Marconi MCN7000™
System Applications Guide

206-005-01

Marconi

First Edition: December 2001

A publication of:
Marconi Communications Optical Networks Corp.
1375 Trans-Canada
Dorval, Quebec
Canada H9P 2W8
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Printed in Canada

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Preface

The Multiservice Carrier Node, MCN7000, is part of Marconi's complete end-to-end managed Optical Network Solutions. Marconi's solutions incorporate forward-looking technology to support service providers' network and services requirements today and well into the future. Whether TDM, Packet, or Lambda-based, Marconi delivers flexible and easy-to-use intelligent optical solutions for providing end-to-end services.

This guide describes the Marconi MCN7000–supported cross-connections, protection schemes, network deisign, ring interconnection, and synchronization.

Related Documents

While reading this guide, you may want to refer to the following documents:

Hardware Installation

- *MCN Hardware Reference Guide (203-023)*
- *MCN Subrack Installation Guide (203-024)*

OverView Software

- *OverView 3000 User's Guide (206-004)*
- *OverView 30 User's Guide (206-006)*

General Documents

- *MCN General System Description (214-003)*

Network Turn-up Sequence

The following table displays a network turn-up sequence and where to find user information:

Sequence	Description	Where to look
Plan your network	Plan the following: • Ring design & protection scheme • Bandwidth requirements & reuse • Ring interconnection & timing	Chs. 1 through 7 of the *MCN7000 Subrack System Applications Guide (206-003)* *MCN Hardware Reference Guide (203-023)*
Install MCN7000	Install MCN7000 and repeat installation for all NEs	*MCN Subrack Installation Guide (203-024)*
Install the EMS	Installation instructions for OverView 30 or OverView 3000	Ch. 1 of the *OverView 30 User's Guide (206-006)* Ch. 2 of the *OverView 3000 User's Guide (206-004)*
Initial connection	Perform the following: • Connect to and set up a session between the PC & MCN7000 • Set the SID, and Real Time Clock	Chs. 1 through 4 of the *OverView 30 User's Guide (206-006)* Ch. 3 & 7 of the *OverView 3000 User's Guide (206-004)*
Configure IP	Configure the IP Stack, IP Interface and IP Route	Ch. 6 of the *OverView 30 User's Guide (206-006)* Ch. 6 of the *OverView 3000 User's Guide (206-004)*
Provision mappers	Perform the following: • Provision bandwidth & XCONs • Provisioning optical, electrical & ethernet mappers	Ch. 7 of the *OverView 30 User's Guide (206-006)* Ch. 7 & 8 of the *OverView 3000 User's Guide (206-004)*
Other provisioning	Perform the following: • Create equipment protection groups • Activate termination points & SoftKey features	Ch. 9 & 11 of the *OverView 30 User's Guide (206-006)* Ch. 9 & 12 of the *OverView 3000 User's Guide (206-004)*

Sequence	Description	Where to look
Configure OSI	Perform the following: • Set the ULDCC and LLSDCC • Initialize the OSI Stack	Ch. 10 of the *OverView 30 User's Guide (206-006)* Ch. 16 of the *OverView 3000 User's Guide (206-004)*
Set the system clock	Perform the following: • Set System Clock • Provision Clock source on an optical line, or BITS clock • Provision the TSG	Ch. 13 of the *OverView 30 User's Guide (206-006)* Ch. 14 of the *OverView 3000 User's Guide (206-004)*
Provision mapper bandwidth	Provision mapper bandwidth	Ch. 7 of the *OverView 30 User's Guide (206-006)* Ch. 9 of the *OverView 3000 User's Guide (206-004)*
Provision cross-connections	Provision cross-connections	Ch. 7 of the *OverView 30 User's Guide (206-006)* Ch. 10 of the *OverView 3000 User's Guide (206-004)*

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http://support.marconicomms.ca

If a customer support representative concludes that it is necessary for you to return your equipment for repair or exchange, you will be given a Return Material Authorization (RMA) number. You must have an RMA number before you ship equipment to Marconi for repair. Call the Repair Department at 1-877-262-2511 (toll free) or 1-(514)-685-1737 for an RMA number.

A representative will assign an RMA number and fax you a commercial invoice. Pack all equipment in antistatic material with sufficient protection against shipping damage and ship the equipment back to Marconi. It is highly recommended that you insure your package.

Make sure that the RMA number is clearly marked on the packaging.

For those in the USA, send the equipment to:

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Champlain NY 12919

For those in Canada and elsewhere, send the equipment to:

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CSE Department
1375 Trans-Canada
Dorval, Quebec
Canada H9P 2W8

Chapter 1

The MCN7000—A Multiservice Carrier Node

The Marconi MCN7000 is an advanced multi-service platform that cross-connects and manages networks that carry SONET, packet, and cell-based traffic. It is a cost-effective package that addresses a wide range of applications in terms of bandwidth growth, density, and diversity—with built-in robustness. The MCN7000 incorporates the latest technology to address and manage today's networks with tomorrow in mind, bringing a new level of flexibility to SONET networks. Network survivability is offered via proven SONET topologies such as UPSR, BLSR and linear ADM.

The MCN7000 extends Marconi's Multiservice Access System (MAS) capabilities from the edge to the core, by providing increased capacity, functionality, and intelligence to support higher traffic services. The MCN7000 takes these capabilities one level further into backbone networks by interfacing with Marconi's SmartPhotoniX DWDM systems such as the PMM and the PMA32, using colored optics.

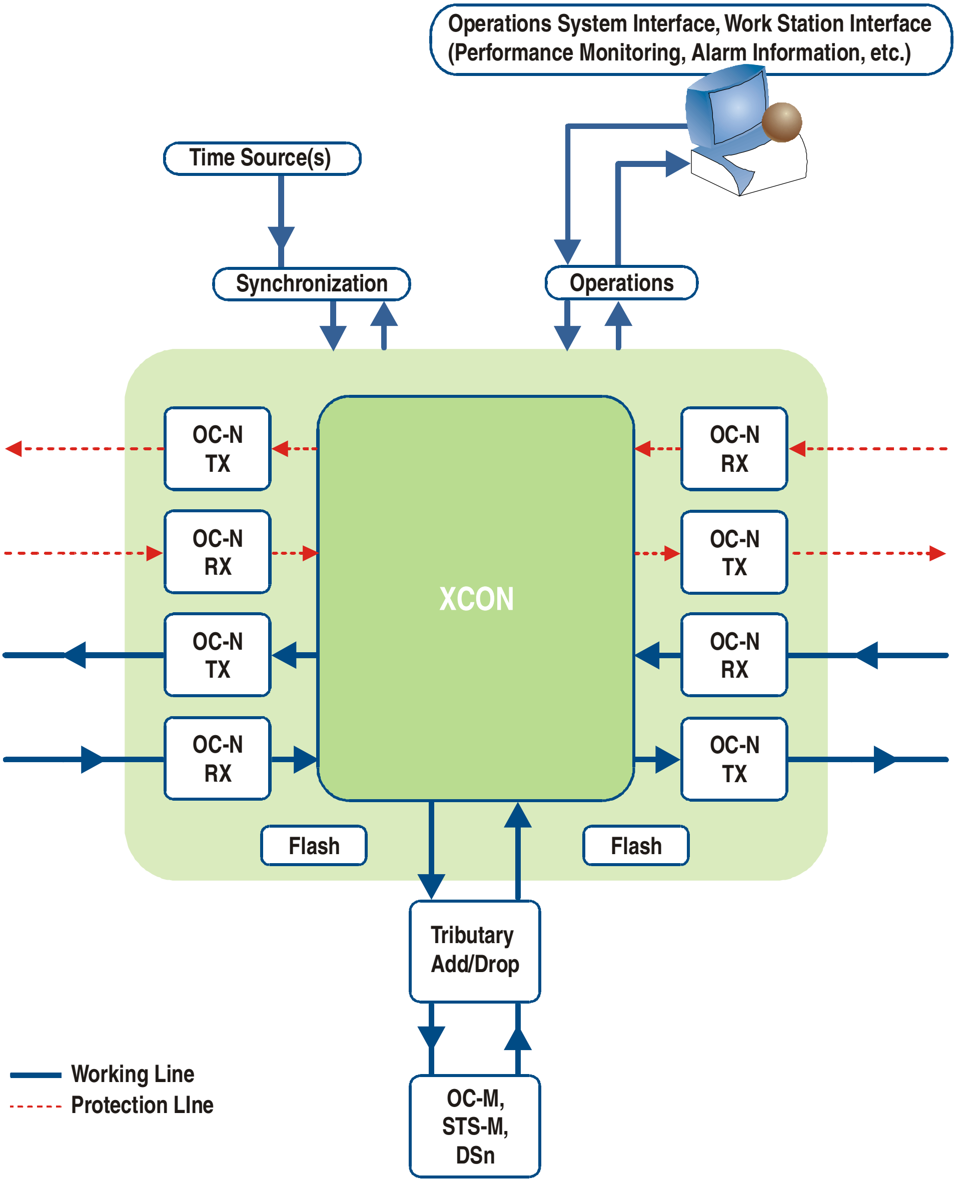
MCN7000 System Description

The MCN7000 system consists of the following suite of components:

- Transport interface module
- Operations interface module
- XCON DCS matrix
- NE software
- Synchronization module

The following digram illustrates these system components:

Figure 1 MCN7000 System Components



Transport Interface Module

The transport interface modules are the plug-in units connecting to customer traffic. This traffic is bi-directional optical (OC-n), asynchronous (DS1, DS3), data (Ethernet/ATM), or wavelength based (WDM). The transport interface module monitors basic traffic quality (e.g., Loss of Signal (LOS), and traffic framing).

Operations Interface Module

The operations interface module controls all operation, administration, maintenance, and provisioning (OAM&P) functions.

Specifically, this interface:

- Links the OverView 3000 Element Management System (EMS) to the Data Communications Channel (DCC) to broadcast provisioning information to interconnected NEs. Each DCC is terminated at the MCN7000 and re-routed to the appropriate location.
- Manages multiple operators. For example, more than one operator can be logged on to an MCN7000 concurently. These may be a combination of remote Central Office (CO) and local craft connections.
- Administers Gateway Network Element (GNE) functionality. The MCN7000 can act as a GNE, translating Network Management instructions to interconnected multi-vendor rings and mesh networks.

XCON DCS Matrix

The MCN7000's Digital Cross-connect is known as the XCON unit. The XCON terminates digital signals and provisions cross-connects. The XCON manages all bandwidth entering the Subrack and gives visibility to embedded tributaries. The XCON can groom tributaries as they enter the Subrack, without terminating the higher order signal. Cross-connect configurations are stored in a database, which can be restored in the event of equipment failure.

The XCON performs the following cross-connect types:

- Unidirectional
- Bidirectional
- Loopback
- Broadcast

While most DCSs cross-connect at the STS-1 level, the MCN7000's XCON can cross-connect at both the STS-1 and VT levels. Further, the XCON can cross-connect equivalent SONET and SDH signals, which is useful for IXC/ILEC International connections.

The XCON is also responsible for path protection switching and alarm report generation.

The XCON functions are user configurable via the OverView Element Management Software (EMS). Each MCN7000 contains two XCONs for redundancy.

For more information on XCON features, see "Cross-connection Types" on page 29.

NE Software

The NE software controls and manages all MCN7000 components. NE software is responsible for the following tasks:

- Completes user-defined functions issued in TL1 from the Element Management System (EMS).
- Monitors system performance and generates alarms when necessary.
- Monitors and activates/deactivates ports used to communicate with the EMS.
- Maintains a database of cross-connect settings and generates an inventory upon request.
- Monitors network security levels for varying user access.
- Stores an overwritable backup copy for system restoration and upgrades.

Each MCN7000 contains two disks, each storing duplicate configurations, for redundancy.

Synch. Module

The SONET protocol is a synchronous standard based on Time Division Multiplexing (TDM). The synchronization module generates timing for all internal MCN7000 components, and broadcasts timing to interconnected network elements. For equipment to communicate accurately, each network element must have a common timing reference.

Subrack timing may be generated in the following ways:

- Directly from an MCN7000, using a Stratum 3E clock
- Indirectly from a Building Integrated Timing Supply (BITS), or an incoming OC-n signal.

Lines Versus Tributaries

The definition of lines and tributaries is relative. However, lines are generally considered to be the highest capacity signal entering and exiting the MCN7000. Therefore, tributaries are considered to be lower capacity signals. The XCON concentrates several **tributaries** into a single **line**.

For example, in a typical optical access ring, an OC-12 signal is considered the line and lower capacity signals (e.g., DS1/DS3) are considered tributaries. In this example, the relationship is clear:

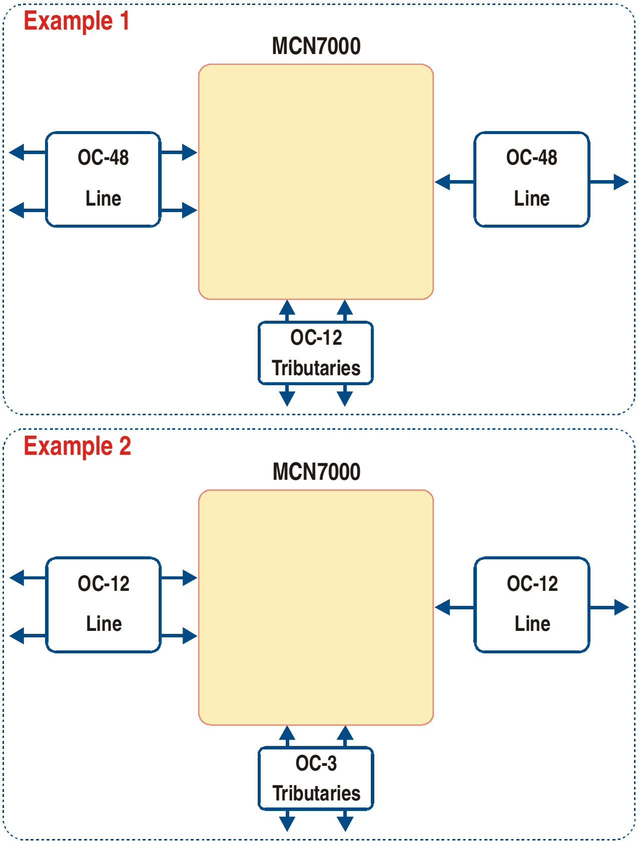
- There are many tributaries to one line
- Tributaries are asynchronous signals whereas the line is a SONET optical signal
- The line signal is part of an optical ring topology which is involved in *line* transport

Because of the MCN7000's flexibility the definition is more complex. Lines and tributaries have the following characteristics:

- Lines are higher or equal capacity to the signal entering or exiting the Subrack.
- Because of its capacity, the MCN7000 may have more than one line entering or exiting the subrack.
- Lines may collect, or concentrate, more than one tributary signal.
- Tributaries are any signal capacity lower or equal to the line. Tributaries may be optical (e.g, OC-3/OC-12) or asynchronous (DS1/DS3) signals.

The lines and tributaries may be illustrated as follows:

Figure 2 Lines and Tributaries



Chapter 2
XCON Functionality

The XCON card is the central point of exchange for all the traffic coming from and going to each and every traffic-carrying slot of the shelf. The card routes the traffic between all the optical and electrical mappers in the system and controls system timing. The XCON card can switch signals from incoming lines to outgoing lines at a level of STS-1.

This chapter describes how these functions are implemented using individual cross-connect types. The last section describes some of the most common applications for Digital Cross-connect Systems (DCS), such as the XCON.

XCON Applications

This section describes the following DCS functionality:

- Signal Grooming
- Add/Drop
- Facility Rolling
- Signal Broadcast
- Performance Monitoring

Signal Grooming

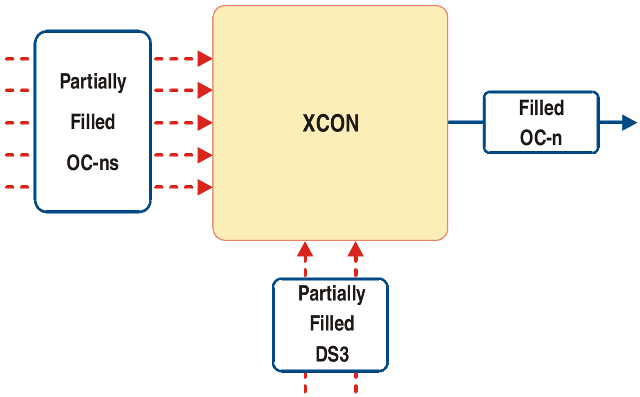
Signal grooming groups and re-organizes signals entering the MCN7000 before they are transmitted on optical lines. Grooming uses traffic consolidation and segregation to make maximum use of the high-speed line bandwidth between optical nodes.

Consolidation

The MCN7000 uses consolidation to aggregates incoming signals from partially used bandwidth. Traffic exits the MCN7000 in a concentrated form, leaving fewer empty timeslots along expensive fiber-optic routes.

The following diagram illustrates consolidation:

Figure 3 Signal Consolidation



Segregation

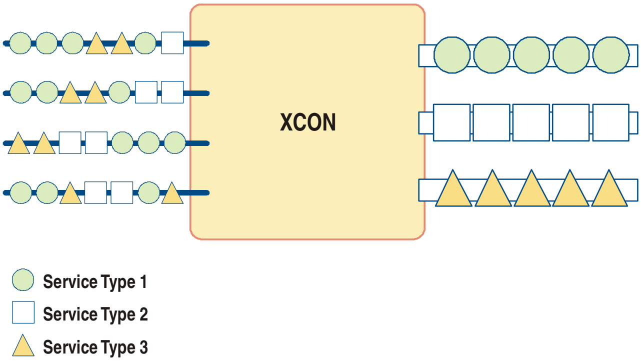
Segregation sorts mixed incoming tributary traffic and sends out line traffic that is uniform. Traffic is sorted by:

- Service type
- Destination
- Protection level

Segregation simplifies maintenance and restoration procedures.

The following diagram illustrates segregation:

Figure 4 Signal Segregation



Add/Drop

Add/drop gives access to embedded tributaries within a high-speed terminating line signal. Tributaries can then be dropped from the shelf to external equipment, or added to a different network segment.

The XCON's Add/drop functionality is similar to that of an Add Drop Multiplexer (ADM), however the XCON also provides dynamic bandwidth management known as Time Slot Interchange (TSI).

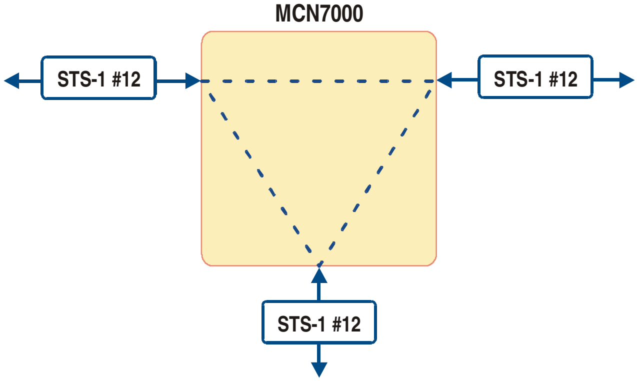
The MCN7000 manages all bandwidth entering or exiting in the following ways:

- Time slot assignment
- Time slot interchange

Time Slot Assignment

Time Slot Assignment (TSA) requires through signals to maintain the same timeslot on the incoming and outgoing signals. However, add/dropp traffic can added or dropped from/to any bandwidth timeslot. TSA allows for efficient concentration of signals and may save costly tributary ports at the drop site. TSA is the standard mode for ADMs and is the default passthrough mode for the MCN7000 add/drop cross-connections.

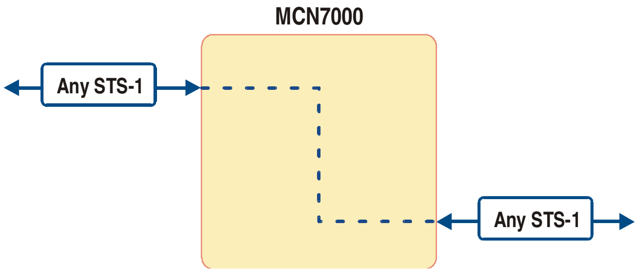
Figure 5 Time Slot Assignment



Time Slot Interchange

Time Slot Interchange (TSI) supports flexible assignment of both add/drop and through traffic. Using TSI, the XCON passes traffic through on any STS-1, regardless of the STS-1 entering the subrack. This feature is automatic and is useful when the network nears full capacity so that expensive bandwidth can be groomed and fully utilized.

Figure 6 Time Slot Interchange



Facility Rolling

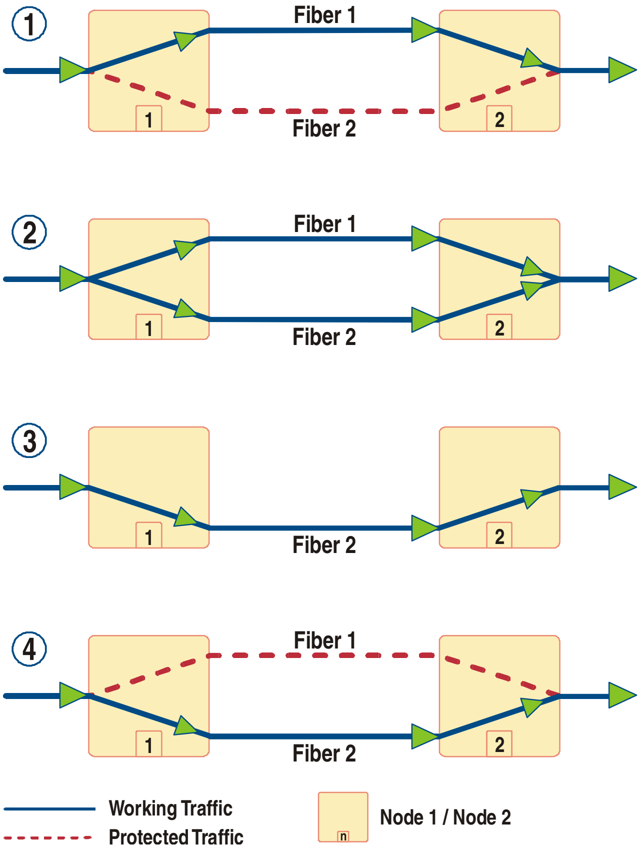
Facility rolling is performed between two or more MCN7000s for non-service affecting transport facility upgrades (e.g., OC-12 to OC-48). Traffic is duplicated and tramsnitted on multiple STS-1s through duplicate transport facilities. Traffic is switched from one line to the next, as the opposite equipment is upgraded.

