Current Status of EPOS GNSS Working Group

Rui Fernandes
on behalf of WG4 members
# Current Status

## WG4 Composition

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Official ROLE within WG4</th>
<th>Country</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rui</td>
<td>Fernandes</td>
<td>WG Chair</td>
<td>PORTUGAL</td>
<td>SEGAL (UBI/IDL)</td>
</tr>
<tr>
<td>Luisa</td>
<td>Bastos</td>
<td>WG co-Chair</td>
<td>PORTUGAL</td>
<td>FC UP</td>
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<tr>
<td>Carine</td>
<td>Bruyninx</td>
<td>WG co-Chair</td>
<td>BELGIUM</td>
<td>ROB</td>
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<tr>
<td>Nicola</td>
<td>D'Agostino</td>
<td>WG co-Chair</td>
<td>ITALY</td>
<td>INGV</td>
</tr>
<tr>
<td>Jan</td>
<td>Dousa</td>
<td>WG co-Chair</td>
<td>CZECH REPUBLIC</td>
<td>Geodetic Observatory Pecny</td>
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<tr>
<td>Athanassios</td>
<td>Ganas</td>
<td>WG co-Chair</td>
<td>GREECE</td>
<td>NOA</td>
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<td>Martin</td>
<td>Lidberg</td>
<td>WG co-Chair</td>
<td>SWEDEN</td>
<td>LM</td>
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<tr>
<td>Andrzei</td>
<td>Araszkiewicz</td>
<td>WG Member (National Representative)</td>
<td>POLAND</td>
<td>Military University of Technology</td>
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<tr>
<td>Matthias</td>
<td>Becker</td>
<td>WG Member (National Representative)</td>
<td>GERMANY</td>
<td>TU Darmstadt</td>
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<tr>
<td>Richard</td>
<td>Bingley</td>
<td>WG Member (National Representative)</td>
<td>UNITED KINGDOM</td>
<td>University of Nottingham</td>
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<tr>
<td>Rahsan</td>
<td>Cakmak</td>
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<td>TURKEY</td>
<td>TUBITAK MAM</td>
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<tr>
<td>Mary</td>
<td>Carter</td>
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<td>GSI</td>
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<td>Mariusz</td>
<td>Figurski</td>
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<td>Jorge</td>
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<td>Halfdan</td>
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<td>Shfaqat</td>
<td>Khan</td>
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<td>DTU-Space</td>
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<td>Alexandra</td>
<td>Muntean</td>
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<td>NIEP</td>
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<td>VEDUR</td>
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<td>Giulio</td>
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<td>Gunter</td>
<td>Stangl</td>
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<td>AUSTRIA</td>
<td>IWF</td>
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<tr>
<td>Bojan</td>
<td>Stopar</td>
<td>WG Member (National Representative)</td>
<td>SLOVENIA</td>
<td>University of Ljubljana</td>
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<tr>
<td>Hans</td>
<td>van der Marel</td>
<td>WG Member (National Representative)</td>
<td>NETHERLANDS</td>
<td>Delft University of Technology</td>
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<tr>
<td>Andrea</td>
<td>Waldersdorf</td>
<td>WG Member (National Representative)</td>
<td>FRANCE</td>
<td>University of Grenoble</td>
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<tr>
<td>Caporali</td>
<td>Alessandro</td>
<td>WG Member (GNSS)</td>
<td>ITALY</td>
<td>Univ. Of Padova</td>
</tr>
<tr>
<td>David</td>
<td>Zuliani</td>
<td>WG Member (GNSS)</td>
<td>ITALY</td>
<td>INOGS</td>
</tr>
<tr>
<td>Olivier</td>
<td>Francis</td>
<td>WG Member (Gravity)</td>
<td>LUXEMBOURG</td>
<td>UNILU</td>
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<tr>
<td>Sylvain</td>
<td>Bonvalot</td>
<td>WG Member (Gravity)</td>
<td>FRANCE</td>
<td>BGI</td>
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<tr>
<td>Jonathan</td>
<td>Jones</td>
<td>WG Member (Meteo)</td>
<td>UNITED KINGDOM</td>
<td>Meteo UK</td>
</tr>
<tr>
<td>Artur</td>
<td>Rocha</td>
<td>WG Member (WG7)</td>
<td>PORTUGAL</td>
<td>INESC-P</td>
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</tbody>
</table>

**EUREF2014, Vilnius, Lithuania, European Union, 04 June 2014**
EPOS a long term integration plan of research infrastructures for solid Earth Science in Europe

Preparatory Phase Project

www.epos-eu.org

Massimo Cocco
epos@ingv.it
What is EPOS?

