LDP Principles and Configurations

Foreword

- Multiprotocol Label Switching (MPLS) implements data forwarding based on short and fixed-length labels carried in packets.
- A fundamental concept in MPLS is that two LSRs must agree on the meaning of the labels used to forward traffic between them. The Label Distribution Protocol (LDP) can be used by an LSR to send its label binding information to other LDP-capable LSRs, helping implement correct forwarding of labeled packets.
- This course describes the principles, features, and basic configurations of LDP.

- LDP mentioned in this course refers to that defined in RFC 3036 for the first time. This protocol has been replaced by RFC 5036.
- Other label distribution protocols include MP-BGP and RSVP.

Objectives

- On completion of this course, you will be able to:
  - Understand LDP's basic concepts and working mechanisms.
  - Describe the MPLS label distribution control mode, advertisement mode, and retention mode.
  - Perform basic LDP configurations.

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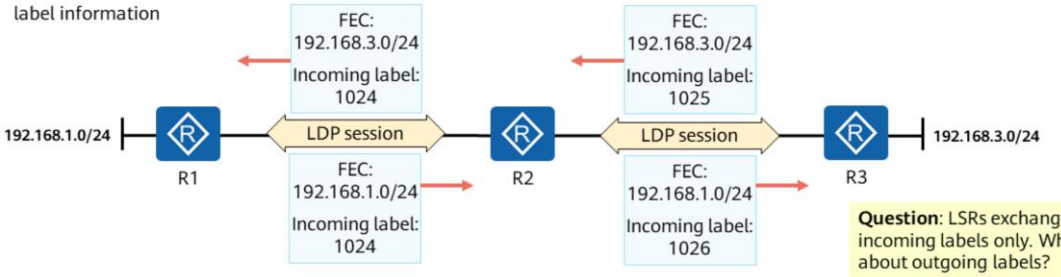
LDP Overview

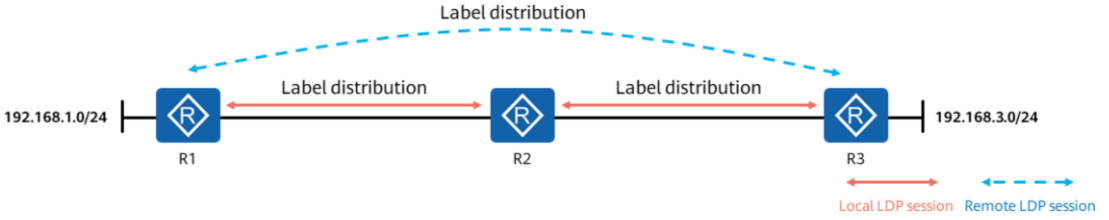
- LDP is an MPLS control protocol, which is similar to a signaling protocol on a traditional network. LDP is responsible for FEC classification, label distribution, and LSP establishment and maintenance. LDP defines the messages used in label distribution as well as the message processing procedures.
- The working process of LDP involves:
  1. LDP session establishment between LSRs
  2. Dynamic exchange of FEC-label mapping information between LSRs over LDP sessions, as well as LSP establishment based on label information



Question: LSRs exchange incoming labels only. What about outgoing labels?

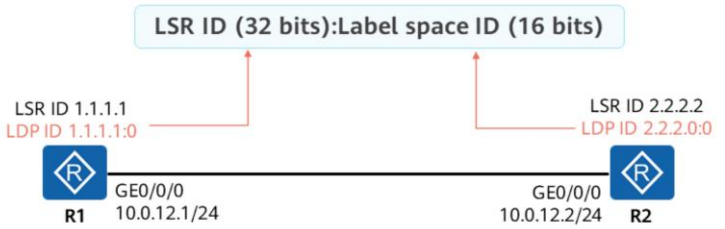
LDP Session, Adjacency, and Peer

- An LDP session must be established before LSRs can exchange label binding information. LDP sessions are classified into the following types:
  - Local LDP session: can be established between two LSRs that are directly connected.
  - Remote LDP session: can be established between two LSRs that are directly or indirectly connected.
- An adjacency is established between two LSRs after they exchange Hello messages.
- After an adjacency is established between two LSRs, they exchange LDP session messages to establish an LDP session. An LDP peer relationship is then established between them.



LSR ID and LDP ID

- Each LDP-capable LSR must have an LDP ID, in addition to an LSR ID.
  - An LDP ID is 48 bits long and consists of a 32-bit LSR ID and a 16-bit label space ID.
  - An LDP ID is presented in the format of "LSR ID:Label space ID", for example, 2.2.2.2:0.
- The meaning of a label space ID varies according to its value:
  - 0: indicates a device-based label space.
  - Non-zero value: indicates an interface-based label space.



- This course takes the device-based label space as an example.

LDP Messages

LDP-capable LSRs exchange LDP messages to discover peers, establish and maintain sessions, and manage labels.

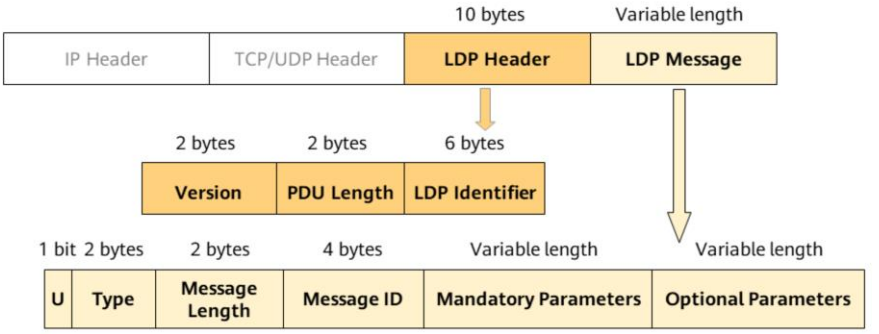
Message Category	Message Name	Transport Layer Protocol	Function
Discovery message	Hello	UDP	Advertises local LSRs and discovers peers in the LDP discovery process.
Session message	Initialization	TCP	Negotiates parameters in an LDP session establishment process.
	KeepAlive		Monitors the TCP connection integrity of LDP sessions.
Advertisement message	Address		Advertises interface addresses.
	Address Withdraw		Withdraws interface addresses.
	Label Mapping		Advertises FEC-label mapping information.
	Label Request		Requests label mappings for FECs.
	Label Abort Request		Aborts undone Label Request messages.
	Label Withdraw		Withdraws FEC-label mappings.
	Label Release		Releases labels.
Notification message	Notification		Informs LDP peers of errors.

- LDP messages are classified into four types by function: discovery, session, advertisement, and notification.
  - Discovery messages: announce and maintain the presence of LSRs on a network. Hello messages belong to this category.
  - Session messages: establish, maintain, and terminate sessions between LDP peers. Initialization and KeepAlive messages belong to this category.
  - Advertisement messages: generate, change, and delete label mappings for FECs.
  - Notification messages: provide advisory information and signal error information.
- LDP messages are carried over UDP or TCP, with the port number being 646. Discovery messages, which are used to discover peers, are carried over UDP. Other LDP messages must be transmitted in a reliable and ordered manner. Therefore, LDP uses TCP to establish sessions. Session, advertisement, and notification messages are transmitted over TCP.

LDP Packet Encapsulation

An LDP packet consists of an LDP header and an LDP message.

- An LDP header carries information such as the LDP version and packet length.
- An LDP message carries information such as the message type and message length.



