Chapter 22

Layer 2 Circuit Configuration Guidelines

To configure a Layer 2 circuit, include the l2circuit statement:

```
l2circuit {
    neighbor address {
        interface interface-name {
            community community-name;
            (control-word | no-control-word);
            description text;
            protect-interface interface-name;
            virtual-circuit-id identifier;
        }
    }
    traceoptions {
        file filename <replace> <size size> <files number> <nostamp>;
        flag flag <flag-modifier> <disable>;
    }
}
```

You can include the l2circuit statement at the following hierarchy levels:

```
[edit protocols]

[edit logical-routers logical-router-name protocols]
```

This chapter describes how to configure Layer 2 circuits, discussing the following topics:

Configure Interfaces for Layer 2 Circuits

To configure interfaces for Layer 2 circuits, you do the following:

Configure the Neighbor and Interface

Each Layer 2 circuit is represented by the logical interface connecting the local provider edge (PE) router to the local customer edge (CE) router. All the Layer 2 circuits using a particular remote PE router designated for remote CE routers are listed under the neighbor statement (“neighbor” designates the PE router). Each neighbor is identified by its IP address and is usually the end-point destination for the label-switched path (LSP) tunnel transporting the Layer 2 circuit.

To configure a PE router as a neighbor, include the neighbor statement:

neighbor *address* { ... }

You can include the neighbor statement at the following hierarchy levels:

[edit protocols l2circuit]

[edit logical-routers *logical-router-name* protocols l2circuit]

To configure an interface, include the interface statement:

interface *interface-name* { ... }

You can include the interface statement at the following hierarchy levels:

[edit protocols l2circuit neighbor *address*]

[edit logical-routers *logical-router-name* protocols l2circuit neighbor *address*]

Configure the Protect Interface

The logical interface linking the PE router to the CE router can have a protect interface. A protect interface provides a backup for the protected interface in case of failure. Network traffic uses the primary interface only so long as the primary interface functions. If the primary interface fails, traffic is switched to the protect interface. The protect interface is optional.

To configure the protect interface, include the protect-interface statement:

protect-interface *interface-name*;

You can include the protect-interface statement at the following hierarchy levels:

[edit protocols l2circuit neighbor *address* interface *interface-name*]

[edit logical-routers *logical-router-name* protocols l2circuit neighbor *address* interface *interface-name*]

For an example of how to configure a protect interface for a Layer 2 circuit, see "Layer 2 Circuits Example" on page 453.

Configure the Interface Encapsulation Type for Layer 2 Circuits

The Layer 2 encapsulation type is carried in the Label Distribution Protocol (LDP) forwarding equivalence class (FEC). You can configure either circuit cross-connect (CCC) or translational cross-connect (TCC) encapsulation types for Layer 2 circuits. For more information, see the *JUNOS Internet Software MPLS Applications Configuration Guide*.

To configure the interface encapsulation for a Layer 2 circuit, include the encapsulation statement:

encapsulation *encapsulation-type*;

You can include the encapsulation statement at the following hierarchy levels:

[edit interfaces *interface-name*]

[edit logical-routers *logical-router-name* interfaces *interface-name*]

Configure ATM2 Interfaces for Layer 2 Circuits

You can configure Asynchronous Transfer Mode 2 (ATM2) interfaces for Layer 2 circuits by using Layer 2 circuit ATM Adaptation Layer 5 (AAL5) transport mode, Layer 2 circuit ATM cell relay mode, and the Layer 2 circuit ATM trunk mode.

The configuration statements are as follows:

```
atm-l2circuit-mode aal5

atm-l2circuit-mode cell

atm-l2circuit-mode trunk
```

For more information on these statements and configuring ATM2 interfaces, see the *JUNOS Internet Software Network Interfaces and Class of Service Configuration Guide*.

The JUNOS software implementation of sequence number processing for Layer 2 circuit ATM cell relay mode and Layer 2 circuit AAL5 mode differs from that described in the Internet draft draft-martini-l2circuit-encap-mpls-*version*.txt, *Frame Relay Encapsulation over Pseudo-Wires*.

