Natural Resources Canada (NRCan), Modernized GNSS Data Connection and Distribution Infrastructure

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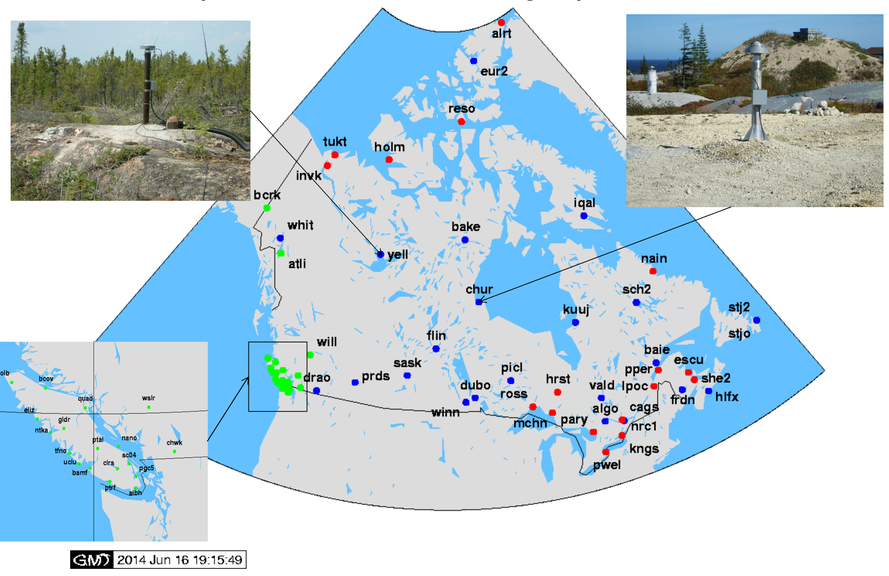
Abstract

Natural Resources Canada (NRCan) is finalizing the upgrade of its GNSS infrastructure with the goal of supporting real-time collection and distribution of observation data from all GNSS constellations. NRCan has recently upgraded its station hardware and software to support modernized GPS, GLONASS and Galileo (4 stations), with BeiDou support planned for the coming year. Typical station hardware includes: GNSS receiver, atomic frequency standard, power management system, and a data collection computer. All observed GNSS data is saved at the station and sent to two real-time data centres. Every fifteen minutes the data centre files are checked for completeness and (if required) any missing 1 Hz epochs are retrieved from the station data archive to update the data centre file. Radio Technical Commission for Maritime (RTCM) Services Special Committee 104 (SC-104) standard formats and protocols are used throughout the data collection and distribution infrastructure. NRCan operate three data centres: two are used for production purposes and the other is used for test and development applications. Each data centre receives real-time data streams from all NRCan stations as well as the IGS Real-Time Service (IGS-RTS) stations. Station data is archived in RTCM files and then converted to RINEX 2.11 and 3.02 (summer of 2014) formats. Data originating from NRCan stations is run through a quality control process every fifteen minutes (1 Hz data) and submitted to NRCan and/or IGS global data centres. NRCan data is also merged, decimated to 30 seconds, validated through a quality control process, and posted to the NRCan and/or IGS global data centres hourly. Each production data centre also hosts a Network Transport of RTCM using Internet Protocol (NTRIP) caster that supports the distribution of legacy RTCM observation data (GPS 1004 messages), RTCM-MSM (1077,1087,1097, and support messages), as well as RTCM-state space representation GPS Correction messages.

1. NRCan IGS GNSS Network and Station Management Environment

The current NRCan IGS network consists of 25 core stations (blue) operated by the Canadian Geodetic Survey (CGS), 17 regional stations (red) operated by CGS, as well as 21 regional sites (green) operated by the Geological Survey of Canada (GSC). The NRCan network currently includes 27 GNSS + 26 GPS only stations. In addition, several of the most important sites including algo, chur, drao, stjo, and yell have multiple monuments in order to monitor the stability of the monument and the data quality.



