KENWOOD

DMR System Guide (Tier II)

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Revision History

Revision	Edition
1.00	First Edition
2.00	For NXR-1700/1800

Document Revision

This document shall from time to time be changed without notice. This document is created and published for the products having the following design specifications.

Firmware Version

Item	Version	How to Verify
NXR-1700/1800	2.20.00	Tools > Repeater Information dialog box of KPG-D7
NX-1000 series	2.30.00	Tools > Transceiver Information dialog box of KPG-D6
NX-3000 series	K 4.15.00	Read/Write > Transceiver Information dialog box of KPG-D3
NX-5000 series	K 5.16.00	Tools > Transceiver Information dialog box of KPG-D1
TK-Dx40 Portable Mobileseries	1.48.00 1.50.00	Tools > Transceiver Information dialog box of KPG-166D

Programming Software Version

Item	Version	How to Verify
KPG-D7	2.20	About dialog box of KPG-D7
KPG-D6	3.30	About dialog box of KPG-D6
KPG-D3	4.10	About dialog box of KPG-D3
KPG-D1	5.10	About dialog box of KPG-D1
KPG-166D	2.33	About KPG-166D dialog box of KPG-166D

Application Software Version

Item	Version	How to Verify
KPG-180AP	5.10	About KPG-180AP dialog box of KPG-180AP
KAS-20	3.17	About dialog box of KAS-20

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Contents

1. DMR Digital System

Digital Mobile Radio (DMR) is an open standard defined in the European Telecommunications Standards Institute (ETSI).
DMR is a digital radio communication protocol using 4-level FSK. DMR improves spectrum efficiency by using 2-slot Time Division Multiple Access (TDMA) in the existing channel spacing of 12.5 kHz used for land mobile bandwidth.

This chapter explains the features of the DMR digital system.

1.1. Introduction

The Kenwood range of DMR hand portable, mobile radios, and repeaters meet with ETSI TS 102 361* Tier II: Conventional DMR. Kenwood's experience in radio design, audio quality, and outstanding quality have made DMR the best digital conventional system solution available today.

The range includes low, mid and high-tier hand portables and mobiles; all designed to meet the requirements of users operating commercial and operations critical radio systems and specifically requiring an ETSI compliant, multi-vendor solution.

With the introduction of the innovative NX-5000/3000/1000 series, Kenwood adds true multi-protocol capability and future-proof flexibility to its DMR line-up, giving you the advanced features and functions you need to build a digital two-way communications solution.

In addition, Kenwood DMR capabilities can be further extended to include multiple user groups and increased coverage by employing NXR-1700/1800.

You can see the DMR interoperability on the DMR Association website.
https://dmrassociation.org/iop-certificates-and-test-results.html

Figure 1-1 DMR Models

1.2. Digital Technology

This section compares TDMA and FDMA and explains the major advantages of digital technology employed by our radios and repeaters.

1.2.1. TDMA and FDMA

DMR is designed based on the TDMA access method. FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access) are the three major channel access methods for radio communication. CDMA will not be explained in this document.

TDMA allows several users to share the same frequency channel by dividing the signal into different time slots. FDMA divides the given spectrum into channels by the frequency domain.

Figure 1-2 shows TDMA that divides a 12.5kHz channel into two slots and FDMA that divides a 12.5kHz channel into 6.25kHz bandwidths.

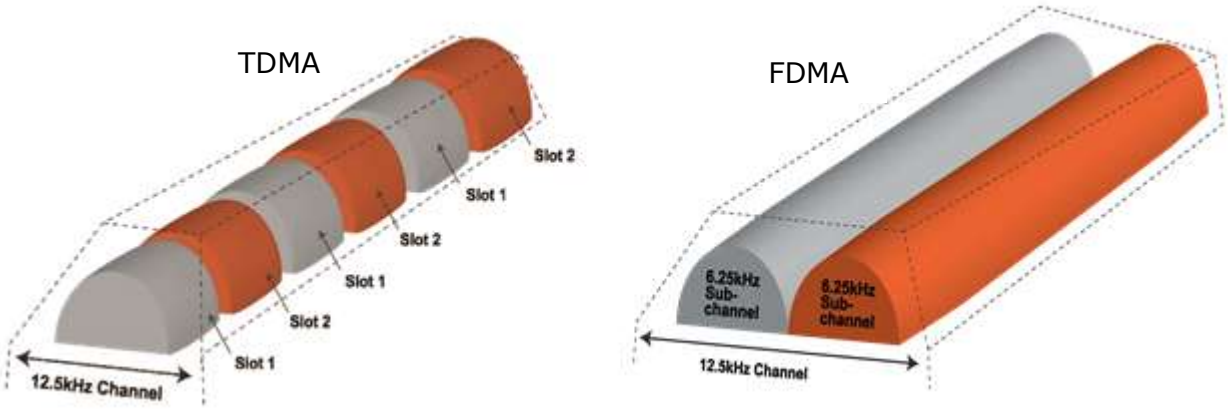


Figure 1-2 TDMA and FDMA

TDMA has the following features.

- The number of repeaters relative to the number of necessary channels can be reduced because of the doubled capacity of the repeater. This expects a cost-effective infrastructure in case of migration from 12.5kHz FM.
- Energy efficiency leads to longer battery life due to intermittent TX.
- Requires accurate timeslot management, tends to be affected by frequency selective multipath fading.
- Intermittent TX might generate burst noise emission.

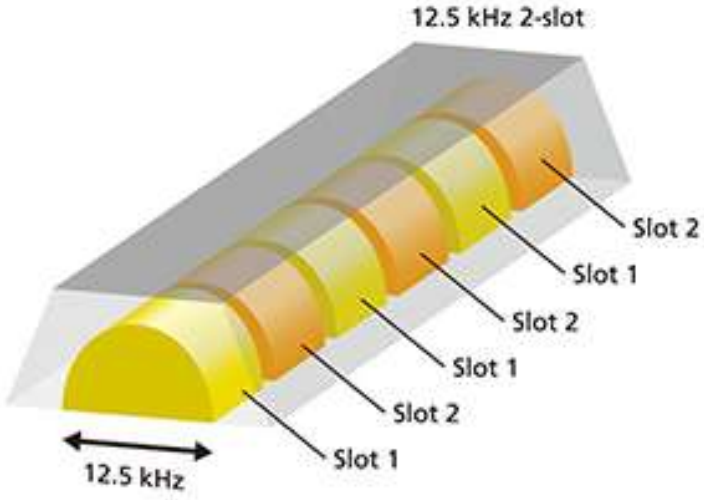
FDMA has the following features.

- 6.25kHz very narrow bandwidth has wider coverage compared to digital 12.5kHz bandwidth operation due to superior C/N ratio.
- Quite stable, because of its simplicity

1.2.2. Spectrum Efficiency

TDMA employed by DMR divides a channel of 12.5kHz bandwidth into two alternating time slots. (refer to Figure 1-3) Each call uses only one of the two slots. Thereby the independent call is possible in 2 time slots (two logical channels) of the one physical channel. Each RF frequency of the two logical channels is exactly the same and each bandwidth is still 12.5kHz.

Figure 1-3 shows a gap named "guard time" between slot 1 and slot 2. This is a time to



allow ramping and propagation delay of TX power.

Figure 1-3 Two-slot TDMA in 12.5kHz Channel

In FDMA, a 12.5kHz bandwidth channel is divided into two very narrow channels of 6.25kHz bandwidth. (Refer to Figure 1-4)

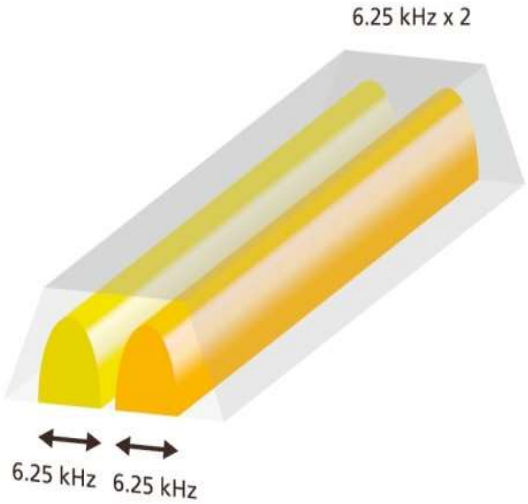


Figure 1-4 FDMA in 12.5kHz Channel

1.2.3. Vocoder

The Vocoder is a device or software object that converts baseband analog audio into digital data for transmission and back from digital to analog on reception. This digital data is a digital representation of the voice Audio Profile Feature. The vocoder has inherent noise reduction techniques as well as error correction techniques. They can be categorized into three types:

Waveform coding

This coding method minimizes distortion between the source audio signal and the coded audio signal. Increasing the bit rate can lead to better audio quality. When the bit rate is not sufficient, audio quality drops exponentially. It is low compression but has better audio loopback delay and low cost. As examples, there are MBE (Multi-Band Excitation), LSP (Line Spectrum Pair), PARCCR (PARtial auto-CORrelation), WI (Waveform Interpolation), and MELP (Mixed Excitation Linear Prediction) coding methods.

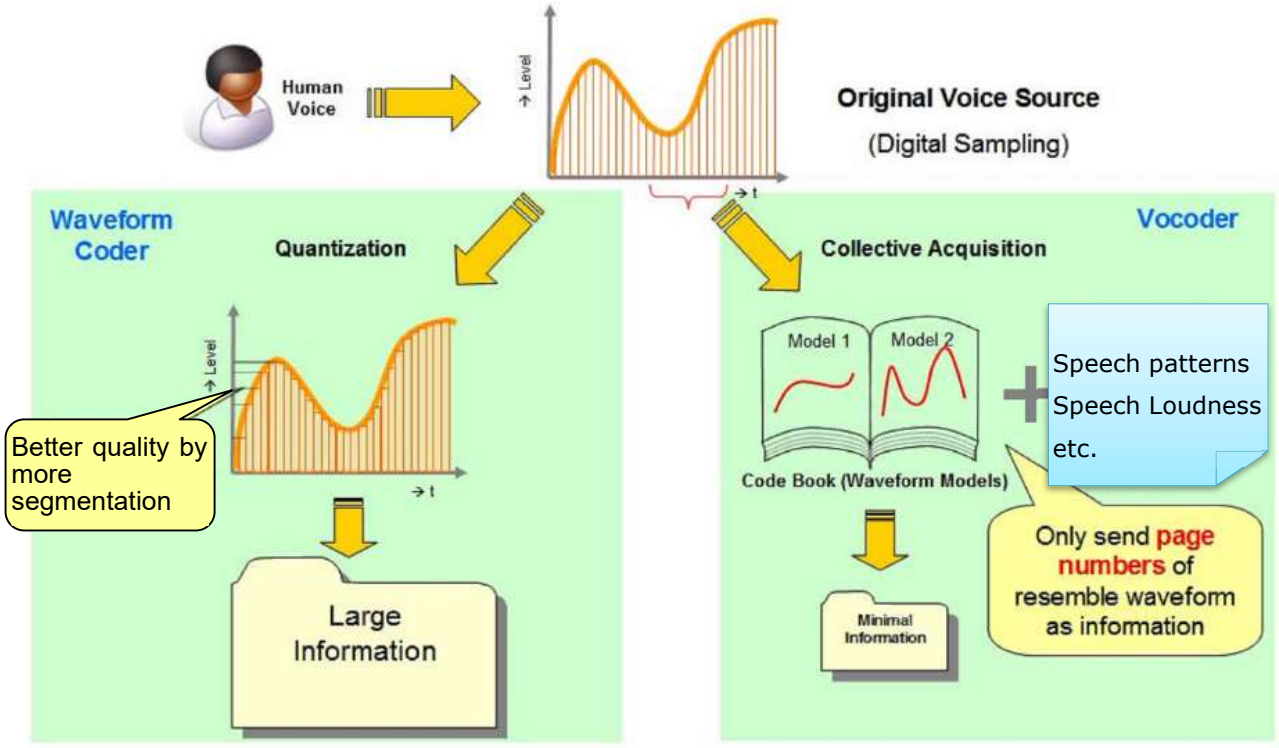
Vocoder (Analysis-by-Synthesis Coding)

The vocoder extracts audio signal parameters as synthetic wave models by analyzing the digitalized voice audio signal at the coding stage and based on the parameters, it synthesizes the voice audio signal at the decoding stage. As the vocoder only transfers the extracted and analyzed parameters and does not aim to precisely reproduce the source signal. This can drastically reduce the bit rate. However, the audio quality depends on the synthetic wave modeling, and even a higher bit rate cannot improve the audio quality in general. As vocoder examples, there are MBE (Multi-Band Excitation), LSP (Line Spectrum Pair), PARCCR (PARtial auto-CORrelation), WI (Waveform Interpolation), and MELP (Mixed Excitation Linear Prediction).

Hybrid

In addition, hybrid coding can be introduced. It involves modeling the signal elements of the source audio and transferring both audio element parameters and other information that cannot be modeled in parameters by minimizing the distortion from the source waveform using the Analysis-by-Synthesis (A-b-S) process. For instance, CELP (Code Excited Linear Prediction coding), VSELP (Vector Sum Excited Linear Prediction), and PSI-CELP (Pitch Synchronous Innovation Code Excited Linear Prediction) are categorized as hybrid vocoders. Since the hybrid coding also models the source audio signal, it can be considered as one of the Vocoder coding. The AMBE+2™ can be placed in the Vocoder category.

Figure 1-5 Vocoder



As mentioned, a vocoder is a voice audio data compressor that leverages human acoustic characteristics. As it extracts and sends characteristic voice formants from the source audio, it can drastically reduce the data quantity as compared to the waveform coding types. However, due to artificial voice generators used in the decoder stage, the output audio could sound like robot speech. Despite improvements in vocoder technologies over the years, the audio quality is still noticeably different from analog.

Digital processing merits against Analog need to be mentioned here again. The biggest benefit of digital processing is the "Narrow Band Transmission". It can robustly convey the message with minimal data. Thus, NXDN's AMBE+2 vocoder attains 6.25 kHz band-width communication which is only half the bandwidth of conventional analog 12.5 kHz technologies. Moreover, the Vocoder-equipped error correction processing contributes to improved voice clarity maintaining high quality communications in extremely noisy environments and in areas where the radio unit is operating at its sensitivity limit.

In a sense, vocoder technologies for wireless telecommunication prioritize securely conveying key elements of the source audio sacrificing the fidelity in the interfered condition where errors occur.

1.2.4. Active Noise Reduction (ANR)

Active Noise Reduction (ANR) is the function to cancel the noise component of the collected audio in order to improve the transmitted audio quality. The noise cancellation function can be collectively configured according to the usage environment. Also, selecting “Custom” enables the detailed configuration of the noise cancellation function.

Each function of the noise cancellation characteristic is automatically configured according to the configuration of the ANR Preset.

2. Main Applications

This chapter explains the main applications employed DMR digital system.

The DMR standard defines three of Tier I, Tier II, and Tier III. The following explains each feature briefly.

DMR Tier I
This is used for PMR446 (Private Mobile Radio) applications. It is with the limited number of channels, low TX power (0.5W), and only the direct mode using no repeater. It is for small-scale communication purpose. DMR Tier I will not be explained in this document.

DMR Tier II
This is used for the Conventional system and covers both direct mode which uses no repeater and repeater mode. It employs 2 slots TDMA technology.

DMR Tier III
This is used for the Trunked system. It employs 2 slots TDMA technology. DMR Tier III will not be explained in this document.

DMR Tier II is explained in this document.

2.1. Mixed Mode

A very effective feature for migrating from an analog system to a digital system is Mixed Mode. The Mixed Mode allows the DMR Conventional system to wait to receive both an analog signal and a DMR digital signal. An analog and DMR mode are seamlessly and automatically toggled so that both modes can be operated easily.

DMR repeaters such as NXR-1700/1800 switch between analog and digital modes depending on the mode of receiving signal. The repeater transmits an analog signal if the received signal is analog, and the repeater transmits a DMR digital signal if the received signal is a DMR digital signal.

NXR-1700/1800 enables IP Network construction in Analog Mode, which allows DMR/Analog settings in the Conventional Multi-Site.

For system owners or integrators, the migration plan from a current analog system is one of the biggest concerns from the investment perspective. The Mixed Mode allows smooth migration while maintaining continuous operation.

