

NT4K00LA

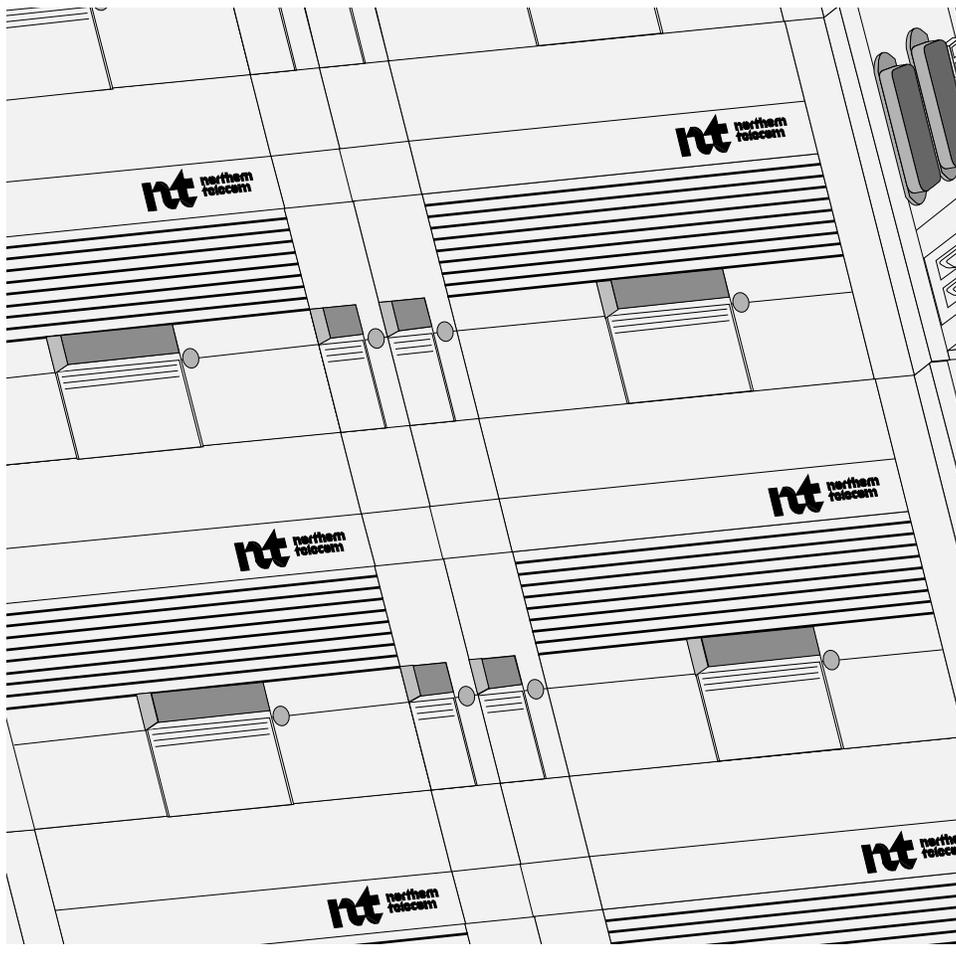
323-3001-100

SONET Products

AccessNode

Configuration and Equipment Description

Issue 3.0 October 1999



NORTEL
NETWORKS™

SONET Products

AccessNode

Configuration and Equipment Description

Publication number: 323-3001-100

Document release: Issue 3.0

Date: October 1999

Copyright © 1993–1999 Nortel Networks, All Rights Reserved.

Printed in Canada

All information contained in this document is subject to change without notice. Nortel Networks reserves the right to make changes to equipment design or program components, as progress in engineering, manufacturing methods, or other circumstances may warrant.

ACCESSNODE, NORTEL, NORTEL NETWORKS, and SUPERNODE are trademarks of Nortel Networks Corporation. SLC-96 is a trademark of American Telephone & Telegraph Company. X Window System is a trademark of the Massachusetts Institute of Technology. UNIX is a trademark licensed exclusively through X/Open Company Ltd.

Publication history

October 1999

AN17.20 Standard release of the document, Issue 3.0. Changes include the following:

- Added references throughout the document to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.
- Added description of D4 channel bank interface.

June 1999

AN17 Standard release of the document, Issue 2.0. Added information about the GR-303 MVI to Chapter 2.

February 1999

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

- added information about the matched nodes feature to Chapter 3 and Chapter 7
- added information about the ring orderwire (MIC firmware) to Chapter 9
- added information about the new single test head version of IRTU to Chapter 8
- added information about the cooling unit CR to Chapter 6 and Chapter 7
- updated Chapters 6, 7, and 8 with information about the BA BIP and the new card and connector layout

June 1998

AN15 Standard 01.01 release of the document. For this release, changes and additions regarding DMS Direct Connect and DMS Access have been added.

September 1997

AN14 Standard 01.01 release of the document.

May 1997

AN14 Issue 3.0 release of the document.

April 1997

AN12.21 Standard 01.01 release of the document to cover the AN12.21 release. For this release, synchronization changes to Chapter 11 have been added.

July 1996

AN12 Standard 01.01 release of the document. For this release, the following material was added to this document:

- Chapter 10, “Interfaces to AccessNode”
- Chapter 11, “Synchronization”
- Appendix A, “SONET Overview”
- information about the OC-12 virtual tributary bandwidth management (VTBM) circuit pack
- information about VTBM
- information about the VTM ring topology
- information about the new through-flow cooling unit
- information on the new FST-in-a-bay configuration
- additional Modular Business Package configurations
- information about synchronization-status messaging

November 1995

AN11 Standard 02.01 release of the document. This version includes AN11 feature set description, Full Services Terminal (FST) application description, and OC-3 tributary application description.

May 1995

An updated AN10 Standard version of the document in hard copy form. 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 ESI card was changed on page 7-7. 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 7. (The other parts of the document continued to bear the date April 1995.)

April 1995

AN10 Standard release of the document. For this release, the following material was added to this document:

- description of DS1-fed AccessNode
- description of single-ended AccessNode

December 1994

AN08 Standard release of the document. The following material was added:

- a description of the TR08 interface supported by AccessNode
- mentions of the new software (core and optional) available for AN08

November 1994

Reissue of the AN07 Standard release of the document.

April 1994

AN07 Standard release of the document. For this release, the following material was added to this document:

- descriptions of cards and cables for DS3 traffic and OC-3 traffic
- description of serial I/O cards
- description of multihosting (multiple digital hosts)
- description of new line cards:
 - manual ringdown 2-wire line card
 - universal voice grade station line card
 - Epsilon station line card
- mention of new core and optional software

May 1993

FWP06 Standard release of the document.

Contents

About this document	xv
Audience	xv
How to use this document	xv
References in this document	xvi
<hr/>	
Overview of AccessNode equipment	1-1
Chapter contents	1-1
Important terms	1-2
Application	1-2
Cluster	1-2
Configuration	1-2
Cserver	1-3
FCOT	1-3
Multihosting	1-3
Network element	1-4
OPC	1-4
OPC shelf	1-5
RFT	1-5
System	1-5
Topics of subsequent chapters	1-6
<hr/>	
Types of AccessNode systems	2-1
Chapter contents	2-1
What is AccessNode?	2-2
Packaging options	2-2
AccessNode system types	2-2
Point-to-point or virtual tributary bandwidth manager ring fiber-fed systems	2-3
Network elements in the system	2-4
Essential characteristic of a fiber-fed system	2-5
Traffic supported by a fiber-fed AccessNode	2-5
Operations controller for a fiber-fed system	2-5
Application for fiber-fed systems	2-6
DS1-fed AccessNode system	2-6
Essential characteristics of a DS1-fed system	2-7
Traffic supported by a DS1-fed AccessNode	2-7
Operations controller for a DS1-fed system	2-7
Limitations of DS1-fed systems	2-8

- Applications for DS1-fed systems 2-8
- Single-ended AccessNode system 2-8
 - Essential characteristic of a single-ended system 2-10
 - Traffic supported by a single-ended AccessNode 2-10
 - Operations controller for a single-ended system 2-10
 - Limitations of single-ended systems 2-11
 - Applications for single-ended systems 2-11
- GR-303 MVI 2-11

Topology

3-1

- Chapter contents 3-1
- Topology 3-2
- Fiber-fed system 3-2
 - Point-to-point topology 3-2
 - Ring topology 3-2
 - Bandwidth management in fiber-fed systems 3-6
- Operations controller for a fiber-fed system 3-8
- Locations for the operations controller for a fiber-fed system 3-8
 - In the system's FCOT 3-8
 - In another FCOT 3-8
 - In an OPC shelf 3-8
 - In a portable OPC 3-10
- Matched nodes 3-10
 - Primary gateways 3-11
 - Secondary gateways 3-11
 - Protection methods 3-12
 - Drop and continue on working 3-13
 - Drop and continue on protection 3-14
 - Hardware and software requirements 3-15
 - Connection rules 3-16
 - Single and double fault failures 3-19
 - Switching 3-20
- DS1-fed system 3-22
 - Compatibility of DS1-fed systems with external equipment 3-23
- Operations controller for a DS1-fed system 3-25
 - Connectivity between the OPC and the RFTs 3-26
- Locations for the operations controller for a DS1-fed system 3-28
 - In available slots in another network element 3-28
 - In the access bandwidth manager shelf in a DS1-fed RFT 3-28
 - In a TBM OPC shelf sharing a bay with another network element 3-29
 - In a stand-alone TBM OPC shelf 3-29
 - In a stand-alone ABM OPC shelf 3-30
- Single-ended system 3-31
 - Operations controller for a single-ended system 3-32
- Locations for the operations controller for a single-ended system 3-32
 - In available slots in an S/DMS TransportNode network element 3-33
 - In the ABM shelf in a single-ended RFT 3-33
 - In a TBM OPC shelf sharing a bay with another network element 3-33
 - In a stand-alone ABM OPC shelf 3-33
 - In a stand-alone TBM OPC shelf 3-34

Applications 4-1

- Chapter contents 4-1
 - Business-access application 4-2
 - Cost-effective flexibility 4-2
 - Central-office-modernization application 4-4
 - SONET feeder application 4-6
 - Interworking of AccessNode and DMS-1 Urban 4-8
-

Interfaces to host switches 5-1

- Chapter contents 5-1
 - Types of host switches 5-2
 - Analog switches 5-2
 - Digital switches 5-2
 - Single hosting and multihosting 5-3
 - General meaning of the term multihosting 5-3
 - Specific meaning of the term multihosting as used in this library 5-3
 - Compatible with all AccessNode systems 5-4
 - How multihosting works 5-4
 - GR-303 interface 5-7
 - TR-08 interface provided by AccessNode 5-8
 - Compatible with all AccessNode systems 5-8
 - Mapping TR-08 lines 5-8
 - System handling TR-08 traffic 5-9
 - DMS Access interface 5-11
 - Access processor card 5-12
 - Virtual line concentrating module 5-13
 - Services and line cards 5-13
 - DMS-X Interface to APC-100 5-14
 - Multi-IG/Multi-SMA 5-14
-

Hardware packaging 6-1

- Chapter contents 6-1
 - Bays 6-2
 - Configurations packaged in bays 6-2
 - Bay configurations with ABM shelves 6-2
 - Bay prewired for 672 copper lines 6-3
 - Bay with add-drop start-up configuration 6-5
 - Bay with multiplexer configuration 6-7
 - Bay configurations with TBM shelves 6-9
 - Transport single-shelf bay configuration 6-10
 - Transport two-shelf and three-shelf bay configurations 6-13
 - Enhanced TBM shelf bay configurations 6-15
 - Operations controller shelves 6-16
 - Stand-alone ABM OPC shelf 6-16
 - Stand-alone TBM OPC shelf 6-16
 - Bay-sharing TBM OPC shelf 6-16
 - Modular business package 6-17
 - Master cabinet description 6-19
-

- Expansion cabinet description 6-23
 - MPP cabinets 6-27
 - Series 800A outside-plant cabinet 6-31
 - Basic cabinet configuration 6-31
-

Shelf modules and bay-assembly modules **7-1**

- Chapter contents 7-1
 - Where to find information about the operations controller shelf 7-2
 - Access bandwidth manager shelf 7-3
 - Functions of the ABM shelf 7-4
 - Architecture 7-5
 - Structure of the ABM shelf 7-6
 - Layout of the ABM shelf 7-8
 - Where the ABM shelf installs 7-14
 - Breaker interface panel, model NT4K14BA 7-19
 - Breaker interface panel, model NT7E56 7-25
 - Cooling units 7-31
 - Connections on the left side of the cooling unit 7-32
 - Copper-distribution shelf 7-35
 - Structure of the copper-distribution shelf 7-35
 - Modules used in the copper-distribution shelf 7-40
 - Fiber management storage tray and the fiber storage panel 7-41
 - Fiber management storage tray 7-41
 - Fiber storage panel 7-42
 - Fiber storage tray 7-43
 - Local craft access panel used with an access bandwidth manager shelf 7-44
 - Transport bandwidth manager shelf 7-48
 - Functions of the transport bandwidth manager shelf 7-49
 - Structure of the transport bandwidth manager shelf 7-49
 - Layout of the transport bandwidth manager shelf 7-51
 - Cable organizer panel (NT4K1930) 7-61
 - Cable organizer panel/cooling unit 7-61
 - Fiber storage panel (NT7E58) 7-63
 - Local craft access panel used with the TBM shelf 7-64
-

Plug-in modules **8-1**

- Chapter contents 8-1
 - Plug-in modules used in the common-equipment shelves 8-2
 - Access interface card (NT4K55) 8-5
 - BNC I/O card (NT4K30) 8-5
 - Common-equipment power card (NT4K58MA) 8-5
 - DS1 input card (NT4K32) 8-5
 - DS1 output card (NT4K33) 8-5
 - DS1 protection bridge card (NT4K31) 8-6
 - DS1 mapper (NT7E04) 8-6
 - DS3/STS-1 protection switch card (NT4K60) 8-6
 - DS3 mapper (NT7E08) 8-6
 - STS-1 interface (NT7E09) 8-7
 - External synchronization interface card (NT7E27) 8-7
-

Integrated remote test unit (NT4K57)	8-7
Maintenance interface card (NT4K53)	8-8
OC-12 interface circuit pack (NT7E02)	8-9
OC-12 VTBM circuit pack (NT7E05)	8-10
VTBM support of OC-3 concatenated tributaries	8-10
OC-3 interface circuit pack (NT7E01)	8-11
Operations controller module (NT7E24)	8-12
PGTC/MTA card (NT4K58DA)	8-12
Processor card (NT4K52)	8-13
Serial I/O card (NT4K58LA)	8-13
Test access card (NT4K54)	8-13
Test access path card (NT4K58KA)	8-14
Test bypass pair card (NT4K58CA)	8-14
Timing and cross-connect card (NT4K75)	8-14
Transport interface card (NT4K56)	8-15
Plug-in modules used in the copper-distribution shelf	8-16
Modules outside the copper-distribution drawers	8-16
Modules inside the copper-distribution drawers	8-16
Line cards	8-19
Drawer common-equipment modules	8-20
Plug-in modules used in the breaker interface panel	8-22
NT4K14BA BIP	8-22
NT4K14AB BIP	8-22

Software packaging	9-1
Chapter contents	9-1
Software load for an AccessNode	9-2
Core software	9-2
Optional software	9-6

Interfaces to AccessNode	10-1
Chapter contents	10-1
Overview of AccessNode interfaces	10-2
Interfaces to optical feeder lines	10-2
Interface to optical tributary lines	10-2
Interfaces to digital lines	10-2
Interfaces to copper lines	10-3
Interface to an external timing source	10-3
Interfaces to the operations controller module	10-3
Ethernet connector on the OPC module	10-4
First serial DTE port of the operations controller module	10-4
Second serial DTE port of the operations controller module	10-4
Third serial DTE port of the operations controller module	10-5
Interface to Ethernet	10-5
X11 terminal support	10-5
X.25 interface	10-5
Interface to control network	10-6
Interfaces for parallel telemetry	10-6
Interfaces for serial telemetry	10-6

- Interfaces for orderwire 10-7
 - Orderwire capabilities 10-7
 - Connectors for orderwire access 10-7
 - Orderwire push-buttons, LEDs, and audible alarm 10-8
 - Orderwire extension 10-8
- User interfaces 10-9
 - User interfaces to the processor card 10-9
 - User interfaces to the OPC 10-9
- Metallic test access 10-10
- Interfaces on the side interconnect left circuit packs 10-10
- Interfaces on the local craft access panel 10-13

Synchronization **11-1**

- Chapter contents 11-1
- Introduction to synchronization 11-2
 - Timing sources 11-2
 - Stratum clocks 11-2
 - Synchronization hierarchy 11-3
 - Building-integrated timing supply 11-3
- Network element synchronization modes 11-4
 - Freerun timing 11-5
 - External timing 11-6
 - Loop timing 11-6
 - Line timing 11-7
- System synchronization applications 11-11
 - Point-to-point topology 11-11
 - Ring topology 11-11
- Clock source 11-13
- Timing sources and timing distribution 11-15
 - External timing references for ESI card 11-15
 - Network element's choice of a timing reference signal 11-16
 - Timing reference output signals from the ESI card 11-17
- External synchronization interface hardware 11-18
- Timing modes for external synchronization interface cards 11-18
 - Freerun mode 11-19
 - Acquire mode 11-19
 - Fast mode 11-20
 - Normal mode 11-20
 - Holdover mode 11-20
 - Audits of ESI timing modes 11-22
- Timing deviation detection and recovery by ESI cards 11-23
 - ESI Version NT7E27AA 11-23
 - ESI Versions NT7E27BA and NT7E27DA 11-23
 - ESI Versions NT7E27CA and NT7E27EA 11-24
- Timing distribution by ESI cards 11-24
- Additional external synchronization interface information 11-26
- Timing for a network element containing OC-12 VTBM circuit packs 11-26
 - ESI timing 11-26
 - OC-12 VTBM timing 11-26
 - Timing modes of the OC-12 VTBM circuit pack 11-26

Freerun mode	11-27
Acquire mode	11-27
Normal mode	11-27
Holdover mode	11-28
User provisioning of the target timing mode for OC-12 VTBM circuit packs	11-28
Automatic control of the current timing mode	11-29
Synchronization-status messages	11-31
User-specified quality levels for timing sources	11-33
Application scenarios	11-33
Benefits of synchronization-status messaging	11-35
Insertion of alarm indication signal into G1OUT and G2OUT	11-45
Summary of network element timing	11-47

Appendix A: SONET overview	12-1
-----------------------------------	-------------

STS-1 building block	12-1
Overhead	12-3
STS path-level overhead (9 bytes)	12-4
STS line-level overhead (18 bytes)	12-4
STS section-level overhead (9 bytes)	12-4
Access to the STS overhead layers	12-6
Virtual tributaries	12-6
VT grouping	12-6
DS1 visibility	12-10
Pointers	12-10
Concatenated payloads	12-12

Index	13-1
--------------	-------------

About this document

This document describes the AccessNode product, the equipment that composes it, and the various configurations for installing the equipment. The document also briefly describes the AccessNode software and subnetwork topologies.

This document is written for AccessNode products. For descriptive information on the AccessNode Express, see *Configuration and Equipment Description*, 323-3051-100, in the *AccessNode Express* volume.

Audience

The intended 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 a reference work. It provides a high-level nontechnical description of the equipment.

Some of the topics included in this manual are discussed in greater technical detail in other parts of the AccessNode documentation set. In such cases, this document contains references to those sources of detailed information.

References in this document

This document refers to the following additional documents:

Engineering, Configuration, and Ordering Guide, Volume 1

- *Engineering and Ordering Information*, 323-3001-032
- *Mapper Layouts Planning Guide*, 323-3001-154

Description, Volume 2A

- *Signal Flow and Circuit Pack Description*, 323-3001-102
- *Alarms and Surveillance Description*, 323-3001-104

Description, Volume 2B

- *Line and Loop Testing Overview*, 323-3001-115
- *System Specifications*, 323-3001-180

Operations, Administration, and Provisioning, Volume 4B

- *Provisioning and Operations Procedures*, 323-3001-310
- *Line Card Provisioning Procedures*, 323-3001-315
- *Line Card Testing Procedures*, 323-3001-316

Separately bound documents

- *Modular Business Package Description*, 323-3001-110
- *Series 800A Outside Plant Cabinet Description*, 323-3001-118
- *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*

Overview of AccessNode equipment

This chapter contains the following information:

- definitions of important terms in AccessNode documentation
- topics covered in following chapters

Note: To find information quickly about a specific topic, use the index at the end of this document or the *Master Index*, 323-3001-002.

Chapter contents

This chapter includes the following topics:

Topic	See
Important terms	page 1-2
Topics of subsequent chapters	page 1-6

Important terms

This section defines the major terms that describe the AccessNode documentation.

Application

An AccessNode application is a purpose for which an operating company deploys AccessNode in the network.

For example, central-office modernization is a typical AccessNode application. For descriptions of typical applications, see Chapter 4, “Applications.”

Cluster

A cluster includes all the network elements within the span of control of an operations controller (OPC). For example, if an OPC serves 16 network elements, then those network elements are in the same cluster.

Configuration

The term configuration refers to the set of components installed in an AccessNode network element. The capabilities of an AccessNode depend on the set of components, so the configuration indicates the function performed by that AccessNode.

To simplify the equipment-selection process, a limited number of configurations have been defined in detail, and each of these configurations has been assigned a unique product engineering code (PEC). A bay frame houses each of the predefined configurations.

The following predefined configurations are available for AccessNodes housed in bay frames:

- configuration prewired for 672 copper lines
- add-drop start-up configuration
- multiplexer configuration
- transport single-shelf bay configuration
- transport two-shelf bay configuration
- transport three-shelf bay configuration

Note 1: AccessNode is not limited to a few predefined configurations. AccessNode can be deployed with a mixed configuration, to combine the functions of two or more configurations.

Note 2: For information on a mixed DS1-fed AccessNode system (CDS, EU9000 and ANX VMs) controlled by one ABM shelf, refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

For detailed descriptions of the predefined configurations listed on this page, see Chapter 6, “Hardware packaging.” For information about ordering, see *Engineering and Ordering Information*, 323-3001-032, in *Engineering, Configuration, and Ordering Guide*, Volume 1.

Cserver

Cserver is an abbreviated form of the term “communications server.” A Cserver is an access bandwidth manager (ABM) OPC shelf that supports DS1 links to the remote fiber terminals (RFTs) served by the operations controller. A Cserver is a network element. It is commissioned as an fiber central office terminal (FCOT), but does not carry any traffic to and from the host switch like other FCOTs.

FCOT

In a basic fiber-fed system, the fiber central office terminal (FCOT) is the network element that is located in a central office. It interfaces to central-office equipment such as switches, and it multiplexes the traffic that flows through the AccessNode system. It is the center of operations, administration, and provisioning control for the system.

The operations controller (OPC) that serves the system is located in or near the FCOT. (The OPC may be in equipment other than the FCOT. It may be in a collocated FCOT (an FCOT that is part of another system) or a collocated OPC shelf. A local area network (LAN) links the collocated FCOT or collocated OPC shelf to the system’s FCOT.)

Multihosting

The term multihosting has a general meaning and a specific meaning in this library.

General meaning of the term multihosting

The term multihosting refers to an arrangement in which

- some of the switched lines from an RFT are switched by (“hosted” by) one switch
- other lines from the RFT are switched by another switch

Each line has a fixed association with only one switch, but different lines or groups of lines from the RFT are allotted to different switches.

Specific meaning of the term multihosting as used in this library

Wherever multihosting is used in the AccessNode library (unless the text contains an explicit statement to the contrary), it refers to only one arrangement, the arrangement in which different *digital* host switches switch different lines or groups of lines from an RFT.

Multiple Interface Groups (Multi-IG)

Up to 5 interface groups can exist between a Local Digital Switch (LDS) or switches (either DMS-100 or another supported vendor's switch) and an RFT (the AccessNode network element). The interface groups can extend from an RFT to multiple integrated digital terminals (IDTs) within a single LDS, spread across multiple LDSs, or a combination.

More than one GR-303 MVI host can be provisioned. This allows the AccessNode to communicate with more than one GR-303 MVI host.

Multiple Subscriber Module Access (Multi-SMA)

One DMS host switch can have multiple IDTs to the same RFT, but spread across multiple SMAs.

Note: For more information on multihosting, multi-IG, and multi-SMA, see Chapter 5, "Interfaces to host switches."

Network element

Each discrete AccessNode is a network element. A network element is a collection of equipment at one location that functions and is administered as a single entity.

OPC

OPC stands for operations controller. The OPC is a piece of equipment that performs the following:

- It provides and controls operations, administration, maintenance, and provisioning (OAM&P) for all the AccessNode network elements in its span of control. Its span of control may include multiple systems, up to 16 network elements. (A system may include one or more network elements.)
- It acts as an operations system (OS) gateway device (a mediation device for communication between the AccessNode network elements and external network OSs).
- It performs software management. It stores software on its hard disk. When a component within its span of control needs to have its software reloaded or upgraded, the software is downloaded to the component from the OPC.
- It stores the database that contains provisioning information.

Every AccessNode system requires the services of an OPC. However, every system does not need to contain an OPC, because one OPC can serve multiple systems.

OPC shelf

An OPC shelf is a common-equipment shelf that houses the operations controller module. A stand-alone OPC shelf is installed in its own bay. An access bandwidth manager (ABM) shelf used as a stand-alone OPC shelf is referred to as a stand-alone ABM OPC shelf; a transport bandwidth manager (TBM) shelf used as a stand-alone OPC shelf is referred to as a stand-alone TBM OPC shelf.

In some cases it may be possible to install a bay-sharing OPC shelf rather than a stand-alone OPC shelf. A bay-sharing OPC shelf is a TBM OPC shelf that shares a bay with one or two other TBM shelves. An OPC shelf is a network element. It is commissioned as an FCOT, but it does not carry any traffic to and from the host switch like other FCOTs.

RFT

RFT stands for remote fiber terminal. An RFT is an AccessNode network element that interfaces to subscribers' loops. Typically, an RFT is located at a remote location (a location remote from the central office). An RFT may be located at a central office.

Note: In a basic fiber-fed system serving an integrated application, the RFT fulfills the role of the remote digital terminal (RDT).

System

A system is the AccessNode hardware and software installed to serve an application. A system may include one or more network elements. The following types of AccessNode systems are available:

- fiber-fed AccessNode
- DS1-fed AccessNode
- single-ended AccessNode

These system types are described in Chapter 2, "Types of AccessNode systems."

Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*

Topics of subsequent chapters

Subsequent chapters in this document cover the following topics:

- Chapter 2 describes the available types of AccessNode systems:
 - basic fiber-fed AccessNode
 - DS1-fed AccessNode
 - single-ended AccessNode
- Chapter 3 describes the topology for each type of AccessNode system, including ring topology.
- Chapter 4 describes some of the applications for AccessNode systems.
- Chapter 5 describes switch interfaces, including the following:
 - multihosting
 - TR-08
- Chapters 6, 7, and 8 describe equipment packaging, as follows:
 - Chapter 6 covers the packaging options available for an AccessNode network element.
 - Chapter 7 describes the shelves contained in an AccessNode network element.
 - Chapter 8 describes the modules that are installed in the shelves.
- Chapter 9 contains a brief description of AccessNode software.
- Chapter 10 describes the interfaces to AccessNode equipment.
- Chapter 11 describes the synchronization of fiber-fed systems.
- Appendix A describes the SONET standard for optical communication.

Types of AccessNode systems

This chapter provides a brief overview of AccessNode. It introduces the various types of AccessNode systems.

Chapter contents

This chapter includes the following topics:

Topic	See
What is AccessNode?	page 2-2
AccessNode system types	page 2-2
Point-to-point or virtual tributary bandwidth manager ring fiber-fed systems	page 2-3
DS1-fed AccessNode system	page 2-6
Single-ended AccessNode system	page 2-8
GR-303 MVI	page 2-11

What is AccessNode?

AccessNode is the name of a group of products that handle traffic to and from subscriber loops in the telephone network.

AccessNode is installed in units referred to as systems. An AccessNode system interfaces to one or more host switches. For information on the interfaces between switches and AccessNode system, see Chapter 5, “Interfaces to host switches.”

An AccessNode system interfaces to subscriber loops. A subscriber loop is the copper wiring to the subscriber’s telephone equipment. The subscriber loop connects to a remote fiber terminal (RFT), which is a type of AccessNode equipment.

Packaging options

A variety of packaging options can house the individual pieces of AccessNode equipment. For information on the packaging options, see Chapter 6, “Hardware packaging.”

AccessNode system types

In this release, the following types of AccessNode systems are available:

- fiber-fed system, in either a point-to-point or virtual tributary bandwidth manager (VTBM) ring topology
- DS1-fed system
- single-ended system

The following pages summarize the differences between these types of systems and present an example of each type.

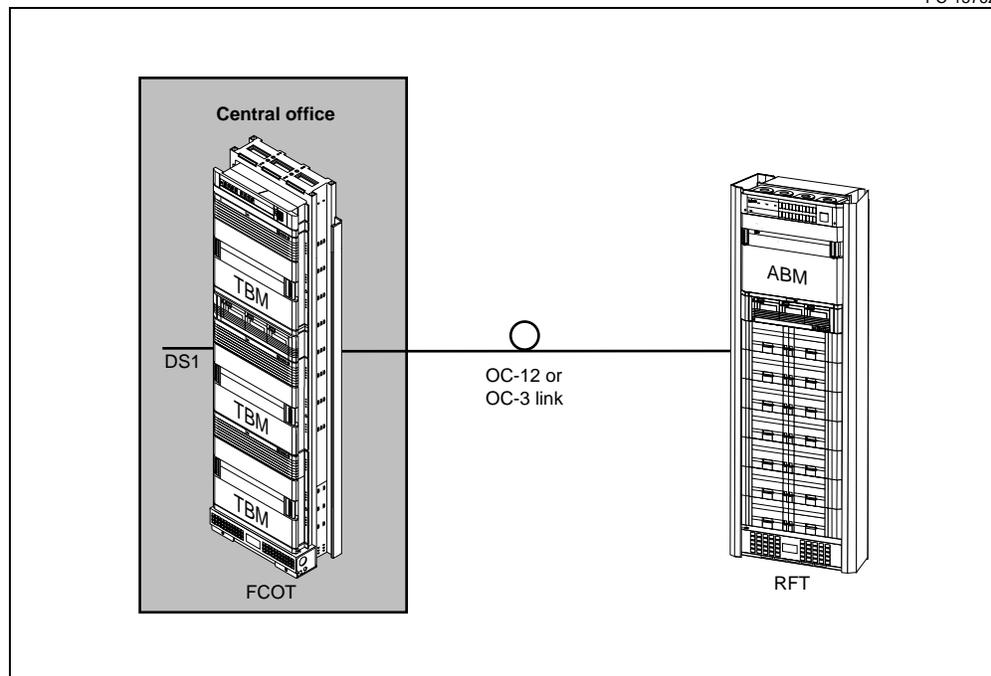
Point-to-point or virtual tributary bandwidth manager ring fiber-fed systems

A fiber-fed system contains a fiber central office terminal (FCOT) and one or more remote fiber terminals (RFTs). The link between the FCOT and the one or more RFTs is a fiber-optic link. The FCOT is located in a central office. It interfaces to the host switch and multiplexes the traffic. RFTs are located either in central offices or at remote sites, and interface to subscriber loops.

Figure 2-1 shows an example of an AccessNode fiber-fed system with point-to-point topology.

Figure 2-1
AccessNode fiber-fed system with point-to-point topology

PC-15762

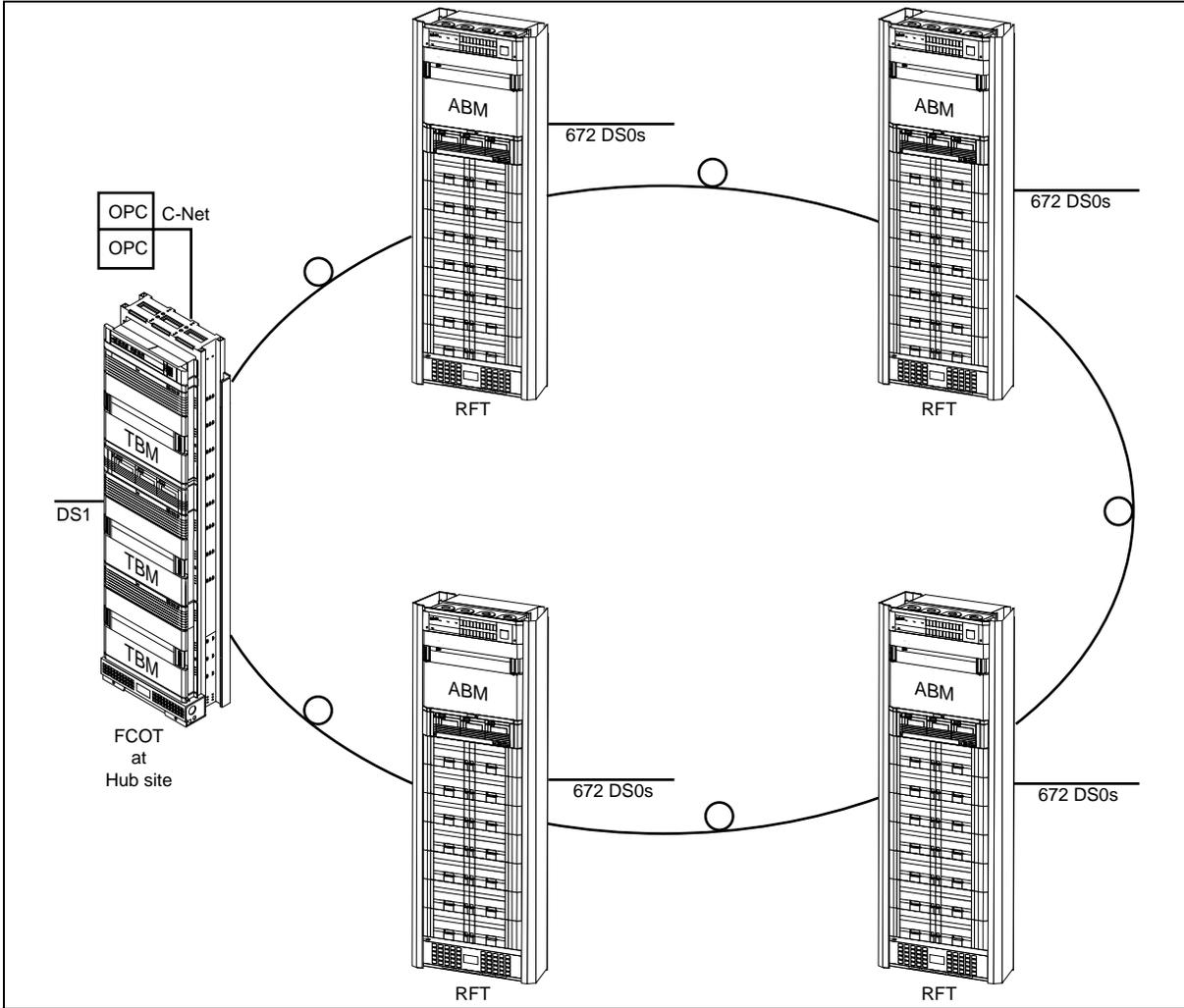


2-4 Types of AccessNode systems

Figure 2-2 shows an example of a fiber-fed AccessNode system with virtual tributary bandwidth manager (VTBM) ring topology.

Figure 2-2
AccessNode fiber-fed system with VTBM ring topology

PC-15761



Network elements in the system

A fiber-fed system has one FCOT and one or more RFTs in one of the following topologies:

- If a fiber-fed system has point-to-point topology, it has one FCOT and one RFT.
- If a fiber-fed system has VTBM ring topology, it has at least one FCOT and up to 15 RFTs with a total of 16 network elements. Network elements in VTBM rings are called ring nodes.

The link between the FCOT and an RFT is a fiber-optic link. The FCOT is located in a central office. It interfaces to the host switch and multiplexes the traffic. The RFTs are located either in a central office or at a remote site. They interface to subscriber loops.

Essential characteristic of a fiber-fed system

The essential characteristic that distinguishes the fiber-fed system from the DS1-fed and single-ended types is the equipment in the central office that multiplexes the traffic. The FCOT in a fiber-fed system fulfills that role.

Although the other types of systems (DS1-fed and single-ended) may contain network elements that are commissioned as FCOTs, those FCOTs do not multiplex the traffic.

Traffic supported by a fiber-fed AccessNode

A fiber-fed AccessNode supports the following types of traffic:

- universal digital loop carrier (UDLC)
- tandem
- GR-303
- TR-08
- transport DS1s
- OC-3 tributary
- DS3s
- STS-1 tributary (TN_BLSR only)

For descriptions of the traffic types, see *Engineering and Ordering Information*, 323-3001-032, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

Operations controller for a fiber-fed system

An operations controller module (OPC) handles central control of operations, administration, maintenance, and provisioning (OAM&P) for an AccessNode system. The OPC for a fiber-fed system can be located in the common-equipment shelf in the FCOT. Alternatively, it can be located in another piece of central-office equipment connected to the FCOT through control network. For a description of control network, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

For more information on the possible locations for the operations controller in a fiber-fed system, see “Locations for the operations controller for a fiber-fed system” on page 3-8.

Application for fiber-fed systems

An example of a fiber-fed AccessNode system application is when the AccessNode provides service to subscribers living in a suburban area. The RFT can be installed in a locking cabinet on a concrete slab in a central location.

DS1-fed AccessNode system

In a DS1-fed AccessNode system, each remote fiber terminal (RFT) receives traffic directly from one or more digital switches and transmits traffic directly to the switch or switches. (A DS1-fed system does not interface to analog switches.) The interface between an RFT and a digital switch is through external equipment that is capable of supporting DS1s. (The external equipment is so-called because it is external to the AccessNode system. For more information on the external equipment, see “Compatibility of DS1-fed systems with external equipment” on page 3-23.)

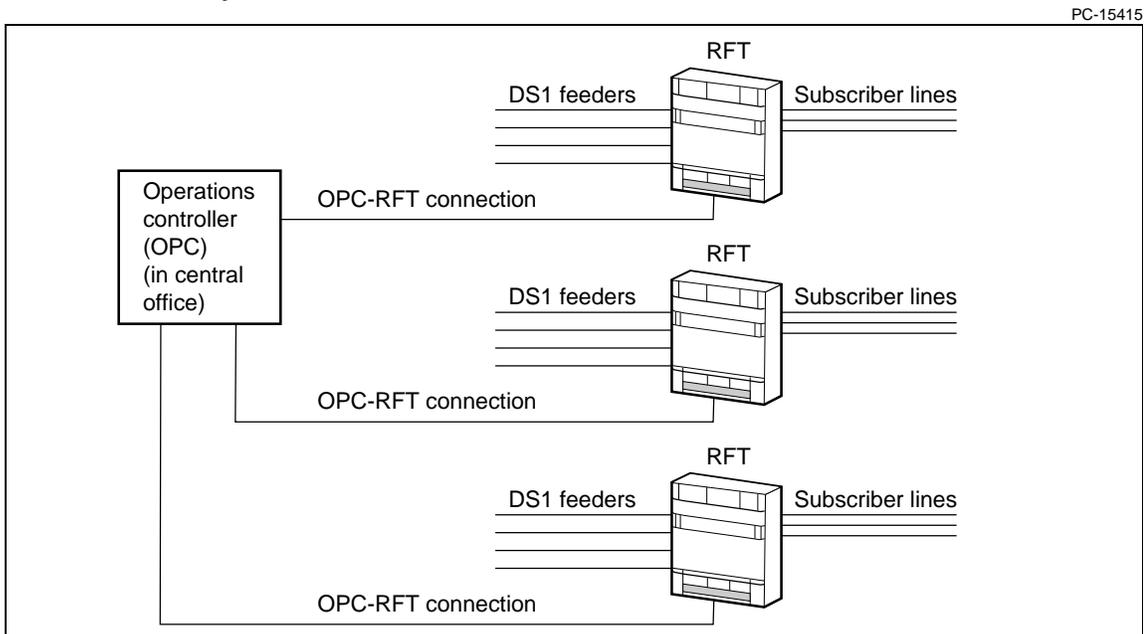
The DS1-fed RFT can interface to the following types of DS1s:

- tandem DS1s
- GR-303 DS1s
- TR-08 DS1s

Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

Figure 2-3 shows an example of a DS1-fed AccessNode system.

Figure 2-3
DS1-fed AccessNode system



Essential characteristics of a DS1-fed system

The essential characteristic that distinguishes the DS1-fed system from the other types (basic fiber-fed and single-ended) is that the traffic between the RFT and the host switch travels through external equipment that is capable of supporting DS1s, rather than using an optical fiber.

Other distinguishing qualities of a DS1-fed system

The DS1-fed AccessNode system has the following qualities that distinguish it from the other types:

- It is the only type of system in which operations maintenance channels (OMCs) can be used for communication between the operations controller and the RFTs.
- It does not contain a dedicated multiplexer that interfaces to the host switch, as the fiber central office terminal (FCOT) does in a basic fiber-fed system.

Note: Although a DS1-fed system may contain a network element commissioned as an FCOT, that network element does not multiplex traffic.

Traffic supported by a DS1-fed AccessNode

A DS1-fed AccessNode supports the following types of traffic:

- tandem
- GR-303
- TR-08

For descriptions of the traffic types, see *Engineering and Ordering Information*, 323-3001-032, in *Engineering, Configuration, and Ordering Guide*, Volume 1.

Operations controller for a DS1-fed system

An operations controller handles central control of operations, administration, maintenance, and provisioning (OAM&P) for an AccessNode system. A single operations controller can serve up to 16 DS1-fed RFTs with up to 10 connected by CNet cabling.

The operations controller is located in equipment in the central office.

For more information on the possible locations for the operations controller in a DS1-fed system, see “Locations for the operations controller for a DS1-fed system” on page 3-28.

Connection between the operations controller and the RFT

In a DS1-fed system, the operations controller can be connected to an RFT using an OMC DS1. An OMC DS1 carries an OMC, and does not carry any traffic. For a detailed description of the operations maintenance channel, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in *Description*, Volume 2A.

Alternatively, the operations controller can be connected to an RFT using control network or a combination of control network and a communications DS1. For a description of control network, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in *Description*, Volume 2A.

Limitations of DS1-fed systems

The following limitations apply to DS1-fed systems:

- UDLC traffic is not supported.
- DS3s are not supported.
- OC-3 tributaries are not supported.
- Orderwire is not supported. If you need orderwire service, you must implement it by using additional equipment.

Applications for DS1-fed systems

The DS1-fed AccessNode system has the following major applications:

- a telephone company with a large installed base of T1 spans.
- a telephone company that has already deployed fiber multiplexer systems with DS1 extensions serving as feeders for remote digital terminals (RDTs). The telephone company may not yet be prepared to upgrade its entire system to fiber-fed systems.
- a telephone company that has deployed TransportNode OC-12 Rings and wants to add narrowband services.

Single-ended AccessNode system

A single-ended AccessNode system connects the RFTs to one or more digital switches using a SONET fiber multiplexer other than an FCOT.

A single-ended system can connect to its switch or switches in either of the following ways:

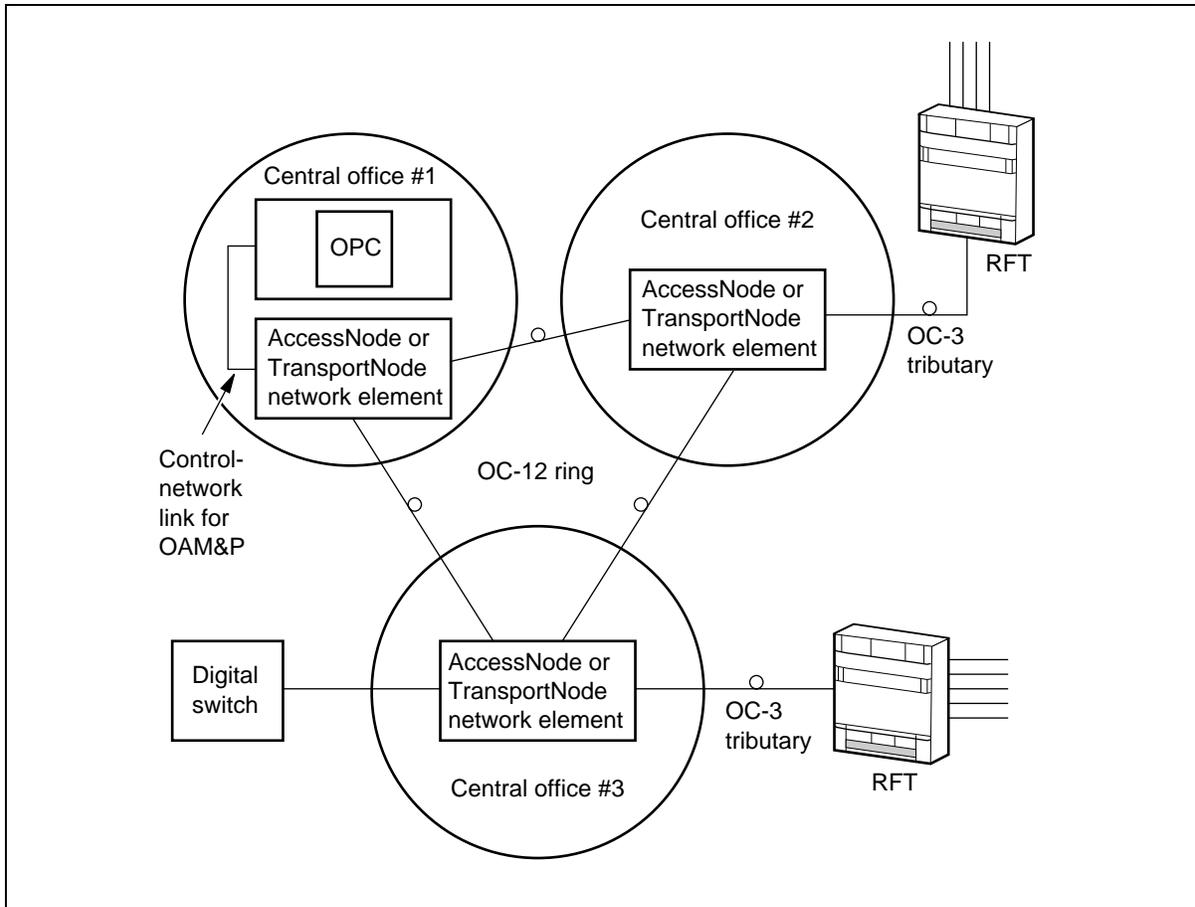
- through an AccessNode or S/DMS TransportNode OC-12 ring
An OC-3 tributary links each single-ended RFT to one or the other of the network elements in the AccessNode or S/DMS TransportNode OC-12 ring. DS1s from one or more switches go into the S/DMS TransportNode network element at the central office.
- through an OC-12 fiber-fed RFT

An OC-3 tributary links each single-ended RFT is linked to a fiber-fed RFT. DS1s from one or more switches go into the FCOT at the central office.

Figure 2-4 shows an example of a single-ended AccessNode system connected to an S/DMS TransportNode OC-12 ring.

Figure 2-4
Single-ended AccessNode connected to an AccessNode or S/DMS TransportNode ring

PC-15416



Essential characteristic of a single-ended system

The essential characteristic that distinguishes the single-ended system from the other AccessNode types is that the single-ended RFTs connect to one or more digital switches using an intermediary system.

Traffic supported by a single-ended AccessNode

A single-ended AccessNode system can carry the following types of traffic:

- GR-303
- tandem
- TR-08

For descriptions of these traffic types, see *Engineering and Ordering Information*, 323-3001-032, in *Engineering, Configuration, and Ordering Guide*, Volume 1.

GR-303 traffic, tandem traffic, and TR-08 traffic are carried in GR-303 DS1s, tandem DS1s, and TR-08 DS1s, respectively. Each DS1 is carried in a VT1.5, and each VT1.5 is part of an STS-1 in the SONET payload.

To route traffic to a single-ended RFT, use the Configuration Manager tool in the user interface of the operations controller serving the S/DMS TransportNode OC-12 ring. Use that tool to set up STS-1 connections around the OC-12 ring so that traffic for the single-ended RFT is routed to an OC-3 tributary at the remote OC-12 network element connected to the RFT. The OC-3 tributary carries the traffic to and from the single-ended RFT.

A single-ended RFT does not support DS3 traffic.

Operations controller for a single-ended system

An operations controller handles central control of OAM&P for a single-ended system. A single operations controller can serve up to 16 RFTs.

The operations controller is located in a piece of equipment in the central office. For example, it may be located in a bay that contains S/DMS TransportNode equipment.

Note: The single-ended AccessNode system requires its own operations controller. A single operations controller cannot serve both AccessNode and S/DMS TransportNode.

For more information on the possible locations for the operations controller in a DS1-fed system, see “Locations for the operations controller for a single-ended system” on page 3-32.

Limitations of single-ended systems

The following limitations apply to single-ended systems:

- UDLC traffic is not supported.
- The default mappings for STS-1s are in effect, and you cannot alter those mappings. Since the OC-3 tributary carries only three STS-1s (#1, #2, and #3), the default map has the following consequences:
 - STS-1 #1 is for the GR-303 traffic, tandem traffic, and TR-08 traffic (it is for the DS0-based traffic switched by digital switches). In a single-ended RFT, the traffic goes to and from the line cards.
 - STS-1 #2 is for UDLC traffic, which is traffic switched by analog switches or by digital switches with analog interfaces. A single-ended system does not interface to such switches; therefore, STS-1 #2 cannot be used.
 - STS-1 #3 is mapped to slots 1 and 2 in the single-ended RFT. You can install working DS1/VT mappers in those slots. Each mapper can handle a maximum of 14 DS1s.
- DS3 traffic is not supported because the default map for STS-1s does not support DS3s in the three STS-1s (#1, #2, and #3) that are available at the RFT.
- Orderwire is not supported from the single-ended RFTs, because the OC-3 tributaries that feed the RFTs do not support orderwire in the SONET overhead.
- Provisioning of single-ended RFTs from the OPS/INE external operations system is not supported.

Applications for single-ended systems

The single-ended AccessNode system has the following applications:

- connecting to a fiber-fed AccessNode system
- connecting to an OC-12 TransportNode ring
- connecting to an OC-3 AccessNode Express system

GR-303 MVI

GR-303 multivendor interface (MVI) is supported by all AccessNode topologies: point-to-point, DS1-fed, single-ended, and VTBM AccessNode systems equipped with CDSs.

Two to 28 DS1s can be provisioned between the AccessNode and the local digital switch (LDS).

Figure 2-5 illustrates a point-to-point system connected to a GR-303 MVI host switch.

Figure 2-5
AccessNode point-to-point system homed on a GR-303 MVI host

PC-16109

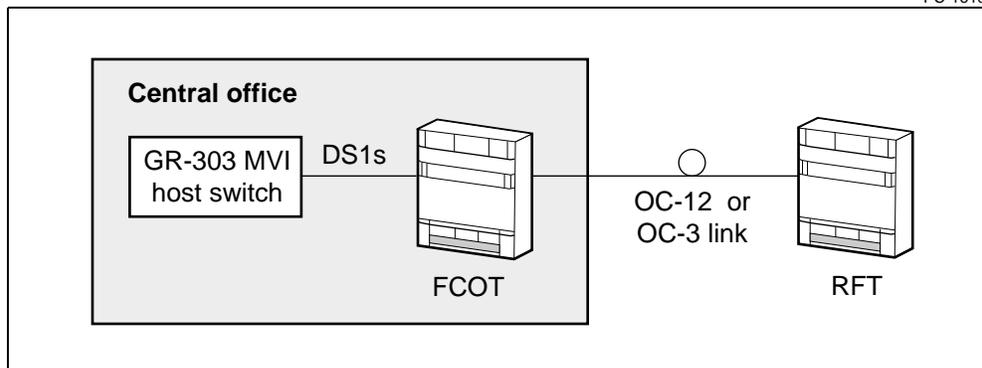


Figure 2-6 illustrates an AccessNode DS1-fed system connected to a GR-303 MVI host switch.

Figure 2-6
AccessNode DS1-fed system homed on a GR-303 MVI host

PC-16110

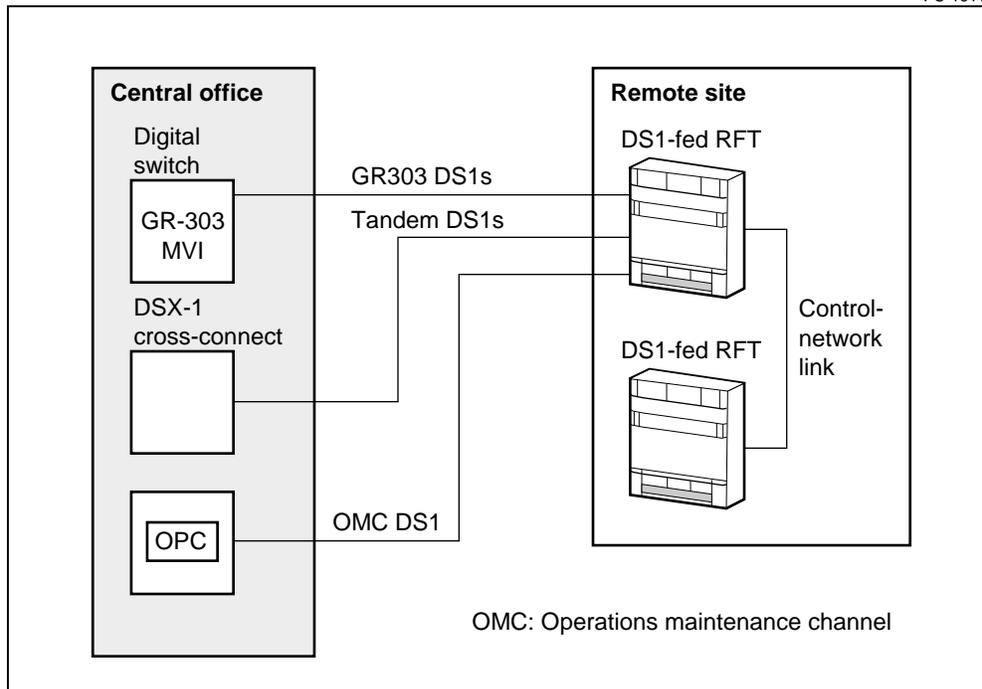


Figure 2-7 illustrates an AccessNode single-ended system connected through an S/DMS TransportNode system to a GR-303 MVI host switch.

Figure 2-7
AccessNode single-ended system homed on a GR-303 MVI host

PC-16111

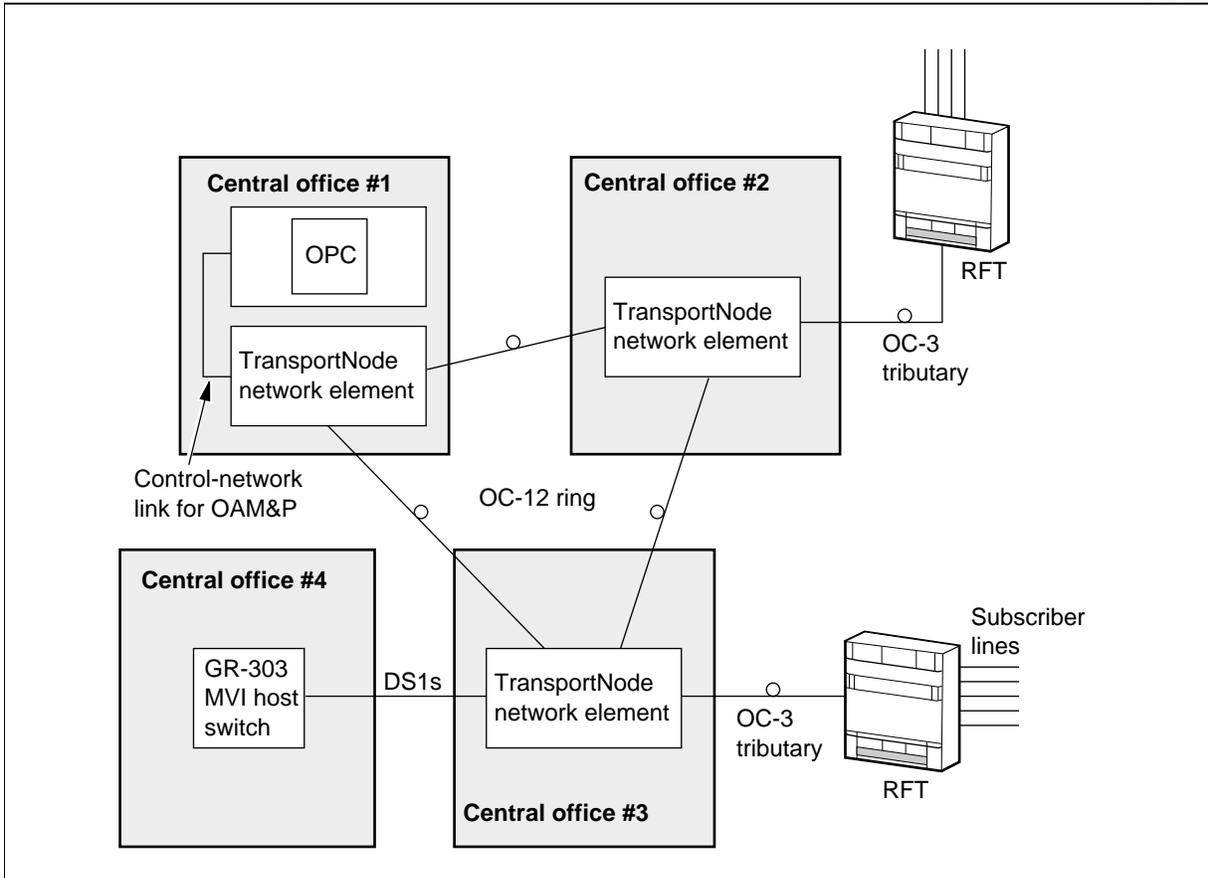
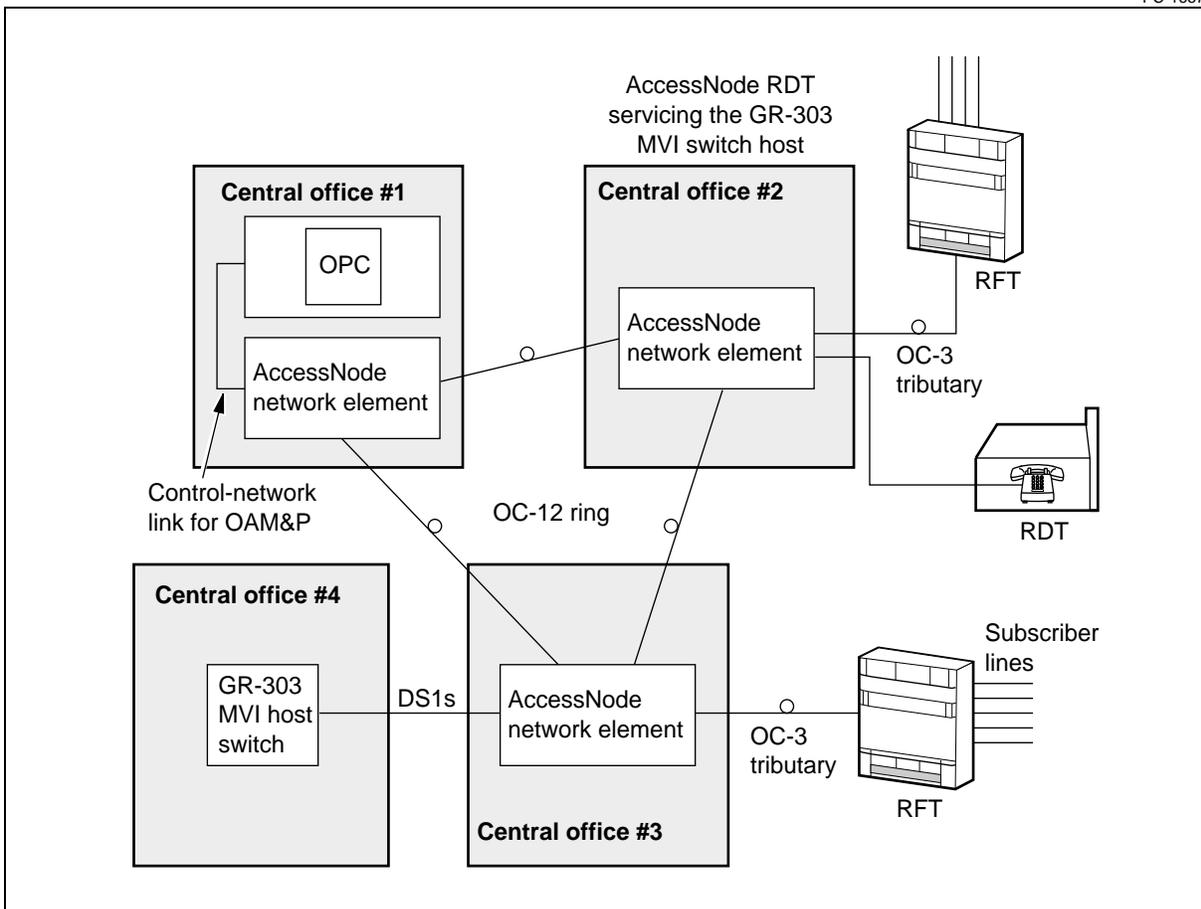


Figure 2-8 illustrates an AccessNode VTBM system connected to a GR-303 MVI host switch.

Figure 2-8
AccessNode VTBM system homed on a GR-303 MVI host

PC-16572



Topology

This chapter briefly describes the topology of AccessNode systems, and describes the possible locations in which you can install the operations controller.

Chapter contents

This chapter includes the following topics:

Topic	See
Topology	page 3-2
Fiber-fed system	page 3-2
Operations controller for a fiber-fed system	page 3-8
Locations for the operations controller for a fiber-fed system	page 3-8
Matched nodes	page 3-10
DS1-fed system	page 3-22
Operations controller for a DS1-fed system	page 3-25
Locations for the operations controller for a DS1-fed system	page 3-28
Single-ended system	page 3-31
Operations controller for a single-ended system	page 3-32
Locations for the operations controller for a single-ended system	page 3-32

For descriptive information on the AccessNode Express, see *Configuration and Equipment Description*, 323-3051-100, in the *AccessNode Express* volume. For ordering information on the AccessNode Express, see *AccessNode Express Ordering Guide*, 323-3051-032, in the *AccessNode Express* volume.

Topology

The topology of an AccessNode system is the spatial relationship of the network elements to each other and to the host switch or switches. In simpler terms, the topology of a system is the pattern you would see if you were to draw a map of the system.

Fiber-fed system

A fiber-fed AccessNode system uses either a point-to-point topology or a ring topology. The following sections describe each of these topologies.

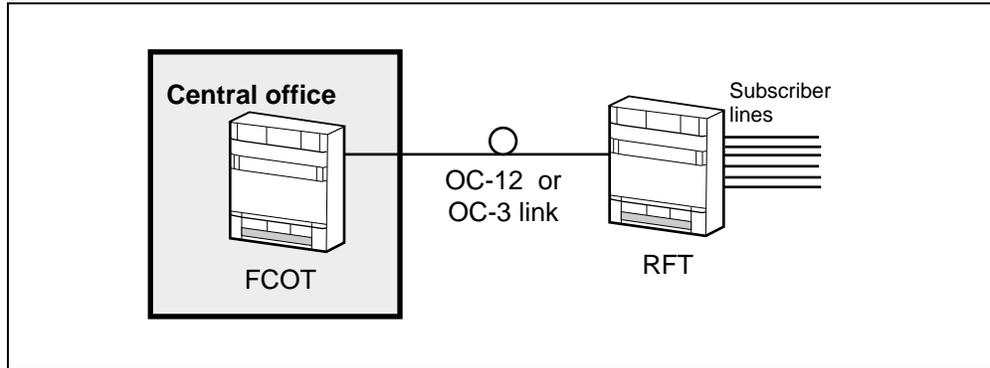
Point-to-point topology

A point-to-point topology has a straight line pattern. The system has two network elements, a fiber office central terminal (FCOT) and a remote fiber terminal (RFT). The FCOT, located in a central office, interfaces to the central-office equipment. The RFT, at the remote end, interfaces to subscriber loops.

Figure 3-1 shows an example of fiber-fed point-to-point topology.

Figure 3-1
Basic fiber-fed system with point-to-point topology

PC-15414



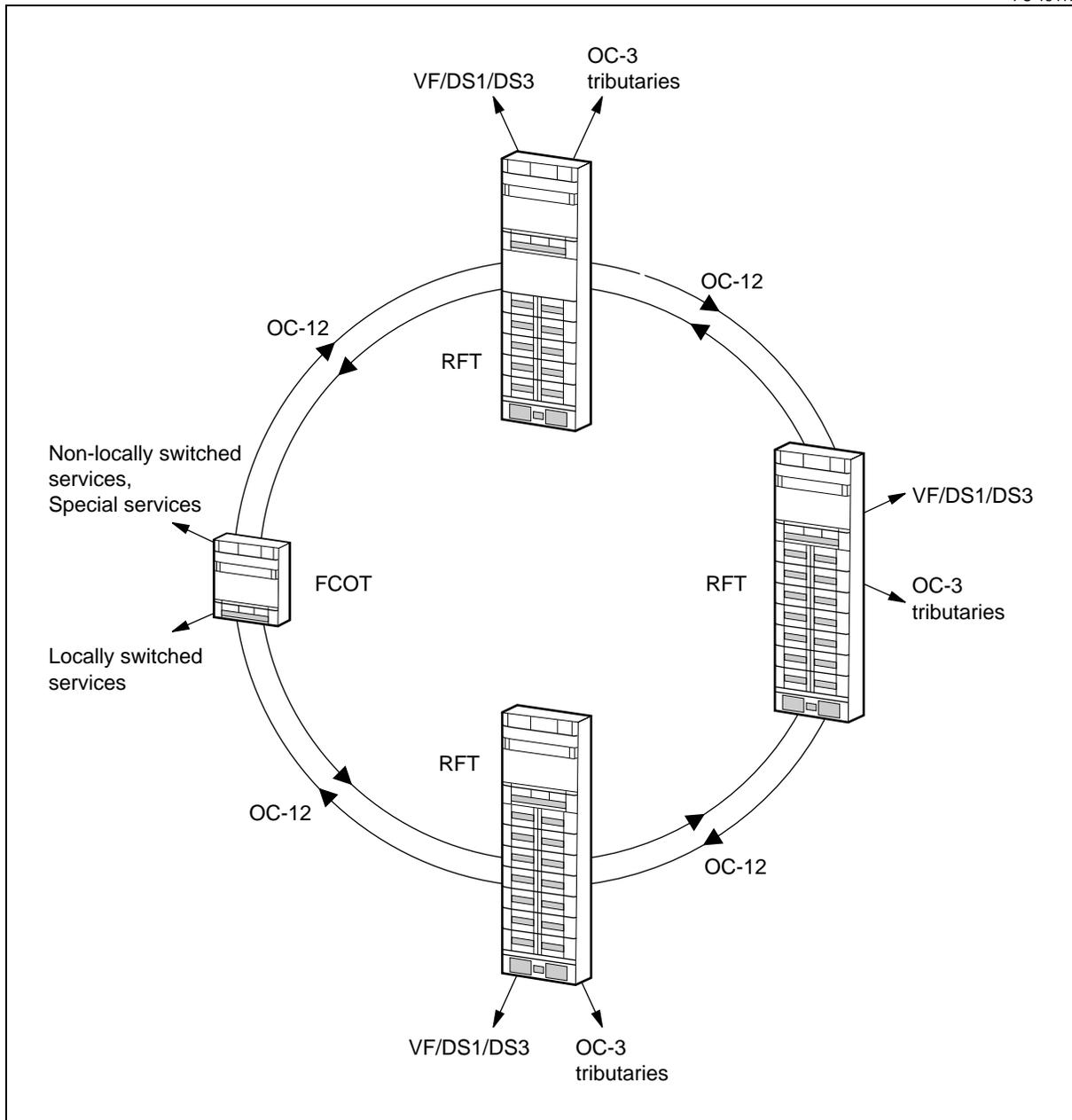
Ring topology

A ring topology has a ring pattern. The system has up to 16 network elements, an FCOT, and up to 15 RFTs. The FCOT, located in a central office, interfaces to the central-office equipment. Each RFT interfaces to subscriber loops.

Figure 3-2 shows an example of a fiber-fed system that has ring topology.

Figure 3-2
Fiber-fed system with ring topology

PC-15417



Ring node

Each network element in the ring is referred to as a ring node.

Span

A span is the fiber optic connection between any two adjacent ring nodes.

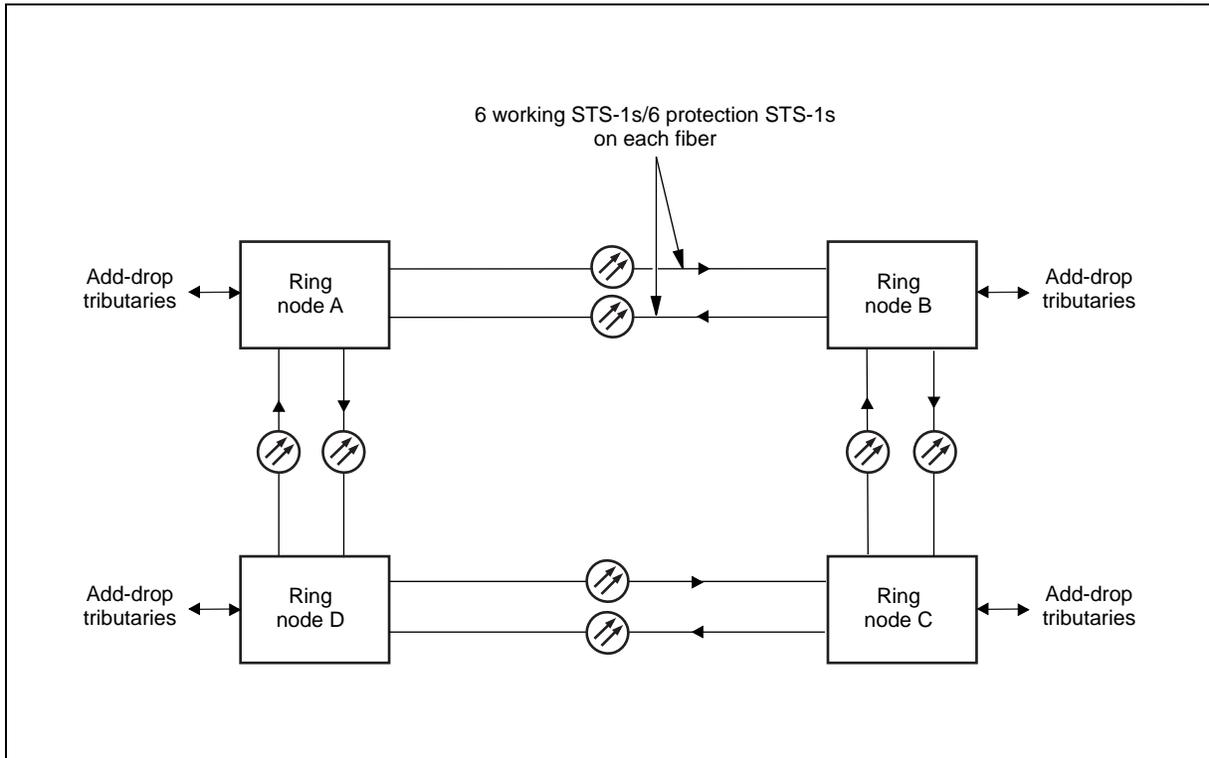
Bidirectional line-switched ring

An AccessNode ring is a bidirectional line-switched ring (BLSR). In a BLSR, the ring nodes are arranged in a closed fiber loop. As shown in Figure 3-3, two fibers, one for each direction of transmission, interconnect adjacent ring nodes. Each fiber carries traffic at the OC-12 rate.

Note: You can add or drop OC-3 tributaries at ring nodes, but the fiber optic feeder linking the ring nodes must be an OC-12 feeder.

Figure 3-3
AccessNode system with ring topology, using bidirectional line-switched ring

PC-15410



Traffic routes around the ring

In any span of the ring (the connection between two adjacent ring nodes), each fiber has 12 STS-1 time slots, but each fiber carries only six STS-1s of working traffic. In each direction, six STS-1 time slots are reserved for protection. STS-1 time slots one to six carry the working traffic, and STS-1 time slots seven to twelve are reserved for protection.

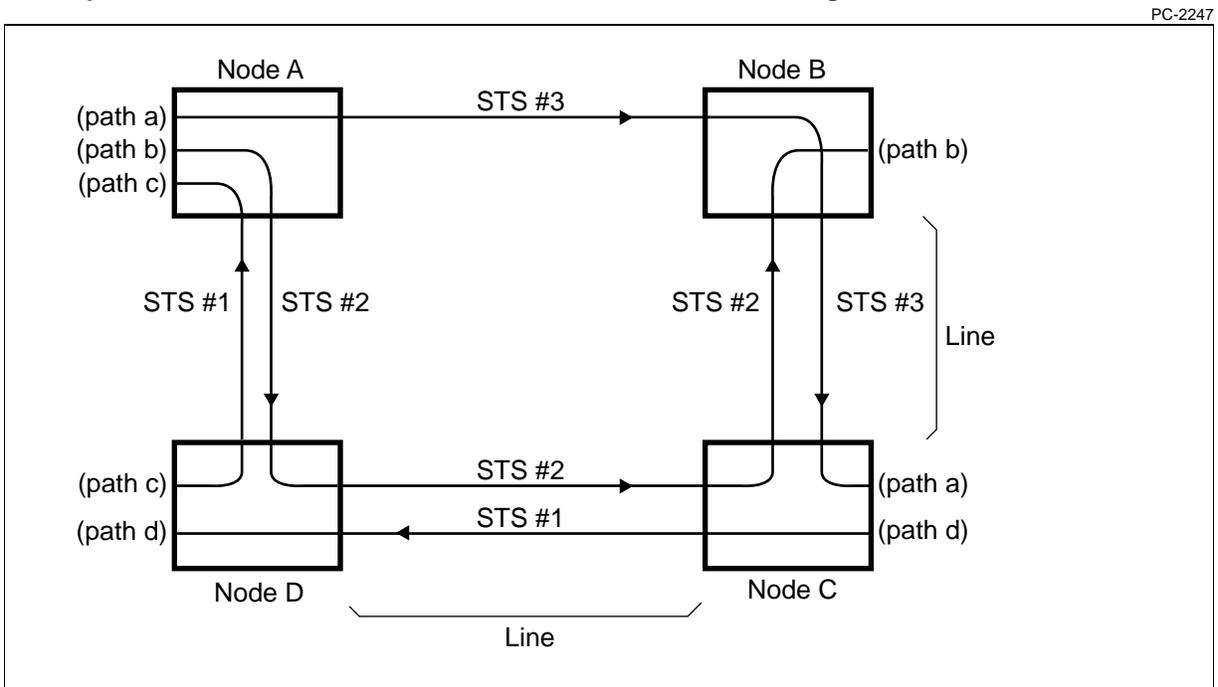
When you specify the traffic that flows through the ring, you specify the route by which the traffic travels. You do this using the Connection Manager, an operations controller (OPC) tool. For example, if a DS3 travels between nodes A and B in Figure 3-4, you specify the STS-1 time slot in which the DS3 travels, and you specify the route, either the short route from A to B or the long

route by way of nodes D and C. Probably you would specify that the DS3 between nodes A and B should travel by the short route. Your specification would then be in effect during normal operation.

Two possible routes are available for any given point-to-point connection, one in each direction around the ring. To achieve maximum bandwidth use in a ring, traffic between the network elements is usually routed through the shortest path.

Figure 3-4 shows an example of STS-1 paths defined in a four-node bidirectional line-switched ring.

Figure 3-4
STS-1 paths defined in a four-node bidirectional line-switched ring



Line switches maximizes the use of facilities in the ring because only time slots on the spans required to complete a route from origin to destination are assigned to a particular connection. The same time slots on unused spans can be used for other connections. For example, if a connection required STS-1s two and three from node A to node B, STS-1s two and three are available for other connections on lines B to D, D to C, and C to A.

The bidirectional nature of the ring permits a payload to be carried on both fibers over two different paths. For example, when a payload exceeds the capacity of 6 STS-1 time slots, the additional payload can be routed in the opposite direction over the working time slots of the second fiber.

Ring protection

When a failure occurs, ring protection automatically reroutes the traffic to bypass the failure. The traffic is rerouted at the switching nodes, which are the nodes nearest to the failure. At each switching node, the traffic goes from one OC-12 virtual tributary bandwidth manager (VTBM) circuit pack in the common-equipment shelf to the companion OC-12 VTBM circuit pack, which handles traffic flowing in the opposite direction around the ring. The companion circuit pack then maps the traffic into the protection STS-1 time slots, and transmits it.

For example, if you have a DS3 flowing between nodes A and B using the shortest route (through the single span between those nodes) and if a fiber cut occurs in that span, automatic ring protection occurs. Nodes A and B are the switching nodes. In each switching node, the DS3 is switched into a protection time slot. The DS3 then flows between nodes A and B using nodes D and C. Traffic from A to B travels in the counterclockwise direction; traffic from B to A travels in the clockwise direction.

Note: For a more detailed description of ring protection, see *Protection Switching Description*, 323-3001-103, in this volume.

Ring synchronization

Every network element in a ring must be synchronized. To synchronize the ring, external timing references enter the ring at one of the network elements, or, optionally, at two network elements. Any network element that receives timing signals from an external source must contain an external synchronization interface (ESI) card. The other network elements in the ring do not require the ESI card. In those network elements, the OC-12 VTBM circuit packs handle the synchronization. See Chapter 11, “Synchronization,” for more information about synchronization.

Bandwidth management in fiber-fed systems

To specify bandwidth management, at the STS-1 level or the VT level, use the Connection Manager, which is an operations controller (OPC) tool. For information on the Connection Manager, see *OPC User Interface Description*, 323-3001-301, in *Operations, Administration, and Provisioning*, Volume 4A.

STS-1 bandwidth management

You can specify bandwidth management at the STS-1 level in any fiber-fed system, regardless of its topology.

STS-1-level time slot assignment (TSA) allows you to assign a tributary signal to any STS-1 time slot between two network elements. An STS-1 time slot can carry 28 DS1s, which is the traffic handled by two DS1 mappers.

Alternatively, an STS-1 time slot can carry one DS3. An OC-3 tributary has three channels each occupying three STS-1 time slots. One port of an STS-1 interface occupies one time slot.

VT bandwidth management

You can specify VTBM in a fiber-fed system that has ring topology. (VTBM is not available in a system that has point-to-point topology.)

VTBM is available for the VT1.5s handled by the DS1/VT mappers in the ring nodes. The following types of VTBM functionality are available:

- VT add-drop at each network element
- VT time slot assignment for traffic from one network element to another

VT time slot assignment (VT TSA) allows you to assign a DS1 tributary signal to a VT time slot on the optical signal between network elements.

In a system with ring topology, the signals traveling between network elements are optical signals at the OC-12 rate. Each OC-12 signal is composed of 12 STS-1s, and each STS-1 can carry 28 VT1.5s.

To perform VT-level traffic management in a ring, you specify that some or all of the STS-1s between the ring nodes are to be VT-managed STS-1s. In a VT-managed STS-1 the cross-connects at the endpoint network elements involve VTs. Within the VT-managed STS-1s, you can specify VT time slot assignments.

If	Then
you have a ring with four nodes (see Figure 3-4 on page 3-5)	you can provision STS-1s one to three in each direction in each span as VT-managed STS-1s, then assign traffic to specific VT time slots in those STS-1s
you assigned a certain DS1 to a certain VT time slot in STS-1 number one and routed that traffic from Node B to Node A by way of the long route (by way of nodes C and D)	traffic would use the same VT time slot in the same STS-1 when traveling from Node B to Node C, from Node C to node D, and from Node D to Node A.

Note: Once you have assigned a DS1 to a VT time slot in a VT-managed STS-1, the DS1 travels through the system to its destination in that time slot. If the VT passes through one or more intermediate network elements on its way to its destination, those network elements do not switch the VT into another time slot in the SONET signal.

Operations controller for a fiber-fed system

Every fiber-fed system requires the services of an operations controller (OPC), but every system does not need to contain its own OPC. A single OPC can serve up to 16 network elements. Therefore, a single OPC module can serve multiple systems if all the following are true:

- the fiber central office terminals (FCOTs) for multiple separate fiber-fed systems are collocated in a central office
- the FCOTs and the OPC are linked by a control-network local area network (LAN)
- the total number of network elements (FCOTs and RFTs) in the systems is 16 or fewer

Locations for the operations controller for a fiber-fed system

You can place the operations controller (OPC) for a fiber-fed system in any of the following locations:

- the system's fiber central office terminal (FCOT)
- another FCOT
- an OPC shelf
- a portable OPC

In the system's FCOT

You can place the OPC in the common-equipment shelf (access bandwidth manager (ABM) or transport bandwidth manager (TBM)) in the system's FCOT.

In another FCOT

You can place the OPC in the common-equipment shelf in another FCOT that is part of a separate system. If the operations controller is in another FCOT, then that FCOT and the system's FCOT must be collocated, and they must be linked by control network. For a description of control network, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

In an OPC shelf

An OPC shelf is a shelf that houses the operations controller module. You may want to install the operations controller in a separate OPC shelf rather than in an FCOT. Removing the operations controller from the FCOT supplies four extra slots in its common-equipment shelf so the shelf can carry more traffic.

If the operations controller is in an OPC shelf, then the OPC shelf and the system's FCOT must be collocated, and they must be linked by control network. For a description of control network, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

You can use either the ABM shelf or the TBM shelf as an OPC shelf. These are referred to as an ABM OPC shelf and a TBM OPC shelf.

The following types of OPC shelf are available:

- TBM OPC shelf sharing a bay with another network element
- stand-alone ABM OPC shelf
- stand-alone TBM OPC shelf

In a TBM OPC shelf sharing a bay with another network element

If a shelf position is available in a bay that houses one or two TBM shelves, you can install a TBM OPC shelf in the bay. The TBM OPC shelf is connected to the NT7E56 breaker interface panel in the bay. Therefore, alarming of the OPC shelf is not possible. This is because the other one or two TBM shelves are parts of a separate network element, and the alarm indicators on the breaker interface panel serve that network element rather than the OPC shelf.

