WHITE PAPER

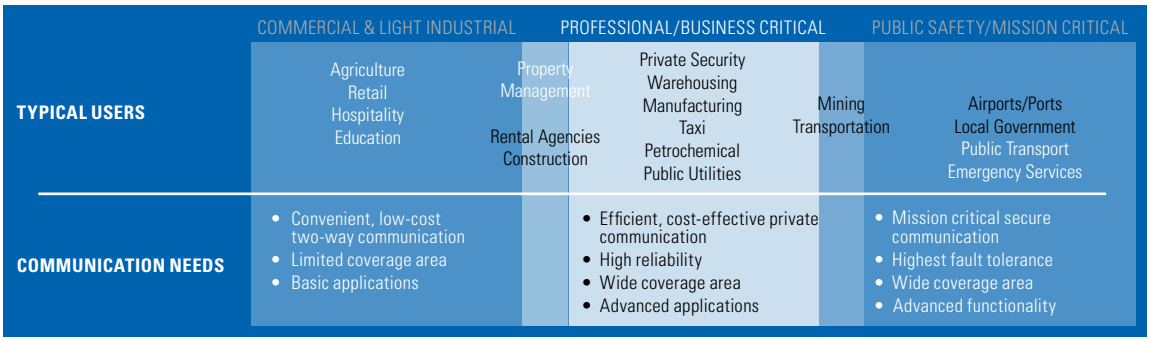
STANDARDS FOR PROFESSIONAL MOBILE RADIO

MAKING A BUSINESS CRITICAL CHOICE FOR THE FUTURE

MOTOROLA

EXECUTIVE SUMMARY

Today, both regulatory bodies and the needs of users are encouraging the move toward digital mobile radio technology to improve spectral efficiency and take advantage of advanced voice and data functionality. The professional market, the largest group of two-way radio users, is now deciding which digital technology will best meet their needs, now and in the future. TDMA two-slot digital mobile radio, the standards-based solution created for these users, offers the best option. The Digital Mobile Radio (DMR) standard on which it is based was designed to deliver a cost-effective, highly functional communication system for professional mobile radio users, as well as the smoothest path toward future interoperability and multi-vendor flexibility.



Worldwide digital two-way radio markets can be roughly divided into three categories.

THE SITUATION: THE PROFESSIONAL MOBILE RADIO MARKET

DEFINING THE PROFESSIONAL MARKET

Users of two-way radio communication fall roughly into three groups, each with their own needs and expectations. At one end of the continuum are organizations that simply need fast, convenient, low-cost communication over a limited range. For these businesses, basic low-power radios meet their needs quite adequately.

At the opposite end are those organizations with mission-critical communication needs, such as police and fire departments, public transport and emergency services. The nature of their work demands the top-level reliability, security and wide geographic range that come only with high functionality, often in customized radio networks. Such systems can be costly, but are an essential component of fulfilling the organization's mission.

Between these two lies the largest group, the professional mobile radio market. These organizations need to communicate with and provide information to a workforce that is mobile, moving about a geographic area to accomplish their jobs. They work in a variety of industries, including transportation, construction, manufacturing, energy and utilities. Some communicate across a single campus — at an institution of learning, a building site or a resort. Others, such as local governments or public safety organizations, need to communicate across multiple sites in a wider region.

For all of them, though, superior communications quality, reliability, functionality, and mobility are business-critical. Professional mobile radio users need clear, unbroken, reliable communications because for them, communication problems create business problems — reduced productivity, wasted time and wasted money. When they can't reach their workers, essential services are interrupted. Customers needs go unmet. Business is lost.

PROFESSIONAL USERS, PROFESSIONAL NEEDS

Because the mobile professional depends so heavily on reliable communication, the selection of a communication technology becomes a business-critical decision. Aligning the right solution with business goals means choosing a technology that will grow with the organization, offering functionality that streamlines workflow, enhances productivity and improves operational efficiency.

Although every organization has its own unique business goals, professional mobile radio users typically have these in common:

Clear, reliable communication across the service area — when reliability across a wide area is important, unlicensed on-site two-way radios are usually rejected because of their susceptibility to interference and congestion. In addition, their limited range does not meet the needs of many professional market users. Even licensed analog two-way radios, in today's crowded spectrum, can suffer interference and voice quality degradation at the edge of coverage. Analog solutions also are limited in capacity and expandability as a result of spectral crowding.

