EPOS PP

European Plate Observing System | FP7 Preparatory Phase Project

Towards an effective integration of GNSS data in Europe:

EPOS vision and strategic approach

*Massimo Cocco, **Daniele Bailo** and the EPOS Consortium*

www.epos-eu.org

EUREF 2013

EPOS EUROPEANPLATEOBSERVINGSYSTEM

OUTLINE

PART1: What is EPOS?

Mission, community, EPOS framework.

PART2: Data integration plan

ICT architecture, models, metadata, functional architecture

PART1

What is EPOS?

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

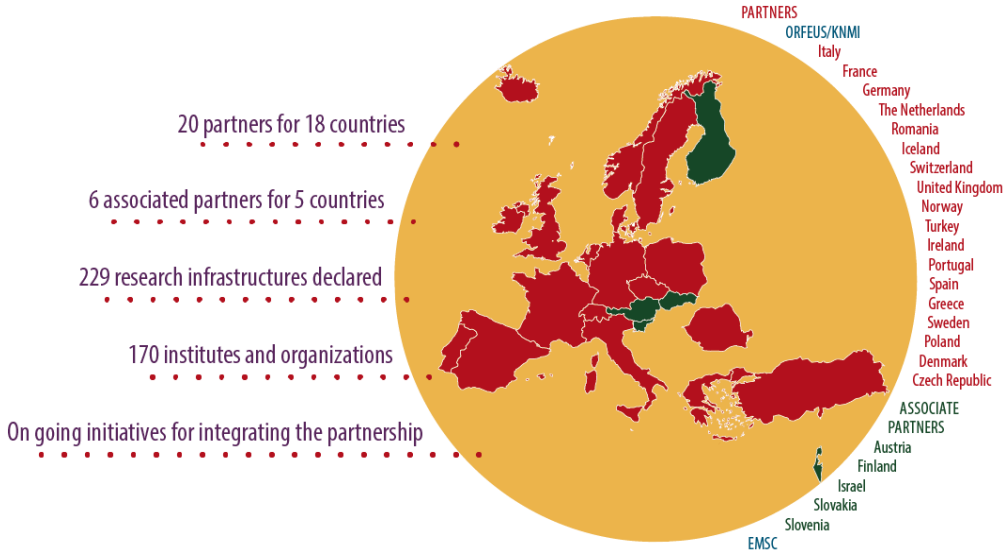
EPOS PP Mission

- 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
- EPOS aims at integrating the **existing advanced European facilities** into **one**, distributed **multidisciplinary Research Infrastructure** (RI) taking full advantage of new e-science opportunities
- The EPOS RI will allow geoscientists to study the causative processes acting from **10^{-3} s to 10^{6} years** and from **μm to 10^{3} km**

