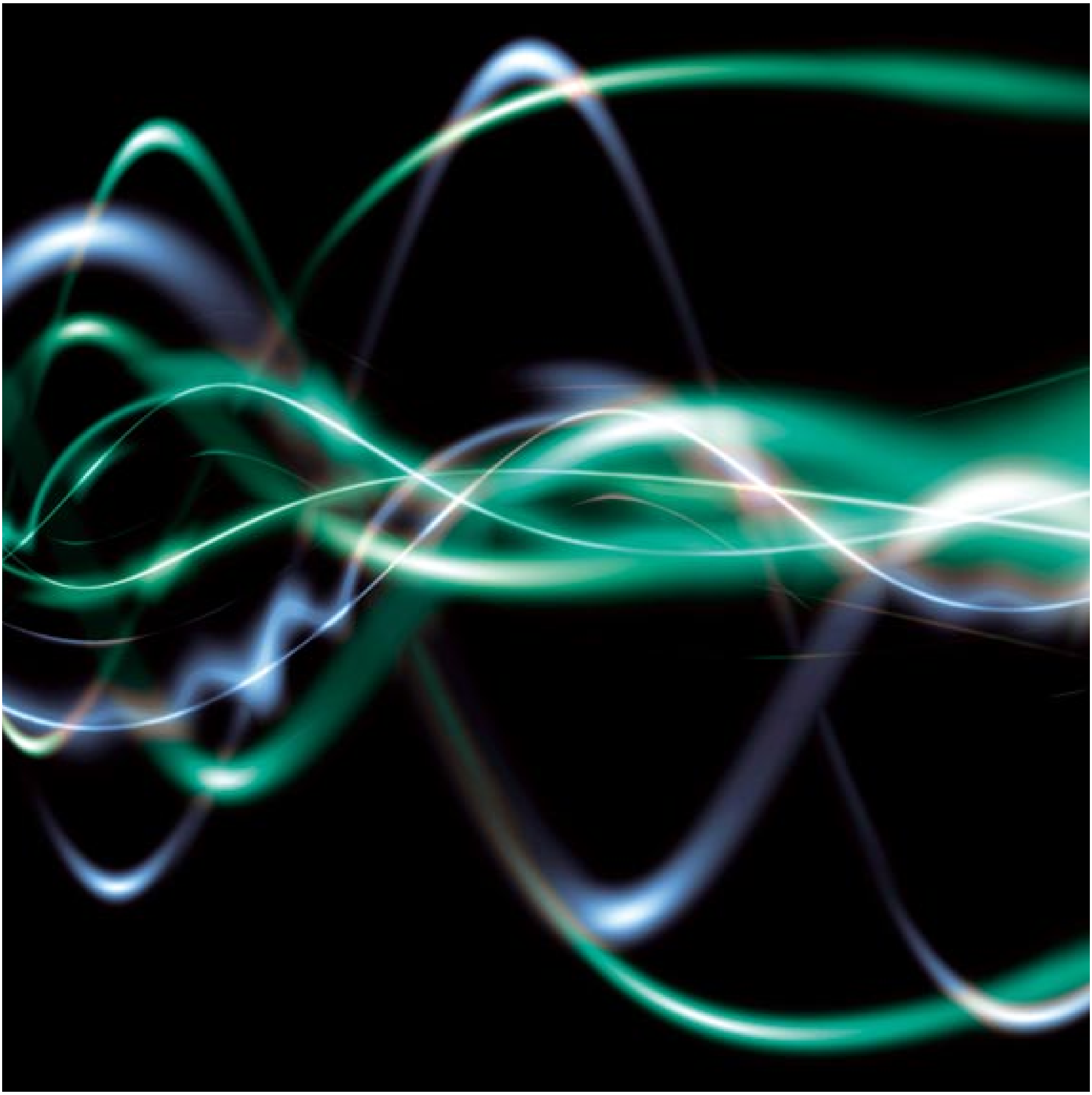
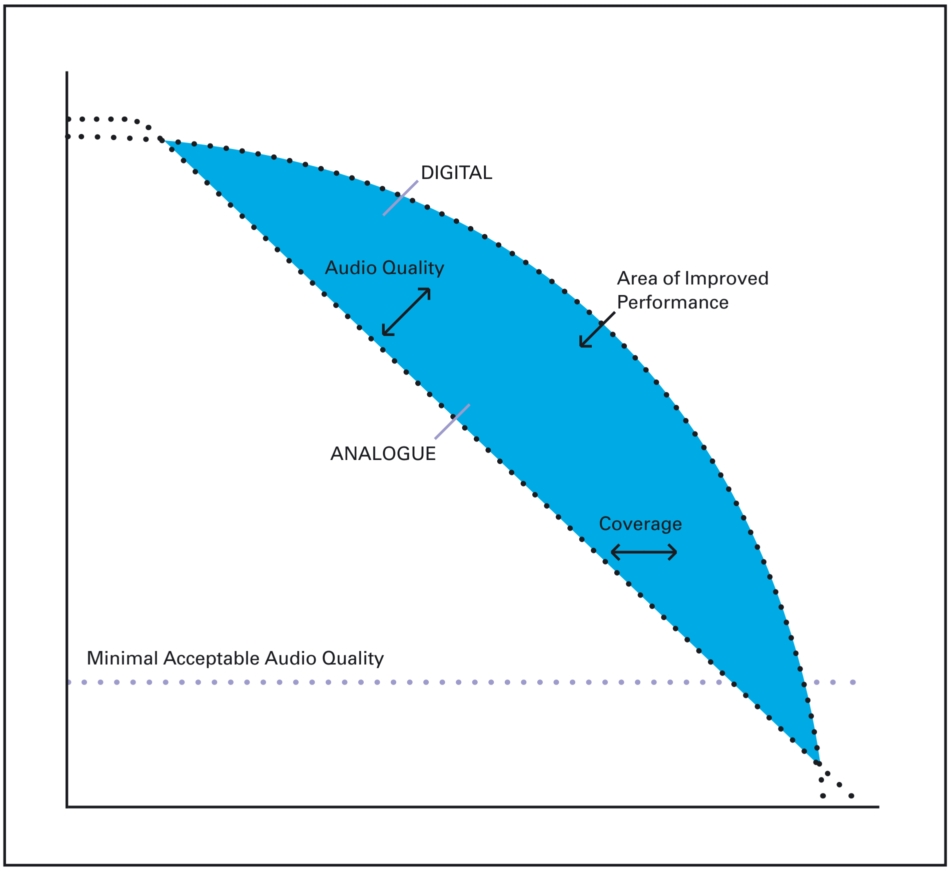
WHITE PAPER

