

Hytera DMR Conventional Series

Roaming
Application Notes



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Contents

1. Overview	3
1.1 Definition.....	3
1.2 Application	3
1.3 Principle.....	3
1.4 Version.....	4
1.5 Restriction	5
2. References.....	6
3. Requirements	7
3.1 Requirements on Devices.....	7
4. Configurations	8
4.1 Tools	8
4.2 Parameter Configurations	8
4.2.1 Configuring the Terminal.....	8
4.2.2 Configuring the Repeater	12
5. Roaming Introduction	14
5.1 Roaming Methods.....	14
5.1.1 Auto Site Roam	14
5.1.2 Active Site Roam	15
5.2 Enabling the Roaming Feature	17
5.3 Configuring the Roaming Feature	18
5.3.1 Configuring the Roam List.....	18
5.3.2 Configuring the RSSI Threshold	19
5.3.2.1 Overlapping coverage.....	20
5.3.2.2 Non-overlapping coverage	21
5.3.2.3 Linear coverage	22
5.3.2.4 Multilayer coverage.....	22
5.3.3 Setting Beacon TX Mode, Beacon Duration and Beacon Interval	24
5.4 Roaming Interactions	27
5.4.1 Interaction between Scan and Roaming.....	27
5.4.2 Interaction between Menu and Roaming	28
5.4.3 Interaction between Talk Around and Roaming	28
5.4.4 Interaction between Encrypt, Power Level and Roaming	29
5.4.5 Interaction between Ctrl Services and Roaming	30
5.4.6 Interaction between Emergency and Roaming.....	30
5.4.7 Interaction between RRS, GPS Revert and Roaming	31
5.4.8 Interaction between Repeater and Roaming.....	32
5.4.09 Interaction between Priority Interrupt and Roaming	32
5.4.10 Interaction between Phone and Roaming	33
5.4.11 Interaction between Other Functions and Roaming.....	33
5.5 Performance while Roaming	33
6. FAQ	35

1. Overview

1.1 Definition

Roaming is a function, which allows mobile terminals to move between sites in the IP Multi-site Connect system without dropping connection. It is fully automatic to users.

1.2 Application

The Roaming feature, mainly used in the IP Multi-site Connect system, can bring users seamless communication within the area covered by multiple repeaters.

1.3 Principle

Hytera DMR digital terminals are capable of auto roaming from one site to another within the IP Multi-site Connect system.

A roam list can be configured to the mobile terminal. It contains a series of channels, each of which is corresponding to a repeater in the IP Multi-site Connect system (namely, a wide area channel). When the Roaming feature is enabled, the mobile terminal will keep detecting the signal strength of each channel in the roam list, select one with the strongest signal and regard it as the master site. Then the mobile terminal will stay on this site. Once its signal strength falls below the pre-programmed RSSI threshold value, the mobile terminal will try to find a new master site. If a better site is not found, it will still identify the previous master site as its own master site.

Note: The terminal cannot roam when it is in a call.

If there is no activity in the IP Multi-site Connect system, e.g. no voice or data service transmitting, the beacon configured for the repeater will be sent automatically. Once the terminal finds which master site is idle, it will wait for this beacon and detect its signal

strength, measuring the coverage of the site and determining the relation between the terminal and the site. If no voice, data service, or the beacon has been received in the expected duration, the mobile terminal will be deemed to exceed the coverage of the master site and attempt to search for a new master site.

As the Roaming function can be enabled or disabled via the programmable keys or the menu, the users can not only decide when and where to enable the Roam feature of the mobile terminal, but also disable this feature to a specific site, or keep roaming to choose a proper site.

During roaming, voice or data service is initiated, which fails to activate the repeater at the master site at times. In this case, the terminal will search sites in the roam list and select an appropriate one to make a call. If the right site is not found, the out-of-range message will be given. To manually change the site, users can rotate the Channel Selector knob to the desired channel. Then the mobile terminal always begins to roam from this channel.

When the mobile terminal is roaming, the corresponding status icon and the master site (channel) alias will be displayed on the LCD. Also you can determine whether the terminal is searching or staying on the site with the help of the LED.

1.4 Version

- 1) R3.5: to release the Roaming feature for the first time;
- 2) R5.0: to release the Roam improvement, Auto Start Roam and Follow All Master Site Config.

** This file (R1.0) is intended to give a rough description about the Roaming feature. More information will be given later.*

** Consult your dealer for more information on DMR Conventional Series Software.*

1.5 Restriction

The Roaming feature must work with the IP Multi-site Connect system only.

2. References

N/A

3. Requirements

3.1 Requirements on Devices

- 1) Repeaters (see Hytera device list for details)
- 2) Mobile terminals (see Hytera device list for details)

** Please refer to Hytera DMR Conventional Series Device List. You can contact your dealer for details.*

4. Configurations

4.1 Tools

The parameter configurations of the Roaming feature are associated with these of the IP Multi-site Connect. In general, the involved parameters include:

- 1) Terminal parameters
- 2) Repeater parameters

** Please refer to Hytera DMR Conventional Series CPS List. Contact your dealer for details.*

4.2 Parameter Configurations

4.2.1 Configuring the Terminal

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

A terminal is capable of roaming in the IP Multi-site Connect mode by configuration via the Customer Programming Software (CPS) in advance.

To configure a terminal, do as follows:

- 1) Run the CPS and read the existing configuration data.
- 2) Go to “Channel->Digital Channel -> CH DN”. See Figure 4.2.1-1.
- 3) Set the “Receive Frequency (MHz)” and “Transmit Frequency (MHz)” respectively to different frequencies. Note: Make sure that these frequencies are different. Otherwise, other parameters about the Roaming feature can not be configured. See Figure 4.2.1-1.
- 4) Select the “IP Multi-site Connect” option to enable the Roaming feature on the current channel. Only when this option is selected, the current digital channel can be selected as

a member in the roam list. See Figure 4.2.1-1.

5) Go to “Channel -> Digital Channel -> Scan List/Roam List”, and choose the desired roam list. Then the terminal starts to roam according to this list. This parameter is associated with “Roam -> Roam List N”. See Figure 4.2.1-1.

