REAL-TIME DATA AND PRODUCT PERFORMANCE METRICS AT NASA GSFC CDDIS

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Abstract

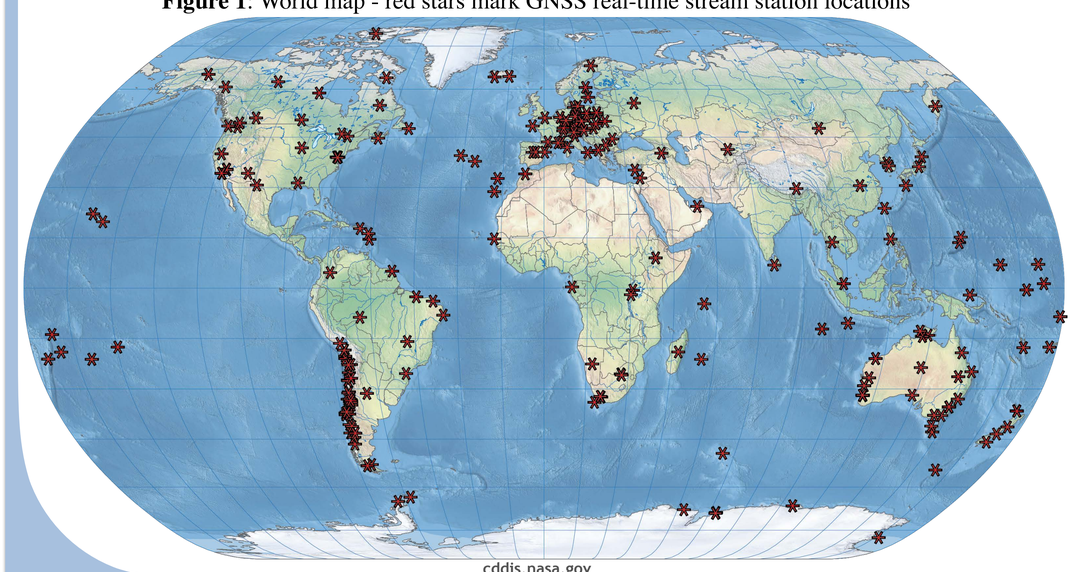
The International GNSS Service (IGS) Real-time Service (RTS) provides high-accuracy orbit and clock corrections that enable applications such as precise point positioning, time synchronization, and disaster monitoring to the global GNSS community. The Crustal Dynamics Data Information System (CDDIS) is a NASA distributed active archive center, and distributor of real-time GNSS data and product streams in support of the IGS RTS. The CDDIS NTRIP (Networked Transport of RTCM via Internet Protocol) caster is operated by NASA Goddard Space Flight Center and broadcasts 268 GNSS data and 37 products streams, most available in RTCM V3 format.

Network performance and real-time stream integrity impacts data centers, real-time applications, and end-users. At the CDDIS the BKG NTRIP Client (BNC, courtesy of Bundesamt für Kartographie und Geodäsie) is used to capture and convert real-time streams into high-rate (15 minute observations with 1-second sampling rate) files for archival, and to collect performance metrics, such as the mean latency, uncertainty, and epoch, for each CDDIS caster monument site over specific time intervals. Captured real-time stream files, performance metrics, and associated measurements will be archived and made available to IGS and the greater GNSS community. Methods used to capture, extract, and analyze real-time metrics will be presented and future goals will be discussed.

Background

- CDDIS participated in the real-time working group to form the IGS RTS
- In 2014 CDDIS installed a caster for receiving and broadcasting real-time GNSS data and product streams
- CDDIS is one of three primary casters supporting the IGS RTS
- Available streams include precise GNSS orbit and clock corrections to broadcast ephemeris
- The CDDIS caster collects and distributes real-time streams using BKG NTRIP software
- CDDIS disseminates 268 real-time data (including NASA JPL receivers) and 37 product streams (Figure 1)

