DMR Two-Way Radio Systems

DMR Repeater and Trunking Systems

with Scalable Upgrade Paths

WHITE PAPER

Hytera

EAGLE COMMUNICATIONS
34 Waterworks Way, Irvine, CA 92618

Toll Free 1 (800) 600-EAGLE
Local (949) 837-8788 (Orange County)
Fax (949) 837-2511
www.two-wayradio.com

Introduction

This white paper will cover the different DMR radio systems and provide an overview of the equipment required, how they work, the benefits to radio users, and their flexible and scalable migration paths.

- Radio-to-Radio Communications
- DMR Tier II Base Station Systems
- IP Connect between multiple DMR Tier II Repeater Sites
- Extended Pseudo Trunking (XPT) Systems
- DMR Tier III Trunking Systems

What is Digital Mobile Radio?

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 the initial launch of fully compliant DMR two-way radios.

DMR is a digital radio standard used in professional mobile radio applications. DMR uses two-slot TDMA (Time Division Multiple Access) technology to divide a single 12.5kHz channel into two time slots, allowing two separate conversations to take place at the same time. DMR with TDMA and 12.5kHz channel spacing offers numerous advantages over analog radio systems:

- Improved voice quality
- Longer battery life
- Dual-slot operation doubles the number of users that can operate on a single frequency
- Interoperability with existing analog systems

DMR radio systems also support a variety of call types:

- Group Call – a one to many call, and probably the most often used type of call
- Private Call – Individual radio-to-radio calls
- Emergency Call and All Call – A special call that will broadcast to every radio on a channel, or with XPT, all the radios on the system.
- Priority Calls – Emergency and All Calls have a higher priority than Private or Group Calls and DMR radio systems end the lower priority call to receive the higher priority call.
- Text Messaging – Free form texting, or text messages can be pre-programmed to specific buttons
- Dedicated data channels – If the radio system involves heavy GPS data, large fleets, DMR delivers GPS data via specific data channels so as not to interfere with voice traffic.

DMR systems typically support the 150 to 174 VHF and 400-512 UHF frequency ranges. DMR systems are also available in the low band of 66-88MHz (rarely used) and high band range of 806-941MHz.

The Importance of DMR Standard Compliance

DMR standards compliance ensures that all radios and base stations operate to 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 – This ensures that radios and repeaters from different manufacturers can interoperate seamlessly. This interoperability increases flexibility in equipment choices and reduces costs for users.

Improved Performance – DMR standards compliance ensures that all equipment meets certain technical specifications, resulting in better voice quality, improved coverage, and reduced interference.

Future-Proofing – Enables users to invest in equipment with confidence that it will remain compatible and functional for years to come.

Learn about the importance of the DMR standard, the compelling benefits of DMR technology, and the easy migration path from analog to DMR radios.

[Access the DMR Radios White Paper]

DMR Radio-to-Radio Deployments

For smaller groups of radio users, a radio-to-radio system can be deployed. This is simply a group of radios talking to each other. This can typically start out with analog radios because of the low cost and ease of use.

Migrate to Digital

As the groups of users get larger, they can upgrade to DMR radios to leverage the benefits of DMR standard-based technology. 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.

Users with existing analog radios can easily and gradually migrate to DMR radios. This is because 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.

Types of DMR Radios

There are two types of DMR radios: Commercial and Professional. Commercial DMR radios are also known as On Site Business (OBR) radios, commercial walkie talkies, or Business Service Radios (BSR). These radios have lower transmission power that run on dedicated frequencies and do not require FCC frequency licenses. Commercial DMR radios cannot be deployed on repeater systems and are typically used in short-range applications like restaurants, retail stores, and small businesses. Professional DMR radios have higher transmission power and require FCC frequency licenses. Professional DMR radios support advanced features like GPS and texting and can be deployed on repeater and trunking systems.

Professional DMR radios are available as handheld radios, mobile radios, and desktop radios. Handheld (or portable) radios are available in different sizes and feature sets and can be worn with a belt clip. Mobile radios are deployed in vehicles and have a higher transmit power (up to 50 Watts) due to the farther range required. Both mobile and handheld radios can have a display screen and full keypad for advanced features. Desktop radios are mobile radios installed in a desktop chassis with a power supply and are used by someone in the office typically functioning as a centralized dispatcher.

Handheld DMR Radios

Mobile DMR Radios

Desktop DMR Radios

DMR radio-to-radio deployments are also easy and cost effective. Program the call groups and the system is up and running with no need for any radio system infrastructure.

Limitations of Radio-to-Radio Deployments

The limitations of DMR radio-to-radio deployments are call capacity and coverage area. Coverage area is limited to the transmit power and the transmit and receive technology built into the radios. The transmit power of a typical DMR radio is typically 4 to 5 Watts and can achieve a moderate transmission range of a few miles on open land with a clear line of site. Radio transmission range is dramatically limited and by obstacles like hills and buildings, and this can vary based on the unique landscape of the deployment. Call capacity is limited to the two-slot talk channel of the DMR standard.

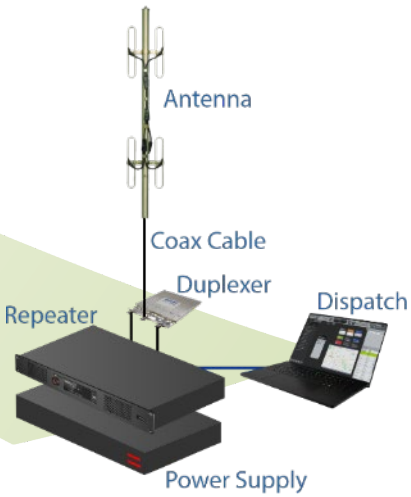
DMR Tier II (Licensed Conventional)

A DMR Tier II radio system is a professional two-way radio system that uses repeaters for voice and data communications. Tier II uses DMR standard compliant radios and requires FCC licenses. Both DMR radios and Analog radios can be deployed on Tier II repeater systems.

Tier II systems are for medium and large size organizations that require wide-area coverage throughout a school campus, business complex, or open rural area. DMR Tier II radios are available from several manufacturers, allowing for easy integration with existing analog radio systems.

How It Works – The Components of Tier II Repeater Site

A DMR Tier II Repeater Site consists of a DMR repeater, antenna systems, and supporting equipment which typically includes power supplies, backup batteries, and monitoring systems. The repeater and associated equipment that makes up a Conventional Tier II system is sometimes referred to as a Base Station.



DMR Tier II repeater systems are installed by authorized radio system dealers who are professional radio system integrators that can configure and install all the necessary radio system components.

DMR Tier II Repeaters – the repeater is the heart of a professional DMR radio system. It is responsible for receiving and transmitting radio signals over a wide area. Repeaters receive low-level signals from handheld and mobile DMR radios and retransmit the information at a higher power level over a greater area. This is

commonly referred to as the range of the repeater, the area within which you can activate the repeater with the transmitted signal. Two or more repeaters can be deployed together and assigned to different call groups.