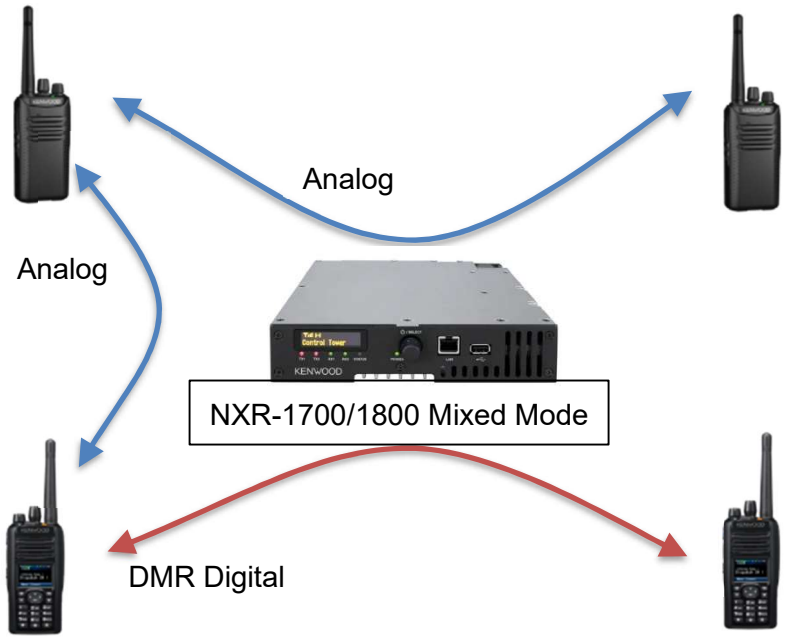


Figure 2-1 Mixed Mode

2.2. Conventional Direct Mode

Direct Mode provides the simplest and the most elementary operating style in radio communication. It is called P-to-P (Peer to Peer) communication made between terminals using a simplex frequency. Communication coverage is determined by a radio unit's transmitting output power and receiving sensitivity. One or multiple terminals could be a Base Station at a fixed location with a high-performance antenna system in order to obtain wide coverage. A single frequency is used essentially among terminals in a field. KENWOOD DMR radio supports a maximum of two calls simultaneously using one physical channel in Direct Mode.

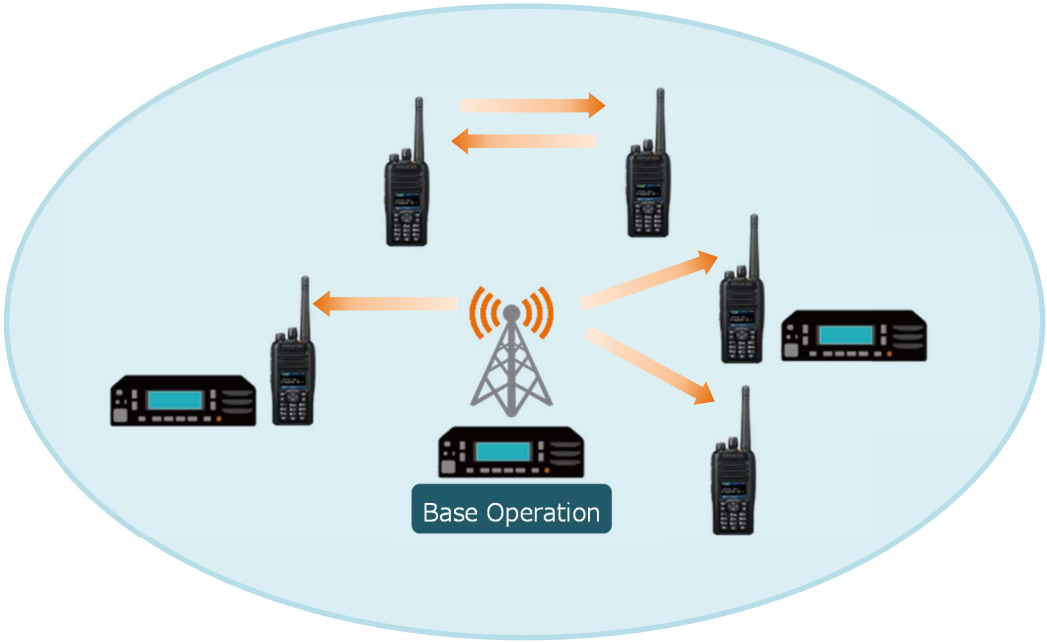


Figure 2-2 Conventional Direct Mode

2.3. Conventional Repeater Mode

Conventional Repeater Mode provides a call between terminals via a repeater. In order to expand coverage, a repeater is often installed on a high site. NXR-1700/1800 repeaters can be used as a base terminal by connecting a microphone to the panel. The transmission towards the repeater is called Uplink or Inbound while the other direction is called Downlink or Outbound, and different frequencies are applied to them. Together with Direct Mode operation, Repeater Mode operation is also called Conventional operation as opposed to Trunking Mode operation.

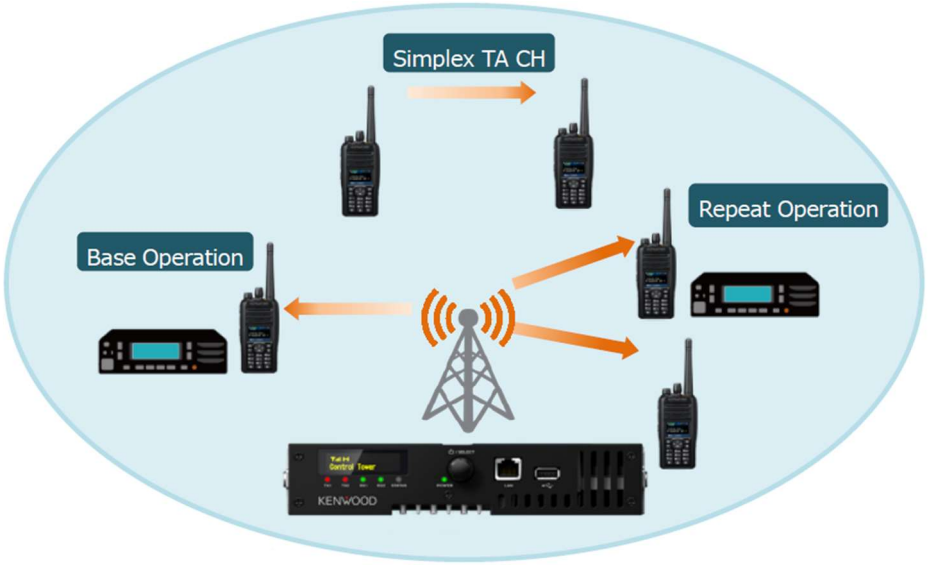


Figure 2-3 Conventional Repeater Mode

2.4. Conventional IP Network Mode

Conventional IP Network is a mode to expand coverage by interconnecting multiple repeaters installed in different locations over an IP network. This enables the radio unit to communicate with a distant radio unit via the IP network. It supports both multi-frequency and simulcast. TKR-D710/810 repeater connects to an IP network using an interface unit KTI-5.

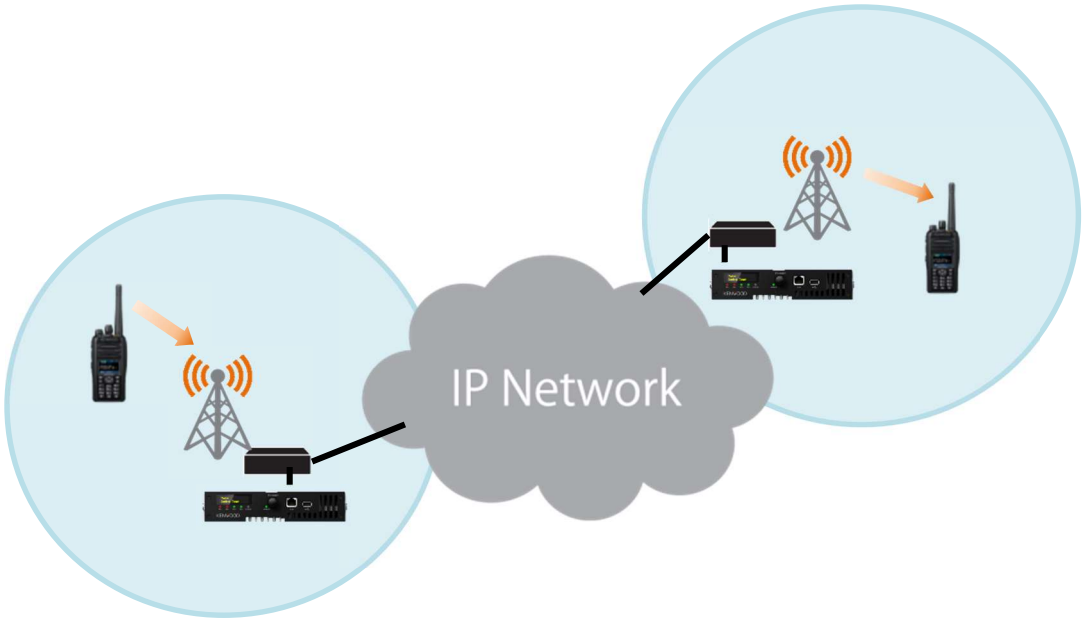
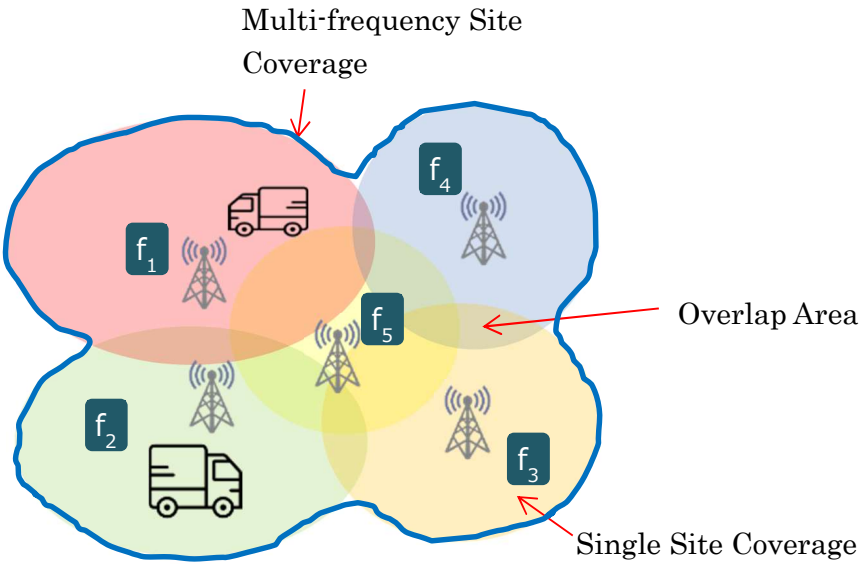


Figure 2-4 Conventional IP Network

2.4.1. Multi-frequency

Multiple repeaters which are connected to the IP network and configured with different frequencies can be operated. A radio unit can use Site Roaming which is a function to automatically switch a radio to a better radio environment site.

Figure 2-5 Multi-frequency Site (TKR-D710/810)



2.4.2. Simulcast

In Simulcast, all the repeaters in the same system use the same RF Frequency. It functions like a single "big repeater" because all the repeaters synchronize with each other using such as a GPS and transmit the same signal with the same frequency at the same timing. This allows the radio unit to communicate with an appropriate repeater depending on its location without scanning such as Site Roaming.

The main advantages of Simulcast are the following.

- Using the same RF channel over the whole coverage area gives a "big cell" single repeater functioning.
- No channel change or scan through different repeaters: Easy to use, fast call set-up.
- Frequency saving.
- Easy expandable because the introduction of a new site doesn't require any additional frequency.

The Simulcast system can be constructed with KAIROS repeaters.

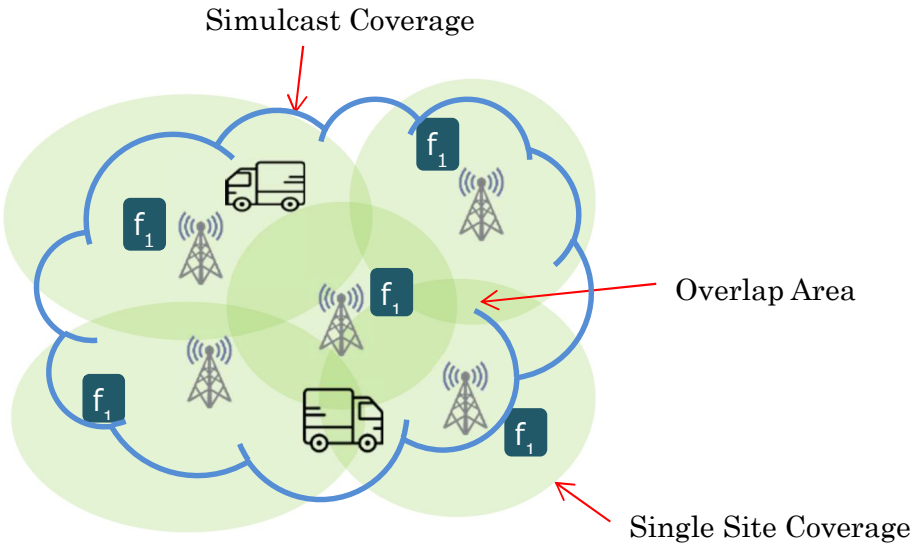
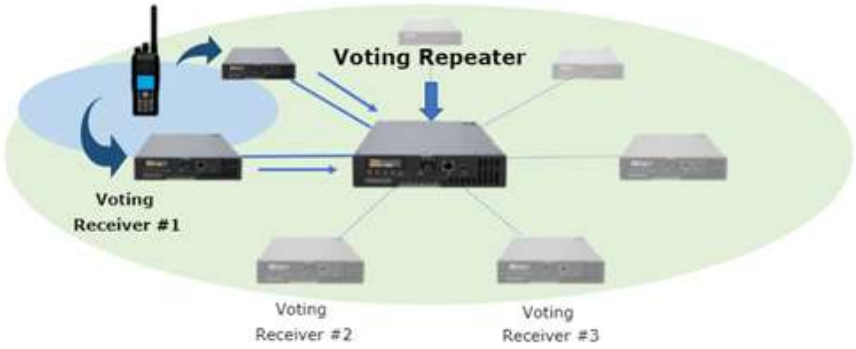


Figure 2-6 Simulcast System (KAIROS)

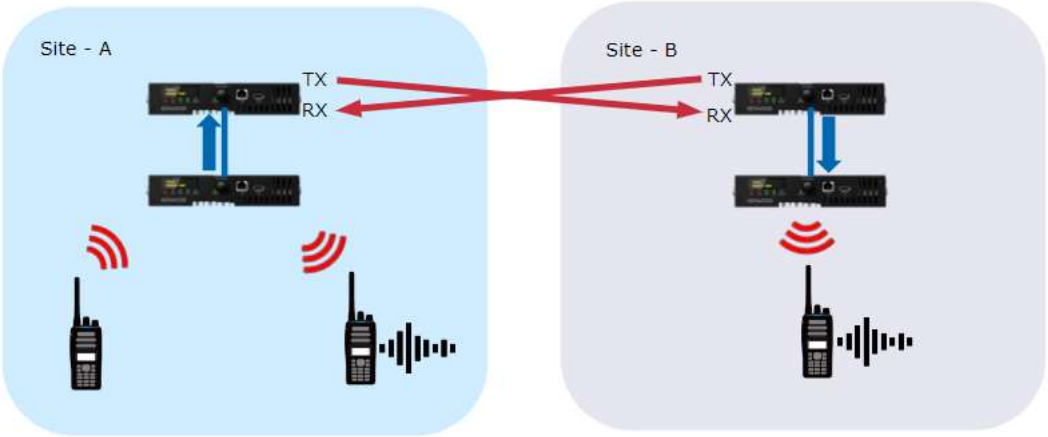
2.4.3. Voting

The transmission output of the Subscriber Unit is low in comparison with that of the Repeater, and therefore, the Subscriber Unit can receive the downstream signal from the Repeater to the Subscriber Unit, but the Repeater may not receive the upstream signal to the Repeater from the Subscriber Unit.
To prevent this, the Voting System is effective.
The Voting System enables repeat transmission by placing multiple receive-only repeaters (Voting Receivers) with the same reception frequency within the transmission range of the Subscriber Unit and relaying them via an IP.
The Repeater that controls data transferred from the Voting Receivers is called a Voting Repeater and selects communication with the best reception level among the communication forwarded from the Voting Receivers for repeat transmission. The system consists of the Voting Repeater and multiple Voting Receivers is called a Voting System. And in this system, a maximum of 15 Voting Receivers can be connected to one Voting Repeater.



