JUNIPER NETWORKS

Network Configuration Example

Configuring Packet Optical Networks with PTX Series Devices

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CHAPTER 1

Configuring Packet Optical Networks with PTX Series Devices

About This Network Configuration Example

This network configuration example provides an overview of packet optical networking and describes how to implement packet optical networking on PTX Series devices using optical transport network (OTN) parameters and wavelength-division multiplexing (WDM). It offers configurations for 100 Gbps Ethernet interfaces, forward error correction (FEC), MPLS label-switched paths (LSPs), and OTN/WDM parameters to illustrate a sample use case showing how these technologies support preemptive MPLS fast reroute (FRR) with minimal traffic disruption due to link degradation in a converged supercore backbone router network.

Packet Optical Network Overview

Packet optical devices, such as Juniper Networks PTX Series devices properly equipped with suitable line cards, are capable of placing packets directly onto optical transports and receiving packets the same way. In a packet optical network, the packets leave the router in an optical transport envelope at the correct wavelength and arrive the same way, bypassing much of the other external networking equipment needed to groom or otherwise process electrical or optical signals originating on the router.

The advantages to having a direct optical network interface on the device are many. Among them are having access to optical span performance parameters such as signal strength and noise, gathering trend information about corrected and uncorrected bit errors, and (in the case of copper tail-ends) eliminating the low-performance copper links at the ends of the span. Packet optical networks can record and analyze optical performance and even provide protection switching if the bit error rate (BER) exceeds a configured threshold.

However, the advantages of fiber optical networks extend to more than just error rates.

The full list of advantages that fiber optical networks hold over copper networks (or even networks with limited amounts of copper) is considerable:

- Lower BERs—Fiber offers lower bit error rates (BERs) than any other transmission media. If the BER of a fiber link is 1000 times better than on copper (coax, twisted pair), which is not unusual, this is about the same ratio of 1 day to 3 years of 365 days each. So all the errors seen yesterday take about 3 years to occur (1000 to 1 ratio).
- Higher bandwidths—Fiber offers unsurpassed bit rates. And, unlike copper media, fiber speeds are increasing constantly, in some cases by orders of magnitude. If the ratio of pre-fiber to fiber bandwidth is also 1000:1 (not unusual), that means you can send over this link tomorrow all the bits you have sent in the past 3 years.
- Longer distances without repeaters—Fiber links require fewer repeaters than the same length of cable composed of other media. Digital repeaters, which detect and repeat the string of 0s and 1s, require power and add potential points of failure.
- Immunity from interference—Noise interference is an issue in copper because such cables are long antennas. Fiber does not pick up electromagnetic noise from the environment.
- Security—The act of tapping into a fiber optical cable adds some signal loss. Fiber networks can be monitored for sudden signal loss increases, which could indicate damage or tapping..
- Fewer maintenance costs—Solid state fiber optic components need less maintenance than other devices used in older copper networks.
- Small size and weight—Some copper cables weigh several pounds per foot. The same crew can install more fiber length in 1 day than any other cable media.
- Bandwidth upgrades—It is possible to increase the bandwidth available on the fiber link by upgrading the sender and receiver components.

Initially, networks deployed single links of fiber between devices, usually surrounded by masses of legacy copper links. But, as can be seen from the previous list, the advantages of fiber optics can best be realized when all of the links between devices are fiber optical links. After all, if the end-to-end path includes one high bit-error link, then the overall bit error cannot be better than this “weakest” link. The same is true in some sense for bandwidth: throughput is limited by one slow link in the whole series.

Today, many packet optical networks conform to the optical transport network (OTN) standard. The international standard for OTNs is G.709. This standard includes wavelength values for wavelength-division multiplexing (WDM), a method that allows a single physical fiber to carry multiple bit streams, all using different wavelengths.

However, because single wavelength links can still be used between devices, some of the parameters for fiber optical links, such as G.709 wavelengths, are configured on Juniper Networks devices under OTN options and others are not.

It should be noted that copper multiplexing channels are traditionally distinguished by frequency, and WDM channels by the length of the waves, mainly because light was historically considered very different than other electromagnetic waves and have been traditionally distinguished by wavelength. This can be confusing, but wavelength is the reciprocal of frequency, so they are really closely related.

Configuration of Juniper Networks packet optical devices establishes the most important optical parameters for fiber optic links and OTNs. These include:

- **signal-degrade**—This parameter establishes thresholds and intervals for monitoring link performance.
  - **interval**—This parameter establishes the interval at which the link is checked for conformance to performance parameters.
  - **ber-threshold-signal-degrade**—This parameter establishes the BER threshold for the link to be considered degraded.
  - **ber-threshold-clear**—This parameter establishes the BER threshold for the link to be considered recovered from a degraded condition.
- **preemptive-fast-reroute**—This parameter establishes that when the link crosses the degraded performance threshold, the link is declared down (failed), and the system takes steps to build new paths for traffic.
  - **signal-degrade-monitor-enable**—This parameter establishes that link degradation is monitored for fast reroute opportunities.
  - **backward-frr-enable**—This parameter establishes that link degradation at the receiver is sent “backward” to the sender so that fast reroute can be invoked.

Related Documentation

- Packet Optical Network Use Cases and Technical Overview on page 7
- Example: Configuring Packet Optical Networks with PTX Series Devices on page 10

Packet Optical Network Use Cases and Technical Overview

Packet optical networking is useful in any network with a converged supercore that needs to transport traffic in as efficient and effective a manner as possible. Three key technologies make packet optical networking practical for these use cases.

Specifically, the key factors indicating use of packet optical networking are as follows:

- Low latency is critical—Many applications, from streaming video and music to cloud-based data mining with many scatter-gather stages to active constant webpages built from elements stored in many data centers, need low latency (propagation and nodal processing delay) to be effective. Delays due to slow failovers are unacceptable to these users.
- High bandwidth is required—In modern converged supercores, the same physical links could carry aggregated traffic from streaming applications, replicated database queries, and user views of information passed from a remote data center in content delivery networks. Yet enough bandwidth must be available at all times for these often variable workloads.

- CoS/QoS is needed—Users often have service-level agreements in place that spell out the exact class of service (CoS) or quality of service (QoS) in terms of latency and reliability provided by the network. The more stringent the requirements, and the more burdensome the penalties, the more likely these needs can be met by a packet optical network.
- Resends due to errors are not practical—Certain applications, such as streaming video and IP-based voice, cannot pause for resends. Errors show up as breaks in the bit stream or rebuffering hesitations. Packet optical networks include support for several forms of forward error correction (FEC) that help improve data quality when resends are not possible or practical.

When it comes to technology, packet optical networks and links depend on three key concepts:

- Optical networking with wavelength multiplexing
- Forward error correction (FEC)
- MPLS fast reroute

Although all three of these technologies were developed independently, packet optical networks benefit greatly when they are all used together. When used in combination, these three technologies allow for unsurpassed path protection through a PTX Series core network using packet optical links and MPLS with fast reroute. This network configuration example shows how they all work together.

