VxLAN BGP-EVPN

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Agenda

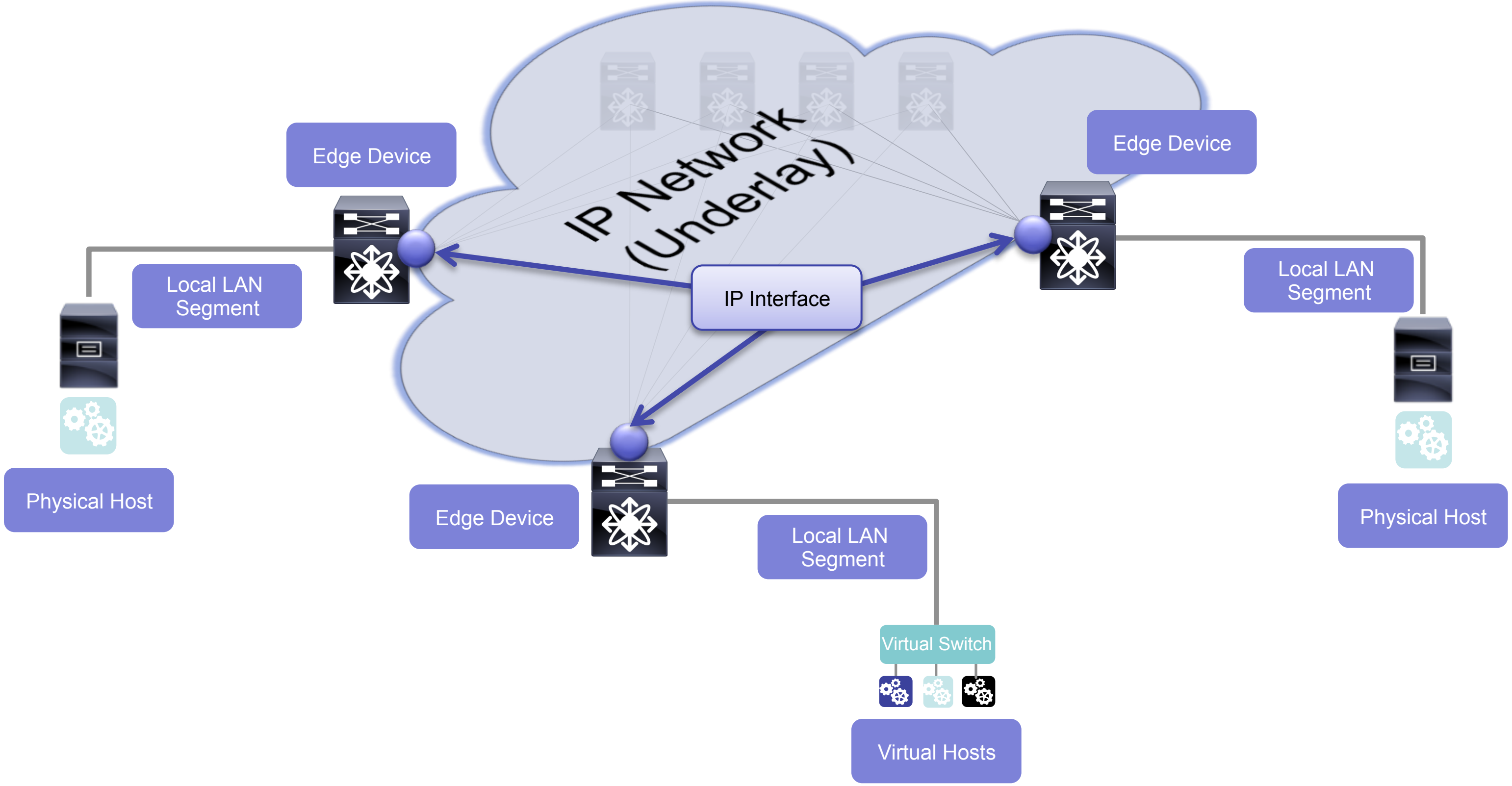
- VxLAN Overview
  - Flood & Learn Mechanism
  - Ingress Replication
- Intro to VxLan BGP EVPN
  - Components / Features
  - BGP EVPN Route Types and Fields

