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MOTOROLA

The Future of Professional Two-Way Radio: Digital.

WHITE PAPER

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Executive Summary

Two-way voice was one of the first commercial applications of radio technology. In 1933, the first two-way mobile radio system was installed in patrol cars of the Bayonne, New Jersey police department. Since then, two-way radio has moved beyond the realm of public safety to become an invaluable tool for mobile professionals in a wide range of enterprises.

The term "two-way radio" conjures up a variety of images. Many people think of public safety officers using expensive equipment and licensed spectrum to convey mission-critical information at the site of an incident. Others think of hobbyists and sales clerks using low-cost, low-power "walkie talkies" in the unlicensed spectrum to keep in touch over relatively short distances. But there's a vast and growing market between these two extremes for professional users who need high-quality yet affordable equipment that takes advantage of the power, range and coexistence characteristics of licensed channels.

In transportation, energy, government, retail, hospitality and many other industries, licensed professional two-way radio systems offer capabilities that no other mobile technology can provide. Unlike competing technologies, only two-way radio can offer professionals instant, private and cost-effective communication in virtually any environment — anywhere and anytime. With two-way radio, there's no need to deploy supporting infrastructure in a field situation, or to rely on subscriber-based public networks that may be under-supported or even completely unavailable.

For most of its history, two-way radio has been an analog medium, and to this day the vast majority of systems are still analog. But that's about to change. In the same way that digital technology has transformed other media, it's now revolutionizing the way mobile professionals communicate in the field. Like the digitization of music, TV and other traditionally analog media, digital two-way radio technology offers several advantages over the analog systems of the past.

For example, compared to analog two-way radio, digital two-way radio can offer greater spectral efficiency for higher calling capacity, enhanced voice quality at the farthest margins of the RF range, and more reliable coverage — making it easier to hear and understand conversations, even at long range and in difficult environments. Digital two-way radio also offers many features and capabilities that analog simply can't provide. For example, digital systems can:

- Provide enhanced signaling for user-friendly operation and advanced features
- Enable longer battery life in the field by requiring less transmit power, depending on the specific transmit methods and power-management technologies used in the device
- Enable flexible privacy between individual users and groups, without degrading voice quality or requiring configuration of add-on hardware
- Combine voice communication and wireless data applications in the same device, literally transforming the way field workers get the job done

This white paper gives an overview of two-way digital technology and the advantages it offers to mobile professionals in industries such as transportation, education, building construction and manufacturing, energy and utilities, private security, public safety and local government, and service-intensive businesses such as hotels, motels and casinos. We'll explore unique needs of these mobile workers, and discuss the ways that digital technology serves these needs in ways that analog radio can't. And we will describe how Motorola is leading the establishment of standards, technologies and solutions for the new, digital generation of two-way radio and wireless computing.

Why Two-Way Radio?

Before we look at the advantages of digital, there's a more fundamental question. With alternative and emerging technologies — such as cellular, push-to-talk over cellular, and Voice-over-WLAN–is there any reason for enterprises to stick with two-way radio at all?

While there's no single answer to this question for every organization, two-way radio offers certain advantages that make it the clear choice for the vast majority of mobile professionals who require an affordable, flexible, highly reliable solution — along with the power and range available only in licensed bands. Advantages of two-way radio include:

- Low total cost of ownership. Two-way radio requires a small up-front investment, with no recurring monthly fees. A two-way radio solution can typically pay for itself in less than 18 months compared with cellular or public carrier solutions that require recurring monthly fees.
- Customizable coverage and features. Two-way radio was developed and has continued to evolve to meet the specific needs of group-oriented communications and dispatch environments. The ability to tailor a two-way solution to meet the needs of businesses — with quick, reliable one-to-one, one-to-many and many-to-many communications — remains unequaled. Carrier-based solutions don't provide comparable levels of customization and performance.
- Simple, reliable implementation. On-site and in-the-field solutions often require no infrastructure at all. Users simply turn on their radios and talk directly to each other — for miles — using rugged devices designed for everyday use in the most demanding environments. For group voice calls, with coverage requirements measured in miles rather than feet, two-way radio will continue to provide simplicity and reliability unmatched by cellular, VoWLAN and other competing technologies.

