# GNSS CORS Infrastructure and General Principles

*FIG Regional Conference*

*TS 02*
*GNSS CORS Fundamentals*

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**San Jose, Costa Rica, November 12th, 2007**



## Structure

- Definitions
- GNSS Error Sources
- CORS Network Principle
- Realtime Processing
- CORS Infrastructure
  - CORS
  - CORS Network
  - exemplary CORS Networks
- Conclusions





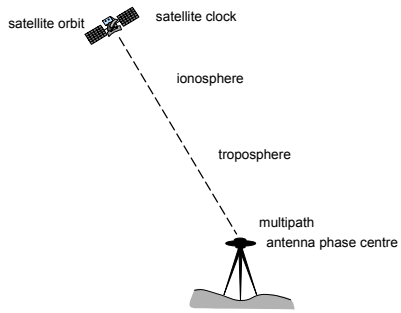
## Definitions

- **GNSS – Global Navigation Satellite Systems**
  **currently:**
  **G**lobal **P**ositioning **S**ystem (US) and
  **GLO**bal **NA**vigation **S**atellite **S**ystem (Russian)
  **future:**
  e.g.: Galileo (European) and Compass (Chinise)
- **CORS** – Continously Operating Reference Station
- **CORS Network** – a network of connected CORS
  - for real time applications
  - for post-processing





## GNSS Error Sources







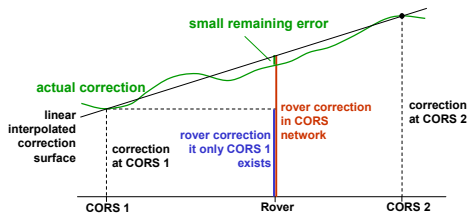

## Precise Differential GNSS

- **Relative respectively differential GNSS delivers high accuracy by using simultanously measuring Reference (may be a CORS) and Rover**
- **Elimination respectively reduction of errors partly depends on the baseline length**
- **Errors sources that show an effect depending on the baseline length:**
  **- satellite orbit and clock**
  **- ionosphere**
  **- troposphere**
- **Solution: Network Approach !**





## Network GNSS Principle



## Classification of GNSS CORS Networks

- ...with respect to acuracy
  - code solution = DGPS networks
  - phase solution = PDGPS networks
- ...with respect to data availability
  - real time solution
    = Real Time Kinematic (RTK) networks
  - post-processed solution
  - raw data for post-processing

**Focus on PDGPS with different data availability !**





## GNSS CORS Network Realtime Processing (1)

- *Acquisition* of all measurements within the network,
- *Fixing* of the ambiguities within the network,
- Determination of area correction parameters (*FKP*),
- Generation of measurements for *one reference* station,
- Estimation of the measurements for a virtual reference station (*VRS*) by the use of the approximate position of the rover,
- Determination of the *baselines* and finally the *rover position* using the *rover measurements*.





## GNSS CORS Network Realtime Processing (2)

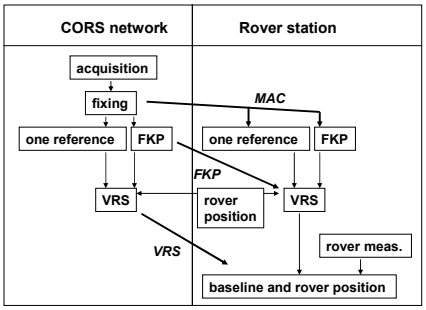
Three Concepts

- VRS – virtual reference station
- FKP – area correction parameters
- MAC – master auxiliary concept





## GNSS CORS Network Realtime Processing (3)







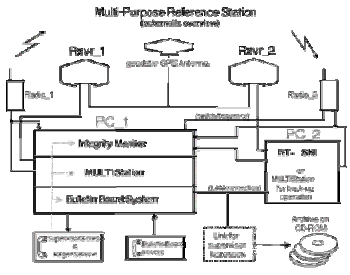

## GNSS COORS Infrastructure

- GPS / GNSS receiver and antenna
- Power supply
- Computer for data storage, data transmission and control of the receiver
- Data transmission / communication with the user via:
  - radio communication
  - mobile network e.g. GSM
  - satellite
  - internet (NTRIP = Network transported RTCM via internet protocol)
  - fixed line telefon network (post-processing only)
  - internet using RINEX format (post-processing only)
- Software to generate the output for users (RTCM or RINEX format)
- Optional: complete second system for back-up





