# The BIG Digital Decision

Photo courtesy Motorola

Know your options and how they're being deployed in the North American market before you invest in a digital mobile radio technology.

**By Todd Ellis**

Current LMR system operators have a major decision to make — how to accommodate the FCC's rulemaking that mandates 12.5-kilohertz migration. Many systems still operate on 25 kilohertz-spaced channels and require retuning or replacement to meet the 2013 12.5-kilohertz narrowbanding deadline. Another issue to consider is that by 2011 manufacturers can only request FCC type acceptance for new products meeting 6.25-kilohertz channel bandwidths or an equivalence, such as two signals within a 12.5-kilohertz channel. Current 25-kilohertz system operators should consider whether to modify their existing analog systems to operate at 12.5-kilohertz, hopscotch to digital technologies or migrate from 12.5-kilohertz analog to digital technology. Considering budget cycles typically run one to three years, system deployment decisions need to be made soon.

To operate on 6.25-kilohertz channels, transmission techniques might include a digital mode that provides 4,800-baud vocoding or its equivalent using faster baud rates on 12.5- or 25-kilohertz channels. Many mobile applications are now leaning toward IP for mobile data application support and multisite transport. Several different digital voice transmission products are commercially available, and the purpose of this article is to objectively provide a comparison.

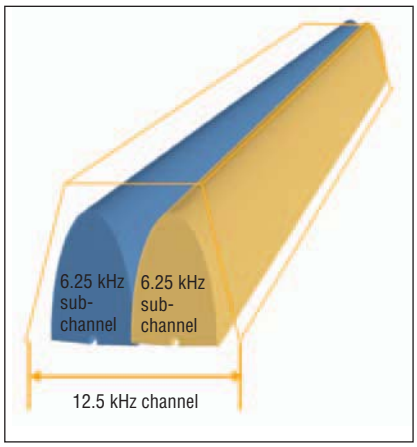
Essentially there are two major types of digital systems: time division multiple access (TDMA) and frequency division multiple access (FDMA). TDMA-based systems use a wider signal — a 12.5 kilohertz-spaced channel — but provide for multiple time slots in that same bandwidth. FDMA systems use a pair of narrower channels — adjacent 6.25-kilohertz channels — and provide one voice/data path for each spectrum slice. Each method has its benefits and drawbacks.

## Project 25

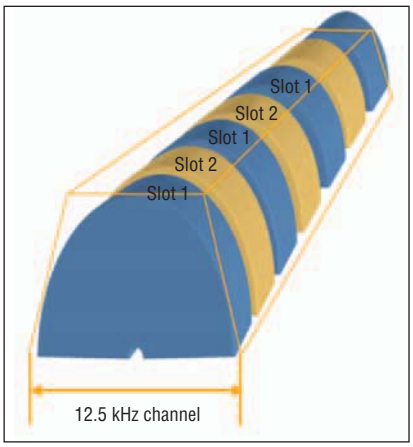
For public safety, the Project 25 (P25) standard is designated for both 12.5- and 6.25-kilohertz-spaced channel use. The Phase 1 digital standard describes a 12.5-kilohertz digital transmission system that is FDMA based, while the P25 Phase 2 digital standard — not yet completed — calls for a 12.5-kilohertz TDMA transmission system for 6.25-kilohertz channel equivalence.

Although backward compatibility of features is called for, implementing Phase 2 systems may require a forklift upgrade because of the change in modulation schemes. P25 is a family of interfaces created as an open architecture system, but some infrastructure elements remain proprietary to specific vendors to allow them to recover research and development (R&D) costs. The P25 Compliance Assessment Program (CAP), which aims to narrow incompatibilities, is under way.

Numerous suppliers offer P25 equipment. Subscriber unit equipment is the most competitive, while trunked and simulcast infrastructure equipment



Two FDMA channels within a 12.5-kilohertz space



Two TDMA channels time slotted within a 12.5-kilohertz channel

have the smallest number of suppliers. While several manufacturers are producing Phase 1 mobile and portable equipment, most are waiting for a final approval of the Phase 2 standard before moving forward with Phase 2 product releases.

## TETRA

TETRA is chiefly a European open standard for public-safety communications developed by the European Telecommunications Standards Institute (ETSI) that is gaining worldwide acceptance. Similar to P25, TETRA has two releases that outline methodologies, interfaces and features. Both releases are TDMA-based, and Release 2 adds high-speed data capability using wideband spectrum. The standard was developed for public safety but is expanding into other vertical markets, including transportation and utilities.

TETRA's first release had inherent TDMA timing issues that prevented some wide-area use where subscriber radios operated more than a certain distance from base stations. Release 2 expands that distance, but in most implementations of the technology, high subscriber densities are needed to substantiate the cost of the infrastructure. Furthermore, while considered an open architecture, intellectual property right (IPR) issues stifle any North American involvement in TETRA. About 25 manufacturers supply core TETRA products around the world excluding North America.

