

# The GNSS Component of the European Plate Observing System (EPOS)

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# Outline

- **Introduction**
- Integrated Core Services
- Thematic Core Services - GNSS component
  - Motivation
  - Data Provision
  - Product Provision
  - Service Providers
- How to join?
- Conclusions



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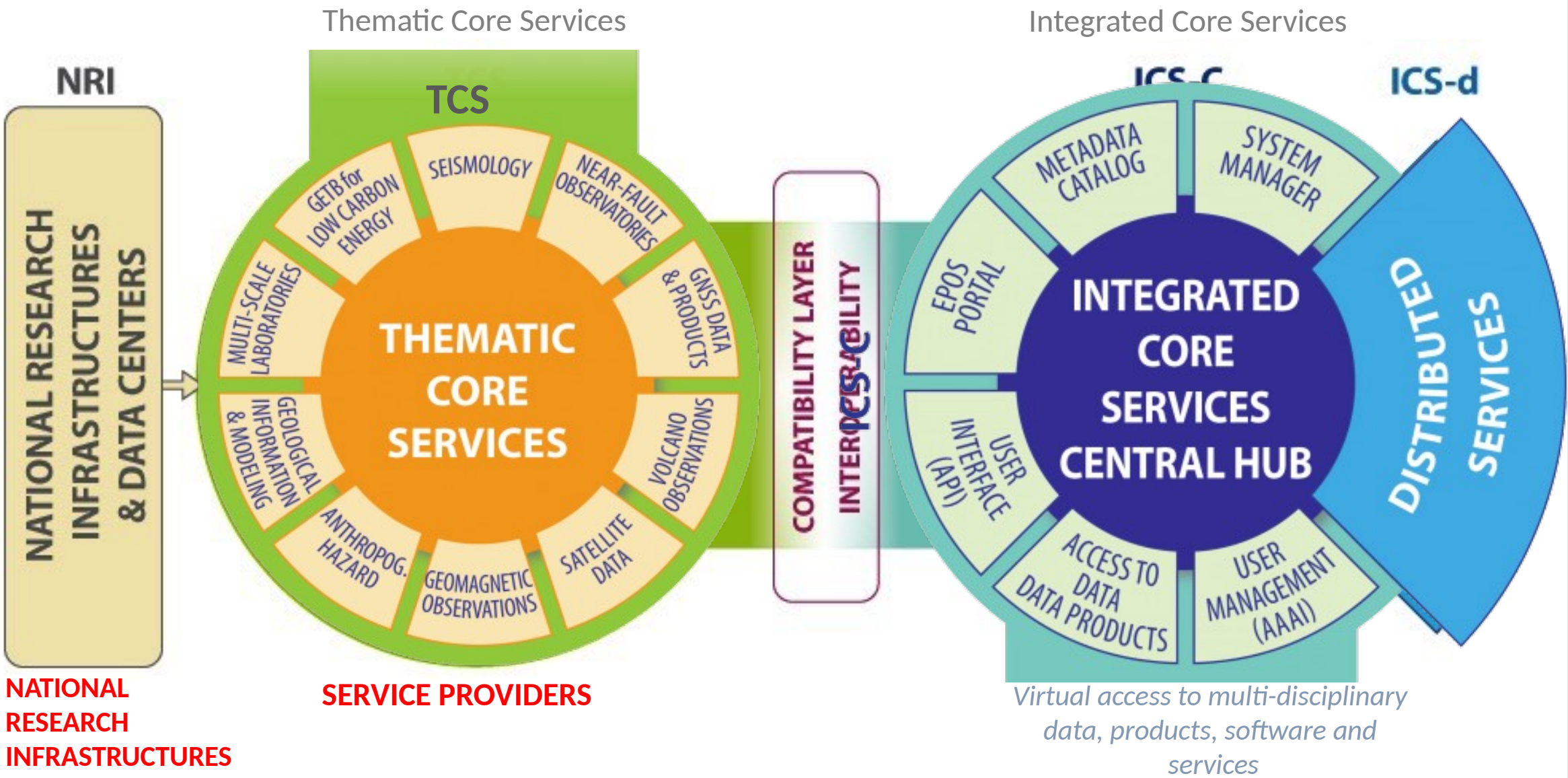


# Environmental European Research Infrastructures

source <http://envri.eu/>

EPOS is the European  
Research  
Infrastructure serving  
Solid Earth science





**NATIONAL RESEARCH INFRASTRUCTURES**

**SERVICE PROVIDERS**

Provide **(open) access** to multi-disciplinary data and products from TCS as well as tools for visualization, processing and analysis through the EPOS ICS portal.



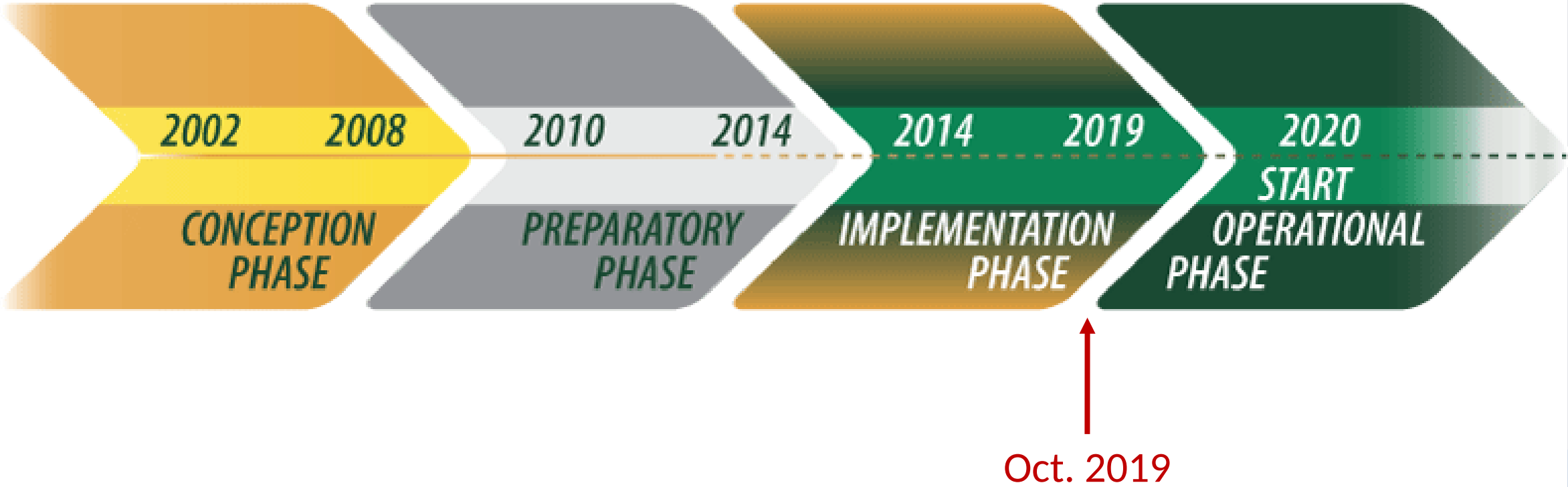
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D-SCI



# EPOS currently in Testing Phase before start of Operational Phase in 2020+





# European Research Infrastructure Consortium (ERIC) - 30 Oct 2018

Consortium signed by the countries, who pay annual membership fees.

## Members

Belgium, Denmark, France, Greece, Italy, Norway, Poland, Portugal, Slovenia, Netherlands, United Kingdom

