Photo courtesy Tait Electronics

Your Guide to **Digital**

Before you purchase your next radio system, know the advantages and disadvantages of each technology.

By Tom Mockridge

You have most likely noticed a standards competition in the professional mobile radio (PMR) industry. As different technologies and industry players vie for their share of the digital market, there has been a proliferation of groups promoting different digital technologies and a deluge of marketing material giving the virtues of different approaches. It can be hard to get clarity through the haze created by all this activity, so it is important to have a guide to help you understand the key areas of debate.

There are four widely promoted digital standards, three of which originate from the European Telecommunications Standards Institute (ETSI) in Europe, TETRA, Digital Mobile Radio (DMR) and digital Private Mobile Radio (dPMR), and one standard, Project 25 (P25), developed by the Telecommunications Industry Association (TIA) in the United States. There is also NXDN, a proprietary technology owned by Kenwood and Icom. Each technology is backed by its own trade association. All the protocols have strengths and weaknesses and different market positions. Anyone considering the purchase of a radio system would be wise to understand the advantages and disadvantages of each solution with respect to their short- and long-term needs.

What is clear are the benefits of digital. Compared with analog, digital delivers clarity of voice and better performance at the edge of coverage areas through error correction and signal processing, easier integration with IP-based data applications or external tools such as GPS, and the availability of novel features because of the possibility to manipulate bit streams in innovative ways. Of the five technologies, TETRA and P25 can be considered in a separate category because of their maturity and dominance of the public-safety market segments, and they won't be the focus of the following information.

DMR Details

Outside of the high-tier trunked market segments, the DMR community claims it is the most widely adopted digital standard with deployments in more than 100 countries and more than 450,000 radios sold. The DMR Association announced in May the successful completion of the first formal interoperability testing session between vendors. Until recently, there were only three radio manufacturers — Selex Communications, Radio Activity and Motorola — with DMR products in the market, but this is changing rapidly.

Hytera launched DMR-compliant products at the International Wireless Communications Expo (IWCE) in Las Vegas in March, and Tait, Team Simoco, Sepura and Vertex Standard have all announced upcoming DMR models in a mixture of conventional and trunked formats. German rail radio specialist Funkwerk Koelleda is committed to DMR, and Chinese maker Kirisun Electronics has publicly discussed launching a DMR radio in 2010.

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DMR's main advantages are that it is plug and play with respect to existing 12.5-kilohertz licenses while at the same time doubling the capacity of existing systems through the use of two-slot TDMA technology. This effectively splits a license holder's existing channels into two communications paths while maintaining the same channel profile as a legacy 12.5-kilohertz analog system. Maintaining the channel profile also enables a smooth migration path and happy co-existence of legacy analog and new digital radios because the spectrum needs of the two types of radios are identical. Of the other digital standards, only P25 can claim a similar feature.

DMR is also plug and play with respect to infrastructure; old analog repeaters are removed and new digital ones installed. Doubling the capacity of a system is particularly helpful because user needs are increasingly driven by capacity-hungry data applications as well as traditional voice services.

When only one channel is needed, DMR is less spectrally efficient than a 6.25-kilohertz FDMA-based system, and this can be a disadvantage in a low-end system, depending on the licensing regime. Two DMR manufacturers are supplying simulcast DMR solutions, which can deliver spectral efficiency in multisite implementations. Another criticism of DMR is that repeaters are needed to coordinate time slots to give two communications paths in a channel. This means in direct mode operation, when there is no repeater for coordination, a 12.5-kilohertz channel can only give one path — less efficient than 6.25-kilohertz FDMA. However, DMR is being deployed in more sophisticated systems, and the repeaters needed for time slot coordination are in place.

DMR manufacturers also state that TDMA delivers longer battery life. Many factors, such as power management wizardry in radio software, impact battery life but for a given power of transmission, DMR radios transmit for 50 percent of the time of an FDMA radio for a given transmission of bits. The best advice is to make sure you read the product literature and carefully compare the battery capacity of the devices.

