GNSS CORS
Reference Frames and Services

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OUTLINE

- Introduction
- Reference Frames – ITRF and WGS84
- GNSS CORS and GNSS CORS Networks
- Linking CORS Networks and ITRF
- Examples and Positioning services
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INTRODUCTION

- Using "absolute" GPS gives you a position in WGS84.
- Accuracy around or even better than 10 metres (2D, 95 %)
- To improve the accuracy, a common method is to use "known points".
- The "known point" or the "network of known points" will define the reference frame.
- Realisation by a permanent station (CORS) or a network linked to ITRF (International Terrestrial Reference Frame).

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WHAT IS ITRF?

- Versions: ITRF89, …, ITRF2000, ITRF2005 (ITRF2008 planned for 2009)
- Producer: International Earth Rotation Service (IERS)
- Ellipsoid: GRS1980
- Epoch: Updated
  - e.g. ITRF97 1999.5
- Both: co-ordinates and velocities
- Methods: VLBI, SLR, LLR, DORIS, GPS
- Application: e.g. Computation of precise orbits (IGS), accurate GPS-calculations, scientific studies

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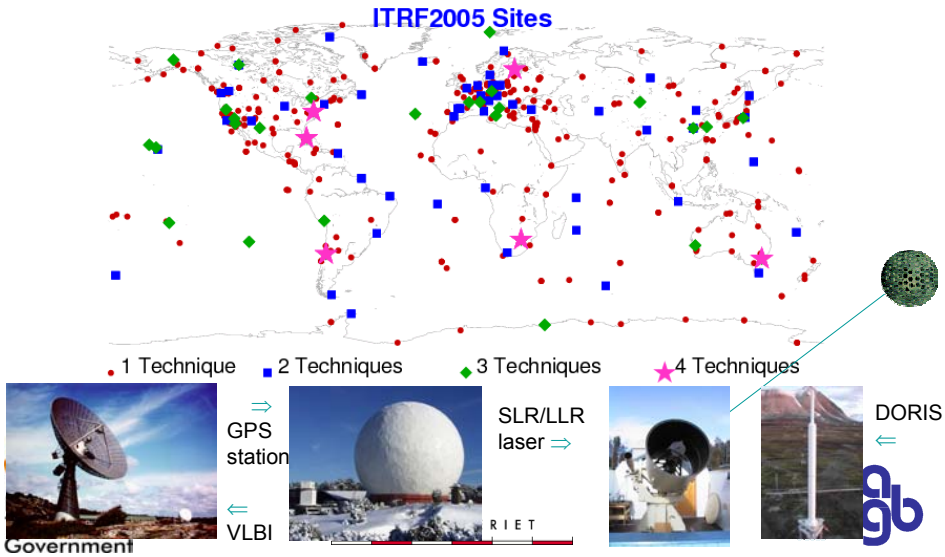
Recent ITRF2005



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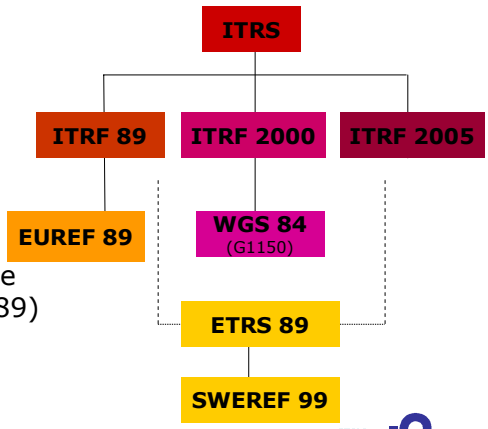
Global 3D REFERENCE FRAME

- International Terrestrial Reference System (ITRS)
  - Realised through International Terrestrial Reference Frame XX (ITRF XX)
- World Geodetic System XX (WGS XX)
- European Terrestrial Reference System 89 (EUREF 89, ETRS 89)
- Swedish Reference Frame 99 (SWEREF 99)



WGS84

- Versions: WGS60, ..., WGS72, WGS84
- Producer: National Imagery and Mapping Agency (NIMA), USA
- Ellipsoid: WGS1984 (~GRS1980)
- Epoch: Since 1994 updated
- WGS84 (G1150) aligned to ITRF2000 epoch 2001.0 on cm level
- Method: GPS

