

Pan-European GNSS CORS Infrastructures

COMPLEMENTARITY AND MUTUAL BENEFITS

Eric Pottiaux, Carine Bruyninx, Andras Fabian, Juliette Legrand, Anna Miglio - Royal Observatory of Belgium (ROB)

Rosa Pacione – e-GEOS S.p.A, ASI/CGS, Italy

Ambrus Kenyeres – Lechner Non-profit Ltd., Hungary

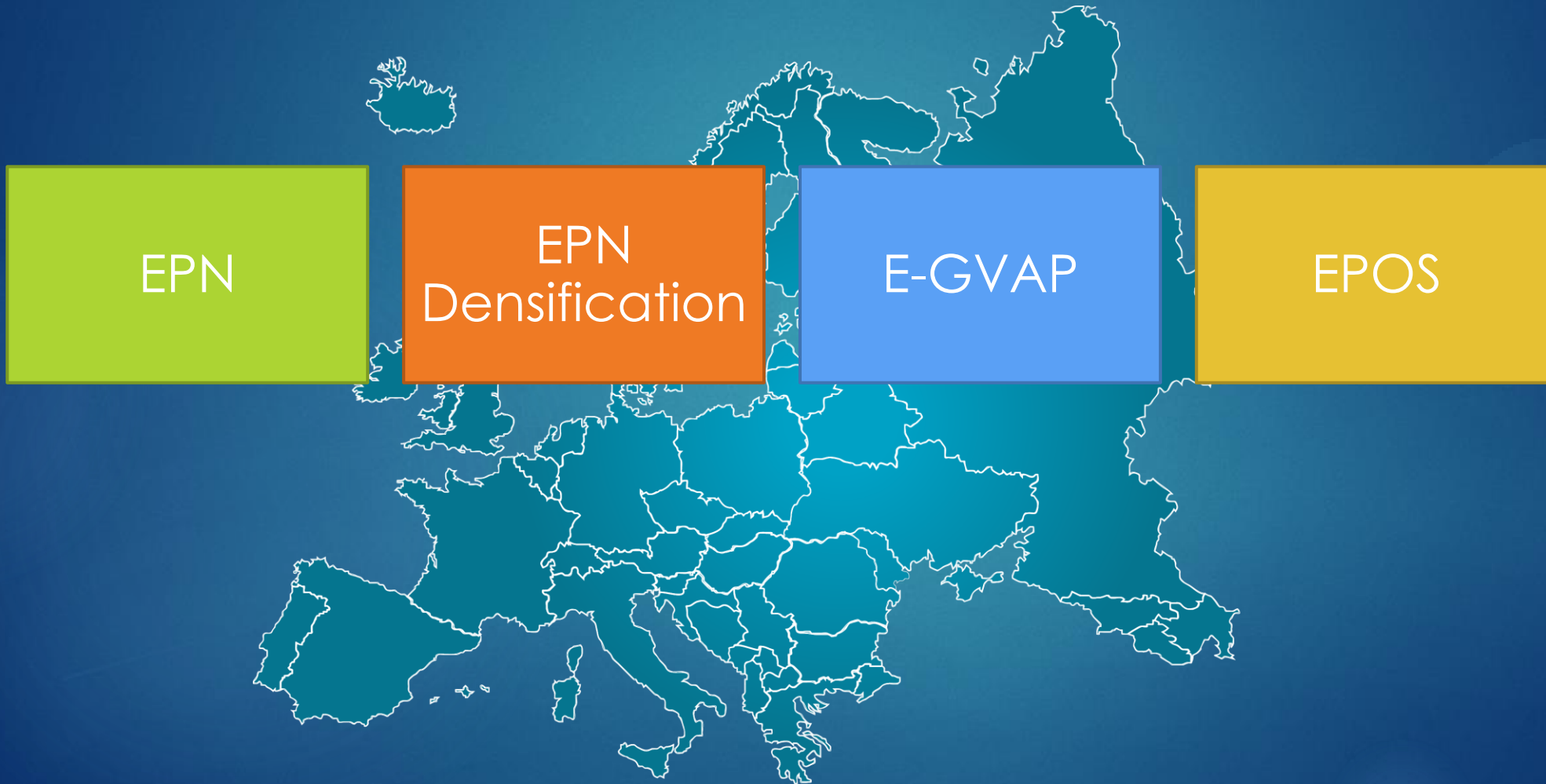
Context

OBSERVATION: INFRASTRUCTURES OVERLAPS AND COMPLEMENTARITY

Pan-European GNSS CORS Infrastructures

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4 Major Infrastructures (existing or in implementation)



