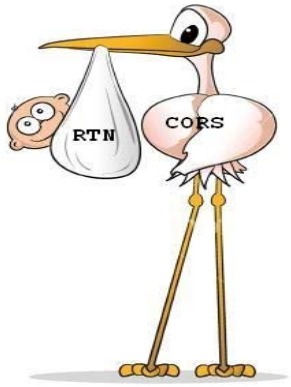
Report on the 8th Annual CORS USERS FORUM Savannah, Georgia 16 September 2008



NOAA's National Geodetic Survey (NGS)--in cooperation with the U.S. Department of Transportation and the U.S. Coast Guard--organized the 8th annual CORS (Continuously Operating Reference Station) Users Forum on 16 September 2008. This Forum was an integral part of the Civil GPS Service Interface Committee (CGSIC) meeting, held at the Marriott Riverfront Hotel in Savannah, GA, 15-16 September 2008. The Institute of Navigation's GNSS Conference convened 16-19 September 2008 in the Savannah Convention Center.

The CORS network is comprised of numerous subnetworks operated by almost 200 organizations. Collectively, these networks include more than 1,200 sites--each containing a geodetic quality, dual-frequency GPS receiver--and the CORS network is growing at a rate of about 15 sites per month. NGS and its partners collect, process, and distribute data from the CORS sites on a continuous basis in support of numerous activities including land surveying, navigation, GIS development, remote sensing, weather forecasting, satellite tracking, geophysics, and time transfer.

This year's Forum focused on the relationship between the CORS system and the rapidly growing number of real-time GNSS networks (RTN) in the United States.

The purpose of the Forum is to provide CORS users with the latest information about CORS, its partners, its tools and its support for real time positioning , while hearing from these users about their experiences and what NGS can do to improve its products and services.

Statue from St. Bonaventure Cemetery, Savannah

Agenda

1:30 **Welcome**
Richard Snay, NOAA's National Geodetic Survey

1:35 **CORS/OPUS: Overview and Status**
Giovanni Sella, NOAA's National Geodetic Survey

1:50 **NGS Support for Real-Time GNSS Positioning**
William Henning, NOAA's National Geodetic Survey

2:05 **PANEL SESSION: Real-Time GNSS Networks**

Gavin Schrock, Washington State Reference Network
Art Andrew, Orange County, California
Lewis Lapine, South Carolina Geodetic Survey
Ken Bays, Oregon Department of Transportation
Jim Waters, Tennessee Department of Transportation

2:45 **Question & Answer Session with Panel of the Speakers**

3:30 **Break**

3:45 **Interactive Sessions within Small Discussion Groups**

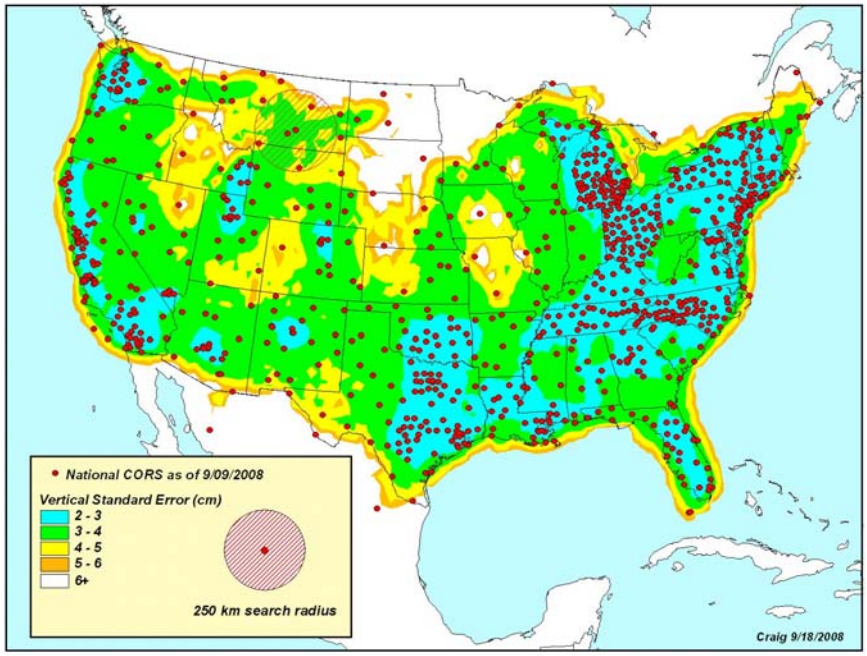
5:00 **End of Forum**

The PowerPoint files for each of the formal presentations may be viewed and/or downloaded at http://www.ngs.noaa.gov/CORS/CorsPP/PPT.html .

Welcome
Richard Snay
NOAA's National Geodetic Survey

This year's Forum is focused on the relationship between the CORS system and the rapidly growing number of real-time GNSS networks (RTN) in the United States. Some have estimated there to be about 75 RTN's in our country. CORS and RTN's are similar in that they both enable centimeter-level positioning accuracies. They are different in that CORS has traditionally addressed post-processing applications whereas RTN's address real-time applications. They are similar in that both rely on ground-based GNSS tracking stations. They are different in that CORS is a highly coordinated nationwide effort, whereas the existing RTN's are comprised of a somewhat disjoint collection of regional and local networks. In some instances, two or more RTN's may even compete for the same customer base. Some coordination, however, does exist among those RTN's that share the use of their GNSS tracking stations with each other.

To better coordinate the growth of RTN's across the United States, the administrators of five regional RTN's have been invited to participate in this Forum and share with us their experiences. Also, leaders from NOAA's National Geodetic Survey have been invited to report on the status of the CORS system and to describe what NGS is doing to support real-time GNSS positioning.



Vertical standard error achievable when a user submits 15 minutes of GPS data to OPUS-RS.

CORS/OPUS: Overview and Status
Giovanni Sella
NOAA's National Geodetic Survey

In January 2008, NGS became the Analysis Center Coordinator for the International GNSS Service (IGS) for the next four years. As such, NGS is now responsible for coordinating the generation of precise GPS and GLONASS products; including orbits, satellite clock parameters, Earth rotation parameters, and atmospheric refraction parameters.