ETSI DMR Standard

For Professional Two-Way Radio Communications

MOTOROLA





Advanced Features and Flexibility

In a traditional FDMA two-way radio implementation, each transmission occupies the entire channel. A single channel can accommodate a single, half-duplex call. Since DMR employs a TDMA protocol, then it isn't bound by these technical restrictions. The two time slots could be used to carry two half-duplex conversations, but with no need for extra equipment and no danger of reduced performance. Alternatively, it's also possible to use the second TDMA time slot for other purposes such as "reverse-channel signalling". This feature can be used for priority call control, remote-control of the transmitting radio, emergency call pre-emption, and more. The second time-slot could also be used for transmitting application data such as text messaging or location data in parallel with call activity — a useful capability, for example, in dispatch systems that provide both verbal and visual dispatch instructions.

DMR also offers the flexibility to adapt as new applications emerge to make additional use of the two time slots — preserving initial investments while providing an open path to future usage models for digital two-way radio. For example, DMR includes the ability to temporarily combine slots for increased data rates or to use both slots together to enable full-duplex private calls. Additional capabilities will also emerge, as driven by the real-world needs of two-way radio users in the professional marketplace. With DMR products, professionals can immediately gain benefits such as 2:1 voice capacity and reverse-channel signalling within a single channel, with the option to add other capabilities as they become available.

Reduced Equipment Costs

DMR achieves two-channel equivalency using single-channel equipment, thereby halving the number of repeaters and the amount of combining equipment required. Also, since fewer combining losses are incurred, then this improves the overall system coverage.

