



# Configuring Static MPLS

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## Licensing Requirements

For a complete explanation of Cisco NX-OS licensing recommendations and how to obtain and apply licenses, see the [Cisco NX-OS Licensing Guide](#).

## About Static MPLS

Generally, label switching routers (LSRs) use a label distribution protocol to dynamically learn the labels that they should use to label-switch packets. Examples of such protocols include:

- Label Distribution Protocol (LDP), the Internet Engineering Task Force (IETF) standard that is used to bind labels to network addresses
- Resource Reservation Protocol (RSVP), which is used to distribute labels for traffic engineering (TE)
- Border Gateway Protocol (BGP), which is used to distribute labels for MPLS virtual private networks (VPNs)

To use a learned label to label-switch packets, an LSR installs the label into its Label Forwarding Information Base (LFIB).

The static MPLS feature enables you to statically configure the following:

- The binding between a label and an IPv4 or IPv6 prefix
- The action corresponding to the binding between a label and an IPv4 or IPv6 prefix (label swap or pop)
- The contents of an LFIB cross-connect entry

## Label Swap and Pop

As a labeled packet traverses the MPLS domain, the outermost label of the label stack is examined at each hop. Depending on the contents of the label, a swap or pop (dispose) operation is performed on the label stack. Forwarding decisions are made by performing an MPLS table lookup for the label carried in the packet header. The packet header does not need to be reevaluated during packet transit through the network. Because the label has a fixed length and is unstructured, the MPLS forwarding table lookup process is both straightforward and fast.

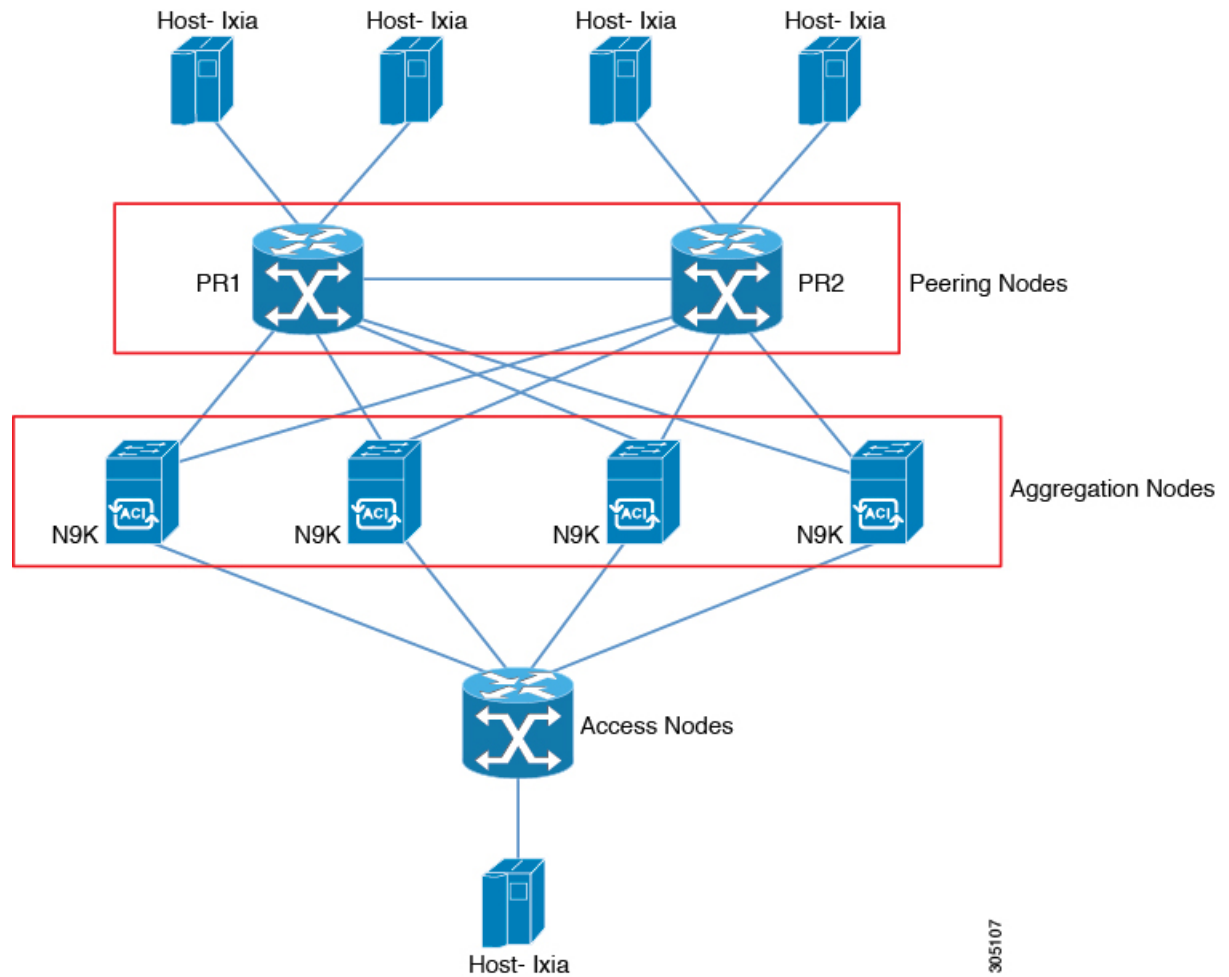
In a swap operation, the label is swapped with a new label, and the packet is forwarded to the next hop that is determined by the incoming label.

