EUREF Analysis and Data Center at BEV Vienna



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Abstract

Reliable data infrastructure components are the fundamental background for scientific work with global distributed geodetic GNSS permanent stations. Therefore, the Federal Office of Metrology and Surveying (BEV) in Vienna decided to contribute to these long term activities on different levels. Besides creating one of the Data Centers within EUREF we also established an Analysis Center which processes one of the biggest network parts of the European Permanent Network EPN. This is a valuable contribution to the international reference frame community. In addition to the European Network we also monitor a dense Austrian network which is used for the determination of intraplate velocities.

Keywords: EUREF, GNSS, Data Center, Analysis Center, Reference System

Kurzfassung

Um im wissenschaftlichen Bereich mit global verfügbaren GNSS Permanentstationen arbeiten zu können ist eine verlässliche Dateninfrastruktur notwendig. Das Bundesamt für Eich- und Vermessungswesen (BEV) in Wien hat sich dazu entschlossen dauerhaft dazu auf mehreren Ebenen beizutragen. Neben dem Betreiben eines von zwei EUREF Datenzentren wurde ein Analysezentrum aufgebaut, in dem eines der größten EPN (European Permanent Network) Teilnetzwerke ausgewertet wird. Das stellt einen wertvollen Beitrag zur internationalen Gemeinschaft der Referenzsysteme dar. Zusätzlich zum europäischen Netzwerk wird ein verdichtetes österreichisches Netzwerk ausgewertet, um Geschwindigkeiten auf der europäischen Erdplatte zu bestimmen.

Schlüsselwörter: EUREF, GNSS, Datenzentrum, Analysezentrum, Referenzsystem

1. Introduction

The Reference Frame Sub-Commission for Europe (EUREF) of the International Association of Geodesy (IAG) was established in the year 1990. EUREF main goals are the definition, realisation and maintenance of the European Geodetic Reference Frame, which includes the 3D European Terrestrial Reference Frame (ETRF89) as well as the 1D European Vertical Reference System (EVRS).

For realising 3D reference frames a combination of data all over Europe is important. The European Permanent Network (EPN) was established to connect the data of GNSS permanent stations all over Europe and to make the data available to the whole community. EPN monitors the availability of the data and the metadata while the quality of the data is monitored by a combination of the network solutions of several analysis centers.

Austria acts as a Data Center (DC) as well as an Analysis Center (AC). Our contribution has a long tradition starting in the 90s of the last century. The Austrian Academy of Sciences (AAS) and the Federal Office of Metrology and Surveying started their contribution under the name Observatory Lustbühel Graz (OLG). OLG got one of the biggest ACs and one of two DCs as well. Nevertheless, AAS decided in 2016 that they will stop their contribution to the GNSS community. Consequently, BEV migrated these services from the AAS IT Infrastructure in Graz to the BEV Infrastructure in Vienna. The transition phase was used for a complete redesign of the services embedded in the new infrastructure in order to reach a better level of security and higher service availability. In the beginning of 2017 (day of year 100) the transition was completed. The higher service level and the improvement of our solutions were shown at the EUREF symposium 2019 in Tallinn, Estonia.

For the public the Data Center of BEV consists of one ftp server, which is accessible via *ftp://gnss.bev.gv.at*. RINEX files can be down- and uploaded there. In the background an admin server is among other things responsible for the verification of these files. In addition to this IT infrastructure a couple of servers were installed

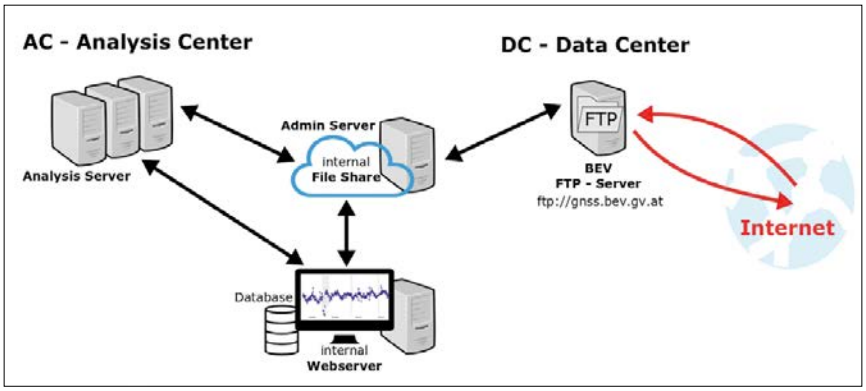

Fig. 1: Overview of IT infrastructure of Analysis and Data Center in BEV

for processing within the Analysis Center. Last but not least an internal webserver is used for an easy monitoring of AC and DC. Figure 1 shows a simplified overview of this IT infrastructure.

