Nortel Networks Multiservice Switch

7400/15000/20000

Operations: Multiprotocol Label Switching

NN10600-445

Nortel Networks Multiservice Switch 7400/15000/20000

Operations: Multiprotocol Label Switching

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About this document

This guide describes how to configure multiprotocol label switching (MPLS) with Resource ReSerVation Protocol for Traffic Engineered LSP Tunnels (RSVP-TE). For configuration of the Label Distribution Protocol (LDP), refer to NN10600-582 *Nortel Networks Multiservice Switch 7400/15000/ 20000 VPN Configuration Management*.

The following topics are discussed in this section:

- "Who should read this document and why" (page 13)
- "What you need to know" (page 14)
- "How this document is organized" (page 14)
- "What's new in this document" (page 14)
- "Text conventions" (page 15)
- "Procedure conventions" (page 16)
- "Related documents" (page 19)
- "How to get more help" (page 19)

Who should read this document and why

This guide is for those people who perform the following tasks for MPLS:

- planning
- engineering
- installing and configuring
- provisioning

- operating and maintaining
- troubleshooting

What you need to know

This guide assumes that you understand Nortel Networks Multiservice Switch network architecture. You can learn more about Multiservice Switch networks and products by reading NN10600-030 *Nortel Networks Multiservice Switch 7400/15000/20000 Overview*.

How this document is organized

This document contains the following sections:

- "MPLS configuration" (page 21)
- "RSVP-TE software installation" (page 25)
- "LER configuration in an RSVP-TE network" (page 27)
- "LSP configuration on the source LER" (page 41)
- "MPLS overview" (page 53)
- "Monitoring and troubleshooting RSVP-TE" (page 71).

What's new in this document

The following feature was added to this document:

- "RSVP-TE on Router Model" (page 14)

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*.

RSVP-TE on Router Model

The following sections were updated for this feature:

- "MPLS configuration" (page 21)

- “RSVP-TE software installation” (page 25)
- “LER configuration in an RSVP-TE network” (page 27)
- “LSP configuration on the source LER” (page 41)
- “MPLS overview” (page 53)
- “Monitoring and troubleshooting RSVP-TE” (page 71)

Information related to LSR configuration for ATM was removed.

Text conventions

This document uses the following text conventions:

- `nonproportional spaced plain type`

  Nonproportional spaced plain type represents system generated text or text that appears on your screen.

- **nonproportional spaced bold type**

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

- *italics*

  Statements that appear in italics in a procedure explain the results of a particular step and appear immediately following the step.

  Words that appear in italics in text are for naming.

- `[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.

- UPPERCASE, lowercase

  Nortel Networks Multiservice Switch node commands are not case-sensitive and do not have to match commands and parameters exactly as shown in this document, with the exception of string options values (for example, file and directory names) and string attribute values.

- |

  This symbol separates items from which you may select one; for example, ON|OFF indicates that you may specify ON or OFF. If you do not make a choice, a default ON is assumed.

- ...

  Three dots in a command indicate that the parameter may be repeated more than once in succession.

The term absolute pathname refers to the full specification of a path starting from the root directory. Absolute pathnames always begin with the slash (/) symbol. A relative pathname takes the current directory as its starting point, and starts with any alphanumeric character (other than /).

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 17).

- 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. The system 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. The Nortel Networks Multiservice Switch system 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

Several procedures in this document ask that you complete the configuration changes. When you complete the configuration changes, you are activating the 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 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

Related documents

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

See the following documents for information related to MPLS:

- NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*
- NN10600-800 *Nortel Networks Multiservice Switch 7400/15000/20000 IP Technology Fundamentals*
- NN10600-801 *Nortel Networks Multiservice Switch 7400/15000/20000 IP Configuration Management*
- NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*
- NN10600-500 *Nortel Networks Multiservice Switch 6400/7400/15000/20000 Alarms Reference*

How to get more help

For information on training, problem reporting, and technical support, see the "Nortel Networks support services" section in NN10600-030 *Nortel Networks Multiservice Switch 7400/15000/20000 Overview*.

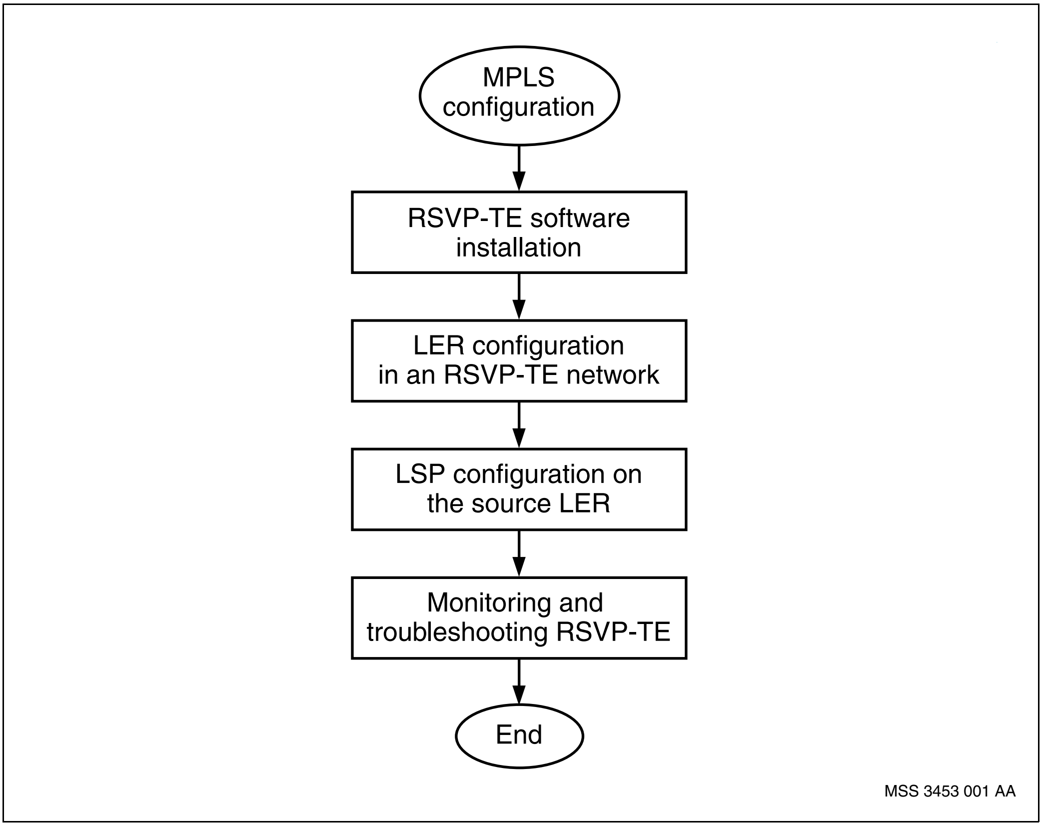
Chapter 1
MPLS configuration

Configure MPLS to set up a label-swapping networking technology that forwards packet traffic over multiple underlying layer-2 media (layer-2 media as defined by the Open Systems Interconnection (OSI) reference model).

MPLS configuration tasks

This task flow shows the sequence of procedures you perform to configure MPLS. To link to any task, go to “MPLS configuration task navigation” (page 22).

Figure 1
MPLS configuration tasks



MPLS configuration task navigation

- “MPLS configuration tasks” (page 22)
- “RSVP-TE software installation” (page 25)
- “LER configuration in an RSVP-TE network” (page 27)
- “LSP configuration on the source LER” (page 41)
- “Monitoring and troubleshooting RSVP-TE” (page 71)

For supporting conceptual and reference information about MPLS, please refer to the following sections:

- “What is MPLS technology?” (page 53)
- “How is MPLS implemented in Multiservice Switch networks?” (page 55)
- “Why use MPLS?” (page 55)
- “How does MPLS work?” (page 56)
- “Label switched paths (LSPs)” (page 60)
- “MPLS on Multiservice Switch nodes” (page 67)
- “Traffic engineering with MPLS” (page 68)

Chapter 2
RSVP-TE software installation

Install resource reservation protocol for traffic engineered LSP tunnels (RSVP-TE) to enable explicit routing in MPLS core networks. Before you can configure the RSVP-TE network, you must install the RSVP-TE software on GigE trunk card.

Prerequisites to RSVP-TE software installation

- For more information about installing and configuring software, see NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation*.
- GigE Trunk cards must be provisioned and validated to the RSVP-TE feature specification.

Procedure steps

1. Add a logical processor type for RSVP-TE.

   ```
   add Sw Lpt/<lpt_name>
   ```

2. Set the LPT feature list to include *mplsRsvpTe*, *ip*, and *atmMpe*.

   ```
   set Sw Lpt/<lpt_name> featureList mplsRsvpTe ip atmMpe
   ```

3. Set a logical processor to the FP.

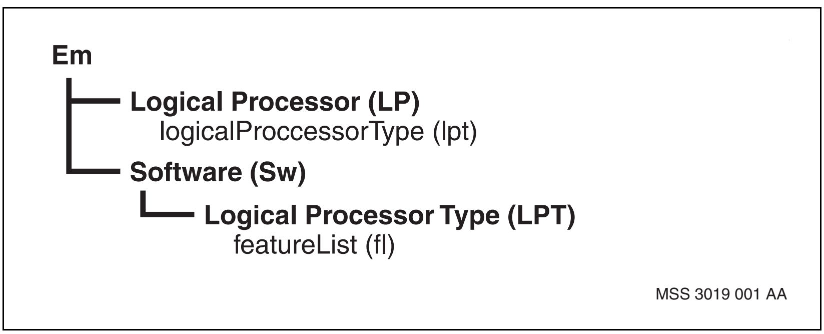
   ```
   set Lp/<n> logicalProcessorType Sw Lpt/<lpt_name>
   ```

4. Activate the configuration changes. See “Activating configuration changes” (page 18).

Variable definitions

Variable	Definition
<n>	is the LP number for the FP.
<lpt_name>	is the name of the lpt and is a mnemonic (for example, mpls_lp).

Figure 2
RSVP-TE LER software installation component hierarchy



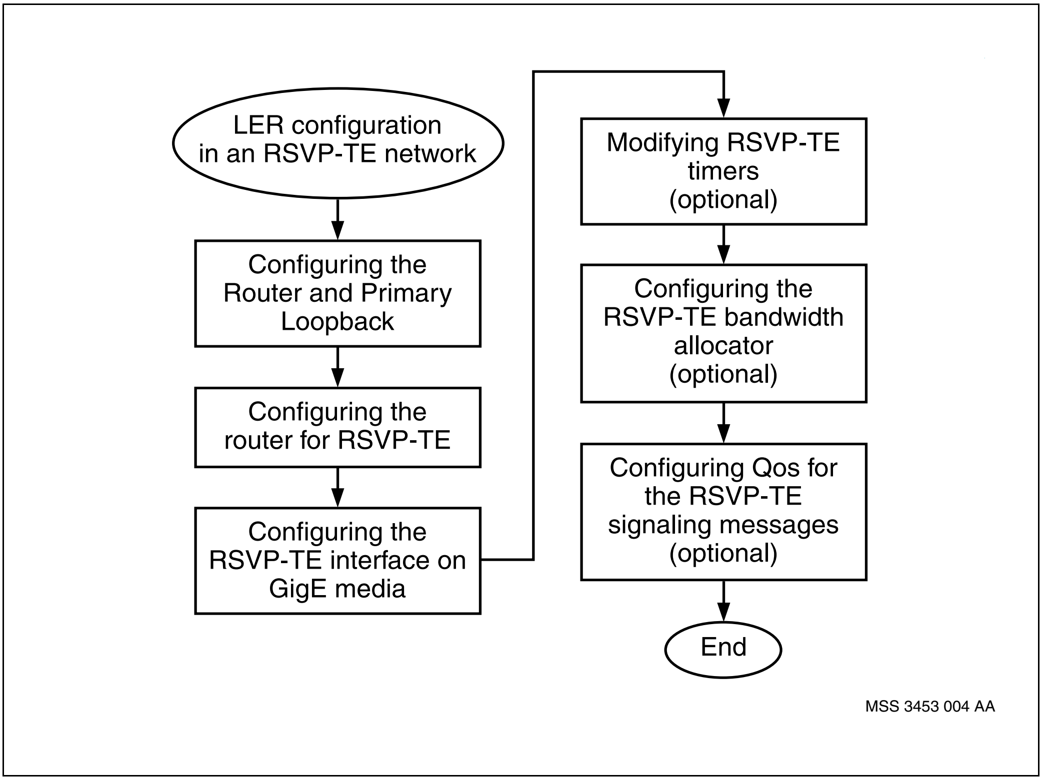
Chapter 3
LER configuration in an RSVP-TE network

Configure the label edge router (LER) in an RSVP-TE network.

LER configuration in an RSVP-TE network procedures

This task flow shows you the sequence of procedures you perform to configure the LER in an RSVP-TE network. To link to any procedure, go to "LER configuration in an RSVP-TE network navigation" (page 28).

Figure 3
LER configuration in an RSVP-TE network procedures



LER configuration in an RSVP-TE network navigation

- "Configuring the Router's Primary Loopback" (page 29)
- "Configuring the Router for RSVP-TE" (page 31)
- "Configuring the RSVP-TE interface on GigE media" (page 32)
- "Modifying the RSVP-TE timers" (page 34)
- "Configuring the RSVP-TE bandwidth allocator" (page 37)
- "Configuring the Qos for the RSVP-TE signaling messages" (page 39)

Configuring the Router's Primary Loopback

Configure the Router's mandatory instance of loopback media with the mode set to primary loopback. The address of this component is called the *primaryloopback* address.

Prerequisites

- The Router must be provisioned and configured for OSPF. For information about provisioning Router and OSPF, see NN10600-801 *Nortel Networks Multiservice Switch 7400/15000/20000 IP Configuration Management*.

Procedure steps

1 Add the interface with the loopback address.

```
add -s router/<router_name> interface/<ip_address>
loopback
```

2 Set the netmask. This variable must be 32-bit.

```
set router/<router_name> interface/<ip_address>
netmask 255.255.255.255
```

3 Set the mode to primaryLoopback.

```
set router/<router_name> interface/<ip_address>
loopback mode primaryLoopback
```

4 Add the OSPF broadcast capability to the loopback interface.

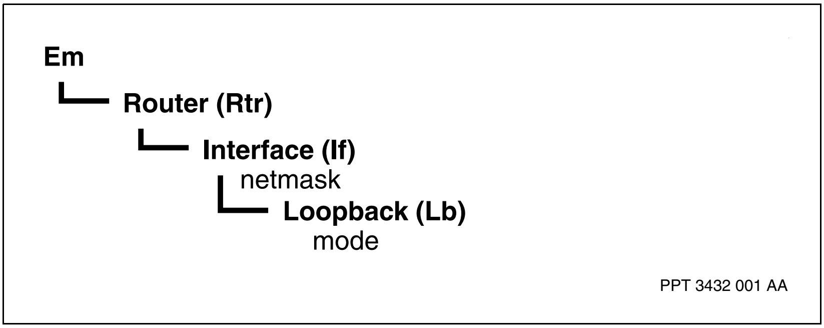
```
add router/<router_name> interface/<ipaddress> ospfif
```

Variable definitions

Variable	Definition
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).
<ip_address>	is a 32-bit address assigned to the interface from which the routing information is derived.
<mask>	is the network mask to be used with the IP address and must be 32-bit.

