



Nortel Networks Multiservice Switch

7400/15000/20000

Operations: Path-Oriented Routing System

NN10600-435

Nortel Networks Multiservice Switch 7400/15000/20000

Operations: Path-Oriented Routing System

Publication: NN10600-435

Document status: Standard

Document version: 6.1S1

Document date: August 2004

Copyright © 2004 Nortel Networks.

All Rights Reserved.

Printed in Canada

NORTEL, NORTEL NETWORKS, the globemark design, the NORTEL NETWORKS corporate logo, and PASSPORT are trademarks of Nortel Networks.

Publication history

August 2004

6.1S1 Standard

General availability. Contains information on Nortel Networks Multiservice Switch 7400, 15000, and 20000 for the PCR6.1 release.

Contents

About this document	15
How this document is organized	15
What's new in this document	16
Text conventions	16
Procedure conventions	17
Operational mode	17
Provisioning mode	18
Activating configuration changes	18
Related documents	19
Multiservice Switch documents	20
How to get more help	21
<hr/>	
Chapter 1	
PORS configuration	23
<hr/>	
Chapter 2	
Basic PORS configuration	25
Installing PORS software	28
Optimizing paths	29
Configuring manual paths for managed cut-through switching	31
Configuring manual paths for a PLC	33
Defining bandwidth sharing on Multiservice Switch trunks	35
Configuring the path count for Multiservice Switch trunks	36
Configuring tandem suppression	37
Configuring NSAP addressing	38
Configuring Multiservice Switch clusters	39

Chapter 3	
Configuring ATM service over PORS	43
Configuring a PORS profile for ATM services	45
Configuring the path administrator mapping mode	46
Configuring the switch for ATM routing	47
<hr/>	
Chapter 4	
Configuring PORS across topology regions	49
Reconfiguring VTDS services to use NSAP	51
Configuring a routing gateway	53
Configuring inter-region Multiservice Switch trunks	55
Configuring segmented PORS optimization	56
<hr/>	
Chapter 5	
PORS monitoring and troubleshooting	59
Displaying PORS connections and trunk information	62
Determining path characteristics	63
Determining Multiservice Switch trunk utilization	64
Finding all the paths on a Multiservice Switch trunk	65
Finding the end points of a path on a Multiservice Switch trunk	66
Forcing a path to reroute	67
Displaying Multiservice Switch topology information	68
Variable definitions	73
Displaying node NSAP addresses	74
Displaying reachable NSAP addresses	75
Monitoring PORS	77
Path utilization	77
Round trip delay	77
NSAP address information	77
Troubleshooting	78
Possible route selection problems	78
Effect on PA of locking a Multiservice Switch trunk	79
<hr/>	
Chapter 6	
Introduction to Path-Oriented Routing System	81
Overview	81

Services that use PORS	82
Features and characteristics	83
Summary of PORS transport characteristics	83
Summary of packet management features	84
Summary of bandwidth and congestion management features	85

Chapter 7

Routing fundamentals

87

Packet transport characteristics	87
A path as a sequence of logical channels	88
Path-oriented packet forwarding (inbound trunk)	89
Path-oriented packet header	91
Path-oriented data mode	93
Path-oriented inband control mode	93
Path-oriented outband control mode	93
Importance and urgency of packets	94
Guidelines for setting emission and discard priorities	94
Introduction to route selection	96
Route selection attributes	97
Destination application name	98
Setup and holding priorities	98
Emission and discard priority	99
Required bandwidth	100
Security	100
Traffic type	101
Multiservice Switch trunk type	101
Customer defined parameter	102
Minimization criteria	103
Maximum acceptable cost	103
Maximum acceptable delay	104
Manual path	104
Manual path with forced bandwidth	105
Terminate when rerouting	105
Optimization	105
Bump preference	106

- PORS routing profile 106
- Instantiating the route 107
- Rerouting paths 110
 - Bumping paths 110
 - Network rerouting around component failure 111
 - Rerouting by operator command 113
 - Path optimization 114
- Transporting data on the path 116
- Terminating a route 118
 - Termination of logical connection - reroute implications 118

Chapter 8

Routing applications

121

- Selecting paths based on cost and delay 121
 - Specifying a maximum cost for a path 122
 - Specifying a maximum delay for a path 123
- Restricting traffic 123
 - Restricting traffic to certain types of Multiservice Switch trunks 124
- Restricting paths 124
 - Security 124
 - Defining general parameters to restrict paths 125
 - Specifying a path manually 126
 - Tandem suppression 127
- Configuring ATM services over PORS on a Multiservice Switch node 129
 - PORS profiles for ATM services 130
 - Path administrator mode for the trunk 132
 - NSAP addressing 132
- PORS across topology regions 133
 - Overview 135
 - Segmented optimization 136
 - Bandwidth load spreading 138
 - Manual path connection between topology regions 139
 - Multiservice Switch clusters 140
 - Guidelines for Multiservice Switch clusters 142

Chapter 9	
Traffic management	143
Introduction to bandwidth management	143
Path bandwidth reservation	144
Maximum reserved outbound bandwidth	144
Path instantiation failures: causes	147
Path instantiation failures: retry response	147
Path instantiation failures: bumping response	149
Multiservice Switch trunk bandwidth sharing	151
Multiservice Switch trunk bandwidth allocation	152
Multiservice Switch trunk bandwidth sharing under congestion	155
Guidelines for setting Multiservice Switch trunk bandwidth attributes	155
Dynamic trunk speed change	156
Speed change reporting mechanism	158
PORS trunks	158
Congestion management	160
Points of congestion	161
Multiservice Switch trunk congestion	161
Congestion notification	163
Congestion management by packet discard	163
Network management to prevent congestion	164

List of figures

- Figure 1 PORS configuration tasks 24
- Figure 2 Basic PORS configuration procedures 26
- Figure 3 Configuring ATM service over PORS procedures 44
- Figure 4 Configuring PORS across topology regions
procedures 50
- Figure 5 PORS monitoring and troubleshooting tasks 60
- Figure 6 Displaying Multiservice Switch cluster information
component hierarchy 68
- Figure 7 Node address and reachable address component
hierarchy and attributes 78
- Figure 8 Example of a logical connection and a route: topology
perspective 89
- Figure 9 Example of a logical connection and a route: logical
perspective 89
- Figure 10 Example of the path-oriented forwarding (POFWD)
tables along a route 90
- Figure 11 Path-oriented routing protocol data unit 91
- Figure 12 Multiservice Switch trunk candidates based on customer
defined parameters 103
- Figure 13 Path setup packet 108
- Figure 14 Path for cost or delay using
trunkAttributeToMinimize 122
- Figure 15 Path determined using a requiredSecurity value of
4 125
- Figure 16 Path using a requiredCustomerParameter of 4 126
- Figure 17 Tandem suppression 128
- Figure 18 Isolated node 129
- Figure 19 Segmented optimization across topology regions 137
- Figure 20 Display of overrideTrunkDelay attribute 138
- Figure 21 PORS inter-region manual path connections 140
- Figure 22 Path bandwidth reservation 146
- Figure 23 Learning about bandwidth errors after a setup
failure 148
- Figure 24 Bandwidth available at different holding and setup
priorities 150
- Figure 25 Multiservice Switch trunk bandwidth reservation limit
control options 153
- Figure 26 Multiservice Switch trunk path-oriented bandwidth
fluctuation about its reservation 155

- Figure 27 Efficiency versus loss rate on a Multiservice Switch trunk carrying bursty traffic 156
- Figure 28 Congestion situation 160
- Figure 29 Types of Nortel Networks Multiservice Switch trunk congestion 162
- Figure 30 Impact of congestion types 162

List of tables

Table 31	Operator commands at a backbone node and cluster node	69
Table 32	Path-oriented routing PDU protocol data elements	92
Table 33	Summary of path-oriented routing modes	93
Table 34	Four extremes of traffic assignment to emission and discard priority	95
Table 35	ATM-to-PORS QoS mapping	131

About this document

This user guide describes how to configure, monitor and troubleshoot the Nortel Networks Multiservice Switch Path-oriented Routing System (PORS).

Who should read this document and why

This guide is for anyone who performs the following tasks for PORS on the Nortel Networks Multiservice Switch system:

- planning
- installing and provisioning
- operating and maintaining

What you need to know

This guide assumes that you are familiar with the concepts relating to PORS and Nortel Networks Multiservice Switch trunking.

How this document is organized

The NN10600-435 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Path-Oriented Routing System* is organized as follows:

- “PORS configuration” (page 23)
- “Basic PORS configuration” (page 25)
- “Configuring ATM service over PORS” (page 43)
- “Configuring PORS across topology regions” (page 49)
- “PORS monitoring and troubleshooting” (page 59)
- “Introduction to Path-Oriented Routing System” (page 81)

- “Routing fundamentals” (page 87)
- “Routing applications” (page 121)
- “Traffic management” (page 143)

What’s new in this document

There were no new features added to this document.

Other changes made to this document include the following:

- The terms Passport and PVG have been rebranded in conjunction with the new Nortel Networks’ brand simplified naming format. Passport is now referred to as the Nortel Networks Multiservice Switch, and PVG is now Media Gateway 7480/15000. For more information on the product rebranding, refer to NN10600-000 *Nortel Networks Multiservice Switch 7400/15000/20000 What’s New in PCR6.1*.
- Changes made throughout the document to enhance compliance with Nortel Networks documentation standards (for example, Modular Task Based Information standards).

Text conventions

This document uses the following text conventions:

- **nonproportional spaced bold type**

Nonproportional spaced bold type represents words that you should type or that you should select on the screen.

- *italics*

Words that appear in italics indicate a software component or attribute name.

- [optional_parameter]

Words in square brackets represent optional parameters. The command can be entered with or without the words in the square brackets.

- `<general_term>`

Words in angle brackets represent variables which are to be replaced with specific values.

Procedure conventions

This document uses the following procedure conventions:

- You can enter commands using full component and attribute names, or you can abbreviate them. The commands used in the procedures contain the full component and attribute names in the first instance. In the second instance, the component and attribute names are abbreviated. For more information on abbreviating component and attribute names, see NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*. All component and attribute names are formatted in italics.
- The introduction of every procedure states whether you must perform the procedure in operational mode or provisioning mode. For more information on these modes, see “Operational mode” (page 17) or “Provisioning mode” (page 18).
- When you complete a procedure, you can verify your changes and then activate them as the new node configuration. For more information on completing configuration changes and exiting provisioning mode, see “Activating configuration changes” (page 18).

Operational mode

Procedures contained within this document can either be performed in operational mode or provisioning mode. When you initially log into a Nortel Networks Multiservice Switch node, you are in operational mode. Multiservice Switch uses the following command prompt when you are in operational mode:

```
#>
```

where:

is the current command number

In operational mode, you work with operational components and attributes. In operational mode, you can

- list operational components and display operational attributes to determine the current operating parameters for the node
- control the state of parts of the node by locking and unlocking components
- set certain operational attributes and enter commands to perform diagnostic tests

Provisioning mode

To change from operational mode to provisioning mode, type the following command at the operator prompt:

```
start Prov
```

Only one user can be in provisioning mode at a time. Nortel Networks Multiservice Switch uses the following command prompt whenever you are in provisioning mode:

```
PROV #>
```

where:

is the current command number

In provisioning mode, you work with the provisionable components and attributes that contain the current and future configurations of the node. You can add and delete components, and display and set provisionable attributes. For information on completing the configuration changes, exiting provisioning mode, and returning to operational mode see “Activating configuration changes” (page 18).

For information on operational and provisionable attributes, see NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*.

Activating configuration changes

Activate configuration changes when prompted to complete the configuration changes by procedures elsewhere in this document. When you complete the configuration changes, you are activating those configuration changes,

confirming that you want to activate them, and saving the changes. You are instructed to complete the configuration changes only at the end of procedures that you perform in provisioning mode.

**CAUTION****Activating a provisioning view can affect service**

Activating a provisioning view can result in a CP reload or restart, causing all services on the Nortel Networks Multiservice Switch node to fail. See NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference*, for more information.

- 1 Verify that the provisioning changes you have made are acceptable.
`check Prov`
Correct any errors and then verify the provisioning changes again.
- 2 If you want to store the provisioning changes in a file, save the provisioning view.
`save Prov`
- 3 If you want these changes as well as other changes made in the edit view to take effect immediately, activate, confirm, and commit the provisioning changes.
`activate Prov`
`confirm Prov`
`commit Prov`
- 4 End the provisioning session.
`end Prov`
- 5 Continue the task that you were performing prior to activation.

Related documents

For the complete list of documents in the Nortel Networks Multiservice Switch documentation library, see NN10600-001 *Nortel Networks Multiservice Switch 7400/15000/20000 Basics: Customer Documentation*.

The following sections contain documents related to the information in this guide:

- “Multiservice Switch documents” (page 20)

Multiservice Switch documents

The following documents containing information related to PORS and the Nortel Networks Multiservice Switch system are available from Nortel Networks:

- NN10600-001 *Nortel Networks Multiservice Switch 7400/15000/20000 Basics: Customer Documentation*
- NN10600-005 *Nortel Networks Multiservice Switch 7400/15000/20000 Terminology*
- NN10600-030 *Nortel Networks Multiservice Switch 7400/15000/20000 Overview*
- NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference*
- NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*
- NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*
- NN10600-500 *Nortel Networks Multiservice Switch 6400/7400/15000/20000 Alarms Reference*
- NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*
- NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*
- NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*
- NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*
- NN10600-170 *Nortel Networks Multiservice Switch 7400 Hardware Description*

- *NN10600-175 Nortel Networks Multiservice Switch 7400 Hardware Installation, Maintenance, and Upgrade*

How to get more help

For information on training, problem reporting, and technical support, see the “Nortel Networks works support services” section in the product overview document.

Chapter 1

PORS configuration

Use the tasks listed in this section to configure PORS.

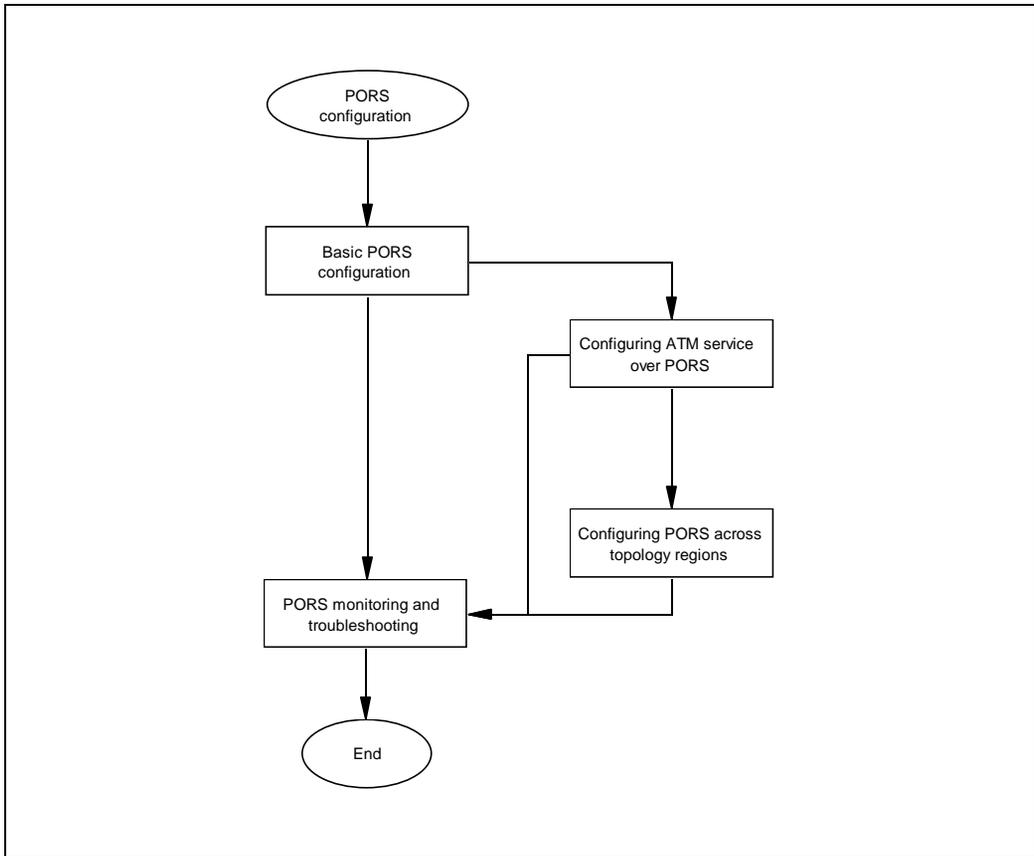
Prerequisites to PORS configuration

- Supporting Nortel Networks Multiservice Switch nodes are properly installed and configured.
- Base software is installed.
- ATM is configured (if it is being used).
- See “Introduction to Path-Oriented Routing System” (page 81) for conceptual information about PORS.

PORS configuration tasks

This task flow shows you the tasks involved in configuring PORS. To link to any procedure, go to “PORS configuration task navigation” (page 24).

Figure 1
PORS configuration tasks



PORS configuration task navigation

- “Basic PORS configuration” (page 25)
- “Configuring ATM service over PORS” (page 43)
- “Configuring PORS across topology regions” (page 49)
- “PORS monitoring and troubleshooting” (page 59)

Chapter 2

Basic PORS configuration

Configure the Path-Oriented Routing System on Nortel Networks Multiservice Switch trunks.

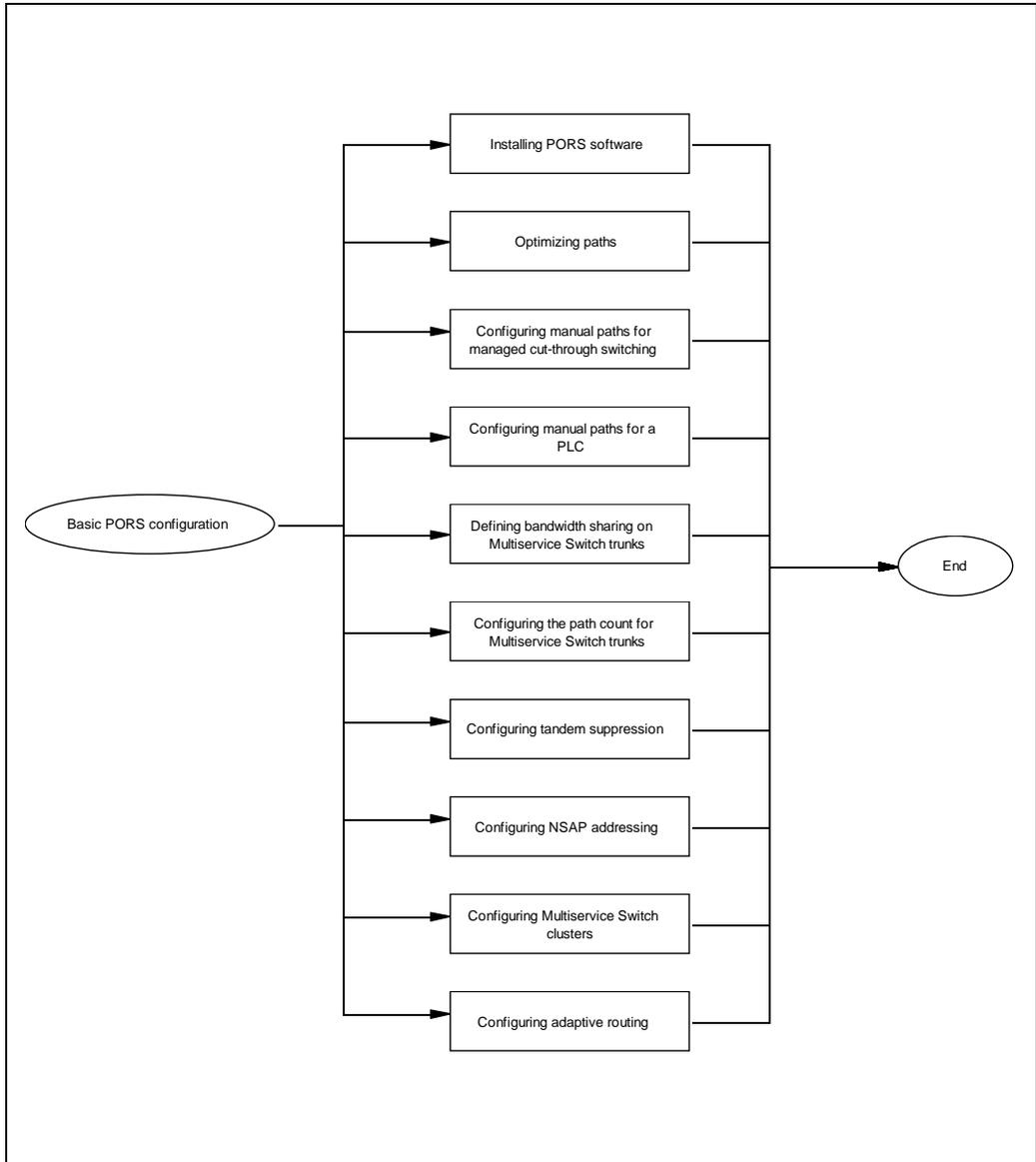
Prerequisites to basic PORS configuration

- The required processor cards have been provisioned.
- For supporting information about overall PORS configuration, see “Introduction to Path-Oriented Routing System” (page 81).
- For supporting information about PORS routing, see “Routing fundamentals” (page 87).
- For supporting information about PORS applications, see “Routing applications” (page 121).
- For supporting information about traffic management with PORS, see “Traffic management” (page 143).
- For procedure to monitor and troubleshoot PORS connections, see “PORS monitoring and troubleshooting” (page 59).

Basic PORS configuration procedures

This task flow shows you the sequence of procedures you perform to configure basic PORS functions. To link to any procedure, go to “PORS configuration procedure navigation” (page 27).

Figure 2
Basic PORS configuration procedures



PORS configuration procedure navigation

- “Installing PORS software” (page 28)
- “Optimizing paths” (page 29)
- “Configuring manual paths for managed cut-through switching” (page 31)
- “Configuring manual paths for a PLC” (page 33)
- “Defining bandwidth sharing on Multiservice Switch trunks” (page 35)
- “Configuring the path count for Multiservice Switch trunks” (page 36)
- “Configuring tandem suppression” (page 37)
- “Configuring NSAP addressing” (page 38)
- “Configuring Multiservice Switch clusters” (page 39)

Installing PORS software

Install PORS software using the procedures in NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation*.

Optimizing paths

Optimize paths by specifying whether the connection allows PORS optimization. If this attribute is set to disabled, the PLC will not optimize the connection regardless of the setting for the *optimizationInterval* attribute. If set to enabled, the connection is optimized as specified through the *optimizationInterval* attribute.

Prerequisites

- A connection must be in service for at least 1 minute prior to an optimization request otherwise the optimization process does not proceed for that connection.
- For supporting information about optimizing paths, see “Routing fundamentals” (page 87).

Procedure steps

- 1 Start the optimize process.
`optimize Routing Pors`
- 2 Determine the effects of the optimization by displaying the attributes for the *Routing Pors* component.
`display -o Routing Pors`
- 3 Optionally, set automated optimization.
`set <service>/<instance> PermanentLogicalConnection optimization <opt_setting>`
`set Routing Pors optimizationInterval <opt_value>`
- 4 Repeat steps 1 to 3 for each node that supports PORS.

Variable definitions

Variable	Value
<instance>	decimal from 1 to 65 535, which identifies the instance of the service on the switch. There is no default value.
(Sheet 1 of 2)	

Variable	Value
<opt_setting>	either disabled or enabled. The default value is enabled.
<service>	either HdlicTransparentDataService or BitTransparentDataService. There is no default value.
(Sheet 2 of 2)	

Configuring manual paths for managed cut-through switching

Configure manual paths for managed cut-through switching. A manual path consists of a sequence of hops, identified by node name and egress trunk for managed cut-through switching. Services linked to a manual path can also override the manual path setting through the *manualPath* or *porsManualPath* attribute associated with connections for that service. You can link multiple services to the same manual path on a Nortel Networks Multiservice Switch series node.

Note: If you change the configuration of an existing manual path to specify a different route, the services that use that *ManualPath* component automatically switch to the new route. You do not need to lock or disable the service.

Prerequisites

- For supporting information about manual paths, see “Routing applications” (page 121) and “Routing fundamentals” (page 87).
- For supporting information about linking multiple services, see NN10600-720 *Nortel Networks Multiservice Switch 7400/15000/20000 AAL1 Circuit Emulation Operations* and NN10600-440 *Nortel Networks Multiservice Switch 7400 Operations: Frame Relay Managed Cut Through Switching*.

Procedure steps

- 1 Add the *ManualPath* component with an instance number.

```
add Routing PathOrientedRoutingSystem ManualPath/<n>
```
- 2 Define the first hop in the route by specifying the originating node and the trunk used to leave that node for the next node in the path.

```
set Rtg Pors MPath/<n> route <index> "<switch> <trunk>"
```
- 3 Define the next hop in the route by specifying the trunk used to leave the second node in the path.

```
set Rtg Pors MPath/<n> route ,index. "<switch> <trunk>"
```

- 4 Repeat step 3 for each hop in the route, specifying the trunk that leaves the node at each hop. The last entry in the route identifies the trunk leaving the second-last node in the path. The destination node is not explicitly defined.
- 5 Link the service to the *ManualPath* component.

```
set Rtg Pors MPath/<n> users <comp_type>/instance>
<comp_type>/instance ... <comp_type>/instance>
```

Variable definitions

Variable	Value
<index>	decimal from 0 to 19 that indicates the position of the hop in the route. The first hop is assigned index 0, the second is assigned index 1, and so on.
<n>	decimal of 1 to 255 that identifies the PORS manual path. There is no default value.
<switch> <trunk>	ASCII string of up to 40 characters that defines the originating node in the path and the trunk used to leave the node. The string must be enclosed in double quotation marks (" ").

Example of configuring manual paths for managed cut-through switching

- 1 Add the *ManualPath* component with an instance number.


```
add Routing PathOrientedRoutingSystem ManualPath/<n>
```
- 2 Define the first hop in a route that originates at node EM/a, leaving on trunk 10.


```
set Rtg Pors MPath/1 route 0 "EM/a trk/10"
```
- 3 Define the secondhop in a route that leaves node EM/b, on trunk 2.


```
set Rtg Pors MPath/1 route 1"EM/b trk/20"
```
- 4 Link the service to the *ManualPath* component.


```
set Rtg Pors MPath/<n> users <comp_type>/instance>
<comp_type>/instance ... <comp_type>/instance>
```

Configuring manual paths for a PLC

Configure manual paths for a PLC. A manual path consists of a sequence of hops, identified by node name and egress trunk for transparent data services (TDS). Services linked to a manual path can also override the manual path setting through the *manualPath* or *porsManualPath* attribute associated with connections for that service.

Note: If you change the configuration of an existing manual path to specify a different route, the services that use that *ManualPath* component automatically switch to the new route. You do not need to lock or disable the service.