Cost-effective, customized communications — while unlicensed two-way radios are cost-effective, their basic feature set cannot offer customization to the specific needs of the organization. Radios designed to high-functionality standards aimed at mission critical needs, such as P25 in the U.S. or Terrestrial Trunked Radio (TETRA) in Europe, can be customized, but may not be cost-justifiable for a professional business organization. A public infrastructure solution such as Push-to-Talk over Cellular, with its recurring service usage fees and potentially higher total cost of ownership, can also fall short of meeting cost goals for the professional market.

Integrated data communications — to easily send and receive images and information, or quickly locate vehicles and personnel in the field – such abilities have become an expectation, rather than a luxury, for today's mobile worker. Licensed analog two-way radios lack these integrated data applications. Digital technologies are needed to support these requirements.

These needs, then, create today's search for a comprehensive, cost-effective and future-ready radio solution for the mobile professional.

THE SOLUTION: DIGITAL MOBILE TECHNOLOGY

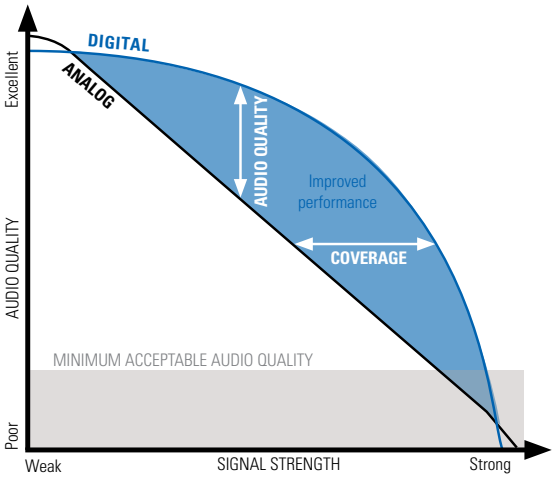
DELIVERING PERFORMANCE AND PRODUCTIVITY

With the emergence of digital two-way radio technologies, professional organizations are being offered an increasing variety of systems, both proprietary and standards-based, that can better align with their business goals. Digital technology achieves new levels of performance and productivity, with a richer feature set to meet the needs of the professional user.

Digital mobile radio also delivers cost-effectiveness and greater spectrum efficiency, by using less of the available spectrum capacity per call. That provides higher overall capacity with clearer voice services throughout a geographic range. At the same time, digital protocols enable access to integrated data to improve organizational responsiveness and productivity.

Depending on the technologies used, digital systems can be designed to:

- Make more efficient use of available, licensed RF spectrum
- Combine voice and data access in the same device, delivering more information while empowering field workers with systems that are more portable, flexible, and much easier to use than two different and incompatible systems
- Enable integration and interoperability with back-end data systems and external systems
- Combine analog and digital voice in the same device, easing the migration to digital while preserving investments in analog technology
- Provide strong, practical, easy-to-use privacy solutions without the significant loss in voice quality that analog scrambling can cause
- Enable flexible and reliable call control and signaling capabilities
- Provide increased capacity without additional base stations
- Flexibly adapt to changing business needs and new applications through a modular architecture



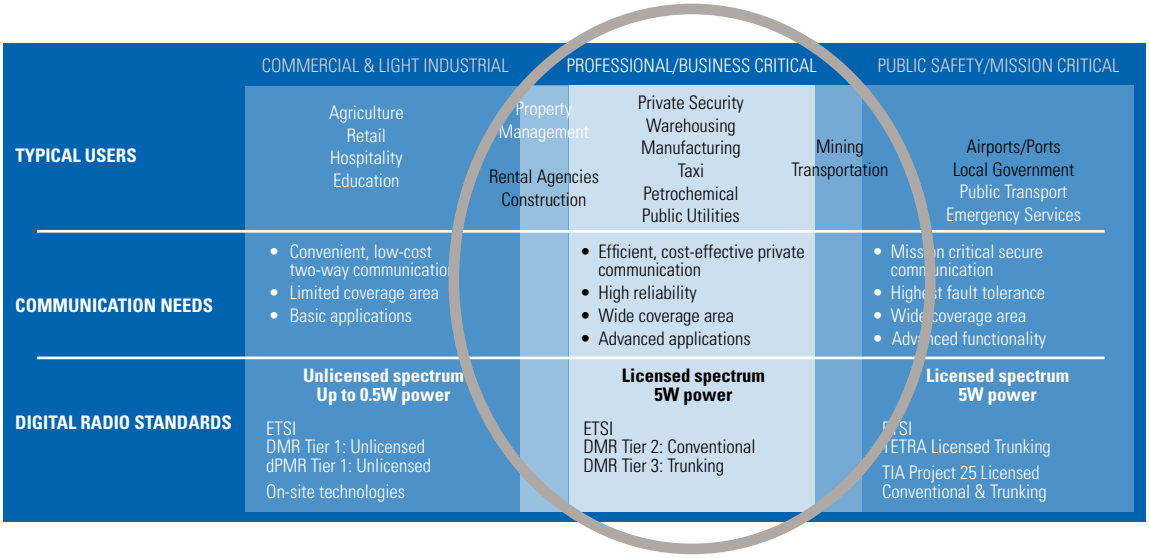
Digital voice retains better quality than analog as signal strength decreases.