Repeaters provide an intelligent and seamless communication platform with the flexibility to connect with a variety of systems. Repeaters can provide inter-system connectivity to SIP/PBX/VoIP phone systems, dispatching systems, and DMR Tier II, Tier III, and XPT Trunking Systems.

Repeaters are available as network equipment that can be installed in a standard 19” rack typically found in a data closet, and as compact repeaters that have integrated antennas for applications like use in tight spaces like farm enclosures, rural outbuildings, or on ships and yachts. Compact repeaters can also support portable applications like racing teams and feature integrated battery packs for carrying the repeater in mobile applications like fighting wildfires and search and rescue operations.

The repeater typically consists of a receiver, transmitter, and a duplexer. The receiver receives incoming radio signals and filters them to ensure that only the desired signals are transmitted to the transmitter. The transmitter then amplifies and retransmits the signal over a wider area. The duplexer is used to separate the incoming and outgoing signals, allowing the repeater to operate on two frequencies (Tx and Rx) on one antenna.

Multiple repeaters can be deployed in Tier II systems for additional channel capacity.

Antenna Systems – Antenna systems are used to transmit and receive radio signals between the base station and mobile and portable radios. A DMR base station can consist of several antennas, including a main antenna and auxiliary antennas. The main antenna is used to transmit and receive radio signals over a wide area, while the auxiliary antennas are used to provide coverage in specific areas, such as buildings or tunnels. Some DMR Tier II systems use more than one frequency and have a separate antenna for each frequency. Antenna patterns can be adjusted so that a repeater range can cover a certain area or direction only, but the majority of antennas are omnidirectional.

Supporting Equipment – Additional equipment is used to provide power and network connectivity for the repeater site. This equipment typically includes power supplies, backup batteries for mission critical operations during natural disasters. The power supplies provide the necessary power to operate the base station, while backup batteries are used to provide backup power in case of a power outage. Repeater sites may also include optional

network infrastructure such as servers, routers, switches, and other networking equipment required to connect the different components of the DMR Tier II radio system.

Dispatching and Monitoring Systems – A dispatch application (also called a dispatch console) is a client software application that provides centralized control and monitoring of the DMR Tier II radio system, including voice calls, GPS location tracking, messaging functions, and voice recording. It enables the dispatcher to communicate with multiple radio terminals simultaneously and monitor the activity on the system. A dispatcher will communicate with the radios on the system using a microphone and speaker connected to the PC running the dispatch application.

A Sample Dispatch Application Making and Monitoring Calls and Tracking User Locations

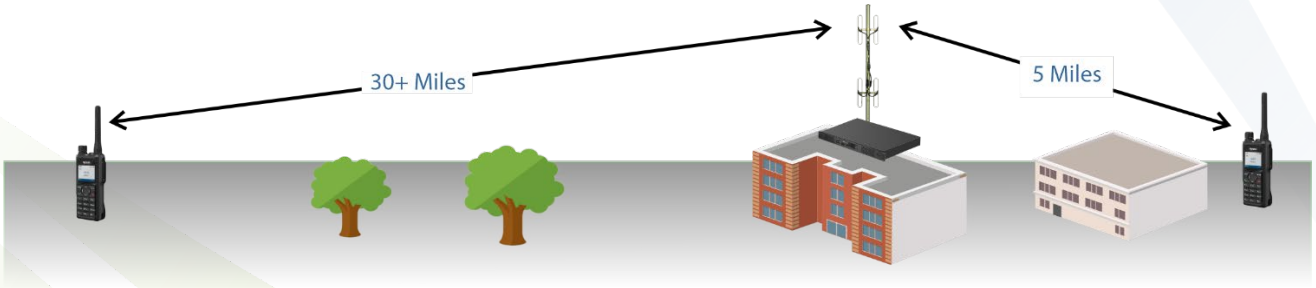
Monitoring applications provide alerts if a repeater has a power failure, antenna issue, and can monitor the call traffic and generate alerts for dropped calls. Both dispatching and monitoring applications run on PCs connected to the repeater; either through a direct connection to the Ethernet port, or through an IP network linked to the repeater.

Range of DMR Tier II Systems

A common question asked is “What is the range of a repeater system?” Unfortunately, the answer is “It depends”.

UHF and VHF radio frequencies travel at different frequencies, but they are line of site, meaning the distance they travel is based on what is in the way.

The range of a repeater system can be anywhere between 30 and 75 miles. That includes the distance of one radio to the repeater, and the distance from the repeater to the other radio. For example, 5 miles to the repeater, plus 30 miles to the other radio would equal 35 miles.



There are several variables that impact the range of a repeater system:

Obstacles – The primary determinant of the range of radio systems is obstacles like buildings, trees, and the geologic landscape (mountains, hills, etc.). UHF and VHF wavelengths go farthest with a line of site, like in flat open country or on the ocean. Obstacles dramatically shorten the range, especially mountains and thick concrete walls in buildings. Dense buildings can limit the range to a few hundred feet.

Antenna – Another key factor of repeater system range is the height of the antenna. The higher the antenna, the fewer obstacles for the radio signal. This is why antennas are installed on tops of buildings and mountains.

The Radios – The transmit power or the radio, Rx sensitivity, antenna gain, and attenuation will also impact the transmission range.

The bottom line is that professional DMR system dealers and installers are experts in designing systems that will cover the required areas. They will conduct a site survey with test equipment and design a system that provides the necessary coverage throughout the facility.

Key Benefits of DMR Tier II Repeater Systems

Enhanced Coverage and Range – DMR Tier II conventional repeater systems significantly enhance coverage and range compared to direct radio-to-radio communication. By strategically placing repeaters at elevated locations, these systems can extend the signal coverage area, overcoming obstacles such as buildings and terrain. This ensures that users can communicate seamlessly over a broader geographic area, improving overall operational efficiency.

Improved Signal Quality – One of the primary benefits of DMR Tier II conventional repeater systems is the improvement in signal quality. The repeaters receive weak signals from portable or mobile radios and retransmit them at a higher power level, resulting in clearer and more reliable communication. This ensures that messages are transmitted with minimal distortion or interference, leading to enhanced clarity and intelligibility.

Increased Group Calling Capacity – Conventional repeater systems allow for simultaneous communication between multiple users to increase call capacity. With DMR Tier II, users can access the repeater and communicate with one another concurrently, promoting efficient group communication. This feature is particularly beneficial in scenarios where multiple teams or individuals need to coordinate their activities in real-time.

Scalability and Flexibility – DMR Tier II conventional repeater systems offer excellent scalability and flexibility. As the system's capacity is determined by the number of available channels, it can be easily expanded by adding more repeaters or increasing the number of available channels. This scalability enables organizations to adapt their communication infrastructure to growing needs without the need for a complete overhaul.

Enhanced Privacy and Security – Privacy and security are paramount in professional communication systems, and DMR Tier II conventional repeaters offer robust features in this regard. Encryption capabilities are built into DMR Tier II, ensuring that sensitive information remains protected and confidential. Additionally, repeaters can be configured with advanced access control features to limit unauthorized usage, providing an additional layer of security.

