HP 5920 & 5900 Switch Series

TRILL

Configuration Guide

Part number: 5998-3377
Software version: Release2207
Document version: 6W100-20121130

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Configuring TRILL

Transparent Interconnect of Lots of Links (TRILL) uses IS-IS to provide transparent Layer 2 forwarding.

Overview

TRILL combines the simplicity and flexibility of Layer 2 switching with the stability, scalability, and rapid convergence capability of Layer 3 routing. All these advantages make TRILL very suitable for large flat Layer 2 networks in data centers.

Basic concepts

- **RBridge**—Routing bridge (RB for short) that runs TRILL. RBs are classified into ingress RBs, transit RBs, and egress RBs, depending on their positions in the TRILL network. A frame enters the TRILL network through an ingress RB, travels along transit RBs, and leaves the TRILL network through an egress RB, as shown in Figure 2.
- **TRILL network**—A Layer 2 network comprised of RBs, as shown in Figure 3.
- **Nickname**—Unique identifier of an RB in the TRILL network. TRILL automatically assigns nicknames to RBs.
- **Link State Database**—The LSDB contains all link state information in the TRILL network.
- **Link State Protocol Data Unit**—An LSP describes local link state information and is advertised between neighbor devices.
- **Appointed VLAN-x Forwarder (AVF)** and **appointed port**—TRILL supports VLANs. To avoid loops, TRILL requires all the traffic of a VLAN on a network segment to enter and leave the TRILL network through the same port of an RB. The RB is the AVF of the VLAN, and the port is the appointed port.
- **Designated Routing Bridge**—The DRB corresponds to the DIS in IS-IS. It helps simplify network topology and appoints AVFs for VLANs on each RB.

For more information about LSDB, LSPDU, and DIS, see *Layer 3—IP Routing Configuration Guide*.

TRILL frame formats

TRILL frames include control frames and data frames.

TRILL control frames include TRILL Hello, LSP, CSNP, PSNP, MTU-prob, and MTU-ack. These control frames use 802.1Q encapsulation, and have a fixed destination multicast address 0180-C200-0041.

TRILL data frames have a specific format, as shown in Figure 1. A TRILL header and an outer Ethernet header are added to the original Ethernet frame.

Figure 1 TRILL data frame format

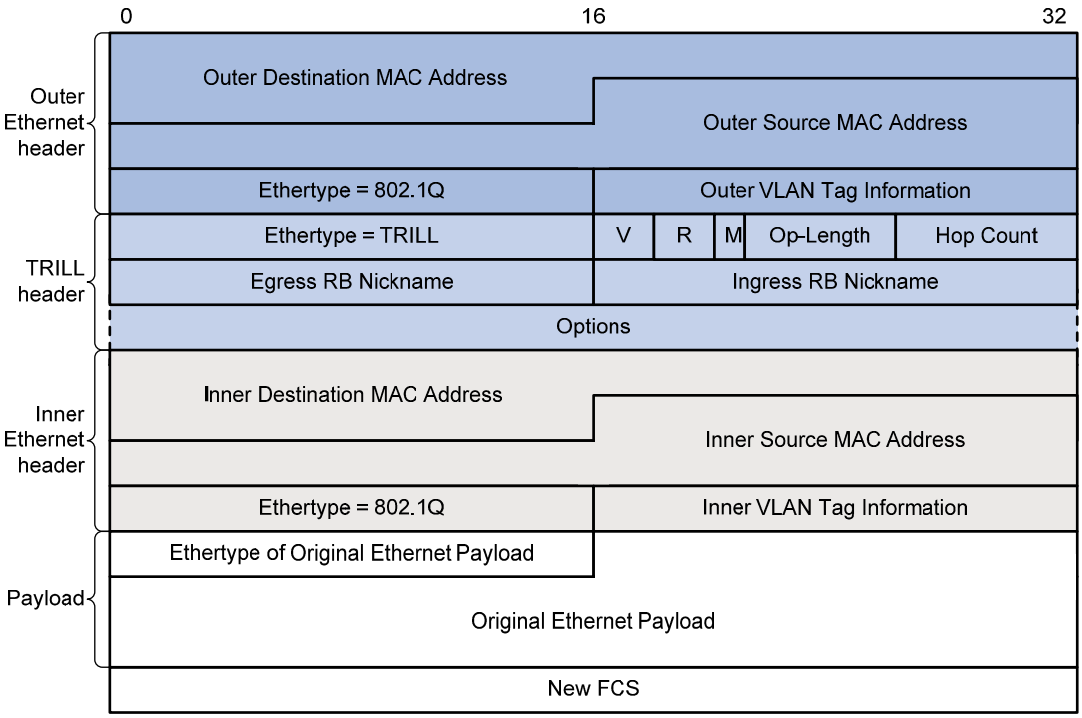


Table 1 describes the fields in the TRILL header.