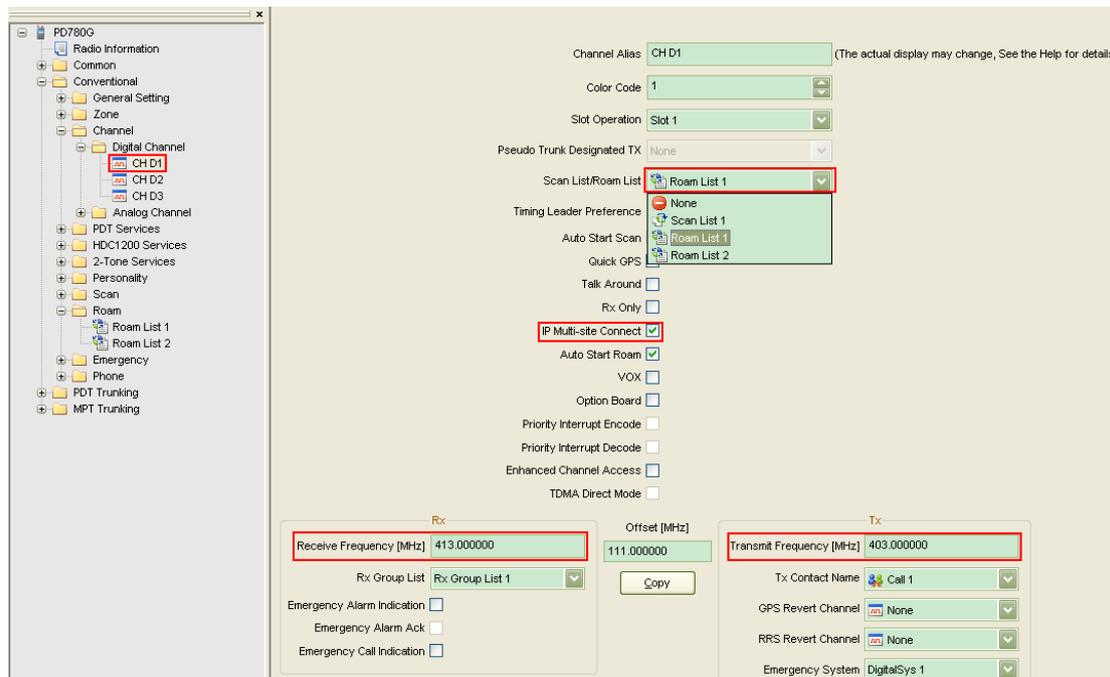


Figure 4.2.1-1 Setting Digital Channel for the Terminal

6) Go to “Roam -> Roam List”. See Figure 4.2.1-2.

7) Choose the desired channel (repeater) from the “Available” list and add it to the “Members” list. Note: there must be two or more channels in the “Members” list. Otherwise, the Roaming feature can not be triggered. If there is only one channel in the “Members” list, the roaming indication will not be given and the Roaming feature will be disabled by default. See Figure 4.2.1-2.

8) Configure the “RSSI Threshold” parameter. It allows the user to determine whether roaming will occur automatically. You can refer to **Configuring the RSSI Threshold** for details. See Figure 4.2.1-2.

9) Set the “Active Site Roam” parameter. It allows the user to determine whether the active site roam occurs automatically. With this parameter checked, if the user presses the

PTT and the corresponding repeater on the current channel does not wake up, the terminal will search members stored in the roam list. In other words, the terminal attempts to wake up each repeater to find an active one for transmission. The signal strength of this active repeater shall exceed the RSSI threshold. With this parameter unchecked, if, the user presses the PTT and the corresponding repeater on the current channel does not wake up, the failure indication will be provided to the user See Figure 4.2.1-2.

10) Set the “Return To Selected CH” parameter: When the terminal stays on the channel designated for roaming during roaming, the terminal will operate on the selected channel after roaming ends if this parameter is checked. If this parameter is not checked, the terminal will not operate on the selected channel after roaming ends. See Figure 4.2.1-2.

11) Set the “Follow All Master Site Config” parameter. All the information of the current channel will be consistent with that of the Active Site Roam channel if this parameter is checked. If this parameter is not checked, part of the current channel's information will be consistent with the information of Active Site Roam channel, and the other part of the information remains unchanged. You can refer to **Configuring the Roam List** for details. See Figure 4.2.1-2.

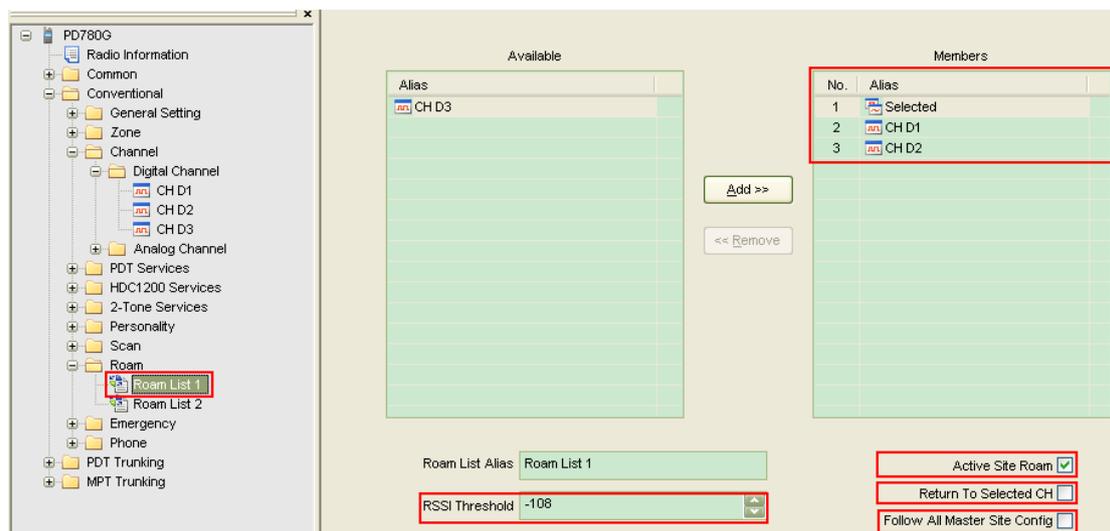


Figure 4.2.1-2 Setting Roam List for the Terminal

12) Go to “General Setting -> Network”. See Figure 4.2.1-3.

13) Set the “Beacon Interval[s]” parameter. As this parameter is associated with the

repeater and may affect the Roaming function in the IP Multi-site Connect network, only technicians are allowed to modify it. You can refer to **Configuring the RSSI Threshold** for details. See Figure 4.2.1-3.

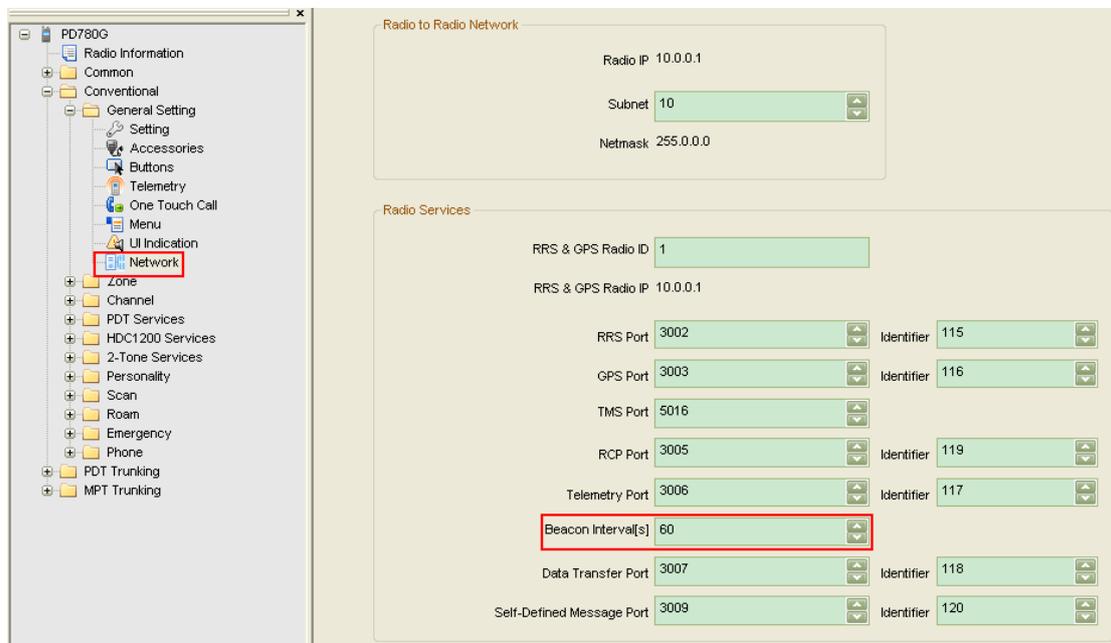


Figure 4.2.1-3 Setting Beacon Interval for the Terminal

12) Go to “General Setting -> Menu”. See Figure 4.2.1-4.

