

# RTN 101

**R**eal Time Networks (RTNs) are truly a worldwide amenity. Depending on how one defines a true RTN, there are well over 200 active, and many of the network operators with over five years' experience in full production. RTNs have evolved from the "science experiment" stage to becoming successful, high production, multi-discipline user-driven, fully sanctioned, and even mandatory (in some rare cases) amenities.

In 2004 an international operator seminar was held in Munich, Germany that drew participants from all over the globe (see "International GPS Conference" in the Nov. 2004 issue). In subsequent years, for practical reasons like travel costs, language, and regional issues, operator meetings were held in several areas throughout the world. This year, for the first time, three coordinated events were held within a 30-day period: seminars in Denver (for the Americas), Barcelona (for Europe, Africa, Middle East), and Chengdu China (for the Asia-Pacific region).

While these three representative events were organized for and by operators of networks utilizing the GPSNet™ suite of infrastructure software from Trimble, the subjects, trends, and issues discussed by the more than 100 network practitioners represented at the gatherings serve as a general meter on the state of RTNs worldwide.

The key message was obvious from the turnout and enthusiasm at each event; the RTN boom is full-on and sustainable.

## Denver – May 10, 2007

This seminar for the Americas is in its second year. While the 2006 gathering was a



Denver, at the Webb Municipal Building. Artist Larry Kirkland used the "plumb bob" to represent the beginning of all building processes; this one framed by two heads facing "the future and the past".

# RTN-101:

## Denver, Barcelona, and Chengdu Host 2007 Regional RTN Operators Conferences (Part 8)

great opportunity for the network operators to meet for the first time and compare notes on their respective networks, 2007 took on a more practical tone.

In 2006 the attendance went beyond the network operators to include other interested parties and looky-loos, and the agenda was more of a show-and-tell; "Hello, my name is [blah-blah] and my network has [X number of] stations..." This year's agenda was designed to open dialogue among the network operators on specific elements of operation, implementation, customer service, and important issues.

"The seminar was geared more towards the operator this time," noted Wes Kanzawa, network administrator for

eGPS, the successful statewide commercial network in Georgia. Wes added, "We got to jump right into some cool technical discussions among the operators like where to get a certain piece of gear, or how to hook up a certain combination of gear; what works, what doesn't."

Some of the operator presentations served to kick off open discussion, and hot topics included: network quality monitoring (through the use of dedicated rovers set at static locations), multi-server configurations, the omnipresent issue of how to best extend or leverage cellular communications, multi-constellation support, and best practices for field use.

>> By Gavin Schrock, LS



The fiducial station on the Sichuan seismic and active control network. This was a “sunny” day; pollution has taken its toll (that used to be a clear dome!).

With a few years of GPSNet use under their respective belts, operators have been able to further tap additional utilities and elements of their network software. A great example of network usage monitoring was presented by Andre Fuegner, administrator of the Texas Department of Transportation (TXDOT) network. Utilizing the built-in administrative functions of the suite, and passing the results to a GIS mapping application has given TXDOT the capability to monitor crew and contract compliance.

A large Canadian firm (250 crews... *youzai!*) has done a lot of research into field procedures to produce optimal repeatability and positional integrity on a single site visit (*e.g.*, a remote site where a second visit may be prohibitive). The solution bucks the old conventional wisdom on reinitializing by “dipping the rod.” The new method: pacing off a minimum offset and raising the antenna to reinitialize produces excellent results (I’ve tried it). As a necessity in managing data from so many crews, the firm has developed its own software to analyze field data and session logs. To some degree, each of the operators had explored similar concepts, but this was a particularly sophisticated example.

The event even sparked a spin-off seminar, held the day before at the same venue and organized separately by a number of the operators, in conjunction with NGS and states participating in the Height Modernization program. This all-day seminar on geoids as they relate to regional spatial reference initiatives (including RTNs) drew an overlapping audience, with other interested parties from around the country.

