

# Link Layer Discovery Protocol



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Juniper Networks, Inc.  
1194 North Mathilda Avenue  
Sunnyvale, California 94089  
USA  
408-745-2000  
www.juniper.net

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#### *Link Layer Discovery Protocol*

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# About the Documentation

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## Documentation and Release Notes

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If the information in the latest release notes differs from the information in the documentation, follow the product Release Notes.

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## Supported Platforms

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For the features described in this document, the following platforms are supported:

- MX Series
- T Series
- PTX Series

## Using the Examples in This Manual

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If you want to use the examples in this manual, you can use the **load merge** or the **load merge relative** command. These commands cause the software to merge the incoming configuration into the current candidate configuration. The example does not become active until you commit the candidate configuration.

If the example configuration contains the top level of the hierarchy (or multiple hierarchies), the example is a *full example*. In this case, use the **load merge** command.

If the example configuration does not start at the top level of the hierarchy, the example is a *snippet*. In this case, use the **load merge relative** command. These procedures are described in the following sections.

## Merging a Full Example

To merge a full example, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration example into a text file, save the file with a name, and copy the file to a directory on your routing platform.

For example, copy the following configuration to a file and name the file **ex-script.conf**. Copy the **ex-script.conf** file to the **/var/tmp** directory on your routing platform.

```
system {
  scripts {
    commit {
      file ex-script.xml;
    }
  }
}
interfaces {
  fxp0 {
    disable;
    unit 0 {
      family inet {
        address 10.0.0.1/24;
      }
    }
  }
}
```

2. Merge the contents of the file into your routing platform configuration by issuing the **load merge** configuration mode command:

```
[edit]
user@host# load merge /var/tmp/ex-script.conf
load complete
```

## Merging a Snippet

To merge a snippet, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration snippet into a text file, save the file with a name, and copy the file to a directory on your routing platform.

For example, copy the following snippet to a file and name the file **ex-script-snippet.conf**. Copy the **ex-script-snippet.conf** file to the **/var/tmp** directory on your routing platform.

```
commit {
  file ex-script-snippet.xml; }
```



2. Move to the hierarchy level that is relevant for this snippet by issuing the following configuration mode command:

```
[edit]
user@host# edit system scripts
[edit system scripts]
```

3. Merge the contents of the file into your routing platform configuration by issuing the **load merge relative** configuration mode command:

```
[edit system scripts]
user@host# load merge relative /var/tmp/ex-script-snippet.conf
load complete
```

For more information about the **load** command, see the CLI User Guide.

## Documentation Conventions

Table 1 on page ix defines notice icons used in this guide.

Table 1: Notice Icons





Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.

Table 2 on page ix defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
<b>Bold text like this</b>	Represents text that you type.	To enter configuration mode, type the <b>configure</b> command:  user@host> <b>configure</b>
Fixed-width text like this	Represents output that appears on the terminal screen.	user@host> <b>show chassis alarms</b> No alarms currently active

Table 2: Text and Syntax Conventions (*continued*)

Convention	Description	Examples
<i>Italic text like this</i>	<ul style="list-style-type: none"> <li>Introduces or emphasizes important new terms.</li> <li>Identifies book names.</li> <li>Identifies RFC and Internet draft titles.</li> </ul>	<ul style="list-style-type: none"> <li>A policy <i>term</i> is a named structure that defines match conditions and actions.</li> <li><i>Junos OS System Basics Configuration Guide</i></li> <li>RFC 1997, <i>BGP Communities Attribute</i></li> </ul>
<i>Italic text like this</i>	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name:  [edit] root@# <b>set system domain-name</b> <i>domain-name</i>
<b>Text like this</b>	Represents names of configuration statements, commands, files, and directories; configuration hierarchy levels; or labels on routing platform components.	<ul style="list-style-type: none"> <li>To configure a stub area, include the <b>stub</b> statement at the [edit protocols ospf area area-id] hierarchy level.</li> <li>The console port is labeled <b>CONSOLE</b>.</li> </ul>
< > (angle brackets)	Enclose optional keywords or variables.	<b>stub &lt;default-metric metric&gt;;</b>
(pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	<b>broadcast   multicast</b>  <i>(string1   string2   string3)</i>
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	<b>rsvp { # Required for dynamic MPLS only</b>
[ ] (square brackets)	Enclose a variable for which you can substitute one or more values.	<b>community name members [ community-ids ]</b>
Indentation and braces ( { } )	Identify a level in the configuration hierarchy.	[edit] routing-options { static { route default { nexthop <i>address</i> ; retain; } } }
;(semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
<b>J-Web GUI Conventions</b>		
<b>Bold text like this</b>	Represents J-Web graphical user interface (GUI) items you click or select.	<ul style="list-style-type: none"> <li>In the Logical Interfaces box, select <b>All Interfaces</b>.</li> <li>To cancel the configuration, click <b>Cancel</b>.</li> </ul>
> (bold right angle bracket)	Separates levels in a hierarchy of J-Web selections.	In the configuration editor hierarchy, select <b>Protocols&gt;Ospf</b> .

## Documentation Feedback

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- Document or topic name
- URL or page number
- Software release version (if applicable)

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- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the *JTAC User Guide* located at <http://www.juniper.net/us/en/local/pdf/resource-guides/7100059-en.pdf>.
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- JTAC hours of operation—The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

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- Search for known bugs: <http://www2.juniper.net/kb/>
- Find product documentation: <http://www.juniper.net/techpubs/>
- Find solutions and answer questions using our Knowledge Base: <http://kb.juniper.net/>
- Download the latest versions of software and review release notes: <http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications: <https://www.juniper.net/alerts/>

- Join and participate in the Juniper Networks Community Forum:  
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- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool: <https://tools.juniper.net/SerialNumberEntitlementSearch/>

## Opening a Case with JTAC

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- Use the Case Management tool in the CSC at <http://www.juniper.net/cm/>.
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, see <http://www.juniper.net/support/requesting-support.html>.

## PART 1

# Overview

- [Link Layer Discovery Protocol on page 3](#)



## CHAPTER 1

# Link Layer Discovery Protocol

- [LLDP Overview on page 3](#)

## LLDP Overview

---

The Link Layer Discovery Protocol (LLDP) is an industry-standard, vendor-neutral method to allow networked devices to advertise capabilities, identity, and other information onto a LAN. The Layer 2 protocol, detailed in IEEE 802.1AB-2005, replaces several proprietary protocols implemented by individual vendors for their equipment.

LLDP allows network devices that operate at the lower layers of a protocol stack (such as Layer 2 bridges and switches) to learn some of the capabilities and characteristics of LAN devices available to higher layer protocols, such as IP addresses. The information gathered through LLDP operation is stored in a network device and is queried with SNMP. Topology information can also be gathered from this database.

Some of the information that can be gathered by LLDP (only minimal information is mandatory) is:

- System name and description
- Port name and description
- VLAN name and identifier
- IP network management address
- Capabilities of the device (for example, switch, router, or server)
- MAC address and physical layer information
- Power information
- Link aggregation information



**NOTE:** LLDP media endpoint discovery (LLDP-MED) is not supported on T Series routers.

LLDP frames are sent at fixed intervals on each port that runs LLDP. LLDP protocol data units (LLDP PDUs) are sent inside Ethernet frames and identified by their destination Media Access Control (MAC) address (**01:80:C2:00:00:0E**) and Ethertype (**0x88CC**).

Mandatory information supplied by LLDP is chassis ID, port ID, and a time-to-live value for this information.

LLDP is a powerful way to allow Layer 2 devices to gather details about other network-attached devices.

**Related  
Documentation**

- [Configuring LLDP on page 7](#)
- [Tracing LLDP Operations on page 9](#)
- [Example: Configuring LLDP on page 10](#)
- [LLDP Operational Mode Commands on page 47](#)



## PART 2

# Configuration

- [Link Layer Discovery Protocol on page 7](#)
- [Network Interfaces Configuration Statements and Hierarchy on page 13](#)
- [Statement Summary on page 15](#)



## CHAPTER 2

# Link Layer Discovery Protocol

- [Configuring LLDP on page 7](#)
- [Tracing LLDP Operations on page 9](#)
- [Example: Configuring LLDP on page 10](#)

## Configuring LLDP

---

You configure LLDP by including the **lldp** statement and associated parameters at the **[edit protocols]** hierarchy level. The complete set of LLDP statements follows:

```
lldp {  
  advertisement-interval seconds;  
  disable;  
  hold-multiplier number;  
  interface (all | interface-name) {  
    disable;  
  }  
  lldp-configuration-notification-interval seconds;  
  port-id-subtype {  
    interface-name;  
    locally-assigned;  
  }  
  ptopo-configuration-maximum-hold-time seconds;  
  ptopo-configuration-trap-interval seconds;  
  traceoptions {  
    file filename <files number> <size size> <world-readable | no-world-readable>;  
    flag flag <flag-modifier> <disable>;  
  }  
  transmit-delay seconds  
}
```

The following statements have default values:

- **advertisement-interval**—The default value is 30 seconds. The allowable range is from 5 through 32768 seconds.
- **hold-multiplier**—The default values is 4. The allowable range is from 2 through 10.

