Let's go

The bridge to possible

VXLAN BGP EVPN Multi-Site

Architecture and Technology

Lukas Krattiger, Cisco Fellow
@CCIE21921

BRKDCN-2913

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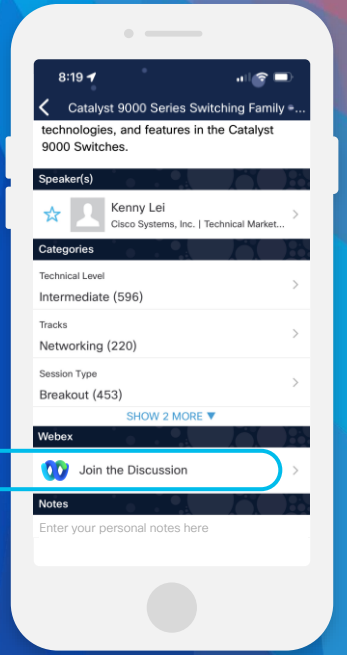

https://ciscolive.ciscoevents.com/ciscolivebot/#BRKDCN-2913

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Agenda

- Introduction
- What is Multi-Site?
- Use Cases
- Multi-Site – A Deeper Look
- Conclusion

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Introduction

Introduction

- A brief touchpoint of the work at the IETF (Internet Engineering Task Force) and what RFC (Request for Comment) are Standard and what Informational
- What is this Multi-Site about – why do we have it and what is it good for
- Use Cases and Deployment Scenarios
- The Border Gateway (BGW)

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What is Multi-Site

What is RFC 9014?
By the Standards Body

[Search] [txt|html|xml|pdf|bibtex] [Tracker] [WG] [Email] [Diff1] [Diff2] [Nits]
From: draft-ietf-bess-dci-evpn-overlay-10 Proposed Standard
IPR declarations

Internet Engineering Task Force (IETF) J. Rabadan, Ed.
Request for Comments: 9014 S. Sathappan
Category: Standards Track W. Henderickx
ISSN: 2070-1721 Nokia
A. Sajassi
Cisco
J. Drake
Juniper
May 2021

Interconnect Solution for Ethernet VPN (EVPN) Overlay Networks

Abstract

This document describes how Network Virtualization Overlays (NVOs) can be connected to a Wide Area Network (WAN) in order to extend the Layer 2 connectivity required for some tenants. The solution analyzes the interaction between NVO networks running Ethernet Virtual Private Networks (EVPNs) and other Layer 2 VPN (L2VPN) technologies used in the WAN, such as Virtual Private LAN Services (VPLSs), VPLS extensions for Provider Backbone Bridging (PBB-VPLS), EVPN, or PBB-EVPN. It also describes how the existing technical specifications apply to the interconnection and extends the EVPN procedures needed in some cases. In particular, this document describes how EVPN routes are processed on Gateways (GWs) that interconnect EVPN-Overlay and EVPN-MPLS networks, as well as the Interconnect Ethernet Segment (I-ES), to provide multihoming. This document also describes the use of the Unknown MAC Route (UMR) to avoid issues of a Media Access Control (MAC) scale on Data Center Network Virtualization Edge (NVE) devices.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9014.

- Internet Engineering Task Force (IETF) Request for Comment (RFC)
- Categorized for Standards Track
- Internet Standard since 2021
- Existing Industry Adoption
- Interconnect Solution for Ethernet VPN (EVPN) Overlay Networks
- Co-Authored by Cisco

