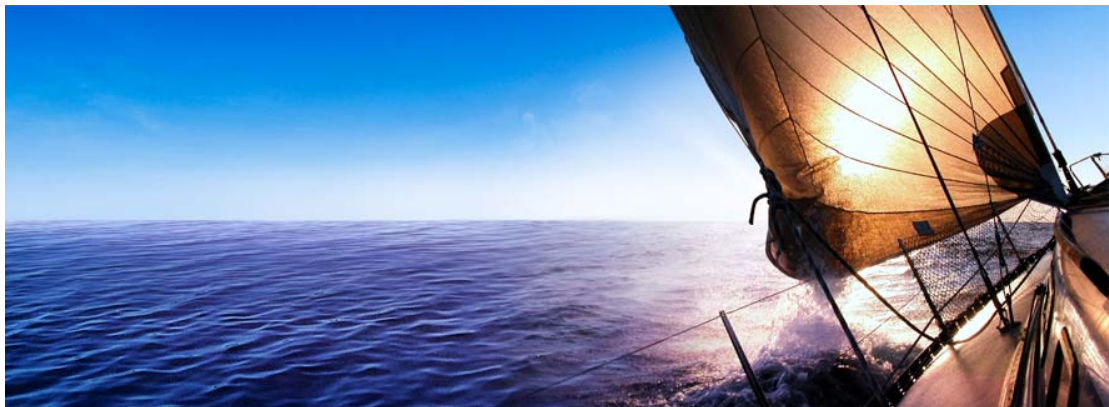# Hytera DMR Conventional Series

IP Multi-site Connect
Application Notes

Hytera DMR Conventional Series

IP Multi-site Connect

Application Notes

Version 1.0

Date: January 28, 2011
Web: http://www.hytera.com

Revision History

Version	Date	Description	Remarks
R1.0	01-28-2011	Initial release	

Contents

1. Overview

1.1 Definition

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

1.2 Application

IP Multi-site Connect can bring users these typical benefits:

1) To connect two or more conventional communication systems in different areas.

For example, you can use this function to connect two repeaters over a large geographic area.

2) To construct a more effective communication area with wider coverage

For example, you can deploy multiple repeaters in a large building to ensure seamless communication. This can help fight the problems from unfavorable terrains.

3) To broadcast a message to all connected repeaters

For example, the dispatcher can send an instruction to all repeaters in IP Multi-site Connect mode in case of an emergency.

4) To connect repeaters working with varied frequency bands

For example, UHF repeaters and VHF repeaters can be connected so that data and voice can be exchanged among them.

5) To use multiple IP-based applications

For example, when IP Multi-site Connect is enabled, you can use multiple IP-based software (such as Dispatcher) as well as API-based software developed by any third party to realize more functions.

Consult your dealer for more information on supported software.

Consult your dealer for more information on development of API-based software.

1.3 Principle

1) IP Multi-site Connect

IP Multi-site Connect is designed to extend the communication coverage by connecting multiple repeaters in dispersed locations over a TCP/IP-based network.

In IP Multi-site Connect mode, DMR protocol is transported by TCP/IP protocol and a Hytera-owned protocol at Application Layer. Accordingly, it is reasonable to conclude that this mode only changes the DMR transmission media without affecting the services of DMR terminals.

One Repeater - Coverage

N Sites

IP Multi-site Connect - Coverage
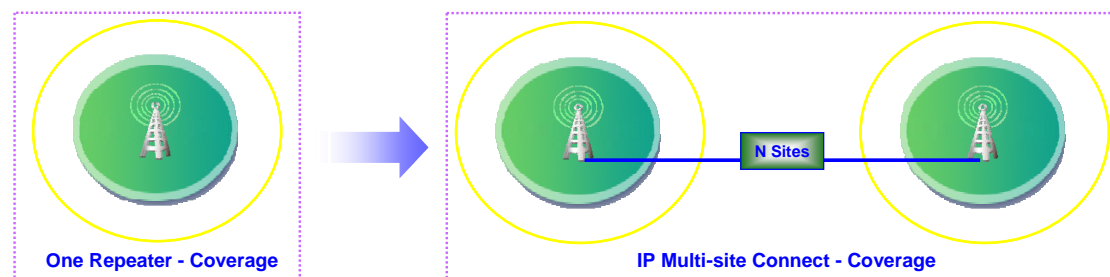
Figure 1.3-1 Wider Coverage in IP Multi-site Connect Mode

2) TCP/IP Model

The figure below describes how IP Multi-site Connect works:

Application layer	Hytera-owned transmission protocol	
Transport layer	TCP	UDP
Network layer	IP ICMP	
Physical layer	Subject to specific requirements	

Figure 1.3-2 TCP/IP Model

- Physical layer: the lowest layer of TCP/IP.

- Network layer: also called IP layer. It is responsible for routing IP packets.

- Transport layer: to set up a session between the source host and

the destination host. It consists of Transmission Control Protocol (TCP) and User Datagram Protocol (UDP).

- Application layer: to combine and realize the function of Session Layer and Presentation Layer. It provides application-specific protocols.

As can be seen from the above figure, our IP Multi-site Connect function uses UDP at Transport Layer and self-owned transmission protocol at Application Layer. At Network Layer and Physical Layer, different protocols and devices may apply depending on actual requirements.

1.4 Version

1) R3.0: to release IP Multi-site Connect for the first time;

2) R3.5: to improve IP Multi-site Connect; to release the function "Roaming" and the application "Repeater Diagnostic and Control" (RDAC);

* R1.0 is designed to give a rough introduction to IP Multi-site Connect, and more information will be available after R3.5.

* Consult your dealer for more information on DMR conventional series software.

1.5 Restraint

The use of IP Multi-site Connect may be subject to the following conditions:

1) The repeater must operate in Digital mode;

2) The repeater configurations;

3) The network type and the configurations of network devices.

2. Requirements

2.1 Requirements on Devices

   1) Repeaters (see Hytera device list for details)

   2) Terminals (see Hytera device list for details)

   3) Exchange devices (consult your supplier for details)

   4) Routing devices (consult your supplier for details)

   5) Broadband wireless access devices (consult your supplier for details)

   6) Network cables

2.2 Requirements on Network

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

   2) A number of technologies are supported by the 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. For the latter, it is unnecessary to fix its IP address and UDP port.

   5) The repeater can locate behind the firewall, router or NAT.

   6) IP address instead of proxy server shall be used to access the WAN.

3. References

N/A

4. Network Architecture

4.1 Four Basic Schemes

4.1.1 Heavy Overlapping Coverage

In the overlapping areas, different frequencies are used, while in the non-overlapping areas, the same frequency is employed but different color codes are required for roaming service. In this scenario, a 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.
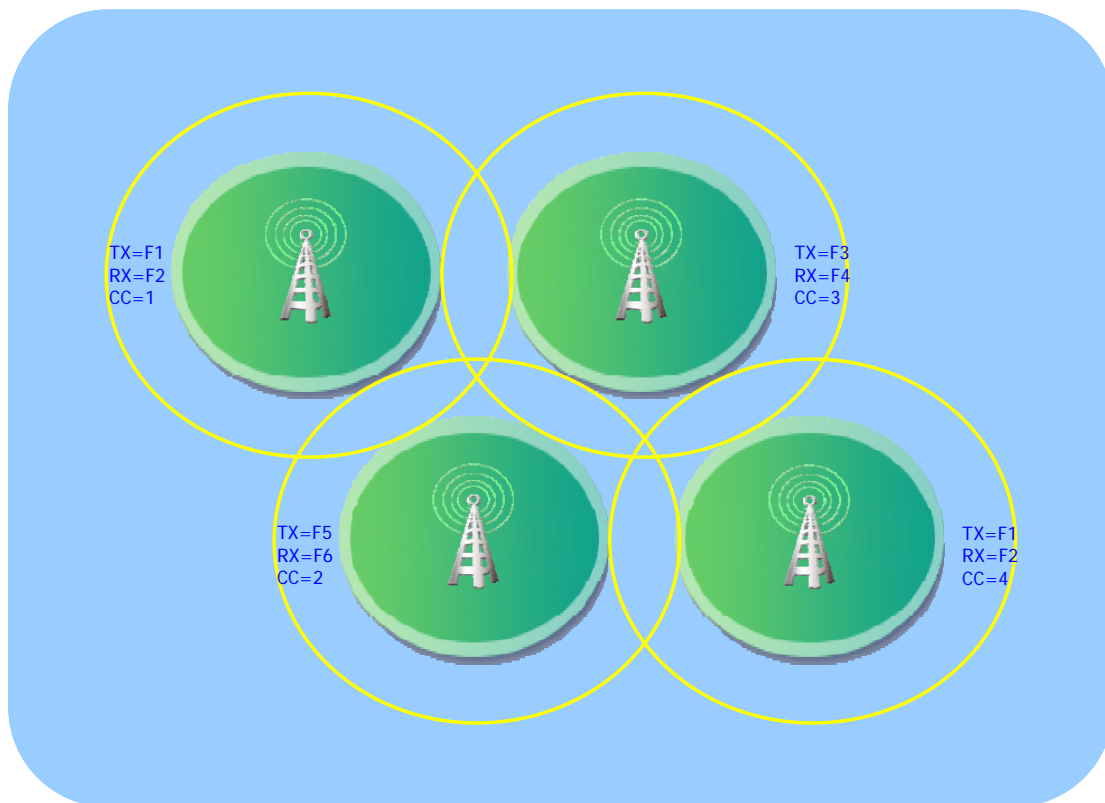

Figure 4.1.1-1 Heavy Overlapping Coverage

4.1.2 Non-overlapping Coverage

This scheme is designed for countryside or part of a small city. It involves multiple separate sites and no overlapping coverage is present. In the non-overlapping areas, the same frequency is used while different color codes are required for roaming service. In this scenario, a user can only enjoy the coverage