VxLAN Overview

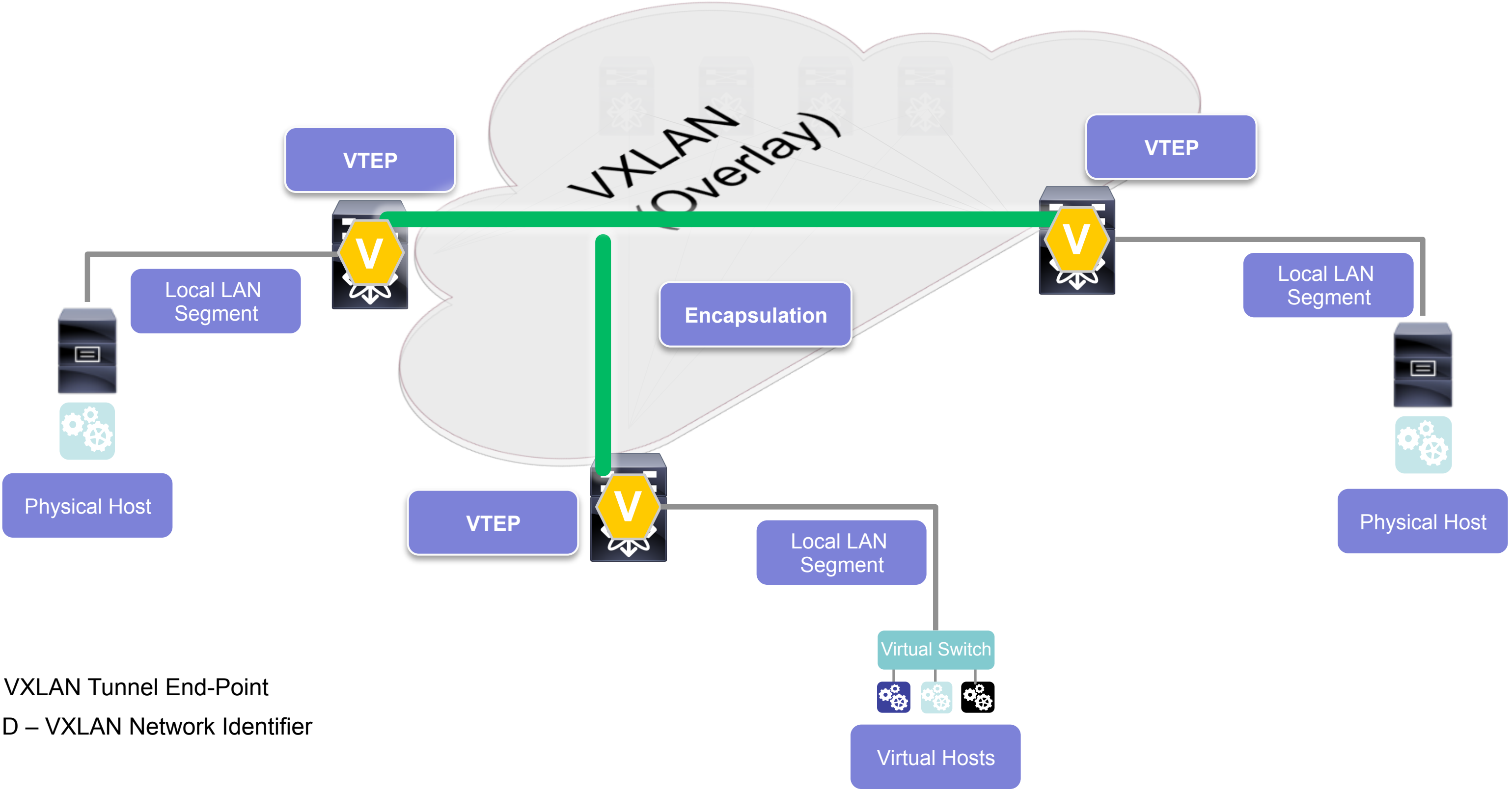
Simple Definition

- VXLAN Overlay
  - Layer 2 overlay on top of your Layer 3 underlay
- VxLAN Network Identifier
  - Each VxLAN segment is identified by a unique 24-bit segment ID
  - Only hosts on the same VNI are allowed to communicate with each other
- Benefits
  - Overcome 4094 VLAN Scale limitation
  - Better utilization of available network paths
  - Multi-Tenant with virtualization