The XCON automates facility rolling, so that the only manul portion of an upgrade procedure, involves physical replacement of the line cards.

Note: The Four-port OC-3/OC-12 optical mapper eliminates the need for physical card upgrade. Optical ports can be upgraded remotely using Marconi's SoftKey feature. For more information, see the *MCN General System Description (214-003)* or the *MCN Hardware Reference Guide (203-023)*.

The following example illustrates a general facility rolling example:

Figure 7 Facility Rolling



General steps are as follows:

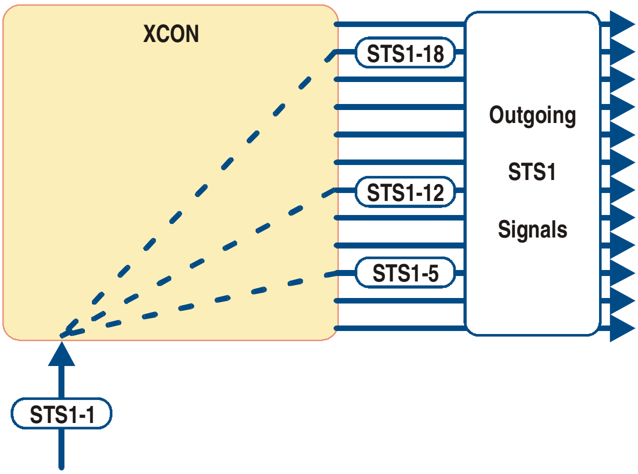
1. Master signal is transported on fiber 1. Fiber 1 to be upgraded.
2. Master signal is duplicated (fiber 1 and fiber 2)
3. Node 2 transport facility is upgraded. Traffic switches from fiber 1 to 2. Node 1 is notified of cut and transmits on fiber 2 exclusively.
4. Node 1 transport facility is upgraded. Traffic may revert to fiber 1, depending on how it is provisioned.

Signal Broadcast

Signal broadcast is the XCON's capacity to replicate one incoming signal to be the source for one or more outgoing signals. Signal broadcast is a 1-to-many relationship consisting of unidirectional cross-connections. A typical use of broadcast is for cable video service delivery.

The following diagram illustrates the XCON's broadcast functionality:

Figure 8 Signal Broadcast



Performance Monitoring

The XCON's Performance Monitoring (PM) feature analyzes incoming signal quality. PM statistics are recorded for each signal over various time intervals. If signal quality degrades below established thresholds, alarms may occur.

Cross-connection Types

Cross-connections are the building blocks used to provison DCS applications described in “XCON Applications” on page 24. The MCN7000 can establish cross-connections at the STS-1 and VT levels.

The MCN7000 supports the followings basic signal building blocks from which many applications can be created. Each building block, or cross-connection, can be created between any timeslot. The following four cross-connections exist:

- Unidirectional unprotected cross-connection
- Unidirectional protected cross-connection
- Bi-directional unprotected cross-connection
- Bi-directional protected cross-connection

Protected cross-connections are designed for signal redundancy purposes. However, optical networks protect traffic at various different levels. Therefore, an unprotected cross-connection does not necessarily mean that its traffic is left unprotected. Protection for this traffic may be provided at the path, line, or even ring architecture level (e.g., linear APS).

For more information on other protection mechanisms, see “Protection Schemes (2996)” on page 46.

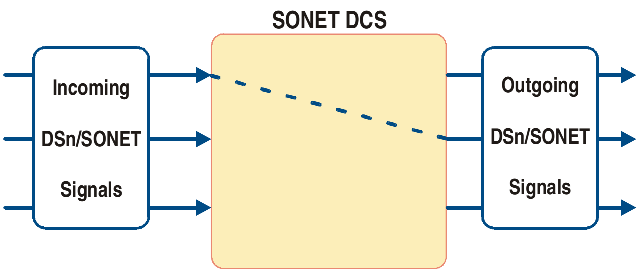
For detailed application provisioning instructions using these cross-connection types, see the *OverView 3000 User’s Guide (206-004)* and the *OverView 30 User’s Guide (206-006)*.

Unidirectonal Unprotected

A unidirectional unprotected cross-connection is not path protected. It is provisioned between bandwidth timeslots through the XCON matrix at a given signal rate (e.g., STS-1 or VT1.5). This cross-connection provides an outgoing timeslot with a single traffic source.

The following graphic displays this cross-connection:

Figure 9 Unidirectional Unprotedted Cross-connection

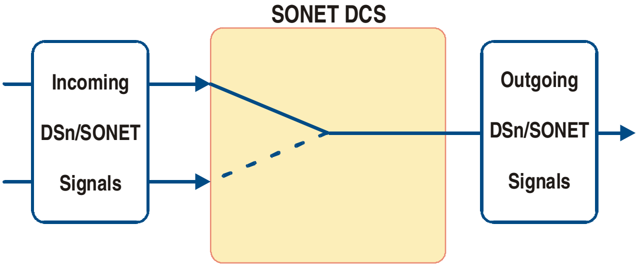


Unidirectional Protected

A unidirectional protected cross-connection is a path protected cross-connect. It is provisioned between bandwidth timeslots through the XCON matrix at a given signal rate (e.g., STS-1 or VT1.5). This cross-connection provides an outgoing timeslot with two sources of identical traffic for redundancy.

The following graphic displays this cross-connection:

Figure 10 Unidirectional Protected Cross-connection

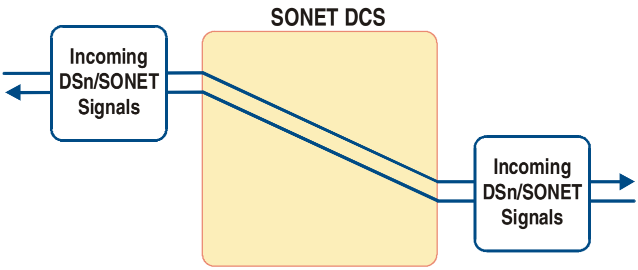


Bidirectional Unprotected

A bidirectional unprotected cross-connection is not path protected. This cross-connection connects the same time slots in both the transmit and receive direction at a given signal rate (e.g., STS-1 or VT1.5).

The following graphic displays this cross-connection:

Figure 11 Bidirectional Unprotected Cross-connection

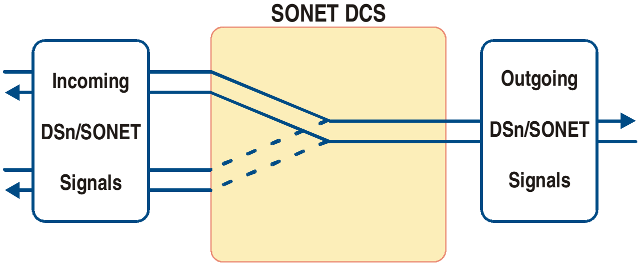


Bidirectional Protected

A bidirectional protected cross-connection is path protected. This cross-connection connects the same time slots in both the transmit and receive direction at a given signal rate (e.g., STS-1 or VT1.5). This cross-connection provides each outgoing timeslot with two sources of identical traffic for redundancy.

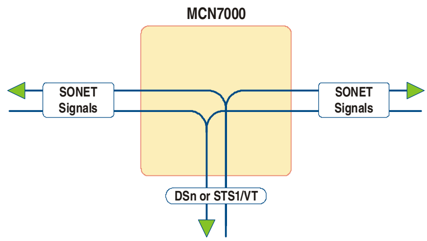
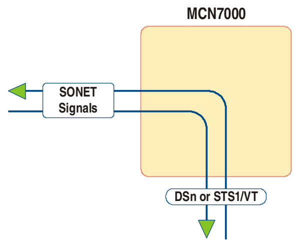
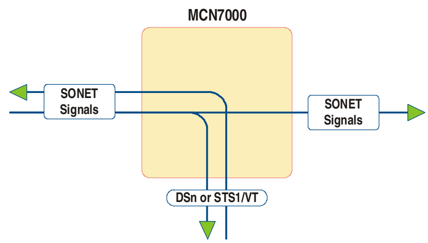
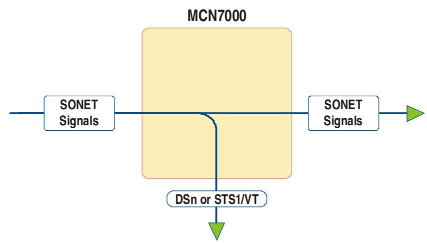
The following graphic displays this cross-connection:

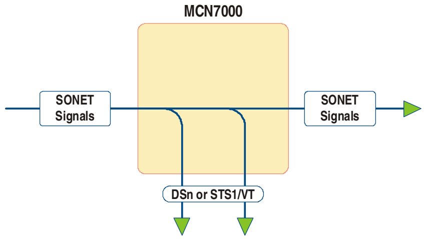
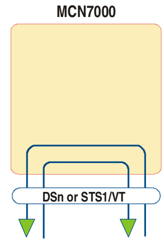
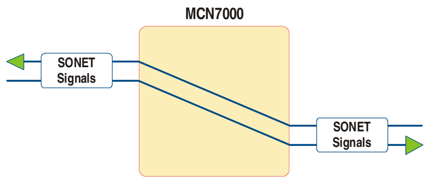
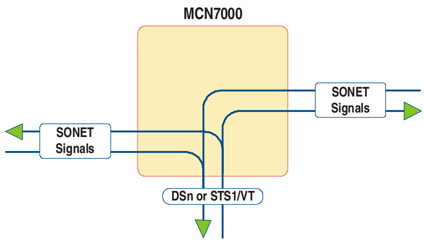
Figure 12 Bidirectional Protected Cross-connection



Connection Types

Connection types are configurations comprised of one or more cross-connections. Connections are provisioned in conjunction, usually between more than one NE, to provision logical traffic flow patterns. Connections must be compatible in order to support traffic patterns and network architecture.

Connection Type	Purpose	View
Add/Drop to same time slot in both directions	This connection is used for add/drop traffic supportiing TSA. This connection would typically be provisioned for a ring-based UPSR ADM application.	
Add/Drop to east or west only	This connection is used for add/drop traffic in a BLSR or point-to-point DCS application	
Drop-and-continue for bi-directional traffic	This connection is used for broadcast applications in a BLSR. This connection would typically be provisioned for ring-based BLSR video broadcast applications.	
Drop-and-continue for unidirectional traffic (broadcast)	This connection is uesd for broacast applicatoins, supporting TSA. This connection wold typically be provisioned for ring-based UPSR video broadcast applications.	

Connection Type	Purpose	View
Drop multiple copies of same traffic (broadcast)		
Tributary hairpinning		
Grooming of high speed timeslots	This conncetion supports TSI and can be used for signal grooming (consolidation or segregation). This connection is typically used for a head-end DCS application or in a Metro BLSR where bandwidth is at a premium.	
Add/Drop to different high speed timeslots	This connection is used for add/drop traffic supporting TSI. This connection is typically provioned for a ring-based UPSR ADM application.	

For more information on how these connections are used in network applications, see “Types of UPSR Paths” on page 65 and “BLSR Architecture (1230)” on page 70.

Specific Applications

Two of the main service applications for DCSs are point-to-point or ring-based Add/Drop Multiplexing and signal Transmultiplexing.

For detailed application provisioning instructions, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

Add/Drop Multiplexing

Add/Drop multiplexing is a method of extracting partial signals from the incoming bandwidth and dropping them locally. Low speed signals can enter the Subrack and be multiplexed onto a high-speed signal for long-haul transport. Add/Drop multiplexers support TSA.

The MCN7000 is a multi-service carrier node with a high drop capacity as well as the XCON digital cross-connect unit which supports TSI. This is a ring-based DCS and eliminates the need for extra equipment—the Add/Drop multiplexer and the Digital Cross-connect.

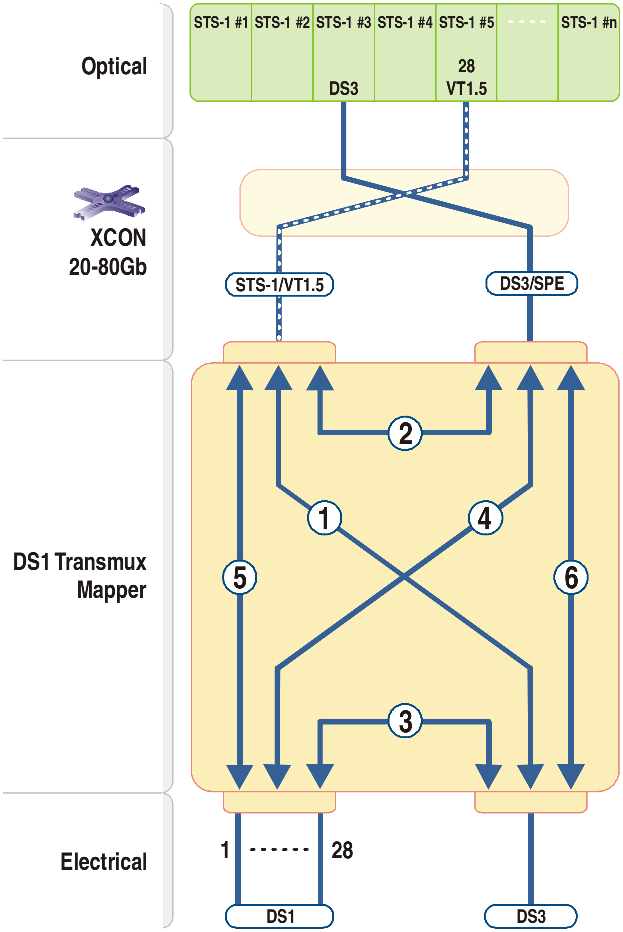
Trans-multiplexing

Transmultiplexing converts incoming to different capacities or granularities. For example, DS3 signals can be converted into constituent DS1s, which are mapped into SONET VT1.5s. This VT-visibility eliminates the need for extra M13 Digital Cross-connects.

The MCN7000 is a multi-service carrier node supporting M13 cross-connect functionality. The MCN7000's DS1 mapper with Transmux supports 28 Telcordia compliant GR-499 DS1 channels and one Telcordia compliant GR-499 DS3 channel. It includes integrated transmultiplexing functionality.

The functionality of this mapper is illustrated as follows:

Figure 13 DS1 Mapper with Transmux Functionality



The trans-multiplexing and cross-connection capabilities shown in the above illustration are defined as follows:

1. DS3 to STS-1/VT1.5 transmux
2. DS3/SPE to STS-1/VT1.5 transmux
3. DS1 to DS3 M13
4. DS1 to DS3/SPE transmux
5. DS1 to STS-1/VT1.5 cross-connect
6. DS3 to STS-1 cross-connect

Chapter 3

Basic Network Architecture

This chapter gives a basic overview of telecommunication network architectures all of which are supported by the MCN7000. Network survivability and protection switching mechanisms are also described.

Network Architectures

This section describes basic network architecture supported by the MCN7000.

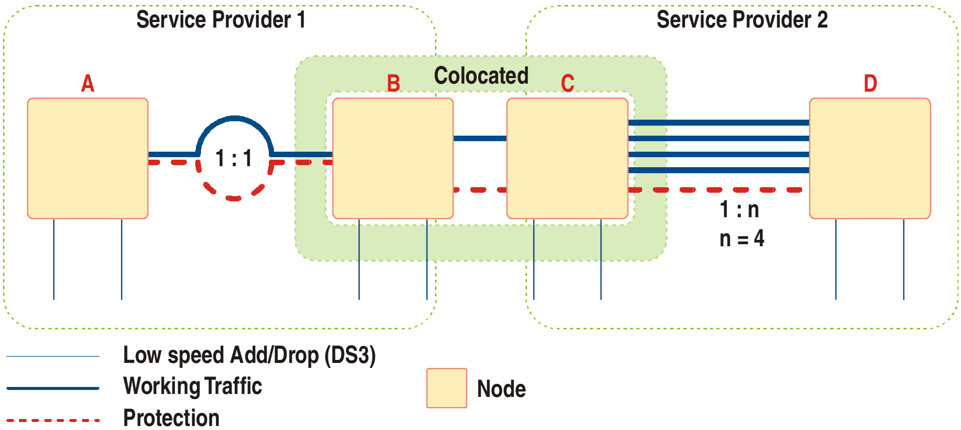
Linear System

A Linear system consists of two or more DCSs connected serially using fiber-optic cables. Low speed tributaries (e.g., DS3) can be added and dropped at each DCS along the linear chain.

Linear systems interface with redundant cables between DCSs. One line is used for working traffic and the second for protection. If there is a fiber cut, traffic switches to the protection fiber. Cables between DCSs take different physical routes to protect against fibercuts. This is known as route diversity.

The following graphic displays a Linear system:

Figure 14 Linear System Architecture



Point-to-point networks are a special case of a Linear system consisting of only two DCSs. Each end network element is known as Line Terminating Equipment (LTE).

Rings

A ring consists of a series of nodes where both ends are closed to form a loop. Nodes in a ring can be either Add/Drop Multiplexers (ADMs) or Ring-based DCSs. Rings are typically owned and operated by a single service provider and are provisioned using a single Network Element Management System (NEMS).

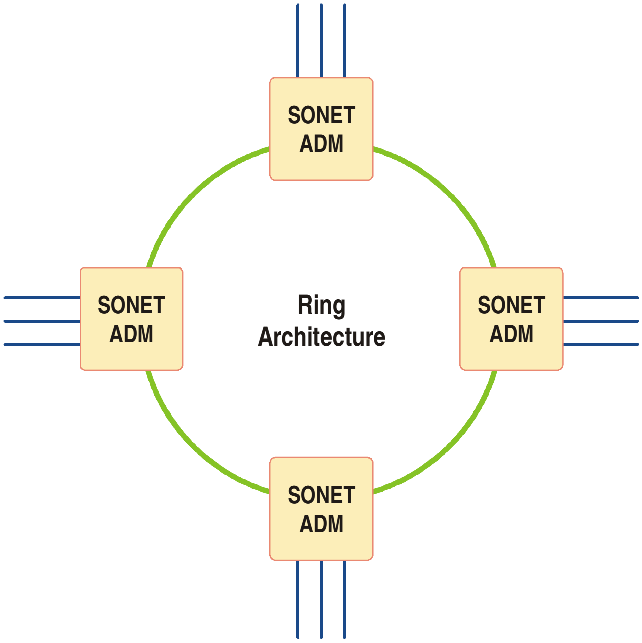
There are three basic ring types:

- Unidirectional Path Switched Rings (UPSR)
- 2-Fiber Bidirectional Line Switched Rings (BLSR)

- 4-Fiber Bidirectional Line Switched Rings (BLSR)

The following graphic displays a Ring network:

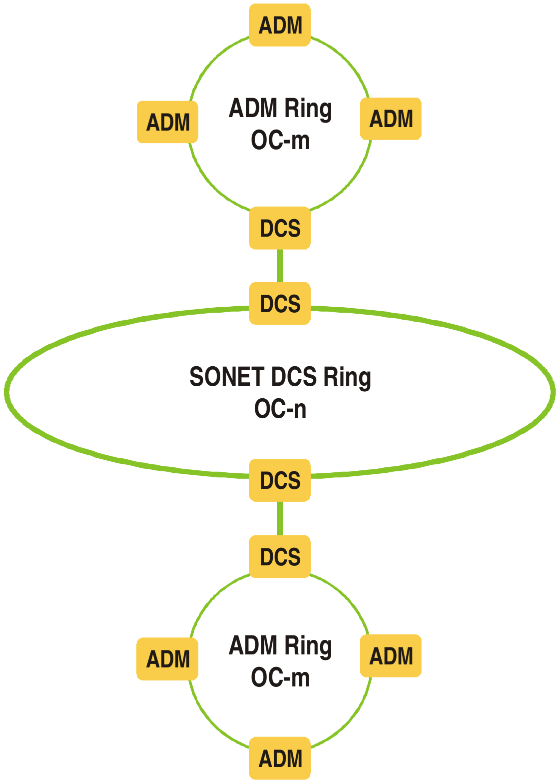
Figure 15 Ring Architecture



Ring topology can become much more complex when rings are interconnected. Protection switching and signal grooming must be coordinated between multiple service providers across separate rings.

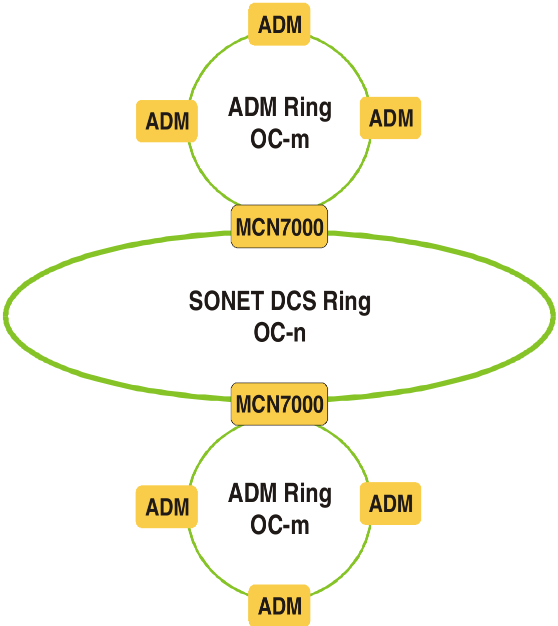
The following diagram displays the DCSs required between rings to perform signal grooming.

