

AFREF IMPLENTATION & Continuously Operating Reference Station(CORS)

- ***AFREF(objectives, requirements, implementation)***
- ***CORS(components, hardware & software, implementation, advantages, challenges)***
- ***Muya CORS***
- ***Questions & Discussions***

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Objectives of AFREF



To establish modern continental reference system as a basis for national reference networks.

To establish permanent GNSS base stations-Continuously Operating Reference Stations and contribute data to AFREF servers

To realize a unified vertical datum and to support efforts to establish a precise African geoid.

Existing networks

Based on old technologies
Most monuments destroyed
Not consistent
Different coordinates systems
Heights not accurate
Location/sites difficult to access
Hill tops
Not safe
Not easy to access



AFREF based

Establish National Networks based on Modern technologies including GNSS with Regional & Global Connection.

Uniform Accurate

Coordinate regional/continental
Implement national via regional mapping
organizations including RCMRD,
RECTAS,

Two levels of implementation- AFREF
network-active via CORS
National networks-Active or/and passive

IMPLEMENTATION STRATEGY

National GNSS Networks

National working groups

NMO to lead plus other relevant public
& private organizations academia
Guide the implementation
Formulate the implementation plan
Plan the network configuration
Sensitize for support

Establish New network

GNSS based, CORS
Campaign based
Accessible site, roads etc
Simple & cost effective monuments

Connection to existing network

For transformation parameter

Connection to existing leveling network

Geoid model
Global models available say EGM2008

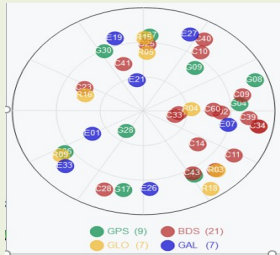
Establish GNSS Centre

Holding, processing and dissemination
Establish mechanisms for submission
of GNSS raw(RINEX) for continuous
densification

Pull resources

Encourage Public Private
Partnership(PPP)

Components of CORS



GNSS Receiver System

- Tracks GNSS satellite-GPS, GLONASS, BDS, GALILEO
- Streams GNSS data to network control centre in real time



Network Control Centre

- Controls the network & Archival of GNSS RAW data
- Computes GNSS network DGPS and RTK corrections
- Disseminates the corrections and RAW GNSS data to user on request



User/Rover GNSS Receiver System; For all spatial applications

- Low applications(sub meter), uses DGPS corrections.
- High accuracy applications(cm level), using RTK corrections
- Very high accuracy applications(mm level) using Post processing





Reference Base station Antenna & Receiver



- Independent Antenna and Receiver compared to single enclosures housing both Antenna & Receiver in Base/Rover RTK systems



- GNSS Geodetic Antenna with Multipath mitigation features
- Lightening protection systems



- GNSS Geodetic Receiver, at least dual frequency, triple frequency available
- Internet Communication devices(modem, port..)
- Communication with Antenna- cables(15m, 30m, 50m can be available)
- Power: mains power ports(primary) and where possible over the internet cables, internal batteries(secondary), Others- UPS, Solar...





Reference Base station

Site & station Distribution



Basic minimum

Clear sky, no objects which could cause multipath, no radio transmitters which could cause GNSS Signal Interference, security, roof tops of stable building bests sites.

Internet Availability;

- Field stations to CPC; Continuous data streams via internet/Dedicated lines, 3G/4G mobile networks
- CPC to Users(internet); NTRIP- Networked Transport of RTCM via Internet Protocol, RTCM-Radio Technical Commission for Maritime Services is a data transmission format.

