BGP ADD-PATH

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ADD-PATH

Agenda

1. Overview
2. Use Cases
3. Details / Caveats
4. Configuration
5. Best Practices
6. Troubleshooting
7. Demo
8. Resources
## Definitions

### Acronyms

- **MP-BGP**  
  Multi-Protocol Border Gateway Protocol
- **AF**  
  Address Family (Ex: IPv4, IPv6 or EVPN address families used in MP-BGP)
- **EVPN**  
  Ethernet Virtual Private Network
- **L2VPN**  
  Layer2 Virtual Private Network
- **MB-BGP EVPN**  
  Refers to the EVPN address family in MP-BGP
- **ADD-PATH**  
  BGP ADD-PATH capability
- **NLRI**  
  Network Layer Reachability Information
Overview

Reminder

- BGP, by default, does not provide multiple paths for a given prefix.

- A Route-Reflector will only advertise the **best path** as determined by the BGP route selection process. It will never advertise more than **one path** to a RR client irrespective of whether the RR has one or more paths for the given prefix.

- The BGP path advertisement of a prefix with new attributes replaces the previous announcement of that prefix. This behavior is known as an implicit withdraw, which effectively **prevents the advertisement of multiple paths for the same prefix**.
# BGP route selection reminder

## Part 1: commonly used

<table>
<thead>
<tr>
<th>Step</th>
<th>BGP attribute / criteria</th>
<th>Attribute type</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>next hop reachability</td>
<td></td>
<td>Next-hop in routing table (ex: in OSPF)</td>
</tr>
<tr>
<td>2</td>
<td>highest weight</td>
<td>proprietary</td>
<td>local to router</td>
</tr>
<tr>
<td>3</td>
<td>highest local-preference</td>
<td>discretionary</td>
<td>Globally defined within the AS. Default LP=100</td>
</tr>
<tr>
<td>4</td>
<td>router originated</td>
<td></td>
<td>route locally originated by itself (like redistribution or route leaking)</td>
</tr>
<tr>
<td>5</td>
<td>shortest AS-PATH length</td>
<td>Mandatory</td>
<td>• Can be skipped with bgp bestpath as-path ignore.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Selection can be stopped with bgp bestpath as-path multipath-relax</td>
</tr>
<tr>
<td>6</td>
<td>lowest origin type</td>
<td>Mandatory</td>
<td>IGP &lt; EGP &lt; incomplete</td>
</tr>
<tr>
<td>7</td>
<td>lowest Multi-Exit-Discriminator</td>
<td>Optional non-transitive</td>
<td>MEDs are compared if routes came from the same remote AS or if bgp always-compare-med is enabled</td>
</tr>
<tr>
<td>8</td>
<td>eBGP preferred over iBGP or confederation</td>
<td></td>
<td>confinement paths are treated as iBGP</td>
</tr>
<tr>
<td>9</td>
<td>lowest IGP cost to the BGP next-hop</td>
<td></td>
<td>closest IGP neighbor</td>
</tr>
</tbody>
</table>
# BGP route selection reminder

Part 2: routing design should avoid usage of these criterias

<table>
<thead>
<tr>
<th>Step</th>
<th>BGP attribute / criteria</th>
<th>Attribute type</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Oldest eBGP route</td>
<td>N/A</td>
<td>most stable path</td>
</tr>
<tr>
<td>11</td>
<td>lowest router ID OR lowest originator ID (in case of RR)</td>
<td>Mandatory</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>lowest cluster list length</td>
<td>Optional non-transitive</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>lowest BGP peer IP address</td>
<td>IPv6 is preferred over IPv4</td>
<td></td>
</tr>
</tbody>
</table>
Example of traditional route selection

Topology with RR
Example

BGP peering
Example

iBGP next-hop learnt from OSPF
Without ADD-PATH

BGP RIB

SW-A# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
 i internal, e external, S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.100.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.3</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>192.168.3.31</td>
<td>192.168.3.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Total number of entries 2