If you're one of the tens of millions of professionals who rely on two-way radio today, it will continue to be your technology of choice tomorrow. And if you're not a two-way radio user today, you owe it to yourself and your business to explore what two-way has to offer.

Digital Two-Way Radio: A Modern Solution for Modern Needs

Analog radio works well, and proves itself every day in countless deployments around the world. However, analog two-way radio has reached the limits of innovations. Virtually everything that can be imagined using analog radio has been already been attempted or achieved over more than a half-century of experimentation and innovation. Today, a new platform is required to break through to new levels of performance and productivity.

Many enterprises are finding they need more than the fundamentals that analog two-way radio delivers. Perhaps their licensed channels are becoming crowded and they need more capacity. Perhaps they need more flexible ways to communicate with users both inside and outside the work team. Perhaps they need access to data in combination with voice to improve responsiveness and productivity. Digital radio provides a powerful, flexible platform that professional organizations can adapt to meet these needs and more.

By migrating from analog to digital two-way radio communications, these organizations can fill many of these needs immediately and build a strong technical foundation for adding new functionality to meet new needs in the future.

Let's take a look at each of these enterprise mobility needs in turn, and explore how digital radio technology can support a more responsive and adept mobile team.

Need: Efficient Use of RF Spectrum

For many two-way users, the most important benefit of digital radio is to make more efficient use of licensed 25 kHz and 12.5 kHz channels. The airwaves are becoming more and more crowded, and the old licensed channel structures — originally designed with the principal goal of serving a handful of broadcasters — are no longer adequate to carry the increasing broadcast and private radio traffic projected in the future.

Regulatory agencies are responding to an impending crisis in RF congestion by mandating more efficient use of licensed spectrum. For example, in the U.S., the FCC is requiring manufacturers to offer only devices that operate within 12.5 kHz channels by 2011. By the year 2013, all users will be required to operate in 12.5 kHz — making it possible for twice as many users to share the airwaves as compared with today's 25 kHz licenses.

The next logical step is to further improve the effective capacity of 12.5 kHz channels. It's only a matter of time before the ability to carry two voice paths into a single 12.5 kHz channel, also known as 6.25 kHz equivalent efficiency, becomes a requirement. But with digital radio, there's no need to wait for a mandate. Devices that incorporate Time-Division Multiple Access (TDMA) can achieve 6.25 kHz equivalency today — doubling the capacity of a currently licensed 12.5 kHz channel or quadrupling the capacity of a 25 kHz channel.

That means many more people can communicate over an enterprise's existing licensed channels, without worrying about interference. And because each TDMA "slot" works independently, these virtual 6.25 kHz channels can be used flexibly according to the organization's needs. For example, two slots within one channel can be used to carry two separate and private conversations, or else one slot could be used for data or priority signaling in conjunction with a conversation on the other slot.

As application designers create new ways to use the additional capacity — for example, combining channels to support full-duplex calling or to increase the data rate — TDMA-based digital devices will be ready to adapt. In fact, well-designed digital radios can adapt to changing usage models on the fly, in the field. And even organizations that need only basic calling capabilities can benefit from the increased capacity of TDMA-based radios by getting two-for-one value for infrastructure such as repeaters and antennas.