## Observers

Iceland, Switzerland

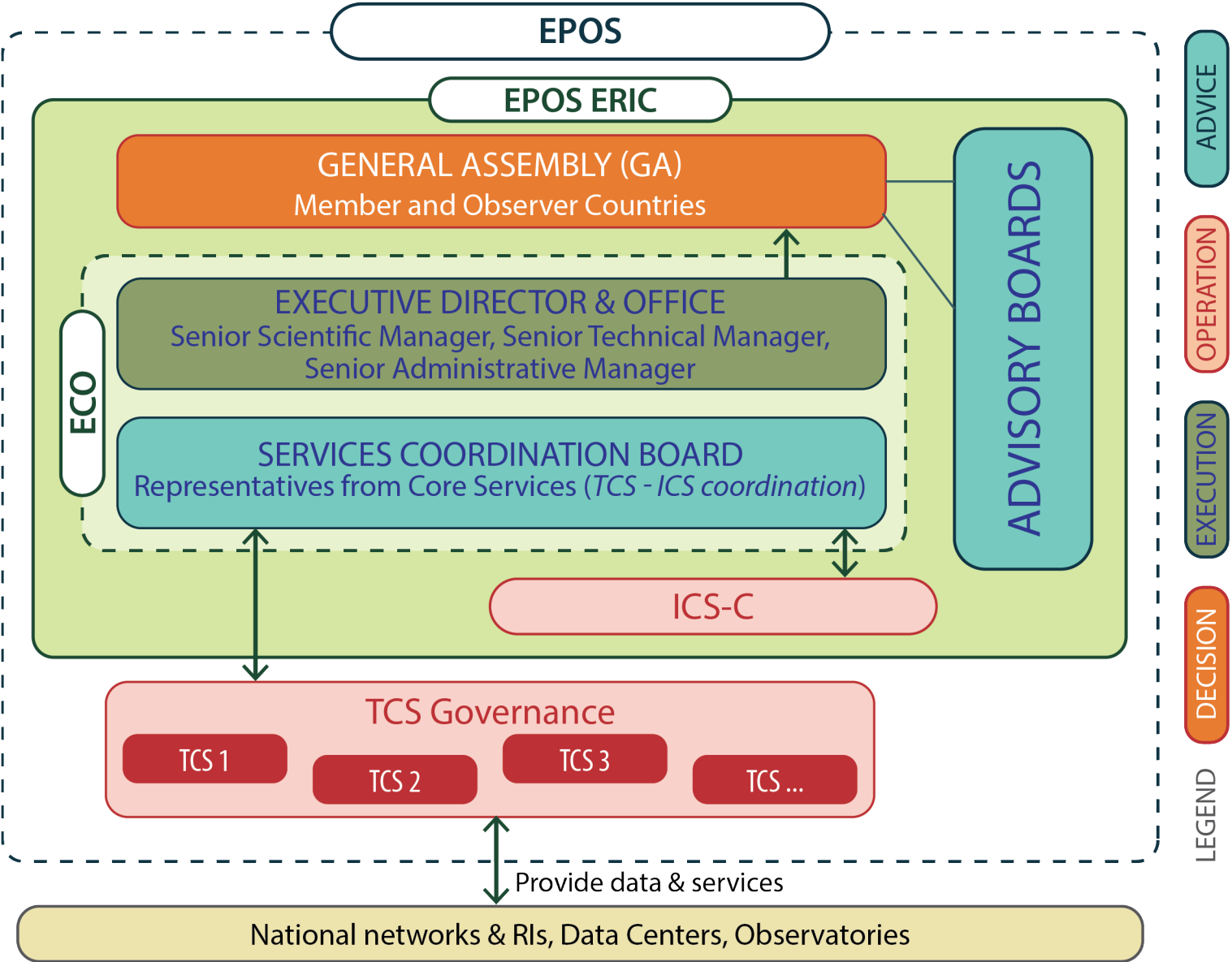


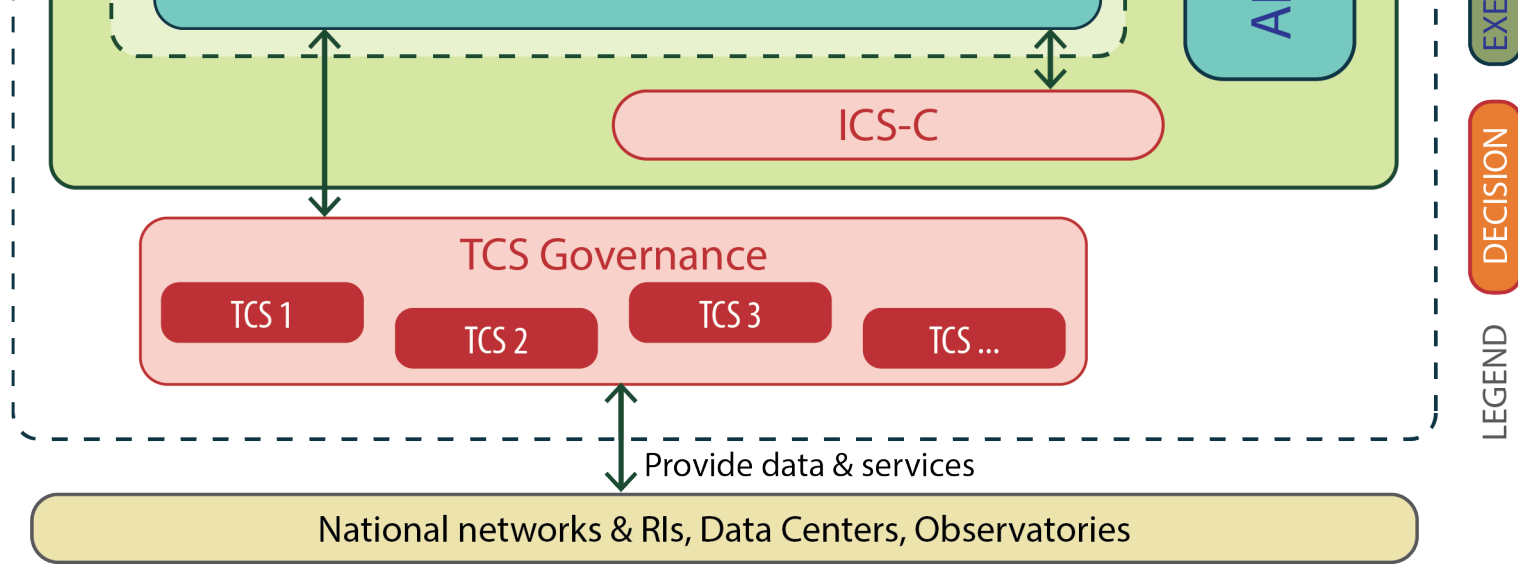
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# EPOS ERIC Governance Model





TCS partners providing pan-European services sign a

1. **Consortium Agreement** amongst eachother
  - Governance
  - Who does what
  - New partners
  
2. **Cooperation Agreement** with EPOS-ERIC
  - commit to provide specific services to EPOS

Process currently on-going

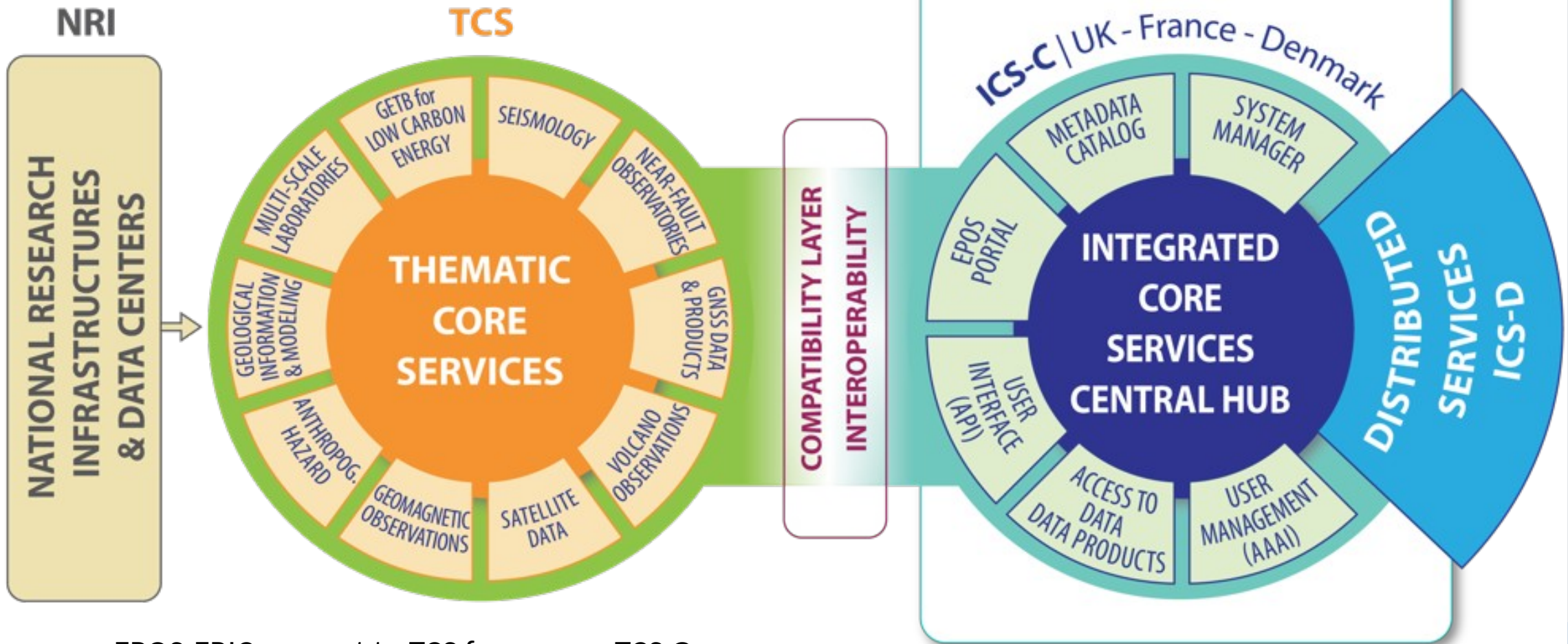
Expected in 2020



Table 1. Membership fees per country. \*based on calculations using the GDP at current prices for 2015 from the AMECO macro-economic database.

Member/ Permanent Observer	GDP* (b€)	GDP (%)	Membership fee (k€/year)		Votes
			Nominal ( <i>mfi</i> )	Contributed	
Albania	10	0.1	64		
Austria	340	2.0	108		
Belgium	410	2.5	117	80	0.7
Bulgaria	46	0.3	69		
Croatia	44	0.3	69		
Cyprus	18	0.1	65		
Czech Republic	167	1.0	85	85	1
Denmark	266	1.6	98	50	0.5
Estonia	20	0.1	66		
Finland	209	1.3	91	91	1
France	2181	13.1	350	200	1
Germany	3033	18.2	462	200	1
Greece	176	1.1	86	50	0.6
Hungary	110	0.7	77		
Iceland	15	0.1	65		
Ireland	256	1.5	97	97	1
Italy	1642	9.8	279	200	1
Latvia	24	0.1	66		
Lithuania	37	0.2	68		
Luxembourg	51	0.3	70		

Macedonia	9	0.1	64		
Montenegro	4	0.0	63		
The Netherlands	677	4.1	152	50	0.3
Norway	348	2.1	110	110	1
Poland	430	2.6	121	121	1
Portugal	180	1.1	87	80	0.9
Romania	160	1.0	84	84	1
Serbia	34	0.2	67		
Slovakia	79	0.5	73		
Slovenia	39	0.2	68	50	0.7
Spain	1076	6.4	205	100	0.5
Sweden	447	2.7	122		
Switzerland	605	3.6	144	144	
Turkey	645	3.9	148		
United Kingdom	2577	15.4	402	200	1
<b>TOTAL</b>	<b>16363</b>	<b>100.0</b>	<b>4400</b>		



EPOS-ERIC support to TCS focuses on TCS Governance  
Travel costs for attending TCS Consortium Board meetings

# EPOS Data Policy

- Open data policy
- Default CC BY license
  - National Research Infrastructures: Data supplier letter to provide EPOS permission to distribute data/products
  - Service Providers: Cooperation agreement

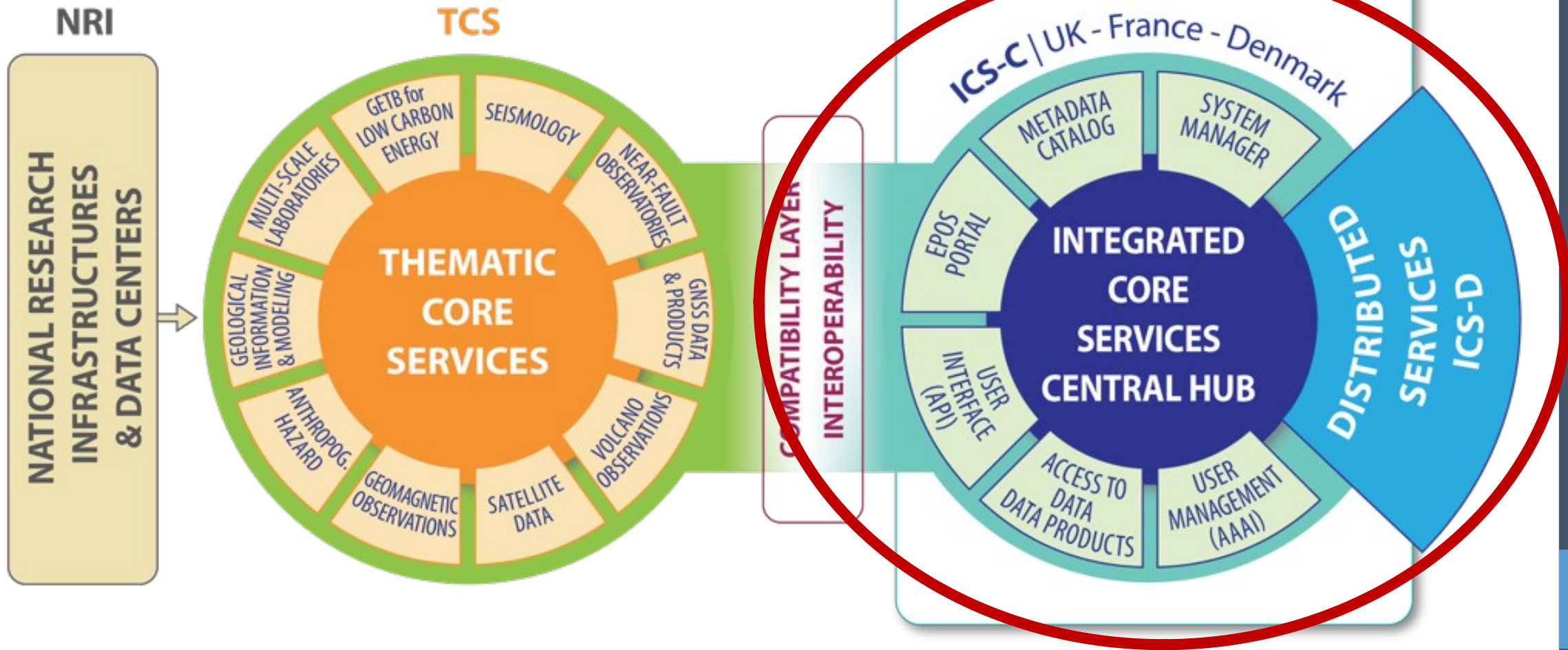
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# EPOS ERIC Governance Model