13) Set the “Roaming” parameter. It allows the user to determine whether to include Roaming on the radio menu and access it via the menu. See Figure 4.2.1-4.

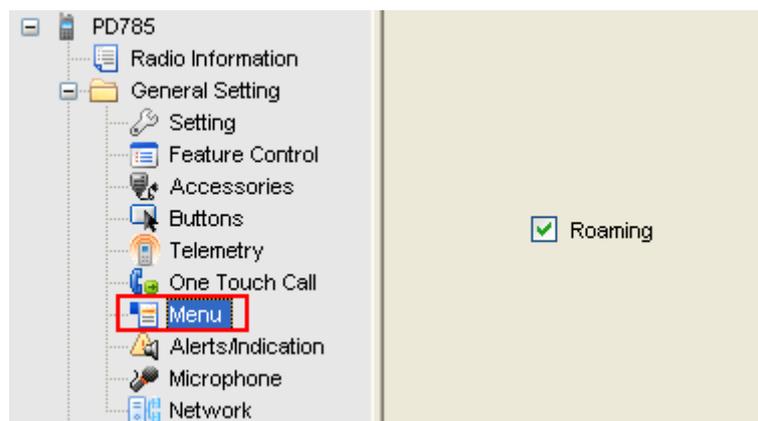


Figure 4.2.1-4 Setting Roaming to the Menu

14) Go to “General Setting -> Buttons”. See Figure 4.2.1-5.

15) Set the “Roam” button. It allows the user to enable or disable the Roaming function via the programmable key. See Figure 4.2.1-5.

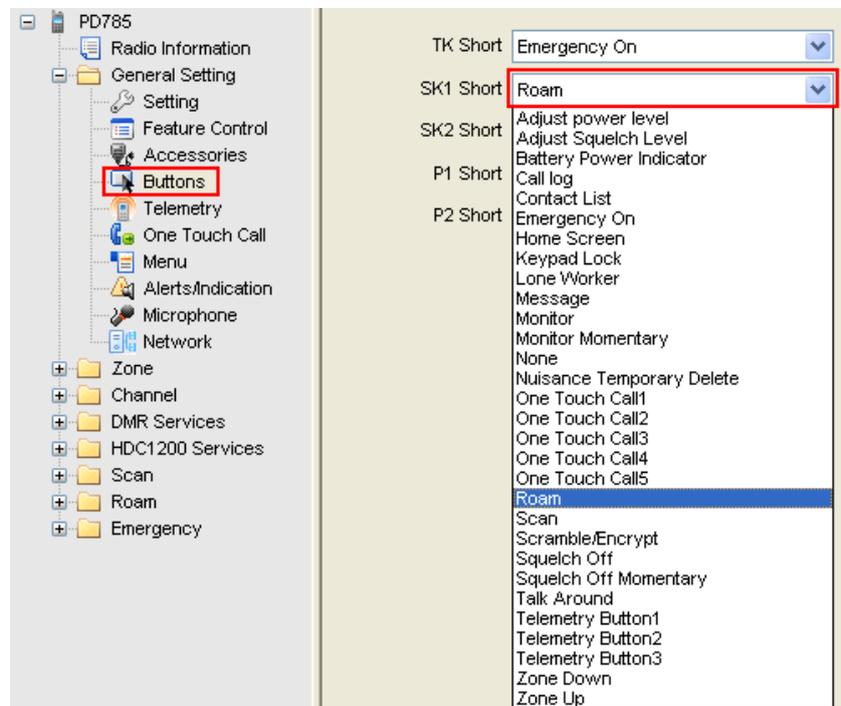


Figure 4.2.1-5 Setting the Roam Programmable Key

16) Finally write the new configuration data into the terminal via CPS.

4.2.2 Configuring the Repeater

As the Roaming function is based on the IP Multi-site Connect network, it is required to configure the repeater for optimal performance.

To configure a repeater, do as follows:

- 1) Run the CPS and read the existing configuration data.
- 2) Go to “DMR Services -> Basic”. See Figure 4.2.2-1.
- 3) Set the “Beacon TX Mode” parameter. This parameter decides the beacon transmission duration and interval for each repeater in IP Multi-site Connect mode. In Local mode, the beacon transmission duration and interval are designated from Beacon Duration and Beacon Interval; in Network mode, the beacon transmission duration and interval will be

obtained from the master in the IP Multi-site Connect system. The beacon transmission duration of the repeater will be the same with that of the master. See Figure 4.2.2-1.

4) Set the “Beacon Interval[s]” parameter to determine how often the repeater sends the beacon. As this parameter is associated with the terminal and may affect the Roaming function in the IP Multi-site Connect network, only technicians are allowed to modify it. You can refer to **Configuring the RSSI Threshold** for details. See Figure 4.2.2-1.

5) Set the “Beacon Duration[ms]” parameter to determine how long the beacon signal lasts. As this parameter may affect the Roaming function in the IP Multi-site Connect network, only technicians are allowed to modify it. You can refer to **Configuring the RSSI Threshold** for details. See Figure 4.2.2-1.