Topcon GNSS Receivers

Computer

Communication Equipment

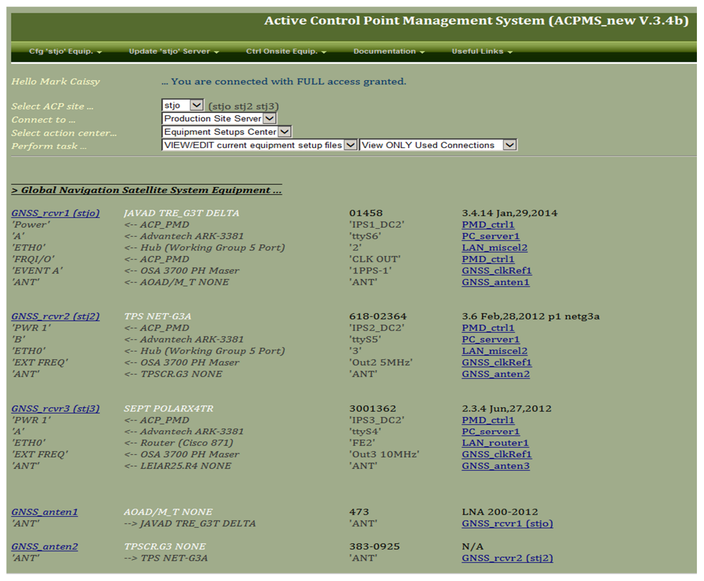
Rubidium Clock

Power Manager & Site Monitor

Power regulator

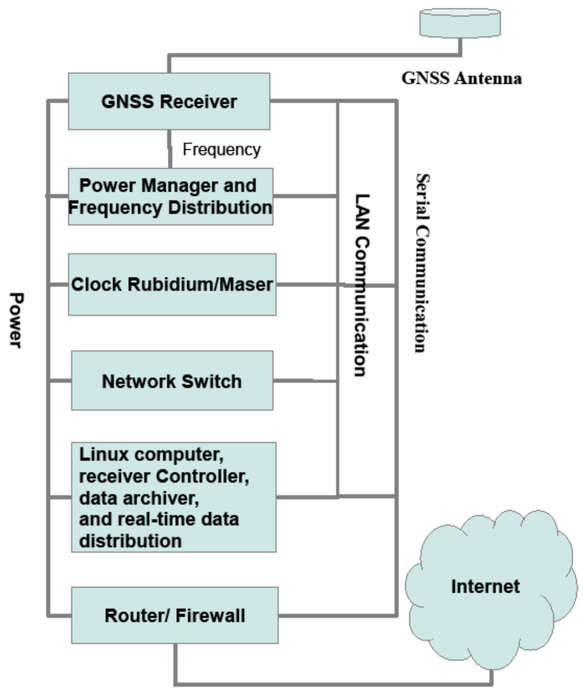
Batteries & Charger 3 days of backup

Managing a GNSS network can be a challenge. Our Active Control Management Environment has centralized and semi-automated many of the day-to-day activities for station operators. This environment provides web based tools, automated site installations and upgrades, station configuration analysis, station equipment tracking, and a user's guide complete with tool tips.

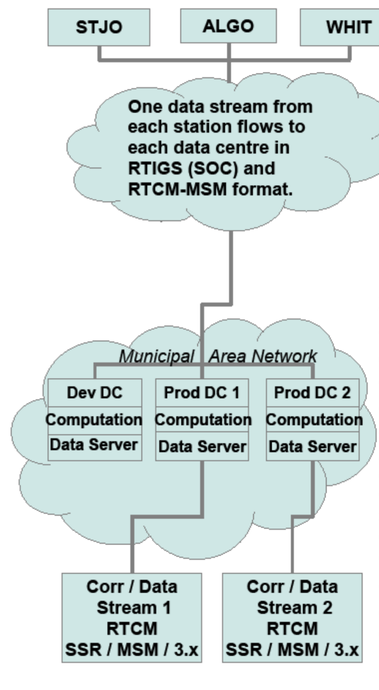


2. NRCan's Station Hardware Configuration and Real-time Data and Products Flow Diagrams

NRCan Station Equipment Configuration



NRCan Data Collection and Distribution Diagram



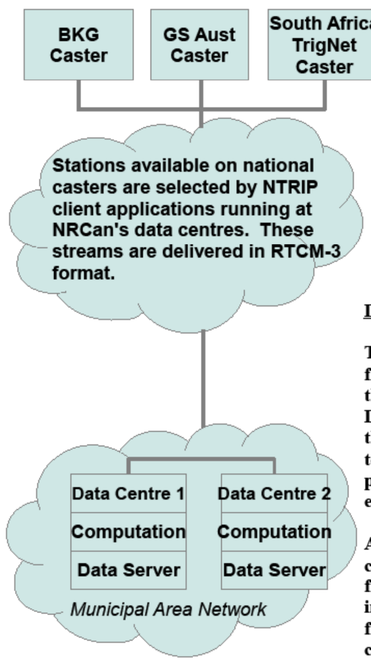
Data Centre (DC) Layer

Three independent data centres; one for development and two for production.

Three redundant station data streams are available for use at each computation centre. Geographic and network redundancy are configured into the computation engine.

Two Independent correction and observation data streams are available to users.

NRCan Global Data Flow Diagram



Data Centre Layer

Two independent streams flow from national Casters to the NRCan data centres. Data servers then multicast this data making it available to applications in both the production and development environments

Applications are configured to use data from different providers in the same area and from different access channels to provide network and geographic robustness from a region.

3. RTCM Data Messages (Stream and File)

Real-time RTCM data is streamed from the station to the data centres at fixed time intervals. The data centre archives the RTCM messages in 15 minute files, ordered as shown below. Since each RTCM file contains receiver and antenna information the stream can be compared to the data centre station log file.

Message Number	Message Description and Content
1013	List of messages broadcast or saved in the file. Header: Station ID, MJD, Seconds of Day, List of all messages: number, sync . flag and transmission interval (issued every 10 seconds, with Random Start Time (RST))
1033	Antenna and Receiver Description: Station ID, antenna: description, setup ID, S/N and receiver: description firmware version, Serial Number (issued every 10 seconds, with RST)
1006	Station ID, Antenna Reference Point(X,Y,Z and height) (issued every 10 seconds, with RST)
1008	Station ID, Antenna: description, serial number and setup ID (issued every 10 seconds, with RST)
1019-1020	GPS and GLONASS Navigation Data (issued every 900 seconds, with RST and upon update)
1045	Galileo Navigation Data (Planned Fall of 2014)
1004-1077	Standard GPS and RTCM-MSM high precision message (header contains setup ID) (issued every second)
1087	RTCM-MSM high precision message (header contains setup ID) (issued every second)
1097	Galileo high precision RTCM-MSM (header contains setup ID) (issued every second)
1117, 1127	BeiDou high precision RTCM-MSM (header contains setup ID) (Planned 2014-15)
1230	GLONASS Code /Phase Bias Correction

4. Real-Time Data Stream Quality Monitoring

Precise point positioning solutions are computed in real time using NRCan's real-time orbit and clock corrections. The figures below (top left then clockwise) illustrate: 2D RMS, phase RMS, receiver clock offset and code RMS. The statistics were based on a kinematic solution using 1 Hz data.