## EPOS Architecture Framework



# EPOS Integrated Core Services (ICS) Portal

**EPOS ICS** ? Login

## EUROPEAN PLATE OBSERVING SYSTEM

- SEISMOLOGY
- NEAR-FAULT OBSERVATORIES
- GNSS DATA AND PRODUCTS
- VOLCANO OBSERVATIONS
- SATELLITE DATA
- GEOMAGNETIC OBSERVATIONS
- ANTHROPOGENIC HAZARDS
- GEOLOGICAL INFORMATION AND MODELING
- MULTI-SCALE LABORATORIES
- GEO-ENERGY TEST BEDS FOR LOW CARBON ENERGY

**DATA ACCESS**  
Access to scientific data from the communities

Feedback

web UNDER CONSTRUCTION



# EPOS Integrated Core Services (ICS) Portal

**EPOS ICS** ? Login

°North (°N) °South (°S) °East (°E) °West (°W) ✓ YYYY-MM-DD HH:mm:ss YYYY-MM-DD HH

**SEARCH**

**Advanced Search** Map Graph Data

**Results (215)**

- ⊕ Anthropogenic Hazard Observations (41)
- ⊕ Geology (8)
- ⊕ Geoelectromagnetism (19)
- ⊕ Geo-energy Test Beds (0)
- ⊕ Geodesy (13) ←
- ⊕ Multi-scale Laboratory Data (0)
- ⊕ Near Fault Observations (37)
- ⊕ Satellite Observations (8)
- ⊕ Seismology (45)
- ⊕ Volcano Observations (44)

**Selected Items (0)** Clear

51.06153 : -10.78315

Leaflet | Powered by Esri | Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX

Details Configuration

Please Select a Service.



# EPOS Integrated Core Services (ICS) Portal

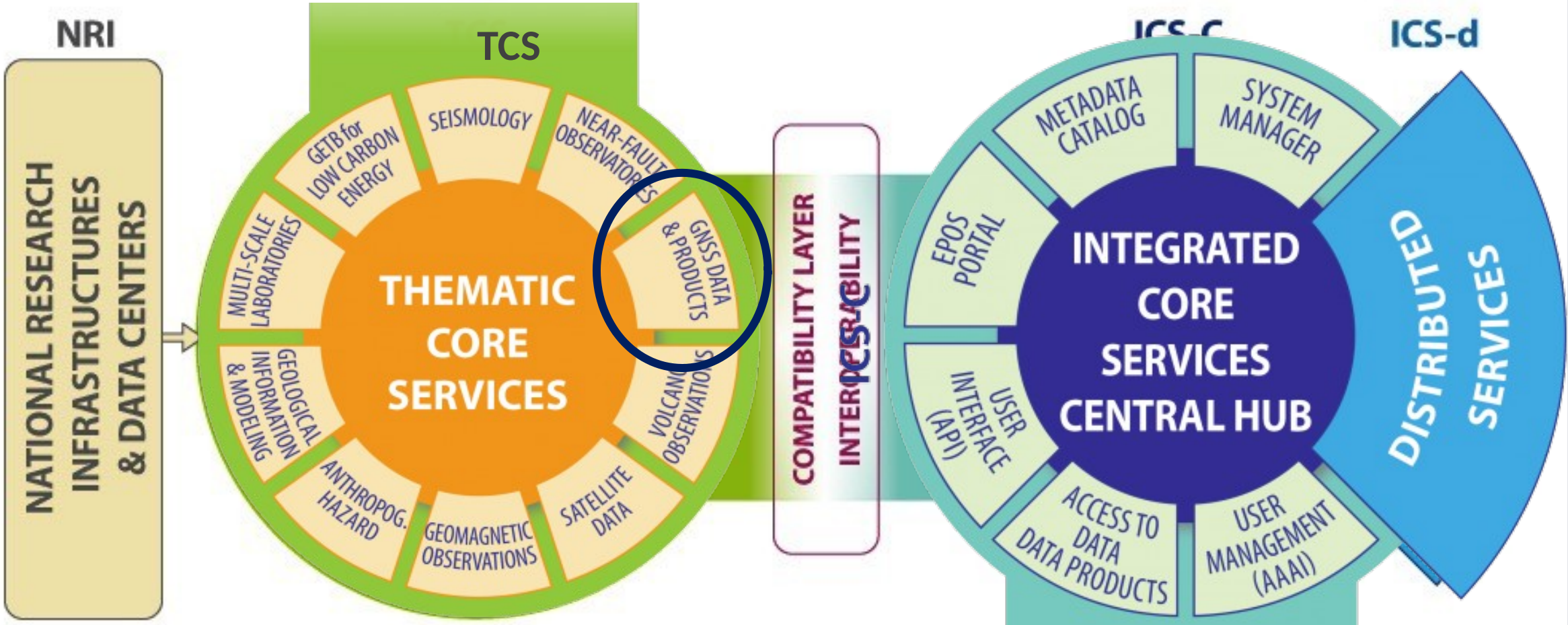
The screenshot displays the EPOS ICS web application interface. At the top, there is a navigation bar with the title 'EPOS ICS', a help icon, and a 'Login' button. Below this is a toolbar with various icons for map navigation and search. The main content area is divided into three sections: 'SEARCH', 'WORKSPACE', and 'PROCESSING'. The 'SEARCH' section on the left shows an 'Advanced Search' dropdown and a list of 'Results (215)' categorized by domain: Anthropogenic Hazard Observations (41), Geology (8), Geoelectromagnetism (19), Geo-energy Test Beds (0), Geodesy (13), and Data (3). The 'PROCESSING' section contains several tasks, including 'Stations with RINEX data', 'List RINEX Files search parameters', 'GET RINEX Files', 'Products (10)', 'Coordinates (2)', and 'Time series (3)'. A red arrow points to the 'Time series (3)' section. The 'Map' section on the right shows a satellite view of Europe with numerous red circular markers indicating station locations. A search bar at the top of the map displays the coordinates '32.65676 : -9.03249'. The bottom of the interface includes a 'Details' and 'Configuration' tab, and a 'Console' button.



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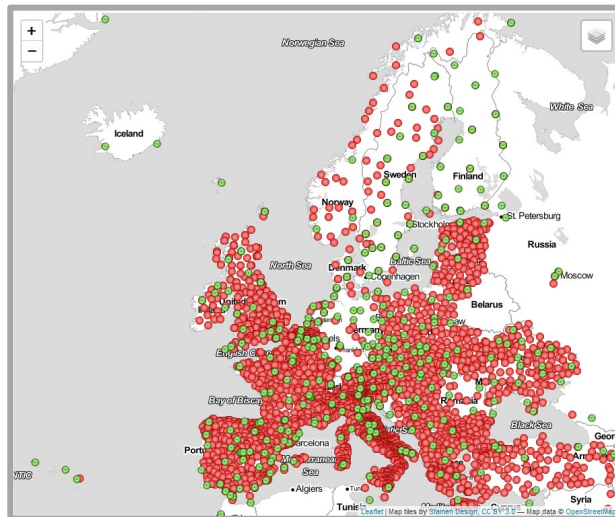


# Why Create a New GNSS Infrastructure?

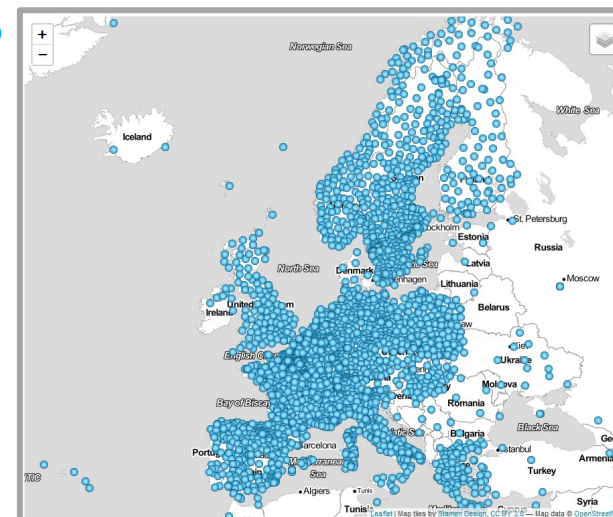
- EUREF (Permanent Network) = EPOS GNSS component?
- EPOS: 3000+ GNSS stations responding to less strict guidelines
  - Site logs
  - Data availability
  - Products focusing on solid earth research



