The FAIR-GNSS project: an Open Data Portal for European and Belgian GNSS data collections, built upon FAIR guiding principles

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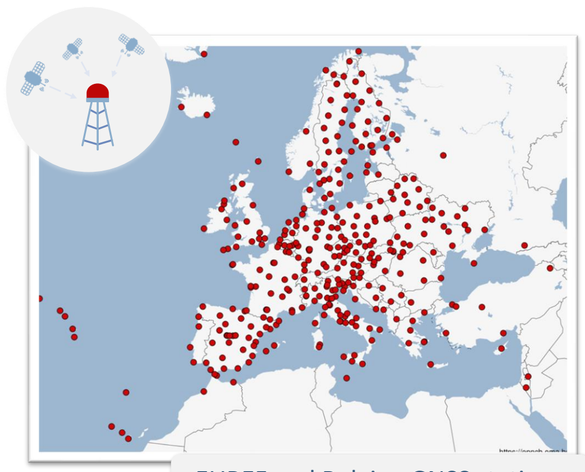
In the context of scientific research becoming more and more data-driven, it is essential that data are properly documented, preserved and accessible to both humans and machines.

FAIR data principles are a community-agreed set of guidelines for finding, accessing, integrating, and reusing data. However, FAIR data principles are general principles and putting them into practice can be challenging.

The Royal Observatory of Belgium (ROB) maintains repositories containing decades of observation data from Belgian and European stations permanently tracking Global Navigation Satellite Systems (GNSS) e.g. GPS or Galileo. ROB has embarked on a project focused on the application of FAIR principles to improve GNSS data management and foster reuse of GNSS data.

Motivation



EUREF and Belgian GNSS stations

ROB maintains repositories containing **observation data** from Belgian and European stations permanently tracking Global Navigation Satellite Systems (**GNSS**).

GNSS data allow precisely measuring ground deformations, monitoring space weather, providing evidence of climate trends, input for numerical weather predictions, etc.

ROB's GNSS data repositories were in need of a thorough **modernization** and it was also necessary to respond to the demands of GNSS users, station managers and the scientific community:

- **acknowledge (cite) data providers**
- **provide data license information**
- **maximize interoperability and discoverability of geodetic products/services, …**

FAIR-GNSS objectives & methodology

Gap analysis: FAIR assessment tools

Turn data into a FAIR Digital Object: metadata and PIDs

Restructure data repositories to become FAIR-enabling AND Trustworthy

Use standard communications protocols to retrieve metadata and data

Open Data Portal

FAIR data principles

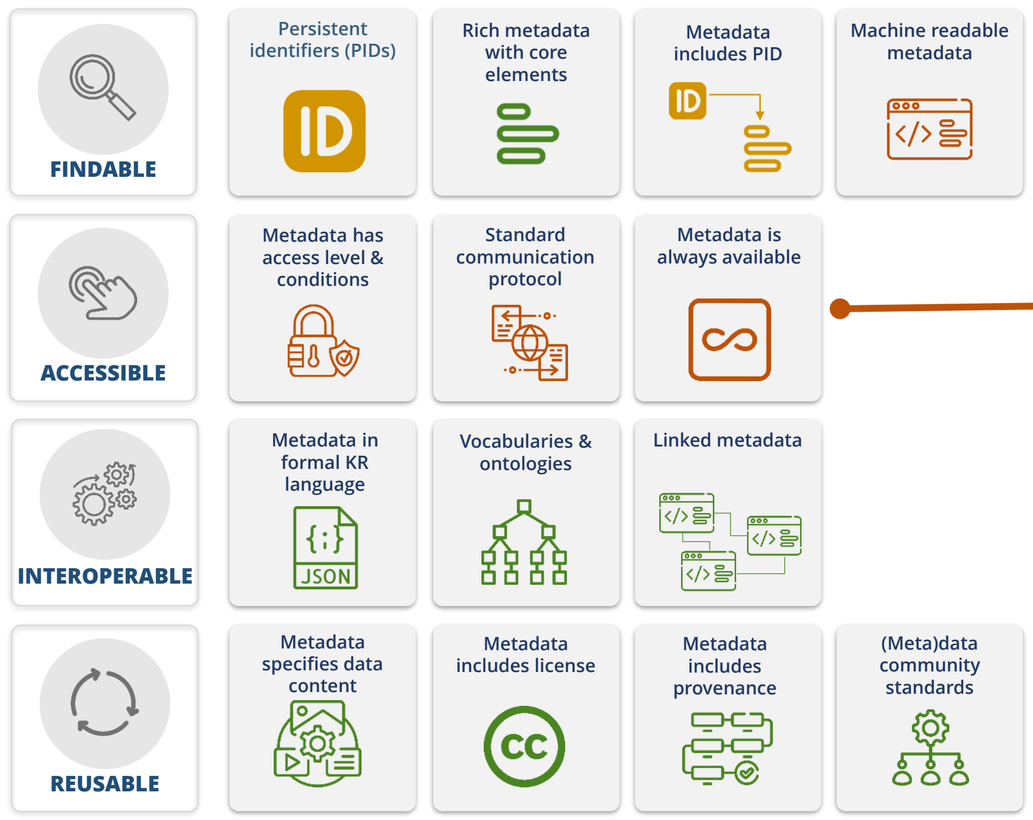


Image: UGent Data Stewards, adapted from Australia Research Data Commons (ARDC)

