



A fine day for surveying in Albuquerque, New Mexico. Richard Gutierrez and Jason Rodriguez of the City's Survey Section use the ARTGN to position topo points in front of a cascading water fountain.

Real Time GNSS Network in New Mexico

Think RTK without a base station and you have a Real Time Network (RTN). No more shuffling through datasheets to find a nearby control point or doing recon for a station with unobstructed sky visibility and clear line of sight to the jobsite. No need to set up the unit in morning and tear it down in the evening. No more searching for an open frequency. Just get out of your vehicle and start surveying.

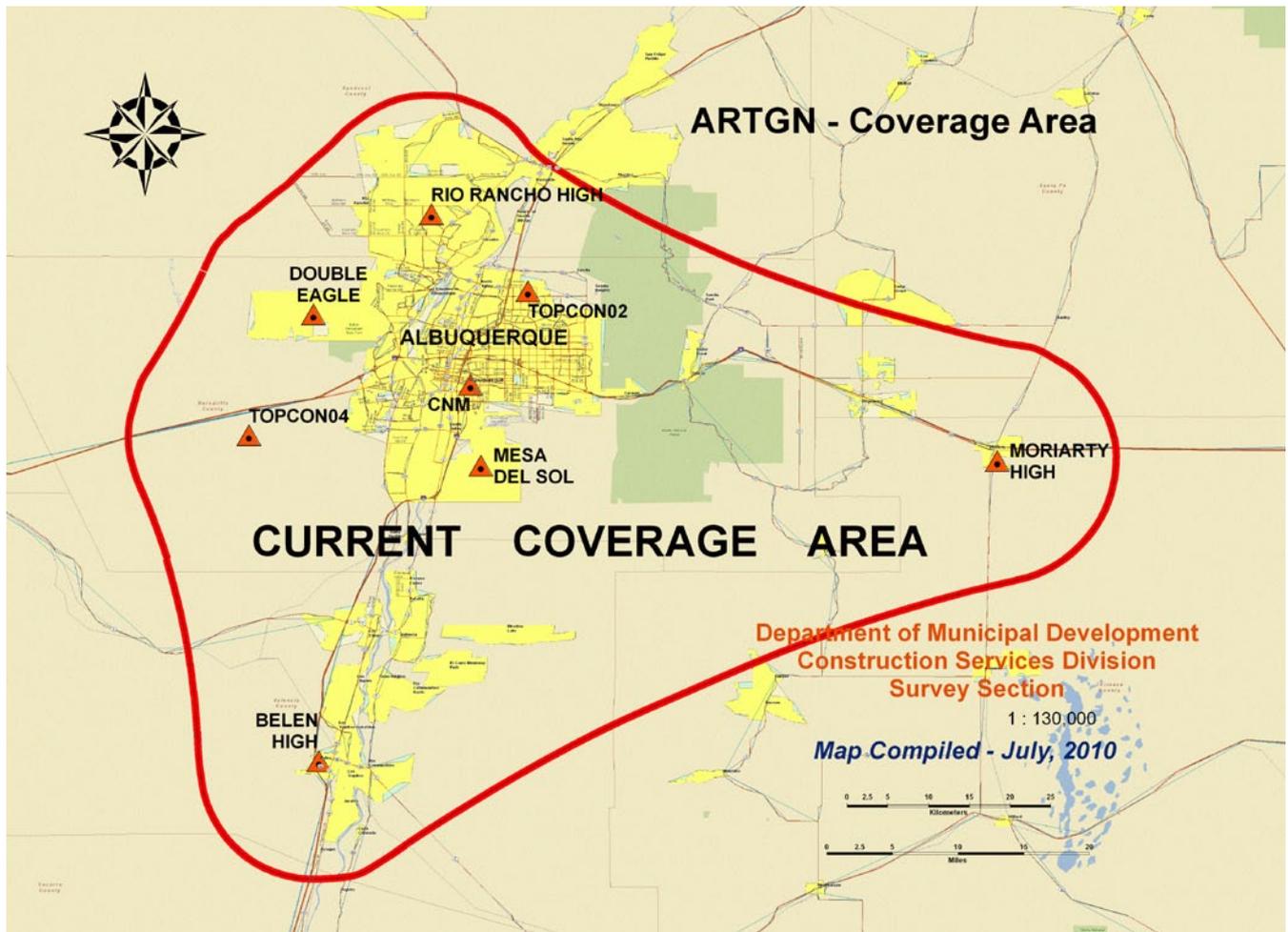
Albuquerque's valuable Real Time GNSS Network (ARTGN) has demonstrated that RTN technology can remove much of the difficulty of positioning infrastructure. It provides

