



## Implementing MPLS Static Labeling

The MPLS static feature enables you to statically assign local labels to an IPv4 prefix per VRF. 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.

Static labels are more advantageous than dynamic labels because static labels:

- 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.

To perform static binding of MPLS labels, you need to:

- [Enable MPLS Encapsulation on an Interface, on page 2](#)
- [Define a Range for Static MPLS Labels, on page 3](#)
- Allocate static label:
  - [Setup a Static LSP, on page 4](#)
  - or
  - [Allocate Static MPLS Label to an IP Prefix and Configure a LSP, on page 5](#)
  - [Allocate Static MPLS Label for a Specific VRF, on page 7](#)
- [Verify MPLS Static Bindings, on page 8](#)
- [Identify and Clear Label Discrepancy, on page 9](#)

### Restrictions

- Static labeling on IPv6 packets is not supported.
- 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.
- The MPLS per-VRF labels cannot be shared between MPLS static and other applications.

### Feature History for Implementing MPLS Static Labeling

Release	Modification
Release 5.1.1	This feature was introduced.

- [Enable MPLS Encapsulation on an Interface, page 2](#)
- [Define a Range for Static MPLS Labels, page 3](#)
- [Setup a Static LSP, page 4](#)
- [Allocate Static MPLS Label to an IP Prefix and Configure a LSP, page 5](#)
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## Enable MPLS Encapsulation on an Interface

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.

### SUMMARY STEPS

1. **configure**
2. **mpls static**
3. **interface *interface***
4. Use the **commit** or **end** command.

### DETAILED STEPS

**Step 1**      **configure**

**Example:**

```
RP/0/0/CPU0:router# configure
Enters global configuration mode.
```

**Step 2**      **mpls static**

**Example:**

```
RP/0/0/CPU0:router(config)# mpls static
Enters MPLS-static configuration mode.
```

**Step 3** `interface interface`**Example:**

```
RP/0/0/CPU0:router(config-mpls-static)# interface gigabitethernet 0/0/0/3
```

Enables MPLS encapsulation on the specified interface.

**Step 4**

Use the **commit** or **end** command.

**commit**—Saves the configuration changes and remains within the configuration session.

**end**—Prompts user to take one of these actions:

- **Yes**— Saves configuration changes and exits the configuration session.
- **No**—Exits the configuration session without committing the configuration changes.
- **Cancel**—Remains in the configuration session, without committing the configuration changes.

**What to Do Next**

To verify the interfaces on which MPLS is enabled, use the **show mpls interfaces** command from the EXEC mode. For example:

```
RP/0/0/CPU0:router# show mpls interfaces
Mon May 12 06:21:30.937 DST
Interface                LDP          Tunnel      Static      Enabled
-----
GigabitEthernet0/0/0/3  No           No          Yes         Yes
```

For the interface on which MPLS static is enabled, the "Static" column displays "Yes".

## Define a Range for Static MPLS Labels

The MPLS label range configuration defines the dynamic label range. 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**

The allocable range for MPLS labels is from 16 to 1048575. Label values from 0 to 15 are reserved according to [RFC-3032](#).

**SUMMARY STEPS**

1. **configure**
2. **mpls label range** *minimum\_value maximum\_value*
3. Use the **commit** or **end** command.

## DETAILED STEPS

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### Step 1 **configure**

#### Example:

```
RP/0/0/CPU0:router# configure
Enters global configuration mode.
```

### Step 2 **mpls label range** *minimum\_value maximum\_value*

#### Example:

```
RP/0/0/CPU0:router(config)# mpls label range 20000 30000
```

Specifies the range through which dynamic MPLS labels are allocated. All labels falling outside this range (16 to 19999 and 30001 to 1048575) can be manually allocated as static labels.

### Step 3 Use the **commit** or **end** command.

**commit**—Saves the configuration changes and remains within the configuration session.

**end**—Prompts user to take one of these actions:

- **Yes**— Saves configuration changes and exits the configuration session.
  - **No**—Exits the configuration session without committing the configuration changes.
  - **Cancel**—Remains in the configuration session, without committing the configuration changes.
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## Setup a Static LSP

In this task, a static MPLS LSP is setup for a specific ingress label.

### SUMMARY STEPS

1. **configure**
2. **mpls static**
3. **address-family ipv4 unicast**
4. **local-label** *label-value* **allocate**
5. **forward path** *path\_id* **nexthop** *nexthop\_address* *interface\_type* *interface\_id* **out-label** *outgoing\_label*
6. Use the **commit** or **end** command.

