

IP Multi-site Connect Application Instructions

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1. Overview

1.1 Definition

IP Multi-site Connect is a function which enables repeaters in different areas to exchange voice, data and packets over a TCP/IP-based network in IP Multi-site Connect network mode.

1.2 Application Range

IP Multi-site Connect mode supports these typical application demands as follows:

- 1) To connect two or more conventional communication systems in different areas.
For example, if you have one repeater in the office building and another one in the factory in the other side of the city, the two repeaters can be connected by using this function.
- 2) To construct a wider and more effective communication coverage.
For example: you can deploy multiple repeaters in a large building to ensure a seamless communication coverage, which can effectively solve the problems of complex terrains and buildings.
- 3) To broadcast messages to all the repeaters in IP Multi-site Connect mode
For example, all the repeaters in IP Multi-site Connect mode can receive instruction messages in case of emergencies from the dispatcher or by using the emergency alarms.
- 4) To connect repeaters in different frequency ranges
For example, UHF repeater and VHF repeater can be connected so that data or voice can be exchanged among them.

1.3 Principle

1) Working principle of IP Multi-site Connect

IP Multi-site Connect is designed to extend the communication coverage by connecting multiple repeaters dispersed in different locations over a TCP/IP-based network. During the TCP/IP-based transporting process in IP Multi-site Connect mode, DMR protocol is supported by TCP/IP protocol and MAXON-owned transport protocol at Application Layer. Accordingly, it is reasonable to conclude that IP Multi-site Connect

only changes the DMR transmission media without affecting the services of DMR protocol supported by DMR terminals or repeaters.

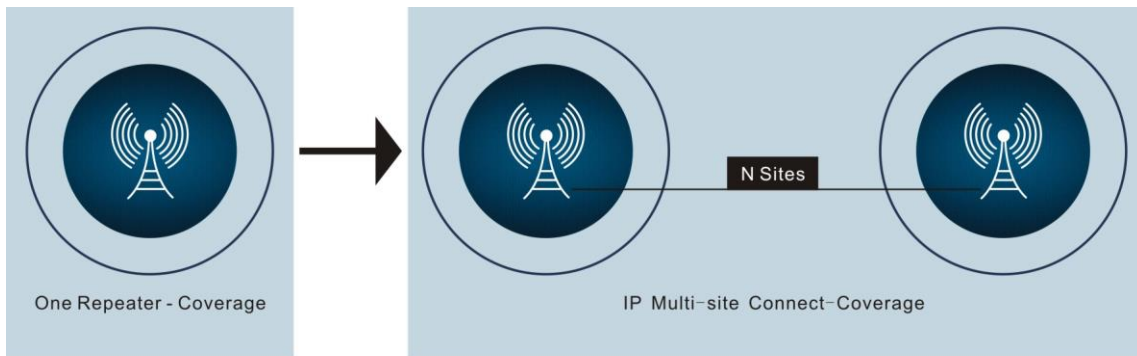


Figure1.3-1 Wider Coverage in IP Multi-site Connect Mode

1.4 Restraint Conditions

- 1) The repeater in IP Multi-site Connect mode must be configured with digital mode;
- 2) The use of IP Multi-site Connect is subject to the repeater's configurations;
- 3) The use of IP Multi-site Connect is subject to the network type and the configurations of network devices.

2. Requirements

2.1 Requirement on Devices

- 1) Repeaters (DMR repeater series products)
- 2) Terminals (DMR terminal series products)
- 3) Switch devices
- 4) Routing devices
- 5) Broadband wireless access devices
- 6) Network cables

2.2 Requirement on Network

- 1) The IP Multi-site Connect network can either be dedicated network or an internet provided by Internet Service Provider (ISP).

- 2) A large number of technologies are provided by ISPs, including dial-up, xDSL, cable modem, broadband wireless access, Canopy, ISDN, satellite internet access, and so on. Currently, the IP network is not applicable to dial-up connection due to narrow bandwidth or satellite internet access due to large delay.
- 3) Sufficient bandwidth is required for IP network.
- 4) In IP network, there must be a static IP address and UDP port for Master repeater and Slave repeater. But it is unnecessary to fix Slave repeater's IP address and UDP port.
- 5) The repeater can locate behind the firewall, router or NAT.
- 6) Only direct IP access instead of proxy server shall be used to access the WAN.

3. References

N/A

4. Network Architecture Diagrams

4.1 Four Basic Schemes of Site Coverage

4.1.1 Heavy Overlapping Coverage (Urban Type)

This type of communication coverage includes intensive sites and a large number of overlaps, which is typically applied in big cities and densely populated areas.

Overlapping sites use different frequencies, while the non-overlapping sites share the same frequency, but use different color codes for roaming, which is unnecessary to be considered in IP Multi-site Connect at present. In this type of communication coverage, the user may be in the coverage involving 3 to 4 sites at the same time, and it takes about 10 minutes to move from one site to another.