Interoperability – This is a crucial advantage of DMR Tier II conventional repeater systems. DMR is an open digital radio standard, ensuring compatibility among different manufacturers' equipment. This allows organizations to choose from a wide range of DMR-compatible radios and infrastructure components, promoting interoperability and eliminating vendor lock-in.

Enhanced Management and Monitoring – DMR Tier II conventional repeater systems offer advanced management and monitoring capabilities. System administrators can remotely monitor and manage the repeaters, perform diagnostics, and optimize system performance. These features enable proactive maintenance, efficient troubleshooting, and swift resolution of any issues, leading to increased uptime and operational reliability.

Advanced Features and Functionality – Repeater systems offer additional features and functionality that can enhance operational efficiency. These include features like emergency signaling, remote monitoring, network connectivity, and dispatcher consoles.

DMR Tier II Limitations and Upgrade Path

DMR Tier II systems provide many benefits, but the coverage is limited to a single repeater site. If an enterprise or organization requires communication between multiple locations with DMR Tier II repeaters, they can be linked over an IP-based network using IP Connect. The upgrade path from standalone repeaters to an IP Connect system is relatively simple and cost effective. It requires the addition of network routers for IP network connectivity, some repeater programming, and an upgrade license.

IP Connect

IP Connect is a digital interconnect that uses Internet Protocol (IP) to link multiple DMR Tier II repeater sites together, creating a wide-area network. With IP Connect, multiple repeater sites can be connected over a standard IP network, allowing users in different locations to talk over wide areas. IP Connect is typically deployed by organizations that have several remote locations with radio systems and they need communications between these sites. For example, a K12 school district needs to communicate between campuses, a university may have satellite campuses and the security and maintenance teams require communication between all locations, or a company may have a manufacturing facility, a warehouse logistics center, and administrative offices that need to communicate.

How IP Connect Works

The IP link can be achieved using third-party IP networks, including wide-area networks like the internet, LAN/WAN, VPNs, or microwave links. Standard network routers are used to provide IP network connectivity. The DMR protocol is transported by TCP/IP protocol at the Application layer, so IP Connect only changes the DMR transmission media without affecting the services of DMR radios and repeaters. Because the IP network carries the information that conforms to the DMR Standard, it carries all the DMR features and calling options.

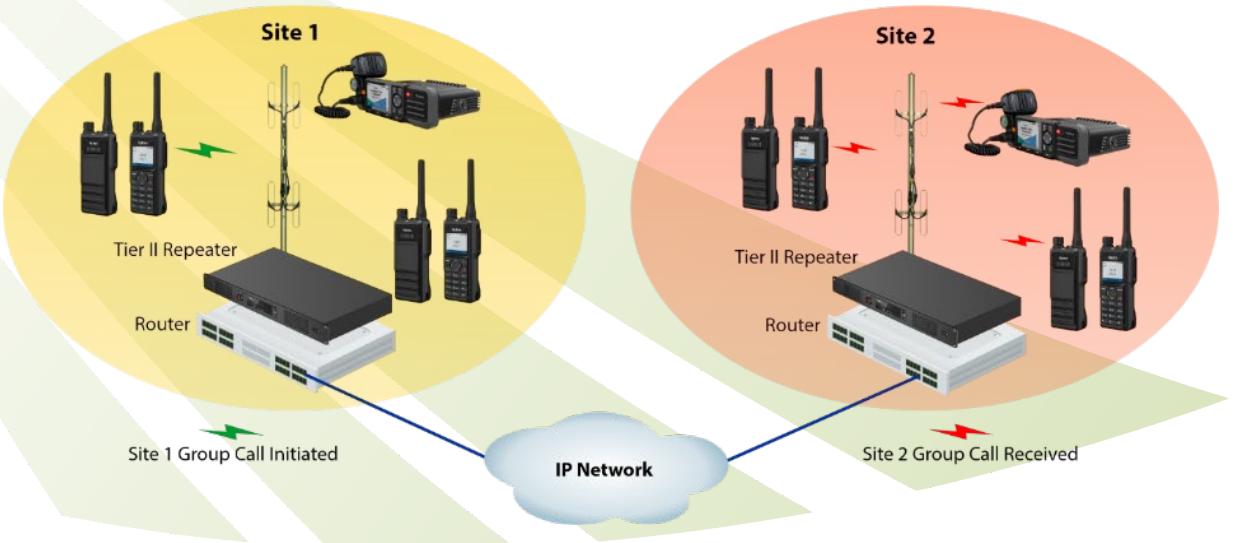
The repeater sites support all the same DMR Tier II functionality as described in the previous section.

Repeaters are typically connected to the IP network via Ethernet ports on the repeaters. The IP network required bandwidth is calculated on the amount of data transferred by one repeater. A DMR repeater with two time slots has a data rate of about 70Kbps, including digital data and GPS data. Multiply that data rate by the number of repeaters in the system for the total required IP network pipe bandwidth. Based on this, a 100Mbps data rate can accommodate about a dozen repeaters.

Carrier-grade Ethernet services are recommended with guaranteed performance to minimize the delay and jitter and dropped packets that can impact the transmission delay. Typically, an organization's IT manager will set up the network connectivity through a third-party service provider.

The network security is guaranteed by a set of security mechanisms: data encryption, authorization code for registration, application layer protocol compliance and communication protocol command encryption. To connect to a public network, it is recommended to use a firewall.

IP Connect uses Tier II repeaters with the IP Connect license applied, along with a router to extend the DMR protocol from one repeater to many repeaters over the IP network. The local repeater communications are heard at the remote repeater site in real time, as if you were operating from there.