The JUNOS software implementation has the following differences:

1. A packet with a sequence number of 0 is treated as out of sequence.
2. A packet that does not have the next incremental sequence number is considered out of sequence.

When out-of-sequence packets arrive, the expected sequence number for the neighbor is set to the sequence number in the Layer 2 circuit control word.

Configure the Virtual Circuit ID

You configure a virtual circuit ID on each interface. Each virtual circuit ID uniquely identifies the Layer 2 circuit among all the Layer 2 circuits to a specific neighbor. The key to identifying a particular Layer 2 circuit on a PE router is the neighbor address and the virtual circuit ID. An LDP-FEC-to-label binding is associated with a Layer 2 circuit based on the virtual circuit ID in the FEC and the neighbor that sent this binding. The LDP-FEC-to-label binding enables the dissemination of the VPN label used for sending traffic on that Layer 2 circuit to the remote CE router.

To configure the virtual circuit ID, include the virtual-circuit-id statement:

virtual-circuit-id *identifier*;

You can include the virtual-circuit-id statement at the following hierarchy levels:

[edit protocols l2circuit neighbor *address* interface *interface-name*]

[edit logical-routers *logical-router-name* protocols l2circuit neighbor *address* interface *interface-name*]

Configure LDP for Layer 2 Circuits

Use LDP as the signaling protocol to advertise ingress labels to the remote PE routers. When configured, LDP examines the Layer 2 circuit configuration and initiates extended neighbor discovery for all the Layer 2 circuit neighbors (for example, remote PEs). This process is similar to how LDP works when tunneled over Resource Reservation Protocol (RSVP). You must run LDP on the lo0.0 interface for extended neighbor discovery to function correctly.

For detailed information about how to configure LDP, see the *JUNOS Internet Software MPLS Applications Configur ation Guide*.

Configure Layer 2 Circuit Policies

You can configure JUNOS routing policies to control the flow of packets over Layer 2 circuits. This capability allows you to provide different level of service over a set of equal-cost Layer 2 circuits. For example, you can configure a circuit for high-priority traffic, a circuit for average-priority traffic, and a circuit for low-priority traffic. By configuring Layer 2 circuit policies, you can ensure that higher-value traffic has a greater likelihood of reaching its destination.

To configure Layer 2 circuit policies, do the following:

Configure the Layer 2 Circuit Community on page 444

Configure the Policy Statement for the Layer 2 Circuit Community on page 445

Verify the Layer 2 Circuit Policy Configuration on page 447

Configure the Layer 2 Circuit Community

To configure a community for Layer 2 circuits, include the community statement.

```
community name {
    members [ community-ids ];
}
```

You can include the community statement at the following hierarchy levels:

[edit policy-options]

[edit logical-routers *logical-router-name* policy-options]

name identifies the community or communities.

community-ids identifies the type of community or extended community:

A normal community uses the following community ID format:

as-number:*community-value*

as-number is the autonomous system (AS) number of the community member.

community-value is the identifier of the community member. It can be a number from 0 through 65,535.

An extended community uses the following community ID format:

type:*administrator*:*assigned-number*

type is the type of target community. The target community identifies the route's destination.

administrator is either an AS number or an Internet Protocol version 4 (IPv4) address prefix, depending on the type of community.

assigned-number identifies the local provider.

You need to associate the communities with the appropriate Layer 2 circuits. To associate a community with a Layer 2 circuit, include the virtual-circuit-id and community statements:

```
virtual-circuit-id number;
community community-name;
```

You can include these statements at the following hierarchy levels:

[edit protocols l2circuit neighbor *address* interface *interface-name*]

[edit logical-routers *logical-router-name* protocols l2circuit neighbor *address* interface *interface-name*]

Configure the Policy Statement for the Layer 2 Circuit Community

To configure a policy to send community traffic over a specific LSP, include the policy-statement statement:

```
policy-statement policy-name {
    term term-name {
      from community community-name;
      then {
        install-nexthop (except | lsp lsp-name | lsp-regex lsp-regular-expression);
        accept;
      }
    }
}
```