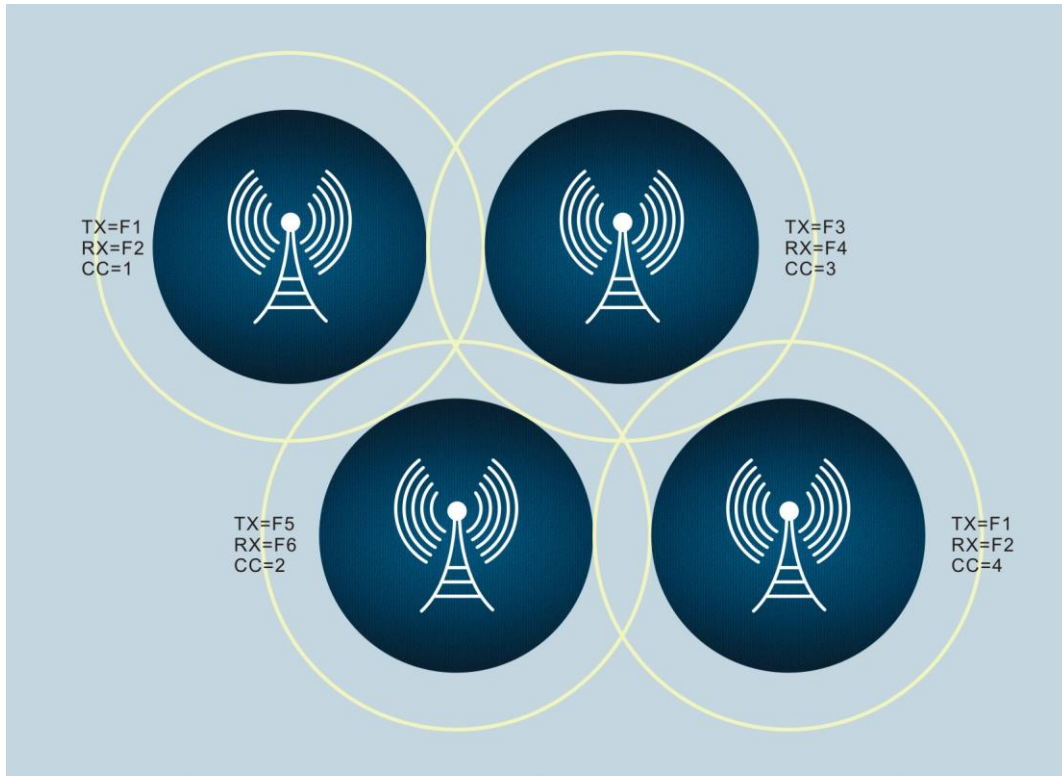


Figure 4.1.1-1 Heavy Overlapping Coverage

4.1.2 Non-overlapping Coverage (Rural Type)

This scheme is designed for countryside or part of a small city, it involves multiple separated sites without overlapping coverage. The non-overlapping sites can share the same frequency, but have to use different color codes for roaming, which is unnecessary to be considered in IP Multi-site Connect at present. In this type of communication coverage, the user can only be in the coverage of one site at the same time, and it takes several hours to move from one site to another.

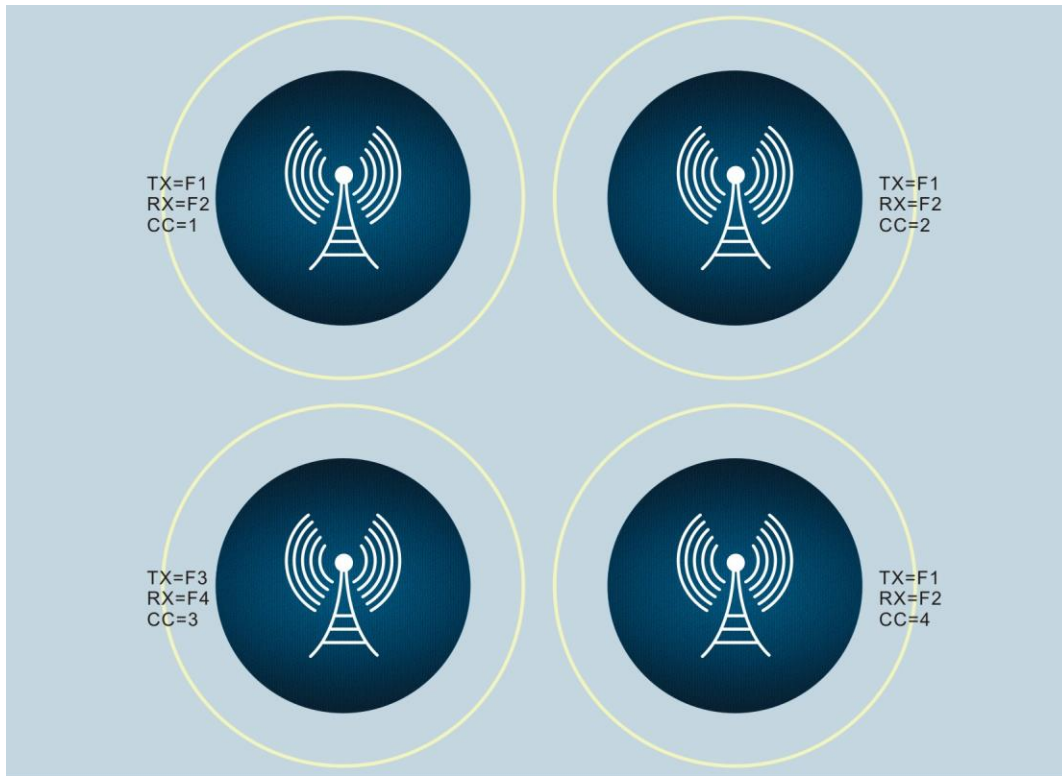


Figure 4.1.2-1 Non-overlapping Coverage

4.1.3 Minimal Overlapping Coverage

This scheme is designed for communication services along the road, railway, coastline or river, it involves multiple sites and minimal overlapping coverage. Frequency multiplexing is common because the communication coverage of one site only overlaps with that of the two adjacent sites, but different color codes are required for roaming, which is unnecessary to be considered in IP Multi-site Connect at present. In this type of communication coverage, the user can be in the coverage involving one or two sites at the same time, and it takes about an hour to move from one site from another.

