

CCIE Service Provider Lab Workbook v4.0 (<http://labs.ine.com/workbook/toc/service-provider-v4>) » CCIE SP v4 Advanced Technology Labs - MPLS

Basic LDP

« [Multi-Topology IS-IS \(/workbook/view/service-provider-v4/task/multi-topology-is-is-Mjg0NQ%3D%3D\)](/workbook/view/service-provider-v4/task/multi-topology-is-is-Mjg0NQ%3D%3D) | [LDP OSPF Autoconfig \(/workbook/view/service-provider-v4/task/ldp-ospf-autoconfig-Mjg0Nw%3D%3D\)](/workbook/view/service-provider-v4/task/ldp-ospf-autoconfig-Mjg0Nw%3D%3D) »

Last updated: April 23, 2016

Note:

Initial Configuration & Diagrams: [Load the initial configuration files for the section named OSPFv2, which can be found in CCIE SPv4 Topology Diagrams & Initial Configurations \(<http://labs.ine.com/workbook/view/service-provider-v4/task/ccie-spv4-topology-diagrams-initial-configs>\).](#) [Refer to the Base IPv4 Diagram in order to complete this task.](#)

Task

- Configure MPLS Label Distribution with LDP on all links connecting R2, R3, R4, R5, R6, and XR1.
- Statically set their MPLS LDP Router-IDs to be their Loopback0 interfaces.

Configuration [Click to collapse](#)

```
R2:
mpls label protocol ldp
!
interface GigabitEthernet1.23
  mpls ip
!
interface GigabitEthernet1.24
  mpls ip
!
mpls ldp router-id Loopback0
```

```
R3:
mpls label protocol ldp
!
interface GigabitEthernet1.23
  mpls ip
!
interface GigabitEthernet1.34
  mpls ip
!
interface GigabitEthernet1.36
  mpls ip
!
mpls ldp router-id Loopback0
```

```
R4:
mpls label protocol ldp
!
interface GigabitEthernet1.24
  mpls ip
!
interface GigabitEthernet1.34
  mpls ip
!
interface GigabitEthernet1.45
  mpls ip
!
interface GigabitEthernet1.46
  mpls ip
!
mpls ldp router-id Loopback0
```

```
R5:
mpls label protocol ldp
!
interface GigabitEthernet1.45
  mpls ip
!
interface GigabitEthernet1.56
  mpls ip
!
interface GigabitEthernet1.519
  mpls ip
```

```

!
mpls ldp router-id Loopback0

R6:
mpls label protocol ldp
!
interface GigabitEthernet1.36
  mpls ip
!
interface GigabitEthernet1.46
  mpls ip
!
interface GigabitEthernet1.56
  mpls ip
!
interface GigabitEthernet1.619
  mpls ip
!
mpls ldp router-id Loopback0

XR1:
mpls ldp
  router-id 19.19.19.19
  interface GigabitEthernet0/0/0.519
  !
  interface GigabitEthernet0/0/0.619
  !
!

```

Verification

show mpls interfaces is a good way to quickly verify that LDP, TDP, RSVP, BGP, etc. labeling is enabled on the correct links.

```

R6#show mpls interfaces

Interface          IP           Tunnel  BGP Static Operational
GigabitEthernet1.36  Yes (ldp)   No      No  No      Yes
GigabitEthernet1.46  Yes (ldp)   No      No  No      Yes
GigabitEthernet1.56  Yes (ldp)   No      No  No      Yes
GigabitEthernet1.619  Yes (ldp)   No      No  No      Yes

RP/0/0/CPU0:XR1#show mpls interfaces

Thu Apr 30 00:28:10.775 UTC

Interface          LDP    Tunnel  Static  Enabled
-----
GigabitEthernet0/0/0.519  Yes    No      No      Yes
GigabitEthernet0/0/0.619  Yes    No      No      Yes