from 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, river or coastline. It involves multiple sites and minimal overlapping coverage. The overlapped areas share a single frequency, but different color codes are required for roaming service. In this scenario, a user can enjoy the coverage involving one or two sites at the same time, and it takes about an hour to move from one site to 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 from each other and multiple overlapping coverage. Since the coverage of each site is limited due to adverse geology conditions, frequency reuse is seldom available, and quick signal attenuation occurs frequently. In this scenario, a user can enjoy the coverage from one or two sites at the same time, and it takes about 1 minute to move from one site to another.
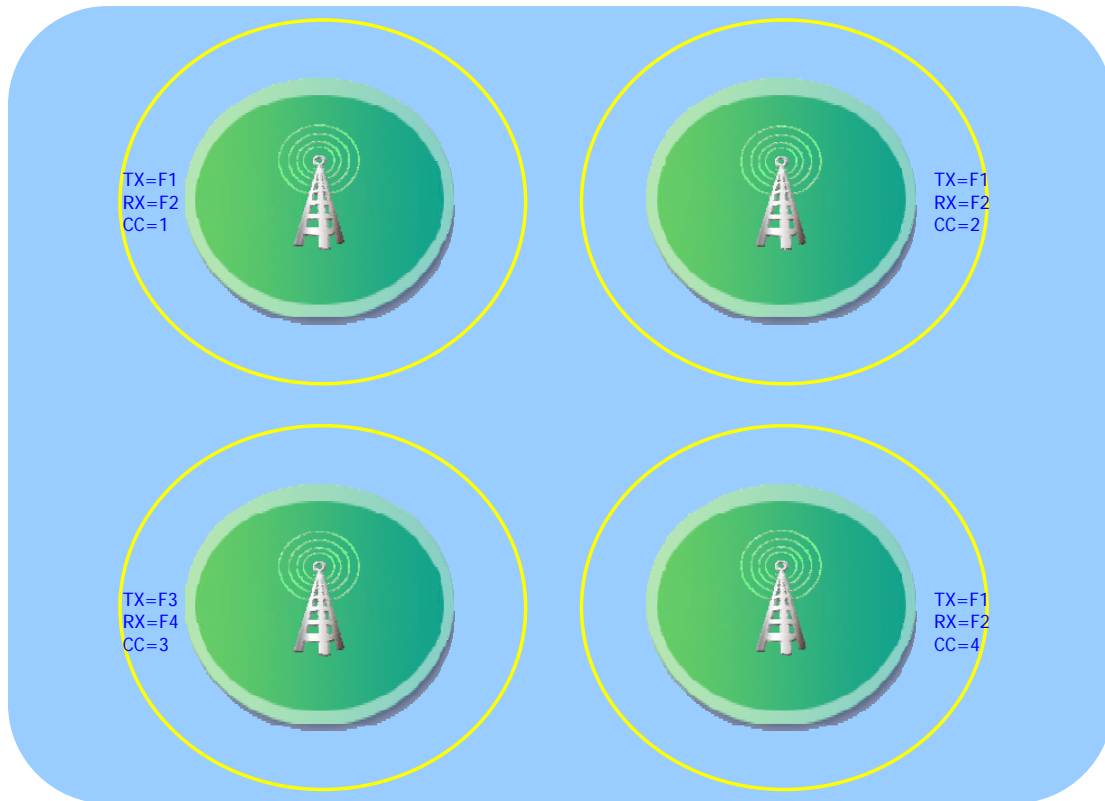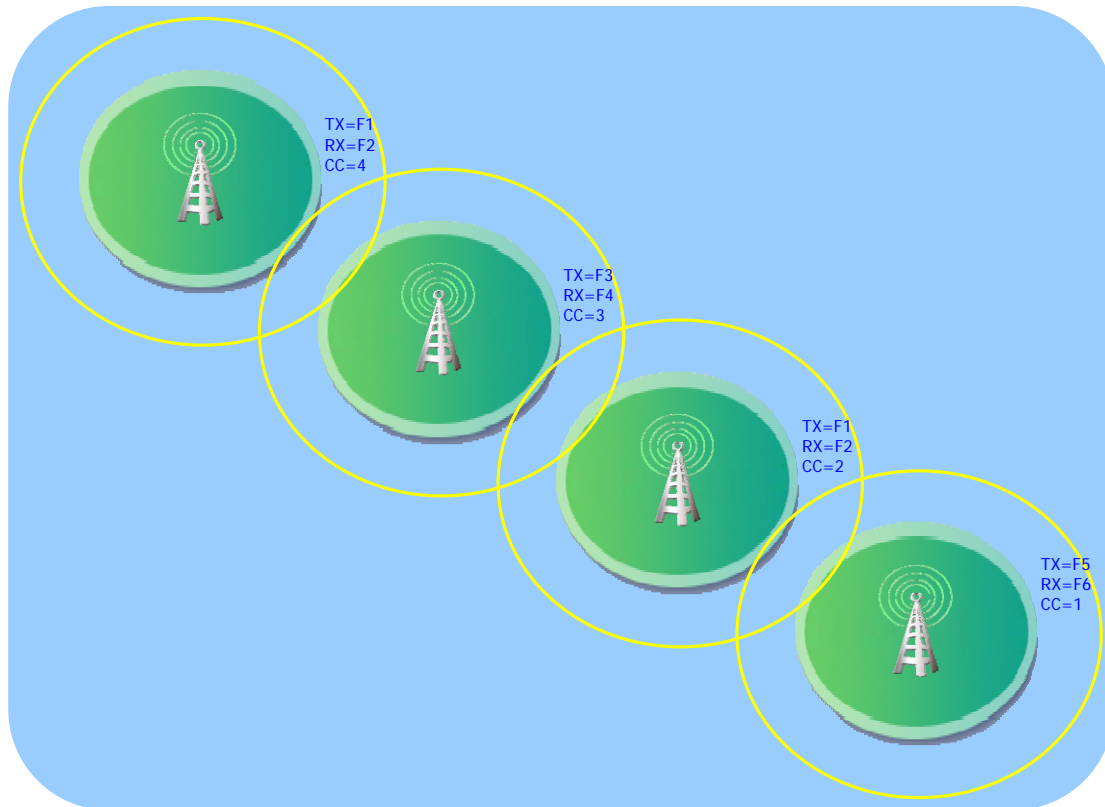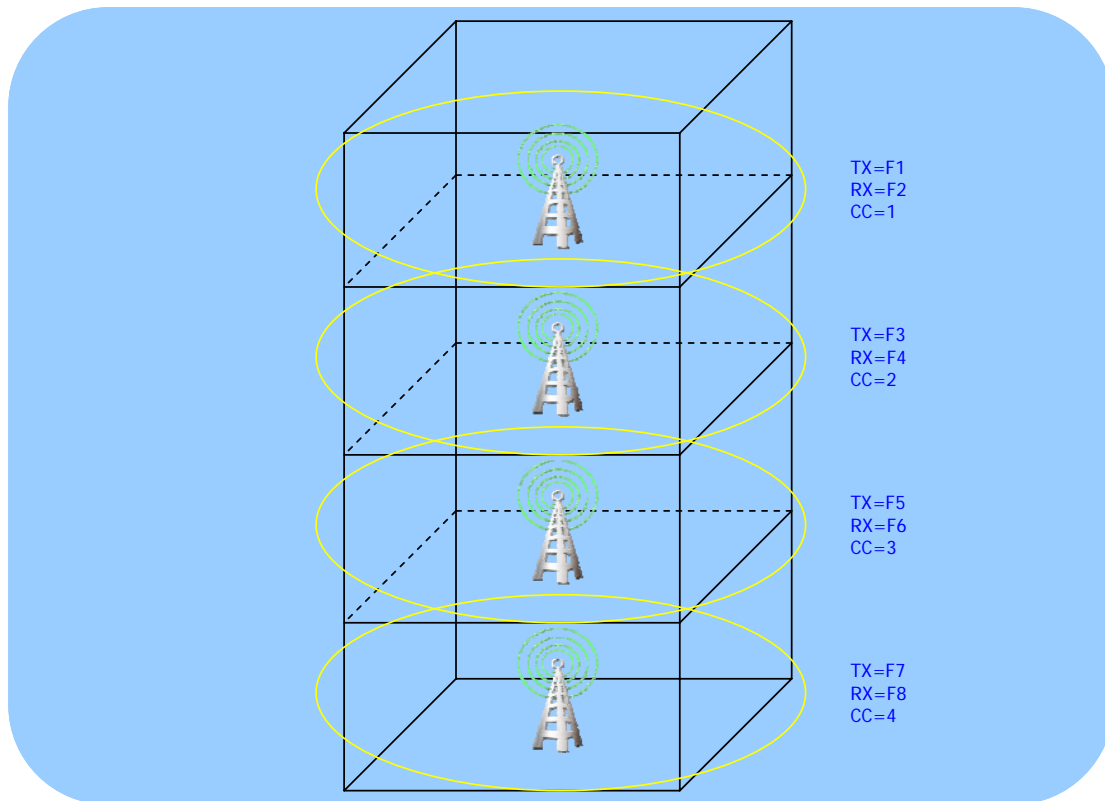
Figure 4.1.4-1 Multiple Overlapping Coverage

4.2 Network Topology of IP Multi-site Connect

The network topology of IP Multi-site Connect can operate with many networks or can connect all Wide Area Channels (WACH) via a physical network, depending upon the repeater location and the network connection. Typically, there are two kinds of network topologies:

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

In most cases, LAN and WAN together constitute the network topology. In the following sections, details on LAN and WAN will be given respectively.

* The same network configurations may apply to analog/digital repeaters, enabled/disabled repeaters, wide area/local repeaters or any device developed by a third party based on IP Multi-site Connect protocols.

4.2.1 Local Area Network

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

- **Dedicated LAN**

- **A company's LAN**

- **Dedicated radio communication system**

Despite variable 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. In order for the system to operate at its best, however, the technicians must have a good knowledge of bandwidth required by related devices.

Additionally, only the Master repeater needs a static IPv4 address, which the other network devices can use to connect the wide area system.

The following figure shows an example of IP Multi-site Connect operating with LAN. Note that the network devices 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 Wide Area Network

The biggest advantage of IP Multi-site Connect lies in that it can connect dispersed sites quickly through the internet provided by an ISP, which provides a range of technologies for IP Multi-site Connect:

- Dedicated T1
- DSL (typically ADSL)
- Cable modem
- Broadband wireless access such as Canopy
- ISDN
- Frame relay
- others

At present, the IP network is not applicable to dial-up connection due to narrow

bandwidth or satellite internet access due to large delay. In order for the system to operate at its best, the system engineering personnel must have a good knowledge of bandwidth and time delay required by related devices. In addition, a sound understanding of bandwidth and time delay between two sites is also required, especially between two distant sites. In general, the time delay of satellite access across 5 continents is unacceptable, whereas this problem does not exist with cable communication.

It is necessary to note that a repeater's communication request will be sent to all other repeaters in the same system. In other words, the bandwidth required by a site correlates with the sum of repeaters in the system. When a new repeater is added, all other repeaters would require extra bandwidth.

The IP Multi-site Connect network can work with many routers, NAT and firewalls. It is recommended to install the repeater behind these devices.

Most routers have a useful function -- secure VPN (Virtual Private Network). The VPN will not pose a burden on the bandwidth but may result in time delay.

To receive unrequested messages from other repeaters, the Master repeater needs a static IPv4 address, which the other network devices can use to connect the wide area system. Additionally, the router, NAT or firewall connecting Master repeater must be configured properly as well.

The following figure shows an example of IP Multi-site Connect operating with WAN.

