Tree Segment Identifier (Tree-SID) Multicast Traffic Engineering

Tree-SID is a method of implementing tree-like multicast flows over a segmented routing network. Using Tree-SID, an SDN controller (a device running SR-PCE using PCEP), calculates the tree. Each node (device) in the tree has a specific role in routing the multicast data through the tree. These roles include Ingress for the root or headend node, Transit or Bud for midpoint nodes that are not leaf nodes, and Egress for destination leaf nodes. The tree itself is assigned a single SID label, which represents all of the tree segments and devices in it. The SDN controller is highly flexible, as it understands the segmentation and can construct routing paths using any kind of constraints that network architects can specify.

The most interesting use case for constraint-based Tree-SID use is where routers are configured to deliver two P2MP streams with the same content over different paths. Here, the multicast flow is forwarded twice through the network, each copy following a unique path. The two copies never use the same node or link to reach the destination, reducing packet loss due to network failures on any one of the paths.

For detailed information on Tree-SID, see the Segment Routing Tree-SID configuration documentation for your specific device (for example: Segment Routing Configuration Guide for Cisco NCS 540 Series Routers).

This section contains the following topics.

- Visualize Tree-SID Policies, on page 1
- View a Point-to-Multipoint Tree on the Topology Map, on page 2
- Create Static Tree-SID Policies, on page 6
- Modify a Tree-SID Policy, on page 9

Visualize Tree-SID Policies

Crosswork UI provides the ability to view details of the Tree-SID root, transit, leaf nodes and bud nodes in the UI and allows you to easily confirm that Tree-SID is implemented correctly in your network (see View a Point-to-Multipoint Tree on the Topology Map, on page 2).

The Tree-SID policy has the following nodes:

- Root node—Encapsulates the multicast traffic, replicates it, and forwards it to the transit nodes.
- Transit node—Acts as a leaf (egress) node as well as a mid-point (transit) node toward the downstream sub-tree.
- Leaf node—Decapsulates the multicast traffic and forward it to the multicast receivers.

- Bud Node—Has a separate leaf node path and is displayed separately in the topology map.

You can visualize the following Tree-SID policies:

- **Static:** A Static Tree-SID policy is configured via SR-PCE, either directly using SR-PCE CLI or from the Crosswork UI. You can refer to the Tree-SID configuration documentation for your specific device to find out more information and examples of the supported configuration commands. (for example: Segment Routing Configuration Guide for Cisco ASR 9000 Series Routers
- **Dynamic:** A Dynamic Tree-SID policy is not explicitly configured, it is configured as part of a L3VPN/ mVPN service.

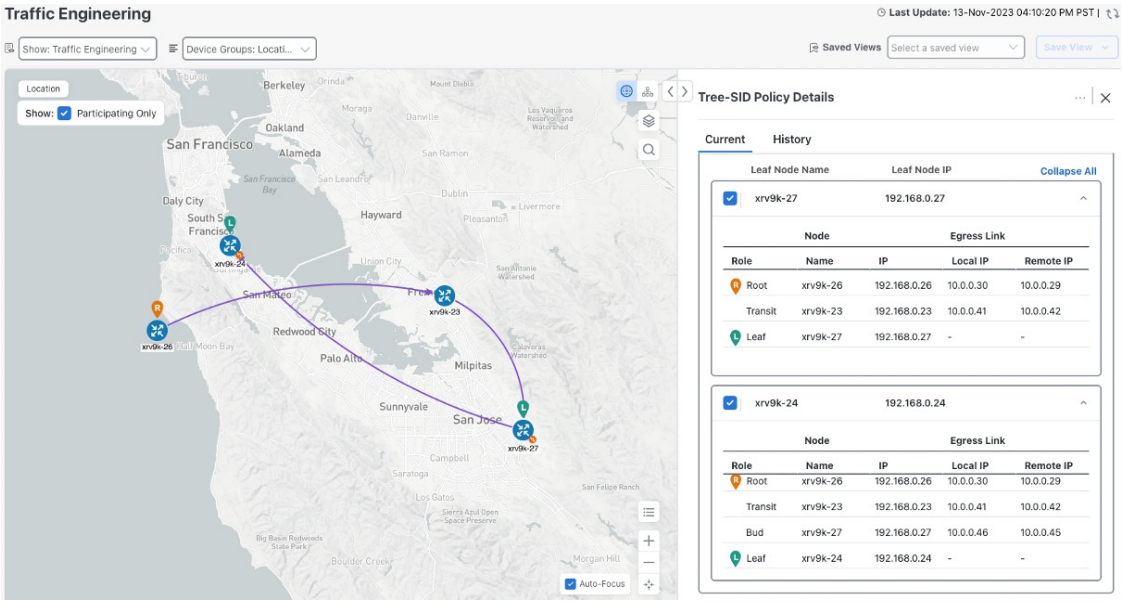
Note Static and Dynamic Tree-SID policies support fast reroute (FRR).