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- An LDP header is 10 bytes long. It consists of three parts: Version, PDU Length, and LDP Identifier.
  - The Version field occupies 2 bytes. It indicates the LDP version number. The current version number is 1.
  - The PDU Length field occupies 2 bytes. It indicates the packet length in bytes, excluding the Version and PDU Length fields.
  - The LDP Identifier field (that is, LDP ID) occupies 6 bytes. The first 4 bytes uniquely identify an LSR, and the last 2 bytes identify the label space of the LSR.
- An LDP message consists of five parts.
  - The U field occupies 1 bit, which is an unknown message. When an LSR receives an unknown message, the LSR returns a notification message to the message originator if the U field is 0, but ignores the message and does not respond with a notification message if the U field is 1.
  - Message Length occupies 2 bytes. It indicates the total length of Message ID, Mandatory Parameters, and Optional Parameters, in bytes.
  - Message ID occupies 32 bits. It identifies a message.
  - Each of the Mandatory Parameters and Optional Parameters fields has a variable length.
  - Message Type indicates a specific message type. Currently, common messages defined by LDP include Notification, Hello, Initialization, KeepAlive, Address, Address Withdraw, Label Mapping, Label Request, Label Abort Request, Label Withdraw, and Label Release.

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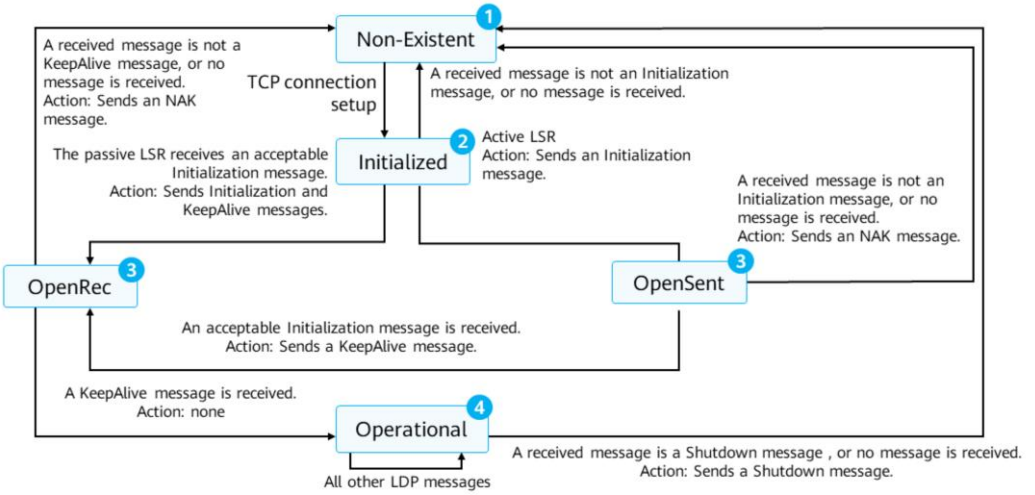
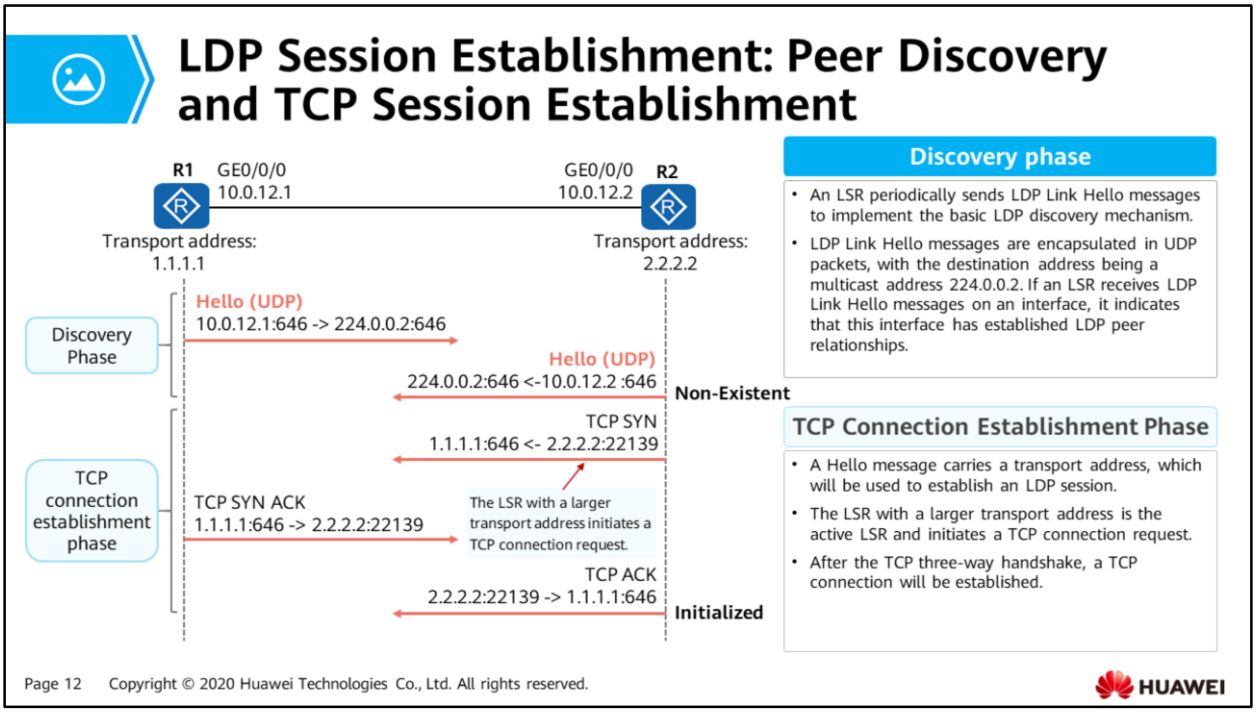
LDP Session State Machine

LDP uses five states to describe the LDP session state machine.

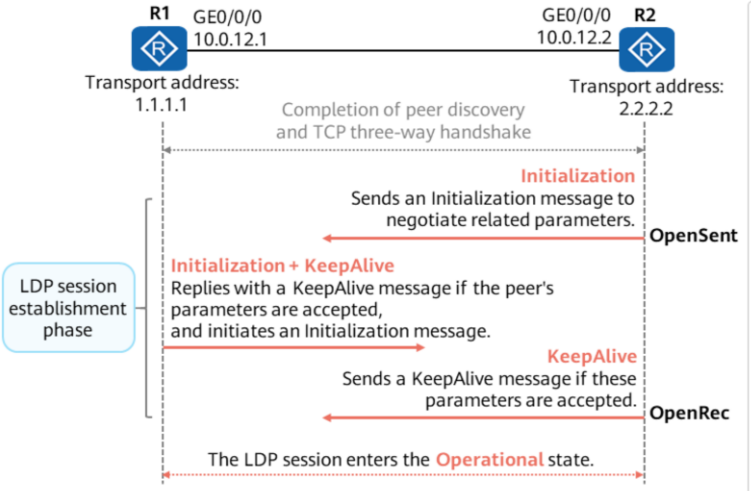


- The LDP session negotiation process can be described through the state machine. As shown in the figure, there are five states. They are Non-Existent, Initialized, OpenRec, OpenSent, and Operational.
  - Non-Existent: It is the initial state of an LDP session. In this state, both LSRs send Hello messages to elect the active LSR. After a TCP connection establishment success event is received, the state changes to Initialized.
  - Initialized: In this state, the active LSR sends an Initialization message to the passive LSR, sets the session state to OpenSent, and waits for an Initialization message. The passive LSR waits for the Initialization message sent by the active LSR. If the parameters in the received Initialization message are accepted, the passive LSR sends Initialization and KeepAlive messages, and sets the session state to OpenRec. When the active and passive LSRs receive any non-initialization message or the waiting period times out, both of them set the session state to Non-Existent.
  - OpenSent: It is a state after the active LSR sends an Initialization message. In the OpenSent state, the active LSR waits for the passive LSR to respond to the Initialization and KeepAlive messages. If the parameters in the received Initialization message are accepted, the active LSR sets the session state to OpenRec. However, if the parameters are not accepted or the Initialization message times out, the active LSR tears down the TCP connection and sets the session state to Non-Existent.
  - OpenRec: In this state, both the active and passive LSRs wait for a KeepAlive message from the peer end after they send KeepAlive messages. An LSR sets the session state to Operational state after receiving a KeepAlive message, but sets the session state to Non-Existent if a non-KeepAlive message is received or the KeepAlive message times out.