Note that the network devices may belong to different wide area systems, for example, there are multiple dispatching centers.
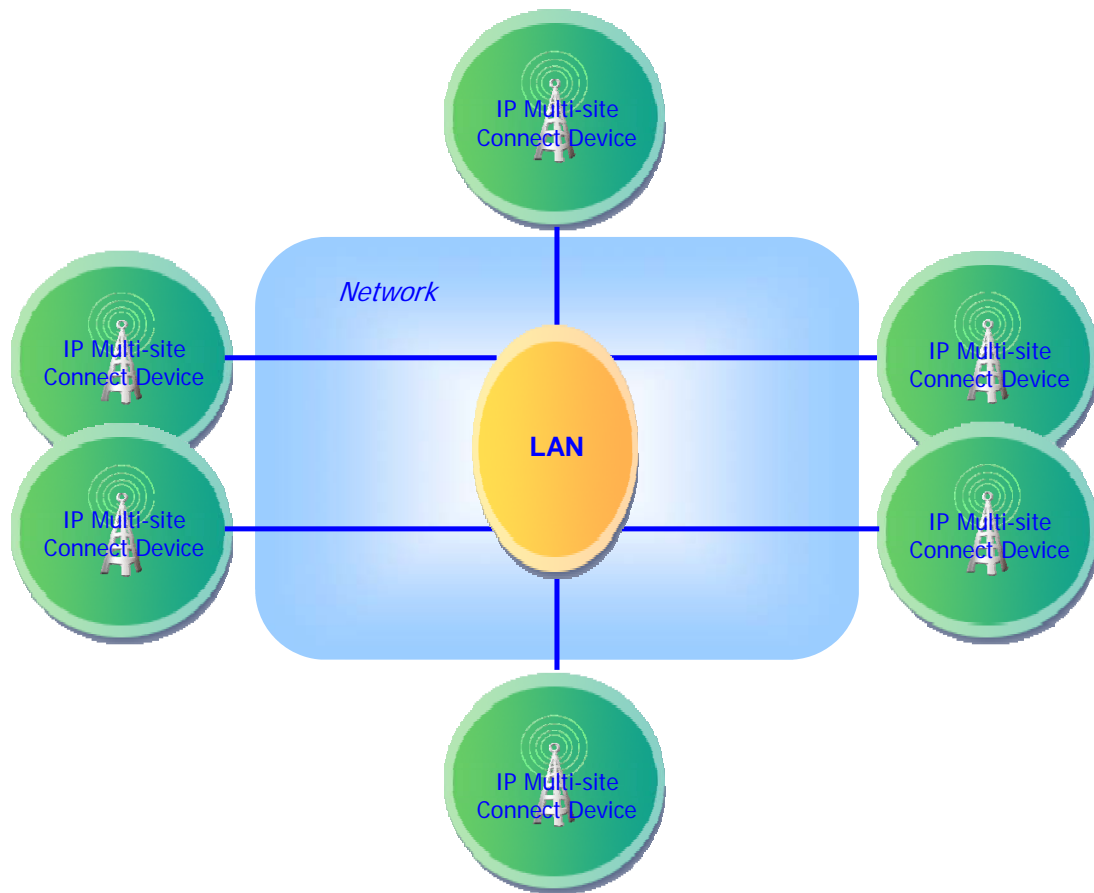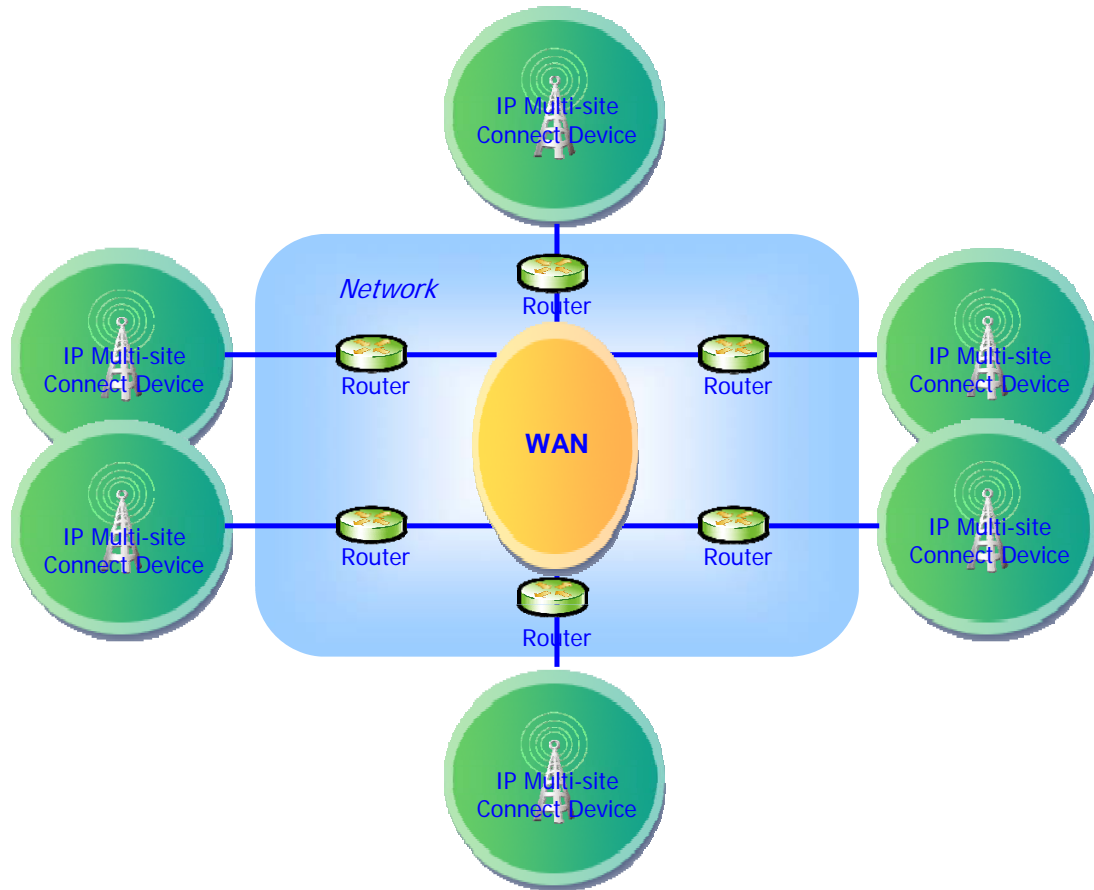
Figure 4.2.2-1 IP Multi-site Connect Network Operating with WAN

4.2.3 WAN and LAN

Generally, WAN and LAN together constitute the network topology, for example, multiple remote sites or the LAN of two sites can be connected via an ISP.

For WAN, its required bandwidth is related to the number of network devices in IP Multi-site Connect system, that is, the value shall be the sum of required bandwidth of each network device; for a site, since the communication request of a repeater will be sent to all other repeaters in the same system, the ISP bandwidth required for a site is the sum of all other sites' bandwidth. When a new repeater is added, all other repeaters would require extra bandwidth.

Similar to WAN, to receive messages from other repeaters, the Master repeater needs a static IPv4 address, which the other network devices can use to connect the wide area system. In a LAN, the repeater containing a static IP address is

deemed as the Master repeater by default.

Likewise, the router, NAT or firewall connecting Master repeater must be configured properly to receive unrequested messages from other repeaters.

For the IP Multi-site Connect network to work over IPv4, the routers in wide area network must support "HairPinning" – a function that will send the source address a message indicating how to reach the destination.

The following figure shows an example of IP Multi-site Connect operating with WAN and LAN.

Note that the network devices may belong to different wide area systems, for example, there are multiple dispatching centers.
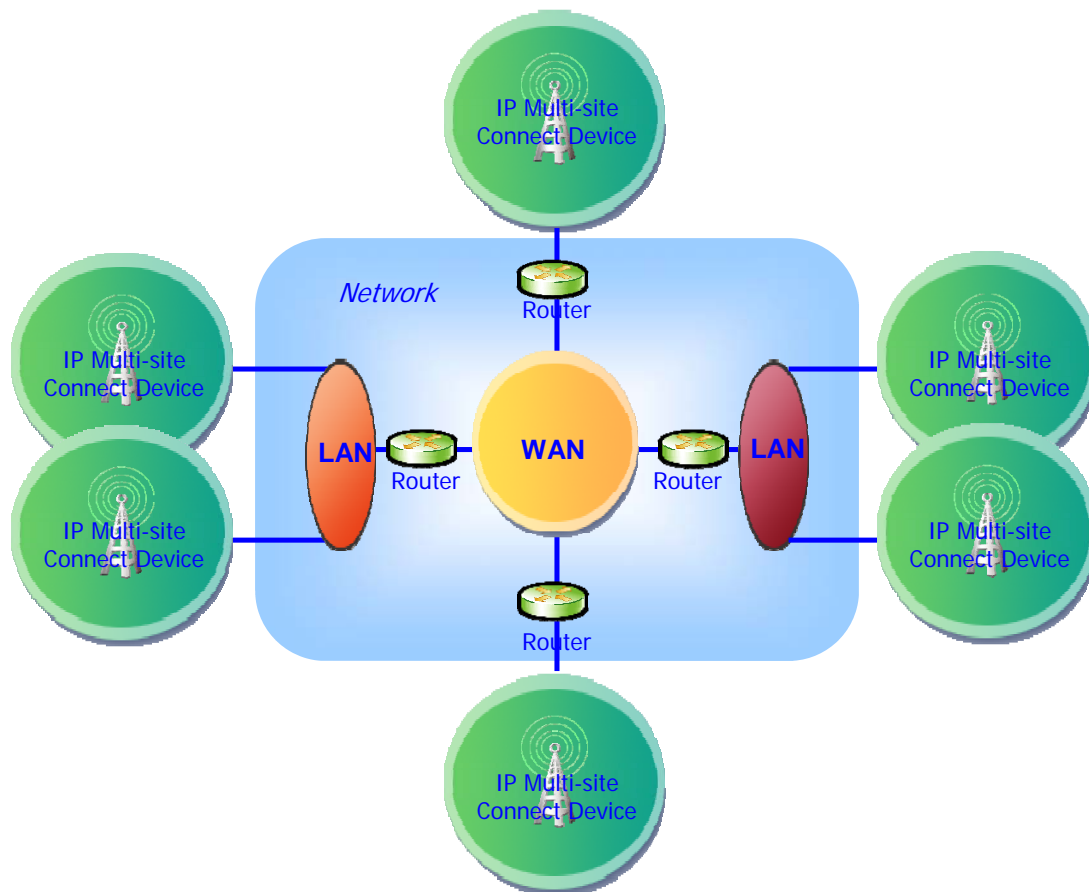

Figure 4.2.3-1 IP Multi-site Connect Network System Operating with WAN and LAN

Note: the number of IP devices has an impact on the bandwidth requirement of WAN.

4.3 Broadband Wireless Access

IP Multi-site Connect provides a number of schemes for broadband wireless access to meet your actual needs.

The typical schemes are illustrated as below.

* You can contact your dealer for more information on how to use broadband wireless access devices (PTP, PMP SM, PMP AP, etc).

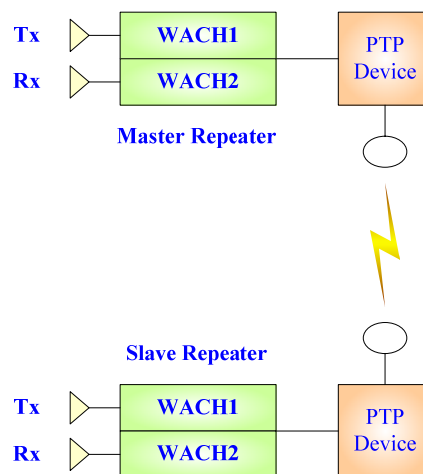## 4.3.1 Point-to-Point (PTP) and Ethernet Cable

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

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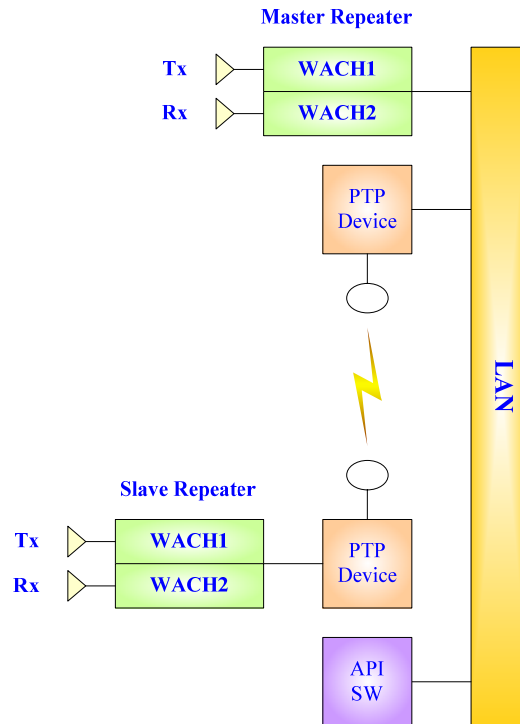
Figure 4.3.2-1 By Point-to-Point (PTP) and Local Area Network (LAN)