View a Point-to-Multipoint Tree on the Topology Map

Crosswork allows you to visualize Tree-SID policies configured in your network.

The following example shows a representation of a Tree-SID policy in the Crosswork topology map. The root node (R) and leaf nodes (L) are clearly marked, and the arrows denote the path through the transit nodes from the root to the leaf nodes.

You can drill down on the nodes and the links to see more details about the Tree-SID policy and validate the configuration.



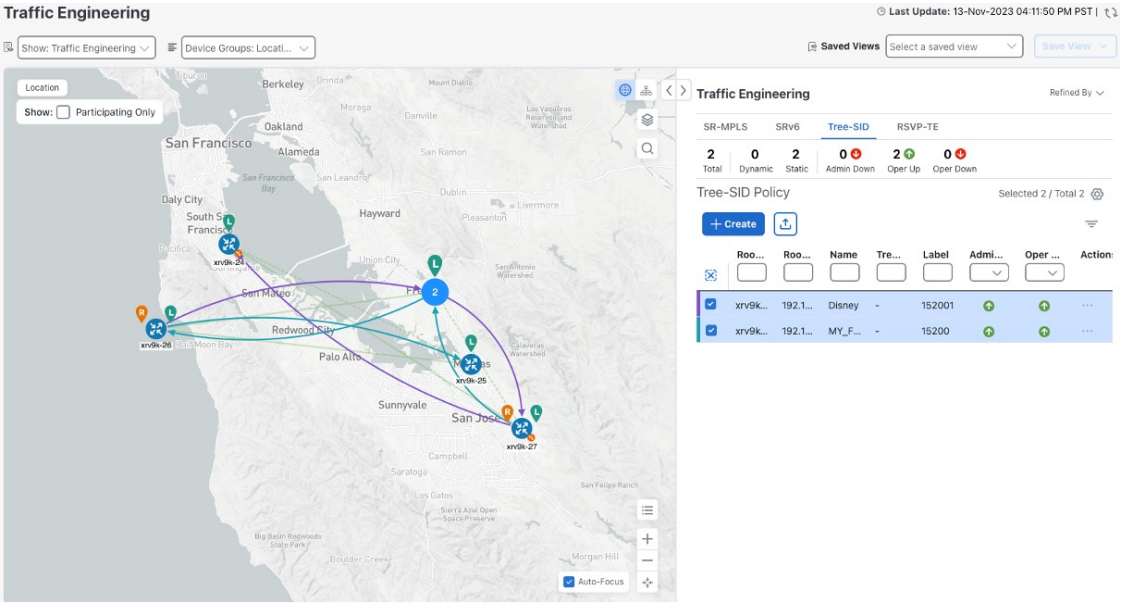
Before you begin

To visualize a multicast tree in the topology map, Tree-SID policies must be configured in your network. For more information, see the SR Tree-SID configuration documentation for your specific device (for example: Segment Routing Configuration Guide for Cisco NCS 540 Series Routers).

Step 1 From the main menu, select **Traffic Engineering** > **Traffic Engineering** > **Tree-SID** tab.

