DMR Two-Way Radios

The Benefits of DMR Two-Way Radio Technology, and Migrating from Analog to Digital

WHITE PAPER

Hytera

Introduction

This white paper will cover:

- An overview of the DMR Standard and why it is important
- The features and benefits DMR provides over analog radios
- How DMR Radios provide reliable uptime for mission critical continuity
- How DMR radios enable a simple and cost-effective analog to digital migration path
- The key advantages and differentiators of Hytera DMR radios

Digital Mobile Radio (DMR) is a digital radio standard used in professional mobile radio applications. DMR offers numerous advantages over analog radio systems, such as improved voice clarity, better range, longer battery life, and increased calling capacity.

Digital Mobile Radio (DMR) is the open radio industry standard developed by the European Telecommunications Standards Institute (ETSI) and promoted worldwide by the DMR Association. Hytera was instrumental in the development of the DMR standard, and was the first company to deploy a fully compliant DMR Tier III radio system.

The Importance of DMR Standard Compliance

DMR standards compliance ensures that all radios and base stations operate on a common standard and enables the creation of a robust and reliable communication system that is more effective than a system based on proprietary technologies.

Manufacturer Interoperability – DMR standards compliance ensures that radios and repeaters from different manufacturers can interoperate seamlessly. A user can purchase a radio from one manufacturer and a repeaters from another manufacturer and still have them communicate with each other. This interoperability increases flexibility in equipment choices and reduces costs for users.

Improved Performance – Compliance with DMR standards ensures that all equipment meets certain technical specifications, which improves the performance of the entire radio communication system. This results in better voice quality, improved coverage, and reduced interference.

Future-Proofing – Compliance with DMR standards ensures that equipment is compatible with future upgrades and improvements to the technology. This future proofing allows users to invest in equipment with confidence that it will remain compatible and functional for years to come.

The Benefits of DMR Radio Technology

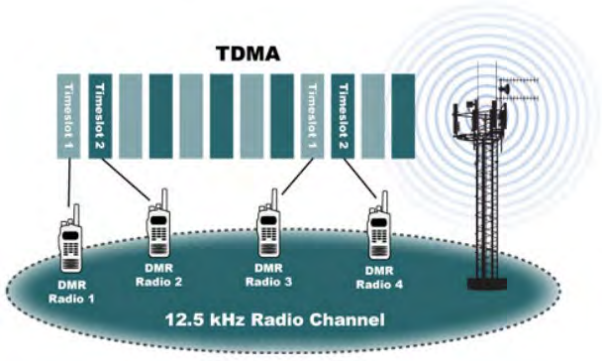
DMR digital capabilities improve radio communications and provide several advantages over legacy analog radio systems:

- Instant push-to-talk individual and group calling with radio identification
- Doubles the capacity of existing licensed radio channels
- Provides efficient use of infrastructure equipment
- Enables power efficiency for longer battery life
- Superior audio performance over longer distances
- Supports data transmission for digital applications

TDMA and 12.5 MHz Channel Spacing

Time Division Multiple Access (TDMA) and 12.5 MHz channel spacing are two key technologies that are utilized in DMR two-way radios. These technologies provide a range of benefits that improve the performance and reliability of DMR radios. This is a key benefit over analog radios that have one frequency shared by all users.

TDMA allows multiple users to share the same radio frequency by dividing it into time slots. Each radio is assigned a specific time slot in which it can transmit and receive data, and the radio switches between these time slots rapidly, giving the impression of simultaneous communication. This technology is highly efficient as it allows multiple users to use the same radio frequency without causing interference or congestion.



Two Timeslot TDMA structure of DMR Radios

Under the DMR standard, TDMA retains the 12.5 kHz channel width and divides it into two alternating timeslots A and B (illustrated in the Diagram above) where each timeslot acts as a separate communication path. Radios 1 and 3 are talking on timeslot 1, and Radios 2 and 4 are talking on timeslot 2.

TDMA technology and 12.5kHz channel spacing provides several benefits:

Double the Call Capacity – TDMA technology doubles the number of users that can access a radio frequency. In contrast to analog systems, which can only allow one user at a time to communicate on a channel, TDMA technology can support two users per channel. This capability results in a more efficient use of radio spectrum, which is a finite resource.