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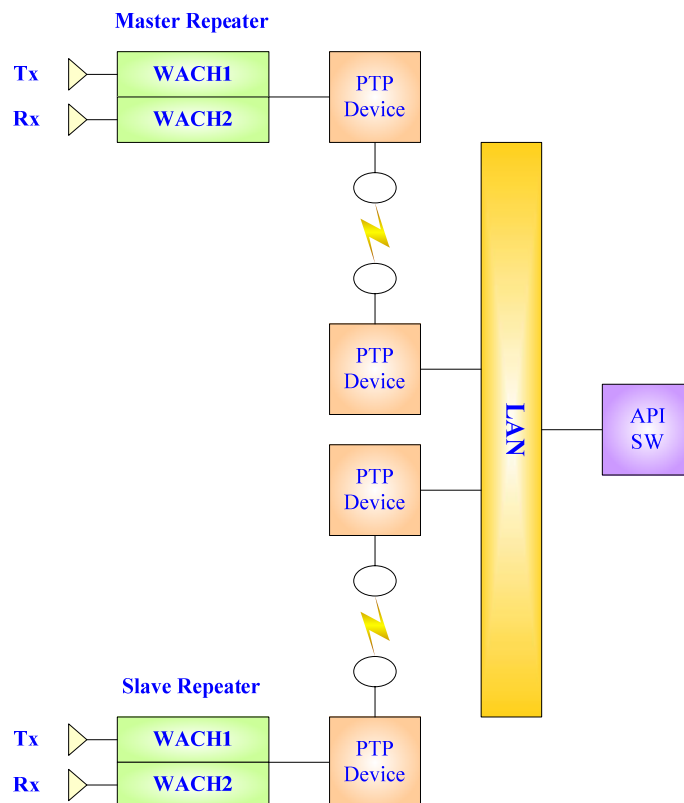
Figure 4.3.3-1 By Point-to-Point (PTP) Cluster and Local Area Network (LAN)

4.3.4 Point-to-Point (PTP) and Wide Area Network (WAN)
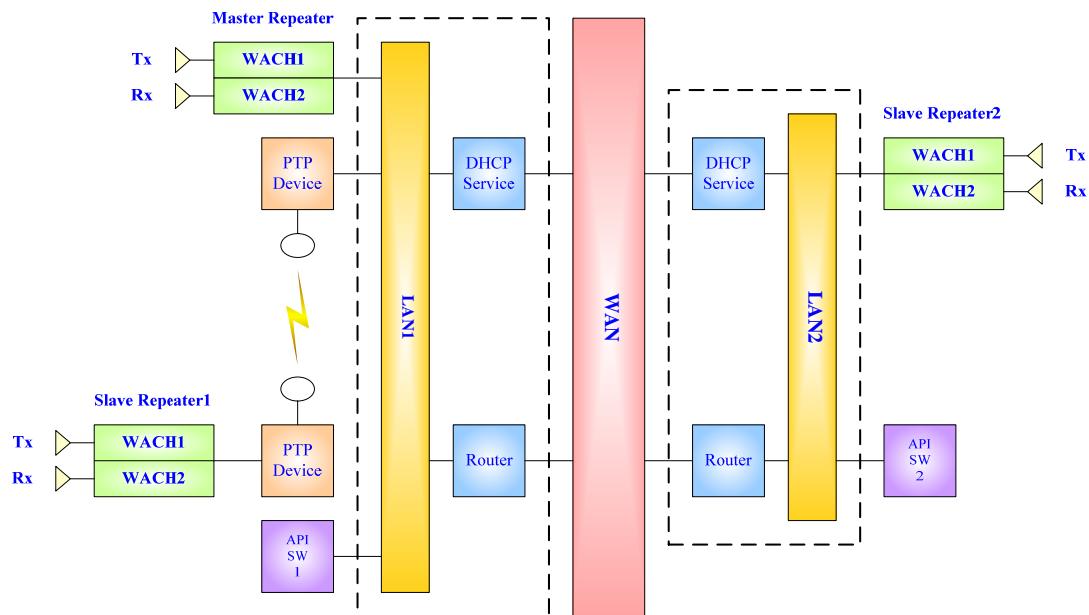
Figure 4.3.4-1 By Point-to-Point (PTP) and Wide Area Network (WAN)

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

Figure 4.3.5-1 By Point-to-Multipoint (PMP) and Wide Area Network (WAN)

4.3.6 Point-to-Multipoint (PMP) Cluster and Local Area Network (LAN)
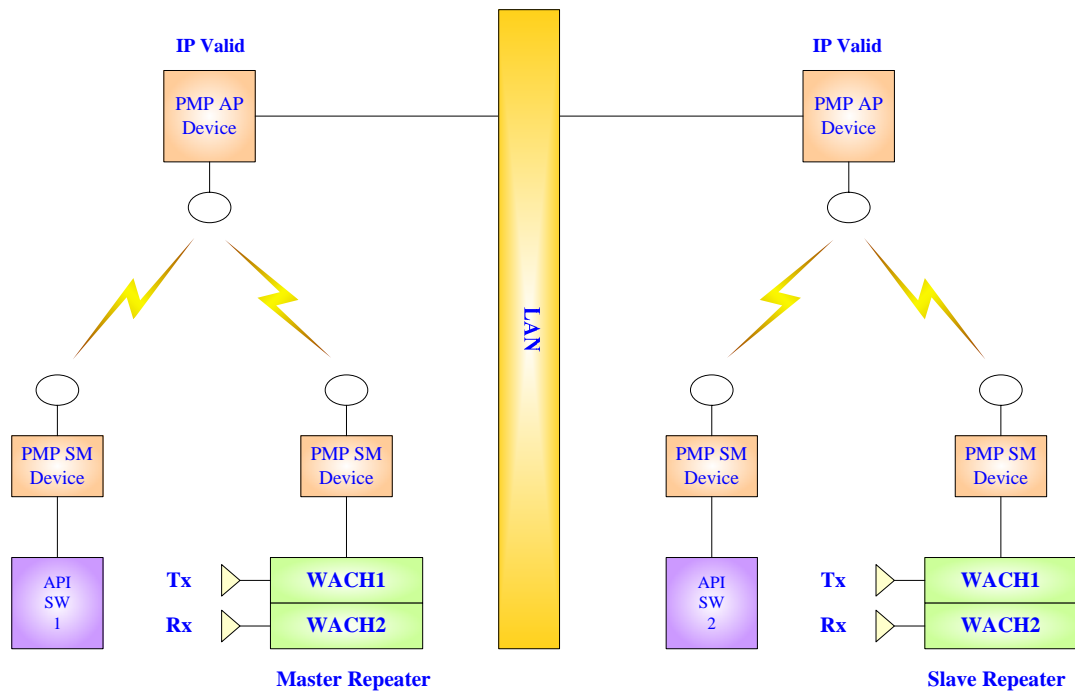
Figure 4.3.6-1 Point-to-Multipoint (PMP) Cluster and Local Area Network (LAN)

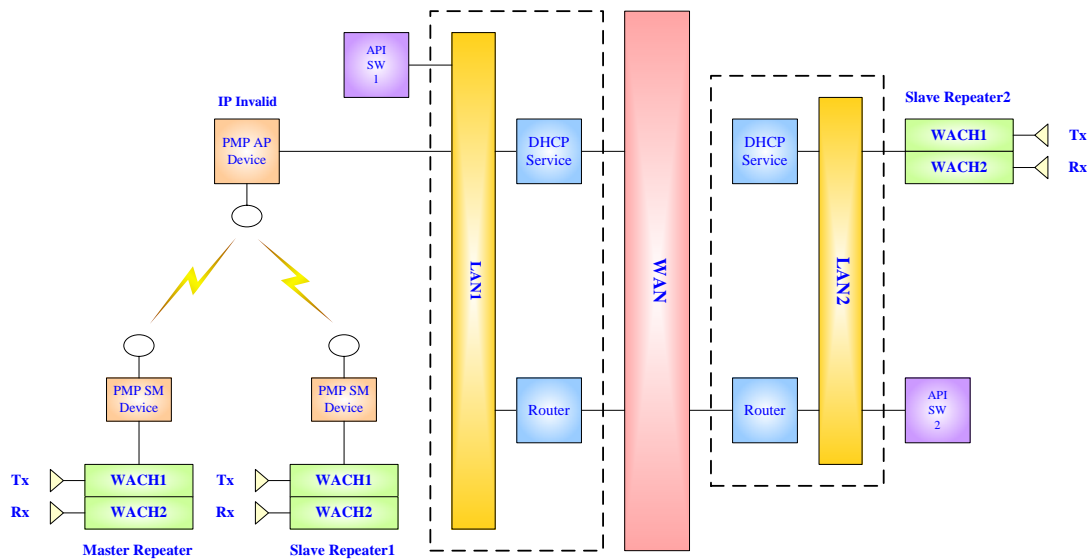## 4.3.7 Point-to-Multipoint (PMP) Cluster and Wide Area Network (WAN)
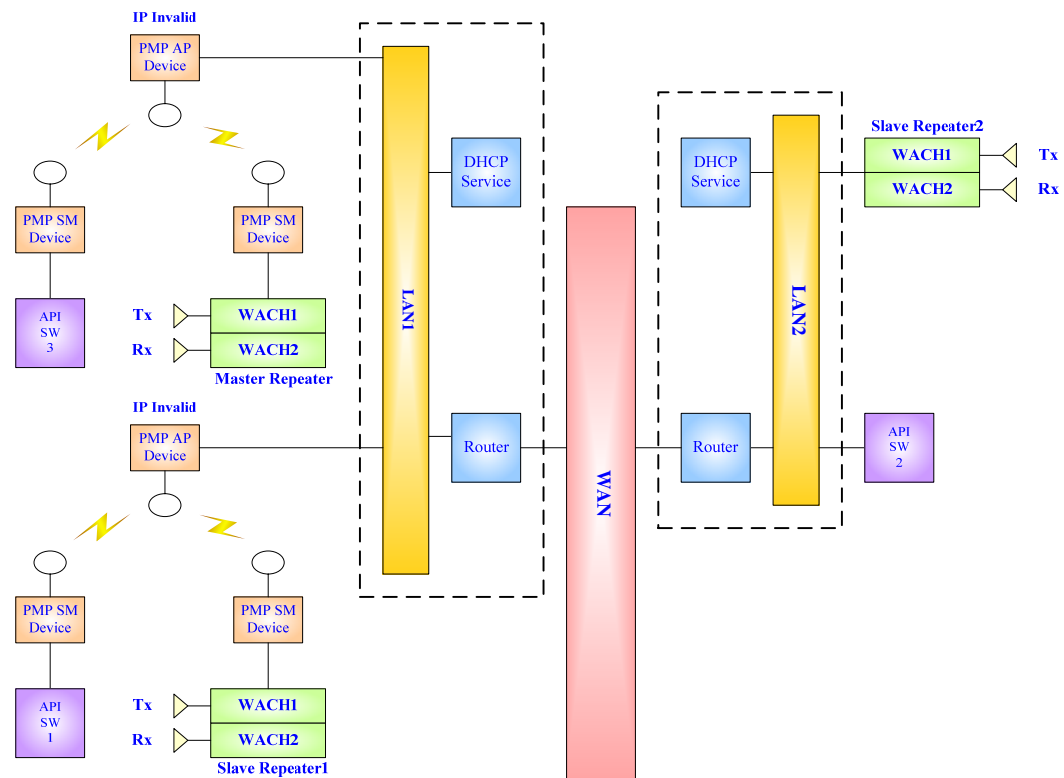
Figure 4.3.7-1 Point-to- Multipoint (PMP) Cluster and Wide Area Network (WAN)

5. Equipment Connection and Configuration

5.1 Parameter Configurations

The appropriate configuration scheme shall be selected on the basis of network topology and the actual application. In general, the involved parameters include:

1) Terminal parameters

2) Repeater parameters

3) Routing parameters

4) Broadband wireless access parameters

Routing devices contain firewall, NAT, router and etc. You can contact your dealer for their specific configurations.