You can include the policy-statement statement at the following hierarchy levels:

[edit policy-options]

[edit logical-routers *logical-router-name* policy-options]

To prevent the installation of any matching next hops, include the install-nexthop statement with the except option:

install-nexthop except;

You can include the install-nexthop statement at the following hierarchy levels:

[edit policy-options policy-statement *policy-name* term *term-name* then]

[edit logical-routers *logical-router-name* policy-options policy-statement *policy-name* term *term-name* then]

To assign traffic from a community to a specific LSP, include the install-nexthop statement with the lsp *lsp-name* option and the accept statement:

install-nexthop lsp *lsp-name*;
accept;

You can include these statements at the following hierarchy levels:

[edit policy-options policy-statement *policy-name* term *term-name* then]

[edit logical-routers *logical-router-name* policy-options policy-statement *policy-name* term *term-name* then]

You can also use a regular expression to select an LSP from a set of similarly named LSPs for the install-nexthop statement. To configure a regular expression, include the install-nexthop statement with the lsp-regex option and the accept statement:

```
install-nexthop lsp-regex lsp-regular-expression;
accept;
```

You can include these statements at the following hierarchy levels:

[edit policy-options policy-statement *policy-name* term *term-name* then]

[edit logical-routers *logical-router-name* policy-options policy-statement *policy-name* term *term-name* then]

Example: Configure a Policy for a Layer 2 Circuit Community

The following example illustrates how you might configure a regular expression in a Layer 2 circuit policy. You create three LSPs to handle gold-tier traffic from a Layer 2 circuit. The LSPs are named alpha-gold, beta-gold, and delta-gold. You then include the the install-nexthop statement with the lsp-regex option with the LSP regular expression .*-gold at the [edit policy-options policy-statement *policy-name* term *term-name* then] hierarchy level:

```
[edit policy-options]
policy-statement gold-traffic {
    term to-gold-LSPs {
        from community gold;
        then {
            install-nexthop lsp-regex .*-gold;
            accept;
        }
    }
}
```

The community gold Layer 2 circuits can now use any of the -gold LSPs. Given equal utilization across the three -gold LSPs, LSP selection is made at random.

You need to apply the policy to the forwarding table. To apply a policy to the forwarding table, configure the export statement at the [edit routing-options forwarding-table] hierarchy level:

```
[edit routing-options forwarding-table]
export policy-name;
```

Verify the Layer 2 Circuit Policy Configuration

To verify that you have configured a policy for the Layer 2 circuit, issue the show route table mpls detail command. It should display the community for ingress routes that corresponds to the Layer 2 circuits, as shown by the following example:

```
user@host> show route table mpls detail
so-1/0/1.0 (1 entry, 1 announced)
        *L2VPN  Preference: 7
                Next hop: via so-1/0/0.0 weight 1, selected
                Label-switched-path to-community-gold
                Label operation: Push 100000 Offset: -4
                Next hop: via so-1/0/0.0 weight 1
                Label-switched-path to-community-silver
                Label operation: Push 100000 Offset: -4
                Protocol next hop: 10.255.245.45
                Push 100000 Offset: -4
                Indirect next hop: 85333f0 314
                State: <Active Int>
                Local AS:   100
                Age: 22
                Task: Common L2 VC
                Announcement bits (2): 0-KRT 1-Common L2 VC
                AS path: I
                Communities: 100:1
```

For more information on how to configure routing policies, see the *JUNOS Internet Software Policy Framework Configuration Guide*.

Configure the Control Word for Layer 2 Circuits

To emulate the virtual circuit (VC) encapsulation for Layer 2 circuits, a 4-byte control word is added between the Layer 2 protocol data unit (PDU) being transported and the VC label that is used for demultiplexing.

The following sections discuss how to configure the control word for Layer 2 circuits:

Configure the Control Word for Frame Relay Interfaces

On interfaces with Frame Relay CCC encapsulation, you can configure Frame Relay control bit translation to support Frame Relay services over IP and Multiprotocol Label Switching (MPLS) backbones by using CCC, Layer 2 VPNs, and Layer 2 circuits. When you configure translation of Frame Relay control bits, the bits are mapped into the Layer 2 circuit control word and preserved across the IP or MPLS backbone.