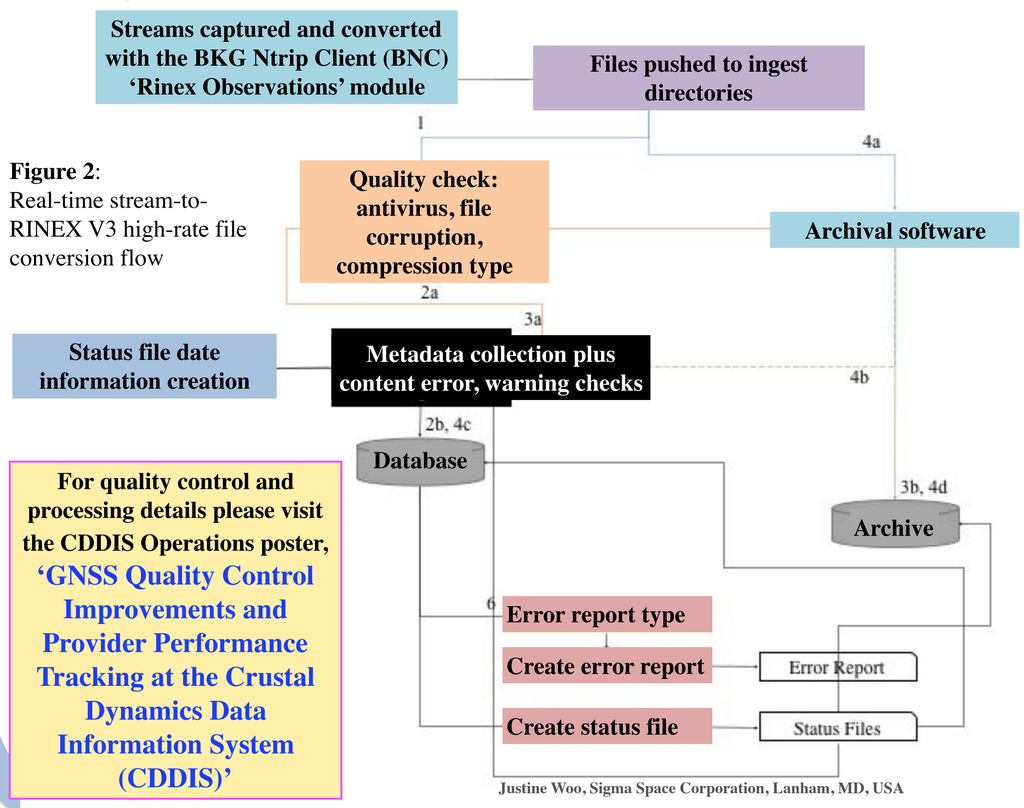
Figure 1: World map - red stars mark GNSS real-time stream station locations



RTCM to RINEX V3 Conversion

The CDDIS has recently begun preliminary work to convert RTCM streams into RINEX version 3 high-rate observation files. Our strategy is to generate a variety of high-rate RINEX V3 files from real-time stations that supplement the receiver-generated, high-rate files already being ingested, processed, and archived. The contents of converted high-rate files must first be carefully tested to ensure data quality, completeness, and consistency. Only then will they be processed (see Figure 2), archived, and released to the community. Contents include: file, monument, and marker names, RINEX and data versions, agency, receiver and antenna type, observation start and end times, and observations (GPS, GLONASS, GALILEO, SBAS, BEIDOU, QZSS, IRNSS). Converted files will be named appropriately to distinguish creation from real-time streams.

Figure 2: Real-time stream-to-RINEX V3 high-rate file conversion flow



For quality control and processing details please visit the CDDIS Operations poster, 'GNSS Quality Control Improvements and Provider Performance Tracking at the Crustal Dynamics Data Information System (CDDIS)'

Performance Metrics

An internal website is being developed to visualize and monitor caster performance and stream integrity.

Latency data and associated metrics, logged in 15 minute intervals, that are collected with the BNC Miscellaneous module, are extracted and analyzed using CDDIS-developed Python scripts, to evaluate caster performance and data integrity over time. This interactive dashboard (Figure 3) is updated every quarter hour, and enables time series (Figure 4), and other visualizations (Figures 5, 6, and 7) to be accessed by clicking on a selected stream, as in the BSHM0 station example to the right.