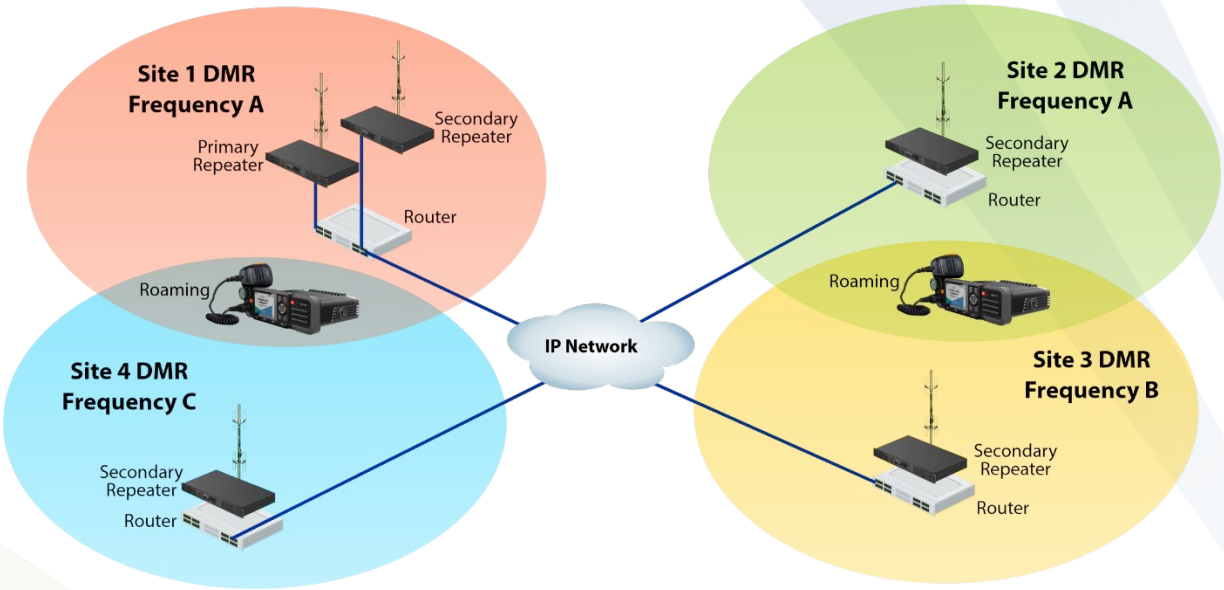


In this example application diagram, and organization has two different sites and requires radio communications to all users at both sites. The repeaters are connected to routers that provide connectivity to the IP network that links both sites. If someone needs to speak with a group of workers at another site, IP Connect can make this happen. Since call groups are assigned to channels, it is as easy as changing channels on a radio.

When the system is configured, call groups can be defined for the radio channels to talk over IP Connect to groups of local users at each site. Multiple channels (talk groups) can be defined for each site and for the IP Connect locations.

- Site 1 user changes channel on the radio to the Site 2 channel and the radio traffic is sent to the Site 1 repeater
- The Site 1 repeater sends that radio traffic through the IP network
- The Site 2 repeater receives that radio traffic from the IP network and sends the traffic to the appropriate users in the Site 2 channel.
- All of this works in real time as if the users were at the same location

Scalability, Flexibility, and Overlapping Coverage



IP Connect systems can link multiple repeaters at a site and can support up to 255 locations by configuring primary and secondary repeaters.

Each location can use a different frequency or DMR standard compliant radios of any manufacturer.

In addition, the IP network transport of the DMR digital data is transparent and agnostic, meaning any type of network or multiple networks of different transmission media (optical fiber, microwave, etc.) can be used to connect the repeaters in an IP Connect system.

When the coverage of IP Connect repeater locations overlap there is feature called roaming that allows the radio to switch between sites instantly and automatically. Overlapping IP Connect repeater locations must have different frequencies based on radio theory, so the radios can be programmed to switch between frequencies. This is typically for mobile radios in vehicles that drive between different repeater site locations and is like traveling with a cell phone and getting continuous connectivity from cell site to cell site.

Benefits of IP Connect

Enhanced Coverage – IP Connect is perfect to add additional coverage to additional repeater sites, or increase coverage in poor coverage areas like large parking garages and below-ground floors.

Simple Deployments – IP Connect supports repeater site connectivity over a variety of widely available IP networks, including the internet, private wide area networks, LANs and VPNs. If the existing repeaters are already Hytera, no new hardware is needed to create this wider area radio network, simply install an IP connect license and configure the repeater.

Carries True DMR Protocol – Adding Hytera IP Connect to your repeaters carries the DMR protocol. That means your existing DMR radios, regardless of manufacturer, will work on the extended IP Connect radio system for flexible deployments without being locked into proprietary systems.

Convenient and Familiar Operation – Because the IP Connect uses DMR protocol, users do not need to learn a new radio system. Group Calls, Individual Calls, Emergency Call still work as they normally do.

Local and Wide Area Channel Programming – In a Hytera IP Connect system, Talkgroups can be programmed to call users only on the local repeater, or across the IP Connected multi-site network. This is especially handy for school districts, where each school campus can have its own local repeater communications but are always available to emergency broadcasts or any other calls that need to be heard across all campuses.

IP Connect Limitations and Upgrade Path

IP Connect enables users at multiple repeater sites to communicate over wide areas, but no matter how many repeaters, there are only two talk channels (TDMA time slots). While the coverage area is limitless, the call capacity of an IP Connect system that links DMR Tier II repeaters is limited to a single talk channel. This is where trunking is required to expand call capacity.

IP Connect repeaters can be upgraded to XPT trunking with a repeater license and some simple programming.

Extended 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 is best suited for organizations that require high-capacity and high-reliability group communications.

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

A key advantage of an XPT Trunking system is that it enables greater efficiency and dynamic channel allocation with less hardware that Tier III trunking systems, and does so without the use of an FCC FB8 Control Channel Frequency further maximizing site capacity.

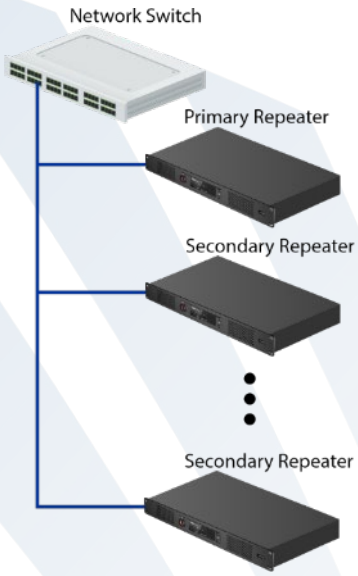
Capabilities of Hytera XPT:

- Enables high-capacity group calling and high-reliability communications
- Efficient use of available frequency spectrum
- Maintains all the functions and capabilities of Tier II systems, including voice and data services, text messaging, and GPS tracking

How XPT Works

The XPT Trunking System enables the combination of multiple talk channels, or trunking, by connecting multiple repeaters operating in pseudo trunking mode. The system allows the radios to use any of the idle repeaters in the system.

The repeaters in an XPT site have similar power supplies, antenna, and associated equipment as a DMR Tier II or IP Connect repeater site, but XPT uses multiple repeaters. There is a maximum of eight repeaters at a single XPT site that provides a maximum of sixteen voice channels. The repeaters communicate with each other through a Layer-2 network switch.



The repeaters consist of one **Primary Repeater** and up to seven **Secondary Repeaters**. There can be only one Primary repeater in an XPT system.

These XPT repeaters are assigned different roles in the repeater group:

Home Repeater – In the XPT site, each talk group (radios programmed to participate in different group calls) must be assigned with a repeater in this site as its Home Repeater. The radio always monitors its Home Repeater to determine whether any call is made to the radio in the XPT system. The radio initiates a call preferentially on the slot of Home Repeater in last transmission. Any repeater at the XPT site can be a Home Repeater to one or more talk groups.

Free Repeater – In each XPT site, any registered voice repeater with one or two idle slots can be assigned as a Free Repeater. Only one Free Repeater can exist at a time in one XPT site. When the Home Repeater is busy, the radio switches to the channel where the Free Repeater is operating to monitor. If the free repeater is busy at the same time, it will assign another on-line and idle repeater as the new free repeater.