Prerequisites

- For supporting information about manual paths, see “Routing applications” (page 121) and “Routing fundamentals” (page 87).
- For information about linking multiple services to the same manual path on a Multiservice Switch series node, see NN10600-720 *Nortel Networks Multiservice Switch 7400/15000/20000 AAL1 Circuit Emulation Operations* and NN10600-440 *Nortel Networks Multiservice Switch 7400 Operations: Frame Relay Managed Cut Through Switching*.

Procedure steps

- 1 Add the btdds instance at the source node.

```
add btdds/<instance>
```

- 2 Set the interface name.

```
set btdds/<instance> framer interfaceName Lp/<instance>  
x21/<instance>
```

- 3 Set the path type to manual.

```
set btdds/<instance> plc pathType manual
```

- 4 Set the remote name.

```
set btdds/<instance> plc remoteName "<switch>"
```

- 5 Define the first hop in the route by specifying the originating node and the path to be taken in order to exit the node.

```
set btdds/<instance> plc manual path 0 "<switch>  
<trunk>"
```

0 is the decimal that indicates the position of the hop. the first hop is assigned index 0, the seconds assigned index 1, and so on.

- 6 At the destination node, repeat steps 1 and 2.
- 7 Optionally, set the PathType to manual, using a different path to accommodate any failure on the primary path.

Variable definitions

Variable	Value
<index>	decimal from 0 to 19 that indicates the position of the hop in the route. The first hop is assigned index 0, the second is assigned index 1, and so on.
<n>	decimal of 1 to 255 that identifies the PORS manual path. There is no default value.
<switch> <trunk>	ASCII string of up to 40 characters that defines the originating node in the path and the trunk used to leave the node. The string must be enclosed in double quotation marks (" ").

Defining bandwidth sharing on Multiservice Switch trunks

Define bandwidth sharing on Multiservice Switch trunks by setting the percentage of trunk bandwidth that can be reserved for path-oriented traffic. This setting also prevents path-oriented traffic from using more than the percentage specified. This attribute controls the allocation limit for path-oriented traffic, and is not enforced in real time on the Nortel Networks Multiservice Switch trunk.

Prerequisites

- For supporting information, see “Multiservice Switch trunk bandwidth sharing” (page 151).

Procedure steps

- 1 Set the reserved bandwidth as a percentage.

```
set Trunk/<trk_n> PathAdministrator maxReservedBwOut
<percentage>
```

Variable definitions

Variable	Value
<percentage>	decimal of 0 to 100, which defines the percentage of trunk bandwidth allocated to path-oriented traffic. The default value is 50.
<trk_n>	decimal instance value of the trunk

Configuring the path count for Multiservice Switch trunks

Configure the path count for Multiservice Switch trunks (the maximum number of logical channels permitted on a trunk). The value for the *maxLc* attribute can be as large as FP memory allows. The memory requirements for a given value in *maxLc* is defined as

$$\text{memory} = 10,000 \text{ bytes} + (\text{maxLc} * 36 \text{ bytes})$$

If the PathAdmin components at each end of a Multiservice Switch trunk are configured with different values for the *maxLc* attribute, the switch generates an alarm. PORS selects the value that is smallest for the trunk instance. If the value for the *maxLc* attribute is too large for available memory, the switch generates an alarm and the connection request is ignored. The value set for the *maxLc* attribute should be added to the *connectionPoolCapacity* attribute under the *Lp Eng Arc Ov* component. This ensures that PORS connections will establish on map mode trunks.

Prerequisites

- Familiarity with ATM configuration. See NN10600-710 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Configuration Management*.

Procedure steps

- 1 Set the number of logical channels for the trunk.

```
set Trunk/<trk_n> PathAdministrator maxLc <value>
```

Variable definitions

Variable	Value
<trk_n>	decimal representing the instance value of the trunk
<value>	decimal between 0 and 65 435, and indicates the maximum number of logical channels that the trunk can support. The default value is 512.

Configuring tandem suppression

Configure tandem suppression to prevent tandem traffic from traversing selected switches and to give the network operator control over routing behavior. This feature only applies to Multiservice Switch 7400 series nodes.

Prerequisites

- For supporting information, see “Tandem suppression” (page 127).

Procedure steps

- 1 Set the *tandemTraffic* attribute under the *Routing* component.

```
set Routing tandemTraffic <permissions>
```

Variable definitions

Variable	Value
<permission>	either allowed or denied. The default value is denied.

Configuring NSAP addressing

Configure NSAP addressing for the node prefix and the alternate PORS prefixes. For routing purposes, PORS converts these addresses to Nortel Networks Multiservice Switch node identifiers.



CAUTION

Changing a prefix will cause the node to reboot

Changing a prefix is a critical configuration change that will cause the node to reboot (unless the prefix was initially blank). Once the prefix is changed, it can never be reset to blank.

Prerequisites

- For supporting information, see “NSAP addressing” (page 132).
- For additional information about NSAP addressing, see NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

Procedure steps

- 1 Set the prefix for the node.

```
set ModuleData nodePrefix "<prefix>"
```

- 2 Optionally, set the alternate PORS prefixes for the node.

```
set ModuleData alternatePorsPrefix 1:"<alt_pref>"
[2:"<alt_pref>" [3:"alt_pref" [4:"<alt_pref>"]]]
```

Variable definitions

Variable	Value
<alt_pref>	string of 1 to 40 characters. The default is "".
<prefix>	string of 0 to 26 characters, and is a valid NSAP address prefix. There is no default value.

Configuring Multiservice Switch clusters

Configure Multiservice Switch clusters to allow for a larger number of Multiservice Switch nodes to be deployed in a topology region or RID subnet. Clusters also allow for improved network scaling in terms of CPU, memory, and control traffic bandwidth.

Note: This procedure assumes that clusters are being deployed in a network with existing PORS services present on planned cluster links.

Prerequisites

- Identify the backbone-cluster boundary that divides the backbone nodes and the cluster nodes. The backbone nodes and cluster nodes are connected by cluster links.
- Provision node NSAP addresses on all nodes running PORS services. Refer to “Configuring NSAP addressing” (page 38) for details.
- Reconfigure VTDS services for addressing based on NSAP addressing. Refer to “Reconfiguring VTDS services to use NSAP” (page 51) for details.
- Verify that all function processors (FP) being used for border nodes are supported. Refer to NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference* for a list of supported FPs.
- Ensure that the *overrideTrunkDelay* attribute under the *Trunk Pa* component is properly configured for all future cluster links. Refer to “Bandwidth load spreading” (page 138) for more details.
- For DPN considerations, ensure that the call server resource module (CSRM) is in the backbone, and that all local call routers on cluster nodes are removed.
- For supporting information, see “Multiservice Switch clusters” (page 140).

Procedure steps

- 1 Configure the *RoutingGateway* component on the backbone border nodes and cluster border nodes in order to route PORS services across the planned cluster link. For details on configuring the *RoutingGateway* component, see “Configuring a routing gateway” (page 53).

2 If load sharing and redundancy are required in the event of an LP failure, configure more than one *RoutingGateway* instance on each cluster border node and backbone border node.

3 Optionally, set the *fullTopExchgOnClusterLinks* attribute to enabled on all planned cluster nodes if legacy PORS traffic exists on the planned cluster.

```
set rtg fullTopExchgOnClusterLinks enabled
```

4 Deploy Multiservice Switch cluster nodes starting from the edge of the topology region or RID subnet. Set the *clusterNode* attribute to yes on a node-by-node bases, in order to provision a cluster node.

```
set rtg clusterNode yes
```

5 Configure reachable addresses on all cluster links. See “Configuring inter-region Multiservice Switch trunks” (page 55).

6 Optionally, if the NSAP address plan allows for summarization, configure summary addresses on cluster border nodes or backbone nodes.

```
add Routing SummaryAddress/<sum_add>
```

```
set Routing SummaryAddress/<sum_add> cost <cost_value>
```

See “NSAP address information” (page 77).

7 Wait for one hour.

8 Verify that the backbone topology has aged out of the topology database on cluster nodes.

```
display rtg top node/*
```

9 Segment all PORS calls crossing the cluster-backbone boundary either by locking and subsequently unlocking each service instance, causing the call to reestablish on the source end point (SEP), or by clearing all the logical channels on all cluster links.

10 If set previously in step 3, set the *fullTopExchgOnClusterLinks* attribute to disabled on all cluster nodes that have PORS traffic.

```
set rtg fullTopExchgOnClusterLinks disabled
```

Variable definitions

Variable	Value
<cost_value>	value of the <i>cost</i> attribute
<sum_add>	instance value of the <i>SummaryAddress</i> subcomponent

Chapter 3

Configuring ATM service over PORS

Configure ATM service over PORS.

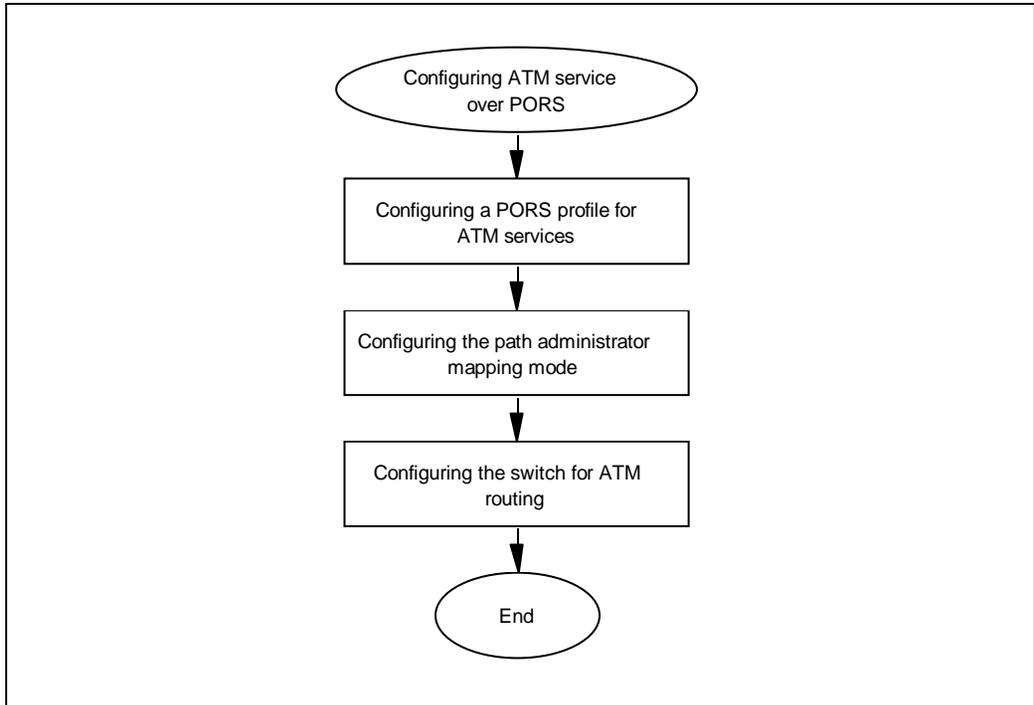
Prerequisites to configuring ATM services over PORS

- The PORS service must be initially installed and configured. See “Basic PORS configuration” (page 25).
- To understand how to set up a PORS network for ATM services, see “Configuring ATM services over PORS on a Multiservice Switch node” (page 129).
- For supporting conceptual and reference information about ATM configuration, see NN10600-710 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Configuration Management*.

Configuring ATM service over PORS procedures

This task flow show you the sequence of procedures you perform to configure ATM service over PORS. To link to any procedure, go to “Configuring ATM service over PORS procedure navigation” (page 44).

Figure 3
Configuring ATM service over PORS procedures



Configuring ATM service over PORS procedure navigation

- “Configuring a PORS profile for ATM services” (page 45)
- “Configuring the path administrator mapping mode” (page 46)
- “Configuring the switch for ATM routing” (page 47)

Configuring a PORS profile for ATM services

Configure a PORS profile for ATM services.

Prerequisites

- For supporting information, see “PORS profiles for ATM services” (page 130).

Procedure steps

- 1 Add a routing profile for PORS.

```
add Routing PathOrientedRoutingSystem Profile/
<instance>
```

- 2 Display the default PORS attributes for this profile.

```
display Rtg Pors Prof/<instance>
```

- 3 Override the discard priority for the ATM service category that uses this profile.

```
set Rtg Pors Prof/<instance> discardPriority
<dp_value>
```

- 4 Override the ATM bandwidth values for both the receive and transmit directions.

```
set Rtg Pors Prof/<instance> requiredTx 18100,
requiredRx 18100
```

- 5 Continue configuring ATM service over PORS. See “Configuring ATM service over PORS procedures” (page 43).

Variable definitions

Variable	Value
<instance>	decimal from 1 to 255. There is no default value.
<dp_value>	sameAsApplication, dp1, dp2, or dp3. The default value is sameAsApplication.

Configuring the path administrator mapping mode

Configure the path administrator mapping mode by setting ATM subcomponent of the connection path administrator to support AAL1 traffic on PORS. In this configuration, the path administrator creates new virtual channel connections (VCC) for each new logical channel that it sets up.

Note: Mapping can only be used in a directly connected Nortel Networks Multiservice Switch configuration or in a network configuration where a virtual path is dedicated to the PA. Logical trunks cannot be configured in mapped mode.

Prerequisites

- The trunk is already configured.
- For supporting information about the path administrator, see “Routing fundamentals” (page 87) and “Path administrator mode for the trunk” (page 132).

Procedure steps

- 1 Set the connection path administrator for ATM access.

```
set Trunk/<trk_n> PathAdmin AtmAccess
```
- 2 Set map mode.

```
set Trunk/<trk_n> PathAdmin AtmAccess mapping
```
- 3 Continue configuring ATM service over PORS. See “Configuring ATM service over PORS procedures” (page 43).

Variable definitions

Variable	Value
<trk_n>	decimal from 1 to 65 535. There is no default value.

Configuring the switch for ATM routing

Configure the switch for ATM routing. ATM routing protocols handles the address resolution.

Prerequisites

- For supporting information, see “Routing fundamentals” (page 87).
- For additional information, see NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

Procedure steps

- 1 Add the atmIisp, atmUni, and atmPnni features to the feature list for at least one logical processor.

```
set Software LogicalProcessorType/ATM featureList  
atmIisp atmUni atmPnni
```

- 2 Add ATM routing functionality.

```
add AtmRouting
```


Chapter 4

Configuring PORS across topology regions

Configure PORS across topology regions to allow Nortel Networks Multiservice Switch nodes to select and establish a call path from a source end point in one topology region to a destination end point in another topology region.

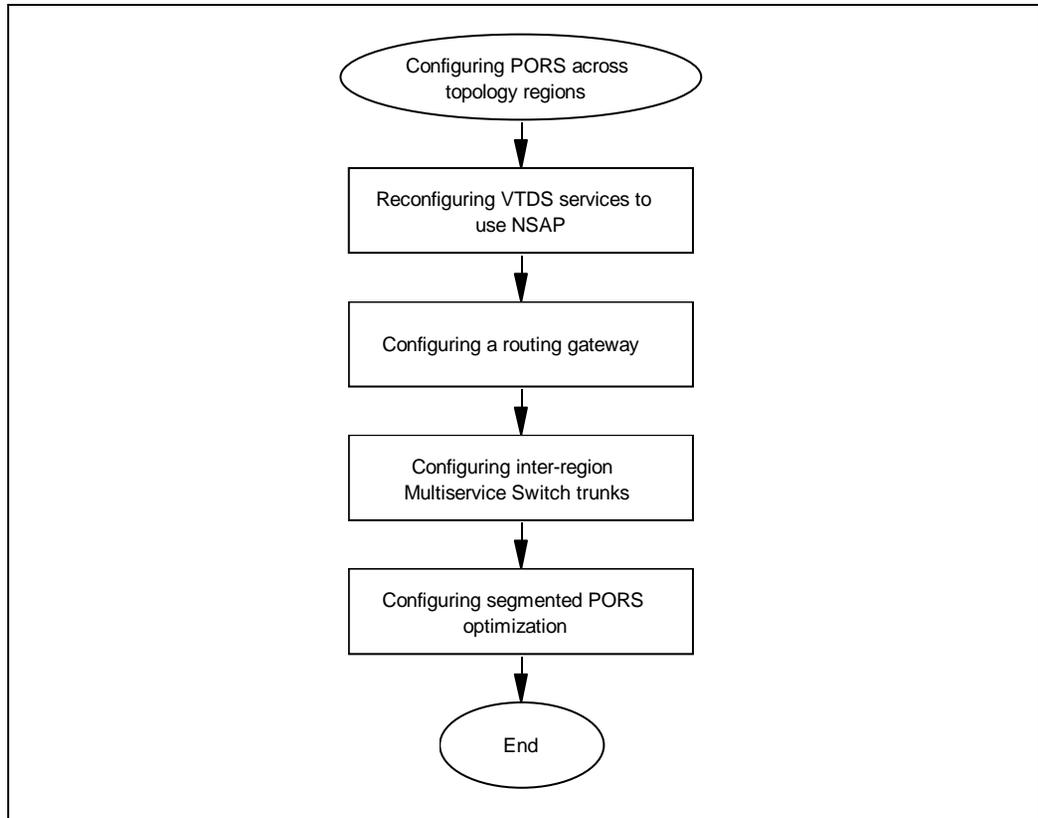
Prerequisites to configuring PORS across topology regions

- The PORS service must be initially installed and configured. See “Basic PORS configuration” (page 25).
- PORS must be configured for ATM routing and NSAP node addresses must be defined. See “Configuring ATM service over PORS” (page 43).
- For supporting conceptual and reference information about PORS across topology regions, see “Selecting paths based on cost and delay” (page 121).

Configuring PORS across topology regions procedures

This task flow shows you the sequence of procedures you perform to configure PORS across topology regions. To link to any procedure, go to “Configuring PORS across topology regions procedure navigation” (page 50).

Figure 4
Configuring PORS across topology regions procedures



Configuring PORS across topology regions procedure navigation

- “Reconfiguring VTDS services to use NSAP” (page 51)
- “Configuring a routing gateway” (page 53)
- “Configuring inter-region Multiservice Switch trunks” (page 55)
- “Configuring segmented PORS optimization” (page 56)

Reconfiguring VTDS services to use NSAP

Reconfigure voice transparent data services (VTDS) to use NSAP in order to make calls across topology regions using NSAP addressing. You can configure VTDS services for calling from source to destination and from destination to source, or only for calls from source to destination.

Prerequisites

- “PORS across topology regions” (page 133).

Procedure steps

- 1 On the node at the near end point, define the local address.

```
set <service>/<instance> PermanentLogicalConnection  
localAddress "<loc_addr>"
```
- 2 Define the address of the far end node.

```
set <service>/<instance> Plc addressToCall  
"<rem_addr>"
```
- 3 Set the upper bound on the gateway cost metric for the route.

```
set <service>/<instance> Plc  
maximumAcceptableGatewayCost "<value>"
```
- 4 If you are configuring VTDS services for calling from source to destination and from destination to source, on the node at the remote end, repeat step 1 through step 3.
- 5 If you are configuring VTDS services for calls only from source to destination, on the node at the remote end, define a remote name setting.
- 6 Activate the configuration on both nodes.
- 7 When the call has been verified, set the name of the remote endpoint address for both the near and far end nodes to an empty string.

```
set <service>/<instance> Plc remoteName " "
```
- 8 Continue configuring PORS across topology regions. See “Configuring PORS across topology regions procedures” (page 49).

Variable definitions

Variable	Value
<instance>	decimal from 1 to 65 535, which identifies the instance of the service on the node. There is no default value.
<loc_addr>	string of 1 to 40 characters. The default is “”. This string is a valid NSAP address and represents the address for the node.
<rem_addr>	string of 1 to 40 characters. The default is “”. This string is a valid NSAP address and represents the address for the node at the remote end. This address is the destination relative to the near end node.
<service>	either HdlicTransparentDataService or BitTransparentDataService.
<value>	decimal from 1 to 65 535, which identifies the instance of the service on the node. The default value is 2048.

Configuring a routing gateway

Configure a routing gateway to bridge calls from one topology region to another.

Note: Because the *way* component is memory and CPU intensive, allocate the component on a service function processor if one is available. When a *RoutingGateway* component is configured on a function processor that is dedicated to other tasks such as trunking, the *RoutingGateway* component is configured with a limit on the maximum number of calls supported. This call limit prevents the *RoutingGateway* component from exhausting all memory and CPU resources for the function processor.

Prerequisites

- “PORS across topology regions” (page 133).
- “Multiservice Switch clusters” (page 140).

Procedure steps

- 1 Add a routing gateway.
`add RoutingGateway/<instance>`
- 2 Specify the logical processor on which the routing gateway resides.
`set RGty/<instance> logicalProcessor LogicalProcessor/
<lp_n>`
- 3 Specify the maximum number of calls for the routing gateway.
`set RGty/<instance> maxcalls <max>`
- 4 Continue configuring PORS across topology regions. See “Configuring PORS across topology regions procedures” (page 49).

Variable definitions

Variable	Value
<instance>	decimal from 1 to 65 535. There is no default value.
(Sheet 1 of 2)	

Variable	Value
<lp_n>	decimal between 0 to 15, and identifies the logical processor number. There is no default value.
<max>	decimal from 0 to 1 000 000. The default value is 1 000 000.
(Sheet 2 of 2)	

Configuring inter-region Multiservice Switch trunks

Configure inter-region Multiservice Switch trunks with link-reachable addresses. In a multi-topology region network, nodes at the edge of each topology region are configured with an inter-region Multiservice Switch trunk to another topology region; and the addresses that can be reached through that inter-region Multiservice Switch trunk.

Prerequisites

- “PORS across topology regions” (page 133).

Procedure steps

- 1 Add a trunk.


```
add TRunk/<trk_n>
```
- 2 Define an address that can be reached through that trunk.


```
add Trunk/<trk_n> Address <address>
```
- 3 Set the cost for the address.


```
set Trunk/<trk_n> Address <address> cost <cost>
```
- 4 Repeat step 2 and step 3 for each address that is reachable through this trunk.
- 5 Continue configuring PORS across topology regions. See “Configuring PORS across topology regions procedures” (page 49).

Variable definitions

Variable	Value
<address>	string of 1 to 40 characters, and is a valid NSAP address. This is no default value.
<cost>	decimal from 1 to 65 435. The default value is 200.
<trk_n>	decimal from 1 to 65 535. There is no default value.

Configuring segmented PORS optimization

Configure segmented PORS optimization. Specify whether each segment of a segmented PORS connection allows PORS optimization. You can configure segmented optimization at the source node, the outbound gateway node, and the inbound gateway node of a segmented PORS connection.

Prerequisites

- The *Routing Pors* component must be added. For supporting information, see “Path optimization” (page 114).

Procedure steps

- 1 Configure the *optimizationScope* attribute at the source node to enable optimization of segmented calls originated on the node.

```
set Routing Pors optimizationScope applicationService
```
- 2 Invoke segmented PORS optimization on all segmented PORS connections on the source node.

```
optimize -segmented rtg pors
```
- 3 Configure the *optimizationScope* attribute at a gateway node to enable optimization of outbound call segments.

```
set Routing Pors optimizationScope outboundRGty
```
- 4 Invoke segmented PORS optimization on all segmented PORS connections on the outbound gateway node.

```
optimize -segmented rtg pors
```
- 5 Configure the *optimizationScope* attribute at a gateway node to enable optimization of inbound call segments.

```
set Routing Pors optimizationScope inboundRGty
```
- 6 Invoke segmented PORS optimization on all segmented PORS connections on the inbound gateway node.

```
optimize -segmented rtg pors
```
- 7 Disable segmented optimization on a node.

```
set Routing Pors optimizationScope !
```

- 8 Optionally, configure the *optimizationScope* attribute to enable multiple options (for example, inboundRGty and outboundRGty options on a gateway node).

```
set Routing Pors optimizationScope ! outboundRGty
inboundRGty
```


Chapter 5

PORS monitoring and troubleshooting

Monitor and troubleshoot the Path-Oriented Routing System using the procedures in this section.

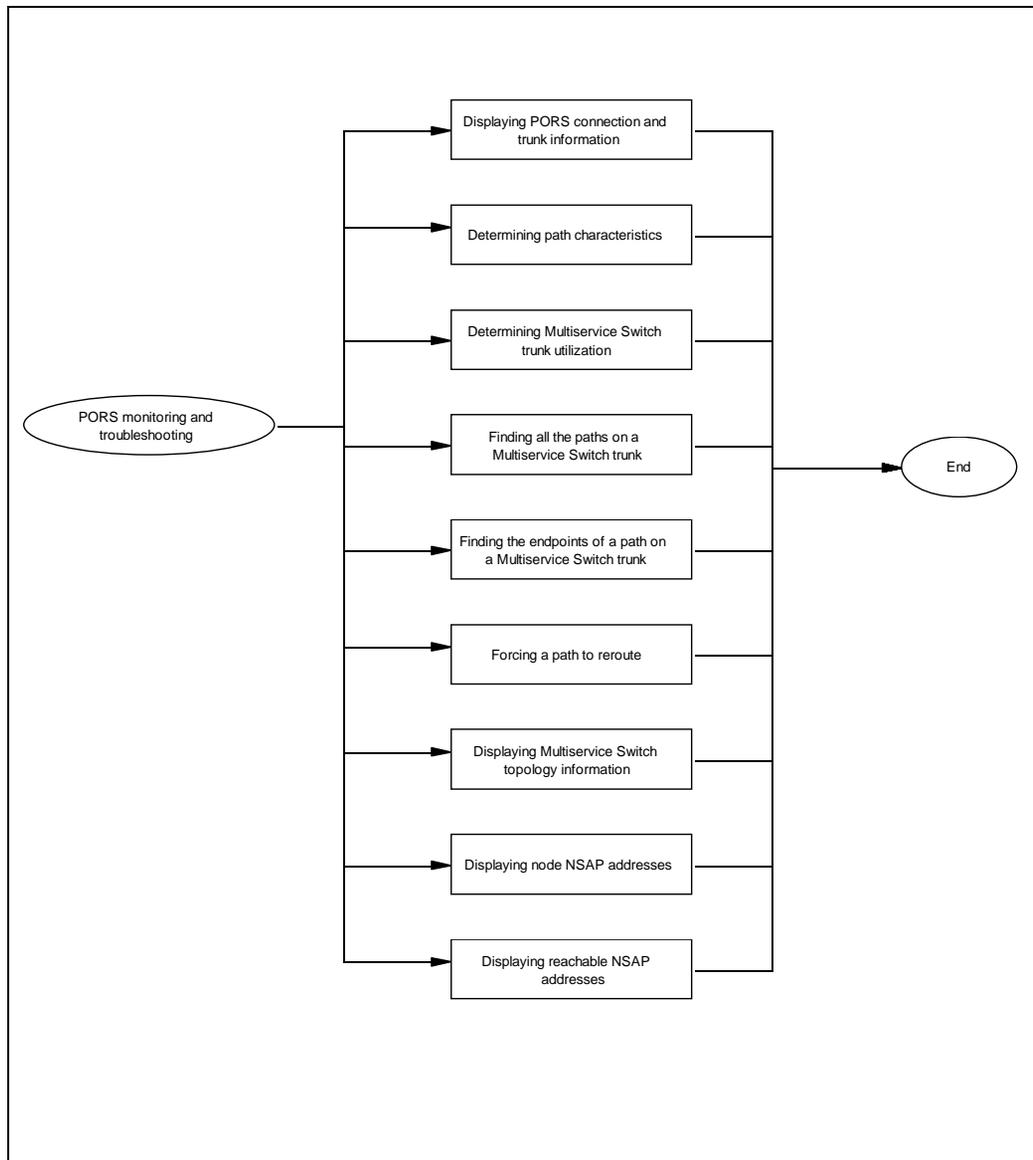
Prerequisites to PORS monitoring and troubleshooting

- The PORS service must be initially installed and configured. See “Basic PORS configuration” (page 25), “Configuring ATM service over PORS” (page 43) and “Configuring PORS across topology regions” (page 49).
- See “Monitoring PORS” (page 77) for in-depth information about trunk monitoring.
- See “Troubleshooting” (page 78) for reference information regarding troubleshooting trunks.