Procedure job aid

Figure 4
Configuring the router and primary loopback component hierarchy



Configuring the Router for RSVP-TE

Configure the router for RSVP-TE processing.

Procedure steps

1 Add RSVP-TE under the *Router* component.

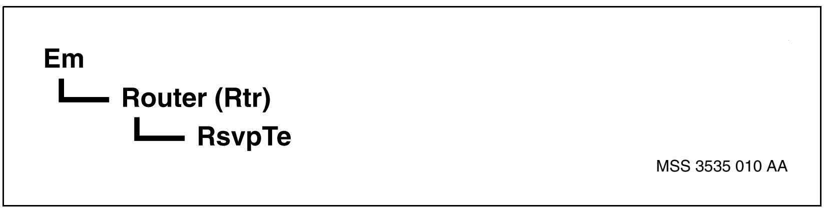
```
add Router/<router_name> RsvpTe
```

Variable definitions

Variable	Definition
<router_name>	is name of router and is a mnemonic (for example, RTR1).

Procedure job aid

Figure 5
Configuring the router for RSVP-TE component hierarchy



Configuring the RSVP-TE interface on GigE media

Configure the RSVP-TE interface (RsvpTeIF) on GigE media.

Prerequisites

- The RSVP-TE software must be installed.
- A Logical Processor (Lp) must be configured.
- Ethernet must be configured on the appropriate Lp.

Procedure steps

1 Add the interface and set the netmask.

```
add Router/<router_name> Interface/<ip_address>
netmask <netmask>
```

2 Add the *EnetApplication* component.

```
add Router/<router_name> Interface/<ip_address> Enet
```

3 Add an Ethernet port.

```
add Lp/<lp_id> Eth
```

4 Add the *LanApplication* component.

```
add La/<la_name>
```

The *Framer* subcomponent is automatically added.

5 Link the LanApplication to the GigE port.

```
set La/<la_name> Framer interfaceName Lp/<lp_id> Eth/
<ether_port>
```

6 Link to the LanApplication.

```
set Router/<router_name> Interface/<ip_address> Enet
linkToEnetIf La/<la_name>
```

7 Add the RSVP-TE protocol capability under the interface. Add the *RsvpTeIf* subcomponent under the interface.

```
add Router/<router_name> Interface/<ip_address>
RSVPTeIF
```

8 Enable IP routing on the interface (in this case, OSPF).

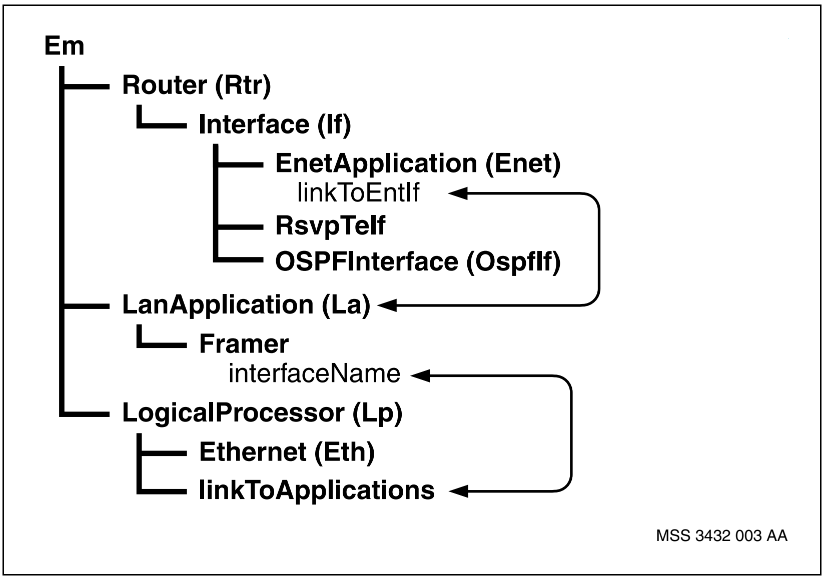
```
add Router/<router_name> Interface/<ip_address> Ospfif
```

Variable definitions

Variable	Value
<ether_port>	is the number of the Ethernet port. The range is 0 to 7.
<ip_address>	is the 32-bit address assigned to the interface from which the routing information is derived.
<la_name>	is the identifier assigned to the LanApplication.
<lp_id>	is the identifier assigned to the GigE LP.
<netmask>	is the identifier netmask for the interface. It determines the subnet prefix length. (For example, 255.255.255.0)
<router_name>	is the name of the route and is a mnemonic (for example, RTR1).

Procedure job aid

Figure 6
Configuring the RSVP-TE interface on GigE media component hierarchy



Modifying the RSVP-TE timers

Optionally, modify the value of timers to reduce the amount of control traffic (extend values), or to ensure faster convergence time (reduce values).

When the hello exchange under RsvpTeIf is enabled, the need for frequent soft state refresh is reduced. It is recommended to enable the hello exchange under all RsvpTeIf throughout the network and to extend the refresh intervals.

Prerequisites

- The *RsvpTeIf* component must be added under the router interface.

Procedure steps

1 Modify the default timer value for the entire shelf including all *RsvpTeIf* components that use the default sameAsRsvpTe value.

```
set Router/<router_name> RsvpTe refreshInterval
<refreshInterval_value>
```

```
set Router/<router_name> RsvpTe refreshKeepMultiplier
<refreshKeepMultiplier_value>
```

```
set Router/<router_name> RsvpTe helloInterval
<helloInterval_value>
```

```
set Router/<router_name> RsvpTe helloMultiple
<helloMultiple_value>
```

```
set Router/<router_name> RsvpTe slewMax
<slewMax_value>
```

2 Modify the timer values for a particular interface.

```
set Router/<router_name> Interface/<ip_address>
RsvpTeIf refreshInterval <refreshInterval_value>
```

```
set Router/<router_name> Interface/<ip_address>
RsvpTeIf refreshKeepMultiplier
<refreshKeepMultiplier_value>
```

```
set Router/<router_name> Interface/<ip_address>
RsvpTeIf helloInterval <helloInterval_value>
```

```
set Router/<router_name> Interface/<ip_address>
RsvpTeIf helloMultiple <helloMultiple_value>
```

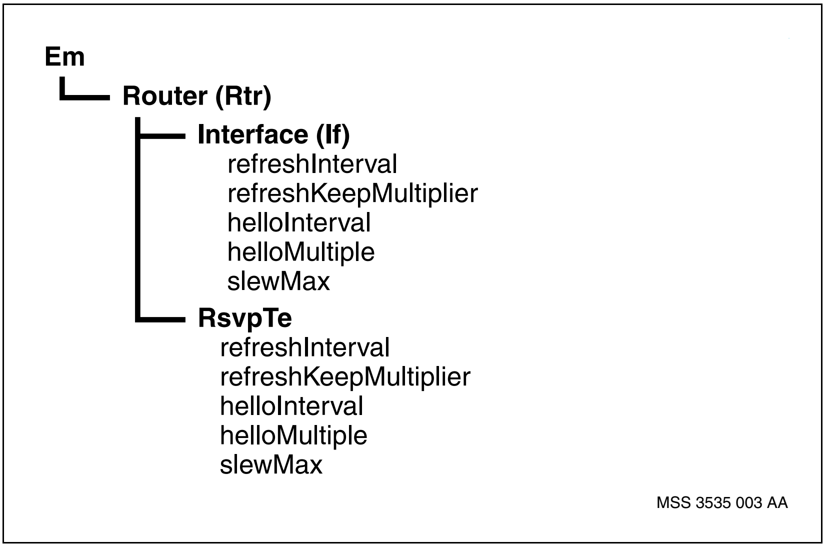
```
set Router/<router_name> Interface/<ip_address>
RsvpTeIf slewMax <slewMax_value>
```

Variable definitions

Variable	Definition
<ip_address>	is the 32-bit address assigned to the interface from which the routing information is derived.
<refreshInterval_value>	is the interval (R), in the range 1 to 1800, between the generation of successive PATH or RESV refresh messages to the downstream and upstream LSRs respectively. The default value is 30 seconds.
<refreshKeepMultiplier_value>	is the value (K), in the range 1 to 50, used to calculate the lifetime of PATH state blocks (PSBs) and RESV state blocks (RSBs) states, avoiding their premature loss. The default value is 3. The lifetime value is based both on the value of K and R.
<helloInterval_value>	is a value that specifies the default interval between hello messages sent by the LSR. The default is 0.5 seconds. A value of disabled indicates the Hello mechanism is not enabled.
<helloMultiple_value>	is a value that specifies the default minimum number of hello intervals that must pass before the RSVP-TE connection is considered to be down. The default is 3.5 seconds.
<slewMax_value>	The limit value, in the range 1 to 200, on how fast the refresh timer (R) can be increased. The ratio of two successive values of R2/R1 must not exceed 1 + SlewMax. The default value is 30%.
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).

Procedure job aid

Figure 7
Modifying the RSVP-TE timers component hierarchy



Configuring the RSVP-TE bandwidth allocator

Optionally, configure the RSVP-TE bandwidth allocator parameters for the *RspvTeIf*.

Prerequisites

- The *RsvpTeIf* component must be added under the Router Interface.

Procedure steps

1 Optionally, set the *mediaCapacity* for the interface depending on the frame size.

```
set router/<router_name> interface/<ip_address>
RsvpTeIF mediaCapacity <mediaCapacity_value>
```

2 Optionally set the *reservableFactor* to reserve some capacity for other traffic running over the interface.

```
set router/<router_name> interface/<ip_address>
RsvpTeIF reservableFactor <reservableFactor_value>
```

3 Optionally, set the *overbookingFactor* to allow over or under reservation of bandwidth for the LSPs.

```
set router/<router_name> interface/<ip_address>
RsvpTeIF overbookingFactor <overbookingFactor_value>
```

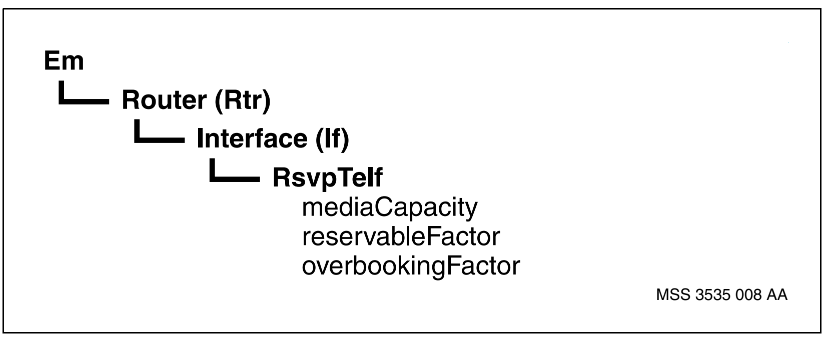
Variable definitions

Variable	Definition
<router_name>	is the name of the router and a mnemonic (for example, RTR1).
<ip_address>	is a 32-bit address assigned to the interface from which the routing information is derived.
<mask>	is a 32-bit identifier for the network mask to be used with the IP address.
(Sheet 1 of 2)	

Variable	Definition
<mediaCapacity_value>	is the capacity in kbits/s of the underlying media link for the interface. Calculate this value: <mediaCapacity_value> = (125000000 Bps x framesize in bytes) / (framesize in bytes + 32) x 8/1000 The default of 860000 kbit/sec is calculated using a frame size of 200 bytes.
<reservableFactor_value>	is a percentage that specifies the media bandwidth available for LSP tunnel reservations over the interface. A value of 0 prevents any bandwidth allocation for LSPs. A value of 100 allows RSVP-TE exclusive use of available bandwidth. An intermediate value allows sharing of bandwidth between RSVP-TE and other applications. The default is 50%.
<overbookingFactor_value>	is a percentage that specifies the reservable bandwidth that can be made available for the RSVP-TE bandwidth pool. 100% results in allocations using the exact signalled bandwidth. A value less than 100% allows under subscription of the link. A value more than 100% allows over subscription of the link. The default is 100%.
(Sheet 2 of 2)	

Procedure job aid

Figure 8
Configuring the RSVP-TE bandwidth allocator component hierarchy



Configuring the Qos for the RSVP-TE signaling messages

Optionally configure the Qos for the RSVP-TE signaling messages exchanged with neighbors.

Prerequisites

- RSVP-TE must be provisioned on the Router.

Procedure steps

1 Add the *DiffServDomain* component under the Router. The subcomponent *MplsMap/0* is automatically added.

```
add Router/<router_name> DiffServDomain/multiservice
```

2 Display the Per Hop Behavior (PHB) for the RSVP-TE control packets. The default is CS6.

```
d Router/<router_name> DiffServDomain/multiservice
phbRoutingSource
```

3 Optionally, set another PHB.

```
set Router/<router_name> DiffServDomain/multiservice
phbRoutingSource <phb>
```

4 Optionally, set the scheduling class for the PHB.

```
set Router/<router_name> DiffServDomain/multiservice
Phb/<phb> trafficClass <trafficClass>
```

5 Optionally, set the discard priority for the PHB.

```
set Router/<router_name> DiffServDomain/multiservice
Phb/<phb> dropPrecedence <dropPrecedence>
```

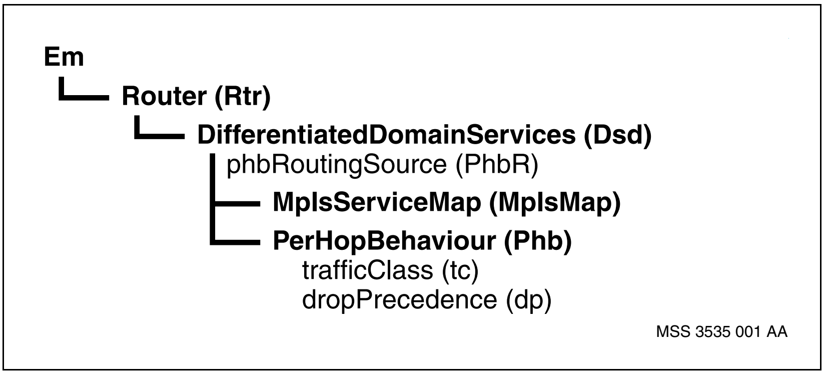
Variable definitions

Value	Definition
<dropPrecedence>	is the setting of the discard priority and is low, medium, or high.
<phb>	is the alphanumeric name of the Per Hop Behavior instance for the router. The default is CS6.
(Sheet 1 of 2)	

Value	Definition
<router_name>	is the router name and is a mnemonic (for example, RTR1).
<trafficClass>	is the name of the traffic class instance of the Router that specifies the desired queuing treatment. The traffic class is one the following: critical, network, premium, platinum, gold, silver, bronze or standard.
(Sheet 2 of 2)	