Other metrics include:

- Minimum and maximum latencies with uncertainties
- Observation interval epoch
- Date and timestamps
- Number of gaps observed
- Qualitative data completeness (reported/expected epoch)

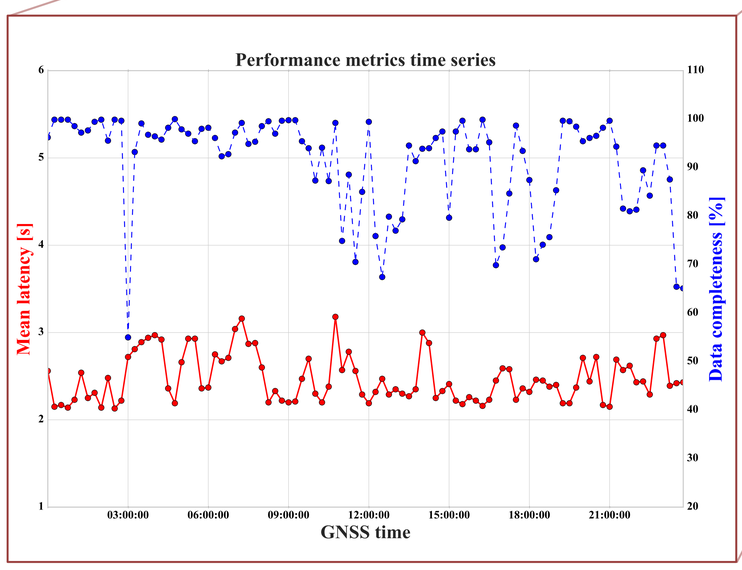


Figure 4: Time series for station BSHM0, with mean latencies (red) and data completeness percentage (blue) plotted every 15 minutes over 24 hours

Collected metrics will be archived and released to the community. Actionable insights from metrics analysis may include bit-rate comparisons, mean latencies averaged over all streams for a given source caster (Figure 5), network (Figure 6), country, or timezone.

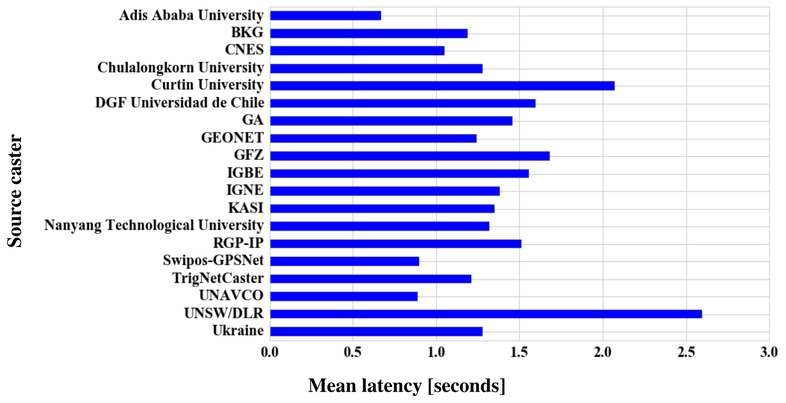


Figure 5: CDDIS data streams were grouped by unique source caster and the mean latency (reported per stream over a single 15 minute observation interval), averaged over all streams per source caster, is plotted

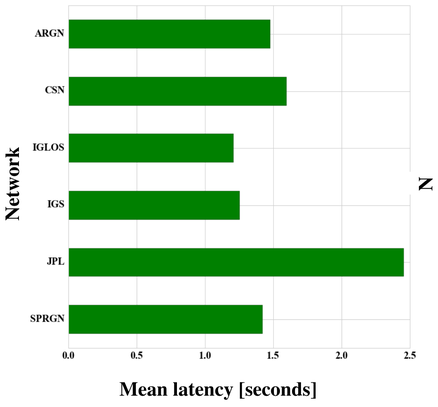


Figure 6: CDDIS data streams grouped by unique network, the mean latency (reported per stream over a single 15 minute observation interval) is averaged over all streams per network and plotted