SW-B# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external, S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.200.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.11</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>192.168.3.10</td>
<td>192.168.3.9</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Total number of entries 3

SW-C# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external, S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.100.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.4</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>192.168.3.11</td>
<td>192.168.3.9</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Total number of entries 2

SW-D# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external, S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.110.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.12</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>192.168.3.11</td>
<td>192.168.3.9</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Total number of entries 2

SW-E# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external, S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.110.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>192.168.3.12</td>
<td>192.168.3.9</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Total number of entries 2
Detailed Routes Exchange

BGP UPDATE messages

1. SW-B to SW-A: empty update message
2. SW-A to SW-B: empty update message and NLRI update for 192.168.1.10/32
3. SW-B to SW-A: NLRI update for 10.1.0.0/16
4. SW-A to SW-B: NLRI update for 10.1.0.0/16
5. SW-B to SW-A: Withdraw for 10.1.0.0/16
Without ADD-PATH

Convergence time on link failure >3s

SW-D# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.100.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 192.168.3.9 0 100 0 200 65001 ?
Total number of entries 2

SW-E# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.200.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 192.168.3.11 0 100 0 65001 ?
Total number of entries 2

SW-B# show bgp ipv4 unicast neighbors 192.168.1.1 advertised-routes
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.1.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 192.168.3.8 0 100 0 100 ?
Total number of entries 2

SW-A# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.1.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 192.168.3.10 0 100 0 200 65001 ?
Total number of entries 2

SW-C# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.1.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 0.0.0.0 0 0 0 200 65001 ?
Total number of entries 2

OSPF area 0

SW-A# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.1.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 0.0.0.0 0 0 0 200 65001 ?
Total number of entries 2

SW-D# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.100.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 0.0.0.0 0 0 0 200 65001 ?
Total number of entries 2

SW-A# show bgp ipv4 unicast neighbors 192.168.1.1 advertised-routes
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S State, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 192.168.1.1

Network NextHop Metric LocPrf Weight Path
*=> 192.168.1.10/32 192.168.3.10 0 100 0 200 65001 ?
Total number of entries 2
ADD-PATH

Overview

- ADD-PATH feature enables RR to send more than one path (called additional paths) for the same prefix.
- ADD-PATH is a BGP capability, with capability Code 69.
- With ADD-PATH, a BGP speaker can send and/or receive additional paths to/from a BGP Peer. It is a BGP extension that allows the advertisement of multiple paths (ADD-PATH) for the same prefix (NLRI).
- The additional paths include the first (N-1) best paths. The total paths for an address prefix received by a BGP speaker will include the best path plus the additional paths determined by its BGP peer.
- A BGP speaker uses the Address Prefix and a Path Identifier to uniquely identify a path advertised to a neighbor.
- A BGP speaker must generate a route update for the <AFI, SAFI> based on the combination of the Address Prefix and the Path Identifier, and use the extended NLRI encoding for PATH Identifier.
- Every device that needs to send or receive multiple paths must supports ADD-PATH capability.
- The alternate path's next-hop must be different than the primary path.
ADD-PATH

Not identical to

- AS-PATH multipath-relax (supported on AOS-CX)

<table>
<thead>
<tr>
<th>SW-A(config-bgp)# bgp bestpath as-path</th>
</tr>
</thead>
<tbody>
<tr>
<td>ignore                   Do not consider as-path in best-path selection</td>
</tr>
<tr>
<td>multipath-relax    Consider routes with different AS-path but same length as ECMP</td>
</tr>
</tbody>
</table>

- BGP PIC (Prefix Independent Convergence)
  

  Instead of having a separate list of next-hops for each destination, all destinations sharing the same list of next-hops can point to a **single copy of this list** thereby allowing fast convergence by making changes to a single shared list of next-hops rather than possibly a large number of destinations.
Use Cases
Use-Cases
Mainly for RR

- **Faster routing convergence**
  ADD-PATH helps to achieve faster re-convergence, as an alternative path is immediately available when a primary path fails.