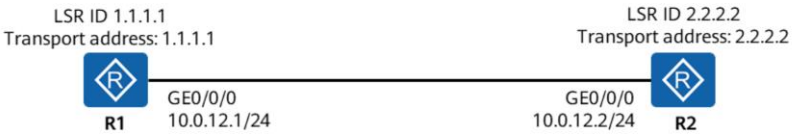
- In addition to the basic discovery mechanism, the extended discovery mechanism is supported, which can be used to discover indirectly connected remote adjacencies. For details, see RFC 5036.
- LDP transport addresses are used to establish TCP connections with peers.
  - Before establishing an LDP session, two LSRs need to establish a TCP connection to exchange LDP packets.
  - A transport address of an LSR is contained in LDP Hello messages, through which an LSR can learn the transport addresses of its peers.
  - After two LSRs discover each other and learn each other's transport address through Hello messages, the LSRs attempt to perform the TCP three-way handshake (based on the transport addresses), and exchange LDP Initialization messages, Label Mapping messages, and so on. All these messages use the transport addresses of the two ends as source and destination IP addresses.
  - An LSR must have a route to the transport address of its peer.
  - By default, the transport address for a device on a public network is the LSR ID of the device, and the transport address for a device on a private network is the primary IP address of an interface on the device.
  - The **mpls ldp transport-address** command can be run in the interface view to change a transport address.

LDP Session Establishment - Session Establishment and Maintenance



- After a TCP connection is established, R2 (active LSR with a larger transport address) sends an LDP Initialization message to negotiate parameters related to LDP session establishment.
- These parameters include the LDP version, label distribution mode, KeepAlive timer value, maximum PDU length, and label space.
- After R1 receives the Initialization message, it replies with a KeepAlive message if it accepts R2's parameters. To improve transmission efficiency, R1 also sends an Initialization message.
- After R2 receives the Initialization message, it replies with a KeepAlive message if it accepts R1's parameters.
- After both ends receive each other's KeepAlive message, the session is established successfully. They periodically send KeepAlive messages to maintain the session.

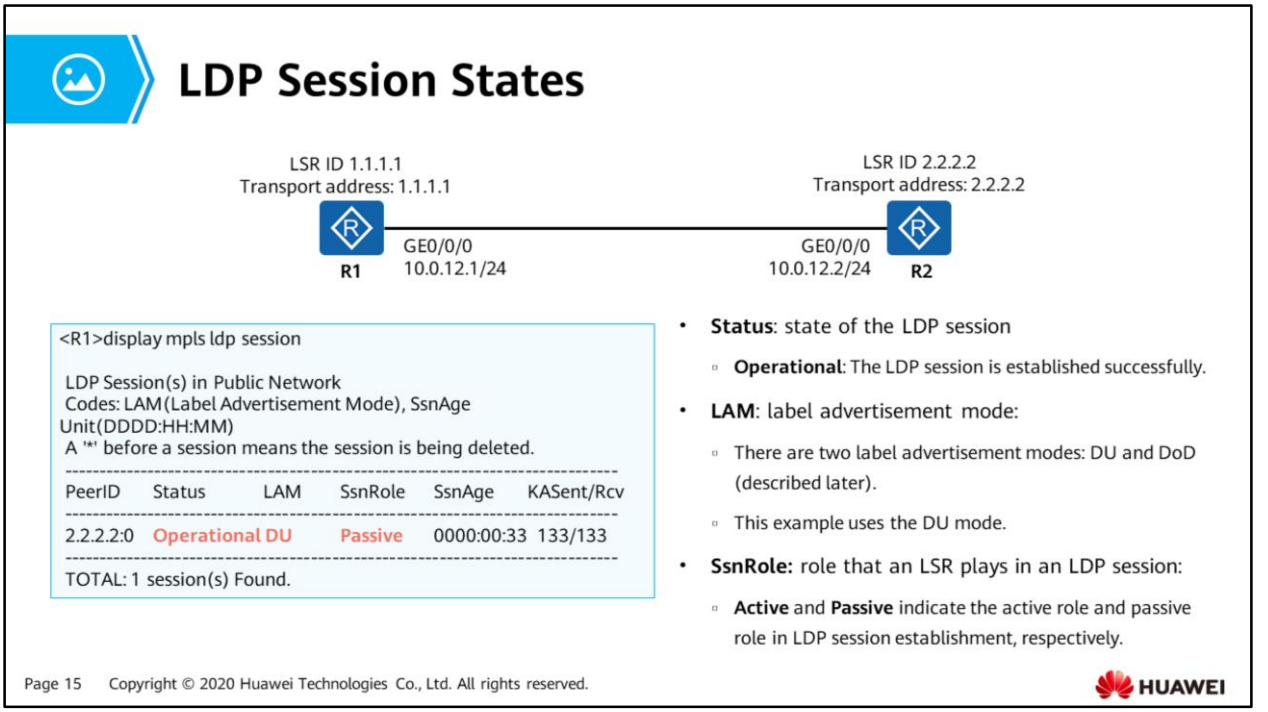
LDP Peer State




```
<R1>display mpls ldp peer

LDP Peer Information in Public network
A '*' before a peer means the peer is being deleted.
------------------------------------------------------------------------------
PeerID            TransportAddress  DiscoverySource
------------------------------------------------------------------------------
2.2.2.2:0         2.2.2.2           GigabitEthernet0/0/0
------------------------------------------------------------------------------
TOTAL: 1 Peer(s) Found.
```

- **PeerID**: LDP ID of the peer
  - **2.2.2.2**: LSR ID of the peer
  - **0**: device-based label space
- **TransportAddress**: transport address of the peer
  - **2.2.2.2**: IP address used to establish a TCP connection



- LDP session states:
  - NonExistent: initial state of an LDP session. In this state, the two ends send Hello messages to each other. After the TCP connection establishment success event is triggered, the session enters the Initialized state.
  - Initialized: The LDP session is being initialized.
  - OpenSent: The active LSR sends an Initialization message to the passive LSR and waits for a reply.
  - Open Recv: LDP peers at both ends of the LDP session wait for a KeepAlive message from each other after the session enters the initialization state. If they receive each other's KeepAlive message, the LDP session enters the Operational state.
  - Operational: The LDP session is established successfully.

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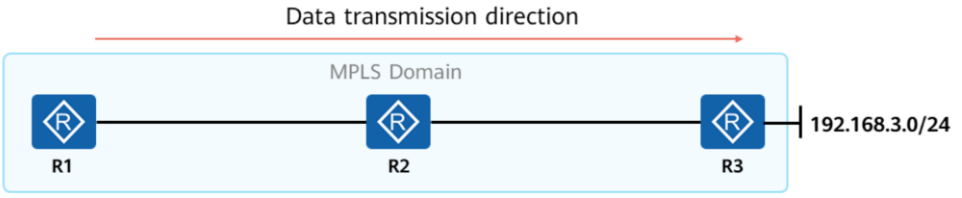
Label Advertisement and Management

- On an MPLS network, a downstream LSR determines the bindings between labels and FECs and advertises the bindings to its upstream LSR.
- To establish LSPs, LDP sends Label Request and Label Mapping messages to advertise the bindings between labels and FECs.
- Label advertisement and management are determined by the label advertisement mode, label distribution control mode, and label retention mode.

