# EUREF – The Continental ITRF and IGS Densification for Europe


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Bangalore, India

# EUREF

- Creation in 1987 at the IUGG General Assembly in Vancouver
- Sub-commission 1.3a of IAG, Secretary in Munich, Central Bureau of EPN in Brussels
- Permanent committee is the Technical Working Group (15 members, 3 meetings per year)
- Links to about 130 European organizations, agencies, universities (positioning and navigation)

# Outline

(1) Mission

(2) Definition and Realization of European Geodetic Reference Systems

(3) EUREF-IP Real-Time Activities

(4) Special Projects

(5) Contributions to ICG

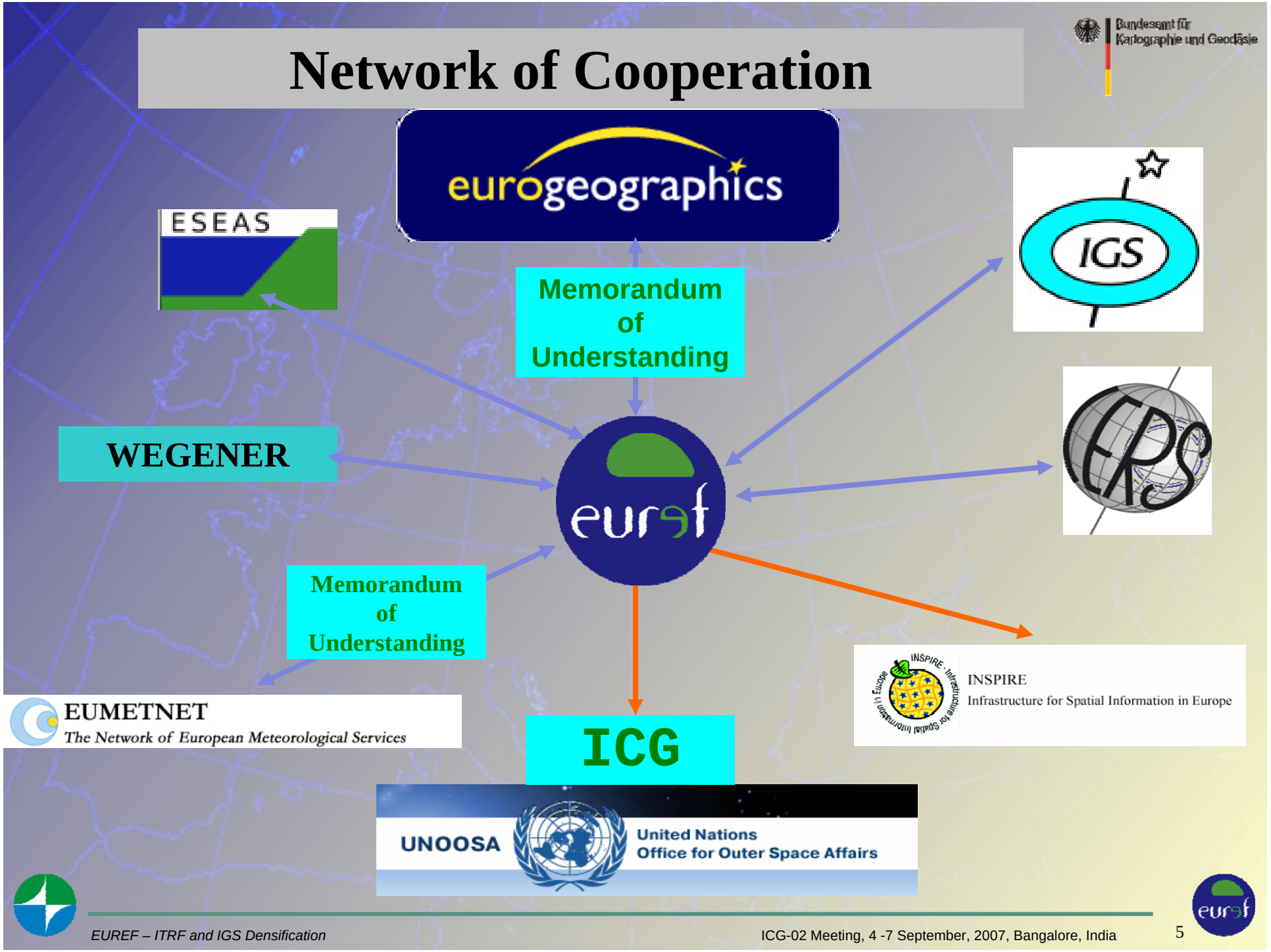
# (1) EUREF Mission

Bundesamt für Kartographie und Geodäsie

## Definition, realization and maintenance of the European Geodetic Reference Systems

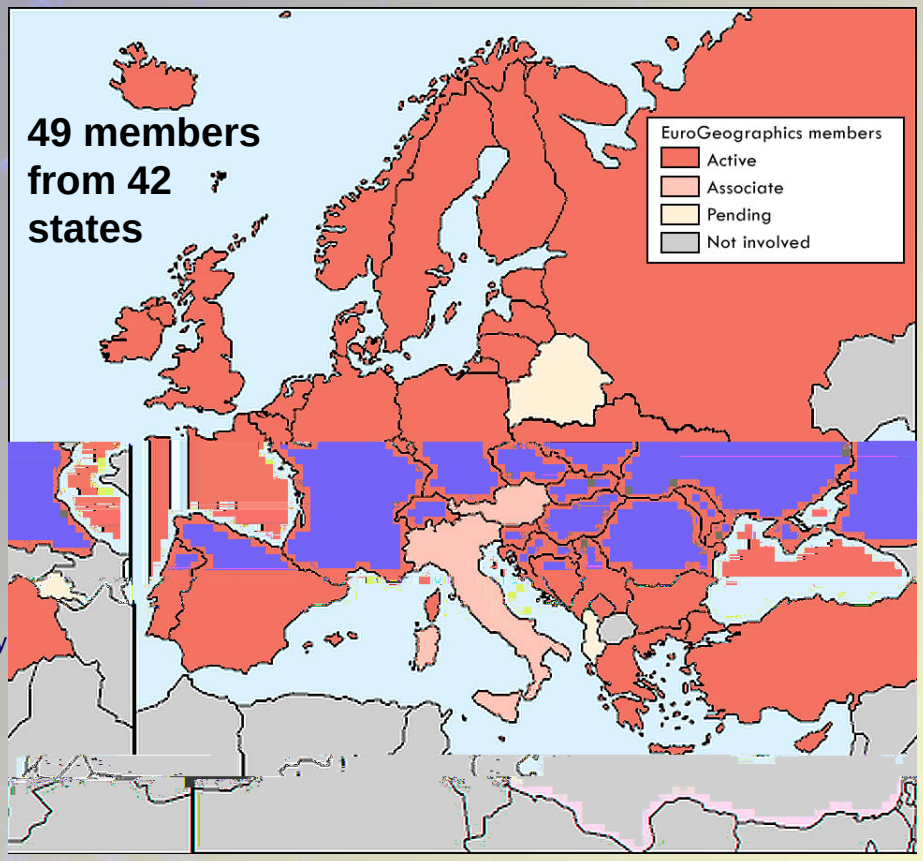
- Promotion and assistance of the adoption and use of European Terrestrial Reference System (ETRS89) in Europe in alignment to ITRFxx
- The EUREF GNSS Permanent Network (EPN) is the ground based GNSS infrastructure for scientific and practical applications in positioning and navigation (GGOS, IGS-RT)
- The definition and realization of the European Vertical Reference System will arrive 2007 a new stage (EVRS2007)
- Provides all its products on the "best effort" basis and free of charge to the public

# Network of Cooperation



# NMCA's

| | | |
|---|---|---|
| 1. | Albania | Institut Studimit Tokave |
| 2. | Armenia | State Committee of the Real Property Cadastre |
| 3. | Austria | BEV - Bundesamt für Eich- und Vermessungswesen |
| 4. | Belarus | State Committee for Land Resources, Geodesy and Cartography |
| 5. | Belgium | - Nationaal Geografisch Instituut / Institut Géographique National<br>- Administration du Cadastre, de L'Enregistrement et des Domaines/ Administratie van het Kadaster, de Registratie en de Domeinen |
| 6. | Bosnia & Herzegovina | Federal Administration for Geodetic and Real Property Affairs |
| 7. | Bulgaria | Ministry of Regional Development and Public Works |
| 8. | Croatia | Drzavna Geodetska Uprava |