Table 1 TRILL header fields

Field	Description
Ethertype	The Ethertype is fixed to TRILL.
V	Version number, which is 0. When an RB receives a TRILL frame, it checks the **V** field and drops the frame if the **V** field is not 0.
R	Reserved for future extension. An ingress RB sets the R field to **0** when adding a TRILL header. Transit RBs and egress RBs ignore the field.
M	Multi-destination attribute: • **0**—Known unicast frame. • **1**—Multicast, broadcast, or unknown unicast frame.
Op-Length	Length of the **Options** field. **0** indicates that the **Options** field does not exist.
Hop Count	Hop count, which is used to avoid loops. An RB drops a TRILL frame whose hop count is decremented to 0.
Egress RB Nickname	Nickname of the egress RB.
Ingress RB Nickname	Nickname of the ingress RB.
Options	Options field. This field exists when the **Op-Length** field is non-zero.

How TRILL works

TRILL establishes and maintains adjacencies between RBs by periodically advertising Hello frames, distributes LSPs among RB neighbors, and generates an LSDB for all RBs in the network. Based on the LSDB, each RB uses the SPF algorithm to calculate forwarding entries destined to other RBs.

TRILL forwarding mechanisms

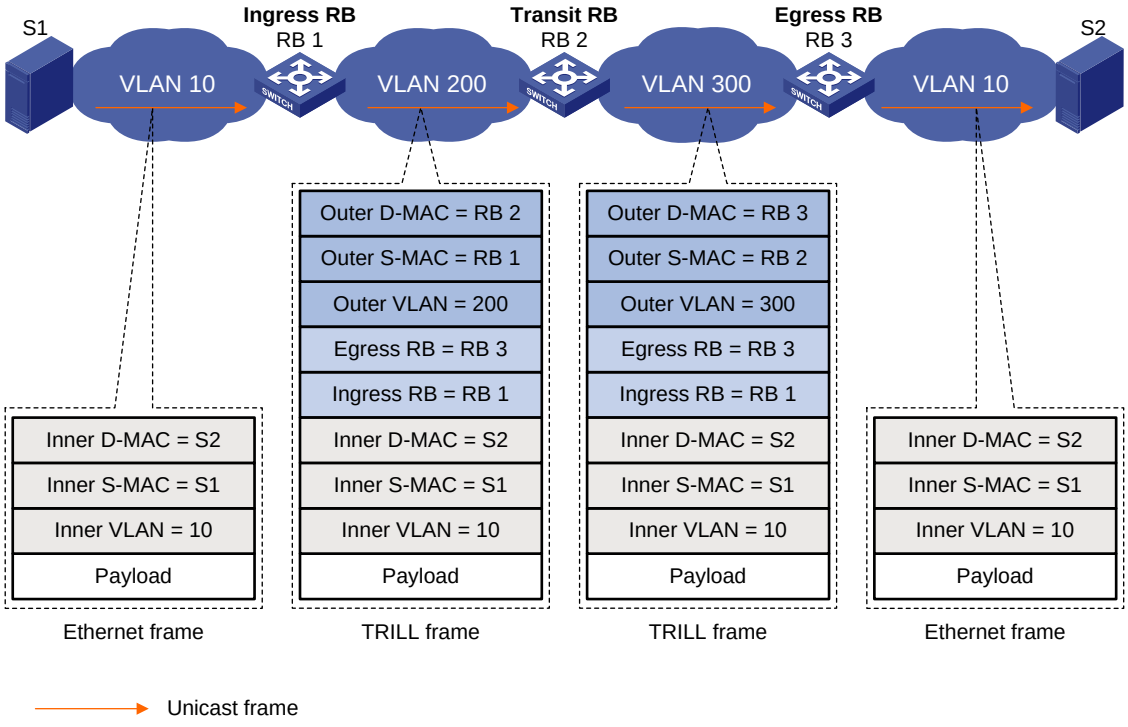
Different types of frames are forwarded using different forwarding mechanisms. The following sections describe these mechanisms.

Unicast frame forwarding mechanism

As shown in Figure 2, a unicast frame is forwarded as follows:

1. When a unicast frame enters the TRILL network, the ingress RB encapsulates the original Ethernet frame with a TRILL header (like an IP header) and an outer Ethernet header (like the Ethernet header of a regular Ethernet frame).
2. RBs forward the frame hop by hop according to the egress RB nickname in the TRILL header to the egress RB in the same way routers forward IP packets. Each hop replaces the outer Ethernet header with an appropriate outer Ethernet header, and decrements the hop count in the TRILL header.
3. Upon receiving the TRILL frame, the egress RB de-encapsulates it to obtain the original Ethernet frame, and sends the frame to the target device.

Figure 2 Unicast frame forwarding flow



The outer Ethernet header enables traditional Ethernet switches to forward TRILL frames, and RBs can be connected through traditional Ethernet switches.