Item	Mode	Default Mode (Yes/No)?	Description
Label advertisement mode	Downstream unsolicited (DU)	Yes	An LSR assigns and distributes labels to a FEC without receiving Label Request messages from its upstream LSR.
	Downstream on demand (DoD)	No	An LSR assigns and distributes labels to a FEC only after receiving Label Request messages from its upstream LSR.
Label distribution control mode	Independent	Yes	A local LSR assigns and binds a label to a FEC and then advertises the binding to the upstream LSR, without waiting for the label distributed by the downstream LSR.
	Ordered	No	An LSR sends the label mapping of a FEC to its upstream device only if the LSR has received Label Mapping messages from the next hop of the FEC or if the LSR is the egress of the FEC.
Label retention mode	Liberal	Yes	An LSR retains all label mappings received from a peer, regardless of whether the peer is its next hop.
	Conservative	No	An LSR retains the label mappings received from a peer only if the peer is its next hop.

Upstream and Downstream

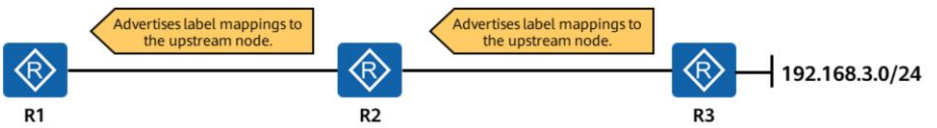
- MPLS determines the upstream and downstream relationships based on the data forwarding direction. Labeled packets are sent from an upstream LSR, and received and processed by a downstream LSR.
- As shown in the figure, for the LSP to 192.168.3.0/24, R3 is the downstream LSR of R2, and R1 is the upstream LSR of R2.



Label Advertisement Mode — DU

DU mode

- An LSR assigns and distributes labels to a FEC without having to receive Label Request messages from its upstream LSR.
- An LSR actively advertises the labels of a FEC to its upstream peer without having to receive Label Request messages from the peer.

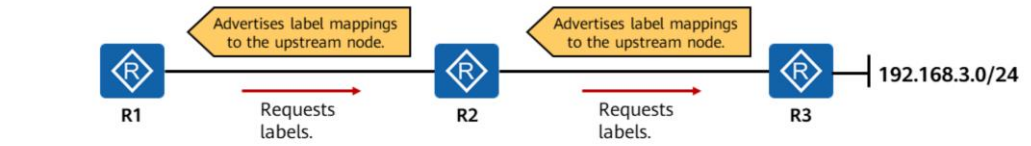


- Label assignment: An LSR assigns a label from the local label space and binds it with a FEC.
- Label distribution: An LSR notifies the upstream LSR of the binding between labels and FECs.
- When the DU label advertisement mode is used, an LSR can assign labels to all its peers by default. Specifically, each LSR can distribute label mappings to all its peers, regardless of whether the LSR is an upstream or a downstream one. If an LSR distributes labels only to upstream peers, it must identify its upstream and downstream nodes based on routing information before sending Label Mapping messages. An upstream node cannot send Label Mapping messages to its downstream node.

Label Advertisement Mode — DoD

DoD mode

- An LSR assigns and distributes labels to a FEC only after receiving Label Request messages from its upstream LSR.
- Generally, a Label Request message is triggered when an access request to a particular FEC arises.



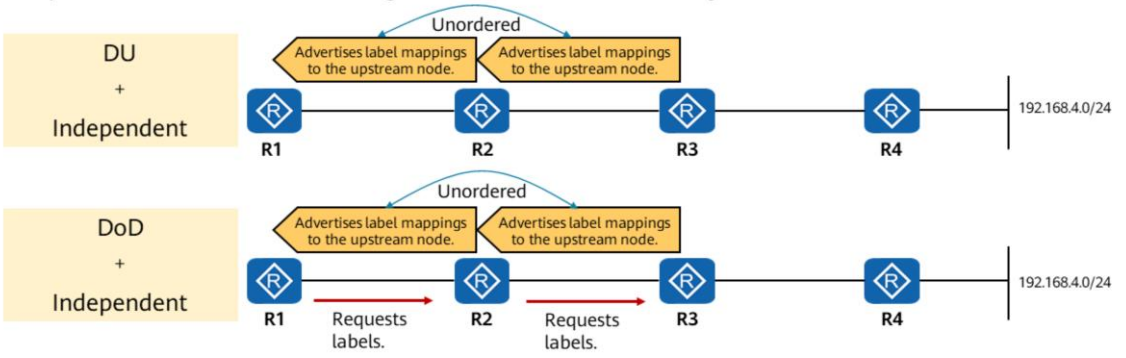
R1 requires to access the 192.168.3.0/24 network segment.

- An LSR advertises label mappings to an upstream peer only after receiving Label Request messages from the upstream peer.

Label Distribution Control Mode — Independent

Independent mode

- A local LSR assigns and binds a label to a FEC and then advertises the binding to the upstream LSR, without waiting for the label distributed by the downstream LSR.



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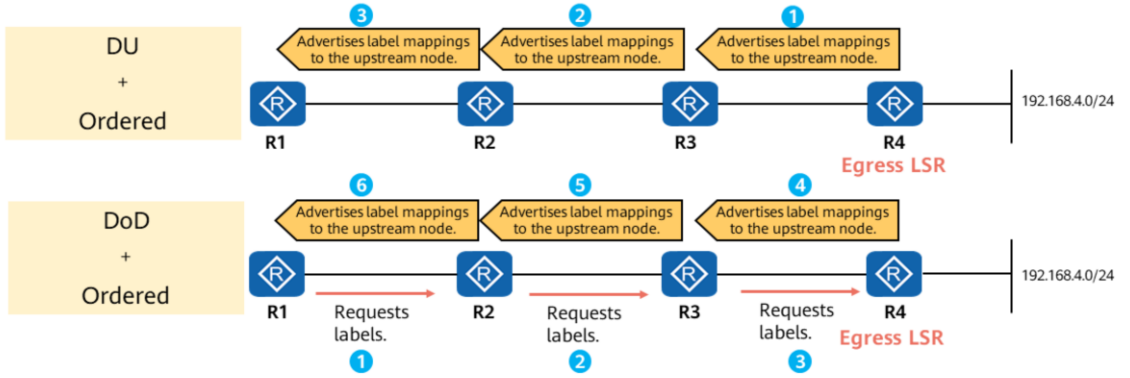
- The label distribution control mode works with the label advertisement mode:
  - If the network shown in the figure uses the DU label advertisement mode, R2 and R3 can actively notify the upstream LSR of the label binding for the FEC 192.168.4.0/24 even if the upstream LSR does not send Label Request messages and R2 and R3 do not receive label binding information from the downstream LSR.
  - If the network uses the DoD label advertisement mode, R2 and R3 can notify the upstream LSR of the label binding for the FEC 192.168.4.0/24 given that R2 and R3 have received Label Request messages from the upstream LSR, regardless of whether R2 and R3 have received label binding information from the downstream LSR.

Label Distribution Control Mode — Ordered

Ordered mode

- An LSR sends the label mapping of a FEC to its upstream device only if the LSR has received Label Mapping messages from the downstream of the FEC or if the LSR is the egress of the FEC.