In a scheduling coup, this pre-seminar was able to attract as speakers both Dr. Dan Roman, principal scientist on the

NGS Geoid Team, and Dr. Rene Forsberg of the Danish Space Center. These two are among the very top in their fields and the audience was treated to an in-depth treatise in geoid theory and examples of amazing geoid projects from around the world. It is hoped that such relevant and timely seminars can be arranged in conjunction with future RTN seminars.

Also in the pre-seminar, and to provide the context and “punch line” for the “deep-geekness” of the geoid seminar, Larry Signani of W&H Pacific and geodesist for the Washington State Reference Network shared his research into the relationships between the progressive national adjustments and the respective geoid models. The conclusions point towards recommended diligence in establishing reference frameworks for RTNs, ties to NGS CORS-based adjustments, and no mixing of reference elements.

This subject of geodesy and “ge-odd-ity” sparked a great deal of discussion, which spilled over into the next day’s RTN seminar. The results of Larry’s research, citing vertical repeatabilities (in millimeters) opened a lot of eyes to the notion that some network quality issues may have more to do with the underlying geodesy than any other factors.

The vendor kept a low profile; this was an operator show and discussions went on well into the night. A new online operator-only forum was also announced, along with plans for next year.

While the U.S. got a late start in this RTN boom, we have gained a lot of ground, especially in the last year.

### Barcelona – May 29-30, 2007

Europe is where RTNs really got their start, with the longest running and most numerous networks. This year, Europe was joined by Africa, the Middle East, and Eastern Europe for the seminar this operator presented in Barcelona, Spain.

The gracious host and venue for the event was the ICC – *Institut Cartogràfic Catalunya* (Institute of Cartography and RTN operator for the Catalonia region of

At the nerve center of the Sichuan Seismic Network. The RTN software feeds real-time high precision positions of the CORS directly to the seismic monitoring system (pictured). Seismic study systems can now take advantage real-time actual displacements to augment the conventional “magnitude-only” readings (previously only available after-the-fact through post processing).



Spain). The ICC (under its current formation for 25 years) provides geographic, mapping, GIS, and cadastral services for this very proud region. Catalonia has its own language, cuisine, an enviable climate, overwhelming charm, and hospitality (certainly demonstrated by our hosts).

Held at the scenic ICC headquarters in the Montjuic area of Barcelona (near the Olympic venues), a facility with a pleasantly distracting display of historical

maps, the event spanned two days of fast-paced sessions. Presentations were in English (ironically, the common language in Europe) and ranged from highly theoretical academic subjects, to user implementation case studies. Europe has had such seminars since 2004 (though this is the first outside of Germany) so organizers have long since eschewed the “show-and-tell” phase and now concentrate on operator issues.

The host presentation by Ernest Bosch, administrator for the ICC RTN (CATNET) focused on the results of some extensive analysis of network usage, which yielded some amazing numbers considering the network has only been in open use for one year. The numbers were certainly an eye opener: how did ICC get such high usage in such a short amount of time? User outreach, meetings, and good dealer support made a difference.

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Denver. Another Larry Kirkland plumb bob inside the atrium of the municipal building. The plumb bob is 20' tall and made out of gold leaf rings. This installation is intended to reinforce the notion that a civic center a place where the public can seek the true, the centered, or the truth about their cultural and built environment. On the other hand, this is just plain cool for surveyors.

Timing has also had an impact – when ICC opened the service a year ago there had already been a great number of RTNs in Europe for some time and the general knowledge and acceptance was already in place. One humorous note in the analysis: in graphs of hourly daytime usage there was a great drop from 1:00 p.m. - 3:00 p.m., the afternoon lunch and break commonly practiced in Spain. Perhaps we could learn from this idea?