VxLAN Overview



VxLAN Overview



VTEP – VXLAN Tunnel End-Point

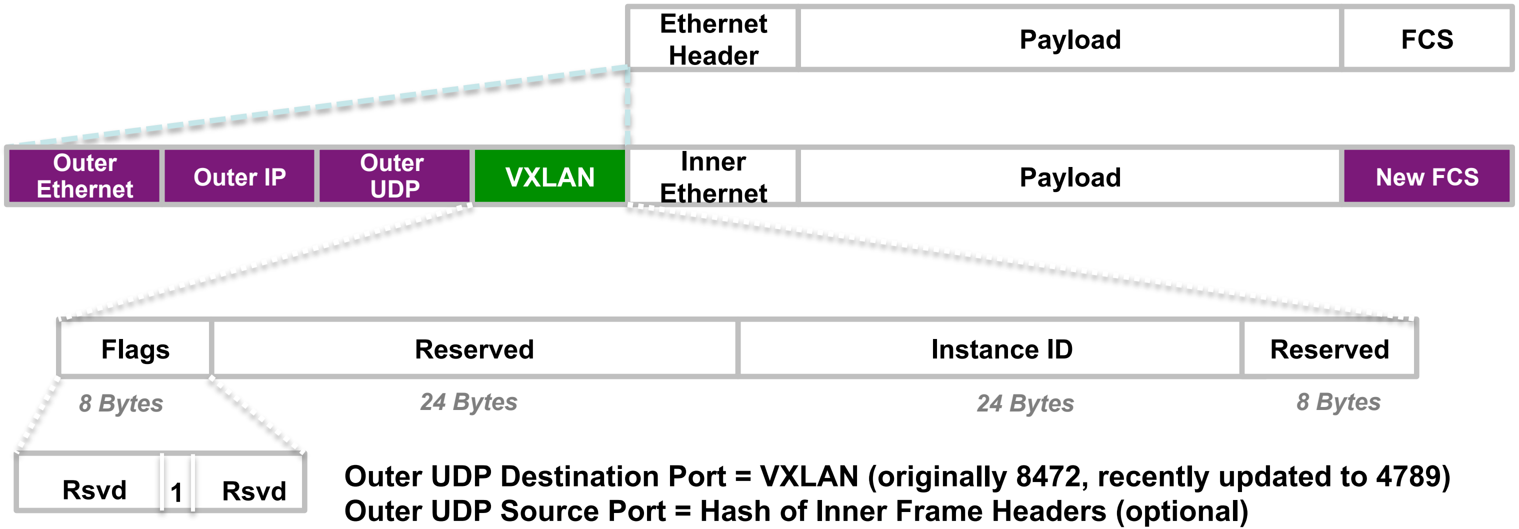
VNI/VNID – VXLAN Network Identifier

VxLAN Overview

VXLAN Concepts

- VXLAN Overlay
  - A VXLAN Overlay or VXLAN segment is a Layer-2 broadcast domain identified by the VNID that extends or tunnels traffic from one VTEP to another.
- VXLAN Tunnel End Point (VTEP)
  - A VTEP is a device that provides both encapsulation and de-capsulation of classical Ethernet and VXLAN packets to and from a VXLAN segment
  - Each VTEP may have the following types of interfaces:
    - Switchport interfaces on the local LAN segment to support local endpoints
    - Layer-3 interfaces to the transport IP network
    - SVI interfaces
- VXLAN Gateway
  - A VTEP that bridges traffic between VXLAN segments

VXLAN Encapsulation



Ethernet Header	Payload	FCS

Outer Ethernet	Outer IP	Outer UDP	VXLAN	Inner Ethernet	Payload	New FCS

Flags	Reserved	Instance ID	Reserved
8 Bytes	*24 Bytes*	*24 Bytes*	*8 Bytes*

Rsvd	1	Rsvd

Outer UDP Destination Port = VXLAN (originally 8472, recently updated to 4789)
Outer UDP Source Port = Hash of Inner Frame Headers (optional)

The outer IP header has the source IP and destination IP of the VTEP endpoints
The outer Ethernet header has the source MAC of the source VTEP and the destination MAC of the immediate Layer-3 next hop