- RFC 9014
  - https://datatracker.ietf.org/doc/html/rfc9014

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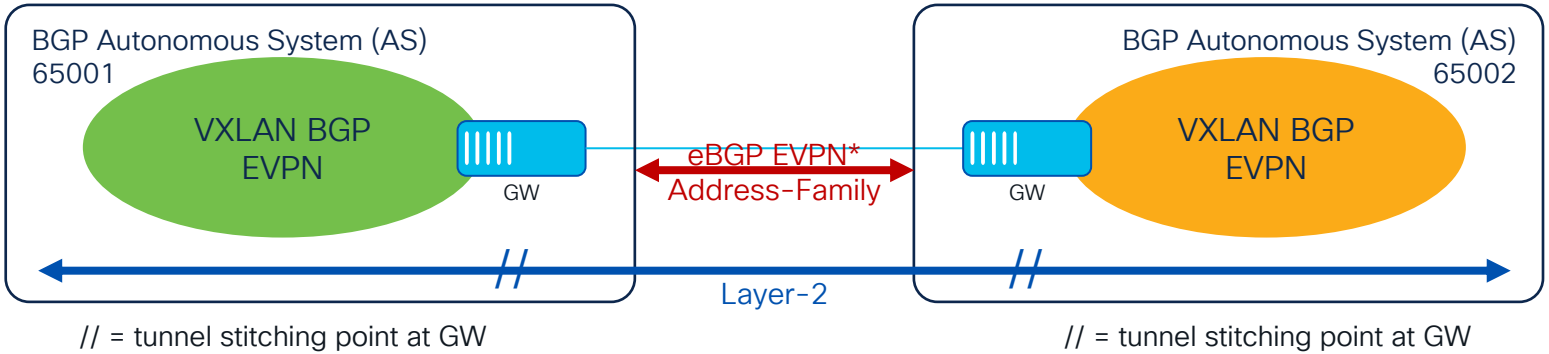
RFC 9014 at a glance
By the Standards Body

- DCI EVPN Overlay (aka RFC 9014)
- Interconnect Solution for Ethernet VPN (EVPN) Overlay Networks
- From the Abstract "*extend the Layer 2 connectivity required for some tenants.*"



*RFC 9014 supports more than just EVPN for the Interconnect Network

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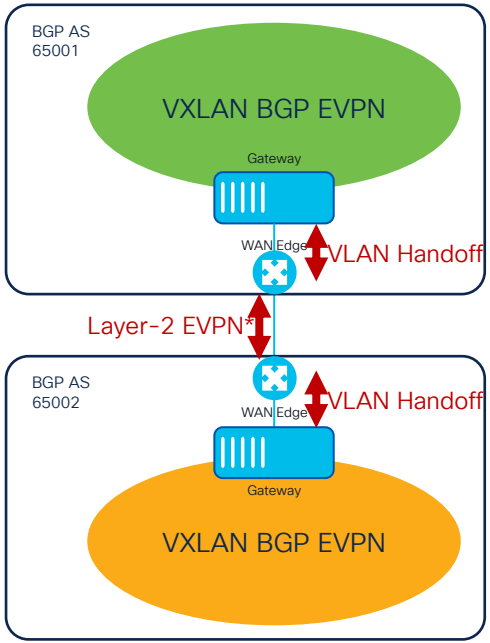
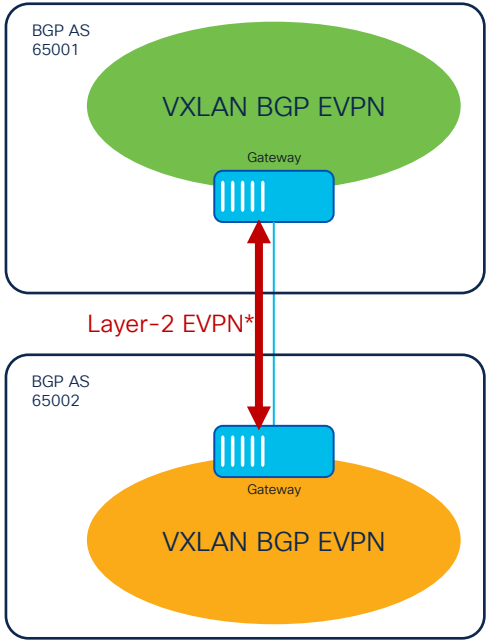
RFC 9014 Gateway Model Side-by-Side
Decoupled and Integrated Gateway

Decoupled Gateway (Section 3)



Integrated Gateway (Section 4)