In a pop operation, the label is removed from the packet, which may reveal an inner label below. If the popped label was the last label on the label stack, the packet exits the MPLS domain. Typically, this process occurs at the egress LSR. A failure of the primary link in the aggregator reroutes the MPLS traffic to the backup link and results in a swap operation.

## Static MPLS Topology

This diagram illustrates the static MPLS source routing topology. The access nodes perform the swap operation, and the aggregation nodes perform the pop operation for the primary path and the swap operation for the backup path.

Figure 1: Static MPLS Topology



## Benefits of Static MPLS

- Static bindings between labels and IPv4 or IPv6 prefixes can be configured to support MPLS hop-by-hop forwarding through neighbor routers that do not implement LDP label distribution.
- Static cross-connects can be configured to support MPLS label switched path (LSP) midpoints when neighbor routers do not implement either LDP or RSVP label distribution but do implement an MPLS forwarding path.

## Prerequisites for Static MPLS

Static MPLS has the following prerequisites:

- You must configure the ACL TCAM region size for MPLS, save the configuration, and reload the switch.



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**Note** By default the MPLS region size is zero. You need to configure this region to 256 in order to support static MPLS.

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## Guidelines and Limitations for Static MPLS

Static MPLS has the following guidelines and limitations:

- Static MPLS and MPLS stripping cannot be enabled at the same time.
- Adjacency statistics are supported for Cisco Nexus 3100 Series switches but not for Cisco Nexus 3000 Series switches.
- Equal-cost multipath (ECMP) is not supported with label pop.
- Label pop and swap operations are supported, but label push operations are not.
- MPLS packets will be forwarded as long as the ingress label matches the configured label and the configured FEC (prefix) is in the routing table.
- The device performs as a label switching router (LSR). It performs as a label edge router (LER) only for penultimate hop popping (PHP), when the outermost label of an MPLS tagged packet is removed by an LSR before the packet is passed to an adjacent LER. This means that label switching router (LSR) functions with 2 (or more) incoming labels.

The device generally performs as a label switching router (LSR). It performs as a label edge router (LER) for penultimate hop popping, by installing the explicit null label as the out-label in the label FIB (LFIB) by an LSR before the packet is passed to an adjacent LER. This means that label switching router (LSR) functions with 1 or more labels.



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**Note** If user intentionally uses implicit-null CLI on LSR, the output packet going to LER, will still have an explicit-null and the inner label.

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- Static MPLS supports up to 128 labels.
- The backup path is supported only for a single adjacency and not for ECMP.
- The output for most of the MPLS commands can be generated in XML or JSON. See [Verifying the Static MPLS Configuration, on page 8](#) for an example.
- VRFs, vPCs, FEX, and VXLAN are not supported with static MPLS.
- Subinterfaces are not supported for static MPLS.
- The Forwarding Equivalence Class (FEC) should exactly match routes in the routing table.
- When you configure fast reroute (backup), you can specify only the connected next hop (and not the recursive next hop) as the next-hop prefix in the backup configuration.
- When multiple FECs are sharing the backup (the same next-hop and interface), any change to the backup configuration requires a reconfiguration of all the other FECs that are sharing the backup configuration.

