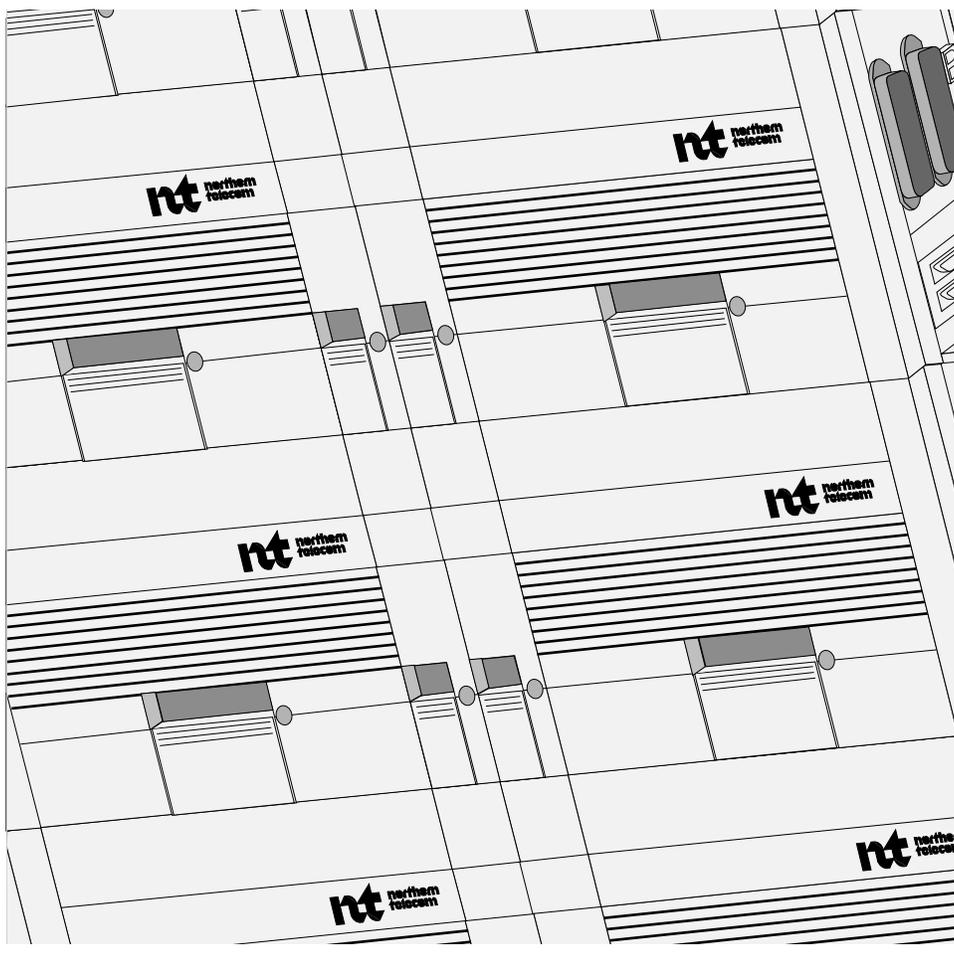**NT4K00LA**　　　　　　　　　　　　　　　　**323-3001-103**

SONET Products

AccessNode

Protection Switching Description

Issue 2.0　June 1999

NORTEL
NETWORKS™

SONET Products

AccessNode

Protection Switching Description

Publication history

June 1999

AN17 Standard release of the document, Issue 2.0.

February 1999

AN16 Standard release of the document, Issue 1.0. Changes include the following:

- deleted full services terminal information in Chapter 7

- added matched nodes information in Chapter 3 and Chapter 4

June 1998

AN15 Standard 01.01 release of the document.

September 1997

AN14 Standard 01.01 release of the document.

July 1996

AN12 Standard 01.01 release of the document.

November 1995

AN11 Standard 02.01 release of the document.

May 1995

An updated AN10 standard version of the document is printed. This version is identified as version 1.02. It contains updates identical to those made in the updated AN10 standard version released on compact disc. (For details, see the next entry in this publication history.)

May 1995

An updated AN10 standard version of the document was released on compact disc. In the updated version, information about the forced-switching command for optical interface circuit packs was changed on page 3-6. In the updated version, the following parts of the document bore the date May 1995: the front and back covers, the title page, the publication history, and Chapter 3. (The other parts of the document continued to bear the date April 1995.)

April 1995

Standard AN10 release of the document. In this release, the following information was added to the document: a description of protection switching for the timing and cross-connect card.

December 1994

Standard AN08 release of the document.

November 1994

Reissue of the standard AN07 release of the document.

April 1994

Standard AN07 release of the document. In this release, the following information was added to the document: a description of DS3 protection switching.

May 1993

Standard FWP06 release of the document.

Contents

About this document

This document explains the concepts of protection switching and redundancy. It also discusses the types of protection switching that AccessNode network elements use.

Audience

The audience for this document includes the following groups:

- strategic and current planners
- provisioners
- transmission engineers
- network administrators

How to use this document

This document is divided by application. Refer to the appropriate chapter for the type of application you need.

References in this document

This document refers to the following documents:

Engineering, Configuration, and Ordering Guide, Volume 1

- *Engineering and Ordering Information*, 323-3001-032

Description, Volume 2A

- *Configuration and Equipment Description*, 323-3001-100
- *Signal Flow and Circuit Pack Description*, 323-3001-102

Operations, Administration, and Provisioning, Volume 4B

- *Protection Switching Procedures*, 323-3001-311

Overview of protection switching

This chapter explains the concept of protection switching and defines the terms used throughout this document.

Chapter contents

The following table lists the topics discussed in this chapter.

Topic	See
Definition of protection	page 1-1
Definition of protection switching	page 1-1
System-initiated and user-initiated protection switching	page 1-2
Revertive and nonrevertive protection switching	page 1-2
Protection by dual plane equipment configuration	page 1-3

Definition of protection

Protection refers to a feature or group of features that protect the integrity of the connections in a device. An AccessNode network element is an example of a device that has protection features.

Definition of protection switching

Protection switching is the switching of activity from one piece of equipment to a second piece of equipment when a failure occurs in the first piece of equipment.

Protection switching occurs within an AccessNode network element. Such switching is possible because the network element contains components that serve as backup units, also referred to as protection units.

System-initiated and user-initiated protection switching

In an AccessNode network element, protection switching can be initiated either by the network element itself or by you.

The network element can initiate system-initiated or automatic protection switching. The network element monitors its own performance, and when a failure occurs in one of its working components, the protection unit takes over the functions of the failed unit. The switching operation is completed within 50 ms of the detection of the failure condition.

You can initiate protection switching by entering a forced-switching command or a manual-switching command. The difference between forced and manual protection switching is that forced protection switching can override automatic protection switching, but manual protection switching cannot.

Revertive and nonrevertive protection switching

Two types of protection switching are used in AccessNode: revertive and nonrevertive.

The terms revertive and nonrevertive refer to what happens after automatic protection switching has occurred, and after the original failure finally clears, and the unit that failed is ready to resume its function.

For example, assume the working unit (unit A) fails, causing the protection unit (unit B) to take over the activity. Later, the failure clears, and unit A is in good working order once again. If units A and B have revertive switching, the activity reverts to unit A, and unit B resumes its role as the backup unit. In contrast, if units A and B have nonrevertive switching, unit B continues to carry out the activity, and unit A becomes the protection unit.

1:n revertive protection switching

With revertive protection switching, a designated protection unit backs up one or more primary units. In normal operation, each primary unit carries out its activity. When a failure occurs in a primary unit, the protection unit takes over the activity. When the failure on the primary unit clears, the activity reverts to the primary unit, and the protection unit resumes its backup role.

For brevity, revertive protection switching is referred to as 1:n protection switching. The digit 1 refers to the protection unit. The letter n stands for the number of primary units, which can be one or more. The colon (:) indicates that the switching is revertive. For example, if one protection unit backs up four working units, that switching is an example of 1:4 protection.

1+1 nonrevertive protection switching

With nonrevertive protection switching, two units are paired. At any time, one of the units is the working unit and the second unit is the protection unit. If a failure occurs in the working unit, the activity switches to the second unit, which then becomes the working unit. It remains the working unit even after the failure on the other unit clears. When the failure clears, the unit that failed becomes the protection unit. Each time a protection-switching request occurs, the two units exchange roles.

For brevity, nonrevertive protection switching is referred to as 1+1 protection switching. The plus sign (+) indicates that the switching is nonrevertive.

Protection by dual plane equipment configuration

Nortel Networks strongly recommends the use of dual plane equipment configurations if outages present a critical situation. In a single plane system there is one traffic route, so traffic may be lost if there is a failure in a key hardware component. The dual plane configuration's redundancy enables protection switching, which allows traffic to switch to the redundant hardware without an outage.

Protection architecture

This chapter describes the architecture of the system-initiated or automatic protection for the AccessNode.

Chapter contents

The following table lists the topics discussed in this chapter.

Topic	See
Components for which protection is available	page 2-1
Locations of protected modules in ABM shelves	page 2-3
Locations of protected modules in TBM shelves	page 2-11
Locations of duplicated modules in copper-distribution drawers	page 2-20
Protection details	page 2-20
Path protection switching	page 2-23

Components for which protection is available

Table 2-1 lists the components that have protection switching, the protection that is available for those components, and the location of the components.

Table 2-1
Protected components in AccessNode

Component	Where used	Details
OC-12 or OC-3 interface circuit packs for the primary fiber optic feeder	One pair of these is required equipment in each bandwidth manager shelf (transport or access) in fiber-fed systems. The 2 circuit packs install in slots 9 and 10.	Protection is 1+1 type.
OC-3 optical interface circuit packs for OC-3 tributaries	Optional equipment in any access bandwidth manager shelf or transport bandwidth manager shelf in any AccessNode in a fiber-fed system in which the primary fiber optic feeder is an OC-12.	Provision of a protection unit for each OC-3 tributary is optional. If provided, protection is 1+1 type.
Processor card	Required in every access bandwidth manager (ABM) shelf and in every transport bandwidth manager (TBM) shelf.	Provision of a protection unit is optional. If provided, protection is 1+1 type.
External synchronization interface (ESI) cards. (Two cards are in an external synchronization carrier.)	The carrier and cards are required equipment in the TBM shelf in an FCOT serving an integrated application. They are also required in an ABM shelf that is providing the DS0DP option available with Digital Data Service (DDS).	Protection is 1+1 type.
DS1 mapper	Optional equipment in any ABM shelf or TBM shelf in any AccessNode.	Protection is 1:n type.
DS3 mapper	Optional equipment in any ABM shelf or TBM shelf in any AccessNode.	Provision of a protection unit is optional. If provided, protection is 1:n type.
STS-1 interface	Optional equipment in TN_BLSR only.	Provision of a protection unit is optional. If provided, protection is 1:n type.
Narrowband line-interface cards (NLICs)	One pair of NLICs is required equipment in each copper-distribution drawer in each copper-distribution shelf.	Protection is 1+1 type.
—continued—		

Table 2-1   (continued)
Protected components in AccessNode

Component	Where used	Details
Timing and cross-connect card (TXC)	Used instead of optical interface circuit packs in the ABM shelf in every DS1-fed RFT, and in any OPC shelf that uses OMC DS1s for connectivity to RFTs.	Provision of a protection unit is optional. If provided, protection is 1:1 type.
Transport interface card (TIC)	Used in an ABM shelf that supports one or more copper-distribution shelves.	Provision of a protection unit is optional. If provided, protection is 1:1 type.
—end—		

Locations of protected modules in ABM shelves

Figure 2-1 on page 2-4 to Figure 2-7 on page 2-10 show access bandwidth manager shelves with protected modules. Refer to the following table to find the page you need.

If the shelf supports	Then refer to
copper-distribution shelves	page 2-4
DS1 mappers	page 2-5
DS3 mappers	page 2-8
OC-3 tributaries	page 2-10

Protected modules for ABM shelves that support CDSs

Figure 2-1 shows the locations of the protected modules in an access bandwidth manager shelf that supports copper-distribution shelves. In this access bandwidth manager shelf, the transport interface cards, which handle the traffic to and from the copper-distribution shelves, are duplicated. The shelf also has a pair of optical interface (OC-3) circuit packs and duplicated processor cards.

Figure 2-1
ABM shelf with duplicated components that support CDSs

Protected modules in ABM shelves with DS1s

Figures 2-2 through 2-4 on page 2-7 show ABM shelves with protected DS1 mappers. Figures 2-2 through 2-3 on page 2-6 show ABM shelves from network elements in fiber-fed AccessNode systems. Each shelf has a pair of optical interface (OC-12 or OC-3) circuit packs for shelf feeders and duplicated processor cards. Figures 2-4 shows an ABM shelf from a network element in a DS1-fed AccessNode system.

Protection for ABM FCOT or FCOT_BLSR shelves with DS1s and an OPC

Figure 2-2 shows an ABM FCOT or FCOT_BLSR shelf that has three working DS1 mappers and a protection mapper. The presence of the OPC module in slots 5 to 8 limits the number of mappers that can be equipped.

Figure 2-2
ABM FCOT or FCOT_BLSR shelf with three working DS1 mappers and an OPC
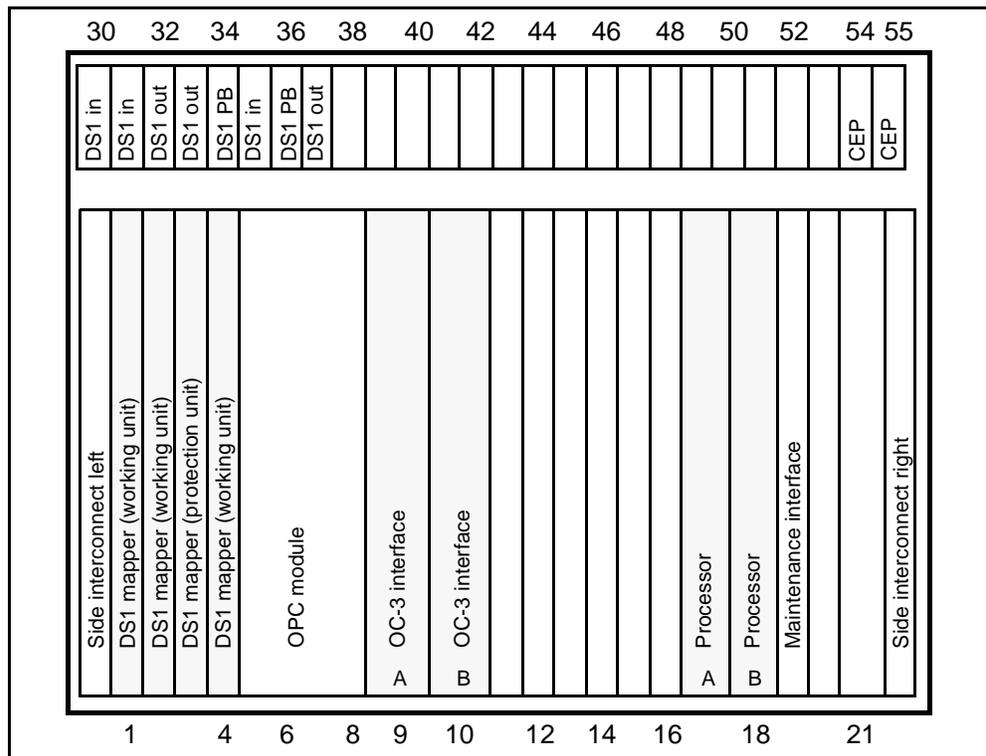
Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the common-equipment power cards (CEP), the DS1 protection bridge cards (DS1 PB), and the DS1 input and output cards.

Protection for ABM FCOT or FCOT_BLSR shelves with DS1s

Figure 2-3 shows an ABM FCOT or FCOT_BLSR shelf that has seven working DS1 mappers and a protection mapper. This shelf does not contain an OPC module. (The system is served by an OPC module in another FCOT. The connection to that other FCOT is by way of a control-network link.)

Figure 2-3
ABM FCOT or FCOT_BLSR shelf with seven working DS1 mappers

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards, the DS1 protection bridge cards (DS1 PB), the DS1 input cards, and the DS1 output cards.

Protected modules in an ABM shelf in a DS1-fed system

Figure 2-4 shows an ABM shelf in a DS1-fed system. The shelf has three working DS1 mappers and a protection mapper. The shelf also has a pair of timing and cross-connect cards, duplicated processor cards, and duplicated transport interface cards.

Figure 2-4
ABM shelf in a DS1-fed system

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards, the DS1 protection bridge cards (DS1 PB), the DS1 input and output cards, and the access interface cards.

Protected modules in ABM shelves with DS3s

Figures 2-5 and 2-6 show access bandwidth manager shelves with protected DS3 mappers. All these shelves are in network elements in fiber-fed AccessNode systems. Each shelf has a pair of optical interface (OC-12 or OC-3) circuit packs for shelf feeders and duplicated processor cards.

Protection for ABM shelves with DS3s and an OPC

Figure 2-5 shows an access bandwidth manager shelf that has one working DS3 mapper and a protection mapper. The presence of the OPC module in slots 5 to 8 limits the number of mappers that can be equipped.

Note: The shelf function for this configuration can be FCOT, FCOT_BLSR, RFT, or RFT_BLSR.

Figure 2-5
ABM shelf with one working DS3 mapper and an OPC
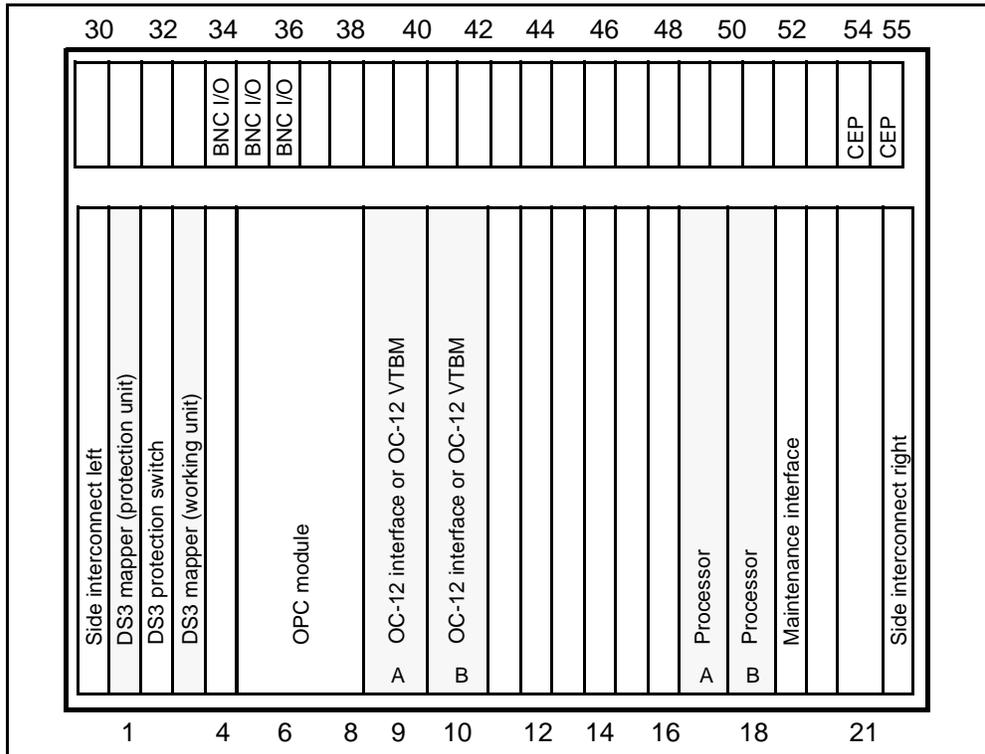
Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the BNC I/O cards.

Protection for ABM shelves with DS3s

Figure 2-6 shows an ABM shelf that has three working DS3 mappers and a protection mapper. In contrast to the shelf shown in Figure 2-5, this shelf does not contain an OPC module. (The system is served by an OPC module in another FCOT. The connection to that other FCOT is by way of a control-network link.)

Note: The shelf function for this configuration can be FCOT, FCOT_BLSR, RFT, or RFT_BLSR.

Figure 2-6
ABM shelf with three working DS3 mappers

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the BNC I/O cards.

Protected modules in ABM shelves with OC-3 tributaries

Figure 2-7 shows the locations of the protected modules in an ABM shelf that has OC-3 interface circuit packs that handle OC-3 tributaries.

Note: An AccessNode system can support OC-3 tributaries only if it is a fiber-fed system with an OC-12 primary fiber optic feeder.

This ABM shelf has two pairs of OC-3 interface circuit packs. Each pair handles one OC-3 tributary. Each pair of circuit packs is in a 1+1 protection-switching arrangement. The shelf also has a pair of OC-12 optical interface circuit packs that interface to the primary fiber optic feeder, duplicated transport interface cards, duplicated processor cards, and duplicated ESI cards.

