JUNIPER NETWORKS

# Network Configuration Example

## Configuring the Accumulated IGP Attribute for BGP

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*Network Configuration Example Configuring the Accumulated IGP Attribute for BGP*
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## Introduction

This document provides information about configuring the accumulated IGP (AIGP) metric attribute for BGP in your network.

## Advantages of Using the Accumulated IGP Metric Attribute for BGP

The accumulated IGP (AIGP) metric attribute for BGP enables deployments in which a single administration can run several contiguous BGP autonomous systems (ASs). Such deployments allow BGP to make routing decisions based on the interior gateway protocol (IGP) metric. In such networks, it is possible for BGP to select paths based on metrics as is done by IGPs. In this case, BGP chooses the shortest path between two nodes, even though the nodes might be in two different ASs.

Using the AIGP metric attribute allows the network to use the shortest paths between the source and destination provider edge (PE) routers in the different autonomous systems that comprise the global network.

Using the AIGP attribute also has these advantages:

- It improves scaling when implementing interprovider Layer 3 VPN Option C as described in RFC 4364, *BGP/MPLS IP Virtual Private Networks (VPNs)*. Improved scaling allows service providers to offer more services without incurring additional cost.
- It allows BGP to use the IGP metric for path selection decisions when the autonomous systems are in the same administration domain, thus reducing the number of route advertisements, improving scaling, and improving path utilization.
- It enables the service provider's inter-AS network to appear to customers as a single network. This reduces administrative cost for the customer.
- It prevents the addition of a new PE router in a local autonomous system from having any global impact on a remote OSPF routing domain. This reduces administrative cost for the service provider and improves network stability.

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## Understanding the Accumulated IGP Attribute for BGP

The interior gateway protocols (IGPs) are designed to handle routing within a single domain or an autonomous system (AS). Each link is assigned a particular value called a metric. The distance between the two nodes is calculated as a sum of all the metric values of links along the path. The IGP selects the shortest path between two nodes based on distance.

BGP is designed to provide routing over a large number of independent ASs with limited or no coordination among respective administrations. BGP does not use metrics in the path selection decisions.

The accumulated IGP (AIGP) metric attribute for BGP enables deployment in which a single administration can run several contiguous BGP ASs. Such deployments allow BGP to make routing decisions based on the IGP metric. In such networks, it is possible for BGP to select paths based on metrics as is done by IGPs. In this case, BGP chooses the shortest path between two nodes, even though the nodes might be in two different ASs.

The AIGP attribute is particularly useful in networks that use tunneling to deliver a packet to its BGP next hop. The Juniper Networks® Junos® operating system (Junos OS) currently supports the AIGP attribute for two BGP address families, **family inet labeled-unicast** and **family inet6 labeled-unicast**.

AIGP impacts the BGP best-route decision process. The AIGP attribute preference rule is applied after the local-preference rule. The AIGP distance is compared to break a tie. The BGP best-route decision process also impacts the way the interior cost rule is applied if the resolving next hop has an AIGP attribute. Without AIGP enabled, the interior cost of a route is based on the calculation of the metric to the next hop for the route. With AIGP enabled, the resolving AIGP distance is added to the interior cost.

The AIGP attribute is an optional non-transitive BGP path attribute and is specified in Internet draft draft-ietf-idr-aigp-06, *The Accumulated IGP Metric Attribute for BGP*.

**Related Documentation**

- Selecting the Correct ABR While Implementing AIGP on page 72
- Example: Configuring the Accumulated IGP Attribute for BGP on page 3
- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Readvertising the AIGP Metric on page 49
- Understanding AIGP Policy Restrictions on page 41
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- Understanding the Path Selection Algorithm and the BGP Decision-Making Process on page 51
- Using Policy to Originate AIGP on page 46

## Example: Configuring the Accumulated IGP Attribute for BGP

This example shows how to configure the accumulated IGP (AIGP) metric attribute for BGP.



### Requirements

This example uses the following hardware and software components:

- Seven BGP-speaking devices.
- Junos OS Release 12.1 or later.

### Overview

The AIGP attribute enables deployments in which a single administration can run several contiguous BGP autonomous systems (ASs). Such deployments allow BGP to make routing decisions based on the IGP metric. With AIGP enabled, BGP can select paths based on IGP metrics. This enables BGP to choose the shortest path between two nodes, even though the nodes might be in different ASs. The AIGP attribute is particularly useful in networks that use tunneling to deliver a packet to its BGP next hop. This example shows AIGP configured with MPLS label-switched paths.

To enable AIGP, you include the **aigp** statement in the BGP configuration on a protocol family basis. Configuring AIGP on a particular family enables sending and receiving of the AIGP attribute on that family. By default, AIGP is disabled. An AIGP-disabled neighbor does not send an AIGP attribute and silently discards a received AIGP attribute.

Junos OS supports AIGP for **family inet labeled-unicast** and **family inet6 labeled-unicast**. The **aigp** statement can be configured for a given family at the global BGP, group, or neighbor level.

By default, the value of the AIGP attribute for a local prefix is zero. An AIGP-enabled neighbor can originate an AIGP attribute for a given prefix by export policy, using the **aigp-originate** policy action. The value of the AIGP attribute reflects the IGP distance to the prefix. Alternatively, you can specify a value, by using the **aigp-originate distance *distance*** policy action. The configurable range is 0 through 4,294,967,295. Only one node needs to originate an AIGP attribute. The AIGP attribute is retained and readvertised if the neighbors are AIGP enabled with the **aigp** statement in the BGP configuration.

The policy action to originate the AIGP attribute has the following requirements:

- Neighbor must be AIGP enabled.
- Policy must be applied as an export policy.

- Prefix must have no current AIGP attribute.
- Prefix must export with next-hop self.
- Prefix must reside within the AIGP domain. Typically, a loopback IP address is the prefix to originate.

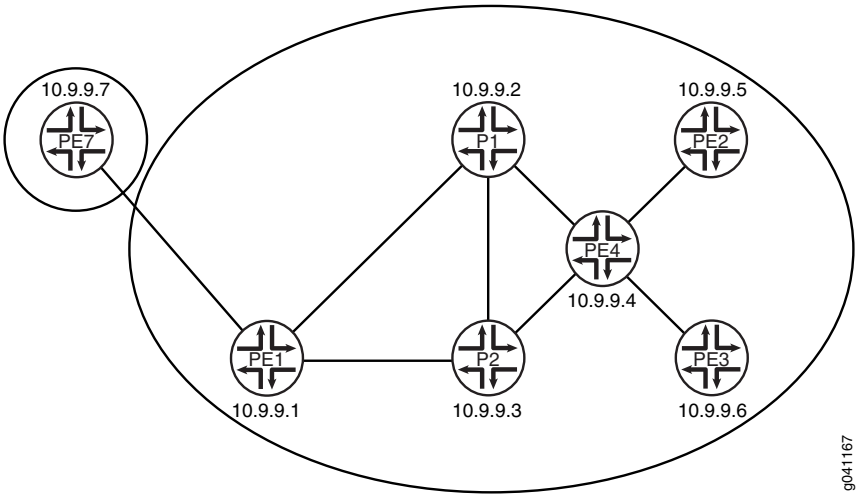
The policy is ignored if these requirements are not met.

## Topology Diagram

Figure 1 on page 4 shows the topology used in this example. OSPF is used as the interior gateway protocol (IGP). Internal BGP (IBGP) is configured between Device PE1 and Device PE4. External BGP (EBGP) is configured between Device PE7 and Device PE1, between Device PE4 and Device PE3, and between Device PE4 and Device PE2. Devices PE4, PE2, and PE3 are configured for multihop. Device PE4 selects a path based on the AIGP value and then readvertises the AIGP value based on the AIGP and policy configuration. Device PE1 readvertises the AIGP value to Device PE7, which is in another administrative domain. Every device has two loopback interface addresses: 10.9.9.x is used for BGP peering and the router ID, and 10.100.1.x is used for the BGP next hop.

The network between Device PE1 and PE3 has IBGP peering and multiple OSPF areas. The external link to Device PE7 is configured to show that the AIGP attribute is readvertised to a neighbor outside of the administrative domain, if that neighbor is AIGP enabled.

### Figure 1: Advertisement of Multiple Paths in BGP




For origination of an AIGP attribute, the BGP next hop is required to be itself. If the BGP next hop remains unchanged, the received AIGP attribute is readvertised, as is, to another AIGP neighbor. If the next hop changes, the received AIGP attribute is readvertised with an increased value to another AIGP neighbor. The increase in value reflects the IGP distance to the previous BGP next hop. To demonstrate, this example uses loopback interface addresses for Device PE4's EBGP peering sessions with Device PE2 and Device PE3. Multihop is enabled on these sessions so that a recursive lookup is performed to determine the point-to-point interface. Because the next hop changes, the IGP distance is added to the AIGP distance.

## Configuration



**CLI Quick Configuration**

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

**Device P1**

```
set interfaces fe-1/2/0 unit 1 description P1-to-PE1
set interfaces fe-1/2/0 unit 1 family inet address 10.0.0.2/30
set interfaces fe-1/2/0 unit 1 family mpls
set interfaces fe-1/2/1 unit 4 description P1-to-P2
set interfaces fe-1/2/1 unit 4 family inet address 10.0.0.29/30
set interfaces fe-1/2/1 unit 4 family mpls
set interfaces fe-1/2/2 unit 8 description P1-to-PE4
set interfaces fe-1/2/2 unit 8 family inet address 10.0.0.17/30
set interfaces fe-1/2/2 unit 8 family mpls
set interfaces lo0 unit 3 family inet address 10.9.9.2/32
set interfaces lo0 unit 3 family inet address 10.100.1.2/32
set protocols rsvp interface fe-1/2/0.1
set protocols rsvp interface fe-1/2/2.8
set protocols rsvp interface fe-1/2/1.4
set protocols mpls label-switched-path P1-to-P2 to 10.9.9.3
set protocols mpls label-switched-path P1-to-PE1 to 10.9.9.1
set protocols mpls label-switched-path P1-to-PE4 to 10.9.9.4
set protocols mpls interface fe-1/2/0.1
set protocols mpls interface fe-1/2/2.8
set protocols mpls interface fe-1/2/1.4
set protocols bgp group internal type internal
set protocols bgp group internal local-address 10.9.9.2
set protocols bgp group internal family inet labeled-unicast aigp
set protocols bgp group internal neighbor 10.9.9.1
set protocols bgp group internal neighbor 10.9.9.3
set protocols bgp group internal neighbor 10.9.9.4
set protocols ospf area 0.0.0.1 interface fe-1/2/0.1 metric 1
set protocols ospf area 0.0.0.1 interface fe-1/2/1.4 metric 1
set protocols ospf area 0.0.0.0 interface fe-1/2/2.8 metric 1
set protocols ospf area 0.0.0.0 interface 10.9.9.2 passive
set protocols ospf area 0.0.0.0 interface 10.9.9.2 metric 1
set protocols ospf area 0.0.0.0 interface 10.100.1.2 passive
set protocols ospf area 0.0.0.0 interface 10.100.1.2 metric 1
set routing-options router-id 10.9.9.2
set routing-options autonomous-system 13979
```

**Device P2**

```
set interfaces fe-1/2/0 unit 3 description P2-to-PE1
```

```
set interfaces fe-1/2/0 unit 3 family inet address 10.0.0.6/30
set interfaces fe-1/2/0 unit 3 family mpls
set interfaces fe-1/2/1 unit 5 description P2-to-P1
set interfaces fe-1/2/1 unit 5 family inet address 10.0.0.30/30
set interfaces fe-1/2/1 unit 5 family mpls
set interfaces fe-1/2/2 unit 6 description P2-to-PE4
set interfaces fe-1/2/2 unit 6 family inet address 10.0.0.13/30
set interfaces fe-1/2/2 unit 6 family mpls
set interfaces lo0 unit 5 family inet address 10.9.9.3/32
set interfaces lo0 unit 5 family inet address 10.100.1.3/32
set protocols rsvp interface fe-1/2/1.5
set protocols rsvp interface fe-1/2/2.6
set protocols rsvp interface fe-1/2/0.3
set protocols mpls label-switched-path P2-to-PE1 to 10.9.9.1
set protocols mpls label-switched-path P2-to-P1 to 10.9.9.2
set protocols mpls label-switched-path P2-to-PE4 to 10.9.9.4
set protocols mpls interface fe-1/2/1.5
set protocols mpls interface fe-1/2/2.6
set protocols mpls interface fe-1/2/0.3
set protocols bgp group internal type internal
set protocols bgp group internal local-address 10.9.9.3
set protocols bgp group internal family inet labeled-unicast aigp
set protocols bgp group internal neighbor 10.9.9.1
set protocols bgp group internal neighbor 10.9.9.2
set protocols bgp group internal neighbor 10.9.9.4
set protocols ospf area 0.0.0.0 interface fe-1/2/2.6 metric 1
set protocols ospf area 0.0.0.0 interface 10.9.9.3 passive
set protocols ospf area 0.0.0.0 interface 10.9.9.3 metric 1
set protocols ospf area 0.0.0.0 interface 10.100.1.3 passive
set protocols ospf area 0.0.0.0 interface 10.100.1.3 metric 1
set routing-options router-id 10.9.9.3
set routing-options autonomous-system 13979
```

Device PE4

```
set interfaces fe-1/2/0 unit 7 description PE4-to-P2
set interfaces fe-1/2/0 unit 7 family inet address 10.0.0.14/30
set interfaces fe-1/2/0 unit 7 family mpls
set interfaces fe-1/2/1 unit 9 description PE4-to-P1
set interfaces fe-1/2/1 unit 9 family inet address 10.0.0.18/30
set interfaces fe-1/2/1 unit 9 family mpls
set interfaces fe-1/2/2 unit 10 description PE4-to-PE2
set interfaces fe-1/2/2 unit 10 family inet address 10.0.0.21/30
set interfaces fe-1/2/2 unit 10 family mpls
set interfaces fe-1/0/2 unit 12 description PE4-to-PE3
set interfaces fe-1/0/2 unit 12 family inet address 10.0.0.25/30
set interfaces fe-1/0/2 unit 12 family mpls
set interfaces lo0 unit 7 family inet address 10.9.9.4/32
set interfaces lo0 unit 7 family inet address 10.100.1.4/32
set protocols rsvp interface fe-1/2/0.7
set protocols rsvp interface fe-1/2/1.9
set protocols rsvp interface fe-1/2/2.10
set protocols rsvp interface fe-1/0/2.12
set protocols mpls label-switched-path PE4-to-PE2 to 10.9.9.5
set protocols mpls label-switched-path PE4-to-PE3 to 10.9.9.6
set protocols mpls label-switched-path PE4-to-P1 to 10.9.9.2
set protocols mpls label-switched-path PE4-to-P2 to 10.9.9.3
set protocols mpls interface fe-1/2/0.7
```

```
set protocols mpls interface fe-1/2/1.9
set protocols mpls interface fe-1/2/2.10
set protocols mpls interface fe-1/0/2.12
set protocols bgp export next-hop
set protocols bgp export aigp
set protocols bgp group internal type internal
set protocols bgp group internal local-address 10.9.9.4
set protocols bgp group internal family inet labeled-unicast aigp
set protocols bgp group internal neighbor 10.9.9.1
set protocols bgp group internal neighbor 10.9.9.3
set protocols bgp group internal neighbor 10.9.9.2
set protocols bgp group external type external
set protocols bgp group external multihop ttl 2
set protocols bgp group external local-address 10.9.9.4
set protocols bgp group external family inet labeled-unicast aigp
set protocols bgp group external peer-as 7018
set protocols bgp group external neighbor 10.9.9.5
set protocols bgp group external neighbor 10.9.9.6
set protocols ospf area 0.0.0.0 interface fe-1/2/1.9 metric 1
set protocols ospf area 0.0.0.0 interface fe-1/2/0.7 metric 1
set protocols ospf area 0.0.0.0 interface 10.9.9.4 passive
set protocols ospf area 0.0.0.0 interface 10.9.9.4 metric 1
set protocols ospf area 0.0.0.0 interface 10.100.1.4 passive
set protocols ospf area 0.0.0.0 interface 10.100.1.4 metric 1
set protocols ospf area 0.0.0.2 interface fe-1/2/2.10 metric 1
set protocols ospf area 0.0.0.3 interface fe-1/0/2.12 metric 1
set policy-options policy-statement aigp term 10 from protocol static
set policy-options policy-statement aigp term 10 from route-filter 44.0.0.0/24 exact
set policy-options policy-statement aigp term 10 then aigp-originate distance 200
set policy-options policy-statement aigp term 10 then next-hop 10.100.1.4
set policy-options policy-statement aigp term 10 then accept
set policy-options policy-statement next-hop term 10 from protocol bgp
set policy-options policy-statement next-hop term 10 then next-hop 10.100.1.4
set policy-options policy-statement next-hop term 10 then accept
set policy-options policy-statement next-hop term 20 from protocol direct
set policy-options policy-statement next-hop term 20 from route-filter 10.9.9.4/32 exact
set policy-options policy-statement next-hop term 20 from route-filter 10.100.1.4/32
  exact
set policy-options policy-statement next-hop term 20 then next-hop 10.100.1.4
set policy-options policy-statement next-hop term 20 then accept
set routing-options static route 44.0.0.0/24 discard
set routing-options router-id 10.9.9.4
set routing-options autonomous-system 13979
```

Device PE1

```
set interfaces fe-1/2/0 unit 0 description PE1-to-P1
set interfaces fe-1/2/0 unit 0 family inet address 10.0.0.1/30
set interfaces fe-1/2/0 unit 0 family mpls
set interfaces fe-1/2/1 unit 2 description PE1-to-P2
set interfaces fe-1/2/1 unit 2 family inet address 10.0.0.5/30
set interfaces fe-1/2/1 unit 2 family mpls
set interfaces fe-1/2/2 unit 14 description PE1-to-PE7
set interfaces fe-1/2/2 unit 14 family inet address 10.0.0.9/30
set interfaces lo0 unit 1 family inet address 10.9.9.1/32
set interfaces lo0 unit 1 family inet address 10.100.1.1/32
set protocols rsvp interface fe-1/2/0.0
set protocols rsvp interface fe-1/2/1.2
```

```
set protocols rsvp interface fe-1/2/2.14
set protocols mpls label-switched-path PE1-to-P1 to 10.9.9.2
set protocols mpls label-switched-path PE1-to-P2 to 10.9.9.3
set protocols mpls interface fe-1/2/0.0
set protocols mpls interface fe-1/2/1.2
set protocols mpls interface fe-1/2/2.14
set protocols bgp group internal type internal
set protocols bgp group internal local-address 10.9.9.1
set protocols bgp group internal family inet labeled-unicast aigp
set protocols bgp group internal export SET_EXPORT_ROUTES
set protocols bgp group internal vpn-apply-export
set protocols bgp group internal neighbor 10.9.9.4
set protocols bgp group internal neighbor 10.9.9.2
set protocols bgp group internal neighbor 10.9.9.3
set protocols bgp group external type external
set protocols bgp group external family inet labeled-unicast aigp
set protocols bgp group external export SET_EXPORT_ROUTES
set protocols bgp group external peer-as 7019
set protocols bgp group external neighbor 10.0.0.10
set protocols ospf area 0.0.0.1 interface fe-1/2/0.0 metric 1
set protocols ospf area 0.0.0.1 interface fe-1/2/1.2 metric 1
set protocols ospf area 0.0.0.1 interface 10.9.9.1 passive
set protocols ospf area 0.0.0.1 interface 10.9.9.1 metric 1
set protocols ospf area 0.0.0.1 interface 10.100.1.1 passive
set protocols ospf area 0.0.0.1 interface 10.100.1.1 metric 1
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol direct
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol bgp
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then next-hop
  10.100.1.1
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then accept
set routing-options router-id 10.9.9.1
set routing-options autonomous-system 13979
```