Multiplexing has been used since the early days of networking, and fiber optic links use it as well. Many optical fibers are engineered to do more than carry one very fast serial bit stream. The bandwidth available on these types of fiber optic cables, just as certain forms of copper cables (especially coaxial cables) can carry more than one serial bit stream. In copper networks, the various channels are distinguish by frequency, but in optical networks, it makes more sense to distinguish the channels by wavelength. Various wavelengths can be multiplexed onto a single strand of fiber—and demultiplexed at the opposite end of the link—with a process known as wavelength-division multiplexing. If the separation of wavelengths is narrow enough and the resulting channels are dense enough (and there are at least 8 channels on the fiber), the result is known as dense wavelength-division multiplexing (DWDM). In this system, “non-dense” WDM is known as coarse wavelength-division multiplexing (CWDM).

Today, DWDM is standardized for international use as part of the optical transport network (OTN) defined as G.709 by the International Telecommunications Union (ITU). Operation of these advanced fiber optical networks is tied to the use of FEC codes to raise BER performance to unprecedented levels.

Why are FECs needed? Because with this increased DWDM bit-carrying capacity comes an increased risk. A failed or marginally operating link can threaten not only the loss of one stream of bits, but many bit streams that flow on the same physical link. A failed link carrying many gigabits of information can be catastrophic for a network unless some method to compensate for these losses is used. These methods include not only FECs but fast traffic reroute. First, however, consider FEC codes.

When first encountered, FEC codes seem like some mathematical magic that could not possibly work. Yet they do, and very well. Most of them do not even double the number of bits sent, which is a simple scheme on its own ("just send everything twice"). Of course, the mathematics of a FEC is much more complex, and the "code space" is carefully chosen to allow certain patterns of bit errors, such as single bit errors or limited bursts, to not only be detected, but corrected without a retransmission.

FECs have been around for a long time, often as some form of what are called Hamming Codes. These codes are useful when it is slow and expensive to send bits, like with a deep space probe, and when pausing to acknowledge receipt of a message and when asking for a resend is impractical.

To mathematicians, of course, FEC codes are just what numbers constructed and used in a certain way do, like square roots. FECs would be a lot less mysterious if I said to you, before we communicated over a distance, "Okay, when I send a number to you between 0 and 99, I'll send two numbers that have to add up to 200, and one of the numbers is 97." If I receive 97 and then 102, I know that there was an error when sending the second number and that this number should be corrected to 103. In practice, naturally, real FECs are much more sophisticated.

The advantage of FEC is that its use allows for constant monitoring of the uncorrected BER on the link (that is, before the FEC is applied to correct errors). So if the uncorrected BER is steadily increasing, this could be a sign that the link might fail soon, possibly due to environmental conditions. Packet optical networks often allow a user to establish a threshold value for optical parameters such as the BER to signal link failure at the end devices before the link actually fails.

Why would a service provider want to fail a link before it actually breaks? Because this allows more control over the network, and lets operators establish a more structured process to invoke in case of a failure. But this also raises the question of what exactly should be done when a link fails. In packet optical networks, the answer is often tied in with MPLS and fast reroute.

MPLS is a technology that allows multiple hops between two routers to be seen at the IP layer as one hop because the label-switched path (LSP) tunnels created do not require any IP header processing between LSP source (ingress) and destination (egress). Also, MPLS labels are switched at intermediate nodes by a simple table lookup rather than requiring complete packet header processing and forwarding table lookup (and packet routing often requires multiple forwarding table lookups). In contrast to IP, MPLS is connection-oriented: a signaling protocol (or manual configuration) is needed to set up an MPLS tunnel between two routers.

The advantage of MPLS, besides this simple and fast one-hop connection, is that traffic on the MPLS path LSP follows the same sequence of nodes. So, not only is sequential delivery guaranteed (barring physical link loss), but the LSP connection makes a convenient place to establish CoS/QoS parameters that are otherwise hard to enforce in traditional best-effort connectionless IP routing.

But what if a link between two intermediate devices on an LSP fails? In most connection-oriented networks, the signaling protocol must start from scratch and establish a new path (LSP) to the destination for the traffic to follow. In the meantime, of course, all traffic from source to destination must be discarded (or thrown from the LSP network onto the best-effort routing network, where it is likely to be discarded).

In MPLS, fast reroute can be preemptive. In that case, other LSPs might be terminated to make way for the rerouted traffic, which has been given a higher priority on the network. Although possible, preemptive fast reroute does not play a role in the configuration in this network configuration example. In other words, the secondary LSP does not carry user traffic of low priority that needs to be preempted.

Related Documentation

- Packet Optical Network Overview on page 5
- Example: Configuring Packet Optical Networks with PTX Series Devices on page 10

Example: Configuring Packet Optical Networks with PTX Series Devices

This network configuration example configures three PTX3000 routers with 100 Gbps Ethernet interfaces, forward error correction (FEC), MPLS label-switched paths (LSP), preemptive fast reroute, and optical transport network (OTN) and wavelength-division multiplexing (WDM) parameters to show how these technologies support preemptive fast reroute with minimal traffic disruption due to link degradation in a converged supercore backbone router network.

Requirements

This example uses the following hardware and software components:

- 3 PTX3000 routers (PTX5000 Series routers can also be used)
- 3 FPC-SFF-P1A Flexible PIC Concentrators for the PTX3000 routers
- 6 P1-PTX-2-100G-C-WDM-C 2-port 100G DWDM OTN PIC for the PTX3000 routers
- Junos OS Release 14.2 R1 or later

Before you configure packet optical networking on the PTX Series routers, be sure that you have:

- Installed all links and linecard hardware correctly
- Configured all basic parameters such as router names

Overview

This network requires high-gigabit rate user traffic to be transported over a core of three PTX3000 routers from source interface to destination interface with very low latency, minimal nodal processing, and fast reroute of traffic in the case of link quality degradation. The best way to satisfy these requirements is to use OSPF as an interior gateway protocol

(IGP), then use MPLS with LDP and Reservation Protocol with Traffic Engineering (RSVP-TE) to establish a label-switched path (LSP) from the ingress PTX Series router to the egress PTX Series router. Then primary and secondary LSPs are created among the PTX Series routers to enable preemptive fast reroute of traffic in case of a link degradation or failure.