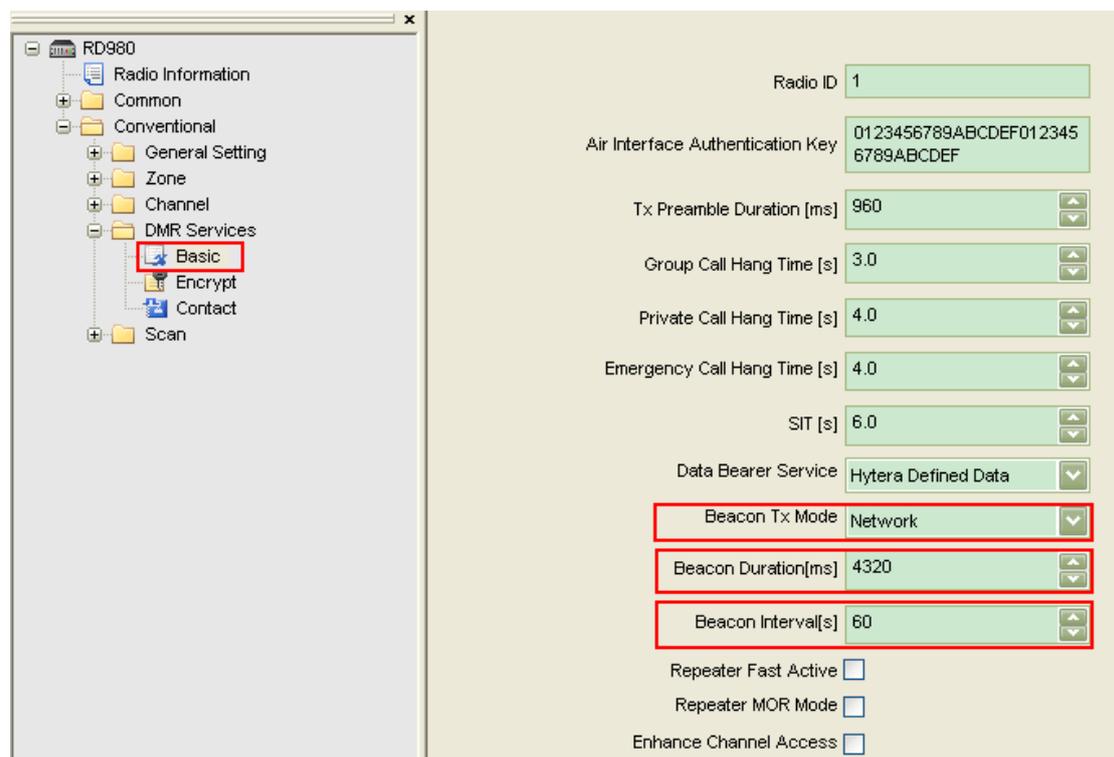


Figure 4.2.2-1 Setting the Beacon

6) Finally write the new configuration data into the terminal via CPS.

5. Roaming Introduction

5.1 Roaming Methods

The type of roaming method includes auto site roam and active site roam.

5.1.1 Auto Site Roam

If the Roaming feature is enabled and the signal strength value of the current channel falls below the pre-programmed RSSI threshold, the mobile terminal will keep detecting the signal strength of each channel (site) in the roam list, select one with the strongest signal, and regard it as the master site. Afterwards, the mobile terminal will stay on this site. Once the signal strength of the master site falls below the RSSI threshold, the mobile terminal will try to find a new master site. If a better site is not found, it will still identify the previous channel as its own master site. If the mobile terminal comes across other activities while performing the auto site roam, it will identify the current repeater as the master site. In addition, all sites in the roam list will be ranked according to their signal strength, so as to achieve better roaming performance. Sites that have been detected in previous roam and are assumed to be near by are searched before those that have not been detected before. Additionally, when the mobile terminal is roaming, it will detect the current master site during the interval of checking other two sites, to minimize the duration away from the master site. This strategy gives the priority to the previous master site and minimizes the possibility of missing transmissions in the process of roaming.

When the auto site roam is initiated, the mobile terminal will be temporarily away from the master site and detect other sites. In this case, it may miss the communication with the master site. In other words, auto site roam shall occur when the mobile terminal is so far from the master site that its signal strength had deteriorated below the RSSI threshold or when there is no signal at all.

Both the activation of auto site roam and site selection are subject to the repeater transmission. If there is no activity in the system and the repeater stops transmission, auto

site roam can not detect any repeater. Consequently, the repeater can be configured to send the beacon periodically in case of no transmission and interference. Both the beacon duration and interval can be set.

In the event of no activity in the system, the mobile terminal will use the signal strength of the beacon to determine whether it is required to roam and which site it should roam to. If the mobile terminal does not receive the beacon within the interval, it is deemed to be out of the repeater's range and roams to another site.

Auto site roam is not triggered by one of the following events:

- The mobile terminal is transmitting
- The mobile terminal is receiving a call or data service
- The mobile terminal is in Emergency mode
- The mobile terminal is in strong signal coverage
- The mobile terminal is operating in Talk Around mode
- The mobile terminal is killed
- The mobile terminal is monitoring remotely
- The palm microphone of the mobile terminal is off-hook.
- The menu of the mobile terminal is active
- The mobile terminal operates on the channel with a scan list

5.1.2 Active Site Roam

With the active site roam enabled, if the user presses the PTT or the emergency key, or the message is sent, the mobile terminal will first try to wake up the repeater on the current channel. If a repeater is not available, the mobile terminal will repeat this process for each member in the roam list till an active one (site) is found. Afterwards, the mobile terminal will synchronize itself with this active repeater, finish the transmission and identify

it as the master site. If the entire roam list is searched and no site is found, a failure indication will be provided to the user.

The active site roam will occur when the mobile terminal initiates a call but the corresponding repeater on the current channel is not waked up.

This entire process of discovering and synchronizing with an active repeater increases the voice access time of the transmission (time from PTT press to Talk Permit Tone). But this increase only takes place in the first transmission, as the later transmission will perform normally on the new site.

Note: the wake-up message is always sent politely. This indicates that if the mobile terminal detects the inference signal, it will not send this message to members in the roam list. But it will carry on the active site roam according to the next roam list.

Note: the mobile terminal does not perform any auto site roam in emergency mode. No auto roaming will occur when the mobile terminal is reverted during the emergency.

However, when the revert emergency channel is configured to the current channel and with the active site roam enabled, the mobile terminal will perform the active site roam automatically, if the signal strength of the repeater falls below the pre-programmed RSSI threshold, or no repeater beacon is detected.

Please note that the wake-up message caused by the active site roam will be transmitted to each member's frequencies in the roam list till the available site is found. But the active site roam will not occur in the area where frequency overlapping and sharing is common. In order to minimize the unnecessary transmission, the mobile terminal only sends one piece of wake-up message politely. If this is not acceptable, the active site roam shall be disabled and the beacon be set as short as possible. This ensures that the auto site roam finds a new site rapidly and disallows the user to initiate the active site roam.

Note: roaming will not occur in the emergency mode if the active site roam is disabled.

5.2 Enabling the Roaming Feature

The mobile terminal can enable or disable the Roaming feature through the following method:

1) via the menu

2) through the programmable keys

3) auto entry

a) The mobile terminal will start to roam automatically upon powering on, if it is turned off while roaming.

b) With the Roaming feature enabled, the mobile terminal will roam, if it switches from the channel without the function to the channel with the function, or from the zone without the function to the zone with the function.

4) Auto Start Roam

a) Upon power-on or switching channel, and if Auto Start Roam is checked in the current channel, the terminal will start roaming automatically.

b) Auto Start Roam feature will not affect the terminal status whether it is roaming or not.

c) Disabling the Roam feature via menu or programmable keys will disable the terminal roaming status, no matter through which way the Roam feature is enabled.

d) When the terminal starts roaming automatically, enabling the Roam feature via menu will not affect the terminal status.

e) When the terminal starts roaming automatically, if then the Roam feature is disabled, enabling the Roam feature again will affect the terminal status.

5.3 Configuring the Roaming Feature

5.3.1 Configuring the Roam List

It must be noted that a system contains more than one IP Multi-site Connect system, namely, a wide area system. In general, a wide area system comprises one or multiple wide area channels, each of which is a separated voice path. Hence, the user only needs to configure the required wide area channel to the roam list.

You can refer to [IP Multi-site Connect Application Notes for details about the wide area system](#).