- **ptopo-configuration-maximum-hold-time**—The default value is 300 seconds. The allowable range is from 1 through 2147483647 seconds.
- **transmit-delay**—The default value is 2 seconds. The allowable range is from 1 through 8192 seconds.

The following statements must be explicitly configured:

- **lldp-configuration-notification-interval**—The allowable range is from 0 through 3600 seconds. There is no default value.
- **ptopo-configuration-trap-interval**—The allowable range is from 1 through 2147483647 seconds. There is no default value.

To disable LLDP on all or a particular interface, include the **interfaces** statement at the **[edit protocols lldp]** hierarchy level:

```
interface (all | interface-name) {  
    disable;  
}
```

To disable LLDP on all interfaces, use the **all** option. To disable LLDP on a particular interface, include the **disable** statement with the interface name.

To configure LLDP on a T Series router within a TX Matrix, you must specify the interface name in the LLDP configuration for the TX Matrix. For information about interface names for TX Matrix routers, see TX Matrix Router Chassis and Interface Names. For information about FPC numbering, see Routing Matrix with a TX Matrix Router FPC Numbering



**NOTE:** The **interface-name** must be the physical interface (for example, **ge-1/0/0**) and not a logical interface (unit).

---

The advertisement interval determines the frequency that an LLDP interface sends LLDP advertisement frames. The default value is 30 seconds. The allowable range is from 5 through 32768 seconds. You adjust this parameter by including the **advertisement-interval** statement at the **[edit protocols lldp]** hierarchy level.

The hold multiplier determines the multiplier to apply to the advertisement interval. The resulting value in seconds is used to cache learned LLDP information before discard. The default value is 4. When used with the default advertisement interval value of 30 seconds, this makes the default cache lifetime 120 seconds. The allowable range of the hold multiplier is from 2 through 10. You adjust this parameter by including the **hold-multiplier** statement at the **[edit protocols lldp]** hierarchy level.

The transmit delay determines the delay between any two consecutive LLDP advertisement frames. The default value is 2 seconds. The allowable range is from 1 through 8192 seconds. You adjust this parameter by including the **transmit-delay** statement at the **[edit protocols lldp]** hierarchy level.

The physical topology configuration maximum hold time determines the time interval for which an agent device maintains physical topology database entries. The default

value is 300 seconds. The allowable range is from 1 through 2147483647 seconds. You adjust this parameter by including the **ptopo-configuration-maximum-hold-time** statement at the **[edit protocols lldp]** hierarchy level.

The LLDP configuration notification interval determines the period for which trap notifications are sent to the SNMP Master Agent when changes occur in the database of LLDP information. This capability is disabled by default. The allowable range is from 0 (disabled) through 3600 seconds. You adjust this parameter by including the **lldp-configuration-notification-interval** statement at the **[edit protocols lldp]** hierarchy level.

The physical topology configuration trap interval determines the period for which trap notifications are sent to the SNMP Master Agent when changes occur in the global physical topology statistics. This capability is disabled by default. The allowable range is from 0 (disabled) through 3600 seconds. The LLDP agent sends traps to the SNMP Master Agent if this interval has a value greater than 0 and there is any change during the **lldp-configuration-notification-interval** trap interval. You adjust this parameter by including the **ptopo-configuration-trap-interval** statement at the **[edit protocols lldp]** hierarchy level.

By default, LLDP generates the SNMP index of the interface for the port ID Type, Length, and Value (TLV). Starting with Junos OS Release 12.3R1, you can generate the interface name as the port ID TLV by including the **interface-name** statement at the **[edit protocols lldp port-id-subtype]** hierarchy level. When configure the **interface-name** statement on the remote LLDP neighbor, the **show lldp neighbors** command displays the interface name in the **Port ID** field rather than the SNMP index of the interface, which is displayed by default. If you change the default behavior of generating the SNMP index of the interface as the Port ID TLV, you can reenable the default behavior by including the **locally-assigned** statement at the **[edit protocols lldp port-id-subtype]** hierarchy level.

#### Related Documentation

- [LLDP Overview on page 3](#)
- [Tracing LLDP Operations on page 9](#)
- [Example: Configuring LLDP on page 10](#)
- [LLDP Operational Mode Commands on page 47](#)
- [TX Matrix Router Chassis and Interface Names](#)
- [Miscellaneous Commands for a Routing Matrix with a TX Matrix Router](#)

## Tracing LLDP Operations

To trace LLDP operational traffic, you can specify options in the global **traceoptions** statement included at the **[edit routing-options]** hierarchy level, and you can specify LLDP-specific options by including the **traceoptions** statement:

```
traceoptions {
  file filename <files number> <size size> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
```

You can include this statement at the following hierarchy levels:

- `[edit protocols lldp]`
- `[edit routing-instances routing-instance-name protocols lldp]`

You can specify the following LLDP-specific options in the LLDP **traceoptions** statement:

- **all**—Trace all operations.
- **config**—Log configuration events.
- **interface**—Trace interface update events.
- **protocol**—Trace protocol information.
- **rtsock**—Trace real-time socket events.
- **vlan**—Trace VLAN update events.



**NOTE:** Use the trace flag **all** with caution. This flag may cause the CPU to become very busy.

---

For general information about tracing and global tracing options, see the statement summary for the global **traceoptions** statement in the Junos OS Routing Protocols Configuration Guide.

**Related  
Documentation**

- [LLDP Overview on page 3](#)
- [Configuring LLDP on page 7](#)
- [Example: Configuring LLDP on page 10](#)
- [LLDP Operational Mode Commands on page 47](#)

---

## Example: Configuring LLDP

The following example configures LLDP on interface **ge-1/1/1** but disables LLDP on all other interfaces, explicitly configures the default values for all automatically enabled features, and configures a value of 30 seconds for the LLDP configuration notification interval and a value of 30 seconds for the physical topology trap interval.

```
[edit]
protocols {
  lldp {
    advertisement-interval 30;
    hold-multiplier 4;
    interface all {
      disable;
    }
    interface ge-1/1/1;
    lldp-configuration-notification-interval 30;
    ptopo-configuration-maximum-hold-time 300;
    ptopo-configuration-trap-interval 30;
    transmit-delay 2;
```

```
}
}
```

You verify operation of LLDP with several show commands:

- **show lldp <detail>**
- **show lldp neighbors *interface-name***
- **show lldp statistics *interface-name***
- **show lldp local-information**
- **show lldp remote-global-statistics**

You can clear LLDP neighbor information or statistics globally or on an interface:

- **clear lldp neighbors *interface-name***
- **clear lldp statistics *interface-name***

You can display basic information about LLDP with the **show lldp detail** command:

```
user@host> show lldp detail
LLDP                : Enabled
Advertisement interval : 30 Second(s)
Transmit delay       : 2 Second(s)
Hold timer           : 4 Second(s)
Notification interval : 30 Second(s)
Config Trap Interval : 300 Second(s)
Connection Hold timer : 60 Second(s)
```

Interface	LLDP	Neighbor count
ge-1/1/1	Enabled	0

LLDP basic TLVs supported:

Chassis identifier, Port identifier, Port description, System name, System description, System capabilities, Management address.

LLDP 802 TLVs supported:

Link aggregation, Maximum frame size, MAC/PHY Configuration/Status, Port VLAN ID, Port VLAN name.

For more details about the output of these commands, see the Junos OS Operational Mode Commands.