Figure 16 Ring Interconnection via DSC



The MCN7000 has both add/drop and ring-based cross-connect functionality. The following diagram displays how the MCN eliminates the need for external equipment:

Figure 17 Ring Interconnection via the MCN7000



For more information on rings, see "Unidirectional Path Switched Rings" on page 57 and "Bidirectional Line Switched Rings" on page 69.

Ring-based Traffic

Ring-based nodes are interconnected in a way so that they have knowledge of other nodes on the ring. For end-to-end traffic, each node must handle singnals in an appropriate way to complete the path. For example, nodes at both ends of a logical path add and drop signals to/from the ring, while intermediate nodes pass traffic along. A portion of the SONET signal overhead instructs the node on the final traffic destination as it enters the shelf.

Ring-based nodes handle traffic in one of three ways:

- Pass-through traffic
- Add/drop traffic
- Drop-and-continue traffic

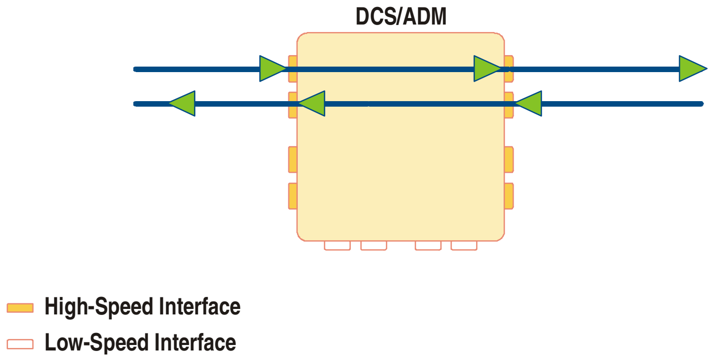
For detailed ring provisioning instructions using these connection types, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

Pass-through Traffic (1375)

Pass-through traffic channels pass through a node without dropping from the ring to lower speed tributaries. Because the XCON terminates all incoming signals, the signal must be reassigned to the outgoing port on the same ring. Because the XCON supports TSI, signal grooming can be performed on pass-through traffic. However, signal grooming is not possible in a typical ADM.

The following graphic illustrates pass-through traffic:

Figure 18 Pass-through Traffic



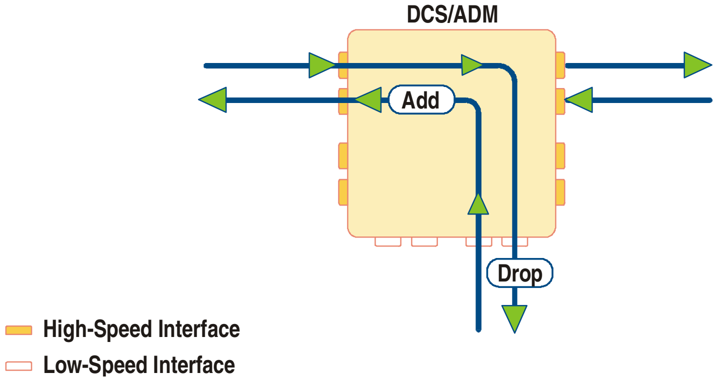
Add/Drop

Traffic either enters or exits the ring at nodes with channels provisioned in add/drop mode. Adding signals are concentrated, or multiplexed, onto high-speed fiber-optic lines for ting transport. For drop signals, tributaries of the high-speed signal are de-multiplexed and exit the node through a lower speed tributary port. Traffic can be added/dropped as either synchronous traffic (e.g., OC-3c/STM-1c) or asynchronous (e.g, DS1/E1).

For bi-directional (duplex) channels, each timeslot drop from a node is associated with an timeslot add (the reply).

For BLSRs, duplex add/drop cross-connections are configured in the following way:

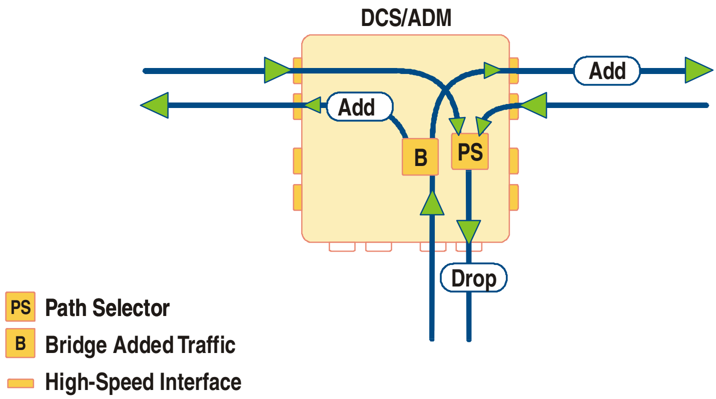
Figure 19 BLSR Add/Drop Traffic



UPSR add/drop cross-connections differ from those of BLSRs. UPSR uses path protection to protect network traffic. Add traffic is copied, or bridged, and transmitted in opposite directions on separate fibers around the ring. For drop traffic, a path selector chooses the best signal entering the shelf. Path switching protects against fiber cuts.

For UPSRs, duplex add/drop cross-connections are configured in the following way:

Figure 20 UPSR Add/Drop Ttaffic



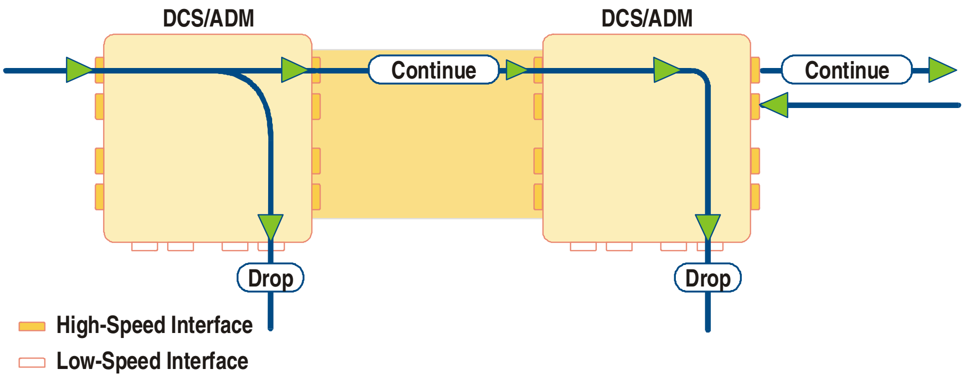
Drop-and-Continue

Drop-and-contine traffic is copied, or bridged, at the node it enters. One copy is cross-connected to a low-speed interface and dropped from the node, and the second is re-multiplexed into the high-speed signal and continued around the ring.

Drop-and-continue is typically used for broadcast traffic, such as cable television service.

The following graphic illustrates drop-and-continue traffic:

Figure 21 Drop-and-continue Traffic



A special case of drop-and-continue is used to interconnect rings which can withstand multiple fiber cuts, or interconnect equipment failure. For more information on interconnected rings, see “Ring Interconnection” on page 79.

Mesh

A Mesh network consists of multiple interconnected DCSs. Segments within the Mesh network can consist of linear networks or rings.

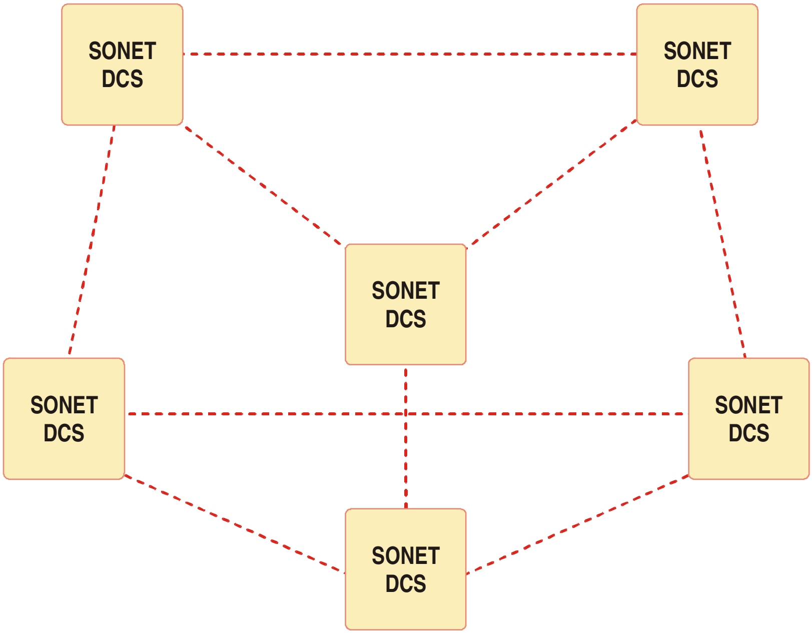
Mesh networks typically exist in metropolitain areas where the public telecommunications network is heterogeneous and signal diversity is high. Further, with deregulation and the proliferation of multiple services, such as the Internet, the number of service providers has increased. Start-up corporations, such as CAPs and CLECs, compete directly with established RBOCs and ILECs for customer revenue.

Mesh networks can consist of linear networks and ring. Sections of a mesh network can contain diverse equipment, such as ADMs, M13 DCSs, and ring-based DCSs.

By definitione, mesh networks contain all protection schemes. For more information, see “Protection Schemes (2996)” on page 46.

The following graphic displays a Mesh network:

Figure 22 Mesh Architecture



Protection Schemes (2996)

SONET contains several network traffic protection schemes. Each scheme must be appropriate to the network architecture (linear, mesh, and ring) and is performed automatically by each DCS.

Those mechanisms include Linear APS, the UPSR, the BLSR and 1+1 path protection (logical rings).

For detailed application provisioning instructions using these cross-connection types, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

Route Diversity

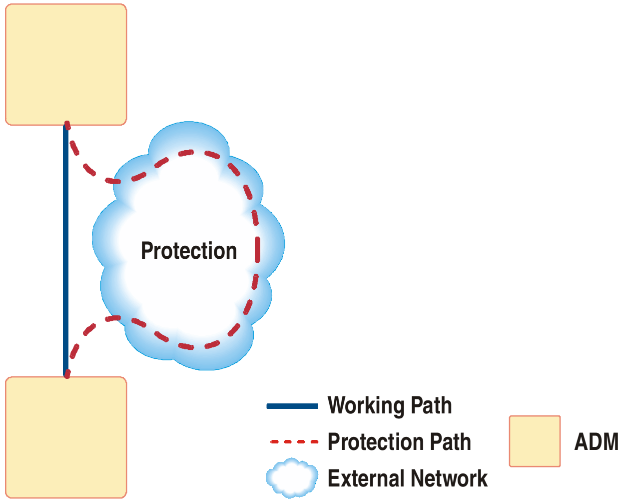
Redundancy is the key to protecting telecommunications traffic. Network equipment is protected by redundant power sources, memory banks, and components. Traffic between network elements is protected by redundant fiber paths, from end-to-end. Protecting traffic between nodes is known as route diversity.

Telecommunicaions traffic must form logical connections between end-points. In today's heterogeneous public telecommunications network, this logical connection is established across a mix of linear, mesh, and ring-based networks. These networks consist of multi-vendor equipment operated by multiple service providers.

In heterogeneous networks that are SONET-based, traffic is protected using route diversity. Route diversity refers to a network design where a logical ring is formed from end-to-end across the heterogeneous network. Logical rings ensure that working and protection traffic take separate physical routes across the network fabric. This design protects against any single instance of fibercut or equipment failure.

The following diagram displays a logical ring:

Figure 23 Example of a Logical Ring



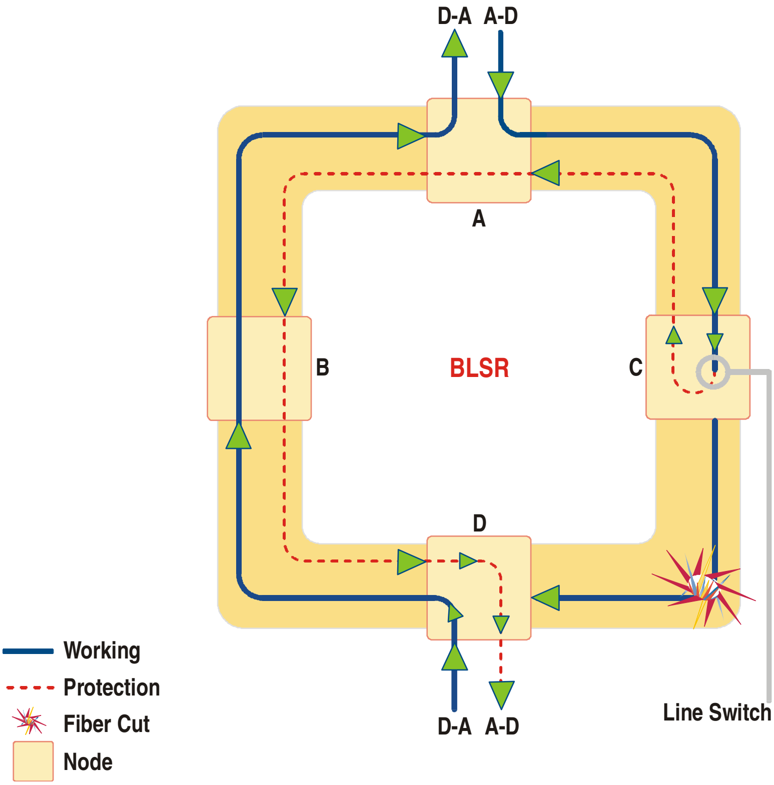
Selectors at either end of the traffic path select the highest quality signal being received.

Line Protection Switching (253)

Line Protection Switching (LPS) occurs at the SONET line layer. In the event of equipment failure or fiber cut, a Line Alarm Indication Signal (AIS-L) is injected into the network by the node which has failed to receive traffic. A switch request is then issued and traffic switches to a separate physical fiber-optic line between nodes.

The following illustrates an example of LPS in a BLSR:

Figure 24 Example of Line Protection Switching



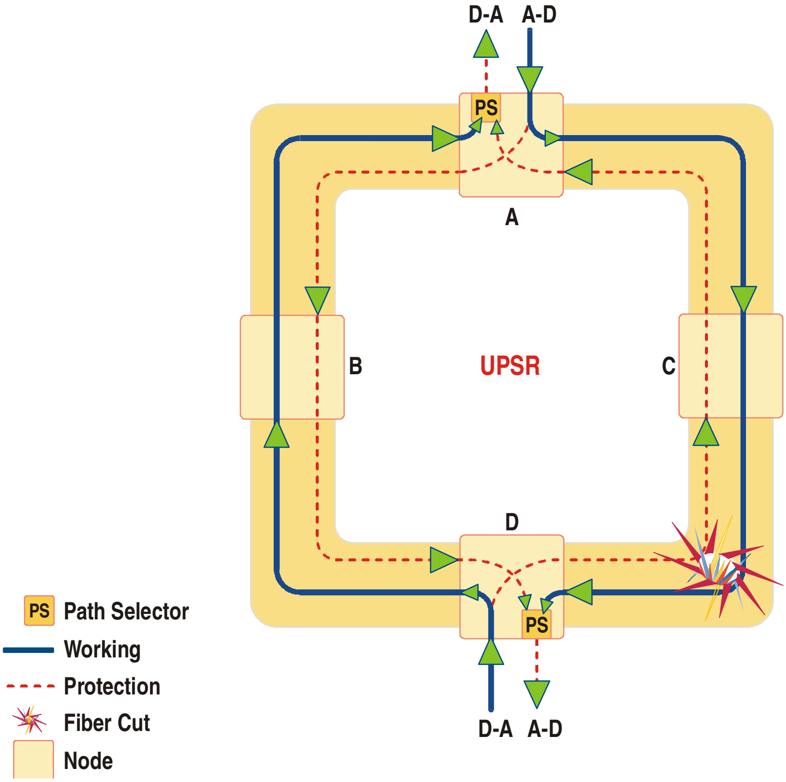
Note: In line protection switching, such as that used in a BLSR, both the transmit and receive nodes must co-ordinate the line switch because ther is an actual physical line change.

Path Protection Switching

Path Protection Switching (PPS) occurs at the SONET path layer. In networks using PPS, such as the UPSR, traffic entering a network is bridged, or copied, and transmitted along diverse routes. In the event of working path interruption (e.g., equipment failure or fiber cut), a selector chooses traffic which has arrived at the node from a separate, protection path.

The following illustrates an example of PPS in a UPSR:

Figure 25 Example of Path Protection Switching



Note: In path protection switching, such as that used in a UPSR, only the receiving node is involved in switching. The transmit node still bridges traffic to both paths whether they are intact or not.

Linear Automatic Protection Switching

Linear Automatic Protection Switching (APS) occurs at the SONET line layer. Linear APS protects traffic by switching to alternate equipment from end-to-end, including fiber-optic lines, in the event of traffic interruption. Linear APS is typically used for point-to-point long haul networks.

There are two types of Linear APS:

- 1+1 protection switching
- 1:n protection switching

1+1 Protection Switching

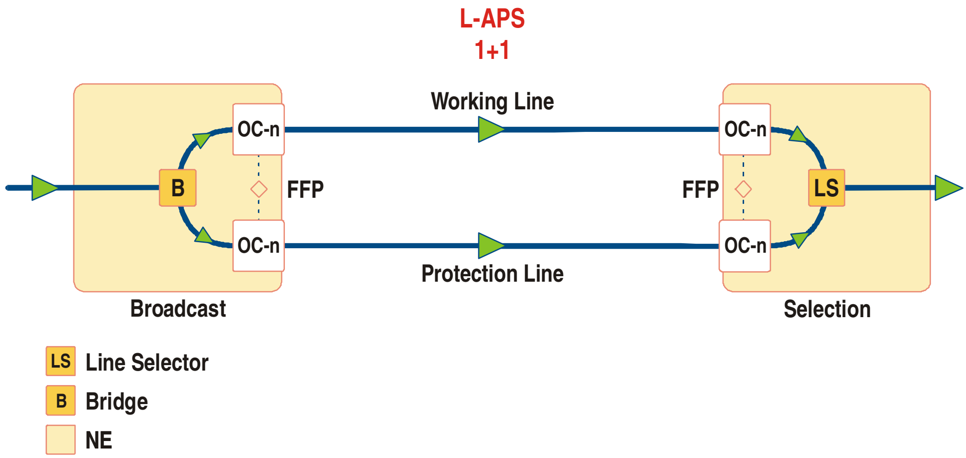
The 1+1 protection scheme is used for networks on which there is complete redundancy, from end-to-end. Traffic is bridged, or copied, at one end of the network. Working and protection traffic are then transmitted by separate optical equipment on separate fiber-optic lines with route diversity. Receiving equipment monitors both signals and selects the best one. Because traffic is bridged, both working and protection bandwidth are fully occupied. Therefore, provisioning extra traffic is not possible.

By deafult the 1+1 architecture is non-revertive. In the event of traffic interruption, the path selector switches to the protection line. When the working line is restored, the path selector does not automatically switch back to the working path. Using OverView 3000, you can modify the MCN7000 so that 1+1 traffic is revertive.

1+1 protection is used by networks with two traffic paths. However, if more lines are added to the network, the protection scheme can be modified to 1:n. For more information on 1:n protection, see the following section.

The following illustrates an example of 1+1 protection switching:

Figure 26   1+1 LAPS Protection Switching



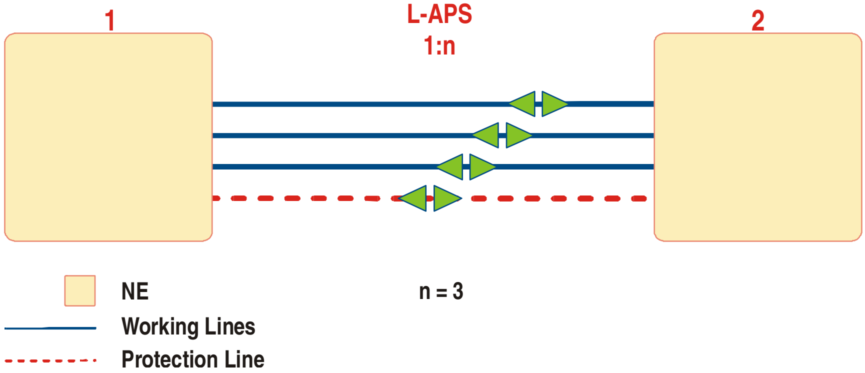
1:n Protection Switching

1:n protection switching is used when there are multiple lines from end-to-end. One line is reserved as protection for up to 14 working lines. Because there are multiple working lines, there is no path selector. Each line carries unique traffic, and there is no traffic duplication. Because the protection line does not carry bridged, or copied, traffic (as in 1+1), extra traffic can be provisoned on this bandwidth. In 1:n systems, switching is revertive by default.

Note: 1:n protection is also possible when n is equal to 1. Extra traffic may be provisioned on the protection line of a 1:1 architecture.

The following illustrates an example of 1:n protection switching:

Figure 27 1:n LAPS Protection Switching



Chapter 4

Linear and Mesh Networks

In today's public telecommunications network, access networks, such as those found in major metropolitain areas, have become a heterogeneous mix of equipment.

Linear and mesh networks use schemes that protect on a per-link basis (such as 1+1 or 1:n). This is becuase, at any given node, traffic may be routed to another service provider or vendor's equipment using a separate protection scheme.

This chapter describes linear network topology and provides several protection switching examples.

For detailed application provisioning instructions, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

Linear Networks (3000)

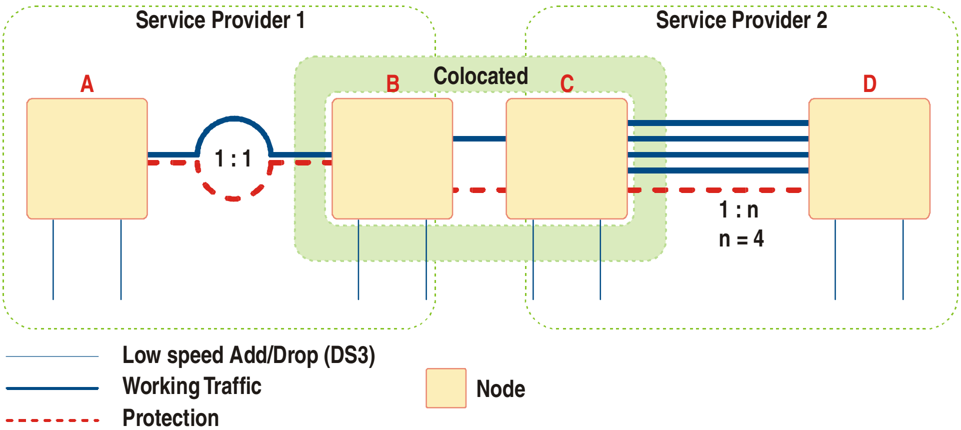
A Linear system consists of two or more DCSs connected serially using fiber-optic cables. Low speed tributaries (e.g., DS1/DS3) can be added and dropped at each DCS along the linear chain. Linear networks are typically used for long haul backbone traffic.

