Towards GNSS Services – The new Data Monitoring Center of the GFZ

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INTRODUCTION

Motivation

With the steadily increasing number of networks, stations and data, the current GNSS Data Center software of the GFZ has reached the end of its life cycle. Developed for the sequential processing of RINEX v.2 data for a limited number of stations, it can hardly keep up with the daily amount of data that passes the processing line. The introduction of RINEX v.3 (Multi-GNSS with additional observation types) into operation in 2012 added to this overload. Currently a total of ~ 1000 stations and ~ 50.000 observation files (RINEX v.2 and RINEX v.3) is processed at our Data Center each day.

Another disadvantage of the current system is the lack of a proper station and network quality control. The quality control system is limited by the requirement of manual checking of a website by an operator. There is not yet an automatic report or error handling system implemented.

Objective

The objective of this project is the development of a system for the pre-processing, monitoring, management and quality control of GNSS data (**DAQMON** – **D**ata **A**ssessment and **Q**uality **Mon**itor) in a more sophisticated way.

The software aims to handle all available data files in the field of GNSS. This includes receiver vendor (binary) files from major manufacturers as well as RINEX v.2/v.3 observation, navigation and meteorological files. All relevant metadata from RINEX observation files will be determined by using **GFZRNX+TB** (TB is the pre-processor of GFZ's EPOS.P8 software) and stored in a database.

One of the major goals is to operate the GNSS Data Center in a web-based environment. All actions required will be accessible and executed via a Graphical User Interface (GUI).

DAQMON (DATA ASSESSMENT AND QUALITY MONITOR)

Requirements

DAQMON is designed to meet the expenses of an environment with high requirements regarding reliability, availability and latency, as shown in the box below.

Service availability:	~ 99.9% (~ 8 hrs downtime/year)
Data latency:	max. 2 minutes after incoming
Data backup:	every 6 hours, backed up on three servers in total
Database backup:	streaming replication

Based on the experiences with the old Data Center software system(s) the main focus was on the configuration, flexibility and scalability of the software.

The system is self-controlled: which means that it detects problems automatically and triggers actions based on each individual event (e.g. automatic server switches).

Database and backend

The backbone of the whole system is the central PostgreSQL database that contains all relevant information for the data processing chain:

- System log information,
- Process information for each individual process started,
- Queue information for the condition-based transmission of files,
- System configuration,
- Metadata of processed RINEX files.

The backend is written in Perl and consists out of three major monitors:

ThreadMonitor
- Create a list of sorted files
- Start individual plugins (e.g. operations for converting binary files to RINEX, splicing, sample or export)
- Thread-based processing of the files

ServerMonitor
- Monitor changes in the configuration and software environment
- Monitor server vitality
- Start, stop and monitor *n* ThreadMonitors

MainMonitor
- Start, stop and monitor *n* ServerMonitors

The high amount of incoming files at peak times and the strict data latency requirement makes it necessary to run every plugin in a threaded environment. This will avoid jams and make it possible to timeout hanging processes.

Frontend / Implemented Features

To ensure a comfortable human-machine interaction a web-based Graphical User Interface (GUI) is endorsed. The GUI is designed as a dashboard and built on Laravel's PHP Framework, jQuery and HTML5/CSS. It includes the following features:

Web-based multi-server configuration
The system configuration is realised via web-based forms and stored in the database. This allows an on-demand check for validity of the input parameters. The actual backend software is loading JSON configuration files as input.

Web-based process monitoring
All information about expected, started and stopped processes will be stored in the database and visualised in a tabular way via the GUI. All processes can be reached and executed via web.

Data availability and quality monitoring
Monitoring the quality of stations and networks is one of the major tasks in this environment. All possible statistical information is extracted by the use of GFZRNX+TB (RINEX v.3 Multi-GNSS). The following parameters will be tracked:

- Count of expected/existing/useful epochs per satellite
- Count of expected/existing/useful observations per satellite
- Determination of multipath effects
- Determination of Intersystem Biases (ISB)
- Determination of coordinates and accuracy

This will give the user the opportunity to perform a broad range of statistical analysis for stations and networks. Figure 1 shows one representation for the visualisation of the availability of a single station.

Instant detection of station misbehaviors
Figure 2 shows a list of problematic stations. The detection of station misbehaviors is necessary for an instant reaction by operators. The data quality statistics include information about bad observations, missing frequencies, missing satellite systems, coordinate jumps and unexpected raises in multipath.

Network Analysis Tool
The Network Analysis Tool is an application that builds relations between multiple parameters (e.g. GNSS hardware information, location, tracked satellites etc.) for low quality data. The calculation is based on correlation. The output is an overview of the most likely reasons for station misbehaviors.

Ticket System
There are two ticket types available. Automatic tickets generated by the data processing software and manually created tickets by users. Figure 3 shows a snapshot of the implemented ticket system. By using tickets operators can detect problems easier and all changes to the system and GNSS network are well documented.