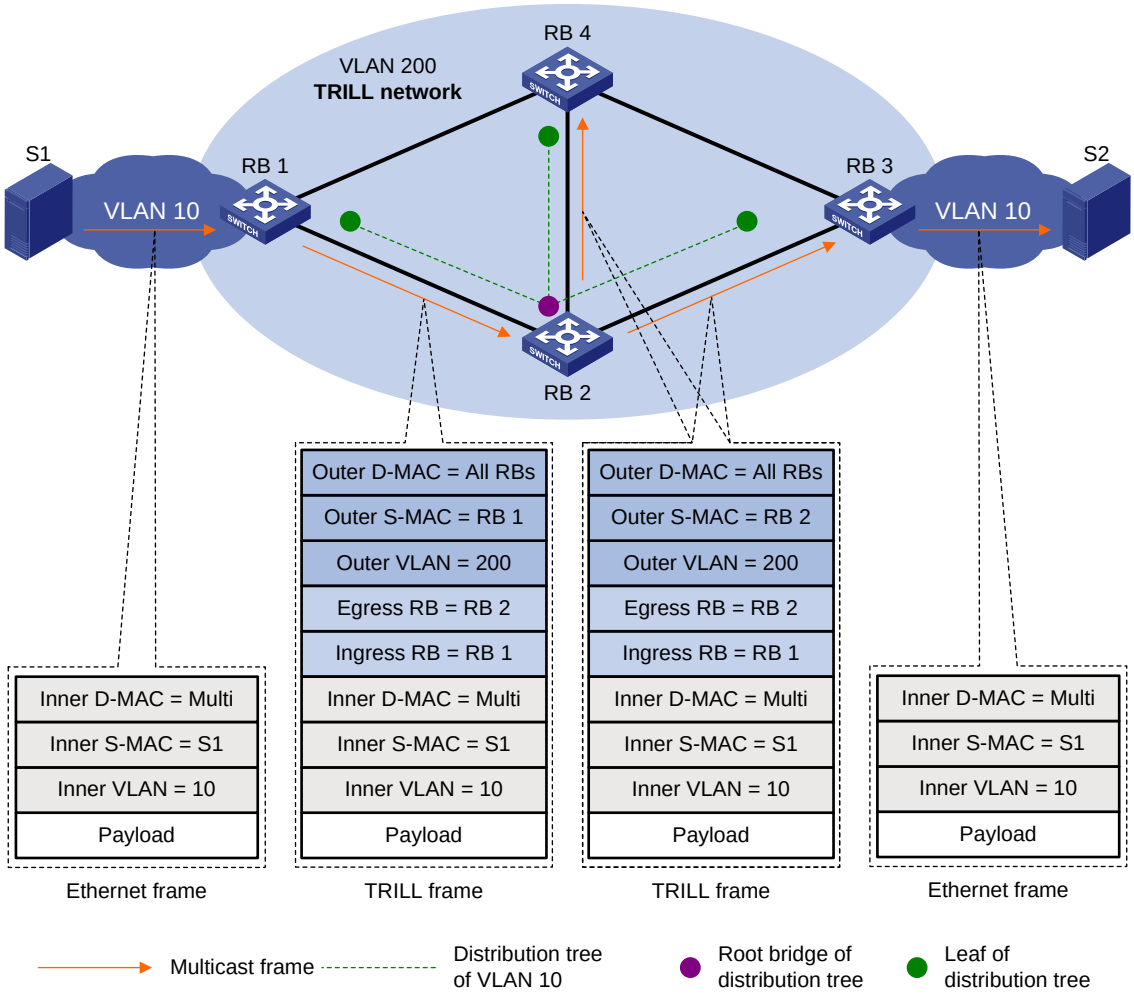
Multi-destination frame forwarding mechanism

In a TRILL network, RBs compute a distribution tree for each VLAN according to the LSDB and use the distribution tree to guide the forwarding of multi-destination frames, which include multicast, broadcast, and unknown unicast frames in the VLAN.

As shown in Figure 3, when a multicast frame from VLAN 10 enters the TRILL network, RB 1, which is an ingress RB, encapsulates the multicast frame into a TRILL frame. In the frame, the egress RB is RB 2, the root bridge of the distribution tree for VLAN 10. When the frame arrives at the root bridge, it is distributed throughout the distribution tree. Then, the TRILL frame is decapsulated by RB 3 and sent to the destination

station S2. Because the network segment where RB 4 resides does not have a receiver of this frame, RB 4 drops the frame.

Figure 3 Multicast frame forwarding flow



Protocols and standards

- RFC 6325: *Routing Bridges (RBridges): Base Protocol Specification*
- RFC 6326: *Transparent Interconnection of Lots of Links (TRILL) Use of IS-IS*
- RFC 6327: *Routing Bridges (RBridges): Adjacency*
- RFC 1195: *Use of OSI IS-IS for Routing in TCP/IP and Dual Environments*

TRILL configuration task list

When you configure TRILL, follow these guidelines:

- Configuration in Ethernet interface view takes effect on only the current port. Configuration in aggregate interface view takes effect on the current interface and its member ports. Configuration on the member port of an aggregate interface takes effect after the member port leaves the aggregation group.