#### Related Documentation

- [LLDP Overview on page 3](#)
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## CHAPTER 3

# Network Interfaces Configuration Statements and Hierarchy

- [\[edit protocols lldp\] Hierarchy Level on page 13](#)

### [\[edit protocols lldp\] Hierarchy Level](#)

---

```
protocols {
  lldp {
    disable;
    advertisement-interval seconds;
    hold-multiplier seconds;
    interface (all | interface-name) {
      disable;
    }
    lldp-configuration-notification-interval seconds;
    ptopo-configuration-maximum-hold-time seconds;
    ptopo-configuration-trap-interval seconds;
    traceoptions {
      file filename <files number> <size maximum-file-size> <world-readable |
        no-world-readable>;
      flag flag <disable>;
    }
    transmit-delay seconds;
  }
}
```

#### Related Documentation

- [Notational Conventions Used in Junos OS Configuration Hierarchies](#)
- [\[edit protocols\] Hierarchy Level](#)



## CHAPTER 4

# Statement Summary

- [\[edit protocols lldp\] Hierarchy Level on page 15](#)

### [\[edit protocols lldp\] Hierarchy Level](#)

---

```
protocols {  
  lldp {  
    disable;  
    advertisement-interval seconds;  
    hold-multiplier seconds;  
    interface (all | interface-name) {  
      disable;  
    }  
    lldp-configuration-notification-interval seconds;  
    ptopo-configuration-maximum-hold-time seconds;  
    ptopo-configuration-trap-interval seconds;  
    traceoptions {  
      file filename <files number> <size maximum-file-size> <world-readable |  
        no-world-readable>;  
      flag flag <disable>;  
    }  
    transmit-delay seconds;  
  }  
}
```

#### Related Documentation


- [Notational Conventions Used in Junos OS Configuration Hierarchies](#)
- [\[edit protocols\] Hierarchy Level](#)

## lldp

---

<b>Syntax</b>	<pre>lldp {     advertisement-interval <i>seconds</i>;     disable;     hold-multiplier <i>number</i>;     interface (all   <i>interface-name</i>) {         disable;     }     lldp-configuration-notification-interval <i>seconds</i>;     port-id-subtype {         interface-name;         locally-assigned;     }     ptopo-configuration-maximum-hold-time <i>seconds</i>;     ptopo-configuration-trap-interval <i>seconds</i>;     traceoptions {         file <i>filename</i> &lt;files <i>number</i>&gt; &lt;size <i>maximum-file-size</i>&gt; &lt;world-readable           no-world-readable&gt;;         flag <i>flag</i> &lt;disable&gt;;     } }</pre>
<b>Hierarchy Level</b>	[edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	(MX Series and T Series routers only) Specify LLDP configuration parameters.
<b>Options</b>	The statements are explained separately.
<b>Required Privilege Level</b>	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">Configuring LLDP on page 7</a></li></ul>

## advertisement-interval


<b>Syntax</b>	<code>advertisement-interval seconds;</code>
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6 for MX Series and T Series routers. Statement introduced in Junos OS Release 9.0 for EX Series switches. Statement introduced in Junos OS Release 11.1 for the QFX Series.
<b>Description</b>	<p>For MX Series and T Series routers, configure an interval for LLDP advertisement.</p> <p>For switches configured for Link Layer Discovery Protocol, configure the frequency at which LLDP advertisements are sent.</p> <p>The <b>advertisement-interval</b> value must be greater than or equal to four times the <b>transmit-delay</b> value, or an error will be returned when you attempt to commit the configuration.</p> <div>  <p><b>NOTE:</b> The default value of <b>transmit-delay</b> is 2 seconds. If you configure the <b>advertisement-interval</b> as less than 8 seconds and you do not configure a value for <b>transmit-delay</b>, the default value of <b>transmit-delay</b> is automatically changed to 1 second in order to satisfy the requirement that the <b>advertisement-interval</b> value must be greater than or equal to four times the <b>transmit-delay</b> value.</p> </div>
<b>Default</b>	Disabled.
<b>Options</b>	<p><b>seconds</b>—Interval between LLDP advertisement.</p> <p><b>Default:</b> 30</p> <p><b>Range:</b> 5 through 32768</p>
<b>Required Privilege Level</b>	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">Configuring LLDP on page 7</a></li> <li>• <code>show lldp</code></li> <li>• Configuring LLDP (CLI Procedure)</li> <li>• Understanding 802.1X and LLDP and LLDP-MED on EX Series Switches</li> <li>• <code>transmit-delay</code></li> <li>• Understanding LLDP</li> </ul>

## disable

---

<b>Syntax</b>	disable;
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit protocols <a href="#">lldp interface</a> (all   <i>interface-name</i> )], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp interface</a> (all   <i>interface-name</i> )]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	<p>(MX Series and T Series routers only) Disable LLDP globally or on an interface.</p> <p>For information about interface names, see Interface Naming Overview. For information about interface names for TX Matrix routers, see TX Matrix Router Chassis and Interface Names. For information about FPC numbering on TX Matrix routers, see Routing Matrix with a TX Matrix Router FPC Numbering.</p>
<b>Required Privilege Level</b>	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">Configuring LLDP on page 7</a></li></ul>

## fast-aps-switch

<b>Syntax</b>	fast-aps-switch;
<b>Hierarchy Level</b>	[edit interfaces <i>interface-name</i> sonet-options aps]
<b>Release Information</b>	Statement introduced in Junos OS Release 12.1.
<b>Description</b>	(M320 routers with Channelized OC3/STM1 Circuit Emulation PIC with SFP only) Reduce the Automatic Protection Switching (APS) switchover time in Layer 2 circuits.
	<div>  <p><b>NOTE:</b></p> <ul style="list-style-type: none"> <li>Configuring this statement reduces the APS switchover time only when the Layer 2 circuit encapsulation type for the interface receiving traffic from a Layer 2 circuit neighbor is SAToP.</li> <li>When the fast-aps-switch statement is configured in revertive APS mode, you must configure an appropriate value for revert time to achieve reduction in APS switchover time.</li> <li>To prevent the logical interfaces in the data path from being shut down, configure appropriate hold-time values on all the interfaces in the data path that support TDM.</li> <li>The fast-aps-switch statement cannot be configured when the APS annex-b option is configured.</li> <li>The interfaces that have the fast-aps-switch statement configured cannot be used in virtual private LAN service (VPLS) environments.</li> </ul> </div>
<b>Required Privilege Level</b>	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>Reducing APS Switchover Time in Layer 2 Circuits</li> </ul>

## hold-multiplier

---

<b>Syntax</b>	<code>hold-multiplier <i>number</i>;</code>
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	(MX Series and T Series routers only) Configure a value for the LLDP hold multiplier.  Hold timer interval in seconds to cache learned LLDP information before discarding.
<b>Options</b>	<b><i>number</i></b> —Advertisement interval multiplier for LLDP cache discard. <b>Default:</b> 4 (giving 120 second LLDP cache lifetime with other defaults) <b>Range:</b> 2 through 10
<b>Required Privilege Level</b>	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">Configuring LLDP on page 7</a></li></ul>



## interface

<b>Syntax</b>	interface (all   <i>interface-name</i> ) { <b>disable</b> ; }
<b>Hierarchy Level</b>	[edit protocols <b>lldp</b> ], [edit routing-instances <i>routing-instance-name</i> protocols <b>lldp</b> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	(MX Series and T Series routers only) Specify an LLDP interface.
<b>Options</b>	<i>interface-name</i> —A valid physical interface name.



**NOTE:** On MX Series and T Series routers, you run LLDP on a physical interface, such as ge-1/0/0, and not at the logical interface (unit) level.

For information about interface names, see [Interface Naming Overview](#). For information about interface names for TX Matrix routers, see [TX Matrix Router Chassis and Interface Names](#). For information about FPC numbering on TX Matrix routers, see [Routing Matrix with a TX Matrix Router FPC Numbering](#).

**all**—Run LLDP on all interfaces.

**disable**—Disable LLDP on the specified interface

<b>Required Privilege Level</b>	routing—To view this statement in the configuration.
	routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">Configuring LLDP on page 7</a></li> </ul>

## lldp-configuration-notification-interval

---

<b>Syntax</b>	lldp-configuration-notification-interval <i>seconds</i> ;
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	(MX Series and T Series routers only) Configure a time for the period of SNMP trap notifications to the Master Agent to wait regarding changes in database information.
<b>Options</b>	<b><i>seconds</i></b> —Time for the period of SNMP trap notifications about the LLDP database. This feature is disabled by default. <b>Range:</b> 0 through 3600
<b>Required Privilege Level</b>	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">Configuring LLDP on page 7</a></li></ul>

## port-id-subtype

---

<b>Syntax</b>	port-id-subtype { interface-name; locally-assigned; }
<b>Hierarchy Level</b>	[edit protocols lldp] [edit routing- instances <i>routing-instance-name</i> protocols lldp]
<b>Release Information</b>	Statement introduced in Junos OS Release 12.3R1
<b>Description</b>	(MX Series ,T Series, and PTX routers only) For Link Layer Discovery Protocol, configure the port ID Type, Length, and Value (TLV).
<b>Options</b>	<p><b>interface-name</b>—Generate the interface name as the port ID TLV. When you configure this statement on the remote LLDP neighbor, the interface name is displayed in the <b>Port ID</b> field of the <b>show lldp neighbors</b> command</p> <p><b>Default: locally-assigned</b>—Generate the SNMP Index of the interface as the port ID TLV. By default, the SNMPif Index of the remote neighbor is displayed in the <b>Port ID</b> field of the <b>show lldp neighbors</b> command.</p>
<b>Required Privilege Level</b>	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">lldp on page 16</a></li> <li>• <a href="#">Configuring LLDP on page 7</a></li> <li>• <a href="#">show lldp neighbors on page 39</a></li> </ul>