Point-to-point networks are a special case of a Linear system consisting of only two DCSs. Each end network element is known as Line Terminating Equipment (LTE).

Protection Switching

Linear networks use linear APS, such as 1+1 or 1:1 as a protection scheme. The following diagram illustrates two separate linear networks operated by separate service providers:

Figure 28 Linear Architecture

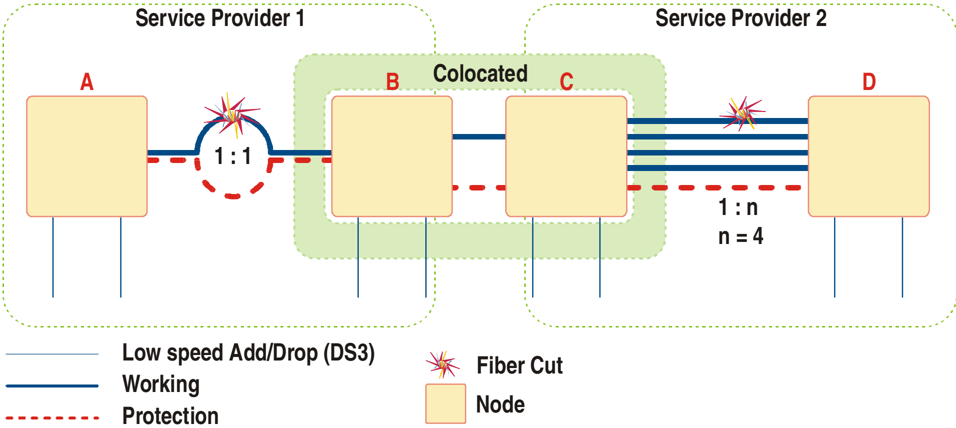


Service provider 1 uses 1+1 linear protection between nodes A and B. Each fiber pair travels in a separate fiber conduit to provide route diversity. Traffic in both directions is bridged, or copied, and transmitted on both working and protection fibers. To ensure survivaility, service provider 1 cannot provision extra traffic on the protection fiber. A path selector at each node monitors signal quality and selects the best signal.

Nodes B and C are collocated at the Central Office (CO) of service provider 2. Service provider 2 uses 1:4 linear protection between nodes C and D. If one of the 4 working lines fails, traffic switches to the protection line. However, until this happens, service provider 2 can provision extra traffic on the protection fiber. Service provider 2 must assign a switching priority to each fiber. In the event of multiple traffic interruption (e.g., fiber cut), traffic with the highest priority switches to the protection fiber.

The following diagram illustrates protection switching behavior in the event of a fiber cut:

Figure 29 Linear Architecture–Fiber Cut



For the 1+1 network, path selectors at nodes A and B detect signal failure on the working fiber and select traffic from the protection fiber, switching within 50 ms.

For the 1:4 network, optical signal receivers at nodes C and D detect a lack of traffic and request a switch to the protection fiber. Extra traffic provisioned on the protection fiber is lost.

Chapter 5

Unidirectional Path Switched Rings

UPSRs typically consist of SONET ADMs with little or no signal grooming capability. UPSRs are typically used as SONET access rings. They collect signals from small regions (e.g., business parks, college campuses) and hand taffic off to city-wide or nation-wide rings at a head-end node. Many DCSs or multi-service nodes, such as the MCN7000, support UPSR so they can serve as the head-end node and interface with the collected signals.

This chapter describes UPSR architecture, applications and protection switching.

For detailed application provisioning instructions, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

UPSR Architecture (1400)

Unidirectional Path Switched Rings (UPSR) transmit SONET traffic by briding, or copying it, at an entry node and broadcasting it in separate directions around the ring. At the receiving node, a path selector monitors both incoming signals for quality and selects the best one.

The incoming signal is monitored for the following parameters:

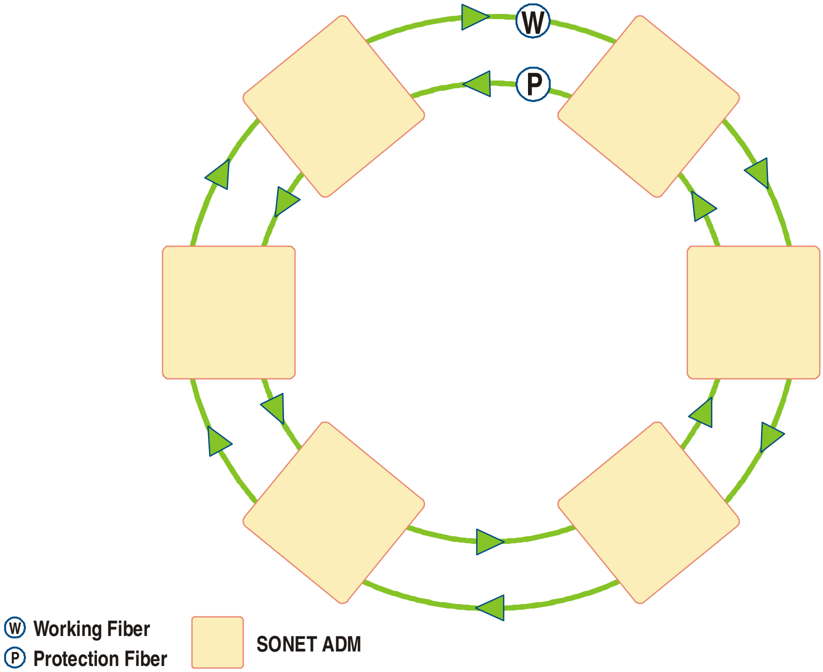
- Path Alarm Indication Signal (AIS-P)
- Path Loss of Pointer (LOP-P)
- Unequiped Signal Label (UNEQ)
- Path Degrate Indication (PDI-P)
- Bit Error Rate (BER)

These parameters may indicate such things as equipment failure, fiber cut, or problems with SONET signal framing itself.

UPSRs can transmit and monitor signals at the VT, STS, and OC-n levels. Because UPSRs use 1+1 architecture, protection traffic is immediately available to the path selector, guaranteeing switching time of 50 ms or less.

The following diagram illustrates a UPSR:

Figure 30 UPSR Topology



Because of the 1+1 protection scheme, total bandwidth is limited to the capacity of the ring. For example, for an OC-12 UPSR, traffic is shared by each node, all the way around the ring. Therefore, bandwidth cannot be upgraded simply by adding nodes.

During a protection switch, the ring works conceptually as a linear network between nodes.

UPSR Network Applications

This section describes typical UPSR applications.

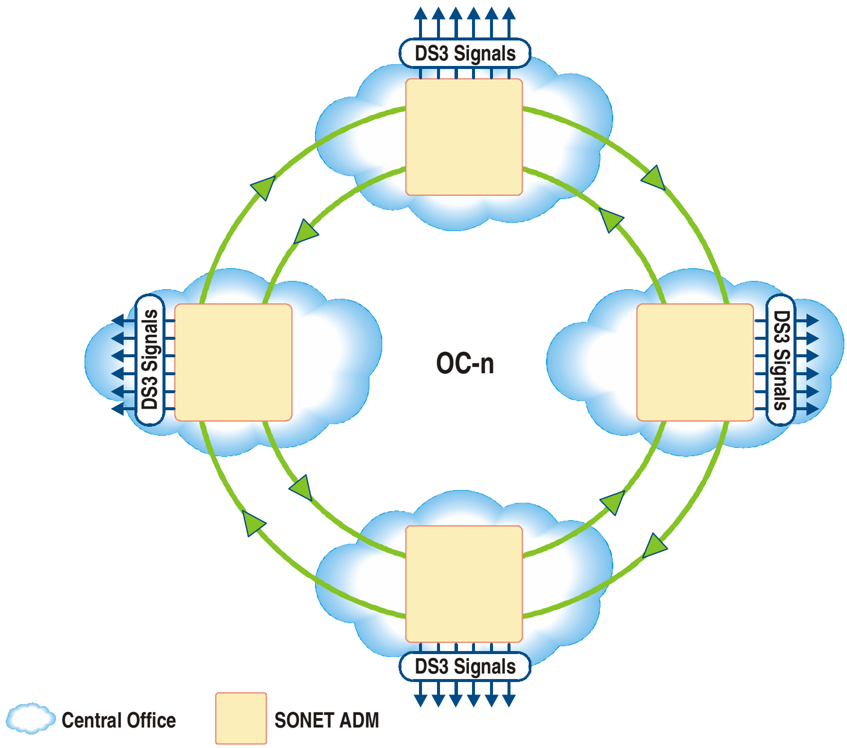
Central Office Connection

UPSRs can be used to provide survivable DS3 interconnection between telecommunication service provider Central Offices (CO).

UPSR ADMs are located at each CO. The UPSRs OC-n capacity must be high enough to accomodate the cummulative number of DS3 channels required between COs. For example, if 2 DS3 channels are required by each if the 4 COs, ring capacity must be OC-12. Eight of the 12 STS-1s are occupied by this traffic. Because the UPSR uses 1+1 protection, the bandwidth *pool* is shared all around the ring.

An example of CO connection appears below:

Figure 31 Central Office Connection



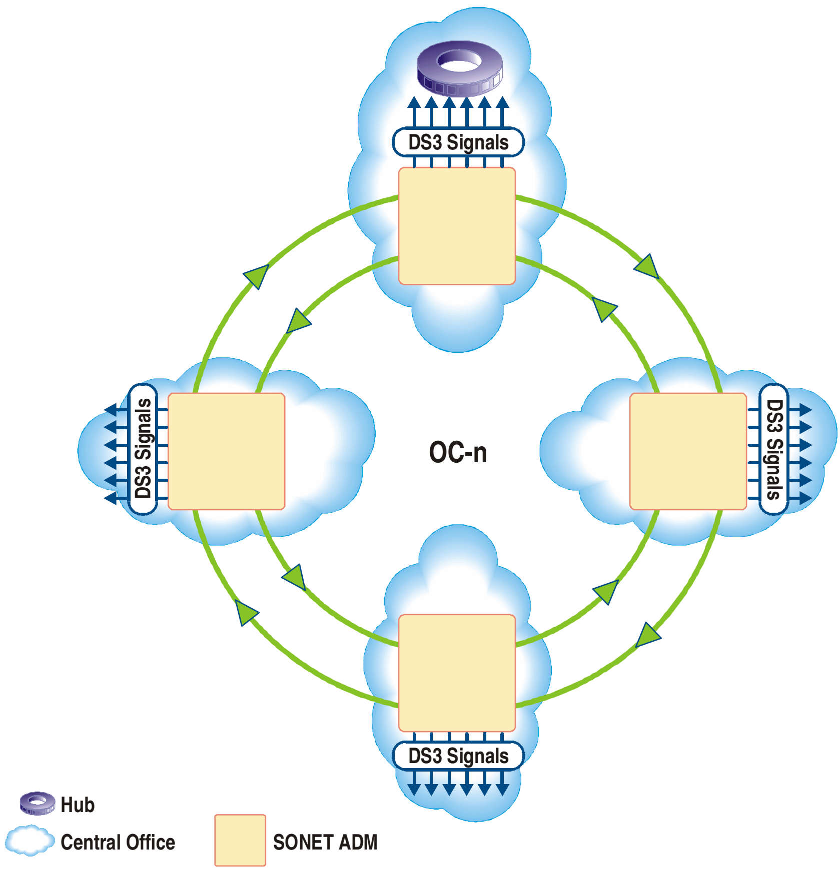
Optical Access Ring

UPSRs can be used as optical access collector rings. DS1/DS3 signals are added to the bandwidth *pool* around the ring and collected and concentrated at a head-end node for hand-off to a higher order network. For example, an OC-3 UPSR can hand-off to a Metropolitain Access Network (MAN), such as an OC-48 BLSR.

A DCS may be required to be collocated with the head-end node, to perform signal grooming or to interface to multiple high-speed networks. However, the MCN7000 can perform both UPSR ADM and DCS cross-connections in the same physical unit.

An example of an optical access ring appears below:

Figure 32 Optical Access Ring



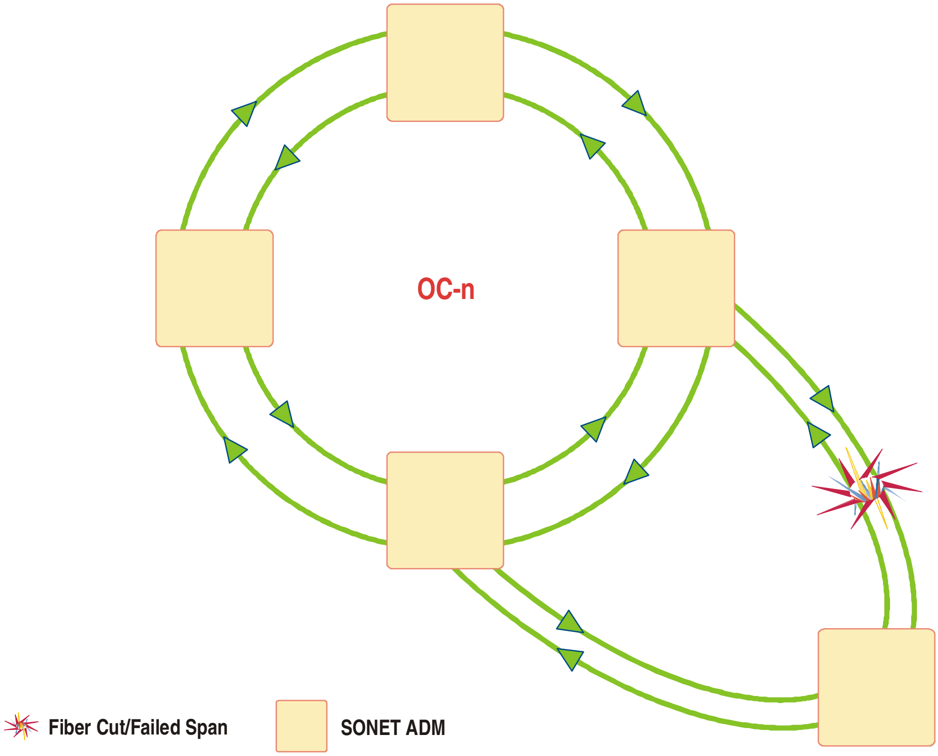
Dual Homing

UPSRs transport traffic all the way around the ring using redundant paths. As a benefit of this ring design, path protection can be extended to external equipment. This is known as Dual Homing.

In this application, external equipment is connected to two separate UPSR ADMs to provide redundancy. Traffic between the two entry/exit ADMs is provisioned as drop-and-continue. This situation supports full survivability in the event of ADM failure or external line cut.

An example of dual homing with an external line cut appears below:

Figure 33 Dual Homing

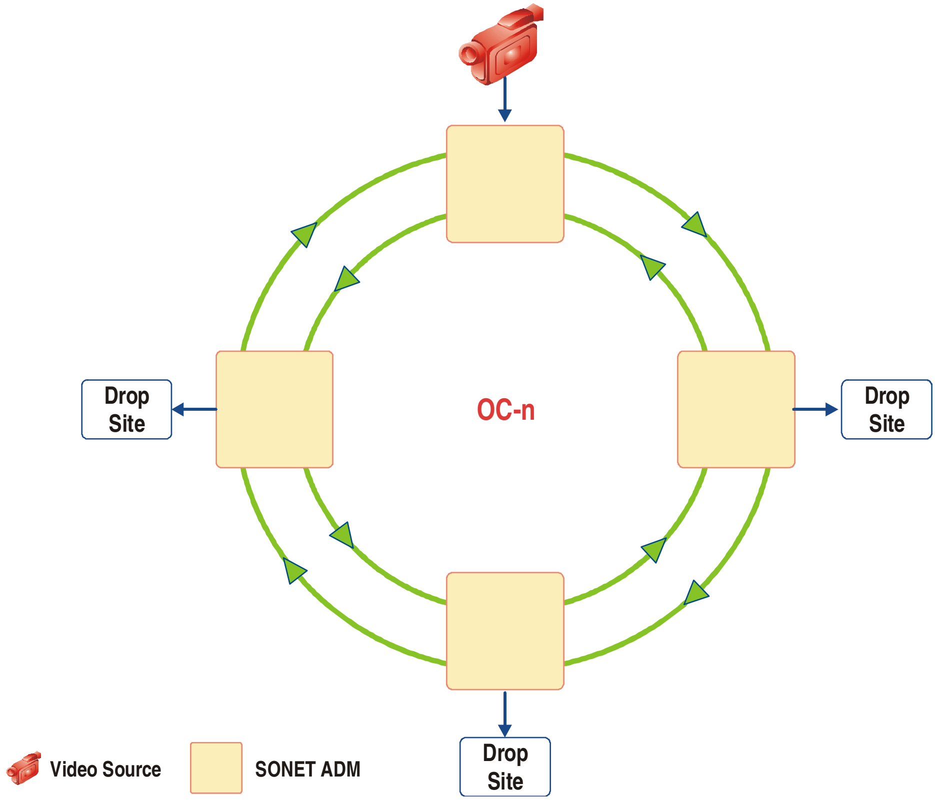


Video Broadcast

UPSRs are well suited to video broadcast applications. The video signal enters the network as add/drop through an ADM located in a CO closest to the broadcaster. Video traffic is provisioned as drop-and-continue at each ADM and completes its path around the ring. Provisioned for add/drop, the source node receives the same signal it broadcasted and can monitor the signal for quality.

An example of a video broadcast application appears below:

Figure 34 Video Broadcast

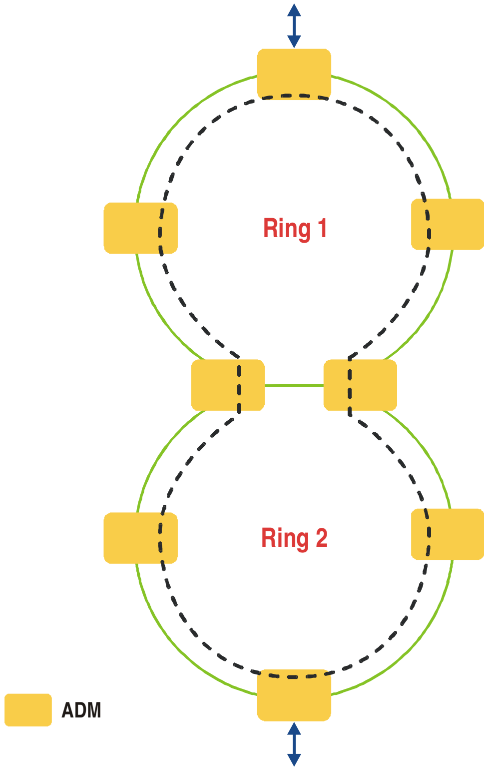


Logical Ring Application

A logical ring consists of an ene-to-end connection which supports the 1+1 protection scheme across multiple networks, including linear, mesh and ring-based networks. Paths are bridged, or copied, at the entry point and transmitted along redundant paths. A path selector at the destination node chooses the best signal quality.

The following diagram illustrates the concept of a logical ring:

Figure 35 Logical Ring

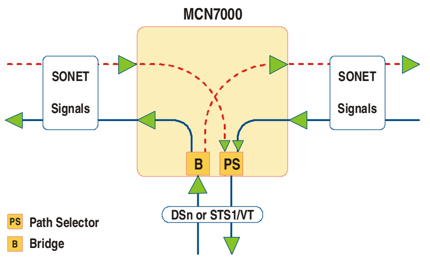


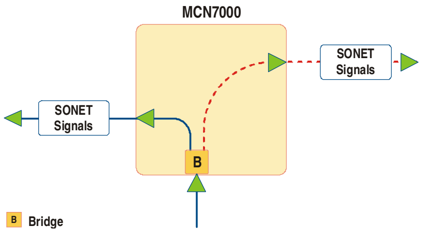
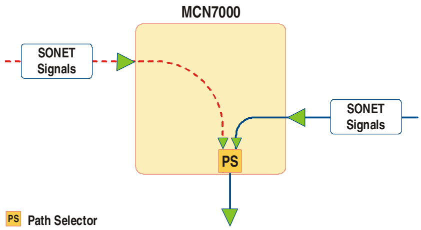
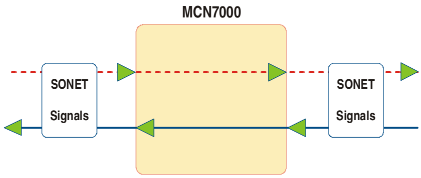
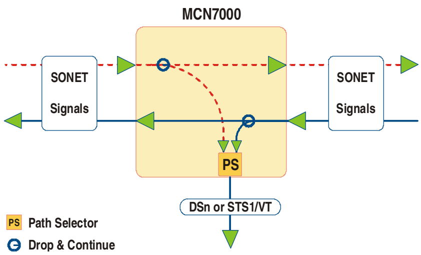
Note: Because 1+1 protection must be supported across the entire logical ring, all SONET equipment must work in conjunction to support this protection scheme.

For more information on logical rings, see "Ring Interconnection" on page 79.

Types of UPSR Paths

This section describes the cross-connections most commonly provisioned to build different UPSR applications.

Cross-connect	Purpose	View
Add/Drop	Add/Drop is for 2-way voice traffic. Add/Drop refers to Add to Working **&** Protection bandwidth/Drop from Working **or** Protection bandwidth. Two Add/Drop cross-connects must be provisioned, one for each end of a circuit.	