Note: The shelf function for this configuration can be FCOT, FCOT_BLSR, RFT, or RFT_BLSR.
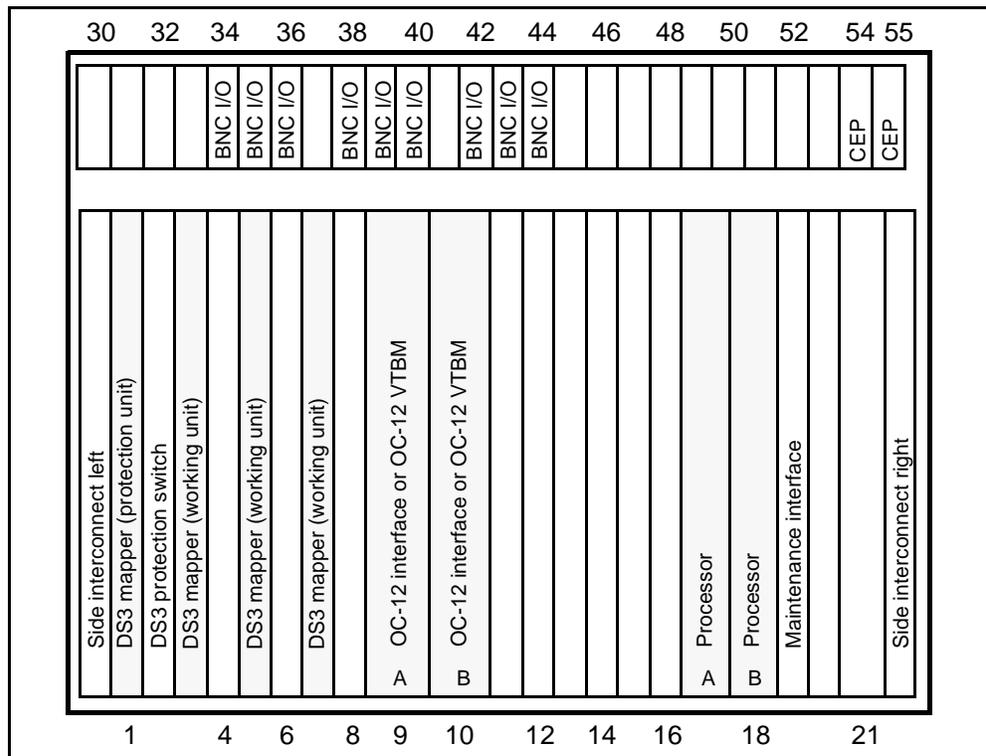
Figure 2-7
ABM shelf with protected OC-3 tributaries
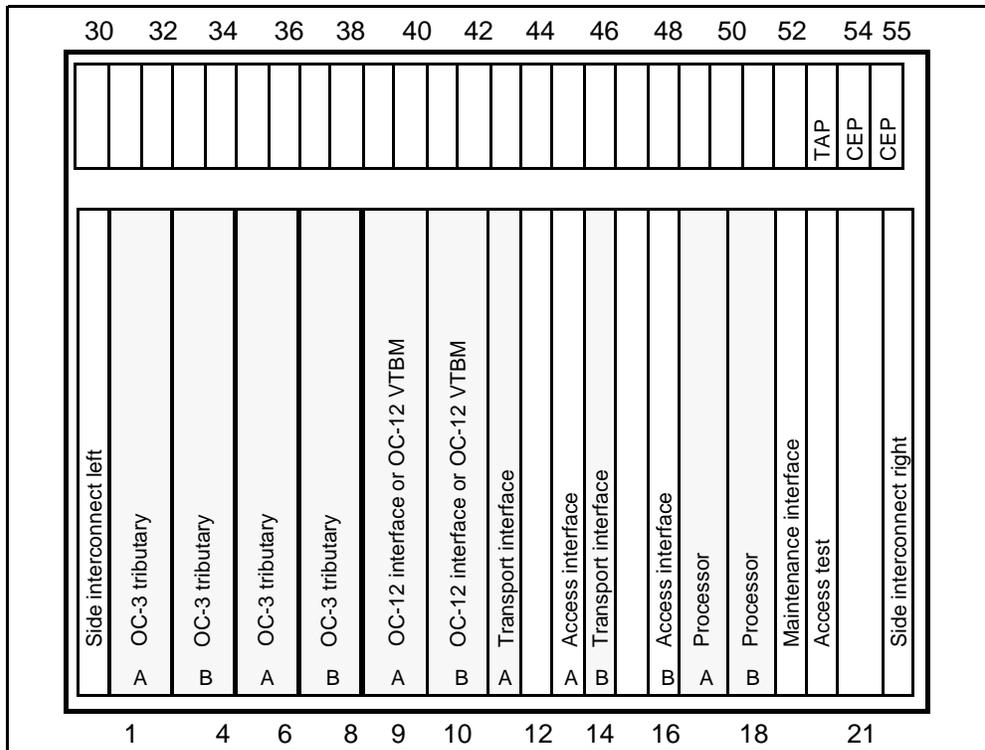
Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the access interface cards.

Locations of protected modules in TBM shelves

Figures 2-8 through 2-16 on page 2-19 show TBM shelves with protected modules. Refer to the following table to find the page you need.

If the TBM shelf supports	Then refer to
DS1 mappers	page 2-11
DS3 mappers	page 2-14
OC-3 tributaries	page 2-19
STS-1 tributaries	page 2-17

Protected modules in TBM shelves with DS1s

Figures 2-8 through 2-10 on page 2-13 show protected modules in TBM shelves that are equipped with DS1 mappers.

Protection for TBM FCOT shelves with DS1s

Figure 2-8 shows a TBM shelf that has nine working DS1 mappers and a protection mapper. The shelf also has a pair of OC-12 interface circuit packs, duplicated processor cards, and duplicated ESI cards.

Figure 2-8
TBM FCOT shelf with nine working DS1 mappers

Top row slot numbers: 30 32 34 36 38 40 42 44 46 48 50 52 54 55

Top row modules (left to right): DS1 in, DS1 in, DS1 out, DS1 out, DS1 in, DS1 in, DS1 out, DS1 out, DS1 PB, DS1 in, DS1 PB, DS1 out, DS1 in, DS1 in, DS1 out, DS1 out, DS1 in, DS1 in, DS1 out, DS1 out, CEP, CEP

Lower row modules (left to right): Side interconnect left; DS1 mapper (working unit); DS1 mapper (working unit); OPC module; OC-12 interface or OC-12 VTBM (A); OC-12 interface or OC-12 VTBM (B); DS1 mapper (working unit); DS1 mapper (working unit); DS1 mapper (protection unit); DS1 mapper (working unit); DS1 mapper (working unit); DS1 mapper (working unit); DS1 mapper (working unit); ESC; ESI card (G2); ESI card (G1); Maintenance interface; Processor (A); Processor (B)

Bottom row slot numbers: 1 4 6 8 9 10 12 14 16 18 20 23

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards, the DS1 protection bridge cards, and the DS1 input and output cards.

Protection for TBM FCOT_BLSR shelves with DS1s

Figure 2-9 shows a TBM FCOT_BLSR shelf that is found in an AccessNode VTBM ring. The shelf has 11 working DS1 mappers and a protection mapper. The shelf also has a pair of OC-12 VTBM circuit packs and duplicated processor cards.

Figure 2-9
TBM FCOT_BLSR shelf with 11 working DS1 mappers

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards, the DS1 input cards, and the DS1 output cards.

Protection for TBM TN_BLSR shelves with DS1s

Figure 2-10 shows a TBM TN_BLSR shelf that is found in an AccessNode VTBM ring. The shelf has twelve working DS1 mappers and a protection mapper. The shelf also has a pair of OC-12 VTBM circuit packs. The TN_BLSR shelf function is similar to the FCOT_BLSR shelf function with the following differences:

- one additional DS1 working group exists compared to the FCOT_BLSR shelf function: g7 (slots 13, 42, 44)

- the DS1 protection group P is in slot 19, with no protection bridge cards required compared to the FCOT_BLSR shelf function which has a protection mapper in slot 13 and I/O cards in slots 42 and 44

- only one processor is supported (in slot 21)

- ESI is in slot 23 compared to slot 19 for the FCOT_BLSR shelf function

Figure 2-10
TBM TN_BLSR shelf with 11 working DS1 mappers

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards, the DS1 input cards, and the DS1 output cards.
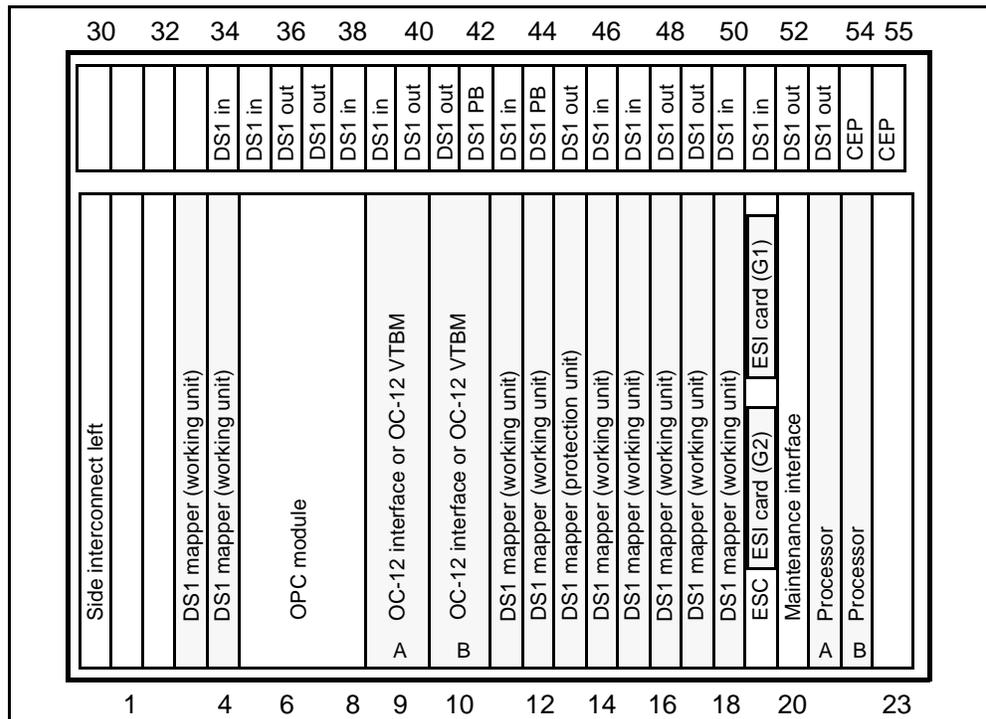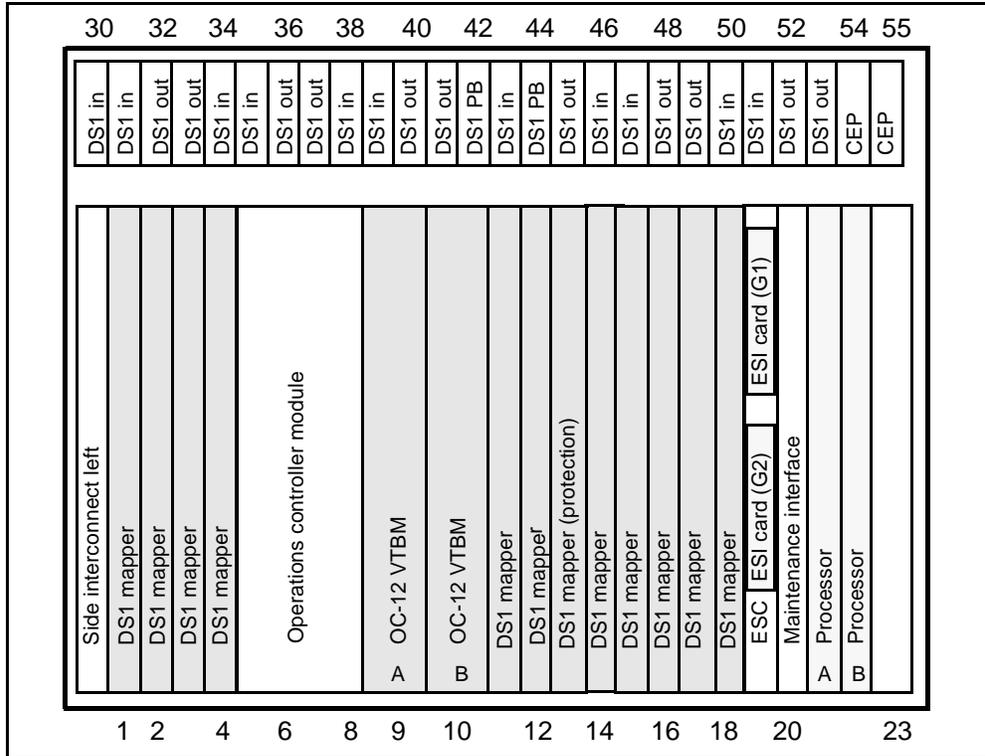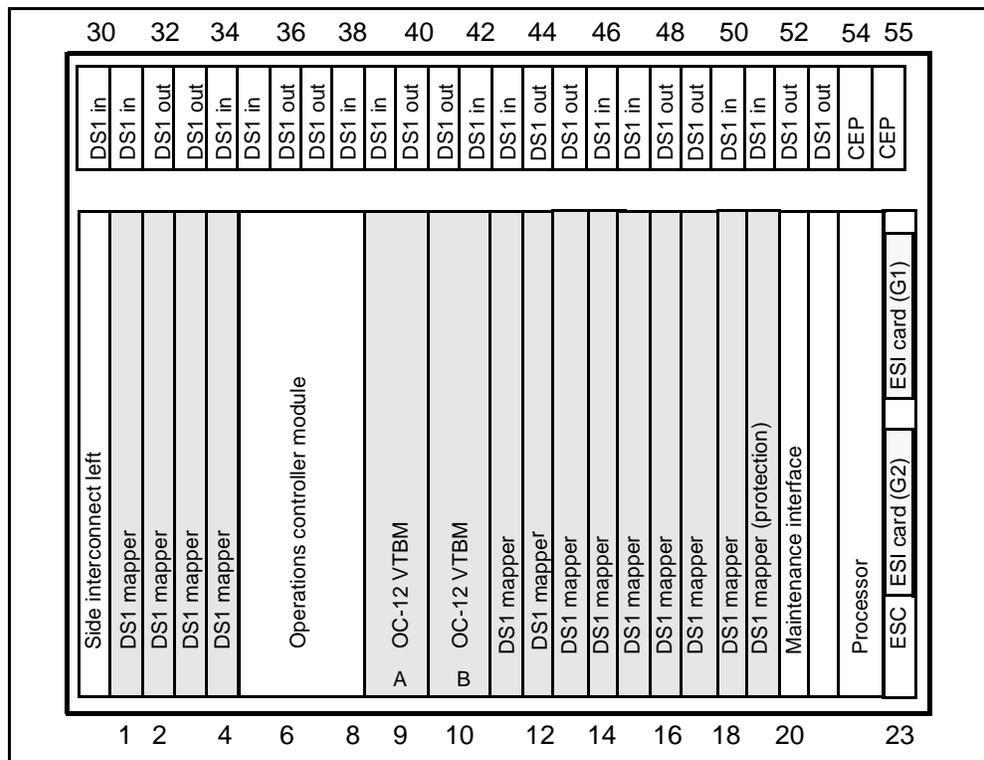
Protected modules in TBM shelves with DS3s

Figures 2-11 through 2-13 on page 2-16 show protected modules in transport TBM shelves that are equipped with DS3 mappers.

Protection for TBM FCOT shelves with DS3s

Figure 2-11 shows an TBM FCOT shelf that has three working DS3 mappers and a protection mapper. The shelf also has a pair of OC-12 interface circuit packs, duplicated processor cards, and duplicated ESI cards.

Figure 2-11
TBM FCOT shelf with three working DS3 mappers

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the BNC I/O cards.

Protection for TBM FCOT_BLSR shelves with DS3s

Figure 2-12 shows a TBM FCOT_BLSR shelf that has four working DS3 mappers and a protection mapper. This shelf cannot contain any DS1s if you provision the DS3 mapper in slot 13. The shelf also has a pair of OC-12 VTBM interface circuit packs, duplicated processor cards, and duplicated ESI cards.

Figure 2-12
TBM FCOT_BLSR shelf with four working DS3 mappers

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the BNC I/O cards.

Protection for TBM TN_BLSR shelves with DS3s

Figure 2-13 shows a TBM TN_BLSR shelf that has four working DS3 mappers and a protection mapper. This shelf cannot contain any DS1s if you provision the DS3 mapper in slot 13. The shelf also has a pair of OC-12 VTBM interface circuit packs. The TN_BLSR shelf function is similar to the FCOT_BLSR shelf function with the following exceptions:

- only one processor is supported (in slot 21)
- ESI is in slot 23 compared to slot 19 for the FCOT_BLSR shelf function

Figure 2-13
TBM TN_BLSR shelf with four working DS3 mappers

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the BNC I/O cards.
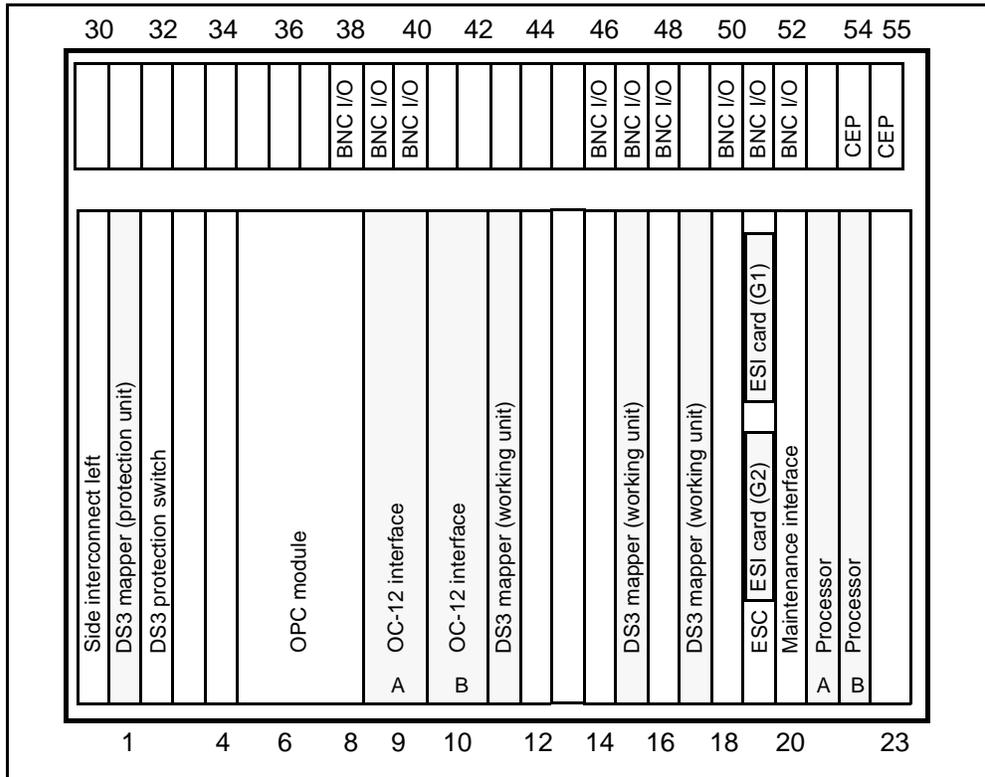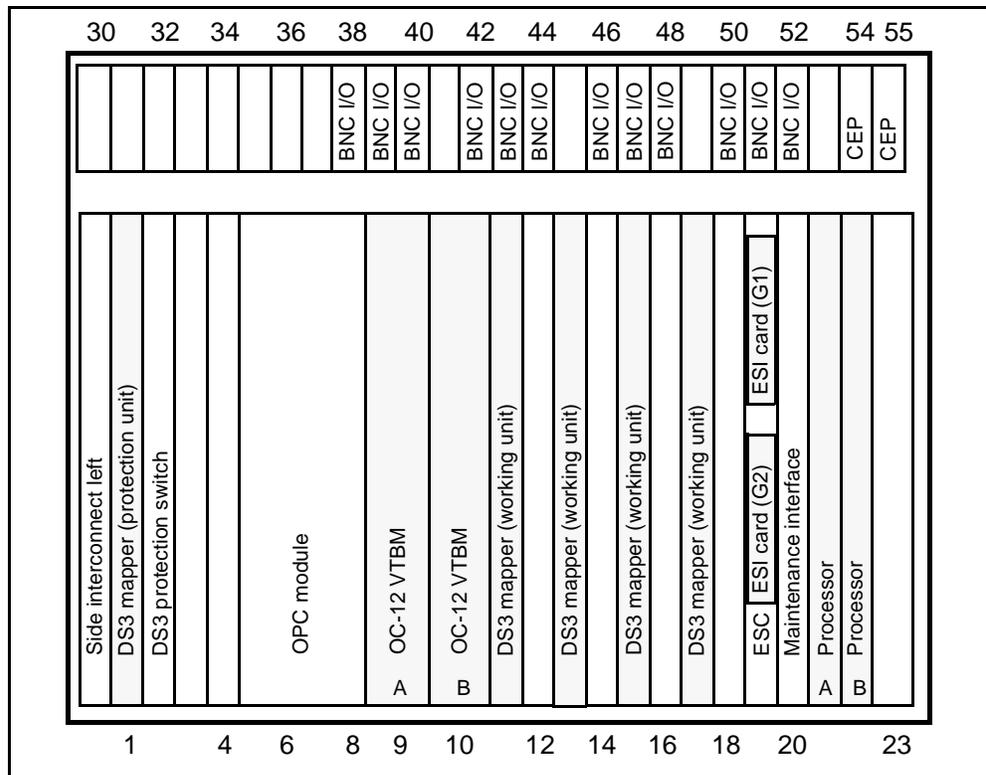
Protection for TBM TN_BLSR shelves with STS-1s

Figure 2-14 shows a TBM TN_BLSR shelf that has four working STS-1 interfaces and a protection mapper. This shelf cannot contain any DS1s if you provision the STS-1 interface in slot 17. The shelf also has a pair of OC-12 VTBM interface circuit packs. The TN_BLSR shelf function is similar to the FCOT_BLSR shelf function with the following exceptions:

- only one processor is supported (in slot 21)

- ESI is in slot 23 compared to slot 19 for the FCOT_BLSR shelf function

Figure 2-14
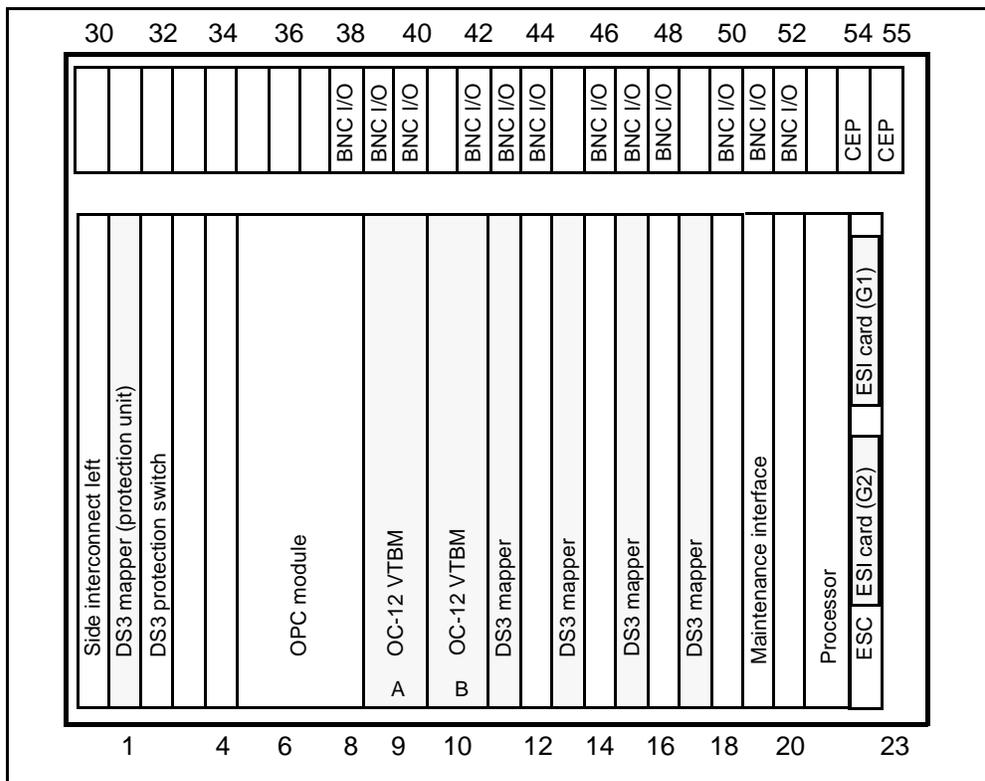**TBM TN_BLSR shelf with four working STS-1 interfaces**

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the BNC I/O cards.