- When the backup path is active, the **show mpls switching labels** command will not show the out label/out interface/next hop and related statistics. You can use the **show forwarding mpls label label stats platform** command to check the statistics.
- If traffic ingresses or egresses on a non-default unit (where the default unit is unit0), the corresponding ULIB statistics will not be displayed in the output of the **show mpls switching labels low-label-value [high-label-value] detail** command. You can use the **show forwarding mpls label label stats platform** command to check the statistics.
- If the backup and primary paths are pointing to the same interface, the backup action swap takes precedence.
- Physical (Ethernet) and port channels are supported only for backup.

## Configuring Static MPLS

### Enabling Static MPLS

You must install and enable the MPLS feature set and then enable the MPLS static feature before you can configure MPLS static labels.

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
<b>Step 2</b>	<b>[no] install feature-set mpls</b>  <b>Example:</b> switch(config)# install feature-set mpls	Installs the MPLS feature set. The <b>no</b> form of this command uninstalls the MPLS feature set.
<b>Step 3</b>	<b>[no] feature-set mpls</b>  <b>Example:</b> switch(config)# feature-set mpls	Enables the MPLS feature set. The <b>no</b> form of this command disables the MPLS feature set.
<b>Step 4</b>	<b>[no] feature mpls static</b>  <b>Example:</b> switch(config)# feature mpls static	Enables the static MPLS feature. The <b>no</b> form of this command disables the static MPLS feature.
<b>Step 5</b>	(Optional) <b>show feature-set</b>  <b>Example:</b> switch(config)# show feature-set Feature Set Name      ID            State	Displays the status of the MPLS feature set.

	Command or Action	Purpose
	mpls 4 enabled	
<b>Step 6</b>	(Optional) <b>show feature   inc mpls_static</b>  <b>Example:</b> switch(config)# show feature   inc mpls_static mpls_static 1 enabled	Displays the status of static MPLS.

## Reserving Labels for Static Assignment

You can reserve the labels that are to be statically assigned so that they are not dynamically assigned.

### Before you begin

Ensure that the static MPLS feature is enabled.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
<b>Step 2</b>	<b>[no] mpls label range min-value max-value</b> <b>[static min-static-value max-static-value]</b>  <b>Example:</b> switch(config)# mpls label range 17 99 static 100 10000	Reserves a range of labels for static label assignment.  The range for the minimum and maximum values is from 16 to 471804.
<b>Step 3</b>	(Optional) <b>show mpls label range</b>  <b>Example:</b> switch(config)# show mpls label range	Displays the label range that is configured for static MPLS.
<b>Step 4</b>	(Optional) <b>copy running-config startup-config</b>  <b>Example:</b> switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

## Configuring Static Label and Prefix Binding Using the Swap and Pop Operations

In a top-of-rack configuration, the outer label is swapped to the specified new label. The packet is forwarded to the next-hop address, which is auto-resolved by the new label.

In an aggregator configuration, the outer label is popped, and the packet with the remaining label is forwarded to the next-hop address. Pop operations are performed in the primary path, and swap operations are performed in the backup path.