<table>
<tr><th>Cross-connect</th><th>Purpose</th><th>View</th></tr>
<tr><td>Add Only</td><td>Add Only is provisioned for the source of 1-way traffic (e.g., video broadcast). Add Only traffic can be added to Working or Protection bandwidth, or both. Add Only cross-connects are typically provisioned with one or more Drop-type cross-connects which receive the 1-way signal from its source.</td><td>
</td></tr>
<tr><td>Drop Only</td><td>Drop Only is provisioned for the receiving end of 1-way traffic (e.g., video conference). Drop Only traffic can be dropped from Working or Protection bandwidth, but not both. Typically, Drop Only cross-connects are provisioned in multiple locations throughout a ring.</td><td>
</td></tr>
<tr><td>Pass-through</td><td>Because UPSR ring design supports traffic pass-through as the default, these cross-connects do not have to be provisioned. Pass-through, also known as flow through, is automatically provisioned by OverView 30/3000 in conjunction with the MCN7000's FLASH disk software.</td><td>
</td></tr>
<tr><td>Drop-and-continue</td><td>Drop-and-continue is provisioned for the receiving end of 1-way traffic (e.g., video broadcast). Drop-and-continue traffic can be dropped from Working or Protection bandwidth, but not both. Drop-and-continue supports dropped traffic as well as passive passthrough traffic, which continues around the ring.</td><td>
</td></tr>
</table>

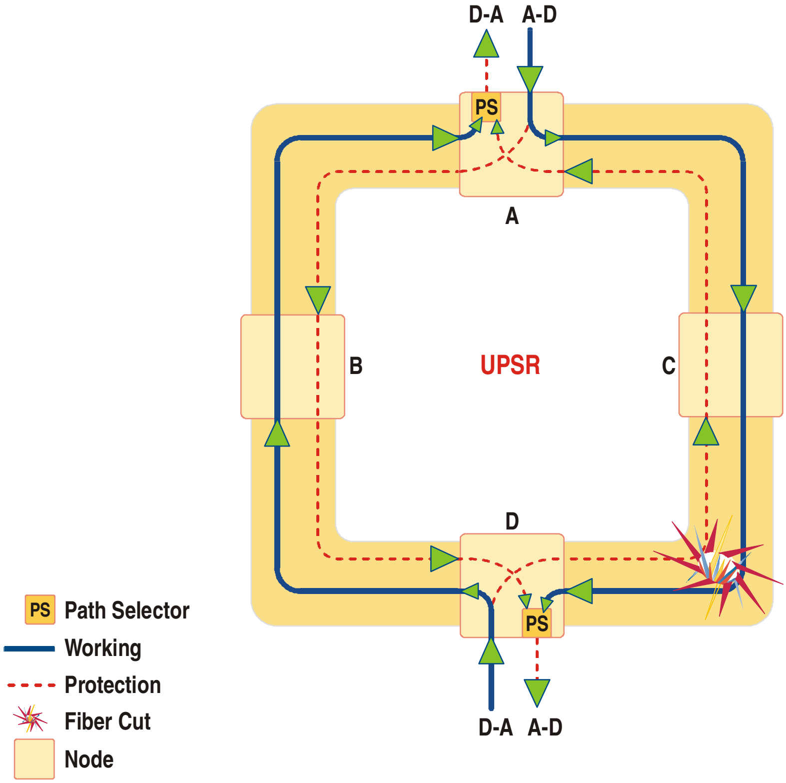
For detailed application provisioning instructions using these cross-connection types, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

Protection Switching

UPSRs protect their traffic at the path level which occurs at the SONET path layer. Traffic enter a network and is bridged, or copied, and transmitted along diverse routes. In the event of working path interruption (e.g., equipment failure or fiber cut), a selector chooses traffic which has arrived at the node from a separate, protection path.

The following illustrates an example of path protection switching in a UPSR:

Figure 36 UPSR Protection Switching

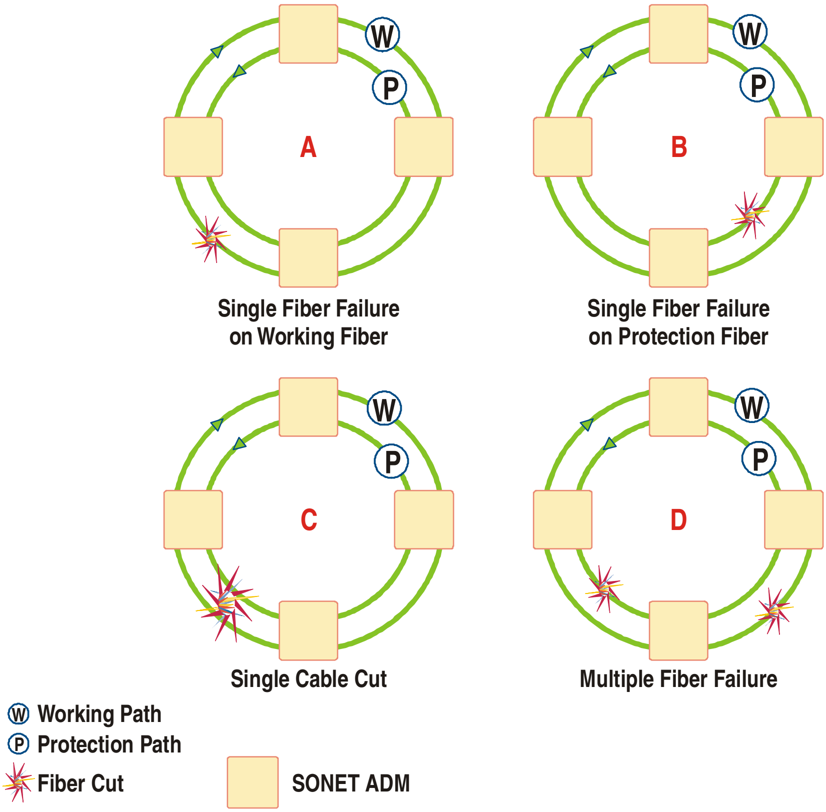


Two Add/Drop cross-connection are provisioned on the same bandwidth timeslot: one at Node A and one at Node D. Node A adds traffic to working fiber (clockwise) and adds a copy to protection fiber (counterclockwise). A path selector at Node D receives working traffic and monitors signal quality. When the fiber cut occurs, signal quality degrades and prompts the path selector to switch to protection traffic. When the fiber cut is repaired, the path selector may or may not revert to the working fiber, depending on provisioned settings.

Reply traffi, from Node D to Node A behaves in the same way.

In the event of multiple fiber cuts or equipment failure, UPSR design can withstand up to two fiber cuts on the same ring segment (condition C below). UPSR path protection is not guaranteed if both paths were cut (condition D below). This would depend on the location of fiber cuts and node placement.

Figure 37 UPSR Protection Switching Cont'd



Chapter 6

Bidirectional Line Switched Rings

Bidirectional Line Switched Rings (BLSR) are deployed in heavy traffic, multi-vendor/multi-service provider network environments. BLSRs consist of SONET network elements with signal grooming capability. The advantage of BLSR design compared to UPSR is that is makes more efficient use of bandwidth in many circumstances, particularly important in today's metro networks.

This chapter describes BLSR architecture, applications and protection switching.

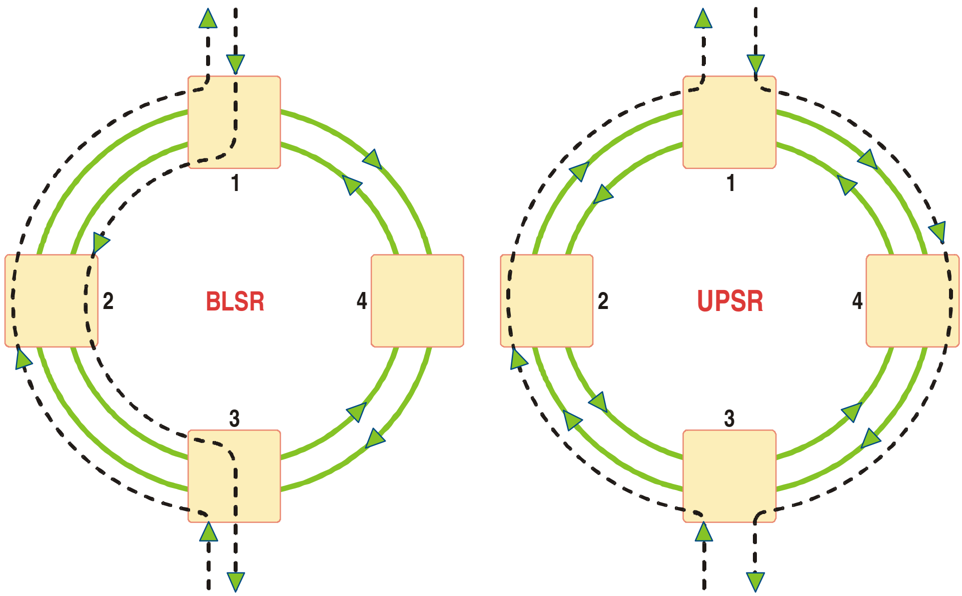
For detailed application provisioning instructions, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

BLSR Architecture (1230)

BLSRs transmit a single copy of SONET traffic in one direction around the ring. Traffic is not bridged, or copied, unlike UPSR traffic flow. The SONET overhead contains the destination node address and traffic is dropped when it reaches that node.

Unlike UPSRs, BLSRs transmit and receive traffic share the same path. In the following case, bidirectional ring traffic between nodes 1 and 3 share the same path in the BLSR compared to separate paths in the UPSR.

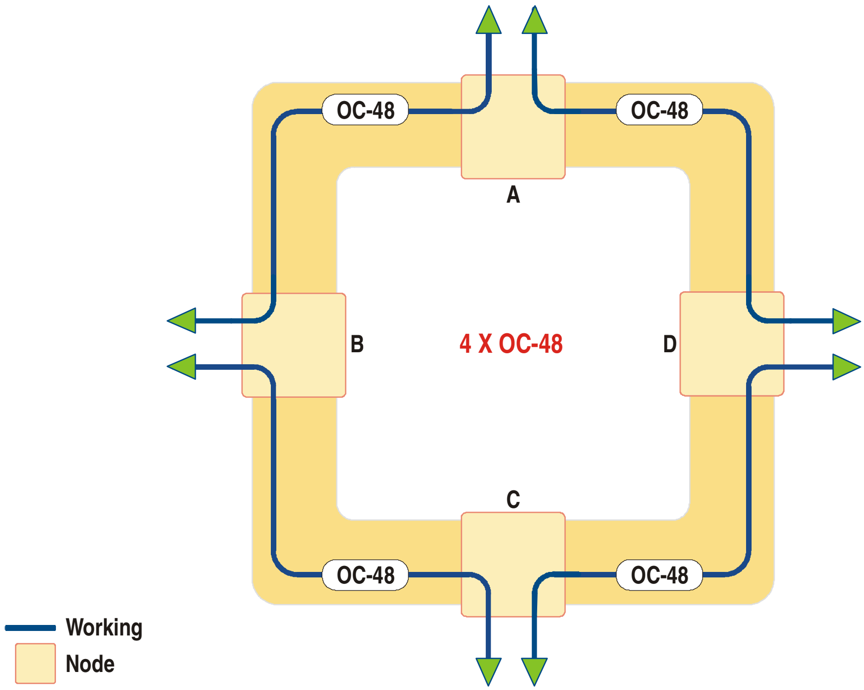
Figure 38 BLSR versus UPSR



Network capacity in BLSRs is quite complex. Ring capacity is dependent upon traffic patterns. If all traffic is between adjacent nodes, network capacity is equal to N times the span capacity (e.g., OC-48), where N equals the number of nodes.

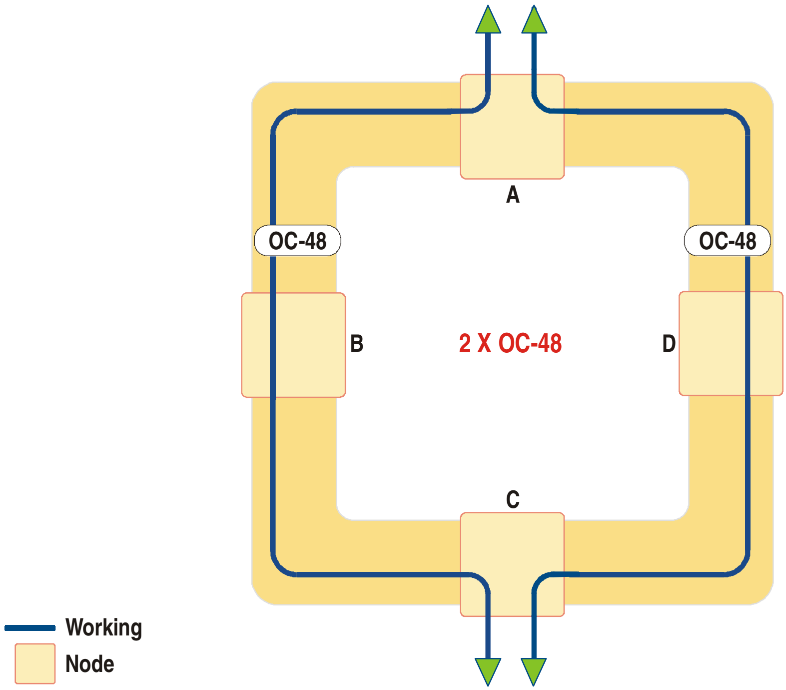
If another node is inserted between nodes and carries traffic to adjacent nodes only, network capacity increases 1 time. In the following example (Figure 39), full OC-48 bandwidth exists between nodes A, B, and C. Virtually, this represents 3 full OC-48 rings. If node D is added to the network, full OC-48 bandwidth still exists between all nodes and represent 4 full OC-48 rings.

Figure 39 BLSR Network Capacity (Adjacent Nodes)



However, in the opposite extreme, if all traffic homes to one node, capacity is limited to that of the network sections approaching the head-end node. In Figure 40, traffic approaching node A from nodes B, C, and D is limited in the final network span to the bandwidth of one OC-48.

Figure 40 BLSR Network Capacity (Homing Site)



There are two main BLSR configurations:

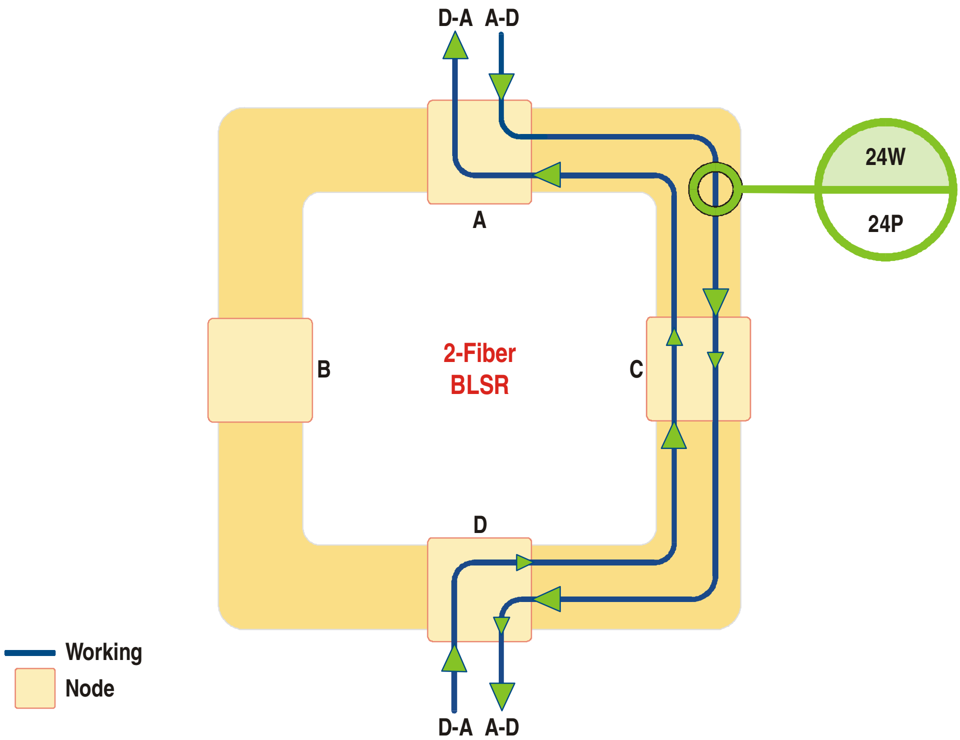
- 2-fiber BLSR
- 4-fiber BLSR

2-fiber BLSR

A 2-fiber BLSR carries traffic between nodes bidirectionally using only one fiber pair. 2-fiber BLSRs divide bandwidth into working and protection for a given span, but transmit both on the same physical fiber. For example, a 2-fiber OC-48

BLSR assigns 24 STS1s to working traffic and another 24 STS1s to protection. A full 48 STS1s (24 working + 24 protection) are transmitted both ways around the ring.

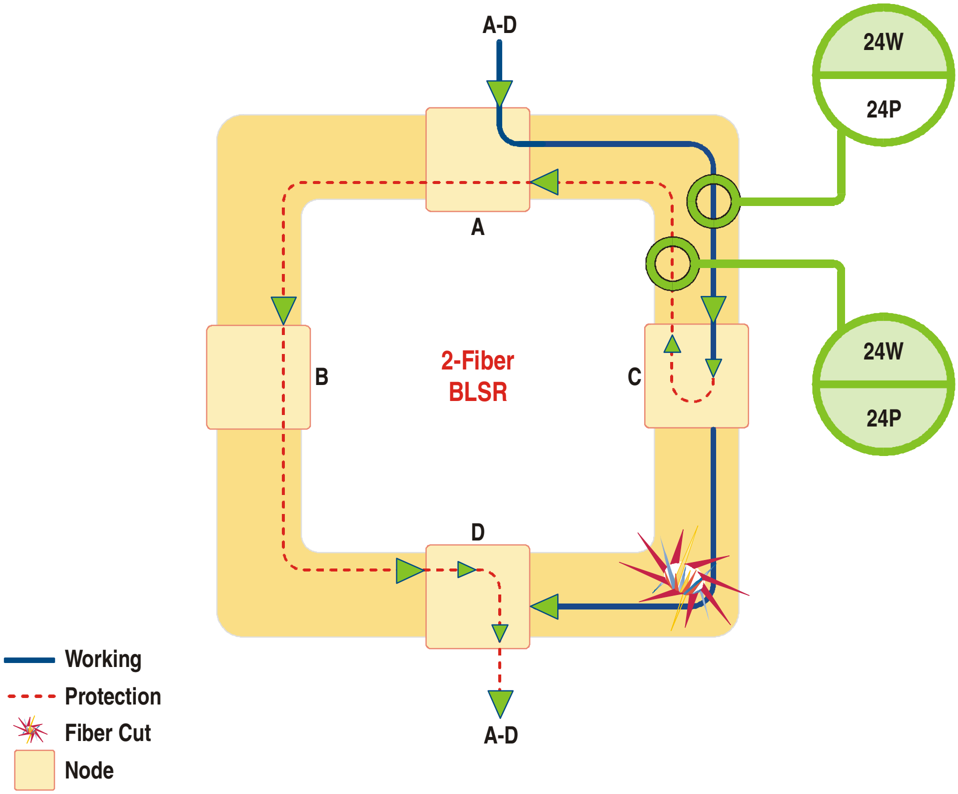
Figure 41 2-fiber BLSR Topology



Protection Switching

In the UPSR topology, protection bandwidth contains a copy of working bandwidth at all times and is immediatley deliverable in the event of a fibercut. Unlike a UPSR, protection bandwidth in a BLSR remains empty unless a fibercut occurs. If working traffic in one direction encounters a fibercut, it is loopedback at the closest node into protection bandwidth traveling in the opposite direction.

Figure 42 Protection Switching in a 2-fiber BLSR



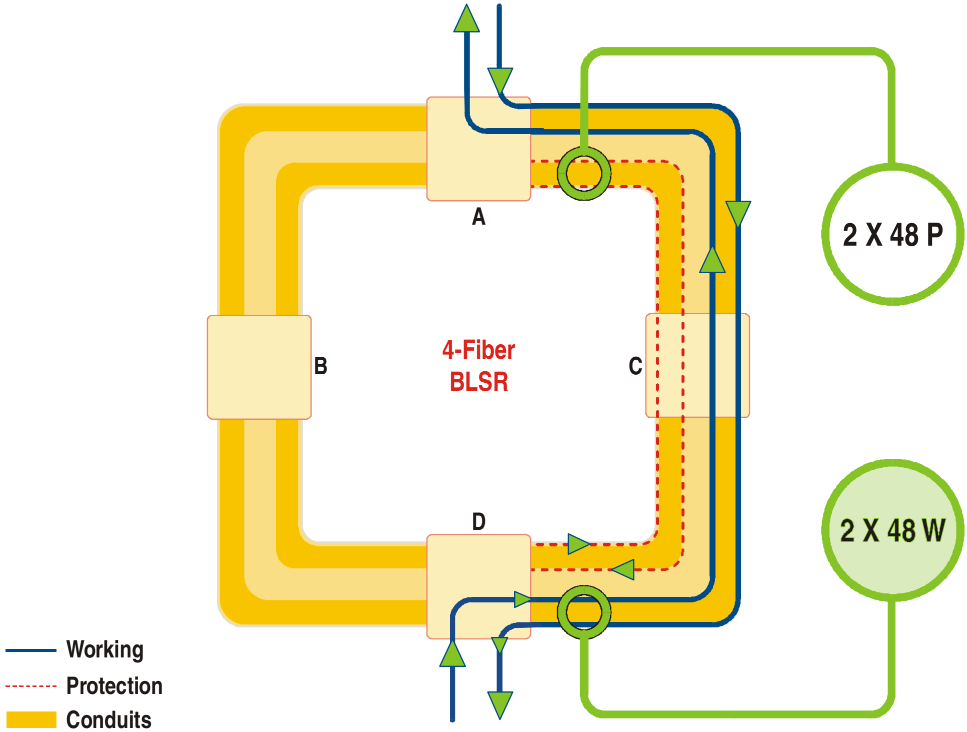
There is an important design difference in protection switching between UPSRs and BLSRs. Because each UPSR node contains a path selector and can always choose from two copies of traffic, protection swtiching can be performed unilaterally by one node. However, because BLSRs never bridge traffic, protection swtiching must be performed in conjunction between nodes. For example, in the previous graphic, actions are required by both nodes C and D. Node C must switch traffic to protection bandwidth and node D must be instructed to select traffic from this new path.