EPN  
EPN Densification



E-GVAP

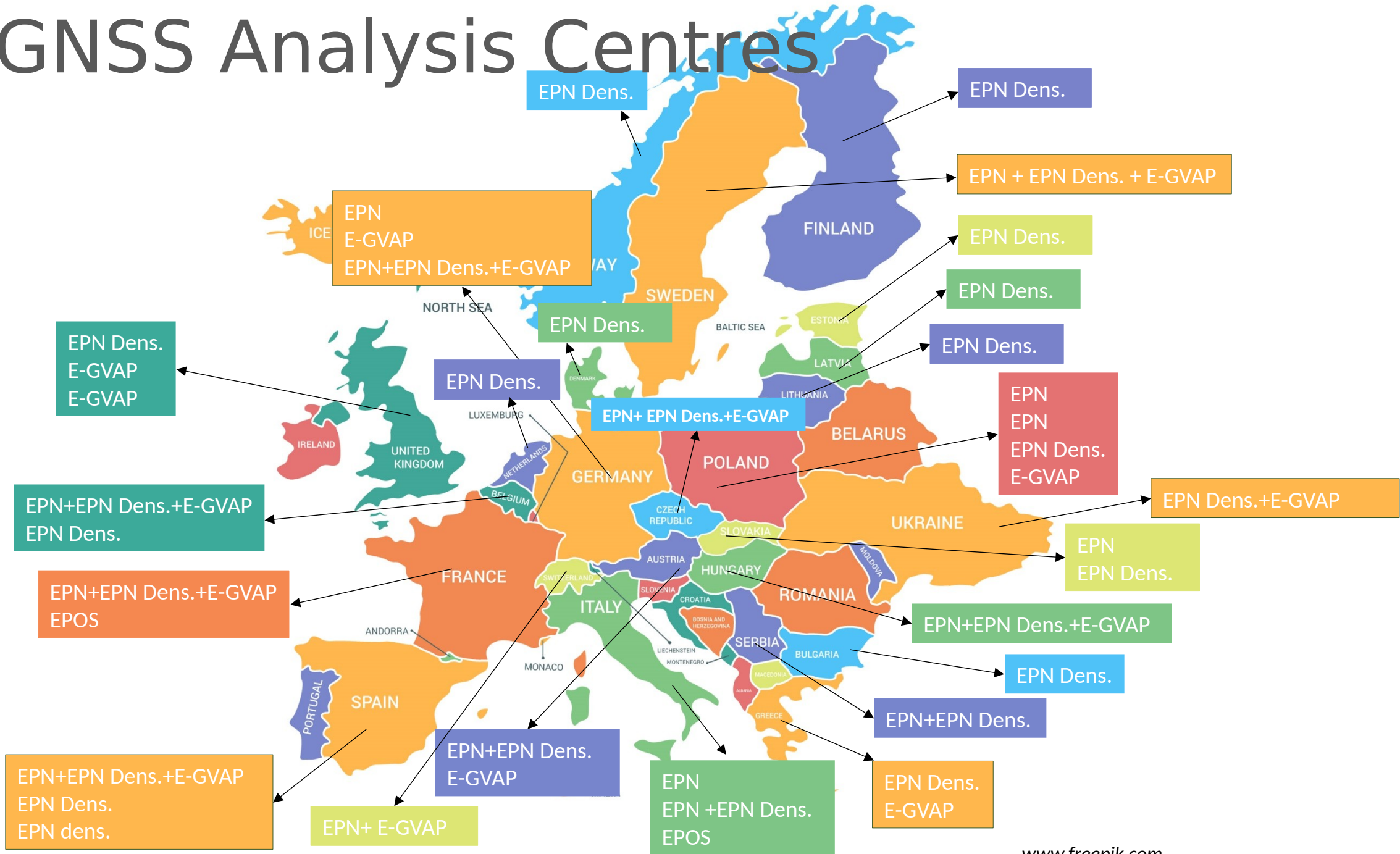


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# GNSS Analysis Centres





# Why Create a New GNSS Infrastructure?

- EUREF (Permanent Network) = EPOS GNSS component?
- EUREF is not a legal entity and EUREF Governing Board cannot take any commitments for all the contributors to the EPN
- In seismology: ORFEUS signs agreement with EPOS on behalf of all its data providers
- GNSS situation is much more complex, EUREF cannot handle it all based on its voluntary best-effort basis
- Governments committed to support agencies contributing to EPOS
- Harmonization with EUREF is important



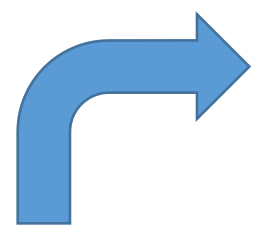
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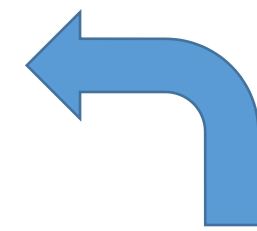


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The screenshot shows the EPOS ICS homepage. At the top, it says "EPOS ICS" and "EUROPEAN PLATE OBSERVING SYSTEM". Below this is a row of ten circular icons representing different data types: Seismology, Near-fault Observatories, GNSS Data and Products, Volcano Observations, Satellite Data, Geomagnetic Observations, Anthropogenic Hazards, Geological Information and Modeling, Multi-scale Laboratories, and Geo-energy Test Beds for Low Carbon Energy. In the center, there is a database icon with the text "DATA ACCESS" and "Access to scientific data from the communities". A "Feedback" button is on the right side.



EPOS GNSS **Data** Portal: <http://gnssdata-epos.oca.eu>

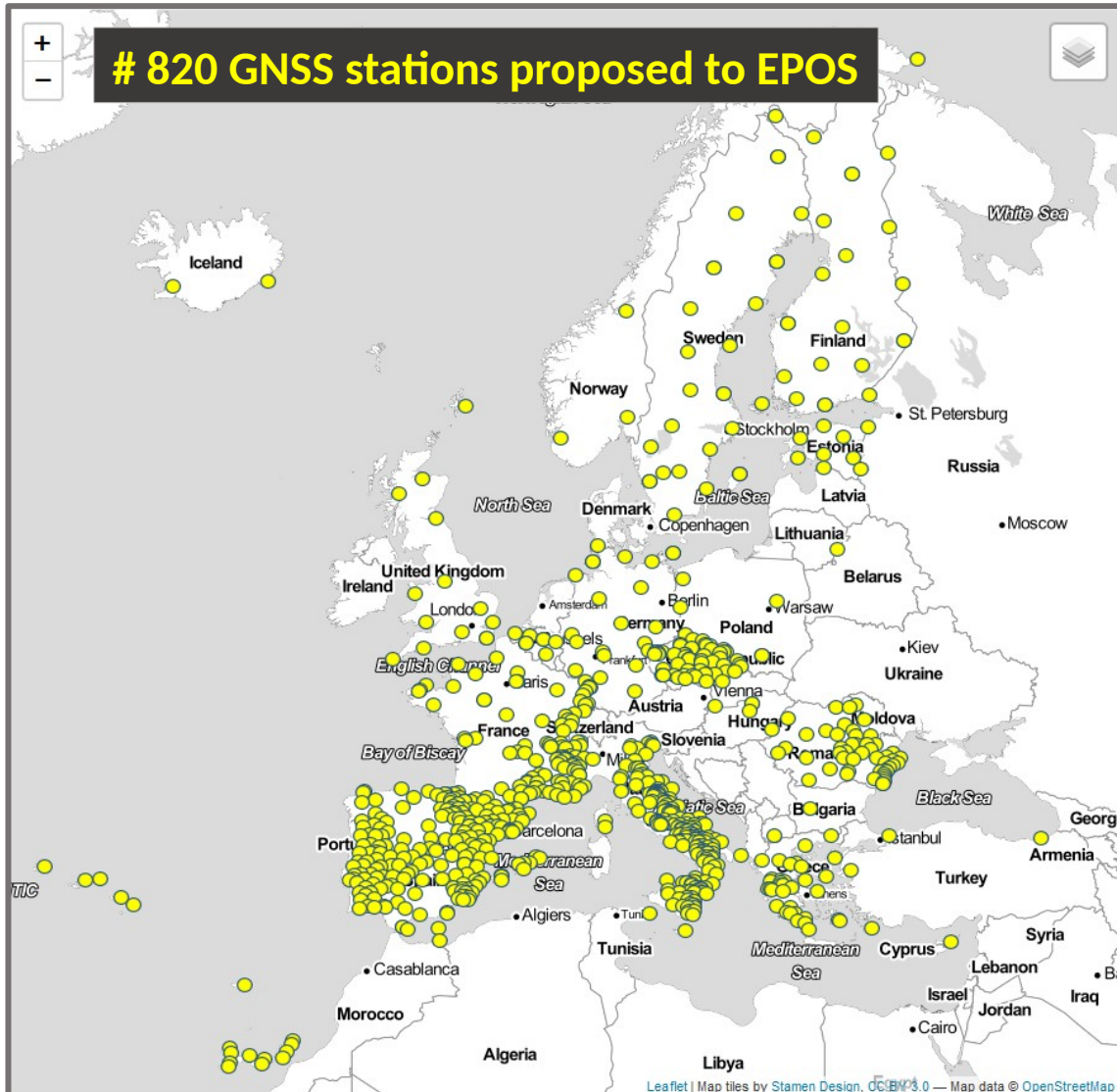
The screenshot shows the EPOS GNSS Data Gateway interface. It features a map of Europe with various GNSS stations marked by colored dots. On the left, there are "Spatial selection" options for "Rectangle" (with Lat-Lon Bounding Box input) and "Circle" (with Latitude, Longitude, and Radius (Km) input). At the top, there are search buttons for "Metadata Search", "Files Search", "Clear", and "Show advanced search". A "Products portal" link is also visible.

EPOS GNSS **Product** Portal: <https://gnssproducts.epos.ubi.pt/>

The screenshot shows the EPOS GNSS Products Portal interface. It features a map of Europe with GNSS stations marked by numbered colored circles. On the right, there are "Data Controls" and "Filters" panels. The "Data Controls" panel includes tabs for "Timeseries", "Velocities", "Power Spectral Density", and "Strain Rate", with "Timeseries Residuals" set to "Off" and "Frequency" set to "Daily". The "Filters" panel includes "Networks" (RENAG, RGP, EUREF) and "Analysis Centres" (BFKH, INGV, UGA) with toggle switches.