For information on how to configure the control bits, see the *JUNOS Internet Software Network Interfaces and Class of Service Configuration Guide*.

Disable the Control Word for Layer 2 Circuits

To emulate the VC encapsulation for Layer 2 circuits, a 4-byte control word is added between the Layer 2 PDU being transported and the VC label that is used for demultiplexing. Various networking formats (ATM, Frame Relay, Ethernet, and so on) use the control word in a variety of ways.

The JUNOS software supports the control word for Frame Relay. However, it does not support the control word for any other networking format, meaning that it is not fully compliant with the Internet draft in cases where the control word is mandatory. To be minimally compliant with the Internet draft, the JUNOS software supports a null control word (a control word of all zeros). If the JUNOS software receives a packet with a control word attached, the control word is discarded before the packet is forwarded to its destination.

The JUNOS software can typically determine whether a neighboring router supports the control word. However, if you want to explicitly disable its use on a specific interface, include the no-control-word statement:

```
no-control-word;
```

For a list of hierarchy levels at which you can configure this statement, see the statement summary section for this statement.

Configure ATM Trunking on Layer 2 Circuits

You can configure Layer 2 circuits to transport ATM traffic from directly connected ATM switches across an MPLS core network. Traffic from an ATM switch is received on the local PE router. The ATM cells are given an MPLS label and then sent across the MPLS network to the remote PE router. The receiving router removes the MPLS label from the ATM cell and then forwards the cell the receiving ATM switch.

NOTE: ATM trunking on Layer 2 circuits is supported only on T-series routing platforms and ATM2 PICs.

Figure 48: ATM Trunking on Layer 2 Circuits

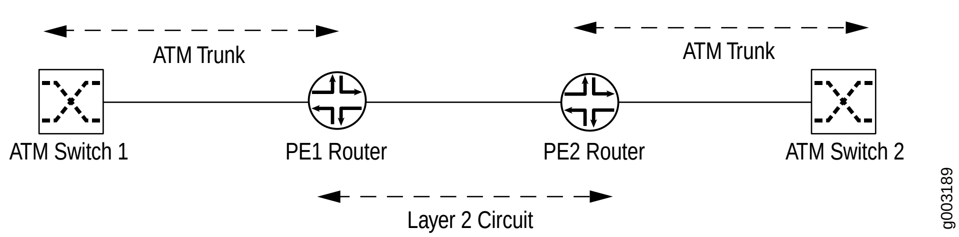

Figure 48 illustrates how ATM switches could be linked together by a Layer 2 circuit. The PE1 Router is configured to receive ATM trunk traffic from ATM Switch 1. As each ATM cell is received on the PE1 Router, it is classified by means of the class of service (CoS) information in the cell header and then encapsulated as a labeled packet. The CoS information and cell loss priority (CLP) of the ATM cell are copied into the experimental (EXP) bits of the MPLS label. The labeled packet is then transported across the service provider network to the PE2 Router by means of a Layer 2 circuit.

On the PE2 Router, the label is removed and the plain ATM cell is forwarded to ATM Switch 2. The CoS and CLP are extracted from the EXP bits and are then used to select the correct output queue and determine whether the ATM cell should be dropped.

The ATM physical port on the router can support 32 logical trunks when network-to-network interface (NNI) is used and 8 logical trunks when user-to-network interface (UNI) is used. A trunk can carry traffic on 32 virtual path identifiers (VPIs), numbered 0 through 31. Each ATM trunk is associated with an MPLS label and a logical interface. On the ingress router, one or more of these trunks are mapped to a Layer 2 circuit.

The configuration for the Layer 2 circuit between PE routers is conventional. Follow the procedures outlined in this chapter for configuring the circuit. However, there is some specific configuration you need to complete for the Layer 2 circuit to carry traffic from an ATM trunk.