PORS monitoring and troubleshooting tasks

This task flow show you the procedures you can perform to monitor and troubleshoot PORS. To link to any procedure, go to “PORS monitoring and troubleshooting task navigation” (page 61).

Figure 5
PORS monitoring and troubleshooting tasks



PORS monitoring and troubleshooting task navigation

- “Displaying PORS connections and trunk information” (page 62)
- “Determining path characteristics” (page 63)
- “Determining Multiservice Switch trunk utilization” (page 64)
- “Finding all the paths on a Multiservice Switch trunk” (page 65)
- “Finding the end points of a path on a Multiservice Switch trunk” (page 66)
- “Forcing a path to reroute” (page 67)
- “Displaying Multiservice Switch topology information” (page 68)
- “Displaying node NSAP addresses” (page 74)
- “Displaying reachable NSAP addresses” (page 75)

Displaying PORS connections and trunk information

Display a list of operational and configuration attributes for each PORS trunk going in the direction from the first node specified to the second node specified.

Procedure steps

- 1 Display information on the number of PORS connections on a node and the status of optimization for all paths.

```
display Routing PathOrientedRoutingSystem
```

- 2 Display data about PORS trunks in the network.

```
display Routing Topology Node/<node_name1> LinkGroup/  
<node_name2> PorsTrunkObject/*
```

Variable definitions

Variable	Value
<node_name1>	name of the node from which the PORS trunks are outgoing.
<node_name2>	name of the node to which the PORS trunks are going.

Determining path characteristics

Determine path characteristics on a per logical channel basis. Information can be queried from both the trunk level and the service level. If all path characteristics are required, the end point of the path must be queried.

Procedure steps

- 1 Display a specific logical channel under a specific trunk.

```
display Trunk/<trk_n> LogicalChannel/lc_n
```
- 2 Query the service characteristics.

```
display <servicetype>/st_n LogicalConnection
```
- 3 Display the appropriate *LogicalChannel* component.

```
display Trunk/<trk_n> LogicalChannel/lc_n
```
- 4 Query the service characteristics.

```
display <servicetype>/st_n LogicalConnection
```

Variable definitions

Variable	Value
<lc_n>	decimal from 0 to 65 535, representing the logical channel trunk instance. There is no default value.
<servicetype>	VoiceService, BitTransparentDataService, HdlcTransparentDataService, or Aal1Ces
<st_n>	instance identifier for the service type.
<trk_n>	decimal from 0 to 65 535, representing the trunk instance. There is no default value.

Determining Multiservice Switch trunk utilization

Determine how much path-oriented traffic a particular Nortel Networks Multiservice Switch trunk is forwarding. Statistics showing how many interrupting and non-interrupting packets were received as well as discarded are displayed.

Procedure steps

- 1 Display PORS statistics for the trunk.

```
display Trunk/<tnk_n> porsStatistics
```

Variable definitions

Variable	Value
<trk_n>	decimal from 0 to 65 535, representing the trunk instance. There is no default value.

Finding all the paths on a Multiservice Switch trunk

Find all the paths on a Multiservice Switch trunk.

Procedure steps

- 1 List the logical channel for the *Trunk* component to display a summary listing.

```
display Trunk/<trk_n> LogicalChannel/*
```

- 2 Display the logical channels for the *Trunk* component for a full listing.

```
display Trunk/<trk_n> LogicalChannel/*
```

Variable definitions

Variable	Value
<trk_n>	decimal from 0 to 65 535, representing the trunk instance. There is no default value.

Finding the end points of a path on a Multiservice Switch trunk

Find the end points of a path on a Multiservice Switch trunk.

Procedure steps

- 1 Display the next hop.

```
display Trunk/<trk_n> LogicalChannel/<lch_n> nextHop
```

- 2 Repeat step 1, using the value of the nextHop attribute displayed through step 1 as the logical channel instance until the value of the nextHop attribute is a service component and not another logical channel instance.

Variable definitions

Variable	Value
<lch_n>	decimal from 1 to 65 535, representing the logical channel instance. There is no default value.
<trk_n>	decimal from 0 to 65 535, representing the trunk instance. There is no default value.

Forcing a path to reroute

Force a path to reroute. You can trigger the rerouting of an established path which runs a specific service.

Procedure steps

- 1 Attempt to reroute the path.

```
reroute <servicetype>/<st_n> LogicalConnection
```

This command attempts to reroute the service path to a new path as long as the new path is not worse than the current path in terms of delay or cost, depending on whichever attribute the service is attempting to minimize.

- 2 If the reroute request in step 1 does not reroute the current connection, force the path to reroute using the clear command.

```
clear Trunk/<trk-n> LogicalConnection/<lc_n>
```



CAUTION

Forcing the path to reroute can affect service

This command interrupts in-service connections and the reroute attempt occurs immediately.

Variable definitions

Variable	Value
<lc_n>	decimal from 1 to 65 535, representing the logical channel instance. There is no default value.
<servicetype>	VoiceService, BitTransparentDataService, HdlcTransparentDataService, or Aal1Ces
<st_n>	instance identifier for the service type.
<trk_n>	decimal from 0 to 65 535, representing the trunk instance. There is no default value.

Displaying Multiservice Switch topology information

Display Multiservice Switch topology information, providing a view of a backbone node and a cluster node.

Procedure steps

- 1 Use the display and list operator commands provided in table “Operator commands at a backbone node and cluster node” (page 69) to obtain information about a cluster node or a backbone node.

Procedure job aid

Figure 6
Displaying Multiservice Switch cluster information component hierarchy

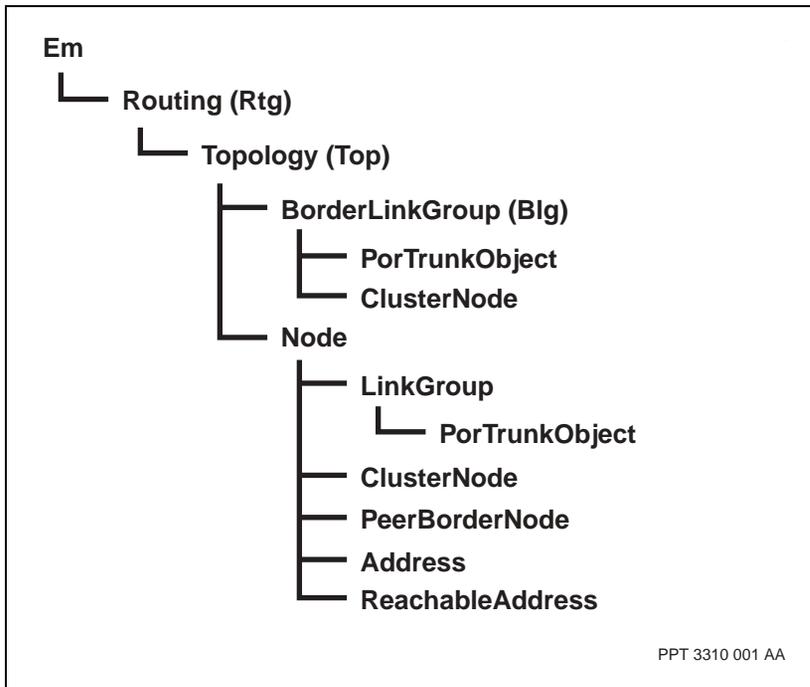


Table 1
Operator commands at a backbone node and cluster node

Operator command	Backbone node	Cluster node
I Rtg Top *	Lists all dynamic subcomponents of the <i>Topology</i> component. It shows all nodes in the backbone and cluster link groups staged on the local node.	Lists all dynamic subcomponents of the <i>Topology</i> component. It shows all nodes in the cluster and cluster link groups staged on the local node.
I Rtg Top Node/*	Shows the node names of all backbone nodes in the topology region.	Shows the node names of all cluster nodes in the cluster.
I Rtg Top Node/<x> *	Lists all dynamic subcomponents of the <i>Node</i> component (this includes the <i>LinkGroup</i> , <i>ClusterNode</i> , <i>Address</i> , and <i>ReachableAddress</i> components). The <i>LinkGroup</i> component exists if node x has at least one active neighbor node. A <i>ClusterNode</i> component exists if there is at least one cluster connected to node x. The <i>Address</i> component exists if there is a node prefix or an alternate PORS prefix provisioned on node x. The <i>ReachableAddress</i> component exists if there are trunk addresses or summary addresses provisioned on node x.	Lists all dynamic subcomponents of the <i>Node</i> component (this includes the <i>LinkGroup</i> , <i>BackboneNode</i> , <i>Address</i> , and <i>ReachableAddress</i> components). The <i>LinkGroup</i> component exists if node x has at least one active cluster node. A <i>BackboneNode</i> component exists when node x is connected to a backbone node. The <i>Address</i> component exists if there is a node prefix or an alternate PORS prefix provisioned on node x. The <i>ReachableAddress</i> component exists if there are trunk addresses or summary addresses provisioned on node x.
I Rtg Top Node/<x> ClusterNode/*	Lists the node names of all cluster nodes that can be reached through node x.	Shows an "invalid syntax" response.
(Sheet 1 of 4)		

Table 1 (continued)
Operator commands at a backbone node and cluster node

Operator command	Backbone node	Cluster node
l Rtg Top Node/<x> PeerBorderNode/*	Shows an “invalid syntax” response.	Lists the node names of all backbone border nodes that can be reached through node x.
d Rtg Top Node/<x> ClusterNode/<y>	Shows the delay and throughput metrics of the best path from node x to the cluster node.	Shows an “invalid syntax” response.
d Rtg Top Node/<x> PeerBorderNode/<z>	Shows an “invalid syntax” response.	Shows the delay and throughput metrics of the best path from node x to the backbone border node.
l Rtg Top Node/* Addr/*	Lists all dynamic <i>Address</i> subcomponents. Shows all broadcast node prefixes and alternate PORS prefixes for all backbone nodes in the topology region.	Lists all dynamic <i>Address</i> subcomponents. Shows all broadcast node prefixes and alternate PORS prefixes for all cluster nodes in the cluster.
d Rtg Top Node/* Addr/*	Shows the attributes of the dynamic <i>Address</i> subcomponent, for all backbone nodes in the topology region.	Shows the attributes of the dynamic <i>Address</i> subcomponent, for all cluster nodes in the cluster.
l Rtg Top Node/* Raddr/*	Lists all dynamic <i>ReachableAddress</i> subcomponents. The subcomponents represent non-summarized <i>Address</i> and <i>SummaryAddress</i> components provisioned for all backbone nodes in the topology region.	Lists all dynamic <i>ReachableAddress</i> subcomponents. The subcomponents represent non-summarized <i>Address</i> and <i>SummaryAddress</i> components provisioned for all cluster nodes in the cluster.
d Rtg Top Node/* Raddr/*	Shows the attributes of the dynamic <i>ReachableAddress</i> subcomponent for all backbone nodes in the topology region.	Shows the attributes of the dynamic <i>ReachableAddress</i> subcomponent for all cluster nodes in the cluster.

(Sheet 2 of 4)

Table 1 (continued)
Operator commands at a backbone node and cluster node

Operator command	Backbone node	Cluster node
I Rtg Top Node/<x> Addr/*	Lists all dynamic <i>Address</i> subcomponents on node x. The subcomponents represent the node prefixes and alternate PORS prefixes provisioned on node x.	Lists all dynamic <i>Address</i> subcomponents on node x. The subcomponents represent the node prefixes and alternate PORS prefixes provisioned on node x.
d Rtg Top Node/<x> Addr/*	Shows the attributes of the dynamic <i>Address</i> subcomponents on node x.	Shows the attributes of the dynamic <i>Address</i> subcomponents on node x.
I Rtg Top Node/<x> Raddr/*	Lists all dynamic <i>ReachableAddress</i> subcomponents on node x. The subcomponents represent non-summarized <i>Address</i> and <i>SummaryAddress</i> components provisioned on node x.	Lists all dynamic <i>ReachableAddress</i> subcomponents on node x. The subcomponents represent non-summarized <i>Address</i> and <i>SummaryAddress</i> components provisioned on node x.
d Rtg Top Node/<x> Raddr/*	Shows the attributes of the dynamic <i>ReachableAddress</i> subcomponent on node x.	Shows the attributes of the dynamic <i>ReachableAddress</i> subcomponent on node x.
I Rtg Top Node/* Lg/*	Lists all dynamic <i>LinkGroup</i> subcomponents. The subcomponent represents all the dynamic link groups that are present in the topology region backbone.	Lists all dynamic <i>LinkGroup</i> subcomponents. The subcomponent represents all the dynamic link groups that are present in the cluster.
I Rtg Top Node/* Lg/* PorTrunkObject/*	Lists all dynamic <i>PorTrunkObject</i> subcomponents. The subcomponent represents PORS trunks provisioned for all backbone nodes in the topology region.	Lists all dynamic <i>PorTrunkObject</i> subcomponents. The subcomponent represents PORS trunks provisioned for all cluster nodes in the cluster.
(Sheet 3 of 4)		

Table 1 (continued)
Operator commands at a backbone node and cluster node

Operator command	Backbone node	Cluster node
d Rtg Top Node/* Lg/* PorTrunkObject/*	Shows the characteristics and operational attributes of all PORS trunks in the topology region backbone.	Shows the characteristics and operational attributes of all PORS trunks in the cluster.
I Rtg Top Blg/*	Shows all active cluster link groups staged on the local node.	Shows all active cluster link groups staged on the local node.
d Rtg Top Blg/<node_name>	Shows the delay and throughput metrics as well as the LNNs supported by the cluster link group.	Shows the delay and throughput metrics as well as the LNNs supported by the cluster link group.
I Rtg Top Blg/<node_name> *	Shows all dynamic subcomponents of the cluster link group (this includes the <i>PorTrunkObject</i> and <i>ClusterNode</i> components). The <i>PorTrunkObject</i> component exists if there is any PA configured in the cluster link group. The <i>ClusterNode</i> component exists if there is at least one cluster node reachable through the cluster link group.	Shows all dynamic subcomponents of the cluster link group (this includes the <i>PorTrunkObject</i> component). The <i>PorTrunkObject</i> component exists if there is any PA configured in the cluster link group.
I Rtg Top Blg/<node_name> PorTrunkObject/*	Shows all PORS trunks provisioned in the cluster link group.	Shows all PORS trunks provisioned in the cluster link group.
d Rtg Top Blg/<node_name> PorTrunkObject/<link_id>	Shows the characteristics and operational attributes of the specified PORS trunk.	Shows the characteristics and operational attributes of the specified PORS trunk.
I Rtg Top Blg/<node_name> ClusterNode/*	Shows all cluster nodes that are reachable through the cluster link group.	Shows an “invalid syntax” response.
d Rtg Top Blg/<node_name> ClusterNode/<y>	Shows the delay and throughput metrics from the border node to reach the cluster node x through the specified cluster link group.	Shows an “invalid syntax” response.

(Sheet 4 of 4)

Variable definitions

Variable	Value
<link_id>	instance value of the <i>PorTrunkObject</i> component.
<node_name>	instance value of the <i>Blg</i> component. This value refers to a specified cluster link group.
<x>	instance value of the <i>Node</i> component.
<y>	instance value of the <i>ClusterNode</i> component.
<z>	instance value of the <i>PeerBorderNode</i> component.

Displaying node NSAP addresses

Display node NSAP addresses that are stored in the Base Routing Topology database in order to manage network connectivity.

Note: Commands can also be used on a network divided into topology regions; however, any command issued within a specific region will only display the node address contained within that region.

Procedure steps

- 1 Display the node addresses stored in the Base Routing Topology database.

```
display rtg top node/<x> nodeAddress/<y>
```

The node address <y> is displayed on a local node if it is present in the local Base Routing Topology database. To be present in the local Base Routing Topology database:

- node <x> must be reachable from the local node
- on node <x>, at least one of the attributes *nodePrefix* or *alternatePorsPrefixes* must be provisioned as equal to <y>
- the local Base Routing Topology database must be up-to-date

Variable definitions

Variable	Value
<x>	node stored in the Base Routing Topology database
<y>	displayed addresses. If <x> is the local node, the displayed addresses <y> are provisioned locally. If <x> is a remote node, the displayed addresses <y> have been learned by topology broadcasts from its neighboring nodes.

Displaying reachable NSAP addresses

Display reachable NSAP addresses in order to diagnose connectivity problems. In situations where a network is divided into various topology regions, reachable addresses are used to establish connections from one region to another. Each node broadcasts the *address* and *summaryAddress* subcomponents to all nodes in the same region, storing this information in the local Base Routing Topology database of each node within the same region.

Note 1: Commands can also be used on a network divided into topology regions; however, any command issued within a specific region will only display the reachable addresses contained within that region.

Note 2: Reachable addresses are generally not used in flat networks.

Procedure steps

- 1 Display the reachable addresses stored in the Base Routing Topology database.

```
display rtg top node/<x> reachableAddress/<y,n>
```

The reachable address is displayed on a local node if it is present in the local Base Routing Topology database. To be present in the local Base Routing Topology database:

- node <x> must be reachable from the local node
- on node <x>, at least one of the subcomponents *address* or *summaryAddress* must be provisioned as equal to <y>
- the local Base Routing Topology database must be up to date

Variable definitions

Variable	Value
<n>	linkId. If <x> is the local node, the value of <n> is the linkId of the trunk to which the address <y> belongs. If <x> is a remote node, the value of <n> is always 0. Though a reachable address <y> can be displayed several times on a local node with different non-zero values of <n>, it appears only once on a remote node, with the value of <n> always equal to 0.
(Sheet 1 of 2)	

Variable	Value
<x>	node stored in the Base Routing Topology database.
<y>	displayed addresses. If <x> is the local node, the displayed addresses <y> are provisioned locally. If <x> is a remote node, the displayed addresses <y> have been learned by topology broadcasts from its neighboring nodes.
(Sheet 2 of 2)	

Monitoring PORS

Path utilization

Determining path utilization is not possible on a per logical channel basis.

Round trip delay

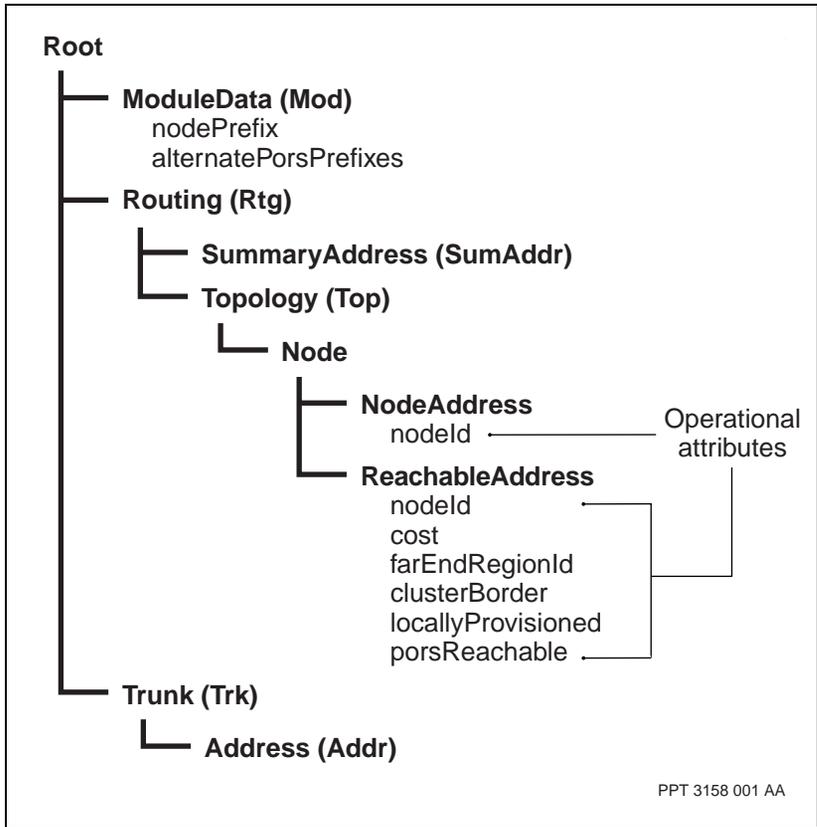
You can determine the round trip delay for a path by querying from one of its end points. If you do not know the end points, see “Finding the end points of a path on a Multiservice Switch trunk” (page 66).

NSAP address information

A component administration system (CAS) interface is available to display NSAP address information. While there is no configuration involved in setting up the CAS interface, an understanding of node addresses and reachable addresses is required.

Node NSAP addresses refer to the attributes *nodePrefix* and *alternatePorsPrefixes* that are provisioned under the *moduleData* component. Reachable NSAP addresses refer to the subcomponents *address* and *summaryAddress*, provisioned under the *Trunk* and *Routing* components respectively. Both of these NSAP addresses are broadcast and stored in the Base Routing Topology database of each node. Refer to the diagram “Node address and reachable address component hierarchy and attributes” (page 78) for a visual representation of these attributes and subcomponents.

Figure 7
Node address and reachable address component hierarchy and attributes



For detailed information on the operational attributes of node addresses and reachable addresses, refer to NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*.

Troubleshooting

Possible route selection problems

The route selection process can fail for the following reasons:

- There is no route that satisfies the transport characteristics.

- All available routes have a cost metric higher than the maximum cost metric and bumping is impossible.
- All available routes have a delay metric higher than the maximum delay metric and bumping is impossible.
- All available routes have number-of-hops larger than the maximum of ten and bumping is impossible.

Failure to select a route causes the logical connection and the call to retry periodically or to terminate if the path is rerouting due to a failure.

Effect on PA of locking a Multiservice Switch trunk

When a *Trunk* component is locked, it enters the shutting down state and the path administrator of that Nortel Networks Multiservice Switch trunk no longer permits new paths to set up on the Multiservice Switch trunk. All existing paths remain up but when they clear (of their own accord) they are no longer permitted back on this Multiservice Switch trunk. Eventually there are no more logical channels on the trunk at which time the Multiservice Switch trunk immediately enters the locked state. Note that since the logical channels are not forced off the trunk and the majority of the paths are permanent it can take a very long time before a shutting down Multiservice Switch trunk enters the locked state. If you want to take the Multiservice Switch trunk rapidly down you must issue a lock-force. However, lock-force disrupts service on all existing logical channels.

It is worth noting that while a Multiservice Switch trunk in the shutting down state is still supporting logical connections the connectionless traffic can still flow unaffected over that Multiservice Switch trunk. It is only when the last logical connection supported by that trunk clears that the connectionless traffic is pushed off the Multiservice Switch trunk and the Multiservice Switch trunk enters the locked state.

Chapter 6

Introduction to Path-Oriented Routing System

This section introduces conceptual and supporting information about the Path-Oriented Routing System. For an overview of the procedures relating to this service, see “PORS configuration” (page 23).

The Path-Oriented Routing System (PORS) is a connection-oriented routing system that runs on Nortel Networks Multiservice Switch nodes. PORS establishes and maintains an end-to-end digital transmission path for both voice and digitized data on a trunk-by-trunk basis. PORS provides ordered transmission of data with minimal delay variance. Examples of non-voice data include HDLC and any bit-stream data.

PORS software is required on all Multiservice Switch nodes in the network that support transport services.

This section provides an overview of the Path-Oriented Routing System (PORS), its features, and how it works. Overview information is organized under the following headings:

- “Services that use PORS” (page 82)
- “Features and characteristics” (page 83)

Overview

PORS supports both switched logical connections (SLC) and permanent logical connections (PLC). The use of an SLC or a PLC depends on the application that uses PORS. When a call is placed, a PLC or an SLC, and a route are created between the two end points (source and destination) of the

call. Either end point can initially try to establish a path. The first end point to establish a path becomes the calling end (source), the remote end point becomes the called end (destination).

The path is created by

- selecting a route that satisfies the transport characteristics
- instantiating the route by
 - verifying that the required bandwidth is available on all Multiservice Switch trunks
 - reserving the bandwidth on all Multiservice Switch trunks
 - setting up the *LogicalChannel* components required on all Multiservice Switch trunks

Upon completion of these steps, a logical connection and path are established. It is up to the access service, for example Voice Transport, to use the path.

Services that use PORS

PORS supports the following services:

- Voice Transport (see NN10600-750 *Nortel Networks Multiservice Switch 7400 Operations: Voice Transport*)
- HDLC transparent data service (see NN10600-770 *Nortel Networks Multiservice Switch 7400 Operations: HDLC Transparent Data Service*)
- bit transparent data service (see NN10600-775 *Nortel Networks Multiservice Switch 7400 Operations: Bit Transparent Data Service*)
- AAL1 circuit emulation service (see NN10600-720 *Nortel Networks Multiservice Switch 7400/15000/20000 AAL1 Circuit Emulation Operations*)

PORS can also be used to transport frame relay data using multiservice cut-through switching (MCS). MCS provides many-to-one multiplexing of connections for data services and uses PORS facilities to route the traffic. For more information on MCS, see NN10600-440 *Nortel Networks Multiservice Switch 7400 Operations: Frame Relay Managed Cut Through Switching*.

Features and characteristics

PORS features and characteristics are presented under the following headings:

- “Summary of PORS transport characteristics” (page 83)
- “Summary of packet management features” (page 84)
- “Summary of bandwidth and congestion management features” (page 85)

Summary of PORS transport characteristics

The selection of a connection path is based on criteria that is set by a network operator. There is no need to manually select a route for every connection, although manual configuration is available. PORS preferentially selects paths that minimize cost or delay, within the bounds of a maximum cost or delay metric. The routing mechanism at each hop consists of a table lookup using the connection identifier as an index. A connection is re-routed if a component on the path fails.

The following transport characteristics of a route are configurable:

- the bandwidth required in each direction of the route
- the priority at which the route is set up and the priority it holds after being set up
- the security level of the route
- the type of Nortel Networks Multiservice Switch trunks that can be used on the route (such as terrestrial, satellite)
- the type of traffic carried on the path (such as voice, data, video)
- the optional customer defined parameter supported on the Multiservice Switch trunks of the path
- the primary route metric to minimize: cost or delay
- the maximum cost metric that a path can tolerate; calculated from a value assigned to Multiservice Switch trunking facilities by a network administration
- the maximum delay metric that a path can tolerate; calculated from the transmission delay of the Multiservice Switch trunking facilities

- NSAP link-reachable addresses and their costs (for routing across topology regions)
- maximum region cost

An operator can manually select a route where all of the configured PORS characteristics must still be met by the manually selected Multiservice Switch trunks before path is instantiated.

