Lucent Technologies
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APX 8000™/MAX TNT®

Frame Relay Configuration Guide

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About This Guide

What is in this guide

This guide describes how to configure Frame Relay operations on any unit that supports the TAOS command-line interface (CLI) and for which you have obtained the Lucent Technologies Frame Relay software license. To use this guide, you must have already installed the unit and connected a workstation to the controller's serial port. If you have not already finished those tasks, see the hardware installation guide for the unit.

Note: This manual describes the full set of features for APX 8000™ and MAX TNT® units running True Access™ Operating System (TAOS) software version 9.0.0 or later. Some features might not be available with earlier versions or specialty loads of the software.

This manual hereafter refers to your product as a *TAOS unit*.

Warning: Before installing your TAOS unit, be sure to read the safety instructions in the *Edge Access Safety and Compliance Guide*. For information specific to your unit, see the "Safety-Related Electrical, Physical, and Environmental Information" appendix in your unit's hardware installation guide.

Documentation conventions

Following are all the special characters and typographical conventions used in this manual:

Convention	Meaning
`Monospace text`	Represents text that appears on your computer's screen, or that could appear on your computer's screen.
`Boldface monospace text`	Represents characters that you enter exactly as shown (unless the characters are also in ***`italics`***—see *Italics*, below). If you could enter the characters but are not specifically instructed to, they do not appear in boldface.
Italics	Represent variable information. Do not enter the words themselves in the command. Enter the information they represent. In ordinary text, italics are used for titles of publications, for some terms that would otherwise be in quotation marks, and to show emphasis.
[ ]	Square brackets indicate an optional argument you might add to a command. To include such an argument, type only the information inside the brackets. Do not type the brackets unless they appear in boldface.
|	Separates command choices that are mutually exclusive.

Convention	Meaning
>	Points to the next level in the path to a parameter or menu item. The item that follows the angle bracket is one of the options that appears when you select the item that precedes the angle bracket.
Key1-Key2	Represents a combination keystroke. To enter a combination keystroke, press the first key and hold it down while you press one or more other keys. Release all the keys at the same time. (For example, Ctrl-H means hold down the Control key and press the H key.)
Press Enter	Means press the Enter, or Return, key or its equivalent on your computer.
Note:	Introduces important additional information.
 **Caution:**	Warns that a failure to follow the recommended procedure could result in loss of data or damage to equipment.
 **Warning:**	Warns that a failure to take appropriate safety precautions could result in physical injury.
 **Warning:**	Warns of danger of electric shock.

Documentation set

The APX 8000/MAX TNT documentation set consists of the following manuals.

- **Read me first:**
  - *Edge Access Safety and Compliance Guide*
    Contains important safety instructions and country-specific compliance information that you must read before installing a TAOS unit.
  - *TAOS Command-Line Interface Guide*
    Introduces the TAOS command-line environment and shows how to use the command-line interface effectively. This manual describes keyboard shortcuts and introduces commands, security levels, profile structure, and parameter types.
- **Installation and basic configuration:**
  - *APX 8000 Hardware Installation Guide*
    Shows how to install APX 8000 hardware and includes APX 8000 technical specifications.
  - *MAX TNT Hardware Installation Guide*
    Shows how to install MAX TNT hardware and includes technical specifications for these units.
  - *APX 8000/MAX TNT Physical Interface Configuration Guide*
    Shows how to configure the cards installed in a TAOS unit and their line attributes for such functions as framing, signaling, and channel usage. It also describes how calls are routed through the system and includes information about configuring the unit in a

Signaling System 7 (SS7) environment. This guide explains shelf controller redundancy for an APX 8000 unit.

- **Configuration:**
  - *APX 8000/MAX TNT ATM Configuration Guide*
    Describes how to configure Asynchronous Transfer Mode (ATM) operations on a TAOS unit. This guide explains how to configure physical layer attributes and how to create permanent virtual circuit (PVC) and switched virtual circuit (SVC) ATM interfaces. It includes information about ATM direct and ATM-Frame Relay circuits.
  - *APX 8000/MAX TNT Frame Relay Configuration Guide (this manual)*
    Describes how to configure Frame Relay operations on a TAOS unit. This guide explains physical layer configuration and restrictions and how to create permanent virtual circuit (PVC) and switched virtual circuit (SVC) interfaces. It includes information about Multilink Frame Relay (MFR) and link management, as well as Frame Relay and Frame Relay direct circuits.
  - *APX 8000/MAX TNT WAN, Routing, and Tunneling Configuration Guide*
    Shows how to configure LAN and WAN routing for analog and digital dial-in connections on a TAOS unit. This guide includes information about IP routing, Open Shortest Path First (OSPF) routing, Internet Group Management Protocol (IGMP) routing, multiprotocol routers, Virtual Routers (VRouters), and tunneling protocols.
  - *MultiVoice™ for APX 8000/MAX TNT Configuration Guide*
    Shows how to configure the MultiVoice application to run on an APX 8000 or MAX TNT unit in both Signaling System 7 (SS7) and H.323 Voice over IP (VoIP) configurations.
- **RADIUS:** *TAOS RADIUS Guide and Reference*
  Describes how to set up a TAOS unit to use the Remote Authentication Dial-In User Service (RADIUS) server and contains a complete reference to RADIUS attributes.
- **Administration and troubleshooting:** *APX 8000/MAX TNT Administration Guide*
  Describes how to administer a TAOS unit, including how to monitor the system and cards, troubleshoot the unit, and configure the unit to use the Simple Network Management Protocol (SNMP).
- **Reference:**
  - *APX 8000/MAX TNT Reference*
    An alphabetic reference to all commands, profiles, and parameters supported on TAOS units.
  - *TAOS Glossary*
    Defines terms used in documentation for TAOS units.

Getting Started

1

Overview of Frame Relay operations

To configure Frame Relay, you first allocate bandwidth and set line parameters for the physical line used to connect to a Frame Relay network. You must also define a data link interface that defines how a TAOS unit interoperates with the far-end equipment, and at least one virtual circuit to enable the system to pass data on the interface. Multiple virtual circuits can share a data link to a Frame Relay network.

Physical interfaces that support Frame Relay

An *interface* is a point of ingress (entrance) to or egress (exit) from the system. TAOS units support Frame Relay operations on the physical-interface types shown in Table 1-1.

Table 1-1. Slot cards that support Frame Relay

Slot cards	APX 8000	MAX TNT
Channelized T1 with Hybrid Access termination	√	√
Channelized E1 with Hybrid Access termination	√	√
Channelized T3 with Hybrid Access termination	√	√
FrameLine (unchannelized T1 or E1)		√
Frame Relay unchannelized DS3		√
Serial WAN (SWAN)		√

Hybrid Access slot cards provide the HDLC processing for data streams sent and received on T1, T3, or E1 slot cards, and must be used to terminate digital connections to those cards. FrameLine and serial WAN slot cards provide their own termination of access resources. You configure a physical interface in a line profile for an installed slot card.

Frame Relay data link interfaces

A Frame Relay data link interface is a logical configuration that enables the unit to communicate with Frame Relay equipment across the physical interface.

You configure a data link interface in a Frame-Relay profile or RADIUS `frdlink` profile. The data link configuration binds the logical interface to a particular physical port and specifies how the TAOS unit will be integrated into the Frame Relay network.

Frame Relay virtual circuits

To enable the unit to exchange data on a data link interface, you must also configure at least one virtual circuit in a Connection or RADIUS user profile. The virtual circuit can be one of the following types:

- Permanent virtual circuit (PVC), which uses nailed bandwidth and is always available
- Switched virtual circuit (SVC), which uses nailed bandwidth but is brought up on demand using SVC signaling
- Switched PVC connection, which uses switched bandwidth and an ISDN dial-up to establish the connection

Many virtual circuits can share a data link. Each virtual circuit requires a data link connection identifier (DLCI). Connections can be forwarded to the data link interface on the basis of IP routing, a Frame Relay direct configuration, or a circuit configuration. Each type of connection can be configured in a Connection or RADIUS profile.

IP routing over Frame Relay

When the unit terminates a Frame Relay connection and routes IP over it, the system encapsulates the data as specified in RFC 2427, *Multiprotocol Interconnect over Frame Relay.* With this type of connection, the TAOS unit uses Frame Relay as a transport to an IP destination.

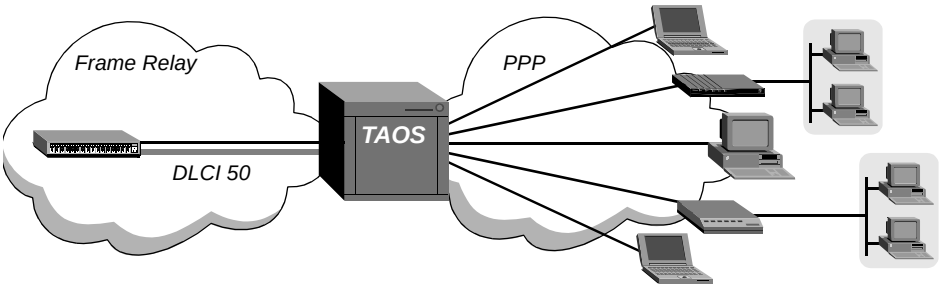
For information about using OSPF with Frame Relay, see the description of OSPF with nonbroadcast multiaccess (NBMA) networks in the *APX 8000/MAX TNT WAN, Routing, and Tunneling Configuration Guide*.

Frame Relay direct

With a Frame Relay direct configuration, the incoming data streams of Point-to-Point Protocol (PPP) dial-in connections are sent directly out on a Frame Relay link. The system does not examine the packets to forward data streams onto the data link interface. However, for the system to route packets received on the data link interface back to the proper PPP dial-in client, the PPP connection must use IP routing.

Figure 1-1 shows a unit with a Frame Relay direct connection.

Figure 1-1. Directing PPP data streams onto a Frame Relay network

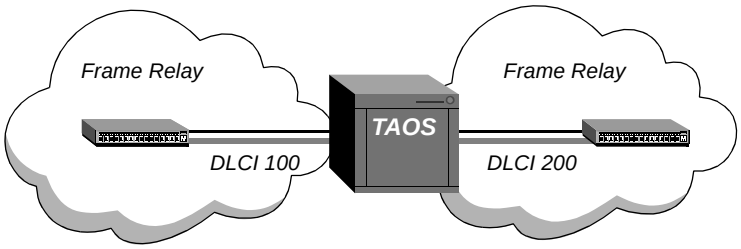


Frame Relay circuits

Frame Relay circuits consists of a pair of virtual circuit end points. The system operates as a switch between the two end points. The TAOS unit does not examine the packets, but it examines the packet headers and switches the packets to the paired end point on the basis of the DLCI.

A circuit configuration uses two Connection or RADIUS user profiles, and pairs the two profiles by means of a common circuit name. Figure 1-2 shows a TAOS unit operating as a Frame Relay switch.

Figure 1-2. Switching from one circuit end point to another



ATM-Frame Relay circuits operate in a similar manner, in that the TAOS unit examines only the packet headers and switches the packets to the paired end point. For ATM-Frame Relay circuits, the circuit end points use different media types, so the packet encapsulation must be changed as part of the circuit switching. For details about ATM-Frame Relay circuits, see the *APX 8000/MAX TNT ATM Configuration Guide*.

Multilink Frame Relay (MFR)

Multilink Frame Relay (MFR) provides a way to aggregate Frame Relay PVCs to provide additional bandwidth to an application. You can aggregate the underlying data link interfaces or individual DLCI interfaces. The concept is similar to Multilink PPP (MP).

Overview of Frame Relay configuration

Before you configure a TAOS unit for Frame Relay, Lucent recommends creating a diagram that illustrates how the Frame Relay access lines will interoperate with your current network

configuration. Creating a comprehensive network diagram helps prevent problems during installation and configuration, and can help in troubleshooting any problems later.

After you have installed the required slot cards, you must complete the following configuration tasks:

1 Configure the physical interfaces on installed slot cards.

2 Configure the Frame Relay data link interface.

3 Configure at least one connection that forwards data onto the interface.

Note: TAOS configuration settings are stored in onboard flash memory, and must be backed up to a TFTP host whenever changes are made. For details about backing up and restoring the TAOS configuration, see the *APX 8000/MAX TNT Administration Guide*.

Frame Relay management features

To enable you to configure the system and monitor its activity, TAOS units support profiles, commands, and status windows in the command-line interface. TAOS units also support SNMP management, RADIUS profiles, and the ability to upload (back up) and download software and configuration files via the Trivial File Transfer Protocol (TFTP) or a serial connection.

For an introduction to the command-line interface and its shortcuts, see the *TAOS Command-Line Interface Guide*.

SNMP support

In addition to configuring and monitoring Frame Relay by means of the command-line interface, you can configure and manage the unit by using a Simple Network Management Protocol (SNMP) management station such as the NavisAccess™ product.

A TAOS unit can generate SNMP traps to indicate alarm conditions. Following are supported traps related specifically to Frame Relay:

```
[in TRAP/""]
fr-linkup-enabled = yes
fr-linkdown-enabled = yes
```

For information about using SNMP with TAOS units, see the *APX 8000/MAX TNT Administration Guide*.

RADIUS support

You can use RADIUS to store user profiles for Frame Relay circuits and other data connections. To use RADIUS, you must configure the TAOS unit to communicate with the RADIUS server. In addition, the RADIUS server must be compliant with vendor-specific attributes (VSAs), as defined in RFC 2138, and the TAOS unit must be configured in VSA compatibility mode. Following are the relevant settings:

```
[in EXTERNAL-AUTH]
auth-type = radius
```

```
[in EXTERNAL-AUTH:rad-auth-client]
auth-radius-compat = vendor-specific
```

For details, see the *TAOS RADIUS Guide and Reference*.

Where to go next

When you have planned your network, you are ready to configure the TAOS unit. You can perform configuration tasks in any order you want. Table 1-2 shows where to look for the information you need.

Table 1-2. Where to go next

Task	Where to go for information
Install required slot cards	The hardware installation guide for your unit
Configure physical interfaces	Chapter 2, “Physical Interface Considerations” and the *APX 8000/MAX TNT Physical Interface Configuration Guide*
Set up specialized call routing	
Define a Frame Relay data link	Chapter 3, “Configuring Data Link Interfaces”
Configure a Frame Relay PVC	“Configuring a PVC” on page 4-2
Configure a Frame Relay SVC	“Configuring an SVC” on page 4-11
Configure a switched PVC	“Configuring a switched PVC” on page 4-8
Set up Frame Relay direct	Chapter 5, “Configuring Frame Relay Direct”
Configure Frame Relay circuit switching	Chapter 6, “Configuring Frame Relay Circuits”
Check details about profiles, parameters, and commands	*APX 8000/MAX TNT Reference*
Use SNMP with the unit	*APX 8000/MAX TNT Administration Guide*
Configure login permissions	
Back up configuration data	

Physical Interface Considerations

2

For details about which slot cards support Frame Relay in your TAOS unit, see "Physical interfaces that support Frame Relay" on page 1-1. Table 2-1 shows which slot cards can be configured for the various Frame Relay connection features supported in TAOS.