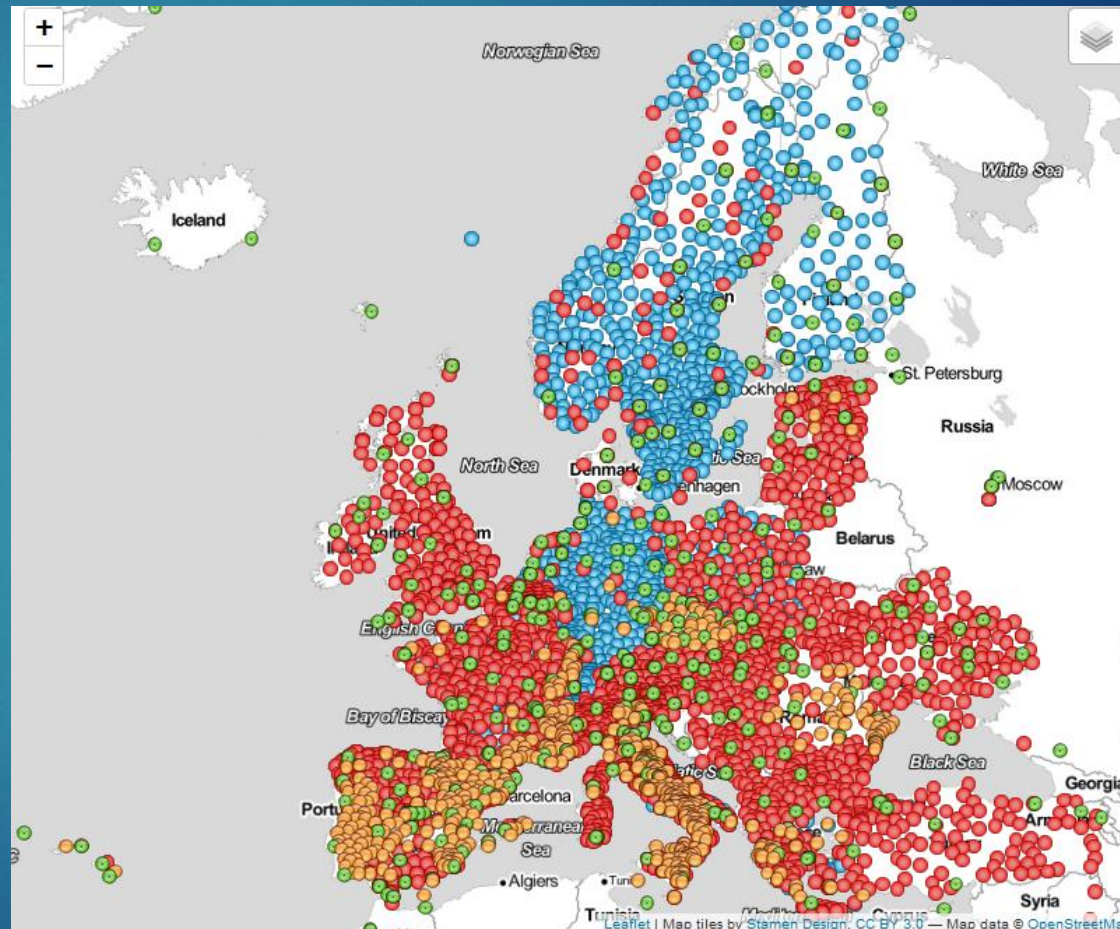
➤ Pan-European GNSS CORS Infrastructures

Pan-European Observing Networks

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Alltogether, 4916 GNSS stations

- EPN (~340)
- EPOS (~820)
- E-GVAP (~2700)
- EPN Densification (~3500)



➤ Pan-European GNSS CORS Infrastructures

EUREF Permanent Network (EPN)

Sub-Commission of the International Association of Geodesy (IAG)

- Primary mission: Maintain and provide access to the European Terrestrial Reference System (ETRS89) using selected GNSS reference stations
- How?
 - Maintaining precise ETRS89 coordinates for the EPN stations
 - Distributing GNSS observation data and metadata
 - EPN stations are used as reference stations when computing ETRS89 coordinates

