Chapter 13

LDP Overview

The Label Distribution Protocol (LDP) is a protocol for distributing labels in non-traffic-engineered applications. LDP allows routers to establish label-switched paths (LSPs) through a network by mapping network-layer routing information directly to data link layer-switched paths.

These LSPs might have an endpoint at a directly attached neighbor (comparable to IP hop-by-hop forwarding), or at a network egress node, enabling switching through all intermediary nodes. LSPs established by LDP can also traverse traffic-engineered LSPs created by RSVP.

LDP associates a forwarding equivalence class (FEC) with each LSP it creates. The FEC associated with an LSP specifies which packets are mapped to that LSP. LSPs are extended through a network as each router chooses the label advertised by the next hop for the FEC and splices it to the label it advertises to all other routers. This process forms a tree of LSPs that converge on the egress router.

This chapter discusses the following topics:

LDP Standards

LDP is described in the following RFC and Internet draft:

RFC 3036, *LDP Specification*

The JUNOS software supports the required elements of RFC 3036, except the following:

loop detection

CR-LDP

The RFC establishes three modes that the JUNOS software only partially supports:

Label distribution control mode

Label retention mode

Label advertisement mode

The following values for these modes are supported:

Label distribution control mode: ordered

Label retention mode: liberal

Label advertisement mode: downstream unsolicited

The following values for these modes are not supported:

Label distribution control mode: independent

Label retention mode: conservative

Label advertisement mode: downstream on demand

Internet draft draft-ietf-mpls-ldp-restart-00.txt, *Graceful Restart Mechanism for LDP* (expires July 2002)

To access Internet RFCs and drafts, go to the IETF Web site at http://www.ietf.org/.

JUNOS LDP Protocol Implementation

The JUNOS implementation of LDP supports LDP version 1. The JUNOS software supports a simple mechanism for tunneling between routers in an interior gateway protocol (IGP), to eliminate the required distribution of external routes within the core. JUNOS allows a Multiprotocol Label Switching (MPLS) tunnel next hop to all egress routers in the network, with only an IGP running in the core to distribute routes to egress routers. Edge routers run BGP but do not distribute external routes to the core. Instead, the recursive route lookup at the edge resolves to an LSP switched to the egress router. No external routes are necessary on the transit LDP routers.

LDP Operation

You must configure LDP for each interface on which you want LDP to run. LDP creates LSP trees rooted at each egress router for the router ID address that is the subsequent Border Gateway Protocol (BGP) next hop. The ingress point is at every router running LDP. This process provides an inet.3 route to every egress router. If BGP is running, it will attempt to resolve next hops by using the inet.3 table first, which binds most, if not all, of the BGP routes to MPLS tunnel next hops.

Two adjacent routers running LDP become neighbors. If the two routers are connected by more than one interface, they become neighbors on each interface. When LDP routers become neighbors, they establish an LDP session to exchange label information. If per-router labels are in use on both routers, only one LDP session is established between them, even if they are neighbors on multiple interfaces. For this reason, an LDP session is not related to a particular interface.

LDP operates in conjunction with a unicast routing protocol. LDP installs LSPs only when both LDP and the routing protocol are enabled. For this reason, you must enable both LDP and the routing protocol on the same set of interfaces. If this is not done, LSPs might not be established between each egress router and all ingress routers, which might result in loss of BGP-routed traffic.

For LDP to run on an interface, MPLS must be enabled on a logical interface on that interface. For more information, see the *JUNOS Network Interfaces and Class of Service Configuration Guide*.

LDP Label Filtering

You can apply policy filters to labels received from and distributed to other routers through LDP. Policy filters provide you with a mechanism to control the establishment of LSPs.

Tunneling LDP LSPs in RSVP LSPs

You can tunnel LDP LSPs over RSVP LSPs. The following sections describe how tunneling LDP LSPs in RSVP LSPs works:

Tunneling LDP LSPs in RSVP LSPs Overview

If you are using RSVP for traffic engineering, you can run LDP simultaneously to eliminate the distribution of external routes in the core. The LSPs established by LDP are tunneled through the LSPs established by RSVP. LDP effectively treats the traffic-engineered LSPs as single hops.