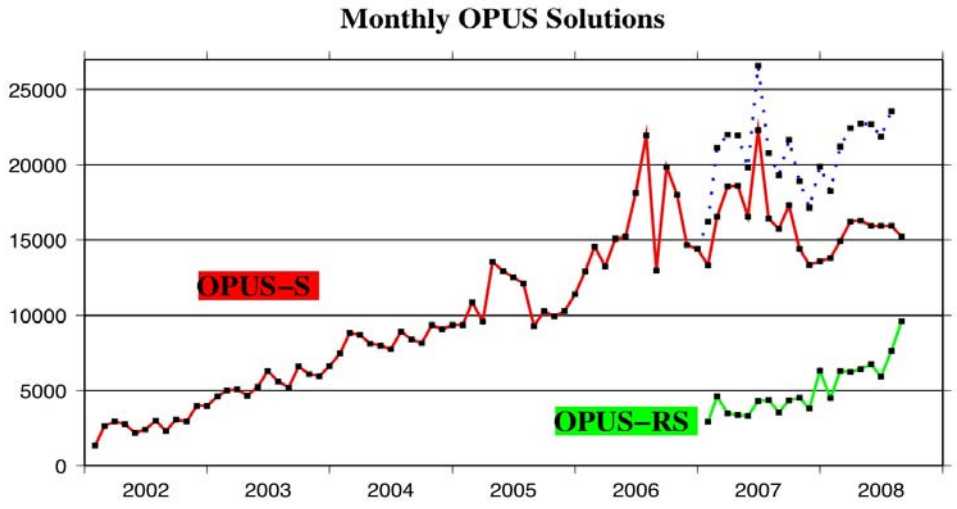
In June 2008, NGS released version 3.0 of the Horizontal Time-Dependent Positing (HTDP) software for operational use. This new model contains a significantly improved model for predicting horizontal crustal velocities occurring in western CONUS as developed by Robert McCaffrey of Troy Geophysics. HTDP also introduces a model for the 3D displacements associated with the M7.9 Denali earthquake which devastated central Alaska in 2002. The Denali earthquake model was developed by Julie Elliot and her colleagues at the University of Alaska.

NGS has begun to reprocess all IGS and CORS data collected since 1994 to help develop a new realization of the International Terrestrial Reference System, as well as a new realization of the North American Datum of 1983.

NGS incorporated about 270 new sites into the National CORS network in FY2008.

NGS has begun to transition from using "relative" antenna calibration parameters to "absolute" antenna calibration parameters for processing GPS data.

Usage of the OPUS-RS (rapid static) utility increased by about 77% in FY2008 relative to FY2007.

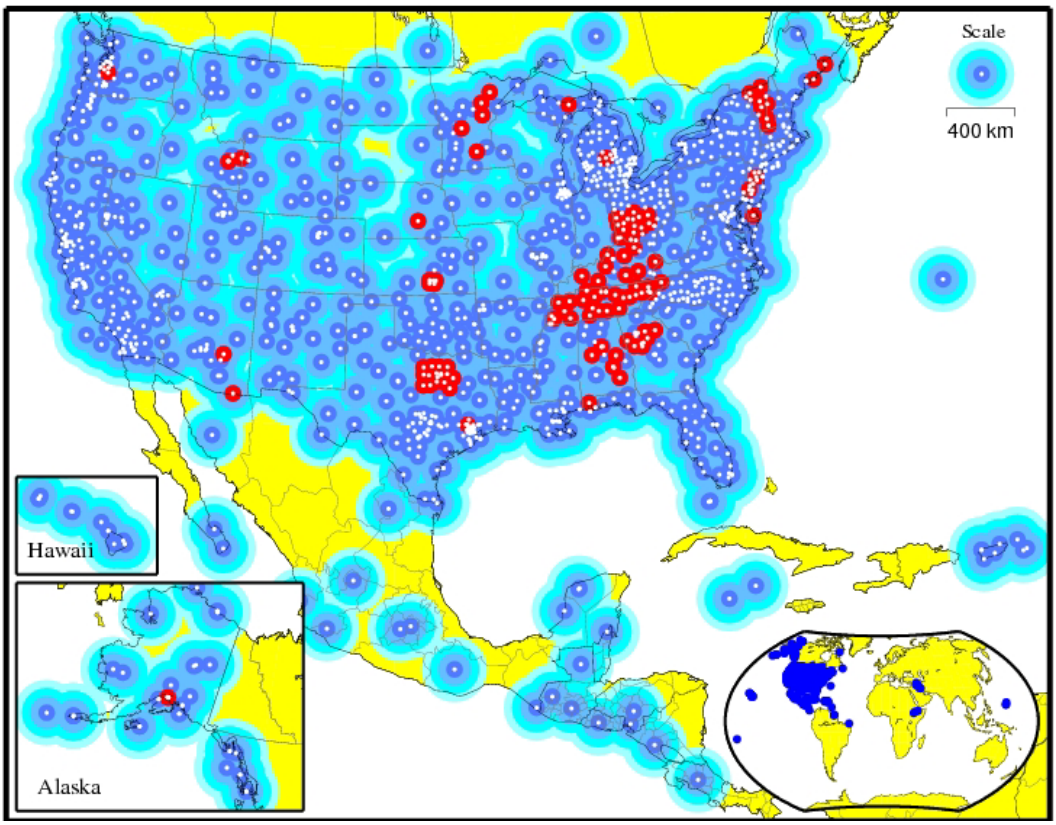


NGS introduced the OPUS-DB utility as an operational prototype in FY2008. OPUS-DB allows OPUS users to share their results with others by storing the OPUS-computed coordinates with pertinent metadata in a NGS-maintained database.

With support from the U.S. Agency for International Development, NGS established four CORS in Ethiopia.

NGS is supporting the installation of new CORS in Iraq and Afganistan.

NGS will distribute GLONASS and L2C data from selected CORS starting in FY2009.



Red circles identify CORS sites that collect both GPS and GLONASS data.

NGS Support for Real-Time Positioning

William Henning
NOAA's National Geodetic Survey

NOAA's National Geodetic Survey (NGS) endorses the development of GNSS technology to provide accurate and reliable real-time positioning services that are consistent with the U.S. National Spatial Reference System (NSRS).

