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NXDN: A Digital Trunking Option

Photos courtesy TGS

Users around the world, including a Turkish airport ground services firm and a U.S. public-safety agency, are deploying digital technology for mission-critical communications.

By Jens Toobe

Much has been written about the migration to digital trunked radio systems from an established analog environment. However, the focus should be which technology can and should be used to provide the best system performance and resilience for a given application and how that goal is achieved. Of course, there is no simple answer to this question.

Radio industry experts are unanimous in agreeing to a, "It depends" viewpoint. The list of contributing factors is long, including the application, user requirements, deployed environment, user preferences, associated costs and more. The list of digital technologies is also extensive, and includes Project 25 (P25), TETRA, Digital Mobile Radio (DMR), digital Private Mobile Radio (dPMR) and NXDN. Differentiators such as FDMA- or TDMA-based system access and respective spectral efficiency properties further divide the group.

Digital Standards

TETRA has been operating since 1990, and about 30 companies manufacture TETRA core products and radios. More companies are involved in providing applications, solutions, accessories and services. TETRA is an open standard.

DMR and its early predecessor can be traced back to the mid-2000s. The DMR standard was ratified in 2005, and currently there are about a dozen active core and equipment manufacturers. DMR is also an open standard.

By the end of the second quarter, NXDN standards and technical documentation will be opened to the public domain as announced by the NXDN Forum in February. The NXDN Forum will continue to operate and accept new members after opening the technical specifications and will maintain the specification and related interoperability testing. Currently, 19 international radio and

test equipment manufacturers support the technology with some members designing and manufacturing radio equipment since 2007. Support for the different operating modes such as digital conventional and digital trunking is high, with the number of supporting manufacturers steadily increasing.

Trunking Fundamentals

A trunked radio system is fundamentally different from a conventional two-way radio system in that it pools all available channels and allocates capacity as required. A conventional radio system employs a dedicated or fixed channel for each individual group of users, and when channel capacity is reached, the user will have to wait until it is freed. Put simply, a conventional system is limited by the number of users calling on its capacity at the same time, while a trunked system allows virtually unlimited user groups and provides the most efficient use of the radio frequencies and channels allocated to a system.

When a user places a call on a trunked system, a channel is allocated to all participants, and once the call is completed, the channel is returned to the pool for other users. This sharing of the channel capacity increases the availability of the system to all radio users, maximizing availability, especially important at times of peak use.

A trunked radio system is configured on the basis that with any given number of users, not all will require channel access at the same time. Fewer individual radio channels are required, providing a number of benefits including savings in the cost of channel licenses, the ability to accommodate more users and user groups, the flexibility to configure access between user groups, increased security against eavesdropping and increased availability of the system at all times.

The control channel is a vital instrument in the management of a trunked radio system, ensuring seamless operation in all situations. It can be used to transmit small data messages between radios even if all other channels are occupied, and it provides pre-emptive call handling to ensure radio access in case of emergencies.

NXDN Basics

While other technologies may not need RF combining systems in small channel number deployments, the technologies are vulnerable to a critical component, endangering the whole system in case of a failure. A failure of one repeater could leave the complete radio population without means of wide-area communications. NXDN trunking has followed a different route.

The philosophy behind NXDN can be traced to the MPT 1327 standard. MPT 1327, established by various companies in Europe and adopted throughout the world, was a dominant radio system concept and standard for more than 20 years in mission-critical installations ranging from airports, utilities, public-safety agencies, public transport, and business and industry applications. The standard was first published in 1988 by the British Radio Communication Agency, now called OFCOM. MPT 1327 wasn't a European Telecommunications Standards Institute (ETSI) standard.

NXDN trunking was developed based on the experience gained from working with MPT 1327 systems.

An MPT 1327 system uses a control channel to manage radio access, a major contributor to its widespread adoption. A control channel-based system offers the ability to control radio call requests based on system infrastructure capability and programmed parameters. It does not overly rely on any intelligence in the radio itself to find the next rest channel, because it can still deliver messages to radios, even if all voice channels are occupied and provide resilience. Emergency calls can be treated with maximum efficiency and importance by allowing the clear-down of calls in progress to make voice channel resources available for emergency call-handling purposes. TETRA and GSM systems also use the control channel (or slot) concept.

NXDN trunking was developed based on the experience gained from working with MPT 1327 systems. The standard combines a proven infrastructure concept with digital signal processing (DSP), RF and vocoder technology, creating a high-performance digital, 6.25-kilohertz-capable, spectrally efficient, secure and reliable digital radio system.