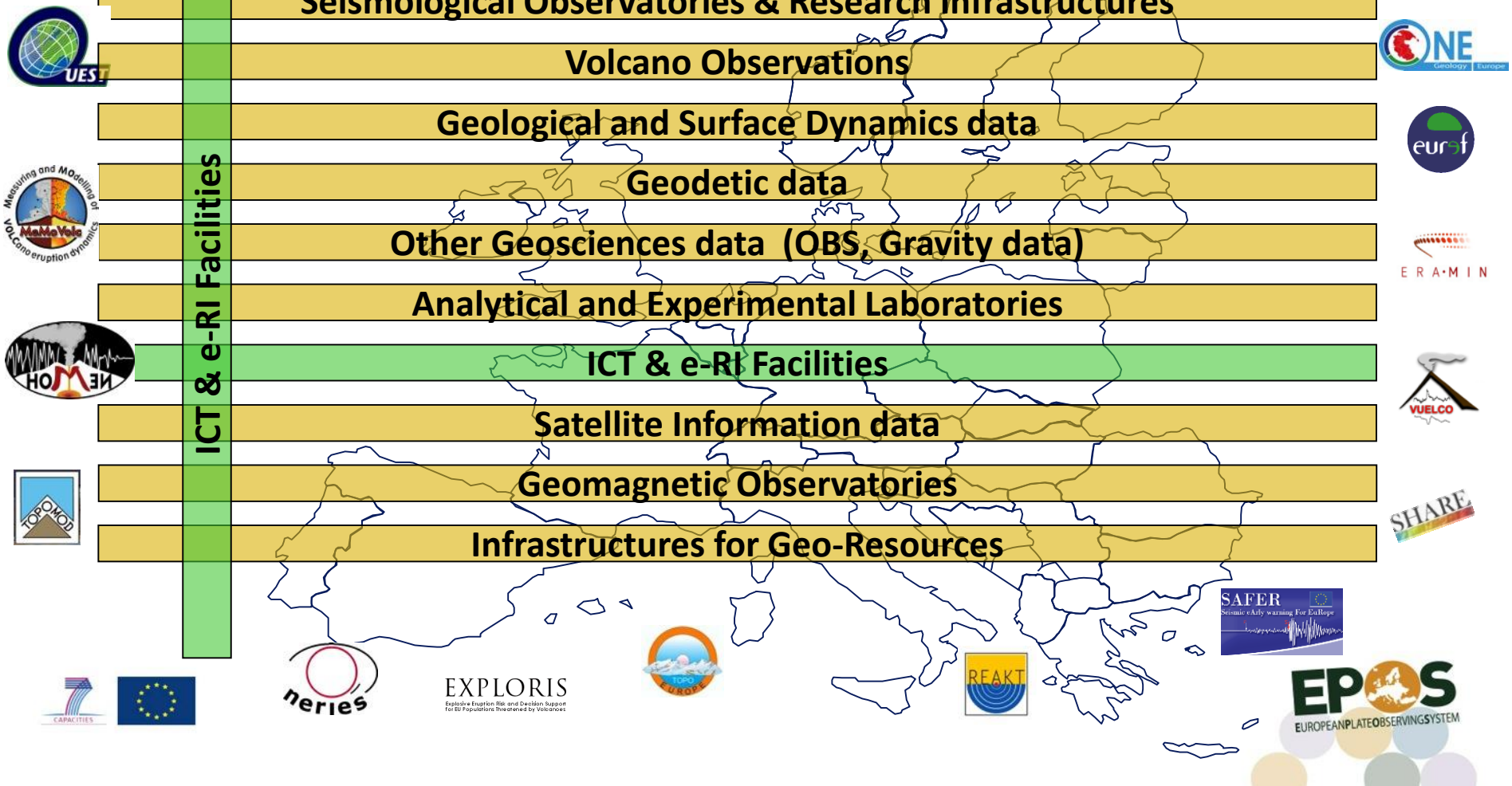
EPOS PP Timeline

mid-way through the PP

www.epos-eu.org



EPOS Framework



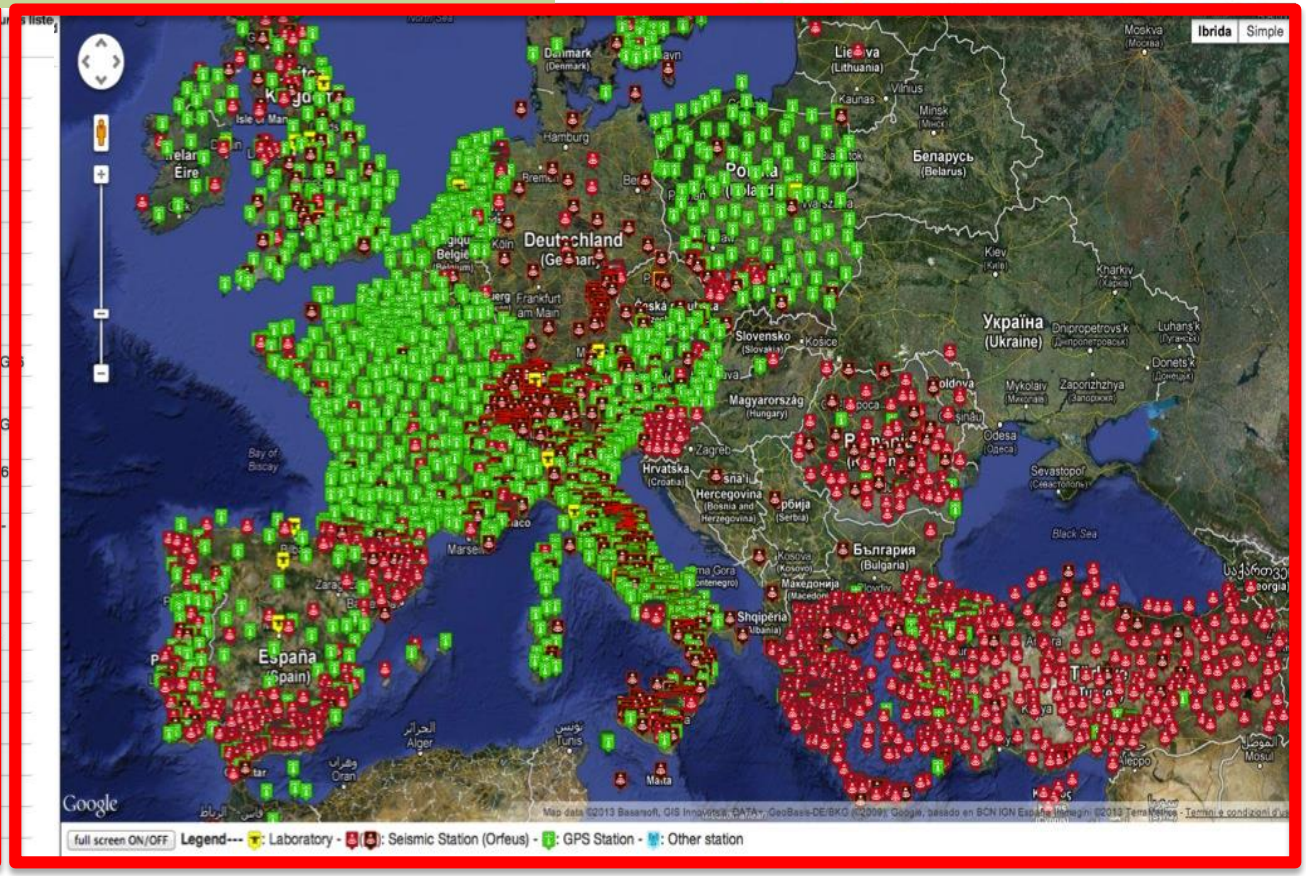
EPOS Contents

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

MAP OF:
- GPS stations
-Laboratories
--...

Research Infrastructure List

- **226 Research Infrastructures**
- **1658 GPS receivers (out of 2500)**
- **2517 seismic stations**
- **385 TB Seismic data**
- **913 TB Storage capacity**
- **109 storage data centers**
- **512 instruments in laboratories**



Present status of the PP project

EPOS Roadmap

Identification

- Data providers & users
- Legal & Governance models
- Costs & sustainability

Technical & financial requirements

Done

May 2012

Design

- Data infrastructures
- Core Services & architecture
- Governance & Legal structure

Promotion & participation

We are here

July 2013

Validation & Testing

- Assess operability & prototype (services)
- Elaborate a funding model
- Draft Statute

May 2014

Delivery

- Operational Prototype of Core Services
- Implementation plan for construction

EPOS KEYWORDS

- **Integration** of the existing national and trans-national RIs
- **Interoperability** of thematic services for a multidisciplinary community of users
- **Open access** to a multidisciplinary research infrastructure for promoting cross-disciplinary research
- **Progress in Science** by providing prompt and continuous availability of high quality data and the means to process and interpret them
- Data infrastructures and novel core services, which will contribute to **information**, **dissemination**, **education** and **training**.
- **Implementation** plans, which require strategic investment in research infrastructures at national and international levels.
- **Societal** contributions: hazard assessment and risk mitigation

EPOS Open Access Policies

- **Data and facilities owned by National RIs**
- **No requirements for a pricing** policy has been identified
- **Open Access to**:
  - Freely available data in real time or with some time delay
  - Data available without charge to specific users or for specified purposes
- **Access rules**: authentication will be required including statements on purpose of using data
- **Data Licensing:** Creative Commons (CC-BY-NC) wherever possible
- **Access to metadata** allowing discovery of other relevant data
- **Access to facilities** under equitable rules (details under discussion)
- **Services and software available** under CC licensing

EPOS Achievements

- **ERIC** has been chosen as the legal model for EPOS
- **Governance** model has been designed and approved by the Council
- **Data Policies & IPR** are presently under discussion
- **Financial Plan: cost assessment** completed and presently under revision
- **Business Plan** implementation organized

EPOS Stakeholders

1. **Data and service providers from the Earth science community**
   - ✧ **National data and service providers**
   - ✧ **International data and service providers (EUREF?)**
   - ✧ **Data products providers**
2. **Scientific user community**
   - ✧ **Researchers from the solid Earth sciences**
   - ✧ **Solid Earth science community projects**
   - ✧ Training and educational institutions, projects and initiatives
   - ✧ Researchers and organizations from outside the solid Earth science
3. **Governmental organizations & funding agencies**
   - ✧ **National governments**
   - ✧ Funding agencies
   - ✧ Civil protection authorities
   - ✧ European Commission
4. **Other data and service providers and users**
   - ✧ IT projects and experts
   - ✧ Industry
   - ✧ **Private data and service providers**

INVOLVEMENT

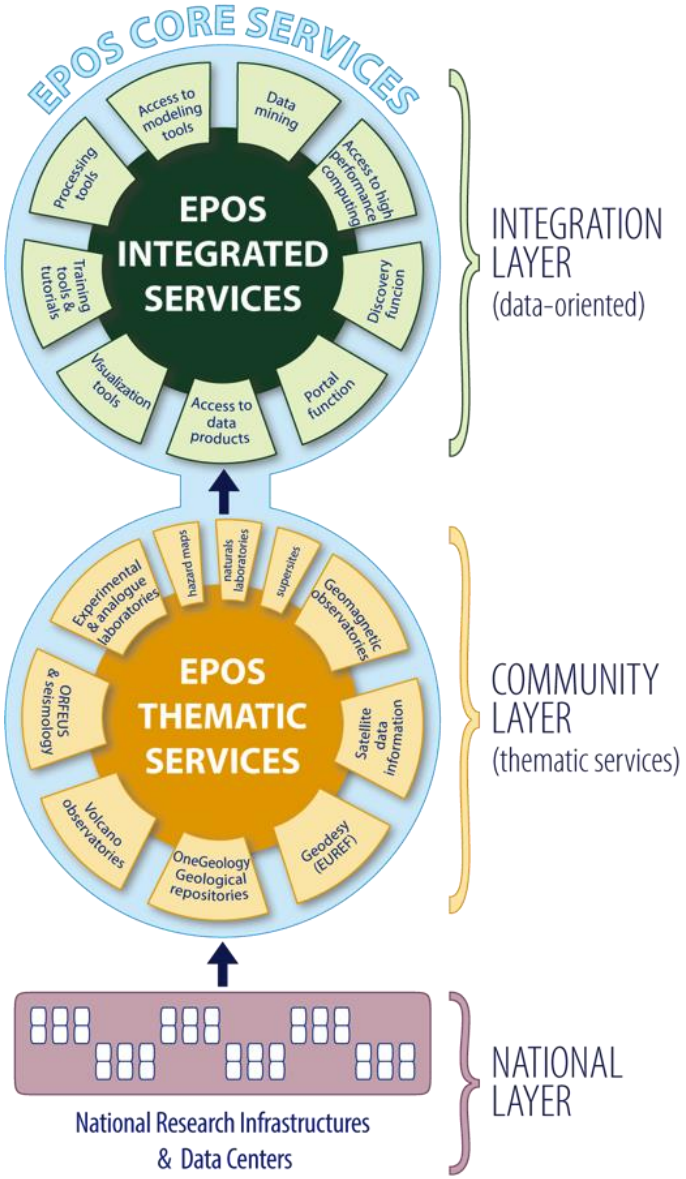
User Community

- Working Groups members ≈300
- Collaborative Area users 377
- Newsletter readers 480
- Potential EU users ≈ 10^4 – 10^5
- Potential global users: to be evaluated