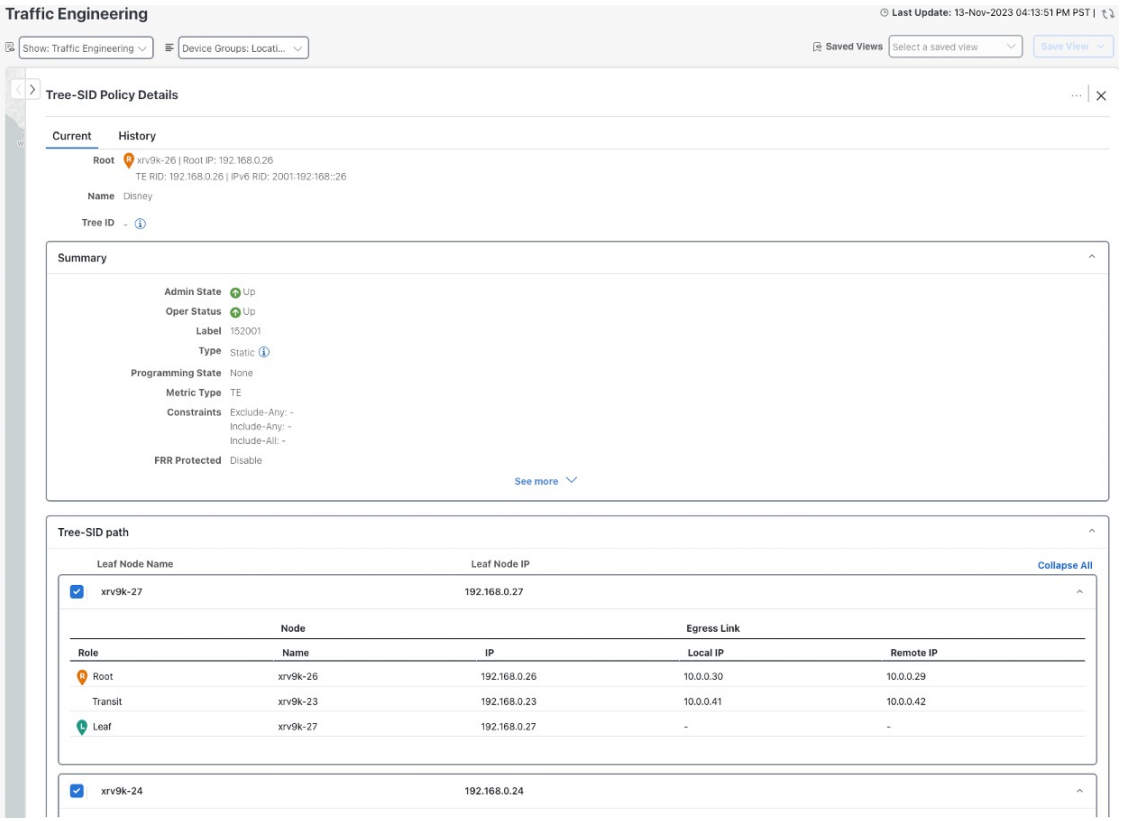
Step 2 Select the Tree-SID policies you want to view on the topology map.

Note You can view a maximum of two policies on the topology map at the same time.