Device PE2

```
set interfaces fe-1/2/0 unit 11 description PE2-to-PE4
set interfaces fe-1/2/0 unit 11 family inet address 10.0.0.22/30
set interfaces fe-1/2/0 unit 11 family mpls
set interfaces lo0 unit 9 family inet address 10.9.9.5/32 primary
set interfaces lo0 unit 9 family inet address 10.100.1.5/32
set protocols rsvp interface fe-1/2/0.11
set protocols mpls label-switched-path PE2-to-PE4 to 10.9.9.4
set protocols mpls interface fe-1/2/0.11
set protocols bgp group external type external
set protocols bgp group external multihop ttl 2
set protocols bgp group external local-address 10.9.9.5
set protocols bgp group external family inet labeled-unicast aigp
set protocols bgp group external export next-hop
set protocols bgp group external export aigp
set protocols bgp group external export SET_EXPORT_ROUTES
set protocols bgp group external vpn-apply-export
set protocols bgp group external peer-as 13979
set protocols bgp group external neighbor 10.9.9.4
set protocols ospf area 0.0.0.2 interface 10.9.9.5 passive
set protocols ospf area 0.0.0.2 interface 10.9.9.5 metric 1
set protocols ospf area 0.0.0.2 interface 10.100.1.5 passive
set protocols ospf area 0.0.0.2 interface 10.100.1.5 metric 1
set protocols ospf area 0.0.0.2 interface fe-1/2/0.11 metric 1
```

```
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol direct
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol static
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol bgp
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then next-hop
  10.100.1.5
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then accept
set policy-options policy-statement aigp term 10 from route-filter 55.0.0.0/24 exact
set policy-options policy-statement aigp term 10 then aigp-originate distance 20
set policy-options policy-statement aigp term 10 then next-hop 10.100.1.5
set policy-options policy-statement aigp term 10 then accept
set policy-options policy-statement aigp term 20 from route-filter 99.0.0.0/24 exact
set policy-options policy-statement aigp term 20 then aigp-originate distance 30
set policy-options policy-statement aigp term 20 then next-hop 10.100.1.5
set policy-options policy-statement aigp term 20 then accept
set policy-options policy-statement next-hop term 10 from protocol bgp
set policy-options policy-statement next-hop term 10 then next-hop 10.100.1.5
set policy-options policy-statement next-hop term 10 then accept
set policy-options policy-statement next-hop term 20 from protocol direct
set policy-options policy-statement next-hop term 20 from route-filter 10.9.9.5/32 exact
set policy-options policy-statement next-hop term 20 from route-filter 10.100.1.5/32
  exact
set policy-options policy-statement next-hop term 20 then next-hop 10.100.1.5
set policy-options policy-statement next-hop term 20 then accept
set routing-options static route 99.0.0.0/24 discard
set routing-options static route 55.0.0.0/24 discard
set routing-options router-id 10.9.9.5
set routing-options autonomous-system 7018
```

Device PE3

```
set interfaces fe-1/2/0 unit 13 description PE3-to-PE4
set interfaces fe-1/2/0 unit 13 family inet address 10.0.0.26/30
set interfaces fe-1/2/0 unit 13 family mpls
set interfaces lo0 unit 11 family inet address 10.9.9.6/32
set interfaces lo0 unit 11 family inet address 10.100.1.6/32
set protocols rsvp interface fe-1/2/0.13
set protocols mpls label-switched-path PE3-to-PE4 to 10.9.9.4
set protocols mpls interface fe-1/2/0.13
set protocols bgp group external type external
set protocols bgp group external multihop ttl 2
set protocols bgp group external local-address 10.9.9.6
set protocols bgp group external family inet labeled-unicast aigp
set protocols bgp group external export next-hop
set protocols bgp group external export SET_EXPORT_ROUTES
set protocols bgp group external vpn-apply-export
set protocols bgp group external peer-as 13979
set protocols bgp group external neighbor 10.9.9.4
set protocols ospf area 0.0.0.3 interface 10.9.9.6 passive
set protocols ospf area 0.0.0.3 interface 10.9.9.6 metric 1
set protocols ospf area 0.0.0.3 interface 10.100.1.6 passive
set protocols ospf area 0.0.0.3 interface 10.100.1.6 metric 1
set protocols ospf area 0.0.0.3 interface fe-1/2/0.13 metric 1
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol direct
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol static
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol bgp
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then next-hop
  10.100.1.6
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then accept
```

```
set policy-options policy-statement next-hop term 10 from protocol bgp
set policy-options policy-statement next-hop term 10 then next-hop 10.100.1.6
set policy-options policy-statement next-hop term 10 then accept
set policy-options policy-statement next-hop term 20 from protocol direct
set policy-options policy-statement next-hop term 20 from route-filter 10.9.9.6/32 exact
set policy-options policy-statement next-hop term 20 from route-filter 10.100.1.6/32
  exact
set policy-options policy-statement next-hop term 20 then next-hop 10.100.1.6
set policy-options policy-statement next-hop term 20 then accept
set routing-options router-id 10.9.9.6
set routing-options autonomous-system 7018
```

Device PE7

```
set interfaces fe-1/2/0 unit 15 description PE7-to-PE1
set interfaces fe-1/2/0 unit 15 family inet address 10.0.0.10/30
set interfaces lo0 unit 13 family inet address 10.9.9.7/32
set interfaces lo0 unit 13 family inet address 10.100.1.7/32
set protocols bgp group external type external
set protocols bgp group external family inet labeled-unicast aigp
set protocols bgp group external export SET_EXPORT_ROUTES
set protocols bgp group external peer-as 13979
set protocols bgp group external neighbor 10.0.0.9
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol direct
set policy-options policy-statement SET_EXPORT_ROUTES term 10 from protocol bgp
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then next-hop
  10.100.1.7
set policy-options policy-statement SET_EXPORT_ROUTES term 10 then accept
set routing-options router-id 10.9.9.7
set routing-options autonomous-system 7019
```

### Configuring Device P1

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Device P1:

1. Configure the interfaces.

```
[edit interfaces]
user@P1# set fe-1/2/0 unit 1 description P1-to-PE1
user@P1# set fe-1/2/0 unit 1 family inet address 10.0.0.2/30
user@P1# set fe-1/2/0 unit 1 family mpls
user@P1# set fe-1/2/1 unit 4 description P1-to-P2
user@P1# set fe-1/2/1 unit 4 family inet address 10.0.0.29/30
user@P1# set fe-1/2/1 unit 4 family mpls
user@P1# set fe-1/2/2 unit 8 description P1-to-PE4
user@P1# set fe-1/2/2 unit 8 family inet address 10.0.0.17/30
user@P1# set fe-1/2/2 unit 8 family mpls
user@P1# set lo0 unit 3 family inet address 10.9.9.2/32
user@P1# set lo0 unit 3 family inet address 10.100.1.2/32
```

2. Configure MPLS and a signaling protocol, such as RSVP or LDP.

```
[edit protocols]
user@P1# set rsvp interface fe-1/2/0.1
```

```
user@P1# set rsvp interface fe-1/2/2.8
user@P1# set rsvp interface fe-1/2/1.4
user@P1# set mpls label-switched-path P1-to-P2 to 10.9.9.3
user@P1# set mpls label-switched-path P1-to-PE1 to 10.9.9.1
user@P1# set mpls label-switched-path P1-to-PE4 to 10.9.9.4
user@P1# set mpls interface fe-1/2/0.1
user@P1# set mpls interface fe-1/2/2.8
user@P1# set mpls interface fe-1/2/1.4
```

3. Configure BGP.

```
[edit protocols bgp group internal]
user@P1# set type internal
user@P1# set local-address 10.9.9.2
user@P1# set neighbor 10.9.9.1
user@P1# set neighbor 10.9.9.3
user@P1# set neighbor 10.9.9.4
```

4. Enable AIGP.

```
[edit protocols bgp group internal]
user@P1# set family inet labeled-unicast aigp
```

5. Configure an IGP, such as OSPF, RIP, or IS-IS.

```
[edit protocols ospf]
user@P1# set area 0.0.0.1 interface fe-1/2/0.1 metric 1
user@P1# set area 0.0.0.1 interface fe-1/2/1.4 metric 1
user@P1# set area 0.0.0.0 interface fe-1/2/2.8 metric 1
user@P1# set area 0.0.0.0 interface 10.9.9.2 passive
user@P1# set area 0.0.0.0 interface 10.9.9.2 metric 1
user@P1# set area 0.0.0.0 interface 10.100.1.2 passive
user@P1# set area 0.0.0.0 interface 10.100.1.2 metric 1
```

6. Configure the router ID and the autonomous system number.

```
[edit routing-options]
user@P1# set router-id 10.9.9.2
user@P1# set autonomous-system 13979
```

7. If you are done configuring the device, commit the configuration.

```
user@P1# commit
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@P1# show interfaces
fe-1/2/0 {
   unit 1 {
      description P1-to-PE1;
      family inet {
         address 10.0.0.2/30;
      }
      family mpls;
   }
}
```

```
fe-1/2/1 {
    unit 4 {
        description P1-to-P2;
        family inet {
            address 10.0.0.29/30;
        }
        family mpls;
    }
}
fe-1/2/2 {
    unit 8 {
        description P1-to-PE4;
        family inet {
            address 10.0.0.17/30;
        }
        family mpls;
    }
}
lo0 {
    unit 3 {
        family inet {
            address 10.9.9.2/32;
            address 10.100.1.2/32;
        }
    }
}
```

```
user@P1# show protocols
rsvp {
    interface fe-1/2/0.1;
    interface fe-1/2/2.8;
    interface fe-1/2/1.4;
}
mpls {
    label-switched-path P1-to-P2 {
        to 10.9.9.3;
    }
    label-switched-path P1-to-PE1 {
        to 10.9.9.1;
    }
    label-switched-path P1-to-PE4 {
        to 10.9.9.4;
    }
    interface fe-1/2/0.1;
    interface fe-1/2/2.8;
    interface fe-1/2/1.4;
}
bgp {
    group internal {
        type internal;
        local-address 10.9.9.2;
        family inet {
            labeled-unicast {
                aigp;
            }
        }
```

```
        neighbor 10.9.9.1;
        neighbor 10.9.9.3;
        neighbor 10.9.9.4;
    }
}
ospf {
    area 0.0.0.1 {
        interface fe-1/2/0.1 {
            metric 1;
        }
        interface fe-1/2/1.4 {
            metric 1;
        }
    }
    area 0.0.0.0 {
        interface fe-1/2/2.8 {
            metric 1;
        }
        interface 10.9.9.2 {
            passive;
            metric 1;
        }
        interface 10.100.1.2 {
            passive;
            metric 1;
        }
    }
}
```

```
user@P1# show routing-options
router-id 10.9.9.2;
autonomous-system 13979;
```

## Configuring Device P2

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Device P2:

1. Configure the interfaces.

```
[edit interfaces]
user@P2# set fe-1/2/0 unit 3 description P2-to-PE1
user@P2# set fe-1/2/0 unit 3 family inet address 10.0.0.6/30
user@P2# set fe-1/2/0 unit 3 family mpls
user@P2# set fe-1/2/1 unit 5 description P2-to-P1
user@P2# set fe-1/2/1 unit 5 family inet address 10.0.0.30/30
user@P2# set fe-1/2/1 unit 5 family mpls
user@P2# set fe-1/2/2 unit 6 description P2-to-PE4
user@P2# set fe-1/2/2 unit 6 family inet address 10.0.0.13/30
user@P2# set fe-1/2/2 unit 6 family mpls
user@P2# set lo0 unit 5 family inet address 10.9.9.3/32
user@P2# set lo0 unit 5 family inet address 10.100.1.3/32
```

2. Configure MPLS and a signaling protocol, such as RSVP or LDP.

```
[edit protocols]
user@P2# set rsvp interface fe-1/2/1.5
user@P2# set rsvp interface fe-1/2/2.6
user@P2# set rsvp interface fe-1/2/0.3
user@P2# set mpls label-switched-path P2-to-PE1 to 10.9.9.1
user@P2# set mpls label-switched-path P2-to-P1 to 10.9.9.2
user@P2# set mpls label-switched-path P2-to-PE4 to 10.9.9.4
user@P2# set mpls interface fe-1/2/1.5
user@P2# set mpls interface fe-1/2/2.6
user@P2# set mpls interface fe-1/2/0.3
```

3. Configure BGP.

```
[edit protocols bgp group internal]
user@P2# set type internal
user@P2# set local-address 10.9.9.3
user@P2# set neighbor 10.9.9.1
user@P2# set neighbor 10.9.9.2
user@P2# set neighbor 10.9.9.4
```

4. Enable AIGP.

```
[edit protocols bgp group internal]
user@P2# set family inet labeled-unicast aigp
```

5. Configure an IGP, such as OSPF, RIP, or IS-IS.

```
[edit protocols ospf]
user@P2# set area 0.0.0.0 interface fe-1/2/2.6 metric 1
user@P2# set area 0.0.0.0 interface 10.9.9.3 passive
user@P2# set area 0.0.0.0 interface 10.9.9.3 metric 1
user@P2# set area 0.0.0.0 interface 10.100.1.3 passive
user@P2# set area 0.0.0.0 interface 10.100.1.3 metric 1
```

6. Configure the router ID and the autonomous system number.

```
[edit routing-options]
user@P2# set router-id 10.9.9.3
user@P2# set autonomous-system 13979
```

7. If you are done configuring the device, commit the configuration.

```
user@P2# commit
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@P2# show interfaces
fe-1/2/0 {
   unit 3 {
      description P2-to-PE1;
      family inet {
         address 10.0.0.6/30;
      }
      family mpls;
```

```
    }
  }
  fe-1/2/1 {
    unit 5 {
      description P2-to-P1;
      family inet {
        address 10.0.0.30/30;
      }
      family mpls;
    }
  }
  fe-1/2/2 {
    unit 6 {
      description P2-to-PE4;
      family inet {
        address 10.0.0.13/30;
      }
      family mpls;
    }
  }
  lo0 {
    unit 5 {
      family inet {
        address 10.9.9.3/32;
        address 10.100.1.3/32;
      }
    }
  }
```

```
user@P2# show protocols
rsvp {
  interface fe-1/2/1.5;
  interface fe-1/2/2.6;
  interface fe-1/2/0.3;
}
mpls {
  label-switched-path P2-to-PE1 {
    to 10.9.9.1;
  }
  label-switched-path P2-to-P1 {
    to 10.9.9.2;
  }
  label-switched-path P2-to-PE4 {
    to 10.9.9.4;
  }
  interface fe-1/2/1.5;
  interface fe-1/2/2.6;
  interface fe-1/2/0.3;
}
bgp {
  group internal {
    type internal;
    local-address 10.9.9.3;
    family inet {
      labeled-unicast {
        aigp;
```

```
        }
      }
      neighbor 10.9.9.1;
      neighbor 10.9.9.2;
      neighbor 10.9.9.4;
    }
  }
  ospf {
    area 0.0.0.0 {
      interface fe-1/2/2.6 {
        metric 1;
      }
      interface 10.9.9.3 {
        passive;
        metric 1;
      }
      interface 10.100.1.3 {
        passive;
        metric 1;
      }
    }
  }
```

```
user@P2# show routing-options
router-id 10.9.9.3;
autonomous-system 13979;
```

## Configuring Device PE4

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Device PE4:

1. Configure the interfaces.

```
[edit interfaces]
user@PE4# set fe-1/2/0 unit 7 description PE4-to-P2
user@PE4# set fe-1/2/0 unit 7 family inet address 10.0.0.14/30
user@PE4# set fe-1/2/0 unit 7 family mpls
user@PE4# set fe-1/2/1 unit 9 description PE4-to-P1
user@PE4# set fe-1/2/1 unit 9 family inet address 10.0.0.18/30
user@PE4# set fe-1/2/1 unit 9 family mpls
user@PE4# set fe-1/2/2 unit 10 description PE4-to-PE2
user@PE4# set fe-1/2/2 unit 10 family inet address 10.0.0.21/30
user@PE4# set fe-1/2/2 unit 10 family mpls
user@PE4# set fe-1/0/2 unit 12 description PE4-to-PE3
user@PE4# set fe-1/0/2 unit 12 family inet address 10.0.0.25/30
user@PE4# set fe-1/0/2 unit 12 family mpls
user@PE4# set lo0 unit 7 family inet address 10.9.9.4/32
user@PE4# set lo0 unit 7 family inet address 10.100.1.4/32
```

2. Configure MPLS and a signaling protocol, such as RSVP or LDP.

```
[edit protocols]
```

```
user@PE4# set rsvp interface fe-1/2/0.7
user@PE4# set rsvp interface fe-1/2/1.9
user@PE4# set rsvp interface fe-1/2/2.10
user@PE4# set rsvp interface fe-1/0/2.12
user@PE4# set mpls label-switched-path PE4-to-PE2 to 10.9.9.5
user@PE4# set mpls label-switched-path PE4-to-PE3 to 10.9.9.6
user@PE4# set mpls label-switched-path PE4-to-P1 to 10.9.9.2
user@PE4# set mpls label-switched-path PE4-to-P2 to 10.9.9.3
user@PE4# set mpls interface fe-1/2/0.7
user@PE4# set mpls interface fe-1/2/1.9
user@PE4# set mpls interface fe-1/2/2.10
user@PE4# set mpls interface fe-1/0/2.12
```

3. Configure BGP.

```
[edit protocols bgp]
user@PE4# set export next-hop
user@PE4# set export aigp
user@PE4# set group internal type internal
user@PE4# set group internal local-address 10.9.9.4
user@PE4# set group internal neighbor 10.9.9.1
user@PE4# set group internal neighbor 10.9.9.3
user@PE4# set group internal neighbor 10.9.9.2
user@PE4# set group external type external
user@PE4# set group external multihop ttl 2
user@PE4# set group external local-address 10.9.9.4
user@PE4# set group external peer-as 7018
user@PE4# set group external neighbor 10.9.9.5
user@PE4# set group external neighbor 10.9.9.6
```

4. Enable AIGP.

```
[edit protocols bgp]
user@PE4# set group external family inet labeled-unicast aigp
user@PE4# set group internal family inet labeled-unicast aigp
```

5. Originate a prefix, and configure an AIGP distance.

   By default, a prefix is originated using the current IGP distance. Optionally, you can configure a distance for the AIGP attribute, using the **distance** option, as shown here.

```
[edit policy-options policy-statement aigp term 10]
user@PE4# set from protocol static
user@PE4# set from route-filter 44.0.0.0/24 exact
user@PE4# set then aigp-originate distance 200
user@PE4# set then next-hop 10.100.1.4
user@PE4# set then accept
```