Power Availability

- 24/7/365 /Back up systems /Internal GPS receivers batteries, Generators, UPS, Solar

Economic activities and population

- Establish the stations where they are economically required
- High population density reflects high economic activity

CORS software Functions

Software components

- Network Server Management
- Client Server management
- Operator Management
- Antenna Management
- Receiver Management
- FTP Management
- Event Management
- RINEX converter

Network Server

- Coordinate computation
- RTK processing
- Data archival
- Receiver configurations
- Site parameters

Client management

- Registration
- Avail RTK corrections
- Subscription
- Users location

Receiver configuration

- General receiver setting
- Satellite tracking
- Data logging/streaming

Site Parameters

- Site name & code
- Coordinate input
- Receiver type
- Antenna type & offsets
- Recording interval



Physical or Cloud Server
Backup Server

CORS Software Examples

SPIDER-LEICA, TPP-Trimble
TOP Net-Topcon, CDC-COMNAV,
NRS-South, CPS-CHCNAC etc

Most manufacturers have such software

Communication

- Antenna to receiver; Cable or wireless(blue tooth in future)
- Field CORS to Network server; internet; CDMA, GSM, fiber,
- Network server to Users; Internet(GSM/CDMA) via internet

Basic minimum

- GNSS Receiver-Smart Antenna
- Communication with Network control Centre via internet/NTRIP(GPRS/GSM, CDMA)
- Store static GNSS data for post processing
- Process RTK solutions using any of the Network computational strategies

All positioning applications

- Surveying & mapping
- Transportation
- Structural Monitoring
- Construction
- Agriculture-Precise farming
- Weather focusing-supplements via humid values determination
- Earth Crust monitoring and geodynamics
- Geodesy- Earth surface modelling-size





CORS: Products



- RAW GNSS DATA
 - Different products, based sampling intervals, file lengths etc
- DGPS CORRECTIONS
 - sub meter/decimeter accuracy
- RTK CORRECTIONS
 - cm accuracy/up to 30k for single base/70 for network
 - Single CORS- Nearest or Known CORS
 - Network based- VRS, FKP,
- Post processing GNSS data
 - User sends static survey data and automatic post processing of data is performed and reports generated and sent to user

RTK data streams-Source Tables in form of RTCM formats ver. 2 & 3

Mount Points	Description
CORS RTCM 2.x & 3.X	Single RTK: Corrections from the nearest CORS
NEAREST RTCM 2.x	
NEAREST RTCM 3.x	
NEAREST RTCM 3.x	
VRS RTCM 2.3	Networked RTK: Corrections from more than one CORS, the best choice!
VRS RTCM 3.1	
VRS RTCM 3.2	



RTK concept, Single base

1 CORS+CNC+Multi Rover



CORS



**Control
Centre**



RTK Rover



DGPS

- Continuous Operating Reference Station(CORS) tracks GPS satellites and send data to control centre via internet
- Control Centre with specialized software computes GPS data for RTK and DGPS corrections among other products
- RTK rover tracks satellites and receives RTK corrections via internet and updates her position
- Hand receiver with internet also receive DGPS corrections via internet