Voice Repeater – Used to repeat voice services, message and signaling services between radios.

Data Repeater – Used to repeat dedicated data services sent by radios to dispatch station. For example, for AVL dispatching, the radio is required to report its GPS positioning information periodically, so that the dispatch station can position the radio and monitor its track. A large amount of Radio Registration data and GPS data transmission is required for dispatching. A data repeater can improve the transmission efficiency of the XPT system. It is recommended to configure one or more data repeaters in an T system when radio dispatching is required.

In an XPT system a call is always started through that group's Home Repeater. If that repeater is busy (both voice slots are occupied), the radio will automatically switch to a designated Free Repeater. That is, a repeater that is idle or available. In this case, where the Home Repeater is busy, the radio will already know the Home Repeater is busy, and it will automatically use the Free Repeater. This happens before the user presses the Push-to-Talk button. This process minimizes system access time and further increases efficiency and capacity. This also ensures that there is a very low probability that all voice channels will be busy at the same time.

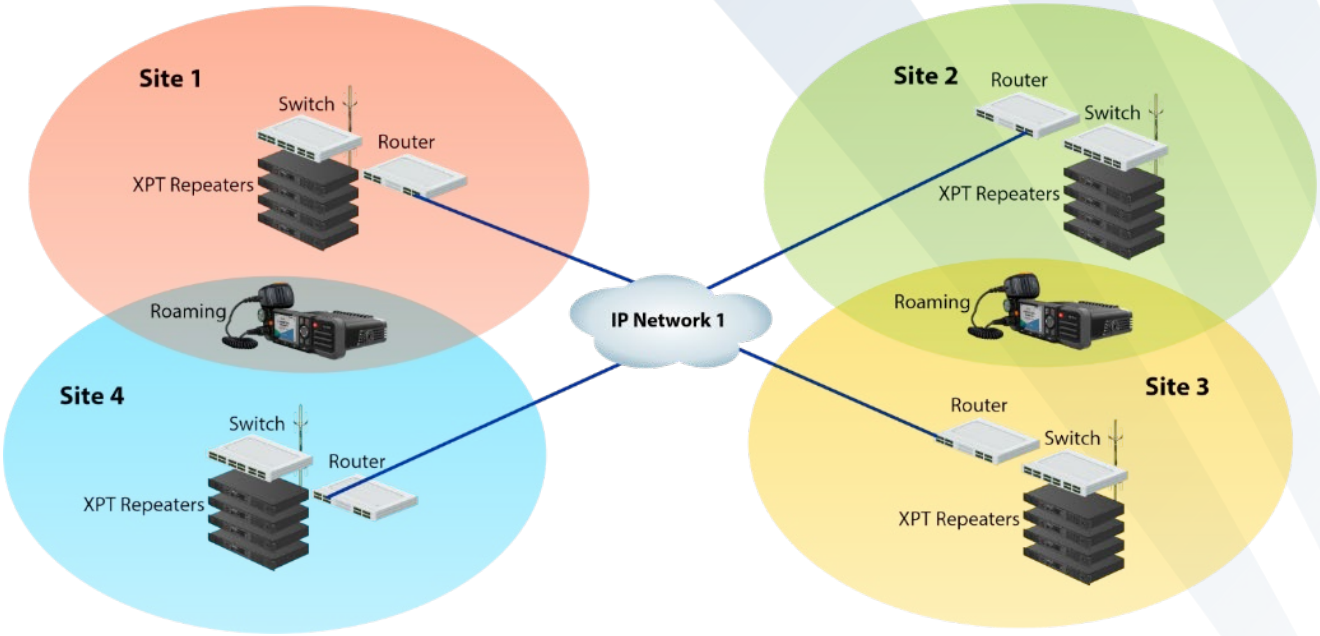
For example, a conventional radio system has five talk groups: G1, G2, G3, G4, and G5; and there are two repeaters with each repeater having two voice channels, or time slots. The radio talk groups are programmed to use each repeater: G1, G2, and G3 uses Repeater 1, and G4, G5 uses Repeater 2. If G1 and G2 are currently talking (and using Repeater 1), and G3 tries to talk, they will get a busy signal. Even if repeater 2 is not being used. That is a challenge with conventional repeater systems.

But if the repeaters are operating with XPT mode, G3 will automatically use repeater 2, with no input or notification of the user. Also, anyone else in Group 3 will also move to repeater 2 for the duration of the call. All calls are efficiently managed with no busy signals.

Multi-Site XPT

XPT Repeaters expand the call capacity at a radio system site by adding talk channels to the system using multiple repeaters. Multiple XPT systems at different locations can connect over an IP network like IP Connect, but with the added benefit of multi-channel trunking functionality to expand the calling capacity over all XPT sites. Group calls can be made across the IP network to other XPT sites.

XPT uses routers to connect each site to the IP network, with the XPT repeaters at each site connected to each other with a layer-2 switch. There is still only one Primary repeater, but new kind of repeater called the Sub-Primary is deployed at each site to control the networked trunking calls from other sites. It is common for overlapping with XPT multi-site so roaming is a widely used feature.



The Benefits of XPT

It is Easy to Migrate to XPT – Migrating from conventional DMR 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. Organizations can start with a single-site implementation and gradually add additional sites as needed. All Hytera professional DMR radios support XPT trunking and can be deployed on XPT systems.

Hytera XPT is designed to be scalable and can accommodate growing organizations without significant upfront costs. No need for forklift upgrades and completely throwing out the old system simply because growing communication needs require additional system capacity.

XPT is Easy to Operate – Because XPT trunking is based off the DMR Tier II standard, operation is familiar with little interaction needed from the end user. Switching Talk Groups is as easy changing the channel knob on the radio. No need to figure out the correct repeater to use, or where the rest of your Group is. XPT takes care of that on the backend keeping you in touch with your people with reliability and confidence.

XPT is Scalable with Expanded Capacity – An XPT trunking site supports up to 16 voice channels and 16 data channels as well as support for up to 1,200 radios. That is far more than a convention repeater system. XPT systems can also be connected for multi-site applications. Currently XPT systems can be as small as 2 sites or as large as 16 sites. All sites are connected, and roaming is built-in for those that travel between sites.

Improved Security – XPT has an Authorization Key that prevents any unauthorized (pirate) users from connecting to the XPT system. Trunking systems in general provide inherent security and privacy as the typical 'scanner' user cannot hear a complete conversation because the call can jump channels frequently which the scanner user cannot track. XPT also includes DMR encryption and licensed AES 128-bit encryption.

Does not Require a Dedicated Control Channel – A key advantage of an XPT Trunking system is that it enables efficiencies and dynamic channel allocation with less hardware and without an expensive Control Channel frequency (also known as an FCC FB8 control channel frequency Trunking License). Unlike Tier III DMR Digital Trunking, XPT DMR Tier II Trunking does not use a Dedicated Control Channel. This Dedicated Control Channel in Tier III systems must be operational all the time to manage all the other channels on the system, and requires a special FCC license, which is expensive and difficult to get in high-density metropolitan areas. This could be a non-starter for any new Tier III trunking systems. XPT uses a series of beacons sent by each repeater to optimize channel usage and keep the radios in the field informed of system status. Another benefit of not requiring a Dedicated Control Channel is that that frequency can be used for voice traffic. This is even more important with smaller systems that may start out with two XPT repeaters. Not having to give up a voice channel for a Dedicated Control Channel allows for maximum efficiency of the radio system.