### DETAILED STEPS

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#### Step 1 **configure**

**Example:**

```
RP/0/0/CPU0:router# configure
Enters global configuration mode.
```

**Step 2**     **mpls static****Example:**

```
RP/0/0/CPU0:router(config)# mpls static
Enters MPLS-static configuration mode.
```

**Step 3**     **address-family ipv4 unicast****Example:**

```
RP/0/0/CPU0:router(config-mpls-static)# address-family ipv4 unicast
Applies the static configuration to an IPv4 address family in the default VRF.
```

**Step 4**     **local-label label-value allocate****Example:**

```
RP/0/0/CPU0:router(config-mpls-static-af)# local-label 30500 allocate
Specifies the incoming label value as 30500.
```

**Step 5**     **forward path path\_id nexthop nexthop\_address interface\_type interface\_id out-label outgoing\_label****Example:**

```
RP/0/0/CPU0:router(config-mpls-static-af-lbl)# forward path 1 nexthop 10.2.2.2 gigabitEthernet 0/0/0/1
out-label 30501
```

For packets that are received with the label, 30500, the MPLS protocol swaps labels and applies the label, 30501. After applying the new label, it forwards the packets to the next hop, 10.2.2.2, through the GigabitEthernet interface, 0/0/0/1.

**Step 6**

Use the **commit** or **end** command.

**commit**—Saves the configuration changes and remains within the configuration session.

**end**—Prompts user to take one of these actions:

- **Yes**— Saves configuration changes and exits the configuration session.
- **No**—Exits the configuration session without committing the configuration changes.
- **Cancel**—Remains in the configuration session, without committing the configuration changes.

## Allocate Static MPLS Label to an IP Prefix and Configure a LSP

Static MPLS label bindings for IP prefixes are used by MPLS applications such as Label Distribution Protocol (LDP) or Border Gateway Protocol (BGP) for MPLS switching. It is possible to define a static LSP for the static label.

**SUMMARY STEPS**

1. **configure**
2. **mpls static**
3. **address-family ipv4 unicast**
4. **local-label *label-value* allocate per-prefix *IPv4\_prefix\_entry***
5. **forward path *path\_id* nexthop *nexthop\_address* out-label *outgoing\_label***
6. Use the **commit** or **end** command.

**DETAILED STEPS****Step 1**      **configure****Example:**

```
RP/0/0/CPU0:router# configure
Enters global configuration mode.
```

**Step 2**      **mpls static****Example:**

```
RP/0/0/CPU0:router(config)# mpls static
Enters MPLS-static configuration mode.
```

**Step 3**      **address-family ipv4 unicast****Example:**

```
RP/0/0/CPU0:router(config-mpls-static)# address-family ipv4 unicast
Applies the static configuration to an IPv4 address family in the default VRF.
```

**Step 4**      **local-label *label-value* allocate per-prefix *IPv4\_prefix\_entry*****Example:**

```
RP/0/0/CPU0:router(config-mpls-static-af)# local-label 30500 allocate per-prefix 100.1.1.0/24
The MPLS protocol requests label 30500 to be statically bound as a local label for the prefix 100.1.1.0/24.
```

**Step 5**      **forward path *path\_id* nexthop *nexthop\_address* out-label *outgoing\_label*****Example:**

```
RP/0/0/CPU0:router(config-mpls-static-af-lbl)# forward path 1 nexthop 10.2.2.2 out-label 30501
For packets that are received with the label, 30500, the MPLS protocol swaps labels and applies the label, 30501. After applying the new label, it forwards the packets to the next hop, 10.2.2.2.
```

**Example:**

```
RP/0/0/CPU0:router(config-mpls-static-af-lbl)# forward path 1 nexthop gigabitEthernet 0/0/0/4 out-label
pop
```

For packets that are received with the label, 30500, the MPLS protocol removes the existing label. After removing the label, it forwards the packets to the next hop through the egress interface, GigabitEthernet 0/0/0/4.

**Step 6**      Use the **commit** or **end** command.

**commit**—Saves the configuration changes and remains within the configuration session.

**end**—Prompts user to take one of these actions:

- **Yes**— Saves configuration changes and exits the configuration session.
- **No**—Exits the configuration session without committing the configuration changes.
- **Cancel**—Remains in the configuration session, without committing the configuration changes.

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## Allocate Static MPLS Label for a Specific VRF

In this task, a static MPLS label is allocated to an IP prefix for a specific VRF.

**Note**

When a static MPLS label is allocated to an IP prefix for a specific VRF, it is not possible to define a static LSP for that static label.

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### SUMMARY STEPS

1. **configure**
2. **mpls static**
3. **vrf *vrf\_name* address-family ipv4 unicast**
4.
  - **local-label *label-value* allocate per-prefix *IPv4\_prefix\_entry***
  - **local-label *label-value* allocate per-vrf forward path *path-id* pop-and-lookup**
5. Use the **commit** or **end** command.