VxLAN Overview

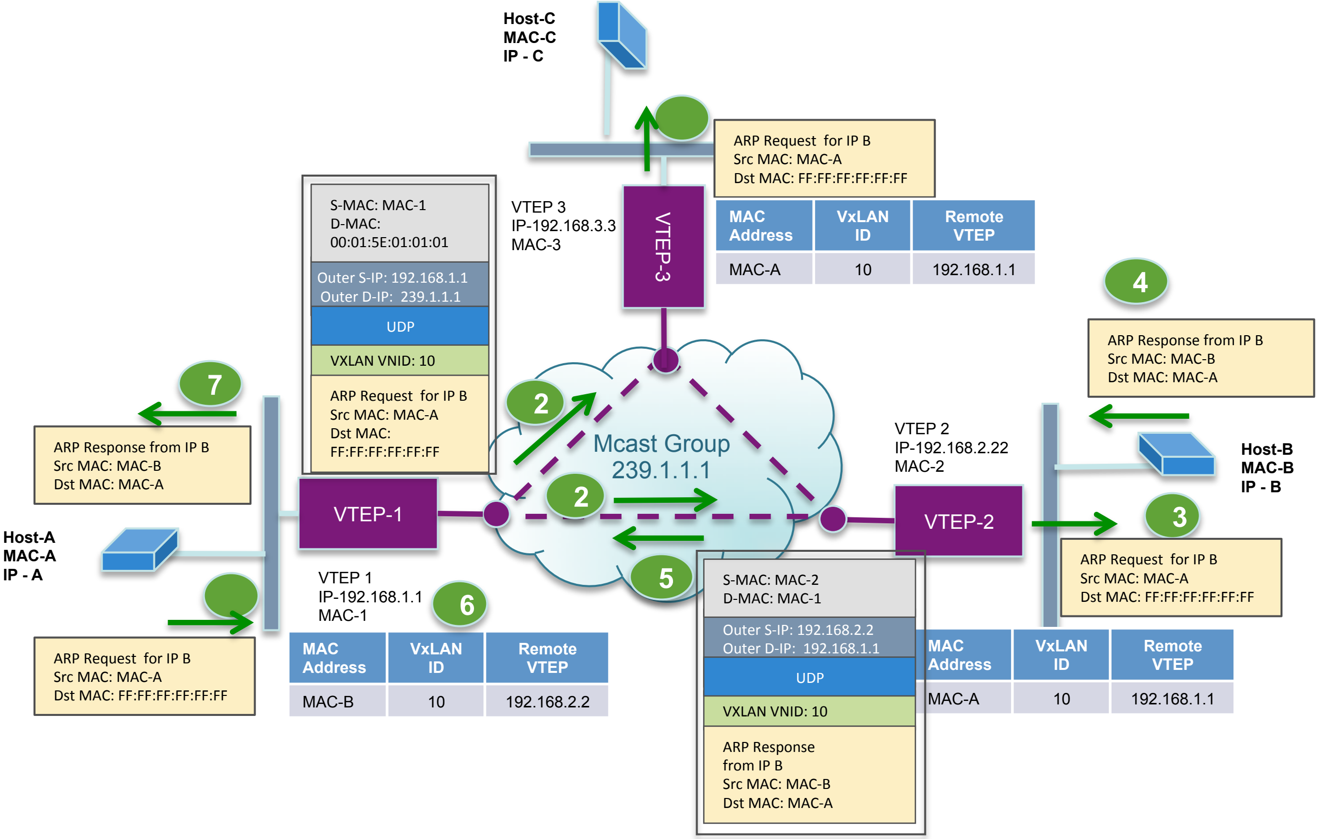
VxLAN Gateway Types

- Layer 2 Gateway
  - The layer 2 gateway is required when the layer 2 traffic (IEEE 802.1q tagged traffic) comes from VLAN into VxLAN segment (encapsulation) or
  - The Ingress VxLAN packet egresses out an 802.1q tagged interface (de-encapsulation), where the packet is bridged to a new VLAN.
- Layer 3 Gateway
  - A layer 3 gateway is used when there is a VxLAN to VxLAN routing
  - The ingress packet is a VxLAN packet on a routed segment but the packet egresses out on a tagged 802.1q interface and the packet is routed to a new VLAN

VxLAN – Flood and Learn

Overview

- Data Plane learning technique for VxLAN
- VNI’s are mapped to a multicast group on a VTEP
- Local MACs are learnt over a VLAN (VNI) on a VTEP
- Broadcast, Unknown Unicast, Multicast (*BUM Traffic*) is flooded to the delivery multicast group for that VNI
- Remote VTEPs part of same multicast group learn host MAC, VNI and source VTEP as the next-hop for the host MAC from flooded traffic
- Unicast packets to the host MAC are sent directly to source VTEP as VxLAN encapsulated packet



ARP Request for IP B
Src MAC: MAC-A
Dst MAC: FF:FF:FF:FF:FF:FF

MAC Address	VxLAN ID	Remote VTEP
MAC-A	10	192.168.1.1

S-MAC: MAC-1
D-MAC: 00:01:5E:01:01:01

Outer S-IP: 192.168.1.1
Outer D-IP: 239.1.1.1

UDP

VXLAN VNID: 10

ARP Request for IP B
Src MAC: MAC-A
Dst MAC: FF:FF:FF:FF:FF:FF

ARP Response from IP B
Src MAC: MAC-B
Dst MAC: MAC-A

ARP Response from IP B
Src MAC: MAC-B
Dst MAC: MAC-A

ARP Request for IP B
Src MAC: MAC-A
Dst MAC: FF:FF:FF:FF:FF:FF

ARP Request for IP B
Src MAC: MAC-A
Dst MAC: FF:FF:FF:FF:FF:FF

MAC Address	VxLAN ID	Remote VTEP
MAC-B	10	192.168.2.2

S-MAC: MAC-2
D-MAC: MAC-1

Outer S-IP: 192.168.2.2
Outer D-IP: 192.168.1.1

UDP

VXLAN VNID: 10

ARP Response from IP B
Src MAC: MAC-B
Dst MAC: MAC-A

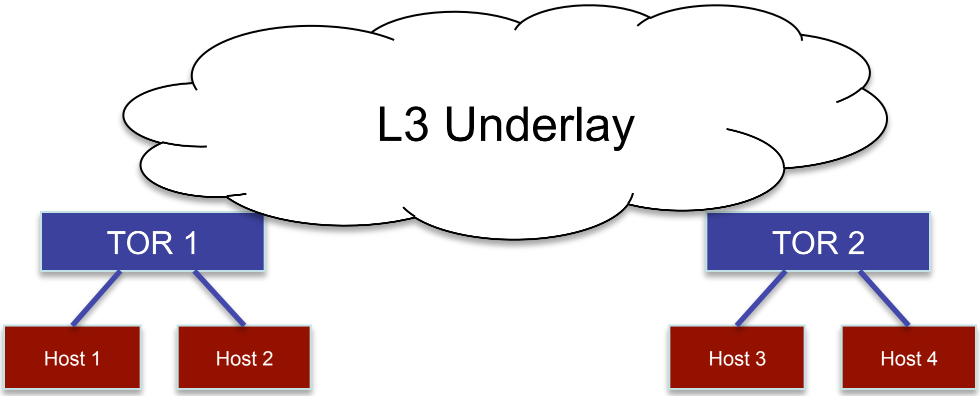
MAC Address	VxLAN ID	Remote VTEP
MAC-A	10	192.168.1.1

