NGS Expands its Role in Real-Time Network Positioning

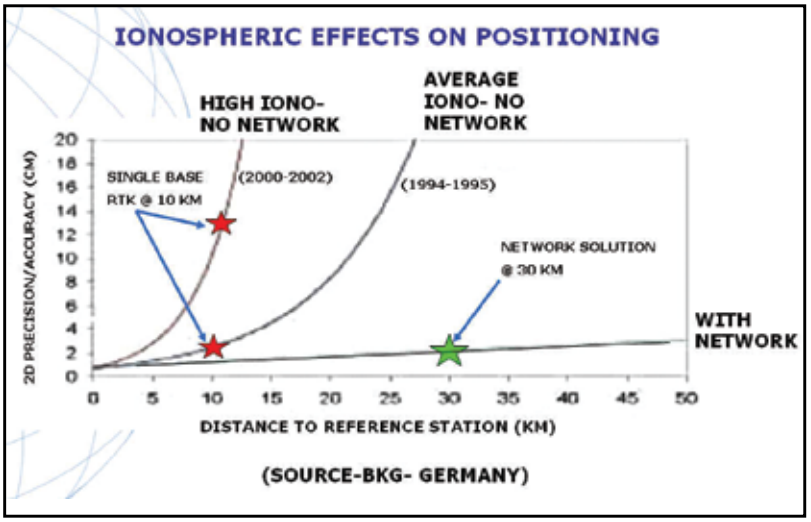
If you take time to notice, you'll see a real-time network (RTN) being planned, built, or operated about as fast as it takes to pump ten dollars worth of gas at your favorite service station. There are estimates of more than 50 RTNs in existence across the United States, and the number grows rapidly.

While Europe and Asia have proven groundbreakers in this Global Navigation Satellite System (GNSS) application, myriad U.S. players have since entered the game. Here are some examples of RTN administrators that have joined the action:

- State departments of transportation (DOT)
- Value added GNSS vendors
- GNSS manufacturers
- Spatial reference centers/geodetic surveys
- Academic institutions
- Scientific groups
- County governments
- City governments
- Private survey/engineering companies
- Agricultural cooperatives

You can also find various combinations of the above across the country.

To put it simply, the real benefits of RTNs over classical real-time kinematic (RTK) surveying are huge savings in time, equipment, personnel, and therefore money. Modeling atmospheric and orbital corrections to the rover position allows it to range freely within an RTN umbrella and experience negligible distance-dependent error (see Chart I as an example of one component).



▲ Chart I – The advantage of ionospheric correction to the rover position

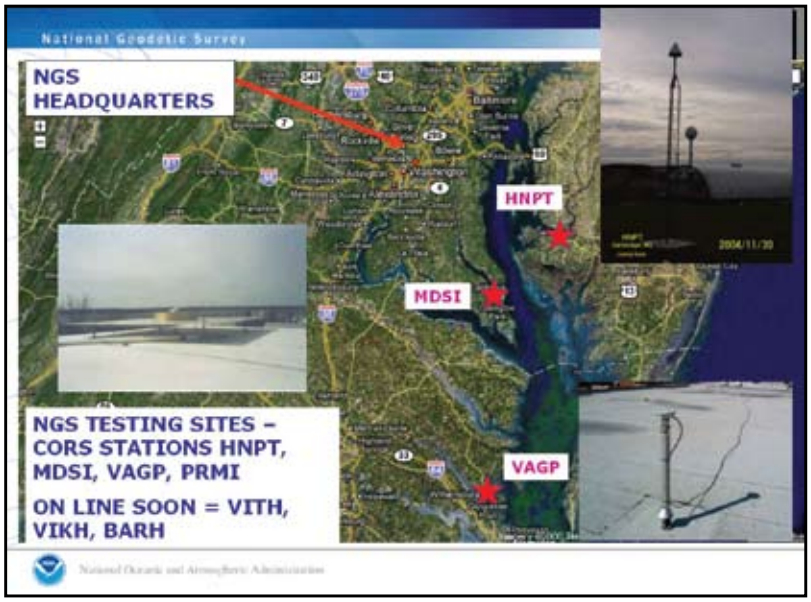
Many modern technologies are converging to drive the explosion of RTNs in the U.S. Cell phone and CDMA data service, easy internet access, mature networking software, robust late-generation real-time GNSS hardware and software, augmented satellite constellations, and the spread of GIS applications are all integral parts. These technologies make real-time positioning (RT) easier to use, and as a result, it is becoming a preferred method of data acquisition and stakeout. This is a departure from the traditional "top down" sharing of precise geodetic control from passive monumentation. NOAA's National Geodetic Survey (NGS) has moved extensively to "active" monumentation via the Continuously Operating Reference Station (CORS) network and its GPS user programs.

