SUPPORT FOR BEIDOU IN SWEPOS NETWORK RTK SERVICE

UPGRADE OF THE SWEPOS INFRASTRUCTURE AND RESULTS FROM TEST MEASUREMENTS IN DIFFERENT SURVEYING ENVIRONMENTS

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LANTMÄTERIET

BACKGROUND

- Since 2018, the Network RTK service has been using GPS/GLO/GAL

- Using BeiDou is a natural step in improving the geodetic infrastructure

- Conditions that need to be met to add support for BeiDou
  - BeiDou generation three (BDS-3) expanded
  - Compatible antennas and reference station receivers
  - New RTCM version with support for the BDS-3 signals
  - Support for all three previous points in the Trimble Pivot Platform (TPP) software
  - IT environment and servers that support the increased CPU- and memory capacity needed for TPP using BDS-3

PREREQUISITES FOR THE INFRASTRUCTURE

- BDS-3 fully deployed in June 2020
  - The new B1C and B2A signals are relevant for network RTK

- Swepos Reference stations compatible with BDS-3 2022
  - Approximately 300 reference station changed to BDS-3 compatible receivers (Trimble Alloy or Septentrio PolarX5)
  - Firmware updated in all receivers

- RTCM support for BDS-3 2022
  - Needed for reference stations that not have a Trimble receiver

- Trimble Pivot Platform support for BDS-3 June 2023
  - Sparse network with Trimble receivers 2020
  - Summer 2023 all our receivers supported with BDS-3 in TPP

- Production servers upgraded November 2023
  - CPU power increased when updating TPP with version that support BeiDou

TEST MEASUREMENTS WITH BEIDOU

- Single station RTK 2020

- Functional test 2021 with Trimble, Leica and Topcon receivers

- Student Bachelor thesis spring 2022

- User specific tests in different surveying environments 2023

- Analysis of data from monitor stations 2021 & 2023

SINGLE STATION RTK 2020

- ## Purpose and test set up:
  - First test of using BeiDou in our receivers
  - Open and forest test sites, 10 km baseline
  - GGG vs, GGGB – 4 h static RTK
  - Series with 20 "user measurements" with 5s and reinitialization

- ## Result and conclusions
  - We can achieve RTK fixed solution using also BeiDou
  - Some second faster time to fix with BeiDou
  - Hard to say something about standard uncertainty
  - Not more fix but maybe less bad fixed solutions (outliers)

FUNCTIONAL TEST 2021

- Purpose and test set up:
  - Evaluation of the sparse network function – if no Trimble receiver at the closest reference station a longer baseline will be used
  - Turn on and turn off systems and signals in both TPP and or Trimble, Leica and Topcon receivers and see how the receivers react
  - Analyzing of data from monitor stations for standard uncertainty estimates

- Results and conclusions:
  - We got fixed solution with only BeiDou for Trimble and Leica
  - Some question marks which signals and systems that was used
  - Some problems for the receivers when the sparse function was activated
  - CPU-power hit the roof
  - No benefit of using sparse network with BeiDou when analyzing data from monitor station
  - Not worth to include support for BeiDou at this stage

STUDENT BACHELOR THESIS 2022

Undersökning av BeiDous påverkan på kvaliteten vid mätning med SWEPOS nätverks-RTK i svåra miljöer

Emil Mårtensson
2022

- ## Purpose and test set up
  - Test net with BeiDou ready reference stations
  - Simulation of measurement environments with three different elevation cut off: 15°, 30° and 40°
  - GGGB vs GGG and BeiDou vs GPS
  - Analysis of 10 and 180 s mean values and time to fix

- ## Result and conclusions
  - GGGB gives more fixed solutions and lower standard uncertainty in height for 40° cut off
  - GPS gives in general little more fixed solutions and faster time to fix than just BeiDou

  - https://urn.kb.se/resolve?urn=urn:nbn:se:hig:diva-40037

USER SPECIFIC TESTS 2023

- ## Purpose and test set up
  - How will a network-RTK user benefit from using BeiDou?
  - GGGB vs GGG at the same time with similar equipment
  - Open, forest and urban environments
  - 4 h static RTK, 8*6 minutes and 8 loops of 5 points for user measurements

- ## Result and conclusions
  - Used Lecia-receivers - result are mostly relevant for Leica users
    - Some question marks which signals that was used
  - Tendency for improved measurement uncertainty in the height component in more difficult measurement environments
  - Indications of increased availability in point measurement, in more difficult measurement environments
  - The user's needs and the available technology solution are important prerequisites for determining the added value of more satellite systems

MONITORDATA 2023

- ## Purpose and test set up
  - Reference stations receivers in RTK mode at permanent station in open surveying environment
  - Compare new and previous versions of TPP using same satellite systems
  - Adding BeiDou to existing GGG-corrections
  - Analysis of days with low and high ionospheric activity

- ## Result and conclusions
  - More fixed solutions using corrections from old version of TPP, but also more outliers and higher standard uncertainty, especially with high ionospheric activity.
  - Go from two to three satellite systems decrease the standard uncertainty, but adding a fourth system don't have any significant change in these open sky tests.

BEIDOU RELEASE 29/2-2024

Network RTK connection points

Connection point	Data format	Data content
MSM_GNSS	RTCM 3.4 MSM4	GPS / Glonass / Galileo / Beidou
MSM_GEC	RTCM 3.4 MSM4	GPS / Galileo / Beidou
MSM_GRE	RTCM 3.4 MSM4	GPS / Glonass / Galileo
RTCM3_GNSS	RTCM 3.1	GPS / Glonass L1+L2
RTCM3_GPS	RTCM 3.1	GPS L1 + L2
RTCM2_GPS	RTCM 2.3	GPS L1 + L2
DGNSS	RTCM 2.3	Network DGNSS with GPS / Glonass

TACK! VI FINNS PÅ…

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