Digital radio offers:

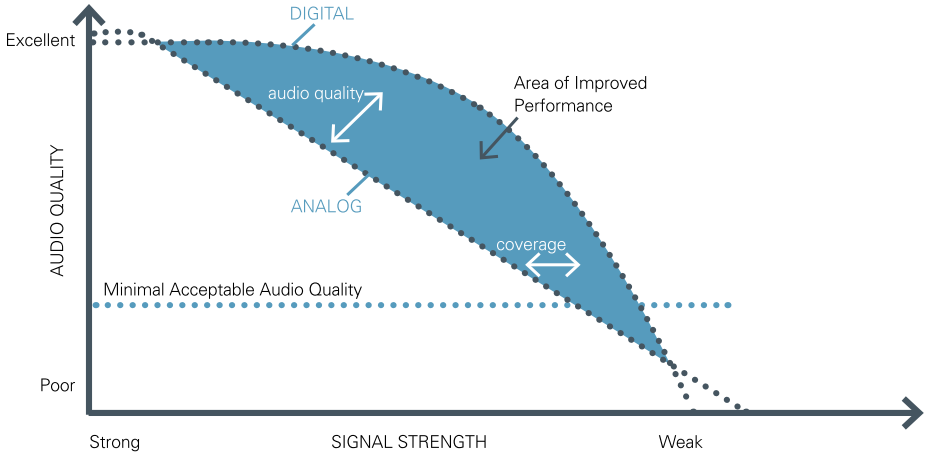
The ability to expand digital voice, data, and control capabilities that can be delivered over a given slice of RF spectrum. By choosing devices that incorporate the appropriate standards and technologies, organizations can get increased capacity and flexibility to support more users and new usage models. For example, devices that use TDMA modulation offer the flexibility to use a single channel for multiple two-way voice conversations, full-duplex conversations, separate voice and data transmissions, control and management capabilities, and more — flexibly switching between usage scenarios as needed.

Lower licensing and equipment costs. 6.25 kHz-equivalent systems based on TDMA enable two virtual channels within a single 12.5 kHz licensed channel, providing twice the calling capacity for the price of one license. And because there's still only one "real" channel, any supporting infrastructure does double-duty as well. A second call doesn't require a second repeater, or expensive combining equipment to route both calls through a single antenna site.

Need: Improved Fundamentals, Including Voice Quality, Privacy, Battery Life, and Additional Features

Professional two-way radio users depend on clear, unbroken, reliable voice communications. A missed call, user error, garbled message, or dead battery can mean lowered productivity, wasted time and money, unsatisfied customers, and lost business.

Due to the inherent nature of RF physics, analog radio can suffer from several limitations that affect the range and clarity of voice. In an analog system, everything in the environment that disrupts or interferes with the signal itself directly impinges on the voice quality at the receiving end. Although it's possible to boost and retransmit a degraded signal, there's no way to reconstitute the original voice quality. The most common result of this degradation is an increase in static and artifacts that makes the signal increasingly unintelligible as the user approaches the margins of the radio's effective range.



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

Signal strength falls off exponentially as the distance from the transmitter increases, following the inverse square law. At the same time, the background RF "noise" level remains constant, so the signal-to-noise ratio declines by a factor of four with each doubling of the distance between transmitter and receiver. Environmental factors — such as line-of-sight obstacles and RF interference — can also severely degrade performance, further shortening the effective range at which analog radio performs with acceptable voice quality.

The only way to retain analog voice quality at the edge of the radio's effective range is to boost signal strength. But this quickly becomes impractical due to the added battery size and drain, the risk of cross-talk and other interference, and regulations governing radio power and spectrum use in various applications. Moreover, techniques that are applied to the analog transmission — such as compounding or voice scrambling for security — alter the quality of the voice signal itself, coloring the sound and adding artifacts that can make it difficult to understand what's being said.

Digital systems, by contrast, incorporate built-in error-correction techniques that reconstitute the voice at nearly its original fidelity throughout most of the RF coverage area.

Depending on the device design, digital systems can also improve field operations through longer battery life and additional features. For example, TDMA-based systems that provide 6.25 kHz equivalency in a 12.5 kHz channel use only half their transmit time to carry a single half-duplex conversation. Since transmitting RF signals is very power-intensive, this means digital systems place less drain on the battery than their analog counterparts. In fact, conversation-for-conversation, TDMA-based digital radios function about 40 percent longer on a battery charge than analog systems.

