

# Implement ACI Transit Routing (Multipod)

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## Introduction

This document describes how to configure transit routing in an Application Centric Infrastructure (ACI) multipod environment.

## Prerequisites

### Requirements

Cisco recommends that you have knowledge of these topics:

1. ACI multipod
2. L3Out
3. Contracts
4. Routing protocols

### Components Used

The information in this document is based on these software and hardware versions:

1. 2 N5K-C5548UP switches, both on NXOS version 7.3(8) (used as external routers)
2. 1 N9K-C9332PQ leaf switch and 1 N9K-C93108TC-EX leaf switch, both on ACI version 14.2(7f)
3. 2 N9K-C9336PQ spine switches, both on ACI version 14.2(7f)
4. 1 N9K-C9232C switch (used as IPN device) on NXOS version 10.3(3)

The information in this document was created using the above devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

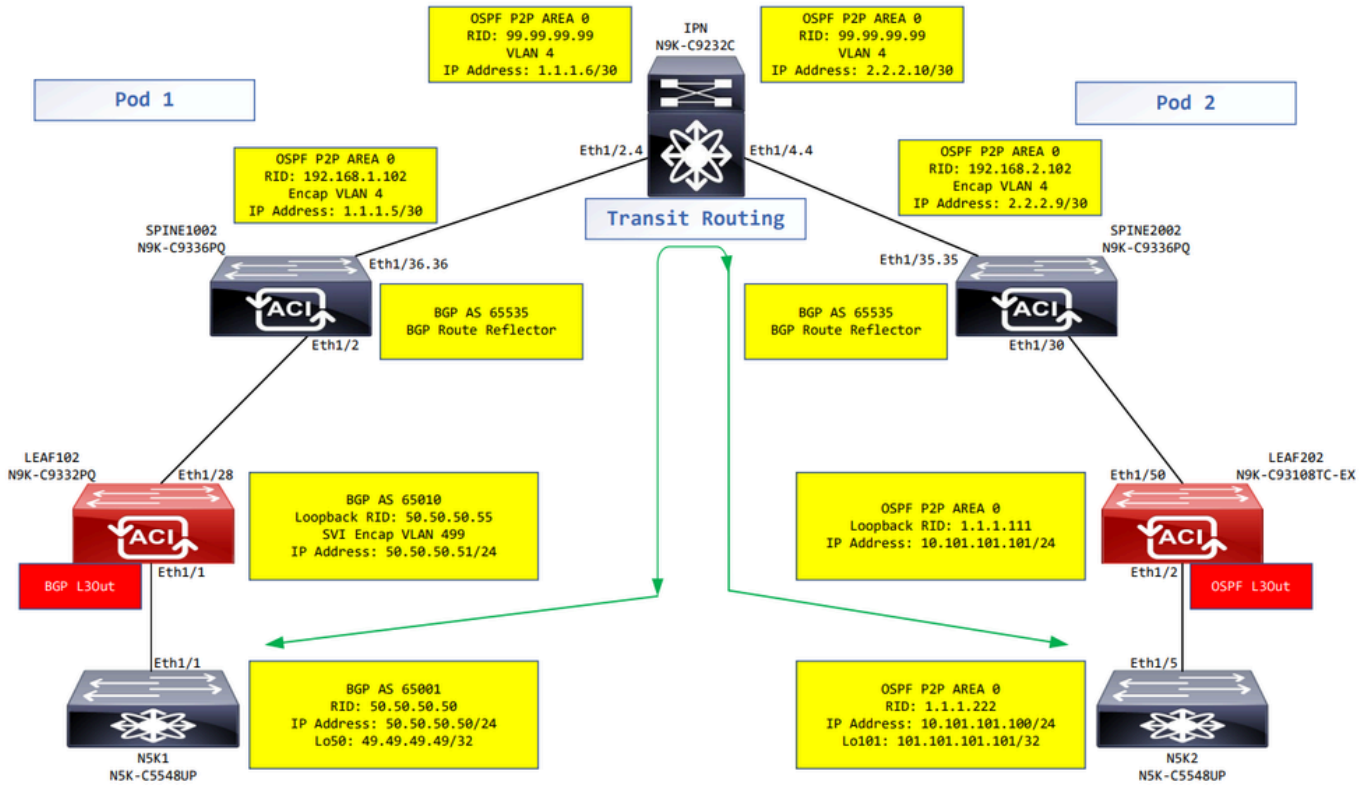
## Background Information

In transit routing, the Cisco ACI fabric advertises the routes that are learned from one Layer 3 Out (L3Out) connection to another L3Out connection. The external Layer 3 domains peer with the fabric on the border

leaf switches. The fabric is a transit Multiprotocol Border Gateway Protocol (MP-BGP) domain between the peers.