Note: Although you could make parallel connections to make both shelves drive the alarm indicators, this is not recommended, because when the breaker interface panel indicated an alarm, you would have to check two operations controllers (the one in the OPC shelf and the one serving the other network element) to determine the source of the alarm.

You commission the TBM OPC shelf as an FCOT with a communications rate of zero.

In a stand-alone ABM OPC shelf

A stand-alone ABM OPC shelf is an ABM OPC shelf in its own bay. The equipment in the bay is similar to that installed in a bay with multiplexer configuration. (For a complete list of the equipment, see “Bay with multiplexer configuration” on page 6-7.) In this case, the alarming of the operations controller is possible.

You commission the bay as an FCOT with a communications rate of zero.

For more information on this type of OPC shelf, see “Stand-alone ABM OPC shelf” on page 7-15.

In a stand-alone TBM OPC shelf

A stand-alone TBM OPC shelf is a TBM OPC shelf in its own bay. The equipment in the bay is similar to that installed in a bay with transport single-shelf bay configuration. (For a complete list of the equipment, see “Transport single-shelf bay configuration” on page 6-10.) In this case, the alarming of the OPC is possible.

You commission the bay as an FCOT with a communications rate of zero.

For more information on this type of OPC shelf, see “TBM OPC shelf” on page 7-58.

In a portable OPC

The OPC can also be located in a portable OPC (NT7E24CC). The portable OPC houses both a tape drive and a hard drive. The factory loads all required software onto the portable OPC. The portable OPC is often used to download or upgrade software onto a shelf-installed OPC. In other instances, the portable OPC is used instead of a shelf-installed OPC. In this second case, the portable OPC is linked with a 9-pin to 9-pin CNet cable to the side interconnect left circuit pack of the common-equipment shelf. It is recommended that a laptop serve as the display terminal. Either a VT100-compatible terminal or a laptop computer with a VT100 emulation package can be used. For more information on the portable OPC, see “Portable OPC” on page 7-59.

Matched nodes

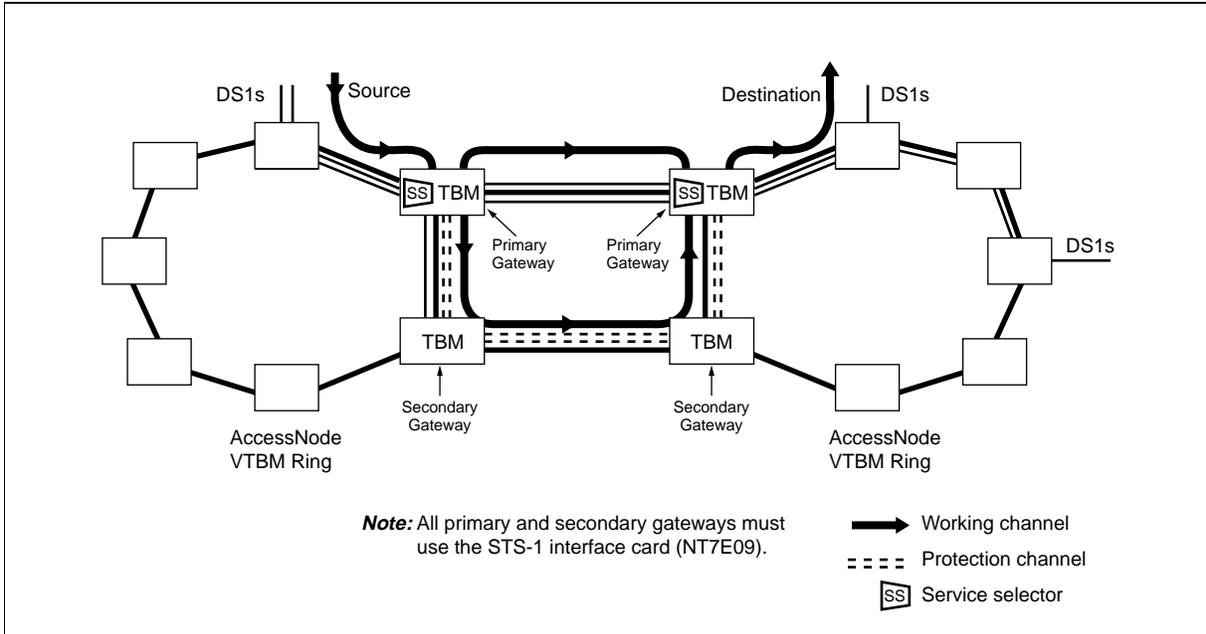
Matched nodes support OC-12 bi-directional line switched ring (BLSR) interconnections with other STS-managed rings to protect against traffic loss between rings. Instead of the traditional single link between rings, matched nodes supply two separate ports for the interconnect. This protects the traffic between two rings against all single fault failures and most double fault failures.

Matched nodes inter-ring traffic is passed through an STS-1 tributary. The network element (NE) where the STS-1 tributary resides is called a gateway for the inter-ring connection. Primary and secondary gateway nodes on one AccessNode ring interconnect to corresponding gateway nodes on another AccessNode ring. In an AccessNode BLSR ring, primary and secondary gateway nodes must be TN_BLSR shelf types.

Figure 3-5 shows a basic matched node configuration.

Figure 3-5
Basic matched nodes configuration

PC-16439



Primary gateways

The primary or working signal leaves the ring at the primary gateway node. On the other ring, the receiving primary gateway's service selector (SS) controls the matched node protection. The SS selects the better of the working signal it receives directly from the other ring's gateway, or the protection signal it receives from its own secondary gateway node. It then transmits the better signal to the connection's service access point (SAP). The SAP is the point at which a signal enters or leaves the SONET interconnection.

The SS defaults to the primary or working signal (the secondary signal is squelched). When a primary gateway receives a valid signal directly from the other ring, it terminates the squelched signal coming from its secondary gateway.

Secondary gateways

The secondary or protection signal leaves the ring at the secondary gateway node. On the other ring, the receiving secondary gateway forwards the signal to its primary gateway node. For more information on protection methods, see the signal flow and protection methods topics in this chapter and in *Protection Switching Description*, 323-3001-103, in this volume.

Protection methods

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

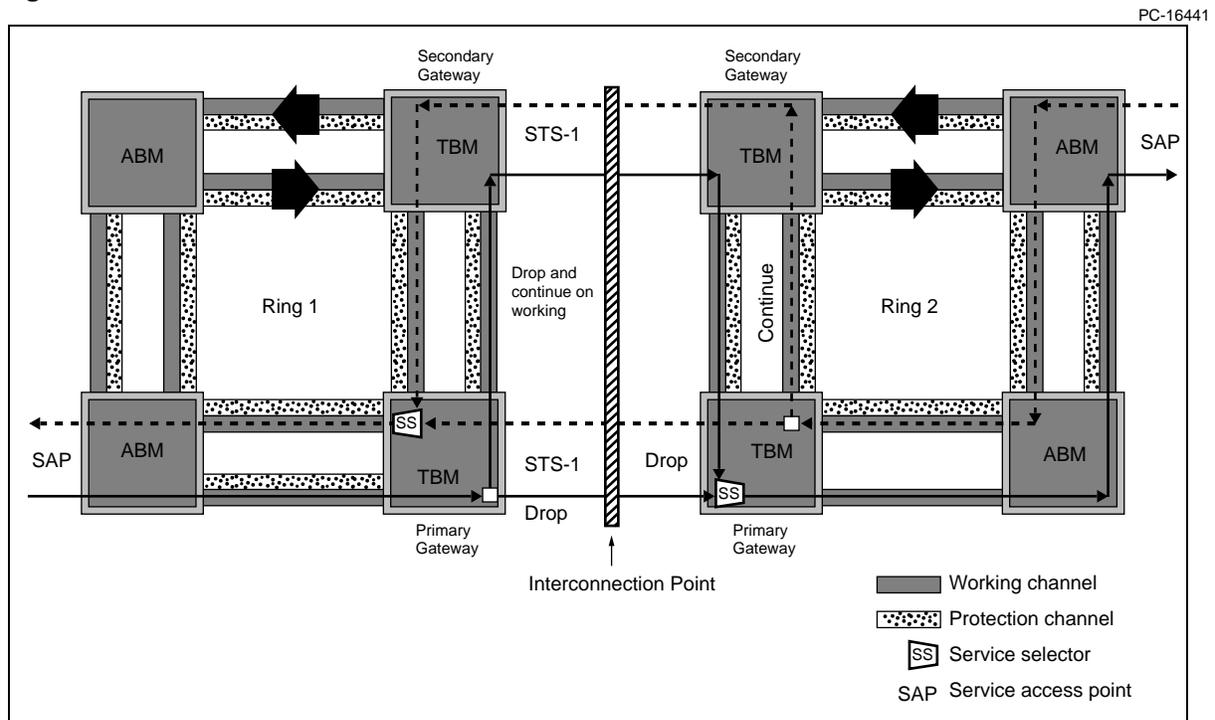
You can assign multiple levels of survivability based on the method you choose.

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 3-6 shows the signal flow in a DCW connection.

Figure 3-6
Signal flow in a DCW connection



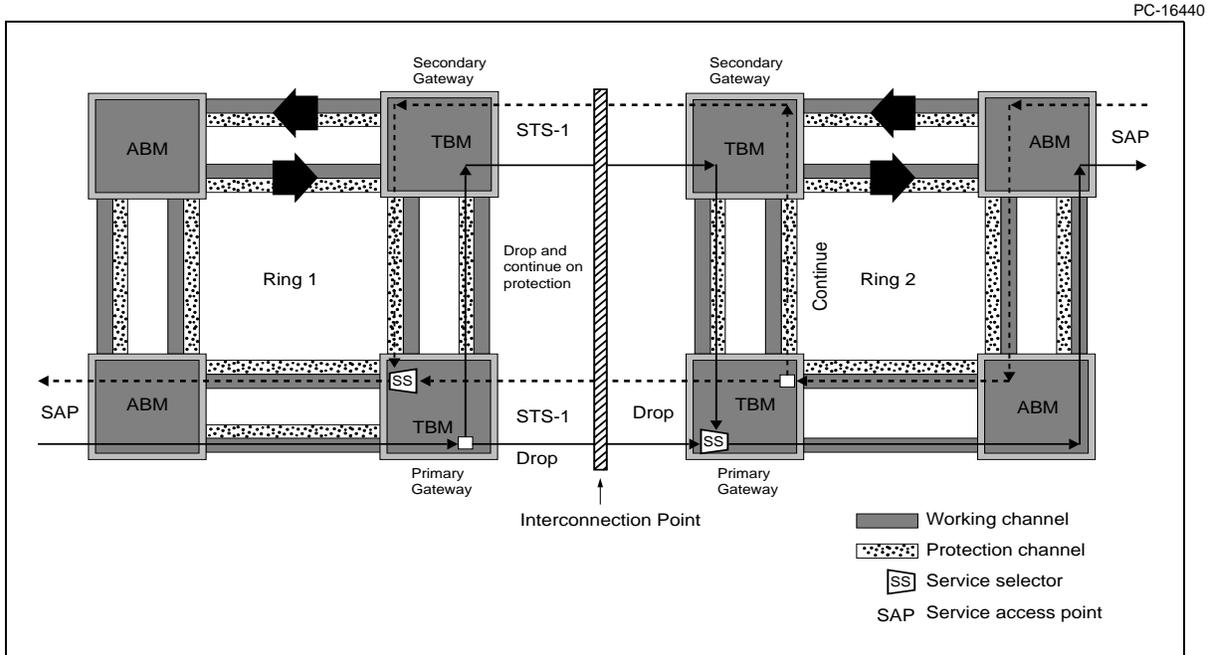
Drop and continue on protection

The DCP protection method carries secondary traffic between 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. This leaves the working bandwidth between the primary and secondary gateway nodes available for extra traffic (ET). If, however, a BLSR protection switch occurs, the matched nodes extra traffic on the protection channel is lost.

Figure 3-7 shows the signal flow in a DCP connection.

Figure 3-7
Signal flow in a DCP connection



Limitations

DCP connections have the following limitations:

- two DCP connections on the same channel cannot cross over at a primary gateway because misconnection and loss of traffic may 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.

Hardware and software requirements

For matched nodes, the primary and secondary gateway nodes must be TBM shelves configured as a TransportNode bi-directional line switched ring (TN_BLSR).

Table 3-1 lists the hardware requirements for TN_BLSR nodes that support matched node connections:

Table 3-1
Matched node hardware requirements

Card	PEC code
STS-1 interface (see Note 1)	NT7E09
STS-1/DS3 I/O BNC (up to 12)	NT4K30
STS-1/DS3 high speed protection switch (dual service/single fault)	NT4K60BA
24 Meg processor (see Note 2)	NT4K52BC or NT4K52BD
VTBM optics	NT7E05
Note 1: Required for all primary and secondary gateway nodes	
Note 2: Required for all primary and secondary gateway nodes	

The network elements (NEs) that are primary and secondary gateways must use AccessNode software. In addition, one operations controller (OPC) must manage all the access bandwidth managers (ABMs) and transport bandwidth managers (TBMs) within each ring.

The OPC and NEs must run the AN16 or greater software release.

Connection rules

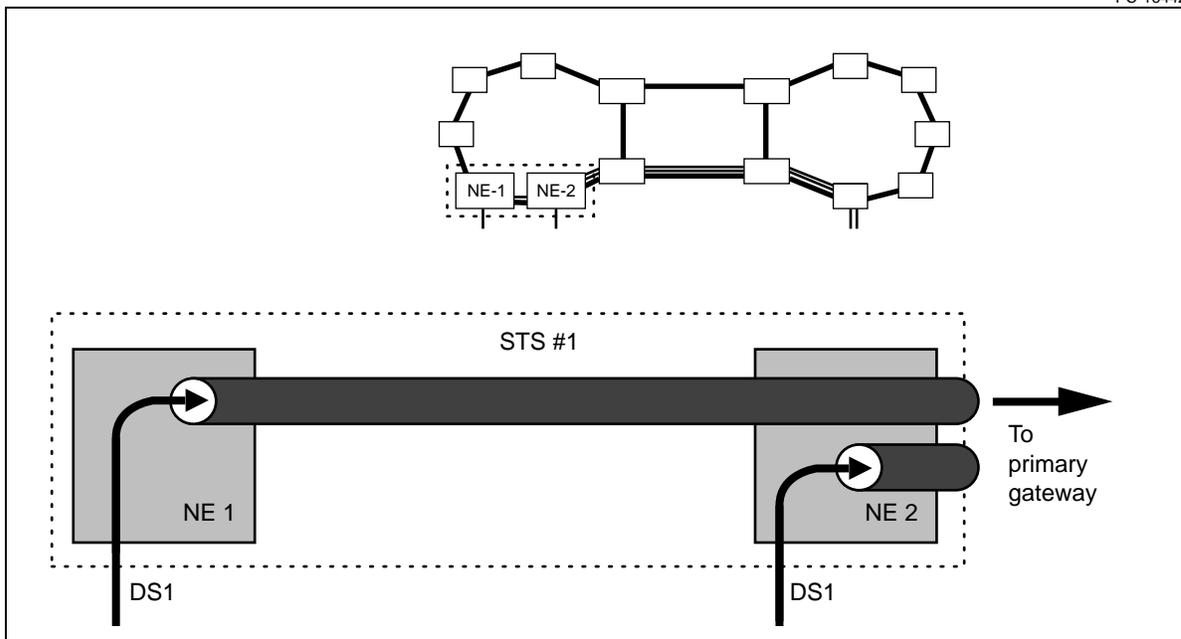
Matched nodes use STS-1 managed connections. If you add two DS1s to separate STSs to carry traffic across to the other ring, the two DS1s must be routed through separate STS channels.

Correct Connection

Figure 3-8 shows an example of an allowable STS-1 managed connection.

Figure 3-8
STS-1 managed matched node connection

PC-16442



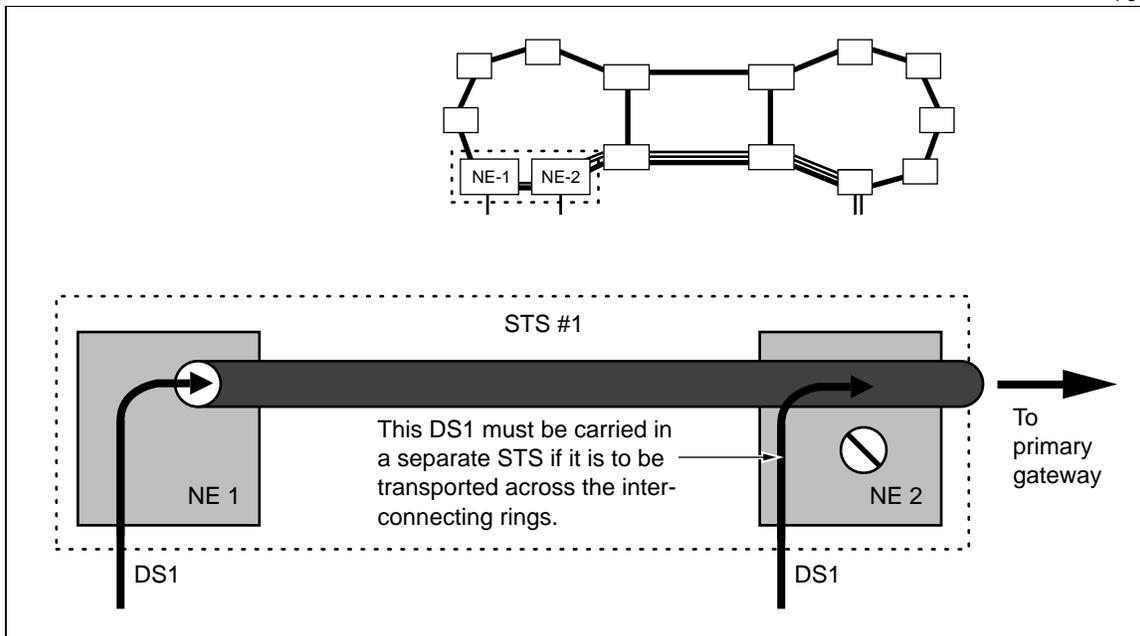
Incorrect connection

Two separate DS1s cannot be added to single STSs. The DS1 must be carried in a separate STS if it is to be transported across the interconnecting rings.

Figure 3-9 shows an example of an incorrect STS-managed matched node connection.

Figure 3-9
Incorrect STS-1 managed matched node connection

PC-16443



Supported connections

Here is a list of supported matched nodes connections on AccessNode BLSRs:

Connection	Shelf functions		
	RFT_BLSR	FCOT_BLSR	TN_BLSR
DS1 merged pair	X	X	X
OC3	X	X	X
DS3	X	X	X
TIC ¹	X	---	---

Note 1: If the connection from the TIC terminates on an STS-1 tributary and the STS-1 signal runs through a digital cross connect (DCC), universal services will operate, but Tandem, IDLC, and TR-08 services will not. This is caused by limitations of byte synchronous support on the TIC and DS1 mappers.

Limitations in matched nodes connections

The number of matched node connections supported by a ring is limited by the bandwidth available between the primary and secondary gateways. When you provision matched node connections, the Include DCP channels button on STS-1 Channel Usage dialog lets you determine available bandwidth and view protection channel status.

If a ring with two gateways uses this protection method	It can have a maximum of
DCW only	6 STS-rate matched node connections
DCP only	6 STS-rate matched node connections
DCW and DCP	12 STS-rate matched node connections

Table 3-2 shows the maximum number of connections for primary and secondary gateway nodes.

Table 3-2
Maximum number of matched node connections

Node type	Maximum number of connections
Primary gateway	6 STS-rate matched node connections. Each connection must have a unique working transport STS channel to prevent misconnections.
Intermediate nodes	6 STS-rate transport channels for DCW. 6 STS-rate transport channels for DCP.
Secondary gateway	6 STS-rate secondary gateway connections for DCW. 6 STS-rate secondary gateway for DCP.

Single and double fault failures

Matched nodes protect against:

- all single fault failures that affect traffic between two rings
- most double fault failures

Single fault failures

Matched node connections protect against all single fault failures (except entry node failure) that affect traffic between two rings. This includes the following types of failures:

- primary or secondary feed
- primary or secondary gateway node
- BLSR switch

The protection switch time for traffic protection because of signal failures is 160 mS.

Primary feed failures

Matched nodes protect against the following primary feed failures:

- signal failures, such as loss of signal or loss of frame that were not recovered by regular tributary protection switching
- line AIS, path AIS
- circuit pack failures that were not recovered by regular tributary protection switching
- facility out of service

Secondary feed failures

Matched nodes protect against the following secondary feed failures:

- signal failures, such as loss of signal or loss of frame that were not recovered by regular BLSR switching (for example, due to a higher priority switch request on some other span in the ring)
- path AIS, line AIS
- circuit pack failures that were not recovered by BLSR switching
- for DCP, any BLSR switch
- path unequipped (STS-1)

Double fault failures

Matched node connections protect against most double fault failures, including:

- BLSR switch and primary gateway node
- BLSR switch and secondary gateway node
- secondary feed
- BLSR switch and primary feed (protected for drop and continue on protection (DCP) only)

Matched nodes do not protect against the combination of a primary gateway or feed failure and a secondary gateway or feed failure. This type of double fault results in lost traffic.

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), or
- 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

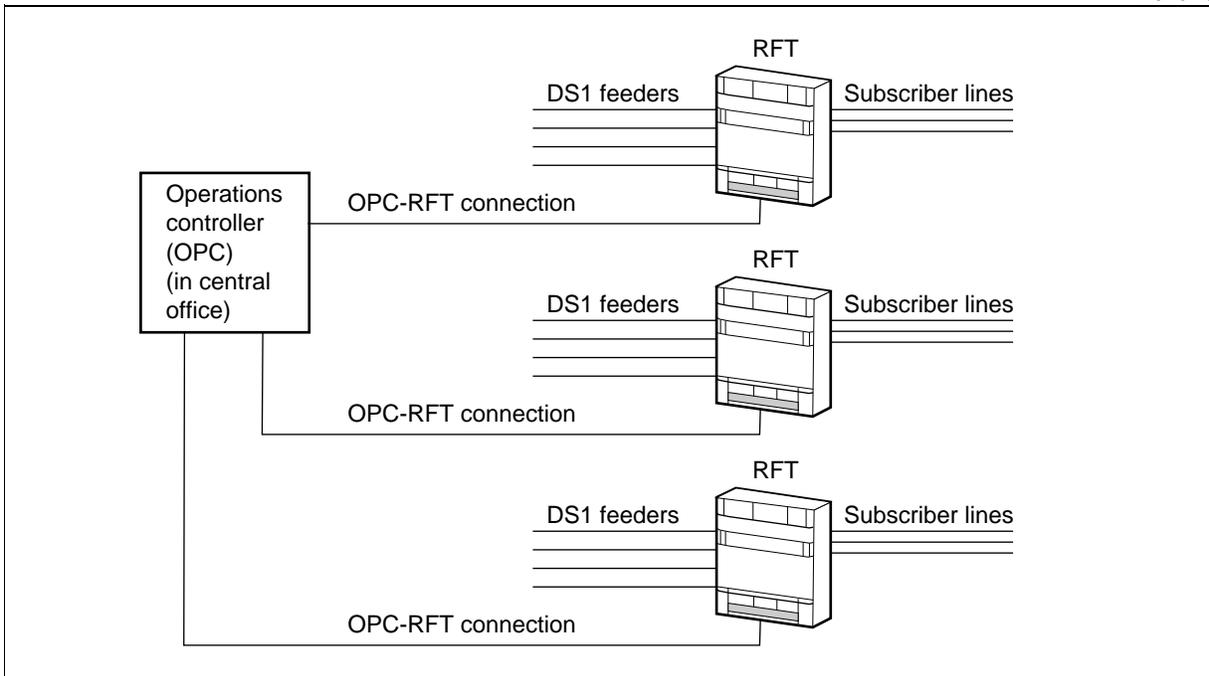
DS1-fed system

Figure 3-10 shows the topology of a DS1-fed AccessNode system. One or more digital switches switch the traffic handled by each DS1-fed remote fiber terminal (RFT). Each DS1-fed RFT connects to the switch or switches using external equipment that can support DS1s. In addition, each DS1-fed RFT must connect to the operations controller for the system.

Note: Figure 3-10 does not show details of the connection between the operations controller and the RFT. The various ways of making this connection are described on the following pages.

Figure 3-10
DS1-fed AccessNode system

PC-15415



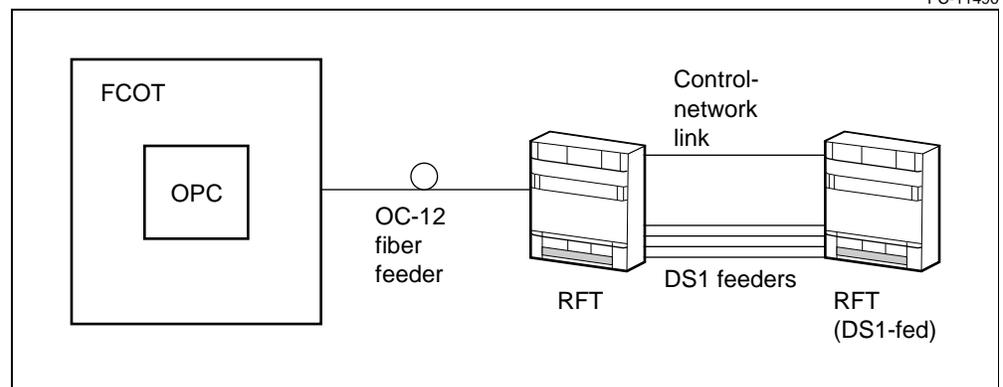
Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

Figure 3-11 shows another example of a DS1-fed system. In this case, the system is composed of a single DS1-fed RFT (shown at the right side of the figure).

The DS1-fed RFT expands the capacity of a basic fiber-fed system. The fiber-fed RFT has a capacity of 672 lines. When that capacity is fully occupied, the DS1-fed RFT is installed in the same location as the fiber-fed RFT, and it is fed by DS1s from the fiber-fed system.

The control-network connection between the two RFTs means that the same operations controller that serves the fiber-fed system can also serve the DS1-fed RFT. In this example, the operations controller (OPC) is in the FCOT.

Figure 3-11
DS1-fed AccessNode system with single DS1-fed RFT



Compatibility of DS1-fed systems with external equipment

In a DS1-fed system such as that shown in Figure 3-10, external equipment carries the DS1s to and from the RFTs. (External equipment means the equipment is external to the AccessNode system.) System tests have verified that DS1-fed systems are compatible with T1 span equipment and with FMT-150 Fiber Multiplex Terminals.

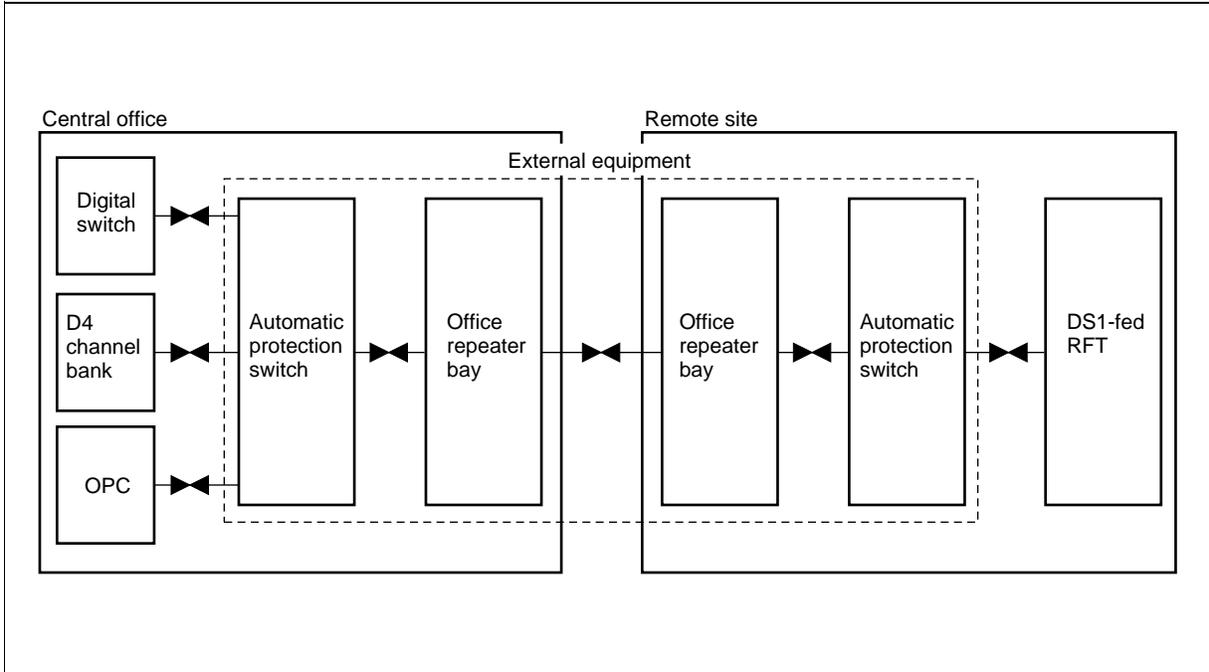
Compatible T1 span equipment

System tests have verified the compatibility of DS1-fed systems and external T1 span equipment. The T1 span equipment used in the tests consisted of a Larus 5601 Automatic Protection Switch in combination with either a Larus 1181 ASPR T1 Repeater (office repeater bay) or a Wescom STS 3192-9L Office Repeater (office repeater bay).

Figure 3-12 shows T1 span equipment used with a DS1-fed system.

Figure 3-12
External T1 span equipment used with a DS1-fed system

PC-11505



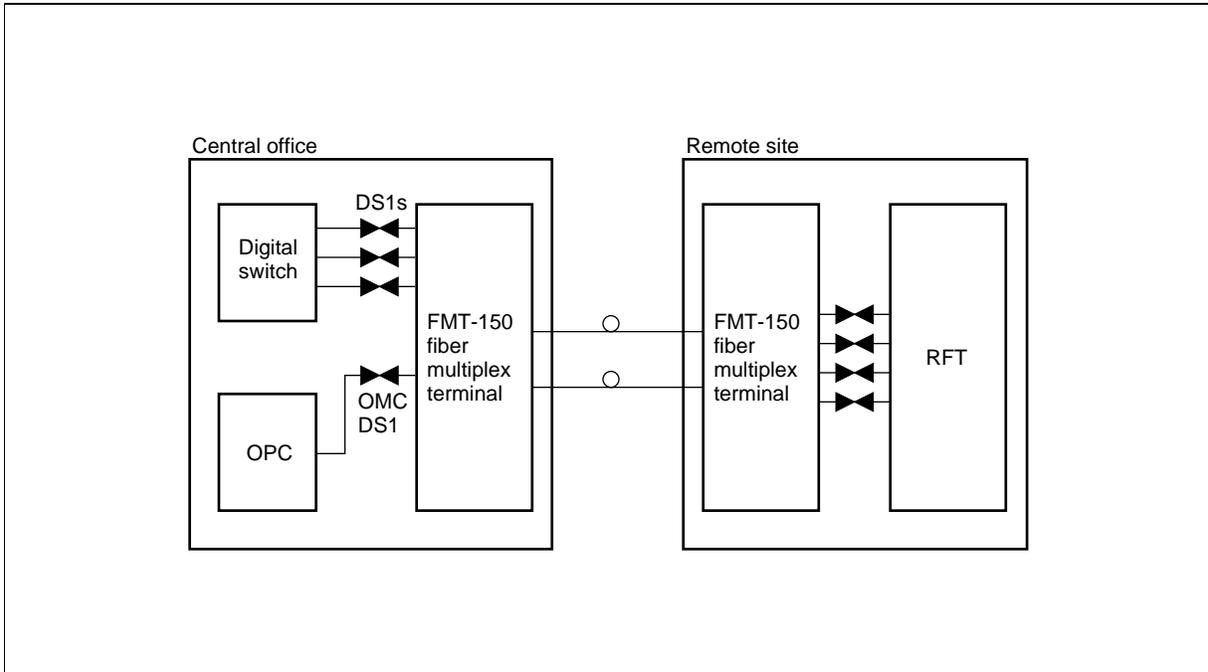
Compatible FMT-150 Fiber Multiplex Terminals

Compatibility testing was also performed transporting DS1s to the RFT using Nortel Networks FMT-150 Fiber Multiplex Terminals.

Figure 3-13 shows FMT-150 Fiber Multiplex Terminals used with a DS1-fed system.

Figure 3-13
FMT-150 Fiber Multiplex Terminals used with a DS1-fed system

PC-11506



Operations controller for a DS1-fed system

The operations controller is located in a central office. The connection between the operations controller (OPC) and a DS1-fed remote fiber terminal (RFT) can use any of the following, either singly or in any combination:

- control network
- SONET data communications channels (SDCC)
- OMC DS1, which is a DS1 carrying an operations maintenance channel (OMC)

For descriptions of control network, the SONET data communications channels, and the OMC, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

Connectivity between the OPC and the RFTs

The following figures illustrate different means of connectivity between the operations controller (OPC) and DS1-fed RFTs. In each case, the OPC is located in a central office. For information about the equipment in which the OPC can be installed, see “Locations for the operations controller for a DS1-fed system” on page 3-28.

Figure 3-14 shows the arrangement in which the OFC and two DS1-fed RFTs are connected using an OMC DS1. An OMC DS1 does not carry any traffic; rather, it carries only an OMC that carries operations, administration, maintenance, and provisioning (OAM&P) messages.

Figure 3-14
OAM&P connectivity for DS1-fed RFTs by way of an OMC DS1

PC-11489

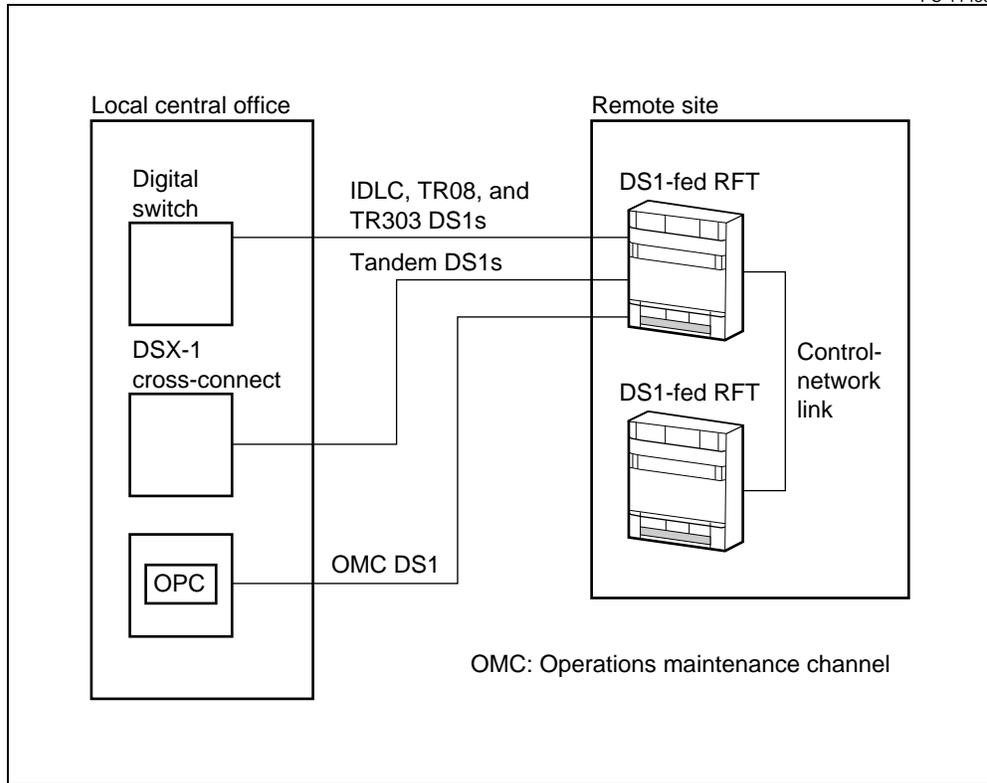
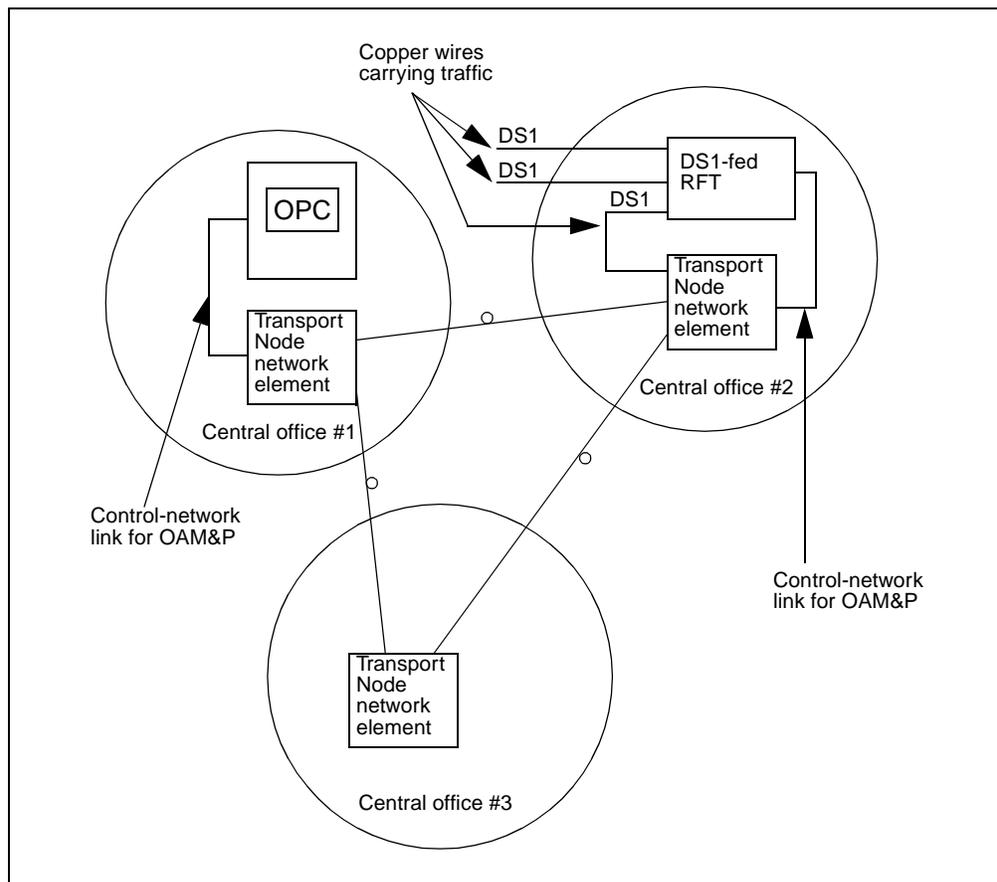


Figure 3-15 shows the arrangement in which the OPC and a DS1-fed RFT are connected using control-network links and the SONET overhead. In this case, an OMC DS1 is not needed for connectivity. In this arrangement, the messages between the operations controller and the RFT are carried around an S/DMS TransportNode OC-12 ring.

Note: In Figure 3-15, only the OAM&P messages must travel through the TransportNode OC-12 ring. The traffic-carrying DS1s can arrive at the RFT from sources completely separate from the S/DMS TransportNode system. Alternatively, some or all of the DS1 traffic received by the RFT can come from the TransportNode network element at central office #2. In that case, the facilities carrying the traffic connect to DS1 mappers at the TransportNode network element.

Figure 3-15
OAM&P connectivity for a DS1-fed RFT by way of SONET overhead



Locations for the operations controller for a DS1-fed system

You may be able to install the operations controller (OPC) in a shelf that serves other purposes. For example, you can install the operations controller in a transport bandwidth manager (TBM) shelf in an S/DMS TransportNode network element, if slots are available in such a shelf.

In other cases, you have to install an OPC shelf. An OPC shelf's only purpose is housing the OPC for an AccessNode system.

Note: The access bandwidth manager (ABM) OPC shelf must be used if the OPC and the remote fiber terminals (RFTs) are connected using operations maintenance channel (OMC) DS1s.

The possible locations for the OPC for a DS1-fed system are as follows:

- in available slots in a shelf that also serves other purposes:
 - in the ABM shelf in a DS1-fed RFT
 - in a TBM OPC shelf sharing a bay with another network element
- in an OPC shelf housing the operations controller:
 - TBM OPC shelf sharing a bay with another network element
 - stand-alone TBM OPC shelf
 - stand-alone ABM OPC shelf

In available slots in another network element

You can install the OPC in a common-equipment shelf in another network element (in an AccessNode or S/DMS TransportNode network element in a separate system). You can choose this option only if

- the appropriate slots are available in the shelf
- the shelf does not already contain another operations controller module
- there is a connectivity path between the operations controller and the DS1-fed RFTs

In a DS1-fed system, you would choose this option only if you did not need to use any OMC DS1s for connectivity between the OPC and the RFTs. (Connectivity without the use of an OMC DS1 is shown in Figure 3-15.)

In this case, alarming of the OPC and carrying remote telemetry (TBOS and E2A) from the RFTs to the central office is not possible.

In the access bandwidth manager shelf in a DS1-fed RFT

You can install the OPC in the ABM shelf in a DS1-fed RFT, but only if the RFT is located in a central office.

In a TBM OPC shelf sharing a bay with another network element

If a shelf position is available in a bay that houses one or two TBM shelves, you can install a TBM OPC shelf in the bay. In a DS1-fed system, you can use a TBM OPC shelf rather than an ABM OPC shelf only if you do not need to use any OMC DS1s for connectivity between the OPC and the RFTs. (Connectivity without the use of an OMC DS1 is shown in Figure 3-15 on page 3-27.)

If you install a TBM OPC shelf in a bay along with another TBM shelf, both shelves are connected to the NT7E56 breaker interface panel in the bay. Therefore, alarming of the OPC shelf is not possible because the alarm indicators on the breaker interface panel serve the TransportNode shelf rather than the OPC shelf.

Note: Although you could make parallel connections to make both shelves drive the alarm indicators, this is not recommended, because when the breaker interface panel indicated an alarm, you would have to check two operations controllers (the one in the OPC shelf and the one serving the other network element) to determine the source of the alarm.

You commission the TBM OPC shelf as a fiber central office terminal (FCOT) with a communications rate of zero.

In a stand-alone TBM OPC shelf

A stand-alone TBM OPC shelf is a TBM OPC shelf in its own bay. In a DS1-fed system, you can use a TBM OPC shelf rather than an ABM OPC shelf only if you do not need to use any OMC DS1s for connectivity between the OPC and the RFTs. (Connectivity without the use of an OMC DS1 is shown in Figure 3-15 on page 3-27.)

If you install a TBM OPC shelf in its own bay, the equipment in the bay is similar to that installed in a bay with transport single-shelf bay configuration. For a complete list of the equipment, see “Transport single-shelf bay configuration” on page 6-10. In this case, remote telemetry (TBOS and E2A) and alarming of the OPC is possible.

You commission the bay as an FCOT with a communications rate of zero.

For more information on this type of OPC shelf, see “TBM OPC shelf” on page 7-58.

In a stand-alone ABM OPC shelf

A stand-alone ABM OPC shelf is an ABM OPC shelf in its own bay. In a DS1-fed system, you must use an ABM OPC shelf if an OMC DS1 is used to connect the OPC and at least one of the RFTs. (Connectivity by way of an OMC DS1 is shown in Figure 3-14 on page 3-26.) You can also use an ABM OPC shelf if connectivity is available by other than OMC DS1s.

You commission the bay as an FCOT with a communications rate of zero.

For more information on this type of OPC shelf, see “Stand-alone ABM OPC shelf” on page 7-15.

Single-ended system

A single-ended AccessNode system uses an intermediary system as the central-office multiplexer for the traffic. The intermediary system multiplexes the traffic and interfaces to one or more digital switches. The intermediary system can be either a fiber-fed AccessNode system or an S/DMS TransportNode OC-12 ring. An OC-3 tributary from a network element in the intermediary system feeds each RFT.

Figure 3-16 shows the topology of a single-ended AccessNode system that uses an S/DMS TransportNode OC-12 ring as the intermediary system. The single-ended RFTs are connected to the network elements in the S/DMS TransportNode OC-12 ring. The operations controller (OPC) is located in a central office where one of the S/DMS TransportNode network elements is located.

Figure 3-16
Single-ended RFTs connecting to an S/DMS TransportNode OC-12 ring

PC-15416

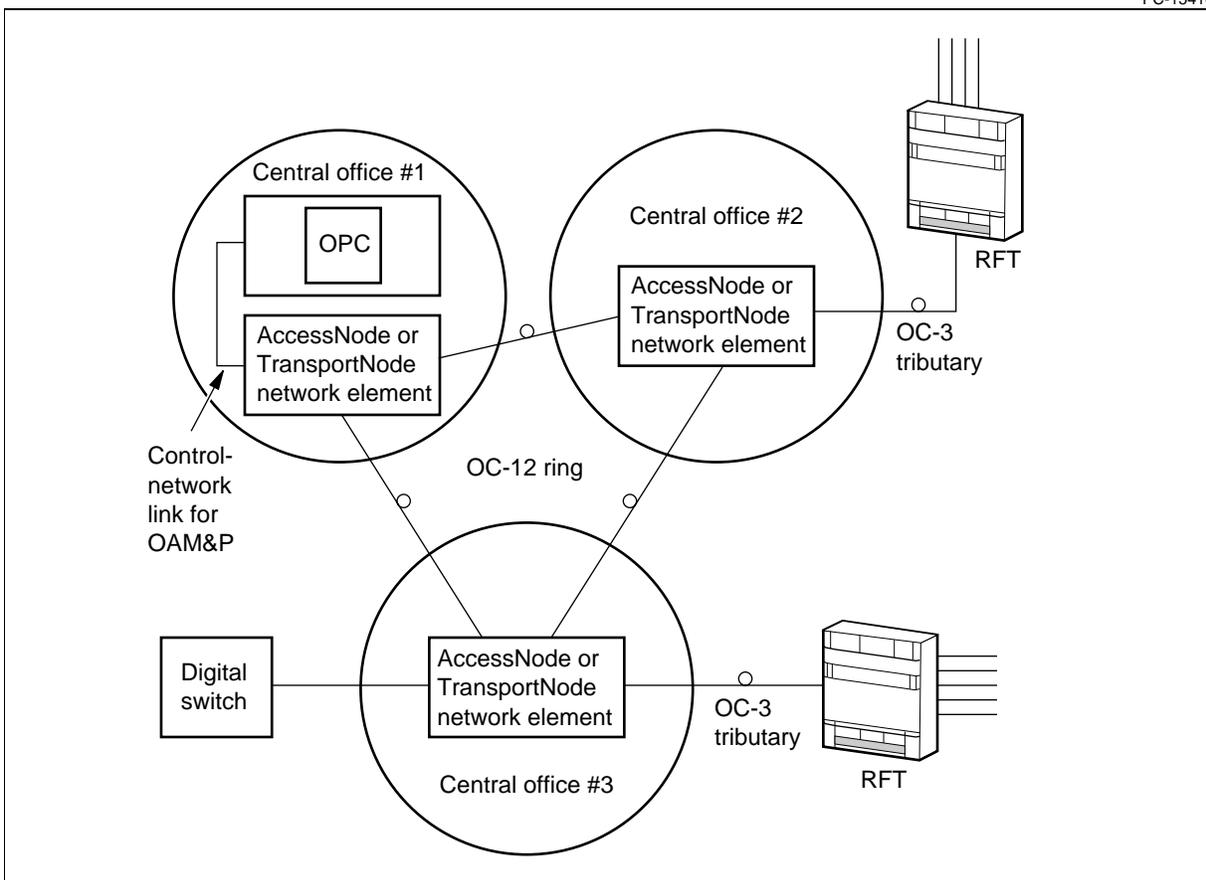
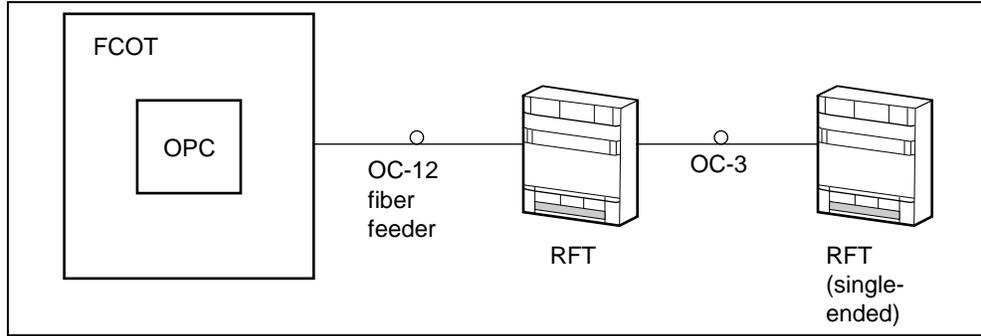


Figure 3-17 shows the topology of a single-ended AccessNode system that uses a fiber-fed AccessNode system as the intermediary system. The operations controller for the single-ended system is located in a central office where one of the AccessNode network elements is located.

Figure 3-17
Single-ended RFTs connecting to an AccessNode fiber-fed system

PC-15418



Operations controller for a single-ended system

The operations controller (OPC) for a single-ended AccessNode system must be located in a central office, usually in a central office that also contains one of the network elements in the intermediary system.

Note: Although the OPC is usually in the same location as AccessNode or S/DMS TransportNode equipment, the OPC for the single-ended system serves only the AccessNode network elements. A single OPC cannot serve both S/DMS TransportNode and AccessNode. The two systems require different software.

Connectivity between the OPC and the intermediary-system network element in the same central office uses control network. In the intermediary system, the SONET data communications channel (SDCC) carries the operations, administration, maintenance, and provisioning (OAM&P) communication between the OPC and the single-ended remote fiber terminal (RFT). The SONET data communications channel goes all the way to the single-ended RFT, because the SDCC is preserved in the OC-3 tributary that feeds the RFT.

Locations for the operations controller for a single-ended system

You may be able to install the operations controller (OPC) in a shelf that serves other purposes. For example, you can install the OPC in a transport bandwidth manager (TBM) shelf in an S/DMS TransportNode network element, if slots are available.

In other cases, you have to install an OPC shelf. An OPC shelf's only purpose is housing the operations controller for an AccessNode system.

The possible locations for the operations controller for a single-ended system are as follows:

- in available slots in a common-equipment shelf in a network element in the intermediary system
- in an OPC shelf housing the operations controller:
 - TBM OPC shelf sharing a bay with another network element
 - stand-alone access bandwidth manager (ABM) OPC shelf
 - stand-alone TBM OPC shelf

In available slots in an S/DMS TransportNode network element

You can install the OPC in a TBM shelf that houses one of the S/DMS TransportNode network elements, but only if the appropriate slots are available in the shelf, and only if the shelf does not already contain another OPC module. In this case, alarming of the OPC is not possible, and carrying remote telemetry (TBOS and E2A) from the remote fiber terminals (RFTs) to the central office is not possible.

In the ABM shelf in a single-ended RFT

You can install the OPC in the ABM shelf in one of the single-ended RFTs, but only if the RFT is housed in a central office. In this case, carrying remote telemetry (TBOS and E2A) from the RFTs to the central office is not possible.

In a TBM OPC shelf sharing a bay with another network element

If a shelf position is available in a bay housing one of the S/DMS TransportNode network elements, you can install a TBM OPC shelf in the bay. In this case, both shelves are connected to the NT7E56 breaker interface panel in the bay. Therefore, alarming of the OPC shelf is not possible because the alarm indicators on the breaker interface panel serve the TransportNode shelf rather than the OPC shelf.

Note: Although you could make parallel connections to make both shelves drive the alarm indicators, this is not recommended, because when the breaker interface panel indicated an alarm, you would have to check two operations controllers (the one in the OPC shelf and the one serving the S/DMS TransportNode) to determine the source of the alarm.

You commission the TBM OPC shelf as a fiber central office terminal (FCOT) with a communications rate of zero.

In a stand-alone ABM OPC shelf

A stand-alone ABM OPC shelf is an ABM OPC shelf in its own bay. The equipment in the bay is similar to that installed in a bay with multiplexer configuration. (For a complete list of the equipment, see “Bay with multiplexer configuration” on page 6-7.) In this case, remote telemetry (TBOS and E2A) and alarming of the OPC is possible.

You commission the bay as an FCOT with a communications rate of zero.

For more information on this type of OPC shelf, see “Stand-alone ABM OPC shelf” on page 7-15.

In a stand-alone TBM OPC shelf

A stand-alone TBM OPC shelf is a TBM OPC shelf in its own bay. The equipment in the bay is similar to that installed in a bay with transport single-shelf bay configuration. (For a complete list of the equipment, see “Transport single-shelf bay configuration” on page 6-10.) In this case, remote telemetry (TBOS and E2A) and alarming of the OPC is possible.

You commission the bay as an FCOT with a communications rate of zero.

For more information on this type of OPC shelf, see “TBM OPC shelf” on page 7-58.

Applications

AccessNode lends itself to many applications. These are applications that a basic fiber-fed system is most likely to serve when it is initially installed.

Chapter contents

This chapter includes the following topics:

Topic	See
Business-access application	page 4-2
Central-office-modernization application	page 4-4
SONET feeder application	page 4-6

Business-access application

In a typical network, AccessNode can provide business access.

With AccessNode, the access network has a single facility with a single piece of equipment in the business building. The traditional network has multiple service-specific facilities and multiple pieces of equipment. This service-specific equipment includes fiber-optic terminal systems, channel banks, digital loop carriers, and voice-frequency transmission equipment.

Typical reasons for deploying AccessNode in the business environment are:

- DS1 demand
- high special-service growth
- unpredictable special-service growth
- high service turnover

Cost-effective flexibility

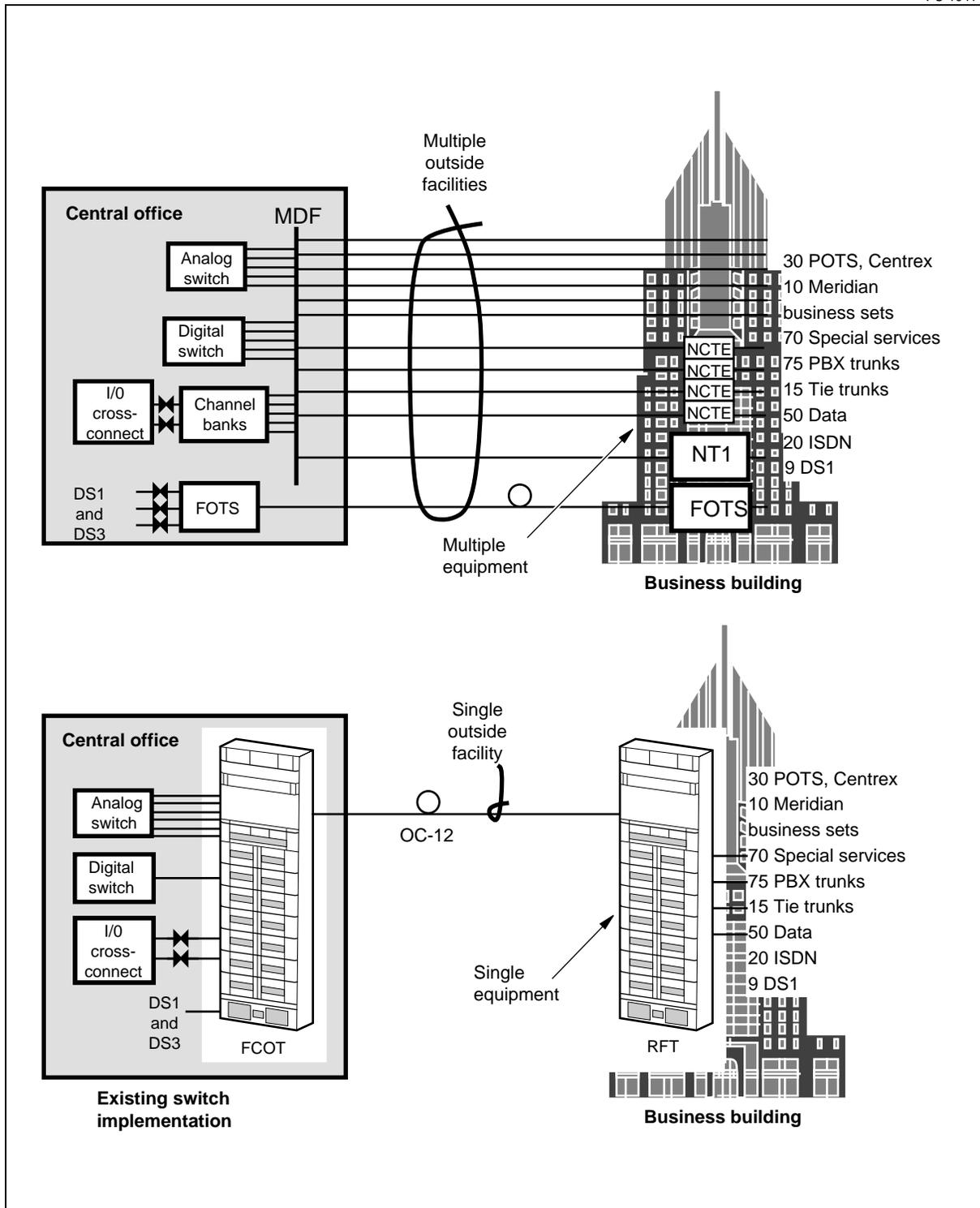
AccessNode can deliver a wide range of business services, simply and cost-effectively. It offers an extensive range of narrowband and wideband interface options. It offers remotely provisionable line-interface units, so the service provider can change the service quickly and economically without the need for a site visit.

This flexibility makes AccessNode ideal in business markets with diverse service requirements and high service turnover. The service provider can simplify the business access network by deploying AccessNode.

Figure 4-1 shows how AccessNode can deliver services to a business building. One AccessNode is deployed in the central office to connect to the equipment there. Another AccessNode is deployed at the remote site in the business building. You can have a mix of services, including plain old telephone service (POTS) lines.

Figure 4-1
Business access provided by AccessNode

PC-10414



Central-office-modernization application

AccessNode can be used for central-office modernization. It allows a graceful transition from the current mixture of central-office equipment. It allows a phased evolution that can be tailored to the requirements of individual installations.

A number of problems are associated with the equipment currently used in central offices:

- Bandwidth is costly to add.
- Bandwidth can be added only in fixed sizes; therefore, adding bandwidth for small applications is not cost-effective.
- The equipment is unable to respond to changing market demands.
- Potential planning mistakes exist.

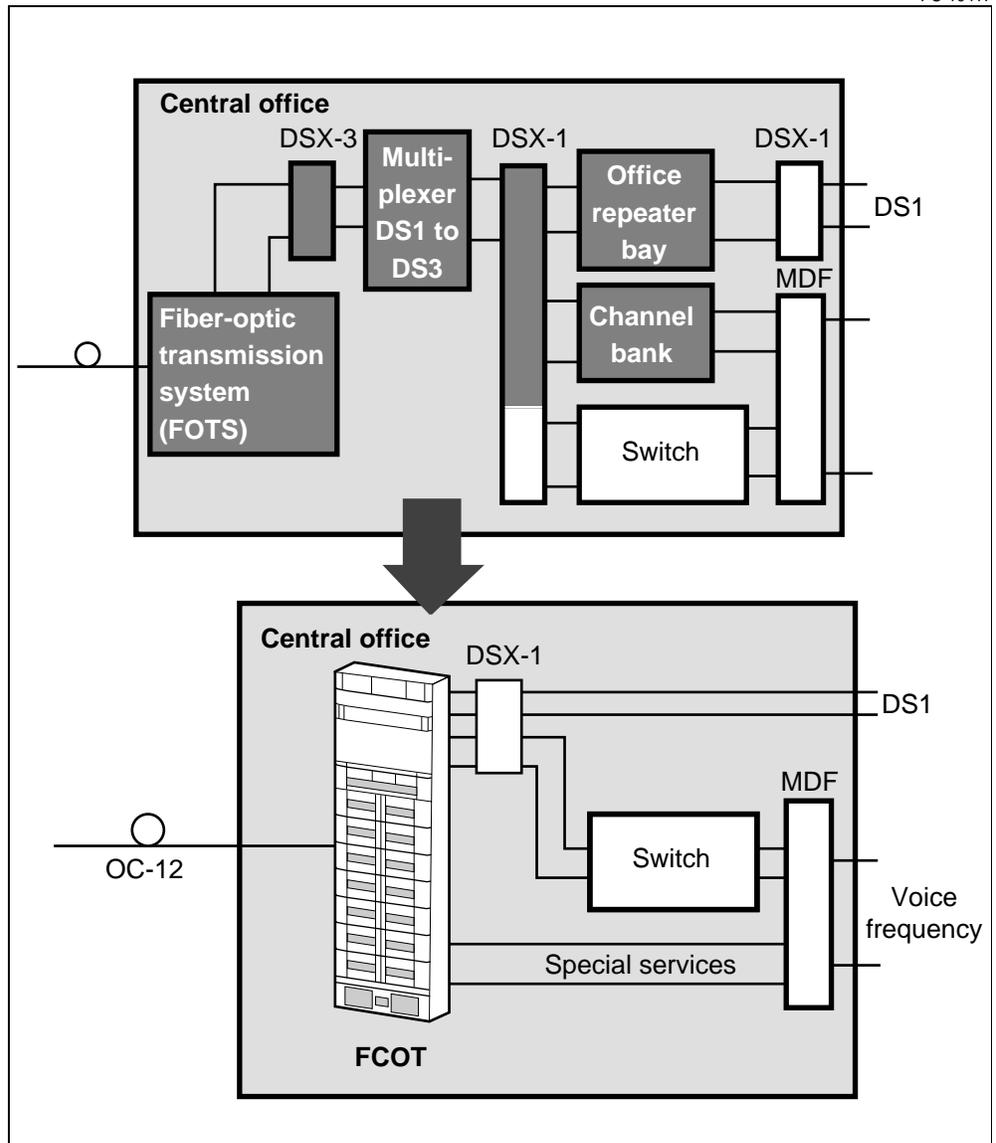
AccessNode solves the problems associated with current central-office equipment by offering the following features and benefits:

- Bandwidth management is simple and cost-effective.
- Bandwidth can be provisioned as needed for any application.
- Line interfaces can adapt quickly and easily to changing service requirements.
- Flexible architecture enables simultaneous narrowband and wideband access capabilities.

Figure 4-2 on page 4-5 shows how AccessNode can modernize a central office. A single AccessNode, shown in the lower portion of the figure, replaces all of the shaded pieces of equipment in the upper portion of the figure. This evolution can proceed in small stages.

Figure 4-2
Central-office modernization using AccessNode

PC-10417



SONET feeder application

SONET feeder is an application in which SONET fiber transports DS1s between the central office and a remote location. At each site an AccessNode acts as a multiplexer.

AccessNode provides a cost-effective solution to increasing demand for DS1 services. To respond to these high-capacity demands, service providers currently use digital copper systems and asynchronous fiber-optic systems. (In an asynchronous fiber-optic system all the equipment is not synchronized to a central clock.) The current systems do not address many existing problems.

A number of problems are associated with the copper systems and asynchronous fiber-optic systems that are currently in use:

- Bandwidth is costly to add.
- Bandwidth can be added only in fixed sizes; therefore, adding bandwidth for small applications is not cost-effective.
- The systems are unable to respond to changing market demands.
- Potential planning mistakes exist.

AccessNode solves the problems associated with current systems by offering the following features and benefits:

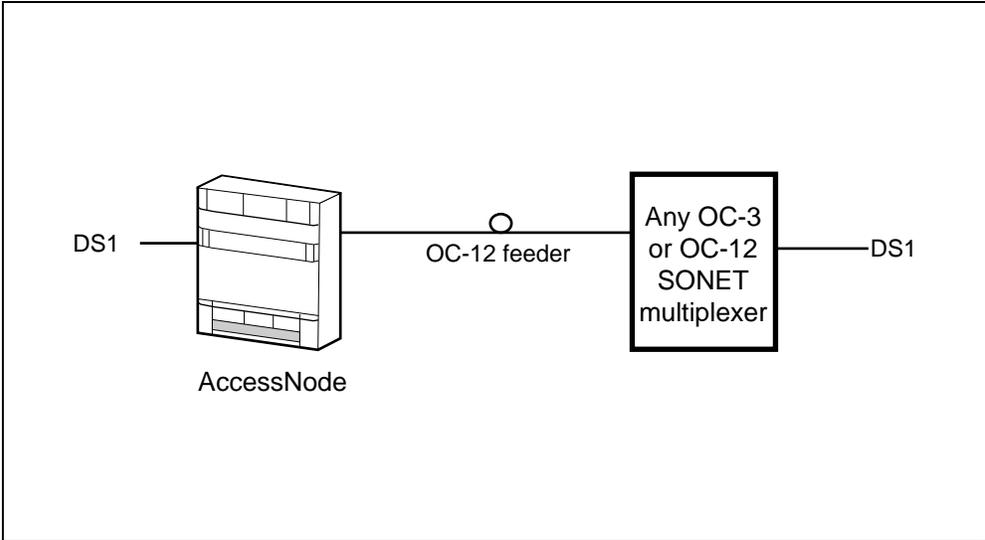
- Bandwidth management is simple and cost-effective.
- Bandwidth can be provisioned as needed for any application.
- Line-interface units can adapt quickly and easily to changing market demands.
- Flexible architecture enables simultaneous narrowband and wideband access capabilities.

AccessNode allows a graceful evolution from the current mixed access-plant environment.

Figure 4-3 illustrates the use of AccessNode in SONET feeder applications in a multivendor environment.

Figure 4-3
SONET-feeder application

PC-10418

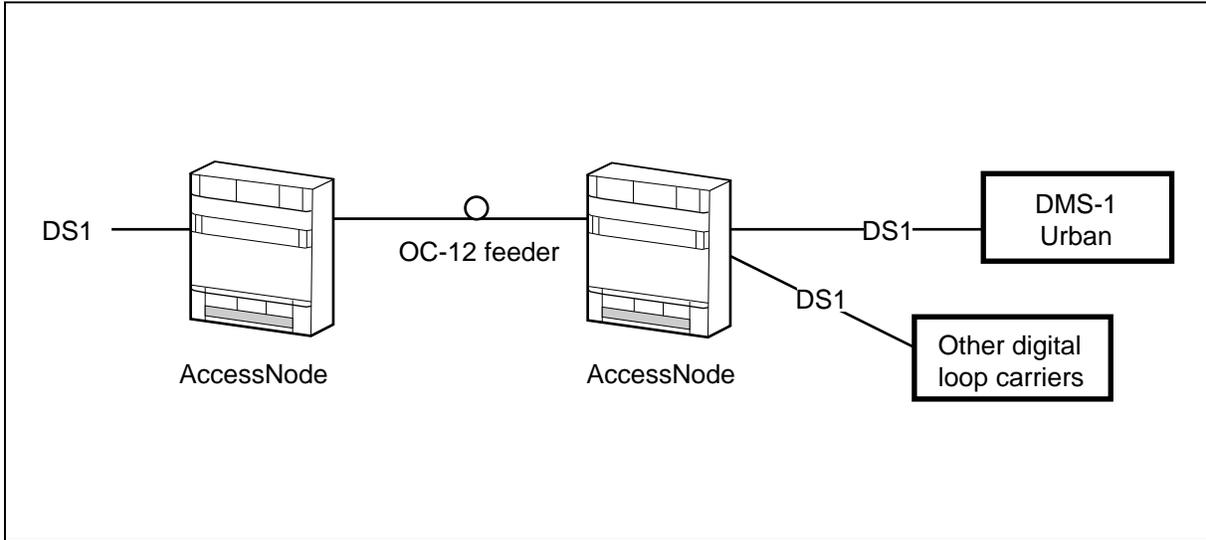


Interworking of AccessNode and DMS-1 Urban

Two systems that work together are said to interwork. AccessNode can interwork with DMS-1 Urban, as illustrated in Figure 4-4.

Figure 4-4
DMS-1 Urban and AccessNode

PC-10420



A carrier serving area (CSA) typically includes a residential community with nearby small businesses. The services are largely plain old telephone service (POTS) with a small percentage of business services. The DMS-1 Urban is deployed in this CSA environment and is linked to its host switch with copper or fiber transport equipment. The SONET feeder application of AccessNode establishes a SONET feeder capability for DMS-1 Urban. AccessNode also provides a SONET feeder with a DS1 interface, for other digital loop carrier (DLC) systems and their host switches. This AccessNode application prepares the CSA for future fiber to the subscriber premises.

AccessNode is backwardly compatible with the DMS-1 Urban. Operations, administration, maintenance, and provisioning (OAM&P) commonality exists among Nortel Networks products, and that commonality extends to DMS-1 Urban as well.

Interfaces to host switches

This chapter discusses the interface between an AccessNode system and the one or more switches that serve the system. Such switches are referred to as host switches.

Chapter contents

This chapter contains the following information:

Topic	See
Types of host switches	page 5-2
Single hosting and multihosting	page 5-3
GR-303 interface	page 5-7
TR-08 interface provided by AccessNode	page 5-8
DMS Access interface	page 5-11
DMS-X Interface to APC-100	page 5-14
Multi-IG/Multi-SMA	page 5-14

Types of host switches

AccessNode systems can interface to the following types of host switches:

- analog switches
- digital switches

Analog switches

An analog switch switches lines carrying analog signals. Also included in the category are digital switches with analog interfaces.

Digital switches

A digital switch switches lines carrying digital signals.

Table 5-1 summarizes the compatibility of the three types of AccessNode systems with digital and analog switches.

Table 5-1
Compatibility of switch types and system types

System type	Digital switches	Analog switches
Fiber-fed system	Compatible	Compatible
DS1-fed system	Compatible	Not compatible
Single-ended system	Compatible	Not compatible

Single hosting and multihosting

Single hosting refers to the arrangement in which all the lines supported by an AccessNode system are switched by a single switch. Multihosting refers to the arrangement in which the lines are switched by more than one switch.

General meaning of the term multihosting

The term multihosting refers to an arrangement in which

- some of the switched lines from an AccessNode system are switched by (“hosted” by) one switch
- other lines from the AccessNode system are switched by another switch

Each line has a fixed association with only one switch, but different lines or groups of lines from the AccessNode system are allotted to different switches.

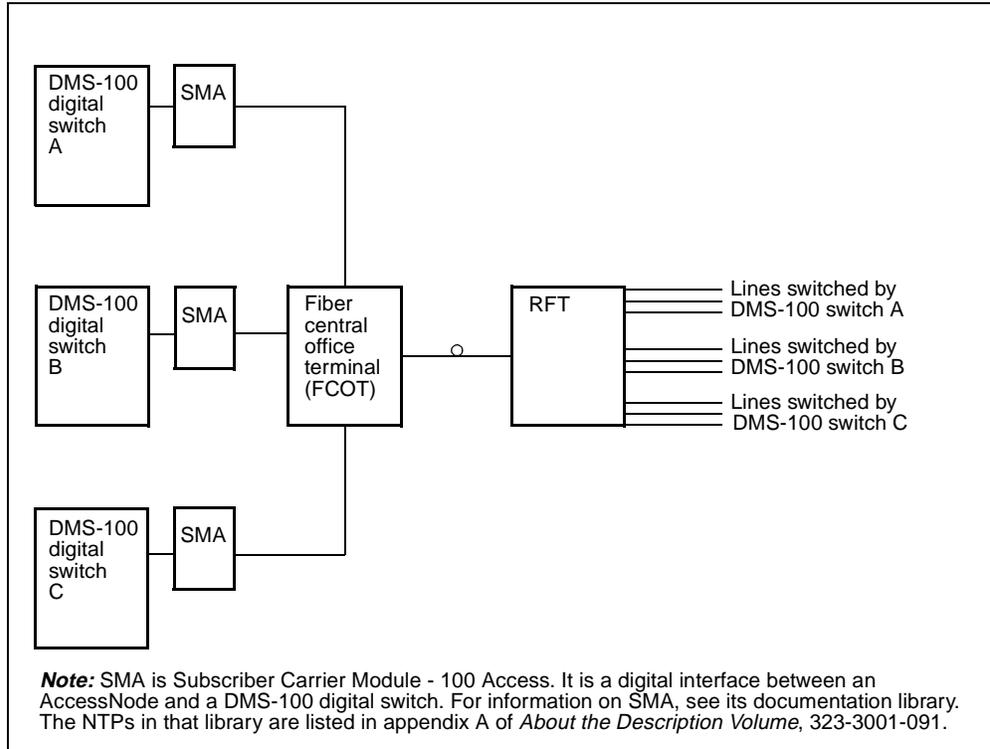
Specific meaning of the term multihosting as used in this library

Wherever multihosting is used in the AccessNode library (unless the text contains an explicit statement to the contrary), it refers to only one arrangement, the arrangement in which different *digital* host switches switch different lines or groups of lines from an AccessNode system (fiber-fed or copper-fed). Each line has a fixed association with only one switch, but the lines are allotted to different digital switches. In this release, the maximum number of digital switches is five. The switches may be located in the same central office or in different central offices.

Note: In addition to the lines allotted to the digital host switches, other lines from the AccessNode system may be allotted to one or more analog host switches (or to digital switches that have analog interfaces). However, the presence or absence of such hosts does not affect whether the arrangement exemplifies multihosting, as the term is used in this library.

Figure 5-1 on page 5-4 shows an example of multihosting in which lines from a remote fiber terminal (RFT) are hosted by three digital host switches.

Figure 5-1
Example of multihosting with three digital host switches



Compatible with all AccessNode systems

Multihosting is compatible with all AccessNode systems (basic fiber-fed systems, DS1-fed systems, and single-ended systems).

How multihosting works

The following is a high-level explanation of how multihosting works in a fiber-fed AccessNode system. This explanation is not a set of instructions for setting up multihosting. For detailed instructions, see *Provisioning and Operations Procedures*, 323-3001-310, in *Operations, Administration, and Provisioning*, Volume 4B.

Multihosting works as follows:

- You specify the digital hosts that will contact the fiber central office terminal (FCOT).
- You route GR-303 DS1s to each digital host.
- You use the maintenance and administration position (MAP) interface of each digital host to provision lines on the RFT. The lines provisioned from a host are switched by that host.

Specifying the digital hosts

You use the operations controller (OPC) tool called Host Provisioning Manager to specify the digital hosts that will contact the fiber central office terminal (FCOT).

GR-303 DS1s for each digital host

The RFT supports 28 DS1s that can carry services switched by digital hosts. A DS1 that carries digitally switched services is called a GR-303 DS1. All 28 of the DS1s are not necessarily GR-303 DS1s, because some or all of them may be tandem DS1s, which carry special services, or TR-08 DS1s, which carry services to a TR-08 interface in a digital switch.

In the FCOT, two DS1/VT mappers installed in an odd-even pair of slots in the access or transport bandwidth manager shelf (for example, slots 5 and 6) handle the 28 VT1.5s carrying the tandem DS1s, TR-08 DS1s, and GR-303 DS1s. In the RFT, the 28 VT1.5s are routed to the transport interface card in the access bandwidth manager shelf. (From the transport interface card, the traffic goes to the access interface cards in the same shelf, then to the line cards in the copper-distribution shelves.)

To designate DS1s as GR-303, TR-08, or tandem, and to route the GR-303 DS1s to the appropriate digital host, you use an operations controller (OPC) tool called the Connection Manager. The RFT contains a database that tracks the DS1s designated as GR-303, TR-08, tandem, and unassigned, and also tracks the GR-303 DS1s routed to each digital host.

You can designate all 28 DS1s as tandem DS1s or as TR-08 DS1s. Alternatively, you can designate all 28 as GR-303 DS1s if you are connecting to an SMA2 switch peripheral, or up to 20 DS1s if connecting to an SMA switch peripheral.

If you route any GR-303 DS1s to a digital host, you must route at least two to the host because the first two GR-303 DS1s routed to the host carry the embedded operations channel (EOC) and the common signaling channel (CSC).

Note: When you use the Connection Manager to change the designation of a DS1 to or from the GR-303 type, you must always coordinate the change with the digital host, and make parallel modifications to the remote digital terminal inventory (RDTINV) table in the MAP interface at the switch. The database in the RFT and the database in the switch must be synchronized. Otherwise, when the digital host detects a discrepancy between its own database and that of the RFT, it issues an alarm indicating the database is corrupt, and rejects all line requests from the AccessNode system. For detailed information on how to avoid this problem, see *Provisioning and Operations Procedures*, 323-3001-310, in *Operations, Administration, and Provisioning*, Volume 4B.

Ownership of lines at the RFT

From any one of the digital hosts, you can provision any unassigned line on the RFT. You can use the MAP interface to provision lines from a digital host. If you provision a line from a digital host, the host owns the line. Any digital host can own any number of lines on the RFT. The lines owned by a host do not need to be grouped together in the copper-distribution shelves of the RFT.

The line termination object (LTO) for a line accepts messages only from the host that owns the line. Therefore, you can deprovision the line only from the host that owns the line.

Note: If an analog host switches a line or if the line carries a tandem circuit, you provision the line from the OPC, and the OPC owns the line.

GR-303 interface

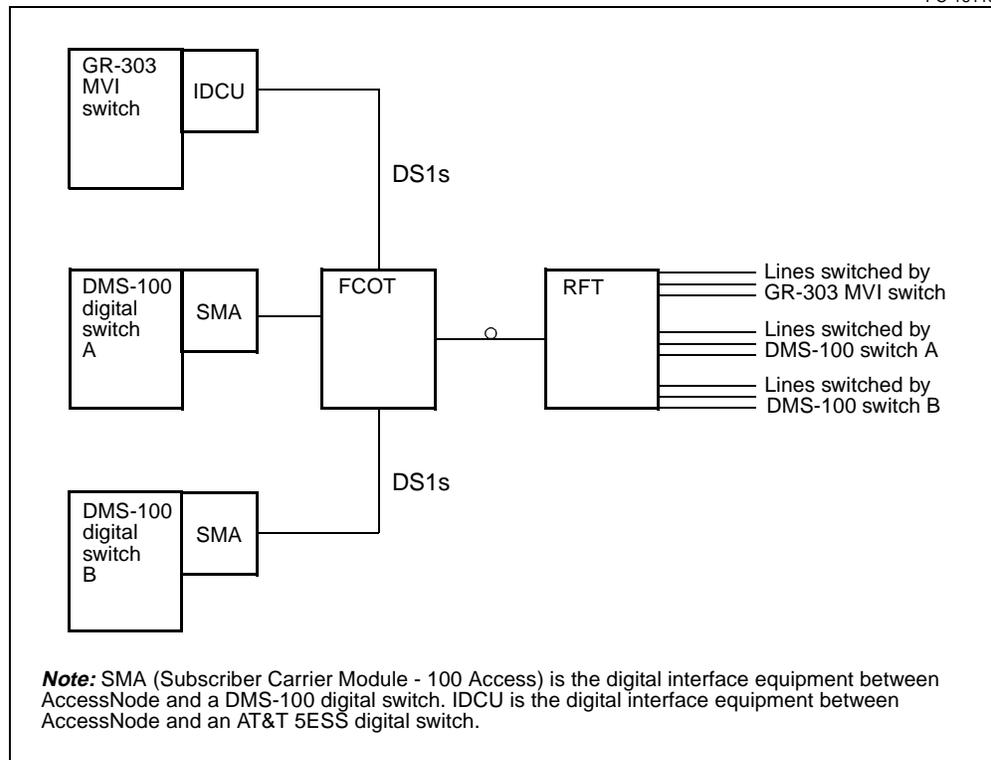
GR-303 multihosting support consists of any combination of one to five GR-303 DMS or GR-303 MVI hosts. The primary host, to which all RFT log and alarm events are reported, must be a GR-303 DMS host. In addition, up to seven TR-08 host switches and any number of analog hosts are supported. Refer to *Provisioning and Operations Procedures, 323-3001-310*, in *Operations, Administration, and Provisioning, Volume 4B*, for the procedure for adding a new host switch to RFT data.

The primary difference between these GR-303 implementations is their call processing method: GR-303 MVI uses the Time-slot Management Channel (TMC), whereas GR-303 DMS uses the Common Signalling Channel (CSC).

Figure 5-2 shows an AccessNode system with multihosting on several switches, including a GR-303 MVI host switch.

Figure 5-2
AccessNode point-to-point system with multihosting

PC-16113



TR-08 interface provided by AccessNode

TR-08 is Bellcore specification TR-TSY-000008, which describes the digital interface between the SLC-96 digital loop carrier system and a local digital switch. TR-08 has three “modes,” designated as I, II, and III. AccessNode supports only mode I. (The DS1 span protection feature of mode I is not supported.)

An SLC-96 system consists of 4 “shelves,” each of which supports up to 24 DS0 channels. The four shelves are identified as A, B, C, and D. An SLC-96 system operating in mode I uses 1 DS1 line to carry the 24 DS0 channels from a shelf. Therefore, to carry the 96 DS0 channels from the 4 shelves in the SLC-96 system, 4 DS1 lines are required. The four DS1 signals are designated as the A span, the B span, the C span, and the D span. The A span carries a special communication channel called the derived data link (DDL). For information on the DDL, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

Compatible with all AccessNode systems

The TR-08 interface is compatible with all AccessNode systems (basic fiber-fed systems, DS1-fed systems, and single-ended systems).

Mapping TR-08 lines

The following two methods of mapping TR-08 lines are available:

- standard mapping
- random mapping

The following paragraphs contain brief descriptions of the two methods. For detailed information on slot usage and mapping, see *Line Card Testing Procedures*, 323-3001-316, in *Operations, Administration, and Provisioning*, Volume 4B.

For provisioning procedures, see *Line Card Provisioning Procedures*, 323-3001-315, in *Operations, Administration, and Provisioning*, Volume 4B.

Standard mapping

In standard mapping, the line cards in a single copper-distribution shelf handle the DS0 channels for a TR-08 system, and the DS0 channels have known mappings to the line-card slots in a copper-distribution shelf. To implement standard mapping for a copper-distribution shelf, you can provision each circuit individually, or you can use the TR-08 Default Provisioning Manager tool, which provisions all the circuits for the TR-08 system.

