IP SLAs

This chapter contains the following sections:

About ACI IP SLAs

Many companies conduct most of their business online and any loss of service can affect their profitability. Internet service providers (ISPs) and even internal IT departments now offer a defined level of service, a service level agreement (SLA), to provide their customers with a degree of predictability.

IP SLA tracking is a common requirement in networks. IP SLA tracking allows a network administrator to collect information about network performance in real time. With the Cisco ACI IP SLA, you can track an IP address using ICMP and TCP probes. Tracking configurations can influence route tables, allowing for routes to be removed when tracking results come in negative and returning the route to the table when the results become positive again.

ACI IP SLAs are available for the following:

- Static routes:
  - New in ACI 4.1
  - Automatically remove or add a static route from/to a route table
  - Track the route using ICMP and TCP probes
- Policy-based redirect (PBR) tracking:
  - Available since ACI 3.1
  - Automatically remove or add a next -hop
  - Track the next-hop IP address using ICMP and TCP probes, or a combination using L2Ping
  - Redirect traffic to the PBR node based on the reachability of the next-hop

For more information about PBR tracking, see Configuring Policy-Based Redirect in the *Cisco APIC Layer 4 to Layer 7 Services Deployment Guide*.

Note For either feature, you can perform a network action based on the results of the probes, including configuration, using APIs, or running scripts.

ACI IP SLA Supported Topologies

The following ACI fabric topologies support IP SLA:

- **Single Fabric:** IP SLA tracking is supported for IP address reachable through both L3out and EPG/BD
- **Multi-Pod**
  - You can define a single object tracking policy across different Pods.
  - A workload can move from one Pod to another. The IP SLA policy continues to check accessibility information and detects if an endpoint has moved.
  - If an endpoint moves to another Pod, IP SLA tracking is moved to the other Pod as well, so that tracking information is not passed through the IP network.
- **Remote Leaf**
  - You can define single object tracking policies across ACI main data center and the remote leaf switch.
  - IP SLA probes on remote leaf switches track IP addresses locally without using the IP network.
  - A workload can move from one local leaf to a remote leaf. The IP SLA policy continues to check accessibility information and detects if an endpoint has moved.
  - IP SLA policies move to the remote leaf switches or ACI main data center, based on the endpoint location, for local tracking, so that tracking traffic is not passed through the IP network.

Cisco ACI IP SLA Operation

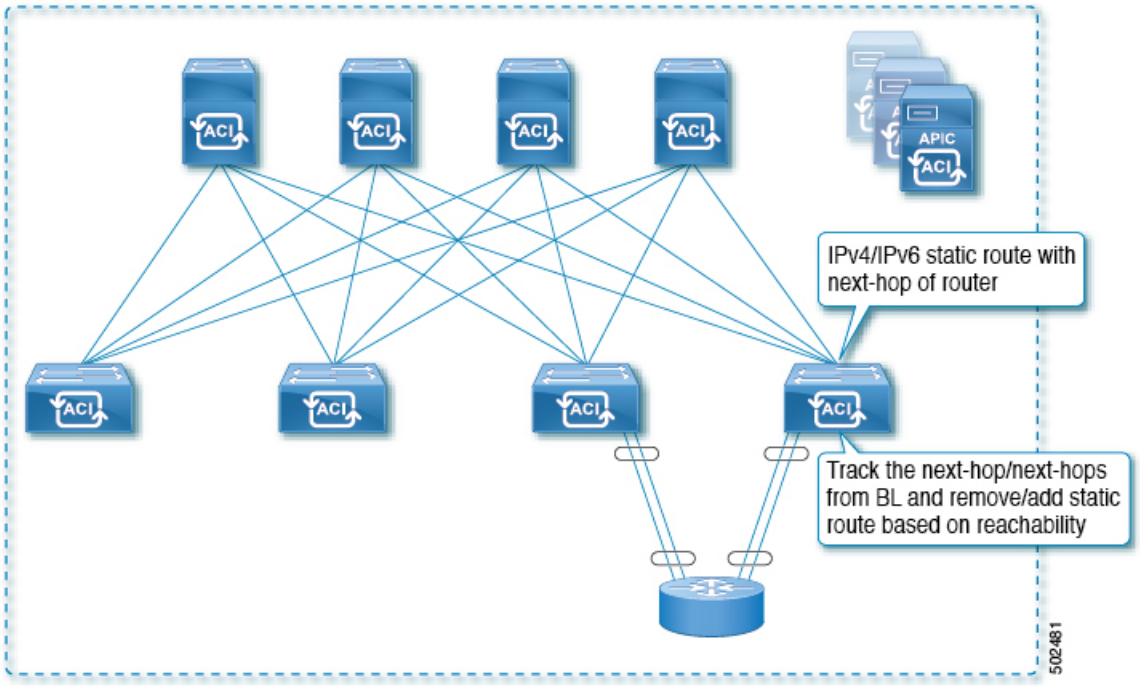
A Cisco ACI IP SLA provides monitoring capabilities on the ACI fabric allowing the SLA probing to occur across the data center network and out to the external network. This is accomplished by configuring an IP SLA monitoring policy which defines the probe type used during monitoring. The monitoring policy is then associated with monitoring probe profiles known as "track members". Once configured, track members define an endpoint or next-hop by IP address, the associated monitoring policy, and the scope (bridge domain or L3Out). One or more track members can be assigned to a "track list". Track lists configure thresholds that, if exceeded, determine if a track list is available (up) or unavailable (down).