6. Enable the policies.

```
[edit policy-options policy-statement next-hop]
user@PE4# set term 10 from protocol bgp
user@PE4# set term 10 then next-hop 10.100.1.4
user@PE4# set term 10 then accept
user@PE4# set term 20 from protocol direct
user@PE4# set term 20 from route-filter 10.9.9.4/32 exact
user@PE4# set term 20 from route-filter 10.100.1.4/32 exact
```

```
user@PE4# set term 20 then next-hop 10.100.1.4
user@PE4# set term 20 then accept
```

7. Configure a static route.

```
[edit routing-options]
user@PE4# set static route 44.0.0.0/24 discard
```

8. Configure an IGP, such as OSPF, RIP, or IS-IS.

```
[edit protocols ospf]
user@PE4# set area 0.0.0.0 interface fe-1/2/1.9 metric 1
user@PE4# set area 0.0.0.0 interface fe-1/2/0.7 metric 1
user@PE4# set area 0.0.0.0 interface 10.9.9.4 passive
user@PE4# set area 0.0.0.0 interface 10.9.9.4 metric 1
user@PE4# set area 0.0.0.0 interface 10.100.1.4 passive
user@PE4# set area 0.0.0.0 interface 10.100.1.4 metric 1
user@PE4# set area 0.0.0.2 interface fe-1/2/2.10 metric 1
user@PE4# set area 0.0.0.3 interface fe-1/0/2.12 metric 1
```

9. Configure the router ID and the autonomous system number.

```
[edit routing-options]
user@PE4# set router-id 10.9.9.4
user@PE4# set autonomous-system 13979
```

10. If you are done configuring the device, commit the configuration.

```
user@PE4# commit
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE4# show interfaces
fe-1/0/2 {
    unit 12 {
        description PE4-to-PE3;
        family inet {
            address 10.0.0.25/30;
        }
        family mpls;
    }
}
fe-1/2/0 {
    unit 7 {
        description PE4-to-P2;
        family inet {
            address 10.0.0.14/30;
        }
        family mpls;
    }
}
fe-1/2/1 {
    unit 9 {
        description PE4-to-P1;
```

```
      family inet {
        address 10.0.0.18/30;
      }
      family mpls;
    }
  }
  fe-1/2/2 {
    unit 10 {
      description PE4-to-PE2;
      family inet {
        address 10.0.0.21/30;
      }
      family mpls;
    }
  }
  lo0 {
    unit 7 {
      family inet {
        address 10.9.9.4/32;
        address 10.100.1.4/32;
      }
    }
  }

user@PE4# show policy-options
policy-statement aigp {
  term 10 {
    from {
      protocol static;
      route-filter 44.0.0.0/24 exact;
    }
    then {
      aigp-originate distance 200;
      next-hop 10.100.1.4;
      accept;
    }
  }
}
policy-statement next-hop {
  term 10 {
    from protocol bgp;
    then {
      next-hop 10.100.1.4;
      accept;
    }
  }
  term 20 {
    from {
      protocol direct;
      route-filter 10.9.9.4/32 exact;
      route-filter 10.100.1.4/32 exact;
    }
    then {
      next-hop 10.100.1.4;
      accept;
    }
```

```
    }
}

user@PE4# show protocols
rsvp {
    interface fe-1/2/0.7;
    interface fe-1/2/1.9;
    interface fe-1/2/2.10;
    interface fe-1/0/2.12;
}
mpls {
    label-switched-path PE4-to-PE2 {
        to 10.9.9.5;
    }
    label-switched-path PE4-to-PE3 {
        to 10.9.9.6;
    }
    label-switched-path PE4-to-P1 {
        to 10.9.9.2;
    }
    label-switched-path PE4-to-P2 {
        to 10.9.9.3;
    }
    interface fe-1/2/0.7;
    interface fe-1/2/1.9;
    interface fe-1/2/2.10;
    interface fe-1/0/2.12;
}
bgp {
    export [ next-hop aigp ];
    group internal {
        type internal;
        local-address 10.9.9.4;
        family inet {
            labeled-unicast {
                aigp;
            }
        }
        neighbor 10.9.9.1;
        neighbor 10.9.9.3;
        neighbor 10.9.9.2;
    }
    group external {
        type external;
        multihop {
            ttl 2;
        }
        local-address 10.9.9.4;
        family inet {
            labeled-unicast {
                aigp;
            }
        }
        peer-as 7018;
        neighbor 10.9.9.5;
        neighbor 10.9.9.6;
```

```
    }
  }
  ospf {
    area 0.0.0.0 {
      interface fe-1/2/1.9 {
        metric 1;
      }
      interface fe-1/2/0.7 {
        metric 1;
      }
      interface 10.9.9.4 {
        passive;
        metric 1;
      }
      interface 10.100.1.4 {
        passive;
        metric 1;
      }
    }
    area 0.0.0.2 {
      interface fe-1/2/2.10 {
        metric 1;
      }
    }
    area 0.0.0.3 {
      interface fe-1/0/2.12 {
        metric 1;
      }
    }
  }
```

```
user@PE4# show routing-options
static {
  route 44.0.0.0/24 discard;
}
router-id 10.9.9.4;
autonomous-system 13979;
```

## Configuring Device PE1

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Device PE1:

1. Configure the interfaces.

```
[edit interfaces]
user@PE1# set fe-1/2/0 unit 0 description PE1-to-P1
user@PE1# set fe-1/2/0 unit 0 family inet address 10.0.0.1/30
user@PE1# set fe-1/2/0 unit 0 family mpls
user@PE1# set fe-1/2/1 unit 2 description PE1-to-P2
user@PE1# set fe-1/2/1 unit 2 family inet address 10.0.0.5/30
user@PE1# set fe-1/2/1 unit 2 family mpls
user@PE1# set fe-1/2/2 unit 14 description PE1-to-PE7
```

```
user@PE1# set fe-1/2/2 unit 14 family inet address 10.0.0.9/30
user@PE1# set lo0 unit 1 family inet address 10.9.9.1/32
user@PE1# set lo0 unit 1 family inet address 10.100.1.1/32
```

2. Configure MPLS and a signaling protocol, such as RSVP or LDP.

```
[edit protocols]
user@PE1# set rsvp interface fe-1/2/0.0
user@PE1# set rsvp interface fe-1/2/1.2
user@PE1# set rsvp interface fe-1/2/2.14
user@PE1# set mpls label-switched-path PE1-to-P1 to 10.9.9.2
user@PE1# set mpls label-switched-path PE1-to-P2 to 10.9.9.3
user@PE1# set mpls interface fe-1/2/0.0
user@PE1# set mpls interface fe-1/2/1.2
user@PE1# set mpls interface fe-1/2/2.14
```

3. Configure BGP.

```
[edit protocols bgp]
user@PE1# set group internal type internal
user@PE1# set group internal local-address 10.9.9.1
user@PE1# set group internal export SET_EXPORT_ROUTES
user@PE1# set group internal vpn-apply-export
user@PE1# set group internal neighbor 10.9.9.4
user@PE1# set group internal neighbor 10.9.9.2
user@PE1# set group internal neighbor 10.9.9.3
user@PE1# set group external type external
user@PE1# set group external export SET_EXPORT_ROUTES
user@PE1# set group external peer-as 7019
user@PE1# set group external neighbor 10.0.0.10
```

4. Enable AIGP.

```
[edit protocols bgp]
user@PE1# set group internal family inet labeled-unicast aigp
user@PE1# set group external family inet labeled-unicast aigp
```

5. Enable the policies.

```
[edit policy-options policy-statement SET_EXPORT_ROUTES term 10]
user@PE1# set from protocol direct
user@PE1# set from protocol bgp
user@PE1# set then next-hop 10.100.1.1
user@PE1# set then accept
```

6. Configure an IGP, such as OSPF, RIP, or IS-IS.

```
[edit protocols ospf area 0.0.0.1]
user@PE1# set interface fe-1/2/0.0 metric 1
user@PE1# set interface fe-1/2/1.2 metric 1
user@PE1# set interface 10.9.9.1 passive
user@PE1# set interface 10.9.9.1 metric 1
user@PE1# set interface 10.100.1.1 passive
user@PE1# set interface 10.100.1.1 metric 1
```

7. Configure the router ID and the autonomous system number.

```
[edit routing-options]
user@PE1# set router-id 10.9.9.1
```

```
user@PE1# set autonomous-system 13979
```

8. If you are done configuring the device, commit the configuration.

```
user@PE1# commit
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE1# show interfaces
fe-1/2/0 {
    unit 0 {
        description PE1-to-P1;
        family inet {
            address 10.0.0.1/30;
        }
        family mpls;
    }
}
fe-1/2/1 {
    unit 2 {
        description PE1-to-P2;
        family inet {
            address 10.0.0.5/30;
        }
        family mpls;
    }
}
fe-1/2/2 {
    unit 14 {
        description PE1-to-PE7;
        family inet {
            address 10.0.0.9/30;
        }
    }
}
lo0 {
    unit 1 {
        family inet {
            address 10.9.9.1/32;
            address 10.100.1.1/32;
        }
    }
}
```

```
user@PE1# show policy-options
policy-statement SET_EXPORT_ROUTES {
    term 10 {
        from protocol [ direct bgp ];
        then {
            next-hop 10.100.1.1;
            accept;
        }
    }
```

```
}
user@PE1# show protocols
rsvp {
   interface fe-1/2/0.0;
   interface fe-1/2/1.2;
   interface fe-1/2/2.14;
}
mpls {
   label-switched-path PE1-to-P1 {
      to 10.9.9.2;
   }
   label-switched-path PE1-to-P2 {
      to 10.9.9.3;
   }
   interface fe-1/2/0.0;
   interface fe-1/2/1.2;
   interface fe-1/2/2.14;
}
bgp {
   group internal {
      type internal;
      local-address 10.9.9.1;
      family inet {
         labeled-unicast {
            aigp;
         }
      }
      export SET_EXPORT_ROUTES;
      vpn-apply-export;
      neighbor 10.9.9.4;
      neighbor 10.9.9.2;
      neighbor 10.9.9.3;
   }
   group external {
      type external;
      family inet {
         labeled-unicast {
            aigp;
         }
      }
      export SET_EXPORT_ROUTES;
      peer-as 7019;
      neighbor 10.0.0.10;
   }
}
ospf {
   area 0.0.0.1 {
      interface fe-1/2/0.0 {
         metric 1;
      }
      interface fe-1/2/1.2 {
         metric 1;
      }
      interface 10.9.9.1 {
         passive;
```

```
        metric 1;
      }
      interface 10.100.1.1 {
        passive;
        metric 1;
      }
    }
  }
```

```
user@PE1# show routing-options
router-id 10.9.9.1;
autonomous-system 13979;
```

## Configuring Device PE2

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Device PE2:

1. Configure the interfaces.

```
[edit interfaces]
user@PE2# set fe-1/2/0 unit 11 description PE2-to-PE4
user@PE2# set fe-1/2/0 unit 11 family inet address 10.0.0.22/30
user@PE2# set fe-1/2/0 unit 11 family mpls
user@PE2# set lo0 unit 9 family inet address 10.9.9.5/32 primary
user@PE2# set lo0 unit 9 family inet address 10.100.1.5/32
```

2. Configure MPLS and a signaling protocol, such as RSVP or LDP.

```
[edit protocols]
user@PE2# set rsvp interface fe-1/2/0.11
user@PE2# set mpls label-switched-path PE2-to-PE4 to 10.9.9.4
user@PE2# set mpls interface fe-1/2/0.11
```

3. Configure BGP.

```
[edit protocols bgp]
user@PE2# set group external type external
user@PE2# set group external multihop ttl 2
user@PE2# set group external local-address 10.9.9.5
user@PE2# set group external export next-hop
user@PE2# set group external export aigp
user@PE2# set group external export SET_EXPORT_ROUTES
user@PE2# set group external vpn-apply-export
user@PE2# set group external peer-as 13979
user@PE2# set group external neighbor 10.9.9.4
```

4. Enable AIGP.

```
[edit protocols bgp]
user@PE2# set group external family inet labeled-unicast aigp
```

5. Originate a prefix, and configure an AIGP distance.

   By default, a prefix is originated using the current IGP distance. Optionally, you can configure a distance for the AIGP attribute, using the **distance** option, as shown here.

   ```
   [edit policy-options policy-statement aigp]
   user@PE2# set term 10 from route-filter 55.0.0.0/24 exact
   user@PE2# set term 10 then aigp-originate distance 20
   user@PE2# set term 10 then next-hop 10.100.1.5
   user@PE2# set term 10 then accept
   user@PE2# set term 20 from route-filter 99.0.0.0/24 exact
   user@PE2# set term 20 then aigp-originate distance 30
   user@PE2# set term 20 then next-hop 10.100.1.5
   user@PE2# set term 20 then accept
   ```

6. Enable the policies.

   ```
   [edit policy-options]
   user@PE2# set policy-statement SET_EXPORT_ROUTES term 10 from protocol
     direct
   user@PE2# set policy-statement SET_EXPORT_ROUTES term 10 from protocol
     static
   user@PE2# set policy-statement SET_EXPORT_ROUTES term 10 from protocol
     bgp
   user@PE2# set policy-statement SET_EXPORT_ROUTES term 10 then next-hop
     10.100.1.5
   user@PE2# set policy-statement SET_EXPORT_ROUTES term 10 then accept
   user@PE2# set policy-statement next-hop term 10 from protocol bgp
   user@PE2# set policy-statement next-hop term 10 then next-hop 10.100.1.5
   user@PE2# set policy-statement next-hop term 10 then accept
   user@PE2# set policy-statement next-hop term 20 from protocol direct
   user@PE2# set policy-statement next-hop term 20 from route-filter 10.9.9.5/32
     exact
   user@PE2# set policy-statement next-hop term 20 from route-filter 10.100.1.5/32
     exact
   user@PE2# set policy-statement next-hop term 20 then next-hop 10.100.1.5
   user@PE2# set policy-statement next-hop term 20 then accept
   ```

7. Enable some static routes.

   ```
   [edit routing-options]
   user@PE2# set static route 99.0.0.0/24 discard
   user@PE2# set static route 55.0.0.0/24 discard
   ```

8. Configure an IGP, such as OSPF, RIP, or IS-IS.

   ```
   [edit protocols ospf area 0.0.0.2]
   user@PE2# set interface 10.9.9.5 passive
   user@PE2# set interface 10.9.9.5 metric 1
   user@PE2# set interface 10.100.1.5 passive
   user@PE2# set interface 10.100.1.5 metric 1
   user@PE2# set interface fe-1/2/0.11 metric 1
   ```

9. Configure the router ID and the autonomous system number.

   ```
   [edit routing-options]
   user@PE2# set router-id 10.9.9.5
   ```

```
user@PE2# set autonomous-system 7018
```

10. If you are done configuring the device, commit the configuration.

```
user@PE2# commit
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE2# show interfaces
fe-1/2/0 {
    unit 11 {
        description PE2-to-PE4;
        family inet {
            address 10.0.0.22/30;
        }
        family mpls;
    }
}
lo0 {
    unit 9 {
        family inet {
            address 10.9.9.5/32 {
                primary;
            }
            address 10.100.1.5/32;
        }
    }
}
```

```
user@PE2# show policy-options
policy-statement SET_EXPORT_ROUTES {
    term 10 {
        from protocol [ direct static bgp ];
        then {
            next-hop 10.100.1.5;
            accept;
        }
    }
}
policy-statement aigp {
    term 10 {
        from {
            route-filter 55.0.0.0/24 exact;
        }
        then {
            aigp-originate distance 20;
            next-hop 10.100.1.5;
            accept;
        }
    }
    term 20 {
        from {
            route-filter 99.0.0.0/24 exact;
```

```
      }
      then {
        aigp-originate distance 30;
        next-hop 10.100.1.5;
        accept;
      }
    }
}
policy-statement next-hop {
  term 10 {
    from protocol bgp;
    then {
      next-hop 10.100.1.5;
      accept;
    }
  }
  term 20 {
    from {
      protocol direct;
      route-filter 10.9.9.5/32 exact;
      route-filter 10.100.1.5/32 exact;
    }
    then {
      next-hop 10.100.1.5;
      accept;
    }
  }
}
```

```
user@PE2# show protocols
rsvp {
  interface fe-1/2/0.11;
}
mpls {
  label-switched-path PE2-to-PE4 {
    to 10.9.9.4;
  }
  interface fe-1/2/0.11;
}
bgp {
  group external {
    type external;
    multihop {
      ttl 2;
    }
    local-address 10.9.9.5;
    family inet {
      labeled-unicast {
        aigp;
      }
    }
    export [ next-hop aigp SET_EXPORT_ROUTES ];
    vpn-apply-export;
    peer-as 13979;
    neighbor 10.9.9.4;
  }
```

```
}
ospf {
   area 0.0.0.2 {
      interface 10.9.9.5 {
         passive;
         metric 1;
      }
      interface 10.100.1.5 {
         passive;
         metric 1;
      }
      interface fe-1/2/0.11 {
         metric 1;
      }
   }
}
```

```
user@PE2# show routing-options
static {
   route 99.0.0.0/24 discard;
   route 55.0.0.0/24 discard;
}
router-id 10.9.9.5;
autonomous-system 7018;
```

## Configuring Device PE3

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Device PE3:

1. Configure the interfaces.

```
[edit interfaces]
user@PE3# set fe-1/2/0 unit 13 description PE3-to-PE4
user@PE3# set fe-1/2/0 unit 13 family inet address 10.0.0.26/30
user@PE3# set fe-1/2/0 unit 13 family mpls
user@PE3# set lo0 unit 11 family inet address 10.9.9.6/32
user@PE3# set lo0 unit 11 family inet address 10.100.1.6/32
```

2. Configure MPLS and a signaling protocol, such as RSVP or LDP.

```
[edit protocols]
user@PE3# set rsvp interface fe-1/2/0.13
user@PE3# set mpls label-switched-path PE3-to-PE4 to 10.9.9.4
user@PE3# set mpls interface fe-1/2/0.13
```

3. Configure BGP.

```
[edit protocols bgp group external]
user@PE3# set type external
user@PE3# set multihop ttl 2
user@PE3# set local-address 10.9.9.6
user@PE3# set export next-hop
user@PE3# set export SET_EXPORT_ROUTES
```

```
user@PE3# set vpn-apply-export
user@PE3# set peer-as 13979
user@PE3# set neighbor 10.9.9.4
```

4. Enable AIGP.

```
[edit protocols bgp group external]
user@PE3# set family inet labeled-unicast aigp
```

5. Enable the policies.

```
[edit policy-options]
user@PE3# set policy-statement SET_EXPORT_ROUTES term 10 from protocol
  direct
user@PE3# set policy-statement SET_EXPORT_ROUTES term 10 from protocol
  static
user@PE3# set policy-statement SET_EXPORT_ROUTES term 10 from protocol
  bgp
user@PE3# set policy-statement SET_EXPORT_ROUTES term 10 then next-hop
  10.100.1.6
user@PE3# set policy-statement SET_EXPORT_ROUTES term 10 then accept
user@PE3# set policy-statement next-hop term 10 from protocol bgp
user@PE3# set policy-statement next-hop term 10 then next-hop 10.100.1.6
user@PE3# set policy-statement next-hop term 10 then accept
user@PE3# set policy-statement next-hop term 20 from protocol direct
user@PE3# set policy-statement next-hop term 20 from route-filter 10.9.9.6/32
  exact
user@PE3# set policy-statement next-hop term 20 from route-filter 10.100.1.6/32
  exact
user@PE3# set policy-statement next-hop term 20 then next-hop 10.100.1.6
user@PE3# set policy-statement next-hop term 20 then accept
```