When you configure the router to run LDP across RSVP-established LSPs, LDP automatically establishes sessions with the router at the other end of the LSP. LDP control packets are routed hop-by-hop, rather than carried through the LSP. This routing allows you to use simplex (one-way) traffic-engineered LSPs. Traffic in the opposite direction flows through LDP-established LSPs that follow unicast routing rather than through traffic-engineered tunnels.

If you configure LDP over RSVP LSPs, you can still configure multiple Open Shortest Path First (OSPF) areas and Intermediate System-to-Intermediate System (IS-IS) levels in the traffic engineered core and in the surrounding LDP cloud.

Label Operations

Figure 23 depicts an LDP LSP being tunneled through an RSVP LSP. (For definitions of label operations, see “Label Description” on page 26.) The shaded inner oval represents the RSVP domain, whereas the outer oval depicts the LDP domain. RSVP establishes an LSP through routers B, C, D, and E, with the sequence of labels L3, L4. LDP establishes an LSP through routers A, B, E, F, and G, with the sequence of labels L1, L2, L5. LDP views the RSVP LSP between routers B and E as a single hop.

When the packet arrives at Router A, it enters the LSP established by LDP, and a label (L1) is pushed onto the packet. When the packet arrives at Router B, the label (L1) is swapped with another label (L2). Because the packet is entering the traffic-engineered LSP established by RSVP, a second label (L3) is pushed onto the packet.

This outer label (L3) is swapped with a new label (L4) at the intermediate router (C) within the RSVP LSP tunnel, and when the penultimate router (D) is reached, the top label is popped. Router E swaps the label (L2) with a new label (L5), and the penultimate router for the LDP-established LSP (F) pops the last label.

Figure 23: Swap and Push When LDP LSPs Are Tunneled Through RSVP LSPs

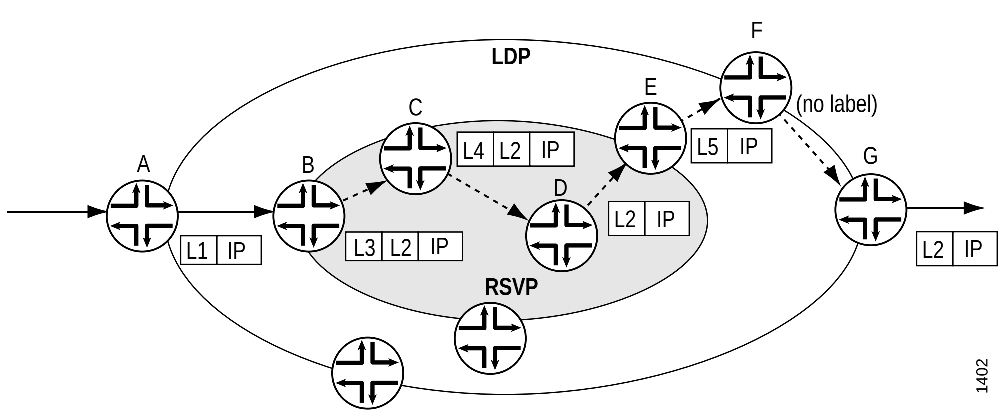
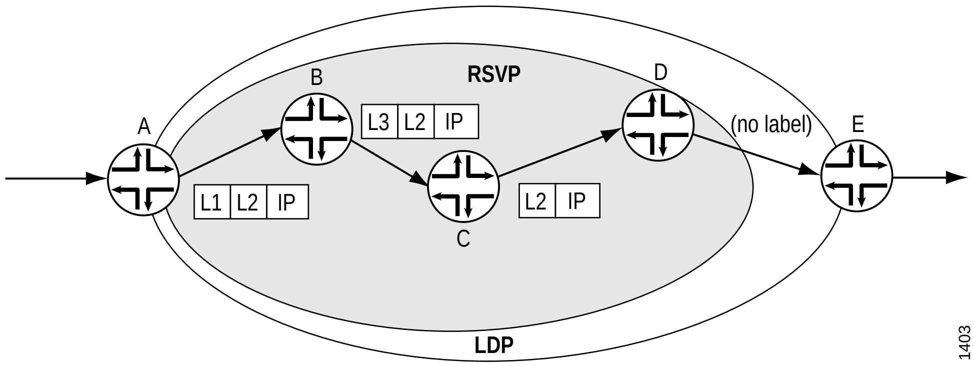


Figure 24 depicts double push label operation (L1L2), which is used when the ingress router (A) of the LDP and the RSVP are the same router. Note that Router D is the penultimate hop for the LDP-established LSP, so L2 is popped from the packet by Router D.

