



MPLS Static Labeling

The MPLS static feature enables you to statically assign local labels to an IPv4 prefix. Also, Label Switched Paths (LSPs) can be provisioned for these static labels by specifying the next-hop information that is required to forward the packets containing static label.

If there is any discrepancy between labels assigned statically and dynamically, the router issues a warning message in the console log. By means of this warning message, the discrepancy can be identified and resolved.

The advantages of static labels over dynamic labels are:

- Improve security because the risk of receiving unwanted labels from peers (running a compromised MPLS dynamic labeling protocol) is reduced.
- Gives users full control over defined LSPs.
- Utilize system resources optimally because dynamic labeling is not processed.
- Static labeling on IPv6 packets is supported.

Restrictions

- The router does not prevent label discrepancy at the time of configuring static labels. Any generated discrepancy needs to be subsequently cleared.
- Equal-cost multi-path routing (ECMP) is not supported.
- Interfaces must be explicitly configured to handle traffic with static MPLS labels.
- When paths of different technologies are resolved over ECMP, it results in *heterogeneous* ECMP, leading to severe network traffic issues. Don't use ECMP for any combination of the following technologies:
 - LDP.
 - BGP-LU, including services over BGP-LU loopback peering or recursive services at Level-3.
 - VPNv4.
 - 6PE and 6VPE.
 - EVPN.
 - Recursive static routing.
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Restrictions For MPLS

- MPLS statistics is not supported.

Define Label Range and Enable MPLS Encapsulation

By default, MPLS encapsulation is disabled on all interfaces. MPLS encapsulation has to be explicitly enabled on all ingress and egress MPLS interfaces through which the static MPLS labeled traffic travels.

Also, the dynamic label range needs to be defined. Any label that falls outside this dynamic range is available for manually allocating as static labels. The router does not verify statically-configured labels against the specified label range. Therefore, to prevent label discrepancy, ensure that you do not configure static MPLS labels that fall within the dynamic label range.



Note For Cisco IOS XR software release 7.5.2 onwards, MPLS static supports 200G Ethernet.

Configuration Example

You have to accomplish the following to complete the MPLS static labeling configuration. Values are provided as an example.

1. Define a dynamic label range, which in this task is set between 17000 and 18000.
2. Enable MPLS encapsulation on the required interface.
3. Setup a static MPLS LSP for a specific ingress label 24035.
4. Specify the forwarding information so that for packets that are received with the label, 24035, the MPLS protocol swaps labels and applies the label, 24036. After applying the new label, it forwards the packets to the next hop, 10.2.2.2, through the specified interface.

```
RP/0/RP0/CPU0:router (config) #mpls label range table 0 17000 18000
RP/0/RP0/CPU0:router (config) #commit

RP/0/RP0/CPU0:router (config) #mpls static

RP/0/RP0/CPU0:router (config-mpls-static) # interface HundredGigE 0/9/0/0
RP/0/RP0/CPU0:router (config-mpls-static) #address-family ipv4 unicast
RP/0/RP0/CPU0:router (config-mpls-static-af) #local-label 24035 allocate

RP/0/RP0/CPU0:router (config-mpls-static-af-lbl) #forward
RP/0/RP0/CPU0:router (config-mpls-static-af-lbl-fwd) #

RP/0/RP0/CPU0:router (config-mpls-static-af-lbl-fwd) # commit
```

Verification

Verify the interfaces on which MPLS is enabled

```
RP/0/RP0/CPU0:router# show mpls interfaces
Mon May 12 06:21:30.937 DST
Interface                LDP      Tunnel   Static   Enabled
-----
TenGigE0/0/0/5          No       No       Yes      Yes
```

Verify that the status is "Created" for the specified label value.

```
RP/0/RP0/CPU0:router#show mpls static local-label all
Tue Apr 22 18:21:55.764 UTC
Label  VRF      Type      Prefix      RW Configured  Status
-----
24035  default  X-Connect NA          Yes            Created
```

Check the dynamic range and ensure that the specified local-label value is outside this range.

```
RP/0/RP0/CPU0:router#show mpls label range
Mon Apr 28 19:56:00.596 IST
Range for dynamic labels: Min/Max: 17000/18000
```