Note: Standard mapping does not mean that the copper-distribution shelf acquires an identity as a TR-08 system. You can depart from standard mapping at any time by deleting standard-mapped circuits and reprovisioning them for other TR-08 systems, or as non-TR-08 circuits.

Random mapping

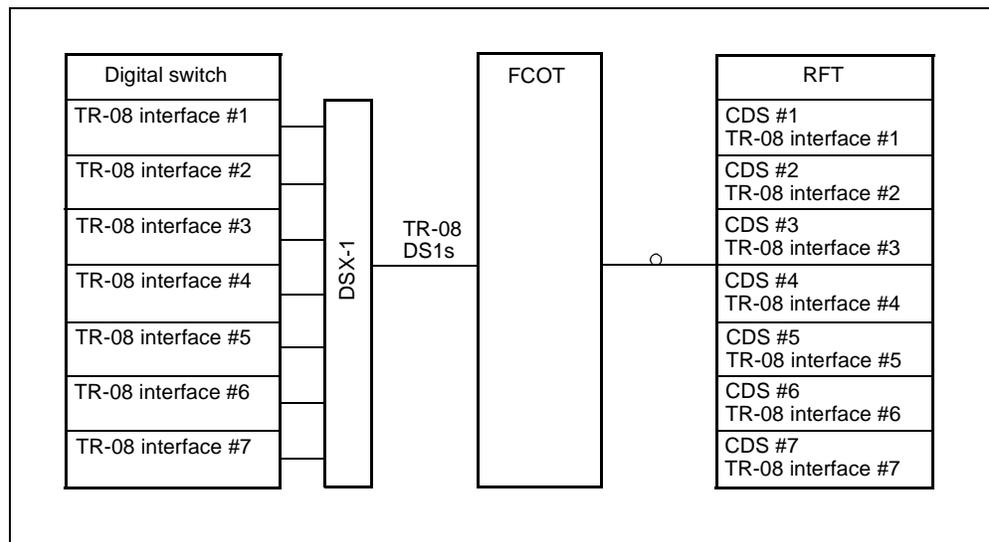
In random mapping, any line-card slot in any copper-distribution shelf can be mapped to any DS0 in any DS1 designated as a TR-08 DS1.

System handling TR-08 traffic

Figure 5-3 illustrates a basic fiber-fed AccessNode system that handles TR-08 traffic and uses standard mapping. The RFT emulates seven SLC-96 systems, one SLC-96 system for each copper-distribution shelf. The traffic to and from each emulated SLC-96 system amounts to 96 DS0 channels. To carry the 96 DS0s between the remote fiber terminal (RFT) and the fiber central office terminal (FCOT) requires 4 VT1.5s. Therefore, to carry the traffic to and from the 7 emulated SLC-96 systems requires 28 VT1.5s. The SONET payload mapped to the first port of the transport interface card (TIC) in the RFT carries those VT1.5s in STS-1.

At the FCOT, a pair of DS1/VT mappers handles STS-1 #1 of the SONET payload. The mappers convert the traffic to DS1s. The DS1s are routed to a DSX-1 cross-connect, then to the digital switch, which contains TR-08 interfaces to handle the traffic.

Figure 5-3
TR-08 application



TR-08 DS1s

TR-08 DS1s carry TR-08 traffic between the switch and the FCOT. VT15s carry TR-08 traffic between the FCOT and the RFT. Each VT1.5 handles 24 DSOs, which is the equivalent of one DS1. Each SLC-96 system that the RFT emulates requires four VT1.5s. The RFT supports 28 VT1.5s capable of carrying TR-08 traffic. If some of the 28 available VT1.5s are not used for TR-08 traffic, they can be designated for other purposes (for example, to carry tandem traffic).

In the FCOT, two DS1/VT mappers installed in an odd-even pair of slots in the access or transport bandwidth manager (TBM) shelf (for example, slots 5 and 6) handle the VT1.5s carrying the TR-08 traffic.

In the RFT, the VT1.5s carrying the TR-08 traffic are routed to the transport interface card in the access bandwidth manager (ABM) shelf. From the transport interface card, the TR-08 traffic goes to the access interface cards in the same shelf, and then to the line cards in the copper-distribution shelves.

The traffic to and from each copper-distribution shelf in the RFT designated as a TR-08 interface requires four VT1.5s. One of the four VT1.5s for each TR-08 interface carries the maintenance and alarm messages in its virtual tributary (VT) overhead. The transport interface card (TIC) can access those TR-08 messages only in the overhead of the first, fifth, ninth, thirteenth, seventeenth, twenty-first, and twenty-fifth VT1.5s carried in the STS-1. This corresponds to the following DS1 mapper ports: G1 (left) ports one, five, nine, and thirteen; G2 (right) ports three, seven, and eleven.

Note: TR-08 traffic can be handled only by the pair of DS1/VT mappers whose traffic is carried in the STS-1 (of the SONET payload) that is mapped to the first port of the TIC in the RFT. Therefore, the DS1/VT mappers in the FCOT that handle the TR-08 traffic must be carried on the STS-1 mapped to the first port of the transport interface card on the RFT. For information on mappings for DS1s, see *Mapper Layouts Planning Guide*, 323-3001-154, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

To designate VT1.5s to carry TR-08 traffic, you use an operations controller (OPC) tool called the Connection Manager. The RFT contains a database that tracks the designations that you apply.

DMS Access interface

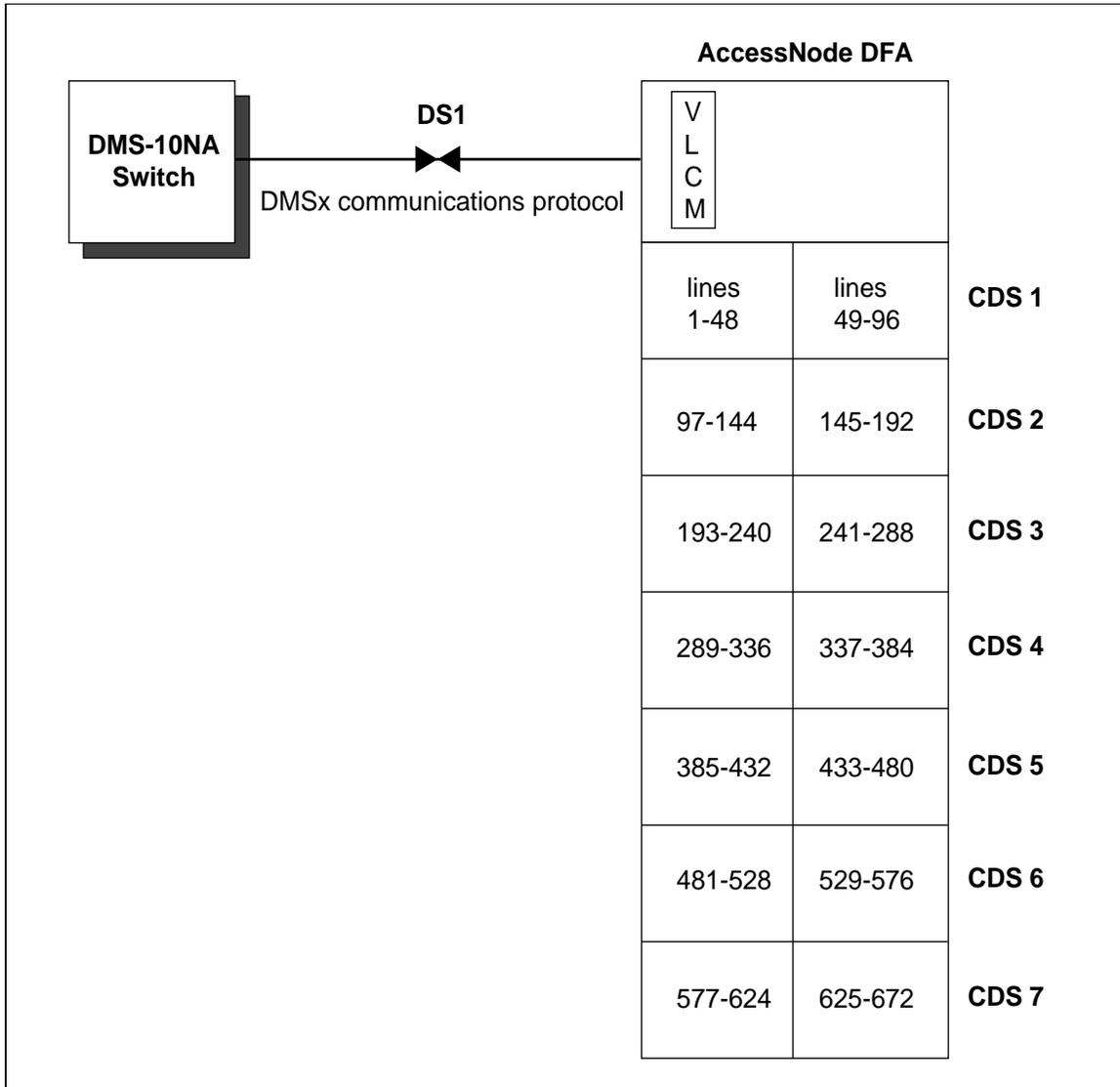
You can connect a DMS-10NA switch to a AccessNode using the DMS- X communications protocol. The AccessNode emulates a remote line concentrating module (RLCM), becoming a virtual line concentrating module (VLCM).

Note: DMS-10NA means North American version of the DMS-10 switch. For information about how AccessNode lines translate to lines on the DMS-10NA switch, see *Line Card Provisioning Procedures*, 323-3001-315, in *Operations, Administration, and Provisioning*, Volume 4B.

Figure 5-4 shows an AccessNode with line cards in copper distribution shelves connected to a DMS-10NA switch.

Figure 5-4
AccessNode connected to a DMS-10NA switch

PC-16268



You can multihost an AccessNode off of a DMS-10NA switch running DMS-X communications protocol and up to five other digital switches running GR-303.

Access processor card

When you use the DMS-X communications protocol to connect a DMS-10NA to the AccessNode, you must install the NT4K52GB access processor card (APC) in the AccessNode. The APC emulates the RLCM, which is the usual connection to the DMS-10NA, at the AccessNode. The APC links the DMS-10NA switch to the line cards in the copper distribution shelves in the AccessNode.

Virtual line concentrating module

The AccessNode emulates the remote line concentrating module, becoming the virtual line concentrating module (VLCM). An AccessNode Express system with a 64Mb APC supports two VLCMs.

Each VLCM has 640 lines and connects to a DMS-10NA using four DS1s. Two DS1s carry only speech channels, and the other two are used for speech and signaling channels. Therefore, 92 channels are available for carrying speech for each VLCM.

Note: There are two types of signaling channels: one for line concentrating module messages (LCM) and one for remote maintenance module (RMM) messages.

Services and line cards

The following services are available when you use the DMS-X communications protocol to connect the AccessNode to the DMS-10NA:

- POTS (loop start and ground start)
- P-phone
- Coin, including coin-dial-tone first (CDF), coin-semi-post pay (CSP), and coin-coin first (CCF)

The Omega or Epsilon line cards are supported on the AccessNode. The 6X17, 6X18, and 6X21 line cards on the DMS-10NA are datafilled during provisioning. The 6X18 and 6X21 line cards can only be datafilled at the switch when Omega line cards are on the AccessNode.

The following table shows the services and line card combinations that are available when you use the DMS-X interface.

Services	DMS-10NA line cards			AccessNode line cards	
	6X17	6X18	6X21	Omega	Epsilon
POTS loop start	✓	✓		✓	✓
POTS ground start		✓		✓	
Coin		✓		✓	
P-phone			✓	✓	

DMS-X Interface to APC-100

This feature allows the AccessNode to connect to an APC-100 switch as if the AccessNode were a Remote Line Concentrating Module (RLCM) without a Remote Maintenance Module (RMM). All switch commissioning and provisioning for the switch are the same as the procedures for regular RLCMs and RLCM lines.

For more information on this interface, see *Configuration and Equipment Description*, 323-3051-100, in *AccessNode Express* volume.

Multi-IG/Multi-SMA

This feature permits direct integration of an AccessNode with GR-303 compliant digital switches. It includes the following features:

- Multiple interface groups (Multi-IG) allows up to 5 interface groups to exist between a local digital switch (LDS) or switches (either DMS-100 or another supported vendor’s switch) and an RFT. The interface groups can extend from the RFT to multiple integrated digital terminals (IDT) within a single LDS, spread across multiple LDSs, or a combination. Multi-IG allows more than one GR-303 MVI host to be provisioned. This means that AccessNode can communicate with more than one GR-303 MVI host. In AN12 only multiple GR-303 DMS hosts were allowed with a maximum of one GR-303 MVI host.
- Multiple subscriber module access (Multi-SMA) allows one DMS host switch to have multiple IDTs to the same RFT, but spread across multiple SMAs.

Note: Multi-IG and multi-SMA only work with software changes available in the DMS-100 product’s NA006 release with a multi-IG/multi-SMA software patch or the NA007 release.

Figure 5-5 on page 5-15 shows the variety of interfaces supported for RFT-to-IDT connections.

Figure 5-5
Interface groups supported for RFT to IDT connection

PC-16132

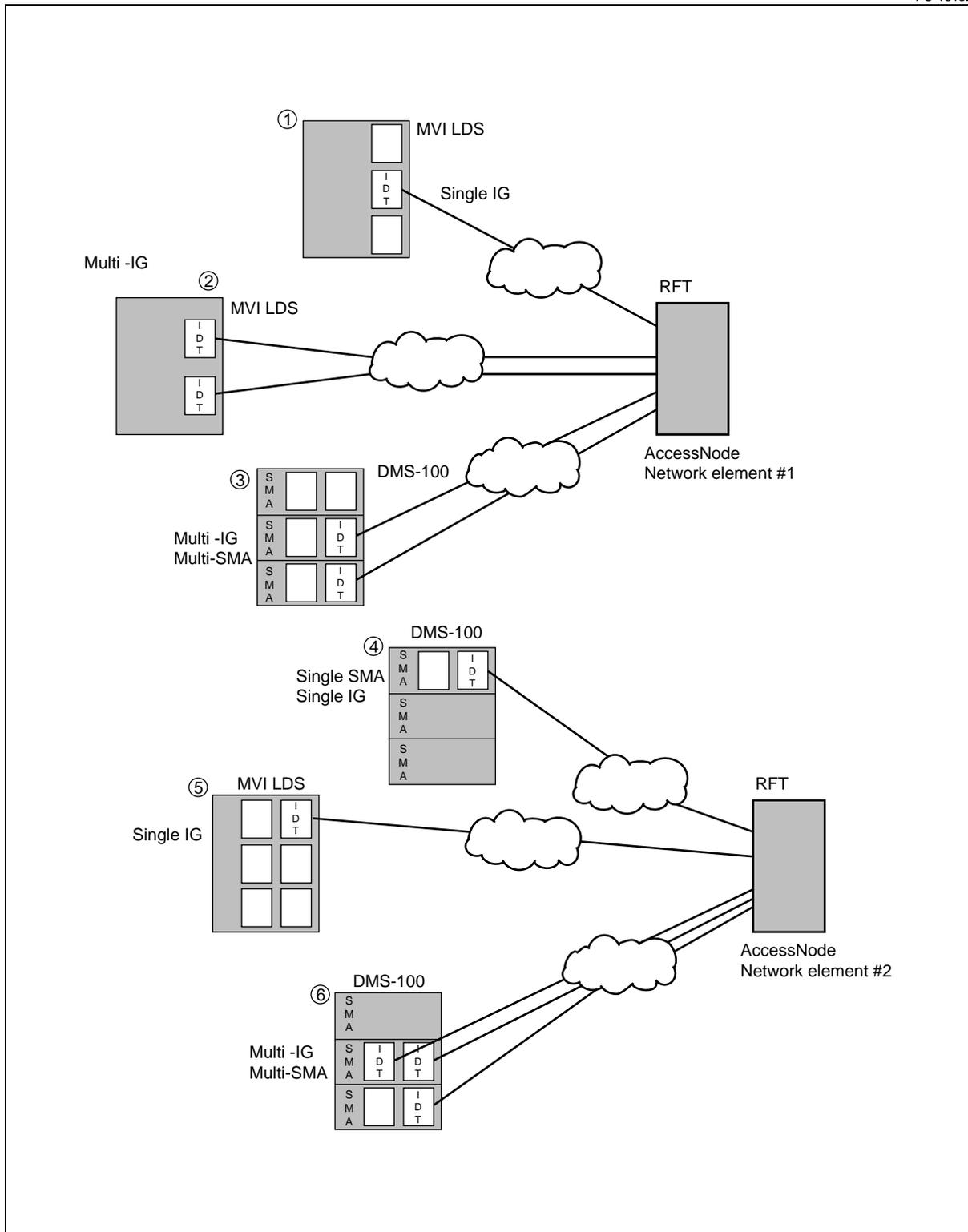


Table 5-2 explains Figure 5-5.

Table 5-2
Explanation of Figure 5-5

Reference Number	Type of Connection	Description
1	single IG/single SMA	A single interface group between an RFT and a GR-303 MVI host. The GR-303 MVI LDSs supported are the #5ESS (Lucent), the EWSD (Siemens) and the GTD-5 (GTE). The OPC's Connection Manager tool Manage Facility Assignment screen allows you to designate DS1s as carrying DS1 Tandem, GR-303 DMS, Multivendor GR-303 or TR-08 traffic.
2	multi-IG	Two interface groups between the RFT and a single MVI LDS. The interface groups connect to different IDTs residing in the same MVI host switch.
3	multi-IG/multi-SMA	Two interface groups from the RFT to IDTs that reside in different SMAs of a DMS-100. An IDT can be used in only one interface group at a time.
4	single IG/single SMA	A single interface group between an RFT and an IDT residing in an SMA in a DMS-100.
5	single IG/single SMA	A single interface group between an RFT and an MVI GR-303 host.
6	multi IG/multi-SMA	Three interface groups between the RFT and three different IDTs residing in two different SMAs. The lower connection is between an RFT and an SMA. The top two connections are between the RFT and two different IDTs residing in the same SMA.

Provisioning

You provision GR-303 DMS and GR-303 MVI switches via the OPC's Host Provisioning Manager Tool. The host's name (CLLI), IDT number, and interface type must be supplied. An interface group number 1 through 5 is automatically assigned. The IDT number combined with the host name uniquely identifies an interface group.

The first GR-303 DMS host added in the Host Provisioning Manager is the default Primary Host. The Host Provisioning Manager allows you to assign an RFT to multiple host switches. Up to 5 interface groups can be created and distributed among up to 5 host switches. The selection of the primary alarm

host which receives all alarms generated by the RFT, is also made with the Host Provisioning Manager tool. Only GR-303 DMS interface groups may be selected as the primary alarm host.

Note: Each interface group must have at least two DS1 links to carry the active and stand-by messaging channels. Multiple GR-303 DMS or GR-303 MVI interface groups from the same AccessNode to the same IDT residing on a DMS-100 or generic GR-303 LDS are not supported.

Hardware packaging

The following packaging options are available for AccessNodes:

- bay frames
- modular business package (MBP) cabinets
- Series 800A outside-plant (OSP) cabinets

Chapter contents

This chapter includes the following topics:

Topic	See
Bays	page 6-2
Bay configurations with TBM shelves	page 6-9
Operations controller shelves	page 6-16
Modular business package	page 6-17
Series 800A outside-plant cabinet	page 6-31

For descriptive information about AccessNode Express, see *Configuration and Equipment Description*, 323-3051-100, in the *AccessNode Express* volume.

Bays

The dimensions of a standard bay frame are as follows:

width	25.9 in. (657.9 mm)
depth	12.0 in. (305 mm)
height	7 ft (2.13 m), or 9 ft (2.74 m), or 11.5 ft (3.51 m)

A bay can house an AccessNode in any of the following locations:

- a central office
- a hut
- a controlled-environment vault (CEV)
- the entrance room of a large building

Note 1: Equipment is installed in bays only in areas where access is restricted (for example, locked equipment rooms allowing access only to the operating company’s craftpersons).

Note 2: The floor must be able to support the weight of a bay. For detailed information about floor loading, see *System Specifications*, 323-3001-180, in *Description*, Volume 2B.

Configurations packaged in bays

The following predefined configurations are available for AccessNodes packaged in bays. These configurations use either of the following shelf types:

- access bandwidth manager (ABM) shelf
- transport bandwidth manager (TBM) shelf

Bay configurations with ABM shelves

The following bay configurations contain ABM shelves.

Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

Configuration prewired for 672 copper lines

This configuration contains an ABM shelf and seven copper-distribution shelves. For more details on this configuration, see “Bay prewired for 672 copper lines” on page 6-3.

Add-drop start-up configuration

This configuration comes equipped with an ABM shelf. In addition, you can order the number of copper-distribution shelves that you need, from one to seven. Alternatively, you do not have to order any copper-distribution shelves. For more details on this configuration, see “Bay with add-drop start-up configuration” on page 6-5.

Multiplexer configuration

This configuration includes an ABM shelf, but does not contain any copper-distribution shelves or the internal cables for copper-distribution shelves. For more details on this configuration, see “Bay with multiplexer configuration” on page 6-7.

Bay prewired for 672 copper lines

This type of bay supports up to six hundred and seventy-two 2-wire copper lines. The bay contains the following:

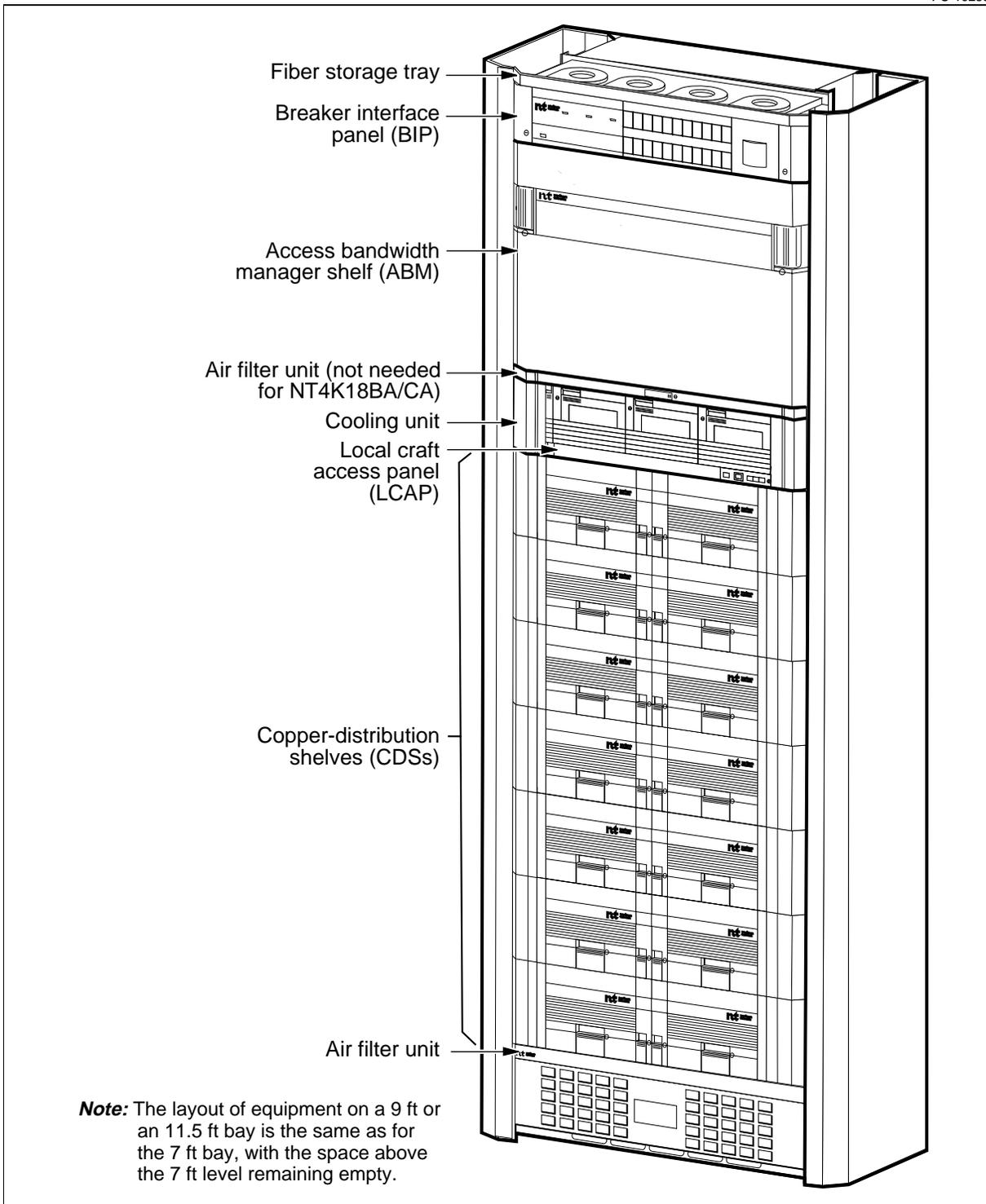
- one fiber storage tray
- one breaker interface panel (model NT4K14)
- one 8-fan cooling unit (NT4K18CA)
- two fiber storage trays for mini-variable optical attenuators (brackets that attach to both sides of the cooling unit)
- one local craft access panel (model NT4K16)
- one ABM shelf
- seven copper-distribution shelves
- an air filter below the lowest copper-distribution shelf
- all the intershelf cabling required to connect the ABM shelf to the copper-distribution shelves

Figure 6-1 shows a 7 ft (2.13 m) bay with this configuration.

Note: In a 9 ft (2.74 m) or 11.5 ft (3.51 m) bay, the shelf modules are installed at the same heights as shown in Figure 6-1, and the extra space at the top of the bay remains empty.

Figure 6-1
Bay prewired for 672 copper lines

PC-10238



Bay with add-drop start-up configuration

This type of bay can support DS1 and DS3, and OC-3 channels immediately, and can support copper lines either immediately or in the future. You can order the number of copper-distribution shelves that you need. If you order any copper-distribution shelves, then you must also order an air filter unit that installs below the lowest copper-distribution shelf.

This type of bay contains all the intershelf cabling required for copper-distribution shelves.

The bay contains the following basic equipment:

- one fiber storage tray
- one breaker interface panel (model NT4K14)
- one 8-fan cooling unit (NT4K18CA)
- two fiber storage trays for mini-variable optical attenuators (a bracket that attaches to both sides of the cooling unit)
- one local craft access panel (model NT4K16)
- one ABM shelf
- all the intershelf cabling required to connect the ABM shelf to up to seven copper-distribution shelves

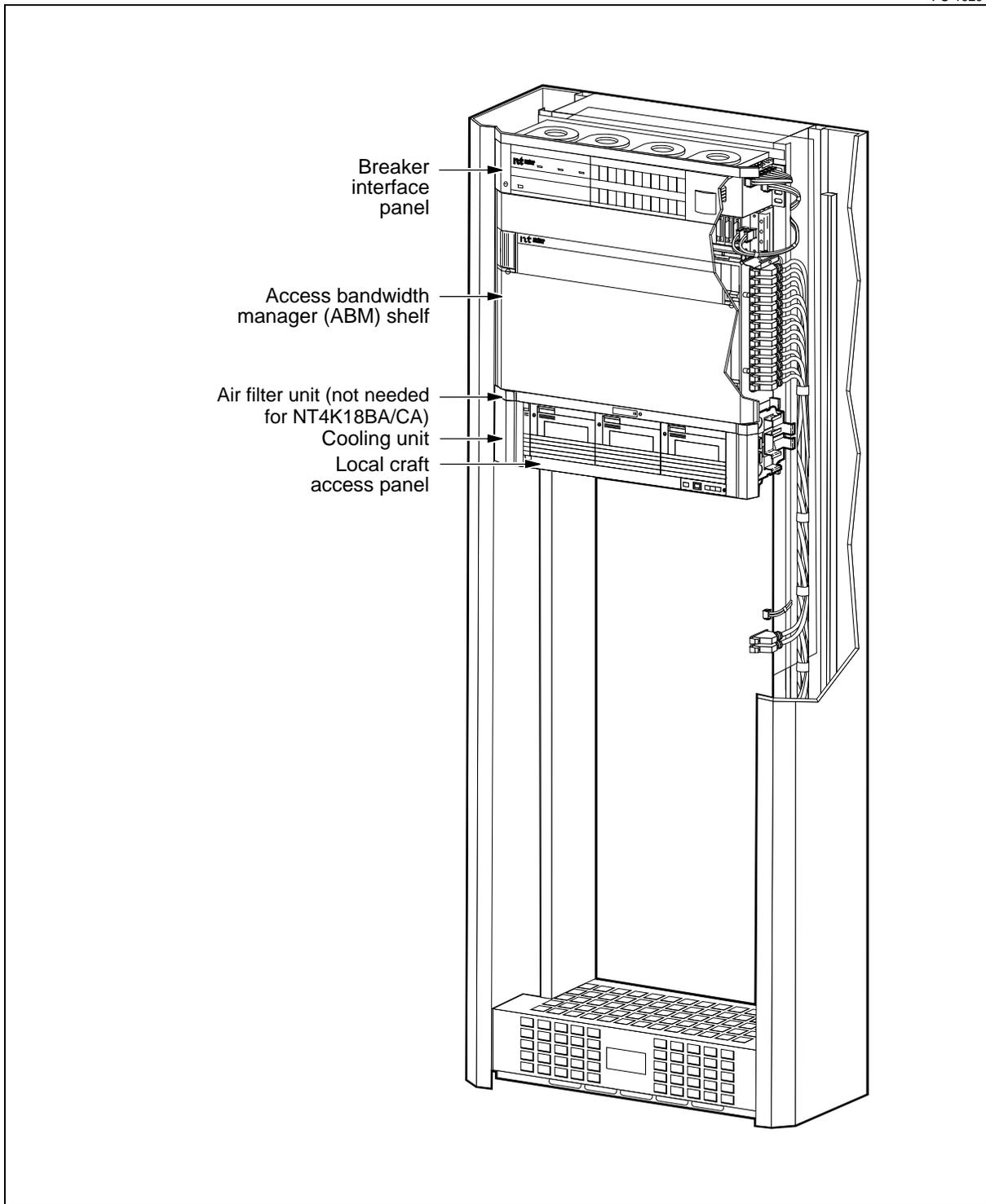
Figure 6-2 shows a 7 ft (2.13 m) bay with this configuration.

Note: In a 9 ft (2.74 m) or 11.5 ft (3.51 m) bay, the shelf modules are installed at the same heights as shown in Figure 6-2 on page 6-6, and the extra space at the top of the bay remains empty.

Figure 6-2 does not show the following items, which are not part of the basic equipment for the configuration: copper-distribution shelves, the air filter unit required below the lowest copper-distribution shelf, and the bottom cover assembly required below the lowest copper-distribution shelf if there are six or fewer shelves.

Figure 6-2
Bay with add-drop start-up configuration

PC-10201



Bay with multiplexer configuration

This type of bay supports DS1 and DS3, and OC-3 traffic. It does not contain any copper-distribution shelves or any of the intershelf cabling required for copper-distribution shelves.

The bay contains the following:

- one fiber storage tray
- one breaker interface panel (model NT4K14)
- one 8-fan cooling unit (NT4K18CA)
- two fiber storage trays for mini-variable optical attenuators (brackets that attach to both sides of the cooling unit)
- one local craft access panel (model NT4K16)
- one ABM shelf

Figure 6-3 shows a 7 ft (2.13 m) bay with this configuration.

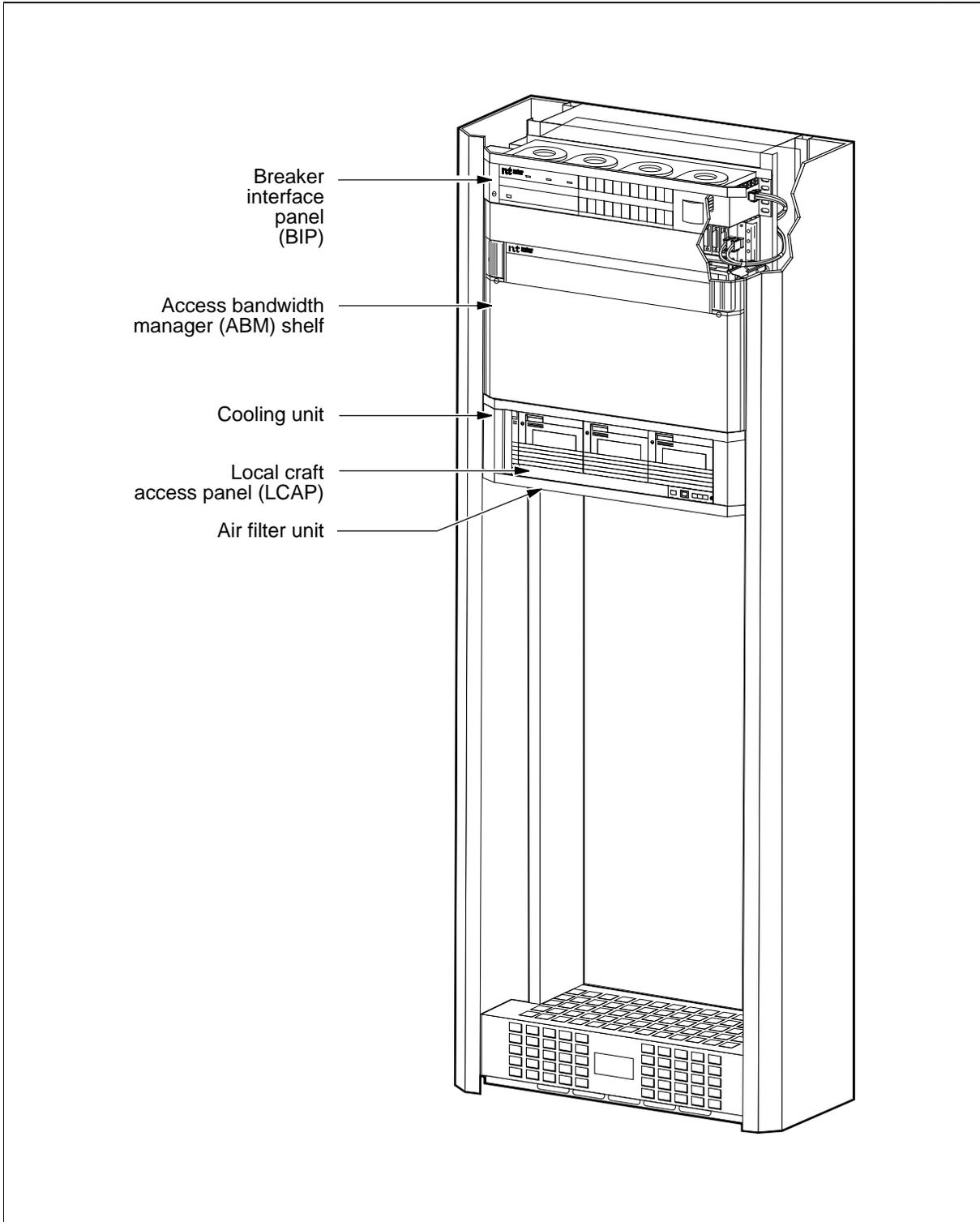
Note: In a 9 ft (2.74 m) or 11.5 ft (3.51 m) bay, the shelf modules are installed at the same heights as shown in Figure 6-3 on page 6-8, and the extra space at the top of the bay remains empty.

Stand-alone ABM operations controller shelf

When you need to install a stand-alone ABM operations controller (OPC) shelf (an ABM OPC shelf in its own bay), you use the multiplexer configuration. For more information on the stand-alone ABM OPC shelf, including shelf layouts, see “Stand-alone ABM OPC shelf” on pages 7-15. Instructions for ordering OPC shelves are included in *Engineering and Ordering Information*, 323-3001-032, in *Engineering, Configuration, and Ordering Guide*, Volume 1.

Figure 6-3
Bay with multiplexer configuration

PC-16308



Bay configurations with TBM shelves

The following bay configurations contain transport bandwidth manager (TBM) shelves:

Transport shelf bay configurations

These configurations include one, two, or three TBM shelves. These configurations do not contain any copper-distribution shelves or the internal cables for copper-distribution shelves.

Table 6-1 lists the available configurations.

Table 6-1
Bay configurations with TBM shelves

Configuration	See
transport single-shelf bay configuration (overhead cabling)	page 6-10
transport single-shelf bay configuration (raised-floor cabling)	page 6-10
transport two-shelf bay configuration	page 6-13
transport three-shelf bay configuration	page 6-13

Enhanced TBM shelf bay configurations

Like the transport shelf bay configurations, the enhanced TBM shelf bay configurations include one, two, or three TBM shelves, and contain neither copper-distribution shelves nor the internal cables for copper-distribution shelves. The enhanced configurations have greater cooling capacity. They must be used if the TBM shelves are going to contain OC-12 virtual tributary bandwidth manager (VTBM) circuit packs.

The following configurations are available:

- enhanced TBM single-shelf bay configuration for the following:
 - overhead cabling. For details, see “Enhanced TBM single-shelf bay configuration” on page 6-15.
 - raised-floor cabling. For details, see “Enhanced TBM single-shelf bay configuration” on page 6-15.
- enhanced TBM two-shelf bay configuration. For details, see “Enhanced TBM two-shelf bay configuration” on page 6-15.
- enhanced TBM three-shelf bay configuration. For more details on this configuration, see “Enhanced TBM three-shelf bay configuration” on page 6-16.

Note 1: The transport two-shelf and three-shelf bays, and the enhanced TBM two-shelf and three-shelf bays are the only predefined configurations capable of housing multiple network elements. Each TBM shelf in such a bay is a fiber central office terminal (FCOT) or an operations controller (OPC) shelf. (Each of the other predefined configurations houses only a single network element.)

Note 2: The OPC shelf is not a predefined configuration. For information on the packaging of OPC shelves, see “Stand-alone ABM operations controller shelf” on page 6-16, “Stand-alone TBM OPC shelf,” on page 6-16, and “Bay-sharing TBM OPC shelf,” on page 6-16.

Transport single-shelf bay configuration

This type of bay contains a TBM shelf. It supports DS1, DS3, and OC-3 channels. You cannot add copper-distribution shelves to this type of bay assembly, because the TBM shelf does not support them.

This configuration is used in the FCOTs in basic fiber-fed systems serving integrated applications. It is one of the configurations that can be used in the FCOTs in basic fiber-fed systems serving multiplexer applications.

Different models for overhead cabling and raised-floor cabling

The single TBM shelf may be in the middle position in the bay, as shown in Figure 6-4 on page 6-12, or in the top position. The position of the shelf depends on the type of cabling to the bay.

- **Raised floor:** In a bay installed on a raised floor with cabling under the floor, the shelf is installed in the top position (position one).
- **Overhead cabling:** In a bay with overhead cabling, the shelf is installed in the middle position (position two).

The bay contains the following:

- one breaker interface panel (model NT7E56)
- one enhanced cooling unit (NT4K18BA), equipped with the following:
 - three cooling modules (NT4K17AA)
 - one air filter unit
- one local craft access panel (model NT7E5047)
- one cable organizer panel
- one TBM shelf (NT4K19AB)
- an air filter below the TBM shelf if that shelf is below the cooling unit

Figure 6-4 on page 6-12 shows a front view of a 7 ft (2.13 m) bay with the transport single-shelf bay configuration, for overhead cabling. The bay contains all the modules listed above, as well as a fiber storage panel, which is optional.

Note 1: The single TBM shelf may be in the middle position in the bay, as shown in Figure 6-4, or in the top position. The position of the shelf depends on the type of cabling to the bay.

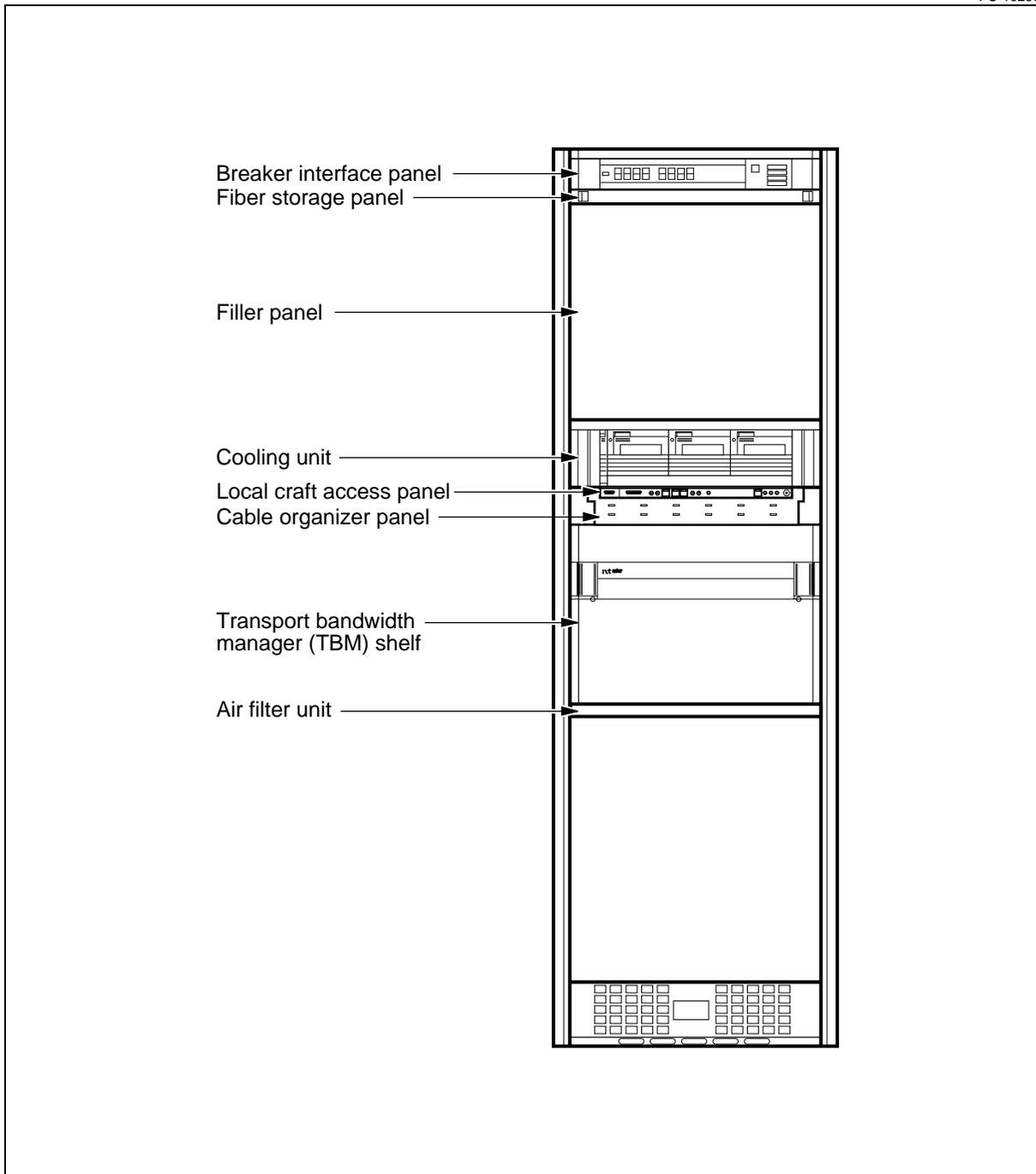
Note 2: In a 9 ft (2.74 m) or 11.5 ft (3.51 m) bay, the shelf modules are installed at the same heights as shown in Figure 6-4 on page 6-12, and the extra space at the top of the bay remains empty.

Stand-alone TBM OPC shelf

To install a stand-alone TBM OPC shelf (a TBM OPC shelf in its own bay), you use the multiplexer configuration. For more information on the stand-alone TBM OPC shelf, including the shelf layout, see page 7-58. Instructions for ordering OPC shelves are included in *Engineering and Ordering Information*, 323-3001-032, in *Engineering, Configuration, and Ordering Guide*, Volume 1.

Figure 6-4
Transport single-shelf bay configuration

PC-10267



Transport two-shelf and three-shelf bay configurations

The transport two-shelf bay configuration contains two TBM shelves; the transport three-shelf bay configuration contains three TBM shelves. The two or three TBM shelves are connected to each other by a local area network called control network. For a description of control networks, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

In a transport two-shelf or three-shelf bay configuration, each TBM shelf in the bay is either the FCOT for a separate system or an OPC shelf. You can install a transport two-shelf or three-shelf bay configuration in a location in which you would otherwise have to use two or three transport single-shelf bay configurations.

Note 1: All the TBM shelves in a transport two-shelf or three-shelf bay must be used as AccessNode network elements. You cannot use any of the shelves as an S/DMS TransportNode OC-12 network element.

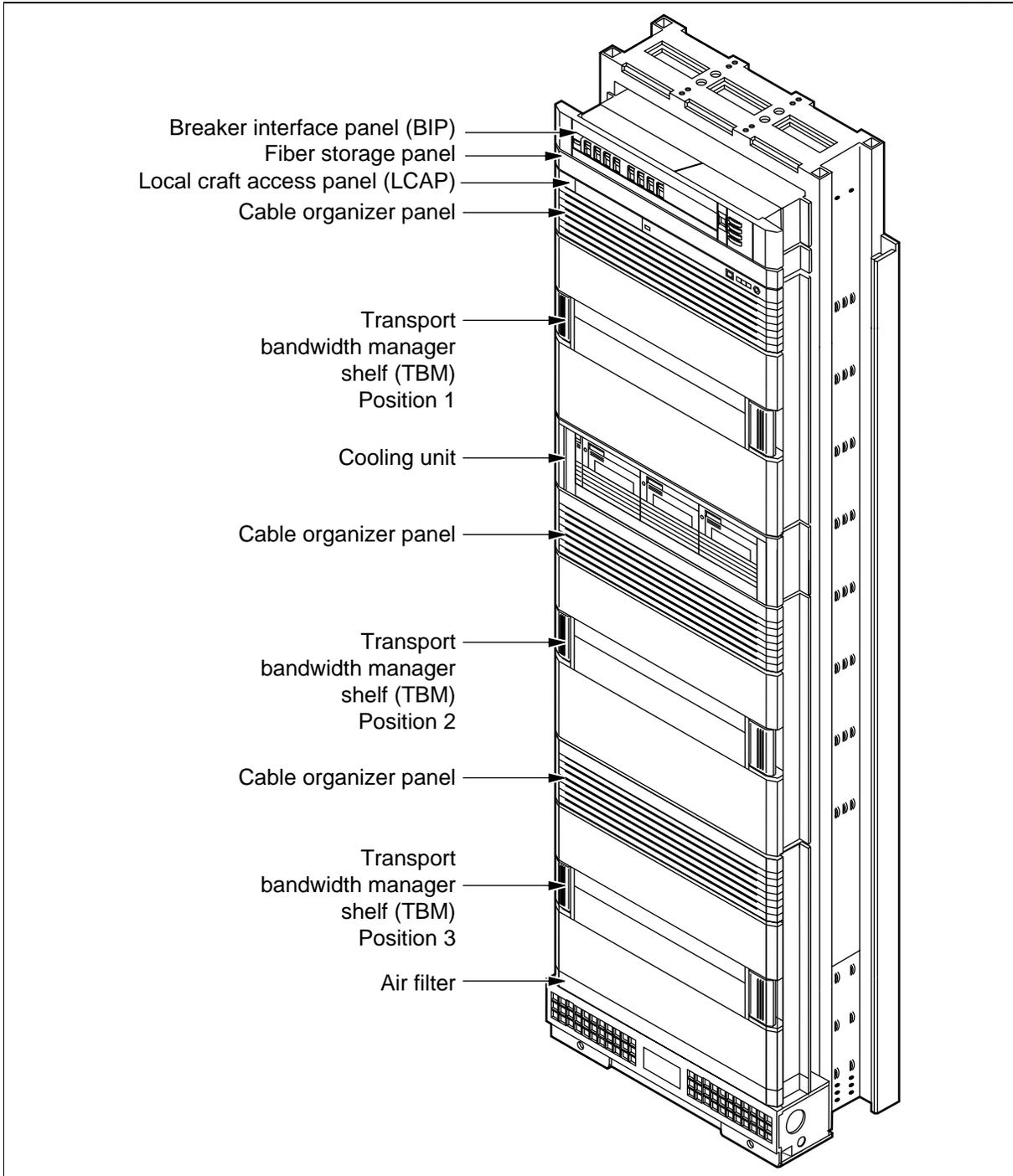
The bay for a transport two-shelf or three-shelf bay configuration contains the following:

- one breaker interface panel (model NT7E56)
- one cooling unit (NT4K18AA), equipped with the following:
 - three cooling modules (NT4K17AA)
 - one air filter unit (NT4K15AA)
- one local craft access panel (model NT7E5047) for each TBM shelf
- TBM shelves:
 - two in a two-shelf bay, occupying the top and middle positions (positions one and two)
 - three in a three-shelf bay
- one cable organizer panel for each TBM shelf

Figure 6-5 on page 6-14 shows a front view of a 7 ft (2.13 m) bay with the transport three-shelf configuration. The bay contains the modules listed above, as well as a fiber storage panel, which is optional.

Figure 6-5
Transport three-shelf bay configuration

PC-11504



Note 1: The transport two-shelf and three-shelf bay configurations are available in 7 ft (2.13 m) bays, 9 ft (2.74 m) bays, or 11.5 ft (3.51 m) bays. In a 9 ft (2.74 m) or 11.5 ft (3.51 m) bay, the extra space at the top of the bay remains empty.

Note 2: Although an individual TBM shelf can accommodate up to 9 working DS1/VT mappers, the maximum number of working DS1/VT mappers in a transport three-shelf bay is 24, not 27. Only enough room for cabling to 24 mappers is available. If you have 24 mappers in a bay, you can distribute them as you wish, either equally (8 per shelf) or unequally.

Enhanced TBM shelf bay configurations

The enhanced TBM shelf bay configurations are similar to the transport shelf bay configurations, but have greater cooling capacity. The enhanced TBM bays are used for all OC-12 VTBM applications.

The enhanced bays with the through-flow cooling unit (NT4K18BA) contain three replaceable fan modules that operate at high speed constantly. The fans force cooling air upwards through the TBM shelves. Although the appearance of the through-flow cooling unit (NT4K18BA) and its fan modules is similar to the cooling unit (NT4K18AA) and fan modules, they are not interchangeable.

Enhanced TBM single-shelf bay configuration

The enhanced TBM single-shelf bay configuration is similar to the transport single-shelf bay configuration described on page 6-10 and shown in Figure 6-4 on page 6-12, except for the following differences:

- The enhanced bay contains the through-flow cooling unit (NT4K18BA).
- An air filter unit is below the cooling unit if the TBM shelf is in the top position in the bay (position one).

The single TBM shelf may be in the middle position in the bay or in the top position. The position of the shelf depends on the type of cabling to the bay.

- **Raised floor.** In a bay installed on a raised floor with cabling under the floor, the shelf is installed in the top position (position one).
- **Overhead cabling.** In a bay with overhead cabling, the shelf is installed in the middle position (position two).

Enhanced TBM two-shelf bay configuration

The enhanced TBM two-shelf bay configuration is similar to the transport two-shelf bay configuration described on page 6-13, except the enhanced bay contains the through-flow cooling unit (NT4K18BA).

Enhanced TBM three-shelf bay configuration

The enhanced TBM three-shelf bay configuration is similar to the transport three-shelf bay configuration described on page 6-13 and shown in Figure 6-5 on page 6-14, except for the following differences:

- The enhanced bay contains the through-flow cooling unit (NT4K18BA).
- The enhanced bay contains model NT4K19AC as the TBM shelf in the lowest position in the bay (position three). That model comes with a cable organizer panel/cooling unit (COP/CU) rather than an ordinary cable organizer panel. The COP/CU has four fans to help cool the bay. See Chapter 7, “Shelf modules and bay-assembly modules,” for more information on the COP/CU.

Operations controller shelves

An operations controller (OPC) shelf is a special-purpose configuration of the access bandwidth manager (ABM) shelf or the transport bandwidth manager (TBM) shelf.

Instructions for ordering OPC shelves are included in *Engineering and Ordering Information*, 323-3001-032, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

Stand-alone ABM OPC shelf

To install a stand-alone ABM OPC shelf (an ABM OPC shelf in its own bay), you use the multiplexer configuration. For more information on the stand-alone ABM OPC shelf, including shelf layouts, see page 7-15.

Stand-alone TBM OPC shelf

To install a stand-alone TBM OPC shelf (a TBM OPC shelf in its own bay), you use the transport single-shelf bay configuration. For more information on the stand-alone TBM OPC shelf, including the shelf layout, see page 7-58.

Bay-sharing TBM OPC shelf

In a transport two-shelf or three-shelf bay configuration or in an enhanced TBM two-shelf or three-shelf bay configuration, one of the TBM shelves may be a TBM OPC shelf sharing the bay. For more information on the bay-sharing TBM OPC shelf, see page 7-58.

Modular business package

The modular business package (MBP) packaging option can be used only for AccessNodes that are installed as customer-located equipment, or for central-office installations. All AccessNodes with this packaging option are remote fiber terminals (RFTs).

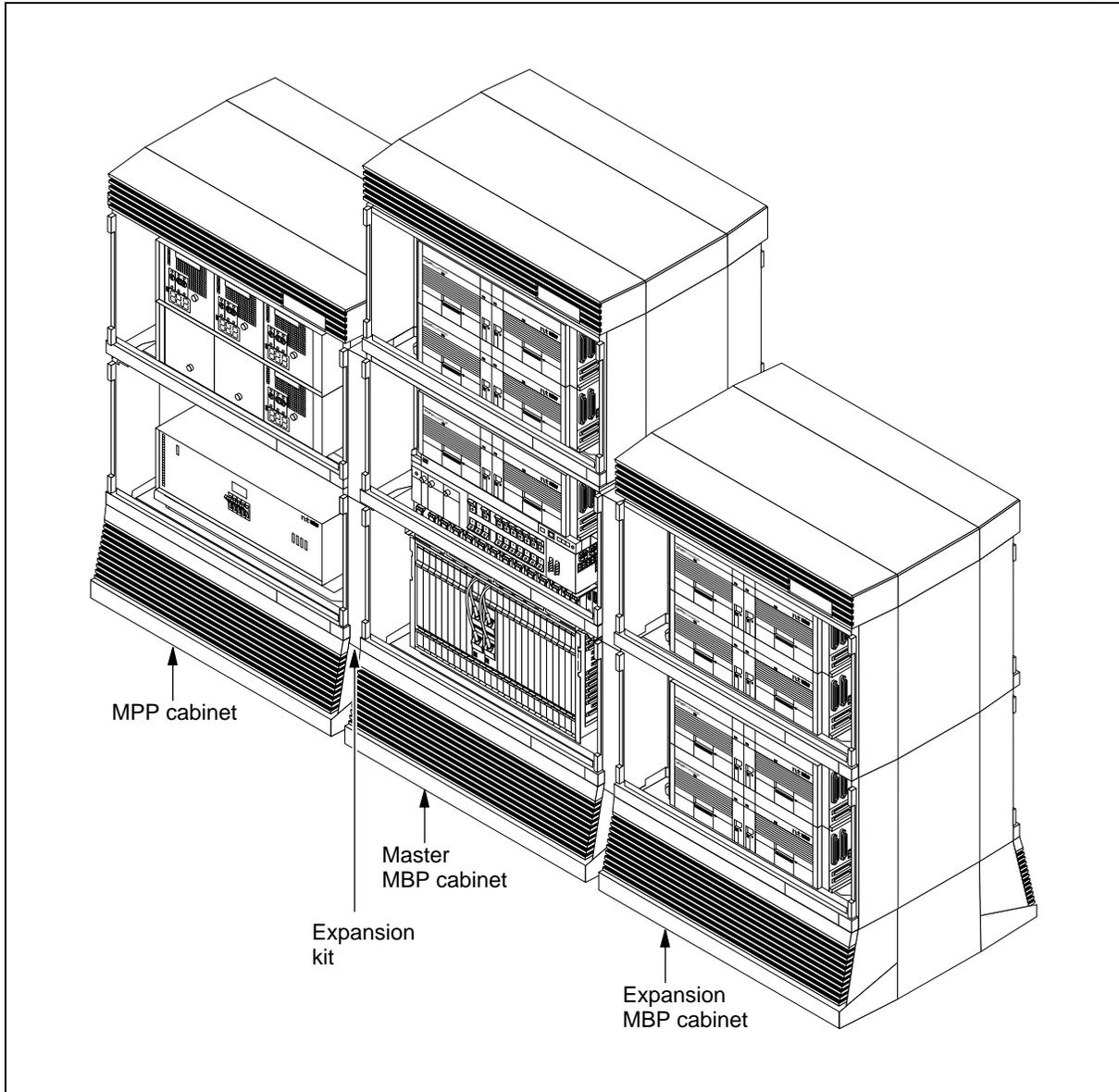
An AccessNode with the MBP packaging option can contain up to three cabinets:

- one MBP cabinet
- one optional expansion cabinet
- one modular power package (MPP) cabinet

A complete standard configuration depicting all three of these cabinets is shown in Figure 6-6 on page 6-18. The MBP cabinets contain the shelf modules that compose the RFT. The MPP cabinet converts a supply of alternating current to -48 V dc for powering the AccessNode equipment inside the MBP cabinets. Table 6-2 on page 6-30 provides a summary of all the cabinets available in the Modular Business package.

Figure 6-6
MBP configuration with an expansion MBP cabinet and attached MPP cabinet

PC-11374



Master cabinet description

The first MBP cabinet is the master cabinet. An MBP AccessNode system always contains a master cabinet. The standard master cabinet consists of a pedestal, a dual equipment module (DEM) containing the ABM shelf, a local craft access panel (LCAP), and a breaker interface panel (BIP). Other cabinet and equipment modules are added to the standard cabinet as orderable options.

Master cabinets are also available in defined configurations for specific applications and services such as synchronous transport signal bandwidth manager (STSBM) applications and OC-12 virtual tributary bandwidth manager (VTBM) applications.

Master cabinet configurations

The MBP master cabinet configurations are:

- NT4K06AA standard MBP master cabinet (Figure 6-7 on page 6-20)
- NT4K06EA Zone 2 STSBM ring configuration (Figure 6-8 on page 6-21)
- NT4K06EC Zone 4 STSBM ring configuration (Figure 6-8 on page 6-21)
- NT4K06ED Zone 4 VTBM ring configuration (Figure 6-9 on page 6-22)

The MBP master cabinets are expanded by ordering additional cabinet and equipment modules described in the following section.

Figure 6-7
MBP standard master cabinet configuration

PC-10827

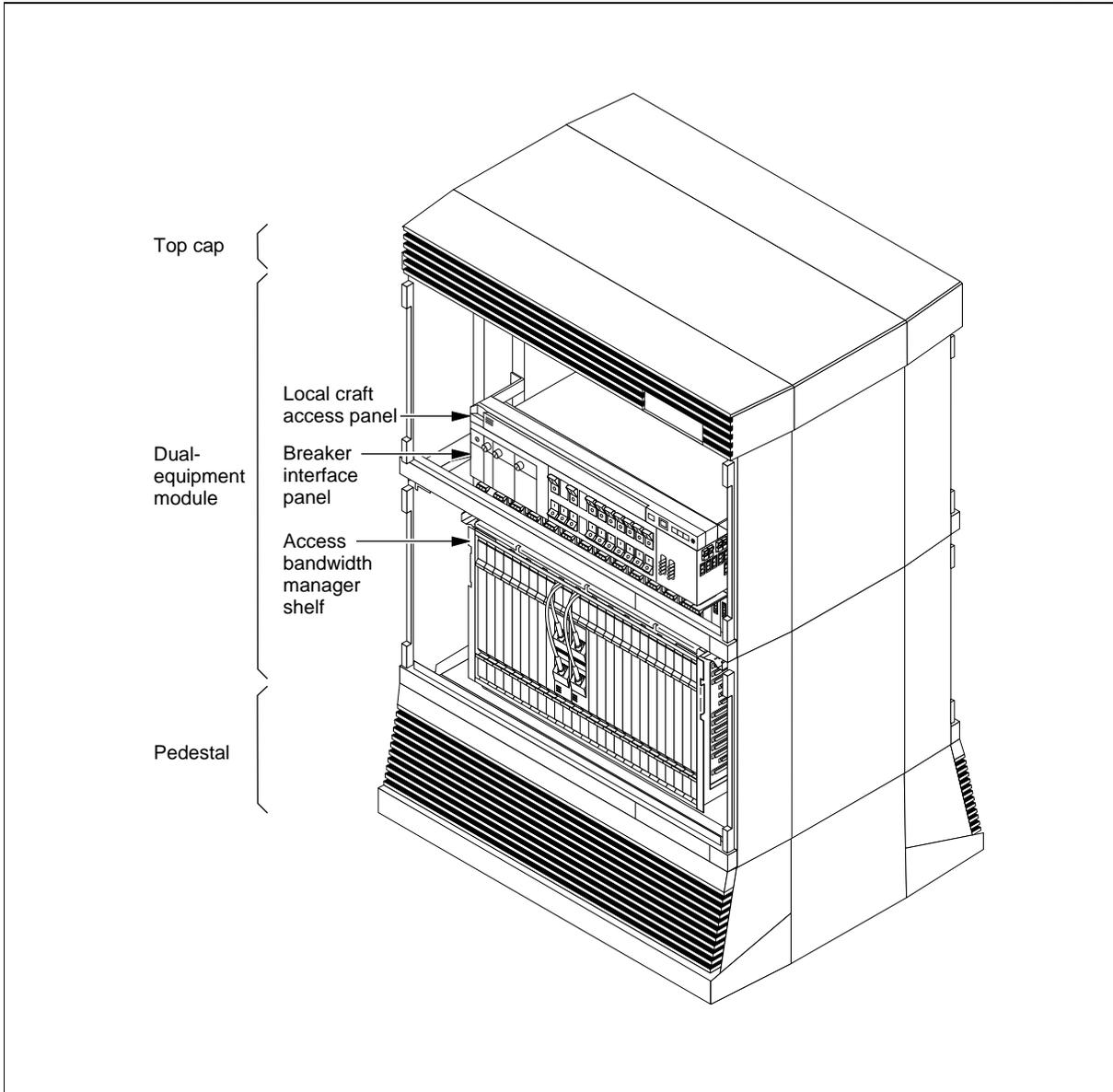


Figure 6-8
NT4K06EA/EC MBP STSBM fiber ring master cabinet configuration

PC-15366

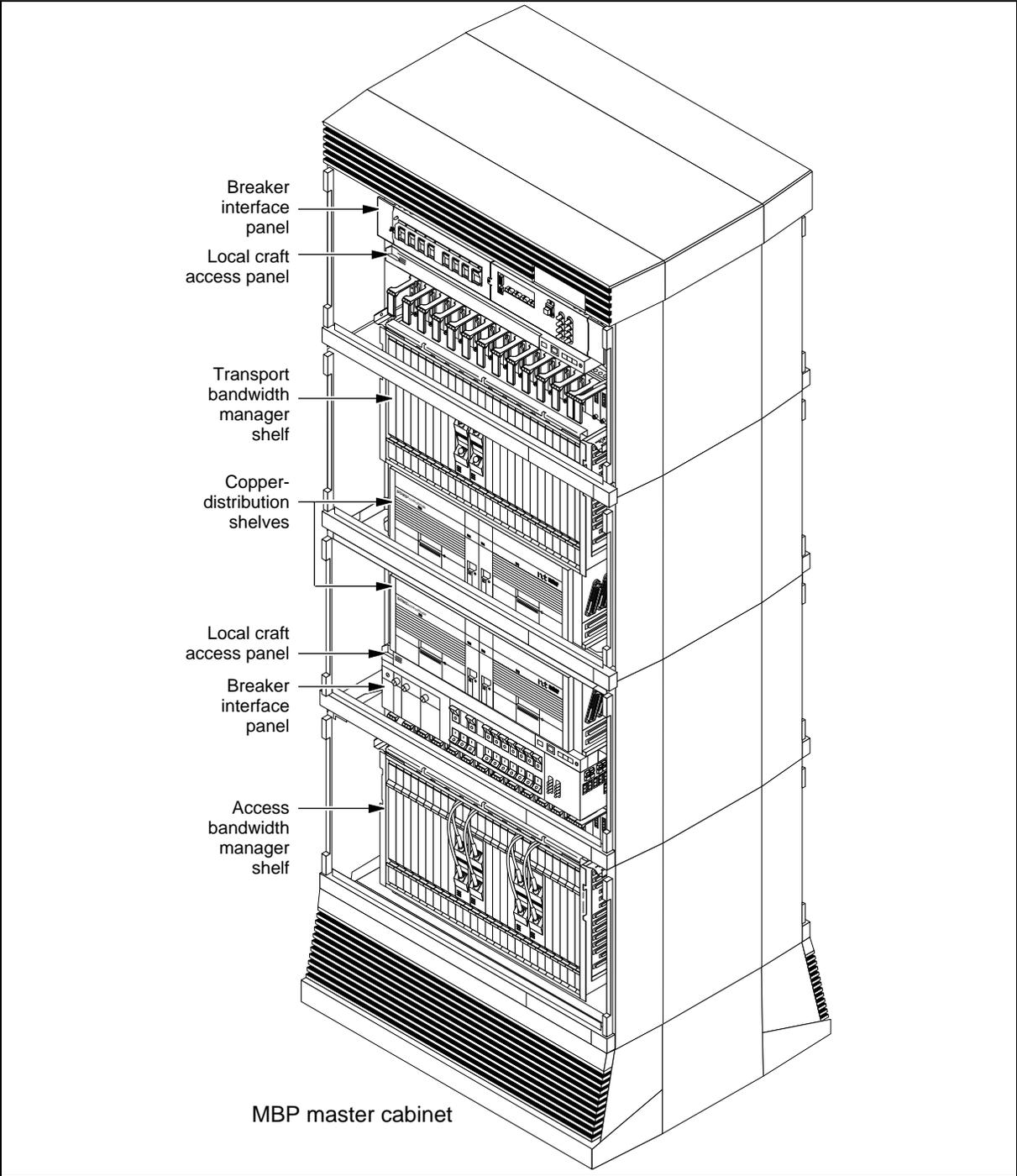
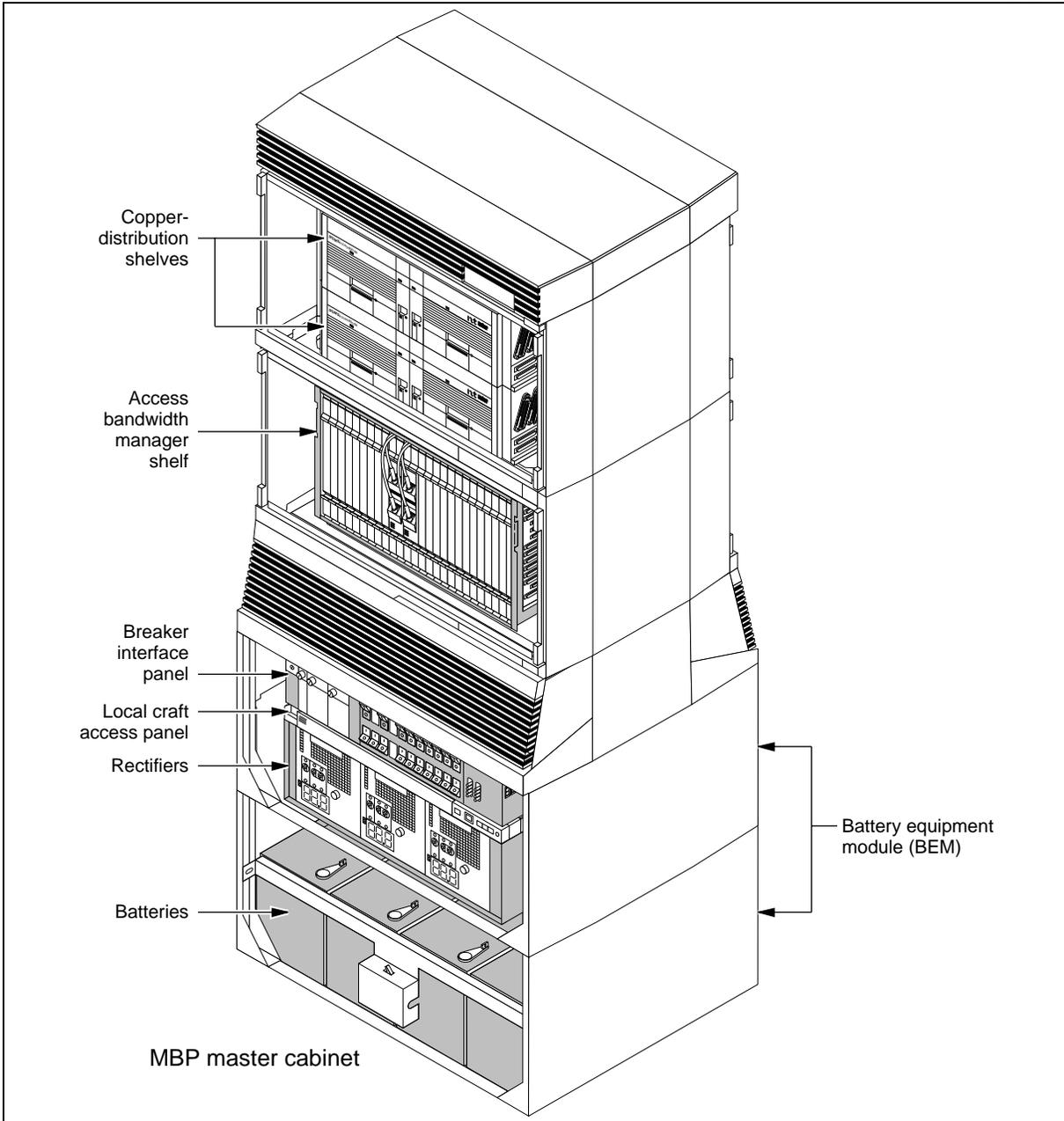


Figure 6-9
NT4K06ED MBP VTBM fiber ring master cabinet configuration

PC-15360



Expansion cabinet description

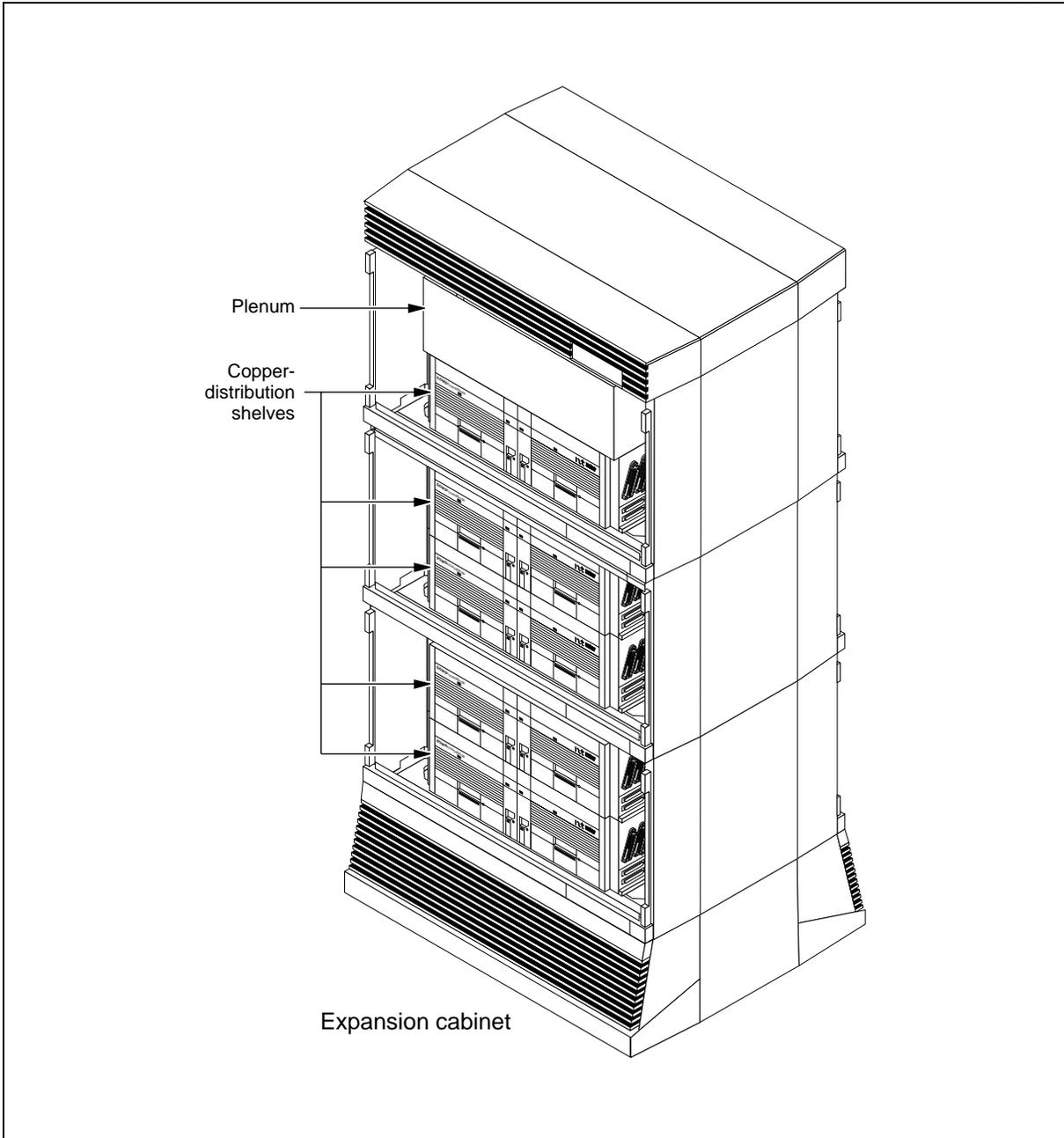
The second MBP cabinet, which is optional, is the expansion cabinet. An expansion cabinet is added to house additional peripheral shelves or to expand DS0 services. The expansion cabinet is attached to the master cabinet using a cable duct called an expansion kit and is on the right of the master cabinet when the system is viewed from the front.

Expansion cabinets can contain a repeater shelf, a DSX-1 cross-connect shelf or up to 5 copper-distribution shelves for 480-lines of DS0 service.

Figure 6-10 on page 6-24 shows the standard MBP expansion cabinet configuration with three single equipment modules (SEMs) containing two copper-distribution shelves, a repeater shelf and a DSX-1 cross-connect shelf. It is used in the standard MBP configuration and also in the STSBM fiber ring configuration.

Figure 6-10
NT4K06BA standard MBP expansion cabinet with three SEMs

PC-15362



Expansion cabinets are also available in defined configurations for specific applications and services such as STSBM OC-12 fiber ring applications and VTBM OC-12 fiber ring applications.

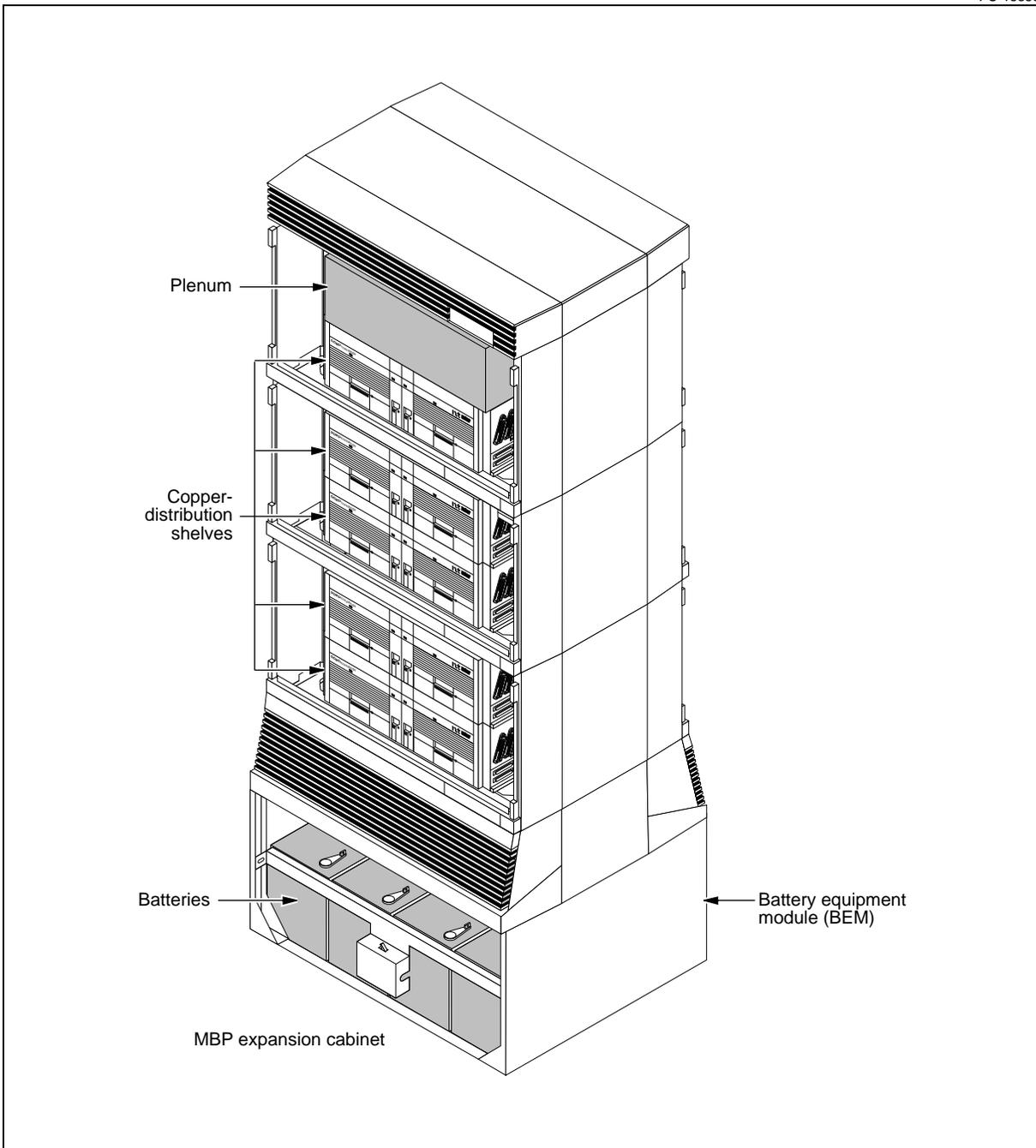
Expansion cabinet configurations

The MBP expansion cabinet configurations are as follows:

- NT4K06BA standard MBP expansion cabinet (see Figure 6-10 on page 6-24)
- NT4K06BB Zone 4 MBP VTBM OC-12 ring configuration expansion cabinet (see Figure 6-11 on page 6-26)

Figure 6-11
NT4K06BB expansion cabinet VTBM configuration

PC-15359



Order additional cabinet and equipment modules to expand the NT4K06BA standard MBP expansion cabinet.

A more detailed product structure defines the NT4K06BB configuration, and can be expanded by adding copper-distribution shelves.

MPP cabinets

The third cabinet in an MBP configuration is the MPP, which is optional. The MPP cabinet powers the AccessNode equipment inside the MBP master and expansion cabinets where the AccessNode MBP system requires a -48 V dc power source. The MPP converts a supply of alternating current to -48 V dc. The two models of the MPP cabinet are as follows:

- the standard master MBP cabinet
- the MBP cabinet in STSBM configurations

Note: VTBM applications do not require a MPP cabinet because the VTBM master cabinet already contains the rectifiers, the battery breaker panel, and a battery equipment module (BEM) for battery back-up.

MPP cabinet description

The MPP cabinet must be attached to the master MBP cabinet if the system is installed in an unrestricted area. The MPP cabinet can be attached or remote if the system is located in a restricted area (a locked area to which only authorized personnel can gain access).

If the MPP cabinet is attached to the master cabinet, all power cables that run between the cabinets must pass through a cable duct called an expansion kit. If the MPP cabinet is attached, it is on the left of the master cabinet when viewed from the front.

If the MPP is in a remote location, the power cables between the MPP cabinet and the master MBP cabinet can run under a raised floor or in an overhead cable rack.

MPP cabinet configurations

The standard MPP cabinet configurations are:

- NT4K07AA standard MPP cabinet configuration (see Figure 6-12 on page 6-28)
- NT4K07BA Zone 2 STSBM OC-12 fiber ring MPP cabinet configuration (see Figure 6-13 on page 6-29)
- NT4K07BB Zone 4 STSBM OC-12 fiber ring MPP cabinet configuration (see Figure 6-13 on page 6-29). The NT4K07BB Zone 4 MPP cabinet is identical to the NT4K07BA MPP except that it is Zone 4 compliant.

