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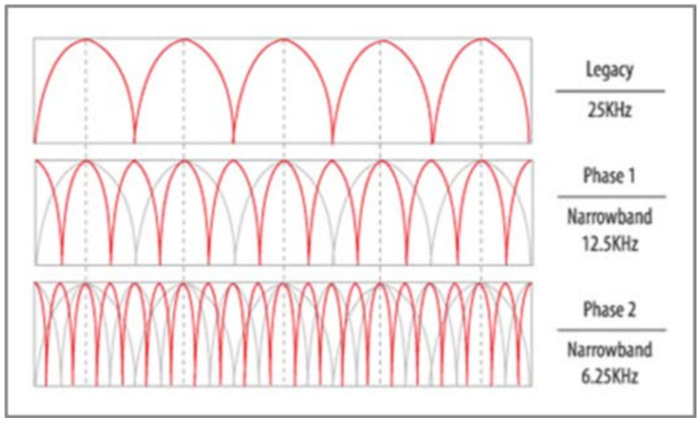
Public Safety Interoperability Implications of non-P25 Radio Technologies

In recent years, a number of disparate technologies have been introduced to the public safety market in the U.S. as an alternative to P25 technology. Among those technologies are TETRA, DMR (Digital Mobile Radio), NXDN™[1], and dPMR™[2] (digital Private Mobile Radio). Although these technologies were introduced in the U.S. a few years ago primarily to support business, industrial, and transportation radio systems, they have recently gained interest from some public safety agencies looking for an alternative solution to meet FCC narrowband mandates or to take advantage of interstitial channels, otherwise unusable to other technologies. For many, it is not clear how the introduction of these technologies might affect interoperability among public safety users.

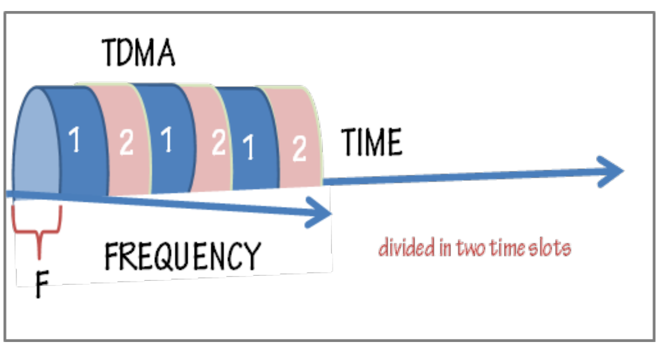


The diagram to the right shows how the FCC is planning for better utilization of critical spectrum resources by forcing voice communications into more narrow bandwidths. While many legacy systems still utilize 25 kHz channels, Phase I represents the current technology that allows for voice and data communications in a 12.5 kHz channel width, while Phase 2 represents emerging technologies that utilize even narrower bandwidths.

WHAT ARE THESE TECHNOLOGIES?

TETRA

TETRA is an ETSI (European Telecommunications Standards Institute) radio standard developed in 1995 as a replacement for older European trunked LMR standards such as MPT 1327 that could not offer the advanced features needed by its users. The goal of TETRA was to increase interoperability and spectrum efficiency among a variety of users in the EU, especially Public Safety, Military, Transportation, and Utilities. It uses a 4-slot Time Division Multiple Access (TDMA) architecture allowing 4 voice paths in one 25 kHz channel with a spectral efficiency equivalency of a 6.25 kHz channel. It has gained considerable market share and acceptance in over 120 countries and is, arguably, the global leader in standardized digital land mobile radio installations.[3]



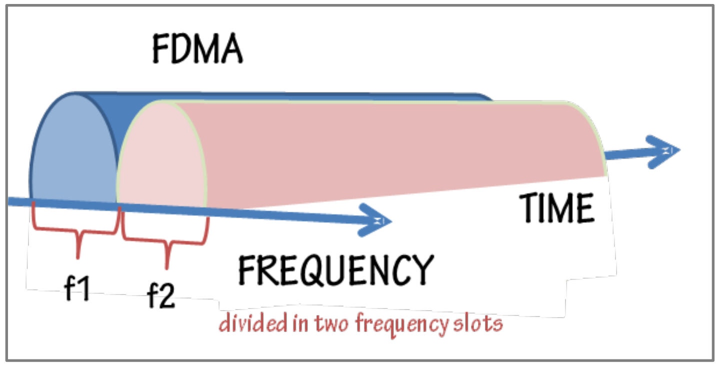
[1] NXDN is a Trademark of Icom Incorporated and JVC KENWOOD Corporation.
[2] dPMR is a Trademark of the dPMR Association.
[3] Detailed information regarding the TETRA standard is published by the TETRA+Critical Communications Association (TCCA) at http://www.tandcca.com/