The following four examples show the supported use cases for ACI IP SLAs in static routes.

Example 1: Static Route Availability by Tracking the Next-Hop

The following figure shows the network topology and the operation for tracking the static route availability of a router.

Figure 1: Static Route Availability by Tracking the Next-Hop



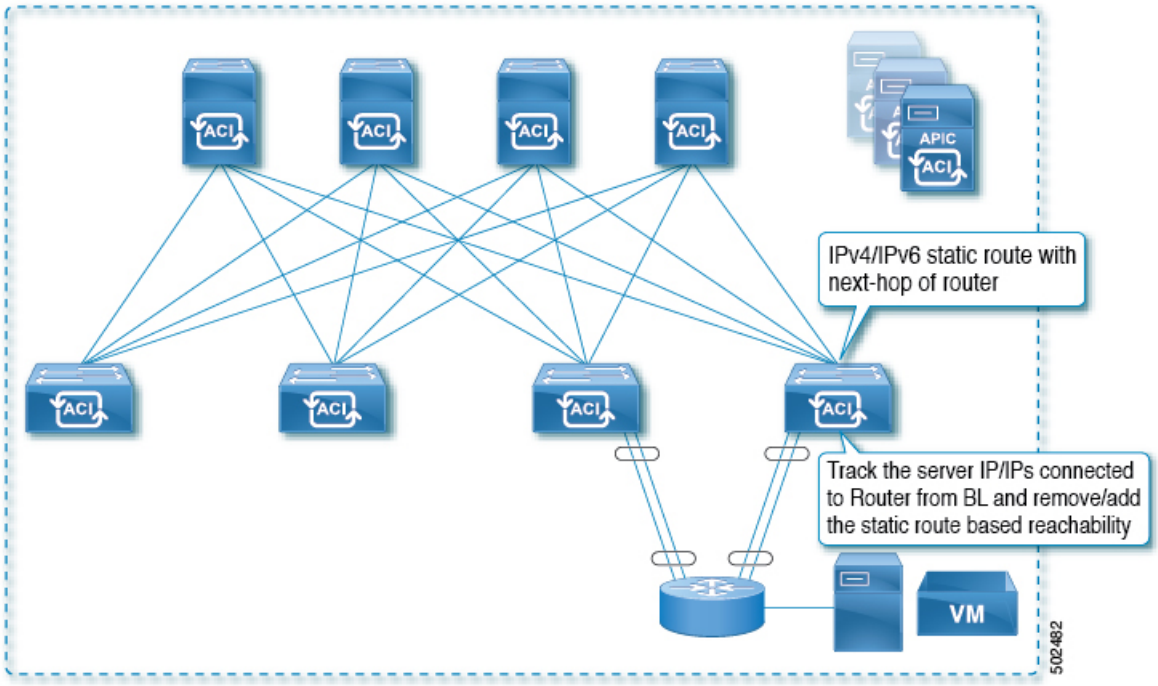
For this use case:

- The next-hop can be direct or indirect meaning that the next-hop can be a loopback IP address of the router.
- The next-hop can be accessed through a physical interface, sub-interface, port channel (PC), PC sub-interface, vPC, or switch virtual interface (SVI).
- The static route is configured under the L3out external network and can be removed or added from/to the route table based on the accessibility of the next-hop .

Example 2: Static Route Availability by Tracking an IP Address Through L3Out

The following figure shows the network topology and the operation for tracking the static route availability of a server through an L3Out external route.

Figure 2: Static Route Availability by Tracking an IP Address Through L3Out



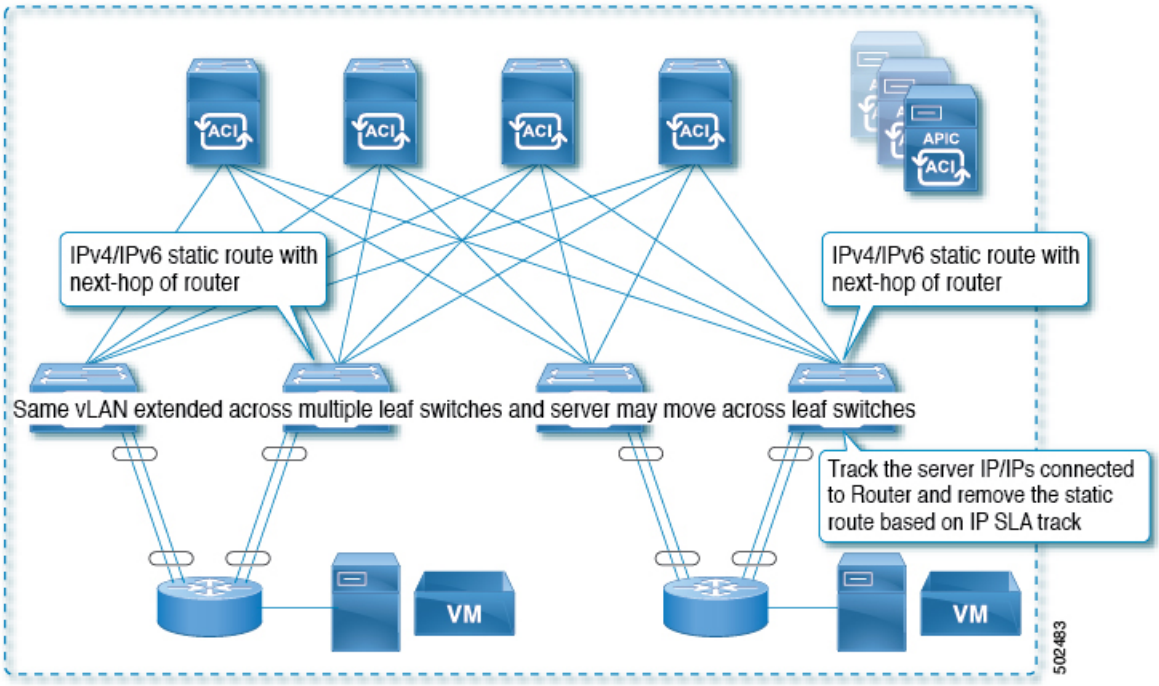
For this use case:

- Track the server IP address connected to the router from the ACI fabric (border leaf) and remove or add the static route based on accessibility of the server.
- The L3Out can be through a port channel (PC), PC sub-interface, vPC, switch virtual interface (SVI), L3 interface, or an L3 sub-interface.
- The static route is configured under L3Out and is removed or added based on the accessibility of the IP address.

Example 3: Static Route Removal by Tracking an IP Address Through L3Out

The following figure shows the network topology and the operation for tracking the static route availability of a server through an L3Out external route. The route is removed if it is not accessible through the L3Out/VRF.

Figure 3: Static Route Removal by Tracking an IP Address Through L3Out



For this use case:

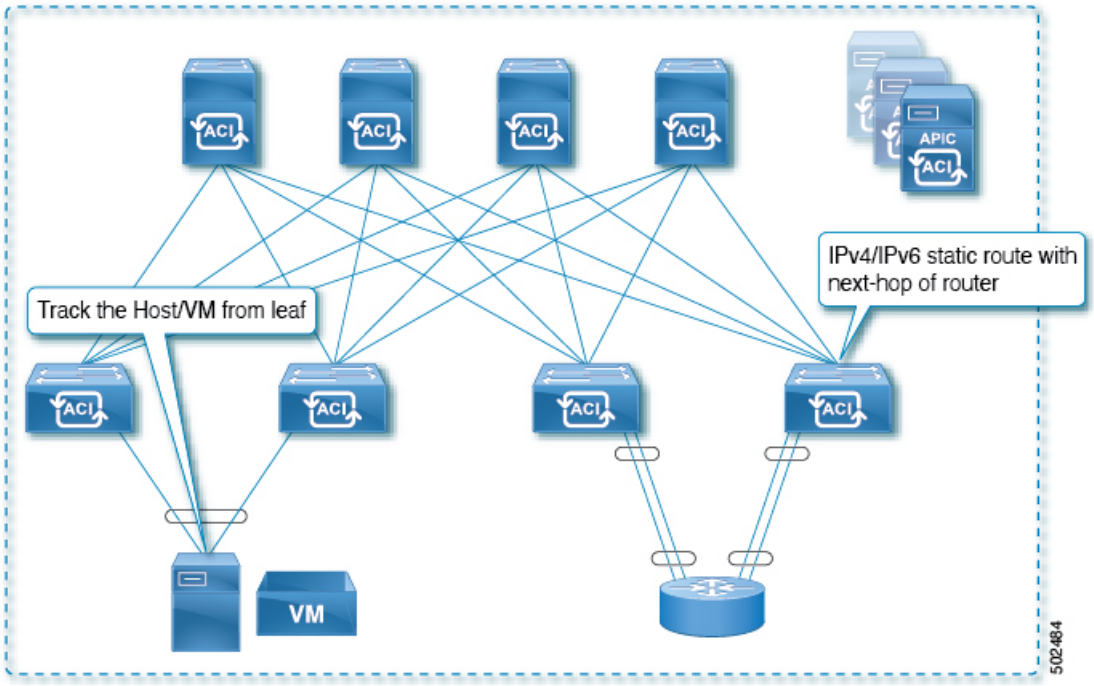
- The L3Out is configured over VLAN/SVI, and that SVI is extended across multiple leaves.
- The server IP address that is accessible through the L3Out can move across leaves.
- Track the server IP address(es) and if they are not accessible through the L3Out/VRF, then remove the static route from the route table.
- The static route is added back to the route table when server is accessible again.

Example 4: Static Route Removal by Tracking an IP Address in the ACI Fabric

Although, as shown in the previous examples, the probe IP of IP SLA for routes is typically the next-hop of the route or an external IP address that should be reachable via the route, you can also use an endpoint IP address in the ACI BD as the probe IP, even if the endpoint does not reside behind the route targeted by the IP SLA. This might be helpful when the static route is to be used solely by certain specific endpoints inside ACI. If such endpoints don’t exist, there is no use for the route.