DIGITAL VOCODER

What is a digital vocoder?

- A digital vocoder reduces a complex speech signal into a small number of parameters.
- Rather than transmitting the analog speech in its entirety, which requires a relatively large amount of bandwidth, a digital radio transmits only the important parameters. Because these parameters can be represented by small number of digital bits they require less bandwidth.

The vocoding process

- The vocoding process begins by dividing the speech into short segments, typically 20 to 30 milliseconds in length. Each segment of speech is analyzed and the important parameters such as pitch, level, frequency response are extracted. These parameters are then encoded using a small number of digital bits.
- Before transmission, the encoded speech parameters are also protected by the addition of Forward Error Correction (FEC) bits.
- During reception, the FEC is used to correct bit errors that may have occurred due to RF channel impairments. While the FEC cannot correct all errors that may occur, it can completely correct a reasonable number of bit errors, providing minimal audio degradation through much of the coverage area.

Moreover, the two-for-one channel capacity of a TDMA-based system can be used to carry a second conversation, to provide dispatch data in parallel with verbal instructions, to enable enhanced call-control and emergency pre-emption, and for a variety of other existing and future applications. In the same way that digital technology is creating new possibilities for wired and cellular communications, digital two-way radio gives mobile workgroups flexible access to more kinds of information — so they can work faster and more effectively than ever before.

Digital radio offers:

Enhanced voice communications over a greater range. While digital radio signals are subject to the same RF physics as analog, a degraded transmission can still deliver the digital content to its destination intact. Even though signal strength drops off exponentially — just as it does with analog radio — digital error-correction technology can reconstitute the voice with virtually no loss over a far greater area.

Static and noise rejection. Analog signals are often distorted in ways that produce audible static. This can be mildly annoying, or it can become progressively worse until the conversation is almost impossible to understand. By contrast, digital receivers simply reject anything they interpret as an error. Although a "dirty" signal can produce artifacts on a digital receiver — such as a brief dropout or mechanical-sounding burst of noise — they never result in the persistent static that can plague analog systems in difficult environments. If the receiver can understand the digital voice signal, it can decode it and reproduce the voice clearly. Moreover, some digital systems incorporate background noise suppression at the transmitter — so, for example, background crowd or traffic noise is never transmitted, and therefore never heard at the receiver.

Privacy without loss of quality. Digital systems can provide voice and privacy without requiring extra hardware or altering the quality of the transmission on the receiving end. Moreover, analog systems typically send information at the beginning of a call that is used by the receiver to descramble the voice — which means that someone who joins the call late doesn't get the descrambling information and can't understand the call. Digital systems, in contrast, repeat the descrambling information several times per second so that late entries can join a private call in progress. And digital systems allow you to easily separate users into private workgroups — each with its own encryption key — so one group isn't distracted by the operations of another.

Longer battery life. Because TDMA-based digital systems divide power-intensive transmissions into two independent time slots, each individual transmission uses only half the battery power of an analog system transmitting at the same wattage. Since transmitting is the most energy-intensive operation, digital two-way radios can typically function 40 percent longer between recharges compared to analog radios.

Flexibility. Digital radios can be designed to provide additional features in addition to two-way voice. For example, the second time slot in a two-slot TDMA-based system can be used for a second call, dispatch data, enhanced call control, emergency pre-emption, reverse-channel signaling, or other functions. Digital systems can be flexibly configured to meet the specific needs of each mobile enterprise, enhancing productivity and responsiveness in the field.

Need: Integrated, Rapid Data Access

Mobile workers who depend on analog two-way radio are realizing that they can work even more effectively in the field if they also have wireless access to applications and data. For example, construction contractors that have relied on two-way radio for decades are now adding on-site access to work schedules, materials ordering systems, and other tools that can't be accessed effectively through a voice call. It's just as common these days to see a site foreman using a wirelessly connected laptop as a radio.