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ITRF BASED DATUMS

- E.g. ETRS89
- These datums uses fixed coordinates. Mapping authorities as well as cadastre wants to have ”non-changable” coordinates (no velocities !)
- WGS84 and ITRFXX changes due to plate tectonics
- Therefore national or regional realizations are needed of ITRF, the respective epoch is hold on
- Some commercial services as Omnistar deliver coordinates in WGS84
- In general difference between WGS and ITRF based datums are at the level of cms-dms

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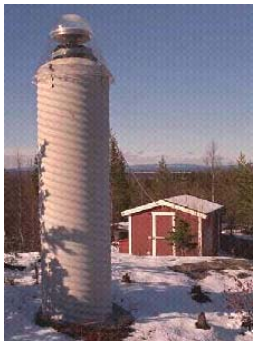
CORS

- Continuously Operating Reference Station



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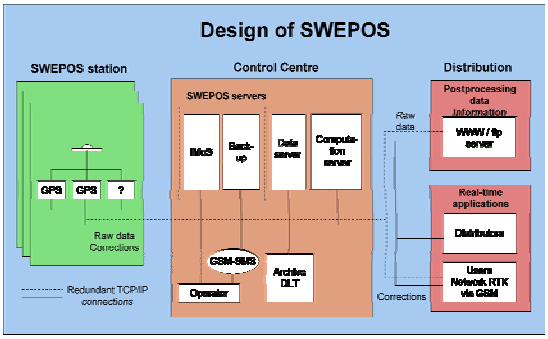
CORS - Infrastructure



Example: CORS – Infrastructure for the SWEPOS-network

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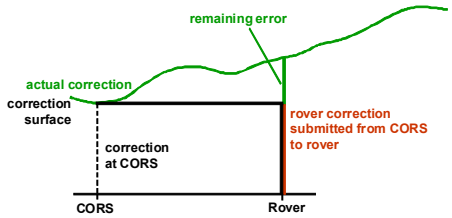
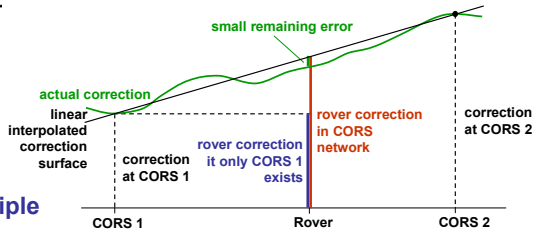
GNSS CORS Networks



DGNSS-Principle



DGNSS / RTK Network-Principle

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GNSS CORS Network Classification

Type of CORS network	DGNSS	Smoothed DGNSS	PDGNSS
Accuracy	1 – 3 m	appr. 0.5 m	1 – 2 cm
Observations	L1 code	L1 code, L1 carrier phase for smoothing only	L1 code, L1/L2 carrier phase for positioning
Reference Station Spacing	appr. 500 km	appr. 300 km	20 – 50 km
Real time / Post-Processing	real time	real time (and post-processing)	both
Correction generation	pseudo-ranges	pseudo-ranges or state space	state space and all measurements
Transmission media, real time	radio, wireless	communication satellites, wireless	mobile phones, wireless, ntrip (internet)
Transmission media, post-processing	not avialable	ftp, email	web-portal, ftp, email, fixed-line phone

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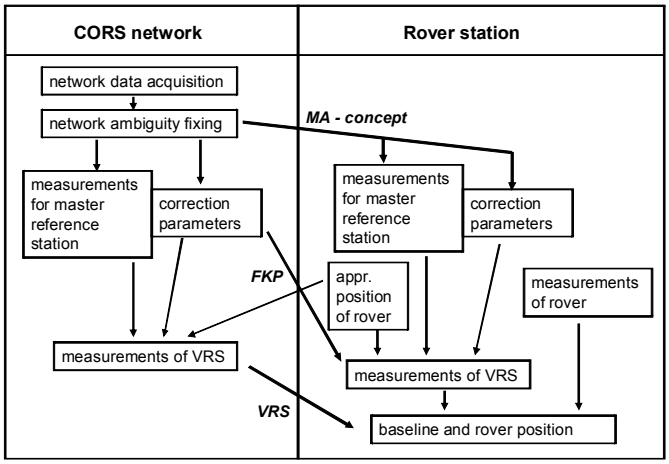
PDGNSS CORS Network Processing