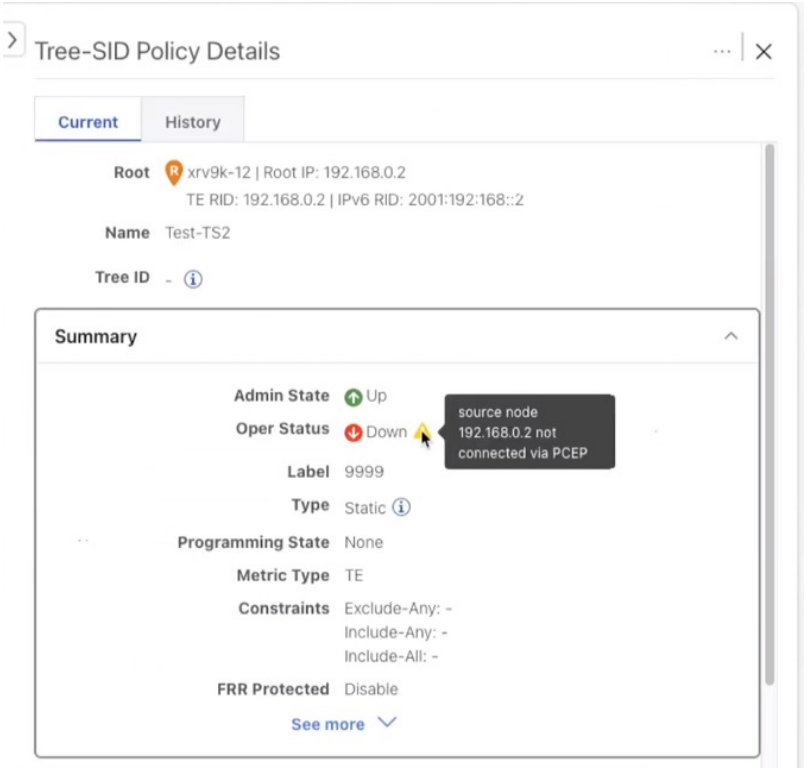
Note Any change in end-points is captured as an event in the historical data tab. For information on Tree-SID Historical Data see, View TE Event and Utilization History

Step 3 To view the Tree-SID Details, from the **Actions** column, click ... > **View Details** for one of the Tree-SID policies.

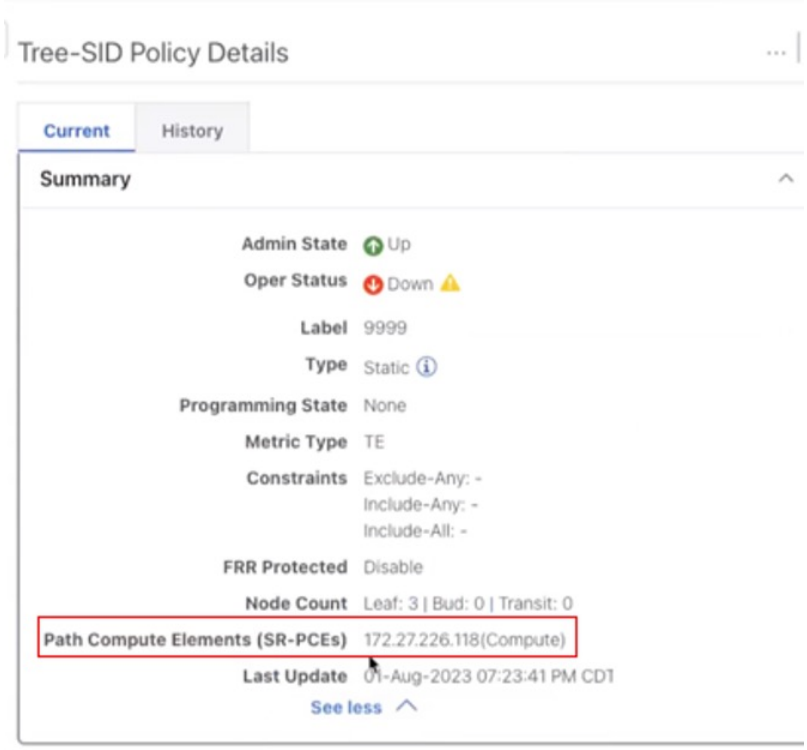


Step 4 You can view the Tree-SID details and verify the path and node details to ensure that Tree-SID is correctly configured.

Note When viewing Tree-SID Policy Details, if a Source Node is not available, a warning icon and message appear next to the Oper Status field (hover your mouse over the warning icon), detailing where the connection issue resides.



Note A (Compute) label, next to the SR-PCE field, details the SR-PCE used to create the policies.