```

All routers should have formed an LDP adjacency with their directly connected neighbors. Note that this adjacency requires an IGP route to the Transport Address of the LDP session (similar to the BGP update source), which will be the highest Loopback address by default, the same as the LDP Router-ID.

```
R6#show mpls ldp neighbor
```

```
Peer LDP Ident: 3.3.3.3:0; Local LDP Ident 6.6.6.6:0
```

```
TCP connection: 3.3.3.3.646 - 6.6.6.6.31475
```

```
State: Oper; Msgs sent/rcvd: 24/24; Downstream
```

```
Up time: 00:01:55
```

```
LDP discovery sources:
```

```
GigabitEthernet1.36, Src IP addr: 20.3.6.3
```

```
Addresses bound to peer LDP Ident:
```

```
20.2.3.3      20.3.4.3      20.3.6.3      3.3.3.3
```

```
Peer LDP Ident: 4.4.4.4:0; Local LDP Ident 6.6.6.6:0
```

```
TCP connection: 4.4.4.4.646 - 6.6.6.6.29814
```

```
State: Oper; Msgs sent/rcvd: 24/24; Downstream
```

```
Up time: 00:01:55
```

```
LDP discovery sources:
```

```
GigabitEthernet1.46, Src IP addr: 20.4.6.4
```

```
Addresses bound to peer LDP Ident:
```

```
20.2.4.4      20.3.4.4      20.4.5.4      20.4.6.4  
4.4.4.4
```

```
Peer LDP Ident: 5.5.5.5:0; Local LDP Ident 6.6.6.6:0
```

```
TCP connection: 5.5.5.5.646 - 6.6.6.6.44270
```

```
State: Oper; Msgs sent/rcvd: 24/24; Downstream
```

```
Up time: 00:01:55
```

```
LDP discovery sources:
```

```
GigabitEthernet1.56, Src IP addr: 20.5.6.5
```

```
Addresses bound to peer LDP Ident:
```

```
20.4.5.5      20.5.6.5      20.5.19.5     5.5.5.5
```

```
Peer LDP Ident: 19.19.19.19:0; Local LDP Ident 6.6.6.6:0
```

```
TCP connection: 19.19.19.19.64567 - 6.6.6.6.646
```

```
State: Oper; Msgs sent/rcvd: 23/24; Downstream
```

```
Up time: 00:01:39
```

```
LDP discovery sources:
```

```
GigabitEthernet1.619, Src IP addr: 20.6.19.19
```

```
Addresses bound to peer LDP Ident:
```

```
20.5.19.19    20.6.19.19    10.19.20.19   19.19.19.19
```

```
RP/0/0/CPU0:XR1#show mpls ldp neighbor
```

```
Thu Apr 30 00:32:41.907 UTC
```

```
Peer LDP Identifier: 5.5.5.5:0
```

```
TCP connection: 5.5.5.5:646 - 19.19.19.19:12149
```

```
Graceful Restart: No
```

```
Session Holdtime: 180 sec
```

```
State: Oper; Msgs sent/rcvd: 27/27; Downstream-Unsolicited
```

```
Up time: 00:05:02
```

```
LDP Discovery Sources:
```

```
GigabitEthernet0/0/0/0.519
```

```
Addresses bound to this peer:
```

```
5.5.5.5      20.4.5.5      20.5.6.5      20.5.19.5
```

```
Peer LDP Identifier: 6.6.6.6:0
```

```
TCP connection: 6.6.6.6:646 - 19.19.19.19:64567
```

```
Graceful Restart: No
```

```
Session Holdtime: 180 sec
```

```
State: Oper; Msgs sent/rcvd: 28/27; Downstream-Unsolicited
Up time: 00:05:02
LDP Discovery Sources:
  GigabitEthernet0/0/0/0.619
Addresses bound to this peer:
  6.6.6.6      20.3.6.6      20.4.6.6      20.5.6.6
  20.6.19.6
```

Once the LDP adjacencies are formed, labels should be advertised for all IGP learned prefixes, along with all connected interfaces running IGP and LDP. *Pop Label* in the below output indicates that the local device is the Penultimate Hop (next-to-last hop), and that the top-most label in the MPLS stack should be removed when forwarding traffic towards the destination. *No Label* or *Unlabeled*, as seen in XR1's output on the link towards XR2, indicates that the outgoing interface is not running MPLS, and that the entire MPLS stack should be removed when forwarding traffic towards that link. Normally in the MPLS core you should not see the *No Label* or *Unlabeled* output; this should only be seen on the edge of the network.