2.4.4. RF Link

When an IP Network is not available for site-to-site communication, this RF Link function enables site-to-site communication via an RF, allowing voice and data transfer in each protocol by constructing two sites. Even in the case of analog operation sites, voice communication is possible by adding a Repeater that is separately configured to the RF Link.



3. KENWOOD DMR Feature Outline

This chapter explains a function overview of DMR which is available with Kenwood's radio and repeater or KAIROS repeater.

3.1. Calls

This section explains representative functions for calls in the DMR Conventional system.

3.1.1. Individual Call

Calling with specifying an individual unit ID enables one-to-one conversation (Individual Call). A function is available in which Individual Calls override Group Calls while the radio is receiving an Individual Call.

Individual Call has two types, initiating a call after confirming whether or not the called radio is available to communicate (Individual Call Acknowledge Request), and initiating a call without the confirmation (Individual Call). Individual Call Acknowledge Request can initiate a call by ensuring the called radio is in the coverage because waiting for an acknowledgment from the called radio. The Individual Call type to be used can be preconfigured using FPU.

Note: Individual Call Acknowledge Request corresponds to OACSU (Off Air Call Setup) in ETSI DMR Standard. Individual Call corresponds to PATCS (Press And Talk Call Setup) in ETSI DMR Standard.

Making an Individual Call

An Individual Call can be started by one of the following methods.

- Individual Call Mode
  Transmit an Individual Call by selecting a Unit ID from the Individual ID List or directly entering a Unit ID using a keypad in Individual Call Mode.
- Talkback
  Press the PTT button while the Auto Reset Timer is counting down after the radio receives an Individual Call.
- Stack Mode
  Select a target from the incoming call history in Stack Mode and transmit.
- Selcall on PTT
  Select a channel that is configured as initiating an Individual Call when the PTT button is pressed and transmit. The Unit ID must be preconfigured to the channel with FPU.

- Call button
  Pressing a Call button to which the Unit ID you wish to make a call is registered.
  For Mobile, AUX input ports play function as the Call buttons 1 to 6.
- PC command
  Individual Calls can also be started using a PC command.

Alert on a radio
The following alerts are available in transmission and receipt of Individual Calls.

- The tone that emits when PTT is pressed (Call Request Tone)
- The tone that emits during the waiting time for ACK (Call Processing Tone)
- The tone that emits when a voice call becomes available (PTT Proceed Tone/Call in Progress Tone)
- The tone that emits when a radio receives an Individual Call (Alert Tone)
- The LED that blinks when a radio receives an Individual Call (Selective Call Alert LED)
- The indication of caller Unit ID or caller ID name of Individual Call ※1

※1: Using the Over-the-Air Alias feature, the radio can display the caller's ID Name even if the radio receives a call from a unit ID that is not pre-registered on the receiving radio.

3.1.2. Group Call

Calling with specifying a Group ID enables a call to the group members (Group Call). When specifying a Group ID, all the radios in the standby state with the same Group ID are called.

To initiate a Group Call, each group must be assigned a different Group ID and registered in the Group ID List using FPU.

Specify the Group Call to receive
All the desired Group IDs to make Group Calls must be preconfigured using FPU. The Group IDs for reception can be specified from the following types.

- The Group ID that is configured in Selcall on PTT of the channel
- The Group ID that is configured in Selcall on PTT of the channel and some of the Group ID List (when Persistent Group ID is enabled)
- All of the Group IDs that are listed on the Group ID List (when Group ID Scan is enabled)

Making a Group Call
A Group Call can be started by one of the following methods.

- Group Call Mode
  Transmit a Group Call by selecting a Group ID from the Group ID List in Group Call Mode.
- Talkback
  Press the PTT button while the Auto Reset Timer is counting down after the transceiver receives a Group Call.
- Stack Mode
  Select a target group from the incoming call history in Stack Mode and transmit.
- Selcall on PTT
  Select the channel which is configured a target Group ID in Selcall on PTT and transmit.
- PC command
  Group Calls can also be startes also using a PC command.

Alert on a radio
The following alert is available in transmission and receipt of Group Call.

- The tone that emits when PTT is pressed (PTT Proceed Tone)
- The tone that emits when a radio receives a Group Call (Alert Tone)
- The LED that blinks when a radio receives a Group Call (Selective Call Alert LED)
- The indication of Group ID, Group ID Name, caller Unit ID, or caller Unit ID Name※1

※1: Using the Over-the-Air Alias feature, the radio can display the caller's ID Name even if the radio receives a call from a unit ID that is not pre-registered on the receiving radio.

3.1.3. Busy Channel Lockout

Busy Channel Lockout is the function to automatically restrict the transmission so as not to interfere with other communications. The following type can be selected in the DMR Conventional system.

- Not restricts a transmission even if the channel on which the radio tries to transmit is busy.
- Restricts a transmission if the radio is receiving a carrier on the channel
- Restricts a transmission if the radio is receiving a carrier on the channel and the received Color Code is the same as the configured Color Code in the radio.

The NX-1000/3000/5000 series has an In-call Busy Channel Lockout feature which allows setting how the radio restricts a transmission when receiving a call to its own station. The following type can be selected.

- Not restricts a transmission even if the radio is in a call.
- Follows the setting of Busy Channel Lockout even if the radio is on a call.
- Terminates the call that is being is receiving by using Call Interruption messages.

3.1.4. Auto Slot Select

In the channel with the enabled Auto Slot Select feature, a user can start a call on another available slot even if one of the slots is in use. This does not require any specific user operation. Switching the slots automatically makes efficient use of a channel. This feature is available only in the repeater mode.

For the DMR Conventional system, two calls are possible in one channel. On the other hand, when a slot to try initiating a call is busy, a user cannot start the call unless the user switches the slot to another available slot. Using this Auto Slot Select feature can start a call by switching to the available slot automatically. The called radio can receive the call by switching automatically to the originating slot. This feature is very useful because the system can use a vacant slot effectively without user operation like a small trunked system.

On a channel that has disabled the Auto Slot Select feature, a user can communicate on a fixed specified slot. The originating radio can start a call if the configured slot is not in use. A target radio can receive the call if the slot of a standby channel is the same as the calling slot.

3.1.5. Paging Call

Paging Call notifies a target of the call without making a voice call. A called user can see the incoming call history in Stack Mode even if the called user is unable to respond (talkback) at the time. Also, serial Outputting of Caller IDs that are received by Paging Call is possible. This feature benefits a system that uses Individual Calls without the acknowledge request.

Making a Paging Call

A Paging Call can be started by one of the following methods.

- Individual Call Mode
  Press the programmable button for Paging Call and transmit a Paging Call, after selecting a Unit ID from the Individual ID List or directly entering a Unit ID using the keypad in Individual Call Mode.
- Talkback
  Press the PTT button while the Auto Reset Timer is counting down after the transceiver receives a Paging Call.
- Stack Mode
  Select a target from the incoming call history in Stack Mode and transmit.
- PC Command
  Paging Call can also be started using a PC command.

Alert on a radio

The following alert is available in transmission and receipt of Paging Call.

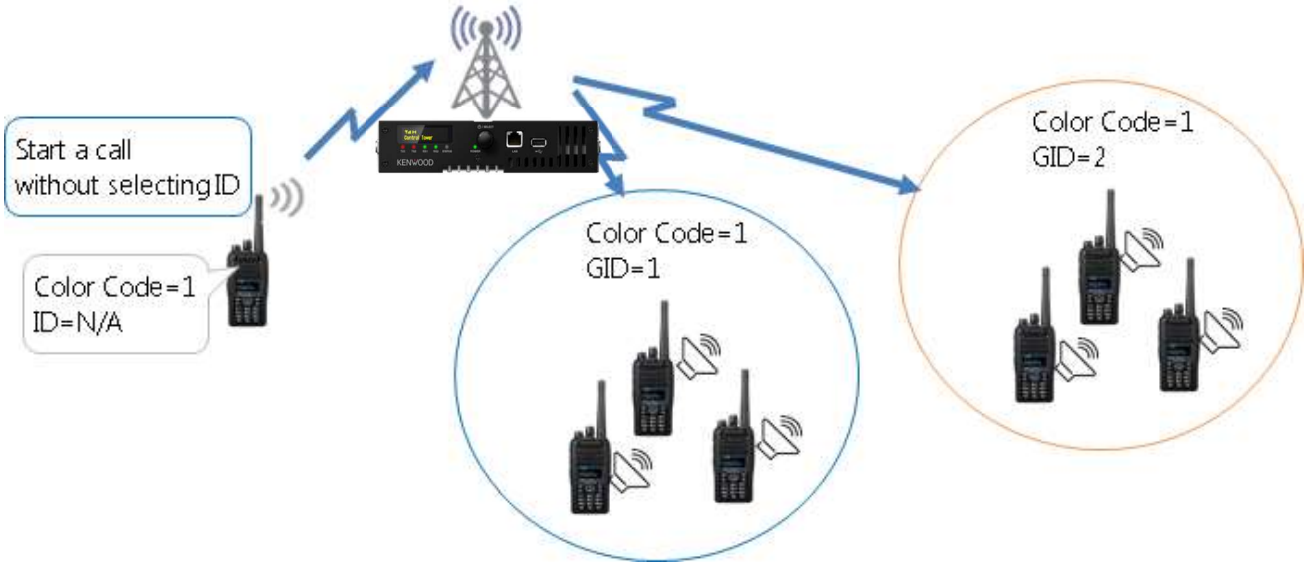
- The tone (Complete Tone) and the text display to notify the successful completion of the Paging Call
- The tone (No Reply Tone/Busy Tone) and the text display to notify the failure of a Paging Call
- The tone that emits when a radio receives a Paging Call (Alert Tone)
- The LED that blinks when a radio receives a Paging Call (Selective Call Alert LED)
- The indication of caller Unit ID or caller ID name of Paging Call※1

※1: Using the Over-the-Air Alias feature, the radio can display the caller's ID Name even if the radio receives a call from a unit ID that is not pre-registered on the receiving radio.

3.1.6. Unaddressed Call

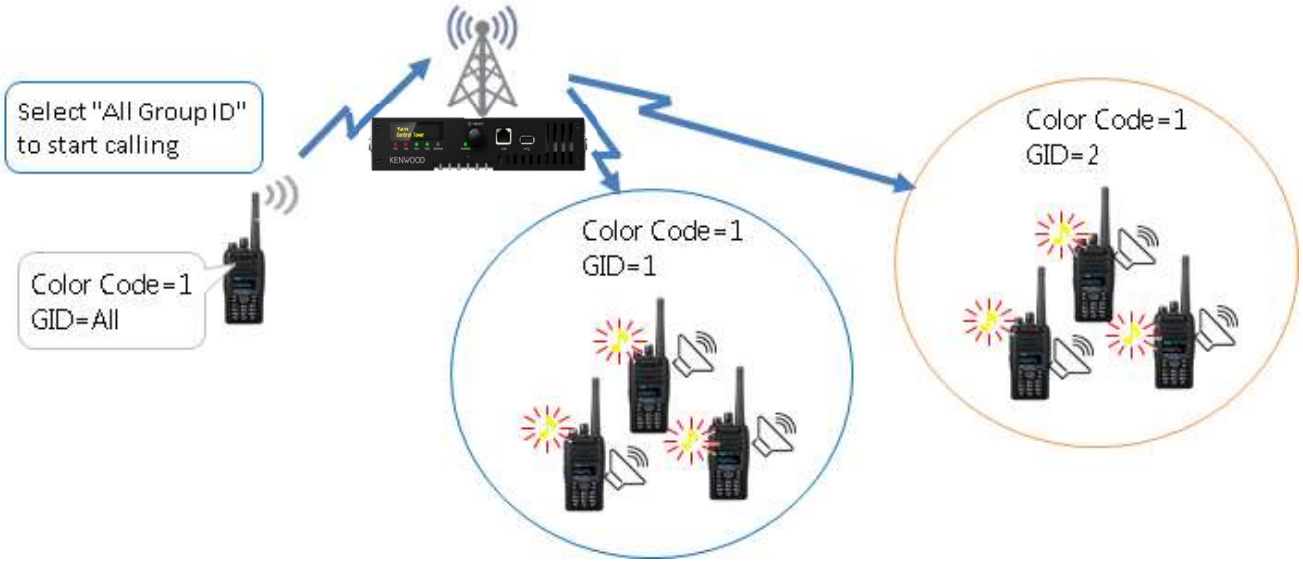
Unaddressed Call is the function that can call any radio having the same Color Code on the same channel. A Group Call can communicate only with the radio having the same Group ID, on the other hand, an Unaddressed Call has no restriction on the Group IDs. This function benefits users who are in an emergency and so on and want to communicate with other calling groups.

To make the Unaddressed Call, the PTT button is pressed on a channel where no target ID is configured for Selcall on PTT, without specifying an ID. The Unaddressed Call can also be started using a PC command. Talkback is not available when a user receives the Unaddressed Call. In the Unaddressed Call, the user can hear voice and sound through the radio, but the alert tone for notification of receiving cannot be heard. In addition, the receiving record cannot be checked in Stack Mode.



3.1.7. All Call

A Group call to all the radio can be initiated by specifying the All Group ID. There is no additional configuration for receiving the All Calls. To receive, the recipient needs to be on the same channel. To make an All Call, the All Group ID must be preconfigured to the radio by using FPU. The recipient cannot talk back the received All Group Call to the caller. Pressing the PTT button starts a transmission according to the Selcall on PTT.



3.1.8. Broadcast Call

Broadcast Group Call can be used to engage in one-way informative voice calls to the group members. The recipient cannot talk back the received Broadcast Group Call to the caller. To make a Broadcast Group Call, the specified Group ID must be transmitted after enabling the broadcast feature by operating the radio. To make a Broadcast Call, this feature must be enabled beforehand by using FPU. A Broadcast Call can also be started using a PC command.

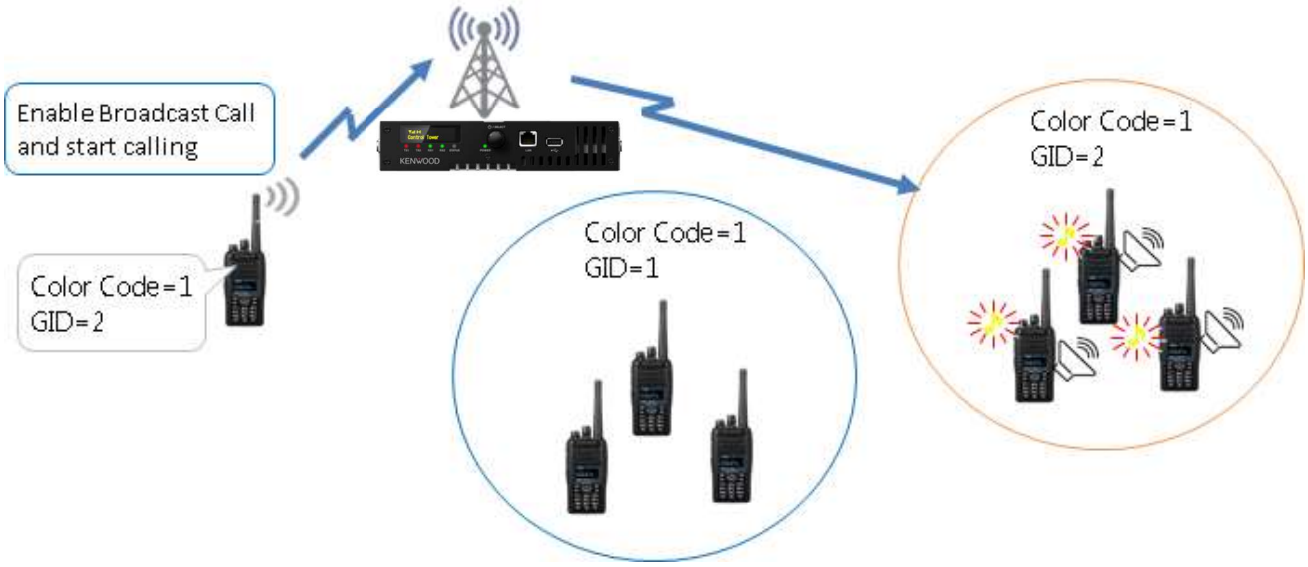
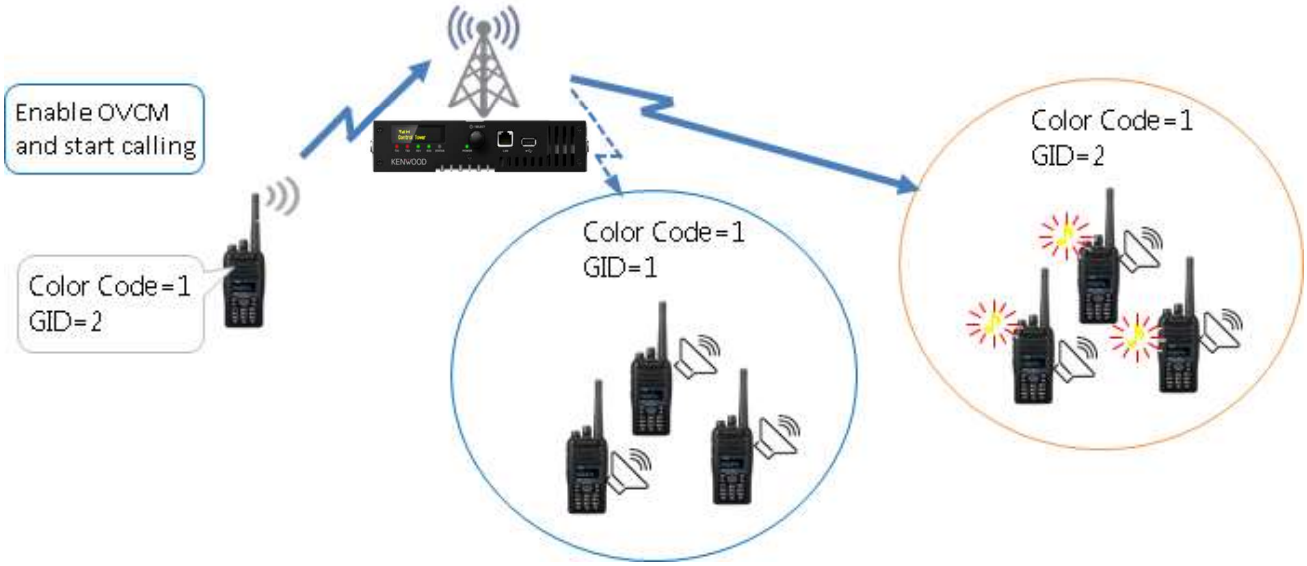