Figure 6-12
NT4K07AA standard MPP cabinet configuration

PC-15242

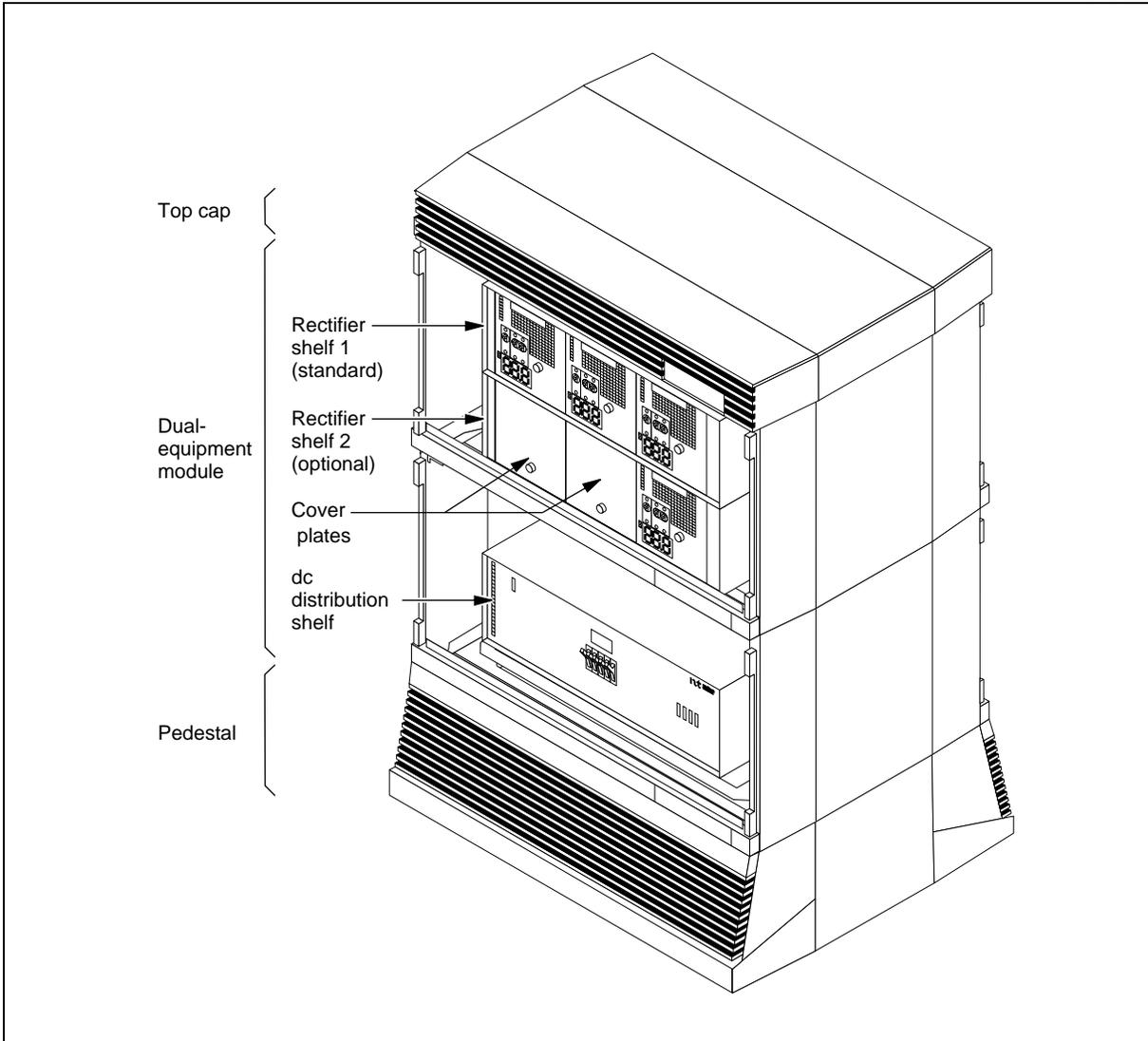


Figure 6-13
NT4K07BA/BB MPP cabinet STSBM configuration

PC-15363

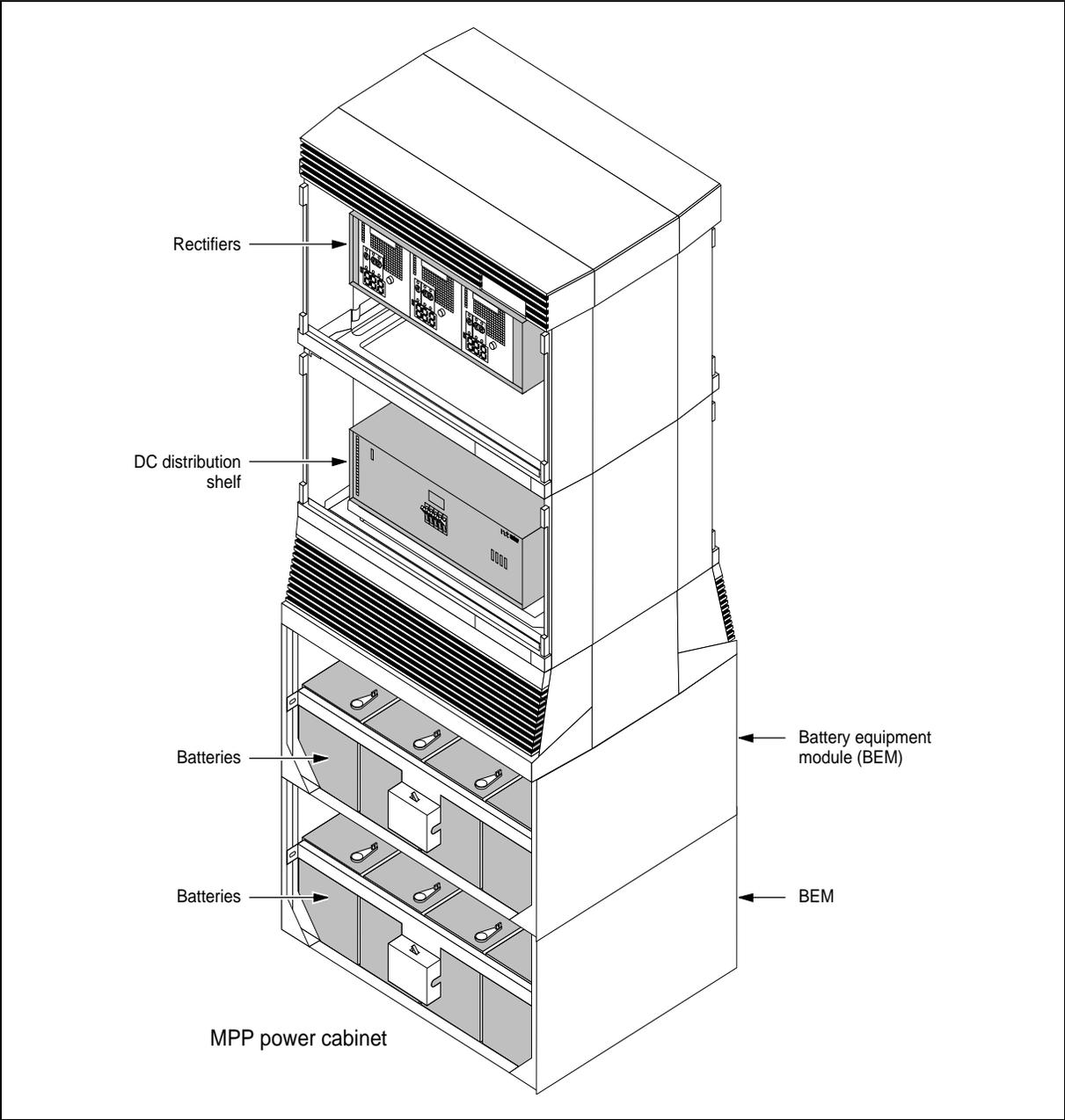


Table 6-2 summarizes the MBP cabinet configurations.

Table 6-2
Summary of MBP cabinets

Cabinet	Required/ Optional
Standard	
Master MBP: NT4K06AA Standard MBP master cabinet	Required
Expansion Cabinet: NT4K06BA standard MBP expansion cabinet	Optional
MPP: NT4K07AA standard MPP cabinet	Optional
STSBM Applications	
Master Cabinet: NT4K06EA Zone 2 STSBM ring configuration NT4K06EC Zone 4 STSBM ring configuration	Required
Expansion Cabinet: NT4K06BA standard MBP expansion cabinet	Optional
MPP: NT4K07BA Zone 2 STSBM OC-12 fiber ring MPP cabinet NT4K07BB Zone 4 STSBM OC-12 fiber ring MPP cabinet	Required
VTBM Applications	
Master: NT4K06ED Zone 4 VTBM ring configuration	Required
Expansion: NT4K06BB Zone 4 MBP VTBM OC-12 ring configuration expansion cabinet	Optional
MPP: none	not needed

Note: For more detailed information on the modular business package, see *Modular Business Package Description*, 323-3001-110.

Series 800A outside-plant cabinet

The Series 800A outside-plant (OSP) cabinet is a packaging option for AccessNodes that are installed as remote fiber terminals (RFTs).

The Series 800A OSP cabinet is a high-capacity environmentally controlled enclosure with integrated voice frequency (VF) and T1 access and fiber transport services. The cabinet complies with UL/CSA safety regulations, NEC electrical regulations, and FCC emissions regulations.

The cabinet is an above-ground enclosure with a volume of 80 to 120 cubic feet. It is insulated to protect against cold weather and sun load, and contains the following items:

- an optional heat exchanger or air-induction cooling system
- a battery vault
- an add-on ac compartment
- separate compartments for electronics, OSP cable termination, and ac power

Basic cabinet configuration

The basic Series 800A system consists of the following items:

- an AccessNode
- ac and dc power distribution
- environmental controls
- a rectifier/charger
- optional battery backup
- a service protection center that provides the primary protection for VF and T1 pairs

The cabinet has doors on the front and rear and on the left and right sides. Table 6-3 shows which doors to use when accessing cabinet components.

Table 6-3
Accessing Series 800A OSP components

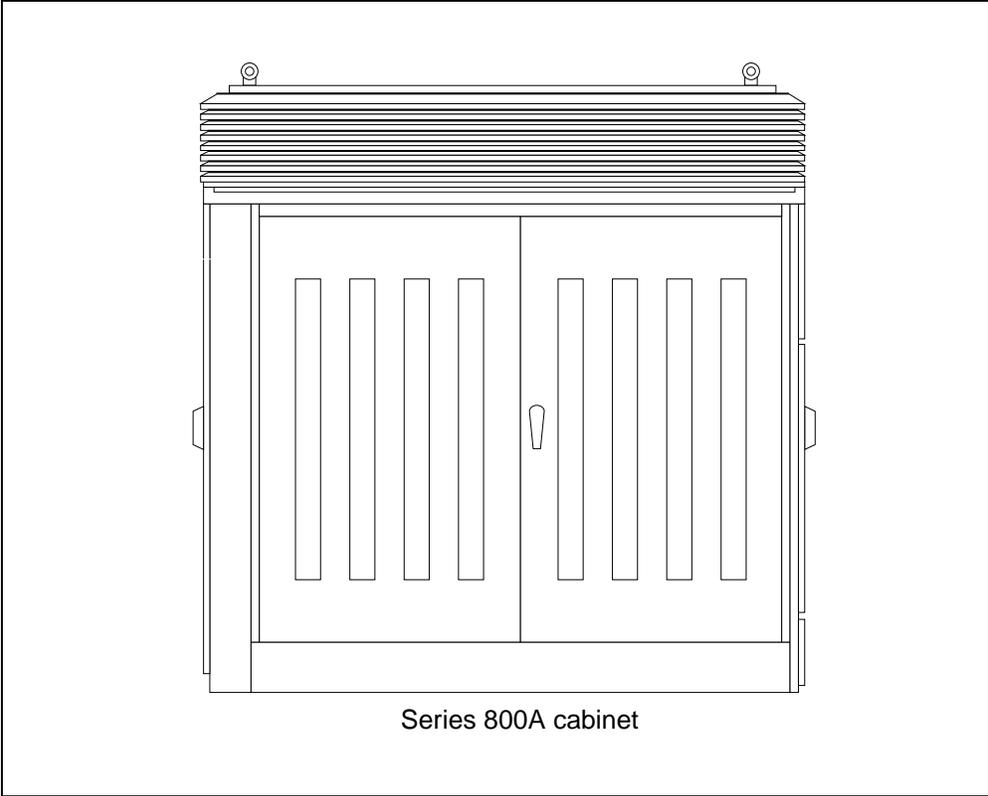
Use the	To access
front doors	line cards ABM shelf LCAP BIP
rear doors	system power and batteries repeaters DSX cross connect dc-distribution shelf battery breaker panel rectifier shelf fiber patch panel
right side door	ac power compartment
left side door	termination compartment, which provides termination and lightning protection for the VF and DS1 cable pairs used in the cabinet

Note: For detailed information on the Series 800A OSP cabinet, see *Series 800A Outside Plant Cabinet Description*, 323-3001-118.

Figure 6-14 shows a Series 800A cabinet with a heat-exchanger roof.

Figure 6-14
Series 800A outside-plant cabinet with heat-exchanger roof

AN-1043



Shelf modules and bay-assembly modules

This chapter discusses the shelf modules and bay-assembly modules used in AccessNodes.

Chapter contents

This chapter contains the following information:

Equipment type	Topic	See	Type of module:	
			Shelf	Bay-assembly
	"Where to find information about the operations controller shelf"	page 7-2		
ABM equipment	"Access bandwidth manager shelf"	page 7-3	X	
	"Breaker interface panel, model NT4K14BA"	page 7-19		X
	"Breaker interface panel, model NT7E56"	page 7-25		X
	"Cooling units"	page 7-31		X
	"Copper-distribution shelf"	page 7-35	X	
	"Fiber management storage tray and the fiber storage panel"	page 7-41		X
	"Fiber storage tray"	page 7-43		
	"Local craft access panel used with an access bandwidth manager shelf"	page 7-44		X
TBM equipment	"Transport bandwidth manager shelf"	page 7-48	X	
	"Cable organizer panel (NT4K1930)"	page 7-61		X
	"Fiber storage panel (NT7E58)"	page 7-63		X
	"Local craft access panel used with the TBM shelf"	page 7-64		X

Where to find information about the operations controller shelf

An operations controller (OPC) shelf is a special-purpose configuration of the access bandwidth manager (ABM) shelf or the transport bandwidth manager (TBM) shelf.

For information about the ABM OPC shelf, including shelf layouts, see the following:

- “Stand-alone ABM OPC shelf.” on page 7-15
- “Stand-alone ABM OPC shelf for a DS1-fed system with OMCs.” on page 7-17

For information on the TBM OPC shelf, including shelf layouts, see the following:

- “TBM OPC shelf” on page 7-58

For descriptive information about AccessNode Express, see *Configuration and Equipment Description*, 323-3051-100, in the *AccessNode Express* volume.

Access bandwidth manager shelf

In AccessNode systems, the access bandwidth manager (ABM) shelf has the following main purposes:

- to interface to copper-distribution shelves in the same network element
- to hold an operations controller (OPC)

Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

The ABM shelf interfaces to copper-distribution shelves and holds an OPC when used in a fiber-fed system as the common-equipment shelf in an FCOT.

The ABM shelf interfaces to copper-distribution shelves when used in a fiber-fed system, a single-ended system, or a DS1-fed system used as the common-equipment shelf in a remote fiber terminal (RFT).

The ABM shelf serves only as an OPC shelf when used in the following:

- a single-ended system as an OPC shelf, where it is commissioned as a non-traffic-carrying fiber central office terminal (FCOT)
- a DS1-fed system as an OPC shelf referred to as a communications server, where it is commissioned as a non-traffic-carrying FCOT
- a fiber-fed system as a separate OPC shelf, linked by control network to a traffic-carrying FCOT
- a DS1-fed system or a single-ended system as a separate OPC shelf, linked by control network to a network element in an AccessNode or S/DMS TransportNode OC-12 ring, where the ring carries the operations, administration, maintenance, and provisioning (OAM&P) messages between the operations controller and the RFTs

Note: The ABM shelf in a traffic-carrying FCOT can serve both purposes: it can support copper-distribution shelves and house an operations controller.

Functions of the ABM shelf

The ABM shelf performs the following functions:

- provides central control for the network element when used as the common-equipment shelf in a network element (FCOT or remote fiber terminal [RFT])
- provides OAM&P for the network element when used as the common-equipment shelf in an network element (FCOT or RFT)
- provides the primary interface to the fiber optic feeder, which carries traffic at the OC-12 or OC-3 rate in FCOTs and RFTs in fiber-fed systems
- provides the interface to the OC-3 tributary in RFTs in single-ended systems
- supports digital interfaces (DS1 and DS3)
- supports OC-3 tributaries
- performs bandwidth management, which supports the following functions:
 - multiplexing and demultiplexing
 - grooming the traffic at the VT1.5 (DS1) and STS-1 (DS3) levels
 - routing portions of the SONET payload to digital interfaces in the AccessNode
- performs bandwidth management at the DS0 level, and can route traffic to the copper-distribution shelves
- contains circuit packs and cards that interface to the equipment in copper-distribution shelves
- contains circuit packs and cards that help test the line cards in copper-distribution shelves

Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

ABM shelf as interface to copper-distribution shelves

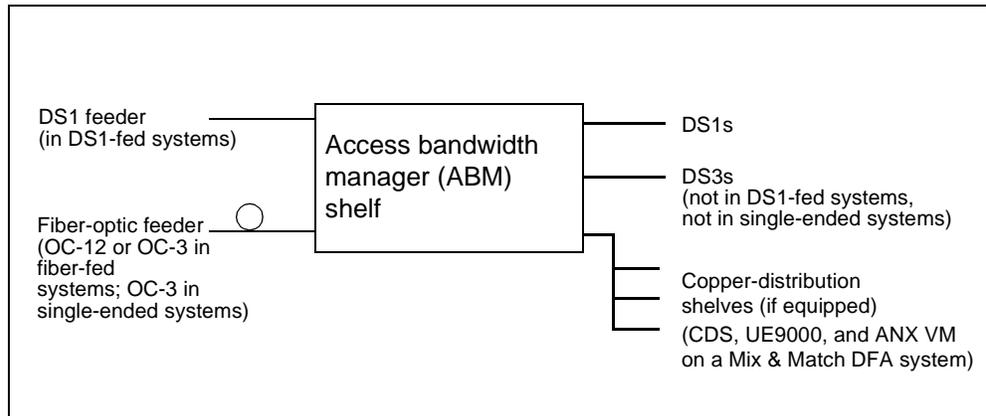
The ABM shelf contains modules that interface to the copper-distribution shelves in the bay. One ABM shelf can support up to 7 copper-distribution shelves, providing 672 voice frequency interfaces, as well as DS1 and DS3 interfaces.

An RFT that supports services offered over conventional copper loops contains one or more copper-distribution shelves. A traffic-carrying FCOT in a fiber-fed system contains one or more copper-distribution shelves if the FCOT interfaces to analog equipment (switches or cross-connects) in the central office.

Architecture

Figure 7-1 shows the interface options available on the ABM shelf.

Figure 7-1
ABM shelf interfaces



When used as the common-equipment shelf in a fiber-fed system, an ABM shelf can interface to a fiber-optic feeder at the OC-12 or OC-3 rate. The ABM shelf supports

- copper-distribution shelves
- D-link extender shelves, which are used only in RFTs
- protected DS1s, protected DS3s
- OC-3 tributaries, which are supported only at RFTs in fiber-fed systems with OC-12 feeders

The optical feeder interface offers 1+1 protection, while the DS1 and DS3 interfaces offer 1:n protection.

When used as the common-equipment shelf in an RFT in a single-ended system, an ABM shelf can interface to a fiber-optic feeder at the OC-3 rate. The ABM shelf supports

- copper-distribution shelves
- protected DS1s

The optical feeder interface offers 1+1 protection, while the DS1 interfaces offer 1:n protection.

When used as the common-equipment shelf in an RFT in a DS1-fed system, an ABM shelf can interface to a copper feeders at the DS1 rate. The ABM shelf supports

- copper-distribution shelves
- protected DS1s

Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

The DS1 interfaces offer 1:n protection.

Note: For detailed information on the DS1s, DS3s, and OC-3 tributaries that an ABM shelf can support, see the *Mapper Layouts Planning Guide*, 323-3001-154, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

Structure of the ABM shelf

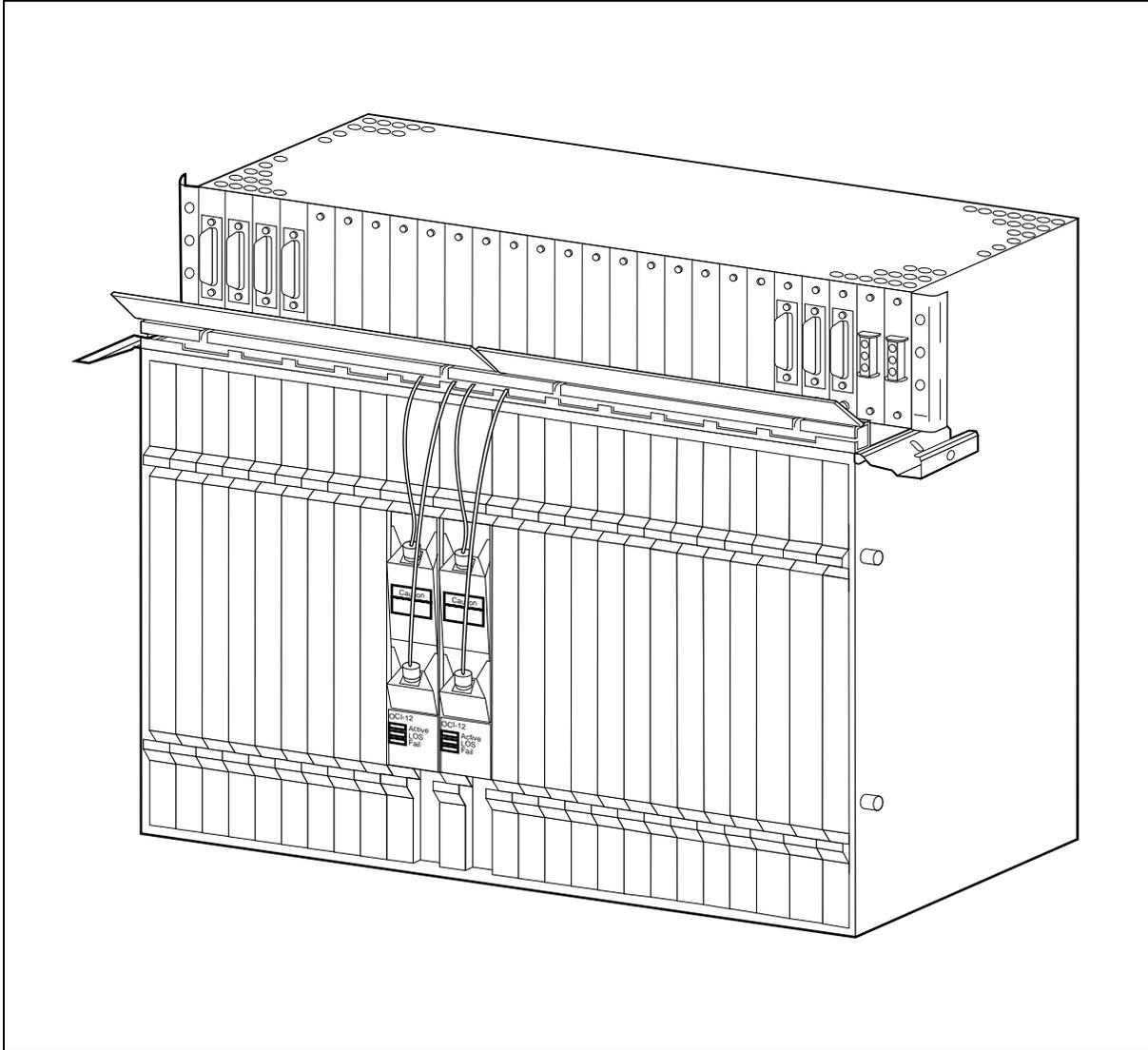
The ABM shelf has full front access. The dimensions of the shelf are as follows:

width	23 in. (584 mm)
height	15.5 in. (394 mm)
depth	12.2 in. (310 mm)

Figure 7-2 shows an ABM shelf.

Figure 7-2
ABM shelf

PC-10243



Layout of the ABM shelf

The ABM shelf has two levels of slots, which are numbered from left to right. A label strip on the shelf identifies the slot numbers in the upper and lower levels of the shelf. The strip extends across the front of the shelf from left to right. Table 7-1 shows slot levels in an ABM shelf.

Table 7-1
Slot levels in an ABM shelf

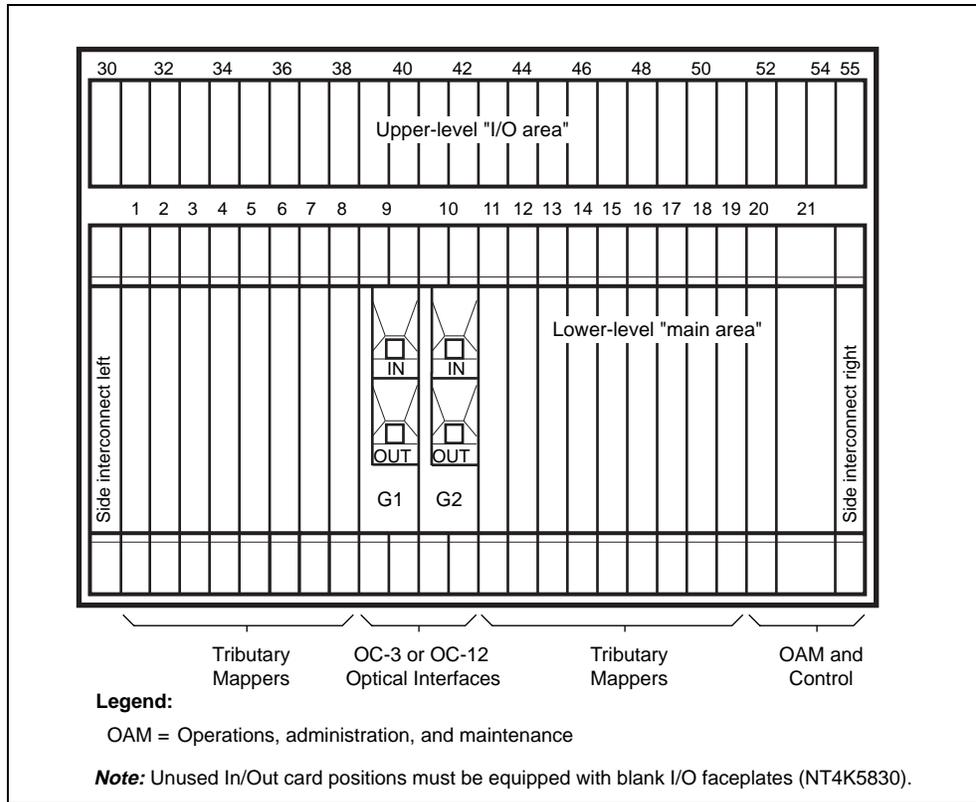
Position	Slots	Accommodate	Dimensions
lower level	1 to 21	circuit packs and cards	11.5 in. (292 mm) high and 10.15 in. (258 mm) deep
upper level	30 to 55	I/O personality cards	2.25 in. (57 mm) high and 7.1 in. (180 mm) deep

All the circuit packs and I/O personality cards plug in to the shelf backplane.

Figure 7-3 shows the layout of the ABM shelf.

Figure 7-3
ABM shelf, with slot numbers shown

PC-15863



Side interconnect circuit packs

Cabling enters the ABM shelf at the ends of the shelf, at the side interconnect left circuit pack and the side interconnect right circuit pack. The side interconnect circuit packs are installed in unnumbered slots at the ends of the shelf. The slots are unnumbered because the side interconnect circuit packs are parts of the shelf assembly.

Side interconnect left circuit pack in the ABM shelf (NT4K50AA)

The following connectors listed in Table 7-2 are located on the side interconnect left circuit pack for the ABM shelf:

Table 7-2
Connectors on the ABM side interconnect left circuit pack

Connector Number	Type	Purpose
J13	44-pin D connector labeled BIP Ctl	for a cable that goes to the breaker interface panel (BIP).
J12	25-pin D connector labeled Ext Sync IF	for a cable from an external timing source such as a building integrated timing source (BITS). Timing information flows between the BITS and the working external synchronization interface card in the ABM shelf.
J11	44-pin D connector labeled Parallel Telemetry	for a cable carrying parallel-telemetry between AccessNode and external equipment.
J10	9-pin D connector labeled Ctl Net In	for an incoming control-network cable. Control network is a local area network (LAN) that can link multiple AccessNodes if they are collocated. The maximum length of the LAN cable connection is 400 ft. The connector is for the cable coming from the previous AccessNode in the LAN. If an incoming control-network cable does not exist, a control-network termination plug must be installed on this connector.
—continued—		

7-10 Shelf modules and bay-assembly modules

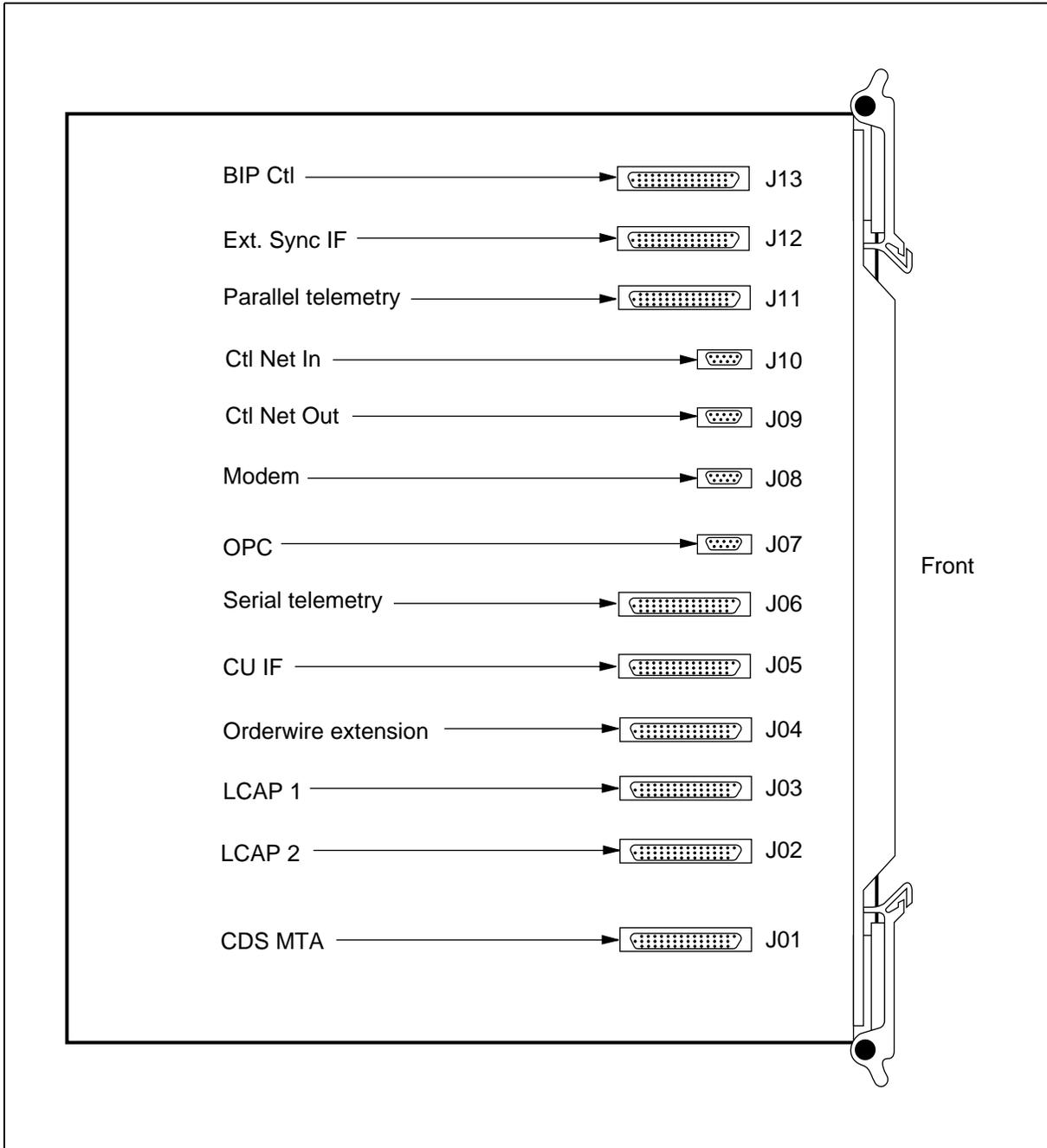
Table 7-2 (continued)
Connectors on the ABM side interconnect left circuit pack

Connector Number	Type	Purpose
J09	9-pin D connector labeled Ctl Net Out	for an outgoing control-network cable. Control network is a LAN that can link multiple AccessNodes if they are collocated. The maximum length of the LAN cable connection is 400 ft. The connector is for the cable going to the next AccessNode in the LAN. If an outgoing control-network cable does not exist, a control-network termination plug must be installed on this connector.
J08	9-pin D connector labeled Modem	for an RS-232C port supported by the maintenance interface card in the shelf. A remote terminal, connected to this connector using an external modem, can access the processor card in the shelf.
J07	9-pin D connector labeled OPC	for serial port #1 of the operations controller (OPC) This DTE port uses the RS-232C standard. The port supports either asynchronous or synchronous protocols to a maximum data rate of 19,200 baud. For instructions on configuring the port, see <i>System Administration Procedures</i> , 323-3001-302, in <i>Operations, Administration, and Provisioning</i> , Volume 4A.
J06	25-pin D connector labeled Serial Telemetry	for a cable carrying serial-telemetry data. The maintenance interface card in the shelf supports two 2-wire serial ports. Both ports use this connector.
J05	25-pin D connector labeled CU IF	for a cable to the cooling unit.
J04	25-pin D connector labeled Orderwire Extension	for a cable carrying the orderwire channel to another piece of equipment in the office.
J03	44-pin D connector labeled LCAP 1	for a cable to the LCAP.
J02	25-pin D connector labeled LCAP 2	for a cable to the LCAP.
J01	25-pin D connector labeled CDS MTA	for a cable that carries the two metallic test buses to first copper-distribution shelf.
—end—		

Figure 7-4 shows the connectors located on the side interconnect left circuit pack.

Figure 7-4
Connectors on the side interconnect left circuit pack for the ABM shelf (NT4K50AA)

PC-10169



Side interconnect right circuit pack

An ABM shelf that supports copper-distribution shelves requires a side interconnect right circuit pack. An ABM shelf that does not support such shelves may have a blank cover piece in place of a side interconnect right circuit pack.

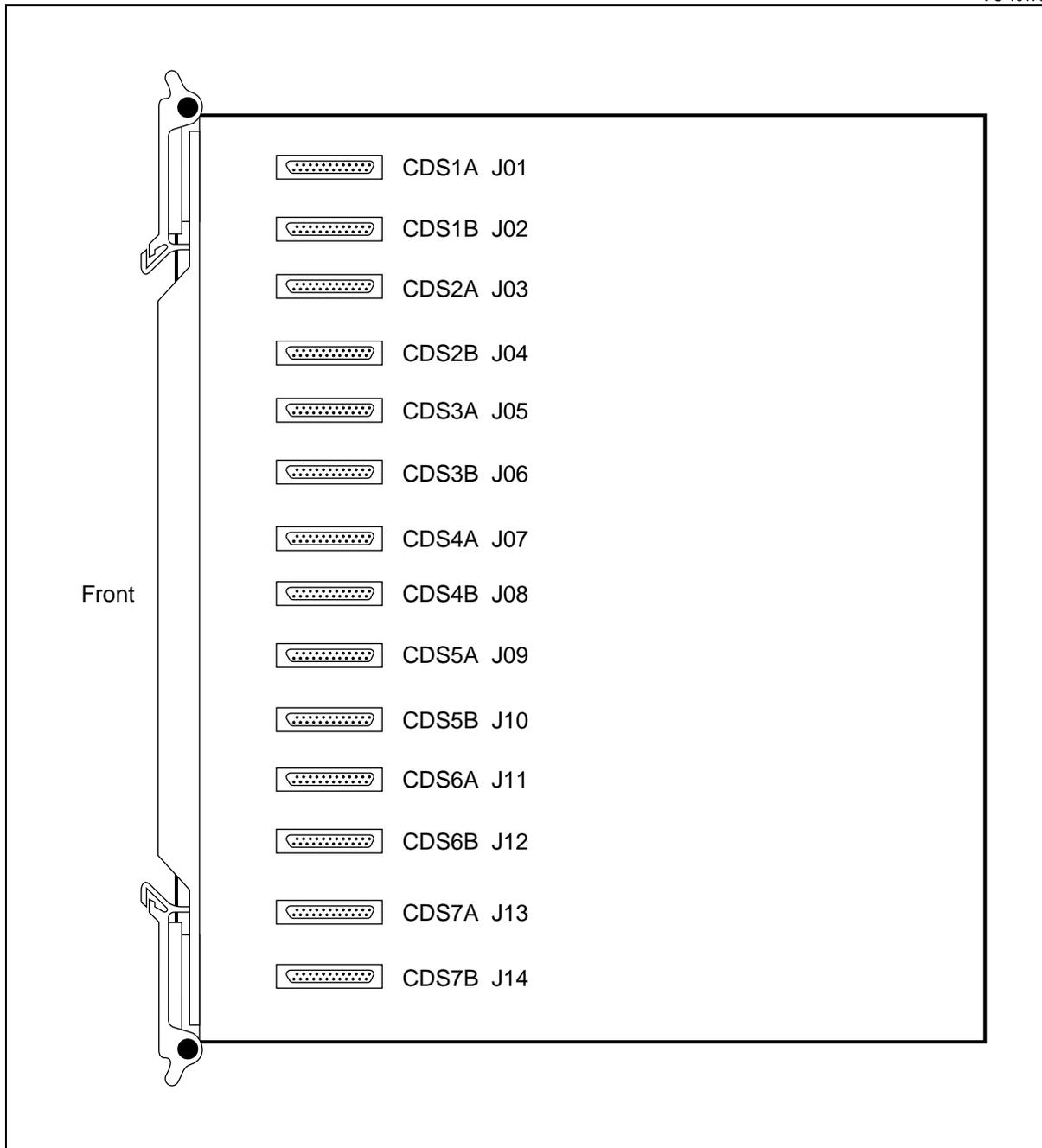
As shown in Figure 7-5, the side interconnect right circuit pack has fourteen 44-pin D connectors. Each connector has the D-links for a copper-distribution drawer. (A copper-distribution shelf housed in a bay contains two copper-distribution drawers.)

Power connections

Power cables from the breaker interface panel connect to the two common-equipment power cards installed in upper level of the ABM shelf in the two slots nearest the right-hand end of the shelf (slots 54 and 55). The power cables enter the front of the cards.

Figure 7-5
Connectors on the side interconnect right circuit pack

PC-10170

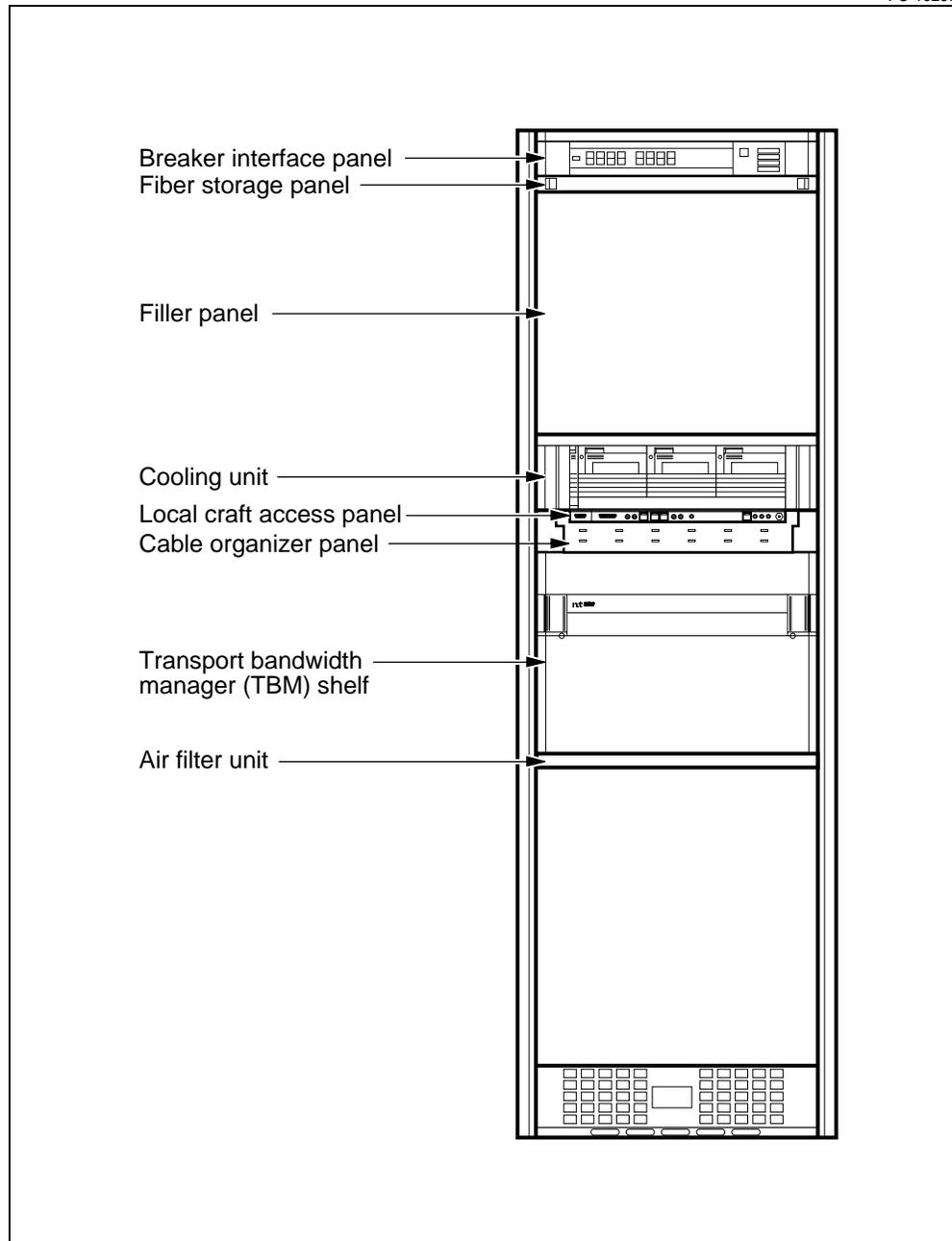


Where the ABM shelf installs

A bay can contain only one ABM shelf that can be installed in only one position in the bay. That position is immediately below the fiber storage panel, as shown in Figure 7-6. The cooling unit and the local craft access panel (LCAP) are installed below the ABM shelf.

Figure 7-6
Location of the ABM shelf in a bay

PC-10267



For more information on the modules installed in the ABM shelf, see Chapter 8, “Plug-in modules.” For more detailed information, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

Stand-alone ABM OPC shelf

Figure 7-7 on page 7-16 shows an ABM shelf used as a stand-alone OPC shelf. A stand-alone OPC shelf is installed in its own bay. It is a separate network element, and is commissioned as an FCOT with a communication rate of zero. The ABM OPC shelf can serve any type of AccessNode system. The OPC in the shelf can serve one or more systems. The connection to each of the network elements served by the OPC is through control network, the SONET data communications channels (SDCC), or a combination of control network and SDCC.

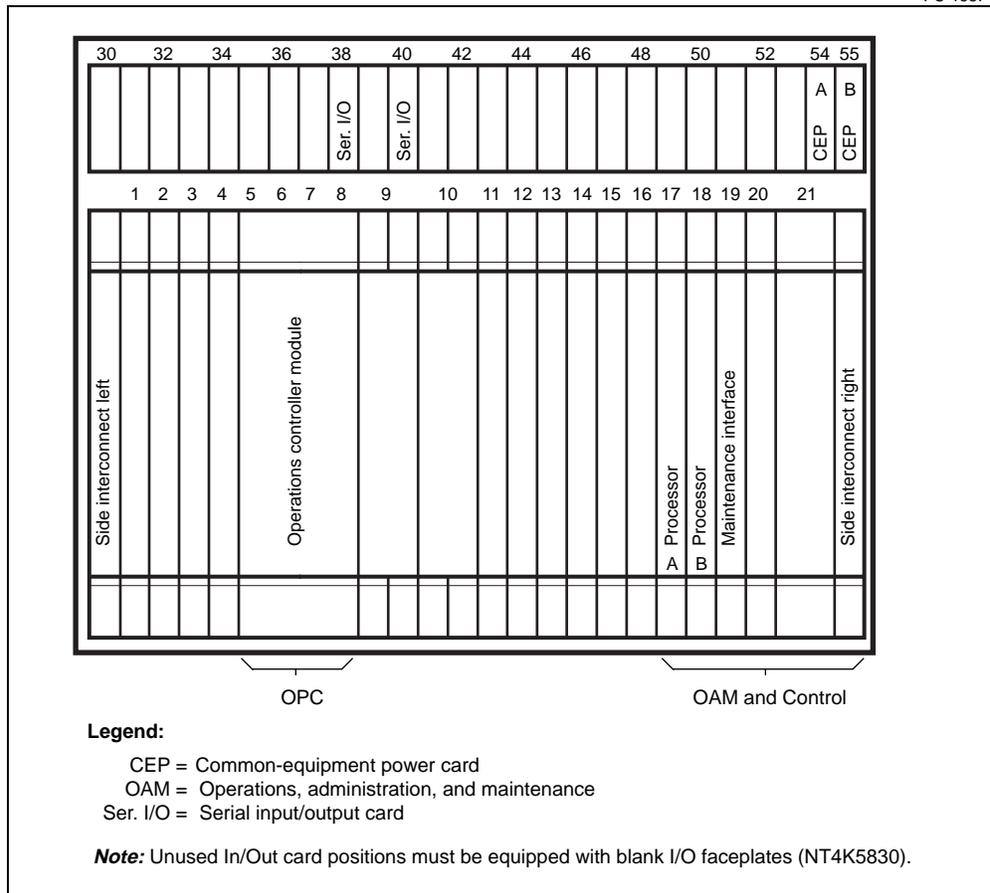
Note: Although this ABM OPC shelf does not support OMC DS1 links, it can serve a DS1-fed system if using a control network connection does not require OMC DS1s for connection to the DS1-fed RFTs.

The following modules shown in Figure 7-7 are optional in this shelf: the serial I/O cards in slots 38 and 40 and the processor card in slot 18. The serial I/O cards allow access to serial ports two and three of the operations controller.

For more information on the modules installed in the ABM shelf, see Chapter 8, “Plug-in modules.” For more detailed information, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

Figure 7-7
ABM FCOT shelf equipped as a stand-alone ABM OPC shelf

PC-15871



Stand-alone ABM OPC shelf for a DS1-fed system with OMCs

Figure 7-8 shows an ABM shelf used as stand-alone OPC shelf for a DS1-fed system in which the OPC connects to the DS1-fed RFTs using OMC DS1s.

A stand-alone OPC shelf is installed in its own bay. It is a separate network element and is commissioned as an FCOT with a communication rate of zero. The operations controller communicates with each DS1-fed RFT using an operations maintenance channel, which is carried in an OMC DS1. For a description of the operations maintenance channel, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

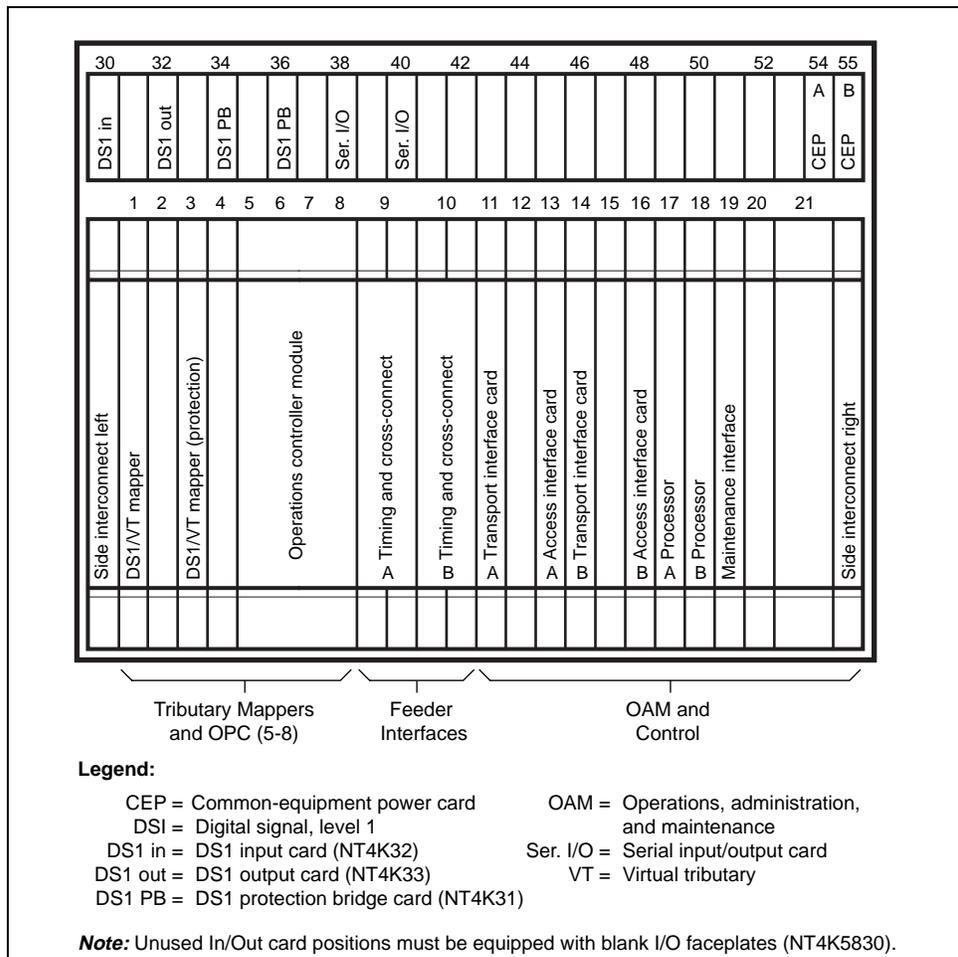
The stand-alone ABM OPC shelf contains timing and cross-connect cards rather than optical interface (OC-12 or OC-3) circuit packs because the signals entering and leaving the shelf are DS1s rather than optical signals.

The following modules shown in Figure 7-8 on page 7-18 are optional in this shelf: the serial I/O cards in slots 38 and 40, the modules in slots 3, 34, 36, 14, and 18, all of which are for protection. The serial I/O cards allow access to serial ports two and three of the operations controller.

For more information on the modules installed in the ABM shelf, see Chapter 8, “Plug-in modules.” For more detailed information, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

Figure 7-8
ABM RFT shelf equipped as an OPC shelf supporting OMC DS1s

PC-15872



Breaker interface panel, model NT4K14BA

In an AccessNode that contains an access bandwidth manager shelf (ABM), the breaker interface panel (BIP) is a model NT4K14BA with redundant power feed feature. Figure 7-9 shows the NT4K14BA BIP.

Note: If an AccessNode contains a transport bandwidth manager (TBM) shelf (TBM), the model-NT7E56 BIP is used. For information on that model, see Figure 7-12 on page 7-25.

Breaker interface panels are bay-assembly modules. Every AccessNode contains a BIP for distribution protected power to AccessNode shelves. The BIP redundancy feature when utilized provides continuous power to the system even if one of the feeds on each side are shorted or removed from service. A BIP performs the following functions:

- distributes battery power to the ABM shelf and to the copper-distribution shelves
- distributes power to the cooling unit(s) in a bay
- distributes talk battery power to the copper-distribution shelves
- processes alarms from within the AccessNode and from external equipment

Figure 7-9
Breaker interface panel, model NT4K14BA

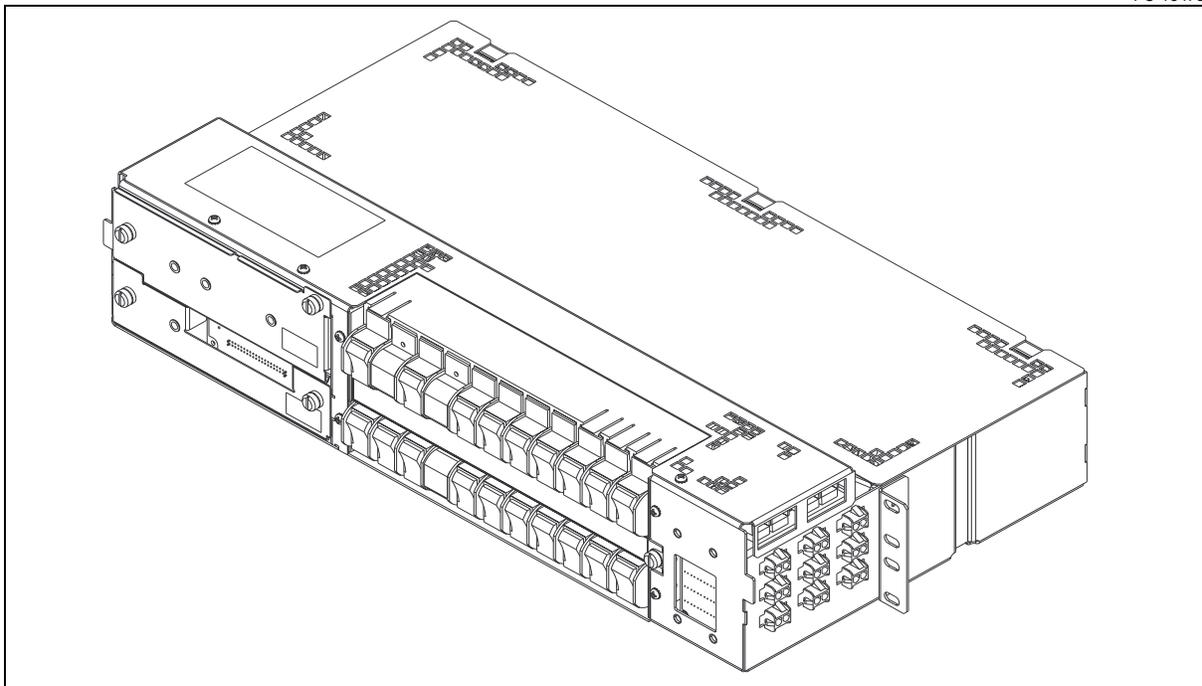


Table 7-3 shows the dimensions of the breaker interface panel.

Table 7-3
Breaker interface panel dimensions

BIP part	Dimensions
chassis	21.3 in. (541 mm) wide, 11.5 in. (37 mm) deep, and 4.5 in. (114 mm) high
front cover	0.5 in. (13 mm) thick, so the total depth to 12.0 in. (305 mm)
bay frame	84 (2134 mm) wide, 23 in (584 mm) high

To facilitate mounting in the uppermost 3.5-inch (89 mm) mounting position in a standard NEBS bay frame, a 1.0 in. (25.4 mm) x 8.0-in. (203.2 mm) section is removed across the full width of the panel. Removing this section prevents interference with the crossmember of the bay frame and provides a 1.0 in. (25.4 mm) x 1.0-in. (25.4 mm) trough for routing a ground bar. The top and bottom of the breaker interface panel are open to allow cooling air to pass through.

From left to right, the visible features on the front of the breaker interface panel are as follows:

- the talk battery filter card (NT4K61BA)
- the alarm relay card (NT4K64BA)
- the red breaker-trip LED on the front of the alarm relay card, which is lit whenever any breaker is open
- the wirewrap pins, which serve various purposes, as explained in “Wirewrap pin field.” on page 7-23
- two horizontal rows of circuit breakers
- the following bay power and alarm indicators:
 - green LED: power-on indicator (always lit with power applied to the unit)
 - red LED: critical alarm indicator (lit whenever a critical alarm is present)
 - red LED: major alarm indicator (lit whenever a major alarm is present)
 - yellow LED: minor alarm indicator (lit whenever a minor alarm exists)

The circuit-breaker housing in the BIP has multiple cavities for inserting a circuit breaker. The following 19 circuit breakers are installed for NT4K14 AB or NT4K14 BA BIPs:

- seven 15 A breakers labeled CDS1 to CDS7 to protect the power feeds to the 7 copper-distribution shelves
- seven 10 A breakers labeled power TB1 to TB7 to protect the talk battery feeds to the 7 copper-distribution shelves
- NT4K14AB release 03 and below: two 10 A breakers, labeled CU A and CU B, to protect the A and B power feeds to the cooling unit
- NT4K14AB release 04 and above and NT4K14BA: two 15A breakers, labeled CU A and CU B, to protect the A and B power
- two 15 A breakers labeled CEA and CEB, to protect the A and B power feeds to the ABM shelf
- one 1 A breaker to protect the test access card (TAC)

Blank plastic plates cover each unused cavity in the circuit breaker housing.

As shown in Figure 7-10 on page 7-22, the I/O printed circuit board (PCB), on the right-hand side of the BIP has the following connections:

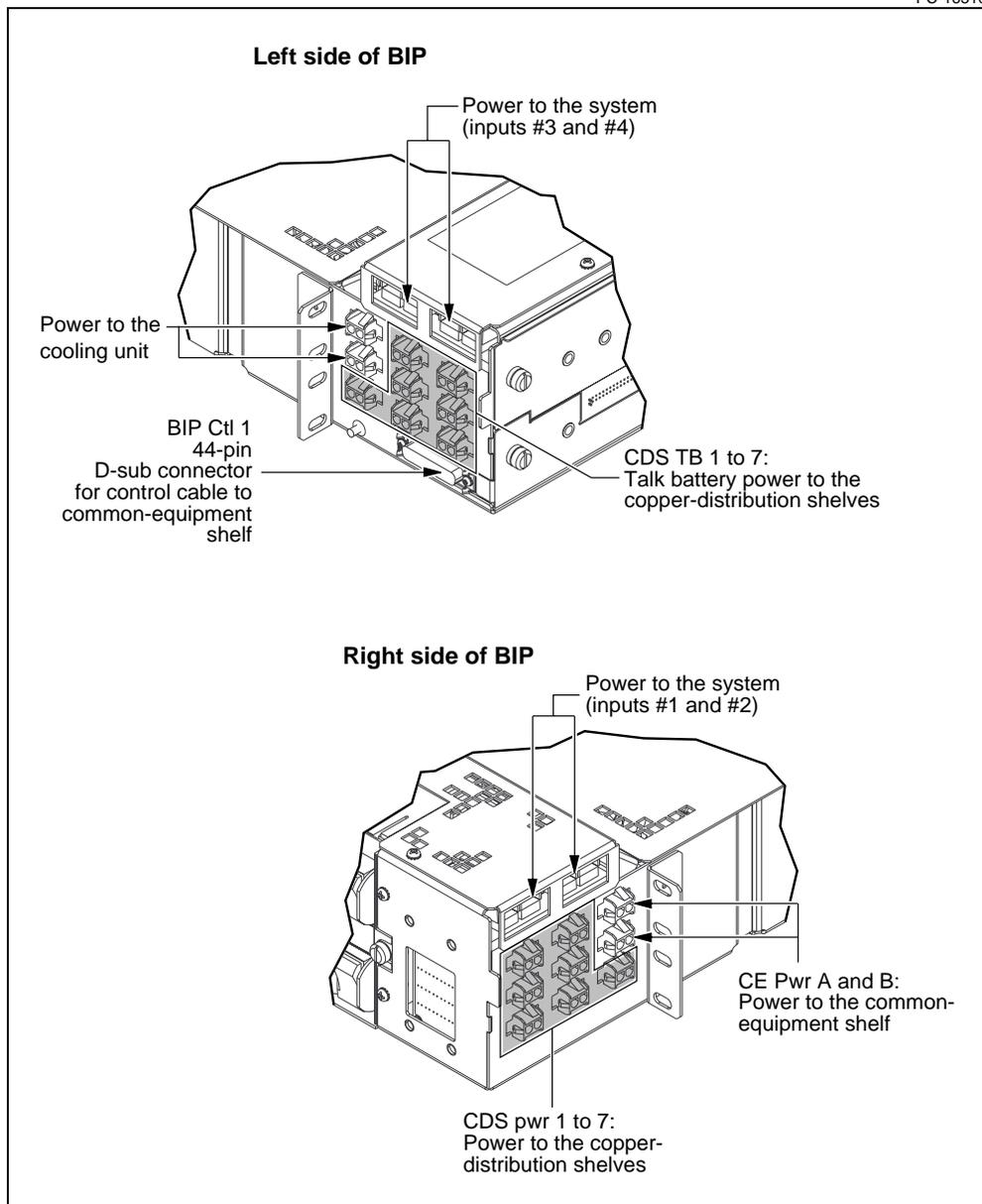
- connectors labeled Ret2, Bat2, Ret1, and Bat1 for cables bringing power to the BIP from the main power source such as the battery distribution frame board (BDFB)
- connectors labeled CDS Pwr 1 to 7 for cables sending logic battery power to the copper-distribution shelves
- connectors labeled CE Pwr B and A for cables sending power to the common-equipment power cards in the upper level of the access bandwidth manager shelf

As shown in Figure 7-10 on page 7-22, the I/O PCB on the left-hand side of the BIP has the following connectors:

- connectors labeled Ret3, Bat3, Ret4, and Bat4 for cables bringing power to the breaker interface panel from the main power source such as the battery distribution frame board (BDFB).
- connectors labeled CDS TB 1 to 7 for cables sending talk battery power to the copper-distribution shelves
- connectors labeled CU Pwr A and B for two pairs of wires sending power (talk battery, unfiltered) to the cooling unit
- one 44 pin D-sub connector labeled BIP Ctl 1 serves as control interface between the BIP and the ABM.

Figure 7-10
Connections on the sides of the NT4K14BA breaker interface panel

PC-16510



Wirewrap pin field

The wirewrap pin field card is housed in the Alarm relay card. Wirewrap pins provide:

- User interface to external alarm sensors.
- User interface to external alarm indicators.
- User interface to audible alarm cut-off.
- User interface to tip, ring, and orderwire.

All alarms are customer selectable for example, the user may set their own customized alarm description and severity

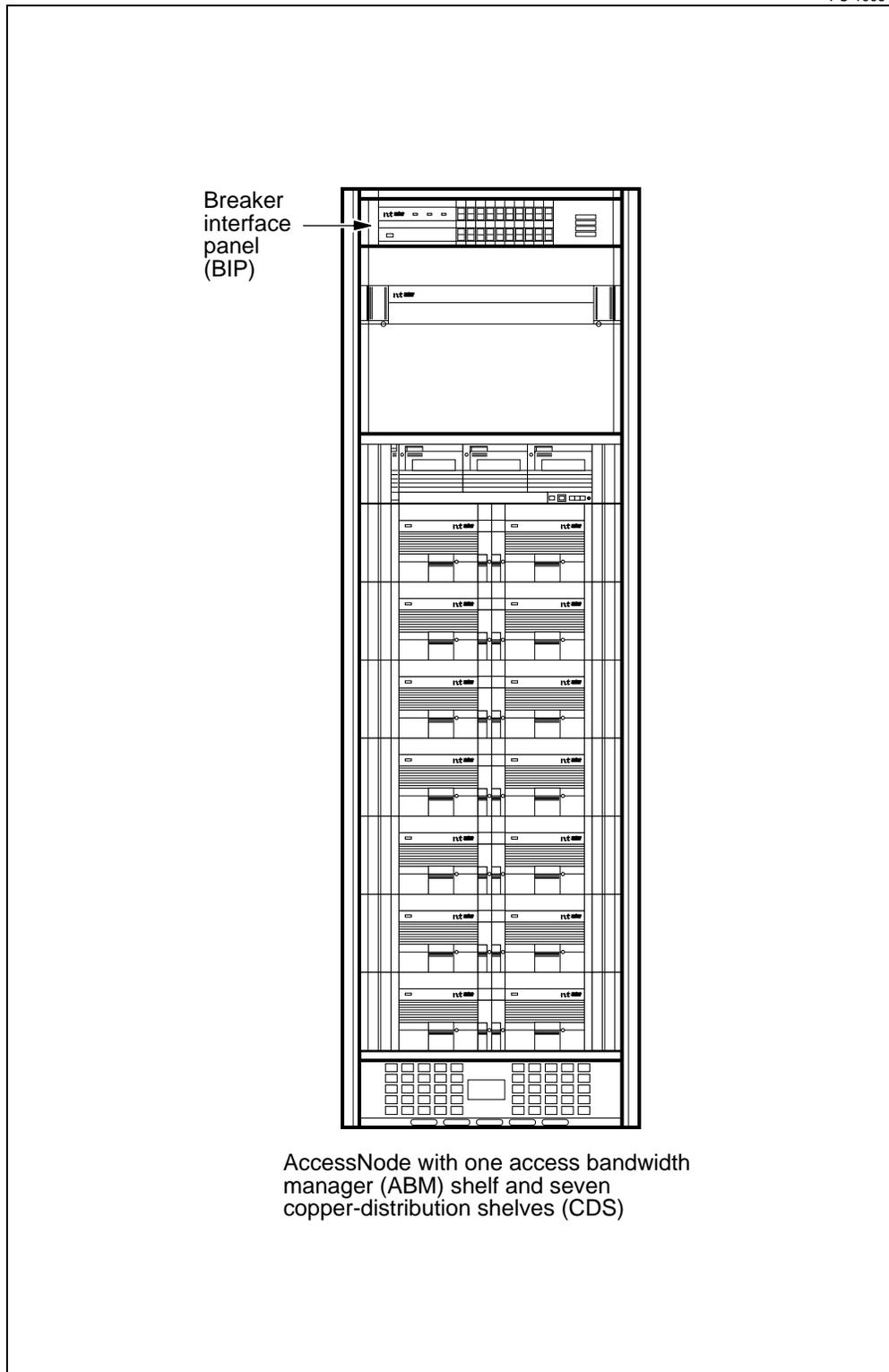
For detailed information regarding the signals carried by the wirewrap pins, see *Alarms and Surveillance Description*, 323-3001-104, in this volume.

Where the NT4K14 breaker interface panel installs

In a bay, the model-NT4K14 breaker interface panel installs at the top of the bay, as shown in Figure 7-11 on page 7-24.

Figure 7-11
Location of the NT4K14 BIP in a bay

PC-10064



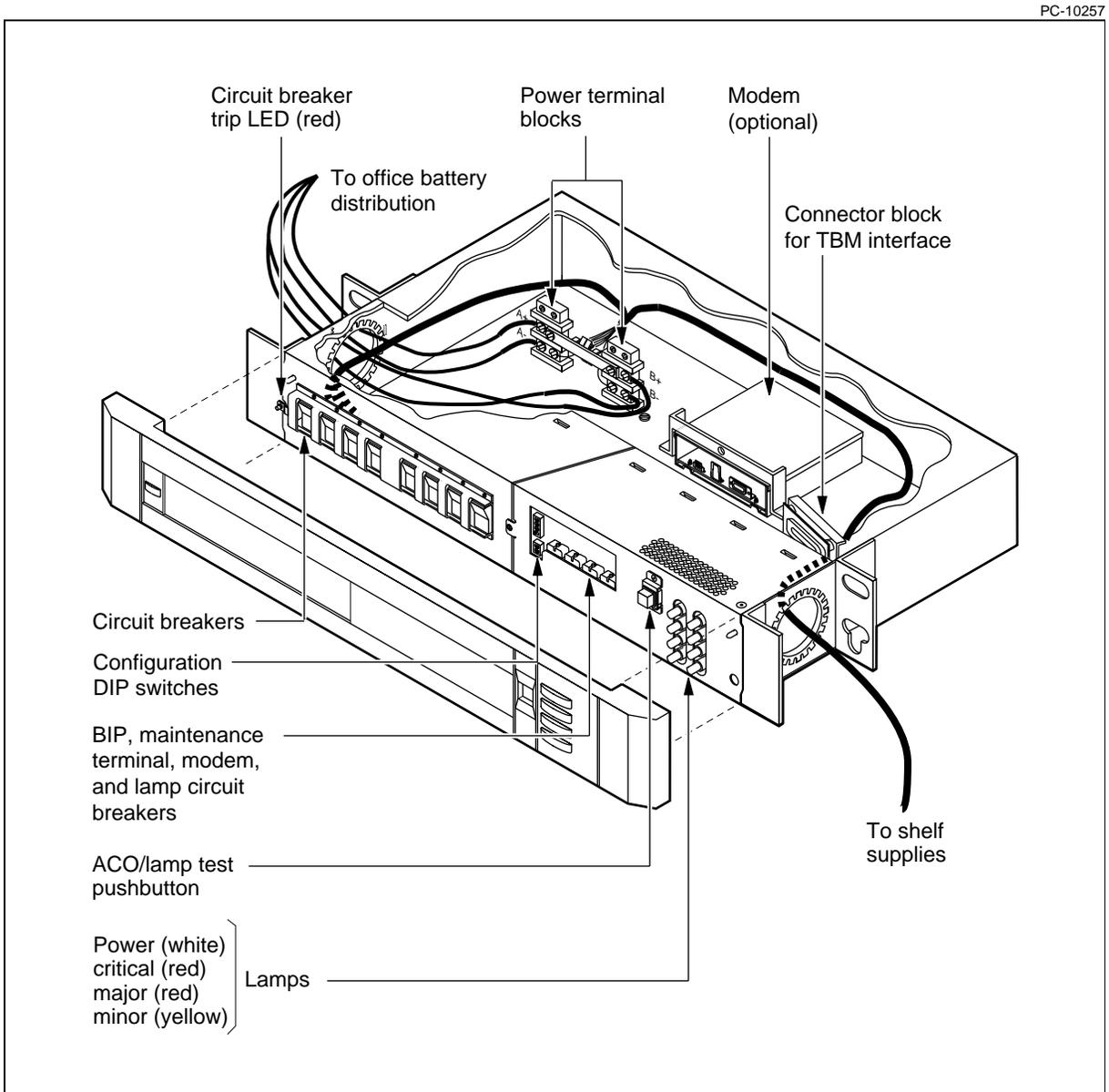
AccessNode with one access bandwidth manager (ABM) shelf and seven copper-distribution shelves (CDS)

Breaker interface panel, model NT7E56

The NT7E56 BIP is used in an AccessNode that contains a transport bandwidth manager (TBM) shelf. Two redundant office battery inputs (-48 V dc) independently feed two power-terminal blocks. Each block has two 15A circuit breakers that feed equipment in the bay.

Figure 7-12 is a three-dimensional view of the NT7E56 breaker interface panel.

Figure 7-12
Breaker interface panel, model NT7E56, three-dimensional view



The right and left sides of the front cover of the breaker interface panel are hinged and open to allow access to the parts inside. Figure 7-13 shows the right-hand side of the front cover in the open position. The right-hand side of the front cover allows access to the wirewrap pins. (The wirewrap pins are discussed in greater detail on page 7-29.) Also behind the right side of the cover is room for the optional modem. (The optional modem is discussed in greater detail on page 7-29.) The left-hand side of the front cover opens to allow access to the power-terminal blocks. The terminal blocks are shown in Figure 7-12 on page 7-25.

Figure 7-13
Location of the wirewrap pins on the model NT7E56 BIP, used with the transport bandwidth manager shelf

PC-10609

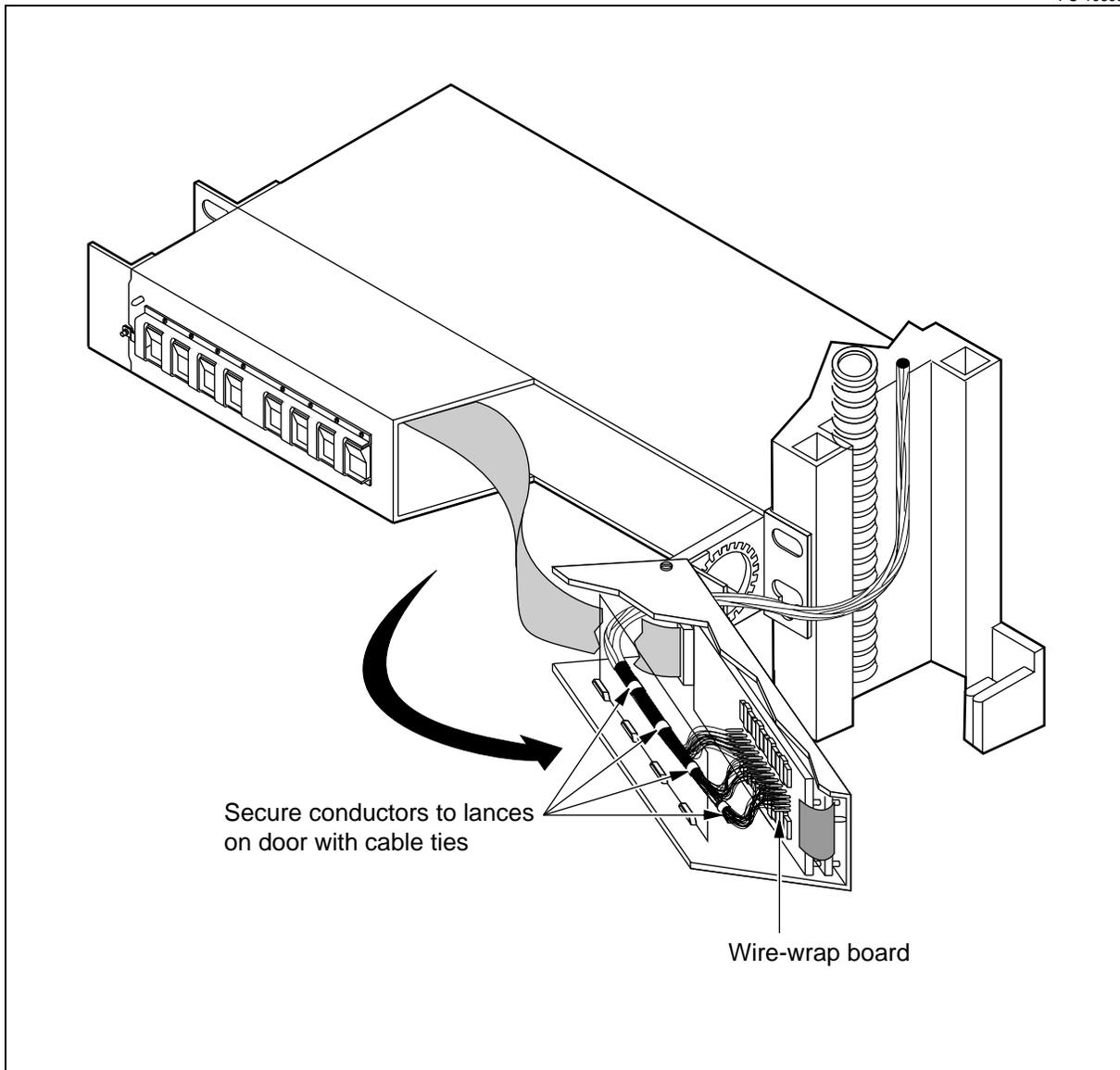
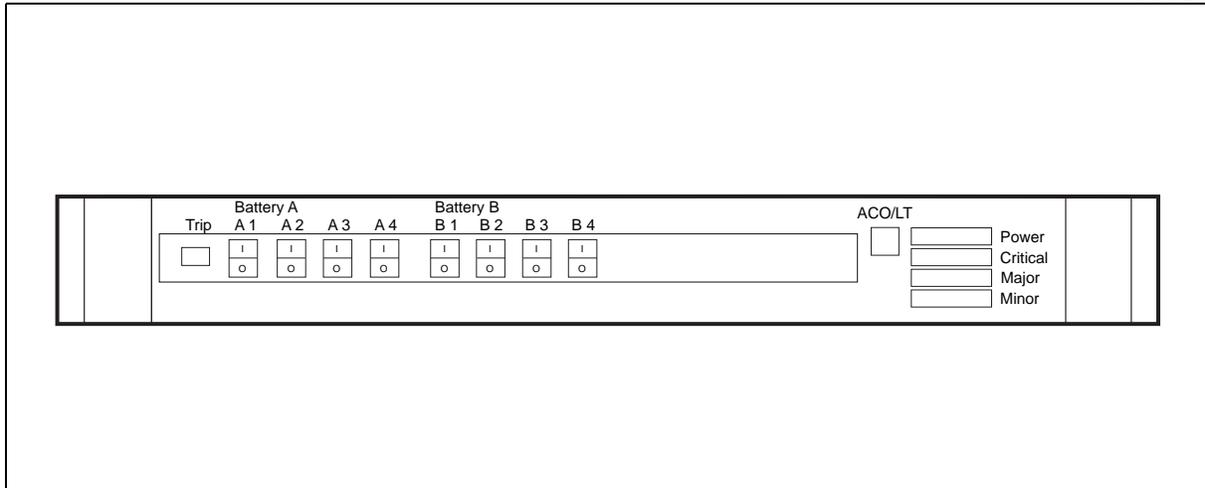


Figure 7-14 is a front view of the NT7E56 breaker interface panel with the front cover installed.

Figure 7-14
Breaker interface panel, model NT7E56, front view

PC-10255



From left to right, the features on the front of the breaker interface panel are as follows:

- a red circuit-breaker-trip LED, which is lit whenever any one of the breakers is tripped
- a group of four 15A circuit breakers, corresponding to battery A
- a group of four 15A circuit breakers, corresponding to battery B
- the configuration DIP switches, which are not shown in Figure 7-14 because they are behind the breaker interface panel cover, that allow you to do the following:
 - disable the major alarms from unequipped shelves
 - enable audible office alarms
 - indicate whether the optional modem is installed

Note: For instructions on setting the DIP switches, see *Bay in Central Office Installation Manual—TBM*, 323-3001-202.

- a group of four auxiliary 2A circuit breakers, which are not shown in Figure 7-14 because they are behind the breaker interface panel cover, that supply power for the following:
 - the breaker interface panel
 - the optional modem
 - the indicator lamps on the breaker interface panel

- The alarm cutoff (ACO)/lamp-test button and indicator.
 - The indicator is a pushbutton with a square cap and a green LED.
 - The lamp lights up if an active alarm cuts off. The button cuts off active cuttable alarms. Alternatively, if there are no active cuttable alarms, the button performs a lamp test that lights all the lamps and LEDs on the breaker interface panel. The test continues until the button is released.

Note: To test the other lamps and LEDs on the bay, use the ACO/lamp-test button on the local craft access panel.

- the following bay power and alarm indicators:
 - the power-on indicator (white)
 - the critical alarm indicator (red)
 - the major alarm indicator (red)
 - the minor alarm indicator (yellow)

Power distribution

The breaker interface panel receives two –48 V dc battery inputs, labelled –48 A and –48 B. The two ground returns (RETA and RETB) are isolated from the bay ground.

The two battery feeds are monitored separately and if either one fails or drops below –38 V dc, a minor alarm is raised.

Each of the two power supplies feeds a set of four 15 A circuit breakers that feed equipment in the bay. The two sets of four breakers are accessible on the front of the breaker interface panel.

BIP power failure

A total loss of power to the breaker interface panel causes a critical alarm on the office-alarm system. You can use one of the DIP switches on the front of the breaker interface panel to disable the critical office relay contacts that terminate on the office-alarm interface panel.

Office-alarm board

The office-alarm board is located behind the right-hand hinged cover on the breaker interface panel. The board contains the control circuitry for the breaker interface panel. Mounted on the board are the wirewrap pins and an ACO/lamp test pushbutton and indicator.

Wirewrap pins

The wirewrap pins are inside the right side of the front cover on the office-alarm board. Some of the pins are the connections for the office-alarm relays. The breaker interface panel has two sets of office-alarm relays: those for visual alarm indicators and those for audible alarm indicators. The visual alarms are noncuttable and the audible alarms are cuttable. Control circuitry in the office-alarm board drives all the relays.

Some of the wirewrap pins are connections for optional remote ACO/lamp-test buttons.

For detailed information regarding the signals carried by the wirewrap pins, see *Alarms and Surveillance Description*, 323-3001-104, in this volume.

Optional modem

The TBM breaker interface panel can have an optional modem (2400 baud). The optional modem allows access the network-element user interface from a remote terminal.

The optional modem and its power supply reside on the modem card, which is a single printed circuit board mounted in the BIP housing, on the right-hand side. The breaker interface panel supplies fused -48 V dc power to the modem card.

The RS-232 port of the modem resides on the modem card. The interface is through a 9-pin D-subminiature connector on the card. The modem interfaces to connector J10 on the side interconnect left circuit pack in the transport bandwidth manager shelf using a TBM modem cable (NT7E44DD, DE, or DF).

Interface to the transport bandwidth manager shelf

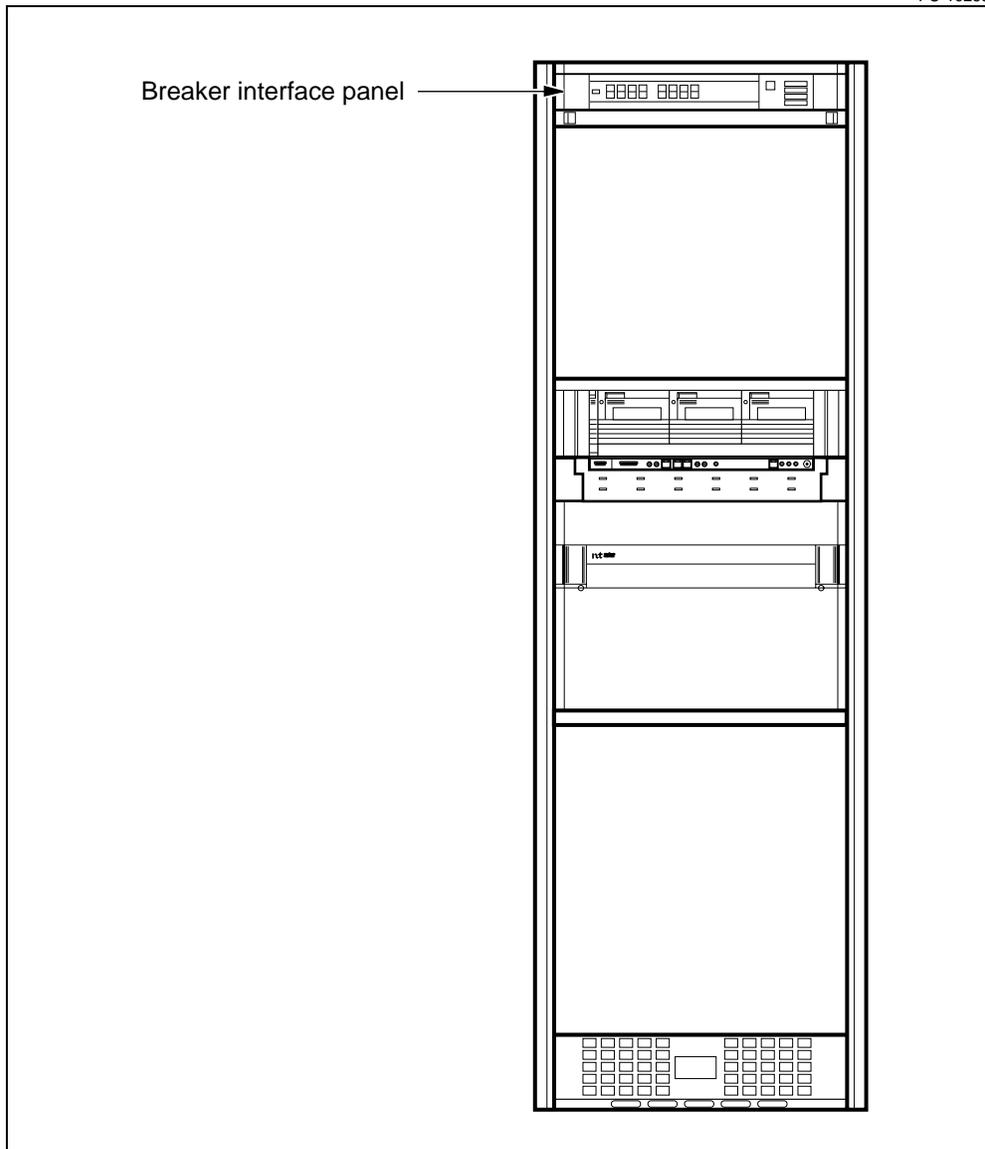
The interface to the TBM shelf is through the BIP control cable. At the transport bandwidth manager shelf, the cable attaches to the J06 connector on the side interconnect left circuit pack. The cable enters the right-hand side of the breaker interface panel and attaches to a 25-pin D connector on a connector block. The connector block is located behind the right side of the front cover to the right of the optional modem. Figure 7-12 on page 7-25 shows the location of the connector block.