First, enable ATM trunking for Layer 2 circuits. To enable ATM trunking for Layer 2 circuits, specify the trunk option for the atm-l2circuit-mode statement:

```
atm-l2circuit-mode trunk (uni | nni);
```

You can include the atm-l2circuit-mode statement at the [chassis fpc *number* pic *number*] hierarchy level.

Specify the uni option for UNI trunks and the nni option for NNI trunks. The default option is uni.

You also need to configure each ATM trunk for a specific logical interface. Each ATM trunk has a trunk identifier in the range 0 to 31. This configuration step is in addition to the typical configuration steps you follow related to configuring interfaces for Layer 2 circuits, as described in “Configure Interfaces for Layer 2 Circuits” on page 440.

To associate a specific trunk identifier with a logical interface, include the trunk-id statement:

```
trunk-id <number>;
```

You can include the trunk-id statement at the following hierarchy levels:

```
[edit interfaces interface-name unit number]
[edit logical-router logical-router-name interfaces interface-name unit number]
```

Since ATM trunking is supported on ATM2 PICs only, the only value you can configure for the pic-type statement is atm2. If you do not configure the pic-type statement but you do configure the trunk option for the atm-l2circuit-mode statement (at the [chassis fpc *number* pic *number*] hierarchy level), the pic-type statement defaults to atm2.

Configure Bandwidth Allocation and Call Admission Control

You can configure bandwidth allocation and call admission control (CAC) on Layer 2 circuits. This feature is available for RSVP-signaled LSPs traversing an MPLS network.

When you enable bandwidth allocation on a Layer 2 circuit, attempts to establish an RSVP-signaled LSP are preceded by a check of the available bandwidth on the network. This check is the CAC. The available bandwidth is compared to the bandwidth requested by the LSP. If there is insufficient bandwidth, the Layer 2 circuit is not established and an error message is generated. To apply CAC to a Layer 2 circuit, a bandwidth constraint must be configured.

You can specify the bandwidth for a Layer 2 circuit without configuring a bandwidth for each class type (queue). To specify the bandwidth allocation for a Layer 2 circuit, include the bandwidth statement:

bandwidth *bandwidth*;

Specify the bandwidth in bits per second.

You can include the bandwidth statement at the following hierarchy levels:

[edit protocols l2circuit neighbor *address* interface *interface-name*]

[edit logical-routers *logical-router-name* protocols l2circuit neighbor *address* interface *interface-name*]

Alternatively, you can configure the bandwidth for each class type on a Layer 2 circuit. If you use this type of configuration, you cannot simultaneously configure the nonclass type of bandwidth configuration for the Layer 2 circuit (the commit fails).

To configure the bandwidth for each class type on an Layer 2 circuit, include the bandwidth statement:

```
bandwidth {
    ct0 bandwidth;
    ct1 bandwidth;
    ct2 bandwidth;
    ct3 bandwidth;
}
```

You can include the bandwidth statement at the following hierarchy levels:

[edit protocols l2circuit neighbor *address* interface *interface-name*]

[edit logical-routers *logical-router-name* protocols l2circuit neighbor *address* interface *interface-name*]

NOTE: It is mandatory to configure a bandwidth model when the bandwidth allocation is per class. For information on how to configure a bandwidth model, see the *JUNOS Internet Software MPLS Applications Configuration Guide*.

Specify the bandwidth for each class type in bits per second. It is not necessary to specify a bandwidth for all four class types.

Trace Layer 2 Circuit Creation and Changes

To trace the creation of and changes to Layer 2 circuits, you can specify options in the traceoptions statement:

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

You can include the traceoptions statement at the following hierarchy levels:

[edit protocols l2circuit]

[edit logical-routers *logical-router-name* protocols l2circuit]

The following tracing flags display the operations associated with Layer 2 circuits:

connections—Layer 2 circuit connections (events and state changes)

error—Error conditions

FEC—Layer 2 circuit advertisements received or sent using LDP

topology—Layer 2 circuit topology changes caused by reconfiguration or advertisements received from other PE routers