Dr. Manuel Hernandez-Pajares of the Catalonian Polytechnic University explored research into the effects of acute ionospheric activity and efforts to extend the range of RTK. The fundamentals, expected performance and potential applications were covered. This was timely, as it opened up the inevitable discussions on multi-constellations, and multi-frequencies in dealing with such anomalies. The good news is that even current configurations perform quite well.

Quite a few presentations centered on issues of business models. The successful networks in Europe, including both commercial and public, have certainly met their original expectations. Some like the GPSNet.DK, a nationwide commercial network in Denmark, have exceeded expectations despite an otherwise competing cooperative network. Network owner principal Soren Ellegard chalked this up to their being a solid dealer as well, and their concentration on customer service (could it be this simple? It seems to have worked for outfits like eGPS in the U.S.)

Another trend in business models is for the network infrastructure owners to “hand over” the user support and subscription services to a third party, or parties. In the case of the Ordnance Survey of the UK, the government entity that operates a nationwide network “leases” data streams to two commercial providers; one operating a Spider network, and the other one of the new Trimble VRS Now™ models (Trimble VRS Now is also available in Germany and the Denver area of Colorado). This “brokering” trend is not new; Japan has been doing this for many years, but it will be interesting to see how these models fare in coming years.

Watching specific applications develop over the years yields some winners and some losers; one that is definitely in the “win” column is the utility mapping and field operations suite developed and implemented by Energie AG, and presented by Karl Draxler. Their Netfocus application is the base for mobile GIS,

field mapping, work order reconciliation, and vehicle tracking. Karl demonstrated the applications both on-screen and on a nifty tablet field device. I would hope that as our U.S. networks mature, we may implement such applications.

I asked a number of the operators if they had run into many challenges in the “legality” of real-time technology (a question I hear at many survey association gatherings back home). There had

been some discussion many years ago, but as the subject had been put to rest over a decade ago with the advent of classical RTK, the respondents usually chuckled, and one even said, “You Americans have too many lawyers.” And indeed a number of countries have not only settled the issue (and subsequently put to rest some of the posturing between manufacturers), but have gone so far as to publish best

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The Olympic venues built for the 1992 Barcelona Summer Olympics provides good open space with lots of good control for testing and training on the local RTN.



Many of the CATNET (RTN of Catalonia region of Spain) are linked by satellite. Though the latencies have been of concern in the past, they now have proven to be manageable.

practices for optimal use. I was told this is a very much a non-issue.

In attendance were representatives from the new national RTN of Greece, a 100-station network in development on an ambitious schedule to be completed later this year. Greece is representative of another trend in some developed countries, and even more so in developing countries: to build nationwide networks with assistance from international finance funds and loans for sustainable development. In the case of Greece, it was an EU (European Union) grant that partially funded the network. In the case of developing countries, there have been initiatives from such bodies as the World Bank and USAID. The drivers for such networks include land registration (cadastral) projects, water resources, mining, and other resources. Perhaps it is the countries with meager means and the need to keep positioning costs lowest that see the utility of such networks the most.

### Chengdu - June 6, 2007

The first Asia-Pacific RTN seminar of this kind turned out to be an almost all-China affair, but this was understandable with the logistics involved. While there were attendees from other parts of Asia (and even Europe and the U.S.), the proceedings were in Mandarin (fortunately there were translators available).

What can one say about China? The economic boom is glaringly evident, from the 400kph ride on the Maglev train from the airport to Shanghai, where the skyline that was open fields less than a decade ago now seems to dwarf Manhattan, but where hand drawn carts navigate the rural roads. You can find a statue of Buddha, Mao, and a Wal-Mart all within the same city block. All politics and international commerce discussions aside, the economic and technological boom is also evident in the rise of RTNs.

This first operator's seminar was held in Chengdu, a city of over seven million that serves as the political and economic center of Sichuan Province. Readers may be familiar with a noted export from that region; the very spicy cuisine known in the U.S. as "Schezuan" cooking. The seminar was held at an international hotel in the hot, humid, smoggy, and incredibly busy center of the city. These conditions were in great contrast to the easygoing and hospitable nature of the locals.