An operator can also force a path to follow the manually selected route, regardless of path characteristics. A forced manual path still reserves the bandwidth on the Multiservice Switch trunk; if not enough bandwidth is available, it reserves only up to the maximum available limit on that Multiservice Switch trunk.

For information on the PORS addressing system, see NN10600-030 *Nortel Networks Multiservice Switch 7400/15000/20000 Overview*.

Summary of packet management features

The key features of PORS packet management include the following:

- Identical forward and backward data path facilitates the exchange of network management information between all points on the route.
- Periodic optimization of a PORS path provides network efficiency.
- Minimal delay variance exists between packets. All packets follow the same route.
- Preservation of packet ordering prevents a packet from overtaking another.
- Duplication (retransmission) of packets is avoided.
- Packet emission priority allows packets that are sensitive to delays to be urgently emitted from a Multiservice Switch trunk.
- Packet discard priority allows less important packets to be discarded during congestion.
- Distribution of congestion information to the service end points is done in the packets.

- Best effort delivery is provided (but packet loss can occur during periods of congestion).
- Loadspreading allows traffic to be spread across link groups.
- Network partitioning allows autonomous topology regions.
- Tandem suppression allows the network operator to control routing behavior by preventing tandem traffic from traversing the selected nodes.

For Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 nodes, PORS can be configured as a warm standby feature. A warm standby application or feature can operate together with a hot standby application or feature on the same function processor without affecting the ability of the hot standby application or feature to provide hitless services during an equipment switchover.

See NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures* for a description of hitless services and hot, warm and cold standby applications and features.

Summary of bandwidth and congestion management features

PORS allows a network administration to efficiently manage the bandwidth on Nortel Networks Multiservice Switch trunking facilities. The key features of PORS bandwidth management include the following:

- Bandwidth for PORS traffic is reserved on all Multiservice Switch trunks on the route. The reserved portion can be set to the service peak, average, or any other arbitrary bandwidth usage that the service requires.

Bandwidth can be allocated in a statistical fashion by reserving only a portion of the bandwidth required for the connection, or in a conservative fashion by reserving the peak bandwidth requirements.

- Bandwidth on a Multiservice Switch trunk is shared between connectionless and connection-oriented traffic. Bandwidth that one traffic type does not use is unused by one traffic type can be used by the other.

The network operator can configure the maximum amount of bandwidth allowed for reservation by path-oriented connections.

- Bandwidth on a Multiservice Switch trunk is statistically shared amongst all of the paths.
- A Multiservice Switch trunk is not used as part of a path if it exceeds the trunk's total reserved bandwidth.
- Bandwidth overhead is low. The packet headers contain a route identifier rather than a full destination address.
- PORS uses both frame-cell trunks and Multiservice Switch trunks over ATM. There are three modes of operation for PORS traffic on Multiservice Switch trunks over ATM: AAL5-mux mode, SPO-mux mode and map mode (see NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*).

For Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 nodes, PORS trunking can be configured as a warm standby feature. However, PORS routing is interrupted during an equipment switchover and becomes available after

- the switchover to the standby function processor is complete
- Multiservice Switch trunks over ATM are re-established

Chapter 7

Routing fundamentals

This section describes the fundamentals of routing used by Nortel Networks Multiservice Switch Path-Oriented Routing System (PORS). Information is organized under the following headings:

- “Packet transport characteristics” (page 87)
- “Introduction to route selection” (page 96)
- “Route selection attributes” (page 97)
- “Instantiating the route” (page 107)
- “Rerouting paths” (page 110)
- “Transporting data on the path” (page 116)
- “Terminating a route” (page 118)

For information on specific applications of PORS outside of the default implementation for services, see “Routing applications” (page 121).

Packet transport characteristics

Information on packet transport characteristics is organized under the following headings:

- “A path as a sequence of logical channels” (page 88)
- “Path-oriented packet forwarding (inbound trunk)” (page 89)
- “Path-oriented packet header” (page 91)
- “Path-oriented data mode” (page 93)

- “Path-oriented inband control mode” (page 93)
- “Path-oriented outband control mode” (page 93)
- “Importance and urgency of packets” (page 94)
- “Guidelines for setting emission and discard priorities” (page 94)

A path as a sequence of logical channels

The figure “Example of a logical connection and a route: topology perspective” (page 89) shows a connection between nodes A and D from the perspective of network topology. The Nortel Networks Multiservice Switch route selector defines the connection as

```
EM/A Trunk/4 -> EM/B Trunk/6 -> EM/C Trunk/5
```

The figure “Example of a logical connection and a route: logical perspective” (page 89) shows the same connection from a logical perspective. The connection has the following characteristics:

- the connection consists of three hops: EM/A Trunk/4 over LogicalChannel/25, EM/B Trunk/6 over LogicalChannel/7, and EM/C Trunk/5 over LogicalChannel/12
- The route selector chooses the route from the Multiservice Switch trunks but does not select the logical channel numbers (LCN) at each hop
- LCNs are allocated during path instantiation in a Multiservice Switch network
- an LCN is local to a Nortel Networks Multiservice Switch trunk and is generally different at each trunk along the route

Figure 8
Example of a logical connection and a route: topology perspective

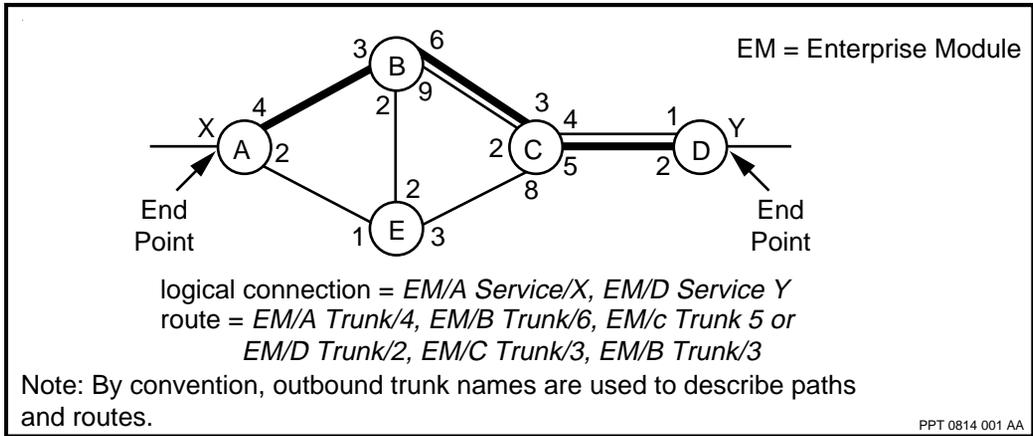
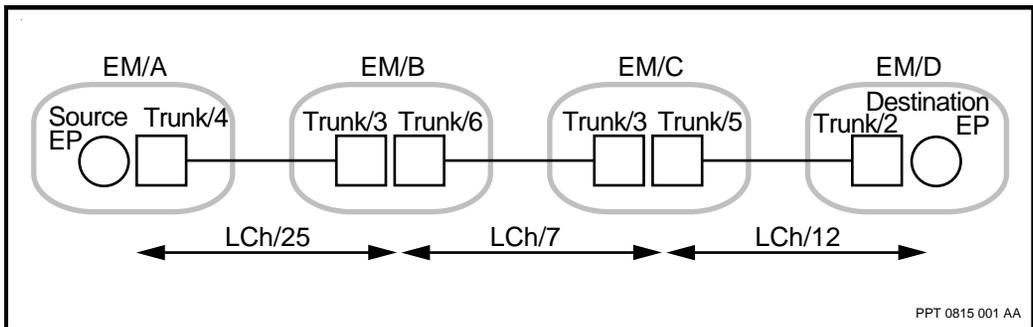


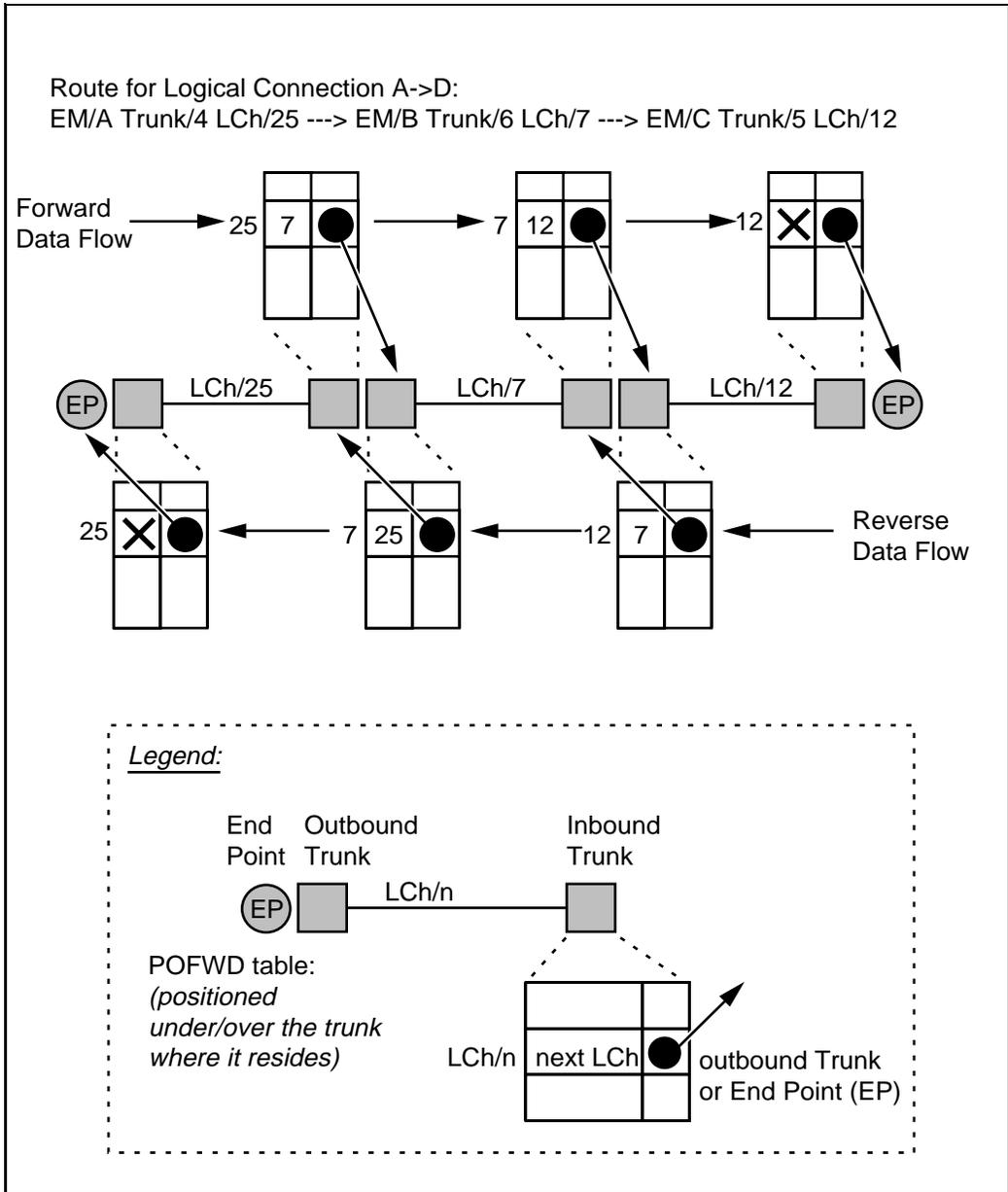
Figure 9
Example of a logical connection and a route: logical perspective



Path-oriented packet forwarding (inbound trunk)

When a path-oriented packet arrives at an inbound Nortel Networks Multiservice Switch trunk for forwarding to the next outbound trunk, PORS packet forwarding uses the inbound logical channel to determine the outbound logical channel. The figure “Example of the path-oriented forwarding (POFWD) tables along a route” (page 90) shows the logical connection from nodes A to node D. The packet forwarding (POFWD) table for the trunk stores the information necessary for the forward and the reverse data flow.

Figure 10
Example of the path-oriented forwarding (POFWD) tables along a route



PORS uses the LCN of the packet to index into the POFWD table on the inbound trunk to determine the outbound Multiservice Switch trunk and next LCN to use. The reverse data flow is much the same. The LCNs used in both directions of a path are identical.

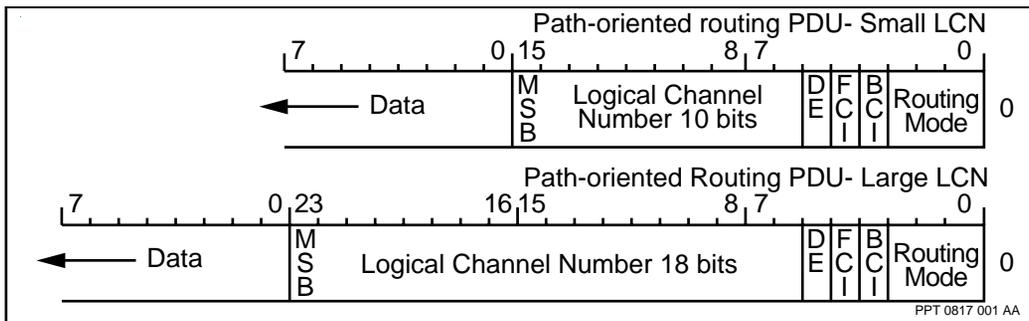
Path-oriented packet header

Path-oriented routing protocol data units (PDU) have a routing common header followed by an LCN followed by the data (packet payload). Two sizes are available for LCN resulting in two general formats for the path-oriented routing PDUs. These headers are shown in the figure “Path-oriented routing protocol data unit” (page 91). All three routing modes of path-oriented routing PDUs share the same format. See

- “Path-oriented data mode” (page 93)
- “Path-oriented inband control mode” (page 93)
- “Path-oriented outband control mode” (page 93)

Note: Traffic from ATM services, such as circuit emulation service (CES), does not need a PORS header. This type of traffic is routed with an ATM header only.

Figure 11
Path-oriented routing protocol data unit



The table “Path-oriented routing PDU protocol data elements” (page 92) describes the contents of the PDUs. The table “Summary of path-oriented routing modes” (page 93) summarizes characteristics of the routing modes.

Table 2
Path-oriented routing PDU protocol data elements

Field	Meaning
Routing mode	<p>The following routing modes define path-oriented routing PDUs:</p> <ul style="list-style-type: none"> • 000 - path-oriented data • 010 - path-oriented inband control • 100 - path-oriented outband control <p>These Routing Modes are described in more detail later.</p>
FCI	On a received packet, the presence of the Forward Congestion Indication bit indicates that this packet has encountered congestion on travels across the network.
BCI	On a received packet, the presence of Backward Congestion Indication bit indicates that packets being sent by this end are encountering congestion as they cross the network.
DE	The Discard Eligibility bit is set on a packet to cause the packet to be treated with lowest possible discard priority whenever discard priority decisions are made. Packets with this bit set are the first candidates for discard.
LCN	<p>The LCN associates this PDU with a particular logical channel.</p> <p>LCN 0 is a special logical channel used for path management on a Multiservice Switch trunk. All other logical channels are available for data flow.</p> <p>Two ranges are available for LCNs: small, 1-1023 (10 bits); and large, 1-262144 (18 bits) depending on the needs of the facility. (Actually, nothing prevents future faster facilities from having larger LCNs if they want to spend the bits).</p> <p>Facilities operating at DS1, E1 speeds, and lower use the small logical channel range to conserve bandwidth. Facilities operating above these speeds use the large LCNs to permit greater channel handling capacity. For convenience, in the rest of this document these are referred to as small and large Multiservice Switch trunks, respectively.</p> <p>The size of the LCN is a local issue for the facility.</p>

Table 3
Summary of path-oriented routing modes

Characteristic	Path-oriented data	Path-oriented inband control	Path-oriented outband Control
Discard priority	From connection table	0	0
Emission priority	From connection table	Same as path-oriented data	1
Packet size	Selected by service	Less or equal path-oriented data	Any

Path-oriented data mode

Packets with this mode follow the path using the emission and discard priority associated with the path during path establishment. The LCN field contains the LCN of the logical channel for this hop of the path and is changed for each hop. The packet is delivered to the service at the far end. This mode is used exclusively for VC data packets which are being transported on behalf of the service.

Path-oriented inband control mode

Packets with this mode are handled along the path in exactly the same fashion as path-oriented data except that at the destination they are extracted from the data stream and delivered to the PEP. Round-trip delay measuring packets use this routing mode so that they follow exactly the same path as the data and therefore return an accurate measure. These packets must meet the same size criteria as the data so that they do not upset queuing and congestion management, especially when they go through the interrupting queue.

Path-oriented outband control mode

These packets come in two types: those with an LCN of 0 and those without. LCN 0 packets go hop-by-hop and are delivered to the TPA at each hop. Path setup packets are an example of this kind of packet. LCN 0 is also used for all TPA management packets which cross a Nortel Networks Multiservice Switch trunk. Non-LCN 0 packets follow the same path as the data packets except that they are always treated as Emission Priority 1 (high, not

interrupting) and Discard Priority 0 (high). This allows the VC to send larger control packets on this mode since these packets do not end up on the interrupting queue.

Importance and urgency of packets

The next logical channel and outbound Nortel Networks Multiservice Switch trunk fields in the forwarding table are sufficient to forward a packet along a fixed route. Other transport properties include the importance of delivery and the urgency of emission. Urgency and importance define the quality of service (QOS) that PORS provides on the path. The path-oriented header does not carry fields to indicate packet importance and urgency since these attributes are defined at the path level.

Packet importance is defined as discard priority, which implies the likelihood of the packet reaching its destination (the probability of loss or discard). Paths can contain important data which, if lost, can cause problems for a service or customer. Important packets are given a high guarantee of delivery and are therefore less likely to be discarded in the event of network problems or congestion. The discard priority defined for a path indicates the importance of all the packets on the path. Independently of the path discard priority, individual packets can be marked as the least important packets by setting the discard eligible (DE) bit in the packet header.

Packet urgency defines emission priority, which implies how quickly a packet is forwarded to its destination. Urgent traffic can consist of packets that must be delivered within a specific time frame for the application to function correctly. Packets of paths with a high emission priority are queued on a Multiservice Switch trunk queue that is serviced before other Multiservice Switch trunk queues.

Guidelines for setting emission and discard priorities

The purpose of having four different emission and discard priorities is to allow the network traffic to be partitioned into groups requiring similar quality of service. In this manner, traffic requiring better service can be dealt with more promptly and/or with less loss than a service requiring a lesser QOS. Normally, an access service is aware of the QOS required for its path and automatically sets the attribute to the desired values. However, some applications allow one or both attributes to be adjusted.

For each type of priority there are two extremes, either all traffic has the same value, or traffic is distributed among the priorities. See the table “Four extremes of traffic assignment to emission and discard priority” (page 95).

Table 4
Four extremes of traffic assignment to emission and discard priority

Attribute	All traffic at same priority	Traffic distributed throughout all levels
discard priority	All traffic is considered equally important. Under congestion, the decision of which packet to discard is randomly distributed amongst all packets.	Traffic has four distinct levels of importance. Under congestion, DE priority packets are discarded first, then priority 3, then 2, then 1 and finally 0.
emission priority	All traffic is considered equally urgent and is emitted on a first come first serve basis. When congested, the Multiservice Switch trunk emission delay increases for all packets.	Traffic has three distinct levels of urgency. When congested, the first packets emitted are those at priority 0 followed by priority 1 and finally priority 2.

Taking into consideration the fact that high urgency voice and bit-sliced transparent data must run at the highest emission priority, use the following guidelines:

- If all traffic is equally important, use a middle discard priority (that is, 2) for all traffic.

This approach permits raising or lowering the priority of individual traffic sources later to increase or decrease their relative importance.

- If there are clearly different levels of importance, the priority levels must be spread evenly among the different kinds of traffic.

This approach permits the network to make the most precise choices about packets to throw away at congested points. Consider the tolerance to loss of the individual service when setting the discard priority. If the service can tolerate small amounts of loss, do not use discard priority 0. Use discard priority 0 for services that are seriously degraded by a lost packet.

- If all traffic is equally urgent, use a middle emission priority (that is, 1) for all traffic except voice and bit transparent data.

This approach permits raising or lowering the priority of individual traffic sources later to increase or decrease their relative urgency.

- If all traffic is equally urgent, use emission priority 0 for voice and bit-sliced transparent data only.
- If there are clearly different levels of urgency, use emission priority 0 for voice and bit-sliced transparent data. Evenly apply the remaining priority levels to the remaining services.

Introduction to route selection

In a well-engineered network, there can be several routes between two nodes. A route selector chooses the route to the destination end point based on the transport characteristics configured for the permanent logical connection.

Route selection is made using a modified Dijkstra shortest path routing algorithm and the same topology database as is used by Nortel Networks Multiservice Switch connectionless routing.

The route selector prunes from the topology the Multiservice Switch trunks that do not conform to the transport characteristics and solves the shortest route problem on the remaining Multiservice Switch trunks, using cost or delay characteristics as the criteria.

The route selector requires an accurate view of the bandwidth available on each Multiservice Switch trunk in the network to select the optimum route. It learns this information from

- regular topology updates
- reports from path setups that have failed or cannot be instantiated
- reports from local Multiservice Switch trunk path administrators (PAs) about unreserved PORS bandwidth on outgoing Multiservice Switch trunks
- reports from distant PAs about significant bandwidth releases on distant Multiservice Switch trunks

The description of route selected by the route selector is returned to the end point.

Route selection attributes

A Nortel Networks Multiservice Switch trunk is a candidate for route selection if its configuration agrees with the values configured for the logical connection.

The following transport characteristics are defined for each logical connection. Most characteristics apply to both switched and permanent connections except where noted in the following descriptions. The transport characteristics marked with an asterisk (*) are not used during route selection.

- “Destination application name” (page 98)
- “Setup and holding priorities” (page 98) (holding priorities only*)
- “Emission and discard priority” (page 99)*
- “Required bandwidth” (page 100)
- “Security” (page 100)
- “Traffic type” (page 101)
- “Multiservice Switch trunk type” (page 101)
- “Customer defined parameter” (page 102)
- “Minimization criteria” (page 103)
- “Maximum acceptable cost” (page 103)
- “Maximum acceptable delay” (page 104)
- “Manual path” (page 104)*
- “Manual path with forced bandwidth” (page 105)*
- “Terminate when rerouting” (page 105)*
- “Optimization” (page 105)*
- “Bump preference” (page 106)

For ATM services, these attributes (except destination application name) can be specified in a PORS routing profile instead for the PLC.

Destination application name

The application name is the PLC remote end point address in the format of a Nortel Networks Multiservice Switch component name. This name is specified by the *remoteName* attribute located under the *PermanentLogicalConnection* component. End points are identified using a node name and a service name. If the service uses data network address (DNA) or network service access point (NSAP) addressing, PORS converts the address to a node ID. If the *remoteName* attribute is configured, it must match the remote name of the other end or the connection is not be established even if the remote end is configured correctly.

The *overrideRemoteName* attribute located under the *LogicalConnection* component can also be used to change the remote end points address. If this attribute is set, and the *remoteName* attribute is blank, then the remote end points address specified by the *overrideRemoteName* attribute overrides the blank PLC *remoteName* attribute. The advantage of using the *overrideRemoteName* attribute is that the user does not use configuration to change the remote end point address. The disadvantage of this attribute is that the *overrideRemoteName* attribute is not permanent so in the event of a resetting of the function processor or node, this override setting is lost.

Note 1: To use the *overrideRemoteName* attribute, the user configures the new remote end points address using the *overrideRemoteName* attribute.

Note 2: The *override* attribute cannot be used with non-PLC based PORS services, such as AAL1 CES.

Setup and holding priorities

PORS reserves the bandwidth required by a path on each Nortel Networks Multiservice Switch trunk of the route. If a route with sufficient bandwidth cannot be found, existing paths can be rerouted to reallocate the bandwidth to the new path. This is the process of bumping paths. Setup and holding priorities are used to rank existing paths (holding priority) and the new path (setup priority) to determine if the new path can bump an existing path.

The *setupPriority* of a new *PermanentLogicalConnection* component and the *holdingPriority* attributes of the *PermanentLogicalConnection* components for existing paths are used to specify these priorities. The higher the holding

priority, the less likely it is for PORS to reallocate its bandwidth to a new path. Similarly, the higher the setup priority, the more paths PORS can bump to set up the path. See “Bumping paths” (page 110) for more details.

The setup and holding priority values range from zero (0) to four (4). The value zero (0) is the priority assigned to the most important path. It is referred to as the highest priority. Four (4) is the priority for the least important path.

An existing path can be bumped if and only if the value for the *setupPriority* attribute of the new path is numerically less than the value for the *holdingPriority* attribute of the existing path.

To illustrate the use of the setup and holding priority, consider a network which supports both voice and data services in its corporate network. The voice traffic is given a low setup priority because new voice paths can use the public network if the corporate network cannot accommodate the new path. However, the voice traffic is given a high holding priority since it is undesirable for the path to be rerouted during an active voice call. For data traffic, high setup and holding priorities are desirable since data paths cannot be established on an alternate network.

Emission and discard priority

The emission priority is a measure of how urgently a packet is emitted on the Nortel Networks Multiservice Switch trunk. There are three possible values, from zero (0) to two (2). Zero (0) is the highest priority, or the fastest emission, and two (2) is the lowest priority, or the slowest emission. Zero uses the interrupting queue on Multiservice Switch trunks.

The discard priority is a measure of the importance of a packet. It is used to decide on which packets are discarded first during congestion. There are four discard levels: zero (0) is assigned for paths whose packets are the last ones to be discarded, and three (3) is assigned to paths whose packets can be discarded first. Discard level 0 is reserved for control packets.

Emission and discard priorities are set independently. Taking a voice path as an example, it has a high emission priority because a low delay must be experienced on the path, but it has a low discard priority since a small number of discarded packets do not significantly impact the quality of a voice call.

The emission and discard priorities are transport characteristics of a path. These are not used for route selection. “Importance and urgency of packets” (page 94) discusses these transport characteristics in detail.

Required bandwidth

PORS reserves the required bandwidth for a path on every Nortel Networks Multiservice Switch trunk on the route and in each direction of transmission. The required bandwidth is an indication of the potential bandwidth utilization of the path. It is not enforced by PORS, and is only used as an indication of the number and size of paths that can be set up on a Multiservice Switch trunk.

The *PermanentLogicalConnection* component has the *requiredTxBandwidth* and *requiredRxBandwidth* attributes to indicate the bandwidth to reserve in transmit and receive directions. It is an ordered pair that specifies the bandwidth required in bits/second in the outgoing and incoming direction (that is, to and from the far end point respectively). This is the minimum bandwidth that PORS must provide in order to set up the path. The required bandwidth attributes must take into account both the payload and the packet overhead.