# Proposed EPOS-GNSS stations



Requirements for EPOS-GNSS stations:

- Signed EPOS-GNSS data supplier letter
- Site log in M<sup>3</sup>G
- RINEX data discoverable through EPOS-GNSS data portal

Proposed EPOS-GNSS station

Proposed EPOS-GNSS stations:

202 EPN stations

480 EPN densification stations

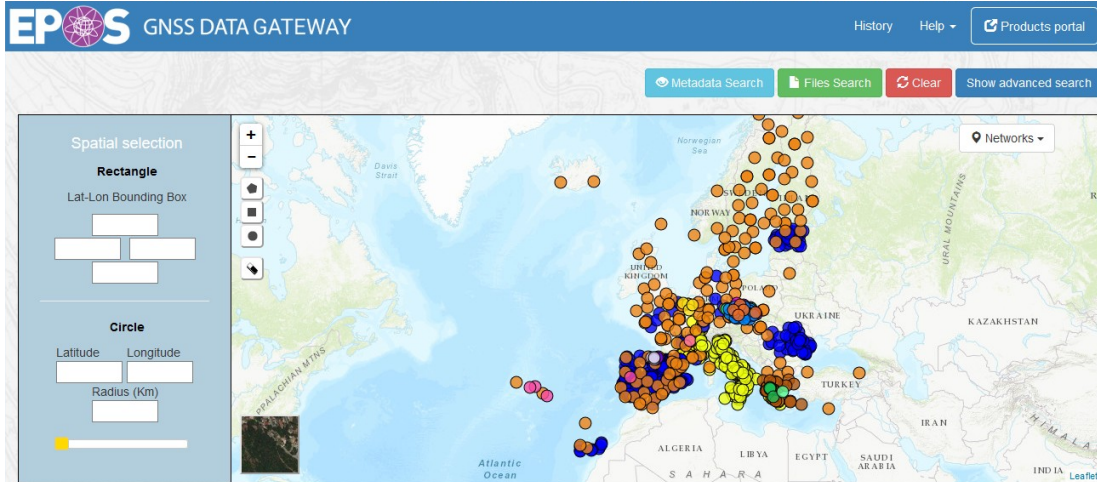
138 other stations

<ftp://gnss-metadata.eu/station/log>

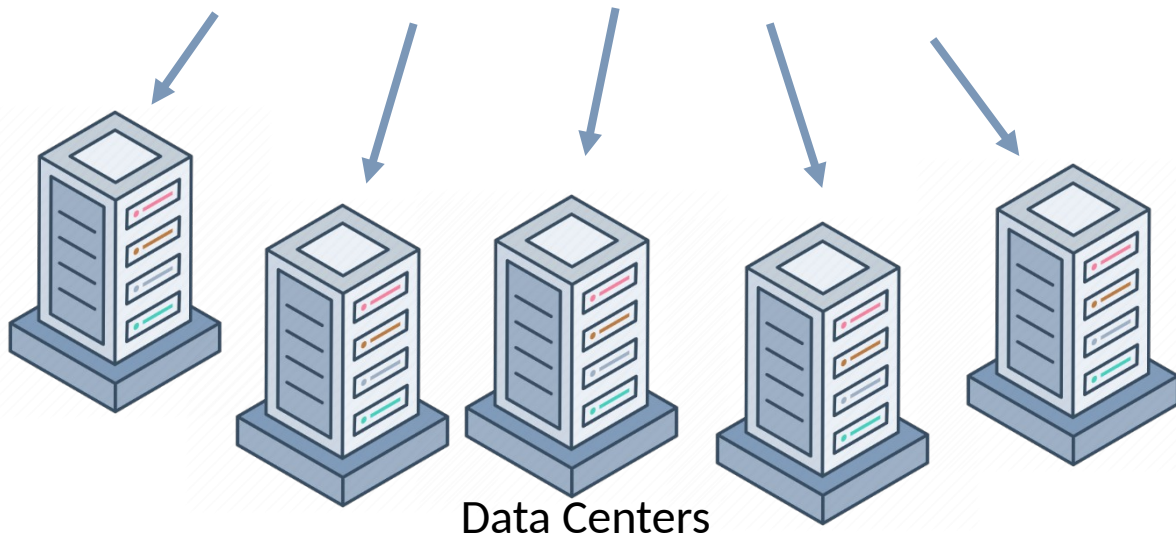


# RINEX Data Discoverability: Concept

EPOS GNSS Data Portal: <http://gnssdata-epos.oca.eu>



Provides links to RINEX data in distributed data centers



## GLASS (light) software

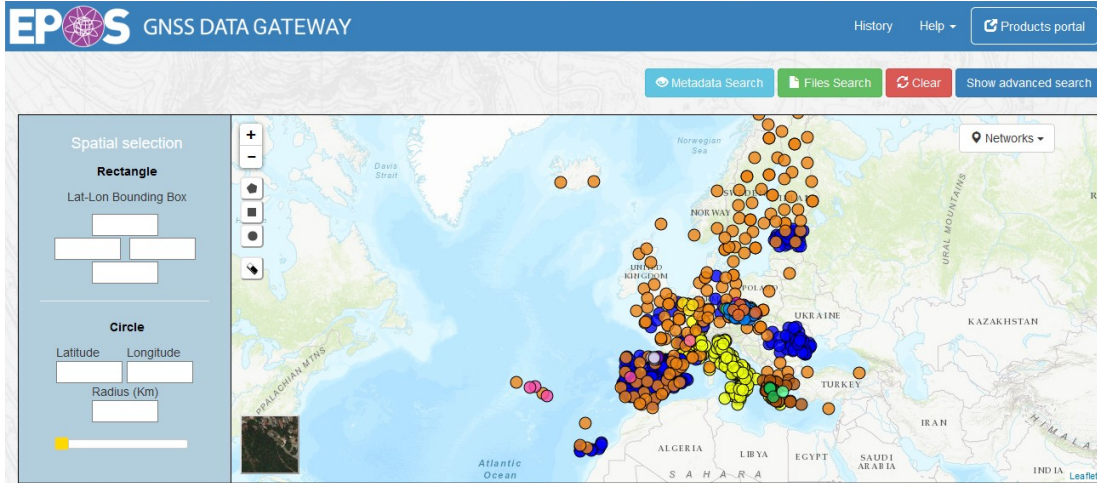
*Makes GNSS data in data center DISCOVERABLE to EPOS GNSS Data portal*

- ✓ Collects information on file name, size, location (ftp://...)
- ✓ Generates information on data quality (Anubis)
- ✓ Puts all info in a data base
- ✓ Provides info in the data base to the EPOS-GNSS data portal

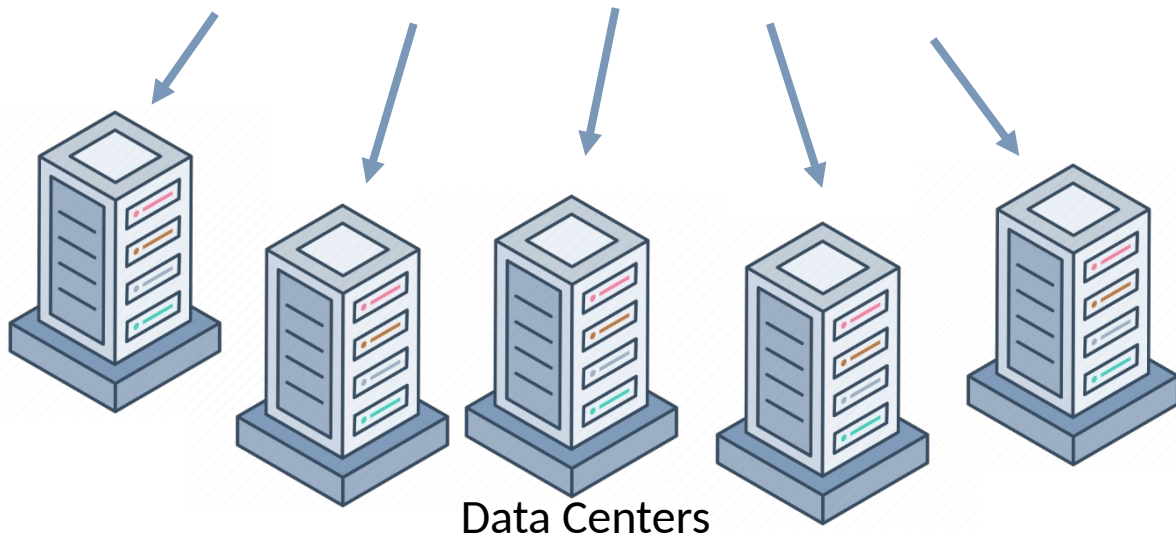
*(the above is a simplification!)*

# RINEX Data Discoverability: Concept

EPOS GNSS Data Portal: <http://gnssdata-epos.oca.eu>



Provides links to RINEX data in distributed data centers



Several options to connect data center to EPOS GNSS data portal:

**[GLASS NODE]:** Data centers **install GLASS** node software to become an EPOS GNSS data node

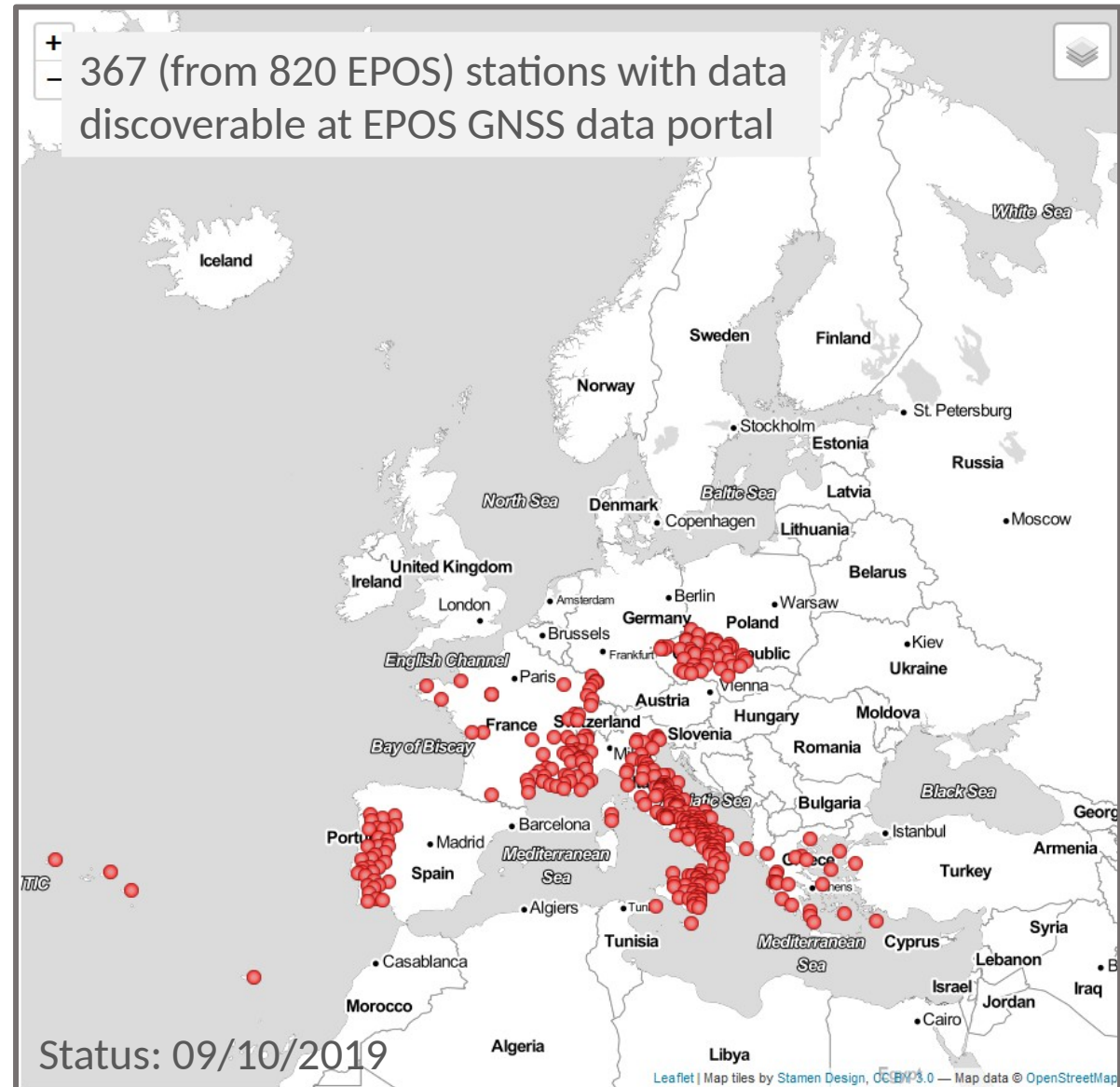
**[GLASS LIGHT]:** Data centers **install 'GLASS-light'** software and provide RINEX metadata to an EPOS GNSS data node