Table 2-1. Slot cards and supported Frame Relay virtual circuit features

Slot cards	PVC	SVC	Switched PVC	MFR
Channelized T1 with Hybrid Access	√	√	√	√
Channelized E1 with Hybrid Access	√	√	√	√
Channelized T3 with Hybrid Access	√	√	√	√
FrameLine (unchannelized T1 or E1)	√	√	N/A	√
Frame Relay unchannelized DS3	√	N/A	N/A	N/A
Serial WAN (SWAN)	√	√	N/A	N/A

Channelized bandwidth with Hybrid Access

Hybrid Access slot cards provide the HDLC processing required for packetized data sent and received on the channelized T1, T3, or E1 slot cards. Call-routing profiles route inbound data to a terminating Hybrid Access channel. Outbound data is routed first to a Hybrid Access slot card to be packetized before being transmitted on the T1 or E1 line.

Note: Some terminating slot cards, such as the Series56™ II and Series56 III Digital Modem slot cards or the MultiDSP™ slot cards, perform HDLC processing but do not support Frame Relay. For this reason, you might need to consider customized call routes if the TAOS unit has both modems and Hybrid Access slot cards installed and you are using channelized bandwidth for Frame Relay. For details, see the *APX 8000/MAX TNT Physical Interface Configuration Guide*.

When configuring nailed bandwidth for Frame Relay, make sure that the number of channels you configure in the TAOS unit matches the number of channels used by the device at the other

end of the link. In addition, make sure that only one line profile specifies the Nailed-Group number to be used by the Frame Relay data link.

Typical nailed T1 configuration

In the following example, the T1 line is configured for nailed usage with a group number of 13. Channels bound to a nailed group must be contiguous. The name assigned to the T1 profile is optional. (It is not used by the software.)

```
admin> read t1 { 1 10 3 }
T1/{ shelf-1 slot-10 3 } read
admin> set name = ct1-1.10.3
admin> set line-interface enabled = yes
admin> set line-interface frame-type = esf
admin> set line-interface encoding = b8zs
admin> set line-interface clock-priority = high-priority
admin> set line-interface robbed-bit-mode = inc-w-400
admin> set line-interface channel 1 channel-usage = nailed-64-channel
admin> set line-interface channel 1 nailed-group = 13
```

Repeat the preceding channel configuration settings for each of the 23 B channels, or for the number of B channels required by the data link. Channels bound to a nailed group must be contiguous.

```
admin> write
T1/{ shelf-1 slot-10 3 } written
```

You associate a data link interface with this T1 line by specifying the line's Nailed-Group number in the Frame-Relay profile. For example:

```
admin> new frame-relay ct1-1.10.3
FRAME-RELAY/ct1-1.10.3 read
admin> set nailed-up-group = 13
admin> write
FRAME-RELAY/ct1-1.10.3 written
```

For information about configuring Frame-Relay profiles, see Chapter 3, "Configuring Data Link Interfaces." For details about the T1 line settings, see the *APX 8000/MAX TNT Reference*. For more information about configuring channelized bandwidth, see the *APX 8000/MAX TNT Physical Interface Configuration Guide*.

Typical nailed E1 configuration

In the following example, the E1 line is configured for nailed usage with a group number of 11. Channels bound to a nailed group must be contiguous. The name assigned to the E1 line profile is optional. (It is not used by the software.)

```
admin> read e1 { 1 8 3 }
E1/{ shelf-1 slot-8 3 } read
admin> set name = ce1-1.8.3
admin> set line-interface enabled = yes
```

```
admin> set line-interface signaling-mode = e1-no-signaling
admin> set line-interface channel 1 channel-usage = nailed-64-channel
admin> set line-interface channel 1 nailed-group = 11
```

Repeat the preceding settings for each of the 30 B channels, or for the number of B channels required by the data link. Channels bound to a nailed-group must be contiguous.

```
admin> write
E1/{ shelf-1 slot-8 3 } written
```

You associate a data link interface with this E1 line by specifying the line's Nailed-Group number in the Frame-Relay profile. For example:

```
admin> new frame-relay ce1-1.8.3
FRAME-RELAY/ce1-1.8.3 read
admin> set nailed-up-group = 11
admin> write
FRAME-RELAY/ce1-1.8.3 written
```

For information about configuring Frame-Relay profiles, see Chapter 3, "Configuring Data Link Interfaces." For details about the E1 line settings, see the *APX 8000/MAX TNT Reference*. For more information about configuring channelized bandwidth, see the *APX 8000/MAX TNT Physical Interface Configuration Guide*.

Typical T1 configuration for switched PVCs

Following is an example of a channelized T1 configuration that uses ISDN PRI signaling connecting to an AT&T switch:

```
admin> new t1 { 1 7 1}
T1/{ shelf-1 slot-7 1 } read
admin> set line-interface signaling-mode = isdn
admin> set line-interface switch-type = att-pri
admin> set line-interface channel 1 channel-usage = switched-channel
```

Repeat the preceding settings for the number of B channels required by the switched PVC. Then configure the D channel and save the settings.

```
admin> set line-interface channel 24 channel-usage = d-channel
admin> write
T1/{ shelf-1 slot-7 1 } written
```

To establish a switched PVC by placing an outgoing call, the TAOS unit initiates the call in the usual way. When the call has been placed and the B channels are available, the system begins exchanging Local Management Interface (LMI) frames to establish Frame Relay link operations. For more details, see "Configuring a switched PVC" on page 4-8.

Unchannelized bandwidth (MAX TNT only)

The FrameLine slot cards and the unchannelized DS3 slot card provide unchannelized bandwidth on the MAX TNT platforms.

Each unchannelized line contains a serial communications adapter (SCA) for receiving and transmitting HDLC frames. Because there is only one SCA per T1 or E1 line, the full bandwidth of an unchannelized line is dedicated to one link. The bandwidth cannot be split across multiple destinations.

For unchannelized slot cards, call-routing profiles are not used for a data stream sent and received on the line. The data stream is directed to the onboard SCA rather than a terminating resource such as a Hybrid Access slot card, and it cannot be routed to another host slot card. All packetization of outbound data also occurs locally.

When configuring the unchannelized slot cards, make sure that the number of channels matches the number used by the device at the other end of the link, and that only one line profile specifies the Nailed-Group number to be used by the Frame Relay data link. For these slot cards, channel usage must be either `nailed-64-channel` or `unused`.

In the following example, the unchannelized T1 (FrameLine) interface is configured with a group number of 7. The name assigned in the line profile is optional. (It is not used by the software.)

```
admin> read t1 { 1 11 2 }
T1/{ shelf-1 slot-11 2 } read

admin> set name = ut1-1.11.2

admin> set line-interface enabled = yes

admin> set line-interface frame-type = esf

admin> set line-interface encoding = b8zs

admin> set line-interface clock-priority = low-priority

admin> set line-interface robbed-bit-mode = inc-w-400

admin> set line-interface channel 1 channel-usage = nailed-64-channel

admin> set line-interface channel 1 nailed-group = 7
```

Repeat the preceding channel settings for each channel needed for the data link. Channels need not be contiguous on the unchannelized slot cards. For unused channels, set Channel-Usage to `unused`.

```
admin> write
T1/{ shelf-1 slot-11 2 } written
```

You associate a data link interface with this FrameLine port by specifying the line's Nailed-Group number in the Frame-Relay profile. For example:

```
admin> new frame-relay ut1-1.11.2
FRAME-RELAY/ut1-1.11.2 read

admin> set nailed-up-group = 7

admin> write
FRAME-RELAY/ut1-1.11.2 written
```

For information about configuring Frame-Relay profiles, see Chapter 3, "Configuring Data Link Interfaces." For more detailed information about T1 and E1 line settings, see the *APX 8000/MAX TNT Reference*. For more information about configuring channelized bandwidth, see the *APX 8000/MAX TNT Physical Interface Configuration Guide*.

Serial WAN (MAX TNT only)

The serial WAN (SWAN) slot card provides four V.35 serial ports, which are typically used for connecting to a Frame Relay switch. In the following example, the serial interface is configured with a group number of 1021. The name assigned in the line profile is optional. (It is not used by the software.)

```
admin> read swan { 1 12 1}
SWAN/{ shelf-1 slot-12 1 } read

admin> set name = swan-1.12.1

admin> set enabled = yes

admin> set line-config nailed-group = 1021

admin> write
SWAN/{ shelf-1 slot-12 1 } written
```

You associate a data link interface with this serial WAN port by specifying the line's Nailed-Group number in the Frame-Relay profile. For example:

```
admin> new frame-relay swan-1.12.1
FRAME-RELAY/swan-1.12.1 read

admin> set nailed-up-group = 1021

admin> write
FRAME-RELAY/swan-1.12.1 written
```

For information about configuring Frame-Relay profiles, see Chapter 3, "Configuring Data Link Interfaces." For details about the serial WAN line settings, see the *APX 8000/MAX TNT Reference*. For more information about configuring serial interfaces, see the *APX 8000/MAX TNT Physical Interface Configuration Guide*.

Multilink Frame Relay (MFR) bandwidth requirements

Multilink Frame Relay (MFR) provides a way to bundle Frame Relay data link or DLCI interfaces to increase the available bandwidth or maximize bandwidth usage to a particular destination. For details about configuring multilink Frame Relay, see Chapter 7, "Configuring Multilink Frame Relay (MFR)."

Requirements and limitations for bundled links

MFR bundles use nailed bandwidth and can reside on the following slot cards:

- Hybrid Access
- FrameLine

With the current software version, the MFR implementation is subject to the following bandwidth limitations:

- *All member data links of an MFR bundle must reside on the same slot card.* This requirement is the only limitation on the number of links in a bundle.
- MFR using SVCs or switched PVCs is not supported.

Hybrid Access call routing requirements

MFR is supported on Hybrid Access slot cards with T1, E1, or T3 slot cards. However, if more than one Hybrid Access slot card is installed in the system, the aggregate bandwidth of the bundle must be bound to a single Hybrid Access slot card by means of Call-Route profiles. If member data links of an MFR bundle span Hybrid Access slot cards, the link fails.

Note: If the system supports only one Hybrid Access slot card, no call routing configuration is required. However, if more than one Hybrid Access slot card is installed, you must define Call-Route profiles to map the bandwidth of the MFR bundle to the same Hybrid Access slot card.

The following sample output shows a system with four E1 slot cards and two Hybrid Access slot cards:

```
admin> show
Shelf 1 ( standalone ):
    { shelf-1 slot-1 0 }       UP       8e1-card
    { shelf-1 slot-2 0 }       UP       8e1-card
    { shelf-1 slot-3 0 }       UP       hdlc2-card
    { shelf-1 slot-4 0 }       UP       hdlc2-card
    { shelf-1 slot-15 0 }      UP       8e1-card
    { shelf-1 slot-16 0 }      UP       8e1-card
```

Note: Because one Hybrid Access slot card can provide 186 channels (31 x 6) for MFR, one Hybrid Access slot card can support up to six Call-Route profiles that bind its channels to up to six back-to-back E1 ports. This setup places a limitation on the size of the MFR bundle when you are using a Hybrid Access slot card.

Typical MFR bundle with two E1 lines

In this example, the administrator creates two Call-Route profiles for the Hybrid Access slot card in slot 3, with each profile binding 31 HDLC channels to a single E1 line on the slot card in slot 2. The default Call-Route profile for the Hybrid Access slot card can be deleted or left unmodified, but must not be modified to specify an explicit route.

For example, the following commands create a Call-Route profile for the Hybrid Access slot card in slot 3 and set the preferred source to the first E1 interface in slot 2:

```
admin> new call-route { { { shelf-1 slot-3 0 } 0 } 1 }
CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 1 } read

admin> set preferred-source = { { 1 2 1 } 0 }

admin> list
[in CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 1 } (new) (changed)]
index* = { { { shelf-1 slot-3 0 } 0 } 1 }
trunk-group = 0
telephone-number = ""
preferred-source = { { shelf-1 slot-2 1 } 0 }
call-route-type = digital-call-type

admin> write
CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 1 } written
```

The next set of commands creates another Call-Route profile for the Hybrid Access slot card and sets the preferred source to the second E1 interface in slot 2:

```
admin> new call-route { { { shelf-1 slot-3 0 } 0 } 2 }
CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 2 } read

admin> set preferred-source = { { 1 2 2 } 0 }

admin> write
CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 2 } written
```

Note that the default Call-Route profile for the Hybrid Access slot card was not modified. It still specifies a general route for the slot card as a whole, as shown in the following listing:

```
admin> get call-route { { { shelf-1 slot-3 0 } 0 }0}
[in CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 0 }]
index* = { { { shelf-1 slot-3 0 } 0 } 0 }
trunk-group = 0
telephone-number = ""
preferred-source = { { any-shelf any-slot 0 } 0 }
call-route-type = digital-call-type
```

Typical MFR bundle with six E1 lines

If the MFR bundle aggregates enough bandwidth to utilize all of the channels on a Hybrid Access slot card (up to 186, or six E1 lines), you can create a single Call-Route profile that maps the E1 slot card to the Hybrid Access slot card. Only six of the E1 lines are usable for MFR, however.

For example, the following commands modify the default Call-Route profile to specify the E1 slot card in slot 2 as the preferred source for the slot card:

```
admin> read call-route { { { shelf-1 slot-3 0 } 0 } 0 }
CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 0 } read

admin> set preferred-source = { { 1 16 0 } 0 }

admin> list
[in CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 0 } (changed)]
index* = { { { shelf-1 slot-3 0 } 0 } 0 }
trunk-group = 0
telephone-number = ""
preferred-source = { { shelf-1 slot-16 0 } 0 }
call-route-type = digital-call-type

admin> write
CALL-ROUTE/{ { { shelf-1 slot-3 0 } 0 } 0 } written
```

Configuring Data Link Interfaces

3

A Frame Relay data link interface is a logical configuration that enables a TAOS unit to establish a link with Frame Relay equipment across a particular physical interface. You configure a data link interface by following these steps:

1. Configure the physical port. (See Chapter 2, "Physical Interface Considerations.")
2. Configure a Frame-Relay profile or RADIUS `frdlink` pseudo-user profile defining data link operations and associating the interface with the physical port.
3. Configure a DLCI interface to the far-end device in a Connection or RADIUS profile. At least one DLCI interface is required for the unit to forward data on the link. For details, see Chapter 4, "Configuring Frame Relay Virtual Circuits."