Bandwidth can be determined automatically by the application and signalled to PORS.

If enough free bandwidth is not available, path bumping is required. In this case, the bandwidths of enough existing paths with a holding priority less than the setup priority of the new path is made available for the new path. Bumping is possible if there is enough bandwidth currently reserved for lower holding priority paths.

Security

The security option specifies the minimum security level required for transporting the packets for the service. PORS supports eight possible security levels, between zero (0) and seven (7). A value of zero (0) indicates the highest security, while seven (7) indicates the lowest.

A Nortel Networks Multiservice Switch trunk is a candidate for route selection if it provides at least the required path security. PORS can use a more secure Multiservice Switch trunk than the one requested.

The security level is specified in the *requiredSecurity* attribute of the *PermanentLogicalConnection* component. A corresponding attribute exists on Multiservice Switch trunks, called *trunkSecurity*. A Multiservice Switch trunk is chosen for route selection, if the numeric value of the *trunkSecurity* attribute is equal or less than the numeric value of the *requiredSecurity* attribute.

Traffic type

The traffic type is used to allow Nortel Networks Multiservice Switch trunks on a route that support a specific traffic type. During route selection, potential candidate Multiservice Switch trunks for a route are those that support the required traffic type. An administration can use this attribute to prevent a traffic type from using certain Multiservice Switch trunks, or to reserve Multiservice Switch trunks for one traffic type.

The *PermanentLogicalConnection* component has an attribute called the *requiredTrafficType*, which specifies the traffic type transported on the path. There is a corresponding attribute on Multiservice Switch trunks, called the *supportedTrafficType*, which is a set of traffic types that can be carried on the Multiservice Switch trunk.

A Multiservice Switch trunk can be used for route selection, if the *requiredTrafficType* attribute value for the path is a member of the *supportedTrafficTypes* attribute on the Multiservice Switch trunk.

PORS allows eight possible traffic types for both the *requiredTrafficType* and *supportedTrafficTypes* attributes.

As an example, voice, data and video are possible traffic types supported by PORS. If voice or data are specified in the *requiredTrafficType* attribute, only those Multiservice Switch trunks which include voice or data in their *supportedTrafficTypes* attribute are considered for a route.

Multiservice Switch trunk type

The *trunkType* attribute on a Nortel Networks Multiservice Switch trunk indicates the type of facilities that a Multiservice Switch trunk uses. Examples of Multiservice Switch trunking facilities are terrestrial or satellite links. A Multiservice Switch trunk can be one of eight possible Multiservice Switch trunk types.

The *PermanentLogicalConnection* component has an attribute called *permittedTrunkTypes*, which specifies a set of possible Multiservice Switch trunk types that can be used on the route. There can be up to eight Multiservice Switch trunk types specified.

A Multiservice Switch trunk is considered a potential candidate for route selection, if and only if its *trunkType* is one specified in the *permittedTrunkTypes* attribute in the *PermanentLogicalConnection* component.

As an example, if the *permittedTrunkTypes* attribute is the set to terrestrial or satellite, then only those Multiservice Switch trunks with terrestrial or satellite *trunkType* attribute are considered potential candidates for route selection. To prevent a route from using satellite links, the *trunkType* representing satellite links must be omitted from the *permittedTrunkTypes* set.

Customer defined parameter

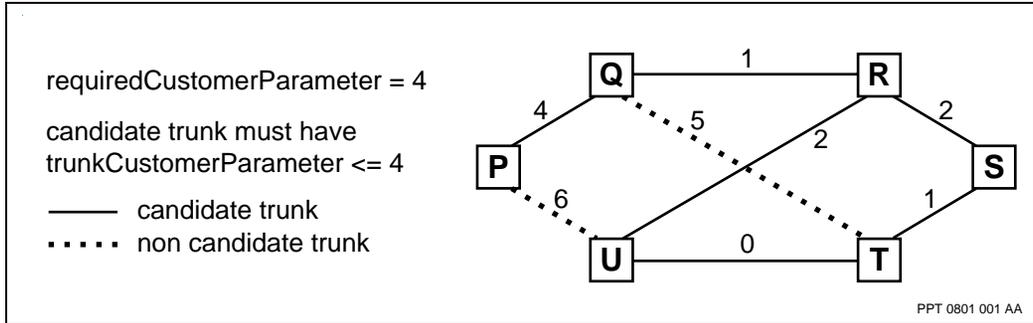
PORS provides the network administration (our customer) with the flexibility to define a parameter for route selection to tailor the route to their special needs that are not explicitly addressed by PORS.

The customer can specify an attribute in the *PermanentLogicalConnection* component, called *requiredCustomerParameter*, which defines a level which must be satisfied by the Nortel Networks Multiservice Switch on the chosen route. It has possible values from zero (0) to seven (7). A corresponding Multiservice Switch trunk attribute, the *trunkCustomerParameter*, specifies the level supported on the Multiservice Switch trunk.

The Route Selector only considers Multiservice Switch trunks with a *trunkCustomerParameter* attribute which is numerically less than or equal to the *requiredCustomerParameter* attribute of the path.

Figure 12, “Multiservice Switch trunk candidates based on customer defined parameters,” (page 103) shows an example of candidate trunks based on the customer defined parameter. The *requiredCustomerParameter* attribute is 4, and the *trunkCustomerParameter* attribute is indicated on each trunk. The solid line shows the Multiservice Switch trunks that are candidates for establishing a route.

Figure 12
Multiservice Switch trunk candidates based on customer defined parameters



Minimization criteria

The Route Selector algorithm computes a minimum path with respect to only one metric: cost or delay for the Nortel Networks Multiservice Switch node. It uses the second metric to select between Multiservice Switch trunks of equal (first) metric within a link group. Therefore, the *trunkAttributeToMinimize* attribute of the *PermanentLogicalConnection* specifies one of two possible minimization criteria:

- minimization of the route cost. For Multiservice Switch trunks of equal cost, the trunk with the least delay is selected.
- minimization of the route delay. For Multiservice Switch trunks of equal delay, the trunk with least cost is selected.

Maximum acceptable cost

The cost is a metric assigned to a Nortel Networks Multiservice Switch trunk in the *trunkCost* attribute, which is representative of the amount of network resources consumed when the Multiservice Switch trunk is used. For example, cost can indicate monetary instrument such as dollar value that an administration charges for the use of a Multiservice Switch trunk, a geographic distance, a hop count, or the speed of the Multiservice Switch trunk or a composite function of the above. The cost metric can be used by an administration to favor or discourage the use of some Multiservice Switch trunks over others.

The *maximumAcceptableCost* attribute specifies the highest value of the total cost of all Multiservice Switch trunks of a route. If a potential route has a cost greater than the value specified for the *maximumAcceptableCost* attribute, the route is not selected.

The following situation can happen when route delay is minimized. Route Selector for the Multiservice Switch node can find a non-optimal route within the *maximumAcceptableDelay* and *maximumAcceptableCost* attributes, which does not cause bumping. Otherwise bumping at the next priority level (starting at the lowest) is attempted until a route is found or all choices are exhausted.

Maximum acceptable delay

The *maximumAcceptableDelay* attribute of a *PermanentLogicalConnection* specifies the upper bound of the total delay experienced on any selected routes. Each Nortel Networks Multiservice Switch trunk has a delay metric associated with it. The metric is measured by the Multiservice Switch trunks. Currently the metric is a delay value that approximates the delay for packets across a Multiservice Switch trunk.

During selecting a route, the Route Selector for the Multiservice Switch node adds all the delay metrics of all the Multiservice Switch trunks on the route. The route is acceptable only if this total is less than or equal to the value set for the *maximumAcceptableDelay* attribute.

Manual path

Although PORS selects the best route between two end points, it is desirable to have a network operator manually select the route for a PLC. Typical applications are restrictions on the route that cannot be expressed in the path characteristics (such as policy based routing), the need for a test PLC, or when routing between two or more topology regions. Manual paths apply to PLCs only.

Using the manual path capability depends on the type of service using PORS routing:

- For transparent data services (TDS), use a manual path to select a route manually for a single PLC.

- For managed cut-through switching (MCS), use a manual path to select a route manually for multiple connections. The *ManualPath* component and attributes contain the sequence of Nortel Networks Multiservice Switch trunk component names to be used on the route.

The bandwidth requirements and the configured PORS characteristics still apply to manually-selected paths.

Manual path with forced bandwidth

When a path is selected by an operator, if the *pathType* attribute of the *PermanentLogicalConnection* is set to forced, the path characteristics are not checked on the specified route. (The *pathType* route selection attribute applies to *PermanentLogicalConnection* components only.) The required bandwidth is reserved, even if it exceeds the reservation limit, *maxReservedBwOut*. The forced manual path can violate the path characteristics and the bandwidth reservation rules and therefore is used with caution for testing purposes only.

Note: If a forced bandwidth pushed the allocated bandwidth over 100%, the Path Administrator will not account for this bandwidth properly when the bandwidth falls below 100%.

Terminate when rerouting

Some services cannot tolerate the delays imposed when a path is rerouted. The *pathFailureAction* attribute of the *PermanentLogicalConnection* is used to cause a logical connection to terminate instead of having its path be rerouted. The logical connection is terminated whenever the path fails because of bumping, a component failure on the route, or load shedding due to congestion.

This requirement is not used during route selection.

Optimization

The *optimization* attribute is used to determine if the connection can attempt to follow through with the optimization process when requested by PORS Connection Control. If this attribute is set to disabled, the connection cannot be optimized even though it has been requested to do so by PORS Connection Control. If set to enabled, then the connection is optimized as requested by PORS Connection Control. For more information on optimizing paths, see “Path optimization” (page 114).

Bump preference

The *bumpPreference* attribute allows bumping to occur in the route selection process. A connection with a higher (numerically less) setup priority can bump a connection with a lower (numerically higher) holding priority in order to acquire its bandwidth and become established.

When set to *bumpWhenNecessary*, an optimizing connection or any new connection attempts to establish a path where bandwidth is available. At this point, it cannot bump current connections. Where bandwidth is available, the path is chosen along this new route. If bandwidth is not available and the connection is optimizing then the optimization is aborted. This is because optimization is a non-disruptive process by default. That is, optimization of one connection must not cause rerouting of another connection. For new connections attempting to establish a path where bandwidth is not available, the new connection establishes a path by bumping current connections which have a lower (numerically higher) holding priority than the setup priority for this connection. When set to *bumpToObtainBestRoute*, an optimizing connection or any new connection always bumps current connections in order to establish an absolutely optimal path when bandwidth along that path is reserved by connections with holding priority lower (numerically higher) than the setup priority for this connection. For more information on optimizing paths, see “Path optimization” (page 114).

PORS routing profile

For ATM services transmitted over PORS, the transport characteristics can be defined in a PORS routing profile, instead of the *PermanentLogicalConnection* component. The *Profile* component is associated with the calling, or source, end point of the ATM service.

The PORS profile contains most of the transport characteristic attributes that are defined in the *PermanentLogicalConnection* component for other services. These attributes include the type of routing to be done, cost minimization of delay minimization, and the types of Nortel Networks Multiservice Switch trunks that are acceptable for the call.

A profile can be shared by many services of different types. For example, you can design one profile to represent setup and holding priority 1 CES circuits, another for lower-priority CES circuits, and another for MCS calls.

Alternatively, you can use one profile for each call, or each type of call, or each service. The only limit is the maximum number of profiles for a module, which is 255.

Two areas of the PORS profile that differ from the PORS PLC are bandwidth reservation (*requiredTxBandwidth* and *requiredRxBandwidth* attributes), and emission and discard priorities, known as quality of service (QOS). The QOS and bandwidth reservation values are signalled to PORS by the application. PORS uses the signalled values unless you override them in a profile.

If you do not provide a profile for an ATM service configured over PORS, the default values for the transport characteristics are assigned automatically to each connection.

Instantiating the route

After the route selector selects a route, the source end point instantiates it. At each Nortel Networks Multiservice Switch trunk of the selected route, and for each direction of transmission, PORS

- verifies that the required bandwidth is available from the pool of unreserved bandwidth configured for path-oriented traffic
- reserves the required bandwidth
- assigns an LCN to the path on the trunk. The LCN is the same for both directions of transmission over the Multiservice Switch trunk

The path instantiation procedure involves laying down the path using the least cost/delay route chosen by the Route Selector on a hop-by-hop basis. Bandwidth availability is verified and is reserved, and the LCNs are allocated on all Multiservice Switch trunks on the route, for both directions of traffic.

Path instantiation is done in a progressive fashion, by sending a path setup packet along the selected route, as illustrated in Figure 13, “Path setup packet,” (page 108). The packet travels in the forward direction, from the source end point to the destination end point, stopping at all Multiservice Switch trunks along the way. The backward direction is from the destination to source end point. The outbound Multiservice Switch trunk is the one which emits the path setup packet, while the inbound Multiservice Switch trunk receives the packet.

- creation of the *LogicalChannel* components, one per Multiservice Switch trunk

On the inbound Multiservice Switch trunks, the *LogicalChannel* component for the transfer of packets in the forward direction of the path is created. The outbound Multiservice Switch trunks create the *LogicalChannel* component for the backward direction of the path.

- allocation of the LCN to be used on each Multiservice Switch trunk

The outbound Multiservice Switch trunk chooses the LCN which must be confirmed by the inbound Multiservice Switch trunk.

When the path setup packet reaches the destination end point, a path setup confirmation packet is returned to the source end point in the backward direction, stopping at all Multiservice Switch trunks along the way. When this packet arrives at the calling end, path for data transfer is enabled.

The selected path can fail to instantiate under the following conditions:

- There is not enough bandwidth available.
- There is a failure (node, FP or Multiservice Switch trunk) along the chosen route.
- The Multiservice Switch trunk has reached the maximum number of paths that it can support (*maxLc* attribute).

In case of failure, a path tear down packet is returned from the point of failure back to the source end point. All the LCNs and the bandwidth reserved prior to the failure point are de-allocated as the packet travels down the backward route. The end point reports to the route selector the failure reason of actual bandwidth available or the component failure, and requests a new route. The route selector updates topological information before selecting another route for the same path, thus learning from the failure, and selects another route. The route selector therefore learns from its mistake and does not repeatedly select unavailable routes. If another route is selected by the route selector, the end point starts the instantiation procedure again. If another route is not available, route selector informs the end point that there is no route.

For manually selected paths, route selector learns from the failure but does not attempt to select another path. Forced manual paths only fail to instantiate if there is a failure on the selected route.

Rerouting paths

A path is expected to follow the same route for the lifetime of the logical connection. However, under certain conditions, a new route is needed for an existing connection.

Manual and forced paths cannot be rerouted or optimized. Also, paths for PLCs that have been configured to disconnect when a momentary interruption occurs cannot reroute to other paths. These paths can, however, be optimized. This capability is possible because rerouting causes the service to go down for the duration of the rerouting while optimization is transparent to the service. Paths that cannot be rerouted are terminated when a rerouting condition is encountered.

Information on rerouting is organized under the following headings:

- “Bumping paths” (page 110)
- “Network rerouting around component failure” (page 111)
- “Rerouting by operator command” (page 113)
- “Path optimization” (page 114)

Bumping paths

Paths being established are assigned a setup priority, while established paths are assigned a holding priority. There are five setup and five holding priorities. A path that is being established can bump an existing path with a holding priority that is lower than the setup priority for the new path. This allows higher priority calls to steal the bandwidth from lower priority calls. The bumped path is rerouted to an alternate route that can satisfy its requirements. If the bumped path cannot be rerouted, it is terminated. The setup and holding priorities can be different to allow setup at one priority and holding at an independent priority. This allows some calls not to invoke bumping and not to be bumped at the same time.

Bumping by default only happens as a last resort when there are no routes available for a given path. That is, *bumpPreference* attribute of the *PermanentLogicalConnection* component is set to *bumpWhenNecessary* by default. When this attribute is set to *bumpToObtainBestRoute* then bumping occurs to establish an absolutely optimal path. For more information on this attribute, see “Bump preference” (page 106).

Bumping occurs when there is no single piece of bandwidth to suit the current requirements, or when the cost and delay are such that only certain occupied routes satisfy the current path request.

When bumping is necessary, the RS tries to minimize disruption caused by bumping and for this result it recomputes a route using a topology whose Nortel Networks Multiservice Switch trunks bandwidth does not include as reserved the lowest holding priority paths (numerically highest). If a route is still not available, it considers bandwidth from the next higher holding priority paths. This is repeated until the bandwidth for all paths of lesser holding priority than the setup priority for the new path has been considered.

During the instantiation of a path which must bump other paths, lower holding priority paths are bumped before higher priority paths. The decision as to which of the available paths are bumped at each intermediate node by the new path is arbitrary.

Network rerouting around component failure

When the failure of a component on a route is detected, the network attempts to reroute all affected paths to bypass the failed component.

Detection of a failure is propagated towards the end points from either side of the failure, de-allocating resources along the way. The network terminates the old path and the source end point proceeds with the path establishment procedure. Failure to find a new route results in path termination.

PORS is concerned with failures that cause unavailability of a Nortel Networks Multiservice Switch trunk and thus prematurely terminate all the paths carried on the Multiservice Switch trunk. Multiservice Switch trunk unavailability can be caused by

- data link failure

- failure of a subsystem which interacts with the Multiservice Switch trunk within the function processor (such as a link controller)
- failure of the function processor itself
- failure of the entire node

More than one Multiservice Switch trunk becomes unavailable if the function processor that failed was servicing more than one data link. A failure causing outage of the node makes unavailable all Multiservice Switch trunks connected to it.

A failure usually initiates a lot of activity outside of PORS. A down event triggers alarm generation, system diagnosis, and network topology updates. The updates are performed by the topology manager components residing in the control processors of each node. These activities are simultaneous with the PORS reactions that minimize loss of data packets and the length of the service disruption. The loss of data packets is minimized by promptly informing the applications at both ends of the logical connections about unavailability of the path and the necessity to stop sending data packets. The length of the service disruption is minimized by promptly initiating the rerouting process and maximizing its effectiveness. Rerouting is initiated by the source end point as soon as it receives the information about path failure.

The effectiveness of rerouting is maximized by quick termination of the paths that were carried on the unavailable Multiservice Switch trunk. Path termination causes the return of the path bandwidth to the free-bandwidth pool for the Multiservice Switch trunk. The network topology data base at the source of the path is updated on the released bandwidth.

The termination process is distributed along every path affected by the failed component. Tear down packets are sent on each path from the failure point and propagated in each direction towards the source and destination end points. Software controlling all Multiservice Switch trunks on the failed paths receive updates on the failure, and then terminate the failed logical channels to free up the reserved bandwidth.

Information about the failure is simultaneously broadcast to all nodes in the network by the topology maintenance system. This broadcast permits prompt updating of the topology database in each node. There are two ways that the end point can be informed of the failure: broadcast notification and reception of a tear down packet.

Rerouting by operator command

An operator can initiate rerouting of an established path that supports the following services:

- Voice Service
- bit transparent data service (BTDS)
- HDLC transparent data service (HTDS)
- AAL1 circuit emulation service (AAL1 CES)
- multiservice cut-through switching (MCS)

Operator-initiated rerouting is achieved through the CAS reroute command. See “Forcing a path to reroute” (page 67).

This command attempts to reroute the service path to a new path as long as the new path has the same or better characteristics for delay or cost, depending on the characteristics that the service is minimizing.

If the reroute command is unsuccessful, the network operator can ask for the path of an existing logical connection to be rerouted by clearing a logical channel of the path. In this scenario, the node at the far end undertakes the following checks:

- 1 if the *pathFailureAction* attribute is set to the *disconnectConnection* attribute, does not initiate the reroute
- 2 terminates the path by transmitting a tear down packet
- 3 requests a new route from the route selector in a Multiservice Switch node; if this request fails, terminates the logical connection
- 4 if a new route is selected, instantiates the path on the new route; if setup fails, repeats the check in point 3

It is possible that the new path that results from clearing a logical channel is not better (in terms of the cost and/or delay metrics) than the previous path. The operator is taking a chance that a worse route can be chosen given the current network load, or that the path fails to reroute and is terminated.

Path optimization

The objectives of automatic or manual optimization are twofold:

- move a PORS connection to a lower cost or delay route if one exists
- if the path is already on the best route, then balance the bandwidth usage of the links within the link groups along the route supporting the path being optimized

Balancing the bandwidth between the various links is accomplished by moving one or more connections to paths on different links within the link group until load balancing is achieved. The load is balanced when individual links in the same link group each carry approximately the same proportion of PORS traffic to the total bandwidth for the link.

More than one optimization cycle might be required to achieve both objectives described above. For example, one path moving to a better route might introduce some load imbalance that can't be rectified in the same optimization cycle because all the other paths along that route have already been optimized during this cycle. The next optimization cycle re-balances the load if it is possible.

Note: A link in this context is defined as a Nortel Networks Multiservice Switch trunk, not a physical link.

The optimization process is administered by PORS connection control which resides on each Multiservice Switch node in the network.

Benefits of optimization

Optimization offers the following benefits:

- Optimization maximizes total network bandwidth by rerouting the highest bandwidth connections to routes with the least number of hops.
- As new Multiservice Switch trunks are configured or come back to service, these trunks are used at the next optimization interval.

- A network using optimization has lower bandwidth consumption across the network, freeing up bandwidth for other traffic.
- A manual reroute command is available which allows the user to reroute specific connections.
- Optimization balances link groups along connection paths in terms of bandwidth utilization.

Triggering the optimization process

Optimization of a connection on a node can occur in one of three ways:

- automatic optimization of a node through configuration
- manual optimization of a node by operator command
- manual optimization of a connection by operator command

Automatic optimization on a node is enabled when the operator enters configuration mode and types the command

```
add Routing Pors
```

to activate the optimization feature on that node by creating PORS Connection Control. Thirty minutes after activating the feature, PORS Connection Control begins automatic optimization. Automatic optimization works on paths from the calling end only, provided these paths have been operational for at least one minute, and have their *optimization* attribute for the *PermanentLogicalConnection* set to enabled.

Manual optimization of a node by operator command occurs when the operator types the command

```
optimize Routing Pors
```

This command causes all connections on that local node to be optimized. Manual optimization applies to paths from the calling and called end. Paths do not have to be operational for one minute for them to be optimized, but they must have their *optimization* attribute set to enabled. If optimizing a path from the called end, the *remoteName* attribute must be specified. Also the attributes for the *PermanentLogicalConnection* on the called side must be identical to that on the calling side.

Note: Only one path is optimized per second during automatic and manual optimization of a node.

Manual optimization of a connection by operator command occurs when an operator types the command

```
reroute <servicetype>/ n lco
```

where <servicetype> can be Voice Service, BitTransparentDataService, HdlcTransparentDataService, or Aal1Ces. This command attempts to optimize the service path to a new path as long as the new path is not worse than the current path in terms of delay or cost, depending on whichever attribute the service is attempting to minimize. If the reroute command is issued on the called end, *remoteName* attribute must be specified. Also the attributes for the *PermanentLogicalConnection* on the called side must be identical to that on the calling side.

Note: Reroute command disregards the *optimization* attribute. That is, optimization occurs whether optimization is enabled or disabled. It is possible that the reroute command results in a path selection that is identical to the original path.

This command triggers the rerouting of an established path which runs on a specific service. It attempts to optimize the current connection and result in the change of the current path to a better one if one exists.

Transporting data on the path

The packets transmitted on the path are delivered in order of transmission since all packets follow the same route in the network. Procedures to insure orderly delivery of packets are used during rerouting and optimization. This removes the necessity for end point buffering to re-establish order, or the need for sequencing packets at the routing level, thus requiring less bandwidth for each packet.

The current PORS design is to be used by services which tolerate loss of packets. PORS does not support end-to-end data reliability, windowing, and flow control, but it is possible to add these functions on top of PORS. When adding these functions, take care that configurations do not affect existing PORS performance. Because packet loss is permitted, bandwidth usage is

more efficient since packets are never retransmitted. The lack of retransmitted packets also insure that packets cannot be duplicated. Packet loss can be due to

- poor quality facilities losing packets
- packets discarded to alleviate congestion in the network
- packets discarded or lost when a path is being rerouted or optimized

The path-oriented packets make efficient use of the bandwidth by requiring only minimal information in the Multiservice Switch routing header:

- An LCN is used instead of a lengthy destination end point address.
- There is no need for packet sequence numbers at the routing level.
- Destination of the next hop, emission priority and discard priority are kept at each hop of the route instead of in the packet header.

PORS makes use of packet forwarding procedures that distinguish between the urgency at which packets are emitted, and the importance of emitting those packets. These procedures also provide a mechanism to accomplish bandwidth sharing between connectionless and path-oriented traffic.

The urgency of a packet is reflected by the emission priority. The emission priority associated with a path is an indication of the queue (software or hardware) that a packet waiting to be emitted on a Multiservice Switch trunk is inserted in, which in turn is a reflection of how often a queue gets serviced by the Multiservice Switch trunk.

The discard priority of a packet indicates the importance of a packet. This is used in the decision to discard packets in congested situations or for bandwidth sharing purposes. Each packet can also be individually labelled by the end points as being eligible for discard in preference to others in congested situations.

Terminating a route

The path termination is the process of releasing the reserved bandwidth and de-allocating the LCNs used on the Nortel Networks Multiservice Switch trunks on the route of a path. Path termination is accompanied by a topology update with information on the bandwidth released on a particular Multiservice Switch trunk.

A path is terminated in the following cases:

- The service requests the path termination.
- The path is being rerouted due to bumping by a path with higher setup priority or failure and the rerouting path cannot be established.
- The path is being rerouted due to bumping by a path with higher setup priority or failure and the *pathFailureAction* attribute under the path *PermanentLogicalConnection* is set to *disconnectConnection*.

The logical connection is also terminated when the path is terminated, except when the termination is due to a reroute attempt. For reroute attempts, the logical connection is terminated only if the reroute fails or is not allowed.

The path termination is done in a progressive fashion. A path termination packet is sent from the end point initiating the termination, all the way to the remote end point. At each Multiservice Switch trunk along the path, the reserved bandwidth for both directions of transmission is released. The LCN is marked as terminating but it cannot be released until the path termination procedure is completed. This prevents data packets from being transferred on the path.

At the remote end point, a path termination confirmation packet is returned to the initiating end point. It de-allocates the LCN used for the path.

Termination of logical connection - reroute implications

A logical connection whose path is being rerouted terminates under the following conditions:

- A failure has terminated one of the end points of the logical connection.

- For the Nortel Networks Multiservice Switch node, the Route Selector cannot find a route satisfying the path requirements, even when bumping has been permitted.

Note: In a Multiservice Switch node, a path instantiation failure never causes a termination of the rerouting procedure since it always results in a request to the Route Selector for another route.

- The logical connection has the *pathFailureAction* attribute set to `disconnectConnection`.

If this attribute is set to `disconnectConnection`, no attempt is made to select another route and the logical connection is terminated. This is desirable for applications which cannot tolerate the delay and service disruptions encountered because rerouting process.