DMR

DMR is also an ETSI radio standard developed in 2005 to address a need in the EU for an affordable, low-complexity digital radio, predominantly for business applications. DMR uses a 2-slot TDMA (depicted in the diagram above[4]) digital technology in a 12.5 kHz channel width, allowing 2 talk paths with a 6.25 kHz equivalent spectral efficiency when communicating through the repeater. Because it is digital and TDMA, it provides a variety of features that are not generally available with analog technology, including messaging, data, improved power performance, and spectral efficiency. DMR also allows for both Digital and Analog FM operation in the same system, which provides a more graceful transition from a legacy analog system to a more modern digital system that improves spectrum efficiency and provides a greater feature set.

NXDN™

NXDN™ is an open[5] standard originally developed through a collaboration between Icom and JVC KENWOOD in 2003, with the first NXDN™ capable conventional radio products introduced in 2006. It is based on a 6.25 kHz bandwidth digital technology with an FDMA (Frequency Division Multiple Access, depicted below) architecture allowing two voice paths for each 12.5 kHz channel, currently allowed by the FCC. The technology offers all the benefits of digital plus a very narrow bandwidth, allowing it to make the most of available bandwidth. Its success is partially based on the ability to use a number of 6.25 *interleaved* channels that cannot be used by any 12.5 kHz technology, including DMR's 2-slot TDMA approach. Some manufacturers offer P25 and NXDN™ protocols in dual-mode subscriber units.



dPMR™

dPMR™ (digital Private Mobile Radio) is another 6.25 kHz FDMA protocol, similar in many ways to NXDN™. It is based on an ETSI standard developed in the last 10 years that is primarily for the Business and Industrial markets that do not require a high degree of complexity. There are many manufacturers of this technology that offer single site and multi-site systems in frequencies from 66-960 MHz. Some manufacturers offer dual-standard (NXDN™ and dPMR™) flexibility and other systems will be available in the U.S. market in the near future.

WHAT ARE THE POTENTIAL BENEFITS TO PUBLIC SAFETY?

In the move to narrowband channels to improve spectral efficiency, these technologies offer a number of advantages over analog FM. They are generally less expensive and less complex than other top-tier digital technologies. Since TETRA, DMR, NXDN™ and dPMR™ are digital, they typically provide voice and performance (range) improvements over analog, especially at the edge of coverage. They also allow more flexible data services including messaging, and simultaneous voice and data capabilities. Although DMR is TDMA, it has a distinct advantage over TETRA in that it has an analog 12.5 kHz FM mode of operation in many applications, enabling a degree of interoperability to current analog systems and as mentioned above, a more graceful migration to digital.

Manufacturers assert that DMR can be configured to require less infrastructure equipment at repeater sites than other technologies, decreasing system costs. Arguably, this advantage comes from its typical TDMA architecture (low-site, low-power), which can be beneficial for a small public safety agency with limited coverage requirements. In these cases, DMR can allow for less infrastructure, making it attractive in a budget sensitive economy. On the other hand, 6.25 kHz FDMA infrastructure is less complex than TDMA, allowing quicker recovery from system failures.

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[4] Although the TDMA figure depicts 2-slot TDMA, 4-slot TDMA works in the same manner. Additional time slots increase the occupied bandwidth.

[5] Although not developed or endorsed by a recognized Standards Development Organization, the standard is an open standard, available for interested technology providers.

NXDN™ and dPMR™ both offer an occupied bandwidth advantage over other technologies, in that they are considered very narrowband FDMA technologies, capable of operating in a 6.25 kHz bandwidth. In the U.S., there are over 3,000 channels dedicated as 6.25 kHz channels and the FCC has recently announced a ruling allowing licensing of two 6.25 kHz channels within a single 12.5 kHz channel.

TETRA systems have been available commercially for more than 10 years, yet it has only recently gained acceptance in the U.S., predominantly in the Utilities, Business, and Transportation sectors. The attraction of TETRA for these sectors may lie in the fact that the TETRA architecture adapts well to infrastructure-rich, high-density systems that are typical of these services. The spectrum efficiency of 4-slot TDMA systems and the generally lower cost of subscriber units make TETRA a viable alternative for these sectors.