VxLAN Overview

Ingress Replication

- Some customers not comfortable deploying multicast in their core
- With *Ingress Replication* (*IR*), BUM traffic ingress access side is replicated to remote VTEP as unicast
- Static IR VETP tunnel is kept alive as long as the route to the VTEP is available.
- Support multiple VTEPs per VNI and a VTEP in multiple VNIs
- Up to 16 static IR VTEPs recommended – on Cisco Platforms
- Multicast and IR config can co-exist on the same switch nodes but on different VNI's

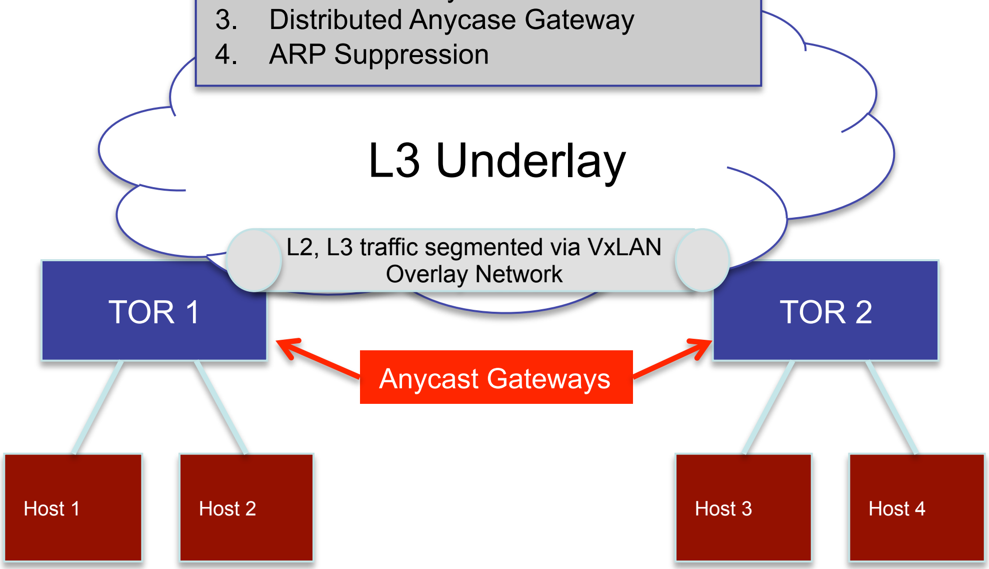
Problem Definition



- Host placement anywhere, and mobility
- Optimal east-west traffic
- Segmentation of tenant L2 and L3 tenant traffic
- Minimum flooding traffic

Elements of Solution

1. BGP Extension: Advertisement of Host MAC, IP routes
2. VxLAN Overlay
3. Distributed Anycase Gateway
4. ARP Suppression



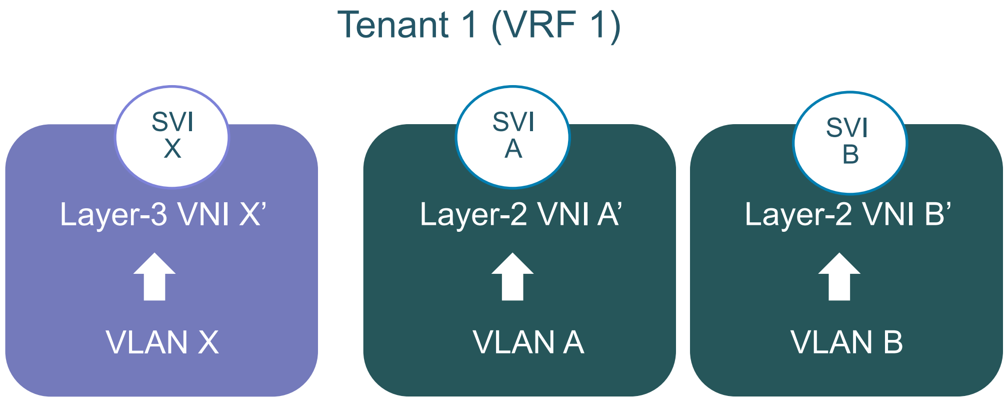
BGP for VxLAN

WHY?

- Control plane learning for end host Layer-2 and Layer-3 reachability information to build more robust and scalable VXLAN overlay networks.
- Leverages the decade-long MP-BGP VPN technology to support scalable multi-tenant VXLAN overlay networks.
- EVPN address family carries both Layer 2 and Layer 3 reachability information. This provides integrated bridging and routing in VXLAN overlay networks.