Overview of Frame Relay data links

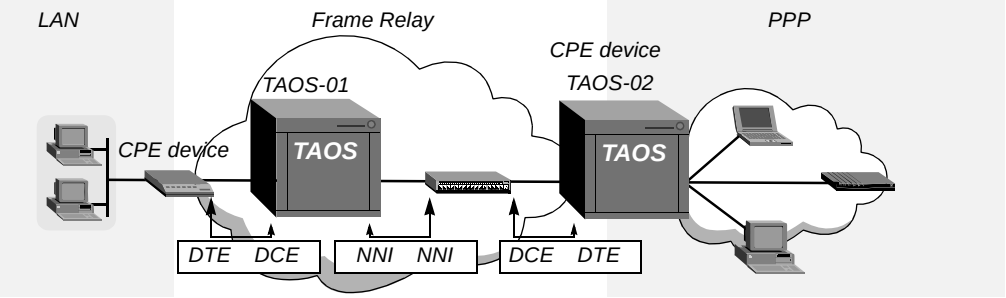
Frame-Relay or RADIUS `frdlink` profiles define data link operations, associate the interface with a particular physical port, and specify how the unit is integrated into the Frame Relay network. Depending on how a TAOS unit is integrated into a Frame Relay network, it can operate as a Frame Relay terminating unit (customer premises equipment, or CPE) or as a Frame Relay switch.

User-side and network-side operations

A CPE device is the source or destination of data traversing the Frame Relay service. For example, the TAOS unit labeled TAOS-02 in Figure 3-1 is operating as a CPE device because it terminates the Frame Relay encapsulated data stream. In the user-to-network interface (UNI), it acts as the user-side data terminal equipment (UNI-DTE). A device with a UNI-DTE interface communicates with a network-side data circuit-terminating equipment (UNI-DCE) interface of another Frame Relay device, such as a switch.

The TAOS unit labeled TAOS-01 in Figure 3-1 receives Frame Relay encapsulated frames from a CPE device and forwards them on a Frame Relay network. It acts as the network side (UNI-DCE) communicating with the user side (UNI-DTE) interface of a CPE device.

Figure 3-1. Network-side and user-side data link interfaces



The TAOS unit labeled TAOS-01 in Figure 3-1 also receives frames from a Frame Relay switch and switches them to another Frame Relay data link interface. When it is configured with a network-to-network (NNI) interface to Frame Relay, the TAOS-01 unit performs switch-to-switch communication on that interface. Switch-to-switch communication includes both user-side (NNI-DTE) and network-side (NNI-DCE) functions, because it both requests and responds to requests for network information.

Link management options

Frame Relay link management enables you to retrieve information about the status of the data link interface via special management frames with a unique data link connection identifier (DLCI) address. (DLCI 0 is the default for link-management frames.) Link-management frames are used to monitor the interface and provide information about DLCI status.

On a UNI interface to Frame Relay, link-management procedures occur in one direction. The UNI-DTE device requests information, and the UNI-DCE device provides it. On an NNI interface, link-management procedures are bidirectional. Switches perform both the NNI-DTE and NNI-DCE link-management functions, because both sides of the connection request information from their peer switches.

Link-management settings are optional. You can set up a data link interface and pass data across it without setting these parameters. However, they do provide a mechanism for retrieving information about the status of the interface and its DLCIs.

Configuring data link operations

You can define the operations of a data link interface in a local Frame-Relay profile or a RADIUS `frdlink` pseudo-user profile.

Data link settings in a Frame-Relay profile

Following are the Frame-Relay parameters (shown with default settings) for defining data link operations:

```
[in FRAME-RELAY/""]
fr-name* = ""
active = no
nailed-up-group = 1
nailed-mode = ft1
```

```
called-number-type = 2
switched-call-type = 56k-clear
phone-number = ""
billing-number = ""
transit-number = ""
call-by-call-id = 0
link-mgmt = none
link-type = dte
n391-val = 6
n392-val = 3
n393-val = 4
t391-val = 10
t392-val = 15
MRU = 1532
dceN392-val = 3
dceN393-val = 4
link-mgmt-dlci = dlci0
mfr-bundle-name = ""
svc-options = { no "" }
```

Note: Parameters identified with an asterisk (*) in the following table do not apply when the bandwidth is nailed (for PVCs or SVCs). For switched PVCs, the setting in the Frame-Relay profile is not currently used. Instead, the information is taken from the Connection profile. See "Configuring a switched PVC" on page 4-8.

Parameter	Specifies
FR-Name	Frame-Relay profile name, which must be unique, lowercase, and no longer than 15 characters.
Active	Availability of this profile for use. The default is `no`.
Nailed-Up-Group	Group number assigned to nailed channels in a line profile, such as a T1 or E1 profile. The default is 1. For PVCs and SVCs, this parameter must be set to the nailed group of a physical interface.
Nailed-Mode	Type of connection. For a PVC or SVC, the parameter must be set to `ft1` (the default), which specifies nailed channels. For a switched PVC, the parameter must be set to `off`.
Called-Number-Type*	Type of number in the Phone-Number field.
Switched-Call-Type	Type of bearer channel capability. If a T1 line is set for extended superframe (ESF) format and bipolar 8-zero substitution (B8ZS) encoding, the remote switch or router typically requires that you set this parameter to `64k-clear`. A setting of `56k-clear` (the default) is required if the line is set for superframe (D4) format and alternate mark inversion (AMI) encoding. E1 lines typically use `64k-clear`. This parameter does not apply to switched PVCs or SVCs.
Phone-Number*	Telephone number to dial.
Billing-Number*	Number to use for billing purposes.
Transit-Number*	String for use in the transit network.

Parameter	Specifies
Call-by-Call-ID*	ID for call-by-call PRI signaling.
Link-Mgmt	Link-management protocol. Settings are `none` (the default, which disables link management), `ansi-t1.617` (Annex D), and `ccitt-q.933a` (CCITT Q.933 Annex A). To ensure interoperability with equipment from different vendors, use the same version of management protocol at each end of the Frame Relay link.
Link-Type	Type of operations performed by the unit on the link interface. Settings are `dte` (the default), `dce`, and `nni`.
N391-Val	Number of T391 polling cycles between full Status Enquiry messages. The default is 6, which specifies that after six status requests (which occur at the interval specified by T391-Val), the UNI-DTE device requests a Full Status report. This parameter does not apply if Link-Type is `dce`.
N392-Val	Number of errors that, if occurring within the number of DTE monitored events specified by N393-Val, causes the user side to declare the network-side procedures inactive. The value must be less than that of N393-Val (which can be from 1 to 10). The default value is 3. This parameter does not apply when Link-Type is `dce`.
N393-Val	Maximum number of events in a DTE-monitored event count (from 1 to 10). The default is 4. This parameter does not apply when Link-Type is `dce`.
T391-Val	Link integrity verification polling timer. Enter a value less than that of T392-Val. The default is 10, which specifies that status requests are spaced 10 seconds apart. You can multiply the value by the number of polling cycles specified by N391-Val to calculate the interval at which the UNI-DTE device requests a Full Status report. This parameter does not apply when Link-Type is `dce`.
T392-Val	Interval (in seconds) within which Status Enquiry messages must be received (default 15). If the network does not receive a Status Enquiry message within the specified number of seconds, the network records an error. This parameter does not apply when Link-Type is `dte`.
MRU	Maximum number of bytes the unit can receive in a single packet across the link interface. Usually the default of 1532 is the correct setting. However, if the far-end device is using a significantly smaller maximum transmission unit (MTU), it might be more efficient to set this parameter to a lower number.
DCEN392-Val	Number of errors that, if occurring within the number of DCE-monitored events (DCEN393-Val), causes the network side to declare the user-side procedures inactive. The value should be less than that of DCEN393-Val (which can be from 1 to 10). The default value is 3. This parameter does not apply when Link-Type is `dte`.

Parameter	Specifies
DCEN393-Val	Maximum number of events in a DCE-monitored event count (from 1 to 10). The default is 4. This parameter does not apply when Link-Type is `dte`.
Link-Mgmt-DLCI	DLCI to use for LMI link management on the Frame Relay data link. Valid values are `dlci0` (the default) and `dlci1023`. For SVCs, `dlci0` is required.
MFR-Bundle-Name	Name of the multilink Frame Relay (MFR) bundle to which this data link belongs. See Chapter 7, "Configuring Multilink Frame Relay (MFR)."
SVC-Options	Enable/disable SVC signaling (Q.933) and assign an address. See "Configuring an SVC" on page 4-11.

Data link settings in a RADIUS profile

An `frdlink` profile is a pseudo-user profile in which the first line has this format:

`frdlink-`*`name`*`-N Password="ascend", Service-Type = Dialout-Framed-User`

The *name* argument is the system name (specified by the Name parameter in the System profile). It cannot include embedded spaces. *N* is a number in a sequential series, starting with 1, that applies to this type of pseudo-user profile (`frdlink`-*name*-1, `frdlink`-*name*-2, and so forth). Make sure no numbers are missing in the series specified by *N*. If a gap occurs in the sequence of numbers, the TAOS unit stops retrieving the profiles when it encounters the gap.

The following attribute-value pairs can be used to define a `frdlink` pseudo-user profile:

RADIUS attribute	Value
Ascend-FR-Profile-Name (180)	Frame-Relay profile name (up to 15 characters), to be specified in profiles that use this datalink. If the name is specified in local Connection profiles, it must be lowercase. The name cannot duplicate the name of a local Frame-Relay profile.
Ascend-FR-Nailed-Grp (158)	Group number assigned to nailed channels in a line profile, such as a T1 or E1 profile. The default is 1. If the channels are on a nailed T1 line, make sure that the number of channels the unit uses for the link matches the number of channels used by the device at the other end of the link, and that only one T1 profile specifies the Nailed-Group number to be used by the Frame Relay data link.
Ascend-Call-Type (177)	Type of nailed connection. Nailed (1) is the default, which is required for PVCs.
Ascend-Data-Svc (247)	Type of data service on the nailed link. Typically set to Nailed-64K for a Frame Relay PVC.

RADIUS attribute	Value
Ascend-FR-Link-Mgt (160)	Link management protocol. Settings are Ascend-FR-No-Link-Mgt (0) (link management protocol is disabled), Ascend-FR-T1-617D (1) (Annex D), and Ascend-FR-Q-933A (2)(CCITT Q.933 Annex A). Ascend-FR-No-Link-Mgt is the default. To ensure interoperability with equipment from different vendors, use the same version of management protocol at each end of the Frame Relay link.
Ascend-FR-Type (159)	Type of operations the TAOS unit performs on this interface. Settings are Ascend-FR-DTE (0), Ascend-FR-DCE (1), or Ascend-FR-NNI (2). Ascend-FR-DTE is the default. (For more information, see “Typical UNI-DTE interface configuration” on page 3-7, “Typical UNI-DCE interface configuration” on page 3-8, and “Typical NNI interface configuration” on page 3-9.)
Ascend-FR-N391 (161)	Number of T391 polling cycles between full Status Enquiry messages. The default is 6, which specifies that after six status requests (which occur at the interval specified by T391-Val), the UNI-DTE device requests a Full Status report. This attribute-value pair does not apply when Ascend-FR-Type is Ascend-FR-DCE.
Ascend-FR-DTE-N392 (163)	Number of errors that, if occurring in the number of DTE monitored events specified by Ascend-FR-DTE-N393, causes the user side to declare the network-side procedures inactive. The value must be less than that of Ascend-FR-DTE-N393l (which can be from 1 to 10). The default value is 3. This attribute-value pair does not apply when Ascend-FR-Type is Ascend-FR-DCE.
Ascend-FR-DTE-N393 (165)	DTE monitored event count (from 1 to 10). The default is 4. This attribute-value pair does not apply when Ascend-FR-Type is Ascend-FR-DCE.
Ascend-FR-T391 (166)	Link integrity verification polling timer. Use a value less than that of T392-Val. The default is 10, which specifies that status requests are spaced 10 seconds apart. You can multiply the value by the number of polling cycles specified by N391-Val to calculate the interval at which the UNI-DTE device requests a Full Status report. This attribute-value pair does not apply when Ascend-FR-Type is Ascend-FR-DCE.
Ascend-FR-T392 (167)	Interval within which Status Enquiry messages must be received (from 5 to 30 seconds). The default T392 value is 15. An error is recorded if no Status Enquiry message is received within the specified number of seconds. This attribute-value pair does not apply when Ascend-FR-Type is Ascend-FR-DTE.
Framed-MTU (12)	Maximum number of bytes the unit can receive in a single packet across the link interface. Usually the default of 1532 is the correct setting. However, if the far-end device is using a significantly smaller maximum transmission unit (MTU), it might be more efficient to set this attribute to a lower number.

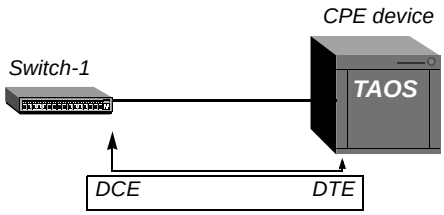
RADIUS attribute	Value
Ascend-FR-DCE-N392 (162)	Number of errors that, if occurring in the number of DCE-monitored events specified by Ascend-FR-DCE-N393, causes the network side to declare the user-side procedures inactive. The value must be less than that of Ascend-FR-DCE-N393 (which can be from 1 to 10). This attribute-value pair does not apply when Ascend-FR-Type is Ascend-FR-DTE.
Ascend-FR-DCE-N393 (164)	DCE-monitored event count (from 1 to 10). The default is 4. This attribute-value pair does not apply when Ascend-FR-Type is Ascend-FR-DTE.
Ascend-FR-Link-Status-Dlci (106)	DLCI to use for LMI link management on the Frame Relay data link. Valid values are `dlci0` (the default) and `dlci1023`. For SVCs, `dlci0` is required.

Typical UNI-DTE interface configuration

On a UNI-DTE interface, a TAOS unit acts as the user side communicating with the network-side DCE switch. It initiates link-management functions by sending a Status Enquiry message to the UNI-DCE device. Status Enquiry messages can include queries about the status of PVC segments the DTE has detected and the integrity of the data link between the UNI-DTE and UNI-DCE interfaces.

The UNI-DTE interface uses the values of the N391-Val, N392-Val, N393-Val, and T391-Val parameters in the Frame-Relay profile to define the timing of its Status Enquiry messages to the DCE and its link integrity parameters. These parameters correspond to the Ascend-FR-N391, Ascend-FR-DTE-N392, Ascend-FR-DTE-N393, and Ascend-FR-T391 attributes in a RADIUS profile. Figure 3-2 shows a TAOS unit with a UNI-DTE interface.

Figure 3-2. UNI-DTE interface connecting to switching equipment



In this example, the interface will be configured as a PVC. The following commands specify Nailed-Group 11 as the bandwidth for the sample DTE interface:

```
admin> new frame-relay ct1-1.3.1
FRAME-RELAY/ct1-1.3.1 read

admin> set active = yes

admin> set switched-call-type = 64k-clear

admin> set link-type = dte

admin> set nailed-up-group = 11

admin> set link-mgmt = ccitt
```

```
admin> write
FRAME-RELAY/ct1-1.3.1 written
```

With these link-management settings, the TAOS unit uses the CCITT Q.933 Annex A link-management protocol to communicate with the Frame Relay DCE. It initiates link-management functions by sending a Status Enquiry message to the DCE every 10 seconds.