The following figure shows the network topology and the operation for tracking an IP address in the ACI fabric.

Figure 4: Static Route Availability by Tracking an IP Address in the ACI Fabric



For this use case:

- Track the IP reachability of the endpoints that are connected through the EPG/BD.
- Based on the accessibility of the endpoints, the static route will be removed or added in the L3Out.
- Even if the endpoint moves from one location to another within the fabric, as long as there is the IP reachability to the endpoint from the same BD, IP SLA monitoring considers it accessible and there will be no impact to the validity of the static route.

IP SLA Monitoring Policy

IP Service Level Agreements (SLAs) use active traffic monitoring to generate traffic in a continuous, reliable, and predictable manner, and analyze it to measure the network performance. Measurement statistics that are provided by the IP SLA monitoring policy operations can be used for troubleshooting, problem analysis, and designing network topologies.

With Cisco ACI, the IP SLA monitoring policy is associated with:

- Service Redirect Policies: All the destinations under a service redirect policy are monitored based on the configurations and parameters that are set in the monitoring policy.
- Static Routes: Adding an IP SLA monitoring policy to a track list or track member and associated it with a static route provides the mechanism for monitoring the availability of the next hop segments of the route.

An IP SLA monitoring policy identifies the probe frequency and the type of probe.

ACI IP SLA Monitoring Operation Probe Types

Using ACI IP SLAs, you can monitor the performance between any area in the network: core, distribution, and edge. Monitoring can be done anytime, anywhere, without deploying a physical probe. ACI IP SLAs use generated traffic to measure network performance between two networking devices such as switches. The types of IP SLA operations include:

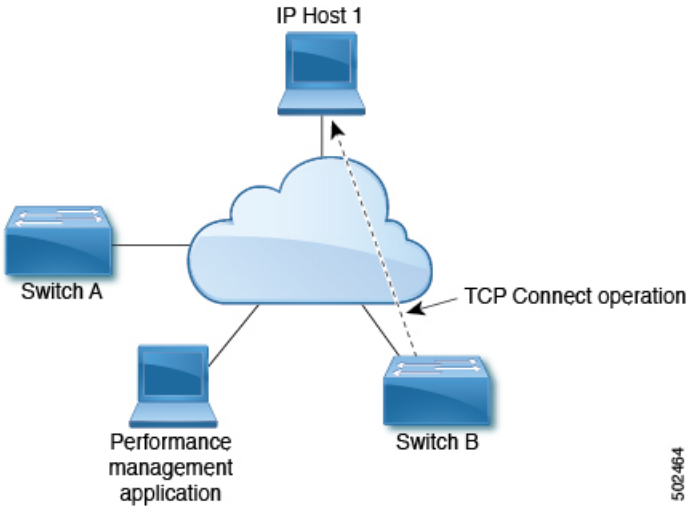
- ICMP: Echo Probes
- TCP: Connect Probes

TCP Connect Operation

The IP SLAs TCP connect operation measures the response time that is taken to perform a TCP probe between a Cisco switch and an IP device. TCP is a transport layer (Layer 4) Internet Protocol that provides reliable full-duplex data transmission. The destination device can be any device using IP.

In the following figure, Switch B is configured as the source IP SLA device based on the configured static route. A TCP connect operation is configured in the IP SLA monitoring policy (associated with the static route) with the destination device as IP Host 1.

Figure 5: TCP Connection Operation Example



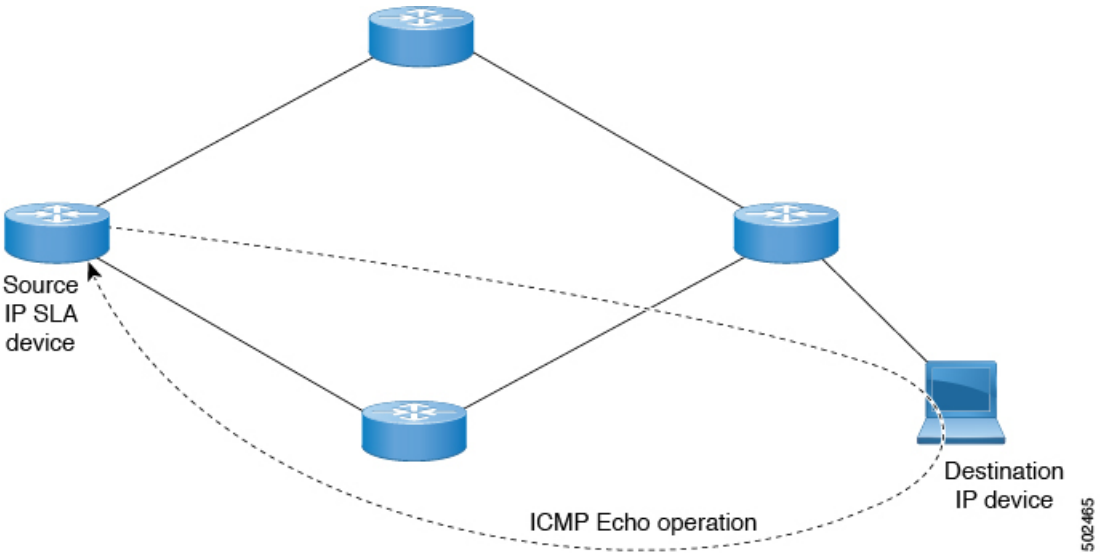
The connection response time is computed by measuring the time that is taken between sending a TCP request message from Switch B to IP Host 1 and receiving a reply from IP Host 1.