### DETAILED STEPS

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**Step 1**      **configure**

**Example:**

```
RP/0/0/CPU0:router# configure
Enters global configuration mode.
```

**Step 2**      **mpls static**

**Example:**

```
RP/0/0/CPU0:router(config)# mpls static
Enters MPLS-static configuration mode.
```

**Step 3**      **vrf *vrf\_name* address-family ipv4 unicast**

**Example:**

```
RP/0/0/CPU0:router(config-mpls-static)# vrf vrf1 address-family ipv4 unicast
```

Applies the static configuration to an IPv4 address family in the VRF named *vrf1*.

**Step 4**

- **local-label** *label-value* **allocate per-prefix** *IPv4\_prefix\_entry*
- **local-label** *label-value* **allocate per-vrf** forward **path** *path-id* **pop-and-lookup**

**Example:**

```
RP/0/0/CPU0:router(config-mpls-static-vrf-af)# local-label 30500 allocate per-prefix 100.1.1.0/24
```

The MPLS protocol requests label 30500 to be statically bound as a local label for the prefix 100.1.1.0/24 in the VRF named *vrf1*.

**Example:**

```
RP/0/0/CPU0:router(config-mpls-static-vrf-af)# local-label 30500 allocate per-vrf forward path 1 pop-and-lookup
```

The MPLS protocol requests single label 30500 to be statically bound as a local label for all the prefixes in the VRF named *vrf1*. When the router receives packets with VRF label 30500, it removes the label and then performs IP-based lookup to forward the packets.

**Step 5**

Use the **commit** or **end** command.

**commit**—Saves the configuration changes and remains within the configuration session.

**end**—Prompts user to take one of these actions:

- **Yes**— Saves configuration changes and exits the configuration session.
- **No**—Exits the configuration session without committing the configuration changes.
- **Cancel**—Remains in the configuration session, without committing the configuration changes.

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## Verify MPLS Static Bindings

These are the show commands that can be used to verify MPLS static bindings and LSPs.

**SUMMARY STEPS**

1. **show mpls static local-label** *label\_value*
2. **show mpls label range**
3. **show mpls lsd forwarding**

**DETAILED STEPS**


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**Step 1**     **show mpls static local-label** *label\_value*



**Example:**

```
RP/0/0/CPU0:router#show mpls static local-label 200
Tue Apr 22 18:21:55.764 UTC
Label  VRF          Type          Prefix          RW Configured  Status
-----
200    default        Per-Prefix    10.10.10.10/32  Yes            Created
```

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

**Step 2** **show mpls label range****Example:**

```
RP/0/0/CPU0:router#show mpls label range
Mon Apr 28 19:56:00.596 IST
Range for dynamic labels: Min/Max: 16000/1048575
```

Checks the dynamic range and ensures that the specified local-label value is outside this range.

**Step 3** **show mpls lsd forwarding****Example:**

```
RP/0/0/CPU0:router#show mpls lsd forwarding
Tue Apr 29 15:59:52.011 UTC
In_Label, (ID), Path_Info: <Type>
89, (IPv4, 'default':4U, 5.6.78.55/32), 1 Paths
  1/1: IPv4, 'default':4U, Gi0/0/0/21, nh=0.0.0.0, lbl=89, tun_id=0, flags=0x0 ()
110, (IPv4, 'default':4U, 2.2.2.2/32), 1 Paths
  1/1: IPv4, 'default':4U, Gi0/1/0/0, nh=1.12.1.2, lbl=Pop, tun_id=0, flags=0x0 ()
120, (IPv4, 'default':4U, 3.3.3.3/32), 1 Paths
  1/1: IPv4, 'default':4U, Gi0/1/0/0, nh=1.12.1.2, lbl=0, tun_id=0, flags=0x0 ()
130, (IPv4, 'default':4U, 4.4.4.4/32), 1 Paths
  1/1: IPv4, 'default':4U, Gi0/1/0/0, nh=1.12.1.2, lbl=200, tun_id=0, flags=0x0 ()
```

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

## 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 (per VRF) 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.

Complete these steps to identify and clear the discrepancies.

**Step 1** To identify a label discrepancy, execute one of these:

- **show mpls static local-label discrepancy**
- **show log**

**Example:**

```
RP/0/0/CPU0:router#show mpls static local-label discrepancy
Tue Apr 22 18:36:31.614 UTC
Label   VRF           Type           Prefix          RW Configured   Status
-----
16003   default      Per-Prefix    1.1.1.1/32     No              Discrepancy
```

**Example:**

```
RP/0/0/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 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.
```

**Step 2**    **clear mpls static local-label discrepancy all****Example:**

```
RP/0/0/CPU0:router# clear mpls static local-label discrepancy all
```

Clears label discrepancy by allocating a new label to those IP prefixes that are allocated dynamic label. The static label configuration takes precedence while clearing discrepancy. Traffic can be affected while clearing discrepancy.

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