2. Data Center DC

A EUREF Data Center is responsible for collecting GNSS data, which are observed by the EPN. Further, it has to insure that the data provided satisfy certain standards, such as naming conventions, compression types etc. The Data Center connects the stations, which collect the data, with the analysts, which produce the final results in the Analysis Center. Therefore, it is a pivotal point in the processing chain and demands high reliability and redundancy. The EUREF community insures this by operating two completely independent Data Centers. They are managed by the Bundesamt für Kartographie und Geodäsie (BKG) in Germany and by the BEV in Austria. The Data Centers can be accessed at *ftp://gnss.bev.gv.at* and *ftp://igs.bkg.bund.de* respectively.

The BEV operates the EUREF Regional Data Centers for more than 20 years. During the migration from OLG to BEV the infrastructure of the Data Center was renewed completely and the data processing was brought up to current standards. However, the whole processing chain that downloads, checks and uploads the data was implemented in a serial fashion, which led from time to time to unforeseen availability delays of a couple of minutes at our ftp server. In order to address this issue the processing chain of the Data Center was parallelised. This was realised with the state of the art message broker RabbitMQ [1] which distributes incoming files to so called consumers, which process the data in parallel. The old Data Center was replaced in May 2019.

The BEV Data Center processes about 45,000 files per day, which amounts to about 2.7 GB of data. Since near real time products are derived from the uploaded data the Data Center is time sensitive. In practice this means that hourly as well as daily files, which contain data from the last hour and day respectively, are uploaded to the Data Center. In particular, the hourly files should be available within the first ten minutes after the finished hour. Data is provided in the standardised RINEX 3 as well as RINEX 2 format [2]. In total more than 4 million daily RINEX files (1.6 TB) and 42 million hourly RINEX files (1.2 TB) from 1996 until now are available at BEV Data Center (see Figure 2).

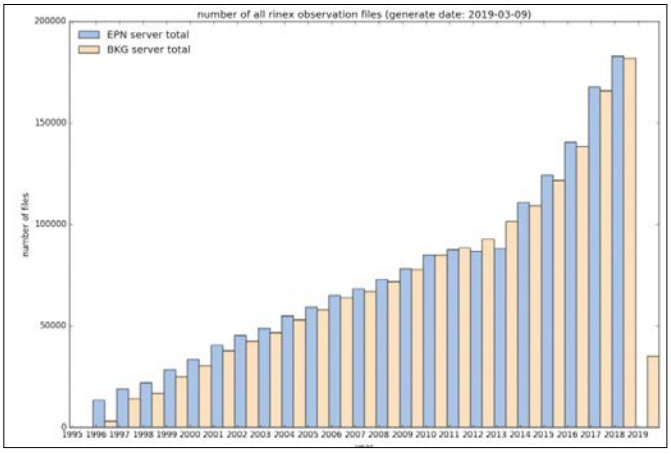

Fig. 2: Growing number of daily RINEX files in BEV Data Center

3. Analysis Center AC

After terminating the joint cooperation OLG between the Austrian Academy of Sciences and BEV in 2017 the BEV also took over parts of the OLG Analysis Center. In the Analysis Center RINEX observation files are evaluated in post-processing. For this process the worldwide known high-precision multi-GNSS software BERNESE (Version 5.2) is used [3]. OLG has analysed five networks in total. Besides the Austrian sub-networks of EPN (EUREF Permanent GNSS Network) and AMON (Austrian Monitoring Network), which are designed to realise the reference system ETRS89 in Austria, three other networks were processed with a geo-kinematic focus. These are CERGOP (Central European Geodynamics, 85 stations, started 1999), GREECE (120 stations, started 2013) and MON (Plate Boundaries in the Eastern Mediterranean, 70 stations, started 2000). In the new Analysis Center of BEV the focus is on the main two networks (EPN, AMON) and therefore CERGOP, GREECE and MON are no longer processed.

Fig. 3: EPN stations in sub-network of BEV Analysis Center [4]

3.1 EPN - EUREF Permanent GNSS Network

The EUREF Permanent GNSS Network (EPN) consists of more than 340 permanent GNSS tracking stations. The BEV operates one of the 16 EPN Analysis Centers and therefore contributes to the realisation of the reference system ETRS89 [4]. In 1996 the OLG started analysing a sub-network, which was taken over by BEV in 2017. At GPS week 1954, after a test phase of several weeks with the Analysis- and the Troposphere-Coordinator, the first contribution from BEV was submitted.