Goals:

NGS will support real-time GNSS positioning by implementing an action plan to:

1) Provide low-latency access to GNSS data from selected Continuously Operating Reference Stations (CORS) via the Internet. All streaming data from these CORS will be provided free of charge, without correctors, in current Radio Technical Commission for Maritime Services (RTCM) formats.
2) Develop standards, specifications, and guidelines to help users obtain optimal results from real-time GNSS positioning technologies. This would include specific documents for users of single-base technology as well as for users of real-time GNSS networks (RTN).
3) Develop standards, specifications, and guidelines for administrating a RTN. This may include:
   a. Reference station siting and construction considerations
   b. Policy to promote the use of open source, generic data formats such as RTCM through the use of the most current Networked Transport of RTCM via Internet Protocol (NTRIP) programs
   c. Policy to encourage the RTN to support as many different GNSS hardware and firmware packages as possible
   d. Guidelines to enable RTN results to be consistent within the NSRS. This may include methods to archive and quality check RTN data
   e. Guidelines to determine accurate positional coordinates and velocities for RTN reference stations
4) Provide a service to RTN administrators and users to verify that the positional coordinates obtained from their RTN are consistent with the NSRS.
5) Maintain a strong participatory presence and seek leadership roles at various conferences, meetings and venues where real time positioning is addressed.
6) Participate in education and outreach to both disseminate relevant information as well as to acquire feedback regarding the suitability of guidelines promoted by NGS.
7) Research phenomena affecting accurate positioning, including but not limited to: satellite orbits, refraction, multipath, antenna calibration, and crustal motion.

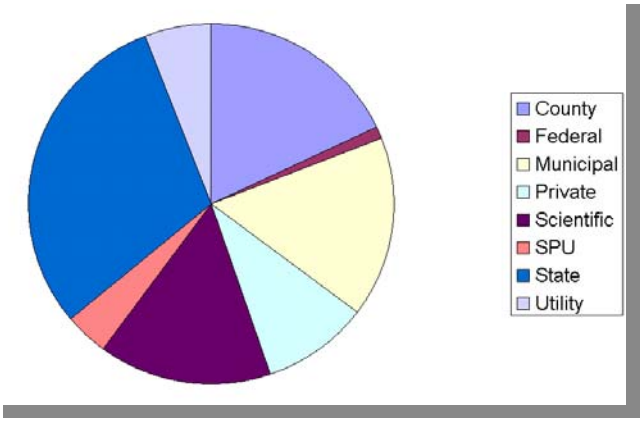
With regard to Goal (1), NGS is now distributing GPS data from seven CORS (see following figure) as an operational prototype.

With regard to Goal (2), NGS has drafted guidelines for "single-base" real-time GNSS positioning. These guidelines are available at http://www.ngs.noaa.gov/PUBS_LIB/NGSRealTimeUserGuidelines.v2.0.4.pdf .

With regard to Goal (3), NGS is now working with several people throughout the positioning community to develop guidelines for operating a real-time GNSS network (RTN).

Washington State Reference Network
Gavin Schrock
City of Seattle

The Washington State Reference Network (WSRN) is a cooperative RTN spanning Washington. This network involves sites operated by various federal, state, and local governments, as well as by academic and private institutions. 90 of the planned 95 stations have been established.



Users have opened over 600 accounts with the WSRN. Accounts for partners are free, as are accounts for academic users and trainer/dealers. Other subscribers pay $1,900/yr for a single account, $5,700/yr for 5 accounts, and $10,000/yr for 10 accounts.

Seattle Public Utilities funds and operates the central processing facility, and Central Washington University funds and operates a mirror processing facility.

Differential precisions are at the 1-cm level in the horizontal dimensions and at the 3-cm level in the (geometric) vertical dimension.

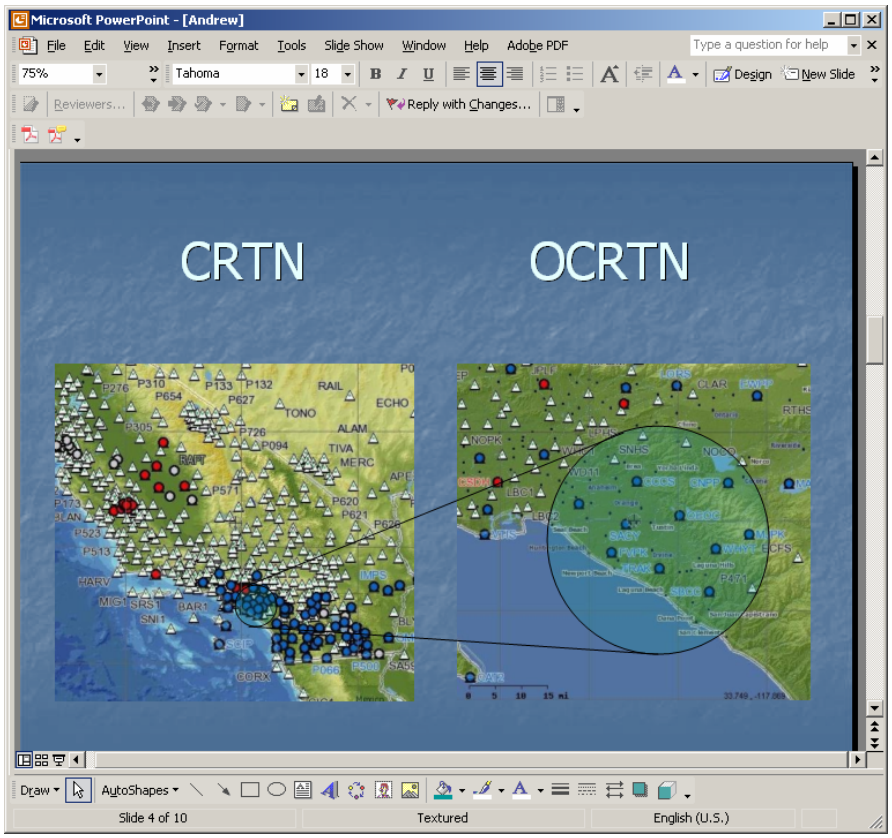
Station spacing ranges from 50km to 70km for the most part (lowest = 30 km, highest = 100km).