Create Static Tree-SID Policies

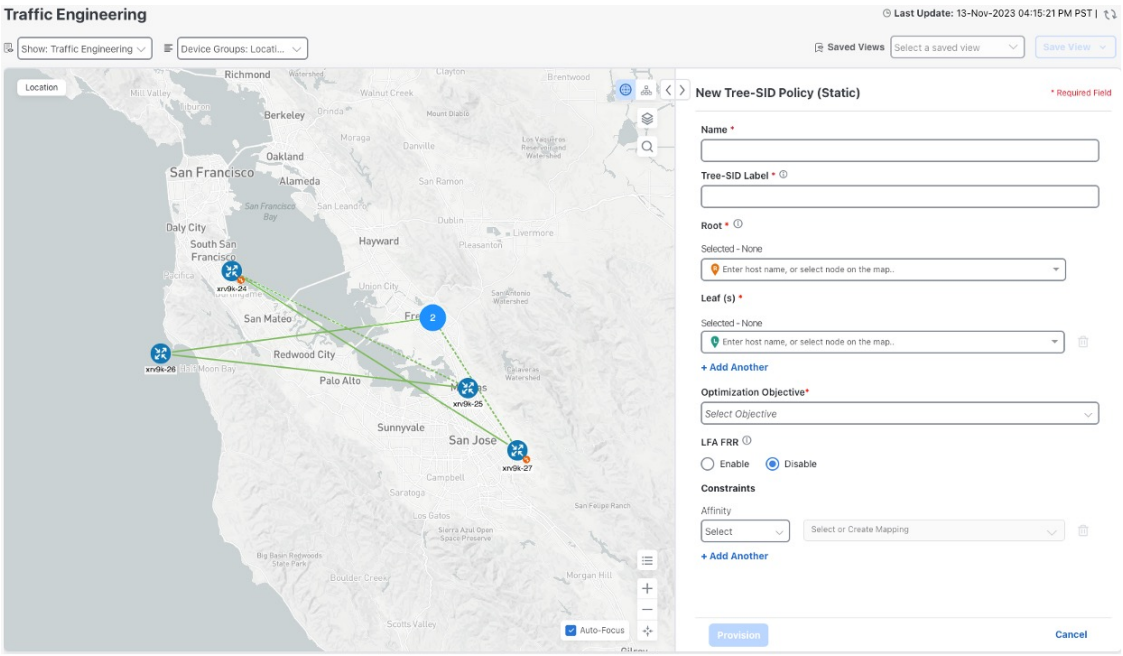
This task will explain how to create a static Tree-SID policy each representing a leaf or a root node.

Tip If you plan to use affinities, collect affinity information from your devices and then map them in Cisco Crosswork before creating a static Tree-SID policy. For more information, see Configure TE Link Affinities.

Step 1 From the main menu, choose **Traffic Engineering** > **Traffic Engineering** > **Tree-SID** tab and click **Create**.

Step 2 Enter or select the required Tree-SID policy values. Hover the mouse pointer over ⓘ to view a description of the field.

Note You can only add PCC nodes with a PCEP session to PCE as root nodes.



Step 3 Add leaf nodes that will be part of the Tree-SID policy.

Step 4 Under **Affinity**, define any applicable affinities. For more information on Affinities, see Configure TE Link Affinities

Step 5 To commit the policy, click **Provision**.

Step 6 Validate the Tree-SID policy creation:

a. Confirm that the new Tree-SID policy appears in the Tree-SID table. You can also click the check box next to the policy to see it highlighted in the map.

Note The newly provisioned Tree-SID policy may take some time to appear in the Tree-SID table, depending on the network size and performance. The **Tree-SID** table is refreshed every 30 seconds.

b. View and confirm the new Tree-SID policy details. From the topology map click **Tree-SID**, click ⋯ and select **View**.