Figure 3-3 Broadcast Call

OVCM (Open Voice Channel Mode)

Enabling the OVCM feature when the Individual Call, the Group Call, or the Broadcast Call is initiated, you can hear conversation even if the IDs do not match when the radio receives the calls. With the radio having the unmatched Group ID, the user can hear the voice and sound through the radio, but the alert tone for notification of receiving cannot be heard. To receive an OVCM call, the reception must be enabled beforehand using FPU. This function must be enabled beforehand using FPU to make the OVCM calls.



3.1.10 Late Entry

In the DMR Conventional system, the radio can participate in an ongoing voice call even if received during the conversation. When the radio is turned on or enters into the coverage area in the middle of the call, the radio can participate in the ongoing voice call as long as the radio is a member of the call.

3.2. Call Interruption

Call Interruption is a function that allows the radio to initiate another call by interrupting the ongoing call when the channel is occupied. The radio can initiate another voice call, data call, emergency call, or Remote Stun/Kill message by interrupting a call. This Call Interruption feature can interrupt not only the call that is being established by the other party but also the call addressed to its own ID.

A call encrypted using one of AES, DES or Enhanced Encryption (ARC4) cannot be interrupted. A call encrypted using the bit scramble type can be interrupted.

3.3. Over-the-Air Alias

Over-the-Air Alias is a feature that a target radio can display the ID Name of a caller because the caller sends a voice call including the caller ID Name. This feature is useful for adding a radio to the current operating system without additional configuration such as entering the Unit ID Name of the new device.

3.4. Scan

Scan has the following three types in the DMR Conventional system.

- Single Scan

  The radio scans target channels in the same zone.

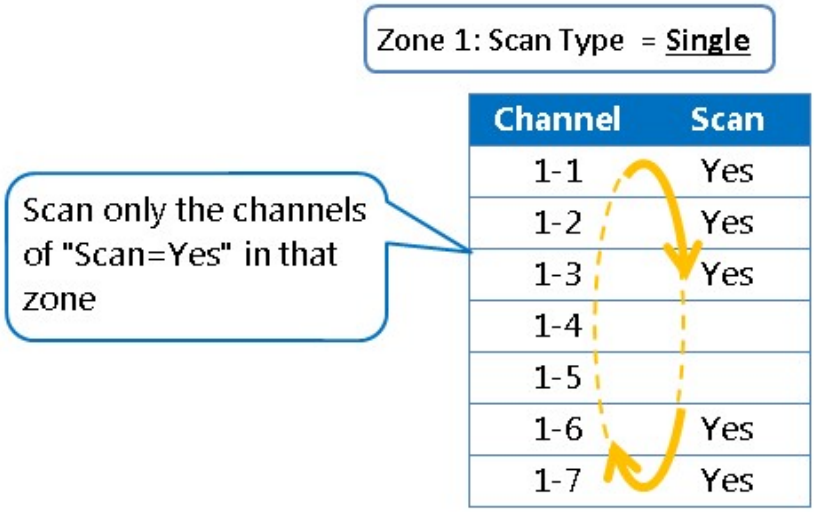


Figure 3-5 Single Scan

- List Scan

  The radio scans the Zone-channel registered as a member in a Scan List.

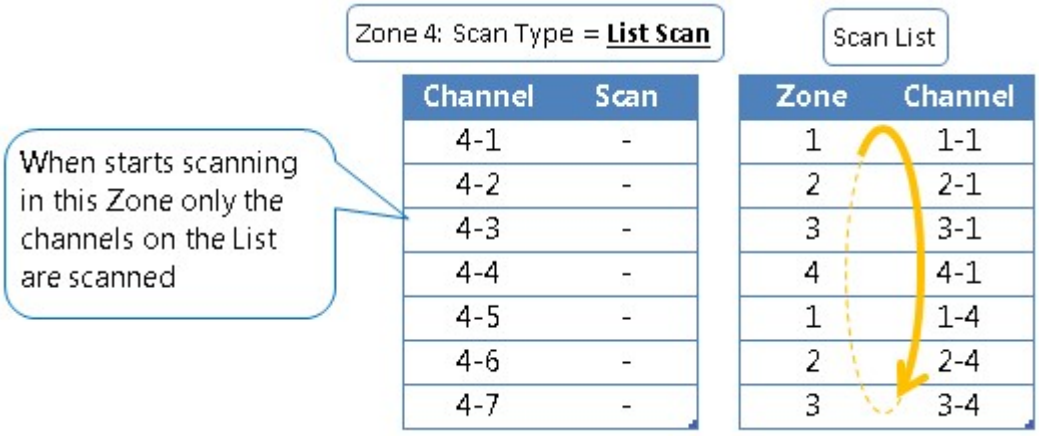


Figure 3-6 List Scan

・ Multi-Zone Scan

The radio scans all target channels in the target zones.

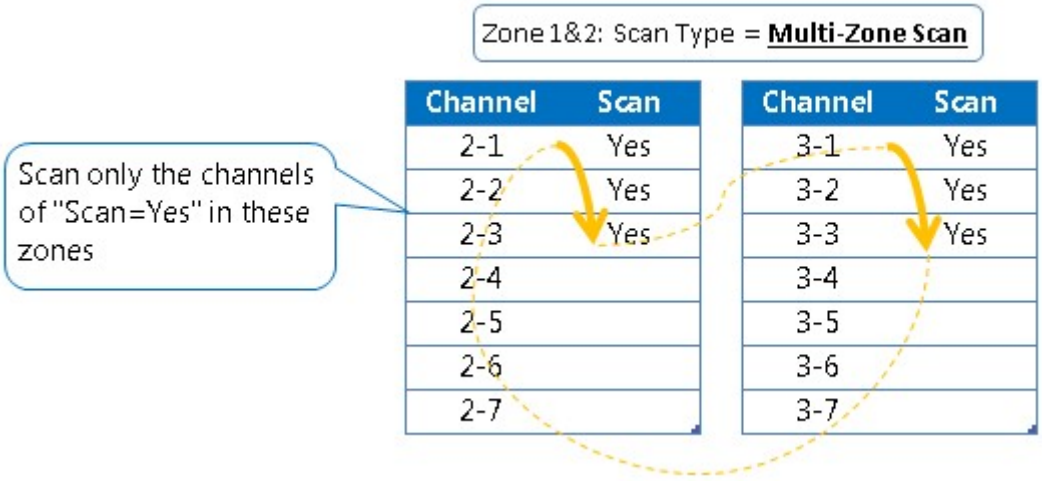


Figure 3-7 Multi-Zone Scan

・ Priority Scan

It is possible to give the higher scan priority order to the particularly important channels in the scan target channels. Up to two channels can be set for each Single Scan, List Scan, and Multi-Zone Scan.

Figure 3-8 Priority Scan

Which type of scan is operated depends on the configuration of the zone-channel that is selected when the Scan is started.

Starting a Scan

A Scan can be started by one of the following methods.

- Pressing the Scan button (toggle operation)
- Selecting in Menu Mode (toggle operation)
- Operating the lever switch (Portable radio only)
- Switching the AUX Input port (Mobile radio only)
- Switching the microphone hook status (Mobile radio only)
- Turning on the power (If the Power-on Scan function is enabled)
- Selecting the channel enabled Auto Scan function

Revert Channel

Revert Channel is the Zone-channel which is used when the radio transmits by pressing the PTT button during the scan. The following type can be selected for the Revert Channel.

- The last-called zone-channel (when scanning)
- A channel where is paused scanning (when paused of a scan)
- The changed zone-channel if the zone-channel is changed.
- Priority 1
- Priority 2

3.5. Site Roaming

If a radio works in the DMR Conventional system configured by multiple sites with different frequencies, the channel is switched to a site that provides a better radio environment automatically. A recommended maximum number of sites for roaming in one system is 16 sites for NXR-1700/1800.

The radio sequentially receives a synchronization signal from the registered sites and the channel will move to the site with the strongest signal level. The moved site becomes the Revert Channel. If the site with the strongest signal level has a different Color Code from the radio, the channel will move to the second strongest site.

When the radio no longer receives any synchronization signals or when the Color Codes do not match, the radio resumes Site Roaming.

3.6. Emergency

A radio automatically enters the Emergency Mode and repeats transmission and reception for emergency purposes in case of emergency. The surrounding sound picked up by the microphone will also be transmitted, which is useful for knowing what the emergency status is. In addition to the sound, an Emergency Status that shows a trigger for entering to Emergency Mode can be sent.

The behavior of the radio in Emergency Mode has two types of Audible and Silent. Setting to Audible type, the radio emits the received audio from such as a base station in the same manner as in normal mode even while in Emergency Mode. The people around the radio in Emergency Mode can know the place of the emergency occasion by emitting the Locator Tone from the radio. Setting to Silent type, the radio mutes any sound even if the radio receives a signal. If the power switch to be off, it seems that the power turns off, but in fact, it does not off the power and Emergency Mode continues. Silent type is useful in that the radio user in Emergency Mode does not want the people around there to know that is in Emergency Mode.

Receiving an Emergency Status displays text strings that shows the kind of emergency. Receiving an Emergency Alarm may notify the recipient user of the reception by the display, tone, or Horn Alert.

The radio enters Emergency Mode by the following triggers.

- Pressing the Emergency button
- An input signal into an AUX input terminal
- Lone Worker (the situation that the radio is not operated for a certain period of time)
- Man-down Detection (the situation that the radio becomes tilted continuously for a certain period of time)
- Stationary Detection (the situation that the radio becomes continuously stationary for a certain period of time)
- Motion Detection (the situation that the radio is strongly shaken or swung continues for a certain period of time)
- Heart Rate (the situation that a heart rate sensor connected with a radio by Bluetooth LE detects the heart rate of out of range configured)
- Injury Detection (the situation that the radio detects Injury Detection by Bluetooth LE)

It is possible to configure which channel is to be in Emergency Mode, either a specified channel preconfigured or a channel used the last time is used. The destination must be configured beforehand to be either a specific Unit ID, Group ID, or Unaddressed.

3.7. Data Service

This section explains the message and data that can be communicated in the DMR Conventional system. A destination of data (Base ID) can be configured for each system. Configuring a specific channel used for data communication in advance is also possible.

3.7.1. Status Call

Using the Status Call feature allows simple communication that sends Status numbers configured beforehand in both the caller and called radios. Since the message is replaced by status number, communication traffic can be reduced.

The destination of Status Call is Base ID, however, it is also possible to select a Unit ID or Group ID by operating the radio.

The behavior of a radio receiving a Status

When the Status is received, Alert Tone will be emitted and the received message and ID of the sender will be displayed. The message is displayed depending on a preconfigured list of correspondence between the Status and the message.
The received Status Message can be stored in the stack memory (receive history). A user can read the received message in Stack Mode.

Sending a Status Message

- In Status Mode, select a Status from a Status List or directly enter a Status number by the keypad. And then, send the Status by pressing the PTT button or [Menu] button.
- Assign the Status sending function to the Call button and then, send the Status by pressing the Call button.
- Status Call is transmitted by receiving a PC command to send a Status message.

Automatically send a Status message depending on the situation

The following situations automatically send a Status message.

- When the power of the radio becomes on or off.
  This is useful if a user needs to inform the start of the work or turning off of the radio to the console.
- When the AUX input port is switched to Low or High.
  For example, if a water level sensor at a river is connected with the AUX input port, the radio automatically sends the Status message when the water level goes to the specified level and the AUX input port is switched. By using this way, the situation can be grasped in a timely even from a remote place.

3.7.2. Short Data Call

Text strings can be transmitted and received in the DMR Conventional system. For Group Calls, up to 365 characters can be sent and up to 369 characters can be received. For Individual Calls, up to 489 characters can be sent and up to 493 characters can be received.

The destination of Short Data Call is Base ID, however, it is also possible to select a Unit ID or Group ID by operating the radio.

The behavior of a radio receiving a Short Message

When the Short Message is received, the Alert Tone will be emitted, and the received message and ID of the sender will be displayed. The received Short Message can be stored in the stack memory (receive history). A user can read the received message in Stack Mode.

Sending a Short Message

- Enter manually a message in Short Message Mode. Then, send a Short Message by pressing the PTT button or [Menu] button.
- Short Message will be sent when a PC command to send a Short Message is received.

3.7.3. Long Data Call

Up to 4096 bytes of text strings per time can be transmitted and received in the DMR Conventional system. The Long Data Calls are for communication between external devices such as an MDT or PC via the radios. A received message is not shown on the radio display even if the Long Data Call is received. Transparent
Communicating simple serial data outputted from external devices such as a card reader or barcode reader between two radios is possible. This is used for a telemetry system and so on. It supports sending and receiving data that is compliant with Serial Interface Protocol. The radio and the external device are connected using a serial interface port or Bluetooth serial port.

When serial data is input from the external device to the radio, the radio automatically sends the data without any operation, and the data received by another radio will automatically be output to the external device. In the DMR Conventional system, the data is divided into data blocks of 1496 bytes per block.

3.7.4. GPS Report

The radio equipped with the GPS unit can send GPS data to the base station or so on.

Timing of GPS Report

GPS data can be automatically sent at the timing configured beforehand or sent by responding to a Polling request.

Timings of automatically sending are:

- The time intervals configured beforehand
- When the radio is located at the distance configured beforehand from the previous sending.
  Using this setting for the radio which moves a little, saves the battery and traffics.
- When sending the particular Status
  This setting grasps the location in the situations like the particular Status will be sent, but not periodically.
- Voice Call communication
  This setting grasps the location in situations such as when the voice call which does not occur periodically is started.

Channel Mode of GPS Report

The Channel Mode to send the GPS Report can be fixed either to Analog or DMR. For example, the voice calls can use digital and data calls can use the analog when the system is migrated from the analog to the digital.

Destination of GPS Report

Basically, the GPS Report is sent to the Base ID of the current system same as the destination of the other data call. If it is required to send the GPS Report only to a particular ID, the dedicated destination can also be set.

In addition, a particular channel can be set as a destination.

3.8. Remote Control (Radio Unit)

Using remote operation by radio communication can control an individually specified radio. When a radio sends messages for remote control and a target radio receives the message, the target radio can be controlled.