the city with built in quality control and makes the positioning aspect of the surveyor's job easier, quicker, less prone to mistakes and more cost effective. It's a win-win situation all around.

The system has been operating for more than three years. It has been tested extensively for positioning accuracy, initialization capability and connectivity and passed every test with flying colors. Users have no trouble connecting through the Internet, getting initialized quickly and achieving satisfactory positioning accuracy.

It took about three years to get a system in place, beginning in 2004 when the Geodetic Surveyor for the City of

>> By Cliff Wilkie, LS



Originally only covering the metropolitan area, the ARTGN now covers a good portion of the central urban area of the state, including neighboring Rio Rancho, the East Mountains and the burgeoning suburban areas of Belen and Moriarty.

Albuquerque met with local surveyors to gauge the interest. There clearly was strong interest, so follow up meetings began at different levels of the city government between local engineering/surveying companies and various entities within the city. Ultimately a broad variety of engineering and surveying companies—ranging from small Mom-and-Pop operations to the largest engineering and land development firms within the city—met and expressed a strong interest in developing an RTN to serve the Albuquerque area. Eventually the go ahead was given to purchase a core system of five base stations, processing servers and software. After several more months of working through the hurdles of developing and advertising open-bid public purchasing discussions with the legal department and financial arrangements, a purchase was made of a Topcon system through a local vendor. Initial network connectivity was through

existing city intranet already in place. Base stations were placed at existing city structures such as police stations, fire departments and administrative buildings. The process provided a textbook example of collaboration between local government and surveyors to develop a better means of geospatial positioning that provides benefits to the general public through better quality control and more efficient and economical positioning of myriad infrastructure need such as homes, subdivision, powerlines, sewerlines and roads.

System installation began in the spring of 2007. It wasn't long before the system proved itself as a superior means of positioning. In the intervening three years a good deal of testing has been done, and, in summary, the system functions as expected. It provides both direct connections to network base stations or compiled data from a non-physical or "virtual" base station. The non-physical

provides slightly better positioning, especially in the vertical component, but there is not much difference. Users generally cannot tell from the results which approach they are using. Likewise, use of GLONASS as well as GPS makes very little difference either in positioning accuracy or initialization times. We leave the option to the user, but because GLONASS provides more raw data in the mix, it provides a more robust and reliable approach. Initialization times are the same as the older RTK approaches and have now become so short as to often be irrelevant. The base stations were robustly positioned to NAD83 and also to the 800 plus GPS positioned passive ground points of the Albuquerque Geodetic Reference System (AGRS). Users are able to connect to the ARTGN, check into a nearby AGRS reference point, and begin work quickly within NAD83 at RTK positioning accuracies. Both

the users and the city have an unprecedented built-in level of quality control of positioning accuracy that is readily attainable and actually difficult to misuse. The city has also developed a local geoidal model that enables time saving determination of orthometric heights. So everyone has a much greater confidence level in positioning accuracy, positioning can be done more rapidly without a base station and labor intensive leveling operations can be eliminated. It is a better way to do things.

As a government entity, Albuquerque has been able to develop collaborations with various neighboring school districts to increase the coverage area. Now after three years the core area has been expanded to more than triple the original size. A large local land development company also contributed by providing a datastream from their existing base station at no charge to the city. These additional base stations were connected to the core system through the Internet and were brought in at no cost to either the city or users of the system.