ICMP Echo Operation

The Internet Control Message Protocol (ICMP) Echo operation measures the end-to-end response time between two devices that use IPv4 or IPv6. The response time is computed by measuring the time that is taken between sending an ICMP Echo request message to the destination and receiving a reply. An ICMP Echo is useful for troubleshooting network connectivity issues. The results of the ICMP Echo operation can be displayed and analyzed to determine how the network IP connections are performing.

In the following figure, the ICMP Echo operation uses a ping-based probe to measure the response time between the source IP SLAs device and the destination IP device. Many customers use IP SLA ICMP-based operations, in-house ping testing, or ping-based dedicated probes for response time measurements.

Figure 6: ICMP Echo Operation Example



The IP SLA ICMP Echo operation conforms to the same IETF specifications for ICMP ping testing and the two methods result in the same response times.

IP SLA Track Members

An IP SLA track member identifies the:

- IP address to be tracked
- IP SLA monitoring policy (probe frequency and type)
- Scope (bridge domain or L3Out)

IP SLA Track Lists

An IP SLA track list aggregates one or more IP SLA track members representing a network segment to be monitored. The track list determines what percentage or weight of track members must be up or down for the static route to be considered available or unavailable. If the track list is up, based on the threshold percentage or weight, then the static route remains in routing table. If the track list is down, then the static route is removed from the routing table until the track list recovers.

The following is an example of configuring four track members in a track list using the threshold percentage option.

Threshold configuration:

- Set the Percentage Up parameter to 100 (percent)
- Set the Percentage Down parameter to 50 (percent)

In this track list, each of the four track members is assigned 25%. For the track list to become unreachable (down), two of the four track members must be unreachable (50%). For the track list to return to reachable (up), all four track members must be reachable (100%).

Note When a track list is associated with a static route and the track list becomes unreachable (down), the static route is removed from the routing table until the track list becomes reachable again.

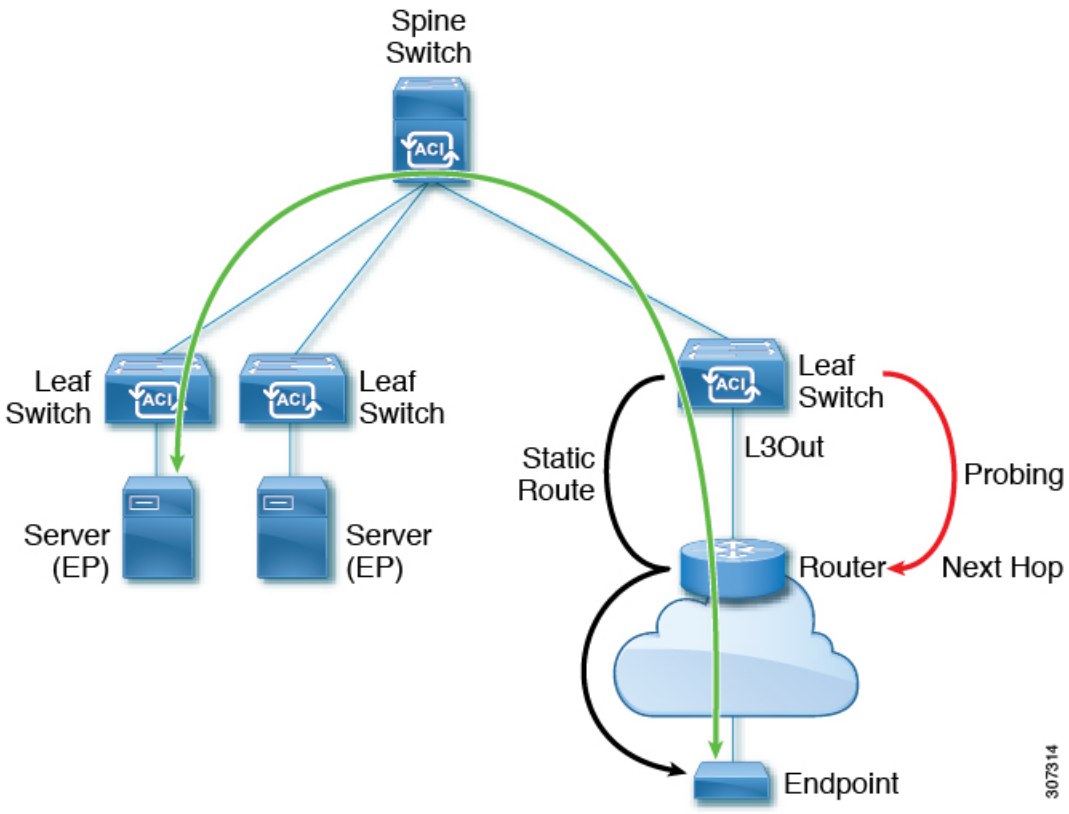
Example IP SLA Configuration Component Associations

ACI IP SLAs rely on track members and track lists to identify the types of probes to send and where to send them. Planning the configuration will help make the task easy and fast. This section uses an example to explain how to set up the IP SLA.