Static Tree-SID Policy Configuration Example through Crosswork UI

The output below shows the static Tree-SID policy, configured from Crosswork UI, on the compute SR-PCE.

```
RP/0/RP0/CPU0:cw-xrv56#sh pce lsp p2mp


Tree: 50-52-54, Root: 3.3.3.50
 PCC: 3.3.3.50
 Label:   505254
 Operational: up  Admin: up  Compute: Yes
 Local LFA FRR: Disabled
 Metric Type: IGP
 Transition count: 1
 Uptime: 00:01:45 (since Thu Apr 27 10:54:49 PDT 2023)
 Destinations: 3.3.3.52, 3.3.3.54
```

```
 Nodes:
  Node[0]: 3.3.3.50 (cw-xrv50)
   Delegation: PCC
   PLSP-ID: 205
   Role: Ingress
   Hops:
    Incoming: 505254 CC-ID: 1
    Outgoing: 505254 CC-ID: 1 (11.1.28.54) [cw-xrv54]
    Outgoing: 505254 CC-ID: 1 (11.1.1.51) [cw-xrv51]
  Node[1]: 3.3.3.54 (cw-xrv54)
   Delegation: PCC
   PLSP-ID: 148
   Role: Egress
   Hops:
    Incoming: 505254 CC-ID: 2
  Node[2]: 3.3.3.51 (cw-xrv51)
   Delegation: PCC
   PLSP-ID: 187
   Role: Transit
   Hops:
    Incoming: 505254 CC-ID: 3
    Outgoing: 505254 CC-ID: 3 (11.1.2.52) [cw-xrv52]
  Node[3]: 3.3.3.52 (cw-xrv52)
   Delegation: PCC
   PLSP-ID: 247
   Role: Egress
   Hops:
    Incoming: 505254 CC-ID: 4
```

The output below shows the same static Tree-SID policy on the High Availability (HA) peer SR-PCE.

```
RP/0/RP0/CPU0:cw-xrv63#sh pce lsp p2mp

Tree: 50-52-54, Root: 3.3.3.50
 PCC: 3.3.3.50
 Label:   505254
 Operational: standby  Admin: up  Compute: No
 Local LFA FRR: Disabled
 Metric Type: IGP
 Transition count: 0
 Destinations: 3.3.3.52, 3.3.3.54
 Nodes:
  Node[0]: 3.3.3.54 (cw-xrv54)
   Delegation: PCE (3.3.3.56)
   PLSP-ID: 148
   Role: Egress
   Hops:
    Incoming: 505254 CC-ID: 2
  Node[1]: 3.3.3.52 (cw-xrv52)
   Delegation: PCE (3.3.3.56)
   PLSP-ID: 247
   Role: Egress
   Hops:
    Incoming: 505254 CC-ID: 4
  Node[2]: 3.3.3.51 (cw-xrv51)
   Delegation: PCE (3.3.3.56)
   PLSP-ID: 187
   Role: Transit
   Hops:
    Incoming: 505254 CC-ID: 3
    Outgoing: 505254 CC-ID: 3 (11.1.2.52)
  Node[3]: 3.3.3.50 (cw-xrv50)
   Delegation: PCE (3.3.3.56)
   PLSP-ID: 205
```

```
Role: Ingress
Hops:
 Incoming: 505254 CC-ID: 1
 Outgoing: 505254 CC-ID: 1 (11.1.28.54)
 Outgoing: 505254 CC-ID: 1 (11.1.1.51)
```

Modify a Tree-SID Policy

To modify a Tree-SID policy, do the following:

Note You cannot modify the name, label and root of a Tree-SID policy.

Step 1 From the main menu, choose **Traffic Engineering** > **Traffic Engineering**.

Step 2 From the **Traffic Engineering** window, click the **Tree-SID** tab.

Step 3 Locate the Tree-SID policy you are interested in and click ⋯.

Step 4 Choose **Edit**.

Note
- You can only modify or delete a static Tree-SID policy that is created using the Crosswork UI or API as opposed to one created using SR-PCE CLI
- After updating the Tree-SID policy details, you can preview the changes on the map before saving it.