The ARTGN is only one of at least three others operating in New Mexico today. There is a commercial network that overlays approximately the same area as the ARTGN, a network in the Las Cruces area, one from the El Paso, Texas area, and another commercial network close to beginning operations. All offer the same money saving benefits to users. With various networks serving the same group of users, the payback



Base station antenna mounts were customized to each site, but this site at a local airport is typical.

to some network operators has not been as good as anticipated. In a broad sense, the growth of RTN technology worldwide and in the United States has been phenomenal. From a few small networks in Europe in 2000, it is now difficult to find areas of the world that do not have an RTN. However, for a variety of reasons, growth varies from one region to the next, and in central New Mexico users haven't signed on as fast as anticipated.

The economic slowdown has certainly had an impact, even though using a network, even for a few days a month can save the end user money and enable them to operate with lower costs. Spending money to save money is more difficult to envision during slow economic times.

Since RTNs are such new technology there is no standardized approach to paying the startup and maintenance costs. Most government entities, at least within the United States, charge a much smaller fee or no fee. These systems are typically justified by the added value of the network quality control along with the obvious saving to any contractor using the network for positioning either directly or indirectly for the government entity. Additionally, the overall cost-savings of positioning with a network are ultimately passed on to the public in lower costs and better quality control of positioning.

However, each situation is unique. When the City of Albuquerque began considering development of a system, the first question was how to pay for it. As a government entity, the city could not use the system to make a profit, but was expected to raise enough funds to pay for it. Representatives from local surveying companies met with the city and a poll was taken of even more potential users to determine the quantity of a fee that would attract enough users to pay off the system within a reasonable time frame. Evaluation indicated that \$200 per month would attract 20-30 users and would pay for the system within a reasonable three years. Regardless of polling results and expressed user interests, so far the city only has been able to get the number of users up to about half the anticipated use.

Network software runs on both a dedicated server and a backup at City Hall, and is operated remotely by the author from his office.



So the City of Albuquerque has some concerns about the long-term viability of the project. Growth was slower than anticipated originally but was growing steadily until the recent economic downturn. The number of users has remained constant for quite some time. The state has expressed an interest, but so far has not been able to find funds either for developing its own system or collaborating with the ARTGN or

any other system as a foundation for a larger system. Information about how the other networks in the State are faring is not publically available, but it is known that one commercial network has more than halved its original rates. Looking at the overall situation today, RTNs seem to be faring well throughout the country and the world, even though the use is not catching on as fast in New Mexico. Ultimately, user response

will determine whether the long term approach is supported by government or the commercial providers, and in fact whether or not Real Time Networks will even be in use in the state.

However, regardless of local variations, the broader trend is clearly one of strong growth. Even in these trying economic times, many networks have experienced significantly greater growth in the last year than in previous years. Surveyors and other users are seeing networks as a way to cut costs.

It is too early to say whether government entities or private enterprise will dominate the use of RTNs in the long run or if the situation will continue with the current mixed approach. Who the users of network will be and the nature of their needs will also be determined, whether in support of land surveying applications, machine control (network guided earthmoving equipment such as motor graders, bulldozers and backhoes), or agriculture. In regions of large commercial farming, GPS guidance systems have proved extremely cost effective means of cutting overall farming costs. GIS managers, public and private utilities are also increasing in numbers, even in the Albuquerque area. Worldwide, the numbers of scientific and monitoring users are growing as well.

With so many types of users vying for access to networks, their needs will play a large part in the manner in which networks are ultimately implemented. In the long run, the needs of surveyors may not be the predominate factors in how widely networks are used. While RTNs are a key to managing urban growth, the bottom line appeal, at least to the local surveyor, is still the original one. It is nice to simply get out of the vehicle, connect to the Internet and start surveying. *AS*

Note: The author would like to thank Gavin Schrock, of the WSRN network and Loyal Olson for their comments and review of this article.

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