The sub-network from OLG has consistently been extended and currently consists of 115 stations (see Figure 3). The processing of RINEX files with the BERNESE software starts automatically when final satellite orbits are available. This automatic solution is then reviewed and, if necessary, reprocessed. In the end a daily and weekly solution of the BEV's sub-network is submitted to the BKG server in SINEX file format. The solutions of all EPN Analysis Centers are combined by the EPN ACC (Analysis Combination Center) in Poland to get a complete solution of the whole EPN network. In the final solution every station will have been analysed by at least three Analysis Centers.

In 2019 (GPS week 2044) the BEV Analysis Center started the processing of GALILEO data in addition to GPS and GLONASS data. In order to accommodate GALILEO data the workflow was adapted by using MGEX (Multi-GNSS Experiment) orbits and RINEX 3 data now. This resulted in an improvement of up to 30 % in accuracy compared to the mean solution of all ACs. In the near future it is also planned to derive a daily solution with rapid orbits and an hourly solution with ultra rapid orbits.

3.2 AMON – Austrian Monitoring Network

BEV generated an Austrian realisation of ETRS89 called "ETRS89/ETRF2000 Austria 2002.56", which was approved by the EUREF governing board in 2003. This solution was derived with 14 GPS stations during a one week measurement campaign. Just seven of these stations are also part of the Austrian RTK service APOS (Austrian Positioning Service) [5]. The APOS network consists currently of 65 stations, 36 of these are in Austria.

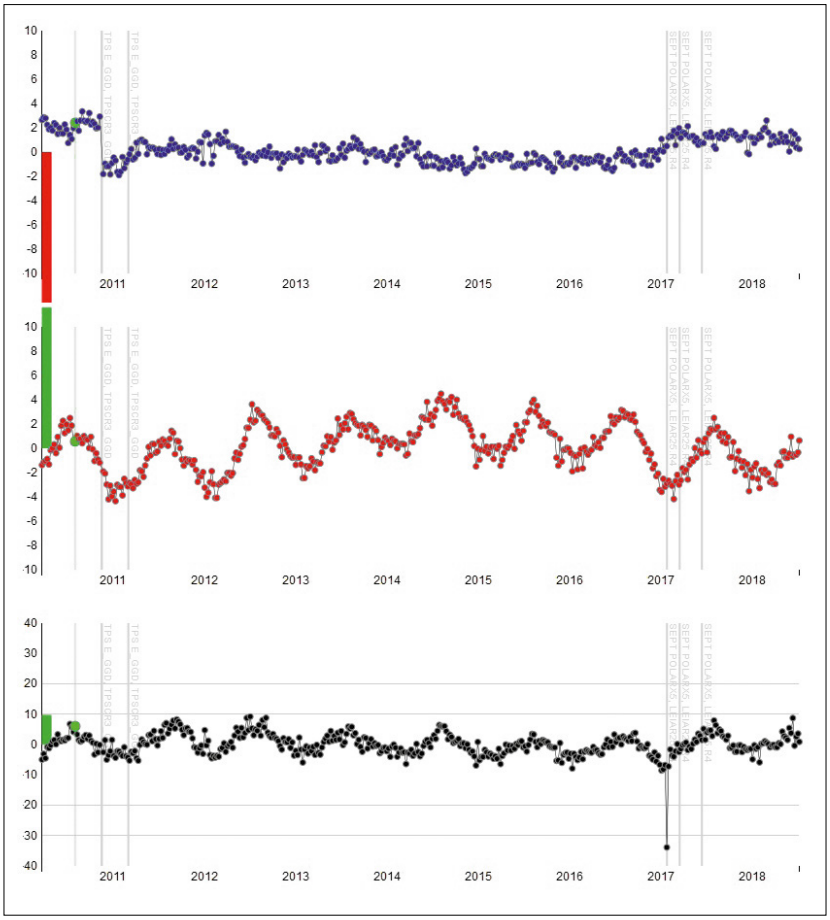

Fig. 4: Variation (mm) in time of AMON station WIEN in north (blue), east (red) and up (black) component

The AMON (Austrian Monitoring Network) was established in 2001 to monitor the Austrian ETRS89 realisation and consequently also all APOS stations. This denser Austrian network is used to derive a time series of all stations for the determination of intraplate velocities. Figure 4 illustrates the coordinate changes of the station WIEN. This station in particular experiences seasonal changes in east and up component in the range of a view millimeter.

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