But as mobile enterprises increasingly adopt wireless data solutions, they face a dilemma: Should they acquire and maintain separate voice and data systems, or adopt a converged system that provides both voice and data in a single unit? And for organizations that already have multiple systems in deployment, how can they preserve their current investment without committing to a continuing investment in incompatible, side-by-side technologies in the years ahead?

A complete system change-out scenario is impractical for most organizations in the short term. But going forward, it's wise to invest in backward-compatible systems that don't require an ongoing commitment to separate acquisition, training, and maintenance costs. If it meets the needs of your business, moving to a converged voice and data platform over time can simplify system administration, and empowers users with systems that are more portable, flexible, and much easier to use than two different and incompatible systems.

Digital radio offers:

Enhanced operational control, capacity and efficiency, while providing the mobile workforce with in-field access to operational intelligence. With only one system to install, train, and support, instant access to voice and data becomes both simpler and more affordable. Integrated command and control applications make dispatch, security, scheduling, and other support functions more responsive.

Leverage the power of two-way for voice and data. To be clear, data services that are integrated into licensed two-way radio systems won't readily enable users to surf the web, send video images, or synchronize their office desktops — it is just not the right technology for such bandwidth-hungry applications. However, it is a great technology for productivity-enhancing applications like messaging, location based services, simple database queries, bar code reading, and fill-in-the-form type of applications. And it is built into your private, licensed communications system — so there are no monthly fees or dependencies on public carrier services, and you control what applications workers can access.

More applications, simplified integration. Compared to methods for utilizing analog radio systems for data, digital radio offers several clear advantages. Digital systems can readily support industry standard protocols, such as IP addressing and IP packet data services. And rather than relying upon external modems, digital radios can connect directly to computer equipment with standard network interfaces such as USB or Ethernet. This simplifies and lowers the cost of integrating with applications, and at the same time expands the universe of potential applications that organizations can deploy.

Flexibility to allocate channels to voice and/or data as needed. With combined digital voice/data systems, there's no need to allocate dedicated systems and channels for voice and data communications. Instead, workers can have one system with the operational flexibility to meet changing needs in the field. And they can work far more efficiently, communicating and accessing all the wireless information they need in just one portable, easy-to-use device.

Need: Ease of Migration From Analog to Digital, While Helping to Preserve Investment

Nobody can afford so-called "disruptive technology" to disrupt their day-to-day operations or their IT budget. Fear of disruption is probably the biggest deterrent to organizations that have used analog radio for years, even when they realize that digital capabilities could greatly enhance their productivity and responsiveness.

Once the benefits of digital systems become impossible to ignore, organizations must choose a viable migration path. One option is to deploy separate digital systems for data, while retaining analog radio for voice communications. While this helps preserve the existing investment in analog radios, the drawback to this approach is that it entails an indefinite commitment to analog, preventing the organization from enjoying the benefits of digital radio for the foreseeable future.

Another option is to plan for an extended period in which analog and digital systems — including two-way radio devices — exist side-by-side, with the goal of phasing out the analog systems over time. This enables the organization to maximize the return on investment (ROI) of legacy systems, control the budget, and ease the IT burden associated with transitioning end users.

Such a migration strategy must be implemented carefully in order to achieve the intended benefits. This means choosing devices that are specifically designed for flexibility — so that digital and analog systems don't just exist side-by-side, but work together to provide the optimum communication method for any situation.

Digital radio offers:

Available devices that provide analog and digital voice side-by-side in the same unit. Organizations can choose devices that offer both analog and digital radio, as well as digital data, in a single, affordable, easy-to-use unit. By adopting these dual-mode devices, rather than separate analog and digital units, each team within the organization can migrate according to an optimum schedule. The old analog units can remain in deployment as long as they're still productive, while key team members can use compatible analog/digital units that provide access to all the benefits of digital.