4-fiber BLSR

4-fiber BLSRs are similar to 2-fiber BLSRs except that there are two fiber pairs between each network section instead of only one. For any network span, 4-fiber BLSRs have twice the bandwidth of 2-fiber BLSRs.

In the following eample, traffic enters the network at node A, and travels clockwise toward node D and reply traffic returns counter-clockwise toward node A. Under normal operation, only one fiber pair is used for traffic on this network segment. Therefore, bandwidth on this timeslot is not used the long way around and the ring and is available for other traffic. The protection fiber pair for this span can also be provisioned with extra traffic.

Figure 43 4-fiber BLSR Topology

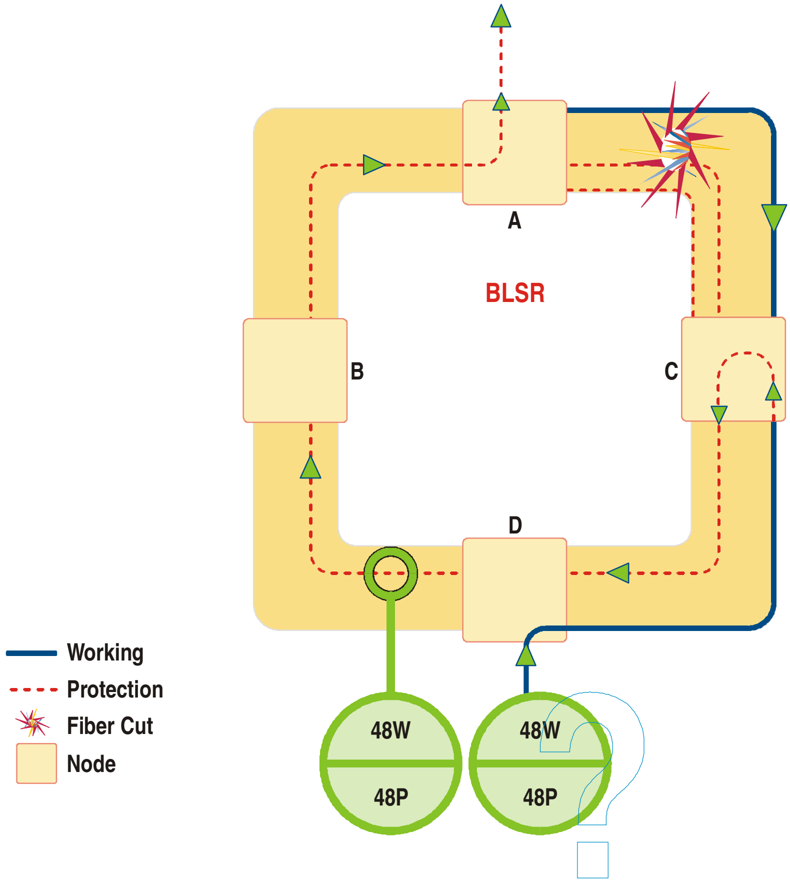


Ring Protection Switching

If a fiber cut occurs between two nodes that affects both working and protection fibers (e.g., cable cut), automatic ring protection features route traffic along the alternate fiber pair the long way around the ring (Figure 44).

Since the fiber cut occured between nodes A and D, only those nodes switch to the alternate path. Pass-through traffic is looped back onto the protection fiber pair at nodes A and D. Traffic between nodes A and D are also switched to the protection fiber.

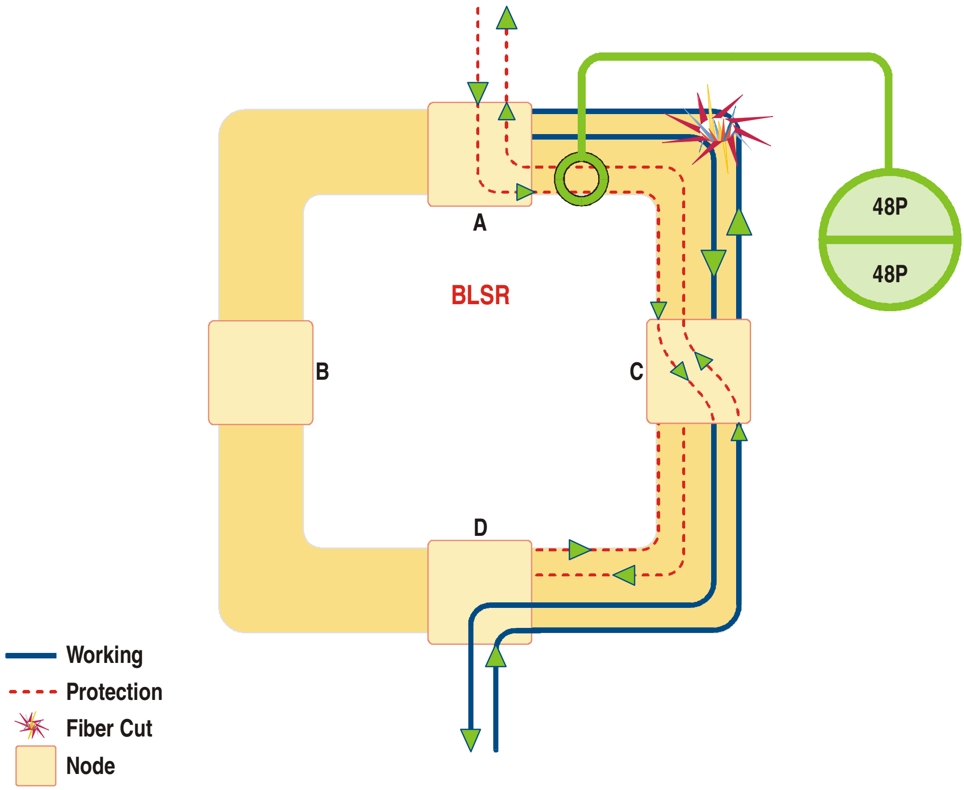
Figure 44 4-fiber BLSR Ring Protection Switching



Span Protection Switching

Figure 45 shows a single fiber pair failure between nodes A and D. Automatic span protection switches traffic to the redundant fiber pair between these nodes. One important difference between ring types is that 2-fiber BLSRs cannor perform span protection, whereas 4-fiber BLSRs can.

Figure 45 4-fiber BLSR Span Protection Switching



2- and 4-Fiber Comparison

2-fiber BLSRs only offer ring protection, not span protection. In the case of multiple equipment and cable failure, 4-fiber BLSRs are more robust as there are more spans which can be protected simultaneously in the ring. But, because the 2-fiber BLSR uses fewer components and requres less fiber, single equipment failure is less likely.

However, the most important difference is failures per STS1. Because a 4-fiber ring has a larger capacity for any given span, traffic density on any one piece of equipment is lower than on a heavily loaded 2-fiber ring. Therefore the liklihood of any single STS1 encountering a failed piece of equipment is lower in a 4-fiber ring.

Unless ring capacity is low, 4-fiber rings offer all of the features of 2-fiber rings with twice the capacity. Ring maintenance and the complexity of mixed 2-fiber/ 4-fiber rings must be considered while planning a network.

Chapter 7

Ring Interconnection

Efficient ring interconnection is crucial in today's multi-carrier, multi-vendor and increasingly de-regulated telecommunications industry.

The MCN7000 system supports multiple ring interconnections. These features reduce maintenance and operation costs.

The MCN7000 supports SONET payload interoperability at the optical and tributary level. SONET overhead parameters (e.g., Sync Messaging, Payload label, and K bytes) are used to allow smooth interconnection between the MCN7000 and other vendor's equipment. MCN7000s and MAS shelves can also be interconnected to form various ring topologies.

Because the MCN7000 can house multiple OC-48 Optical Mappers, more than one ring can pass through the same subrack. If required, the MCN7000 can be used to pass traffic between rings. More than two working optical mappers are required for this application (two for each ring).

This chapter provides a representative sample of possible ring applications for the MCN7000:

- Logical rings
- Matched nodes
- Subtended rings
- Embedded optical rings
- Interconnected rings

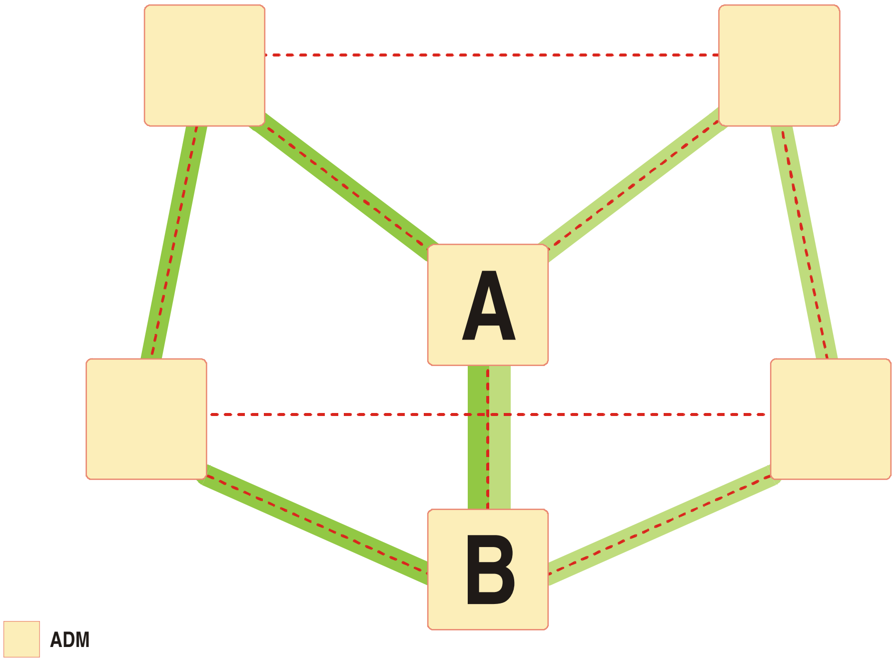
For detailed application provisioning instructions, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

Logical Ring

A logical ring consists of an ene-to-end connection which supports the 1+1 protection scheme across multiple networks, including linear, mesh and ring-based networks. Paths are bridged, or copied, at the entry point and transmitted along redundant paths. A path selector at the destination node chooses the best signal quality.

Logical rings can be defined in a flexible way, wherever the networks support these architecture. Multiple logical rings can also exist on the same network equipment (see Figure 46) in different portions of the bandwidth.

Figure 46 Interconnected Logical Rings



Matched Nodes

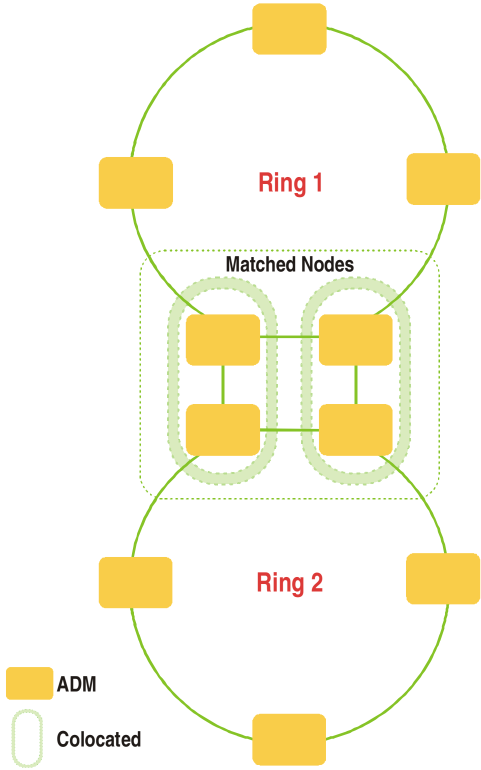
Matched nodes, similar to dual homing, adds reliability to the logical ring. Matched nodes provides path redundancy via redundant ring interconnections. Typically between two and four nodes are interconnected between rings to protect against node failure and fiber cuts. Bridges between rings are established at at appropriate level for intra-ring traffic. For example, OC-3 rings may be interconnected via redundant EC-1 bridges.

Typical applications for the matched node configuration include the following:

- Hospital Communication Links
- Military Networks
- 911 lines
- Emergency Services
- Police Communications
- Power Utility Networks
- Other Mission Critical Applications

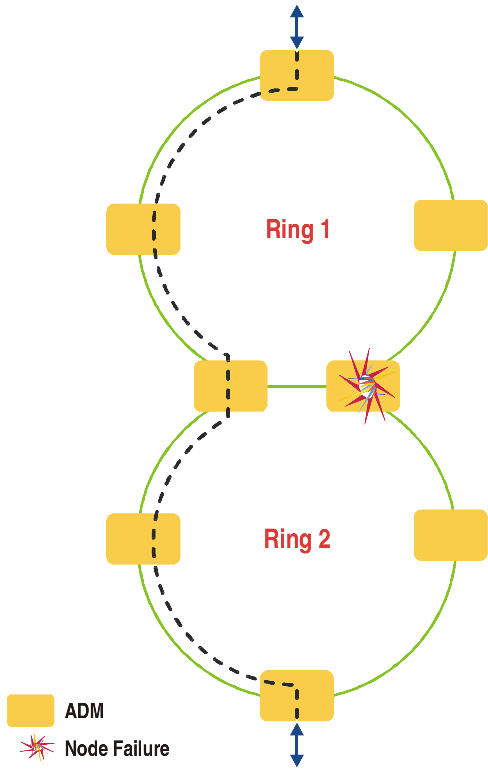
The following graphic displays the matched nodes topology:

Figure 47 Matched Nodes Topology



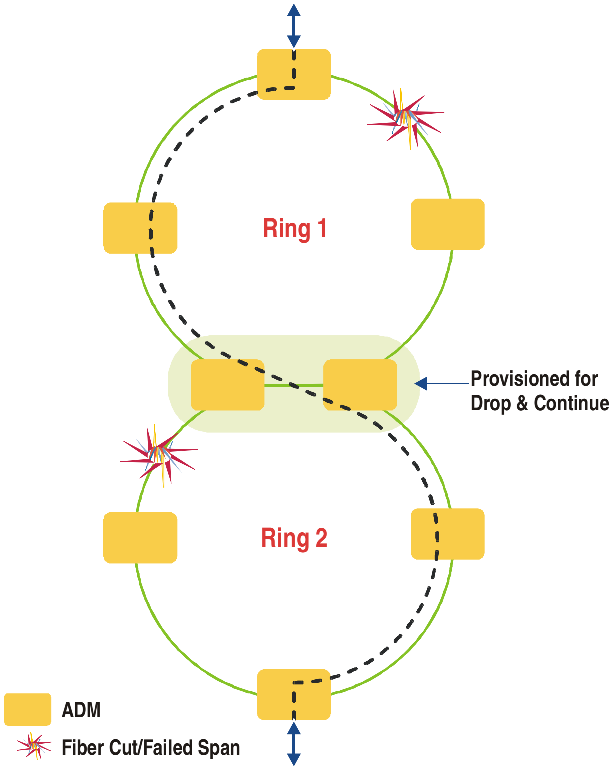
If a matched node, or the bridge between nodes, fails traffic is still able to reach its destination.

Figure 48 Matched Node Failure



Ring-based traffic between nodes must be provisioned as drop-and-continue in the matched nodes application. Matched nodes are resilient enough to withstand multiple fiber cuts, however, drop-and-continue ensures survivability with fiber cuts in each ring.

Figure 49 Matched Node Failure



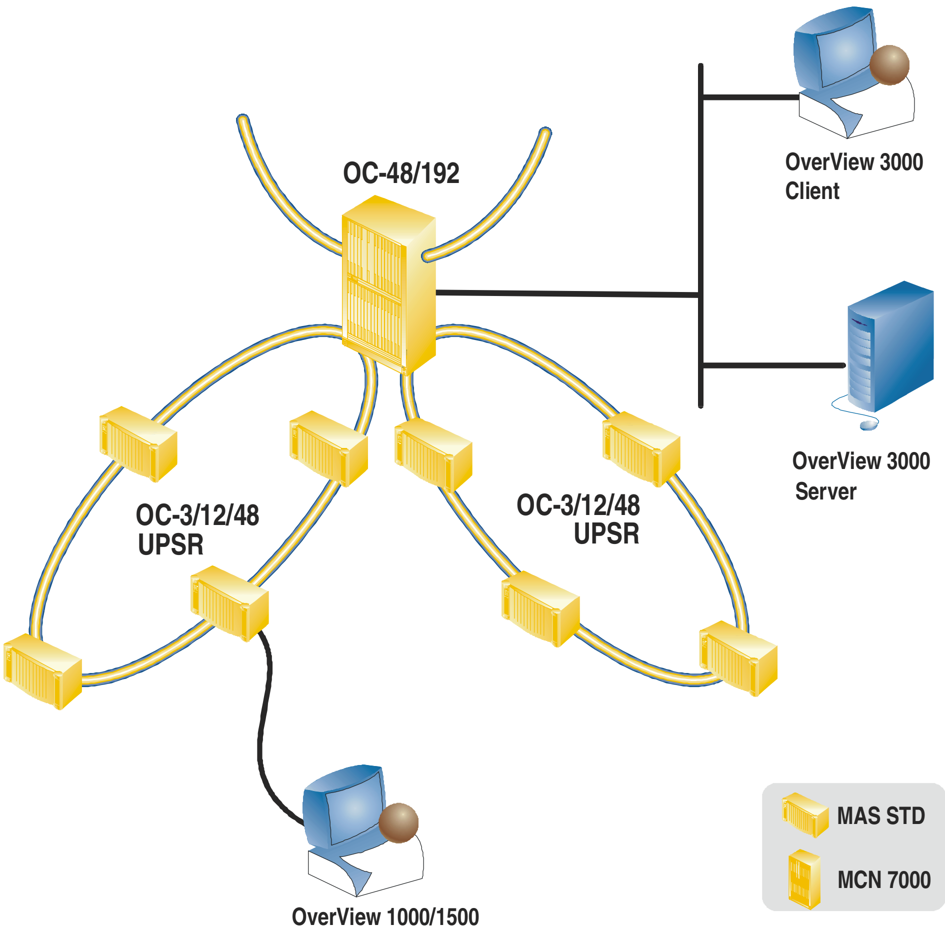
Subtending Rings

Subtended rings are lower capacity rings which home to a higher order network. Typically, several low capacity collector rings home to the same high capacity ring-based DCS. For example, several OC-3 access rings may form a ring-based OC-192 DCS.

The MCN7000 can act as an optical head-end for many lower capacity optical rings. For example an OC-48 optical mapper may aggregate OC-12 signals from four separate rings. In the illustration below, an MCN7000 OC-48 rings collect smaller rings, the subtended rings, and hand off signals to other subtended rings.

Additionally, if an organization owns both the OC-48 and the subtended rings, its network administrators can provision the entire network, including the subtended rings, from a single console.

Figure 50 Subtended Rings



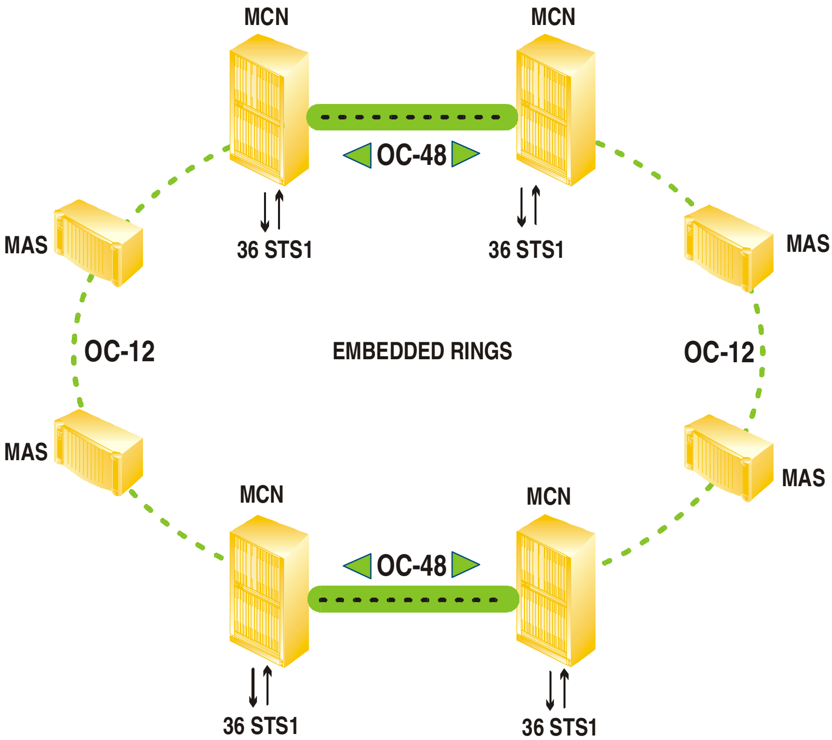
Embedded Rings

Embedded optical rings are virtual ring architectures provisioned over existing network equipment. For example, an OC-12 UPSR may be configured where one or more ring segments are embedded in an OC-48 point-to-point system. Although the OC-3 bandwidth is embedded within the OC-48 signal, the OC-3 UPSR forms an overlaid closed ring topology.

In the following diagram, the OC-12 ring owner may be a CAP/CLEC leasing bandwidth from a larger service provider's long haul point-to-point or backbone network. For the CLEC it makes sense to lease, rather than laying extensive fiber-optic cabling. And the larger Telco benefits by maximizing bandwidth on an existing network segment.