It is necessary to store the required site into the roam list. This list shall contain a logic channel, which includes the frequency pair, color code and time slot combination.

It is important to understand that when the mobile terminal determines a new master site to be a member in the roam list, only the logical attributes in this list are utilized and other attributes are used from the selected channel personality.

The following logic attributes of the master site shall be utilized:

- Transmit frequency and transmit reference frequency
- Receive frequency and receive reference frequency
- Color code
- Time slot
- Talk Around setting
- GPS Revert channel
- Emergency (include Emergency Revert Channel)

More attention shall be paid to GPS revert and emergency revert. Because the logical channels for each site are different, the revert channels must be changed when the mobile terminal roams from one site to another. We recommend that emergency configurations for all channels should remain the same within a roam list. Otherwise, the mobile terminal

may perform an emergency differently when it moves from one site to another.

The remaining attributes, such as Transmit and Receive Group List, Channel Access, etc, should be utilized from the currently selected channel, no matter which site the mobile terminal currently roams to. Preferably, the attributes of these parameters in the roam list shall keep the same, so that the mobile terminal operates consistently no matter whether it roams to the channel or the user selects the channel.

When Follow All Master Site Config is checked, the terminal will use the Roam List of the selected channel, and the information of the current channel will be consistent with that of the Active Site Roam channel when roaming.

5.3.2 Configuring the RSSI Threshold

The RSSI Threshold is a configurable parameter via the CPS. If the signal strength of the current master site is above the specified RSSI threshold, the terminal will stay on the site and will not roam. Once the signal strength falls below the threshold, the auto site roaming will occur to search for a site with higher signal strength. This parameter actually controls the distance away from a site a user will begin searching for another site. The RF coverage is not a perfect circle in reality, but to simplify this explanation, we regard it as a circle.

Please note that the terminal will temporarily leave the current master site to determine whether a stronger site is available during auto site roaming. Since the terminal is temporarily away from the master site, it may miss the beginning of a transmission (i.e. late entry into a call). Therefore, it is not advisable to perform auto site roaming all the time. The RSSI threshold should be set properly. If it is too low, the terminal will always stay on the master site with low signal strength even if there might be a better site available; if it is too high, the terminal will frequently roam and cause late entry. The figure below illustrates the situations when the RSSI threshold is set too high or too low. Strong signals exist in the area circled by the dotted line, and terminals can roam in the light blue area. The RSSI

Threshold value ranges from -120dBm to -80dBm.

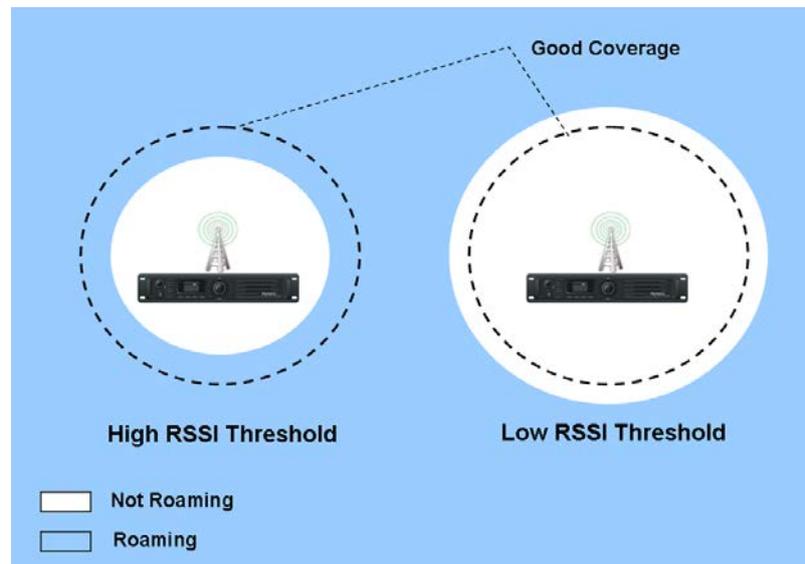


Figure 5.3.2-1 Roaming Triggered by RSSI Threshold

The default value is -108dBm, which indicates approximately 80% of the good coverage. Therefore, roam will occur in the left 20% of the coverage. The default value is ideal for most configurations, but may not be the best in some particular configurations. Accordingly, the user must take the actual site configuration into account before setting the RSSI threshold. Generally, the following four site configurations are available for your reference.

5.3.2.1 Overlapping coverage

This scheme is designed for a large city or an area where a large population is present. It involves a number of sites and much overlapping coverage. In the overlapped areas, multiple frequencies are used, while the non-overlapped areas share frequencies, but different color codes are required for roaming service. In some cases, a user may be within coverage of three to four sites at the same time, and it takes about 10 minutes to move from one site to another.

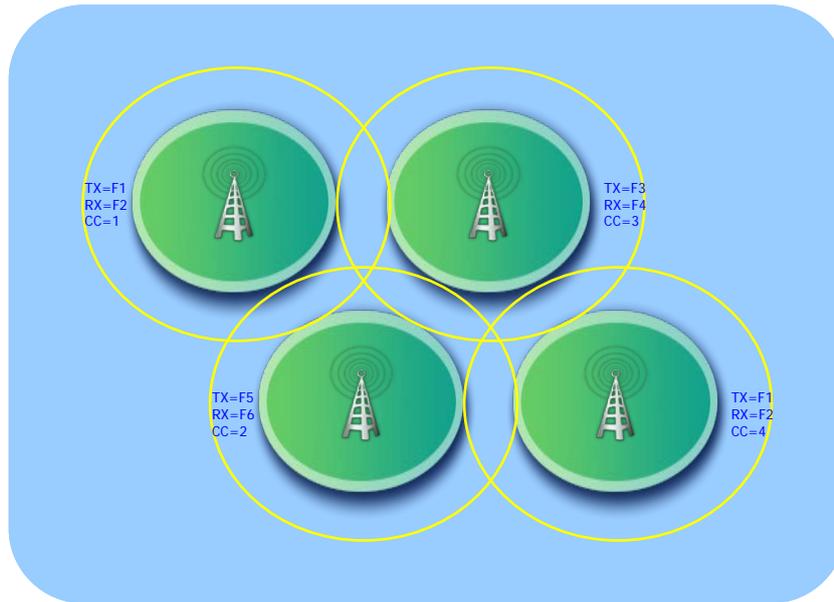


Figure 5.3.2.1-1 Overlapping Coverage

5.3.2.2 Non-overlapping coverage

This scheme is designed for the countryside or a single part of a small city. It involves multiple separate sites and no overlapping coverage is present. The non-overlapped areas share frequencies, but different color codes are required for roaming service. With this scheme, a user may be within coverage of one site at the same time, and it takes several hours to move from one site to another.

