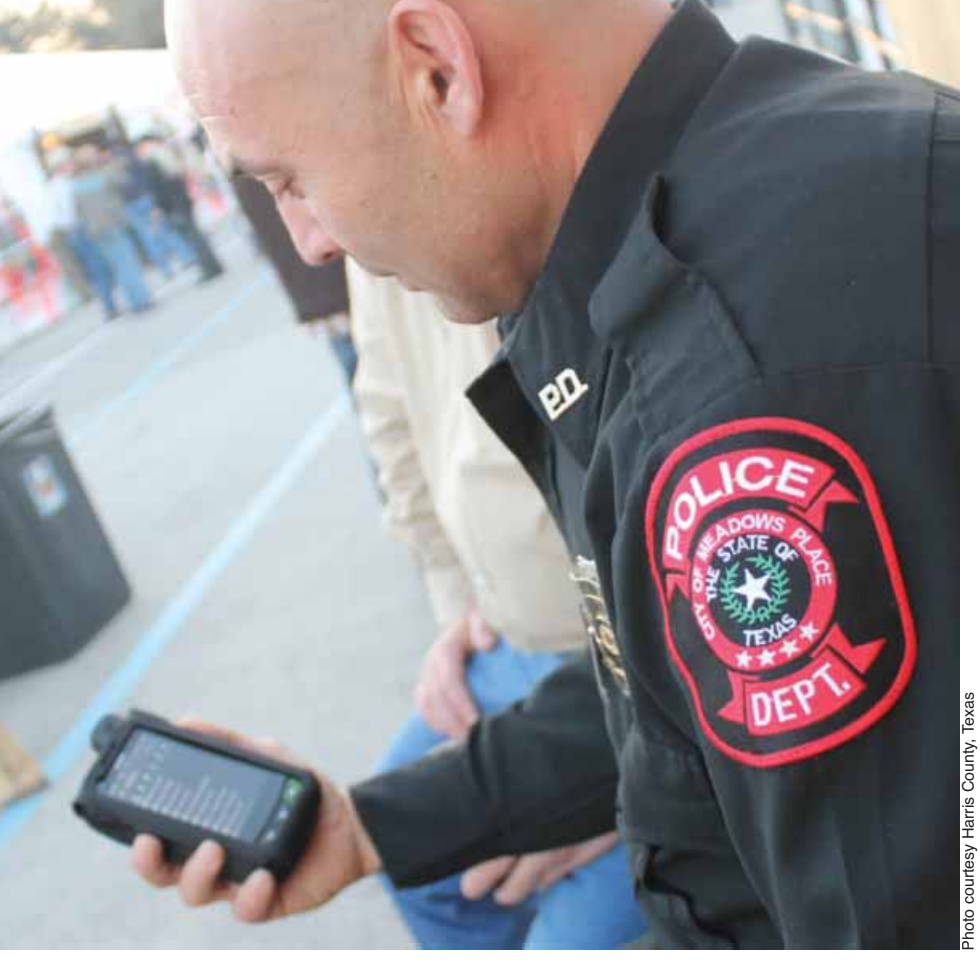

Photo courtesy Harris County, Texas

Band 14 LTE in Houston

One of the five early builder public-safety Long Term Evolution (LTE) networks offers helpful information on coverage, throughput and more.

By Jim McMillan

Harris County, Texas, has been operating one of the first public-safety dedicated band 14 Long Term Evolution (LTE) networks for a number of years in partnership with the state of Texas. The network is one of five early builder projects throughout the United States designated to provide information to the First Responder Network Authority (FirstNet).

The county's mission is to provide valuable data about everything from extended range to special events to the state and FirstNet teams. The network, and the other four early builder networks, continues to operate while states evaluate the recently released state plans. Harris County is working closely with the state, FirstNet and FirstNet partner AT&T on a plan moving forward for the early builder network.

System Coverage

The system gives users mobile coverage across 95 percent of the county. County officials rely on externally mounted antennas connected to in-vehicle modems for mobile coverage. This allows the county to operate a system with less overall tower sites than the number of sites required to operate a portable coverage system, which would more than double the number of existing sites. Add in an indoor coverage requirement, and it becomes nearly unattainable without a significant capital investment.

Forty sites across the county provide mobile coverage. Based on county coverage mapping, officials estimate 96 sites are needed to get the required portable coverage. This could increase slightly depending on the exact locations, as the predicted areas often do not match perfectly with what can be achieved through the site acquisition process.

Uplink is typically the weakest link, so when evaluating coverage, the county focuses on inbound signal coverage, optimization and site placement based on predictions and drive tests. The county conducted drive testing as well as predictions to determine coverage. The drive tests were overlaid with the predictions to verify that they matched, and for the most part, they did. The predictions were a little optimistic in dense urban areas, requiring the county to plan an additional site in the downtown areas.

Harris County primarily uses the Verizon Wireless commercial LTE service as a backup to band 14, so when users drive outside the coverage area, the devices reselect to Verizon. Some partner agencies choose to hand over to AT&T as their backup. Harris County has 50 phones from Sonim Technologies set up with dual subscriber identity modules (SIM), meaning they are registered on both the AT&T commercial network and the Harris county network. Currently, these devices require a manual

switch, so the end user has to be trained to do that.