### Before you begin

Ensure that the static MPLS feature is enabled.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b> <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
<b>Step 2</b>	<b>interface <i>type slot/port</i></b> <b>Example:</b> switch(config)# interface ethernet 2/2 switch(config-if)#	Enters the interface configuration mode for the specified interface.
<b>Step 3</b>	<b>[no] mpls ip forwarding</b> <b>Example:</b> switch(config-if)# mpls ip forwarding	Enables MPLS on the specified interface. The <b>no</b> form of this command disables MPLS on the specified interface.
<b>Step 4</b>	<b>mpls static configuration</b> <b>Example:</b> switch(config-if)# mpls static configuration switch(config-mpls-static)#	Enters MPLS static global configuration mode.
<b>Step 5</b>	<b>address-family {ipv4   ipv6} unicast</b> <b>Example:</b> switch(config-mpls-static)# address-family ipv4 unicast switch(config-mpls-static-af)#	Enters global address family configuration mode for the specified IPv4 or IPv6 address family.
<b>Step 6</b>	<b>local-label <i>local-label-value</i> prefix <i>destination-prefix destination-prefix-mask</i></b> <b>Example:</b> switch(config-mpls-static-af)# local-label 2000 prefix 1.255.200.0 255.255.255.25 switch(config-mpls-static-af-lbl)#	Specifies static binding of incoming labels to IPv4 or IPv6 prefixes. The <i>local-label-value</i> is the range of the static MPLS label defined in the <b>mpls label range</b> command.
<b>Step 7</b>	<b>next-hop {auto-resolve   <i>destination-ip-next-hop out-label implicit-null</i>   backup <i>local-egress-interface destination-ip-next-hop out-label output-label-value</i>}</b>	Specifies the next hop. These options are available: <ul style="list-style-type: none"> <li>• <b>next-hop auto-resolve</b>—Use this option for label swap operations.</li> </ul>

	Command or Action	Purpose
	<b>Example:</b> <pre>switch(config-mpls-static-af-lbl)# next-hop auto-resolve</pre>	<ul style="list-style-type: none"> <li>• <b>next-hop</b> <i>destination-ip-next-hop out-label implicit-null</i>—Use this option for the primary path in label pop operations.</li> <li>• <b>next-hop backup</b> <i>local-egress-interface destination-ip-next-hop out-label output-label-value</i>—Use this option for the backup path in label pop operations.</li> </ul>
<b>Step 8</b>	(Optional) <b>copy running-config startup-config</b> <b>Example:</b> <pre>switch(config-mpls-static-af-lbl)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

## Verifying the Static MPLS Configuration

To display the static MPLS configuration, perform one of the following tasks:

Command	Purpose
<b>show feature   inc mpls_static</b>	Displays the status of static MPLS.
<b>show feature-set</b>	Displays the status of the MPLS feature set.
<b>show ip route</b>	Displays routes from the unicast Routing Information Base (RIB).
<b>show mpls label range</b>	Displays the label range that is configured for static MPLS.
<b>show mpls static binding {all   ipv4   ipv6}</b>	Displays the configured static prefix or label bindings.
<b>show mpls switching [detail]</b>	Displays MPLS switching information.
<b>show mpls switching label [detail]</b>	Displays the MPLS switching label information.
<b>show forwarding mpls [label label] stats</b>	Displays the adjacency statistics based on the label enabled.
<b>show forwarding adjacency mpls stats</b>	Displays the adjacency statistics

This example shows sample output for the **show mpls static binding all** command:

```
1.255.200.0/32: (vrf: default) Incoming label: 2000
  Outgoing labels:
    1.21.1.1 implicit-null
    backup 1.24.1.1 2001

2000:1:255:201::1/128: (vrf: default) Incoming label: 3000
  Outgoing labels:
    2000:1111:2121:1111:1111:1111:1111:1111:1 implicit-null
```



```
backup 2000:1:24:1::1 3001
```

This example shows sample output for the **show mpls switching detail** command:

```
VRF default

IPv4 FEC
  In-Label           : 2000
  Out-Label stack    : Pop Label
  FEC                : 1.255.200.0/32
  Out interface      : Po21
  Next hop           : 1.21.1.1
  Input traffic statistics : 0 packets, 0 bytes
  Output statistics per label : 0 packets, 0 bytes
IPv6 FEC
  In-Label           : 3000
  Out-Label stack    : Pop Label
  FEC                : 2000:1:255:201::1/128
  Out interface      : port-channel21
  Next hop           : 2000:1111:2121:1111:1111:1111:1
  Input traffic statistics : 0 packets, 0 bytes
  Output statistics per label : 0 packets, 0 bytes
```