Superior Voice Quality – Unlike analog systems that are susceptible to interference and background noise, TDMA provides clear and crisp audio quality, even in noisy environments.

Longer Battery Life – TDMA transmits information in short bursts, which conserves the radio's battery power, resulting in longer battery life. For example, in a typical duty cycle of 5 percent transmit, 5 percent receive, and 90 percent idle, the transmit time accounts for a high proportion of the drain on the radio's battery. By cutting the effective transmit time in half, two-slot TDMA can enable up to 40 percent improvement in talk time in comparison with analog radios. This feature is particularly useful in environments where a radio user may be away from a power source for an extended period, such as in remote areas or during extended shifts.

Longer Range and Coverage – TDMA 12.5 MHz channel spacing allows for better frequency reuse, which increases the coverage area of the radio system. This capability is particularly useful in large-scale operations, such as transportation, and education.

TDMA technology and 12.5 MHz channel spacing are two important technologies utilized in DMR two-way radios. These technologies provide a range of benefits that improve the performance, reliability, and efficiency of DMR radios, and has resulted in the widespread adoption of DMR radios.

DMR Audio Quality

Digital two-way radios provide excellent audio quality, which is essential for clear and effective communication. Unlike analog radios, digital radios support advanced noise-canceling features that provide clear and crisp sound that makes it easier to communicate even in noisy environments.

DMR digital technology reduces noise and preserves voice quality over a greater range than analog radios, especially at the farthest edges of the transmission range. One of the reasons that DMR has an excellent range performance is the Forward Error Correction (FEC) and Cyclic Redundancy Check (CRC) coders specified in the DMR standard. These coders enable receiving radios to detect and correct transmission errors by analyzing bits inserted into messages that allow the receiving radio to tell if there is an error.

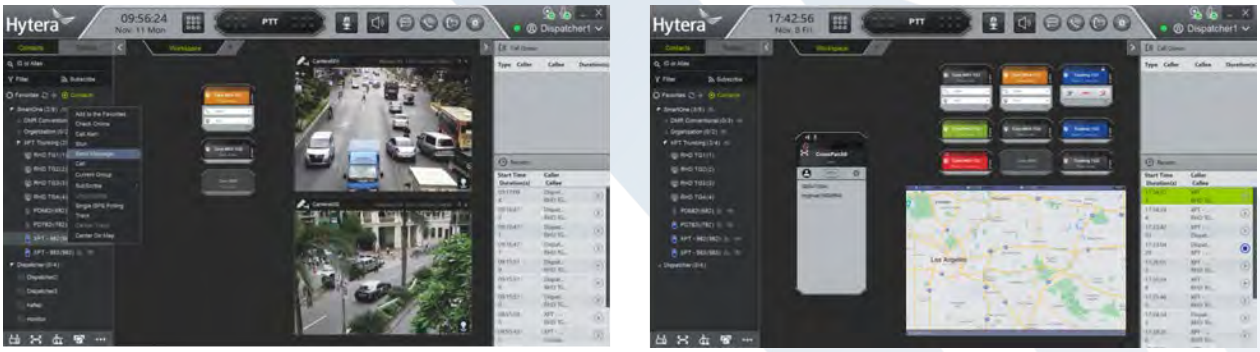
Range and Audio Quality Improvement with DMR Compared to Analog

Using coders and other techniques, digital processing can screen out noise and reconstruct signals from degraded transmissions. The result is an increase in the radio system's effective range where users can hear everything being said more clearly over longer distances.

Transmission of Digital Data

The end-to-end digital nature of DMR enables applications such as text messaging, GPS, and telemetry to be easily added onto radio devices and systems. As the DMR standard also supports the transmission of IP data over the air, this enables the easy development of standard applications. In a world which increasingly relies on data as well as voice communication, this ability to add a wide range of data applications to your system results in the

greatest possible return on your investment. In fact, one of the key drivers for users switching to digital is to add business enhancing data services and applications to radio systems. The doubling of channel capacity that DMR implementations achieve is also key to adding data applications.



Examples of the Hytera SmartOne DMR Dispatch Applications utilizing GPS, video, images, and text messages

Flexible Calling and Interconnect Options

The DMR standard defines a variety of call types that give users the communication flexibility to define specific types of radio calls that fit the circumstances of each specific application.

