NXDN®

NXDN Technical Specifications

Part 1:
Air Interface

Sub-part F:
Trunking Procedures (Type-D)

NXDN TS 1-F Version 1.0

November 2012

NXDN Forum

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1. Introduction

This document provides basic operating procedure in which Subscriber Unit with NXDN Distributed Control Trunking function and Trunking Repeater in Trunking Repeater Site to control Subscriber Unit establish communication on traffic channel, such as voice call, data call, additional service communication, and other communication related to location registration and authentication.
This document includes the following contents.

- How to use function CH when performing link connection and communication and its judgment method
- Packetization method for data communication and procedure of data communication including retry
- Overview and operating procedure of location registration, authentication and encryption

2. References

Reference documents are listed below. This document and the references are mutually supplemented.

REF [1] Part 1-E Common Air Interface (Type-D)

3. Abbreviations

To help understand this document, abbreviations are listed below.

CAI	Common Air Interface
DMO	Direct Mode Operation
FACCH1	Fast Associated Control Channel 1
FACCH3	Fast Associated Control Channel 3
FS	Fixed Station
FSW	Frame Sync Word
FDMA	Frequency Division Multiple Access
ISM	Inbound Signaling Message
L1	Layer 1
L2	Layer 2
L3	Layer 3
LICH	Link Information Channel
MS	Mobile Station
OSM	Outbound Signaling Message
PBX	Private Branch Exchange
PSTN	Public Switched Telephone Network
RU	Repeater Unit
RTCH2	RF Traffic Channel 2
SCCH	Signaling Control Channel
SU	Subscriber Unit
TC	Trunking Controller
TR	Trunking Repeater
TRS	Trunking Repeater Site
UDCH2	User Data Channel 2
USC	User Specific Channel
VCH	Voice Channel

4. Trunked System

This chapter explains the overview of NXDN Type-D (Distributed Control Trunked System) and standard setting for function CH in each communication method.

4.1. Outline

One Trunked System consists of one or more TRSs that are connected each other. Trunked System with one TRS is called Single Site and one with multiple TRSs is called Multi Site.
Normally, Multi Site Trunked System needs to have a database to store Unit ID for SU and terminal information such as ESN as well as a database to store SU location registration information. These databases are installed in each control device or exclusive database facility.
There are two types of NXDN Type-D (Distributed Control Trunked System) according to system size and requirements. One is Single Trunked System for Single Site and the other is network-compatible Multi Trunked System for Multi Site.

All SU of Single Trunked System has Home Repeater, which is a Repeater ID assigned by a system operator in order to receive most of the control information by always monitoring during standby time. When other SU communication is in use, function channel SCCH enable us to control a line connection on the same traffic channel. The Area included in SCCH is used to avoid interference of shared channel.

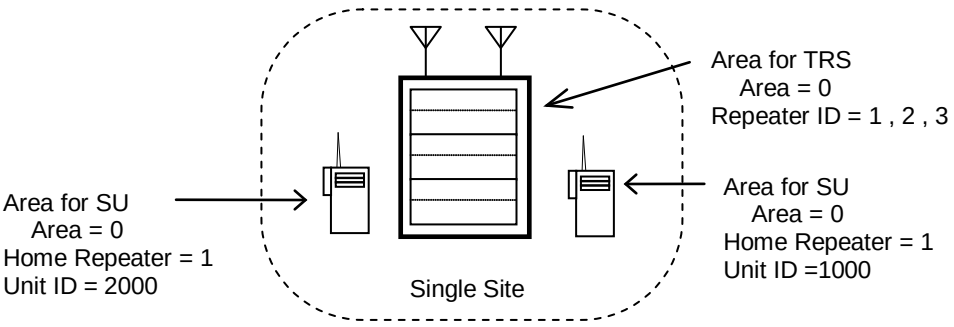


Figure 4.1-1 Concept configuration of Single Trunked System

Multi Trunked System has uniquely assigned System ID and Site Code information in addition to Area of Single Trunked System and Repeater ID. System ID contains two information elements; Integrator Code and System Code. Integrator Code is an identification code of the operations manager of a system, and System Code is uniquely assigned identifying information according to each Integrator Code.
Site Code is identifying information that system operator assigns for each site in the system.

To operate properly in Trunked System, SU with Trunking mode needs to store seven information; unique Prefix in the system assigned by system operator, Unit ID, System ID as Home System, Site Code, Area, Home Repeater, and unique ESN written by SU maker at a plant.
Trunked System accepts communication only from SU with authorized System ID, and SU connects to only TRS with corresponding Site Code.

Depending on system requirements, there is a case to communicate between different systems by connecting systems. In order to support such Multi System operation, different processing from Single System is required both in TRS and SU.
Trunked System needs to have a visitor database to accept SU with different System ID as well as gateway device to exchange database information between systems. But implementation measures are system-dependent.

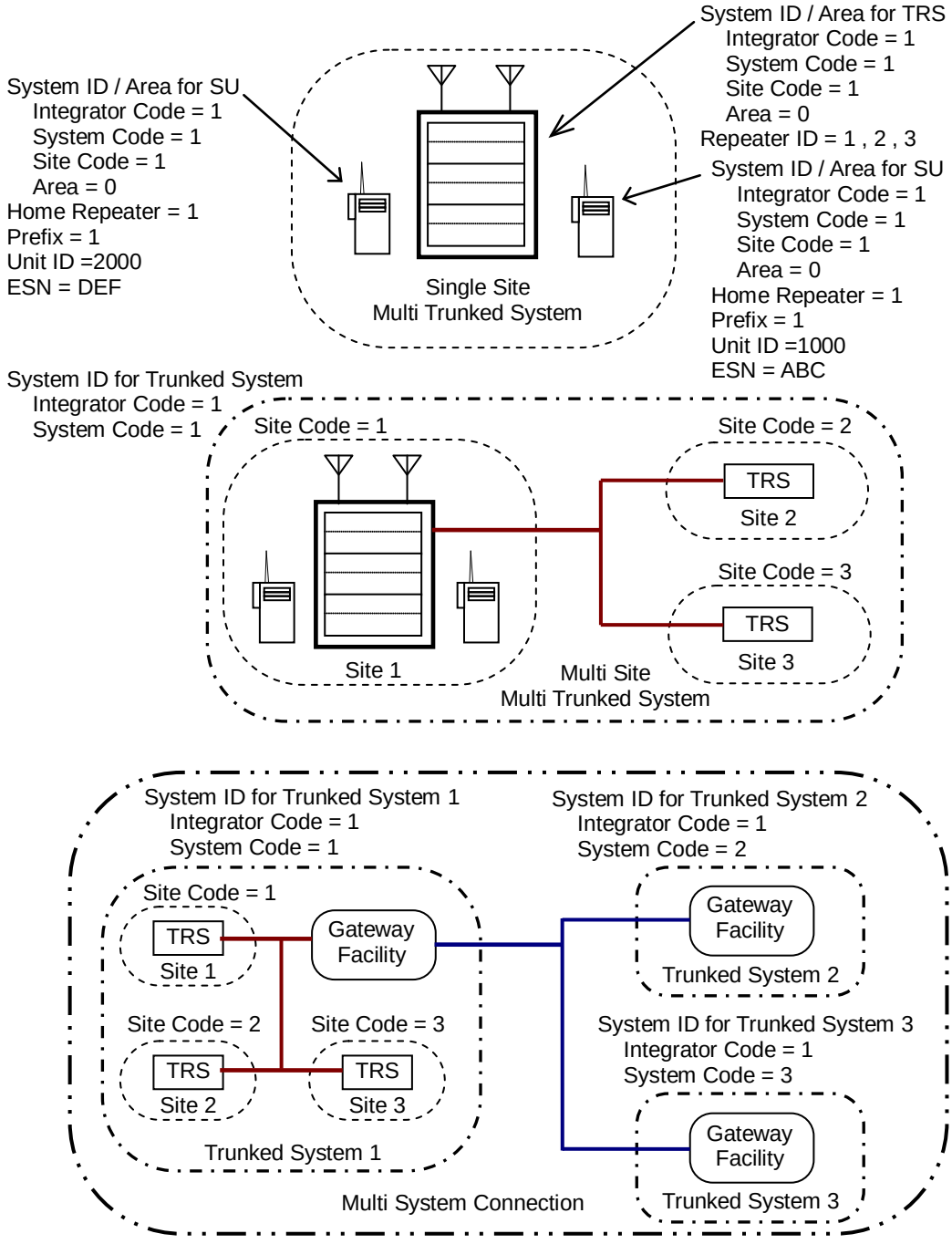


Figure 4.1-2 Concept configuration of Multi Trunked System

4.2. System Identification

4.2.1. Trunked Type

SUs of Single Trunked System and Multi Trunked System are identified by value of T-Type included in CC Option, which is defined in REF [1].
Note that communication between these two types is not supported.

4.2.2. Single Trunked System

Following are identification levels for Single Trunked System.

- The same channel interference detection using Area
- Identifying TR in transit using Repeater ID

As shown in Figure 4.1-1, same Area and Repeated ID should be configured for TRS and SU.
TRS receives signals only from SU using the same value as Repeater ID (Go to Repeater).
Similarly, SU receives signals only from TR using the same value as Area and Repeater ID configured for the SU.

4.2.3. Multi Trunked System

Following are identification levels for Multi Trunked System.

- Identifying systems using Integrator Code and System Code in System ID
- Identifying Sites using Site Code
- CH Interference detection using same Area
- Identifying TR in transit using Repeater ID

As shown in Figure 4.1-2, by comparing Integrator / System Code preset in TRS and SU, it can be determined if they are same System or not.
Also, by comparing Site Code of TR and Site Code configured in SU, it can be determined which Site Area in the System SU has been transferred.

In Multi Site system environment, the same frequency can be used in different sites repeatedly. In such a case, depending on the positional relation of Site and SU, SU may receive signals from multiple sites using the same frequency. To detect same CH interference, Area is used in this system though Color Code is usually used to identify a Site.

This system identifies a Site by using Site Code. Site Code is included in Site ID Message, which is arbitrarily configured by an administrator.

As for System Code, 0 - 32767 (15 bit) is defined in REF [1]. But System code whose bit are all “0” or all “1” cannot be assigned.

5. Distributed Control Channels

This section provides the overview of wireless traffic channels by distributed control method.

5.1. Home Repeater

All SU(s) have one of the Repeater ID(s) as its Home Repeater assigned by the System Operator. When a SU is in the standby state, it is always monitoring its Home Repeater to receive most of its Control Information.
When other SU communication is in use, function channel SCCH enable us to control a line connection on the same traffic channel.

In Multi Trunked System, Prefix number shows Home Repeater of each site.
Multi Trunked System may not establish a communication link if each of the SU(s) is required to register any one dedicated Home Repeater by assigning Repeater ID to each Repeater like a Single Site Trunked System.
As an example, for Multi Trunked System, take the case in which a SU is allocated Repeater ID = 4 as its Home Repeater in Site A which shares five Repeaters.
When the SU roams from Site A to Site B which shares three Repeaters and has no Repeater ID=4 assigned as its home Repeater, there is no Home Repeater of the SU in Site B, therefore the SU cannot establish a communication link（Figure 5.1-1）.
For convenience in improving the above-mentioned shortcomings, Prefix number is allocated to the SU instead of assigning a Repeater ID indicating its Home Repeater. By allocating a Repeater ID that represents a Home Repeater of each SU to each separate site from one Prefix number to another, the occurrence of the above-mentioned problem will be circumvented.
In the above case, Prefix =1 is allocated to the SU, and then make the settings by adjusting Repeater ID = 4 as a Home Repeater of the SU in Site A, and Repeater ID = 3 in Site B, respectively. In this case, the SU uses the channel frequency of Repeater ID = 4 as its Home Repeater in Site A, and that of Repeater ID =3 as its Home Repeater in Site B.
（Figure 5.1-2）

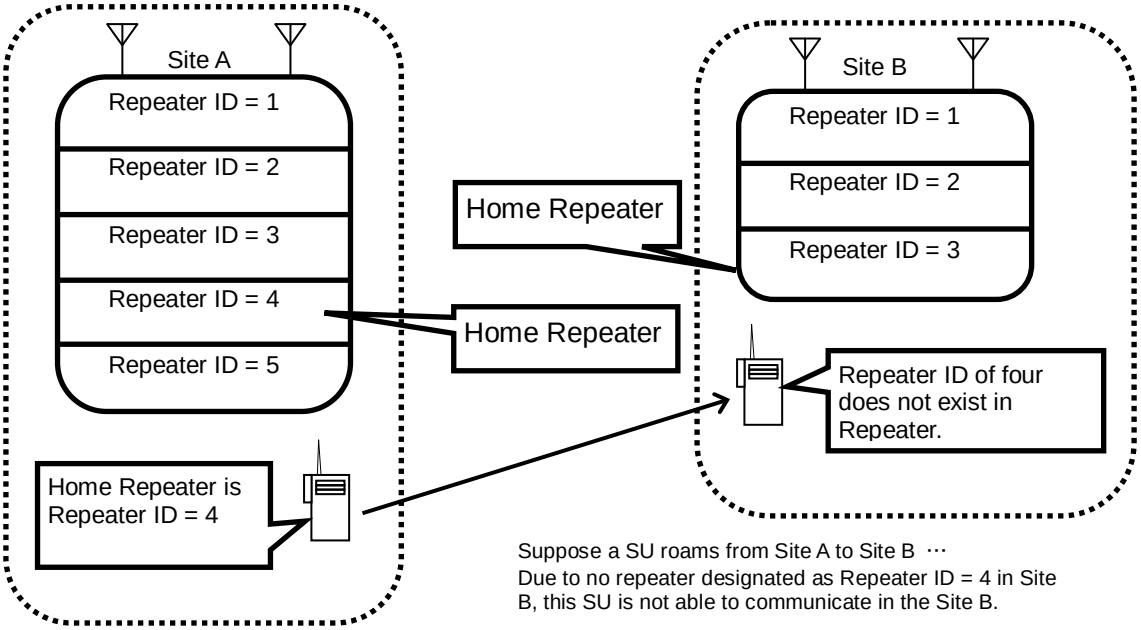


Figure 5.1-1 In the case where a Repeater ID indicating a Home Repeater is allocated:

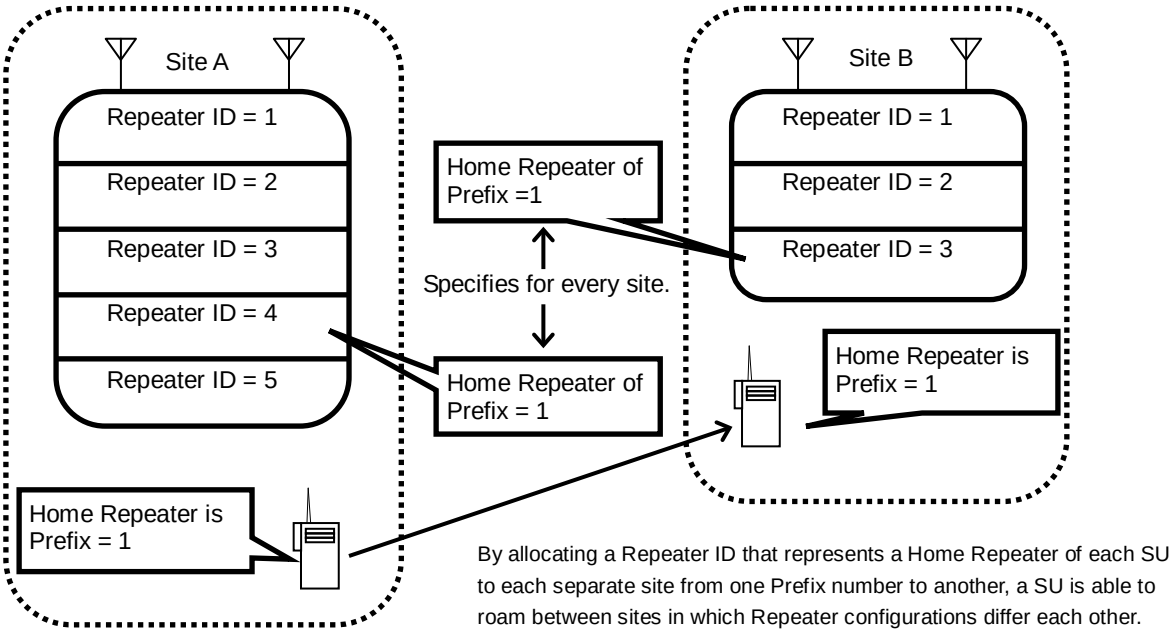


Figure 5.1-2 In the case where a Prefix number indicating a Home Repeater is allocated:

When Home Repeater is in the idle state, it passes Idle Repeater Message regularly through function channel SCCH.
Home Repeater in Multi Trunked System regularly passes Site ID Message for Site identification through function channel SCCH.
In order to communicate SU(s) of different Prefix, multiple Prefix can be assigned to the same Home Repeater. In this case, to communicate at all sites in the system, multiple Prefix must be assigned to the same Home Repeater at each site.

5.2. Collect Repeater

Collect Repeater is a specifically assigned Repeater which allows a SU to operate on the Multi Trunked System to automatically register with appropriate site. It is recommended that a Collect Repeater and Home Repeater be set up separately in each of the Sites, though, Collect Repeater can be commonly used as a Repeater for Traffic Channel with a lower priority.

Collect Repeater regularly passes Site ID Message for making SU identify a site through function channel SCCH.

5.3. Non-Home Repeater

When a Traffic Repeater is exclusively used for communication and not used for Home Repeater or Collect Repeater and it is in the idle state including 2nd Collect Repeater, signals are not passed.

6. Collect Channel Acquisition and Retention

6.1. Roaming Algorithm

Basic operation of roaming has three states of SU, idle, active and roaming, as shown in Figure 6.1-1. Roaming is started when power of SU is turned on, site change operation is made, or valid signal is lost during the idle state under set time or condition.

If a valid site is detected during roaming process and registration process is successful, it moves to the idle state.

When SU becomes active for transmission, roaming check is terminated. For background search from the idle state, it is not recommended because it is a system that doesn't have exclusive control channel for constant transmission, and it might take time to acquire a site and miss a call request.

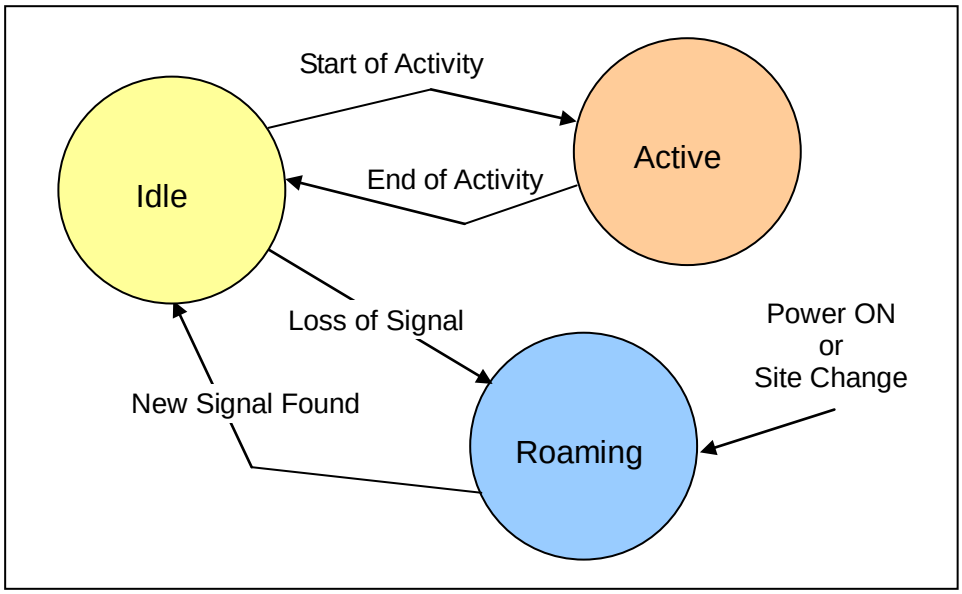


Figure 6.1-1 Basic Data Flow for Roaming Process

6.1.1. Sequence to acquire a site

Figure 6.1-2 describes an overview of a procedure to acquire a site. When power of SU is turned ON or site is changed, SU gives priority to a set site and stays on the site for up to about Tr_site + 1 seconds until it receives Site Code Message.
When SU is in the idle state, it will maintain the idle state as long as judgment criteria shown in Section 6.1.2 are met for Site Code of valid site.
When signal intensity falls below the judgment standard, roaming is started. During roaming, it searches for each site set in SU.
When signal is found, it will stay there for up to about Tr_site + 1 seconds to detect valid Site Code. When a valid Site Code is detected, it tries to register with the site. If SU cannot register with the site or valid Site Code cannot be detected, SU doesn't search on the site for the next 10 seconds.

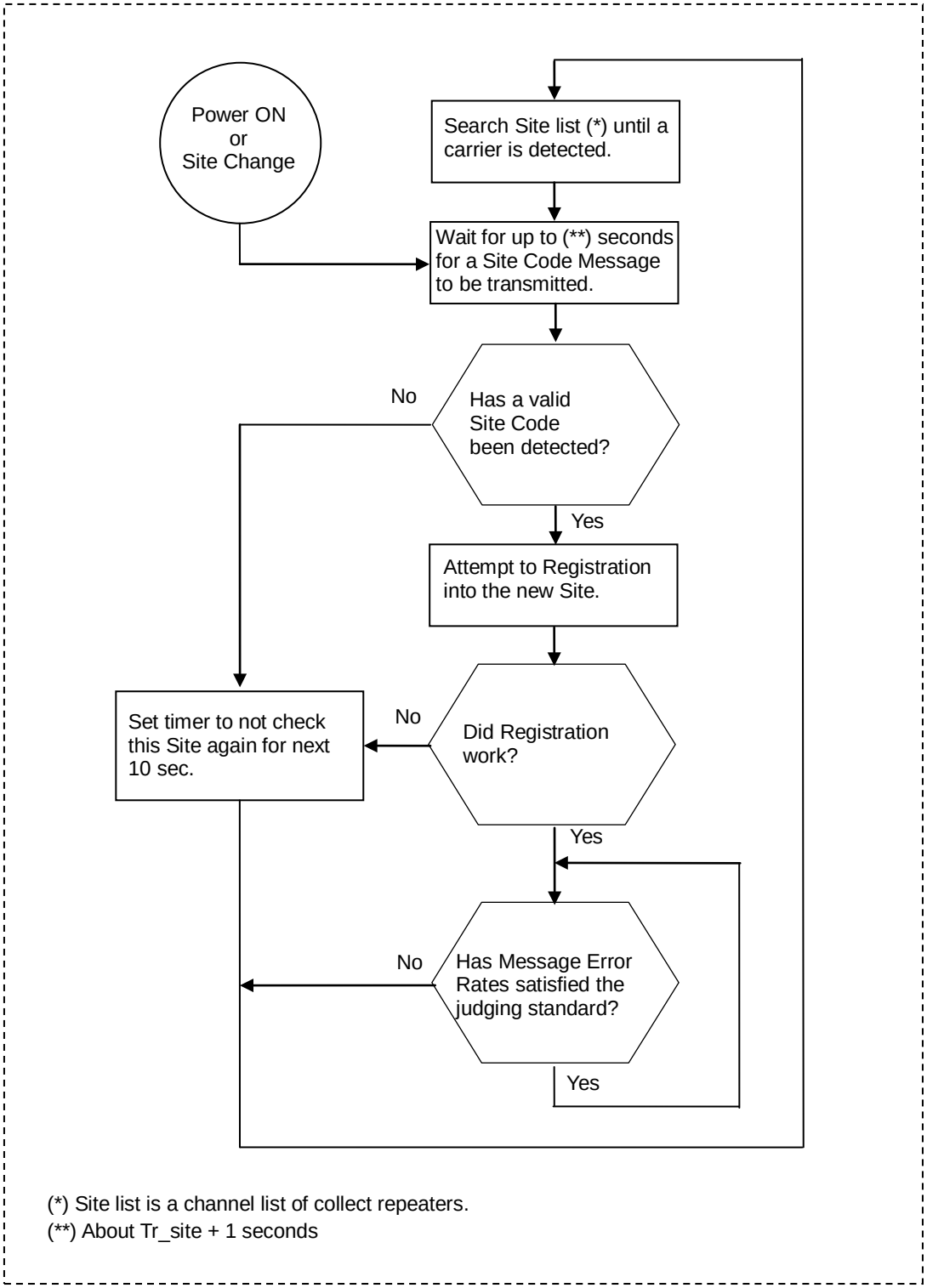


Figure 6.1-2 Sequence Diagram for Registration

6.1.2. Standard to judge idle state

In a system that doesn't have exclusive control channel, it is necessary to judge by an intermittent signal sent by Home Repeater. Usually RSSI is used to judge availability and strength of signal, but disadvantage of using only RSSI for intermittent signal is stability level is low for fading signal or weak signal.

Until a valid site is found by roaming, signal intensity by RSSI is used. During the idle state, it can also be used Massage Error Rates, which is using Site ID Message sent every Tr_site through SCCH message.
Furthermore, it is designed to be able to change criteria of judgment in accordance with Site Type message included in INFO4 (Site ID Message).

7. Mode of Operation

7.1. Trunking Mode

As Trunking Mode of Trunked System, TC is based on Transmission Trunking Mode, in which it doesn't use Hold Time except during system data communication or telephone communication.

This behavior is to allocate traffic channel each time SU transmits. And TC disconnects from traffic channel as soon as SU transmission ends on traffic channel.

When SU on traffic channel performs Talkback, depending on the timing of pressing PTT, it starts to send communication request to a traffic channel indicated by Free Repeater in TX_REL or Free Repeater acquired back in Home Repeater.

When repeating transmission and receiving in a short time, such as Acknowledge during data communication, there is Message Trunking Mode as an optional function of SU. TC holds traffic channel during a preset Hold time by not passing EOT of SCCH. During that time, a SU participating communication can transmit repeatedly on the same traffic channel without link motion. When there is no traffic on traffic channel during Hold Time, TC disconnects from traffic channel.

In addition, when performing individual address call on Trunked System, it is possible to choose Transmission Trunking Mode or Message Trunking Mode for calling.

7.2. Link Establishment Time

This section explains transmission timing between SU and TR when SU starts communication.

Regarding Repeater operation of TR, refer to Chapter 8.

7.2.1. Link Time for Group Call on Idle Home Repeater

This section explains transmission timing between SU and TR when SU starts communication.

Figure 7.2-1 shows an example of processing timing at SU and TR when SU-A makes Group Call to SU-B during Home Repeater TR-1 is in the idle state. This example is a case of idealistic processing timing and providing the minimum link time.

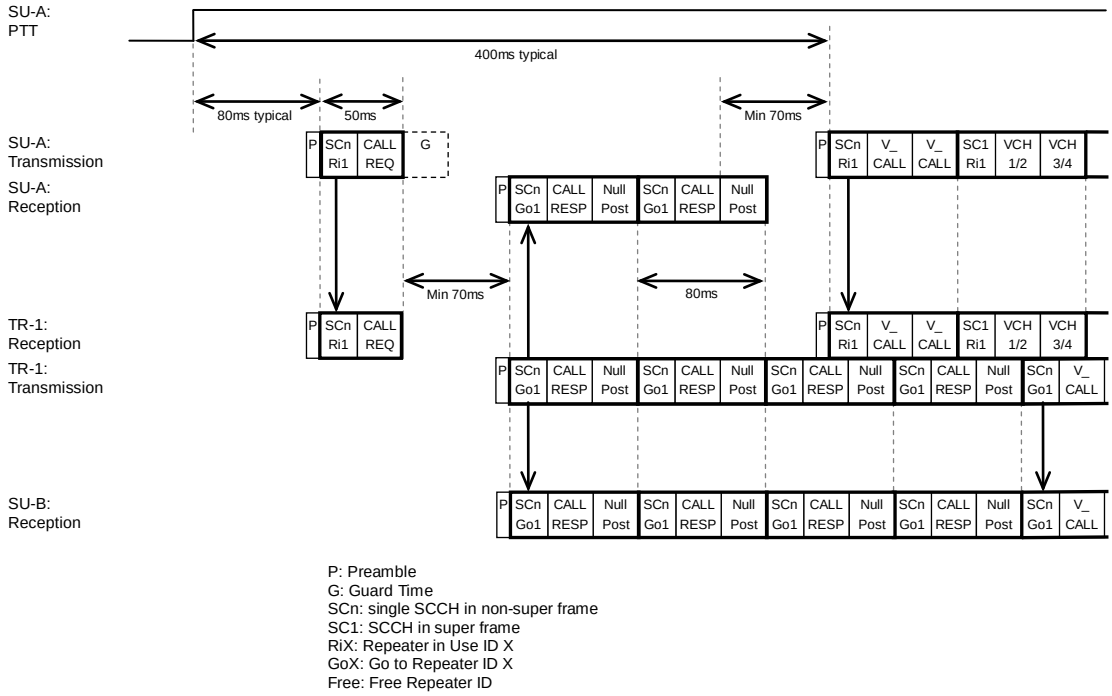


Figure 7.2-1 Link Time for Group Call on Idle Home Repeater

When PTT of SU-A is started, SU-A transmits CALL_REQ to TR-1 using random access operation at Inbound RTCH2. Shortly after that, at Outbound RTCH2, TR-1 transmits CALL_RESP, which means success of CALL_REQ. SU-A receives CALL_RESP, which means success of CALL_REQ, and from Inbound RTCH2, it starts to transmit voice call of Group Call to TR-1.
SU-B receives CALL_RESP from TR-1 or Go to Repeater (TR-1) at the same timing as SU-A, and SU-B stays on TR-1 to continue reception operation.
In this example, the link time from PTT at SU-A is started until it restarts transmission on RTCH2 is about 400ms. However, frame of outbound RTCH2 is based on the timing created by one TC as a Master connected to TR. Therefore, CALL_RESP cannot always be sent back in this timing and link time may be longer than this example link time.

7.2.2. Link Time for Group Call with Busy Home Repeater

Figure 7.2-2 shows an example of processing timing at SU and TR when SU-A makes Group Call to SU-B during Home Repeater TR-1 is busy. This example is a case of idealistic processing timing and providing the minimum link time.

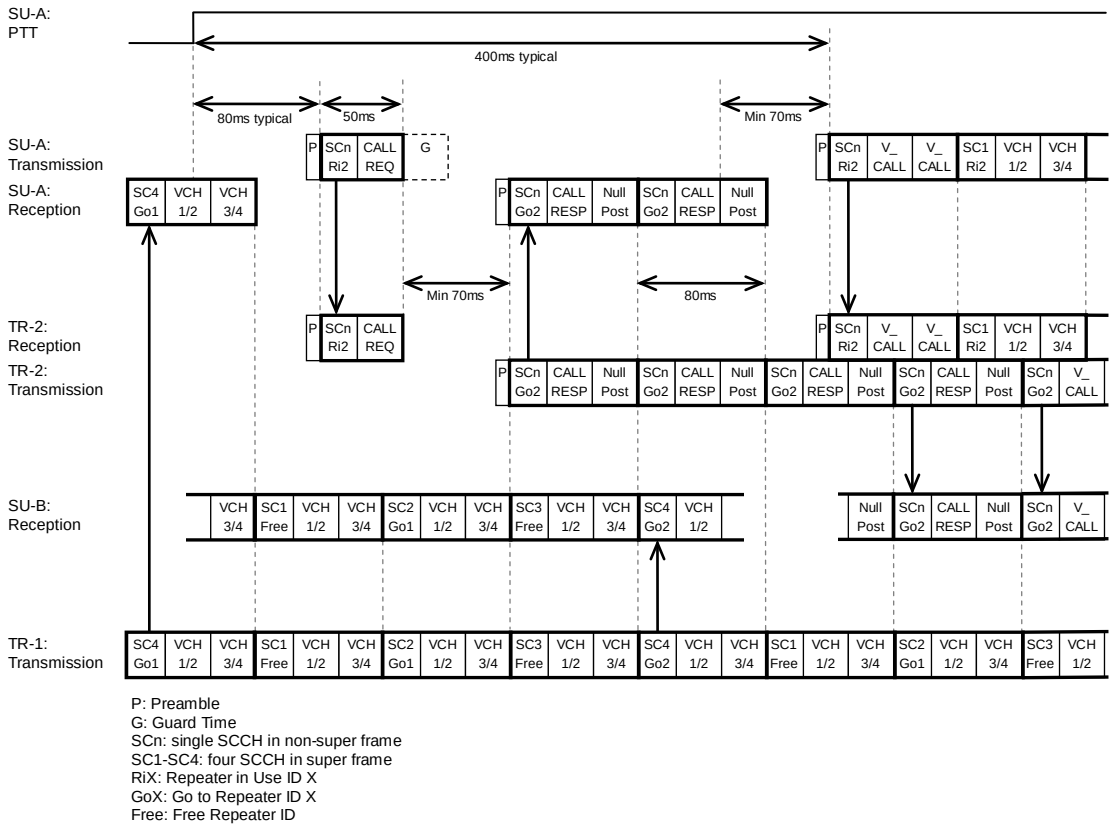


Figure 7.2-2 Link Time for Group Call with Busy Home Repeater

When PTT of SU-A is started, SU-A transmits CALL_REQ to Free Repeater(TR-2), which is already obtained from TR-1 and kept, using random access operation at Inbound RTCH2. Shortly after that, at Outbound RTCH2, TR-2 transmits CALL_RESP, which means success of CALL_REQ and at the same time, it transfers INFO4 information from SU-A to data bus.
SU-A receives CALL_RESP, which means success of CALL_REQ, and from Inbound RTCH2, it starts to transmit voice call of Group Call to TR-2.
Shortly after that, at Outbound RTCH2, TR-1 transmits INFO4 information from SU-A, which was transferred by TR-2 to data bus, as INFO4 (or INFO2) information.

SU-B receives Go to Repeater (TR-2) in INFO4 from TR-1, and change a traffic channel from TR-1 to TR-2. Then it receives CALL_RESP or Go to Repeater（TR-2） from TR-2 to stay on TR-2 to continue reception operation. In this example, SU-B changes a channel to TR-2 and receives CALL_RESP, but if it receives VCALL, it won't be Late Entry.

In this example, the link time from PTT at SU-A is started until it restarts transmission on RTCH2 is about 400ms. However, similar to Figure 4.4-1, link time may be longer than this example link time.

7.3. Synchronous Reset

TX_REL signifies the termination of transmitting signal, and after accepting this message, SU and TR resets synchronization, and then become a standby mode. Furthermore, EOT signifies the release of repeater channel.

8. Repeater Operation

This chapter explains the basic operations to communicate using TR.
Communication with consoles connected to TC and other external devices is not explained here.

8.1. Condition of Repeat Operation

This chapter explains how to judge availability of repeat operation in TR.

In Single Trunked System, if a called SU has received CALL_REQ and INFO4 which a calling SU transmitted as a link connection permission request, the called SU evaluates the description of Area and Repeater in Use messages that are included in INFO4, and then in case where those messages agree with Area and Repeater ID of a TR, the TR starts a data transmission as a response to link connection permission request at the instructed cannel frequency in accordance with INFO4 and CALL_CONN_RESP messages representing a Free Repeater; or at the cannel frequency in accordance with INFO4 and CALL_RESP messages transmitted from a site in which Area, Go to Repeater and System ID messages are the same as those of the called SU. However, INFO4 can switch to another repeater such as Go to Repeater to receive the higher priority call. In a system in which a Cause will not be used, CALL_CONN_RESP can be omitted.

In Multi Trunked System, if a called SU has received CALL_REQ and INFO4 which a calling SU transmitted as a link connection permission request, the called SU evaluates the description of Area and Repeater in Use messages that are included in INFO4, as well as System ID that is included in CALL_REQ, and then in case where those messages agree with Area and Repeater ID of a TR, the TR starts a data transmission as a response to link connection permission request at the instructed cannel frequency in accordance with INFO4 and CALL_CONN_RESP messages representing a Free Repeater; or at the cannel frequency in accordance with INFO4 and CALL_RESP messages transmitted from a site in which Area, Go to Repeater and System ID messages are the same as those of the called SU.
However, INFO4 can switch to another repeater such as Go to Repeater to receive the higher priority call.

After TR starts transmission, confirm the transmission from SU is held temporarily. And when Area and Repeater in Use sent through SU within Hold Time are the same, TR judges Repeat Operation is available and continue outbound transmission.

Regarding Judgment of Repeat Operation availability by TC, for Single Trunked System, it is based on agreement of Area and Repeater in Use. For Multi Trunked System, it is based on agreement of System ID, Area and Repeater in Use. Judgment of Repeat Operation availability for higher-level information related to selective call for Prefix (Home repeater), Group ID and Unit ID is optional. Only control information using SCCH and Free Repeater information are replaced between inbound and outbound. High-level information such as Group ID and Unit ID are repeated as they are.

8.2. Link Procedure

When a SU starts the communication, it needs to establish a link. Here, the procedure by which a link is established will be explained. The following procedural steps are subject to the satisfaction of the conditions that System ID, Area and Repeater ID that are included in a CALL_REQ message agree with those of the SU's Site. In Single Trunked System, System ID is not required.

8.2.1. Unit Request

SU sends CALL_REQ message to the Free Repeater instructed by INFO4 (Free Repeater Message) by executing random access operation, and waits to the data that is echoed back from TC.

8.2.2. Controller Actions

A TC shall carry out the following as valid replies to REG_REQ from a SU:

a) In case of allowing the communication, informs System ID and Prefix /Unit ID allocated to SU, and sends a CALL_RESP message that includes INFO4 (Go to Repeater information).
b) In case of using Traffic Repeater, SU sends an INFO4 message that represents Go to Repeater or a message that includes INFO2 from its Home Repeater.
c) In case of making a call request standby state, to send a CALL_CONN_RESP message that includes Cause representing a queue status.
d) In case of rejecting the communication, informs System ID and Prefix /Unit ID allocated to SU, and sends a CALL_CONN_RESP message that includes the cause of rejection.
e) In case in which a System ID does not agree with that of the SU's System, to inform System ID and Prefix /Unit ID allocated to SU, and sends a CALL_CONN_RESP message that includes the cause in correspondence with that situation.

8.2.3. Unit Actions

An SU having sent CALL_REQ shall carry out the following as valid replies to the messages from a TC:

a) When Calling Unit receives CALL_RESP indicating the communication is allowed,
    i) It sends message information.
b) If Calling Unit receives CALL_CONN_RESP that represents queue status,
    i) Set a specified period of time, and continuously wait to the data that is echoed back from Controller.
    ii) When a response CALL_CONN_RESP indicating queue status has been received within a specified period of time Ts_ack,
    iii) Re-set a specified period of time, and continuously wait to the data that is echoed back from Controller.
    iv) When no response allowing communication can be received within a specified period of time Ts_ack,
    v) Shift the channel frequency to that of Home Repeater, and then become a idle mode, or;
    vi) when no response allowing communication can be received from TC after attempting to repeat the transmitting of a communication permission request

Ns_ret times, shift the channel frequency to that of Home Repeater, and then become an idle mode.

c) When (a) Calling Unit has received CALL_CONN_RESP indicating that the communication is rejected,
   i) After sending TX_REL/EOT, shift the channel frequency to that of Home Repeater, and then become an idle mode.
d) When a Calling Unit has received a CALL_CONN_RESP message transmitted from a system whose System ID is not the same as its allocated System ID, updates records of the site whose System ID does not agree with that of the Calling Unit's System, and then;
   After sending TX_REL/EOT, shift the channel frequency to that of Home Repeater, and then become an idle mode
e) When Calling Unit receives neither CALL_CONN_RESP nor CALL_RESP within a specified period of time Ts_ack,
   i) shift the channel frequency to that of Home Repeater, and then become a idle mode, or ;
   ii) when no response allowing communication can be received from TC after attempting to repeat the transmitting of a communication permission request Ns_ret times, shift the channel frequency to that of Home Repeater, and then become an idle mode.
f) When a Called Unit has received Go to Repeater information that includes the instructed Destination Prefix/Destination ID,
   i) shift the channel frequency based on Go to Repeater information that is included in SCCH.

8.3. Timing

This section explains the overview of timing to start and finish Repeat Operation in TR

8.3.1. Timing to start Repeat Operation

As explained in Layer 2 in REF [1], inbound and outbound inter-frame offset is not specified. This is because frame timing of inbound and outbound are independent; inbound from SU is based on random-access operation with contention method during link connection, while outbound is generated based on the timing of one TC, which is Master connected to TR. Delay time caused by changing frames from inbound to outbound to put VCH or other data in frame is 120 ms in the shortest as shown in Figure 8.3-1, and longest delay time is not specified.

As explained in Chapter 16, in encrypted communication, there is relation between Encryption cycle and placement of VCH. Therefore it is necessary to replace the contents of frame from inbound frame to outbound frame without disturbing the relation.

As shown in Chapter 11, inbound transmission signal from SU transmits a certain preamble before transmitting the first frame. Similarly, outbound transmission signal of TR transmits a certain preamble before transmitting the first frame.

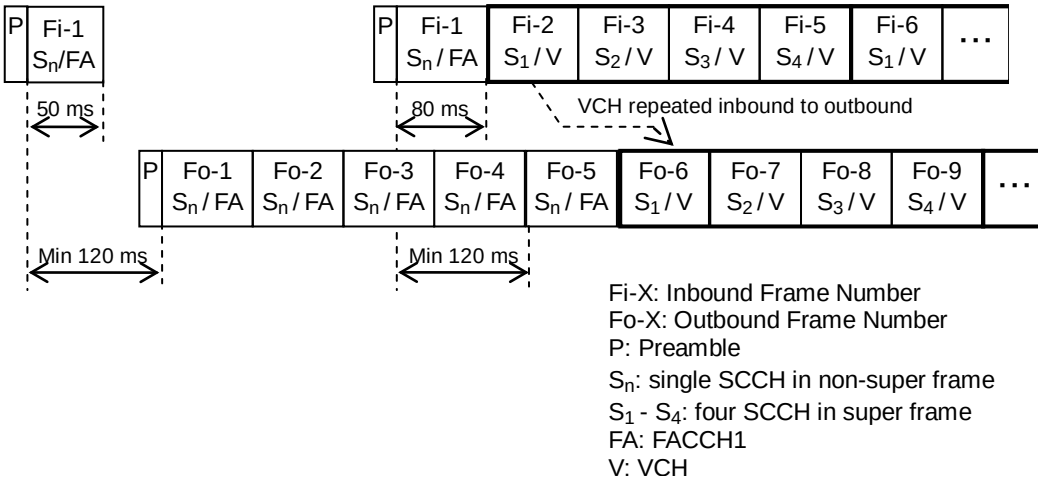


Figure 8.3-1 Timing of Repeat Operation

8.3.2. Timing to terminate Repeat Operation

As shown in Chapter 11, after SU transmits TX_REL including EOT in the final frame, transmission is terminated. With a reception of TX_REL as a trigger, TR terminates repeat operation, and terminates transmission after sending TX_REL.

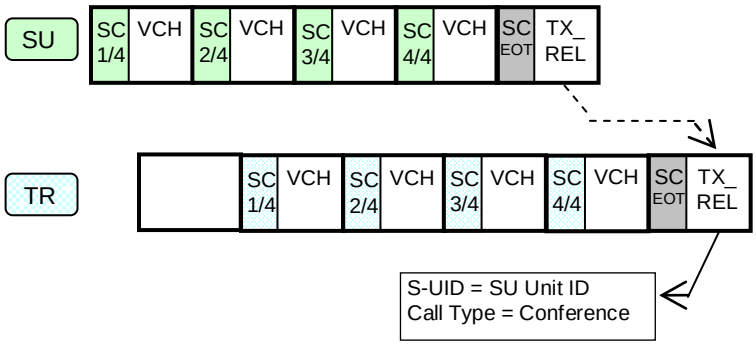


Figure 8.3-2 Repeat Termination Operation

Figure 8.3-2 shows an example of Repeat Termination Operation of Group Voice Call. This is recommended operation for normal termination, but it is possible to user other operation for abnormal termination or even for normal termination.
When repeat operation is terminated, if SU with the same Home Repeater ID is communicating at other TR, it will continue the transmission operation.

Also TR can configure arbitrary Hold Time. When Hold Time is up, outbound transmission is terminated. Figure 8.3-3 shows an example of operation when Repeat operation is terminated, SU transmits TX_REL without STAT_REQ and EOT.