# Configure

## Network Diagram



Network diagram

## Configurations

A logical node profile is used to identify the leaf switch that is connected to external networks, and that can deploy the routing protocol or static routes towards it. To view the logical node profile in the L3Out, navigate to your Tenant > Networking > L3Outs > L3Out > Logical Node Profiles > Logical Node Profile as shown in the image.

The screenshot shows the network management interface for configuring a Logical Node Profile. The left sidebar displays the navigation tree with 'MR-BGP' selected. The main panel shows the 'Logical Node Profile - MR-BGP\_nodeProfile' configuration page with tabs for Policy, Faults, and History. The Properties section shows Name: MR-BGP\_nodeProfile, Description: optional, Alias: (empty), and Target DSCP: Unspecified. The Nodes table lists a node with Node ID: topology/pod-1/node-102, Router ID: 50.50.50.55, and Loopback Address: 50.50.50.55. The BGP Peer Connectivity section shows Peer IP Address: 50.50.50.24, Peer Controls: (empty), and Interface: Pod-1/Node-102/eth1/1.

Logical node profile for LEAF102

Logical Node Profile - MR-OSPF\_nodeProfile

Policy | Faults | History

Properties

Name: MR-OSPF\_nodeProfile  
 Description: optional  
 Alias:   
 Target DSCP: Unspecified

Nodes:

Node ID	Router ID	Loopback Address
topology/pod-2/node-202	1.1.1.111	1.1.1.111

Create BGP Protocol Profile:

Logical node profile for LEAF202

A logical interface profile is used to identify the L3Out interface that connects to the external device. You see several function elements that are defined for virtual routing and forwarding (VRF): Address Resolution Protocol (ARP), Border Gateway Protocol (BGP), Neighbor Discovery, and Open Shortest Path First (OSPF) as a consequence of both profiles. To view the logical interface profile in the L3Out, navigate to your Tenant > Networking > L3Outs > L3Out > Logical Node Profiles > Logical Node Profile > Logical Interface Profiles > Logical Interface Profile. In these examples, an SVI is configured in the logical interface profile.

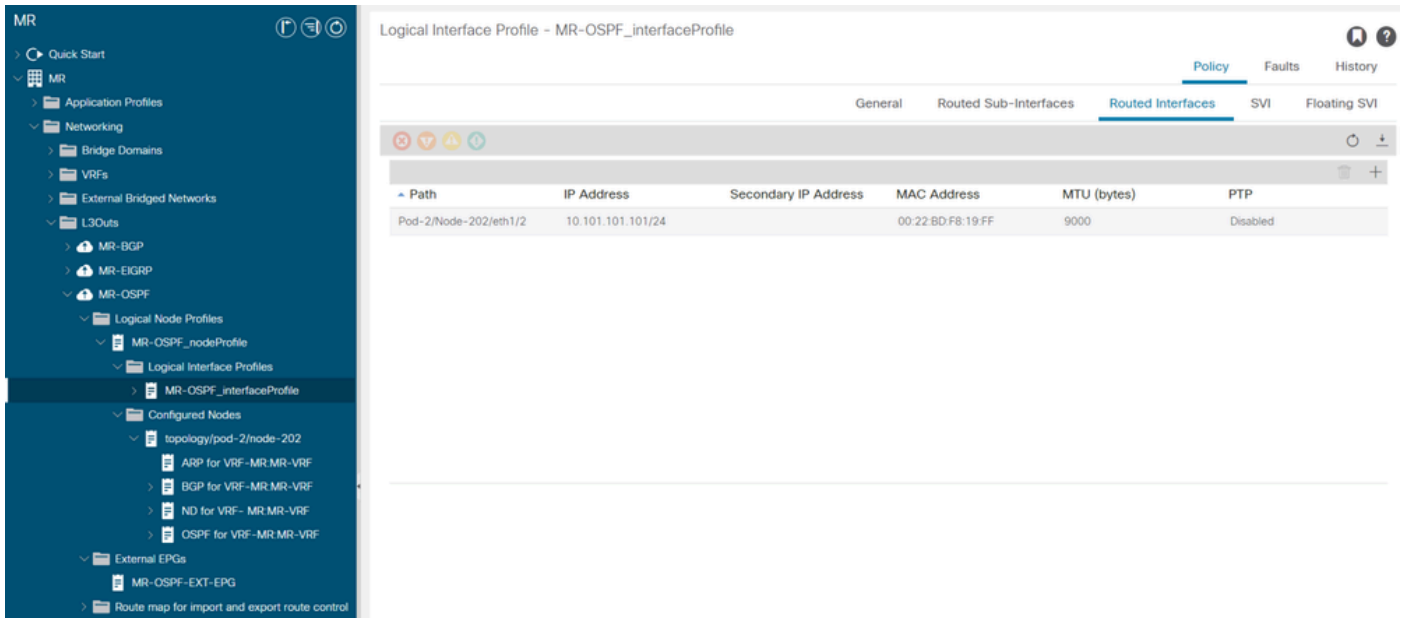
Logical Interface Profile - MR-BGP\_interfaceProfile