PART2

Data integration plan

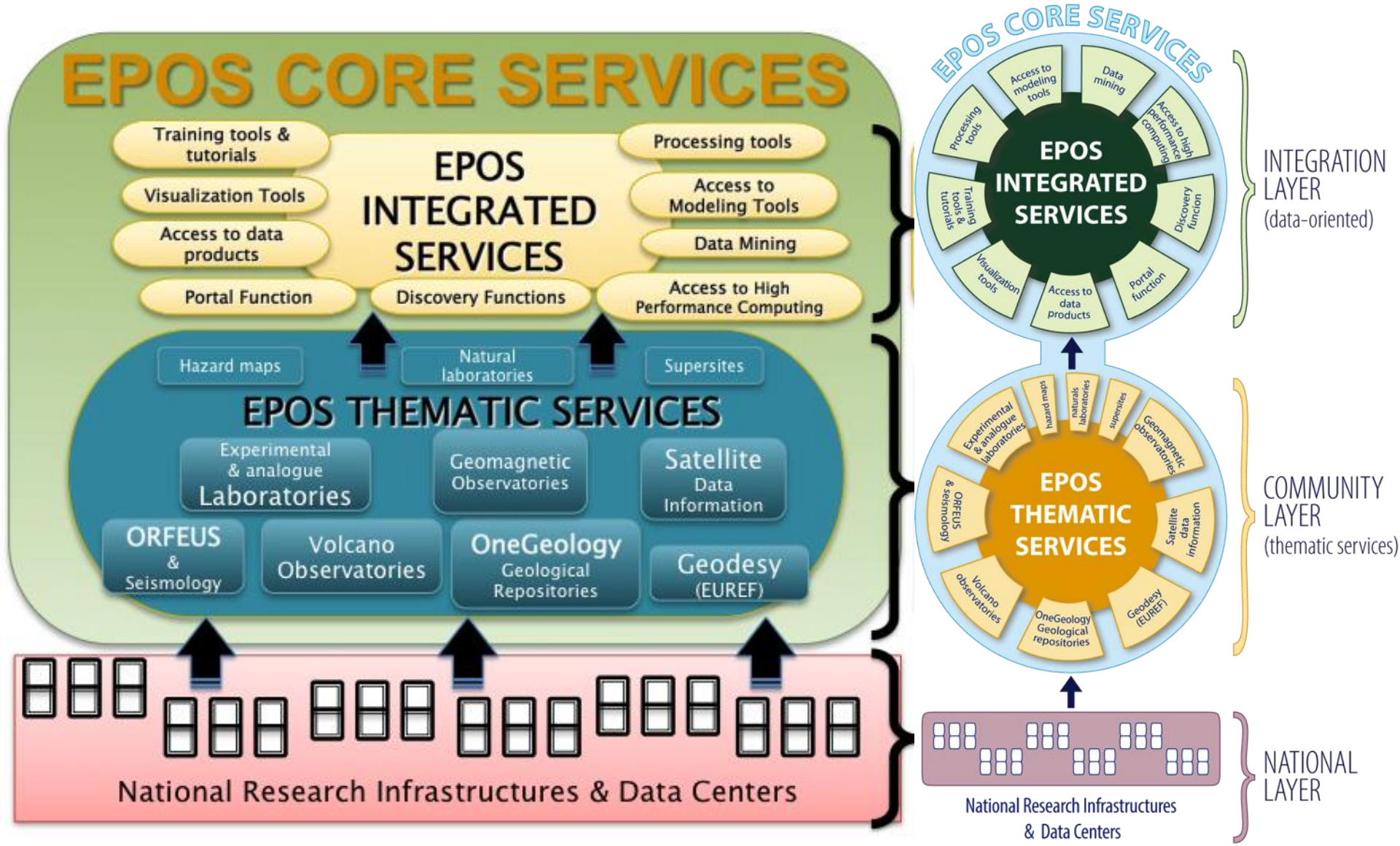
EPOS services



The **EPOS Integrated Core Services** will provide access to multidisciplinary data, data products, synthetic data from simulations, processing and visualization tools, ... Not just data access but EPOS means to **integrate**, **analyze**, **compare**, **interpret** and **present** data and information about **Solid Earth**

Thematic Core Services provide data services to specific communities (they can be international organizations, such as ORFEUS for seismology)

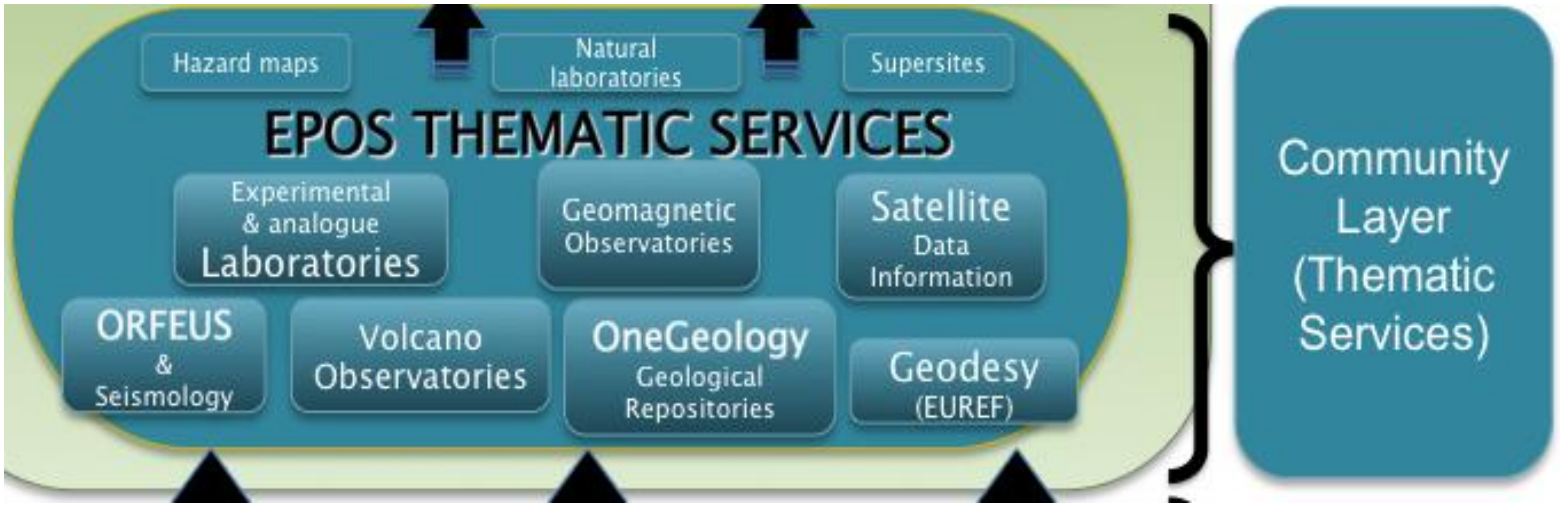
National Research Infrastructures and facilities provide services at national level and send data to the European thematic data infrastructures.


EPOS CORE SERVICES
Training tools & tutorials
Visualization Tools
Access to data products
Portal Function
EPOS INTEGRATED SERVICES
Processing tools
Access to Modeling Tools
Data Mining
Discovery Functions
Access to High Performance Computing
Hazard maps
Natural laboratories
Supersites
EPOS THEMATIC SERVICES
Experimental & analogue Laboratories
Geomagnetic Observatories
Satellite Data Information
ORFEUS & Seismology
Volcano Observatories
OneGeology Geological Repositories
Geodesy (EUREF)
National Research Infrastructures & Data Centers
EPOS CORE SERVICES
Access to modeling tools
Data mining
Access to high performance computing
Discovery funcion
Portal function
Access to data products
Visualization tools
Training tools & tutorials
Processing tools
EPOS INTEGRATED SERVICES
INTEGRATION LAYER
(data-oriented)
EPOS THEMATIC SERVICES
COMMUNITY LAYER
(thematic services)
National Research Infrastructures & Data Centers
NATIONAL LAYER

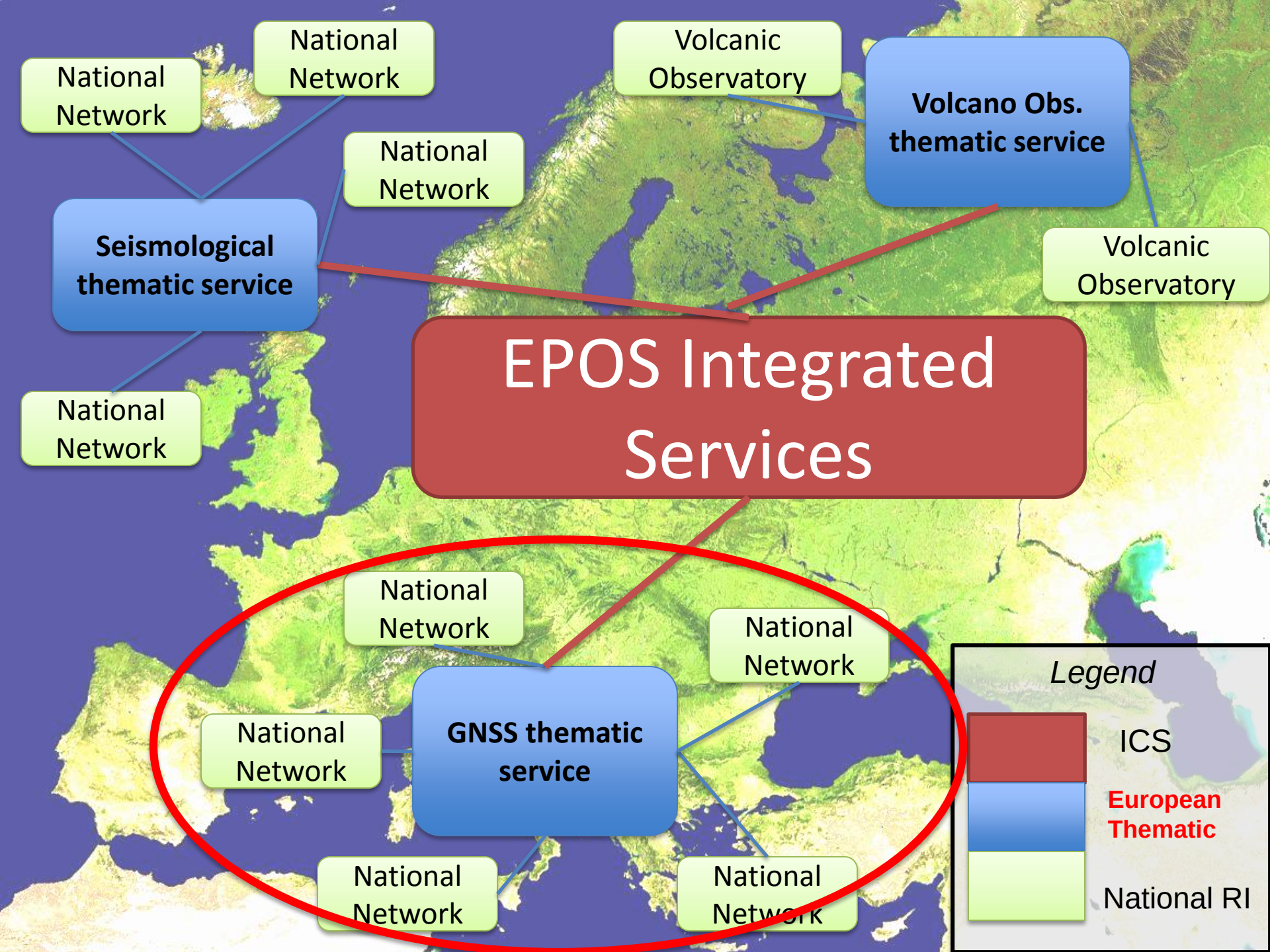
The Integration Layer/EPOS Integrated Services