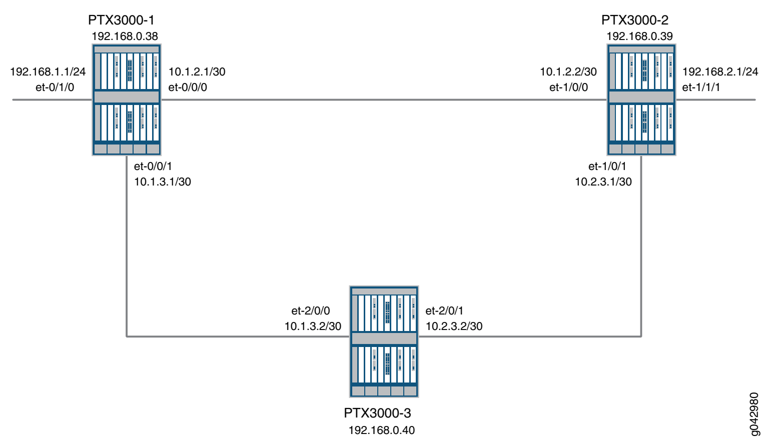
Topology

This configuration example uses three PTX3000 routers named PTX3000-1, PTX3000-2, and PTX3000-3. Streaming traffic enters PTX3000-1 from the interface having IP address 192.168.1.1 and exits from PTX3000-2 to the interface having IP address 192.168.2.1. PTX3000-1 and PTX3000-2 are directly connected with a point-to-point fiber link. In case this link fails or exceeds an established error threshold, the streaming traffic can be routed from 192.168.1.1 to 192.168.2.1 through intermediate router PTX3000-3, which has direct links to both PTX-3000-1 and PTX3000-2.

Finally, packet optical parameters are established to detect primary path optical link degradation and to reroute traffic quickly onto the secondary LSP.

The topology used in the configuration example is shown in Figure 1 on page 11.

Figure 1: Topology for the Packet Optical Network



This example configures the following on all three PTX3000 routers:

- Fiber optical interfaces—For the inter-PTX links, each interface establishes a jumbo frame size of 9192 bytes used for high-speed Ethernet interfaces, and sets the WDM wavelength at 1529.55 nanometers (nm), a wavelength used for 10-Gigabit or 100-Gigabit Ethernet Dense WDM (DWDM) interfaces only, part of the C-band ITU-Grid tunable optics standard. Setting optical wavelengths in device software instead of in an external device is a characteristic of packet topical networks. Then we set optical transport network (OTN) options: set the reporting interval in milliseconds (10) and establish the bit error rate (BER) thresholds for declaring the link degraded or failed (a pre-forward error correction (FEC) BER value of 5 .0e-3, or 1 bit in 1000) or cleared (5.0e-7, or 1 bit in 10 million). Note that FEC might still recover from many of these bit errors. For more information about FEC operation for OTNs on the PTX Series routers, especially BER threshold operation, see Understanding Pre-FEC BER Monitoring and BER Thresholds. Finally, this example configures preemptive fast reroute to enable monitoring of signal degradation and the feedback of the result to the source (MPLS LSPs are rerouted from the source). For more information about configuring 100-Gigabit Ethernet, see 100-Gigabit Ethernet OTN Options Configuration Overview.
- OSPF as the IGP—All networks need to run a routing protocol to learn the network topology and to know what devices are reachable. This example configures OSPF as the IGP, but IS-IS could be used if preferred, as long as the same IGP is run throughout the network. The indirect route through PTX3000-3 is given a very high metric (10000) so that traffic does not use the link unless the direct link has failed.
- LDP as MPLS signaling protocol—MPLS uses a signaling protocol to establish LSPs from source to destination routers. This example configures LDP, which automatically seeks out all possible routes in the network, as the basic MPLS signaling protocol. LDP uses the same metrics as established for the IGP (OSPF).
- MPLS as the packet switching technology—MPLS establishes LSPs from ingress to egress router. In between, IP packets are encapsulated with an MPLS label and are switched, not routed. The nice thing about MPLS is that an LSP, no matter how many routers it passes through, looks like one hop at the IP layer. So LSP reroutes through PTX3000-3 look essentially the same to the source and destination systems.
- RSVP-TE to set up the active and standby traffic engineering LSPs—This example uses RSVP-TE signaling to establish primary and standby LSPs in the network between PTX3000 routers. This example configures link protection on the inter-PTX Series router interfaces.

Configuration

Configuring packet optical networking in the PTX Series devices involves:

- Configuring Optical Interfaces on page 16
- Configuring OSPF on page 19
- Configuring LDP on PTX3000-1 and PTX3000-2 on page 19
- Configuring MPLS on page 19

- Configuring RSVP-TE LSPs on page 21
- Results on page 21

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove line breaks, change any details such as interface designations and IP addresses to match your network, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

PTX3000-1

```
set interfaces et-0/0/0 description “Direct link to PTX3000-2”
set interfaces et-0/0/0 mtu 9192
set interfaces et-0/0/0 optics-options wavelength 1529.55
set interfaces et-0/0/0 otn-options laser-enable
set interfaces et-0/0/0 otn-options signal-degrade interval 10
set interfaces et-0/0/0 otn-options signal-degrade ber-threshold-clear 5.0e-7
set interfaces et-0/0/0 otn-options signal-degrade ber-threshold-signal-degrade 5.0e-3
set interfaces et-0/0/0 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
set interfaces et-0/0/0 otn-options preemptive-fast-reroute backward-frr-enable
set interfaces et-0/0/0 unit 0 family inet address 10.1.2.1/30
set interfaces et-0/0/0 family mpls
set interfaces et-0/0/1 description “Direct link to PTX3000-3”
set interfaces et-0/0/1 mtu 9192
set interfaces et-0/0/1 optics-options wavelength 1529.55
set interfaces et-0/0/1 otn-options laser-enable
set interfaces et-0/0/1 otn-options signal-degrade interval 10
set interfaces et-0/0/1 otn-options signal-degrade ber-threshold-clear 5.0e-7
set interfaces et-0/0/1 otn-options signal-degrade ber-threshold-signal-degrade 5.0e-3
set interfaces et-0/0/1 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
set interfaces et-0/0/1 otn-options preemptive-fast-reroute backward-frr-enable
set interfaces et-0/0/1 unit 0 family inet address 10.1.3.1/30
set interfaces et-0/0/1 family mpls
set interfaces et-0/1/0 description “Traffic Source”
set interfaces et-0/1/0 mtu 9192
set interfaces et-0/1/0 optics-options wavelength 1529.55
set interfaces et-0/1/0 otn-options laser-enable
set interfaces et-0/0/1 unit 0 family inet address 192.168.1.1/24
set interfaces et-0/0/1 unit 0 family mpls
set interfaces lo0 description “Loopback Interface”
set interfaces lo0 unit 0 family inet address 192.168.0.38/24 preferred
set interfaces lo0 unit 0 family inet address 127.0.0.1/32
set protocols ospf traffic-engineering
set protocols ospf area 0.0.0.0 interface et-0/0/0.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface et-0/0/1.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface et-0/0/1.0 metric 10000
set protocols ospf area 0.0.0.0 interface et-0/1/0.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface lo0.0 passive
set protocols ldp track-igp-metric
set protocols ldp interface et-0/1/0.0
set protocols ldp interface lo0.0
set protocols mpls optimize-aggressive
set protocols mpls smart-optimize-timer 10
set protocols mpls optimize-timer 10
set protocols mpls label-switched-path to-ptx3000-2 to 192.168.0.39
set protocols mpls label-switched-path to-ptx3000-2 ldp-tunneling
```



```
set protocols mpls label-switched-path to-ptx3000-2 link-protection
set protocols mpls label-switched-path to-ptx3000-2 primary direct-ptx3000-2
set protocols mpls label-switched-path to-ptx3000-2 secondary indirect-ptx3000-3
   standby
set protocols mpls label-switched-path to-ptx3000-2 secondary indirect-ptx3000-3
   adaptive
set protocols mpls path direct-ptx3000-2 10.1.2.2 strict
set protocols mpls path indirect-ptx3000-3 10.1.3.2 strict
set protocols mpls path indirect-ptx3000-3 10.2.3.1 strict
set protocols mpls interface et-0/0/0.0
set protocols mpls interface et-0/0/1.0
set protocols mpls interface et-0/1/0.0
set protocols rsvp interface et-0/0/0.0 link-protection
set protocols rsvp interface et-0/0/1.0 link-protection
```