Cisco ACI IP SLA L3Out Example

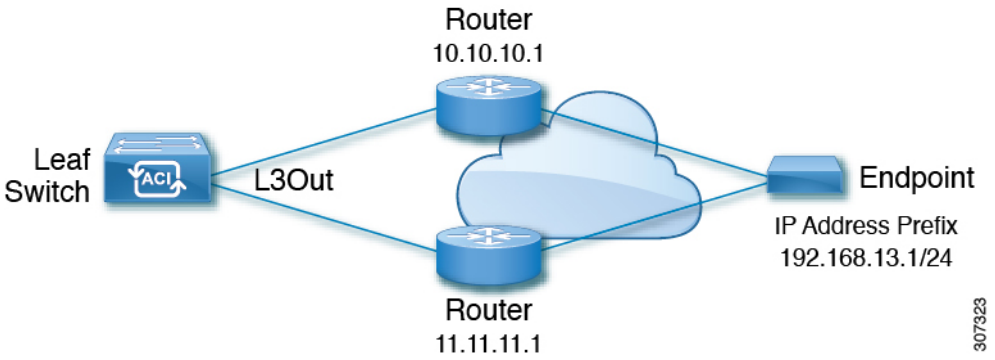
The following figure shows a Cisco ACI IP SLA providing monitoring/probing of a specific configured static route within the ACI fabric and including an external endpoint.

Figure 7: Example ACI L3Out IP SLA



The following image shows a static route for the endpoint prefix of 192.168.13.1/24. It also shows a pair of routers in a static route between an L3Out leaf switch and a consumer endpoint.

Figure 8: Example Static Route



To configure an ACI IP SLA based on the figure above, the router must be monitored to ensure connectivity to the consumer endpoint. This is accomplished by creating a static route, track members, and track lists:

- Static route for 192.168.13.1/24 with next hops of 10.10.10.1 and 11.11.11.1
- Track Member 1 (TM-1) includes the router IP address 10.10.10.1 (this is the next hop probe)
- Track Member 2 (TM-2) includes the router IP address 11.11.11.1 (this is the next hop probe)
- Track List 1 (TL-1) with TM-1 and TM-2 included (track list associated with a static route. The track list contains list of next hops through which configured prefix end points can be reached. Thresholds determining if the track list is reachable or unreachable are also configured.)
- Track List 2 (TL-2) with TM-1 included (associated with a next hop entry included in a static route)
- Track List 3 (TL-3) with TM-2 included (associated with a next hop entry included in a static route)

For a generic static route, you can associate TL-1 with the static route, associate TL-2 with the 10.10.10.1 next hop, and associate TL-3 with the 11.11.11.1 next hop. For a pair of specific static routes (both 192.168.13.1/24), you can associate TL-2 on one and TL-3 on the other. Both should also have TL-2 and TL-3 associated with the router next hops.

These options allow for one router to fail while providing a back-up route in case of the failure. See the following sections to learn more about track members and track lists.

Guidelines and Limitations for IP SLA

Consider the following guidelines and limitations when planning and configuring IP Service Level Agreements:

- IP SLA supports both IPv4 and IPv6 addresses
- IP SLA is supported in all Cisco Nexus second generation switches, which includes the -EX and -FX chassis.
- Beginning in Cisco Application Policy Infrastructure Controller (APIC) release 4.1(1), the IP SLA monitor policy validates the IP SLA port value. Because of the validation, when TCP is configured as the IP SLA type, Cisco APIC no longer accepts an IP SLA port value of 0, which was allowed in previous releases. An IP SLA monitor policy from a previous release that has an IP SLA port value of 0 becomes invalid if the Cisco APIC is upgraded to release 4.1(1) or later. This results in a failure for the configuration import or snapshot rollback.

The workaround is to configure a non-zero IP SLA port value before upgrading the Cisco APIC, and use the snapshot and configuration export that was taken after the IP SLA port change.

- You must enable global GIPo if you are supporting remote leaf switches in an IP SLA:
  1. On the menu bar, click **System** > **System Settings**.
  2. In the System Settings navigation pane, click **System Global GIPo**.
  3. In the System Global GIPo Policy work pane, click **Enabled**.
  4. In the Policy Usage Warning dialog, review the nodes and policies that may be using the GIPo policy and, if appropriate, click **Submit Changes**.
- Statistics viewed through Fabric > Inventory > Pod *number* > Leaf Node *name* > Protocols > IP SLA > ICMP Echo Operations or TCP Connect Operations can only be gathered in five minute intervals. The interval default is **15 Minute**, but this must be set to **5 Minute**.
- IP SLA policy is not supported for endpoints connected through vPod.
- IP SLA is supported for single pods, Cisco ACI Multi-Pod, and remote leaf switches.
- IP SLA is not supported when the destination IP address to be tracked is connected across Cisco ACI Multi-Site.
- If a border leaf switch has a static route that is redistributed in MP-BGP (Multiprotocol Border Gateway Protocol) for the VRF, the MP-BGP route has the same administrative distance as the static route as shown below:

```
leaf102# show ip route 10.10.10.10/32 vrf test:VRF-1
IP Route Table for VRF "test:VRF-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

10.10.10.10/32, ubest/mbest: 1/0
*via 102.0.0.2, vlan45, [1/0], 01w00d, static
```