Protection for TBM TN_BLSR shelves with a mix of STS-1s and DS3s

Figure 2-15 shows a TBM TN_BLSR shelf that has STS-1 and DS3 mappers and a protection mapper. This shelf cannot contain any DS1s if you provision a DS3 or STS-1 interface in slot 17. The shelf also has a pair of OC-12 VTBM interface circuit packs. The TN_BLSR shelf function is similar to the FCOT_BLSR shelf function with the following exceptions:

- only one processor is supported (in slot 21)
- ESI is in slot 23 compared to slot 19 for the FCOT_BLSR shelf function

Figure 2-15
TBM TN_BLSR shelf with two working STS-1 interfaces and two working DS3 mappers
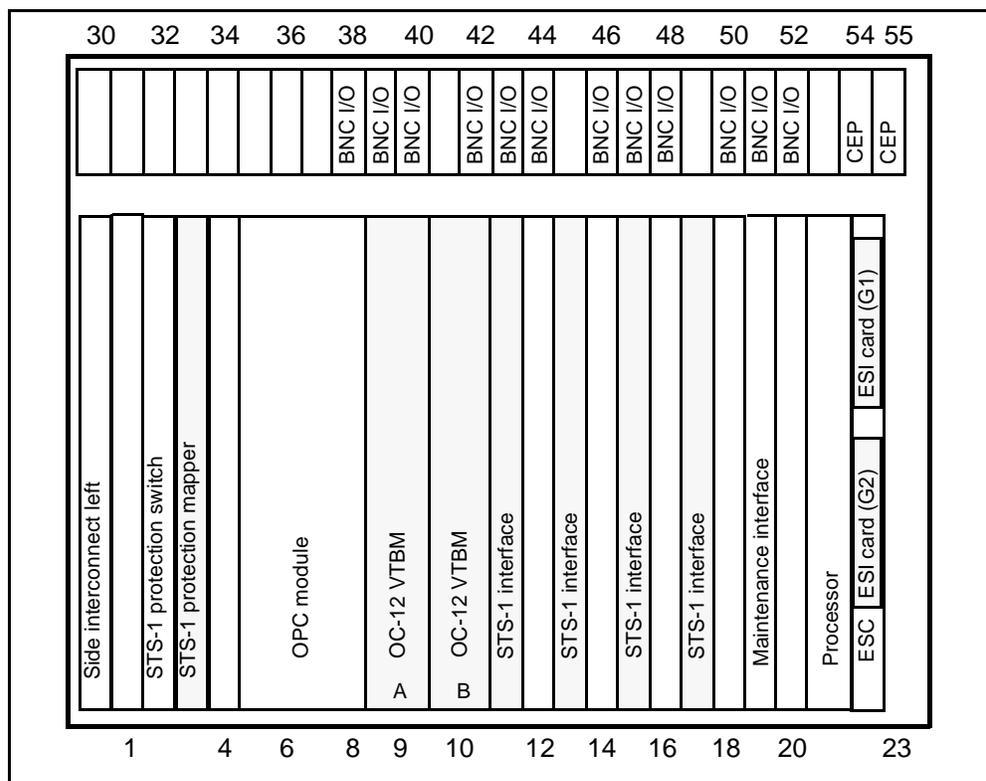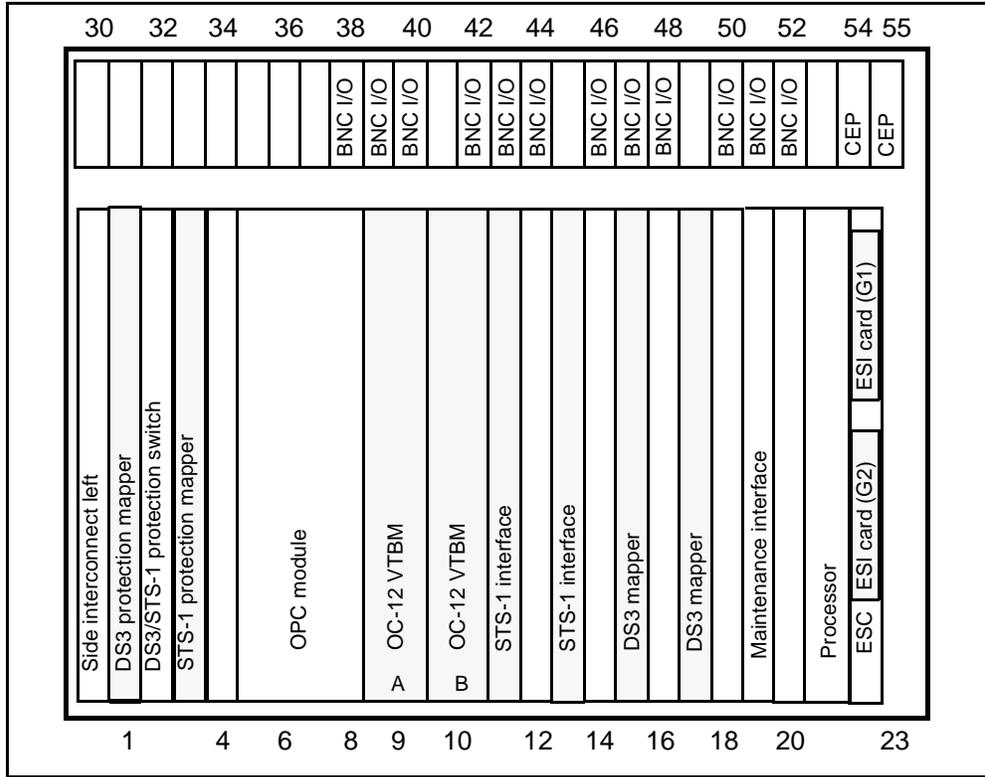

Note: Multiples of certain modules in the shelf provide increased capacity, not protection. Examples are the CEP cards and the BNC I/O cards.

Protected modules in TBM shelves with OC-3 tributaries and an OPC

Figure 2-16 shows the locations of the protected modules in a TBM shelf that has OC-3 tributaries.

> *Note:* An AccessNode system can support OC-3 tributaries only if it is a fiber-fed system whose primary fiber optic feeder is an OC-12.

This TBM shelf has three pairs of OC-3 interface circuit packs. Each pair handles one OC-3 tributary. Each pair of circuit packs is in a 1+1 protection-switching arrangement. The shelf also has a pair of OC-12 optical interface circuit packs that interface to the primary fiber optic feeder, duplicated processor cards, and duplicated ESI cards.

Figure 2-16
TBM FCOT or FCOT_BLSR shelf with 3 protected OC-3 tributaries and an OPC
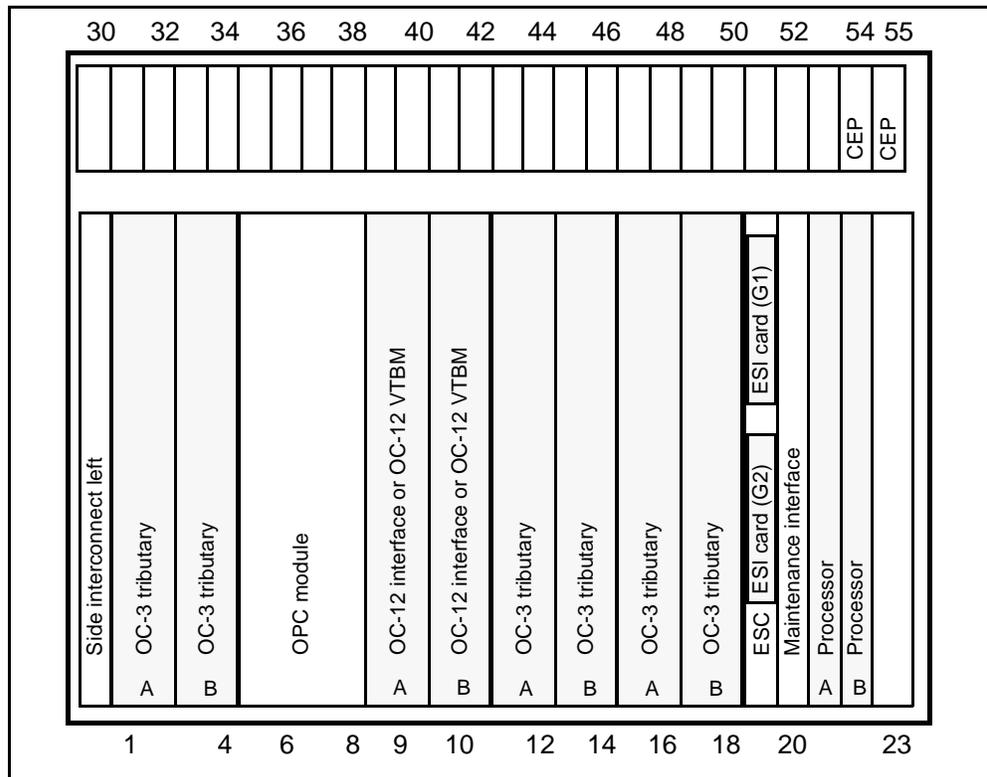
> *Note:* The CEP cards are duplicated in the shelf but do not protect each other.

Locations of duplicated modules in copper-distribution drawers

Each copper-distribution drawer must contain duplicated narrowband line-interface cards (NLIC). Figure 2-17 shows the locations of the NLICs in a copper-distribution drawer. The figure shows the layout of the left-hand copper-distribution drawer, which contains NLIC A and NLIC B. The right-hand drawer contains NLIC C and NLIC D.

Figure 2-17
Locations of the duplicated line-interface cards in a copper-distribution drawer

Power termination		Power filter
I/O board terminations		
Line card	Midplane	Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
Line card		Line card
NLIC A		NLIC B
MTA card		

Front of the copper-distribution drawer
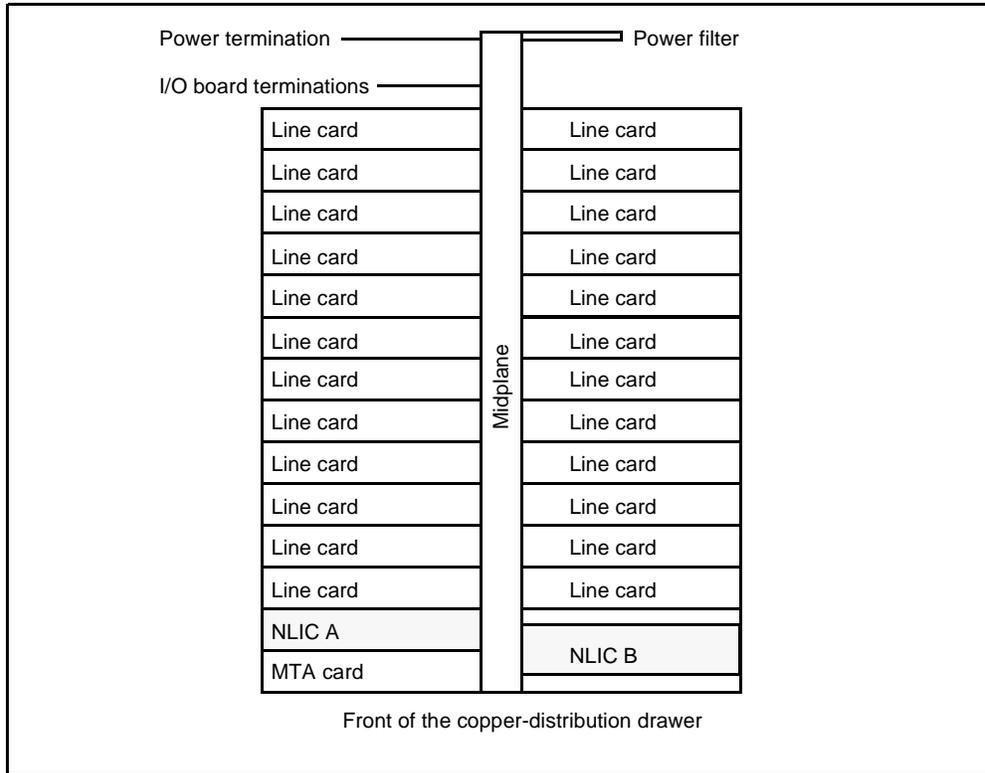
Protection details

The following sections provide summary information regarding the modules for which protection switching is available. More detailed information is available in subsequent chapters.

Protection for optical feeder interface circuit packs (OC-12 or OC-3)

Optical interface circuit packs (OC-12 or OC-3) that interface to the primary fiber optic feeder for the network element are installed only in pairs. Each pair provides 1+1 protection switching. Protection switching can be initiated either by the user, or automatically as a result of signal failure or signal degradation. The user can specify the thresholds at which signal degradation triggers automatic protection switching.

For detailed information on protection switching for optical interface circuit packs, see Chapter 3, "Protection for optical interface circuit packs".

Protection for OC-3 tributary optical interface circuit packs

OC-3 interface circuit packs that handle OC-3 tributaries can be installed individually or in pairs. If they are installed individually, they are not protected. If they are installed in pairs, each pair provides 1+1 protection switching. Protection switching can be initiated either by the user, or automatically as a result of signal failure or signal degradation. The user can specify the thresholds at which signal degradation triggers automatic protection switching.

For detailed information on protection switching for OC-3 optical interface circuit packs, see Chapter 3, "Protection for optical interface circuit packs".

Protection for OC-12 VTBM circuit packs

OC-12 VTBM circuit packs are used in the network elements in fiber-fed systems with ring topology. In each network element in such a system, a pair of OC-12 VTBM circuit packs interface to the fiber optic feeder. Protection switching can be initiated either by the user, or automatically as a result of signal failure or signal degradation. The user can specify the thresholds at which signal degradation triggers automatic protection switching.

For information on protection switching for OC-12 VTBM circuit packs, and information on ring protection switching, see Chapter 4, "Ring protection".

Protection for DS3 mappers

Digital DS3 signals entering an ABM shelf or a TBM shelf are handled by DS3 mappers. The mappers support 1:n protection switching. Protection switching can be initiated either by the user, or automatically as a result of circuit pack failure. For detailed information on protection switching for DS3 mappers, see Chapter 4, "Ring protection".

Protection for STS-1 interfaces

Digital STS-1 signals entering a TBM shelf (TN_BLSR only) are handled by STS-1 interfaces. The mappers support 1:n protection switching. Protection switching can be initiated either by the user, or automatically as a result of circuit pack failure. For detailed information on protection switching for STS-1 interfaces, see Chapter 4, "Ring protection".

Protection for DS1 mappers

Digital DS1 signals entering an ABM shelf or a TBM shelf are handled by DS1 mappers. The mappers support 1:n protection switching. Protection switching can be initiated either by the user, or automatically as a result of circuit pack failure.

Note: An optional software feature package titled DS1 protection switching supports protection switching for DS1 mappers in the RFT. Core software supports protection switching for the DS1 mappers in the network element.

For detailed information on protection switching for DS1 mappers, see Chapter 5, "Protection for DS1, DS3, and STS-1 interfaces".

Protection for processor cards

The processor card provides central control in an ABM shelf or a TBM shelf. To provide 1+1 protection for the processor card, you can install a second card in the shelf (except for TN_BLSR shelves, which can only handle one processor). Protection switching can be initiated either by the user, or automatically as a result of a hardware failure or a software error on the active processor card.

For detailed information on protection switching for processor cards, see Chapter 5, "Protection for DS1, DS3, and STS-1 interfaces".

Protection for external synchronization interface cards

Two external synchronization interface (ESI) cards are housed in the external synchronization carrier, which installs in an FCOT, in the ABM shelf or in the TBM shelf. The working ESI card receives timing reference signals from an external reference timing source such as a building integrated timing source (BITS) and provides the timing reference to the AccessNode. The two ESI cards protect each other. They perform protection switching on a 1+1 (nonrevertive) basis.

For detailed information on protection switching for ESI cards, see Chapter 5, "Protection for DS1, DS3, and STS-1 interfaces".

Note: Also in Chapter 5, there is information on protection switching for the timing-reference signals that the ESI cards receive.

Protection for timing and cross-connect cards

Timing and cross-connect cards are used in the ABM shelves in the RFTs in a DS1-fed system. They are also used in the OPC shelf, if connectivity between the operations controller and the RFTs is by way of OMC DS1s. You can install either one or two of these cards. If you install only one card, there is no

protection. If you install two cards, they provide 1+1 protection switching. Protection switching can be initiated either by the user, or automatically as a result of an equipment failure.

For detailed information on protection switching for timing and cross-connect cards, see Chapter 5, "Protection for DS1, DS3, and STS-1 interfaces".

> *Note:* Also in Chapter 5, there is information on protection switching for the timing-reference signals that the timing and cross-connect cards receive.

Protection for traffic to and from copper-distribution shelves

In an AccessNode that has one or more copper-distribution shelves, the line cards in each copper-distribution shelf support narrowband services over conventional copper loops.

Within each copper-distribution drawer are two narrowband line-interface cards. These cards protect each other, performing 1+1 protection switching.

In the ABM shelf, two transport interface card can be installed, to provide 1+1 protection for the traffic going to and from the copper-distribution drawers.

For more information on protection for traffic going to and from the copper-distribution shelves, see Chapter 6, "Protection for processor cards, ESI cards, and TXC cards".

Path protection switching

Both automatic and manual path protection switching (PPS) is supported for redundant EOC, TMC, and CSC channels. One channel is active and the second is on standby. Messages that coordinate path protection switching are carried over protection path links (PPLs).

Automatic path protection switching can occur automatically upon detection of a link fault by the local digital switch or the AccessNode. Automatic switching by the AccessNode is disabled when the standby link is out of service.

Manual switching can be performed from the AccessNode or the local digital switch. From the AccessNode network element user interface, manual switching has two modes: normal and forced. A normal PPS request is accepted if the standby link is in service. A forced PPS request is accepted even if the standby link is out of service. Refer to *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B, for the procedure for performing a manual protection switch.

Protection for optical interface circuit packs

Optical interface circuit packs are used in the network elements in fiber-fed systems and single-ended systems. (Optical interface circuit packs are not used in DS1-fed systems.)

This chapter contains the following information about optical interface circuit pack protection:

Topic	See page
Optical interface circuit packs	3-1
Switching modes	3-2
Protecting optical interface circuit packs	3-4
Maintenance features for OC-12 and OC-3 interface circuit packs	3-7
Hierarchy of protection features for OC-12 and OC-3 interface circuit packs	3-9

Optical interface circuit packs

OC-3 or OC-12 optical interface circuit packs interface the fiber optic feeder for a network element to a fiber-fed system with point-to-point topology. The fiber optic feeder for such a network element is an OC-3 line or an OC-12 line, depending on the data rate of the system. You install a pair of the circuit packs for this purpose. The circuit packs install in slots nine and ten in an access or transport bandwidth manager shelf.

There are two types of optical interface circuit packs:

- OC-12 interface circuit packs
- OC-3 interface circuit packs.

Protection switching for both types is the 1+1 nonrevertive type.

Note: Neither OC-3 optical interface circuit packs nor OC-12 optical interface circuit packs can be used to interface to the fiber optic feeder in a system with ring topology. In the network elements in such a system, OC-12 VTBM circuit packs interface to the fiber optic feeder and provide ring protection. For more information on ring protection, see Chapter 4.

You use OC-3 optical interface circuit packs to interface to the primary fiber optic feeder for a single-ended RFT. The fiber optic feeder for a single-ended RFT is an OC-3 line. The circuit packs install in slots nine and ten in an access or transport bandwidth manager shelf.

You can use OC-3 optical interface circuit packs to interface to OC-3 tributaries. You install either one or two circuit packs for each OC-3 tributary.

Note: An AccessNode network element can handle OC-3 tributaries only if it is in a fiber-fed system whose primary fiber optic feeder is an OC-12.

