Cisco – MPLS FAQ For Beginners

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Q. What is Multi–Protocol Label Switching (MPLS)?
   A. MPLS is a packet–forwarding technology which uses labels to make data forwarding decisions. With MPLS, the Layer 3 header analysis is done just once (when the packet enters the MPLS domain). Label inspection drives subsequent packet forwarding. MPLS provides the following beneficial applications: Virtual Private Networking (VPN), Traffic Engineering (TE), Quality of Service (QoS) and ATM over MPLS (AToM). Additionally, it decreases the forwarding overhead on the core routers. MPLS technologies are applicable to any network layer protocol.

Q. What is a label? What is the structure of the label?
   A. A label is a short, four–byte, fixed–length, locally–significant identifier which is used to identify a Forwarding Equivalence Class (FEC). The label which is put on a particular packet represents the FEC to which that packet is assigned.
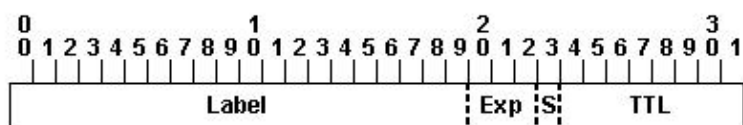
Label: Label Value (Unstructured), 20 bits
Exp: Experimental Use, 3 bits; currently used as a Class of Service (CoS) field.
S: Bottom of Stack, 1 bit
TTL: Time to Live, 8 bits

Q. Where will the label be imposed in a packet?
   A. The label is imposed between the data link layer (Layer 2) header and network layer (Layer 3) header. The top of the label stack appears first in the packet, and the bottom appears last. The network layer packet immediately follows the last label in the label stack.
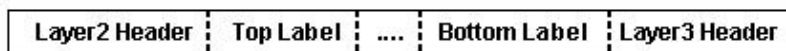

Q. What is a Forwarding Equivalence Class (FEC)?

A. FEC is a group of IP packets which are forwarded in the same manner, over the same path, and with the same forwarding treatment. An FEC might correspond to a destination IP subnet, but it also might correspond to any traffic class that the Edge–LSR considers significant. For example, all traffic with a certain value of IP precedence might constitute a FEC.

Q. What is an upstream label switch router (LSR)? What is a downstream LSR?

A. Upstream and downstream are relative terms in the MPLS world. They always refer to a prefix (more appropriately, an FEC). The following examples further explain this.
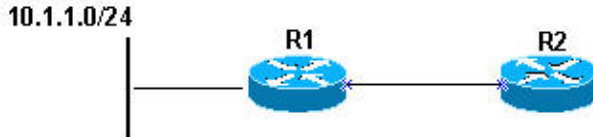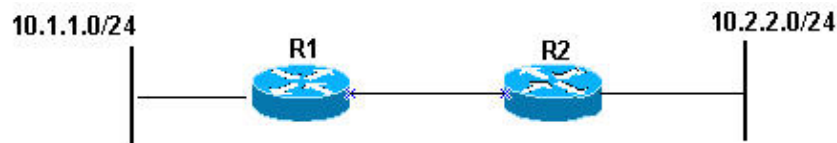

For FEC 10.1.1.0/24, R1 is the "Downstream" LSR to R2.
For FEC 10.1.1.0/24, R2 is the "Upstream" LSR to R1.

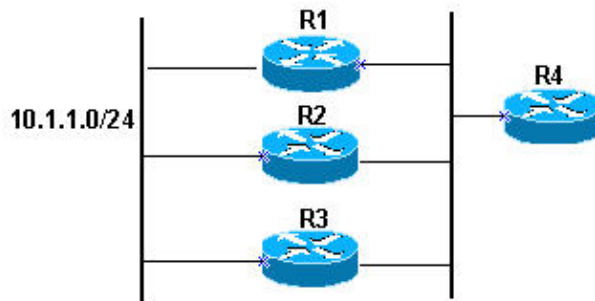For FEC 10.1.1.0/24, R1 is the "Downstream" LSR to R2.
And, R2 is the "Downstream" LSR to R3.

For FEC 10.1.1.0/24, R1 is the "Downstream" LSR to R2.
For FEC 10.2.2.0/24, R2 is the "Downstream" LSR to R1.

To conclude, data flows from upstream to downstream to reach that network (prefix).


The R4 routing table has R1 and R2 as the "next–hops" to reach 10.1.1.0/24.

Question: Is R3, a "Downstream" LSR to R4 for 10.1.1.0/24?

Answer: No, data flows from upstream to downstream.

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Q. What do the terms incoming, outgoing, local, and remote mean when referring to labels?