6. Configure an IGP, such as OSPF, RIP, or IS-IS.

```
[edit protocols ospf area 0.0.0.3]
user@PE3# set interface 10.9.9.6 passive
user@PE3# set interface 10.9.9.6 metric 1
user@PE3# set interface 10.100.1.6 passive
user@PE3# set interface 10.100.1.6 metric 1
user@PE3# set interface fe-1/2/0.13 metric 1
```

7. Configure the router ID and the autonomous system number.

```
[edit routing-options]
user@PE3# set router-id 10.9.9.6
user@PE3# set autonomous-system 7018
```

8. If you are done configuring the device, commit the configuration.

```
user@PE3# commit
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE3# show interfaces
fe-1/2/0 {
```

```
    unit 13 {
      description PE3-to-PE4;
      family inet {
        address 10.0.0.26/30;
      }
      family mpls;
    }
  }
  lo0 {
    unit 11 {
      family inet {
        address 10.9.9.6/32;
        address 10.100.1.6/32;
      }
    }
  }
```

```
user@PE3# show policy-options
policy-statement SET_EXPORT_ROUTES {
    term 10 {
        from protocol [ direct static bgp ];
        then {
            next-hop 10.100.1.6;
            accept;
        }
    }
}
policy-statement next-hop {
    term 10 {
        from protocol bgp;
        then {
            next-hop 10.100.1.6;
            accept;
        }
    }
    term 20 {
        from {
            protocol direct;
            route-filter 10.9.9.6/32 exact;
            route-filter 10.100.1.6/32 exact;
        }
        then {
            next-hop 10.100.1.6;
            accept;
        }
    }
}
```

```
user@PE3# show protocols
rsvp {
    interface fe-1/2/0.13;
}
mpls {
    label-switched-path PE3-to-PE4 {
        to 10.9.9.4;
    }
    interface fe-1/2/0.13;
```

```
}
bgp {
  group external {
    type external;
    multihop {
      ttl 2;
    }
    local-address 10.9.9.6;
    family inet {
      labeled-unicast {
        aigp;
      }
    }
    export [ next-hop SET_EXPORT_ROUTES ];
    vpn-apply-export;
    peer-as 13979;
    neighbor 10.9.9.4;
  }
}
ospf {
  area 0.0.0.3 {
    interface 10.9.9.6 {
      passive;
      metric 1;
    }
    interface 10.100.1.6 {
      passive;
      metric 1;
    }
    interface fe-1/2/0.13 {
      metric 1;
    }
  }
}
```

```
user@PE3# show routing-options
router-id 10.9.9.6;
autonomous-system 7018;
```

## Configuring Device PE7

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see Using the CLI Editor in Configuration Mode in the CLI User Guide.

To configure Device PE7:

1. Configure the interfaces.

```
[edit interfaces]
user@PE7# set fe-1/2/0 unit 15 description PE7-to-PE1
user@PE7# set fe-1/2/0 unit 15 family inet address 10.0.0.10/30
user@PE7# set lo0 unit 13 family inet address 10.9.9.7/32
user@PE7# set lo0 unit 13 family inet address 10.100.1.7/32
```

2. Configure BGP.

```
[edit protocols bgp group external]
user@PE7# set type external
user@PE7# set export SET_EXPORT_ROUTES
user@PE7# set peer-as 13979
user@PE7# set neighbor 10.0.0.9
```

3. Enable AIGP.

```
[edit protocols bgp group external]
user@PE7# set family inet labeled-unicast aigp
```

4. Configure the routing policy.

```
[edit policy-options policy-statement SET_EXPORT_ROUTES term 10]
user@PE7# set from protocol direct
user@PE7# set from protocol bgp
user@PE7# set then next-hop 10.100.1.7
user@PE7# set then accept
```

5. Configure the router ID and the autonomous system number.

```
[edit routing-options]
user@PE7# set router-id 10.9.9.7
user@PE7# set autonomous-system 7019
```

6. If you are done configuring the device, commit the configuration.

```
user@PE7# commit
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@PE7# show interfaces
interfaces {
    fe-1/2/0 {
        unit 15 {
            description PE7-to-PE1;
            family inet {
                address 10.0.0.10/30;
            }
        }
    }
    lo0 {
        unit 13 {
            family inet {
                address 10.9.9.7/32;
                address 10.100.1.7/32;
            }
        }
    }
}
```

```
user@PE7# show policy-options
policy-statement SET_EXPORT_ROUTES {
```

```
    term 10 {
      from protocol [ direct bgp ];
      then {
        next-hop 10.100.1.7;
        accept;
      }
    }
}

user@PE7# show protocols
bgp {
  group external {
    type external;
    family inet {
      labeled-unicast {
        aigp;
      }
    }
    export SET_EXPORT_ROUTES;
    peer-as 13979;
    neighbor 10.0.0.9;
  }
}

user@PE7# show routing-options
router-id 10.9.9.7;
autonomous-system 7019;
```

## Verification

Confirm that the configuration is working properly.

- Verifying That Device PE4 Is Receiving the AIGP Attribute from Its EBGP Neighbor PE2 on page 34
- Checking the IGP Metric on page 35
- Verifying That Device PE4 Adds the IGP Metric to the AIGP Attribute on page 35
- Verifying That Device PE7 Is Receiving the AIGP Attribute from Its EBGP Neighbor PE1 on page 36
- Verifying the Resolving AIGP Metric on page 37
- Verifying the Presence of AIGP Attributes in BGP Updates on page 39

### Verifying That Device PE4 Is Receiving the AIGP Attribute from Its EBGP Neighbor PE2

**Purpose** Make sure that the AIGP policy on Device PE2 is working.

**Action**

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 299888
     Nexthop: 10.100.1.5
     AS path: 7018 I
     AIGP: 20

* 99.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 299888
     Nexthop: 10.100.1.5
     AS path: 7018 I
     AIGP: 30
```

**Meaning** On Device PE2, the **aigp-originate** statement is configured with a distance of 20 (**aigp-originate distance 20**). This statement is applied to route 55.0.0.0/24. Likewise, the **aigp-originate distance 30** statement is applied to route 99.0.0.0/24. Thus, when Device PE4 receives these routes, the AIGP attribute is attached with the configured metrics.

### Checking the IGP Metric

**Purpose** From Device PE4, check the IGP metric to the BGP next hop 10.100.1.5.

**Action**

```
user@PE4> show route 10.100.1.5
inet.0: 30 destinations, 40 routes (30 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

10.100.1.5/32      *[OSPF/10] 05:35:50, metric 2
                    > to 10.0.0.22 via fe-1/2/2.10
                    [BGP/170] 03:45:07, localpref 100, from 10.9.9.5
                      AS path: 7018 I
                    > to 10.0.0.22 via fe-1/2/2.10
```

**Meaning** The IGP metric for this route is 2.

### Verifying That Device PE4 Adds the IGP Metric to the AIGP Attribute

**Purpose** Make sure that Device PE4 adds the IGP metric to the AIGP attribute when it readvertises routes to its IBGP neighbor, Device PE1.

**Action**

```
user@PE4> show route advertising-protocol bgp 10.9.9.1 extensive

* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group internal type Internal
     Route Label: 300544
     Nexthop: 10.100.1.4
     Flags: Nexthop Change
     Localpref: 100
     AS path: [13979] 7018 I
     AIGP: 22

* 99.0.0.0/24 (1 entry, 1 announced)
 BGP group internal type Internal
     Route Label: 300544
     Nexthop: 10.100.1.4
     Flags: Nexthop Change
     Localpref: 100
     AS path: [13979] 7018 I
     AIGP: 32
```

**Meaning** The IGP metric is added to the AIGP metric (20 + 2 = 22 and 30 + 2 = 32), because the next hop is changed for these routes.

### Verifying That Device PE7 Is Receiving the AIGP Attribute from Its EBGP Neighbor PE1

**Purpose** Make sure that the AIGP policy on Device PE1 is working.

**Action**

```
user@PE7> show route receive-protocol bgp 10.0.0.9 extensive
* 44.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 300096
     Nexthop: 10.0.0.9
     AS path: 13979 I
     AIGP: 203

* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 300112
     Nexthop: 10.0.0.9
     AS path: 13979 7018 I
     AIGP: 25

* 99.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 300112
     Nexthop: 10.0.0.9
     AS path: 13979 7018 I
     AIGP: 35
```

**Meaning** The 44.0.0.0/24 route is originated at Device PE4. The 55.0.0.0/24 and 99.0.0.0/24 routes are originated at Device PE2. The IGP distances are added to the configured AIGP distances.

### Verifying the Resolving AIGP Metric

**Purpose** Confirm that if the prefix is resolved through recursion and the recursive next hops have AIGP metrics, the prefix has the sum of the AIGP values that are on the recursive BGP next hops.

**Action**

1. Add a static route to 66.0.0.0/24.

   ```
   [edit routing-options]
   user@PE2# set static route 66.0.0.0/24 discard
   ```

2. Delete the existing terms in the **aigp** policy statement on Device PE2.

   ```
   [edit policy-options policy-statement aigp]
   user@PE2# delete term 10
   user@PE2# delete term 20
   ```

3. Configure a recursive route lookup for the route to 66.0.0.0.

   The policy shows the AIGP metric for prefix 66.0.0.0/24 (none) and its recursive next hop. Prefix 66.0.0.0/24 is resolved by 55.0.0.1. Prefix 66.0.0.0/24 does not have its own AIGP metric being originated, but its recursive next hop, 55.0.0.1, has an AIGP value.

   ```
   [edit policy-options policy-statement aigp]
   user@PE2# set term 10 from route-filter 55.0.0.1/24 exact
   user@PE2# set term 10 then aigp-originate distance 20
   user@PE2# set term 10 then next-hop 10.100.1.5
   user@PE2# set term 10 then accept
   user@PE2# set term 20 from route-filter 66.0.0.0/24 exact
   user@PE2# set term 20 then next-hop 55.0.0.1
   user@PE2# set term 20 then accept
   ```

4. On Device PE4, run the **show route 55.0.0.0 extensive** command.

   The value of Metric2 is the IGP metric to the BGP next hop. When Device PE4 readvertises these routes to its IBGP peer, Device PE1, the AIGP metric is the sum of AIGP + its Resolving AIGP metric + Metric2.

   Prefix 55.0.0.0 shows its own IGP metric 20, as defined and advertised by Device PE2. It does not show a resolving AIGP value because it does not have a recursive BGP next hop. The value of Metric2 is 2.

   ```
   user@PE4> show route 55.0.0.0 extensive
   inet.0: 31 destinations, 41 routes (31 active, 0 holddown, 0 hidden)
   55.0.0.0/24 (1 entry, 1 announced)
   TSI:
   KRT in-kernel 55.0.0.0/24 -> {indirect(262151)}
   Page 0 idx 0 Type 1 val 928d1b8
       Flags: Nexthop Change
       Nexthop: 10.100.1.4
       Localpref: 100
       AS path: [13979] 7018 I
       Communities:
       AIGP: 22
   Path 55.0.0.0 from 10.9.9.5 Vector len 4.  Val: 0
           *BGP    Preference: 170/-101
                   Next hop type: Indirect
   ```

```
                    Address: 0x925da38
                    Next-hop reference count: 4
                    Source: 10.9.9.5
                    Next hop type: Router, Next hop index: 1004
                    Next hop: 10.0.0.22 via fe-1/2/2.10, selected
                    Label operation: Push 299888
                    Label TTL action: prop-ttl
                    Protocol next hop: 10.100.1.5
                    Push 299888
                    Indirect next hop: 93514d8 262151
                    State: <Active Ext>
                    Local AS: 13979 Peer AS:  7018
                    Age: 22:03:26   Metric2: 2
                    AIGP: 20
                    Task: BGP_7018.10.9.9.5+58560
                    Announcement bits (3): 3-KRT 4-BGP_RT_Background 5-Resolve
tree 1
                    AS path: 7018 I
                    Accepted
                    Route Label: 299888
                    Localpref: 100
                    Router ID: 10.9.9.5
                    Indirect next hops: 1
                            Protocol next hop: 10.100.1.5 Metric: 2
                            Push 299888
                            Indirect next hop: 93514d8 262151
                            Indirect path forwarding next hops: 1
                                    Next hop type: Router
                                    Next hop: 10.0.0.22 via fe-1/2/2.10
                            10.100.1.5/32 Originating RIB: inet.0
                              Metric: 2                     Node path count: 1
                              Forwarding nexthops: 1
                                    Nexthop: 10.0.0.22 via fe-1/2/2.10
```

5. On Device PE4, run the **show route 66.0.0.0 extensive** command.

   Prefix 66.0.0.0/24 shows the Resolving AIGP, which is the sum of its own AIGP metric and its recursive BGP next hop:

   66.0.0.1 = 0, 55.0.0.1 = 20, 0+20 = 20

```
user@PE4> show route 66.0.0.0 extensive
inet.0: 31 destinations, 41 routes (31 active, 0 holddown, 0 hidden)
66.0.0.0/24 (1 entry, 1 announced)
TSI:
KRT in-kernel 66.0.0.0/24 -> {indirect(262162)}
Page 0 idx 0 Type 1 val 928cefc
    Flags: Nexthop Change
    Nexthop: 10.100.1.4
    Localpref: 100
    AS path: [13979] 7018 I
    Communities:
Path 66.0.0.0 from 10.9.9.5 Vector len 4.  Val: 0
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Address: 0x925d4e0
                Next-hop reference count: 4
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 1006
                Next hop: 10.0.0.22 via fe-1/2/2.10, selected
                Label operation: Push 299888, Push 299888(top)
                Label TTL action: prop-ttl, prop-ttl(top)
```

```
                    Protocol next hop: 55.0.0.1
                    Push 299888
                    Indirect next hop: 9353e88 262162
                    State: <Active Ext>
                    Local AS: 13979 Peer AS:  7018
                    Age: 31:42      Metric2: 2
                    Resolving-AIGP: 20
                    Task: BGP_7018.10.9.9.5+58560
                    Announcement bits (3): 3-KRT 4-BGP_RT_Background 5-Resolve
tree 1
                    AS path: 7018 I
                    Accepted
                    Route Label: 299888
                    Localpref: 100
                    Router ID: 10.9.9.5
                    Indirect next hops: 1
                            Protocol next hop: 55.0.0.1 Metric: 2 AIGP: 20
                            Push 299888
                            Indirect next hop: 9353e88 262162
                            Indirect path forwarding next hops: 1
                                    Next hop type: Router
                                    Next hop: 10.0.0.22 via fe-1/2/2.10
                            55.0.0.0/24 Originating RIB: inet.0
                              Metric: 2                     Node path count: 1
                              Indirect nexthops: 1
                                    Protocol Nexthop: 10.100.1.5 Metric: 2 Push
299888
                                    Indirect nexthop: 93514d8 262151
                                    Indirect path forwarding nexthops: 1
                                            Nexthop: 10.0.0.22 via fe-1/2/2.10
                                    10.100.1.5/32 Originating RIB: inet.0
                                      Metric: 2                             Node
 path count: 1
                                       Forwarding nexthops: 1
                                            Nexthop: 10.0.0.22 via fe-1/2/2.10
```

### Verifying the Presence of AIGP Attributes in BGP Updates

**Purpose** If the AIGP attribute is not enabled under BGP (or the **group** or **neighbor** hierarchies), the AIGP attribute is silently discarded. Enable **traceoptions** and include the **packets** flag in the **detail** option in the configuration to confirm the presence of the AIGP attribute in transmitted or received BGP updates. This is useful when debugging AIGP issues.

**Action**

1. Configure Device PE2 and Device PE4 for **traceoptions**.

```
user@host> show protocols bgp
  traceoptions {
    file bgp size 1m files 5;
    flag packets detail;
  }
```

2. Check the **traceoptions** file on Device PE2.

   The following sample shows Device PE2 advertising prefix 99.0.0.0/24 to Device PE4 (10.9.9.4) with an AIGP metric of 20:

```
user@PE2> show log bgp
Mar 22 09:27:18.982150 BGP SEND 10.9.9.5+49652 -> 10.9.9.4+179
Mar 22 09:27:18.982178 BGP SEND message type 2 (Update) length 70
```

```
Mar 22 09:27:18.982198 BGP SEND Update PDU length 70
Mar 22 09:27:18.982248 BGP SEND flags 0x40 code Origin(1): IGP
Mar 22 09:27:18.982273 BGP SEND flags 0x40 code ASPath(2) length 6: 7018
Mar 22 09:27:18.982295 BGP SEND flags 0x80 code AIGP(26): AIGP: 20
Mar 22 09:27:18.982316 BGP SEND flags 0x90 code MP_reach(14): AFI/SAFI 1/4
Mar 22 09:27:18.982341 BGP SEND         nhop 10.100.1.5 len 4
Mar 22 09:27:18.982372 BGP SEND     99.0.0.0/24 (label 301664)
Mar 22 09:27:33.665412 bgp_send: sending 19 bytes to abcd::10:255:170:84
(External AS 13979)
```

3. Verify that the route was received on Device PE4 using the **show route receive-protocol** command.

   AIGP is not enabled on Device PE4, so the AIGP attribute is silently discarded for prefix 99.0.0.0/24 and does not appear in the following output:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0
* 99.0.0.0/24 (2 entries, 1 announced)
     Accepted
     Route Label: 301728
     Nexthop: 10.100.1.5
     AS path: 7018 I
```

4. Check the **traceoptions** file on Device PE4.

   The following output from the **traceoptions** log shows that the 99.0.0.0/24 prefix was received with the AIGP attribute attached:

```
user@PE4> show log bgp
Mar 22 09:41:39.650295 BGP RECV 10.9.9.5+64690 -> 10.9.9.4+179
Mar 22 09:41:39.650331 BGP RECV message type 2 (Update) length 70
Mar 22 09:41:39.650350 BGP RECV Update PDU length 70
Mar 22 09:41:39.650370 BGP RECV flags 0x40 code Origin(1): IGP
Mar 22 09:41:39.650394 BGP RECV flags 0x40 code ASPath(2) length 6: 7018
Mar 22 09:41:39.650415 BGP RECV flags 0x80 code AIGP(26): AIGP: 20
Mar 22 09:41:39.650436 BGP RECV flags 0x90 code MP_reach(14): AFI/SAFI 1/4
Mar 22 09:41:39.650459 BGP RECV         nhop 10.100.1.5 len 4
Mar 22 09:41:39.650495 BGP RECV     99.0.0.0/24 (label 301728)
Mar 22 09:41:39.650574 bgp_rcv_nlri: 99.0.0.0/24
Mar 22 09:41:39.650607 bgp_rcv_nlri: 99.0.0.0/24 belongs to meshgroup
Mar 22 09:41:39.650629 bgp_rcv_nlri: 99.0.0.0/24 qualified bnp->ribact 0x0
l2afcb 0x0
```

**Meaning** Performing this verification helps with AIGP troubleshooting and debugging issues. It enables you to verify which devices in your network send and receive AIGP attributes.