**[NO GLASS]:** Data centers **send RINEX data** to an EPOS GLASS node



# RINEX Data Discoverability: Status

GLASS NODES

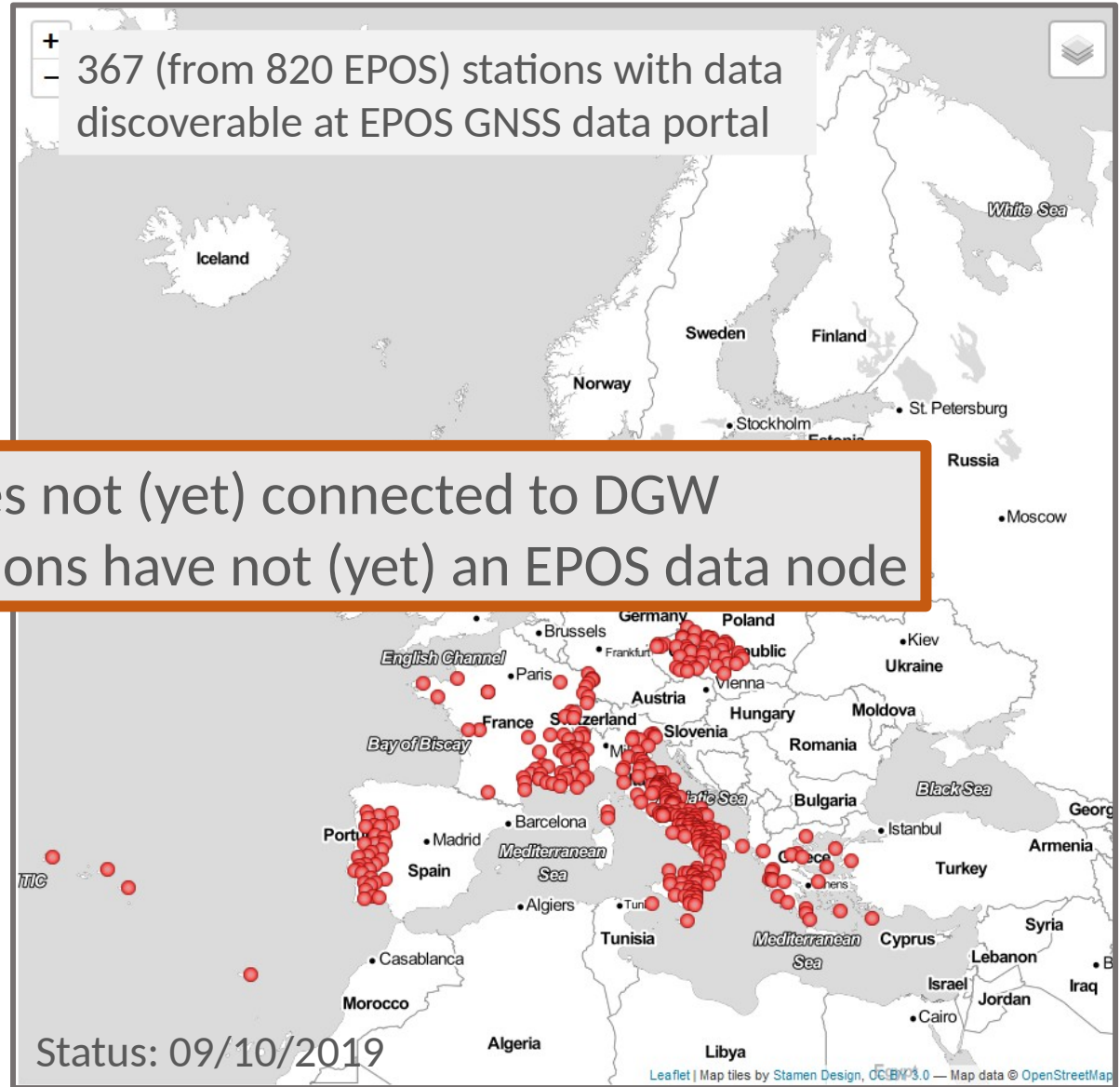


# RINEX Data Discoverability: Status

## GLASS NODES

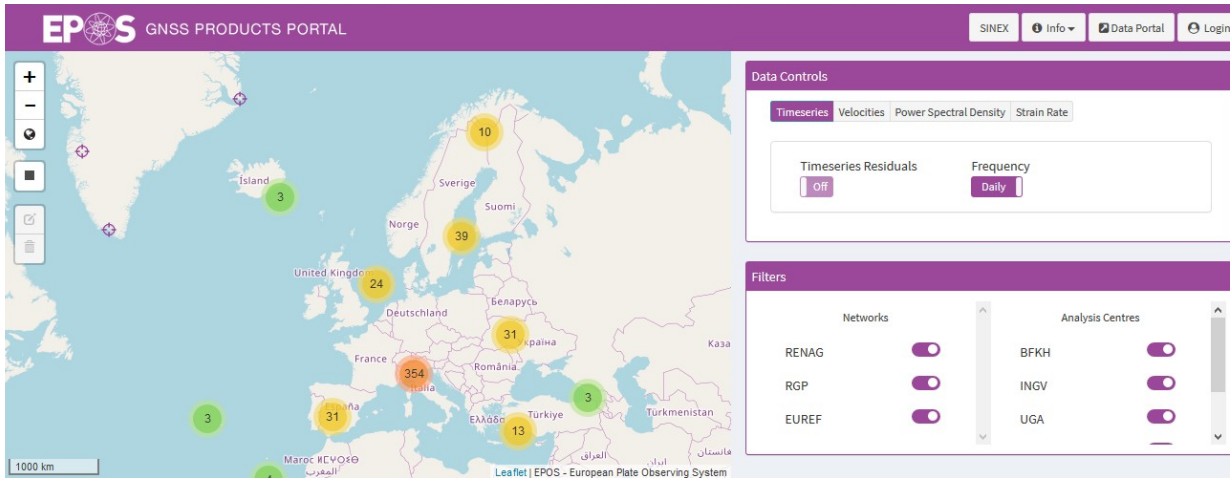


- Some data nodes not (yet) connected to DGW
- Some EPOS stations have not (yet) an EPOS data node



# GNSS Products

EPOS GNSS **Product** Portal: <https://gnssproducts.epos.ubi.pt/>



Analysis Centers **UPLOAD** products to product portal

Products can be based on data from EPOS and non-EPOS stations

## Uploaded Products

- A. EPOS-specific solutions
  1. Double difference
  2. PPP
  
- B. EUREF solutions
  1. EPN daily/weekly combined solution
  2. EPN reference frame solution
  3. EPN densification solution
  
- C. EPOS+EUREF solutions
  1. Combination of A.1, A.2, B.3
  2. Strain rates



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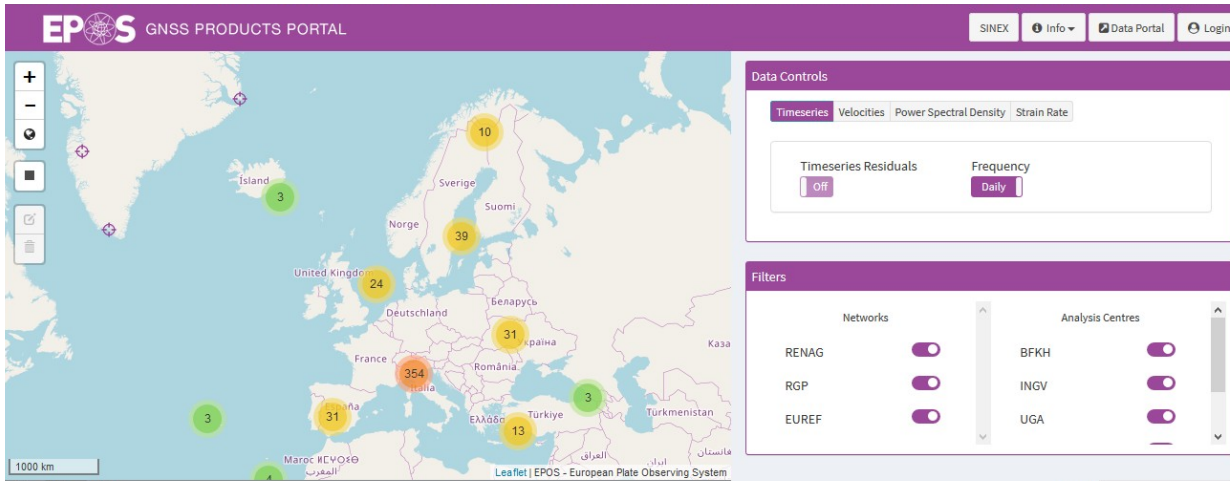
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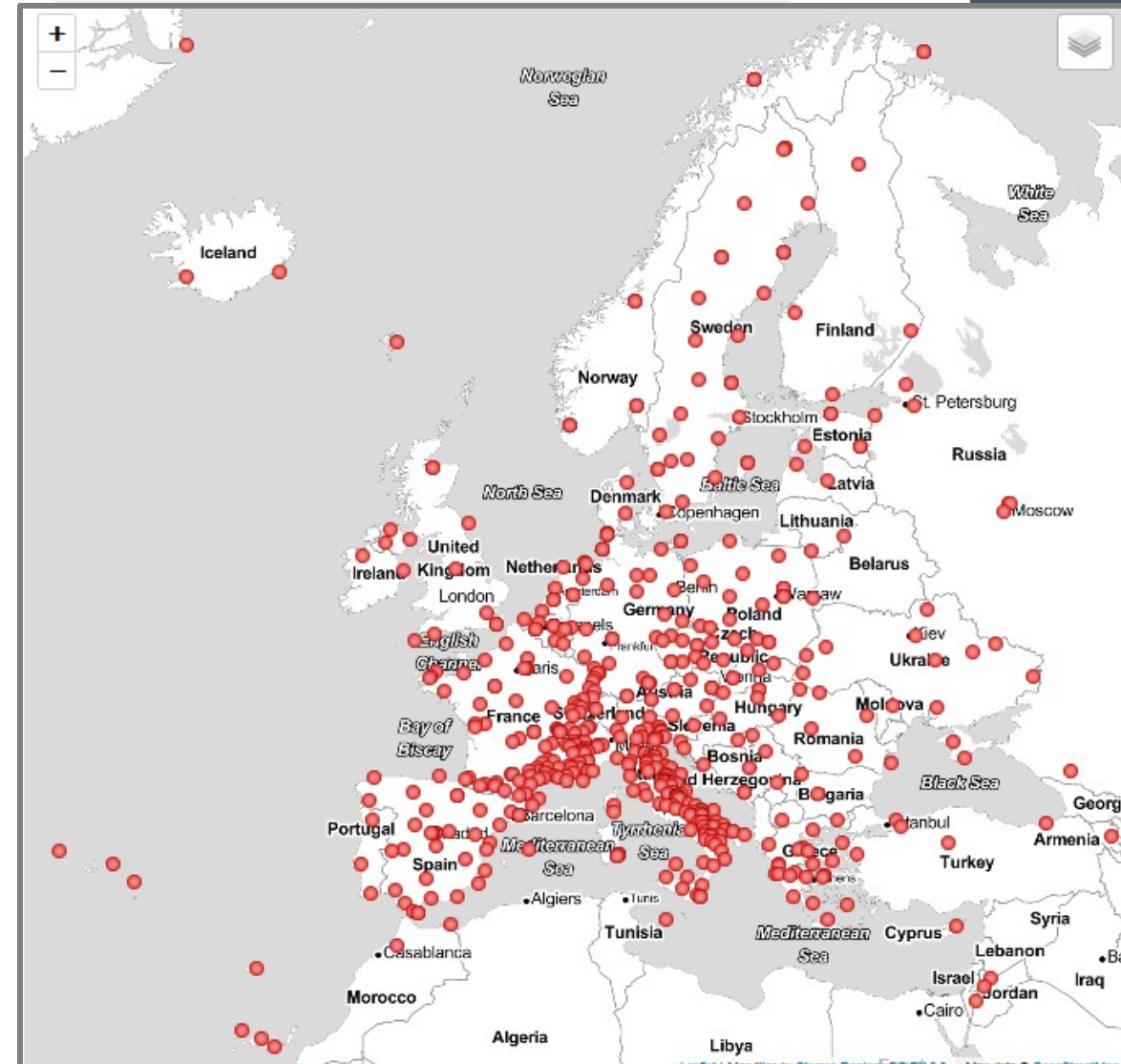