- When both TRILL and a spanning tree protocol are enabled on a port, TRILL processes the BPDUs received on the port. To make sure the STP network can properly interoperate with the TRILL network, disable the spanning tree protocol on TRILL ports. For more information about spanning tree protocols, see *Layer 2—LAN Switching Configuration Guide*.
- HP recommends not enabling loop detection on TRILL ports, because TRILL networks prevent loops from being generated. For more information about loopback detection, see *Layer 2—LAN Switching Configuration Guide*.

Complete the following tasks to configure TRILL:

Tasks at a glance
(Required.) Enabling TRILL
(Optional.) Configuring the link type of a TRILL port
(Optional.) Configuring the DRB priority of a TRILL port
(Optional.) Configuring TRILL timers
(Optional.) Adjusting LSP parameters
(Optional.) Configuring distribution tree parameters
(Optional.) Enabling logging of TRILL neighbor changes
(Optional.) Configuring TRILL GR

Enabling TRILL

To enable TRILL on a port, first enable TRILL globally.

Enable or disable TRILL on all ports in a VLAN, so that the ports in a VLAN have the same TRILL status (enabled or disabled).

Do not enable both TRILL and EVB on a port. The allowed VLAN list of a TRILL-enabled port cannot overlap with that of an EVB-enabled port. For more information about EVB, see *EVB Configuration Guide*.

After you enable TRILL on a port, TRILL can operate normally by using default settings. A port with TRILL enabled is called a "TRILL port."

To enable TRILL:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enable TRILL globally and enter TRILL view.	**trill**	By default, TRILL is disabled globally.
3.	Return to system view.	**quit**	N/A
4.	Enter Ethernet or aggregate interface view.	**interface** *interface-type interface-number*	N/A
5.	Enable TRILL on the port.	**trill enable**	By default, TRILL is disabled on a port.

Configuring the link type of a TRILL port

The following link types are available for a TRILL port:

- **Access**—An access port can process only local data frames and Hello frames.
- **Hybrid**—A hybrid port combines the attributes of an access port and a trunk port, and can process local data frames and passing data frames.
- **Trunk**—A trunk port can process passing data frames and some of Layer 2 protocol frames (for example, LLDP frames), but it cannot process local data frames.

To configure the link type of a TRILL port:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter Ethernet or aggregate interface view.	**interface** *interface-type interface-number*	N/A
3.	Configure the link type of a TRILL port.	**trill link-type** { **access** | **hybrid** | **trunk** }	By default, the link type of a TRILL port is **access**.

Configuring the DRB priority of a TRILL port

On a broadcast network, TRILL must elect a DRB. An RB with a higher DRB priority is preferred. When two RBs have the same DRB priority, the RB with a higher MAC address takes precedence.

To configure the DRB priority of a TRILL port:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter Ethernet or aggregate interface view.	**interface** *interface-type interface-number*	N/A
3.	Configure the DRB priority of a TRILL port.	**trill drb-priority** *priority*	By default, the DRB priority of a TRILL port is 64.

Configuring TRILL timers

You can configure the following TRILL timers:

- **Hello interval** and **Hello multiplier**—An RB advertises Hello frames at the Hello interval to maintain a TRILL adjacency. The shorter the Hello interval, the faster the network convergence. However, a shorter Hello interval consumes more system resources. The adjacency holding time is obtained by multiplying the Hello interval by the Hello multiplier. The RB advertises the adjacency holding time to neighbors through Hello frames. If a neighbor does not receive any Hello frame from the RB before the adjacency holding time expires, it removes the TRILL adjacency with the RB.
- **Inhibition time**—An RB that acts as the AVF of a VLAN guarantees that frames from the VLAN have only one incoming port or one outgoing port along a link. When other RBs receive frames from the VLAN, they do not perform any processing. However, when the RB detects that a root bridge

change occurs on a link or that the AVF advertised by other RBs conflicts with the local AVF, the RB inhibits the local AVF for a certain time to avoid loops. When the inhibition time expires, if the RB is still the AVF of the VLAN, the RB restores the role of AVF.

- **CSNP interval**—On a broadcast network, the DRB advertises CSNPs at the CSNP interval to perform network-wide LSDB synchronization. A CSNP records all LSP digests of the local LSDB. When an RB receives a CSNP, the RB compares the CSNP against the local LSDB to verify whether some LSPs are aged out or missing. If the CSNP has an LSP digest that the local LSDB does not have, the RB sends a PSNP packet to request the LSP.