Switching modes

Protection switching between optical interface circuit packs can operate in two modes:

- bidirectional mode, which is the default mode
- unidirectional mode
- service selector (SS) switching

These modes are independent of the 1+1 architecture.

Bidirectional protection switching

In bidirectional protection switching, when transmission in one direction fails, both directions of transmission are transferred to the protection channel.

Unidirectional protection switching

In unidirectional protection switching, when transmission in one direction fails, transmission in that direction is transferred to the protection channel, but transmission in the other direction is not transferred.

For information on how to specify the protection-switching mode for optical circuit packs, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Note: An alarm is raised if a switching-mode mismatch exists between the local network element and the far-end network element.

Receive-active circuit pack

Because protection switching can be set to unidirectional mode, both optical interface circuit packs in a shelf may be active. The circuit pack that is receiving is said to be receive-active.

Service selector (SS) switching

Service selector (SS) switching is revertive, requiring a wait to restore (WTR) period of five minutes. In a revertive matched nodes scenario, the primary feed is preferable to the secondary feed.

The SS selects a workable secondary feed automatically in the following situations:

- during primary feed failure (PFF)
- while the primary feed is recovering from a previous PFF (during a wait to restore period)

Before performing a switch to secondary feed due to primary feed failure, the SS checks the secondary feed. If the secondary feed is faulty, then no switch occurs. This is equivalent to a revertive 1:1 protection scheme.

Forced switch

You can switch to the secondary feed by issuing a service selector forced switch from the Primary Gateway Selector Status screen in the OPC Connection Manager. If you do this, the secondary feed remains selected no matter what the current status of both feeds is.

The priority in matched nodes switching for drop and continue on working (DCW) is

- forced switch, then
- auto switch

The priority for drop and continue on protection (DCP) is

- ring switch, then
- forced switch, then
- auto switch

Service selection and conditioning

Service selection and conditioning is not available on a primary gateway node during:

- NE software download
- restart (30 to 60 seconds)
- processor removal
- processor failure
- dead system recovery
- VTM card reset

Protecting optical interface circuit packs

To provide the 1+1 protection for optical interface circuit packs, the standby optical interface circuit pack is maintained in a hot-standby state. In the transmitting direction, both optical interface circuit packs that interface the primary fiber optic feeder receive STS-1s from other circuit packs in the common-equipment shelf. The following distinctions apply to access bandwidth manager shelves and transport bandwidth manager shelves:

- In an access bandwidth manager shelf, STS-1s can be received from active DS1/VT mappers, from active DS3/STS mappers, from OC-3 interface circuit packs that handle OC-3 tributaries (for OC-12 feeders only), and from the active transport interface card.

- In a transport bandwidth manager shelf, STS-1s can be received from active DS1/VT mappers, from active DS3/STS mappers, and from OC-3 interface circuit packs that handle OC-3 tributaries (for OC-12 feeders only).

Figure 3-1 illustrates the transmit and receive functions of the optical interface circuit packs that interface to the primary fiber optic feeder in a network element in a fiber-fed system with point-to-point topology.

User-initiated protection switching

You can initiate forced switching or manual switching by means of commands accessed under the "protection" option in the network-element user interface. For instructions on how to invoke these features, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Maintenance switching for optical interface circuit packs is also supported (lockout, forced switching, and manual switching).

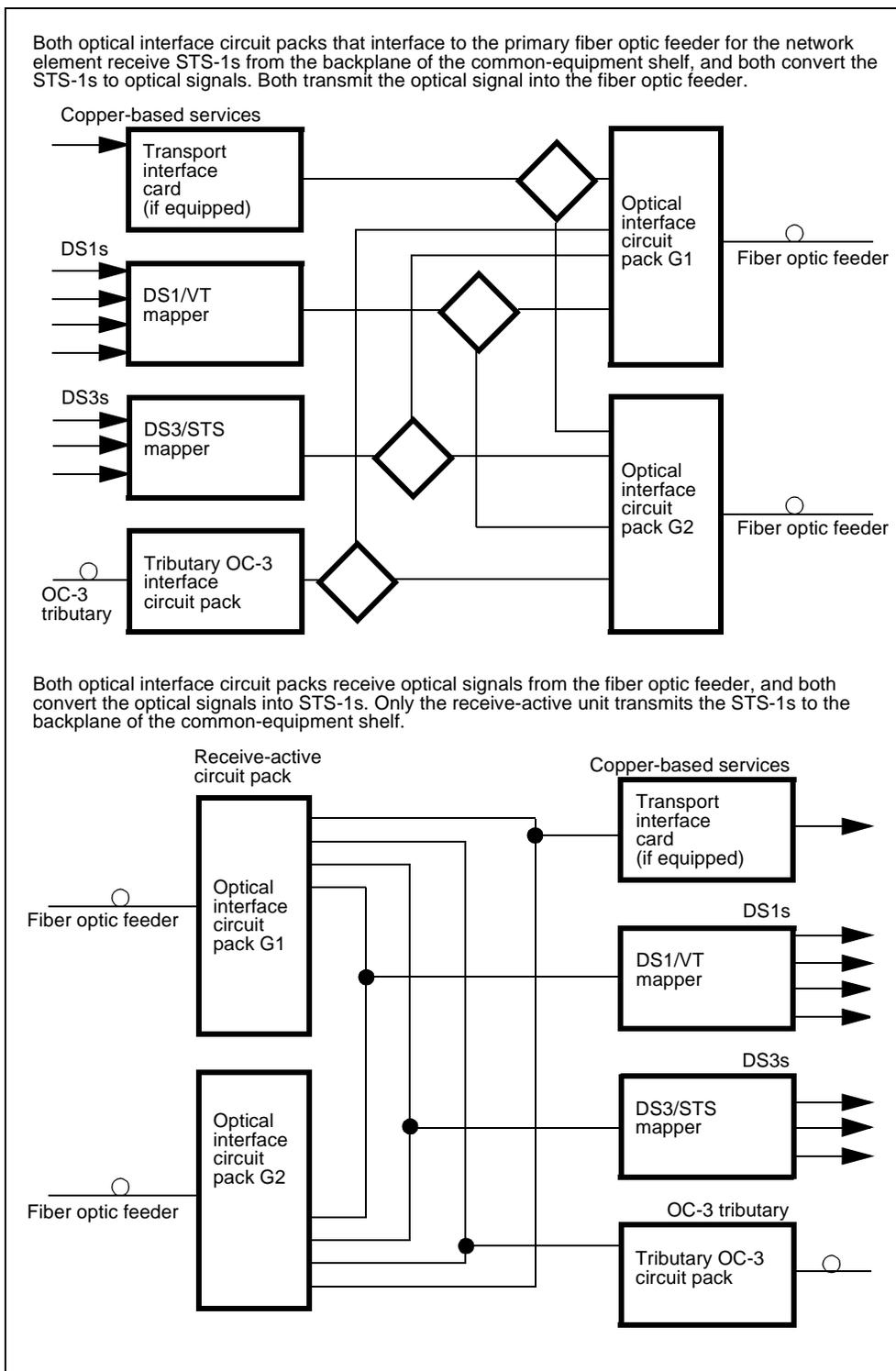## Automatic protection switching

Failures in the optical interface circuit pack and in the optical lines are automatically protected on a nonrevertive 1+1 basis. The system initiates high-speed protection switching when it detects any of the following:

- loss of signal (LOS)
- loss of optical frame (LOF)
- line alarm indication signal (AIS)
- failure of the active optical interface circuit pack
- signal degradation

Time required to detect signal failure

If the OC-12 or OC-3 signal fails, the system takes 10 ms or less to detect the failure. Included in the 10 ms is a frame-loss-detection holdoff of 3 ms, which prevents unnecessary switching from occurring.

Figure 3-1
Protection for optical interface circuit packs in a point-to-point system
(logical representation)

Time required to detect signal degradation

Signal degradation triggers automatic protection switching when the optical bit error rate (BER) exceeds a user-selectable threshold ranging from 10^{-4} to 10^{-10}. If the signal degrades, the detection time depends on the BER threshold that you have selected, as shown in Table 3-1.

Table 3-1
Time required to complete protection switching

BER threshold	Detection time	TA-TSY-00253 requirement
10^{-4}	35 ms	100 ms
10^{-5}	370 ms	1 s
10^{-6}	3 s	10 s
10^{-7}	30 s	100 s
10^{-8}	300 s	16.7 min
10^{-9}	55 min	2.8 h4
10^{-10}	8.9 hr	-

Note: The times shown in this table reflect cases in which errors are distributed uniformly.

Time required to complete protection switching

The protection-switching times comply with the Bellcore TA-TSY-000253 specification of 10 ms or less to detect the fault, and 50 ms or less from detection to completion of the switching. For a single circuit-pack failure, the time from the occurrence of the failure to the completion of the switching is 60 ms or less.

Clearing a signal-degradation condition

A signal-degradation condition clears when the bit error rate declines by a factor of 10, for example, from 10^{-8} to 10^{-9}.

Protection-oscillation control

This feature was formerly called automatic lockout or autolockout.

Protection-oscillation control prevents the equipment from switching repeatedly if there are recurring failures. Protection-oscillation control works as follows. If the number of protection switches occurring within a certain time period (the oscillation period) exceeds a specified threshold (oscillations), then lockout is invoked automatically, and remains in effect for a specified length of time (the lockout period).

To inspect the values assigned to the parameters (oscillation period, oscillations, and lockout period), see the OC-12 Protection Provisioning screen in the network-element user interface.

For details on how to access the screen, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Maintenance features for OC-12 and OC-3 interface circuit packs

The following sections describe the maintenance features that are available for OC-12 and OC-3 interface circuit packs. You can invoke these features by means of commands accessed under the "protection" option in the network-element user interface. For instructions on how to invoke the features, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Lockout command

The lockout command excludes a circuit pack from protection switching. The lockout command overrides all other protection features including automatic protection switching.

The lockout command for optical interface circuit packs always denies access to the G2 unit. If you enter the lockout command when the G2 unit is the active unit, activity switches to the G1 unit and then the lockout goes into effect. The lockout prevents protection switching from occurring.

> *Note 1:* In a VTBM ring, when a lockout of protection command is operated on any span in the ring, all protection is locked out for the entire ring including the span that has the active lockout protection switch.
>
> *Note 2:* If you issue the lockout of working command from the local network element user interface, you must explicitly enter it at both ADM nodes terminating the span. If the command is entered at only one end, a protection switch is still prevented on that span. However, if a protection switch is requested at the far end, a "Protection switch fail" alarm is raised. Entering the command at both ends prevents this alarm from being raised.
>
> *Note 3:* Matched nodes do not support lockout.

Forced-switching command

The forced-switching command forces the standby unit to take over the functions of the working unit. The forced-switching command does not override lockout.

In this release, any forced switching specified for optical interface circuit packs takes effect as long as no lockout or other forced switch is active. It takes effect even if a signal-degrade condition exists on the standby unit, and even if the standby unit is in the failed condition.

If you intend to force a switch to a failed optical interface circuit pack, you must first verify that the route-diversity protection parameter has been turned on. For details on how to set the route-diversity parameter, see the instructions on provisioning OC-3 or OC-12 protection parameters in *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Note: Matched nodes support a forced switch.

Manual-switching command

The manual-switching command requests the standby unit to take over the functions of the specified working circuit pack, provided that the standby unit is fully operational.

The manual-switching command does not override automatic protection switching.

Note: Matched nodes do not support manual switching.

Exerciser command

The exerciser is a routine that tests the different protection mechanisms associated with protection switching. It establishes bridges between the working and protection circuit packs, that is, it simulates a switch to the point of completion but without actually completing the switch. By verifying the integrity of the signal to the point at which the final switch is to be made, the exerciser detects failures in the protection path. The exerciser runs on a shelf basis for all circuit packs that are in the in-service state and on the working channel.

The exerciser is the lowest-priority user command. It does not run if a higher-priority feature or command is in effect. If a failure occurs while the exerciser is running, the exerciser is aborted, a protection-path-failure alarm is raised, and an extra ten ms are required in addition to the usual protection-switching time.

In a VTBM ring, the exerciser cannot establish the bridge between the working and protection circuit packs. The exerciser is used only to test the K-Byte signaling around the ring. This test can still be performed with matched node connections. Matched nodes have no noticeable effect on the exerciser functionality.

Hierarchy of protection features for OC-12 and OC-3 interface circuit packs

Table 3-2 shows the protection-switching features that apply to OC-12 and OC-3 interface circuit packs. Table 3-2 indicates how each feature can be activated, whether automatically, or by the user.

Table 3-2
Hierarchy of protection-switching features for optical interface circuit packs

Feature	Priority level	Source of control	
		User	Automatic
Lockout	Highest	X	X
Forced switching		X	
Automatic switching due to signal failure			X
Automatic switching due to signal degradation			X
Manual switching		X	
Exerciser	Lowest	X	

Note: The exerciser test does not perform an actual switch, but it does test the protection signaling between the local network element and the far end.

Ring protection

This chapter explains the strategy of protection switching for systems with bidirectional line-switched ring (BLSR) topology.

It describes the signal flow in a ring under normal conditions, as well as how the signal flow changes when protection switching occurs.

This chapter also includes descriptions of protection in response to various types of failures and descriptions of the maintenance features supported by the OC-12 VTBM circuit pack.

Chapter contents

The following table lists the topics discussed in this chapter.

BLSR rings

You can configure the AccessNode into a bidirectional line-switched ring (BLSR) configuration. In a BLSR ring, nodes connect to form a circle or ring instead of forming linear patterns like the point-to-point configurations do. The ring topology allows for more sophisticated protection switching schemes.

In fiber-fed systems that have ring topology, the protection switching for ring protection is performed by the OC-12 VTBM circuit packs. In each network element in a ring, two OC-12 VTBM circuit packs interface to the fiber optic feeder.

> *Note:* Throughout the rest of this chapter, the network elements in fiber-fed systems with ring topology are referred to as ring nodes.

Signal flow in a ring

Figure 4-1 illustrates signal flow in a ring under normal conditions. The traffic on the two fibers between adjacent ring nodes travels in opposite directions. The 12 STS-1 channels on each fiber are divided into six working channels (STS-1 time slots 1 to 6) and six protection channels (STS-1 time slots 7 to 12). The lower working time slots on one fiber are protected by the upper protection time slots on the second fiber, which travel in the other direction around the ring.

Figure 4-1
AccessNode bidirectional line-switched ring
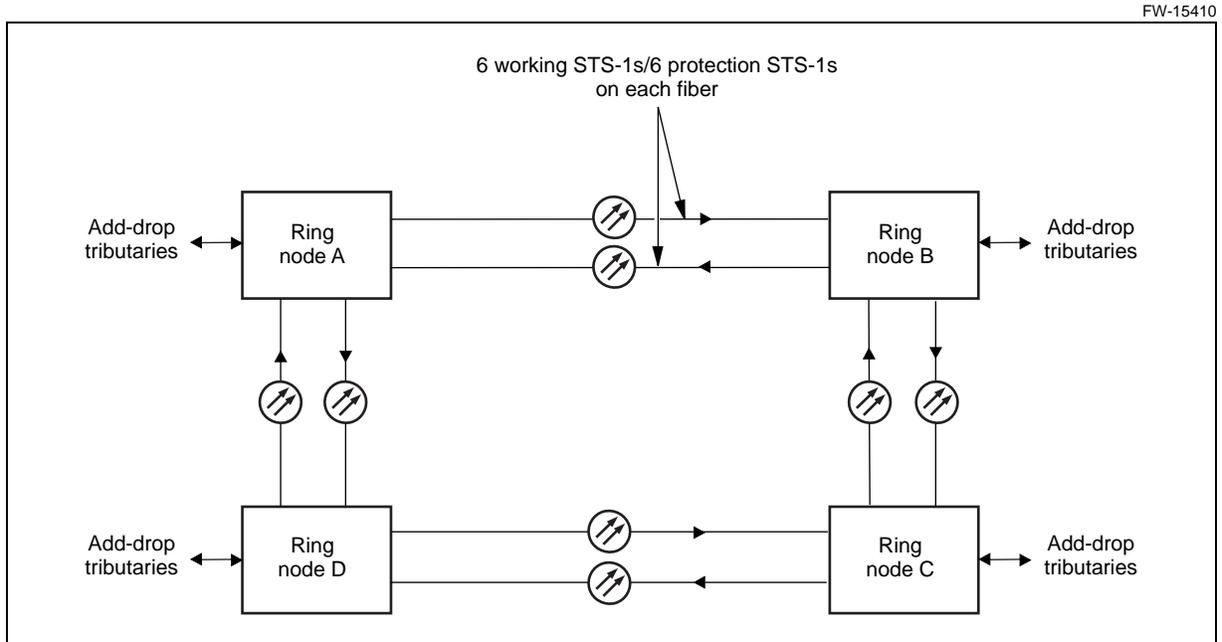
The OC-12 transport signals are terminated at each ring node by the OC-12 VTBM circuit packs in slots nine and ten (circuit-pack groups G1 and G2, respectively). These circuit packs provide the add-drop multiplexing and demultiplexing functions.

Signal flow under normal conditions

Figure 4-2 shows the signal flow in a ring node under normal conditions.

Each tributary signal is routed to and from the OC-12 VTBM circuit pack that handles the direction of transmission (clockwise or counterclockwise) in which the tributary is supposed to travel. For any tributary, the direction of transmission depends on the specifications you entered using the Connection Manager. Each DS1 tributary occupies a VT1.5, having been mapped into the VT1.5 by the DS1 mapper; each DS3 tributary occupies an STS-1, having been mapped into the STS-1 by the DS3 mapper. Each OC-3 tributary occupies three STS-1s.

Each OC-12 VTBM circuit pack contains an ANSI switch that has three output ports:

• the add-drop port, which is dedicated to the add-drop bus

• the line port, which is dedicated to the unit's STS-12 line interface

• the pass-through port, which interfaces to the R-link

The tributaries are routed to the add-drop port on the ANSI switch. Each switch places the VT1.5s and STS-1s that it handles in the time slots that you specify for them using the Connection Manager. In each OC-12 VTBM circuit pack, the working traffic is placed in STS-1s one to six, and STS-1s seven to twelve are reserved for protection.

The OC-12 VTBM circuit pack converts the 12 STS-1s into an OC-12 signal, and transmits that OC-12 signal into the fiber optic feeder.

Figure 4-2
Signal flow in a ring node under normal conditions

PC-15432
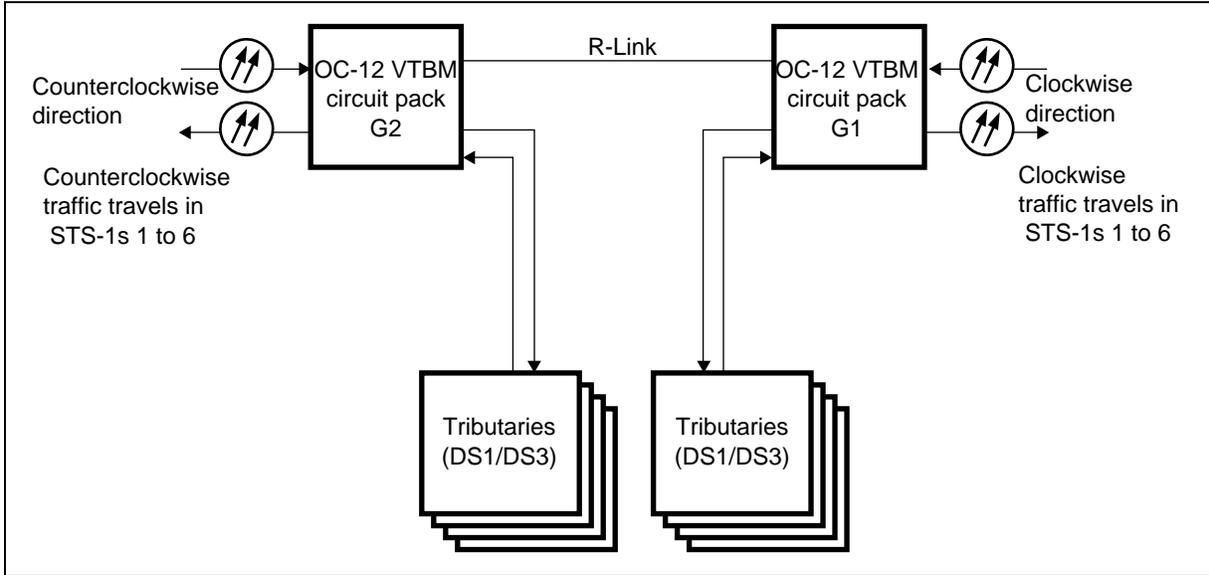
Signal flow under failure conditions

Figure 4-3 shows the signal flow in a ring node under failure conditions. The figure shows what happens when a line cut interrupts the clockwise direction of transmission between two adjacent ring nodes.

Just as under normal conditions, each tributary is routed to and from the OC-12 VTBM circuit pack that handles the direction of transmission (clockwise or counterclockwise) in which the tributary is supposed to travel.

Just as under normal conditions, the tributaries are routed to the add-drop ports on the ANSI switches in the OC-12 VTBM circuit packs. Each switch places the VT1.5s and STS-1s that it handles in the time slots that you specify for them using the Connection Manager. In each OC-12 VTBM circuit pack, the traffic is placed in STS-1s one to six.

In the failure condition illustrated in Figure 4-3, the OC-12 VTBM circuit pack responsible for the clockwise direction of transmission cannot send an OC-12 signal to the adjacent ring node. Therefore, the contents of STS-1s one to six are sent to the other OC-12 VTBM circuit pack by way of the R-link. (The R-link connects the pass-through ports in the ANSI switches in the two OC-12 VTBM circuit packs.) When the clockwise traffic arrives at the ANSI switch in the OC-12 VTBM circuit pack responsible for the counterclockwise direction of transmission, that ANSI switch maps that traffic into STS-1s seven to twelve. The system converts the 12 STS-1s into an OC-12 signal and transmits it in the counterclockwise direction to the adjacent ring node.