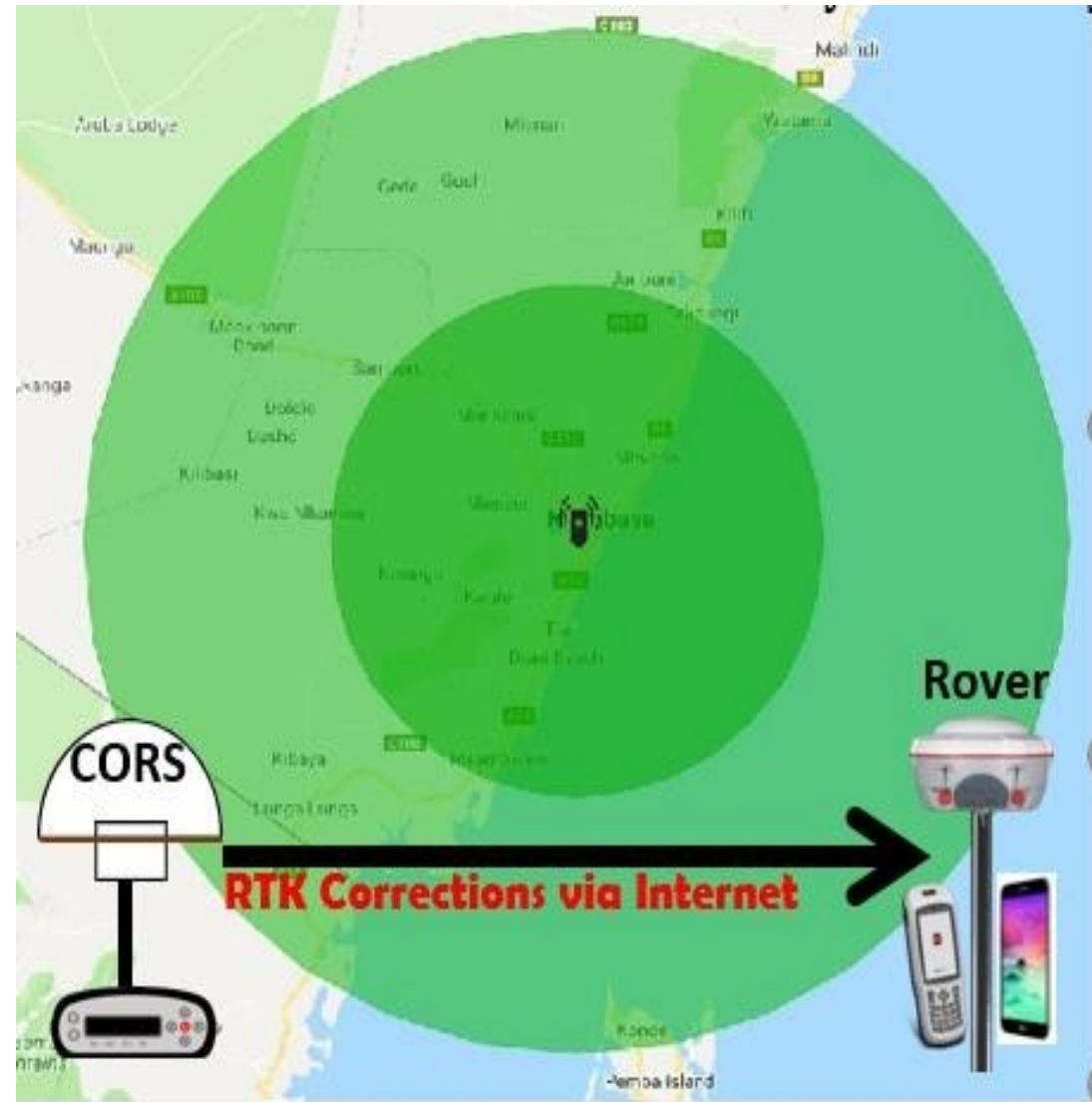


RTK- Single base

1 CORS+CNC+Multi Rovers



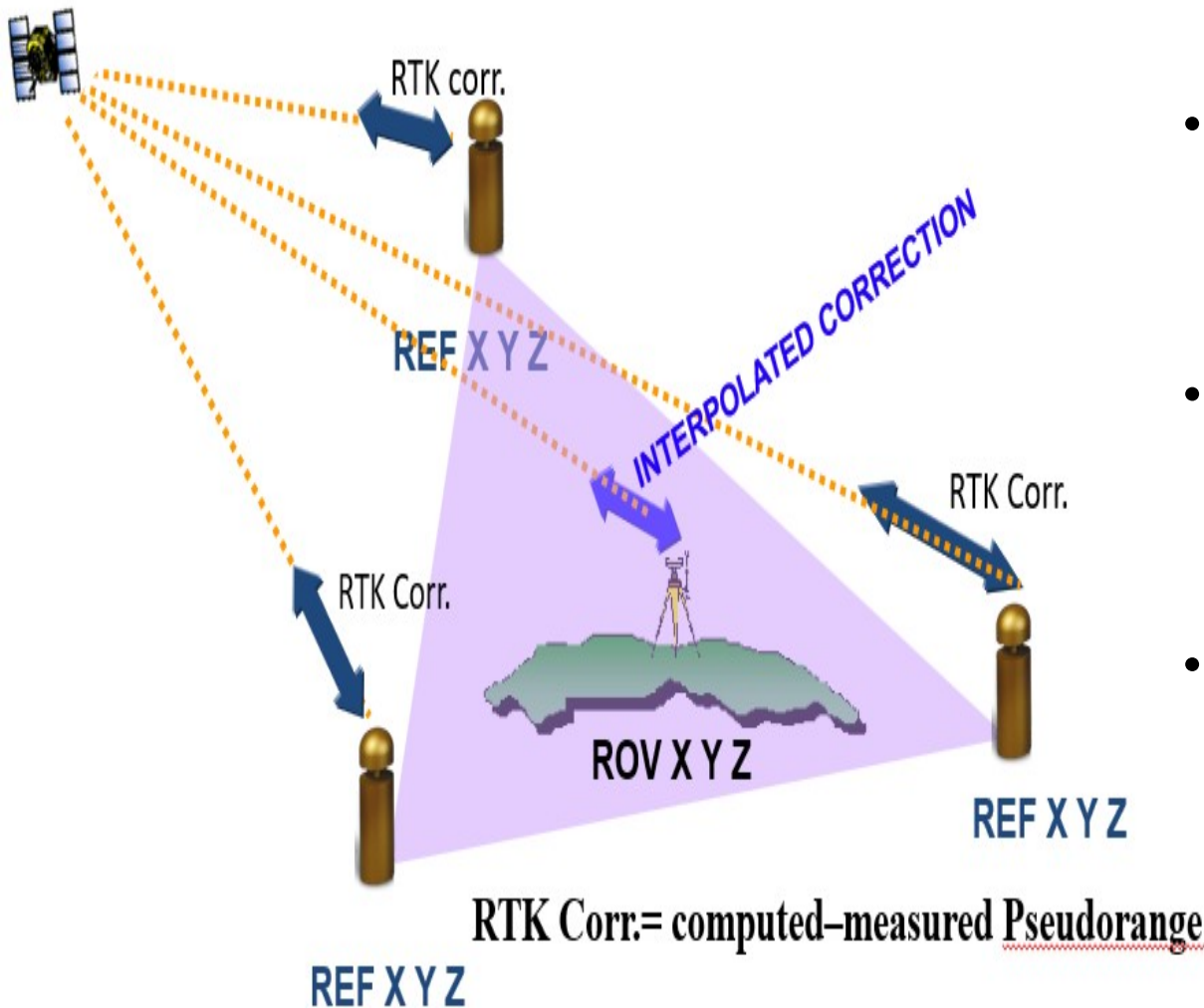
- 1cm accuracy within 30km from the CORS as indicated by green circles
- <5cm accuracy within 50km from the CORS(dark green areas on the map)
- <10cm accuracy within 100km from the CORS(light green areas on the map)
- <50cm accuracy within 400km from the CORS