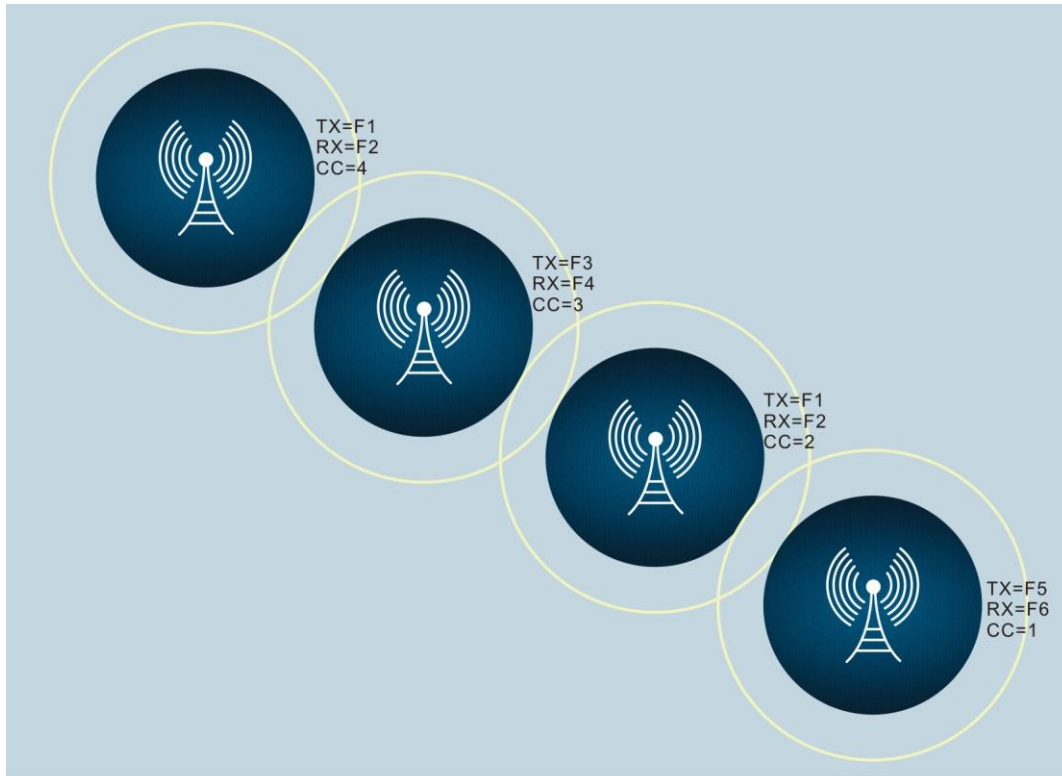


Figure 4.1.3-1 Minimal Overlapping Coverage

4.1.4 Multiple Overlapping Coverage

This scheme is designed for a high-rise building or a deep well, it involves multiple sites standing close to each other and multiple overlapping coverage. Since the coverage of each site is limited, frequency multiplexing is seldom available. And quick signal attenuation occurs frequently due to indoor coverage. In this type of communication coverage, the user can be in the coverage involving one or two sites at the same time, and it takes about 1 minute to move from one site to another.

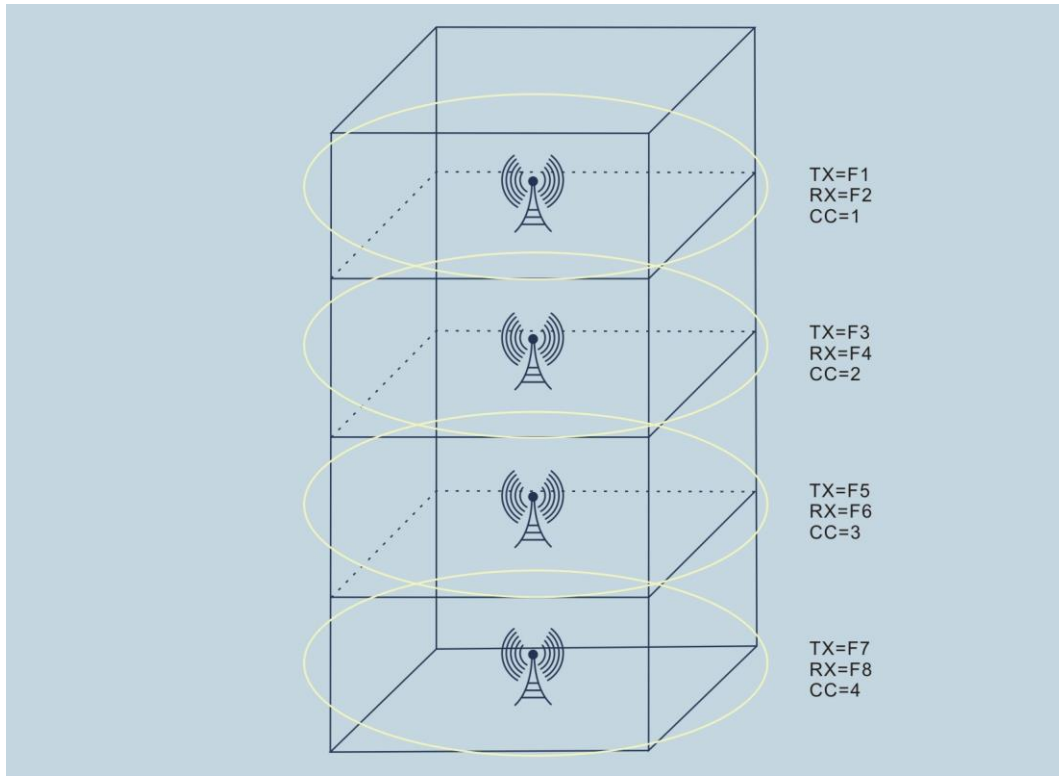


Figure 4.1.4-1 Multiple Overlapping Coverage

4.2 Network Topology of IP Multi-site Connect Mode

The network topology of IP Multi-site Connect can be operated based on multiple networks or can connect all Wide Area Channels (WACH) via a physical network. The actual network topology depends on repeater's location and network connection. Typically, network topology includes two kinds of basic configurations:

Local area network (LAN) configuration
Wide area network (WAN) configuration

Please note that most network topologies of IP Multi-site Connect mode consist of LAN and WAN, details on each configuration will be given respectively in the following sections.

4.2.1 LAN

4.2.1 Local Area Network (LAN)

In IP Multi-site Connect mode, the following networks are supported:

Dedicated LAN
A company's LAN

Dedicated radio communication system

There can be various kinds of LAN configurations. The IP Multi-site Connect network system can work properly once all devices are in the same LAN or connected to some other networks via a router or NAT. Bandwidth is not a problem to LAN configuration, however, the technicians must have a good knowledge of bandwidth required by every device of IP Multi-site Connect network for the system working at its best. Additionally, only the Master repeater needs a static IPv4 address that other IP Multi-site Connect network devices can use to connect the wide area system. The following figure shows the connection of IP Multi-site Connect devices in different sites via LAN. Note that the IP Multi-site Connect devices shown in the figure may belong to different wide area systems, for example, there are multiple dispatching centers.