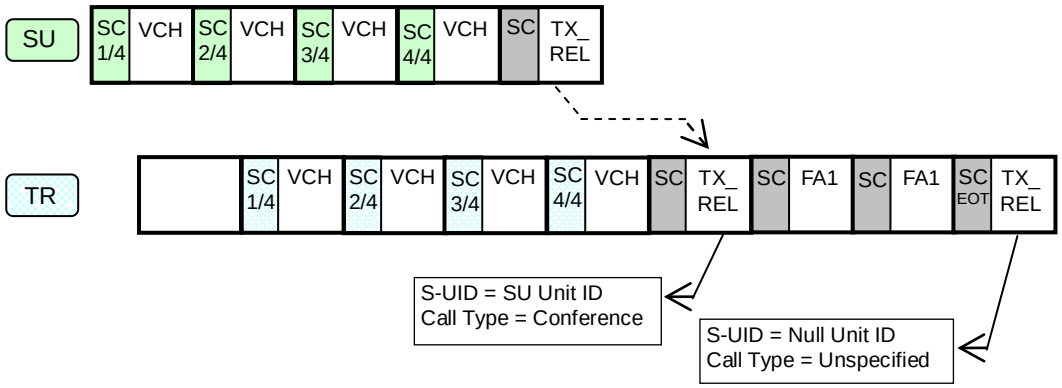


Figure 8.3-3 Repeat Termination Operation with hold Time

TR repeats up to TX_REL sent through SU, and when arbitrary Hold Time is up, it transmits TX_REL from TR to terminate Repeater operation. For configuration of TX_REL in TR, Null Unit ID is used for Source Unit ID, and Unspecified Cal is used for Call Type. SCCH message to be sent during Hold Time transmits INFO4 in accordance with the distribution method in Section 8.4. For a message using FACCH1, there is no special restriction.

8.3.3. Transmission interval of Idle Repeater Message

After a transmission, TR transmits two-frame Idle Repeater Message shown in Figure 8.3-4 and TX_REL towards all Su, which are configured as Home Repeater when they are not used, in order to communicate its existence within communication area. Idle Repeater Message can be distinguished by replacing GID of INFO4 in SCCH to 2046.
The transmission interval of this Idle Repeater Message is Tr_idle in Single Trunked System, but because it is system-dependent, presence or absence of transmission and its interval is not specified.
For Home Repeater of Multi Trunked System, it is transmitted with Site ID Message as shown in Figure 8.3-6.

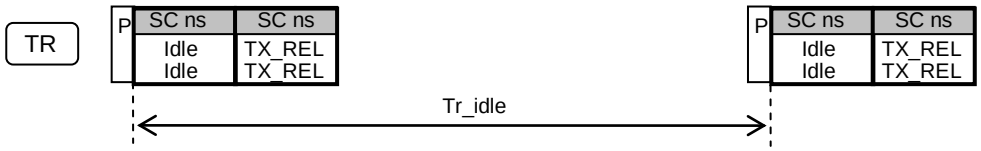


Figure 8.3-4 Transmission interval of Idle message

8.3.4. Timing of SU in Outbound Signal Synchronization

As described in Section 8.3.1, normally SU starts transmission by its own timing, and TR starts repeating based on the timing of TC, which is a Master.
In a different case, when SU starts transmission during Hold Time of TR, it is recommended that SU should transmit inbound frame with 40ms offset against received outbound frame from TR.

As shown in Figure 7.2-2, when reception channel is changed by Go to Repeater from TR, which configured by SU as Home Repeater, it is recommended to change channel with synchronization maintained.

8.3.5. Communication Timing of Site ID Message

In Multi Trunked System, it is necessary to communicate information to identify the site for SU to start roaming. This communicated information is transmitted from TR configured as Home Repeater or Collect Repeater. It is not recommended, but when sharing Collect Repeater and Home Repeater, communication timing of Home Repeater is prioritized.

(1) Report Timing of Collect Repeater
Site ID Message is information to identity the site of TRS. While Repeater is used for SU transmission, Site ID Massage is transmitted with INFO4 or INFO2 through SCCH by the frame distribution method explained in Section 8.4. If TR is not used continuously after transmission, Tr_site interval shown in Figure 8.3-5, it transmits Idle Repeater Message and TX_REL using INFO4 of SCCH, following 6 frames of Site ID Message.
For Site ID Message, it is possible to omit transmission of Idle Repeater Message by 2-frame unit.
Site ID Message can be distinguished by replacing GID of INFO4 in SCCH to 2041.
Concurrently with the communication timing of Site ID Message, Broadcast Message indicating SRV_INFO or ADJ_SITE_INFO is communicated through the first half of FACCH1 channel, which is transmitted following SCCH channel. The second half of FACCH1 channel is N /Post here, and Bit setting for LICH needs to be configured accordingly.

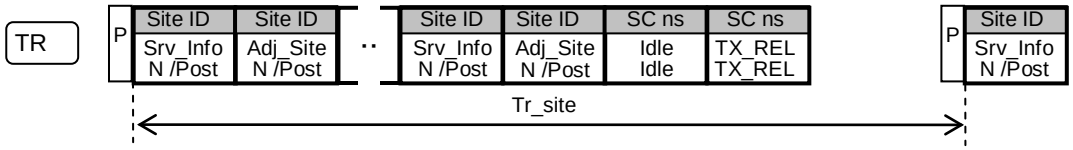


Figure 8.3-5 Transmission interval of Site ID message on Collect Repeater

(2) Report Timing of Home Repeater

Site ID Message in SCCH is transmitted every Tr_site as information to identify the site of TRS. When Repeater is used for a communication of SU, Site ID Message transmits four frames by frame distribution method in Section 8.4 using INFO4 or INFO2 message through SCCH.

Site ID Message in SCCH is transmitted every Tr_site as information to identify the site of TRS. When Repeater is used for a communication of SU, Site ID Message transmits four frames by frame distribution method in Figure 8.3-6 using INFO4 or INFO2 message through SCCH.

Concurrently with the communication timing of Site ID Message, Broadcast Message indicating SRV_INFO or ADJ_SITE_INFO is communicated through the first half of FACCH1 channel, which is transmitted following SCCH channel. The second half of FACCH1 channel is N /Post here, and Bit setting for LICH needs to be configured accordingly.

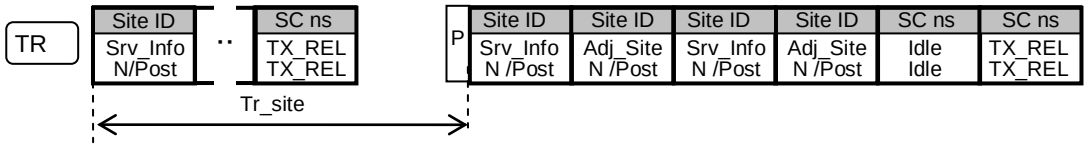


Figure 8.3-6 Transmission interval of Site ID message on Home Repeater

8.4. Outbound Signaling Message Distribution

Figure 8.4-1 shows an example of control information distributed to outbound SCCH frame in the case that SU, which is configured in the same Home Repeater, is communicating using one or more TR.

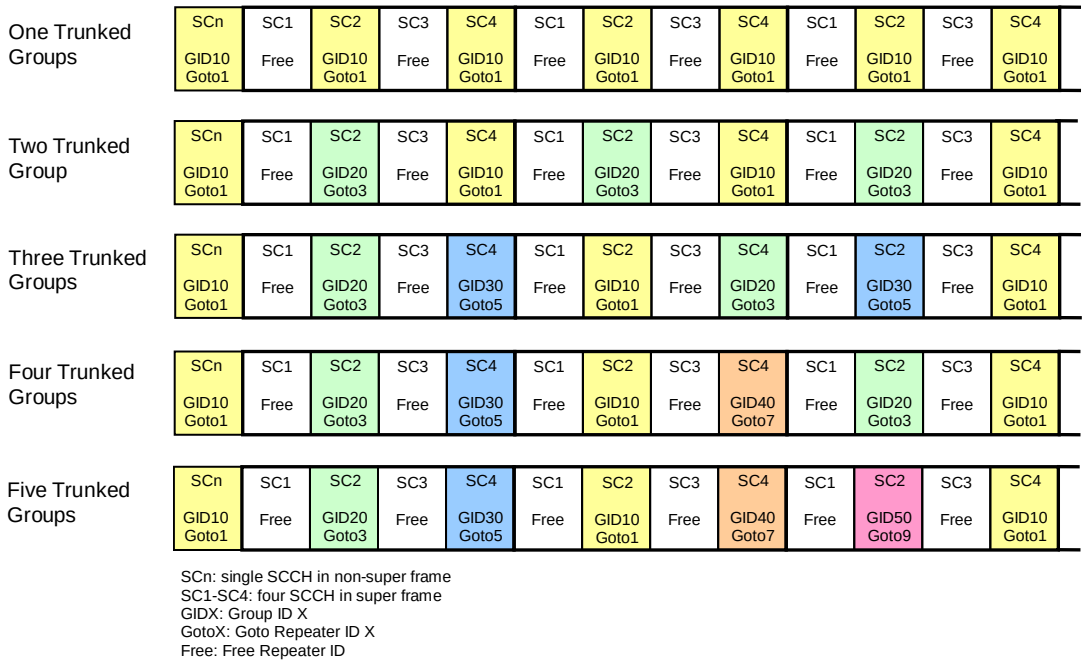


Figure 8.4-1 OSM Distribution

When Trunked Group is three or less, Go to Repeater of Home and non-Home is sequentially sent. When Trunked Group is four or more, Home is sent once every three times of the sending of Go to Repeater, Non-home is sequentially sent at other two times. During voice call, because SCCH is Super Frames Structure, INFO1 and INFO3 in SC1 and SC3 frames transmit Free Repeater information, and INFO2 and INFO4 in SC2 and SC4 transmit Go to Repeater information. Note that during Hold Time of voice call or in Data Call, SCCH is non Super Frames Structure; therefore, Free Repeater and Go to Repeater should be transmitted by only INFO4 in SCn frame. The distribution method is same as the pattern in voice call. When transmitting Free Repeater information by INFO4, it is distinguished from Go to Repeater information by replacing GID to 2044. Regardless of the example shown in Figure 8.4-1, when a new call request is started, Go to Repeater information should be transmitted on a priority basis.

8.5. Method to select Free Repeater Information

As shown in Figure 8.4-1, TR transmits Free Repeater information, but it doesn't specify the detail of procedure to select Free Repeater information. When there are several unused TR, same TR doesn't transmit continuously, but several TRs must take it in turns to transmit.

If there are several pieces of Free Repeater information acquired by SU just before transmission, selection process is unspecified.

8.5.1. Operation of Home Repeater

Home Repeater is not necessarily required to be selected even though the channel frequency of the Home Repeater is Free mode for communication. However, in case that the channel frequency of Home Repeater is Free(idle for communication), and Traffic is in use, a message that includes Go to Repeater information has to be transmitted from Home Repeater.

8.5.2. Operation of Collect Repeater

As a Free repeater that Collect Repeater selects during transmission, 2nd Collect Repeater should be selected as a highest priority. As a Free Repeater that 2nd Collect Repeater selects during transmission, Collect Repeater should be selected as a lowest priority.

9. Registration

This chapter describes the procedure for SU and TC about the Registration process upon the detection of a valid control channel.
The main purpose of Registration is to provide service access only to a valid SU.
The second purpose of Registration is to record information as to which site in the network controls a SU. This information prevents a TC from searching a SU across the entire network, and can reduce Call Setup time and control channel loads.
There are two ways of registering as follows:

- Registering both SU location and participating group
- Registering SU participating group

Additionally, there is the Registration Clear process for when a SU leaves a registered site and the process for requesting a SU to perform Registration.

9.1. Registration Procedure

This section describes the procedure to register both the location and the group of a SU. A SU shall perform Registration in the following conditions:

a) Power is turned ON.
b) A SU migrates to another site.
c) REG_COMM is received.

In the conditions shown above, if the following conditions are satisfied, a SU can start Registration on a Collect Repeater:

a) RTCH2 with signal strength stronger than a given level is hunted for by the Collect Repeater hunting, and
b) At least one Site ID Message is received, and
c) Its Site Code is identical with either of the registerable systems configured for a SU, and
d) There is Collect Repeater available to send, and
e) Access restriction is not valid in Restriction Information

In the condition of d), When Free Repeater available to send was not acquired after the elapse of a certain period of time, update the site information and go to the next procedure to acquire Collect Repeater.
In the condition of e), if there is access restriction, SU need to do Registration process in accordance with the restriction.

Location Registration sequence is shown in Figure 18.3-1 and Figure 18.3-2 and Figure 18.3-3.

9.1.1. Unit Request

When conditions to do Registration are met, SU should change the channel and transmit CALL_REQ to TR of Free Repeater acquired just before the transmission, then receive CALL_RESP from TR, transmit REG_REQ after link connection is established, and wait for response from TC.

9.1.2. Controller Actions

A TC shall carry out the following as valid replies to REG_REQ from a SU:

a) When permit both location registration and group registration, the TC sends REG_RESP containing Prefix/Unit ID of the SU and Cause for permission.
b) When permit only location registration and reject group registration, the TC sends REG_RESP containing Prefix/Unit ID of the SU and Cause for permission and rejection.
c) When permit only Location registration while group registration is failed, the TC sends REG_RESP containing Prefix/Unit ID of the SU and Cause for permission and failure.
d) When reject, the TC sends REG_RESP containing Prefix/Unit ID of the SU and Cause for rejection.
e) When fail, the TC sends REG_RESP containing Prefix/Unit ID of the SU and Cause for failure.
f) If there was location registration of SU from a system by which System ID is different, transmit Prefix/Unit ID of group SU and REG_RESP including indication of a reason for corresponding to the condition.

9.1.3. Unit Actions

An SU having sent REG_REQ shall carry out the following as valid replies to the messages from a TC:

a) If REG_RESP indicating permission is received:
   i) A SU updates the site information when its location is registered, and
   ii) moves to Home Repeater, and
   iii) proceeds to the idle state.
b) If REG_RESP indicating permission for location registration and reject for group registration is received:
   i) A SU updates information of rejected site, and
   ii) proceeds to Collect Repeater hunt procedure.
c) If REG_RESP indicating permission for location registration and failure for group registration is received:
   i) A SU updates the site information when its location is registered, and
   ii) proceeds to Group Registration process.
d) If REG_RESP indicating rejection is received:
   i) A SU updates information of the rejected site, and
   ii) proceeds to the Collect Repeater hunt procedure.
e) If REG_RESP indicating failure is received:
   i) A SU moves to Home Repeater, and
   ii) proceeds to the idle state, or
   iii) proceeds to Collect Repeater hunt procedure.
f) If REG_RESP from a system by which System ID is different is received:
   i) Update record of a system site by which System ID is different, and
   ii) Go to a process to acquire Collect Repeater.
g) If REG_RESP cannot be received before Ts_ack timer expires:
   i) A SU proceeds to the Collect Repeater hunt procedure.

9.2. Registration Command Procedure

This section describes the process when the TC orders a SU to register. The TC may execute the Registration Command at any time as needed.
The Registration Command sequence is represented in Figure 18.4-1.

9.2.1. Controller Request

TC transmits REG_COMM to TR set as a Home Repeater and wait for response from SU.

9.2.2. Unit Actions

A SU checks for contents of REG_COMM sent by a TC, and the sequence described in Section 9.1 is started if the Prefix/Unit ID match this preconfigured for the SU.

9.3. Registration Clear Procedure

This section describes the procedure when a SU clears registration.
A SU can perform Registration Clear in the following conditions.

a) To turn off the power.
b) To migrate to another site.

Sequence diagram for the Registration Clear procedure is shown in Figure 18.5-1.

9.3.1. Unit Request

When conditions to Clear Registration are met, SU should change the channel and transmit CALL_REQ to TR of Free Repeater acquired just before the transmission, then receive CALL_RESP from TR, transmit REG_C_REQ after link connection is established, and wait for response from TC.

9.3.2. Controller Actions

A TC shall carry out the following as valid responses to REG_C_REQ from a SU.

a) When permit the request, the TC sends REG_C_RESP containing Prefix/Unit ID of the SU and Cause for permission.
b) When reject the request, the TC sends REG_C_RESP containing Prefix/Unit ID of the SU Cause for rejection.
c) When fail, the TC sends REG_C_RESP containing Prefix/Unit ID of the SU and Cause for failure.
d) In a case of system by which System ID is different, Prefix/Unit ID of SU and REG_C_RESP including indication of a reason for corresponding to the condition should be transmitted.

9.3.3. Unit Actions

The SU that sent REG_C_REQ shall carry out the following as valid responses to the messages from a TC:

a) If REG_C_RESP indicating permission is received:
   i) The SU updates the record of the site information for where its location registration is cleared, and
   ii) migrates to another site to perform the location registration.

b) If REG_C_RESP indicating rejection is received:
   i) The SU updates the record of the site information for where its location registration is cleared, and
   ii) migrates to another site to perform the location registration.
c) If REG_C_RESP indicating failure is received:
   i) The SU updates the record of the site information for where its location registration is cleared, and
   ii) migrates to another site to perform the location registration.
d) When receiving REG_C_RESP from a system by which System ID is different:
   i) The SU updates the record of the site information for where its location registration is cleared, and
   ii) migrates to another site to perform the location registration.
e) If REG_C_RESP cannot be received before Ts_ack timer expires:
   i) The SU updates the record of the site information for where its location registration is cleared, and
   ii) migrates to another site to perform the location registration.

9.4. Group Registration Procedure

This section describes the procedure when a SU participates in a group.
By registering the affiliation group in a trunked radio system, a user of SU can make a group call with other units having the same Group ID. A SU performs the group registration in the following conditions. The sequence diagram is shown in Figure 18.6-1 and Figure 18.6-2.

a) A user selects a different Group ID.
b) A Group ID not group-registered is used to transmit.

In the conditions shown above, if the following conditions are satisfied, a SU can start group registration on a Collect Repeater:
a) Group Registration Service is presented in Service Information, and
b) Access restriction is not valid in Restriction Information.

When Group Registration Service is not provided in a), the group registration procedure shall not be required.
When access is restricted in b), a SU shall perform the group registration procedure according to the restriction.

9.4.1. Unit Request

When conditions to do Group Registration are met, SU should change the channel and transmit CALL_REQ to TR of Free Repeater acquired just before the transmission, then receive CALL_RESP from TR, transmit GRP_REG_REQ after link connection is established, and wait for response from TC.

9.4.2. Controller Actions

A TC shall carry out the following as valid responses to GRP_REG_REQ from a SU.

a) When permit, the TC sends GRP_REG_RESP containing Cause for permission.
b) When reject, the TC sends GRP_REG_RESP containing Cause for rejection.
c) When fail, the TC sends GRP_REG_RESP containing Cause for failure.

9.4.3. Unit Actions

A SU having sent GRP_REG_REQ shall carry out the following as valid responses to the messages from a TC:

a) If GRP_REG_RESP indicating the permission is received:
   i) The SU moves to Collect Repeater, and
   ii) proceeds to the idle state.
b) If GRP_REG_RESP indicating the rejection is received:
   i) The SU updates information of the rejected site, and
   ii) proceeds to Collect Repeater hunt procedure.
c) If GRP_REG_RESP indicating the failure is received:
   i) The SU moves to Home Repeater, and
   ii) proceeds to the idle state, or
   iii) proceeds to Collect Repeater hunt procedure.
d) If GRP_REG_RESP cannot be received before Ts_ack timer expires:
   i) The SU proceeds to the Collect Repeater hunt procedure.

9.5. Authentication Procedure during Registration

In Multi Trunked System, if TC（or a devie connected toController) has an authentication processing capability, TC can also conduct Authentication processing for SU under registration processing at the same time.
Figure 18.7-1 and Figure 18.7-2 show a sequence to start Authentication processing during Registration processing.

9.5.1. Controller Inquiry

The inquiring TC sends back AUTH_INQ_REQ on a Collect Repeater to start the authentication process by the SU which sent REG_REQ.

9.5.2. Controller Actions

A TC shall carry out the following operations as valid responses to the message from a SU:

a) If AUTH_INQ_RESP is received and the Authentication Value of the SU is qualified:
   i) The TC carries out the operation for REG_REQ and sends back REG_RESP according to the Registration procedure described in Section 9.1.
b) If AUTH_INQ_RESP is received and the Authentication Value of the SU is disqualified:
   i) The TC sends back REG_RESP which includes Cause for the rejection.
c) If AUTH_INQ_RESP cannot be received before Tr_ask timer expires:
   ii) The TC sends back REG_RESP which includes Cause for the failure.

9.5.3. Unit Actions

A SU having sent REG_REQ shall carry out the following operations as valid responses to the messages from a TC:

a) If AUTH_INQ_REQ that includes SU’s Prefix/Unit ID as Destination Prefix/Unit ID is received:
   i) The SU calculates Authentication Value using Authentication Parameter, and
   ii) sends back AUTH_INQ_RESP embedding the calculated vale.
   iii) If any valid REG_RESP cannot be received before the Ts_ack timer expires
   iv) the SU proceeds to Collect Repeater hunt procedure.

b) If REG_RESP with includes SU's Prefix/Unit ID as Destination Prefix/Unit ID is received, the Registration procedure described in Section 9.1.
c) If AUTH_INQ_REQ or AUTH_INQ_RESP cannot be received before Ts_timer expires:
   i) The SU proceeds to Collect Repeater hunt procedure.

9.6. Data Write Procedure during Registration

In Multi Trunked System, TC (or a device connected to Controller) can transmit data such as channel information of a site to SU processing Registration.
Figure 18.9-1 and Figure 18.9-2 show a sequence to start data transmission during Registration processing.

9.6.1. Controller Inquiry

After TC transmits REG_REQ to SU, TC sends DWR (Header) on Collect Repeater so that SU will start data transmission processing.

9.6.2. Controller Actions

A TC shall carry out the following operations as valid responses to the message from a SU:
a) If it is judged that SU received the message correctly by receiving DWR_ACK,
   i) The TC carries out the operation for REG_REQ and sends back REG_RESP according to the Registration procedure described in Section 9.1.
b) If DWR_ACK cannot be received before Tr_ask timer expires:
   i) The TC sends back REG_RESP which includes Cause for the failure.

9.6.3. Unit Actions

A SU having sent REG_REQ shall carry out the following operations as valid responses to the messages from a TC:

a) If REG_RESP indicating permission is received:
   i) A SU updates the site information when its location is registered, and
   ii) moves to Home Repeater, and
   iii) proceeds to the idle state.
b) If REG_RESP indicating permission for location registration and reject for group registration is received:
   i) A SU updates information of rejected site, and
   ii) proceeds to Collect Repeater hunt procedure.
c) If REG_RESP indicating permission for location registration and failure for group registration is received:
   i) A SU updates the site information when its location is registered, and
   ii) proceeds to Group Registration process.
d) If REG_RESP indicating rejection is received:
   i) A SU updates information of the rejected site, and
   ii) proceeds to Collect Repeater hunt procedure.
e) If REG_RESP indicating failure is received:
   i) SU proceeds to the idle state, or
   ii) proceeds to the Traffic channel hunt procedure.
f) If REG_RESP from a system by which System ID is different is received:
   i) Update record of a system site by which System ID is different, and
   ii) Go to a process to acquire Collect Repeater.
g) If REG_RESP cannot be received before Ts_ack timer expires:
   i) A SU proceeds to the Collect Repeater hunt procedure.

10. Authentication Procedure

This chapter outlines the authentication procedure and its operational procedure. Trunked System has following two types of authentication procedures to correspond to different cases.

- When TR does authentication processing for SU
- When SU does authentication processing for other SU

10.1. Layer for Authentication

Authentication is a function to confirm the validity of a SU that is requesting to connect to the system. An authenticating side equipped with an authentication facility checks for a response from the SU as an authenticated side and confirms the validity. The authentication facility may be installed in a SU, TRS or a console connected to these and is not specified in this document.

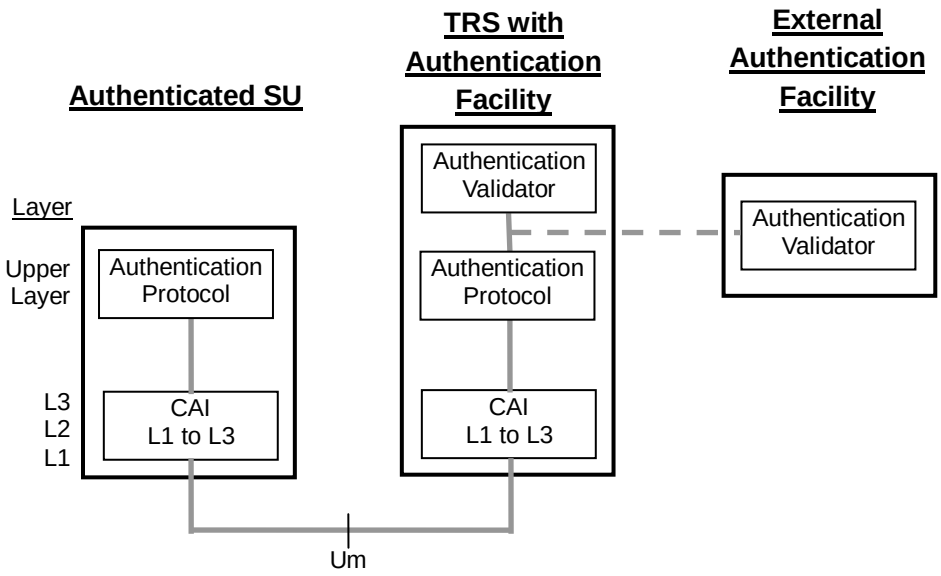


Figure 10.1-1 Layer for Authentication Protocol

10.2. Authentication Protocol

A block diagram of the authentication process is presented in Figure 10.2-1. The following information elements are used in the authentication process:

ESN (48-bit length)
Authentication Parameter (16-bit length)
Authentication Value (56-bit length)

The authentication facility generates the Authentication Parameter using the Authentication Parameter Generator and sends it to an authenticated SU. The Authentication Parameter is also stored in the authentication facility. An authenticated SU calculates the Authentication Value using the Authentication Value Encoder from the received Authentication Parameter and the prestored ESN, and sends back the value to the authentication facility. The authentication facility extracts an ESN of the authenticated SU from the received Authentication Value and the stored Authentication Parameter, and

confirms the validity of the authenticated SU based on whether the extracted ESN exists in the valid ESN database stored in the authentication facility.

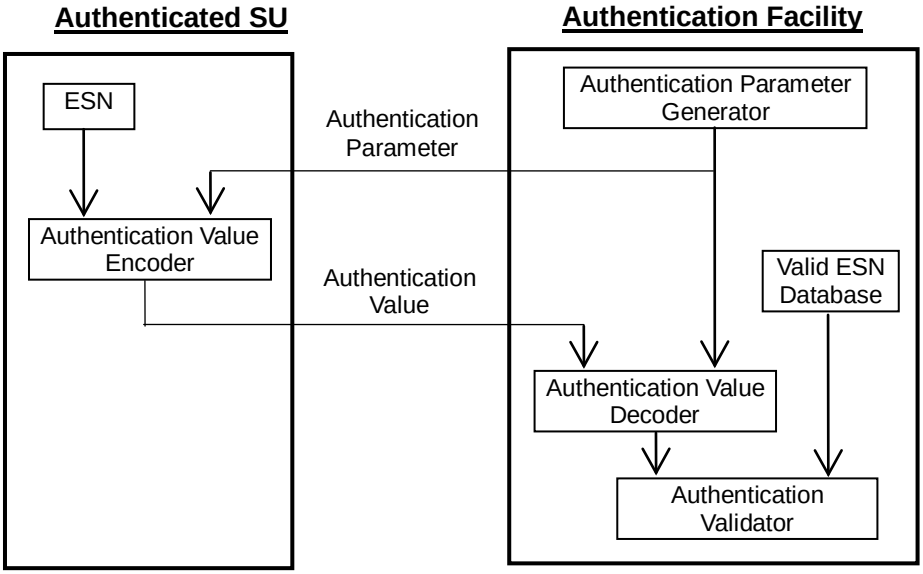


Figure 10.2-1 Block Diagram for Authentication

10.3. Cryptography Technique

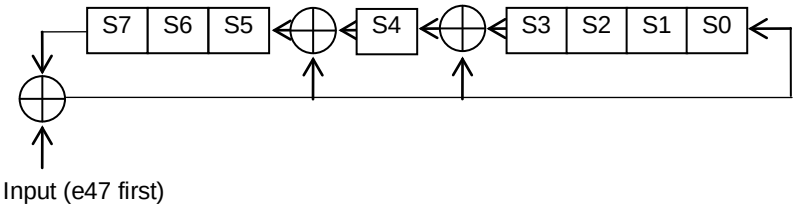
This section describes the cryptography technique used in the authentication process.

10.3.1. Authentication Parameter Generator

Authentication Parameter is 16-bit length, and the generation method of its bit sequence is not specified in this document. Any bit sequence other than all zero can be used, and the bit sequence shall be random and different each time it is generated.

10.3.2. Authentication Value Encoder/Decoder

This section describes the encoding procedure to obtain the Authentication Value. 8-bit parity is calculated using the polynomial $G(x) = X^8 + X^5 + X^4 + 1$ from a 48-bit ESN to build a 56-bit data sequence. Figure 10.3-1 shows the parity calculation using the shift register and the bit allocation. The default values of the all shift register are set to 1.



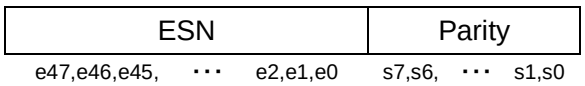


Figure 10.3-1 Parity Calculation and Bit Allocation

The Authentication Value is obtained by a bit scramble processing using an exclusive-or operation among the 56-bit data sequence and the data sequence of a polynomial P(x). Figure 10.3-2 shows the bit scramble processing.

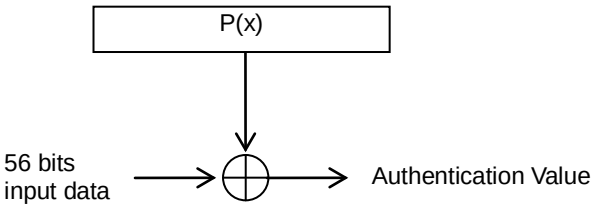


Figure 10.3-2 Scramble Method

10.4. ESN Validation

ESN Validation function is designed to check whether or not an ESN allocated to SU is valid, in order to prevent invalid use of Trunked System.
As an example, in case in which an ESN received from Authentication Inquiry by Trunking Repeater is invalid, to issue notification for rejection by sending a Cause(VD) message included in CALL_CONN_RESP and not to send CALL_RESP.
SU receives no CALL_RESP message that is echoed back from TR, therefore link connection will not be established.
SU executes the operation based on the procedure shown in Cause(VD). The details of the operation will not be described.
Furthermore, in Multi Trunked System, Registration for an invalid ESN can be rejected via Authentication Procedure during Registration.

10.5. Authentication Inquiry by Trunking Repeater

If TR (or device connected to TR) has a capability of authentication, TR can authenticate SU. Figure 18.8-1 shows a sequence of TR to start authentication.

10.5.1. Controller Inquiry

Inquiring TR transmits AUTH_INQ_REQ to make SU start authentication.

10.5.2. Controller Actions

TR performs the following operation as valid response to the message sent through SU.

a) When receiving AUTH_INQ_RESP
   1) Transfer Authentication Value of SU to authentication device.
   2) Validity judgment is depending on the system and following operation is not specified.
b) It is possible to set an arbitrary timer. If AUTH_INQ_RESP cannot be received within the time,
   1) Following operation is depending on the system and not specified.

10.5.3. Unit Actions

Standing-by SU performs the following operations when its Unit ID and Unit ID in AUTH_INQ_REQ match,

a) When receiving AUTH_INQ_REQ with matching Destination Unit ID
   1) Using Authentication Parameter, calculate Authentication Value,
   2) Send AUTH_INQ_RESP embedding the calculation result,
   3) Go back to Stand-by state.

11. Voice Call Operation

This section provides the overview of the methods to transmit a function CH from Transmission SU and to determine a function CH at receiving SU in Voice call.

11.1. Super Frames Structure

In other types of communication than Voice call, there is no need to considered Super Frames Structure. But for Voice call, two types of structures should be considered; Non Super Frames Structure and Super Frames Structure.
When performing voice call, initial frame and final frame that are transmitted after link operation and link establishment have Non Super Frames Structure. On the other hand, regular transmission basically has Super Frames Structure, which consists of four frames.

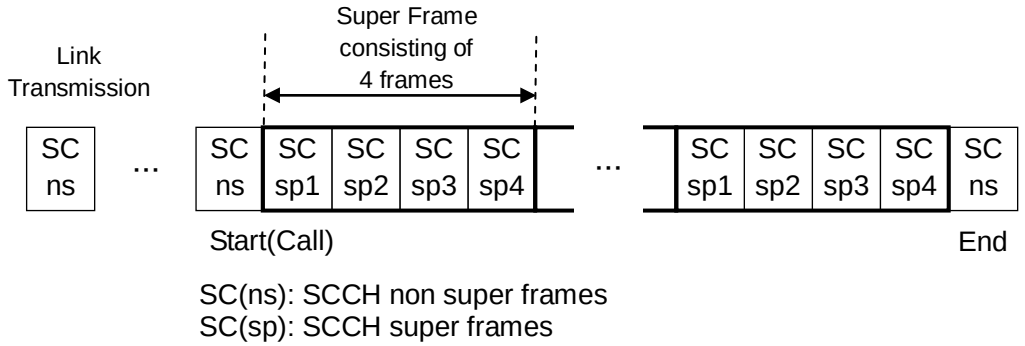


Figure 11.1-1 Frames Structure for Voice Call

Only SCCH has Super Frames Structure. There is no need to consider Super Frames Structure when sending some layer 3 messages at FACCH1 by stealing VCH during voice call. It's possible to use FACCH1 with arbitrary single or continuous frames.
During regular voice call, INFO1 through INFO4 messages are embedded in SCCH. However when changing to other message during Repeater operation of TR, it has to change while maintaining Super Frames Structure.

There are three exceptional situations for Super Frames Structure. First exceptional case is response processing for Status call or Simultaneous Data communication during voice call. There are two situations that voice call is received with Status call or Simultaneous Data communication at the same time and response is made for them.

- User pushes PTT and starts to transmit Talkback, and response at the same time.
- Without performing Talkback, only response is made.

Because the first case is performing a voice call, it applies Super Frames Structure after link establishment.
The second case is not performing voice call, and exception is applied to this case. Figure 11.1-2 shows the Frames Structure for this case. After link establishment, it doesn't use Super Frames Structure. The frames consist of only two frames; Initial frame and final frame of Non Super Frames Structure. It is prohibited to continue Non Super Frames Structure more than three frames except the following two cases and the third case.

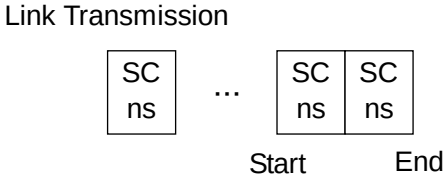


Figure 11.1-2 Super Frames Structure Exception 1

The second exception of Super Frames Structure is transmitting period without voice call, such as Hold Time period during repeater operation and Go to Repeater transmission period, when a repeating SU finishes communication and other SU with the same Home Repeater ID is communicating through other TR. In these periods, continuous transmission is possible by Non Super Frames Structure without restriction.

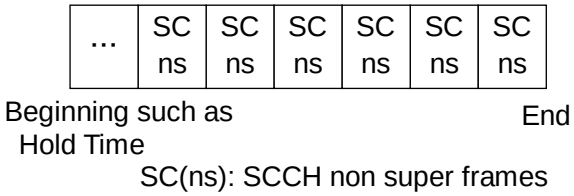


Figure 11.1-3 Super Frames Structure Exception 2

The third exception of Super Frames Structure is a period that TR transmits CALL_RESP message in response to CALL_REQ message from SU. During the period between link establishment of SU and restarting transmission, continuous transmission is possible by Non Super Frames Structure.

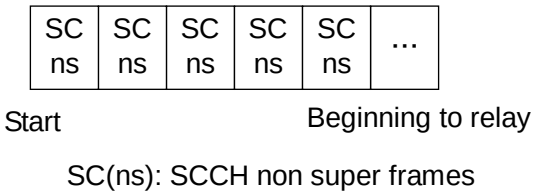


Figure 11.1-4 Super Frames Structure Exception 3

11.2. Late Entry

A TRS shall perform a process that a SU can join in a late entry while a traffic channel is in use.

Late entry in a trunked radio system has two kind of meaning. Late entry basically means participating in an ongoing call like a late entry in a conventional system, however, there is a case of the meaning of notification of Unit ID or Group ID currently used at a traffic channel.

Late entry for participation to an ongoing call can work only in voice calls as well as a conventional system even if a trunked radio system. In case of data calls, since Header information including ID information can not be received in a late entry situation, the late entry operation in data calls is not guaranteed.

After a calling SU has established a link connection, in the case in which a Called SU cannot receive any messages properly via the first frame, and moves into a Late Entry mode, a SCCH has to be received through a plurality of frames as a Layer 3 Message can only be included in a SCCH. A SCCH that includes data may vary with the timing at which data is received, though, that will be enough each of INFO1 to INFO4 information will be appropriately received.
Downlink signals of INFO1 and INFO3 include Free Repeater information, and the immediately preceding information is required to be updated and stored.

11.3. Conference Group Call Procedure

The procedure by which a SU calls the Group will be explained. A sequence diagram is shown in Figure 18.11-1.

11.3.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits voice data(VCH) to TR after sending VCALL.

11.3.2. Controller Actions

TC executes the following operation.

a) TC relays VCALL and voice data from SU.
b) When TC has received TX_REL/EOT from the Calling SU, it terminates the relay transmission procedure.

11.3.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL/EOT when the PTT switch is turned OFF, and;
b) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately and;
c) becomes an idle mode.
d) When Called Unit has received TX_REL/EOT,
e) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
f) becomes an idle mode.

11.4. Broadcast Group Call Procedure

The procedure by which a SU performs One-Way Broadcast Speaker Call to a group of cell will be explained. In Broadcast Speaker Call, no terminal devices except Initiator SU is allowed to transmit a message, and when the transmission has ended, immediately log off the communication channel to terminate the service. A sequence diagram is the same as shown in Figure 18.11-1.

11.4.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits voice data(VCH) to TR after sending VCALL.

11.4.2. Controller Actions

TC executes the following operation.

a) TC relays VCALL and voice data from SU.
b) When TC has received TX_REL/EOT from the Calling SU, it terminates the relay transmission procedure.

11.4.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL/EOT when the PTT switch is turned OFF, and;
b) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately and;
c) becomes an idle mode.
d) When Called Unit has received TX_REL/EOT,
e) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
f) becomes an idle mode.

11.5. Individual Call Procedure

The procedure in which SU calls another SU will be explained. A sequence diagram for Transmission Trunking Mode is shown in Figure 18.12-1. Configuration method for Message Trunking Mode shall be properly designed by manufacturer. One explanatory example will be shown in section 19.9.

11.5.1. Transmission Trunking Mode

The procedure of implementing the Transmission Trunking Mode will be explained.

11.5.1.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits vocal data (VCH) to TC after sending VCALL.

11.5.1.2. Controller Actions

TC executes the following operation.

a) TC relays VCALL and voice data from SU.
b) When TC has received TX_REL/EOT from the Calling SU, it terminates the relay transmission procedure.

11.5.1.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL/EOT when the PTT switch is turned OFF, and;
b) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately and;
c) becomes an idle mode.
d) When Called Unit has received TX_REL/EOT,
e) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
f) becomes an idle mode.

11.6. Emergency Call Procedure

User can inform the dispatcher of emergency status.
Emergency Call is a peculiar type of Voice Call, and the sequence of its procedure is basically the same as Voice Call. The differences are as follows.

a) Use the value representing a predetermined Emergency as Voice Call description.

11.7. Unit to PSTN Call Procedure

The procedure in which SU calls PSTN will be explained. The procedural steps to follow in establishing connection with PSTN are out of description of this specification(s). A sequence diagram is shown in Figure 18.13-1 and Figure 18.13-2.

11.7.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits VCALL_REQ to TC.

11.7.2. Controller Actions

TC performs the following operations in response to the VCALL_REQ message that SU has transmitted.

a) send a VCALL_ASSGN message which instructs allocation of communication CH.

11.7.3. Unit Actions

SU that has transmitted a VCALL_REQ message or SU in a standby mode perform the following operations in response to the VCALL_REQ message that TC has transmitted.

a) When a VCALL_ASSGN message has been received,
   i) proceeds to the process of confirming the validity of a transmitted message.

11.8. PSTN to unit Call Procedure

The procedure in which PSTN calls a specified Unit will be explained. A sequence diagram is shown in Figure 18.14-1and Figure 18.14-2.

11.8.1. Controller Actions

Suppose that TC has received a call from PSTN. In this case, TC executes the following operation.

b) When a VCALL_ASSGN massage has been received,
   i) proceeds to the process of confirming the validity of a transmitted message.

11.9. Talk Around Operation

This section explains how Transmission SU transmits function CH during direct communication between SUs using Talk Around function. Reception of SU is same as regular reception of TR.

Because Talk Around function temporarily uses outbound frequency to transmit when SU is outside of TRS area. Talk Around function is limited to Single Trunked System.

11.9.1. Transmission Operation

Based on the regular Voice Call procedure in Figure 7.2-1, operation to send messages is shown in Figure 11.9-1. In Figure 11.9-1, it becomes the operation to which the link connection processing procedure with TR was abbreviated.

PTT	TX		Channel	Description
		1)		PTT was pushed
		2)		Start transmission
		3)	Preamble	After a transmission starts, prescribed Preamble is transmitted
			LICH	RTCH2 / Single-SC / First half FA1 / Second half FA1 /Inbound
		4)	SCCH	INFO4
			FACCH1	VCALL
			FACCH1	VCALL
			LICH	RTCH2 / Multi-SC / First half VCH / Second half VCH /Inbound
		5)	SCCH	INFO1 (1/4)
			VCH 1/2	Voice Data
			VCH 3/4	Voice Data
			LICH	RTCH2 / Multi-SC / First half VCH / Second half VCH /Inbound
		6)	SCCH	INFO2 (2/4)
			VCH 1/2	Voice Data
			VCH 3/4	Voice Data
			LICH	RTCH2 / Multi-SC / First half VCH / Second half VCH /Inbound
		7)	SCCH	INFO3 (3/4)
			VCH 1/2	Voice Data
			VCH 3/4	Voice Data
			LICH	RTCH2 / Multi-SC / First half VCH / Second half VCH /Inbound
		8)	SCCH	INFO4 (4/4)
			VCH 1/2	Voice Data
			VCH 3/4	Voice Data
			LICH	RTCH2 / Multi-SC / First half VCH / Second half VCH /Inbound
		9)	SCCH	INFO1 (1/4)
			VCH 1/2	Voice Data
			VCH 3/4	Voice Data
			LICH	RTCH2 / Single-SC / First half FA1 / Second half FA1 /Inbound
		10)	SCCH	INFO4 (EOT)
			FACCH1	TX_REL
			FACCH1	TX_REL
		11)		Finish transmission

Figure 11.9-1 Voice Call Transmission on Talk Around

1) User pushes PTT of SU and start voice call operation.
2) When SU cannot receive signals from Home Repeater, it will change the frequency to outbound channel of Home Repeater TR and start transmission.
3) After a transmission starts, prescribed Preamble is transmitted.
4) The First Frame uses a single SCCH (Non Super Frames) and two FACCH1. INFO4 message is transmitted through SCCH and VCALL messages is transmitted though FACCH1, using at least one of FACCH1. This frame transmits single SCCH, and both first and second half are FACCH1. Because it is transmission through RTCH2, Bit setting for LICH needs to be configured accordingly.
5) The Second Frame transmits ISM message using four SCCH (Super Frame).
   In this Frame, INFO1, meaning the first, is transmitted. It is using VCH to transmit voice data, which is in the regular state. Because this Frame transmits through SCCH in Super Frames Structure, and all becomes VCH, Bit setting for LICH needs to be configured accordingly.
6) The Third Frame continues to be in the regular voice call state following the previous Frame. And INFO2, meaning the second is transmitted.
7) The Fourth Frame is in the regular voice call state and INFO3, meaning the third is transmitted.
8) The Fifth Frame is in the regular voice call state and INFO4, meaning the fourth is transmitted.
9) The Sixth Frame is in the regular voice call state and same as 8), INFO1, meaning the first is transmitted. At this time, it is considered that user releases PTT.
10) The Seventh Frame uses single SCCH (Non Super Frames) to indicate the end of transmission. In SCCH, EOT message is transmitted by using INFO4, and in FACCH1, TX_REL message meaning the end of transmission is transmitted by using at least one FACCH1. The reception side processes the end of reception by receiving TX_REL.
    Because this frame transmits single SCCH, and both first and second half are FACCH1, Bit setting for LICH needs to be configured to correspond to it. Super Frames send in the situation 12) is not completed yet, but it is OK to switch the structure of SCCH and send the final Frame containing TX_REL. Here, TX_REL is sent in the Frame, which was a subsequent Frame when PTT was released. But if there is remaining data, it is OK to send TX_REL after completing all Vocoder data transmission.
11) After having sent a last frame including TX_REL, the transmission is stopped.