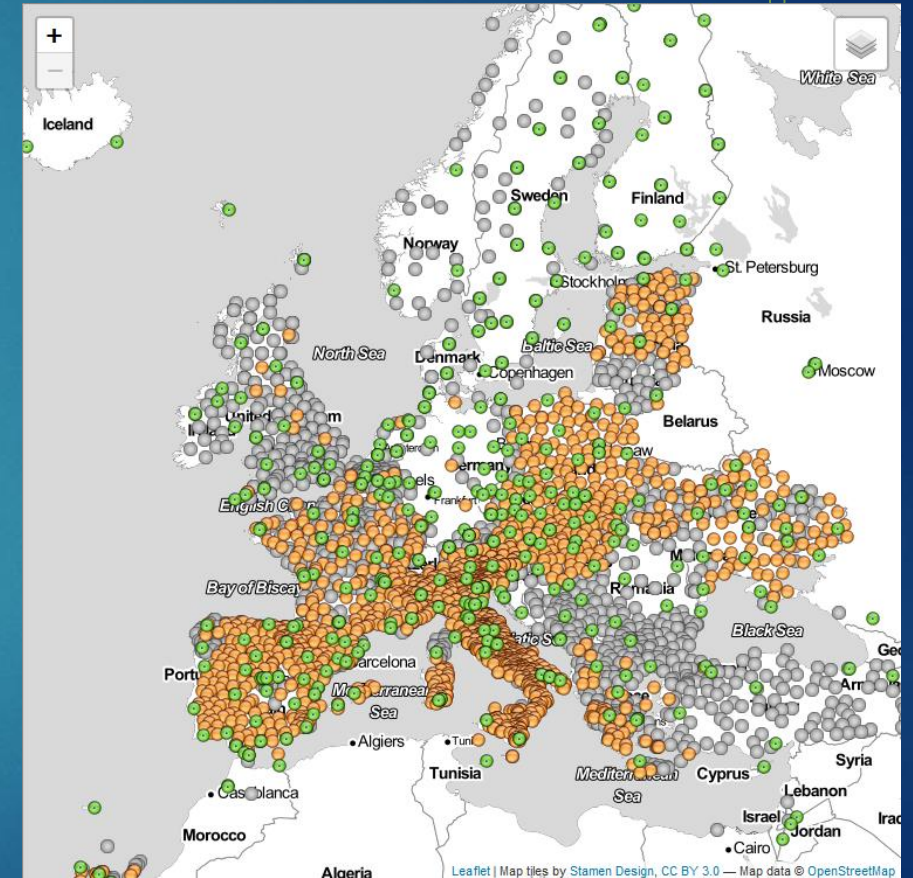


EPN Densification

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Sub-Commission of the International Association of Geodesy (IAG)

- Primary mission: Provide a continental-scale homogeneous, high quality position and velocity product using all possible geodetic GNSS stations in Europe.
- How?
 - By combining, each week, the position solutions provided by the Analysis Centres
 - Using the weekly combined solution, compute multi-year station positions and velocities



● EPN station
● EPN densification station with station log at the EPN CB
● EPN densification station without station log at the EPN CB

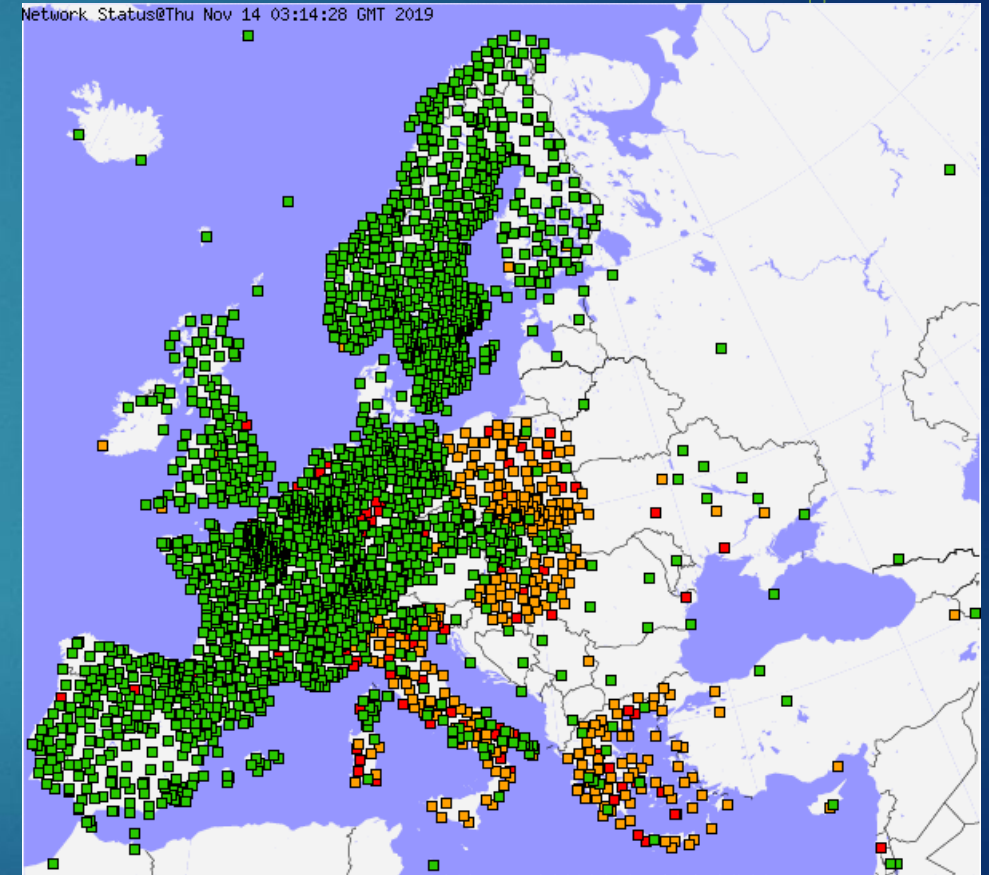
E-GVAP

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Program within EUMETNET

➤ Primary mission and how:

You know it better than me 😊



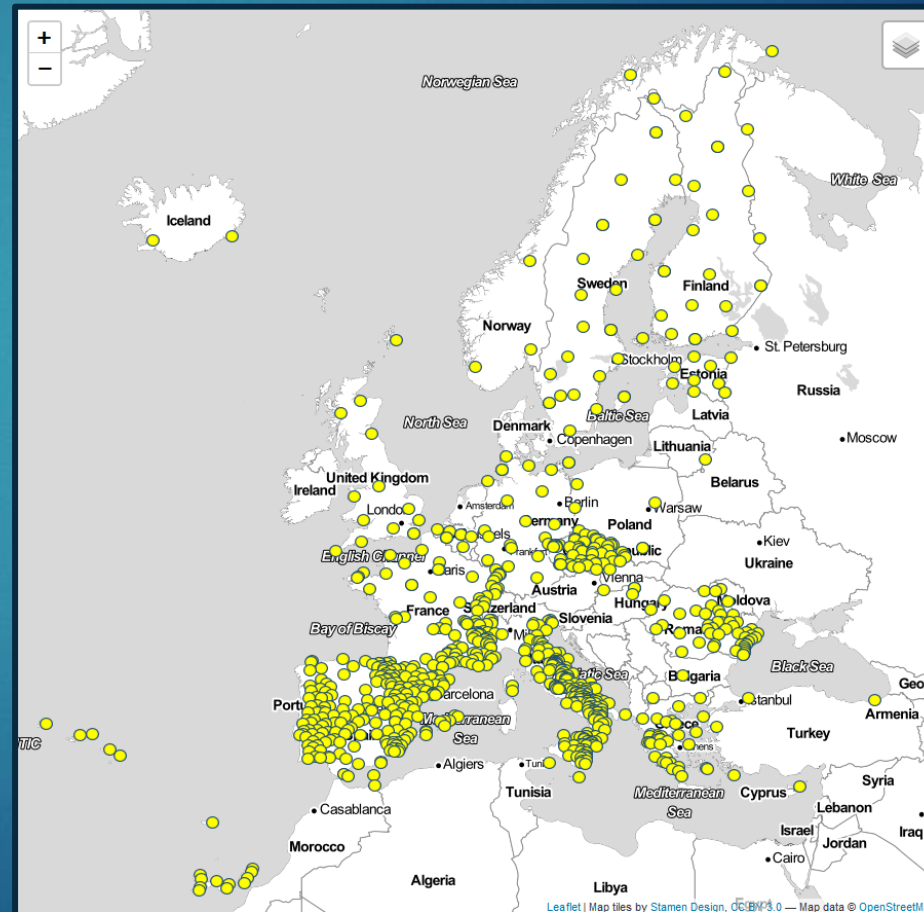
European Plate Observing System (EPOS)

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European Research Infrastructure Consortium (signed by the countries)

- ▶ **Primary mission:** support Solid Earth Science in Europe
- ▶ **How ?**
 - ▶ Distribute **GNSS** observation **data** and **metadata** from 3000+ continuously observing stations
 - ▶ Distribute GNSS **products** for Solid Earth Science
 - ▶ Coordinate time series
 - ▶ Station velocities
 - ▶ Strain rates

820 GNSS stations proposed to EPOS



▶ Pan-European GNSS CORS Infrastructure

4 Pan-European Infrastructures

COMPLEMENTARITIES AND SYNERGIES

Comparison of the Networks

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➤ Complementarity and Synergies between Initiatives

		EPN	EPN Dens.	E-GVAP	EPOS
RINEX DATA	OPEN	MANDATORY	UNKNOWN	UNKNOWN	MANDATORY
	ARCHIVING	AT DATA CENTRES	UNKNOWN	UNKNOWN	ENCOURAGED
	CENTRALISED ACCESS	YES	NO	NO	YES
METADATA	SITELOG	MANDATORY	ENCOURAGED	NO	MANDATORY
DATA ANALYSIS	STATION	TOP DOWN	BOTTOM UP	BOTTOM UP	TOP DOWN

For the missing pieces of the puzzle → sent a short enquiry to EPN densification and E-GVAP analysis centres to get ideas on futures priorities.

GNSS (RINEX) Data

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➤ Complementarity and Synergies between Initiatives

		EPN	EPN Dens.	E-GVAP	EPOS
RINEX DATA	OPEN	MANDATORY	UNKNOWN	UNKNOWN	MANDATORY
	ARCHIVING	AT DATA CENTRES	UNKNOWN	UNKNOWN	ENCOURAGED
	CENTRALISED ACCESS	YES	NO	NO	YES

▶ Questionnaire:

- ▶ Large majority of AC uses daily RINEX data and consider centralized European data archive beneficial
- ▶ Data usage by third parties
 - ▶ 8% of networks with data not freely available
 - ▶ 30% of networks: unknown
 - ▶ Rest available to third parties (free or with agreement)
- A lot of missing information
- ▶ Data archived for 90% of networks (mostly by ACs) → Few GNSS data potentially lost

GNSS Metadata

Importance of the Metadata

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➤ Complementarity and Synergies between Initiatives

		EPN	EPN Dens.	E-GVAP	EPOS
METADATA	SITELOG	MANDATORY	ENCOURAGED	NO	MANDATORY

- ▶ FAIR (*) and correct metadata are very important :
 - ▶ Station identification (naming, coordinates, responsible agencies...)
 - ▶ Correct processing
 - ▶ Jumps identifications
 - ▶ ...
- ▶ What kind of metadata do we have ?
 - ▶ EPN, EPOS : list of stations + locations + all site logs
 - ▶ EPN densification: list of stations + locations + some site logs
 - ▶ E-GVAP: list of stations + locations *(thanks to Owen Lewis et Gemma Bennit, UK MetOffice)*