Broadband wireless access devices include Canopy and etc. You can contact your dealer for their specific configurations.

5.2 Ethernet Cable

5.2.1 Connection Method

An Ethernet cable is required to connect two repeaters in this scheme. The disadvantage of the scheme lies in poor expandability.
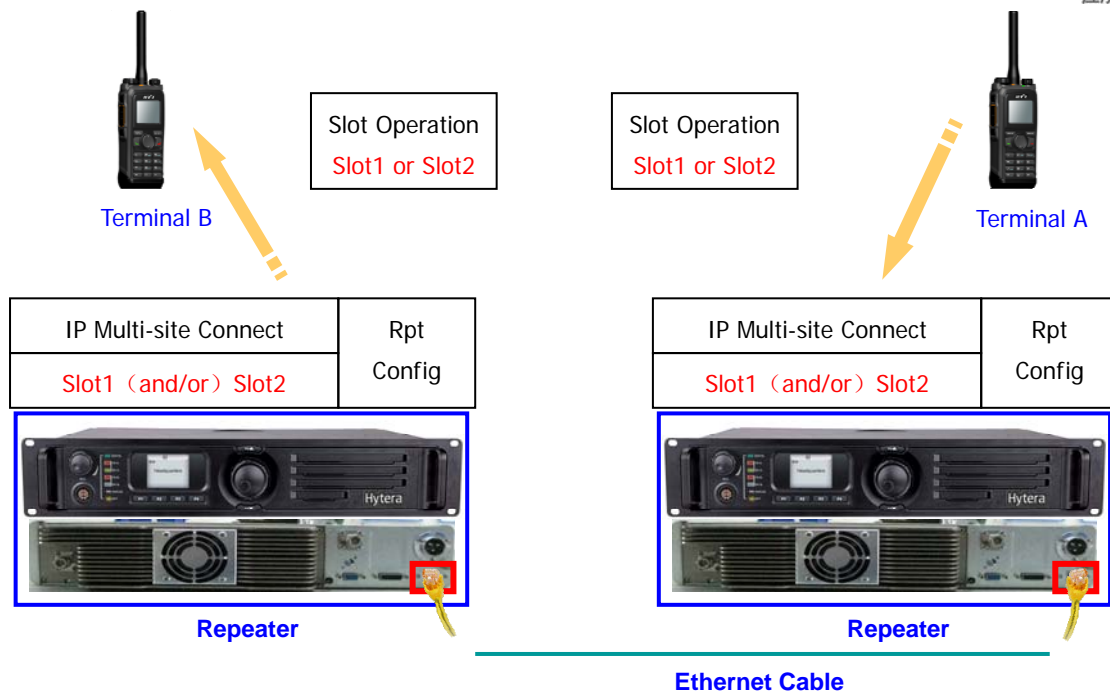
Figure 5.2.1-1 Ethernet Cable Connection

5.2.2 Configuring a Terminal

A terminal may be a portable radio or mobile radio. Please refer to Hytera DMR Conventional Series Terminal List. You can contact your dealer for details.

As the terminal works the same way in both IP Multi-site Connect mode and single repeater mode, you can refer to the parameter settings in the single repeater mode to configure it.

To configure a terminal, do as follows:

1) Configure the settings applicable to single repeater mode.

2) Do define the "Slot Operation" option; otherwise, the terminal only operates in DM mode. For the terminal and repeater, ensure that the same slot must be selected in the configuration. For example:

2.1) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to " Slot 2" for the repeater, the terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.2) If the "Slot Operation" option is set to "Slot 1" or "Slot 2" for the terminal and "IP Multi-site Connect" to "None" for the repeater, the

terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.3) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to "Slot 1" or "Slot1&Slot2" for the repeater, the terminal can operate in IP Multi-site Connect mode.

3) The Color Code for the terminal must be consistent with the current repeater. Otherwise, the terminal can not work in the system.

Figure 5.2.2-1 Time Slot and Color Code Configuration

5.2.3 Configuring a Repeater

The simplest IP Multi-site Connect network can be established by connecting two repeaters back to back. In other words, you can use an Ethernet cable to connect two repeaters directly. Generally, this scheme is used for cross-band communication or network service demonstration.

To configure a Master repeater, do as follows:

1) Run the CPS and read the existing configuration data.

Figure 5.2.3-1 Setting ID for the Master Repeater

2) Go to "General Setting->IP Multi-site Network", and set the "Repeater Type"

option to "IP Multi-site Master".(See Figure 5.2.3-2)

3) Leave the "Authentication Key" field at its default values.

4) Be sure that the DHCP option is not selected.

Input static values for the Ethernet IP, Gateway IP, and Netmask. As for all

repeaters in the system, the Ethernet IP and gateway IP shall share the same

network address (192.168.2. ×××). (See Figure 5.2.3-2)

- **Ethernet IP (192.168.2.102): The Master repeater's static address must be unique in the system.**

- **Gateway IP (192.168.2.228): this defines an abstract gateway address. There is no gateway for this configuration, but it is necessary to define an abstract address.   The address must be unique and it is highly recommended that the last digit should not be set to "0".**

- **Netmask: it defines the IP addresses range-192.168.2.x (x=0-255).**
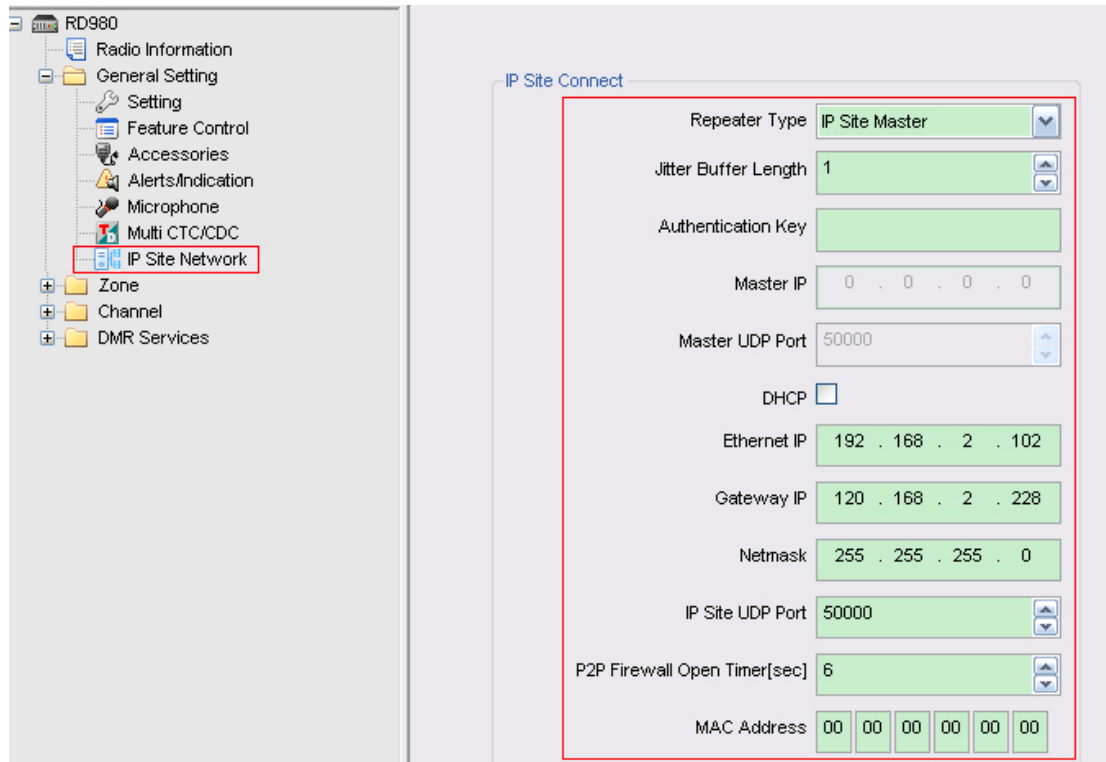
Figure 5.2.3-2 Setting IP Multi-site Network Parameters for the Master Repeater

5) Leave the "IP Multi-site UDP Port" and "P2P Firewall Open Timer (sec)" at their default values.

6) Go to "Channel->Digital Channel->CH D1->IP Multi-site Connect", and choose the desired slot from the dropdown list. Then, the corresponding slot works as a wide area channel.

Fig 5.2.3-3 Setting IP Multi-site Connect for the Master Repeater

7) Finally write the new configuration data into the Master repeater via CPS.

To configure a Slave repeater, do as follows:

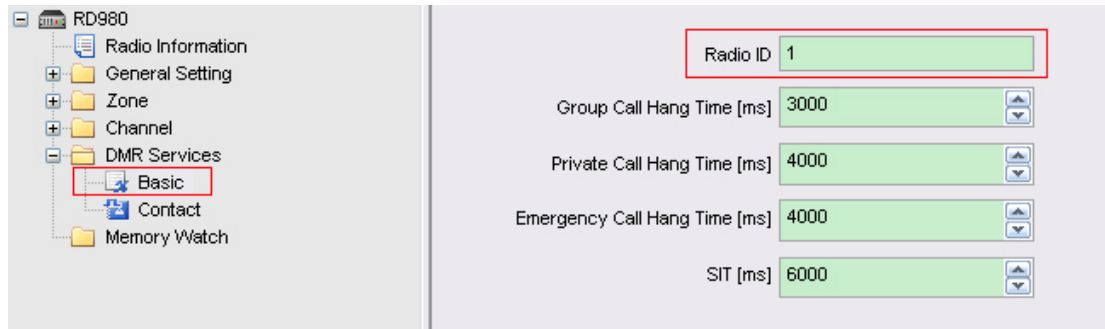1) Run the CPS and read the existing configuration data.

Figure 5.2.3-4 Setting ID for the Slave Repeater

2) Go to "General Setting->IP Multi-site Network", and set the "Repeater Type" option to "IP Multi-site Slave".(See Figure 5.2.3-5)

3) Leave the "Authentication Key" field at its default values.

4) Configure the "Master IP", "Master UDP port" and "Ethernet IP address" in accord with the Master repeater.

5) Be sure that the DHCP option is not selected.

6) The proper static values must be entered for the Ethernet IP, Gateway IP and Netmask, making it possible to share the same subnet with Master repeater. (See Figure 5.2.3-5)

- **Ethernet IP (192.168.2.12): The Slave repeater's static address must be unique in the system.**

- **Gateway IP (192.168.2.228): Configured in accordance with the Master repeater.**

- **Netmask: Configured in accordance with the Master repeater.**

7) Leave the "IP Site UDP Port" and "P2P Firewall Open Timer (sec)" at their default values.