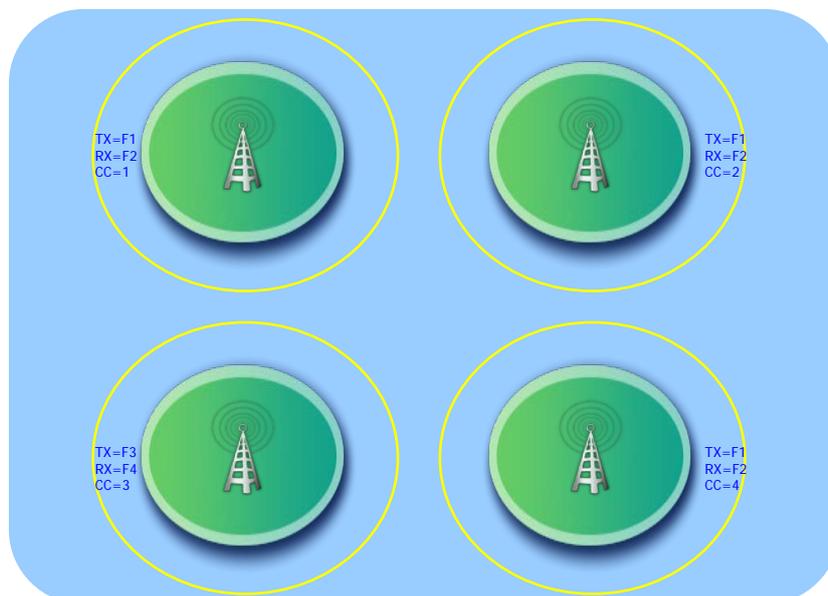


Figure 5.3.2.2-1 Non-overlapping Coverage

5.3.2.3 Linear coverage

This scheme is designed for communication services along the road, railway, river or coastline. It involves multiple sites and overlapping coverage is present on a small scale. The overlapped areas share frequencies, but different color codes are required for roaming service. With this scheme, a user may be within the coverage of one or two sites at the same time, and it takes about an hour to move from one site to another.

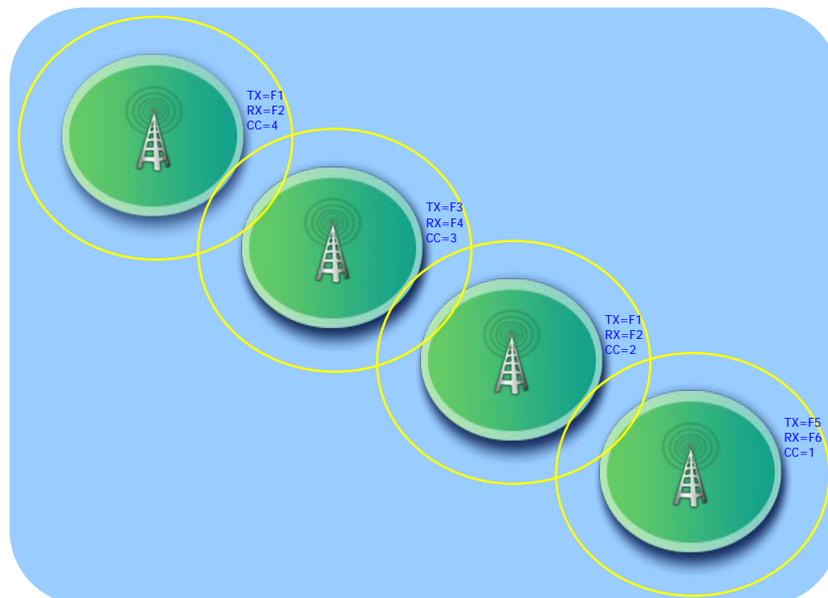


Figure 5.3.2.3-1 Linear Coverage

5.3.2.4 Multilayer coverage

This scheme is designed for a high-rise building or a deep well. It involves multiple sites standing close from each other and overlapping coverage is present on a large scale. Since the coverage of each site is limited due to unfavorable geology conditions, frequency reuse is seldom available, and quick signal attenuation occurs frequently. However, different color codes are required for roaming services. With this scheme, a user may be within the coverage of one or two sites at the same time, and it takes about 1

minute to move from one site to another.

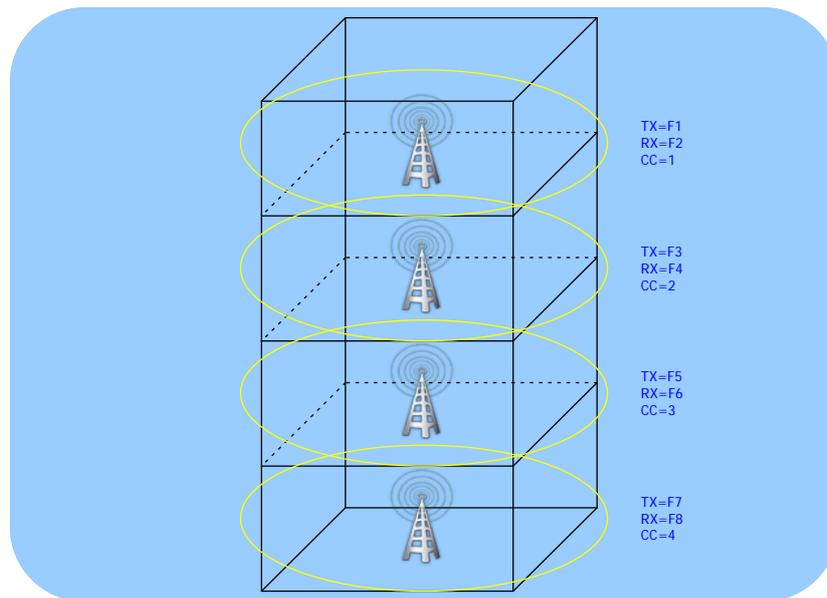


Figure 5.3.2.4-1 Multilayer Coverage

To set the RSSI threshold, the actual site configuration must be considered. For example, the threshold can be set to the lowest value (-120dBm) for non-overlapping coverage, because the terminal does not need to roam as long as it is within the coverage. For multilayer coverage, the threshold can be set a higher value. In this way, the terminal can search for stronger sites. The table below lists reference values for the four typical site configurations. In actual applications, a combination of site configuration may be used. Therefore, the system designer should take all configurations into consideration and set an appropriate value.

Site Configuration	Recommended RSSI threshold	% of Outer Range Radio Will Roam
Non-overlapping Coverage	-120dBm	0
Linear Coverage	-110dBm	10%
Overlapping Coverage	-108dBm	20%

Multilayer Coverage	-102dBm	50%
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Please note that the above RSSI thresholds assume the outbound and inbound RF coverage of the system is balanced. In other words, when the terminal is within good outbound coverage of the repeater, the terminal's inbound transmission can reach the repeater. As the roaming algorithm uses outbound transmission to decide when to roam, the terminal cannot roam in an unbalanced system even though it cannot reach the repeater. In this way, the transmission from the terminal cannot reach the repeater and so cannot be repeated.

The solution to this problem is to reduce the outbound TX power of the repeater, so as to shorten the outbound coverage. In this way, the terminal can send successfully as long as it can receive successfully. If reducing the outbound TX power is not desirable, set the RSSI threshold to a value higher than the recommended one, to force the terminal to roam even within good signal coverage. The threshold may be different for portable terminals and mobile terminals because they have different TX power and therefore different inbound coverage. The portable terminal may need a higher RSSI threshold than the mobile terminals.