- provide access to multidisciplinary data from the EPOS thematic services
- **provide access to data products, synthetic data from simulations, processing and visualization tool, and many more …**
- will serve science, industry, education, government, legal and other stakeholders in an integrated fashion through the EPOS User Interface
- consist of a variety of ICT technological services

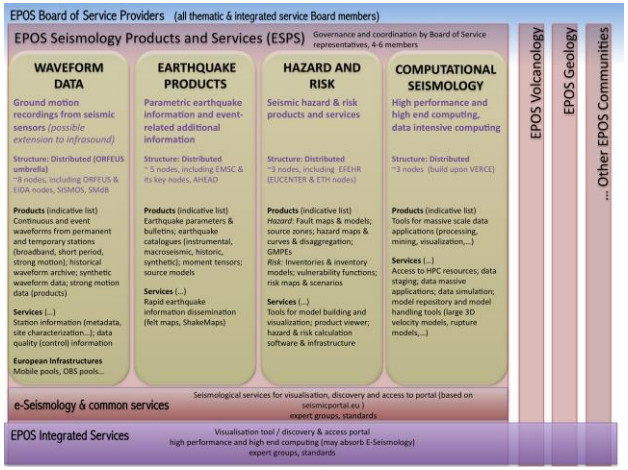
The Community Layer of Thematic Services



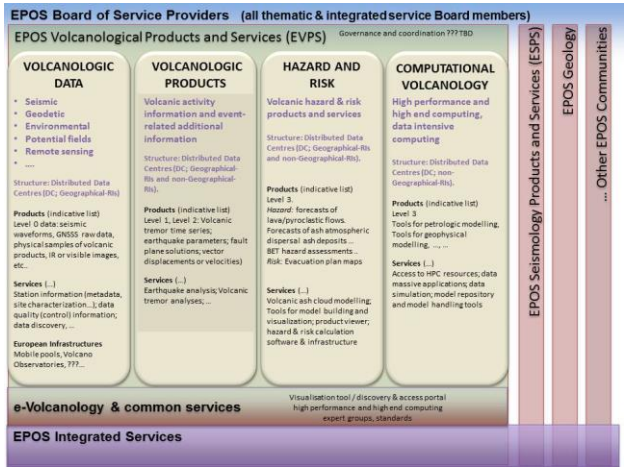
- provide data services to specific communities
- also link the National Research Infrastructures to the EPOS Integrated Services
- **consist of existing (e.g. ORFEUS), developing (e.g. EUREF/GNSS) or still to be developed Service**
- Integrated Laboratories, and RIs spanning multiple EPOS disciplines, will also be included in this layer


National Network
National Network
National Network
National Network
Volcanic Observatory
Volcano Obs. thematic service
Volcanic Observatory
Seismological thematic service
EPOS Integrated Services
National Network
National Network
National Network
GNSS thematic service
National Network
National Network
Legend
ICS
European Thematic
National RI

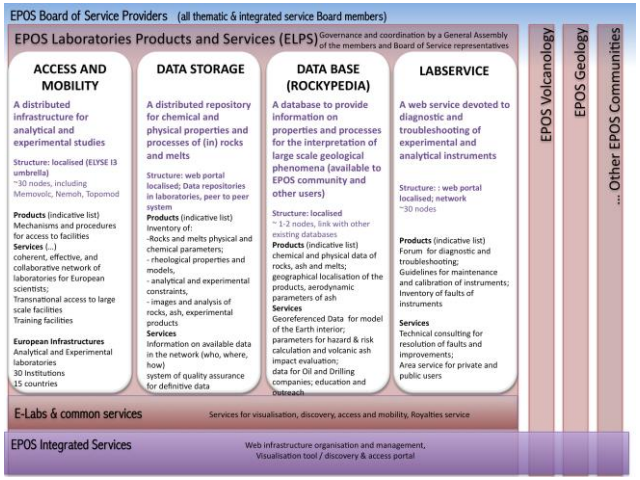
Thematic Services communities proposal



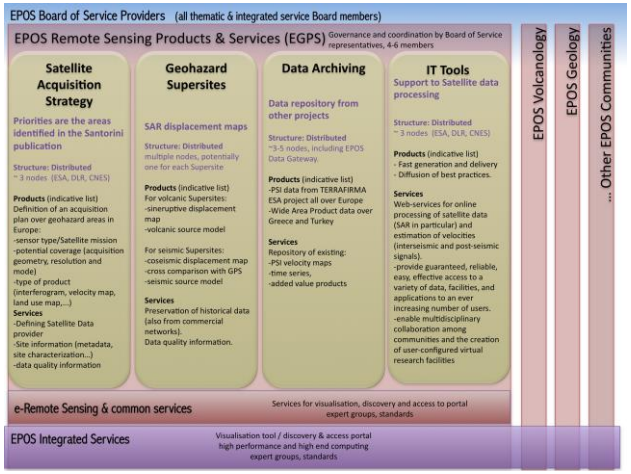
WG1 - seismology



WG2 - Volcanology



WG6 - Laboratories



WG8 – Satellite Data

EPOS Board of Service Providers (all thematic & integrated service Board members)

EPOS Geodetic Products & Services (EGPS)

Governance and coordination by Board of Service representatives, 4-6 members

GNSS DATA DISSEMINATION

RINEX and RTK (stream) data from Permanent Stations

Structure: Distributed (GSAC)
1 EPOS Data Gateway
~6-10 nodes, including EPN Data Centers.

Products (indicative list)
RINEX and RTK data from Permanent Stations:
- GNSS daily (30s), delay of max 1-2 days
- GNSS daily (30s), full history, archived
- GNSS hourly (30s)
- GNSS sub-hourly (1Hz)
- GNSS real-time (>=1Hz)

Services
GNSS Data provider (seamless access)
Station information (metadata, site characterization…); data quality information

GNSS DATA PRESERVATION & MONITORING

RAW and RINEX data from Permanent (and Campaign) Stations

Structure: Distributed
~2-3 nodes, including EPOS Data Gateway. (EUDAT initiative?)

Products (indicative list)
Historical RAW and RINEX data at different observation rates (in particular for >=1Hz).
Metadata for all archived data.
QC of data and metada.

Services
Preservation of historical data (also from commercial networks).
Data quality information.

GNSS ANALYSIS PRODUCTS

Derived from Daily and Kinematic Positions

Structure: Distributed
~3-5 nodes, including EPOS Data Gateway.

Products (indicative list)
Position Solutions.
Real-Time Position solutions (for warning systems).
Derived Velocity Fields (Secular Motions and other periodical and no-periodical signals).
Additional Products: ZTD & TEC

Services
Web-services for online processing of GNSS data and estimation of velocities (secular, co-seismic and post-seismic signals).
Repository of existing:
- time series,
- velocity fields,
- strain rate map,
- GPS derived seismic waveforms

GNSS INFRASTRUCTURE

Support to GNSS activities for Solid Earth research

Structure: Centralized
~1 node (EPOS-GNSS Center)

Products (indicative list)
- Quality Control including rapid analysis.
- Coordination.
- Diffusion of best practices.