Policy | Faults | History

General | Routed Sub-Interfaces | Routed Interfaces | SVI | Floating SVI

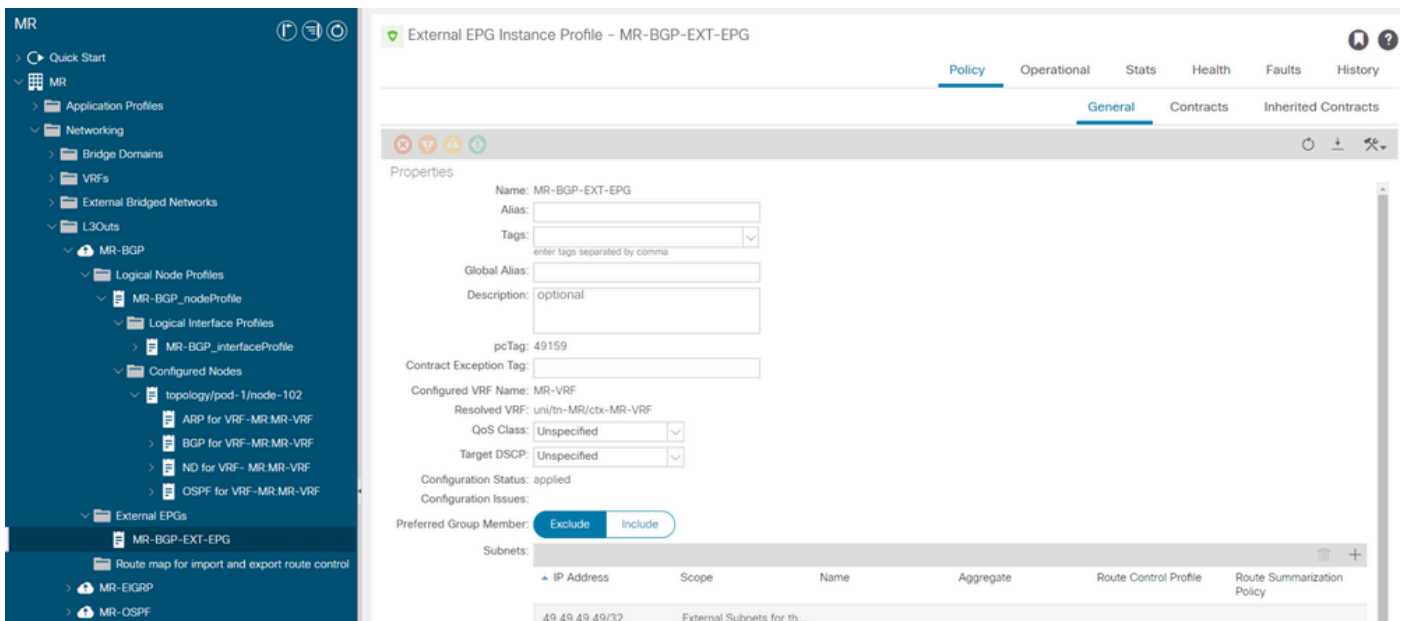
Path	Side A IP	Side B IP	Secondary IP Address	IP Address	MAC Address	MTU (bytes)	Encap	Encap Scope
Pod-1/Node-102/eth1/1				50.50.50.51/24	00:22:BD:F8:19:FF	inherit	vlan-499	Local

Logical interface profile for LEAF102, eth1/1



Logical interface profile for LEAF202, eth1/2

An external EPG instance profile (External EPG, L3Out EPG) represents a group of external subnets that have the same security behavior. Other subnets can also associate with other scopes, which define the routing behavior for that subnet. To view the external EPG in the L3Out, navigate to your Tenant > Networking > L3Outs > L3Out > External EPGs > External EPG as shown in the image.