Procedure job aid

Figure 9
Configuring the Qos for RSVP-TE signaling message component hierarchy



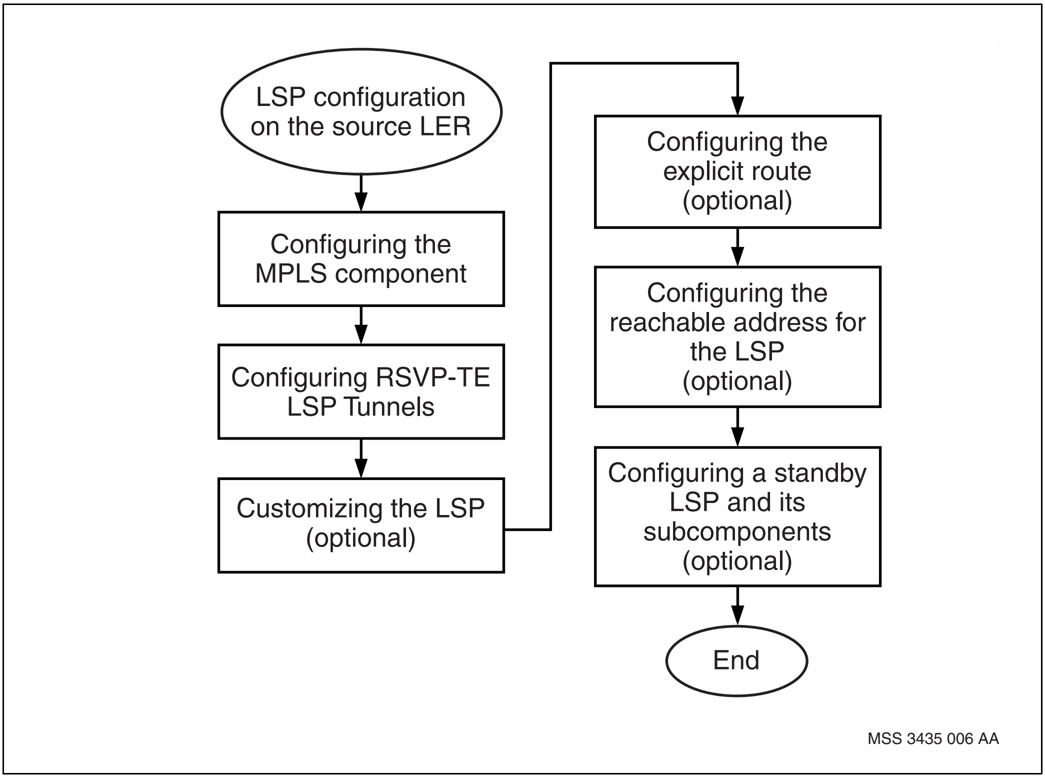
Chapter 4
LSP configuration on the source LER

Configure the label switched path (LSP) on the source LER in an RSVP-TE network.

LSP configuration on the source LER procedures

This task flow shows you the sequence of procedures you perform to configure RSVP-TE interface components in an RSVP-TE network. To link to any procedure, go to "LSP configuration on the source LER procedure navigation" (page 42).

Figure 10
LSP configuration on the source LER task procedures



LSP configuration on the source LER procedure navigation

- "Configuring the MPLS component" (page 43)
- "Configuring RSVP-TE LSP tunnels" (page 44)
- "Customizing an RSVP-TE LSP" (page 45)
- "Configuring the explicit route" (page 47)
- "Configuring a reachable address for the LSP" (page 49)
- "Configuring a standby RSVP-TE LSP and its subcomponents" (page 51)

Configuring the MPLS component

Configure the *MPLS* subcomponent under *Router* component and configure MPLS parameters.

Procedure steps

1 Add the *Mpls* component as a subcomponent of the *Router* component.

```
add Router/<router_name> Mpls
```

2 Optionally, configure the *Mpls* component parameters.

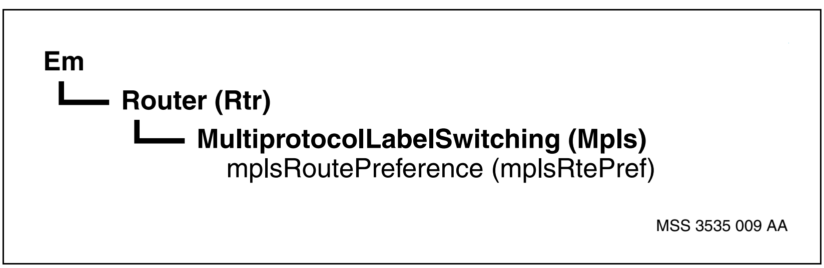
```
set Router/<router_name> Mpls mplsRoutePreference
<route_pref>
```

Variable definitions

Variable	Definition
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).
<route_pref>	is an integral value between 1 and 63. A lesser value specifies a higher preference. The default value of 10 indicates MPLS routes are preferred over IP routing. For more details on selecting route preferences, refer to NN10600-801 *Nortel Networks Multiservice Switch 7400/ 15000/20000 IP Configuration Management*.

Procedure job aid

Figure 11
Configuring the MPLS component hierarchy



Configuring RSVP-TE LSP tunnels

Configure RSVP-TE LSP tunnels to direct incoming IP traffic.

Procedure steps

1 Add an *Lsp* component under the *MPLS* component with a destination address and set it to be a primary LSP.

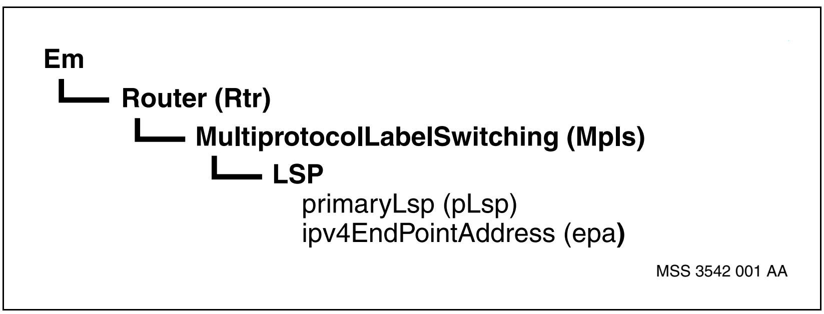
```
add Router/<router_name> Mpls Lsp/<lsp_id> epa
<ip_address>, primayLsp <lsp_id>
```

Variable definitions

Variable	Definition
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).
<lsp_id>	is the identifier assigned to the LSP with a value from 1 - 65535.
<ip_address>	is the 32-bit host address of the destination.

Procedure job aid

Figure 12
Configuring RSVP-TE LSP tunnels component hierarchy



Customizing an RSVP-TE LSP

Customize selected provisionable attributes under the RSVP-TE *Lsp* component. To configure an explicit route, refer to “Configuring the explicit route” (page 47). To configure a standby LSP, refer to “Configuring a standby RSVP-TE LSP and its subcomponents” (page 51).

Procedure steps

1 Optionally, set the bandwidth for the *Lsp* component.

```
set Router/<router_name> Mpls Lsp/<lsp_id> bandwidth
<bandwidth>
```

2 Optionally, set the alarmControl on the LSP to generate an alarm.

```
set Router/<router_name> Mpls Lsp/<lsp_id>
alarmControl <alarm_severity>
```

3 Optionally, disable the installation of the LSP FEC(s) into the IP routing database.

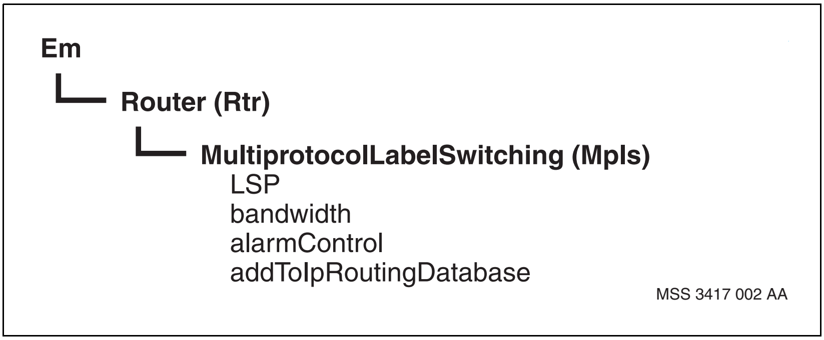
```
set Lsp/<lsp_id> addToIpRoutingDatabase false
```

Variable definitions

Variable	Definition
<alarm_severity>	is the severity value that determines if the *LSP* component will generate alarms when an LSP goes up or down. It also controls the levels that will be generated. The values are none, major, or critical. The default is none.
<bandwidth>	is a value that specifies the bandwidth requirement for an LSP in kbits/s. The value is *clsNoBandwidth*, *nsNoBandwidth*, or a numeric value between 1 and 4294967292. Null service is *nsNoBandwidth* and uses zero bandwidth. Controlled load service is *clsNoBandwidth* and uses zero bandwidth. Standby LSPs can use *sameAsPrimaryLsp* to inherit the bandwidth value from the primary LSP. For inter-operability with third party equipment, use *clsNoBandwidth* when configuring LSPs without bandwidth requirements.
<lsp_id>	is the identifier assigned to the LSP with a value from 1 - 65535.
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).

Procedure job aid

Figure 13
Customizing an RSVP-TE LSP component hierarchy



Configuring the explicit route

Optionally, configure the explicit route by defining the hops within the *Path* component. If you choose to leave the pathname attribute unconfigured, IGP will choose the path on a hop-by-hop basis.

Specify the full path or partial path for each hop. The instance values of the Hop components determine the order of the hops along the LSP path.

Procedure steps

1 Add the explicit route by defining the *path* component.

```
add Router/<router_name> Mpls Path/<path>
```

2 Add a *hop* component under the *path* component.

```
add Router/<router_name> Mpls Path/<path> Hop/<hop>
```

3 Define the hop details.

```
set Router/<router_name> Mpls Path/<path> Hop/<hop>
ipv4Address <hop_address>, ipv4Prefix <hop_prefix>,
mode <hop_mode>
```

4 Optionally, specify each hop along the path. Repeat step 3 and step 4 to specify each hop along the LSP path.

5 Set the LSP to use the explicit path.

```
set Router/<router_name> Mpls Lsp/<lsp_id> pathname
Router/<router_name> Mpls Path/<path>
```

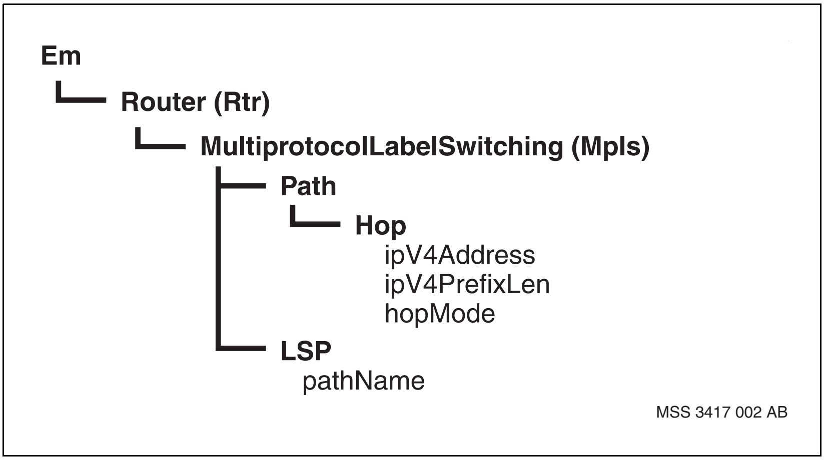
Variable definitions

Variable	Definition
<hop>	The identifier assigned to each hop for a specific path with a value from 1 to 50.
<hop_address>	is the IP address of the specific hop address.
<hop_prefix>	is a value from 8 to 32 that specifies IP prefix length of the interface.
<hope_mode>	is the mode of the path, either strict or loose.
<lsp_id>	is the identifier assigned to the LSP with a value from 1 to 65535.
(Sheet 1 of 2)	

Variable	Definition
<path>	is the identifier assigned to the path with a value from 1 to 10000.
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).
(Sheet 2 of 2)	

Procedure job aid

Figure 14
Configuring the explicit route component hierarchy



Configuring a reachable address for the LSP

Configure a reachable address (RA) for the LSP to act as an additional FEC for the LSP. It is installed in the IP routing database when the LSP establishes. An RA can only be configured when the LSP addToIpRoutingDatabase attribute is set to true (default).

Procedure steps

1 Define an *IpV4ReachableAddress* subcomponent to specify the reachable destination IP address of the LSP. Repeat this step to specify each RA.

```
add Router/<router_name> Mpls Lsp/<lsp_id> RAddr/
<ipv4Address>, <ipv4Prefix>
```

2 Optionally, do not allow the LSP to subsume the better matched IP addresses in the routing database table (only applies if RA is not a 32-bit address).

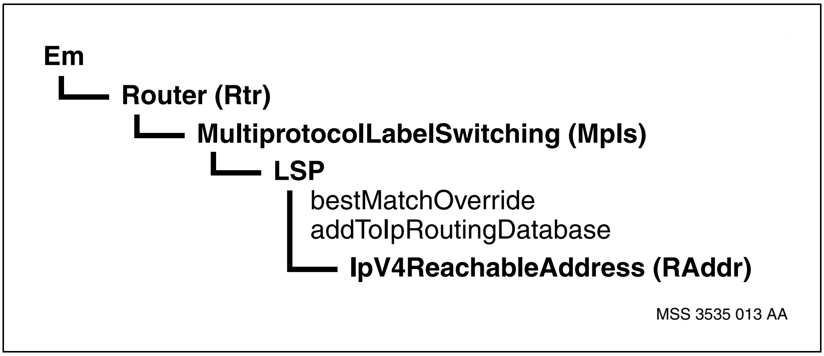
```
set Router/<router_name> Mpls Lsp/<lsp_id>
bestMatchOverride false
```

Variable definitions

Variable	Definition
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).
<ipv4Address>	is the 32-bit host IP address of the destination or a network address.
<ipv4Prefix>	is the prefix length of the IP address specified in the <ipv4Address>.

Procedure job aid

Figure 15
Configuring a reachable address for LSP component hierarchy



Configuring a standby RSVP-TE LSP and its subcomponents

Optionally, configure a hot standby RSVP-TE LSP for an existing primary LSP.

For the standby LSP, only the attributes pathname, bandwidth and alarm control can be customized. All other attributes must be set to sameAsPrimaryLsp and will default to the attribute settings specified for the primary LSP. The exception is ipv4EndPointAddress and it must be set to 0.0.0.0.

Procedure steps

1 Add the standby LSP.

```
add router/<router_name> Mpls Lsp/<lsp_id> primaryLsp
<primaryLsp_id>, addToIpRdb SameAsPLsp,
bestMatchOverride SameAsPLsp
```

2 Link the standby LSP to the primary LSP.

```
set router/<router_name> Lsp/<primaryLsp_id>
standbyLsp <lsp_id>
```

3 Optionally, customize the standby LSP. Refer to “Customizing an RSVP-TE LSP” (page 45).

Variable definitions

Value	Definition
	is a value of 0 to 1000000 the specifies the bandwidth in kbits/s. The default is 0.
<lsp_Id>	is the identifier of the standby LSP with a value from 1 to 65535.
<primaryLsp_id>	is the identifier of the associated primary LSP.