PTX3000-2

```
set interfaces et-1/0/0 description "Direct link to PTX3000-1"
set interfaces et-1/0/0 mtu 9192
set interfaces et-1/0/0 optics-options wavelength 1529.55
set interfaces et-1/0/0 otn-options laser-enable
set interfaces et-1/0/0 otn-options signal-degrade interval 10
set interfaces et-1/0/0 otn-options signal-degrade ber-threshold-clear 5.0e-7
set interfaces et-1/0/0 otn-options signal-degrade ber-threshold-signal-degrade 5.0e-3
set interfaces et-1/0/0 otn-options preemptive-fast-reroute
   signal-degrade-monitor-enable
set interfaces et-1/0/0 otn-options preemptive-fast-reroute backward-frr-enable
set interfaces et-1/0/0 unit 0 family inet address 10.1.2.2/30
set interfaces et-1/0/0 family mpls
set interfaces et-1/0/1 description "Direct link to PTX3000-3"
set interfaces et-1/0/1 mtu 9192
set interfaces et-1/0/1 optics-options wavelength 1529.55
set interfaces et-1/0/1 otn-options laser-enable
set interfaces et-1/0/1 otn-options signal-degrade interval 10
set interfaces et-1/0/1 otn-options signal-degrade ber-threshold-clear 5.0e-7
set interfaces et-1/0/1 otn-options signal-degrade ber-threshold-signal-degrade 5.0e-3
set interfaces et-1/0/1 otn-options preemptive-fast-reroute
   signal-degrade-monitor-enable
set interfaces et-1/0/1 otn-options preemptive-fast-reroute backward-frr-enable
set interfaces et-1/0/1 unit 0 family inet address 10.2.3.2/30
set interfaces et-1/0/1 family mpls
set interfaces et-1/1/1 description "Traffic Destination"
set interfaces et-1/1/1 mtu 9192
set interfaces et-1/1/1 optics-options wavelength 1529.55
set interfaces et-1/1/1 otn-options laser-enable
set interfaces et-1/1/1 unit 0 family inet address 192.168.2.1/24
set interfaces et-1/1/1 unit 0 family mpls
set interfaces lo0 description "Loopback Interface"
set interfaces lo0 unit 0 family inet address 192.168.0.39/24 preferred
set interfaces lo0 unit 0 family inet address 127.0.0.1/32
set protocols ospf traffic-engineering
set protocols ospf area 0.0.0.0 interface et-1/0/0.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface et-1/0/1.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface et-1/0/1.0 metric 10000
set protocols ospf area 0.0.0.0 interface et-1/1/1.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface lo0.0 passive
set protocols ldp track-igp-metric
set protocols ldp interface et-1/1/1.0
```



```
set protocols ldp interface lo0.0
set protocols mpls optimize-aggressive
set protocols mpls smart-optimize-timer 10
set protocols mpls optimize-timer 10
set protocols mpls label-switched-path to-ptx3000-1 to 192.168.0.38
set protocols mpls label-switched-path to-ptx3000-1 ldp-tunneling
set protocols mpls label-switched-path to-ptx3000-1 link-protection
set protocols mpls label-switched-path to-ptx3000-1 primary direct-ptx3000-1
set protocols mpls label-switched-path to-ptx3000-1 secondary indirect-ptx3000-3
  standby
set protocols mpls label-switched-path to-ptx3000-1 secondary indirect-ptx3000-3
  adaptive
set protocols mpls path direct-ptx3000-2 10.1.2.1 strict
set protocols mpls path indirect-ptx3000-3 10.2.3.2 strict
set protocols mpls path indirect-ptx3000-3 10.1.3.1 strict
set protocols mpls interface et-1/0/0.0
set protocols mpls interface et-1/0/1.0
set protocols mpls interface et-1/1/1.0
set protocols rsvp interface et-1/0/0.0 link-protection
set protocols rsvp interface et-1/0/1.0 link-protection
```

PTX3000-3

```
set interfaces et-2/0/0 description “Direct link to PTX3000-1”
set interfaces et-2/0/0 mtu 9192
set interfaces et-2/0/0 optics-options wavelength 1529.55
set interfaces et-2/0/0 otn-options laser-enable
set interfaces et-2/0/0 otn-options signal-degrade interval 10
set interfaces et-2/0/0 otn-options signal-degrade ber-threshold-clear 5.0e-7
set interfaces et-2/0/0 otn-options signal-degrade ber-threshold-signal-degrade 5.0e-3
set interfaces et-2/0/0 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
set interfaces et-2/0/0 otn-options preemptive-fast-reroute backward-frr-enable
set interfaces et-2/0/0 unit 0 family inet address 10.1.3.2/30
set interfaces et-2/0/0 family mpls
set interfaces et-2/0/1 description “Direct link to PTX3000-2”
set interfaces et-2/0/1 mtu 9192
set interfaces et-2/0/1 optics-options wavelength 1529.55
set interfaces et-2/0/1 otn-options laser-enable
set interfaces et-2/0/1 otn-options signal-degrade interval 10
set interfaces et-2/0/1 otn-options signal-degrade ber-threshold-clear 5.0e-7
set interfaces et-2/0/1 otn-options signal-degrade ber-threshold-signal-degrade 5.0e-3
set interfaces et-2/0/1 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
set interfaces et-2/0/1 otn-options preemptive-fast-reroute backward-frr-enable
set interfaces et-2/0/1 unit 0 family inet address 10.1.3.2/30
set interfaces et-2/0/1 family mpls
set interfaces lo0 description “Loopback Interface”
set interfaces lo0 unit 0 family inet address 192.168.0.40/24 preferred
set interfaces lo0 unit 0 family inet address 127.0.0.1/32
set protocols ospf traffic-engineering
set protocols ospf area 0.0.0.0 interface et-2/0/0.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface et-2/0/1.0 interface-type p2p
set protocols ospf area 0.0.0.0 interface lo0.0 passive
set protocols mpls optimize-aggressive
set protocols mpls smart-optimize-timer 10
set protocols mpls optimize-timer 10
set protocols mpls interface et-2/0/0.0
```

```
set protocols mpls interface et-2/0/1.0
set protocols rsvp interface et-2/0/0.0 link-protection
set protocols rsvp interface et-2/0/1.0 link-protection
```

Configuring Optical Interfaces

Step-by-Step Procedure

The following example requires you to navigate to various levels of the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* and *CLI User Guide*.