External EPG instance profile for MR-BGP L3Out

External EPG Instance Profile - MR-OSPF-EXT-EPG

Policy | Operational | Stats | Health | Faults | History

General | Contracts | Inherited Contracts

Properties

Name: MR-OSPF-EXT-EPG

Alias:

Tags:

Global Alias:

Description: optional

pcTag: 49156

Contract Exception Tag:

Configured VRF Name: MR-VRF

Resolved VRF: uni/tn-MR/ctx-MR-VRF

QoS Class: Unspecified

Target DSCP: Unspecified

Configuration Status: applied

Configuration Issues:

Preferred Group Member:  Exclude  Include

Subnets:

IP Address	Scope	Name	Aggregate	Route Control Profile	Route Summarization Policy
101.101.101.101/32					External Subnets for th...

External EPG instance profile for MR-OSPF L3Out

In these examples, the MR-PERMIT-ICMPcontract is applied as both a provided and consumed contract in both external EPGs.

External EPG Instance Profile - MR-BGP-EXT-EPG

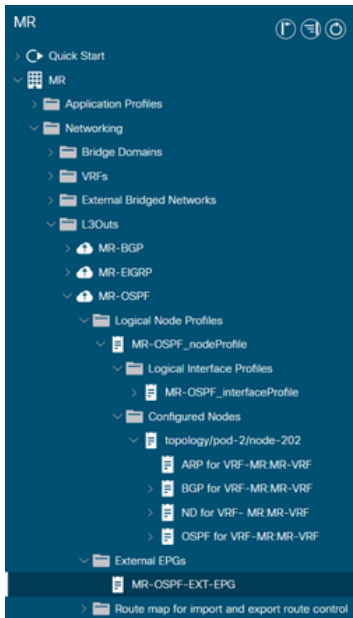
Policy | Operational | Stats | Health | Faults | History

General | Contracts | Inherited Contracts

Healthy

Name	Tenant	Tenant Alias	Contract Type	Provided / Consumed	QoS Class	State	Label	Subject Label
<b>Contract Type: Contract</b>								
MR-PERMIT-ICMP	MR		Contract	Provided	Unspecified	formed		
MR-PERMIT-ICMP	MR		Contract	Consumed	Unspecified	formed		

MR-PERMIT-ICMP contract applied to MR-BGP-EXT-EPG



External EPG Instance Profile - MR-OSPF-EXT-EPG

Policy | Operational | Stats | Health | Faults | History

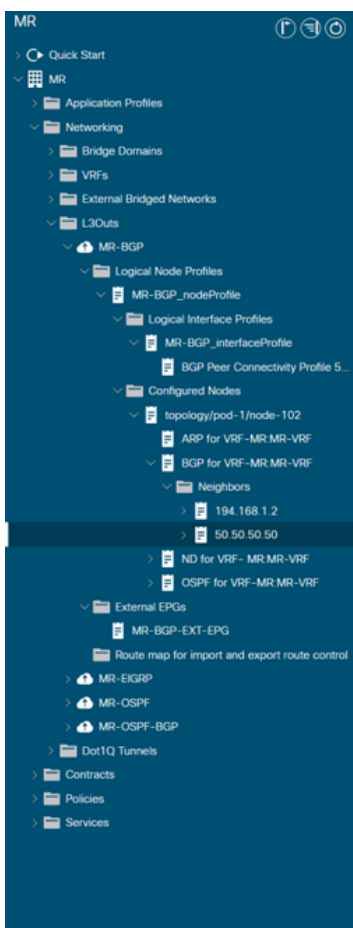
General | **Contracts** | Inherited Contracts

Healthy

Name	Tenant	Tenant Alias	Contract Type	Provided / Consumed	QoS Class	State	Label	Subject Label
<b>Contract Type: Contract</b>								
MR-PERMIT-ICMP	MR		Contract	Provided	Unspecified	formed		
MR-PERMIT-ICMP	MR		Contract	Consumed	Unspecified	formed		

MR-PERMIT-ICMP contract applied to MR-OSPF-EXT-EPG

On LEAF102, BGP is established with neighbor 50.50.50.50 and is receiving the external network 49.49.49.32.