On a UNI-DTE interface, the state of a DLCI is determined by the Full Status report from the DCE or by an asynchronous PVC update. The Full Status report from the DCE specifies active, inactive, and new DLCIs. If the DCE does not specify a DLCI as active or inactive, the DTE considers it inactive.

Following is a comparable RADIUS profile:

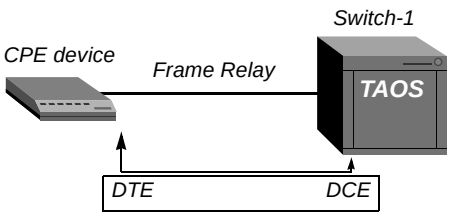
```
frdlink-sys-1 Password = "ascend", Service-Type = Dialout-Framed-User
   Ascend-FR-Profile-Name = "ct1-1.3.1",
   Ascend-Call-Type = Nailed,
   Ascend-FR-Type = Ascend-FR-DTE,
   Ascend-FR-Nailed-Grp = 11,
   Ascend-FR-Link-Mgt = Ascend-FR-Q-933A,
   Ascend-Data-Svc = Nailed-64K
```

Typical UNI-DCE interface configuration

On a UNI-DCE interface, a TAOS unit acts as the network side communicating with the user side (UNI-DTE) of a Frame Relay terminating unit.

The UNI-DCE interface uses the values of the T392-Val, DCEN392-Val, and DCEN393-Val parameters in the Frame-Relay profile to define the parameters of the Status Enquiry messages it expects from the DTE. These parameters correspond to the Ascend-FR-T392, Ascend-FR-DCE-N392, and Ascend-FR-DCE-N393 attributes in a RADIUS profile. For example, the UNI-DCE interface expects a Status Enquiry message from the DTE every T392 seconds. If it does not receive a Status Enquiry message at the specified interval, it records an error. Figure 3-3 shows a TAOS unit with a UNI-DCE interface.

Figure 3-3. UNI-DCE interface connecting to customer premises equipment (CPE)



In this example, the interface will be configured as a PVC. The following commands specify Nailed-Group 36 as the bandwidth for the sample DCE interface:

```
admin> new frame-relay ut1-1.7.8
FRAME-RELAY/ut1-1.7.8 read
admin> set active = yes
admin> set switched-call-type = 64k-clear
admin> set link-type = dce
```

```
admin> set nailed-up-group = 36
admin> set link-mgmt = ccitt
admin> set t392 = 15
admin> write
FRAME-RELAY/ut1-1.7.8 written
```

With these link-management settings, a TAOS unit uses the CCITT Q.933 Annex A link-management protocol to communicate with the CPE end point. It expects a Status Enquiry message at intervals of less than 15 seconds.

On a UNI-DCE interface, if the data link is operational, the DLCI is considered to be operational as well. In the DCE Full Status response to the DTE, if a PVC segment terminates within the DCE, the segment is reported as active. If the PVC segment is not terminated, the DCE requests further information about the DLCI from the next-hop switch, and reports back to the DTE when the segment is confirmed to be active or inactive.

Following is a comparable RADIUS profile:

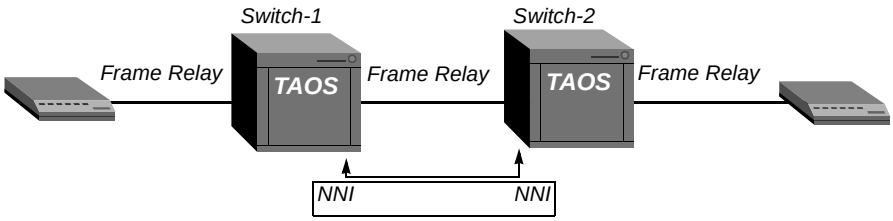
```
frdlink-sys-2 Password = "ascend", Service-Type = Dialout-Framed-User
   Ascend-FR-Profile-Name = "ut1-1.7.8",
   Ascend-Call-Type = Nailed,
   Ascend-FR-Type = Ascend-FR-DCE,
   Ascend-FR-Nailed-Grp = 36,
   Ascend-FR-Link-Mgt = Ascend-FR-Q-933A,
   Ascend-Data-Svc = Nailed-64K,
   Ascend-FR-T392 = 15
```

Typical NNI interface configuration

An NNI interface implements procedures used by Frame Relay switches to communicate status between them. The TAOS unit uses these procedures to inform the peer switch about the status of PVC segments as seen from the unit's side, and about the integrity of the data link between the two switches. The procedure is bidirectional. The switches act as both the user side (DTE) and network side (DCE), because they both send Status Enquiry messages and respond to them.

Because NNI is bidirectional, it uses all the link-management values specified in the Frame-Relay profile. The values of N391-Val, N392-Val, N393-Val, and T391-Val are used to define the user side of the NNI. These values define the timing of the Status Enquiry messages the TAOS unit sends to its peer switch and the boundary conditions that define link integrity. The values of T392-Val, DCEN392-Val, and DCEN393-Val are used by the network side of the NNI to define the parameters of the Status Enquiry messages it expects from the its peer switch. Figure 3-4 shows a TAOS unit with an NNI interface.

Figure 3-4. NNI interface between two switches



To operate as a switch, the TAOS unit requires a circuit configuration in two Connection or RADIUS profiles. For details about circuit configuration, see “Overview of Frame Relay circuit switching” on page 6-1.

Note: The unit relies on the circuit configuration to relay the frames received on one of the circuit end points to the other circuit end point. However, the two Frame Relay end points that make up the circuit do not require NNI data link interfaces.

In this example, the interface will be configured as a PVC. The following commands specify channels in group 52 for the NNI interface to Switch-2 shown in Figure 3-4:

```
admin> new frame-relay ut1-1.7.5
FRAME-RELAY/ut1-1.7.5 read

admin> set active = yes

admin> set switched-call-type = 64k-clear

admin> set link-type = nni

admin> set nailed-up-group = 52

admin> set link-mgmt = ansi-t1.617d

admin> set n391 = 6

admin> set t391 = 10

admin> set t392 = 15

admin> write
FRAME-RELAY/ut1-1.7.5 written
```

With these link-management settings, a TAOS unit uses the ANSI Annex D link-management protocol to communicate with Switch-2. It sends a Status Enquiry message for link integrity verification to Switch-2 every 10 seconds, and requests a Full Status report every sixth enquiry (every 60 seconds). The unit also sends a Full Status report in response to requests from the other switch. If the unit does not receive a Status Enquiry message within a 15-second interval (T392), it records an error. Following is a comparable RADIUS profile:

```
frdlink-sys-3 Password = "ascend", Service-Type = Dialout-Framed-User
   Ascend-FR-Profile-Name = "ut1-1.7.5",
   Ascend-Call-Type = Nailed,
   Ascend-FR-Type = Ascend-FR-NNI,
   Ascend-FR-Nailed-Grp = 52,
   Ascend-FR-Link-Mgt = Ascend-FR-T1-617D,
   Ascend-Data-Svc = Nailed-64K,
   Ascend-FR-N391 = 6,
   Ascend-FR-T391 = 10,
   Ascend-FR-T392 = 15
```

Configuring Frame Relay Virtual Circuits

4

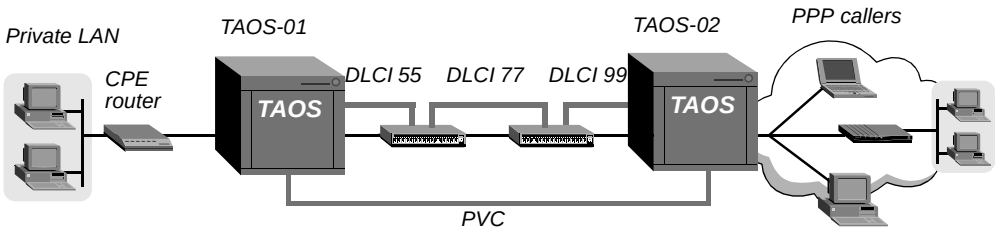
Frame Relay virtual circuits are bidirectional data paths between two end points in a Frame Relay network. The data path between the two end points can include a number of hops in between. Depending on the type of physical interface used to access Frame Relay and the configuration of the other end point, a virtual circuit can be a permanent virtual circuit (PVC), switched virtual circuit (SVC), or a switched PVC.

For details about which slot cards to use for the different types of virtual circuits, see Table 2-1, “Slot cards and supported Frame Relay virtual circuit features,” on page 2-1.

A data link connection identifier (DLCI) is a unique number assigned to a PVC end point. A DLCI has local significance only. In TAOS units, DLCIs can range from 16 to 991. Each data stream on a data link interface requires a unique DLCI. For permanent virtual circuits (PVCs), you obtain the number from the administrator of the Frame Relay network and assign it manually in a Connection or RADIUS profile. For switched virtual circuits (SVCs), the network assigns a DLCI for the duration of the circuit.

Figure 4-1 shows a PVC between two TAOS units. The end point in the unit labeled TAOS-01 is assigned DLCI 55. The end point in the unit labeled TAOS-02 is assigned DLCI 99. The end point configurations are also referred to as DLCI interfaces.

Figure 4-1. Permanent virtual circuit (PVC) end points



Configuring a PVC

A PVC uses nailed bandwidth. PVCs are established on the basis of an exchange of LMI frames and the occurrence of a number of events.

PVCs can have a backup interface if the data link is configured as a UNI-DTE or NNI interface. On these link interfaces, the TAOS unit issues Status Enquiries that check the state of the other end of PVC segments on the interface. If a DLCI becomes inactive, and the profile configuring its nailed interface specifies a backup connection, the TAOS unit uses the backup connection to provide an alternative route to the other end.

Overview of settings for PVC configuration

A PVC that is configured locally in the TAOS unit's command-line interface consists of the data link configuration in a Frame-Relay profile and a DLCI interface in a Connection profile. You can configure multiple PVCs over a single shared data link by specifying the same Frame-Relay profile in each Connection profile.

A PVC configured in RADIUS consists of the data link configuration in an `frdlink` profile and one or more DLCI interfaces in `permconn` profiles.

Frame-Relay profile settings

As for any Frame-Relay profile, you must specify a name for the profile and set the `active` parameter to `yes`. Following are the Frame-Relay profile parameters that are specifically related to configuring a PVC to a far-end device. (The settings shown are the defaults.)

```
[in FRAME-RELAY/""]
nailed-up-group = 1
nailed-mode = ft1
switched-call-type = 56k-clear
```

Parameter	Specifies
Nailed-Up-Group	Group number assigned to nailed channels in a line profile, such as a T1 or E1 profile. The default is 1. This parameter must be set to the nailed group of a physical interface.
Nailed-Mode	Type of connection. Set this parameter to `ft1` (the default) for nailed channels.
Switched-Call-Type	Type of bearer channel capability. If a T1 line is set for ESF-B8ZS signaling, the remote switch or router typically requires that you set this parameter to `64k-clear`. A setting of `56k-clear` (the default) is required if the line is set to D4-AMI. E1 lines typically use `64k-clear`. This setting applies only to PVCs.

Connection profile settings

As for any Connection profile, you must specify a station name and set the Active parameter to `yes`. Following are the Connection profile parameters (shown with default settings) for defining the PVC:

```
[in CONNECTION/""]
encapsulation-protocol = mpp
[in CONNECTION/"":ip-options]
remote-address = 0.0.0.0/0
[in CONNECTION/"":fr-options]
frame-relay-profile = ""
circuit-type = pvc
dlci = 16
[in CONNECTION/"":telco-options]
call-type = off
[in CONNECTION/"":session-options]
backup = ""
```

Parameter	Specifies
Encapsulation-Protocol	Encapsulation protocol to use on the interface. Set to `frame-relay` for PVCs.
Remote-Address	Destination IP address, which lies at the end of a PVC whose first hop is known by the specified DLCI.
Frame-Relay-Profile	Name of the Frame-Relay profile that defines the data link.
Circuit-Type	Type of virtual circuit. This parameter must be set to `pvc` (the default) for PVCs.
DLCI	A DLCI that uniquely identifies this PVC end point. The unit does not allow you to enter duplicate DLCIs on the same data link.
Call-Type	Type of call. Set this parameter to `ft1` for nailed.
Backup	Name of a backup Connection profile to the next hop (optional).

RADIUS attribute-value pairs

The following attribute-value pairs define a PVC in an `frdlink` profile:

RADIUS attribute	Value
Ascend-FR-Profile-Name (180)	Name of the profile. See “Data link settings in a RADIUS profile” on page 3-5.
Ascend-FR-Nailed-Grp (158)	Group number assigned to nailed channels in a line profile, such as a T1 or E1 profile. The default is 1.
Ascend-Call-Type (177)	Type of connection. Nailed (1) is the default, which is required for PVCs.
Ascend-Data-Svc (247)	Type of data service on the link. This attribute is typically set to `nailed-64k` for a Frame Relay PVC.

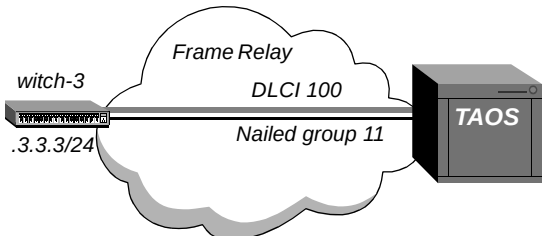
The following attribute-value pairs can be used to define a `permconn` profile that uses Frame Relay:

RADIUS attribute	Value
User-Name (1)	Name of the far-end Frame Relay device.
Framed-Protocol (7)	Encapsulation protocol. Must be set to FR (261).
Ascend-FR-Profile-Name (180)	Name of the Frame-Relay profile that defines the data link.
Ascend-FR-DLCI (179)	DLCI that uniquely identifies this PVC end point. The unit does not allow you to enter duplicate DLCIs on the same data link.
Framed-Address (8)	Destination IP address, which lies at the end of a PVC whose first hop is known by the specified DLCI.
Framed-Netmask (9)	Subnet mask for Framed-Address.
Ascend-Backup (176)	Name of a backup Connection profile to the next hop (optional).

Typical PVC configurations

In the sample setup shown in Figure 4-2, a PVC with DLCI 100 connects to a far-end switch named Switch-3. In this example, the data link uses a nailed T1 interface.