REGULATORY SUPPORT

Around the world, regulatory bodies are already encouraging the digital transition in order to take advantage of its greater bandwidth efficiency. Analog radios use a bandwidth of 25kHz or 12.5 kHz to transmit a call; current digital protocols designed for the professional market tier are two to four times more efficient.

In the United States, the FCC has already mandated that as of January 1, 2011 new licenses in the VHF and UHF bands must operate with an equivalent efficiency of at least one voice path per 12.5 kHz and that existing licensees must do so by January 1, 2013. Further, as of January 1, 2011, 12.5 kHz efficiency equipment in these bands must also include a 6.25 kHz equivalent efficiency mode. Equipment does not have to operate with a 6.25 kHz bandwidth channel, but it does have to include a mode that is the equivalent of one voice path per 6.25 kHz. For example, 2 voice time slots in a 12.5 kHz channels meets the requirement. Canada, likewise, has since 1997 required that all radio equipment be capable of at least 12.5kHz efficiency; after 2010, 12.5kHz systems will be considered “non-standard” to encourage further 6.25kHz equivalency. In Europe, Asia and elsewhere around the world, regulators are urging similar moves toward the more efficient use of existing spectrum and new bands.

The clear advantages of digital radio — along with increasing regulatory pressures to use RF spectrum more efficiently — will drive widespread adoption of professional two-way digital radio solutions in the coming years. Today’s analog radio users will almost certainly be migrating to digital tomorrow. The only remaining question is, how will professional market organizations choose systems that provide them with the greatest benefit over the long term?



European Telecommunications Standards Institute (ETSI) digital two-way radio standards address the needs of each market segment. For the professional mobile radio user, the relevant standard is DMR Tier 2/3.

THE ROLE OF STANDARDS IN DIGITAL MOBILE RADIO

WHY STANDARDS?

Nearly every purchaser of high technology understands the importance of standards. Innovation in technology can take a virtually infinite number of paths. Some will be widely adopted and become another lane on the highway to future success. Others will dead-end. No one wants to find themselves on the wrong road.

Standards bodies collaborate to help users of technology choose a path with confidence. These independent organizations, comprised of industry innovators and thought leaders, come together to clearly define technological progress toward specific industry-shared goals.

Chief among those goals is the development of **defined migration paths and documented upgrades to the technology.** All successful technologies evolve as innovators develop new ideas and enhancements, building on what has gone before. Standards provide a platform for that evolution. Standards bodies develop a timeline for feature introductions that responds to regulatory mandates, while protecting value for users. By soliciting input from industry experts on what is and is not possible, practical and beneficial to users, standards bodies help ensure a robust, realistic and cost-effective future life for the defined technology.

Another key goal of standards bodies is **multi-vendor interoperability and compatibility.** A flexible, interoperable standards-based solution ensures the quality and reliability of a technology solution. It enables competitive vendors to protect their proprietary intellectual property, while providing sufficient commonality to ensure that users have access to multi-vendor alternatives for their solutions. Marketplace competition, in turn, benefits users by helping reduce capital costs for investments in a new technology.