Procedure job aid

Figure 16
Configuring a standby RSVP-TE LSP and its subcomponents component hierarchy

```
Em
└── Router (Rtr)
    └── MultiprotocolLabelSwitching (Mpls)
        └── LSP
              bestMatchOverride
              addToIpRoutingDatabase
              primaryLsp
```

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Chapter 5
MPLS overview

For an overview of multiprotocol label switching (MPLS), see the following sections:

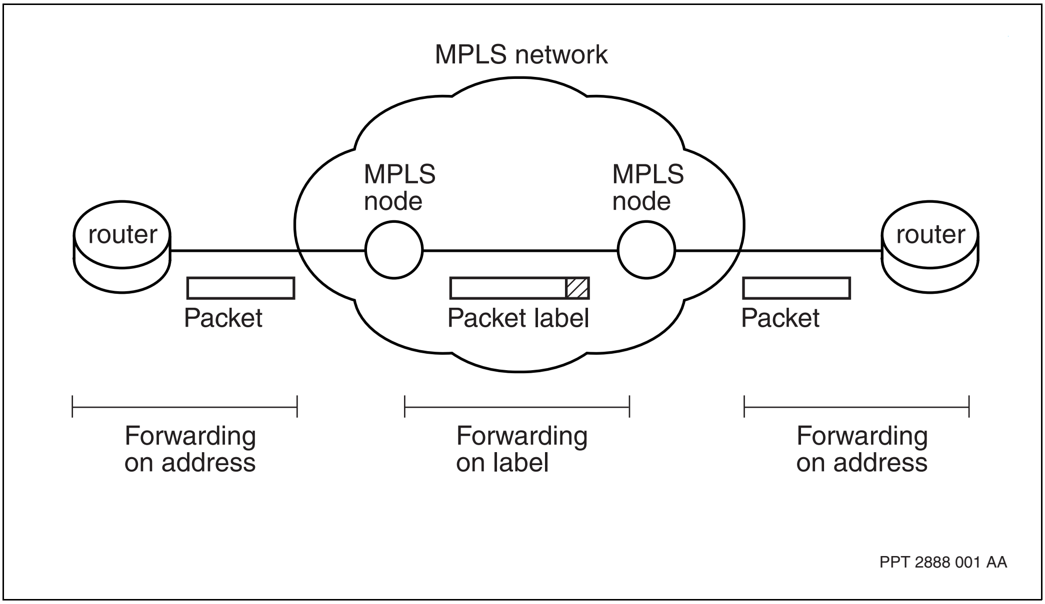
- "What is MPLS technology?" (page 53)
- "How is MPLS implemented in Multiservice Switch networks?" (page 55)
- "Why use MPLS?" (page 55)
- "How does MPLS work?" (page 56)
- "Creation of LSPs" (page 60)
- "LSP recovery" (page 64)
- "Considerations for signaled LSPs" (page 65)
- "Resource reservation protocol for LSP tunnels" (page 65)
- "MPLS on Multiservice Switch nodes" (page 67)
- "Traffic engineering with MPLS" (page 68)

What is MPLS technology?

MPLS is a label-swapping, networking technology that forwards packet traffic over multiple, underlying layer-2 media. This technology integrates layer-2 switching and layer-3 routing by linking the layer-2 infrastructure with layer-3 routing characteristics. Layer-3 routing occurs at the edge of the network, and layer-2 switching takes over in the MPLS network core. See Figure 17, "MPLS technology," (page 54).

Essentially, MPLS forwards a packet by swapping labels at each node in its path. MPLS makes it possible to create new label formats without having to change routing protocols. For example, MPLS traffic can include internet protocol (IP), frame relay, ATM, ethernet, and even optical waveforms.

Figure 17
MPLS technology



In its generic concept, MPLS can swap a frame from any kind of layer-2 link to any other kind of layer-2 link. At this stage in the development of its standards, MPLS supports ATM, frame relay, Ethernet, and point-to-point protocol (PPP). Because traffic flow is independent of the MPLS control protocols, MPLS will be able to support routing protocols that have not yet been defined without any need for the underlying forwarding hardware to change.

With MPLS, layer-3 traffic flows take advantage of the layer-2 traffic engineering abilities and quality of service (QoS) performance, without losing the benefit of existing best-effort, hop-by-hop routing.

MPLS is an emerging standard for network-layer packet forwarding, based on a number of signaling protocols proposed by the Internet Engineering Task Force (IETF). Among these protocols are the label distribution protocol (LDP), the multi-protocol extensions to the border gateway protocol (MP-BGP), and the tunnel extensions for the resource reservation protocol (RSVP-TE). The choice of protocol depends on factors such as the location and role of the node. In some cases, a node uses more than one distribution protocol.

How is MPLS implemented in Multiservice Switch networks?

In Nortel Networks Multiservice Switch networks, MPLS transports IP traffic over GigE allowing carriers and large enterprises to send IP data easily across the backbone. MPLS functionality at the control plane allows carriers to use existing hardware to efficiently transport IP traffic. Multiservice Switch nodes run both an IP routing protocol and the MPLS signaling protocol, RSVP-TE. This protocol allows the nodes to establish label-switched paths. Multiple LSPs, with hot standby LSPs, can be configured to the same destination.

Why use MPLS?

Carrier organizations and large enterprises typically use MPLS in their backbone networks to improve network resource usage. As the key to the future of large-scale IP networks, MPLS provides the following benefits:

- independence of function—In MPLS, the forwarding plane is separated from the routing protocol control plane, so that the MPLS core performs a simple forwarding function completely independent of the packet content. This practice allows policy and routing decisions to be applied only once at the network edge.
- traffic engineering—MPLS channels the operation of IP routing so that traffic can be steered to achieve efficient network resource usage and optimal performance.
- resource control—MPLS allows you to control valuable resources precisely, for example, through the definition of different classes of service.

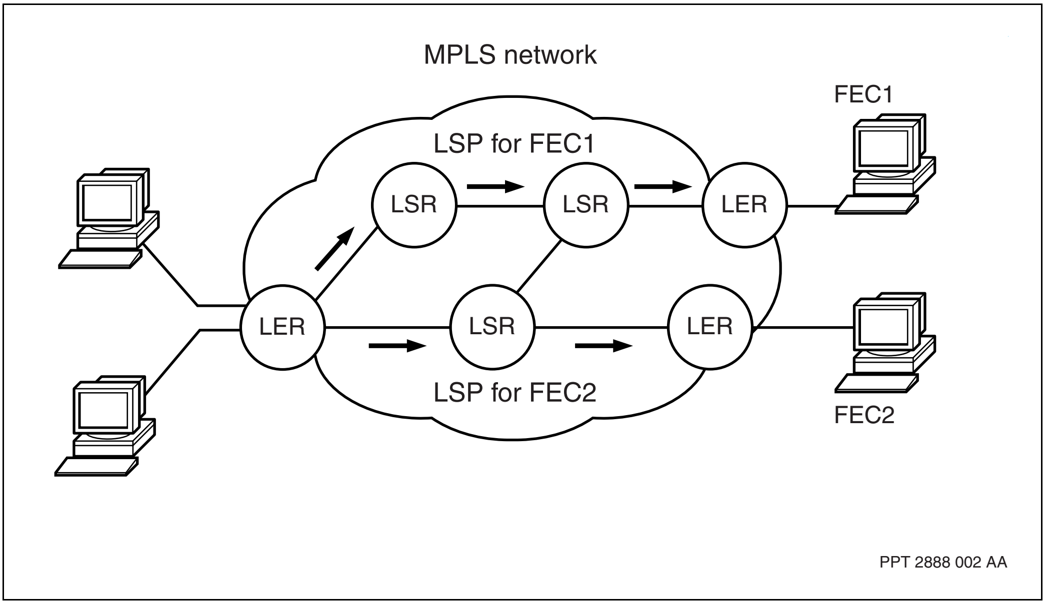
- network evolution—MPLS is developing into a robust network in which a single, unified protocol operates over multiple, underlying layer-2 technologies.

How does MPLS work?

MPLS is a forwarding mechanism that works by applying a label to IP traffic entering the network. The label acts as a shorthand representation of the IP packet header. As the traffic moves through the network, MPLS swaps the label at each node on the route, according to a pre-defined label database at that node. At the egress side of the MPLS network, the packet is decapsulated, and continues under the IP routing protocol.

Figure 18, "MPLS network," (page 57) shows an MPLS network with a number of nodes. The nodes at the edges of the network are label edge routers (LER). The LER nodes provide ingress and egress functions for IP traffic in the MPLS network. The core nodes are label switched routers (LSR). The LSR nodes provide the high-speed switching functions for the network. The path of data between the MPLS nodes is a label switched path (LSP). An LSP is a unidirectional tunnel through the network.

Figure 18
MPLS network



At the edge of the network

When multiservice traffic arrives at an LER, MPLS applies the initial label to the frame. To do this, the LER analyzes the information in the IP packet/frame relay frame/ethernet/ATM cell header, and classifies traffic according to its destination and class of service characteristics. The destination can be as broad as a router identifier, or it can be as specific as a full 32-bit IP host address for a particular interface.

At the LER, MPLS uses the concept of a forwarding equivalence class (FEC) to map incoming traffic to an LSP. Essentially, a FEC defines a group of packets that are forwarded over the same path with the same forwarding treatment. This means that all the packets with the same FEC can be mapped to the same label.

For each FEC, the LER sets up an LSP through the network to the destination defined by the FEC. After the traffic is assigned a FEC, the LER applies a label based on the label information base (LIB). The LIB maps each FEC to an LSP label that defines the next-hop link.

To forward the packet, the LER looks up the FEC in the LIB, and then encapsulates the packet with the LSP label. The LER then sends the packet out on the next-hop interface defined in the LIB.

In the network core

When a labeled packet arrives at an LSR, the LSR extracts the incoming label and uses it as an index into the LIB. When the LSR finds the appropriate LIB entry, it extracts the corresponding outgoing label and swaps it with the incoming label in the packet. The LSR then sends the packet on the outgoing interface to the appropriate next hop specified in the LIB entry.

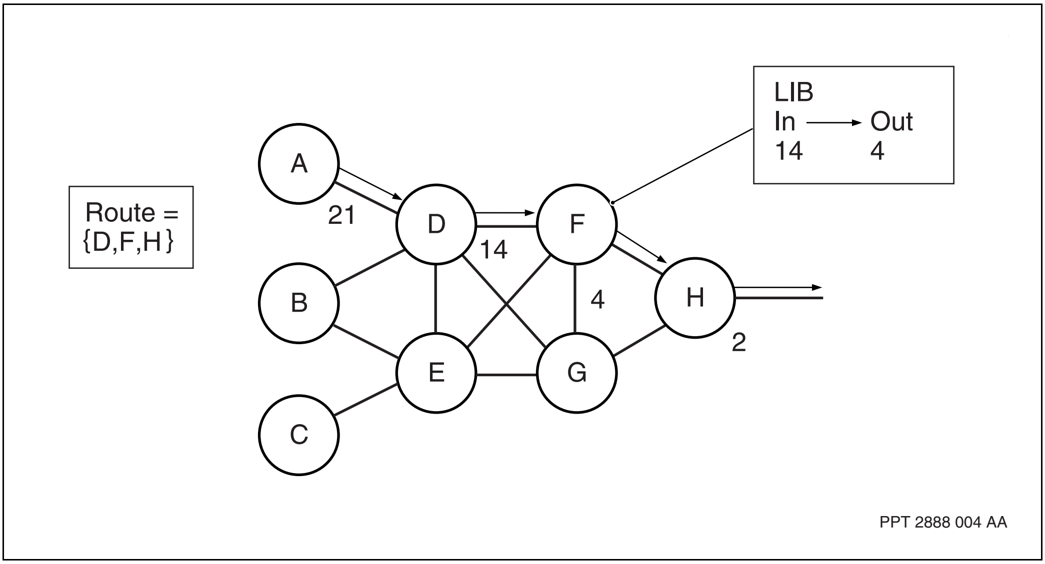
Eventually, the packet reaches the edge of the MPLS network. At that point, an LER removes the encapsulating label, and the packet continues to its destination according to conventional IP/frame relay/ethernet/ATM routing or forwarding methods.

In explicit routes

One of the major advantages of MPLS is its ability to direct traffic flow, for example to avoid congestion or to allow the QoS requirements of the traffic to be met. MPLS allows the network operator at the source node to determine an explicit route LSP (ER-LSP) that defines the path the traffic will take. Multiple ER-LSPs, with different quality of service, can be configured to the same destination.

The ER-LSP builds a path from the source to the destination but it does not have to follow the IP forwarding tree. See Figure 19, “ER-LSP,” (page 59).To build this path, MPLS embeds the explicit route into the label request message.

Figure 19
ER-LSP



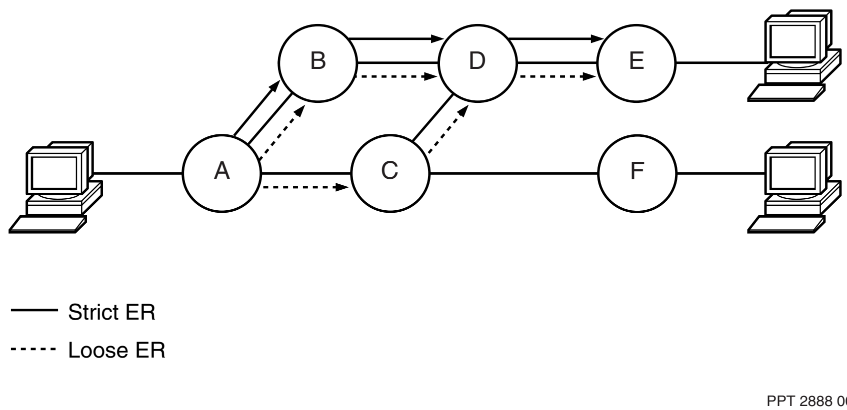
There are two types of ER-LSPs: strict ERs and loose ERs. A strict ER specifies the exact path a packet will take. MPLS at the source node explicitly indicates all the hops along the path between the end points. A loose ER specifies some, but not all, of the hops a packet must traverse on the way to its destination.

Figure 20, "Strict and loose ER LSPs," (page 60) shows the difference between strict and loose ERs. The strict ER in the illustration is specified at LER A as {LSR B, LSR D, LSR E}. In establishing a strict ER, MPLS does not need to check the IP routing tables, since the exact route is defined.

The loose ER in Figure 20, "Strict and loose ER LSPs," (page 60) is specified at LER A as {LSR E}. In the illustration, the complete path can be either {LER A, LSR B, LSR D, LER E} or {LER A, LSR C, LSR D, LER E}. In the loose segment between LER A and LSR E, MPLS checks the IP routing tables during call setup to determine the best next hop to the next specified ER hop in the route.

In Nortel Networks Multiservice Switch MPLS, loose ERs are pinned ERs. This means that, after the route is set up, it does not change unless failure occurs, even if the IP routing tables change.

Figure 20
Strict and loose ER LSPs



Label switched paths (LSPs)

For information about label switched paths (LSPs) see the following sections:

- “Creation of LSPs” (page 60)
- “LSP recovery” (page 64)
- “Considerations for signaled LSPs” (page 65)
- “Resource reservation protocol for LSP tunnels” (page 65)

Creation of LSPs

Before data can transfer over an LSP, the LSP must be set up using RSVP-TE on GigE media. For more information on the RSVP-TE protocol, see “Resource reservation protocol for LSP tunnels” (page 65). For more information on LSP call setup see the following sections:

- “Call setup for RSVP-TE LSPs” (page 61)

- "Call setup for ER-LSPs" (page 63)

> ***Note:*** In the diagrams in this section, the node labelling (A, B, C) represents the actual IP addresses used by the software.