8) Leave the "Jitter Buffer Length" at the default value. Its definition is given in the help file of CPS supplied by Hytera. Only qualified technicians are allowed to change this parameter.
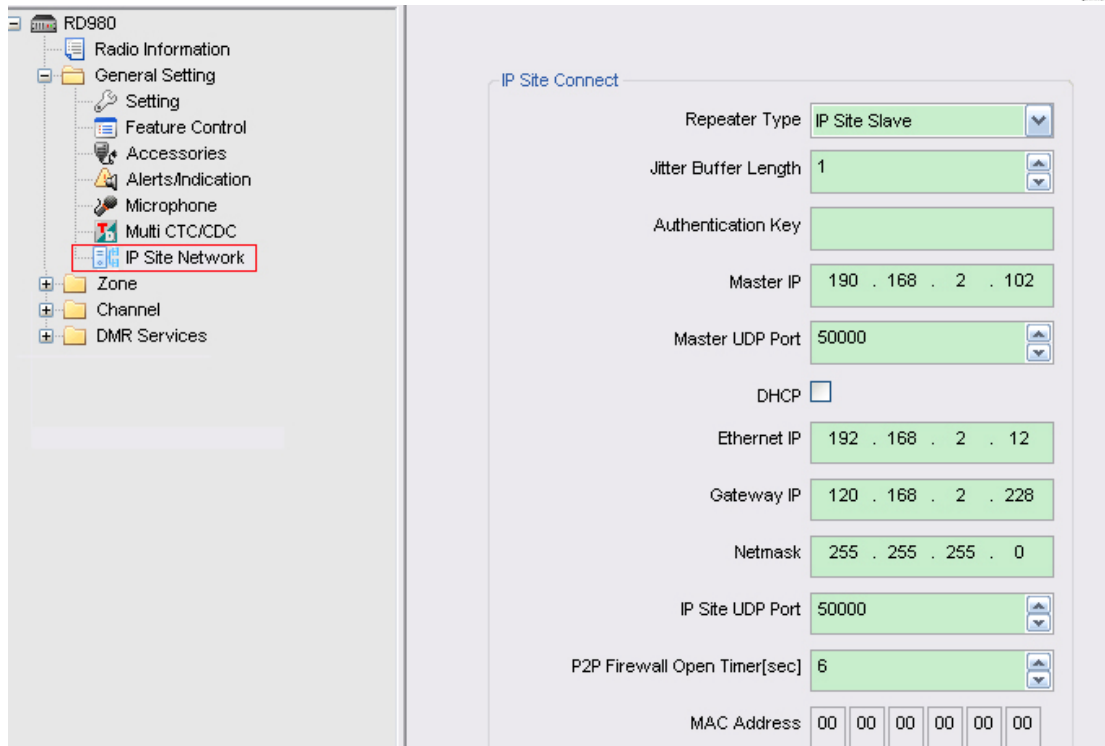
Fig 5.2.3-5 Setting IP Multi-site Network Parameters for the Slave Repeater

9) Go to "Channel->Digital Channel->CH D1->IP Multi-site Connect", and choose the desired slot from the dropdown list. Then, the corresponding slot works as a wide area channel.

Figure 5.2.3-6 Setting IP Multi-site Connect for the Slave Repeater

10) Finally write the new configuration data into the Slave repeater via CPS.

5.3 Local Area Network (LAN)

5.3.1 Connection Method

This scheme is used to connect a switch or multiple switches within the LAN, achieving seamless communication in the same area.

Figure 5.3.1-1 Local Area Network Connection

5.3.2 Configuring a Terminal

A terminal means a portable radio or mobile radio. Please refer to Hytera DMR Conventional Series Terminal List. You can contact your dealer for details.

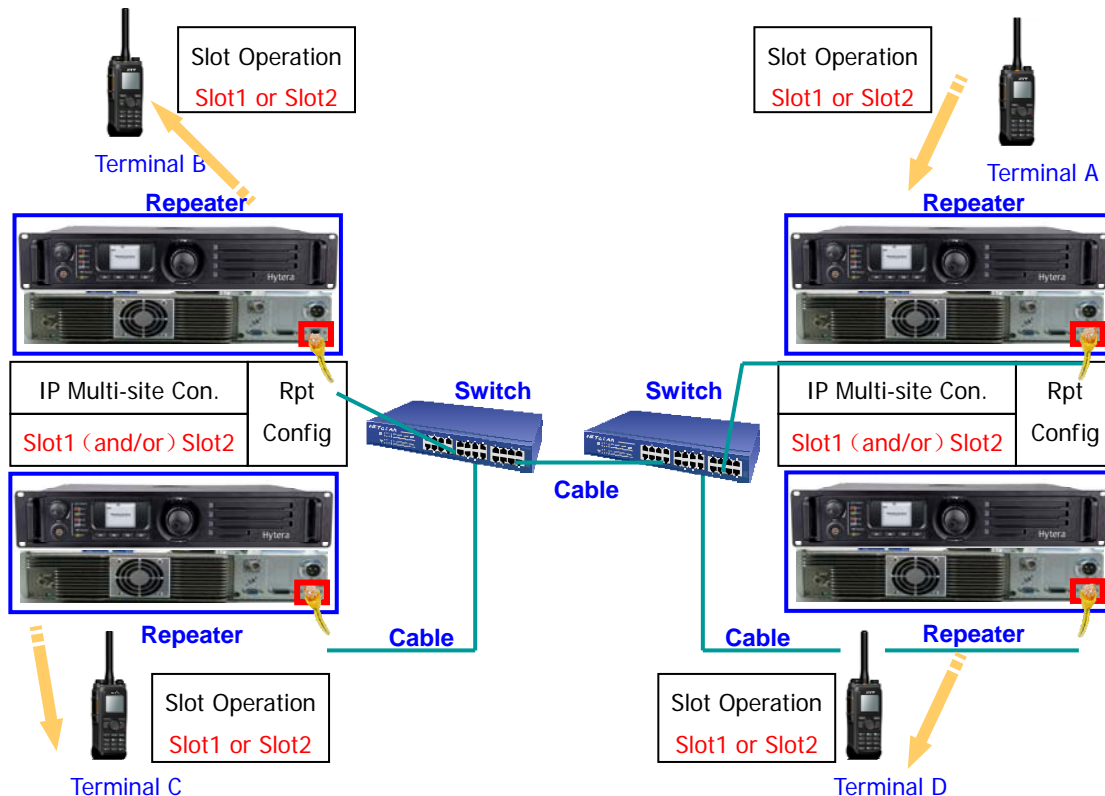As the terminal works the same way in both IP Multi-site Connect mode and single repeater mode, you can refer to the parameter settings in single repeater mode to configure it.

To configure a terminal, do as follows:

1) Configure the settings applicable to single repeater mode.

2) Do define the "Slot Operation" option; otherwise, the terminal only works in DM mode. For the terminal and repeater, ensure that the same slot must be selected in the configuration. For example:

2.1) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to " Slot 2" for the repeater, the terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.2) If the "Slot Operation" option is set to "Slot 1" or "Slot 2" for the terminal and "IP Multi-site Connect" to "None" for the repeater, the terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.3) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to "Slot 1" or "Slot1&Slot2" for the repeater, the terminal can operate in IP Multi-site Connect mode.

3) The Color Code for the terminal must be consistent with the current repeater. Otherwise, the terminal can not work in the system.

Figure 5.3.2-1 Setting Slot Operation and Color Code

5.3.3 Configuring a Repeater

5.3.3.1 LAN Configuration

Adopting the Back to Back configuration, IP Multi-site Connect in the LAN can be achieved by a switch.

The advantage of this scheme is that more IP access devices, Repeater Diagnostic and Control (RDAC) applications and PC applications can be added to the system. In addition, it is useful for explaining network topologies.

There is no DHCP server and Gateway for this LAN configuration. Thus the configuration is consistent with that of "Ethernet Cable". However, the following points should be taken into account.

1) The same Authentication Key must be specified for all repeaters and RDAC applications in the system.

Note: RDAC will be released in R3.5. You can contact your dealer for more information.

2) Go to "General Setting->IP Multi-site Network", and input the same value in the "Authentication Key" field for the Master repeater and the Salve repeater.
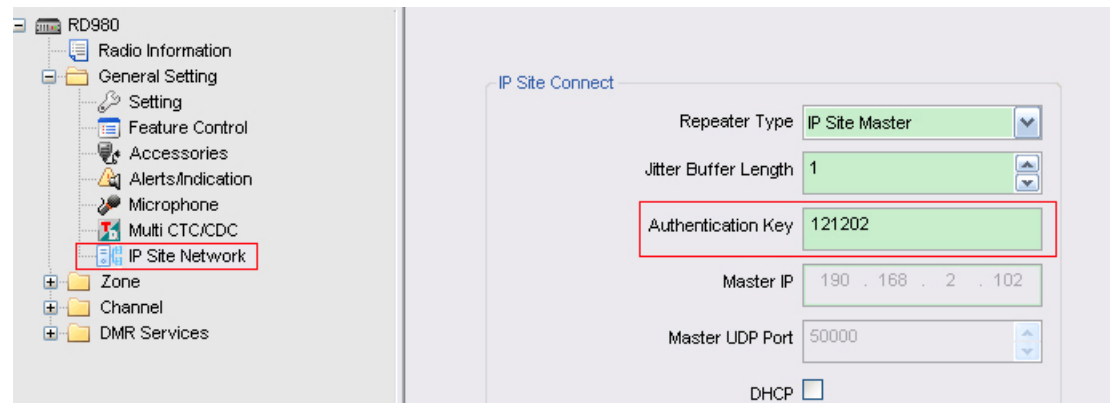

Figure 5.3.3.1-1 Setting Authentication Key

3) If a repeater is to be added to an existing LAN, its Ethernet IP, Gateway IP and netmask must work with all devices in LAN properly. Refer to 5.2.3 for more details about how to create a new LAN or private network.

4) Refer to 5.2.3 for more details about how to configure "IP Multi-site Connect".

5.3.3.2 LAN DHCP Server

A DHCP server is introduced to the IP Multi-site Connect system within the LAN. The configuration is consistent with that of "LAN Configuration"; however the following points should be taken into account.

1) A static IP address shall be assigned to the Master repeater in the system, while the IP addresses for other Slave repeaters and RDAC applications shall be allocated by the DHCP server dynamically.

2) Any static IP address assigned to an IP site must be outside the range of dynamic IP addresses assigned by the DHCP server, but within the range of IP address for the subnet.

3) The IP address for the Slave repeater shall be assigned dynamically as shown in figure 5.3.3.2-1.
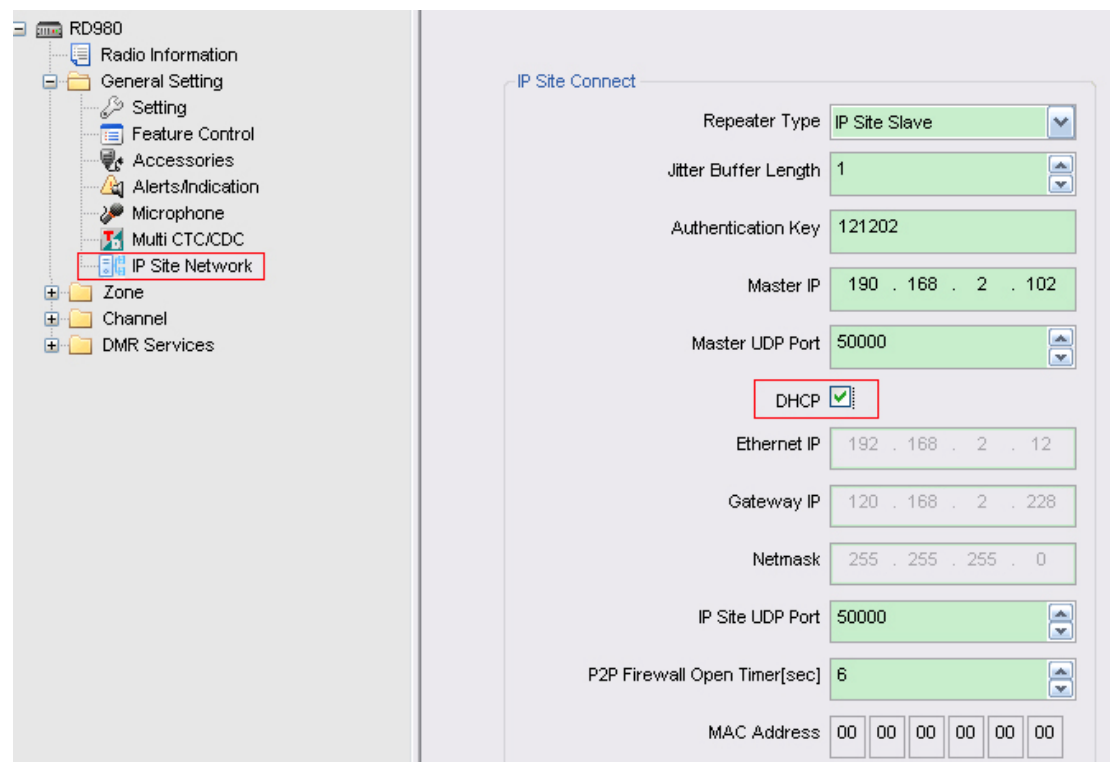
Figure 5.3.3.2-1 Setting DHCP

5.3.4 Configuring the Exchange Device

The configuration depends on the type of exchange devices. Please consult your dealer for more information on their configurations!