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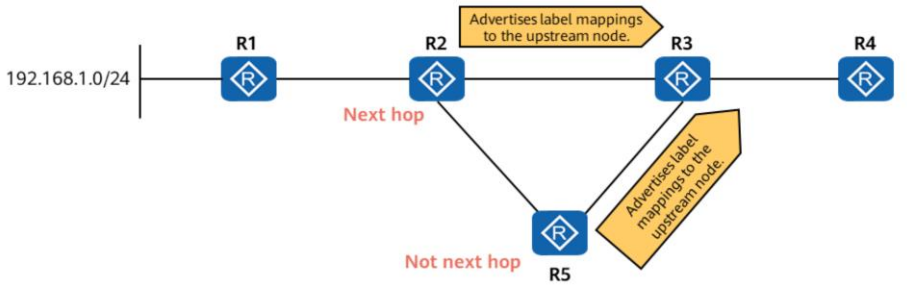
- In ordered label distribution control mode, an LSR can send a Label Mapping message to its upstream node only when the LSR receives Label Mapping messages of a FEC from the downstream of the FEC or when the LSR is the egress of an LSP.
  - If the network shown in the figure uses the DU label advertisement mode, an LSR sends the label binding information of the FEC 192.168.4.0/24 to its upstream node only after the LSR receives the label binding information of the FEC from its downstream node, even if the upstream node has sent Label Request messages. Therefore, the initiator for LSP establishment must be an egress LSR (R4 in this example).
  - If the network uses the DoD label advertisement mode, an LSR advertises the label binding information of the FEC 192.168.4.0/24 to the upstream node only after the LSR receives Label Request messages from the upstream node as well as the label binding information of the FEC from the downstream node. Therefore, a Label Request message can be initiated by the ingress LSR (R1) only. After a Label Request is sent hop by hop to the egress LSR (R4), R4 advertises a Label Mapping message to the upstream LSR to establish an LSP.

Label Retention Mode — Liberal

Liberal mode

- An LSR can receive label mappings from its next hop or non-next hop nodes.
- An LSR retains all label mappings received from a peer, regardless of whether the peer is its next hop.

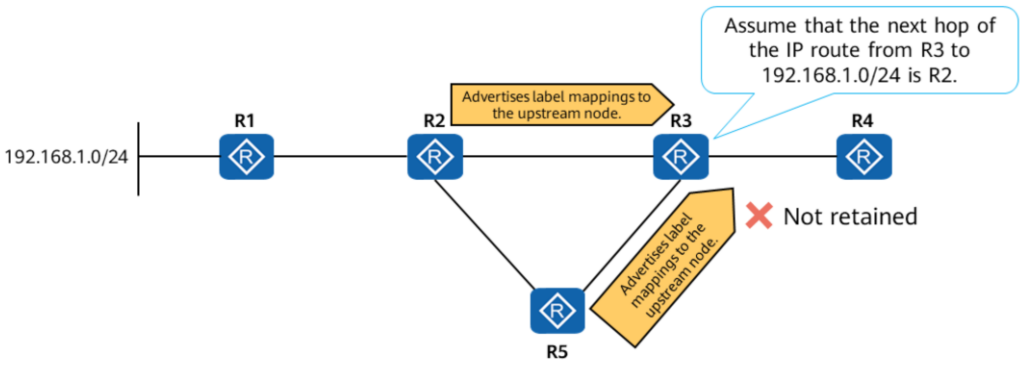


- If MPLS is deployed on an IP network, an LSR uses the IP routing table to determine whether a label mapping is received from the next hop.
- In liberal mode, a new LSP can be quickly established when routes change, because all received labels are retained, which is the biggest advantage of this mode. The disadvantage is that unnecessary label mappings are distributed and maintained.
  - In DU label advertisement mode, if the liberal label retention mode is used, R3 retains the labels of the FEC 192.168.1.0/24 sent by all LDP peers (R2 and R5 in this example), regardless of whether R2 and R5 are the next hops of the routes to 192.168.1.0/24 in the IP routing table.
  - In DoD label advertisement mode, if the liberal label retention mode is used, an LSR requests labels from all LDP peers. However, the DoD label advertisement mode is generally used together with the conservative label retention mode.

Label Retention Mode — Conservative

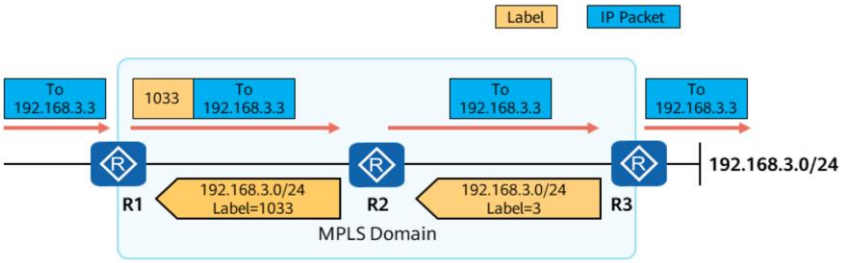
Conservative

- An LSR retains the label mappings received from a peer only if the peer is its next hop.



- The advantage of the conservative mode is that only the labels that will be used to forward data are retained and maintained, thereby saving the label space.
  - In DU label advertisement mode, an LSR may receive Label Mapping messages for the same network segment (FEC) from multiple LDP peers. As shown in the figure, R3 receives Label Mapping messages for the network segment 192.168.1.0/24 from both R2 and R5. If the conservative label retention mode is used, R3 retains only the label sent by the next hop R2 and discards the label sent by the non-next hop R5.
  - In DoD label advertisement mode, an LSR uses routing information to determine its next hop and requests labels only from the next hop.
- If the next hop of a FEC changes, either of the following situations occurs:
  - In liberal label retention mode, the LSR can use an existing label advertised by a non-next hop LSR to quickly establish an LSP. The liberal mode requires more memory and label space.
  - In conservative label retention mode, the LSR retains the labels advertised by the next hop only. This mode saves memory and label space but consumes more time to reestablish the LSP.
  - An LSR that has a limited label space usually uses the conservative mode and DoD mode.

PHP

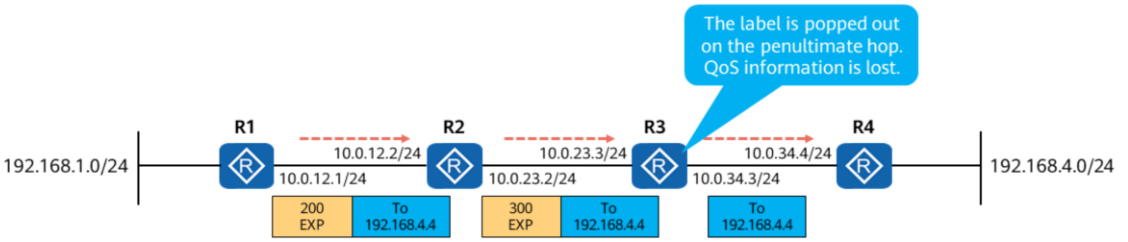


Penultimate hop popping (PHP): If PHP is enabled, an egress assigns a special label (3), to a local route. This label is called an implicit null label. When an LSR forwards a labeled packet and finds that the outgoing label value is 3, the LSR removes the top label from the packet and forwards the inner data to the downstream LSR.

- During label advertisement, R3 is the egress of the FEC 192.168.3.0/24. During label distribution, R3 assigns label 3 to the FEC and advertises the label binding information to R2.
- During data forwarding, R2, as the penultimate hop to 192.168.3.0, finds that the outgoing label value is 3. Then, R2 removes the label header and forwards the IP packet to R3. R3 only needs to query the FIB once to obtain the corresponding forwarding information, improving the forwarding efficiency.

Implicit Null Label and Explicit Null Label (1)

- By default, an egress assigns implicit null labels, that is, label 3, to the penultimate hop.
- However, if QoS is deployed, after the label is popped out, the priority in the label is lost.