Figure 4-2. PVC to a Frame Relay switch



Configuring the data link for a PVC

The following commands configure the data link:

```
admin> new frame-relay ct1-1.11.8
FRAME-RELAY/ct1-1.11.8 read
admin> set active = yes
admin> set switched-call-type = 64k-clear
admin> set nailed-up-group = 11
admin> set link-type = dte
admin> set link-mgmt = ansi-t1.617d
admin> write
FRAME-RELAY/ct1-1.11.8 written
```

Following is a comparable RADIUS `frdlink` profile:

```
frdlink-sys-3 Password = "ascend", Service-Type = Dialout-Framed-User
   Ascend-FR-Profile-Name = "ct1-1.11.8",
   Ascend-Call-Type = Nailed,
   Ascend-FR-Type = Ascend-FR-DTE,
   Ascend-FR-Nailed-Grp = 11,
   Ascend-FR-Link-Mgt = Ascend-FR-T1-617D,
   Ascend-Data-Svc = Nailed-64K,
   Ascend-FR-N391 = 6,
   Ascend-FR-T391 = 10,
   Ascend-FR-T392 = 15
```

Configuring the PVC Connection profile

The following set of commands configures the Connection profile, assigning DLCI 100:

```
admin> new connection switch-3
CONNECTION/switch-3 read

admin> set active = yes

admin> set encapsulation-protocol = frame-relay

admin> set ip-options remote-address = 3.3.3.3/24

admin> set telco-options call-type = ft1

admin> set fr-options frame-relay-profile = ct1-1.11.8

admin> set fr-options circuit-type = pvc

admin> set fr-options dlci = 100

admin> write
CONNECTION/switch-3 written
```

Following is a comparable RADIUS `permconn` profile:

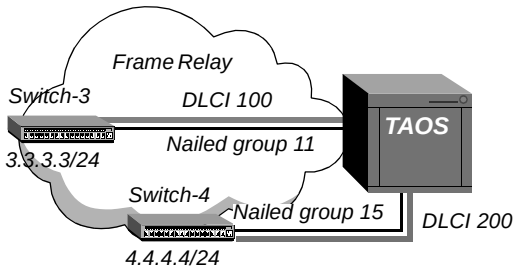
```
permconn-sys-1 Password = "ascend", User-Service = Dialout-Framed-User
    User-Name = "switch-3",
    Framed-Protocol = FR,
    Framed-Address = 3.3.3.3,
    Framed-Netmask = 255.255.255.0,
    Ascend-FR-DLCI = 100,
    Ascend-FR-Profile-Name = "ct1-1.11.8"
```

Note: When IP routing is enabled, the unit creates a route for this destination. Administrators can choose to add static routes to other subnets or to enable RIP updates to or from the router across Frame Relay. The usual considerations for IP routing connections apply.

Typical backup PVC configurations

Figure 4-3 shows a TAOS unit with a primary PVC to a switch named Switch-3. The primary data link interface must be configured for UNI-DTE or NNI link management. The unit has a backup PVC to a switch named Switch-4.

Figure 4-3. Backup PVC



In this example, the remote IP addresses of the primary and backup connections are different. If the connection to Switch-3 becomes unavailable, the unit begins forwarding Frame Relay traffic to Switch-4.

Configuring the backup connection

The following commands specify a backup data link that uses a different set of nailed channels. (For details about configuring a Frame-Relay profile, see Chapter 3, "Configuring Data Link Interfaces.")

```
admin> new frame-relay ct1-1.4.1
FRAME-RELAY/ct1-1.4.1 read
admin> set active = yes
admin> set nailed-up-group = 15
admin> write
FRAME-RELAY/ct1-1.4.1 written
```

The following commands create the backup profile to `switch-4`:

```
admin> new connection switch-4
CONNECTION/switch-4 read
admin> set active = yes
admin> set encapsulation-protocol = frame-relay
admin> set ip-options remote-address = 4.4.4.4/24
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = ct1-1.4.1
admin> set fr-options circuit-type = pvc
admin> set fr-options dlci = 200
admin> write
CONNECTION/switch-4 written
```

Specifying a backup PVC in the primary profile

The following commands modify the Switch-3 profile (defined in "Configuring the PVC Connection profile" on page 4-5) to specify a backup profile if the PVC to Switch-3 becomes unavailable:

```
admin> read connection switch-3
CONNECTION/switch-3 read
admin> set session-options backup = switch-4
admin> write
CONNECTION/switch-3 written
```

Following is a comparable RADIUS `permconn` profile:

```
permconn-sys-1 Password = "ascend", User-Service = Dialout-Framed-User
    User-Name = "switch-3",
    Framed-Protocol = FR,
    Framed-Address = 3.3.3.3,
    Framed-Netmask = 255.255.255.0,
    Ascend-FR-DLCI = 100,
    Ascend-FR-Profile-Name = "ct1-1.11.8",
    Ascend-Backup = "switch-4"
```

Routing table entries showing backup PVC

When the TAOS unit establishes the two Frame Relay PVCs, the routing table includes entries such as the following:

```
...
3.3.3.0/24    3.3.3.3     wan33     rGT     60    1     0    89
3.3.3.0/24    3.3.3.3     wan33     *SG    120    7     0   198
3.3.3.3/32    3.3.3.3     wan33     rT      60    1     0    89
3.3.3.3/32    3.3.3.3     wan33     *      120    7         198
4.4.4.4/32    4.4.4.4     wan32     rT      60    1     0    51
4.4.4.4/32    4.4.4.4     wan33     *S     120    1          89
...
```

At this point, both nailed connections are operational, and the output of the **`ifmgr -d`** command contains entries such as the following:

```
bif slot sif u m p ifname   host-name remote-addr      local-addr
-------------------------------------------------------------------
032 1:03 001 *   p wan32    switch-4  4.4.4.4/32       2.2.2.2/32
033 1:03 002 *   p wan33    switch-3  3.3.3.3/32       2.2.2.2/32
```

If the primary PVC becomes unavailable, the routing table does not change, but the entries in the output of the Ifmgr command are similar to the following:

```
bif slot sif u m p ifname  host-name  remote-addr      local-addr
-------------------------------------------------------------------
032 1:03 001 *   p wan32   switch-4    4.4.4.4/32     2.2.2.2/32
033 1:17 000 +   p wan33   switch-3    3.3.3.3/32     2.2.2.2/32
```

Notice that `switch-3` is shown with a plus sign (+) to show that it is in the Backup Active state (backed up by another connection). When the primary PVC becomes operational again, the data flow is directed to that interface again. At that point, the **`ifmgr -d`** command output again shows both interfaces as operational.

Configuring a switched PVC

TAOS units support PVCs over switched ISDN connections (*switched PVCs*). Switched PVCs are established in the same way as nailed PVCs: on the basis of an exchange of LMI frames and the occurrence of a number of events. However, instead of using nailed bandwidth, a switched PVC uses an ISDN B channel that is made active by an outgoing or incoming call. Switched PVCs can use channels on any channelized card that works with a Hybrid Access card.

To establish a switched PVC by placing an outgoing call, the TAOS unit initiates the call in the usual way, using values taken from the Connection profile. When the call has been established and the B channel is available, the system begins exchanging LMI frames to establish Frame Relay link operations, a process that can take several seconds. Once the link is established, it works just like a PVC with an access rate of 64Kbps or 56Kbps, depending on the ISDN configuration.

To establish a switched PVC by accepting an incoming call, the TAOS unit must preauthenticate the call by using either calling-line ID (CLID) or the Dialed Number Information Service (DNIS). Preauthentication is required to enable the unit to detect that it must begin using Frame Relay encapsulation before answering the call. After the connection has been accepted, the TAOS unit follows the same procedure to establish the PVC as described in the preceding text for outgoing calls. For details about CLID and DNIS authentication, see the *APX 8000/MAX TNT WAN, Routing, and Tunneling Configuration Guide*.

Overview of switched PVC settings

A switched PVC that is configured locally in the TAOS unit's command-line interface consists of the data link configuration in a Frame-Relay profile and a switched PVC Connection profile. You can configure the same settings in RADIUS profiles as you would for a PVC, but with switched call settings.

You can configure multiple switched PVCs over a single shared data link by specifying the same Frame-Relay profile in each Connection profile. However, this approach requires that all PVCs on the same switched connection share the same established call.

Frame-Relay profile settings

As for any Frame-Relay profile, you must specify a name and set the Active parameter to `yes`. Following is the Frame-Relay profile setting related to configuring a switched PVC to a far-end device. (The setting shown is the default.)

```
[in FRAME-RELAY/""]
nailed-mode = ft1
```

Parameter	Specifies
Nailed-Mode	Type of connection. For a switched PVC, the parameter must be set to `off`, which specifies switched channels. To enable the TAOS unit to place an outgoing call to establish the switched PVC, a Connection profile must specify a switched call type and a dial number. To enable the system to accept an incoming call to establish the switched PVC, the Connection profile must specify a CLID or called number, the TAOS unit must require CLID or DNIS, and incoming Frame Relay calls must be enabled.

Note: The Switched-Call-Type setting in a Frame-Relay profile is not used for switched PVCs. The call-type information is taken from the Connection profile and used for switched PVCs just as it is for any other ISDN call.

Answer-Defaults and Connection profile settings

As for any Connection profile, you must specify a station name and set the Active parameter to `yes`. Following are the local Answer-Defaults and Connection profile settings specifically related to configuring a switched PVC. (The settings shown are the defaults.)

```
[in ANSWER-DEFAULTS:fr-answer]
enabled = yes

[in ANSWER-DEFAULTS]
clid-auth-mode = ignore

[in CONNECTION/""]
encapsulation-protocol = mpp
called-number-type = national
dial-number = ""
clid = ""
calledNumber = ""

[in CONNECTION/"":ip-options]
remote-address = 0.0.0.0/0

[in CONNECTION/"":telco-options]
call-type = off
data-service = 56k-clear

[in CONNECTION/"":fr-options]
frame-relay-profile = ""
circuit-type = pvc
dlci = 16
```

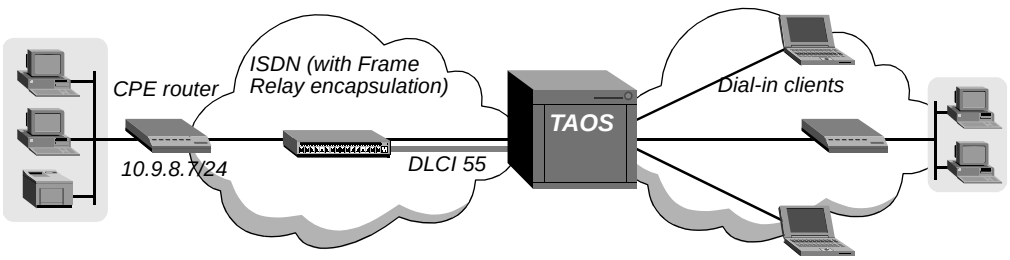
Parameter	Specifies
Enabled	Enable/disable answering of incoming Frame Relay encapsulated calls. (By default, the TAOS unit is configured to answer Frame Relay calls.)

Parameter	Specifies
CLID-Auth-Mode	Enable/disable CLID or DNIS preauthentication for dial-in calls. For switched PVCs initiated by dial-in calls, CLID or DNIS preauthentication is required to enable the unit to begin using Frame Relay encapsulation before answering the call. Set the parameter to `clid-require` to require CLID, or `dnis-require` to require DNIS. For details about the possible settings, see the *APX 8000/MAX TNT Reference*.
Encapsulation-Protocol	Encapsulation protocol to use on the interface. This parameter must be set to `frame-relay`.
Called-Number-Type	Type of telephone number in the Dial-Number field. The default `national` specifies a U.S. telephone number.
Dial-Number	Telephone number to dial out.
CLID	Calling-line ID of the device dialing in to initiate a switched PVC. Either the CLID or the called number is required for dial-in calls.
CalledNumber	Number dialed to reach the TAOS unit.
Remote-Address	Destination IP address, which lies at the end of a PVC whose first hop is known by the specified DLCI.
Call-Type	Type of call. Set this parameter to `off` for switched channels.
Data-Service	Type of service requested of the switch. Set this parameter to `56k-clear` (the default), or `64k-clear`, depending on the configuration of the physical interface used for the connection.
Frame-Relay-Profile	Name of the Frame-Relay profile that defines the data link.
Circuit-Type	Type of virtual circuit. This parameter must be set to `pvc` (the default) for switched PVCs.
DLCI	DLCI that uniquely identifies this PVC end point. The unit does not allow you to enter duplicate DLCIs on the same data link.

Typical switched PVC configuration

Figure 4-4 shows PPP clients dialing into a TAOS unit to reach a customer premises equipment (CPE) router (10.9.8.7/24) that is accessible across Frame Relay.

Figure 4-4. Switched PVC to a Frame Relay switch



If both the Frame-Relay profile and the Connection profile specify a switched call rather than nailed call, the TAOS unit initiates a switched connection on the basis of packet routing (as it typically does for a switched connection). If the Connection profile for the switched PVC also specifies CLID or DNIS, the TAOS unit can also accept an incoming call from 10.9.8.7/24 to bring up the PVC.

The following set of commands configures a sample Frame-Relay profile for an ISDN switched connection to the Frame Relay switch in Figure 4-4:

```
admin> new frame-relay ct1-1.12.7
FRAME-RELAY/ct1-1.12.7 read
admin> set active = yes
admin> set nailed-mode = off
admin> set link-type = nni
admin> set link-mgmt = ansi-t1.617d
admin> write
FRAME-RELAY/ct1-1.12.7 written
```

The following set of commands configures the unit to require DNIS:

```
admin> read answer-defaults
ANSWER-DEFAULTS read
admin> set clid-auth-mode = dnis-require
admin> write
ANSWER-DEFAULTS written
```

The following set of commands configures a Connection profile to the CPE router shown in Figure 4-4, enabling both incoming and outgoing calls:

```
admin> new conn cpe-router
CONNECTION/cpe-router read
admin> set active = yes
admin> set encapsulation-protocol = frame-relay
admin> set dial-number = 853784
admin> set calledNumber = 3783
admin> set ip-options remote-address = 10.9.8.7/24
admin> set telco-options call-type = off
admin> set telco-options data-service = 64k-clear
admin> set fr-options frame-relay-profile = ct1-1.12.7
admin> set fr-options dlci = 55
admin> write
CONNECTION/cpe-router written
```

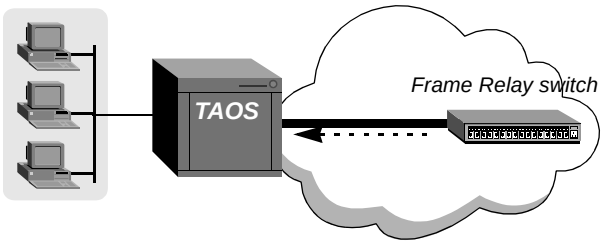
Configuring an SVC

A Frame Relay switched virtual circuit (SVC) is a point-to-point switched connection, which provides a lower cost, usage-based alternative to Frame Relay PVCs. SVCs provide an easier configuration for virtual circuits throughout a Frame Relay network, and allow flexibility in

rerouting virtual circuits when equipment becomes unavailable. Like other types of switched connections, SVCs can be initiated by a dial-in or dial-out call.