- Individual (or Private) one-to-one calls
- Group Calls from an individual to a group, or from one group to another
- All Call (Broadcast call) to everyone regardless of what Group they are in
- Conference calls that enable anyone in two groups talking together on a group call, and typically requires a dispatching application
- Emergency Calls (Including Lone Worker and Man-down Calls)
- Calls requiring GPS information

DMR also supports telephone and gateway calls. PSTN and PABX telephone systems can be connected to DMR radios using DMR repeaters. Gateway calls support connectivity with Push-to-Talk over Cellular (PoC) and analog radio systems. Radio over IP (RoIP) Gateways are inexpensive devices that connect LTE PoC radios, analog radios, and even non-DMR-compliant third-party radios to DMR radio systems.

Caller Identification

An important part of radio communications is knowing who is making a call. Whether it is an individual, a group or a dispatcher, DMR radios can display the Caller ID using the Talking Party Identification service in the DMR standard to display the identity of the radio terminal or dispatcher transmitting in an individual or group call in all other radio terminals receiving the call.

Organizing Communications with Channels, Groups, and Zones

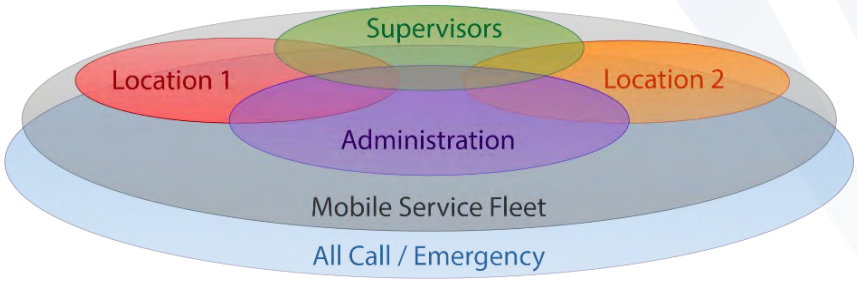
DMR radio systems utilize radio frequencies, channels, groups, and zones to organize clear and effective communication between individuals or groups within a specific range. Understanding the differences between these terms is critical to use two-way radios effectively.

Radio frequencies refer to the range of electromagnetic waves used to transmit and receive signals in two-way radios. These waves are measured in Megahertz (MHz), and two-way radios typically operate in the range of 136-174 MHz VHF and 400-527MHz UHF. It's important to note that radio frequencies are limited, and in the United States, the Federal Communications Commission (FCC) regulates the allocation and use of radio frequencies.

Channels are the two different voice paths on each radio frequency. Two-way radios can use multiple channels to communicate with different individuals or groups. Each channel has a unique frequency, allowing for communication to occur without interference. The number of channels a two-way radio has varies depending on the make and model. Professional DMR radios support up to 1,024 channels (512 digital and 512 analog)

Groups (also known as Talk Groups) refer to specific individuals or teams within a two-way radio communication network. Two-way radios provide instant group calls to multiple users with the press of a Push to Talk (PTT) button on a radio or from a dispatching application. Groups can be made up of individuals with different roles or tasks in the same organization. Using groups on a two-way radio can help minimize distractions by ensuring that only the relevant parties are involved in the conversation.

Call groups can be set up based on All Call and Emergency calls, types of employees (supervisors, administrators, etc.), remote employees and mobile service fleets, employee locations, type of projects, etc. Radio users can belong to multiple groups as shown in the overlapping areas.



Zones are a way of organizing channels and groups within a two-way radio. They enable combining channels and groups together based on geographic location or task. For example, a construction site may have different zones for different areas of the site or different tasks, such as excavation, framing, or finishing. This organization helps to streamline communication and ensures that individuals or groups are only listening to relevant information.

Support for Advanced Features

DMR radios support a variety of advanced features that provide professional users with the functions that enable location tracking, radio configuration options, secure encryption, and text messaging.

DMR radios with GPS can report current location information to other radios, the dispatcher, or third-party applications in real time, enhancing the efficiency of visualized dispatch applications. GPS data can be transmitted during voice calls for immediate location targeting, and GPS data can be compressed to increase channel capacity and reduce hardware cost.

DMR radios with display screens and keypads provide clear display of calling information and device status, and enable configuration of device settings. For example, the multiple user profiles feature can be configured to set different tones, volumes, and vibration settings to match the environment, such as in a noisy outdoor environment or in a conference room meeting.