Coordinates are initially computed by performing at least 15 OPUS solutions, each involving 24 hours of data. Coordinates are referred to the CORS96 realization of the North American Datum of 1983. Coordinate values are constantly monitored in real-time to detect station motion and/or data problems.

60% of the sites are currently GNSS enabled. It is expected that all sites will become GNSS enabled by 2010.

Orange County Real Time Network
Arthur Andrew
County of Orange, California

The Orange County Real Time Network (OCRTN) consists of 10 real-time GPS stations. The real-time data are available to anyone at no cost. OCRTN is a subnetwork of the California Real Time Network (CRTN).



OCRTN currently provides three data streams:

- Single base station mode –standard RTK using RTCM 2.2 format. User has ability to select base station;
- Nearest base station mode – standard RTK using RTCM 2.2 format. Server selects the base station located closest to the rover's position;
- Network solution – requires user to have proprietary software.

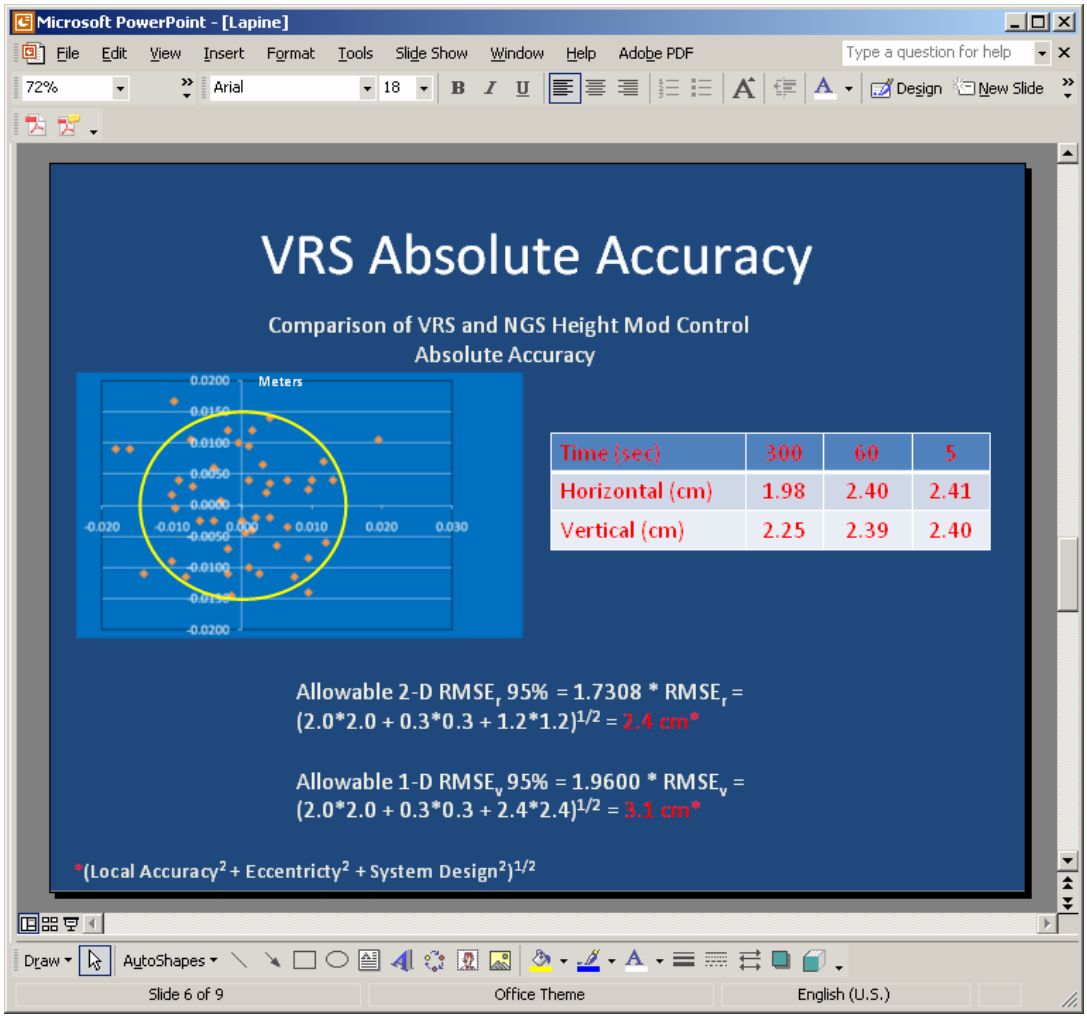
The OCRTN server supports NAD 83 (1991) coordinates at the 1991.35 epoch. The CRTN supports NAD 83 (NSRS2007) coordinates at the 2007.00 epoch.

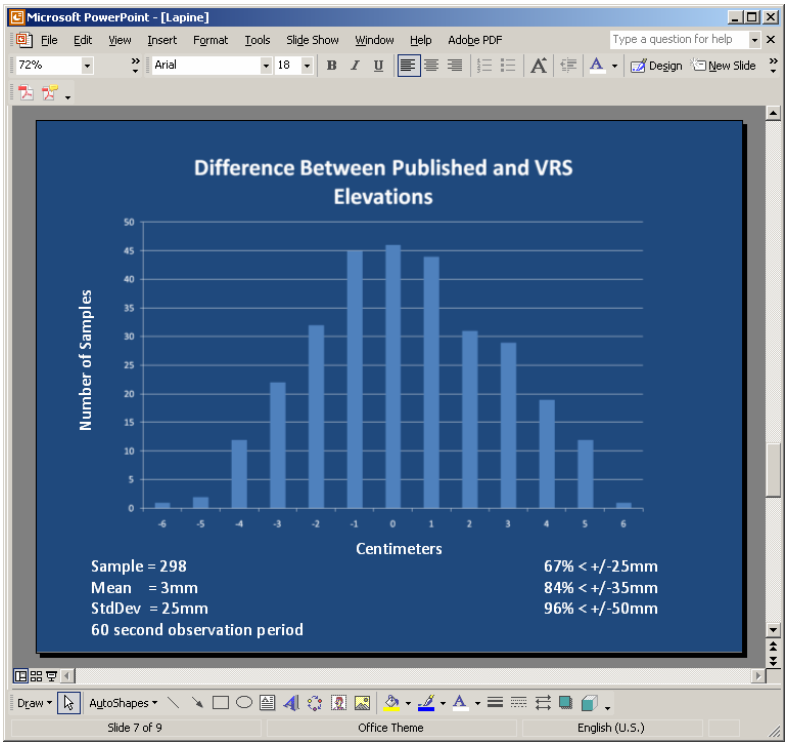
See www.ocgeomatics for additional information about the OCRTN. See http://sopac.ucsd.edu/projects/realtime for additional information about the CRTN.