R6#show mpls forwarding-table

Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
16	16	1.1.1.1/32	0	Gi1.36	20.3.6.3
	16	1.1.1.1/32	0	Gi1.46	20.4.6.4
17	17	2.2.2.2/32	0	Gi1.36	20.3.6.3
	17	2.2.2.2/32	0	Gi1.46	20.4.6.4
18	Pop Label	3.3.3.3/32	0	Gi1.36	20.3.6.3
19	Pop Label	4.4.4.4/32	0	Gi1.46	20.4.6.4
20	Pop Label	5.5.5.5/32	0	Gi1.56	20.5.6.5
21	21	10.1.2.0/24	0	Gi1.36	20.3.6.3
	21	10.1.2.0/24	0	Gi1.46	20.4.6.4
22	Pop Label	10.19.20.0/24	0	Gi1.619	20.6.19.19
23	Pop Label	19.19.19.19/32	0	Gi1.619	20.6.19.19
24	Pop Label	20.2.3.0/24	0	Gi1.36	20.3.6.3
25	Pop Label	20.2.4.0/24	0	Gi1.46	20.4.6.4
26	Pop Label	20.3.4.0/24	0	Gi1.36	20.3.6.3
	Pop Label	20.3.4.0/24	0	Gi1.46	20.4.6.4
27	Pop Label	20.4.5.0/24	0	Gi1.46	20.4.6.4
	Pop Label	20.4.5.0/24	0	Gi1.56	20.5.6.5
28	Pop Label	20.5.19.0/24	0	Gi1.56	20.5.6.5
	Pop Label	20.5.19.0/24	0	Gi1.619	20.6.19.19
29	16014	20.20.20.20/32	0	Gi1.619	20.6.19.19

RP/0/0/CPU0:XR1#show mpls forwarding

Thu Apr 30 00:34:10.141 UTC

Local Label	Outgoing Label	Prefix or ID	Outgoing Interface	Next Hop	Bytes Switched
16000	18	3.3.3.3/32	Gi0/0/0.619	20.6.19.6	0
16001	Pop	6.6.6.6/32	Gi0/0/0.619	20.6.19.6	726
16002	Pop	20.4.6.0/24	Gi0/0/0.619	20.6.19.6	0
16003	Pop	20.3.6.0/24	Gi0/0/0.619	20.6.19.6	0
16004	24	20.2.3.0/24	Gi0/0/0.619	20.6.19.6	0
16005	16	1.1.1.1/32	Gi0/0/0.519	20.5.19.5	0
	16	1.1.1.1/32	Gi0/0/0.619	20.6.19.6	0
16006	17	2.2.2.2/32	Gi0/0/0.519	20.5.19.5	0
	17	2.2.2.2/32	Gi0/0/0.619	20.6.19.6	0
16007	19	4.4.4.4/32	Gi0/0/0.519	20.5.19.5	0
	19	4.4.4.4/32	Gi0/0/0.619	20.6.19.6	0
16008	Pop	5.5.5.5/32	Gi0/0/0.519	20.5.19.5	726
16009	Pop	20.5.6.0/24	Gi0/0/0.519	20.5.19.5	0
	Pop	20.5.6.0/24	Gi0/0/0.619	20.6.19.6	0
16010	Pop	20.4.5.0/24	Gi0/0/0.519	20.5.19.5	0
16011	26	20.3.4.0/24	Gi0/0/0.519	20.5.19.5	0
	26	20.3.4.0/24	Gi0/0/0.619	20.6.19.6	0
16012	25	20.2.4.0/24	Gi0/0/0.519	20.5.19.5	0
	25	20.2.4.0/24	Gi0/0/0.619	20.6.19.6	0
16013	21	10.1.2.0/24	Gi0/0/0.519	20.5.19.5	0
	21	10.1.2.0/24	Gi0/0/0.619	20.6.19.6	0
16014	Unlabelled	20.20.20.20/32	Gi0/0/0.1920	10.19.20.20	0