**Related Documentation**

- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Understanding the Accumulated IGP Attribute for BGP on page 2
- Readvertising the AIGP Metric on page 49
- Selecting the Correct ABR While Implementing AIGP on page 72
- Understanding AIGP Policy Restrictions on page 41
- Understanding Multipath When Implementing AIGP on page 67
- Understanding the Path Selection Algorithm and the BGP Decision-Making Process on page 51

## Understanding AIGP Policy Restrictions

This topic provides information about the AIGP policy restrictions when configuring AIGP in your network. Examples of each restriction are presented to show how the policy behaves.

NOTE: The examples in this topic are based on the topology illustrated in Figure 1 on page 4 in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3. Link protection is also used, which causes the bypass path to appear in the outputs. The following sample outputs might not correspond to the sample outputs shown in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3.

This topic contains the following sections:



### Restriction 1: Neighbor Must Be AIGP-Enabled

For AIGP to be successfully implemented into your network, the neighbor of your AIGP-enabled device must also have AIGP enabled.

For example, Device PE2 advertises the prefix 55.0.0.0/24 with an AIGP value of 20.

```
user@PE2> show route advertising-protocol bgp 10.9.9.4 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group ebgp1 type External
     Route Label: 3
     Nexthop: 10.100.1.5
     Flags: Nexthop Change
     AS path: [7018] I
     AIGP: 20
```

However, neighbor Device PE4 does not have the AIGP attribute enabled under BGP, so it silently discards the AIGP attribute, as shown in the following output:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     AS path: 7018 I
```

As soon as AIGP is enabled on Device PE4 under the **bgp-group** hierarchy, the policy action takes effect and the AIGP attribute is received, as shown in the following output:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     AS path: 7018 I
     AIGP: 20
```

## Restriction 2: BGP Speaker Must Have an Export Policy to Advertise AIGP Metric

In this example, the BGP speaker, Device PE2, advertises prefix 55.0.0.0/24 without any AIGP attribute.

```
user@PE2> show route advertising-protocol bgp 10.9.9.4 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group ebgp1 type External
     Route Label: 3
     Nexthop: 10.100.1.5
     Flags: Nexthop Change
     AS path: [7018] I
```

Device PE4 receives prefix 55.0.0.0/24 from Device PE2 without any AIGP attribute.

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     AS path: 7018 I
```

If the **aigp-originate** statement is used on Device PE4 as an import policy, it does not add an AIGP attribute to the prefix, as shown in the following examples:

```
user@PE4> show policy-options policy-statement aigp-import
term 10 {
    from {
        route-filter 55.0.0.0/24 exact;
    }
    then {
        aigp-originate distance 50;
        next-hop 10.100.1.5;
        accept;
    }
}
    term 20 {
        then accept;
    }

user@PE4> show protocols bgp
group ebgp2 {
    type external;
    multihop;
    local-address 10.9.9.4;
    import aigp-import;
    family inet {
        labeled-unicast {
```

```
        aigp;
      }
    }
    export next-hop;
    peer-as 7018;
    multipath;
    neighbor 10.9.9.5;
    neighbor 10.9.9.6;
  }
```

As expected, the AIGP attribute is not added, and it does not appear in the following output from Device PE4:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     AS path: 7018 I
```

The extensive view of the 55.0.0.0/24 prefix on Device PE4 confirms that the AIGP attribute is absent.

```
user@PE4> show route 55.0.0.0 extensive

inet.0: 67 destinations, 82 routes (66 active, 0 holddown, 1 hidden)
55.0.0.0/24 (1 entry, 1 announced)
TSI:
KRT in-kernel 55.0.0.0/24 -> {indirect(1048575)}
Page 0 idx 0 Type 1 val 913d164
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 7
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 608
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
                Label operation: Push 0
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.5
                Indirect next hop: 925c804 1048575
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 25         Metric2: 2
                Task: BGP_7018.10.9.9.5+62727
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted
                Route Label: 3
                Localpref: 100
                Router ID: 10.9.9.5
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.5 Metric: 2
                        Indirect next hop: 925c804 1048575
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
                        10.100.1.5/32 Originating RIB: inet.3
                          Metric: 2                     Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 20.0.0.30 via fe-1/0/0.0
```

## Restriction 3: Prefix Must Have No Current AIGP Attribute

If the receiving prefix already has an AIGP attribute, the **aigp-originate distance <*value*>** statement in the policy does not take effect. In the following output, Device PE4 receives prefix 55.0.0.0 with an AIGP of 20:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     AS path: 7018 I
     AIGP: 20
```

The AIGP configuration does not take effect when Device PE4 has an export policy to set the AIGP attribute for prefix 55.0.0.0/24 to 30 before Device PE4 readvertises the prefix to its IBGP neighbor Device PE1, as shown in the following example:

```
user@PE4> show policy-options policy-statement aigp
term 10 {
  from {
    route-filter 55.0.0.0/24 exact;
  }
  then {
    aigp-originate distance 30;
    next-hop 10.100.1.4;
    accept;
  }
}
```

The IGP metric value of 22 (IGP metric is 2 and AIGP metric is 20) is coded in the AIGP attribute when the route is readvertised to Device PE1. The AIGP metric did not change to 30, as configured under the policy on Device PE4.

```
user@PE4> show route advertising-protocol bgp 10.9.9.1 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group RR type Internal
     Route Label: 300128
     Nexthop: 10.100.1.4
     Flags: Nexthop Change
     Localpref: 100
     AS path: [13979] 7018 I
     AIGP: 22
```

## Restriction 4: Prefix Must Be Exported With Next-Hop Self

For the policy to originate the AIGP metric, the next-hop address for the prefix should be local to the device. If the next hop is not local to the device, the AIGP metric is not advertised. In this case, the **traceoptions** flag **normal** configured under the **protocols bgp** hierarchy is used to determine why the expected AIGP is not advertised.

As shown in the following example, Device PE2 has an AIGP of 20 configured for prefix 55.0.0.1/24 under the export policy:

```
user@PE2> show policy-options policy-statement aigp
term 10 {
```

```
    from {
      route-filter 55.0.0.1/24 exact;
    }
    then {
      aigp-originate distance 20;
      next-hop 10.1.1.2;
      accept;
    }
  }
```

The 10.1.1.2 prefix does not belong to Device PE2, which is why the configured AIGP metric is not advertised to Device PE4 and does not appear in the following output:

```
user@PE2> show route advertising-protocol bgp 10.9.9.4 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group ebgp1 type External
     Route Label: 3
     Nexthop: 10.1.1.2
     Flags: Nexthop Change
     AS path: [7018] I
```

In the following example, the **traceoptions** are configured with the **normal** flag. With this configuration, the output shows why the AIGP attribute is not advertised/originated.

```
user@PE2> show log bgp | grep aigp
Mar  4 17:03:27.124902 AIGP 20 removed. group ebgp1 type External prefix:
55.0.0.0/24
nexthop: 10.1.1.2 reason: originator, nexthop is not local
```

The same **traceoptions** configuration can be used if an AIGP metric is received but not readvertised due to a non-local next hop for that prefix. In the following output, Device PE4 receives prefix 55.0.0.0/24 with the AIGP metric from Device PE2:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     AS path: 7018 I
     AIGP: 20
```

Device PE4 has an export policy with a non-local next hop for this prefix, as shown in the following output:

```
  user@PE4> show policy-options policy-statement aigp
  term 5 {
    from {
      route-filter 55.0.0.0/24 exact;
    }
    then {
      next-hop 10.1.1.2;
      accept;
    }
  }
```

Since prefix 10.1.1.2 is not local to Device PE4, the AIGP metric is removed and not readvertised to the IBGP neighbor Device PE1, so it does not appear in the following output:

```
user@PE4> show route advertising-protocol bgp 10.9.9.1 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group RR type Internal
     Route Label: 300608
     Nexthop: 10.1.1.2
     Flags: Nexthop Change
     Localpref: 100
     AS path: [13979] 7018 I
```

Again, BGP tracing with the **normal** flag identifies why the AIGP metric is not being readvertised, as shown in the following output:

```
user@PE4> show log bgp | grep aigp
Mar  4 17:13:16.647857 AIGP 20 removed. group RR type Internal prefix: 55.0.0.0/24
 nexthop: 10.1.1.2 reason: non-originator, nexthop not local, nexthop not same
as received nexthop
```

**Related Documentation**

- Selecting the Correct ABR While Implementing AIGP on page 72
- Understanding the Accumulated IGP Attribute for BGP on page 2
- Example: Configuring the Accumulated IGP Attribute for BGP on page 3
- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Readvertising the AIGP Metric on page 49
- Understanding Multipath When Implementing AIGP on page 67
- Understanding the Path Selection Algorithm and the BGP Decision-Making Process on page 51
- Using Policy to Originate AIGP on page 46

## Using Policy to Originate AIGP

An AIGP metric can be originated for static, OSPF, and BGP routes by using a policy statement.

NOTE: The examples in this topic are based on the topology illustrated in Figure 1 on page 4 in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3. Link protection is also used, which causes the bypass path to appear in the outputs. The following sample outputs might not correspond to the sample outputs shown in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3.

This topic discusses the following:

- Originating AIGP for Static Routes on page 47
- Originating AIGP for OSPF Routes on page 48

## Originating AIGP for Static Routes

An AIGP metric can be originated for a static route with the use of a policy. In the following example, Device PE4 is configured to originate an AIGP metric of 200 for static route 44.0.0.0/24 and to advertise it to its IBGP neighbor Device PE1. The following output shows the policy that is configured on Device PE4:

```
user@PE4> show policy-options policy-statement aigp
term 10 {
    from {
        protocol static;
        route-filter 44.0.0.0/24 exact;
    }
    then {
        aigp-originate distance 200;
        next-hop 10.100.1.4;
        accept;
    }
}
```

In the following output, Device PE4 advertises prefix 44.0.0.0/24 with an AIGP metric of 200:

```
user@PE4> show route advertising-protocol bgp 10.9.9.1 extensive
inet.0: 67 destinations, 82 routes (66 active, 0 holddown, 1 hidden)
* 44.0.0.0/24 (1 entry, 1 announced)
 BGP group RR type Internal
     Route Label: 300448
     Nexthop: 10.100.1.4
     Flags: Nexthop Change
     Localpref: 100
     AS path: [13979] I
     AIGP: 200
```

In the following output, Device PE1 receives prefix 44.0.0.0/24 with an AIGP metric of 200 from Device PE4:

```
user@PE1> show route receive-protocol bgp 10.9.9.4 extensive
inet.0: 68 destinations, 70 routes (64 active, 0 holddown, 1 hidden)
* 44.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 300448
     Nexthop: 10.100.1.4
     Localpref: 100
     AS path: I
     AIGP: 200
```

Junos OS has a default AIGP metric of 0 for all local routes. If the distance is not configured, the default metric is advertised. The following output shows the policy configured on Device PE4:

```
user@PE4> show policy-options policy-statement aigp
term 10 {
    from {
        protocol static;
        route-filter 44.0.0.0/24 exact;
    }
```

```
    then {
      aigp-originate;
      next-hop 10.100.1.4;
      accept;
    }
  }
```

The AIGP metric of 0 is advertised to IBGP neighbor Device PE1, as shown in the following output:

```
user@PE4> show route advertising-protocol bgp 10.9.9.1 extensive
inet.0: 67 destinations, 82 routes (66 active, 0 holddown, 1 hidden)
* 44.0.0.0/24 (1 entry, 1 announced)
 BGP group RR type Internal
     Route Label: 300448
     Nexthop: 10.100.1.4
     Flags: Nexthop Change
     Localpref: 100
     AS path: [13979] I
     AIGP: 0
```

## Originating AIGP for OSPF Routes

A policy is also used to originate an AIGP metric for OSPF routes. In the following example, Device PE1 is configured to advertise OSPF routes with an AIGP metric of 20 to its EBGP neighbor Device PE7.

The following is the policy configuration on Device PE1:

```
user@PE1> show policy-options policy-statement aigp-ospf
term 10 {
  from protocol ospf;
  then {
    aigp-originate distance 20;
    next-hop 21.0.0.1;
    accept;
  }
}
```

The following output shows the OSPF routes on Device PE1:

```
user@PE1> show route protocol ospf
inet.0: 68 destinations, 70 routes (65 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both

10.9.9.2/32        *[OSPF/10] 4d 20:15:45, metric 2
                    > to 20.0.0.2 via ae0.0
10.9.9.3/32        *[OSPF/10] 4d 20:15:12, metric 2
                    > to 20.0.0.6 via ae1.0
~
~
```

Device PE1 advertises OSPF routes to EBGP peer Device PE7 with a metric of 20 through its export policy, as shown in the following output:

```
user@PE1> show route advertising-protocol bgp 21.0.0.2 extensive
inet.0: 68 destinations, 70 routes (65 active, 0 holddown, 1 hidden)
* 10.9.9.2/32 (1 entry, 1 announced)
 BGP group aigp type External
```

```
Route Label: 301152
Nexthop: 21.0.0.1
Flags: Nexthop Change
MED: 2
AS path: [13979] I
AIGP: 20
```

**Related Documentation**

- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Understanding the Accumulated IGP Attribute for BGP on page 2
- Example: Configuring the Accumulated IGP Attribute for BGP on page 3
- Readvertising the AIGP Metric on page 49
- Selecting the Correct ABR While Implementing AIGP on page 72
- Understanding AIGP Policy Restrictions on page 41
- Understanding Multipath When Implementing AIGP on page 67
- Understanding the Path Selection Algorithm and the BGP Decision-Making Process on page 51

## Readvertising the AIGP Metric

When the next hop is unchanged, a received AIGP metric is readvertised to another AIGP-enabled neighbor without being changed (like IBGP). A received AIGP metric is readvertised to another AIGP-enabled neighbor after adding the metric to a previous BGP next hop if the BGP next hop is changed (like EBGP or changed by the policy). This is based on the assumption that all BGP neighbors are AIGP-enabled.

NOTE: The examples in this topic are based on the topology illustrated in Figure 1 on page 4 in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3. Link protection is also used, which causes the bypass path to appear in the outputs. The following sample outputs might not correspond to the sample outputs shown in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3.

This topic discusses the following:

- Readvertising an AIGP Metric with an Unchanged Next Hop on page 49
- Readvertising an AIGP Metric with a Changed Next Hop on page 50

### Readvertising an AIGP Metric with an Unchanged Next Hop

In this scenario, the BGP connection between Device PE4 and Device PE3 and the BGP connection between Device PE4 and Device PE2 are changed from EBGP to IBGP. Device PE4 receives prefix 55.0.0.0/24 with an AIGP metric of 20 from IBGP peer Device PE2, as shown in the following output:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0/24
```

```
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     Localpref: 100
     AS path: I
     AIGP: 20
```

Device PE4 advertises prefix 55.0.0.0/24 to its IBGP peer Device PE1. Because all the devices are IBGP peers, the next hop is not changed and neither is the AIGP metric, as shown in the following output:

```
user@PE4> show route advertising-protocol bgp 10.9.9.1 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group RR type Internal
     Route Label: 3
     Nexthop: 10.100.1.5
     Localpref: 100
     AS path: [13979] I
     Cluster ID: 1.1.1.1
     Originator ID: 10.9.9.5
     AIGP: 20
```

Device PE1 receives an AIGP metric of 20 for prefix 55.0.0.0/24 from its IBGP peer Device PE4, as shown in the following output:

```
user@PE1> show route receive-protocol bgp 10.9.9.4 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     Localpref: 100
     AS path: I (Originator) Cluster list:  1.1.1.1
     AS path:  Originator ID: 10.9.9.5
     AIGP: 20
```

## Readvertising an AIGP Metric with a Changed Next Hop

Device PE4 receives prefix 55.0.0.0/24 from its EBGP peer Device PE2. The AIGP metric is 20, as shown in the following output:

```
user@PE4> show route receive-protocol bgp 10.9.9.5 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 3
     Nexthop: 10.100.1.5
     AS path: 7018 I
     AIGP: 20
```

The IGP metric to get to the next hop Device PE2 (10.100.1.5) is 2, as shown in the following output:

```
user@PE4> show route 10.100.1.5
inet.0: 67 destinations, 82 routes (66 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both

10.100.1.5/32      *[OSPF/10] 00:25:05, metric 2
                    > to 20.0.0.30 via fe-1/0/0.0
```

Because the next hop changes on Device PE4 for prefix 55.0.0.0/24, the router also alters the AIGP metric by adding 2 (the metric to reach next hop 10.100.1.5) to the original AIGP metric of 20 before readvertising it to Device PE1:

**20 (AIGP metric) + 2 (IGP metric) = 22 (updated AIGP metric)**

The following output from Device PE4 shows the updated AIGP metric:

```
user@PE4> show route advertising-protocol bgp 10.9.9.1 extensive | find 55.0.0.0
* 55.0.0.0/24 (1 entry, 1 announced)
 BGP group RR type Internal
     Route Label: 300832
     Nexthop: 10.100.1.4
     Flags: Nexthop Change
     Localpref: 100
     AS path: [13979] 7018 I
     AIGP: 22
```

Device PE1 thus receives prefix 55.0.0.0/24 from Device PE4, as shown in the following output:

```
user@PE1> show route receive-protocol bgp 10.9.9.4 extensive | find 55.0.0.0/24
* 55.0.0.0/24 (1 entry, 1 announced)
     Accepted
     Route Label: 300832
     Nexthop: 10.100.1.4
     Localpref: 100
     AS path: 7018 I
     AIGP: 22
```

**Related Documentation**

- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Understanding the Accumulated IGP Attribute for BGP on page 2
- Example: Configuring the Accumulated IGP Attribute for BGP on page 3
- Selecting the Correct ABR While Implementing AIGP on page 72
- Understanding AIGP Policy Restrictions on page 41
- Understanding Multipath When Implementing AIGP on page 67
- Understanding the Path Selection Algorithm and the BGP Decision-Making Process on page 51
- Using Policy to Originate AIGP on page 46

## Understanding the Path Selection Algorithm and the BGP Decision-Making Process

When AIGP is implemented, the path selection process is altered.

The following factors are considered in path selection when AIGP is implemented:

- The IGP distance to the next hop is the last next hop after all recursive resolution of the next hop has completed, and is seen as **Metric2** in the sample outputs.
- The AIGP value to be compared is the sum of the AIGP value on the route and the IGP distance to the next hop.

- The interior cost value in the decision-making process is the sum of the IGP distance to the next hop and the sum of all AIGP values on any recursive BGP next hops.

The BGP decision-making process is modified to support AIGP by having the attribute factored in right after the local preference. If the local preference is the same, the next tie-breaking element becomes the AIGP metric, with the prefix having the lower AIGP metric preferred. The tie-breakers after the AIGP metric are the multiple exit discriminator (MED) and the IGP metric, respectively.

NOTE: The examples in this topic are based on the topology illustrated in Figure 1 on page 4 in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3. Link protection is also used, which causes the bypass path to appear in the outputs. The following sample outputs might not correspond to the sample outputs shown in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3.

This topic contains the following sections:



## Local Preference

Local preference is the first tie-breaker in the BGP path selection process. This example illustrates the AIGP-modified path selection behavior when the local preference is not the same. Device PE4 receives prefix 99.0.0.0/24 from Device PE2 with an AIGP metric of 30, and from Device PE3 with an AIGP metric of 20. The local preference for routes received from Device PE2 is 200, while routes received from Device PE3 have a local preference of 100. The route with the higher local preference is selected even though it has a higher AIGP metric. Local preference takes precedence over the AIGP metric, and the **Inactive reason** is **Local Preference**.

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 62 destinations, 77 routes (61 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048589)}
Page 0 idx 0 Type 1 val 913cff8
        *BGP    Preference: 170/-201
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 624
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
                Label operation: Push 301360
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.5
                Push 301360
```

```
                Indirect next hop: 925c558 1048589
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 4:12       Metric2: 2
                AIGP: 30
                Task: BGP_7018.10.9.9.5+57517
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted
                Route Label: 301360
                Localpref: 200
                Router ID: 10.9.9.5
 ~
        BGP     Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 1
                Source: 10.9.9.6
                Next hop type: Router, Next hop index: 626
                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
                Label operation: Push 301408
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.6
                Push 301408
                Indirect next hop: 925c720 1048591
                State: <Ext>
                Inactive reason: Local Preference
                Local AS: 13979 Peer AS:  7018
                Age: 3:22       Metric2: 2
                AIGP: 20
                Task: BGP_7018.10.9.9.6+64800
                AS path: 7018 I
                Accepted
                Route Label: 301408
                Localpref: 100
                Router ID: 10.9.9.6
                Indirect next hops: 1
  ~
  ~
```

## AIGP

As explained in "Understanding the Accumulated IGP Attribute for BGP" on page 2, AIGP is the sum of the AIGP value and the IGP distance to the BGP next hop. When the local preference is the same, the AIGP metric becomes the next tie-breaker in the BGP decision-making process.