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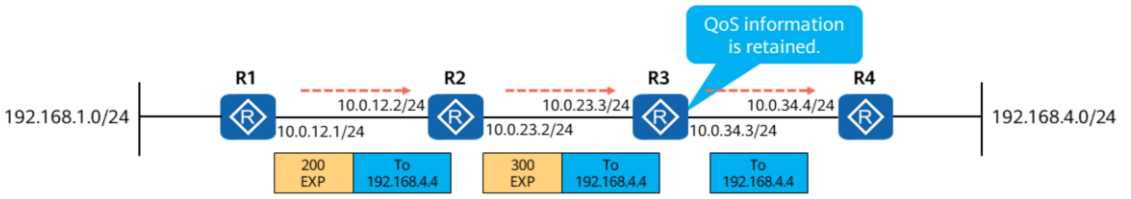
Implicit Null Label and Explicit Null Label (2)

- In the explicit null label mechanism, an egress assigns label 0 to the penultimate hop.
- When R3 forwards a labeled packet of which the outgoing label is 0, R3 does not pop out the label header, and therefore QoS information is retained. When R4 receives a packet with label 0, it directly pops out the label without searching for an ILM entry.
- By default, an egress assigns implicit null labels. You can run the **label advertise explicit-null** command to enable the egress to assign explicit null labels to the penultimate hop.



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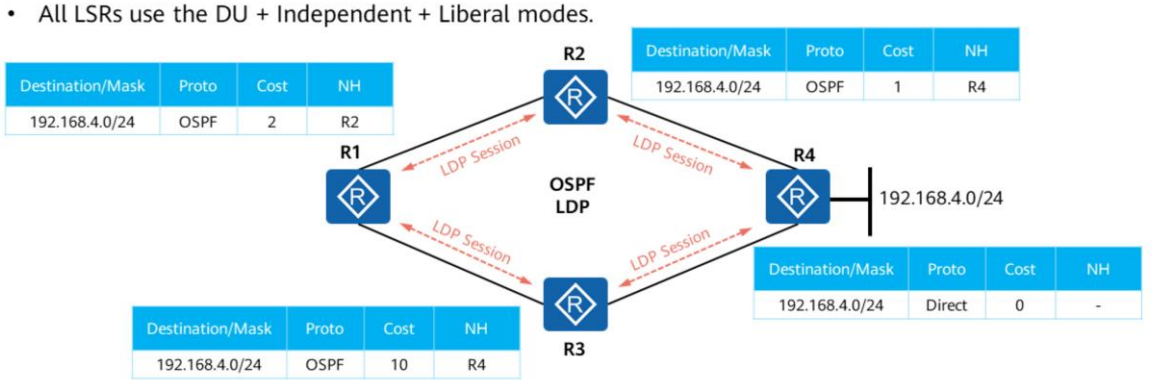
- Run the **label advertise { explicit-null | implicit-null | non-null }** command in the MPLS view to configure the label to be assigned to the penultimate hop.
- You can specify one of the following parameters:
  - **implicit-null**: is the default value. If this parameter is set, an egress assigns an implicit null label with the value of 3 to the penultimate hop.
  - **explicit-null**: If this parameter is set, an egress assigns an explicit null label with the value of 0 to the penultimate hop. The **explicit-null** parameter can be set if MPLS QoS attributes need to be used.
  - **non-null**: If this parameter is set, an egress assigns a common label with a value greater than or equal to 16 to the penultimate hop.

Contents

Networking Overview

- OSPF has been deployed on the network, and devices can learn routes from each other.
- MPLS and LDP have been enabled on devices and interfaces, and local LDP sessions have been established between neighboring devices.
- All LSRs use the DU + Independent + Liberal modes.



Destination/Mask	Proto	Cost	NH
192.168.4.0/24	OSPF	2	R2

Destination/Mask	Proto	Cost	NH
192.168.4.0/24	OSPF	1	R4

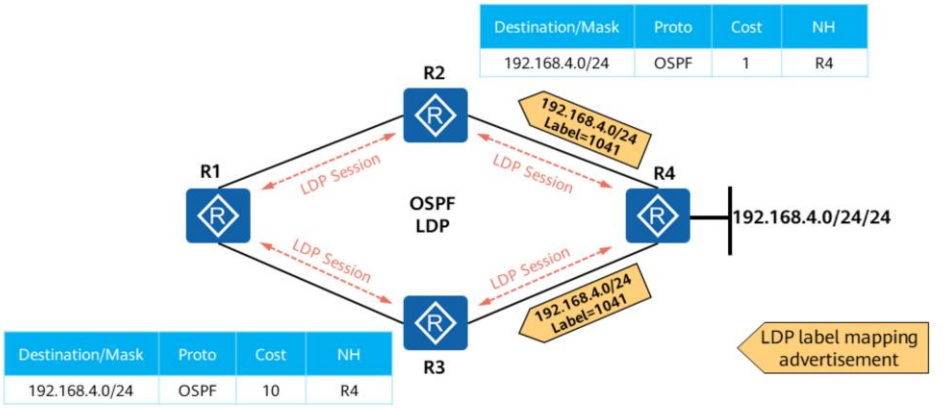
Destination/Mask	Proto	Cost	NH
192.168.4.0/24	OSPF	10	R4

Destination/Mask	Proto	Cost	NH
192.168.4.0/24	Direct	0	-

- Currently, Huawei devices use the DU + Ordered + Liberal modes by default.
- For a packet that enters the MPLS domain from R1 and is destined for 192.168.4.0/24, R1 is the ingress LSR, and R4 is the egress LSR.

Label Distribution — Egress LSR

R4 is directly connected to the network segment 192.168.4.0/24. R4 actively assigns labels, such as 1041, to routes destined for this network segment and advertises label mapping information to its LDP peers (R2 and R3) through LDP packets.



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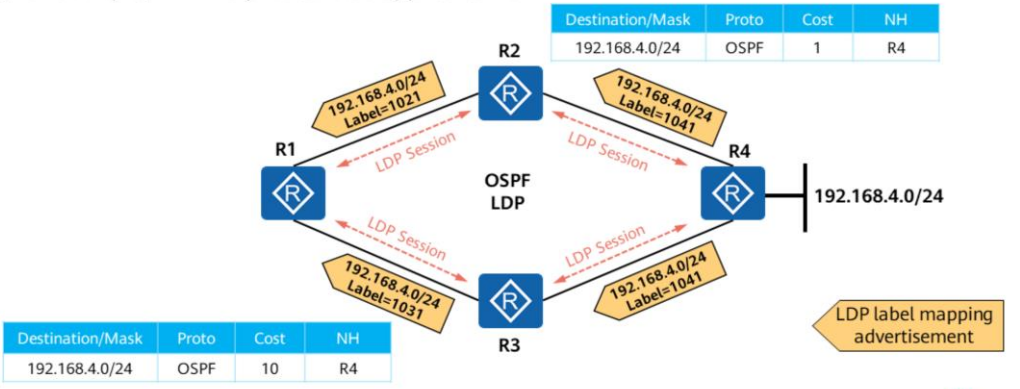
- Note: By default, 32-bit host IP routes are used to trigger LSP establishment. You can manually trigger the establishment of an LSP with non-32-bit host IP routes.

Label Distribution — Transit LSR

Take R2 as an example. In its routing table, the next hop of the route 192.168.4.0/24 is R4. When R2 receives a Label Mapping message for the route 192.168.4.0/24 from R4, R2 assigns label 1021 to the route because the message is sent by a downstream LDP peer, and advertises the label mapping to the LDP peer, for example, R1. This process also applies to R3.



