Future and Development of the European Combined Geodetic Network ECGN

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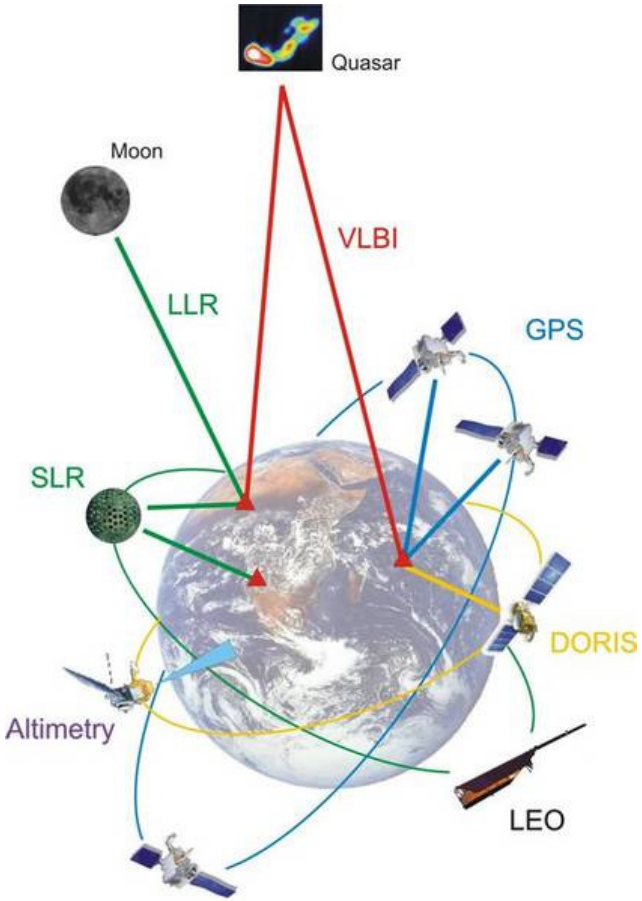
Motivation and background

- Geodetic observations and permanent observing networks have provided a more detailed picture of the Earth's surface and gravity, their temporal variations in all scales, and global changes in the Earth's shape, mass distribution, sea level and orientation in the inertial frame in the accuracy down *to 1 mm level*
- With increased accuracy many concerns on data and products
  - ✓ Geodetic networks of different techniques have been separated (reference frames, levelling, gravity)
  - ✓ Connection of observations of different techniques is essential
  - ✓ Availability of data, access of data and distribution of products to the scientific community and to other users
  - ✓ Different ways to apply corrections or physical parameters
  - ✓ Quality control of data
  - ✓ Continuation and stability of the infrastructure
  - ✓ Response to political and societal needs; selection of products
  - ○ Public unawareness of geodesy and geodetic methods
  - ○ Lack of interest in geodetic community

Geodetic Observing systems and multi technique sites

- To observe various aspects of Earth-related parameters down to mm-level we need several techniques combined
- This implies: GNSS, SLR, VLBI, AG, SCG, levelling, relative gravimetry, altimetry, InSAR, …
- Also local ties down to 1 mm level between co-located techniques, processing multi technique data (possibly data assimilation), unified handling of parameters and constants, …