## ptopo-configuration-maximum-hold-time

---

<b>Syntax</b>	ptopo-configuration-maximum-hold-time <i>seconds</i> ;
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	(MX Series and T Series routers only) Configure a time to maintain dynamic topology entries.
<b>Options</b>	<b><i>seconds</i></b> —Time to maintain interval dynamic topology entries. <b>Default:</b> 300 <b>Range:</b> 1 through 2147483647
<b>Required Privilege Level</b>	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">Configuring LLDP on page 7</a></li></ul>

## ptopo-configuration-trap-interval

---

<b>Syntax</b>	ptopo-configuration-trap-interval <i>seconds</i> ;
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	(MX Series and T Series routers only) Configure a time for the period of SNMP trap notifications to the Master Agent to wait regarding changes in topology global statistics.
<b>Options</b>	<b><i>seconds</i></b> —Time for the period of SNMP trap notifications about global statistics. This feature is disabled by default. <b>Range:</b> 0 through 3600
<b>Required Privilege Level</b>	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">Configuring LLDP on page 7</a></li></ul>

## traceoptions

<b>Syntax</b>	<pre> traceoptions {     file <i>filename</i> &lt;files <i>number</i>&gt; &lt;size <i>maximum-file-size</i>&gt; &lt;world-readable       no-world-readable&gt;;     flag <i>flag</i> &lt;disable&gt;; } </pre>
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	Set LLDP protocol-level tracing options.
<b>Default</b>	The default LLDP protocol-level trace options are inherited from the global <b>traceoptions</b> statement.
<b>Options</b>	<p><b>disable</b>—(Optional) Disable the tracing operation. One use of this option is to disable a single operation when you have defined a broad group of tracing operations, such as <b>all</b>.</p> <p><b>file <i>filename</i></b>—Name of the file to receive the output of the tracing operation. Enclose the name in quotation marks. We recommend that you place spanning-tree protocol tracing output in the file <code>/var/log/stp-log</code>.</p> <p><b>files <i>number</i></b>—(Optional) Maximum number of trace files. When a trace file named <b>trace-file</b> reaches its maximum size, it is renamed <b>trace-file.0</b>, then <b>trace-file.1</b>, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you must also specify a maximum file size with the <b>size</b> option.</p> <p><b>Range:</b> 2 through 1000 files</p> <p><b>Default:</b> 1 trace file only</p> <p><b>flag</b>—Tracing operation to perform. To specify more than one tracing operation, include multiple <b>flag</b> statements. The following are the LLDP-specific tracing options:</p> <ul style="list-style-type: none"> <li>• <b>all</b>—Trace all operations.</li> <li>• <b>config</b>—Log configuration events.</li> <li>• <b>interface</b>—Trace interface update events.</li> <li>• <b>protocol</b>—Trace protocol information.</li> <li>• <b>rtsock</b>—Trace socket events.</li> <li>• <b>vlan</b>—Trace vlan update events.</li> </ul>

The following are the global tracing options:

- **all**—All tracing operations.
- **config-internal**—Trace configuration internals.
- **general**—Trace general events.
- **normal**—All normal events. This is the default. If you do not specify this option, only unusual or abnormal operations are traced.
- **parse**—Trace configuration parsing.
- **policy**—Trace policy operations and actions.
- **regex-parse**—Trace regular-expression parsing.
- **route**—Trace routing table changes.
- **state**—Trace state transitions.
- **task**—Trace protocol task processing.
- **timer**—Trace protocol task timer processing.

**no-world-readable**—(Optional) Prevent any user from reading the log file. This is the default. If you do not include this option, tracing output is appended to an existing trace file.

**size maximum-file-size**—(Optional) Maximum size of each trace file, in kilobytes (KB) or megabytes (MB). When a trace file named **trace-file** reaches this size, it is renamed **trace-file.0**. When the **trace-file** again reaches its maximum size, **trace-file.0** is renamed **trace-file.1** and **trace-file** is renamed **trace-file.0**. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

If you specify a maximum file size, you must also specify a maximum number of trace files with the **files** option.

**Syntax:** **xk** to specify KB, **xm** to specify MB, or **xg** to specify GB

**Range:** 10 KB through the maximum file size supported on your system

**Default:** 1 MB

**world-readable**—(Optional) Allow any user to read the log file.

Required Privilege Level	routing—To view this statement in the configuration.
	routing-control—To add this statement to the configuration.
Related Documentation	<ul style="list-style-type: none"><li>• <a href="#">Tracing LLDP Operations on page 9</a></li></ul>

---

## transmit-delay

---

<b>Syntax</b>	<code>transmit-delay <i>seconds</i>;</code>
<b>Hierarchy Level</b>	[edit protocols <a href="#">lldp</a> ], [edit routing-instances <i>routing-instance-name</i> protocols <a href="#">lldp</a> ]
<b>Release Information</b>	Statement introduced in Junos OS Release 9.6.
<b>Description</b>	(MX Series and T Series routers only) Configure a delay between two successive LLDP advertisements.
<b>Options</b>	<b><i>seconds</i></b> —Delay between two successive LLDP advertisements. <b>Default:</b> 2 <b>Range:</b> 1 through 8192
<b>Required Privilege Level</b>	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">Configuring LLDP on page 7</a></li></ul>





## PART 3

# Administration

- [Monitoring Commands on page 31](#)
- [Command Summary on page 47](#)



## CHAPTER 5

# Monitoring Commands

## clear lldp neighbor

---

<b>Syntax</b>	<b>clear lldp neighbor</b> <b>&lt;interface <i>interface-name</i>&gt;</b>
<b>Release Information</b>	Command introduced in Junos OS Release 9.6.
<b>Description</b>	<p>On MX Series and T Series routers, clear information regarding all Link Layer Discovery Protocol (LLDP) neighbors or LLDP neighbors of the specified interface.</p> <p>For information about interface names, see <a href="#">Interface Naming Overview</a>. For information about interface names for TX Matrix routers, see <a href="#">TX Matrix Router Chassis and Interface Names</a>. For information about FPC numbering on TX Matrix routers, see <a href="#">Routing Matrix with a TX Matrix Router FPC Numbering</a>.</p>
<b>Options</b>	<b>interface <i>interface-name</i></b> —(Optional) Clear the LLDP neighbors on the specified interface.
<b>Required Privilege Level</b>	clear
<b>Related Documentation</b>	<ul style="list-style-type: none"><li>• <a href="#">clear lldp statistics on page 33</a></li></ul>
<b>List of Sample Output</b>	<a href="#">clear lldp statistics on page 32</a>
<b>Output Fields</b>	When you enter this command, you are provided no feedback on the status of your request. You can enter the <b>show lldp neighbors</b> command before and after clearing the LLDP neighbors to verify the clear operation.

## Sample Output

```
clear lldp statistics      user@host> clear lldp statistics
                           user@host> clear lldp statistics interface ge-0/2/0
```

## clear lldp statistics

<b>Syntax</b>	<code>clear lldpp neighbor</code> <code>&lt;interface <i>interface-name</i>&gt;</code>
<b>Release Information</b>	Command introduced in Junos OS Release 9.6.
<b>Description</b>	<p>On MX Series and T Series routers, clear all Link Layer Discovery Protocols (LLDP) statistics or LLDP statistics associated with the specified interface.</p> <p>For information about interface names, see Interface Naming Overview. For information about interface names for TX Matrix routers, see TX Matrix Router Chassis and Interface Names. For information about FPC numbering on TX Matrix routers, see Routing Matrix with a TX Matrix Router FPC Numbering.</p>
<b>Options</b>	<code>interface <i>interface-name</i></code> —(Optional) Clear LLDP statistics on the specified interface.
<b>Required Privilege Level</b>	clear
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">clear lldp neighbor on page 32</a></li> </ul>
<b>List of Sample Output</b>	<a href="#">clear lldp neighbor on page 33</a>
<b>Output Fields</b>	When you enter this command, you are provided no feedback on the status of your request. You can enter the <b>show lldp statistics</b> command before and after clearing the LLDP statistics to verify the clear operation.

## Sample Output

```
clear lldp neighbor      user@host> clear lldp neighbors
                        user@host> clear lldp neighbors interface ge-0/2/2
```

## show lldp

<b>Syntax</b>	<code>show lldp</code> <code>&lt;detail&gt;</code>
<b>Release Information</b>	Command introduced in Junos OS Release 9.6.
<b>Description</b>	On MX Series and T Series routers, display information about the Link Layer Discovery Protocol (LLDP).
<b>Options</b>	<b>detail</b> —(Optional) Display the detailed output level.
<b>Required Privilege Level</b>	view
<b>List of Sample Output</b>	<a href="#">show lldp on page 36</a> <a href="#">show lldp detail on page 36</a>
<b>Output Fields</b>	<a href="#">Table 3 on page 34</a> describes the output fields for the <b>show lldp</b> command. Output fields are listed in the approximate order in which they appear.