To configure optical interfaces and loopback on PTX3000-1:

1. Configure the et-0/0/0 interface to PTX3000-2.

```
[edit interfaces]
user@ptx3000-1# set et-0/0/0 description “Direct link to PTX3000-2”
user@ptx3000-1# set et-0/0/0 mtu 9192
user@ptx3000-1# set et-0/0/0 optics-options wavelength 1529.55
user@ptx3000-1# set et-0/0/0 otn-options laser-enable
user@ptx3000-1# set et-0/0/0 otn-options signal-degrade interval 10
user@ptx3000-1# set et-0/0/0 otn-options signal-degrade ber-threshold-clear
  5.0e-7
user@ptx3000-1# set et-0/0/0 otn-options signal-degrade
  ber-threshold-signal-degrade 5.0e-3
user@ptx3000-1# set et-0/0/0 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
user@ptx3000-1# set et-0/0/0 otn-options preemptive-fast-reroute
  backward-frr-enable
user@ptx3000-1# set et-0/0/0 unit 0 family inet address 10.1.2.1/30
user@ptx3000-1# set et-0/0/0 family mpls
```

2. Configure the et-0/0/1 interface to PTX3000-3.

```
[edit interfaces]
user@ptx3000-1# set et-0/0/1 description “Direct link to PTX3000-3”
user@ptx3000-1# set et-0/0/1 mtu 9192
user@ptx3000-1# set et-0/0/1 optics-options wavelength 1529.55
user@ptx3000-1# set et-0/0/1 otn-options laser-enable
user@ptx3000-1# set et-0/0/1 otn-options signal-degrade interval 10
user@ptx3000-1# set et-0/0/1 otn-options signal-degrade ber-threshold-clear
  5.0e-7
user@ptx3000-1# set et-0/0/1 otn-options signal-degrade
  ber-threshold-signal-degrade 5.0e-3
user@ptx3000-1# set et-0/0/1 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
user@ptx3000-1# set et-0/0/1 otn-options preemptive-fast-reroute
  backward-frr-enable
user@ptx3000-1# set et-0/0/1 unit 0 family inet address 10.1.3.1/30
user@ptx3000-1# set et-0/0/1 family mpls
```

3. Configure the et-0/1/0 interface (the streaming traffic source).

```
[edit interfaces]
user@ptx3000-1# set et-0/1/0 description “Traffic Source”
user@ptx3000-1# set et-0/1/0 mtu 9192
user@ptx3000-1# set et-0/1/0 optics-options wavelength 1529.55
user@ptx3000-1# set et-0/1/0 otn-options laser-enable
```



```
user@ptx3000-1# set et-0/0/1 unit 0 family inet address 192.168.1.1/24
user@ptx3000-1# set et-0/0/1 unit 0 family mpls
```

4. Configure lo0 interface (to Routing Engine).

```
[edit interfaces]
user@ptx3000-1# set lo0 description “Loopback Interface”
user@ptx3000-1# set lo0 unit 0 family inet address 192.168.0.38/24 preferred
user@ptx3000-1# set lo0 unit 0 family inet address 127.0.0.1/32
```

Step-by-Step Procedure

To configure optical interfaces and loopback on PTX3000-2:

1. Configure the et-1/0/0 interface to PTX3000-1.

```
[edit interfaces]
user@ptx3000-2# set et-1/0/0 description “Direct link to PTX3000-1”
user@ptx3000-2# set et-1/0/0 mtu 9192
user@ptx3000-2# set et-1/0/0 optics-options wavelength 1529.55
user@ptx3000-2# set et-1/0/0 otn-options laser-enable
user@ptx3000-2# set et-1/0/0 otn-options signal-degrade interval 10
user@ptx3000-2# set et-1/0/0 otn-options signal-degrade ber-threshold-clear
  5.0e-7
user@ptx3000-2# set et-1/0/0 otn-options signal-degrade
  ber-threshold-signal-degrade 5.0e-3
user@ptx3000-2# set et-1/0/0 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
user@ptx3000-2# set et-1/0/0 otn-options preemptive-fast-reroute
  backward-frr-enable
user@ptx3000-2# set et-1/0/0 unit 0 family inet address 10.1.2.2/30
user@ptx3000-2# set et-1/0/0 family mpls
```

2. Configure the et-1/0/1 interface to PTX3000-3.

```
[edit interfaces]
user@ptx3000-2# set et-1/0/1 description “Direct link to PTX3000-3”
user@ptx3000-2# set et-1/0/1 mtu 9192
user@ptx3000-2# set et-1/0/1 optics-options wavelength 1529.55
user@ptx3000-2# set et-1/0/1 otn-options laser-enable
user@ptx3000-2# set et-1/0/1 otn-options signal-degrade interval 10
user@ptx3000-2# set et-1/0/1 otn-options signal-degrade ber-threshold-clear
  5.0e-7
user@ptx3000-2# set et-1/0/1 otn-options signal-degrade
  ber-threshold-signal-degrade 5.0e-3
user@ptx3000-2# set et-1/0/1 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
user@ptx3000-2# set et-1/0/1 otn-options preemptive-fast-reroute
  backward-frr-enable
user@ptx3000-2# set et-1/0/1 unit 0 family inet address 10.2.3.2/30
user@ptx3000-2# set et-1/0/1 family mpls
```

3. Configure the et-1/1/1 interface (the streaming traffic destination).

```
[edit interfaces]
user@ptx3000-2# set et-1/1/1 description “Traffic Destination”
user@ptx3000-2# set et-1/1/1 mtu 9192
user@ptx3000-2# set et-1/1/1 optics-options wavelength 1529.55
user@ptx3000-2# set et-1/1/1 otn-options laser-enable
user@ptx3000-2# set et-1/1/1 unit 0 family inet address 192.168.2.1/24
```



```
user@ptx3000-2# set et-1/1/1 unit 0 family mpls
```

4. Configure lo0 interface (to Routing Engine).

```
[edit interfaces]
user@ptx3000-2# set lo0 description "Loopback Interface"
user@ptx3000-2# set lo0 unit 0 family inet address 192.168.0.39/24 preferred
user@ptx3000-2# set lo0 unit 0 family inet address 127.0.0.1/32
```

Step-by-Step Procedure

To configure optical interfaces and loopback on PTX3000-3:

1. Configure the et-2/0/0 interface to PTX3000-1.

```
[edit interfaces]
user@ptx3000-3# set et-2/0/0 description "Direct link to PTX3000-1"
user@ptx3000-3# set et-2/0/0 mtu 9192
user@ptx3000-3# set et-2/0/0 optics-options wavelength 1529.55
user@ptx3000-3# set et-2/0/0 otn-options laser-enable
user@ptx3000-3# set et-2/0/0 otn-options signal-degrade interval 10
user@ptx3000-3# set et-2/0/0 otn-options signal-degrade ber-threshold-clear
  5.0e-7
user@ptx3000-3# set et-2/0/0 otn-options signal-degrade
  ber-threshold-signal-degrade 5.0e-3
user@ptx3000-3# set et-2/0/0 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
user@ptx3000-3# set et-2/0/0 otn-options preemptive-fast-reroute
  backward-frr-enable
user@ptx3000-3# set et-2/0/0 unit 0 family inet address 10.1.3.2/30
user@ptx3000-3# set et-2/0/0 family mpls
```

2. Configure the et-2/0/1 interface to PTX3000-2

```
[edit interfaces]
user@ptx3000-3# set et-2/0/1 description "Direct link to PTX3000-2"
user@ptx3000-3# set et-2/0/1 mtu 9192
user@ptx3000-3# set et-2/0/1 optics-options wavelength 1529.55
user@ptx3000-3# set et-2/0/1 otn-options laser-enable
user@ptx3000-3# set et-2/0/1 otn-options signal-degrade interval 10
user@ptx3000-3# set et-2/0/1 otn-options signal-degrade ber-threshold-clear
  5.0e-7
user@ptx3000-3# set et-2/0/1 otn-options signal-degrade
  ber-threshold-signal-degrade 5.0e-3
user@ptx3000-3# set et-2/0/1 otn-options preemptive-fast-reroute
  signal-degrade-monitor-enable
user@ptx3000-3# set et-2/0/1 otn-options preemptive-fast-reroute
  backward-frr-enable
user@ptx3000-3# set et-2/0/1 unit 0 family inet address 10.1.3.2/30
user@ptx3000-3# set et-2/0/1 family mpls
```

3. Configure lo0 interface (to Routing Engine).

```
[edit interfaces]
user@ptx3000-3# set lo0 description "Loopback Interface"
user@ptx3000-3# set lo0 unit 0 family inet address 192.168.0.40/24 preferred
user@ptx3000-3# set lo0 unit 0 family inet address 127.0.0.1/32
```


Configuring OSPF

Step-by-Step Procedure

To configure OSPF on all interfaces:

1. Enable OSPF on PTX3000-1.

```
[edit protocols ospf]
user@ptx3000-1# set traffic-engineering
user@ptx3000-1# set area 0.0.0.0 interface et-0/0/0.0 interface-type p2p
user@ptx3000-1# set area 0.0.0.0 interface et-0/0/1.0 interface-type p2p
user@ptx3000-1# set area 0.0.0.0 interface et-0/0/1.0 metric 10000
user@ptx3000-1# set area 0.0.0.0 interface et-0/1/0.0 interface-type p2p
user@ptx3000-1# set area 0.0.0.0 interface lo0.0 passive
```

2. Enable OSPF on PTX3000-2.

```
[edit protocols ospf]
user@ptx3000-2# set traffic-engineering
user@ptx3000-2# set area 0.0.0.0 interface et-1/0/0.0 interface-type p2p
user@ptx3000-2# set area 0.0.0.0 interface et-1/0/1.0 interface-type p2p
user@ptx3000-2# set area 0.0.0.0 interface et-1/0/1.0 metric 10000
user@ptx3000-2# set area 0.0.0.0 interface et-1/1/1.0 interface-type p2p
user@ptx3000-2# set area 0.0.0.0 interface lo0.0 passive
```

3. Enable OSPF on PTX3000-3.

```
[edit protocols ospf]
user@ptx3000-3# set traffic-engineering
user@ptx3000-3# set area 0.0.0.0 interface et-2/0/0.0 interface-type p2p
user@ptx3000-3# set area 0.0.0.0 interface et-2/0/1.0 interface-type p2p
user@ptx3000-3# set area 0.0.0.0 interface lo0.0 passive
```

Configuring LDP on PTX3000-1 and PTX3000-2

Step-by-Step Procedure

To configure LDP:

1. Enable LDP on PTX3000-1 traffic and loopback interfaces.

```
[edit protocols ldp]
user@ptx3000-1# set track-igp-metric
user@ptx3000-1# set interface et-0/1/0.0
user@ptx3000-1# set interface lo0.0
```

2. Enable LDP on PTX3000-2 traffic and loopback interfaces.

```
[edit protocols ldp]
user@ptx3000-2# set track-igp-metric
user@ptx3000-2# set interface et-1/1/1.0
user@ptx3000-2# set interface lo0.0
```

Configuring MPLS

Step-by-Step Procedure

To configure MPLS on PTX3000-1:

1. Configure parameters and LSPs on PTX3000-1.

```
[edit protocols mpls]
```

```
user@ptx3000-1# set optimize-aggressive
user@ptx3000-1# set smart-optimize-timer 10
user@ptx3000-1# set optimize-timer 10
user@ptx3000-1# set label-switched-path to-ptx3000-2 to 192.168.0.39
user@ptx3000-1# set label-switched-path to-ptx3000-2 ldp-tunneling
user@ptx3000-1# set label-switched-path to-ptx3000-2 link-protection
user@ptx3000-1# set label-switched-path to-ptx3000-2 primary direct-ptx3000-2
user@ptx3000-1# set label-switched-path to-ptx3000-2 secondary
  indirect-ptx3000-3 standby
user@ptx3000-1# set label-switched-path to-ptx3000-2 secondary
  indirect-ptx3000-3 adaptive
user@ptx3000-1# set path direct-ptx3000-2 10.1.2.2 strict
user@ptx3000-1# set path indirect-ptx3000-3 10.1.3.2 strict
user@ptx3000-1# set path indirect-ptx3000-3 10.2.3.1 strict
user@ptx3000-1# set interface et-0/0/0.0
user@ptx3000-1# set interface et-0/0/1.0
user@ptx3000-1# set interface et-0/1/0.0
```

2. Configure parameters and LSPs on PTX3000-2.

```
[edit protocols mpls]
user@ptx3000-2# set optimize-aggressive
user@ptx3000-2# set smart-optimize-timer 10
user@ptx3000-2# set optimize-timer 10
user@ptx3000-2# set label-switched-path to-ptx3000-1 to 192.168.0.38
user@ptx3000-2# set label-switched-path to-ptx3000-1 ldp-tunneling
user@ptx3000-2# set label-switched-path to-ptx3000-1 link-protection
user@ptx3000-2# set label-switched-path to-ptx3000-1 primary direct-ptx3000-1
user@ptx3000-2# set label-switched-path to-ptx3000-1 secondary
  indirect-ptx3000-3 standby
user@ptx3000-2# set label-switched-path to-ptx3000-1 secondary
  indirect-ptx3000-3 adaptive
user@ptx3000-2# set path direct-ptx3000-2 10.1.2.1 strict
user@ptx3000-2# set path indirect-ptx3000-3 10.2.3.2 strict
user@ptx3000-1# set path indirect-ptx3000-3 10.1.3.1 strict
user@ptx3000-2# set interface et-1/0/0.0
user@ptx3000-2# set interface et-1/0/1.0
user@ptx3000-2# set interface et-1/1/1.0
```