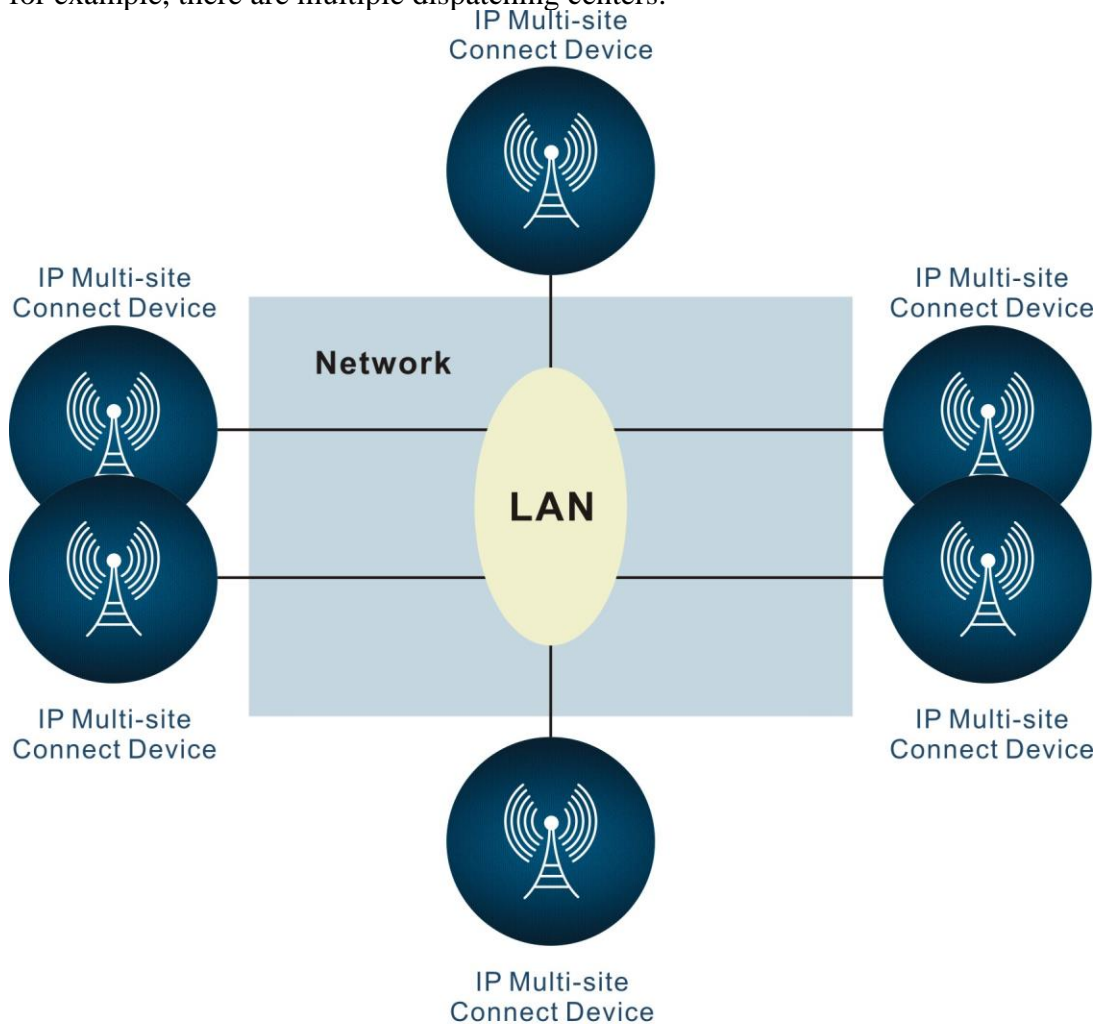


Figure 4.2.1-1 IP Multi-site Connect Network Operating with LAN

4.2.2 WAN

4.2.2 Wide Area Network (WAN)

The biggest advantage of IP Multi-site Connect network lies in that it can connect dispersed sites through the internet provided by an ISP as quickly as by using the dedicated network. ISP provides various technologies to support the network, IP Multi-site Connect network supports these technologies as follows:

- ☐ Dedicated T1
- ☐ DSL (typically ADSL)
- ☐ Cable modem
- ☐ Broadband wireless access
- ☐ ISDN
- ☐ Frame relay
- ☐ Others

At present, the IP network may not be applicable to some dial-up connection due to too narrow bandwidth and satellite internet access due to large delay. In order to make the system operate at its best via internet, the system engineering personnel must have a good knowledge of bandwidth and time delay required by every device of IP Multi-site Connect network. In addition, a sound understanding of bandwidth and time delay among every site is also required especially among the distant sites. In general, the time delay caused by satellite access across 5 continents is unacceptable, whereas this problem does not exist with cable connection.

It is also necessary to note that the communication initiated from one repeater will be sent to all other repeaters in the same system. In other words, the ISP connection bandwidth required by a site correlates with the quantity of repeaters in the system. When a new repeater is added, extra bandwidth would be required for all the sites.

The IP Multi-site Connect work can work with most routers, NAT and firewalls, and it is recommended to install the repeater behind those devices even though it is not a must. IP Multi-site Connect network also supports secure VPN (Virtual Private Network) which is not a function of the IP Multi-site Connect network device but router. The VPN will not pose a burden on the bandwidth but may result in extra time delay.

Only the Master repeater needs a static IPv4 address, while other IP Multi-site Connect devices can use the static address which can be accessed by the internet to connect the wide area system. Additionally, extra configuration (open the port) of the router/NAT/firewall connected to Mater repeater is required for Mater repeater to receive unrequested messages from other repeaters.

The following figure shows the connection of IP Multi-site Connect devices in different sites via LAN. Note that the IP Multi-site Connect devices shown in the figure may belong to different wide area systems, for example, there are multiple dispatching centers.