5.4 Wide Area Network (WAN)

5.4.1 Connection Method

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

* Routing devices include firewall, NAT, router and etc.

Figure 5.4.1-1 WAN Connection

5.4.2 Configuring a Terminal

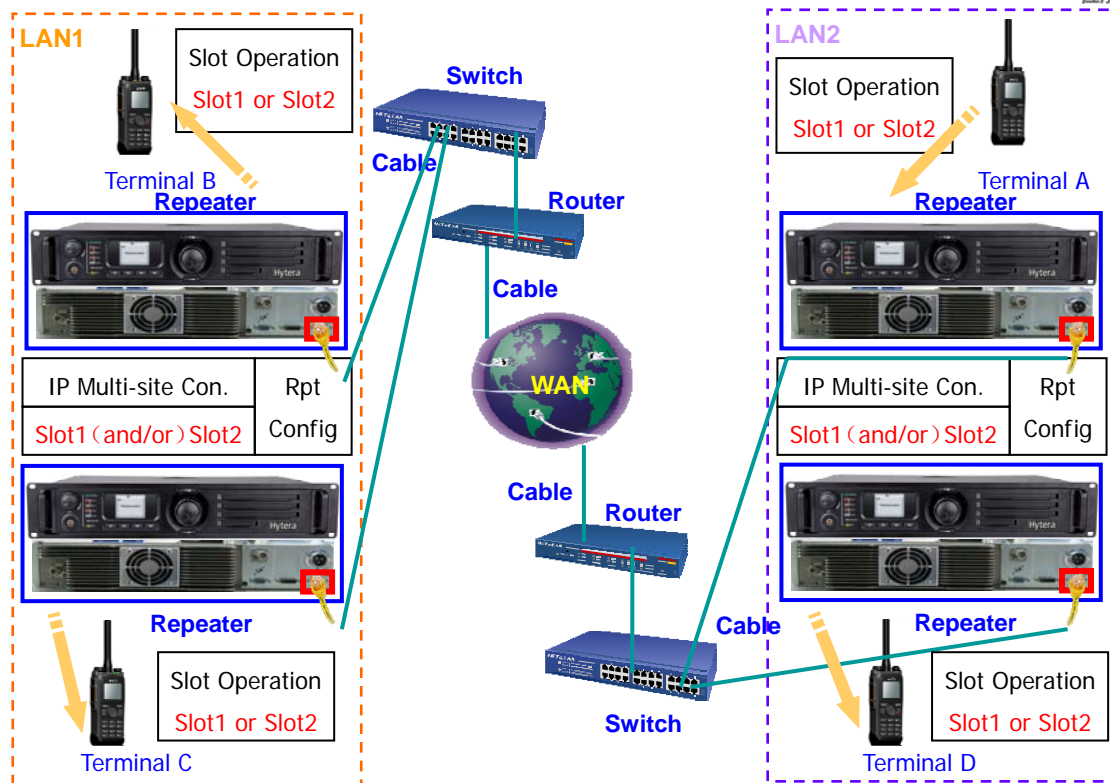*A terminal means a portable radio or mobile radio. Please refer to Hytera DMR Conventional Series Terminal List. You can contact your dealer for details.*

As the terminal works the same way in both IP Multi-site Connect mode and single repeater mode, you can refer to the parameter settings in single repeater mode to configure it.

To configure a terminal, do as follows:

1) Configure the settings applicable to single repeater mode.

2) Do define the "Slot Operation" option; otherwise, the terminal only works in DM mode. For the terminal and repeater, ensure that the same slot must be selected in the configuration. For example:

2.1) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to " Slot 2" for the repeater, the terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.2) If the "Slot Operation" option is set to "Slot 1" or "Slot 2" for the

terminal and "IP Multi-site Connect" to "None" for the repeater, the terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.3) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to "Slot 1" or "Slot1&Slot2" for the repeater, the terminal can operate in IP Multi-site Connect mode.

3) The Color Code for the terminal must be consistent with the current repeater. Otherwise, the terminal can not work in the system.

Figure 5.4.2-1 Setting Slot Operation and Color Code
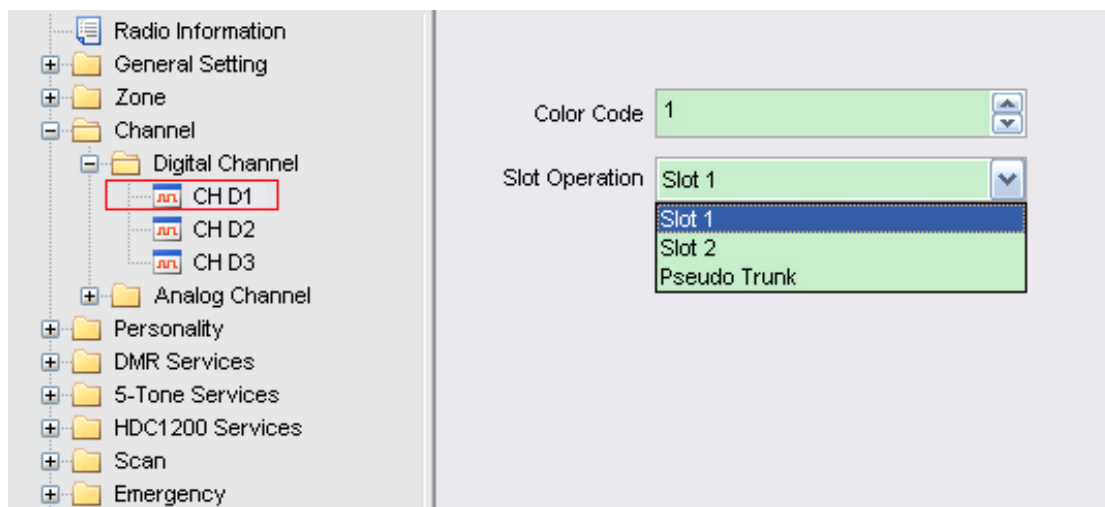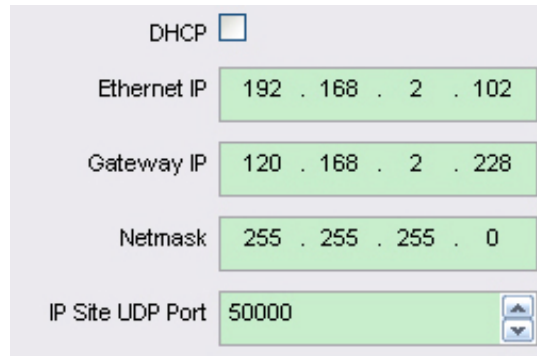
5.4.3 Configuring a Repeater

As usual, the IP Multi-site Connect system contains many Wide Area Networks and Local Area Networks linked by routers. The public network is a typical example, which is capable of connecting many LANs to the WAN by ADSL.

In the above system, the IP address for the Master repeater is assigned to LAN1 statically, as the following figure shows.
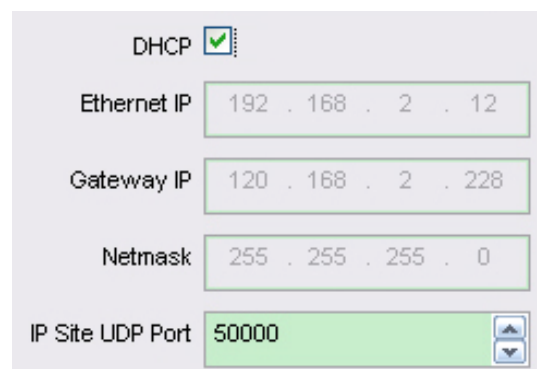
Figure 5.4.3-1 Setting IP Address for the Master Repeater

The Ethernet IP (e.g. the Master repeater's IP address) is beyond the range of IP addresses assigned by the DHCP Server, but still within the range of IP addresses for the subnet (as specified by the Gateway Netmask for the devices on the LAN). Thus the Gateway IP address shall conform to the LAN1 IP address of the router.
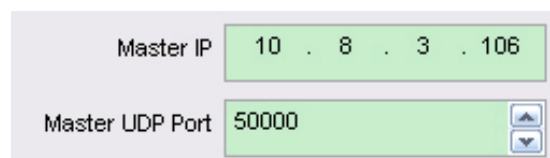
As a result, all Slave repeater and RDAC applications shall get the IP address assigned by their respective LAN DHCP servers.

Figure 5.4.3-2 Assigning IP Address by the DHCP Server

The WAN address used by the Master repeater must be shared by all Slave repeaters and RDAC applications.

Figure 5.4.3-3 Setting the WAN Address for the Slave Repeater

When configuring the Slave repeaters and RDAC application, the WAN address of router in LAN 1 shall be applied to the IP address field of Master repeater, because the IP addresses of all devices are configured within the router netmask, so they can not be identified in the WAN. Thus, "Port Forwarding" must be

configured for all LAN1 routers, forwarding the incoming packet from the defined port of the WAN to the Master repeater. In the current configuration, the UDP port in the WAN is the same as in the Master repeater. In reality, different UDP ports can be defined to the WAN and the Master repeater, as long as all Slave repeaters and RDAC applications share the same port in the WAN.

The following points should be taken into account in this configuration:

1）Do not configure "Port Forwarding" for the Slave repeater and RDAC applications, since their routers can perform it automatically.

2) The public IP addresses for all Slave repeaters and RDAC applications are notified by the Master repeater upon connecting the Slave repeaters.

3) The Slave repeaters on a certain LAN do not need to be configured with same UDP port, as the router will distribute a unique port during forwarding.

4) The public IP address and port assigned by the router to a given Slave repeater will be taken back if they are not in use within a pre-defined time limit. In this case, all Slave repeaters and RDAC applications must transmit "Keep Alive" message regularly. The frequency for transmitting such messages can be set in the "P2P Firewall Open Timer (sec)" field. Make sure that the value of this field is less than the duration which the router keeps alive.

P2P Firewall Open Timer[sec] 6

Figure 5.4.3-4 Setting P2P Firewall Open Timer (sec)

5) The IP address of the Master repeater must be configured into the WAN address rather than the LAN address, as for all Slave repeaters and RDAC applications on the Master repeater's LAN. Otherwise, repeaters from other LANs can not link with RDAC applications.

6) The LAN 1 and LAN 2 routers must support "HairPinning", which ensures that the WAN address can not be replaced by the subnet address.

7) Some routers that support partial "HairPinning" may not support all repeaters and RDAC applications on the Master repeater's LAN. But they can still support other repeaters and RDAC applications, which are not in the same LAN as

the Master repeater

8) The Delay will be introduced by the IP network.