12. Packet Data Transmission

This Chapter explains method of data packetization, method of sequence synchronization, and method of retry control when transmitting user data information by Data Call procedure.
Link connection operation between System Data Call and TR is omitted in this explanation.
When transmission is repeated in the short time, such as for automatic acknowledgement, it is possible to omit link connection by keeping traffic channel at TR for preset Hold Time by holding EOT transmission through SCCH as optional function of SU. But details of this operation are not specified.

12.1. Type of Data Call

There are four types of Data Call for NXDN : System Data Call, Data Call, Short Data Call, and Simultaneous Data Call.

System Data Call

System Data Call is a Data Call between TC and SU on traffic channel. It can transmit system data limited no greater than 65534 bits per message.
This call uses FACCH3 as function CH, and DWR and DWR_ACK as layer 3 messages.

Data Call

Data Call is a high-speed data communication on traffic channel and it can transmit user data without restriction.
This call uses UDCH2 as function CH, and DCALL and DCALL_ACK as layer 3 messages.

Short Data Call

Short Data Call is a data communication on traffic channel.
In this call, user data limited to no greater than 100 bits can be transmitted.
This call uses FACCH1 as function CH, and SDCALL_REQ and SDCALL_RESP as layer 3 messages.

Simultaneous Data Call

Simultaneous Data Call is a low-speed data communication, which is simultaneously transmitted with voice call on traffic channel. Because it is transmitted at the same time with voice call, in this communication, user data is limited to no greater than 100 bits, which is about the same as short Data Call.
This call also uses FACCH1 as function CH, and SDCALL_REQ and SDCALL_RESP as layer 3 messages.

12.2. Concept of Data Partitioning

Figure 12.2-1 shows a Concept of Data Partitioning of User Data to sent user data to each function CH.

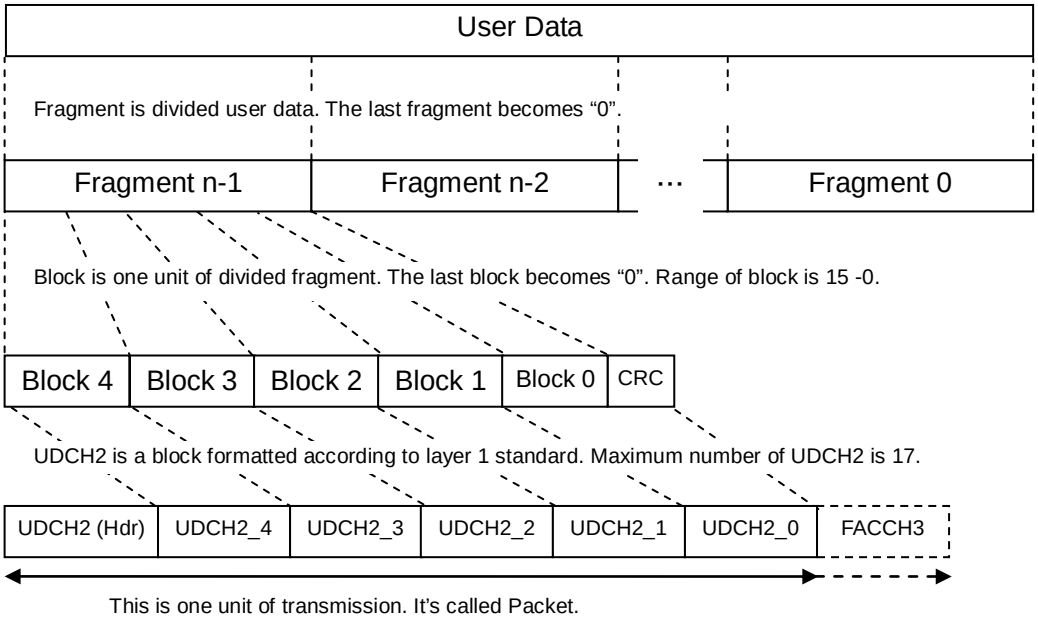


Figure 12.2-1 Concept of Data Partitioning

Figure 12.2-1 describes the method of User Data division to transmit one fragment using five UDCH2 as a function channel. FACCH3 becomes the same the method of User Data division. However, FACCH1 can use only one fragment.
Divided user data to transmit is called fragment, and divided fragment in units of function channel is called block. Because a block is divided user data by each function CH, function channels of block and UDCH2 have the same meaning. One transmission is called packet, and user data sent in one transmission is one fragment. Therefore, fragment and packet is same thing.

Due to possible range of “Block Count” in Header part, maximum of 17 UDCH2 can be sent in one transmission. The block which a fragment is divided into is up to 16, and one header part block is added to them. Therefore, total block is 17 at a maximum. The initial frame of transmission uses DCALL message (Header format) including Header part, and this message doesn’t contain user data. Other frames than the initial frame mainly uses DCALL message (User Data format), which is consisting of User Data part, and this message can contain 18 bits user data. The last block contains 4 bits Message CRC, therefore one fragment becomes 284 bits at maximum and all user data will be transmitted by using multiple fragments.
By sending TX_REL message using FACCH3 in the last frame of transmission, transmission of one packet is completed. Regarding TX_REL by FACCH3, it can be send by using two FACCH1.

Considering traffic volume on traffic channel, Short Data Call using FACCH1 can transmit at a maximum of 100 bits User Data as a basic specification. This can be changed for each system. In inbound transmission from SU, the initial frame of transmission uses

SDCALL_REQ message (Header format) including Header part, and this message doesn't contain user data. Other frames than the initial frame mainly uses SDCALL_REQ message (User Data format), which is consisting of User Data part, and this message can contain 8 bits user data. The last block contains 4 bits Message CRC, therefore one fragment becomes 124 bits at maximum and User Data will be transmitted by using only one fragment.
Because User Data should be 100 bits at a maximum as a basic specification, it is recommended that maximum FACCH1 (100 bits User Data) should be limited to 14.

Simultaneous Data Call is also using FACCH1, and it is same as Short Data Call.

12.3. Synchronization of Fragments

To divide User Data into multiple fragments, information elements of "TX Fragment Count", "Start Fragment Flag", and "Circular Fragment Flag" are used. By using these three information elements, it can correspond to both formats with limited data length and unlimited data length to transmit.
When sending User Data consisting of multiple fragments, "Start Fragment Flag" is set to "1" in the initial packet. For other packets, it is set to "0". "TX Fragment Count" is indicating an order of fragment, and if "Circular Fragment Flag" is "0", "TX Fragment Count" doesn't circulate and it's possible to construct 512 fragments at a maximum. If "Circular Fragment Flag" is "1", "TX Fragment Count" does circulate, there is no limit for number of fragments. If data length is preset and number of fragments is less than 512, "TX Fragment Count" doesn't need circulate, therefore "Circular Fragment Flag" is configured as "0". If data length is indefinite, number of fragments is unknown in advance, therefore "Circular Fragment Flag" should be configured as "1", which is showing possibility of circulating counter.
If "Circular Fragment Flag" is "0", "TX Fragment Count" is set to (-1 from the number of fragment) for the initial packet, and it is decremented for the following packet, and for the last packet, "TX Fragment Count" will become "0".
If "Circular Fragment Flag" is "1", "TX Fragment Count" is set to 511 for the initial packet, and it is decremented for the following packet. When "TX Fragment Count" becomes "0" for the 512th packet, reset "TX Fragment Count" to 511 for the next packet.
Table 12.3-1 describes setting values of information elements for three conditions: only one fragment is sent, 5 fragments are sent, and unlimited fragments are sent.

Table 12.3-1 Usage of information elements of fragment

Condition	Start Fragment	Circular Fragment	TX Fragment Count
1. only one packet	1	0	0
2. Initial packet of 5 packets	1	0	4
Middle packet of 5 packets	0	0	n (n = 3 to 1)
Last packet to 5 packets	0	0	0
3. Initial packet of indefinite number of packets	1	1	511
Middle packet of indefinite number of packets	0	1	n (n = 511 to 0)

12.3.1. Processing of Confirmed Type Packet

Transmitter embed “TX Fragment Count” (called N(S) for short), which is number of packet, in transmission packet. Receiver embeds “RX Fragment Count” (called N(R) for short), which is the number of last packet received in acknowledge packet.
As internal variables for SU or Repeater, it has variable V(S) and variable V(R) to retain synchronism of packet.

When data length is fixed and number of packets to send is known in advance, in other words, when “Circular Fragment Flag” is “0” is described below. First, transmitter saves the value of (number of packet -1) to V(S), and set N(S) same as V(S), then transmit the first packet.
When it’s ready to transmit next packet, decrement V(S) and set N(S) same as V(S), then transmit the next packet. The last packet becomes V(S) = N(S) = 0.
Receiver saves received N(S) to V(R), then set N(R) same as V(R) before returning acknowledge packet.

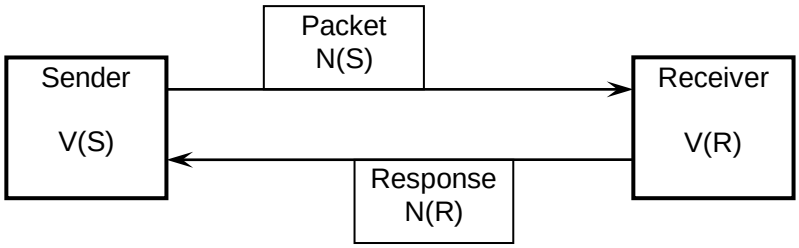


Figure 12.3-1 Conceptual diagram of packet synchronism

In the state that Transmitter send the latest packet, it is V(S) = N(S). When it’s ready to transmit new packet, decrement V(S). But it Transmitter cannot receive Response Packet from Receiver and retry the transmission, V(S) is not decremented but use the same value.

12.3.2. Retry indication for packet

To distinguish if it is a packet with complete data or packet with partial data for selective retry, “Selective Retry Flag” is used.
Table 12.3-2 describes how to configure flags for different conditions.

Table 12.3-2 Setting of Selective Retry Flag

Condition	Selective Retry Flag
Normal Packet	0
Full Retry Packet	0
Selective Retry Packet	1

12.3.3. Detection of Duplicated Packet

Every time new packet is sent, N(S) is decremented. Receiver can detect overlapped packet by comparing N(S) in received packet and V(R) in memory. When sending ACK Response Packet, by recording N(S) of received packet in V(R), the latest N(S) is saved. When receiving a packet, receiver compares N(S) with variables V(R). The result can be one of the following three statuses.

(1) N(S) = V(R) - 1

This means packets were received in correct order. Receiver save CRC values of arbitrarily more than oneUDCH2, decrement V(R), then return ACK Response Packet, which is N(R) = N(S).

(2) N(S) = V(R)

This means overlapped packets were received. It is caused when packet reception was successful, and receiver returned ACK Response Packet, but Transmitter cannot receive the Response Packet.

To confirm the overlap, compare the CRC value of received packet and saved CRC value of the last received packet. If those values are the same, it is an evidence of overlapped packet. Then receiver should return ACK Response Packet and delete the overlapped packets. If CRC values are different, it might be a case that new session has started and N(S) happens to have the same value accidentally. Therefore a receiver should check other Header information than N(S), and take appropriate action.

(3) N(S) = anything else

This means a new session has started. It happens when reception of packet was successful, and receiver returned ACK acknowledgment packet, but transmitter failed to receive the packet and run out retry opportunities, and discontinued the communication. Receiver should check other Header information than N(S), and take appropriate action.

Figure 12.3-2 describes how “Start Fragment Flag” and N(S) value changes depending on packet transmission status.

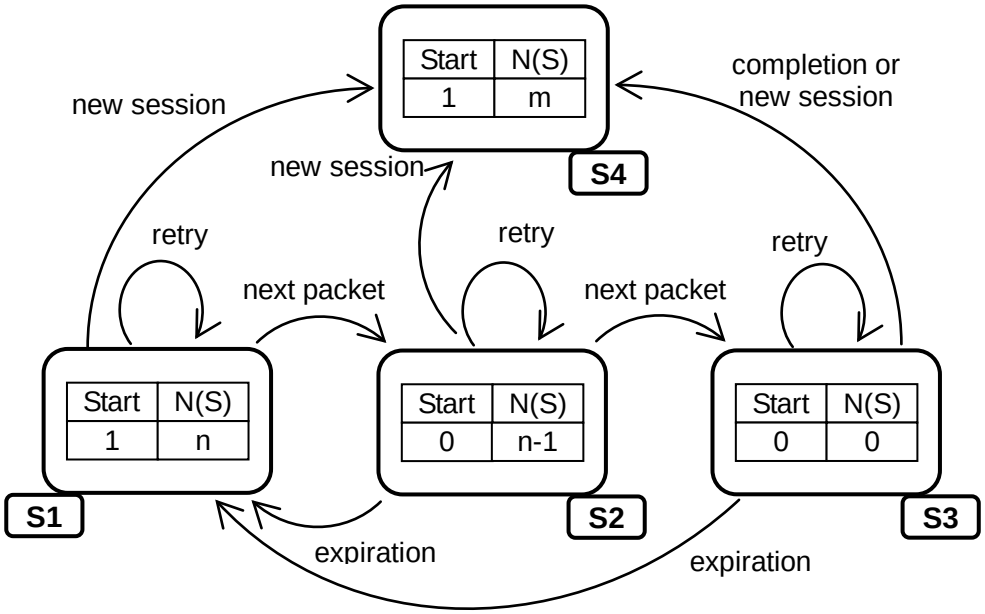


Figure 12.3-2 State transition of transmission packet

Here, Status of S1 to S4 is described below. Note that n and m are arbitrary values.
- S1: Status of sending the initial packet to start Data Call
- S2: Status of sending middle packets
- S3: Status of sending the last packet
- S4: Status of sending the initial packet to start different Data Call than S1.

Start Data Call at the status of S1, and move to the next status S2 when receiving ACK Response Packet. When reception of Response Packet is failed, retry with S1 status.
If retry opportunities are run out with the status of S1, it's possible to repeat S1 or to move to a different session S4. If reception of Response Packet failed with the status of S2 or S3 and retry opportunities are run out, it's possible to go back to the first status S1 or to move to a different session S4. If ACK Response Packet is received with the status of S3, this Data Call session is finished.

12.4. Synchronization of Block

"Block Count", "Block Number" and "Packet Flame Number" are used to confirm number and order of blocks included in a packet between Transmitter and Receiver.
By "Block Count" included in Header part of transmission packet, receiver can judge number of blocks included in one packet. And by "Block Number", which indicates the order of each block consisting fragment, receiver can judge if blocks are received in correct order.
When conducting selective retry, Receiver sends selective retry request in Response Packet and "Error Block Flag" to show block number of failed reception, so that Transmitter can identify which block needs selective retry. Transmitter receiving Response Packet will set "Selective Retry Flag" to "1" in Header part of retry packet, and calculate "Block Count" by number of retry blocks. In other blocks than the initial block,

block number is set in “Block Number” and frame number of retry packet in “Packet Flame Number”. Receiver can synchronize the number and order of blocks between Transmitter and Receiver by judging if Transmitter is conducting selective retry by “Selective Retry Flag”, and confirming the number of “Error Block Flag” specified in Response Packet agrees to “Block Count”, and judging if “Block Number” agrees to the number specified in “Error Block Flag”.

Figure 12.4-1 shows how information elements are configured when sending a packet consisting of five blocks, and the second block (UD2_2) and fourth block (UD2_4) are resend as selective retry. Note that FACCH3 is omitted here.

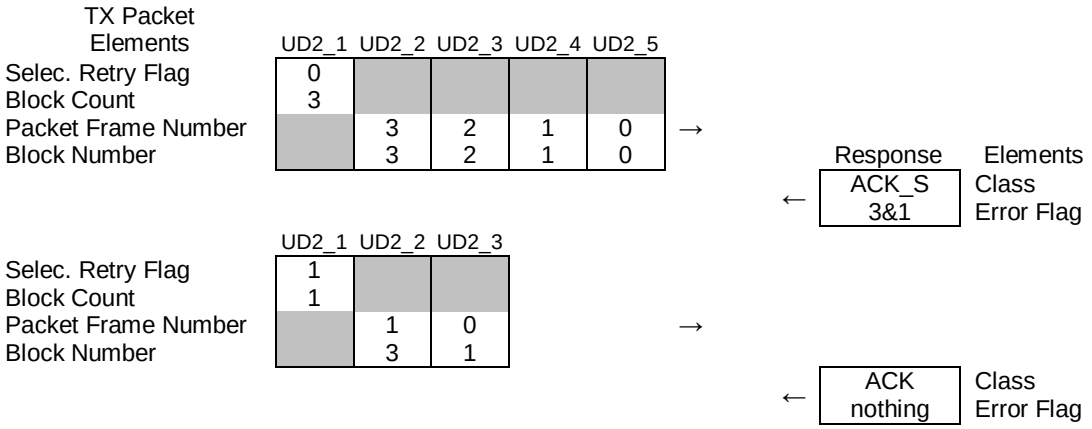


Figure 12.4-1 Information elements configuration for Selective Retry

UDCH2_1 is Header format including Header part, and others are User Data format including User Data parts. In the initial packet transmission, “Selective Retry Flag” is initialized at Header part, and it indicates the packet includes four units of User Data format by "Block Count" indicating that Packet Frame Number starts from 3. When receiving this packet, if there is an error in CRC test of UDCH2_2 and UDCH2_4, receiver should set ACK_S to “Class” and return Response Packet with bits in “Error Block Flag” corresponding to the blocks with error in order to request selective retry. Transmitter judges which block should be sent as retry by “Error Block Flag” in Response Packet, and recalculate “Block Count” from the number of blocks for retry, and create “Selective Retry Flag” and reconstruct Header part. In “Block Number” and “Packet Flame Number” of UDCH2_2 and UDCH2_3, block number and new frame number for retry are configured. Then retry packet is constructed, and selective retry is conducted. After receiver confirms if the number specified in “Error Block Flag” and “Block Number” agree, selective retry processing will be completed by returning ACK Response Packet.

12.5. Procedure of Confirmed Delivery Packet

12.5.1. Transmission Procedure

Following is a procedure of sending one Confirmed Delivery Packet. When exceeding the limit of retry time, or receiving ACK Response Packet, this procedure is completed.
This procedure uses following parameters.

Response Packet Wait Time: T_resp
Number of Retry: N_retry
Maximum Number of Retry: N_retry_max

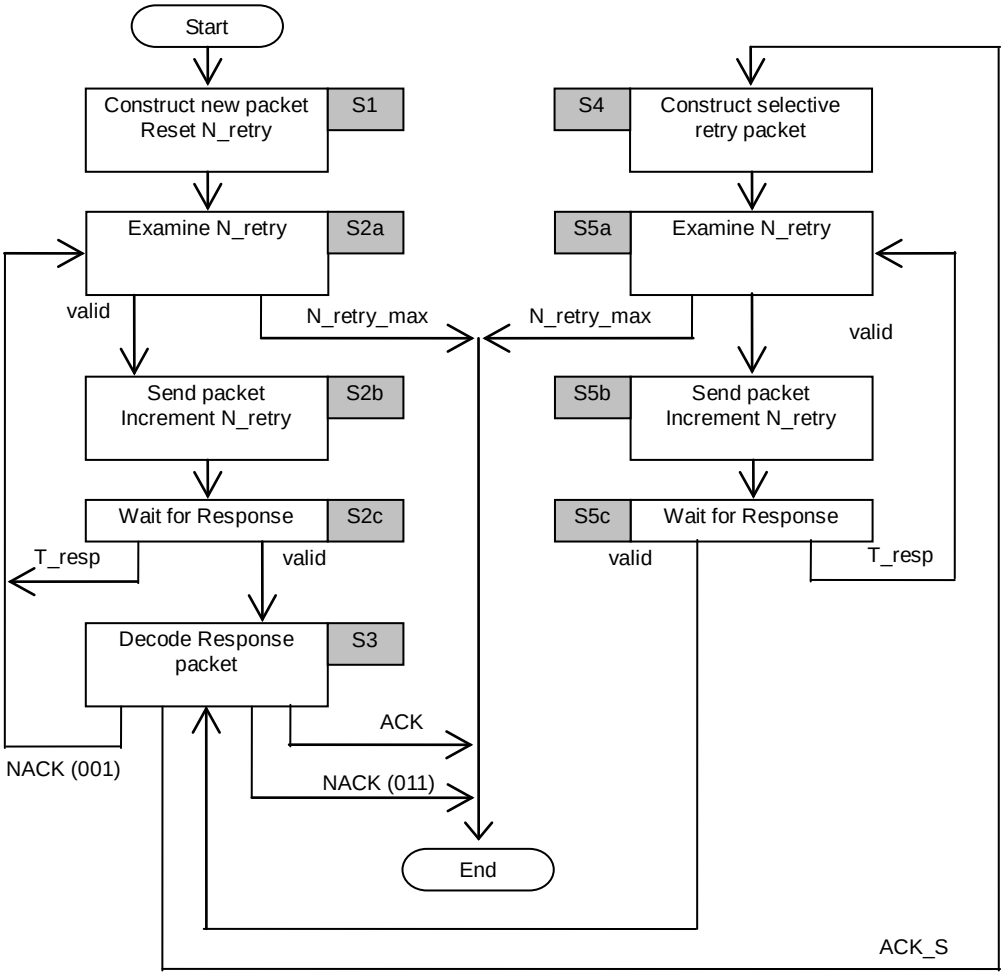


Figure 12.5-1 State diagram of confirmed packet transmission

Step 1. Construction of packet

Step 1.1 Setting N(S)

Configure “Start Fragment Flag” if it is the initial fragment or not. If it is an initial fragment, initialize V(S) according to the number of fragment, and set the number to N(S). If it is not an initial fragment, decrement V(S) and set the number to N(S).

Step 1.2 Addition of Message CRC

Calculate Message CRC from fragment and add it to the last part of fragment. If the fragment with added Message CRC is too short, adjust the length by adding Null Octet.

Step 1.3 Calculating block

Divide a fragment into blocks and calculate the number of blocks. Then put “Block Number” to each block so that the “Block Number” of the last block will be “0”.

Step 1.4 Formatting

Regarding Header format,
Set “Selective Retry Flag” = 0.
Set the value of (block number calculated in Step 1.3)-1 to “Block Count”.
Set “Pad Octet Count” from Null Octet added in Step 1.2.
Regarding User Data format,
Put “Packet Frame Number” and “Block Number” to each block.
According to Layer 3 standard, formatting Header format and User Data format. Then according to layer 1 standard, add CRC data and FEC coding.

Step 1.5 Initialization

Initialize N_retry to “0”

Step 2. The transmission of the first packet

Step 2.1 Transmission

If N_retry = N_retry_max, Finish the procedure. If not, transmit a packet.
Increment N_retry.

Step 2.2 Waiting for acknowledgement

Wait for Response Packet from receiver. Response Packet includes “Class”, “Type”, and “RX Fragment Count” that are values indicating status. Typical values are shown in Table 12.5-1.

Table 12.5-1 Parameter of Response Packet

Class	Type	RX Fragment Count	Contents
00	001	N(R)	ACK: successful reception
01	001	N(R)	ACK_S: needs selective retry
11	001	N(R)	NACK: CRC check failed
11	011	N(R)	NACK: Abort

If T_resp time comes without receiving Response Packet, go back to Step 2.1. If valid Response Packet can be received, go to Step 3.

Step 3. Judgment of Response Packet

Response Packet is processed according to Table 12.5-2.

Table 12.5-2 Judgment of Response Packet

Contents of received Response Packet	Next step
Successful packet reception （single packet）	Finish the procedure
Successful packet reception （multiple packets）	Repeat the same procedure to send the next packet. If it's the final packet, finish the procedure.
CRC check failed	Go back to Step 2.1
Abort	Finish the procedure
Selective retry request	Go to Step 4

Step 4. Construction of selective retry packet

Step 4.1 Judgment of blocks to retry

Read "Error Block Flag" in a Response Packet, and identify "Block Number" to retry.

Step 4.2 Formatting

Regarding Header format,

Set "Selective Retry Flag" = 1.

Recalculate "Block Count" by the number of blocks to retry.

For "Pad Octet Count", regardless of whether Message CRC is included blocks to retry, setting remains the same as Step 1.4.

Regarding User Data format,

Put a new "Packet Frame Number" to each block.

According to Layer 3 standard, formatting Header format and User Data format. Then according to layer 1 standard, add CRC data and FEC coding.

Step 5. Transmission of selective retry packet

Step 5.1 Transmissions

If N_retry = N_retry_max, finish the procedure. If not, transmit a packet.

Increment N_retry.

Step 5.2 Waiting for a response

Wait for a valid response shown in Table 12.5-1. If T_resp time comes without receiving Response Packet, go to Step 5.1. If valid Response Packet can be received, go back to Step 3.

12.5.2. Reception Procedure

This section explains a procedure to follow to receive a Confirmed Delivery Packet. When “Circular Fragment Flag” = 0, there are different procedures for two different cases. One is receiving the initial packet, and the other is receiving other packets than the initial packet. When the following conditions are fulfilled, packet reception processing will start.

When Header format is decoded in a packet and passes CRC check.

For packet reception procedure, following parameter is used.

Waiting time for retry T_retry

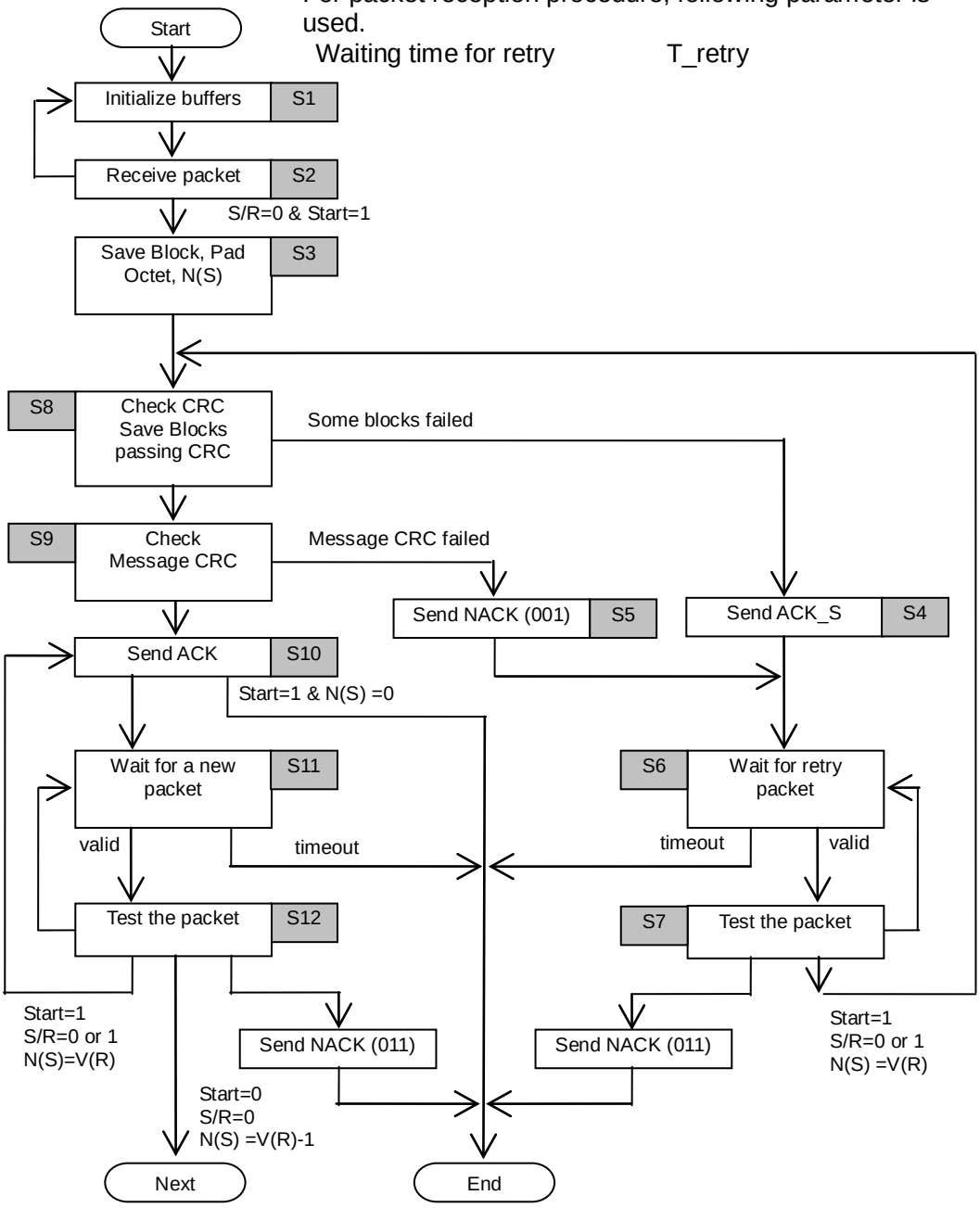


Figure 12.5-2 State Diagram of receiving the initial confirmed packet.

Step 1. Initialization

Initialize the buffer to store packet. Receiver stays in this state until a packet comes.

Step 2. The reception of the first packet

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 0, go to Step 3.

If not, it is invalid packet. So delete the packet and go back to Step 1.

Step 3. Obtaining parameter of a packet

Judge the structure of received packet by “Block Count” and “Pad Octet Count”, and judge the number of packets following the initial packet by “Start Fragment Flag” and “TX Fragment Count” = N(S).

If “Start Fragment Flag” = 1 and N(S) = 0, it is a single packet.

To distinguish the received packet from other packets transmitted later, set variables V(R) as N(S).

Go to Step 8.

Step 4. Selective Retry

Set “Class” = 01, “Type” = 001, and “RX Fragment Count” = N(S). Return ACK_S Response Packet set with “Error Block Flag” to specify “Block Number”, which needs to retry.

Go to Step 6.

Step 5. Full Retry

Set “Class” = 11, “Type” = 001, and “RX Fragment Count” = N(S). Return NACK Response Packet set with all “Error Block Flag”

Go to Step 6.

Step 6. Waiting for retry

Waiting for Transmitter to send a packet again. If T_retry time comes without receiving retry packet, finish the procedure. If valid retry packet can be received, go to Step 7.

Step 7. Retry packet test

Step 7.1 Test after sending ACK_S

Case 1:

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 0 in received packet, and N(S) = V(R), this means the same packets are received. This case applies to when Full Retry was made after Transmitter couldn’t receive ACK_S Response Packet and T_resp time came.

Go to Step 8

Case 2:

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 1 in received packet, and N(S) = V(R), this means expected selective retry packet was received.

Go to Step 8.

Case 3:

When synchronization of counter was lost, or discontinue reception processing, return NACK Response Packet with the setting of “Class” = 11, “Type” = 011, and “RX Fragment Count” = N(S), and finish the procedure.

Case 4:

For cases other than above, go back to Step 6.

Step 7.2 Test after sending NACK(001)

Case 1:

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 0 in received packet and N(S) = V(R), this means expected selective retry packet was received.

Go to Step 8.

Case 2:

When synchronization of counter was lost, or discontinue reception processing, return NACK Response Packet with the setting of “Class” = 11, “Type” = 011, and “RX Fragment Count” = N(S), and finish the procedure.

Case 3:

For cases other than above, go back to Step 6.

Step 8. CRC check and Store the blocks passing CRC

If CRC of User Data format passes, update the buffer for received block according to “Block Number”. Then save “Block Number”, which passed CRC test not to request Selective Retry for these blocks.

If there is at least one block, which didn’t pass CRC, go back to Step 4. If not, go to Step 9.

Step 9. Message CRC Test

If reception of all blocks is successful, test the received packet by checking Message CRC. Go back to Step 5 if it does not pass Message CRC

Otherwise go to Step 10.

Step 10. Return ACK

Return ACK Response Packet with the setting of “Class” = 00, “Type” = 001, and “RX Fragment Count” = N(S).

At Step 3, if “Start Fragment Flag” = 1 and N(S) = 0, which means it is a single packet, finish the procedure. If they are multiple packets, go to Step 11.

Step 11. Waiting for new packet transmission

Wait for a Transmitter to send a next packet. If T_retry time comes without receiving a packet, finish the procedure. If valid packet can be received, go back to Step 12.

Step 12. Test for a new packet.

Case 1:

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 0 in received packet and N(S) = V(R), this means expected selective retry packet was received.

This case applies to when Retry was made after Transmitter couldn’t receive ACK Response Packet and T_resp time came.

Go back to Step 10.

Case 2:

When ACK was sent for received Selective retry packet after Selective Retry was processed, if “Start Fragment Flag” = 1 and “Selective Retry Flag” = 1 in received packet and N(S) = V(R), this means the same Selective retry packet were received. This case applies to when Transmitter couldn’t receive ACK Response Packet and another selective retry was made after T_resp time came.

Go back to Step 10.

Case 3:

If “Start Fragment Flag” = 0 and “Selective Retry Flag” = 0 of received packet and N(S) = V(R) – 1, this means the next expected packet is received.

Go to the procedure to receive non-head packet.

Case 4:

When synchronization of counter was lost, or discontinue reception processing, return NACK Response Packet with the setting of “Class” = 11, “Type” = 011, and “RX Fragment Count” = N(S), and finish the procedure.

Case 5:

For cases other than above, go back to Step 11.

In the following section, the procedure to receive non-head packet is explained.

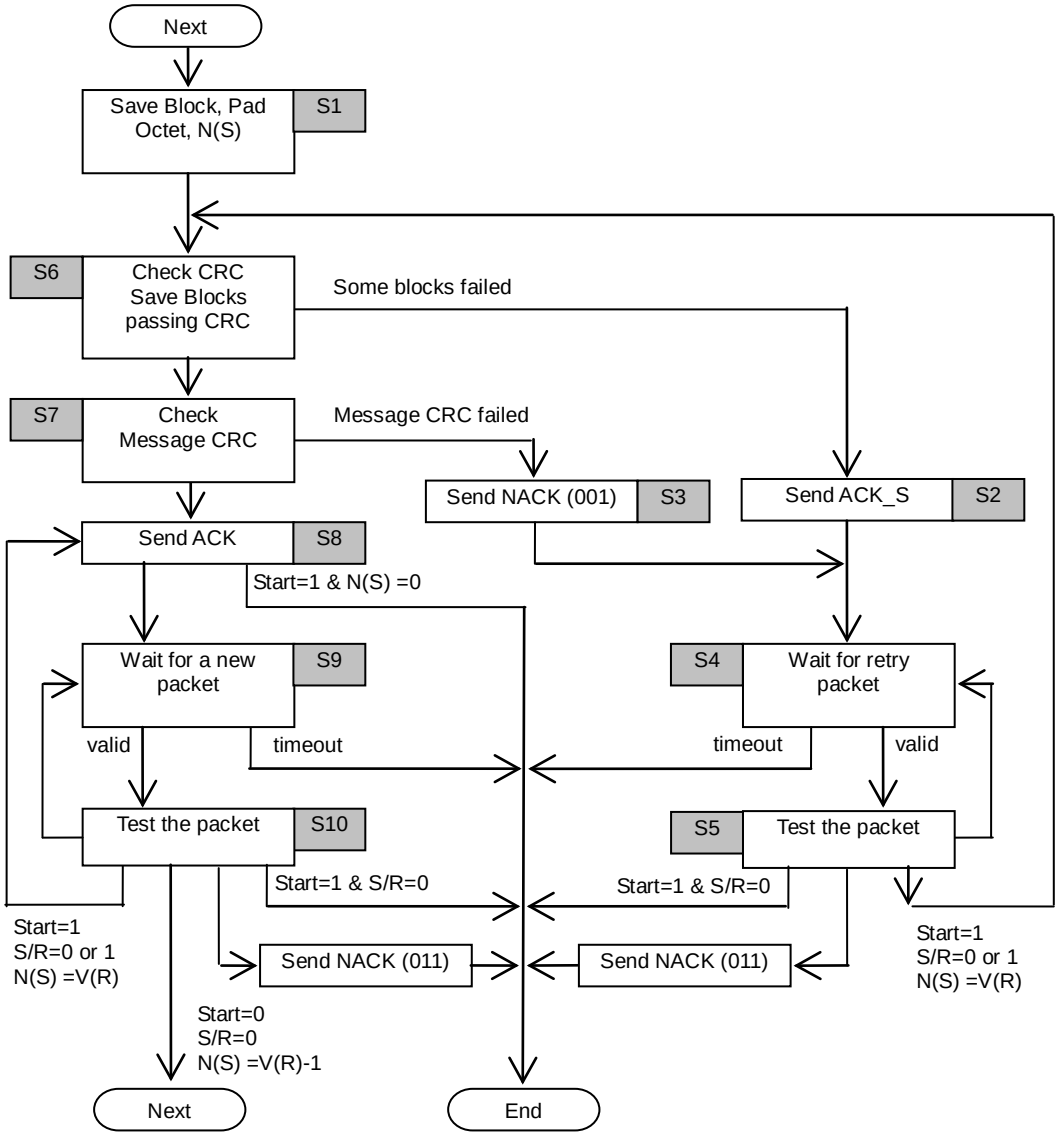


Figure 12.5-3 State Diagram of receiving non-initial confirmed packet.

Step 1. Obtaining parameter of a packet

Judge the structure of received packet by “Block Count” and “Pad Octet Count”, confirm “Start Fragment Flag” = 0 and N(S) = V(R) – 1, and identify they are consecutive packets.

If N(S) = 0, it is considered the final packet of consecutive packets. To distinguish the received packet from other packets transmitted later, set variables V(R) as N(S).

Go to Step 6.

Step 2. Selective Retry

Set “Class” = 01, “Type” = 001, and “RX Fragment Count” = N(S). Return ACK_S Response Packet set with “Error Block Flag” to specify “Block Number”, which needs to retry.

Go to Step 4.

Step 3. Full Retry

Set “Class” = 11, “Type” = 001, and “RX Fragment Count” = N(S). Return NACK Response Packet set with all “Error Block Flag”

Go to Step 4.

Step 4. Waiting for retry

Waiting for Transmitter to send a packet again. If T_retry time comes without receiving retry packet, finish the procedure. If valid retry packet can be received, go to Step 5.

Step 5. Retry packet test

Step 5.1 Test after sending ACK_S

Case 1:

If “Start Fragment Flag” = 0 and “Selective Retry Flag” = 0 in received packet, and N(S) = V(R), this means the same packets are received. This case applies to when Full Retry was made after Transmitter couldn’t receive ACK_S Response Packet and T_resp time came.

Go to Step 6.

Case 2:

If “Start Fragment Flag” = 0 and “Selective Retry Flag” = 1 in received packet, and N(S) = V(R), this means expected selective retry packet was received.

Go to Step 6.

Case 3:

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 0 in received packet, this means a new packet is received.

Finish the procedure and start reception processing of the initial packet again.

Case 4:

When synchronization of counter was lost, or discontinue reception processing, return NACK Response Packet with the setting of “Class” = 11, “Type” = 011, and “RX Fragment Count” = N(S), and finish the procedure.

Case 5:

For cases other than above, go back to Step 4.

Step 5.2 Test after sending NACK(001)

Case 1:

If “Start Fragment Flag” = 0 and “Selective Retry Flag” = 0 in received packet and N(S) = V(R), this means expected selective retry packet was received.

Go to Step 6.

Case 2:

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 0 in received packet, this means a new packet is received.

Finish the procedure and start reception processing of the initial packet again.

Case 3:

When synchronization of counter was lost, or discontinue reception processing, return NACK Response Packet with the setting of “Class” = 11, “Type” = 011, and “RX Fragment Count” = N(S), and finish the procedure.

Case 4:

For cases other than above, go back to Step 4.

Step 6. CRC check and Store the blocks passing CRC

If CRC of User Data format passes, update the buffer for received block according to “Block Number”. Then save “Block Number”, which passed CRC test not to request Selective Retry for these blocks.

If there is at least one block, which didn’t pass CRC, go back to Step 2. If not, go to Step 7.

Step 7. Message CRC Test

If reception of all blocks is successful, test the received packet by checking Message CRC. To request a retry due to failure to pass Message CRC and other reasons, go back to Step 3.
Otherwise go to Step 8.

Step 8. Return ACK

Return ACK Response Packet with the setting of “Class” = 00, “Type” = 001, and “RX Fragment Count” = N(S).
If “Start Fragment Flag” = 0 and N(S) = 0, which means the last packet in Step 1, finish the procedure. If it is a middle packet, go to Step 9.

Step 9. Waiting for new packet transmission

Wait for a Transmitter to send a next packet. If T_retry time comes without receiving a packet, finish the procedure. If valid packet can be received, go back to Step 10.

Step 10. Test for a new packet

Case 1:

If “Start Fragment Flag” = 0 and “Selective Retry Flag” = 0 in received packet and N(S) = V(R), this means expected selective retry packet was received.
This case applies to when Retry was made after Transmitter couldn’t receive ACK Response Packet and T_resp time came.
Go back to Step 8.

Case 2:

When ACK was sent for received Selective retry packet after Selective Retry was processed, if “Start Fragment Flag” = 0 and “Selective Retry Flag” = 1 in received packet and N(S) = V(R), this means the same Selective retry packet were received. This case applies to when Transmitter couldn’t receive ACK Response Packet and another selective retry was made after T_resp time came.
Go back to Step 8.

Case 3:

If “Start Fragment Flag” = 0 and “Selective Retry Flag” = 0 of received packet and N(S) = V(R) – 1, this means the next expected packet is received.
Go back to Step 1 and begin the reception procedure of the non-first packet again.

Case 4:

If “Start Fragment Flag” = 1 and “Selective Retry Flag” = 0 in received packet, this means a new packet is received.
Finish the procedure and start reception processing of the initial packet again.

Case 5:

When synchronization of counter was lost, or discontinue reception processing, return NACK Response Packet with the setting of “Class” = 11, “Type” = 011, and “RX Fragment Count” = N(S), and finish the procedure.

Case 6:

For cases other than above, go back to Step 9.

13. Data Call Operation

The general outlines of procedural steps to follow including data re-transmission, a way for a calling SU to transmit a functional CH, and a way for a called SU to evaluate the validity of the functional CH transmitted from the calling SU will be explained.

13.1. Broadcast Data Call Procedure

The procedure in which SU performs Broadcast Data Call to a group of cell will be explained. A sequence diagram is shown inFigure 18.15-1.

13.1.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits DCALL (Data) to TC after sending “DCALL (Header)”.

13.1.2. Controller Actions

TC executes the following operation.

a) TC relays DCALL (Header) and DCALL(Data) from SU.
b) When TC has received TX_REL/EOT from the Calling SU, it terminates the relay transmission procedure.

13.1.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL/EOT when the communication has ended, and;
b) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately and;
c) becomes an idle mode.
d) When Called Unit has received TX_REL/EOT,
e) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
f) becomes an idle mode.

13.2. Unit to Unit Data Call Procedure

The procedure in which SU performs Unit to Unit Data Call toward another SU will be explained. A sequence diagram is shown in Figure 18.16-1, and Figure 18.16-2.

13.2.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits DCALL (Data) to TC after sending “DCALL (Header)”.