To configure TRILL timers:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter Ethernet or aggregate interface view.	**interface** *interface-type interface-number*	N/A
3.	Configure the Hello interval.	**trill timer hello** *interval*	The default setting is 10 seconds. In order to quickly detect DRB failure, set the Hello interval of the DRB to 1/3 of the Hello interval of the RB.
4.	Configure the Hello multiplier.	**trill timer holding-multiplier** *count*	The default setting is 3.
5.	Configure the inhibition time.	**trill timer avf-inhibited** *time*	The default setting is 30 seconds.
6.	Configure the CSNP interval.	**trill timer csnp** *interval*	The default setting is 10 seconds.

Adjusting LSP parameters

You can modify the following LSP parameters:

- **LSP maximum age**—An LSP originated by an RB uses the maximum age as the remaining lifetime. When the remaining lifetime of an LSP in the LSDB is 0 seconds, the RB removes the LSP's content, keeps the LSP's digest, and purges the LSP from the network by advertising the LSP that has the remaining lifetime set to 0.
- **LSP refresh interval**—When the remaining lifetime of a locally originated LSP is no greater than (maximum age – refresh interval), the LSP is refreshed even if no change occurs to it. This mechanism avoids frequent LSP aging and ensures network stability.
- **Minimum LSP interval** and **maximum number of LSPs transmitted per time**—To avoid frequent LSP aging in the network, RBs periodically advertise LSPs. The actual refresh interval of an LSP is determined by both the minimum LSP interval and the maximum number of LSPs transmitted per time. To prevent LSPs from being aged out accidentally, set the LSP maximum age and the LSP refresh interval appropriately.

To adjust LSP-related parameters:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A

Step		Command	Remarks
2.	Enter TRILL view.	**trill**	N/A
3.	Set the LSP maximum age.	**timer lsp-max-age** *time*	The default setting is 1200 seconds.
4.	Set the LSP refresh interval.	**timer lsp-refresh** *time*	The default setting is 900 seconds.
5.	Return to system view.	**quit**	N/A
6.	Enter Ethernet or aggregate interface view.	**interface** *interface-type interface-number*	N/A
7.	Configure the minimum LSP interval and the maximum number of LSPs transmitted per time.	**trill timer lsp** *interval* [**count** *count*]	By default, the minimum LSP interval is 10 milliseconds, and the maximum number of LSPs transmitted per time is 5.

Configuring distribution tree parameters

In a TRILL network, RBs compute distribution trees according to the LSDB, and use the distribution trees to guide the forwarding of multicast, broadcast, and unknown unicast frames. An RB with a higher priority is selected as the root bridge of a distribution tree.

An LSP carries distribution tree information that includes the number of distribution trees that the RB wants all RBs to compute, the maximum number of distribution trees that the RB can compute (this number is fixed at 15), and the number of distribution trees that the RB has computed.

An RB determines the number of distribution trees to compute (*n*) as follows: select the lower value between the number of distribution trees that the highest-priority RB wants all RBs to compute and the smallest value of the maximum number of distribution trees that each RB can compute. From the nickname list in the LSP advertised by the RB with the highest priority, the first *n* nicknames comprise the root bridge list that the local RB uses to compute distribution trees.

To configure the distribution tree parameters:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter TRILL view.	**trill**	N/A
3.	Set a priority for the RB.	**tree-root priority** *priority*	The default setting is 32768.
4.	Configure the number of distribution trees that the RB wants all RBs to compute.	**trees calculate** *count*	The default setting is 1.

Enabling logging of TRILL neighbor changes

Perform this task to output logs of TRILL neighbor changes to the configuration terminal.

To enable logging of TRILL neighbor changes:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter TRILL view.	**trill**	N/A
3.	Enable logging of TRILL neighbor changes.	**log-peer-change enable**	By default, logging of TRILL neighbor changes is enabled.

Configuring TRILL GR

Graceful Restart (GR) ensures the continuity of packet forwarding when a protocol restarts or an active/standby switchover occurs. The device on which a protocol restarts or an active/standby switchover occurs advertises the restart status to the neighbors, and allows the neighbors to re-establish the neighborship, instead of terminating the connections. GR involves the following roles:

- **GR Restarter**—Graceful restarting router. It must be GR capable.
- **GR Helper**—A neighbor of the GR Restarter. It helps the GR Restarter to complete the GR process.

To configure TRILL GR:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter TRILL view.	**trill**	N/A
3.	Enable GR for TRILL.	**graceful-restart**	By default, GR is disabled for TRILL.
4.	(Optional.) Configure the GR interval for TRILL.	**graceful-restart interval** *interval*	The default setting is 300 seconds.

Displaying and maintaining TRILL

Execute the **display** commands in any view and the **reset** command in user view.

