Experience with GNSS Data Quality Monitoring of the SKPOS Reference Stations

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SKPOS®

- 33 Slovak stations (GPS+GLO+GAL+BDS)
- 21 foreign stations (APOS, gnssnet.hu, CZEPOS, ASG-EUPOS, ZAKPOS)
SKPOS Quality Control

- new web application developed at GKÚ Bratislava for tracking, monitoring and analyzing:
  - Time Series
  - Data Quality:
    - Number and percentage of observations
    - Cycle slips
    - Multipath errors
    - Skyplots
  - RINEX availability
  - Real-time data delay (station -> control software)
SKPOS Quality Control

- **Input data:**
  - SINEX (Bernese GNSS Software 5.2)
  - RINEX (G-Nut/Anubis 2.2.2)
  - Real-time data (Trimble Pivot Platform)

- **Output data:**
  - Plots
    - Time Series
    - Observations, cycle slips, multipath errors
    - Skyplots
  - Tables
    - RINEX availability
    - Real-time data delay
SKPOS Quality Control

- **App features:**
  - automatic data processing / data updating
  - e-mails alerts
  - interactive plots with marked GNSS HW changes
  - zoom-in/out, direct export to PNG
  - data of 86 stations (SKPOS / foreign SKPOS / EPN)
  - quality data of **GPS & GLONASS** observations
SKPOS Quality Control

- **User Interface:**
  - client-server application available through web browser
  - only for SKPOS administrators
  - programming languages:
    - HTML
    - CSS
    - Javascript (Angular 5)
    - PHP
    - MySQL
    - Batch
SKPOS Quality Control

- Graphic User Interface:
Data Quality Monitoring

- **Time Series:**
  - „RAW“ time series of permanent stations in IGS14 & ETRF2000
Data Quality Monitoring

- **Time Series:**
  - identified problem with Trimble Zephyr Geodetic Model 2 GNSS antenna (S/N: 3013) – GANP, GKU4, KUZA, SKLV, SKVK
Data Quality Monitoring

- **Data Quality:**
  - quality of GNSS data in RINEX v2.11 files since 2007:
    - percentage & number of observations (L1, L2, L5)
    - multipath errors (L1, L2, L5)
    - cycle slips
Data Quality Monitoring

- **Data Quality:**
  - quality of GNSS data in RINEX v2.11 files since 2007:
    - percentage & number of observations (L1, L2, L5)
    - multipath errors (L1, L2, L5)
    - cycle clips
Data Quality Monitoring

Data Quality:

- quality of GNSS data in RINEX v2.11 files since 2007:
  - percentage & number of observations (L1, L2, L5)
  - multipath errors (L1, L2, L5)
  - cycle slips
Data Quality Monitoring

- **Data Quality:**
  - lost signals at L2, L5 frequencies at Trimble Choke Ring antennas – BASV, BBYS, KAME, KOSE
Data Quality Monitoring

- **Data Quality:**
  - identified problem with firmware version 5.30 (Trimble NETR9)
  - detected jump in multipath errors (GLONASS L2)
Data Quality Monitoring

- **Data Quality:**
  - reduced multipath errors (Trimble NETR8 -> Trimble ALLOY)
Data Quality Monitoring

**Skyplots:**

- trajectory of visible GPS and GLONASS satellites
- identification of objects that cause GNSS signal blockage
Data Quality Monitoring

- **Skyplots:**

  *roof vs. monument (pillar) stabilization*
Data Quality Monitoring

- **Data Availability:**
  - availability of daily 30s RINEX 2.11 files
Data Quality Monitoring

- **Real-time Delay:**
  - data flow delay from SKPOS and foreign stations to Trimble Pivot Platform
  - delays: actual, average, maximum

<table>
<thead>
<tr>
<th>SKPOS stations</th>
<th>Foreign stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station</td>
<td>Last Delay</td>
</tr>
<tr>
<td>BASV</td>
<td>50 ms</td>
</tr>
<tr>
<td>BBYS</td>
<td>299 ms</td>
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<tr>
<td>BRIZ</td>
<td>63 ms</td>
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<tr>
<td>DCPL</td>
<td>30 ms</td>
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<td>GANP</td>
<td>0 ms</td>
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<td>OKJU</td>
<td>2 ms</td>
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<tr>
<td>HUVO</td>
<td>36 ms</td>
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<tr>
<td>JABO</td>
<td>33 ms</td>
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<tr>
<td>KAME</td>
<td>81 ms</td>
</tr>
<tr>
<td>KOLS</td>
<td>50 ms</td>
</tr>
<tr>
<td>KOSIE</td>
<td>63 ms</td>
</tr>
<tr>
<td>KUZA</td>
<td>23 ms</td>
</tr>
</tbody>
</table>
Data Quality Monitoring

- **Real-Time Delay:**
  - detected data flow delay from foreign stations
  - detected problems with internet
Summary

- **Present:**
  - effective and automatic data quality monitoring
  - ability to detect GNSS SW/HW problems
  - reverse analysis of historical quality data

- **Future:**
  - add new quality parameters (healthy satellites, ...)
  - add data availability of RINEX v3 files
  - extend quality monitoring for Galileo and BeiDou
Thank you for your attention

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