South Carolina Real Time Network
Lewis Lapine
South Carolina Geodetic Survey

RTN concept at the South Carolina Geodetic Survey (SCGS):

- Started with a clean sheet of paper
- Determined an optimal spacing would be under 100km
- Required redundancy in case as many a 5 non-adjacent stations become inoperative
- Requirement to be operational during and after a hurricane event
- 31 stations will marginally cover the state, SCGS operates 38 and eventually 45
- Future activities include sharing RTN stations with North Carolina
- Involvement of the IT office is critical to our success
- RTN design accuracy is 2.4cm horizontal, 3.1cm vertical 95% of the time.





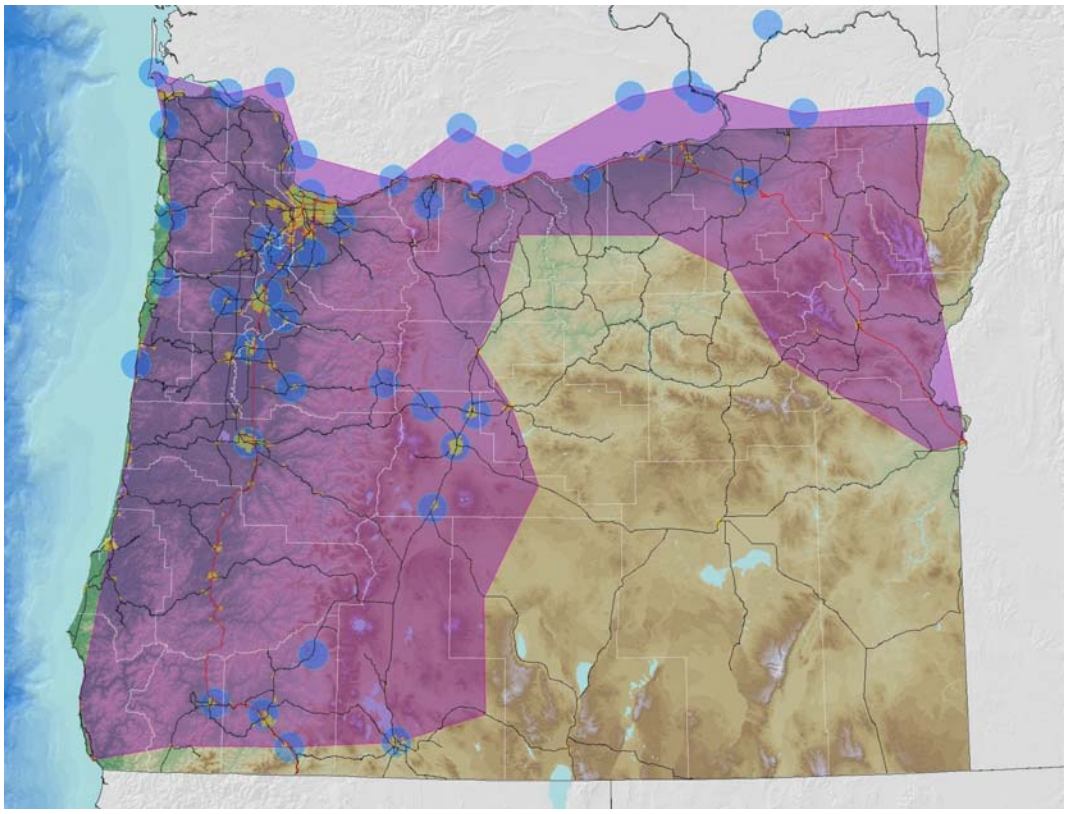
Motion of site (SCHG): September 3 – 10, 2008

Oregon Real-Time GPS Network
Ken Bays
Oregon Department of Transportation

Oregon is building the Oregon real-time network in cooperation with public and private partners.

Anyone who is not a partner and wants access to RTK correctors from the network must establish an account at www.TheORGN.net. There are no direct user fees at this time, but there may be a minimal fee in the future to cover operations, maintenance, and upgrades; but not to cover the cost of building the network infrastructure.

Plan for network coverage by July 2009:

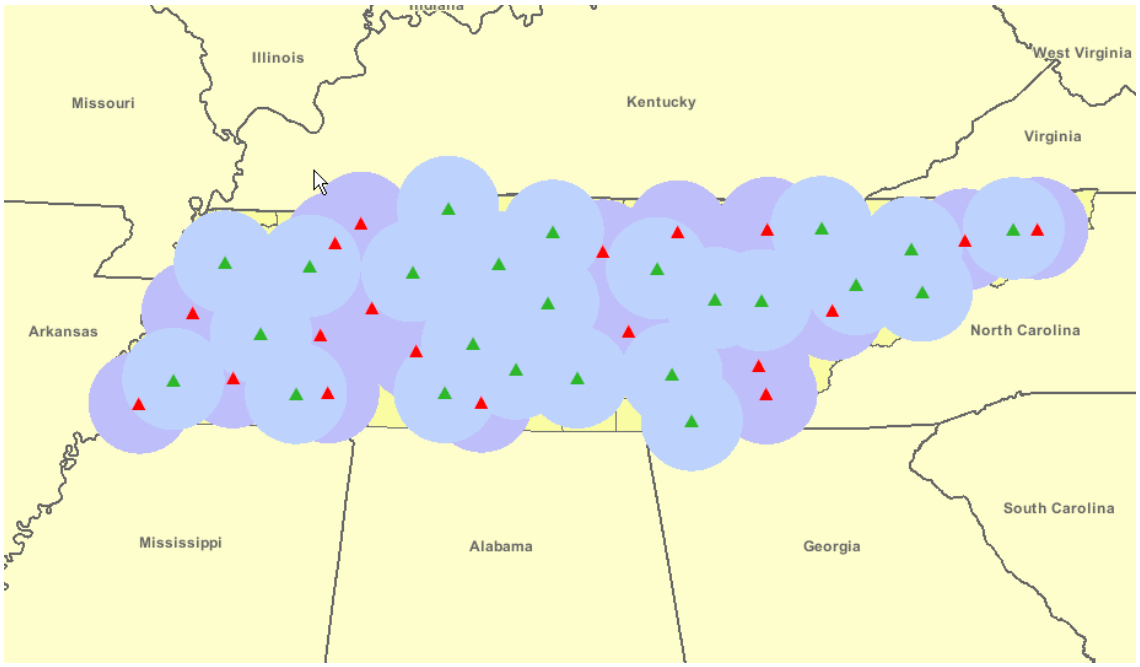


Site criteria standards:

- 60km station spacing
- Clear view of the sky
- No electromagnetic interference
- Pre-installation data quality sets: 3 days of GPS data
- Continuous power with backup
- Internet connectivity.