BGP Peer Entry - 50.50.50.50

General | Address | Health | Faults | History

Properties

Vrf Name: MR-MR-VRF  
 BGP Version: BGP Version 4  
 Remote Router Id: 50.50.50.50  
 BGP State: Established  
 Up For: 2022-07-27T17:17:22.493+00:00  
 Remote As: 65001  
 Update Source: vlan14  
 Restart Time Advertised By Peer: Default  
 Hold Time: 180  
 Keepalive Interval: 60  
 Neighbor: 50.50.50.50  
 Link: eBGP  
 Peer Index: 1  
 Shutdown Reason: Unspecified  
 State Reason: none  
 Directly Attached Interface: vlan14  
 Tcp Md5 Authentication: disabled  
 Connection Established: 1  
 Connection Dropped: 0  
 Connection Attempts: na

Message Statistics

	Sent	Rcvd
Opens	1	1
Notifications	0	0
Updates	8	2
Keepalives	1692	1689
Route Refresh	0	0
Capability	1	1
Total	1702	1693
Total bytes	32485	32186
Bytes in queue	0	0

Next Hop

Address: Resolved Using:

Health: Last Reset By Us: 1970-01-01T00:00:00+00:00  
 Major Error Reset By Us: None  
 Minor Error Reset By Us: None  
 Last Error Value By Us: 0  
 Last Error Len By Us: 0  
 Last Error Data By Us: Last Reset By Peer: 1970-01-01T00:00:00+00:00  
 Major Error Reset By Peer: None  
 Minor Error Reset By Peer: None  
 Last Error Value By Peer: 0  
 Last Error Len By Peer: 0  
 Last Error Data By Peer: Capabilities Advertised: AS4 capable,Dynamic,Dynamic graceful restart,Dynamic multiprotocol,Dynamic old,Dynamic refresh,Graceful restart helper,IPv4 unicast,Refresh,Refresh  
 Capabilities Received: AS4 capable,Capability parameter,Dynamic,Dynamic graceful restart,Dynamic multiprotocol,Dynamic old,Dynamic refresh,Graceful restart,IPv4 unicast,Refresh,Refresh

BGP peer entry on LEAF102

```

LEAF102# show ip bgp summary vrf MR:MR-VRF
BGP summary information for VRF MR:MR-VRF, address family IPv4 Unicast
BGP router identifier 50.50.50.55, local AS number 65535
BGP table version is 37, IPv4 Unicast config peers 4, capable peers 2
14 network entries and 16 paths using 1952 bytes of memory
BGP attribute entries [12/1776], BGP AS path entries [0/0]
BGP community entries [0/0], BGP clusterlist entries [5/28]

Neighbor      V    AS MsgRcvd MsgSent  TblVer  InQ  OutQ  Up/Down  State/PfxRcd
50.50.50.50   4 65001  1691   1700    37   0    0    1d04h  1

```

BGP summary for VRF MR:MR-VRF on LEAF102

```

LEAF102# show ip route bgp vrf MR:MR-VRF
IP Route Table for VRF "MR:MR-VRF"
'*' denotes best ucast next-hop
 '**' denotes best mcast next-hop
 '[x/y]' denotes [preference/metric]
 '%<string>' in via output denotes VRF <string>

49.49.49.49/32, ubest/mbest: 1/0
 *via 50.50.50.50%MR:MR-VRF, [20/0], 1d04h, bgp-65535, external, tag 65010

```

BGP route for VRF MR:MR-VRF on LEAF102

On LEAF202, OSPF is established with neighbor 1.1.1.222 and is receiving the external network 101.101.101.101/32.

OSPF - MR:MR-VRF

General Health Faults History

PROPERTIES

Name: MR-MR-VRF  
Route ID: 1.1.1.111  
Distance: 110  
Max EGMP: 8  
Bandwidth Reference (Mbps): 40000  
Operational State: Up

STATS

Interface Count: 2  
Activeareact: 1  
Active Nssa Areact: 0  
Active Stub Areact: 0  
Active Ext Areact: 1  
Extareact: 1  
Nssa Areact: 0  
Stubareact: 0  
Areact: 1  
Ext Lsact: 1  
Opaqas Lsact: 0

Neighbors

Neighbor Id	State	Peer Ip	Interface
1.1.1.222	Full	10.101.101.100	eth1/2

Page 1 Of 1 Objects Per Page: 15 Displaying Objects 1 - 1 Of 1

Inter Protocol Route Leak Into OSPF

Name	Redistribution Protocol	Route Map	Scope	Asn
MR-MR-VRF	BGP	exp-ctx-PROTO-2555906	Inter protocol leak	65535
MR-MR-VRF	COOP	exp-ctx-st-2555906	Inter protocol leak	1
MR-MR-VRF	Direct	exp-ctx-st-2555906	Inter protocol leak	1
MR-MR-VRF	EIGRP	exp-ctx-PROTO-2555906	Inter protocol leak	1
MR-MR-VRF	Static	exp-ctx-st-2555906	Inter protocol leak	1