Where the NT7E56 breaker interface panel installs

In a bay, the model-NT7E56 breaker interface panel is installed at the top of the bay, as shown in Figure 7-15 on page 7-30.

Figure 7-15
Location of the NT7E56 breaker interface panel in a bay

PC-10268



Cooling units

Two versions of the cooling unit are available. The enhanced transport bandwidth manager (TBM) shelf bay configurations use the through-flow cooling unit (NT4K18BA); all other bay configurations use the 8-fan cooling unit (NT4K18CA).

The NT4K18CA 8-fan cooling unit is a bay assembly module and must be replaced as a whole assembly. This unit contains eight fans that force cooling air upwards through the access bandwidth manger shelf. On the front panel of this assembly is one red LED that lights if the unit fails (see Figure 7-16).

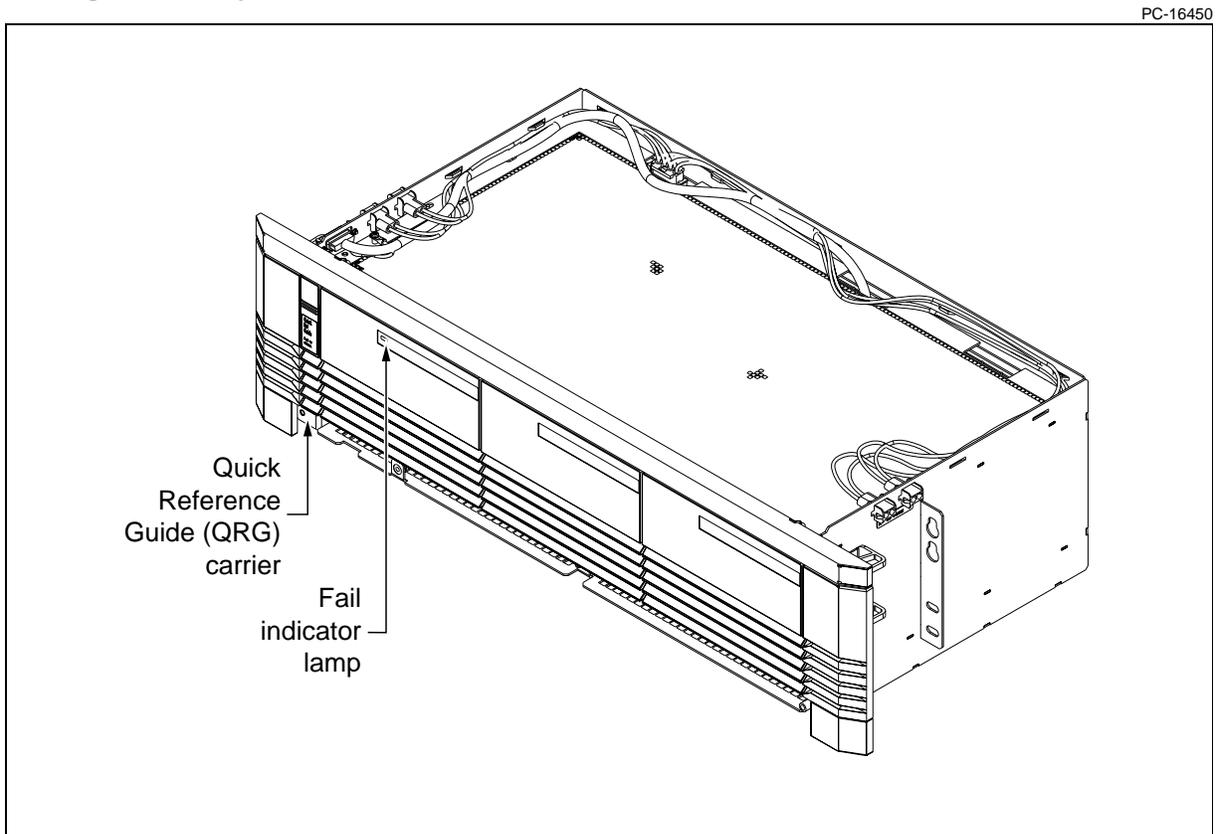
The NT4K18BA through flow cooling unit is a bay-assembly module. This type contains two replaceable cooling modules, as follows:

- NT4K17BA cooling modules in the through-flow cooling unit.

The NT4K17BA cooling module contains two fans. The fans force cooling air upwards through the transport bandwidth manager shelf. On the front of each cooling module is a red LED that is lit if the module fails.

Cooling unit for bays

Figure 7-16
Cooling unit for bays



The NT4K17BA cooling modules contain single-speed fans.

The NT4K18CA provides two operational fan speeds automatically switched depending on shelf temperature.

The through-flow cooling unit (NT4K18BA) and the 8-fan cooling unit do not contain an air filter unit.

Quick Reference Guide

A copy of the *Quick Reference Guide* (the on-product documentation for AccessNode) is attached to the NT4K18CA or BA cooling unit. It is in a slot on the left side of the cooling unit. The slot is covered by a panel labeled Quick Reference Guide (see Figure 7-16 on page 7-31). To access the guide, press and release the labeled panel.

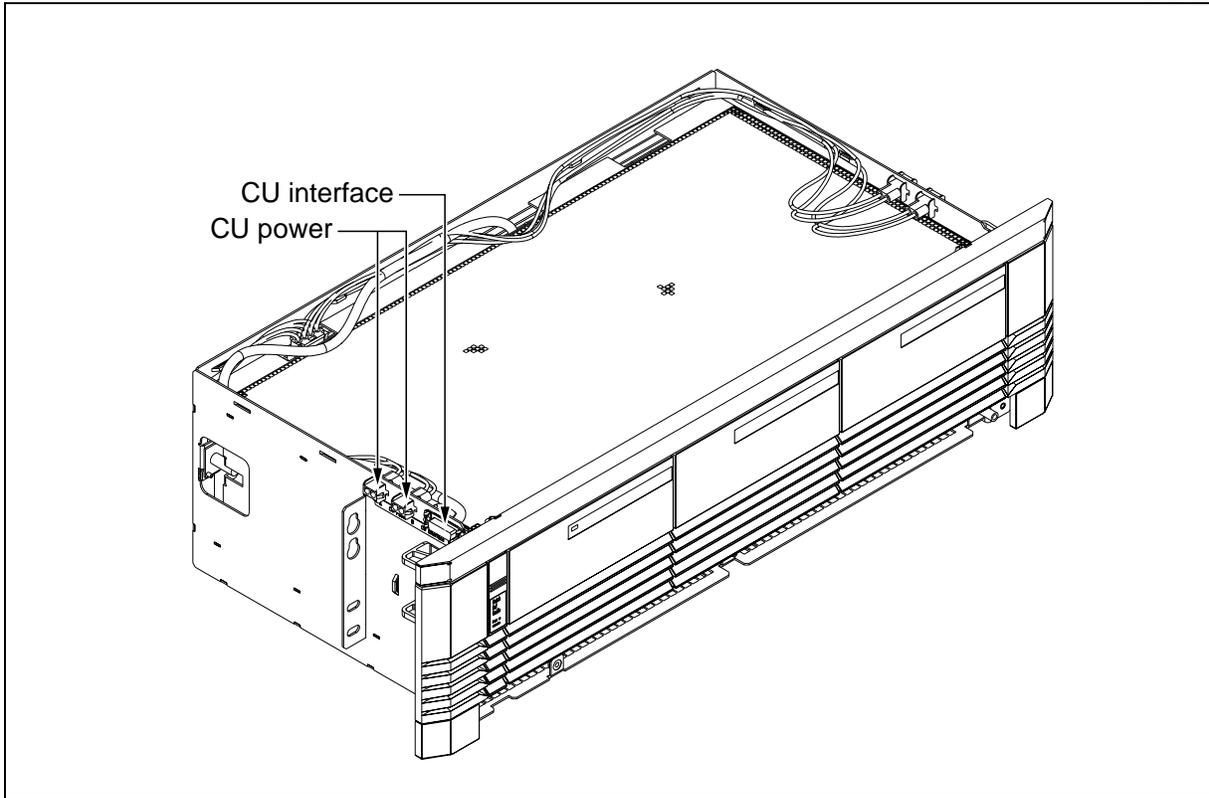
Connections on the left side of the cooling unit

On the NT4K18CA or BA cooling unit, all the connectors for intershelf cables are on the left side. The connectors, as shown in Figure 7-17 on page 7-33, are as follows:

- connectors labeled CU Pwr A and B, for two pairs of wires bringing power from the breaker interface panel (BIP)
- 15-pin D connector labeled CU Interface for a cable from the access or TBM shelf for controlling the fans

Figure 7-17
Connectors on the left side of the cooling unit

PC-16449

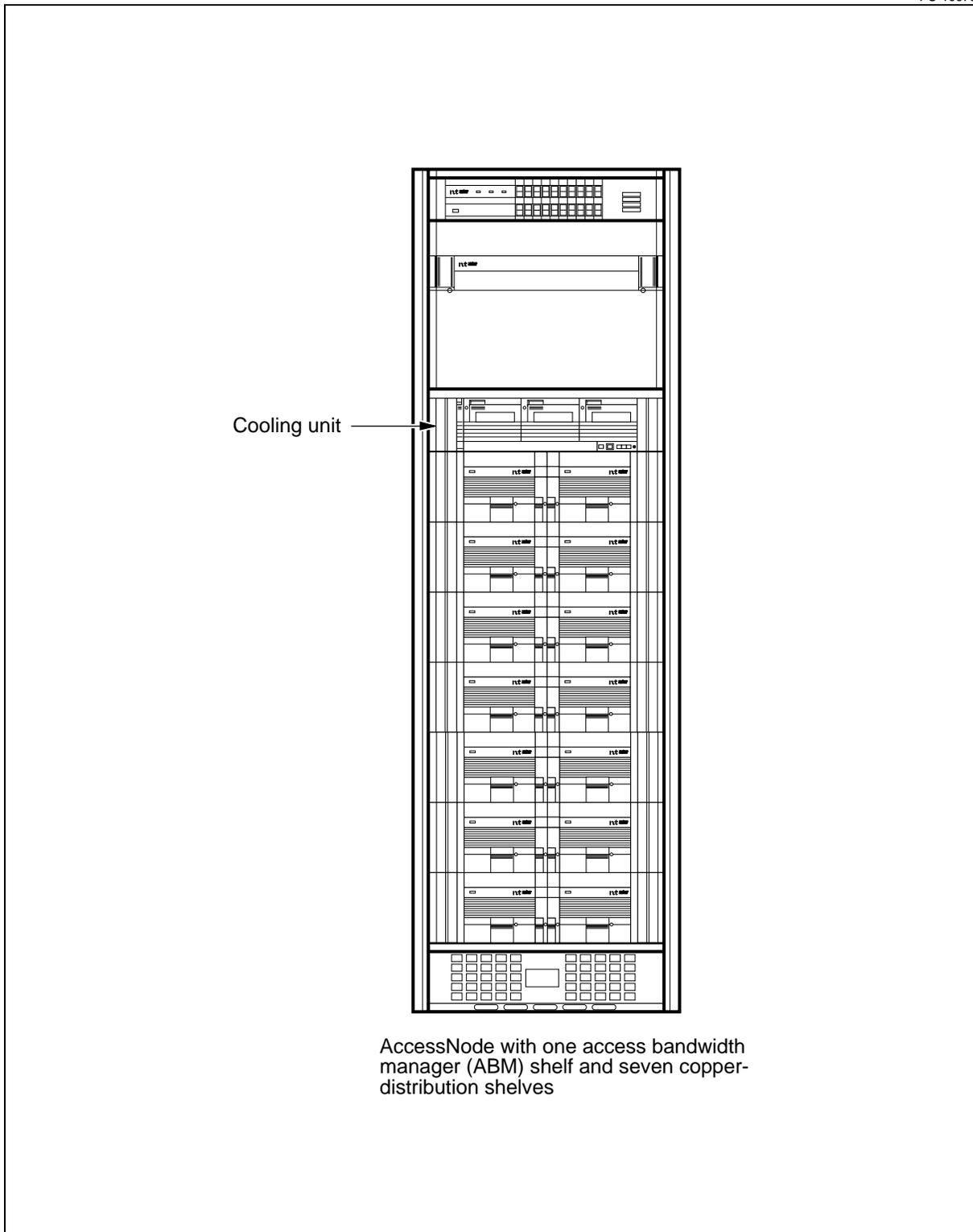


Where the cooling unit installs

In a bay, the NT4K18CA or BA cooling unit installs immediately below the access bandwidth manager (ABM) shelf or the transport bandwidth manager shelf. Figure 7-18 on page 7-34 shows where the cooling unit is installed in a bay.

Figure 7-18
Location of the cooling unit in a bay

PC-10075



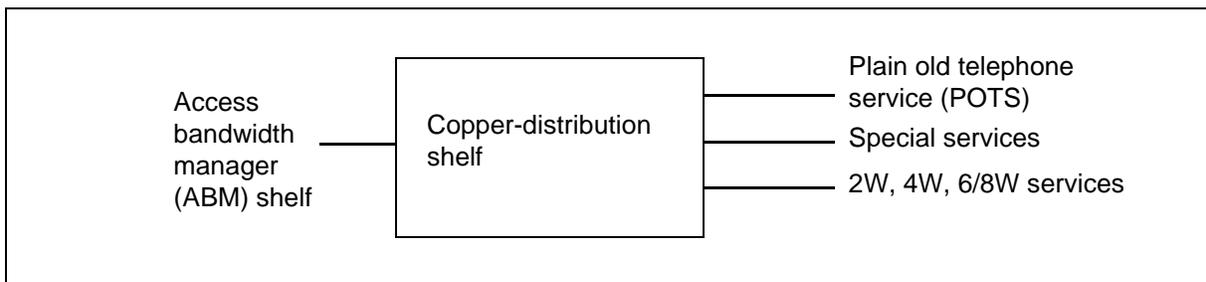
Copper-distribution shelf

An AccessNode housed in a single bay can contain up to seven copper-distribution shelves.

The copper-distribution shelf provides interfaces to copper lines. In a remote fiber terminal (RFT), copper-distribution shelves (CDS) support narrowband services offered to subscribers over conventional copper loops. In a fiber central office terminal (FCOT), copper-distribution shelves interface at the voice frequency (VF) level to equipment at the central office (for example, to an analog switch or to a digital switch that has analog interfaces).

Figure 7-19 illustrates the various interface options available on the copper-distribution shelf.

Figure 7-19
Copper-distribution shelf functionality



Structure of the copper-distribution shelf

The copper-distribution shelf has full front access. The dimensions of the shelf are as follows:

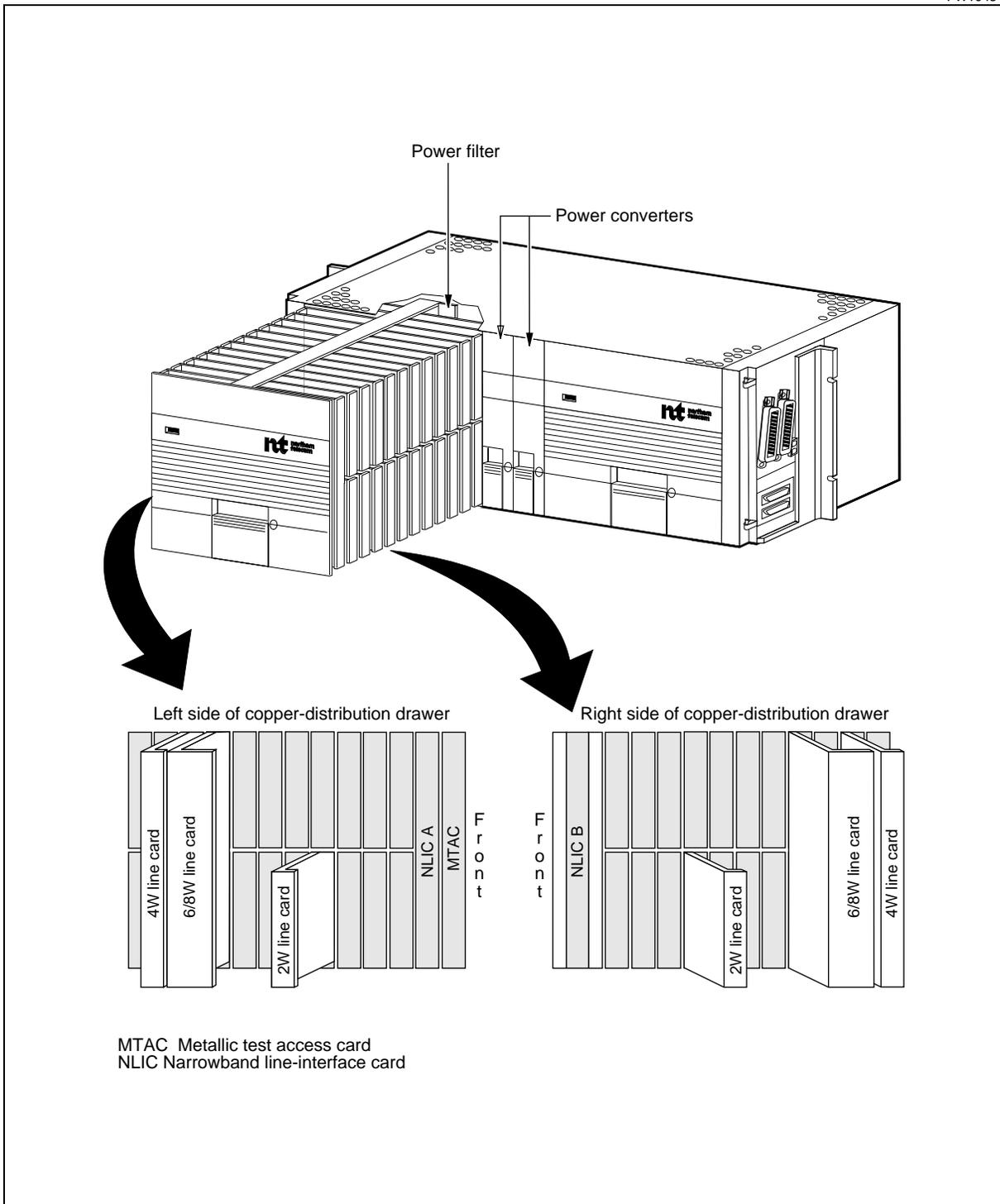
width	23 in. (584 mm)
height	7 in. (178 mm)
depth	12.2 in. (310 mm)

The copper-distribution shelf contains two front-accessible pull-out copper-distribution drawers, one on the left and one on the right. Between the two copper-distribution drawers are the two power converters. The copper lines enter the shelf at the left-hand and right-hand ends of the shelf. The cables interfacing to the circuit packs in the access bandwidth manager (ABM) shelf enter the copper-distribution shelf at the right-hand end. The cables carrying the two metallic test buses (used for testing the line cards in the copper-distribution drawers) enter the copper-distribution shelf at the left-hand end.

Figure 7-20 on page 7-36 shows the copper-distribution shelf and the copper-distribution drawer.

Figure 7-20
The copper-distribution shelf and the copper-distribution drawer

FW10431



The copper-distribution drawers contain the line cards. The line cards support a wide range of copper-based services.

Each copper-distribution drawer has a midplane running down the middle from front to back. The line cards fit into slots on each side of the midplane. The slots radiate from the midplane at 90° angles. Each copper-distribution drawer has 48 slots: 24 radiating from the left side of the midplane and 24 radiating from the right side of the midplane. On each side of the midplane, the slots are arranged in two rows of 12, an upper row and a lower row.

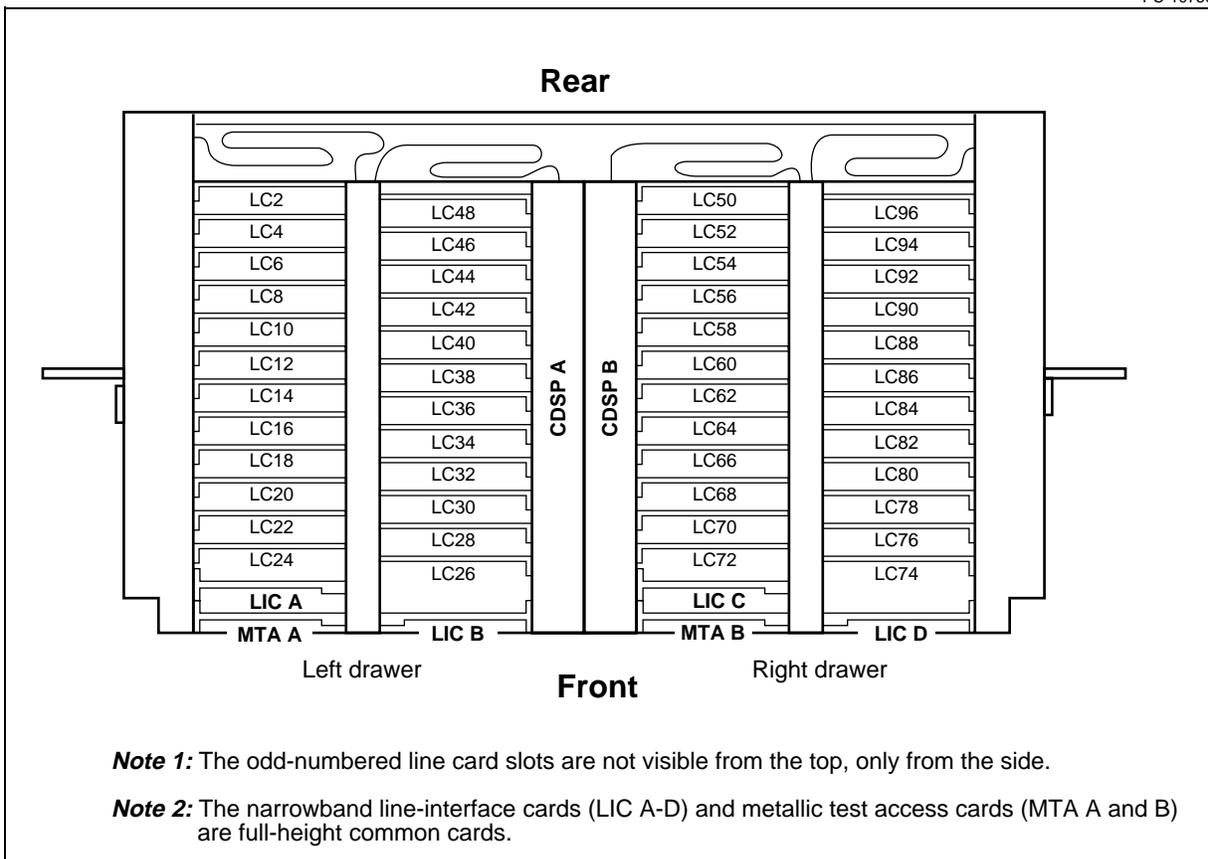
As shown in Figure 7-20 on page 7-36, a 2-wire line card requires one slot, a 4-wire line card requires 2 slots, and a 6/8-wire line card requires 4 slots. Any combination of line cards can be used to fill the slots in a copper-distribution drawer. There are no restrictions on the placement of specific types of line cards.

Numbering of the line-card slots

Figure 7-21 on page 7-37 shows the numbering of the line-card slots in a copper-distribution shelf.

Figure 7-21
Numbering of the line-card slots in a copper-distribution drawer

PC-10750



Connectors on the shelf

As shown in Figure 7-22 on page 7-39, the left side of the copper-distribution shelf has the following connectors:

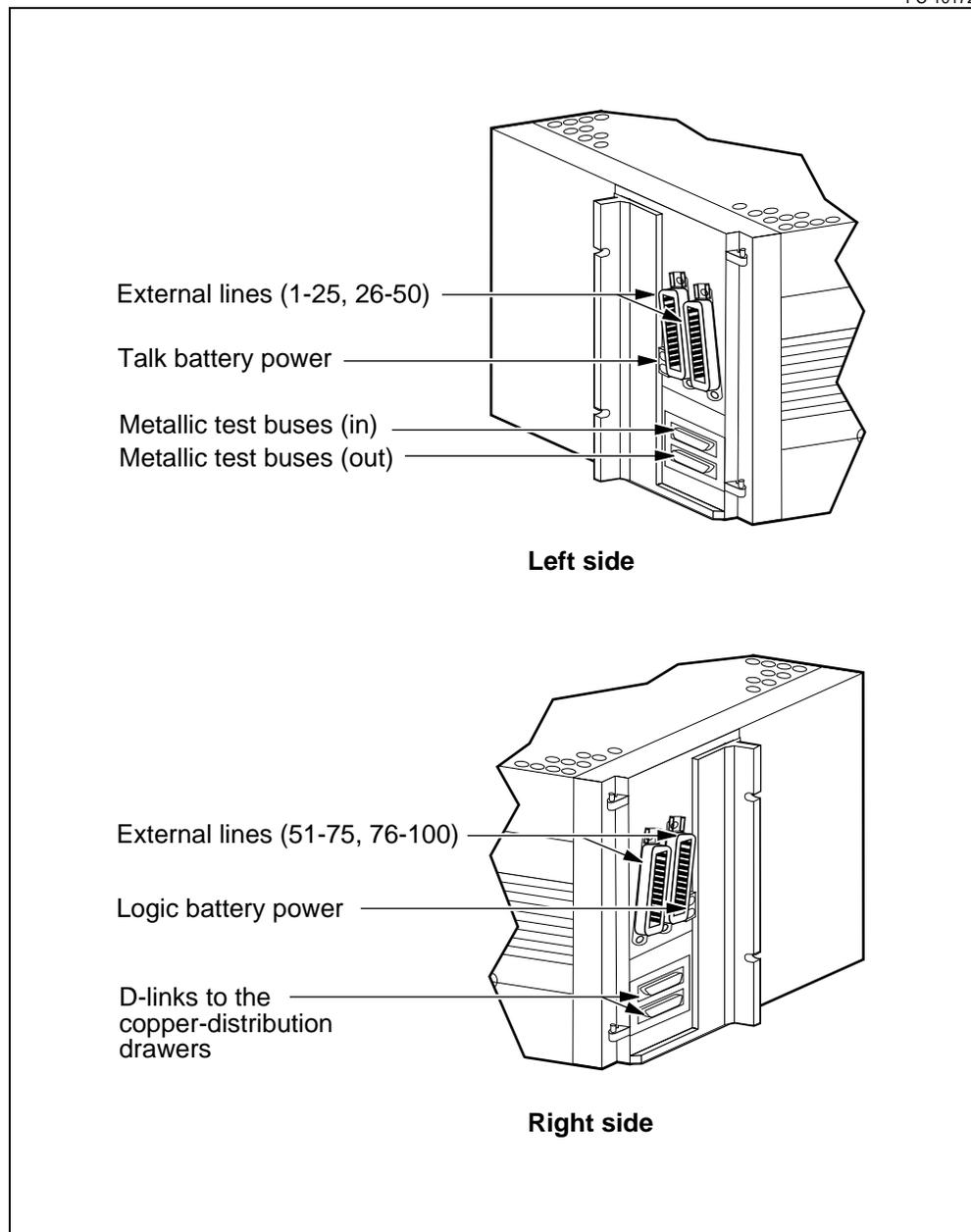
- two connectors, labeled Pairs 01–25 and Pairs 26–50, for cables carrying the external lines handled by the line cards in the left-hand copper-distribution drawer
- one connector, labeled TB, for a pair of wires bringing talk battery power from the breaker interface panel (BIP)
- two connectors, labeled CDS MTA In and CDS MTA Out, for the cables carrying the two metallic test buses with the upper connector carrying both buses in from the shelf above, and the lower connector carrying both buses out to the copper-distribution shelf below

As shown in Figure 7-22 on page 7-39, the right side of the copper-distribution shelf has the following connectors:

- two connectors, labeled Pairs 51–75 and Pairs 76–100, for cables carrying the external lines handled by the line cards in the right-hand copper-distribution drawer
- one connector, labeled CDS Pwr, for a pair of wires bringing logic battery power from the breaker interface panel
- two connectors, labeled CDS A and CDS B for the cables carrying the D-links between the copper-distribution drawers and the access bandwidth manager shelf with one cable carrying the D-links to the left-hand drawer (the A drawer), and one cable carrying the D-links to the right-hand drawer (the B drawer)

Figure 7-22
Connections on the end caps of the copper-distribution shelf

PC-10172

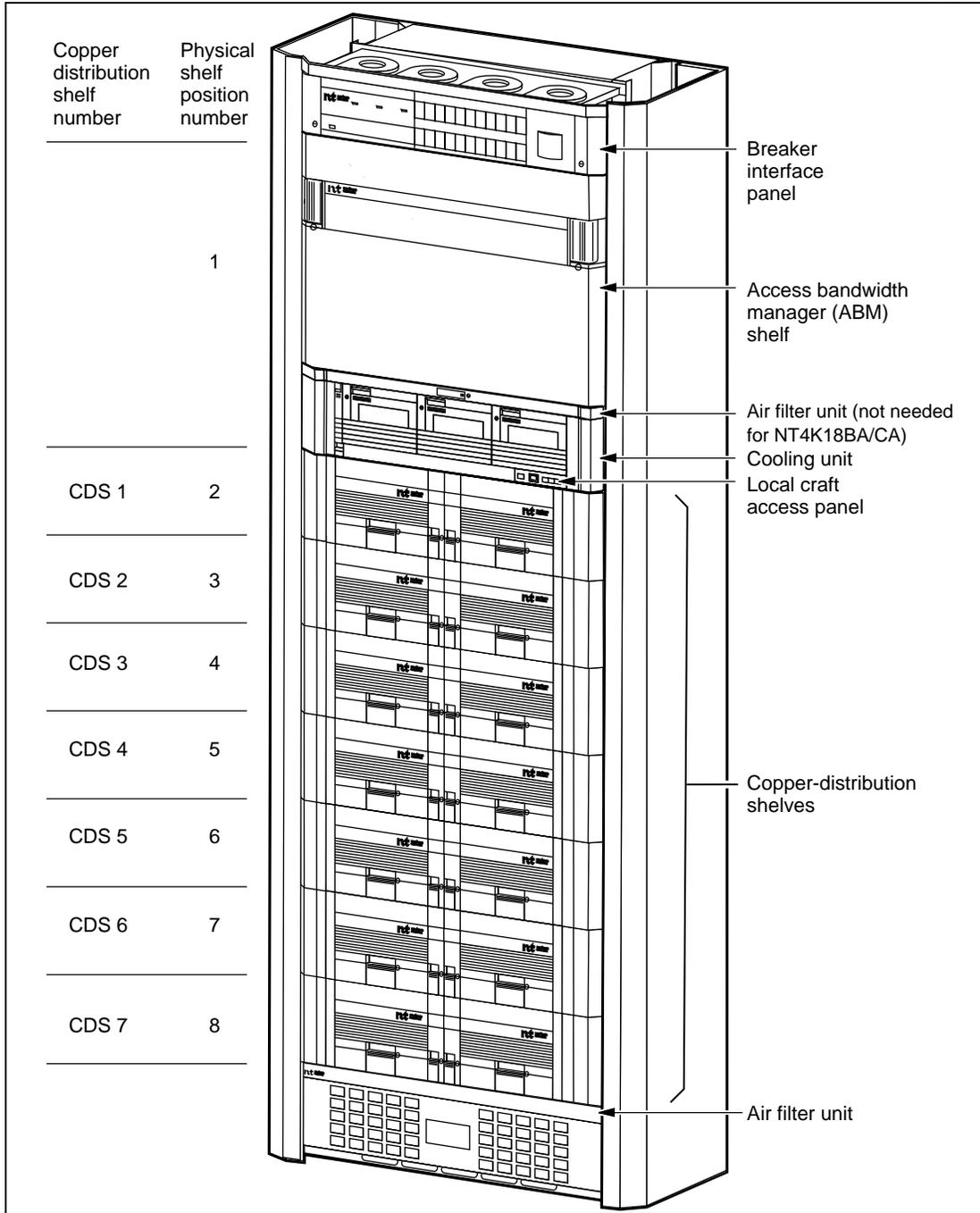


Where the copper-distribution shelves install

In a bay, the first copper-distribution shelf is installed immediately below the local craft access panel (LCAP), as shown in Figure 7-23 on page 7-40. Successive additional copper-distribution shelves are installed below the first one.

Figure 7-23
Location of the copper-distribution shelves in a bay

PC-10261



Modules used in the copper-distribution shelf

For descriptions of the modules used in the copper-distribution shelf, see Chapter 8, “Plug-in modules.”

Fiber management storage tray and the fiber storage panel

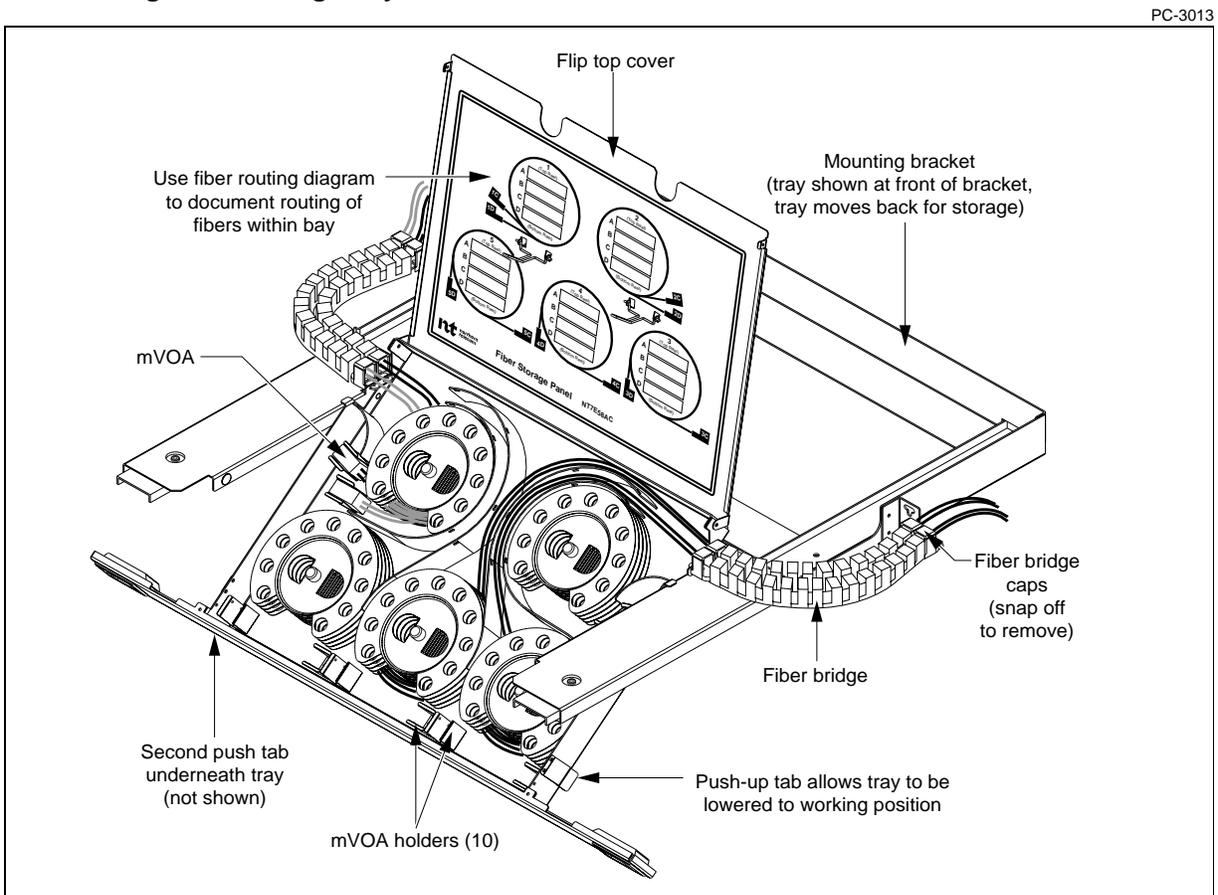
The fiber management storage tray and the fiber storage panel are optional bay-assembly modules. Both contain compartments for storing excess lengths of fiber patch cords. The fiber management storage tray has storage for more fibers than does the fiber storage panel. These bay-assembly modules can be used only in AccessNodes that contain transport bandwidth manager shelves (TMB). The fiber management storage tray or the fiber storage panel is installed immediately below the breaker interface panel (BIP).

Fiber management storage tray

The fiber management storage tray (NT7E58AC) has a pull-out drawer that tilts down for easy access. This tray holds a maximum of 20 fibers, 10 of which can have minivariable optical attenuators. The tray houses five stacks of spindles. Each stack consists of four fiber reels mounted on a spindle, and each reel can store up to 2.8 meters of slack fiber.

Figure 7-24 shows the fiber management storage tray.

Figure 7-24
Fiber management storage tray



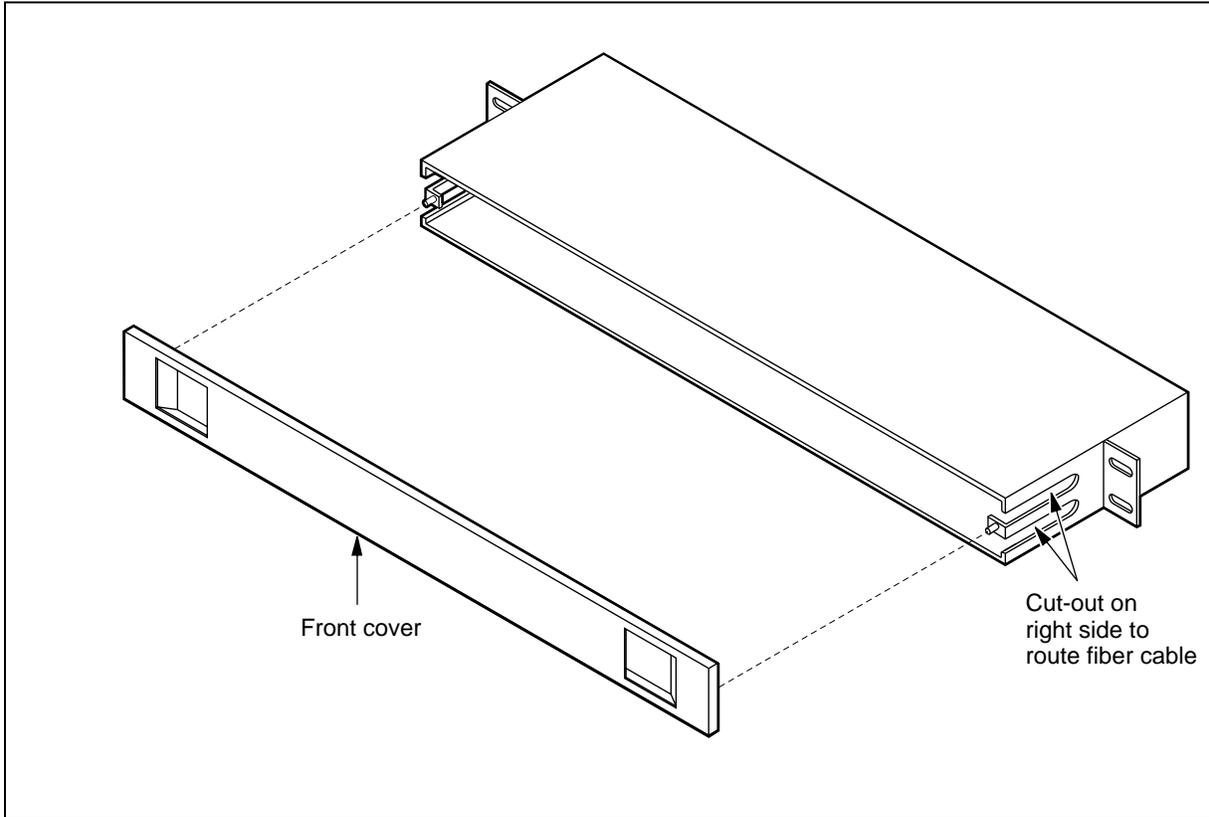
Fiber storage panel

The fiber storage panel (NT7E58AB) contains compartments into which you can coil any excess lengths of fiber patch cords. The compartments are located behind a removable cover. Fibers enter the panel through cut-outs at each side. Grommets on the front edge and at entrance points prevent damage to the fibers.

Figure 7-25 shows the fiber storage panel.

Figure 7-25
Fiber storage panel

PC-11299



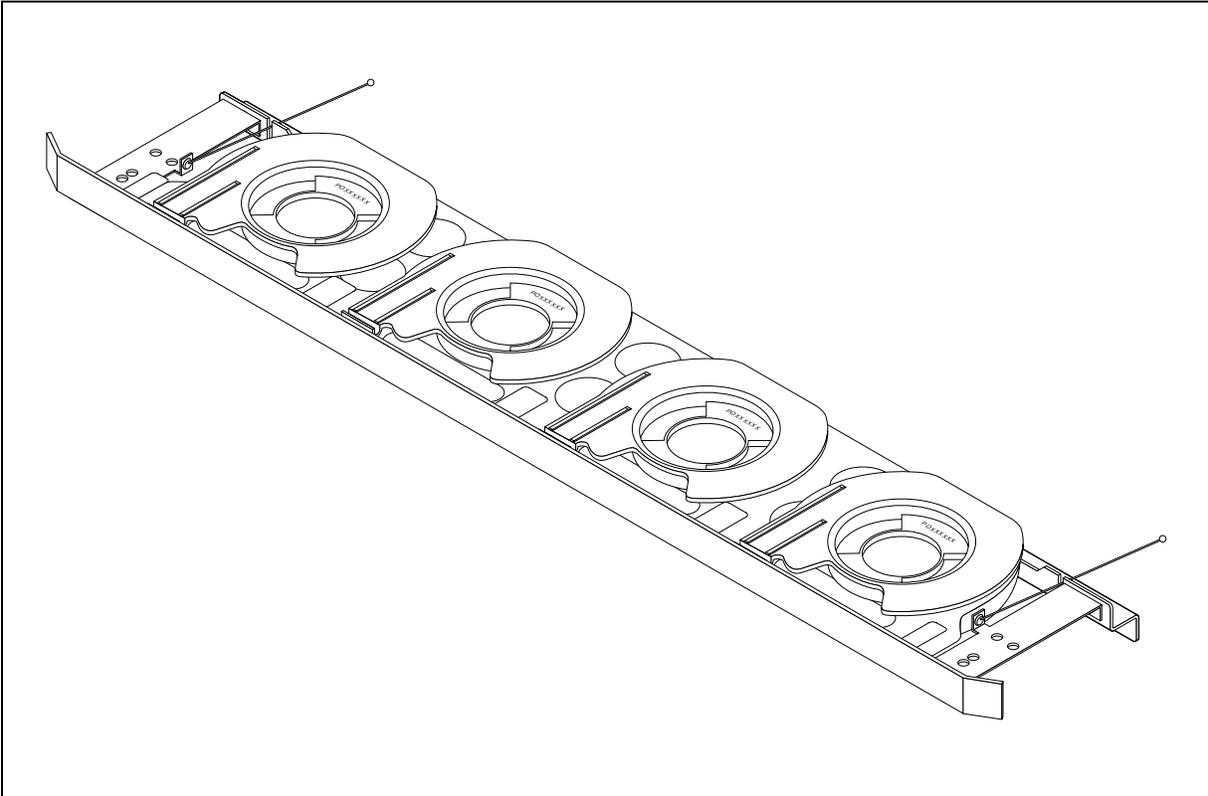
Fiber storage tray

The fiber storage tray is standard equipment in an AccessNode housed in a bay that contains an access bandwidth manager (ABM) shelf. The tray is located above the NT4K14 breaker interface panel (BIP). In the tray, you can coil any excess lengths of the fiber patch cords.

Figure 7-26 shows the fiber storage tray.

Figure 7-26
Fiber storage tray

PC-11012



Local craft access panel used with an access bandwidth manager shelf

The NT4K16 local craft access panel (LCAP) is used with an access bandwidth manager (ABM) shelf.

Note: With a transport bandwidth manager (TBM) shelf, the NT7E5047 LCAP is used. For information on that model, see page 7-64.

The LCAP is a bay-assembly module. It provides the craftsperson with common-equipment shelf status information, alarms, and local test access. The LCAP houses all the hardware for the local craft access, such as the orderwire, the connector for the RS-232C user interface to the network element, and the line test jacks.

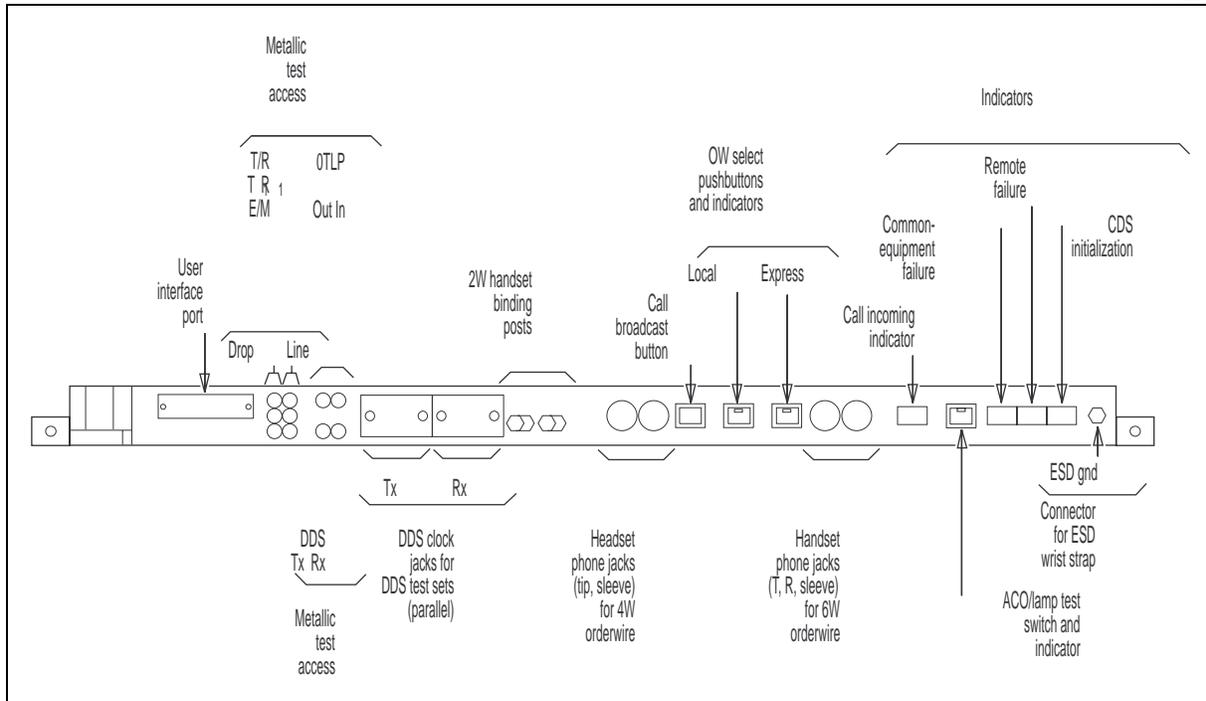
The NT4K16 local craft access panel attaches with two screws. In a bay-mounted AccessNode, the LCAP attaches to the cooling unit. It fits into a recessed area at the bottom of the cooling unit. In a customer-located equipment enclosure, the LCAP attaches to an extension bracket that attaches to the frame.

All cables are routed to the left side of the LCAP. Two intershelf cables pass through an opening in the left side of the LCAP. Both cables go to the side interconnect left circuit pack in the ABM shelf. The cables connect to the LCAP 1 and LCAP 2 connectors on the side interconnect left circuit pack.

Figure 7-27 shows the model NT4K16 LCAP.

Figure 7-27
Local craft access panel (LCAP), model NT4K16

PC-10208



From left to right, the following connectors, buttons, and lamps are on the front of the NT4K16 LCAP:

- a 25-pin D connector for the user-interface port, which
 - is an RS-232C DCE-type port supported by the maintenance interface card in the ABM shelf
 - supports connection to DTE-type devices
 - allows a local VT100-type terminal to access the processor card in the ABM shelf
- three pairs of bantam jacks for the following (top to bottom):
 - T and R, labeled T/R
 - T1 and R1, labeled T1R1
 - E & M, labeled E/M
- two pairs of bantam jacks for the following (top to bottom):
 - zero test level point (OTLP), labeled Out and In
 - digital-data-services (DDS) access, labeled Tx and Rx

- a pair of connectors for DDS clock jacks for DDS test sets, labeled Tx and Rx
- a pair of binding posts, which are not used
- a pair of tip-sleeve phone jacks for access by headset for 4-wire orderwire
- the orderwire call button, labeled Call, is a pushbutton with a square cap
- the local orderwire select button, labeled Local, is a pushbutton with a square cap and a green LED
- the express orderwire select button, labeled Express, is a pushbutton with a square cap and a green LED
- a pair of orderwire handset tip-ring-sleeve phone jacks for access by handset for 6-wire orderwire
- a green lamp that lights up when an incoming call is waiting on the orderwire
- the ACO/lamp-test button and indicator is a pushbutton with a square cap and a green LED.
 - The lamp lights up if an active alarm is cut off.
 - The button does one of the following: cuts off active cuttable alarms, or, if there are no such alarms, performs a lamp test that lights all the lamps on the bay for 30 seconds.
- a red LED that lights up whenever a failure occurs on any of the circuit packs or cards in the access bandwidth manager shelf
- a red LED that lights up whenever there is an alarm at another network element in the system
- a green LED that lights up during the initialization of the copper-distribution shelf, while diagnostics on line cards are in progress
- the connector for the electrostatic-discharge (ESD) wrist strap

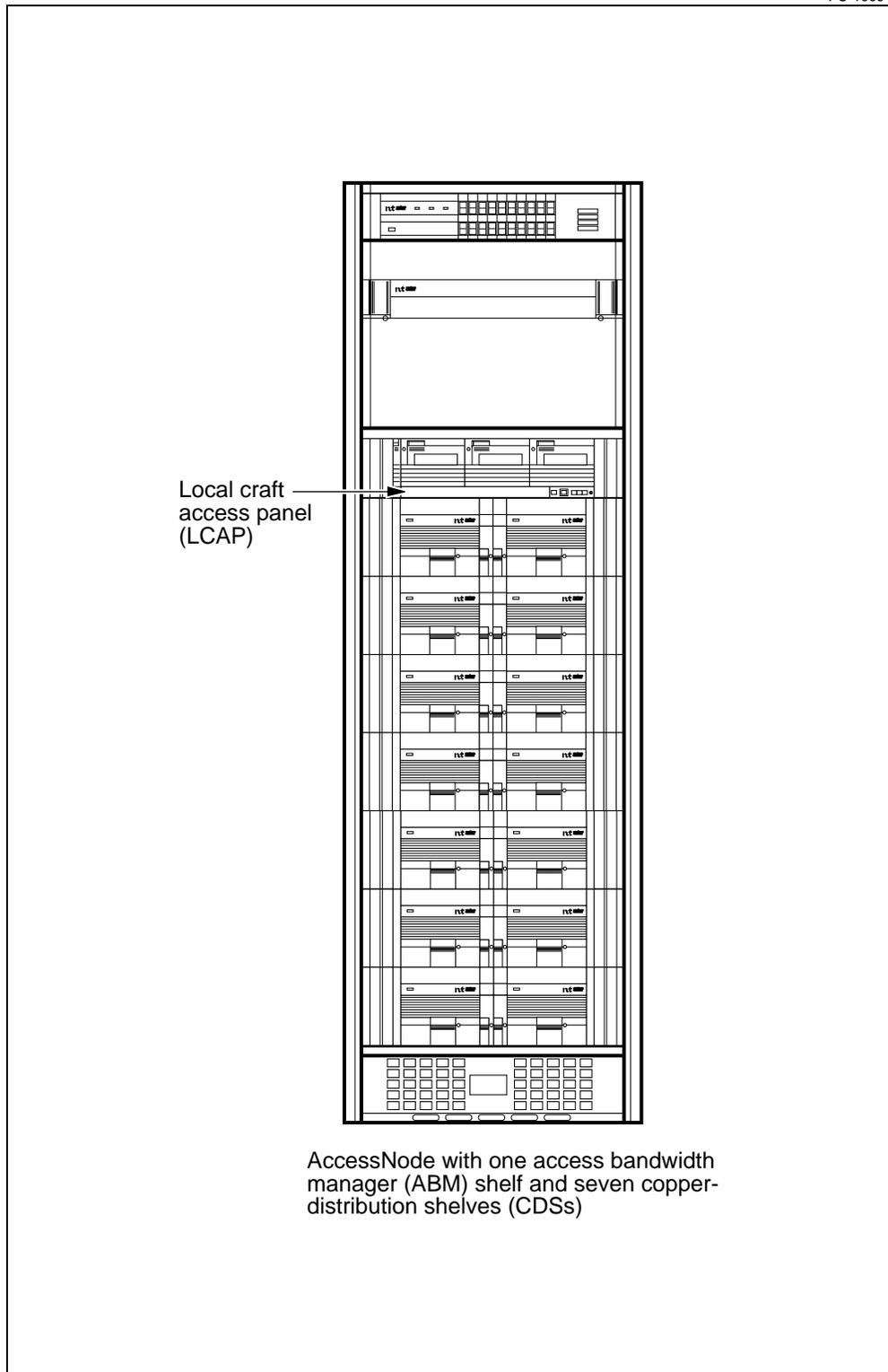
Where the NT4K16 local craft access panel installs

In a bay, the NT4K16 LCAP installs below the cooling unit. The LCAP fits into a recessed area at the bottom of the cooling unit, and two screws secure it to the cooling unit,

Figure 7-28 on page 7-47 shows the location of the model NT4K16 LCAP in a bay.

Figure 7-28
Location of the NT4K16 LCAP in a bay

PC-10094



Transport bandwidth manager shelf

In AccessNode systems, the transport bandwidth manager (TBM) shelf can serve the following uses:

- as the common-equipment shelf in the fiber central office terminal (FCOT) in a point-to-point or a virtual tributary bandwidth manager (VTBM) ring fiber-fed system serving an integrated application or a multiplexer application.

Note: If a fiber-fed system is serving an integrated application, the transport bandwidth manager shelf is always used as the common-equipment shelf in the FCOT. If a fiber-fed system is serving a multiplexer application, the common-equipment shelf in the FCOT can be either the transport bandwidth manager shelf or the access bandwidth manager (ABM) shelf. (Two possibilities exist in this case because you can order either a transport single-shelf configuration or a multiplexer configuration for the FCOT.)

- as the primary or secondary gateway in a matched nodes configuration. For more information on primary and secondary gateways, see “Matched nodes” on page 3-10.
- as an OPC shelf in an AccessNode system with the OPC shelf linked by control network to a network element as shown in Table 7-4.

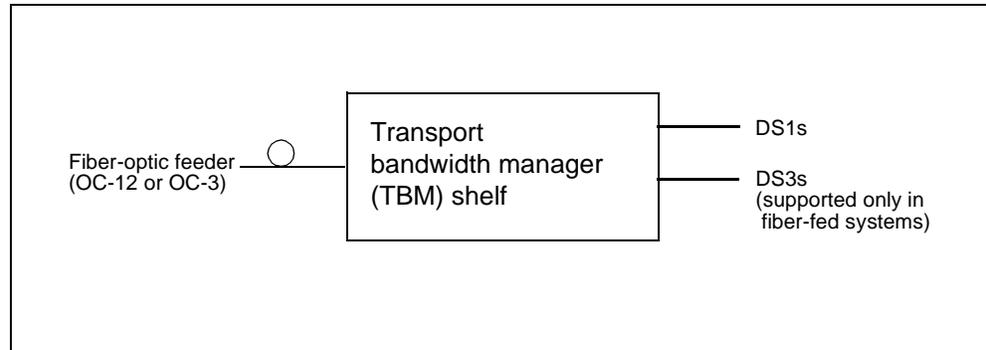
The TBM shelf terminates the OC-12 or OC-3 optical feeder, grooms the payload at the VT1.5 and STS-1 levels, and dynamically routes it to the appropriate digital interface.

Table 7-4
OPC shelf links by control network to network elements

If the operations controller serves	Then link the OPC shelf to
one or more fiber-fed systems	a traffic-carrying FCOT in one of those systems
a single-ended system fed by an AccessNode or S/DMS TransportNode OC-12 ring	one of the OC-12 network elements
a DS1-fed system	any conveniently located AccessNode or S/DMS TransportNode network element

Figure 7-29 shows the TBM shelf interface.

Figure 7-29
TBM shelf interfaces



Functions of the transport bandwidth manager shelf

The TBM shelf performs the following functions:

- provides central control for the FCOT when used as the common-equipment shelf in an FCOT. (The TBM shelf is not used as the common-equipment shelf in remote fiber terminals (RFTs).)
- provides operations, administration, maintenance, and provisioning (OAM&P) for the FCOT when used as the common-equipment shelf in an FCOT.
- provides the primary interface to the fiber optic feeder, which carries traffic at the OC-12 or OC-3 rate in FCOTs in fiber-fed systems
- supports digital interfaces (DS1 and DS3)
- supports OC-3 and STS-1 tributaries
- performs bandwidth management by
 - multiplexing and demultiplexing
 - grooming the traffic at the VT1.5 (DS1) and STS-1 (DS3) levels
 - routing portions of the SONET payload to digital interfaces
- provides a primary or secondary gateway in a matched nodes configuration (For more information, see “Matched nodes” on page 3-10.)

Structure of the transport bandwidth manager shelf

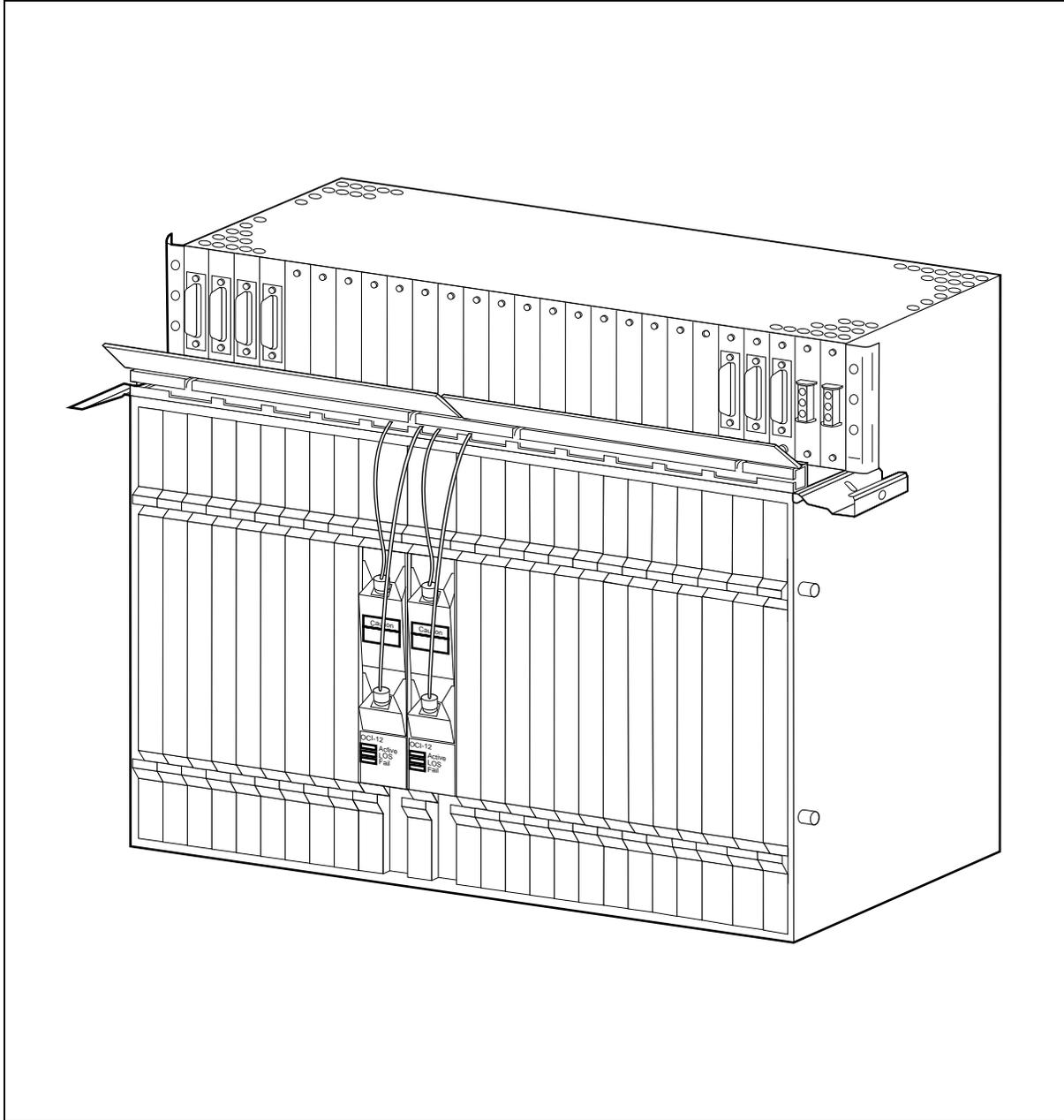
The transport bandwidth manager shelf has full front access. The dimensions of the shelf are as follows:

width	23 in. (584 mm)
height	15.5 in. (394 mm)
depth	12.2 in. (310 mm)

Figure 7-30 shows the transport bandwidth manager shelf.

Figure 7-30
Transport bandwidth manager shelf

PC-10243



Layout of the transport bandwidth manager shelf

The transport bandwidth manager (TBM) shelf has two levels of slots, which are numbered from left to right. Table 7-5 shows the slot levels in a TBM shelf.

Table 7-5
Slot levels in a TBM shelf

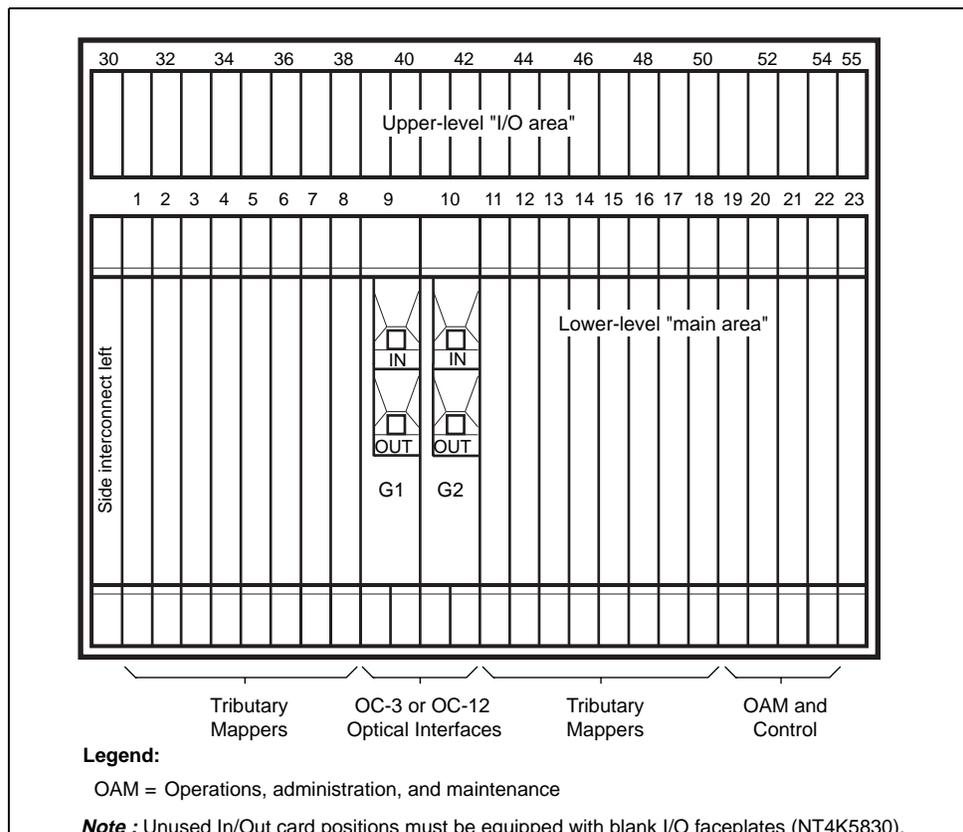
Position	Slots	Accommodate	Dimensions
lower level	1 to 23	circuit packs and cards	11.5 in. (292 mm) high and 10.15 in. (258 mm) deep
upper level	30 to 55	I/O personality cards	2.25 in. (57 mm) high and 7.1 in. (180 mm) deep

All the circuit packs and I/O personality cards plug in to the shelf backplane.

Figure 7-31 shows the layout of the TBM shelf.

Figure 7-31
Transport bandwidth manager shelf, with slot numbers shown

PC-15873



Side interconnect left circuit pack in the transport bandwidth manager shelf (NT4K50BA)

Cabling enters the TBM shelf at the left end of the shelf at the side interconnect left circuit pack. The side interconnect left circuit pack is installed in an unnumbered slot at the end of the shelf. The slot is unnumbered because the side interconnect left circuit pack is part of the shelf assembly.

Note 1: The side interconnect left circuit pack for the TBM shelf has different connectors from the similarly named circuit pack for the access bandwidth manager (ABM) shelf.

Note 2: The TBM shelf does not contain a side interconnect right circuit pack. A filler plate covers the right side of the shelf.

Table 7-6 shows the connectors located on the side interconnect left circuit pack for the TBM shelf.

Table 7-6
Connectors on the TBM side interconnect left circuit pack

Connector Number	Type	Purpose
J14	44-pin D connector	for the NT4K14-series breaker interface panel (BIP). If an NT4K14-series BIP is not installed, J14 is the connector for the PSTN interface cable, which connects the orderwire to the public switched telephone network. <i>Note:</i> The NT4K14 BIP is not used with the TBM shelf. The NT7E56 BIP is used instead. The cable from that BIP attaches to connector J06.
J13	25-pin D connector	for a cable from an external timing source such as a building integrated timing source (BITS). Timing information flows between the BITS and the working external synchronization interface card in the TBM shelf.
J12	44-pin D connector	for a cable carrying parallel-telemetry between AccessNode and external equipment.
—continued—		

Table 7-6 (continued)
Connectors on the TBM side interconnect left circuit pack

Connector Number	Type	Purpose
J11	9-pin D connector	<p>for an outgoing control-network cable, which is a local area network (LAN) that can link multiple AccessNodes if they are collocated.</p> <p>The maximum length of the LAN cable connection is 400 feet. The connector is for the cable going to the next AccessNode in the LAN.</p> <p>If an outgoing control-network cable does not exist, a control-network termination plug must be installed on this connector.</p>
J10	9-pin D connector	<p>for an RS-232C port supported by the maintenance interface card in the shelf.</p> <p>A remote terminal, connected to this connector through an external modem, can access the processor card in the shelf.</p>
J09	9-pin D connector	<p>for serial port #1 of the operations controller (OPC). This is a DTE port using the RS-232C standard. The port supports either asynchronous or synchronous (LAPB, LAPD, or X.25) protocols to a maximum data rate of 19,200 baud.</p>
J08	25-pin D connector	<p>for a cable carrying serial-telemetry data. The maintenance interface card in the transport common-equipment shelf supports two 2-wire serial ports. Both ports use this connector.</p>
J07	25-pin D connector	<p>for serial port #2 of the operations controller (OPC). This port uses RS-422 drivers and receivers.</p>
J06	25-pin D connector	<p>for the model-NT7E56 breaker interface panel (BIP), if such a BIP is installed. The model-NT7E56 BIP is used with the TBM shelf.</p>
J05	25-pin D connector	<p>for a cable carrying the orderwire channel to another piece of equipment in the office.</p>
J04	44-pin D connector	<p>for the cable to the local craft access panel</p>
—continued—		

Table 7-6 (continued)
Connectors on the TBM side interconnect left circuit pack

Connector Number	Type	Purpose
J03	25-pin D connector	for the cable to the cooling unit. This connector is used only if the TBM shelf is the principal common-equipment shelf in the AccessNode. On any TBM shelf that is the second or third common-equipment shelf in a bay, a termination plug (NT4K85JB) must be installed on this connector.
J02	9-pin D connector	for an incoming control-network cable, which is a local area network (LAN) that can be used to link multiple AccessNodes if they are collocated. The maximum length of the LAN cable connection is 400 feet. The connector is for the cable coming from the previous AccessNode in the LAN. If there is no incoming control-network cable, a control-network termination plug must be installed on this connector.
J01	25-pin D connector.	J01 is not used
—end—		

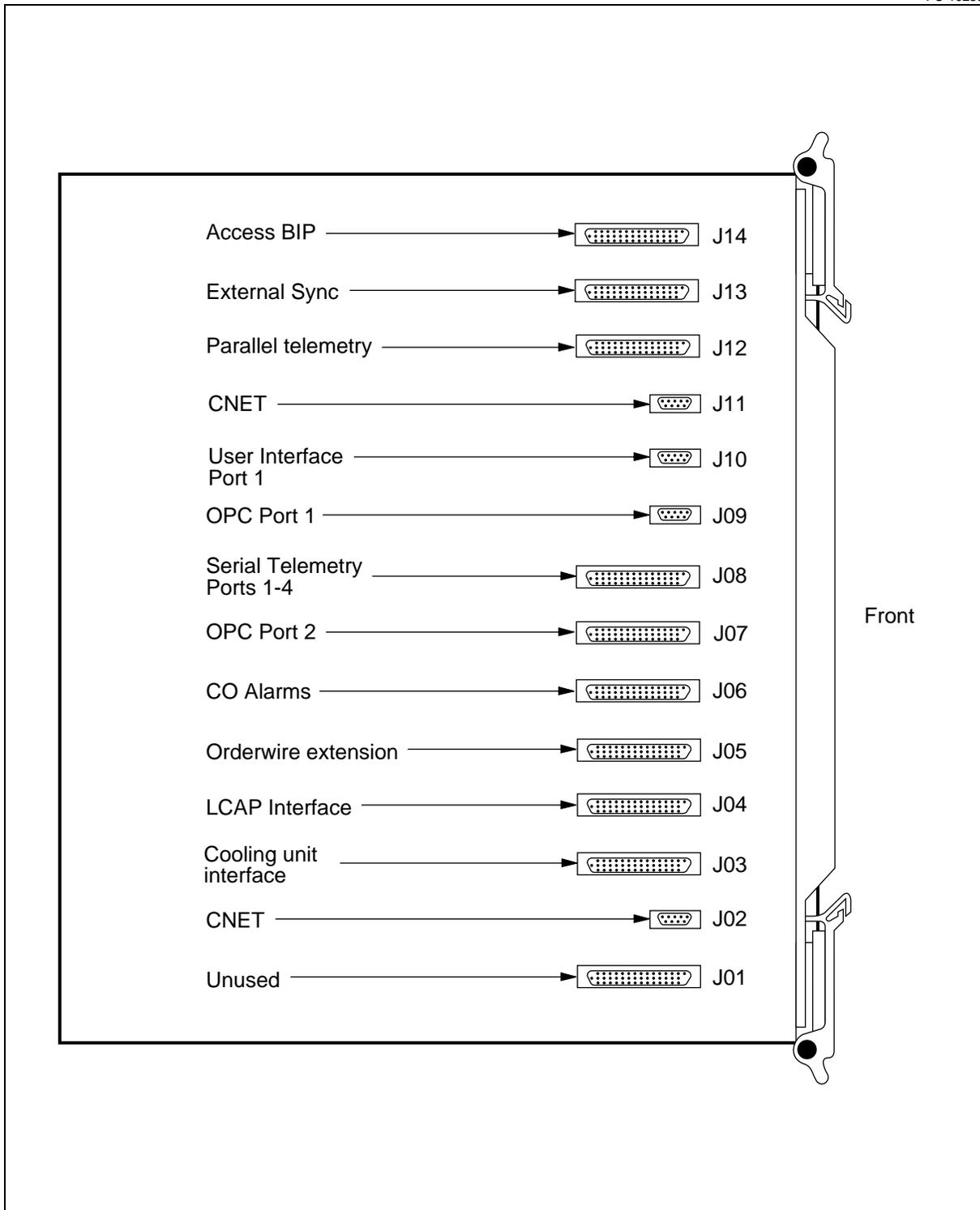
Power connections

Power from the breaker interface panel (BIP) enters the TBM shelf at the common-equipment power cards. These power cards are installed in the upper level of the shelf, in the two slots nearest the right-hand end of the shelf (slots 54 and 55). The power cables enter the front of the cards. Two cards are available.

Figure 7-32 on page 7-55 shows the connectors located on the side interconnect left circuit pack.

Figure 7-32
Connectors on the side interconnect left circuit pack for the transport bandwidth manager shelf (NT4K50BA)

PC-10239



Where the TBM shelf installs

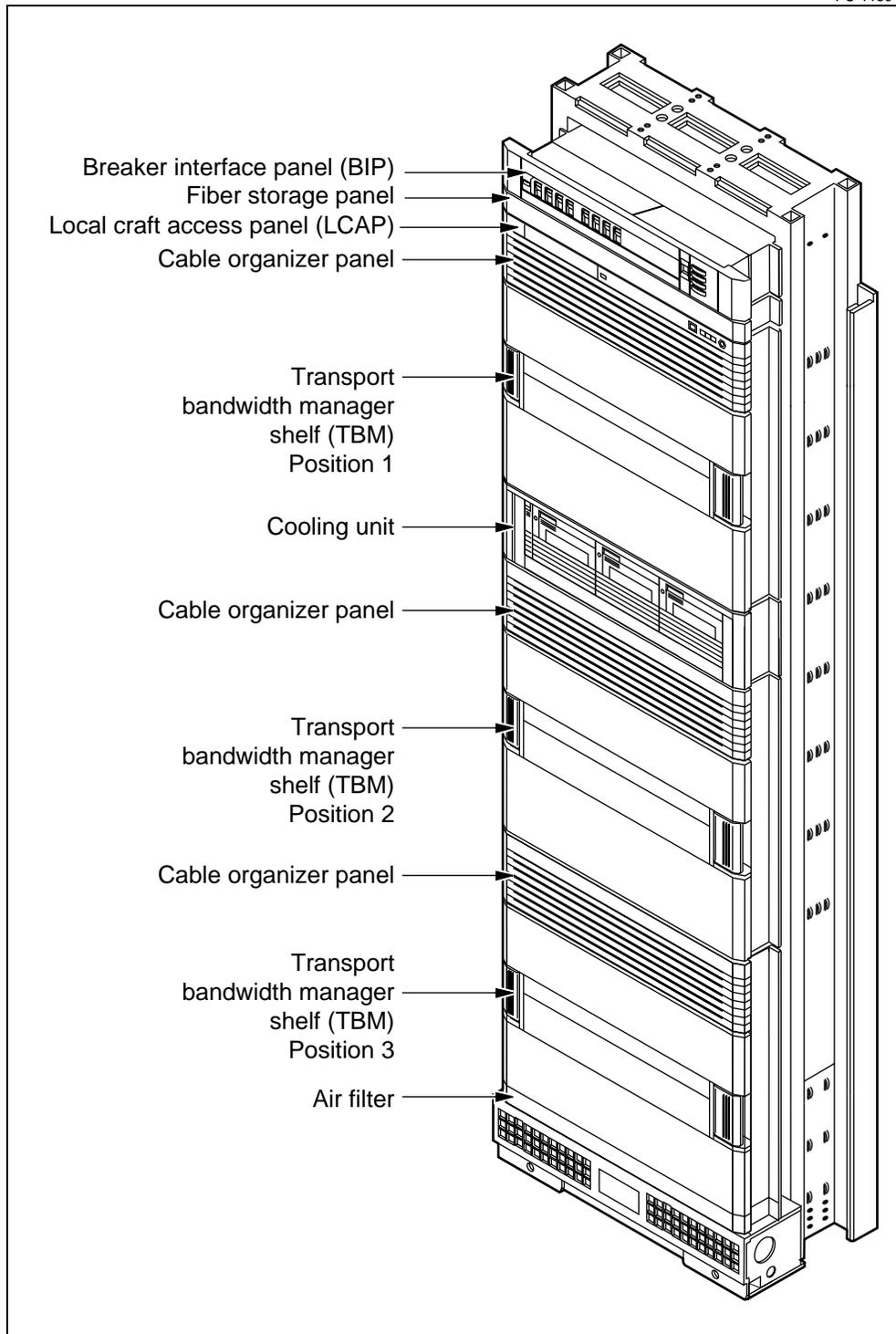
Up to three transport bandwidth manager shelves can be installed in a bay. As shown in Figure 7-33 on page 7-57, the positions for the transport bandwidth manager shelves are numbered from top to bottom. Depending on the type of transport bay configuration that you order, the transport bandwidth manager shelves are installed in the following positions:

- In a single-shelf bay for raised-floor cabling, the shelf is in position one.
- In a single-shelf bay for overhead cabling, the shelf is in position two.
- In a two-shelf bay, the shelves are in positions one and two.
- In a three-shelf bay, the shelves are in positions one, two, and three.

Figure 7-33 on page 7-57 shows a transport three-shelf bay configuration.

Figure 7-33
Locations of the TBM shelves in a transport three-shelf bay

PC-11504



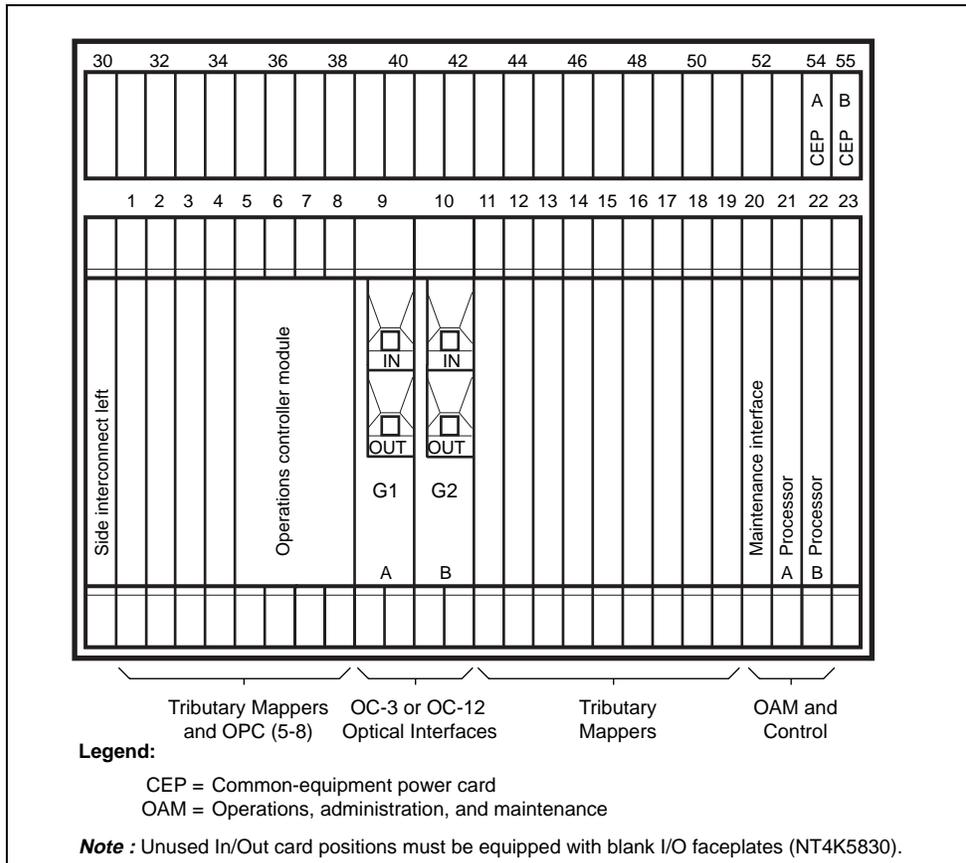
For information on the modules installed in the transport bandwidth manager shelf, see Chapter 8, “Plug-in modules.” For more detailed information, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume. For mapper layout information, see *Mapper Layouts Planning Guide*, 323-3001-154, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

TBM OPC shelf

Figure 7-34 shows a transport bandwidth manager shelf that is used as a stand-alone OPC shelf or a bay-sharing OPC shelf. A stand-alone OPC shelf is installed in its own bay. It is a separate network element and is commissioned as an FCOT with a communication rate of zero. A bay-sharing TBM OPC shelf shares a bay with one or two other transport bandwidth manager shelves.

Figure 7-34
TBM shelf equipped as a TBM OPC shelf

PC-15880



The TBM OPC shelf can serve any type of AccessNode system. The operations controller in the shelf can serve one or more systems. The connection to each of the network elements served by the operations controller is through control network or the SONET data communications channels (SDCC), or a combination of control network and SDCC.

Note: Although a TBM OPC shelf does not support OMC DS1 links, it can serve a DS1-fed system if OMC DS1s are not required for connection to the DS1-fed remote fiber terminals (RFTs) and control network connections can be used.

The processor card in slot 22, which is for protection (shown Figure 7-34 on page 7-58), is optional in this shelf.