Task	Command
Display TRILL ardency table information.	**display trill adjacent-table** [**count** | **nickname** *nickname* **interface** *interface-type interface-number*]
Display brief TRILL information.	**display trill brief**
Display TRILL FIB information.	**display trill fib** [**count** | **nickname** *nickname*]
Display TRILL GR status.	**display trill graceful-restart status**
Display TRILL port information.	**display trill interface** [*interface-type interface-number*]
Display TRILL LSDB information.	**display trill lsdb** [**local** | **lsp-id** *lsp-id* | **verbose**] *
Display all ingress entries in the TRILL multicast FIB (MFIB).	**display trill mfib ingress** [**vlan** *vlan-id* [**local-entry** | **remote-entry**]]
Display all egress entries in the TRILL MFIB.	**display trill mfib transit** [**nickname** *nickname* [**prune-entry** | **rpf-entry** | **vlan** *vlan-id* [**mac-address** *mac-address*]]]
Display information about the TRILL multicast routing table.	**display trill multicast-route** [**tree-root** *nickname* [**vlan** *vlan-list* [**mac-address** *mac-address*]]]

Task	Command
Display the TRILL neighbor table.	**display trill neighbor-table**
Display the TRILL neighbor statistics.	**display trill peer** [**interface** *interface-type interface-number*]
Display the TRILL RPF check table information.	**display trill rpf-table tree-root** *nickname*
Display information about the TRILL unicast routing table.	**display trill unicast-route** [**verbose**]
Clear dynamic running statistics of the TRILL process.	**reset trill**

TRILL configuration example

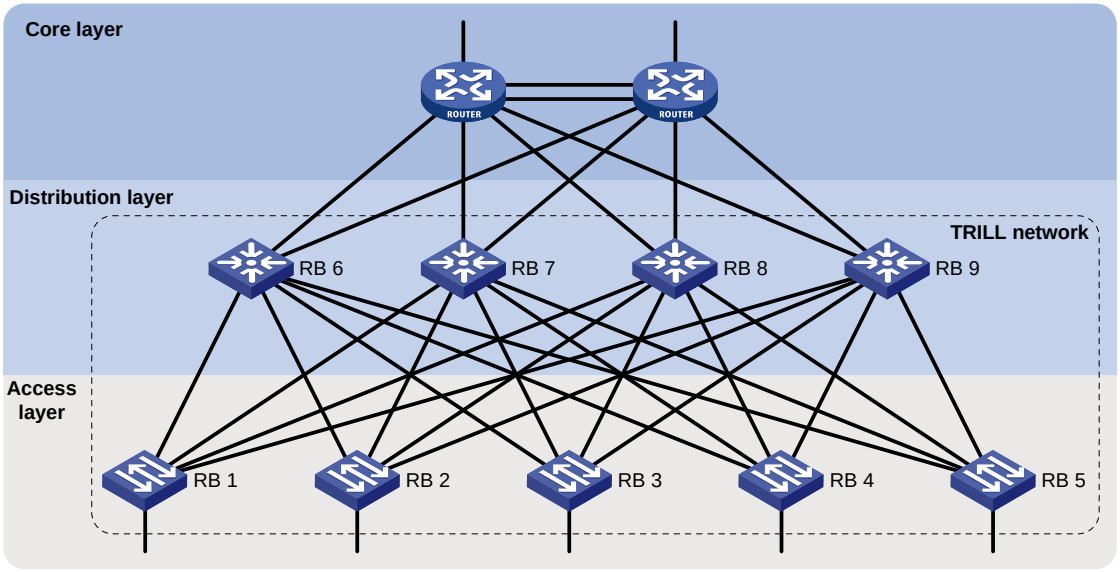
Network requirements

As shown in Figure 4, configure TRILL in the Layer 2 data center network as follows:

- Enable TRILL on the downlink ports of access layer devices to connect terminal devices to the TRILL network.
- Enable TRILL on the uplink ports of access layer devices, and configure these uplink ports as trunk ports to pass TRILL frames to the TRILL network.
- Enable TRILL on the downlink ports of distribution layer devices, and configure these downlink ports as trunk ports to forward TRILL data frames.
- Enable TRILL on the uplink ports of the distribution layer devices. These ports send the decapsulated TRILL data frames to the core layer.
- In the TRILL network, configure four distribution trees with RB 6 through RB 9 as the root bridges. RB 6 through RB 9 are in descending priority order.

A hierarchical network has three layers (from top to bottom): the core layer, distribution layer, and access layer. Usually, a port connecting to a higher layer device is called an uplink port, and a port connecting to a lower layer device is called a downlink port.

Figure 4 Network diagram



Configuration procedure

This section provides only TRILL-related configurations.

1. Configure the downlink ports of access layer devices:

   # Enable TRILL globally on RB 1, and enable TRILL on downlink port Ten-GigabitEthernet 1/0/1 of RB 1.

   ```
   <RB1> system-view
   [RB1] trill
   [RB1-trill] quit
   [RB1] interface ten-gigabitethernet 1/0/1
   [RB1-ten-gigabitethernet1/0/1] trill enable
   [RB1-ten-gigabitethernet1/0/1] quit
   ```

   # Configure RB 2 through RB 5 as you configured RB 1.

2. Configure the uplink port of access layer devices:

   # Enable TRILL on uplink port Ten-GigabitEthernet 1/0/2 through Ten-GigabitEthernet 1/0/5 of RB 1, and configure these ports as trunk ports.