(*) FAIR: Findable, Accessible, Interoperable, and Re-usable - <https://www.go-fair.org/fair-principles/>

GNSS Metadata

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Harmonization and Centralisation of the Metadata



Metadata Management and distribution system for Multiple GNSS Networks

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

- ▶ EPN, EPN densification, and EPOS: harmonized and centralized the metadata through the M³G infrastructure
- ▶ Questionnaire sent to E-GVAP ACs:
 - ▶ Large majority of AC uses a priori **metadata** for data analysis. If no site log, metadata reconstructed from RINEX headers
 - ▶ Consider centralized European metadata archive beneficial (100% for E-GVAP AC)
- ▶ Site logs existing at national level could be integrated in M³G (such as for the regional Belgian networks)

➤ Complementarity and Synergies between Initiatives

EPN, EPN Densification, EPOS

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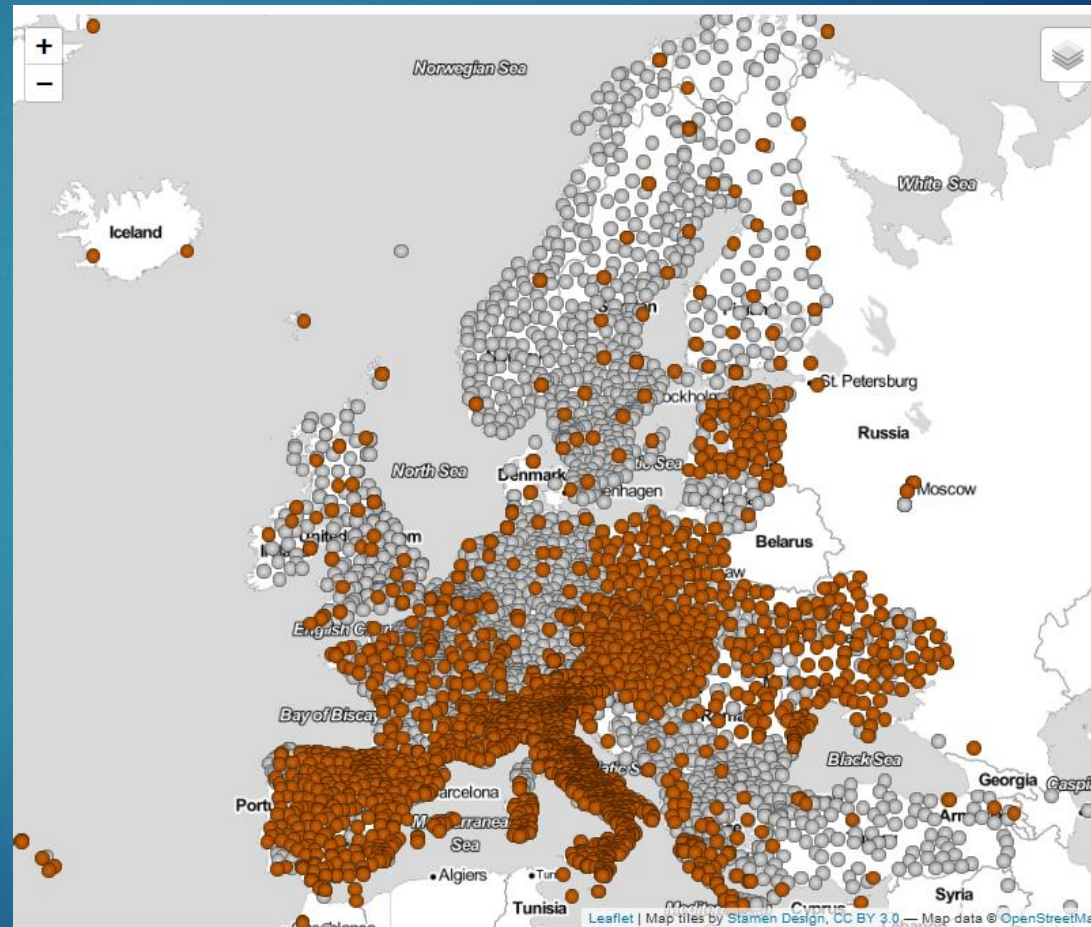
In total, 4916 GNSS stations

- 58% without centralized site log
- 42% with centralized site log in M³G

Site log availability in M³G:

EPN	100%
EPN densification	54%
EPOS	100%
E-GVAP (*)	35%

(*) thanks to overlaps with other networks



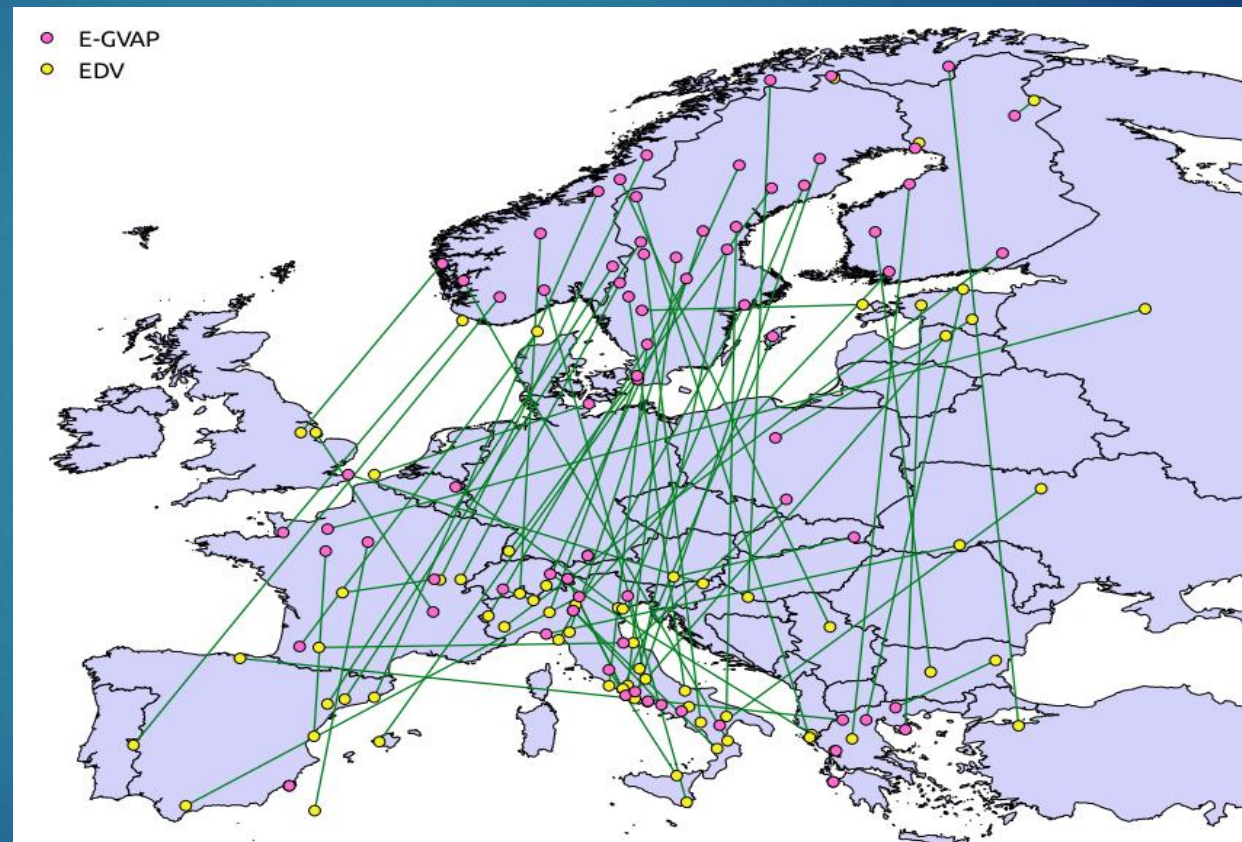
Complementarity and Synergies between Initiatives

GNSS Metadata and Station Naming

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E-GVAP vs EPN Densification Station Naming

- 1836 stations are included in both networks and (name + coordinates) agree
- 324 stations show name conflict
- 193 stations with same names but their coordinates conflict
- 1424 stations are included only in E-GVAP or EPN densification



➤ Complementarity and Synergies between Initiatives

Hamonized and centralized metadata helps preventing station naming and coordinate conflicts

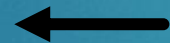
GNSS Data Analysis & Products

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➤ Complementarity and Synergies between Initiatives