Each device keeps a data structure for each prefix to label binding. XR1 created local label 16000 for 3.3.3.3/32. This label binding is being advertised to R5 and R6, outlining the downstream unsolicited label allocation mode of LDP. R5 and R6 each advertise their local label binding for 3.3.3.3/32, which is label 18 for both.

```
RP/0/0/CPU0:XR1#show mpls ldp bindings 3.3.3.3/32 detail
Thu Apr 30 00:35:14.336 UTC
3.3.3.3/32, rev 24
  Local binding: label: 16000
  Advertised to: (2 peers)
    5.5.5.5:0      6.6.6.6:0
  Acked by: (2 peers)
    5.5.5.5:0      6.6.6.6:0
  Remote bindings: (2 peers)
    Peer          Label      Stale
    -----
    5.5.5.5:0     18        N
    6.6.6.6:0     18        N
```

Traceroutes from R1 and XR2 indicate the traffic between them is normal unlabeled IPv4 traffic on their links to R2 and XR1 respectively, but is MPLS label switched when it goes into the core of the network. The label values seen in the traceroute output will vary depending on the particular destination you are trying to reach.

```
R1#traceroute 20.20.20.20
Type escape sequence to abort.
Tracing the route to 20.20.20.20
VRF info: (vrf in name/id, vrf out name/id)
 1 10.1.2.2 4 msec 1 msec 1 msec
 2 20.2.4.4 [MPLS: Label 29 Exp 0] 12 msec 12 msec 12 msec
 3 20.4.5.5 [MPLS: Label 30 Exp 0] 12 msec 12 msec 12 msec
 4 20.5.19.19 [MPLS: Label 16014 Exp 0] 12 msec 16 msec 16 msec
 5 10.19.20.20 20 msec * 12 msec

RP/0/3/CPU0:XR2#traceroute 1.1.1.1
Thu Apr 30 00:43:10.494 UTC
Type escape sequence to abort.
Tracing the route to 1.1.1.1
 1 10.19.20.19 9 msec 0 msec 0 msec
 2 20.5.19.5 [MPLS: Label 16 Exp 0] 9 msec 0 msec 0 msec
 3 20.4.5.4 [MPLS: Label 16 Exp 0] 9 msec 0 msec 0 msec
 4 20.2.4.2 [MPLS: Label 16 Exp 0] 0 msec 0 msec 0 msec
 5 10.1.2.1 0 msec * 0 msec
```

Input and output labels along the transit path can be tracked by looking at the mpls forwarding table, or by viewing the output of **debug mpls packet**. Rx indicates packets received, while tx indicates packets transmitted. Rx packets should have their label values correlated with the *Local Label* field in the **show mpls forwarding-table** output, while tx with the *Outgoing Label* value. Note that the CSR1000v does not support debugging of mpls packets.

According to the traceroute from R1 to XR2, R2 is pushing label 29 as the packets are being forwarded towards 20.20.20.20. At this point, R2 does a routing lookup, encapsulates the packets with a single label, and forwards them towards R4. <https://t.me/learningnets>

```
R2#show mpls forwarding-table 20.20.20.20
```

Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
30	30	20.20.20.20/32	0	Gi1.23	20.2.3.3
	29	20.20.20.20/32	0	Gi1.24	20.2.4.4

```
R2#show ip cef 20.20.20.20 detail
```

```
20.20.20.20/32, epoch 2, per-destination sharing
```

```
local label info: global/30
```

```
nexthop 20.2.3.3 GigabitEthernet1.23 label 30
```

```
nexthop 20.2.4.4 GigabitEthernet1.24 label 29
```

R4 receives the labeled packet and does a lookup in the LFIB, resulting in a label SWAP operation. The packet is forwarded towards R5 as label 29 is swapped with label 30. Notice that the 'Bytes Switched' counter is increasing for this entry.

```
R4#show mpls forwarding-table labels 29
```

Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
29	30	20.20.20.20/32	5998	Gi1.45	20.4.5.5
	29	20.20.20.20/32	0	Gi1.46	20.4.6.6

R5 receives the labeled packet and performs a similar operation - SWAP.

```
R5#show mpls forwarding-table labels 30
```

Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
30	16014	20.20.20.20/32	6372	Gi1.519	20.5.19.19

XR1 receives the labeled packet, removes the label, and forwards the unlabeled packet towards XR2.

```
RP/0/0/CPU0:XR1#show mpls forwarding | utility egrep "16014"
```

```
Thu Apr 30 01:04:55.554 UTC
```

```
16014 Unlabelled 20.20.20.20/32 Gi0/0/0.1920 10.19.20.20 8414
```

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