Controllable functions are:

- Remote Monitor
  It makes the target radio transmit for a certain period of time. Monitoring surrounding sound via the microphone of the radio is possible.
- Radio Check
  It makes the target radio transmit an Acknowledgment. Confirmation of whether the target radio is working or not is possible.
- Remote Stun/Kill
  This disables a target radio.
- Remote Revive
  The Stun state of the target radio can be released. The target radio in the Killed state, on the other hand, cannot be released using the Remote Revive message. FPU can release the radio in the Killed state only.

3.9. Scrambler/Encryption

Encrypting data such as voice or short messages can enhance secrecy in communications on the DMR digital channels.
The following encryption types are available for the NX-1000/3000/5000 series.

- Bit Scramble
- Enhanced Encryption (ARC4)
- DES (only NX-3000/5000 series)
- AES (only NX-3000/5000 series)

The secrecy of encryption is high in the following order.
Bit Scramble < Enhanced Encryption (ARC4) < DES < AES

For the NX-3000/5000 series, an option will be required to use the AES or DES encryption type.

Enable or disable channels beforehand as required to make an encrypted communication. The enabled channel can manually be disabled, and then, it can also be back to the enabled state. The encrypted communication will be decrypted on the receiving radio. For example, in communication via an IP network, the encrypted data remains encrypted on the communication path until the data is decrypted on the receiving radio.

3.9.1. Encryption Key

The decryption of the encrypted communication requires an Encryption Key configured in the radio or SCM (Secure Cryptographic Module). Though the Encryption Key is configured on the channel beforehand it can be changed by manually operating the radio at transmitting.
Such as when the radio is stolen, the Encryption Key can be deleted depending on the setting.

3.9.2. Bit Scramble

Bit Scramble is the simplest encryption type that only encrypts voice data. The received data will be decrypted using the Encryption Key configured on the received channel.

3.9.3. Enhanced Encryption (ARC4)

For Enhanced Encryption, the internal memory of the radio has the Encryption Key.

3.9.4. DES

For DES, the internal memory of the radio has the Encryption Key. For the NX-5000 series, DES encryption can be used with SCM or the internal memory.

3.9.5. AES

AES is the most enhanced encryption type using a 256-bit key length.

3.10. Digital Encode/Decode Format

For the NX-3000/5000 series, users can customize the radio behavior by programming with Digital Encode/Decode Format. This allows the radio to carry out a behavior that is not standard depending on individual user convenience.

Users can control the radio behavior when the following call is received by combining the commands.

- Individual Call
- Group Call
- Broadcast Group Call
- Paging Call
- Status Message Call

These are some examples to control a radio using Digital Encode/Decode Format. Users can combine and execute them.

Start and Stop for Scan

When a particular Status message is received, the specified tone will be emitted, the specified text strings will be displayed, and the scan will be started.
When a particular Status message is received, the specified tone will be emitted, and the scan will be stopped.

Light-off and light-on of the backlight

When a call from a particular ID is received, the backlight will be turned off.
when a call from a particular ID is received, the backlight will be turned on.

Lock and Release of the button operation of the radio

When a particular Status message is received, the button operation will be locked.
When a particular Status message is received, the button lock status will be released.

Control of external devices

When a particular Status message is received, the AUX port will be activated for the specified time. This can be repeated at regular intervals.

Move a channel or zone

When a particular Status message is received, the channel will be moved to a specified channel. Using this control, radios belonging to different talk groups can be concentrated temporarily on the same channel to make a group call.

Change the receiving behavior depending on the ID of the caller

For example, when a call from caller ID 1000 to 1999 is received. the radio blinks blue LED, displays the specified text strings and emit Alert Tone 1. For example, when a call from caller ID 2001 is received, the radio blinks orange LED and emits Alert Tone 2.

Change the receiving behavior depending on the received ID
For example, a call from Group ID 100 to 110 is received, the radio emits Alert Tone 1. When the received Group ID is registered on Group ID List orange LED is blinked, and Alert Tone 2 is emitted.

3.11. Task Request

NX-3000/5000 series has a Task Request feature which manages tasks using a Short Message in the DMR Conventional system. With this feature, an application such as HotSOS will be available.

Task Manager can send task directions to the radio user from the dispatch console. The receiving user can respond to the task instruction by a simple operation with the user's radio. Because the task status automatically changes depending on the response from the radio user, both the task manager and the radio user can know the task status easily.

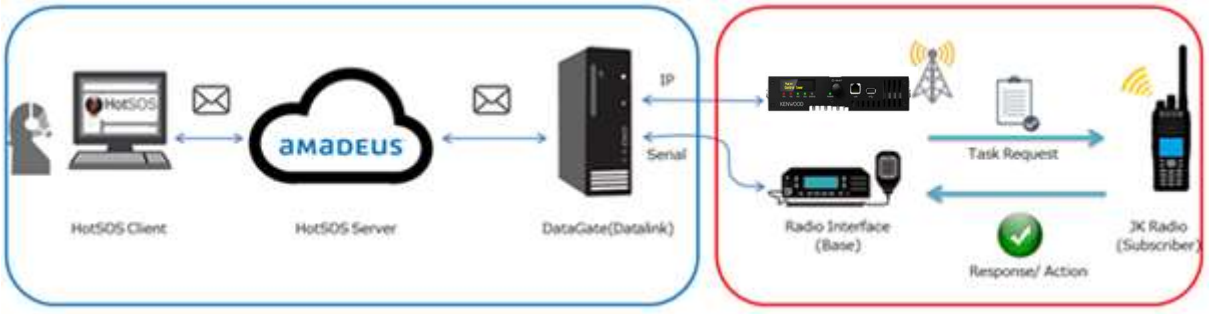


Figure 3-9 Example of Task Request System

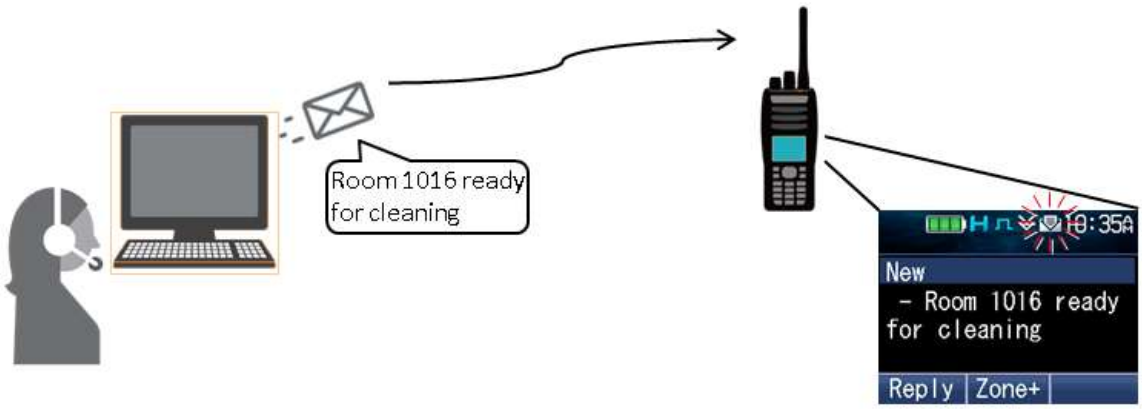


Figure 3-10 Task Request Image

3.12. PC Interface Protocol

The communication between a console application and the radio uses the Kenwood original command (PC Command). Using the PC Command can control the radio. The PC command is divided roughly into the following three groups.

Control Command
The radio can be controlled by the control command.
The radio connected via a COM port can be controlled to send a Long Message, a Status message, or GPS data.

Response Command
The radio can respond to the Control Command.
The radio responds whether to execute the received Command when receiving or after the received Control Command is completed.

Information Command
This is to inform the status or information of the radio to external devices.
The data is output when the PTT button is turned on/off or when the battery voltage falls during the transmission and so on. Also, the data is output when the radio receives the Status message or other messages.

3.13. User List

For NXR-1700/1800, using the User List feature can restrict users who can use the repeater on a channel of the DMR Conventional system. For example, when your radio is stolen, it can be prevented from using the repeater by deleting the ID.

There are four types of User Lists and the best suited for the system can be selected: the Individual Unit ID, the range of Unit ID, the individual Group ID, and the range of Group ID. For the channel which enables the User List feature, only the calls from the user or talkgroup listed on the User List are available.

3.14. Site Group Table

For NXR-1700/1800, using the Site Group Table feature can restrict sites to communicate for each target Unit ID or target Group ID when making an Intersite Call in the DMR Conventional system. If a system manager knows that a certain user or talkgroup only uses a certain site, this feature enables effective use of the sites.

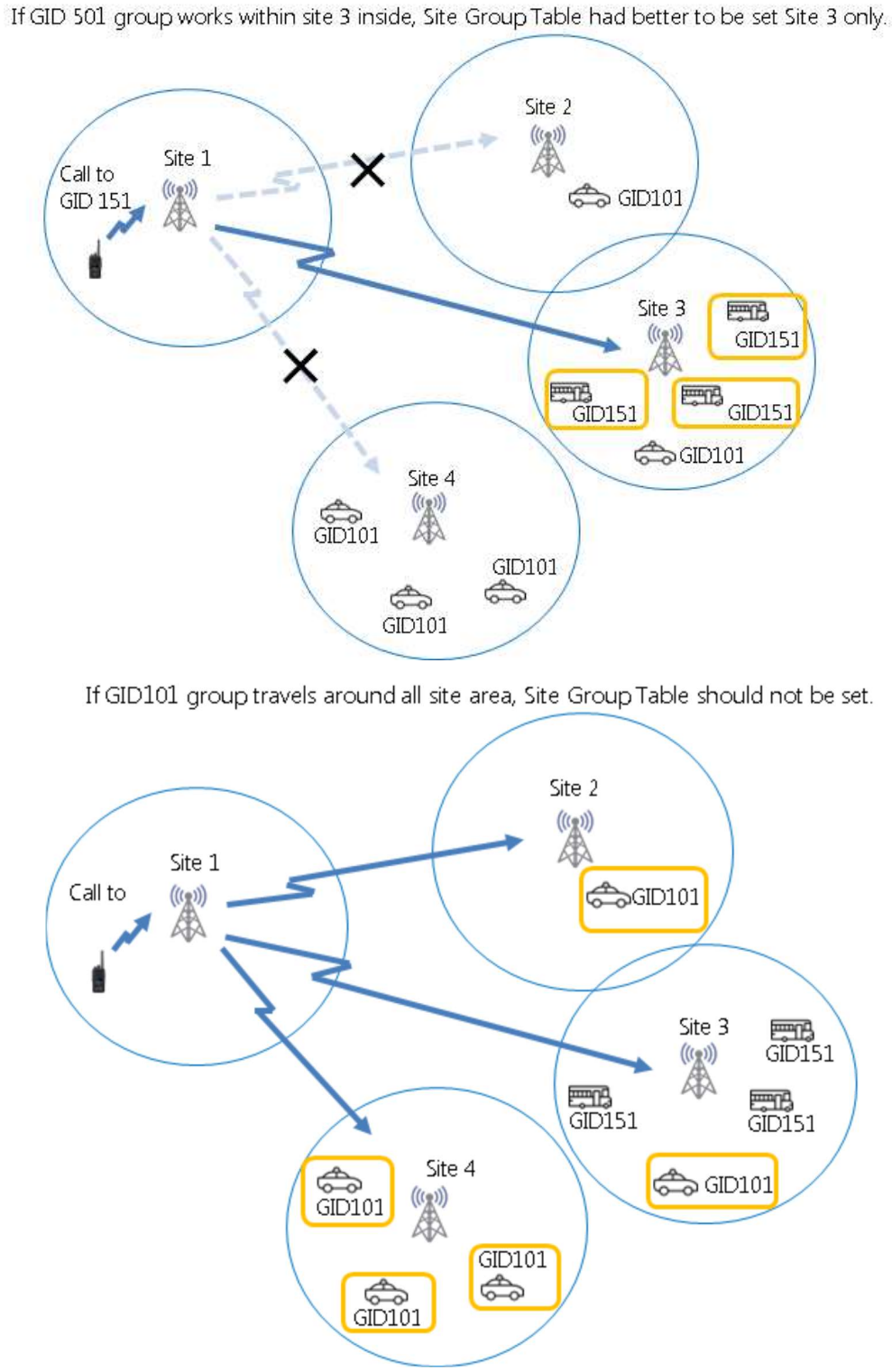
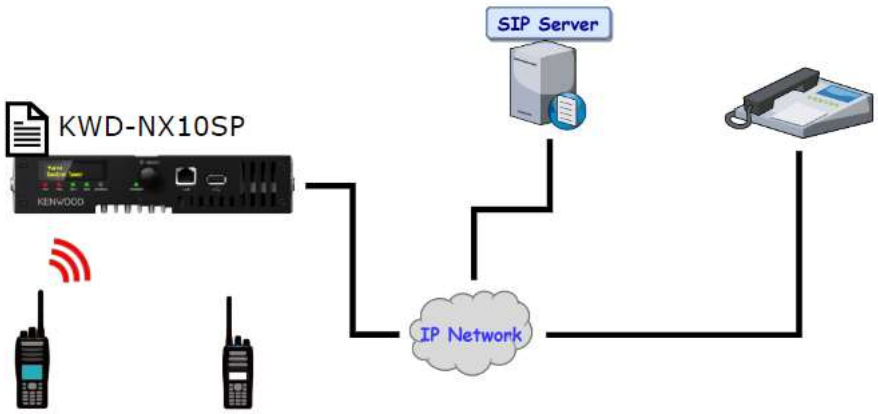


Figure 3-11 Site Group Table

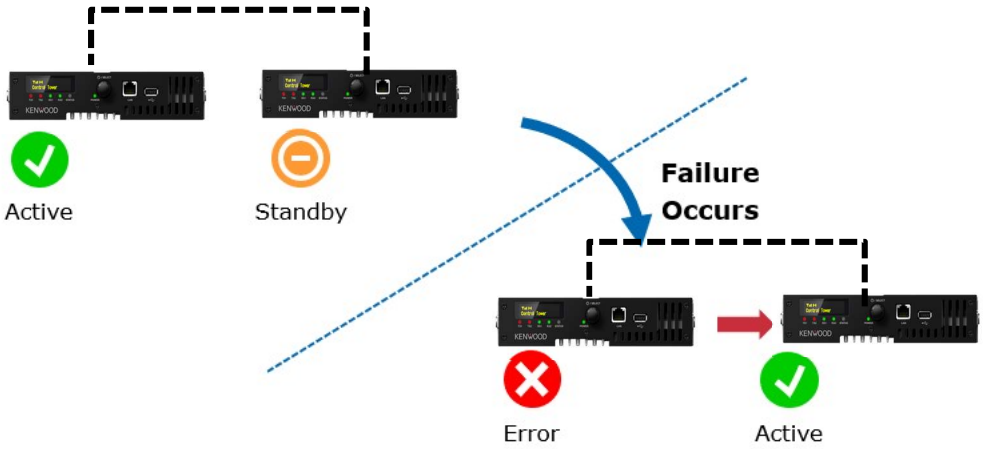
3.15. SIP Phone

The Repeater and the SIP Phone Server are connected to enable communication between the NXR-1700/1800 Subscriber Unit and the SIP Phone, allowing communication with PABX and PSTN SIP Phones.
The Repeaters enabling the SIP Phone function is connected to the SIP Phone Server by SIP Session/TLS Session to relay voice.



3.16. Hot Standby

In the NXR-1700/1800, the Hot Standby function switches the Main to the Spare Repeater automatically when an error occurs and configures the Active Repeater and the Standby Repeater as par in a Redundancy method to prevent System outages.
The Active Repeater is a Repeater that operates normally and performs wireless communication, while the Standby Repeater is a Repeater that waits until a failure is detected in the Active Repeater without performing wireless communication. They are synchronized with each other via an IP communication and monitor each other.



4. Network

The system may be built out as a Unicast network environment of up to 16 sites in DMR Conventional system. If more than 16 sites are required to make a Group Call, then the IP structure must be the multi-cast to support the additional site requirement. The third-party products as a switching hub or router equipment are required to be used. The IP network will require the use of third-party products such as a switching hub or router equipment. When using the public Internet for the site connection, make sure to use the VPN technology for security and operation. The private IP network is also recommended unless the system is the sole user of the network. It is highly recommended to ask a network engineer for the network configuration.

4.1. Network Infrastructure

Several network configurations may be considered for interconnecting sites. Necessary configuration will be decided by the system administrator based on their needs and the requirement of the system in terms of bandwidth, environment, and existing infrastructure. The following are several possible configurations that could be employed.