Network RTK

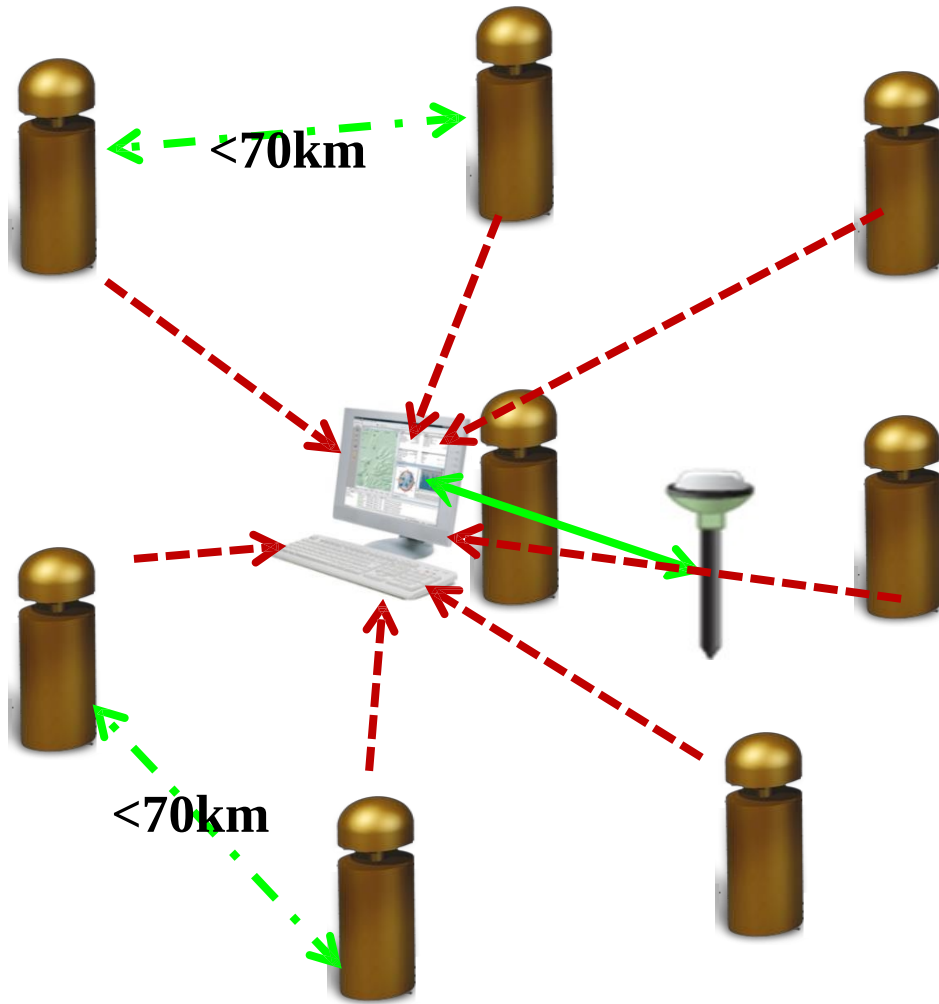
Multi-CORS+CNC+ Multi Rovers



- CORS at over 70-150km spans
- All CORS tracks GNSS satellites and transmits data streams to control processing centre(CPC) via internet
- Similarly, Rovers track GNSS satellites and communicate their position to CPC to enable it to identify suitable/nearest CORS
- CPC computes and disseminates networked(interpolated/averaged) RTK corrections to users

Network RTK

Multi-CORS+CNC- Multi User Rove



- Users receives averaged /interpolate/networked RTK corrections via internet and updates their coordinates
- Networked RTK corrections includes VRS and Area(FKP)
- Requires high capacity servers and a network CORS software