Brazos County, Texas — northwest of Houston where College Station and Texas A&M University are located — has one site because of the FirstNet spectrum management lease agreement (SMLA). The county is only partially covered but has nearly 70 modems on the system and Verizon LTE service as a backup. The county uses technology for session persistence so that the handover to Verizon and back to the Harris County LTE network occurs seamlessly.

Throughput: How Much and How Fast?

Public-safety users can't stream 20 4K-resolution cameras at full resolution simultaneously in the same sector to be viewed on a 720p desktop monitor. It is important to understand and set expectations, and have discussions with end users as devices are activated on the system.

On average, the throughput is 30 Megabits per second (Mbps) downlink and 15 Mbps uplink, sometimes worse, sometimes better. The county uses four-way receive (4xRX) diversity on nearly half of its sites and typically achieves higher averages in the uplink on those sites.

4xRX is a technique where four receive elements are used, which gives an overall gain of 4 dBm on average and provides more coverage on the cell edge. Improved signal-to-interference-plus-noise ratio (SINR) allows for higher modulation to be used, giving an overall system performance gain. This is typically an option or license feature for a carrier and is highly recommended. The costs of the license could potentially offset the cost of an unnecessary additional site. Coverage modeling can be set to account for 4xRx, as well as antenna spacing on the tower, and produces vastly different results when run with no spacing and only two-way receive (2xRx). Industry partner Motorola Solutions owns the prediction tool that was used in these cases, and the county's drive testing showed the model was accurate.

At the end of the day, 20 megahertz of spectrum limits what can be done. The announcement by AT&T that priority is being offered on all LTE spectrum is exciting because this opens up the ability to see much higher throughput averages than seen on just band 14. Advanced standards of LTE allow for techniques such as carrier aggregation, meaning that 700 MHz bands 14 and 17 could potentially be combined in a session without any user inputs to give a user access to 40 megahertz of spectrum in that instant.

Super Bowl LI

During preparations for Super Bowl LI, held in February, Harris County demonstrated that in-building coverage on portable devices was lacking, and something had to be done to support the venues where the National Football League (NFL) had

Public-safety LTE indoor coverage was deployed for the Super Bowl in February.

major events scheduled. This prompted deployment of the first commercial LTE band 14-capable indoor distributed antenna system (DAS). Houston's George R. Brown Convention Center along with the adjacent Discovery Green Park served as the venue for the NFL Experience event.

This event was identified as key for the band 14 LTE use cases defined in several working groups. Initial walk testing inside the venue showed nearly zero coverage throughout. Harris County partnered with the city of Houston, and this partnership helped get the DAS completed in time for the event. The system supported LMR and 700 MHz band 14 LTE, along with commercial carrier networks. Many hours spent by both city of Houston and Harris County officials to assist the vendor with system optimization and commissioning were critical for the successful deployment of the much-needed indoor system.

A recently released "FirstNet After Action Report" on the Super Bowl reported that it was the first large-scale special event to incorporate the use of mobile apps as key operational tools to support public-safety communications from the beginning of the planning process. The use of mobile data and applications became a core element of the communications during the event and proved incredibly valuable in augmenting LMR for improved situational awareness and multiagency information sharing.

Applications for the Event

Harris County coupled Moxtra, a collaboration application used for portable devices, with Sting for situational awareness. For in-vehicle modems, the county used NetMotion for seamless network handoff. Other applications used included ESChat's push to talk (PTT) over broadband application, Neon's indoor tracking software and GoCoder for mobile live streaming.

Nearly 1,000 public-safety personnel across 10 local, state and federal agencies, including 250 to 400 daily active users, were trained on the apps. Messaging, picture/video sharing and field reporting were the primary uses. Law-enforcement users included undercover, security supervisors, special events and specialized units. Fire and EMS users included medics, hazardous materials (HAZMAT) and special events.

In the absence of a prescribed planning process in the incident command system (ICS) framework, the team developed an ad hoc process that included:

- Creating a concept of operation to guide product selection and device distribution;
- Developing an information architecture to support the organizational structure and operations plans; and
- Writing standard operating procedures (SOP) to guide who produced/received content, how information was distributed, naming conventions and other operational and technical elements to facilitate efficient and secure information sharing.

A Successful Deployment

Houston Police Department (HPD) was the lead organization for public-safety operations for the Super Bowl. HPD leadership recognized Harris County as the experts in LTE and looked for guidance to facilitate the process while it provided the necessary participation of key staff to develop and execute a plan that would successfully support the overall incident action plan (IAP).

The deployment was successful. The use of the LTE system and mobile apps significantly reduced radio traffic and dispatch time through real-time location services. The network also provided a secured mechanism for sharing sensitive information and improved information sharing across agencies and different units within those agencies. Group messaging allowed for the immediate redistribution of information. Redistribution of original content and sharing of pictures and videos reduced the amount of misinformation. The incident commander (IC) could monitor events in real time from any location, and there was reduced noise and chaos in the forward command post.

One significant lesson learned from the event is that it is important to provide ubiquitous coverage throughout an operational area so that end users have access to the tools regardless of their location. The system did not see any throughput issues during the Super Bowl, although only public-safety personnel used the system.

Public safety in general will benefit from FirstNet. Without a doubt, a new standard is on the rise in data communications, and FirstNet has already changed the game. With the offering from AT&T on the table for opt-in states and the competitive nature of other providers, we will soon see a shift to priority service models and offerings no matter the carrier. The lessons and knowledge learned from early builder projects can assist in public safety's transition to broadband technology. ■

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