Figure 4-3
Signal flow in a ring node under failure conditions

PC-15433
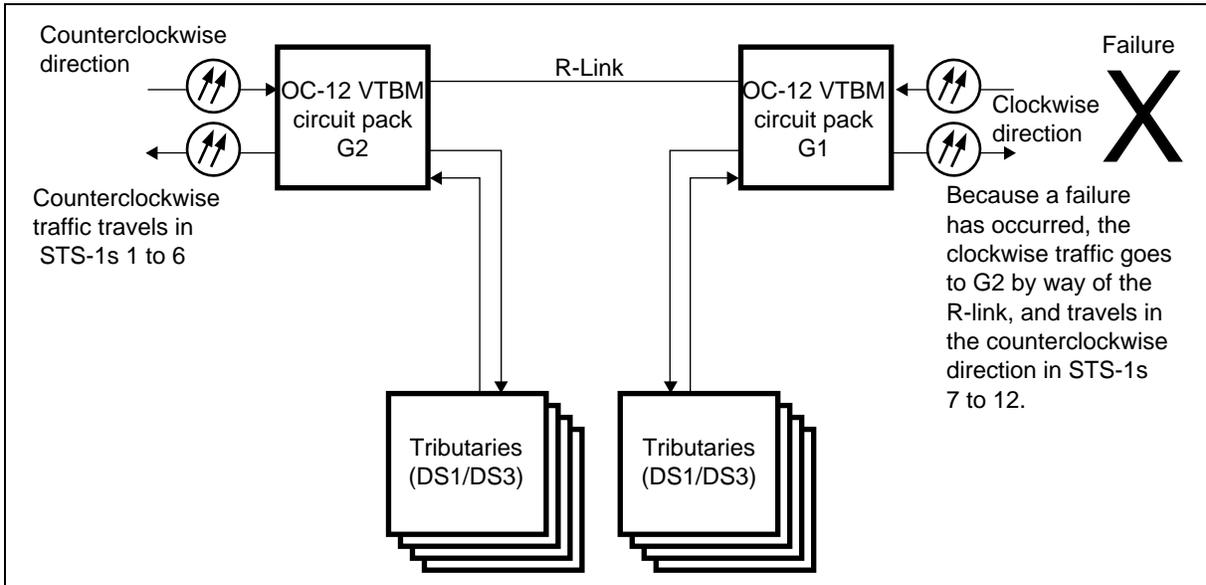
Ring node management

In a ring, each node is given a unique identifier called the automatic protection-switch identifier (APS ID) which takes a value in the range 0 to 15. The APS ID is independent of the unique network element identifier (NE ID) each node is also assigned. The maximum number of nodes in the ring is 16. Only ring ADM nodes are given an APS ID.

The ring nodes are spaced apart according to engineering limits.

In each node, the traffic to/from the adjacent node in the clockwise direction is handled by one of the OC-12 VTBM circuit packs (G1 in slot nine or G2 in slot ten). The traffic to/from the adjacent node in the counter-clockwise direction is handled by the other OC-12 VTBM circuit pack.

It is good practice to consistently connect OC-12 circuit pack G1 of one node to OC-12 VTBM circuit pack G2 at the adjacent node. Likewise, you should consistently connect OC-12 VTBM circuit pack G2 to OC-12 VTBM circuit pack G1 at the other adjacent node.

Node map

The node map for a ring defines the connections between the ring nodes. The OPC generates and maintains the node map. The node map is based on the G1 connectivity that you define. (You define that connectivity using the Configuration Manager.) The connectivity in the reverse direction is derived

from the G1 connectivity. The combined data defines a closed, bidirectional ring. The OPC downloads the node map to each ring node. The map is stored in the OC-12 VTBM circuit packs.

Squelch map

The Connection Manager provides an STS-1 squelch map and a VT squelch map for each ring node. A squelch map defines which STS-1 or VT time slots are to be automatically injected with an alarm indication signal (path AIS) in the event of a node failure or other ring segmentation.

High-speed protection in a ring

The protection switching performed by rings is bidirectional and revertive; after a failure is cleared, traffic reverts from the protection STS-1s on one fiber to the working STS-1s on the other fiber, after a wait-to-restore period.

Only the protection STS-1s necessary to restore service are used.

Protection switching requires that all ring nodes are operating normally, prior to the failure, with all protection circuits configured and in service. In each ring node, all the protection circuits are handled by the OC-12 VTBM circuit packs.

The operations controller monitors the protection status of all the ring nodes on a scheduled basis and reports this information through the Network Summary tool.

Protected operation

The ring is designed to protect against catastrophic failures such as optical line cuts, ring node failures, and signal degradation. The ring automatically detects and isolates trouble and reroutes traffic around the failed portion of the network.

Automatic ring protection switching occurs whenever a ring node detects a loss of transport signal, a transport equipment failure, or a signal degrade (where the bit error rate is greater than a provisioned threshold). In the event of multiple faults around the ring, the ring is divided into as many individually protected segments as required to restore traffic within the interconnected subnetworks.

The protection switching is invoked on the basis of the node map that defines the order of the nodes around the ring. In each ring node, the node map is contained in the OC-12 VTBM circuit packs.

Figure 4-4
Bidirectional line-switched ring—normal operation

PC-15411
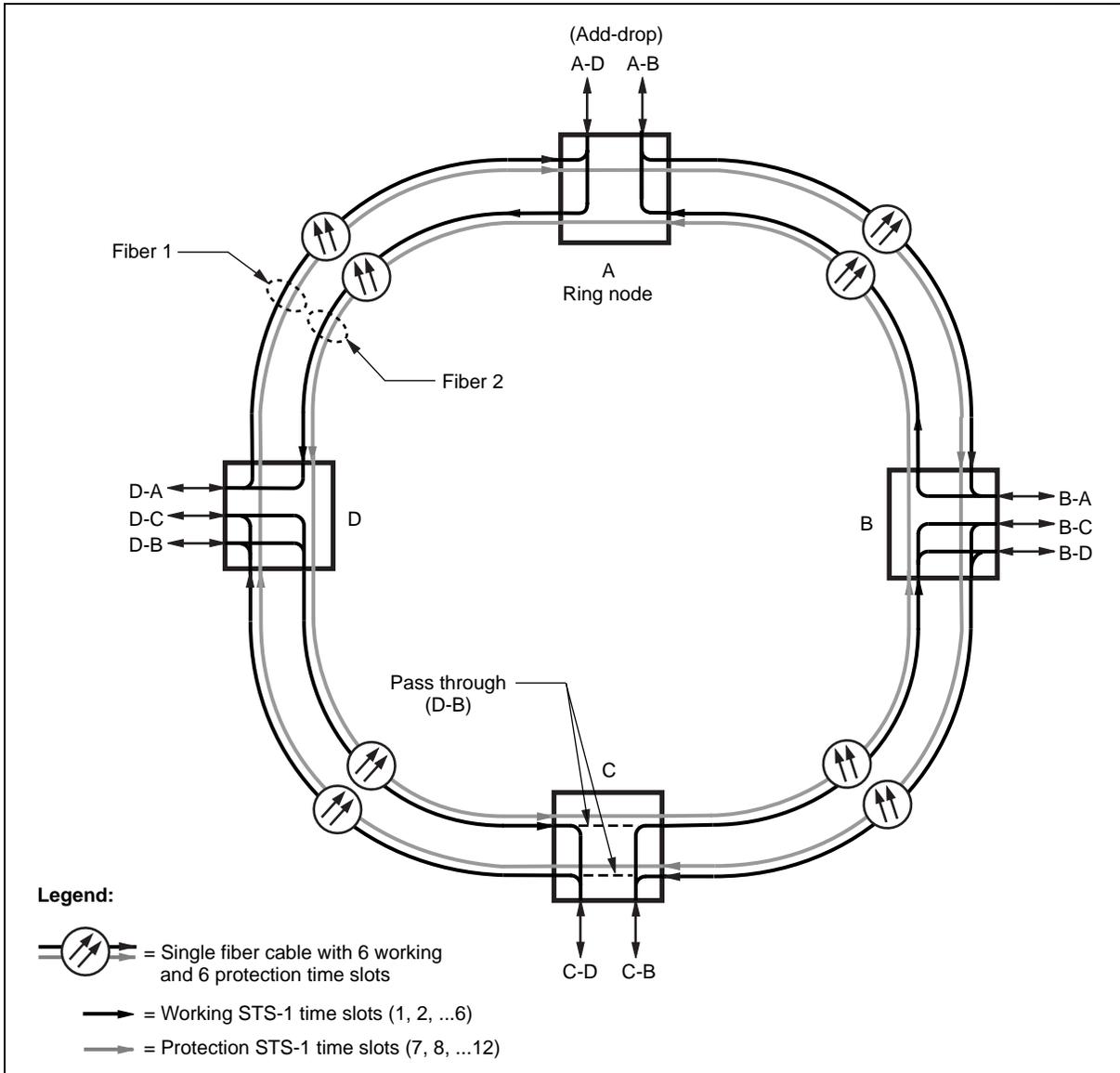
Protection switching occurs on a line basis at the ring nodes on either side of the failure. As well as having a map of its position in the ring relative to its two neighboring nodes, each node also knows the interconnections of the fiber spans between it and its neighbor nodes based on their respective optical interfaces. (The optical interfaces are OC-12 VTBM circuit-pack groups G1 and G2 in each node.)

Protection switching is invoked on the basis of the automatic protection-switch identifiers (APS IDs), using signaling in the K-bytes in the SONET overhead, and is applied at the circuit-pack-group level.

Protected operation in response to a link failure

Link failures occur due to many problems including module failures and fiber cuts.

During a link failure, the ring enters into a bidirectional protected state of operation, as shown in Figure 4-5. Because the ring protection scheme is based on the SONET line layer, the system invokes all protection operations at the nodes in the ring that are adjacent to the fault. These nodes adjacent to a failure are called bridge and switch nodes. The nodes that are not adjacent to the fault allow the pass-through protection channel to be transmitted.

When a link failure occurs, traffic using the working STS-1 time slots of the affected fiber is rerouted to the protection STS-1 time slots on the other fiber and proceeds in the opposite direction around the ring to the destination node. Traffic on working time slot 1 is rerouted to protection time slot 7 on the other fiber, working time slot 2 is rerouted to protection time slot 8, and so on.

Figure 4-5 shows a fiber cable cut between nodes C and D. When the link failure is detected, add/drop and pass-through traffic on that link is treated as follows on the bridge and switch nodes (nodes C and D):

*   STS-1 time slots that would normally be added to working time slots on the affected link are routed instead onto the corresponding protection STS-1 time slots and are transported in the opposite direction around the ring.

*   STS-1 time slots that are to be dropped as tributaries are received on the protection time slots from the opposite direction and terminated normally (along with those received normally in the working time slots).

*   For bridging and switching nodes (the nodes that are adjacent to the failure), working channel pass-through traffic is looped back from the working STS-1 time slots to the corresponding protection time slots and from the protection time slots to the corresponding working time slots. Figure 4-5 shows how the signal that is transmitted from originating node B on a working time slot is rerouted by node C back through the originating node on the protection time slot to complete the connection to terminating node D during a protection switch.

Nodes A and B allow the pass-through protection channel to be transmitted.

Figure 4-5
**Bidirectional line-switched ring—link failure**
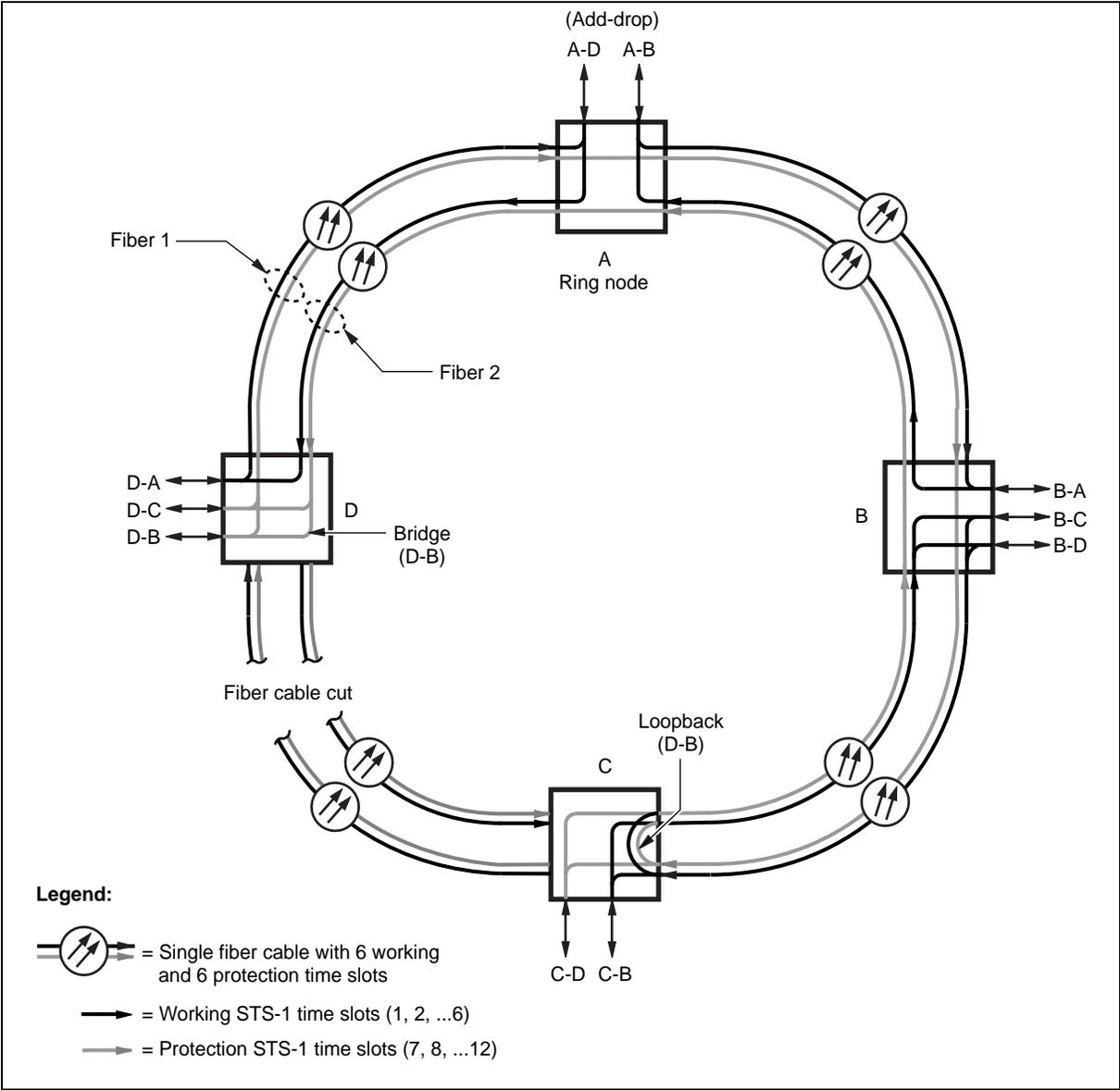
Protected operation in response to a node failure

In the event of a node failure, the ring enters the bidirectional protected state of operation. Figure 4-6 illustrates a failure of node C. Traffic normally transported through node C is rerouted to the corresponding protection time slots at nodes B and D.

Figure 4-6
Bidirectional line-switched ring—node failure

PC-15413
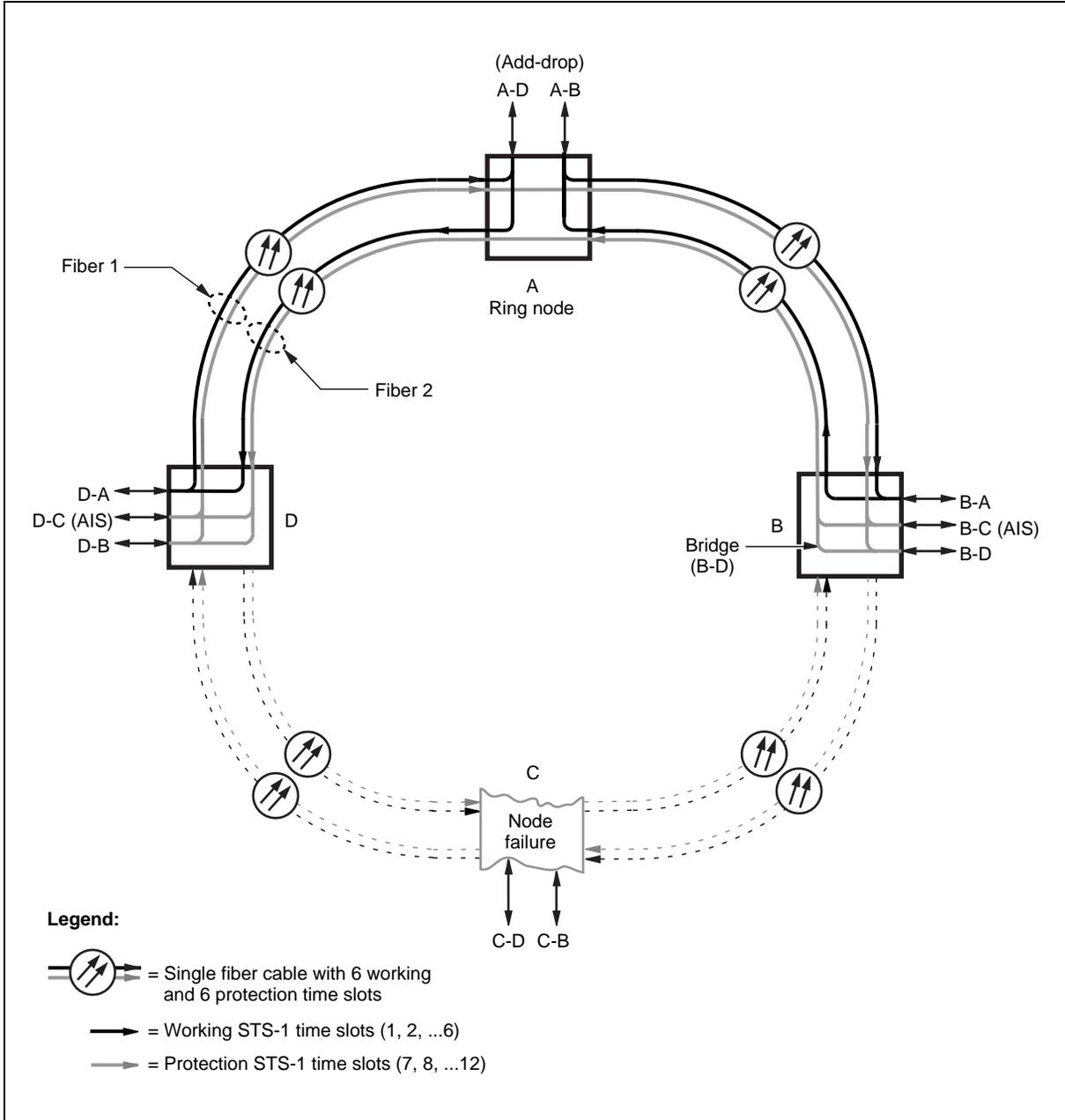
Add-drop traffic at a failed node cannot be protected. Adjacent nodes inject a path alarm indication signal (path AIS) into both the working and protection time slots used by this traffic, in the direction away from the failed node.

The path AIS is transported along the path in the ring until it exits at the service access point. It is then transmitted through the tributary to the signal source. Receipt of path AIS informs the signal originator of a failure to complete transmission.

The use of path AIS to replace the normal signal prevents misconnection in the network. The introduction of path AIS during ring failure conditions is known as squelching.

The squelching is performed by the switch nodes (the nodes adjacent to the failure) on the basis of a squelch map. The squelch map has an entry for each STS-1 or VT connection provisioned at the ring node, and defines which STS-1 and VT time slots are to be automatically injected with path AIS in the event of a protection switch. The squelch map is created at the same time the STS-1s and VTs are provisioned, with the Connection Manager tool in the OPC. The squelch map is downloaded, along with the node map, to the OC-12 VTBM circuit packs in each ring node.

Ring nodes periodically perform a scheduled audit that compares the squelch map stored in the network-element database with the squelch map stored in the OC-12 VTBM circuit packs. If a discrepancy is found, the OC-12 VTBM circuit packs are updated from the network-element database.

The operations controller monitors the protection status of all the nodes in the ring on a scheduled basis and reports this information as event logs.

Figure 4-7 shows a four-node ring with several defined STS-1 paths. Three of the connections run through node D. The following table specifies the STS-1 squelch map for node D.