Device PE4 receives prefix 99.0.0.0/24 from EBGP peers Device PE3 and Device PE2. The IGP metric for both next hops is the same at 2. The AIGP metric for the prefix received from Device PE2 is 30, while the AIGP metric for the prefix received from Device PE3 is 20. The following sample shows that the lower AIGP metric is selected and the **Inactive reason** is **AIGP**:

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 62 destinations, 77 routes (61 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048591)}
Page 0 idx 0 Type 1 val 913cff8
```

```
*BGP    Preference: 170/-101
        Next hop type: Indirect
        Next-hop reference count: 4
        Source: 10.9.9.6
        Next hop type: Router, Next hop index: 626
        Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
        Label operation: Push 301408
        Label TTL action: prop-ttl
        Protocol next hop: 10.100.1.6
        Push 301408
        Indirect next hop: 925c720 1048591
        State: <Active Ext>
        Local AS: 13979 Peer AS:  7018
        Age: 21:37:53   Metric2: 2
        AIGP: 20
        Task: BGP_7018.10.9.9.6+64800
        Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
        AS path: 7018 I
        Accepted
        Route Label: 301408
        Localpref: 100
        Router ID: 10.9.9.6
        Indirect next hops: 1
                Protocol next hop: 10.100.1.6 Metric: 2
                Push 301408
                Indirect next hop: 925c720 1048591
                Indirect path forwarding next hops: 1
                        Next hop type: Router
                        Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                10.100.1.6/32 Originating RIB: inet.3
                  Metric: 2                     Node path count: 1
                  Forwarding nexthops: 1
                        Nexthop: 20.0.0.26 via fe-0/0/0.0
 BGP    Preference: 170/-101
        Next hop type: Indirect
        Next-hop reference count: 1
        Source: 10.9.9.5
        Next hop type: Router, Next hop index: 624
        Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
        Label operation: Push 301360
        Label TTL action: prop-ttl
        Protocol next hop: 10.100.1.5
        Push 301360
        Indirect next hop: 925c558 1048589
        State: <Ext>
        Inactive reason: AIGP
        Local AS: 13979 Peer AS:  7018
        Age: 21:38:06   Metric2: 2
        AIGP: 30
        Task: BGP_7018.10.9.9.5+57517
        AS path: 7018 I
        Accepted
        Route Label: 301360
        Localpref: 100
        Router ID: 10.9.9.5
        Indirect next hops: 1
                Protocol next hop: 10.100.1.5 Metric: 2
                Push 301360
                Indirect next hop: 925c558 1048589
                Indirect path forwarding next hops: 1
                        Next hop type: Router
```

```
        Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
10.100.1.5/32 Originating RIB: inet.3
  Metric: 2                       Node path count: 1
  Forwarding nexthops: 1
        Nexthop: 20.0.0.30 via fe-1/0/0.0
```

Table 1 on page 55 and the following output show that the routes received from both EBGP peers have the same AIGP metric of 20, and the IGP metric to the BGP next hop has changed. The IGP metric to the BGP next hop for Device PE2 is 2, and 11 for Device PE3. The prefix with the lower accumulated sum is preferred.

**Table 1: AIGP Metrics: Comparing Device PE3 and Device PE2**

| Metrics | Device PE3 | Device PE2 |
|---|---|---|
| AIGP | 20 | 20 |
| IGP Distance (**Metric2**) | 11 | 2 |
| Total | 31 | 22 (preferred) |

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 62 destinations, 77 routes (61 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048589)}
Page 0 idx 0 Type 1 val 913cff8
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 624
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
                Label operation: Push 301360
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.5
                Push 301360
                Indirect next hop: 925c558 1048589
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 54         Metric2: 2
                AIGP: 20
                Task: BGP_7018.10.9.9.5+57517
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted
                Route Label: 301360
                Localpref: 100
                Router ID: 10.9.9.5
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.5 Metric: 2
                        Push 301360
                        Indirect next hop: 925c558 1048589
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
                        10.100.1.5/32 Originating RIB: inet.3
                          Metric: 2                       Node path count: 1
```

```
                    Forwarding nexthops: 1
                          Nexthop: 20.0.0.30 via fe-1/0/0.0
        BGP     Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 1
                Source: 10.9.9.6
                Next hop type: Router, Next hop index: 626
                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
                Label operation: Push 301408
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.6
                Push 301408
                Indirect next hop: 925c720 1048591
                State: <Ext>
                Inactive reason: AIGP
                Local AS: 13979 Peer AS:  7018
                Age: 21:49:08   Metric2: 11
                AIGP: 20
                Task: BGP_7018.10.9.9.6+64800
                AS path: 7018 I
                Accepted
                Route Label: 301408
                Localpref: 100
                Router ID: 10.9.9.6
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.6 Metric: 11
                        Push 301408
                        Indirect next hop: 925c720 1048591
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                        10.100.1.6/32 Originating RIB: inet.3
                          Metric: 11                    Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 20.0.0.26 via fe-0/0/0.0
```

The AIGP metric is compared if all routes have an AIGP value. If all routes do not have an AIGP attribute, the route with an AIGP value is preferred over a route without an AIGP value. At this time, the IGP metric to the next hop is not considered in path calculation.

In the following output, Device PE4 receives prefix 99.0.0.0/24 from EBGP peers Device PE3 and Device PE2. Device PE2 does not send an AIGP attribute, and the IGP metric to the **Protocol next hop: 10.100.1.6** next hop is 2. Device PE3 sends an attribute of AIGP 20, and the IGP metric to the **Protocol next hop: 10.100.1.6** next hop is 11. Although the IGP metric to Device PE3 is higher than the IGP metric to Device PE2, the prefix from Device PE3 is selected because it has an AIGP attribute while Device PE2 does not. The **Inactive reason** is **AIGP**.

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 62 destinations, 77 routes (61 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048591)}
Page 0 idx 0 Type 1 val 913cff8
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.6
```

```
        Next hop type: Router, Next hop index: 626
        Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
        Label operation: Push 301408
        Label TTL action: prop-ttl
        Protocol next hop: 10.100.1.6
        Push 301408
        Indirect next hop: 925c720 1048591
        State: <Active Ext>
        Local AS: 13979 Peer AS:  7018
        Age: 22:05:43   Metric2: 11
        AIGP: 20
        Task: BGP_7018.10.9.9.6+64800
        Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
        AS path: 7018 I
        Accepted
        Route Label: 301408
        Localpref: 100
        Router ID: 10.9.9.6
        Indirect next hops: 1
                Protocol next hop: 10.100.1.6 Metric: 11
                Push 301408
                Indirect next hop: 925c720 1048591
                Indirect path forwarding next hops: 1
                        Next hop type: Router
                        Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                10.100.1.6/32 Originating RIB: inet.3
                  Metric: 11                    Node path count: 1
                  Forwarding nexthops: 1
                        Nexthop: 20.0.0.26 via fe-0/0/0.0
BGP     Preference: 170/-101
        Next hop type: Indirect
        Next-hop reference count: 1
        Source: 10.9.9.5
        Next hop type: Router, Next hop index: 624
        Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
        Label operation: Push 301360
        Label TTL action: prop-ttl
        Protocol next hop: 10.100.1.5
        Push 301360
        Indirect next hop: 925c558 1048589
        State: <Ext>
        Inactive reason: AIGP
        Local AS: 13979 Peer AS:  7018
        Age: 7:21       Metric2: 2
        Task: BGP_7018.10.9.9.5+57517
        AS path: 7018 I
        Accepted
        Route Label: 301360
        Localpref: 100
        Router ID: 10.9.9.5
        Indirect next hops: 1
                Protocol next hop: 10.100.1.5 Metric: 2
                Push 301360
                Indirect next hop: 925c558 1048589
                Indirect path forwarding next hops: 1
                        Next hop type: Router
                        Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
                10.100.1.5/32 Originating RIB: inet.3
                  Metric: 2                     Node path count: 1
                  Forwarding nexthops: 1
                        Nexthop: 20.0.0.30 via fe-1/0/0.0
```

## MED

If the AIGP value is the same, the multiple exit discriminator (MED) attribute becomes the next tie-breaker in the BGP decision-making process (again, do not consider other BGP attributes here). In this example, Device PE4 receives prefix 99.0.0.0/24 from Device PE2 with an AIGP metric of 20 and a MED of 20 (**Metric**). Device PE4 also receives the same route from Device PE3 with an AIGP metric of 20 and a MED of 30 (**Metric**). The local preference is the same for both routes. The route with the lower MED is selected because the AIGP value is the same for both prefixes. The **Inactive reason** is the **MED comparison**.

NOTE: **Metric2** in the following output refers to the IGP metric, which is discussed in "IGP Metric (Interior Cost)" on page 59.

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 65 destinations, 79 routes (64 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048578)}
Page 0 idx 0 Type 1 val 913cff8
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 611
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
                Label operation: Push 301648
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.5
                Push 301648
                Indirect next hop: 925c720 1048578
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 51         Metric: 20    Metric2: 2
      AIGP: 20
                Task: BGP_7018.10.9.9.5+62727
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted
                Route Label: 301648
                Localpref: 100
                Router ID: 10.9.9.5
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.5 Metric: 2
                        Push 301648
                        Indirect next hop: 925c720 1048578
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
                        10.100.1.5/32 Originating RIB: inet.3
                          Metric: 2                     Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 20.0.0.30 via fe-1/0/0.0
          BGP   Preference: 170/-101
                Next hop type: Indirect
```

```
                Next-hop reference count: 1
                Source: 10.9.9.6
                Next hop type: Router, Next hop index: 604
                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
                Label operation: Push 301504
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.6
                Push 301504
                Indirect next hop: 925c558 1048574
                State: <NotBest Ext>
                Inactive reason: Not Best in its group - Route Metric or MED comparison
                Local AS: 13979 Peer AS:  7018
                Age: 4:18       Metric: 30    Metric2: 2
AIGP: 20
                Task: BGP_7018.10.9.9.6+60257
                AS path: 7018 I
                Accepted
                Route Label: 301504
                Localpref: 100
                Router ID: 10.9.9.6
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.6 Metric: 2
                        Push 301504
                        Indirect next hop: 925c558 1048574
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                        10.100.1.6/32 Originating RIB: inet.3
                          Metric: 2                     Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 20.0.0.26 via fe-0/0/0.0
```

## IGP Metric (Interior Cost)

The IGP metric is the interior cost, and is the next tie-breaker of the BGP path selection process. The IGP metric is the sum of the IGP distance to the BGP next hop and the sum of all AIGP values on any recursive BGP next hops. Note that the last resolving route, which is the route that does not need any resolution and is normally an IGP route, is not considered for contributing an AIGP value in the previous calculation. This route, however, is used to provide the IGP distance to the next hop. The resolving AIGP value does not contribute to the calculation until the best route, as defined by BGP rules, has an AIGP value that is the same as the other routes being considered.

In the following example, Device PE4 receives prefix 99.0.0.0/24 from EBGP peers Device PE3 and Device PE2. Device PE2 advertises prefix 99.0.0.0/24 with a next hop of 66.0.0.1. Prefix 66.0.0.0/24 has an AIGP metric of 20, and its BGP next hop is 55.0.0.0.1. The prefix 55.0.0.0/24 has an AIGP metric of 20, and its BGP next hop is 10.100.1.5. Prefix 10.100.1.5 is the last resolving route and does not need resolution. Device PE3 advertises the same prefix 99.0.0.0/24 with a next hop of 88.0.0.1. The route 88.0.0.0/24 has an AIGP metric of 30, and its next hop is 77.0.0.1. The route 77.0.0.0/24 has an AIGP metric of 30, and its BGP next hop is 10.100.1.6. The prefix 10.100.1.6 is the last resolving route and does not need resolution. The AIGP metric of prefix 10.100.1.6 is not considered in the calculation. Prefix 99.0.0.0/24 received from Device PE3, and Device PE2 does not have

any AIGP metric to compare. This results in the resolving AIGP metric contributing to the path selection calculation.

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 66 destinations, 81 routes (65 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048589)}
Page 0 idx 0 Type 1 val 913cff8
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 624
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
                Label operation: Push 301360
                Label TTL action: prop-ttl
                Protocol next hop: 66.0.0.1
                Push 301360
                Indirect next hop: 925cab0 1048589
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 21:40:07   Metric2: 2
      Resolving-AIGP: 40
                Task: BGP_7018.10.9.9.5+57517
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted Multipath
                Route Label: 301360
                Localpref: 100
                Router ID: 10.9.9.5
                Indirect next hops: 1
                        Protocol next hop: 66.0.0.1 Metric: 2 AIGP: 40
                        Push 301360
                        Indirect next hop: 925cab0 1048589
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
                        66.0.0.0/24 Originating RIB: inet.0
                          Metric: 2                     Node path count: 1
                          Indirect nexthops: 1
                                Protocol Nexthop: 55.0.0.1 Metric: 2 AIGP: 20
                                Indirect nexthop: 925c8e8 1048593
                                Indirect path forwarding nexthops: 1
                                        Nexthop: 20.0.0.30 via fe-1/0/0.0
                                55.0.0.0/24 Originating RIB: inet.0
                                  Metric: 2                             Node path count: 1
                                  Indirect nexthops: 1
                                        Protocol Nexthop: 10.100.1.5 Metric: 2
                                        Indirect nexthop: 925c9cc 1048594
                                        Indirect path forwarding nexthops: 1
                                                Nexthop: 20.0.0.30 via fe-1/0/0.0
                                        10.100.1.5/32 Originating RIB: inet.3
                                         Metric: 2                                      Node path count:
 1
                                          Forwarding nexthops: 1
                                                Nexthop: 20.0.0.30 via fe-1/0/0.0
        BGP     Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 1
```

```
                Source: 10.9.9.6
                Next hop type: Router
                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
                Label operation: Push 301408
                Label TTL action: prop-ttl
                Protocol next hop: 88.0.0.1
                Push 301408
                Indirect next hop: 925c804 -
                State: <NotBest Ext>
                Inactive reason: Not Best in its group - IGP metric (plus Resolving-AIGP)
                Local AS: 13979 Peer AS:  7018
                Age: 1:33       Metric2: 2
      Resolving-AIGP: 50
                Task: BGP_7018.10.9.9.6+64800
                AS path: 7018 I
                Accepted
                Route Label: 301408
                Localpref: 100
                Router ID: 10.9.9.6
                Indirect next hops: 1
                        Protocol next hop: 88.0.0.1 Metric: 2 AIGP: 50
                        Push 301408
                        Indirect next hop: 925c804 -
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                        88.0.0.0/24 Originating RIB: inet.0
                          Metric: 2                     Node path count: 1
                          Indirect nexthops: 1
                                Protocol Nexthop: 77.0.0.1 Metric: 2 AIGP: 20
                                Indirect nexthop: 925cc78 1048597
                                Indirect path forwarding nexthops: 1
                                        Nexthop: 20.0.0.26 via fe-0/0/0.0
                                77.0.0.0/24 Originating RIB: inet.0
                                  Metric: 2                             Node path count: 1
                                  Indirect nexthops: 1
                                        Protocol Nexthop: 10.100.1.6 Metric: 2
                                        Indirect nexthop: 925c474 1048588
                                        Indirect path forwarding nexthops: 1
                                                Nexthop: 20.0.0.26 via fe-0/0/0.0
                                        10.100.1.6/32 Originating RIB: inet.3
                                         Metric: 2                                      Node path count:
 1
                                          Forwarding nexthops: 1
                                                Nexthop: 20.0.0.26 via fe-0/0/0.0
```

When the IGP metric to the BGP next hop is increased for Device PE2, the sum of the IGP distance and the **Resolving-AIGP** metric becomes lower for a prefix received from Device PE3 than from Device PE2, as shown in the following output from Device PE4:

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 66 destinations, 81 routes (65 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048600)}
Page 0 idx 0 Type 1 val 913cff8
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.6
```

```
                Next hop type: Router, Next hop index: 630
                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
                Label operation: Push 301504
                Label TTL action: prop-ttl
                Protocol next hop: 88.0.0.1
                Push 301504
                Indirect next hop: 925cd5c 1048600
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 24:46      Metric2: 2
      Resolving-AIGP: 50
                Task: BGP_7018.10.9.9.6+60257
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted
                Route Label: 301504
                Localpref: 100
                Router ID: 10.9.9.6
                Indirect next hops: 1
                        Protocol next hop: 88.0.0.1 Metric: 2 AIGP: 50
                        Push 301504
                        Indirect next hop: 925cd5c 1048600
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                        88.0.0.0/24 Originating RIB: inet.0
                          Metric: 2                     Node path count: 1
                          Indirect nexthops: 1
                                Protocol Nexthop: 77.0.0.1 Metric: 2 AIGP: 20
                                Indirect nexthop: 925c804 1048597
                                Indirect path forwarding nexthops: 1
                                        Nexthop: 20.0.0.26 via fe-0/0/0.0
                                77.0.0.0/24 Originating RIB: inet.0
                                  Metric: 2                             Node path count: 1
                                  Indirect nexthops: 1
                                        Protocol Nexthop: 10.100.1.6 Metric: 2
                                        Indirect nexthop: 925c474 1048588
                                        Indirect path forwarding nexthops: 1
                                                Nexthop: 20.0.0.26 via fe-0/0/0.0
                                        10.100.1.6/32 Originating RIB: inet.3
                                         Metric: 2                                      Node path count:
1
                                           Forwarding nexthops: 1
                                                Nexthop: 20.0.0.26 via fe-0/0/0.0
         BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 1
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 627
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
                Label operation: Push 301472
                Label TTL action: prop-ttl
                Protocol next hop: 66.0.0.1
                Push 301472
                Indirect next hop: 925cab0 1048594
                State: <NotBest Ext>
                Inactive reason: Not Best in its group - IGP metric (plus Resolving-AIGP)
                Local AS: 13979 Peer AS:  7018
                Age: 59:33      Metric2: 21
      Resolving-AIGP: 40
                Task: BGP_7018.10.9.9.5+179
```

```
AS path: 7018 I
Accepted
Route Label: 301472
Localpref: 100
Router ID: 10.9.9.5
Indirect next hops: 1
        Protocol next hop: 66.0.0.1 Metric: 21 AIGP: 40
        Push 301472
        Indirect next hop: 925cab0 1048594
        Indirect path forwarding next hops: 1
                Next hop type: Router
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
        66.0.0.0/24 Originating RIB: inet.0
          Metric: 21                    Node path count: 1
          Indirect nexthops: 1
                Protocol Nexthop: 55.0.0.1 Metric: 21 AIGP: 20
                Indirect nexthop: 925c8e8 1048592
                Indirect path forwarding nexthops: 1
                        Nexthop: 20.0.0.30 via fe-1/0/0.0
                55.0.0.0/24 Originating RIB: inet.0
                  Metric: 21                            Node path count: 1
                  Indirect nexthops: 1
                        Protocol Nexthop: 10.100.1.5 Metric: 21
                        Indirect nexthop: 925c558 1048589
                        Indirect path forwarding nexthops: 1
                                Nexthop: 20.0.0.30 via fe-1/0/0.0
                        10.100.1.5/32 Originating RIB: inet.3
                         Metric: 21                                     Node path count:
1
                          Forwarding nexthops: 1
                                Nexthop: 20.0.0.30 via fe-1/0/0.0
```

The resolving AIGP for prefix 99.0.0.0/24 received from Device PE2 is lower than the resolving AIGP from Device PE3. But the IGP distance to the BGP next hop for the Device PE2 route is much higher than that for Device PE3. The sum of the IGP distance and the resolving AIGP is lower for the route received from Device PE3 than the route received from Device PE2:

**Resolving AIGP + IGP distance to next hop**

Table 2 on page 63 compares the metrics for Device PE2 and Device PE3.