Call setup for RSVP-TE LSPs

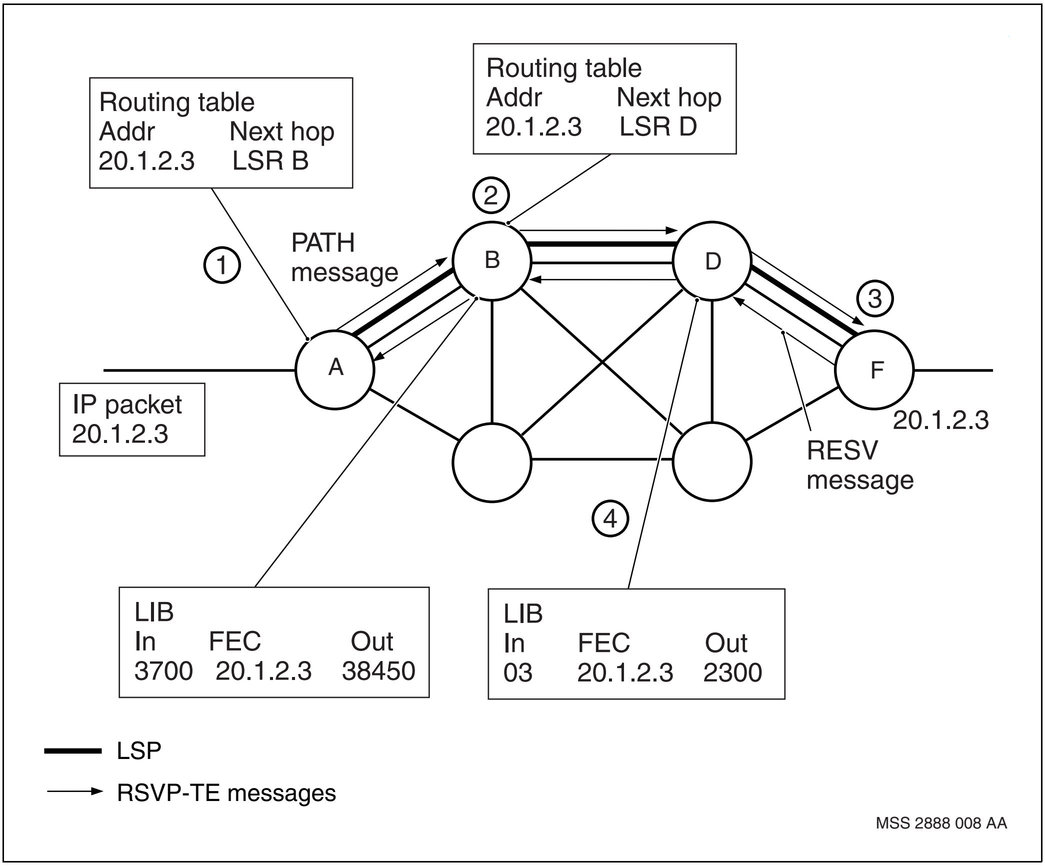
Figure 21, "Call setup for RSVP-TE LSPs," (page 62) shows the hop-by-hop LSP setup process. The diagram shows the downstream-on-demand label advertisement mode and the ordered distribution control mode used in the Nortel Networks Multiservice Switch network.

1. At LER A, MPLS generates a label request message. LER A determines the link to the next hop (LSR B in the example) from the IP routing table, and sends on a label request message to LSR B.
2. At LSR B, MPLS receives the label request. MPLS determines the link to the next hop (LSR D in the example) from the IP routing table, and sends on a label request message. The same process occurs at LSR D.
3. The label request message terminates at the destination LER, node F. MPLS at node F sends a label mapping message back to LSR D. The mapping message contains the label for LSR D to use in sending packets to LER F.

   In the example, MPLS at LER F sends a message to LSR D containing the label 17.

4. MPLS at LSR D receives the mapping message and updates the LIB with the label information for LER F. In the example, MPLS updates the database with 17 as the outgoing label for FEC 20.1.2.3.
5. This process continues until the originating LER receives the mapping message and establishes the LSP.

Figure 21
Call setup for RSVP-TE LSPs



MPLS creates label switched paths (LSPs) by mapping network-layer routing information to data link-layer switched paths. MPLS uses a label distribution protocol to set up, maintain, and tear down LSPs. MPLS routes are not supported by other IP routing protocols, such as OSPF, ISIS, and BGP. LSPs are similar to static routes, and do not get exported; they appear only in the local routing table.

For more information on RSVP-TE, see “Resource reservation protocol for LSP tunnels” (page 65).

Call setup for ER-LSPs

Figure 20, "Strict and loose ER LSPs," (page 60) illustrates the ER-LSP setup process for a strict ER. The process takes the following steps:

1 MPLS at LER A generates a label request message. The message contains an explicit route object that defines the ER path through nodes C and E to LER F.

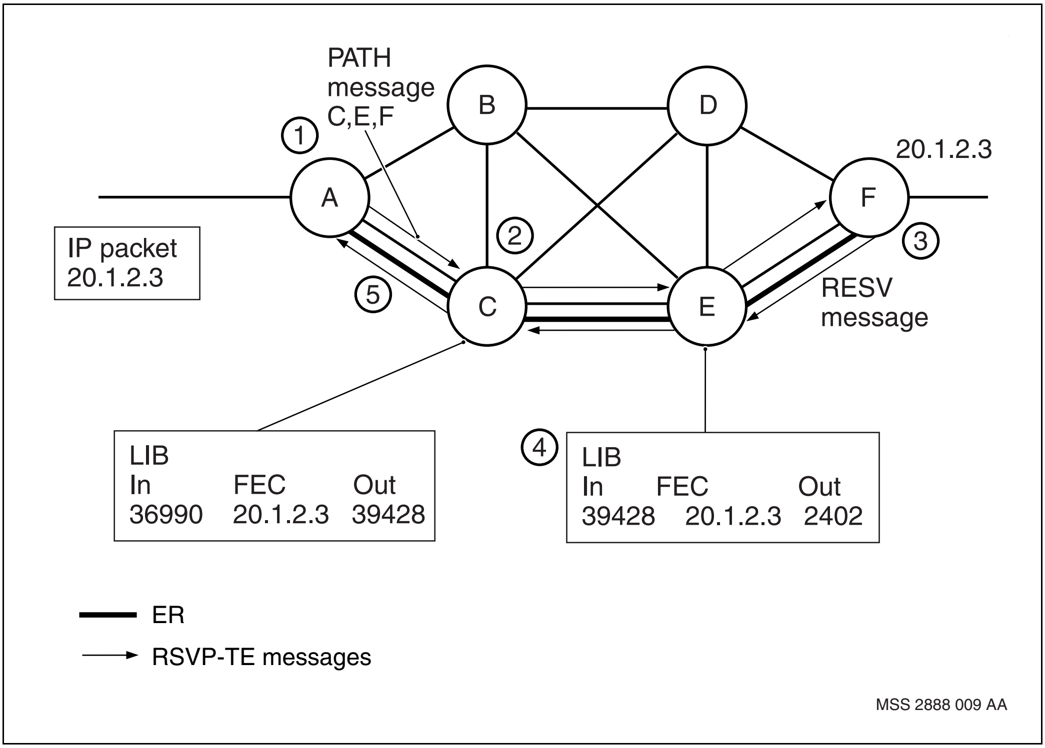
2 At LSR C, MPLS receives the label request message and determines from the ER hop list that the next-hop node is LSR E. Since the route is pre-defined, there is no need to check the IP routing table. MPLS removes LSR C from the path list, and sends the message to LSR E. The process repeats at LSR E.

3 At LER F, the request message terminates. MPLS sends a label mapping message back to LSR E. The mapping message contains the label for node E to use in sending packets to LER F. In the example, the label is 13.

4 LSR E receives the mapping message, and updates the LIB entry for LER F.

5 This process continues until LER A receives the mapping message and establishes the ER.

Figure 22
Call setup for ER-LSPs



Call setup for a loose ER is a combination of the process for a hop-by-hop LSP and the process for a strict ER. The loose ER setup works like the strict ER setup for those segments of the route that have defined end points. In the loose segments, MPLS accesses the IP routing tables to get next-hop information.

LSP recovery

If a failure occurs during LSP setup, the LSR immediately downstream from the failure point releases the LSP to the egress LER. The LSR immediately upstream from the failure point sends a notification message to the ingress LER to tear down the connection.

The ingress LER releases the LSP to the failure point and begins a recovery process. If there is a hot stand-by path configured, the LER shifts the traffic to the stand-by path. Otherwise, the LER attempts to set up a new LSP to the destination. This rerouting attempt is called global repair.

Considerations for signaled LSPs

Signaled LSPs are created through automatic signaling, initiated by the upstream node with downstream nodes assigning MPLS label values. Each node maintains a view of the network topology and uses this view to compute available paths.

Nortel Networks Multiservice Switch nodes support signaled LSPs through RSVP-TE LER functionality on GigE media.

- Load sharing between label switched paths (LSPs) is not supported.
- Setup and holding priority are not supported but are included in the message label request.
- MPLS is considered warm when it comes to supporting Carrier Grade. The addition of MPLS software on a card does not prevent standby behavior in that MPLS packages support hitless software migration (HSM) and equipment protection (EP).

Resource reservation protocol for LSP tunnels

The extensions to Resource ReSerVation Protocol for LSP Tunnels (RSVP-TE) is an MPLS label distribution protocol used for creating LSPs in MPLS networks. Nortel Networks Multiservice Switch nodes provide LER functionality on GigE in an RSVP-TE network for LSP tunnels. LSPs can be used for the implementation of network performance optimization, such as manual routing of LSP tunnels away from network congestion.

All routers in the path of an RSVP-TE signaled LSP must be RSVP-TE capable LSRs, otherwise LSP setup is not possible.

RSVP-TE protocol supports only downstream-on-demand label distribution mode, in which a request to bind labels to an LSP tunnel is initiated by an ingress node through an RSVP PATH message. Subsequently, the labels are allocated downstream and distributed upstream through an RSVP RESV message.

RSVP-TE basic messages

The following is a full list of RSVP-TE signaling messages:

- PATH: message sent downstream (from the source to the destination) to request the setup of the LSP.
- RESV: message sent upstream (from the destination to the source) in response to PATH message, carrying allocated label value.
- PATH_TEAR: message sent downstream to tear down an LSP, reserving both PATH and RESV state.
- RESV_TEAR: message sent upstream to tear down RESV state.
- PATH_ERR: message sent upstream in response to errors when processing a PATH message. PATH_ERR messages can also be originated by a terminating Multiservice Switch LER in local failure that results in LSP connection loss.
- RESV_ERR: message sent downstream in response to errors when processing a RESV message.
- RESV_CONF: message sent by ingress node if requested by egress node in RESV message.

RSVP-TE sessions

An RSVP-TE session may consist of multiple LSP tunnels. The reservation style selected for the session determines if two LSPs share resources. All LSPs that belong to the same session have the same style. The two reservation styles supported by RSVP-TE are:

- Fixed Filter (FF): creates a distinct reservation for traffic from each sender (ingress LSR) that is not shared by other senders.
- Shared Explicit (SE): creates a reservation for traffic from each sender that is shared by the other senders.
    - — Nortel Networks Multiservice Switch systems acting as the source LER will always originate an SE request and will respond to an SE request with an SE reservation.
    - — Multiservice Switch will respond to an FF request with an FF reservation.

Traffic engineering with RSVP-TE

Traffic engineering controls where traffic flows in order to achieve efficient network resource utilization and network performance optimization. RSVP-TE implements Global Repair, which allows an LSP to retry the setup via an alternative route (if loosely routed) if the LSP goes down. The retry is attempted until a new route becomes available or the original one recovers. Nortel Networks Multiservice Switch systems also support other robustness mechanisms, such as hot standby LSP.

Record Route Object (RRO) capability

The route the LSP takes when the tunnel is established is recorded by the RRO, which is represented by *Rtr RsvpTe Tunnel pathRro* and *resvRro* attributes. This service is enabled if RRO is included in the message received from the downstream or upstream node. Multiservice Switch always includes RRO when originating LSPs.

Explicit route (ER)

RSVP-TE supports both the strict and loose types of Explicitly Routed Label Switched Paths (ER-LSPs). These ER-LSPs are supported as point-to-point only. The ER information is carried in a PATH message within the EXPLICIT_ROUTE object (ERO). Each ERO subobject defines one hop in the ER, using an IPv4 address prefix, a router identifier (as an IPv4 loopback address), or a combination of both, and specifies whether the ER is strict or loose.

Service class to Quality of Service mapping

RSVP-TE uses IntServ parameters to map Quality of Service. There are two Intserv service classes supported by RSVP-TE on a Multiservice Switch: Controlled-Load Service (CLS) and Null Service Type.

Loop detection

Loop detection functionality is supported by RSVP-TE. Loop detection starts when an RRO object is included in the PATH message. In Nortel Networks Multiservice Switch systems, the RRO object is always included in the PATH message.

MPLS on Multiservice Switch nodes

Nortel Networks Multiservice Switch nodes have LER functionality on GigE media and can originate and terminate both ER-LSPs and hop-by-hop LSPs.

MPLS using GigE media

The supporting layer-2 medium for Nortel Networks Multiservice Switch systems as an LER is GigE.

Traffic engineering with MPLS

With the growth of the Internet, carriers need a network infrastructure that is dependable and offers consistent, predictable network performance. The traffic engineering capabilities of MPLS provide a solution for this situation. The cornerstone of the MPLS solution is the ER-LSP, which the network operator can manipulate to control the transport of IP traffic.

For more information, see the following:

• “MPLS QoS” (page 68)

MPLS QoS

The ER-LSP can be used to map traffic flows onto the network, independently of the layer-3 topology, so that each application receives the QoS it needs. MPLS allows the network operator to configure multiple LSPs to the same FEC destination. Each primary LSP can have up to seven hot standby LSPs.

Figure 23, “MPLS traffic engineering,” (page 69) shows a simple example of MPLS traffic engineering. In the example, a video server is configured at LER A on the ingress side, and a video client is configured at LER F on the egress side. Regular IP traffic runs from LER A to LER F, following a best-effort, shortest path. If the video stream is introduced on this path, the path becomes congested, and the QoS will degrade. With MPLS, the network operator can configure an ER-LSP through LSR B and LSR D. The ER-LSP forces the video traffic to follow the longer route, but maintains the QoS.