Services
- Support to Research projects
- Support to installation of Permanent stations
- Realization of Scientific and Technical Courses

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 (may absorb E-Seismology)
expert groups, standards

EPOS Volcanology

EPOS Geology

Other EPOS Communities

UNDER DISCUSSION

UNAVCO – GSAC test

TEST sites:

INGV - Grotta Minarda

GSAC is:

- Federation of nodes
- Access all data from a single node

Candidate for Thematic Core Services

Technical features

1. web browser-based user interface for search and discovery
2. web services API
3. Downloading instrument data files
4. Command line cliend

Handles different format (SOPAC XML site logs, RINEX, GAMIT station.metadata, and more)

Data integration plan:

ICT Architecture

1. The models

Architecture: the models

Complete cohort of researchers, research managers, innovators, media

User Model — interaction with data, processing, persons

Processing Model — providing what the user requires

representing research — Data Model

representing ICT — Resource Model

Complete ICT environment for research

USE CASES

High Level Use Cases
(what the user is trying to achieve)

Medium level Use Cases
(steps to achieve)

ICT Requirements
(what the ICT system has to deliver)
functional and non-functional

High Level Use Case Examples

1. **There is geo-activity around Vesuvius**. Suggest when it will erupt and the consequences so that civil emergency planning can be prepared.
2. **An Icelandic volcano has started to erupt**. Predict the composition and movement of the ash and its effect on air travel.
3. **An insurance company offers building insurance**. What is the likelihood of geo-hazard in the area.

MEDIUM Level Use Case

UC: Realistic prediction of ground motion in a particular area based on available data and models

STEPS

1. **Discover** largest earthquakes in the area (From recent and historical catalogues)
2. **Retrieve** moment tensors (MT) of the earthquakesin 1.
3. **Retrieve** finite fault (if available) or extrapolate the fault finiteness using the available relationships between magnitude, mechanism and fault width, length and slip.
4. **Retrieve** macro seismic fields for the earthquakes in 1.
5. **Retrieve** shakemaps for the earthquakes in 1. for the different PGMs
6. **Retrieve** velocity structure
7. **Retrieve** geologic map of the target area
8. **Render** graphically model+geologic map+hypocenters using interactive 3D graphics
9. **Obtain and plot** the available waveform data
10. **Perform** waveform forward modeling for the earthquakes in 1. and MTs in 2.
11. **Calculate** misfit btw observed and calculated waveforms
12. **Modify** velocity model and redo steps 9. and 10.
13. If happy with match btw observed and synthetics, **plot** the PGMs on a map of the area
14. **Compare** calculated and observed shakemap.

MEDIUM Level Use Case

Extension of the use case to study the deformation of the area

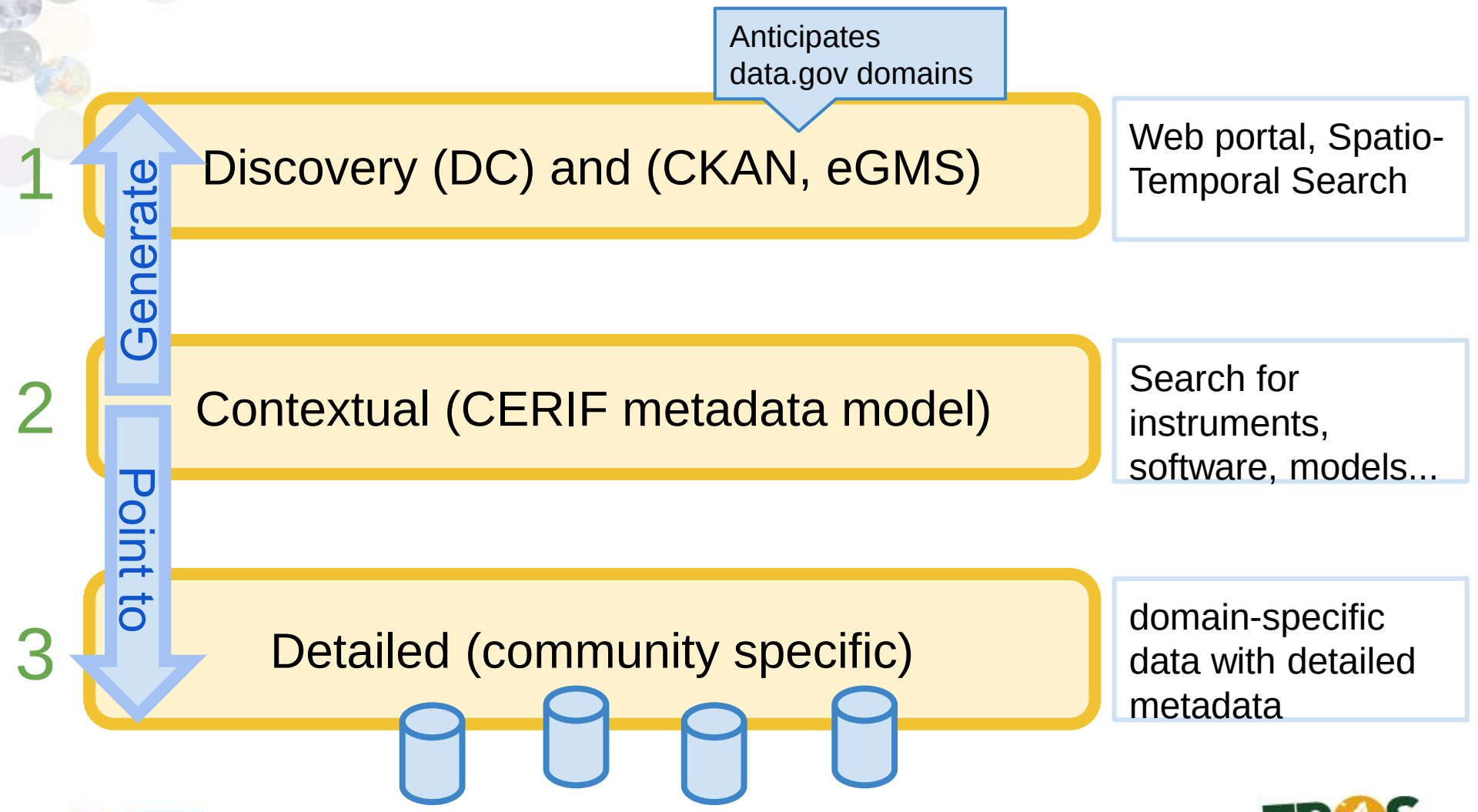
- Retrieve GPS data
- Determine velocity and deformation field
- Superpose the velocity field onto the geology and in 3D into the velocity structure and render it
- Determine the deformation field resulting from occurrence of the earthquakes in 1. And 2. Of the initial use case and compare to the secular deformation obtained from GPS

And all on an iPad

(acknowedgement to Alberto Michelini)

2. Metadata

3 layer metadata model



Metadata Catalog

- Metadata Catalog
  - Relational database
    - Performance
    - Reliability
    - Toolset available

Open Source

Postgres

- Links with formal syntax and declared semantics
  - Resolve to URI

CERIF

Common European Research Information Format

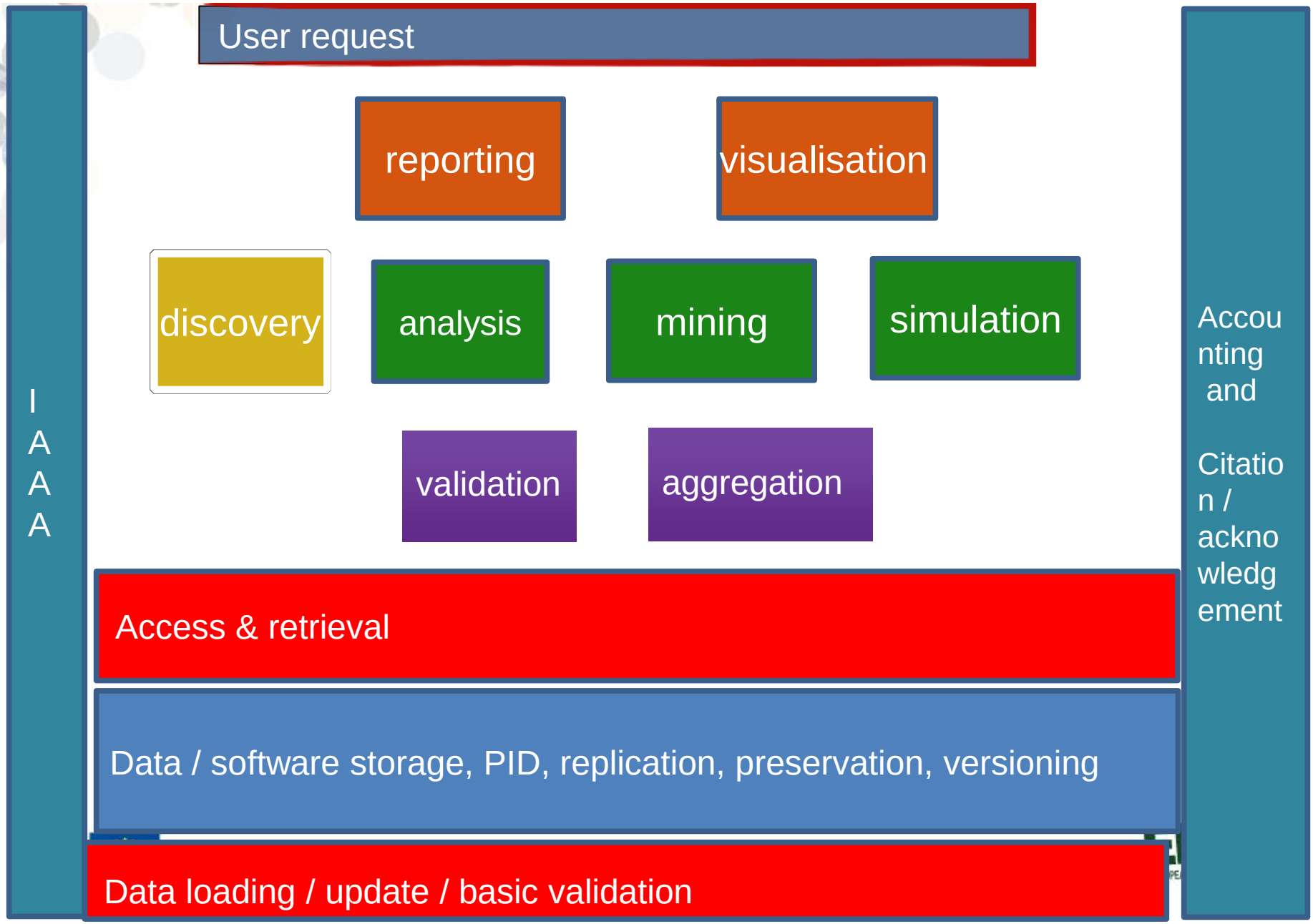
euroCRIS
Current Research Information Systems