Limitations of XPT and Upgrade Path

XPT is a very popular radio network solution due to the low cost and the expanded calling capacity for a high volume of group calls over a multi-site coverage area. Although Hytera XPT is based on the DMR Tier II Conventional industry standard, XPT is a proprietary Hytera system and requires Hytera radios and repeaters.

Advanced, large-scale deployments and operators of radio networks with a high volume of individual radio-to-radio calls require even more calling efficiency and capabilities from the radio network. In addition, they require more functionality, remote radio programming, improved security, and more monitoring and control.

DMR Tier III systems deliver all these capabilities and more with an upgrade path that requires an FCC FB8 Control Channel Frequency and additional network equipment at each site.

DMR Tier III Trunking Systems

DMR Tier III Trunking is the pinnacle technology of radio communications systems and was developed using the ETSI DMR open standard and is designed for the most complex communications operations in large organizations. Since it is based on an open industry standard, multiple manufacturers provide Tier III compliant systems and radios. DMR Tier III is an IP-based digital trunking system designed to provide high-capacity individual and group calling, dispatching, and radio management capabilities across wide geographic areas.

Tier III trunked radio systems optimize voice or data traffic through a limited number of frequencies, maximizing the available resources for a large group of users, and utilizes repeater technology with a dedicated control channel, managed by servers.

How DMR Tier III Works

DMR Tier III is an IP-based system with a centralized networking approach to intelligently manage resources. The DMR Tier III Trunking System consists of a central controller called a Mobile Switching Office (MSO), a Base Station Controller Unit (BSCU) server at each radio repeater site, multiple repeaters to carry the traffic, and a wide area network that connects all the different pieces together. Like IP Connect, IP network connectivity is provided by a variety of third-party internet, LAN, or VPN network operators. All the radio sites connect to the MSO, which provides the routing functions, the gateways to telephone networks and other systems, as well as managing the

trunking of calls across the system. The MSO offers high availability standby, while multi-level fallback options can be deployed to ensure high reliability.

DMR Tier III requires a dedicated FCC FB8 frequency control channel that is always available for radios to register and request service from the network. The remaining channels in the system are allocated to the radio as they are needed and are therefore a shared or trunked resource called a traffic channel. As soon as a traffic channel is available, a user will be assigned to use the channel, without having to wait for a specific channel to become available.

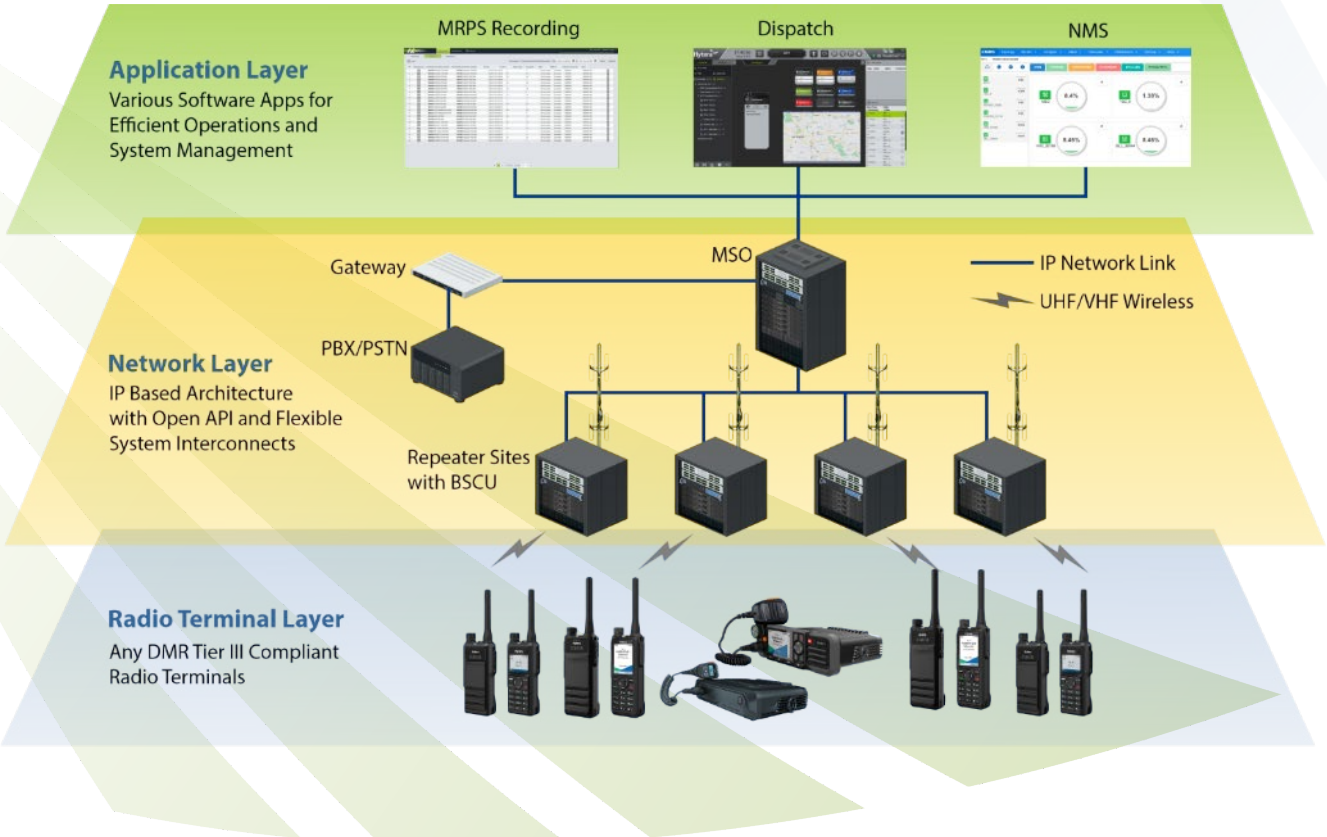
DMR Tier III MSO systems are available as preconfigured and integrated solutions within a network cabinet. They include several radio network components, including repeaters, servers, switches, network gateways, and redundant power supplies. The repeaters are available as standard 19" repeaters or blade servers with triple failover redundancy for mission critical applications. In addition, the MSO can include a server that functions as a Key Distribution Management Center (KDMC) that is used to manage all the access rights to the network, and a Media Translation Unit (MTU) that converts the digital data to analog voice signals.

The system consists of three layers: the application layer, the network layer, and the radio terminal layer.

The application layer includes the dispatching software for centralized communications control and GPS location tracking, network management software for monitoring and configuring the radio network, and Multimedia Recording and Playback System (MRPS), which is a logging recorder system collecting data from radio systems to maintain the integrity of incident data and archiving of communications to reduce liability and improve accountability.