For more information on the modules installed in the TBM OPC shelf, see Chapter 8, “Plug-in modules.” For more detailed information, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

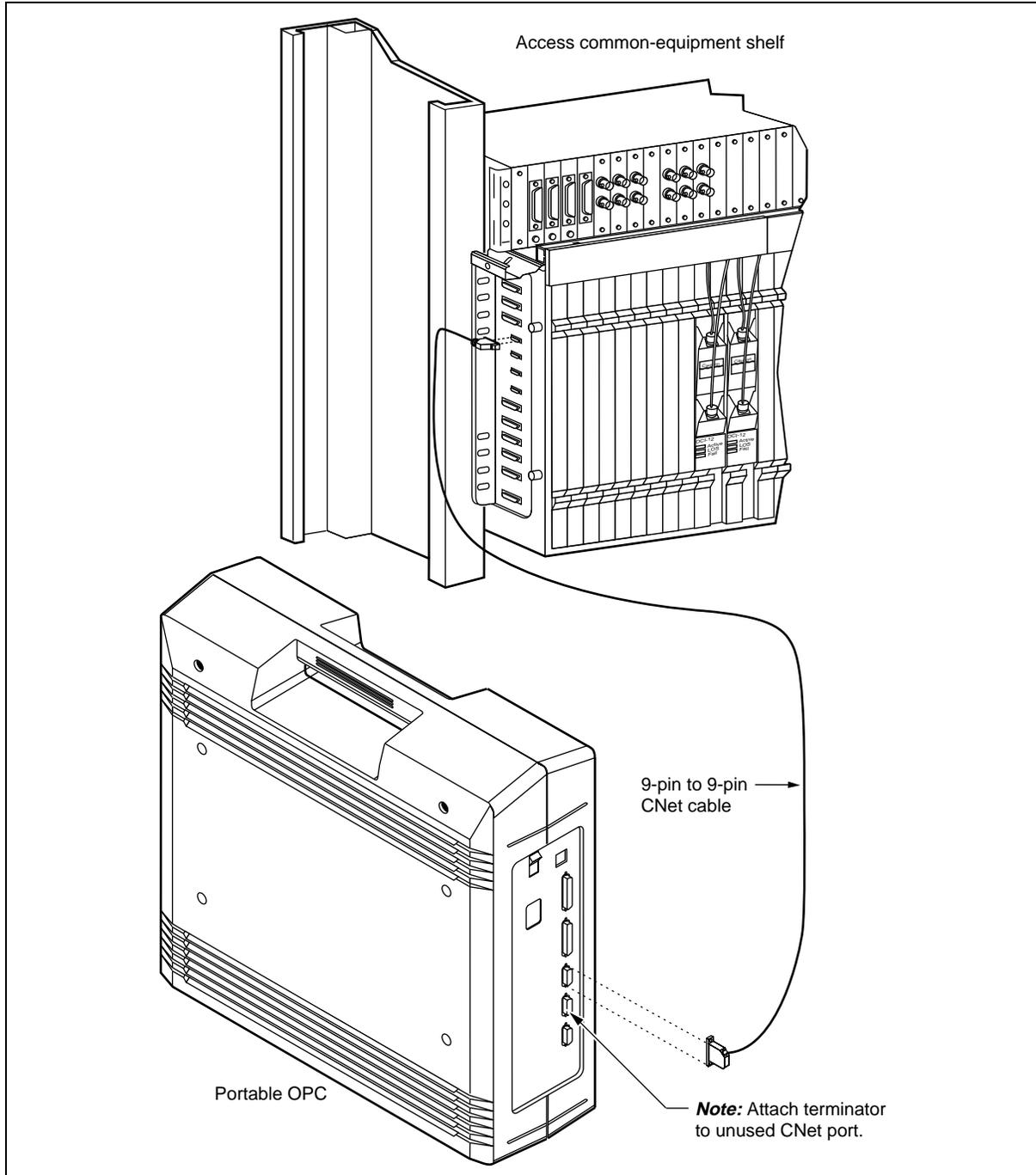
Portable OPC

The portable OPC can be connected to either a TBM or an ABM shelf. The portable OPC is connected to the common-equipment shelf in the network element using a 9-pin to 9-pin control-network cable. It is connected to the control network (CNET) ports on the portable OPC and to the Ctl Net In connector on the side interconnect left circuit pack on the common-equipment shelf. Two control-network terminator plugs cover the unused control-network ports on the portable OPC and on the side interconnect left circuit pack.

Figure 7-35 shows the portable OPC connected to a TBM shelf.

Figure 7-35
Portable OPC connected to the TBM shelf

PC-10248



Cable organizer panel (NT4K1930)

A cable organizer panel (COP) is installed with each NT4K19AA transport bandwidth manager (TBM) shelf. (In AccessNode systems, all transport bandwidth manager shelves are NT4K19AA models, except for the lowest transport bandwidth manager shelf in an enhanced TBM three-shelf bay configuration, which is an NT4K19AC model.) The COP is installed just above the transport bandwidth manager shelf. Figure 7-33 on page 7-57 shows the locations of the cable organizer panels installed with the transport bandwidth manager shelves in positions one and two. At the top of the COP is a horizontal slot that accommodates the NT7E5047 local craft access panel (LCAP).

Cable organizer panel/cooling unit

The cable organizer panel/cooling unit (COP/CU) is installed with the NT4K19AC transport bandwidth manager shelf. In AccessNode systems, the NT4K19AC transport bandwidth manager shelf is installed in only one case. In an enhanced TBM three-shelf bay configuration, the NT4K19AC shelf is used in the lowest position (position three) in the bay. The COP/CU is installed in the same location as that shown for the lowest cable organizer panel in Figure 7-33 on page 7-57.

At the top of the COP/CU is a horizontal slot that accommodates both the NT7E5047 local craft access panel and the NT7E7801 cooling unit. The NT7E7801 cooling unit is behind the local craft access panel, as shown in Figure 7-36 on page 7-62. The cooling unit in the COP/CU has four fans that boost the air flow through the bay.

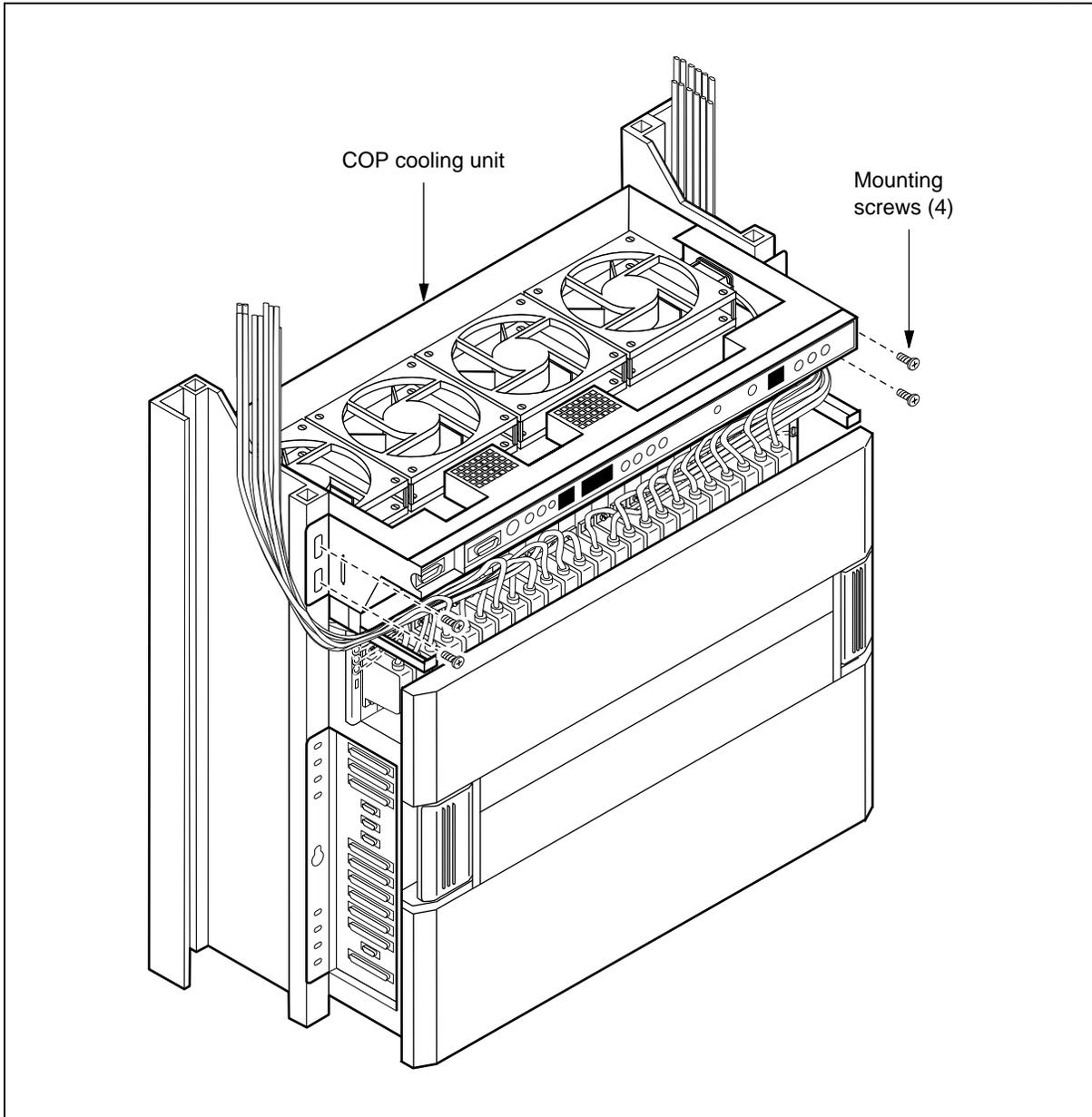
Connectors for the COP/CU

The COP/CU has power connectors on the right end and an alarm connector on the left end. The A and B power connectors on the right end of the COP/CU are for the power cables that run from the right end of the NT4K18AC cooling unit to the COP/CU. (At the right end of the NT4K18AC cooling unit, those power cables connect to the NT7E5654 power cables that come from the breaker interface panel (BIP).) The alarm connector on the left end of the COP/CU is a D connector for the alarm cable (NT7E7802) that connects to the cooling-unit connector (J03) on the side interconnect left circuit pack of the transport bandwidth manager shelf in position three.

Figure 7-36 shows a cutaway view of the cooling unit and the LCAP in the COP/CU.

Figure 7-36
Cutaway view showing the cooling unit and the LCAP in the COP/CU

PC-11544



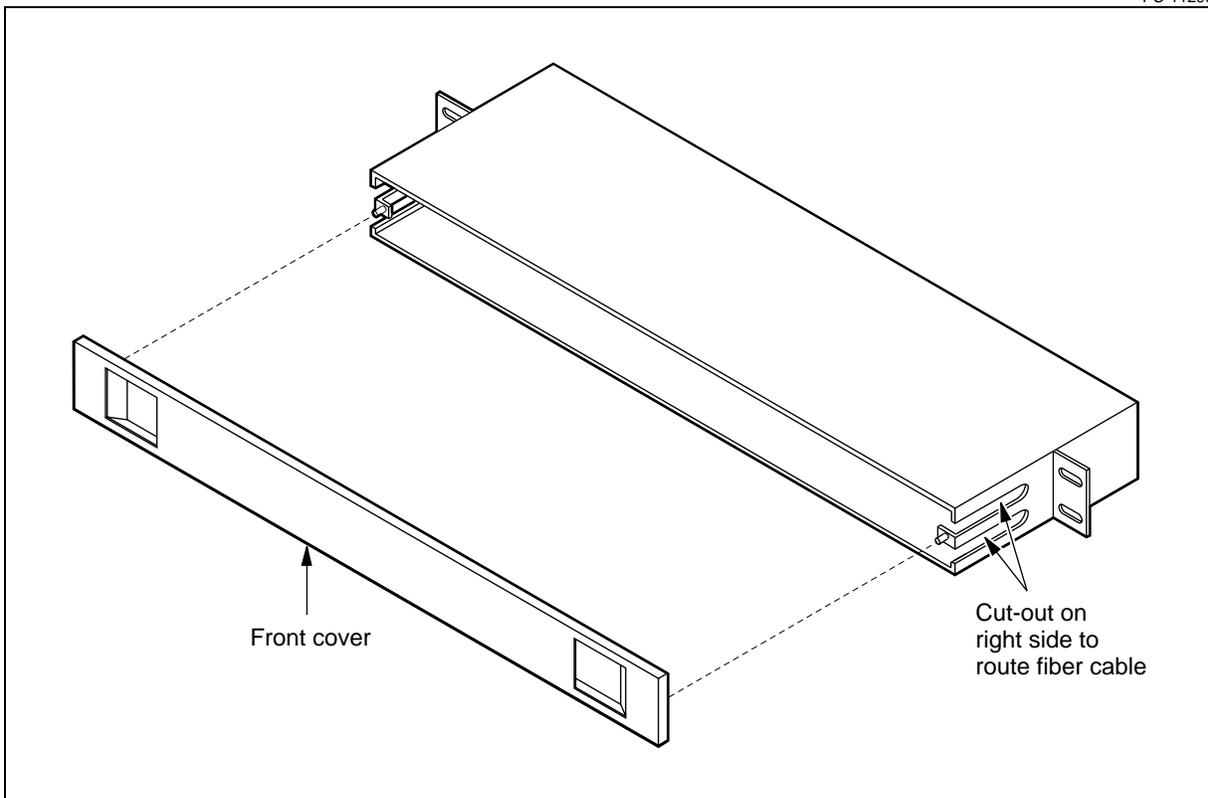
Fiber storage panel (NT7E58)

The fiber storage panel is an optional bay-assembly module. It can be used only in an AccessNode that contains a transport bandwidth manager (TBM) shelf. The fiber storage panel is installed immediately below the breaker interface panel. The fiber storage panel contains compartments where you can coil any excess lengths of the fiber patch cords. The compartments are behind a removable cover.

Figure 7-37 shows the fiber storage panel.

Figure 7-37
Fiber storage panel

PC-11299



Local craft access panel used with the TBM shelf

The NT7E5047 local craft access panel (LCAP) is used in an AccessNode that contains a transport bandwidth manager (TBM) shelf.

Note: With an access bandwidth manager (ABM) “shelf, the NT4K16 local craft access panel is used. For more information, see “Local craft access panel used with an access bandwidth manager shelf” on page 7-44.

The local craft access panel is a bay-assembly module. It contains a user interface port, orderwire handset and headset jacks, orderwire call pushbuttons, an alarm-cutoff and lamp-test pushbutton, alarm indicators, and an electrostatic discharge (ESD) grounding jack.

The NT7E5047 local craft access panel fits into a horizontal slot in the top of the metal housing of the cable organizer panel. (For information on the cable organizer panel, see “Cable organizer panel (NT4K1930)” on page 7-61.)

A control cable links the transport bandwidth manager shelf and the local craft access panel. The cable attaches to the J04 connector on the side interconnect left circuit pack in the transport bandwidth manager shelf. From the connector, the cable goes up the left side of the transport bandwidth manager shelf, then across the cable organizer panel. The cable enters the local craft access panel from below through an opening in the slot housing the panel. The opening is located near the face of the panel, just below the alarm-cutoff pushbutton.

From left to right, the following connectors, buttons, and lamps are on the front of the NT7E5047 local craft access panel:

- a 15-pin female D connector for orderwire extension, which
 - provides a remote orderwire interface
 - supports full handset or headset orderwire operation
- a 25-pin D connector for the user-interface port 2, which is an RS-232C DCE-type port supported by the maintenance interface card in the TBM shelf. The user-interface port
 - supports connection to DTE-type devices
 - allows a local VT100-type terminal to access the processor card in the TBM shelf
- a pair of tip-sleeve phone jacks for access by headset for 4-wire orderwire
- the orderwire call button is a pushbutton with a square cap
- the local orderwire select button is a pushbutton with a square cap
- the express orderwire select button is a pushbutton with a square cap and a green LED

- a pair of orderwire handset tip-ring-sleeve phone jacks for access by handset for 6-wire orderwire
- a green lamp that lights up when an incoming call is waiting on the orderwire
- the ACO/lamp-test button and indicator is a pushbutton with a square cap and a green LED. It does the following:
 - the lamp lights up if an active alarm is cut off
 - the button cuts off active cuttable alarms or, if there are no active cuttable alarms, the button performs a lamp test that lights all the lamps and LEDs on the bay for 30 seconds except those on the NT7E56 breaker interface panel

Note: To test the lamps and LEDs on the NT7E56 breaker interface panel, use the ACO/lamp-test button on that panel.

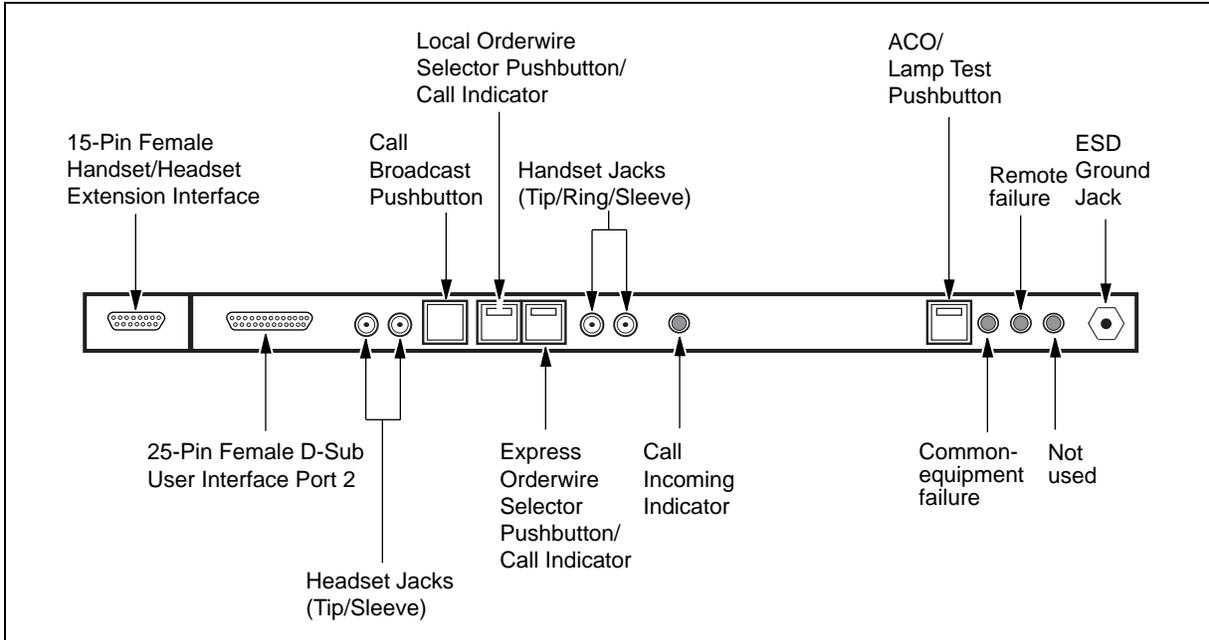
- an indicator that lights up whenever a failure occurs on any of the circuit packs or cards in the TBM shelf
- an indicator that lights up whenever there is an alarm at another network element in the system
- an indicator that is not used when the local craft access panel is installed in an AccessNode
- the connector for the electrostatic-discharge (ESD) wrist strap

An audible ring indicator in the local craft access panel sounds when there is an incoming orderwire call. The audible indication lasts up to 45 seconds.

Figure 7-38 shows the NT7E5047 local craft access panel.

Figure 7-38
Local craft access panel (LCAP), model NT7E5047

PC-10253



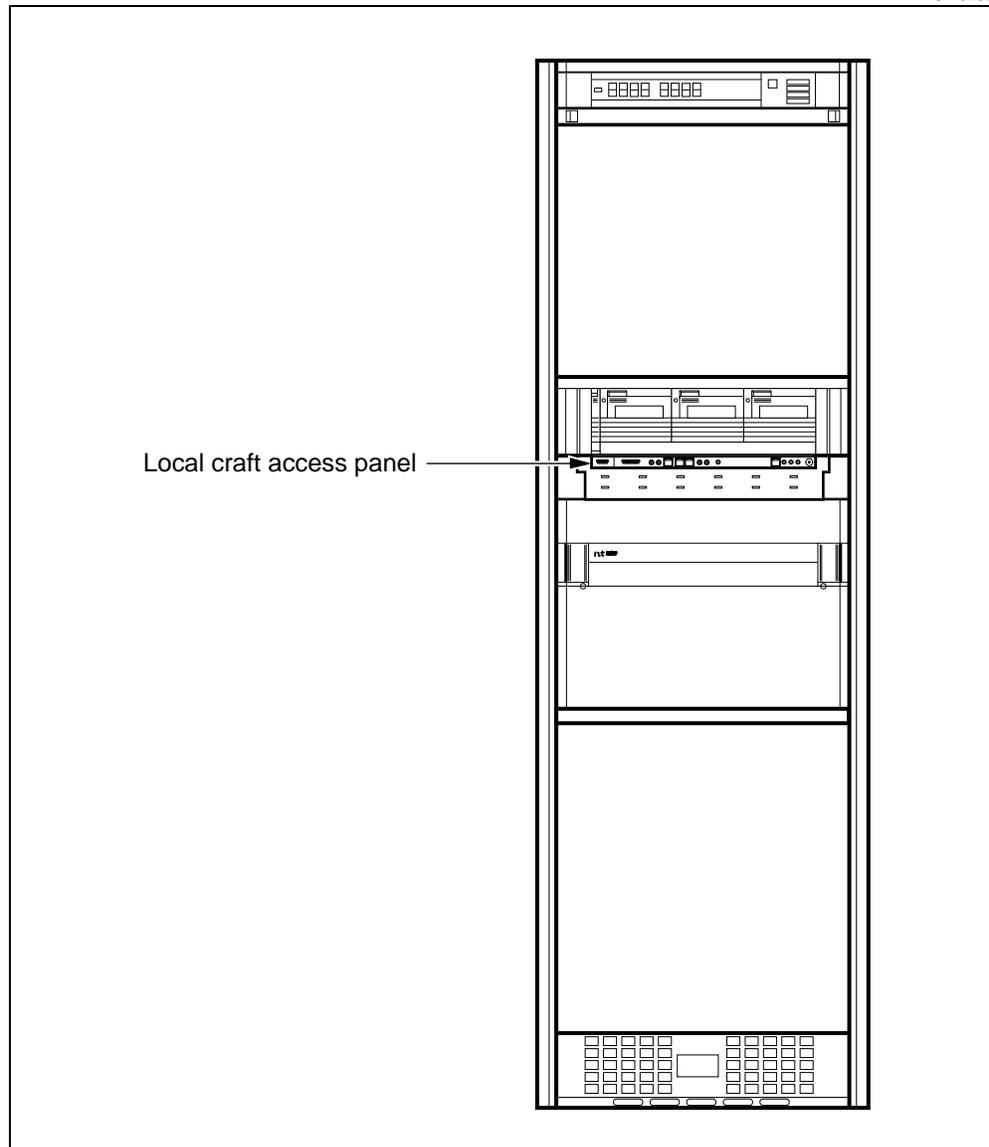
Where the NT7E5047 local craft access panel installs

In a bay, the NT7E5047 local craft access panel is installed in a horizontal slot in the cable organizer panel.

Figure 7-39 shows the location of the NT7E5047 LCAP.

Figure 7-39
Location of the NT7E5047 LCAP in a bay

PC-10269



Plug-in modules

This chapter briefly describes the main functions of the plug-in modules used in AccessNode.

For detailed descriptions of the plug-in modules, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

Chapter contents

This chapter includes the following topics:

Topic	See
Plug-in modules used in the common-equipment shelves (the access bandwidth manager shelf and the transport bandwidth manager shelf)	page 8-2
Plug-in modules used in the copper-distribution shelf	page 8-16
Plug-in modules used in the breaker interface panel (used with the access bandwidth manager shelf)	page 8-22

For descriptive information on the AccessNode Express, see *Configuration and Equipment Description*, 323-3051-100, in the *AccessNode Express* volume.

Plug-in modules used in the common-equipment shelves

The following types of common-equipment shelves are available for use in AccessNodes:

- the access bandwidth manager (ABM) shelf
- the transport bandwidth manager (TBM) shelf

The different types of common-equipment shelves accept many of the same modules. Figure 8-1 and Figure 8-2 show the two-level layout of each shelf. The slots are 2.24 in. (57 mm) wide and 7.1 in. (180 mm) deep.

Figure 8-1
Two-level layout of the access bandwidth manager shelf

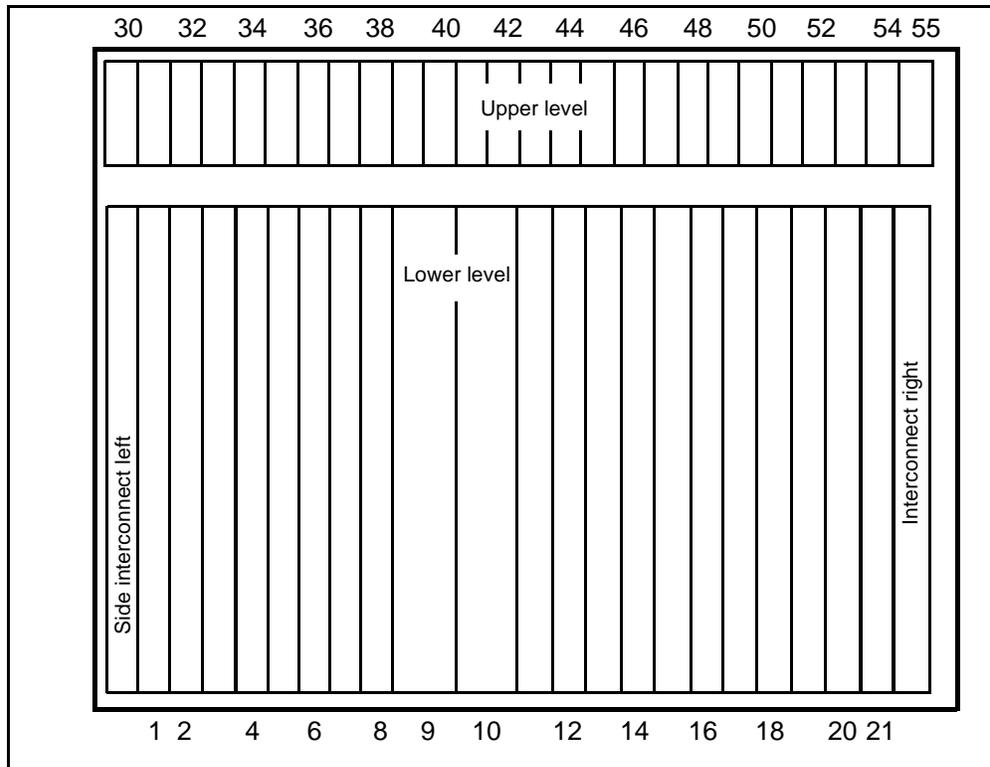
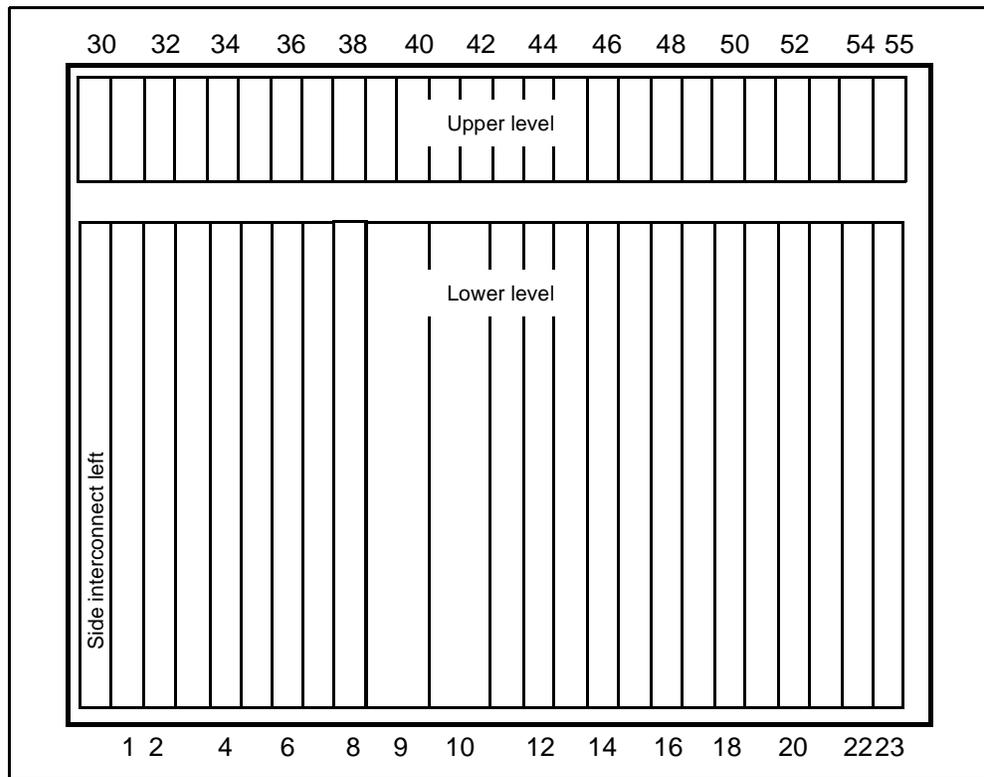


Figure 8-2
Two-level layout of the transport bandwidth manager shelf



The modules discussed in this chapter are in alphabetic order. To find information on a specific module, see Table 8-1 on page 8-4 and refer to the appropriate page.

For each module, Table 8-1 shows the shelf or shelves in which the module can be used. The table also shows whether the module is installed in the upper level of the shelf or in the lower level. For more information about the access bandwidth manager shelf and the transport bandwidth manager shelf, see Chapter 7 of this document.

A brief description of each module is included after Table 8-1. For more detailed information about a specific plug-in module, see *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

8-4 Plug-in modules

Table 8-1
Common-equipment-shelf modules discussed in this chapter

Module	See page	Shelf type where used:		Level: upper / lower
		Access	Transport	
Access interface card	8-5	Yes	No	lower
BNC I/O card	8-5	Yes	Yes	upper
Common-equipment power card	8-5	Yes	Yes	upper
DS1 input card	8-5	Yes	Yes	upper
DS1 output card	8-5	Yes	Yes	upper
DS1 protection bridge card	8-6	Yes	Yes	upper
DS1 synchronous mapper	8-6	Yes	Yes	lower
DS3/STS-1 protection switch card	8-6	Yes	Yes	lower
DS3 mapper	8-6	Yes	Yes	lower
STS-1 interface	8-7	No	Yes	lower
External synchronization interface card (NT7E27)	8-7	Yes	Yes	lower
Integrated remote test unit	8-7	Yes	No	lower
Maintenance interface card	8-8	Yes	Yes	lower
OC-12 interface circuit pack	8-9	Yes	Yes	lower
OC-12 VTBM circuit pack	8-10	Yes	Yes	lower
OC-3 interface circuit pack	8-11	Yes	Yes	lower
Operations controller (OPC) module	8-12	Yes	Yes	lower
PGTC/MTA card	8-12	Yes	No	upper
Processor card	8-13	Yes	Yes	lower
Serial I/O card	8-13	Yes	No	upper
Test access card	8-13	Yes	No	lower
Test access path card (TAP)	8-14	Yes	No	upper
Test bypass pair card (TBP)	8-14	Yes	No	upper
Timing and cross-connect card (TXC)	8-14	Yes	No	lower
Transport interface card	8-15	Yes	No	lower

This chapter does not include equipping rules. For complete equipping rules regarding the modules, see the *Mapper Layouts Planning Guide*, 323-3001-154, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

Access interface card (NT4K55)

The access interface cards (AICs) interface between the transport interface card and the equipment in the copper-distribution shelves. All the narrowband services from the copper-distribution shelves enter the access bandwidth manager shelf through the AICs.

The AICs are the central access points in the access bandwidth manager shelf for the DS0 channels carrying narrowband services. They provide the DS0-level bandwidth management, the messaging buffer for communication with the line cards in the copper-distribution shelves, and the D-link interfaces.

The AICs are used in the access bandwidth manager shelf. They install in the lower level of the shelf.

BNC I/O card (NT4K30)

Each BNC I/O card handles both directions of one DS3 line. An input signal enters the AccessNode, goes to the BNC I/O card, then to the associated DS3 mapper. An output DS3 signal goes from the DS3 mapper to the BNC I/O card, then out of the AccessNode.

Both the access and transport bandwidth manager shelves use the BNC I/O card. Each DS3 mapper requires three BNC I/O cards, and the three cards install in contiguous slots in the upper level of the shelf.

Common-equipment power card (NT4K58MA)

The common-equipment power card (CEP) interfaces the -48 V local battery feed to the shelf. The power cables from the breaker interface panel plug into the front of the CEP.

The ABM shelf and the TBM shelf. use the CEP. It installs in the upper level of the shelf. Two CEPs are installed.

DS1 input card (NT4K32)

Each DS1 input card handles 14 DS1 channels of input (all the DS1 input to a DS1 mapper). Input DS1 signals enter the AccessNode at the DS1 input card and go to the associated DS1 mapper.

Both the access and transport bandwidth manager shelves use the DS1 input card. It installs in the upper level of the shelf.

DS1 output card (NT4K33)

Each DS1 output card handles 14 DS1 channels of output (all the DS1 output from a DS1 mapper). Output DS1 signals go from the DS1 mapper to the associated DS1 output card, then out of the AccessNode.

Both the access and transport bandwidth manager shelves use the DS1 output card. It installs in the upper level of the shelf.

DS1 protection bridge card (NT4K31)

Two DS1 protection bridge cards are installed in a shelf if one of the DS1 mappers in the shelf is to be a protection unit.

The DS1 protection bridge card connects the DS1 protection bus in the shelf backplane and the DS1 mapper used as a protection unit. When a protection-switching request occurs for a working DS1 mapper, the DS1 input card associated with that mapper switches incoming DS1s to the protection bus. Then the DS1 output card associated with that mapper switches to receive outgoing DS1s from the protection bus. The DS1 protection bridge card is just the connector bridging the protection bus to the tracks in the backplane that lead to the protection DS1 mapper.

Both the access and transport bandwidth manager shelves use the DS1 protection bridge card. It installs in the upper level of the shelf.

DS1 mapper (NT7E04)

Each DS1 mapper can process up to 14 DS1 transmit and 14 DS1 receive signals independently. The DS1 mapper generates an STS-1 signal from up to 14 DS1 signals. Each DS1 is mapped as a VT1.5, and the VT1.5s are multiplexed into an STS-1. The STS-1 goes to the OC-12 or OC-3 interface circuit pack through the shelf backplane.

Both the access and transport bandwidth manager shelves use the DS1 mapper. It installs in the lower level of the shelf.

DS3/STS-1 protection switch card (NT4K60)

The DS3 protection switch card (PSW) is an optional card that must be installed if protection switching is provided for the working DS3 and STS-1 interfaces. The PSW must be installed in slot 2. If a fault occurs in a working DS3 or STS-1 interface, relays in the PSW route the traffic away from the faulty mapper and to the protection mapper.

There are two versions of the DS3 protection switch card. The NT4K60BA is used for TN_BLSR applications. The NT4K60CA is used for all others. Both the access and transport bandwidth manager shelves use the DS3 protection switch card. It installs in the lower level of the shelf.

DS3 mapper (NT7E08)

The DS3 mapper supplies interface circuitry between one, two, or three BNC I/O cards and the optical interface circuit packs. Each working DS3 mapper can support up to three DS3 lines. Each DS3 channel (44.736 Mb/s) maps into an STS-1 signal (51.84 Mb/s) that goes to the optical interface circuit pack through the backplane.

Both the access and transport bandwidth manager shelves use the DS3 mapper. It installs in the lower level of the shelf.

STS-1 interface (NT7E09)

The STS-1 interface supplies interface circuitry between one, two, or three BNC I/O cards and the optical interface circuit packs. Each working STS-1 interface can support up to three STS-1 lines.

External synchronization interface card (NT7E27)

The external synchronization interface (ESI) card receives timing reference signals from an external reference timing source such as a building integrated timing source (BITS). The ESI also provides the timing reference (a signal with a frequency of 51.84 Mhz) that is used as the system clock.

The ESI card is installed in the external synchronization carrier (NT7E19AA), and the carrier is installed in a slot in the lower level of the common-equipment shelf. One or two ESI cards can be installed in the carrier. If two ESI cards are installed, they protect each other. At any time, one of the ESI cards is the working unit; the other, the protection unit.

The FCOT of a basic fiber-fed system requires the ESI card if the system serves a GR-303 application or a TR-08 application or Digital Data Services (DDS). For more information on DDS, see *Line Card Application and Special Services Engineering*, 323-3001-155, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

DS1-fed AccessNode systems do not use ESI cards. In a DS1-fed system, the timing and cross-connect card provides timing.

Both the access and transport bandwidth manager shelves use the ESI card.

Integrated remote test unit (NT4K57)

The integrated remote test unit (IRTU) supports enhanced testing capabilities for AccessNode. Two versions of the IRTU are available:

- dual test head IRTU
- single test head IRTU

The dual test head IRTU contains two integrated measurement heads to support simultaneous testing of locally switched services and of special services. The single test head IRTU can support only one test session at a time.

IRTU Upgrades

When a single test head IRTU is removed and a dual test head IRTU is inserted after the IRTU initializes and completes the diagnosis process, the second test head is out of service. The craftsperson must manually put the second test in service from the eq irtu screen.

Capabilities

Both versions of the IRTU have the following testing capabilities:

- loop testing of locally switched services from a Centralized Automated Loop Reporting System (CALRS) operations system or an NT local test cabinet
- testing of nonswitched and nonlocally switched services
 - from a Switched-Access Remote Test System (SARTS) operations system
 - from a Digital Analog Remote Test System (DARTS) operations system
 - from the operations controller (OPC) user interface

The IRTU is optional. Only the access bandwidth manager (ABM) shelf in remote fiber terminals (RFTs) use the integrated remote test unit. The test access card must accompany the IRTU. For more information, see *Line and Loop Testing Overview*, 323-3001-115, in *Description*, Volume 2B.

The IRTU installs in the lower level of the shelf.

Maintenance interface card (NT4K53)

The maintenance interface card (MIC) performs the following major functions:

- It gathers and distributes alarm data as follows:
 - It scans the on/off condition of internal and external hardware, breakers, switches, and miscellaneous internal hardware, and notifies the processor card when a state change occurs.
 - It can receive parallel-telemetry data when installed in a fiber central office terminal (FCOT) or a stand-alone operations controller (OPC) shelf.
 - It drives signals for access and transport card-fail LEDs.
 - It controls circuits for alarm lights on the breaker interface panel (BIP).
 - It controls circuits that can send alarms to parallel-telemetry systems.
- It activates signals that open and close the relays in the DS1 and DS3 signal paths to carry out protection switching. (The relays for DS1 protection switching are on the DS1 input card and the DS1 output card; the relays for DS3 protection switching are on the DS3 protection switch card.)
- It supports user interfaces.
- It handles orderwire for voice-frequency communication using the SONET overhead bus (SOH bus).

Note: Orderwire is not available in DS1-fed systems and single-ended systems.

Both the ABM and TBM shelves use the maintenance interface card. It installs in the lower level of the shelf.

OC-12 interface circuit pack (NT7E02)

The OC-12 interface circuit pack is one of the three optical interface circuit packs used in an AccessNode network element. (The OC-12 virtual tributary bandwidth manager (VTBM) and OC-3 interface circuit packs are the others.) OC-12 interface circuit packs are installed in pairs that are in nonrevertive protection-switching arrangements.

The OC-12 interface circuit pack interfaces between the AccessNode network element and a fiber optic link. The circuit pack generates an OC-12 optical signal from STS-1 electrical signals. Each OC-12 interface circuit pack processes a maximum of 12 STS-1 signals in each direction (transmit and receive).

An AccessNode network element contains one pair of OC-12 interface circuit packs. These circuit packs are the primary interface to the fiber optic feeder.

The OC-12 interface circuit packs (working and protection) receive electrical STS signals through the backplane of the shelf. The electrical signals come from the working transport interface circuit pack, the DS1 mappers, and the standby transport interface circuit pack (if installed).

The OC-12 interface circuit packs perform electrical-to-optical conversion. Both OC-12 interface circuit packs transmit optical signals over the fiber optic link. (The far end uses the signal from the working OC-12 interface circuit pack.) The OC-12 interface circuit packs (working and protection) receive optical signals from a fiber optic link and perform optical-to-electrical conversion. The working OC-12 interface circuit pack transmits STS-1 signals over the backplane of the shelf.

The two types of OC-12 interface circuit packs are long-reach and intermediate-reach. The customer has the choice of biconic, ST, SC, or FC connectors.

Both the access and transport bandwidth manager shelves use the OC-12 interface circuit pack. It installs in the lower level of the shelf.

OC-12 VTBM circuit pack (NT7E05)

The OC-12 VTBM circuit pack interfaces to the primary fiber optic feeder in network elements in fiber-fed systems that have ring topology. Two units are required. One unit handles the working and protection channels traveling in the east-to-west direction, and the other unit handles the working and protection channels traveling in the west-to-east direction.

The OC-12 VTBM circuit pack provides the following:

- interface to the OC-12 signal
- bandwidth management at the STS-1 level and at the virtual tributary (VT) level
- timing to maintain the synchronization of the network element

Both the access and transport bandwidth manager shelves use the OC-12 VTBM circuit pack. It installs in the lower level of the shelf. The customer has the choice of ST, SC, or FC connectors.

The two types of OC-12 VTBM interface circuit packs are long-reach and intermediate-reach.

VTBM support of OC-3 concatenated tributaries

In AN14, the two vintages of the VTBM optic cards are an initial release and an enhanced version. The initial version (listed in Table 8-2) does not support OC-3 concatenated (OC-3c) tributaries. The enhanced version (listed in Table 8-3) does support concatenated OC-3c tributaries. The initial cards are upgradable to the enhanced version.

In bidirectional line-switched ring (BLSR) configurations supporting OC-3c concatenated tributaries, the enhanced VTBM optic cards are required in both the network element where the OC-3c tributary originates and in the network element where the OC-3c tributary terminates.

Table 8-2 lists the OC-12 VTBM hardware that does not support OC-3c tributaries.

**Table 8-2
OC-12 VTBM hardware not supporting OC-3c tributaries**

PEC	Description
NT7E05AB	OC-12 VTBM long reach (FC)
NT7E05AC	OC-12 VTBM long reach (ST)
NT7E05AD	OC-12 VTBM long reach (SC)
—continued—	

Table 8-2 (continued)
OC-12 VTBM hardware not supporting OC-3c tributaries

PEC	Description
NT7E05BB	OC-12 VTBM intermediate reach (FC)
NT7E05BC	OC-12 VTBM intermediate reach (ST)
NT7E05BD	OC-12 VTBM intermediate reach (SC)
—end—	

Table 8-3
OC-12 VTBM hardware supporting OC-3c tributaries

PEC	Description
NT7E05AF	OC-12 VTBM enhanced long reach (FC)
NT7E05AG	OC-12 VTBM enhanced long reach (ST)
NT7E05AH	OC-12 VTBM enhanced long reach (SC)
NT7E05BF	OC-12 VTBM enhanced intermediate reach (FC)
NT7E05BG	OC-12 VTBM enhanced intermediate reach (ST)
NT7E05BH	OC-12 VTBM enhanced intermediate reach (SC)

OC-3 interface circuit pack (NT7E01)

The OC-3 interface circuit pack is one of the optical interface circuit packs used in an AccessNode network element. (Alternatively, the OC-12 interface circuit pack can be used.) OC-3 interface circuit packs install in pairs that are in nonrevertive protection-switching arrangements.

The OC-3 interface circuit pack is like the OC-12 interface circuit pack, except that it can process a maximum of only three STS-1 signals in each direction (transmit and receive).

In a network element in a fiber-fed system, a pair of OC-3 interface circuit packs can serve as the primary interface to the fiber optic feeder, if the feeder carries traffic at the OC-3 rate.

OC-3 interface circuit packs can interface to OC-3 tributaries. Only fiber-fed systems in which the feeder carries traffic at the OC-12 rate support OC-3 tributaries. An ABM shelf can handle up to two OC-3 tributaries; a TBM shelf can handle up to four.

Operations controller module (NT7E24)

The operations controller (OPC) module is an operations engine that runs the UNIX operating system. The major functions of the OPC module are the following:

- It provides and controls operations, administration, maintenance, and provisioning (OAM&P) for all the AccessNode network elements in its span of control.
- It acts as an operations system (OS) gateway device (as a mediation device for communication between the AccessNode network elements and external network OSs).
- It performs software management. It stores software on its hard disk. When a component within its span of control needs its software reloaded or upgraded. The OPC downloads the software to the component.
- It stores the database that contains provisioning information.

Span of control

Every AccessNode system requires the services of an OPC. However, every system does not need to contain an OPC, because one OPC can serve multiple systems (up to a limit of 16 network elements). (A system may include one or more network elements.)

If an OPC serves a system, it must serve all the network elements in the system. Allotting some of the network elements in a system to one OPC and some to another is not possible.

A single OPC can serve multiple systems if a control-network local area network (LAN) links the equipment containing the OPC module (an FCOT or an OPC shelf) to the FCOTs of the other systems. The equipment containing the OPC must be collocated with the other fiber central office terminals (FCOTs) because the control-network LAN cable connection has a maximum length of 400 ft.

An access or transport bandwidth manager shelf can use the OPC module. It installs in the lower level of the shelf.

PGTC/MTA card (NT4K58DA)

Only FCOTs containing copper-distribution shelves use the pair gain test controller (PGTC)/metallic test access (MTA) card. The card performs the following functions that are required by the test access card:

- It provides relays for the PGTC interface.
- It provides relays and resistive terminations for the MTA interface.

Only the ABM shelf uses the PGTC/MTA card. It installs in the upper level of the shelf.

Processor card (NT4K52)

The processor card is the main processor in the shelf. It provides central control functions for the shelf. The processor card supplies central control for the AccessNode network element. Every common-equipment shelf (every access bandwidth manager shelf and every transport bandwidth manager shelf) contains one processor card, and a second can be installed for protection.

The following are the principal functions performed by the processor card:

- call processing
- host communications
- operations, administration, and maintenance (OAM)

Both the ABM and TBM shelves use the processor card. It installs in the lower level of the shelf.

Note: Use the NT4K52GA or NT4K52GB processor card in the ABM shelf when a DS1-fed AccessNode (DFA) or AccessNode Express host digital terminal (HDT) is connected to a DMS-10NA switch.

Serial I/O card (NT4K58LA)

Serial I/O cards supply the connectors the external operations systems (OSs) use to access the operations controller module. Each serial I/O card is an independent serial port of the operations controller, capable of handling input and output. Each serial I/O card connects to the operations controller module by tracks in the backplane of the shelf.

Only the ABM shelf uses Serial I/O cards. The shelf can accommodate two such cards. They install in the upper level of the shelf.

Note: The serial I/O cards are serial ports 2 and 3 of the operations controller. These ports are supported only if you have purchased the enhanced-administration optional software feature package.

Test access card (NT4K54)

The test access card (TAC) supplies circuit-test access to line cards. In addition, if the AccessNode network element contains an IRTU, the test access card supplies control and test access for the IRTU over a serial data link. (For information on the IRTU, see page 8-7.) AccessNode FCOTs and RFTs containing copper-distribution shelves use the test access card.

The ABM shelf uses the test access card. It installs in the lower level of the shelf.

Test access path card (NT4K58KA)

The test access path card (TAP) performs the following functions:

- It supplies the external interface connection required for metallic-test-access-unit (MTAU) testing. The test access card requires this connection
- It supplies the external interface for the test bypass pairs in an RFT.

Only the ABM shelf uses the test access path card. It installs in the upper level of the shelf. It is used only in RFTs.

Test bypass pair card (NT4K58CA)

The test bypass pair card (TBP) provides the external interface connection for six test bypass pairs. The test access path card requires this connection.

Only the ABM shelf uses the TBP card. It installs in the upper level of the shelf. It is used only in FCOTs. (At an RFT, the connection for the test bypass pairs uses the TAP card.)

Timing and cross-connect card (NT4K75)

The timing and cross-connect card (TXC) performs the following functions:

- It supplies the system clocks from which the other cards take their timing.
- It cross-connects STS-1 signals between the transport interface card and the DS1 mappers.

Only ABM shelves use the timing and cross-connect card, and only in DS1-fed systems. It is used in DS1-fed RFTs. It is also used in a stand-alone ABM OPC shelf serving a DS1-fed system, if connectivity between the OPC shelf and the DS1-fed RFTs is through operations maintenance channel (OMC) DS1s.

The timing and cross-connect card installs in the lower level of the access bandwidth manager shelf.

Transport interface card (NT4K56)

The transport interface card (TIC) is the transport formatter that interfaces with the OC-12 interface circuit packs. The working transport interface card provides SONET formatting of DS0s into virtual tributaries (VT1.5s). The TIC can multiplex VT1.5s into STS format.

Both the ABM shelf and the common-equipment shelf use the TIC. It installs in the lower level of the shelf.

There are three models of transport interface cards (TICs):

- **standard TIC (NT4K56AC)** — three-port TIC which accommodates all of the default services available from the standard user interfaces.
- **asynchronous TIC, or ATIC (NT4K56CA)** – three-port TIC which provides the same capability as the standard TIC plus the following functionality when used with the appropriate AccessNode software release:
 - TR-08 links on all three ports (rather than just the first)
 - circuit logic to monitor/modify D4 channel bank signaling and pulse-code modulation payload
 - asynchronous payload handling in fiber-fed configurations
- **enhanced TIC, or ETIC (NT4K56BA)** — six-port TIC which provides the same capability as the standard TIC plus supports a second set of LAIC circuit packs for a Mix and Match system.

The main functions of the TICs are to

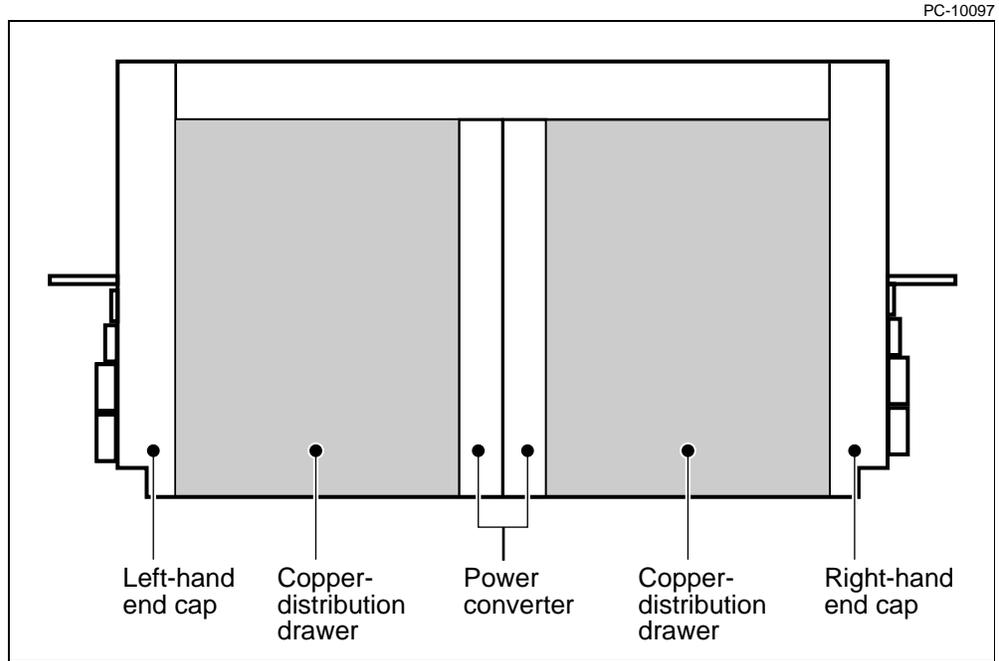
- terminate up to 2,016 DS0s from the LAIC and multiplex them into byte synchronous VT1.5s. With ATIC, multiplexing of VT1.5s also can be done in asynchronous mode. The VT1.5s are combined into STS-1s, which are transmitted toward the TXC using STS-links.
- process the three access STS-1s—or six access STS-1s, if an ETIC—from the working TXC card by demultiplexing the payloads into VT1.5s. The VT1.5s are decomposed into DS0s, which are transmitted to the LAIC using T-links.

The HDT requires two TICs for normal operation: one primary (active) and one secondary (backup). The primary and secondary TICs must be the same model (NT4K56AC, NT4K56CA, or NT4K56BA) for the system to operate properly.

Plug-in modules used in the copper-distribution shelf

In a copper-distribution shelf, some of the plug-in modules install outside the copper-distribution drawers, and some install inside the drawers. Figure 8-3 shows the locations of the drawers and of the modules installed outside the drawers.

Figure 8-3
Layout of the copper-distribution shelf, viewed from above



Modules outside the copper-distribution drawers

In a copper-distribution shelf, the two copper-distribution shelf power converters (NT4K62) plug in parts of the shelf other than the copper-distribution drawers.

Copper-distribution shelf power converter (NT4K62)

A single copper-distribution shelf power (CDSP) converter can supply all the power used by the copper-distribution shelf. For protection, two power converters are installed in each shelf. The two power converters are located in the middle of the copper-distribution shelf between the two copper-distribution drawers.

Modules inside the copper-distribution drawers

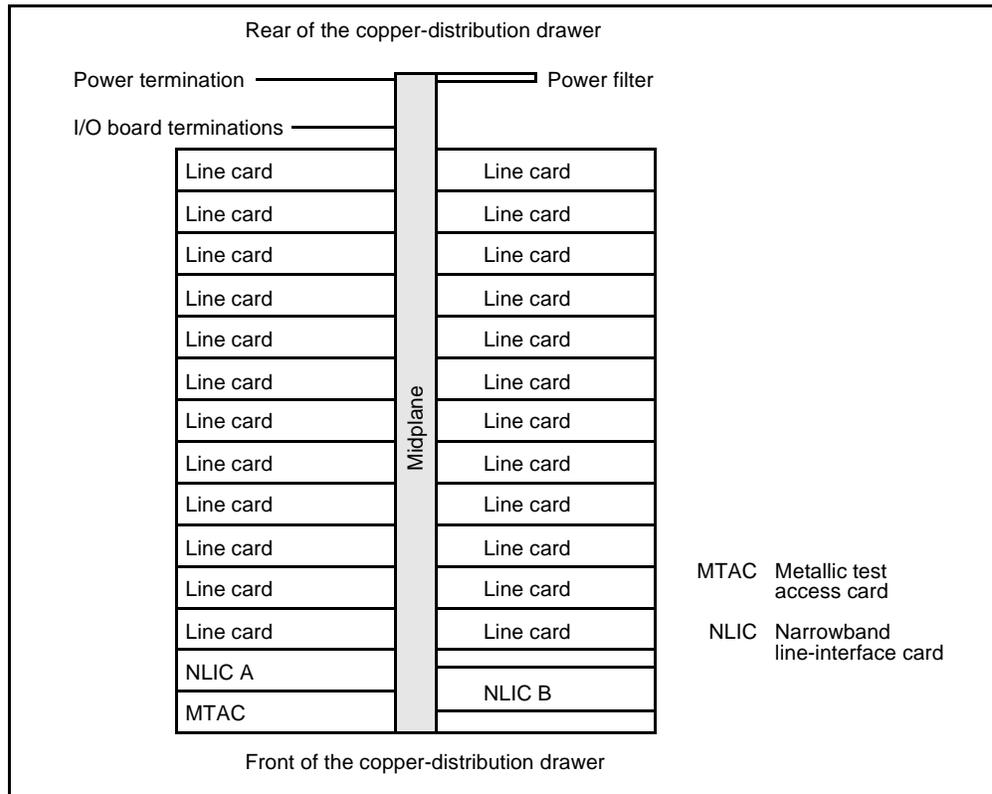
Each copper-distribution shelf can accommodate two copper-distribution drawers, one on the left-hand side of the shelf to the left of the power converters, and one on the right-hand side.

The following plug-in modules are installed in copper-distribution drawers:

- line cards
 - Epsilon station line card (NT4K65)
 - Omega 2-wire station line card (NT4K67)
 - Omega 2-wire office line card (NT4K68)
 - Omega 4-wire line card (NT4K69)
 - Omega 6/8-wire line card (NT4K77)
 - manual ringdown 2-wire line card (NT4K78)
 - universal voice grade (UVG) station line card (NT4K79)
- drawer common-equipment modules
 - narrowband line-interface card (NT4K70)
 - metallic test access card (NT4K73)
 - power filter (NT4K63)

Figure 8-4 shows the locations in which the plug-in modules are installed in a copper-distribution drawer.

Figure 8-4
Locations for plug-in modules in the left-hand copper-distribution drawer, viewed from above



Line cards

The copper-distribution drawers contain the line cards. The line cards support a full range of copper-based services. Each line card interfaces with one line.

Some of the line cards used in AccessNode are service-adaptive, which means that a single line card can support any one of a variety of services. Therefore, a full range of copper services can be provided using only a few types of line cards.

Epsilon station line card (NT4K65)

The Epsilon station line card is not service-adaptive. It supports 2-wire plain old telephone service (POTS) services only. The Epsilon station line card is a less costly alternative to the Omega 2-wire station line card. It is used only in remote fiber terminals (RFTs). If an analog switch (or a digital switch with an analog interface) serves the line, the corresponding line card at the fiber central office terminal (FCOT) is an Omega 2-wire office line card. This line card supports the following TR-08 services: POTS, universal voice grade (UVG), and Custom Local Area Signalling Service (CLASS).

The NT4K65CA Epsilon station line card supports 2-wire POTS for Hong Kong. NT4K65CA meets Hong Kong's CR01 standards for ringing signal frequency, input impedance, and balance impedance.

Omega 2-wire station line card (NT4K67)

The Omega 2-wire station line card is a service-adaptive line card. It supports most 2-wire services in RFTs. In FCOTs, it supports the following 2-wire services: Direct Inward Dialing (DID), Off Premise Station (OPS), IDSL, and ISDN. This line card supports the following TR-08 services: POTS, coin, UVG, dial-pulse terminating, and CLASS.

Omega 2-wire office line card (NT4K68)

The Omega 2-wire office line card is a service-adaptive line card. It supports most 2-wire services in FCOTs. In RFTs, it supports the following 2-wire services: DID and OPS.

Omega 4-wire line card (NT4K69)

The Omega 4-wire line card is a service-adaptive line card. It supports all 4-wire services except T1/DS1-type services. Both FCOTs and RFTs can use this card.

Omega 6/8-wire line card (NT4K77)

The Omega 6/8-wire line card is a service-adaptive line card. It handles all special services employing ear and mouth (E&M) signaling, tandem (TDM), or pulse link repeater (PLR) dc signaling on circuits having six or eight leads. Both FCOTs and RFTs can use this card.

Manual ringdown 2-wire line card (NT4K78)

The manual ringdown 2-wire line card provides a 2-wire point-to-point private line, which is a nonswitched special service. The line card supplies the interface to the ringdown signaling and the interface between the voice frequency and the AccessNode digital carrier.

AccessNode provides only point-to-point manual ringdown service. External Bridging units, which are not supplied by Nortel, support multipoint configurations. When external bridging is done, there must be a manual ringdown line card at the RFT and a line-card appearance of the service at the central office.

Note: Manual ringdown is a nonswitched special service. Customers with this service press a button at their telephone to generate ringing current to the line. The ringing is passed to the called end. When the called end answers, a conversation can take place. Transmission in the circuit is always enabled unless ringing is present. Manual ringdown is a two-way special service; therefore, both ends of the circuit must be able to send or receive ringing.

Universal voice grade station line card (NT4K79)

Only RFTs use the UVG station line card. If an analog switch (or a digital switch with an analog interface) serves the line, the corresponding line card in the FCOT is an Omega 2-wire office line card.

The UVG station line card is a low-cost alternative to the Omega 2-wire station line card. It supports POTS and UVG functionality, including PBX trunks and lines, WATS trunks and lines, 800 trunks and lines, and secretarial lines. The UVG line card does not support certain services and features that are supported by the Omega line cards, including integrated services digital network (ISDN), coin, P-phone, DID, Datapath, and message waiting.

No signaling or transmission options need to be provisioned for the UVG line card, except the on-hook transmission feature (OHT), which can either be provisioned or left in the default mode.

Drawer common-equipment modules

The following common-equipment modules are in each copper-distribution drawer:

- narrowband line-interface cards (NT4K70)
- metallic test-access card (NT4K73)
- power filter (NT4K63)

The following paragraphs describe these modules.

Narrowband line-interface cards (NT4K70)

Narrowband line-interface cards (NLICs) interface between the line cards in the copper-distribution drawer and circuit packs and cards in the access bandwidth manager (ABM) shelf. The NLIC supports all types of line cards.

Each copper-distribution drawer contains two NLICs. The two cards are in a nonrevertive protection-switching arrangement.

Metallic test access card (NT4K73)

Each copper-distribution drawer contains one metallic test access card (MTAC). The MTAC makes connections necessary for testing the line cards and for sparing.

Metallic test access card (NT4K73CA)

The metallic test access card (MTAC) is used to switch the drawer test busses onto the shelf metallic test busses as required for metallic test access and sparing. Additional circuitry monitors for fault with any card in the CDS drawer and for Talk Battery loss at the drawer level. If a card fault is detected, the red fail LED remains constant. If loss of Talk Battery is detected, the red fail LED flashes. (The LED is located on the surface of the printed circuit board and shines through the front of the drawer.) A Talk Battery Loss alarm is also generated in the system software.

Power filter (NT4K63)

Each copper-distribution drawer contains a power filter that filters incoming power. (The power comes from the power converters by way of the power flex.) The power filter also supplies termination for the clock lines in the drawer midplane.

Plug-in modules used in the breaker interface panel

In an AccessNode that contains an access bandwidth manager (ABM) shelf, the model-NT4K14 breaker interface panel (BIP) is used. The following field-replaceable plug-in modules can be installed in two available BIPs:

NT4K14BA BIP

- one alarm relay card (NT4K64BA) (mandatory) and
- one talk battery filter card (NT4K61BA) (mandatory)

NT4K14AB BIP

- one alarm relay card (NT4K64AA) (mandatory) and
- two talk battery filter cards (NT4K61AA) (optional - use if one or more CDSs are installed in the system).

Note: No field-replaceable plug-in modules are available in the NT7E56 BIP, which is used with the transport bandwidth manager (TBM) shelf.

Software packaging

This chapter briefly describes the software available with this release of AccessNode.

Chapter contents

This chapter includes the following topics:

Topic	See
Software load for an AccessNode	page 9-2
Core software	page 9-2
Optional software	page 9-6

Software load for an AccessNode

The software load for an AccessNode is delivered to the operations controller. The operations controller (OPC) stores the software load and downloads software to individual cards that require it. Each of the following cards receives a software download from the OPC:

- the processor card

Note: In the current software version, the ABM shelves require the NT4K52FB, or NT4K52GB processor. For more information, see *Engineering and Ordering Information*, 323-3001-032, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

- the test access card
- the integrated remote test unit
- each of the service-adaptive line cards

The software load is composed of the following:

- core software
- optional software feature packages

For instructions on purchasing software, see *Engineering and Ordering Information*, 323-3001-032, in the *Engineering, Configuration, and Ordering Guide*, Volume 1.

Core software

The core software includes the following features:

- OC-3/OC-12 optical performance monitoring
- OC-3 optical performance monitoring for OC-3 tributaries
- timing-reference provisioning
- protection provisioning for timing references
- synchronization-status messaging
- automatic protection exerciser for network elements in a ring
- Hong Kong as well as North American support
- control bus interface
- DS1-fed AccessNode
- log archive
- SONET phase 1 standards compliance
- SONET phase 2 standards compliance
- 1+1 protection switching for optical interface (OC-12 and OC-3) circuit packs

- hardware redundancy for the following modules:
 - processor card (hardware and software)
 - processor card (software only)
 - access interface card
 - narrowband line-interface card
 - transport interface card
 - copper-distribution-shelf power converter
- system diagnostics and maintenance for the following modules:
 - processor card
 - external synchronization interface card
 - maintenance interface card
 - operations controller module
 - OC-12 interface circuit pack
 - OC-3 interface circuit pack
 - access interface card
 - metallic test access card
 - narrowband line-interface card
 - timing and cross-connect card
 - test access card
 - transport interface card
 - copper-distribution-shelf power converter
 - integrated remote test unit
 - DS1/VT synchronous mapper
- path maintenance and fault isolation
 - path maintenance base
 - carrier group alarm
 - DS0 trunk conditioning
- local alarm indicators
- circuit-pack status and alarm LEDs
- lamp test
- alarm cutoff (ACO)
- remote alarm cutoff
- alarm surveillance, network-element view
- alarm surveillance, network view

- alarm screening at the network-element level
- alarm and indicator management
- line-card-alarm enhancements
- protection exerciser (OC-12/OC-3)
- point-to-point topology
- orderwire, fiber central office terminal-remote fiber terminal (FCOT-RFT)
- time-of-day synchronization
- external synchronization interface
- 2-wire, 4-wire, and 6/8-wire services
- operations controller (OPC) configuration: single OPC module
- I/O ports on the FCOT
 - input parallel telemetry
 - output parallel telemetry (basic)
 - output parallel telemetry (enhanced)
 - RS-232C port
 - RS-422 port for telemetry byte-oriented serial (TBOS)
- I/O ports on the RFT
 - input parallel telemetry
 - output parallel telemetry (basic)
 - output parallel telemetry (enhanced)
 - RS-232C port
 - RS-422 port for TBOS serial telemetry
- basic security (ID and password)
- command-screening and read/write control
- network-wide security administration
- system line up and test (SLAT) with portable OPC for access bandwidth manager (ABM) and transport bandwidth manager (TBM)
- commissioning (ABM and TBM)
- basic provisioning
- alarm provisioning
- telemetry provisioning
- protection provisioning
- user-provisionable protection oscillation control (previously known as automatic lockout) for optical interface (OC-12 and OC-3) circuit packs

- preprovisioning of line cards
- support for locally switched services (integrated and universal applications)
- support for nonswitched services and nonlocally switched services
- autoprovisioning of line cards (integrated and universal applications)
- default provisioning
- manual provisioning of optical interface (OC-12 and OC-3) circuit packs
- manual provisioning of DS1s
- flexible assignment of DS1s for GR-303 and for tandem
- capability of supporting a mix of DS1s and DS3s in a single shelf
- autoprovisioning of optical interface (OC-12 and OC-3) circuit packs
- autoprovisioning of DS1s
- flow-through provisioning, phase 1
- flow-through provisioning, phase 2
- E2A operations system (OS) support
- testing using the test bypass pair
- jack access (metallic and OTLP)
- dual-craft line up of special services
- line and loop testing
- line-card diagnostics
- loop testing for locally switched services: no-test-trunk access
- testing using integrated remote test unit (IRTU) line cards
- station installation tests
 - silent switchman
 - station ringer test
 - dialable short circuit (using an IRTU or a test bypass pair)
- VT100 user interface, English-language
- hand-held terminal (HHT) user interface, full-screen VT100-compatible
- HHT user interface, line-by-line
- on-line help
- alarm archive
- network element (NE) event logs (base)
- access logs
- software delivery to OPC (tape)

- software download (OPC to network element)
- database backup and recovery (network-element)
- software generic upgrades (OPC and network element)
- automated or customized software upgrade
- software backward compatibility, AccessNode to DMS
- software upgrade by single-step process
- inventory (network-element view)
- 672-line system
- FCOT-to-analog-switch interface
- FCOT-to-nonswitched interfaces
- DS0 bandwidth management
- STS bandwidth management
- single-ended operations
- remote login
- remote access
- DS1 loopback
- DS1 interfaces provided by the DS1/VT synchronous mapper
- support for 98 DS1s in an ABM shelf
- support for 126 DS1s in a TBM shelf
- multihosting support (up to five DMS SuperNodes)
- multi-IG/multi-SMA

Note: The multihosting core feature refers to the arrangement in which different lines or groups of lines at the RFT are switched by different switches, including a single DMS SuperNode switch and one or more analog switches (or digital switches with analog interfaces). This is not the usual meaning of the term multihosting as used in the AccessNode library. For details on multihosting, multi-IG, or multi-SMA, see “Single hosting and multihosting” on page 5-3.

Optional software

The optional software feature packages offer enhanced capabilities not provided by the core software.

The following optional software feature packages are available:

- Centralized Automated Loop Reporting System (CALRS) testing
- Digital Analog Remote Testing System (DARTS) testing
- DMS SuperNode integration

- DS1 performance monitoring
- DS1 protection switching
- DS3 interfaces
- STS-1 interfaces
- DS3 performance monitoring
- STS-1 performance monitoring
- OC-3 tributary support
- enhanced administration
- Cornerstone Voice
- enhanced maintenance
- high-speed performance-monitoring
- inventory, network view
- ISDN-U integration
- ISNMS TL1 surveillance OS interface
- Meridian Electronic Business Set (EBS)
- multihosting with multiple digital hosts
- NEC TL1 provisioning OS interface
- Network Manager

Note: Network Manager is a software application that runs on a UNIX workstation. All the other software (core and optional) runs on an AccessNode network element.

- NMA TL1 surveillance operations system (OS) interface over either X.25 or Ethernet
- OC-3 tributary feature
- OC-12 virtual tributary bandwidth manager (VTBM) ring feature
- OPC special-services testing (loop testing)
- OPS/INE TL1 provisioning OS interface
- single-ended AccessNode
- standby OPC
- TA-201 analog special-service testing (SARTS testing)
- TL1 generic provisioning OS interface
- TL1 generic surveillance OS interface
- GR-303

9-8 Software packaging

- TR08
- X.25 interface feature package

Interfaces to AccessNode

This chapter discusses the interfaces available with the AccessNode.

Chapter contents

This chapter includes the following topics:

Topic	SEE
Overview of AccessNode interfaces	page 10-2
Interfaces to optical feeder lines	page 10-2
Interface to optical tributary lines	page 10-2
Interfaces to digital lines	page 10-2
Interfaces to copper lines	page 10-3
Interface to an external timing source	page 10-3
Interfaces to the operations controller module	page 10-3
Interface to Ethernet	page 10-5
X11 terminal support	page 10-5
X.25 interface	page 10-5
Interface to control network	page 10-6
Interfaces for parallel telemetry	page 10-6
Interfaces for serial telemetry	page 10-6
Interfaces for orderwire	page 10-7
User interfaces	page 10-9
Metallic test access	page 10-10
Interfaces on the side interconnect left circuit packs	page 10-10
Interfaces on the local craft access panel	page 10-13

For descriptive information on the AccessNode Express, see *Configuration and Equipment Description*, 323-3051-100, in the *AccessNode Express* Volume.

Overview of AccessNode interfaces

AccessNode connects to external interfaces on the side interconnect left circuit pack in the common-equipment shelf (the access or transport bandwidth manager shelf) and on the local craft access panel (LCAP).

For your convenience, this chapter includes illustrations of the side interconnect left circuit packs used in AccessNodes on pages 10-11 and 10-12. It also includes illustrations of the LCAPs used in AccessNodes on pages 10-13 and 10-14.

Interfaces to optical feeder lines

Optical interface circuit packs supply optical feeder interfaces for the AccessNode. These packs can be OC-12 interface circuit packs or OC-3 interface circuit packs. For protection, optical interface circuit packs are always installed in pairs, either two OC-12s or two OC-3s. Protection switching is the 1+1 nonrevertive type.

The optical interface circuit packs offer long-reach and intermediate-reach optics. You have a choice of biconic connectors, straight-tip connectors (ST), subscriber connectors (SC), or ferrule connectors (FC). The biconic connectors are low-reflective SPA connectors.

Interface to optical tributary lines

OC-3 optical interface circuit packs supply optical tributary interfaces for the AccessNode. For protection, it is recommended that the OC-3 circuit packs always be installed in pairs. Protection switching is the 1+1 nonrevertive type. Only fiber-fed systems with OC-12 optical feeders support OC-3 tributaries.

The OC-3 circuit pack offers long-reach and intermediate-reach optics. You have a choice of biconic connectors, straight-tip connectors (ST), subscriber connectors (SC), or ferrule connectors (FC). The biconic connectors are low-reflective SPA connectors.

Interfaces to digital lines

AccessNode can interface to digital DS1 and DS3 lines. The digital lines come from interconnecting equipment such as digital cross-connects.

Interfaces to DS1 lines use DS1 input cards and DS1 output cards in the upper level of the common-equipment shelf. Each DS1 input card and each DS1 output card has a 44-pin D connector on its front. Each DS1 input card handles 14 incoming DS1 channels; each DS1 output card handles 14 outgoing DS1 channels. One DS1 input card and one DS1 output card handle all the input and output for one DS1 mapper (14 DS1 channels).

Interfaces to DS3 lines use bayonet-locking connector (BNC) I/O cards in the upper level of the common-equipment shelf. Each BNC I/O card has two BNC-type connectors on its front, one for input and one for output. Each BNC I/O card handles both directions of one DS3 line. Up to three BNC I/O cards can be associated with a DS3 mapper, which can handle both directions of up to three DS3 lines.

Interfaces to copper lines

AccessNode can interface to copper lines and can support narrowband services offered over conventional copper loops. The external lines connect to the AccessNode using connectors on the end caps of the copper-distribution shelf. On each end cap (left and right) are two such connectors. The connectors on the left-hand end cap are labeled Pairs 1-25 and Pairs 26-50; those on the right-hand end cap are labeled Pairs 51-75 and Pairs 76-100. (A copper-distribution shelf supports up to 96 lines.)

Note: For information on a Mix & Match DFA system (CDS, EU9000 and ANX VMs controlled by one ABM shelf), refer to the *AccessNode/AccessNode Express Mix & Match DFA Reconfiguration Quick Reference Guide*.

Interface to an external timing source

A fiber central office terminal (FCOT) can interface to an external timing source such as a building integrated timing source (BITS). The external synchronization interface (ESI) card in the common-equipment shelf can either receive timing signals from the external source or derive a timing signal from a terminating fiber and provide timing signals to a BITS. (The two functions are mutually exclusive.)

Timing signals received from the external source can be in either DS1 format or composite-clock format. If the ESI card provides timing signals to a BITS, the signals are in DS1 format. The interface between the ESI card and the BITS uses a 25-pin D connector on the side interconnect left circuit pack in the common-equipment shelf.

Interfaces to the operations controller module

If an AccessNode contains an operations controller (OPC) module, the module can be accessed through an Ethernet port and through multiple serial data-terminal-equipment (DTE) ports. If the OPC module is in an access bandwidth manager (ABM) shelf, three DTE ports are available; if the OPC module is in a transport bandwidth manager (TBM) shelf, two DTE ports are available.

Ethernet connector on the OPC module

An Ethernet 802.3 LAN port is on the faceplate of every OPC module. The connector is a shielded RJ-45 connector. The 802.3 local area network (LAN) supplies an interface for a third-party X11 terminal or workstation for an enhanced graphics interface to the OPC. The data rate supported is 10 MBit/s with a distance limitation of 100 m.

Note 1: The software to support the Ethernet port and the X11 terminals is included in an optional software feature package, the enhanced administration package. For information on software packaging, see Chapter 9, “Software packaging.”

Note 2: OPC support of X terminals is limited to the following NCD models: NCD19 with Xserver PROM and NCD19R with Xserver PROM.

First serial DTE port of the operations controller module

The connector for the first serial DTE port of the OPC is a 9-pin D connector located on the side interconnect left circuit pack in the access or transport bandwidth manager shelf. On the ABM shelf, the connector is labeled OPC; in the TBM shelf, it is labeled OPC port 1.

This port can be used for asynchronous teletypewriter (TTY) or printer, or as an X.25 port.

The configuration of the first serial DTE port of the OPC is under software control. The port uses RS-232C drivers and receivers. The RS-232C drivers and receivers support either asynchronous or synchronous (LAPB, LAPD, or X.25) protocols, to a maximum data rate of 19,200 baud.

Note 1: For information about the X.25 interface to the OPC, see “X.25 interface” on page 10-5.

Note 2: Only one port at a time can support X.25.

Note 3: X.25 is not supported at 64 kbit/s data rate.

Second serial DTE port of the operations controller module

If an OPC module is installed in a transport bandwidth manager shelf, the connector for the second serial DTE port of the OPC is a 25-pin D connector located on the side interconnect left circuit pack. The connector is labeled OPC port 2.

If an OPC module is located in an ABM shelf, the connector for the second serial DTE port of the OPC is a 25-pin D connector located on the serial I/O card in slot 38 in the upper level of the shelf. The serial I/O card is an optional card.

This port is used primarily as a high-speed X.25 port. It uses RS-422 drivers and receivers, which support synchronous (LAPB, LAPD, or X.25) protocols, up to data rates of 56k baud and beyond.

Note 1: The software to support the X.25 protocol is in an optional software feature package, the X.25 interfaces package. For information on software packaging, see Chapter 9, “Software packaging.”

Note 2: Only one port at a time can support X.25.

Note 3: X.25 is not supported at 64 kbit/s data rate.

Third serial DTE port of the operations controller module

If an OPC module is located in an ABM shelf, the connector for the third serial DTE port of the OPC is a 25-pin D connector located on the serial I/O card in slot 40 in the upper level of the shelf. The serial I/O card is an optional card.

This port can be used for asynchronous tty or printer.

The third serial DTE port of the OPC is under software control. The port uses RS-232C drivers and receivers.

If an OPC module is installed in a TBM shelf, the third serial DTE port is not available.

Interface to Ethernet

An AccessNode that contains an operations controller (OPC) module can interface to Ethernet using the connector on the faceplate of an OPC module. For more information on this connector, see “Interfaces to the operations controller module” on page 10-3.

X11 terminal support

An X11 terminal can be connected to the Ethernet port of the operations controller (OPC). For more information, see “Ethernet connector on the OPC module” on page 10-4.

X.25 interface

An X.25 can interface to an operations controller (OPC). The X.25 interface uses either serial data terminal equipment (DTE) port 1 to the OPC or serial DTE port 2. Only one port at a time can support the X.25 interface. The X.25 interface does not support a 64 kbit/s data rate.

The X.25 interface can support simultaneous connections to multiple VT100-type terminals, as well as simultaneous connections to multiple external operations systems (OSs).

Note 1: The software to support the X.25 protocol is in an optional software feature package, the X.25 interfaces package. For information on software packaging, see Chapter 9, “Software packaging.”

Note 2: The software to support multiple simultaneous VT100-type terminals over the X.25 interface is included in an optional software feature package, the enhanced administration package. For information on software packaging, see Chapter 9, “Software packaging.”

Interface to control network

Control network is a token-bus local area network (LAN). It follows the 802.4 standard and has a 2M data rate on twisted pair media. Control network can provide communication between collocated shelves.

Two 9-pin connectors for control-network signals are on the side interconnect left circuit pack in each common-equipment shelf. On the access bandwidth manager (ABM) shelf, the connectors are labeled Ctl Net In and Ctl Net Out. On the transport bandwidth manager (TBM) shelf, the connectors are labeled J11 and J02. The ports use RS-485 drivers and receivers.

Interfaces for parallel telemetry

AccessNode can interface to a parallel-telemetry system. The parallel-telemetry feature allows an AccessNode to distribute alarm and status signals to external systems, and to receive signals from other equipment. The maintenance interface card in an AccessNode has signal-distribution relays, each of which can send a signal to external systems.

The maintenance interface card also has scan points for receiving environmental information (such as a door-open signal) and alarms from other equipment. The interface to both the relays and scan points is through a 44-pin D connector on the side interconnect left circuit pack on the common-equipment shelf. The connector is labeled Parallel Telemetry. The connector handles both input and output of parallel-telemetry data.

The wirewrap pins on an NT4K14 breaker interface panel (used with the access bandwidth manager shelf) also provide interfaces to some of the scan points and to some of the signal-distribution relays. For detailed information about these interfaces, see *Alarms and Surveillance Description*, 323-3001-104, in this volume.

Interfaces for serial telemetry

Note: Serial telemetry is not available for AccessNode systems using the Modular Business Package (MBP) option.

AccessNode can interface to serial-telemetry systems. The interfaces are through a 25-pin D connector on the side interconnect left circuit pack in the common-equipment shelf. The connector is labeled Serial Telemetry. The connector handles two 2-wire serial ports. Each port uses the RS-422 standard that requires two twisted pairs per port, one for each direction of transmission. The processor card can configure each port independently, controlling baud rate, parity, and synchronous or asynchronous operation. Shielded or unshielded cable can be used and tied at one end or at both ends to equipment ground. Communication is through the Telemetry Byte Oriented Serial (TBOS) protocol, a 2400 baud ASCII interface.

Interfaces for orderwire

Orderwire provides voice frequency (VF) communications on a party-line basis between maintenance personnel at different sites or network elements connected by SONET interfaces.

AccessNode supports local orderwire and express orderwire. The express and local orderwire channels enable craftpersons at different network elements to communicate with each other.

Orderwire capabilities

The orderwire unit supports the following capabilities:

- local orderwire (accessible at all sites except DFAs)
- express orderwire (accessible at all sites except DFAs)
- local and remote headsets or handsets
- access to the public switched telephone network (PSTN)

Connectors for orderwire access

Access to the orderwire circuits is through the local craft access panel (LCAP), shown in Figure 10-3 on page 10-13 and Figure 10-4 on page 10-14. The LCAP provides a variety of physical and mechanical interfaces to access orderwire functions.

Model-NT4K16

The model-NT4K16 LCAP has the following connectors for orderwire:

- a pair of tip-ring-sleeve phone jacks for access by dial handset (NT2E36AA type) for 6-wire orderwire
- a pair of binding posts for attaching leads for handset access for 2-wire orderwire
- a pair of orderwire headset jacks for a 4-wire headset (NT 52 type)

Model-NT7E5047

The model-NT7E5047 LCAP has the following connectors for orderwire:

- a pair of tip-ring-sleeve phone jacks for access by dial handset (NT2E36AA type) for 6-wire orderwire
- a pair of orderwire headset jacks for a 4-wire headset (NT 52 type)
- a 15-pin D connector for remote orderwire connection

Orderwire push-buttons, LEDs, and audible alarm

The LCAP provides three push-buttons used to perform orderwire operations. Two are used to perform local or express channel selection. The third (the Call Broadcast push-button) is used to initiate a call on the selected channel to all applicable NEs in the system. Each channel select push-button has a green integrated light-emitting diode (LED) that indicates the status:

- OFF
- ON (active channel)
- FLASHING (incoming call)

The channel select LEDs are situated inside the LCAP cover and cannot be seen when the cover is closed. However, the Call Incoming Indicator is situated on the outside of the cover of the LCAP to provide a visual indication of an incoming call on either channel.