DMR radios also feature encryption for secure and private communications. Advanced 256 bit encryption is supported through the radio hardware and software with the secure and reliable ARC4 and AES encryption algorithms. Radio authentication is a feature that prevents unauthorized users from listening to calls or accessing the system.

Worker Safety Features

DMR two-way radios support several features designed for worker safety. If employees work alone, in remote areas, or in a potentially dangerous environment, these safety features can be critical in preventing injury or death.

DMR radios feature emergency buttons for generating emergency alarms or calls. The emergency button on a radio is usually a raised orange button at the top of the radio so it is easily visible and found by touch. Once the emergency button is pressed, an alarm is sent over the radio system along with the user ID of the sender, and that alarm can be a voice or text message, or a tone alarm.

Other DMR radio safety features include:

The Man Down option automatically triggers an emergency alarm if a radio is laying down flat or at a certain angle for a pre-defined period of time. This may happen if the user has fallen or is unconscious or injured.

The Lone Worker option has a timer in the radio which measures inactivity. When the pre-programmed time period is reached, a warning is issued, and if there is no response from the user, the alarm is triggered. This is designed to function as a check-in system to ensure safety for workers alone in remote areas. Radios that feature integrated GPS can send a signal that can help locate the person who has issued the alarm or who is in a man-down situation.

Priority Interrupt allows a dispatcher to clear a channel in an emergency by interrupting existing calls on a channel with important emergency information. The emergency call button can also be programmed for Priority Interrupt to clear the channel and ensure the emergency call gets across.

Remote Monitor allows dispatcher to remotely initiate the PTT button on a radio and listen in an emergency. This is useful if someone sends an emergency alarm, but the dispatcher cannot get a reply. Using Remote Monitor, the dispatcher can listen to the radio's microphone and possibly determine details about the situation.

Stun and Revive prevents access to secure radio communications, malicious use, and unauthorized use of lost or stolen radios by centrally deactivating (stun) and reactivating (revive) radios by dispatch if required.

Scalable Growth with Repeaters and Trunking Systems

One of the key advantages of DMR radio systems is the ability to scale up repeater systems as the number of users and call capacity increases. There are several DMR radio systems available, including DMR Tier II, IP Connect, Pseudo Trunking, and DMR Tier III.

DMR Tier II (Licensed Conventional) – For smaller groups of radio users, a simple radio-to-radio system can be deployed. For medium and large size groups (typically 50 to 100 radio users) that have higher call traffic, a cost-effective DMR Tier II base station will be deployed for repeating signals and extending coverage area. DMR Tier II systems are often deployed to replace legacy analog radio systems.

A base station is an essential component of a professional DMR Tier II radio system. It is responsible for receiving and transmitting radio signals over a wide area. The base station consists of several components, including a DMR repeater, antenna systems, and supporting equipment which includes power supplies, backup batteries, controllers, and monitoring systems.

IP Connect – This is a digital interconnect that uses Internet Protocol (IP) to link multiple DMR Tier II sites together, creating a wide-area network. The IP link can be achieved with an internet connection, a private LAN network, VPN, or with microwave links. IP Connect is best suited for larger organizations that require wide-area coverage and multi-site connectivity, and is typically deployed by organizations that have several remote locations with radio systems and they need communications between these sites. For example, a university may have satellite campuses and the security and maintenance teams require communication between all locations.

Pseudo Trunking (Hytera XPT) – Developed exclusively by Hytera, the Extended Pseudo Trunking (XPT) system is based on the DMR Tier II Conventional Standard and adds capabilities normally found in higher cost Tier III trunking systems.

XPT makes DMR Tier II repeater systems more efficient to provide more channel capacity and adds valuable new features without the purchase of additional radio infrastructure hardware. Migrating from conventional DMR Tier II to XPT trunking is easy, especially if you are currently using Hytera DMR repeaters. XPT is as simple as adding the license to the repeaters, reprogramming the repeater, and adding a network switch for them to communicate. A

key advantage of an XPT Trunking system is that it enables efficiencies and dynamic channel allocation with less hardware and without a Control Channel Frequency.