VxLAN BGP-EVPN Overview

VXLAN EVPN VNI Types



Tenant 1 (VRF 1)

SVI X

Layer-3 VNI X’

VLAN X

SVI A

Layer-2 VNI A’

VLAN A

SVI B

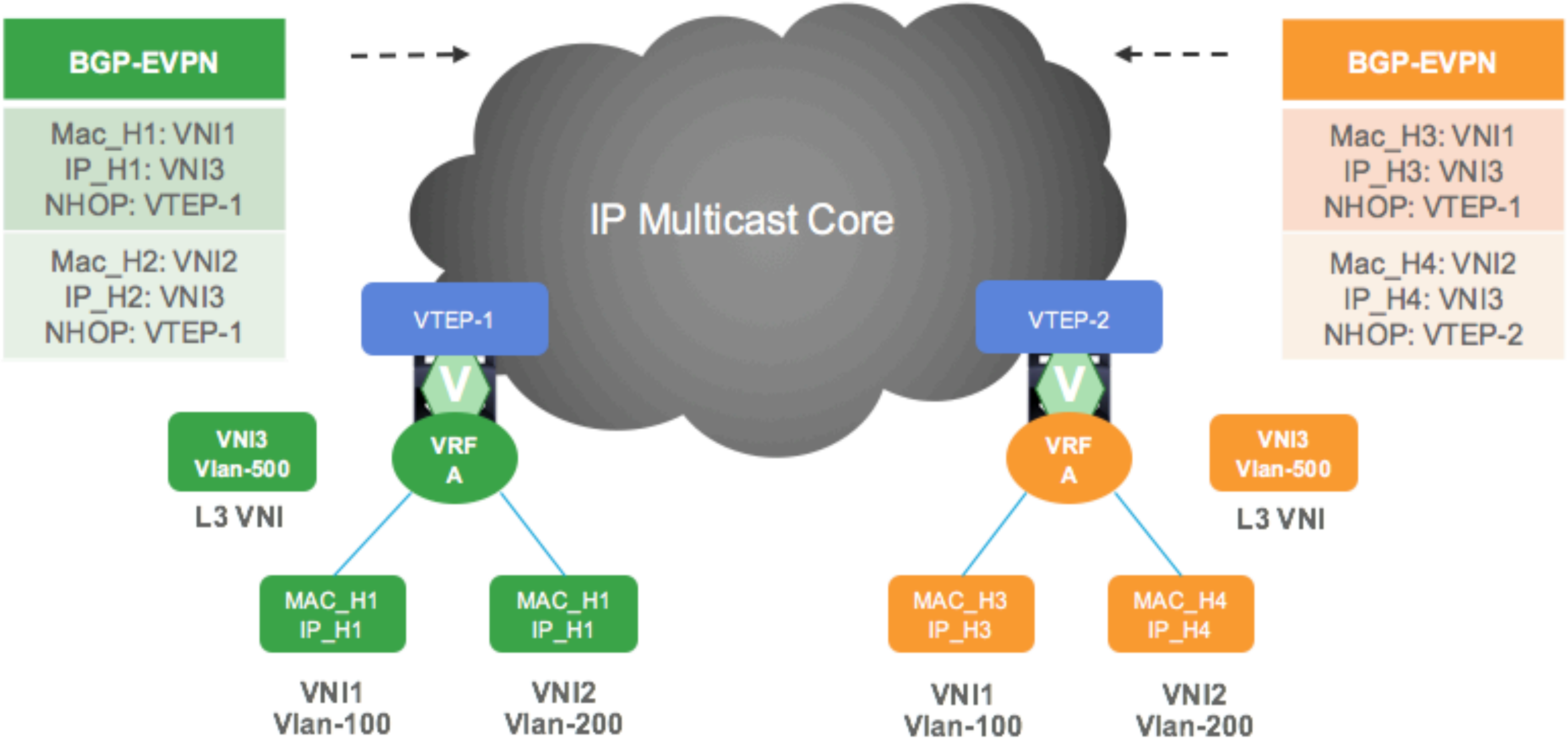
Layer-2 VNI B’

VLAN B

- 1 Layer-3 VNI per Tenant (VRF) for routing
- VNI X’ is used for routed packets

- 1 Layer-2 VNI per Layer-2 segment
- Multiple Layer-2 VNIs per tenant
- VNI A’ and B’ are used for bridged packets

VxLAN BGP-EVPN Overview



BGP-EVPN

Mac_H1: VNI1
IP_H1: VNI3
NHOP: VTEP-1

Mac_H2: VNI2
IP_H2: VNI3
NHOP: VTEP-1

BGP-EVPN

Mac_H3: VNI1
IP_H3: VNI3
NHOP: VTEP-1

Mac_H4: VNI2
IP_H4: VNI3
NHOP: VTEP-2

BGP for VxLAN

Advantages

- Minimizes network flooding through protocol-driven host MAC/IP route distribution and ARP suppression on the local VTEPs.
- Provides optimal forwarding for east-west and north-south bound traffic with the distributed any-cast function
- Provides VTEP peer discovery and authentication which mitigates the risk of rouge VTEPs in the VXLAN overlay network.