Figure 24: Double Push When LDP LSPs Are Tunneled Through RSVP LSPs



LDP Message Types

LDP uses the following types of messages to establish and remove mappings and to report errors. All LDP messages have a common structure that uses a type length value (TLV) encoding scheme.

Discovery Messages

Discovery messages announce and maintain the presence of a router in a network. Routers indicate their presence in a network by sending the hello message periodically. This hello message is transmitted as a UDP packet to the LDP port at the group multicast address for all routers on the subnet.

Session Messages

Session messages establish, maintain, and terminate sessions between LDP peers. When a router establishes a session with another router learned through the hello message, it uses the LDP initialization procedure over Transmission Control Protocol (TCP) transport. When the initialization procedure is completed successfully, the two routers are LDP peers and can exchange advertisement messages.

Advertisement Messages

Advertisement messages create, change, and delete label mappings for FECs. Requesting a label or advertising a label mapping to a peer is a decision made by the local router. In general, the router requests a label mapping from a neighboring router when it needs one and advertises a label mapping to a neighboring router when it wants the neighbor to use a label.

Notification Messages

Notification messages provide advisory information and signal error information. LDP sends notification messages to report errors and other events of interest. There are two kinds of LDP notification messages:

- Error notifications, which signal fatal errors. If a router receives an error notification from a peer for an LDP session, it terminates the LDP session by closing the TCP transport connection for the session and discarding all label mappings learned through the session.

- Advisory notifications, which pass information to a router about the LDP session or the status of some previous message received from the peer.

LDP Graceful Restart

LDP graceful restart allows a router whose LDP control plane is undergoing a restart to continue to forward traffic while recovering its state from neighboring routers. It also allows a router on which helper mode is enabled to assist a neighboring router that is attempting to restart LDP.

During session initialization, a router advertises its ability to perform LDP graceful restart or to take advantage of a neighbor performing LDP graceful restart by sending the graceful restart type length value (TLV). This TLV contains two fields relevant to LDP graceful restart: the reconnect time and the recovery time. The values of the reconnect and recovery times indicate the graceful restart capabilities supported by the router.

The reconnect time is configured in the JUNOS software as 60 seconds and is not user-configurable. When a router discovers that a neighboring router is restarting, it waits until the end of the recovery time before attempting to reconnect. The recovery time is the amount of time a router waits for LDP to restart gracefully. The recovery time period begins when an initialization message is sent or received. This time period is also typically the amount of time that a neighboring router maintains its information about the restarting router, allowing it to continue to forward traffic.

You can configure LDP graceful restart in both the master instance for the LDP protocol and for a specific routing instance. You can disable graceful restart at the global level for all protocols, at the protocol level for LDP only, and on a specific routing instance. LDP graceful restart is disabled by default, because at the global level graceful restart is disabled by default. However, helper mode (the ability to assist a neighboring router attempting a graceful restart) is enabled by default.

The following are some of the behaviors associated with LDP graceful restart:

- Outgoing labels are not maintained in restarts. New outgoing labels are allocated.

- When a router is restarting, no label-map messages are sent to neighbors that support graceful restart until the restarting router has stabilized (label-map messages are immediately sent to neighbors that do not support graceful restart). However, all other messages (keepalive, address-message, notification, and release) are sent as usual. Distributing these other messages prevents the router from distributing incomplete information.

- Helper mode and graceful restart are independent. You can disable graceful restart in the configuration, but still allow the router to cooperate with a neighbor attempting to restart gracefully.