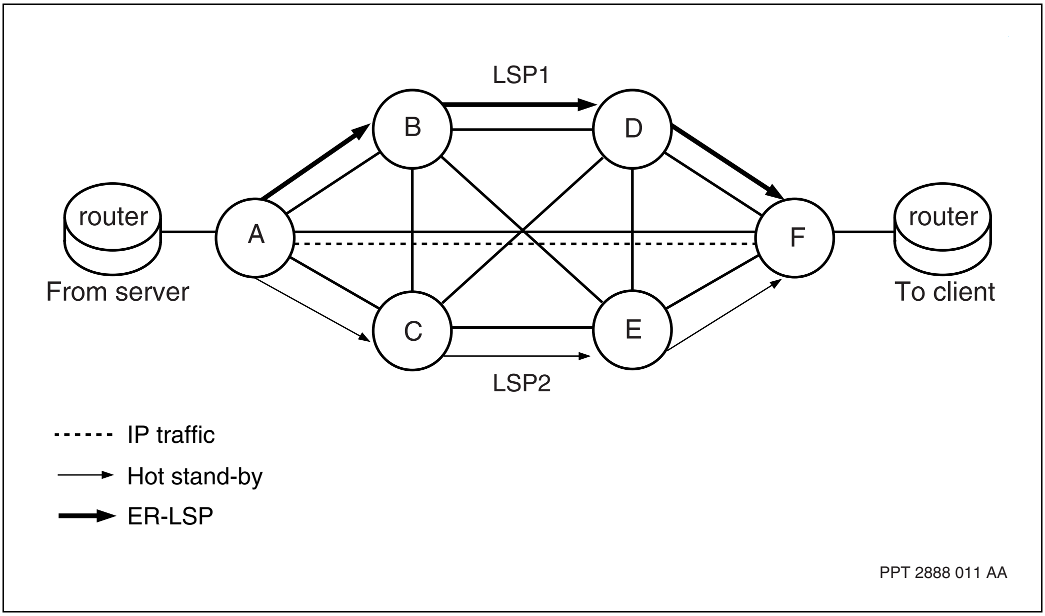
To guarantee the service in case of link failures, the network operator can configure a maximum of seven standby LSPs per primary LSP. A standby LSP is an LSP that can take over the traffic carried by the primary LSP, or another standby LSP, if that LSP should fail. The standby LSP can have different attributes from its primary LSP, including bandwidth requirement and path. To maximize the degree of redundancy, it is recommended that the standby LSP take a different explicit route than the primary LSP at every hop.

Standby LSPs can be ordered under their primary LSP by the network operator. The ordering determines the preference for a standby LSP to take over the traffic when a primary LSP fails. In order to provide fast switchover capability, a standby LSP is kept in the established state, and occupies bandwidth along the standby LSP path.

Since the primary LSP is intended to be the preferred LSP for use, the traffic is changed from a standby LSP to the primary LSP whenever the primary LSP is recovered. The traffic is not changed among standby LSPs unless the standby LSP that carried traffic fails.

LSP2 represents a standby LSP path from LER A through LSR C and LSR E to LER F. If a link fails on LSP1, the traffic changes to LSP2, the first standby in the primary LSP's standby list.

Figure 23
MPLS traffic engineering



Chapter 6
Monitoring and troubleshooting RSVP-TE

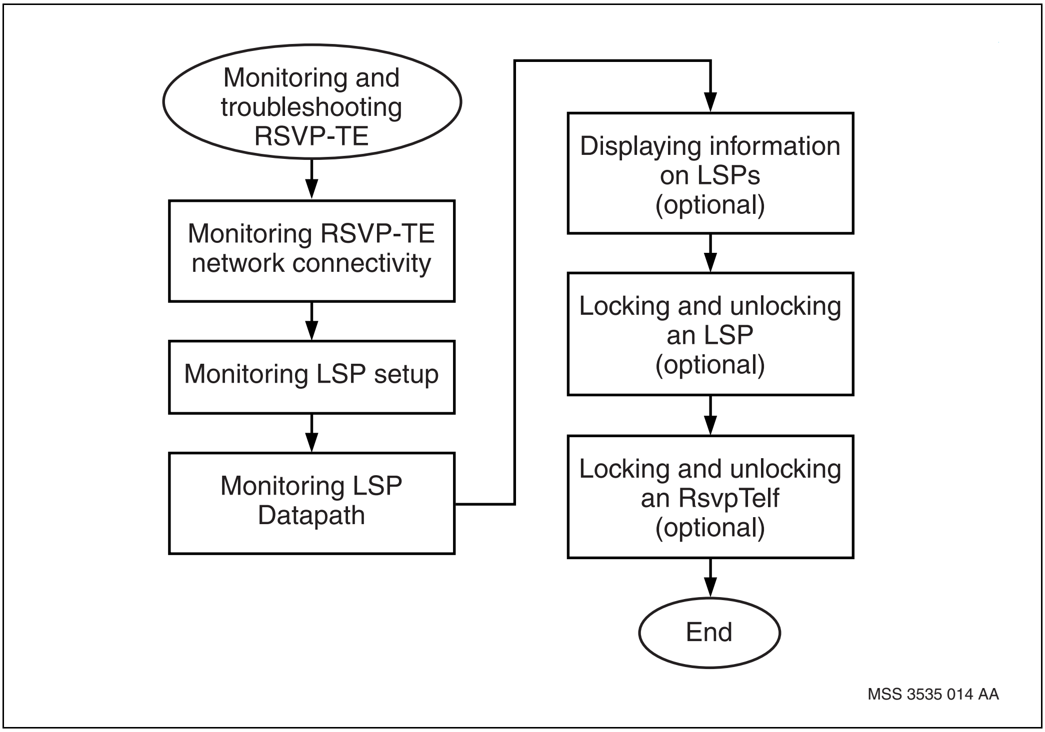
Monitor and troubleshoot RSVP-TE to determine the source of errors, isolate problems, and maintain operating efficiency.

For general information about maintenance procedures, see NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*.

Monitoring and troubleshooting RSVP-TE LSPs procedures

This task flow shows you the sequence of procedures you perform to monitor and troubleshoot RSVP-TE. To link to any procedure, go to “Monitoring and troubleshooting RSVP-TE LSPs procedure navigation” (page 72).

Figure 24
Monitoring and troubleshooting RSVP-TE procedures



Monitoring and troubleshooting RSVP-TE LSPs procedure navigation

- "Monitoring RSVP-TE network connectivity" (page 73)
- "Monitoring LSP setup" (page 76)
- "Monitoring LSP datapath" (page 79)
- "Displaying information on LSPs" (page 82)
- "Locking and unlocking an LSP" (page 84)
- "Locking and unlocking an RsvpTeIf" (page 85)

Monitoring RSVP-TE network connectivity

Monitor network connectivity to determine if a node has RSVP-TE connectivity to its immediate neighbors. To successfully setup LSPs, RSVP-TE requires all nodes along the LSP route to be RSVP-TE capable with adjacent interfaces configured for RSVP-TE.

Procedure steps

1 List all the RSVP-TE neighbors to the node to determine if the node has RSVP-TE connectivity through its interfaces.

```
l Router/<router_name> RsvpTe Nbr/*
```

2 If there is no neighbor listed for a particular interface, display the local *RsvpTeIf* status to determine if the local *RsvpTeIf* status is enabled.

```
d Router/<router_name> If/<local_ip_address> RsvpTeIf
```

3 If the *RsvpTeIf* OSI *adminState* is locked, unlock it operationally or provisionally as required. Refer to “Locking and unlocking an LSP” (page 84)

4 If *RsvpTeIf* OSI state is unlocked, enabled and active and the *HelloState* is down, display the control statistics under the associated *IfStats* component. The *rsvpDiscards* and *lastRsvpDiscardinfo* attributes indicate if RSVP-TE message are being discarded by the interface and indicate the type of messages being discarded. If *RsvpTeIf HelloState* is disabled, enable it. Refer to “LER configuration in an RSVP-TE network” (page 27)

```
d Router/<router_name> rsvp ifStats/<local_ip_address>
```

5 If the statistics indicate the RSVP-TE message is being discarded on receipt or there is no receipt or discards of the message, repeat step 1 to step 4 for the adjacent neighbor.

6 If the *RsvpTeIf* OSI *operationalState* is disabled, display the *interface* to determine if the *Interface* component is down. If the parent *Interface* is down, refer to NN10600-801 *Nortel Networks Multiservice Switch 7400/15000/20000 IP Configuration Management*.

```
d Router/<router_name> If/<local_ip_address>
```

7 If the *interface* is enabled, display the OSPF neighbor to check the IP routing connectivity. The local *RsvpTeIf* needs knowledge of the IP address of its adjacent remote interface to be fully enabled. If there is no OSPF neighbor, or the status is not full, then there is no IP routing connectivity. For more information on IP routing connectivity to the neighbor, refer to NN10600-801 *Nortel Networks Multiservice Switch 7400/15000/20000 IP Configuration Management*.

```
d Router/<router_name> Ospf Nbr/<remote_ip_address>
```

8 If the *Interface* OSI *operationalState* is disabled, display the underlying *LanApplication* component status.

```
d La/<la_name>
```

9 Display the GigE port linked to the Logical Processor (Lp) to determine if the ethernet is configured on the Lp. If the ethernet is not enabled, check the physical link connectivity and LP status.

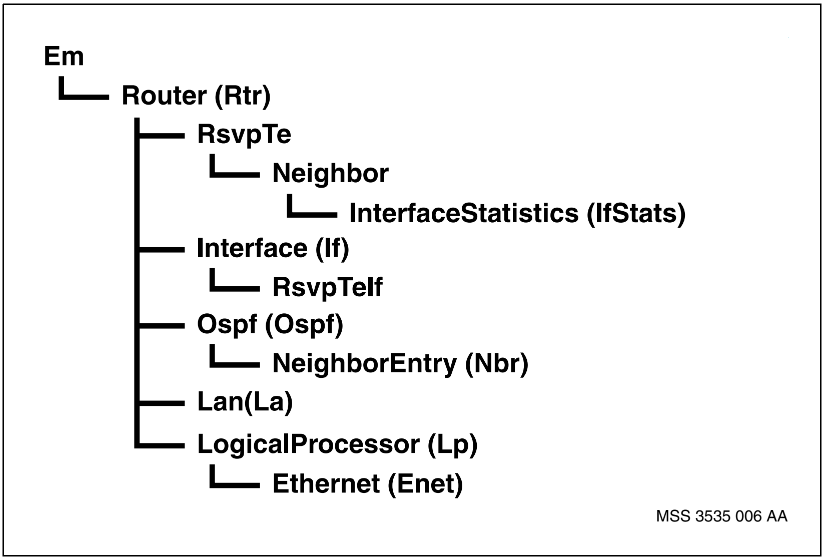
```
d Lp/<lp_id> Eth/<ether_port>
```

Variable definitions

Variable	Definition
<router_name>	is the name of the router and is a mnemonic (for example, RTR1).
<local_ip_address>	is the unmasked address assigned to the local interface.
<remote_ip_address>	is the unmasked address assigned to the remote neighbor's interface.
<ether_port>	is a numeric identifier from 0 to 7 for the ethernet port.
<la_name>	is a identifier assigned to the *LanApplication* component.
<lp_id>	is a numeric identifier assigned to the GigE Lp.

Procedure job aid

Figure 25
Monitoring RSVP-TE network connectivity component hierarchy



Monitoring LSP setup

Monitor label switched path (LSP) setup to confirm establishment or determine point of failure.

To successfully setup LSPs, RSVP-TE requires that all interfaces along the route of the LSP be RSVP-TE capable. In the case of a strictly routed hop, the specified interface must be RSVP-TE capable. If there is no strict route configured for a particular hop, the interface associated with the Interior Gateway Protocol (IGP)-preferred next hop for the LSP, based on the next loose hop or end-point address, must be configured for RSVP-TE.

For more information, refer to “Identifying LSP failures at the source” (page 87) and “RSVP-TE Signaling Statistics” (page 92).

Procedure steps

1 Display the *LSP* component on the source LSR to confirm that the LSP is established.

```
d Router/<router_name> Mpls Lsp/<lsp_id> status
```

2 If the status is not established, display the *lastTearDownReason* to determine the cause of the failure. Refer to Table 1, “LSP failure reasons,” (page 87) for an explanation of LSP failure reasons.

```
d Router/<router_name> Mpls Lsp/<lsp_id> tearDown
```

3 For routing related errors, display the forwarding entry for the gateway of the next hop in the LSP route, using the configured hop or end point address. The local Router interface corresponding to the gateway must be configured with an *RsvpTeIf* subcomponent. Refer to “Configuring the RSVP-TE interface on GigE media” (page 32) for more information about configuring *RsvpTeIf* under an interface.

```
d Router/<router_name> Fwd/*
```

4 Display RSVP-TE protocol message exchange statistics for the *Rtr RsvpTe* component. This action identifies the interface associated with the most recent error or discard and displays the statistics reflecting the exchange of other protocol messages, such as PATH, RESV, and hello across the shelf.

```
d Router/<router_name> RsvpTe statistics
```

5 Display RSVP-TE protocol message exchange statistics for an individual *RsvpTeIf* interface. The response displays the RSVP error or discard statistics if an *RsvpTeIf* exists for the interface.

```
d Router/<router_name> RsvpTe IfStatistics/
<local_ip_address>
```

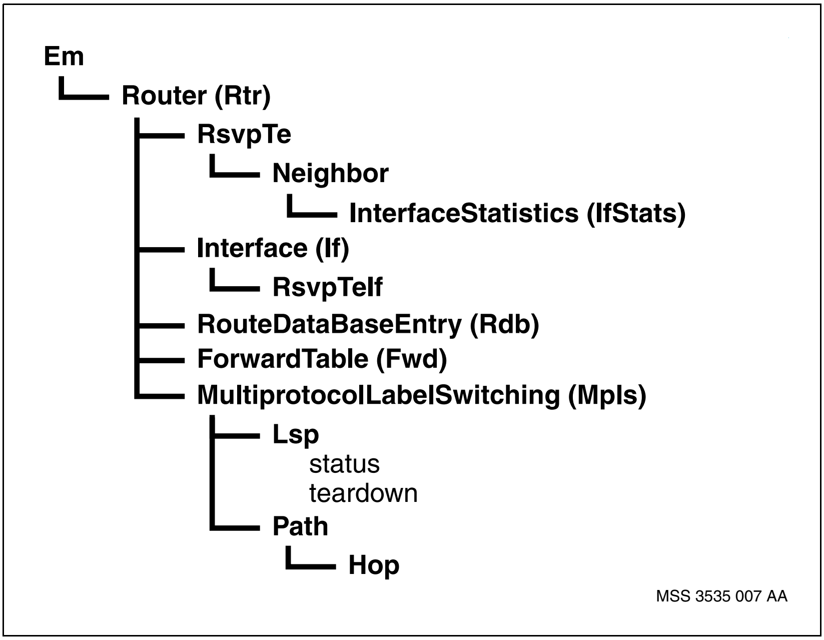
6 If there is an *RsvpTeIf* interface, the PATH or RESV code and value in the RSVP-TE protocol message exchange statistics provide information on the error. Refer to "MPLS RSVP-TE PATH error codes and values" (page 94) and "MPLS RSVP-TE RESV error codes and values" (page 99). It may be necessary to check other nodes along the route to find the point of failure.

Variable definitions

Variable	Definition
<local_ip_address>	is the unmasked address assigned to the local interface.
<lsp_id>	is the identifier assigned to the LSP with a value from 1 - 65535.
<router_name>	is any mnemonic (for example, RTR1).

Procedure job aid

Figure 26
Monitoring LSP setup component hierarchy



Monitoring LSP datapath

Monitor the LSP datapath to determine if the *RsvpTeIf* is transmitting and receiving frames over the LSP, as appropriate. On a source node, the *RsvpTeIf* transmits frames. On a tandem node, the ingress *RsvpTeIf* receives frames and the egress *RsvpTeIf* transmits frames. On a destination node, the *RsvpTeIf* receives frames.

For more information, refer to "Transport Statistics" (page 103).