Verify that the MPLS static configuration has taken effect, and the label forwarding is taking place.

```
RP/0/RP0/CPU0:router#show mpls lsd forwarding
Wed Nov 25 21:40:57.918 UTC
In_Label, (ID), Path_Info: <Type>
24035, (Static), 1 Paths
  1/1: IPv4, 'default':4U, BE1.2, nh=10.20.3.1, lbl=35001, flags=0x0, ext_flags=0x0
```

Associated Commands

- mpls static
- mpls label range
- show mpls interfaces

Identify and Clear Label Discrepancy

During configuring or de-configuring static labels or a label range, a label discrepancy can get generated when:

- A static label is configured for an IP prefix that already has a binding with a dynamic label.
- A static label is configured for an IP prefix, when the same label value is dynamically allocated to another IP prefix.

Verification

Identify label discrepancy by using these show commands.

```
Router#show mpls static local-label discrepancy
Tue Apr 22 18:36:31.614 UTC
Label  VRF      Type      Prefix      RW Configured  Status
-----
```

```
24000 default X-Connect NA Yes Discrepancy
```

```
Router#show mpls static local-label all
```

```
Tue Apr 22 18:36:31.614 UTC
Label VRF Type Prefix RW Configured Status
-----
24000 default X-Connect N/A Yes Discrepancy
24035 default X-Connect N/A Yes Created
```

```
RP/0/RP0/CPU0:router#show log
```

```
Thu Apr 24 14:18:57.655 UTC
Syslog logging: enabled (0 messages dropped, 0 flushes, 0 overruns)
  Console logging: level warnings, 199 messages logged
  Monitor logging: level debugging, 0 messages logged
  Trap logging: level informational, 0 messages logged
  Buffer logging: level debugging, 2 messages logged
```

```
Log Buffer (307200 bytes):
```

```
RP/0/RSP0/CPU0:Apr 24 14:18:53.743 : mpls_static[1043]:
%ROUTING-MPLS_STATIC-7-ERR_STATIC_LABEL_DISCREPANCY :
The system detected 1 label discrepancies (static label could not be allocated due to
conflict with other applications).
Please use 'clear mpls static local-label discrepancy' to fix this issue.
RP/0/RSP0/CPU0:Apr 24 14:18:53.937 : config[65762]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
committed by user 'cisco'.
Use 'show configuration commit changes 1000000020' to view the changes.
```

Rectification

Label discrepancy is cleared by allocating a new label to those IP prefixes that are allocated dynamic label. The static label configuration takes precedence while clearing discrepancy. Clearing label discrepancy may result in traffic loss for the dynamic label which got cleared.

```
Router# clear mpls static local-label discrepancy all
```

Verify that the discrepancy is cleared.

```
Router# show mpls static local-label all
Wed Nov 25 21:45:50.368 UTC
Label VRF Type Prefix RW Configured Status
-----
24000 default X-Connect N/A Yes Created
24035 default X-Connect N/A Yes Created
```

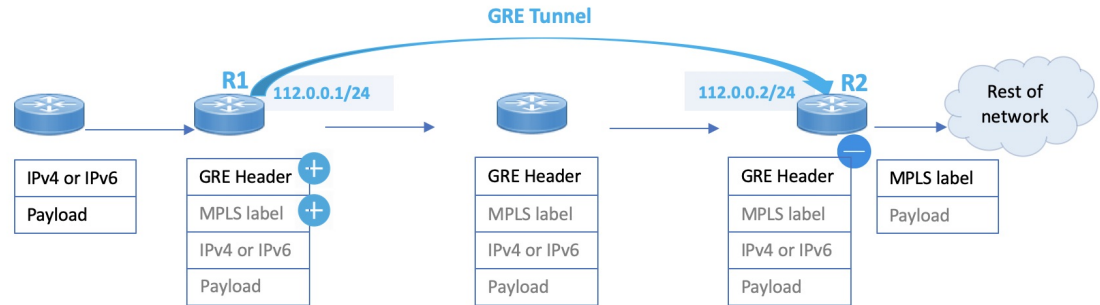
Associated Commands

- show mpls static local-label discrepancy
- clear mpls static local-label discrepancy all

MPLS Over Single-Pass GRE Tunnels

This feature supports MPLS static forwarding over a single-pass GRE tunnel at line rate. One use case is of a Provider router sending incoming customer traffic over the GRE tunnel, addressed to an anycast virtual IP address (VIP) destination shared by a set of load balancing servers.

