Real-time GNSS data and product streams at NASA GSFC CDDIS IN23B-0779

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Crustal Dynamics Data Information System

https://cddis.nasa.gov

Introduction

The Crustal Dynamics Data Information System (CDDIS) is a NASA distributed active archive center (DAAC) and global distributor of real-time GNSS data and product streams in support of the International GNSS Service (IGS) Real-Time Service (RTS) which provides high-accuracy orbit and clock corrections to the GNSS community, enabling applications such as precise point positioning, time synchronization, and disaster monitoring. The CDDIS NTRIP (Networked Transport of RTCM via Internet Protocol) caster is operated by the NASA Goddard Space Flight Center (GSFC) and broadcasts over 400 GNSS data and 41 products streams provided by a variety of international caster sources.

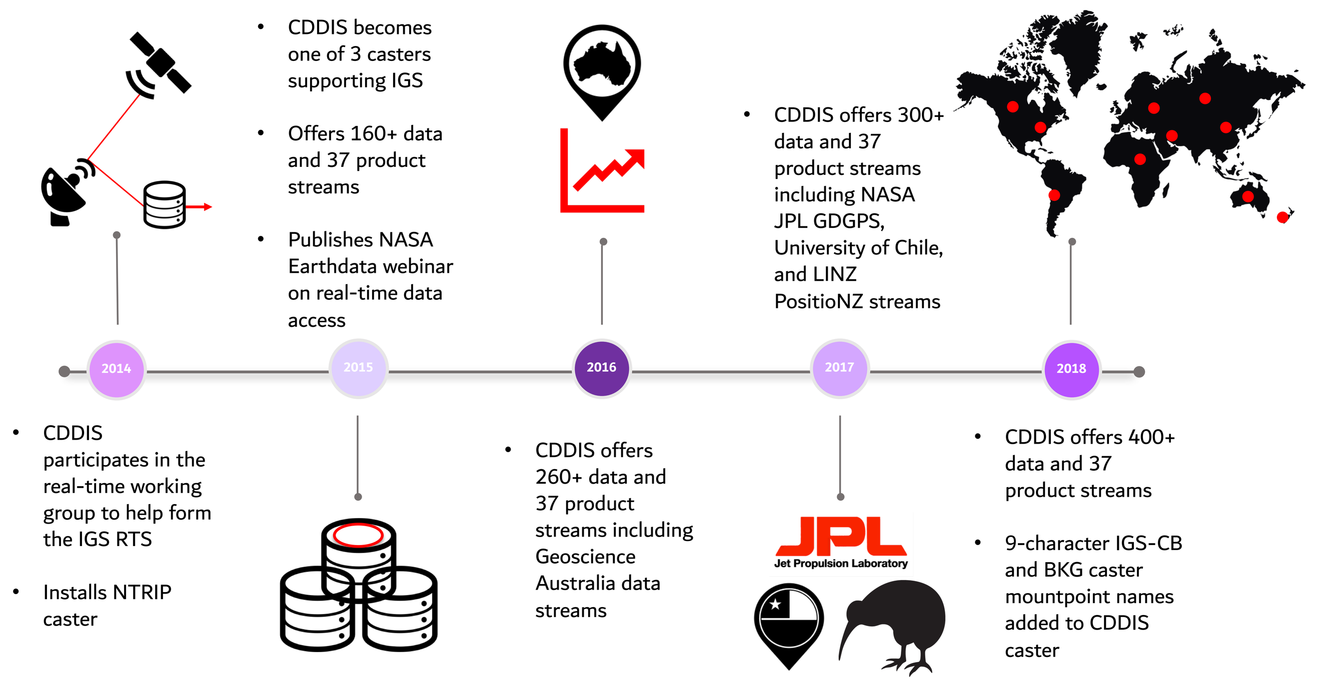

Figure 1: CDDIS NTIRP caster timeline, 2014 – 2018 [1]

The CDDIS is dedicated to continuous caster improvements and performance monitoring to provide reliable data and product streaming with help-desk supported accessibility to the global community (Figure 1). The Bundesamt für Kartographie und Geodäsie (BKG) NTRIP Client (BNC) is used to collect performance metrics, such as mean latencies with uncertainties and epochs, for each CDDIS caster stream, and will be used to capture and convert real-time streams into high-rate (15 minute observations with 1-second sampling rate) files. Captured and converted real-time stream files, and performance metrics with associated measurements will be archived and made available at the CDDIS for the GNSS community and beyond. An overview of these processes, and updates to CDDIS real-time data and services will be presented.