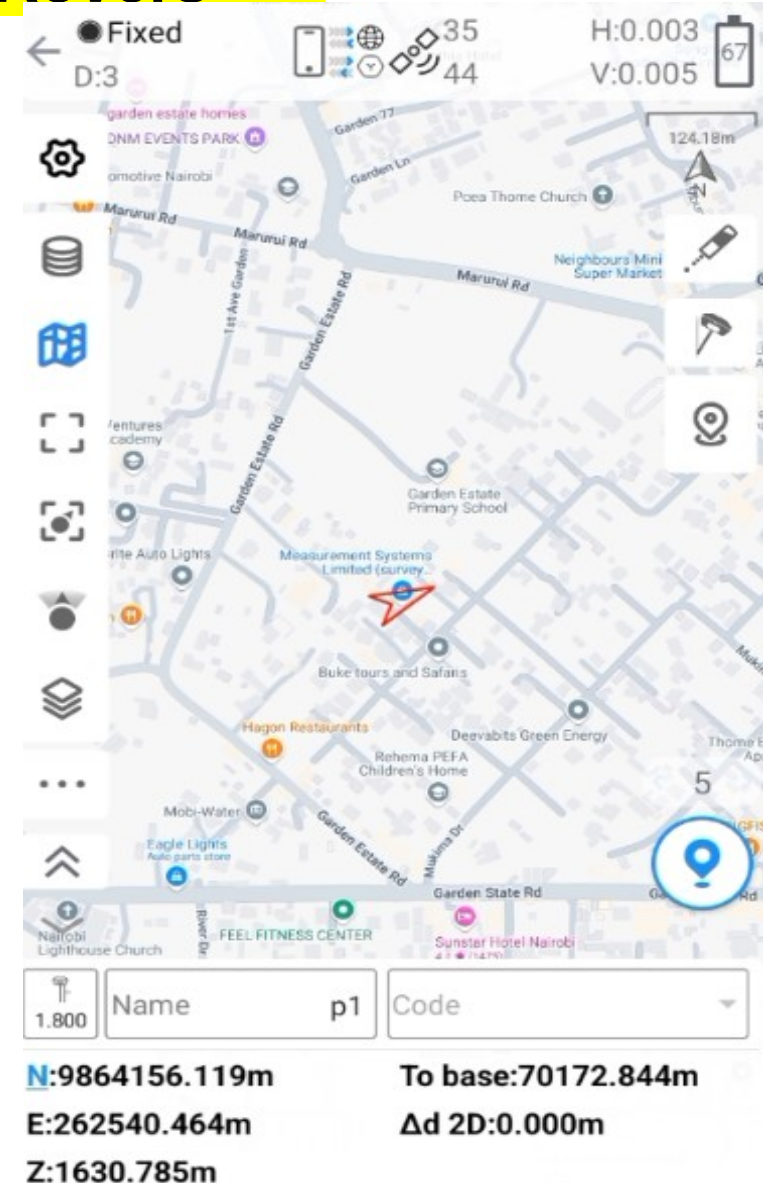
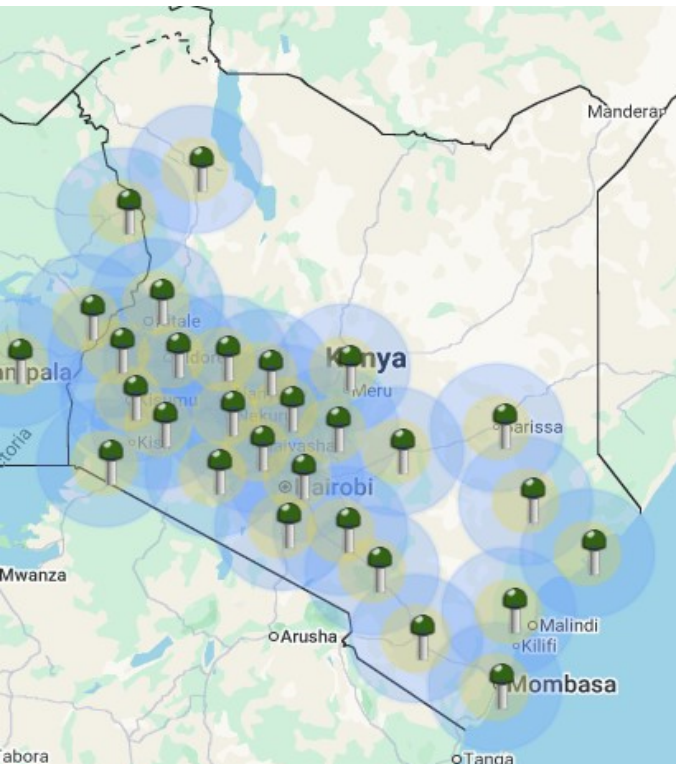


Network RTK



Multi-CORS/Multi User/Rovers

- <1cm accuracy within the area covered by a network of CORS, say 70km
- Available within the areas 50km-yellow and 100km – blue
- Requires special strategies to compute area RTK corrections including VRS, FKP and MAC





Carrying out survey with CORS



Following are the steps of carrying out a survey with CORS

- Visit the site
- Ensure internet availability on site and on GNSS rover device
- Create project file and configurations-GNSS field software
- Connect with RTK provider using IP/port and user name/password requesting the source provider table
- Select the desired mount points ensuring RTK streams are same in both rover and from the provider. Most providers will name their mount points according to RTCM formats for example Nairobi(station name) RTCM 2.x & 3.x, Nearest RTCM3.x & 2.x, VRS RTCM 2.x & 3.x etc

Coordinate System

- ITRF reference frame and coordinate systems
- Local coordinates via transformation parameters