Tennessee Real-Time GNSS Network
Jim Waters
Tennessee Department of Transportation

The Tennessee Real-Time GNSS network is one of the first to use both GPS and GLONASS. It currently contains 24 reference stations (green triangles in the following figure), with at least another 20 (red triangles) in the planning stages.



Each reference station has an Uninterrupted Power Supply and In-Line Lightning Protection.

The Tennessee Department of Transportation (TDOT) is pursuing agreements with other TN State agencies to establish supplemental reference stations.

A public sector user agreement is under development, and public access is scheduled to begin in December 2008.

User fees will be charged to cover TDOT costs in support of public sector access.

For additional information, see http://tdotcors.state.tn.us:8080/TopNETweb/ .

Question & Answer Session with Speakers

Question (I. Leveson): Will a super RTN evolve in the United States, that is, a RTN that covers multiple states?

Answers:
(W. Henning) Some regional RTN's already extend beyond the borders of a single state. These larger RTN's exist in the private sector. Most public RTN's are confined to a single state or some part of a state.

(L. Lapine) IT infrastructure constitutes the biggest impediment to network growth. South Carolina and North Carolina are planning to share some RTN sites located near their common border, but for this to work, the IT system for South Carolina will need to treat the North Carolina sites in the same manner that it treats the South Carolina sites.

(A. Andrews) Does not foresee the existing RTN in California extending beyond California.

(G. Schrock) The NTRIP protocol has been developed to enable organizations to share real-time data among networks. Washington State shares data with Canada, for example. He does not foresee a common operator, but he proposes that all RTN's adopt a common reference system.

Question (L. Sears and J. Stowell) Are existing RTN's providing infrastructure for (1) machine control, (2) precision agriculture, and (3) positive train control?

Answers:
(L. Lapine) Some users of the South Carolina RTN are involved in machine control, but more often they operate their own GNSS base stations.

(A. Andrew) Organizations involved in machine control will often rebroadcast the correctors supplied by the California RTN.

(K. Bayes) Cell phones and Internet communications may not be sufficiently reliable for machine control applications. Hence, those involved in machine control will often rebroadcast the RTN correctors on FM radio frequencies.

Question (?) Will the CORS system adopt the RINEX 3.0 format?

Answer: (G. Sella) NGS has no plans to adopt RINEX 3.0 at this time. NGS will re-evaluate the situation in the future.

Question (C. Whitaker) Should there be restrictions as to who can publish spatial coordinates?

Answers:
(G. Schrock) Everyone who sets up a RTK base station implicitly provides coordinates, but these mostly involve a local set of relative coordinates.

(W. Henning) NGS is establishing guidelines for RTN administrators to help them promulgate coordinates that will be consistent with the National Spatial Reference System.

Question (G. Mader) Does GLONASS help RTN operations?

Answers:
(L. Lapine) Initiation times for RTN surveys are one-third as long when using GPS & GLONASS data as compared with initiation times when using GPS data alone.

(?) Because RTK surveys require a minimum of 5 visible satellites, these surveys can be performed with less interruptions when they use both GPS and GLONASS data than when they use only GPS data.

Comment (G. Mader): Regarding the plans of Washington State to use "bluebook" procedures to submit GPS survey results to NGS for archival purposes, Mader suggests that Washington State consider using OPUS-DB instead.

Question (?) Should RTN administrators be concerned with establishing RTN base stations on top of buildings that have metal roofs?

(G. Sella) Because a metal roof may increase the likelihood of multipath corrupting GNSS signals, NGS is not accepting GPS base stations located on metal roofs into the CORS network. The CORS network forms the foundation for accurate positioning in the United States, and therefore it should contain sites whose data we can trust to be of high quality. NGS, however, is planning to perform research to better quantify the effect of metal roofs on GNSS data.

(W. Henning) NGS has organized an inter-organizational committee to develop guidelines for RTN administrators. This committee is favoring the creation of a classification scheme for RTN base stations in which those located on metal roofs would be classified lower than what current standards allow for base stations being accepted into the CORS network.

(R. Snay) If a classification scheme is adopted, who would be responsible for classifying individual GPS base stations? NGS does not have the resources to perform this activity.

Question (C. Whitaker) What is the effect of using "absolute" antenna patterns rather than "relative" antenna patterns?

Answer (G. Mader) Relative antenna patterns are okay for short baselines, but absolute antenna patterns are more correct for those longer baselines where the curvature of the earth comes into play.

Discussion Group A: CORS and Real-Time Networks

Moderator: Ken Bays, Oregon DOT
Recorder: Sky Chaleff, NGS

Participants:

Christina Kempe	Lantmateriet, Sweden
Art Andrew	Orange County, California
Cecilia Whitaker	Metropolitan Water District, California
Brian Wiseman	Metropolitan Water District, California
James Stowell	Consultant
Richard Snay	NGS
Lew Lepine	South Carolina
Doug Brown	NGS

There were 4 main issues discussed:

1. Improving OPUS to support deformation studies
2. NGS real-time streaming and competition
3. CORS Funding
4. Radomes

Summary:

James Stowell requested that NGS upgrade OPUS with the options to select the epoch, the coordinate system, and obtain a running average of the estimated positions to support deformatiom studies. He would like to use the data for the last 30 days for such averaging. Richard Snay indicated that OPUS will soon be outputting OPUS results in XML format which will allow users to create software that meet some of these customized requirements.