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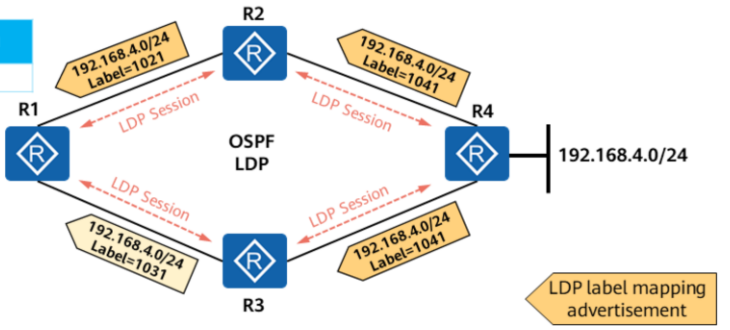
Label Distribution — Ingress LSR

After R1 receives the label mappings for the route 192.168.4.0/24 advertised by R2 and R3, R1 **stores** both of the label mappings. However, R1 only **uses** label 1021 advertised by R2, because the next hop of the route to 192.168.4.0/24 is R2, as shown in R1's routing table.

Destination/Mask	Proto	Cost	NH
192.168.4.0/24	OSPF	2	R2



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- Note: If R2 fails, OSPF routes re-converge. The next hop of the route 192.168.4.0/24 in the routing table of R1 is switched to R3. In this case, R1 uses the label advertised by R3 for 192.168.4.0/24.

Label-based Forwarding — Ingress LSR

As an ingress LSR, R1 pushes a label into each received IP packet, and forwards packets based on labels.

Routing table of R1

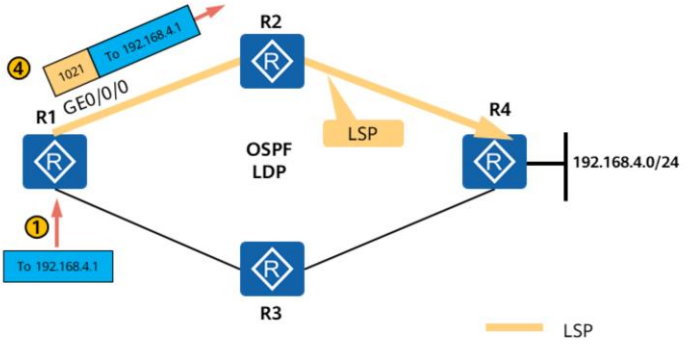
Destination/Mask	Proto	Cost	NH
192.168.4.0/24	OSPF	2	R2

FIB of R1 ②

Destination/Mask	Proto	Cost	NH	Tunnel ID
192.168.4.0/24	OSPF	2	R2	0x12

NHLFE table of R1 ③

Tunnel ID	Out intf	OPER	NH	Out Label
0x12	GE0/0/0	push	R2	1021



- When R1 receives an IP packet destined for 192.168.4.1, it searches the FIB for a forwarding entry matching the destination IP address of the packet, and finds that the tunnel ID in the matching entry is not 0. As such, R1 continues to search for an NHLFE matching the tunnel ID, pushes a label to the IP packet, and forwards the packet. The outbound interface is GE 0/0/0, the next hop is R2, and the outgoing label is 1021. Therefore, R1 adds a label header to the packet and forwards the packet.

Label-based Forwarding — Transit LSR

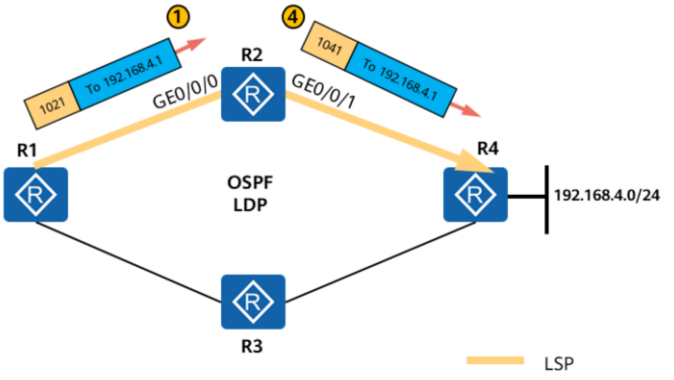
As a transit LSR, R2 needs to swap labels in received IP packets and forward the packets.

ILM table of R2 ②

In Label	Tunnel ID
1021	0x12

NHLFE table of R2 ③

Tunnel ID	Out intf	OPER	NH	Out Label
0x12	GE0/0/1	Swap	R4	1041



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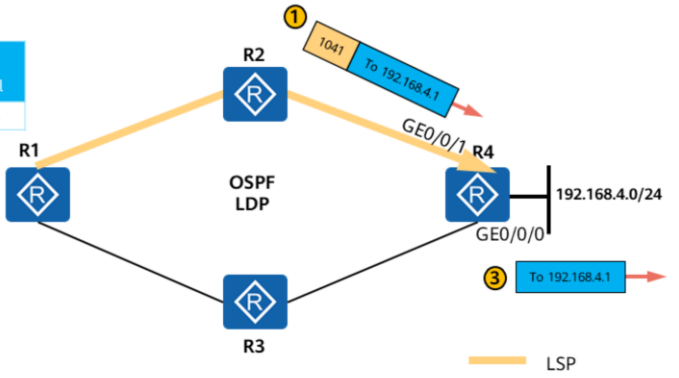
- When R2 receives a packet with label 1021, it searches for a matching ILM entry and an NHLFE matching the ILM entry. Then, R2 changes the label of the packet to 1041 and forwards the packet through the matching outbound interface.

Label-based Forwarding — Egress LSR

As an egress LSR, R4 needs to perform the pop operation on received IP packets to remove labels and forward the packets through IP.

ILM table of R4 ②

In Label	Tunnel ID	Out intf	OPER	NH	Out Label
1041	0x12	GE0/0/0	Pop	-	Null



- When R4 receives a packet with label 1041, it searches for a matching ILM entry and finds that the operation type is pop. R4 then performs a pop operation to remove the outer label from the packet. The packet then becomes a standard IP packet, and therefore R4 performs the standard IP forwarding on the packet.
- When R4 forwards the packet, it searches the LFIB and FIB. How can the forwarding efficiency be improved on the egress LSR (R4)?

Summary of an LDP-Capable LSR's Operations on an MPLS Network

- An LSR runs an IGP (such as OSPF or IS-IS) to construct a routing table and FIB.
- LDP assigns labels to route prefixes (FECs) in the routing table based on the label assignment mode it uses.
- LDP advertises the labels assigned to the route prefixes to LDP peers through LDP Label Mapping messages based on the label advertisement mode it uses.
- An LSR stores the labels that it assigns to route prefixes and the labels that LDP peers advertise to the route prefixes, and associates the labels with information such as outbound interfaces and next-hop addresses (label forwarding entries).
- When an LSR forwards a labeled packet destined, the LSR always uses the outgoing label advertised by the downstream LDP peer. The downstream peer is the next-hop device to the destination network in the routing table.

Contents

Basic LDP Configuration Commands (1)

1. Enable LDP.

   [Huawei] **mpls ldp**

   The **mpls ldp** command enables LDP and displays the LDP view.

   [Huawei-GigabitEthernet0/0/0] **mpls ldp**

   Enable LDP on an interface. Before running this command, enable LDP globally.

2. Configure a remote LDP peer.

   [Huawei] **mpls ldp remote-peer** *remote-peer-name*

   The **mpls ldp remote-peer** command creates a remote peer and displays the remote peer view.

   [Huawei-mpls-ldp-remote-PeerName] **remote-ip** *ip-address*

   Set the **remote-ip** *ip-address* parameter to the IP address of a remote LDP peer.