Immediate enhancement of operations, with benefits that continue to grow over time as more users migrate to digital. With each digital or dual digital/analog device added to the fleet, mobile teams will experience increased operational efficiency. Depending on the systems used, these benefits could include increased capacity, enhanced digital audio performance, enhanced signaling and call control, emergency preemption, enhanced remote monitoring, extended battery life, and virtually any or all of the other benefits we've discussed to this point.

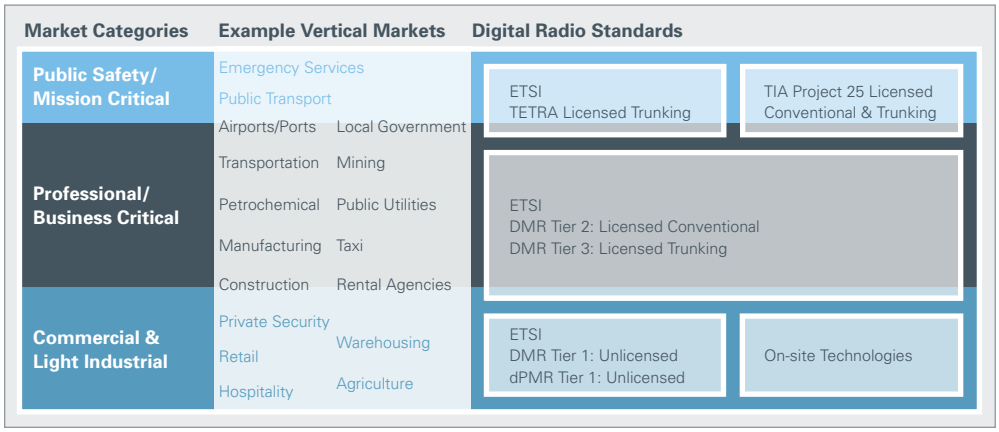
A flexible, future-facing architecture. Digital two-way radio and data systems provide a migration path for organizations to enhance and extend their digital networks into the field. By acquiring new communications platforms that work with new and emerging mobile applications, today's mobile workforce has the foundation to add new, advanced capabilities in the years to come.

Need: Appropriate Standards and Technology For Professional Users

With the emergence of digital two-way radio technologies, professional users can expect to be offered an increasing variety of systems, both proprietary and standards-based. Professional organizations selecting systems based on widely accepted standards will benefit from reliable operation, as well as to ensure compatibility and interoperability among competitively priced products from multiple manufacturers.

Multiple standards and technologies exist to meet the varying needs of the radio communications marketplace, from consumer and light industrial applications to professional business-critical applications and to first-responders engaged in mission-critical public safety applications. The most relevant standard for professional, business critical applications of digital mobile radio is the European Telecommunications Standards Institute Tier-2 standard for licensed, conventional, unit-to-unit and repeater-based radio operations. Developed by ETSI, this globally recognized standard provides spectral efficiency, advanced features, and integrated packet data services in licensed bands for professional users.

Digital Radio Standards and Markets



The ETSI Tier-2 standard for digital mobile radio addresses the needs of the great majority of professional users around the world.

One of the most important components of the Tier-2 standard is the use of two-slot TDMA technology, which enables professional users to double the efficiency of their licensed 12.5 kHz repeater channels. For example, two-slot TDMA allows two digital conversations to take place simultaneously within a single channel, with no need to deploy extra infrastructure such as additional repeaters. The second slot can also be used to deliver advanced features — such as IP-based dispatch data or enhanced call-control and priority signaling — in parallel with a call on the other slot. By choosing products that adhere to the ETSI Tier-2 standard, including two-slot TDMA, professional users can essentially double their ROI while gaining support for new capabilities that allow them to work more effectively.