➢ **Geodetic Observing Systems (GOS)**



+ terrestrial

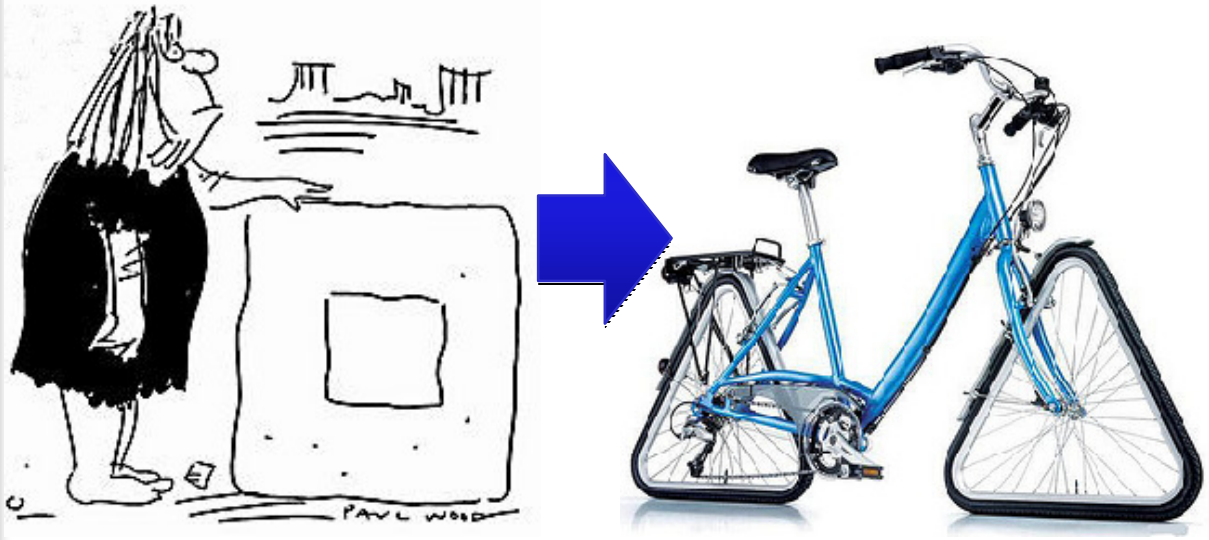
levelling, AG, SCG, rel.g, tide gauges, …

… but we need not to re-invent a wheel

(almost all necessary infrastructure and facilities exist)

Several initiatives for a geodetic observing system:

- *GGOS* (Global Geodetic Observing System), IAG initiative; global
- *ECGN* (European Combined Geodetic Network), EUREF initiative; regional
- *NGOS* (Nordic Geodetic Observing System), NKG initiative; regional



(In the history of mankind it was a great innovation to use a 3-corner wheel instead of a 4-corner wheel because a 3-corner wheel causes one bump less in every revolution…)

Geodetic Observing Systems

- GGOS is the global system, others are regional
- Necessary infrastructure is mostly in place,
  - GGOS: IAG Services
  - ECGN: EPN, UELN, …
  - NGOS: NKG Working Groups, national networks
- Originally, regional GOS's were thought to become densifications of the global system.
- Development of the GGOS, however, led into a structure where regional GOS's do not play a significant role in GGOS, but GGOS is based on the existing IAG services.
- Question about status and role of regional GOSs; **why ECGN**

Three pillars of GOS

1. Stations
   - Multi-technique sites with at least 2 techniques (gravity + GNSS)
   - Criteria and guidelines for stations
   - Long-term stability and existence of stations

2. Data Banks
   - Data should be available in data banks
   - Update of the respective metadata bank

3. Combination/products
   - To be organized by the respective host
   - Analysis, reductions, parameters in a unified way; reliability
   - Common voice of geodesy

ECGN as a regional GOS

1. Stations
   - Fundamental stations and several other stations belong to GGOS
   - No need to repeat IAG Services
   - Much more dense network than GGOS
   - Some techniques not in GGOS (e.g. levelling)
2. Data Banks
   - A lot of data already in global data banks (e.g. IAG Services) or regional data banks (e.g. EPN, UELN)
   - Web portals and metadata banks needed for user access
3. Combination/products
   - To be organized by the regional host (EUREF, NKG)
   - Connection and compatibility to the products of GGOS
   - Analysis, reductions, parameters in a unified way; reliability