13.2.2. Controller Actions

TC executes the following operation.

a) TC receives and relays DCALL (Header) and DCALL(Data) from SU, and;
b) activates Timer Tr_hold, and then transmits IDLE.
c) When DCALL_ACK message from Called Unit cannot be received within a specified period of time,
    i) Transmits TX_REL/EOT.
d) TC receives and relays DCALL_ACK and TX_REL from Called Unit, and;

e) activates Timer Tr_hold, and then transmits IDLE.
f) When TX_REL/EOT message from Calling Unit cannot be received within a specified period of time,
   i) transmits TX_REL/EOT
g) When TC has received TX_REL/EOT from the Calling Unit, it terminates the relay transmission procedure.

13.2.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL/EOT after the transmission of signal has ended, and;
   i) activates the Timer Ts_ack, and continuously wait to the data that is echoed back from TC.
b) When Called Unit has received a valid signal, it transmits DCALL_ACK and TX_REL.
c) When Calling Unit receives no response allowing communication within a specified period of timer,
   i) It moves to idle mode, or;
   ii) when no response allowing communication can be received from TC after attempting to repeat the transmitting of a communication permission request “Ns_ret” times, it moves to idle mode.
d) Calling Unit transmits TX_REL/EOT after receiving DCALL_ACK and TX_REL, and;
e) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately, and;
f) moves to idle mode.
g) When Called Unit has received TX_REL/EOT,
h) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
   i) moves to idle mode.

13.3. Delayed Header Operation

In Data Call, ID information is transmitted in the initial frame. Therefore if the initial frame is not received, communication cannot be established. Therefore, during reception machine is operating scanning, the possibility to receive the initial frame becomes low. By sending HEAD_DLY message as a dummy frame including ID information, certainty of Data Call will be improved. HEAD_DLY message can be used in all non-voice call including Status Call.

13.3.1. Transmission Operation

This section explains how to send HEAD_DLY message in Data Call.
Based on the regular Data Call procedure, operation to add three HEAD_DLY message is shown in Figure 13.3-1. In Figure 13.3-1, FSW is omitted and function CH is written in chronological order to be transmitted.

PTT	TX		Channel	Description
		1)		PTT was pushed.
		2)		Start transmission.
		3)	Preamble	After a transmission starts, prescribed Preamble is transmitted.
			LICH	RTCH2 / Single-SC / FA1 / G / Inbound
		4)	SCCH	INFO4
			FACCH1	CALL_REQ
			G	Guard Time
		5)		Link connection operation.
		6)	Preamble	After a transmission starts, prescribed Preamble is transmitted.
			LICH	RTCH2 / Single-SC / FACCH3 / Inbound
		7)	SCCH	INFO4
			FACCH3	HEAD_DLY (Delay Count = 2)
			LICH	RTCH2 / Single-SC / FACCH3 / Inbound
		8)	SCCH	INFO4
			FACCH3	HEAD_DLY (Delay Count = 1)
			LICH	RTCH2 / Single-SC / FACCH3 / Inbound
		9)	SCCH	INFO4
			FACCH3	HEAD_DLY (Delay Count = 0)
			LICH	RTCH2 / Single-SC / UDCH2 / Inbound
		10)	SCCH	INFO4
			UDCH2	DCALL (Header format)
			LICH	RTCH2 / Single-SC / UDCH2 / Inbound
		11)	SCCH	INFO4
			UDCH2	DCALL (User Data format)
			LICH	RTCH2 / Single -SC / UDCH2 / Inbound
		12)	SCCH	INFO4
			UDCH2	DCALL (User Data format)
			LICH	RTCH2 / Single -SC / FACCH3 / Inbound
		13)	SCCH	INFO4 (EOT)
			FACCH3	TX_REL
		14)		Finish transmission.

Figure 13.3-1 Data Call Transmission (with HEAD_DLY)

1) User pushes PTT of SU and start data call operation.
2) SU starts transmission after changing channel to TR of Free Repeater, which was most recently obtained.
   Note that when Home Repeater is in the idle state, it starts transmission without changing channel.
3) After a transmission starts, prescribed Preamble is transmitted.
4) This frame is to request connection to TR and only uses a single SCCH (Non Super Frames) and first half of FACCH1. It transmits INFO4 message in SCCH and CALL_REQ message in FACCH1. The TR number SU is transmitting in ISM Area and Repeater in Use. Second half is G (Guard Time), which is part of the time to change from transmission to reception for link connection processing.
   This frame also transmits single SCCH, and first half is FACCH1 and second half is G. Because it is transmission through RTCH2, Bit setting for LICH needs to be configured accordingly.
5) During this time, SU compares a connection response message from TR and connection request message it just sent. If the contents of these messages are same except Free Repeater, link connection is established. And it will switch from receipt to transmission again in order to move on the sequence after 6).
   When it cannot receive connection response message from TR, it will repeat the sequence after 2) again. If the connection response message is different from the connection request message, it will change a channel to TR in Free Repeater, which is included in FACCH1, and repeat the sequence after 3).
6) After a transmission starts, prescribed Preamble is transmitted.
7) Using FACCH3, transmit HEAD_DLY message and IDLE message. By configuring Delay Count = 2 for Delay Count information elements, it indicates two frames are left until DCALL (Header) is transmitted.
8) Transmit the second HEAD_DLY message. By decrementing Delay Count, it indicates one frame is left until DCALL (Header) is transmitted.
9) Transmit the third HEAD_DLY message and IDLE message. By decrementing Delay Count, it indicates zero frames are left until DCALL (Header) is transmitted.
10) From here, frames are regular Data Call frame.

14. Short Data Call

This section explains the procedure of Short Data Call.

14.1. Broadcast Short Data Call Procedure

The procedure in which a SU performs Broadcast Short Data Call to a group of cell will be explained. A sequence diagram is shown in Figure 18.17-1.

14.1.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits SDCALL_REQ to TC.

14.1.2. Controller Actions

TC executes the following operation.

a) TC relays SDCALL_REQ message from SU.
b) When TC has received TX_REL/EOT from the Calling SU, it terminates the relay transmission procedure.

14.1.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL/EOT after the communication has ended,
b) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately, and;
c) moves to idle mode.
d) When Called Unit has received TX_REL/EOT,
e) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
f) moves to idle mode.

14.2. Unit to Unit Short Data Call Procedure

The procedure in which SU performs Unit to Unit Short Data Call to another SU will be explained. A sequence diagram is shown in Figure 18.15-1 and, Figure 18.18-2.

14.2.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits SDCALL_REQ to TC.

14.2.2. Controller Actions

TC executes the following operation.

a) When TC has received SDCALL_REQ and TX_REL transmitted from the Calling SU, it relays those messages, and;
b) activates the Timer Tr_hold , and transmits IDLE.
c) If no SDCALL_RESP is received from Called Unit within a specified period of time,
   i) sends TX_REL/EOT
d) When TC has received SDCALL_RESP and TX_REL transmitted from the Called SU, it relays those messages, and;

e) activates the Timer Tr_hold , and transmits IDLE.
f) If no TX_REL/EOT is received from Calling Unit within a specified period of time,
   i) sends TX_REL/EOT.
g) When TC has received TX_REL/EOT from the Calling Unit, it relays the message and then terminates the relay transmission procedure.

14.2.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL after the transmission of signal has ended,
   i) activates the Timer Ts_ack, and continuously wait to a message that is echoed back from TC.
b) When Called Unit has received a valid signal, it transmits SDCALL_RESP and TX_REL.
c) When Calling Unit receives no response allowing communication within a specified period of time,
   i) It moves to idle mode, or;
   ii) when no response allowing communication can be received from TC after attempting to repeat the transmitting of a communication permission request Ns_ret times, it moves to idle mode.
d) Calling Unit transmits TX_REL/EOT after receiving SDCALL_RESP and TX_REL, and;
e) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately, and;
f) moves to idle mode.
g) When Called Unit has received TX_REL/EOT,
h) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
   i) moves to idle mode.

15. Supplementary Services

This section explains some additional services.

a) Status Call
b) Status Inquiry
c) Emergency Alert
d) Remote Control

15.1. Status Call Procedure

The procedure in which SU informs another SU of its current status via Confirmation Mode will be explained. A sequence diagram is shown in Figure 18.19-1 and, Figure 18.19-2.
In case of non- Confirmation Mode, any response from Target Unit is not required, accordingly, the sequence of procedure is the same as Broadcast Status Call shown in Section 15.2.

15.1.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits STAT_REQ to TC.

15.1.2. Controller Actions

TC executes the following operation.

a) When TC has received STAT_REQ and TX_REL transmitted from the Calling SU, it relays those messages, and;
b) activates the Timer Tr_hold, and transmits IDLE.
c) If no STAT_RESP is received from Called Unit within a specified period of time,
   i) sends TX_REL/EOT
d) When TC has received STAT_RESP and TX_REL transmitted from the Called SU, it relays those messages, and;
e) activates the Timer Tr_hold, and transmits IDLE.
f) If no TX_REL/EOT is received from Calling Unit within a specified period of time,
   i) sends TX_REL/EOT.
g) When TC has received TX_REL/EOT from the Calling Unit, it relays the message and then terminates the relay transmission procedure.

15.1.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL after the transmission of signal has ended,
   i) activates the Timer Ts_ack, and continuously wait to a message that is echoed back from TC.
b) When Called Unit has received a valid signal, it transmits STAT_RESP and TX_REL.
c) When Calling Unit receives no response allowing communication within a specified period of time,
   i) It moves to idle mode, or;

   ii) when no response allowing communication can be received from TC after attempting to repeat the transmitting of a communication permission request Ns_ret times, it moves to idle mode.
d) Calling Unit transmits TX_REL/EOT after receiving STAT_RESP and TX_REL, and;
e) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately, and;
f) moves to idle mode.
g) When Called Unit has received TX_REL/EOT,
h) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
   i) moves to idle mode.

15.2. Broadcast Status Call Procedure

The procedure in which SU informs a group of cell of its current status will be explained. A sequence diagram is shown in Figure 18.21-1.

15.2.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits STAT_REQ to TC.

15.2.2. Controller Actions

TC executes the following operation.

a) TC relays STAT_REQ message from SU.
b) When TC has received TX_REL/EOT from the Calling SU, it terminates the relay transmission procedure.

15.2.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL/EOT after the communication has ended, and;
b) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately, and;
c) moves to idle mode.
d) When Called Unit has received TX_REL/EOT,
e) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
f) moves to idle mode.

15.3. Paging Procedure

User can inform a specified SU of the occurrence of call request by using an alert voice or indicator.

Paging function shall be included in Status function, and a specifically predetermined Status message will be used. The procedure is the same as Status Call.

15.4. Status Inquiry Procedure

The procedure in which SU inquires about the current status of another SU will be explained. A sequence diagram is shown in Figure 18.20-1 and, Figure 18.20-2.

15.4.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits STAT_INQ_REQ to TC.

15.4.2. Controller Actions

TC executes the following operation.

a) When TC has received STAT_INQ_REQ and TX_REL transmitted from the Calling SU, it relays those messages, and;
b) activates the Timer Tr_hold, and transmits IDLE.
c) If no STAT_INQ_REQ is received from Called Unit within a specified period of time,
    i) sends TX_REL/EOT.
d) When TC has received STAT_INQ_RESP and TX_REL transmitted from the Called Unit, it relays those messages, and;
e) activates the Timer Tr_hold, and transmits IDLE.
f) If no TX_REL/EOT is received from Calling Unit within a specified period of time,
    i) sends TX_REL/EOT
g) When TC has received TX_REL/EOT from the Calling Unit, it relays the message and then terminates the relay transmission procedure.

15.4.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL after the transmission of signal has ended,
    i) activates the Timer Ts_ack, and continuously wait to a message that is echoed back from TC.
b) When Called Unit has received a valid signal, it transmits STAT_INQ_RESP and TX_REL.
c) When Calling Unit receives no response allowing communication within a specified period of time,
    i) It moves to idle mode, or;
    ii) when no response allowing communication can be received from TC after attempting to repeat the transmitting of a communication permission request Ns_ret times, it moves to idle mode.
d) Calling Unit transmits TX_REL/EOT after receiving STAT_RESP and TX_REL, and;
e) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately, and;
f) moves to idle mode.
g) When Called Unit has received TX_REL/EOT,
h) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
    i) moves to idle mode.

15.5. Emergency Alert Procedure

User can inform the dispatcher of emergency status.
"Emergency Alert" is a peculiar type of Status Call, and the sequence of its procedure is basically the same as Status Call. The differences are as follows.

a) Use the value representing a predetermined Emergency as Status description.

15.6. Remote Control procedure

The procedure in which a SU remotely controls another SU will be explained. The procedure includes the following 4 varieties. These procedural steps to follow are the same over communication CH, however, final steps differ in accordance with the description of each Control Command. Each sequence diagram of Stun/Revival/Kill and Remote Monitor is shown in Figure 18.22-1, and Figure 18.23-1 and Figure 18.23-2, respectively.

a) Stun
b) Revival
c) Kill
d) Remote Monitor

15.6.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits REM_CON_REQ to TC.

15.6.2. Controller Actions

TC executes the following operation.

a) When TC has received REM_CON_REQ and TX_REL transmitted from the Calling SU, it relays those messages, and;
b) activates the Timer Tr_hold, and transmits IDLE.
c) If no REM_CON_RESP is received from Called Unit within a specified period of time,
   i) sends TX_REL/EOT.
d) When TC has received REM_CON_RESP and TX_REL transmitted from the Called Unit, it relays those messages, and;
e) activates the Timer Tr_hold, and transmits IDLE.
f) If neither TX_REL/EOT(Stun/Revival/Kill) nor VCALL(Remote Monitor) is received from Calling Unit within a specified period of time,
   i) sends TX_REL/EOT.
g) When TC has received TX_REL/EOT(Stun/Revival/Kill) from the Calling Unit, it relays the message and then terminates the relay transmission procedure.
h) When TC has received VCALL(Remote Monitor) from the Called Unit, it relays the message and then terminates the relay transmission procedure.

15.6.3. Unit Actions

Calling Unit and Called Unit execute the following operation, respectively.

a) Calling Unit transmits TX_REL after the transmission of signal has ended,
   i) activates the Timer Ts_ack, and continuously wait to a message that is echoed back from TC.

b) When Called Unit has received a valid signal, it transmits REM_CON_RESP and TX_REL.
c) When Calling Unit receives no response allowing communication within a specified period of time,
   i) It moves to idle mode, or;
   ii) when no response allowing communication can be received from TC after attempting to repeat the transmitting of a communication permission request “Ns_ret” times, it moves to idle mode.
d) In case of Stun/Revival/Kill,
   i) Calling Unit transmits TX_REL/EOT after receiving REM_CON_RESP and TX_REL, and;
   ii) If transmission is performed via any of repeaters other than the Home Repeater, the Calling Unit returns to the channel frequency of the Home Repeater immediately,
   iii) and moves to idle mode.
   iv) When Called Unit has received TX_REL/EOT,
   v) If transmission is performed via any of repeaters other than the Home Repeater, the Called Unit returns to the channel frequency of the Home Repeater immediately, and;
   vi) moves to idle mode.
e) In case of Remote Monitor,
   i) Called Unit sends VCALL within a second.
   ii) Calling Unit receives REM_CON_RESP and TX_REL and continuously waits to a VCALL message.

16. Encryption Procedure

This chapter outlines the encryption function and its operational procedure.

16.1. Layer for Encryption

The encryption shall be done on an end-to-end basis, and the encrypted state shall be maintained throughout the communication path to ensure the security. Since an object of encryption is voice data or user data information, the encryption protocol resides in an upper layer than layer 3 and is implemented inside SUs to handle mainly the voice and user data, or if necessary, inside network consoles.

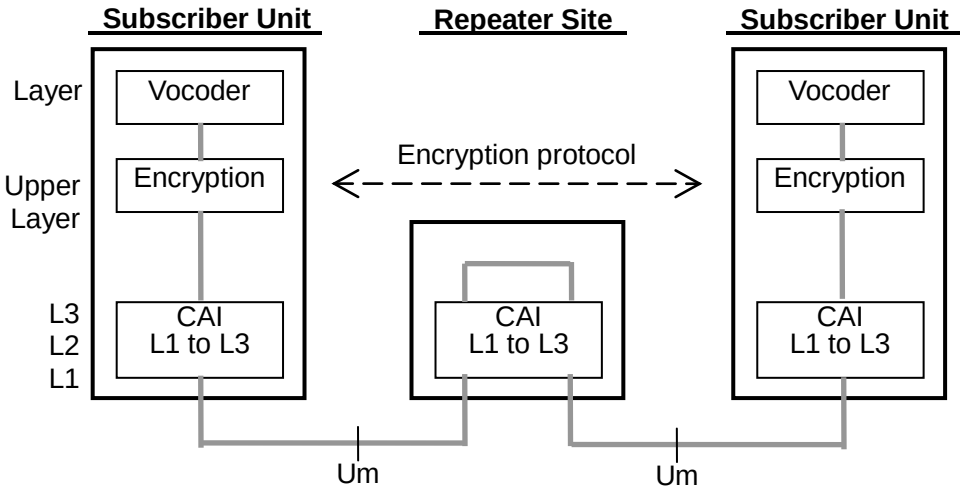


Figure 16.1-1 Layer for Encryption Protocol

16.2. Encryption Processing

Figure 16.2-1 shows the procedure to apply the encryption function to the voice data of vocoder. The encryption processing is added between the voice coding processing and the FEC coding processing in a normal vocoder processing without encryption. The decryption processing is processed in reverse.

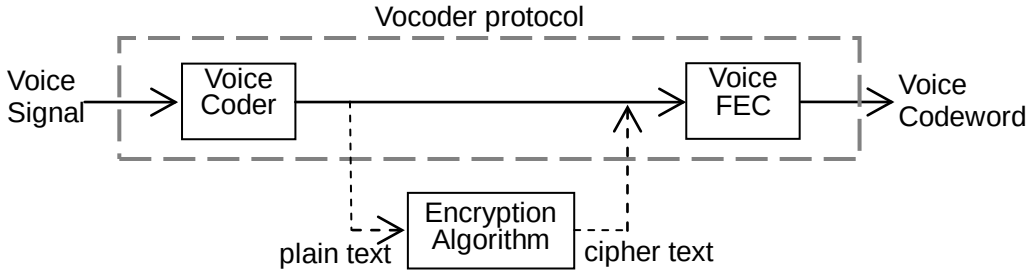


Figure 16.2-1 Encryption Processing Diagram

In the case of encryption to user data information such as a text message, the same encryption processing is applied by regarding the user data as a plaintext. An output

ciphertext is embedded into the User Data field in a packet as well as the case of non-encrypted data packet, so an encrypted data call is achieved.

16.3. Encryption Algorithm

16.3.1. Scramble Encryption

Scramble encryption is an encryption algorithm that is a random bit inversion processing using a bitwise exclusive-or operation between bit sequence of voice or other data and PN bit sequence. Figure 16.3-1 shows a block diagram of this algorithm.
PN sequence uses the polynomial $P(x) = X^{15} + X + 1$ which has a repeat period of 32,767 bits, and an encryption key is used as default for the PN sequence. As PN sequence is generated the 15-stage shift register, the encryption key is selectable from 32,767 keys except all zero.

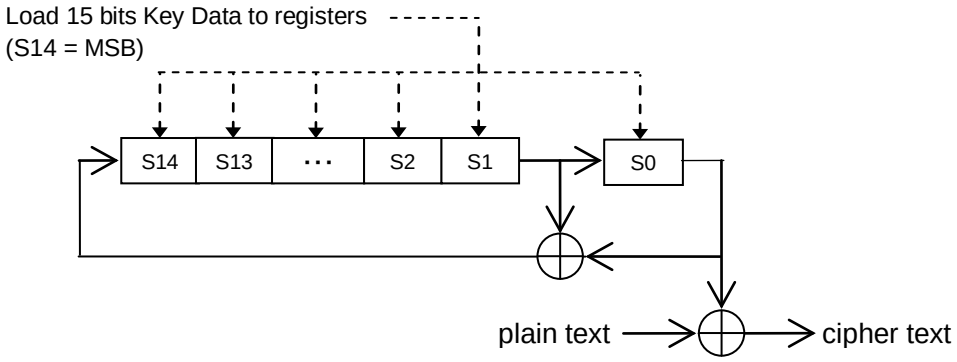


Figure 16.3-1 Scramble Encryption Algorithm

16.4. Procedure for Encrypted Call

This section outlines the procedures of voice calls and data calls using scramble encryption.

16.4.1. Information Element in Encrypted Call

A VCALL message is used in voice calls, while a DCALL message is used in data calls. Table 16.4-1 shows the information elements in these messages used to identify whether encrypted call or not.

Table 16.4-1 Information Element in Encrypted Calls

Information Element	Length	Description
Cipher Type	2bits	Information element to identify encryption algorithm. 3 types of encryption algorithms can be identified.
Key ID	6bits	Information element to indicate alias to identify encryption key. Up to 63 Key IDs can be identified for each Cipher Type.

Table 16.4-2 shows other elements needed inside of transceivers.

Table 16.4-2 Transceiver Internal Information for Encrypted Calls

Element	Length	Description
Encryption Key	15bits	Key data actually used in encryption algorithm. This is default of 15-stage shift register for scramble encryption. The encryption key and Key ID shall be interrelated inside of transceivers.
Key Name	Optional	Name of key to let users easily identify an encryption key.

16.4.2. Voice Calls with Scramble Encryption

In scramble encryption, one encryption session consists of 4 frames in order to synchronize with the period of sending a VCALL in a SCCH with superframe structure. As one frame contains 4
VCHs, the PN sequence of the scramble encryption are applied for 16 VCHs in one encryption session. Figure 16.4-1 shows the relationship between vocoder voice coding data in VCH and PN sequence.

At the start of transmission, the 15-stage register of the scramble pattern generator is initialized by a proper encryption key. The first bit of PN sequence output from the scramble pattern generator is expressed as P0 here. The first bit of the voice coding data of the first VCH in the frame of the first SCCH to send a VCALL is performed the exclusive-or operation with P0. Since the voice coding data is 49 bits length, P0 to P48 are applied to the first VCH and P49 to P97 are applied to the second VCH. The PN sequence is applied to the following third and fourth VCH every 49 bits, and the same operation is performed to frames containing the second to the fourth SCCH. In the end, P783 of the PN sequence is applied to the last bit of voice coding data of the fourth VCH in the fourth frame, and one encryption session ends.
Since the first SCCH starts from the next superframe again, the scramble pattern generator is initialized by the encryption key and the previous PN sequence is applied to the next four frames.

The following rules shall be observed:

- It is prohibitive to change the encryption algorithm, including non-encryption mode, during a call.
- It is prohibitive to change the encryption key during a call.

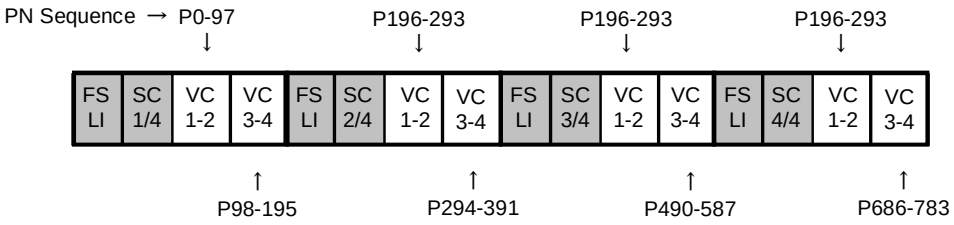


Figure 16.4-1 Relationship between PN sequence and VCH in Scramble Encryption

16.4.3. Data Calls with Scramble Encryption

Since data calls do not support the Late Entry function of voice calls, the encryption session is not based on frames like a scramble encrypted voice call, but one transmission is handled as one encryption session. UDCH2 in the first frame has a DCALL in Header format which Cipher Type and other information elements are embedded in. Figure 16.4-2 shows the relationship between PN sequence and User Data field in the DCALL sent on UDCH.

As shown here, 32,767-bit PN sequence is sequentially applied to the User Data field in a DCALL in User Data format sent on UDCH2 until the last frame is sent.

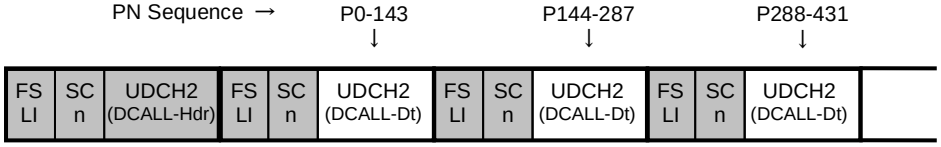


Figure 16.4-2 Relationship between PN sequence and UDCH2 in Scramble Encryption

16.4.4. Simultaneous Data Call

While making a voice call, a data call can be simultaneously carried out at low speed by using FACCH1. In this case, encryption is completely independent in voice calls and data calls. Different encryption algorithms, including non-encryption, can be used between a voice call and a data call.

The procedure to apply scramble encryption to voice calls is described in Section 16.4.2. Even if a VCH is replaced to a FACCH1, the positional relationship between the VCH and the encryption bit sequence is unchanged, and the encryption bit sequence corresponding to the VCH replaced to FACCH1 is unused and discarded by both senders and recipients.

The procedure to apply scramble encryption to data calls is described in Section 16.4.3. The Information elements for encryption in data calls are contained in a SDCALL_REQ (Header) message, therefore the algorithm used in a data call can be specified independently of that of a voice call.

The encryption session for voice call is integer multiples of superframes, but VCH of any frames can be replaced to FACCH1 without considering the superframe structure.

17. System Data Write Procedure

This Chapter provides the overview of formats and information elements to transmit System Data using System Data Area specified in REF [1].
For the procedure of packet transmission, refer to Chapter 12.

17.1. System Data Format

This section shows basic structure of transmission packet in System Data Call.
They are used to transmit system information from Trunking Controller to Subscriber Unit.
To improve transmission efficiency, it is defined as a format to transmit multiple messages in one packet.
There is no special restriction in message combination, but embedding two same massages is prohibited.

Octet \ Bit	7	6	5	4	3	2	1	0
0	System Data length (1) (Opcode + Data) (L_1)							
1								
2	System Data Opcode (1)							
3	Elements for System Data (1)							
・・・								
L_1+1								
L_1+2	System Data length (2) (Opcode + Data) (L_2)							
L_1+3								
L_1+4	System Data Opcode (2)							
L_1+5	Elements for System Data (2)							
・・・								
L_1+L_2+3								
L_1+L_2+4	System Data length (3) (Opcode + Data) (L_3)							
L_1+L_2+5								
L_1+L_2+6	System Data Opcode (3)							
L_1+L_2+7	Elements for System Data (3)							
・・・								
L_1+L_2+L_3+5								

Figure 17.1-1 System Data Format

17.1.1. System Data Length

System Data Length consisting 16 bits shows the total number of bits including System Data and Opcode. Each System Data can transmit up to 65534 bits.

Table 17.1-1 System Data length

Value (Hex)	Definition
0000	No System Data
0001	reserved
0002	Number of bytes of System Data = 1
・・・	・・・
FFFF	Number of bytes of System Data = 65534

17.1.2. System Data Opcode

System Data Opcode consists of eight bits that are four bits of Integrator Code and four bits of Opcode. The contents of System Data can be classified into 16 types at maximum by Opcode. If Integrator Code is configured as identification code given by the operations manager of a system, Opcode can be specified according to the operations manager of a system. And it's possible to add original contents of System Data up to 16 types to classify.

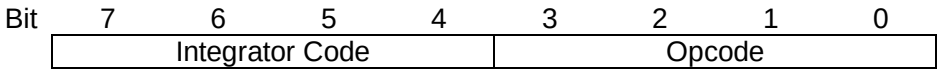


Figure 17.1-2 System Data Opcode Format

17.2. Message Definitions

This Chapter describes the definition of System Data Write Message.

17.2.1. System Data Write Messages

When Integrator Code uses, it is possible to distinguish the contents of System Data up to 16 types by 4 bits Opcode.

Table 17.2-1 Opcode used on System Data Write

Opcode Name (Alias)	Opcode	Description
System Information (SYS_INFO)	0000	It is used when transmitting the system information of TRS which can be registered, and the channel information on Collect Repeater to SU.
Site Channel Information (SITE_CH_INFO)	0001	It is used when transmitting the channel information which can be used to SU.
Memory Data Information (MEM_DATA_INFO)	0010	It is used when Memory Data set as SU is updated.
	0011 - 1111	Reserved

17.2.1.1. System Information (SYS_INFO)

This is a message TC uses on traffic channel when transmitting registerable System information of Trunked System and channel information of Collect Repeater to SU.

Octet \ Bit	7	6	5	4	3	2	1	0
0	Version Number							
1	Site List Number (L) (1)							
2	System ID (1)							
3								
4	Site Code (1)							
5	Site List Option (1)			Collect Repeater (1)				
6	Collect Repeater TX Frequency (1)							
7								
8								
9								
10	Collect Repeater RX Frequency (1)							
11								
12								
13								
14	Site List Number (H) (1)			2nd Collect Repeater (1)				
15	2nd Collect Repeater TX Frequency (1)							
16								
17								
18								
19	2nd Collect Repeater RX Frequency (1)							
20								
21								
22								
23	Site List Number (L) (2)							
24	System ID (2)							
25								
26	Site Code (2)							
27	Site List Option (2)			Collect Repeater (2)				
...	...							
22N-8	Site List Number (H) (N)			2nd Collect Repeater (N)				
22N-7	2nd Collect Repeater TX Frequency (N)							
22N-6								
22N-5								
22N-4								
22N-3	2nd Collect Repeater RX Frequency (N)							
22N-2								
22N-1								
22N								

Figure 17.2-1 System Information Format

17.2.1.2. Site Channel Information (SITE_CH_INFO)

This is a message TC uses on traffic channel when transmitting usable Site Channel Information to SU.

Octet \ Bit	7	6	5	4	3	2	1	0
0	Spare			Repeater Number (1)				
1	Repeater TX Frequency (1)							
2								
3								
4								
5	Repeater RX Frequency (1)							
6								
7								
8								
9	Spare			Repeater Number (2)				
10	Repeater TX Frequency (2)							
11								
12								
13								
14	Repeater RX Frequency (2)							
15								
16								
17								
...	...							
9N-18	Spare			Repeater Number (N-1)				
9N-17	Repeater TX Frequency (N-1)							
9N-16								
9N-15								
9N-14								
9N-13	Repeater RX Frequency (N-1)							
9N-12								
9N-11								
9N-10								
9N-9	Spare			Repeater Number (N)				
9N-8	Repeater TX Frequency (N)							
9N-7								
9N-6								
9N-5								
9N-4	Repeater RX Frequency (N)							
9N-3								
9N-2								
9N-1								

Figure 17.2-2 Site Channel Information Format

17.2.1.3. Memory Data Information (MEM_DATA_INFO)

This is a message TC uses on traffic channel when updating Memory Data configured in SU.

Octet \ Bit	7	6	5	4	3	2	1	0
0	Memory Address							
1								
2	Memory Data Area							
3								
4								
5								
6								
7								
8								
9								
...								
n-1								
n								

Figure 17.2-3 Memory Information Format

17.3. Element Definitions

This Chapter describes the definitions of various information elements embedded in System Data Write Message.

17.3.1. Version Number

Version Number consisting of 8 bits is used to indicate a version of corresponding system information of Trunking Controller and Subscriber Unit.

Table 17.3-1 Version Number Values

Field	Description and Value
Version	It indicates a version of system information. But notation is not specified.

17.3.2. Site List Number

Site List Number which is 8bits consists of Site List Number (L) and Site List Number (H) to indicate the area number to store various information of the sites.

Bit	7 - 5	4 - 0
	Site List Number (H)	Site List Number (L)

Figure 17.3-1 Site List Number Format

Table 17.3-2 Site List Number Values

Field	Description and Value
Site List Number	Indicates the area number to store various information of the sites. 00000000-00101111: 1 site to 48 site 00110000-11111111: Reserved

17.3.3. Site List Option

Site List Option consisting of 3 bits is used to indicate supplementary information of Site List.

Bit	2	1	0
	D/A	Spare	Area

Figure 17.3-2 Site List Option Format

Table 17.3-3 Site List Option Values

Field	Description and Value
D/A	Indicate Deletion (D) or Addition (A) of site information 0: Deletion of site information 1: Addition of site information
Area	Same value as Area of REF [1]

17.3.4. Collect Repeater

Collect Repeater consisting of 5 bits indicates Repeater used when SU acquires a site.

17.3.5. 2nd Collect Repeater

2nd Collect Repeater consisting of 5 bits indicates Repeater used when SU acquires a site and Collect Repeater is occupied for communication.

17.3.6. Repeater TX Frequency

Repeater TX Frequency consisting of 4 bites indicates the downlink frequency of TRS.

Table 17.3-4 Repeater TX Frequency Values

Value (Hex)	Definition
00000000	No TX Frequency Data
…	…
1BAFB520	464,500,000Hz
…	…
7FFFFFFF	2,147,483,647Hz
80000000 – FFFFFFFF	Reserved

17.3.7. Repeater RX Frequency

Repeater RX Frequency consisting of 4 bites indicates the uplink frequency of TRS.

Table 17.3-5 Repeater RX Frequency Values

Value (Hex)	Definition
00000000	No RX Frequency Data
…	…
1BFC0060	469,500,000Hz
…	…
7FFFFFFF	2,147,483,647Hz
80000000 – FFFFFFFF	Reserved

17.3.8. Memory Address

Memory Address consisting of 16 bits is used to indicate Memory Area address of SU.

17.3.9. Memory Data Area

This Area is to indicate Data stored in the address shown by Memory Address of SU.

17.4. System Data Write by Trunking Repeater

The sequence of procedure in which TC starts system data communication is shown in Figure 18.10-1.

17.4.1. Controller Inquiry

TC sends SU DWR (Header) and DWR (Data) that instruct SU to start system data communication.

17.4.2. Controller Actions

TC performs the following operations in response to the message that SU has transmitted.

a) When TC transmits DWR (Header) and DWR (Data),
   i) activates the Timer Tr_hold, and transmits IDLE.
b) If no DWR_ACK can be received within a specified period of time,
   i) the following procedure of operations is system-dependent, therefore will not particularly described.
c) If DWR_ACK has been received within a specified period of time,
   i) sends TX_REL / EOT.

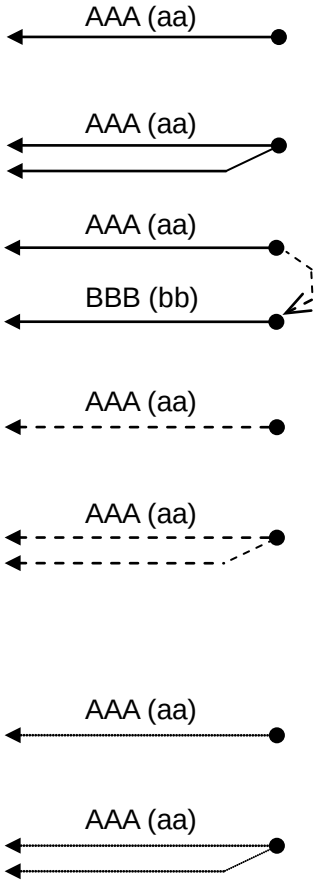
17.4.3. Unit Actions

SU in a standby mode performs the following operations when the Unit ID which is included in its DWR (Header) agrees with the Unit ID of the SU.

a) When SU has received a valid data,
   i) it sends DWR_ACK and TX_REL
b) When SU has received an invalid data,
   ii) The following data is system-dependent, therefore will not particularly described.
c) When SU has received TX_REL / EOT,
   iii) it shifts to the channel frequency of the Home Repeater.

18. Sequence Diagrams

This section describes basic control sequence diagrams for each procedure.
The following symbols are used in control sequence diagrams.



: Normal Message (Single transmission)
This indicates that the message is transmitted once.

: Normal Message (Multiple transmission)
As for outbound, the message is transmitted for the number of specified times.

: Normal message (Continuous transmission)
This indicates that the message is continuously sent until the next message.

: Quasi-normal message (Single transmission)
This indicates that the message is transmitted once.

: Quasi-normal message (Multiple transmission)
This is used only for outbound and indicates that the message is sent for the number of specified times.

: Optional message (Single transmission)
This indicates that the message is optionally sent once.

: Optional message (Multiple transmission)
This is used only for outbound and indicates that the message is optionally sent for the number of specified times.

In notation of XXX (xx), “XXX” represents the name of abbreviated layer 3 message and “xx” represents the name of a functional channel (SCCH Messages).
The solid line represents a normal message that is always used in each procedure.

18.1. Parameter

This section shows parameters that TRS and SU use in Trunked System.
Trunking Repeater Site uses parameter Nr and Tr.
Subscriber Unit uses parameter Ns and Ts.

Table 18.1-1 Counter List

Counter	Min	Default	Max	Description
Nr_ret	0	0	5	Maximum retry number of outbound request message when failing to receive valid inbound acknowledgement message. When reaching Tr_ack, outbound request message is retransmitted.
Ns_ret	0	0	5	Maximum retry number of inbound request message when failing to receive valid outbound acknowledgement message. When reaching Ts_ack, inbound request message is retransmitted.

Table 18.1-2 Timer List

Timer	Min	Default	Max	Description
Tr_hold	0s	1.2s	10s	Hold Timer of traffic channel when failing to receive valid frame or acknowledgement message.
	0s	2.6s	10s	Hold Timer of traffic channel when receiving valid TX_REL message without EOT.
	0s	7s	30s	Hold Timer of traffic channel when communicating individually using Message Trunking Mode connection.
Tr_tch		60s		Communication time limit to occupy traffic channel.
Tr_ack		5s		Maximum waiting time for valid inbound acknowledgement message
Tr_idle		10s		Transmission interval of Idle Repeater Message
Tr_site		5s		Transmission interval of Site ID Message
Ts_ack		5s		Maximum waiting time for valid outbound acknowledgement message

The following parameters will be omitted from the description in a sequence diagram.

SCCH Messages
Area = [option]
Free Repeater 1 = [option]
Free Repeater 2 = [option]

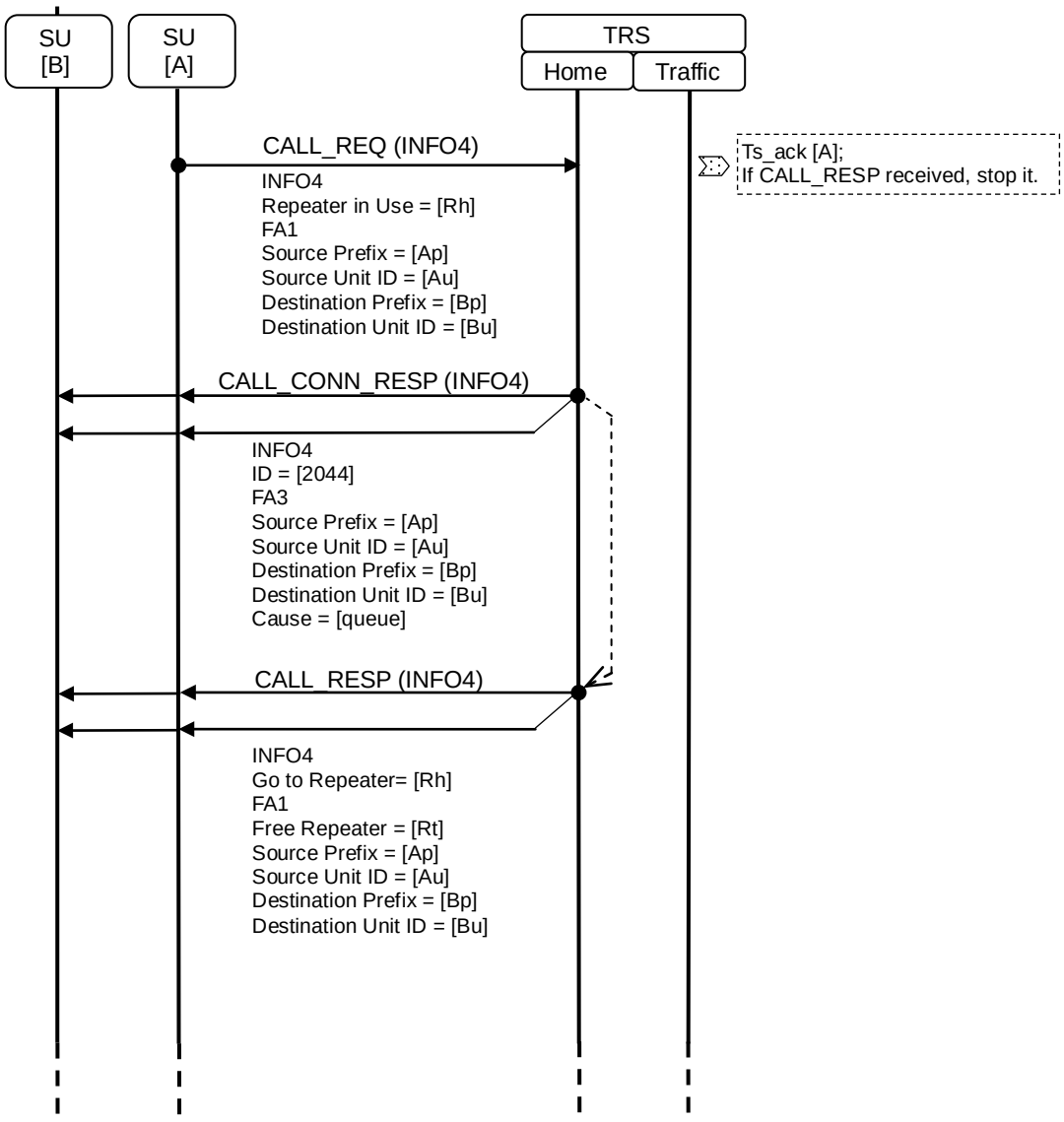
Furthermore, when Destination Prefix and Destination Unit ID (Destination Group ID) that are included in Layer 3 Abbreviated Message agree with those included in Functional Channel (SCCH Messages), only Layer 3 Abbreviated Message will be provided.

Suppose a Repeater ID of Collect Repeater as [Rc], a Repeater ID of Home Repeater as [Rh] and a Repeater ID of Traffic Repeater as [Rt].

18.2. Link

18.2.1. Link Accept

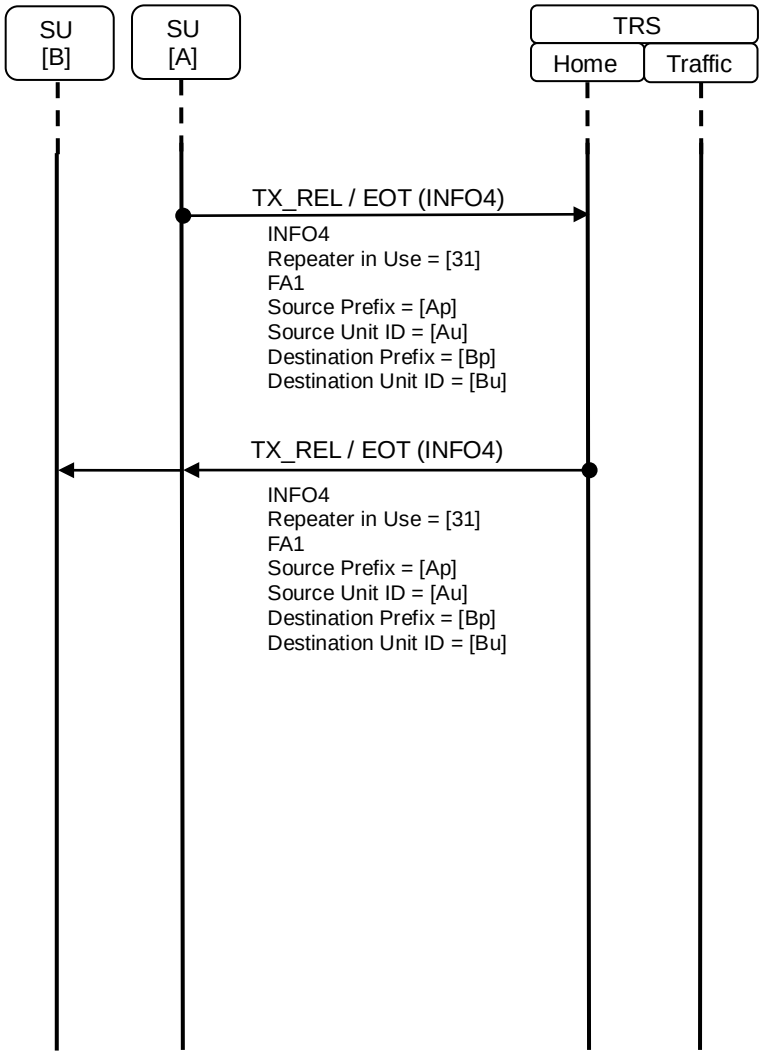
The sequence of control procedure will be shown, in the case where a link with Home Repeater whereby SU [A] (System ID = As、Prefix = Ap、Unit ID = Au) calls SU [B] (System ID = As、Prefix = Bp、Unit ID = Bu) is established successfully.