Microwave
Point-to-point microwave links may be used to establish a private network for the system. This is commonly used in land mobile systems to establish connectivity between sites. Due to the line-of-site nature of microwave, careful siting of the microwave links and choice of frequency bands are extremely important. This closed system of site connectivity will offer the highest level of security and is the least prone to outside influences such as malicious network attacks. It does have its own set of challenges that the system administrator must understand.

IP-VPN service
A closed IP network with a VPN is independent of the public Internet. Security improves because the public Internet is not used. For a closed company or agency, the Wide Area Network (WAN) is considered as a part of their methodology. If this method is used, close attention must be paid to the other users on the network to ensure the system provides adequate bandwidth and service quality required by the radio system. If not, issues will arise.

4.2. IP Network Connection

Interface Devices

Switching Hub

A switching hub, which has more than three ports is a network device to structure LAN. The data is sent only to the port which is connected to the device of the destination depending on the MAC address of the destination of the received data. Multicast system must use a switching hub with an IGMP Snooping feature.

Router

The Router is a network device to connect different networks. The router sends the data to only the port which is connected to the device of the destination depending on the IP address of the destination of the data.

Routers have a user interface to set how the processing of traffic by the router. For example, a broadband router has a function to hide computers behind a single type of firewall. Large-scale routers have features that allow a high-level programming language to write the behavior of a router and so on, or that allow to decide the best way to get the network traffic from point A to point B by communicating with other routers.

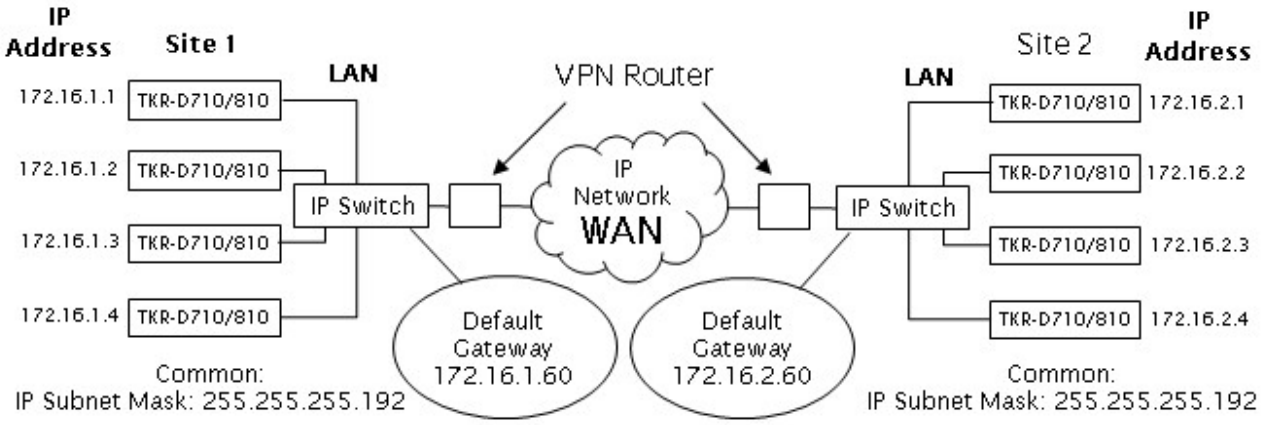


Figure 4-1 example of connection

Network

IP Links

When connecting a multi-site DMR Conventional system via an IP link, the following circumstances should be taken into account. There are many different variations of wireless or wired IP links available. Some of which are more suited to a mission-critical radio system application than others.

Below is a non-exhaustive list of possible IP networks.

- Customers internal, own IP network
- Commercial ISP (Internet Service Provider)
- IP sections within a bigger IP network – so-called Virtual Network
- Transceiver IP Link
- Microwave IP Link

Public IP Networks

Public IP Networks are available for a reasonable commercial value in most areas. Internet Service Providers (ISP's) offer various services that can range from 128 kbps to 10 Mbps or more.

While these offers present a good commercial value, they have potential drawbacks. The system integrator/ installer and end user have no direct influence on the quality of service offered through these ISP's. If a technical fault has occurred with the ISP's hardware, software, or other components, the system integrator and the end user are required to wait until the ISP or responsible party rectifies the fault.

As a result, a potential loss of income, definite effect on intersite services, and operational problems may occur. A service level agreement (SLA) should be part of the contract with the public ISP, whenever possible.

Private IP Networks

There are better and more controllable quality of services although they are more expensive than the Public IP network-based solution.

There are numbers of options, and what is best depends entirely on the budget, available resources, and requirements of a user.

- Using existing IP network of user
  - Consider a required network capacity and security implications
  - Use IP switch with VPN facility to secure radio networks IP access
  - Consider a Virtual IP Network within the customer IP network
- Building a new IP interlink network
  - Wireless network
  - Consider network capacity requirements
  - Consider security requirements
  - Consider network redundancy requirements
  - Consider obstacles existing and not yet existing
  - Wire or GBN (Ground Based Network) based network
  - Consider network capacity requirements
  - Consider security requirements
  - Consider network redundancy requirements

4.3. IP Bandwidth Requirement

Network bandwidth calculations must be discussed in the system design phase considering network type, system size, and future system expansion.

IP bandwidth calculation should be done not only for voice communication (VoIP) but also a console call session initiation process (SIP) which occurs each time the console call is initiated.

For the multicast network, the required bandwidth is just one voice session for core router basically. In case of a VPN connection, the amount of data varies by Encryption and Authentication method. Therefore, the VPN connection is not in the scope of this section.

4.3.1. NXR-1700/1800

Bandwidth per session

Type of Data	Destination	Bandwidth per Session [kbps]
Voice	Remote Site (DMR)	15.2
	Remote Site (Analog)	76.1
	Console (AMBE Codec)	15.2
	Console (μ-Low Codec)	76.1
Long Data Message (Group)	Remote Site (DMR)	14.1
	Console	103,9
Long Data Message (Individual)	Remote Site (DMR)	14.9
	Console	62.7

The symbols using in calculation formula represent as follows.

R:Remote Sites=total number of Sites-1
C_{ambe}: AMBE Codec Consoles registered at the Local Site
$C_{u\text{-}low}$: μ-Low Codec Consoles registered at the Local Site
S:Slots in use (1 or 2)

Voice

- Upstream(*1) and Downstream
  $\{76.1 * C_{u\text{-}low} + 15.2(C_{ambe} + R)\} * S$ [kbps]

LDM (Group)

- Upstream (*1) and Downstream
  $\{103.9 * (C_{u\text{-}low} + C_{ambe}) + 14.1 * R\} * S$ [kbps]

LDM (Individual)

- Upstream and Downstream
  62.7*S [kbps] (*2)

(*1) There is only one Stream when using Multicast and Upstream, therefore: R=1
(*2) When Subscriber Units communicate across sites, more bandwidth is required when LDM communication is performed between the Console and the Subscriber Unit. It is one-to-one communication, and the largest bandwidth is used when communicating with the Console.

4.4. QoS

In the NXR-1700/1800, the switches and routers in the network can prioritize packets including those sent by the repeaters by setting DSCP values for packets sent by Repeaters. DSCP value is assigned as PHB (Per-Hop Behavior) of the designated communication. This allows queuing and scheduling of packets according to the prioritizing settings of the switches and the routers in the network, which can prevent communication delay, fluctuation, and loss.

5. Tools and Applications

This section shows the tool and application which are supported in the DMR Conventional system.

5.1. Web Tool

The Web Tool is used for setting changes without restarting the repeater.
This tool enables handling of Firmware Update, Hot Standby, Monitor, Remoter Control, and Log.

5.2. Dispatching Solution (KAS-20 AVL & Dispatch Software)

KAS-20 AVL & Dispatch system application can track and manage or communicate with mobile stations worked in the DMR Conventional system. It can communicate with the DMR Conventional system via the IP network or the air communication.

The followings show the example of KAS-20 connecting.

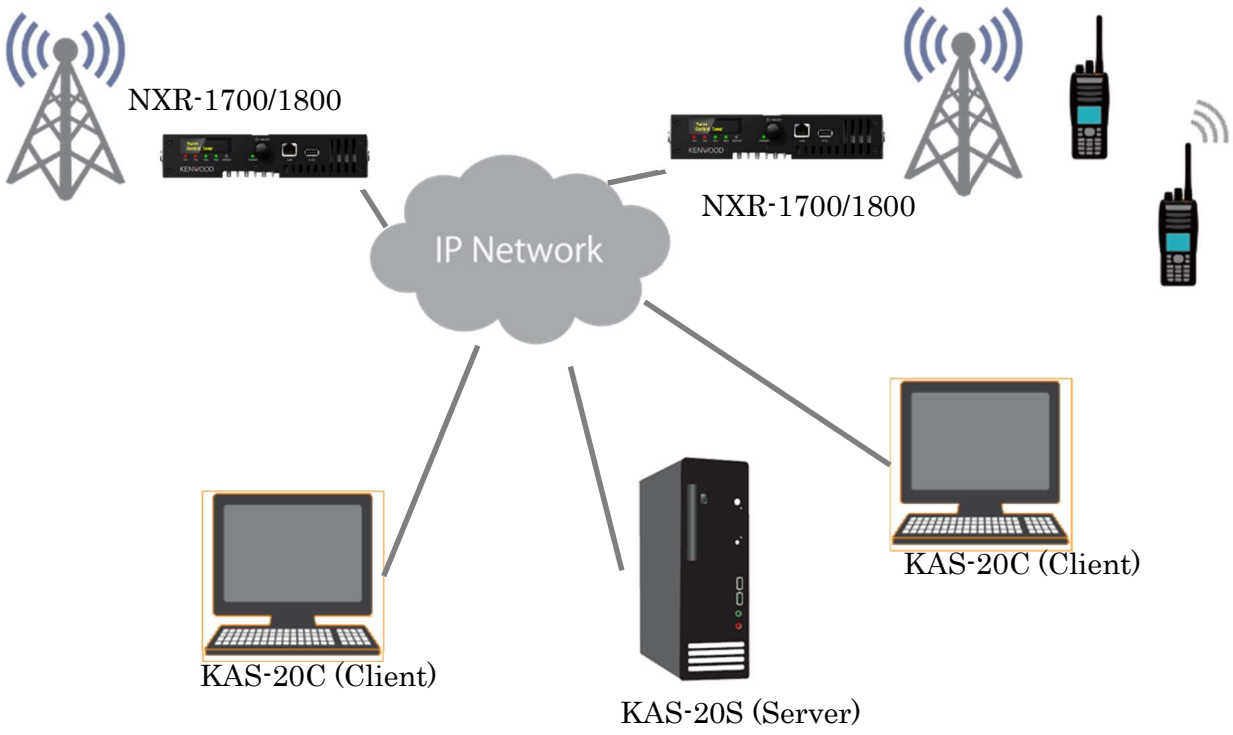


Figure 5-1 Connection for IP Network

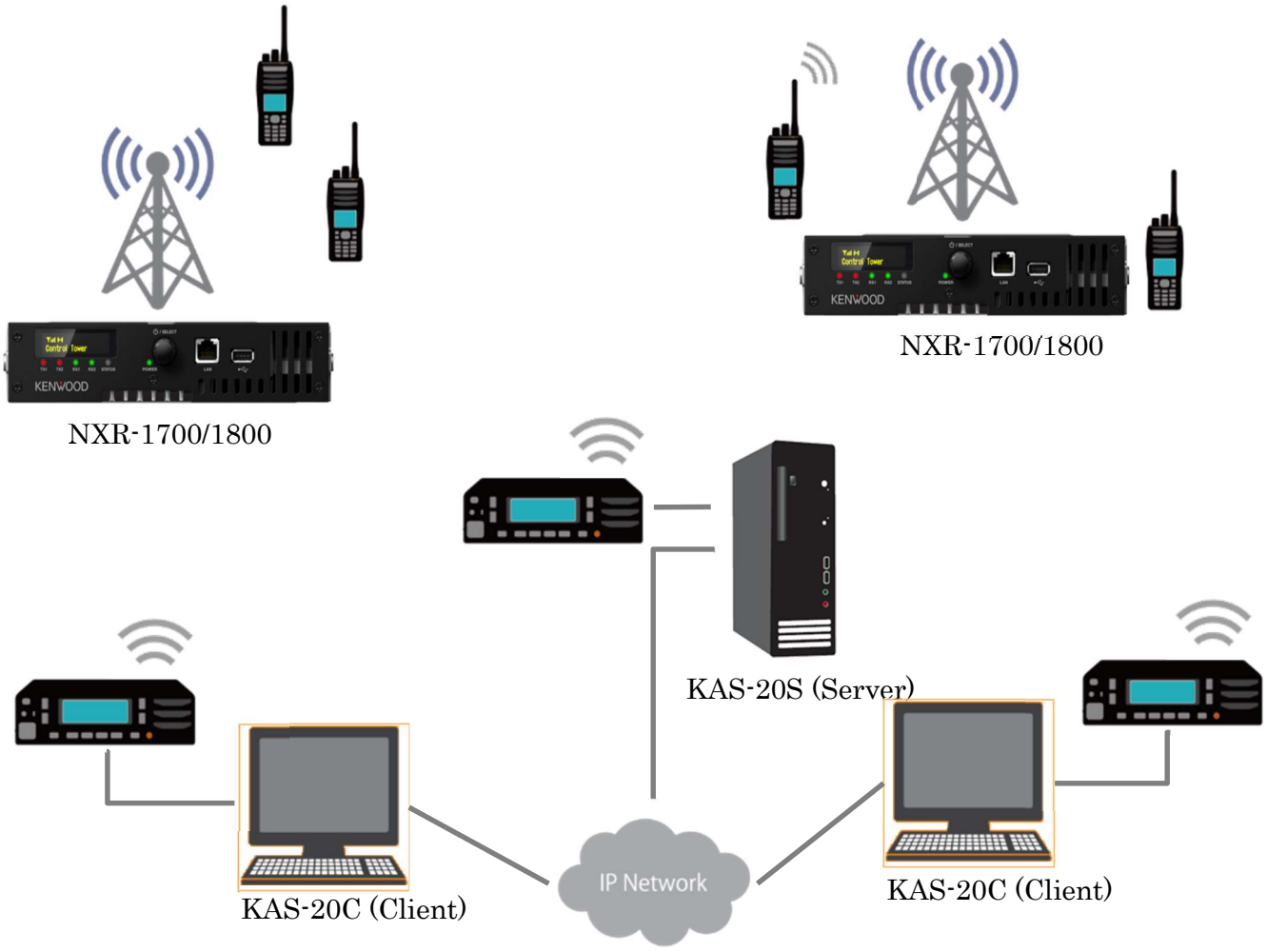


Figure 5-2 Connection for Serial Interface

KAS-20 is a software application consisting of the server (KAS-20S) and the client (KAS-20C). KAS-20S and KAS-20C can also be installed on the same PC.

KAS-20C is a client software equipped with multiple consoles including functions for initiating voice calls and for managing the positional information of the radios. It is possible to perform functions related to voice calls, text messages, and remote control. By gaining access to KAS-20S from KAS-20C, KAS-20C is able to save or browse communication logs and acquire the location information of the radio. At the same time, by accessing the KAS-20S and sharing the database of multiple KAS-20C units, information such as the positional data and voice call logs can be shared.

The following figure shows the data flow when the DMR Conventional system and KAS-20 is connected.