Please note that each roam list is configured with a threshold value. This means if unbalance exists in one site rather than in the other site, it may be difficult to find an appropriate threshold value for both sites.

5.3.3 Setting Beacon TX Mode, Beacon Duration and Beacon Interval

If no activity is present in the system, the repeater will go to the sleep state. In this case, the terminal cannot detect signal strength via auto site roaming, preventing from selecting the strongest site. For this reason, the repeater should be configured to send beacons when no activity or interference is present in the system. During such period, the terminal decides when to roam in accordance with the strength of the beacon. If it does not receive

any beacon within a predefined period, it will suppose that it is out of the coverage and start roaming.

The beacon TX mode, beacon duration and beacon interval are configurable via the CPS. The beacon TX mode and the beacon duration can be configured in the repeater only, while the beacon interval can be configured in the repeater and the terminal.

Beacon TX Mode includes Local and Network. When the repeater operates as a single base station, the Beacon TX Mode is generally set to Local, which indicates beacon transmission duration and interval are designated from Beacon Duration and Beacon Interval; When the repeater operates in IP Multi-site Connect System, the Beacon TX Mode is generally set to Network, which indicates the beacon transmission duration and interval will be obtained from the master in the IP Multi-site Connect system and the beacon TX signals will be synchronized.

The beacon duration depends on the number of sites in the system and therefore in the roam list, while the interval depends on how quickly the terminal roams to another site.

The ratio of the beacon duration to the beacon interval equates to how often the repeater transmits (i.e. beacon transmission ratio) in the case of no inbound activities. This ratio is not configured for the system directly, but it is an important tip for setting the beacon duration and beacon interval. On a shared frequency, the transmission ratio for beacons should be kept low (target ratio: 5%-10%). In other words, the beacon interval should be increased accordingly if the beacon duration is increased.

If the beacon duration is very short, it may be difficult for the terminal to detect it. This is especially true if there are more sites. If the terminal detects a specific site at longer intervals, it is more likely for the terminal to miss the beacon. Typically, a user is within the coverage of no more than four sites at any given time. Therefore even with a large roam list, most of the sites have no activity and can be detected quickly. However, interference may occur if many sites share frequencies.

Note: The nearest site will be detected first because the sites are ordered in accordance with signal strength in the roam list. If a user moves to a site that is not visited recently, the

first roam may take a long time. Once the site is detected, it will be moved to the front of the roam list. To improve the possibility of receiving the beacon, the beacon duration should be increased. It is safer to have a beacon duration longer than shorter. Please note if the beacon duration is increased, the beacon interval will accordingly be increased to satisfy the beacon transmission ratio.

The beacon interval controls how quickly the terminal can roam to a site or away from a site when no activity is present in the system. When roaming with no system activity, the terminal needs a beacon to roam to a new site. If the repeater beacon is sent every one minute, the terminal may be one minute deep into the site before it sees the site and roams to it. Similarly, when roaming with no system activity, the terminal may be one minute outside of the site before it attempts to roam. The influence of this value often changes based on how quickly the user is traveling. For example, a vehicle driving at 60 miles per hour can cover a mile a minute, and so will be one mile into or out of a site before roaming. This is ideal for non-overlapping coverage and linear coverage. For overlapping coverage, the beacon interval should be shorter because the leaving and entering of sites should be quicker. Please note that if a user transmits before the beacon is detected via auto site roaming, the terminal will try to revive the site repeater.

A one minute beacon interval may be proper for walking users if the sites are not very close like in the “Multilayer Coverage” example. In this case, a user in an elevator may move fast between sites. The one minute beacon interval may be improper, because it may be longer than the duration that the user needs to move from the floor to the top. Hence, it is better to set the beacon interval to 20s. Please note that the 5% beacon transmission ratio may not be achievable for a system with multiple repeaters. In this case, the system designer may either decide to abandon this target ratio since indoor coverage usually does not propagate very far, or decrease the beacon duration. The table below lists recommended beacon durations and beacon intervals (8% beacon transmission ratio) for a varying number of sites. The default values for beacon duration and beacon interval are 4.32s and 60s respectively.

No. of Sites	Beacon Duration[s]	Beacon Interval[s]
2	0.72	10
3	1.92	30
4	3.12	40
5	4.32	60
6	5.52	70
7	6.72	90
8	7.92	100
9	9.12	120
10	10.32	130
11	11.52	150
12	12.72	160
13	13.92	180
14	15.12	190
15	16.32	210

If shared use is not a problem in the customer's region, the beacon transmission ratio becomes less important. And it may be desirable to increase the beacon duration and decrease the beacon interval. If the automatic Active Site Roam is disabled, it is recommended to decrease the beacon interval as much as possible, because the terminal finds sites based on the beacon only.

5.4 Roaming Interactions

5.4.1 Interaction between Scan and Roaming

1) A channel cannot be added to the roam list and the scan list both. The terminal does not

support Roam and Scan simultaneously on a channel. Therefore, the user can select either Roam or Scan for a specific channel.

2) A channel associated with a scan list can be added into the roam list. However, the terminal will not start scanning when it roams to the channel even with the Auto Scan feature enabled.

3) A channel with the Roaming feature enabled can be added into the scan list. During scanning, the terminal will not start roaming after it receives voice or data on the channel.

5.4.2 Interaction between Menu and Roaming

1) If the terminal roams to another channel, the menu that it accesses will be associated with the selected channel.

2) The only difference is that the Talk Around setting in the menu is associated with the channel of the master site.

3) During roaming, some channel parameters of the master site is used. However, the Encrypt and Power Level menus are related with the selected channel.

4) If the terminal roams to a non-selected channel and the Roam is disabled, the menus entered are the same as those in item 3) above.

5.4.3 Interaction between Talk Around and Roaming

1) If the Roaming is enabled for the terminal and the Talk Around is checked for the selected channel, the terminal will exit roaming temporarily on the selected channel, upon entry to the Talk Around mode via menu or programmable key. Please note that the Roaming is still enabled in the menu and is still active for the terminal.

2) If the terminal enters the Talk Around mode during roaming, and enters the Repeater mode via menu or programmable key before the Roaming feature is disabled, it will roam again on the channel.

3) If the terminal enters the Talk Around mode during roaming, and enters the Repeater mode via menu or programmable key after the Roaming feature is disabled, it will not roam again.

4) During roaming, if a channel in the roam list is in the Talk Around mode.

A) During auto site roaming, if the channel has the strongest signal and its strength is above the RSSI threshold, the site will be set as the master site and the channel will be switched to the Repeater mode.

B) During auto site roaming, if voice or digital service is received on the channel, it will be switched to the Repeater mode for receiving. The site will be set as the master site after receiving.

C) During active site roaming, if this site is available, the channel will be switched to the Repeater mode for transmitting. After transmitting, the site will be set as the master site.

5) If the repeater enters the Talk Around mode (DM) during roaming, users cannot enable/disable the Roam feature via menu or programmable key in the current channel before the repeater is switched to repeater mode. But users can enable/disable the Roam feature of the repeater via menu or programmable key in other channels in the Roam List (RM).

5.4.4 Interaction between Encrypt, Power Level and Roaming

1) If the Encrypt feature or power level is set via menu or programmable key during roaming, the settings will be saved to the selected channel rather than the current channel in the site.