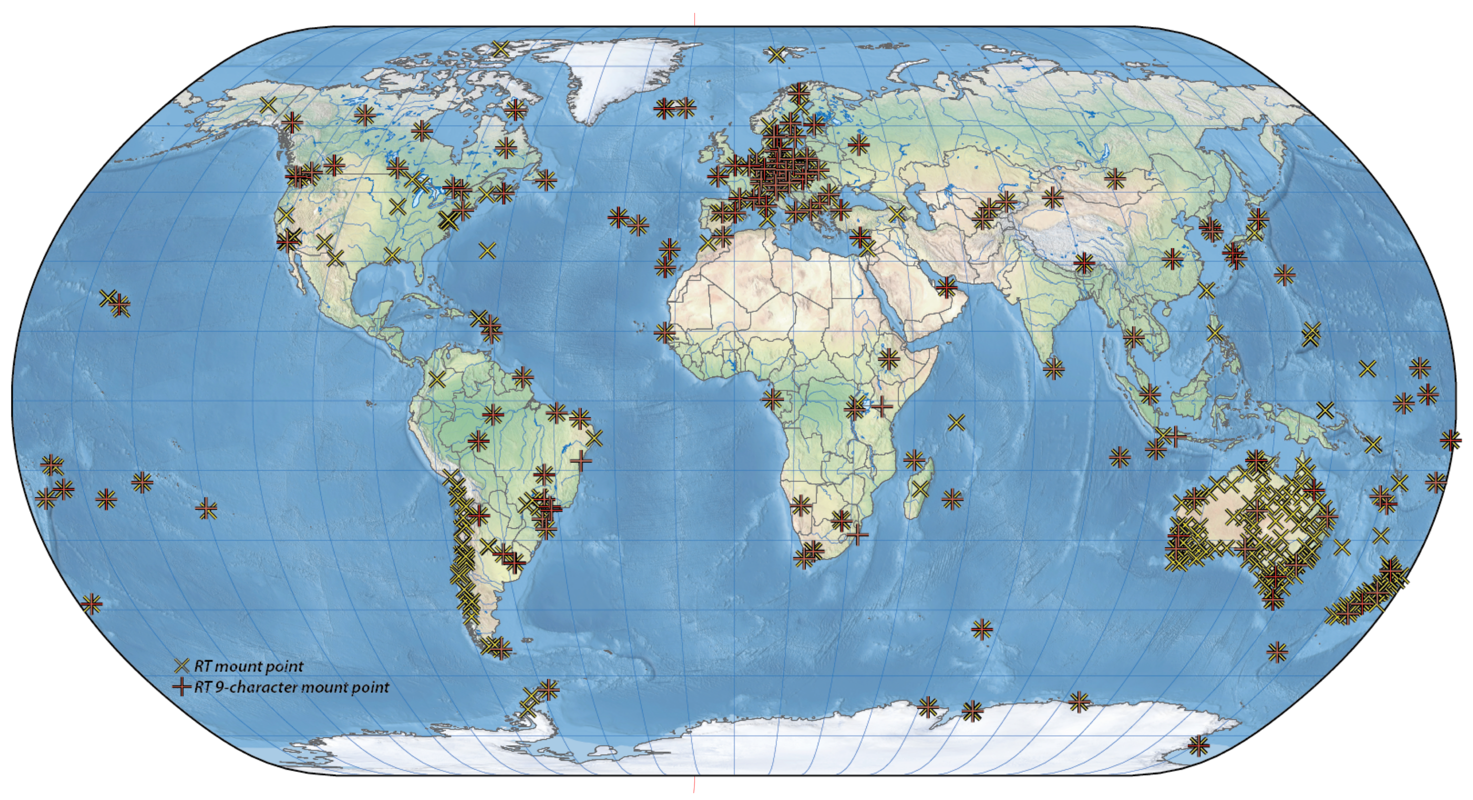

Figure 2: World map - Gold "X" marks GNSS real-time data mount point locations, red crosses are those stations with new IGS-issued 9-character names

Real-time Streams

As of October 2018 the CDDIS NTRIP caster is configured to stream GNSS data from over 400 mount points (Figure 2), along with 41 products, from a variety of caster sources including BKG, NASA JPL's Global Differential GPS (GDGPS), Natural Resources Canada (NRCan), Land Information New Zealand (LINZ) PositioNZ, Geoscience Australia (GA), and the University of Chile. As recommended by the IGS Real Time Working Group (RTWG), CDDIS is replacing 5-character mount point names with new, 9-character names for streams relayed from IGS-Central Bureau and BKG casters. Currently the CDDIS offers 147 9-character name mount point data streams, along with the original 5-character name streams. The CDDIS is typically streaming at any one time about 70% of its current total available streams to its user base, and has the capacity to greatly expand both its total number of streams available and the number of users it serves.