This example shows normal, XML, and JSON sample output for the **show mpls switching** command when the switch is configured with a static IPv4 prefix:

```
switch# show run mpls static | sec 'ipv4 unicast'
address-family ipv4 unicast
local-label 100 prefix 192.168.0.1 255.255.255.255 next-hop auto-resolve out-label 200
```

```
switch# show mpls switching
Legend:
(P)=Protected, (F)=FRR active, (*)=more labels in stack.
IPv4:
In-Label   Out-Label   FEC name           Out-Interface      Next-Hop
-----
VRF default
100         200          192.168.0.1/32    Eth1/23            1.12.23.2
```

```
switch# show mpls switching | xml
<?xml version="1.0" encoding="ISO-8859-1"?> <nf:rpc-reply
xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0"
xmlns="http://www.cisco.com/nxos:1.0:ulib">
  <nf:data>
    <show>
      <mpls>
        <switching>
          <__XML__OPT_Cmd_ulib_show_switching_cmd_labels>
            <__XML__OPT_Cmd_ulib_show_switching_cmd_detail>
              <__XML__OPT_Cmd_ulib_show_switching_cmd_vrf>
                <__XML__OPT_Cmd_ulib_show_switching_cmd__readonly__>
                  <__readonly__>
                    <TABLE_vrf>
                      <ROW_vrf>
                        <vrf_name>default</vrf_name>
                        <TABLE_inlabel>
                          <ROW_inlabel>
                            <in_label>100</in_label>
                            <out_label_stack>200</out_label_stack>
                            <ipv4_prefix>192.168.0.1/32</ipv4_prefix>
                            <out_interface>Eth1/23</out_interface>
```

```

        <ipv4_next_hop>1.12.23.2</ipv4_next_hop>
        <nhlfe_p2p_flag> </nhlfe_p2p_flag>
    </ROW_inlabel>
</TABLE_inlabel>
</ROW_vrf>
</TABLE_vrf>
</__readonly__>
</__XML__OPT_Cmd_ulib_show_switching_cmd__readonly__>
</__XML__OPT_Cmd_ulib_show_switching_cmd_vrf>
</__XML__OPT_Cmd_ulib_show_switching_cmd_detail>
</__XML__OPT_Cmd_ulib_show_switching_cmd_labels>
</switching>
</mpls>
</show>
</nf:data>
</nf:rpc-reply>
]]>]]>

```

```

switch# show mpls switching | json
{"TABLE_vrf": {"ROW_vrf": {"vrf_name": "default", "TABLE_inlabel":
{"ROW_inlabel
": {"in_label": "100", "out_label_stack": "200", "ipv4_prefix":
"192.168.0.1/32"
, "out_interface": "Eth1/23", "ipv4_next_hop": "1.12.23.2",
"nhlfe_p2p_flag": nu
11}}}}}

```

## Displaying Static MPLS Statistics

To monitor static MPLS statistics, perform one of the following tasks:

Command	Purpose
<b>show forwarding [ipv6] adjacency mpls stats</b>	Displays MPLS IPv4 or IPv6 adjacency statistics.
<b>show forwarding mpls drop-stats</b>	Displays the MPLS forwarding packet drop statistics.
<b>show forwarding mpls ecmp [module slot   platform]</b>	Displays the MPLS forwarding statistics for equal-cost multipath (ECMP).
<b>show forwarding mpls label label stats [platform]</b>	Displays MPLS label forwarding statistics.
<b>show mpls forwarding statistics [interface type slot/port]</b>	Displays MPLS forwarding statistics.
<b>show mpls switching labels low-label-value [high-label-value] [detail]</b>	Displays the MPLS label switching statistics. The range for the label value is from 0 to 524286.

This example shows sample output for the **show forwarding adjacency mpls stats** command:

```

FEC                next-hop  interface  tx packets  tx bytes  Label info
-----
1.255.200.0/32    1.21.1.1  Po21      87388      10836236  POP 3
1.255.200.0/32    1.24.1.1  Po24       0           0         SWAP 2001
switch(config)#
switch(config)# show forwarding mpls drop-stats

```

```
Dropped packets : 73454
Dropped bytes : 9399304
```

This example shows sample output for the **show forwarding ipv6 adjacency mpls stats** command:

```
FEC                next-hop          interface  tx packets  tx bytes  Label info
-----
2000:1:255:201::1/128 2000:1.21.1.1  Po21      46604      5778896  POP 3
2000:1:255:201::1/128 2000:1:24:1::1 Po24       0           0        SWAP 3001
```