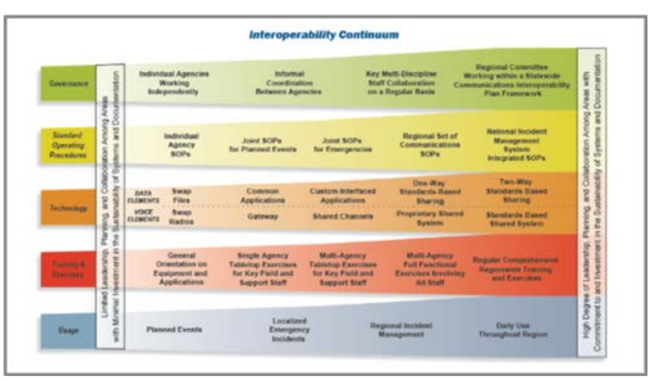
U.S. Public Safety use of TETRA depends largely on how well this technology can adapt to unique U.S. requirements, including the use of U.S. adopted and approved encryption technology, backward compatibility to analog systems, and effective/proven direct mode operation. A number of TETRA manufacturers are offering hybrid TETRA/P25 solutions that allow both technologies to operate together in the same network. How the use of the TETRA waveform may affect existing users of public safety bands is also a question that must be addressed, since it has arguably not been thoroughly tested in a P25 environment.

What are the Interoperability Implications?

Although there may be some advantages in these technologies for some public safety agencies, this benefit can come at a cost to both flexibility and interoperability. Functionally, these alternative technologies can be feature-rich with many of the functions that public safety agencies need, including spectral efficiency, data capabilities, messaging, direct call/direct mode, geolocation, and privacy. As the introduction of these technologies becomes attractive to some public safety agencies, especially smaller agencies without the funding or incentive to procure or install P25 systems, the question of interoperability with neighboring jurisdictions and at a National level becomes an important issue that should be addressed.

On the subject of interoperability, DMR, NXDN™, and dPMR™ all bring similar concerns that the introduction of TETRA has revealed. There is generally no direct interoperability with P25 radio systems in the digital mode other than through gateways and manufacturer-specific interoperability solutions. Although a number of manufacturers of these technologies offer subscriber units that support multiple protocols, it remains a question of how well these subscriber units interoperate in a P25-only infrastructure and how seamlessly these non-P25 standard systems interoperate through the gateways that are offered. More disparate technologies generally mean more complex solutions. Since some of these technologies offer a narrowband analog FM mode, a base level of interoperability can potentially exist, a feature that TETRA does not offer.

The DMR and dPMR™ privacy or encryption methods are not the NIST-approved AES algorithm that is currently a part of the predominant public safety grade radio common in the U.S. today, P25. That can be an issue where information assurance is necessary. Recently, the DMR Association has agreed to allow AES and DES encryption in their products. In addition, NXDN™ manufacturers have also recently introduced an option to add both AES and DES encryption to their products. The TETRA standard offers Air Interface and End to End encryption using the Tetra Encryption Algorithm (TEA), but not AES. TETRA manufacturers in the U.S. have stated they will introduce AES 256 Encryption to their products in the U.S. as necessary, but the TETRA standard itself does not include this algorithm.



These technologies can be an attractive technical and fiscal means to achieve narrowband goals while taking advantage of modern digital features. As they make inroads into the public safety community, the technology path of the Interoperability Continuum begins to diverge, making interoperability more difficult. This result is common to all non-P25 technologies and forces interoperability to a network level or a multi-mode subscriber unit solution, making it functional, but less responsive and less flexible. Awareness will help public safety agencies make better informed decisions regarding which technology best fits their needs and how these decisions impact interoperability at the local, state, and regional level.

In a brief entitled *Non-P25 Digital Technologies Will Negatively Impact Hard-Won Advances in Public Safety Interoperability in the United States*, the National Public Safety Telecommunications Council (NPSTC) stated that the adoption of non-P25 radio systems could "…*pose a virtually insurmountable technical hurdle for successful interoperability*" and further states that "*it potentially negates billions of dollars' worth of investment in P25 LMR systems*". These statements indicate the public safety community is focused on enhancing interoperability among its user agencies and all the technologies above represent a replacement and not a solution to achieving that goal.

Additionally the FCC, in a recent Report and Order (16-48), ruled that modulation on all Public Safety VHF, UHF, and 800 MHz (NPSPAC) calling general interoperability and tactical channels shall be limited to narrowband analog FM. This effectively confines the use of these channels to technologies that allow analog FM operation, further limiting some non-P25 technologies' usefulness to public safety applications.

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