DOI for GNSS data

Motivation:
Lack of citation of GNSS data (providers)

FAIR-GNSS results:
Proposal for assigning DOIs to GNSS data, under discussion with the Global Geodetic Observing System Working Group on DOI:

- harmonization with the community as a goal
- FAIR principles ad key guidelines
- agreement on the level of DOI granularity i.e. **a DOI for the ongoing GNSS data measured for each GNSS station**, DOI for GNSS networks are also allowed
- use of DataCite schema and further standardization of DOI metadata content via standardized vocabularies

Metadata for GNSS data

Motivation:
No metadata accompanying GNSS data files i.e. RINEX files
No existing standard for GNSS file metadata

FAIR-GNSS results:
Rich metadata based on user requests when searching & downloading GNSS data, FAIR data principles (data license, data provenance, standardization, …) and community feedback

GNSS-DCAT-AP: schema proposal for RINEX-dependent metadata. GNSS-DCAT-AP (available on GitHub, see QR code above) is an extension of DCAT Application Profile for open datasets and data portals (DCAT-AP), and includes attributes specific to RINEX files: type of RINEX file (compression format, frequency), antenna type…

GNSS data repository API

Motivation:
Need for machine-operable access to GNSS data AND metadata.

FAIR-GNSS results:
Web **Application Programming Interface (API)** to download RINEX files AND associated metadata:

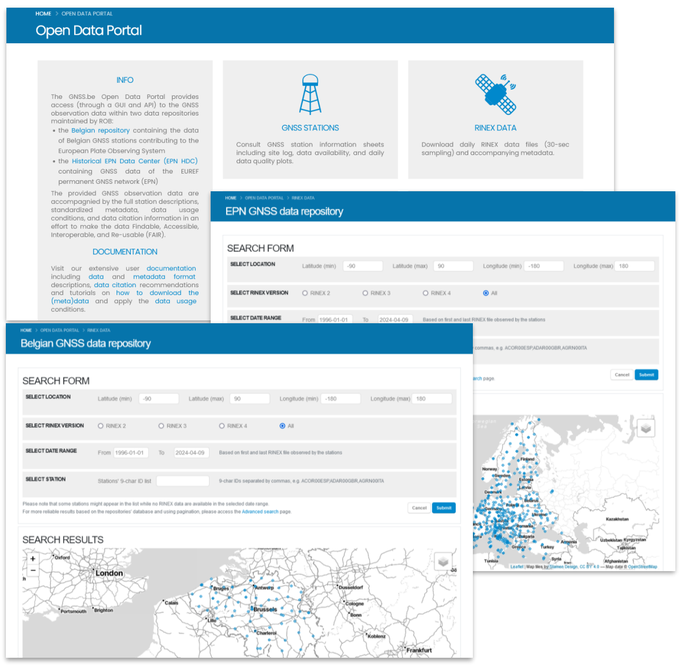
- RESTful API
- metadata in the GNS-DCAT-AP schema
- JSON-LD serialization format
- API documented on the Open Data Portal and on the Swagger dashboard (see QR codes above, one for each repository)

GNSS.be Open data Portal

The **GNSS.be Open Data Portal** provides access (through a GUI and API) to the GNSS observation data within two data repositories maintained by ROB:

- the **Belgian repository** containing the data of Belgian GNSS stations contributing to the European Plate Observing System
- the **Historical EPN Data Center (EPN HDC)** containing GNSS data of the EUREF permanent GNSS network (EPN)

The provided **GNSS observation data are accompanied by the full station descriptions, standardized metadata, data usage conditions, and data citation information** in an effort to make the data Findable, Accessible, Interoperable, and Re-usable (FAIR)



Understanding how to put FAIR principles into practice, navigating among different metadata standards, restructuring the repositories and constant interaction with the scientific community required significant effort and time, but were key to the realization of FAIR-GNSS objectives.

Applying FAIR data principles requires investing resources (including considerable manpower), collaboration with experts (e.g., data stewards), building new expertise e.g. on metadata, long-term planning, and a continuous assessment.

Nonetheless, at each new development cycle, the level of FAIRness increases, ROB's repositories evolve towards becoming trustworthy data repositories, and the core services that ROB has been offering to the EUREF and Belgian GNSS communities improve.

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