   ```
   [RB1] interface ten-gigabitethernet 1/0/2
   [RB1-ten-gigabitethernet1/0/2] trill enable
   [RB1-ten-gigabitethernet1/0/2] trill link-type trunk
   [RB1-ten-gigabitethernet1/0/2] quit
   [RB1] interface ten-gigabitethernet 1/0/3
   [RB1-ten-gigabitethernet1/0/3] trill enable
   [RB1-ten-gigabitethernet1/0/3] trill link-type trunk
   [RB1-ten-gigabitethernet1/0/3] quit
   [RB1] interface ten-gigabitethernet 1/0/4
   [RB1-ten-gigabitethernet1/0/4] trill enable
   [RB1-ten-gigabitethernet1/0/4] trill link-type trunk
   [RB1-ten-gigabitethernet1/0/4] quit
   [RB1] interface ten-gigabitethernet 1/0/5
   ```

```
[RB1-ten-gigabitethernet1/0/5] trill enable
[RB1-ten-gigabitethernet1/0/5] trill link-type trunk
[RB1-ten-gigabitethernet1/0/5] quit
```

Configure RB 2 through RB 5 as you configured RB 1.

3. Configure the downlink ports of distribution layer devices:

Enable TRILL globally on RB 6, enable TRILL on downlink port Ten-GigabitEthernet 1/0/1 through Ten-GigabitEthernet 1/0/5 of RB 6, and configure these ports as trunk ports.

```
<RB6> system-view
[RB6] trill
[RB6-trill] quit
[RB6] interface ten-gigabitethernet 1/0/1
[RB6-ten-gigabitethernet1/0/1] trill enable
[RB6-ten-gigabitethernet1/0/1] trill link-type trunk
[RB6-ten-gigabitethernet1/0/1] quit
[RB6] interface ten-gigabitethernet 1/0/2
[RB6-ten-gigabitethernet1/0/2] trill enable
[RB6-ten-gigabitethernet1/0/2] trill link-type trunk
[RB6-ten-gigabitethernet1/0/2] quit
[RB6] interface ten-gigabitethernet 1/0/3
[RB6-ten-gigabitethernet1/0/3] trill enable
[RB6-ten-gigabitethernet1/0/3] trill link-type trunk
[RB6-ten-gigabitethernet1/0/3] quit
[RB6] interface ten-gigabitethernet 1/0/4
[RB6-ten-gigabitethernet1/0/4] trill enable
[RB6-ten-gigabitethernet1/0/4] trill link-type trunk
[RB6-ten-gigabitethernet1/0/4] quit
[RB6] interface ten-gigabitethernet 1/0/5
[RB6-ten-gigabitethernet1/0/5] trill enable
[RB6-ten-gigabitethernet1/0/5] trill link-type trunk
[RB6-ten-gigabitethernet1/0/5] quit
```

Configure RB 7 through RB 9 as you configured RB 6.

4. Configure the uplink ports of the distribution layer devices:

Enable TRILL on uplink ports Ten-GigabitEthernet 1/0/6 and Ten-GigabitEthernet 1/0/7 of RB 6.

```
[RB6] interface ten-gigabitethernet 1/0/6
[RB6-ten-gigabitethernet1/0/6] trill enable
[RB6-ten-gigabitethernet1/0/6] quit
[RB6] interface ten-gigabitethernet 1/0/7
[RB6-ten-gigabitethernet1/0/7] trill enable
[RB6-ten-gigabitethernet1/0/7] quit
```

Configure RB 7 through RB 9 as you configured RB 6.

5. Configure distribution trees:

Set the RB 6's priority to 65535, and set the number of distribution trees that the RB wants all RBs to compute to 4.

```
[RB6] trill
[RB6-trill] tree-root priority 65535
[RB6-trill] trees calculate 4
```

```
[RB6-trill] quit
```

Set the RB 7's priority to 65534, and set the number of distribution trees that the RB wants all RBs to compute to 4.

```
[RB7] trill
[RB7-trill] tree-root priority 65534
[RB7-trill] trees calculate 4
[RB7-trill] quit
```

Set the RB 8's priority to 65533, and set the number of distribution trees that the RB wants all RBs to compute to 4.

```
[RB8] trill
[RB8-trill] tree-root priority 65533
[RB8-trill] trees calculate 4
[RB8-trill] quit
```

Set the RB 9's priority to 65532, and set the number of distribution trees that the RB wants all RBs to compute to 4.

```
[RB9] trill
[RB9-trill] tree-root priority 65532
[RB9-trill] trees calculate 4
[RB9-trill] quit
```

Verifying the configuration

Suppose that the nicknames of RB 1 through RB 9 are 0x5801 through 0x5809, respectively.