ECGN components and network

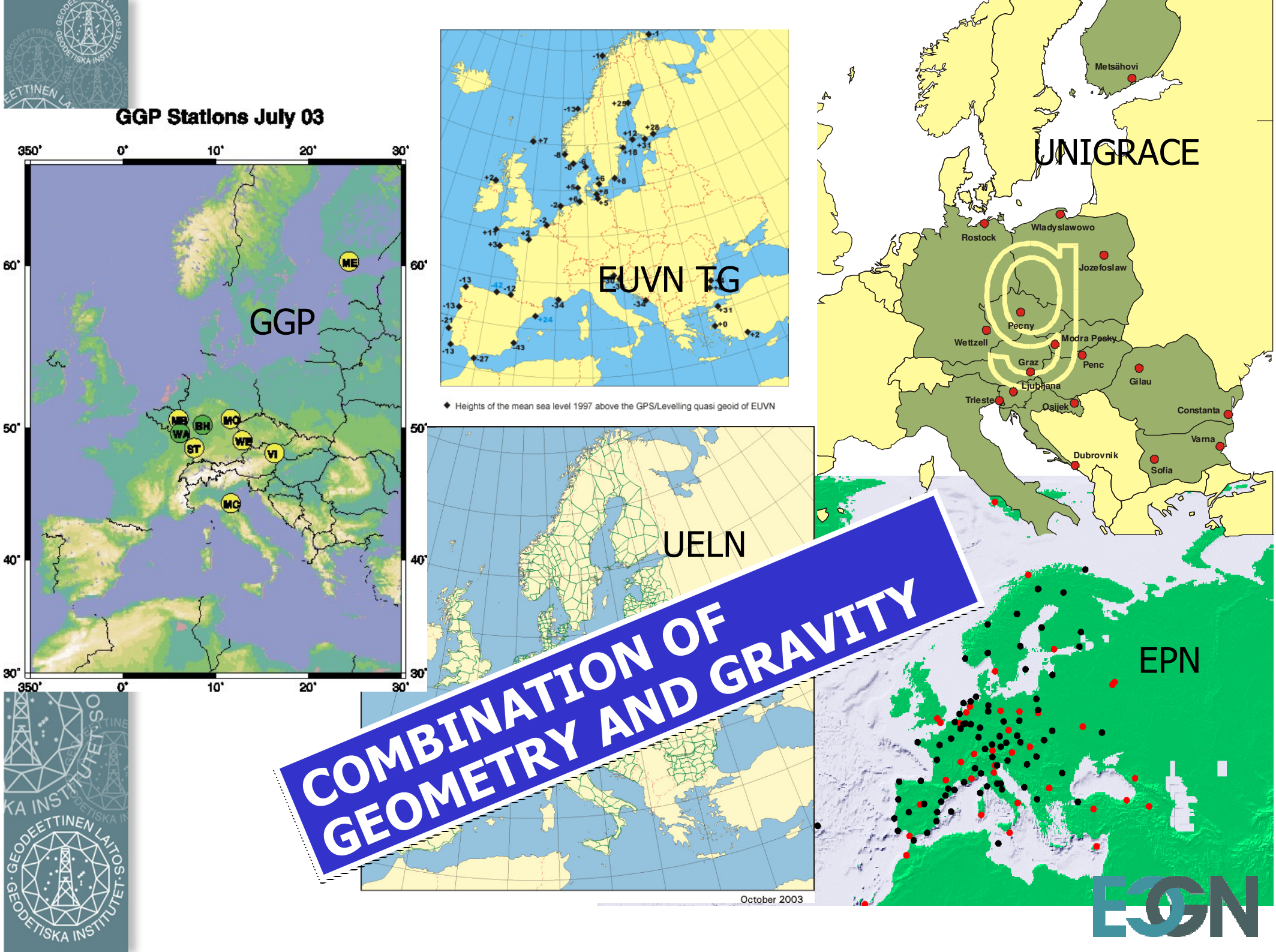
Technique	Objective	Accuracy	Component(s)
VLBI	IVS		
SLR	ILRS		
GNSS	IGS, EPN, ... (OK)		
DORIS	IDS		
Levelling	UELN, Nordic, ... (OK)		
Tide gauges	PSML (OK)		
Absolute gravimeters	AG plan + archive (developing)		
Superconducting gravimeters	GGP (OK, IAG PROJECT ??)		
Spring gravimeters	Many sources, partly available		