VxLAN BGP-EVPN Overview

Distributed Anycast Gateway

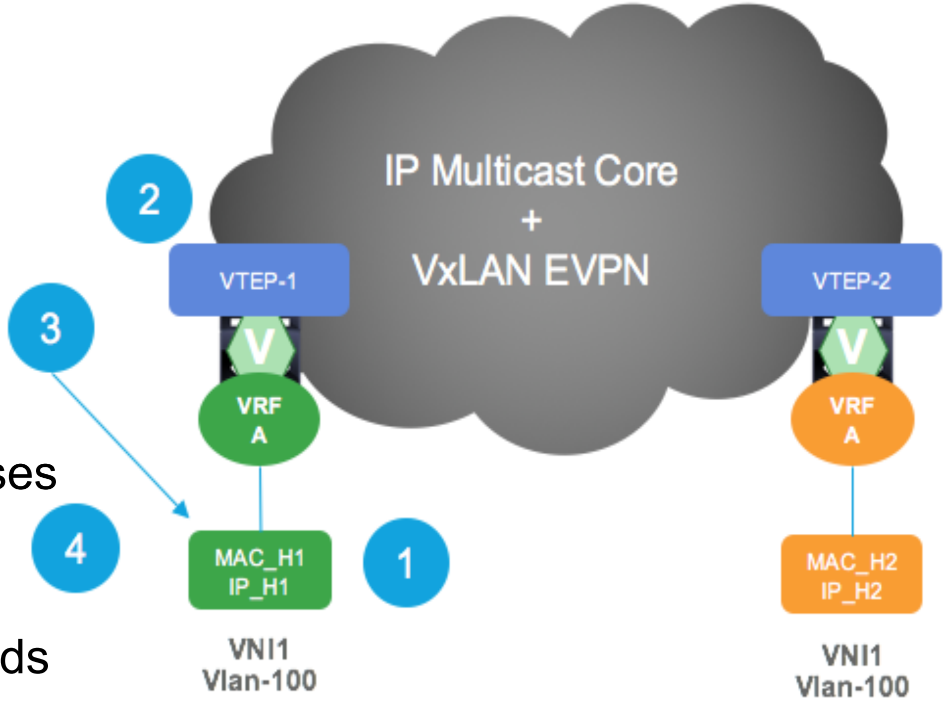
- All VTEPs has same IP address for an L2 VNI
- Anycast Gateway MAC is global to each VTEP for all VNI’s for all Tenants

```
fabric forwarding anycast-gateway-mac 0001.0001.0001
 !
 interface Vlan100
 no shutdown
 vrf context test-evpn-tenant
 ip address 172.16.1.254/24
 fabric forwarding mode anycast-gateway
```

VxLAN BGP-EVPN Overview

ARP Suppression

- Hosts send out G-ARP when they come online
- Local leaf node receives G-ARP, creates local ARP cache and advertises to other leaf by BGP as route type 2
- Remote leaf node puts IP-MAC info into remote ARP cache and supresses incoming ARP request for this IP
- If IP info not found in ARP suppression cache table, VTEP floods the ARP request to other VTEPs



VxLAN BGP-EVPN Overview

Different Integrated Route/Bridge (IRB) Modes

Asymmetric IRB

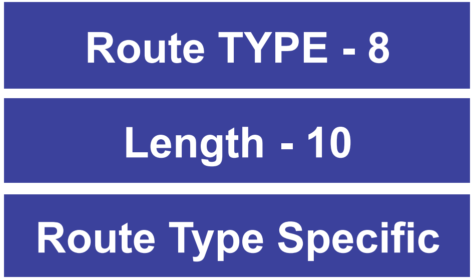
- Uses different path from source to destination and back
- Required to configure the source VTEP with both the source and destination VNIs for both layer 2 and layer 3 forwarding

Symmetric IRB

- Uses same path from source to destination and back
- the ingress VTEP routes packets from source VNI to L3 VNI where the destination MAC address in the inner header is rewritten to egress VTEP’ s router MAC address

EVPN Route Types

- BGP EVPN Route Types
  - Type 1 - Ethernet Auto-Discovery (A-D) route
  - **Type 2 - MAC advertisement route → L2 VNI MAC/MAC-IP**
  - Type 3 - Inclusive Multicast Route → **EVPN IR, Peer Discovery**
  - Type 4 - Ethernet Segment Route
  - **Type 5 - IP Prefix Route → L3 VNI Route**



Route TYPE - 8

Length - 10

Route Type Specific

- Route type 2 or MAC Advertisement route is for MAC and ARP resolution advertisement, MAC or MAC-IP

- Route type 5 or IP Prefix route will be used for the advertisement of prefixes, IP only