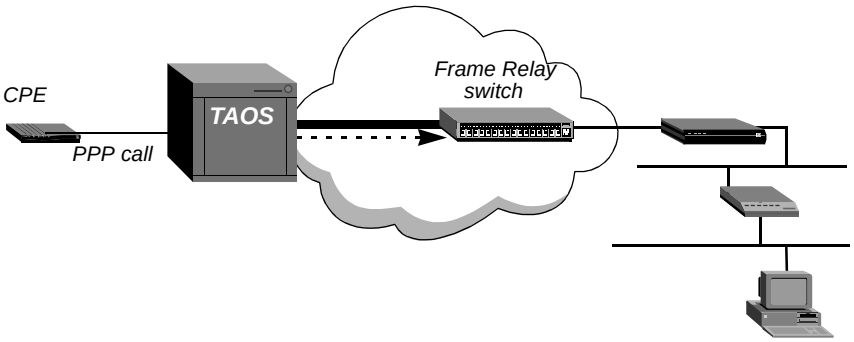
A dial-in Frame Relay SVC terminates locally. The TAOS unit receives the call on a data link interface. The system must enable incoming Frame Relay encapsulated calls (as it does by default). An example of a terminating SVC is shown in Figure 4-5.

Figure 4-5. Terminating SVC



A dial-out SVC is initiated as an outbound call on a data link interface, on the basis of either an explicit dial-out or IP routing. Figure 4-6 shows a Pipeline® unit using PPP or some other type of encapsulation to dial into a TAOS unit. The TAOS unit establishes the inbound call and then dials out on a data link interface on the basis of IP routing, just as it would for another type of switched dial-out call.

Figure 4-6. Dial-out SVC



Unlike permanent virtual circuits (PVCs), which are nailed connections, SVCs are on-demand connections and must use E.164 addresses (ISDN numbers) to identify and route to the SVC interface. For a dial-out SVC, the address is the Dial-Number setting in a Connection or RADIUS profile. For a dial-in SVC, the address can be specified in the Frame-Relay profile or as the CLID in a Connection or RADIUS profile. Dial-in SVCs are CLID authenticated.

To set up an SVC, you must configure SVC options in two locations:

- Frame-Relay profile, for the data link interface associated with a physical T1 or E1 port
- Connection profile, to establish the switched connection on the data link interface

Current limitations

In the current software version, the Frame Relay SVC implementation is subject to the following limitations:

- For SVCs, the TAOS unit operates as a Frame Relay user-side device (DTE only). Network-side operations are not currently supported.
- The ability to request a specific DLCI value for an SVC is not implemented.

Overview of SVC settings

For the system to establish an SVC connection, the data link interface must be operating and configured properly, with SVC (Q.933) signaling enabled. The system initiates the Q.933 signaling sequence when demand for an SVC occurs. All Q.933 call-control information is transmitted over DLCI 0, which must also be used for the link-management protocols if LMI is in use. For SVCs as for PVCs, the LMI setting must match that of the far-end switch. However, LMI is not required.

Frame-Relay profile settings

As for any Frame-Relay profile, you must specify a name and set the Active parameter to `yes`. In addition, the following parameters (shown with default settings) are specifically relevant to SVC configurations:

```
[in FRAME-RELAY/""]
nailed-up-group = 1
link-mgmt-dlci = dlci0

[in FRAME-RELAY/"":svc-options]
enabled = no
fr-address = ""
```

Parameter	Specifies
Nailed-Up-Group	Group number assigned to nailed channels in a line profile, such as a T1 or E1 profile. The default is `1`. This parameter must be set to the nailed group of a physical interface.
Link-Mgmt-DLCI	DLCI to use for LMI link management on the Frame Relay data link. When SVC signaling is enabled, the data link can use either ANSI or CCITT LMI, but Link-Mgmt-DLCI *must* be set to `dlci0`.
Enabled	Enable/disable SVC signaling (Q.933) on the Frame Relay data link. SVC signaling is disabled by default. Note that a single data link interface can support both a PVC and SVC configuration.
FR-Address	E.164 address for this data link. This is the CLID for dial-out SVC connections on this interface. E.164 addresses are ISDN numbers, including telephone numbers. E.164 addresses can include up to 15 digits. For example, standard 10-digit United States telephone numbers, such as 5085551234, are native E.164 addresses.

Note: The Switched-Call-Type setting in a Frame-Relay profile is not used for SVCs. The call-type information is taken from the Connection profile and used for SVCs just as it is for any other dynamic connection.

Answer-Defaults and Connection profile settings

You can configure multiple Connection profiles over a single SVC-enabled Frame Relay data link by specifying the same Frame-Relay profile in each of the Connection profiles.

The Dial-Number parameter must be set in each Connection profile. For both outgoing and incoming circuit establishment requests, the Dial-Number parameter specifies the E.164 address of the remote station. The combination of this setting and the subaddress (if required) must be a unique value.

As for any Connection profile, you must specify a station name and set the Active parameter to `yes`. Following are the local Answer-Defaults and Connection profile settings specifically related to configuring an SVC. (The settings shown are the defaults.)

```
[in ANSWER-DEFAULTS:fr-answer]
enabled = yes

[in CONNECTION/""]
encapsulation-protocol = mpp
called-number-type = national
dial-number = ""
clid = ""
subaddress = ""

[in CONNECTION/"":ip-options]
remote-address = 0.0.0.0/0

[in CONNECTION/"":telco-options]
data-service = 56k-clear

[in CONNECTION/svc-cx:fr-options]
frame-relay-profile = ""
circuit-type = pvc
dlci = 16
```

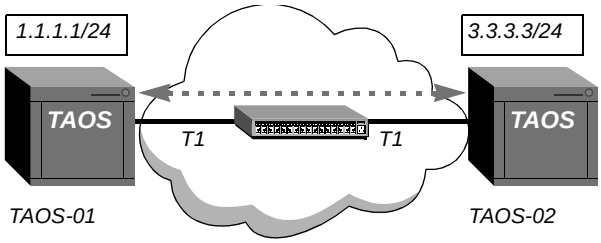
Parameter	Specifies
Enabled	Enable/disable answering of incoming Frame Relay encapsulated calls. (By default, the TAOS unit is configured to answer Frame Relay calls.)
Encapsulation-Protocol	Encapsulation method for the connection. This parameter must be set to `frame-relay`.
Called-Number-Type	Automatically set to `international` when you write a Connection profile that has `circuit-type` set to `svc`.
Dial-Number	E.164 address of the remote station. E.164 addresses are ISDN numbers, including telephone numbers. E.164 addresses can include up to 15 digits. For example, standard 10-digit United States telephone numbers, such as 1235551212, are E.164 addresses. The combination of this setting and the subaddresss must be a unique value.

Parameter	Specifies
CLID	E.164 address of the local end of the SVC. The local E.164 address is typically specified by the FR-Address parameter in a Frame-Relay profile. However, if an E.164 address is specified by the CLID parameter, it overrides the value of FR-Address. You can specify the same CLID in multiple Connection profiles.
Subaddress	Subaddress portion of the E.164 address of the remote station, if a subaddress is required.
Remote-Address	IP address of the remote station.
Data-Service	Automatically set to `frame-relay-svc` when you write a Connection profile that has `circuit-type` set to `svc`.
Frame-Relay-Profile	Name of the Frame-Relay profile for the data link connection.
Circuit-Type	Type of virtual circuit. Set to `svc` to cause the system to establish the connection via Frame Relay SVC call signaling when data transfer is required.
DLCI	The system ignores this parameter for a Connection profile that has `circuit-type` set to `svc`. For an SVC, the DLCI value is assigned to the circuit by the network. The range of DLCI values for circuits is shared between PVCs and SVCs, and is managed by the network and user entities.

Typical Frame Relay SVC configurations

In the sample SVC setup shown in Figure 4-7, the two TAOS units each contain channelized T1 and Hybrid Access cards. The switch is configured for SVC operation on the two T1 lines.

Figure 4-7. SVC between TAOS units with an intervening Frame Relay switch



Configuring the near-end TAOS unit for a Frame Relay SVC

The following commands on the unit labeled TAOS-01 (Figure 4-7) configure a Frame Relay data link interface on a T1 line that uses nailed-group 7:

```
admin> new frame-relay stdx-svc1
FRAME-RELAY/stdx-svc1 read
admin> set active = yes
admin> set nailed-up-group = 7
admin> set link-mgmt = ansi-t1.617d
```

```
admin> set svc-options enabled = yes
admin> set svc-options fr-address = 5085551234
admin> write -f
FRAME-RELAY/stdx-svc1 read
```

The following commands configure the SVC Connection profile to TAOS-02:

```
admin> new connection svc-555
CONNECTION/svc-555 read
admin> set active = yes
admin> set encapsulation-protocol = frame-relay
admin> set dial-number = 1235551212
admin> set ip-options remote-address = 3.3.3.3/24
admin> set fr-options frame-relay-profile = stdx-svc1
admin> set fr-options circuit-type = svc
admin> write -f
CONNECTION/svc-555 written
```

Configuring the far-end TAOS unit for a Frame Relay SVC

The following commands on the unit labeled TAOS-02 (Figure 4-7) configure a Frame Relay data link interface on a T1 line that uses nailed-group 8:

```
admin> new frame-relay stdx-svc2
FRAME-RELAY/stdx-svc2 read
admin> set active = yes
admin> set nailed-up-group = 8
admin> set link-mgmt = ansi-t1.617d
admin> set svc-options enabled = yes
admin> set svc-options fr-address = 1235551212
admin> write -f
FRAME-RELAY/stdx-svc2 read
```

The following commands configure the SVC Connection profile to TAOS-01:

```
admin> new connection svc-937
CONNECTION/svc-937 read
admin> set active = yes
admin> set encapsulation-protocol = frame-relay
admin> set dial-number = 5085551234
admin> set ip-options remote-address = 1.1.1.1/24
admin> set fr-options frame-relay-profile = stdx-svc2
admin> set fr-options circuit-type = svc
admin> write -f
CONNECTION/svc-937 written
```

Configuring Frame Relay Direct

5

Overview of Frame Relay direct settings

TAOS units support Frame Relay direct for concentrating incoming PPP calls onto a Frame Relay link. The Frame Relay direct configuration forwards multiple PPP connections onto the data link as a combined data stream on the basis of the Frame Relay direct configuration. The unit does not examine the packets. An upstream device then examines the packets and routes them appropriately.

Note: A Frame Relay direct connection is not a full-duplex tunnel between a PPP dial-in user and a far-end device. Although the TAOS unit does not route the packets onto the Frame Relay link, it must use the router to send packets received across Frame Relay back to the appropriate PPP caller. For this reason, Frame Relay direct connections must enable IP routing.

Connection profile settings for Frame Relay direct

Following are the relevant Frame Relay direct parameters, shown with default settings:

```
[in CONNECTION/""]
encapsulation-protocol = mpp
[in CONNECTION/"":fr-options]
fr-direct-enabled = no
fr-direct-profile = ""
fr-direct-dlci = 16
[in CONNECTION/"":ip-options]
ip-routing-enabled = yes
remote-address = 0.0.0.0/0
```

Parameter	Specifies
Encapsulation-Protocol	Encapsulation protocol. This parameter must be set to `ppp`, `mp`, or `mpp` for Frame Relay direct connections.
FR-Direct-Enabled	Enable/disable Frame Relay direct for this profile.
FR-Direct-Profile	Name of the Frame-Relay profile for the data link interface.

Parameter	Specifies
FR-Direct-DLCI	DLCI of the Connection profile to the next-hop Frame Relay equipment. Multiple Frame Relay direct profiles can have this parameter set to the same DLCI.
IP-Routing-Enabled	Enable/disable IP routing for this connection. This parameter must be enabled for the TAOS unit to send data back to the appropriate PPP caller.
Remote-Address	PPP caller's IP address. Because the unit receives return packets for many Frame Relay direct connections on the same DLCI, it uses this address to determine which PPP caller receives the return packets.

RADIUS profile settings for Frame Relay direct

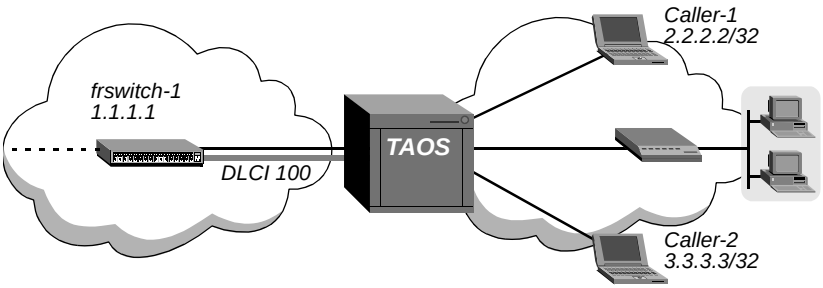
RADIUS uses the following attribute-value pairs for Frame Relay direct connections:

RADIUS attribute	Value
Framed-Protocol (7)	Encapsulation protocol. This attribute must be set to PPP (1), MP (262), or MPP (256) for Frame Relay direct connections.
Ascend-FR-Direct (219)	Enable/disable Frame Relay direct for this connection. FR-Direct-No (0) is the default. Set to FR-Direct-Yes (1) for Frame Relay direct connections.
Ascend-FR-Direct-Profile (220)	Name of the Frame-Relay profile for the data link.
Ascend-FR-Direct-DLCI (221)	DLCI assigned in a Connection profile to a next-hop Frame Relay device. Multiple Frame Relay direct profiles can have this attribute set to the same DLCI.
Ascend-Route-IP (228)	Enable/disable IP routing for this connection. (IP is enabled by default.) If this attribute is present, it must be set to Route-IP-Yes to enable the TAOS unit to send data back to the appropriate PPP caller.
Framed-Address (8)	PPP caller's IP address. Because the unit receives return packets for many Frame Relay direct connections on the same DLCI, it uses this address to determine which PPP caller receives the return packets.
Framed-Netmask (9)	Subnet mask for Framed-Address.

Typical Frame Relay direct configuration

In the sample setup shown in Figure 5-1, a TAOS unit forwards the data stream from two PPP dial-in hosts across Frame Relay on the same DLCI interface.