## GNSS COORS Infrastructure




http://www.gisqatar.org.qa/

http://www.leica-geosystems.com/

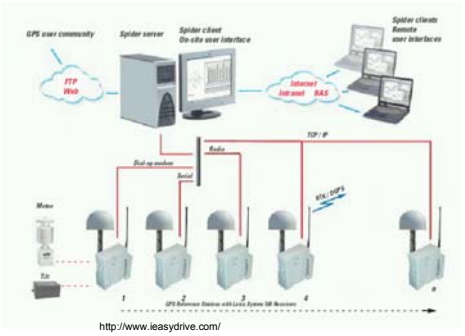
## GNSS CORS Network Infrastructure

- Additionally to GNSS CORS infrastructure communication between the CORS respectively to a computing centre has to be realised; e.g. by radio communication, internet, mobile or fixed line phones.
- Software to compute network solutions (e.g. fixing the ambiguities) and generate output for users (RTCM or RINEX format) as well as FKP or VRS.





## GNSS CORS Network Infrastructure

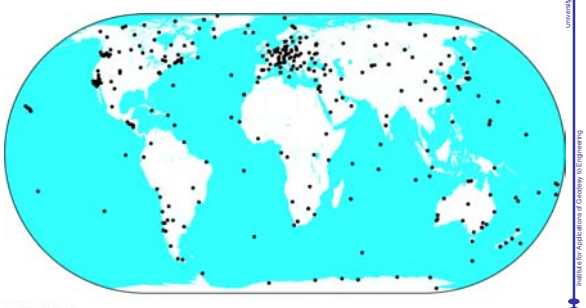



http://www.ieasydrive.com/





## Examples – IGS (PDGPS raw data)

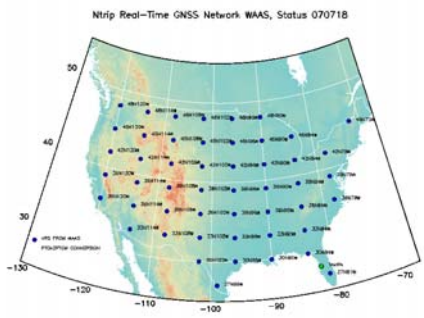


http://igscb.jpl.nasa.gov/images/maps/all_world_clean.png





## Examples – WAAS (DGPS real time)

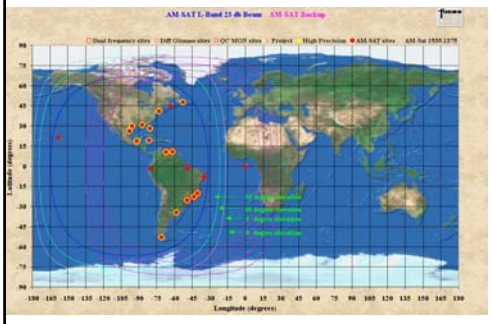



http://igs.bkg.bund.de/root_ftp/NTRIP/maps/networks/





## Examples – Omnistar (PDGPS / DGPS real time)



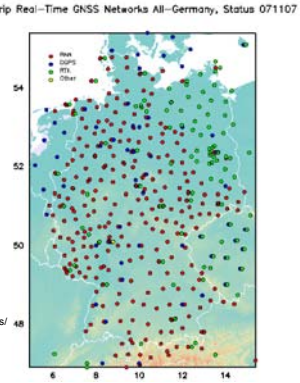

**Part of the network: south and central america**

http://www.omnistar.com/grfx/maps/map_amsat1.gif



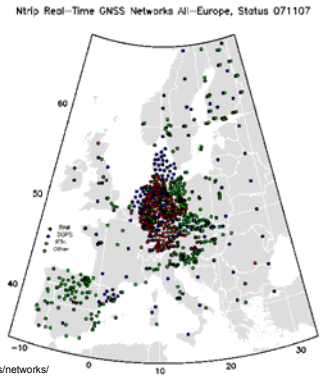


## Examples – NTRIP GNSS in Germany (Real Time)




http://igs.bkg.bund.de/root_ftp/NTRIP/maps/networks/

## Examples – NTRIP GNSS in Europe
(Real Time)




http://igs.bkg.bund.de/root_ftp/NTRIP/maps/networks/





## Conclusions

- CORS are available 24/07
- Strong correlated errors are eliminated by differential GNSS
- Network approach additionally reduces baseline length dependent errors
- Infrastructure for post-processing applications works without problems world-wide
- Real time networks are in operation too
- Main Advantage:
  User needs only one GNSS receiver for positioning !





## Thank you very much for your attention !

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