Chengdu is also home to the Seismological Bureau of Sichuan Province, where the attendees were treated to a

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tour of their facility, and an insight into their unique implementation of RTNs. In a twist on the typical scenario for RTN implementation, the Bureau established their CORS for seismic studies first, but with the full intention of implementing real-time for not only their seismic studies, but for external uses like surveying as well. This is in contrast to elsewhere in the world (and particularly in the U.S.), where CORS established for tectonic studies work in a purely post-processing mode, and otherwise restrict or prohibit use for real-time.

I asked the Bureau Director Yaoqiang Wu how he decided on such a course of action.

His translated reply was, "I saw the future." This referred to both the future for seismic monitoring and for cooperative efforts with respects to CORS and RTNs. Note in the photo a large "cold war era"-style workstation that is actually a sophisticated seismic monitoring station. The workstation uses software of their own design, which receives positional information directly from their suite of GPSNet™ software and about a dozen CORS around the region.

While their control center was like a high-tech "green room" with 50+ servers, the primary CORS station on the roof seemed oddly in shambles (see photo). At closer inspection, the CORS is a fine mount, but the oppressive smog of Chengdu has corroded the metal sheathing. That was once a clear dome!

Sichuan represented one of the main trends evident in Chinese RTNs – the "science first" approach. While it may be prohibitive (bordering on prohibited) to run a commercial network, and local governments may struggle with cost-benefit based on surveying alone (with labor being so cheap), the causes of seismic and structural monitoring are "social" causes and do not need to meet traditional cost-benefit metrics. Similar presentations were made with "science-first" models like that of Dr. Lui of Wuhan University.

In keeping with this academic theme, Mr. Brian Coyle, Regional Engineer for the U.S. Plate Boundary Observatory (PBO, Northern California) presented the PBO story, which has many elements in common with similar regional initiatives in China. Scheduling presentations like Brian's was evidence of a well thought-out agenda.

Another trend evident in subsequent presentations is the willingness to expend great effort in positional quality studies. Perhaps this is a function of the low-cost labor available, but for whatever reason,

each network has conducted very detailed studies of all network services (e.g., RTK, DGPS, VRS, and RTCM flavors of each). The good news is that the results click with our (much less comprehensive) testing Stateside. It would be nice if our academic institutions would run some well controlled and neutral (repeat: *neutral*) testing on our networks.

As discussions moved to the underlying geodesy of the respective networks, a truly puzzling aspect to the RTN saga in China came to light: geodesy in China is quite the mystery. In a country where coordinates are guarded like a state secret, and (in an extreme case) a foreign crew in Shanghai was deported for doing some simple pre-engineering mapping, reconciling RTNs to established earth-centered reference frameworks has been a challenge. While reference to the WGS84 ellipsoid can be done a number of ways, establishing relationships to any national adjustments of reference frameworks or related geoid models (if they exist) eludes most.

While networks are at present small enough to work on local adjustments and can use locally developed geoid models, their utility as a tool for relative observations is not diminished. One of the most rapidly growing uses for such networks is structural integrity monitoring, and many examples were given. Another compelling example was a long offshore causeway where placement of piles would have required expensive and cumbersome platforms for total stations, but where RTK could meet the metrics at a dramatically lower cost.

I listened carefully to the translation of the open-forum questions portion of the seminar, and came to the conclusion that the questions were basically the same as at the other two seminars. The issues, challenges, and triumphs of the RTN operators worldwide are the same, just the languages are different. As we opened up a remote administration session to my own network back in Washington, my Chinese counterparts chuckled as they recognized the same look as their own network interfaces. It was then that it sunk in that this truly is a world amenity. *AS*

Gavin Schrock is a surveyor in Washington State where he is the administrator of the regional cooperative real-time network, the Washington State Reference Station Network. He has been in surveying and mapping for more than 25 years and is a regular contributor to this publication.