| 9. | Cyprus | Department of Lands and Surveys, Ministry of the Interior |
| 10. | Czech Republic | Cesky urad zememericky a katastralni |
| 11. | Denmark | Kort og Matrikelstyrelsen |
| 12. | Estonia | Maa-amet |
| 13. | Finland | - Maanmittauslaitos<br>- Finnish Geodetic Institute |
| 14. | France | IGN – Institut Géographique National |
| 15. | Germany | BKG - Bundesamt für Kartographie und Geodäsie |
| 16. | Great Britain | Ordnance Survey of Great Britain |
| 17. | Greece | - Hellenic Military Geographical Service<br>- Hellenic Mapping and Cadastral Organisation |
| 18. | Hungary | Földügyi és Térképészeti Foosztály |
| 19. | Iceland | - Landmælingar Íslands<br>- Fasteignamat Rikisins |
| 20. | Ireland | Ordnance Survey of Ireland |
| 21. | Italy | Instituto Geografico Militare Italiano |
| 22. | Kosovo | Kosovo Cadastral Agency |
| 23. | Latvia | - LR Valsts zemes dienests<br>- Latvijas Geotelpiskas Informacijas Agentura |
| 24. | Lithuania | - National Land Service<br>- State Enterprise, Centre of Registers |
| 25. | Luxembourg | Administration du Cadastre et de la Topographie |
| 26. | Malta | Malta Environment and Planning Authority |
| 27. | Moldova | National Agency of Cadastre, Land Resources and Geodesy |
| 28. | Northern Ireland | Ordnance Survey of Northern Ireland |
| 29. | Norway | Statens kartverk |
| 30. | Poland | Glówny Urzad Geodezji i Kartografii |
| 31. | Portugal | Instituto Geografico Português |
| 32. | Romania | Agentia Nationala de Cadastru si Publicitate Imobiliara |
| 33. | Russia | Federal Service of Geodesy and Cartography of Russia |
| 34. | Serbia & Montenegro | Republicki Geodetski Zavod |
| 35. | Slovakia | Úrad geodézie, kartografie a katastra SR |
| 36. | Slovenia | Geodetska uprava republike Slovenije |
| 37. | Spain | - Instituto Geográfico Nacional<br>- Dirección General del Catastro |
| 38. | Sweden | Lantmäteriet |
| 39. | Switzerland | Bundesamt für Landestopografie |
| 40. | The Netherlands | Kadaster en Openbare Registers |
| 41. | Turkey | Harita genel komutanligi, General Command of Mapping |
| 42. | Ukraine | State Service of Geodesy, Cartography and Cadastre |