Issues always exist that need to be addressed while implementing an RTN to produce the desired accuracy, especially regarding coordinate compatibility, data precision and accuracy, and network stability. In consideration of its mission statement, the NGS believes it has the role to support these networks to ensure coordinate consistency. Without getting involved in the various RTN types or business models employed, and certainly not to compete with the RTN community, the NGS hopes to encourage RTN administrators to adopt the recommendations and guidelines it is developing to ensure compatibility with the National Spatial Reference System (NSRS). The NSRS is the geodetic foundation of all our national control, comprising not just the database of the coordinates at over a million passive monuments, but also the CORS active network, the foundation for the recent NAD 83 (NSRS2007) readjustment, as well as the National Shoreline and geophysical models such as the geoid.

We know that accuracy requirements continue to grow, both in numeric precision as well as across geospatial fields. Accuracy is addictive. GIS users happy with GPS accuracies of a meter now want centimeters. Agricultural applications that used code phase beacon corrections to get sub-meter row-to-row accuracy are now using RTNs to get centimeter accuracy. Deformation modeling of critical structures such as bridges and dams routinely uses real-time methods for collecting their positional data. Everyone now wants centimeters, not just surveyors and engineers. The NGS wants to make sure everybody's centimeters are consistent. Shouldn't the GIS match seamlessly state to state and region to region? Shouldn't a property monument located with one RTN have the same coordinates as when located with a different one? What about regional emergency management? If all RTNs were aligned to the NSRS at an acceptable accuracy level, we could be reasonably sure that all our positional data would match.

To this end, the NGS is putting forth the following ideas to obtain your feedback:

➪ The NGS will provide real-time, uncorrected GNSS data streams via NTRIP (Networked Transport of RTCM via Internet Protocol, see *http://igs.bkg.bund.de/index_ntrip.htm*) from federally owned/operated sites of the CORS network, beginning with NGS-owned sites. These RTCM data streams will aid in the establishment, validation, and monitoring of the RTN by network administrators. No correctors will be broadcast. The NGS is currently beta-testing the streaming of RTCM data from two CORS in Maryland and has invited the RTN service providers in the area, operating with different GNSS hardware and software, to integrate the data as reference stations in their networks. The latency of the data streams will always depend on the slowest connection, but the speed is more than adequate to get the data to the RTN servers. As a case in point, the latency of real-time data sent from NGS headquarters to Frankfort, Germany is only 0.3 seconds.



▲ NGS begins test broadcasts of uncorrected GNSS data streams via NTRIP

➪ NGS encourages institutions providing real-time positioning services to use the NGS-provided raw data in their operations so as to: (1) supplement the data from other GNSS reference stations, and (2) use the positional coordinates and velocities of the GNSS stations contained in the NGS real-time network as fiducial values for the positional coordinates and velocities of other real-time GNSS stations.

➪ Additionally, NOAA/NGS could stream satellite ephemerides, satellite clock parameters, iono and tropo models, and even crustal motion models for public use.

➪ The NGS will continue its role in support of accurate, reliable positioning and would continue its study of geophysical effects and study phenomena affecting accurate positioning such as satellite orbits, refraction, multipath, antenna phase center variation, geoid models, etc.

➪ The NGS will not re-stream data that is being streamed via NTRIP by another organization.

➪ Real-time networks should meet prescribed criteria in terms of site stability and data quality. For CORS site guidelines, see: *http://www.ngs.noaa.gov/CORS/Establish_Operate_CORS.html*

➪ A rough guide may be to include the greater of either ten percent or at least three of the RTN reference stations in the CORS network, and these sites should be well distributed across the RTN.

➪ Different brands of user equipment can operate with real-time services from the different networks to the greatest extent possible.

➪ The individual RTN administrator produces initial RTN reference station coordinates. However, promulgated coordinates and velocities for the corresponding GNSS reference stations will show daily solutions compatible with the National Spatial Reference System at the level of 2 cm horizontal and 4 cm (ellipsoid) height. The final level will be determined after consideration of all factors.

➪ Automated processes might enable RTN administrators to push daily data from all RTN reference stations to the NGS where a new version of OPUS will position the stations and archive the resulting coordinates.

➪ Three CORS that are part of the RTN will be used as control stations for this new OPUS processing. Then, time series plots will be developed to graphically depict the day-to-day variation of the reference station coordinates.

➪ Data would be quality checked before it is archived

The NGS encourages RTN users and administrators to provide input that will enable documents to be drafted benefiting all geospatial professionals. Topics may include: establishing reference stations, adjusting networks, accuracy expectations versus those obtained, baseline distances, error modeling, communication issues, etc. By partnering with the NGS, RTN administrators can help produce recommendations and guidelines with more real-world detail and in a more timely fashion. The newly formed NGS RTN team invites your comments. Please contact me at: *william.henning@noaa.gov*

These are exciting times for the GNSS community. Working together, we can provide a system that will stand all of us in good stead as we move towards faster and more accurate positioning.

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