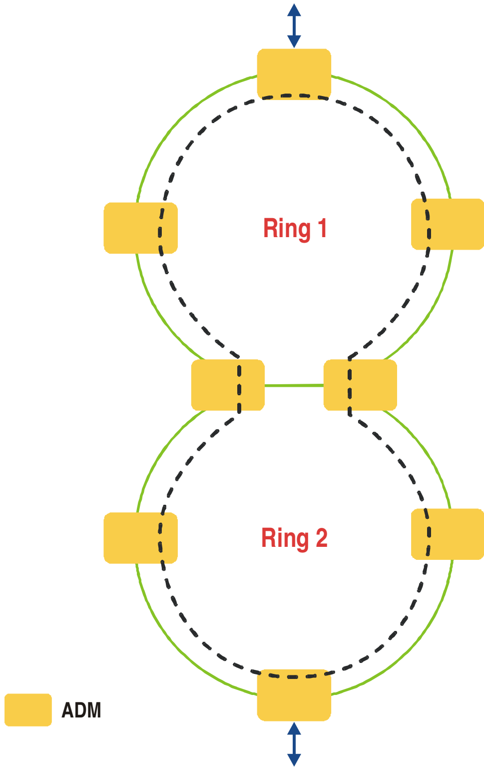
The MCN7000 can support embedded optical rings at the OC-3, OC-12, and OC48 levels. Further, in service upgrades allow the MCN7000 to easily upgrade as embedded optical traffic grows.

Figure 51 Embedeed Optical Rings



Virtual, or logical rings can be defined which overlay existing ring-base infrastructure (Figure 52).

Figure 52 Overlayed Optical Rings



Ring Interconnection Scenarios

This section describes common ring interconnection scenarios, their traffic patterns, and protection switching behavior. The following ring interconnections are described:

- UPSR to UPSR
- BLSR to BLSR
- UPSR to BLSR

UPSR to UPSR

Interconnected UPSRs can be used to agregate and home access traffic to a head-end node for long haul transport hand-off. UPSR interconnection can also be used to connect small regional networks and business parks to mesh and high capacity metropolitain area networks.

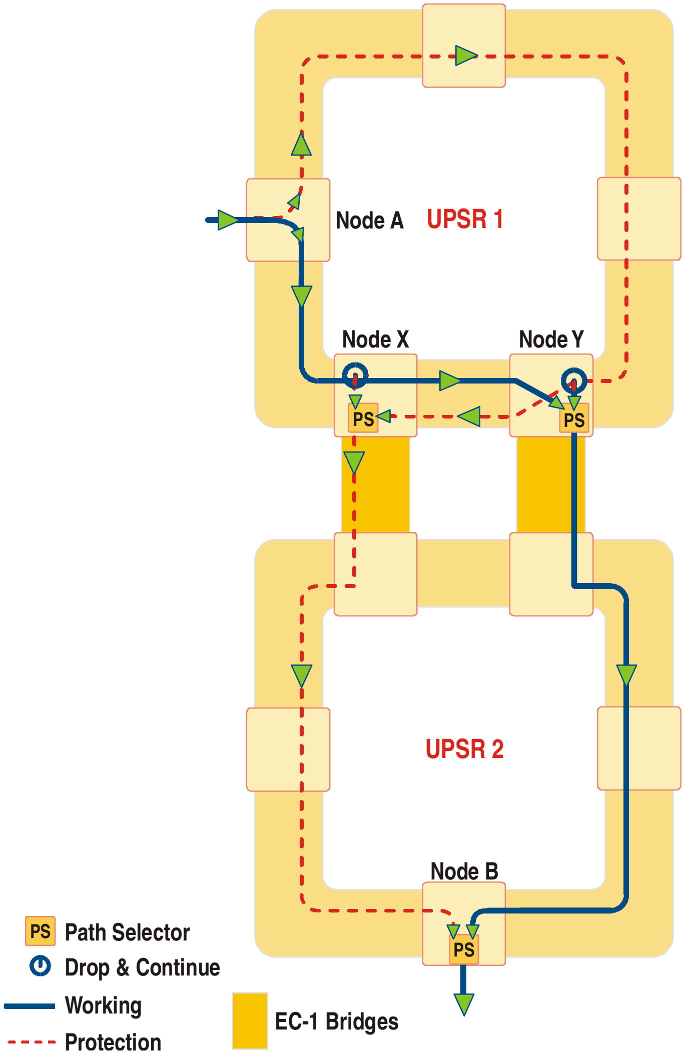
Figure 53 depicts two OC-3 rings which are interconnected in a matched nodes configuration via redundant EC-1 (STS1) bridges. The following information is relevant in this scenario:

- **Bandwidth reuse**—drop-and-continue between matched nodes ensures multi-fibercut survivability across rings. However, some protection can be sacrificed in exchange for bandwidth between ring-based nodes. If nodes are provisioned as drop only, extra traffic can be provisioned in the bandwidth between nodes. This is a network design decision which may be an option when access ring telecom or data traffic grows and extra network capacity is sought.
- **SONET visibility**—UPSRs interconnected via EC-1 bridges ensure SONET visibility for a complete path across rings. This is advantageous as it extends performance monitoring, survivability, software control, and bandwidth on demand beyond a single ring.
- **Subtended rings**—although UPSRs can form subtended rings, interconnected rings of the same capacity are not considered subtended (Figure 53). Subtended rings are typically a series of lower capacity rings homing to a high capacity DCS with multi-fabric switching capability.
- **Network management**—interconnected UPSRs which are OSI compliant can support network management across rings, using features such as IP tunneling or OSMINE. Advanced network management systems can be used to provision traffic and monitor alarms from systems which are located several rings away.
- **Synchronization**—interconnected UPSRs must be timed from a single source. All timing signals must be able to be traced back to this source for the TDM network work properly. Therefore, in Figure 53, a timing signal on

one of the rings must be defined as the source. All other nodes in both rings must be provisioned to accept timing passively and forward those signals to other nodes.

Figure 53 displays protection switching behavior for an interconnected UPSR provisioned as drop-and-continue between matched nodes.

Figure 53 UPSR Ring Interconnection—Protection Switching



BLSR to BLSR

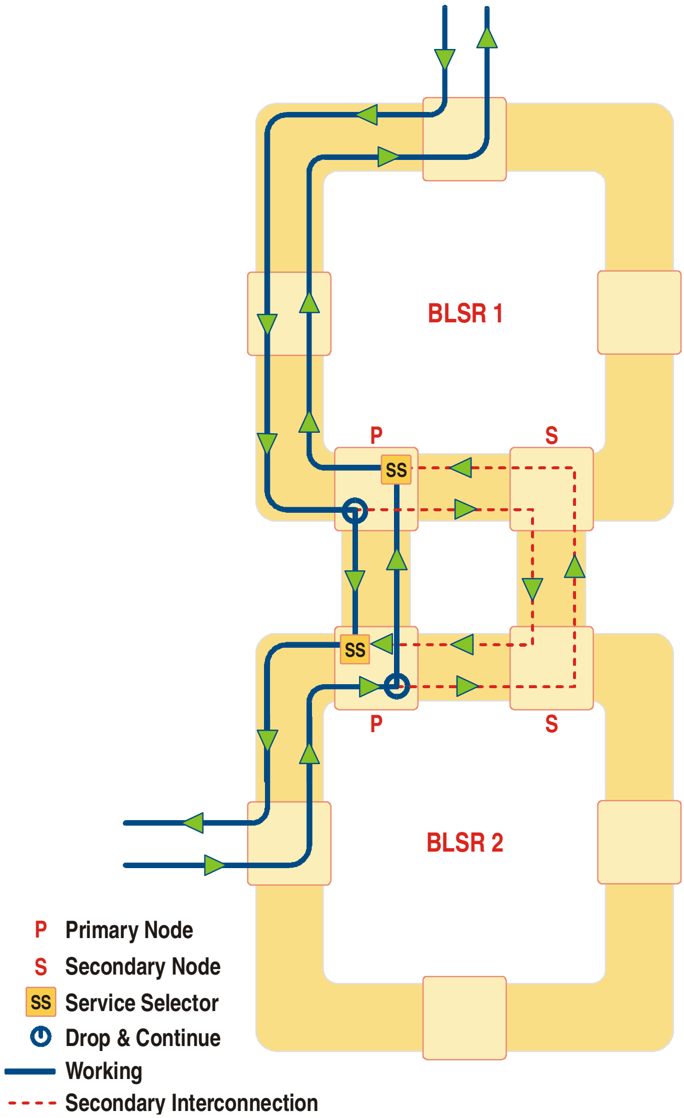
Interconnected BLSRs typically operate in a heterogeneous metro network enevironment where bandwidth is at a premium.

Figure 54 depicts two OC-48 2-fiber BLSRs which are interconnected in a matched nodes configuration via redundant OC-3 bridges. The following information is relevant in this scenario:

- **Bandwidth reuse**—drop-and-continue between matched nodes ensures multi-fibercut survivability across rings. However, some protection can be sacrificed in exchange for bandwidth between ring-based nodes. If nodes are provisioned as drop only, extra traffic can be provisioned in the bandwidth between nodes. This is a network design decision which may be an option when access ring telecom or data traffic grows and extra network capacity is sought.
- **SS Bits**—typically access rings are located in similar geographical regions. However, if BLSRs are interconnected across international boundaries, SS Bits may have to be configured so that the SONET and SDH networks can interoperate.
- **Network management**—interconnected BLSRs which are OSI compliant can support network management across rings, using features such as IP tunneling or OSMINE. Advanced network management systems can be used to provision traffic and monitor alarms from systems which are located several rings away.
- **Synchronization**—interconnected BLSRs must be timed from a single source. All timing signals must be able to be traced back to this source for the TDM network to work properly. Therefore, in Figure 54, a timing signal on one of the rings must be defined as the source. All other nodes in both rings must be provisioned to accept timing passively and forward those signals to other nodes.

Figure 54 displays protection switching behavior for an interconnected BLSR provisioned as drop-and-continue between matched nodes:

Figure 54 BLSR Ring Interconnection—Protection Switching



UPSR to BLSR

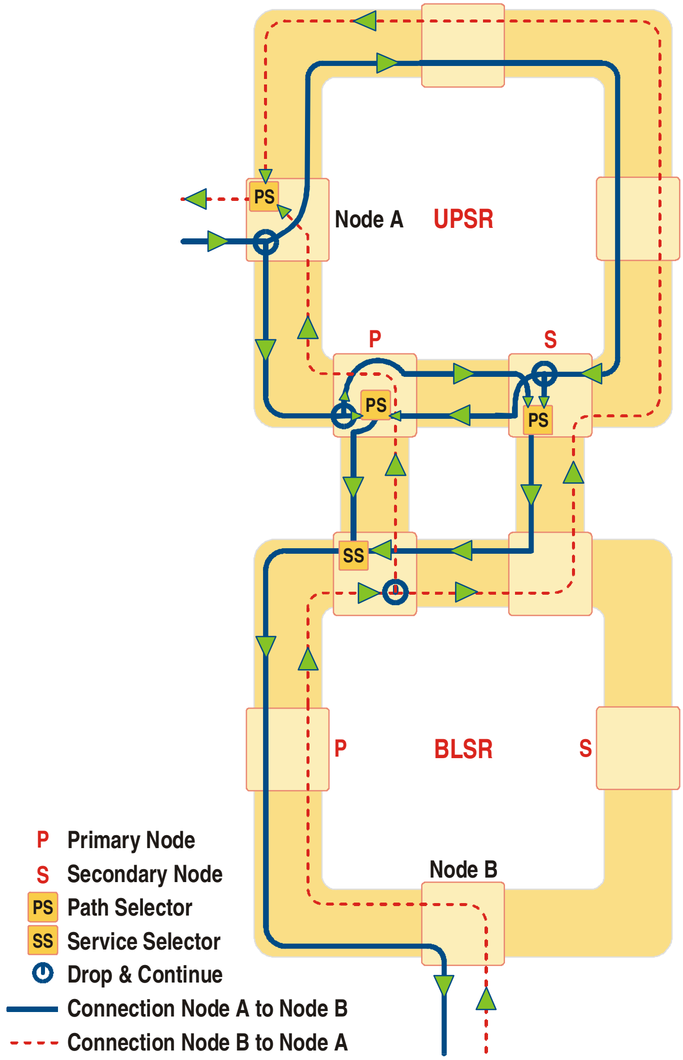
Interconnected UPSRs and BLSRs typically form subtended rings where the UPSR is subtened from the BLSR. Typically, several UPSRs are subtended from one BLSR, however, in Figure 55 only one interconnection is displayed.

The following information is relevant in this scenario:

- **Network management**–interconnected rings which are OSI compliant can support network management across rings, using features such as IP tunneling or OSMINE. Advanced network management systems can be used to provision traffic and monitor alarms from systems which are located several rings away.
- **Synchronization**–interconnected rings must be timing from a single source. All timing signals must be able to be traced back to this source for the TDM network to work properly. Therefore, in Figure 55, a timing signal on one of the rings must be defined as the source. All other nodes in both rings must be provisioned to accept timing passively and forward those signals to other nodes.

The following graphic (Figure 55) displays protection switching behavior for an interconnected UPSR-BLSR provisioned as drop-and-continue between matched nodes:

Figure 55 BLSR-UPSR Ring Interconnection—Protection Switching



Chapter 8

Synchronization

The SONET standard is based on time-division multiplexing (TDM). In TDM, SONET frames are multiplexed/demultiplexed using a system of pointers to add and remove data from the traffic stream. To do this accurately, SONET signals must be synchronized. Therefore, every interconnected SONET network element must be able to trace its timing to a single source.

Within a SONET network there must be only one primary reference source for timing information. This is a master-slave scenario with all SONET equipment receiving timing from this source and propogating it throughout the network.

Each network element is set with a timing mode, depending where it resides in the network.

The following general timing considerations apply:

- Where Building Integrated Timing Supply (BITS) timing is available, NEs are externally timed from this source
- If BITS is not present, NEs receive timing from an incoming OC-n signal
- External timing is supplied from a BITS clock of stratum 3 or better quality
- Outgoing timing from an NE is derived from incoming signals which have terminated there from an OC-n.

For detailed application provisioning instructions, see the *OverView 3000 User's Guide (206-004)* and the *OverView 30 User's Guide (206-006)*.

NE Timing Modes

Each MCN7000 receives timing on an individual basis in one of the following ways:

- External timing
- Line timing
- Loop timing
- Through timing
- Internal, or free run timing

A special case of NE timing is known as derived DS1. Each MCN7000 has two external connectors for independent DS1 timing inputs. Generally, rings interconnected with other SONET networks do not derive timing from asynchronous signals. This is for the following reasons:

- SONET signals have greater clock stability than DS1/DS3s. During DS1/DS3 multiplexing, instabilities such as signal wander may accumulate, causing synchronization problems.
- SONET signals (and timing) are rearranged less frequently than DS1/DS3 tributaries.

The following table summarizes timing modes and references:

Timing Modes	Timing Reference Source
External	Protected DS1 or BITS (Stratum 3 or better)
Line	Incoming OC-n
Loop	Incoming OC-n
Through	Incoming OC-n
Internal (free run)	Protected Stratum 3E clock source on the NE

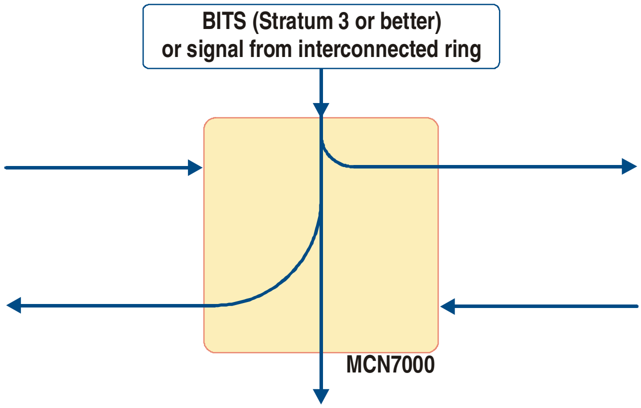
External Timing

External timing implies that a shelf receives timing from an external clock device. This timing device is independent of the SONET network and is not influenced by any optical signal entering the shelf.

External timing may be provided by a Building Integrated Timing Supply (BITS). For example, local exchange carriers often use BITS at their central office (CO). BITS timing is usually derived using a Stratum 1 clock. However, external timing must be derived from at least a Stratum 3 source.

External timing may also be provided by another SONET network interfacing at this NE. For example, an OC-192 backbone ring may provide timing for a series of subtended OC-48 rings.

Figure 56 Example of External Timing

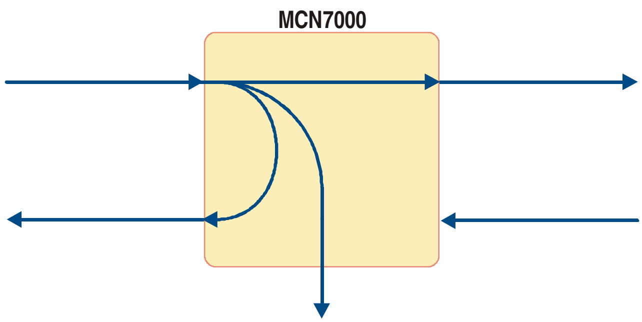


The external timing device becomes the timing reference source for every interconnected SONET NE.

Line Timing

In Line timing, each MCN 7000 receives timing from an incoming optical signal (OC-n).

Figure 57 Example of Line Timing

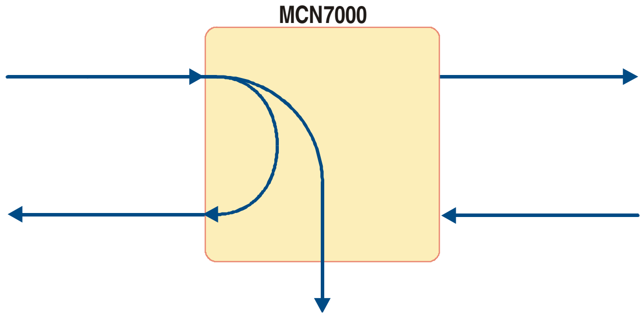


In this timing mode, the timing reference source is **not** the incoming OC-n signal. The OC-n only distributes timing from the reference source. Line timing is typically provisioned for NEs in ADM applications.

Loop Timing

Loop timing is a special case of Line timing. In networks where there is no east line, timing is looped back to the west. In Loop timing, each MCN 7000 receives timing from an incoming optical signal (OC-n).

Figure 58 Example of Loop Timing

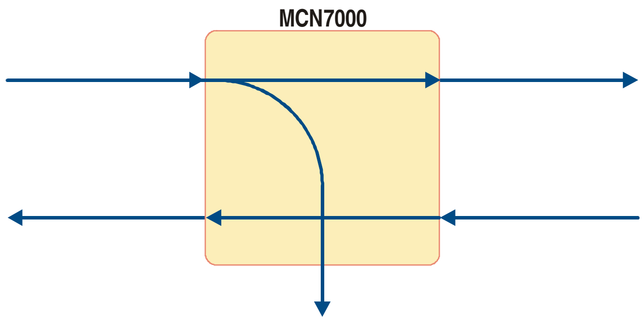


In this timing mode, the timing reference source is **not** the incoming OC-n signal. The OC-n only distributes timing from the reference source. Loop timing is typically provisioned for line terminating equipment.

Through Timing

Through timing is used for passively timed ring-based NEs. In through timing, each MCN7000 receives timing from an incoming signal (OC-n) and continues this signal in the same direction around the ring.

Figure 59 Example of Through Timing

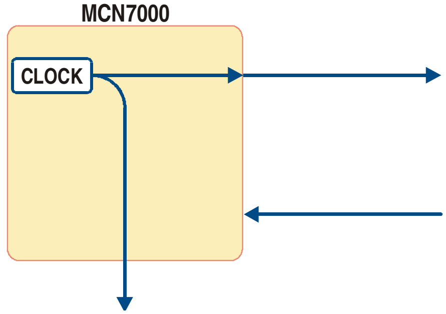


In this timing mode, the timing reference source is **not** the incoming OC-n signal. The OC-n only distributes timing from the reference source. Through timing is typically provisioned for NEs in ADM applications.

Internal Timing

Internal, or Freerun mode is the most basic form of timing. In this mode, the NE acts as the timing reference source itself.

Figure 60 Example of Internal Timing



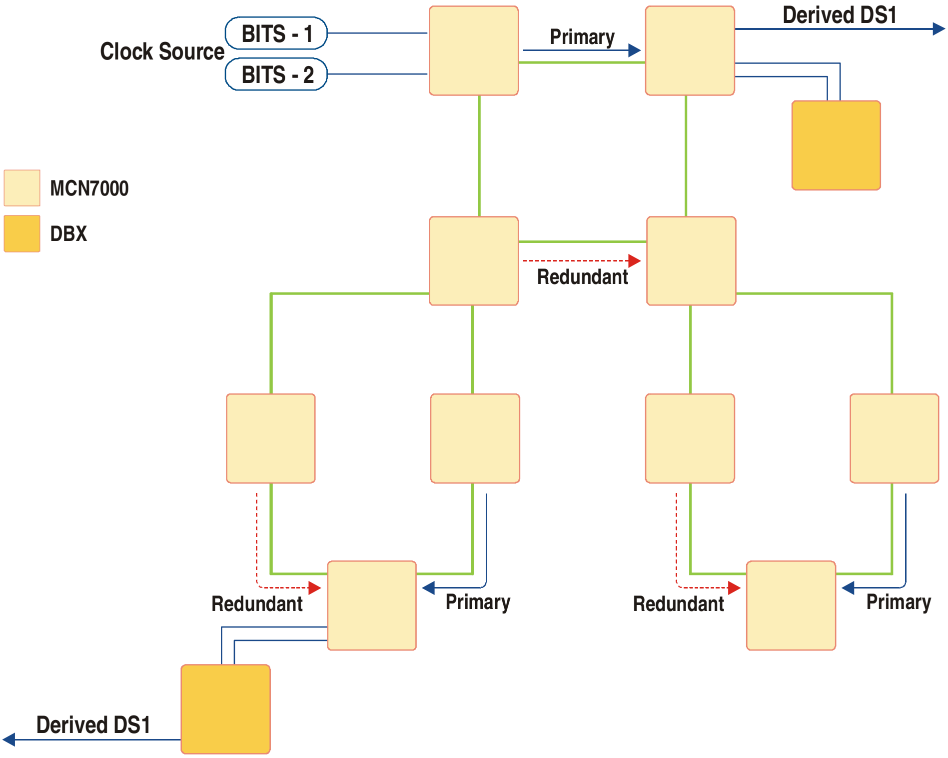
Each MCN7000 includes an internal timing source of Stratum 3E (Stratum 3 Enhanced) quality. This clock is protected by redundant equipment. Either clock can be replaced without affecting service and without removing any unrelated system module.