# (2) Definition and Realization of European Geodetic Reference Systems

Bundesamt für Kartographie und Geodäsie

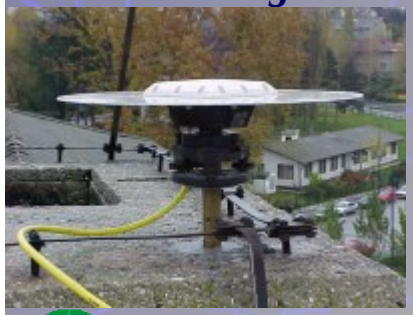
- ETRS89 (European Terrestrial Reference System)
  - The datum is fixed to the stable part of the European Plate at the epoch 1989.0 (ITRF89)
  - Realized by ETRFxx derived from ITRFxx by removing the velocity of the European plate (xx is currently 2005)
  - based on EUREF GNSS Permanent Network EPN
- EVRS (European Vertical Reference System 2007)
  - Related European Vertical Datum (NAP)
  - Realized by the United European Levelling Network (UELN)

# EUREF GNSS Permanent Network - EPN

Bundesamt für Kartographie und Geodäsie

- Science-driven GNSS network serving high precision users in Geodesy, Geophysics, Timing, Navigation
- Densification of the IGS (International GNSS Service) in Europe
- European contribution to global geodetic networks
- Operating under the IGS standards
  - GPS & GPS+GLONASS tracking stations
  - Data Centres providing free access to the observation data (daily & hourly RINEX)
  - Analysis Centres computing station coordinates and by-products

*Sajarevo, Bosnia/Hercegovina*



*Matera, Italy*

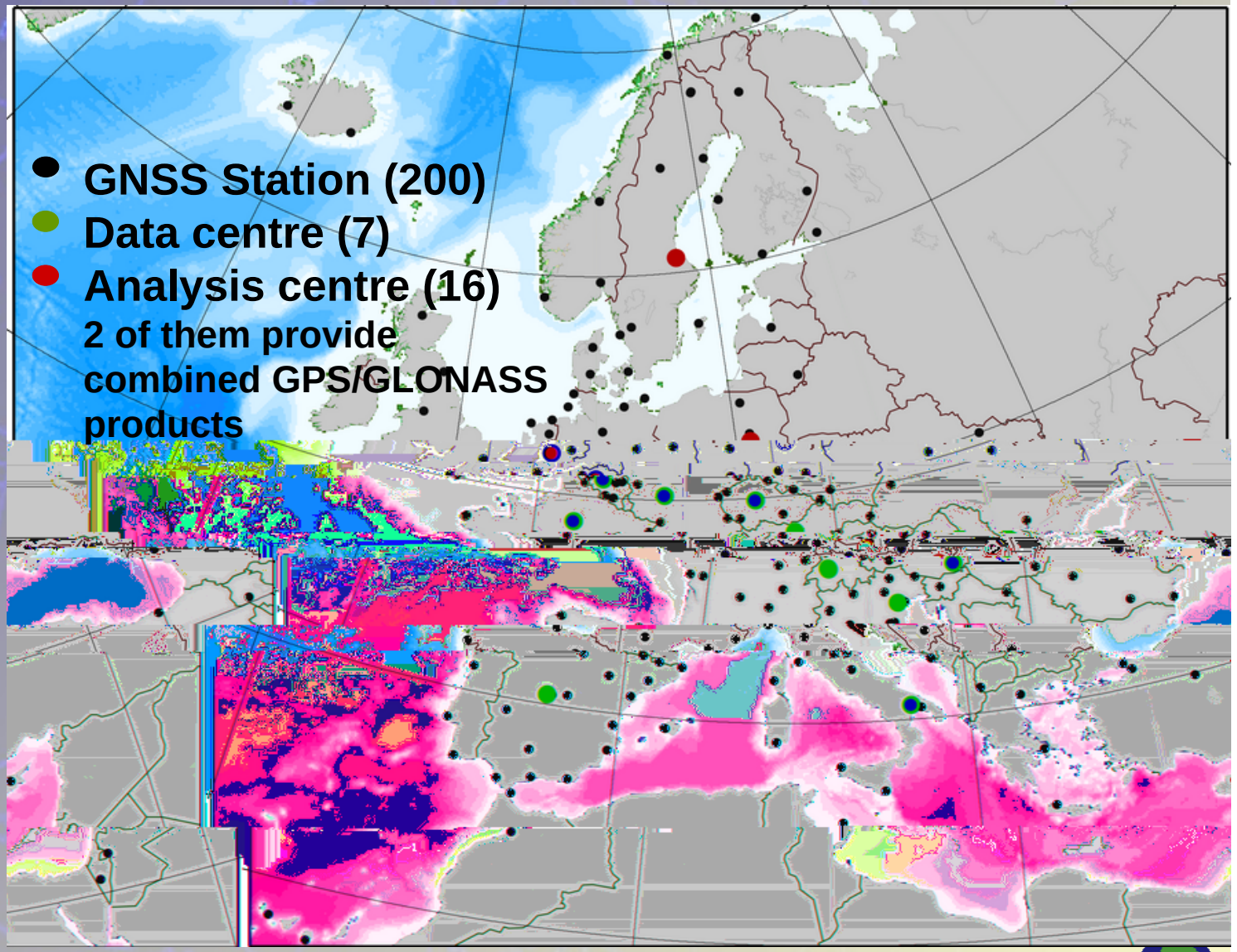
*Brest, France*

*Vaasa, Finland*

# EPN is the Densification of ITRF2005 and the Realization of ETRS89

Bundesamt für Kartographie und Geodäsie

- 200 permanent GNSS stations (40 GPS/ GLONASS)
- 55 of them are IGS stations
- 30 European countries are covered
- 100 contributing agencies