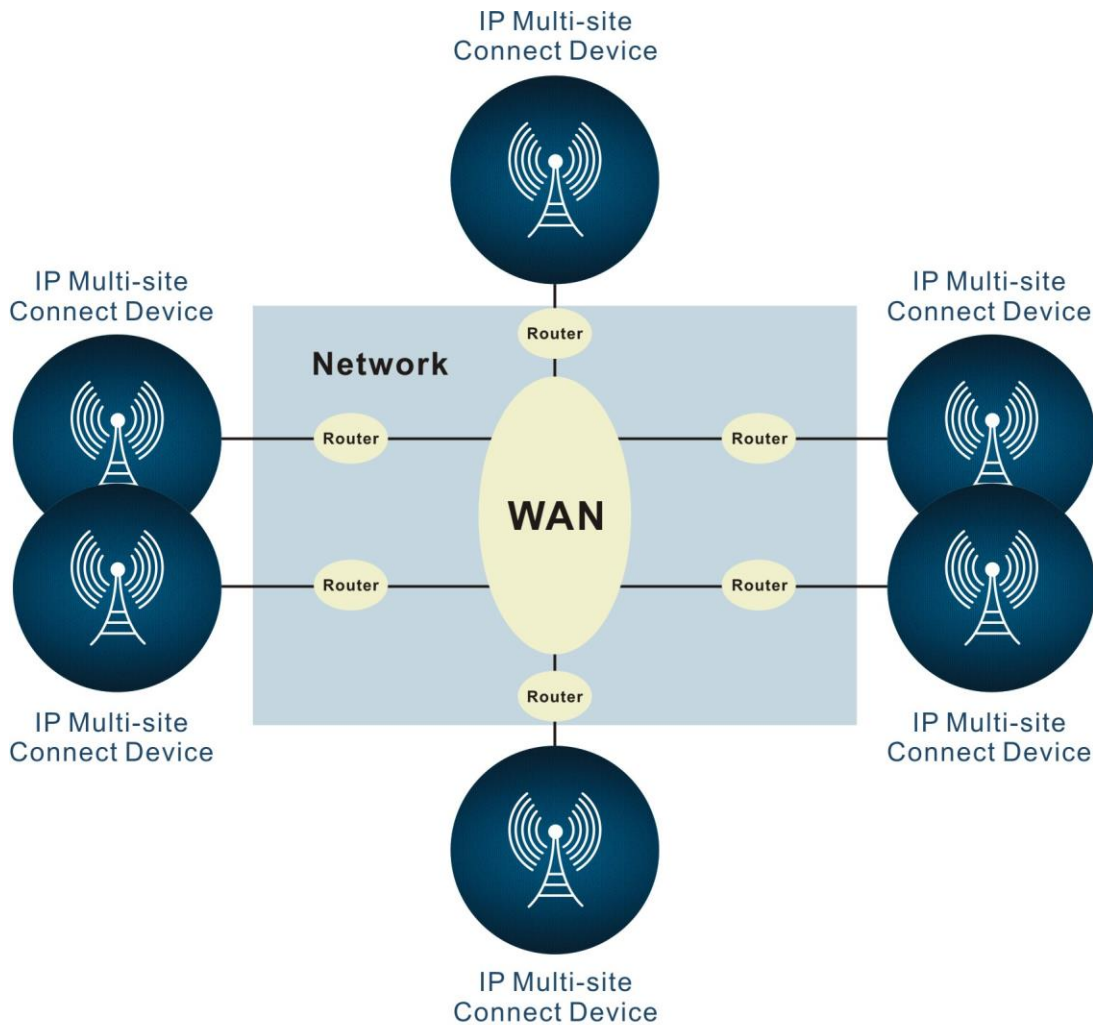


Figure 4.2.2-1 IP Multi-site Connect Network Operating with WAN

4.2.3 WAN and LAN

4.2.3 WAN and LAN

Generally, the network topology consists of LAN and WAN. For example, an ISP is required to connect the LAN of two or more sites or connect one or more remote sites as one network. For WAN, its required bandwidth is related to the number of network devices in IP Multi-site Connect system, the value of the required bandwidth of WAN is the sum of the required bandwidth of each IP network device connected to router. That is, if there are three IP network devices using a single ISP connection, the ISP connection must have enough bandwidth to support the three devices at the same time. Since the data transmitted from one repeater will be sent to all other repeaters in the same system, the required bandwidth of the ISP for a site is the sum of all other sites' bandwidth in the

same system. When a new repeater is added, extra bandwidth would be required for all the sites in the same system. Similar to WAN configuration, only the Master repeater needs a static IPv4 address, while other IP Multi-site Connect devices can use the static address which can be accessed by the internet to connect the wide area system. In the same LAN, the repeater containing a static IP address is deemed as the Master repeater by default. Likewise, extra configuration (open the port) of the router/NAT/firewall connected to Mater repeater is required for Mater repeater to receive unrequested messages from other repeaters. For the IP Multi-site Connect network device in LAN to communicate with other devices over WAN IPv4 address, the routers in WAN must support “HairPinning” which is a function that will send the source address a message indicating how to reach the destination.

The following figure shows the connection of IP Multi-site Connect devices in different sites via LAN and WAN. Note that the IP Multi-site Connect devices shown in the figure may belong to different wide area systems, for example, there are multiple dispatching centers.

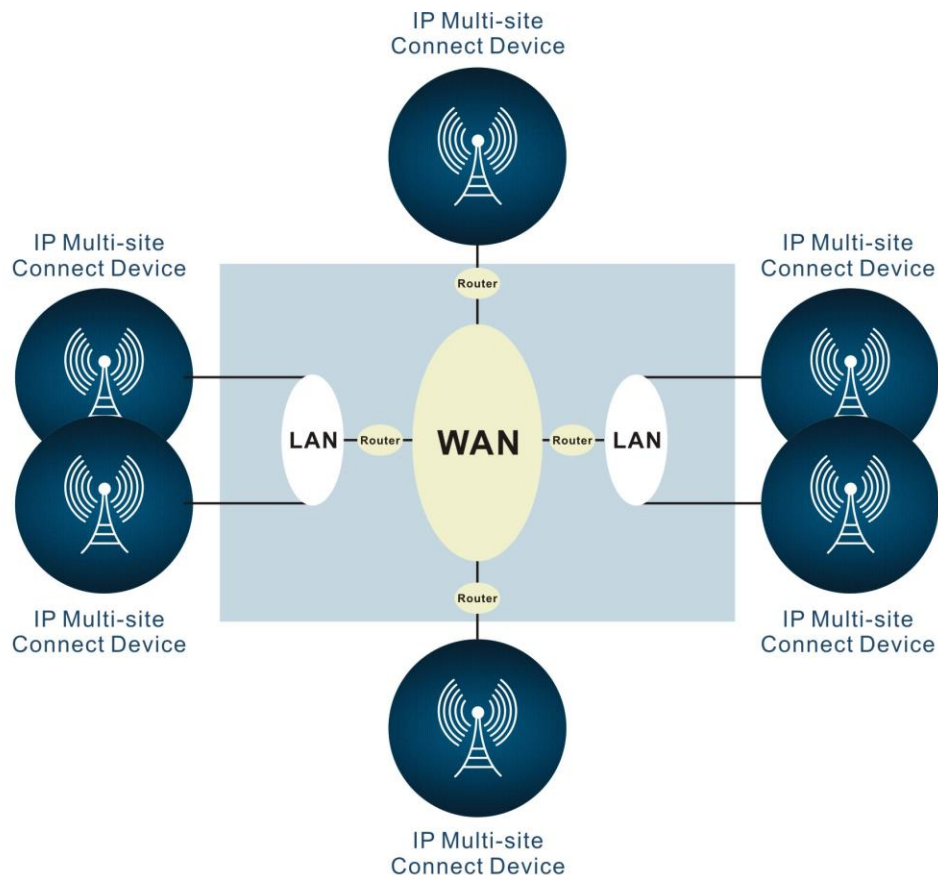


Figure 4.2.3-1 IP Multi-site Connect Network System Operating with WAN and LAN

4.3 Broadband Wireless Access

IP Multi-site Connect provides broadband wireless access which offers you more kinds of schemes of network connection to meet your actual needs. The typical schemes of broadband wireless access are illustrated as below:

4.3.1 Point-to-Point (PTP) and Ethernet Cable

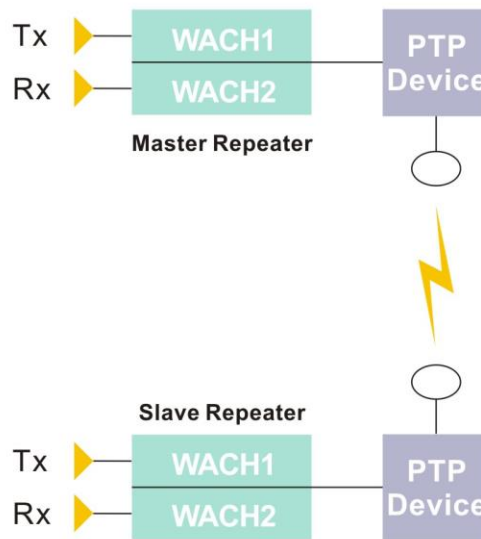


Figure 4.3.1-1 By Point-to-Point(PTP)and Ethernet Cable

4.3.2 PTP and LAN

4.3.2 Point-to-Point (PTP) and Local Area Network (LAN)

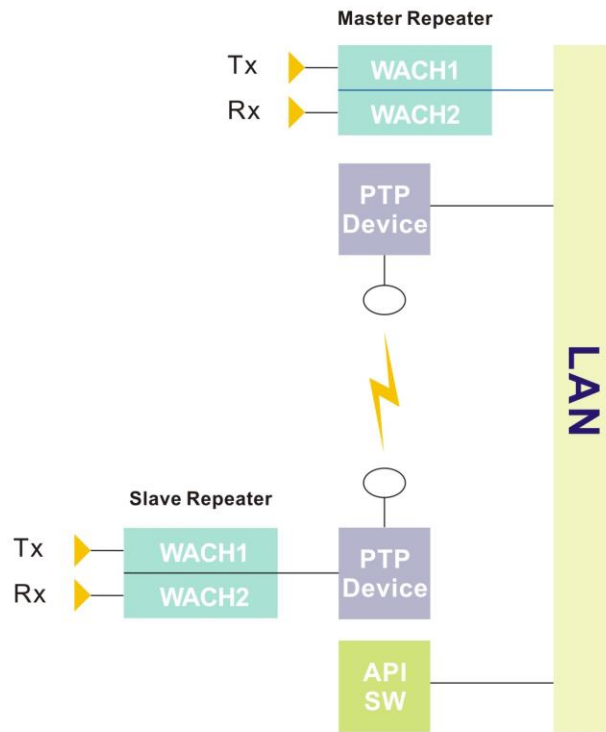


Figure 4.3.2-1 By Point-to-Point(PTP)and Local Area Network(LAN)

4.3.3 PTP Cluster and LAN

4.3.3 Point-to-Point (PTP) Cluster and Local Area Network (LAN)

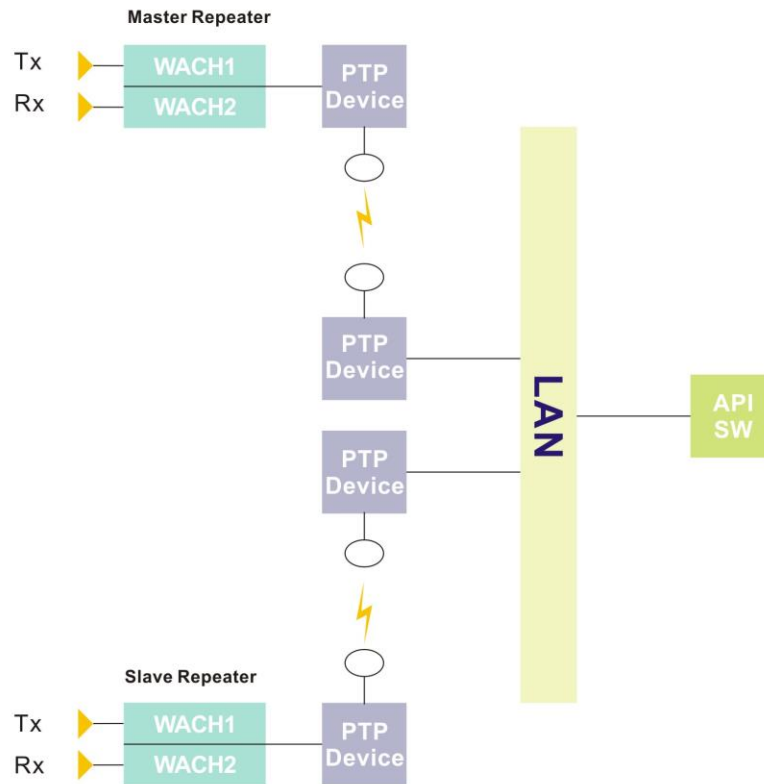
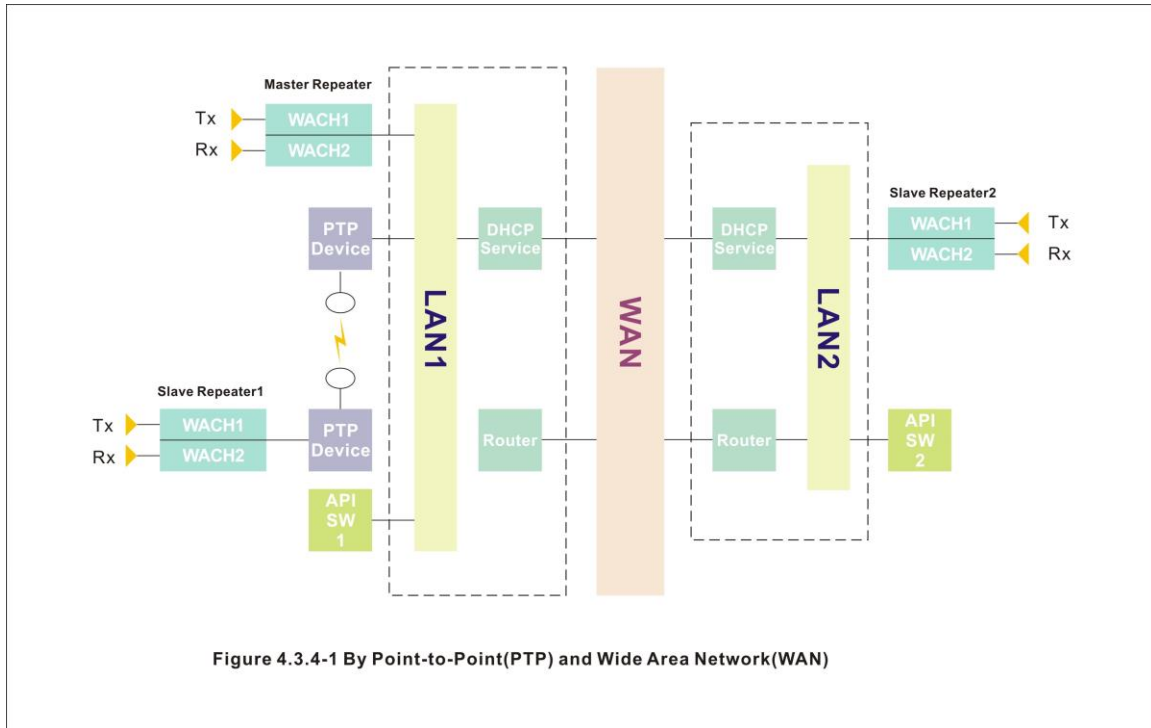