[Notes]

1) A message of Cause = [queue] indicates a queue not specifying any other cause.

Figure 18.2-1 Sequence Diagram for Link accept - 1



[Notes]
1) TC blocks a transmission of “Go to Repeater” information from Home Repeater when a TX_REL / EOT has been received

Figure 18.2-2 Sequence Diagram for Link accept - 2

18.2.2. Link Refuse

The sequence of control procedure will be shown, in the case where a link with Home Repeater whereby SU [A] (System ID = As、Prefix = Ap、Unit ID = Au) calls SU [B] (System ID = As、Prefix = Bp、Unit ID = Bu) is refused.

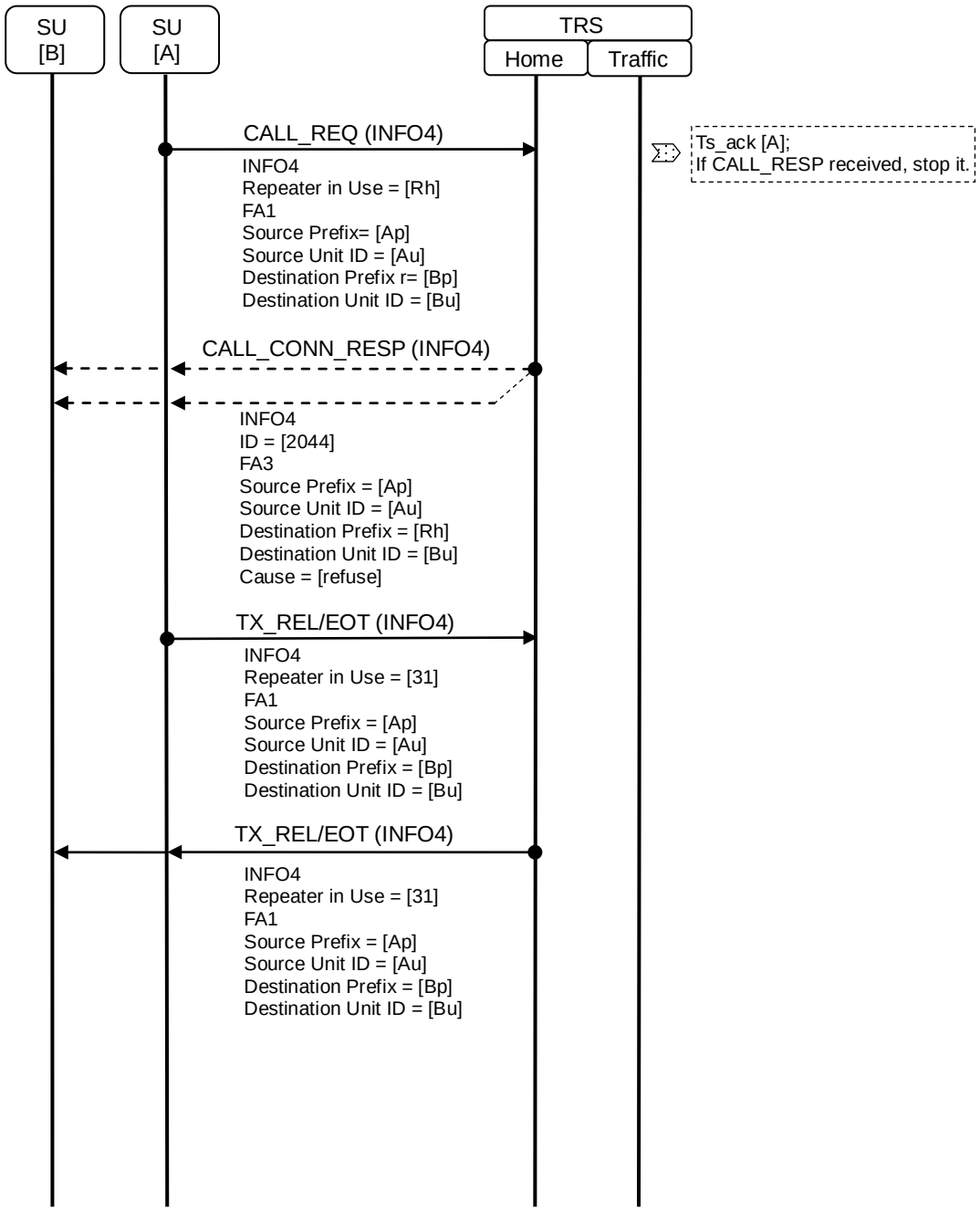
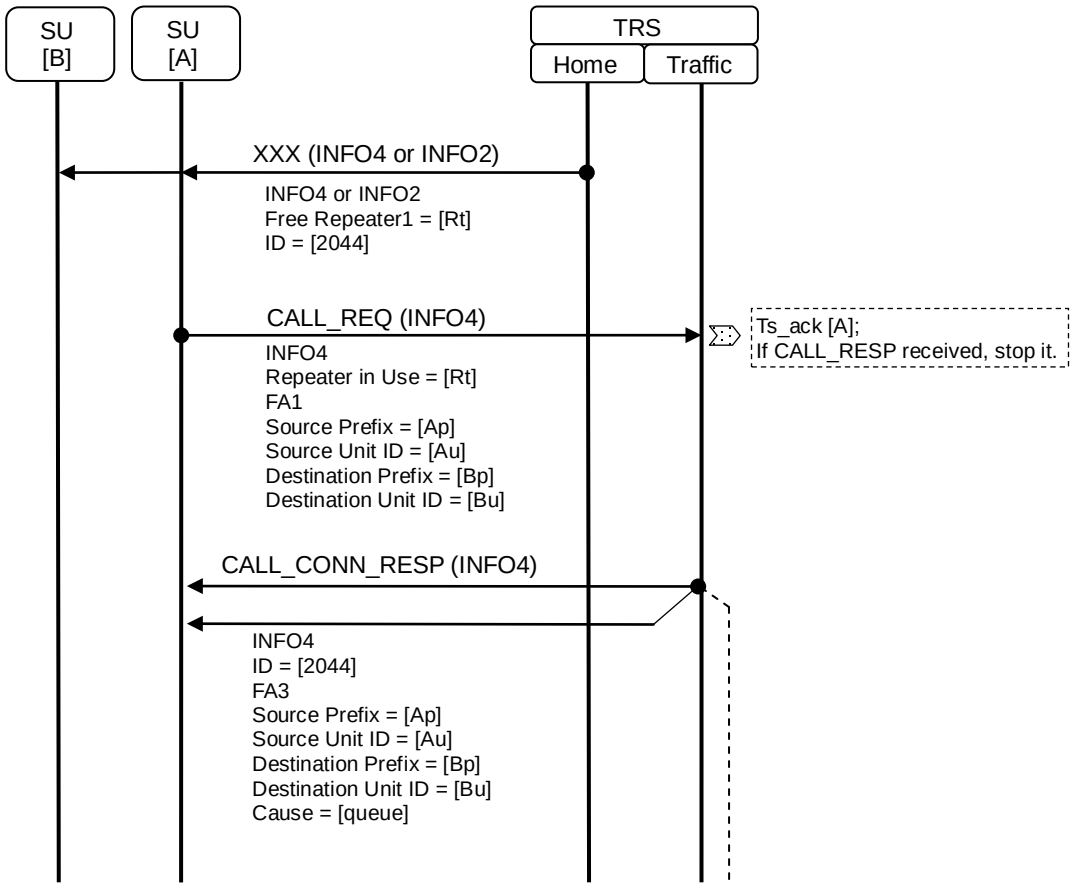


Figure 18.2-3 Sequence Diagram for Link refuse

18.2.3. Link of Traffic Repeater

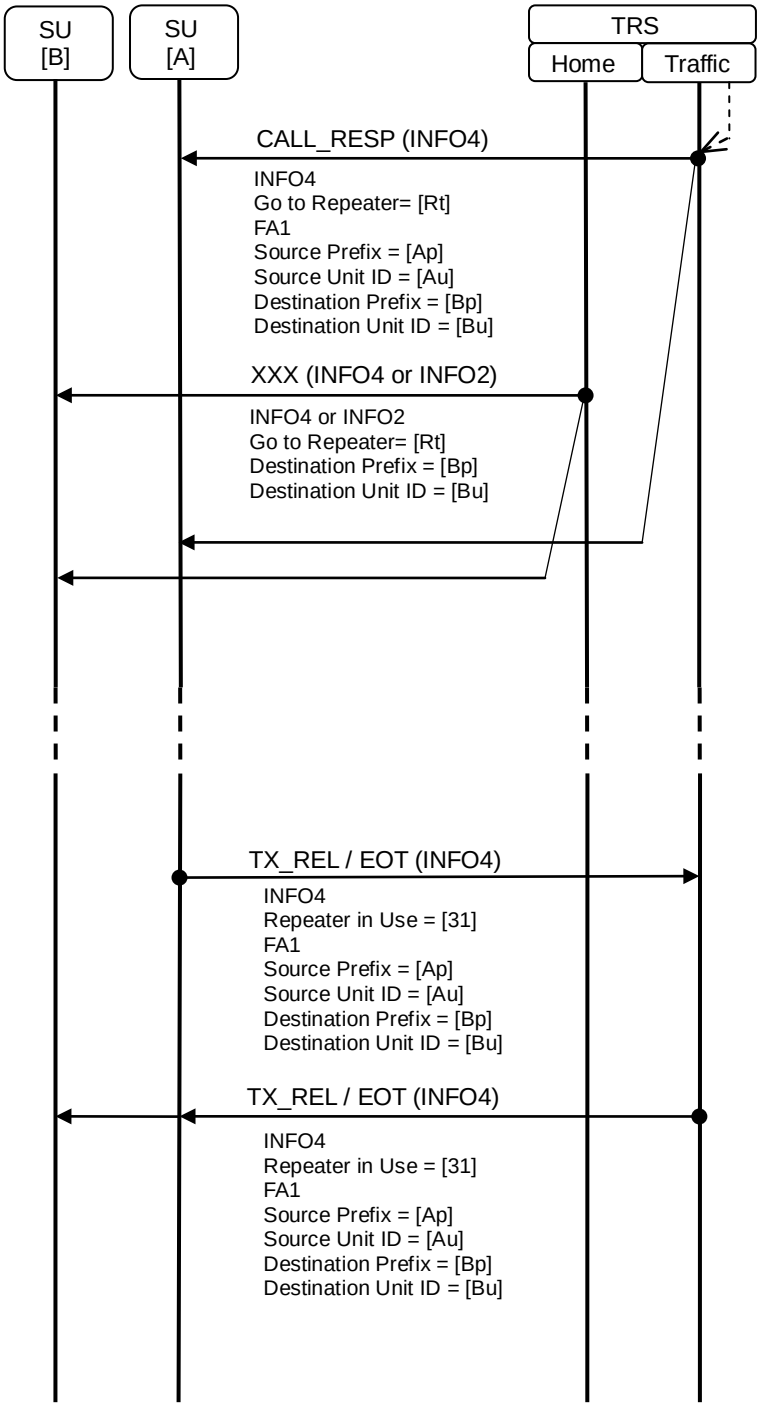
The sequence of control procedure will be shown, in the case where a link with Trafic Repeater whereby SU [A] (System ID = As、Prefix = Ap、Unit ID = Au) calls SU [B] (System ID = As、Prefix = Bp、Unit ID = Bu) is established successfully.



[Notes]

1) A message of Cause = [queue] indicates a queue not specifying any other cause.
2) XXX, which is a Layer3 message, is vary according to the situation.

Figure 18.2-4 Sequence Diagram for Link of Traffic Repeater - 1



[Notes]
1) TC blocks a transmission of “Go to Repeater” information from Home Repeater when a “TX_REL / EOT” has been received
2) XXX, which is a Layer3 message, is vary according to the situation.

Figure 18.2-5 Sequence Diagram for Link of Traffic Repeater - 2

18.3. Registration

This section shows a Controller sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) register with TRS.

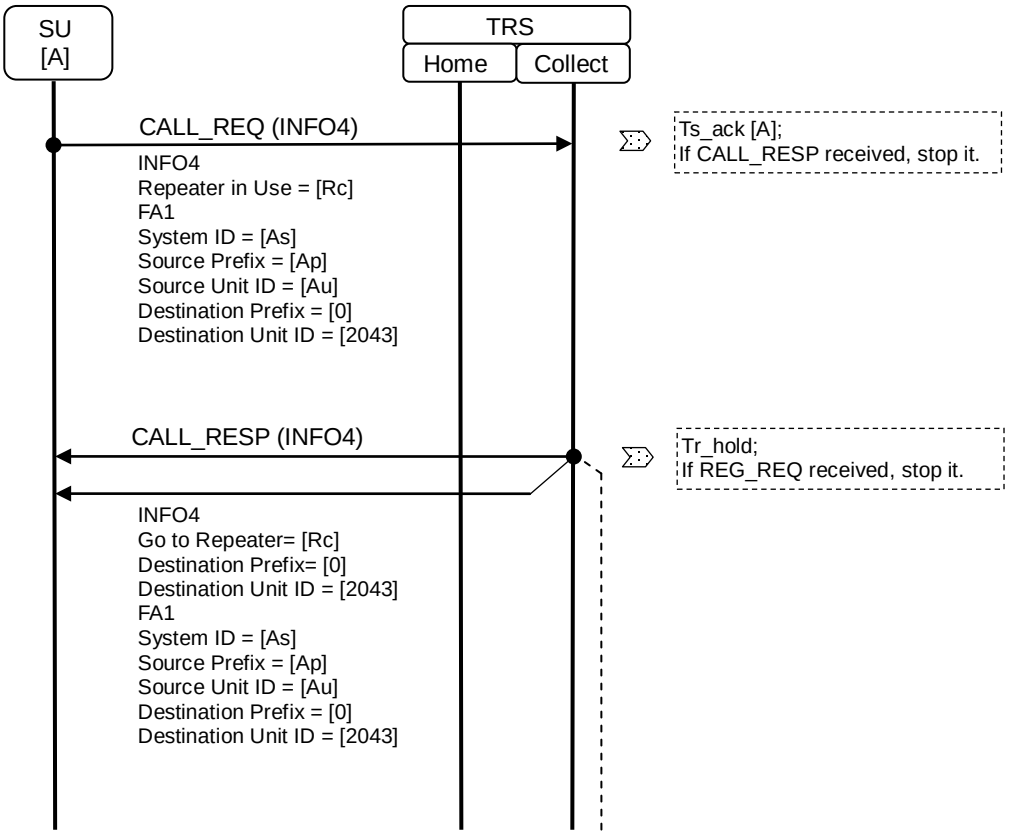


Figure 18.3-1 Sequence Diagram for Registration - 1

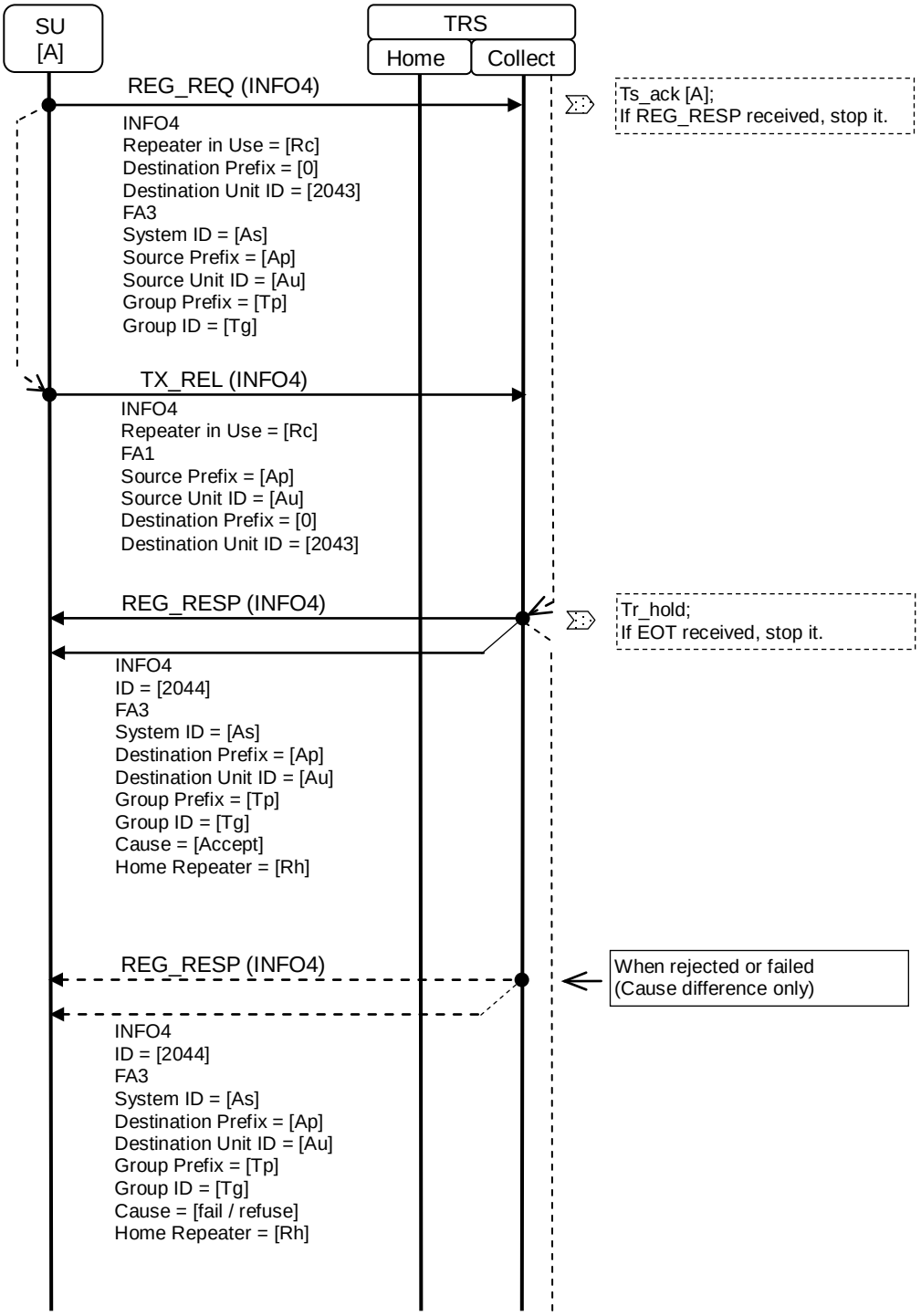
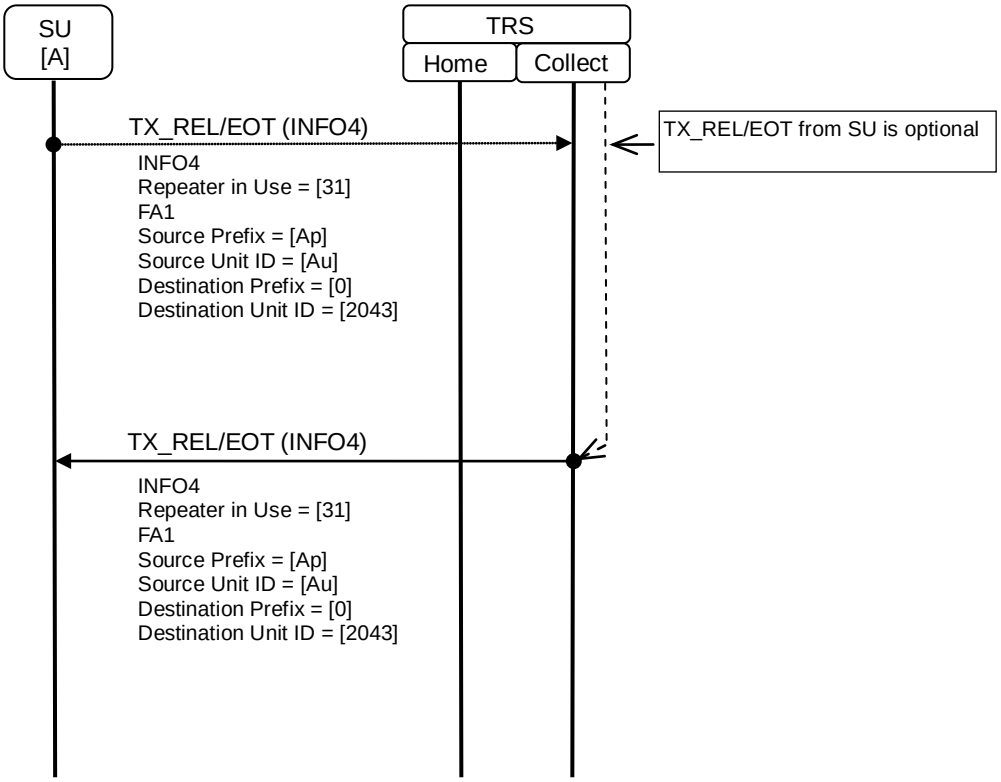


Figure 18.3-2 Sequence Diagram for Registration - 2

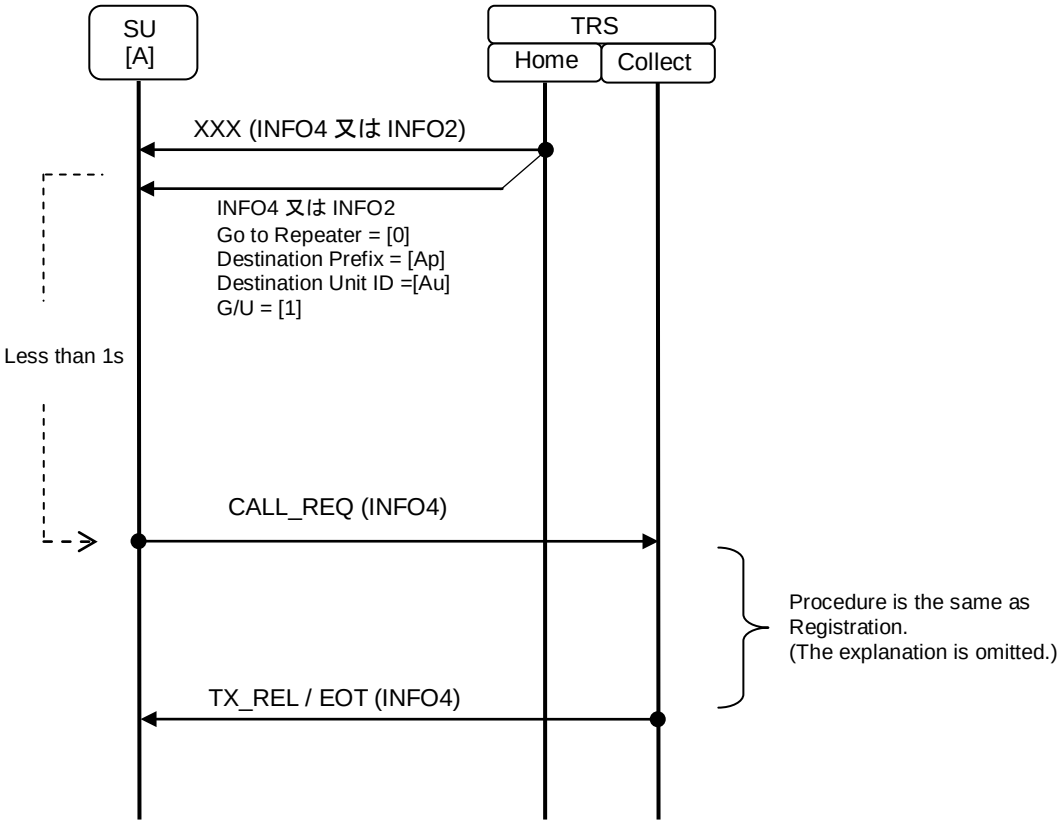


[Notes]
1) Visitor Unit ID and Visitor Group ID in REG_RESP are not used for a registration processing at Home.
2) TRS arbitrary configure unused Visitor Unit ID and Visitor Group ID. For following call requests, SU should use assigned Visitor Unit ID and Visitor Group ID.
3) When registration is rejected or failed, TC configures Null with Visitor Unit ID or Visitor Group ID in accordance with the situation of rejection or failure.

Figure 18.3-3 Sequence Diagram for Registration - 3

18.4. Registration Command

This section shows a control sequence that TRS commands SU [A] (System ID = As, Prefix= Ap, Unit ID = [Au]) to process registration.



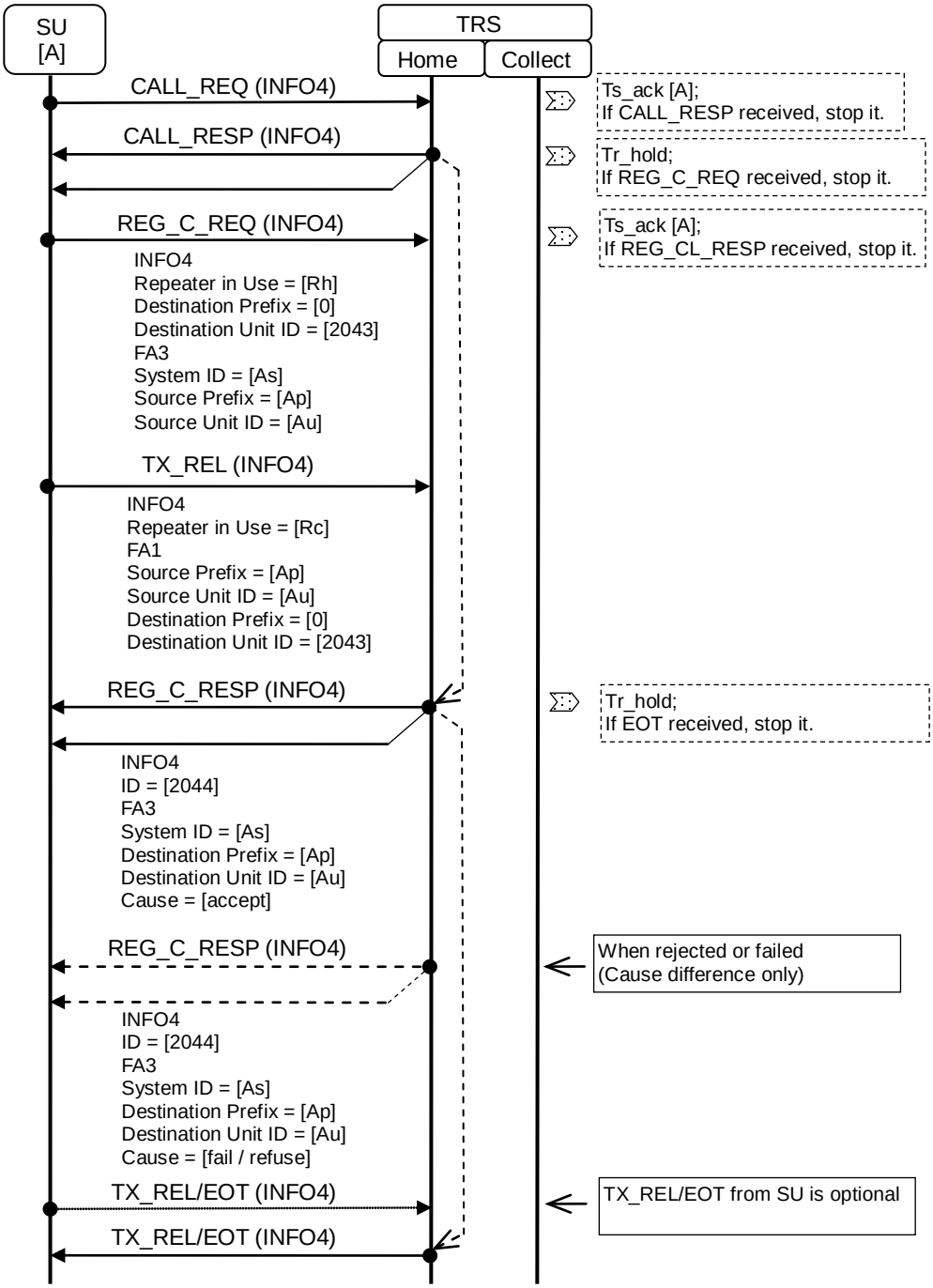
[Notes]

1) In the case of Go to Repeater =[0], G/U = [1], moves to REG_COMM (Registration Command).
2) Because a number of retry Nr_ret of REG_COMM is system-dependant, it is not specified.
3) XXX, which is a Layer3 message, is vary according to the situation.

Figure 18.4-1 Sequence Diagram for Registration Command

18.5. Registration Clear

This section shows a control sequence that SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) processes deletion of registration on TRS.



[Notes]

1) CALL_REQ, CALL_RESP and TX_REL /EOT are the same as those of Registration, therefore the description will be omitted.
2) When Home CH is Busy, to move to Traffic CH, and then perform Registration Clear.

Figure 18.5-1 Sequence Diagram for Registration Clear

18.6. Group Registration

This section shows a control sequence that SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) process registration on TRS.

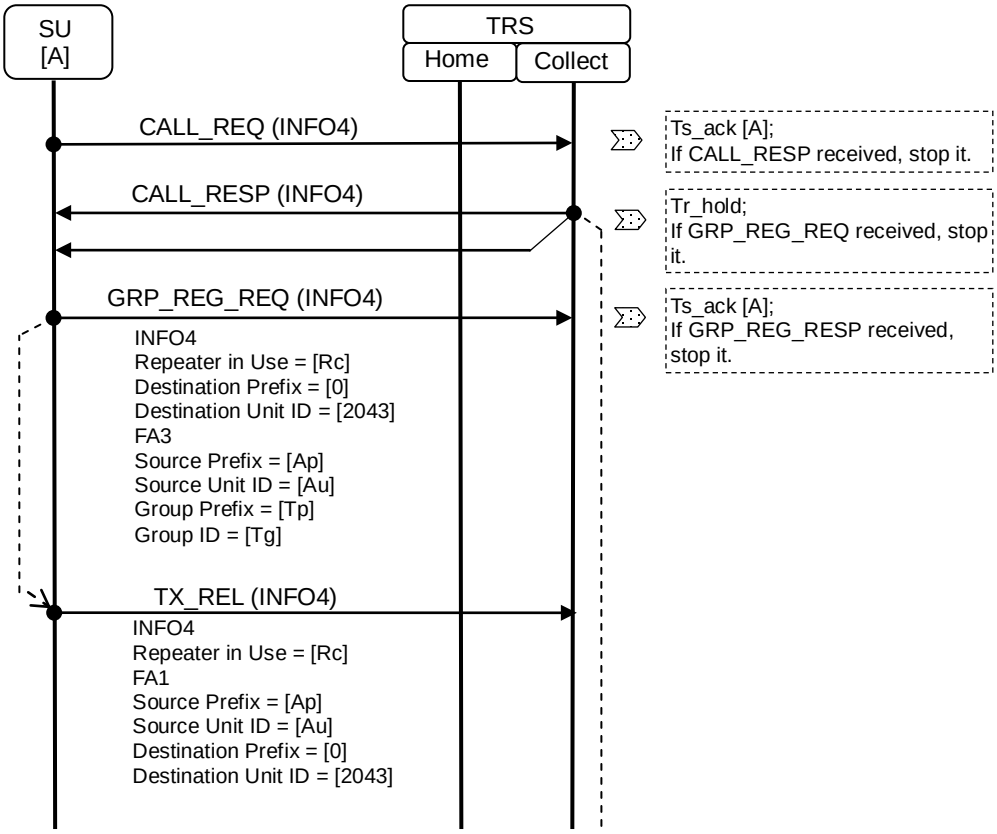
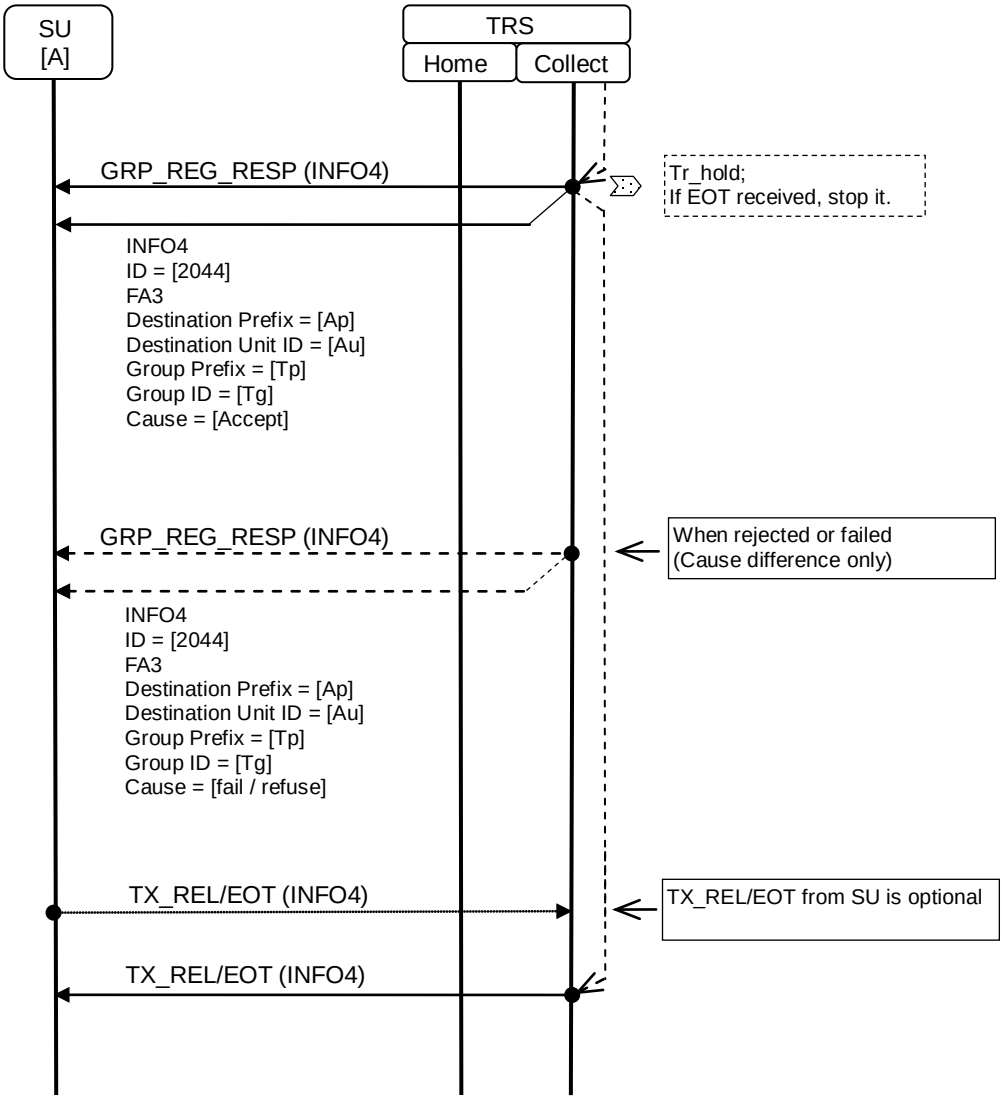


Figure 18.6-1 Sequence Diagram for Group Registration - 1



[Notes]
1) Visitor Group ID in GRP_REG_RESP is not used for a registration processing at Home.
2) TRS configure arbitrary unused Visitor Group ID. For following call requests, SU should use assigned Visitor Group ID.
3) When registration is rejected or failed, TC configures Null with Visitor Group ID in accordance with the situation of rejection or failure.

Figure 18.6-2 Sequence Diagram for Group Registration - 2

18.7. Authentication during Registration Process

This section shows a control sequence that TRS authenticate SU [A] while SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) is processing registration.

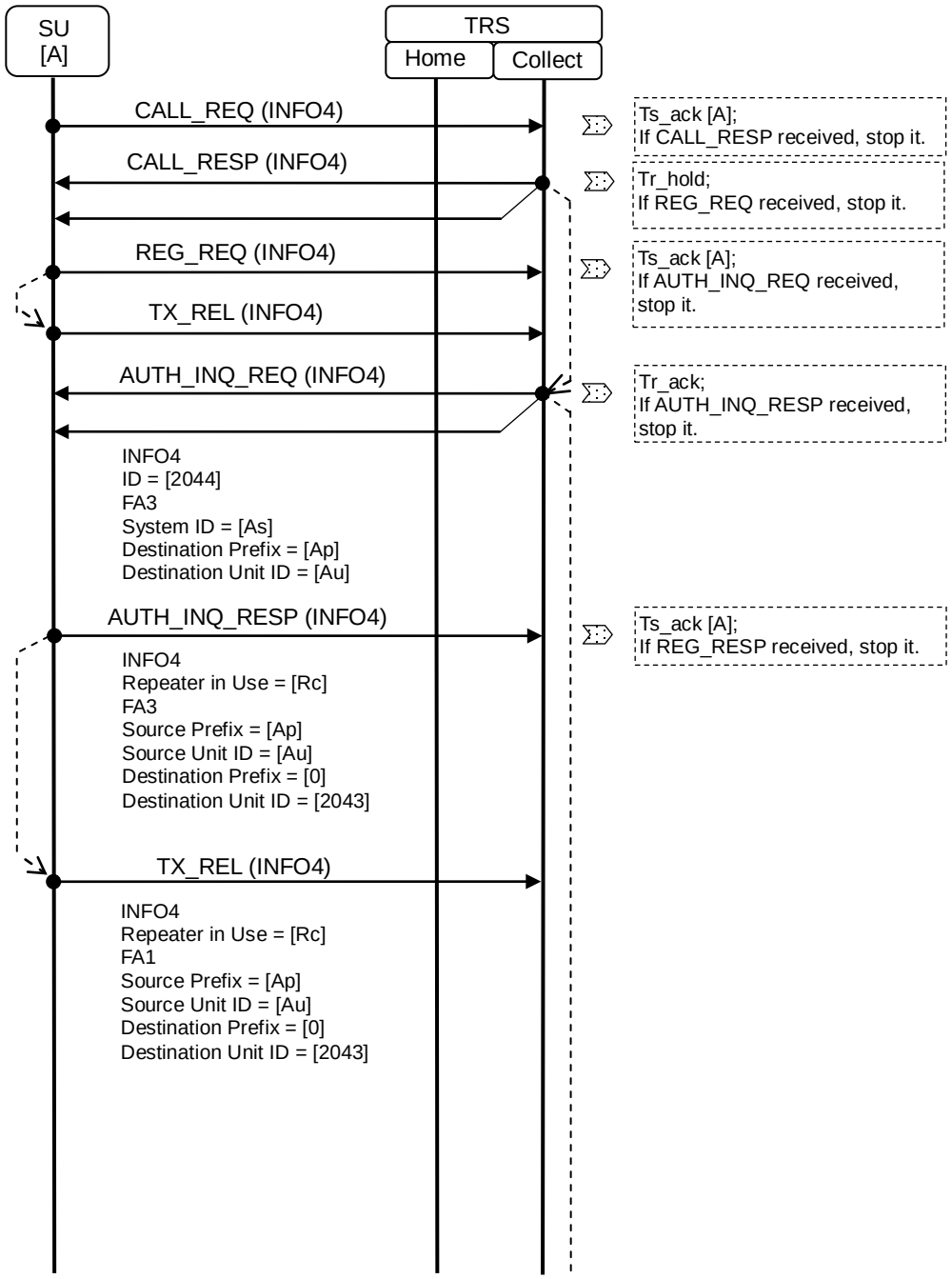


Figure 18.7-1 Sequence Diagram for Authentication during Registration - 1

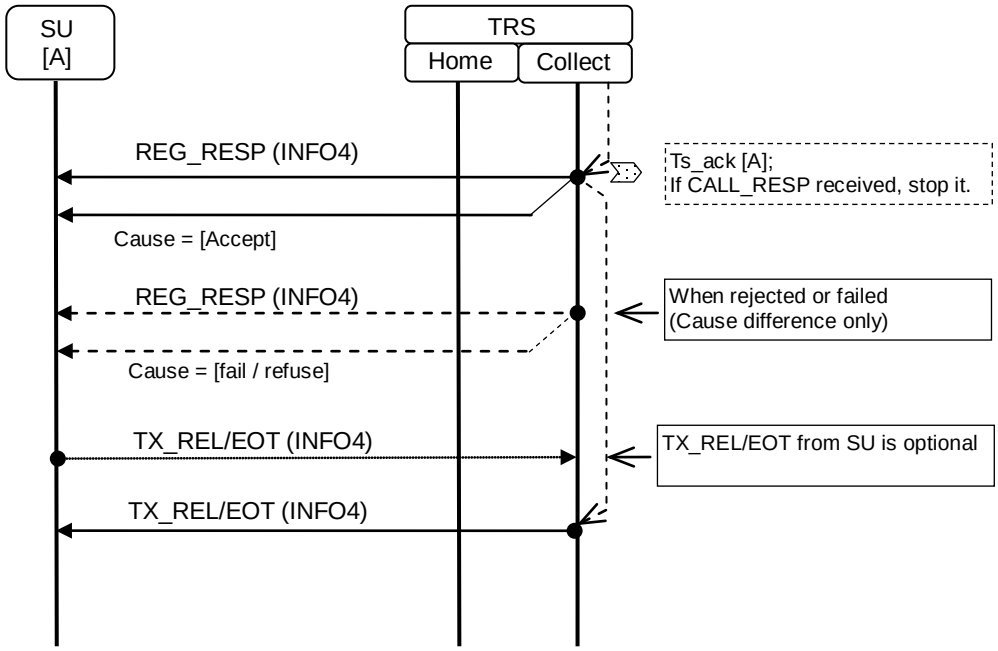
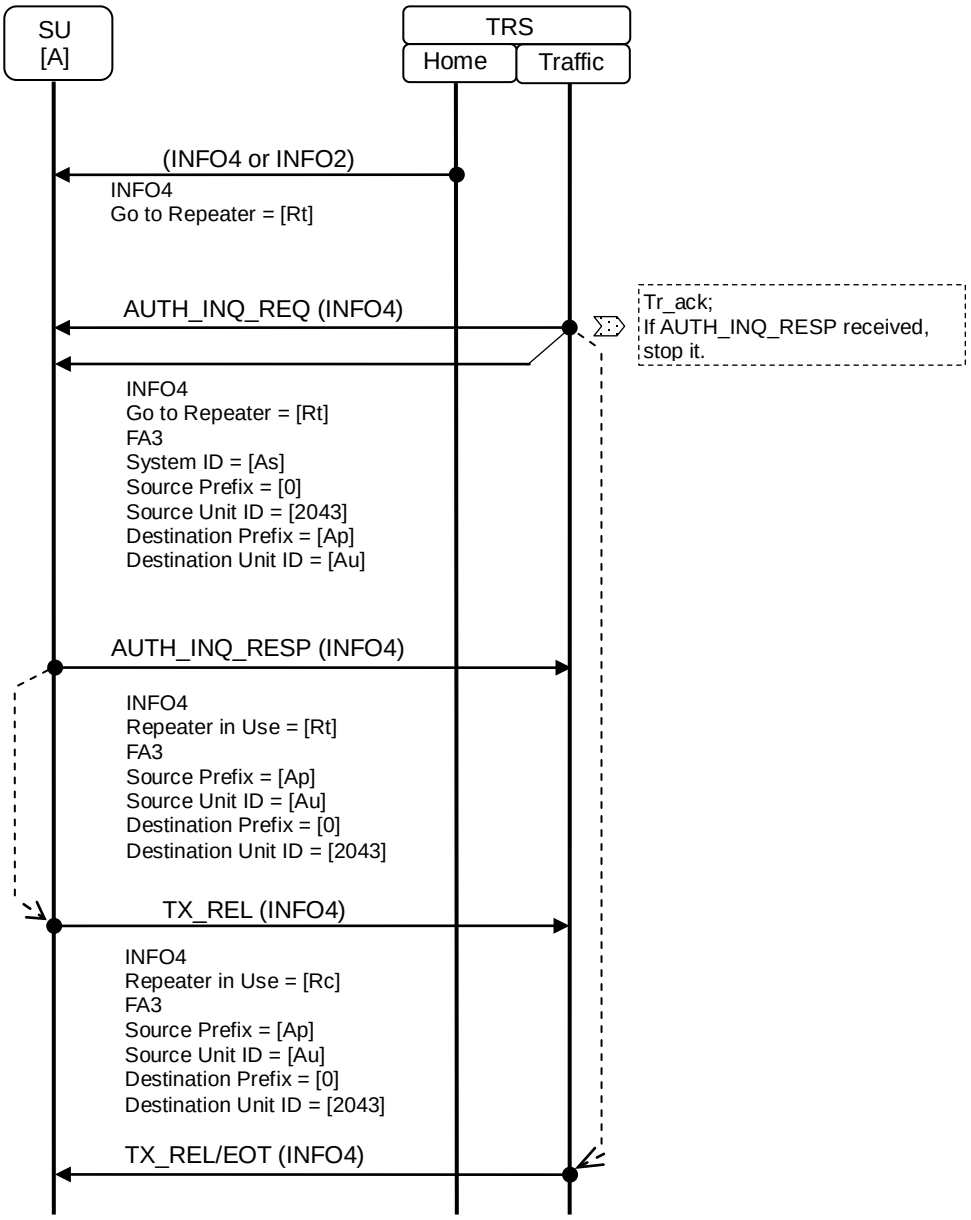


Figure 18.7-2 Sequence Diagram for Authentication during Registration - 2

18.8. Authentication Inquiry by Trunking Repeater

Following is a sequence to authenticate SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) by TR.