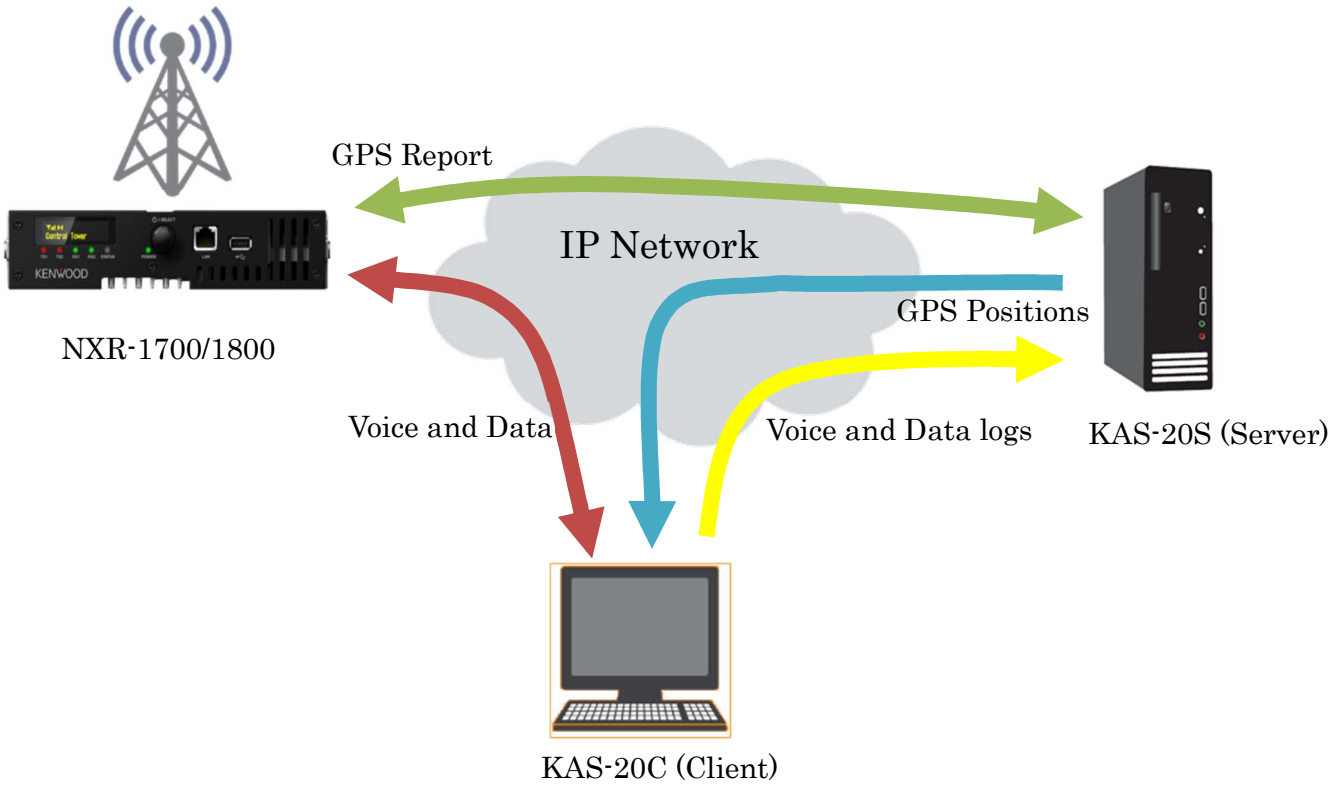


Figure 5-3 Data flow for IP Network Connection

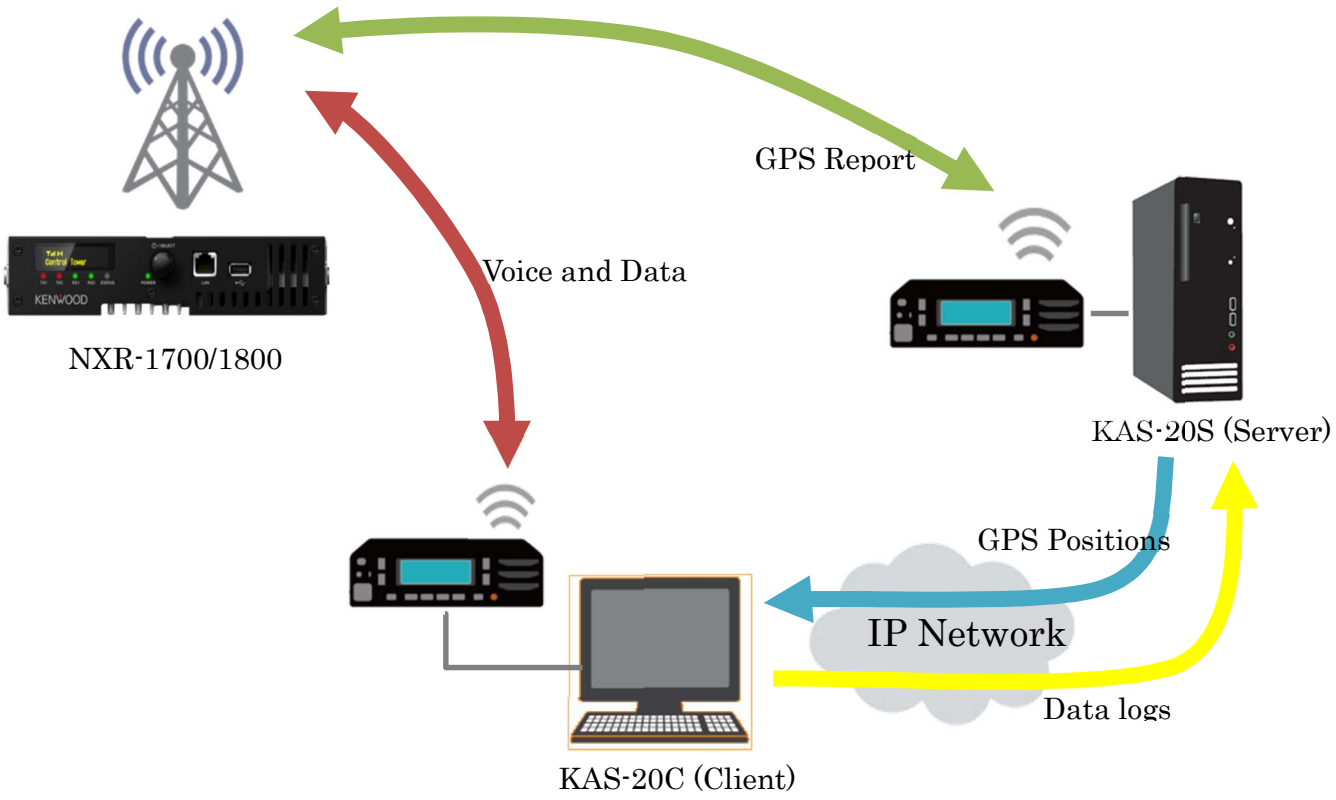


Figure 5-4 Data flow for Serial Interface

AVL (Automatic Vehicle Location)

For the AVL window of KAS-20C, the dispatcher can display icons of the mobile stations on the map and manage the operation status of the mobile stations. Select a mobile station from the map or Radio Resource List, and various menus (for voice calls, sending text messages, special commands such as Stun or Remote Monitor, and viewing the communication log, etc.) regarding the selected mobile station will be displayed.

KAS-20C supports OpenStreetMap, Scanned Map, or Google Earth. GeoJSON and KML files can be overlapped as layers on the map.

When an Alert or Emergency from mobile stations, the icon is highlighted by changing colors, and the received messages are listed on the log pane.

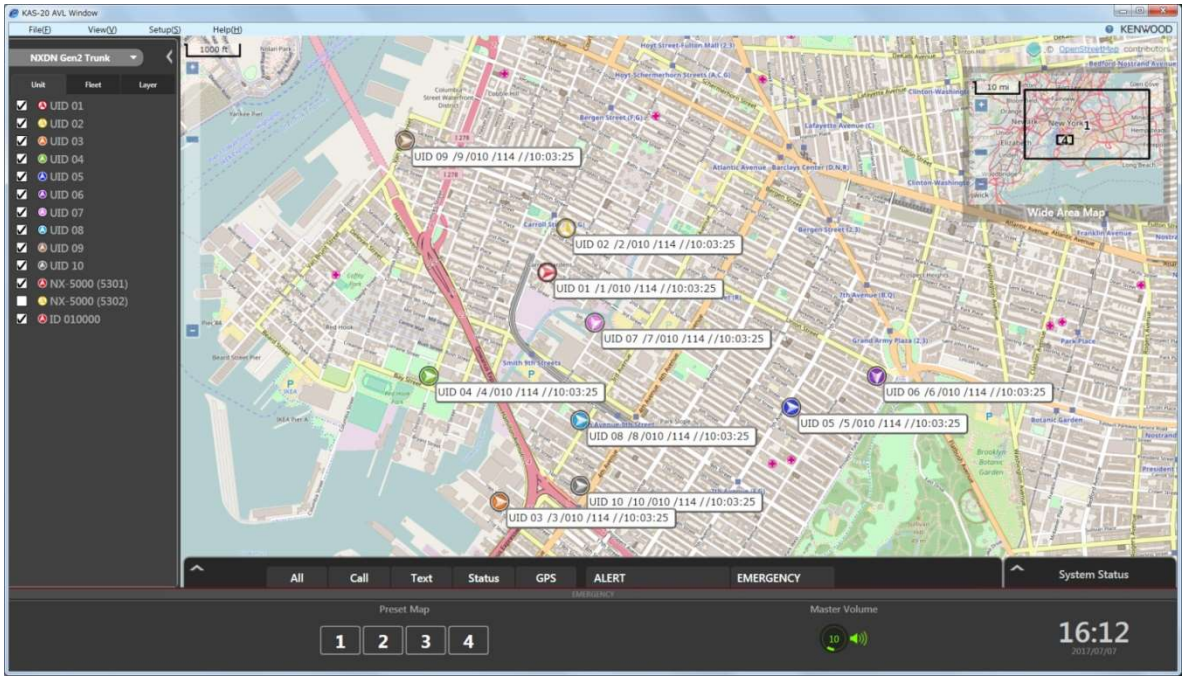


Figure 5-5 AVLk

Dispatch

KAS-20C Dispatch window is designed for the simple operation of All Calls, Group Calls, Individual Calls, etc. to mobile stations. Each mobile station is placed as a tile of which color or size can be configure.

Using KAS-20C can create a temporary talk group even if a group is not registered with the mobile station.

For the IP network connection, KAS-20C can forward the received voice to other mobile stations registered in the same Patch Group. Patch Group can be created with KAS-20C.

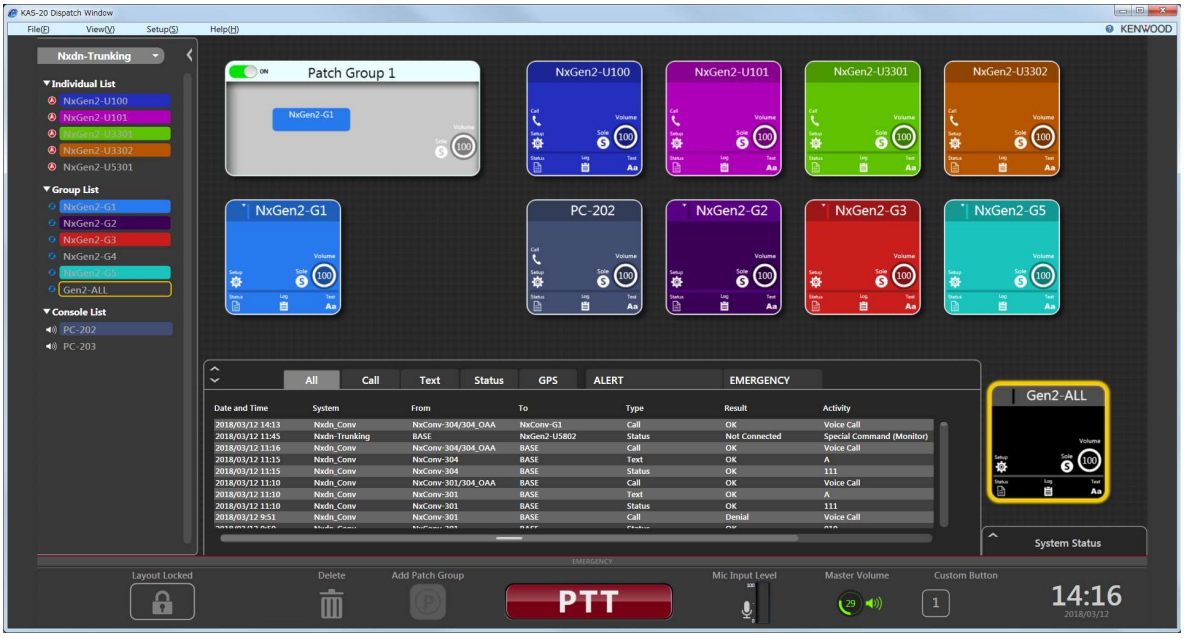
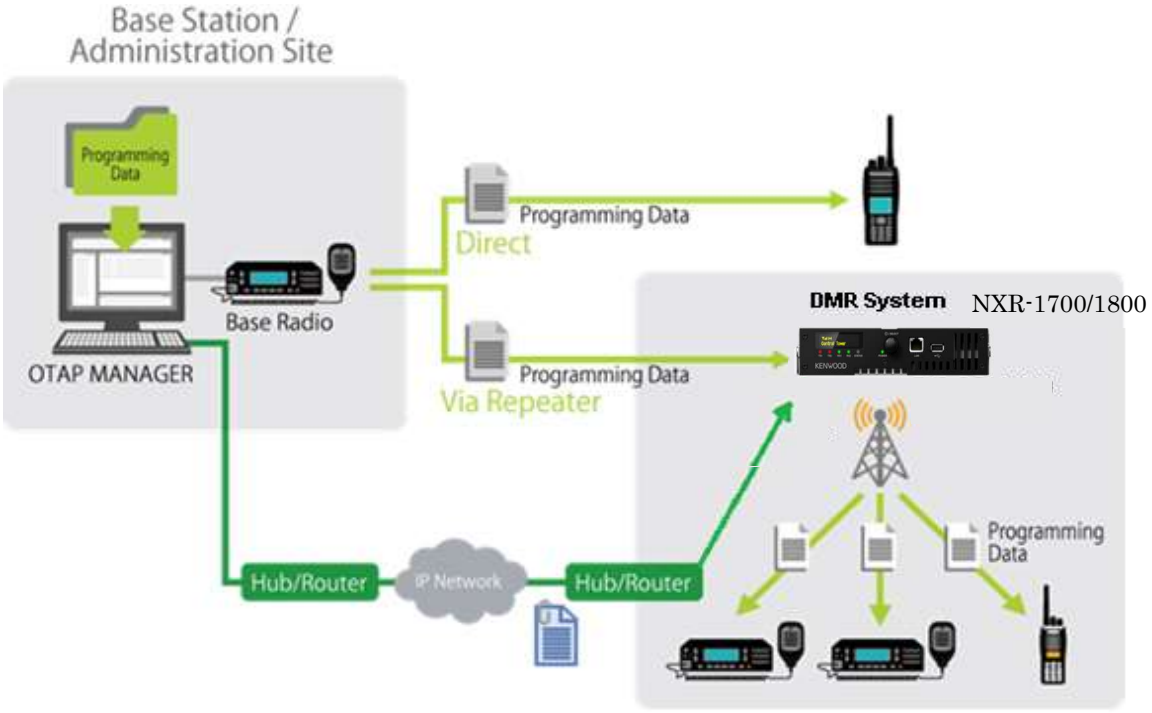


Figure 5-6 KAS-20 Display Example

5.3. Over-the-Air Programming (KPG-180AP)

For the NX-3000/5000 series, the configuration data of the radio created by FPU can be written to the radio by connecting via an IP network or air communication, in addition to connecting the PC and the radio directly via the programming cable. Writing the configuration data via the IP network or air communication benefits the radios working in the field because bringing the radios to the location of PC is not required.

To write configuration data via IP network or air communication, the PC application software named KPG-180AP OTAP (Over-The-Air-Programming) manager will be use. The followings show the example of OTAP manager connection.



igure 5-7 Example of OTAP manager connecting

Overwrite Password

The Overwrite Password function of the FPU is also available using KPG-180AP. Invalid writing can be prevented by using this function.

Configuring the date and time to send data

Use the OTAP manager to send the data on the scheduled date and time or send it by batch processing. It is useful because the writing date and time can be scheduled beforehand at night or on a non-working day.

Optimization of data to send

Either writing all data or writing only the data of difference is available. The OTAP manager judges depending on the data whether which way is efficient and sends the data.

Reactivation

After writing the configuration data to the radio from the OTAP manager, the timing of enabling the data can be selected from the following.

- By rebooting forcefully after writing the data
- By turning power-off and then on again after writing the data
- By operating the programmable button after writing the data
- When a specified date and time which is set at writing the data arrives
- When the Reactivation command is received

Log of sent data
The Log of writing the configuration data can be viewed later. The Log can also be output in the csv file format. It is useful to record the information of the radio which has proceeded the writing successfully or unsuccessfully.

5.4. Down Time

A system will experience limited downtime during site configuration changes, additions to/deletions from the system, or changes/updates to user parameters. Downtime is triggered when data is written to a targeted repeater and firmware is updated.

The following shows the downtime of each case. It is approximate and maximum times experienced.