DMR – A New Beginning for Professional Mobile Radio

The ETSI DMR standard delivers compelling benefits for professional users; increased spectral efficiency and reduced equipment requirements mean significant cost savings, while enhanced audio coverage, longer battery life and advanced "reverse channel" features enable the mobile workforce to operate more effectively and efficiently.

Since the publication of the ETSI DMR standard in 2005, radio manufacturers have switched focus to bringing DMR-based products to market. For example Motorola, the market leader in professional two-way radio is currently launching the MOTOTRBOTM portfolio – for further information visit www.motorola.com/mototrbo

DMR represents a very exciting stage in the evolution of Professional Mobile Radio, strengthening two-way radio's position as number one communication choice for mobile professionals working in demanding environments.

Introduction

Professional two-way radio is making the biggest leap forward since the invention of the transistor — the move from analogue to digital. Digital radio offers many advantages over analogue, including improved voice quality at greater range, better privacy, sophisticated call-control features, the ability to easily integrate with data systems, and more.

We're now at the beginning of what will quickly become a large-scale migration to digital radio in professional applications. At the same time, regulatory pressures combined with real-world operating needs are driving radio manufacturers and users to communicate more information in a given slice of RF spectrum — in other words, to increase "spectral efficiency." Channels that historically carried a single call at a time are now being divided so they can carry two simultaneously.

To meet the challenges of large scale migration of professional users to "digital", ETSI have developed a new digital standard called DMR (Digital Mobile Radio) which is based on a two-slot TDMA protocol. Successful telecommunication standards based on TDMA technology are already widely used around the world (e.g. GSM and TETRA), and future requirements for even greater spectral efficiency are almost certain to be based on TDMA. Today and tomorrow, TDMA technology provides advantages of feature flexibility, lower equipment costs, longer battery life, future-readiness and the proven ability to increase spectral efficiency without risking increased congestion or radio channel interference.

Digital two-way radio - A Modern Solution for Modern Needs

Analogue radio is an essential business tool and proves itself every day in countless deployments around the world. However, analogue two-way radio has reached the limit of innovation. Virtually everything that can be imagined using analogue radio has been already been attempted or achieved over more than a half-century of experimentation and implementation. We have reached the point where 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 analogue 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 analogue to digital two-way radio communications, these organisations can fill many of these needs immediately and build a strong technical foundation for adding new functionality to meet new needs in the future.

Digital Radio Standards and Markets

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 organisations selecting systems based on widely accepted standards will benefit from reliable operation, as well as compatibility and interoperability among competitively priced products from multiple manufacturers.

Although the market landscape for two-way radio varies somewhat throughout the world, markets can be roughly divided into three broad categories: (1) Consumer (and short-range industrial), (2) Professional / Business-Critical applications and (3) Public Safety / Mission-Critical applications. With some overlap, there are relevant European Telecommunications Standards Institute (ETSI) digital two-way radio standards that address the needs of each of these broad market segments.

Market Categories	Example Vertical Markets		Digital Radio Standards
Public Safety / Mission Critical	Emergency Services	PAMR	ETSI: TETRA (Truncking)
	Public Services		
	Airports/Ports	Local Government	
Professional / Business Critical	Transportation	Mining	ETSI: DMR (Conventional & Truncking)
	Petrochemical	Public Utilities	
	Manufacturing	Taxi	
	Construction	Rental Agencies	
	Private Security		
	Warehousing	Agriculture	
Consumer / Short Range Industrial	Retail	Hospitality	ETSI: dPMR Tier 1 (Unlicensed)

Public Safety/Mission Critical

This market category is defined by mission-critical communications, security, and interoperability needs. ETSI have defined a single digital trunking standard which is targeted at these users; Terrestrial Trunked Radio (TETRA) which utilises four-slot TDMA in 25 kHz channels to increase spectral efficiency and allow multiple access. This protocol supports multiple talk groups on multiple frequencies, including one-to-one, one-to-many and many-to-many calls.