# GNSS Products

EPOS GNSS Product Portal: <https://gnssproducts.epos.ubi.pt/>



530 stations with products available from EPOS GNSS product portal



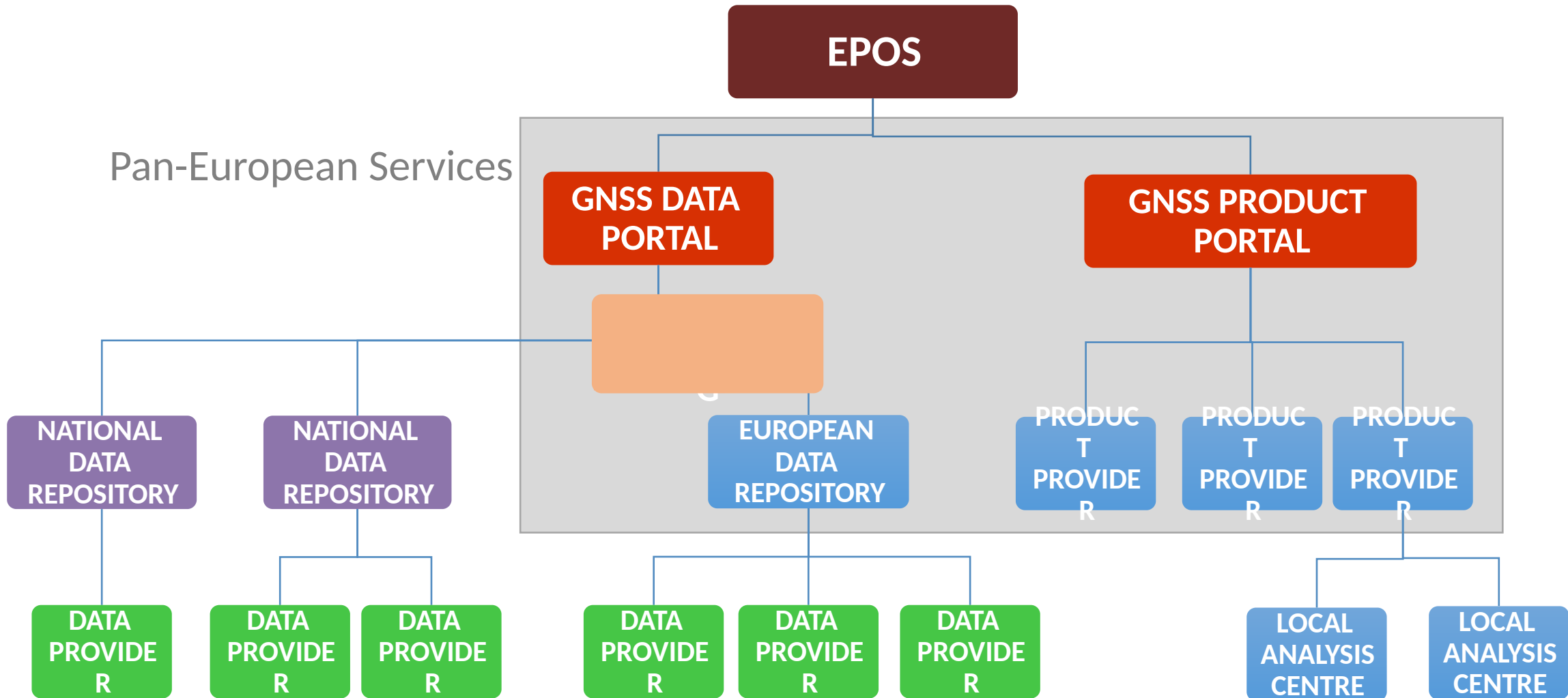
Analysis Centers UPLOAD products to product portal

Products can be based on data from EPOS and non-EPOS stations

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# EPOS-GNSS Service Providers





# EPOS-GNSS Service Providers

Committed to provide pan-European GNSS services to EPOS (Cooperation Agreement)

- Bundesamt für Kartographie und Geodäsie, Germany
- Université Grenoble Alpes, France
- Observatoire de la Côte d'Azur, France
- Centre National de la Recherche Scientifique, France
- Lechner Non-profit Ltd., Hungary
- Istituto Nazionale di Geofisica e Vulcanologia, Italy
- Lantmäteriet, Sweden
- Royal Observatory of Belgium, Belgium
- University Beira Interior, Portugal
- Warsaw University of Technology, Poland

Consortium Agreement signed before end of 2019



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# GNSS Governance

- Consortium Board
  - Representative of each agency providing pan-European Services
  - Strategies/decisions (like EUREF Governing Board)
- Executive Board
  - Day-to-day operations
- External Advisory Committees
  - Data Supplier Committee (like IGS associate members), to be set up
  - User Feedback Group
  - Represented in Consortium Board

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# EUREF 2019 Resolution No2

The IAG Reference Frame Sub-commission for Europe (EUREF) **recognising that that the European Plate Observing System (EPOS) will maintain a sustainable European infrastructure** for solid Earth studies from 2020 onwards, including a GNSS infrastructure and related GNSS-based products

and noting the efforts of the EUREF community towards the derivation of a European deformation model in order to improve cross-boundary positioning

and considering that many European countries active in EUREF are a member (or planning to become a member) of the EPOS European Research Infrastructure Consortium (ERIC)

**encourages the EUREF community to also contribute to EPOS especially to its GNSS component**

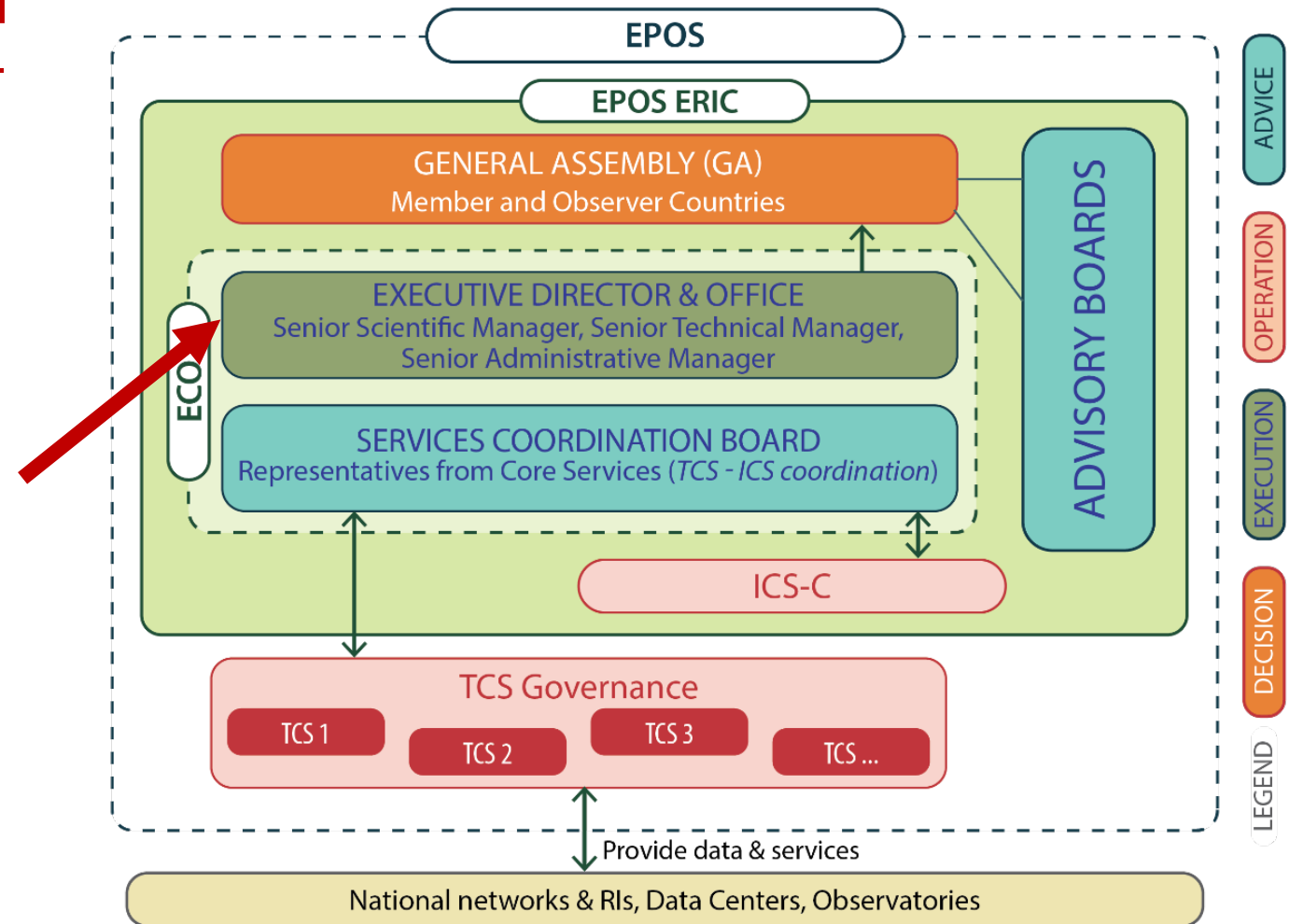


# How to Join EPOS-GNSS?

Everyone can join, independently if your country is a member of EPOS-ERIC!