Figure 1: MPLS Over a Single-Pass GRE Tunnel



In the image, you can see that the GRE tunnel begins at R1. R1 checks ACL configurations, adds an MPLS label to the incoming packet, and then adds a GRE header. Then it sends the traffic towards R2.

R2 uses the PBR process for GRE tunnel decapsulation, and based on the MPLS label, it forwards the traffic towards its destination.

Configuration Example

This example shows how to enable MPLS static forwarding over a single-pass GRE tunnel at line rate.

GRE Tunnel Configuration on R1

The single-pass GRE tunnel starts on R1.

```
R1# configure
R1(config)# interface tunnel-ip1
R1(config-if)# ipv4 address 112.0.0.1 255.255.255.0
R1(config-if)# tunnel mode gre ipv4 encap
R1(config-if)# tunnel source TenGigE0/0/0/2
R1(config-if)# tunnel destination 50.0.0.1
R1(config-if)# commit
```

GRE tunnel destination address is an anycast address. GRE encapsulation must be based on an ACL or a policy-map, or both. A destination can be an individual address or a /28 prefix.

MPLS Static Configuration on R1

```
R1# configure
R1(config)# router static
R1(config-static)# address-family ipv4 unicast
R1(config-static-afi)# 111.0.0.1/32 tunnel-ip1
R1(config-static-afi)# commit

R1(config)# mpls static
R1(config-mpls-static)# lsp test
R1(config-mpls-static-lsp)# in-label 10000 allocate per-prefix 111.0.0.1/32
R1(config-mpls-static-lsp)# forward
R1(config-mpls-static-lsp-fwd)# path 1 nexthop tunnel-ip1 out-label 12000
R1(config-mpls-static-lsp-fwd)# commit
```

GRE Tunnel Configuration on R2

The single-pass GRE tunnel terminates on R2.

```

R2 # configure
R2(config)# interface tunnel-ip1
R2(config-if)# ipv4 address 112.0.0.2 255.255.255.0
R2(config-if)# tunnel mode gre ipv4 decap
R2(config-if)# tunnel source TenGigE0/0/0/2
R2(config-if)# tunnel destination 10.0.0.1
R2(config-if)# commit

```

Verification

Tunnel-IP configuration on R1

```

R1# show running-config interface tunnel-ip 1

interface tunnel-ip1
  ipv4 address 112.0.0.1 255.255.255.0
  tunnel mode gre ipv4 encap
  tunnel source TenGigE0/0/0/2
  tunnel destination 50.0.0.1
!

```

MPLS Static Configuration on R1

```

R1# show running-config router static

router static
  address-family ipv4 unicast
    111.0.0.1/32 tunnel-ip1
  !
!

R1# show running-config mpls static

mpls static
  lsp test
    in-label 1000 allocate per-prefix 111.0.0.1/32
    forward
      path 1 nexthop tunnel-ip1 out-label 12000
    !
!

```

Tunnel-IP Configuration on R2

```

R2# show running-config int tunnel-ip 1

interface tunnel-ip1
  ipv4 address 112.0.0.2 255.255.255.0
  tunnel mode gre ipv4
  tunnel source TenGigE0/0/0/2
  tunnel destination 10.0.0.1
!

```

PBR Configuration for GRE Tunnel Decapsulation on R2

```

R2# show running-config class-map type traffic match-all

class-map type traffic match-all test_gre1
  match protocol gre
  match destination-address ipv4 50.0.0.1 255.255.255.255
  match source-address ipv4 10.0.0.1 255.255.255.255
end-class-map
!
policy-map type pbr P1-test

```

```
class type traffic test_gre1
decapsulate gre
!
class type traffic class-default
!
end-policy-map
!

vrf-policy
vrf default address-family ipv4 policy type pbr input P1-test
!
```