Procedure steps

1 Display the *LSP* component on the source LSR to confirm that the LSP is established. If is not established, refer to "Monitoring LSP setup" (page 76)

```
d Router/<router_name> Mpls Lsp/<lsp_id>
```

2 Display the operational *Rtr RsvpTe Tunnel* component data associated with the LSP.

```
d Router/<router_name> Mpls Lsp/<lsp_id>
tunnelComponentName
```

3 Display LSP tunnel data for any node along the LSP route. The *incomingInterface* and *outgoingInterface* attributes of the *Tunnel* component identify the *Rtr If* component addresses that support the RsvpTeIf for the ingress and egress LSP connections on the node.

```
d Router/<router_name> RsvpTe Tunnel/
<src_ler_addr>,<dest_ler_addr>,<lsp_id>,<lsp_index>
```

4 Optionally, use the ping from the source LER (or a previous hop) to send packets over the LSP.

```
ping -cont -p(<fec>) Router/<router_name> icmp
```

5 Display the send and receive statistics for an *RsvpTeIf* interface to determine if the egress interface is transmitting and the ingress interface is receiving an equal number of frames. The ingress *RsvpTeIf* interface shows increasing Frames and Octets, the egress RsvpTeIf interface shows the same number of outFrames and outOctets.

```
d Router/<router_name> If/<local_ip_address> RsvpTeIf
```

6 If the *RsvpTeIf* interfaces are not transmitting and receiving an equal number of frames, display the *Rtr If* components to view the frame discards statistics.

```
d Router/<router_name> If/<local_ip_address>
```

7 If the *RsvpTeIf* interfaces are not transmitting and receiving an equal number of frames and the *If* statistics do not indicate IP discards, display the *LanApplication Framer* component to view the frame discards statistics.

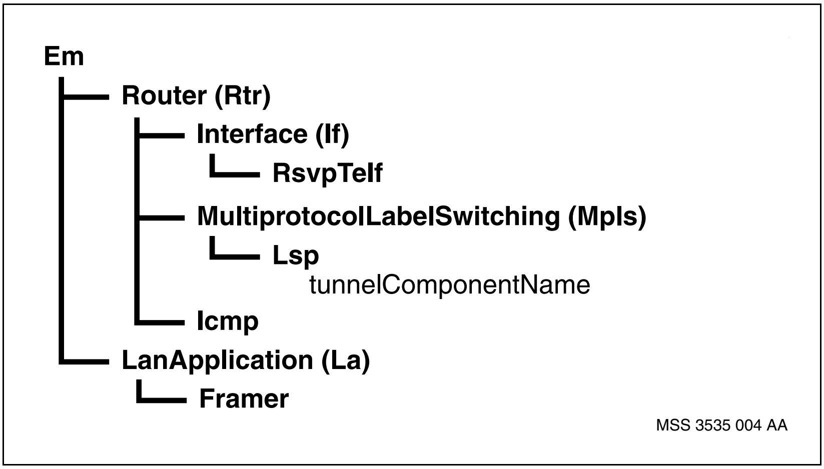
```
d La/<la_name> Framer
```

Variable definitions

Variable	Definition
<dest_ler_addr>	is the IP address of destination LER (the EPA).
<fec>	is the IPv4 end point address or the reachable address for the LSP.
<lsp_id>	is the identifier assigned to the provisioned LSP with a value from 1 - 6553.
<la_name>	is the identifier assigned to the *LanApplication* component.
<lsp_index>	is the LSP index number and is internally assigned. It does not correspond to any other visible component.
<router_name>	is the name of the router and a mnemonic (for example, RTR1).
<src_ler_addr>	is the IP address of source LER.

Procedure job aid

Figure 27
Monitoring LSP datapath component hierarchy



Displaying information on LSPs

To view information on LSPs, display the operational information on LSP component instances and the related operational components.

Procedure steps

1. View operational information on an *Lsp* component at the source LER, including the tunnel instance.

   d Router/<router_name> Mpls Lsp/<lsp_id>

2. View the signaled data for the LSP by displaying the associated *Rtr RsvpTe Tunnel* component. Issue this command at any multiservice switch along the LSP route.

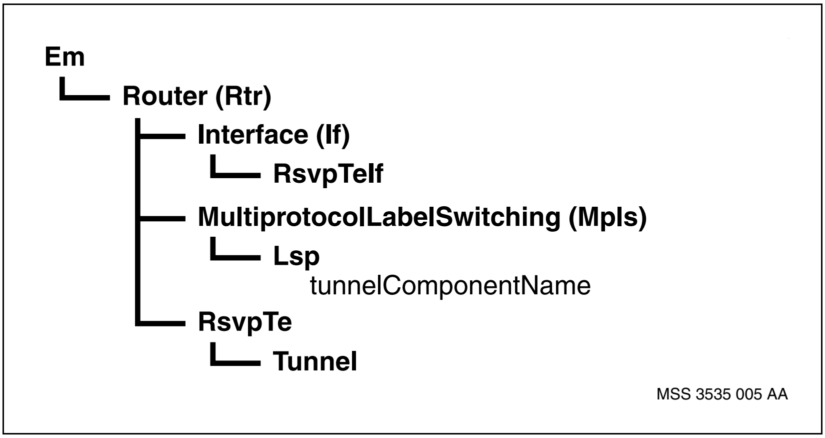
   d Router/<router_name> RsvpTe Tunnel/<src_ler_addr>, <dest_ler_addr>, <lsp_id>, <lsp_index>

Variable definitions

Variable	Definition
<dest_ler_addr>	is the IP address assigned to the destination LER .
<lsp_id>	is the identifier assigned to the LSP with a value from 1 - 65535.
<src_ler_addr>	is the IP address assigned to the source LER .
<lsp_index>	is the LSP index number and is internally assigned. It does not correspond to any other visible component.
<router_name>	is the name of the router and a mnemonic (for example, RTR1).

Procedure job aid

Figure 28
Displaying information on LSPs component hierarchy



Locking and unlocking an LSP

Lock and unlock an LSP to affect any *Hop* component changes in the *Router Mpls Path* component specified by the *Lsp pathName*. An Lsp can also be locked to switch to a hot standby Lsp or revert to an IP datapath.

Procedure steps

1 Lock a signaled *Lsp* component instance.

```
lock Router/<router_name> Mpls Lsp/<lsp_id>
```

2 Unlock a signaled *Lsp* component instance.

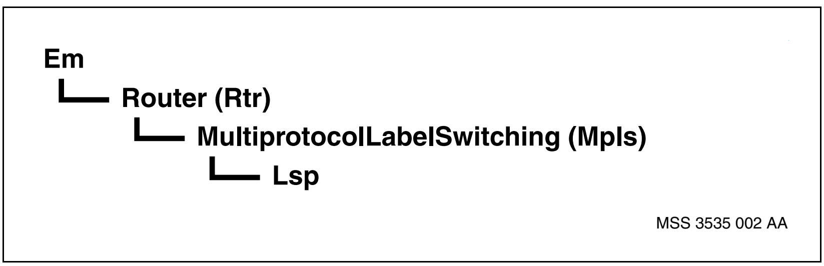
```
unlock Router/<router_name Mpls Lsp/<lsp_id>
```

Variable Definitions

<router_name>	is the name of the router and a mnemonic (for example, RTR1).
<lsp_id>	is the identifier assigned to the LSP with a value from 1 - 65535.

Procedure job aid

Figure 29
Locking and unlocking an LSP component hierarchy



Locking and unlocking an RsvpTeIf

An RsvpTeIf can be locked operationally or provisionally to keep it disabled over resets or switchovers. Locking and unlocking an RsvpTeIf forces an LSP to use the new MTU value. LSP connections are based on the current media Maximum Transfer Unit (MTU) when the connection is created. Changes to the media MTU after the connection is created are not reflected in the previously established LSPs. To force the LSP to use the new MTU value, disable then enable the *RsvpTeIF* component. Disabling the *RsvpTeIF* component automatically clears all LSPs under the interface.

Procedure steps

1 Operationally lock the *RsvpTeIf* to disable the *RsvpTeIf* component.

```
lock Router/<router_name> Interface/<ip_address>
RsvpTeIf
```

2 Operationally unlock the *RsvpTeIf* to enable the *RsvpTeIf* component.

```
unlock Router/<router_name> Interface/<ip_address>
RsvpTeIf
```

3 Provisionally lock the *RsvpTeIf* to stay down over resets and switchovers.

```
set Router/<router_name> Interface/<ip_address>
RsvpTeIf adminStatus disabled
```

4 Provisionally unlock the *RsvpTeIf* to revert back to the default status of enabled.

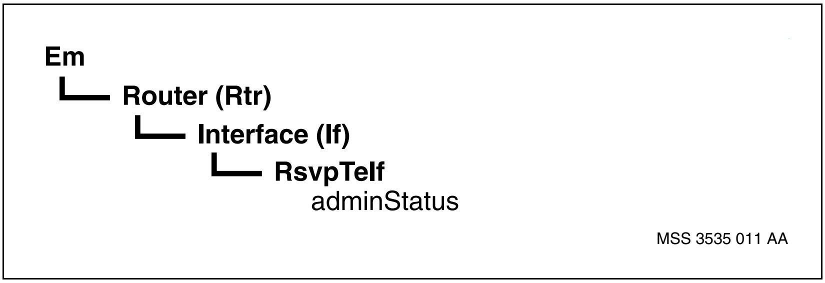
```
set Router/<router_name> Interface/<ip_address>
RsvpTeIf adminStatus enabled
```

Variable definitions

Variable	Definition
<router_name>	is the name of the router and a mnemonic (for example, RTR1).
<ip_address>	32-bit address assigned to the interface.

Procedure job aid

Figure 30
Locking and unlocking an RsvpTeIf component hierarchy



Supporting information

This section contains supporting information on:

- "Identifying LSP failures at the source" (page 87)
- "RSVP-TE LSP path tracing" (page 91)
- "RSVP-TE Signaling Statistics" (page 92)
- "Transport Statistics" (page 103)

Identifying LSP failures at the source

If the *operStatus* attribute indicates that the LSP is *idle*, the administrator can refer to the *lastTearDownReason* attribute for information on why the LSP has not been established.

Table 1, "LSP failure reasons," (page 87) lists the lastTearDownReason attribute values and their meaning. For more information about the error codes associated with the attribute values, refer to "MPLS RSVP-TE PATH error codes and values" (page 94).

Table 1
LSP failure reasons

Lsp failure Reasons (lastTearDownReason)	Meaning	Action
rsvpRoutingProblem	There is no outgoing *RsvpTeif* for the LSP's next hop.	If the *Rtr Mpls Lsp pathName* is set, check the *Hop* components for the specified *Rtr Mpls Path* (particularly the first *Hop*).
rsvpLocked	The *Rtr Mpls Lsp adminState* is locked.	Issue command *unlock Rtr Mpls Lsp* or provisionally set the *operationalState* to enabled.
(Sheet 1 of 4)		

Table 1 (continued)
LSP failure reasons

Lsp failure Reasons (lastTearDownReason)	Meaning	Action
rsvpPathSetupTimeout	The PATH message was successfully sent to the next hop, but a label mapping message was not received within the tolerated setup time interval, and no error message is received to report the failure from downstream.	The PATH message was likely discarded along the route of the LSP by a non-RSVP node. Check the downstream nodes for RSVP-TE configuration and protocol messaging statistics.
rsvpLostPeer	The outgoing *RsvpTeIf* has gone down during or following LSP establishment	Check the outgoing *RsvpTeIf* status.
rsvpLostLabel	A RESV refresh timeout has occurred following LSP establishment.	Check immediate next hop LSR for cause of failure, verifying RSVP-TE configuration and protocol messaging statistics.
rsvpResourceUnavailable	Internal resource exhaustion on the origination of the LER.	Check the *Lp* CPU and memory
rsvpSystemError	Local internal processing or database error.	Check local alarms for failures.
rsvpAdminCtrl	There is insufficient bandwidth to satisfy the LSP requirement.	Check the bandwidth availability indicated by the outgoing *RsvpTeIf availBw* attribute and decrease the *Lsp* bandwidth accordingly, or decrease or remove the other *Lsp* component to free bandwidth or set the *RsvpTeIf* overbookingFactor higher to allow overbooking. Alternatively, if the *RsvpTeIf reservableFactor* is not set to 100%, increase it as necessary.
rsvpRcvResvTear	A RESV tear is received from downstream following LSP establishment.	Check downstream (likely terminating) LSR for failure that would result in label withdraw.
(Sheet 2 of 4)		

Table 1 (continued)
LSP failure reasons

Lsp failure Reasons (lastTearDownReason)	Meaning	Action
rsvpRcvUnsupportedStyle	An invalid style received from downstream following LSP establishment.	Check downstream LSR for reason for protocol failure. Reasons such as incorrectly configured for RSVP-TE. For example, configured for classical RSVP rather then RSPV-TE.
rsvpRcvConflictingStyle	A RESV refresh message is received with a different RESV style from that initially received.	Check downstream (likely terminating) LSR for failure that would result in protocol failure.
rsvpRcvErrNotify	A PATH notification error is received from downstream.	Check the *Rtr RsvpTe IfStats lastPathErrorInfo* attribute for details using the outgoing *Rtr If* address. Next, check the downstream LSRs for point of failure.
rsvpRcvErrRsvpSystem	A PATH system error is received from downstream.	Check the *Rtr RsvpTe IfStats lastPathErrorInfo* attribute for details using the outgoing *Rtr If* address. Next, check the downstream LSRs for point of failure.
rsvpRcvErrTrafficCtrl	A PATH traffic control error is received from downstream.	Check the *Rtr RsvpTe IfStats lastPathErrorInfo* attribute for details using the outgoing *Rtr If* address. Next, check the downstream LSRs for point of failure.
rsvpRcvErrTrafficCtrlSys	A PATH traffic control system error is received from downstream.	Check the *Rtr RsvpTe IfStats lastPathErrorInfo* attribute for details using the outgoing *Rtr If* address. Next, check the downstream LSRs for point of failure.
(Sheet 3 of 4)		

Table 1 (continued)
LSP failure reasons

Lsp failure Reasons (lastTearDownReason)	Meaning	Action
rsvpRcvErrUnknownObjClass	A PATH unknown object or C-type error is received from downstream; protocol failure on downstream LSR.	Check downstream LSR RSVP-TE configuration; the node sends only standard objects.
rsvpRcvErrUnknownObjCType	A PATH unknown object or C-type error is received from downstream; protocol failure on downstream LSR.	Check downstream LSR RSVP-TE configuration; the node sends only standard objects.
rsvpRcvErrAdminCtrl	A PATH error is received from downstream indicating insufficient bandwidth to satisfy the LSP requirement.	Check the downstream LSRs for bandwidth availability.
rsvRcvErrPolicyCtrl	A PATH policy control error is received from downstream; protocol failure on a downstream LSR.	Check downstream LSRs for point of failure.
rsvRcvErrDestPortConflict	A PATH error reporting unmatched destination port number is received.	The switch does not use port numbers. Check downstream LSRs for point of failure.
rsvpRcvErrSendPortConflict	A PATH error reporting unmatched source port number is received.	The switch does not use port numbers. Check downstream LSRs for point of failure.
rsvpRcvErrApi	A PATH API error is received.	Check downstream LSRs for point of failure.
rsvpRcvErrRoutingProblem	A PATH error reporting failure to route the LSP is received; similar to rsvpRoutingProblem but remotely occurring rather than locally.	If the *Rtr Mpls Lsp pathName* is set, check routes for all addresses in the configured *Path Hop* components. If the *pathName* is left empty, check the IP routing entries for the *LSP epa* address at every hop along the route.
(Sheet 4 of 4)		

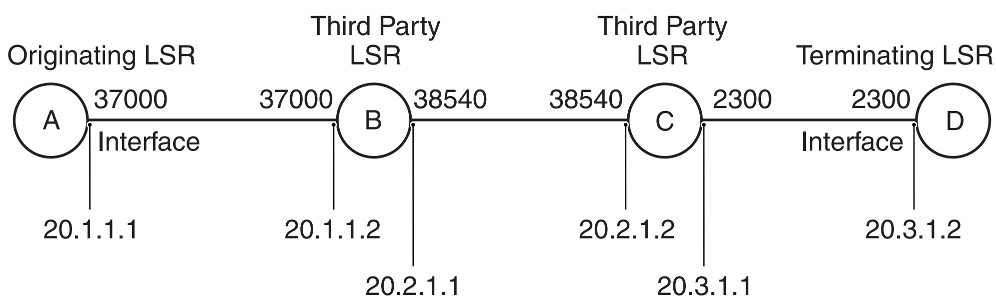
RSVP-TE LSP path tracing

RSVP-TE offers the ability to extend its signaled messages with LSP route information.