• It is an ESFRI project (Preparatory Phase)
  • (European Strategic Forum on Research Infrastructures)

• It aims at integrating existing RIs for solid Earth
  • Supporting construction/implementation of community data centers
  • Building core services for different stakeholders

• It aims at creating the governance structure to manage this distributed RI and its services to users

• It aims at building a legal body to secure funds for maintaining RIs for solid Earth science
EPOS PP Mission

- The European Plate Observing System (EPOS) is a long-term integrated research infrastructure plan to promote innovative approaches for a better understanding of the physical processes controlling earthquakes, volcanic eruptions, unrest episodes and tsunamis as well as those driving tectonics and Earth surface dynamics.

- The EPOS plan aims at integrating the currently scattered, but highly advanced European facilities into one, distributed, but coherent multidisciplinary Research Infrastructure (RI) taking full advantage of new e-science opportunities.

EPOS PP Timeline
EPOS: the Partnership

Who?

20 partners for 18 countries

6 associate partners for 5 countries

On going initiatives for integrating the partnership: Bulgaria, Belgium, Russia, .....
Sociedade de Geografia de Lisboa, 14 January 2008

EUREF2014, Vilnius, Lithuania, European Union, 04 June 2014

Functional Architecture

EPOS INTEGRATED CORE SERVICES

EPOS PORTAL

API

METADATA CATALOGUE
SYSTEM MANAGER
SERVICES

COMPATIBILITY LAYER

XML SEISMOLOGICAL SERVICES
GSAC XML SERVICES
SUPERSITES SERVICES
INDUCED S. CERIF XML

THEMATIC CORE SERVICES

SEISMIC DATACENTRES
GPS DATACENTRES
SUPERSITES INFRASTRUCTURES
INDUCED SEISMICITY DATACENTRES

DISTRIBUTED ICS

Compatibility Layer is the TCS-ICS Interface and it guarantees integration & interoperability.
Background to Geodesy in EPOS

WG4 – “GNSS Data and Other Geodetic Data” is the Working Group of the EPOS project in charge of defining and preparing the integration of the existing Pan-European Geodetic Infrastructures that will support the European Geosciences. It is open to the entire geodetic community. In fact, WG4 also includes members from countries that formally are not part of the current phase of EPOS.

Focus on cGNSS (continuous GNSS) as a start but open to include other geodetic data in the future (there are current efforts focused on gravity data).
Access to Data Products (Taxonomy)

- Level 0: raw data, or basic data
- Level 1: data products coming from nearly automated procedures
- Level 2: data products resulting by scientists’ investigations
- Level 3: integrated data products coming from complex analyses or community shared products
- Level 4: Software, IT tools
EPOS Database (RIDE)

MAP OF:
- Seismic/GPS stations
- Laboratories
- etc....

Diversity in data type and formats

http://www.epos-eu.org/ride/

Research Infrastructure List

- 244 Research Infrastructures
- 138 Institutions
- 22 countries
- 2272 GPS receivers
- 4939 seismic stations
- 464 TB Seismic data
- 1.095 PB Storage capacity
- 828 instruments in 118 Laboratories
About 2200 cGNSS stations, managed by 49 research infrastructures (RI), potentially available for EPOS.
Scientific applications of GNSS data for the EPOS community

<table>
<thead>
<tr>
<th>Application</th>
<th>Data need</th>
<th>Existing projects</th>
<th>EPOS added value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tectonics</td>
<td>30s, daily</td>
<td>...</td>
<td>Dense velocity field</td>
</tr>
<tr>
<td><strong>GNSS-seismology</strong></td>
<td>1Hz, sub-hourly &gt;= 1Hz, real-time (GNSS seismometer)</td>
<td></td>
<td>&gt;1Hz real-time processing, Collocation with seismometers</td>
</tr>
<tr>
<td>GIA</td>
<td>30s, daily</td>
<td></td>
<td>Densification</td>
</tr>
<tr>
<td>Sea-level change</td>
<td>30s, daily</td>
<td>IGS TIGA, SONEL</td>
<td>Collocation with tide gauges,</td>
</tr>
<tr>
<td>Loadings</td>
<td>30s, daily (global)</td>
<td></td>
<td>Densification</td>
</tr>
<tr>
<td></td>
<td>1Hz, sub-hourly (storm surge)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=1Hz, real-time (storm surge)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early warning systems</td>
<td>&gt;=1Hz, real-time</td>
<td></td>
<td>&gt;1Hz real-time processing</td>
</tr>
</tbody>
</table>
Scientific application of GNSS data for other communities