A. Consider R2 and R3 in the following topology. R2 would distribute a label L for FEC F to R3. R3 would use label L when forwarding data to FEC–F (because R2 is his downstream LSR for FEC–F).In the above scenario,
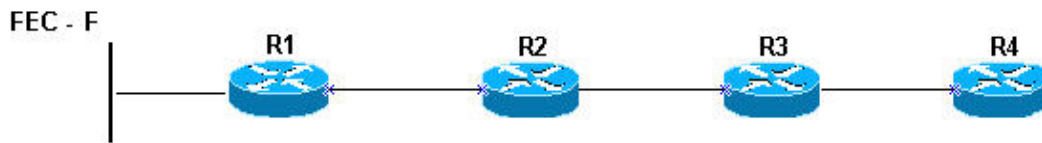
L is the incoming label for F on R2.
L is the outgoing label for FEC–F on R3
L is the local binding for FEC F on R2.
L is the remote binding for FEC–F on R3.

Q. Can an LSR transmit/receive a native IP packet (non–MPLS) on a MPLS interface?

A. Yes, if the IP is enabled on the interface. Native packets are received/transmitted as usual. IP is just another protocol. MPLS packets have a different Layer 2 encoding. The receiving LSR is aware of the MPLS packet, based on the L–2 encoding.

Q. Can an LSR receive/transmit a labeled packet on a non–MPLS interface?

A. No. Packets are never transmitted on an interface which isn't enabled for that protocol. MPLS has a certain Ether type code associated with it (just as IP, IPX, and Appletalk have unique Ether types). When a Cisco router receives a packet with an Ether type which isn't enabled on the interface, it drops the packet. For example, if a router receives an Appletalk packet on an interface which doesn't have Appletalk enabled, it drops the packet. Likewise, if an MPLS packet is received on an interface which doesn't have MPLS enabled, the packet is dropped.

Q. What platforms and Cisco IOSs support MPLS?

A. The Cisco Series 2600, 3620, 3640, 3660, 4500, Catalyst 5000 with Route Switch Module (RSM), 7100, 7200, 7500, Gigabit Switch Router (GSR), Route Processor Module (RPM), and the Universal Broadband Router (UBR) 7200 all support MPLS.
These platforms support the Cisco Tag Distribution Protocol (TDP) as the label distribution protocol.

Label Distribution Protocol (LDP), Resource Reservation Protocol (RSVP), and Border Gateway Protocol (BGP) information can be found using the Software Advisor tool. Software Advisor provides a complete list of feature sets supported in the different Cisco IOS versions and on different platforms. Note that to access Software Advisor, you must be a registered user and you must be logged in.

Q. Generic Routing Encapsulation (GRE) tunnel has a overhead of 24 bytes. How much overhead does an MPLS LSP tunnel have?

A. An MPLS LSP tunnel has one label (four bytes) or two labels (for example, when using Link Protection Fast reroute) of overhead. Unlike GRE tunnel, MPLS doesn't change the IP header. Instead, the label stack will be imposed on to the packet that takes the tunnel path.

Q. How does the LSR know which is the top label, bottom label, and a middle label of the label stack?

A. The label immediately after the L–2 header is the top label, and the label with the S bit set to 1 is the bottom label. No application requires LSR to read/identify the middle labels. However, a label will be a middle label if it is not at the top of the stack and the S bit is set to 0.

Q. What is the range of label values? What label values are reserved? What do the reserved values signify?

A. The following values can also be found in RFC3032 – MPLS Label Stack Encoding.

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Theoretically, the range is 0 through (2^{20}–1). Label values 0–15 are reserved, and values 4–15 are reserved for future use. Values 0–3 are defined as below.

♦ A value of 0 represents the "IPv4 Explicit NULL Label". This label indicates that the label stack must be popped, and the packet forwarding must be based on the IPv4 header. This is useful in keeping Exp bits safe until the egress router. It is used in MPLS based QoS.

♦ A value of 1 represents the "Router Alert Label". When a received packet contains this label value at the top of the label stack, it is delivered to a local software module for processing. The actual packet forwarding is determined by the label beneath it in the stack. However, if the packet is forwarded further, the Router Alert Label should be pushed back onto the label stack before forwarding. The use of this label is analogous to the use of the "Router Alert Option" in IP packets (for example, ping with record route option)

♦ A value of 2 represents the "IPv6 Explicit NULL Label". It indicates that the label stack must be popped, and the packet forwarding must be based on the IPv6 header.

♦ A value of 3 represents the "Implicit NULL Label". This is a label that an LSR may assign and distribute. However, it never actually appears in the encapsulation. It indicates that the LSR will pop the top label from the stack and forward the rest of the packet (labeled or unlabeled) through the outgoing interface (as per the entry in Lfib). Although this value may never appear in the encapsulation, it needs to be specified in the Label Distribution Protocol, so a value is reserved.

Tools Information

To access Software Advisor, please use the tools link below.

For additional resources, refer to Cisco TAC Tools for Routing Protocol Technologies.

Related Information

- **TAC Tools for Routing Protocol Technologies**
- **More MPLS Technical Tips**
- **More Routing Protocols Technical Tips**
- **MPLS Support Page**
- **IP Routing Top Issues**