DMR Tier III (Licensed Trunked) – DMR Tier III is an IP-based Digital Trunking System that uses a centralized server and a special dedicated Control Channel Frequency license to manage radio communications. DMR Tier III is part of the DMR standard and any fully compliant DMR radio can be used on Tier III systems. This system is best suited for large organizations that require high-capacity and high-reliability communications.

DMR Tier III trunking systems consist of a central controller called a Mobile Switching Office (MSO), a Base Station Controller Unit (BSCU) at each radio site, multiple repeaters to carry the traffic, and a wide area network that connects all the different pieces together. IP connectivity is provided by a variety of third-party internet, LAN, or VPN network operators. DMR Tier III systems also provide enhanced security, additional calling and radio access features, and mission critical redundancy.

DMR Tier II conventional systems use repeaters, IP-Connect and Pseudo Trunk systems use multiple repeaters and network equipment, and DMR Tier III systems use repeaters, an MSO, and a BSCU.

DMR Tier II

IP Connect or XPT

DMR Tier III

Mission Critical Reliability and Continuity

Another advantage of DMR radio systems is the guaranteed uptime and mission critical reliability. When lives are on the line and effective communication can make all the difference, having a robust and dependable system is crucial. Unlike broadband cellular systems, DMR radio systems have proven to be the "last man standing" during a natural disaster, ensuring seamless communication in critical situations.

One of the key aspects that set DMR radio systems apart from cellular broadband systems is their built-in redundancy. DMR networks often employ a combination of repeaters, base stations, and redundant infrastructure to establish a comprehensive communication ecosystem. This redundancy ensures that even in the face of equipment failure or network congestion, communication channels remain operational. In contrast, cellular

broadband networks, while widely available, are heavily reliant on centralized infrastructure. A single point of failure, such as a damaged cell tower or overloaded network, can cripple the entire communication system. DMR radio systems, on the other hand, offer distributed architecture, allowing for localized coverage and self-sufficiency.

During emergencies or critical events, it is essential to prioritize communication for security professionals, facility managers, and authorized personnel. DMR radio systems offer features that provide priority access and preemptive capabilities, ensuring that critical messages reach their intended recipients without delay. DMR systems can prioritize specific talk groups or individuals, guaranteeing that urgent communications take precedence over non-essential traffic.

Power outages are not uncommon during critical events or even during daily operations. DMR radio systems address this challenge by employing efficient power management techniques that extend the battery life of devices. Additionally, they often have independent power sources, such as batteries, uninterruptable power supplies, or generators, to ensure continuous operation in the event of a power failure. Cellular broadband systems, on the other hand, rely heavily on centralized power infrastructure and may experience disruptions in communication during power outages.

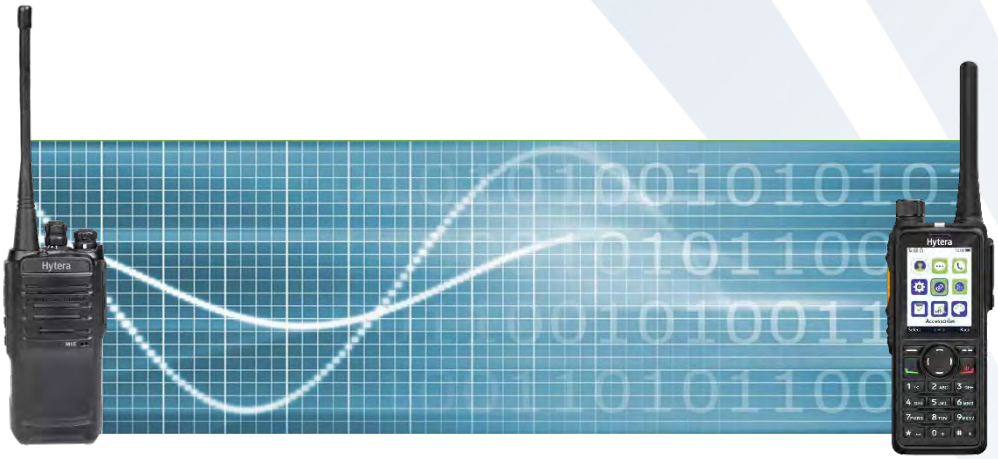
While cellular broadband systems have revolutionized the way we communicate, DMR radio systems continue to be the go-to choice for mission-critical operations where reliability is paramount. The inherent redundancy, resiliency, priority access, and independent power sources of DMR systems make them ideal for organizations where reliable communications is critical.