Figure 4.3.3-1 By Point-to-Point(PTP)Cluster and Local Area Network(LAN)

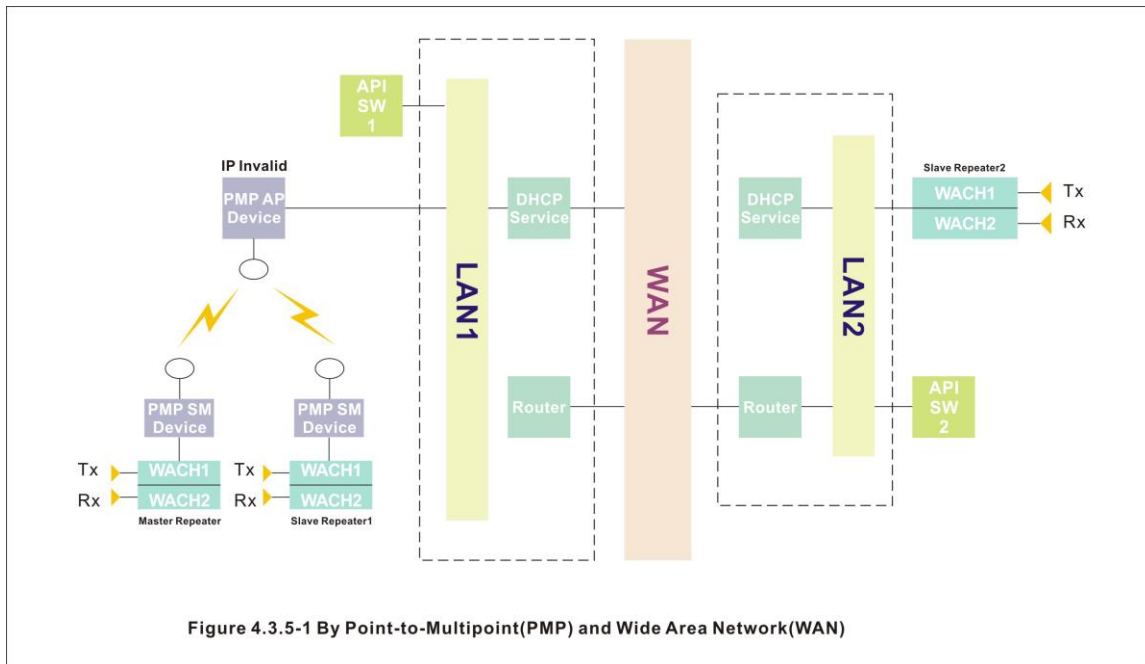
4.3.4 PTP and WAN

4.3.4 Point-to-Point (PTP) and Wide Area Network (WAN)



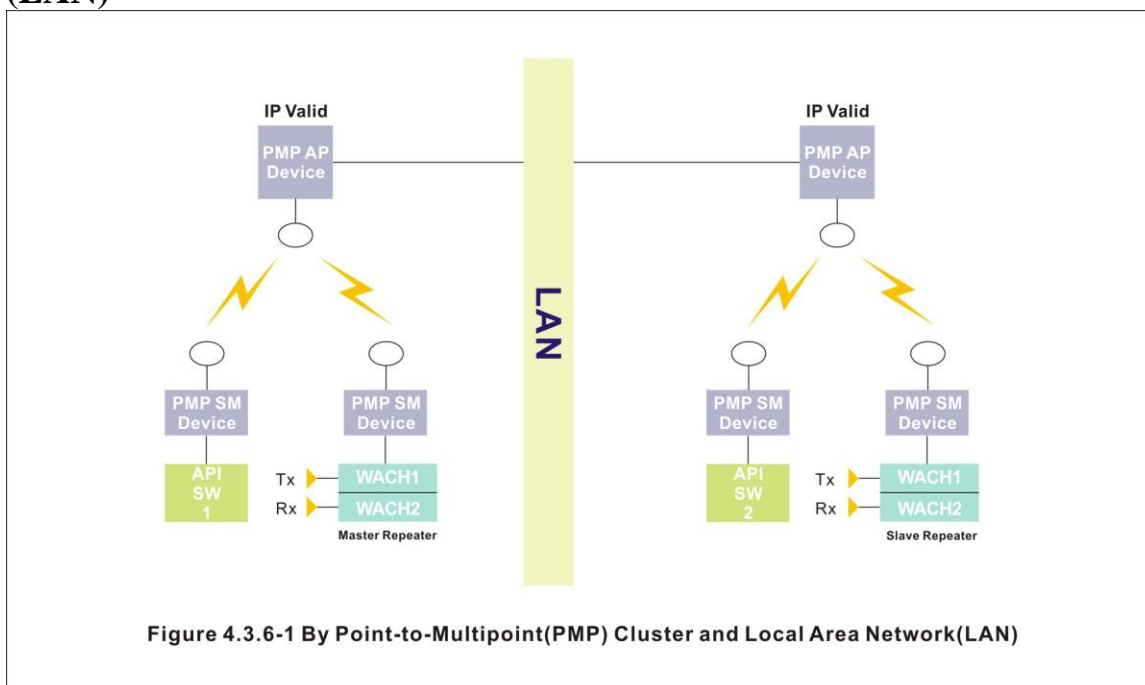
4.3.5 PMP and WAN

4.3.5 Point-to-Multipoint (PMP) and Wide Area Network (WAN)



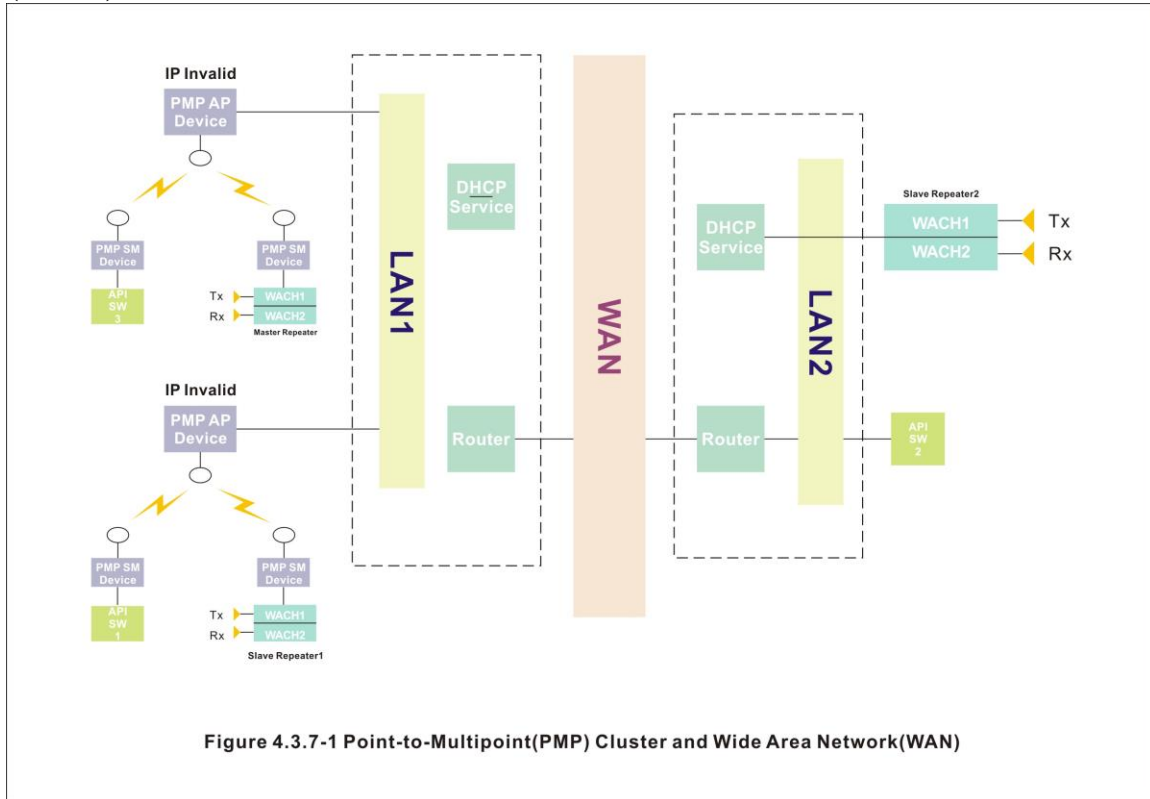
4.3.6 PMP Cluster and LAN

4.3.6 Point-to-Multipoint (PMP) Cluster and Local Area Network (LAN)



4.3.7 PMP Cluster and WAN

4.3.7 Point-to-Multipoint (PMP) Cluster and Wide Area Network (WAN)



5. Methods of Equipment Connection and Configuration

5.1 Configuration Methods

The appropriate configuration scheme shall be selected on the basis of network topology and the actual application to realize the IP Multi-site Connect scheme. To configure a comprehensive IP Multi-site Connect scheme of WAN and LAN, many kinds of parameters that would be involved include:

- 1) Terminal parameters (configured via terminal CPS)
- 2) Repeater parameters (configured via repeater CPS)

- 3) Routing parameters (configured by corresponding configuration method of routing device)
- 4) Broadband wireless access parameters (configured by corresponding configuration method of broadband wireless access device)

5.2 Ethernet Cable Connection

5.2.1 Connection Method

An Ethernet cable is required to connect two repeaters directly in this scheme to realize the IP Multi-site Connect. The disadvantage of this scheme lies in poor expandability of physical space because it can only connect two repeaters.

5.3 Local Area Network (LAN)

5.3.1 Connection Method

This scheme is used for a switch or multiple switches within the LAN to achieve seamless communication in the same area.

5.4 Wide Area Network (WAN)

5.4.1 Connection Method

This scheme is used to connect multiple sites across different areas. The key device of this scheme is the routing device, which can connect multiple repeaters in different locations to achieve IP Multi-site Connect in the WAN.

6. Terminal's Digital Functions Supported in IP Multi-site Connect Mode

Terminals (portable radio and mobile radio) support all services of digital functions in IP Multi-site Connect mode. The following table lists the frequently-used functions in terminal software version:

Terminal's Digital Functions Supported in IP Multi-site Connect Mode				
Voice Service	Supplementary Service	Data Service	Emergency Service	Other Functions
Private Call	PTT ID and Alias	Message	Emergency Alarm	Dual WACH (Slot1 & Slot2)
Group Call	Radio Disable/ Radio Enable	*GPS	Emergency Call w/Alarm	WACH and LACH