STS-1 connection	From end node ID	To end node ID	Squelching on failure of Node D
a	A	C	not applicable
b	A	B	not required; path rerouted
c	D	A	at A
d	C	D	at C

Figure 4-7
STS-1 paths defined in a four-node ring

PC-2247
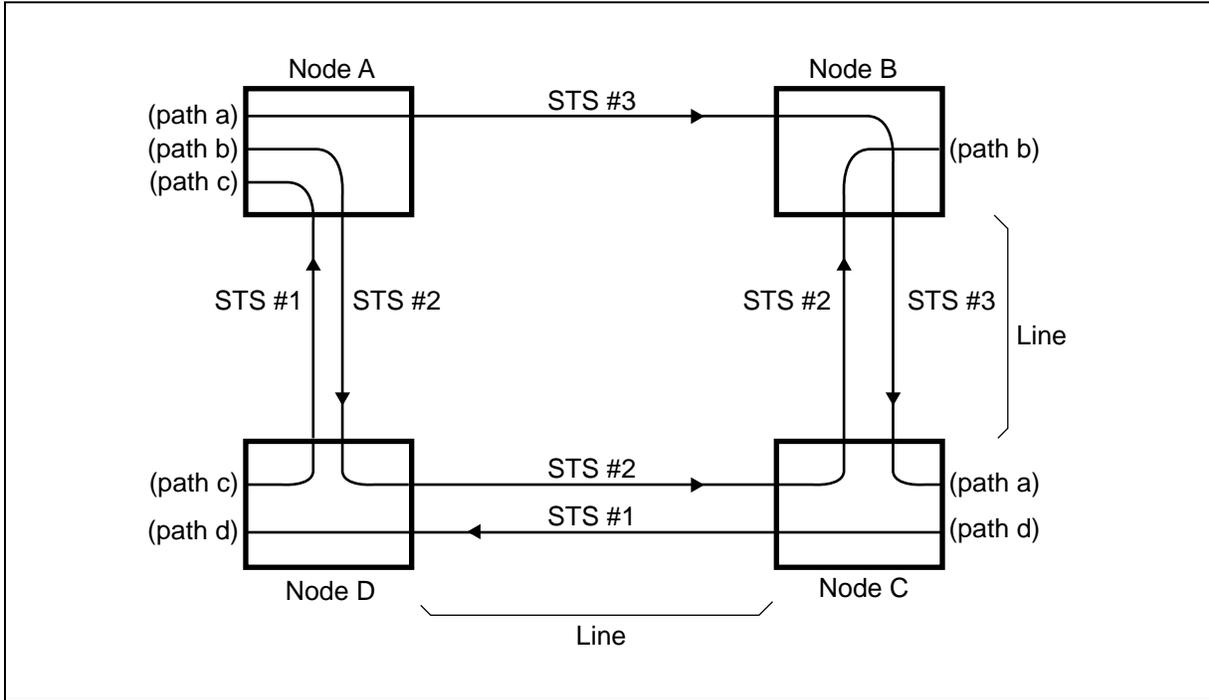
Signal flow and protection for matched nodes

Figure 4-8 illustrates signal flow in a matched nodes configuration under normal conditions.

Figure 4-8
Basic matched nodes configuration

PC-16439
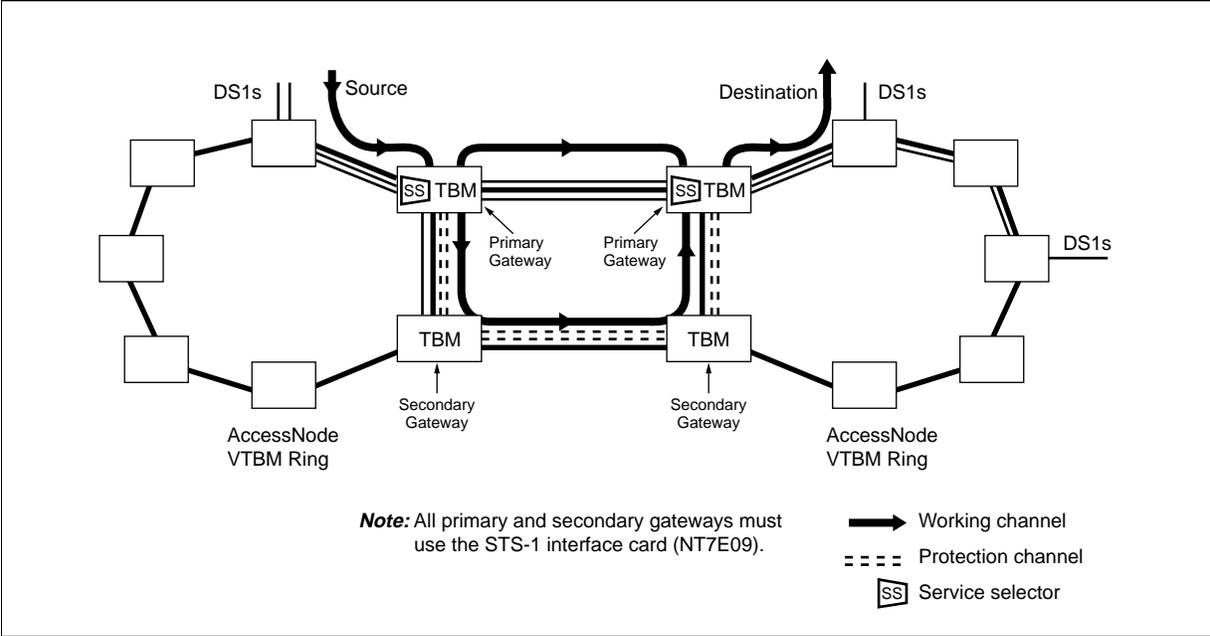
Protection methods for matched nodes

Matched nodes support two protection methods:

- drop and continue on working (DCW)

- drop and continue on protection (DCP)

This protection method	carries the	and provides
drop and continue on working (DCW)	primary and secondary circuits on working bandwidth	the most secure ring interconnection protection method
drop and continue on protection (DCP)	the primary circuits on working bandwidth and the secondary circuits on protection bandwidth	the most bandwidth efficient ring interconnection protection method

You can assign multiple levels of survivability based on the method you choose.

Drop and continue on working

The DCW protection method carries secondary traffic between the primary and secondary nodes using any of the working channels (STS-1 numbers 1 to 6). DCW provides the highest level of protection against multiple failures but uses all the bandwidth between the primary and secondary gateway nodes.

Figure 4-9 shows the signal flow in a DCW connection.
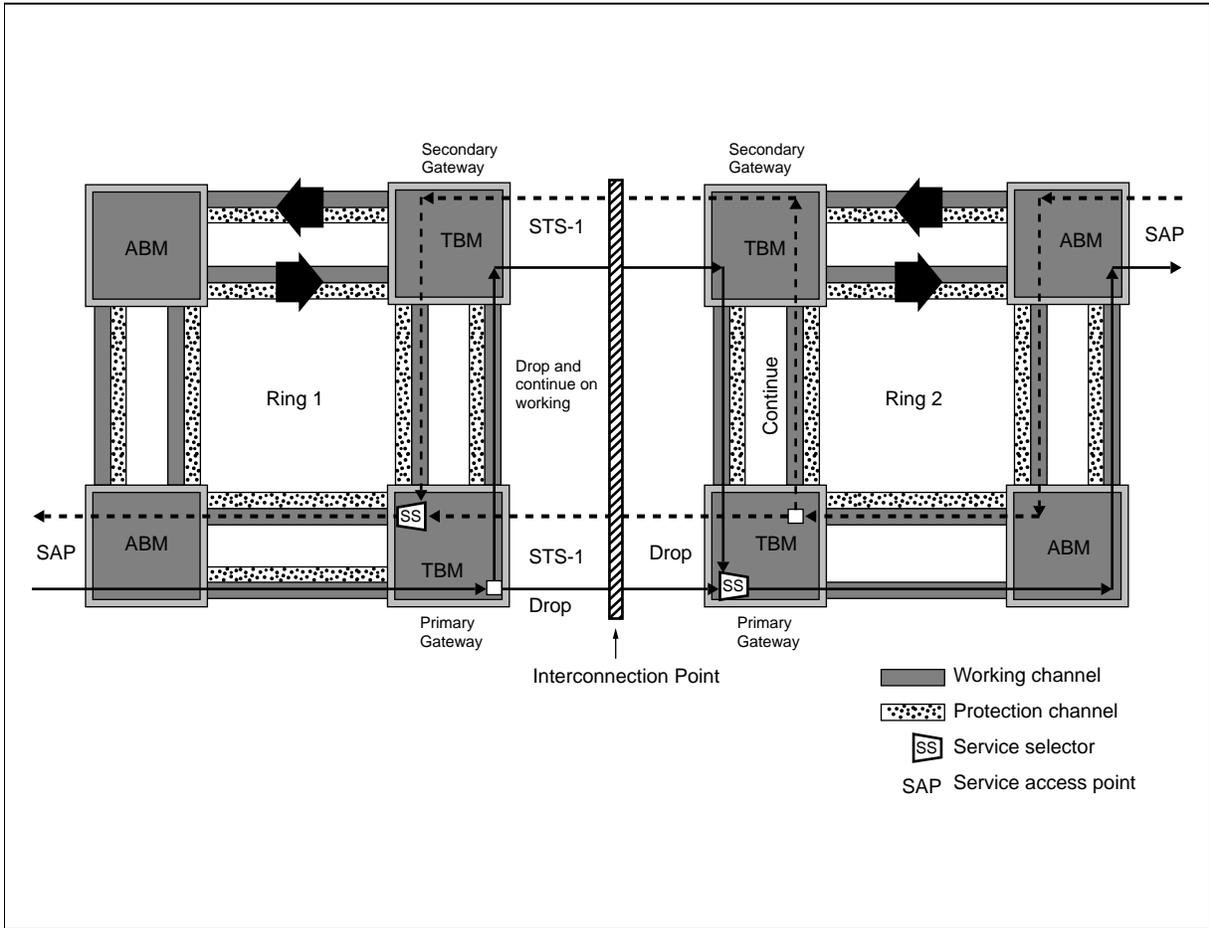
Figure 4-9
Signal flow in a DCW connection

Figure 4-10 illustrates drop and continue on working (DCW) in a matched nodes ring experiencing primary gateway failure.
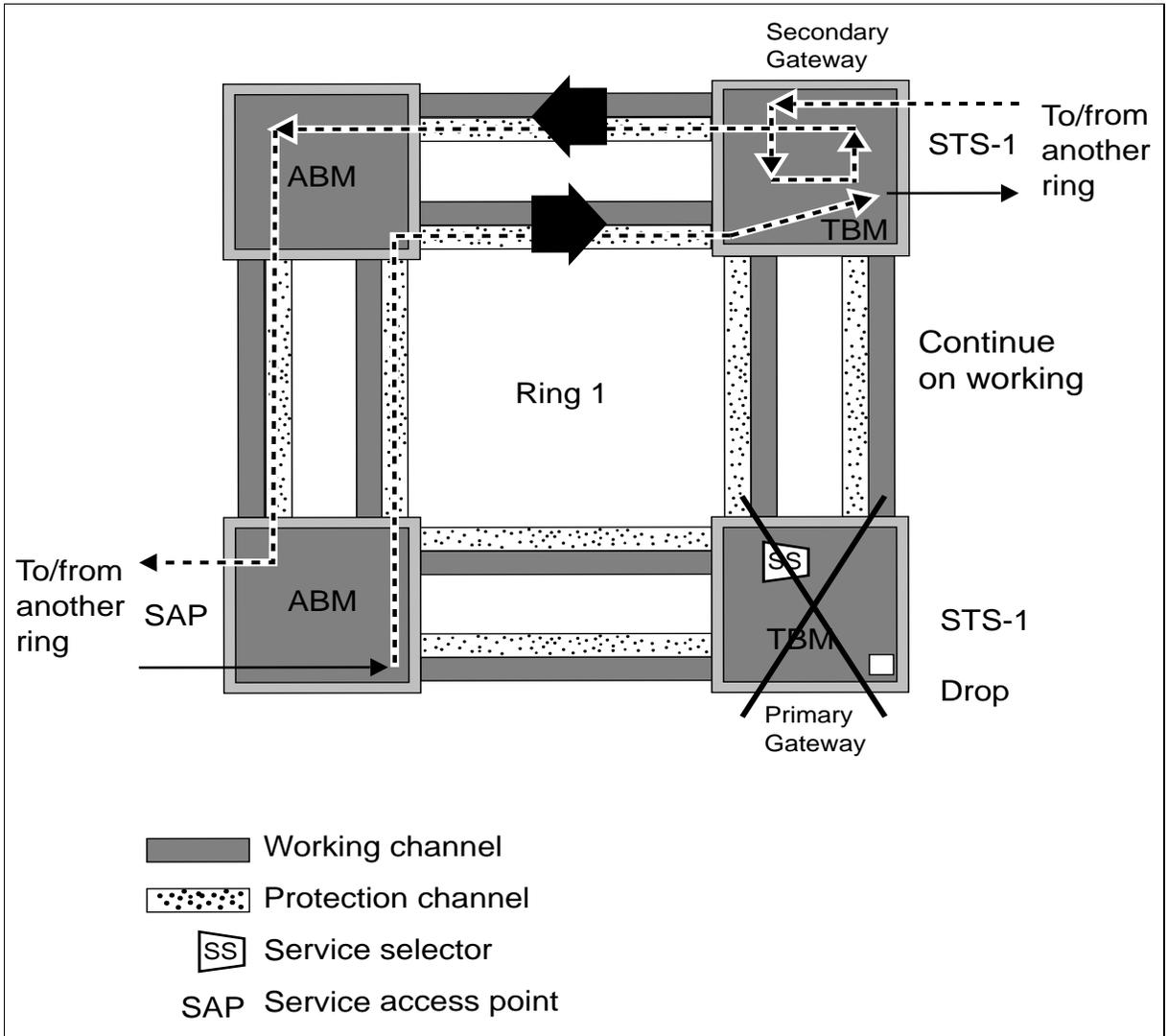
Figure 4-10
DCW-primary gateway node isolation

PC-16472

Secondary Gateway

ABM

STS-1

To/from another ring

TBM

Continue on working

Ring 1

To/from another ring

SAP

ABM

SS

STS-1

TBM

Drop

Primary Gateway

Working channel

Protection channel

SS Service selector

SAP Service access point

Figure 4-11 illustrates drop and continue on working (DCW) in a matched nodes ring experiencing ring fiber failure.

Figure 4-11
DCW-ring fiber failure/ring protection switch
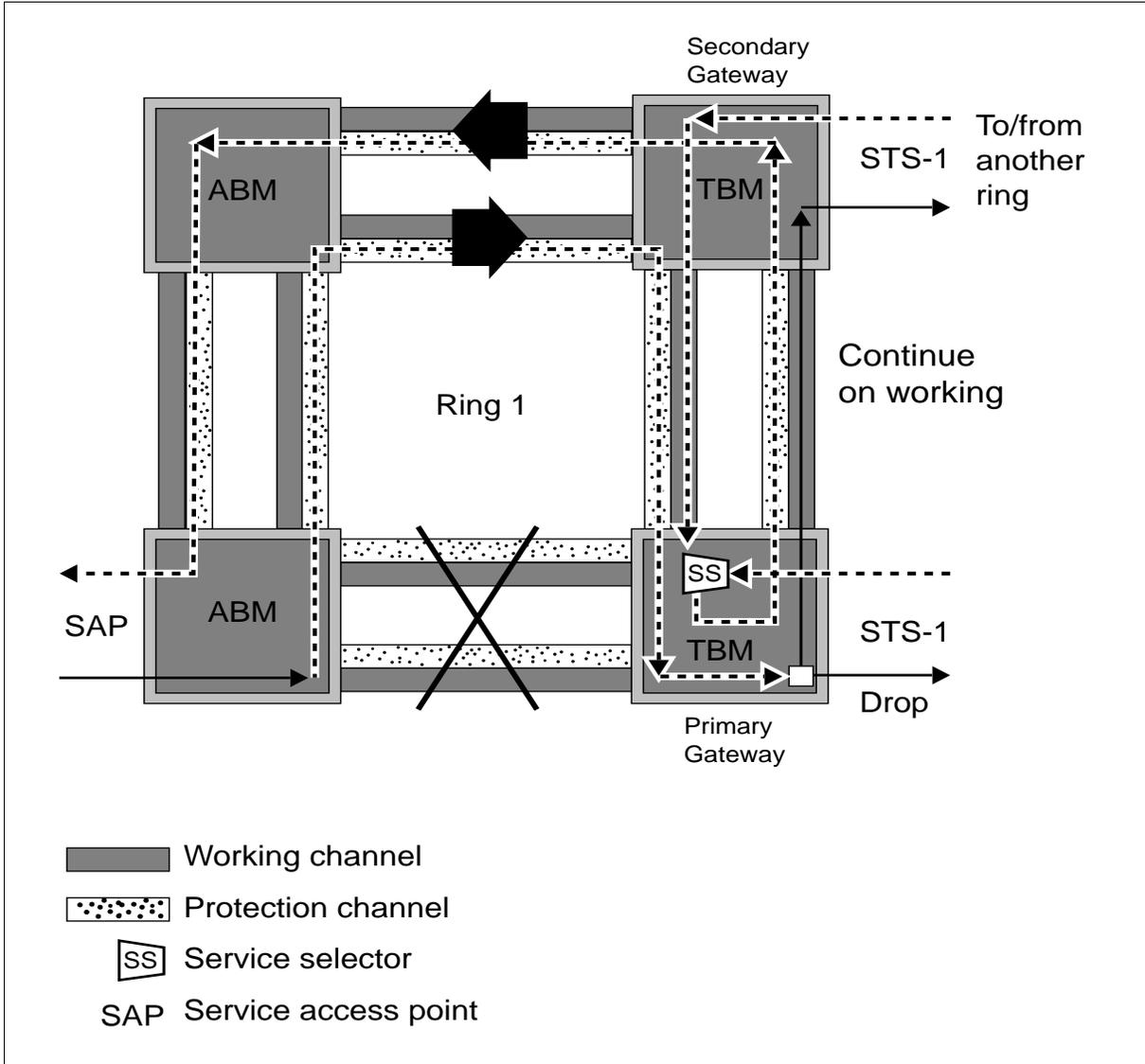
### Drop and continue on protection

The DCP protection method carries secondary traffic through the primary and secondary nodes using any of the protection channels (STS-1 numbers 7 to 12).

Using DCP, traffic at the primary gateway is dropped to the other ring while continuing to the secondary gateway on the protection channel. Therefore, the working bandwidth between the primary and secondary gateway nodes is

available for extra traffic (ET). If, however, a BLSR protection switch occurs, the matched nodes extra traffic on the protection channel is lost. Figure 4-12 shows the signal flow in a DCP connection.

Figure 4-12
Signal flow in a DCP connection

PC-16441
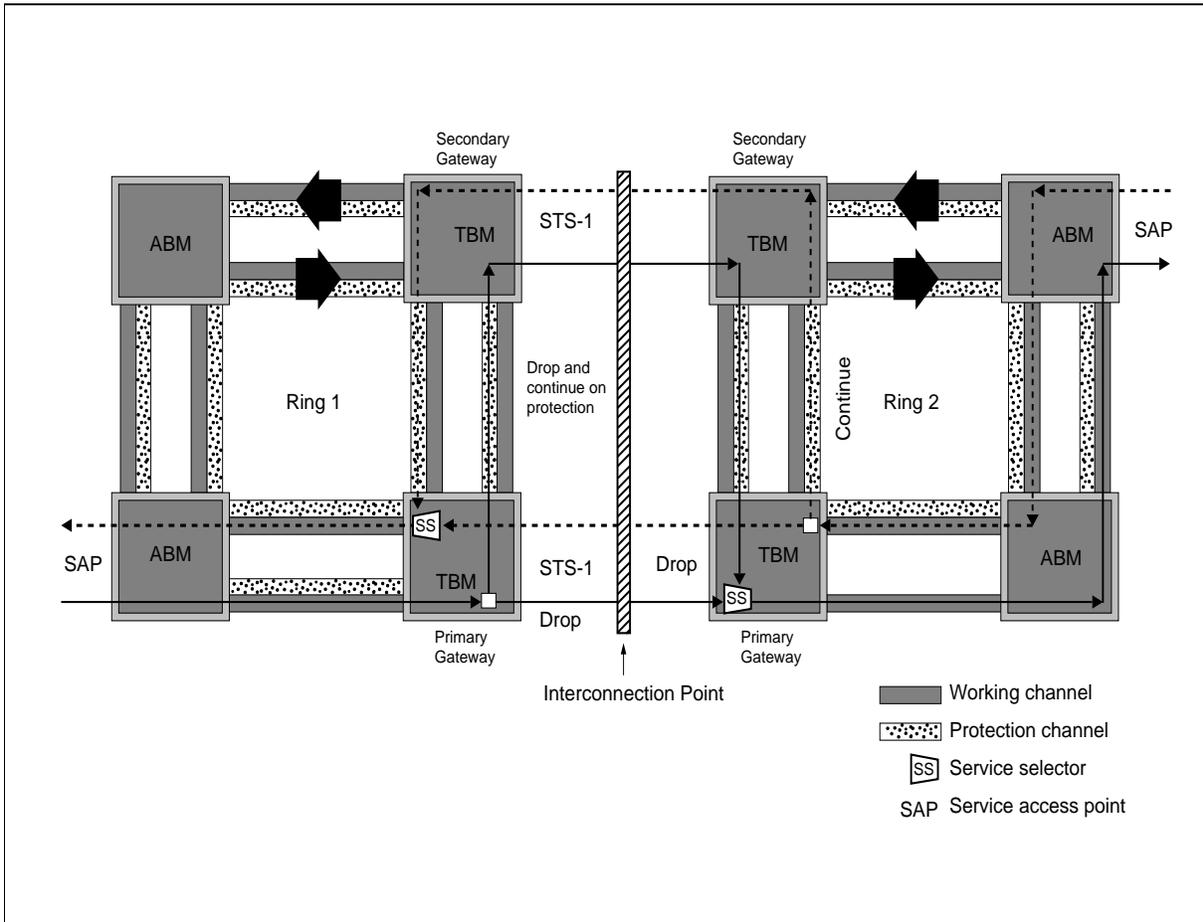
Limitations of DCP
DCP connections have the following limitations:

- Two DCP connections cannot cross over at a primary gateway because misconnection and loss of traffic can occur if the primary node fails. (On a primary gateway, only one DCP connection can correspond to any protection bandwidth channel. That is, only one optic side of the NE can have a DCP connection for any bandwidth allocation.)

- the SAP and secondary gateway cannot be on the same node.

Figure 4-13 illustrates drop and continue on protection (DCP) in a matched nodes ring experiencing a primary gateway failure.