Ken Bays wants to make sure that good coordinates are obtained for all RTN sites. The NGS RTN team can be of great value, by making sure that all states use the same method so that coordinates are compatible from one real-time network to another.

NGS said they will stream only the GPS observables. People expressed concern as to why they are not also streaming correctors. NGS will not provide correctors so as to not compete with private industry. James Stowell mentioned that NGS real-time streams save him money. There have been challenges at the state level between public and private real-time GNSS networks. Ken, playing the devils advocate; saying NGS does not want to compete, but OPUS seems to compete against private industry. Ken said that when there is competition; the state is cheaper, but the service is not on the same level as the more expensive private networks.

Doug Brown mentioned that he is trying to have the CORS program better connected in the NOAA funding process. CORS data are important to several areas of NOAA, but this fact has not been properly recognized. NOAA is a conglomeration of science missions, and CORS is

connected to many of them.

A general discussion on antenna radomes ensued; though no consensus was reached on their benefit or harm.

Statements from Participants

Cecilia Whitaker explained that the Metropolitan Water District (MWD) send their real-time data streams to Scripps Institution of Oceanography who operates the California Real-time Network (CRTN). CRTN uses proprietary software to provide positioning services to users. MWD uses the real-time data for geodetic control, but not deformation studies. They use only post-processed CORS data for deformation studies.

Christina Kempe mentioned that Sweden has been running a national CORS for 15 years and a RTN for the past 5 years. They are the service providers, selling the services to the end users. They use Trimble VRS, with mainly JAVAD and ASHTEC receivers. In Sweden they are experiencing glacial isostatic adjustment (GIA). They use 21 stations set in bedrock to monitor the motion associated with GIA.

James Stowell has been performing deformation studies for geodetic projects and machine control projects occurring in NY. NY has legislated that their contractors use the RTN operated by the NY DOT for coarse grading. The contractor gets paid sooner if they do. NY can QA the results and save money on the processing. The NY DOT machine control budget is 4 to 5 times larger than their surveying budget.

Ken Bays mentioned that the Oregon DOT uses OPUS to compute coordinates for their RTN. According to Ken, the NGS RTN team can be of great value, by making sure that all states use the same method so there are no coordinate compatibility problems as existed with the old HARN networks.

Christina Kempe does not endorse performing land surveys with just a RTK solution. People typically do 5 seconds occupations, and she feels that the resulting coordinates are not accurate. If you use software that uses network least squares solutions, you will obtain more accurate coordinates. She also does not endorse using single baseline solutions.

NGS real-time streaming and competition

NGS said they will only stream the GPS observables without correctors so that NGS will not compete with private industry.

NGS operates the reference stations, and it is not much more work to stream the data for public access. Also, by streaming data, NGS gains valuable experience to help them develop guidelines for RTN administrators.

James Stowell mentioned that NGS real-time streams save him money, but only if the reference stations are located relatively near to where he is working. NGS data are helpful because the control is very stable.

In some European countries, the government owns the CORS infrastructure and sells the data to service providers like Trimble and Leica.

Ken noted that NGS does not want to compete, but OPUS seems to compete against private industry. He said NGS could use the argument that they are providing convenient and reliable access to the National Spatial Reference System.

There have been challenges at the state level between public and private RTN's. The Virginia government's idea of establishing a public RTN was knocked down because a private network is already operational in the Virginia.

Lew Lapine expressed the opinion that freely giving away RTN services is not good because government money streams are not guaranteed. A service fee helps guarantee the service level.

James Stowell said that some subscribers of RTN services discontinue their subscriptions after the first year.

INET in GA, AL, MS and TN has 180 RTN subscribers at $6,000 a year per rover. They provide excellent 24/7 service, including training. You get what you pay for.

Ken said that when there is the competition; the state is cheaper, but the service is not on the same level of quality as the private services.

OPUS improvement for deformation studies

Rather than rely on one OPUS solution, James Stowell wants a 30 day average. He wants to monitor the point moving around at the millimeter level. Then at the end of the 30 days he wants the average location of the point. This is for deformation studies. He would like a drop down menu in OPUS to allow this option.

Richard Snay responded that NGS is developing an XML output for OPUS to allow users to develop software that can manipulate the information and hence do 30-day averages themselves. The XML format is in the process of being reviewed. This will allow machines to talk to each other to automate processes. This will allow companies to build value added services for GIS and other applications.

Richard explained how RTN administrators, who operate reference stations for several years, will begin to see seasonal effects in the coordinates of these stations. One example is ground motion in sedimentary plains, both horizontally and vertically, which correlates with the occurrence of rainfall.

James Stowell addressed how people should manage vertical positioning in machine control; what you want to do is give the machines an average change and a separate corrector to surveyors. The second problem is how to fix the vertical in RTK since it is the worst problem. One of the ideas coming out at the ION conference, according to the abstracts he has read, is the

master auxiliary concept where the rover feedbacks vertical to give a real-time tomography for just that rover.

CORS Funding

Doug Brown said that CORS data is important to many areas of NOAA, but this fact has not been properly recognized.

Lew Lapine said that RTK technology would help ships come into harbor with less help.

NOAA is a conglomeration of science missions, and CORS is connected to many of them. NGS has not made a good case for the applications of geodesy to societal benefits.

James Stowell mentioned that 4 or 5 years ago NGS hosted a group of scientists on how to write a justification for the CORS network and how the data was going to be used. Maybe it is time to do this again.

Radomes

A general discussion on radomes ensued. Someone said they were advised not to use radome, but someone else said that results were based on a test involving a much corroded radome. Someone says they still use radomes. Someone stated that the use of radomes is ok because coordinates are monitored over time.