NXDN supports true mixed-mode operation. While a user can select, via appropriate radio programming, the preferential mode, the radio terminals and repeaters are inherently capable of working in analog or digital mode without user intervention. For example, if an analog radio population needs to be replaced, a soft migration strategy may be advantageous. This means that new digital radios must be able to fit into the existing radio infrastructure and emulate analog signaling systems without the need to add extra option boards to each radio, which would increase the overall costs and delay deployment.

Some industry insiders have suggested that NXDN trunking has not been deployed in important installations. However, several companies have successfully implemented a large number of mission-critical NXDN installations worldwide, including at the G8 and G20 Summits in Toronto, a public-safety system at Christian County, Kentucky, USA, and for the German state of Hessen's highway and road traffic management. NXDN is the recognized standard for the railroad industry in North America.

To further illustrate the case for FDMA 6.25-kilohertz control channel trunking, the first case study is indicative of the type of mission-

The Turkish Ground Services (TGS) uses NXDN technology in six airports in Turkey.

critical applications suited to NXDN trunking and mission-critical deployments in which a trunked two-way radio system is the preferred option.

Turkish Ground Services

Turkey, situated between Europe and Asia, has a population of around 75 million and is about the size of the U.S. state of Texas. Turkey is a leading tourist destination, attracting close to 31 million visitors in 2011. The bulk of tourists arrive by air, so there is a heavy reliance on the smooth and effective operation of its major airports to provide seamless and secure operations for airlines, staff, airport employees and tourists in transit.

Operating in six of the busiest airports in Turkey — Atatürk and Sabiha Gokcen (both in Istanbul), Ankara, Izmir, Antalya and Adana — Turkish Ground Services (TGS) deploys more than 3,000 pieces of equipment and 6,000 staff to deliver ground services operations.

When TGS was awarded the airports contract it was evident that the legacy analog infrastructure needed to be replaced with a high-performance, efficient and reliable radio system. The main problems identified with the existing 50-year-old infrastructure were:

- Analog functionality only
- Lack of advanced functions
- Insufficient number of channels
- Poor coverage
- Poor voice quality
- No built-in redundancy

A number of technology alternatives, including TETRA and DMR, were considered. TETRA requires a minimum of one carrier, which includes one control channel slot and three traffic channel slots. DMR requires one carrier as a minimum, providing two voice channels. But in both cases there is no further system redundancy built in, should the single carrier base stations fail. NXDN trunking uses one base station per carrier with redundancy built into the multicarrier trunked radio system installations.

Competitor companies were established in the ground services segment in Turkey mainly because of the past investment in the radio communications infrastructure. Airport and airline companies typically rented their radio equipment to operate on the existing infrastructure.

After a comprehensive study established the core needs of TGS and the operational requirements at the airports and an extensive review of the existing system and infrastructure, an NXDN 6.25-kilohertz digital trunked radio system was selected. Contributing factors for the project award included the radio coverage that would be provided relative to the site required to provide such coverage, and extended capabilities, scalability and resilience. NXDN trunked radio systems are now deployed in all six airports and demand for more equipment is likely to increase to more than 3,000 radios and 80 channels by 2013.

Christian County, Kentucky

In Christian County, Kentucky, various county departments used their own radio systems, which brought about issues of interoperability between the departments. Some cross-department calls had to be routed through various dispatchers to reach their intended destination, resulting in wasted time and sometimes loss of crucial information.

The need for a homogenous and efficient communications system was one of the driving forces for the Christian County officials to start looking at a new radio system. Officials from Christian County and the city of Hopkinsville formed a committee consisting of the city fire chief, the sheriff, emergency management, dispatchers and other officials to investigate purchasing a new radio system.

An independent and external consultant was engaged to help with the selection process, designed to

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find the most appropriate radio communications solution following the three main criteria set by the committee: interoperability, radio coverage and network capacity. A three-month selection process resulted in an NXDN trunked system chosen as the new mission-critical digital radio system. The system offers talk groups, direct communications with individuals if required, system access priority in case of emergencies, and a clear and structured communications platform across all departments.

NXDN deployments have grown steadily, and the technology is recognized as a contender for mission-critical applications in scenarios throughout the globe. Large, multisite deployments have proven NXDN trunking can deliver an optimum blend of system performance, resilience, security and economy. ■

Jens Toobe started his wireless communications career in 1993 in Germany. Toobe has been with Kenwood/Zetron for 15 years. Some of his current duties include new business development in Europe, Middle East and Africa (EMEA) and government/regulator liaison. Toobe is an active Kenwood representative in local and international industry forums. Email feedback to editor@RRMediaGroup.com.