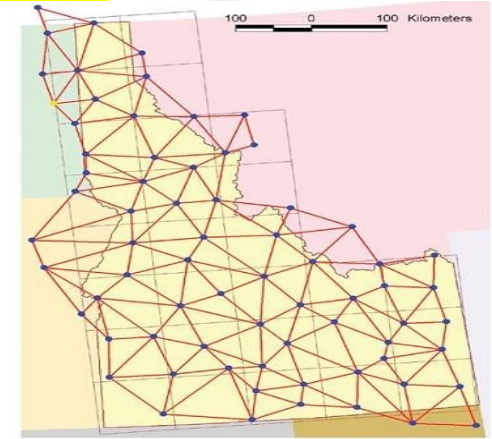
ITRS based and Localization; Rover co-ordinates

- Desired Rovers coordinates are as configured in your field GNSS RTK software. ARC'60/UTM or Cassini
- Localize with known points for ARC 60 datum coordinates UTM or Cassini for beacon search/placings



Non Active(traditional Geodetic networks)

- Similar to what we have traditionally but accurate
- Based on modern Technologies, such as Global Navigation Satellite Systems (GNSS) & International Terrestrial Reference Frame(ITRF)



Active networks/Geodetic Real Time Networks(RTN)

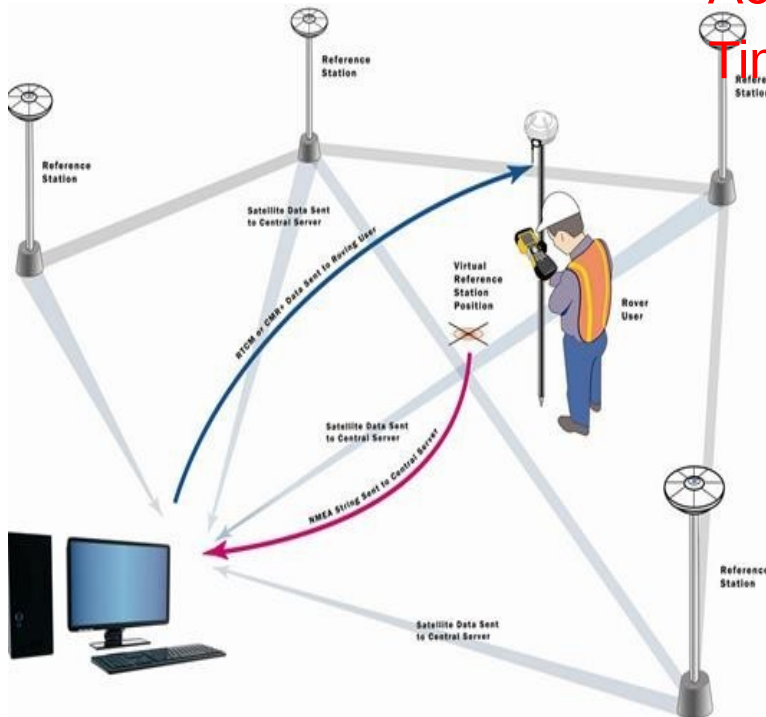


image courtesy of Trimble

- Based on Continuously Operating Reference Station(CORS) as field GNSS base stations, operating 24/7
- Acts as reference stations /controls for all applications
- User Controlled
 1. By registration- user name and password
 2. Multi-users
 3. Products (DGPS, RTK, Raw data, and post processing)

1. CORS would provide seamless and accurate but application dependent positioning solutions and in real time....
2. Is a multi user-serves many people simultaneously
3. Reduced costs on GNSS equipment. only one Rover required
4. Reduced costs on time taken to carry out the survey. No base to set up nor configure. Users only need connect to RTN/RTK provider
5. Controls positioning accuracies on all users. Providers can tracks users and provide users log files as evidence of survey works done. CORS network providers may be requested to avail users log files to National Mapping Organization during survey work approvals. The log contents of the log files may include the positional data including accuracies and RTK solutions.