BGP EVPN Route Fields

```
Leaf1#show bgp l2vpn evpn 8c60.4f93.5ffc
BGP routing table information for VRF default, address family L2VPN
EVPN
Route Distinguisher: 10000:1     (L2VNI 10000)
BGP routing table entry for [2]:[0]:[0]:[48]:[8c60.4f93.5ffc]:[0]:
[0.0.0.0]/216, version 8
Paths: (1 available, best #1)
Flags: (0x00010a) on xmit-list, is not in l2rib/evpn

  Advertised path-id 1
  Path type: local, path is valid, is best path, no labeled nexthop
  AS-Path: NONE, path locally originated
    192.168.1.1 (metric 0) from 0.0.0.0 (192.168.1.1)
      Origin IGP, MED not set, localpref 100, weight 32768
      Received label 10000
      Extcommunity:  RT:10000:1
```

Route Distinguisher – 8 byte

Ethernet Segment ID – 10 byte

Ethernet Tag ID – 4 byte

MAC Address Length – 1 byte

MAC Address – 6 byte

IP Address Length – 1 byte

IP Address – 0, 4, 16 byte

MPLS Label 1 – 3 byte, L2VNI

MPLS Label 2- 3 byte L3VNI

BGP EVPN Route Fields

```
Leaf2#show bgp l2vpn evpn 100.1.1.1
BGP routing table information for VRF default, address family L2VPN
EVPN
Route Distinguisher: 20000:1    (L3VNI 20000)
BGP routing table entry for [2]:[0]:[0]:[48]:[8c60.4f1b.e43c]:[32]:
[100.1.1.1]/272, version 6
Paths: (1 available, best #1)
Flags: (0x00021a) on xmit-list, is in l2rib/evpn, is not in HW,
  Advertised path-id 1
  Path type: internal, path is valid, is best path, no labeled
nexthop
             Imported from 10000:1:[2]:[0]:[0]:[48]:
[8c60.4f1b.e43c]:[32]:[100.1.1.1]/144 (VNI 10000)
  AS-Path: NONE, path sourced internal to AS
    192.168.1.1 (metric 5) from 192.168.10.10 (192.168.10.10)
      Origin IGP, MED not set, localpref 100, weight 0
      Received label 10000 20000
      Extcommunity:  RT:10000:1 RT:20000:1 ENCAP:8 Router MAC:f40f.
1b6f.926f
      Originator: 192.168.1.1 Cluster list: 192.168.10.10
```

Route Distinguisher – 8 byte

Ethernet Segment ID – 10 byte

Ethernet Tag ID – 4 byte

MAC Address Length – 1 byte

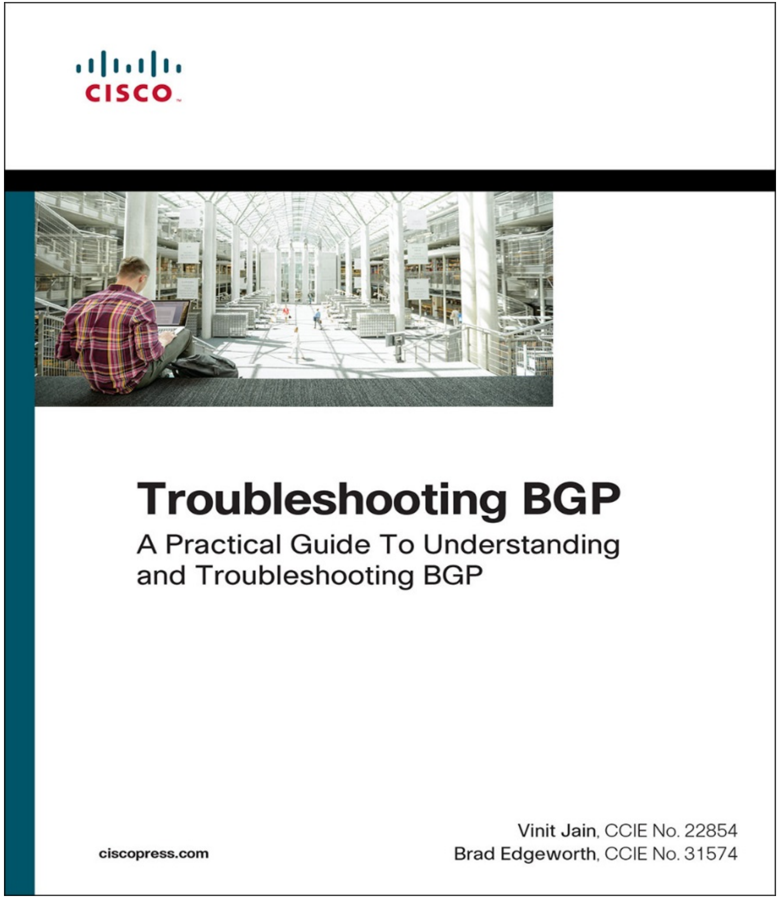
MAC Address – 6 byte

IP Address Length – 1 byte

IP Address – 0, 4, 16 byte

MPLS Label 1 – 3 byte, L2VNI

MPLS Label 2- 3 byte L3VNI



Troubleshooting BGP

A Practical Guide To Understanding and Troubleshooting BGP

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Q&A