In addition, professional users should look for systems that support IP data services, dual analog/digital modes, modular and software upgradeable components, and other technologies that meet their existing needs while offering an adaptable platform for future capabilities. Choices made today can make a huge difference in what will be possible tomorrow, as organizations look to provide in-field access to back-end systems, collaborate across teams and organizations, and integrate new technologies in the future.

The clear advantages of digital two-way radio will quickly drive its widespread acceptance in new deployments. Organizations that remain committed to analog-only devices may find themselves limited when they need additional capacity, next-generation functionality, access to new back-end systems, or the ability to share data to work effectively with other agencies in the field.

Digital radio offers:

Choices for standards-based interoperability. Digital radio and mobile data solutions come in several flavors — from competing proprietary solutions to standards-based solutions. By choosing products based on widely accepted standards, organizations have a platform for building interoperability into their systems. Over time, standards-based products will facilitate increasing levels of integration with multiple back-end systems, as well as with the systems used by cooperating agencies and enterprises.

Doubling of spectral efficiency, with additional capacity for voice and data. Two-slot TDMA-based systems, in compliance with ETSI Tier-2 standards, provide the equivalent of two 6.25 kHz channels within a single 12.5 kHz channel. The extra capacity essentially doubles return on investment by enabling two calls, or one call plus one data stream, to coexist simultaneously in a licensed channel that can today only carry one analog conversation at a time. TDMA-based digital systems also effectively double the capacity of infrastructure such as repeaters and antennas.

A platform to take advantage of network convergence. By choosing digital radio systems that support integrated IP data capabilities, enterprises can take advantage of the ongoing convergence of communications and IP networks. Packet-based data can be used immediately for text messaging, location based services, and other productivity-enhancing applications, and can provide a platform for additional functionality as engineers provide increasing integration and access to more IP-based applications and services.

Adaptability. Although not all digital devices are designed to be adaptable, there is a growing selection of modular platforms that offer rich expansion options and are built for adaptability to a wide range of applications. By choosing wisely, organizations can have a platform appropriately configured for today's exact needs, with the ability to adapt as those needs change in the future.

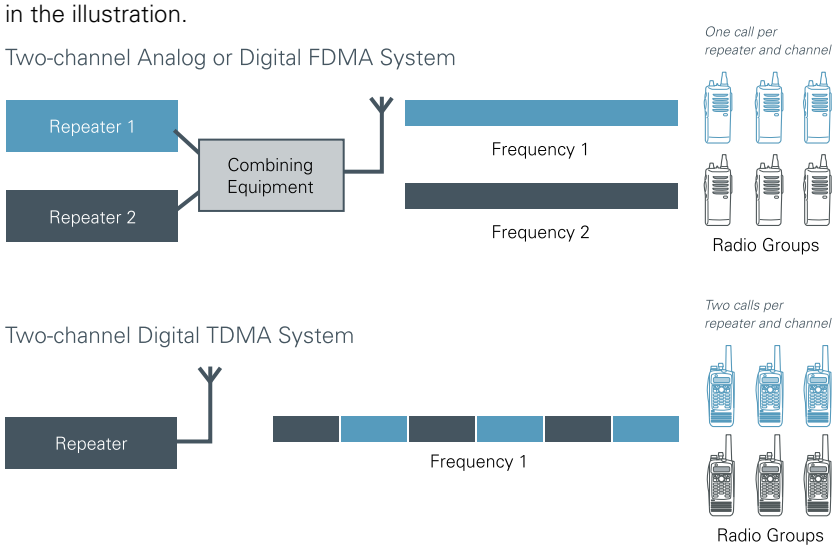
A future-facing platform. By choosing a digital radio and data platform built on a standards-based, flexible, modular architecture, enterprises can take advantage of continuous innovation with backward- and forward-compatibility. Going forward, they can add value to their digital radio solutions by expanding and integrating new technologies to address new requirements. And they can plan for orderly growth — from basic two-way radio, to added infrastructure that provides expanded coverage and capacity, to fully integrated data and voice systems based on IP networks.