		EPN	EPN Dens.	E-GVAP	EPOS
DATA ANALYSIS	STATION	TOP DOWN	BOTTOM UP	BOTTOM UP	TOP DOWN

Information about stations must be acquired through the analysis centers



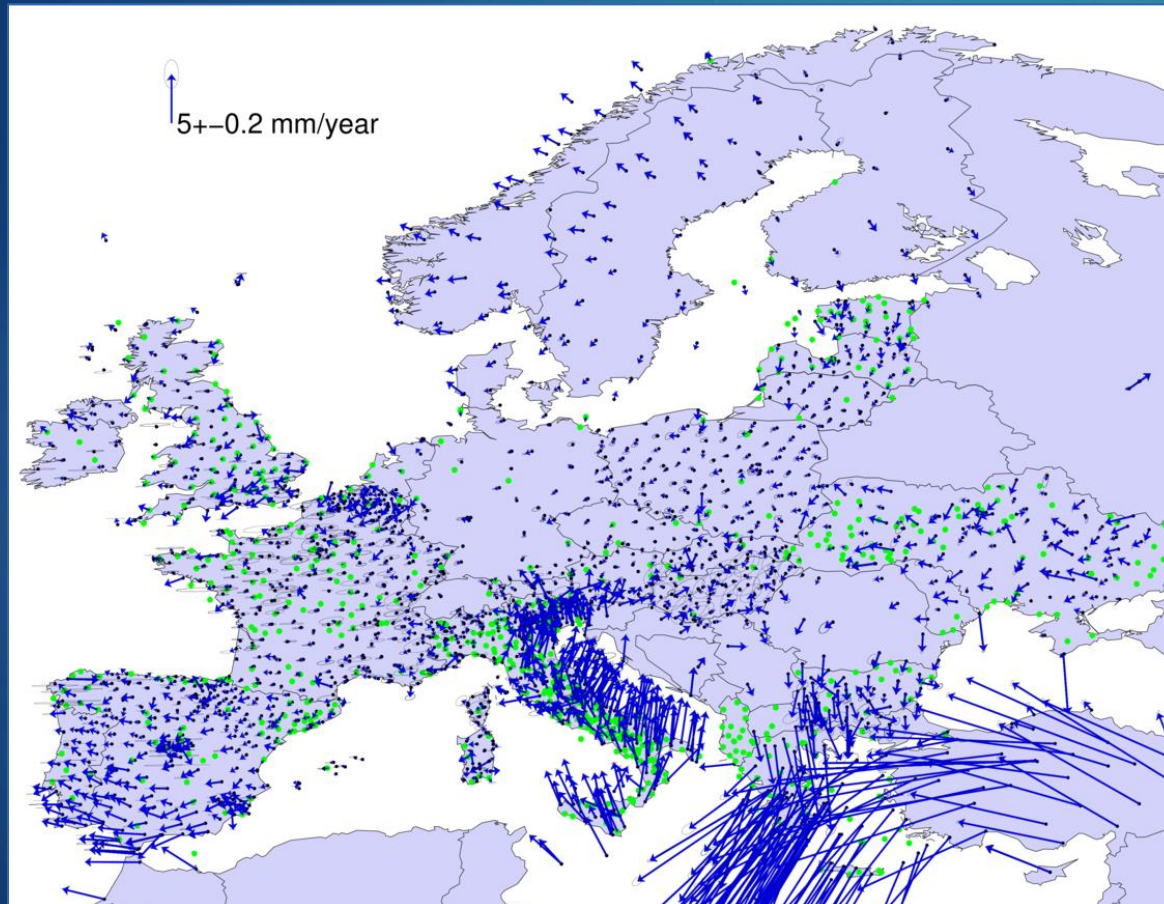
Station is included in network when products for that station are submitted by the analysis center

- ▶ Existing collaboration between EPN, EPN densification and EPOS analysis centres (mutual benefits)
- ▶ Potential collaboration with E-GVAP analysis centres?

EPN Densification

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ESTIMATED 2D VELOCITIES (ETRF2000)