<table>
<thead>
<tr>
<th>Application</th>
<th>Data need</th>
<th>Existing projects</th>
<th>EPOS added value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference frame</td>
<td>30s, daily</td>
<td>EUREF</td>
<td>National level</td>
</tr>
<tr>
<td>Meteorology</td>
<td>30s, hourly (forecasting) 1Hz, sub-hourly (now-casting) &gt;=1Hz, real-time (now-casting)</td>
<td>E-GVAP, COST</td>
<td>Unique access to a common dataset, additional collocations with met sensors, ...</td>
</tr>
<tr>
<td>Climate change</td>
<td>30s, daily</td>
<td></td>
<td>Data density, homogeneity in long-term processing, collocations</td>
</tr>
<tr>
<td>Space weather</td>
<td>30s, hourly (forecasting) 1Hz, sub-hourly (scintillations) &gt;=1Hz, real-time (scintillations)</td>
<td></td>
<td>Densification</td>
</tr>
</tbody>
</table>
GNSS-related European projects

EUREF – European Reference Frame

EPOS aims to deeply cooperate with EUREF in order to benefit from the experience constructed in the last decades.
Other GNSS-related European projects

E-GVAP - *EUMETNET EIG GNSS water vapour programme*

Use of many networks installed for surveying at national and regional level.
GNSS-related European projects – Solid Earth
National Level

And many other national projects dedicated to geodynamics:
- Greece, Turkey, Portugal, etc...

Unfortunately, most of them without public data access.
# European GNSS projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Value to EPOS</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Networks for Solid Earth        | - Natural candidates to contribute to EPOS  
- Use of highest standards for monument setup and data quality control (although no uniform and coordinated effort).                                    | - Many of these networks are not public available  
- Most are project based (time limited).                                                                                                          |
| EUREF                           | - Established as top European forum concerning reference frames. Support of national mapping agencies (main GNSS providers in Europe) and also academia.  
- Dissemination of high standards (close to geodynamics) for monument setup and data quality control.                                               | - Volunteer basis.                                                                        |
| TIGA SONEL                      | - Definition of vertical data and variations on sea and land by linking both the tide gauge and the GNSS databases                                                                                             | - Superposition with EPN sites.                                                          |
| E-GVAP Surveying Networks       | - Very dense networks in most of Europe.  
- Access to much more RTK data                                                                                                                    | - Many stations with unknown quality and difficulties to manage their metadata.          |
Thematic Services (TCS)

- Governance
- Data Products
- Services

WG1 - Seismology
WG2 - Volcanology
WG3 – Geological Data
WG4 – GNSS Data
WG6 – Analytical and Experimental Laboratories
WG8 – Satellite Data
WG9 – Geomagnetic Observ.
WG10 - Infrastructures for Georesources
EPOS Board of Service Providers (all thematic & integrated service Board members)

EPOS Geodetic Products & Services (EGPS)

Steering Committee and Executive Committee

COORDINATION
(see next slide)

GNSS DATA DISSEMINATION & PRESERVATION

LEVEL 0
GNSS Observation and Meta-data from Permanent (and Campaign) Stations

Structure: Distributed (GSAC-like)
1 EPOS Data Gateway
National and Regional nodes.

Products:
- Observation data (streams and files).
- Meta-data (site logs, access conditions, QC, etc.) for all archived data.

Services:
- Seamless and redundant access to Level 0 data through GSAC derived web-services.
- Seamless storage and upload of Level 0 data.
- Conversion from RAW into international standard format (RINEX x.x).
- Checking of essential meta-data.

GNSS PRODUCTS

LEVEL 1,2,3
GNSS Data Analysis and Derived Products

Structure:
1 EPOS Product Gateway
National and Regional nodes.

Products:
- Real-time to post-processed positions
- Velocity Fields
  - Secular Motions
  - Periodical and no-periodical signals.
- Strain Fields

Services:
- Seamless and redundant access to Level 1,2,3 data through GSAC derived web-services
- Web-services for online GNSS data processing
- Repository of existing Level 1,2,3 data.