Chapter 8

Routing applications

This section describes specific applications for the Nortel Networks Multiservice Switch Path-Oriented Routing System (PORS) outside of the default implementation for services. Information in this section is organized under the following headings:

- “Selecting paths based on cost and delay” (page 121)
- “Restricting traffic” (page 123)
- “Restricting paths” (page 124)
- “Configuring ATM services over PORS on a Multiservice Switch node” (page 129)
- “PORS across topology regions” (page 133)

For information on PORS fundamentals, see “Routing fundamentals” (page 87).

Selecting paths based on cost and delay

PORS can select a path based on either the lowest cost or lowest delay. Both cost and delay cannot be minimized. Use the *pathAttributeToMinimize* attribute under the *PermanentLogicalConnection* component to specify cost or delay. The routing system computes a path based on optimization criteria (cost and delay) from

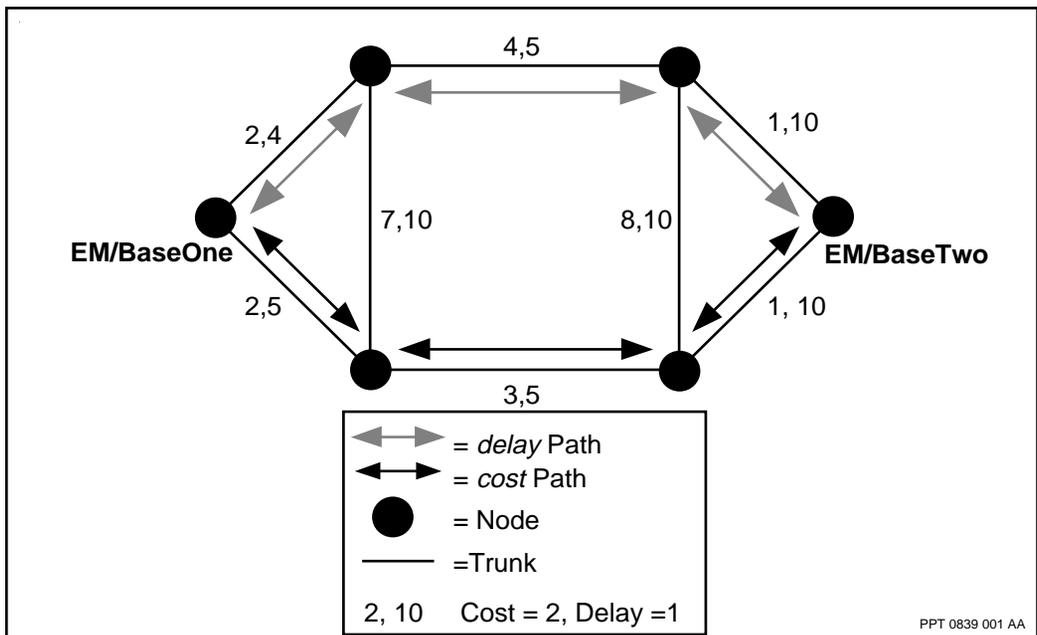
- the values assigned to the Nortel Networks Multiservice Switch trunks (cost)

- measured delay values that are associated with each Multiservice Switch trunk

This calculation is shown in the figure “Path for cost or delay using trunkAttributeToMinimize” (page 122).

To assign a cost to a Multiservice Switch trunk use the *trunkCost* attribute under the *Trunk* component. Cost can be an actual dollar value or any parameter that you want to use. If default values are used, cost represents the hop count. Thus the number of hops across the network is minimized. If you use a parameter for cost that reflects the actual cost of facilities, high cost facilities receive less use and reduce the cost of operating the network. This is the recommended method of using this option.

Figure 14
Path for cost or delay using trunkAttributeToMinimize



Specifying a maximum cost for a path

Providers of network services can restrict some parameters for a particular circuit (for example the number of hops).

To specify the maximum total cost value of a path you can use the *maximumAcceptableCost* attribute under the *PermanentLogicalConnection* component. Although this value is called cost, you can use it to reflect a variety of considerations, including geographic distance, hop count, or real dollar value. The sum of the *trunkCost* attribute values of all Multiservice Switch trunks used in the path is less than or equal to the value specified by the *maximumAcceptableCost* attribute.

Specifying a maximum delay for a path

Delay in PORS is measured for a 512 byte packet in one direction at the time of Nortel Networks Multiservice Switch trunk staging. Over time this measured delay can change to reflect the updated operating delay but does not affect existing paths unless a Multiservice Switch trunk restages. If Multiservice Switch trunk staging is the measurement instance, then new or existing paths do not pick up the new delays. Choose a maximum delay with care since it is dependent on the real delay of a cell on the path.

To specify the maximum delay value of a path, use the *maximumAcceptableDelay* attribute under the *PermanentLogicalConnection* component. The sum of the delay values associated with all Multiservice Switch trunks used in the path are less than or equal to the value specified by the *maximumAcceptableDelay* attribute.

Note: This parameter is used when large delays are unacceptable for the service (for example voice and other interactive data).

Restricting traffic

PORS allows you to specify which types of traffic are carried on a given Nortel Networks Multiservice Switch trunk. Use the *supportedTrafficTypes* attribute, under the *Trunk* component to create an individual list of traffic types for each Multiservice Switch trunk in your network (data, voice, and video for example).

When you configure the connection, use the *requiredTrafficType* attribute to specify which traffic type is transported by the path. PORS chooses Multiservice Switch trunks that include the *requiredTrafficType* attribute list in their *supportedTrafficTypes* attribute list. The *requiredTrafficType* attribute list must be a subset of the *supportedTrafficTypes* attribute list or PORS does not select the Multiservice Switch trunk for the path.

For example if the requiredTrafficType list of a path is data, only Multiservice Switch trunks with supportedTrafficTypes lists that include data are selected for the path.

Restricting traffic to certain types of Multiservice Switch trunks

You can create an indicator of the type of Nortel Networks Multiservice Switch trunk that various traffic types use. Examples of Multiservice Switch trunking facilities might be terrestrial or satellite links. The *trunkType* attribute, under the *Trunk* component allows you to do this for up to eight different types of Multiservice Switch trunks.

The *permittedTrunkTypes* attribute under the *PermanentLogicalConnection* component allows a set of possible Multiservice Switch trunk types to be specified for a route. Only Multiservice Switch trunks with *trunkType* attributes that are found in the *permittedTrunkTypes* attribute list are used to create the path.

Restricting paths

You can restrict certain classes of paths to certain Nortel Networks Multiservice Switch trunks. Most of the commonly used qualifiers are represented in security and traffic type. This is an additional option to be used for any function that you think appropriate.

Security

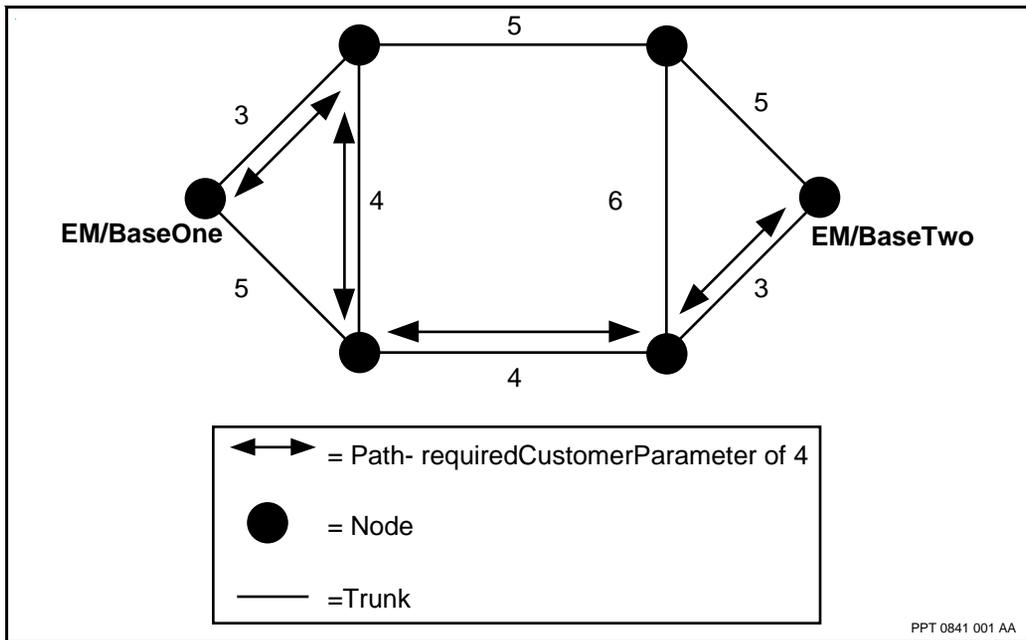
PORS allows you to define varying security levels for the Nortel Networks Multiservice Switch trunks of the network. This option can, for example, prevent sensitive data from traveling over certain Multiservice Switch trunks.

PORS has an option that allows you to specify the minimum security level of a path. To do this, configure a security value for the Multiservice Switch trunks in your Multiservice Switch network using the *trunkSecurity* attribute under the *Trunk* component. When you configure the connection, enter a value for the *requiredSecurity* attribute under the *PermanentLogicalConnection* component.

component. When the path is configured, it can be assigned a value using the *requiredCustomerParameter* attribute under the *PermanentLogicalConnection* component.

PORS assigns the path to Multiservice Switch trunks that have an equal or lower number associated with them. This is illustrated in the example shown in the figure “Path using a requiredCustomerParameter of 4” (page 126).

Figure 16
Path using a requiredCustomerParameter of 4



Specifying a path manually

PORS is designed to select an appropriate route automatically. In an exceptional case, however you can define the set of Nortel Networks Multiservice Switch trunks that are used.

The path can be defined at both ends and the two paths do not have to use the same set of Multiservice Switch trunks. If different paths are defined at each end, however PORS does not guarantee which one is used.

Defining different routes manually at both ends of a connection enhances robustness of the connection against network element failures. If the existing path is subject to a failure, another route is used to reroute the path very quickly without further intervention from network administrator, provided the other route is usable.

If you want to override the automatic selection of a path and specify the Multiservice Switch trunks manually use the *manualPath* attribute of the *PermanentLogicalConnection* component. Enter the outbound sequence of *Trunk* component names for the path that you want.

Note: The path still must satisfy the characteristics specified in the other attributes under the *PermanentLogicalConnection* component, including bandwidth requirements.

To configure a manual path, see “Configuring manual paths for managed cut-through switching” (page 31) and “Configuring manual paths for a PLC” (page 33).

Tandem suppression

The tandem suppression feature gives the network operator increased control over routing behavior by preventing tandem traffic from travelling through specified nodes. When tandem suppression is enabled on a node, the only PORS traffic that the network routes to the node is traffic destined for the node itself. The tandem suppression option applies to PORS automatic calls. PORS manual paths can still traverse tandem-suppressed nodes when the option is in effect.

Tandem suppression is particularly useful for small access Nortel Networks Multiservice Switch nodes and customer premise equipment (CPE) edge nodes. The feature can be used to control traffic flows by

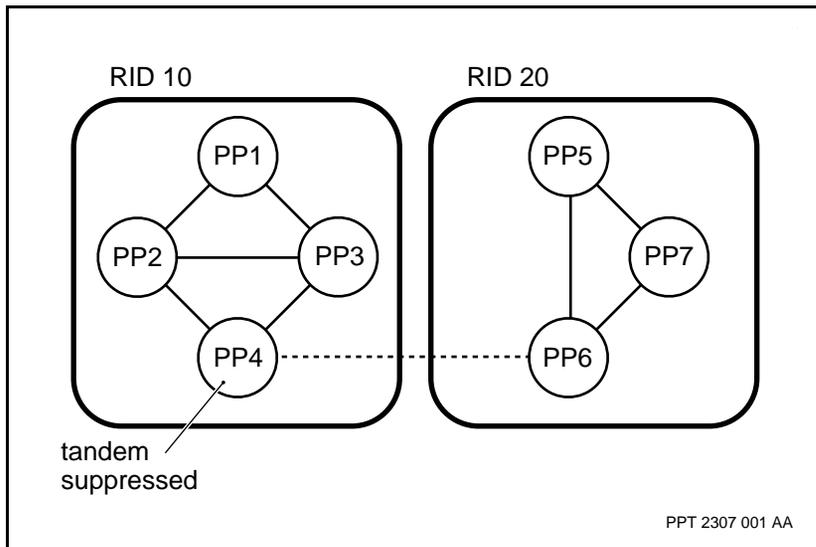
- preventing traffic from routing through nodes with insufficient link capacity
- preventing traffic from routing through CPE
- preventing traffic from flowing through a newly-deployed node until the network operator is sure that the node is up and running successfully

When tandem suppression is enabled on a node, it affects PORS and DPRS traffic.

In the example in the figure “Tandem suppression” (page 128), PP5 is assigned the tandem suppression option, so traffic is not routed to that node from any of the other nodes unless it is destined for PP5.

PORS tandem traffic is not suppressed immediately after the node is configured for tandem suppression. Instead, it is suppressed either when the tandeming *PermanentLogicalConnection* component is re-established, or when PORS optimization reroutes the *PermanentLogicalConnection* component away from the tandem-suppressed node. In most cases, this is not an issue, as most PORS traffic is local traffic to a node that is typically an edge node.

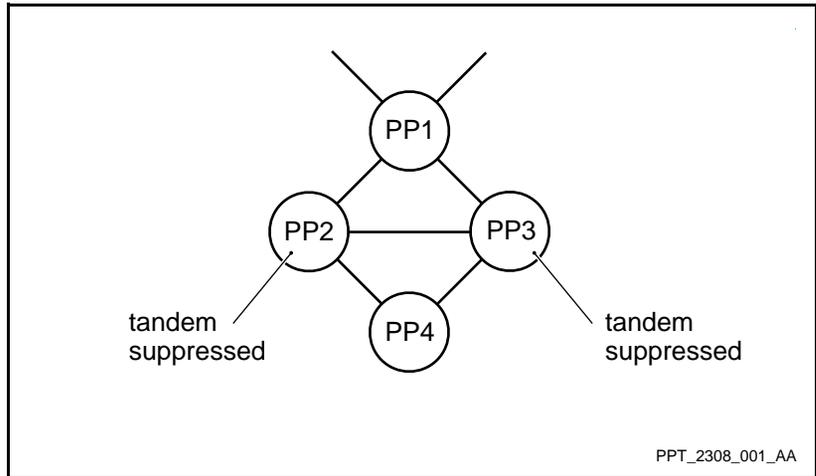
Figure 17
Tandem suppression



When adding a new node at the periphery of the network, it is important to be aware of the tandem-suppression configuration of the connected nodes. If the new node is connected to tandem-suppressed nodes, it is effectively severed from the network. For example, in the figure “Isolated node” (page 129), node PP4 becomes isolated if nodes PP2 and PP3 are tandem suppressed.

Note: This example shows a non-robust network

Figure 18
Isolated node



It is important to set up a robust network that can remain operational even when links go down. For example, assume that only PP3 in the figure “Isolated node” (page 129) is tandem suppressed. If the link between PP2 and PP4 goes down, PP4 is still effectively isolated.

Configuring ATM services over PORS on a Multiservice Switch node

Routing an ATM service over PORS on a Nortel Networks Multiservice Switch node has specific configuration requirements. This section describes these requirements under the following headings:

- “PORS profiles for ATM services” (page 130)
- “Path administrator mode for the trunk” (page 132)
- “NSAP addressing” (page 132)

PORS profiles for ATM services

To create PORS routing profiles for ATM services on a Nortel Networks Multiservice Switch node, do the following:

- create a profile for each service or connection
- customize the profiles to suit each individual service or connection
- associate the profile with the service source end point component (for information on how to create the link, see the appropriate service guide)
- activate the connection (changes to a profile do not take effect until the service launches the next call request)

When a PORS profile is created, attributes are assigned the following default values:

```
setupPriority = 2
holdingPriority = 2
bumpPreference = bumpWhenNecessary
requiredTxBandwidth = 0 bit/s
requiredRxBandwidth = 0 bit/s
requiredTrafficType = data
permittedTrunkTypes = terrestrial satellite tt1 tt2
tt3 ~tt4 ~tt5 ~tt6
requiredSecurity = 4
requiredCustomerParm = 4
pathAttributeToMinimize = cost
maximumAcceptableCost = 1280
maximumAcceptableDelay = 100000 msec
emissionPriority = sameAsUser
discardPriority = sameAsUser
pathFailureAction = reRoutePath
optimization = enabled
```

Customize the profile by changing these default values to values more appropriate for the service. For example, the setup and holding priorities in the profile control the PORS bumping feature. In the default profile, these priorities are set to 2, which specifies average priority. To define an important service that bumps lower-priority services, set the setup and holding priorities to 1.

Another area of the profile that is typically customized to a service is the quality of service (QoS). By default, the emission and discard priorities assigned to a connection are the ATM values signalled by the application. For example, each ATM service connection is defined with a particular service category (such as CBR or VBR), which corresponds to specific emission and discard priorities in Passport switches. By default, the profile does not override the selections made by the application. As a result, PORS assigns emission and discard priorities along the path to the same values as the ATM routing system. However, PORS provides three different emission priorities and three discard priorities, resulting in nine different types of QoS. Since many of these combinations have no counterpart in ATM, PORS profiles provide a way to override the ATM service category. The table Table 5, “ATM-to-PORS QoS mapping,” (page 131) shows the mapping of ATM service category values to PORS QoS combinations, indicating that four of the nine permutations are available from ATM.

Table 5
ATM-to-PORS QoS mapping

ATM service category	<i>emissionPriority</i> attribute	<i>discardPriority</i> attribute
CBR	0	1
VBR-rt	1	1
VBR-nrt	2	2
UBR	2	3

Overriding the original service category allows two applications to run with different QoS values depending on their relative importance. For example, you can have one connection with the default service category, and another with a high discard priority, making its traffic very discardable. This situation can be accomplished by assigning a profile to the second connection, and setting its *discardPriority* attribute to 3. The next time the connection comes up, it uses the default ATM-assigned emission priority for its service category and the new discard priority of 3. In this way, the profiles allow ATM applications access to the full range of Multiservice Switch QoS permutations on an instance-by-instance basis.

The profile also allows you to override the ATM bandwidth values. When there is no profile, or the profile bandwidth values are set to zero, PORS chooses an effective bandwidth based on the ATM peak cell rate (PCR). This is a conservative setting, and can result in under-used links.

To change the reservation used by PORS, you can set the `requiredTxBandwidth` or `requiredRxBandwidth` attributes of the profile. These values are in bits per second, not cells per second, so you must do the appropriate conversions.

For example, a particular service uses 683 cells/second. If you do not use a profile, or if you do not override the bandwidth values, PORS reserves 683x53 octets in both directions on every link the call traverses. If you know that the service is idle 50% of the time, you can reduce the reservations by setting the bandwidth attributes to $(683 \times 53) / 2$. If you combine this under-reservation of bandwidth with a high discard priority (to make the traffic more discardable), substantial bandwidth savings can result.

Path administrator mode for the trunk

At this stage, you must decide which Nortel Networks Multiservice Switch trunk PA ATM mode to use for each Multiservice Switch trunk in the network. To support AAL1 traffic on the PORS network, the trunks over ATM must be run in mapped mode. A mapped mode Multiservice Switch trunk can support ATM services routed by PORS, and non-ATM services routed by PORS, both at full hardware speeds. The rerouting speeds are faster because there is more CPU available for the processing of setup messages. The system runs more smoothly because of the physical separation of the data path resources from the control path resources.

Note: Mapping can only be used in a directly connected Multiservice Switch node configuration or in a network configuration where a virtual path is dedicated to the PA. Logical trunks cannot be configured in mapped mode.

NSAP addressing

ATM services like CES are routed over ATM links on NSAP addresses, rather than component names. When routing these services using PORS, you must provide an NSAP prefix for each node in the network. In addition, a route must be available between the source and destination that consists of entirely

ATM hardware on which *Trunk* and *PathAdmin* components are running in mapped mode. In the sample network, all the Multiservice Switch trunks are running in PORS mapped mode, ready to handle ATM calls.

The NSAP prefixes must be configured so that all NSAP addresses reachable on that node share the node prefix. However, PORS supports five distinct prefixes on each module, so you can use one prefix for CES services, and others for another ATM service.

Simply assign an NSAP prefix to each node, and then make sure all services reachable on that node share that prefix. An address is reachable by a node if the address of the node is a prefix of the address being routed to. For example, the address 123456789 is reachable by a node with an address prefix of 123456. PORS supports a 20-byte NSAP address, using the first 13 bytes as a node prefix and the last 7 bytes to identify the service.

In the sample network, you must assign four unique 13-byte node prefixes and then configure each node accordingly. Assign the values 00...01 through 00...04 to AM/A through EM/D. The following procedure is an example of this process.

By configuring each node with its own prefix, all the other nodes learn about this prefix. You need to configure the prefix only once, and only on the node to which the prefix applies. If you change the prefix, PORS distributes it to the other nodes, updating them accordingly.

NSAP address information stored in the Base Routing Topology subsystem can be displayed through a component administration system (CAS) interface.

Note: If an NSAP address can be displayed on a Multiservice Switch node, it is reachable from the local node.

For more information, refer to “NSAP address information” (page 77).

PORS across topology regions

A topology region is a set of Nortel Networks Multiservice Switch nodes that are partitioned as an autonomous section of the network. All PORS services can route dynamically within a topology region because the topological

information of the region is available to all nodes within the region. PORS across topology regions allows PORS to dynamically route calls across multiple topology regions while maintaining unique capabilities such as bumping, rerouting, and dynamic path attribute (QOS) adjustment. Trunks that span region boundaries are referred to as inter-region Multiservice Switch trunks. A call may be comprised of one or more path segments across a region or inter-region Multiservice Switch trunk.

Path optimization and balancing are only available within a region path segment and not across inter-region Multiservice Switch trunks. Rerouting and bumping may operate independent of other path segments if an alternate route to the same border node is available within the selected path segment.

Given that a number of inter-region Multiservice Switch trunks may originate from a single node, bandwidth load spreading is an option available to avoid the over-utilization of a single link. Bandwidth load spreading is applicable for call establishment across inter-region Multiservice Switch trunks that have been provisioned with identical characteristics by the network operator. Bandwidth load spreading is not applicable in the event of a link failure.

PORS services using NSAP addressing (CES, MCS, and VTDS) are able to route across multiple topology regions because the nodes at the edge of a topology region (the border nodes) are configured as inter-region Multiservice Switch trunks. This configuration provides a connection to a border node in another topology region. Inter-region Multiservice Switch trunks are configured with all of the NSAP addresses that they can reach in other topology regions. NSAP addresses that can be reached through an inter-region Multiservice Switch trunks are called link-reachable addresses. Link-reachable addresses are distributed throughout the topology region of the border node that contains the inter-region Multiservice Switch trunk, ensuring that all link-reachable addresses are known by all nodes within that topology region.

Note: A border node may have more than one inter-region Multiservice Switch trunk through which a link-reachable address exists. In this case, that address should be specified on all inter-region Multiservice Switch trunks.

Information in this sections is organized under the following headings:

- “Overview” (page 135)
- “Segmented optimization” (page 136)
- “Bandwidth load spreading” (page 138)
- “Manual path connection between topology regions” (page 139)
- “Multiservice Switch clusters” (page 140)
- “Guidelines for Multiservice Switch clusters” (page 142)

Overview

Nodes in a topology region know the topology of their own region only, however with PORS across topology regions, inter-region Multiservice Switch trunks are configured with the NSAP addresses that they can reach in other topology regions, and these addresses are broadcast throughout the topology region of the inter-region Multiservice Switch trunk.

In order to route across topology regions, a source node routes to a border node which advertises that it can reach the address of the destination node, the border node routes across an inter-region Multiservice Switch trunk to a border node in the next topology region towards the destination node, and this border node routes to the destination node, or a border node to another topology region, and so on until the destination is reached. The complete path from source to destination is made up of many path segments, and each segment of the path can be balanced, optimized, bumped or rerouted as it is within a topology region.

PORS across topology regions allows for the division of a Multiservice Switch network into smaller subnetworks which do not exchange Multiservice Switch topology information with each other. This allows for the building of large Multiservice Switch networks which are capable of dynamically routing PORS services end to end.

Multiservice Switch clusters offer further possibilities for network growth, by connecting groups of Multiservice Switch access switches around a topology region backbone. Multiservice Switch clusters do not exchange topology information with the backbone nodes, and only a limited amount of routing information is exchanged.

Segmented optimization

The path for a segmented PORS connection consists of $2n+1$ call segments, where n is the number of inter-region links and/or cluster links traversed and the connection does not originate and/or terminate on a gateway node.

Segmented optimization ensures that each PORS connection segment can be switched if a better path segment is available. For more information on optimization, refer to “Path optimization” (page 114).

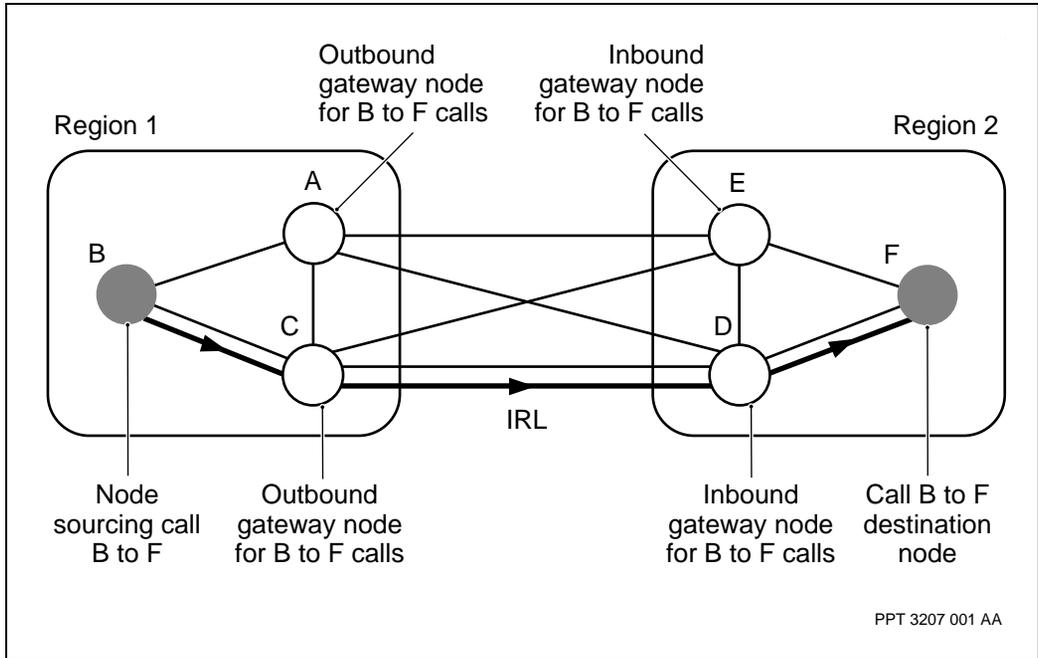
Refer to figure “Segmented optimization across topology regions” (page 137) to see how segmented optimization works. In this example, node B (in Region 1) is the source node, and node F (in region 2) is the destination node. The call comprises three segments: from the source node B to the outbound gateway node C, from the outbound gateway node C to the inbound gateway node D, and from the inbound gateway node D to the destination node F.