## Icom IDAS/Kenwood NXDN

Besides public-safety applications, commercial radio manufacturers are working to develop business and industry (BI) products using ETSI standards. Kenwood and Icom offer products with an FDMA transmission technique that promotes efficient spectrum use based on the digital Private Mobile Radio (dPMR) ETSI standard. Icom calls its technology IDAS, and Kenwood markets its products under the NEXEDGE brand.

In the FDMA format and following segments of ETSI standard TS-102-490, two 6.25-kilohertz-spaced channels are placed in the same spectrum that a single 12.5-kilohertz channel would occupy. This method meets the 6.25-kilohertz equivalency mandate because two distinct frequencies are multiplexed and channelized in this spectrum space. One cost benefit of using two adjacent channels for FDMA — or one 12.5-kilohertz TDMA channel — is that transmitter combining for two channels is no longer necessary; a single, lower cost duplexer can be used in place of a transmitter. However, duplexers require contiguous bandwidth, typically 25 kilohertz at maximum. Channels located in different channel blocks — not contiguous — require combiners.

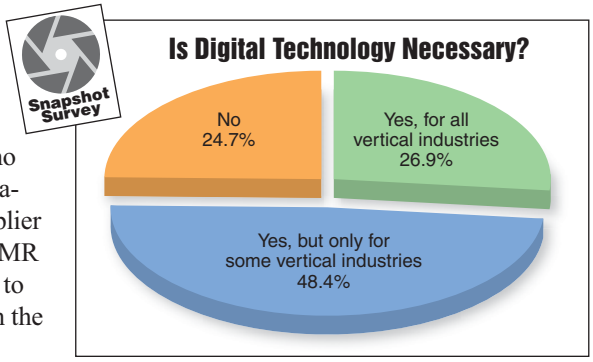
The original ETSI specification was written primarily for point-to-point, referred to in the standard as direct mode, handheld radio use. Kenwood's and Icom's products work interchangeably in conventional mode. Product developers for both companies have designed a trunked mode infrastructure that uses repeaters and links multiple sites via IP gateways. Kenwood's common air interface (CAI) is trademarked as NXDN, while Icom's trunked system is marketed under the IDAS name. Following the ETSI standard, the frame payload for both systems includes provisions for positioning information for AVL, emergency signaling, status messaging and free form messaging. The technology can network up to 16 sites via IP linking, and each site could contain up to 30 channels. Members of the NXDN Forum include Kenwood, Icom, Trident Micro Systems, Ritron, Daniels Electronics and Aeroflex.

## DMR Tiers 2 and 3

Other manufacturers, specifically Motorola and Tait Electronics, are busy with another TDMA-based ETSI standard developed for BI industries, Digital Mobile Radio (DMR). Similar to P25 Phase 2, two time slots are offered over a 12.5-kilohertz channel, providing 6.25-kilohertz equivalence. There are three levels of DMR. Tier 1 was specified to work in direct mode with no repeaters or other infrastructure. Tier 2 is a conventional configuration that also allows multisite access. Tier 3 is a trunked configuration. The ETSI specification states that feature sets are comparable with those found on MPT 1327 systems; both Tier 2 and 3 offer popular features that include text messaging, data payloads and AVL location information.

In Tier 2, multiple sites can be implemented and linked. Motorola's MOTOTRBO system uses four USB ports to allow traffic to flow to up to 16 voice channels. In Tier 3, multiple sites with multiple channels are permitted. For manufacturers such as Tait that already produce analog MPT 1327 systems and plan to move to DMR, Tier 3 adds digital capabilities

that include spectrum efficiencies, IP linking without analog-to-digital routers, and IP connectivity to data devices. Unlike P25 Phase 2, there are no provisions for wideband applications. Motorola is the only supplier with commercially available DMR equipment, although Tait plans to release DMR Tier 3 products in the near future.




## Migration

One common feature for both the NXDN and DMR formats is the capability to operate in analog or digital mode to support mode migration. This allows users to deploy digital-capable infrastructure repeater/control stations, yet allows for controllable cutovers to new fleets of digital-capable mobile and portable radios. Tait's planned migration methodology for DMR Tier 3 is to permit MPT 1327 system owners to convert their existing analog infrastructure to digital. Only reciters — the transmitter and receiver in one plug-in section in the repeater case — need to be replaced, and the control server/node software is updated; intersite networking is already set up for IP routing. This concept provides one way to leverage existing infrastructure investments, assuming a migration to digital might be necessary.

While the FCC mandated refarming the 150 and 450 MHz bands to 12.5-kilohertz-spaced channels, it's optional to leapfrog technologies and go to 6.25 kilohertz and/or its equivalence using a digital mode. For smaller commercial systems using only one or two sites, it may be comparably inexpensive to go directly to a digital technology. For medium- and large-sized commercial systems, it may be more cost effective to move toward a 12.5-kilohertz analog infrastructure with a migration option for digital if deemed necessary. ■

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