- **Load-Balancing**
  It provides also alternative path for support of load balancing.
Faster Convergence
Required ADD-PATH setting

AS 100
SW-D
AS100
AS 100
10.1.0.0/16
192.168.3.8/31
192.168.3.6/31
192.168.3.8/31
SW-A
AS65001
L0: 192.168.1.1
SW-C
AS65001
L0: 192.168.1.10
SW-B
AS65001
L0: 192.168.1.2
SW-E
AS200
192.168.3.10/31
192.168.3.10/31
192.168.3.10/31
192.168.3.10/31

ADD-PATH RECEIVE
No ADD-PATH needed in this example

ADD-PATH SEND

AS 65001
AS 200

eBGP
IBGP
OSPF area 0

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Faster Convergence

BGP RIB

SW-A# show bgp ipv4 unicast 10.1.0.0/16

VRF : default
BGP Local AS 65001       BGP Router-id 192.168.1.1

Network : 10.1.0.0/16
Nexthop : 192.168.1.2
Peer : 192.168.1.2
Origin : incomplete
Metric : 0
Local Pref : 100
Weight : 0
Calc. Local Pref : 100
Best : No
Valid : Yes
Stale : No
Type : internal
Originator ID : 0.0.0.0
Aggregator ID : 
Aggregator AS : 
Atomic Aggregate : 
RFD Flaps : 0
RFD Penalty : 0
AS-Path : 200 100
Cluster List : 
Communities : 
Ext-Communities : 

SW-A# show bgp ipv4 unicast 10.1.0.0/16

VRF : default
Local Router-ID 192.168.1.1

Network : 10.1.0.0/16
Nexthop : 192.168.3.6
Peer : 192.168.3.6
Origin : incomplete
Metric : 0
Local Pref : 100
Weight : 0
Calc. Local Pref : 100
Best : Yes
Valid : Yes
Stale : No
Type : external
Originator ID : 0.0.0.0
Aggregator ID : 
Aggregator AS : 
Atomic Aggregate : 
RFD Flaps : 0
RFD Penalty : 0
AS-Path : 100
Cluster List : 
Communities : 
Ext-Communities : 

Alternate route is already candidate

Best route
Faster Convergence
Reduced number of BGP updates

The alternate route is now the best route
Details / Caveats
### Platform Support

10.6 – ADD-PATH support

<table>
<thead>
<tr>
<th>ADD-PATH support</th>
<th>6200</th>
<th>6300</th>
<th>6400</th>
<th>8360</th>
<th>8320</th>
<th>8325</th>
<th>8400</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP-BGP IPv4 AF</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MP-BGP IPv6 AF</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MP-BGP EVPN AF</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

- **Scale:**
  - BGP additional path feature increases processing load and memory utilization since the additional backup paths increase the BGP table size.
  - This is purely software consumption (no ASIC programming).
  - Time to load the BGP table will be impacted due to the number of additional paths to compute.
  - The number of candidate additional paths selected for each destination should be kept small. A value of 2 is sufficient to calculate the best path and a backup path for each destination.
ADD-PATH Details

OPEN message from ADD-PATH RECEIVER

- RR should be capable of “receiving” the additional paths.
OPEN message from ADD-PATH SENDER

- RR-client for alternate path should be capable of “sending” the additional paths.
Detailed Routes Exchange

BGP UPDATE messages

1. SW-B to SW-A: NLRI update for 10.1.0.0/16 and empty update message

   Border Gateway Protocol - UPDATE Message
   Marker: ffffffff
   Length: 61
   Type: UPDATE Message (2)
   Withdrawn Routes Length: 0
   Total Path Attribute Length: 31
   Path attributes
     Path Attribute - ORIGIN: INCOMPLETE
     Path Attribute - AS_PATH: 200 100
     Path Attribute - NEXT_HOP: 192.168.1.2
     Path Attribute - LOCAL_PREF: 100