Trigger	PC I/F	Condition	Reboot Time
Firmware update	LAN	By SCU	3 min. 53 sec.
	COM	By FPRO	3 min. 6 sec.
FPU data update	LAN	By KPG-174D/174DN	1 min.
	COM		39 sec
Power Cycle			25 sec

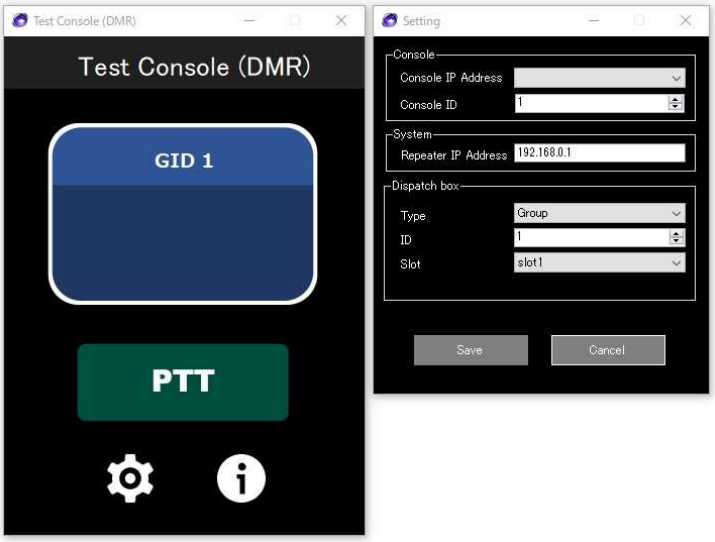
Table 5-8 TKR-D710/810 Downtime of each case

NXR-1700/1800

Trigger	PC I/F	Condition	Reboot Time
Firmware update	LAN	By SCU	1min. 45sce.
FPU data update	LAN	By Web Tool, KPG-D7	2sec.
Power Cycle			34se

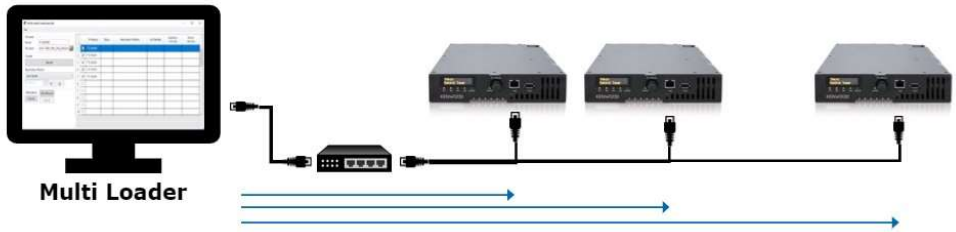
5.5. Test Console

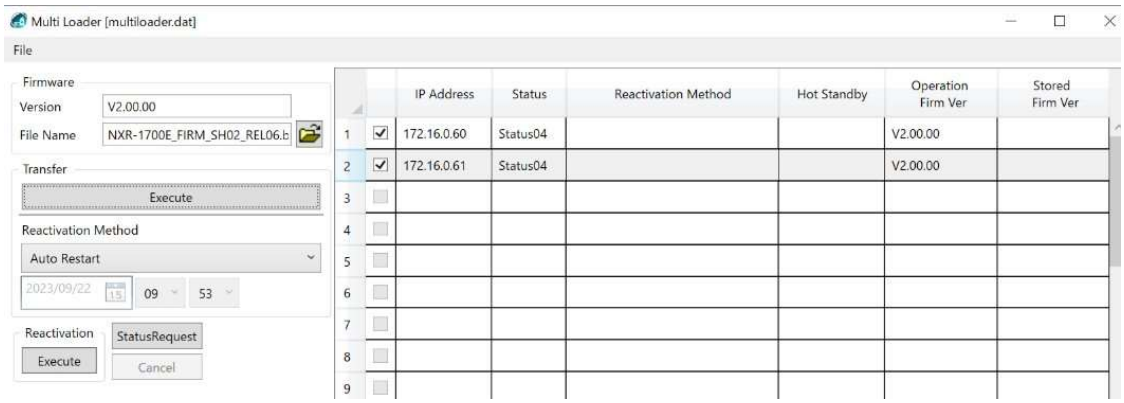
To perform a simple Communication Test for NXR-1700/1800, a Test Console needs to be prepared as an application to check Repeater transmission and reception sound using the PC.
The Test Console application can be downloaded from the Web Tool. We have dedicated Applications for NXDN and DMR.



5.6. Multi Loader

The NXR-1700/1800 Multi Loader is an application that runs on Windows and supports Windows 10/11.
The Multi Loader is distributed with the Programming Software (KPG-D7) installer and is usable without any License.
The Multi Loader is an application for writing firmware to the Repeater via the IP Network and is writable into a batch of several units of Repeaters.





5.7. Voice Logging

Voice Logging is a feature that allows voice calls made in the system to be transferred as VLI packets to a Voice Logger (3rd party voice recording application) using the Voice Logging Interface (VLI).
The Voice calls can be recorded by connecting the repeater to the Voice Logger, which can record Individual Calls, Group Calls, ALL Calls, Unaddress Calls, Null Group ID Calls, and Phone Calls.

5.8. Development Tools

For the system integrator or local solution developer, JVCKENWOOD provides a software development kit. By using the tools, many applications such as special console applications, messaging, and AVL can be developed quickly and without taking much time to investigate specific protocols.

5.8.1 PC Command

A radio unit has a digital data RS-232 interface. The interface protocol document describes the available command set and how to use it. To name a few available functions; calls can be setup and cleared, messages can be sent and received, and radio channels can be altered via the PC Protocol.

5.8.2 Application Interface Specification (AIS)

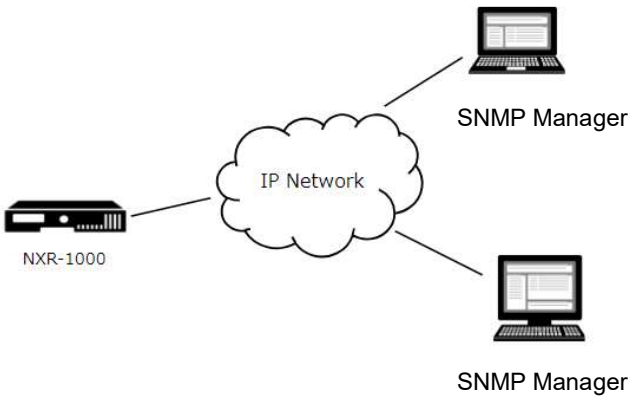
For DMR system, to develop easily applications such as text messaging or dispatching or etc. provides the interface protocol based on the SIP.
AIS is available from the DMR Association.
AIS Console Interface for NXR-1700/1800: V1.01

5.8.3 Software Development Kit (KPT-111SDK)

KPT-111SDK is a software development kit that helps users develop application software for Windows, such as Dispatch Software and AVL Software, designed for communicating with the NXR-1700/1800 DMR conventional system using the AIS. The KPT-111SDK effectively reduces the amount of code and time required to write the AIS protocol, making development easier and less time-consuming and decreasing time-to-market.

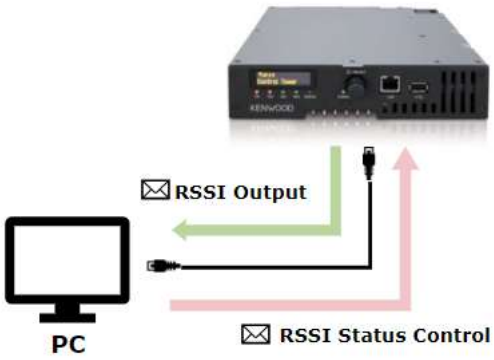
5.8.4 SNMP Function

The NXR-1700/1800 SNMP (Simple Network Management Protocol) is a protocol for managing devices on the IP network that monitors and controls the communication devices connected to TCP/IP Network such as a Server via the network.



5.8.5 IPRCI

A compatible IP console is required when using this function in the actual environment. In the previous models, PC serial interface commands were exchanged over the Serial Connection, however, this feature allows the PC serial interface commands to be used over the IP network. By executing Control Commands over the network, information can be obtained, and the NXR series devices can remotely be controlled.



6. TKR-D710/810, NXR-1700/1800, and KAIROS Comparison

Features comparison of TKR-D710/810, NXR-1700/1800, and KAIROS is following.

GENERAL FEATURES

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Channels (Maximum programming channel number)	30	200	32	
2	Models with Freq. (MHz)	TKR-D710: 136-174 TKR-D810(E,K2): 400-470 TKR-D810(K):450-520	KA-080: 66-88 KA-160: 136-174 KA-350: 350-410 KA-450: 400-470 KA-500: 450-520 KA-900: 806-941	NXR-1700: 136-174 NXR-1800E: 450-520 NXR-1800E2: 400-470	*Ask Availability
3	TX Output Power	E type: - Low: 5W - High: 50W(VHF), 40W(UHF) K type: - Low: 25W - High: 50W(VHF), 40W(UHF)	1-10W (1W Step), 15-25W (5W Step)	NXR-1700: 1-50W NXR-1800: 1-40W	

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
4	Modes (Support Protocol)	DMR Analog FM	DMR Analog FM P25 (Phase 1)	DMR NXDN Analog FM	
5	Mixed Mode	✔	✔	✔	
6	Channel Step (kHz)	VHF : 2.5/3.125kHz UHF : 3.125/5.0kHz	0.05kHz	2.5/3.125/5/6.25 kHz	
7	Channel Spacing (Analog) (kHz)	25.0/12.5kHz	25/20/12.5kHz	12.5/20/25 kHz	USA/Canada: 12.5kHz only
8	DMR System	Tier II	Tier II,III	Tier II	
9	Antenna receptacle	RX:BNC-J, TX:N-J	RX:SMA-J, TX:SMA-J	RX:BNC-J, TX:N-J	
10	Diversity Antenna	N/A	✔	N/A	
11	P25 Digital Mode	N/A	✔	N/A	
12	POCSAG Mode	N/A	✔	N/A	
13	Number of Site (Unicast)	Up to 16	Recommended: up to 33 Max: up to 1025	Up to 16	

BASIC OPERATION

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Power On/Off	✔	✔	✔	
2	AF Volume Control	✔	N/A	✔	
3	Channel Up/Down	✔	N/A	✔	

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
4	Function Key (PF Key)	✔	N/A	✔	
5	Start up	✔	N/A	✔	
6	FAN control	✔	✔	✔	Automatic over 85℃
7	Reset	✔	✔	✔	By the Kairos manager via IP
8	Self Test Mode	N/A	✔	N/A	

TX/RX/REPEAT FUNCTION

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	PTT Priority	✔	✔	✔	
2	Channel Type	✔	✔	✔	Analog, DMR, or P25 is available for KAIROS
3	Transmit Mode	✔	✔	✔	
4	Signaling Reset Timer	✔	N/A	✔	
5	TOT	✔	✔*	✔	*Analog FM Only
6	Local TX Enable/Disable	✔	✔	✔	
7	TX Enable/Disable	✔	✔	✔	
8	Lowest Receive Level Threshold	✔	✔	✔	
9	Standby on Transmit Frequency	✔	✔	✔	
10	Beat Shift	✔	N/A	✔	

SOUND FUNCTION

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Power-on/Control/Warning Tone	✔	N/A	✔	
2	Tone Volume	✔	N/A	✔	
3	Test Tone	✔	N/A	✔	
4	Coutesy Tone	✔	N/A	✔	

ANALOG FM COMMUNICATION

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	QT Decode Delay	✔	N/A	✔	
2	Decode Signaling Enable/Disable	✔	✔	✔	
3	Encode Signaling Enable/Disable	✔	✔	✔	
4	Squelch Tail Elimination	✔	✔	✔	
5	Multiple Encode/Decode Table	✔	✔	✔	
6	Repeater Hold Time	✔	✔	✔	
7	Squelch Off	✔	✔	✔	
8	Squelch Level	✔	✔	✔	
9	Monitor	✔	✔	✔	
10	Busy Channel Lockout (Analog)	✔	N/A	✔	
11	Off-hook Decode	✔	N/A	✔	
12	DTMF Encode/Decode	✔	N/A	✔	

DMR COMMUNICATION

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Own ID	✔	✔	✔	
2	Slot Selection	✔	✔	✔	
3	Signaling (Color Code)	✔	✔	✔	
4	Busy Channel Lockout (DMR)	✔	N/A	✔	
5	Voice Channel Quality Threshold	✔	✔	✔	Shared configuration
6	Data Channel Quality Threshold	✔		✔	
7	Encrypted Channel Quality Threshold	✔		✔	
8	Vocoder FEC Threshold	✔	N/A	✔	
9	Call Hangtime	✔	✔	✔	
10	Data Hangtime	✔	✔	✔	
11	Channel Hangtime	✔	✔	✔	
12	Group Call	✔	✔	✔	
13	Unaddressed Call	✔	N/A	✔	
14	User List (Group ID/ Unit ID)	✔	N/A	✔	
15	Call Interrupt	✔	✔	✔	

CW ID

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	CW ID	✔	✔	✔	
2	Transmit Interval Time	✔	✔	✔	
3	Transmit Delay Time	✔	N/A	✔	
4	CW Speed	✔	✔	✔	

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
5	CW Modulation Delay Time	✔	N/A	✔	
6	Audio Frequency	✔	✔	✔	
7	Interval Activity Transmit	✔	N/A	✔	
8	CW ID Override	✔	N/A	✔	
9	CW ID on Channel Change	✔	N/A	✔	
10	Encode with QT/DQT	✔	N/A	✔	
11	CW ID TX Interrupt	✔	N/A	✔	

FUNCTION PORT

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	AUX Input/Output	✔	✔	✔	
2	AUX Input Trigger	✔	N/A	✔	
3	Logic Type	✔	N/A	✔	

REMOTE CONTROL

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Control PF Key by DTMF	✔	N/A	✔	
2	Control AUX Input by DTMF	✔	N/A	✔	
3	Control AUX Output by DTMF	✔	N/A	✔	
4	Remote Access with QT/DQT	✔	N/A	✔	
5	Clear to Transpond	✔	N/A	✔	
6	Send Voice from Web Access	N/A	✔	N/A	

CONVENTIONAL IP NETWORK

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Intersite Call	✔	✔	✔	
2	Site Roaming	✔	✔	✔	
3	Cross-busy	✔	N/A	✔	
4	Site Group Table	✔	N/A	✔	
5	IP Console	✔ (Up to 100)	✔ (Up to Number of Gateway)	✔ (Up to 100)	
6	RF Link	✔(DMR)	✔(Analog/DMR)	✔(DMR)	
	Voting	N/A	✔(Analog/DMR)	✔(Analog / DMR)	
7	Analog FM	N/A	✔	N/A	
8	Simulcast	N/A	✔	N/A	
9	- Sync method	N/A	GPS/GLONASS, LAN(PTP), PPS Cable etc.	GPS	Redundancy of connecting selection is available
10	LAN port	✔(Option KTI-5)	✔(Bulit-in)	✔(Bulit-in)	Ethernet 10BT/100TX (auto MDI/MDI X) on an RJ45 socket
11	IP multisite bandwidth	(for reference) Voice (Multicast) 14.13*(C+R)*S [kbps] Voice (Unicast)	70 kb/s in analog to/from Master 24 kb/s in DMR to/from Master	(for reference) Voice (Multicast) 15.20*(C+R)*S [kbps] Voice (Unicast)	

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
		15.20*(C+R)*S [kbps] Data (Upstream) 109.3*S [kbps] Data (Downstream) 48.4*R*S [kbps]	(both DMR timeslots)	14.10*(C+R)*S [kbps] Data (Upstream) 103.9*S [kbps] Data (Downstream) 62.7*R*S [kbps]	
12	Max tolerable IP delay	Unknown Spec.	1140ms (round trip)	Unknown Spec	

REMOTE MANAGEMENT

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Web Interface	✔	✔	✔	
2	Firmware Update	✔	✔	✔	
3	Setting Data Update	✔	✔	✔	
4	Site Roaming Status	✔	✔	✔	

RISK MANAGEMENT

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Power Supply Lower Level	✔	✔	✔	
2	Redundancy	N/A	✔	N/A	

PASSWORD

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Read Authorization Password	✔	N/A	✔	

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
2	Overwrite Password	✔	N/A	✔	
3	Network Password	✔	✔	✔	

APPLICATION

	Function	TKR-D710/810	KAIROS	NXR-1700/1800	Remarks
1	Repeater Monitor Software	KPG-149RM/SA (JVCKENWOOD Original)	SNMP Software	SNMP Software	