Figure 4-13
DCP-primary gateway node isolation

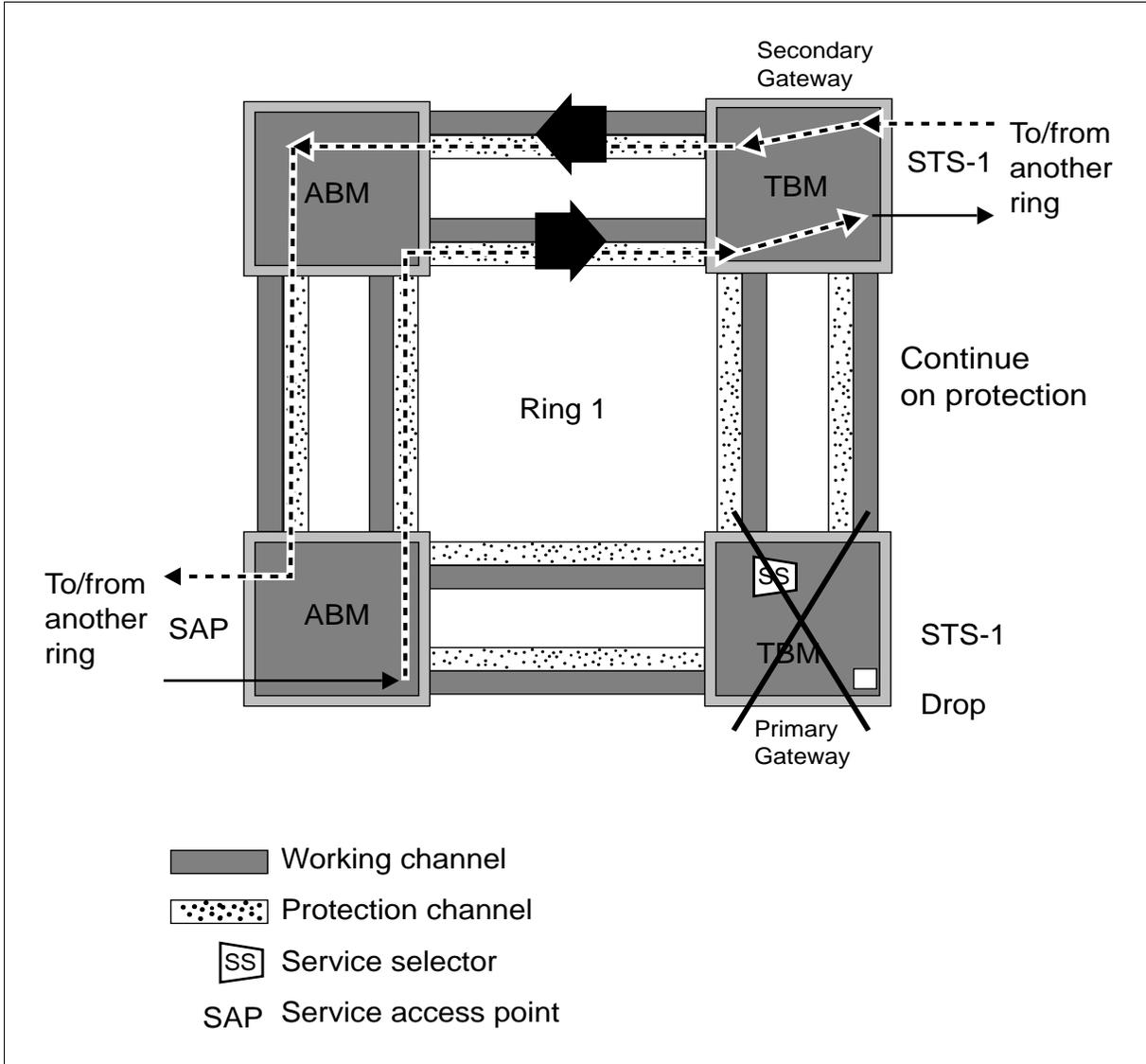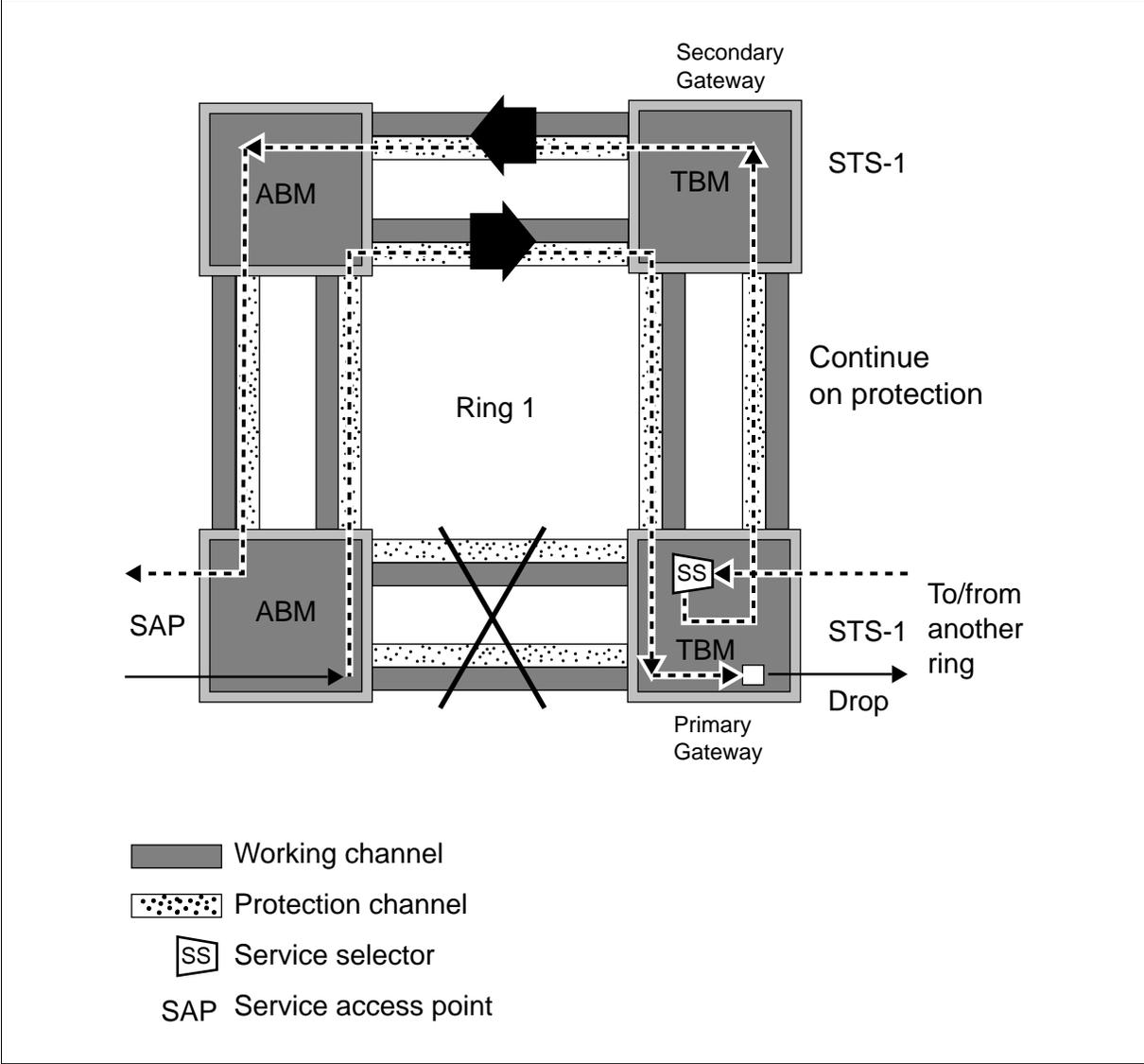PC-16473

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Figure 4-14 illustrates drop and continue on protection (DCP) in a matched nodes ring experiencing ring fiber failure.

Figure 4-14
DCP-ring fiber failure/ring protection switch

Automatic ring protection switching

Automatic ring protection switching occurs when a ring node detects a loss of transport signal, a transport equipment failure, or a signal degrade (where the bit error rate is greater than a provisioned threshold).

Protection-oscillation control

This feature was formerly called automatic lockout or autolockout. Protection-oscillation control prevents the equipment from switching repeatedly if recurring failures occur.

If the number of protection switches occurring within a certain time period (the oscillation period) exceeds a specified threshold (oscillations), then lockout is invoked automatically, and remains in effect for a specified length of time (the lockout period).

To view the values assigned to the parameters (oscillation period, oscillations, and lockout period), see the OC-12 Protection Provisioning screen in the network-element user interface. For details on how to access the screen, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Maintenance features for OC-12 VTBM circuit packs

The following sections describe the maintenance features for OC-12 VTBM circuit packs. You can invoke these features using commands in the "protection" option in the network-element user interface. For instructions on how to use the features, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Note: For information on the maintenance features for OC-12 and OC-3 interface circuit packs, see Chapter 3, "Protection for optical interface circuit packs".

Lockout

For OC-12 VTBM circuit packs, the lockout function overrides all other protection features, including automatic protection switching. Separate commands are provided for the lockout of the working channels and the lockout of the protection channels. The separate commands are required because each of the two fibers in the ring carries six working STS-1s (STS-1s one to six) and six protection STS-1s (STS-1s seven to twelve). The separate commands allow you to lock out the only the working STS-1s or only the protection STS-1s handled by an individual OC-12 VTBM circuit pack at any ring node.

Note 1: In a VTBM ring, when a lockout-of-protection command is operated on any span in the ring, all protection is locked out for the entire ring including the span that has the active lockout protection switch.

Note 2: If you issue the lockout-of-working command from the local network element user interface, you must explicitly enter it at both ADM nodes terminating the span. If the command is entered at only one end, a protection switch is still prevented on that span. However, if a protection switch is requested at the far end, a "Protection switch fail" alarm is raised. Entering the command at both ends prevents this alarm from being raised.

Note 3: Matched nodes do not support lockout.

Lockout of working command

When applied to an OC-12 VTBM circuit-pack group, the lockout-of-working command prevents the working traffic handled by that circuit pack from switching to its protection channel. The working traffic is in STS-1 time slots one to six handled by the OC-12 VTBM circuit pack. The protection channel is composed of STS-1 time slots seven to twelve.

If you want to enter a lockout-of-working command, you must be sure that the ring nodes at each end of the affected span receive notification of the command. If you enter the command in the OPC user interface, the operations controller notifies the two ring nodes.

If you enter the command in the network-element user interface, you must explicitly enter it at both ring nodes. When you enter the command at the first ring node, you receive a warning message indicating that you must also enter the command at the adjacent ring node. If you enter the command at only one ring node, that prevents a protection switch on the span. However, if a protection-switch request is issued at the far end, the system raises a protection-switch-failure alarm, and the protection switch remains pending.

Lockout of protection command

When applied to an OC-12 VTBM circuit-pack group, the lockout-of-protection command prevents traffic from using the protection channels handled by that circuit pack, specifically, STS-1s seven to twelve. If you apply the lockout-of-protection command to an OC-12 VTBM circuit pack at a time when a protection switch has already occurred, the command forces the protected traffic back to its normal channel, which is STS-1s one to six handled by the companion OC-12 VTBM circuit pack. The command forces the traffic back to the normal channel regardless of the condition of that channel.

If more than one lockout-of-protection is in effect in a ring, then the ring is locked and no traffic can be protected. If only one lockout-of-protection is in effect in the ring, the span that is locked is the only span in the ring whose working traffic is protected. All working traffic on all other spans is not protected.

Forced switching command

When applied to an OC-12 VTBM circuit-pack group, the forced-switch command forces the working traffic from the STS-1 time slots (time slots one to six) on the specified OC-12 VTBM circuit pack to the corresponding protection STS-1 time slots (time slots seven to twelve) on the companion OC-12 VTBM circuit pack.

If the forced-switch command is applied to circuit-pack group G1 (the circuit pack in slot nine), the working traffic from G1 is placed on the protection time slots of G2 (the circuit pack in slot ten). Because G1 and G2 handle traffic flowing in opposite directions, the protection switch has the effect of rerouting traffic. After the switch, the traffic that is normally handled by G1 travels around the ring in the direction that is opposite to its usual direction.

A forced-switch command overrides any existing protection switch except a lockout (of working or of protection) or an automatic protection switch caused by signal failure on the protection channel. Several forced switches can exist simultaneously in a ring; however, a forced-switch fails if a signal failure occurs in any part of the ring.

Note: Matched nodes support a forced switch.

Manual switching command

When applied to an OC-12 VTBM circuit-pack group, the manual-switch command does the same thing as the forced-switch command, but does so only if it takes effect. Unlike the forced-switch command, the manual-switch command takes effect only if no failures exist in the companion OC-12 VTBM circuit pack, and only if no failures exist in the protection channel. Furthermore, a manual switch does not override automatic protection, any other protection switch, or a lockout. If the manual-switch command takes effect, it forces the working traffic from the STS-1 time slots (time slots one to six) on the specified OC-12 VTBM circuit pack to the corresponding protection STS-1 time slots (time slots seven to twelve) on the companion OC-12 VTBM circuit pack.

If the manual-switch command is applied to circuit-pack group G1 (the circuit pack in slot nine), the working traffic from G1 is placed on the protection time slots of G2 (the circuit pack in slot ten). Because G1 and G2 handle traffic flowing in opposite directions, the protection switch has the effect of rerouting traffic. After the switch, the traffic that is normally handled by G1 travels around the ring in the direction that is opposite to its usual direction.

At any given time, only one manual-switch is allowed in a ring. If a manual switch is in effect, any additional manual-switch request is denied. Before a second manual switch can take effect, the first one must be released.

Protection switching between the OC-12 VTBM circuit packs is revertive; therefore, you must issue a release-manual-switch command.

Note: Matched nodes do not support manual switching.

Wait-to-restore

In an AccessNode ring, the wait-to-restore feature applies to the ring protection switching that is performed by the OC-12 VTBM circuit packs. The wait-to-restore period begins when all signal failures in the ring are cleared. The processor card then monitors the OC-12 line for the duration of the wait-to-restore period. The wait-to-restore period is user-provisionable in the range 5 minutes to 12 minutes, the default being 5 minutes. After the wait-to-restore period passes, traffic is routed back to its normal channels.

Note: For non-matched nodes connections, a craftsperson can bypass the wait-to-restore period by operating and releasing a manual or forced switch. However, for matched nodes connections, the auto-protection switching is revertive and has a wait-to-restore period of 5 minutes. This 5-minute period is fixed and is not user-provisionable.

Exerciser

When applied to an OC-12 VTBM circuit-pack group, the exercise command exercises ring protection switching of the working traffic handled by that circuit pack, without completing the actual bridge and switch. The command is issued and the responses are checked, but no working traffic is affected. This command has the lowest priority and can run only when there is no ring protection-switching activity.

In a VTBM ring, the exerciser cannot establish the bridge between the working and protection circuit packs. The exerciser is used only to test the K-Byte signaling around the ring. This test can still be performed with matched node connections. Matched nodes have no noticeable effect on the exerciser functionality.

Hierarchy of protection features for OC-12 VTBM circuit packs

Table 4-1 shows the protection-switching features that apply to OC-12 VTBM circuit packs. OC-12 VTBM circuit packs are used as the interfaces to the fiber optic feeder in FCOTs and RFTs in fiber-fed systems with ring topology. Table 4-1 indicates how each protection-switching feature can be activated, whether automatically, or by the user.

Table 4-1
Hierarchy of protection-switching features for OC-12 VTBM circuit packs

| Feature
(in order of priority)	Control
Lockout of protection	User
Lockout of working	User
Automatic switching due to signal failure in the opposite direction (clockwise or counterclockwise, whichever is not handled by the circuit pack)	Automatic
Forced switching	User
Automatic switching due to signal failure in this direction (clockwise or counterclockwise, whichever is handled by the circuit pack)	Automatic
Automatic switching due to signal degradation	Automatic
Manual switching	User
Wait-to-restore	Automatic
Exerciser	User

Protection for DS1, DS3, and STS-1 interfaces

This chapter describes the protection switching scheme for DS1, DS3, and STS-1 interfaces.

Chapter contents

The following table lists the topics discussed in this chapter.

Topic	See
Protection for DS1 mappers	page 5-1
Protection for DS3 and STS-1 interfaces	page 5-4
Time required to complete a switching operation	page 5-6
Automatic protection switching for DS1, DS3, and STS-1 mappers	page 5-6
Maintenance features for DS1, DS3, and STS-1 interfaces	page 5-6
Hierarchy of protection features for DS1, DS3, and STS-1 interfaces	page 5-8

Protection for DS1 mappers

For DS1 mappers in FCOTs, protection switching is standard and is supported by the core software. For DS1 mappers in RFTs, protection switching is optional and is supported by the optional software feature package titled DS1 protection switching.

To protect the DS1 mappers in an access or transport bandwidth manager shelf, the shelf must contain a dedicated protection mapper and two DS1 protection bridge cards.

Refer to Chapter 2, Protection architecture for examples of shelf layouts. For complete equipping rules for DS1 mappers, refer to *Mapper Layouts Planning Guide*, 323-3001-154, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

Note: If the processor cards in the common-equipment shelf do an activity switch, protection switching for DS1 and DS3 mappers becomes unavailable while the activity switch occurs. Protection switching becomes available once again when the activity switch has been completed.

The protection mapper must be capable of handling all types of traffic handled by the working mappers. Therefore, if any one of the working mappers handles TR-08 traffic, the protection mapper must also be capable of handling such traffic. The model that handles TR-08 traffic is identified in *Engineering and Ordering Information*, 323-3001-032, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

Protection for the working DS1 mappers is unavailable if the protection mapper fails.

Software supporting DS1 protection switching

If you want to protect mappers in an RFT, you must also purchase the optional software feature package titled DS1 protection switching. Core software supports protection switching for the DS1 mappers in the FCOT.

Protection switching for DS1 mappers

Each working DS1 mapper is linked to two cards in the upper level of the common-equipment shelf: a DS1 input card and a DS1 output card. DS1 signals between the DSX-1 cross-connect and a working DS1 mapper are routed through these cards. A DS1 input card can handle up to 14 DS1s coming into the AccessNode, and a DS1 output card can handle up to 14 DS1s leaving the AccessNode.

All DS1 input cards and DS1 output cards are connected to the DS1 protection bus, which is located in the shelf backplane. The connections to the bus are through on-card relays. The DS1 protection bridge cards connect the DS1 protection bus to the protection DS1 mapper, as shown in Figure 5-1. In normal operation, traffic does not flow into the DS1 protection bus because the relays on the DS1 input cards and on the DS1 output cards are open. If a protection-switching request occurs for a DS1 mapper, the relays on the associated DS1 input card and DS1 output card close, thus routing the traffic through the protection bus to the protection mapper.

Figure 5-1
DS1 traffic before and after protection switching (logical representation)
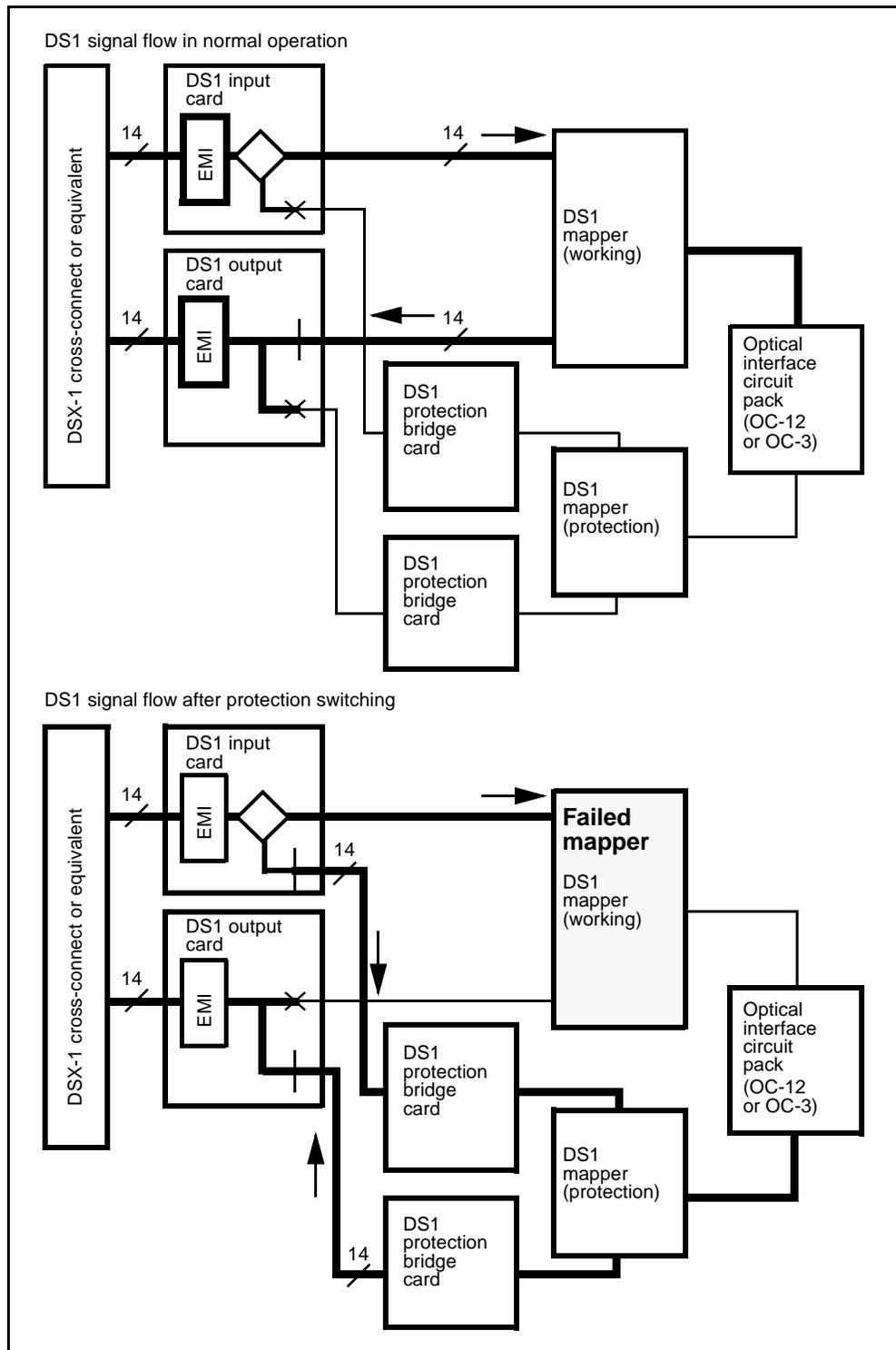
Protection for DS3 and STS-1 interfaces

Protection for both types of mappers is the revertive 1:n type, where one protection mapper protects one or more working mappers.