   Network Layer Reachability Information (NLRI)
   10.1.0.0/16
   Prefix length: 16
   NLRI prefix: 10.1.0.0

2. SW-A to SW-B: NLRI update for 192.168.1.10/32 and empty update message

3. SW-A to SW-B: NLRI update for 10.1.0.0/16
Configuration
ADD-PATH configuration
2 steps per IPv4 or IPv6 AF

- This feature consists in two commands:
  1. **Enable the ADD-PATH capability**: the router notifies its neighbor about its ADD-PATH capability:
     - Routing scenario analysis is required to identify where to set-up ADD-PATH recv or send. It might be useful to configure both in some cases.
     - Depending on use-cases, a RR is configured to receive additional paths.
     - Depending on use-cases, the RR-Client hosting the alternate path is configured to send the corresponding additional paths.
  2. **Configure the total number of best-paths to advertise**:
     - Configure the number of best paths to send to the neighbor.
     - This command is **REQUIRED on the sender**.
     - The default value is 2 (absolute best path + next best path).

SW-A(config-bgp-ipv4-uc)# neighbor 192.168.1.2
SW-A(config-bgp-ipv4-uc)# neighbor 192.168.1.2 add-paths
SW-A(config-bgp-ipv4-uc)# neighbor 192.168.1.2 add-paths recv
SW-B(config-bgp-ipv4-uc)# neighbor 192.168.1.1
SW-B(config-bgp-ipv4-uc)# neighbor 192.168.1.1 add-paths
SW-B(config-bgp-ipv4-uc)# neighbor 192.168.1.1 add-paths send
SW-A(config-bgp-ipv4-uc)# neighbor 192.168.1.2 add-paths recv
SW-A(config-bgp-ipv4-uc)# neighbor 192.168.1.2 add-paths send
SW-B(config-bgp-ipv4-uc)# neighbor 192.168.1.1 add-paths advertise-best
SW-B(config-bgp-ipv4-uc)# neighbor 192.168.1.1 add-paths advertise-best 2
Baseline
Without ADD-PATH

router bgp 65001
    bgp router-id 192.168.1.1
    bgp cluster-id 1.1.1.1
    neighbor 192.168.1.1 remote-as 65001
    neighbor 192.168.1.2 remote-as 65001 update-source loopback 0
    neighbor 192.168.1.10 remote-as 65001 update-source loopback 0
    neighbor 192.168.3.6 remote-as 100
    address-family ipv4 unicast
        neighbor 192.168.1.1 activate
        neighbor 192.168.1.2 next-hop-self
        neighbor 192.168.1.2 route-reflector-client
        neighbor 192.168.1.10 activate
        neighbor 192.168.1.10 next-hop-self
        neighbor 192.168.1.10 route-reflector-client
        neighbor 192.168.3.6 activate
        exit-address-family

SW-A
    AS65001
    L0: 192.168.1.1

SW-B
    AS65001
    L0: 192.168.1.2

SW-C
    AS65001
    L0: 192.168.1.10

exit-address-family

router bgp 65001
    bgp router-id 192.168.1.2
    neighbor 192.168.1.1 remote-as 65001
    neighbor 192.168.1.1 update-source loopback 0
    neighbor 192.168.3.10 remote-as 200
    address-family ipv4 unicast
        neighbor 192.168.1.1 activate
        neighbor 192.168.1.1 next-hop-self
        neighbor 192.168.3.10 activate
        exit-address-family

router bgp 65001
    bgp router-id 192.168.1.10
    neighbor 192.168.1.1 remote-as 65001
    neighbor 192.168.1.1 update-source loopback 0
    address-family ipv4 unicast
        redistribute local loopback
        exit-address-family

exit-address-family
### BGP Local AS 65001

**VRF**: default

**Total number of entries**: 2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.3.6</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.6</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-A