**Table 3: show lldp Output Fields**

Field Name	Field Description
<b>LLDP</b>	Status of LLDP: <b>Enabled</b> or <b>Disabled</b> .
<b>Advertisement interval</b>	Value of the advertisement interval parameter.
<b>Transmit delay</b>	Value of the transmit delay parameter.
<b>Hold timer</b>	Value of the hold timer parameter.
<b>Notification interval</b>	Value of the notification interval parameter.
<b>Config Trap Interval</b>	Value of the configuration trap parameter.
<b>Connection Hold timer</b>	Value of the connection hold timer parameter.
<b>Interface</b>	<p>List of LLDP interfaces, showing status (<b>Enabled</b> or <b>Disabled</b>) and <b>Neighbor count</b> (<b>detail</b> only).</p> <p>For information about interface names, see Interface Naming Overview. For information about interface names for TX Matrix routers, see TX Matrix Router Chassis and Interface Names. For information about FPC numbering on TX Matrix routers, see Routing Matrix with a TX Matrix Router FPC Numbering.</p>
<b>LLDP basic TLVs supported</b>	List of basic LLDP TLVs supported by this device ( <b>detail</b> only).

Table 3: show lldp Output Fields (*continued*)

Field Name	Field Description
LLDP 802 TLVs supported	List of IEEE 802.1 LLDP TLVs supported by this device ( <b>detail</b> only).

## Sample Output

### show lldp

```
user@host> show lldp
LLDP : Enabled
Advertisement interval : 30 Second(s)
Transmit delay : 2 Second(s)
Hold timer : 4 Second(s)
Notification interval : 30 Second(s)
Config Trap Interval : 300 Second(s)
Connection Hold timer : 60 Second(s)
```

Interface	LLDP
ge-0/0/0	Enabled
ge-0/0/1	Enabled
ge-0/0/4	Enabled

## Sample Output

### show lldp detail

```
user@host> show lldp detail
LLDP : Enabled
Advertisement interval : 30 Second(s)
Transmit delay : 2 Second(s)
Hold timer : 4 Second(s)
Notification interval : 30 Second(s)
Config Trap Interval : 300 Second(s)
Connection Hold timer : 60 Second(s)
```

Interface	LLDP	Neighbor count
ge-0/0/0	Enabled	0
ge-0/0/1	Enabled	0
ge-0/0/4	Enabled	0

LLDP basic TLVs supported:

Chassis identifier, Port identifier, Port description, System name, System description, System capabilities, Management address.

LLDP 802 TLVs supported:

Link aggregation, Maximum frame size, MAC/PHY Configuration/Status, Port VLAN ID, Port VLAN name.



## show lldp local-information

<b>Syntax</b>	show lldp local-information
<b>Release Information</b>	Command introduced in Junos OS Release 9.6.
<b>Description</b>	On MX Series and T Series routers, display local Link Layer Discovery Protocol (LLDP) information.
<b>Options</b>	This command has no options.
<b>Required Privilege Level</b>	view
<b>List of Sample Output</b>	<a href="#">show lldp local-information on page 38</a>
<b>Output Fields</b>	<a href="#">Table 4 on page 37</a> describes the output fields for the <b>show lldp local-information</b> command. Output fields are listed in the approximate order in which they appear.

**Table 4: show lldp local-information Output Fields**

Field Name	Field Description
<b>LLDP Local Information details</b>	Information that follows pertains to the local system.
<b>Chassis ID</b>	List of chassis identifiers for local information.
<b>System name</b>	Local system name reported by LLDP.
<b>System descr</b>	Local system description reported by LLDP.
<b>System Capabilities</b>	Capabilities (such as <b>Bridge</b> or <b>Router</b> ) that are <b>Supported</b> or <b>Enabled</b> by system on the interface.
<b>Management Information</b>	Listed by <b>Interface Name</b> , <b>Address Subtype</b> (such as <b>ipv4</b> ), <b>Address</b> (such as <b>192.168.168.229</b> ), <b>Interface Number</b> , and <b>Interface Numbering Subtype</b> .
<b>Interface Name</b>	List of local interfaces.  For information about interface names, see Interface Naming Overview. For information about interface names for TX Matrix routers, see TX Matrix Router Chassis and Interface Names. For information about FPC numbering on TX Matrix routers, see Routing Matrix with a TX Matrix Router FPC Numbering.
<b>Interface ID</b>	List of local interface identifiers.
<b>Interface Description</b>	List of local interface descriptions.
<b>Status</b>	List of interface conditions: <b>UP</b> or <b>DOWN</b> .

## Sample Output

**show lldp**  
**local-information**

user@host> **show lldp local-information**

LLDP Local Information details

Chassis ID : 00:90:69:0a:77:c0

System name : sw-mx-u

System descr : Juniper Networks, Inc. MX 960, Version 9.4I0.1, Build date  
2008-09-04 14:51:50 UTC

### System Capabilities

Supported : Bridge Router

Enabled : Bridge Router

### Management Information

Interface Name : fxp0

Address Subtype : IPv4(1)

Address : 192.168.168.229

Interface Number : 1

Interface Numbering Subtype : ifIndex(2)

Interface Name	Interface ID	Interface Description	Status
ge-0/1/0	18	Avaya Port	UP
ge-0/1/1	27	-	DOWN
ge-0/1/2	13	Port for Hub	UP

## show lldp neighbors

<b>Syntax</b>	<code>show lldp neighbors</code> <code>&lt;interface <i>interface-name</i>&gt;</code>
<b>Release Information</b>	Command introduced in Junos OS Release 9.6.
<b>Description</b>	On MX Series and T Series routers, display information about LLDP neighbors.  For information about interface names, see Interface Naming Overview. For information about interface names for TX Matrix routers, see TX Matrix Router Chassis and Interface Names. For information about FPC numbering on TX Matrix routers, see Routing Matrix with a TX Matrix Router FPC Numbering.
<b>Options</b>	<code>interface <i>interface-name</i></code> —(Optional) Display the neighbor information about a particular physical interface.
<b>Required Privilege Level</b>	view
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li><a href="#">clear lldp neighbor on page 32</a></li> </ul>
<b>List of Sample Output</b>	<a href="#">show lldp neighbors on page 41</a> <a href="#">show lldp neighbors interface ge-0/0/4 on page 41</a>
<b>Output Fields</b>	<a href="#">Table 5 on page 39</a> describes the output fields for the <b>show lldp neighbors</b> command. Output fields are listed in the approximate order in which they appear.

**Table 5: show lldp neighbors Output Fields**

Field Name	Field Description
LLDP Remote Devices Information	Information about remote devices.
LocalInterface	List of local interfaces for which neighbor information is available.
ChassisId	List of chassis identifiers for neighbors.
PortInfo	List of port information gathered from neighbors. This could be the port identifier or port description.
SysName	List of system names gathered from neighbors.
LLDP Neighbor Information	Information about both local and neighbor systems on the interface (appears when the <code>interface</code> option is used).
Local Information	Information about local systems on the interface (appears when the <code>interface</code> option is used).

Table 5: show lldp neighbors Output Fields (*continued*)

Field Name	Field Description
<b>Neighbor Information</b>	Information about both local and neighbor system on the interface (appears when the <b>interface</b> option is used).
<b>Index</b>	Local interface index (appears when the <b>interface</b> option is used).
<b>Time Mark</b>	Date and timestamp of information (appears when the <b>interface</b> option is used).
<b>Time To Live</b>	Number of seconds for which this information is valid (appears when the <b>interface</b> option is used).
<b>Local Interface</b>	Name of the local physical interface (appears when the <b>interface</b> option is used).
<b>Local Port ID</b>	Local port identifier (appears when the <b>interface</b> option is used).
<b>Neighbor Information</b>	Information about neighbor systems on the interface (appears when the <b>interface</b> option is used).
<b>Chassis type</b>	Type of chassis identifier supplied, such as <b>MAC address</b> (appears when the <b>interface</b> option is used).
<b>Chassis ID</b>	Chassis identifier of type listed (appears when the <b>interface</b> option is used).
<b>Port type</b>	Type of port identifier supplied, such as <b>local</b> (appears when the <b>interface</b> option is used).
<b>Port ID</b>	Port identifier of type listed (appears when the <b>interface</b> option is used).
<b>Port description</b>	Port description (appears when the <b>interface</b> option is used).
<b>System name</b>	Name supplied by the system on the interface (appears when the <b>interface</b> option is used).
<b>System Description</b>	Description supplied by the system on the interface (appears when the <b>interface</b> option is used).
<b>System Capabilities</b>	Capabilities (such as <b>bridge</b> or <b>router</b> ) that are <b>Supported</b> or <b>Enabled</b> by the system on the interface (appears when the <b>interface</b> option is used).
<b>Management address</b>	Details of the management address: <b>Address Type</b> (such as <b>ipv4</b> ), <b>Address</b> (such as <b>10.204.34.35</b> ), <b>Interface Number</b> , <b>Interface Subtype</b> , and Organization Identifier ( <b>OID</b> ) (appears when the <b>interface</b> option is used).
<b>Organization Info</b>	One or more entries listing remote information by Organizationally Unique Identifier ( <b>OUI</b> ), <b>Subtype</b> , <b>Index</b> , and <b>Info</b> (appears when the <b>interface</b> option is used).