An audible alarm is mounted on the LCAP to provide an audible indication of an incoming call. The alarm lasts for 5 seconds if the handset/headset is connected and 45 seconds if the handset/headset is not connected.

Orderwire extension

It may be convenient to arrange to extend the orderwire signals from an AccessNode to some other piece of equipment at the same site. For example, if an office contains diverse types of equipment, several of which support orderwire channels, all the orderwire channels can be connected to a single piece of equipment.

To extend the orderwire signals from an AccessNode to another piece of equipment at the same site, a 25-pin D connector labeled Orderwire Extension is available. This connector is located on the side interconnect left circuit pack in the common-equipment shelf.

User interfaces

AccessNode has interfaces for user interfaces to the processor card and to the operations controller (OPC) module (if equipped).

User interfaces to the processor card

The user interface to the processor card is through two RS-232C ports. One port is for a local VT100-type terminal (no modem required). The other port can support a remote terminal connected through an external modem.

RS-232C port for a local VT100-type terminal

The port for a local VT100-type terminal has a 25-pin D connector on the local craft access panel (LCAP). This port provides the human-machine interface to the processor card.

RS-232C port for a remote terminal

A second RS-232C port supports access by a remote terminal. The connector for this port is a 9-pin D connector on the side interconnect left circuit pack in the common-equipment shelf (J08 on the access bandwidth manager shelf, J10 on the transport bandwidth manager shelf). The remote terminal connects to an external modem, and the line from the external modem connects to the D connector.

User interfaces to the OPC

The two means for accessing the user interface of the OPC are as follows: through the Ethernet 802.3 LAN port on the faceplate of the OPC module or through the RS-232C port on the side interconnect left circuit pack.

Ethernet port

The Ethernet port supports a graphical interface to the OPC. The graphical interface uses X windows and requires a graphics terminal. A user working at the OPC uses the graphics interface to perform functions that require a view of multiple network elements. For more information on that port, see “Interfaces to the operations controller module” on page 10-3.

RS-232C port

A VT100-type terminal can access the OPC using the 9-pin D connector on the side interconnect left circuit pack in the common-equipment shelf (J07 on both the ABM shelf and the TBM shelf). The port supports either asynchronous or synchronous (LAPB, LAPD, or X.25) protocols to a maximum data rate of 19,200 baud.

Note: For information about the X.25 interface to the OPC, see “X.25 interface” on page 10-5.

Metallic test access

Metallic test access is for testing the metallic loops on the access sides of the line cards. Metallic test access is required in an AccessNode that contains an access bandwidth manager shelf and one or more copper-distribution shelves. Metallic test access is through jacks on the NT4K16AA local craft access panel (LCAP), which is the LCAP used with the ABM shelf. Jacks for testing 2-wire lines, 4-wire lines, and 6-wire E&M lines are on the LCAP. The test jacks connect to the metallic test buses, which allow switchable access to any line card. Metallic test access can be controlled locally or by dialup using a VT100-type terminal.

The following jacks are supplied on the NT4K16AA LCAP: transmit, receive, E&M, 0TLP, and DDS. The 0TLP jacks provide access to the 0TLP signal point associated with the digital bit stream. The Digital Data Service (DDS) jacks provide the connection point for external DDS test equipment. There are also jacks for the clock source required by the DDS test equipment.

Interfaces on the side interconnect left circuit packs

The side interconnect left circuit packs used in the access and transport bandwidth manager shelves differ in both the layout of the connectors and the number of connectors.

Figure 10-1 on page 10-11 and Figure 10-2 on page 10-12 show the side interconnect left circuit packs used in the access and transport bandwidth manager shelves.

Figure 10-1
Connectors on the side interconnect left circuit pack used in the access bandwidth manager shelf (NT4K50AA)

PC-10169

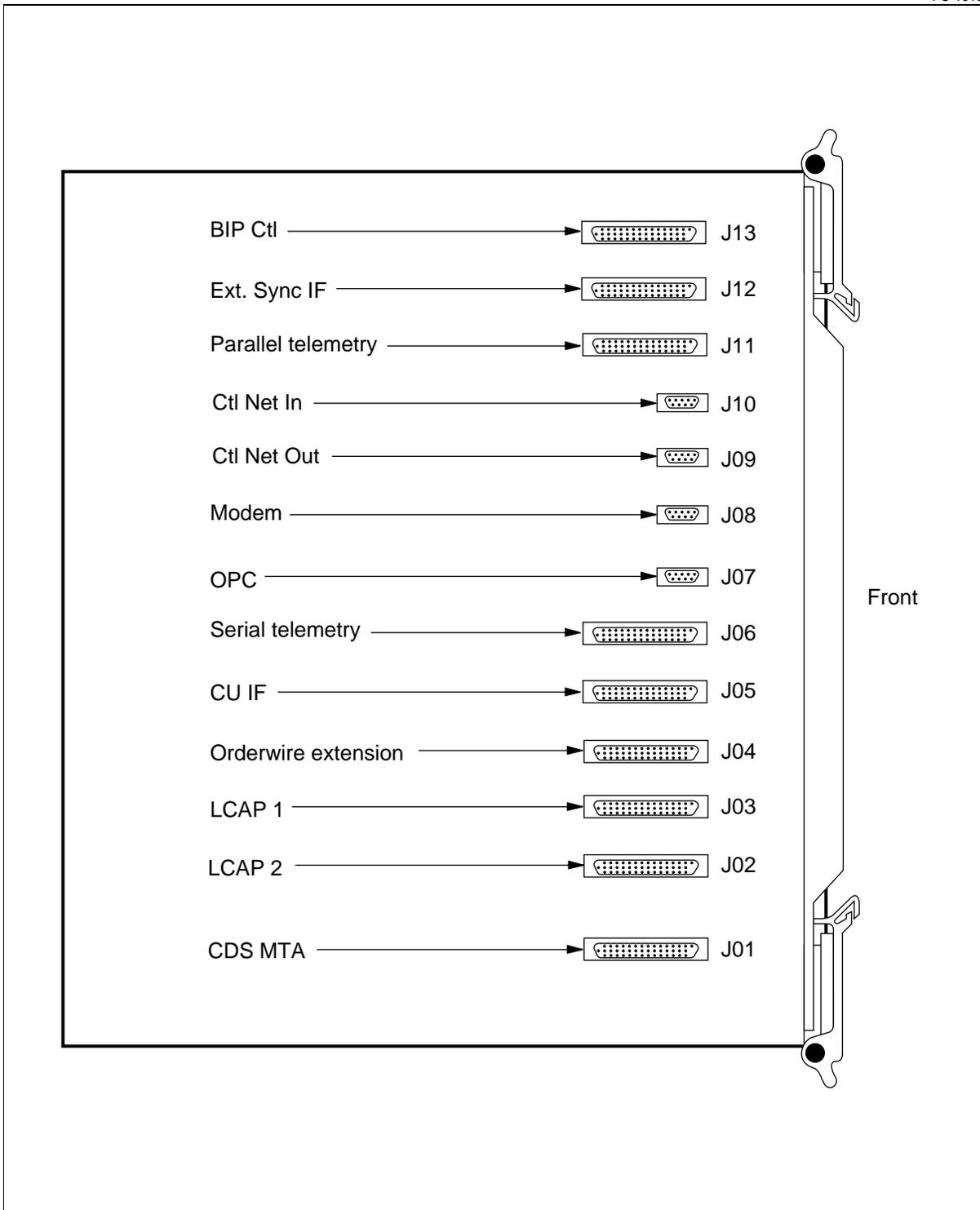
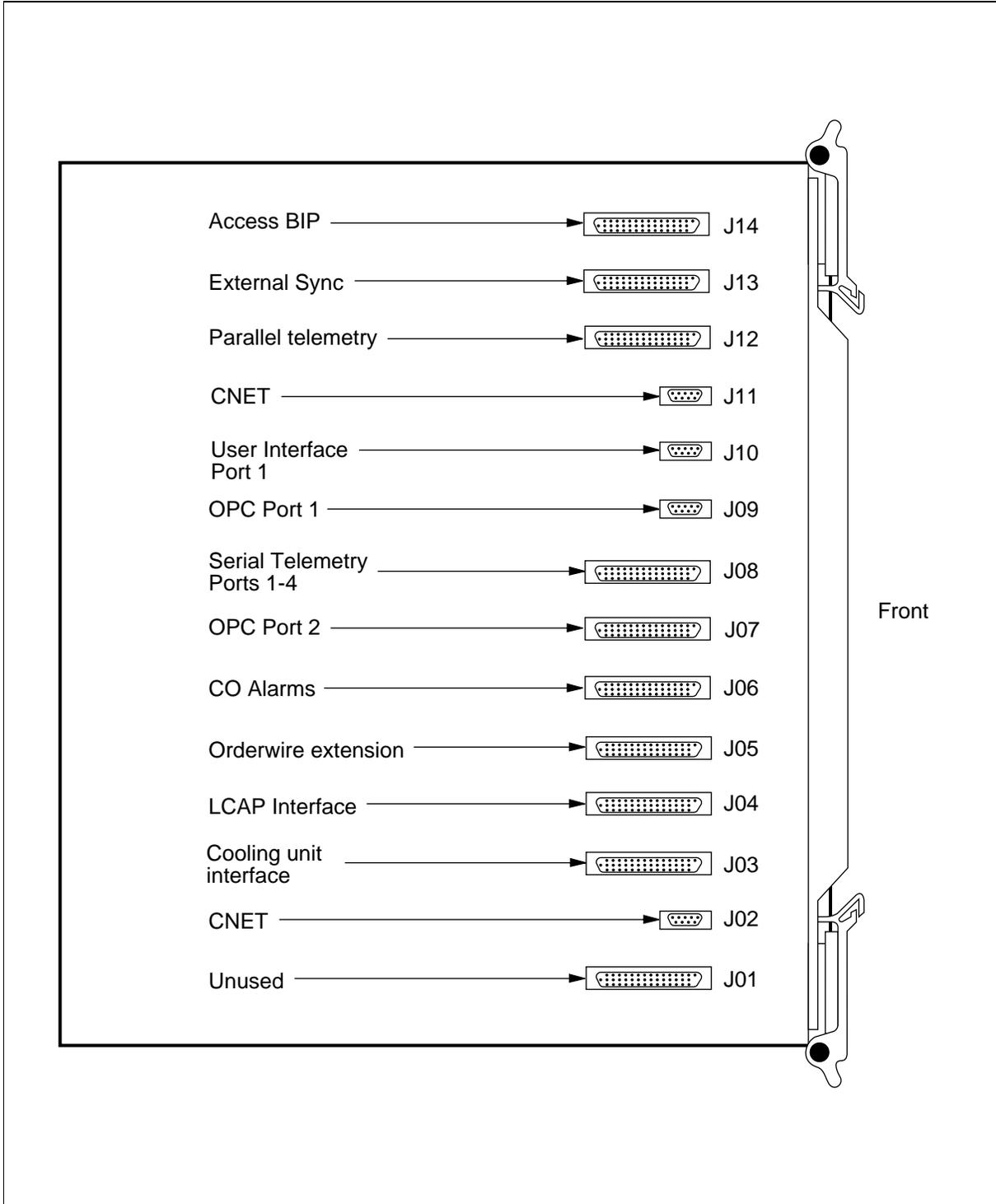


Figure 10-2
Connectors on the side interconnect left circuit pack used in the transport bandwidth manager shelf (NT4K50BA)

PC-10239



Interfaces on the local craft access panel

The local craft access panel (LCAP) houses all the hardware for local craft access, such as orderwire, RS-232C interface for a system configuration of 96 to 672 copper lines, and the jacks for metallic test access.

The type of LCAP used in an AccessNode depends on whether the AccessNode contains an access bandwidth manager shelf (ABM) or a transport bandwidth manager (TBM) shelf, as listed in Table 10-1.

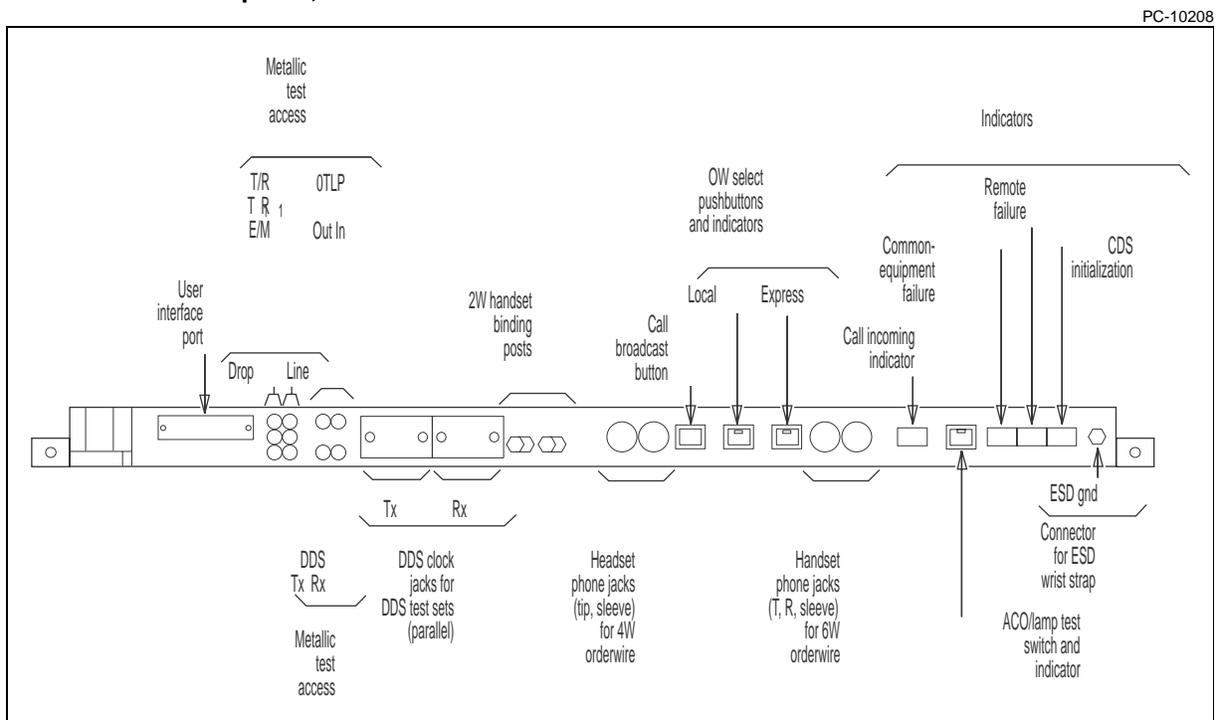
Table 10-1
LCAP types

Shelf type	LCAP model
Access bandwidth manager shelf	LCAP NT4K16
Transport bandwidth manager shelf	LCAP NT7E5047

Figure 10-3 shows the model-NT4K16 LCAP, which is used with the ABM shelf.

Note: For information on LCAP details, see page 7-44.

Figure 10-3
Local craft access panel, model NT4K16



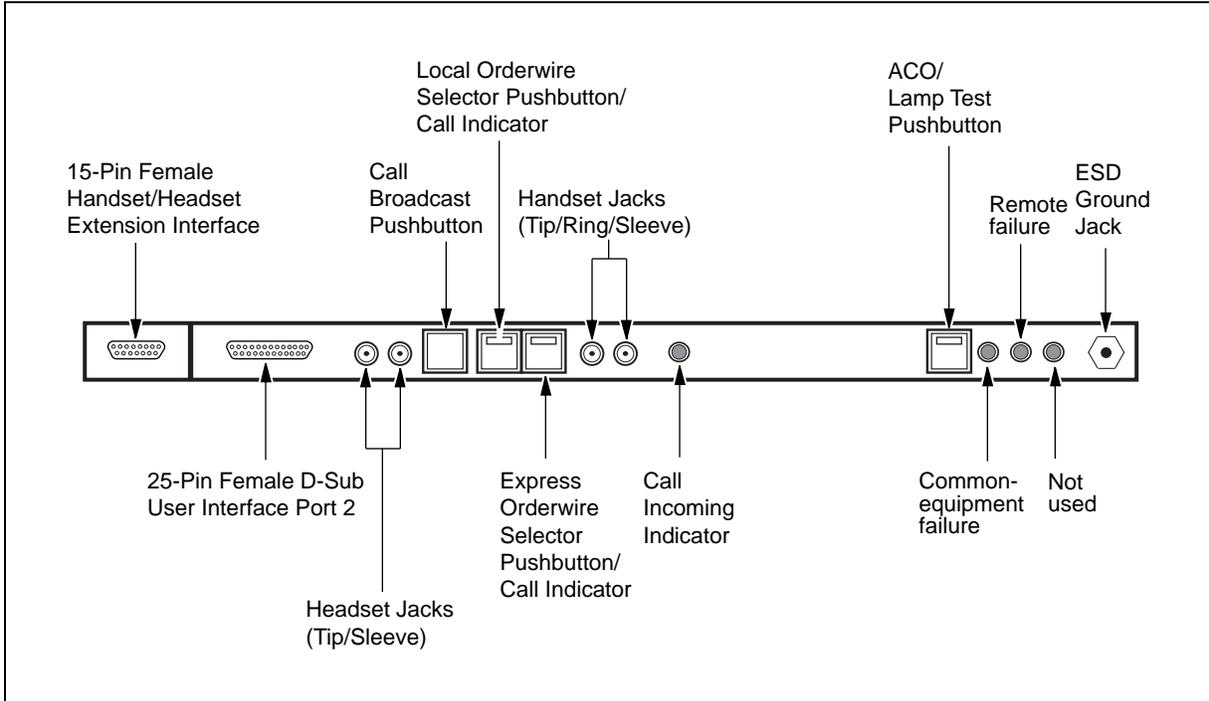
10-14 Interfaces to AccessNode

Figure 10-4 shows the model-NT7E5047 LCAP, which is used with the TBM shelf.

Note: For information on LCAP used with the TBM shelf, see page 7-64.

Figure 10-4
Local craft access panel model NT7E5047

PC-10253



Synchronization

This chapter introduces synchronization and describes the function provided by the AccessNode equipment that supports synchronization. The building-integrated timing supply (BITS), stratum clocks, and the synchronization hierarchy are introduced. Synchronization modes within a network element are introduced along with a description of how synchronization is applied to fiber-fed AccessNode systems.

Chapter contents

This chapter includes the following topics:

Topic	See
Introduction to synchronization	page 11-2
Network element synchronization modes	page 11-4
System synchronization applications	page 11-11
Clock source	page 11-13
Timing sources and timing distribution	page 11-15
External synchronization interface hardware	page 11-18
Timing modes for external synchronization interface cards	page 11-18
Timing deviation detection and recovery by ESI cards	page 11-23
Timing distribution by ESI cards	page 11-24
Additional external synchronization interface information	page 11-26
Timing for a network element containing OC-12 VTBM circuit packs	page 11-26
Synchronization-status messages	page 11-31
Insertion of alarm indication signal into G1OUT and G2OUT	page 11-45
Summary of network element timing	page 11-47

Introduction to synchronization

SONET-based equipment derives many of its basic attributes from synchronous operation. Although some systems can operate adequately in an asynchronous manner, synchronization is required in systems that carry synchronous tributaries and in certain topologies, such as rings. In these cases, the timing among the network elements must be synchronized to avoid the effects of SONET synchronous transport signal (STS) pointer repositioning within the frame in signals travelling around the loop. Once a network element is synchronized, all synchronous tributaries and high-speed signals generated by the network element are synchronized to its timing source.

Timing sources

The source of synchronization timing for a network element can be internal or external. Internal timing sources include a freerunning clock produced within the network element or a signal derived from an incoming SONET frame. A clock of stratum level 3 or better supplies an external timing signal. External sources require the network element to be equipped with external synchronization interface (ESI) hardware.

Stratum clocks

Stratum clocks are stable timing reference signals graded according to their accuracy. ANSI standards have been developed to define four levels of stratum clocks.

Table 11-1 shows the accuracy requirements of these stratum levels.

Table 11-1
ANSI required standard clock strata

Stratum	Minimum accuracy	Minimum holdover stability
1	$\pm 1.0 \times 10^{-11}$	not applicable
2	$\pm 1.6 \times 10^{-8}$	1×10^{-10} per day
3	± 4.6 ppm	± 0.37 ppm during first 24 hours
4	± 32 ppm	not required



CAUTION

Risk of DS1 signal degradation

DS1 signals carried within the SONET payload should not be used for network synchronization. SONET mapping jitter and pointer processing affects the short-term stability of these DS1 signals. DS1 signals derived from an OC-N signal do not have this problem. The ESI timing distribution function uses an OC-N source.

Synchronization hierarchy

A synchronization hierarchy is a network of stratum clocks, containing one stratum level 1 clock and several clocks of lower stratum levels. The stratum 1 clock sends a frequency reference signal to several stratum 2 clocks. These clocks, in turn, transmit synchronization signals to other stratum 2 and stratum 3 entities. Similarly, stratum 3 clocks synchronize other stratum 3 and stratum 4 entities.

Reliable operation is an important consideration for all the parts of a telecommunications network. For this reason, the synchronization network includes primary and secondary (backup) synchronization facilities to each stratum 2 and 3 node and to many stratum 4 nodes. In addition, each stratum 2 and 3 digital node has an internal clock that can bridge short synchronization reference disruptions. This operational mode is called holdover.

If the input reference signals to a clock fail, the clock provides an output signal corresponding to its own stratum level. A stratum level 3 clock therefore produces a stratum level 1 signal when all clocks in the hierarchy are functioning normally, and it produces a stratum level 3 signal when its input reference signal has failed. Intermediate clock or communication failures might cause the same clock to produce a stratum level 2 signal.

Building-integrated timing supply

The building integrated timing supply (BITS) concept stipulates that all digital equipment in a physical structure must receive timing from the same master clock. This master clock is the most accurate and stable clock in the structure. A stratum 3 or better reference signal drives the BITS. This signal can come from the following sources:

- a timing signal derived from a SONET signal, such as the output of an ESI card in the common-equipment shelf of a network element
- an external stratum clock

The BITS distributes a DS1 signal or a composite clock (CC) timing signal at the DS0 rate to all equipment in the physical location.

The implementation of BITS has the following advantages.

Performance

The designation of a master timing supply for each structure simplifies and enhances the reliability of the timing distribution. The BITS concept minimizes the number of synchronization links entering a building since each piece of equipment no longer has its own external timing source.

Utilization of resources

Since BITS provides a large number of signals for distribution, many services within the office can share a single, high-quality reference timing source.

Operations

The BITS is location dependent, not service dependent. Therefore, record keeping for provisioning and maintenance purposes is considerably easier as new digital services are introduced.

Network element synchronization modes

Depending on the timing source, different modes of synchronization are defined for the AccessNode network element.

Table 11-2 summarizes the synchronization modes supported by the AccessNode network elements. The entry for each synchronization mode indicates the following information:

- the applicability of each synchronization mode to system types
- the type of circuit packs that you can equip in slots nine and ten (interfacing to the fiber optic feeder):
 - OC-3 optical interface circuit pack (NT7E01)
 - OC-12 optical interface circuit pack (NT7E02)
 - OC-12 VTBM optical interface circuit pack (NT7E05)
- the requirement of ESI cards in the shelf
- the timing source
- the value to which you must set the clock source parameter for the network element

Table 11-2
Synchronization modes

Synchronization mode, from Figure 10-1	System type	Primary transport interface	ESI	Timing source	Clock source setting (see Note 1)
(a) freerun timing	point-to-point system	NT7E01 or NT7E02	no	internal clock in the circuit pack in slot nine or slot ten	Freerun
(b) external timing	point-to-point system or ring system (see Note 2)	NT7E01 or NT7E02 or NT7E05	yes	external clock	ESI
(c) loop timing	point-to-point system	NT7E01 or NT7E02	no	SONET signal received at slot nine or slot ten	Looptimed
(d) line timing with ESI	point-to-point system or ring system (see Note 3)	NT7E01 or NT7E02 or NT7E05	yes	SONET signal received at slot nine or slot ten	ESI
(e) line timing without ESI	ring system	NT7E05	no	SONET signal received at slot nine or slot ten	Linetimed

Note 1: The value of the clock source parameter controls the timing source. For information on how to change the clock source, see *Provisioning and Operations Procedures*, 323-3001-310, in *Operations, Administration, and Provisioning*, Volume 4B.

Note 2: For a network element containing ESI equipment, you can provision up to 4 timing references. Ordinarily, you would provision external sources as the 2 highest-priority sources.

Note 3: For a network element containing ESI equipment, you can provision up to 4 timing references. Ordinarily, you would provision sources of line timing as the 2 lowest-priority sources.

Freerun timing

Figure 11-2 on page 11-10 shows freerun timing as example a.

SONET freerun

When the clock source is set to freerun, the network element uses timing signals produced by the system clock generator in one or the other of the circuit packs that interface to the fiber optic feeder. (These circuit packs may be OC-3 optical interface circuit packs, OC-12 optical interface circuit packs, or OC-12 virtual tributary bandwidth manager (VTBM) optical interface circuit packs.) These signals are produced without external control. This timing is referred to as SONET freerun. No external synchronization interface (ESI) equipment is required.

ESI freerun

The free-running clock in the ESI equipment can also drive network element timing. However, it is not a normal mode of operation. ESI free-run timing takes effect only in the following situation:

- the clock source is set to ESI and all timing references become unavailable
- the timing references remain unavailable for a length of time that exceeds the time during which the ESI can provide holdover timing

It is important to be aware of the difference between SONET freerun and ESI freerun, because the two clocks have different operating characteristics. (The operating characteristics are listed in Table 11-8 on page 11-47.)

External timing

Figure 11-2 on page 11-10 shows external timing as example b.

External timing uses a timing source that is independent of any internal clock or received transport signal. The external timing source is a highly accurate stratum clock. If the external source is lost, the ESI card provides network element timing internally for short periods, based on the last received reference (a function called holdover).

A network element can use external timing in the following situation:

- the network element contains one or more external synchronization interface cards
- the ESI cards are connected to an external timing source such as a building-integrated timing supply (BITS)
- the clock source is set to ESI

For such a network element, you can provision up to four timing references, and two of those references can be external timing sources.

Note: For information on how to change the clock source, see *Provisioning and Operations Procedures*, 323-3001-310, in *Operations, Administration, and Provisioning*, Volume 4B.

Loop timing

Figure 11-2 on page 11-10 shows loop timing as example c.

Loop timing is a method of deriving timing from a received SONET signal, without filtering by ESI. Point-to-point systems use this method. The timing signal synchronizes the outgoing SONET signal in the return direction and all synchronous tributary signals terminated by the network element.

Line timing

This section explains how AccessNode network elements perform line timing with and without ESI.

Line timing with ESI

Figure 11-2 on page 11-10 shows line timing with ESI as example d.

Line timing with ESI is a method of filtering the timing derived from a received SONET signal through ESI. To specify the SONET signal to be used as the timing source, you specify the circuit pack group that receives the signal (G1 for the circuit pack in slot nine, G2 for the circuit pack in slot ten). A two-stage provisioning action is required, as illustrated in Figure 11-1 on page 11-8.

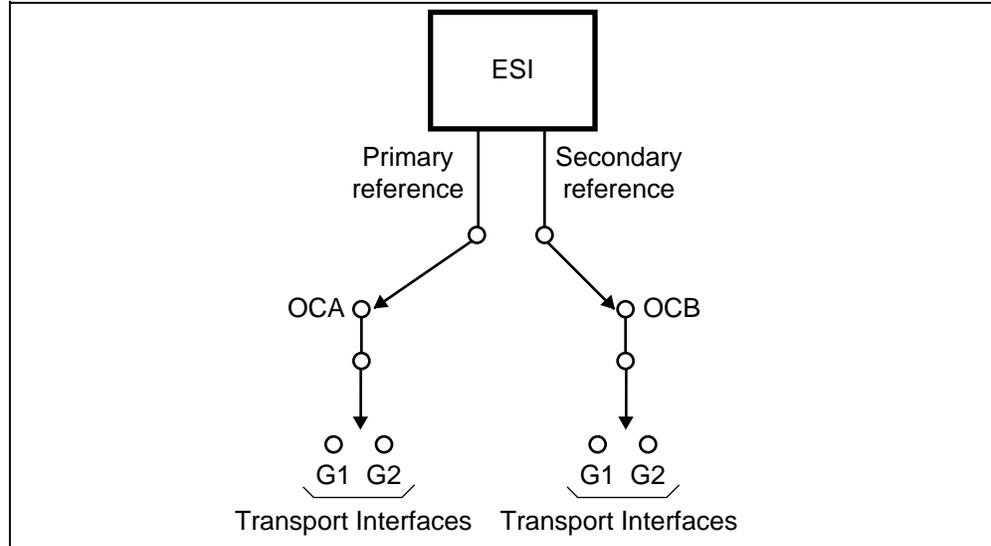
For a network element that contains ESI cards, you can provision up to four timing references, and two of those references can be line timing. The timing references protect each other on a nonrevertive basis. If the primary (or working) reference fails, the ESI unit switches to an alternative (or protection) reference. The network element chooses the highest-quality alternative reference that is available, based on the synchronization-status messages. (For more information on synchronization-status messages, see “Synchronization-status messages” on page 11-31.)

In a network element in a ring system, the timing signal is used to synchronize outgoing transport signals in both directions. In a network element in a point-to-point system, the timing signal is used to synchronize outgoing transport signals in the return direction. All synchronous tributary signals terminated by the network element are also synchronized. The quality of synchronization depends on the stability of the transport signal received from the remote end.

Figure 11-1 shows sample primary and secondary timing references.

Figure 11-1
Selection of the primary and secondary timing references (sample)

PC-15423



Line timing without ESI

Figure 11-2 on page 11-10 shows this method of timing as example e.

Line timing without ESI is used in a network element in a ring system. With this timing method, a ring node derives timing from a received SONET signal, without filtering by ESI. The ring node has OC-12 VTBM circuit packs, and at any given instant, one or the other of them is responsible for network element timing. (In example e in Figure 11-2, the OC-12 VTBM circuit pack that handles the west-to-east direction of traffic is responsible for timing.)

For a network element that does not contain ESI equipment, you can provision two timing references. Both must be sources of line timing.

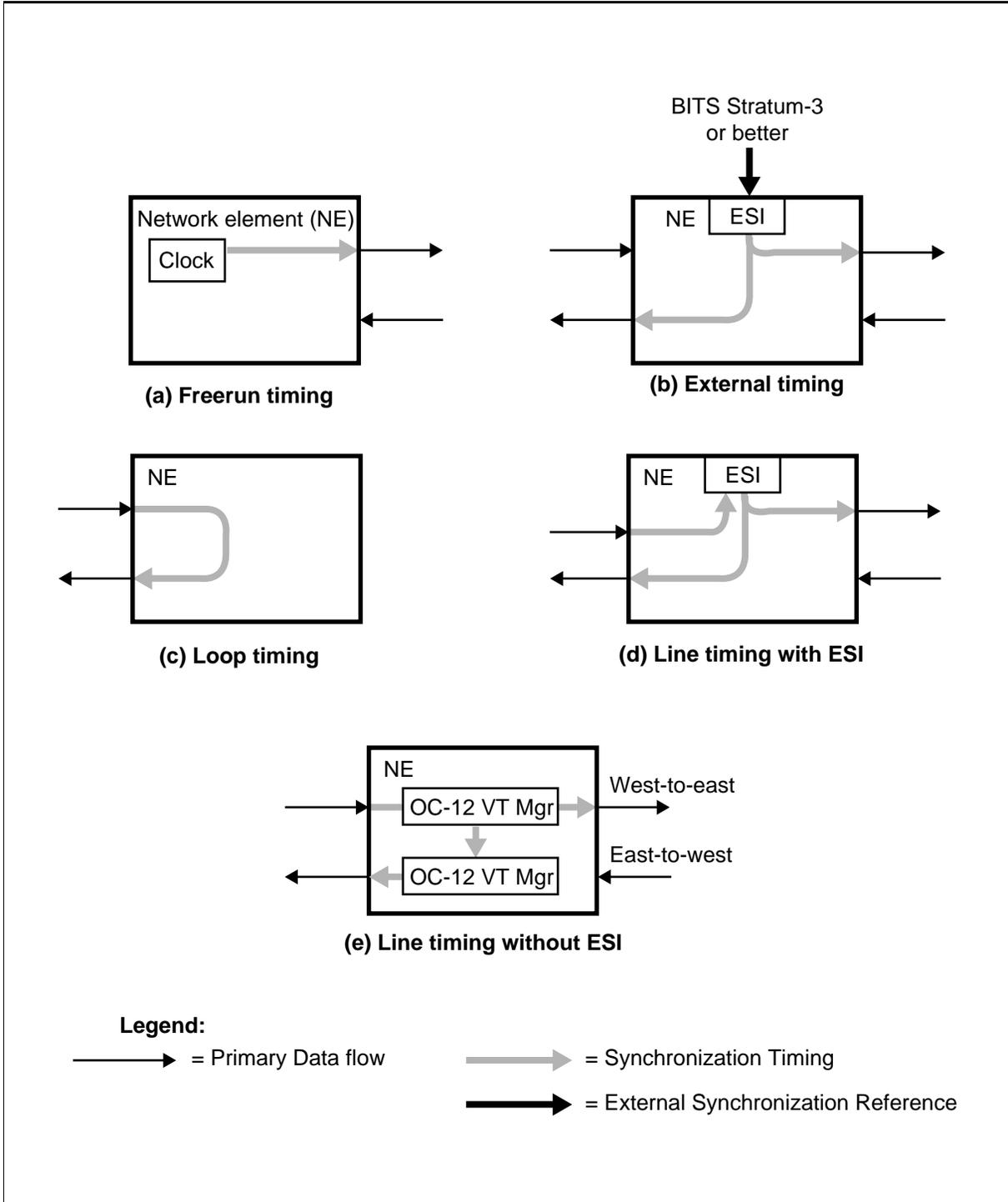
The OC-12 VTBM circuit pack derives timing signals from the incoming OC-12 signal. The system clock generator in the circuit pack locks to the derived timing signal. The network element can use the timing signals derived from either the eastbound or westbound OC-12 signal. If one of the timing signals degrades or becomes unavailable, the network element can automatically switch to the other. If both timing signals are lost, the OC-12 VTBM circuit pack can provide holdover timing for up to 24 hours. The system clock generator in the OC-12 VTBM circuit pack supplies the clocks to synchronize outgoing transport signals in both directions, and all synchronous tributary signals terminated by the ring add-drop multiplexer (ADM).

Note 1: To improve network performance if the externally timed node fails, Nortel Networks recommends externally timing two nodes in the ring from a BITS. If only one node is externally timed, Nortel Networks recommends that the other node be line-timed.

Note 2: An OC-12 VTBM circuit pack can read the synchronization-status messages that are coded in the SONET line overhead. For more information on synchronization-status messages, see “Synchronization-status messages” on page 11-31.

Figure 11-2
Flow of synchronization timing signals for various timing sources (and applications)

PC-15422



System synchronization applications

The selection of a timing mode in an AccessNode network element depends on topology of the system containing the network element. Various combinations of timing modes are possible to ensure proper synchronization of the system. The following cases are described in this section:

- synchronization in a system with point-to-point topology
- timing distribution between systems
- synchronization in a system with ring topology

Point-to-point topology

In a system with point-to-point topology, a remote fiber terminal (RFT) uses loop timing. The fiber central office terminal (FCOT) uses external timing or freerun timing, as follows:

- external timing if the FCOT contains external synchronization interface (ESI) equipment
- freerun timing if the FCOT does not contain ESI equipment

Ring topology

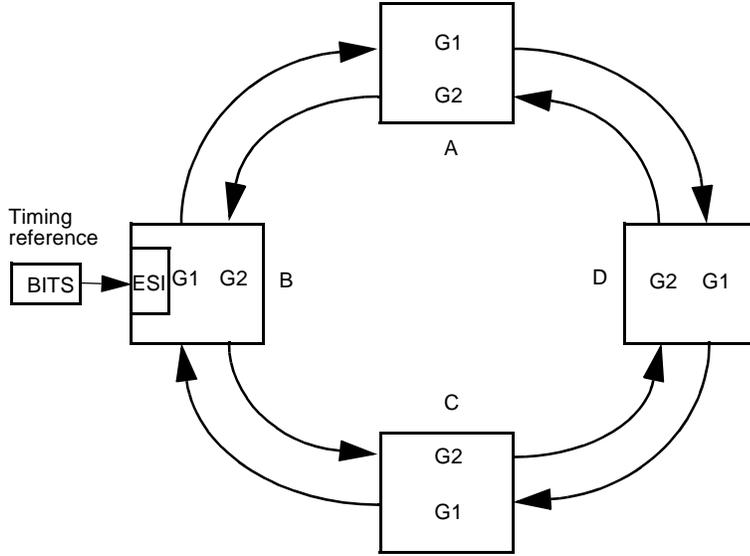
A fiber-fed AccessNode system with ring topology can be synchronized using an external timing reference at one node. The other nodes are line timed using the OC-12 virtual tributary bandwidth manager (VTBM) circuit packs. Alternatively, the system can be synchronized using an external timing reference at two of the nodes and line timing at the others. Both arrangements are illustrated in Figure 11-3 on page 11-12. A ring node needs ESI equipment (one or two ESI cards) only if the node receives an external timing reference. The line-timed ring nodes do not need ESI cards because the OC-12 VTBM circuit packs handle timing and synchronization. Each line-timed ring node can receive timing from either direction. In the application illustrated in the lower part of Figure 11-3, node C can be provisioned to receive timing from either of nodes B or D.

When the ring is in operation, each ring node can perform automatic protection switching from one timing source to another. If such protection switching is required (for example, if the active timing source becomes unavailable) the node switches to the highest-quality timing source available. The node knows the quality of each available source of line timing because the OC-12 VTBM circuit packs can read synchronization-status messages. These messages, which are coded in the SONET line overhead, indicate the quality of timing of the incoming OC-12 signal. (For more information on synchronization-status messages, see “Synchronization-status messages” on page 11-31.)

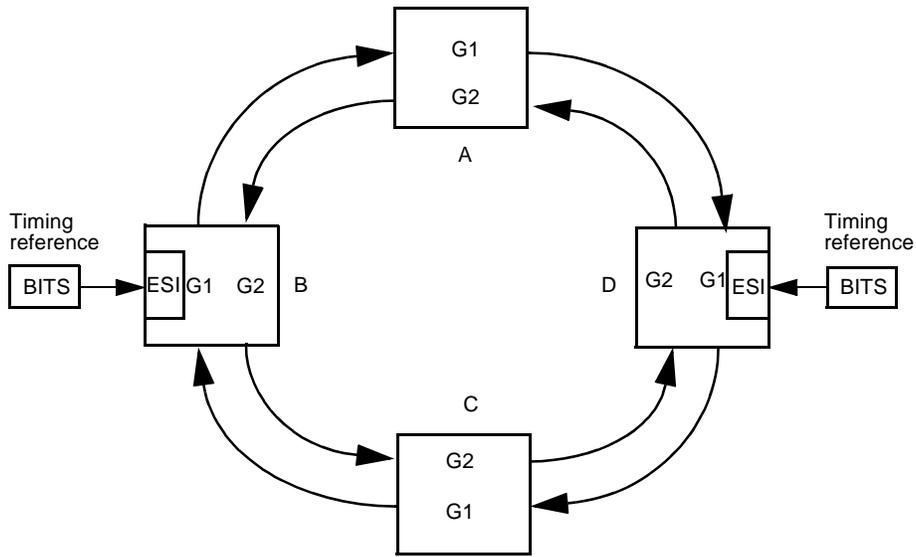
Figure 11-3 shows ring topology timing schemes in fiber-fed AccessNode systems.

Figure 11-3
Timing schemes in fiber-fed AccessNode systems with ring topology

PC-2246 (TBM R11)



(a) Synchronization of a ring with ESI at one node only



(b) Synchronization of a ring with ESI at two nodes

Clock source

The clock source is a parameter whose value is assigned on the shelf equipment screen in the network element user interface. The value of this parameter determines the primary synchronization behavior of an AccessNode network element.

Table 11-3 lists the type of system in which each setting is used and whether external synchronization interface (ESI) is required.

Table 11-3
Clock source modes

Clock source	Used in	ESI required?
Freerun	Network element in a point-to-point system	no
Looptimed	Network element in a point-to-point system	no
Linetimed	Network in a ring system	no
ESI	Network element in a point-to-point system or in a ring system	yes

The following sections briefly describe the possible values of the clock source parameter.

Freerun

This clock source is selected for asynchronous operation in systems with point-to-point topology. The timing source is the transport interface internal free-running clock.

Note: The clock source for a network element in a ring should never be set to freerun.

Looptimed

This clock source is selected for a network element in a system with point-to-point topology, when the received SONET signal is used for network element timing without the benefit of ESI filtering.

Note: The clock source for a network element in a ring should never be set to looptimed.

Linetimed

This clock source is selected for a network element in a system with ring topology if the network element does not contain ESI cards. The network element derives timing from a received SONET signal, without filtering by ESI. The derived timing synchronizes outgoing transport signals in both directions, and all synchronous tributary signals terminated by the network element. The network element can monitor the quality of the line timing it is receiving because the OC-12 virtual tributary bandwidth manager (VTBM) circuit packs can read the synchronization-status messages. If the active timing reference degrades or becomes unavailable, the VTBM ring add-drop multiplexer (ADM) can switch to an alternative source, or, if an alternative source is not available, the system clock generator on the OC-12 VTBM circuit pack goes into holdover timing mode.

ESI

This clock source is selected for any network element that contains one or two ESI cards. The ESI equipment produces network element timing. network element timing is based on a 51.84 MHz timing signal produced by the ESI card. That 51.84 MHz signal goes to the circuit packs that interface to the fiber optic feeder (those located in slots 9 and 10 in the common-equipment shelf). In each of those two circuit packs, the system clock generator produces clock signals at the following rates: 51.84 MHz, 38.88 MHz, and 2 kHz. At any given moment, the network element uses the clock signals from one of the two circuit packs.

The source timing signal that an ESI card uses depends on what timing reference have been provisioned, and on which are available. A network element equipped with one or two ESI cards can use an external timing reference. Alternatively, it can use a source of line timing derived from a received SONET frame. If none of the provisioned timing references is available, the network element uses the free-running clock on the ESI card.

Timing sources and timing distribution

The network elements in an AccessNode system can be integrated into a synchronization timing architecture. This architecture is a timing reference hierarchy that allows all network element timing to be referenced to a common timing source of high accuracy.

If an AccessNode system is to be synchronized, then at least one of the network elements must contain external synchronization interface (ESI) equipment that receives high-quality timing signals from external sources. If the system contains network elements that are not connected to external timing sources, then high-quality timing signals must be distributed to those network elements from the network elements that are connected to external timing sources. The timing signals are distributed in the SONET signal. A network element that receives its timing signals in the SONET signal is line-timed.

External timing references for ESI card

If an AccessNode network element has one or two ESI cards, it can receive timing signals from an external timing source such as a Stratum clock or a building integrated timing source (BITS). The connection between the ESI cards and the external timing source is through a cable that connects to a connector on the side interconnect left circuit pack in the common-equipment shelf. The timing signals from an external timing source are called BITSA and BITSB.

Note: If a network element requires ESI equipment, you can install one ESI card (G1) for unprotected operation. Alternatively, you can install two ESI cards (G1 and G2) to provide 1+1 equipment protection switching.

The ESI card supplies a stable reference frequency of 51.84 Mhz to the primary transport interface circuit packs in the network element. Each of those circuit packs contains a system clock generator. Each system clock generator uses the stable reference frequency as the basis for three system clocks: a 51.84 MHz clock, a 38.88 MHz clock, and a 2 kHz clock.

An ESI card uses an external timing signal as the basis for the stable reference frequency of 51.84 Mhz. If the signal from the external timing source is interrupted, the ESI card enters holdover mode and continues to provide the stable reference frequency to the primary transport interface circuit packs.

BITSA and BITSB are DS1 or composite clock signals. If they are DS1 signals, they can have a line code of either AMI or B8ZS and a frame format of either superframe (SF) or extended superframe (ESF). If a network element contains two ESI cards, the same two external timing reference input signals are applied to both ESI cards. Switching between BITSA and BITSB provides 1+1 reference protection.

You can provision G1OUT and G2OUT to use the best quality timing reference. For more information, see *Provisioning and Operations Procedures*, 323-3001-310, in *Operations, Administration, and Provisioning*, Volume 4B.

Network element's choice of a timing reference signal

The following factors determine which timing reference signal a network element uses:

- by the timing sources that are available to the network element
- whether the network element has ESI equipment
- if it does not contain ESI equipment, whether it contains OC-12 or OC-3 interface circuit packs or OC-12 virtual tributary bandwidth manager (VTBM) circuit packs

The following sections will discuss the following cases:

- a network element with ESI connected to an external timing source
- a network element with ESI but not connected to an external timing source
- a network element without ESI with OC-3 or OC-12 optical interface circuit packs
- a network element without ESI containing OC-12 VTBM circuit packs

Network element with ESI, connected to external timing source

This section assumes that the clock source has been set to ESI.

If a network element (NE) contains ESI equipment, then the ESI equipment in the network element supplies a 51.84 MHz timing signal that the primary transport interface circuit packs use as the basis for timing.

The timing source used by the ESI cards can be either BITS timing or line timing. The choice of a timing source depends on which sources are provisioned for the network element (on the timing reference protection screen in the network element user interface) and which source offers the best quality level.

If all timing signals are unavailable, the ESI card enters holdover mode.

If all ESI cards in the shelf fail or if a lockout command or forced switch command forces the system to use a failed ESI card, then control of the network element timing passes to one of the circuit packs in slots 9 and 10. (Those circuit packs can be OC-3 optical interface circuit packs or OC-12 optical interface circuit packs or OC-12 VTBM circuit packs.) If the circuit packs are OC-3 or OC-12 optical interface circuit packs, they enter SONET freerun mode. If the circuit packs are OC-12 VTBM circuit packs, they go into holdover mode.

NE without ESI, containing OC-3 or OC-12 optical interfaces

For the remote fiber terminal (RFT) in a fiber-fed system with point-to-point topology, the clock source must be set to looptimed. The RFT uses the received SONET signal for timing.

If the fiber central office terminal (FCOT) in a fiber-fed system with point-to-point topology does not contain ESI equipment, the clock source for the FCOT must be set to freerun.

NE without ESI, containing OC-12 VTBM circuit packs

This section assumes that the clock source for the network element has been set to linetimed.

Because the network element is in a ring, it contains OC-12 VTBM circuit packs. Those circuit packs derive timing signals from the incoming SONET signal. If a timing signal degrades or is unavailable, the network element can automatically switch to the highest-quality alternative timing source. (When choosing an alternative source of line timing, the network element circuit pack bases its decision on synchronization-status messages. For more information on synchronization-status messages, see “Synchronization-status messages” on page 11-31.) If all timing signals are unavailable, the OC-12 VTBM circuit pack enters holdover mode.

Timing reference output signals from the ESI card

The ESI card can produce output timing signals for distribution to other network elements in the system. The two output signals are called G1OUT and G2OUT. G1OUT is produced by the G1 ESI card; G2OUT, by the G2 ESI card.

Each of the output signals is an all-1s DS1 with SF or ESF frame format with short, medium, or long line build-out, and with AMI or B8ZS line coding. G1OUT and G2OUT supply the external access to network element timing that supports the timing-distribution function.

The ESI cards can insert an alarm indication signal (AIS) into G1OUT and G2OUT if the quality of the timing falls below a user-selected threshold. For more information on this topic, see “Insertion of alarm indication signal into G1OUT and G2OUT” on page 11-45.

External synchronization interface hardware

The external synchronization interface (ESI) hardware consists of the following physical units:

- external synchronization carrier (NT7E19)
- one or two external synchronization interface (ESI) cards (NT7E27)

External synchronization carrier

The external synchronization carrier is a unit that fits into a slot in the lower level of the common-equipment shelf (slot 21 in an access bandwidth manager (ABM) shelf, slot 19 in a transport bandwidth manager (TBM) shelf). The carrier supplies a mechanical and electrical interface between the shelf and one or two of the ESI cards. The carrier does not process any signal. The carrier must be present in all ESI configurations.

External synchronization interface card

The ESI card can be placed in either the upper (G1) or lower (G2) compartment of the external synchronization carrier. Provisioning two ESI cards provides 1+1 protection of the ESI equipment.

The ESI card receives two redundant timing reference signals to provide timing to the shelf.

Two versions of the ESI card are available. For information on the differences between the two versions, see “Timing deviation detection and recovery by ESI cards” on page 11-23.

For a complete description of the ESI card, refer to *Signal Flow and Circuit Pack Description*, 323-3001-102, in this volume.

Timing modes for external synchronization interface cards

When the clock source is set to external synchronization interface (ESI) and the primary and secondary references are configured, the ESI current clock mode determines the synchronization behavior of a network element. The current clock mode is the current mode of operation of the ESI card. It depends on the selected ESI target clock mode, the availability of the provisioned timing references, and the status of the ESI card.

The following ESI target filter modes of operation can be provisioned:

- freerun
- normal
- holdover

The target clock mode normal is selected during normal operating conditions and represents the intended clock mode. The ESI freerun and holdover modes are used mainly for testing and maintenance purposes or when the timing reference is changed.

The current clock mode normal matches the target clock mode. However, the following modes of operation are defined to support initialization and failure states:

- freerun
- acquire
- fast
- normal
- holdover

Freerun mode

In this mode, the ESI unit provides a stratum 3 freerunning clock timing signal (at an accuracy of ± 4.6 ppm). The ESI freerun mode of operation is selected in the following conditions:

- The ESI target clock mode has been set to freerun.
- No ESI unit is inservice.
- A valid timing reference has never been present.
- All configured reference signals fail while ESI is in the acquire mode.
- A shelf reboot is in progress.

Note: During a reboot, the ESI is forced into freerun mode to ensure the quality of the timing reference. This causes a transient Timing Generation Entry to Freerun alarm that should be ignored.

The clock contained in the OC-3 interface circuit pack, the OC-12 interface circuit pack, and the OC-12 virtual tributary bandwidth manager (VTBM) circuit pack has an accuracy of ± 20 ppm for temperatures between -40°C and 65°C . The ESI free-running clock therefore provides better synchronization performance, even in the freerun mode, over the timing generated when the clock source is set to freerun.

Acquire mode

This mode brings the output clock of the ESI unit into frequency alignment with the selected timing reference input. Large changes in frequency are made, until frequency alignment is within a certain range; then the fast mode is entered. The acquire mode is entered in the following conditions:

- The ESI target clock mode is changed from freerun to normal.
- An ESI unit has just been inserted in the shelf, and target filter mode is normal.

Fast mode

In this mode, the ESI unit makes small changes in frequency to bring its clock into close alignment with the selected timing reference input. The fast mode is entered in the following conditions:

- after the acquire mode, when the output clock is close to frequency alignment with the reference signal
- when an interrupted reference signal is restored and the current clock mode is holdover
- when the current clock mode is normal, and an adjustment to the frequency alignment is required (may be due to temperature changes that affect the internal clock)

Normal mode

When the target clock mode has been specified as normal, and the internal clock of the ESI unit is aligned with the reference signal, the normal mode is entered. Frequency alignment is checked continuously, and the ESI unit enters the fast mode to realign, if necessary.

Holdover mode

When the current clock mode is normal and all configured reference inputs are lost, the ESI unit enters the holdover mode. Alternatively, the target clock mode can be set to holdover. Table 11-4 shows accuracy of the ESI output clock in holdover mode.

Table 11-4
Accuracy of ESI output clock in holdover mode

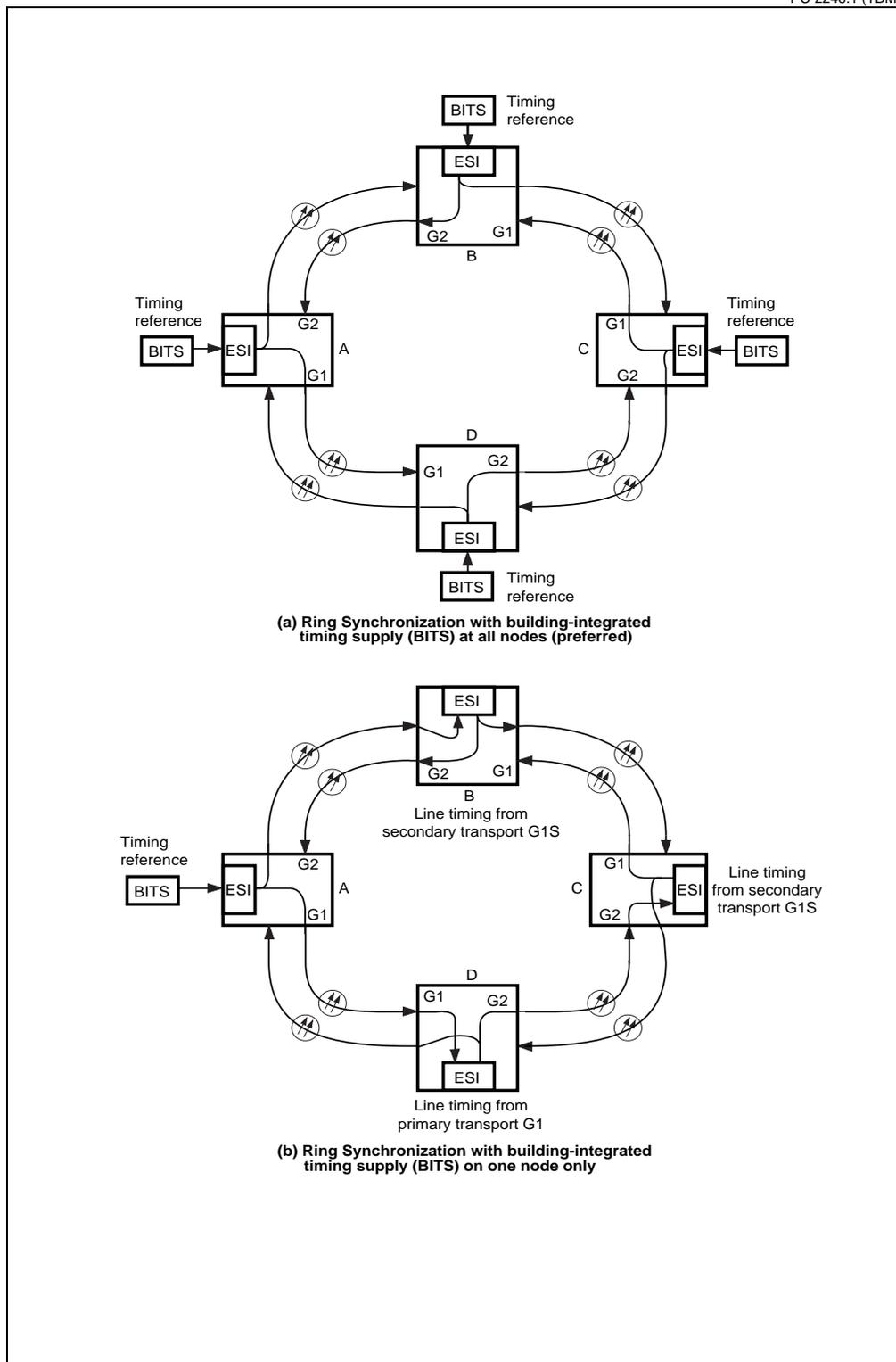
Temperatures	ESI output clock accuracy
between 0°C and 50°C	within ± 0.37 ppm with the previous reference input for 24 hours, and within ± 4.6 ppm of that reference thereafter
over the range of -40°C and 65°C	within ± 2.0 ppm for 24 hours after entering the holdover mode

This provides accurate synchronization timing during a total reference signal failure of short duration.

Figure 11-4 illustrates the ESI current filter mode transitions when the target clock mode is set to normal.

Figure 11-4
ESI timing mode transitions (target clock mode = normal)

PC-2246.1 (TBM)



Audits of ESI timing modes

Audit software runs every five minutes to ensure consistent clock mode operation within the ESI cards. This audit corrects situations such as the following:

- If the clock source is set to ESI before circuit pack initialization (using the Approve command during commissioning), the ESI cards continue to operate in freerun mode until the audit detects the change in clock source.
- After a loss of reference signal, an ESI card can be left in holdover mode. The audit detects this difference between operating and provisioned states, and updates the data in the ESI card.
- After a shelf reboot, the ESI cards can reset to states that are different from the provisioned states. The audit aligns the ESI cards to their proper state.

The following factors determine network element timing:

- the target clock mode of the ESI card
- the setting of the clock source parameter
- the target mode of the OC-12 VTBM circuit packs (if equipped)

Table 11-8 on page 11-47 summarizes the interplay of these factors. (For information on the target modes of the OC-12 VTBM circuit pack, see page 11-27.)

Timing deviation detection and recovery by ESI cards

The following sections describe the functions of the ESI cards.

ESI Version NT7E27AA

The NT7E27AA ESI card supports the detection of hard failures associated with the timing signal (such as loss of signal or loss of frame). Timing deviation detection is supported through the detection of these hard failures.

On OC-3 systems or OC-12 systems, the NT7E27AA ESI card should not require more than 100 seconds to exit the acquire mode when tracking to a stratum 3 quality or better reference. If it exceeds 120 seconds, one of the following failures has occurred:

- Components on the ESI card have failed.
- The currently active timing reference is outside the stratum 3 range.
- There is excess wander on the active timing reference.

ESI Versions NT7E27BA and NT7E27DA

The new NT7E27DA circuit pack replaces the older NT7E27BA circuit pack. Both of these versions support enhanced timing deviation detection and recovery. In addition to hard failures, these versions detect signal failures resulting from deviations in frequency which render the signal unsuitable as a timing reference. The new NT7E27DA circuit pack is backward-compatible with existing software loads.

The new NTE27DA circuit pack can be mixed in the same carrier with the existing NT7E27BA circuit pack. However, to take advantage of the new enhanced performance capabilities, you must have both new circuit packs (NT7E27DA and NT7E27EA) in an ESI carrier. Be aware that enhanced timing deviation detection and recovery is not supported in such a configuration.

On OC-3 systems or OC-12 systems, the NT7E27DA ESI card automatically detects the following:

- a dynamic drift in the input reference frequency of greater than or equal to 4.6 ppm (with 13% accuracy) in an 8-second interval. If the secondary reference is valid, a reference protection switch is automatically performed. The ESI card monitors only the active timing reference to detect and recover from timing deviation caused by dynamic drift.
- a cumulative frequency drift of more than ± 20.5 ppm if the input reference is slowly drifting (static drift, which cannot be detected in the same way as a dynamic drift). This condition causes a degraded clock carrier alarm. If a valid secondary reference is present, a reference protection switch is automatically performed. If there is no valid secondary reference, the ESI card enters freerun mode.

The ESI card continuously monitors primary and secondary timing references to detect and recover from timing deviation caused by static drift.

The offset threshold detection for declaring recovery from static timing deviation is ± 4.5 ppm. Dynamic timing deviation failure is automatically cleared when a reference protection switch is performed.

ESI Versions NT7E27CA and NT7E27EA

The new NT7E27EA replaces the older NT7E27CA circuit pack. Both of these versions support DS1 ESF synchronization status messaging, as well as all the capabilities of the NT7E27BA and NT7E27DA.

The new NT7E27EA circuit pack can be mixed in the same carrier with the existing NT7E27CA circuit pack. However, to take advantage of the new enhanced performance capabilities, you must have both new circuit packs (NT7E27DA and NT7E27EA) in an ESI carrier. A carrier containing mixed circuit packs will only perform to the specifications of the older cards, regardless of which ESI is the primary one.

The DS1 ESF synchronization status messaging enables:

- network elements that have external timing references to extract a synchronization status message from the DS1 input signal (that is, BITSA or BITSB)
- network elements that provide timing distribution to insert a synchronization status message in the DS1 output signal (that is G1OUT or G2OUT)

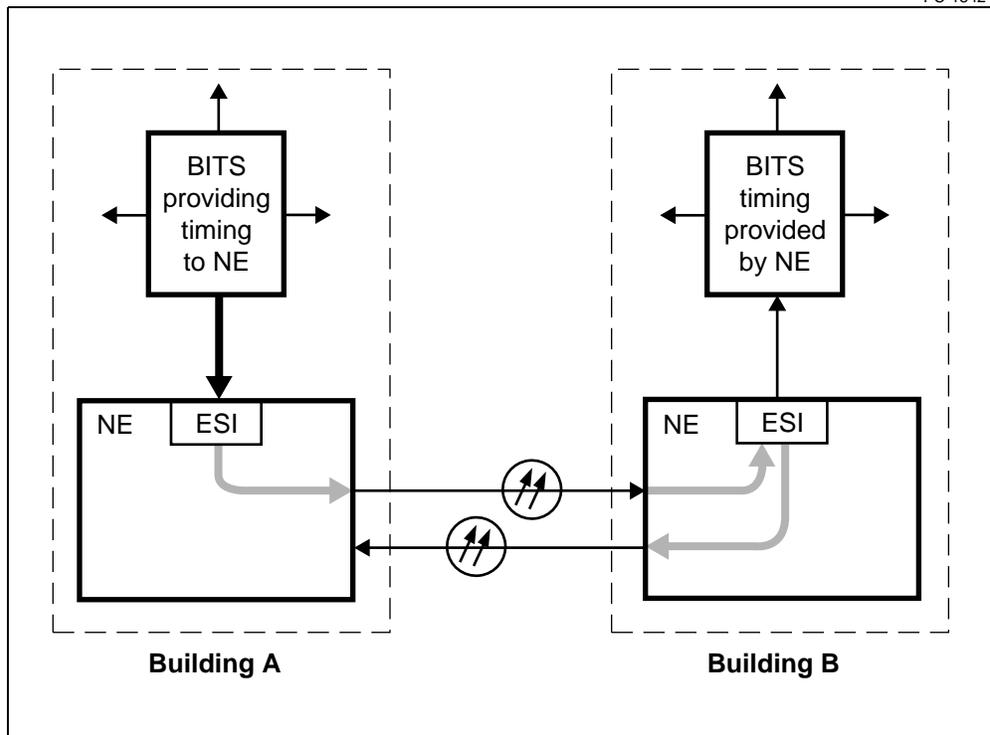
Timing distribution by ESI cards

Timing distribution is the process of making a single timing reference signal available to a large number of systems within many physical locations. The external synchronization interface (ESI) equipment in the AccessNode network element (NE) provides external access to synchronization timing signals derived from accurate sources (building-integrated timing supply (BITS) or SONET). As a result, the AccessNode system can distribute a timing source from one physical location to another.

Figure 11-5 shows the timing distribution in a point-to-point system.

Figure 11-5
Timing distribution in a point-to-point system

PC-15424



Additional external synchronization interface information

For more detailed information on external synchronization interface (ESI), refer to the following documents:

- More detailed information about the ESI hardware and a description of the signal flow is in *Signal Flow and Circuit Pack Descriptions*, 323-3001-102, in this volume.
- Procedures for provisioning external synchronization are in *Provisioning and Operations Procedures*, 323-3001-310, in *Operations, Administration, and Provisioning*, Volume 4B.
- Troubleshooting procedures that relate to alarms associated with ESI cards are in *Alarm and Trouble Clearing Procedures*, 323-3001-543, in *Maintenance*, Volume 5A.
- Procedures for ESI carrier and circuit pack replacement are in *Module Replacement Procedures*, 323-3001-547, in *Maintenance*, Volume 5C.

Timing for a network element containing OC-12 VTBM circuit packs

If a network element contains OC-12 virtual tributary bandwidth manager (VTBM) circuit packs in slots 9 and 10, then the system clock generator in each of those circuit packs produces system clocks at the following rates: 51.84 MHz, 38.88 MHz, and 2 kHz. The timing reference used as the basis for those clocks depends on whether the network element uses timing provided by external synchronization interface (ESI) cards or by the OC-12 VTBM circuit pack.

ESI timing

The network element uses ESI timing if it contains one or two ESI cards and the value of the clock source parameter is set to ESI. In this case, the system clock generator in each OC-12 VTBM circuit pack receives a stable timing reference frequency of 51.84 MHz from the ESI and uses that reference as the basis for the system clocks.

OC-12 VTBM timing

The network element uses OC-12 VTBM timing if the value of clock source parameter is set to *linetimed*. In this case, the system clock generator in each OC-12 VTBM circuit pack derives an 8 kHz reference frequency from a received SONET signal and uses that reference frequency as the basis for the system clocks.

Timing modes of the OC-12 VTBM circuit pack

If a network element contains OC-12 VTBM circuit packs, those circuit packs have both current timing mode and target timing modes.

Note: OC-12 VTBM circuit packs are used in network elements in fiber-fed systems with ring topology.

Target timing mode

The target mode is the mode to which the OC-12 VTBM circuit pack tries to arrive.

Note: Target modes do not apply to the OC-12 interface circuit pack, nor to the OC-3 interface circuit pack.

For the OC-12 VTBM circuit pack, the following target modes of operation can be provisioned:

- freerun
- normal
- holdover

Current timing mode

The current mode is the mode that the OC-12 VTBM circuit pack is actually in. The current mode normally matches the target mode. However, the following modes of operation are defined to support initialization and failure states:

- Freerun
- Acquire
- Normal
- Holdover

Freerun mode

Freerun mode is a target mode that the user can provision. In freerun mode, the voltage-controller crystal oscillator (VCXO) clock in the circuit pack is not locked to a timing reference and runs at its natural frequency.

Acquire mode

Acquire mode is not a user-provisionable target mode. Acquire mode is the current mode when the VCXO clock in the circuit pack tracks a timing reference and the timing-mode-maintenance software brings the clock frequency into approximate agreement with the timing reference frequency. That reference frequency can be the 51.84 MHz signal from an ESI card or the 8 KHz timing signal derived from an incoming SONET signal.

Normal mode

Normal mode is a target mode that the user can provision. It is the default target mode. Normal mode is the current mode when the VCXO clock in the circuit pack locks to a timing reference frequency. That reference frequency may be the 51.84 MHz signal from an ESI card or the 8 KHz timing signal derived from an incoming SONET signal. Normal mode is used during trouble-free operations.

Holdover mode

Holdover mode is a target mode that the user can provision. The circuit pack enters holdover mode automatically if the target mode is lock but all timing references are unavailable. If the circuit pack enters holdover mode automatically, the VCXO clock in the circuit pack holds within a certain frequency range of the last locked-in timing reference. After 24 hours in holdover timing mode, a log is generated indicating that the circuit pack has been in holdover for 24 hours. When a timing reference becomes available again, the circuit pack enters acquire mode.

User provisioning of the target timing mode for OC-12 VTBM circuit packs

You can provision the target timing mode for the OC-12 VTBM circuit packs in a network element. (Any provisioning request applies to both circuit packs.) When you provision the target timing mode, the choices available to you are limited by the current timing mode and by the target mode that has already been provisioned. The following rules apply:

- If the target mode is provisioned to a certain value, any redundant request to provision the target mode to that value is rejected.
- If the current timing mode is acquire, the only target mode that you can select is freerun.
- If the current timing mode is freerun, the target modes that you can select are freerun and normal.
- If the current timing mode is normal, the target modes that you can select are freerun and holdover.
- If the current timing mode is holdover, the target modes that you can select are freerun, holdover, and normal.

Note: If you set the target mode to normal, the current mode changes to normal only if a valid timing reference is available.

Automatic control of the current timing mode

In certain conditions, the current timing mode changes automatically. The examples in Table 11-5 assume that the target timing mode is normal:

Table 11-5
Automatic timing mode changes

Network element	Clock source	Condition	If current timing mode is	Changes automatically to
ESI timing	ESI	start-up	acquire	normal
OC-12 VTBM timing	linetimed	start-up	acquire	normal
ESI timing	ESI	all ESI cards on shelf fail	normal	freerun
ESI timing	ESI	forced switch or lockout command is used that forces the NE to use a failed ESI card that does not provide a valid timing reference signal	normal	freerun
ESI timing	ESI	active ESI card is recovered	holdover	acquire then normal
OC-12 VTBM timing	linetimed	all available timing references are invalid (see Invalid timing references on page 11-30)	normal	holdover
			acquire	freerun
OC-12 VTBM timing	linetimed	valid timing reference becomes available	holdover or freerun	acquire then normal

Invalid timing references

If a network element is set to use OC-12 VTBM timing, the clock source is set to linetimed and there are no ESI cards. The OC-12 VTBM circuit packs must derive 8 kHz timing references from the received SONET signals. This type of timing reference becomes invalid if any of the following occurs:

- problems with the SONET signal
 - loss of signal (LOS)
 - loss of frame (LOF)
 - line alarm indication signal (line AIS)
- problems with the OC-12 VTBM circuit pack that receives the SONET signal
 - hardware failure
 - circuit pack being placed out of service (OOS)

If an OC-12 VTBM circuit pack is in holdover or freerun mode, the circuit pack inserts the code “0000” into the S1 byte in the SONET line overhead. This is a synchronization-status message for the next network element in the system. The message indicates that the quality of the line timing is unknown. (For more information on synchronization-status messages, see “Synchronization-status messages” on page 11-31.)

Synchronization-status messages

Synchronization-status messages indicate the quality of the timing sources currently available to a network element. Only virtual tributary bandwidth manager (VTBM) circuit packs use synchronization-status messages.

When a network element must decide on a timing source, it may have to choose among multiple candidates. For example, the candidates may include external timing from a building-integrated timing supply (BITS), line timing derived from SONET interfaces, and freerun timing based on the network element's own internal clock. To select the most suitable timing source from the available candidates, the network element requires knowledge of the quality level of each candidate. Synchronization-status messages carry that information.

Synchronization-status messages are carried in bits five to eight of the S1 byte in the SONET line overhead. As the timing is passed from one network element to the next, each network element sends synchronization-status messages. If the quality of the timing changes, the synchronization-status messages inform the next network element. Table 11-6 on page 11-32 lists the messages.

Note: See Appendix A in this document for more information on SONET overhead. In Appendix A, Figure 12-3 on page 12-5 shows the position of the S1 byte in the SONET overhead.

Table 11-6
Synchronization-status messages

Description	Quality level	SONET S1 bits (bit 5 to bit 8)	Network Element User Interface designation
Stratum 1	1	0001	ST1
Traceability unknown	2	0000	STU
Stratum 2	3	0111	ST2
Stratum 3	4	1010	ST3
SONET holdover	5	1110	RES (See Note 2.)
SONET clock (±20 ppm clock)	6	1100	SMC
Stratum 4 (See Note 1.)	7		
Do not use for synchronization	8	1111	DUS
<p>Note 1: Quality level 7 applies to DS1 extended superframe (ESF) links and not to synchronization.</p> <p>Note 2: Quality level 5 (RES) identifies SONET holdover nodes.</p>			

Systems with ring topology use synchronization-status messages because some of the network elements rely on line timing. When a fault occurs and the traffic path is reconfigured, the timing-reference source used by one or more of the network elements may become unavailable. Any network element that loses its timing source automatically switches to the highest-quality alternative source that is available. In such a situation, the synchronization-status messages provide information about the quality of available sources.

Following the failure of an externally timed node (for reasons other than loss of service [LOS] or DUS), synchronization-status messaging propagates the RES message. After a 10-second delay, the ring rearranges synchronization to SONET holdover mode. This allows messages to propagate throughout the ring before any rearrangements occur.

User-specified quality levels for timing sources

You can specify the quality level of a timing source, using the timing reference protection screen in the network element user interface.

You must specify the quality level if the network element cannot read synchronization-status messages (for example, if the network element uses OC-3 or OC-12 interface circuit packs rather than OC-12 VTBM circuit packs to interface to the fiber optic feeder).

Another example in which you must specify the quality level is when the timing source comes from equipment that does not support synchronization-status messaging (for example, a BITS or another vendor's equipment).

When you specify a quality level for a timing source, the user interface appends "-P" to the quality level, for example, ST1-P.

Note 1: To accommodate systems in which the equipment cannot write or read synchronization-status messages, the timing reference protection screen in the network element user interface allows you to specify the quality level of the line timing derived from a SONET signal. If timing-reference protection switching is necessary, your specification informs the network element of the quality of the line timing.

Note 2: All network elements in a VTBM Ring that do not use external timing sources should have the quality level set to AUTO for each timing reference source. This will result in the quality level of the timing source being set to the quality level indicated in the synchronization status message.

Application scenarios

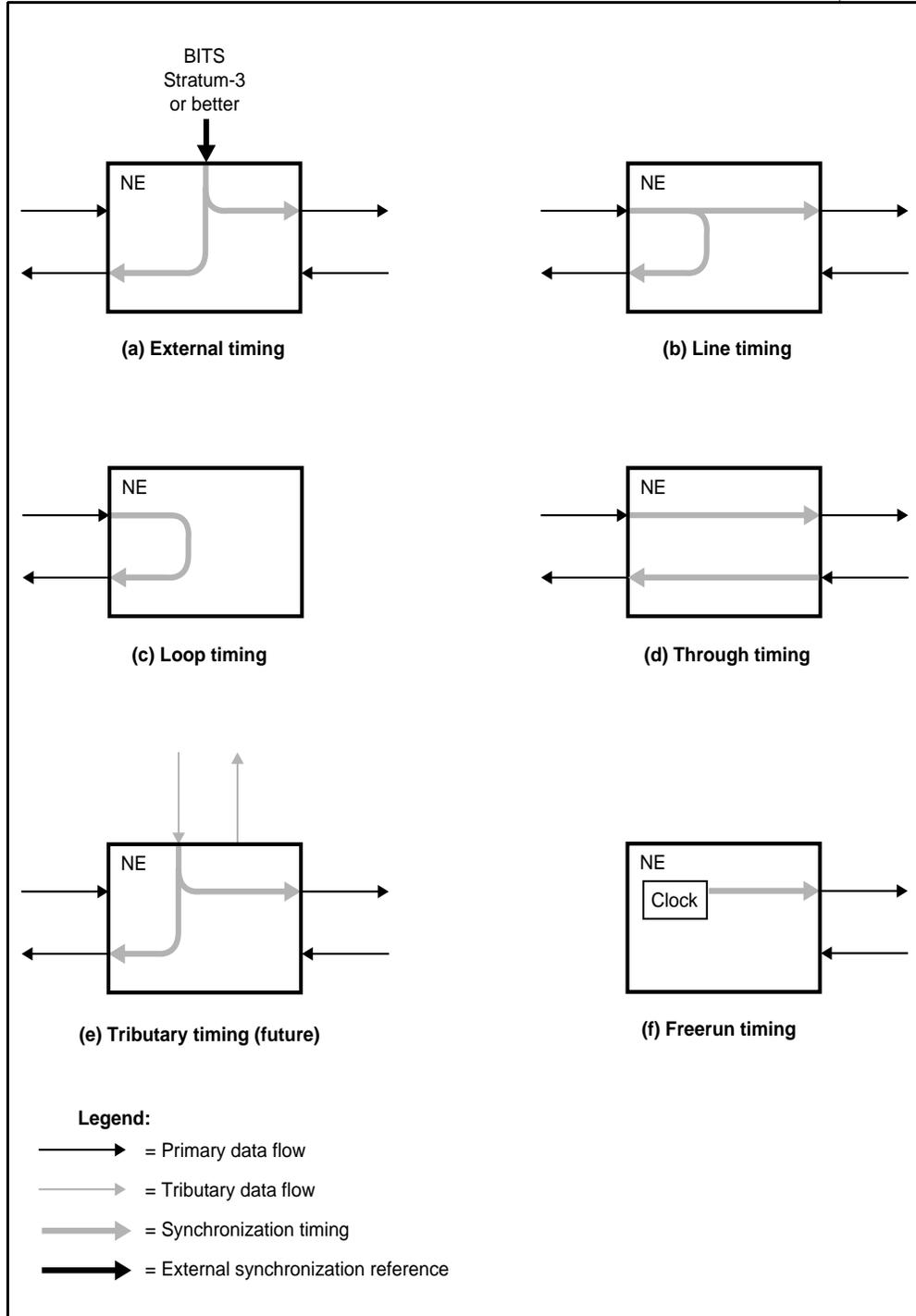
Figure 11-6 on page 11-34 illustrates applications of the message set with different timing modes. Each scenario shows the relationship between the timing mode, input timing references, and the selected reference quality level.

Note 1: In scenario A, the Stratum 3E BITS quality level is considered a Stratum 3 quality level for synchronization-status messaging.

Note 2: In scenario F, the internal clock is a 20 ppm clock. This implies that the network element is in SONET freerun. If the network element were in ESI freerun or ESI holdover, the internal clock would be of Stratum 3 quality, and n=4 (ST3) would be inserted.

Figure 11-6
Synchronization messaging application scenarios

PC-2330 (TBM R11.2)

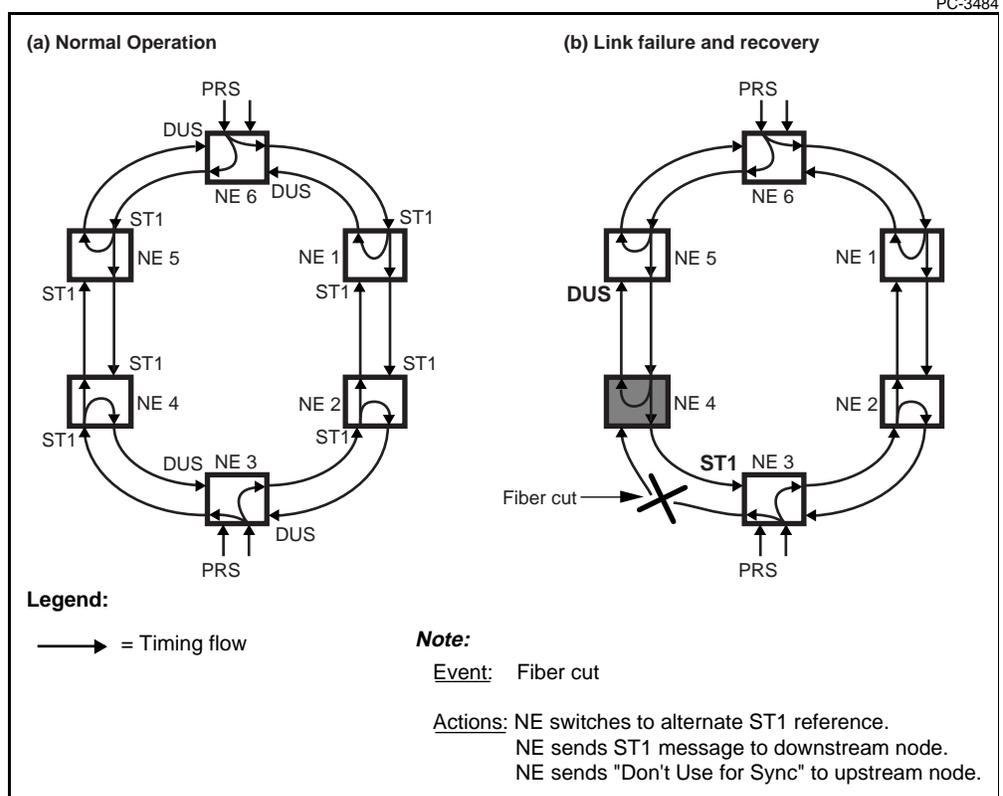


Benefits of synchronization-status messaging

Ring configurations in which reference timing is carried in the SONET signal especially need synchronization-status messaging. If a fault occurs and the traffic path is reconfigured, the timing-reference source used by one or more of the network elements may become unavailable. Any network element that loses its timing source automatically switches to the highest-quality alternative source that is available. In such a situation, the synchronization-status messages inform you of the quality of available sources.

Figure 11-7 shows a timing recovery following a failure in a ring.

Figure 11-7
S1-byte synchronization-status messaging in a SONET ring



Scenario A in Figure 11-7 shows normal operations. The ring has six network elements. Two of the network elements are externally timed from BITS. The remaining network elements are line-timed from fiber.

Scenario B shows the system response to a link failure between two line-timed network elements. The affected network element (shaded in the diagram) switches to the alternate ST1 reference. After the switch, the network element updates the S1-byte synchronization messages to send a DUS (don't use for synchronization) back to the link that supplies timing, and an ST1 to the network element downstream in the timing flow.

Synchronization-status messaging can prevent the formation of timing islands and timing loops and prevent synchronization hierarchy violations. The rest of this section describes the benefits of synchronization-status messaging.

Note: If timing for a network element has been improperly engineered, synchronization-status messaging alone cannot rectify the problem. However, if a network follows solid engineering rules for timing, synchronization-status messaging ensures that the network is timed to the best possible reference at any time.

Synchronization timing islands

Loss of a fiber link can create a timing island, isolating the timing island from the rest of the network. Figure 11-8 shows a small synchronization island caused by a failure to the optical signal timing for network element 5.