Professional/Business Critical

In between the Public Safety / Mission Critical and Consumer market categories lies a huge market for organisations who don’t have the budget or need for expensive, fault-tolerant infrastructure — but who can still benefit from increased capacity in licensed channels, advanced features, wide area coverage and other benefits usually associated with mission-critical systems. Businesses in this category include transportation, education, construction, manufacturing, private security and small municipalities. ETSI have defined a narrow-band digital radio protocol which is targeted at these users; “DMR” which utilises two-slot TDMA in 12.5 kHz channels. This protocol provides spectral efficiency, advanced voice features and integrated IP data services in licensed bands for high-power communications.

Consumer/Short-Range Industrial

A new harmonised 446.1 – 446.2 MHz licence-exempt band is being opened up by several European countries over the next few years and ETSI have defined a narrow-band digital radio protocol for this band; “dPMR” which utilises 6.25 kHz FDMA. This protocol provides for consumer and low-power commercial applications using a maximum of 500mW e.r.p (effective radiated power). With a limited number of channels and no use of repeaters, no use of telephone interconnects, and fixed/integrated antennas, dPMR devices are best suited for personal use, recreation, small retail and other settings that don’t require wide area coverage or advanced features.

The DMR Standard

The DMR standard (ETSI TS 102 361) is targeted primarily at existing analogue professional users operating in the licensed PMR bands. There are many reasons why DMR is the right choice for these users, some of which are listed below.

Increased Spectral Efficiency

For many two-way users, the most important benefit of digital radio is to make more efficient use of the existing licensed 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. DMR utilises the proven TDMA method of improving the spectral efficiency of a 12.5 kHz channel by dividing the channel into two equal time slots. This preserves the well-known RF performance characteristics of the 12.5 kHz signal while at the same time allowing many more people to communicate over an organisation's existing licensed channels in a flexible manner according to that organisation's needs. For example, two slots within one channel could be used to carry two separate and private conversations, alternatively one slot could be used for data or priority signalling in conjunction with a conversation on the other slot.

Spectrum Availability

DMR fits seamlessly into the existing licensed PMR bands. There is no need for re-banding or re-licensing, and no risk of new forms of radio channel interference, thereby making it quick and easy to gain spectral efficiency.

Longer Battery Life

One of the biggest challenges with mobile devices has always been battery life. In the past, there have only been a couple of options for increasing the talk time on a single battery charge. One way is to increase battery capacity. Battery manufacturers have already done a remarkable job of maximising capacity, but further gains are only possible by increasing the size of the battery pack — and therefore decreasing portability. The other option is to decrease transmit power, which is by far the most energy-intensive function of two-way radio. But this means decreasing transmission range and increasing the potential for interference from other devices — an unacceptable trade-off in professional situations.

DMR provides another, very effective option. Since each call uses only one of the two TDMA slots, it requires only half of the transmitter's capacity. The transmitter is idle half the time — that is, whenever it's the unused time-slot's "turn." For example, in a typical duty cycle of 5 percent transmit, 5 percent receive, and 90 percent idle, the transmit time accounts for roughly 80 percent of the total current drain on the radio's battery. By cutting the effective transmit time in half, two-slot TDMA can thus enable up to 40 percent reduction in current battery drain, or up to 40 percent improvement in talk time. As a result, overall battery consumption per call is dramatically reduced, enabling much longer usage time in the field between recharges. DMR also enables sleep and power-management technologies that increase battery life even further.

Enhanced Digital Audio and Coverage

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, analogue radio can suffer from several limitations that affect the range and clarity of voice. In an analogue 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 artefacts that makes the signal increasingly unintelligible as the user approaches the margins of the radio's effective range. This can be mildly annoying, or it can become progressively worse until the conversation is almost impossible to understand.

By contrast, DMR incorporates error-correction techniques that reconstitute the voice at nearly its original fidelity throughout most of the RF coverage area. While the DMR digital radio signal is subject to the same RF physics as analogue, a degraded transmission can still deliver the digital content to its destination intact even though signal strength drops off exponentially.

DMR digital receivers simply reject anything they interpret as an error. Although a "dirty" signal can produce artefacts 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 analogue systems in difficult environments. If the DMR receiver can understand the digital voice signal, it can decode it and reproduce the voice clearly. Moreover, the common DMR decoder (chosen by the DMR MoU) also incorporates background noise suppression at the transmitter, so, for example, background crowd or traffic noise is never transmitted, and therefore never heard at the receiver.

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