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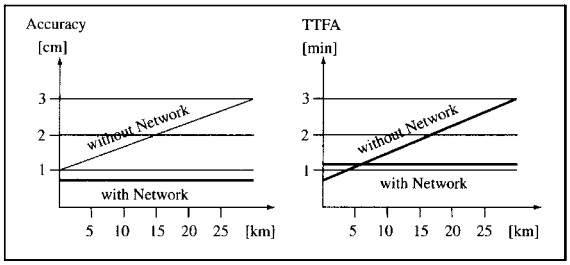
PDGNSS CORS Network

Accuracy and Promptness



Improvement of quality parameters by network approach
(source: Seeber 2003)

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Linking CORS Networks to ITRF

- Select one station in the new network as the "master" or "reference" or "base".
- At the master or the new stand-alone CORS log data using geodetic GNSS receivers (30 second or 1 minute rate is sufficient) for at least 24 hours, but ideally for up to 7 days.
- Download RINEX data from the closest IGS station or from the closest national CORS (in any case a site with known ITRF coordinates).
- Process the baseline from the IGS station, or from the national CORS, to the master using 24 hours of data. If data has been logged for several days, process the baseline for different 24-hour periods and take the mean.
- It is highly recommended to process additional baselines to the master from one or two supplementary IGS or national CORS; again take the mean.
- Result: very accurate ITRF coordinates for the master or the new stand-alone.
- Preferable: Connect more than one CORS site to IGS at same time !
- In any case: Use the same procedure to get ITRF coordinates for the rest of the CORS network
- ITRF coordinates have to be monitored in regular intervals !!

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PDGPS - Real Time versus Post-Processing

RTK – Real Time Kinematik (= real time PDGPS)
all computations are realised in real time,
the user gets the cordinates in the field

Post-Processing (3 possibilities)
- Same procedure as RTK, but in Post-Processing
- Network solution in post-processing realised by the user with own software (adjustment, may be more accurate !)
- Online Processing Service: network solution is computed by experts on the basis of the measurements of the user, coordinates are send back to the user

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CORS Network Examples
Europe

Sweden – SWEPOS
- more 170 stations and data download for post-processing
- network RTK and DGNSS
- standard deviation: 15 mm Hz., 25 mm Vt. (realtime)
- standard deviation: sub-mm (post-processing)

Germany
- three service providers: SAPOS, ASCOS, Trimble VRS Now
- SAPOS driven by sate survey, others by companies
- network RTK and DGNSS and data download for post-processing
- standard deviation: 1 to 2 cm (network RTK) up to 3m (DGNSS)
- standard deviation: sub-cm (post-processing)

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CORS Network Examples
Asia Pacific Region

RTK networks
• Malaysia Real Time Kinematic GPS network (MyRTKnet)
• Singapore Satellite Positioning Reference Network (SiReNT)
• Hong Kong Satellite Positioning Reference Station Network" (SatRef)
• Japans GPS Earth Observation Network System (GEONET)

Post-Processing – data download
• Australian Regional GPS Network (ARGN)
• New Zealand's Global Positioning System Active Control Network (PositioNZ)
• Crustal Movement Observation Network of China (CMONOC)

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ON-LINE PROCESSING SERVICES

- Processing software not available or not suitable
- Submit RINEX files for processing
- Automatic processing using data from nearby IGS stations
- Example of on-line processing services
  - Auto Gipsy (JPL) - Service provided by JPL
  - AUSPOS (Geoscience Australia) - Service provided by Geoscience Australia
  - OPUS - Service provided by NGS, USA
  - SCOUT (SOPAC) - Service provided by SOPAC, USA
  - CSRS-PPP (NRCAN GSD) - Service provided by Natural Resources, Canada

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FACT SHEETS

http://www.fig.net/commission5/wg52/manuals.htm

Technical Manuals, Standards and Fact Sheets
Fact sheet(s) on
GNSS CORS - Standards and Best Practices for GNSS and CORS V3.1
GNSS CORS - Reference Frames and Datums V10
GNSS CORS - Principles V2
GNSS CORS - Linking to ITRF V10
GNSS CORS - Calibration and Testing for GNSS and CORS V3.2

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