For details on GNSS data and product retrieval from CDDIS Caster, and streaming in real-time please visit: https://cddis-casterreg.gsfc.nasa.gov/index.html

Performance Metrics

An internal website has been developed to monitor caster and stream performance, containing plots of data and product stream mean latency and completeness. Mean latencies, logged every 15 minutes, are collected with the BNC Miscellaneous module, extracted, sorted, and plotted using CDDIS-developed Python scripts. The data are plotted as a bar chart with bar length signifying the mean latency in seconds, and bar color the percent completeness (Figure 3; darkest shade is 100% complete). The website, designed to become an interactive dashboard, is updated 3 times an hour, contains links to time series latency plots for individual streams. The data are collected throughout this process and stored in a database, to be eventually released to the GNSS community. They include:

- Mean latencies with minimum and maximum values
- RMS uncertainties
- Observation interval epoch
- Date and time stamps
- Number of gaps observed in stream
- Qualitative data completeness (reported / expected epoch)

NTRIP Caster Modifications

At CDDIS we are working to offer a custom update to the NTRIP caster system that will enable it to work with the newest version of the NASA Earth Observing System Data and Information System (EOSDIS) Earthdata Login. Earthdata Login provides a centralized and simplified mechanism for user registration and profile management for all EOSDIS system components. The updated NTRIP server running at CDDIS will allow users to continue to access CDDIS real-time data and products with their existing Earthdata credentials. This implementation connects CDDIS real-time users and NASA EOSDIS, allowing them to access data and documentation from both sources using the same credentials and keeps the data download process consistent across all methods.

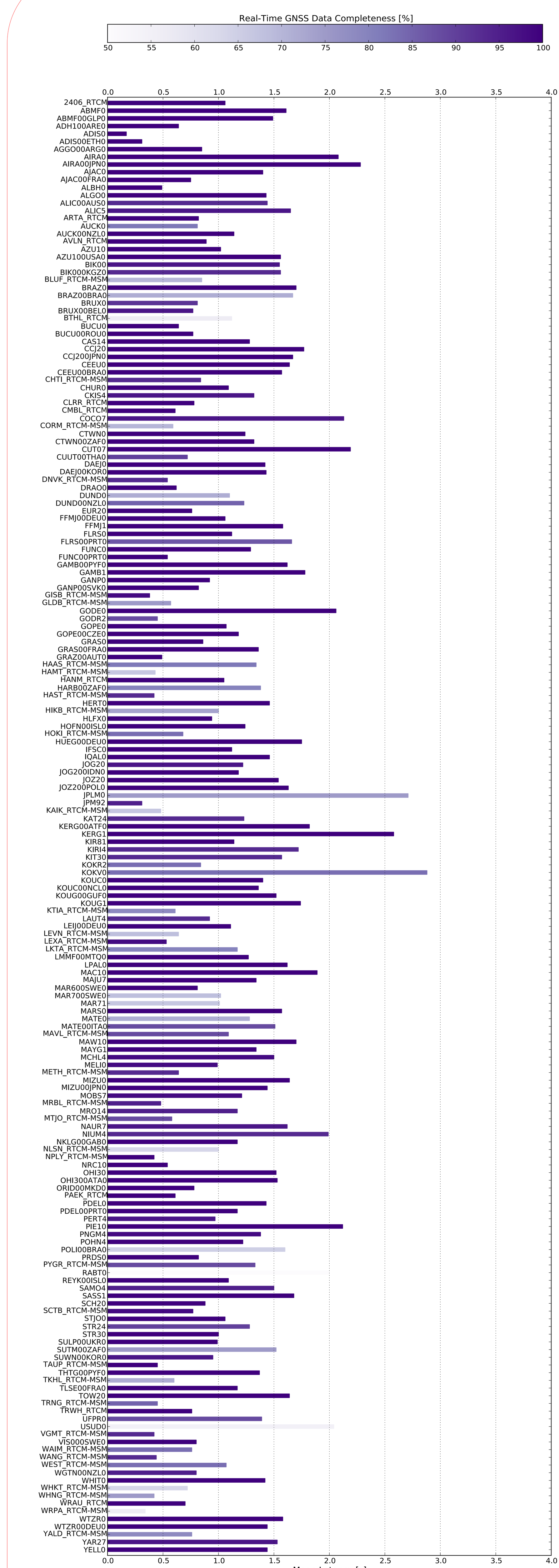

Figure 3: Snapshot of real-time data stream dashboard - Mean latencies [seconds] are plotted and shaded by data completeness percentage for CDDIS data stream stations; each bar is shaded from light to dark violet based on the calculated percent completeness (darkest violet = 100%). For this example, mean latencies were reported over a 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.