3. Configure parameters and LSPs on PTX3000-3.

NOTE: This example configuration requires only minimal MPLS configuration on the “pass-through” router PTX3000-3, where no LSPs originate or terminate. In a production environment, the configuration would be more complex.

```
[edit protocols mpls]
user@ptx3000-3# set optimize-aggressive
user@ptx3000-3# set smart-optimize-timer 10
user@ptx3000-3# set optimize-timer 10
user@ptx3000-3# set interface et-2/0/0.0
user@ptx3000-3# set interface et-2/0/1.0
```


Configuring RSVP-TE LSPs

Step-by-Step Procedure

To configure RSVP-TE link protection:

1. Configure link protection on PTX3000-1.

```
[edit protocols rsvp]
user@ptx3000-1# set interface et-0/0/0.0 link-protection
user@ptx3000-1# set interface et-0/0/1.0 link-protection
```

2. Configure link protection on PTX3000-2.

```
[edit protocols rsvp]
user@ptx3000-2# set interface et-1/0/0.0 link-protection
user@ptx3000-2# set interface et-1/0/1.0 link-protection
```

3. Configure link protection on PTX3000-3.

```
[edit protocols rsvp]
user@ptx3000-3# set interface et-2/0/0.0 link-protection
user@ptx3000-3# set interface et-2/0/1.0 link-protection
```

Results

From configuration mode, confirm your configuration by entering the **show interfaces** and **show protocols** commands. If the output does not display the intended configuration, repeat the instructions and in this example to correct the configuration.

Configuration for PTX3000-1

```
[edit]
user@ptx3000-1> show interfaces
et-0/0/0 {
  description "Direct link to PTX3000-2";
  mtu 9192;
  optics-options {
    wavelength 1529.55;
  }
  otn-options {
    laser-enable;
    signal-degrade {
      interval 10;
      ber-threshold-clear 5.0e-7;
      ber-threshold-signal-degrade 5.0e-3;
    }
    preemptive-fast-reroute {
      signal-degrade-monitor-enable;
      backward-frr-enable;
    }
  }
  unit 0 {
    family inet {
      address 10.1.2.1/30;
    }
    family mpls;
  }
}
et-0/0/1 {
```



```
    description "Direct link to PTX3000-3";
    mtu 9192;
    optics-options {
        wavelength 1550.92;
    }
    otn-options {
        laser-enable;
        signal-degrade {
            interval 10;
            ber-threshold-clear 5.0e-7;
            ber-threshold-signal-degrade 5.0e-3;
        }
        preemptive-fast-reroute {
            signal-degrade-monitor-enable;
            backward-frr-enable;
        }
    }
    unit 0 {
        family inet {
            address 10.1.3.1/30;
        }
        family mpls;
    }
}
et-0/1/0 {
    description "Traffic Source";
    mtu 9192;
    optics-options {
        wavelength 1529.55;
    }
    otn-options {
        laser-enable;
    }
    unit 0 {
        family inet {
            address 192.168.1.1/24;
        }
        family mpls;
    }
}
lo0 {
    description "Loopback Interface";
    unit 0 {
        family inet {
            address 192.168.0.38/24 preferred;
            address 127.0.0.1/32;
        }
        family mpls;
    }
}

[edit]
user@ptx3000-1> show protocols
rsvp {
    interface et-0/0/0.0 {
```



```
        link-protection;
    }
    interface et-0/0/1.0 {
        link-protection;
    }
}
mpls {
    optimize-aggressive;
    smart-optimize-timer 10;
    optimize-timer 10;
    label-switched-path to-ptx3000-2 {
        to 192.168.0.39;
        ldp-tunneling;
        primary direct-ptx3000-2;
        secondary indirect-ptx3000-3 {
            standby;
            adaptive;
        }
    }
    path direct-ptx3000-2 {
        10.1.2.2 strict;
    }
    path indirect-ptx3000-3 {
        10.1.3.2 strict;
        10.2.3.1 strict;
    }
    interface et-0/0/0.0;
    interface et-0/0/1.0;
    interface et-0/1/0.0;
}
ospf {
    traffic-engineering;
    area 0.0.0.0 {
        interface et-0/0/0.0 {
            interface-type p2p;
        }
        interface et-0/0/1.0 {
            interface-type p2p;
            metric 10000;
        }
        interface et-0/1/0.0;
        interface lo0.0 {
            passive;
        }
    }
}
    ldp {
        track-igp-metric;
        interface et-0/1/0.0;
        interface lo0.0;
    }
```

Configuration for PTX3000-2

```
[edit]
user@ptx3000-2> show interfaces
et-1/0/0 {
    description "Direct link to PTX3000-1";
```

```
    mtu 9192;
    optics-options {
      wavelength 1529.55;
    }
    otn-options {
      laser-enable;
      signal-degrade {
        interval 10;
        ber-threshold-clear 5.0e-7;
        ber-threshold-signal-degrade 5.0e-3;
      }
      preemptive-fast-reroute {
        signal-degrade-monitor-enable;
        backward-frr-enable;
      }
    }
    unit 0 {
      family inet {
        address 10.1.2.2/30;
      }
      family mpls;
    }
  }
  et-1/0/1 {
    description "Direct link to PTX3000-3";
    mtu 9192;
    optics-options {
      wavelength 1529.55;
    }
    otn-options {
      laser-enable;
      signal-degrade {
        interval 10;
        ber-threshold-clear 5.0e-7;
        ber-threshold-signal-degrade 5.0e-3;
      }
      preemptive-fast-reroute {
        signal-degrade-monitor-enable;
        backward-frr-enable;
      }
    }
    unit 0 {
      family inet {
        address 10.1.3.2/30;
      }
      family mpls;
    }
  }
  et-1/1/1 {
    description "Traffic Destination";
    mtu 9192;
    optics-options {
      wavelength 1529.55;
    }
    otn-options {
      laser-enable;
```



```
    }
    unit 0 {
        family inet {
            address 192.168.2.1/24;
        }
        family mpls;
    }
}
lo0 {
    description "Loopback Interface";
    unit 0 {
        family inet {
            address 192.168.0.39/24 preferred;
            address 127.0.0.1/32;
        }
        family mpls;
    }
}

[edit]
user@ptx3000-2> show protocols
rsvp {
    interface et-1/0/0.0 {
        link-protection;
    }
    interface et-1/0/1.0 {
        link-protection;
    }
}
mpls {
    optimize-aggressive;
    smart-optimize-timer 10;
    optimize-timer 10;
    label-switched-path to-ptx3000-1 {
        to 192.168.0.38;
        ldp-tunneling;
        primary direct-ptx3000-1;
        secondary indirect-ptx3000-3 {
            standby;
            adaptive;
        }
    }
    path direct-ptx3000-1 {
        10.1.2.1 strict;
    }
    path indirect-ptx3000-3 {
        10.2.3.2 strict;
        10.1.3.1 strict;
    }
    interface et-1/0/0.0;
    interface et-1/0/1.0;
    interface et-1/1/1.0;
}
ospf {
    traffic-engineering;
```

```
  area 0.0.0.0 {
    interface et-1/0/0.0 {
      interface-type p2p;
    }
    interface et-1/0/1.0 {
      interface-type p2p;
      metric 10000;
    }
    interface et-1/1/1.0;
    interface lo0.0 {
      passive;
    }
  }
}
ldp {
  track-igp-metric;
  interface et-1/1/1.0;
  interface lo0.0;
}
```