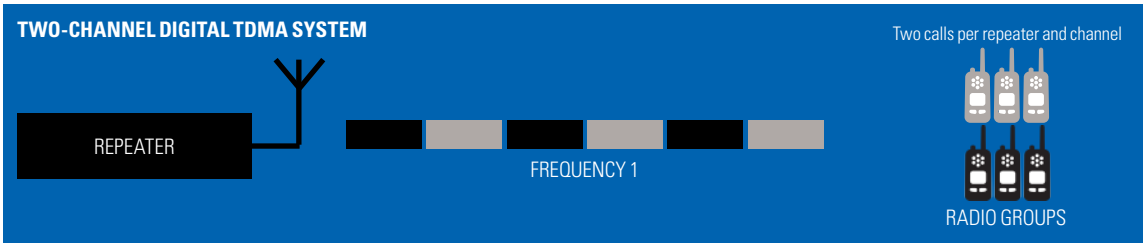
THE DMR STANDARD

To meet the challenges of large scale migration of professional users to digital radio, the globally recognized European Telecommunications Standards Institute (ETSI) has developed a new digital standard called DMR (Digital Mobile Radio). DMR includes standards for all of the broad range of business radio use, but for the conventional radio professional market, the relevant standard is defined in DMR Tier 2.

In developing the DMR Tier 2 standard, ETSI considered a number of alternative technologies. Knowing the needs of the professional/business-critical user, they sought a technology that promised the high reliability, improved range, higher data rates, more efficient use of spectrum, and improved battery life these users demand.

Because the organizations that would use the new standards-based technology work in industries with a broad range of communication demands, ETSI sought a technology path that could support a similarly rich set of features, including fast call set-up, calls to groups and individuals, short data and packet data calls. Their choice would need to support individual calls, group calls, broadcast calls and, of course, a direct communication mode among the mobiles. Other important functions such as emergency calls, priority calls, full duplex communications, short data messages and IP packet data transmissions would also be supported in DMR.

Perhaps most important to professional users, ETSI recognized the significant investment many organizations already have in analog radio systems. The DMR Tier 2 standard was specifically designed to ease their migration from analog to digital. The standard fits in existing bands and imposes no fundamental changes in architecture. Instead, it focuses on changing the over-the-air protocol to facilitate the use of applications that are beyond the capability of analog systems. **The protocol ETSI chose is two-slot TDMA.**



TDMA saves licensing and equipment costs by enabling the equivalent of two 6.25 kHz channels within a single licensed 12.5 kHz channel.

THE STANDARDS-BASED TECHNOLOGY: TDMA DMR

The ETSI DMR Tier 2 standard is based on a two-slot TDMA protocol. In defining its standards for the professional mobile radio market, ETSI was convinced that TDMA technology provides superior advantages for these users, with no changes to existing licensing requirements or rebanding of spectrum. Successful telecommunication standards based on TDMA technology are already widely used around the world — in GSM cell phones, for example. The TETRA radio standard in Europe and the P25 Phase 2 standard under development in the U.S. are also based on the TDMA protocol.

MULTIPLE ACCESS AND SPECTRAL EFFICIENCY

The primary goal of any multiple-access RF technology is to achieve greater spectral efficiency, allowing more users to share a given channel in the licensed RF spectrum. Historically, the licensed airwaves were divided into relatively large 25 kHz channels. There was plenty of room for the broadcasters using these channels to exist side-by-side, without significant interference problems. Over the years, however, the airwaves have become increasingly crowded, creating a need to allow more radio users to share the available spectrum in any given area.

Two-slot TDMA is a 12.5kHz technology that offers a way to divide the channel into two independent time slots, achieving 6.25 kHz-equivalent efficiency today. With two-slot TDMA-based devices, there's no reason to wait for a government mandate to achieve more capacity on existing licensed channels. No relicensing or rebanding is needed; only a straightforward minor change in the emission specified on the license is required. So professional users can take the initiative to achieve greater spectral efficiency well ahead of the inevitable regulations — and ahead of the competition.

LESS INTERFERENCE

One reason that ETSI chose TDMA over alternative protocols (such as FDMA) for professional users is the reduced opportunity for interference that TDMA offers. Analog 25kHz bandwidth provides plenty of room for slight errors in frequency. If a single transmitter or receiver was marginally off in its channel calibration, the effect was usually imperceptible.

However, splitting spectrum into narrower bands means more users are communicating in the same space. Slight errors can now result in dropped signals or in interference in adjacent channels for other users. The narrower the bandwidth becomes, the greater the chance that users will experience performance problems. Yet the cost of constantly recalibrating field-deployed radio units is prohibitive. In protocols that use a discrete 6.25kHz band at low power, such as FDMA in the unlicensed bands, the problem is negligible, since the limited range alone minimizes the chance of interference. With high power radios in the licensed bands, however, it can become a significant issue.