Basic LDP Configuration Commands (2)

3. Configure a policy for triggering LSP establishment.

   [Huawei-mpls] **lsp-trigger** { **all** | **host** | **ip-prefix** *ip-prefix-name* | **none** }

   The **lsp-trigger** command configures the routes (static and IGP routes) that are used to trigger LSP establishment, which are IP routes with a 32-bit mask by default.

   - **all**: All static and IGP routes are used to trigger LSP establishment. If this parameter is set, a significant of LSPs will be established, consuming label resources excessively and slowing down network-wide LSP convergence. Therefore, setting this parameter is not recommended.
   - **host**: IP routes with a 32-bit mask are used to trigger LSP establishment.
   - **ip-prefix** *ip-prefix-name*: Routes matching a specified IP prefix list are used to trigger LSP establishment.
   - **none**: LSP establishment cannot be triggered.

4. Configure a label advertisement mode.

   [Huawei-GigabitEthernet0/0/0] **mpls ldp advertisement** { **dod** | **du** }

   The default label advertisement mode is downstream unsolicited (DU).

   - If the label advertisement mode is DU, the label retention mode is liberal.
   - If the label advertisement mode is DoD, the label retention mode is conservative.

- BGP routes can also be used to trigger LDP LSP establishment. This trigger policy is not covered in this course.

Basic LDP Configuration Commands (3)

5. Configure an LDP label distribution control mode.

   [Huawei-mpls-ldp] **label distribution control-mode** { **independent** | **ordered** }

   The default LDP label distribution control mode is ordered.

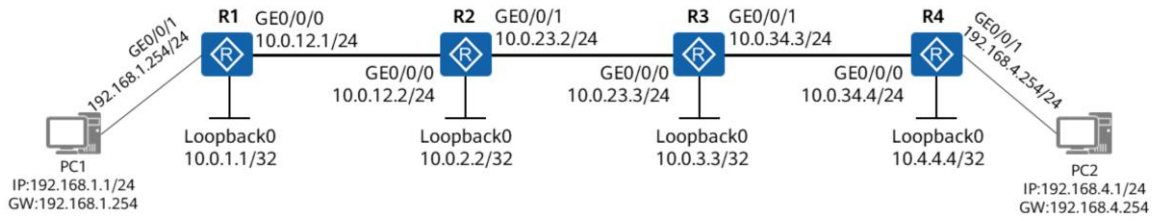
6. Configure PHP.

   [Huawei-mpls] **label advertise** { **explicit-null** | **implicit-null** | **non-null** }

   By default, an egress distributes implicit null labels to a penultimate hop.

   - **explicit-null**: An egress assigns explicit null label to the penultimate hop.
   - **implicit-null**: An egress assigns implicit null labels to the penultimate hop.
   - **non-null**: An egress assigns common labels to the penultimate hop.

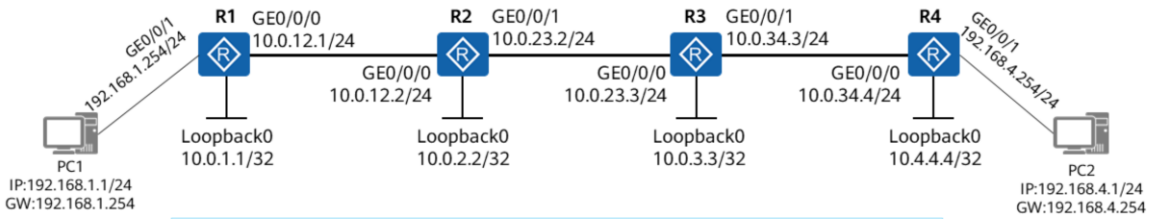
Configuration Examples



Scenario: R1, R2, R3, and R4 run an IGP to implement IP interworking.

Requirement: Configure MPLS and LDP to implement mutual access between the network segments 192.168.1.0/24 and 192.168.4.0/24 through MPLS forwarding.

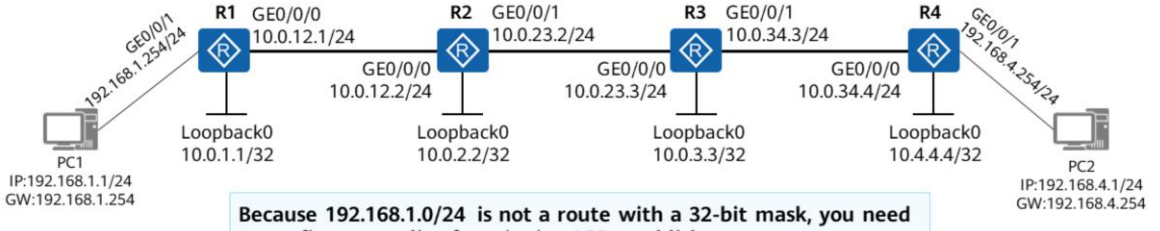
Configuration Procedure (1)



Enable basic MPLS and LDP functions on the devices. The following example uses R1.

```
[R1]mpls
[R1-mpls]quit
[R1]mpls ldp
[R1-mpls-ldp]quit
[R1]interface GigabitEthernet 0/0/0
[R1-GigabitEthernet0/0/0]mpls
[R1-GigabitEthernet0/0/0]mpls ldp
[R1-GigabitEthernet0/0/0]quit
```

Configuration Procedure (2)



Because 192.168.1.0/24 is not a route with a 32-bit mask, you need to configure a policy for trigging LSP establishment.

```
[R1]ip ip-prefix ldp permit 192.168.1.0 24
[R1-mpls]lsp-trigger ip-prefix ldp
```

Perform similar configuration on R4.

```
[R4]ip ip-prefix ldp permit 192.168.4.0 24
[R4-mpls]lsp-trigger ip-prefix ldp
```

Checking the Configuration - Checking LSP Information

Check information about the LDP LSPs created on R1.
[R1]display mpls ldp lsp
LDP LSP Information

DestAddress/Mask	In/OutLabel	UpstreamPeer	NextHop	OutInterface
10.0.2.2/32	1024/3	10.0.2.2	10.0.12.2	GE0/0/0
10.0.3.3/32	1025/1025	10.0.2.2	10.0.12.2	GE0/0/0
192.168.1.0/24	3/NULL	10.0.2.2	192.168.1.254	GE0/0/1
*192.168.1.0/24	Liberal/1027		DS/10.0.2.2	
192.168.4.0/24	1027/1028	10.0.2.2	10.0.12.2	GE0/0/0

Quiz

1. (Single) Which of the following commands can be used to display a label distributed for a specific FEC? ( )
   A. display mpls ldp
   B. display mpls ldp interface
   C. display mpls lsp
   D. display mpls ldp session
2. (Single) What is the default combination of label advertisement mode, label distribution control mode, and label retention mode on Huawei devices?
   A. DU + Independent + Conservative
   B. DU + Ordered+ Liberal
   C. DoD + Independent+ Liberal
   D. DoD + Ordered + Conservative

1. C
2. B

Summary

- MPLS supports multiple label distribution protocols, among which LDP is widely used.
- LDP is a process in which LSRs negotiate the meaning of labels. LDP uses discovery, session, advertisement, and notification packets to establish sessions and distribute labels.
- LDP determines label advertisement and management based on the label advertisement mode, label distribution control mode, and label retention mode. By default, Huawei datacom devices use the DU label advertisement mode + ordered label distribution control mode + liberal label retention mode.
- LDP can directly map network-layer routing information to label information in order to establish LSPs. LSRs are connected according to the incoming label, next hop, and outgoing label corresponding to a specified FEC in the local forwarding table. In this manner, the LSP crossing the entire MPLS domain can be formed.


Thank You
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