Use **display trill unicast-route** to display the TRILL unicast routing table. For example:

Display the TRILL unicast routing table on RB 1.

```
[RB1] display trill unicast-route
Destination    Interface                 NextHop
-----------------------------------------------
0x5801         N/A                       N/A
0x5802         XGE1/0/2                  0x5806
               XGE1/0/3                  0x5807
               XGE1/0/4                  0x5808
               XGE1/0/5                  0x5809
0x5803         XGE1/0/2                  0x5806
               XGE1/0/3                  0x5807
               XGE1/0/4                  0x5808
               XGE1/0/5                  0x5809
0x5804         XGE1/0/2                  0x5806
               XGE1/0/3                  0x5808
               XGE1/0/4                  0x5808
               XGE1/0/5                  0x5809
0x5805         XGE1/0/2                  0x5806
               XGE1/0/3                  0x5807
               XGE1/0/4                  0x5808
               XGE1/0/5                  0x5809
0x5806         XGE1/0/2                  Direct
0x5807         XGE1/0/3                  Direct
0x5808         XGE1/0/4                  Direct
```

```
0x5809         XGE1/0/5                  Direct
```

Use **display trill multicast-route** to display the TRILL multicast routing table. For example:

Display the TRILL multicast routing table on RB 1.

```
[RB1] display trill multicast-route
Root                          Flag
-------------------------------------
0x5806                        Valid
0x5807                        Valid
0x5808                        Valid
0x5809                        Valid
```

Display the TRILL multicast routing table information for the distribution tree with RB 6 as the root bridge on RB 1.

```
[RB1] display trill multicast-route tree-root 5806
Root: 0x5806
LocalRcvFlag: True
List of VLANs:
  1
List of outgoing ports:
  XGE1/0/2
```

Support and other resources

Contacting HP

For worldwide technical support information, see the HP support website:

http://www.hp.com/support

Before contacting HP, collect the following information:

- Product model names and numbers
- Technical support registration number (if applicable)
- Product serial numbers
- Error messages
- Operating system type and revision level
- Detailed questions

Subscription service

HP recommends that you register your product at the Subscriber's Choice for Business website:

http://www.hp.com/go/wwalerts

After registering, you will receive email notification of product enhancements, new driver versions, firmware updates, and other product resources.

Related information

Documents

To find related documents, browse to the Manuals page of the HP Business Support Center website:

http://www.hp.com/support/manuals

- For related documentation, navigate to the Networking section, and select a networking category.
- For a complete list of acronyms and their definitions, see *HP A-Series Acronyms.*

Websites

- HP.com http://www.hp.com
- HP Networking http://www.hp.com/go/networking
- HP manuals http://www.hp.com/support/manuals
- HP download drivers and software http://www.hp.com/support/downloads
- HP software depot http://www.software.hp.com
- HP Education http://www.hp.com/learn

Conventions

This section describes the conventions used in this documentation set.

Command conventions

Convention	Description
Boldface	**Bold** text represents commands and keywords that you enter literally as shown.
Italic	*Italic* text represents arguments that you replace with actual values.
[ ]	Square brackets enclose syntax choices (keywords or arguments) that are optional.
{ x | y | ... }	Braces enclose a set of required syntax choices separated by vertical bars, from which you select one.
[x | y | ...]	Square brackets enclose a set of optional syntax choices separated by vertical bars, from which you select one or none.
{ x | y | ... } *	Asterisk-marked braces enclose a set of required syntax choices separated by vertical bars, from which you select at least one.
[x | y | ...] *	Asterisk-marked square brackets enclose optional syntax choices separated by vertical bars, from which you select one choice, multiple choices, or none.
&<1-n>	The argument or keyword and argument combination before the ampersand (&) sign can be entered 1 to n times.
#	A line that starts with a pound (#) sign is comments.

GUI conventions

Convention	Description
Boldface	Window names, button names, field names, and menu items are in bold text. For example, the **New User** window appears; click **OK**.
>	Multi-level menus are separated by angle brackets. For example, **File** > **Create** > **Folder**.

Symbols

Convention	Description
WARNING	An alert that calls attention to important information that if not understood or followed can result in personal injury.
CAUTION	An alert that calls attention to important information that if not understood or followed can result in data loss, data corruption, or damage to hardware or software.
IMPORTANT	An alert that calls attention to essential information.
NOTE	An alert that contains additional or supplementary information.
TIP	An alert that provides helpful information.

Network topology icons

	Represents a generic network device, such as a router, switch, or firewall.
	Represents a routing-capable device, such as a router or Layer 3 switch.
	Represents a generic switch, such as a Layer 2 or Layer 3 switch, or a router that supports Layer 2 forwarding and other Layer 2 features.

Port numbering in examples

The port numbers in this document are for illustration only and might be unavailable on your device.

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