CORS Network Evolution and Future Developments

Giovanni F. Sella, Richard Snay, Michael Cline and Don Haw

National Geodetic Survey, NOAA, 1315 East-West Highway, Silver Spring, MD 20910

General Description

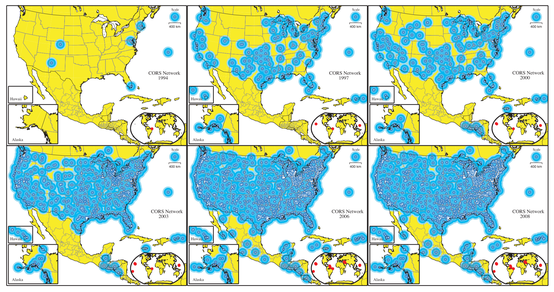
The National Geodetic Survey (NGS), an office of NOAA's National Ocean Service, manages a network of Continuously Operating Reference Stations (CORS) that provide Global Navigation Satellite System (GNSS) data consisting of carrier phase and code range measurements in support of three dimensional positioning, meteorology, space weather, and geophysical applications throughout the United States and its territories.

Surveyors, GIS users, engineers, scientists, and the public at large that collect GPS data can use CORS data to improve the precision of their positions. CORS enhanced post-processed coordinates approach a few centimeters relative to the National Spatial Reference System, both horizontally and vertically.

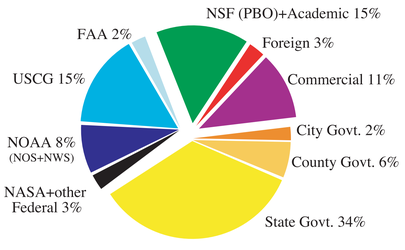
The CORS network is a multi-purpose cooperative endeavor involving government, academic, and private organizations. The sites are independently owned and operated. Each agency shares their data with NGS, and NGS in turn analyzes and distributes the data free of charge. As of May 2008, the CORS network contains over 1,200 stations, contributed by over 200 different organizations, and the network is growing at a rate of 15 stations per month.

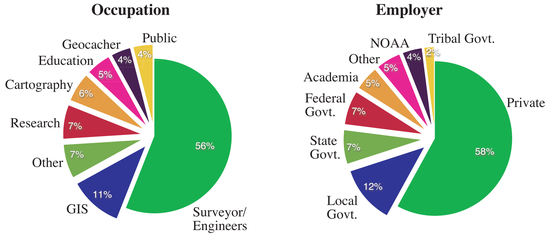
1. Development of the CORS network

In the late 1980's NGS operated the CIGNET network which in 1994 became the core of the newly founded IGS. At this time NGS began developing a US based CORS network. This network was developed as a means for NGS to gain access to a GPS network in the US to update the National Spatial Reference System (NSRS) using the data provided by these stations, without having to build its own stations. The requirements were minimal: site operators agreed to give NGS their data and NGS in turn distributed the data from a centralized location. In 2006 with a network of almost 900 stations some basic site configuration requirements began to be required.



