

Module 9 – MPLS LDP Configuration Lab

Objective: All the routers are pre-configured with basic interface, OSPF and BGP configuration according to the following topology diagram. Need to configure MPLS LDP on all relevant interface of infrastructure routers. After finishing the configuration please ensure that required LSP has been built for all the infrastructure prefixes and you can do LSP ping and LSP traceroute from PE routers to the other PE routers within the Lab.

Prerequisites: Knowledge of IGP, EGP, MPLS, LDP is required.

The following will be the common topology and IP address plan used for the labs.

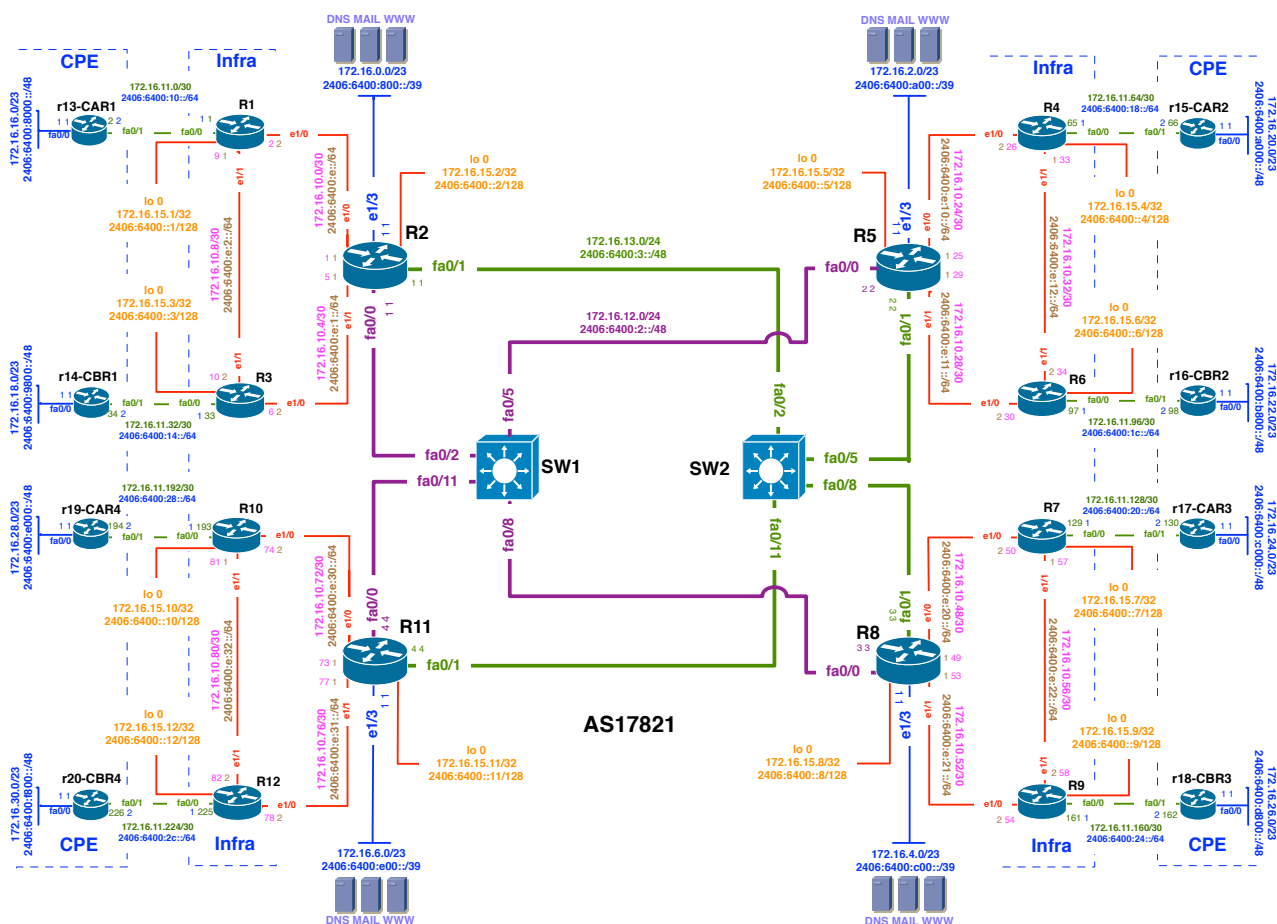


Figure 1 – ISP Lab Basic Configuration

Lab Notes

Out of all 20 routers on the above lab topology R1, R3, R4, R6, R7, R9, R10, R12 are PE (LER) routers. R2, R5, R8, R11 are P (LSR) routers and R13-20 are CE routers. On all PE and P routers interfaces connecting to other PE or P routers we need to configure LDP protocol.

Please spend some time to be familiar with the network topology and addressing plan before you start building the configuration on the routers.

In module 1 all required configurations are done in 3 steps.