Timing Source Protection

Synchronization in SONET networks is based on a hierarchy. Each NE has a primary timing reference located somewhere on the network or on the NE itself. Network timing is ensured by the MCN7000 and path redundancy. Equipment protection switching is activated according to Telcordia's GR-1244-CORE standard.

Timing sources are prioritized as primary and secondary. If the primary source fails, the MCN7000 switches to the secondary source (see Figure 61). If both sources fail, the MCN7000 switches to holdover mode, guaranteeing accuracy better than 10 PPM. Holdover mode guarantees short term synchronization in the event of all timing reference failure.

Figure 61 Primary and Secondary Timing Source



Timing Quality

The quality of the incoming timing signal is monitored via the S1 byte of the SONET frame. Synchronization information is inserted into this portion of the SONET line overhead. These are known as Synchronization Status Messages (SSM) and include information about clock reference quality.

The MCN7000 uses this information to independently allocate timing references, for example, in the event of primary reference source failure. SSMs also ensure accuracy of timing distribution between interconnected networks and rings. SSMs also allow the MCN7000 to autonomously reconfigure clock source without creating timing loops.

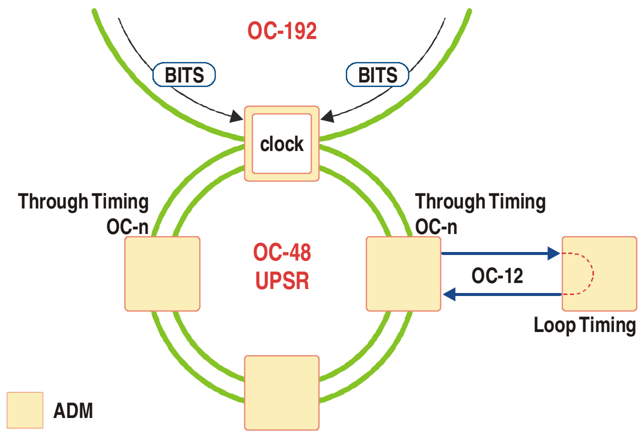
The MCN7000 supports SSM on the DS1 ESF data link and the S1 Byte of all OC-n line interfaces. Where synchronization signals are in the DS1 SF format, the AIS threshold is used to communicate the quality of the reference clock.

Timing Examples

This synchronization example shows an OC-48 UPSR used to collect DS3s for handoff to an OC-192 network at the head-end node. In this case, the head-end node distributes timing to the ring from the OC-192 network. To ensure that there are no timing loops, the timing reference must be traceable to this ring. All other NEs in the OC-48 ring are provisioned for Through timing and accept synchronization from the incoming OC-n signal. The ADM terminating the OC-12 spur is provisioned for loop timing which supplies timing to the returning OC-12 bandwidth.

If this UPSR were not connected to an OC-192 ring, the head-end node could have generated timing from a BITS or internal clock source.

Figure 62 Network Timing Example



Appendix A
Glossary

This glossary includes acronyms and definitions for telecom and datacom applications as well as the MCN Shelf.

Acronyms

The following technical acronyms appear in this document.

ACIU	Alarm and Craftperson Interface Unit.
ADM	Add/Drop Multiplexer
AIS	Alarm Indication Signal (Alarm)
AMS	Air Management System
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
B-DCS	Broadband DCS
BER	Bit Error Rate
BITS	Building Integrated Timing Supply
BIU	Buffer Interface Unit
BLSR	Bi-directional Line Switching Ring
BPV	Bipolar Violation
CAP	Competitive Access Provider (telecom)
CLEC	Competitive Local Exchange Carrier (telecom)
CO	Central Office
COS	Class of Service

CP	Connection Point
CRC	Cyclic Redundancy Code
CRDMISMAT	Card Mismatch (Alarm)
CRDRMVD	Card Removed (Alarm)
CSU	Channel Service Unit
DACS	Digital Access Cross-connect System
DCC	Data Communication Channel
DCS	Digital Cross-connect System
DSn	Digital Signal Level n
DSU	Data Service Unit
E-NUT	Enhanced Non-preemptable Unprotected Traffic
EIA/TIA	Electronic Industry Association/Telecommunications Industry Association
EID	External Interconnection Device
EPS	Equipment Protection Switching
ES	Errored Second
ESF	Extended Superframe
EXZ	Excessive Zeros
FDDI	Fiber-distributed Data Interface
FE	Far End
FEATMSMAT	Feature Mismatch
FRDCSWREQ	Forced Switch Request
IEEE	Institute of Electrical and Electronic Engineers
IP	Internet Protocol
IR	Intermediate Range
LAN	Local Area Network
LCRCD	Loop Code Received
LED	Light Emitting Diode
LOF	Loss of Frame
LOS	Loss of Signal
LOW	Lockout of Working
LPBK	Loopback
LR	Long Range
LTE	Line Terminating Equipment
MAC	Medium Access Control
MAN	Metropolitan Area Network
Mbps	Megabits per Second

MCU	Monitor and Control Unit
MM	Multimode
NE	Network Element (Node)
NIC	Network Interface Card
NIU	Network Interface Unit
NMCU	Network MCU
NOC	Network Operations Center
NSA	Non-Service Affecting
OAM&P	Operations, Administration, Maintenance and Provisioning
OC-N	Optical Carrier level N
OOF	Out of Frame
OS	Operating System
OSI	Open System Interconnect
PBX	Private Branch Exchange
PC	Personal Computer
PFEATMSMAT	Protection Card Feature Mismatch
PM	Performance Monitoring
PPS	Path Protection Switching
QoS	Quality of Service
QSSR	Quasi-Random Signal
RAI	Remote Alarm Indication
RBOC	Regional Bell Operating Company (telecom)
RFI	Remote Failure Indication
RIP	Ring Interconnection on Protection
RX	Receive (optical signal)
SA	Service-Affecting
SES	Severely Errored Second
SF	Superframe
SONET	Synchronous Optical Network
STE	Section Terminating Equipment
STS	Synchronous Transport Signal
TBOS	Telemetry Byte-oriented Serial cable
TCI/IP	Transmission Control Protocol/Internet Protocol
TIU	Tributary Interface Unit
TL1	Transaction Language 1
TOW	Traffic Overwritten
TP	Termination Point

TSA	Timeslot Assignment
TSI	Timeslot Interchange
TX	Transmit (optical signal)
UAS-P	Unavailable Seconds
UPSR	Uni-directional Path Switching Ring
VT	Virtual Tributary
WAN	Wide Area Network

Glossary

The following technical terms appear in this document.

100Base-TX

An alternative contained in the IEEE 802.3 100Base-TX CSMA/CD (Carrier Sense Multiple Access with Collision Detection) proposals for a 100 Mbps Ethernet that specifies two UTP5 pairs.

ADM

Add/Drop multiplexer. See "Multiplexing".

Alarm Indication Signal (AIS)

An AIS is a code signal transported downstream in a digital network as an indication that a failure has been detected upstream. It is associated with multiple transport layers.

APS Request

An APS Request consists of the set of signals to an APS controller that determine its behaviour. They can be initiated automatically or via an external command.

ARP

Address Resolution Protocol (ARP) is the TCP/IP protocol binding a high-level address (e.g., Internet address), to a low-level physical hardware address. ARP operates across a single physical network only.

ATM

Asynchronous Transfer Mode (ATM) is a high speed cell-switching technology used to transmit data, voice and video over both LANs and WANs. ATM uses fixed-length packets to transmit data from source to destination. ATM is also known as BISDN and Cell Relay.

Asynchronous refers to the fact that traffic from an individual user is not periodic.

Automatic Protection Switching (APS)

For 2-fiber BLSRs, automatic protection switching involves switching rings while in 4-fiber BLSRs both ring and span switching are completed.

Auto-provisioning

Auto-provisioning is the assignment of values to parameters within an NE without external intervention by a user or management system.

B8ZS

Binary Eight Zero Suppression (B8ZS) is a data encoding method for T1 transmission facilities.

Backbone

A high capacity network providing an interconnection among other lower capacity networks. Backbone networks typically carry traffic farthest, sometimes continent-wide.

Backplane

An entity which provides connectivity between plug-in cards.

Bandwidth

Bandwidth represents the transmission capacity of a signal, usually measured in thousands of bits per second (kbps). Bandwidth represents the size of the signal payload, not transmission rate.

For example, if a 1-bit signal is transmitted at a certain rate, and a 2-bit signal is transmitted at the same rate, the 2-bit rate carries a larger volume of traffic per unit of time.

A T1 service delivers 1.544 Mbps, whereas narrow-band ISDN service delivers 128 kbps.

Bidirectional Line Switching Ring (BLSR)

A BLSR is a bidirectional ring that uses line level status and specific performance parameters to initiate APS.

Bit Error Rate (BER) Test

A BER test determines the number of error bits received compared to the total number of bits received. BER is usually expressed as a power of 10.

Bit Rate (BR)

The rate of data transmission in bits per second.

BNC connector

A connector type commonly used for coaxial cable connections.

Bridge

The act of transmitting identical traffic in terms of SPE content on both the working (active) and protection channels.

Broadband

A method for transmitting data, voice, and video traffic over significant distances. Broadband uses high-frequency transmission over coaxial cable or optical fibers.

Central Office (CO)

A telephone company location which joins customer lines to switching equipment. Customers can connect to each other through intra- and inter-city trunk lines.

CLEC

Standing for Competitive Local Exchange Carrier, CLECs offer local telephone services.

Data Communication Channel (DCC)

The overhead communications channel in the SONET signal. The DCC is used to send provisioning and management instructions throughout the network. The DCC carries alarm, provisioning, and status information between network nodes.

Data Communication Equipment (DCE)

A DCS is any equipment that maintains and terminates transmission on a network.

Data Terminal Equipment (DTE)

A DTE is the end of a network segment (source or destination). For example, a DTE could be a workstation, repeater, or bridge attaching to a network.

dB

(Decibels), measurement of signal strength.

dBm

dBm (decibels above one milliwatt) is a logarithmic power measurement based upon the power of one milliwatt.

Driver

Software used to communicate between an operating system and a peripheral device.

Drop and continue feature

Drop and continue refers to the ability of traffic on a specific time slot to be dropped at more than one node. The traffic "drops and continues" at every node between the node inserting the traffic and the final node terminating the traffic. This feature can be used to support broadcast services and dual access for inter-ring traffic.

Drop and continue on protection

Drop and contintue on protection refers to the usage of the protection bandwidth to carry the continue portion of drop and continue traffic in a BLSR. The protection bandwidth in this case also carries the duplicate feed from another ring for inter-ring traffic.

Drop traffic

Drop traffic is extracted from working, protection or enhanced non-preemptible unprotected channels on the ring at a given node.

DS1

Digital Signal Level 1 (1.544 Mbps) is a SONET standard used in North America.

DS3

Digital Signal Level 3 (44.736 Mbps) is a SONET standard used in North America. A DS3 signal may be divided into 28 DS1s.

Dual homed service

Dual homed service provides survivability in the event of a node failure and ring interconnection facility failure by allowing a customer's service to enter the ring at two different nodes.

EC-1

EC-1 (Electrical Carrier) has a line rate of 51.840 Mbps. An EC-1 signal can be constructed in two ways: A DS1 can be mapped into a VT1.5 and 28 VT1.5s are multiplexed into one EC-1 signal, or a DS3 can be mapped directly into an EC1.

Element Management System (EMS)

EMS is a management system which provides functions at the Element Management Layer and in some instances, the Network Management Layer. The administrative domain associated with the EMS agent can be delimited in the provider's network by factors such as topology or geographical area.

Extra traffic

Unprotected traffic which travels along the protection channels when the protection channels are not used to backup the working channels. Extra traffic is preempted when the working channels require protection.

FDDI

FDDI (Fiber Distributed Data Interface) is a high-speed networking standard for fiber-optical transmission. The FDDI topology is a dual-attached, counter-rotating Token Ring. The FDDI protocol can also operate over traditional copper wires.

Fiber Optics

A digital signal transmission technology that sends light through thin strands of glass.

Firewall

A firewall is equipment or a software that protects a LAN from Internet intruders. Some firewalls known as Proxy Server hide the internal corporate IP Addresses from the outside world and act as a middle man for all the Internet requests.

Full Duplex

A channel or device which permits transmission in two directions at the same time. Full Duplex supports bi-directional traffic.

GUI

A graphical user interface (GUI) lets you operate a computer program using graphical items such as a icons, pull-down menus and lets you interact using a mouse. OverView is an example of a GUI.

Half Duplex

A channel or device capable of transmitting in two directions, but not at the same time. Half Duplex supports uni-directional traffic.

Head end

The head end is the NE or optics unit where the line overhead is inserted and which executes the bridge to protection. In BLSRs, a node funtions as the head end for the outgoing line and as the tail end for the incoming line on the failed system.

IEEE

The IEEE (Institute of Electrical and Electronics Engineers) is a professional organization involved in creating, promoting, and supporting of specifications and standards for communications.

Internetworking

The concept of communication between devices throughout multiple networks.

Interoperability

The ability of separate networks to connect directly, which enables data to flow between networks without conversion or human intervention.

IP (Internet Protocol)

The gateway protocol which connects networks at the OSI network level and above. IP routes messages across networks.

Jitter

The slight fluctuation of data packets in relation to network timing. Jitter is undesirable and should be minimized.

LAN (Local Area Network)

A network system providing high-speed data transmission throughout a relatively small area. LANs typically include PCs, printers, etc. and are linked by coaxial cable or twisted pair wiring.

Latency

The time between initiating data request and the beginning of signal transfer. Network latency refers to the delay when a packet is momentarily stored, analyzed and then forwarded.

The minimum time required to move data from one point to another. Factors influencing latency are as follows:

1. Physical media limitations (e.g., the time for electricity to pass over copper wires; the time for light to pass through optical-fiber; physical interference from other signals).
2. Signal set-up and break-down time required regardless of connection duration.
3. Signal interfaces.

LED (Light Emitting Diode)

A display technology radiating light at a single frequency when charged.

Line

A line is a transmission medium which when coupled with the associated equipment transports information between two Network Elements (NE). One NE originates the line signal and the other terminates the line signal.

Line Terminating Equipment (LTE)

LTE refers to NEs that originate and/or terminate line (OC-n signals). LTEs can access, modify, originate or terminate transport overhead.

Logical Ring

A logical ring consists of two route diverse paths carrying identical signals where the end nodes use SONET path selection for self-healing functionality. The paths may be carried with linear, mesh or ring networks.

Long path

The path segment away from the span where the request is initiated. The long path usually features other nodes.

Loopback

A test sending and receiving a signal to/from a particular location on a network. Loopbacks lets you test the integrity of a particular path.

or

A procedure in which the optical transmit and receive paths of a fiber-optic network are connected together, used to block out alarms during general equipment testing.

Local Loopback (Facility)

Local loopback signals are sent between an application and network access equipment. Test signals travel from the application to the network access equipment and back to the application without travelling over the network.

Remote Loopback (Terminal)

Remote loopback signals are sent between an application and remote equipment across a network. Signals are used to test path integrity across the network.

MDI

Medium Attachment Interface (MDI) is the mechanical and electrical interface between a cable medium and a 10BASE-T MAU.

MDI-X

Medium Attachment Interface-Cross Over (MDI-X) provides the same interface as MDI but with crossed pairs. MDI-X is used in a 10BASE-T hub when connecting to a 10BASE-T MAU.

Misconnection

A misconnection occurs when traffic destined for a given node is mistakenly routed to another node with no corrective action.

Multiplexing

Combining multiple signals into a common bitstream for transmission over a single communication line or channel. The reverse of multiplexing is de-multiplexing, or dividing a data stream into multiple channels.

MUX

Another term for Multiplexer—a device that performs multiplexing.

Network Management System (NMS)

An entity which performs functions at the Network Management layer and in some instances at the Element Management Layer.

Network Redundancy

The characteristic of having more than one connection path between all nodes on a network. Redundancy indicates that if one network connection is cut, network traffic is not lost.

Node

An element on a network.

OC-1

Optical Carrier Level 1Signal (51.84 Mbps). OC-1 is part of the SONET standard.

OC-3

Optical Carrier Level 3 Signal (155.52 Mbps). OC-3 is part of the SONET standard.

OC-12

Optical Carrier Level 12 Signal (622.04 Mbps). OC-12 is part of the SONET standard.

OC-48

Optical Carrier Level 48 Signal (2.488 Gb/s). OC-48 is part of the SONET standard.

OC-192

Optical Carrier Level 12 Signal (9.952 Gb/s). OC-192 is part of the SONET standard.

OC-N

Optical Carrier Level N Signal is the signal that results from the optical conversion of an STS-N signal.

Opposite-side routing

In a BLSR, routing of inter-ring traffic so that the primary path segment travels through both the primary and secondary nodes.

OSI

OSI (Open System Interconnection) is a seven layer model designed to standardize data transmission functions. Standardization enables different manufacturers equipment to be interconnected.

Pass-through

The action of a node retranmitting the exact information that it received in any given direction (unidirectional or bidirectional). A pass-through refers to the K1 and the K2 bytes as well as the protection channels in BLSRs. Three types of pass throughs are used in BLSRs:K byte pass through, unidirectional full pass-through and bidirectional full pass-through.

Path

A path is the logical connection between the point at which a standard frame format for a signal at a given rate is assembled and the point at which that format is disassembled.

Preferred Path

The preferred path is the path used as the primary signal carrier (active) in a revertive system under normal conditions.

Protection Level

The protection level indicates the network level protection class afforded traffic in the event of a failure. Possible values are: highly protected, protected, unprotected and preemptible. The provisioned protection level indicates the level of protection set via provisioning while the operational protectional level refers to the level of protection actually supported at a specific time.

Protocol

The set of rules or conventions which govern information exchange between networked nodes.

RBOC

Regional Bell Operating Company.

Repeater

A hardware device regenerating LAN signals to extend the full length of a network. Repeaters may also converts signals between media at the same time as regenerating the signal.

Revertive system

A system in which the traffic is switched back to the working channels after the condition which necessitated a switch to protection is removed.

Ring interworking

A network topology where two rings are connected at two different points so that a failure at either point will not result in lost traffic excepting the traffic dropped or inserted at the point of failure.

RJ45

A 10BASE-T standard for connecting UTP cabling.

RS-232

(Recommended Standard-232) A TIA/EIA standard for serial transmission between a PC and peripheral devices (e.g., modem, mouse, etc.). It uses a 25-pin DB-25 or 9-pin DB-9 connector. These cables are normally support a length of 50 feet.

Its normal cable limitation of 50 feet can be extended to several hundred feet with high-quality cable.

Section

The portion of a SONET transmission facility including terminating points (the point after signal regeneration at which performance monitoring may be implemented) between either a terminal NE and a regenerator, or between two regenerators.

Self-healing rings

A self-healing ring provides redundant bandwidth and/or network equipment so in the event of network failure, service can be automatically restored. In an SHR ring, each node is connected to two adjacent nodes by a duplex communications facility.

SNMP (Simple Network Management Protocol)

A popular network monitoring and control protocol in which activity of each network device is directed to the network management workstation.

Span

The set of SONET lines linking two adjacent nodes in a ring.

Squelching traffic

Replacing traffic with path AIS to prevent misconnections. STS squelching occurs only on protection channels and does not interrupt the traffic on working channels.

Survivable network

A network that is capable of restoring traffic should a failure occur. The degree of survivability depends on the network's ability to survive single line failures, mutliple line failures and equipment failures.

Synchronous Transport Signal level 1 (STS-1)

The basic logical building block signal (51.840 Mbit/s) for SONET networks.

T1

North American (SONET) standard for a digital transmission link with a 1.544 Mbit/s capacity.

T3

North American (SONET) standard for a digital transmission link with a 45 Mbit/s capacity, or 28 T1s.

Telnet

An interactive terminal emulation protocol operating over TCP/IP. TELNET lets you log in and control a remote computer over a network.

Time-Slot Assignment (TSA)

TSA refers to the capability to flexibly assign add-dropped signals. Through signals maintain the same time-slot on both the incoming and outgoing signals.

Time-Slot Interchange (TSI)

The capability to flexilby assign through signals in addition to add/dropped signals.

TL1

Transaction Language 1 is a Bellcore defined command-line communications language used to provision and manage nodes on a network.

UTP

Unshielded twisted pair. Wires are twisted to minimize interference from other wires. UTP is widely used for telephone wiring. UTP is more popular than shielded twisted pair (STP) because they are pliable and do not take up as much space as STP wires in areas such as ductwork.

V.35

Describes electrical and connector characteristics for a high-speed synchronous interface between a DTE and a DCE.

Virtual tributary (VT)

A structure designed to transport and switch sub-STS-1 payloads.

VT1.5

Virtual Tributary 1.5, a structure for sub-DS3 switching and transport (1.728 Mbps).

VT access

The termination of a SONET STS Synchronous Payload Envelope (SPE) so that individual VTs or VT groups can be added, dropped, or cross-connected.

Wander

Wander is the maximum positive or negative phase difference between actual and base signal frequency since the beginning of the test. A frequency alternating above and below the base frequency has positive and negative wander.

Working channels

The default (active) channels over which working traffic is transported when there are no switch events.

Working traffic

Traffic traversing a ring carried in working channels under normal conditions. In the event of a switch, working traffic travels on the protection channels.