are setting up a National GNSS Data Centre that will:

- Archive GNSS RINEX data and real-time streams
- Provide network monitoring and health assessment
- Maintain coordinate integrity and support periodic network adjustments
- Serve as the national hub for AFREF/ITRF integration
- Ensure secure backup, redundancy, and disaster recovery

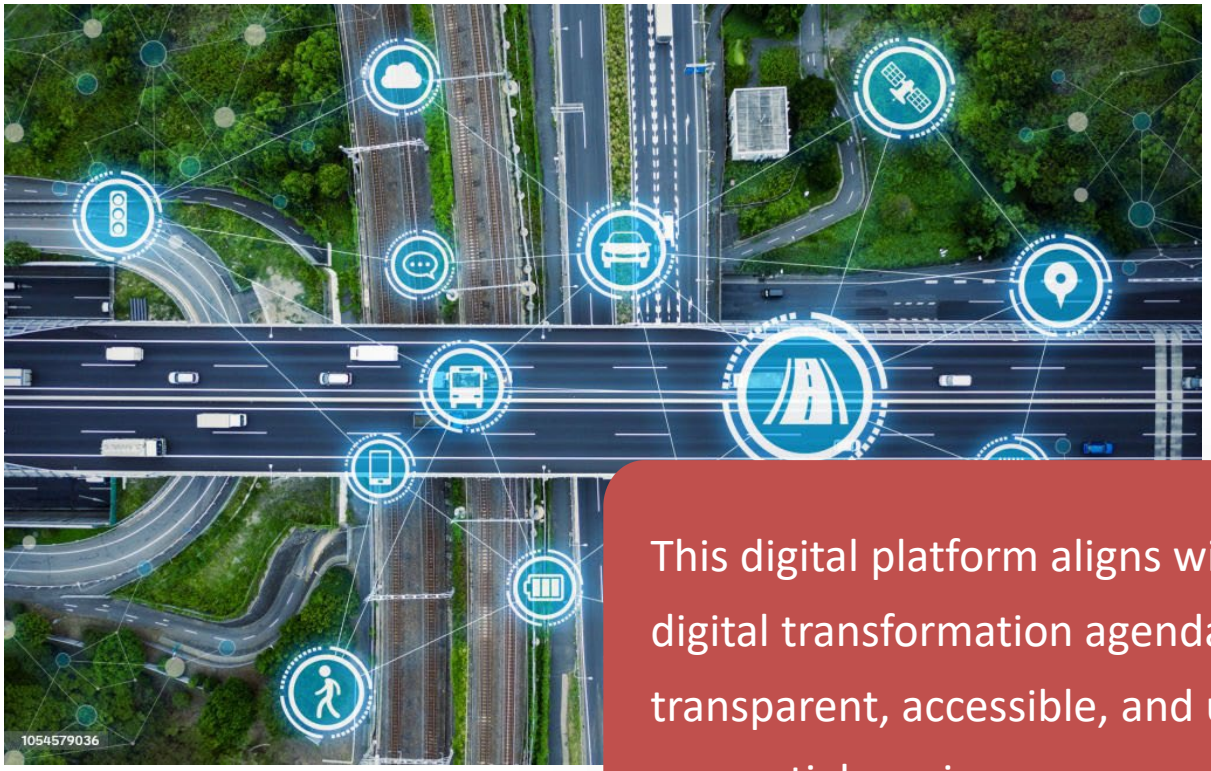
This Data Centre will form the technical backbone of Ghana's geodetic infrastructure.

Online Stakeholder Subscription Portal

To support efficient data access and service delivery, we are developing an online portal where stakeholders will be able to:

- Subscribe to real-time GNSS correction services (RTK and Network RTK)
- Download raw GNSS data for post-processing
- Monitor station performance and metadata
- Manage subscriptions, billing, and service accounts
- Integrate with surveying, GIS, engineering, and academic workflows

Online Stakeholder Subscription Portal cont…



This digital platform aligns with Ghana's broader digital transformation agenda, ensuring transparent, accessible, and user-friendly geospatial services.

Expected Benefits for Ghana

Land Management

- Enhanced accuracy in cadastral surveys
- More reliable land parcel boundary determination
- Improved land registration and reduced disputes

Infrastructure Development

- Precise engineering surveys for roads, railways, water systems, and utilities
- Improved construction alignment and quality assurance
- Enhanced monitoring of large-scale infrastructure and deformation

Environmental and Disaster Monitoring

- stronger support for climate studies, hydrological modeling, and earth observation
- Improved early warning systems through geodynamic monitoring

Geospatial Innovation and Digital Transformation

- Increased adoption of GNSS services in agriculture, mining, utilities, and telecom
- Support for smart city development and IoT infrastructure
- Enhanced decision-making through accurate geospatial intelligence

Conclusion

- Ghana's establishment of a national CORS network marks a major milestone in the modernization of the country's geodetic reference system.

- The collaboration between the Lands Commission, LISAG, GMX Systems Ghana Ltd., and especially the Ghana Water Company Limited, has paved the way for rapid deployment, operational efficiency, and nationwide coverage.

- the establishment of a National GNSS Data Centre and an online subscription portal further strengthens the sustainability, accessibility, and reliability of GNSS data services.

Conclusion cont.....

- Alignment with AFREF and ITRF will position Ghana within a unified continental and global geodetic framework.

- This modernized geospatial infrastructure will support land administration, infrastructure development, environmental management, and digital transformation—advancing Ghana's vision for a resilient and sustainable future.

Recommendations

1. Complete the rollout of all 100 CORS to ensure full national coverage.
2. Fully operationalize the National GNSS Data Centre for data archiving, monitoring, and geodetic maintenance.
3. Launch and maintain the online CORS data subscription portal for efficient stakeholder access.
4. Strengthen partnerships with agencies like GWCL to enhance network stability and expand infrastructure.
5. Enhance capacity building for surveyors, GIS professionals, and engineers.
6. Develop clear operational standards and data-sharing policies for the national CORS network.
7. Secure sustainable funding and maintenance strategies for long-term operations.
8. Promote nationwide awareness of CORS services for improved adoption and impact.


Thank you