Challenges of CORS

Funding

- mostly via world bank and other donors..
- We need to fund ourselves!
- Encourage local PPPs where possible(Users/surveyors group/GNSS resellers

Internet-subscription based/non payment issues..

Power

- failure/interruptions/ non payments
- use multiple power sources including natural(solar/wind)

Maintenance

- IT related hardware/software/updates, parts replacements
- GNSS hardware/software/updates, expense, no budget
- Governments not good at this as we cannot budget for all occurrences
- We need to plan for this..



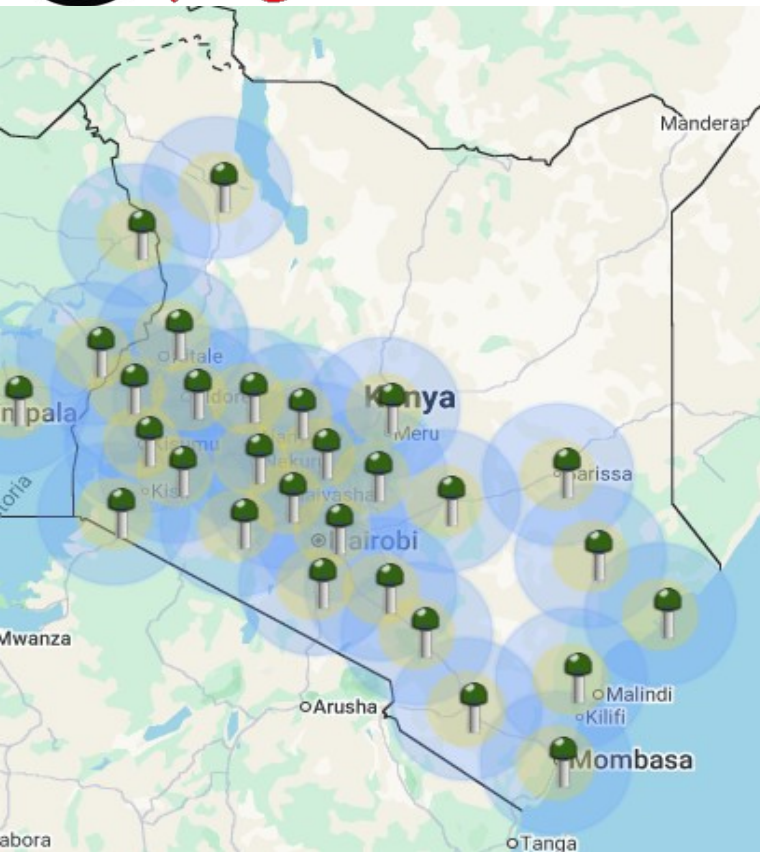
All applications requiring to answer the question

WHERE?

Earth sciences studies

- Geodynamics
- Meteorology(weather)
- Geoid undulation
- and more..

- Survey & Mapping
 - Construction
- Precision Agriculture
- Infrastructure monitoring
 - Navigation
 - and more..



Muya Cors & Distribution

- Ten(27+3) under MSL
- Using CORS from Partners in the region-Uganda
- Full constellation-GPS GLONASS Beidou and Galileo
- COMNAV(China) CORS receivers and Software(CDC)

Coordinate systems & computations

- ITRF2020 Currently based on DOY 001.2026
- Computation using Online processing engines including;
 1. Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP) service -**GPS+GLONASS+Galileo**
 2. Online Positioning User Service(OPUS) National Geodetic Survey (USA)-baseline processing using IGS stations as **controls-GPS+GLONASS** as a check

Registration as a user via, www.muya-cors.com

- ✓ Register for user name & password
- ✓ Subscribe RTK corrections @ our service via a shopping cart
- ✓ Buy or Hire a GNSS rover @ our shop via our shopping cart
- ✓ Download CORS static data @ our shop via our shopping cart
- ✓ Free six months RTK correction on buying our rover
- ✓ Call Chris @ 0728909641for help

I acknowledge LEICA Geo-Systems, Trimble, Pentax from where most of the materials and images in this presentation have been drawn from.

Our contacts



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Thanks you very much for your attention!