ETSI recognized that the TDMA two-slot protocol minimizes this affect. Rather than split the bandwidth to a narrow 6.25kHz slice, TDMA achieves 6.25kHz equivalency in bandwidth efficiency by placing two time slots in the licensed 12.5kHz repeater channels. At 12.5kHz bandwidth, slight deviations have much less effect, resulting in clearer, more reliable communication even at high power.

COST-EFFECTIVE, FEATURE-RICH

Finally, two-slot TDMA offers the rich feature set that professional users need, as well as lower equipment costs, longer battery life, future-readiness and the proven ability to increase spectral efficiency without risking increased congestion or radio channel interference. TDMA doubles the efficiency of licensed 12.5 kHz repeater channels, enabling two digital conversations to take place simultaneously within a single channel. There is no need to deploy extra infrastructure such as additional repeaters; voice communication in a single repeater system is still possible should the repeater be lost via unit-to unit communication. Meanwhile, the second slot can also be used to deliver advanced features such as IP-based dispatch data, enhanced call-control and priority signaling in parallel with a call on the other slot.

By choosing a TDMA solution based on the ETSI DMR Tier 2 standard, professional organizations can choose a solution that doubles their existing call capacity while providing advanced features and capabilities.

A STANDARDS-BASED SOLUTION — MOTOROLA'S MOTOTRBO™ FOR THE PROFESSIONAL MOBILE RADIO MARKET

Motorola has long been a leading supporter of interoperable, multi-vendor standards-based solutions. So in creating our digital radio solution for the professional mobile radio market, we were heavily involved in the development of the ETSI DMR standard. We are proud to be the first to bring a DMR Tier 2 standards-based solution to market, the Motorola MOTOTRBO Professional Digital Two-Way Radio System.

With MOTOTRBO, professional users benefit from:

- Expanded digital voice, data, and control capabilities delivered over a given slice of RF spectrum. TDMA digital two-way radio increases capacity and flexibility to support more users in more ways.
- Increased capacity with lower licensing and equipment costs. TDMA technology enables two virtual channels within a single 12.5 kHz licensed repeater channel. This provides twice the calling capacity for the price of one license. And because there's only one "real" channel, a second call doesn't require a second repeater.
- Clearer voice communications over a greater range. When signal strength drops off with distance, digital error-correction technology can accurately deliver both voice and data content with virtually no loss over a given coverage area. Audio quality is more consistent across a given coverage area.
- Improved battery life. In a two slot system, each individual radio only uses half the battery power of an analog radio transmitting at the same wattage. Since transmitting is the most energy-intensive operation, digital TDMA two-way radios can enable operation up to 40 percent longer than typical analog radios.
- Enhanced functionality. In MOTOTRBO's two-slot TDMA system, each slot delivers an independent virtual channel at the repeater that can be used for voice calls, data communications, or a combination of the two. MOTOTRBO provides improved background noise suppression, built-in privacy, and optimized workgroup communication with one-to-one, one-to-many and one-to-all calling models and signaling features such as push-to-talk ID, emergency, remote monitor, and radio check.
- Easy migration. MOTOTRBO's ability to operate in both analog and digital modes enables a smooth, planned migration at a user's own pace.
- Advanced applications. With built-in GPS, MOTOTRBO provides the ability to track people and assets, such as vehicles. MOTOTRBO also offers text messaging capability, enabling messaging between radios and dispatch systems, radios and email addressable devices and to remote PC clients attached to radios.
- Better design. MOTOTRBO's smaller, lightweight and rugged design includes submersible portable units with intuitive, easy-to-use, menu-driven interfaces.
- Standards-based, future-facing platform. MOTOTRBO was designed to the globally-recognized European Telecommunications Standards Institute (ETSI) Digital Mobile Radio (DMR) Tier 2 standard for professional mobile radio. This provides an open platform that will drive market acceptance and enable multi-vendor interoperability for voice and IP data, assuring competitive pricing while protecting customer investment. MOTOTRBO also meets existing United States regulatory requirements for 12.5kH efficiency in both analog and digital mode, making MOTOTRBO ready for new regulatory requirements.

CONCLUSION

As they prepare to migrate to the greater efficiencies and capabilities of digital mobile radio, professional users need to make a careful choice. Motorola's MOTOTRBO makes the choice easier by adhering to globally recognized standards. A standards-based solution assures a smooth, well defined migration path, as well as the interoperability and compatibility of multi-vendor equipment that provide for fair market, competitive alternatives.

To learn more about Motorola's standards-based solution for professional mobile radio, contact your Motorola representative.

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