Figure 5-1. Frame Relay direct



The following commands specify a PVC to `frswitch-1`:

```
admin> new conn frswitch-1
CONNECTION/frswitch-1 read
admin> set active = yes
admin> set encapsulation-protocol = frame-relay
admin> set ip-options remote-address = 1.1.1.1/24
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = ct1-1.7.5
admin> set fr-options circuit-type = pvc
admin> set fr-options dlci = 100
admin> write
CONNECTION/frswitch-1 written
```

Following is a comparable RADIUS profile:

```
permconn-sys-2 Password = "ascend", User-Service = Dialout-Framed-User
    User-Name = "frswitch-1",
    Framed-Protocol = FR,
    Framed-Address = 1.1.1.1,
    Framed-Netmask = 255.255.255.0,
    Ascend-FR-DLCI = 100,
    Ascend-FR-Profile-Name = "ct1-1.7.5"
```

The following set of commands configures Frame Relay direct Connection profiles:

```
admin> new conn caller-1
CONNECTION/caller-1 read
admin> set active = yes
admin> set encapsulation-protocol = ppp
admin> set ppp-options recv-password = caller1*3
admin> set ip-options remote-address = 2.2.2.2/32
admin> set fr-options fr-direct-enabled = yes
admin> set fr-options fr-direct-profile = ct1-1.7.5
admin> set fr-options fr-direct-dlci = 100
admin> write
CONNECTION/caller-1 written
```

```
admin> new conn caller-2
CONNECTION/caller-2 read
admin> set active = yes
admin> set encapsulation-protocol = ppp
admin> set ppp-options recv-password = caller2!!8
admin> set ip-options remote-address = 3.3.3.3/32
admin> set fr-options fr-direct-enabled = yes
admin> set fr-options fr-direct-profile = ct1-1.7.5
admin> set fr-options fr-direct-dlci = 100
admin> write
CONNECTION/caller-2 written
```

Following are comparable RADIUS profiles:

```
caller-1 Password = "caller1*3"
    User-Service = Framed-User,
    Framed-Protocol = PPP,
    Framed-Address = 2.2.2.2,
    Framed-Netmask = 255.255.255.255,
    Ascend-FR-Direct = FR-Direct-Yes,
    Ascend-FR-Direct-Profile = "ct1-1.7.5",
    Ascend-FR-Direct-DLCI = 100
caller-2 Password = "caller2!!8"
    User-Service = Framed-User,
    Framed-Protocol = PPP,
    Framed-Address = 3.3.3.3,
    Framed-Netmask = 255.255.255.255,
    Ascend-FR-Direct = FR-Direct-Yes,
    Ascend-FR-Direct-Profile = "ct1-1.7.5",
    Ascend-FR-Direct-DLCI = 100
```

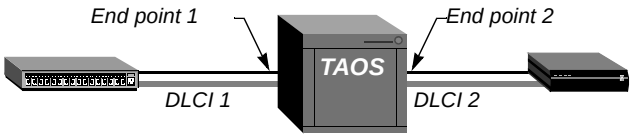
Configuring Frame Relay Circuits

6

Overview of Frame Relay circuit switching

A Frame Relay circuit pairs two DLCI interfaces. A TAOS unit performs the circuit switching internally by transmitting all frames received on one end point to the other end point. For example, in the sample setup shown in Figure 6-1, the unit forwards all frames received on DLCI 1 out to DLCI 2, and vice versa. Each end point is defined in its own Connection or RADIUS profile, which must specify the same circuit name and Frame-Relay-Circuit encapsulation.

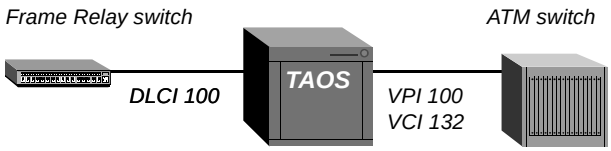
Figure 6-1. Paired end points for circuit switching



Note: In a circuit switching configuration, the TAOS unit simply relays all frames received on one end point of the circuit to the other end point of the circuit. It does not examine the packets. For details about using multilink Frame Relay (MFR) in a circuit configuration, see "MFR circuit switching" on page 7-7.

In an *ATM-Frame Relay* circuit configuration, a TAOS unit can receive frames on a DLCI interface and transmit them on an Asynchronous Transfer Mode (ATM) virtual circuit, or vice versa. The appropriate decapsulation and encapsulation processes typically occur as part of the ATM-Frame Relay circuit switching. For example, in the sample setup shown in Figure 6-2, the unit receives Frame Relay encapsulated frames on DLCI 100. The unit then removes the Frame Relay encapsulation, adds ATM encapsulation, and transmits the data stream out on ATM VPI 100-VCI 132.

Figure 6-2. ATM-Frame Relay circuit switching



For information about ATM-Frame Relay circuits, see the *APX 8000/MAX TNT ATM Configuration Guide*.

Answer-Defaults and Connection profile settings

Following are the relevant Answer-Defaults and Connection parameters (shown with default values) for configuring Frame Relay circuit switching:

```
[in ANSWER-DEFAULTS:fr-answer]
enabled = yes

[in CONNECTION/""]
encapsulation-protocol = mpp

[in CONNECTION/"":ip-options]
ip-routing-enabled = yes

[in CONNECTION/"":telco-options]
call-type = off

[in CONNECTION/"":fr-options]
frame-relay-profile = ""
dlci = 16
circuit-name = ""
```

Note: Two Connection profiles are required for circuit switching, one for each end point.

Parameter	Specifies
Enabled	Receive Frame Relay. To enable the system to receive incoming Frame Relay encapsulated data, make sure that the Enabled parameter is set to `yes` in the Answer-Defaults FR-Answer subprofile.
Encapsulation-Protocol	Encapsulation protocol. Both end points of the circuit must specify `frame-relay-circuit` encapsulation.
IP-Routing-Enabled	Enable/disable IP routing. This parameter can be set to `no` when `frame-relay-circuit` encapsulation is in use.
Call-Type	Type of call. Set this parameter to `ft1` for nailed channels or `off` for switched channels.
Frame-Relay-Profile	Name of the Frame-Relay profile that defines the data link.
DLCI	DLCI for this PVC end point. The unit does not allow you to enter duplicate DLCIs on the same data link.
Circuit-Name	Circuit name (up to 16 characters). The profile for the other end point of the circuit must specify the same name. If only one profile specifies a circuit name, data received on the specified DLCI is dropped. If more than two profiles specify the same circuit name, only two of the profiles are used to form a circuit.

RADIUS profile settings

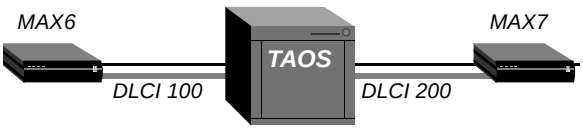
Following are the RADIUS attributes for configuring a Frame Relay circuit. Note that two RADIUS profiles are required for circuit switching, one profile for each end point.

RADIUS attribute	Value
Framed-Protocol (7)	Encapsulation protocol. Both end points of a circuit must specify FR-CIR (263) encapsulation.
Ascend-Call-Type (177)	Type of connection: Nailed (1) is the default.
Ascend-FR-Profile-Name (180)	Name of the Frame-Relay profile that defines the data link.
Ascend-FR-DLCI (179)	DLCI for this PVC end point. The unit does not allow you to enter duplicate DLCIs on the same data link.
Ascend-FR-Circuit-Name (156)	Circuit name (up to 16 characters). The profile for the other end point of the circuit must specify the same name. If only one profile specifies a circuit name, data received on the specified DLCI is dropped. If more than two profiles specify the same circuit name, only two of the profiles are used to form a circuit.

Typical circuit switching configuration

Figure 6-3 shows a TAOS unit with two DLCI interfaces. The following example shows how to configure the unit to forward all frames received on one interface to the other interface.

Figure 6-3. Frame Relay circuit



Using local profiles

The following set of commands defines the two data links in the TAOS unit:

```
admin> new frame-relay ct1-1.1.3
FRAME-RELAY/ct1-1.1.3 read
admin> set active = yes
admin> set nailed-up-group = 111
admin> set link-type = dce
admin> write
FRAME-RELAY/ct1-1.1.3 written
admin> new frame-relay ct1-1.1.5
FRAME-RELAY/ct1-1.1.5 read
admin> set active = yes
admin> set nailed-up-group = 222
```

```
admin> set link-type = dce

admin> write
FRAME-RELAY/ct1-1.1.5 written
```

The next set of commands configures the two end points of the circuit that switches data between the MAX™ units labeled MAX6 and MAX7 in Figure 6-3:

```
admin> read conn max6
CONNECTION/max6 read

admin> set active = yes

admin> set encaps = frame-relay-circuit

admin> set ip-options ip-routing-enabled = no

admin> set telco call-type = ft1

admin> set fr-options frame-relay-profile = ct1-1.1.3

admin> set fr-options dlci = 100

admin> set fr-options circuit-name = fr-cir1

admin> write
CONNECTION/max6 written

admin> read conn max7
CONNECTION/max7 read

admin> set active = yes

admin> set encaps = frame-relay-circuit

admin> set ip-options ip-routing-enabled = no

admin> set telco call-type = ft1

admin> set fr-options frame-relay-profile = ct1-1.1.5

admin> set fr-options dlci = 200

admin> set fr-options circuit-name = fr-cir1

admin> write
CONNECTION/max7 written
```

Using RADIUS profiles

The following profiles define the two data links in RADIUS:

```
frdlink-sys-1 Password = "ascend", User-Service = Dialout-Framed-User
    Ascend-FR-Profile-Name = "ct1-1.1.3",
    Ascend-Call-Type = Nailed,
    Ascend-FR-Type = Ascend-FR-DCE,
    Ascend-FR-Nailed-Grp = 111

frdlink-sys-2 Password = "ascend", User-Service = Dialout-Framed-User
    Ascend-FR-Profile-Name = "ct1-1.1.5",
    Ascend-Call-Type = Nailed,
    Ascend-FR-Type = Ascend-FR-DCE,
    Ascend-FR-Nailed-Grp = 222
```

The next profiles configure the two end points of the circuit that switches data between the units labeled MAX6 and MAX7 in Figure 6-3:

```
permconn-sys-1 Password = "ascend", User-Service = Dialout-Framed-User
    User-Name = "max6",
    Framed-Protocol = FR-CIR,
    Ascend-Route-IP = Route-IP-No,
    Ascend-FR-DLCI = 100,
    Ascend-FR-Profile-Name = "ct1-1.1.3",
    Ascend-FR-Circuit-Name = "fr-cir1"

permconn-sys-2 Password = "ascend", User-Service = Dialout-Framed-User
    User-Name = "max7",
    Framed-Protocol = FR-CIR,
    Ascend-Route-IP = Route-IP-No,
    Ascend-FR-DLCI = 200,
    Ascend-FR-Profile-Name = "ct1-1.1.5",
    Ascend-FR-Circuit-Name = "fr-cir1"
```

Configuring Multilink Frame Relay (MFR) 7

Multilink Frame Relay (MFR) provides a way to aggregate Frame Relay PVCs to provide additional bandwidth to an application. You can aggregate the underlying data link interfaces or individual DLCI interfaces. The aggregated interfaces are referred to as an *MFR bundle*. When you bundle multiple data links, the MFR bundle provides the aggregate bandwidth of the member data links. When you bundle individual DLCIs, a single physical line can support both bundled and nonbundled connections.

In the current software version, MFR in TAOS units is subject to the following limitations:

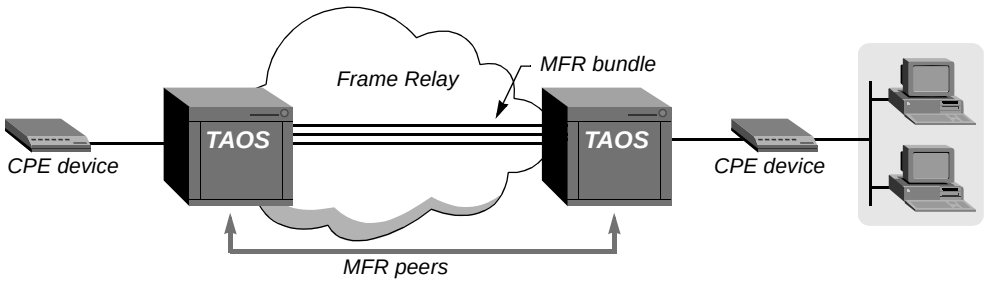
- Bandwidth used by an MFR bundle must reside on the same slot card. This requirement is the only limitation on the number of data links or DLCIs in a bundle.
- End-to-end fragmentation and reassembly are not supported.
- MFR using SVCs or switched PVCs is not supported.

For details about the physical slot-card interface and call-routing requirements, see “Multilink Frame Relay (MFR) bandwidth requirements” on page 2-5.

Overview of MFR

Currently, TAOS units support end-to-end (DTE-DTE) aggregation, which enables MFR bundles to traverse a regular Frame Relay (non-MFR) network. The fact that aggregate bandwidth of multiple links is in use is transparent to the Frame Relay switching equipment that resides between MFR peers. Figure 7-1 shows two CPE devices using an MFR bundle of three data links through a Frame Relay network.

Figure 7-1. Multilink Frame Relay (MFR) DTE-DTE aggregation



To aggregate the bandwidth, the TAOS unit uses a segmentation-sequencing-reassembly protocol described in the Frame Relay Fragmentation Implementation Agreement FRF.12, which is based on the Multilink PPP (MP) protocol described in RFC 1990.

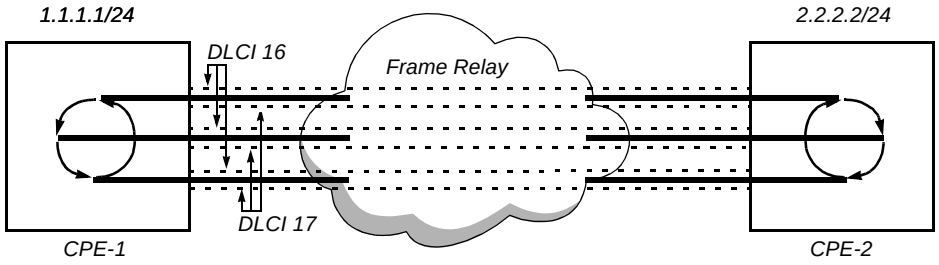
How bundled data links work

Member data links can provide different amounts of bandwidth. However, bundling data links that provide different amounts of bandwidth might result in throughput that is less than the sum of the member data links. Throughput might be reduced because packets are sent to each of the members in a round-robin fashion without taking bandwidth into account. (For example, if an MFR bundle includes two data links on full T1 lines and one on fractional T1, some throughput might be lost because of packet queuing on the full T1 data links.)

Each data link within the bundle also requires at least one DLCI interface to the far-end device (the MFR peer). You must define the bundle first, before creating DLCI interfaces to the peer.

Figure 7-2 shows three bundled data links going through the Frame Relay network. Each data link has two DLCIs: 16 and 17. Data for each DLCI is sent to each of the member data links in a round-robin fashion.

Figure 7-2. MFR peers with three data links supporting two DLCIs



Because the DTE-DTE PVC goes through a non-MFR network, all the individual links support the full user-to-network interface (UNI) standards. As long as one DLCI from any of the bundled data links is active, that DLCI is considered active to the higher layers. For example, if data link 1 is down and DLCI 16 in data link 2 is active, the MFR peers (CPE-1 and CPE-2) consider DLCI 16 to be active.

Link management considerations

TAOS units support Annex D and CCITT Q.933 Annex A link management protocols for Frame Relay data links. The same management protocol must be used at both ends of a link.

To ensure proper performance of an MFR bundle, you should configure both ends of each data link to use link management. When link management is disabled (as it is by default), the TAOS unit establishes the data link as soon as the physical line is activated, but it does not monitor the link for possible problems. Because packets are sent to each of the members in turn, the MFR bundle begins dropping packets if a member data link becomes inactive and the unit does not detect it. In this situation, the performance of the MFR bundle is adversely affected.

Creating MFR bundles

To create an MFR bundle, you define the bundle characteristics in a Multi-Link-FR profile. You then specify the name of that profile in the Frame-Relay profile (to bundle data links) or Connection profile (to bundle DLCIs) of the member interfaces. The only limitation on the number of members in a bundle is that the bandwidth used by the members must reside on the same slot card.