1. LDP protocol configuration.

After the LDP configuration there will be 26 LSP build for the 26 IGP prefix according the table below:

Loopback	Point-to-point	Transport
R1=> 172.16.15.1/32	R2-R1=> 172.16.10.0/30	Purple=> 172.16.12.0/24
R2=> 172.16.15.2/32	R2-R3=> 172.16.10.4/30	Green=> 172.16.13.0/24
R3=> 172.16.15.3/32	R1-R3=> 172.16.10.8/30	
R4=> 172.16.15.4/32	R5-R4=> 172.16.10.24/30	
R5=> 172.16.15.5/32	R5-R6=> 172.16.10.28/30	
R6=> 172.16.15.6/32	R4-R6=> 172.16.10.32/30	
R7=> 172.16.15.7/32	R8-R7=> 172.16.10.48/30	
R8=> 172.16.15.8/32	R8-R9=> 172.16.10.52/30	
R9=> 172.16.15.9/32	R7-R9=> 172.16.10.56/30	
R10=> 172.16.15.10/32	R11-R10=> 172.16.10.72/30	
R11=> 172.16.15.11/32	R11-R12=> 172.16.10.76/30	
R12=> 172.16.15.12/32	R11-R12=> 172.16.10.80/30	

2. Disabling the TTL propagation on the PE routers.

TTL propagation can be disabled to hide the core routers from the end users. Disabling TTL propagation causes routers to set the value 255 into the TTL field of the label when an IP packet is labelled.

3. Conditional Label binding for loopback prefixes only

To scale MPLS in a large environment we will optimize our LFIB table to build LSP for loopback prefixes only, which will be used as nexthop for all external prefix. Those LSP for loopback prefixes will also be used as VPN LSP in our next module when we will do L3 VPN lab. After configuration of conditional LDP LSP will build for following IGP prefix only.

Loopback
R1=> 172.16.15.1/32
R2=> 172.16.15.2/32
R3=> 172.16.15.3/32
R4=> 172.16.15.4/32
R5=> 172.16.15.5/32
R6=> 172.16.15.6/32
R7=> 172.16.15.7/32
R8=> 172.16.15.8/32
R9=> 172.16.15.9/32
R10=> 172.16.15.10/32
R11=> 172.16.15.11/32
R12=> 172.16.15.12/32

Lab Exercise

1. LDP Configuration:

Here is an example configuration for R1

```
config t
ip cef
```

CEF (Cisco Express Forwarding), which enhanced the previous process switching mechanism. For MPLS to work CEF switching is mandatory.

```
mpls ldp router-id loopback 0 force
```

Forcing LDP router ID to be loopback address

```
int e1/0
mpls ip
```

IP MPLS is enabled on the interface

```
mpls label protocol ldp
```

Label distribution protocol is LDP

```
mpls mtu override 1512
```

MPLS MTU size will be changed to 1512 considering 3 stack of 32 bit MPLS label including main label, VPN and Traffic engineering

```
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verify your LDP configuration:

Command to show all the interfaces configured with MPLS and relevant protocol:

```
sh mpls ldp discovery [LDP ID]

sh mpls ldp parameters [LDP version, different LDP timers etc]

sh mpls ldp neighbor [LDP neighbor status etc]

sh mpls ldp bindings [LDP label binding etc]

sh mpls forwarding-table [MPLS forwarding table]

traceroute [router13, router14, router15.....router20]
```

MPLS LDP Debugging

```
debug mpls ldp messages sent/received all

debug mpls packet [Ping from CPE routers]
```

2. Disabling the TTL propagation on the PE routers

Here is an example configuration for R9

```
config t
no mpls ip propagate-ttl forwarded
```

The TTL functionality in MPLS is equivalent to that of traditional IP forwarding. Furthermore, when an IP packet is labeled, the TTL value from the IP header is copied into the TTL field in the label. This is called TTL propagation. This command will disable copying TTL field from the IP packet to the LDP label and set a default value 255 and it will hide the ISP backbone routers from the traceroute perform from CE routers.

```
exit
wr
```

3. Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
```

This prefix list will match all loopback prefix belongs to subnet 172.16.15.0/24 and from range 24 to 32

```
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
```

From the global IGP table filter all prefixes other then those match by prefix list ALL-LOOPBACK then allocate local label and advertise to LDP neighbour.

```
exit
exit
wr
```

Workshop templates for reference purpose only:

LDP protocol configuration

```
R1
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R2
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R3
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R4
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```


Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R5
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R6
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R7
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R8
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R9
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R10
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R11
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int fa0/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```

Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

LDP protocol configuration

```
R12
config t
ip cef
mpls ldp router-id loopback 0 force
int e1/0
mpls ip
mpls label protocol ldp
mpls mtu override 1512
int e1/1
mpls ip
mpls label protocol ldp
mpls mtu override 1512
exit
exit
wr
```


Verification Command:

```
sh mpls ldp discovery [LDP ID]
sh mpls ldp parameters [LDP version, different LDP timers etc]
sh mpls ldp neighbor [LDP neighbor status etc]
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```

Disabling the TTL propagation on the PE routers

```
config t
no mpls ip propagate-ttl forwarded
exit
wr
```

Verification Command:

```
traceroute [router1, router2, router3.....router12]
```

Conditional Label binding for loopback prefixes only

```
config t
ip prefix-list ALL-LOOPBACK seq 15 permit 172.16.15.0/24 le 32
mpls ldp label
allocate global prefix-list ALL-LOOPBACK
exit
exit
wr
```

Verification Command:

```
sh mpls ldp bindings [LDP label binding etc]
sh mpls forwarding-table [MPLS forwarding table]
traceroute [router1, router2, router3.....router12]
```