[Notes]
1) Regarding TX_REL by FACCH3, it is possible to use two FACCH1.

Figure 18.8-1 Sequence Diagram for Authentication Inquiry by Trunking Repeater

18.9. System Data Write during Registration Process

This section shows a control sequence that TRS transmits System Data to SU [A] while SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) is processing registration.

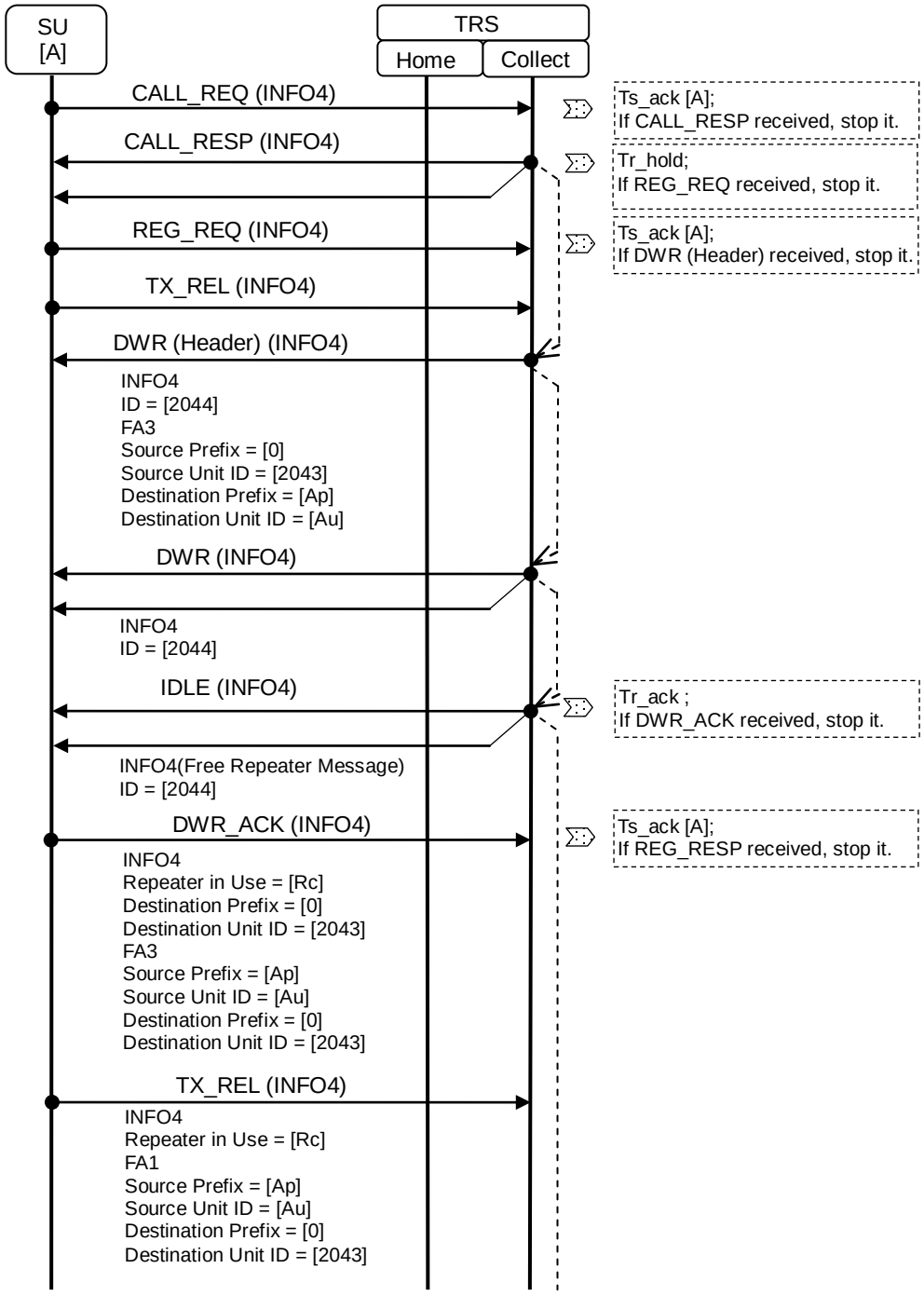


Figure 18.9-1 Sequence Diagram for System Data Write during Registration - 1

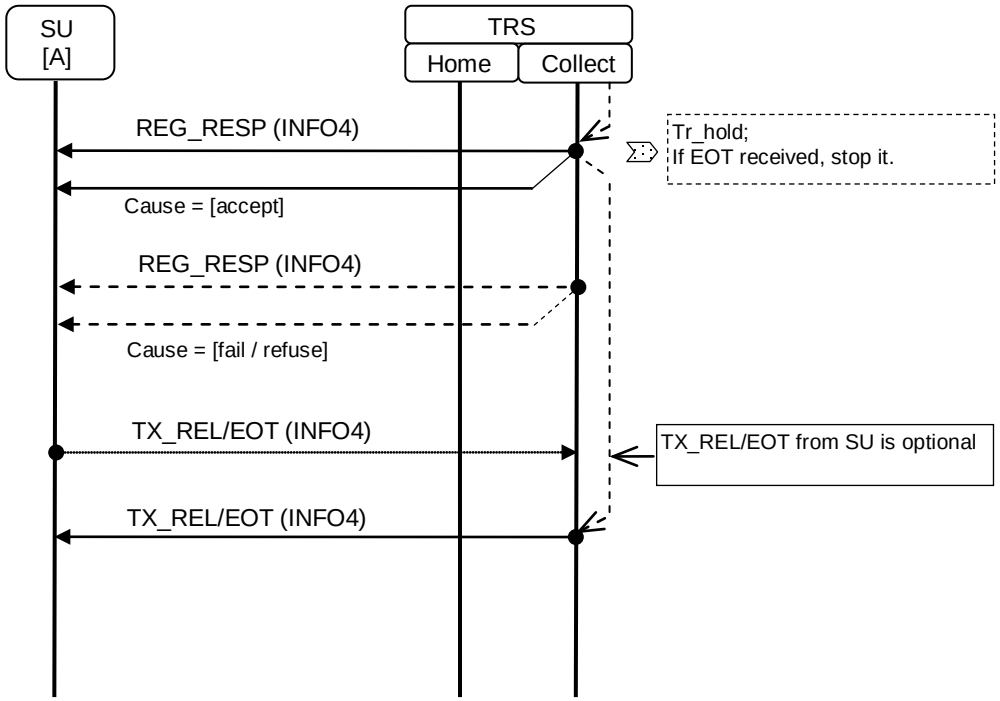
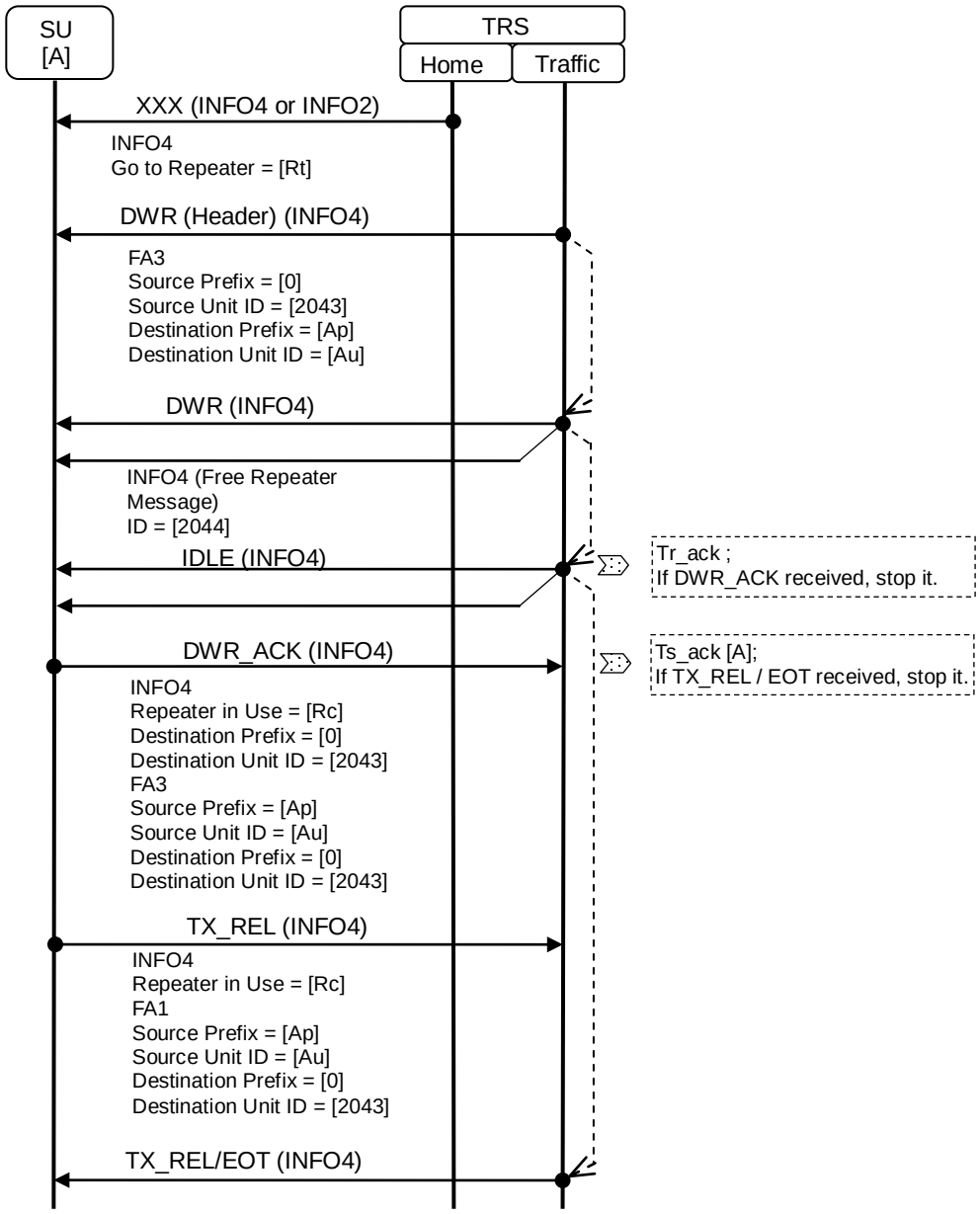


Figure 18.9-2 Sequence Diagram for System Data Write during Registration - 2

18.10. System Data Write by Trunking Repeater

This indicates control sequence when TRS transmits System Data to SU [A] (System ID = As, Prefix = Ap, Unit ID = Au)



[Notes]
1) XXX, which is a Layer3 message, is vary according to the situation.

Figure 18.10-1 Sequence Diagram for System Data Write by Trunking Repeater

18.11. Conference Group Call

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes a Conference Group Call to Talk Group [T] (Prefix = Tp, Group ID = Tg).

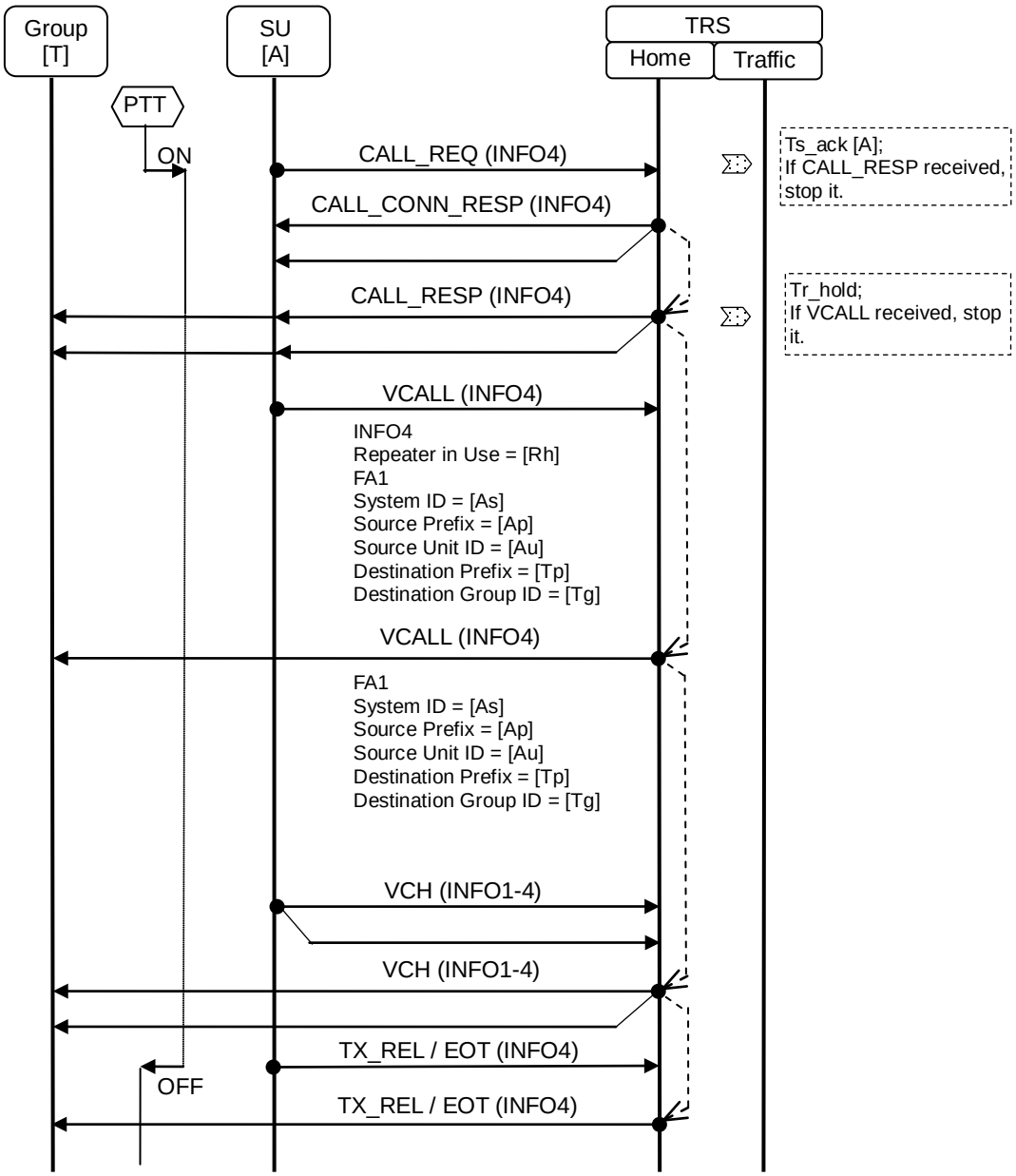


Figure 18.11-1 Sequence Diagram for Conference Group Call

18.12. Individual Call

18.12.1. Individual Call by Transmission Trunking Mode

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes an Individual Call to SU [B] (System ID= As, Prefix = Bp, Unit ID = Bu).

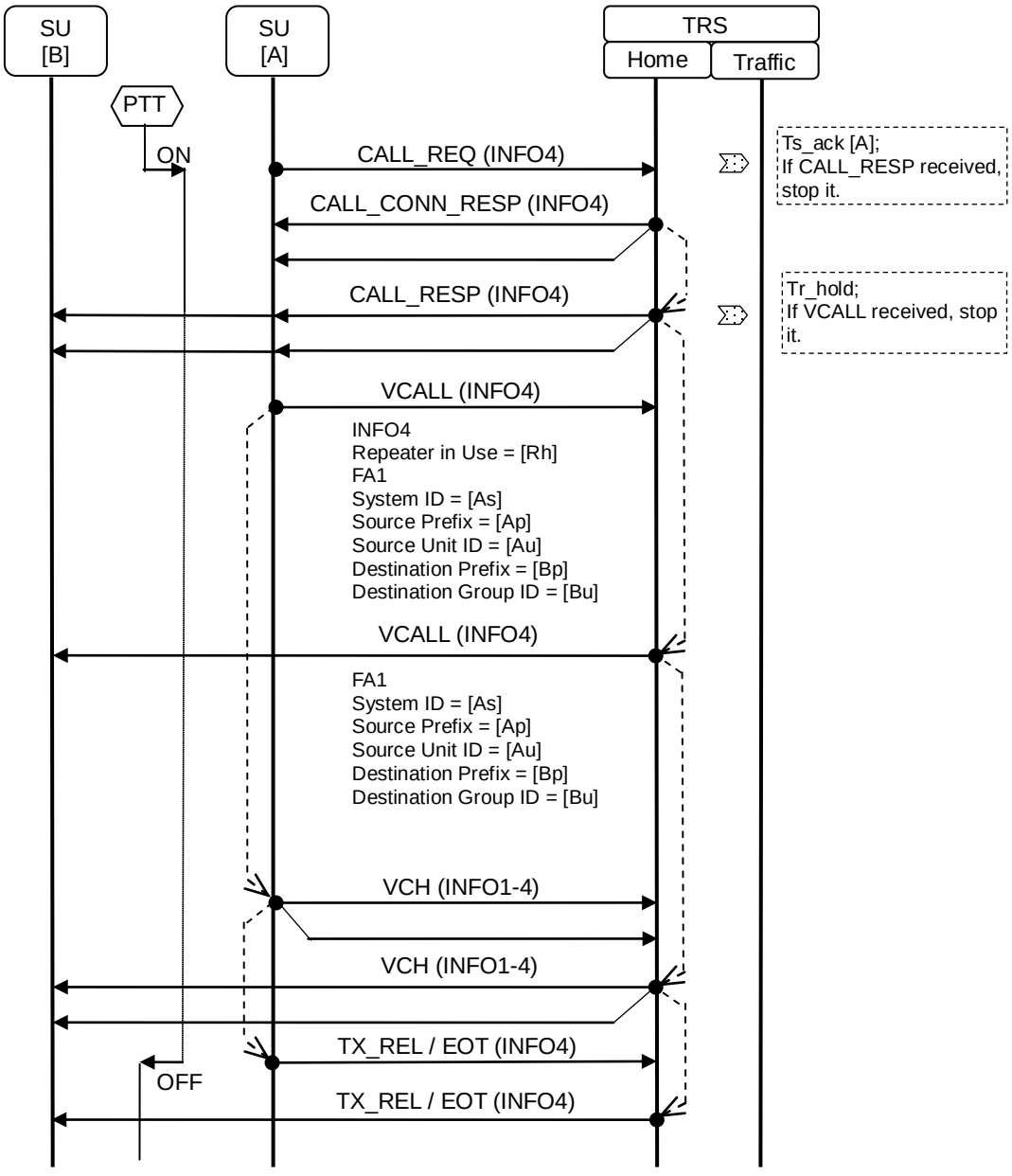


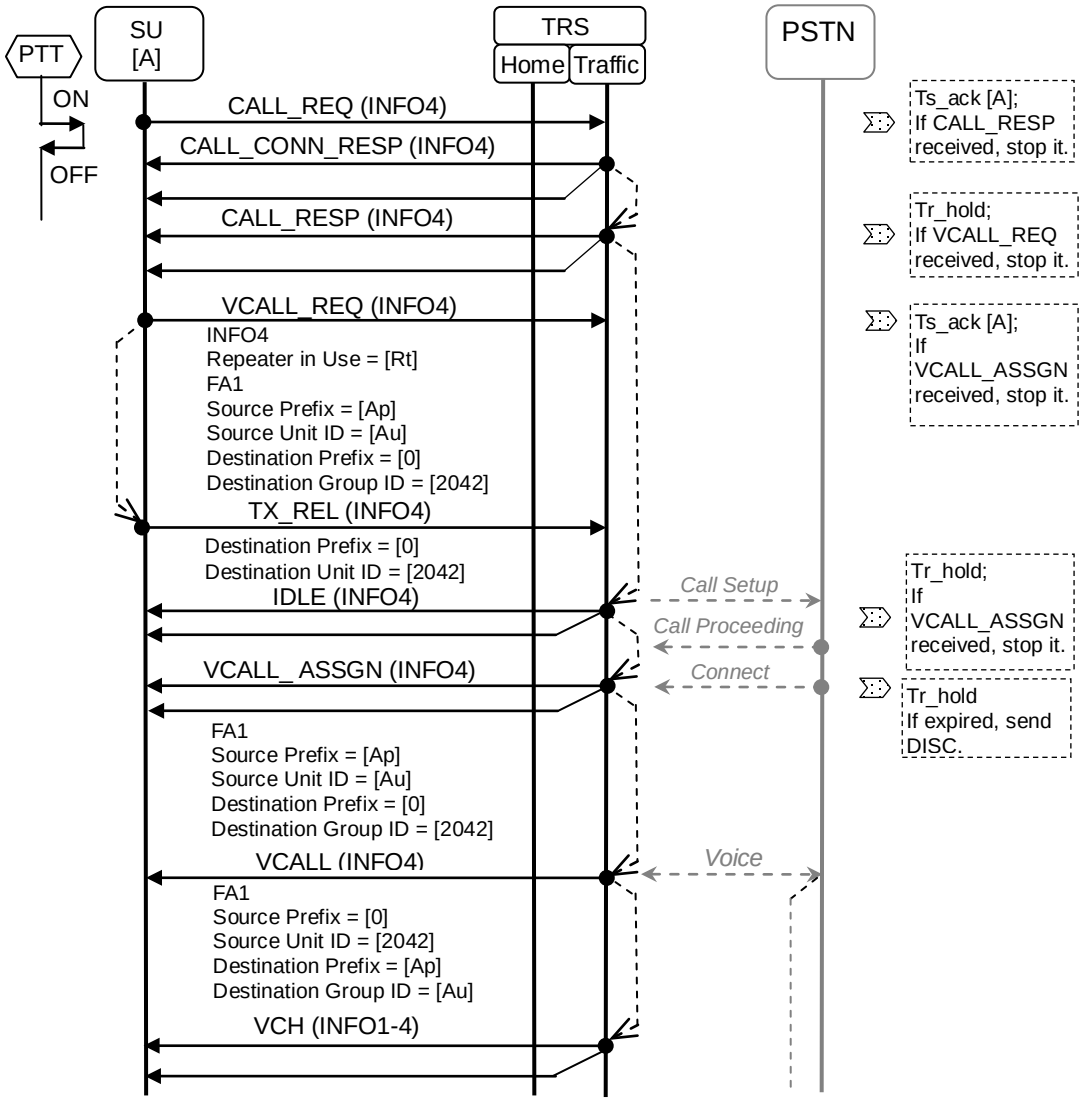
Figure 18.12-1 Sequence Diagram for Individual Call by Transmission Trunked Mode

18.13. Unit to PSTN Voice Call

This section shows control sequence to make PSTN Call from SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) to phone line (Unit ID = 2042) connected to TRS.

18.13.1. From call establishment phase to call phase

The following figure shows a sequence from call request by SU [A] to assignment of RTCH2.

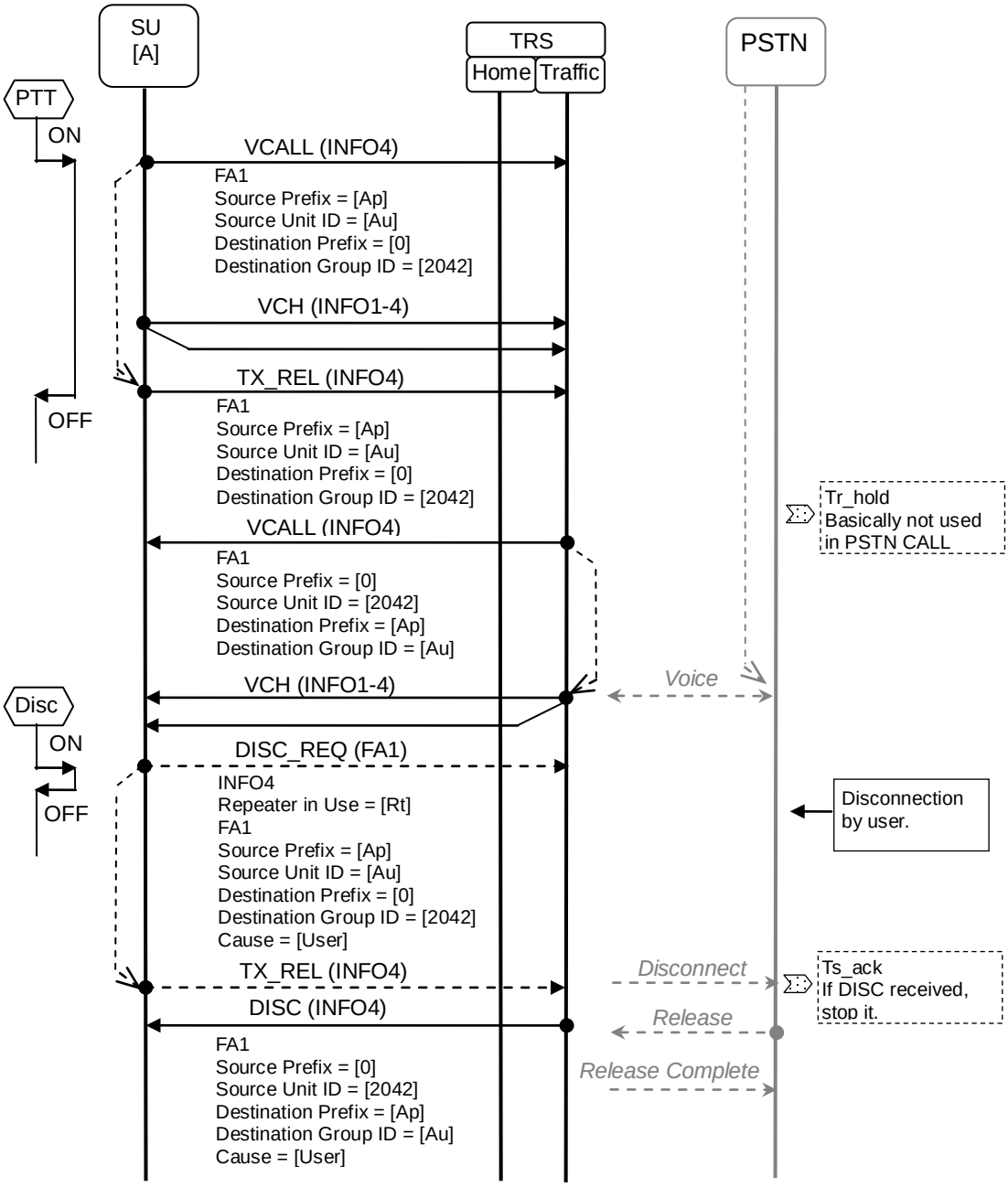


[Notes]
1) This is a case when Home Repeater is Busy and Traffic Repeater is Free
2) Procedure between TRS and PSTN is not specified.

Figure 18.13-1 Sequence Diagram for Unit to PSTN Voice Call – 1

18.13.2. From call phase to call termination phase

The following figure shows a sequence from assignment of RTCH2 to finishing a call by user operation.



[Notes]

1) For PSTN Call, Timer Tr hold is not used basically. Usage of these timers is optional.
2) Because voice signal is always transmitted from PSTN to Outbound RTCH2, TX_REL transmission through outbound RTCH2 at RTCH2 is optional.

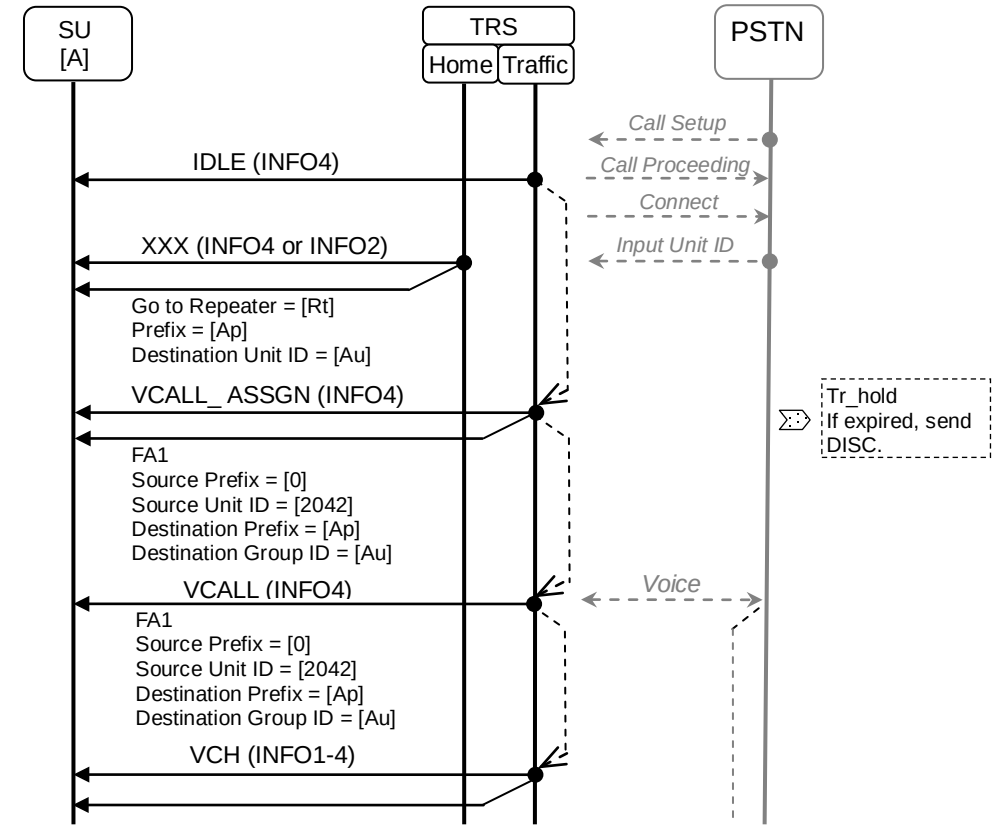
Figure 18.13-2 Sequence Diagram for Unit to PSTN Voice Call – 2

18.14. PSTN to Unit Voice Call

This chapter shows a control sequence to make a voice call from phone line (Unit ID = 2042) connected to TRS to SU [A] (System ID = As, Prefix = Ap, Unit ID = Au).

18.14.1. From call establishment phase to call phase

The following figure shows a sequence to assignment of RTCH2 to SU [A].

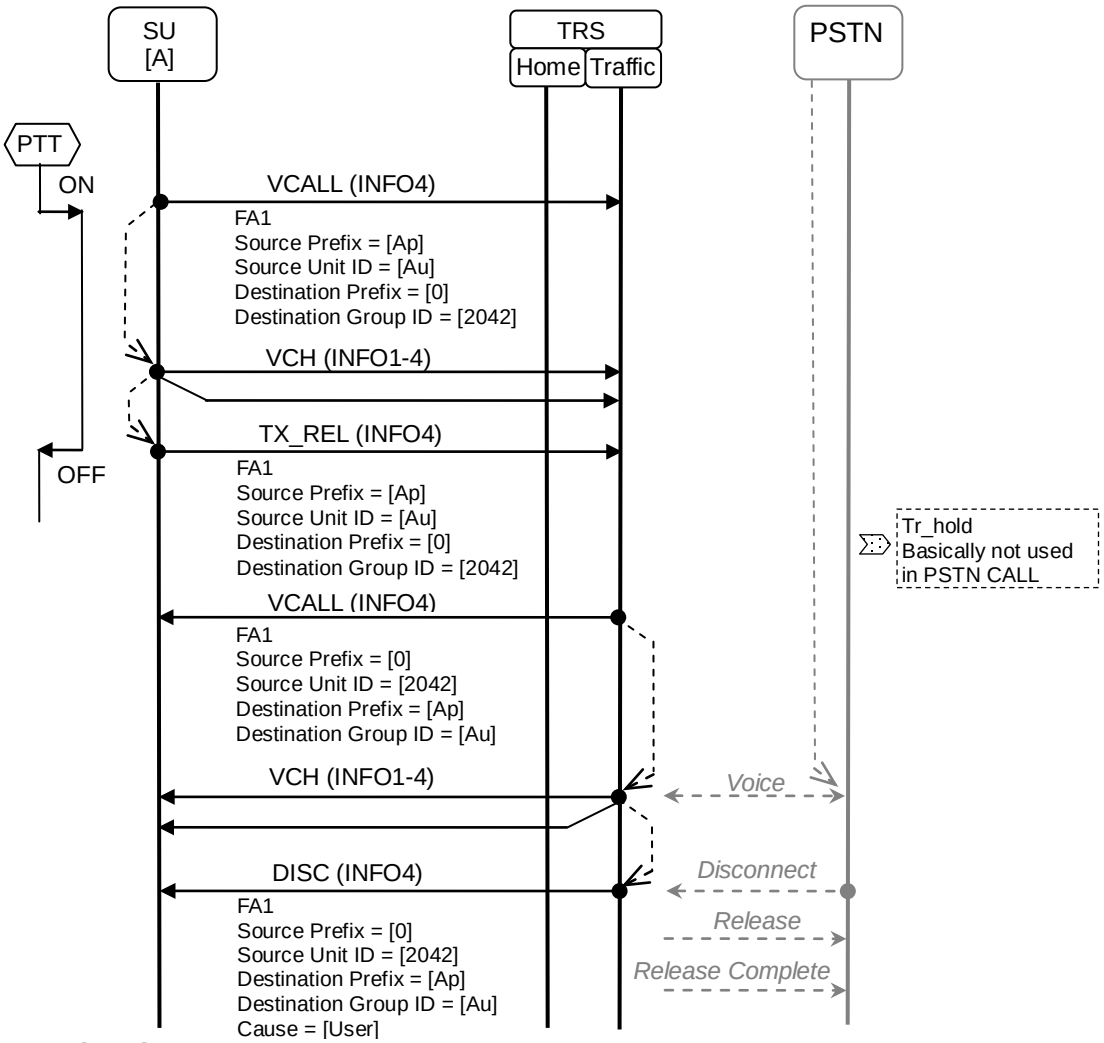


[Notes]
1) This is a case when Home Repeater is Busy and Traffic Repeater is Free.
2) Procedure between TRS and PSTN is not specified.
3) XXX, which is a Layer3 message, is vary according to the situation.

Figure 18.14-1 Sequence Diagram for PSTN to Unit Voice Call - 1

18.14.2. From call phase to call termination phase

The following figure shows a sequence from assignment of RTCH2 to finishing a call by PSTN.



[Notes]

1) For PSTN Call, Timer Tr hold is not used basically. Usage of these timers is optional.

Figure 18.14-2 Sequence Diagram for PSTN to Unit Voice Call – 2

18.15. Broadcast Data Call

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes a Broadcast Data Call to Talk Group [T] (Prefix = Tp, Group ID = Tg).

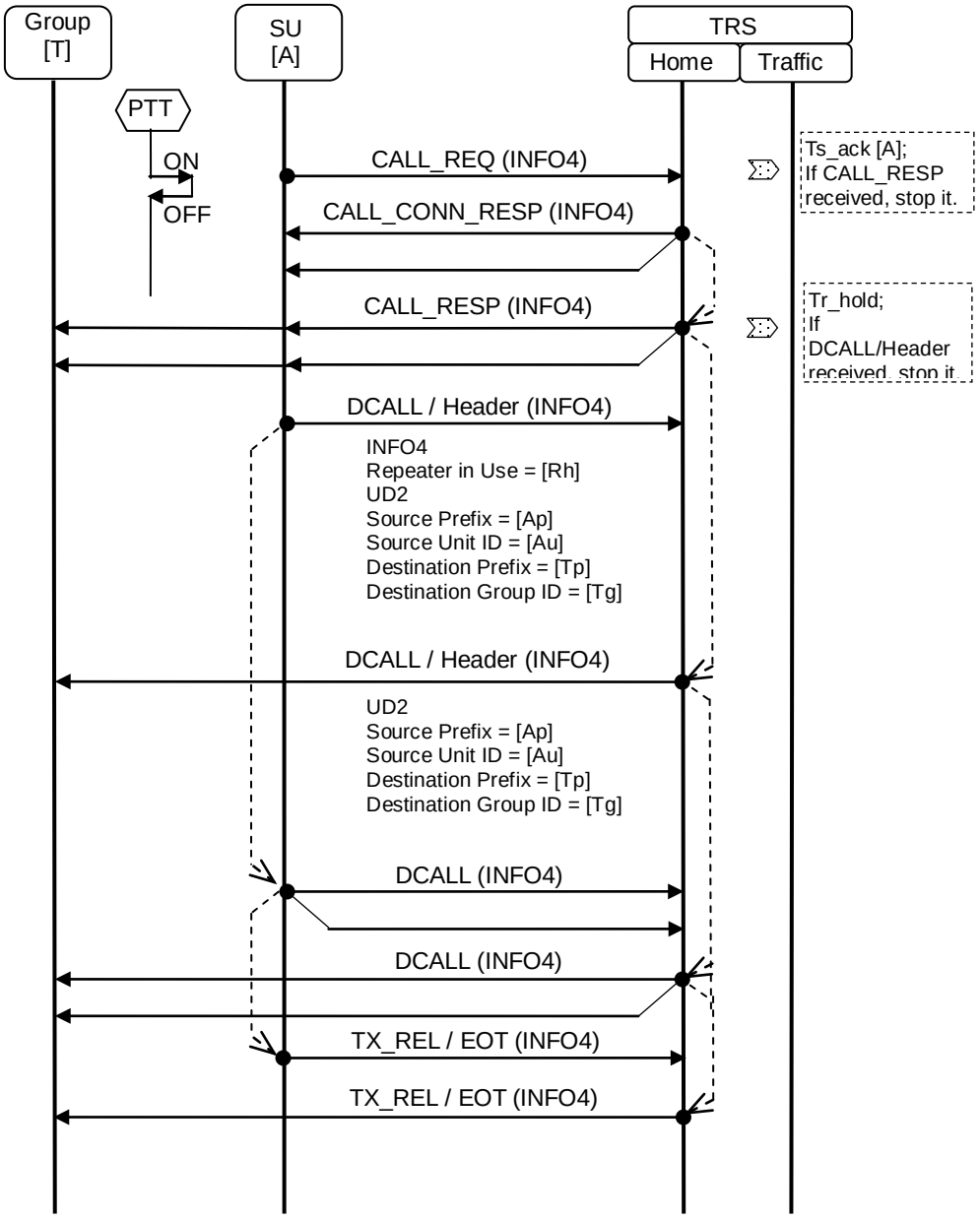


Figure 18.15-1 Sequence Diagram for Broadcast Data Call

18.16. Unit to Unit Data Call

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes an Unit to Unit Data Call to SU [B] (System ID= As, Prefix = Bp, Unit ID = Bu).

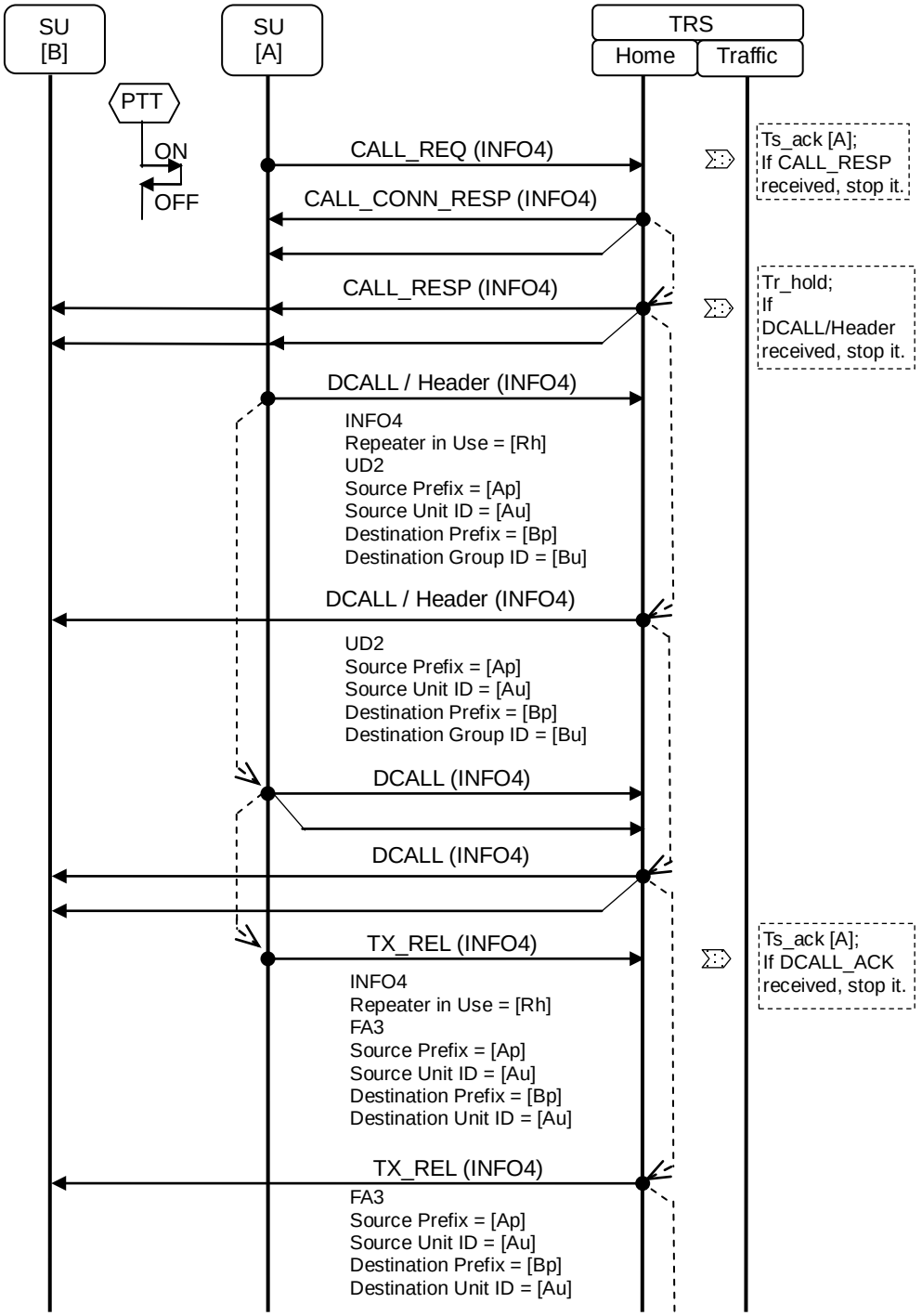
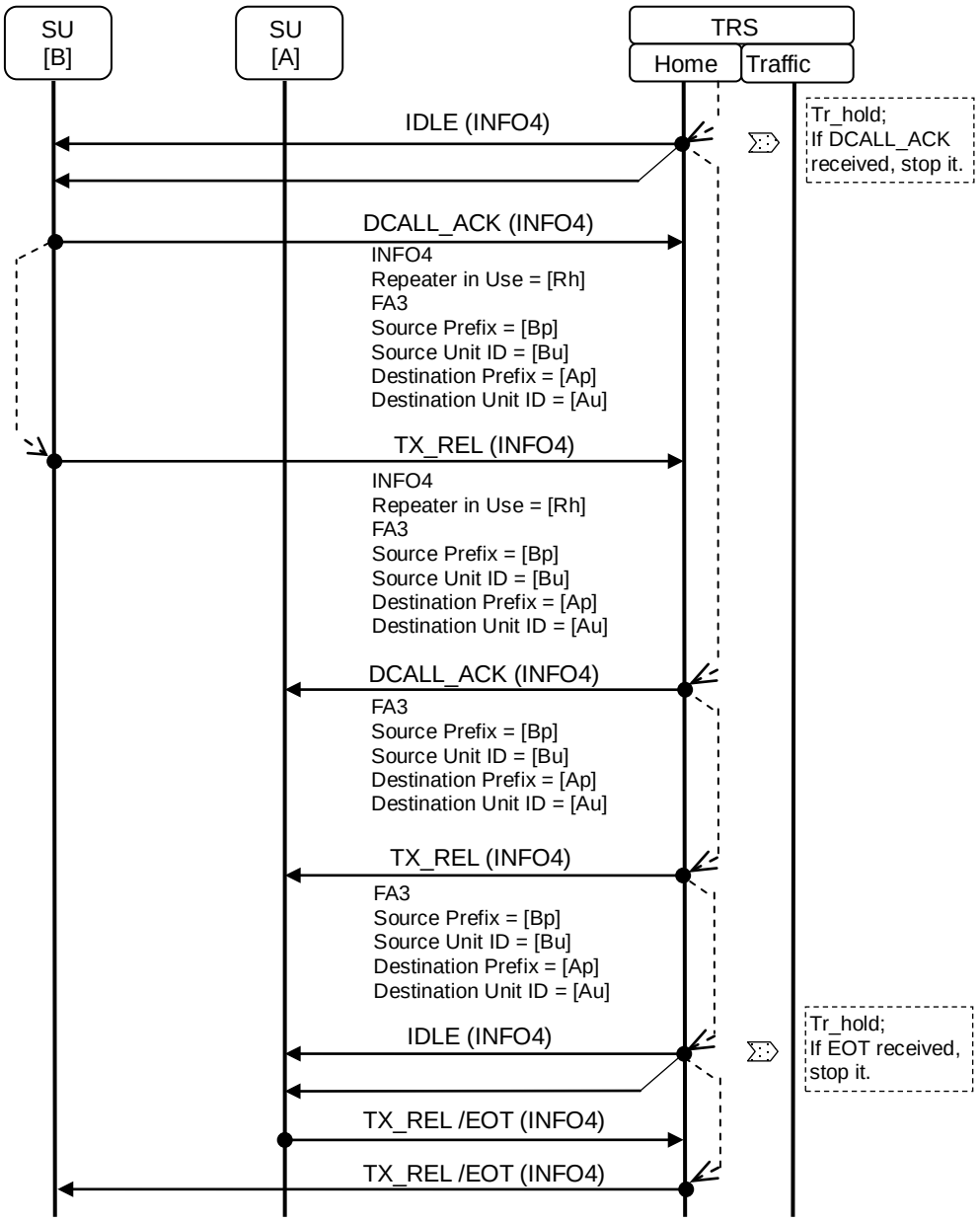


Figure 18.16-1 Sequence Diagram for Unit to Unit Data Call - 1



[Notes]
1) This sequence is applied to a case for one packet. To send multiple packets or to retry, this sequence is repeated.
2) Regarding TX_REL by FACCH3, it is possible to use two FACCH1.