MD collection: Data Taxonomy

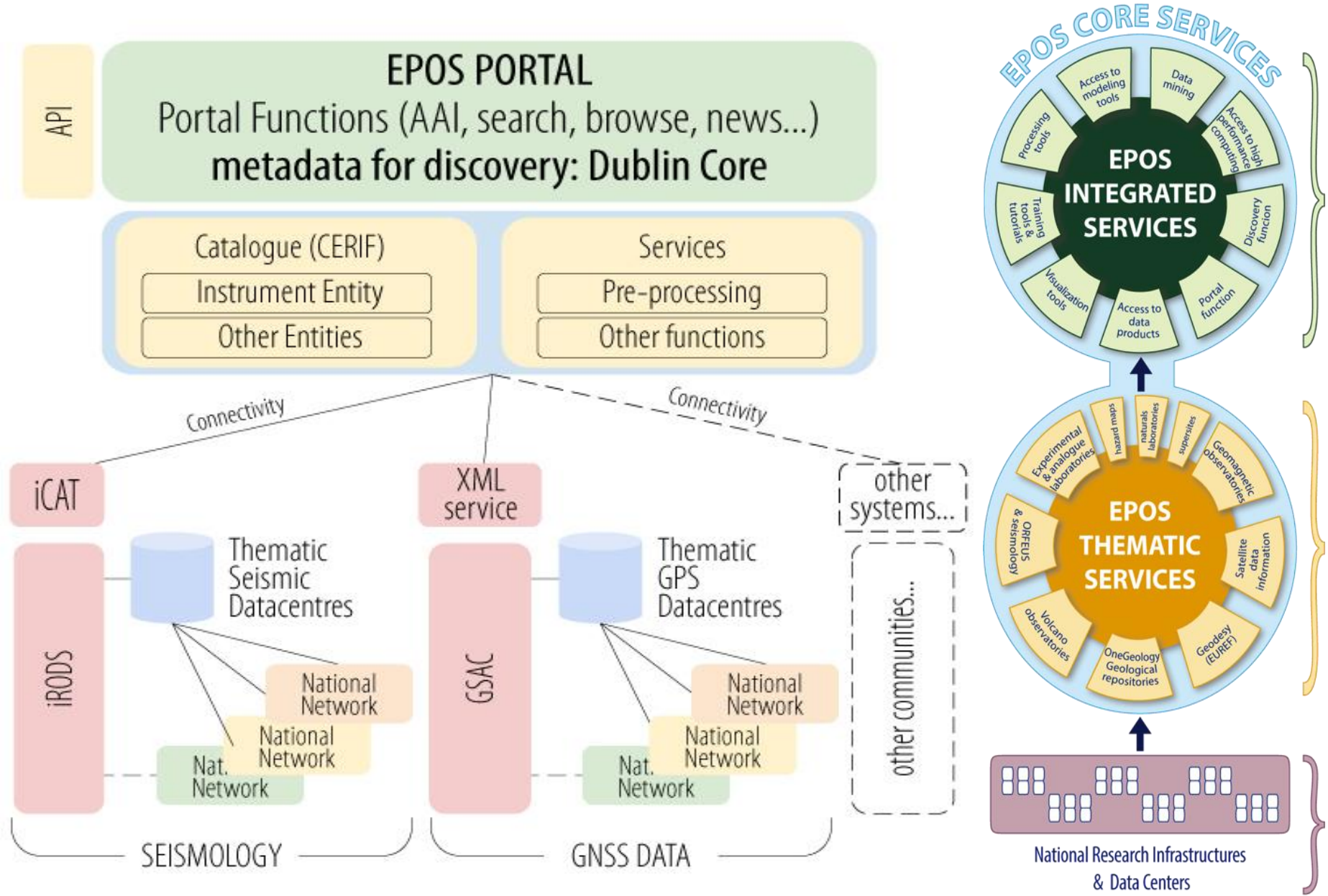
- **Level 0**: raw data, or basic data (example: *seismograms, Raw & Rinex GNSS, GNSS data streams*...)
- **Level 1**: data products coming from nearly automated procedures (*earthquake locations, daily and RTK solutions* ....)
- **Level2**: data products resulting by scientists' investigations (*crustal models, strain maps, GNSS time-series*)
- **Level 3**: integrated data products coming from complex analyses or community shared products (*hazards maps, deformation models*....)

2. Topology and functional diagrams

Functional Architecture



Topological and Functional



TAKE HOME MESSAGE(s)

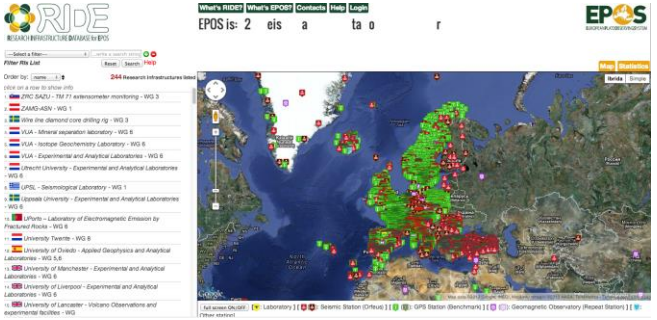
1. EPOS is a **unique opportunity to promote GNSS integration** and community building action
2. Need **to join efforts for developing Thematic Services** through a shared approach and motivated contributions

QUESTION TIME

WebSite

www.epos-eu.org

R.I.D.E.