OSPF neighbor entry on LEAF202

```

LEAF202# show ip ospf neighbors vrf MR:MR-VRF
OSPF Process ID default VRF MR:MR-VRF
Total number of neighbors: 1
Neighbor ID  Pri State           Up Time  Address      Interface
1.1.1.222    1 FULL/ -      2d04h    10.101.101.100 Eth1/2

```

OSPF neighbor for VRF MR:MR-VRF on LEAF202

```

LEAF202# show ip route ospf vrf MR:MR-VRF
IP Route Table for VRF "MR:MR-VRF"
'*' denotes best ucast next-hop
 '**' denotes best mcast next-hop
 '[x/y]' denotes [preference/metric]
 '%<string>' in via output denotes VRF <string>

101.101.101.101/32, ubest/mbest: 1/0
 *via 10.101.101.100, eth1/2, [110/41], 1d00h, ospf-default, intra

```

OSPF route for VRF MR:MR-VRF on LEAF202

On both LEAF102 and LEAF202, the MP-BGP table for the VRF shows the external BGP network, 49.49.49.49/32, but it appears as external on LEAF102 and internal on LEAF202. The OSPF external network, 101.101.101.101/32, also appears in the BGP tables on both leaf switches; on LEAF202 it shows as redistributed from OSPF and on LEAF102 it shows as internal.

```

LEAF102# show bgp vpnv4 unicast vrf MR:MR-VRF
BGP routing table information for VRF overlay-1, address family VPNv4 Unicast
BGP table version is 119, local router ID is 10.0.232.68
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup

   Network          Next Hop          Metric      LocPrf      Weight Path
Route Distinguisher: 102:2555906 (VRF MR:MR-VRF)
*>e49.49.49.49/32   50.50.50.50              41          100          0 65010 65001 i
*>i101.101.101.101/32 20.0.248.0              41          100          0 ?

```

MP-BGP table for VRF MR:MR-VRF on LEAF102

```

LEAF202# show bgp vpnv4 unicast vrf MR:MR-VRF
BGP routing table information for VRF overlay-1, address family VPNv4 Unicast
BGP table version is 95, local router ID is 20.0.248.0
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup

   Network          Next Hop          Metric      LocPrf      Weight Path
Route Distinguisher: 202:2555906 (VRF MR:MR-VRF)
*>i49.49.49.49/32   10.0.232.68              41          100          0 65010 65001 i
*>r101.101.101.101/32 0.0.0.0                41          100          32768 ?

```

MP-BGP table for VRF MR:MR-VRF on LEAF202

The BGP IPv4 table contains equivalent information.

```

LEAF102# show bgp ipv4 unicast vrf MR:MR-VRF
BGP routing table information for VRF MR:MR-VRF, address family IPv4 Unicast
BGP table version is 37, local router ID is 50.50.50.55
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup

   Network          Next Hop          Metric      LocPrf      Weight Path
*>e49.49.49.49/32   50.50.50.50              41          100          0 65010 65001 i
*>i101.101.101.101/32 20.0.248.0              41          100          0 ?

```

BGP IPv4 table for VRF MR:MR-VRF on LEAF102



```

LEAF202# show bgp ipv4 unicast vrf MR:MR-VRF
BGP routing table information for VRF MR:MR-VRF, address family IPv4 Unicast
BGP table version is 31, local router ID is 1.1.1.111
Status: s-suppressed, x-deleted, S-stale, d-dampened, h-history, *-valid, >-best
Path type: i-internal, e-external, c-confed, l-local, a-aggregate, r-redist, I-injected
Origin codes: i - IGP, e - EGP, ? - incomplete, | - multipath, & - backup

  Network          Next Hop          Metric      LocPrf      Weight Path
*>i49.49.49.49/32  10.0.232.68             100          0 65010 65001 i
*r101.101.101.101/32 0.0.0.0                41           100        32768 ?