DISCUSSION Group B: CORS and Real-Time Networks

Moderator: Jim Waters, Tennessee Department of Transportation
Recorder: Rick Foote, NGS

Participants:

Irv Leveson	Leveson Consulting
Gavin Schrock	Washington State Reference Network
Matt Wellslager	South Carolina Geodetic Survey
Seth Gutman	NOAA's Earth Systems Research Laboratory
Dmitry Kolosov	Topcon Positioning Service (Moscow, Russia)
Valery Lupovra	Topson Possitioning Service (Moscow, Russia)
Marc Cheves	American Surveyor Magazine
Gerry Mader	NGS

The group started out with introductions at 4:15. The two Topcon employees are software developers based in Moscow, and their main interest was in weather effects. Marc Cheves is the Editor of American Surveyor magazine. A list of possible questions compiled by Richard Snay, Bill Henning and others was passed around, and the discussion started with a question proposed by Gerry Mader "Would you rather OPUS use published positions or moving 30 day average positions?". Gavin suggested both choices should be available (using OPUS). Matt said that he

would prefer to see accurate long term positions that are stable. He also said that some CORS elevations are as much as 7 cm off, and he notified NGS about two of them 6 months ago and one year ago, and neither one was corrected. Rick Foote suggested that Matt email him with the particulars and that he would check them out. Dmitry said possibly both positions should be made available, and Valery said current positions.

Gavin Schrock said that Washington State is currently computing a velocity model. Presently, they are not using any velocity model to maintain their RTN coordinates. He said that periodic updates are needed for RTK, and older NAD83 realizations require calibrations (he doesn't trust any position unless it is from the most recent realization). He asked Seth Gutman about spacing stations for RTK in more humid areas of the state, and seemed very interested in talking to Seth outside of the group. Seth said dry flatter areas (less than 100 meter change in elevation) can be assumed to have similar tropo parameters up to a distance of 50 kilometers.

Valery mentioned that there are tropo models and asked if there is a humidity model. Seth emphatically said no - it is not possible. Dmitry said that Topcon's tests show that there are clear seasonal position changes, and Seth said that moisture measurements on the ground are not correlated to the upper atmosphere. Seth said that if you are within a 50-km and and a 100m elevation of a weather station, you can use their data (upper atmosphere). Seth volunteered to work with Gavin later. Seth said that there are some very good inexpensive (under $2k) weather sensors. Since there seemed to be a lot of interest in what Seth was talking about, business cards were passed around by Jim, Irv, and Dmitry.

Irv Leveson asked if anyone was interested in Grav-D. Gavin would like to use Grav-D data to determine orthometric heights. Most other attendees were not familiar with Grav-D, so Rick Foote referred them to the NGS homepage to read about this proposed project. Valery asked about NAVD88 accuracies right when Richard Snay happened to walk by, and Richard mentioned coast-to-coast accuracies of about 1 meter, and Grav-D could vastly improve upon this.

Discussion Group C: CORS and Real-Time Networks

Moderator: Giovanni Sella, NGS
Recorder: Renee Shields, NGS

Participants:

Gary Boyak,	National Parks Service (NPS) as proxy for Dick Karsky, NPS;
Ryan Leonard,	Kara Company Inc.;
DeLane R. Meier,	North Dakota DOT;
Francine Coloma,	NOAA's National Geophysical Data Center
Gerry Mader	NGS
Steve Briggs	Topcon Positioning Services

<u>Questions relayed from Dick Karsky who was unable to attend.</u>
What is the possibility of getting any CORS in the Midwest upgraded to GLONASS?

- ID, UT, AZ all have one. No Plate Boundary Observatory (PBO) sites are GLONASS capable, nor will PBO sites be L2C capable. There is a new CORS planned for MT, this might be GLONASS. Suggest contact Curt Smith or site operator.

Question about OPUS Mapper…

- designed for single frequency receivers; still in development stage; may be able to become a beta tester; contact Gerry Mader.
- May not be very good up north, in certain areas

Questions from Ryan Leonard
Re: coordinate systems/datums, where are we going in the future?

- We have been evaluating the processing system for CORS; have made some changes for deficiencies found, some minor, some more significant; a readjustment will be done to ensure consistency in process and results

How does NAD 83 (NSRS2007) relate to NAD 83 (CORS96)? – Dave Doyle and Giovanni Sella changed discussion groups here.

- From Denver to the east, horizontal coordinates are nearly identical for both realizations, very close in vertical; no velocities here.
- In the west, tectonic movement causes problems in NAD 83 with velocities; see modest deformations in NAD 83; NSRS2007 adjustment = snapshot in time; NAD 83 (NSRS2007) and NAD 83 (CORS96) are different realizations of NAD 83.
- When Ryan gets new datasheets, for CORS the coordinates are the same as they were before the NSRS2007 adjustment; however, these coordinates may be revised in 2 years after a new readjustment is performed.
- Ryan mentioned he'd been told he shouldn't use NAD 83 (CORS96) coordinates if he wants NAD 83 (NSRS2007), but in Illinois the two should be essentially the same.
- Discussed getting orthometric heights from GPS; talked about the future of height modernization.

Ryan has 2 stations, KAR1 and perhaps CALU(??), which were cooperative CORS and now becoming National CORS; coordinates are off by 2cm and 7cm; should he republish?

- recommend work with Mike Cline to evaluate velocities over the past years.
- Recommend he get Giovanni's work on isostatic rebound in Great Lakes area.

Gerry Mader came by and had a question: Should CORS coordinates stay fixed till they exceed the positional tolerance, as we do now, or should we publish new coordinates daily or monthly based on a monthly average?

- No real answer, but commented that more and more people are looking for new coordinates.

Ryan question again: He has 9 continuous GPS base stations that don't meet criteria for National CORS; is OPUS DB an option for that?

- Discussed OPUS DB – Dave described how it worked. Renee mentioned that multiple solutions will be published, as a history, so he could submit data monthly and publish new positions and see how stable the coordinates remain over time.

Giovanni and Dave Doyle changed groups back at this point…

Question about changing antennas.

- It can be done and he is free to do it, but if the phase center height changes (i.e. different offset or any of dozens of scenarios or situations that might result in this height being different) then the site is decommissioned and moved to the bottom of the queue.
- Since he has 9 of these, he might try it with one in a more remote area, then see what happens before changing others.

Discussion about whether it is better with or without a choke ring antenna – Gerry and Steve Briggs contributed to this discussion. No resolution.

How long is the waiting queue for new CORS now, and how long before NGS gets to the bottom of it?

- about 220 CORS are now in the waiting queue. Because of how the stations are processed and authorized, they can be done in big chunks, so it is hard to tell. When a problem is found the CORS team doesn't stop to find the problem, they move on to the next stations in the queue.