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.10</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-B

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 3

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.10</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-C

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-D

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 3

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.10</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-E

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-F

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-G

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path

### SW-H

**BGP Local AS 65001**

**VRF**: default

**Total number of entries**: 2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.10</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

**Communities**:

**Cluster List**:

**AS**:

**RFD Flaps**:

**Atomic Aggregate**:

**Aggregator AS**:

**Aggregator ID**:

**Originator ID**:

**Type**:

**Best**:

**Valid**:

**Weight**:

**Metric**:

**Peer**:

**Network**:

**Local Router**

**VRF**: default

**Status codes**:

- i: internal, e: external
- S: Stale, R: Removed
- a: additional-path
ADD-PATH Configuration
ADD-PATH capability + number of paths

```
ADD-PATH RECEIVE
```

```
ADD-PATH SEND
```

```
router bgp 65001
  bgp router-id 192.168.1.1
  bgp cluster-id 1.1.1.1
  neighbor 192.168.1.2 remote-as 65001
  neighbor 192.168.1.2 update-source loopback 0
  neighbor 192.168.1.10 remote-as 65001
  neighbor 192.168.1.10 update-source loopback 0
  neighbor 192.168.2.6 remote-as 100
  address-family ipv4 unicast
    neighbor 192.168.1.2 activate
    neighbor 192.168.1.2 add-paths recv
    neighbor 192.168.1.2 next-hop-self
    neighbor 192.168.1.2 route-reflector-client
    neighbor 192.168.1.10 activate
    neighbor 192.168.1.10 next-hop-self
    neighbor 192.168.1.10 route-reflector-client
    neighbor 192.168.3.6 activate
    exit-address-family

```

```
router bgp 65001
  bgp router-id 192.168.1.2
  neighbor 192.168.1.1 remote-as 65001
  neighbor 192.168.1.1 update-source loopback 0
  neighbor 192.168.2.10 remote-as 200
  address-family ipv4 unicast
    neighbor 192.168.1.1 activate
    neighbor 192.168.1.1 add-paths send
    neighbor 192.168.1.1 add-paths advertise-best 2
    neighbor 192.168.1.1 next-hop-self
    neighbor 192.168.1.10 activate
    exit-address-family

```

```
router bgp 65001
  bgp router-id 192.168.1.10
  neighbor 192.168.1.1 remote-as 65001
  neighbor 192.168.1.1 update-source loopback 0
  address-family ipv4 unicast
    neighbor 192.168.1.1 activate
    neighbor 192.168.1.1 redistribute local loopback
    exit-address-family
```
### ADD-PATH Configuration