Migrating from Analog to Digital DMR Radios

Taking Advantage of Digital Two-Way Radios

Migrating from analog to digital two-way radios offers numerous benefits, including superior audio quality, increased call capacity, better coverage, longer battery life, enhanced privacy and security, and advanced features like GPS and text messaging. Hytera digital radios are among the best on the market, offering versatility, durability, interoperability, and advanced features that enhance communication and increase efficiency.

Investing in digital two-way radios is a smart decision for any business or organization that relies on clear and reliable communication.



Simple and Cost-Effective Migration Path

Users with existing analog radios can easily and gradually migrate to DMR radios. This is because Hytera DMR radios support both digital and analog modes. This enables a cost-effective migration path without a one-time and up-front system purchase. DMR radios can be added over time to an existing analog system as the legacy analog radios need to be replaced.

When all the analog radios have been replaced, a DMR Tier II base station can be installed for extended coverage area and managing the channel traffic. Some planning for talk groups, and channel allocation will be needed, but an authorized radio system dealer will take care of all the planning, equipment programming, and installation.

DMR systems have a long operational life, provide mission critical continuity with power back-up, and are scalable as the radio communication requirements grow with your organization.

Hytera DMR Radios

The New Standard in Quality and Performance

The Hytera H-Series DMR product family is the new standard in functionality, user experience, ruggedness, and scalability. The H-Series is the only fully DMR Tier III compliant system on the market (no proprietary limits or partial compliance).

Industry Leading Audio Quality – Large speakers provide up to 93dB of loudness, and AI-based voice enhancement with deep learning ability that can accurately extract voice from noise in real time.

Farthest Coverage Range – The H-Series extends radio range through increased Tx power, Rx sensitivity, improved antenna gain, and reduced attenuation. This produces a 25% increase in coverage distance and signal penetration through buildings to improve efficiency and reduce costs.

Lightest and Thinnest – H-Series handheld radios have an optimized mechanical design, advanced materials, and lightweight lithium polymer batteries. HP7 radios weigh less than 11 ounces, and HP6 radios weigh less than 10 ounces.

Highest Level of Ruggedness – The HP7 and HP6 handheld radios are IP68 and MIL-STD- 810 G compliant. They are dustproof, submersible to a depth of 2 meters for 4 hours, and withstand multiple drop shock tests at 2 meters. H-Series handheld radios also feature an anti-magnetic speaker that does not attract magnetic metal dust and shavings, and the speaker automatically drains water after being submerged.

Multi-System Operation – H-Series radios can be deployed on Analog and Digital Conventional, XPT Trunking, DMR Tier II Trunking, IP Multi-Site Connect, and DMR Simulcast Systems. HP702, HP782, and HM782 radios can be deployed on DMR Tier III systems.

Longest Battery Life – The latest in lithium polymer technology is used to power the H-Series handheld radios. The battery is light and small, achieving a shift life of up to 24 hours on high transmit power with a duty cycle of 5/5/90.

Advanced Features and Safety – H-Series radios support GPS for dispatching applications, advanced encryption, and Bluetooth for wireless accessories. Worker safety features included dedicated emergency buttons, Man Down, Lone Worker, Priority Interrupt, Remote Monitor, and Stun and Revive.

About Hytera US Inc

Hytera US Inc is a United States corporation with offices, warehouses, and support facilities based in Irvine, California and Sunrise, Florida.

Hytera US Inc boasts an experienced staff of professionals that have been implementing innovative radio communication solutions and are established specialists in DMR, push-to-talk over cellular, and related communications technologies.

We regard ourselves as a solution provider whose core area of expertise is providing cost-effective radio communications systems of the highest reliability, durability, and quality.

Hytera US Inc is an established and growing company with an expanding US radio communications market share. Our solutions are provided to a broad base of customers that range small to medium sized businesses, Fortune 500 companies, and other organizations. There are hundreds of thousands of users nationwide from the industrial, education, hospitality, transportation and logistics, security, construction, energy, and health care markets.

We focus on products specifically designed for the US market and develop our own customized systems and software solutions.

- DMR Two-Way Radios
- DMR Repeater and Trunking Systems
- Push-to-Talk over Cellular Devices and Systems
- Analog Two-Way Radios
- Hytera Communications Systems and Applications

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