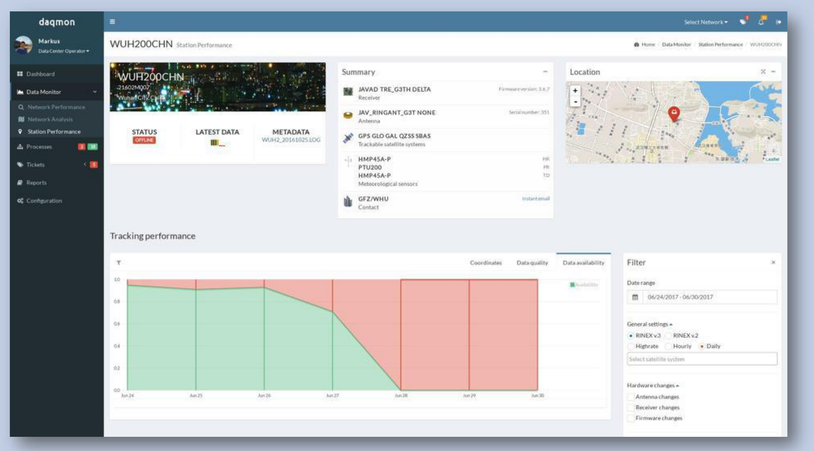

Fig. 1 *Station performance - Showing general station information and data availability*

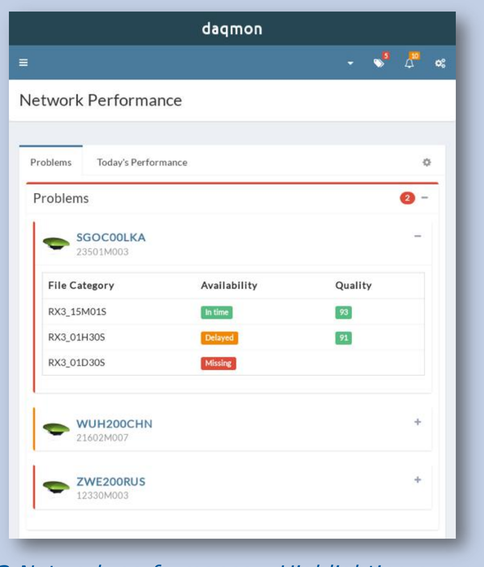

Fig. 2 *Network performance - Highlighting erroneous stations (mobile view)*

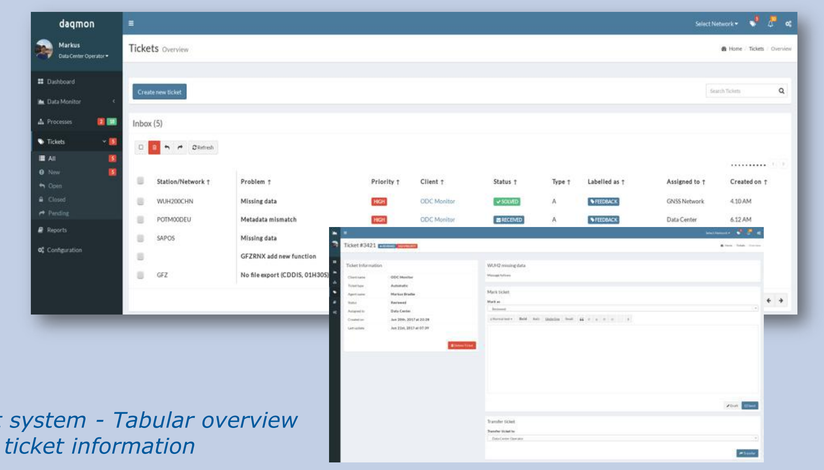

Fig. 3 *Ticket system - Tabular overview and detailed ticket information*

CURRENT STATUS / TOWARDS GNSS SERVICES

The "Data Assessment and Quality Monitor" (**DAQMON**) is currently in an evaluation and test phase to determine whether all of the defined requirements have been met. The plan is to have DAQMON fully operational by the end of the third quarter 2017.

With the development of **SEMISYS** (Sensor Meta Information System), an important step towards the improvement of the GNSS Data Center at GFZ has been taken. The final implementation of DAQMON will be the base for future implementations towards instant and online GNSS analysis services.

One of the next major projects at GFZ concerns the development of a **GNSS Positioning Service**. The plan is to build an application for different communities that are interested in the evaluation of GNSS data. The platform will allow the upload of GNSS observation data of single stations and whole networks. This data will get pre-processed using DAQMON and analysed automatically using GFZ's analysis software EPOS.P8. All primary and secondary products (coordinates, tropospheric parameters, RINEX metadata, etc.) will be stored in a database. The application will allow an instant visualisation of the results and interaction with the users.

SEE ALSO

PS02-09
T. Nischan: GFZRNX – RINEX GNSS Data Conversion and Manipulation Toolbox

PS06-03
B. Männel et al.: IGS Analysis Centre at GFZ: Activities and Developments

http://semisys.gfz-potsdam.de