## Sample Output

show lldp neighbors

```
user@host> show lldp neighbors
LLDP Remote Devices Information
```

LocalInterface	ChassisId	PortInfo	SysName
ge-0/0/0	10.209.192.12	00 19 bb 20 de 80	AVA4C357D
ge-0/0/1	10.209.192.12	00 19 bb 20 de 80	AVA4C357D
ge-0/0/1	10.209.192.13	00 19 bb 20 de 81	AVA4C357E
ge-0/0/3	00 19 bb 20 de 79	5	apg-hp1
ge-0/0/3	00 19 bb 20 de 80	3	apg-hp1
ge-0/0/4	00 19 bb 20 de 79	5	apg-hp1
ge-0/0/4	00 19 bb 20 de 80	3	apg-hp1
ge-0/0/5	00 19 bb 20 de 81	ge-0/0/3	MX480-1
ge-0/0/6	00 19 bb 20 de 82	ge-0/0/4	MX960-2

## Sample Output

show lldp neighbors  
interface ge-0/0/4

```
user@host> show lldp neighbors interface ge-0/0/4
LLDP Neighbor Information:
Local Information:
  Index 6 Time Mark Wed Jun 20 07:34:11 2007 Time To Live 120 seconds
  Local Interface   : ge-0/0/4
  Local Port ID     : 4

Neighbor Information:
  Chassis type      : Mac address
  Chassis ID        : 00 19 bb 20 de 80
  Port type         : local
  Port ID           : 3
  Port description  : 3
  System name       : apg-hp1

System Description : ProCurve J9049A Switch 2900-24G, revision
                    T.11.X1, ROM K....

System Capabilities
  Supported : bridge, router
  Enabled   : bridge

Management address
  Address Type : ipv4
  Address      : 10.204.34.35
  Interface Number : 1
  Interface Subtype : ifIndex(2)
  OID          : 1.3.6.1.2.1.31.1.1.1.1.1

Organization Info
  OUI : 0.18.15
  Subtype : 1
  Index : 1
  Info : 00A0000000

Organization Info
  OUI : 0.18.15
  Subtype : 3
  Index : 2
  Info : 0100000000
```

Organization Info

OUI : 0.18.15  
Subtype : 4  
Index : 3  
Info : 05EA

## show lldp remote-global-statistics

<b>Syntax</b>	show lldp remote-global-statistics
<b>Release Information</b>	Command introduced in Junos OS Release 9.6.
<b>Description</b>	On MX Series and T Series routers, display remote Link Layer Discovery Protocol (LLDP) global statistics.
<b>Options</b>	This command has no options.
<b>Required Privilege Level</b>	view
<b>List of Sample Output</b>	<a href="#">show lldp remote-global-statistics on page 44</a>
<b>Output Fields</b>	<a href="#">Table 6 on page 43</a> describes the output fields for the <b>show lldp remote-global-statistics</b> command. Output fields are listed in the approximate order in which they appear.

**Table 6: show lldp remote-global-statistics Output Fields**

Field Name	Field Description
LLDP Remote Database Table Counters	Information about remote database table counters.
LastchangeTime	Time elapsed between LLDP agent startup and the last change to the remote database table information.
Inserts	Number of insertions made in the remote database table.
Deletes	Number of deletions made in the remote database table.
Drops	Number of LLDP frames dropped from the remote database table because of errors.
Ageouts	Number of remote database table entries that have aged out of the table.

## Sample Output

```
show lldp remote-global-statistics
user@host> show lldp remote-global-statistics
LLDP Remote Database Table Counters
LastchangeTime      Inserts    Deletes    Drops    Ageouts
00:00:76 (76 sec)   192        0          0        0
```



## show lldp statistics

<b>Syntax</b>	show lldp statistics <interface <i>interface-name</i> >
<b>Release Information</b>	Command introduced in Junos OS Release 9.6.
<b>Description</b>	On MX Series and T Series routers, display information about Link Layer Discovery Protocol (LLDP) statistics.
<b>Options</b>	<b>interface <i>interface-name</i></b> —(Optional) Display the statistics about a particular physical interface.
<b>Required Privilege Level</b>	view
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">clear lldp statistics on page 33</a></li> </ul>
<b>List of Sample Output</b>	<a href="#">show lldp statistics on page 46</a> <a href="#">show lldp statistics interface ge-0/1/1 on page 46</a>
<b>Output Fields</b>	<a href="#">Table 7 on page 45</a> describes the output fields for the <b>show lldp statistics</b> command. Output fields are listed in the approximate order in which they appear.

**Table 7: show lldp statistics Output Fields**

Field Name	Field Description
<b>Interface</b>	Interface name.  For information about interface names, see Interface Naming Overview. For information about interface names for TX Matrix routers, see TX Matrix Router Chassis and Interface Names. For information about FPC numbering on TX Matrix routers, see Routing Matrix with a TX Matrix Router FPC Numbering.
<b>Received</b>	Number of LLDP frames received on this interface.
<b>Transmitted</b>	Number of LLDP frames sent on this interface.
<b>Unknown-TLVs</b>	Number of LLDP frames with unsupported content received on this interface.
<b>With-Errors</b>	Number of LLDP frames with errors received on this interface.
<b>Discarded</b>	Number of LLDP frames received on this interface that were discarded because of problems.

## Sample Output

**show lldp statistics**

```
user@host> show lldp statistics
Interface Received Transmitted Unknown-TLVs With-Errors Discarded
-----
ge-0/1/1  544      540          0           0           0
ge-0/1/2  540      500          0           0           0
ge-0/1/3  544      540          0           0           0
ge-0/1/4  544      540          0           0           0
ge-0/1/5  544      540          0           0           0
ge-0/1/6  544      540          0           0           0
ge-0/1/7  0         0            0           0           0
```

## Sample Output

**show lldp statistics  
interface ge-0/1/1**

```
user@host> show lldp statistics interface ge-0/1/1
Interface Received Transmitted Unknown-TLVs With-Errors Discarded
-----
ge-0/1/1  544      540          0           0           0
```

# Command Summary

- [LLDP Operational Mode Commands on page 47](#)

## LLDP Operational Mode Commands

Table 8 on page 47 summarizes the command-line interface (CLI) commands you can use to monitor and troubleshoot the Link Layer Discovery Protocol (LLDP) protocol. Commands are listed in alphabetical order.

Table 8: LLDP Operational Mode Commands

Task	Command
Clear LLDP neighbor information.	<code>clear lldp neighbor</code>
Clear LLDP statistics.	<code>clear lldp statistics</code>
Display basic LLDP information.	<code>show lldp</code>
Display LLDP local information.	<code>show lldp local-information</code>
Display LLDP neighbor information.	<code>show lldp neighbors</code>
Display LLDP remote global statistics.	<code>show lldp remote-global-statistics</code>
Display LLDP statistics.	<code>show lldp statistics</code>

**Related  
Documentation**

- [LLDP Overview on page 3](#)
- [Configuring LLDP on page 7](#)
- [Tracing LLDP Operations on page 9](#)
- [Example: Configuring LLDP on page 10](#)



## PART 4

# Troubleshooting

- [Ethernet on page 51](#)
- [Interface Diagnostics on page 55](#)



## CHAPTER 7

# Ethernet

## traceroute ethernet

<b>Syntax</b>	<b>traceroute ethernet</b> ( <i>mac-address</i>   <i>mep-id</i> ) <b>maintenance-association</b> <i>ma-name</i> <b>maintenance-domain</b> <i>md-name</i> <b>ttl</b> <i>value</i> <b>&lt;wait seconds&gt;</b>
<b>Release Information</b>	Command introduced in Junos OS Release 9.0. <b>mep-id</b> option introduced in Junos OS Release 9.1.
<b>Description</b>	<p>Triggers the linktrace protocol to trace the route between two maintenance points. The result of the traceroute protocol is stored in the path database. To display the path database, use the <b>show oam ethernet connectivity-fault-management path-database</b> command.</p> <p>Before using the traceroute command, you can verify the remote MEP's MAC address using the <b>show oam ethernet connectivity-fault-management path-database</b> command.</p>
<b>Options</b>	<p><b>mac-address</b>—Destination unicast MAC address of the remote maintenance point.</p> <p><b>mep-id</b>—MEP identifier of the remote maintenance point. The range of values is 1 through 8191.</p> <p><b>maintenance-association</b> <i>ma-name</i>—Specifies an existing maintenance association from the set of configured maintenance associations.</p> <p><b>maintenance-domain</b> <i>md-name</i>—Specifies an existing maintenance domain from the set of configured maintenance domains.</p> <p><b>ttl value</b>—Number of hops to use in the linktrace request. The range is 1 to 255 hops. The default is 4.</p> <p><b>wait seconds</b>—(Optional) Maximum time to wait for a response to the traceroute request. The range is 1 to 255 seconds. The default is 5.</p>
<b>Required Privilege Level</b>	network
<b>List of Sample Output</b>	<a href="#">traceroute ethernet on page 53</a>
<b>Output Fields</b>	<p><a href="#">Table 9 on page 52</a> lists the output fields for the <b>traceroute ethernet</b> command. Output fields are listed in the approximate order in which they appear.</p>

**Table 9: traceroute ethernet Output Fields**

Field Name	Field Description
Linktrace to	MAC address of the destination maintenance point.
Interface	Local interface used to send the linktrace message (LTM).