# http://www.epncb.oma.be/

Bundesamt für Kartographie und Geodäsie

EUREF HOME

## EUREF Permanent Network

EPN CB HOME

| ORGANISATION | TRACKING NETWORK | DATA & PRODUCTS | NEWS & MAILS | FTP & WEB ACCESS |
|---|---|---|---|---|
| Creation, Management, Structure, Relation to IGS, Projects, Guidelines, FAQ | Maps, Stations, Equipment, Station coordinates | Data centres, Analysis centres, Products, Time series, IGS products | EUREF mail, LAC mail, News, Papers, Workshops, Web site history, Calendar | Anonymous FTP, Web site index, Related links |

### WELCOME !

The European Terrestrial Reference System 89 (ETRS89) is used as the standard precise GPS coordinate system throughout Europe. Supported by EuroGeographics and endorsed by the EU, this reference system forms the backbone for all geographic and geodynamic projects on the European territory both on a national as on an international level.

The ETRS89 is maintained by the IAG sub-commission EUREF and it is accessed through the EUREF Permanent Network (EPN), a science-driven network of continuously operating GPS reference stations with precisely know coordinates in the ETRS89.

All contributions to the EPN are voluntary, with more than 100 European agencies/universities involved, and the reliability of the network is based on redundancy and extensive guidelines guaranteeing the quality of the raw GPS data to the resulting station positons. Next to its key role in the maintenance of the ETRS89, the EPN data are also used for a wide range of scientific applications such as the monitoring of ground deformations, sea level, space weather and numerical weather prediction.

This web site is part of the EPN Central Bureau Information System, providing both EPN member organizations and the public with information about the EPN organization, the EPN network of stations, and EPN data & products.

Whenever your use of EPN data or products results in a publication, please include a citation.

# Results

**European Commission adopted ETRS89 as the geodetic datum for geo-referenced information of the EC and promote the use of ETRS89 within member states.**

**Promotion of the adoption of ETRS89 by the National Mapping and Cadastral Agencies**

**Adoption of ETRS89 by Eurocontrol**

# (3) EUREF-IP Real-Time Activities (EUREF-IP)

- **RTCM standard for transport of real-time GNSS data and information over Internet – NTRIP technology**
- **Guidelines developed for**
  - Reference stations
  - NTRIP Broadcasters
  - High-rate RINEX Data Centers


- **EUREF-IP Pilot Project turns into routine EPN service**
- **EPN data streams are received at central broadcaster which provides the users with access to the streams**
- **The RTCM/NTRIP standard is realized in most of GNSS receivers**

# The server www.euref-ip.net, running on Port 80 and 2101, operated by BKG

## Contributors to www.euref-ip.net/home

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5. Budapest University of Technology and Economics - Hungary (2)
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7. Czech Technical University CVUT - Czech Republic (1)
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33. National Land Survey - Sweden (3)
34. Ordnance Survey - United Kingdom (2)
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37. SAPOS Berlin - Germany (1)
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44. Telespazio S.p.A. - Italy (2)
45. TopoBreda - Portugal (1)
46. Universitat die Perugia - Italy (2)
47. University Padova - Italy (2)
48. University Rome La Sapienza - Italy (1)
49. VUGTK Geodetic Observatory Pecny - Czech Republic (1)