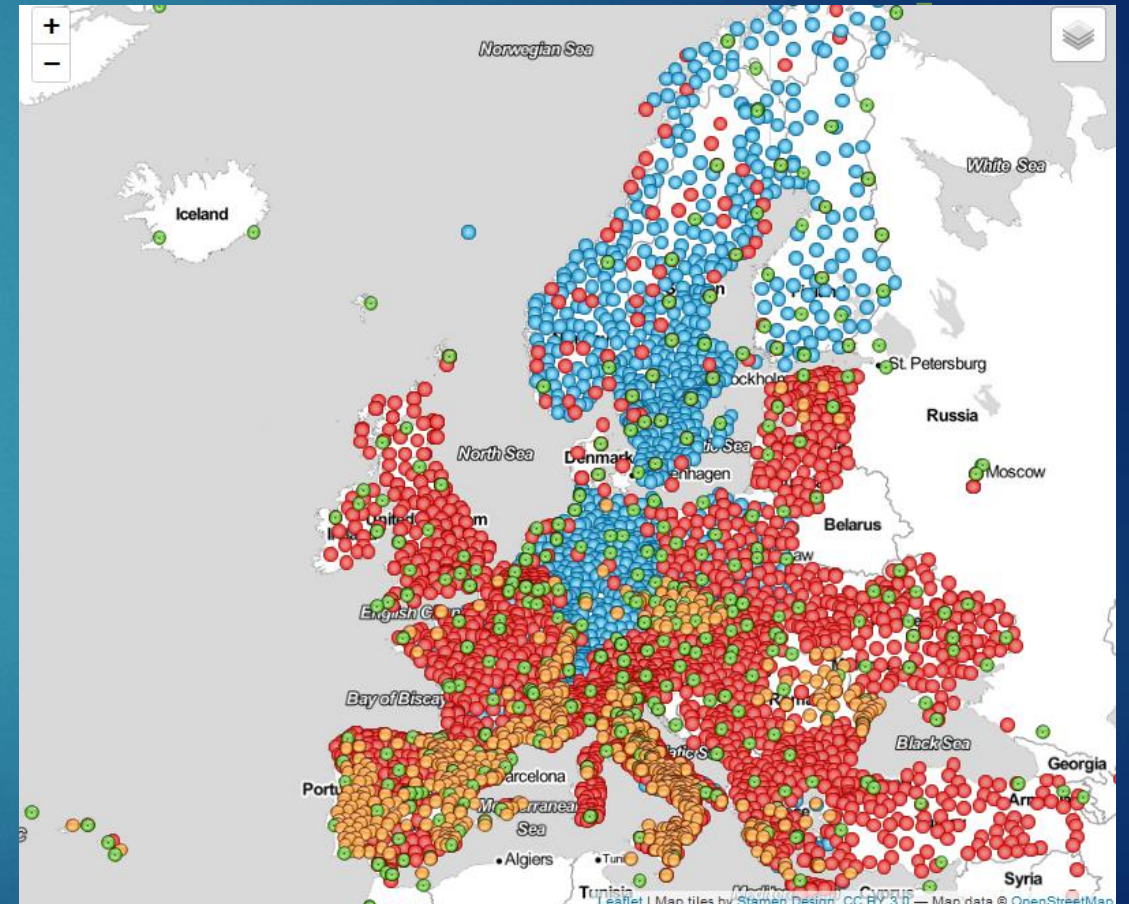
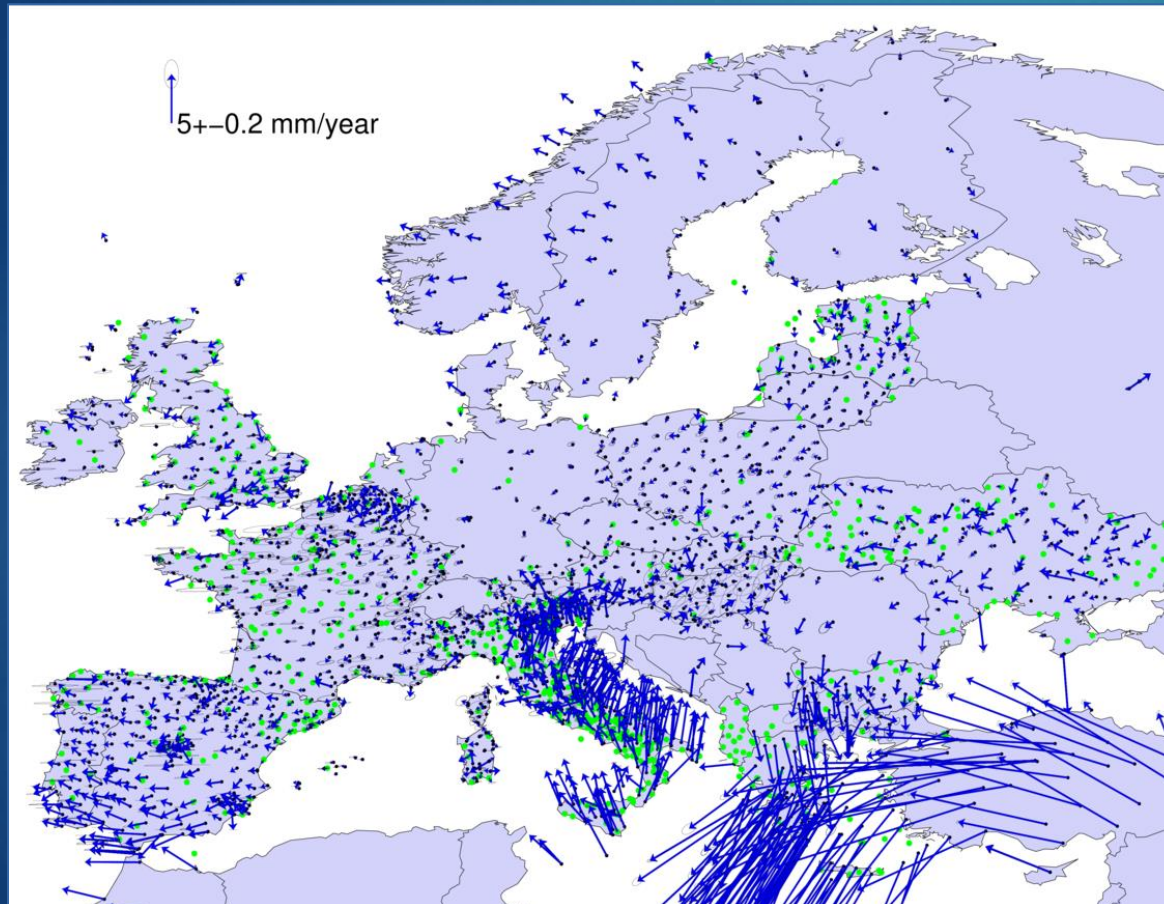


➤ Complementarity and Synergies between Initiatives

EPN Densification

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ESTIMATED 2D VELOCITIES (ETRF2000)



Next steps

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Recommendations to E-GVAP

- ▶ Ensure archiving of all GNSS observation data used within E-GVAP (not necessarily centralized)
- ▶ Strengthen the existing collaboration with EUREF (MOU)
 - ▶ Harmonize station name in collaboration with EUREF and EPOS
 - ▶ Create 'E-GVAP' network (and define rules) within M³G (<https://gnss-metadata.eu/>) to maintain station's site logs and contribute to centralized European GNSS metadata system (site logs)
 - ▶ Provide station's coordinates from E-GVAP solutions to test its added-value for the EPN Densification (needs ACs producing daily or weekly station coordinates in SINEX format, who can contribute?).

Thank you...