www.epos-eu.org/ride

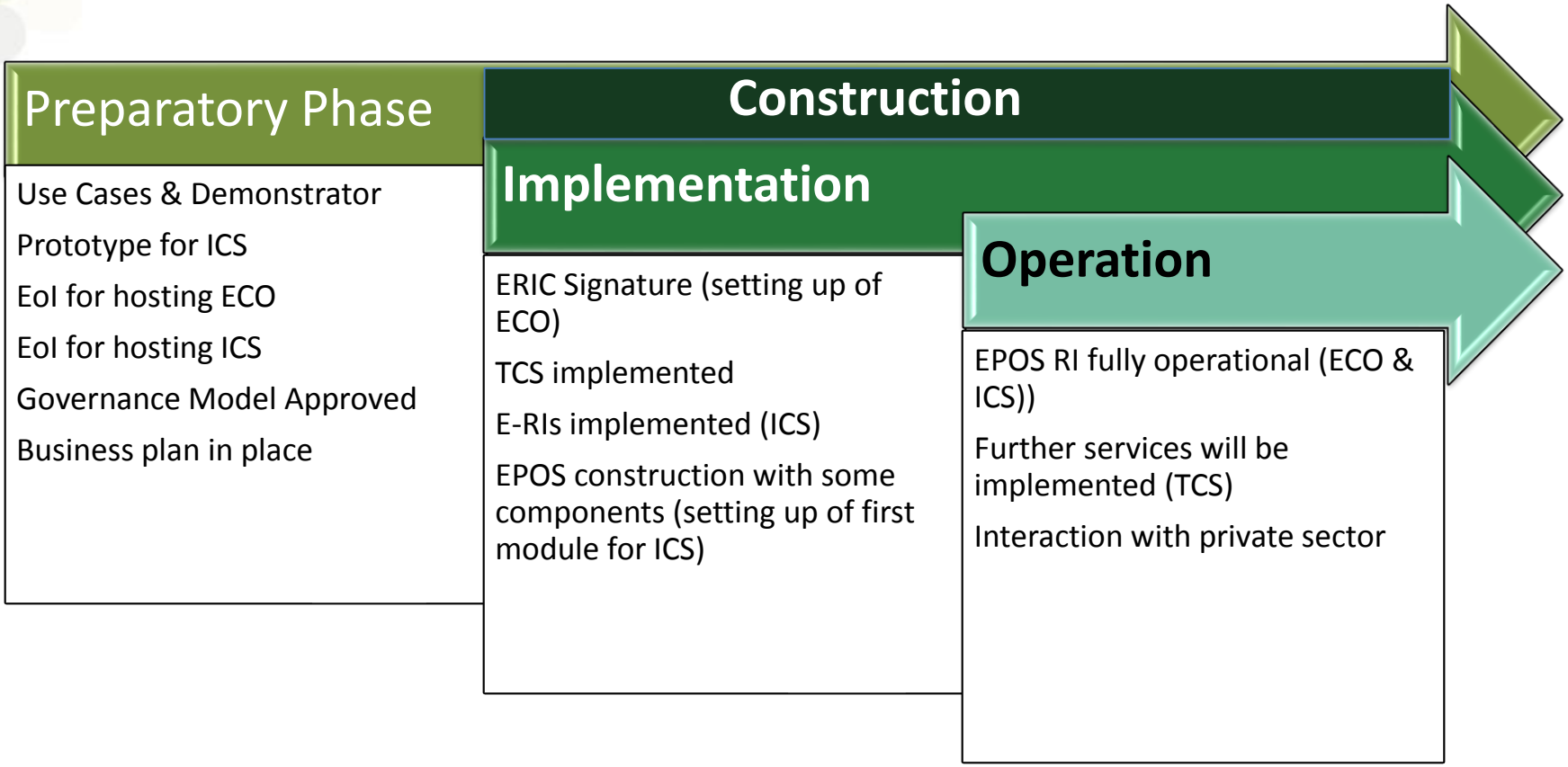
Newsletter

www.epos-eu.org/newsletter

Epos Social

facebook *youtube* *twitter*

Moving towards EPOS Implementation



Collecting IT Requirements for design #1

- **Use Cases**: it is a description of a potential application targeted to specific group of users to respond to a specific question (scientific or societal) with two objectives: collect IT requirements from data providers and facilities' managers and to interact with user groups to promote a common understanding of the core services. Use cases are needed during the Design Phase.

- **Demonstrator**: it is a virtual realization of a piece of the services dedicated to show and disseminate the added value and the features of the integrated core services. Users can play with the demonstrator to understand or perceive what the integrated core services will be. The Demonstrator is needed at the conclusion of the Design phase and during the Validation/Testing Phase.

Collecting IT Requirements for design #2

- **Prototype**: It is the final deliverable of the preparatory phase. It contains the preliminary but quite complete instructions to build and operate the Integrated Core Services (it might also apply to some TCS). It contains a complete list of IT requirements, a check on their availability (existence in TCS) from data providers, a plan for retrieving missing info, the IT and e-science tools and solutions, strategies to build, and needed resources, validation and testing completed, and a designed engineering phase (how to construct) with mid-term sustainability. The prototype is expected at the end of the delivery phase (M48).

Use Cases Identification

High Level Use Cases
(what the user is trying to achieve)

Medium level Use Cases
(steps to achieve)

ICT Requirements
(what the ICT system has to deliver)
functional and non-functional

Use Cases Examples

- *Having multiple data sets on induced seismicity available through the EPOS infrastructure will be a great added value to the seismological community*

- *Seismologist queries non-seismic geo-data for an earthquake*

- *Collect all the data to characterize the seismogenic potential of a seismic area*