FDMA-Based Digital Options

dPMR and NXDN both use 6.25-kilohertz FDMA as the underlying technology, but the protocols are not the same or interoperable. These ultra-narrowband technologies both have their origins in a Japanese standard, digital Kan-i, which also uses FDMA in 6.25-kilohertz channels. Digital Kan-i is a low-tier technology optimized for use without infrastructure in a spectrum-scarce environment. The strengths and weaknesses of dPMR and NXDN as technologies can be traced back to these origins.

Using 6.25-kilohertz channels provides efficient use of spectrum where a user does not have any infrastructure or only needs one channel. In these cases, a user needs only 6.25-kilohertz of bandwidth to set up a communications path. Also, the narrow channel width means less noise in the channel, which can provide greater range for a given transmit power because there is less background noise for the signal to contend with. These are useful characteristics for simple, low-power communications systems. Extending 6.25-kilohertz FDMA into high-power systems can bring drawbacks, however.

When 6.25-kilohertz FDMA systems are used with high power and in multichannel systems, separate infrastructure (repeaters/base stations) is required for each channel, and the problem of oscillator drift needs to be overcome. Drift is the phenomenon whereby all oscillators move from the desired center frequency over time. In ultra-narrowband high-power systems, this can lead to link degradation without the use of specialist equipment. Such equipment is available but adds cost to a system.

Critics of 6.25-kilohertz FDMA systems also argue that licensing regimes around the world are not always 6.25-kilohertz friendly. The licensing picture is certainly variable from country to country. Some jurisdictions have dedicated 6.25-kilohertz channels available, but many do not, and some countries allow two 6.25-kilohertz channels in an existing 12.5-kilohertz license, but some regulators do not. Buyers should make sure they have a detailed understanding of what is possible in their territories.

Turning to the availability of 6.25-kilohertz FDMA equipment itself, dPMR and to a lesser extent NXDN are impacted because they are the most recently developed protocols. There are no vendors of high-power dPMR and, to date, there is only one vendor of low-power dPMR for unlicensed use, Icom. So in market terms, the standard is not deployed yet. NXDN products are available around the world, and Kenwood and Icom are the significant global vendors. No other major vendors have chosen to support NXDN, and it remains outside the standardization process. This proprietary nature of NXDN may influence some buyers' choices.

The debate about the relative range of 12.5-kilohertz TDMA and 6.25-kilohertz FDMA systems has an interesting historical precedent. TETRA is now clearly dominant in European public-safety applications, but a competing technology, Tetrapol, is also used in some countries. Tetrapol is a 12.5-kilohertz FDMA system, and in the early days of digital European public-safety radios, there were arguments that Tetrapol delivered better range than TETRA because it used narrower bandwidth channels and therefore had a lower noise floor. In the end, TETRA has prevailed in the market as the benefits of the TETRA TDMA approach outweighed any coverage benefits of Tetrapol. The fact that TETRA was standards based and offered the market a range of devices and interoperability between manufacturers also had a significant impact.

Buyer Needs

So what does all this diversity mean? Those who seek a unified digital radio standard — similar to those who search for a theory of everything in physics — may be disappointed for some time. But in the world of PMR, perhaps this is not a bad thing. Users have the choice and will determine the future direction of the technology rather than having one imposed upon them. A trick for the buyer will be not to get left behind in an evolutionary cul-de-sac when the final technical direction, or directions, of the industry become clear.


Photo courtesy Selex Communications

Narrow channel widths offer less noise, providing greater range for a given transmit power.

So, as usual, define what you need: What is essential and mandatory; what would be nice to have and what is irrelevant? Balance your nice-to-haves against each other and create a scoring table. Your needs definition should be broad — it should cover functions and features, level of competition, need for many different terminals or a need to have one supplier responsible for all. ■

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