9) The detailed configuration of IP Multi-site Connect is shown in Figure 5.4.3-5.

Note: not all routers are able to support "Port Forwarding".
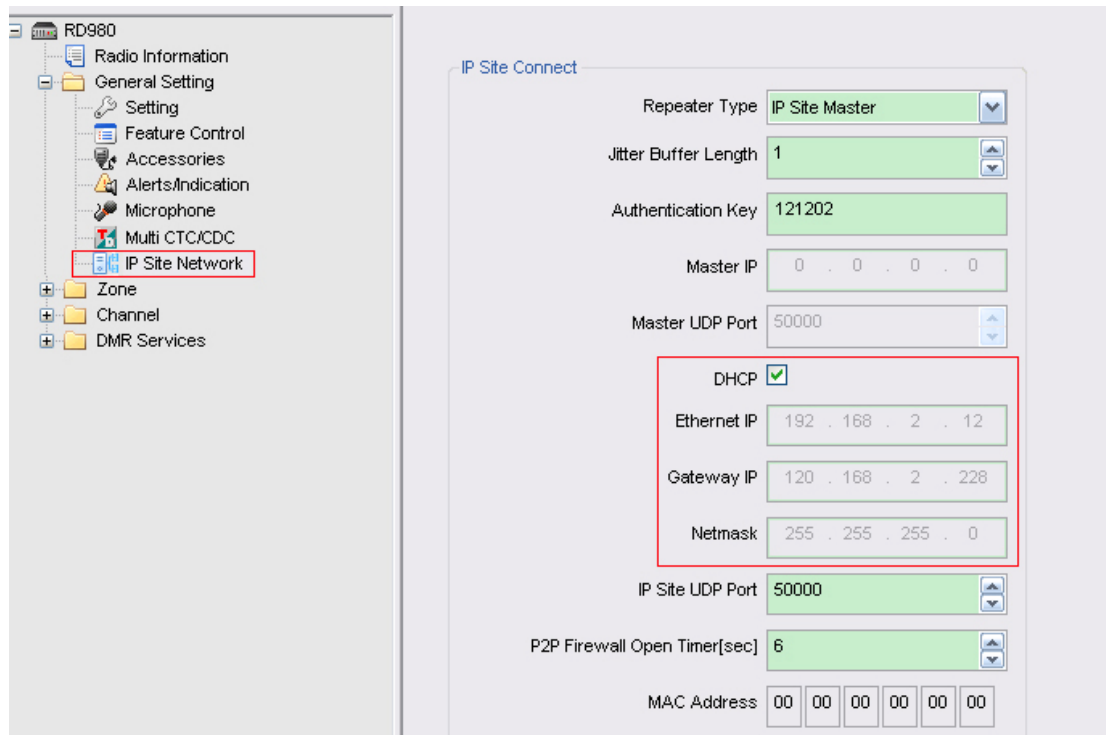
Figure 5.4.3-5 Setting IP Multi-site Network

10) Some private network (e.g. Intranets) is capable of addressing all devices by their IP addresses. When a device is connected to this network, the DHCP server will assign the IP address to it and adjust the router to map the packet to the appropriate Master repeater. Meanwhile, a static IP address is required for the Master repeater.

5.4.4 Configuring the Exchange Device

The configuration varies greatly according to different exchange devices. Please consult your dealer for more information on configurations!

5.4.5 Configuring the Routing Device

The configuration varies greatly according to different routing devices. Please consult your dealer for more information on the specific configuration!

5.5 Broadband Wireless Access

5.5.1 Connection Method

This scheme is used to link multiple sites across areas. The key to this solution is that broadband wireless access devices and Canopy are employed to facilitate the communication of multiple repeaters in dispersed locations. For instance, communication can be achieved by means of the wireless link including microwave, WiFi, 3G and 4G. It is an ideal solution for emergency communication.
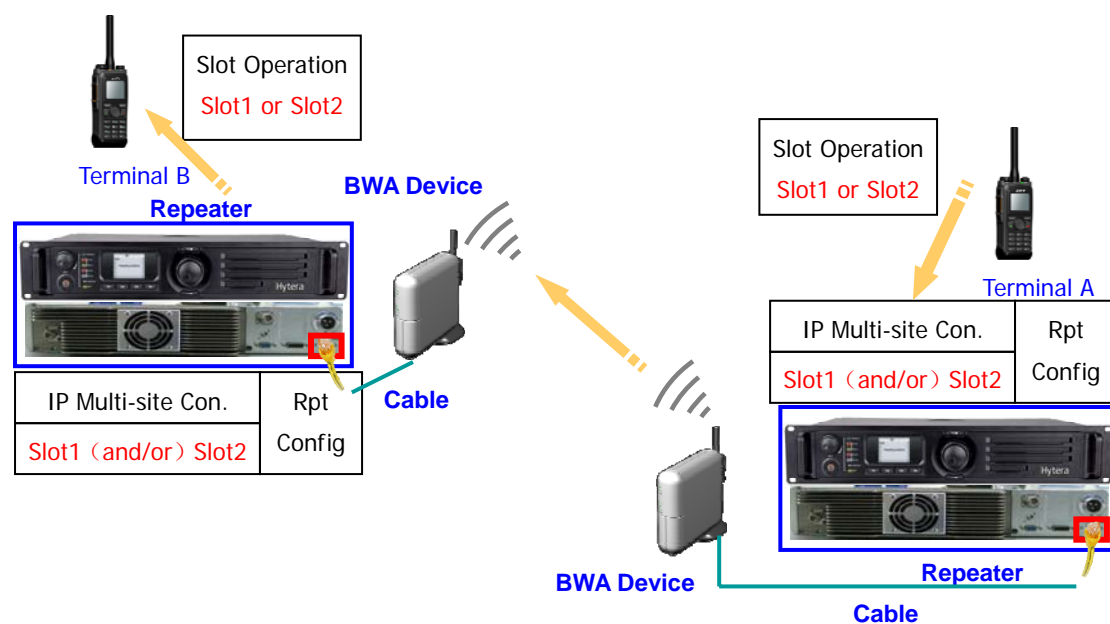
Figure 5.5.1-1 Broadband Wireless Access

5.5.2 Configuring a Terminal

A terminal means a portable radio or mobile radio. Please refer to Hytera DMR Conventional Series Terminal List. You can contact your dealer for details.

As the terminal works the same way in both IP Multi-site Connect mode and single repeater mode, you can refer to the parameter settings in single repeater mode to configure it.

To configure a terminal, do as follows:

1) Configure the settings applicable to single repeater mode.

2) Do define the "Slot Operation" option; otherwise, the terminal only

works in DM mode. Ensure that the same slot must be specified for the terminal and repeater in the system. For example:

2.1) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to " Slot 2" for the repeater, the terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.2) If the "Slot Operation" option is set to "Slot 1" or "Slot 2" for the terminal and "IP Multi-site Connect" to "None" for the repeater, the terminal only operates in single repeater mode rather than in IP Multi-site Connect mode.

2.3) If the "Slot Operation" option is set to "Slot 1" for the terminal and "IP Multi-site Connect" to "Slot 1" or "Slot1&Slot2" for the repeater, the terminal can operate in IP Multi-site Connect mode.

3) The Color Code for the terminal must be consistent with the current repeater. Otherwise, the terminal can not work in the system.

Figure 5.5.2-1 Slot Operation and Color Code

5.5.3 Configuring a Repeater

The repeater is configured as per the specific network used in broadband wireless access mode. For further details, refer to "Ethernet Cable", "Local Area Network" and" Wide Area Network".

If you have any question, please contact your dealer.

5.5.4 Broadband Wireless Access Devices

The configuration varies greatly according to different broadband wireless

access devices. Please consult your dealer for more information on configurations!

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

Terminals (portable radio and mobile radio) are capable of providing a set of digital services (R3.0) in IP Multi-site Connect mode, as the following table shows.

Functions				
Voice Service	Supplementary Service	Data Service	Emergency Service	Other Functions
Private Call	PTT ID and Alias	Message	Emergency Alarm	Dual WACH (Slot1 & Slot 2)
Group Call	Radio Enable/ Radio Disable	*GPS	Emergency Call	WACH and LACH
All Call	Remote Monitor	*API	Emergency Alarm w/Call	Basic and Full Encryption
	Radio Check		Revert Channel	Pseudo Trunking
	Alert Call		Lone Worker	Time-out Timer (TOT)
			Man Down	*Scan
The specific function is subject to the software version.				
* : indicates that the function is partially available at present. For more information, please consult your dealer.				

Table 6-1 Digital Functions Supported in IP Multi-site Connect Mode

7. FAQ

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

At present, the IP Multi-site Connect network supports up to 15 repeaters. If you want to add more repeaters to this network, it is required to improve the hardware performance of the operational devices. Otherwise, the data can not be transmitted to all repeaters within the defined time.

Since the number of terminals available in IP Multi-site Connect mode and single repeater mode is the same, the former only extends the coverage but does not increase the call capacity.

7.2 Can other repeaters work normally when one of the repeaters fails?

Yes. The entire network is similar to a peer-to-peer network. The Master repeater is used for registration and broadcasting address. If a Slave repeater disconnects, the Master repeater can detect and broadcast it to other Slave repeaters; if the Master repeater disconnects, all Slave repeaters still can work. However, new address can not be added and the status of other 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 the proper networking scheme as per your actual needs, as stated in section 4.1. 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.

7.4 What is the difference between IP Multi-site Connect network system and simulcast system?

1) In a simulcast system, the exchange center or server is a must, which is used to receive and transmit data and time sequence. And the repeater acts as a transceiver. Therefore, the exchange center or server shall be available at any time, and a hot backup is required If necessary.

For IP Multi-site Connect network, there is no independent exchange center or server. One repeater operates as the master one and other repeaters as the slave ones. Each works independently.

2) The simulcast system is capable of time sequence synchronization, enabling the transceiver to use the same frequency in overlapping area, but in IP Multi-site Connect network, different repeaters shall use different frequencies to achieve quality communication.

3) At present, the IP Multi-site Connect network supports 15 repeaters at most, while the simulcast system has no limit on the number of repeaters.

7.5 How to upgrade a single repeater system to IP Multi-site Connect network system?

Terminals (portable radio and mobile radio) in single site mode can communicate with those in IP Multi-site Connect mode. If you want to upgrade the single repeater system, you just need to upgrade the existing software and configure all parameters again for the repeater and terminal.

The API application configured for the terminal in single repeater system can work normally in IP Multi-site Network without update.

7.6 What factors shall be considered when establishing an IP Multi-site Connect network?

The network establishment and configuration are determined by the devices

and IP network. You'd better get help from the network administrator due to the complicate networking environments.

Some common factors are listed below:

1) Ensure that there is no conflicting IP address, which can break off communication.   If the DHCP option is selected, the static IP address might as well be outside the range of the addresses which are available to be allocated. It can avoid the conflicting address assigned by the DHCP server.

2) The Quality of Service (QoS) can be introduced to the router in the Ethernet network to assure you quality communication, provided that there are other networking devices acting as IP networking ones in IP Multi-site Connect network. In addition, it is necessary to enhance the communication priority and reserve adequate bandwidth.

3) Be sure that the UDP port is free from restriction of the firewall. Otherwise, it can block the IP address or the UDP port operated in IP network. For more information, please consult the local network administrator or ISP.

4) It is better to choose an ISP who can provide unlimited traffic services, because the voice transmission over internet may lead to heavy traffic. For an IP Multi-site Connect network containing 5/15 repeaters, 20/65 GB traffic is required per month.