This example shows sample output for the **show forwarding mpls label 2000 stats** command:

```
-----+-----+-----+-----+-----+-----
Local  |Prefix  |FEC                |Next-Hop          |Interface  |Out
Label  |Table Id| (Prefix/Tunnel id) |                  |           |Label
-----+-----+-----+-----+-----+-----
2000   |0x1     |1.255.200.0/32     |1.21.1.1          |Po21       |Pop Label
  HH: 100008, Refcount: 1
Input Pkts : 77129                Input Bytes : 9872512
Output Pkts: 77223                Output Bytes: 9575652
```

This example shows sample output for the **show mpls forwarding statistics** command:

```
MPLS software forwarding stats summary:
Packets/Bytes sent       : 0/0
Packets/Bytes received   : 0/0
Packets/Bytes forwarded  : 0/0
Packets/Bytes originated : 0/0
Packets/Bytes consumed   : 0/0
Packets/Bytes input dropped : 0/0
Packets/Bytes output dropped : 0/0
```

## Clearing Static MPLS Statistics

To clear the static MPLS statistics, perform these tasks:

Command	Purpose
<b>clear forwarding [ipv6] adjacency mpls stats</b>	Clears the MPLS IPv4 or IPv6 adjacency statistics.
<b>clear forwarding mpls drop-stats</b>	Clears the MPLS forwarding packet drop statistics.
<b>clear forwarding mpls stats</b>	Clears the ingress MPLS forwarding statistics.
<b>clear mpls forwarding statistics</b>	Clears the MPLS forwarding statistics.
<b>clear mpls switching label statistics [interface type slot/port]</b>	Clears the MPLS switching label statistics.

## Configuration Examples for Static MPLS

This example shows how to reserve labels for static assignment:

```

switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# mpls label range 17 99 static 100 10000
switch(config)# show mpls label range
Downstream Generic label region: Min/Max label: 17/99
Range for static labels: Min/Max Number: 100/10000

```

This example shows how to configure MPLS static label and IPv4 prefix binding in a top-of-rack configuration (swap configuration):

```

switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# interface ethernet 1/1
switch(config-if)# mpls ip forwarding
switch(config-if)# mpls static configuration
switch(config-mpls-static)# address-family ipv4 unicast
switch(config-mpls-static-af)# local-label 2000 prefix 1.255.200.0/32
switch(config-mpls-static-af-lbl)# next-hop auto-resolve out-label 2000

```

This example shows how to configure MPLS static label and IPv6 prefix binding in a top-of-rack configuration (swap configuration):

```

switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# interface ethernet 1/1
switch(config-if)# mpls ip forwarding
switch(config-if)# mpls static configuration
switch(config-mpls-static)# address-family ipv6 unicast
switch(config-mpls-static-af)# local-label 3001 prefix 2000:1:255:201::1/128
switch(config-mpls-static-af-lbl)# next-hop auto-resolve out-label 3001

```

This example shows how to configure MPLS static label and IPv4 prefix binding in an aggregator configuration (pop configuration):

```

switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# interface ethernet 1/1
switch(config-if)# mpls ip forwarding
switch(config-if)# mpls static configuration
switch(config-mpls-static)# address-family ipv4 unicast
switch(config-mpls-static-af)# local-label 2000 prefix 1.255.200.0/32
switch(config-mpls-static-af-lbl)# next-hop 1.31.1.1 out-label implicit-null
switch(config-mpls-static-af-lbl)# next-hop backup Po34 1.34.1.1 out-label 2000

```

This example shows how to configure MPLS static label and IPv6 prefix binding in an aggregator configuration (pop configuration):

```

switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# interface ethernet 1/1
switch(config-if)# mpls ip forwarding
switch(config-if)# mpls static configuration
switch(config-mpls-static)# address-family ipv6 unicast
switch(config-mpls-static-af)# local-label 3001 prefix 2000:1:255:201::1/128
switch(config-mpls-static-af-lbl)# next-hop 2000:1:31:1::1 out-label implicit-null
switch(config-mpls-static-af-lbl)# next-hop backup Po34 2000:1:34:1::1 out-label 3001

```

# Additional References

## Related Documents

Related Topic	Document Title
MPLS TCAM regions	Configuring IP ACLs section in the <i>Cisco Nexus 3000 Series NX-OS Security Configuration Guide</i> .