Table 9: traceroute ethernet Output Fields (*continued*)

Field Name	Field Description
<b>Maintenance Domain</b>	Maintenance domain specified in the traceroute command.
<b>Level</b>	Maintenance domain level configured.
<b>Maintenance Association</b>	Maintenance association specified in the traceroute command.
<b>Local Mep</b>	The local maintenance end point identifier.
<b>Transaction Identifier</b>	4-byte identifier maintained by the MEP. Each LTM uses a transaction identifier. The transaction identifier is maintained globally across all Maintenance Domains. Use the transaction identifier to match an incoming linktrace response (LTR), with a previously sent LTM.
<b>Hop</b>	Sequential hop count of the linktrace path.
<b>TTL</b>	Number of hops remaining in the linktrace message. The time to live (TTL) is decremented at each hop.
<b>Source MAC address</b>	MAC address of the 802.1ag maintenance point that is sending the linktrace message.
<b>Next-hop MAC address</b>	MAC address of the 802.1ag node that is the next hop in the LTM path.

## Sample Output

### traceroute ethernet

```
user@host> traceroute ethernet maintenance-domain md1 maintenance-association ma1
00:90:69:7e:01:ff
```

```
Linktrace to 00:01:02:03:04:05, Interface : ge-5/0/0.0
```

```
  Maintenance Domain: MD1, Level: 7
```

```
  Maintenance Association: MA1, Local Mep: 1
```

Hop	TTL	Source MAC address	Next hop MAC address
Transaction Identifier:100001			
1	63	00:00:aa:aa:aa:aa	00:00:bb:bb:bb:bb
2	62	00:00:bb:bb:bb:bb	00:00:cc:cc:cc:cc
3	61	00:00:cc:cc:cc:cc	00:01:02:03:04:05
4	60	00:01:02:03:04:05	00:00:00:00:00:00



## CHAPTER 8

# Interface Diagnostics

- [Interface Diagnostics on page 55](#)

## Interface Diagnostics

---

You can use two diagnostic tools to test the physical layer connections of interfaces: loopback testing and bit error rate test (BERT) testing. Loopback testing enables you to verify the connectivity of a circuit. BERT testing enables you to identify poor signal quality on a circuit. This section contains the following topics:

- [Configuring Loopback Testing on page 55](#)
- [Interface Diagnostics on page 57](#)

## Configuring Loopback Testing

Loopback testing allows you to verify the connectivity of a circuit. You can configure any of the following interfaces to execute a loopback test: Aggregated Ethernet, Fast Ethernet, Gigabit Ethernet, E1, E3, NxDS0, serial, SONET/SDH, T1, and T3.

The physical path of a network data circuit usually consists of segments interconnected by devices that repeat and regenerate the transmission signal. The transmit path on one device connects to the receive path on the next device. If a circuit fault occurs in the form of a line break or a signal corruption, you can isolate the problem by using a loopback test. Loopback tests allow you to isolate segments of the circuit and test them separately.

To do this, configure a *line loopback* on one of the routers. Instead of transmitting the signal toward the far-end device, the line loopback sends the signal back to the originating router. If the originating router receives back its own data link layer packets, you have verified that the problem is beyond the originating router. Next, configure a line loopback farther away from the local router. If this originating router does not receive its own data link layer packets, you can assume the problem is on one of the segments between the local router and the remote router's interface card. In this case, the next troubleshooting step is to configure a line loopback closer to the local router to find the source of the problem.

There are several types of loopback testing supported by the Junos OS, as follows:

- DCE local—Loops packets back on the local DCE.
- DCE remote—Loops packets back on the remote DCE.

- **Local**—Useful for troubleshooting physical PIC errors. Configuring local loopback on an interface allows transmission of packets to the channel service unit (CSU) and then to the circuit toward the far-end device. The interface receives its own transmission, which includes data and timing information, on the local router's PIC. The data received from the CSU is ignored. To test a local loopback, issue the **show interfaces *interface-name*** command. If PPP keepalives transmitted on the interface are received by the PIC, the **Device Flags** field contains the output **Loop-Detected**.
- **Payload**—Useful for troubleshooting the physical circuit problems between the local router and the remote router. A payload loopback loops data only (without clocking information) on the remote router's PIC. With payload loopback, overhead is recalculated.
- **Remote**—Useful for troubleshooting the physical circuit problems between the local router and the remote router. A remote loopback loops packets, including both data and timing information, back on the remote router's interface card. A router at one end of the circuit initiates a remote loopback toward its remote partner. When you configure a remote loopback, the packets received from the physical circuit and CSU are received by the interface. Those packets are then retransmitted by the PIC back toward the CSU and the circuit. This loopback tests all the intermediate transmission segments.

Table 10 on page 56 shows the loopback modes supported on the various interface types.

**Table 10: Loopback Modes by Interface Type**

Interface	Loopback Modes	Usage Guidelines
Aggregated Ethernet, Fast Ethernet, Gigabit Ethernet	Local	Configuring Ethernet Loopback Capability
Circuit Emulation E1	Local and remote	Configuring E1 Loopback Capability
Circuit Emulation T1	Local and remote	Configuring T1 Loopback Capability
E1 and E3	Local and remote	Configuring E1 Loopback Capability and Configuring E3 Loopback Capability
NxDSO	Payload	Configuring Channelized E1 IQ and IQE Interfaces, Configuring T1 and NxDSO Interfaces, Configuring Channelized OC12/STM4 IQ and IQE Interfaces (SONET Mode), Configuring Channelized STM1 IQ and IQE Interfaces, and Configuring Channelized T3 IQ Interfaces
Serial (V.35 and X.21)	Local and remote	Configuring Serial Loopback Capability
Serial (EIA-530)	DCE local, DCE remote, local, and remote	Configuring Serial Loopback Capability
SONET/SDH	Local and remote	Configuring SONET/SDH Loopback Capability

Table 10: Loopback Modes by Interface Type (*continued*)

Interface	Loopback Modes	Usage Guidelines
T1 and T3	Local, payload, and remote	Configuring T1 Loopback Capability and Configuring T3 Loopback Capability  See also Configuring the T1 Remote Loopback Response

To configure loopback testing, include the **loopback** statement:

**loopback mode;**

You can include this statement at the following hierarchy levels:

- [edit interfaces *interface-name* aggregated-ether-options]
- [edit interfaces *interface-name* ds0-options]
- [edit interfaces *interface-name* e1-options]
- [edit interfaces *interface-name* e3-options]
- [edit interfaces *interface-name* fastether-options]
- [edit interfaces *interface-name* gigether-options]
- [edit interfaces *interface-name* serial-options]
- [edit interfaces *interface-name* sonet-options]
- [edit interfaces *interface-name* t1-options]
- [edit interfaces *interface-name* t3-options]

## Interface Diagnostics

BERT allows you to troubleshoot problems by checking the quality of links. You can configure any of the following interfaces to execute a BERT when the interface receives a request to run this test: E1, E3, T1, T3; the channelized DS3, OC3, OC12, and STM1 interfaces; and the channelized DS3 IQ, E1 IQ, and OC12 IQ interfaces.

A BERT test requires a line loop to be in place on either the transmission devices or the far-end router. The local router generates a known bit pattern and sends it out the transmit path. The received pattern is then verified against the sent pattern. The higher the bit error rate of the received pattern, the worse the noise is on the physical circuit. As you move the position of the line loop increasingly downstream toward the far-end router, you can isolate the troubled portion of the link.

To configure BERT, you must configure the duration of the test, the bit pattern to send on the transmit path, and the error rate to monitor when the inbound pattern is received.