```

BGP IPv4 table for VRF MR:MR-VRF on LEAF202

However, the OSPF external network, 101.101.101.101/32, is not in the routing table of N5K1.

```

N5K1# show ip route vrf MR-BGP
IP Route Table for VRF "MR-BGP"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

49.49.49.49/32, ubest/mbest: 2/0, attached
  *via 49.49.49.49, Lo50, [0/0], 1d07h, local
  *via 49.49.49.49, Lo50, [0/0], 1d07h, direct
50.50.50.0/24, ubest/mbest: 1/0, attached
  *via 50.50.50.50, Vlan499, [0/0], 1d07h, direct
50.50.50.50/32, ubest/mbest: 1/0, attached
  *via 50.50.50.50, Vlan499, [0/0], 1d07h, local

```

RIB for VRF MR-BGP on N5K1

Similarly, the BGP external network, 49.49.49.49/32, is not in N5K2's RIB.

```

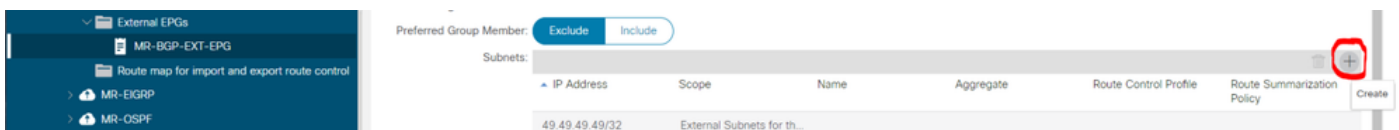
N5K2# show ip route vrf MR-OSPF
IP Route Table for VRF "MR-OSPF"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

1.1.1.111/32, ubest/mbest: 1/0
  *via 10.101.101.101, Eth1/5, [110/41], 2d05h, ospf-1, intra
10.101.101.0/24, ubest/mbest: 1/0, attached
  *via 10.101.101.100, Eth1/5, [0/0], 6d22h, direct
10.101.101.100/32, ubest/mbest: 1/0, attached
  *via 10.101.101.100, Eth1/5, [0/0], 6d22h, local
101.101.101.101/32, ubest/mbest: 2/0, attached
  *via 101.101.101.101, Lo101, [0/0], 2d04h, local
  *via 101.101.101.101, Lo101, [0/0], 2d04h, direct

```

RIB for VRF MR-OSPF on N5K2

In the BGP L3Out, navigate to External EPGs > External EPG > Subnets and select the + icon in the top-right corner of the table. Enter the IP address of the external subnet received from the OSPF L3Out, 101.101.101.101/32. Choose Export Route Control Subnet in the Route Control section and clear the External Subnets for the External EPG classification. Click Submit. The Export Route Control Subnet option allows a network to be exported (advertised) to the external peer.



Create new subnet

### Create Subnet

IP Address:   
address/mask

Name:

Route Control:

Export Route Control Subnet  
 Import Route Control Subnet  
 Shared Route Control Subnet

Aggregate

Aggregate Export  
 Aggregate Import  
 Aggregate Shared Routes

Route Summarization Policy  
 BGP Route Summarization Policy:

Route Control Profile:

Name	Direction

Route control is used for filtering external routes advertised out of the fabric, allowed into the fabric, or leaked to other VRFs within the fabric.

External EPG classification:

External Subnets for External EPG  
 Shared Security Import Subnet

External EPG classification is used to identify the external networks associated with this external EPG for policy enforcement (Contracts).

Configure the correct options for the new subnet

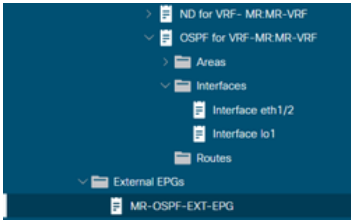
On N5K1, the OSPF external network, 101.101.101.101/32, is now received over BGP.

```
N5K1# show ip route vrf MR-BGP
IP Route Table for VRF "MR-BGP"
'*' denotes best ucast next-hop
 '**' denotes best mcast next-hop
 '[x/y]' denotes [preference/metric]
 '%<string>' in via output denotes VRF <string>

49.49.49.49/32, ubest/mbest: 2/0, attached
 *via 49.49.49.49, Lo50, [0/0], 1d08h, local
 *via 49.49.49.49, Lo50, [0/0], 1d08h, direct
50.50.50.0/24, ubest/mbest: 1/0, attached
 *via 50.50.50.50, Vlan499, [0/0], 1d08h, direct
50.50.50.50/32, ubest/mbest: 1/0, attached
 *via 50.50.50.50, Vlan499, [0/0], 1d08h, local
101.101.101.101/32, ubest/mbest: 1/0
 *via 50.50.50.51, [20/0], 00:00:03, bgp-65001, external, tag 65010,
```

RIB for VRF MR-BGP on N5K1

In the OSPF L3Out, navigate to External EPGs > External EPG > Subnets and select the + icon in the top-right corner of the table. Enter the IP address of the external subnet received from the BGP L3Out, 49.49.49.49/32. Choose Export Route Control Subnet in the Route Control section and clear External Subnets for the External EPG classification. Click Submit.