The network layer is typically deployed as a hub-and-spoke IP network topology with the MSO at the center hub with gateway connectivity to other systems like PBX/PSTN telephones.

The radio layer includes the handheld and mobile radio terminals. Because DMR is an established industry standard, any DMR Tier III compliant radio from any manufacturer can be deployed on the system.



The Key Features and Benefits of Tier III Trunking Systems

Maximum Efficiency and Capacity – DMR Tier III trunking systems increase channel usage efficiencies by dynamically managing their allocation for high traffic calling applications. DMR provides two communication pathways in one 12.5KHz channel. So, combining the efficiencies of trunking technology with the advantages of DMR results in a highly efficient wide area solution. DMR Tier III is designed for applications with high individual calling traffic with many users making radio-to-radio calls, and it always knows where the radio is and can find the most efficient (singular talk path) instead of using all the talk paths on the whole system. All devices are based on IP architecture to ensure flexible networking and system expansion.

Dedicated Management Channel – DMR Tier III trunking increases efficiency of channel usage with large groups of radios users using a dedicated control channel, managed by a server. This allows for maximizing channel frequency resources for high-volume call traffic and multiple user Talkgroups.

Leverages the Full Features of DMR – DMR Tier III systems also support all the features of conventional systems as defined in the DMR industry standard. Calling Features: Group call, all call/broadcast, individual calling, priority calling. Digital Features: integrated GPS, secure encryption, and text messaging (free form and preconfigured). Safety features: emergency calling, man down, lone worker, priority interrupt, remote monitor, and stun and revive.

Versatile Services – In addition to the standard DMR voice and data services, Tier III supports priority, late entry, call back, recording, Public Switched Telephone Network (PSTN) calling. DMR Tier III also supports advanced services like call preemption and call queuing, dynamic site light up, and dynamic group allocation, late entry into a group call, ambience listening, interrupt/override, dynamic group number assignment, voice recording, and group patching.

User Management and Calling Priority – Large organizations organize users into many levels of access required for different types of communication. DMR Tier III Systems offer a multitude of different management services to allow radios to interact with the network. Radios are registered on the network for identification and can be configured with subscriber area restrictions and control channel reselection. DMR Tier III systems also support different call priority levels to ensure calls from supervisors, security, and emergency response, get priority through the system for guaranteed communications in critical situations during heavy call traffic.

System Interoperability – Like DMR Tier II systems, DMR Tier III systems support interconnection gateways to PSTN/SIP/PBX/VoIP phone systems, analog conventional systems, MPT, DMR conventional, etc. DMR Tier III also features an open Application Programming Interface (API) that enables further development based on different customer needs, such as billing systems, e-mail gateways, etc.

Radio Registration Service – Radios register with Tier III systems for access control. This gives the network operator control over who can connect and talk on the system and provides users with registered access levels that enable granular control of call groups, call types, and calling priority.

Enhanced Security – Like most DMR radio systems, Tier III supports standard and advanced (256 bit with AES and ARC4 algorithm) encryption for radio communications, but Tier III adds Electronic Serial Number authentication (ESN Check) that provides security control over system access by confirming the serial number of an individual radio before granting communications access.

Mission Critical Resiliency and Redundancy – DMR Trunking combines optimal radio coverage with intelligent redundancy design, so the availability of the overall system is ensured even on the failure of individual components. DMR Tier III systems have several redundancy mechanisms available to ensure guaranteed operation and service availability. With the MSO at the heart of the system, it supports local and geographical backup and triple failover redundancy to ensure continuous wide-area operation. Other controller hardware can also be used in redundant configurations with several failsafe modes. All these configurations are scalable and can be adjusted at any time during the lifecycle of the system. So, systems can start small, and redundancy can be added as the system grows.

Over The Air Programming – DMR Tier III supports reliable and robust Over the Air Programming (OTAP) that enables centralized control of each radio on the system and provides a very convenient method to automatically

upgrade and reconfigure radios in the field. OTAP saves many hours of time compared to the standard benchtop configuration of radios that requires plugging each radio into a computer and manually programming them.

Powerful Software Applications – Tier III systems include network management software, as well as the dispatcher and voice recorder systems ensure DMR Trunking is a comprehensive and professional solution, providing central management of the radio system and supporting remote maintenance.

SMR Radio Networks

DMR Tier III systems are often deployed as Specialized Mobile Radio Service (SMR) networks. SMR network are commercial radio networks that lease radios and wide-area network access. Operators of SMR networks are typically larger two-way radio dealers and system integrators that have spent considerable amounts of money on FCC frequency licenses and building out the networks that cover cities, counties, and even entire states.

DMR Tier III is often used in SMR networks because of the wide area scalability and roaming capabilities, the capacity for thousands of radio users, the mission critical reliability and security, and the ability to have granular control over the radios and their access to the network.

SMR network customers include municipal and county agencies, schools and universities, utilities, energy companies, hospitals and ambulance companies, tow truck companies, and other organizations that require reliable and cost-effective wide-area radio communications.

Limitations of DMR Tier III Systems

There are virtually no limitations on the capacity, coverage, and capabilities of DMR Tier III systems. Because of this DMR Tier III systems are expensive and complicated to design and install, especially with multiple frequencies over a wide area. But once Tier III systems are installed and operational, they are the most reliable and enduring communications systems available, and are often “the last man standing” after natural disasters.

Summary

Digital Mobile Radio (DMR) is the open radio industry standard used in professional mobile radio applications. DMR uses TDMA technology to divide a single 12.5kHz channel into two time slots, allowing two separate conversations to take place at the same time. DMR offers numerous advantages over analog radio systems, including improved voice quality, longer battery life, double the call capacity, and support a wide variety of flexible calling options.

DMR standards compliance in radio systems ensures that all radios and repeater sites operate to a common standard and enables the creation of a robust and reliable communication system. The benefits of DMR standard compliance include guaranteed manufacturer interoperability, reliable performance, and future-proof systems that remain compatible and functional for years to come.

Radio-to-Radio Systems

For smaller groups of radio users, radio-to-radio deployments provide a simple and cost-effective solution that provides an easy upgrade path from analog to digital DMR radios. Program the call groups and the system is up and running with no need for any radio system infrastructure. The limitations of DMR radio-to-radio deployments are call capacity and coverage area.

DMR Tier II Systems

DMR Tier II repeater sites use DMR standard compliant radios and require FCC licenses. Tier II repeater sites are deployed to increase the coverage area, improve the signal quality, and increase the group calling capacity.

A DMR Tier II Repeater Site consists of a DMR repeater, antenna systems, and supporting equipment. Repeaters receive low-level signals from handheld and mobile DMR radios and retransmit the information at a higher power level over a greater area. Repeaters provide an intelligent and seamless communication platform with the flexibility to connect with a variety of systems.