**Total: 94 Streams**

## Contributors to www.igs-ip.net/home

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15. Florida International University Miami - U.S.A. (1)
16. GOP Research Insitute of Geodesy Topography and Cartographie - Czech Republic (1)
17. GPS Solutions Inc. - U.S.A. (1)
18. Geodetic Institute University Warszawa - Poland (1)
19. Geoinformatics Center Asian Institute of Technology - Thailand (1)
20. Geoscience Australia - Australia (23)
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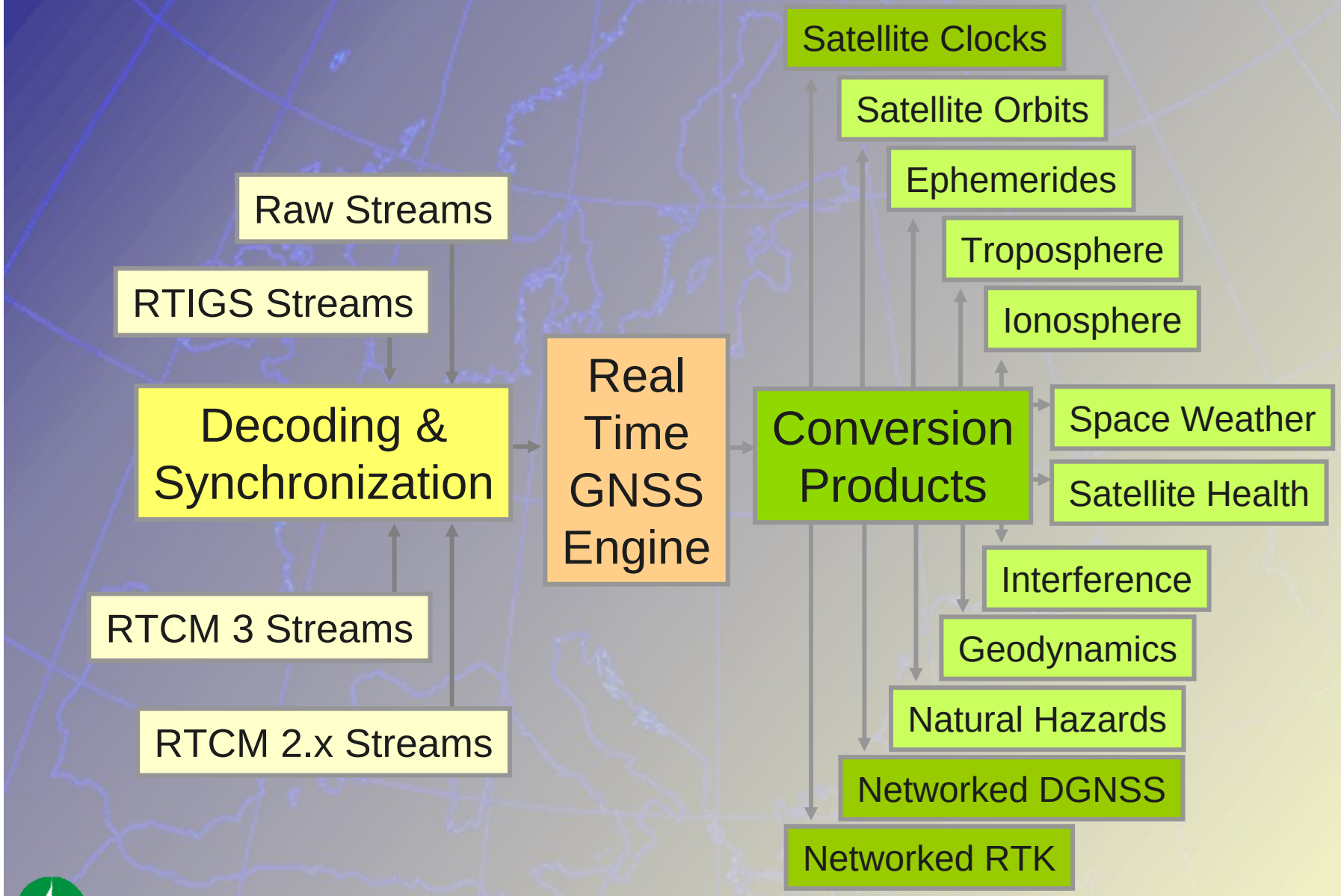
34. Regional Centre for Mapping of Resources for Development - Kenya (1)
35. Royal Observatory - Belgium (1)
36. Scripps Orbit and Permanent Array Center - U.S.A. (1)
37. Solucoes em Posicionamento Global SPG - Brazil (1)
38. Standard Instrument Corporation - Taiwan (1)
39. Survey Research Institute HARAM SRI - Egypt (1)
40. Surveys and Mapping - South Africa (2)
41. SwissTopo - Switzerland (1)
42. Technical University Prague - Czech Republic (4)
43. Universidade Estadual Paulista UNESP/FCT - Brazil (4)
44. Universidade da Baira Interior UBI/CGUL/IDL - Portugal (1)
45. University New South Wales - Australia (1)
46. University Padova - Italy (2)
47. University of New Brunswick - Canada (2)

**Total: 116 Streams**

# EUREF Real-Time GNSS Product Area



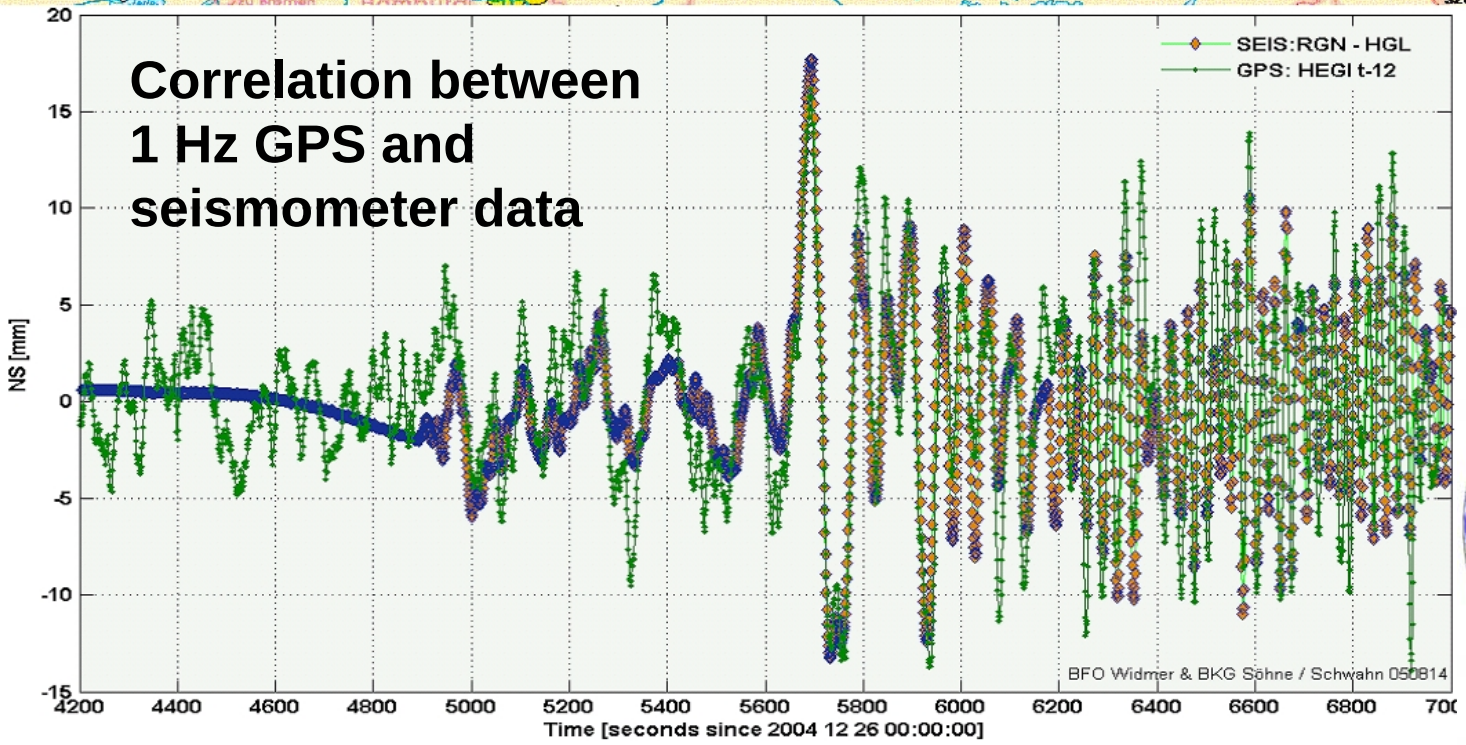
# Example: GNSS RT Application for Geohazard Monitoring