USER COMMUNITY SUPPORT

Support to GNSS activities for Solid Earth research

Structure: Centralized
1 node (EPOS-GNSS Center)

Products:
- Diffusion of best practices and tools.
- Support to Research projects (e.g., pool of instruments, installation support, data management)
- Realization of Scientific and Technical Courses.

DEVELOPMENT OF STANDARD TOOLS
(see next slide)

e-Geodesy & common services
Geodetic services for visualisation, discovery and access to portal expert groups, standards

EPOS Integrated Services
Visualisation tool / discovery & access portal
high performance and high end computing expert groups, standards
EPOS Geodetic Products & Services (EGPS)

**COORDINATION**

Coordination
(based on EUREF experience)

Structure: Centralized
1 node (EPOS-GNSS Center)

**Products:**
- EPOS Geodetic Web Portal:
  - gateway providing access to the geodetic data/products
  - gateway interacting with the EPOS ICS
- Guidelines & Standards

**Services**
- Day-to-Day Network Management & Coordination of Pillars.

**DEVELOPMENT OF STANDARD TOOLS**

Development and Maintenance of software tools in support of other pillars

Structure: Distributed

**Products:**
- Further Development of GSAC
- Further Development of online GNSS processing services
- Further Development of meta-data management tools
- Development of Interfaces between Pillars (e.g., QC tools)
- Development of Interfaces between Pillar 5 and ICS
- Development of Interfaces with existing services (e.g., EUREF)
- Visualization tools

**Services**
- Installation support

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Interaction with other Solid Earth Sciences

Collaboration with other working groups, namely:

- **Seismology (WG1)**
  - Data Standardization
  - GNSS Seismology

- **Volcanology (WG2)**
  - Volcano Instrumentation

- **Satellite Data (WG8)**
  - Co-localization with SAR

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EPOS Integrated Services

Geodetic services for visualisation, discovery and access to portal expert groups, standards

Visualisation tool / discovery & access portal high performance and high end computing expert groups, standards
Benefits of EPOS (for the Geodetic Community)

Formal organization of EPOS will be through “European Research Infrastructure Consortium, ERIC”. Usually countries are members, and RIs and services are included into EPOS through the contribution from each country.

When included in EPOS, there will be a firm commitment from the countries for long term support (and financing!)

EPOS strive to collect, preserve, and utilize all observations that potentially may contribute to scientific progress. Therefore much more stations and raw (RINEX) data are welcomed and asked for.

Data preservation, quality control, archiving and dissemination are priority services to be made available by EPOS WG4 in the near future.
GSAC – Geodetic Seamless ArChive
Data Dissemination

Currently, several WG4 members are already implementing GSAC services in cooperation with UNAVCO:
- Italy, Portugal, Greece, Iceland, France, Belgium
Latest news (03 June 2014)

http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=home

The Council acknowledges the prioritisation process for the implementation of the ESFRI roadmap

In its conclusions of 26th May 2014, the Council acknowledges the work done by ESFRI to identify priority projects which are mature enough to be under implementation in 2015-2016 and whose timely implementation is considered essential to extend the frontiers of knowledge in the fields concerned.

The Council confirms the Member States' commitment to focus their available national resources on the respective prioritised projects they are financially participating in and invites the Commission, under Horizon 2020, to complement the Member States' own financial commitments through a one-time financial contribution for the priority projects, and to financially support the other projects (preparation and implementation) identified by ESFRI and listed in the Annex.

- Council Conclusions of 26 May 2014
- Prioritisation of Support to ESFRI Projects for Implementation, ESFRI report, 7 April 2014 670 KB

The Commission is now in capacity to further define how the priority projects (listed below) will be supported in the framework of Horizon 2020 to develop new world-class research infrastructures. The first support action will be implemented under the call INFRADEV-3-2015: Individual implementation and operation of ESFRI projects, see work programme on Research infrastructures, page 9. A total budget of about 90 million € will be allocated to this action.

Prioritisation of Support to ESFRI Projects for Implementation (ANNEX to Council Conclusion of 26 May 2014)

1. Three Priority Projects for implementation
   - EPOS: European Plate Observing System
   - ELIXIR: The European Life-Science Infrastructure for Biological Information
   - ESS: The European Spallation Source
EPOS: European Plate Observing System

What
The European Plate Observing System (EPOS) is the integrated solid Earth Sciences research infrastructure approved by the European Strategy Forum on Research Infrastructures (ESFRI) and included in the ESFRI Roadmap in December 2008. EPOS is a long-term integration plan of national existing RIs.

Thank You