Table 2: IGP Metrics: Comparing Device PE2 and Device PE3

| Metrics | Device PE2 | Device PE3 |
|---|---|---|
| AIGP | 40 | 50 |
| IGP Distance (**Metric2**) | 21 | 2 |
| Total | 61 | 52 (preferred) |

In the following sample, an AIGP metric of 20 was added to the last resolving route 10.100.1.5, and both EBGP next hops have the same IGP distance:

```
user@PE4> show route 10.100.1.5 extensive
inet.0: 66 destinations, 80 routes (65 active, 0 holddown, 1 hidden)
10.100.1.5/32 (2 entries, 2 announced)
```

```
                    TSI:
                    KRT in-kernel 10.100.1.5/32 -> {indirect(1048589)}
                    Page 0 idx 0 Type 1 val 913d2ec
                            *BGP    Preference: 170/-101
                                    Next hop type: Indirect
                                    Next-hop reference count: 4
                                    Source: 10.9.9.5
                                    Next hop type: Router, Next hop index: 625
                                    Next hop: 20.0.0.30 via fe-1/0/0.0, selected
                                    Protocol next hop: 20.0.0.30
                                    Indirect next hop: 925c63c 1048589
                                    State: <Active Ext>
                                    Local AS: 13979 Peer AS:  7018
                                    Age: 1:22       Metric2: 0
                                    AIGP: 20
                                    Task: BGP_7018.10.9.9.5+179
                    ~
                    ~
```

In the following sample, the AIGP metric of prefix 10.100.1.5 is not contributing to the resolution of the AIGP metric calculation, so the software does not even consider the AIGP metric:

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 66 destinations, 80 routes (65 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048596)}
Page 0 idx 0 Type 1 val 913cff8
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 633
                Next hop: 20.0.0.30 via fe-1/0/0.0, selected
                Label operation: Push 301472
                Label TTL action: prop-ttl
                Protocol next hop: 66.0.0.1
                Push 301472
                Indirect next hop: 925ce40 1048596
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 6:11       Metric2: 0
                Resolving-AIGP: 40
                Task: BGP_7018.10.9.9.5+179
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted
                Route Label: 301472
                Localpref: 100
                Router ID: 10.9.9.5
                Indirect next hops: 1
                        Protocol next hop: 66.0.0.1 Metric: 0 AIGP: 40
                        Push 301472
                        Indirect next hop: 925ce40 1048596
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.30 via fe-1/0/0.0
                        66.0.0.0/24 Originating RIB: inet.0
                          Metric: 0                     Node path count: 1
```

```
                        Indirect nexthops: 1
                              Protocol Nexthop: 55.0.0.1 Metric: 0 AIGP: 20
                              Indirect nexthop: 925cab0 1048594
                              Indirect path forwarding nexthops: 1
                                      Nexthop: 20.0.0.30 via fe-1/0/0.0
                              55.0.0.0/24 Originating RIB: inet.0
                                Metric: 0                             Node path count: 1
                                Indirect nexthops: 1
                                      Protocol Nexthop: 10.100.1.5 Metric: 0
                                      Indirect nexthop: 925c558 1048592
                                      Indirect path forwarding nexthops: 1
                                              Nexthop: 20.0.0.30 via fe-1/0/0.0
                                      10.100.1.5/32 Originating RIB: inet.3
                                       Metric: 0                                    Node path count:
1
                                        Forwarding nexthops: 1
                                              Nexthop: 20.0.0.30 via fe-1/0/0.0
        BGP     Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 1
                Source: 10.9.9.6
                Next hop type: Router, Next hop index: 637
                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
                Label operation: Push 301408
                Label TTL action: prop-ttl
                Protocol next hop: 88.0.0.1
                Push 301408
                Indirect next hop: 925c804 1048600
                State: <NotBest Ext>
                Inactive reason: Not Best in its group - IGP metric (plus Resolving-AIGP)
                Local AS: 13979 Peer AS:  7018
                Age: 34:47      Metric2: 2
                Resolving-AIGP: 50
                Task: BGP_7018.10.9.9.6+64800
                AS path: 7018 I
                Accepted
                Route Label: 301408
                Localpref: 100
                Router ID: 10.9.9.6
                Indirect next hops: 1
                        Protocol next hop: 88.0.0.1 Metric: 2 AIGP: 50
                        Push 301408
                        Indirect next hop: 925c804 1048600
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                        88.0.0.0/24 Originating RIB: inet.0
                          Metric: 2                     Node path count: 1
                          Indirect nexthops: 1
                                Protocol Nexthop: 77.0.0.1 Metric: 2 AIGP: 20
                                Indirect nexthop: 925cc78 1048597
                                Indirect path forwarding nexthops: 1
                                        Nexthop: 20.0.0.26 via fe-0/0/0.0
                                77.0.0.0/24 Originating RIB: inet.0
                                  Metric: 2                             Node path count: 1
                                  Indirect nexthops: 1
                                        Protocol Nexthop: 10.100.1.6 Metric: 2
                                        Indirect nexthop: 925c474 1048588
                                        Indirect path forwarding nexthops: 1
                                                Nexthop: 20.0.0.26 via fe-0/0/0.0
                                        10.100.1.6/32 Originating RIB: inet.3
```

```
                                    Metric: 2                                   Node path count:
 1
                                     Forwarding nexthops: 1
                                           Nexthop: 20.0.0.26 via fe-0/0/0.0
```

NOTE: The OSPF protocol between Device PE4 and Device PE2 was disabled and static routes were defined with a higher preference for the BGP peering addresses. Therefore, the BGP route is preferred for 10.100.1.5 instead of the OSPF or static routes, which is why the metric for the Device PE2 route is 0.

If prefix 10.100.1.5 is not the last resolving route, then the AIGP value is considered in calculating the resolving AIGP value, as shown in the following sample:

```
user@PE4> show route 99.0.0.0 extensive

~
~
         BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 1
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 605
                Next hop: 20.0.0.30 via fe-1/0/0.0, selected
                Label operation: Push 301472
                Label TTL action: prop-ttl
                Protocol next hop: 66.0.0.1
                Push 301472
                Indirect next hop: 925ce40 1048596
                State: <NotBest Ext>
                Inactive reason: Not Best in its group - IGP metric (plus Resolving-AIGP)
                Local AS: 13979 Peer AS:  7018
                Age: 45:00      Metric2: 0
                Resolving-AIGP: 60
                Task: BGP_7018.10.9.9.5+179
                AS path: 7018 I
                Accepted
                Route Label: 301472
                Localpref: 100
                Router ID: 10.9.9.5
                Indirect next hops: 1
                        Protocol next hop: 66.0.0.1 Metric: 0 AIGP: 60
                        Push 301472
                        Indirect next hop: 925ce40 1048596
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.30 via fe-1/0/0.0
                        66.0.0.0/24 Originating RIB: inet.0
                          Metric: 0                     Node path count: 1
                          Indirect nexthops: 1
                                Protocol Nexthop: 55.0.0.1 Metric: 0 AIGP: 40
                                Indirect nexthop: 925cab0 1048594
                                Indirect path forwarding nexthops: 1
                                        Nexthop: 20.0.0.30 via fe-1/0/0.0
                                55.0.0.0/24 Originating RIB: inet.0
                                  Metric: 0                             Node path count: 1
                                  Indirect nexthops: 1
                                        Protocol Nexthop: 10.100.1.5 Metric: 0 AIGP: 20
```

```
                    Indirect nexthop: 925c558 1048592
                    Indirect path forwarding nexthops: 1
                            Nexthop: 20.0.0.30 via fe-1/0/0.0
                    10.100.1.5/32 Originating RIB: inet.0
                     Metric: 0                                          Node path count:
1
                      Indirect nexthops: 1
                            Protocol Nexthop: 20.0.0.30
                            Indirect nexthop: 925c63c 1048589
                            Indirect path forwarding nexthops: 1
                                    Nexthop: 20.0.0.30 via fe-1/0/0.0
                            20.0.0.28/30 Originating RIB: inet.0
                              Node path count: 1
                              Forwarding nexthops:
```

**Related Documentation**

- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Understanding the Accumulated IGP Attribute for BGP on page 2
- Example: Configuring the Accumulated IGP Attribute for BGP on page 3
- Readvertising the AIGP Metric on page 49
- Selecting the Correct ABR While Implementing AIGP on page 72
- Understanding AIGP Policy Restrictions on page 41
- Understanding Multipath When Implementing AIGP on page 67
- Using Policy to Originate AIGP on page 46

## Understanding Multipath When Implementing AIGP

When the accumulated interior gateway protocol (AIGP) attribute is enabled on a device, and the routes available to the device all have the same AIGP value, the device can use multipath and ECMP load balancing to send and receive traffic.

NOTE: The examples in this topic are based on the topology illustrated in Figure 1 on page 4 in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3. Link protection is also used, which causes the bypass path to appear in the outputs. The following sample outputs might not correspond to the sample outputs shown in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3.

This topic discusses the following:

- EBGP Multipath on page 67
- ECMP Load Balancing on page 70

### EBGP Multipath

If the IGP distance to the BGP next hop (**Metric2**), the AIGP metric, and the resolving AIGP metric are the same, the traffic is load-balanced among the multiple paths. In this

example, Device PE4 receives prefix 99.0.0.0/24 from its EBGP peers Device PE3 and Device PE2. The IGP distance (**Metric2**), AIGP metric, and resolving AIGP are the same from both peers, as shown in Table 3 on page 68.

### Table 3: BGP Path Selection Metrics: Comparing Device PE3 and Device PE2

| Metrics | Device PE3 | Device PE2 |
|---|---|---|
| AIGP Metric | 0 | 0 |
| IGP Distance (**Metric2**) | 2 | 2 |
| Resolving AIGP | 40 | 40 |
| Total | 42 | 42 |

The following **show** command uses the **extensive** option and shows the route information for prefix 99.0.0.0 on Device PE4:

```
user@PE4> show route 99.0.0.0 extensive

inet.0: 63 destinations, 79 routes (62 active, 0 holddown, 1 hidden)
99.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 99.0.0.0/24 -> {indirect(1048576), indirect(1048590)}
Page 0 idx 1 Type 1 val 913d5c4
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 4
                Source: 10.9.9.5
                Next hop type: Router, Next hop index: 604
                Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1, selected
                Label operation: Push 301888
                Label TTL action: prop-ttl
                Next hop type: Router, Next hop index: 614
                Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                Label operation: Push 301760
                Label TTL action: prop-ttl
                Protocol next hop: 66.0.0.1
                Push 301888
                Indirect next hop: 925c2ac 1048576
                Protocol next hop: 88.0.0.1
                Push 301760
                Indirect next hop: 925cb94 1048590
                State: <Active Ext>
                Local AS: 13979 Peer AS:  7018
                Age: 30:58      Metric2: 2
      Resolving-AIGP: 40
                Task: BGP_7018.10.9.9.5+50209
                Announcement bits (3): 0-KRT 7-BGP_RT_Background 8-Resolve tree 2
                AS path: 7018 I
                Accepted Multipath
                Route Label: 301888
                Localpref: 100
                Router ID: 10.9.9.5
                Indirect next hops: 2
                        Protocol next hop: 66.0.0.1 Metric: 2 AIGP: 40
                        Push 301888
                        Indirect next hop: 925c2ac 1048576
```

```
                    Indirect path forwarding next hops: 1
                            Next hop type: Router
                            Next hop: 20.0.0.30 via fe-1/0/0.0 weight 0x1
                    66.0.0.0/24 Originating RIB: inet.0
                      Metric: 2                     Node path count: 1
                      Indirect nexthops: 1
                            Protocol Nexthop: 55.0.0.1 Metric: 2 AIGP: 20
                            Indirect nexthop: 925c1c8 1048575
                            Indirect path forwarding nexthops: 1
                                    Nexthop: 20.0.0.30 via fe-1/0/0.0
                            55.0.0.0/24 Originating RIB: inet.0
                              Metric: 2                             Node path count: 1
                              Indirect nexthops: 1
                                    Protocol Nexthop: 10.100.1.5 Metric: 2
                                    Indirect nexthop: 925c0e4 1048574
                                    Indirect path forwarding nexthops: 1
                                            Nexthop: 20.0.0.30 via fe-1/0/0.0
                                    10.100.1.5/32 Originating RIB: inet.3
                                     Metric: 2                                      Node path count:
1
                                       Forwarding nexthops: 1
                                            Nexthop: 20.0.0.30 via fe-1/0/0.0
                    Protocol next hop: 88.0.0.1 Metric: 2 AIGP: 40
                    Push 301760
                    Indirect next hop: 925cb94 1048590
                    Indirect path forwarding next hops: 1
                            Next hop type: Router
                            Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                    88.0.0.0/24 Originating RIB: inet.0
                      Metric: 2                     Node path count: 1
                      Indirect nexthops: 1
                            Protocol Nexthop: 77.0.0.1 Metric: 2 AIGP: 20
                            Indirect nexthop: 925c9cc 1048588
                            Indirect path forwarding nexthops: 1
                                    Nexthop: 20.0.0.26 via fe-0/0/0.0
                            77.0.0.0/24 Originating RIB: inet.0
                              Metric: 2                             Node path count: 1
                              Indirect nexthops: 1
                                    Protocol Nexthop: 10.100.1.6 Metric: 2
                                    Indirect nexthop: 925c804 1048584
                                    Indirect path forwarding nexthops: 1
                                            Nexthop: 20.0.0.26 via fe-0/0/0.0
                                    10.100.1.6/32 Originating RIB: inet.3
                                     Metric: 2                                      Node path count:
1
                                       Forwarding nexthops: 1
                                            Nexthop: 20.0.0.26 via fe-0/0/0.0
            BGP     Preference: 170/-101
                    Next hop type: Indirect
                    Next-hop reference count: 1
                    Source: 10.9.9.6
                    Next hop type: Router, Next hop index: 614
                    Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1, selected
                    Label operation: Push 301760
                    Label TTL action: prop-ttl
                    Protocol next hop: 88.0.0.1
                    Push 301760
                    Indirect next hop: 925cb94 1048590
                    State: <NotBest Ext>
                    Inactive reason: Not Best in its group - Active preferred
                    Local AS: 13979 Peer AS:  7018
```

```
            Age: 30:44      Metric2: 2
    Resolving-AIGP: 40
            Task: BGP_7018.10.9.9.6+179
            AS path: 7018 I
            Accepted
            Route Label: 301760
            Localpref: 100
            Router ID: 10.9.9.6
            Indirect next hops: 1
                    Protocol next hop: 88.0.0.1 Metric: 2 AIGP: 40
                    Push 301760
                    Indirect next hop: 925cb94 1048590
                    Indirect path forwarding next hops: 1
                            Next hop type: Router
                            Next hop: 20.0.0.26 via fe-0/0/0.0 weight 0x1
                    88.0.0.0/24 Originating RIB: inet.0
                      Metric: 2                     Node path count: 1
                      Indirect nexthops: 1
                            Protocol Nexthop: 77.0.0.1 Metric: 2 AIGP: 20
                            Indirect nexthop: 925c9cc 1048588
                            Indirect path forwarding nexthops: 1
                                    Nexthop: 20.0.0.26 via fe-0/0/0.0
                            77.0.0.0/24 Originating RIB: inet.0
                              Metric: 2                             Node path count: 1
                              Indirect nexthops: 1
                                    Protocol Nexthop: 10.100.1.6 Metric: 2
                                    Indirect nexthop: 925c804 1048584
                                    Indirect path forwarding nexthops: 1
                                            Nexthop: 20.0.0.26 via fe-0/0/0.0
                                    10.100.1.6/32 Originating RIB: inet.3
                                     Metric: 2                                      Node path count:
1
                                       Forwarding nexthops: 1
                                            Nexthop: 20.0.0.26 via fe-0/0/0.0
```

The following output from Device PE4 shows that it has chosen both paths as the next hop for prefix 99.0.0.0 in its forwarding table:

```
user@PE4> show route forwarding-table destination 99.0.0.0
Routing table: default.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
99.0.0.0/24        user     0                    ulst 1048591     1
                                                 indr 1048576     2
                                20.0.0.30        Push 301888  604   2 fe-1/0/0.0
                                                 indr 1048590     2
                                20.0.0.26        Push 301760  614   2 fe-0/0/0.0
```

## ECMP Load Balancing

Device PE1 receives prefix 55.0.0.0/24 from its IBGP peer Device PE4. Device PE1 can connect to BGP next hop Device PE4 through area border routers (ABRs) Device P1 and Device P2. The IGP distance to both BGP next hops is the same (**Metric2 = 3**), resulting in load balancing between these two equal-cost multipath ABRs.

The following **show** command uses the **extensive** option and shows the route information for prefix 5.0.0.0/24 on Device PE1:

```
user@PE1> show route 55.0.0.0/24 extensive
```

```
inet.0: 67 destinations, 69 routes (64 active, 0 holddown, 1 hidden)
55.0.0.0/24 (1 entry, 1 announced)
TSI:
KRT in-kernel 55.0.0.0/24 -> {indirect(1048575)}
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 3
                Source: 10.9.9.4
                Next hop type: Router, Next hop index: 1048574
                Next hop: 20.0.0.2 via ae0.0, selected
                Label operation: Push 302096
                Label TTL action: prop-ttl
                Next hop: 20.0.0.6 via ae1.0
                Label operation: Push 302096
                Label TTL action: prop-ttl
                Protocol next hop: 10.9.9.4
                Push 302096
                Indirect next hop: 92740e4 1048575
                State: <Active Int Ext>
                Local AS: 13979 Peer AS: 13979
                Age: 51:34      Metric2: 3
      AIGP: 22
                Task: BGP_13979.10.9.9.4+53926
                Announcement bits (2): 0-KRT 7-Resolve tree 2
                AS path: 7018 I
                Accepted
                Route Label: 302096
                Localpref: 100
                Router ID: 10.9.9.4
                Indirect next hops: 1
                        Protocol next hop: 10.9.9.4 Metric: 3
                        Push 302096
                        Indirect next hop: 92740e4 1048575
                        Indirect path forwarding next hops: 2
                                Next hop type: Router
                                Next hop: 20.0.0.2 via ae0.0
                                Next hop: 20.0.0.6 via ae1.0
                        10.9.9.4/32 Originating RIB: inet.0
                          Metric: 3                     Node path count: 1
                          Forwarding nexthops: 2
                                Nexthop: 20.0.0.2 via ae0.0
                                Nexthop: 20.0.0.6 via ae1.0
```

The forwarding table shows that Device PE1 has both paths (ABRs) as a next hop for prefix 5.0.0.0/24.