  This route will be injected into the fabric MP-BGP routes for the VRF and are discovered by other remote leaf switches as an iBGP route as shown below:

```
leaf103# show ip route 10.10.10.10/32 vrf test:VRF-1
IP Route Table for VRF "test:VRF-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

10.10.10.10/32, ubest/mbest: 1/0
*via 10.0.200.64%overlay-1, [1/0], 01w00d, bgp-65310, internal, tag 65310
recursive next hop: 10.0.200.64/32%overlay-1
```

  However, the adminstrative distance of iBGP route is the same as the adminstrative distance of the static route instead of the adminstrative distance of iBGP AD.

  This observed in both APIC release 4.1(1) and APIC release 5.0(1).

For information on verified IP SLA numbers, refer to the appropriate *Verified Scalability Guide for Cisco APIC* on the Cisco APIC documentation page.

Configuring and Associating ACI IP SLAs for Static Routes

This section describes the tasks that are required to configure and associate the following IP SLA policies and profiles:

- IP SLA Monitoring Policies
- IP SLA Track Members
- IP SLA Track Lists

The previous components are applied to either static routes or next hop profiles.

Configuring an IP SLA Monitoring Policy Using the GUI

To enable Cisco Application Policy Infrastructure Controller (APIC) to send monitoring probes for a specific SLA type using the Cisco APIC GUI, perform the following steps:

Procedure

Step 1 On the menu bar, click **Tenant** > **tenant_name**. In the navigation pane, click **Policies** > **Protocol** > **IP SLA**.

Step 2 Right-click **IP SLA Monitoring Policies**, and click **Create IP SLA Monitoring Policy**.

Step 3 In the **Create IP SLA Monitoring Policy** dialog box, perform the following actions:

a) In the **Name** field, enter a unique name for the IP SLA Monitoring policy.

b) In the **SLA Frequency** field, enter a value, in seconds, to determine the configured frequency to track a packet.

The range is from 1 to 300. The default value is 60.

c) In the **Detect Multiplier** field, enter a value for the number of missed probes in a row that shows that a failure is detected or a track is down.

By default, failures are detected when three probes are missed in a row. Changing the value in the **Detect Multiplier** field changes the number of missed probes in a row that will determine when failures are detected or when a track is considered to be down.

Used in conjunction with the entry in the **SLA Frequency**, you can determine when a failure will be detected. For example, assume you have the following entries in these fields:

- **SLA Frequency (sec)**: 5
- **Detect Multiplier**: 30

A failure would be detected in roughly 150 seconds in this example scenario (5 seconds x 30).

d) In the **SLA Type** field, choose the SLA type.

The SLA type can be **TCP**, **ICMP**, or **L2Ping**. **ICMP** is the default value.

Note **L2Ping** is supported only for Layer 1/Layer 2 policy-based redirect (PBR) tracking.

e) If you chose **TCP**, enter a port number in the **Destination Port** field.

f) Click **Submit**.

The IP SLA monitoring policy is configured.

Configuring IP-SLA Track Members Using the GUI

Use this task to create an IP SLA track member which is one of a number added to an IP SLA track list. Track lists are applied to static routes to monitor performance from one defined next hop to another.

Before you begin

You must have created an IP SLA monitoring policy and know the destination IP address for the next hop this track member represents in a static route.

To configure an IP SLA track member using the APIC GUI, perform the following steps:

Procedure

Step 1 On the menu bar, click **Tenants** > ***tenant-name***.

Step 2 In the Navigation pane, expand **Policies** and then expand **Protocol**.

Step 3 Expand **IP SLA**, right-click **Track Members** and choose **Create Track Member**.

Step 4 Configure the following parameters:

a) In the **Name** field, enter a unique name for the track member.
b) In the **Destination IP** field, enter the IP address of the next hop this configuration represents.
c) In the **Scope of Track Member** drop-down list, choose an existing bridge domain or external network to which this track member belongs.
d) In the **IP SLA Policy** field, select an existing or create a new IP SLA monitoring policy that defines the probe that is used during monitoring.

Step 5 Click **Submit**.

What to do next

Repeat the preceding steps to create the required number of track members for the static route to be monitored. Once all track members are configured, create a track list and add them to it.

Configuring an IP-SLA Track List Using the GUI

Use this task to create an IP SLA track list which defines a group of track members representing the next hops in a static route. Track lists are applied to static routes to monitor performance from one defined next hop to another.

Before you begin

You must have created one or more IP SLA track members.

To configure an IP SLA track list using the APIC GUI, perform the following steps:

Procedure

Step 1 On the menu bar, click **Tenants** > ***tenant-name***.

Step 2 In the Navigation pane, expand **Policies** and then expand **Protocol**.