Preferred Group Member: Exclude Include

Subnets:

IP Address	Scope	Name	Aggregate	Route Control Profile	Route Summarization Policy	Create
101.101.101.101/32	External Subnets for th...					

Create new subnet

### Create Subnet

IP Address:   
address/mask

Name:

#### Route Control:

- Export Route Control Subnet
- Import Route Control Subnet
- Shared Route Control Subnet

#### Aggregate

- Aggregate Export
- Aggregate Import
- Aggregate Shared Routes

#### Route Summarization Policy

#### Route Control Profile:

Name	Direction

Route control is used for filtering external routes advertised out of the fabric, allowed into the fabric, or leaked to other VRFs within the fabric.

#### External EPG classification:

- External Subnets for External EPG
- Shared Security Import Subnet

External EPG classification is used to identify the external networks associated with this external EPG for policy enforcement (Contracts).

Configure the correct options for the new subnet

Now on N5K2, the BGP external network, 49.49.49.49/32, is received over OSPF.

```
N5K2# show ip route vrf MR-OSPF
IP Route Table for VRF "MR-OSPF"
'*' denotes best ucast next-hop
 '**' denotes best mcast next-hop
 '[x/y]' denotes [preference/metric]
 '%<string>' in via output denotes VRF <string>

1.1.1.111/32, ubest/mbest: 1/0
  *via 10.101.101.101, Eth1/5, [110/41], 2d05h, ospf-1, intra
10.101.101.0/24, ubest/mbest: 1/0, attached
  *via 10.101.101.100, Eth1/5, [0/0], 6d22h, direct
10.101.101.100/32, ubest/mbest: 1/0, attached
  *via 10.101.101.100, Eth1/5, [0/0], 6d22h, local
49.49.49.49/32, ubest/mbest: 1/0
  *via 10.101.101.101, Eth1/5, [110/1], 00:01:59, ospf-1, type-2, tag 4294967295,
101.101.101.101/32, ubest/mbest: 2/0, attached
  *via 101.101.101.101, Lo101, [0/0], 2d05h, local
  *via 101.101.101.101, Lo101, [0/0], 2d05h, direct
```

RIB for VRF MR-OSPF on N5K2

Ping works between the two networks because of the MR-PERMIT-ICMP contract that was applied to both external EPGs earlier.

```
N5K1# ping 101.101.101.101 vrf MR-BGP source 49.49.49.49
PING 101.101.101.101 (101.101.101.101) from 49.49.49.49: 56 data bytes
64 bytes from 101.101.101.101: icmp_seq=0 ttl=252 time=3.059 ms
64 bytes from 101.101.101.101: icmp_seq=1 ttl=252 time=2.963 ms
64 bytes from 101.101.101.101: icmp_seq=2 ttl=252 time=7.928 ms
64 bytes from 101.101.101.101: icmp_seq=3 ttl=252 time=2.954 ms
64 bytes from 101.101.101.101: icmp_seq=4 ttl=252 time=2.982 ms

--- 101.101.101.101 ping statistics ---
5 packets transmitted, 5 packets received, 0.00% packet loss
round-trip min/avg/max = 2.954/3.977/7.928 ms
```

*Communication verification on N5K1*

```
N5K2# ping 49.49.49.49 vrf MR-OSPF source 101.101.101.101
PING 49.49.49.49 (49.49.49.49) from 101.101.101.101: 56 data bytes
64 bytes from 49.49.49.49: icmp_seq=0 ttl=252 time=3.107 ms
64 bytes from 49.49.49.49: icmp_seq=1 ttl=252 time=2.99 ms
64 bytes from 49.49.49.49: icmp_seq=2 ttl=252 time=2.98 ms
64 bytes from 49.49.49.49: icmp_seq=3 ttl=252 time=2.986 ms
64 bytes from 49.49.49.49: icmp_seq=4 ttl=252 time=2.99 ms

--- 49.49.49.49 ping statistics ---
5 packets transmitted, 5 packets received, 0.00% packet loss
round-trip min/avg/max = 2.98/3.01/3.107 ms
```

*Communication verification on N5K2*

## Related Information

- [Cisco APIC Layer 3 Networking Configuration Guide, Release 6.0\(x\)](#)
- [Cisco Application Centric Infrastructure Fundamentals, Release 4.2\(x\)](#)
- [Cisco APIC Layer 3 Networking Configuration Guide, Release 3.x and Earlier](#)
- [Cisco Technical Support & Downloads](#)