.2. Network Partners and Users

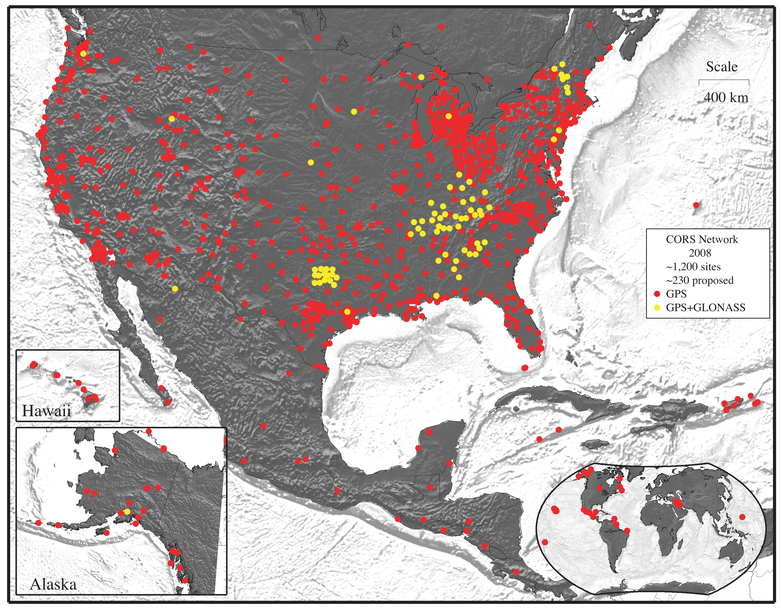




3. Heterogeneous Network with Common Station Components

All stations are required to have a GPS dual-frequency receiver and antenna
Equipment capable of tracking dual constellation, GPS+GLONASS, is increasing
Radomes are strongly discouraged
Monumentation is very varied. Force centering devices are required for all sites.
Minimum sampling rate is 30 seconds most are 1-5 seconds
Data is available from most sites within 1 hour
Most data RINEXed by NGS
Detailed guidelines for establishing and operating a CORS site are available

http://www.ngs.noaa.gov/CORS/Establish_Operate_CORS.html



http://www.ngs.noaa.gov/CORS

4. Data and Analysis Center

- Primary Silver Spring, Maryland, alternate Boulder, Colorado
- 24/7 CORS data acquisition & dissemination
- Web and online storage of all data since 1994 to present
- Data access provided via anonymous FTP and as customized user data sets via web interface (UFCORS)
  GPS data ftp cors.ngs.noaa.gov/cors/rinex
  GPS+GLONASS data ftp.cors.ngs.noaa.gov/cors/tst_gnssrnx
- Real-time data available from selected sites in RTCM 2.3 or 3.1 via NTRIP
- IGS regional data center
- Daily station coordinates analysis (2 day latency)
- OnLine Positioning User Service – OPUS
- IGS analysis center for rapid and final orbits
- IGS analysis coordination center 2008-2012

5. Examples of Supported Services

- ***OPUS (Online Positioning User Service) - Toolbox***

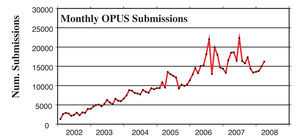
Users may submit GPS dual frequency phase data to NGS, via a Web interface, for processing by NGS. Upon receipt, the data quality is assessed, and three dimensional positional coordinates are calculated. The process generally takes only a few minutes, and the results are emailed back to the user with ITRF (International Terrestrial Reference Frame) coordinates, NAD 83 coordinates, and the appropriate state plane coordinates for the location where the data were collected. The relative three dimensional position between two CORS sites can be determined with a precision (95% confidence level) of 1.0 cm in the horizontal and 3.7 cm in the vertical dimensions, for baselines up to 300 km.

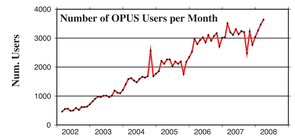
NGS uses two different processing methods depending on the duration of the submitted data sets.

Coordinates for data sets between 2 – 48 hours are calculated by averaging baseline lengths to 3 CORS sites (OPUS-Static).

Coordinates for data sets as short as 15 minutes are calculated using a service called OPUS-Rapid Static (OPUS-RS). Processing shorter duration data sets is possible, because OPUS-RS removes atmospherically-induced errors from the submitted data by using data from three to nine neighbouring CORS sites.

http://www.ngs.noaa.gov/OPUS





6. Current Issues

- Manage data and especially associated metadata from 1,500-2,000 stations
- Upgrade IT infrastructure to support increased data volumes
- Support and improve accuracy of ITRF and the NSRS, both in terms of site infrastructure and coordinate computation
- Expand assessment and advice to users establishing new CORS - data formats, communications, storage, construction
- Provide guidelines for coordinates used in real time networks
- Reprocess all orbits from 1994 to present in conjuction with IGS reprocessing effort
- Reprocess all CORS data in conjuction with IGS reprocessing effort
- Reduce latency of daily CORS processing from 2 days to 1 day
- Expand processing capability to support new GNSS's, current focus is GLONASS
- Complete development of a new data collector to support rapid ingestion of >2000 stations
- Centralize all metadata into a database to simplify tracking of station's equipment changes.

7. Future Plans

- Increase real-time CORS data streams and develop quality control tools
- Identify and support partners in sparsely populated areas to establish CORS
- Expand web tools for accessing CORS data
- Improve coordinate computations from short GNSS data acquisition times
- Compute ultra rapid orbits
- Prepare for Galileo and other GNSS systems develop new processing software to handle new signals
- Construct a series of CORS to be owned and operated by NGS to support the most demanding stability and uptime requirements needed for reference frame purposes.
- Expand, in collaboration with NOS CO-OPS, the number of CORS at tide-gauge stations.