Configure segmented optimization first at node B to optimize the path chosen from the source node to an outbound gateway node advertising a lower gateway cost or better address, or to select a better path to a gateway advertising the same gateway cost. Next, configure the outbound gateway nodes A and C to optimize the connection onto the link advertising the lowest gateway cost or address to the inbound gateway nodes, which may involve switching inbound gateway nodes, in this case nodes D or E. Finally, configure the inbound gateway nodes D and E to optimize the path segment to the destination node (node F); however, this is better left to legacy PORS optimization.

To invoke segmented optimization on nodes A, C, or D, first configure the nodes to enable segmented optimization (refer to “Configuring inter-region Multiservice Switch trunks” (page 55) for details), then issue the following command:

```
optimize -segmented Routing Pors
```

Figure 19
Segmented optimization across topology regions



In order to minimize service disruption, segmented optimization should be run from source towards destination, in this order:

- 1 the source node
- 2 the outbound gateway nodes
- 3 the inbound gateway nodes

Note: Segmented optimization, since it is service disrupting, should only be run once a week, after a network failure, or after commissioning new gateway nodes.

For information on configuring each of these three segments for optimization, refer to “Configuring segmented PORS optimization” (page 56).

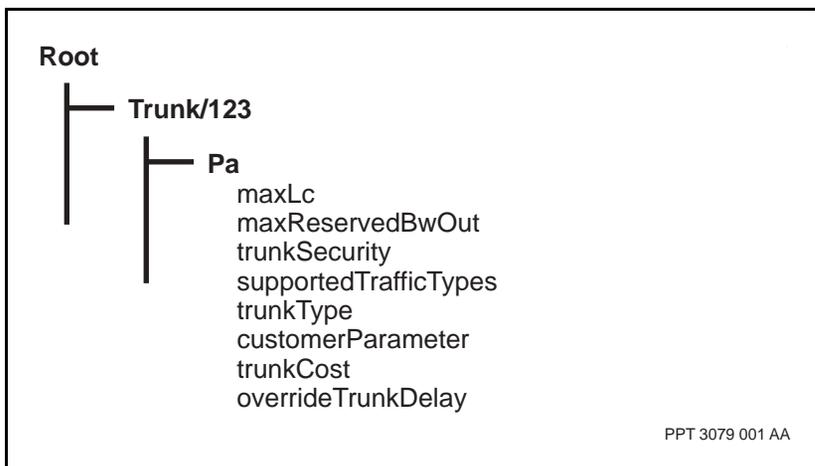
Bandwidth load spreading

If a single border node has several identical inter-region Nortel Networks Multiservice Switch trunks (identical implies that all link-reachable addresses and path costs are the same), then all traffic will be sent to that inter-region Multiservice Switch trunk with the lowest delay. This will continue until that link is fully booked.

Load spreading allows that traffic to be distributed across all inter-region Multiservice Switch trunks based on available bandwidth during normal call establishment. To activate the load spreading capability, configure the *overrideTrunkDelay* attribute. Once configured, the *overrideTrunkDelay* attribute will override the measured trunk delay of a given inter-region Multiservice Switch trunk, with the resulting value being used to determine route selection.

Note: The *overrideTrunkDelay* attribute is optional and configurable under the trunk path administrator. Refer to “Display of *overrideTrunkDelay* attribute” (page 138) for details.

Figure 20
Display of *overrideTrunkDelay* attribute



The *overrideTrunkDelay* attribute can be configured on identical inter-region Multiservice Switch trunks, ensuring that available bandwidth is the final criteria when determining route selection over identical inter-region

Multiservice Switch trunks. This results in traffic being load shared across all identical inter-region Multiservice Switch trunks that have been provisioned with identical addresses, region and path costs, and trunk delay attributes.

Load spreading by bandwidth is not possible when a failure causing multiple connections to reroute occurs (for example, a link going down). Due to connection setup latency, any calls established during this interval are rerouted, while the topology database does not receive any bandwidth updates.

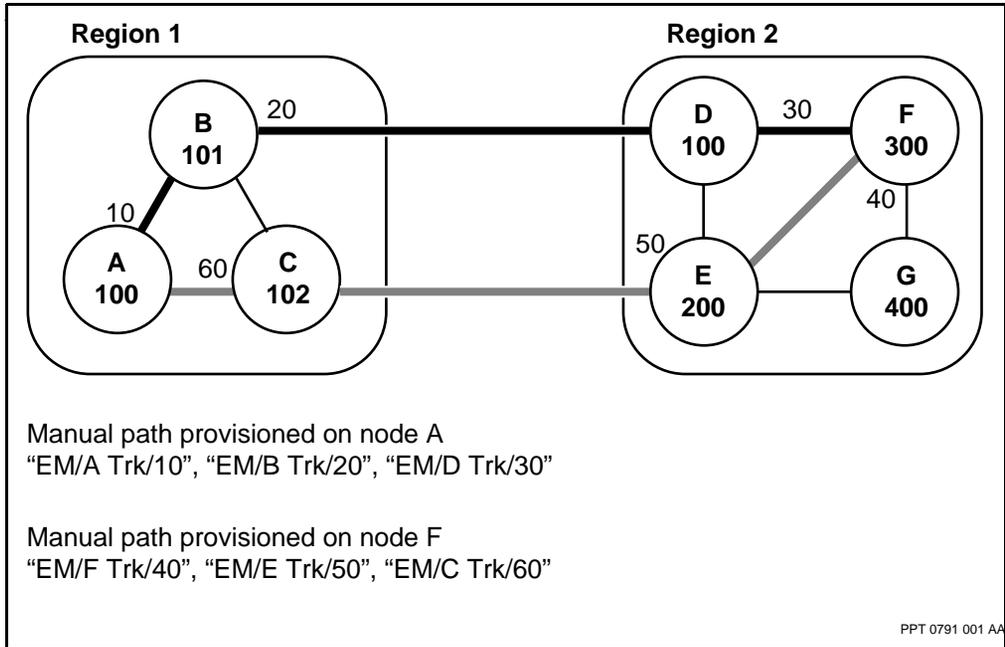
Manual path connection between topology regions

Manual paths are defined at each end point of a call. Once a manual path is specified, it bypasses the PORS automatic route selection. Call establishment using a manual path is performed independent of topology regions and can serve as an alternative to dynamically routed calls across multiple topology regions. NSAP addressing is not required when using a manual path to route an inter-region call.

It is recommended to have two independent routes specified for a manual path by specifying a different manual path (non-symmetric) for each end. The first path to come up is used to route the call. The alternate path is used to reroute the call if a failure occurs on the first path.

Figure 21, “PORS inter-region manual path connections,” (page 140) illustrates two manual paths configured between topology regions.

Figure 21
PORS inter-region manual path connections



When configuring a manual path connection, remember the following details:

- Configure different paths at each end point because, if both ends use the same path, a single point of failure can occur.
- Select paths that have similar metrics.
- Duplicate nodeIds can be used on a manual path.

To configure a manual path connection, see “Configuring manual paths for managed cut-through switching” (page 31) and “Configuring manual paths for a PLC” (page 33).

Multiservice Switch clusters

PORS service support for Nortel Networks Multiservice Switch clusters is achieved by deploying NSAP addressing. See “Configuring NSAP addressing” (page 38) for details. PORS support for Multiservice Switch clusters is achieved by deploying routing gateway functionality and reachable

addresses on cluster links. See “Configuring a routing gateway” (page 53) and “Configuring inter-region Multiservice Switch trunks” (page 55) for details.

From a PORS perspective, routing to or from a cluster is the same as routing across a topology region boundary. As with multi-topology region routing, path establishment consists of multiple path segments: from the source node within one cluster, across the cluster link, within the backbone of the first region, across the inter-region link (IRL), within the backbone of another region, across the cluster link, and within another cluster to the destination node.

On cluster border node cluster links, configure reachable NSAP addresses to the backbone and beyond. If the NSAP address plan allows for summarization of reachable NSAP addresses from the cluster border node to the backbone and beyond, configure summary addresses on the cluster border node.

On backbone border node cluster links, configure reachable NSAP addresses to the cluster. If the NSAP address plan allows for summarization of reachable NSAP addresses from the backbone border node to the cluster, configure summary addresses on the backbone border node.

Reachable NSAP addresses that are not summarized by summary addresses configured on a cluster border node will be broadcast to all nodes in the cluster. In the same way, reachable NSAP addresses that are not summarized by summary addresses configured on a backbone border node will be broadcast to all nodes in the backbone.

The *TrkReachableAddress* component (under the *Trunk* component) is similar to the *SummaryAddress* component, the difference being that it is link-based as opposed to the *SummaryAddress* component, which is node-based. The *SummaryAddress* component provides a summary of the addresses on the entire node, whereas the *TrkReachableAddress* component specifies the reachable addresses on a specific link on that node. NSAP addresses configured using the *TrkReachableAddress* component on the cluster border node (or backbone border node) links are not broadcast in the cluster (or backbone) if they can be summarized by those addresses configured in the *SummaryAddress* component.

For information on configuring Passport clusters, refer to “Configuring Multiservice Switch clusters” (page 39).

Guidelines for Multiservice Switch clusters

Nortel Networks Multiservice Switch clusters are deployed when planning for large network growth, or when approaching the engineering limits for a topology region. Following are some guidelines for Multiservice Switch clusters:

- Multiservice Switch trunks must not be configured between clusters.
- Clusters are configured around a topology region backbone.
- Topology regions are interconnected through backbone nodes rather than cluster nodes.
- All planned cluster nodes and backbone nodes to be connected to a cluster node must first be upgraded to a software level supporting the clusters behavior.

Chapter 9

Traffic management

In the Nortel Networks Multiservice Switch Path-Oriented Routing System (PORS), traffic management consists of bandwidth management, adaptive routing, and congestion management.

This section describes these traffic management capabilities. Information is organized under the following headings:

- “Introduction to bandwidth management” (page 143)
- “Path bandwidth reservation” (page 144)
- “Multiservice Switch trunk bandwidth sharing” (page 151)
- “Dynamic trunk speed change” (page 156)
- “Congestion management” (page 160)

Introduction to bandwidth management

PORS reserves bandwidth for at the connection level for the duration of a logical connection. This approach partitions the network bandwidth among the different services according to priority settings.

The three principal aspects to bandwidth management in a Nortel Networks Multiservice Switch network are:

- path bandwidth reservation, which determines how bandwidth is allocated to an individual path. See the section “Path bandwidth reservation” (page 144)

- trunk bandwidth sharing, which determines how bandwidth is partitioned and shared on a Multiservice Switch trunk between path-oriented and connectionless traffic. See the section “Multiservice Switch trunk bandwidth sharing” (page 151).
- dynamic trunk speed changes, which enables Multiservice Switch trunks and routing to adapt to changes resulting from increasing and reducing bandwidth. See the section “Dynamic trunk speed change” (page 156).

Path bandwidth reservation

Every logical connection has a configured *requiredTxBandwidth* attribute and *requiredRxBandwidth* attribute, which is a pair of numbers indicating the bandwidth in bits per second to reserve in each direction of the connection.

These numbers can represent the peak, average, or an intermediate bandwidth. The exact meaning is controlled by the service reserving the bandwidth.

This section includes the following information:

- “Maximum reserved outbound bandwidth” (page 144)
- “Path instantiation failures: causes” (page 147)
- “Path instantiation failures: retry response” (page 147)
- “Path instantiation failures: bumping response” (page 149)

Maximum reserved outbound bandwidth

Every Nortel Networks Multiservice Switch trunk has a *maxReservedBwOut* attribute indicating how much bandwidth can be reserved on this Multiservice Switch trunk in the outgoing direction. This reserved bandwidth is a percentage of the total Multiservice Switch trunk bandwidth, which is indicated by the Multiservice Switch trunk attribute *measuredSpeedToIf*.

PORS subtracts the values for the *requiredBandwidth* attribute (*requiredTxBandwidth* and *requiredRxBandwidth* attributes) from the available remaining reservable bandwidth in each direction of a Multiservice Switch trunk.

Example of bandwidth reservation

Consider the network illustrated in part (a) of the figure “Path bandwidth reservation” (page 144), with

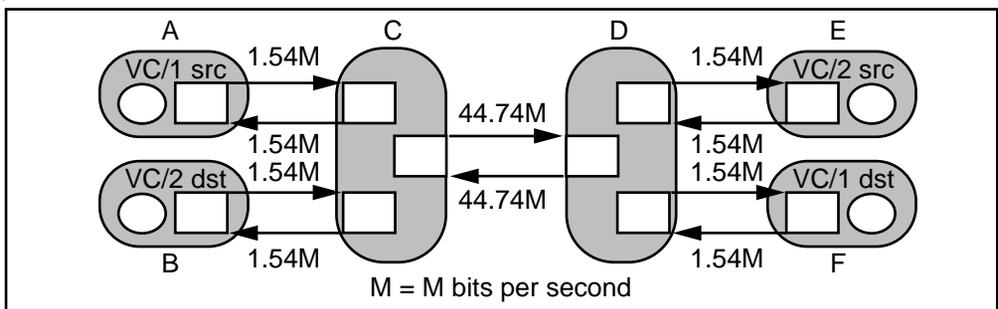
- tandem nodes C and D connected by a DS-3 trunk
- peripheral nodes A, B, E, and F each connected by a DS-1 trunk to one of the tandem nodes

Part (b) of the figure “Path bandwidth reservation” (page 144) illustrates the topology and state after VC/1 has reserved bandwidth on route A->C->D->F, with the *requiredBandwidth* attribute set to (1.0M, 1.54M).

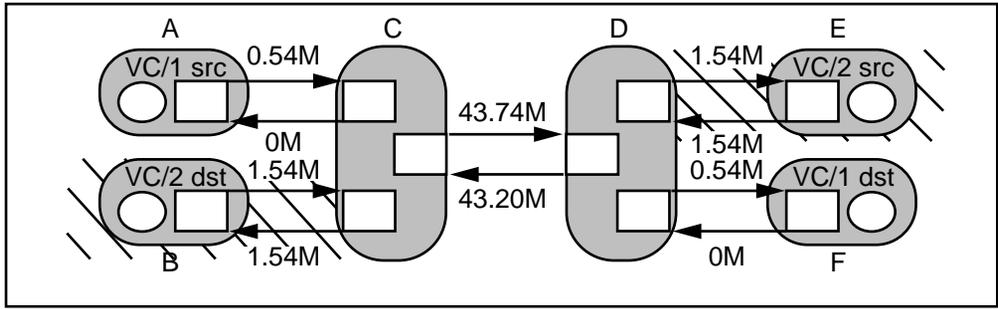
Part (c) of the figure “Path bandwidth reservation” (page 144) illustrates the topology and state after VC/1 has reserved bandwidth as described above, and then VC/2 has reserved bandwidth on route E->D->C->B, with the *requiredBandwidth* attribute set to (1.54M, 1.54M).

Note: In the statements above, the route specifications are simplified for illustrative purposes. Also, the first number in brackets is the bandwidth from source to destination (*requiredTxBandwidth* attribute), and the second number is the bandwidth from destination to source (*requiredRxBandwidth* attribute).

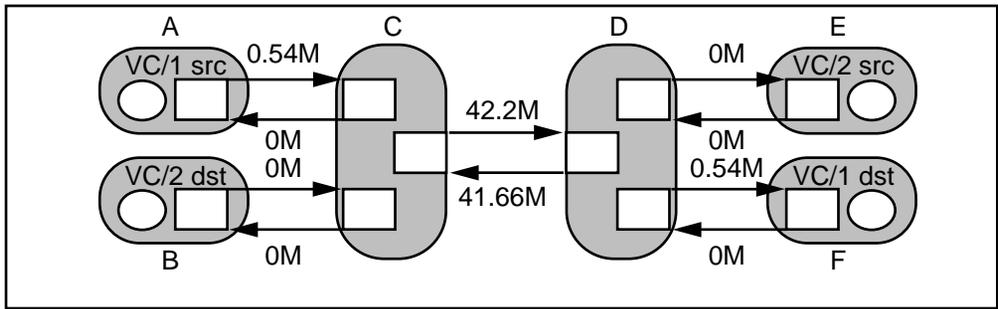
Figure 22
Path bandwidth reservation



(a) Initial Network State (after VCs initialize but before path is setup)



(b) After setup of VC1 with path A->C->D->F and requiredBandwidth (1.0,1.54)



(c) After setup of VC2 with path E->D->C->B and requiredBandwidth (1.54,1.54)

PPT 0805 001 AA

Path instantiation failures: causes

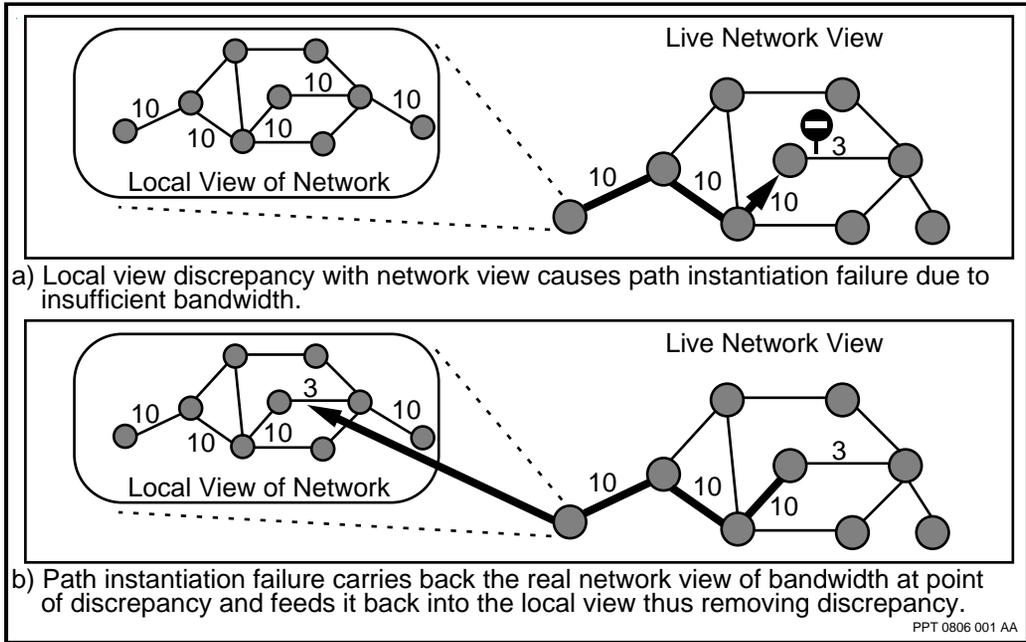
A path can fail to instantiate when it reaches a Nortel Networks Multiservice Switch trunk that does not have any more free LCNs to allocate. The maximum number of LCNs that the Multiservice Switch trunk can support is specified in the *PathAdmin maxLc* attribute. A path can also fail to instantiate when it reaches a Multiservice Switch trunk that does not have sufficient bandwidth to support the logical connection. The *maxReservedBwOut* attribute of a Multiservice Switch trunk indicates the upper limit of the bandwidth that can be reserved for all instantiated paths.

A path can fail to instantiate because of lack of reservable bandwidth caused by unavoidable discrepancies between the Route Selector view of reserved bandwidth and the actual bandwidth reserved on Multiservice Switch trunks in the network. A Route Selector is unaware of the reservations made for routes chosen by other Route Selectors or bandwidth unreserved when paths terminate. It learns of the changed bandwidth reservation of a Multiservice Switch trunk either from the regular topology updates, or from path instantiation failures of its own routes going over the affected Multiservice Switch trunk. Path terminations with significant bandwidth change can also be learned by the RS at the end points.

Path instantiation failures: retry response

In case of failure, path instantiation is terminated and the reserved bandwidth status of (at least) the current Nortel Networks Multiservice Switch trunk is fed back with the failure packets to the end point originating the logical connection. See part (a) of the figure “Learning about bandwidth errors after a setup failure” (page 148). The end point forwards these new bandwidth values to its Route Selector to update its local view of the topology. See part (b) of the figure “Learning about bandwidth errors after a setup failure” (page 148).

Figure 23
Learning about bandwidth errors after a setup failure



This error feedback mechanism is how the Route Selector learns about its mistakes in order to avoid making them repeatedly. Once the actual reserved bandwidth has been fed back into the local topology, the Route Selector is asked by the end point to choose a new route. If a new route is found, path instantiation proceeds again on the new route. This process continues until either the path successfully instantiates, or the Route Selector is unable to find a route with sufficient bandwidth. If unable to find a route with sufficient bandwidth, the Route Select resorts to bumping of existing paths to obtain their bandwidth. This is explained in the section “Path instantiation failures: bumping response” (page 149).

Path instantiation failures: bumping response

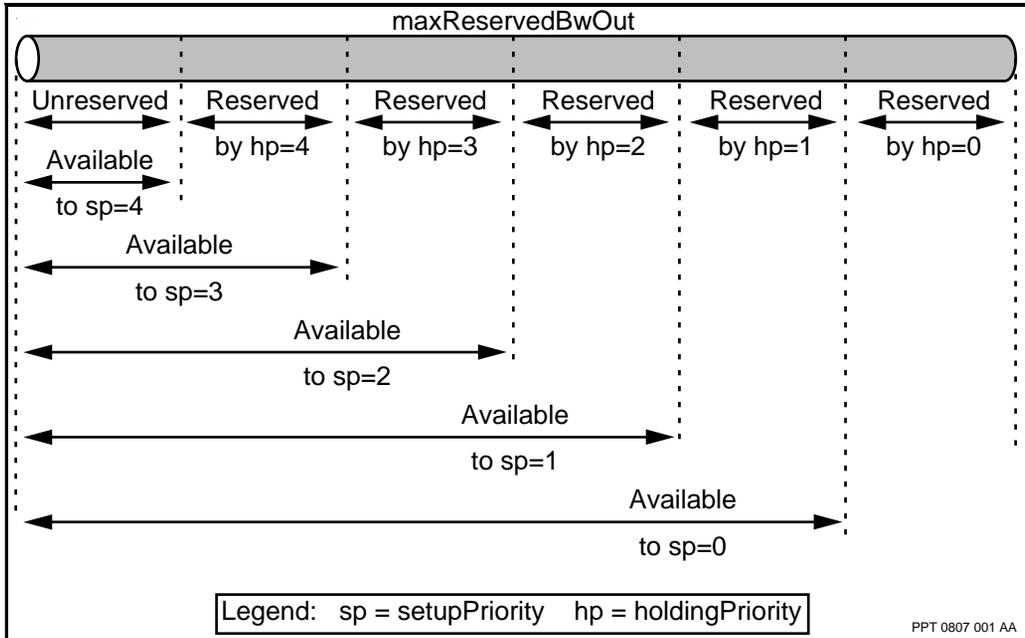
“Path instantiation failures: causes” (page 147) gives the impression that there are only two kinds of bandwidth, free and reserved. PORS actually tracks seven types of bandwidth for each Nortel Networks Multiservice Switch trunk. These types are

- bandwidth currently unreserved
- bandwidth reserved for paths at holding priorities 4 (lowest), 3, 2, 1 and 0 (highest)
- minimum bandwidth reserved for connectionless traffic

These bandwidth types are important. To obtain bandwidth when the network cannot establish a path due to insufficient bandwidth, PORS bumps paths with a lower holding priority than the setup priority for the new path. The perspective of reservable bandwidth depends on the *setupPriority* attribute value assigned to the new path. The bandwidth available for a path at *setupPriority* attribute n consists of the unreserved bandwidth plus all bandwidth reserved by paths at *holdingPriorities* attribute greater than n. See the figure “Bandwidth available at different holding and setup priorities” (page 150).

Note: The highest holding and setup priorities are 0 and the lowest are 4.

Figure 24
Bandwidth available at different holding and setup priorities



The Route Selector mechanism for selecting a route is governed by the *bumpPreference* attribute under the *PermanentLogicalConnection* component.

When the *bumpPreference* attribute is set to *bumpWhenNecessary*, the Route Selector always tries first to establish a route through Multiservice Switch trunks that have enough unreserved bandwidth to satisfy the value set for the *requiredBandwidth* attribute. If unable, it adds to the amount of available bandwidth on all *holdingPriority* attribute 4 bandwidth and tries again, if the new PLC *setupPriority* attribute is 3 or better. This process continues until it reaches a *holdingPriority* attribute equal to the *setupPriority* attribute, at which point it reports that no route is possible.

If adding in bandwidth used by lower holding priority paths results in a successful route, the path instantiation for that route is permitted to bump lower holding priority paths to obtain their bandwidth. Paths that are bumped

are setup on alternate routes, if available. If the bumped path has the *pathFailureAction* attribute set to *disconnectConnection*, the bumped path is terminated instead.

When the *bumpPreference* attribute is set to *bumpToObtainBestRoute*, the Route Selector adds to the amount of available bandwidth. The amount added equals all bandwidth reserved by PLCs with a holding priority that is numerically greater than the setup priority for the new PLC. This is because when the *bumpPreference* attribute under the *PermanentLogicalConnection* component is set to *bumpToObtainBestRoute* and its *setupPriority* attribute is set to 2 then this PLC can bump all paths whose *holdingPriority* attribute is 3 or 4 in order to obtain the best possible path.

Note: The Route Selector does not bump lower *holdingPriority* attribute PLCs unless it is absolutely necessary even when the *bumpPreference* attribute is set to *bumpToObtainBestRoute*.

Multiservice Switch trunk bandwidth sharing

A Nortel Networks Multiservice Switch trunk can carry two broad classes of traffic, connectionless and path-oriented. Connectionless traffic travels through a Multiservice Switch trunk without making any advanced reservations as to its bandwidth requirements, unlike path-oriented traffic which travels along pre-setup paths that have individually reserved some portion of the total Multiservice Switch trunk bandwidth for their use on every Multiservice Switch trunk they traverse.

This section addresses how Multiservice Switch fairly and efficiently shares Multiservice Switch trunk bandwidth between connectionless and path-oriented traffic and includes the following information:

- “Multiservice Switch trunk bandwidth allocation” (page 152)
- “Multiservice Switch trunk bandwidth sharing under congestion” (page 155)
- “Guidelines for setting Multiservice Switch trunk bandwidth attributes” (page 155)

Multiservice Switch trunk bandwidth allocation

The network engineers determine fair and efficient sharing of resources on a Nortel Networks Multiservice Switch trunk. The Trunk PathAdmin component provides configurable parameters that allow different enforceable policies.