Configuration for PTX3000-3

```
[edit]
user@ptx3000-3> show interfaces
et-2/0/0 {
  description "Direct link to PTX3000-1";
  mtu 9192;
  optics-options {
    wavelength 1529.55;
  }
  otn-options {
    laser-enable;
    signal-degrade {
      interval 10;
      ber-threshold-clear 5.0e-7;
      ber-threshold-signal-degrade 5.0e-3;
    }
    preemptive-fast-reroute {
      signal-degrade-monitor-enable;
      backward-frr-enable;
    }
  }
  unit 0 {
    family inet {
      address 10.1.3.2/30;
    }
    family mpls;
  }
}
et-2/0/1 {
  description "Direct link to PTX3000-2";
  mtu 9192;
  optics-options {
    wavelength 1529.55;
  }
  otn-options {
    laser-enable;
    signal-degrade {
```



```
            interval 10;
            ber-threshold-clear 5.0e-7;
            ber-threshold-signal-degrade 5.0e-3;
        }
        preemptive-fast-reroute {
            signal-degrade-monitor-enable;
            backward-frr-enable;
        }
    }
    unit 0 {
        family inet {
            address 10.2.3.2/30;
        }
        family mpls;
    }
}
lo0 {
    description "Loopback Interface";
    unit 0 {
        family inet {
            address 192.168.0.40/24 preferred;
            address 127.0.0.1/32;
        }
        family mpls;
    }
}

[edit]
user@ptx3000-3> show protocols
rsvp {
    interface et-2/0/0.0 {
        link-protection;
    }
    interface et-2/0/1.0 {
        link-protection;
    }
}
mpls {
    optimize-aggressive;
    smart-optimize-timer 10;
    optimize-timer 10;
    interface et-2/0/0.0;
    interface et-2/0/1.0;
}
ospf {
    traffic-engineering;
    area 0.0.0.0 {
        interface et-2/0/0.0 {
            interface-type p2p;
        }
        interface et-2/0/1.0 {
            interface-type p2p;
            metric 10000;
        }
        interface lo0.0 {
```

```
            passive;
          }
        }
      }
```

Verification

Confirm that the configuration is working properly.

- Verifying That the Primary Path Is Working on page 28
- Verifying The the Link Fails When the BER Threshold Is Exceeded on page 28
- Verifying That the Secondary Path Is Working with Fast Reroute on page 29

Verifying That the Primary Path Is Working

Purpose Confirm that the configuration is working properly between PTX3000-1 and PTX3000-2.

Action From operational mode on PTX3000-1, enter the **show interfaces extensive et-0/0/0 | match "Corrected|Uncorrected|alarms|Phy|FEC"** command to make sure that the physical link is up with no alarms or errors.

```
user@ptx3000-1> show interfaces extensive et-0/0/0 | match
"Corrected|Uncorrected|alarms|Phy|FEC"
Physical interface: et-0/0/0, Enabled, Physical link is Up
  Active alarms  : None
  Active defects : None
  OTN alarms        : None
  OTN defects       : None
  OTN FEC Mode      : GFEC-SDFEC
  OTN FEC statistics:
    Corrected Errors                               109036039
    Uncorrected Words                                      0
    Corrected Error Ratio (        117 sec average)  7.33e-06
  OTN FEC alarms:          Seconds        Count  State
    FEC Degrade                  0            0  OK
    FEC Excessive                0            0  OK
```

Meaning The link is up, there are no active alarms or defects, the default FEC mode is enabled, and there are no FEC alarms.

Verifying The the Link Fails When the BER Threshold Is Exceeded

Purpose Confirm that the traffic no longer flows on the primary path if the BER exceeds the established threshold.

Action From operational mode on PTX3000-1, enter the **show interfaces extensive et-0/0/0 | match "Corrected|Uncorrected|alarms|Phy|FEC"** command to make sure link is down with alarms or errors.

```
user@ptx3000-1> show interfaces extensive et-0/0/0 | match
"Corrected|Uncorrected|alarms|Phy|FEC"
Physical interface: et-0/0/0, Enabled, Physical link is Down
  Active alarms  : Link
  Active defects : Link
  OTN alarms        : OTU_FEC_EXE
```



```
OTN defects         : OTU_FEC_EXE, OTU_FEC_DEG
OTN FEC Mode        : GFEC-SDFEC
OTN FEC statistics:
  Corrected Errors                              448990195302
  Uncorrected Words                                115325841
  Corrected Error Ratio (        206 sec average)  1.71e-02
OTN FEC alarms:           Seconds        Count  State
  FEC Degrade                 207            1  Defect Active
  FEC Excessive               207            1  Defect Active
```

Meaning The link is now down due to active alarms and defects.

Verifying That the Secondary Path Is Working with Fast Reroute

Purpose Confirm that the traffic still flows on the secondary path through PTX3000-3.

Action From operational mode on PTX3000-1, enter the **monitor interface traffic** command to make sure that the link to PTX3000-3 carries traffic.

```
user@ptx3000-1> monitor interface traffic

Bytes=b, Clear=c, Delta=d, Packets=p, Quit=q or ESC, Rate=r, Up=^U, Down=^D

Interface    Link  Input packets      (pps)        Output packets    (pps)
…
et-0/0/0     Down  0                 (0)          0                 (0)
et-0/0/1     Up     29994329          (100004)     29994328          (100003)
…
```

Meaning The primary link is now down, but traffic is flowing on the secondary path. This reroute occurs due to exceeding the bit error threshold, not a physical link break.

NOTE: There are other commands that can be used to verify traffic flows before and after failures. The commands used in this section emphasize the physical link operation.

Related Documentation

- Packet Optical Network Overview on page 5
- Packet Optical Network Use Cases and Technical Overview on page 7