Bundesamt für Kartographie und Geodäsie

**The Love wave caused by the Sumatra-Andaman earthquake has reached Germany approx. 5530 seconds since 00:00:00 UTC, Dec 26, 2004 from the East direction after a travel time of approx. 2000 seconds.**

**IGS station Helgoland**


**1 Hz GPS data, Bernese Software 5.0, kinematic mode**




# (4) Special Projects
## European Combined Geodetic Network


Bundesamt für Kartographie und Geodäsie

## European Geodetic Network contribution to GGOS

- 21 countries
- 74 stations with

  - GNSS (EPN)
  - absolut gravity
  - levelling to EVRS
  - 6 super coducting grav.
  - 15 tide gauges

  - 8 ECGN core
  - 42 ECGN
  - 7 candidate
  - 15 proposed

**Status and Techniques** (Standard: GPS, absolute gravity, levelling)

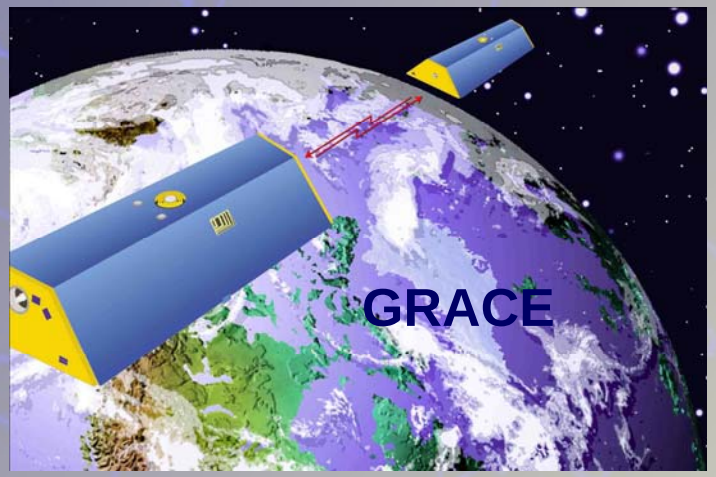
| | | | |
|---|---|---|---|
| core station | ● | super conducting gravimeter | ○ |
| station | ● | tide gauge | △ |
| candidate station | ■ | | |
| proposed station | ✦ | | |