12.5 kHz TDMA or 6.25 kHz FDMA?

In the ongoing quest for greater spectral efficiency, there are two candidate technologies for increasing the capacity of existing 12.5 kHz channels: two-slot 12.5 kHz Time-Division Multiple Access (12.5 kHz TDMA) or 6.25 kHz Frequency-Division Multiple Access (6.25 kHz FDMA). The two technologies are incompatible, so you need to choose one or the other.

FDMA is based on technology originally developed for analog voice, and is widely used in today's 25 kHz and 12.5 kHz channels in analog systems. 12.5 kHz FDMA is also used in Telecommunications Industry Association (TIA) Project 25 Phase I digital radio systems. However, these well-known techniques carry just one voice path per 12.5 kHz channel, and it is difficult to further increase the effective capacity of an existing 12.5 kHz channel using FDMA methods: while it is feasible to develop 6.25 kHz FDMA digital radio protocols, how well this technique will perform hasn't yet been established in real-world implementations on a large scale. Further, there is little or no regulation in place or detailed plans for migrating to 6.25 kHz channel structures in most of the world — how to efficiently utilize a 6.25 kHz signal in a world that's channelized for 12.5 kHz remains a dilemma.

12.5 kHz TDMA, on the other hand, is a globally recognized, approved standard for the professional two-way radio market. Moreover, TDMA can be configured to provide 6.25 kHz equivalent efficiency in an existing 12.5 kHz channel, with no changes to licensing requirements. This means that TDMA can give you two-for-one channel capacity — in other words, the equivalent of two simultaneous channels in repeater mode, as shown in the illustration.



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

This technique reduces overall equipment costs while supporting more users and more information. TDMA's performance and flexibility make it the only serious choice for professional two-way digital radio. 12.5 kHz TDMA methods for achieving 6.25 kHz efficiency in the 12.5 kHz channels offer:

- Twice the transmission capabilities, with decreased spectral congestion. In contrast, a 6.25 kHz FDMA approach doubles the number of RF carriers and in the process increases the likelihood of interference with existing systems.
- Increased performance, reliability, and functionality — while improving battery life by up to 40 percent compared to analog radio.
- Two virtual channels that can be adapted on the fly to meet a wide range of needs, including increased capacity for voice calls and wireless data access, or for advanced control signaling during a call.
- Standards-based platform, as 12.5 kHz TDMA is the recognized standard for professional and commercial two-way radio market both in Europe and the United States.

The bottom line is that TDMA supports more simultaneous users, communicating more information with greater flexibility on existing channels. With TDMA, one repeater can do the work of two — lowering costs, providing enhanced operating characteristics, and giving organizations the capacity and flexibility to tailor voice and data solutions to their specific requirements.

Motorola's Next Generation of Two-Way Radios for the Professional Tier

Motorola invented the first portable two-way radio, and has more than 65 years of experience delivering wireless communications systems for government and industry. Motorola has emerged as the recognized leader in digital two-way radio technology, with proven solutions in the mission critical, professional, and unlicensed tiers.

Now Motorola is enabling innovative solutions for licensed professional tier. MOTOTRBO™ Professional Digital Two-way Radio System is a digital communications platform that combines the best of two-way radio with digital technology based on TDMA to deliver increased capacity and spectral efficiency, integrated data applications and enhanced voice communications. MOTOTRBO is specifically designed to meet the requirements of professional organizations that need a customizable business critical communication solution using licensed spectrum.

MOTOTRBO is a private system that can be tailored to meet the unique coverage and feature needs of group-oriented and dispatch environments. And, MOTOTRBO provides a rapid return on investment requiring only a small up-front investment with no recurring fees, and will typically pay for itself in less than 18 months compared with cellular or public carrier solutions.

For more information on the MOTOTRBO Professional Digital Two-Way Radio System visit www.motorola.com/mototrbo.

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