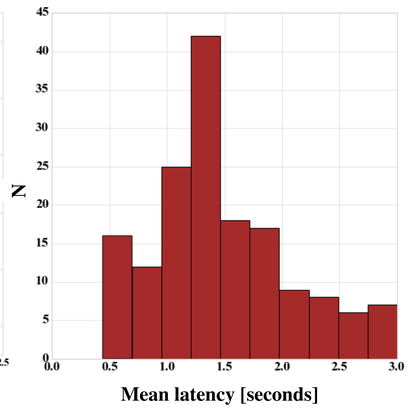


Figure 7: Distribution of mean latencies for 182 CDDIS data streams (reported over a single 15 minute observation interval); in this example most stream latencies are under 2 seconds

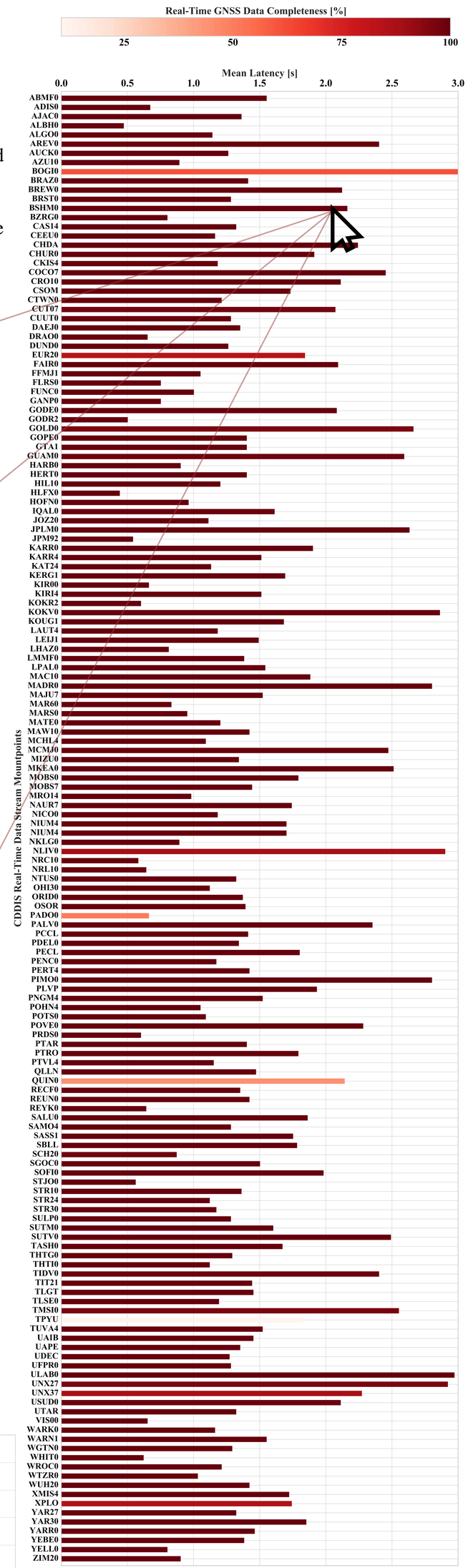


Figure 3: **Snapshot of real-time metrics dashboard** Mean latencies [seconds] are shaded by data completeness percentage for 192 CDDIS data stream stations; each bar is shaded from light to dark red based on the calculated percent completeness (darkest red = 100%)

In this example, mean latencies were reported over a single 15 minute observation interval; stations without a latency value (no bar) were not reported at the time of observation due to outages, connection errors, or other issues. In the future stream interruption and outage information will be included in the analysis.

Future Goals

- Archive and release performance metrics, statistics, and analysis tools to the IGS community
- Generate and archive real-time data to converted into high-rate files (RINEX V3 format)
- Monitor and report stream transmission interruptions and outages
- Real-time stream end-user characterization study
- Include additional real-time streams