The system checks first for a bundle name in a Connection profile. It checks for a bundle name in the Frame-Relay profile only if no bundle name is found in the Connection profile. To enable a line to support both MFR and non-MFR links, the bundle name in the line's Frame-Relay profile must be null.

Following are the parameters (shown with default settings) for defining a bundle and adding members to it:

```
[in MULTI-LINK-FR/""]
mfr-bundle-name* = ""
active = no
mfr-bundle-type = mfr-dte
max-bundle-members = 1
min-bandwidth = 0

[in FRAME-RELAY/""]
link-mgmt = none
mfr-bundle-name = ""

[in CONNECTION/"":fr-options]
mfr-bundle-name = ""
```

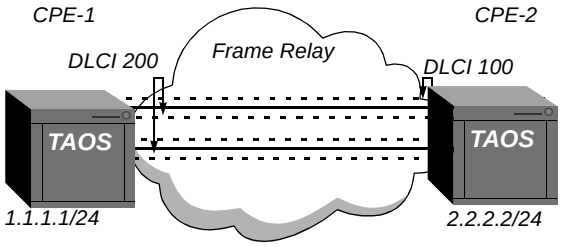
Parameter	Specifies
MFR-Bundle-Name	Name of the bundle, which is the name of a Multi-Link-FR profile. The name can consist of up to 15 characters and must be unique system wide. All bundle members specify the same bundle name. In a Frame-Relay profile, specifying a value for this parameter adds the data link itself (and all DLCIs that make use of the data link) to an MFR bundle. In a Connection profile, specifying a value for this parameter adds the DLCI to an MFR bundle.
Active	Enable/disable the Multi-Link-FR profile for use.
MFR-Bundle-Type	Type of MFR configuration.Currently, the MFR-DTE configuration is supported.
Max-Bundle-Members	Maximum number of data link or DLCI interfaces allowed to join the MFR bundle. The default value is 1. If this parameter is set to a number higher than 1, you can add bandwidth or DLCIs to the bundle dynamically by configuring another Frame-Relay or Connection profile that specifies the same bundle name, until the bundle contains the specified maximum number of members.

Parameter	Specifies
Min-Bandwidth	Minimum aggregated bandwidth before the bundle is considered inactive. Currently, you must leave the default zero value. Because of an unresolved problem in Frame Relay, if Min-Bandwidth is set to any other value, data is not sent on the bundle.
Link-Mgmt	Link management protocol. Settings are `none` (the default, which disables link management), `ansi-t1.617` (Annex D), and `ccitt-q.933a` (CCITT Q.933 Annex A). A setting of `none` is not recommended for MFR. See "Link management considerations" on page 7-2 for details. If the TAOS unit is connected to a Frame Relay switch, set the management protocol to the value used by the switch. If the unit is connected back-to-back to another TAOS unit, set the management protocol to the protocol used by the MFR peer.

Typical MFR data link configuration

Figure 7-3 shows two TAOS units acting as MFR peers across the Frame Relay network. Each unit has two data links, each of which supports two DLCI interfaces.

Figure 7-3. Example of bundling data links to increase available bandwidth



In each of the MFR peers, the bandwidth used by the bundled data links must reside on the same slot card. For each Frame-Relay data link profile in a bundle, you must also define a DLCI interface. Connection profiles for DLCI interfaces on bundled data links must specify the same remote IP address (that of the MFR peer), but must specify different DLCI numbers and Frame-Relay profiles.

Note: MFR configurations require multiple Connection profiles with the same Remote-Address setting. For most other types of configuration, the system prevents this condition. Before allowing you to save a Connection profile with the Remote-Address setting of an existing Connection profile, the system verifies that either the Connection profile or the Frame-Relay profile it uses specifies an MFR bundle name.

Configuring MFR on CPE-1 using FrameLine

On CPE-1, the following commands create an MFR bundle consisting of two data links on a FrameLine (unchannelized T1) slot card:

```
admin> new frame-relay ut1.3-fr
FRAME-RELAY/ut1.3-fr read
admin> set active = yes
admin> set link-type = dte
admin> set nailed-up-group = 10
admin> set link-mgmt = ccitt
admin> set mfr-bundle-name = ut1-mfr
admin> write
FRAME-RELAY/ut1.3-fr written
admin> new frame-relay ut1.8-fr
FRAME-RELAY/ut1.8-fr read
admin> set active = yes
admin> set link-type = dte
admin> set nailed-up-group = 11
admin> set link-mgmt = ccitt
admin> set mfr-bundle-name = ut1-mfr
admin> write
FRAME-RELAY/ut1.8-fr written
admin> new multi-link-fr ut1-mfr
MULTI-LINK-FR/ut1-mfr read
admin> set active = yes
admin> set max-bundle-members = 2
admin> write
MULTI-LINK-FR/ut1-mfr written
```

The following commands on CPE-1 create DLCI interfaces (PVCs) on the bundled data links:

```
admin> new conn mfr1
CONNECTION/mfr1 read
admin> set active = yes
admin> set encaps = frame-relay
admin> set ip-options remote-address = 2.2.2.2/24
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = ut1.3-fr
admin> set fr-options dlci = 100
admin> write
CONNECTION/mfr1 written
admin> new conn mfr2
CONNECTION/mfr2 read
admin> set active = yes
admin> set encaps = frame-relay
admin> set ip-options remote-address = 2.2.2.2/24
admin> set telco-options call-type = ft1
```

```
admin> set fr-options frame-relay-profile = ut1.8-fr
admin> set fr-options dlci = 200
admin> write
CONNECTION/mfr2 written
```

Configuring MFR on CPE-2 using T1

On CPE-2, the following commands create an MFR bundle of two data links that use lines 7 and 8 of a T1 slot card:

```
admin> new frame-relay ct1.7-fr
FRAME-RELAY/ct1.7-fr read
admin> set active = yes
admin> set link-type = dte
admin> set nailed-up-group = 10
admin> set link-mgmt = ccitt
admin> set mfr-bundle-name = ct1-mfr
admin> write
FRAME-RELAY/ct1.7-fr written
admin> new frame-relay ct1.8-fr
FRAME-RELAY/ct1.8-fr read
admin> set active = yes
admin> set link-type = dte
admin> set nailed-up-group = 11
admin> set link-mgmt = ccitt
admin> set mfr-bundle-name = ct1-mfr
admin> write
FRAME-RELAY/ct1.8-fr written
admin> new multi-link-fr ct1-mfr
MULTI-LINK-FR/ct1-mfr read
admin> set active = yes
admin> set max-bundle-members = 2
admin> write
MULTI-LINK-FR/ct1-mfr written
```

The following commands on CPE-2 specify DLCI interfaces on the bundled links:

```
admin> new conn mfr1
CONNECTION/mfr1 read
admin> set active = yes
admin> set encaps = frame-relay
admin> set ip-options remote-address = 1.1.1.1/24
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = ct1.7-fr
admin> set fr-options dlci = 100
```

```
admin> write
CONNECTION/mfr1 written
admin> new conn mfr2
CONNECTION/mfr2 read
admin> set active = yes
admin> set encaps = frame-relay
admin> set ip-options remote-address = 1.1.1.1/24
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = ct1.8-fr
admin> set fr-options dlci = 200
admin> write
CONNECTION/mfr2 written
```

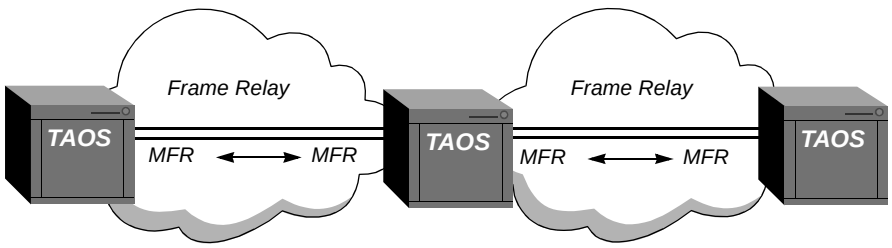
MFR circuit switching

An MFR end point must always be terminated by another MFR end point across the Frame Relay network. However, circuit switching within a TAOS unit can transfer data received on an MFR interface to another MFR interface or to a non-MFR interface.

Supported circuit configurations

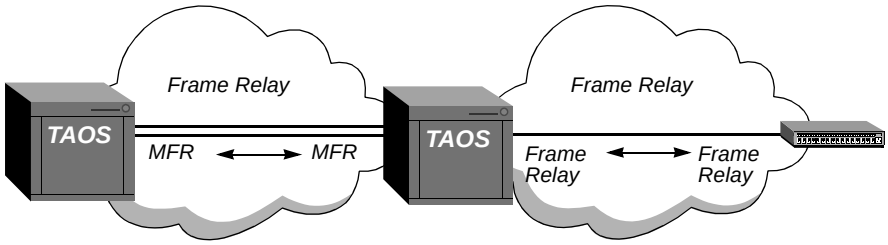
You can configure MFR circuits in which both end points of the circuit use an MFR bundle, as shown in Figure 7-4.

Figure 7-4. MFR-to-MFR circuit



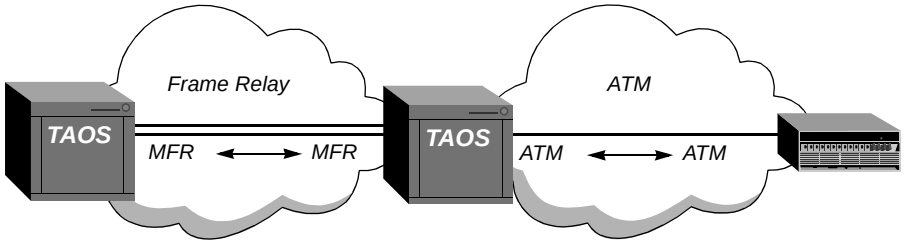
Or, you can configure MFR circuits in which one side of the circuit uses an MFR bundle and the other side uses a single Frame Relay or ATM interface. For example, Figure 7-5 shows a Frame Relay circuit that switches data received from an MFR bundle to a single data link Frame Relay interface.

Figure 7-5. MFR-to-Frame Relay circuit



You can also configure an MFR-ATM circuit. For example, Figure 7-6 shows an ATM-Frame Relay circuit that switches data received from an MFR bundle to a single ATM interface.

Figure 7-6. MFR-to-ATM circuit

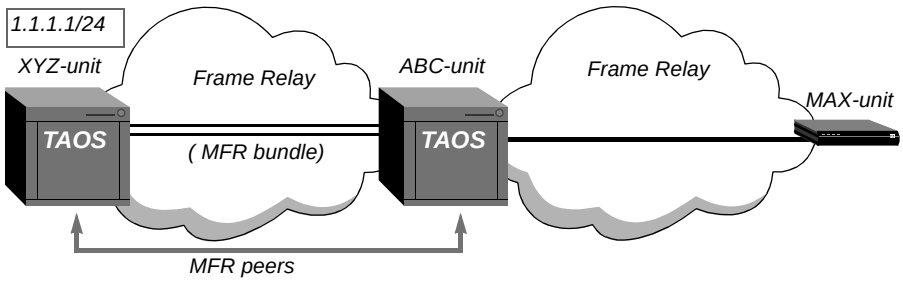


For details about ATM-Frame Relay circuits, see the *APX 8000/MAX TNT ATM Configuration Guide*.

Typical MFR-to-Frame Relay circuit configuration

Figure 7-7 shows a TAOS unit that switches between an MFR bundle on one side and a single data link interface on the other.

Figure 7-7. Circuit between an MFR bundle and a T1 interface



Defining the MFR bundle

The following set of commands defines the MFR bundle that aggregates the bandwidth of the two T1 interfaces to XYZ-unit:

```
admin> new multi-link-fr ut1-mfr
MULTI-LINK-FR/ut1-mfr read
admin> set active = yes
```

```
admin> set max-bundle-members = 2

admin> write
MULTI-LINK-FR/ut1-mfr written
```

The following set of commands configures the two T1 data link interfaces to XYZ-unit:

```
admin> new frame-relay ut1.3-xyz
FRAME-RELAY/ut1.3-xyz read

admin> set active = yes

admin> set link-type = dte

admin> set nailed-up-group = 10

admin> set link-mgmt = ccitt

admin> set mfr-bundle-name = ut1-mfr

admin> write
FRAME-RELAY/ut1.3-xyz written

admin> new frame-relay ut1.8-xyz
FRAME-RELAY/ut1.8-xyz read

admin> set active = yes

admin> set link-type = dte

admin> set nailed-up-group = 11

admin> set link-mgmt = ccitt

admin> set mfr-bundle-name = ut1-mfr

admin> write
FRAME-RELAY/ut1.8-xyz written
```

Both of the preceding sample Frame-Relay profiles specify the MFR bundle name. As described in “Creating MFR bundles” on page 7-3, the bundle name can be specified in either a Frame-Relay profile or a Connection profile.

Configuring the MFR circuit end point

The MFR circuit end point is bundled, and each interface in the bundle requires its own Connection profile.

Note: Although DLCI interfaces that specify different data links can use the same DLCIs, the use of unique DLCIs for these interfaces makes troubleshooting easier. Using unique DLCIs for interfaces that specify different data links in an MFR bundle is recommended, but not required.

In the following example, the MFR bundle name is specified in the Frame-Relay profiles, so it is not repeated in the Connection profiles. Each DLCI interface can specify the bundle name either in the associated Frame-Relay profile or in the Connection profile.

The following commands create the DLCI interfaces for the MFR circuit end point:

```
admin> read conn xyz-1
CONNECTION/xyz-1 read

admin> set active = yes

admin> set encaps = frame-relay-circuit
```

```
admin> set ip-options ip-routing-enabled = no
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = ut1.3-xyz
admin> set fr-options dlci = 116
admin> set fr-options circuit-name = circuit1
admin> write
CONNECTION/xyz-1 written
admin> read conn xyz-2
CONNECTION/xyz-2 read
admin> set active = yes
admin> set encaps = frame-relay-circuit
admin> set ip-options ip-routing-enabled = no
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = ut1.8-xyz
admin> set fr-options dlci = 117
admin> set fr-options circuit-name = circuit1
admin> write
CONNECTION/xyz-2 written
```

Configuring the Frame Relay circuit end point

The following commands configure the T1 data link interface to MAX-unit in Figure 7-7:

```
admin> new frame-relay t1-max
FRAME-RELAY/t1-max read
admin> set active = yes
admin> set link-type = dce
admin> set nailed-up-group = 22
admin> set link-mgmt = ccitt
admin> write
FRAME-RELAY/t1-max written
```

The following set of commands configures the Frame Relay circuit end point to MAX-unit:

```
admin> read conn max-1
CONNECTION/max-1 read
admin> set active = yes
admin> set encaps = frame-relay-circuit
admin> set ip-options ip-routing-enabled = no
admin> set telco-options call-type = ft1
admin> set fr-options frame-relay-profile = t1-max
admin> set fr-options dlci = 200
admin> set fr-options circuit-name = circuit1
admin> write
CONNECTION/max-1 written
```

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