#### ADD-PATH capability

```
SW-A# sh bgp ipv4 unicast neighbors 192.168.1.2
Codes: ^ Inherited from peer-group
VRF : default
BGP Neighbor 192.168.1.2 (Internal)
  Description :
  Peer-group :
  Remote Router Id : 192.168.1.2
  Local Router Id : 192.168.1.2
  Local AS : 65001
  Remote Port : 179
  Local Port : 37939
  State : Established
  Admin Status : Up
  Conn. Established : 1
  Conn. Drops : 0
  Passive : No
  Update-Source : loopback0
  Cfg. Hold Time : 180
  Cfg. Keep Alive : 60
  Max. Retransmit Time : 180
  Up/Down Time : 0h:37m:18s
  Alt. Local-AS : 0
  Local-AS Prefix : No
  BFD : Disabled
  Password :
  Last Err Sent : No Error
  Last SubErr Sent : No Error
  Last Err Rcvd : No Error
  Last SubErr Rcvd : No Error
  Graceful-Restart : Enabled
  Gr. Restart Time : 120
  Gr. Graceful-Restart Time : 120
  TTL : 255
  Local Cluster-ID : 1.1.1.1
  Fail-over : 60
  Confederation-Peers : No

Message statistics
  Sent  Rcvd
  Open  1  1
  Notification  0  0
  Update  5  4
  Keepalives  42  43
  Route Refresh  0  0
  Total  48  48
  Capability
  Advertised  Received
  BGP Capabilities: Yes Yes
  Address family IPv4 Unicast: Yes Yes
  Address family IPv6 Unicast: No No
  Address family L2VPN EVPN: No No
  Address family IPV4 Unicast: Yes Yes

BGP Capabilities
  RT. Reflect. Client : Yes
  Allow-AS in : 0
  Max. Prefix : 64000
  Remove Private-AS : No
  Add-Path : Send
  Originate : Send
  Cfg. Add-Path : Receive
  Cfg. Remove-Path : Receive

SW-B# sh bgp ipv4 unicast neighbors 192.168.1.1
Codes: ^ Inherited from peer-group
VRF : default
BGP Neighbor 192.168.1.1 (Internal)
  Description :
  Peer-group :
  Remote Router Id : 192.168.1.1
  Local Router Id : 192.168.1.2
  Local AS : 65001
  Remote Port : 179
  Local Port : 37939
  State : Established
  Admin Status : Up
  Conn. Established : 1
  Conn. Drops : 0
  Passive : No
  Update-Source : loopback0
  Cfg. Hold Time : 180
  Cfg. Keep Alive : 60
  Max. Retransmit Time : 180
  Up/Down Time : 0h:37m:18s
  Alt. Local-AS : 0
  Local-AS Prefix : No
  BFD : Disabled
  Password :
  Last Err Sent : No Error
  Last SubErr Sent : No Error
  Last Err Rcvd : No Error
  Last SubErr Rcvd : No Error
  Graceful-Restart : Enabled
  Gr. Restart Time : 120
  Gr. Graceful-Restart Time : 120
  TTL : 255
  Local Cluster-ID : 1.1.1.1
  Fail-over : 60
  Confederation-Peers : No

Message statistics
  Sent  Rcvd
  Open  2  2
  Notification  0  0
  Update  3  3
  Keepalives  45  47
  Route Refresh  0  0
  Total  58  58
  Capability
  Advertised  Received
  BGP Capabilities: Yes Yes
  Address family IPv4 Unicast: Yes Yes
  Address family IPv6 Unicast: No No
  Address family L2VPN EVPN: No No
  Address family IPV4 Unicast: Yes Yes

BGP Capabilities
  RT. Reflect. Client : No
  Allow-AS in : 0
  Max. Prefix : 64000
  Remove Private-AS : No
  Add-Path : Send
  Originate : Send
  Cfg. Add-Path : Send
  Cfg. Remove-Path : Send
  Route-map In :
  Route-map Out :
  Cfg. Type : Prefix-list
  Cfg. Capability :
```
**ADD-PATH Configuration**

**Outcome**

---

**SW-A# show bgp ipv4 unicast**
Status code: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, 7 - incomplete

VRF : default
Local Router-ID 192.168.1.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.3.6</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100 ?</td>
</tr>
</tbody>
</table>

**Total number of entries 3**

---

**SW-A# show ip route 10.1.0.0/16**
Displaying ipv4 routes selected for forwarding

'*[a/b]' denotes [distance/metric]

10.1.0.0/16, vrf default, tag 0
via 192.168.3.6, [20/0], bgp

---

**SW-B** show bgp ipv4 unicast
Status code: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, 7 - incomplete

VRF : default
Local Router-ID 192.168.1.2

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100 ?</td>
</tr>
<tr>
<td>* 10.1.0.0/16</td>
<td>192.168.1.10</td>
<td>100</td>
<td>7</td>
<td>100 ?</td>
<td></td>
</tr>
</tbody>
</table>

**Total number of entries 3**

---

**SW-C** show bgp ipv4 unicast
Status code: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, 7 - incomplete

VRF : default
Local Router-ID 192.168.1.10

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0/16</td>
<td>192.168.1.1</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>100 ?</td>
</tr>
</tbody>
</table>