Tree-SID Important Notes

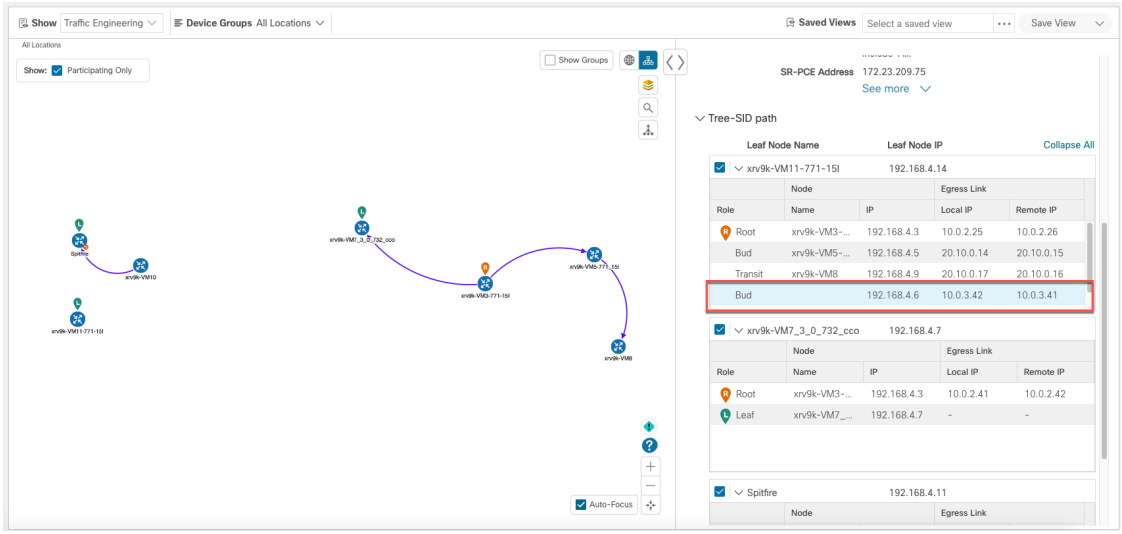
Limitation

- Tree-SID policies are only supported on devices running Cisco IOS XR software.
- PCE high-availability (HA) is supported for static Tree-SID policies configured via the Cisco Crosswork UI, but not supported if configured directly on the SR-PCE CLI.
- Tree-SID policy details based on SRv6 are not supported.
- If a single instance of SR-PCE is used, and the SR-PCE restarts, all static Tree-SID policies that were configured from the Crosswork UI are deleted.
- IPV4 unnumbered interfaces are not supported.

Visualization of Tree-SID Paths with Missing Nodes

Missing Tree-SID nodes can cause the following to happen:

A node on a Tree-SID policy path may not be available in the Crosswork topology information for various reasons. For example, the node is not added to the Crosswork device inventory. This affects how the Tree-SID policy path is displayed on the topology map. The unavailable node will cause one or more root-to-leaf paths to look broken on the map, as shown in the figure below. However, the path details in the right panel will still show the full path.


Show
Traffic Engineering
Device Groups
All Locations
Saved Views
Select a saved view
Save View
Show:
Participating Only
Show Groups
SR-PCE Address
172.23.209.75
See more
Tree-SID path
Leaf Node Name
Leaf Node IP
Collapse All
xrv9k-VM11-771-15I
192.168.4.14
Node
Egress Link
Role
Name
IP
Local IP
Remote IP
Root
xrv9k-VM3-...
192.168.4.3
10.0.2.25
10.0.2.26
Bud
xrv9k-VM5-...
192.168.4.5
20.10.0.14
20.10.0.15
Transit
xrv9k-VM8
192.168.4.9
20.10.0.17
20.10.0.16
Bud
192.168.4.6
10.0.3.42
10.0.3.41
xrv9k-VM7_3_0_732_cco
192.168.4.7
Root
xrv9k-VM3-...
192.168.4.3
10.0.2.41
10.0.2.42
Leaf
xrv9k-VM7_...
192.168.4.7
Spitfire
192.168.4.11
Auto-Focus