The Record Route Object (RRO) can be included in the RSVP-TE signaling messages to provide a record of the LSP route to any LSR along the path. If the Nortel Networks Multiservice Switch is the originating switch, it always includes the RRO in its path label request. At any node along the LSP route, the upstream and downstream hops of an LSP relative to the node can be displayed. On the switch, the component *Rtr RsvpTe Tunnel* displays the RRO. The label used for each segment may be included in the *ResvRRO*.

Figure 31, "Example of an LSR RSVP-TE LSP trace using RRO," (page 91) shows a simple four node topology that illustrates the procedure for operationally tracing the LSP path using the RRO information.

Figure 31
Example of an LSR RSVP-TE LSP trace using RRO



A Rtr/VCG RsvpTe Tunnel/<srcAddr>, <destnAddr>, <tunnelId>, <lspId> resvRro
resvRecordRouteObject = 0: 20.1.1.2 [37000]
1: 20.2.1.2 [38540]
2: 20.3.1.2 [2300]

D d-n Rtr/VCG RsvpTe Tunnel/<srcAddr>, <destnAddr>, <tunnelId>, <lspId> pathRro
pathRecordRouteObject = 0: 20.1.1.2
1: 20.2.1.2
2: 20.3.1.2

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RSVP-TE Signaling Statistics

For an RSVP-TE signaled LSP tandeming through the Nortel Networks Multiservice Switch node, the signaling statistics described in the table "MPLS RSVP-TE statistics" (page 92) provide evidence as to the cause of failure. By monitoring the *Rtr RsvpTe IfStatistics* PATH and RESV transmitted and received error counters at each interface along the LSP route, you can determine where the failure occurs, and, if not overwritten by the failure of another LSP at the same interface, the error code and value identifying the reason for failure.

The table "MPLS RSVP-TE statistics" (page 92) lists the protocol throughput and error statistics for the RSVP-TE signaling interface. All are represented by operational attributes under the *Rtr RsvpTe IfStats* component for a particular interface, and also aggregated under *Rtr RsvpTe stats* for all interfaces on the node. All counters are cumulative starting from the creation of the *Rtr Interface RsvpTeIf* component for *Rtr RsvpTe IfStats* and the creation of the *Rtr Interface* component for *Rtr RsvpTe stats* and wrap to zero when the maximum value is exceeded. The statistics may be 20 seconds out of date because they are a snapshot of FP-based real time counters.

Table 2
MPLS RSVP-TE statistics

Statistics	Description
pathMessages	The number of PATH messages sent out and received by the interface.
pathErrorMessages	The number of PATH error messages sent out and received by the interface.
lastPathErrorInfo	Indicates the error code, error value, and timestamp of the PATH error message most recently sent out and received by the interface. For *Rtr RsvpTe Stats*, the associated interface address is also displayed. Details are outlined in RFC 2205 and 3209, and summarized in the table "MPLS RSVP-TE PATH error codes and values" (page 94). A blank display indicates no PATH error message has been sent or received.
(Sheet 1 of 2)	

Table 2 (continued)
MPLS RSVP-TE statistics

Statistics	Description
pathTearMessages	Indicates the number of PATH tear messages sent out and received by the interface.
resvMessages	Indicates the number of RESV messages sent out and received by the interface.
resvConfirmMessages	Indicates the number of RESV confirmation messages sent out and received by the interface.
resvErrorMessages	Indicates the number of RESV error messages sent out and received by the interface.
lastResvErrorInfo	Indicates the error code, error value, and timestamp of the RESV error message most recently sent out and received by the interface.‘ For *RsvpTe Stats*, the associated interface address is also displayed. Details are outlined in RFC2205, RFC3209, and summarized in the table “MPLS RSVP-TE RESV error codes and values” (page 99). A blank display indicates that no RESV error message was sent or received.
resvTearMessages	Indicates the number of RESV tear messages sent out and received by the interface.
helloMessages	Indicates the number of RESV hello messages sent out and received by the interface.
rsvpDiscards	Indicates the number of sent and received RSVP-TE messages that were discarded.
lastRsvpDiscardInfo	Indicates the message type of the last RSVP-TE protocol message sent and received by the interface and the timestamp of its discard. If there are no discards, this attribute value is left blank.
(Sheet 2 of 2)	

The RsvpTeIf stats attributes include the PATH and RESV error code and values for the last error message(s) sent and received through the interface. The error codes are standardized, documented in classical RSVP RFC 2205 and RSVP-TE RFC 3209. They are described along with their accompanying error values in the tables “MPLS RSVP-TE PATH error codes and values” (page 94) and “MPLS RSVP-TE RESV error codes and values” (page 99).

The error values accompanying the RSVP-TE system error code in PATH and RESV messages (identified by error code *rsvpSystemError*) are not standardized and are subsequently implementation-specific.

The PATH/RESV error message contains the IP address of the node or interface originating the error.

In a case where the Nortel Networks Multiservice Switch LER originates a PATH/RESV error message with error code *rsvpSystemError*, the values are interpreted as described in the tables below.

Table 3
MPLS RSVP-TE PATH error codes and values

Error code	Code description	Value	Value description
admissionControlFailure	Reservation request was rejected by admission control due to unavailable resources.	1	Delay bound specified in PATH message can not be met.
		2	Requested bandwidth is not available.
		> 32768	Implementation-specific; not originated by Multiservice Switch system.
policyControlFailure	PATH rejected for administrative reasons related to policy control; not originated by Multiservice Switch system.	0	
(Sheet 1 of 5)			

Table 3 (continued)
MPLS RSVP-TE PATH error codes and values

Error code	Code description	Value	Value description
conflictingDestPorts	Sessions for same destination address and protocol have appeared with both zero and non-zero destination port fields in PATH message.	0	
conflictingSenderPorts	Sender port is both zero and non-zero in PATH messages for the same session.	0	
unknownObjectClass	Unknown object class encountered during PATH message decode.	variable	The class number and c-type of the unknown object comprise the error value.
unknownObjectCType	Unknown object c-type encountered during PATH message decode.	variable	The class number and c-type of the unknown object comprise error value.
reservedForAPI	Asynchronously detected error that must be reported to the application via an upcall.	applicatio n-specific	
trafficControlError	Traffic control call failed due to the format or contents of the parameters to the request. The PATH message cannot be forwarded, and repeating the call would be futile.	2	Traffic control cannot provide the requested service nor an acceptable replacement.
		4	Bad TSPEC value.
		5	Bad ADSPEC value.
		>32768	Implementation-specific; not originated by Multiservice Switch system.
(Sheet 2 of 5)			

Table 3 (continued)
MPLS RSVP-TE PATH error codes and values

Error code	Code description	Value	Value description
trafficControlSystemError	A system error was detected and reported by the traffic control modules; not originated by Multiservice Switch system.	implementation-specific	
rsvpSystemError	An error occurred during RSVP-TE processing. The accompanying error value provides implementation-specific information on the error.	30	Internal software error encountered during PATH message processing; a SOFTWARE alarm should accompany this error on the originating node.
		31	A PATH message received is missing an RSVP-TE object mandatory for processing.
		32	A PATH message was incorrectly formatted and could not be processed.
		33	There were insufficient system resources available to process the PATH message. Examples include system congestion preventing internal message send.
		41	A PATH message was received containing an incorrectly formatted session object.
		42	A PATH message was received containing an incorrectly formatted sender template.
(Sheet 3 of 5)			

Table 3 (continued)
MPLS RSVP-TE PATH error codes and values

Error code	Code description	Value	Value description
		43	A PATH message was received that was intended to terminate a local repair attempt on the interface; Multiservice Switch nodes do not support local repair termination.
		44	A PATH message was received for an existing LSP with a different RSVP hop object.
		45	A PATH message was received to setup an LSP in an existing TE session that has reached the limit on the number of LSPs per Fixed Filter (FF) session.
		other	Implementation-specific; not originated by Multiservice Switch system.
routingProblem	The desired route cannot be followed to establish the LSP.	1	The Explicit Route Object (ERO) is malformed - the initial subobject is missing.
		2	A strict hop specified in the ERO cannot be reached.
		3	A loose hop specified in the ERO cannot be reached.
		4	The first ERO subobject is incorrect.
		5	No route is available to the specified destination. A node may spontaneously originate this error on the loss of an LSP due to interface failure.
(Sheet 4 of 5)			

Table 3 (continued)
MPLS RSVP-TE PATH error codes and values

Error code	Code description	Value	Value description
		7	The RRO indicated routing loops.
		8	MPLS being negotiated, but a non-RSVP-capable router stands in the path.
		9	MPLS label allocation failure.
		10	The receiver cannot support the L3PID specified in the PATH message; not originated by Multiservice Switch system.
notifyError	Notification of error.	1	Length of RRO causes the PATH message to exceed the interface MTU.
		2	PATH error sent by the receiver in response to a RESV notify error with error value 1 indicating that the RRO grew too large for the MTU; not originated by Multiservice Switch system.
		3	Tunnel locally repaired; not originated by Multiservice Switch system.
		> 32768	Implementation-specific; not originated by Multiservice Switch system.
(Sheet 5 of 5)			

Table 4
MPLS RSVP-TE RESV error codes and values

Error code	Code description	Value	Value description
admissionControlFailure	Reservation request was rejected by admission control due to unavailable resources.	3 > 32768	MTU in RESV FLOWSPEC object is larger than the interface MTU. Implementation-specific; not originated by Multiservice Switch system.
policyControlFailure	RESV rejected for administrative reasons related to policy control; not originated by Multiservice Switch system.	0	
noPathInfo	The RESV message does not correspond to an existing session with PATH state on this interface.	0	
noSenderInfo	The RESV message identifies an existing session with PATH state, but the flow descriptor does not correspond to a sender in that session.	0	
conflictingResvStyle	The reservation style in the RESV message conflicts with the style of the existing RESV state for that session.	variable	The error value identifies the style of the existing session.
unknownResvStyle	The reservation style in the RESV message is unknown.	0	
(Sheet 1 of 5)			

Table 4 (continued)
MPLS RSVP-TE RESV error codes and values

Error code	Code description	Value	Value description
conflictingDestPorts	Sessions for the same destination address and protocol have appeared with both zero and non-zero destination port fields in RESV message.	0	
servicePreempted	The service request defined by the style object and the flow descriptor has been administratively preempted.	> 32768	Implementation-specific; not originated by Multiservice Switch system.
unkownObjectClass	Unknown object class encountered during RESV message decode.	variable	The class number and c-type of the unknown object comprise the error value
unknownObjectCType	Unknown object c-type encountered during RESV message decode.	variable	The class number and c-type of the unknown object comprise the error value.
reservedForAPI	Asynchronously detected error that must be reported to the application via an upcall.	applicatio n-specific	
trafficControlError	Traffic control call failed due to the format or contents of the parameters to the request. The RESV message cannot be forwarded, and repeating the call would be futile.	5 > 32768	Bad FLOWSPEC value. Implementation-specific; not originated by Multiservice Switch system.
(Sheet 2 of 5)			

Table 4 (continued)
MPLS RSVP-TE RESV error codes and values

Error code	Code description	Value	Value description
trafficControlSystemsError	A system error was detected and reported by the traffic control modules; not originated by Multiservice Switch system.	implementation-specific	
rsvpSystemError	An error occurred during RSVP-TE processing. The accompanying error value provides implementation-specific information on the error.	30	internal software error encountered during PATH/ RESV processing.
		31	A RESV message received is missing an RSVP-TE object mandatory for processing.
		32	a RESV message was incorrectly formatted and could not be processed.
		33	There were insufficient system resources available to process the RESV message. Examples include system congestion preventing internal message send.
		34	A RESV message was received that would result in bandwidth sharing between LSPs. Multiservice Switch nodes do not support bandwidth sharing The session employs the SE style and RESV flow descriptor identifies multiple LSPs on the same session through the same interface.
(Sheet 3 of 5)			

Table 4 (continued)
MPLS RSVP-TE RESV error codes and values

Error code	Code description	Value	Value description
		41	A RESV message was received containing an incorrectly formatted session object.
		51	A RESV message was received containing an incorrectly formatted filter spec object.
		52	A RESV message was received containing an incorrectly formatted flow descriptor.
		53	A RESV message was received for an existing LSP with a different label object.
		other	Implementation-specific; not originated by Multiservice Switch system.
routingProblem	The desired route cannot be followed to setup the LSP.	6	The label specified in the RESV message is unacceptable. Possible reasons for rejection: • the label has already been assigned to another LSP and the node originating this error is merge incapable • the implicit null label was assigned, but the node is not capable of doing a penultimate pop for the associated L3PID
		7	The RRO indicated routing loops.
(Sheet 4 of 5)			

Table 4 (continued)
MPLS RSVP-TE RESV error codes and values

Error code	Code description	Value	Value description
		8	MPLS being negotiated, but a non-RSVP-capable router stands in the path.
		9	MPLS label allocation loops.
notifyError	Notification of error.	1	Length of RRO causes the RESV message to exceed the interface MTU.
		3	Tunnel locally repaired; not originated by Multiservice Switch system.
		> 32768	Implementation-specific; not originated by Multiservice Switch system.
(Sheet 5 of 5)			

Transport Statistics

Table “MPLS transport statistics” (page 103) lists the statistics related to the transport of data traffic through RSVP-TE connections on the interface.

Table 5
MPLS transport statistics

Statistic	Meaning
inFrames	Indicates the accumulated number of frames received.
inOctets	Indicates the accumulated number of octets received.
inFrameDiscards	Indicates the accumulated number of frames discarded on receipt.
outFrames	Indicates the accumulated number of frames sent.
(Sheet 1 of 2)	

Table 5 (continued)
MPLS transport statistics

Statistic	Meaning
outOctets	Indicates the accumulated number of octets sent.
outFrameDiscards	Indicates the accumulated number of frames discarded on sen.
(Sheet 2 of 2)	

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