Meta-databases, data archives, partly available

Product availability to users; partly available

Objectives of the ECGN

- To identify a network of stations with collocated techniques shown in previous slide
- To provide access to the related data. This implies maintenance of databases, most of them via existing components, such as EPN, and a metadata base as a part of the ECGN portal
- To contribute to initiatives aiming at the maintenance and improvement of precise geoid models in Europe; Integration of GOCE results with the ECGN gravity data
- Collocation of geometric positioning (C-GNSS time series) with physical height (UELN) and repeated gravity measurements in 1 cm accuracy level or better, and to provide connection to the sea level and sea level changes via tide gauges in the area.
- To contribute to the realisation of the WHS
- To contribute to the evaluation of the uncertainty of the Terrestrial Reference Frame origin
- Monitoring the long time stability of the terrestrial "3D+1" reference system for Europe with an accuracy of 10^{-9}, including 3D geometric parameters together with the gravity related height component.


GGP Stations July 03
GGP
EUVN TG
UNIGRACE
Metsähovi
Rostock
Wladyslawowo
Jozefoslaw
Pecny
Wettzell
Modra Pesky
Graz
Penc
Gilau
Ljubljana
Trieste
Osijek
Constanta
Varna
Dubrovnik
Sofia
Heights of the mean sea level 1997 above the GPS/Levelling quasi geoid of EUVN
UELN
October 2003
COMBINATION OF
GEOMETRY AND GRAVITY
EPN
EUREF

Requirements for an ECGN station

As a minimum, an ECGN station should have a

- C-GNSS receiver
- repeated absolute gravity measurements
- connection to the UELN network.

The stations should belong to IGS or EPN or be a part of national or regional networks which are established and maintained comprising the IGS or EPN guidelines.

The **core stations** should additionally have other major space geodetic techniques fulfilling the GGOS Fundamental Station definition.

A connection to a tide gauge (both 3-D geometric and levelling) and a superconducting gravimeter are options which should be included where available. Local ties between techniques should exist on a sub-cm level.

Structure of ECGN

ECGN will be using existing structures and databases where available. However, following subgroups are foreseen:

- **Stations and local ties**; needed to organize the call for participation, to maintain the list of stations and local ties, and to maintain respective guidelines
- **GNSS**; current organization for EPN already exists and is sufficient for this
- **Gravity and heights**; a coordination is needed between existing groups and networks
- **Tide gauges**; connections to the existing geodetic networks

Tasks for ECGN

- Finalizing the white paper describing the structure, goals and tasks of the ECGN
- Arrange a pilot project
- “Call for participation” to update the list of stations fulfilling the requirements for an ECGN station.
- Develop the metadata base

An example of a pilot project:

Nordic Geodetic Observing System;

- GNSS network
- Repeated gravity measurements on-site
- Connected to the national levelling network
- Common height system available
- We propose a pilot project in Nordic area to demonstrate the ECGN

Future of regional GOSs

- GOS should take a leading role in collecting and distributing geodetic data
- GOS should be the common umbrella for a more easy access to the data and products for ordinary users
- Visibility and outreach
- GOS cannot deliver all possible items but have to concentrate on specific tasks which can done with a limited resources, funding, time…

Future of regional GOSs

- Combining and analyzing multi-technique data (like SLR, VLBI, GNSS) at a limited number of super-stations is mostly done in IAG services; in general, no need to repeat; special projects

- More stations, more dense networks regionally needed for many purposes (GIA, regional reference frames, national coordinates, societal needs,…)

- Main concerns:
  - Stability and existence of stations; budget cuts, political decisions
  - Lack of interest in geodetic community
  - No unified set of data and products; many formats and parameters (example: treatment of permanent tide)

Summary

- The System Earth is very complicated in the viewpoint of precise observations and reference frames
- No single observing technique is sufficient
- Geodetic observing systems *offer* (or will/should offer) *multi-technique data/sites*
- Global Geodetic Observing System will offer data and products valid for global work, reference frames, &c
- Regional observing systems are concentrated on topics specific for their geographic area or specific projects
- We need also *regional dense networks*
- We need regional multi-technique data/sites and products *in a coordinated way*