RTCM to RINEX V3 Conversion

The CDDIS has begun working to convert RTCM data streams into RINEX V3 high-rate (15-minute intervals with 1 second sampling rate) observation files using BNC. First (for testing purposes) RTCM-converted files, with RINEX V3 file names, will be generated for stations with high-rate files already existing at CDDIS. The new BNC-generated, and the corresponding receiver-generated files in the CDDIS archive, will be analyzed with CDDIS-developed scripts, to quantitatively compare their header and data content. After the files have been analyzed the RTCM-converted observation files will be named appropriately to differentiate them from receiver-generated observation files. Once data and header consistency is confidently established the process described here will be conducted for stations not currently submitting high-rate observation files to CDDIS, enabling CDDIS to expand the selection of high-rate observation files available to end-users. Lastly the RTCM-converted high-rate files will be processed, archived, and released to the community (see flow diagram below in Figure 4).

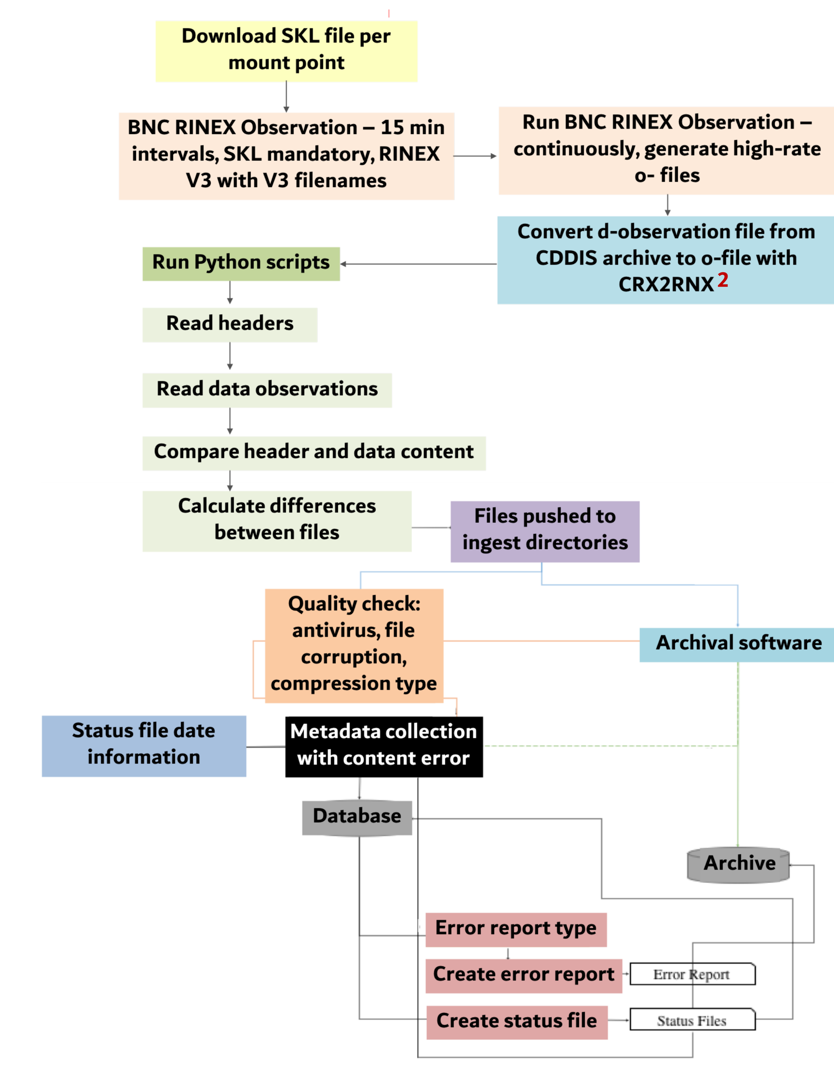

Figure 4: Flow diagram of converting RTCM streams to high-rate RINEX V3 observation files at CDDIS

Future Work

- Archive and make performance metrics data available to the community
- Generate, process, and archive RTCM-converted, high-rate RINEX V3 observation files
- Update CDDIS caster source table in real-time with ntripchecker scripts, written by André Hauschild, German Aerospace Center (DLR)
- Use ntripchecker, with CDDIS-developed scripts, to monitor and report stream interruptions and outages

Acknowledgements

1 **Figure 1 icons**: satellite by Pedro Ramalho, PT, the Noun Project; satellite dish by http://www.free-icons-download.net; database by Mister Pixel, the Noun Project; Australia and Chile by Nikita Kozin, RU, the Noun Project; kiwi by Mike Harding, the Noun Project; world map by Rojal, Web Icons PNG

2 **CRX2RNX**: Hatanaka, Y. (2008), A Compression Format and Tools for GNSS Observation Data, Bulletin of the Geospatioal Information Authority of Japan, 55, 21-30

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