```
user@PE1> show route forwarding-table destination 55.0.0.0/24
Routing table: default.inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
55.0.0.0/24        user     0                    indr 1048575     2
                                                 ulst 1048574     2
                              20.0.0.2     Push 302096  634   1 ae0.0
                              20.0.0.6     Push 302096  657   1 ae1.0
```

**Related Documentation**

- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Understanding the Accumulated IGP Attribute for BGP on page 2

## Selecting the Correct ABR While Implementing AIGP

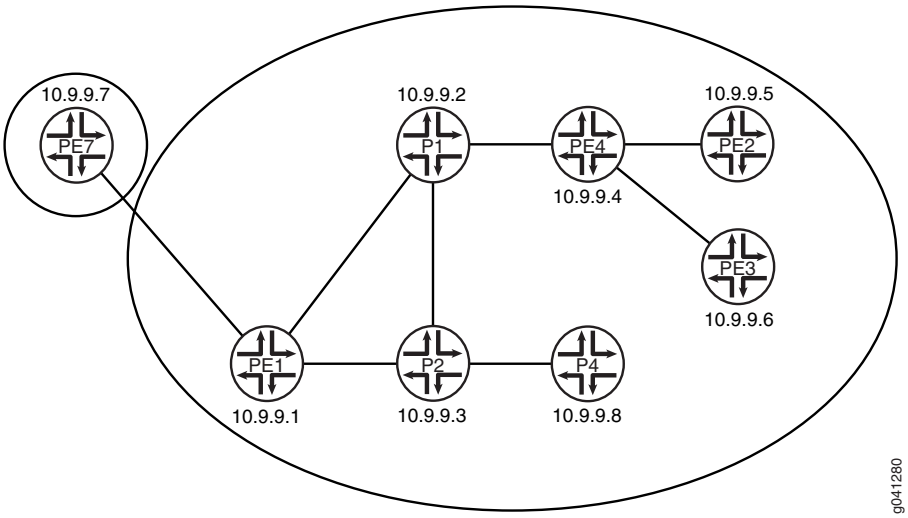
When AIGP is implemented in a network where there is more than one area border router (ABR) available for the forwarding device to use, AIGP enables the device to choose the ABR that is based on the IGP distance to the BGP next hop and the AIGP value.

Figure 2 on page 72 shows the topology of this scenario. Device PE4 is advertising prefix 33.0.0.0/24 with an AIGP metric of 10, and prefix 44.0.0.0/24 with an AIGP metric of 20. Device P4 is advertising prefix 33.0.0.0/24 with an AIGP metric of 20, and prefix 44.0.0.0/24 with an AIGP metric of 10. The IGP distance for Device PE4 and Device P4 is 3.

Device PE4 is connected to Devices P1, PE3, and PE2, and Device P4 is connected to Device P2. The router ID of Device P4 is 10.9.9.8, and the BGP next hop is 10.100.1.8. Device PE1 has two ABRs (Device P1 and Device P2) to choose from since Device PE1 receives the same prefixes from Device PE4 and Device P4. Device PE1 chooses which ABR to use by adding the IGP distance to the BGP next hop and the AIGP value:

**IGP distance to the BGP next hop + AIGP value = ABR metric**

Figure 2: Network Topology for ABR Selection



As shown in Figure 2 on page 72, Device PE1 chooses ABR Device P1 for prefix 33.0.0.0, and Device P2 for prefix 44.0.0.0 based on the AIGP value, because the IGP distance is the same for both. This selection is because prefix 33.0.0.0/24 has a lower AIGP metric coming from Device PE4, and prefix 44.0.0.0/24 has a lower AIGP coming from Device P4.

NOTE: In the following samples, link protection is used, which causes the bypass path to appear in the outputs. Also, the following sample outputs might not correspond to the sample outputs shown in "Example: Configuring the Accumulated IGP Attribute for BGP" on page 3.

The following **show** command uses the **extensive** option and shows the route information for prefix 33.0.0.0 on Device PE1:

```
user@PE1> show route 33.0.0.0 extensive

inet.0: 66 destinations, 70 routes (63 active, 0 holddown, 1 hidden)
33.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 33.0.0.0/24 -> {indirect(1048582)}
Page 0 idx 0 Type 1 val 91495a8
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 5
                Source: 10.9.9.4
                Next hop type: Router, Next hop index: 1048592
                Next hop: 20.0.0.2 via ae0.0 weight 0x1, selected
                Label operation: Push 301664, Push 300896(top)
                Label TTL action: prop-ttl, prop-ttl(top)
                Next hop: 20.0.0.6 via ae1.0 weight 0x8001
                Label operation: Push 301664, Push 300896, Push 301568(top)
                Label TTL action: prop-ttl, prop-ttl, prop-ttl(top)
                Protocol next hop: 10.100.1.4
                Push 301664
                Indirect next hop: 92740e4 1048582
                State: <Active Int Ext>
                Local AS: 13979 Peer AS: 13979
                Age: 11         Metric2: 3
                AIGP: 10
                Task: BGP_13979.10.9.9.4+50932
                Announcement bits (3): 0-KRT 6-BGP_RT_Background 7-Resolve tree 2
                AS path: I
                Accepted
                Route Label: 301664
                Localpref: 100
                Router ID: 10.9.9.4
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.4 Metric: 3
                        Push 301664
                        Indirect next hop: 92740e4 1048582
                        Indirect path forwarding next hops: 2
                                Next hop type: Router
                                Next hop: 20.0.0.2 via ae0.0 weight 0x1
                                Next hop: 20.0.0.6 via ae1.0 weight 0x8001
                        10.100.1.4/32 Originating RIB: inet.3
                          Metric: 3                     Node path count: 1
                          Forwarding nexthops: 2
```

```
                        Nexthop: 20.0.0.2 via ae0.0
                        Nexthop: 20.0.0.6 via ae1.0
        BGP     Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 5
                Source: 10.9.9.8
                Next hop type: Router, Next hop index: 660
                Next hop: 20.0.0.6 via ae1.0, selected
                Label operation: Push 299776
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.8
                Push 299776
                Indirect next hop: 92742ac 1048579
                State: <Int Ext>
                Inactive reason: AIGP
                Local AS: 13979 Peer AS: 13979
                Age: 11         Metric2: 3
                AIGP: 20
                Task: BGP_13979.10.9.9.8+179
                AS path: I
                Accepted
                Route Label: 299776
                Localpref: 100
                Router ID: 10.9.9.8
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.8 Metric: 3
                        Push 299776
                        Indirect next hop: 92742ac 1048579
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.6 via ae1.0
                        10.100.1.8/32 Originating RIB: inet.0
                          Metric: 3                     Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 20.0.0.6 via ae1.0
```

The following **show** command uses the **extensive** option and shows the route information for prefix 44.0.0.0 extensive on Device PE1:

```
user@PE1> show route 44.0.0.0 extensive

inet.0: 66 destinations, 70 routes (63 active, 0 holddown, 1 hidden)
44.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 44.0.0.0/24 -> {indirect(1048579)}
Page 0 idx 0 Type 1 val 9149880
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 5
                Source: 10.9.9.8
                Next hop type: Router, Next hop index: 660
                Next hop: 20.0.0.6 via ae1.0, selected
                Label operation: Push 299776
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.8
                Push 299776
                Indirect next hop: 92742ac 1048579
                State: <Active Int Ext>
                Local AS: 13979 Peer AS: 13979
                Age: 23         Metric2: 3
                AIGP: 10
```

```
        Task: BGP_13979.10.9.9.8+179
        Announcement bits (3): 0-KRT 6-BGP_RT_Background 7-Resolve tree 2
        AS path: I
        Accepted
        Route Label: 299776
        Localpref: 100
        Router ID: 10.9.9.8
        Indirect next hops: 1
                Protocol next hop: 10.100.1.8 Metric: 3
                Push 299776
                Indirect next hop: 92742ac 1048579
                Indirect path forwarding next hops: 1
                        Next hop type: Router
                        Next hop: 20.0.0.6 via ae1.0
                10.100.1.8/32 Originating RIB: inet.0
                  Metric: 3                     Node path count: 1
                  Forwarding nexthops: 1
                        Nexthop: 20.0.0.6 via ae1.0
BGP     Preference: 170/-101
        Next hop type: Indirect
        Next-hop reference count: 5
        Source: 10.9.9.4
        Next hop type: Router, Next hop index: 1048592
        Next hop: 20.0.0.2 via ae0.0 weight 0x1, selected
        Label operation: Push 301664, Push 300896(top)
        Label TTL action: prop-ttl, prop-ttl(top)
        Next hop: 20.0.0.6 via ae1.0 weight 0x8001
        Label operation: Push 301664, Push 300896, Push 301568(top)
        Label TTL action: prop-ttl, prop-ttl, prop-ttl(top)
        Protocol next hop: 10.100.1.4
        Push 301664
        Indirect next hop: 92740e4 1048582
        State: <Int Ext>
        Inactive reason: AIGP
        Local AS: 13979 Peer AS: 13979
        Age: 23         Metric2: 3
        AIGP: 20
        Task: BGP_13979.10.9.9.4+50932
        AS path: I
        Accepted
        Route Label: 301664
        Localpref: 100
        Router ID: 10.9.9.4
        Indirect next hops: 1
                Protocol next hop: 10.100.1.4 Metric: 3
                Push 301664
                Indirect next hop: 92740e4 1048582
                Indirect path forwarding next hops: 2
                        Next hop type: Router
                        Next hop: 20.0.0.2 via ae0.0 weight 0x1
                        Next hop: 20.0.0.6 via ae1.0 weight 0x8001
                10.100.1.4/32 Originating RIB: inet.3
                  Metric: 3                     Node path count: 1
                  Forwarding nexthops: 2
                        Nexthop: 20.0.0.2 via ae0.0
                        Nexthop: 20.0.0.6 via ae1.0
```

If the IGP metric on Device PE1 is changed so that the sum of the IGP distance to the BGP next hop and the AIGP metric is still lower for prefix 44.0.0.0/24 received from Device

P4, then Device PE1 still selects Device P4 as the next hop for route 44.0.0.0/24, but the ABR changes from Device P2 to Device P1, as shown in the following outputs:

```
user@PE1> show route 10.100.1

 inet.0: 66 destinations, 71 routes (63 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both

10.100.1.8/32      *[OSPF/10] 00:00:02, metric 4
                     > to 20.0.0.2 via ae0.0

user@PE1> show route 44.0.0.0 extensive

inet.0: 66 destinations, 71 routes (63 active, 0 holddown, 1 hidden)
44.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 44.0.0.0/24 -> {indirect(1048579)}
Page 0 idx 0 Type 1 val 9149880
        *BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 5
                Source: 10.9.9.8
                Next hop type: Router, Next hop index: 702
                Next hop: 20.0.0.2 via ae0.0, selected
                Label operation: Push 299776
                Label TTL action: prop-ttl
                Protocol next hop: 10.100.1.8
                Push 299776
                Indirect next hop: 92742ac 1048579
                State: <Active Int Ext>
                Local AS: 13979 Peer AS: 13979
                Age: 27:58      Metric2: 4
                AIGP: 10
                Task: BGP_13979.10.9.9.8+179
                Announcement bits (3): 0-KRT 6-BGP_RT_Background 7-Resolve tree 2
                AS path: I
                Accepted
                Route Label: 299776
                Localpref: 100
                Router ID: 10.9.9.8
                Indirect next hops: 1
                        Protocol next hop: 10.100.1.8 Metric: 4
                        Push 299776
                        Indirect next hop: 92742ac 1048579
                        Indirect path forwarding next hops: 1
                                Next hop type: Router
                                Next hop: 20.0.0.2 via ae0.0
                        10.100.1.8/32 Originating RIB: inet.0
                          Metric: 4                     Node path count: 1
                          Forwarding nexthops: 1
                                Nexthop: 20.0.0.2 via ae0.0
         BGP    Preference: 170/-101
                Next hop type: Indirect
                Next-hop reference count: 5
                Source: 10.9.9.4
                Next hop type: Router, Next hop index: 1048592
                Next hop: 20.0.0.2 via ae0.0 weight 0x1, selected
                Label operation: Push 301664, Push 300896(top)
                Label TTL action: prop-ttl, prop-ttl(top)
                Next hop: 20.0.0.6 via ae1.0 weight 0x8001
                Label operation: Push 301664, Push 300896, Push 301568(top)
```

```
Label TTL action: prop-ttl, prop-ttl, prop-ttl(top)
Protocol next hop: 10.100.1.4
Push 301664
Indirect next hop: 92740e4 1048582
State: <Int Ext>
Inactive reason: AIGP
Local AS: 13979 Peer AS: 13979
Age: 27:58      Metric2: 3
AIGP: 20
Task: BGP_13979.10.9.9.4+50932
AS path: I
Accepted
Route Label: 301664
Localpref: 100
Router ID: 10.9.9.4
Indirect next hops: 1
        Protocol next hop: 10.100.1.4 Metric: 3
        Push 301664
        Indirect next hop: 92740e4 1048582
        Indirect path forwarding next hops: 2
                Next hop type: Router
                Next hop: 20.0.0.2 via ae0.0 weight 0x1
                Next hop: 20.0.0.6 via ae1.0 weight 0x8001
        10.100.1.4/32 Originating RIB: inet.3
          Metric: 3                     Node path count: 1
          Forwarding nexthops: 2
                Nexthop: 20.0.0.2 via ae0.0
                Nexthop: 20.0.0.6 via ae1.0
```

In the previous output, the IGP distance (**Metric2**) for ABR Device P2 changed so that the sum of the IGP distance and the AIGP metric for prefix 44.0.0.0/24 coming from Device P4 is higher than Device PE4. Table 4 on page 77 shows the difference between the metric sums of Device PE4 and Device P4.

Table 4: Metric Sums: Comparing Device PE4 and Device P4

| Metrics | Device PE4 | Device P4 |
|---|---|---|
| AIGP | 20 | 10 |
| IGP Distance (**Metric2**) | 3 | 53 |
| Total | 23 (preferred) | 63 |

Although the AIGP metric is still lower for prefix 44.0.0.0/24 from Device P4, the sum of the AIGP metric and the IGP distance from Device PE4 is lower than the sum of the IGP distance and the AIGP metric from Device P4. Device PE1 selected Device PE4 for this reason, as shown in the following output:

```
user@PE1> show route 44.0.0.0/24

inet.0: 66 destinations, 71 routes (63 active, 0 holddown, 1 hidden)
44.0.0.0/24 (2 entries, 1 announced)
TSI:
KRT in-kernel 44.0.0.0/24 -> {indirect(1048582)}
Page 0 idx 0 Type 1 val 9149880
        *BGP    Preference: 170/-101
                Next hop type: Indirect
```

```
        Next-hop reference count: 7
        Source: 10.9.9.4
        Next hop type: Router, Next hop index: 1048592
        Next hop: 20.0.0.2 via ae0.0 weight 0x1, selected
        Label operation: Push 301664, Push 300896(top)
        Label TTL action: prop-ttl, prop-ttl(top)
        Next hop: 20.0.0.6 via ae1.0 weight 0x8001
        Label operation: Push 301664, Push 300896, Push 301568(top)
        Label TTL action: prop-ttl, prop-ttl, prop-ttl(top)
        Protocol next hop: 10.100.1.4
        Push 301664
        Indirect next hop: 92740e4 1048582
        State: <Active Int Ext>
        Local AS: 13979 Peer AS: 13979
        Age: 18:19      Metric2: 3
        AIGP: 20
        Task: BGP_13979.10.9.9.4+50932
        Announcement bits (3): 0-KRT 6-BGP_RT_Background 7-Resolve tree 2
        AS path: I
        Accepted
        Route Label: 301664
        Localpref: 100
        Router ID: 10.9.9.4
        Indirect next hops: 1
                Protocol next hop: 10.100.1.4 Metric: 3
                Push 301664
                Indirect next hop: 92740e4 1048582
                Indirect path forwarding next hops: 2
                        Next hop type: Router
                        Next hop: 20.0.0.2 via ae0.0 weight 0x1
                        Next hop: 20.0.0.6 via ae1.0 weight 0x8001
                10.100.1.4/32 Originating RIB: inet.3
                  Metric: 3                     Node path count: 1
                  Forwarding nexthops: 2
                        Nexthop: 20.0.0.2 via ae0.0
                        Nexthop: 20.0.0.6 via ae1.0
BGP     Preference: 170/-101
        Next hop type: Indirect
        Next-hop reference count: 2
        Source: 10.9.9.8
        Next hop type: Router, Next hop index: 705
        Next hop: 20.0.0.2 via ae0.0, selected
        Label operation: Push 299776
        Label TTL action: prop-ttl
        Protocol next hop: 10.100.1.8
        Push 299776
        Indirect next hop: 92742ac 1048579
        State: <Int Ext>
        Inactive reason: AIGP
        Local AS: 13979 Peer AS: 13979
        Age: 18:19      Metric2: 53
        AIGP: 10
        Task: BGP_13979.10.9.9.8+179
        AS path: I
        Accepted
        Route Label: 299776
        Localpref: 100
        Router ID: 10.9.9.8
        Indirect next hops: 1
                Protocol next hop: 10.100.1.8 Metric: 53
                Push 299776
```

```
Indirect next hop: 92742ac 1048579
Indirect path forwarding next hops: 1
        Next hop type: Router
        Next hop: 20.0.0.2 via ae0.0
10.100.1.8/32 Originating RIB: inet.0
  Metric: 53                      Node path count: 1
  Forwarding nexthops: 1
        Nexthop: 20.0.0.2 via ae0.0
```

**Related Documentation**

- Advantages of Using the Accumulated IGP Metric Attribute for BGP on page 1
- Understanding the Accumulated IGP Attribute for BGP on page 2
- Example: Configuring the Accumulated IGP Attribute for BGP on page 3
- Readvertising the AIGP Metric on page 49
- Understanding AIGP Policy Restrictions on page 41
- Understanding Multipath When Implementing AIGP on page 67
- Understanding the Path Selection Algorithm and the BGP Decision-Making Process on page 51
- Using Policy to Originate AIGP on page 46