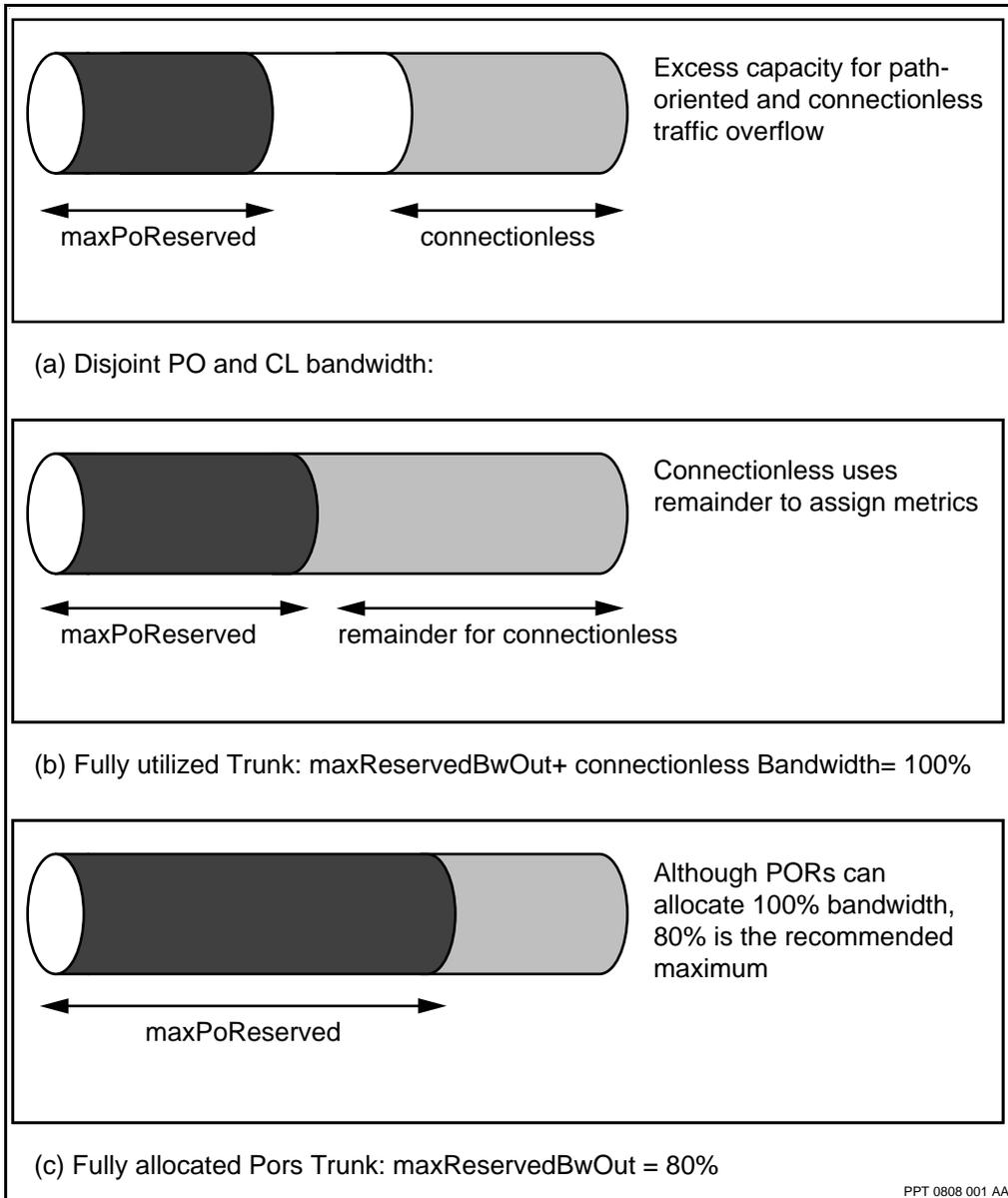
The *maxLc* attribute defines the maximum number of individual logical channels (or paths) that traverse the trunk. When this number is reached, no new paths can instantiate over this Multiservice Switch trunk until some existing paths clear.

Note: The value set for the *maxLc* attribute should be added to the *connectionPoolCapacity* attribute under the *Lp Eng Arc Ov* component. This ensures that PORS connections will establish on map mode trunks. For details, see NN10600-450 *Nortel Networks Multiservice Switch 7400: Operations: DPN-100 Interworking*.

The *maxReservedBwOut* attribute defines the percentage of total Multiservice Switch trunk bandwidth that PORS can allocate among individual Logical Channels. Once this percentage is reached, the Multiservice Switch trunk has no more reservable bandwidth. No paths can instantiate over this Multiservice Switch trunk until some existing paths clear. For example, on a DS-1 trunk at 1.536 Mbit/s, a value of 65% for this Multiservice Switch trunk attribute makes this Multiservice Switch trunk capacity appear to be 0.9984 Mbit/s, and hence PORS never reserves more than 0.9984 Mbit/s of this Multiservice Switch trunk. The actual utilization of path-oriented traffic can exceed the reservation limit since bandwidth utilization is not enforced against the bandwidth reservation. This allows for statistical utilization of the bandwidth on the Multiservice Switch trunks.

When configuring a Multiservice Switch trunk, the apportioning of the total bandwidth between the path-oriented reservation (*maxReservedBwOut* attribute) and connectionless (the remainder) is flexible. The range for the *maxReservedBwOut* attribute is 0 - 100% however only 80% maximum is recommended at this time if the traffic is purely interrupting (Emission Priority 0). A small amount of bandwidth is reserved for connectionless so that the metric is not infinity. This is illustrated in the figure “Multiservice Switch trunk bandwidth reservation limit control options” (page 153).

Figure 25
Multiservice Switch trunk bandwidth reservation limit control options

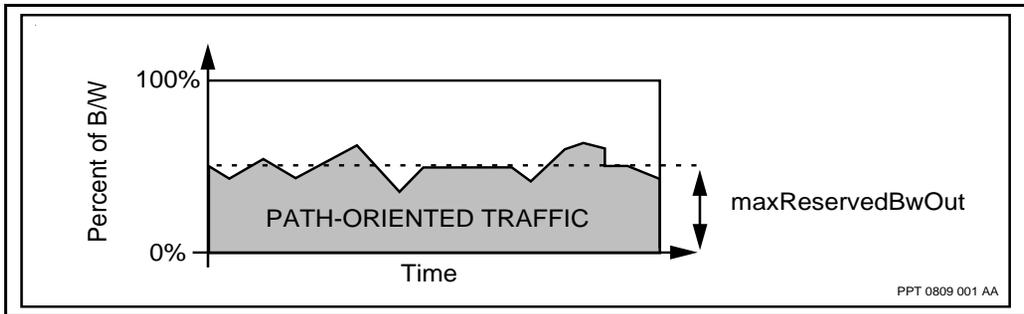


If the path-oriented to connectionless boundary for a Multiservice Switch trunk is non overlapping, the path-oriented traffic is less likely to use the connectionless share of the bandwidth, especially if the value set for the *requiredBandwidth* attribute for each path has been specified as a peak value. See part (a) of the figure “Multiservice Switch trunk bandwidth reservation limit control options” (page 153). This represents a conservative allocation of Multiservice Switch trunk bandwidth. If the path-oriented traffic is not using its entire reservation, the throughput routes chosen by connectionless traffic cannot advertise the unused path-oriented bandwidth. However, if connectionless traffic exceeds 100 - the *maxReservedBwOut* attribute it can take advantage of the unused path-oriented reserved bandwidth. Similarly, the path-oriented traffic exceeding the *maxReservedBwOut* attribute can take advantage of the unused connectionless bandwidth.

If the traffic utilizations are disjoint, there is a safety zone where connectionless and path-oriented traffic can overflow. See part (a) of the figure “Multiservice Switch trunk bandwidth reservation limit control options” (page 153). This gives a lower link utilization, but has a lower probability of contention between path-oriented and connectionless traffic, and thus has minimal packet loss.

The *maxReservedBwOut* attribute is a fairly coarse control of the maximum percentage of a Multiservice Switch trunk which can be occupied by path-oriented traffic. It is coarse because nothing prevents the applications using the paths from over utilizing or under utilizing their reservations. For continuous bit rate applications, the reservations are very accurate, but for bursty applications, the reservation can be under-shot (if reservation is peak) or over-shot (if reservation is statistical). The accuracy with which the *maxReservedBwOut* attribute represents path-oriented Multiservice Switch trunk utilization is a function of how many individual paths are using this bandwidth and the variance of each of these paths from its individual reservation. Typically, a larger number of small statistical reservations have a more predictable sum than a small number of large statistical reservations. See the figure “Multiservice Switch trunk path-oriented bandwidth fluctuation about its reservation” (page 155).

Figure 26
Multiservice Switch trunk path-oriented bandwidth fluctuation about its reservation



At some time, the actual percentage utilizations of path-oriented and connectionless traffic can add up to greater than 100%, and we get a congested Multiservice Switch trunk. The frequency and duration of these congestion periods are directly related to the error in predicting the offered loads of each class of traffic.

Multiservice Switch trunk bandwidth sharing under congestion

Packets are not discarded by Nortel Networks Multiservice Switch trunks when they are under no congestion, regardless of how much a particular application or class of traffic is exceeding its reservation. When congested, packets must be discarded while still providing fair sharing of the Multiservice Switch trunk bandwidth between path-oriented and connectionless traffic. If there is congestion the different packets are discarded by respecting the discard priorities of the individual data packets not with regard to the reservation limits.

Guidelines for setting Multiservice Switch trunk bandwidth attributes

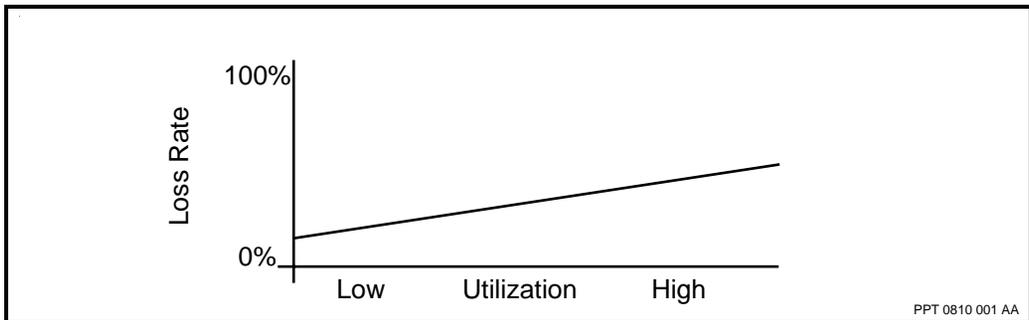
Given a number of configurable attributes all of which affect the bandwidth used by various classes of traffic on a Nortel Networks Multiservice Switch trunk, how do we set them to achieve a desired result?

There is a trade-off between the efficient usage of a Multiservice Switch trunk and the probability of loss due to short term congestion on that Multiservice Switch trunk. This trade-off is highly dependent on the mix of traffic on the

Multiservice Switch trunk. Loss occurs when bursty traffic peaks align, and inefficiency occurs when extra bandwidth is allocated to make room for the small bursts to reduce the loss. The figure “Efficiency versus loss rate on a Multiservice Switch trunk carrying bursty traffic” (page 156) gives an approximation of this, but the steepness and the shape of the curve are traffic dependent, and it is impossible to give a precise graph.

Figure 27

Efficiency versus loss rate on a Multiservice Switch trunk carrying bursty traffic



An important decision to be made is how much loss can the network inflict on its users to ensure that the Multiservice Switch trunk is being used efficiently.

If the objective of the network operator is to give the lowest possible loss rate to its subscribers, the *maxReservedBwOut* attribute is assigned a conservative setting and the individual services accurately reflect the average (peak in some cases) bandwidth utilization.

If the operator wants maximum efficiency of Multiservice Switch trunk bandwidth, connectionless traffic must be able to take advantage of any lulls in path-oriented traffic, and vice versa. To achieve this more statistical bandwidths can be configured on the individual services.

Dynamic trunk speed change

The dynamic trunk speed change feature enables Nortel Networks Multiservice Switch trunking and routing to adapt to changes that result from bandwidth deltas without taking Multiservice Switch trunks out of service. This feature also supports Multiservice Switch trunking on the integrated

Inverse Multiplexing for ATM (IMA). For details on IMA, refer to NN10600-730 *Nortel Networks Multiservice Switch 7400/15000/20000 Inverse Multiplexing for ATM Operations*.

The dynamic trunk speed change feature enables a Multiservice Switch system to interwork with third-party equipment to offer the following functionality:

- ISDN dial backup—resumes connectivity between two Multiservice Switch nodes when a leased line failure occurs
- ISDN dynamic bandwidth on demand (BWoD)—enables a Multiservice Switch node to adapt to additional bandwidth when the capacity of the dedicated facility is exceeded
- inverse multiplexing—enables a Multiservice Switch trunk to support more than four physical connections between adjacent Multiservice Switch nodes

For details on these functionalities of the dynamic trunk speed change feature, refer to NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*.

The dynamic trunk speed change feature offers the following benefits:

- PORS configurable attributes enable selective bumping of connections when bandwidth decreases. (See “Path instantiation failures: retry response” (page 147).
- Changing the *maxReservedBwOut* attribute of the Multiservice Switch trunk bandwidth is a non-critical operation and affects the current PORS connections on a Multiservice Switch trunk.
- Changing the *trunkCost* attribute of the Multiservice Switch trunk bandwidth is a non-critical operation and can attract new PORS connections to a Multiservice Switch trunk.
- All existing PORS features, such as bumping and optimization, are maintained.

Speed change reporting mechanism

A set of Nortel Networks Multiservice Switch trunk attributes enable and disable the reporting of dynamic trunk speed changes to the routing mechanism. By default, the speed change reporting mechanism is disabled on the Multiservice Switch trunk, and Multiservice Switch trunk speed variations are not propagated to PORS.

When the speed change reporting mechanism is enabled, significant Multiservice Switch trunk speed variations are automatically propagated to PORS through the PA. A speed decrease is deemed more significant than a speed increase. PORS then makes a decision (based on the holding priority) whether or not the speed change is propagated to other nodes in the network.

Dampening the generation of speed change reports

To prevent the routing system from an overload of speed change updates, the speed change reporting mechanism can be customized (such as the granularity of the reported speed change and the frequency of the speed change update) through configuring *Trunk speedReportingThresholds* and *speedReportingHoldOff* attributes.

Note: The *speedReportingHoldOff* attribute is not applied to speed decrease updates. Speed decreases are always reported immediately to discourage traffic from using the Multiservice Switch trunk.

For configuration information, see NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*.

PORS trunks

If a PORS trunk is used, a percentage of the Nortel Networks Multiservice Switch trunk speed is allocated to Path-Oriented Routing traffic. A *PathAdmin* component under each *Trunk* component specifies the bandwidth sharing characteristics of the Multiservice Switch trunk.

Voice services (a part of PORS traffic) uses a Short Path-Oriented Multiplexing (SPO-mux) feature. This PORS efficiency feature uses a separate VCC with no ATM adaptation layer for increased efficiency. The rest of the PORS traffic uses AAL5 VCC. The speed for the SPO-mux feature is included in the PORS portion of the reserved bandwidth Multiservice Switch

trunk. When the allocated bandwidth for the Multiservice Switch trunk decreases, the allocated bandwidth of the PORS traffic is decreased in proportion to the Multiservice Switch trunk bandwidth.

If the Multiservice Switch trunk speed change reporting mechanism is enabled when a dynamic speed change occurs on a PORS trunk, the new Multiservice Switch trunk bandwidth is passed from the Multiservice Switch trunk to PORS through the *PathAdmin* component. PORS then recalculates a new PORS trunk bandwidth and propagates to other nodes (if required).

For more information on the PORS efficiency feature, see NN10600-420 *Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Trunking*.

Congestion and re-routing traffic

If the available bandwidth decreases, the available bandwidth can be overcommitted to the applications. Certain PORS connections are rerouted or bumped to other paths when congestion occurs.

When the PORS bandwidth returns to its original value, PORS (via optimization) can reroute paths that were bumped back to the original Multiservice Switch trunks.

PORS percentage

Changing the *maxReservedBwOut* attribute of the Multiservice Switch trunk bandwidth is a non-critical operation (can be modified without disrupting calls); it can be used to affect the current PORS connections on a Multiservice Switch trunk. Similarly, changing the *trunkCost* attribute of the Multiservice Switch trunk bandwidth is a non-critical operation and can be used to attract new PORS connections to a Multiservice Switch trunk.

The PORS bandwidth percentage applies to existing calls, while the Multiservice Switch trunk cost applies to new calls.

Delays and delay variations

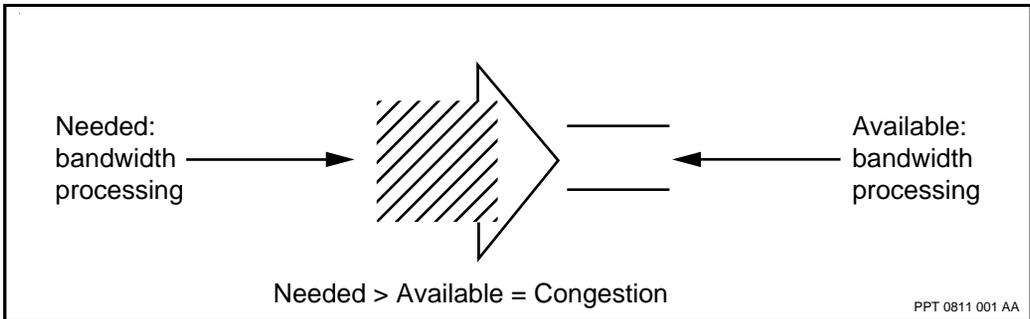
Delays and delay variations are added to the traffic in the transition period (that is, from the time that the leased line fails until the time the backup lines are functional depends on the third-party device used).

These delays and delay variations lead to quality of service (QoS) downgrading and can violate QoS guarantees on voice and video traffic on the PORS trunk. Depending on the functionality provided by the third-party ISDN device, the network can be configured to avoid using the backup lines for PORS traffic.

Congestion management

Congestion occurs whenever the data to be transmitted or processed by a server exceeds the servers capacity. The severity of the congestion is proportional to the persistence and volume of the excess data. An example of congestion is illustrated in the figure “Congestion situation” (page 160).

Figure 28
Congestion situation



While congested, a system exhibits undesirable behavior. For example

- packets are delayed
- packets are discarded
- path instantiation is delayed or fails

PORS congestion management responds to congestion and maintains the committed grade of service.

This section includes the following information on congestion:

- “Points of congestion” (page 161)
- “Multiservice Switch trunk congestion” (page 161)

- “Congestion notification” (page 163)
- “Congestion management by packet discard” (page 163)
- “Network management to prevent congestion” (page 164)

Points of congestion

Congestion occurs where processing and transmitting servers interact. Types of congestion include

- processor congestion—when too many packets are received from the bus or Nortel Networks Multiservice Switch trunk
- bus congestion—when too many packets are sent to the bus
- Multiservice Switch trunk congestion—when too many packets are sent to the Multiservice Switch trunk

Processor and bus congestion are difficult to proactively identify.

Response to congestion

PORS congestion management focuses on avoiding and resolving Multiservice Switch trunk congestion with minimal disruption to high priority data. To accomplish this action, PORS

- notifies applications of the onset of congestion
- applies bandwidth sharing rules and discards packets, if required, based on their relative importance

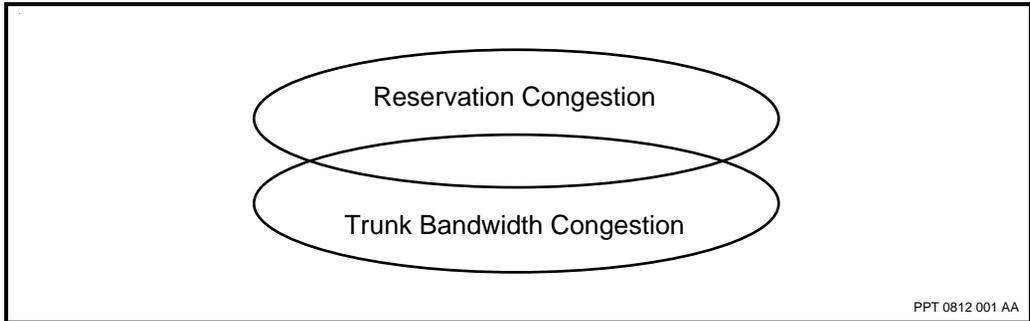
Multiservice Switch trunk congestion

There are two types of Nortel Networks Multiservice Switch trunk congestion:

- Multiservice Switch trunk bandwidth congestion—where the offered load exceeds the Multiservice Switch trunk bandwidth capacity
- Reservation congestion—where the amount of bandwidth reserved for path-oriented traffic is at (or close to) the reservation limit (*maxReservedBwOut* attribute). It can also be caused by reaching the maximum number of paths that can be supported on the Multiservice Switch trunk (*maxLc* attribute).

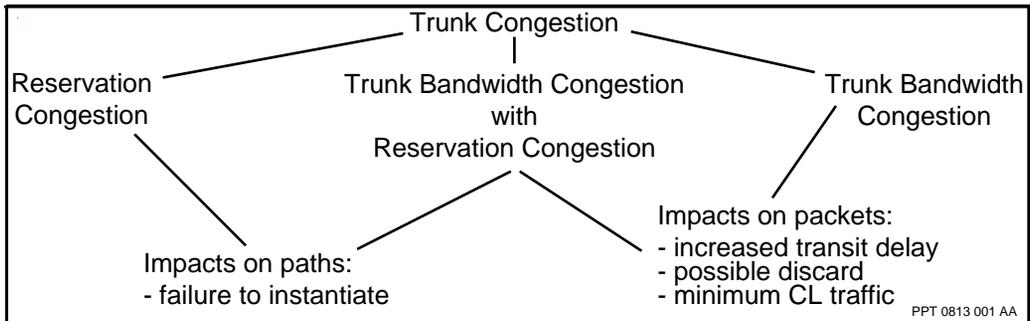
These two types of Multiservice Switch trunk congestion are related as shown in the figure “Types of Nortel Networks Multiservice Switch trunk congestion” (page 162).

Figure 29
Types of Nortel Networks Multiservice Switch trunk congestion



Each type of congestion can occur alone or together with the other type. If reservation congestion occurs simultaneously with Multiservice Switch trunk bandwidth congestion, this means that the entire *maxReservedBwOut* attribute portion of the Multiservice Switch trunk bandwidth has been reserved. At the same time, all the Multiservice Switch trunk bandwidth is being used by the path-oriented traffic, the connectionless traffic, or both. In general, a Multiservice Switch trunk congestion has impact on paths, on path-oriented data packets, or on both, as depicted in the figure “Impact of congestion types” (page 162).

Figure 30
Impact of congestion types



Impact on paths is manifested as a failure of path instantiation for Multiservice Switch trunks. New paths cannot be instantiated over the Multiservice Switch trunk experiencing reservation congestion. Impact on packets of already instantiated paths is manifested by packet delay due to a buildup of packet waiting line, and eventual packet discards if the number of waiting packets grows beyond certain limits.

Congestion notification

When a network becomes congested, packets can be discarded. To avoid packet discard, application end points reduce the amount of traffic they send into the network. Receipt of congestion indication messages triggers this reduction.

PORS transparently transports congestion indication messages to application end points. The congestion management system detects congestion and sets the Forward Congestion Indication (FCI) bit in the packet header of packets travelling in the direction of a congested path. The end point that receives these packets is responsible for notifying the source end point that the path is congested. (In Frame Relay, notification is achieved through the Backward Congestion Indication (BCI) bit on packets sent back to the transmitting end point.) The source end point then reduces the number of packets sent into the network.

HTDS, BTDS, and Voice Transport rely on PORS to transport data in a Nortel Networks Multiservice Switch network. Voice Transport uses FCI to signal congestion and then Voice Transport sends an explicit downspeed or rate control indication to the transmitting side to dynamically reduce the number of packets sent in the network.

Congestion management by packet discard

The Nortel Networks Multiservice Switch trunk bandwidth congestion is volatile since it depends on the process of packet arrivals and packet lengths. Packet discard is invoked when the congestion persists long enough for the emission queues to grow beyond a certain threshold.

The packet discarding mechanism implemented by PORS reduces the rate at which new packets are put into the emission queues. This mechanism is a quick system response to prevent emission buffer overflow which in turn results in uncontrolled packet discarding. Packet discards are based on

- severity of the congestion situation
- packet discard eligibility
- path discard priority
- Multiservice Switch trunk bandwidth sharing mechanism between connectionless and path-oriented traffic

Packets are discarded beginning with packets marked as Discard Eligible (DE). The packet DE bit is set by an application when emitting a packet that can be preferentially discarded in times of congestion. The intent is to discard first the non essential packets or packets transmitted by an application above the requested bandwidth for the service.

If the congestion becomes more severe, non DE-bit packets are discarded, based on the discard priority of the path. The path discard priority is configured through with the *discardPriority* attribute under the *PermanentLogicalConnection* component. This attribute defines the importance of packets which in turn reflects the probability of discard. A packet with a high discard priority is only discarded during severe congestion, while a low discard priority packet is discarded under lower congestion.

Packet discards are done to respect the configured bandwidth sharing mechanism between connectionless and path-oriented traffic. This mechanism is only invoked under a congestion situation since otherwise, there is enough bandwidth for both types of traffic. The section “Multiservice Switch trunk bandwidth sharing under congestion” (page 155) explains this mechanism in detail.

Network management to prevent congestion

Congestion is an indication that the collective bandwidth reservation on a Nortel Networks Multiservice Switch trunk does not match the actual bandwidth usage. By increasing individual path bandwidth reservation requests (*requiredBandwidth* attribute) to more closely reflect usage, you more evenly disperse traffic among the Multiservice Switch trunks.

Decreasing the amount of reservable bandwidth on a Multiservice Switch trunk (*maxReservedBwOut* attribute) reduces the number of paths that can be instantiated. Decreasing the number of instantiated paths (*maxLc* attribute) is also an alternative, but this configuration cannot produce the desired result since a fewer number of paths can still produce congestion if collectively they reserve the same amount of bandwidth as many more paths.

Decreasing the path-oriented bandwidth reservation limit (*maxReservedBwOut* attribute) reduces the bandwidth contention between the two traffic types. Decreasing the *maxReservedBwOut* attribute reduces the path-oriented traffic load (as explained in the previous paragraph), but does not affect the connectionless traffic load. Also by configuring the individual path-oriented services to reflect accurately the bandwidth, in some cases the peak bandwidth for continuous bit rate services such as BTDS, the PORS traffic can be kept within its reservation limits.

As a long term network management reaction to congestion problems, more bandwidth can be provided on frequently congested routes. Increased bandwidth is achieved by one of three methods:

- replacing an existing Multiservice Switch trunk with one of greater capacity
- adding another Multiservice Switch trunk along side a congested Multiservice Switch trunk
- adding Multiservice Switch trunks between other nodes to increase the probability of choosing another route

Nortel Networks Multiservice Switch 7400/15000/20000 Operations: Path-Oriented Routing System

Release 6.1

Copyright © 2004 Nortel Networks.
All Rights Reserved.

NORTEL, NORTEL NETWORKS, the globemark design, the NORTEL NETWORKS corporate logo, and PASSPORT are trademarks of Nortel Networks.

Publication: NN10600-435
Document status: Standard
Document version: 6.1S1
Document date: August 2004
Printed in Canada