Figure 18.16-2 Sequence Diagram for Unit to Unit Data Call - 2

18.17. Broadcast Short Data Call

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes a Broadcast Short Data Call to Talk Group [T] (Prefix = Tp, Group ID = Tg).

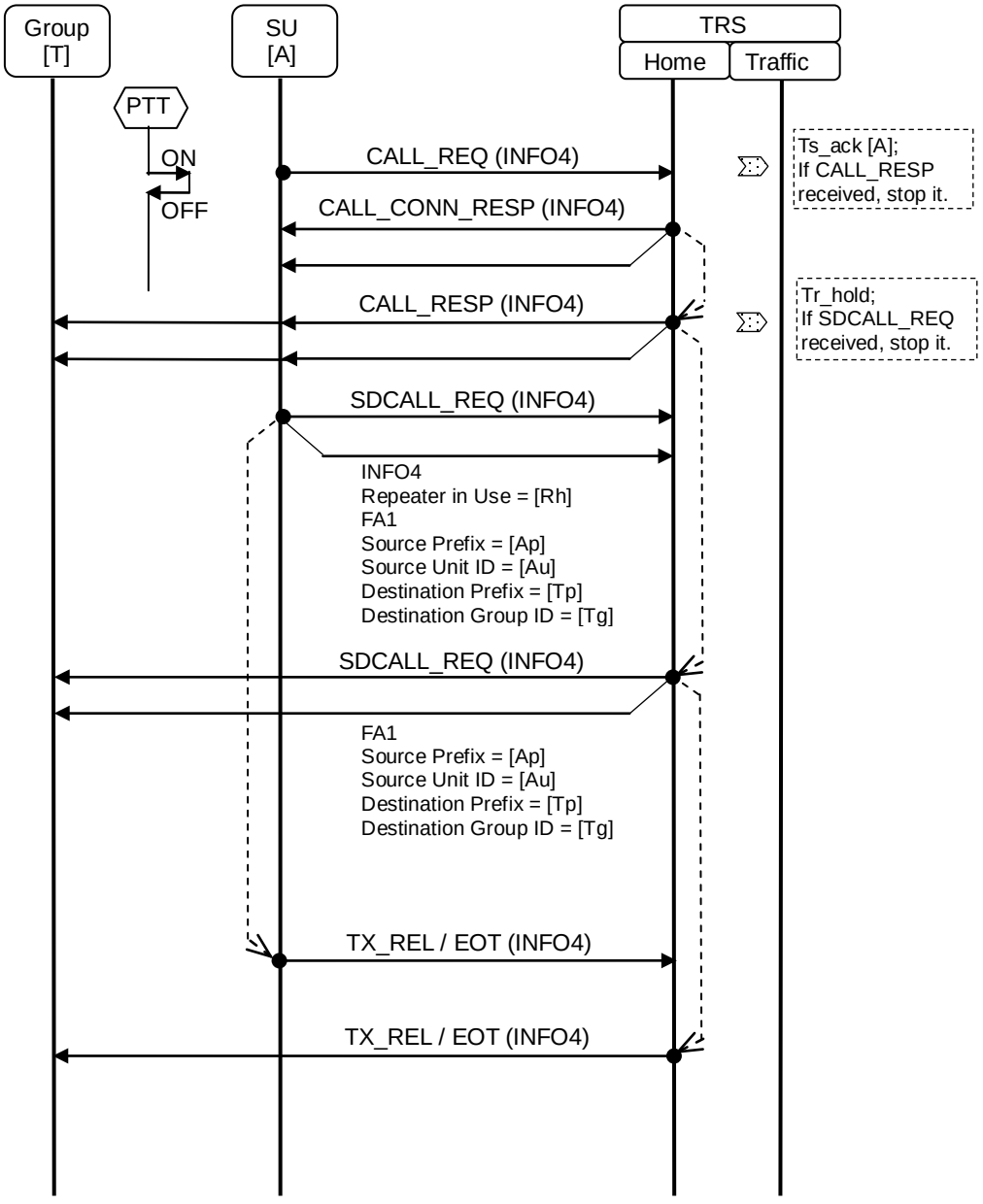


Figure 18.17-1 Sequence Diagram for Broadcast Short Data Call

18.18. Unit to Unit Short Data Call

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes an Unit to Unit Short Data Call to SU [B] (System ID= As, Prefix = Bp, Unit ID = Bu).

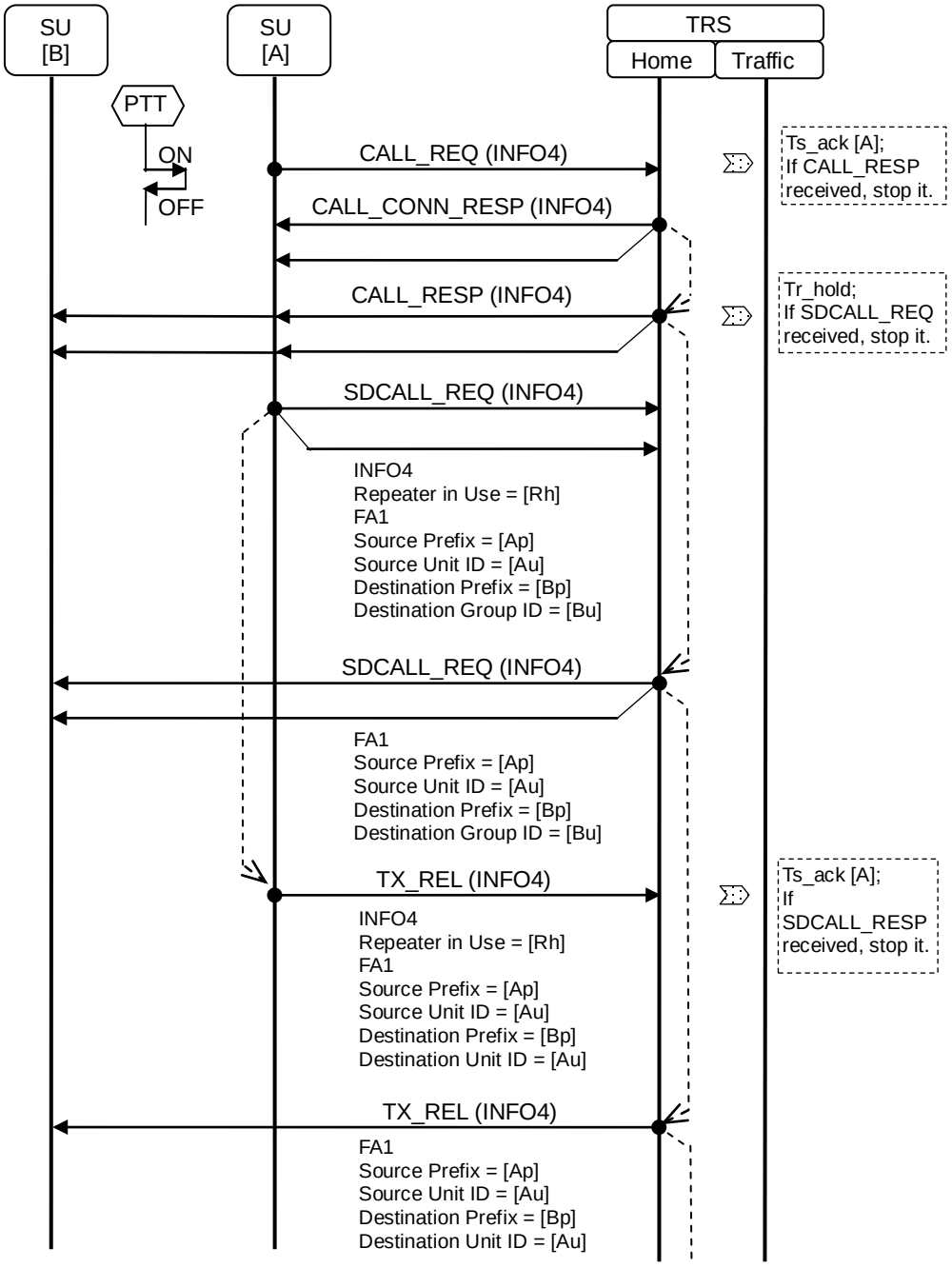
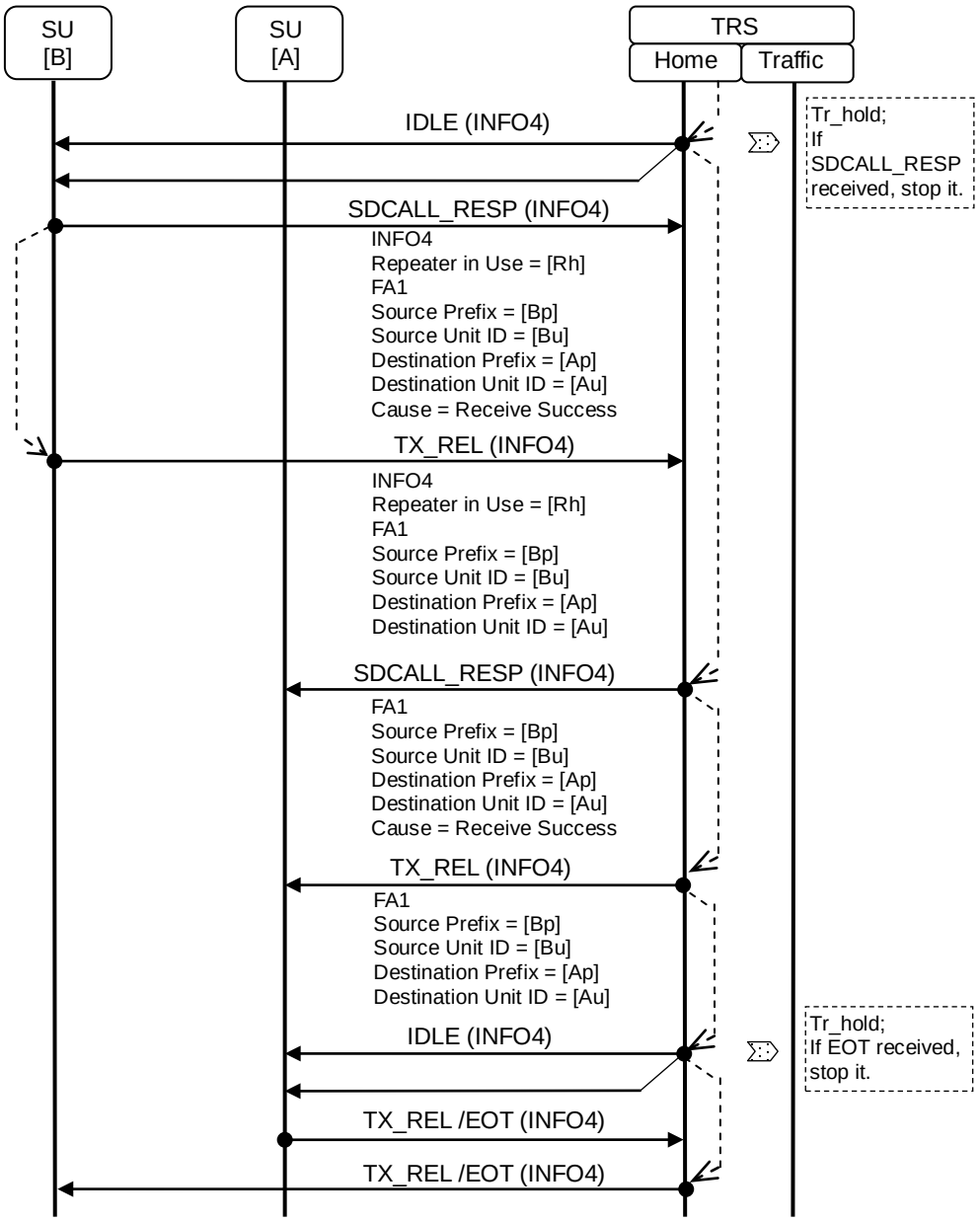


Figure 18.18-1 Sequence Diagram for Unit to Unit Short Data Call - 1



[Notes]
1) SU [A] evaluated based on cause the status of SDCALL_RESP message transmitted from SU [B].

Figure 18.18-2 Sequence Diagram for Unit to Unit Short Data Call - 2

18.19. Status Call

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes Status Call to SU [B] (System ID= As, Prefix = Bp, Unit ID = Bu).

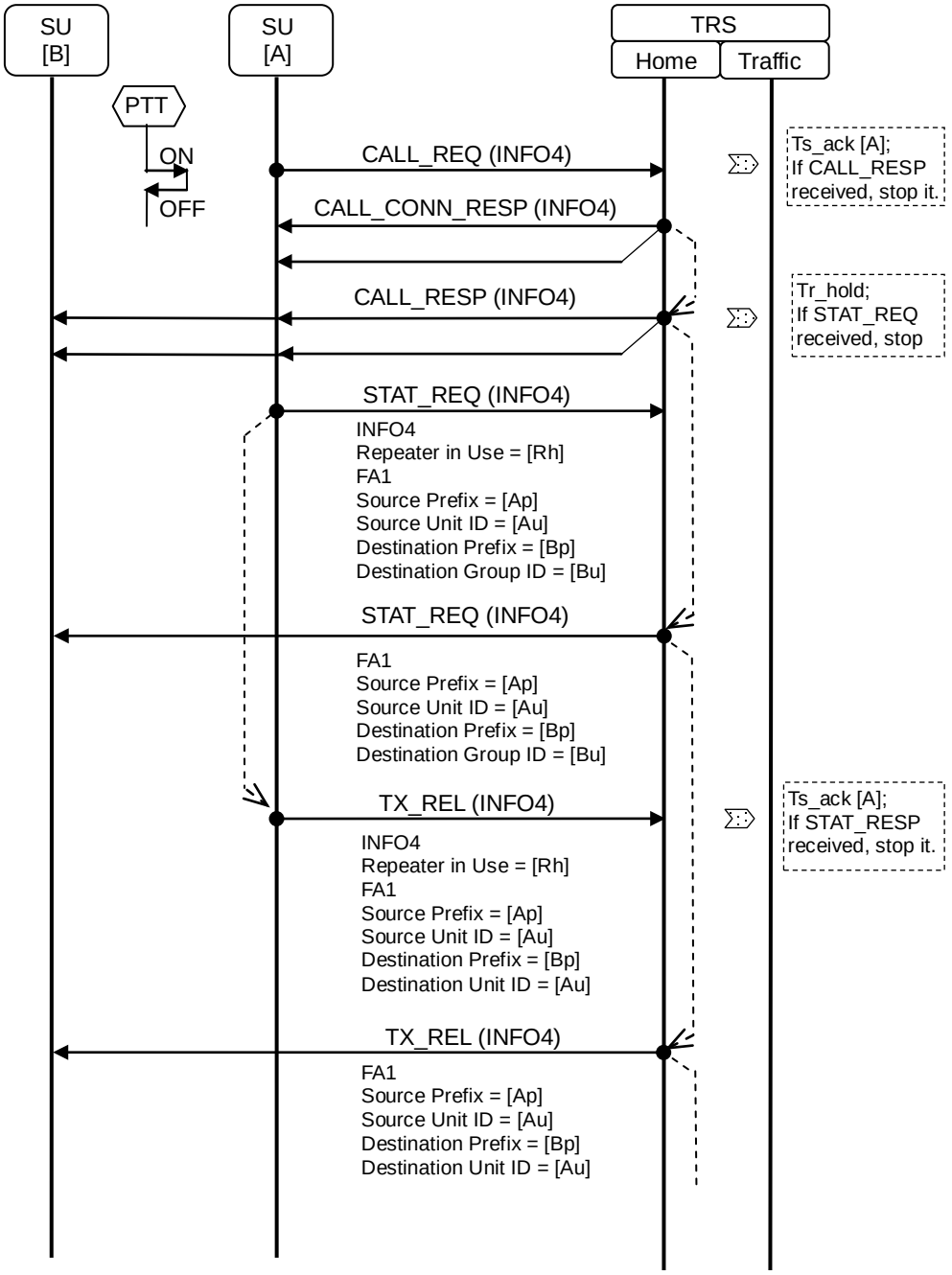
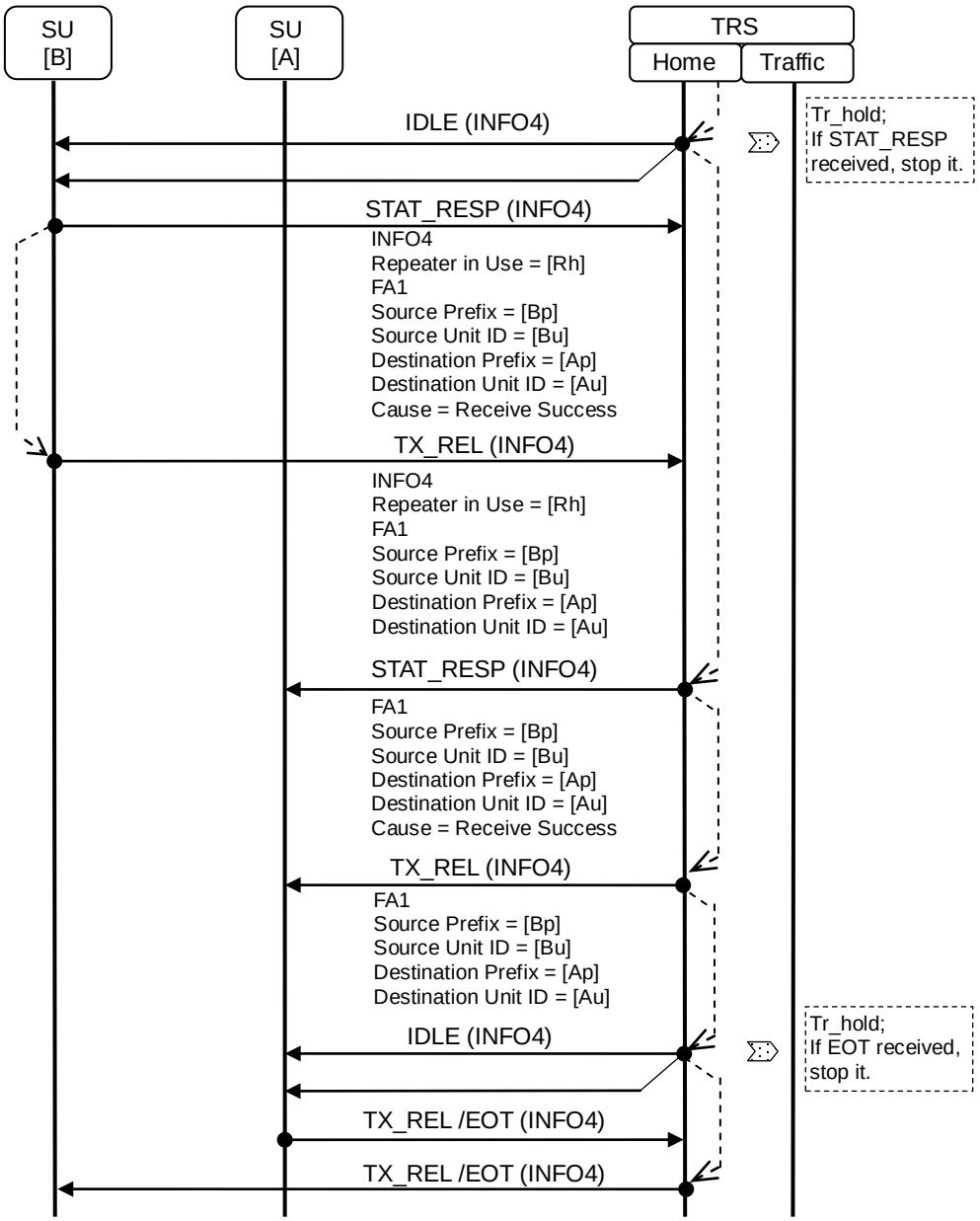


Figure 18.19-1 Sequence Diagram for Status Call - 1



[Notes]
1) SU [A] evaluated based on cause the status of STAT_RESP message transmitted from SU [B].

Figure 18.19-2 Sequence Diagram for Status Call - 2

18.20. Status Inquiry

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes a Status Inquiry to SU [B] (System ID= As, Prefix = Bp, Unit ID = Bu).

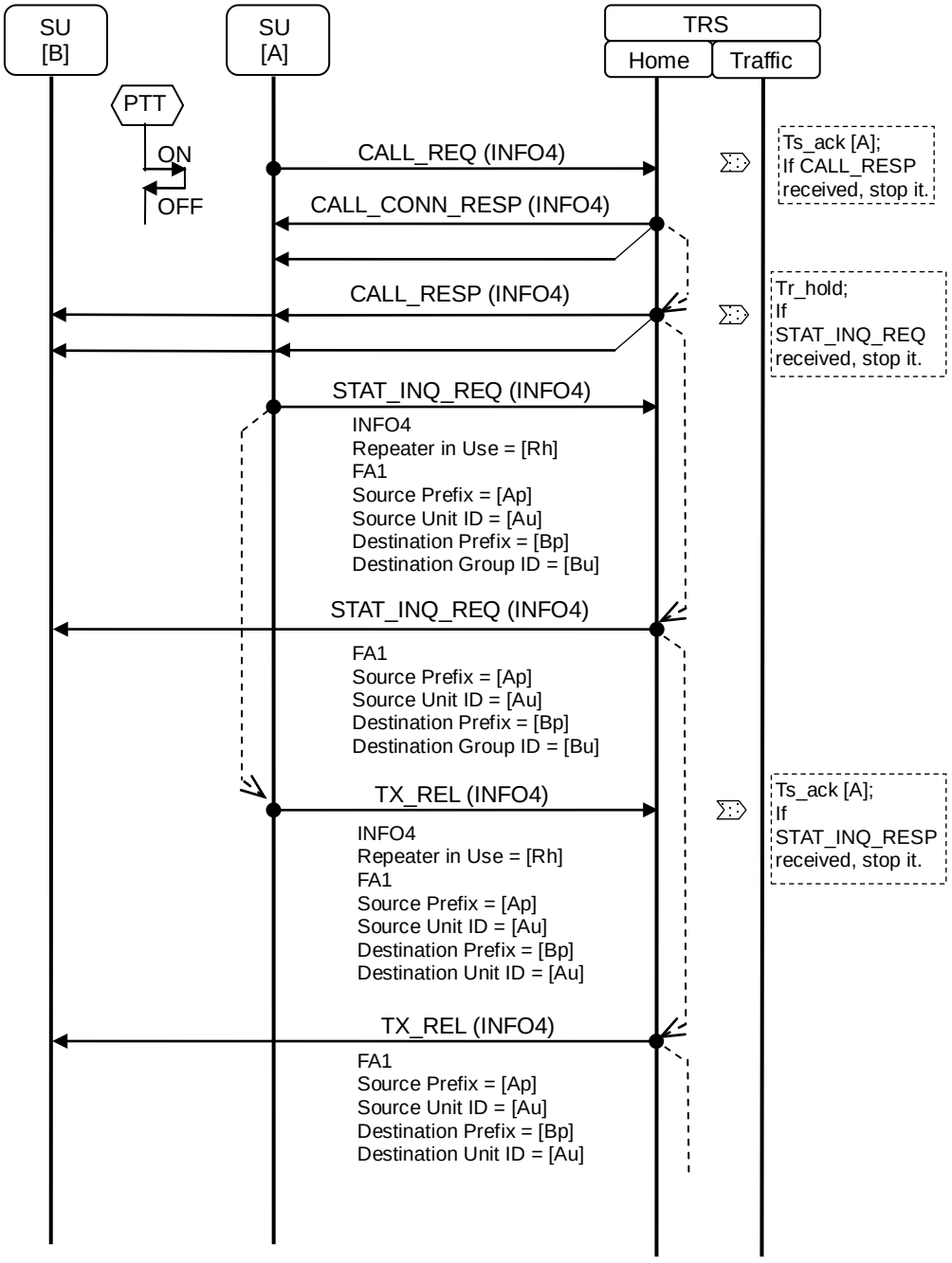
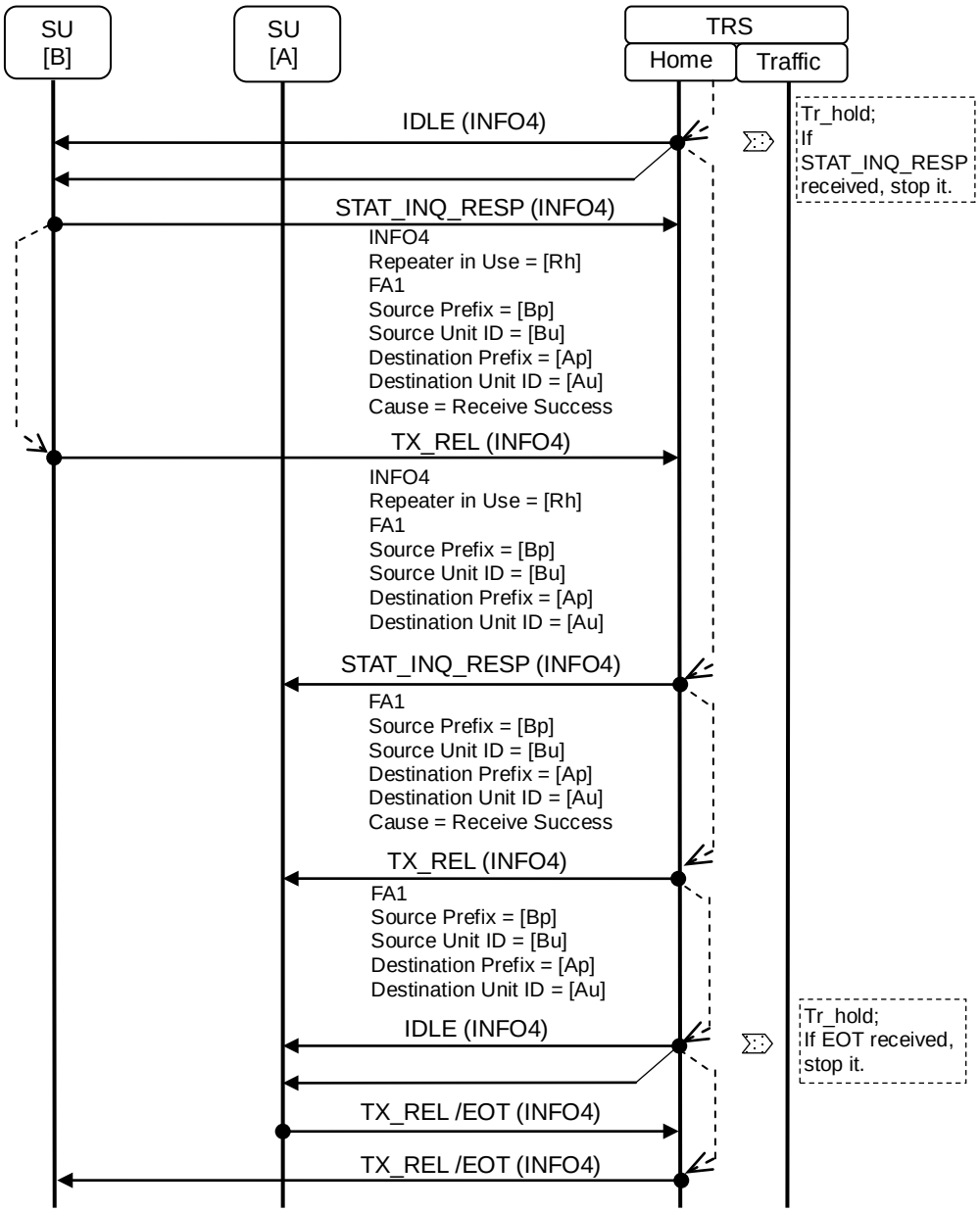


Figure 18.20-1 Sequence Diagram for Status Inquiry- 1



[Notes]
1) SU [A] evaluated based on cause the status of STAT_INQ_RESP message transmitted from SU [B].

Figure 18.20-2 Sequence Diagram for Status Inquiry- 2

18.21. Broadcast Status Call

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes a Broadcast Status Call to Talk Group [T] (Prefix = Tp, Group ID = Tg).

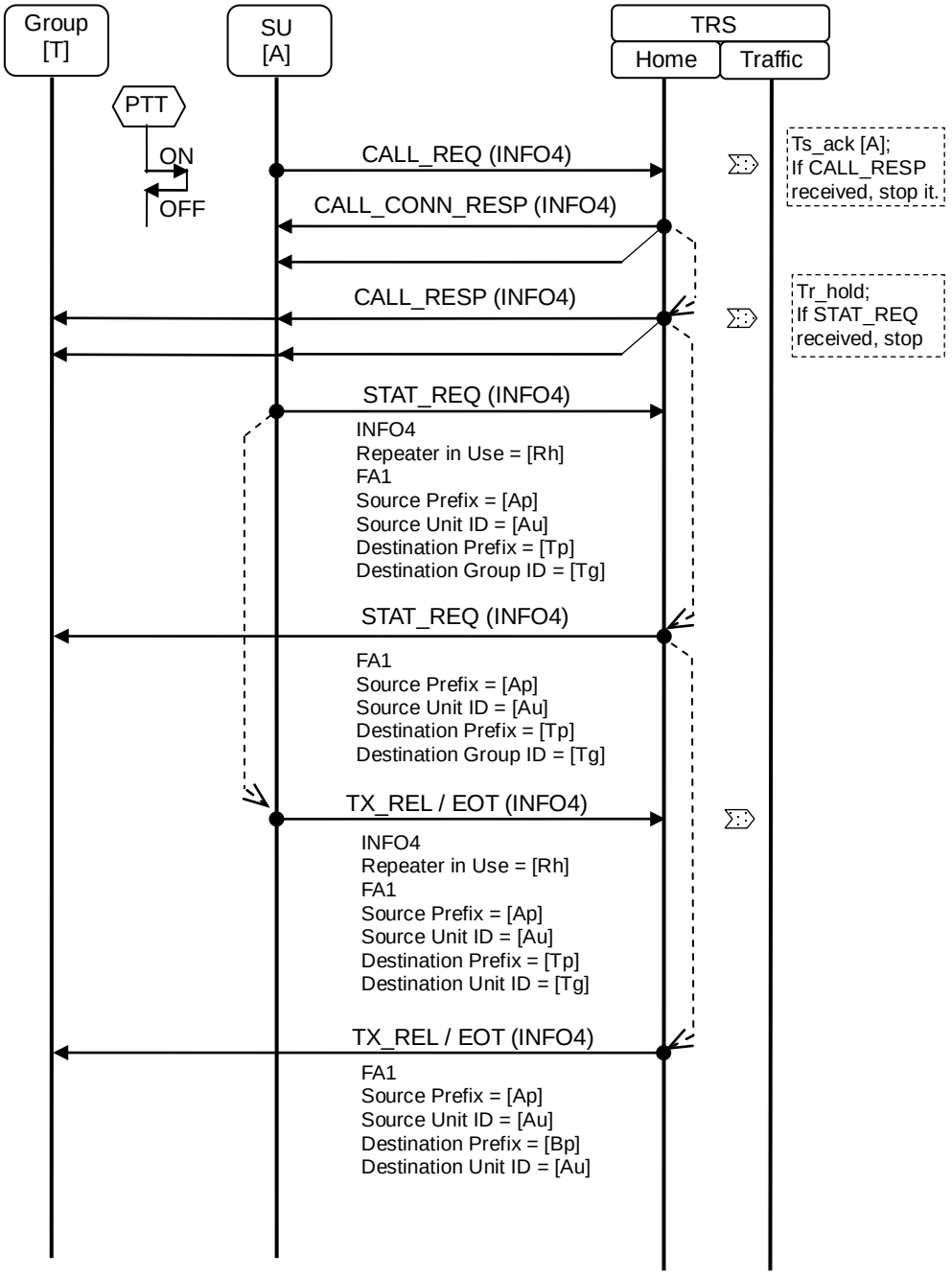


Figure 18.21-1 Sequence Diagram for Broadcast Status Call

18.22. Remote Stun

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes a Remote Stun to SU [B] (System ID= As, Prefix = Bp, Unit ID = Bu).

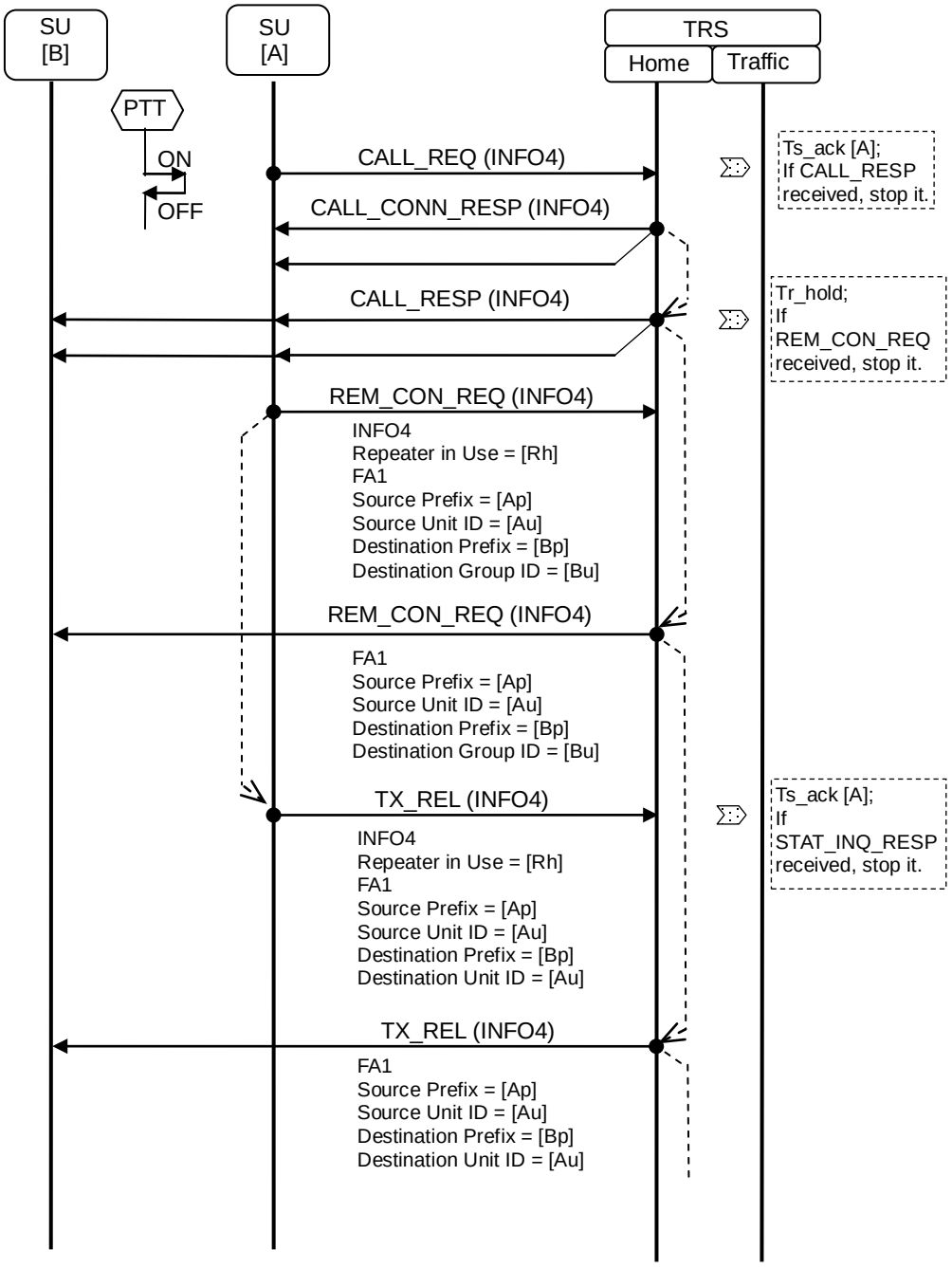
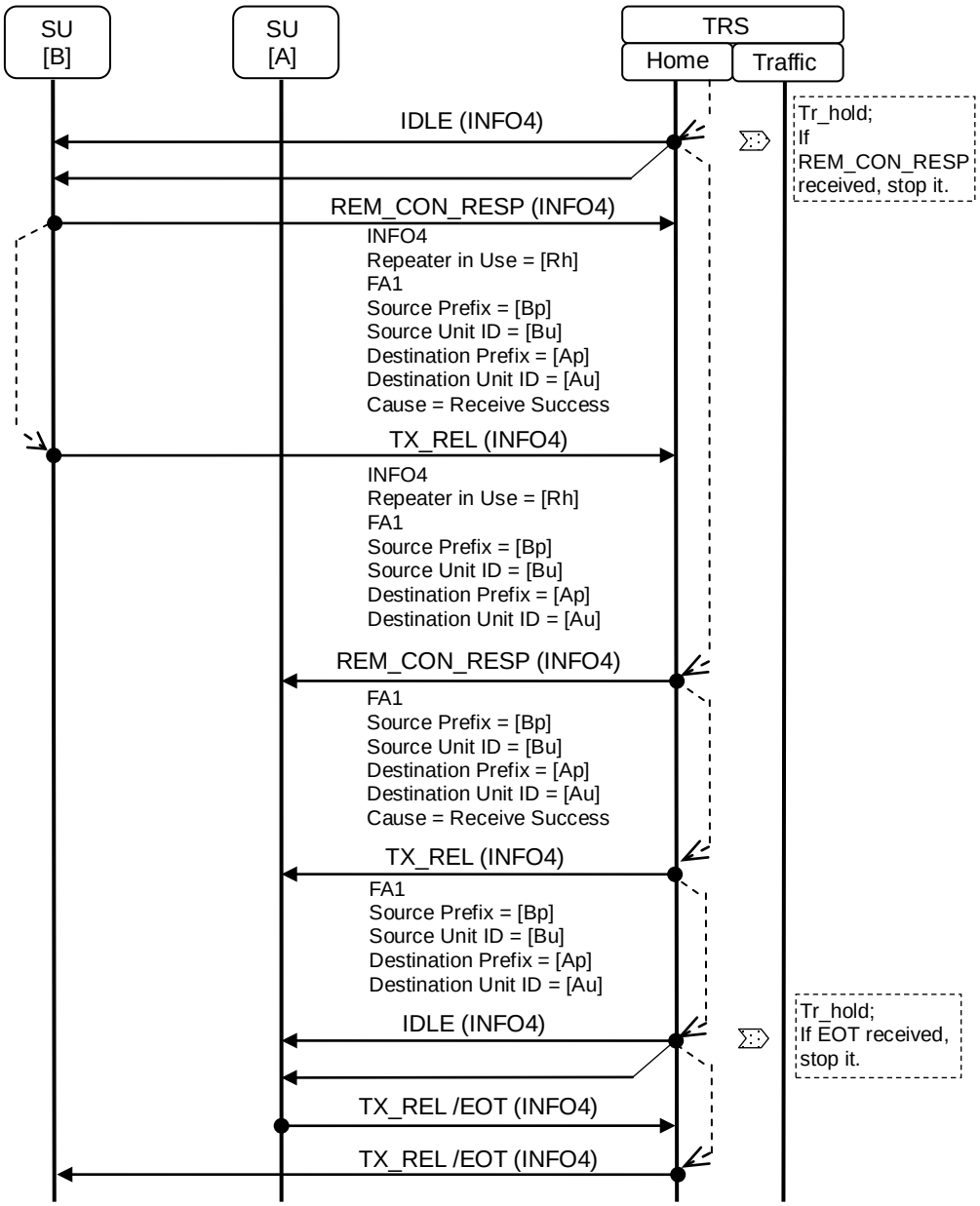


Figure 18.22-1 Sequence Diagram for Remote Stun - 1



[Notes]
1) SU [A] evaluated based on cause the status of REM_CON_RESP message transmitted from SU [B].
2) The same information element of Control Command can be used for Stun/Revival/Kill

Figure 18.22-2 Sequence Diagram for Remote Stun - 1

18.23. Remote Monitor

The following figure shows the control sequence when SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) makes a Remote Monitor to SU [B] (System ID= As, Prefix = Bp, Unit ID = Bu).