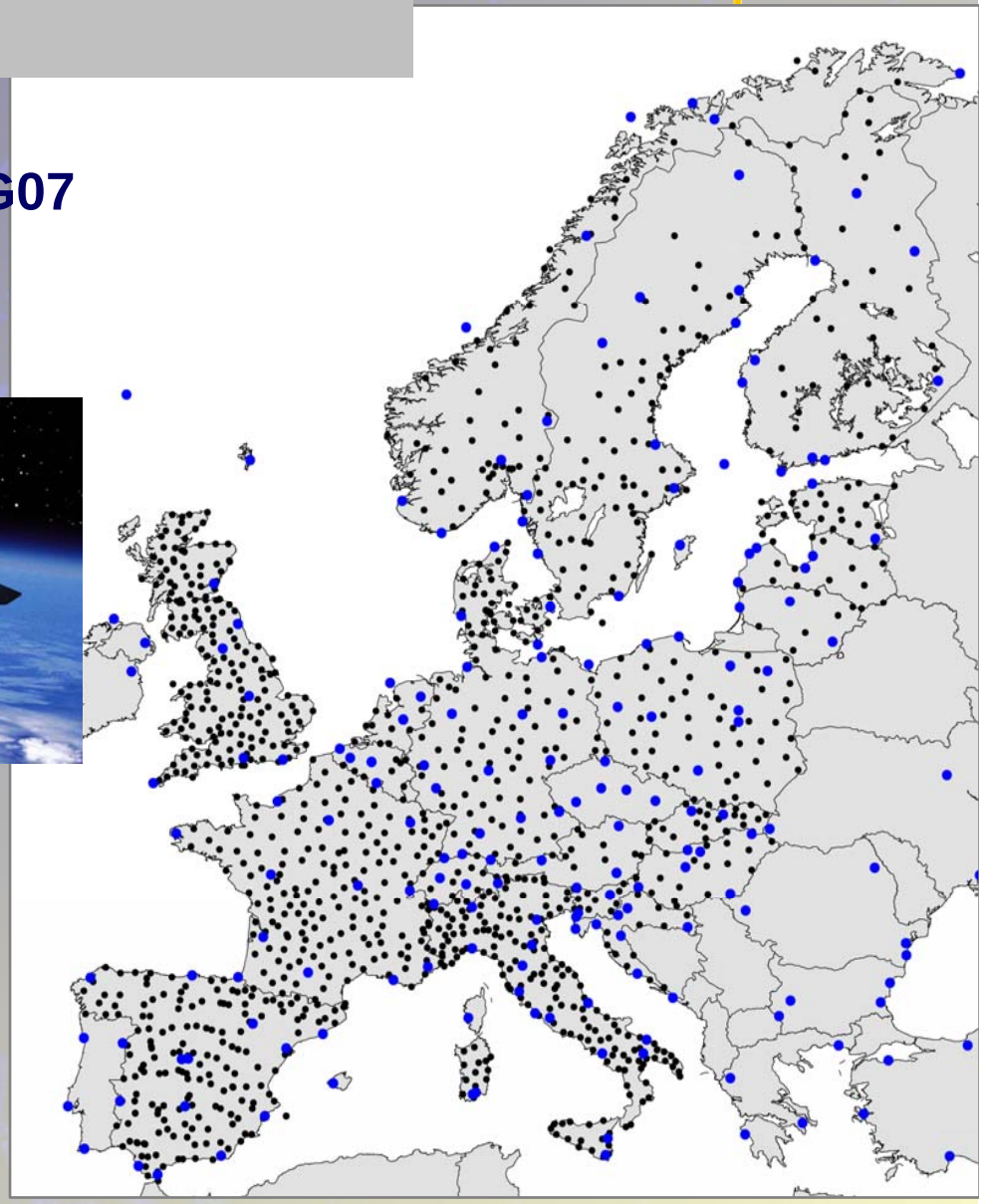
# EUVN Densification Action (EUVN_DA)
# 1200 GNSS/levelling points

Bundesamt für Kartographie und Geodäsie

- GPS/levelling control data for European geoid determination EGG07
- Disturbance potential values of the Earth gravity field for validation of





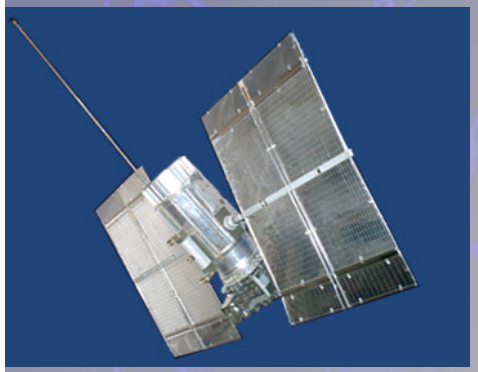
# GLONASS & GALILEO

Bundesamt für Kartographie und Geodäsie

**EPN is extending combined GPS/ GLONASS stations**

**IGS orbit determination**

- CODE (AIUB, swisstopo, BKG)
- ESOC
- BKG



**Development of the GALILEO Terrestrial Reference Frame (GTRF) in alignment to ITRF 3cm**

**GGSP Consortium: GALILEO Geodetic Service Provider Prototype**

GSA

GFZ POTSDAM

ESOC OPERATIONS CENTRE FOR THE EUROPEAN SPACE AGENCY

ggsp

IGN INSTITUT GEOGRAPHIQUE NATIONAL

bkg

AIUB Astronomisches Institut der Universität Bern

WUHAN UNIVERSITY

Natural Resources Canada | Ressources naturelles Canada

# (5) EUREF Contributions to ICG

Bundesamt für Kartographie und Geodäsie

- **Assistance in developing standards for monitoring GNSS networks (NTRIP, EUREF-IP)**
- **Development of GNSS real-time applications in geodynamics**
- **Support for Site Quality, Integrity and Interference Monitoring in real time and post-processing mode**
- **Adding knowledge how to support AFREF**
- **Organization of communication between ICG and the linked institutions of the EUREF community**



# Summary

Bundesamt für Kartographie und Geodäsie

**EUREF is the key organization for the support of the geodetic GNSS ground based infra-structure in Europe - GNSS, Height and Gravity reference frames -**