To configure the duration of the test, the pattern to send in the bit stream, and the error rate to include in the bit stream, include the **bert-period**, **bert-algorithm**, and **bert-error-rate** statements, respectively, at the [edit interfaces *interface-name* *interface-type*-options] hierarchy level:

```
[edit interfaces interface-name interface-type-options]
bert-algorithm algorithm;
bert-error-rate rate;
bert-period seconds;
```

By default, the BERT period is 10 seconds. You can configure the BERT period to last from 1 through 239 seconds on some PICs and from 1 through 240 seconds on other PICs.

**rate** is the bit error rate. This can be an integer from 0 through 7, which corresponds to a bit error rate from  $10^{-0}$  (1 error per bit) to  $10^{-7}$  (1 error per 10 million bits).

**algorithm** is the pattern to send in the bit stream. For a list of supported algorithms, enter a ? after the **bert-algorithm** statement; for example:

```
[edit interfaces t1-0/0/0 t1-options]
user@host# set bert-algorithm ?
Possible completions:
pseudo-2e11-o152      Pattern is 2^11 - 1 (per 0.152 standard)
pseudo-2e15-o151      Pattern is 2^15 - 1 (per 0.152 standard)
pseudo-2e20-o151      Pattern is 2^20 - 1 (per 0.151 standard)
pseudo-2e20-o153      Pattern is 2^20 - 1 (per 0.153 standard)
...
```

For specific hierarchy information, see the individual interface types.



**NOTE:** The 4-port E1 PIC supports only the following algorithms:

pseudo-2e11-o152	Pattern is 2^11 - 1 (per 0.152 standard)
pseudo-2e15-o151	Pattern is 2^15 - 1 (per 0.151 standard)
pseudo-2e20-o151	Pattern is 2^20 - 1 (per 0.151 standard)
pseudo-2e23-o151	Pattern is 2^23 (per 0.151 standard)

When you issue the help command from the CLI, all BERT algorithm options are displayed, regardless of the PIC type, and no commit check is available. Unsupported patterns for a PIC type can be viewed in system log messages.

---



**NOTE:** The 12-port T1/E1 Circuit Emulation (CE) PIC supports only the following algorithms:

```
all-ones-repeating    Repeating one bits
all-zeros-repeating   Repeating zero bits
alternating-double-ones-zeros Alternating pairs of ones and zeros
alternating-ones-zeros Alternating ones and zeros
pseudo-2e11-o152     Pattern is 2^11 - 1 (per 0.152 standard)
pseudo-2e15-o151     Pattern is 2^15 - 1 (per 0.151 standard)
pseudo-2e20-o151     Pattern is 2^20 - 1 (per 0.151 standard)
pseudo-2e7           Pattern is 2^7 - 1
pseudo-2e9-o153      Pattern is 2^9 - 1 (per 0.153 standard)
repeating-1-in-4      1 bit in 4 is set
repeating-1-in-8      1 bit in 8 is set
repeating-3-in-24     3 bits in 24 are set
```

When you issue the help command from the CLI, all BERT algorithm options are displayed, regardless of the PIC type, and no commit check is available. Unsupported patterns for a PIC type can be viewed in system log messages.



**NOTE:** The IQE PICs support only the following algorithms:

```
all-ones-repeating    Repeating one bits
all-zeros-repeating   Repeating zero bits
alternating-double-ones-zeros Alternating pairs of ones and zeros
alternating-ones-zeros Alternating ones and zeros
pseudo-2e9-o153       Pattern is 2^9 - 1 (per 0.153 (511 type) standard)
pseudo-2e11-o152      Pattern is 2^11 - 1 (per 0.152 and 0.153 (2047 type)
standards)
pseudo-2e15-o151      Pattern is 2^15 - 1 (per 0.151 standard)
pseudo-2e20-o151      Pattern is 2^20 - 1 (per 0.151 standard)
pseudo-2e20-o153      Pattern is 2^20 - 1 (per 0.153 standard)
pseudo-2e23-o151      Pattern is 2^23 - 1 (per 0.151 standard)
repeating-1-in-4       1 bit in 4 is set
repeating-1-in-8       1 bit in 8 is set
repeating-3-in-24      3 bits in 24 are set
```

When you issue the help command from the CLI, all BERT algorithm options are displayed, regardless of the PIC type, and no commit check is available. Unsupported patterns for a PIC type can be viewed in system log messages.



**NOTE:** BERT is supported on the PDH interfaces of the Channelized SONET/SDH OC3/STM1 (Multi-Rate) MIC with SFP and the DS3/E3 MIC. The following BERT algorithms are supported:

all-ones-repeating	Repeating one bits
all-zeros-repeating	Repeating zero bits
alternating-double-ones-zeros	Alternating pairs of ones and zeros
alternating-ones-zeros	Alternating ones and zeros
repeating-1-in-4	1 bit in 4 is set
repeating-1-in-8	1 bit in 8 is set
repeating-3-in-24	3 bits in 24 are set
pseudo-2e9-o153	Pattern is $2^9 - 1$ (per 0.153 standard)
pseudo-2e11-o152	Pattern is $2^{11} - 1$ (per 0.152 standard)
pseudo-2e15-o151	Pattern is $2^{15} - 1$ (per 0.151 standard)
pseudo-2e20-o151	Pattern is $2^{20} - 1$ (per 0.151 standard)
pseudo-2e20-o153	Pattern is $2^{20} - 1$ (per 0.153 standard)
pseudo-2e23-o151	Pattern is $2^{23} - 1$ (per 0.151 standard)

Table 11 on page 60 shows the BERT capabilities for various interface types.

**Table 11: BERT Capabilities by Interface Type**

Interface	T1 BERT	T3 BERT	Comments
12-port T1/E1 Circuit Emulation	Yes (ports 0–11)		<ul style="list-style-type: none"> <li>Limited algorithms</li> </ul>
4-port Channelized OC3/STM1 Circuit Emulation	Yes (port 0–3)		<ul style="list-style-type: none"> <li>Limited algorithms</li> </ul>
E1 or T1	Yes (port 0–3)	Yes (port 0–3)	<ul style="list-style-type: none"> <li>Single port at a time</li> <li>Limited algorithms</li> </ul>
E3 or T3	Yes (port 0–3)	Yes (port 0–3)	<ul style="list-style-type: none"> <li>Single port at a time</li> </ul>
Channelized OC12	N/A	Yes (channel 0–11)	<ul style="list-style-type: none"> <li>Single channel at a time</li> <li>Limited algorithms</li> <li>No bit count</li> </ul>
Channelized STM1	Yes (channel 0–62)	N/A	<ul style="list-style-type: none"> <li>Multiple channels</li> <li>Only one algorithm</li> <li>No error insert</li> <li>No bit count</li> </ul>
Channelized T3 and Multichannel T3	Yes (channel 0–27)	Yes (port 0–3 on channel 0)	<ul style="list-style-type: none"> <li>Multiple ports and channels</li> <li>Limited algorithms for T1</li> <li>No error insert for T1</li> <li>No bit count for T1</li> </ul>



These limitations do not apply to channelized IQ interfaces. For information about BERT capabilities on channelized IQ interfaces, see Channelized IQ and IQE Interfaces Properties.

### Starting and Stopping a BERT Test

Before you can start the BERT test, you must disable the interface. To do this, include the **disable** statement at the **[edit interfaces *interface-name*]** hierarchy level:

```
[edit interfaces interface-name]
disable;
```

After you configure the BERT properties and commit the configuration, begin the test by issuing the **test interface *interface-name interface-type-bert-start*** operational mode command:

```
user@host> test interface interface-name interface-type-bert-start
```

The test runs for the duration you specify with the **bert-period** statement. If you wish to terminate the test sooner, issue the **test interface *interface-name interface-type-bert-stop*** command:

```
user@host> test interface interface-name interface-type-bert-stop
```

For example:

```
user@host> test interface t3-1/2/0 t3-bert-start
user@host> test interface t3-1/2/0 t3-bert-stop
```

To view the results of the BERT test, issue the **show interfaces extensive | find BERT** command:

```
user@host> show interfaces interface-name extensive | find BERT
```

For more information about running and evaluating the results of the BERT procedure, see the Junos OS Operational Mode Commands.



**NOTE:** To exchange BERT patterns between a local router and a remote router, include the **loopback remote** statement in the interface configuration at the remote end of the link. From the local router, issue the **test interface** command.

### Example: Configuring Bit Error Rate Testing

Configure a BERT test on a T3 interface. In this example, the run duration lasts for 120 seconds. The configured error rate is 0, which corresponds to a bit error rate of  $10^{-0}$  (1 error per bit). The configured bit pattern of **all-ones-repeating** means that every bit the interface sends is a set to a value of 1.

```
[edit interfaces]
t3-1/2/0 {
  t3-options {
    bert algorithm all-ones-repeating;
    bert-error-rate 0;
    bert-period 120;
```

```
}  
}
```

## PART 5

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