**Total number of entries 2**

---

**SW-B# show bgp ipv4 unicast 10.1.0.0/16**
VRF : default
BGP Local AS 65001 BGP Router-id 192.168.1.2

Network : 10.1.0.0/16 Nexthop : 192.168.1.1
Peer : 192.168.1.1 Origin : incomplete
Metric : 0 Local Pref : 100
Weight : 0 Calc. Local Pref : 100
Best : No Valid : Yes
Type : internal State : No
Originator ID : 0.0.0.0 Path ID : 327681
Aggregator AS : 
Aggregator ID : 
Atomic Aggregate : 
RFD Flaps : 0 RFD Penalty : 0
Path ID : 0
AS-Path : 100
Cluster List :
Communities :
Ext-Communities :

Network : 10.1.0.0/16 Nexthop : 192.168.1.2
Peer : 192.168.1.2 Origin : incomplete
Metric : 0 Local Pref : 100
Weight : 0 Calc. Local Pref : 100
Best : No Valid : Yes
Type : internal State : No
Originator ID : 0.0.0.0 Path ID : 327681
Aggregator AS : 
Aggregator ID : 
Atomic Aggregate : 
RFD Flaps : 0 RFD Penalty : 0
Path ID : 0
AS-Path : 100
Cluster List :
Communities :
Ext-Communities :

Network : 10.1.0.0/16 Nexthop : 192.168.3.10
Peer : 192.168.3.10 Origin : incomplete
Metric : 0 Local Pref : 100
Weight : 0 Calc. Local Pref : 100
Best : No Valid : Yes
Type : external State : No
Originator ID : 0.0.0.0 Path ID : 0
Aggregator AS : 
Aggregator ID : 
Atomic Aggregate : 
RFD Flaps : 0 RFD Penalty : 0
Path ID : 0
AS-Path : 100
Cluster List :
Communities :
Ext-Communities :

Network : 10.1.0.0/16 Nexthop : 192.168.1.10
Peer : 192.168.1.10 Origin : incomplete
Metric : 0 Local Pref : 100
Weight : 0 Calc. Local Pref : 100
Best : No Valid : Yes
Type : external State : No
Originator ID : 0.0.0.0 Path ID : 0
Aggregator AS : 
Aggregator ID : 
Atomic Aggregate : 
RFD Flaps : 0 RFD Penalty : 0
Path ID : 0
AS-Path : 100
Cluster List :
Communities :
Ext-Communities :
Best Practices
ADD-PATH Best Practices

Recommendation

- For capability, use **both**: Configure *advertise and receive* additional paths for the neighbor.
- The number of candidate additional paths selected for each destination should be kept small.
- The number of “best paths” to advertise to the neighbor should be kept as default: a value of 2 is sufficient to populate the best path and the next best backup path for each destination.
Troubleshooting
ADD-PATH Troubleshooting

- Ensure the Capability is exchanged (Send/Receive or Both) for the intended address-family on both sender and receiver.
- Example: For the IPv4 AF neighbor capability of ‘send’ and ‘receive’ are sent.

BGP Neighbor 12.0.0.2 (Internal)
Description :

---omitted the snippet here --

Address Family : IPv4 Unicast

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rt. Reflect. Client</td>
<td>No</td>
</tr>
<tr>
<td>Allow-AS in</td>
<td>0</td>
</tr>
<tr>
<td>Max. Prefix</td>
<td>64000</td>
</tr>
<tr>
<td>Nexthop-Self</td>
<td></td>
</tr>
<tr>
<td>Cfg. Add-Path</td>
<td>Send and Receive</td>
</tr>
<tr>
<td>Neg. Add-Path</td>
<td>Send and Receive</td>
</tr>
<tr>
<td>Send Community</td>
<td></td>
</tr>
<tr>
<td>Adv. Interval</td>
<td>30</td>
</tr>
<tr>
<td>Soft Reconfig In</td>
<td></td>
</tr>
<tr>
<td>Default-Originate</td>
<td></td>
</tr>
</tbody>
</table>