Development of the EPOS Architecture

Complete cohort of researchers, research managers, innovators, media

The IT Vision: The Models

User Model

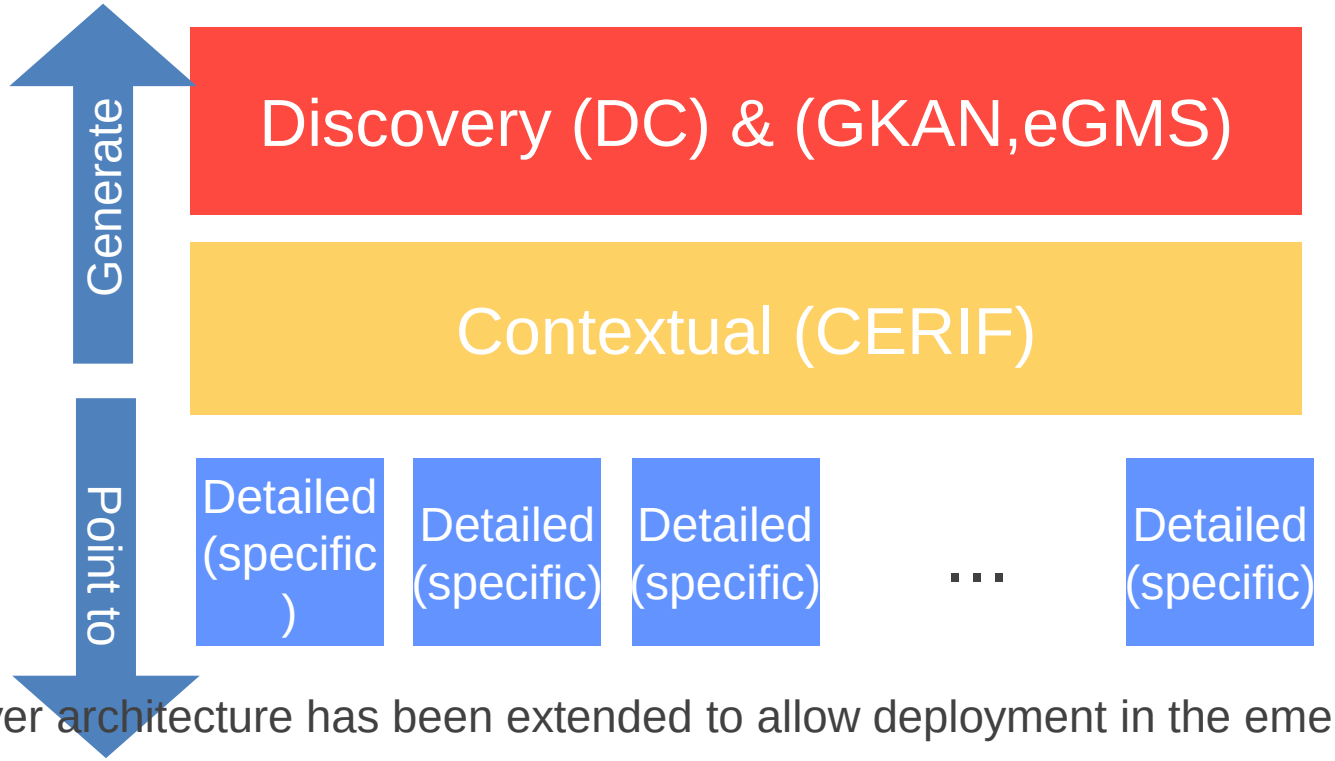
Processing Model

Data Model

Resource Model

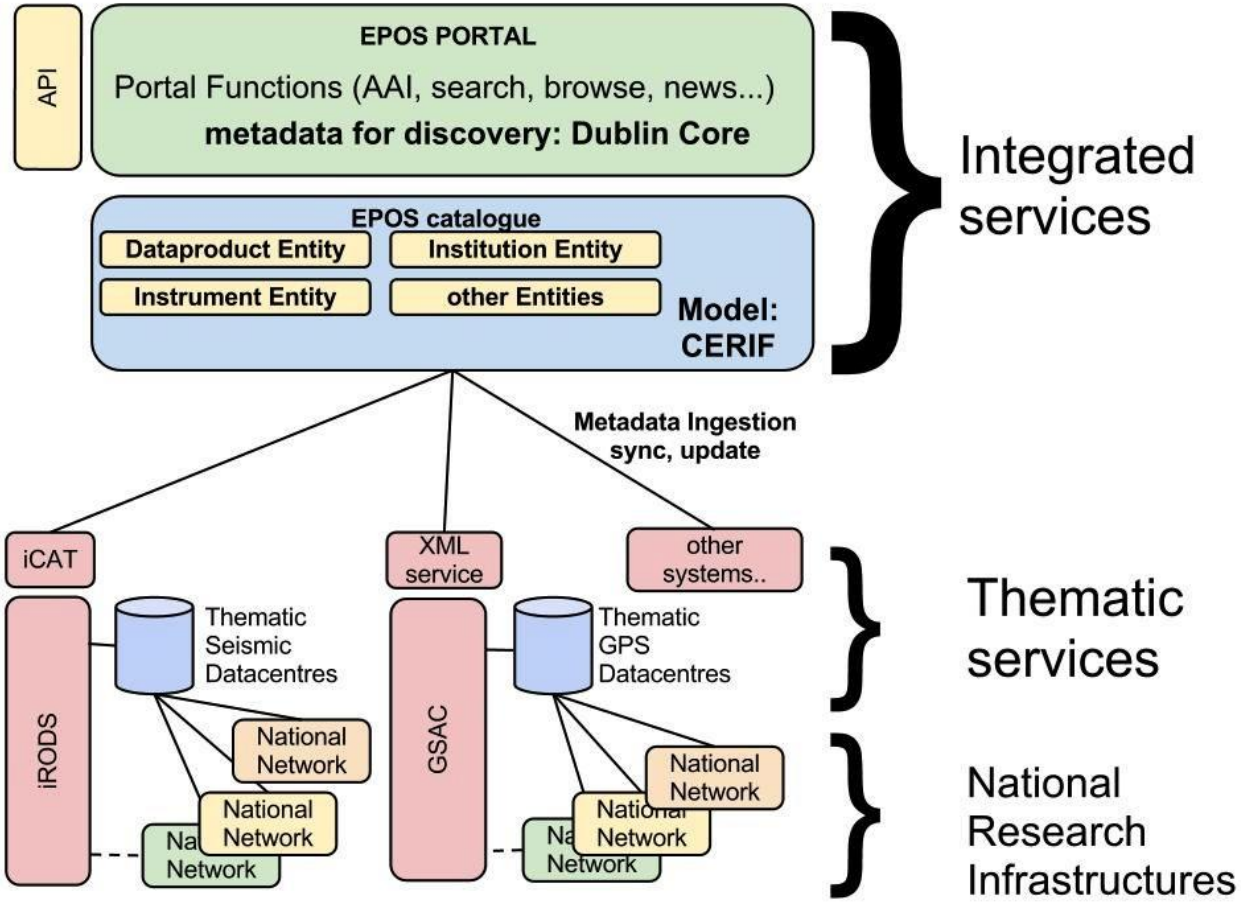
Complete ICT environment for research

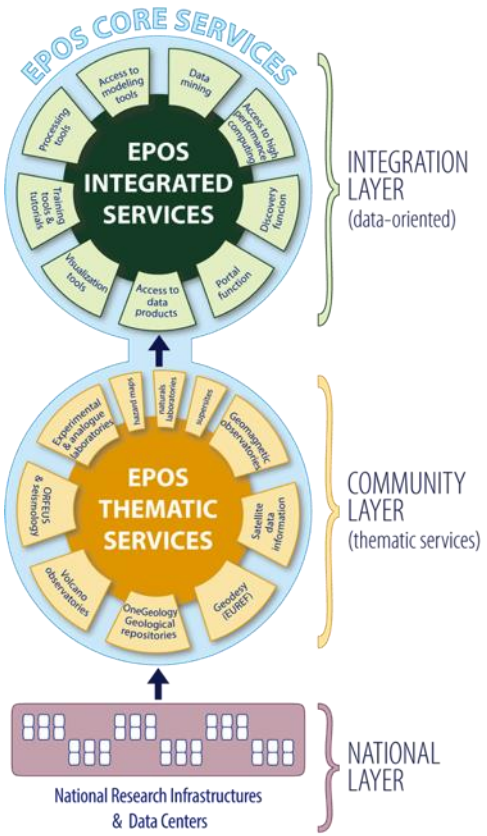
EPOS - Three layer metadata model



The 3 layer architecture has been extended to allow deployment in the emerging agreed open
data environment of government agencies; the so-called ‘data.gov’ environment.
For such extension Open Source Data Portal Platform (CKAN) and electronic Governme
Metadata Standard (eGMS) have been considered, studied, analysed and selected as potential
candidates for future development of EPOS services and interfaces.

Functional Architecture





EPOS
EUROPEANPLATEOBSERVINGSYSTEM

Research Infrastructure and e-science for Data and Observatories on
Earthquakes, Volcanoes, Surface Dynamics and Tectonics

Thank you for attention

Understanding our environment and appreciating hazards due to natural, solid-Earth, phenomena will contribute significantly to economic interests and quality-of-life

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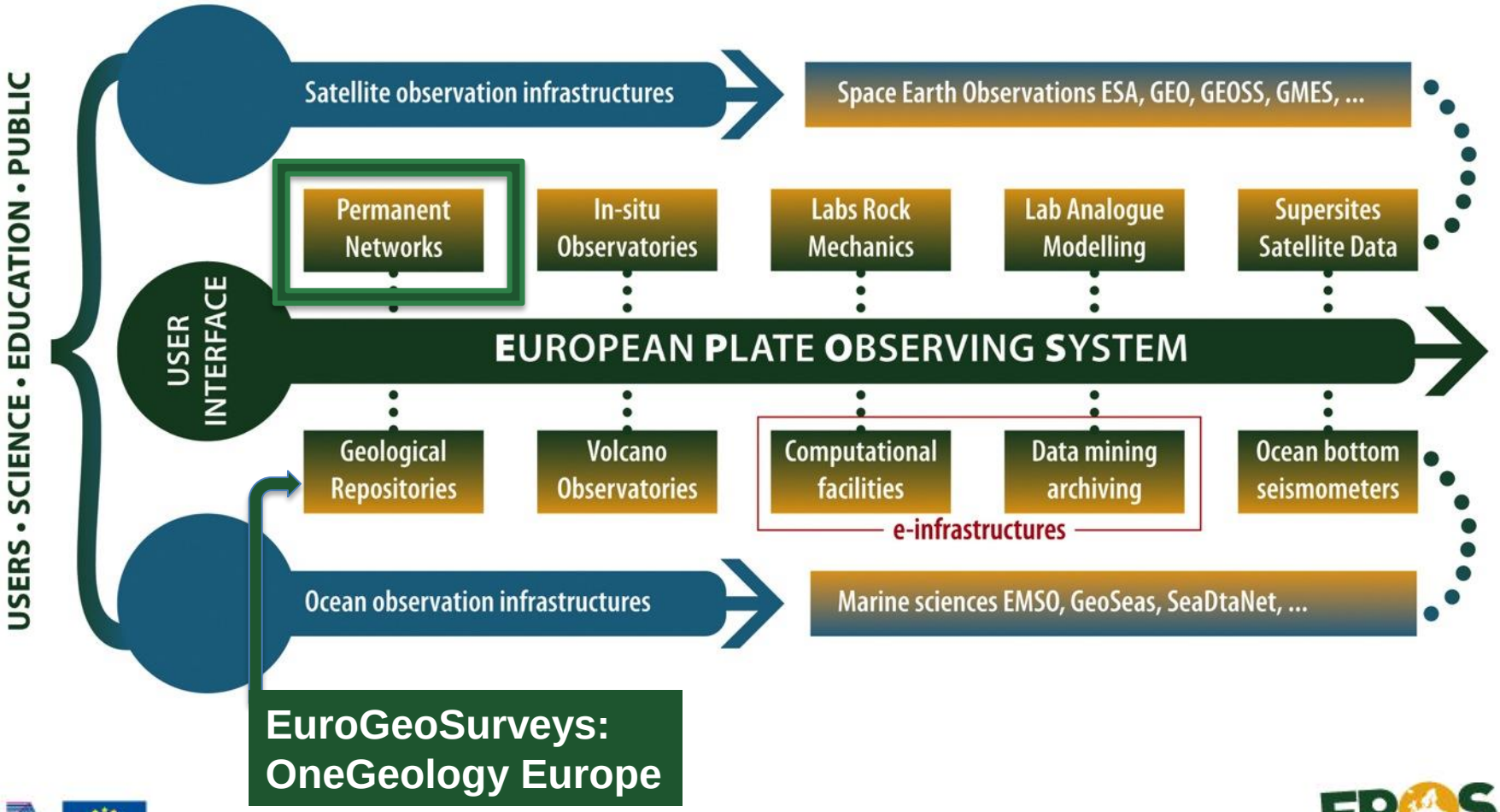
Added Value of a RI

- EPOS is integrating **existing** RIs to develop new **thematic** and **integrated** core services (TCS & ICS)
- EPOS **governance** and **legal** model must be suitable to coordinate the management and implementation of **these Core Services**
- EPOS is more than a mere data portal: it will provide not just data but means to **integrate**, **analyze**, **compare**, **interpret** and **present** data and information about **Solid Earth**

EPOS Components



Why EPOS is important ?

- It will provide **access to multidisciplinary** data, data products, processing tools, visualization software and data from simulations.
- It will allow each community to **open** their data infrastructures to **other stakeholders**, which is a precondition to join the **global data coordination**
- It provides coordination to cooperate with **e-science** community and participate to the **new ICT era**
- It will structure our community to improve our **future fund opportunities → geo-hazards supersites projects**
- It promotes **national implementation plans** that improve the research capacities and opportunities

Milestones


Approving Rules & Requirements for hosting ECO
Approving Rules & Requirements for hosting TCS & ICS
Update Financial Plan
Prototype for ICS


Letters of Intent
Expression of interest for ECO
Launch the Call for hosting ECO
Launch the Call for hosting ICS
Draft Statutes