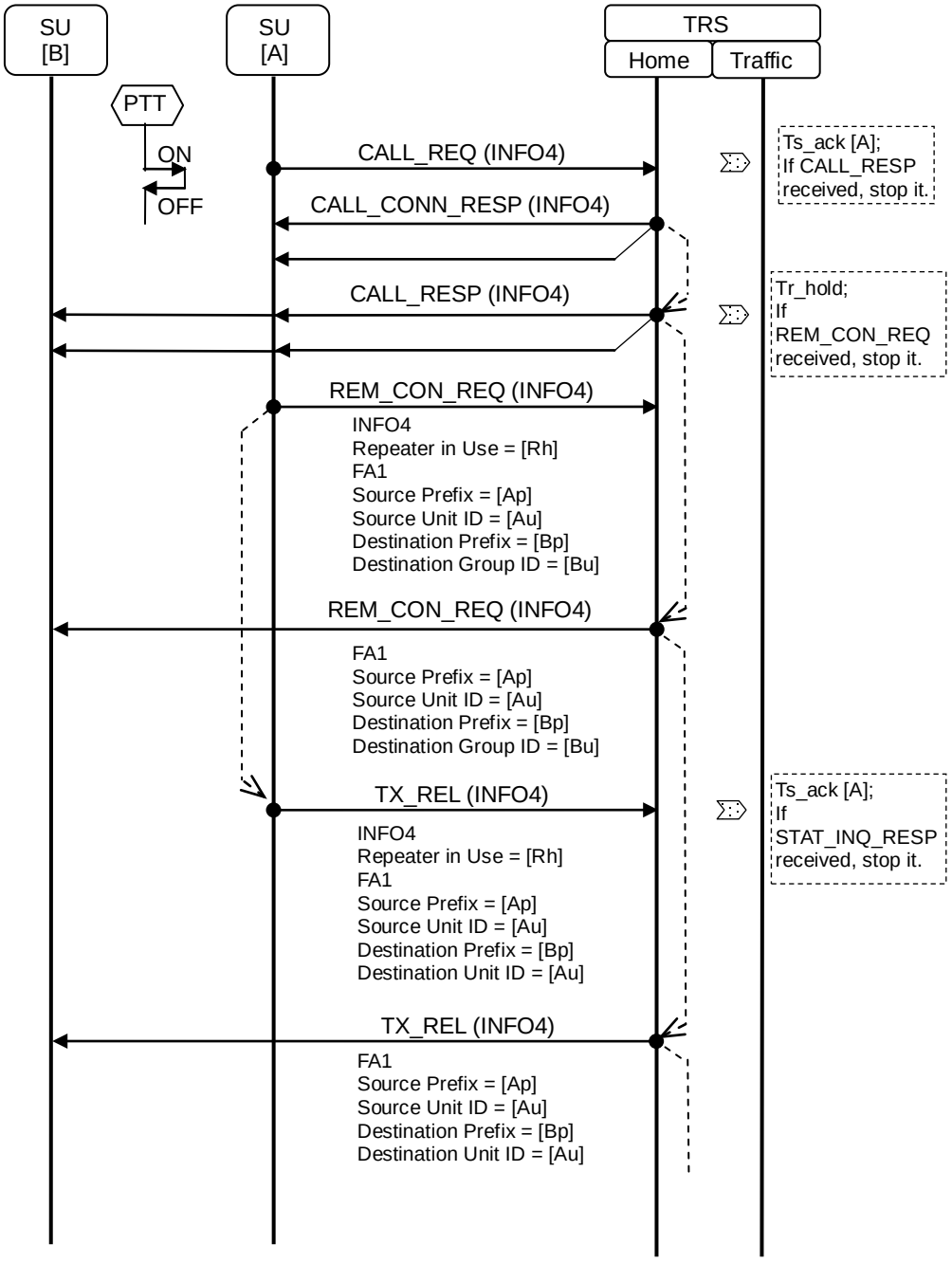


Figure 18.23-1 Sequence Diagram for Remote Monitor – 1

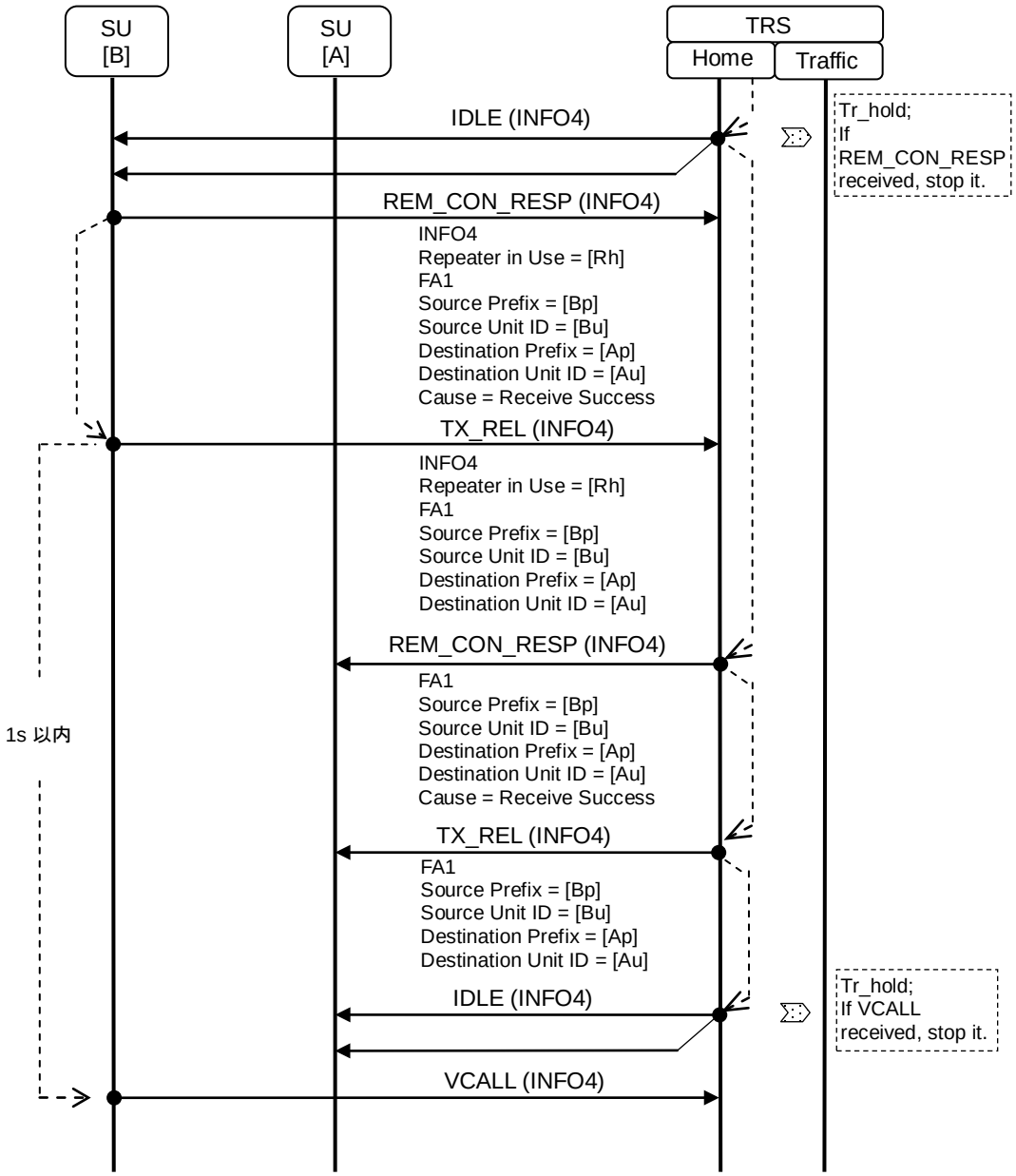


Figure 18.23-2 Sequence Diagram for Remote Monitor - 2

19. Appendices

19.1. ESN

19.1.1. ESN Format

This section describes the 48-bit ESN format. ESN is comprised of the following 2 information elements:

Manufacturers Number (MFN)
This 8-bit information element is a unique number assigned to each manufacturer.
Manufacturer definable field (MFF)
40-bit information elements is field that a manufacturer can freely define with unique serial number to identify SU.

Regarding a format to express ESN externally, MFN can be omitted because name of manufacturer can be identified by its product name. Therefore details are not specified. But manufacturers should carefully make MFF information setting to avoid ENS duplication.

Bit / Octet	7	6	5	4	3	2	1	0
0	Manufacturer Number							
1	Manufacturer definable field							
2								
3								
4								
5								

Figure 19.1-1 ESN Format

19.2. Secondary Home Repeater function

When TR, which was set as Home Repeater for SU, gets out of order, Secondary Home Repeater takes over a line control. Secondary Home Repeater Function is used to provide temporary transmission function until failure restoration.
But detailed setting method and detection method of failure and restoration in TRS and SU are not specified.

TR should be configured as Secondary Home Repeater.
Usually TR transmits Go to Repeater information distributed according to an example shown in Figure 8.4-1 when SU, which configured this TR as its Home Repeater, is transmitting through other TR. However, if failure of TR for Secondary Home Repeater is detected, TR will transmit Go to Repeater information for the SU transmitting on other TR, in addition to the SU, the TR is configured as Secondary Home Repeater.
Idle Repeater Message sent by TR in this period is not in the regular two-frame shown in Figure 8.3-4 to Figure 8.3-6, but it is send as a three-frame Idle Repeater Message with extra one frame is added as the second frame, whose GID is changed to “2046” and upper 5bits of Repeater Number2 is changed to Secondary Home Repeater Number.

This process is performed until the TR configured as Secondary Home Repeater is restored.

SU also should have setting for Secondary Home Repeater.
When SU cannot receive other communication from Home Repeater or SU cannot receive Idle Repeater Message within the preset time, SU will process the following operation.

a) Channel of Home Repeater will be switched to the channel of Secondary Home Repeater.
b) Wen SU cannot receive Idle Repeater Message from Secondary Home Repeater within the preset time, it will go back to Home Repeater. If it cannot receive Idle Repeater Message within the preset time again, it might be outside the range. But operation of SU after that is not specified.
   While it is possible to receive Go to Repeater information of other SU, which has moved to Idle Repeater Message or Secondary Home Repeater, it will continue to stay in Secondary Home Repeater, and this channel is used same as previous Home Repeater.
c) After that, if it cannot receive only additional Idle Repeater Message sent by Secondary Home Repeater within the preset time, it is considered that Home Repeater has been restored, and switch from Secondary Home Repeater channel to Home Repeater channel.

19.3. Halt Repeater function

Halt Repeater Function is used to notify SU that TRS service is temporary unavailable while TR is transmitting CWID by analog FM.
This function is optional depending on a system, for example a case to prioritize the service even during CWID transmission, therefore details of operation is not specified.

Just before transmitting CWID, TR transmits Halt Repeater Message frame that GID of Idle Repeater Message is replaced by “2045” as shown in Figure 8.3-4.
SU judges that a TRS has restored its normal operation in either of the following cases in which any specified period of time has passed since a Halt Repeater Message was received, or in which criteria stipulated by a manufacturer of SU has been met.

19.4. ID Validation function

ID Validation Function is used to validate UID or GID configured to SU for the purpose of prevention of Trunked System abuse.
TRS has 60,000 of UID or GID lists which is configurable with 30 channels of systems at maximum. When SU has transmitted a CALL_REQ message for link connection permission request to TR, to confirm the validity of UID or GID, and in case where an ID is invalid, issue a notification for rejection by sending a Cause (VD) message that is included in CALL_CONN_RESP and not to send CALL_RESP.
Because SU cannot receive CALL_RESP from TR, link connection is failed.
SU performs operations based on the procedure shown in a Cause (VD) message. The details of the operations will not be described.

In Multi Trunked System, when Subscriber Unit is connecting for Location registration, authentication, joining a group and updating of setting information, it transmits CALL_RESP and validate by response message cause (MM) for each processing result.
SU operates in accordance with Cause (MM).

This function is optional depending on a system, therefore details of operation is not specified.

19.5. Priority Monitor function

Priority Monitor allows a SU engaged in communication on a TR to migrate to a higher-priority communication which has begun on other TR.
Priority Monitor is a sort of Group Scan function for a trunked radio system and is conducted according to the level of priority configured for Group ID in group call. However, the method for configuring the level of priority is not specified.

As an example, take the case in which a SU-A is performing a Group Call by using a Group ID with a normal priority at the channel frequency of other than Home Repeater that is provided by a TR-A.
Then, another SU-B has initiated a Group Call by using a Group ID with a higher priority at the channel frequency of other than Home Repeater that is provided by a TR-B.
When a Go to Repeater information transmitted from TR-A (see Figure 8.4-1) has been received, SU-A shifts its Channel frequency to that of a Group Call on TR-B which has a higher priority, and whereby SU-A can receive a Call transmitted from SU-B.
As mentioned above, when a Group Call with a higher priority has been received while a SU-A is carrying out data communications with a normal priority, the SU-A can switch to another repeater to receive the higher priority call.

It is assumed that SU has a Group ID list and priority list data.
For SU conducting Group Call using a Group ID with normal priority level, when the SU receives Go to Repeater during transmission, SU will process the following operation.

a) Judge the priority level included in transmission Group ID and INFO4.
b) If the level of the transmitting Group ID is in the same level or higher, it will stay in the TR.
c) If the level of Group ID in INFO4 is higher, it will move to the TR specified by Go to Repeater information, and join the Group Call.
d) If the call of the Group ID is terminated and TR is released, SU will go back to Home Repeater.
e) If the transmission is continued, follow the command of Go to Repeater information and move to the previous TR and return by Late Entry.

19.6. Intermittent Reception

This section shows the method of intermittent reception operation during SU is in the stand-by reception for Home Repeater.
Note that the Power On/Off timing described in Figure 19.6-1 doesn't include rise time or fall time.

Site information or call request information, and Free Repeater information are transmitted from Home Repeater through SCCH frames alternately. During stand-by reception, it will receive only FS, LICH, SCCH and SCCH2 in frames transmitting site information or call request information.
However, when Site Code is detected, S, LICH, SCCH and SCCH2 in the following frames should be received.
When repeater is in the idle state and transmitting Site Code every five seconds, synchronization should be retained to receive intermittently and continue roaming check.

During intermittent reception with transmitting Home Repeater, Free Repeater information cannot be updated. Therefore, when transmitting, stop intermittent reception just after PTT is pressed so that it can transmit to Free Repeater included in SCCH in the next frame.
In the case of Data Call, which is not Super Frames Structure, Repeater transmits Free Repeater only by INFO4 through SCCH. When Free Repeater is included in INFO4, which was received in intermittent reception, reception timing should be shifted by 1 frame so that site information and call request information can be received always.

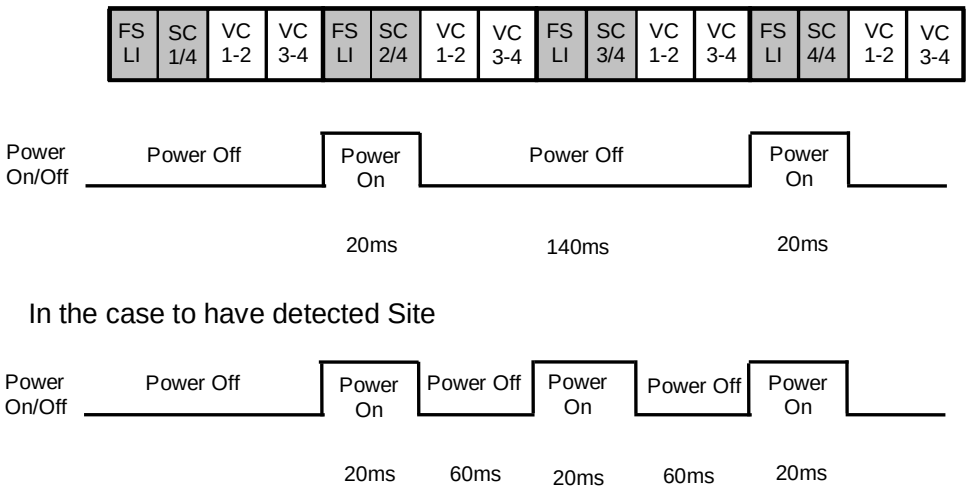


Figure 19.6-1 Timing for Intermittent Reception

19.7. Restriction Control

Restriction control is used as a means to restrict a SU from accessing RTCH2. With the restriction, the traffic density in a TRS can be controlled to avoid congestion, and stable operation can be realized. Also, Emergency calls can be preferentially accepted by performing a priority control to a SU. Restriction control is conducted by the Restriction Information information element contained in SRV_INFO.

19.7.1. Type of Restriction Control

This section describes types of restrictions that can be configured using Restriction Information information element.

(1) Access Group Restriction
Access Group Restriction divides the Unit ID of the SU into 4 groups, and prohibits the SUs belonging to the restricted group from making a location registration or an outgoing call. Since this restriction restricts the number of SUs permitted to initiate a location registration or an outgoing call, the amount of traffic can be reduced. It is also possible to restrict multiple groups at the same time or to change the group to be restricted in a superframe unit.

(2) Location Registration Restriction
Location Registration Restriction prohibits the SUs belonging to the restricted group from initiating a location registration.

(3) Call Restriction
Call Restriction prohibits the SUs belonging to the restricted group from initiating an outgoing call.

(4) Access Cycle Restriction
Access Cycle Restriction restricts the time interval for making a location registration or an outgoing call from a SU to an appropriate cycle. As soon as the restriction to SU is canceled, a number of SUs initiate location registrations or outgoing calls and RTCH2 might become an overloaded state. To avoid this situation, the number of accesses is dispersed by setting the time intervals for access.

(5) Maintenance Restriction
Maintenance Restriction is used to permit only SUs for maintenance to access the site where no service is offered due to site constructions, tests, etc. Since general SUs search for sites except the restricted site, this restriction prevents the SUs from doing false operation. However, the definition of the maintenance SU is system-dependent.

(6) General Mobile Station Restriction
General Mobile Station Restriction prohibits general SUs from initiating a location registration and an outgoing call. With this restriction, access from a higher priority SU such as Emergency can be preferentially accepted. A priority mobile station means a SU in the Emergency state and a SU that is defined as priority in each system.

19.7.2. Description of Operation

This section describes the behavior of each restriction.

19.7.2.1. Access Group Restriction

A TRS broadcasts Restriction Information in which access restriction (Octet 0, Bit 7) is in effect and general station location registration restriction / call restriction (Octet 1, Bit 3-2) and restriction group specification (Octet 1, Bit 7-4) are set appropriately.
When a general mobile station recognizes that access restriction is in effect, the general mobile station judges whether its own mobile station is included in the restricted group. If included, the general mobile station disables the corresponding functions to the restriction contents (call/location registration) of broadcast information. While access group restriction is in effect, the restricted group is periodically changed to prevent mobile stations in a specific group from being restricted. An example of changing restriction groups is presented in Figure 19.7-1.

If the value obtained by adding 1 to the remainder of when Unit ID in decimal is divided by 4 matches the group number to be restricted, the SUs having the Unit ID are subject to restriction.

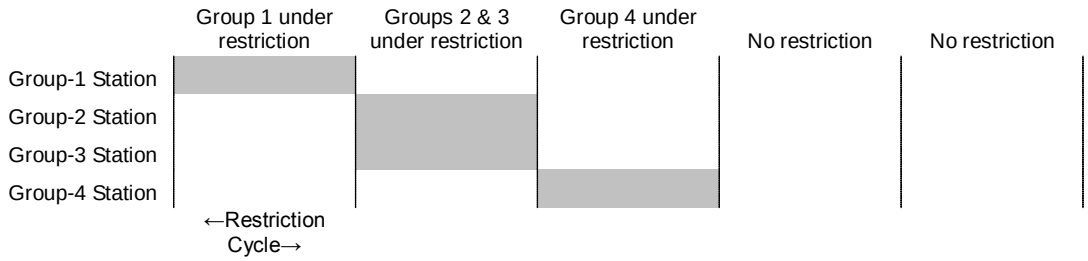


Figure 19.7-1 Example of Changing Restriction Group

If Access Group Restriction is in effect, if a SU ignores the restrictions and makes an outgoing call or location registration, a TRS detects and interrupts the process by SU.

19.7.2.2. Access Cycle Restriction

A TRS broadcasts Restriction Information in which access restriction (Octet 0, Bit 7) is in effect and access cycle intervals (Octet 0, Bit 3-0) is set appropriately. When a general mobile station recognizes that access restriction is in effect, it judges a setting time for the access cycle intervals. Except no restriction, the general mobile station is inhibited from accessing a TRS during the specified cycle intervals as a starting point when requests of an outgoing call or location registration have arisen.

When a TRS has canceled the restriction, SUs which have been released from the restriction access the TRS at the same time and RTCH2 might become an overloaded state. To avoid this situation, the Access Cycle Restriction to SU is applied to disperse the number of accesses when a restriction is canceled. An example that overload of RTCH2 is dispersed by applying the Access Cycle Restriction when the restriction is canceled is represented in Figure 19.7-2.

An example of SU behavior while Access Cycle Restriction is in effect is represented in Figure 19.7-3. This example assumes the state that a TRS applies a call / location registration restriction to SUs in Group 1 as well as Access Cycle Restriction. A SU recognizes the Access Group Restriction and Access Cycle Restriction from Restriction Information. If a SU belonging to Group 1 intends to send a request for an outgoing call or location registration, the outgoing call and location registration are prohibited by Access Group Restriction and an access to a TRS is prohibited until end of the access cycle

interval time from occurrence of the request regardless of Access Group Restriction. Accordingly, since the SUs under restriction do not concurrently access to a TRS when the Access Group Restriction is canceled, the utilization ratio of RTCH2 does not drastically increase. However, the Access Cycle Restriction is independent from other restrictions, therefore once a SU which does not belong to Group 1 accesses a TRS, the SU can not access again for the duration of Access Cycle Intervals.

Access Cycle Restriction is effective for general mobile stations, but not effective for the priority mobile stations.

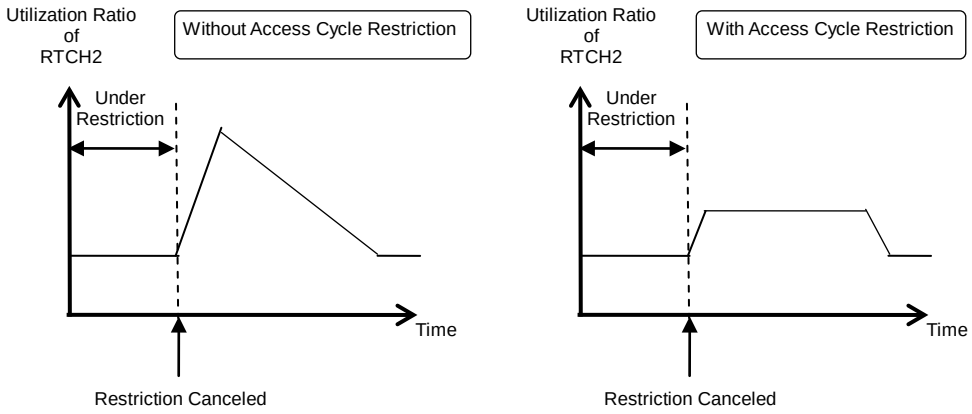


Figure 19.7-2 Utilization Ratio of RTCH2 when Access Restriction is Canceled

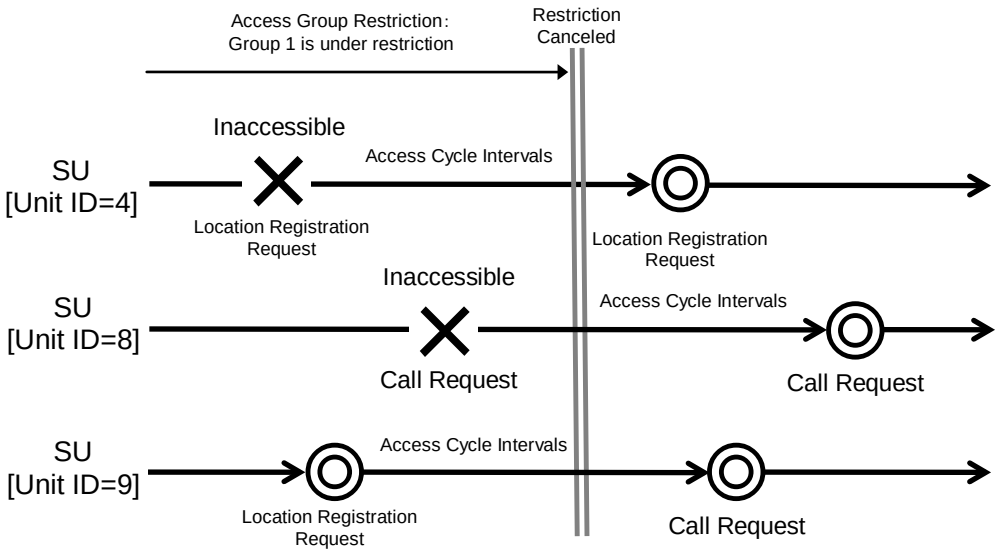


Figure 19.7-3 SU Behavior under Access Cycle & Access Group Restriction

19.7.2.3. Maintenance Restriction

A TRS broadcasts Restriction Information in which maintenance restriction (Octet 0, Bit 6) is in effect. If any SU other than the maintenance mobile station recognizes the

maintenance restriction, the SU starts a Traffic channel hunt and then proceeds to the idle state in other TRS.

19.7.2.4. General Mobile Station Restriction

A TRS broadcasts Restriction Information in which location restriction/ call restriction (Octet 1, Bit 3-2) is set appropriately. By recognizing the location registration/ call restriction, the behaviors of a general mobile station related to contents of the restriction is inhibited.

19.7.3. Procedure for SU Behavior

The behavior of SU corresponding to contents of the restriction is presented in Figure 19.7-4 and Figure 19.7-5.

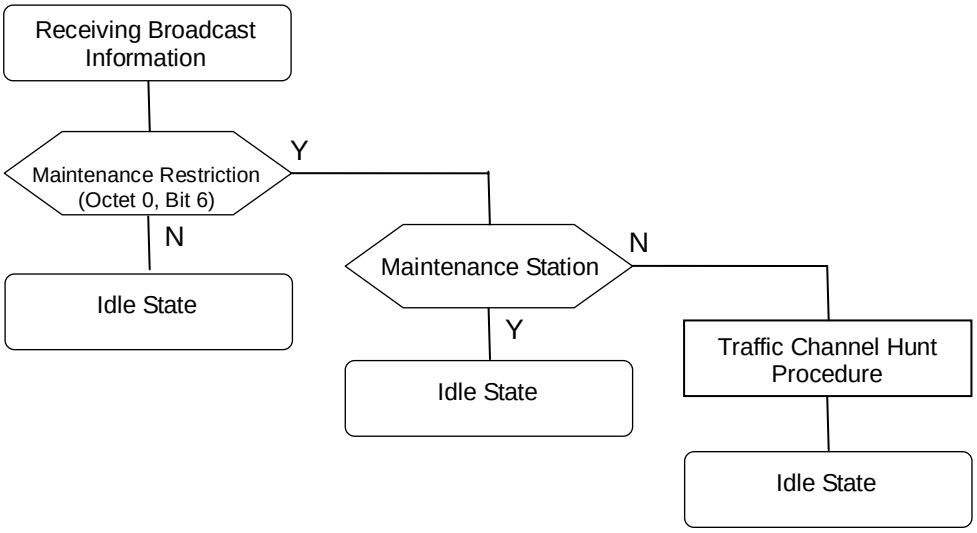
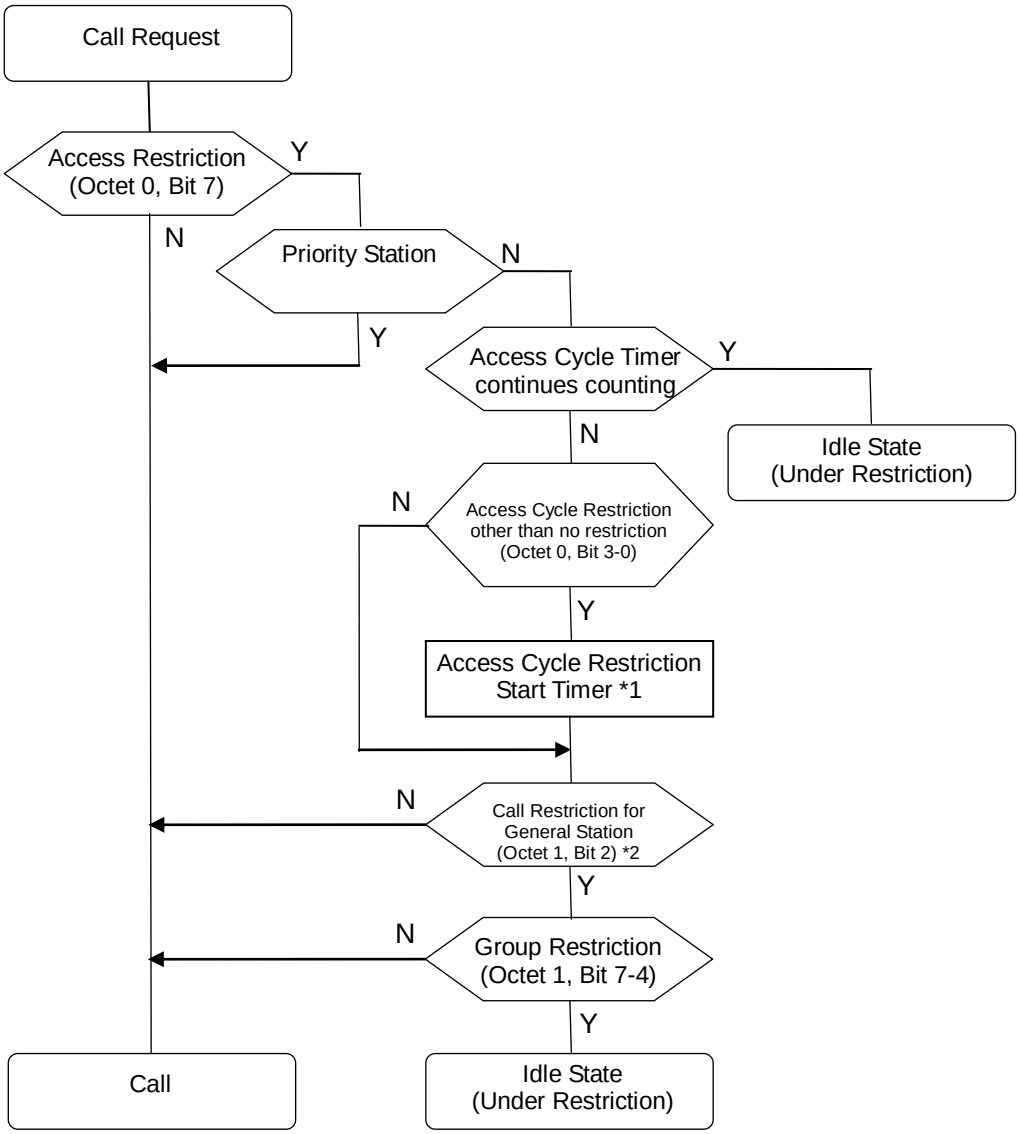


Figure 19.7-4 SU Behavior when Receiving Broadcast Information



*1 The timer expires when the duration configured for access cycle intervals elapses.
*2 The case of a location registration request, the location registration restriction for a general mobile station (Octet 1, Bit 3) is applied.

Figure 19.7-5 SU Behavior in Call Request

19.8. Off the Air Call Processing

When TC starts System Data Call session, it starts transmission to call request for certain SU through traffic channel, which is not used by other transmission.
But if there is no response from SU because SU is outside of the range, or power is off with undeleted registration, the traffic channel is occupied for a while even though session cannot be started.
Off the Air Call Processing Function is to solve this problem. When TC starts session to certain SU, it doesn't transmit during call request, and uses a system that SU side will start session. This method is applied to a case that TC commands SU to process registration in Multi Trunked System.

Regular call request from TR cause a transmission of Go to Repeater Information as shown in Figure 8.4-1, but when TC commands registration processing to SU, Registration Command (REG_COMM) message is transmitted here.

If UID of Registration Command (REG_COMM) message matches with SU, then it moves to Free Repeater and starts Registration session as shown in the sequence diagram in Figure 18.4-1.

19.9. Individual Call by Message Trunking Mode

Configuration method for Message Trunking Mode shall be designed by manufacturer. Here, an explanatory example of procedure of Message Trunking Mode on Multi Trunked System will be explained.

19.9.1. Unit Request

Link sequence follows the procedure shown in Section 8.2. Calling side SU transmits VCALL_REQ to TC.

19.9.2. Controller Actions

TC performs the following operations in response to the VCALL_REQ message that SU has transmitted.

a) The TC sends a VCALL_ASSGN to assign Communication Channel.

19.9.3. Unit Actions

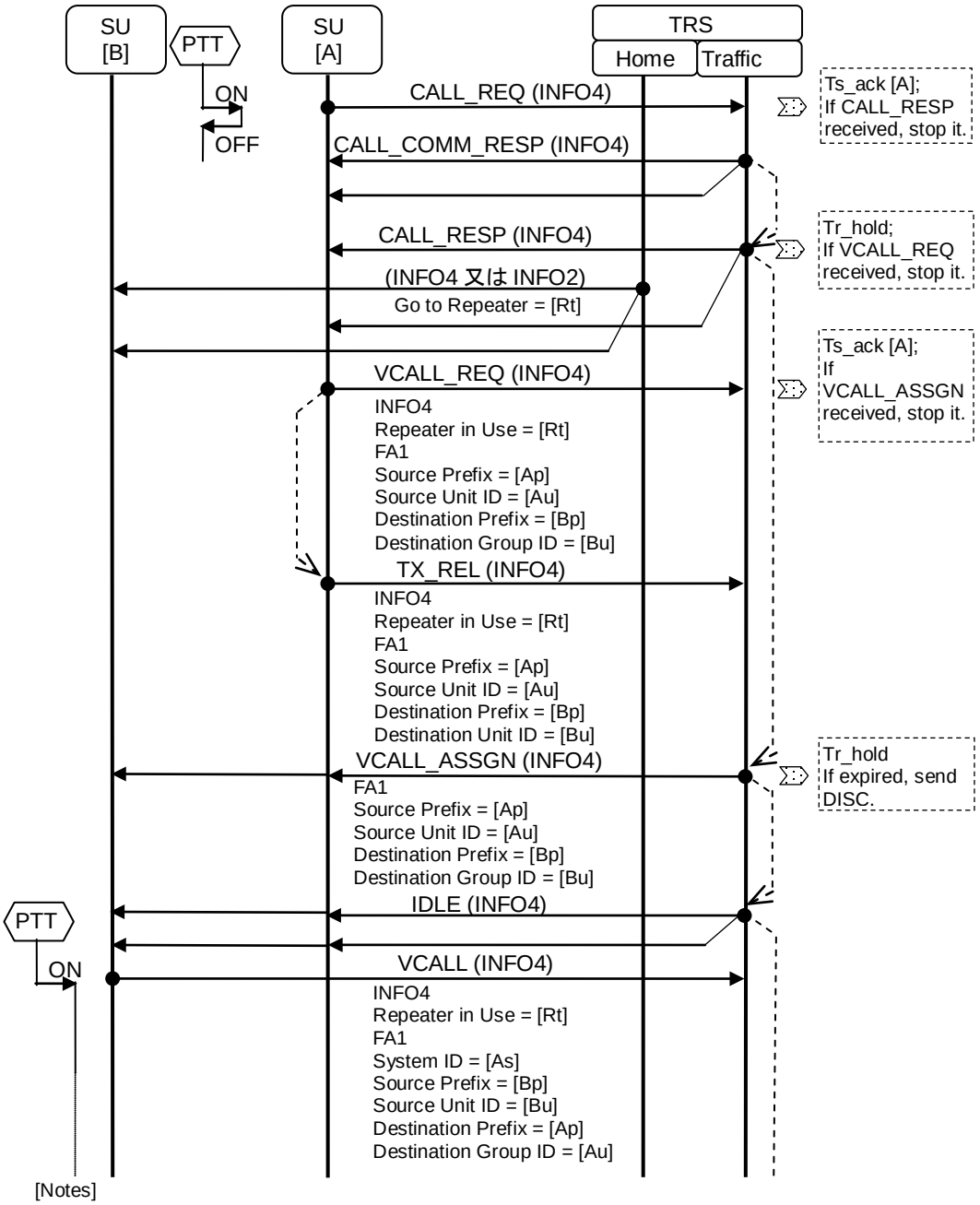
SU which has transmitted a VCALL_REQ message, or SU in standby mode performs the following operations in response to the message that TC has transmitted.

a) When a VCALL_ASSGN message has been received,
   i) To proceed to the process of confirming the validity of a transmitted message.

19.9.4. Sequence

This section shows a control sequence to make an Individual Call from SU [A] (System ID = As, Prefix = Ap, Unit ID = Au) to SU [B] (System ID = As, Prefix = Bp, Unit ID = Bu) in Message Trunking Mode.

19.9.4.1. From call establishment phase to call phase

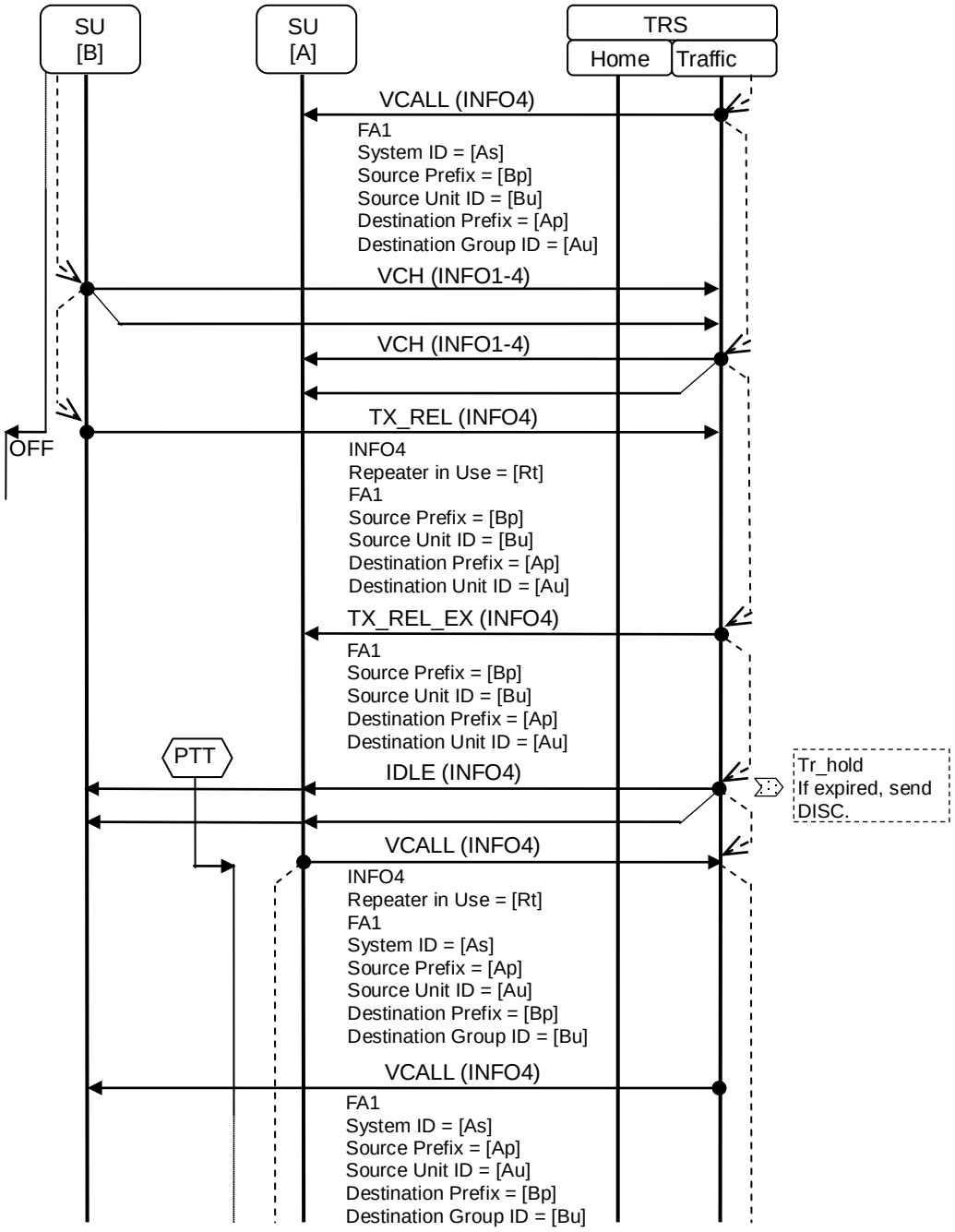


[Notes]

1) This is a case when Home Repeater is Busy and Traffic Repeater is Free.
2) This sequence shows the procedural steps In which a called SU [B] initiates vocal communications, though, a calling SU [A] may also initiate vocal communications.

Figure 19.9-1 Sequence Diagram for Individual Voice Call - 1

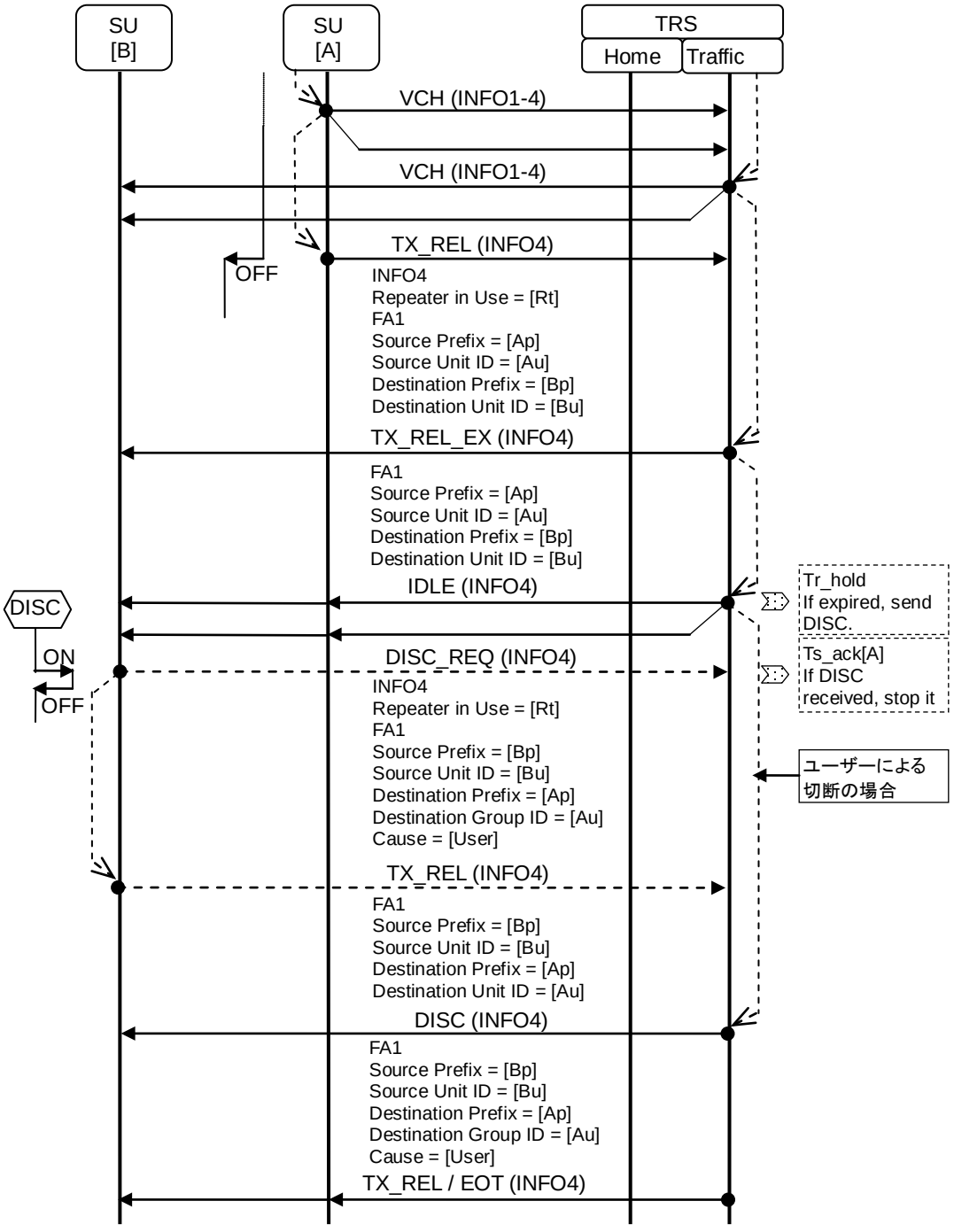
19.9.4.2. Call phase



[Notes]
1) This is a case when Home Repeater is Busy and Traffic Repeater is Free.

Figure 19.9-2 Sequence Diagram for Individual Voice Call - 2

19.9.4.3. From call phase to call termination phase



[Notes]
1) This is a case when Home Repeater is Busy and Traffic Repeater is Free.

Figure 19.9-3 Sequence Diagram for Individual Voice Call - 3

20. Revision History

Version	Date	Revised Contents
1.0	2012.11.2	Version 1.0 release