All Call	Remote Monitor	*API	Auto Emergency Call	Basic Encryption and Advanced Encryption
	Radio Check		Emergency Revert Channel	Virtual Trunking
	Call Alert		Lone Worker	Time-out-Timer (TOT)
			Man Down	*Scan
The specific functions are subject to the terminal's software version.				
* indicates that the function is partially available at present. For more information, please consult your dealer.				

7. FAQ

7.1 What is the system capacity in IP Multi-site Connect network?

At present, IP Multi-site Connect network can support to connect 15 repeaters, hardware performance of the current products needs to be promoted if you need to connect more than 15 repeaters, otherwise data can not be transmitted to all repeaters in the allowed time. The number of terminal supported by the channel in IP Multi-site Connect network configuration is the same with that of single site configuration. Therefore it is necessary to note that IP Multi-site Connect network configuration only adds system's coverage but not the call's capacity comparing with single site configuration.

7.2 Can the others work normally if one of the repeaters fails in IP Multi-site Connect network?

Yes, once the network is built among multiple repeaters, it would not affect other repeaters even though the network problem exists in any repeater in this network. That is because the entire network is similar to a peer-to-peer network in which the Master repeater is used for registration and broadcasting address, if a Slave repeater disconnects, the Master repeater can detect and broadcast it to all other Slave repeaters; If the Master

repeater disconnects, all Slave repeaters can still work, however, new address can not be added and the status of other Slave repeaters can not be acquired until the Master repeater restores to normal operation.

7.3 How to select frequency and color code in IP Multi-site Connect network?

You can select different networking scheme as per your actual needs in different system topologies. In the overlapping area, it is recommended that the frequency of the repeater be different, but the color code can be the same or varied. For adjacent repeaters sharing the same frequency, it is better to use different color code to avoid probable interference. Because using the same frequency and color code in the overlapping coverage will cause interference, therefore it is not recommended to use the same frequency and color code in adjacent repeaters in the overlapping coverage to ensure your normal communication.