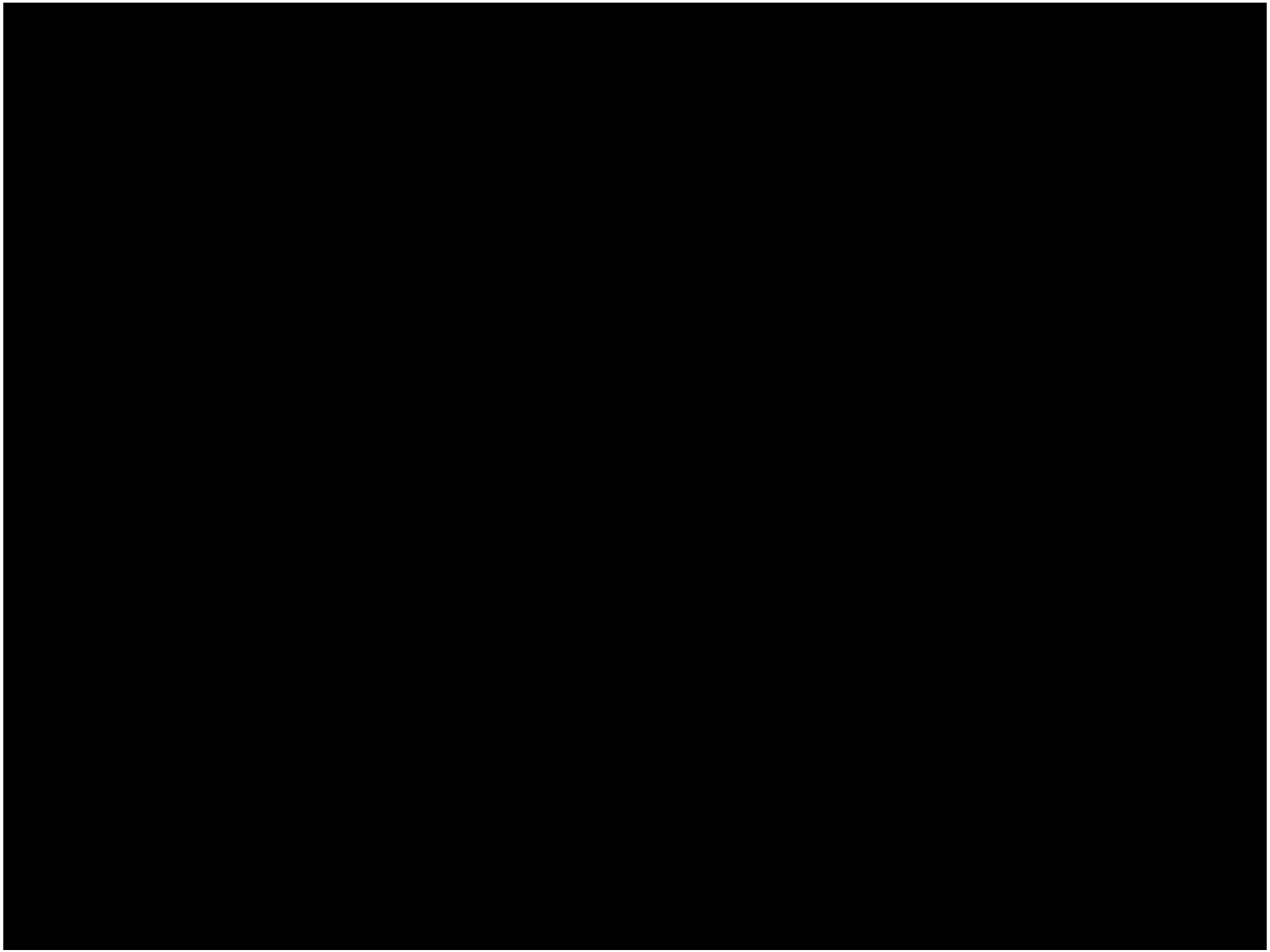
- **EUREF supports the IAG (IGS, GGOS, …) items in EUROPE**
- **EUREF takes over geodetic tasks of EuroGeographics – the European legal entity of 49 European NMCA's in 42 states**
- **EUREF will certainly be an important partner in the implementation of INSPIRE (EC), GGOS (IAG), GEOSS (GEO)**

**www.euref-iag.net**

**www.euref.eu**

# Thank you for your attention!

euref 2007 London



# Addendum

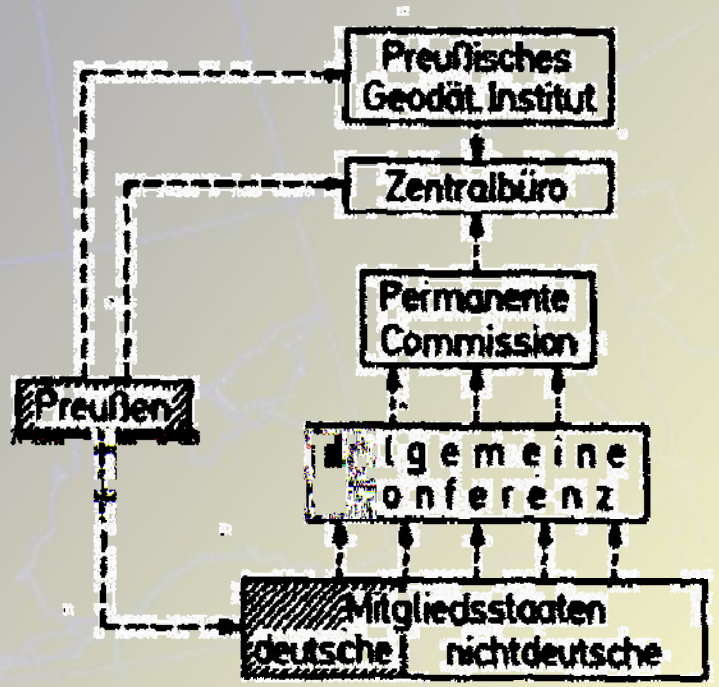
**Is there a need for the creation of a legal basis for International Geodetic Reference Systems?**

**Through an International Treaty prepared by ICG?**

**Foundation of IAG is the creation of the "Mitteleuropäische Gradmessung" 1862,**

**changed in "Internationale Erdmessung" in 1889,**

**on the basis of an International Treaty between Prussia and German and Non-German member states.**




**Closed 1917**

**Continued 1932 through foundation of IAG as non-gouvermental organisation**