ORF type : Prefix-list
ORF capability :
ADD-PATH Troubleshooting

- Sender has \#n of paths expected to be advertised and all of them must have a valid NH for reachability.
- The number of advertised paths can never be more than the configured “add-path advertise-best value”.
- Only paths with associated valid reachable NH is eligible for being candidate backup path for advertisement.
- Example: ensure all the back-up paths marked with * (i.e. valid if NH is reachable)

```
RR# show bgp ipv4 unicast
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 1.1.1.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 12.0.0.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 13.0.0.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 14.0.0.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>*&gt;1 50.0.0.0/24</td>
<td>12.0.0.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>*&gt;1 50.0.0.0/24</td>
<td>13.0.0.3</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>*&gt;1 90.0.0.1/32</td>
<td>12.0.0.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>?</td>
</tr>
</tbody>
</table>

Total number of entries 6
```
ADD-PATH Troubleshooting

- Checking the **advertised** routes from the sender:
  - show bgp ipv4 unicast neighbors <nbr addr> advertised-routes

- Checking the **received** routes on the receiver:
  - show bgp ipv4 unicast neighbors <nbr addr> routes
  - Validity of the back-up paths (reachability of NH.)

```
show bgp ipv4 unicast neighbors 14.0.0.2 advertised-routes
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 1.1.1.1

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt;i 50.0.0.0/24</td>
<td>12.0.0.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>*&gt;i 50.0.0.0/24</td>
<td>13.0.0.3</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>*&gt;i 90.0.0.1/32</td>
<td>12.0.0.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>?</td>
</tr>
</tbody>
</table>

Total number of entries 6
```

```
DUT# show bgp ipv4 unicast neighbors 14.0.0.1 routes
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
i internal, e external S Stale, R Removed, a additional-paths
Origin codes: i - IGP, e - EGP, ? - incomplete
VRF : default
Local Router-ID 5.5.5.5

<table>
<thead>
<tr>
<th>Network</th>
<th>Nexthop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
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<td>*&gt;i 50.0.0.0/24</td>
<td>12.0.0.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>*&gt;i 50.0.0.0/24</td>
<td>13.0.0.3</td>
<td>0</td>
<td>100</td>
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<td>200</td>
</tr>
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<td>*&gt;i 90.0.0.1/32</td>
<td>12.0.0.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>?</td>
</tr>
</tbody>
</table>

Total number of entries 6
```
ADD-PATH Troubleshooting

- These are the following commands available in ‘diagnostic’ mode.
  - “diag bgp dump mib” : This would take lesser time and minimum required for a dev engineer to troubleshoot further.
  - “diag bgp dump all” : This may be more exhaustive and take more time relative to scale. Good if you can collect this.

- Example:
  DUT# diagnostics
  DUT# diag bgp dump all
  ***************show bgp all-vrf all summary***************
  <omitted the o/p here.>

- Note: These are in addition to the supportability files.
Demo
**ADD-PATH demo topology**

**Set-up**

**RR:**
- `*i 50.0.0.0/24  12.0.0.2  0  200  0  200 i`
- `*ai 50.0.0.0/24  13.0.0.3  0  100  0  200 i`

**DUT:**
- `*i 50.0.0.0/24  12.0.0.2  0  200  0  200 i`
- `*ai 50.0.0.0/24  13.0.0.3  0  100  0  200 i`

Without ADD-PATH:
- (RR and DUT)

With ADD-PATH (after enable add-path on RR and DUT):
- (RR and DUT)
Event

ADD-PATH demo event

Event

Result checked: The DUT is choosing the alternative path.

Event: Shut the link between PE1 and CE

50.0.0.1/24
Thank you

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vincent.giles@hpe.com