Figure 11-8
Synchronization timing island

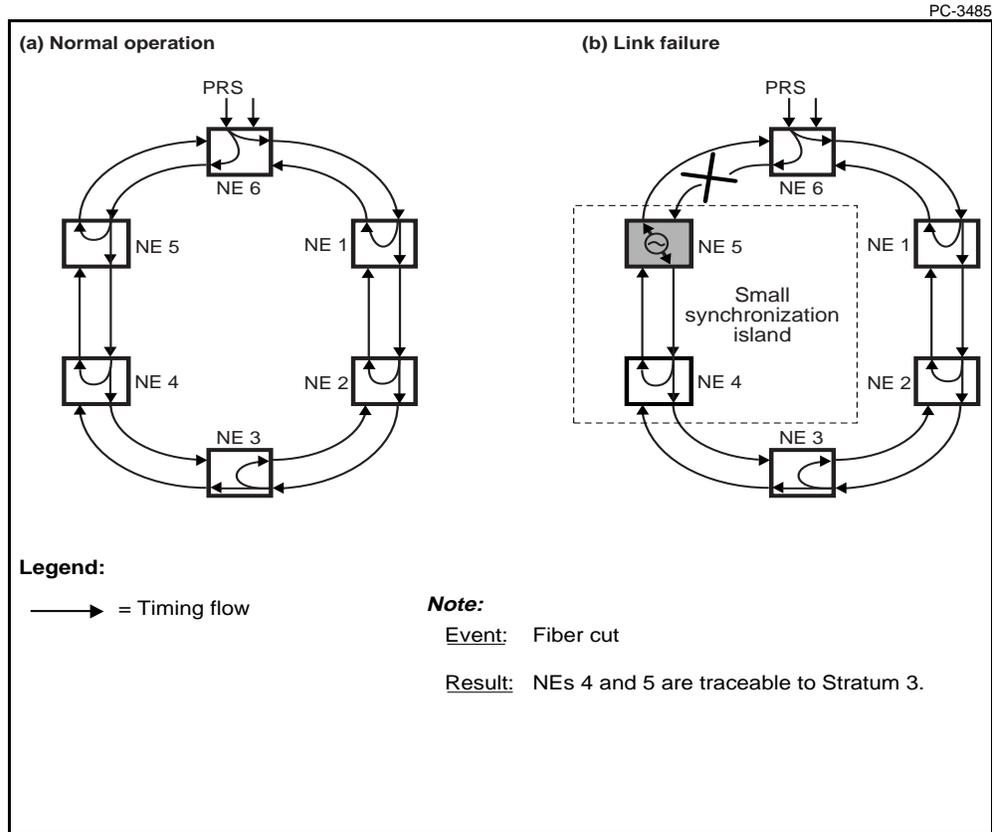


Table 11-7 describes the effect of synchronization failure on traffic.

Table 11-7
Impact of synchronization failure on traffic

Traffic			Impact
Traffic originating and terminating within the degraded island			no impact
	during the first 24 hours of ESI holdover	DS1/DS3 transport	no noticeable degradation
traffic originating from within the degraded island and terminating outside the island	less than or equal 0.37 ppm frequency offset	DS1/DS0 originating or terminating signals	maximum of 255 slips per day
	after the first 24 hours	DS1/DS3 transport	traffic continuity maintained; noticeable increase in payload output jitter, but within the 5 UI network limit
	less than or equal ESI freerun 4.6ppm frequency offset	DS1/DS0 originating or terminating signals	excessive slips; maximum of 2.2 slips per minute
	SONET clock freerun	DS1/DS3 transport	excessive payload output jitter, exceeding the 5 UI limit and causing severely errored seconds (SES) or loss of frame (LOS)
	less than or equal 20 ppm frequency offset	DS1/DS0 originating or terminating signals	excessive slips

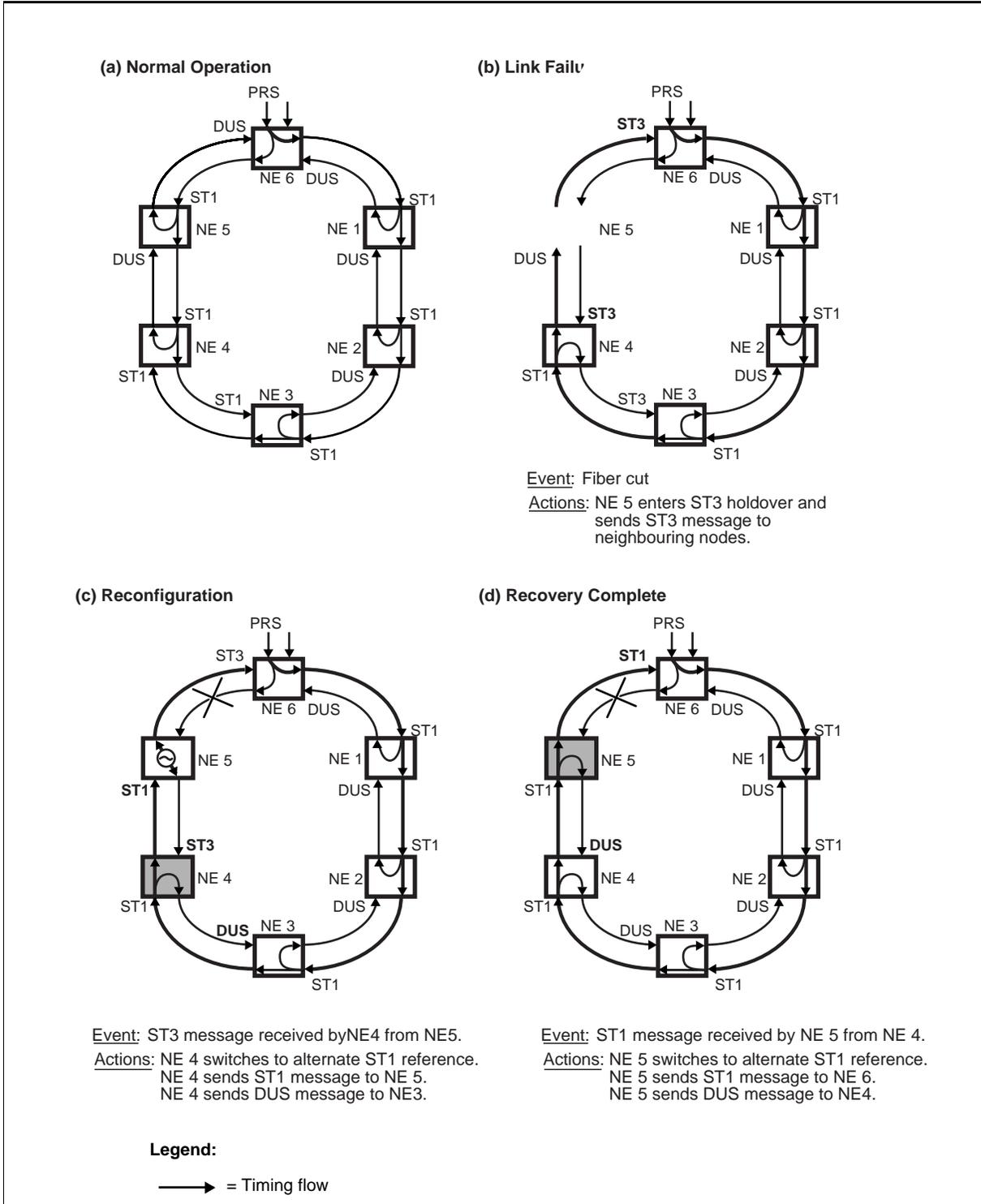
Preventing timing islands using synchronization-status messaging

With synchronization-status messaging, a network element can select from up to four available timing reference signals. The network element performs an automatic timing reference switch to the signal with the highest clock quality. The network element can decide to switch to the facility with the best synchronization quality level (ST1).

Figure 11-9 on page 11-38 shows synchronization in a ring restored to Stratum 1 by synchronization-status messaging. The network is in equilibrium and the synchronization island was prevented.

Figure 11-9
Timing island prevented with synchronization-status messaging

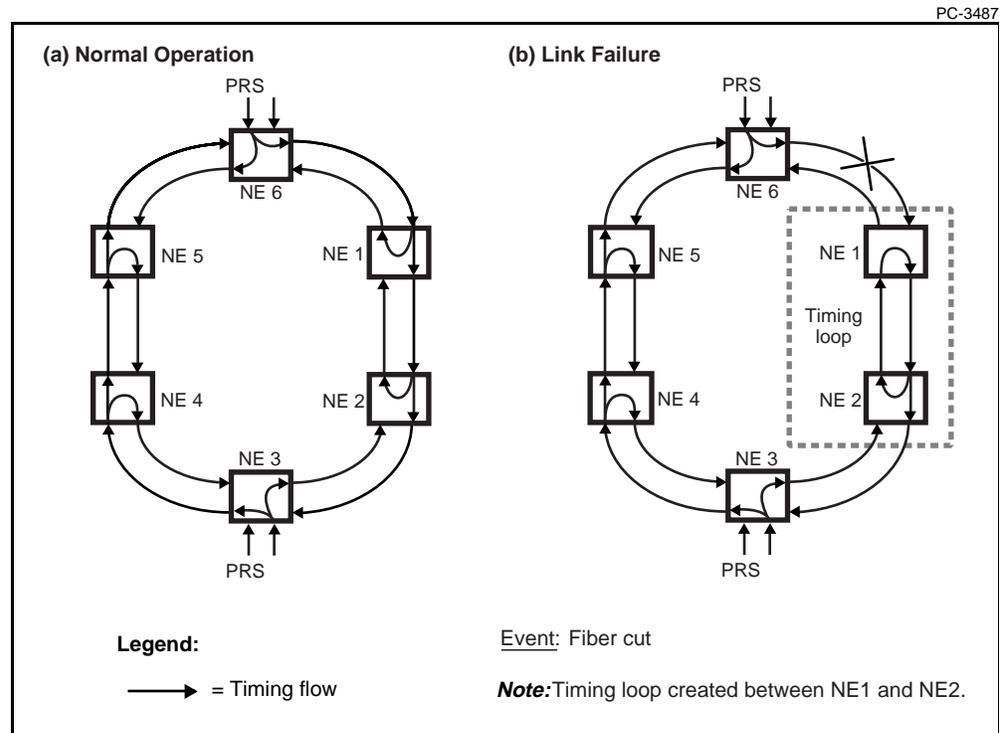
PC-3486



Timing loops

Figure 11-10 shows the creation of a timing loop. Timing loops cause excessive jitter and loss of traffic. Because you cannot always detect a timing loop at the local network element, you should analyze every possible synchronization failure scenario for timing loops and determine how to prevent them.

Figure 11-10
Timing loop



Avoid creating inadvertent timing loops. In particular never commission adjacent network elements so that their ESI cards synchronize to each other. For example, network element 1 in Figure 11-10 is timed from adjacent network element 2, and network element 2 is timed from network element 1. The two network elements form a timing loop, putting them out of synchronization with the external timing source. In this type of timing loop, neither network element detects an abnormality; therefore, no alarms are raised, and you cannot detect the timing loop.

Preventing timing loops using synchronization-status messaging

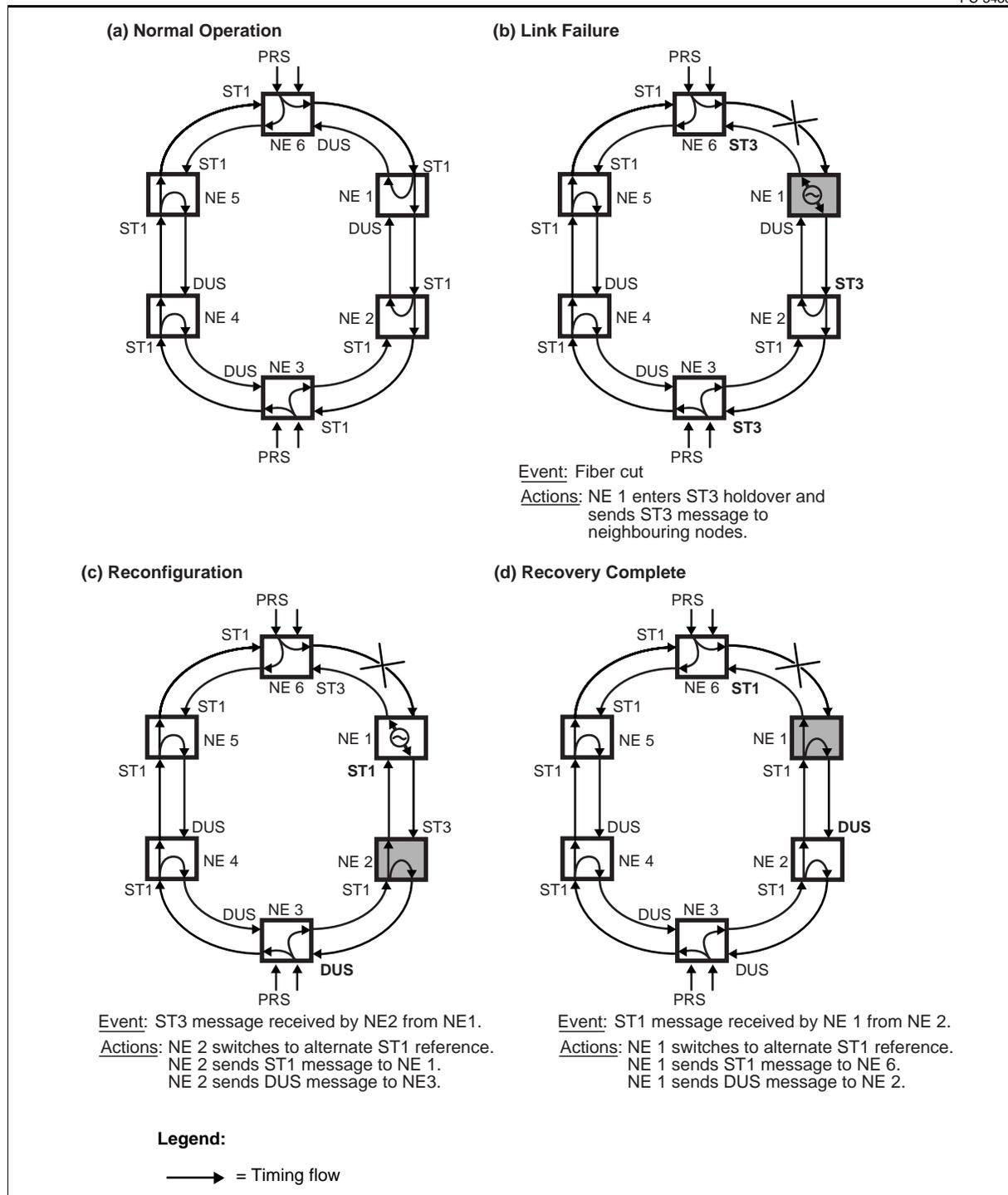
With synchronization-status messaging, a network element can select from up to four available timing reference signals. The network element performs an automatic timing reference switch to the signal with the highest clock quality if the available signals or their defined clock quality changes.

The network element can decide to switch to the facility with the best synchronization quality level (ST1) without creating a timing loop. Synchronization-status messaging sends a DUS (do not use for synchronization) message that the interface is unsuitable as a timing reference. Typically, it uses DUS to indicate a limitation imposed by the path of the signal through the network (use of the reference would form a timing loop).

Figure 11-11 on page 11-41 shows the ability of S1-byte synchronization-status messaging to respond to the fiber cut between network element 6 and network element 1. No timing loop occurs.

Figure 11-11
Timing loop prevented with synchronization-status messaging

PC-3488

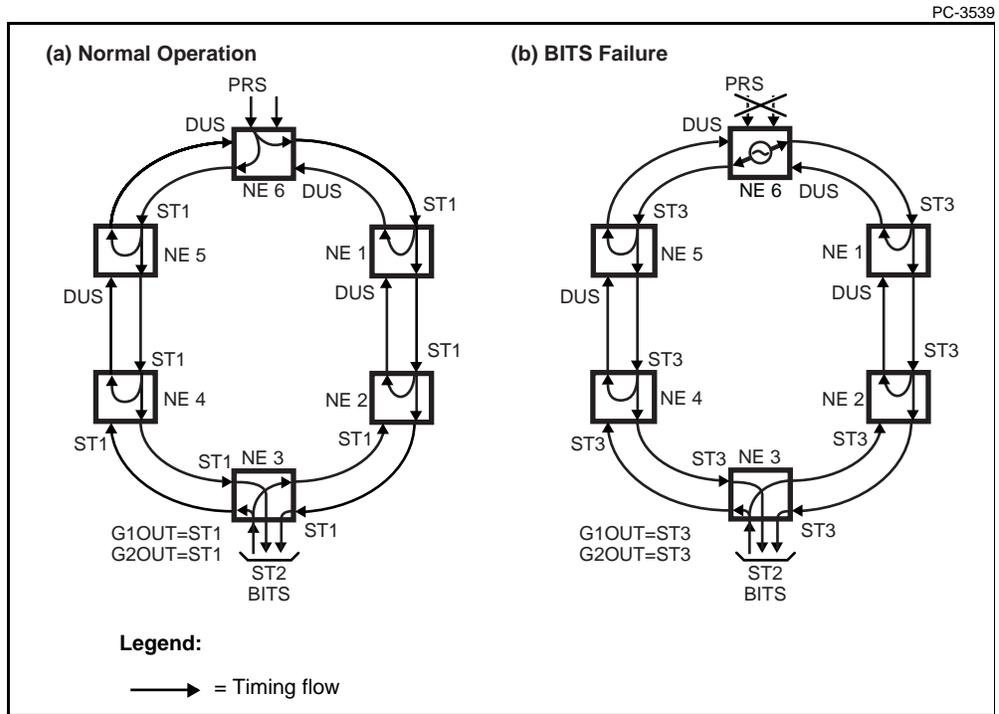


Hierarchy violation

A hierarchy violation occurs when a BITS at one stratum synchronizes to a BITS at a stratum with a larger number (for example, a Stratum 2 BITS receives timing from a Stratum 3 BITS). Stratum 3 has a less stable, accurate clock than the Stratum 2, causing the Stratum 2 BITS to be timed from a less accurate BITS.

Figure 11-12 shows a hierarchy violation. The ESI interface at network element 3 uses the optical signal from network element 2 and network element 4 to derive DS1 timing reference outputs. It then uses the DS1s to synchronize its local BITS.

Figure 11-12
Hierarchy violation



Preventing hierarchy violations using synchronization-status messaging

Timing distribution synchronizes a number of networks within a single physical location to a single timing reference signal. The ESI interfaces use internal sources, identified as OCA and OCB, to derive a timing reference ESI DS1 output (G1OUT or G2OUT). These internal sources are derived from the OC-12 interfaces: G1 and G2.

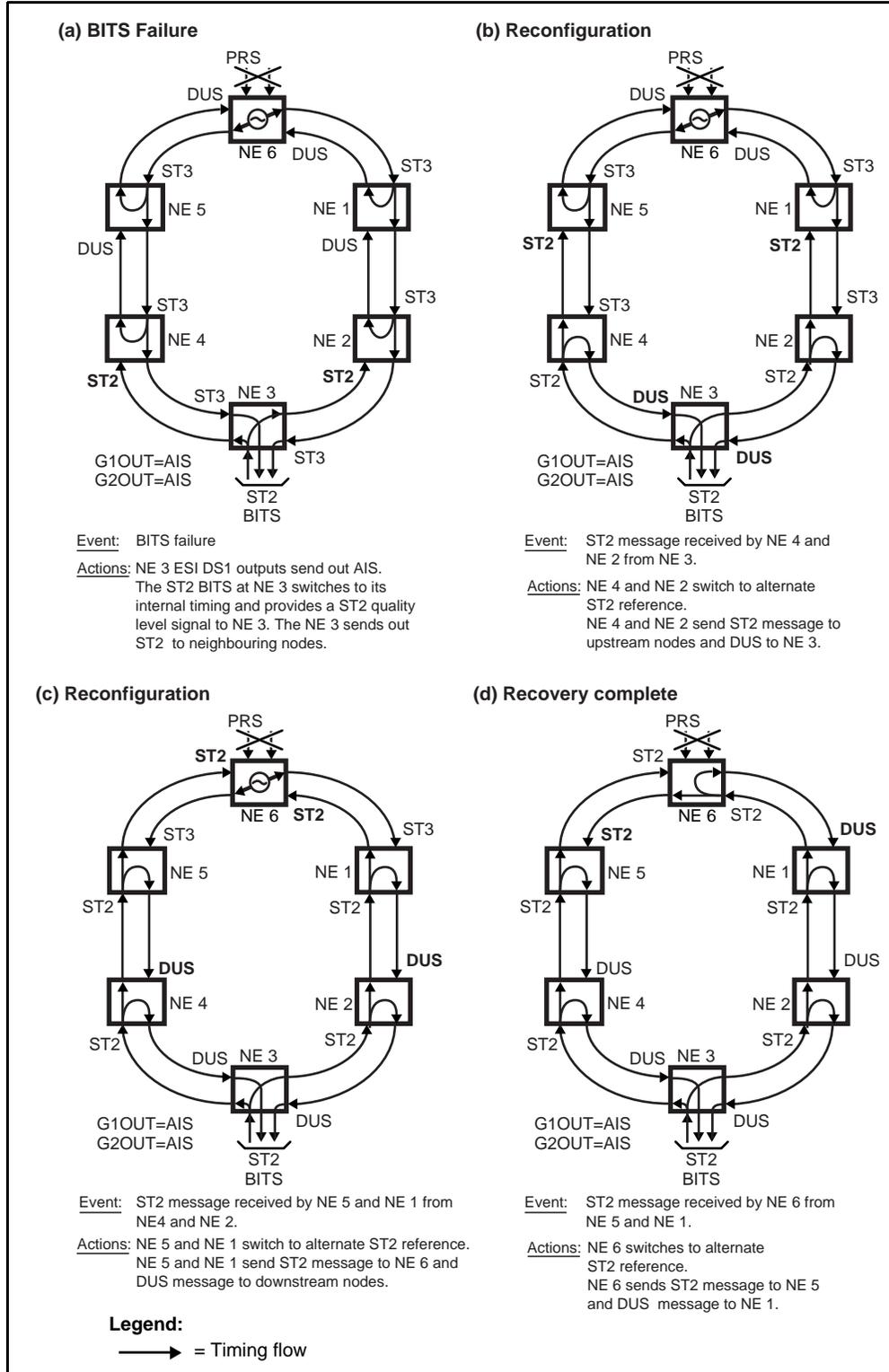
Synchronization-status messaging on SONET network elements (not on BITS) lets the network element monitor the clock quality levels of the timing reference signals. If the timing reference source is of equal or poorer quality than the alarm indication signal (AIS) provisioned by the user, DS1 AIS is inserted on the ESI DS1 output. This prevents the BITS from using the timing distribution ESI DS1 output, thus avoiding a hierarchy violation.

Figure 11-13 on page 11-44 shows how threshold AIS generation prevents hierarchy violations. The AIS threshold value for the ESI DS1 outputs at network element 3 is provisioned to Stratum 2. When the quality level of the timing from the fiber is equal to or lower than the AIS threshold, network element 3 inserts an AIS on the ESI DS1 outputs., The Stratum 2 BITS at network element 3 switches to its internal timing, provides a Stratum 2 quality level to the entire system, and thus prevents a hierarchy violation.

Note: For more information about threshold AIS generation, see “Insertion of alarm indication signal into G1OUT and G2OUT” on page 11-45.

Figure 11-13
Threshold AIS generation

PC-3525



Insertion of alarm indication signal into G1OUT and G2OUT

Threshold alarm indication signal (AIS) generation depends on synchronization-status messages. Threshold AIS generation can be performed by an external synchronization interface (ESI) card that is relying on line timing.

When relying on line timing, the ESI card derives an 8 kHz timing reference signal from the received SONET signal. The ESI card then produces an output DS1 timing signal (G1OUT or G2OUT). The ESI card inserts an AIS into the output DS1 timing signal if the synchronization-status messages in the received SONET signal indicate the quality of the active timing source is at or below a user-selectable threshold.

You select that threshold on the ESI facility screen in the network element user interface. You can choose from the following threshold values:

- ST2 (Stratum 2)
- ST3 (Stratum 3)
- SMC (SONET clock)
- Null

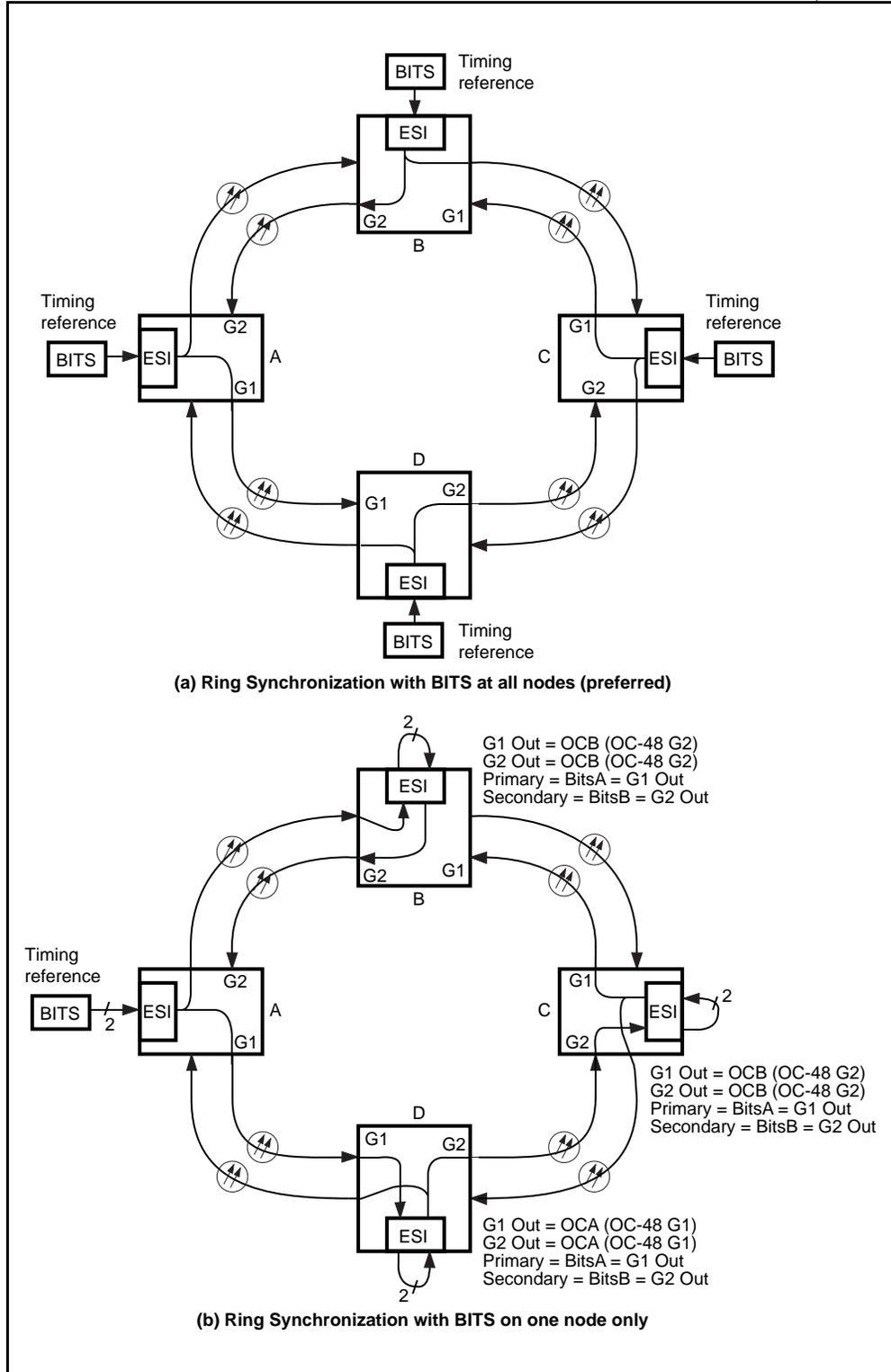
Selecting the null threshold value disables AIS generation.

If you provisioned G1OUT and G2OUT to select the best quality timing reference (the “best” option of source tracking), the DS1 AIS is inserted only when both timing references are at or below the specified threshold. If one of the references is above the threshold, the DS1 output selects the one above the threshold and does not insert an AIS.

Figure 11-14 on page 11-46 shows threshold AIS generation. In the figure, the derived DS1 of network element 1 is synchronized from the fiber from network element 4. The threshold value at network element 1 is provisioned to Stratum 3. Network element 4 extracts timing from an external BITS clock. When the quality level of the timing from the fiber is at or below the provisioned threshold AIS value, network element 1 inserts AIS on the derived DS1 and raises the Tx AIS alarm.

Figure 11-14
Threshold AIS generation

PC-2246 (TBM R11.2)



The insertion of AIS ceases if any of the following events occurs:

- The network element switches to a timing source of greater quality than the provisioned AIS threshold.
- The timing source for the derived DS1 recovers to a quality level greater than the provisioned AIS threshold.
- The user changes the threshold value to be less than the quality level of the active timing source.
- The user disables AIS insertion by changing the threshold value to null.

Summary of network element timing

The following factors determine network element timing:

- the setting of the clock source parameter
- the timing mode of the external synchronization interface (ESI) card or cards (if equipped)
- the timing mode of the OC-12 virtual tributary bandwidth manager (VTBM) circuit packs (if equipped)

Table 11-8 summarizes the factors that determine network element timing in fiber-fed AccessNode systems.

Table 11-8
Summary of network element timing in fiber-fed AccessNode systems

Clock source	Are there ESIs?	Interface to the fiber optic feeder	Target timing modes: ESI/OC-12 VTBM	These settings typically used in	Timing reference	Accuracy
Freerun	No	OC-12 or OC-3 optical interfaces	N.A. / N.A.	FCOT without ESI, in pt.-to-pt. topology	Clock in the OC-12 or OC-3	±20 ppm, -40° to +65°C (SONET freerun)
Looptimed	No	OC-12 or OC-3 optical interfaces	N.A. / N.A.	RFT, in pt.-to-pt. topology	SONET interface	as precise as the remote timing reference
Linetimed	No	OC-12 VTBM	N.A. / Normal	NE without ESI, in ring topology	Incoming optical signal (Note 5)	as precise as the OC-12 VTBM circuit pack's source
—continued—						

Table 11-8 (continued)
Summary of network element timing in fiber-fed AccessNode systems

Clock source	Are there ESIs?	Interface to the fiber optic feeder	Target timing modes: ESI/OC-12 VTBM	These settings typically used in	Timing reference	Accuracy
ESI	Yes	OC-12 or OC-3 optical interfaces	Normal / N.A.	FCOT with ESI, in pt.to-pt. or NE with ESI in ring	SONET interface (Notes 1 and 6) or BITS	as precise as the ESI's source (Note 2)
		OC-12 VTBM	Normal/Normal			
ESI	Yes	OC-12 or OC-3 optical interfaces	Holdover / N.A.		ESI clock (controlled)	±0.37 ppm for 24 hours, 0° to 50°C; ±2.0 ppm, -40° to +65°C
		OC-12 VTBM	Holdover/Norm.			
ESI	Yes	OC-12 or OC-3 optical interfaces	Freerun / N.A.		ESI clock (freerun)	±4.6 ppm, -40° to +65°C
		OC-12 VTBM	Freerun/Normal			
<p>Note 1: If a network element is equipped with external synchronization interface (ESI) cards G1 and G2, then by default, the timing references assigned to the ESI cards are as follows: G1 is provisioned to timing-reference bus OCA and G2 is provisioned to timing-reference bus OCB.</p> <p>Note 2: In this case, the network element may have external timing (BITS A or BITS B) or line timing. The timing source depends on which sources are provisioned for the network element and the quality levels of the sources that are available.</p> <p>Note 3: You edit the target timing mode for the ESI cards on the ESI equipment screen. You edit the target timing mode for the OC-12 virtual tributary bandwidth manager (VTBM) circuit packs on the OC-12 equipment screen. In normal trouble-free conditions, the current timing mode should approach the target timing mode.</p> <p>Note 4: The network element synchronization mapping manager software maintains the mapping between the timing reference buses (OCA and OCB) and the OC-n (OC-3 or OC-12) interfaces that can source those buses (G1 in slot 9 and G2 in slot 10). In each of the common-equipment shelves (access bandwidth manager and transport bandwidth manager), the shelf backplane supports up to two timing references from OC-n interfaces at any one time. These signals can be used as references for timing-distribution DS1s from the ESI cards.</p>						
—continued—						

Table 11-8 (continued)
Summary of network element timing in fiber-fed AccessNode systems

Clock source	Are there ESIs?	Interface to the fiber optic feeder	Target timing modes: ESI/OC-12 VTBM	These settings typically used in	Timing reference	Accuracy
<p>Note 5: In the AN12 release of AccessNode, only network elements in fiber-fed systems with ring topology use the OC-12 VTBM circuit pack. In a ring node containing OC-12 VTBM circuit packs and no ESI cards, the clock source should always be set to linetimed, and the target clock mode of the OC-12 VTBM circuit packs should be set to normal. If all the timing sources provisioned for the network element become unavailable, the OC-12 VTBM circuit pack can enter holdover mode (with an accuracy of ± 4.6 ppm for 24 hr, w. 30°F temperature change, and an accuracy of ± 0.37 ppm for five minutes) or SONET freerun mode (with an accuracy of ± 20 ppm, -40° to +65°C). All network elements in a VTBM Ring that do not use external timing sources should have the quality level set to AUTO for each timing reference source. This will result in the quality level of the timing source being set to the quality level indicated in the synchronization status message.</p> <p>Note 6: For point-to-point systems, you can provision the timing distribution (G1OUT and G2OUT) to track the active optics. You must provision G1 to OCA and G2 to OCB.</p>						
—end—						

Appendix A: SONET overview

SONET is the acronym for Synchronous Optical Network. SONET is a new standard for optical communication. The SONET standard was initiated by Bellcore on behalf of the regional Bell operating companies (RBOCs) for the following key purposes:

- multivendor environment (mid-span meet)
- positioning the network for transport of new services
- synchronous networking
- enhanced operations, administration, and maintenance (OA&M)
- bandwidth-management capabilities

The SONET standard defines optical carrier (OC) levels and their electrically equivalent synchronous transport signals (STS). The base rate is 51.84 Mb/s. This rate is referred to as OC-1 if the signals are optical, or STS-1 if the signals are electrical. Higher rates are direct integer multiples of the base rate.

STS-1 building block

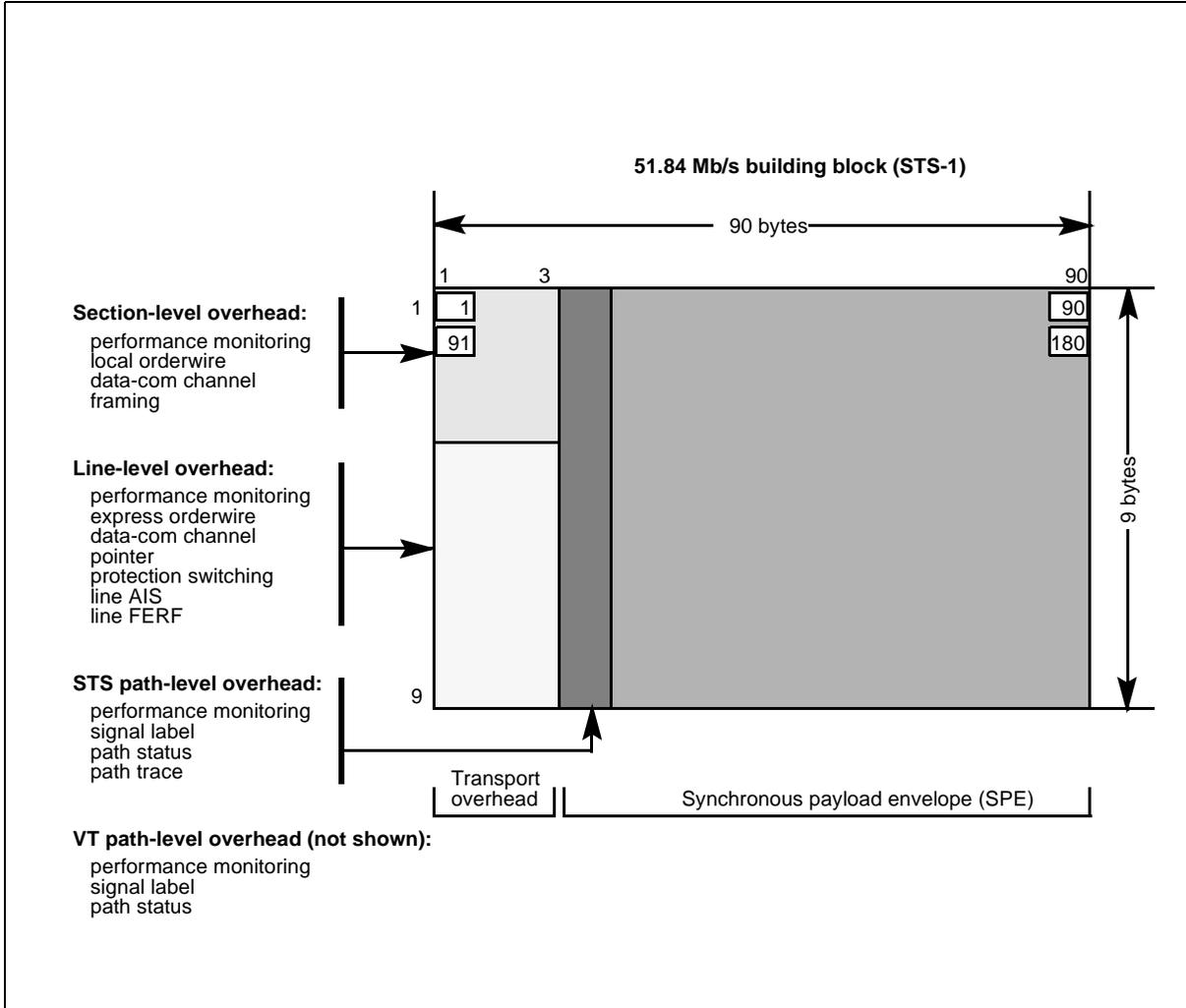
The basic building block used by SONET is an STS-1 electrical signal with a bit rate of 51.84 Mb/s. Higher-level electrical signals are integer multiples of the base rate. For example, an STS-12 has a bit rate of 622.080 Mb/s, which is exactly 12 times the base rate. STS-n indicates an unspecified multiple of STS-1. The currently defined values for n are 1, 3, 9, 12, 18, 24, and 48.

The frame format of the STS-1 signal appears in Figure 12-1. The frame can be divided into two main areas: the transport overhead and the payload. The STS-1 payload can transport any of the following:

- up to 28 DS1s
- up to 14 DS1Cs
- up to 7 DS2s
- 1 DS3
- up to 21 CEPT1s (CCITT-type signals, each with a rate of 2.048 Mb/s)
- combinations of the above

Figure 12-1 shows the STS-1 frame format as a matrix of bytes, 9 rows high by 90 columns wide. Each byte contains eight bits. The entire STS-1 frame (810 bytes) is transmitted in 125 microseconds. Byte 1 is transmitted first, followed by the remaining bytes in the first row (bytes 2 to 90), followed by the bytes in the second row (bytes 91 to 180), and so on.

Figure 12-1
SONET STS-1 frame format



Overhead

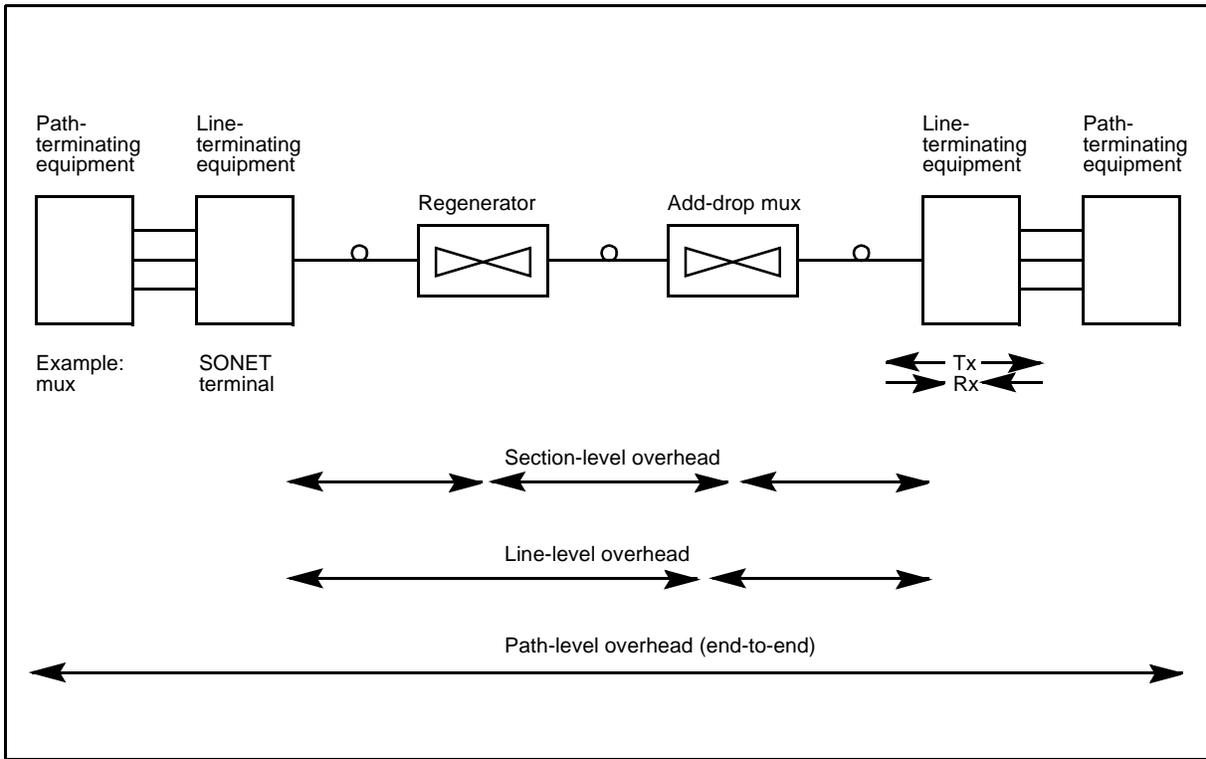
As shown in Figure 12-1, the frame format of the SONET standard can carry a generous amount of overhead information. This results in simpler multiplexing schemes and additional operations, administration, maintenance, and provisioning (OAM&P) capabilities. The overhead carries enough information to allow the network to operate, and to allow OAM&P communications between an intelligent network controller and the individual nodes.

The overhead information has several layers. Figure 12-2 on page 12-4 defines the terminology used for the overhead layers:

- The section-level overhead is for the STS-n signal between any two of the network elements. It occupies 9 bytes per SONET frame.
- The line-level overhead is for the STS-n signal between line terminating equipment. It occupies 18 bytes per SONET frame.
- The path-level overhead is carried from end to end. The path-level overhead is subdivided into two types:
 - STS path overhead occupies 9 bytes per SONET frame.
 - VT path overhead occupies 1 byte per SONET frame.

Note: As shown in Figure 12-1, the section-level overhead and the line-level overhead together are referred to as the transport overhead. The STS path-level overhead and the VT path-level overhead, together with the data, compose the synchronous payload envelope (SPE).

Figure 12-2
Overhead layers



STS path-level overhead (9 bytes)

The synchronous payload envelope includes the STS path-level overhead, as shown in Figure 12-1 on page 12-2. The main function of the STS path-level overhead is to map services into the format required by the STS line-level overhead. Figure 12-3 on page 12-5 shows the functions of the individual bytes in the STS path-level overhead.

STS line-level overhead (18 bytes)

The STS line-level overhead is part of the transport overhead, as shown in Figure 12-1 on page 12-2. The STS line-level overhead provides synchronization, multiplexing, maintenance, and protection switching. Figure 12-3 on page 12-5 shows the functions of the individual bytes in the STS line-level overhead.

STS section-level overhead (9 bytes)

The STS section-level overhead is part of the transport overhead, as shown in Figure 12-1 on page 12-2. The STS section-level overhead deals with the transport of the actual STS-N frame across the physical medium. This layer includes framing, scrambling, and monitoring section errors. Figure 12-3 on page 12-5 shows the functions of the individual bytes in the STS section-level overhead.

Access to the STS overhead layers

Access to the overhead is restricted in a synchronous network. At a regenerator, only the section-level overhead is processed. At a terminal or an add-drop multiplexer (ADM), the line-level overhead is processed. If mapping from an asynchronous format (such as DS1) to a synchronous format (STS-1) is performed at a terminal or an ADM, then the path-level overhead is also processed there.

Virtual tributaries

In addition to the STS-1 base format, the SONET standard also defines synchronous formats at sub-STs-1 levels. Virtual tributaries (VTs) are synchronous signals used to transport low-speed signals. Table 12-1 shows the four sizes of VTs.

Table 12-1
Virtual tributary sizes

Type	Transport for (typically)	VT rate
VT1.5	1 DS1 1.544 Mb/s	1.728 Mb/s
VT2	1 CEPT 1 2.048 Mb/s	2.304 Mb/s
VT3	1 DS1C 3.152 Mb/s	3.456 Mb/s
VT6	1 DS2 6.312 Mb/s	6.912 Mb/s

Within the STS-1, many VTs can be mixed together. An STS-1 payload can carry a maximum of 28 VT1.5s.

VT grouping

Within an STS-1, many VTs can be mixed together. To accommodate different mixes of VTs in an efficient manner, the STS SPE is divided into seven parts, each of which can contain a VT group. Figure 12-4 on page 12-7 shows how pointers indicate the position of the beginning of each VT group. (Figure 12-4 on page 12-7 shows a conceptual view of the VT groups. The VT groups are actually interleaved, as shown in Figure 12-5 on page 12-8.)

A single VT group can accommodate one VT6, two VT3s, three VT2s, or four VT1.5s. All the VTs in a group must be of the same size (for example, VT1.5). VT groups carrying different sizes of VTs can coexist in a single STS-1 SPE.

Each VT group contains VT payloads and VT path-level overhead, which together comprise the VT synchronous payload envelope (VT SPE).

Figure 12-4
Seven VT groups in an STS SPE, each group containing four VT1.5s (conceptual view)

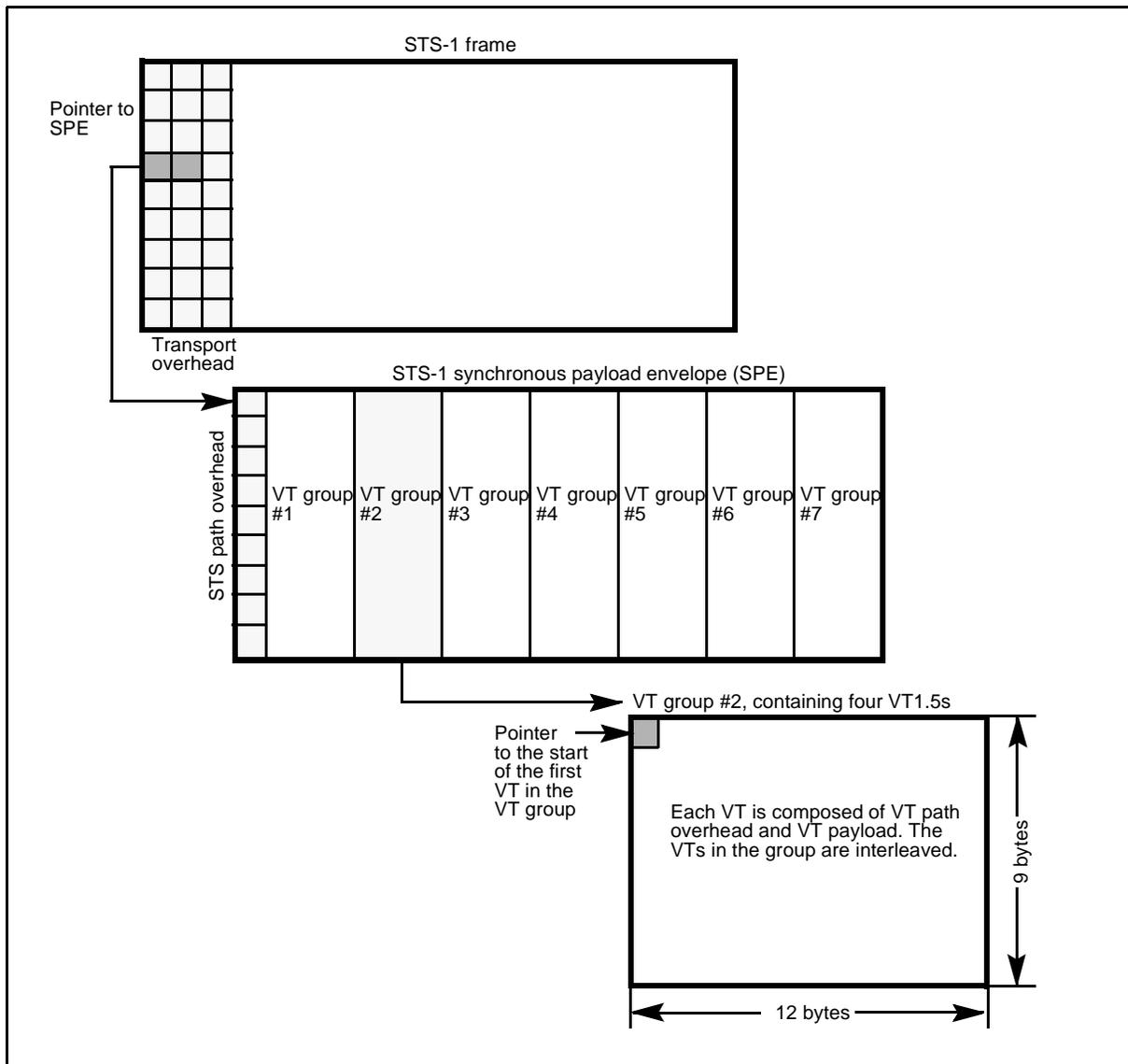


Figure 12-5 on page 12-8 illustrates the interleaving of VTs in an STS-1, using as an example the case in which the STS-1 contains seven groups of VT1.5s, each group containing four VTs. Table 12-2 on page 12-9 restates the same information in tabular form.

Note: This example of interleaving of VTs is for the case in which each of the seven VT groups contains four VT1.5s. The interleaving scheme varies if the STS-1 frame contains VT groups with other sizes of VTs, such as VT2, or VT3, or if groups containing different sizes of VTs coexist in the frame.

Figure 12-5
Interleaving of VTs in an STS-1 with seven VT groups, each with four VT1.5s (actual view)

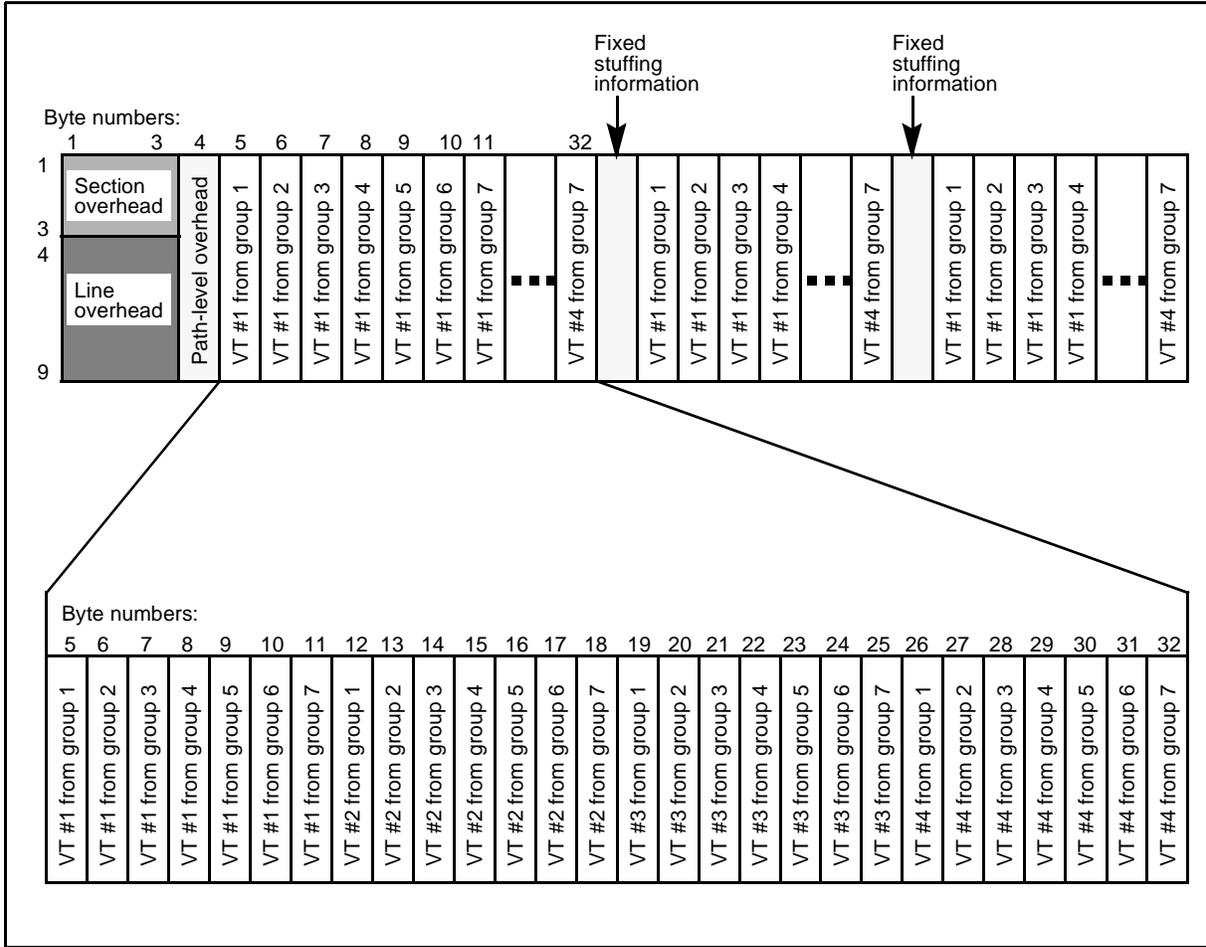


Table 12-2
Logical and physical locations of VTs in an STS-1 frame containing 28 VT1.5s

DS1 number	VT1.5 number	Logical location of the VT1.5	Physical location in the STS-1 frame: the columns headed by the following bytes:
1	1	Group 1, VT #1	2, 34, 63
2	2	Group 2, VT #1	3, 35, 64
3	3	Group 3, VT #1	4, 36, 65
4	4	Group 4, VT #1	5, 37, 66
5	5	Group 5, VT #1	6, 38, 67
6	6	Group 6, VT #1	7, 39, 68
7	7	Group 7, VT #1	8, 40, 69
8	8	Group 1, VT #2	9, 41, 70
9	9	Group 2, VT #2	10, 42, 71
10	10	Group 3, VT #2	11, 43, 72
11	11	Group 4, VT #2	12, 44, 73
12	12	Group 5, VT #2	13, 45, 74
13	13	Group 6, VT #2	14, 46, 75
14	14	Group 7, VT #2	15, 47, 76
15	15	Group 1, VT #3	16, 48, 77
16	16	Group 2, VT #3	17, 49, 78
17	17	Group 3, VT #3	18, 50, 79
18	18	Group 4, VT #3	19, 51, 80
19	19	Group 5, VT #3	20, 52, 81
20	20	Group 6, VT #3	21, 53, 82
21	21	Group 7, VT #3	22, 54, 83
22	22	Group 1, VT #4	23, 55, 84
23	23	Group 2, VT #4	24, 56, 85
24	24	Group 3, VT #4	25, 57, 86
25	25	Group 4, VT #4	26, 58, 87
26	26	Group 5, VT #4	27, 59, 88
27	27	Group 6, VT #4	28, 60, 89
28	28	Group 7, VT #4	29, 61, 90

DS1 visibility

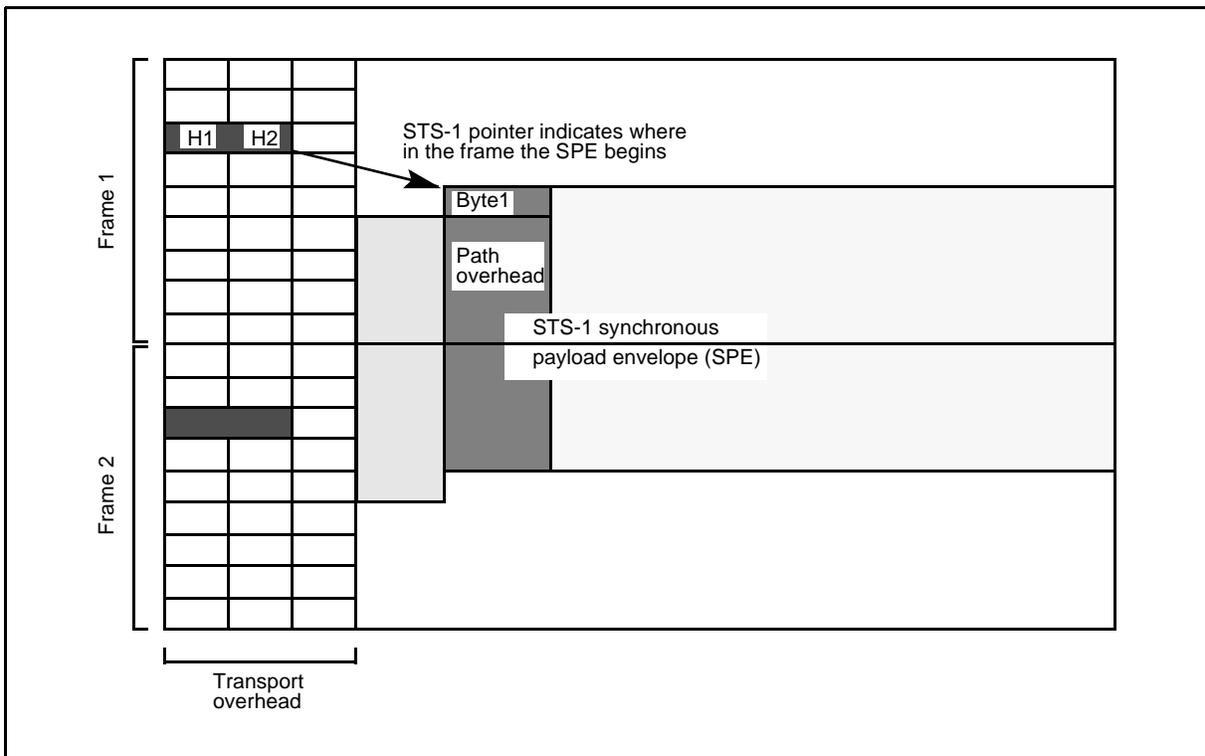
Because SONET multiplexing is synchronous, the low-speed tributaries (input signals) are multiplexed together and are still visible at higher rates, as illustrated in Figure 12-5 on page 12-8 and Table 12-2 on page 12-9. The SONET STS-1 frame format allows each individual DS1 to be visible. An individual VT containing a DS1 can be extracted without demultiplexing the entire STS-1. Visibility is applicable for all sizes of VTs, and is one of the main advantages of synchronous multiplexing. It facilitates switching and grooming at the VT level.

Pointers

In existing asynchronous systems, large frequency variations exist among the terminals, because the terminals are not locked to a common clock. The bit-stuffing technique is used to synchronize the various low-speed signals before they are multiplexed.

In contrast to the asynchronous systems, SONET uses pointers to compensate for frequency and phase variations. The pointer occupies a fixed position in the STS-1 frame, because it is part of the transport overhead, which occupies a fixed position, as shown in Figure 12-4 on page 12-7). The pointer is an offset value that points to the position in the frame where the synchronous payload envelope (SPE) begins, in relation to the transport overhead. Figure 12-6 on page 12-11 depicts a typical case, in which the SPE begins in one STS-1 frame and ends in the next frame. If any frequency or phase variations exist between the STS-1 frame and the SPE, the SPE will slide backward or forward. If the SPE slides, the pointer value adjusts to indicate where the SPE begins. In this way, synchronization is maintained.

Figure 12-6
STS-1 pointer



VTs have pointers that maintain the synchronization of the VT signals. As shown in Figure 12-4 on page 12-7, each VT group occupies 108 bytes within the STS SPE. The first byte of each VT group contains a pointer that indicates where the VT synchronous payload envelope (SPE) begins.

The use of pointers permits the transparent transport of STS-1 SPEs and VT SPEs across boundaries with different timing sources (that is, between nodes with network clocks whose timing is almost the same). The use of pointers prevents the delays and loss of data associated with the use of large (125-microsecond-frame) slip buffers for synchronization. Pointers make it possible to phase-align STS SPEs and VT SPEs, so that these payloads can easily be inserted, dropped, and cross-connected in the network. In addition, pointers readily accommodate transmission signal-wander (low-frequency jitters).

Concatenated payloads

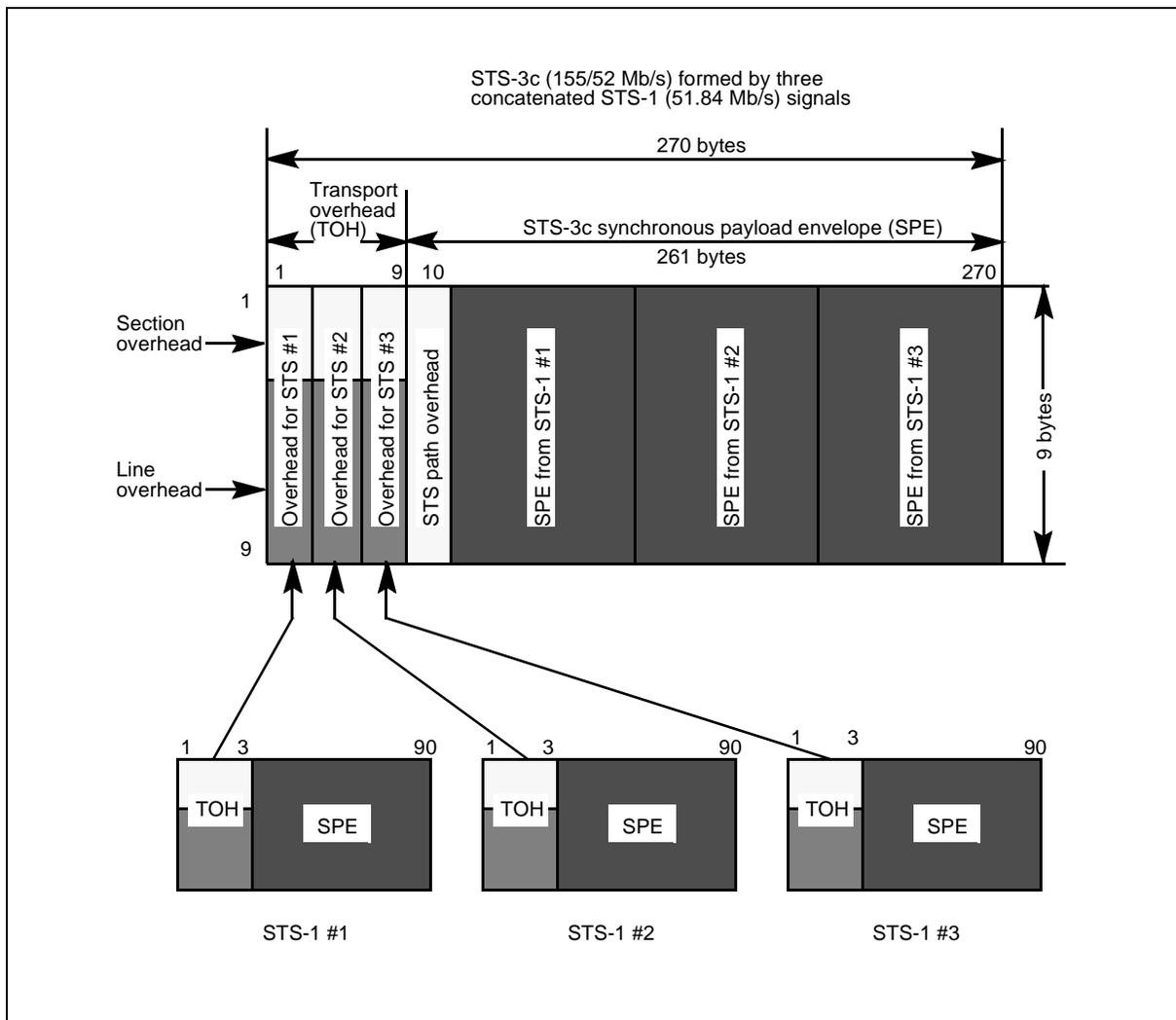
The STS-1 has a capacity of 51.84 Mb/s. That capacity may not be enough to carry future wide-bandwidth services. To carry a service that requires wide bandwidth, multiple VT6s or multiple STS-1s can be concatenated (connected together).

When two or three STS-1s are concatenated, the concatenated signal is referred to as STS-2c or STS-3c. STS-1s can be concatenated up to STS-3. Beyond STS-3, concatenation is done in multiples of STS-3c.

Note: STS-3c connections can be added only for OC-3 tributaries on a virtual tributary bandwidth manager (VTBM) ring.

Figure 12-7 on page 12-13 shows three STS-1s concatenated to provide capacity of 155.52 Mb/s, to transport a Broadband Integrated Services Data Network (B-ISDN) H4 channel. All three concatenated STS-1 payloads are processed as a single service.

Figure 12-7
Concatenation of three STS-1s



Index

A

- Access bandwidth manager shelf
 - dimensions 7-6
 - layout 7-8
 - slots in 7-8
 - structure 7-8
 - usage 7-3
 - used as OPC shelf 7-15
- Access interface card
 - description 8-5
- AccessNode
 - DMS Access 5-11, 5-14
- Add-drop start-up configuration 6-3, 6-5
- AIS insertion into G1OUT and G2OUT 11-45
- Alarm relay card 7-20
 - description 8-22
- Application
 - business access 4-2
 - central-office modernization 4-4
 - definition 1-2
 - SONET feeder 4-6
- Architecture
 - for TR08 5-9
- Asynchronous fiber-optic system 4-6
- Asynchronous transport interface card 8-15
- ATIC 8-15
- Attached MPP 6-27

B

- Basic fiber-fed AccessNode
 - host switches for 5-2
 - product description 2-3

Bay

- dimensions 6-2
 - orderable predefined configurations 6-2
 - possible locations for 6-2
 - predefined configurations 6-2
- BNC I/O card
 - description 8-5
- Breaker interface panel
 - model NT4K14 7-19
 - alarm relay card in 7-20
 - circuit breakers in 7-21
 - connectors on sides of 7-21
 - dimensions 7-20
 - plug-in modules for 8-22
 - talk battery filter card in 7-20
 - wirewrap pins on 7-23
 - model NT7E56 7-25
 - circuit breakers in 7-27
 - DIP switches on 7-27
 - office alarm board in 7-28
 - optional modem in 7-29
 - wirewrap pins on 7-29
- Building integrated timing source 10-3, 11-15
- Business access application 4-2

C

- Cable organizer panel 7-61
 - description 7-61
 - used with transport bandwidth manager shelf 7-61
- Central-office modernization application 4-4
- Circuit breaker
 - NT4K14 breaker interface panel 7-21
 - NT7E56 breaker interface panel 7-27

- Clock source 11-13
 - settings
 - ESI 11-14
 - freerun 11-13
 - linetimed 11-14
 - looptimed 11-13
 - Cluster
 - definition 1-2
 - Common-equipment power card
 - description 8-5
 - Concatenated payload 12-12
 - Configuration
 - definition 1-2
 - predefined, for bays
 - add-drop start-up 6-3, 6-5
 - enhanced TBM shelf bay,
 - single-shelf 6-9
 - enhanced TBM shelf bay,
 - three-shelf 6-9
 - enhanced TBM shelf bay, two-shelf 6-9
 - multiplexer 6-3, 6-7
 - prewired for 672 copper lines 6-2, 6-3
 - transport bay, single-shelf 6-9, 6-10
 - transport bay, three-shelf 6-9, 6-13
 - transport bay, two-shelf 6-9, 6-13
 - standard MBP expansion 6-25
 - standard MBP master 6-19, 6-30
 - standard MPP 6-27
 - STSBM Zone 2 MBP master 6-19, 6-30
 - STSBM Zone 2 MPP 6-27
 - STSBM Zone 4 MBP master 6-19
 - STSBM Zone 4 MPP 6-27, 6-30
 - VTBM Zone 4 MBP expansion 6-25
 - VTBM Zone 4 MBP master 6-19
 - Connection Manager tool 5-10
 - Control network
 - connectors for 10-6
 - Controlled-environment vault
 - location for a bay 6-2
 - Cooling module 7-31
 - Cooling unit 7-31, 7-61
 - description 7-61
 - Copper line
 - interface to 10-3
 - Copper-distribution drawer 7-35
 - Copper-distribution shelf 7-35
 - connectors 7-38
 - plug-in modules
 - copper-distribution shelf power
 - converter 8-16
 - line cards 8-19
 - line cards, Epsilon station 8-19
 - line cards, manual ringdown
 - 2-wire 8-20
 - line cards, Omega 2-wire office 8-19
 - line cards, Omega 2-wire station 8-19
 - line cards, Omega 4-wire 8-19
 - line cards, Omega 6/8-wire 8-19
 - line cards, universal voice grade 8-20
 - metallic test access card 8-21
 - narrowband line-interface card 8-21
 - power filter 8-21
- Copper-distribution shelf power
 - converter 8-16
- Cserver
 - definition 1-3
- ## D
- Digital analog remote test system
 - description 8-8
 - Digital copper system 4-6
 - Digital line
 - interface to 10-2
 - Digital loop carrier system
 - compatibility with AccessNode 4-8
 - DIP switch
 - on NT7E56 breaker interface panel 7-27
 - DMS Access
 - description 5-11
 - VLCM 5-14
 - DMS-1 Urban
 - compatibility with AccessNode 4-8
 - DS1
 - GR-303 DMS 5-5
 - input card
 - description 8-5
 - Operations maintenance channel 2-8
 - output card
 - description 8-5
 - protection bridge card
 - description 8-6

-
- DS1 (continued)
 - TR08 5-9
 - visibility 12-10
 - DS1/VT mapper
 - description 8-6
 - DS1-fed AccessNode 2-6
 - host switches for 5-2
 - topology 3-22
 - DS3
 - not supported in DS1-fed systems 2-8
 - not supported in single-ended systems 2-11
 - protection switch card
 - description 8-6
 - DS3 mapper
 - description 8-6, 8-7
- E**
- Enhanced TBM shelf bay configuration
 - single-shelf 6-9
 - three-shelf 6-9
 - two-shelf 6-9
 - Enhanced transport interface card 8-15
 - Epsilon station line card
 - description 8-19
 - Ethernet port 10-5, 10-9
 - ETIC 8-15
 - Express orderwire
 - interfaces for 10-7
 - External synchronization carrier 11-18
 - External synchronization interface
 - clock source 11-14
 - hardware 11-18
 - External synchronization interface card 11-18
 - clocks provided by 11-15
 - connector 10-3
 - description 8-7
 - older and newer versions of 11-23
 - output timing signals 11-24
 - G1OUT and G2OUT 11-17, 11-45
 - timing modes 11-18
 - acquire mode 11-19
 - fast mode 11-20
 - freerun mode 11-19
 - holdover mode 11-20
 - External synchronization interface card, timing modes (continued)
 - normal mode 11-20
 - External timing 11-6
- F**
- Fan. See Cooling module
 - Fiber central office terminal
 - definition 1-3
 - Fiber management storage tray
 - description 7-41
 - Fiber storage panel
 - description 7-41
 - TBM shelf
 - description 7-63
 - Fiber storage tray
 - description 7-43
 - Fiber-fed system
 - synchronization 11-1
 - topology 3-2
 - ring 3-2
 - Freerun clock source
 - description 11-13
 - Freerun timing 11-5
 - by ESI card 11-19
 - by OC-12 VTBM circuit pack 11-27
 - description 11-13
- G**
- G1OUT and G2OUT 11-17
 - AIS insertion 11-45
 - GR-303 MVI
 - in a DS1-fed system (fig) 2-12
 - in a point-to-point system (fig) 2-12
 - in a single-ended system (fig) 2-13
 - in a VTBM system (fig) 2-14
 - topologies supported 2-11
- H**
- Hierarchy violation 11-42
 - preventing 11-42
 - Holdover timing
 - by ESI card 11-20
 - by OC-12 VTBM circuit pack 11-28
 - Hut
 - location for a bay 6-2
-

I

Integrated remote test unit

description 8-7

Interface

DMS Access 5-11

for control network 10-6

for Ethernet 10-5

for external synchronization interface 10-3

for operations controller 10-3

for orderwire 10-7

for parallel telemetry 10-6

for serial telemetry 10-6

for X.25 10-5

to copper lines 10-3

to digital lines 10-2

to optical lines 10-2

TR08 5-8

Interfaces 10-13

DMS-X interface to APC-100 5-14

J

Jack

for OTLP 10-10

for Digital Data Service 10-10

for metallic test access 10-10

L

Line card

description 8-19

Line timing 11-7

linetimed clock source 11-14

Line-level overhead 12-4

Linetimed clock source 11-14

Local craft access panel

model NT4K16 7-44

connectors and indicators 7-45

interfaces on 10-13

model NT7E5047 7-64

interfaces on 10-13, 10-14

model NT7E5051

connectors and indicators 7-64

Local orderwire

interfaces for 10-7

Local terminal

port for 10-9

Local test cabinet

description 8-8

Lone operations controller

in a DS1-fed system 3-28

in a single-ended system 3-33

Loop timing 11-6

looptimed clock source 11-13

Looptimed clock source 11-13

M

Maintenance interface card

description 8-8

Manual ringdown 2-wire line card

description 8-20

Map

for single-ended systems 2-11

Matched node 3-10

connection rules 3-16

hardware and software requirements 3-15

primary and secondary gateway 7-49

primary and secondary gateways 7-48

primary gateway 3-11

protection methods 3-12

secondary gateway 3-11

Metallic test access 10-10

Metallic test access card

description 8-21

Modem

in NT7E56 breaker interface panel 7-29

Modular Business Package 6-17

configuration

expansion cabinet 6-25

master cabinet 6-19

description

expansion cabinet 6-23

master cabinet 6-19

Modular Power Package

cabinet 6-17

configurations 6-27

description 6-27

Multihosting 5-7

definition 1-3

definition of the term 5-3

figure 5-7

GR-303 DMS DS1s for 5-5

ownership of lines 5-6

Multiplexer configuration 6-3, 6-7

N

Narrowband line-interface card

description 8-21

Network element

definition 1-4

O

OC-12 interface circuit pack

description 8-9

OC-12 VTBM interface circuit pack

description 8-10

timing modes 11-26

acquire mode 11-27

automatic control 11-29

freerun mode 11-27

holdover mode 11-28

normal mode 11-27

provisioning rules 11-28

OC-3 interface circuit pack

description 8-11

Omega 2-wire office line card

description 8-19

Omega 2-wire station line card

description 8-19

Omega 4-wire line card

description 8-19

Omega 6/8-wire line card

description 8-19

OPC shelf 7-2

access bandwidth manager shelf used

as 7-15

bay-sharing TBM

bay configuration used for 6-16

definition 1-5

for a basic fiber-fed system 3-8

for a DS1-fed system 3-29 to 3-30

for a single-ended system 3-33

stand-alone ABM 7-15

bay configuration used for 6-7, 6-16

supporting operations maintenance

channel 7-17

stand-alone TBM 7-58

bay configuration used for 6-11, 6-16

OPC shelf (continued)

transport bandwidth manager shelf used

as 7-58

OPC. See Operations controller

Operations controller module

description 8-12

Ethernet port 10-5, 10-9

in a fiber-fed system 3-8

portable 7-59

ports for 10-3

possible locations

in a basic fiber-fed system 3-8

in a DS1-fed system 3-28

in a single-ended system 3-32

span of control 1-4, 8-12

Operations maintenance channel

DS1s 2-8

OPC shelf supporting 7-17

OPS/INE TL1 provisioning OS interface

software

not supported for single-ended RFTs 2-11

Optical interface circuit packs

OC-12 8-9

OC-12 VTBM 8-10

OC-3 8-11

Optical line

interface to 10-2

Orderwire

audible alarm 10-8

capabilities 10-7

connectors 10-7

interfaces for 10-7

LEDs 10-8

not supported in DS1-fed systems 2-8

not supported in single-ended

systems 2-11

push-buttons 10-8

Overhead

access to layers of 12-6

layers of 12-4

SONET 12-3

STS line-level 12-4

STS path-level 12-4

STS section-level 12-4

VT path-level 12-6

P

- Packaging option
 - bay 6-2
 - Modular Business Package 6-17
 - Series 800A outside plant cabinet 6-31
- Pair gain test controller
 - pair gain test controller/metallic test access card 8-12
- Parallel telemetry
 - port for 10-6
- Path-level overhead
 - STS path-level overhead 12-4
 - VT path-level overhead 12-6
- Payload, concatenated 12-12
- Pointers in SONET system 12-10
- Point-to-point
 - timing 11-11
- Port
 - for external synchronization interface 10-3
 - for local terminal 10-9
 - for operations controller
 - Ethernet 10-9
 - RS-232C 10-9
 - serial 10-4
 - for remote terminal 10-9
 - for serial telemetry 10-7
- Power filter 8-21
- Prewired for 672 copper lines, bay
 - configuration 6-2, 6-3
- Processor card
 - description 8-13
- Protection method
 - drop and continue on protection 3-14
 - drop and continue on working 3-13
- Public switched telephone network
 - cable
 - connector for 7-52

R

- Remote digital terminal
 - RFT as 1-5
- Remote fiber terminal
 - definition 1-5
- Remote terminal
 - port for 10-9

Ring topology. See Topology, of a fiber-fed system, ring

- RS-232C port
 - for operations controller 10-9

S

- Section-level overhead
 - as part of transport overhead 12-4
- Serial I/O card
 - description 8-13
- Serial telemetry
 - ports for 10-6
- Series 800A outside plant cabinet
 - description 6-31
- Service
 - Digital Data Service
 - jacks for 10-10
- Shelf type
 - access bandwidth manager 7-3
 - copper-distribution shelf 7-35
 - transport bandwidth manager 7-48
- Side interconnect left circuit pack
 - on access bandwidth manager shelf 7-9
 - connectors on 10-11
 - on transport bandwidth manager shelf 7-52
 - connectors on 10-12
- Side interconnect right circuit pack 7-12
- Single-ended AccessNode 2-8
 - default maps for 2-11
 - topology 3-31
- SLC-96 5-8
- Software
 - core 9-2
 - optional 9-6
- SONET
 - concatenated payloads 12-12
 - feeder application 4-6
 - frame format 12-2
 - overhead 12-3
 - pointers in 12-10
 - purpose of 12-1
- Span of control
 - operations controller 1-4, 8-12
- Stratum clock
 - synchronization 11-2
- STS. See Synchronous transport signal

-
- Switched Access Remote Test System
 - description 8-8
 - Synchronization
 - AccessNode equipment functions 11-1
 - hierarchy 11-3
 - status messages 11-31
 - status messaging, benefits 11-35
 - stratum clocks 11-2
 - timing islands 11-36
 - timing islands, preventing 11-37
 - Synchronous payload envelope
 - in STS-1 12-3
 - in VT group 12-6
 - Synchronous transport signal
 - base rate 12-1
 - concatenated 12-12
 - System
 - definition of 1-5
 - types of
 - basic fiber-fed. See Basic fiber-fed AccessNode
 - DS1-fed. See DS1-fed AccessNode
 - single-ended. See Single-ended AccessNode
- T**
- Talk battery filter
 - card 7-20
 - circuit card
 - description 8-22
 - TBOS 10-7
 - Test access card
 - description 8-13
 - Test access path card
 - description 8-14
 - Test bypass pair card
 - description 8-14
 - Through-flow cooling unit 7-31
 - TIC 8-15
 - Timing
 - AIS insertion 11-45
 - clock source 11-13
 - ESI 11-14
 - freerun 11-13
 - linetimed 11-14
 - looptimed 11-13
 - Timing (continued)
 - deviation detection by ESI cards 11-23
 - distribution by ESI cards 11-17, 11-24, 11-45
 - external timing 11-6
 - freerun timing 11-5
 - in a point-to-point topology 11-11
 - in a ring topology 11-11
 - line timing 11-7
 - loop timing 11-6
 - output signals 11-17
 - references
 - sources of external timing 11-15
 - sources of line timing 11-7
 - summary 11-47
 - Timing and cross-connect card
 - description 8-14
 - Timing loop 11-39
 - preventing 11-39
 - Timing mode
 - ESI card
 - acquire mode 11-19
 - fast mode 11-20
 - freerun mode 11-19
 - holdover mode 11-20
 - normal mode 11-20
 - OC-12 VTBM circuit pack
 - acquire mode 11-27
 - automatic control 11-29
 - freerun mode 11-27
 - holdover mode 11-28
 - normal mode 11-27
 - provisioning rules 11-28
 - Topology
 - of a DS1-fed system 3-22
 - of a fiber-fed system 3-2
 - ring 3-2
 - ring timing 11-11
 - of a single-ended system 3-28
 - TR-08
 - DS1 5-9
 - interface 5-8
 - Traffic
 - DS3s
 - not supported in DS1-fed systems 2-8
 - not supported in single-ended systems 2-11
-

Traffic (continued)
 supported by
 basic fiber-fed systems 2-5
 basic single-ended systems 2-10
 DS1-fed systems 2-7
 UDLC
 not supported in DS1-fed systems 2-8
 not supported in single-ended systems 2-11
Transport
 DS3s 2-10
Transport bandwidth manager bay
 configuration
 single-shelf 6-9, 6-10
 three-shelf 6-9, 6-13
 two-shelf 6-9, 6-13
Transport bandwidth manager shelf 7-48
 dimensions 7-49
 layout 7-51
 slots in 7-51
 structure 7-51
 used as OPC shelf 7-58
Transport interface card 8-15

U

Universal digital loop carrier traffic
 not supported in DS1-fed systems 2-8
 not supported in single-ended systems 2-11
Universal voice grade station line card
 description 8-20
User interface
 ports for 10-9

V

Virtual line concentrating module
 DMS Access 5-14
 DMS Access, description 5-11
Virtual tributary
 groups 12-6
 sizes 12-6
Visibility, of DS1s in SONET 12-10
VLCM
 DMS Access, description 5-11
VT100-type terminal
 port for 10-9

W

Wirewrap pin
 on NT4K14 breaker interface panel 7-23
 on NT7E56 breaker interface panel 7-29

X

X.25
 interface 10-5
X11 terminal 10-5

SONET Products

AccessNode

Configuration and Equipment Description

Copyright © 1993–1999 Nortel Networks, All Rights Reserved.

All information contained in this document is subject to change without notice. Nortel Networks reserves the right to make changes to equipment design or program components, as progress in engineering, manufacturing methods, or other circumstances may warrant.

ACCESSNODE, NORTEL, NORTEL NETWORKS, and SUPERNODE are trademarks of Nortel Networks Corporation. SLC-96 is a trademark of American Telephone & Telegraph Company. X Window System is a trademark of the Massachusetts Institute of Technology. UNIX is a trademark licensed exclusively through X/Open Company

Publication number: 323-3001-100

Release: Issue 3.0

Date: October 1999

Printed in Canada