Refer to Chapter 2, Protection architecture for examples of shelf layouts. Also, for complete equipping rules for DS3 mappers, refer to the *Mapper Layouts Planning Guide*, 323-3001-154, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

> *Note:* If the processor cards in the common-equipment shelf do an activity switch, protection switching for DS1, DS3, and STS-1 interfaces becomes unavailable while the activity switch occurs. Protection switching becomes available once again when the activity switch has been completed.

If you want to protect mappers, then you must install a dedicated protection mapper in the shelf, and you must install a DS3/STS-1 protection switch card. Protection for the working DS3 and STS mappers is unavailable if the protection mapper fails or if the DS3 protection switch card fails.

Protection switching for DS3 mappers

Each working DS3 mapper is linked to three BNC I/O cards in the upper level of the shelf. Each BNC I/O card handles both directions of one DS3 line: one DS3 coming into the AccessNode, and one DS3 going out.

Each BNC I/O card has connections to the associated working DS3 mapper in the lower level of the shelf. Each card also has connections to the DS3 protection switch card, which then connects to the protection mapper.

On the DS3 protection switch card, there are receiving-direction relays and transmitting-direction relays. The relays on the DS3 protection switch card are normally open, so that the I/O cards are not connected to a protection mapper. In the event of a protection-switching request, the appropriate relays on the DS3 protection switch card close, completing the connections to the protection DS3 mapper.

Figure 5-2 illustrates protection switching for DS3s. The figure shows the flow of three DS3s, in normal conditions, and after protection switching. The figure includes the details of the signal flow through an individual BNC I/O card in normal conditions and after protection switching.

Figure 5-2
DS3 traffic in normal conditions and after protection switching
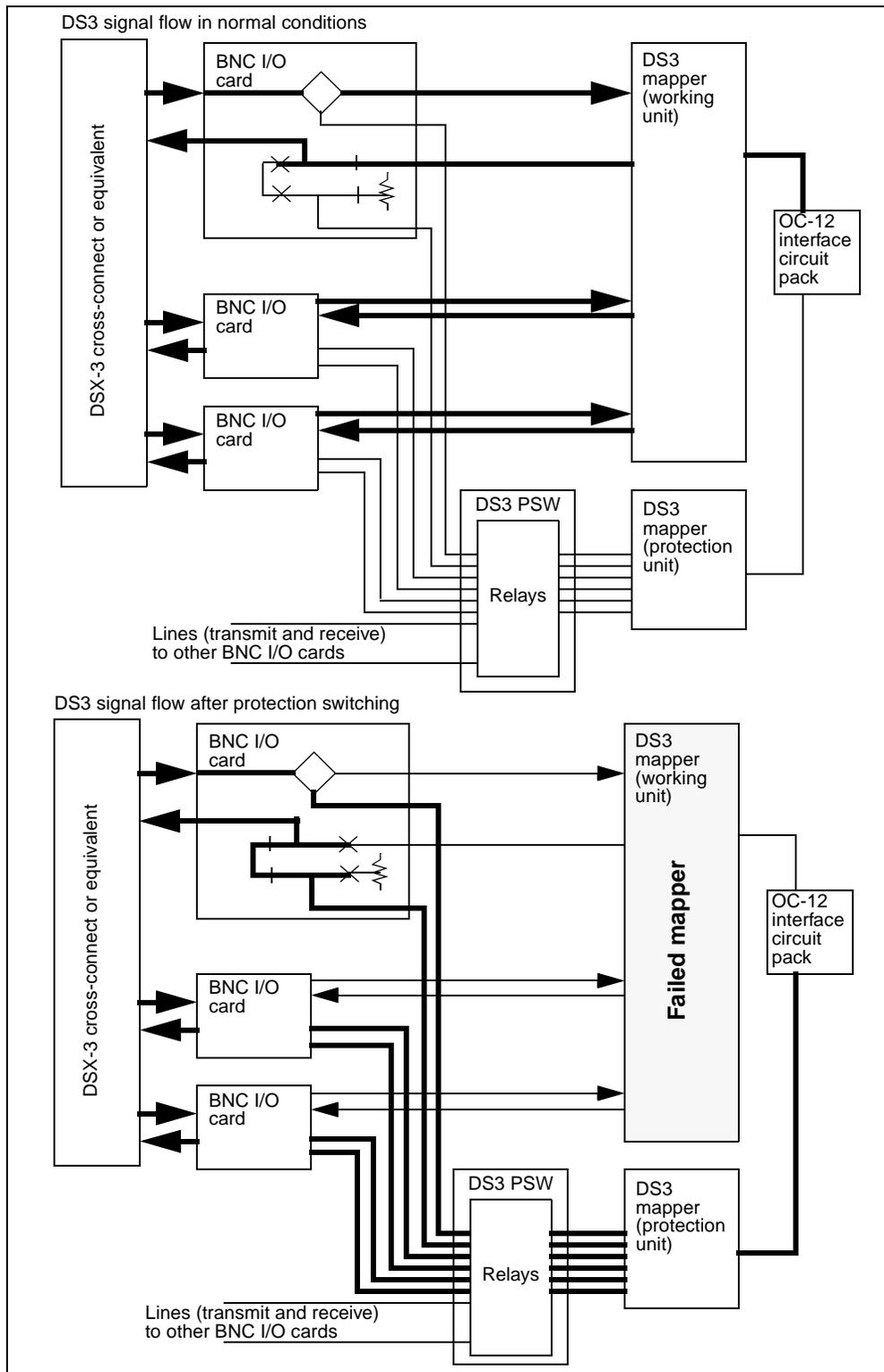
Time required to complete a switching operation

The protection-switching times comply with the Bellcore TA-TSY-000253 specification of 10 ms or less to detect the fault, and 50 ms or less from detection to completion of the switching. In case of the failure of a single DS3 mapper, the time from the occurrence of the failure to the completion of the switching is 60 ms or less.

Automatic protection switching for DS1, DS3, and STS-1 mappers

The system automatically initiates protection switching for mappers if it detects one of the following events:

- a circuit-pack failure in a mapper

- an interruption of service at the VT level

- an interruption of service at the STS level

   Note: The system analyzes every failure to determine its origin, and initiates switching only if appropriate. For example, if a bad facility causes a high bit-error rate on a line, protection switching does not occur.

Maintenance features for DS1, DS3, and STS-1 interfaces

The following sections describe the maintenance features for DS1, DS3, and STS-1 interfaces. You can invoke these features using commands in the "protection" option in the network-element user interface. For instructions on how to invoke the features, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Lockout command

The lockout command excludes a mapper from protection switching. The lockout command overrides all other protection features including automatic protection switching.

If you lock out a working mapper, the protection unit cannot take over for it. You can lock out any number of the working units simultaneously. Locking out the backup unit prevents it from protecting any mapper.

Forced-switching command

The forced-switching command is an unconditional command. It explicitly forces the protection unit to take over the functions of the specified working unit. The forced-switching command unconditionally overrides other protection switching, including automatic protection switching. It does not override a lockout. If the protection unit has automatically taken over the functions of another unit that has failed, a forced-switching request overrides that automatic switching. Forced switching proceeds regardless of the state of the protection unit. The forced-switching command can be used on any protected circuit pack.

Manual-switching command

The manual-switching command is a conditional command. It requests the protection unit to take over the functions of the specified working unit, provided that the protection unit is fully operational. The manual-switching command can be used on any protected circuit pack.

The manual-switching command does not override automatic protection switching. Therefore, if you use the manual-switching command at a time when the protection unit is busy doing the work of another unit that has failed, the manual switching does not proceed.

Priority-select command

A protection unit can take over the functions of only one failed unit at a time. If one protection unit backs up multiple working units, a conflict (contention) occurs if two or more units are in the failed state at the same time. To resolve such contention, you can use the priority-select command to assign priority levels to circuit packs. When contention occurs, the protection unit takes over the function of the failed unit that has the highest priority level.

There are two priority levels: low (the default level) and high. A request for automatic protection switching on behalf of a high-priority circuit pack overrides a request for automatic protection switching on behalf of a low-priority circuit pack.

In cases of contending requests for protection switching from multiple circuit packs that have the same priority level, the requests are dealt with on a first come, first served basis.

You should ensure that high-priority channels are handled by a mapper whose priority level is set to high. For information on how to assign priority levels, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

> *Note:* Regardless of the priority levels involved, forced switching overrides automatic protection switching. If the system has automatically protected a high-priority unit, you can still order forced switching to protect a low-priority unit.

Wait-to-restore period

The wait-to-restore period occurs after you replace a failed unit.

If you replace the failed unit, the newly installed unit does not immediately take over from the protection unit. Instead, the processor card monitors the newly installed circuit pack for a certain period, to ensure that it is functional. This period is the wait-to-restore period. (In an access bandwidth manager shelf or a transport bandwidth manager shelf, the wait-to-restore period is user-provisionable to either 200 s or 300 s.)

If the new unit performs properly during the wait-to-restore period, then at the end of that period, the new unit takes over from the protection unit, and the protection unit resumes its standby role.

Note: If there is a pending request for protection switching, that request overrides the wait-to-restore period. (Refer to Table 5-1.) In that case the wait to restore does not occur.

Hierarchy of protection features for DS1, DS3, and STS-1 interfaces

Table 5-1 lists the protection-switching features that apply to protected DS1, DS3, and STS-1 interfaces. Table 5-1 indicates how each feature can be activated, whether automatically, or by the user, or both.

Table 5-1
Hierarchy of protection-switching features for DS1, DS3, and STS-1 interfaces

Feature	Priority level	Source of control	
		User	Automatic
Lockout	Highest	X	
Forced switching		X	
High priority			
Low priority			
Automatic switching			X
High priority			
Low priority			
Manual switching		X	
High priority			
Low priority			
Wait to restore	Lowest		X

Protection for processor cards, ESI cards, and TXC cards

This chapter explains protection switching for processor cards, external synchronization interface (ESI) cards, and timing and cross-connect (TXC) cards (for DS1-fed AccessNode systems).

Chapter contents

The following table lists the topics discussed in this chapter.

Topic	See
Protection switching for the processor card	page 6-1
Protection switching for ESI cards	page 6-2
Protection switching for timing and cross-connect cards	page 6-4

Protection switching for the processor card

For all ABM and TBM shelf functions except for the TN_BLSR TBM shelf function, you can (but do not have to) install a second processor card for protection. The TBM TN_BLSR shelf only supports one processor so you cannot install a protection card.

If two processor cards are installed in a shelf, they do nonrevertive (1+1) protection switching. During normal operation, the active processor card performs all call-processing, communication, and control functions. The other processor card is a standby, ready to take over if the active processor card fails.

Only one processor card can be active at any time. The standby unit cannot seize control from the active unit. Protection switching occurs only when the active processor card relinquishes its active status.

Protection switching between processor cards can be initiated either automatically or by you as follows:

- Automatic protection switching occurs when the active processor card is removed, or when a serious fault occurs.

- User-controlled protection switching is initiated by means of the switch command.

After a protection switch occurs, you must wait seven minutes before performing another protection switch on the same two processor cards.

You can also invoke the exerciser. The exerciser runs out-of-service diagnostics on the inactive processor card and simulates protection switching just up to the point of completion but does not actually complete the operation.

The commands for invoking these features are accessed under the "equipment" option in the network-element user interface. For information on how to invoke these features, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Protection switching for ESI cards

The external synchronization carrier (ESC) houses two external synchronization interface cards (ESI cards) that protect each other. The two ESI cards perform 1+1 protection switching. At any time, one of the ESI cards is the working unit, the other, the protection unit.

The ESI card receives timing reference signals from an external reference timing source such as a building integrated timing source (BITS) and provides a stable reference frequency of 51.84 Mhz to the optical interface circuit packs. The AccessNode derives its system clock from this reference frequency, and synchronizes all data transmission to this reference. This synchronization makes it possible to integrate AccessNode into a synchronous network.

Initiating ESI protection switching
Protection switching between the ESI cards can be initiated either automatically or by you.

Automatic protection switching
Automatic protection switching is initiated in case of a failure of an ESI card.

Note: If both ESI cards fail, the AccessNode uses the system clock generator on the optical interface circuit pack.

User-initiated protection switching

User-controlled protection switching is initiated by means of commands accessed under the "equipment" option in the network-element user interface. You can invoke the following switching features:

• forced switching

• manual switching

Hierarchy of protection features for ESI cards

Table 6-1 lists the protection-switching features that apply to ESI cards. Table 6-1 indicates how each feature can be activated, whether automatically, or by you, or both.

Table 6-1
Hierarchy of protection-switching features for ESI cards

Feature	Priority level	Source of control	
		User	Automatic
Forced switching		X	
Automatic switching			X
Manual switching	Lowest	X	

For information on how to invoke the switching features for the ESI cards, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Automatic protection switching between timing-reference signals

Each ESI card can accept two external timing reference sources. If one timing reference signal fails, the ESI card switches to the other timing reference. The protection switching is 1+1, that is, nonrevertive.

An ESI card can accept the following types of external reference sources:

• a DS1 timing reference from the BITS

• an 8/64 kHz composite clock from the BITS

The ESI card initiates automatic protection switching from one reference signal to the other in the following cases:

• if the incoming DS1 timing signal from the BITS carries an alarm indication signal (AIS)

• in case of the failure of the incoming DS1 timing signal from the BITS

Note: If both timing-reference signals fail, or the system is forced to a failed timing-reference signal, then the working ESI card enters holdover mode (in which it meets Stratum-3 stability requirements).

Protection switching for timing and cross-connect cards

Timing and cross-connect (TXC) cards are used in the RFTs in a DS1-fed AccessNode system. They are also used in the OPC shelf in such a system, if connectivity between the operations controller and the RFTs is to be by way of OMC DS1s. The TXC cards install in slots 9 and 10, in place of optical interface cards.

This card performs two main functions in a DS1-fed RFT. The timing function is to derive timing from a DS1 connected to the central-office equipment. This timing makes it possible to synchronize the copper-fed RFT. The cross-connect function provides connections between the DS1/VT mappers and the transport interface card in the access bandwidth manager shelf.

> *Note:* ESI cards are not used in DS1-fed systems because the TXC cards perform the synchronization in such systems.

You can choose to install either one or two timing and cross-connect cards. If you install two cards, they provide 1+1 protection switching.

Initiating TXC protection switching

Protection switching between the timing and cross-connect cards can be initiated either automatically or by you.

Automatic protection switching

Automatic protection switching is initiated in case of a failure of a timing and cross-connect card.

User-initiated protection switching

User-controlled protection switching is initiated by means of commands accessed under the "equipment" option in the network-element user interface. You can invoke the following switching features:

- forced switching
- manual switching
- lockout

> *Note:* If you enter the lockout command against a TXC card when the active TXC card is the G2 unit (the unit in slot 10), the lockout command does *not* force traffic to the G1 unit (in slot 9). This is contrary to what happens when there are optical interface circuit (OC-12 or OC-3) packs in slots 9 and 10, in which case a lockout forces traffic to the G1 unit.

Hierarchy of protection features for timing and cross-connect cards

Table 6-2 shows the protection-switching features that apply to timing and cross-connect cards. Table 6-2 indicates how each feature can be activated, whether automatically, or by you, or both.

Table 6-2
Hierarchy of protection-switching features for timing and cross-connect cards

Feature	Priority level	Source of control User	Automatic
Lockout	Highest	X	X
Forced switching		X	
Automatic switching			X
Manual switching	Lowest	X	

For information on how to invoke the protection-switching features for the timing and cross-connect cards, see *Protection Switching Procedures*, 323-3001-311, in *Operations, Administration, and Provisioning*, Volume 4B.

Automatic protection switching between timing-reference signals

Each timing and reference card can accept two external timing reference signals, which are referred to as the primary and secondary timing references. If one timing reference fails, the TXC card switches to the other timing reference. The protection switching is 1+1, that is, nonrevertive.

Note: If both timing-reference signals fail, or if the system is forced to a failed timing-reference signal, then the active TXC card enters holdover mode. In holdover mode it meets Stratum-3 stability requirements.

Primary and secondary timing references for the DS1-fed RFT

The timing and cross-connect card derives its timing source from a DS1 connected to the central-office equipment, that is, to a digital switch. You can provision two DS1s as the primary and secondary timing references. Each timing reference must be handled by a working DS1/VT mapper card in the network element. (You cannot designate a DS1 on the protection mapper as a timing reference.) The primary and secondary timing references must be provisioned on separate mappers. Each of the timing references can be a traffic-carrying DS1.

BITS timing for a DS1-fed RFT

Although there are no BITS inputs to the timing and cross-connect card, you can use a BITS clock to synchronize a DS1-fed RFT. If the BITS is connected to the digital switch, a DS1 can carry the BITS signal to a DS1/VT mapper in the DS1-fed RFT. You can provision that DS1as the primary timing reference.

Protection for traffic to and from line cards in copper-distribution shelves

This chapter explains AccessNode's protection for line card traffic in copper-distribution shelves.

Chapter contents

The following table lists the topics discussed in this chapter.

Topic	See
Dual switching planes	page 7-1

Dual switching planes

If an AccessNode contains one or more copper-distribution shelves, then it also contains an access bandwidth manager shelf that handles the traffic to and from the copper-distribution shelves. Traffic flows between the copper-distribution drawers in the copper-distribution shelves and the optical interface circuit packs in the access bandwidth manager shelf.

To carry that traffic, there are two paths. The two paths are referred to as dual switching planes: plane A and plane B.

Figure 7-1 shows the modules in the dual switching planes in an AccessNode.

Figure 7-1
Dual switching planes
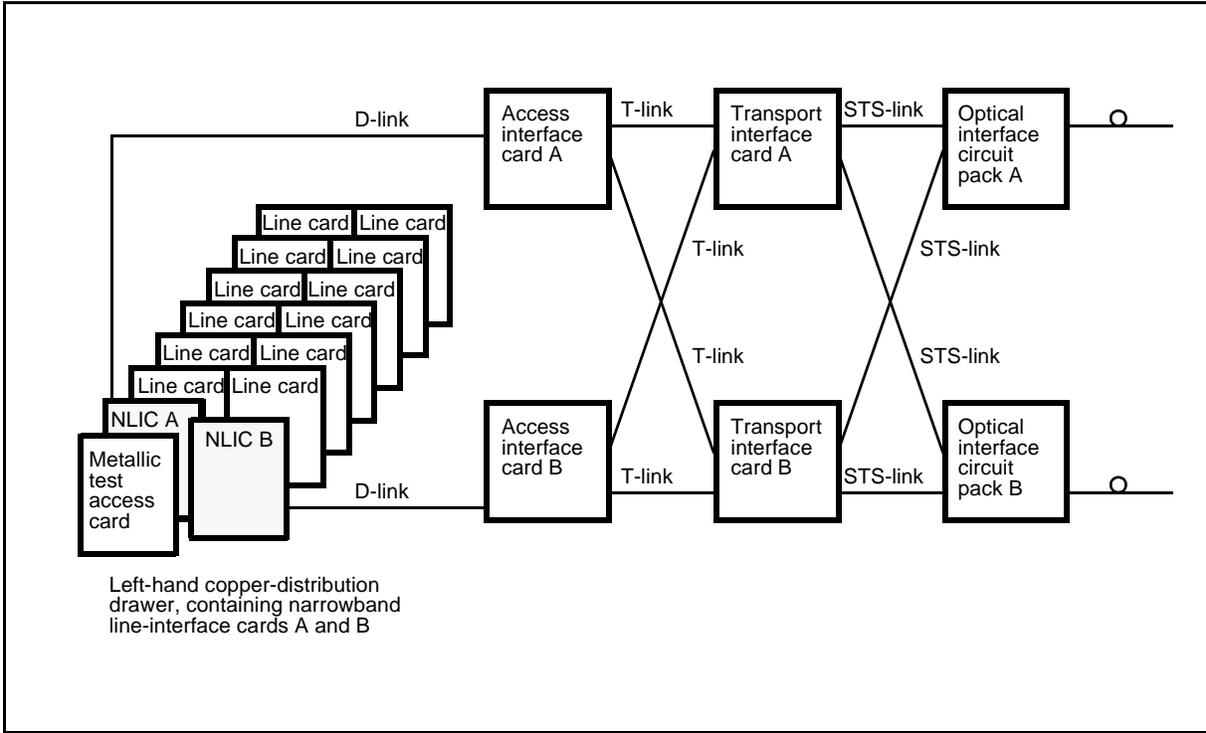
As shown in Figure 7-1, each copper-distribution drawer contains two narrowband line-interface cards (NLICs). At any time, one or the other of the NLICs may be the active unit. The NLIC on the left side of the drawer midplane (NLIC A in the left-hand drawer, NLIC C in the right-hand drawer) is connected to switching plane A; the NLIC on the right side of the drawer midplane (NLIC B in the left-hand drawer, NLIC D in the right-hand drawer) is connected to switching plane B.

Note: There is no protection switching for the access interface cards. Both access interface cards are active, because at any given time, there may be traffic in either or both of the switching planes. Some of the copper-distribution drawers may be using switching plane A, and others may be using switching plane B. Traffic to and from a copper-distribution drawer uses the switching plane to which the active NLIC is connected.

Protection switching from one NLIC to the other is initiated automatically by the hardware or software when a failure is detected.

In addition, the user can initiate switching from one transport interface card to the other.

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SONET Products

AccessNode

Protection Switching Description

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