2) If the terminal roams to a non-selected channel and the Roam is disabled, the Encrypt feature and power level will be processed in the same way as item 1) above.

5.4.5 Interaction between Ctrl Services and Roaming

- 1) If the terminal is killed during roaming, it will lock onto the channel on which it was killed, even after restarted. It is required to make the terminal return to the channel on which it was killed before it can receive a revive command.
- 2) If the roaming terminal receives a call alert, the roaming status will not be affected.

5.4.6 Interaction between Emergency and Roaming

- 1) Roaming is not supported for the “Siren Only” type. The following situations exclude the “Siren Only” type.
- 2) The revert channel depends on the current master site.
- 3) The terminal will not detect the sites in Emergency mode.
- 4) In Emergency mode, if the emergency Revert Channel is set to a non-revert channel, the emergency call transmission will activate site searching. And if the site searching has found a new site, this site will be set as the master site. The terminal will still employ the emergency system associated with the master site and will not affect the Hot Mic transmission times.
- 5) In Emergency mode, if the emergency Revert Channel is set to a revert channel, the emergency call transmission will not activate site searching.
- 6) When the emergency is initiated (the “Call Only” mode is excluded and the Hot Mic is not set) and the repeater for the revert channel associated with the master site is not activated, the terminal will start active site roaming to search for another available site in accordance with the roam list of the selected channel. If no available site is found, the “no emergency!” alert will be given and will disappear automatically later. The following process will be the same as the emergency process. If an available site is found, it will be set as the master site and its emergency system will be used. If the emergency system for this site is set to “Disable”, the “no emergency!” alert will be given and will disappear

automatically later. The roaming process will be started again.

7) The terminal should return to the master site and start roaming again after exiting the Emergency.

8) The roaming terminal will suspend roaming when it receives emergency. After exiting the emergency alert screen, the terminal will start roaming automatically.

9) If the revert channel used by the emergency system is the current channel, the contacts to be used will be those associated with the current channel. If the revert channel is not the current channel, the contacts to be used will be those associated with the revert channel.

In summary:

Function	Auto Site Roam	Active Site Roam (triggered by TX request)
Emergency (non-revert)	Not available	Available
Emergency (revert)	Not available	Available only when the Emergency is initiated

5.4.7 Interaction between RRS, GPS Revert and Roaming

1) The RRS is sent in the same way as other services. The terminal will suspend roaming first. If the repeater in the master site is not activated, the active site roam will occur.

2) To turn off the terminal during roaming, the de-registration code will be sent first. Then exit roaming and turn off the terminal.

3) The GPS revert channel depends on the current master site.

4) If the terminal is out of the coverage of the repeater and does not activate the repeater, reporting information while the terminal is returning to the GPS revert channel will cause data message loss. When the terminal returns to the master site after it fails to go to the GPS revert channel once, the terminal will perform site searching using the Roam List in

the selected channel to ensure it has found a site before it tries to go to the GPS revert channel again.

5) In Emergency mode, when the terminal returns to the emergency Revert Channel after it fails to go to the GPS revert channel once, the terminal will not perform site searching.

6) If auto roaming needs to be started after channel switching, the RRS will register later.

5.4.8 Interaction between Repeater and Roaming

When the repeater is idle, the terminal decides when to roam in accordance with the strength of the repeater's beacon. If the terminal does not receive any beacon within a predefined period, it will suppose that it is out of the coverage and start roaming. Because of this, the repeater should be configured to send beacons when no activity or interference is present in the system.

The beacon duration can be configured in the repeater only, while the beacon interval can be configured for the repeater and the terminal.

The beacon duration depends on the number of sites in the system and therefore in the roam list, while the interval depends on how quickly the terminal roams to another site.

5.4.09 Interaction between Priority Interrupt and Roaming

During roaming, the terminal will use the Slot associated with the master site and Priority Interrupt Encode/Decode settings are associated with the Slot. In this case, the Slot and Priority Interrupt Encode/Decode settings are associated with that of the selected channel. When using this feature during roaming, the Slot and Priority Interrupt Encode/Decode settings of the master site must be consistent with that of the selected channel. If the above settings of the master site are not consistent with that of the selected channel, the Priority Interrupt Encode/Decode feature will malfunction or will be unavailable. It is recommended to keep the Priority Interrupt Encode/Decode settings of all channels in Roam List consistent (Channel: Slot Operation, Priority Interrupt

Encode/Decode, Back Call Interrupt; Terminal: Message Priority Interrupt, Emergency Priority Interrupt).

5.4.10 Interaction between Phone and Roaming

The interaction between Phone and Roaming is the same as that between Digital Communication and Roaming.

5.4.11 Interaction between Other Functions and Roaming

- 1) During roaming, the terminal will only display the appropriate status icon rather than the new message or alert screen for any missed call.
- 2) If “Rx Only” is checked on the selected channel with the Roaming enabled, the Active Site Roam cannot be used, and the terminal will still receive only if it roams to other channels without “Rx Only” checked.

5.5 Performance while Roaming

Please note that roaming may cause performance degradations. Therefore, the RSSI threshold and the terminal’s Site Lock must be set appropriately when not in mobile status. The degradations are similar to what the terminal will experience during scanning.

Degradation may occur in the following:

- Late entry to voice transmission
- Longer preamble required for control message and data
- Increased setup time for Confirmed Private Call
- Group Call Time to Talk Permit may increase if auto site roaming is required

During roaming, the terminal will temporarily leave the current home channel and detect other sites (similar to scan). This means the terminal may not be present on the master site when a call starts. After detecting every other site, the terminal will detect the master site to minimize the time away from it. This is similar to the scanning order for a priority

member.

If the current master site cannot be revived, the terminal will try to locate another site via the automatic active site roaming. When the terminal tries to revive other sites, the user must wait. This increase in time will be recognized as an increase in the time from PTT to receiving the Talk Permit Tone. This will not occur often if the beacon interval for the repeater is appropriately set.

It is expected that the value that the Roaming feature adds is worth these performance degradations. The beacon interval and the RSSI threshold should be appropriately set to minimize the time the terminal needs to search for a site.

6. FAQ

6.1 Is the Roaming feature equivalent to the Scan feature

As described above, the Roaming and Scan features can not be set for the same channel. The Scan feature is mainly used in direct mode or Repeater mode to scan channels in the scan list, while the Roaming feature is mainly used in the IP Multi-site Connect network to scan channels in the Roam list. Therefore, the Roaming feature is not the Scan feature for the conventional communication system.

6.2 Does the Roaming feature affects communication quality

As stated above, the Roaming feature requires specific use environments. Generally, communication made on the master site will not be affected. If the terminal moves from one site to another while communicating, the communication will be interrupted because the terminal needs to connect to the repeater again.

However, the communication quality will be the same no matter which site the terminal operates on.

Communication services such as voice and data cannot be made during roaming. The Roaming feature requires the terminal to searches different channels continuously, while communication services require a specific channel. Therefore, the Roaming feature and communication services cannot be executed simultaneously.

In summary, the mutual influence between the Roaming and communication services mainly depends on the specific use environments.