- Become observer/member country of EPOS-ERIC

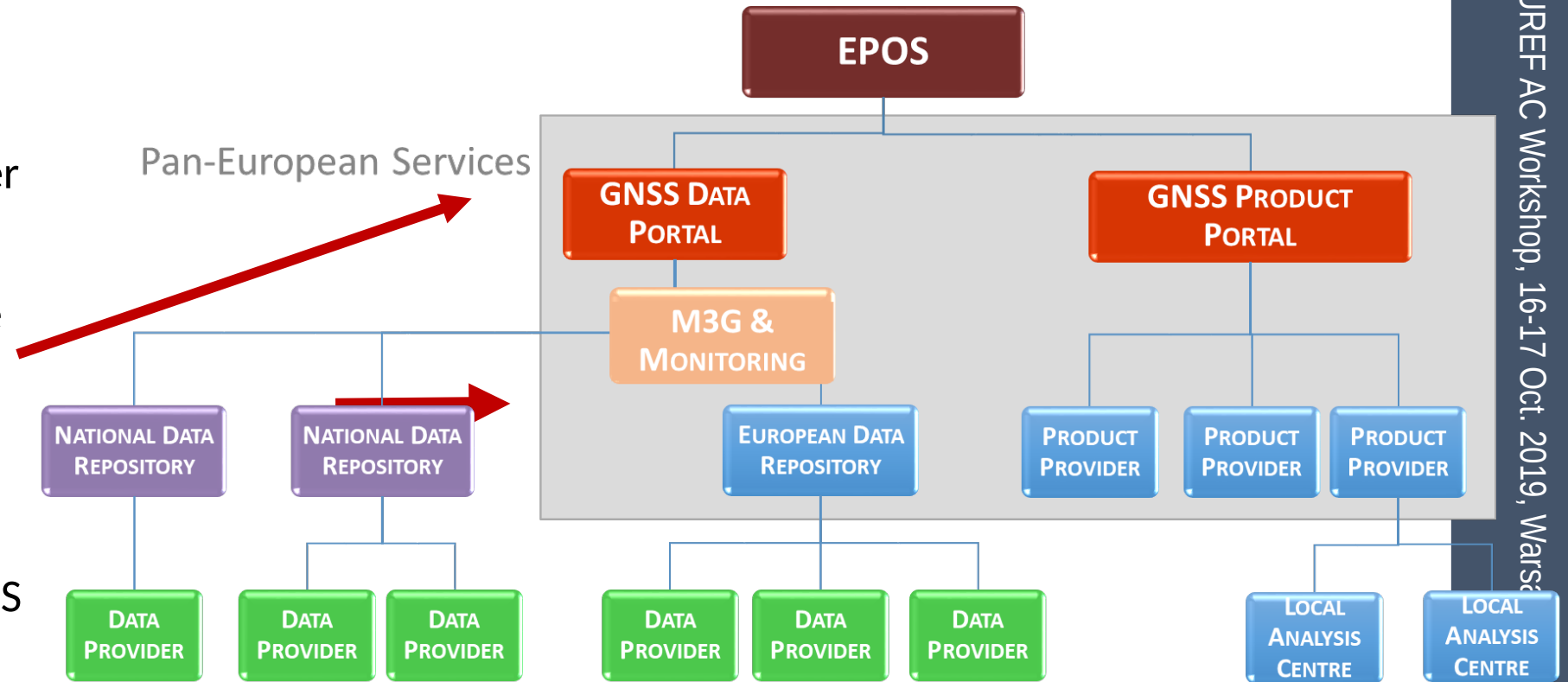
✓ Contact: EPOS-ERIC Executive director, Massimo Coco, Lilli Freda (INGV, [carmela.freda@ingv.it](mailto:carmela.freda@ingv.it))



# How to Join EPOS-GNSS?

## Pan-European Service Provider

- ✓ Demonstrate provision of pan-European GNSS service relevant for EPOS
- ✓ Decision by Consortium Board
- ✓ Contact: Chair of EPOS-GNSS Consortium Board: R. Fernandes (UBI, [rui@segal.ubi.pt](mailto:rui@segal.ubi.pt))



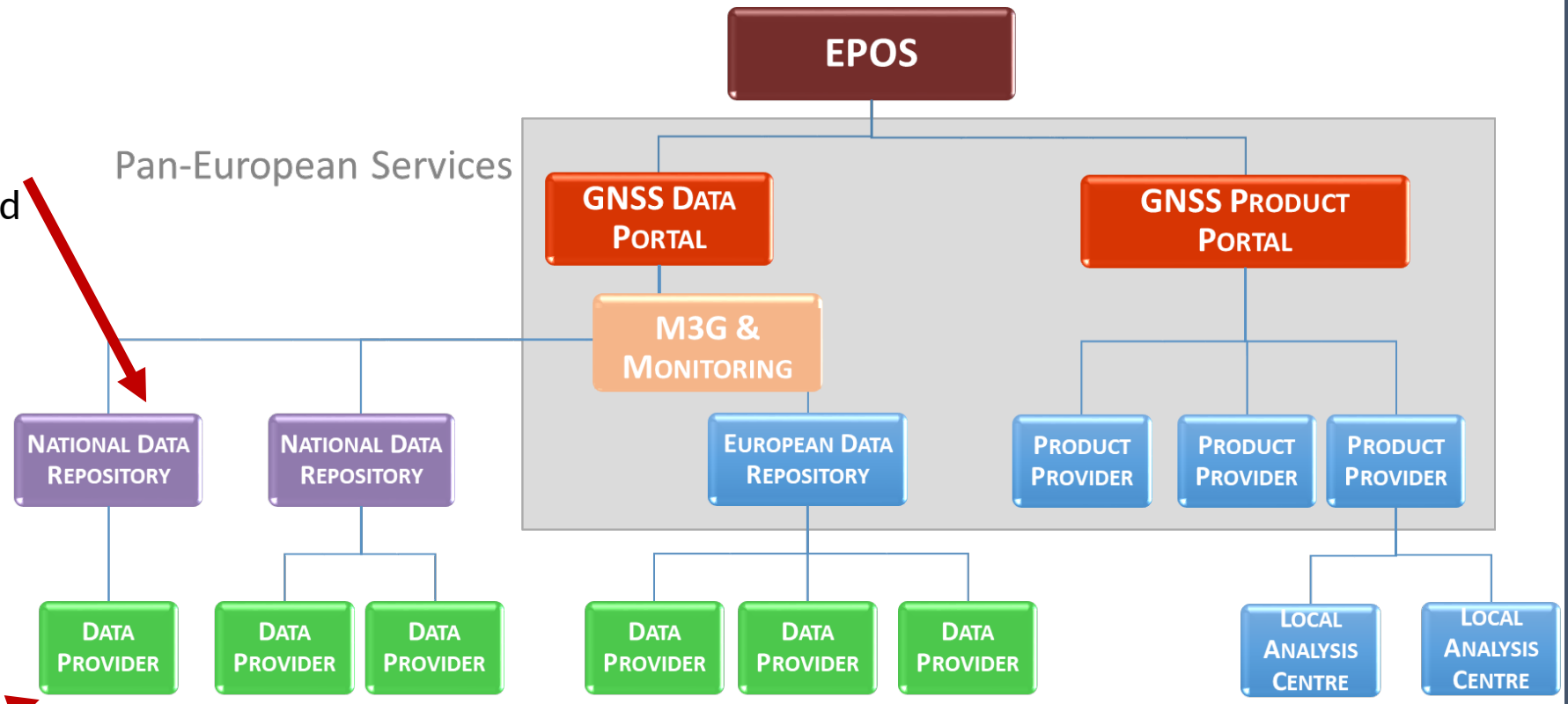
# How to Join EPOS-GNSS?

- Data Node

- ✓ Follow procedure in “Guidelines for setting up and operating and EPOS-GNSS data node”
- ✓ Contact: Jean-Luc Menut (OCA, [menut@geoazur.unice.fr](mailto:menut@geoazur.unice.fr)) and Carine Bruyninx (ROB, [m3g@oma.be](mailto:m3g@oma.be))

- Data Provider

- ✓ Follow
  - ✓ “Procedure for including GNSS stations in EPOS”
  - ✓ “Procedure for including EPN stations in EPOS”
- ✓ Contact: Carine Bruyninx (ROB, [m3g@oma.be](mailto:m3g@oma.be))



- Analysis Centre

- ✓ Join through contributing as AC to EPN or EPN densification
- ✓ Contact: Ambrus Kenyeres (LTK, [ambrus.kenyeres@sgo-penc.hu](mailto:ambrus.kenyeres@sgo-penc.hu))

<https://gnss-metadata.eu/>

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# Conclusions

Pieces of the EPOS–GNSS puzzle are in place :

- EPOS-ERIC is in place with member countries, more countries in the process of joining
- First version of ICS portal available
- GNSS data portal and product portal are on-line and are connected to EPOS ICS
- GLASS software has been installed in several data centers
- M<sup>3</sup>G is used to submit/validate site logs in a harmonized way in both EUREF and EPOS □ EPN CB or/and EPOS-GNSS data portal

# Conclusions

## To be improved :

- ICS portal
- EPOS-GNSS data and product portals
- Link between GLASS nodes and Data portal
- GLASS node software more user-friendly
- Needs for operational production chain

## Data supplier letter □ RINEX data availability □ Product availability

- improve interfaces/communication between service providers
- agree on operational responsibilities about who responds promptly when problems occur.

# Conclusions

- Need time (1-2 years) to become an “fully operational” service
- EPOS-GNSS is not a closed club of friends
- Joining EPOS-GNSS can be done at different levels

QUESTIONS?