Step 3 Expand **IP SLA**, right-click **Track Lists** and choose **Create Track List**.

The **Create Track List** dialog appears.

Step 4 Configure the following parameters:

a) In the **Name** field, enter a unique name for the track list.

b) In the **Type of Track List** field, choose **Threshold percentage** if you want the route availability to be based on the percentage of track members that are up or down. Choose **Threshold weight** if the route availability is based on a weight value that is assigned to each track member.

c) In the **Track list to track member relation** table, click the + icon in the table head to add a track member to the list. Choose an existing track member and, if the **Type of Track List** is **Threshold weight**, assign a weight value.

Step 5 Click **Submit**.

What to do next

Associate the track list with a static route or next hop IP address.

Associating a Track List with a Static Route Using the GUI

Use this task to associate a track list with a configured static route allowing the system to monitor the performance of a series of next hops.

Note The following task assumes that a next hop configuration already exists for the static route.

Before you begin

A configured routed network with a static route must be available. A configured track list must also be available.

To associate an IP SLA track list with a static route using the APIC GUI, perform the following steps:

Procedure

Step 1 On the menu bar, click **Tenants** > ***tenant-name***.

Step 2 In the Navigation pane, expand **Networking** and then expand **L3Outs**.

Step 3 Expand the configured routed network (name), **Logical Node Profiles**, a configured logical node profile (name), and **Configured Nodes**.

Step 4 Click a configured node (name).

The **Node Association** work pane appears.

Step 5 In the **Static Routes** table, double-click the route entry to which you want to add the track list.

The **Static Route** dialog appears.

Step 6 In the **Track Policy** drop-down list, choose or create an IP SLA track list to associate with this static route.

Step 7 Click **Submit**.

Step 8 The **Policy Usage Warning** dialog appears.

Step 9 Verify that this change will not impact other nodes or policies using this static route and click **Submit Changes**.

Associating a Track List with a Next Hop Profile Using the GUI

Use this task to associate a track list with a configured next hop profile in a static route allowing the system to monitor the next hop performance.

Before you begin

A configured routed network with a static route and next hop profile must be available.

To associate an IP SLA track list with a next hop profile using the APIC GUI, perform the following steps:

Procedure

Step 1 On the menu bar, click **Tenants** > ***tenant-name***.

Step 2 In the Navigation pane, expand **Networking** and then expand **L3Outs**.

Step 3 Expand the configured routed network (name), **Logical Node Profiles**, a configured logical node profile (name), and **Configured Nodes**.

Step 4 Click a configured node (name).

The **Node Association** work pane appears.

Step 5 In the **Static Routes** table, double-click the route entry to which you want to add the track list.

The **Static Route** dialog appears.

Step 6 In the **Next Hop Addresses** table, double-click the next hop entry to which you want to add the track list.

The **Next Hop Profile** dialog appears.

Step 7 In the **Track Policy** drop-down list, choose or create an IP SLA track list to associate with this static route.

Note If you add an IP SLA Policy to the next hop profile, a track member and track list is automatically created and associated with the profile.

Step 8 Click **Submit**.

Step 9 The **Policy Usage Warning** dialog appears.

Step 10 Verify that this change will not impact other nodes or policies using this static route and click **Submit Changes**.

Viewing ACI IP SLA Monitoring Information

This section describes the tasks that are required to view IP SLA statistics, track lists, track members, and associated static routes:

- Viewing ACI IP SLA Probe Statistics Using the GUI
- Viewing Track List and Track Member Status Using the CLI

Viewing IP SLA Probe Statistics Using the GUI

ACI IP SLAs generate the following real-time statistics:

ICMP

- ICMP Echo Round Trip Time (milliseconds)
- Number of Failed ICMP Echo Probes (packets)
- Number of Successful ICMP Echo Probes (packets)
- Number of Transmitted ICMP Echo Probes (packets)

TCP

- Number of Failed TCP Connect Probes (packets)
- Number of Successful TCP Connect Probes (packets)
- Number of Transmitted TCP Connect Probes (packets)
- TCP Connect Round Trip Time (milliseconds)

Use this task to view statistics for an IP SLA track list or member currently monitoring a static route or next hop.

Before you begin

You must have created an IP SLA track list and associated it with a static route before viewing statistics.

Procedure

Step 1 On the menu bar, click **Tenants** > ***tenant-name***.

Step 2 In the Navigation section, expand **Policies** and then expand **Protocol**.

Step 3 Expand **IP SLA** and expand either **Track Members** or **Track Lists**.

Step 4 Click an existing track member or track list you want to view.

Step 5 Click the **Stats** tab.

Step 6 Click the **Select Stats** icon to choose the probe statistic types you want to view.

Step 7 Choose a probe statistic type (chosen statistic types are highlighted in blue) and move it from **Available** to **Selected** with the arrow icon. You can move a probe statistics type from **Selected** back to **Available** with the opposite arrow icon.

Step 8 When finished selecting the probe statistic type(s) you want to view, click **Submit**.

What to do next

The statistics chosen in this task are labeled in the legend above the graph. Lines representing the selected probe statistic types should begin to appear on the graph as the counters begin to accumulate.