A dispatch application (also called a dispatch console) is a client software application that provides centralized control and monitoring of the DMR Tier II radio system, including voice calls, GPS location tracking, messaging functions, and voice recording. It enables the dispatcher to communicate with multiple radio terminals simultaneously and monitor the activity on the system.

DMR Tier II systems provide many benefits, but the coverage is limited to a single repeater site (base station) location.

IP Connect Systems

IP Connect uses an IP Network to connect several DMR Tier II repeater sites for a larger radio network. IP Connect offers greater coverage, simple migration, ease of use, and supports instant, real time radio communications between distant radio sites. IP Connect can be deployed with a simple license upgrade to a DMD Tier II repeater and IP network connectivity. IP connect expands the coverage area, but not the calling capacity of Tier II repeater sites.

XPT Systems

Extended Pseudo Trunk (XPT) is an exclusive Hytera radio technology that enables trunking of radio channels to increase the group calling capacity of Tier II repeater sites with the addition of a network switch to manage the talk channels on multiple repeaters. XPT can be deployed at a single repeater site, or the trunked channels can be transported over an IP network to connect multiple XPT sites over a wide area. XPT can be deployed with the addition of a layer 2 switch and an XPT repeater license. While XPT dramatically increases the group calling capacity with a minimal investment in network equipment, it is not designed for organizations that have a high capacity of individual radio-to-radio calls and require comprehensive access control for the radios.

DMR Tier III Systems

DMR Tier III Trunking is the premier radio systems technology and is designed for the most complex communications operations in large organizations. DMR Tier III is an IP-based digital trunking system designed to provide high-capacity individual and group calling, dispatching, and radio management capabilities across wide geographic areas.

Tier III trunked radio systems optimize voice or data traffic through a limited number of frequencies, maximizing the available resources for a large group of users, and utilizes repeater technology with a dedicated control channel, managed by servers. The DMR Tier III Trunking System consists of a central controller called a Mobile Switching Office (MSO), a Base Station Controller Unit (BSCU) server at each radio repeater site, multiple repeaters to carry the traffic, and a wide area network that connects all the different pieces together. Tier III systems consist of the application layer, the network layer, and the radio terminal layer.

SMR networks are wide area commercial radio networks that leverage DMR Tier III technology to deliver secure communications services to thousands of users with mission critical reliability.

Systems Overview Comparison Table

System Type	Coverage	Call Capacity	Software and Features
Radio-to-Radio	Limited to the TX power of the radios	Two Slot TDMA, single channel with simplex calls	Group and individual calling, worker safety features, Bluetooth, and texting
DMR Tier II	Expanded coverage to larger sites using repeaters and antenna	Two Slot TDMA, single channel with full duplex calls	Dispatching, recording, and monitoring software, GPS location tracking, flexible system interconnects, advanced encryption
IP Connect	Connects multiple Tier II repeater sites via IP networks	Two Slot TDMA, single channel with full duplex calls	All radio and DMR Tier II features, plus group calling across multiple remote sites
XPT	Same as a single XPT (Tier II) repeater site, and can connect multiple sites via IP networks	Pseudo trunking expands group calling capacity with up to 16 channels	All radio and DMR Tier II features, plus trunked channels to multiple remote sites
DMR Tier III	Wide area based on number of repeater sites and available frequencies	DMR Tier III trunking enables unlimited individual and group calls based on frequency availability and number of repeaters	All radio and DMR Tier II features, plus redundancy and resiliency, advanced security and access control, user management, and call prioritization

Hytera H-Series DMR Two-Way Radios

The New Standard in Quality and Performance

The Hytera H-Series family of handheld and mobile radios is the new standard in functionality, user experience, ruggedness, and scalability.

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.

Greatest 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 Radios – 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.

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.

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.

Advanced Features– H-Series radios support GPS for dispatching applications, text messaging, advanced encryption, and Bluetooth for wireless accessories. HP7 radios support the advanced network system features including roaming, radio registration service, and telephone calls.

Worker Safety – Worker safety features included dedicated emergency buttons, Man Down, Lone Worker, Priority Interrupt, Remote Monitor, and Stun and Revive.

Hytera DMR Radio Systems

H-Series DMR Tier II Repeaters

HR1062 DMR Repeater – The HR1062 is the new state-of-the-art in digital radio communications, providing a more efficient experience with loud and clear audio, support for multiple types of radio and communications systems, and extended range.

The HR1062 features AC and DC auto-switching power, two simultaneous TDMA voice channels, high performance cooling, and all in a compact 1U form factor. The repeater supports IP-Connect, and XPT systems with license upgrades.

HR652 Compact DMR Repeater – The Hytera HR652 is the next generation compact DMR repeater designed to expand the communication range of DMR radios. The HR65X can be mounted on a flat surface or used in portable applications. With a compact body and built-in duplexer, the HR65X has a compact form factor for installation at sites with very limited space. The HR652 supports IP-Connect with a license upgrade.

IP Connect

Hytera's IP-Connect provides wide area connectivity between Hytera DMR Tier II repeaters deployed with a simple license upgrade to Hytera DMR Tier II repeaters. Hytera DMR Tier II repeaters feature built-in Ethernet ports for the required IP network connectivity via network routers.

Hytera XPT Single Site and Multi-Site

Hytera's exclusive Extended Pseudo Trunk (XPT) expands the calling capacity of Hytera DMR Tier II repeaters by up to 16 voice channels and supports over a thousand users. XPT systems can also grow beyond the local footprint by connecting distant XPT repeater sites via routed IP connections. XPT is very cost effective and is deployed by adding a layer 2 network switch and XPT licenses to multiple Hytera repeaters.

DMR Tier III

Hytera was the first company to deploy a fully functional DMR Tier III trunking system and is the only company that provides DMR Tier III systems with comprehensive standard compliance.

DS6210 DMR Tier III Pro System – The DS6210 DMR Tier III Pro has blade architecture for easy installation and system scalability. It accommodates redundant controllers and power supplies in the same cabinet for immediate fail-over in the unlikely event of a blade card failure. The system is supplied in fully configured cabinets ready for final site installation.

The DS6210 DMR Tier III Pro repeater site channels have triple receive diversity to enhance the uplink receive signal for all field radios and improves the uplink reliability for portable radios at the edge of coverage.

DS6211 DMR Tier III Lite System – The DS-6211 DMR Tier III Lite system uses repeaters with Tier III licenses to reduce the cost compared to the DS6210 DMR Tier III Pro solution. The DS-6211 DMR Tier III Lite system supports all the same feature-rich functionality of the DS-6210 except for the triple diversity. Using standard 19" rack equipment, the DS-6211 DMR Tier III Lite systems provides the ability to install the equipment in standard system racks for additional deployment flexibility.

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 a rapidly 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

Hytera US Inc
info@hytera.us
www.hytera.us
954-846-1011

EAGLE COMMUNICATIONS
34 Waterworks Way, Irvine, CA 92618

Toll Free 1 (800) 600-EAGLE
Local (949) 837-8788 (Orange County)
Fax (949) 837-2511
www.two-wayradio.com