*RFC 9014 supports more than just EVPN for the Interconnect Network

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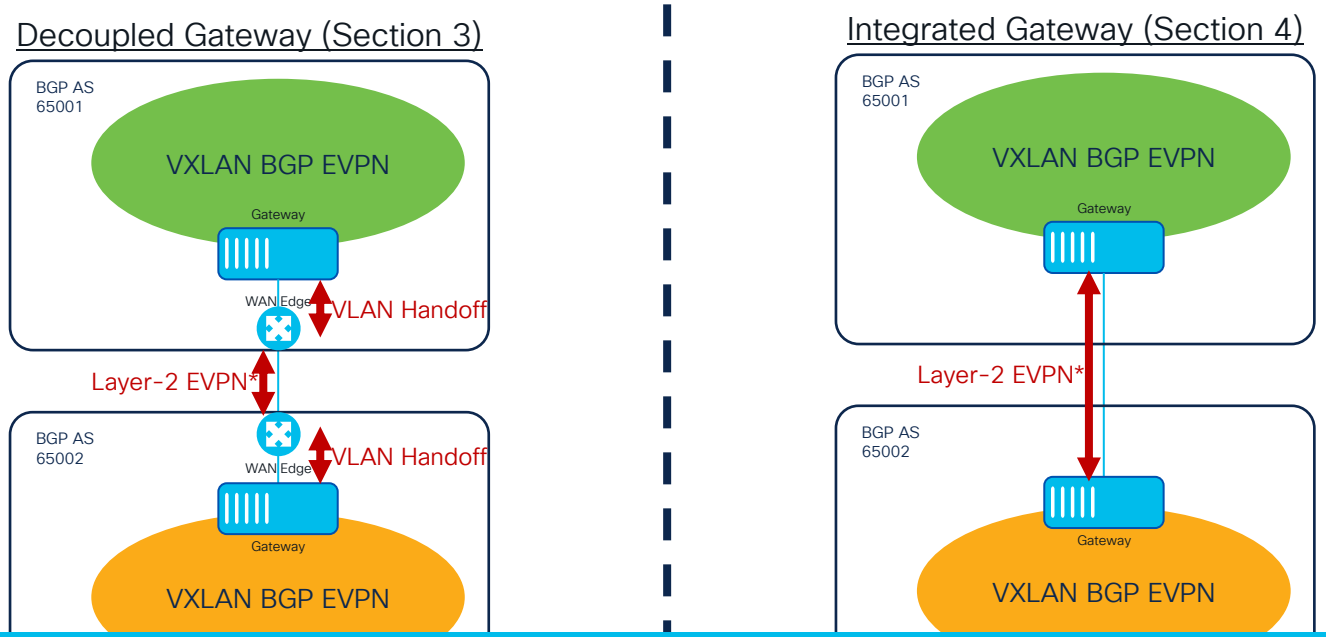
RFC 9014 Gateway Model Side-by-Side
Decoupled and Integrated Gateway



What about Layer-3?

*RFC 9014 supports more than just EVPN for the Interconnect Network

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Multi-Site Solution for Ethernet VPN (EVPN) Overlay

draft-sharma-bess-multi-site-evpn

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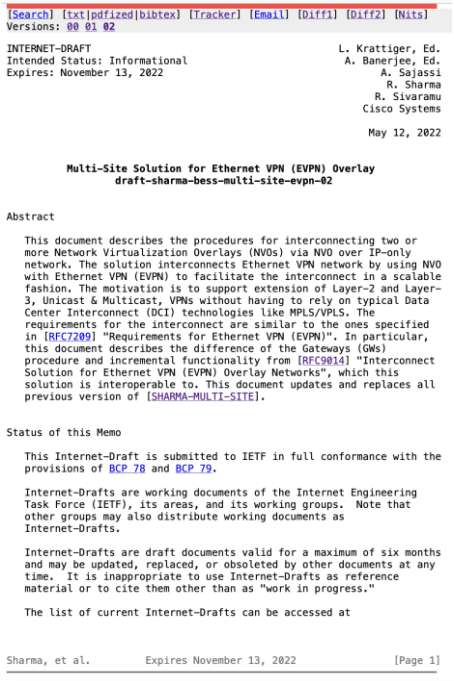
What is Multi-Site?
By the Standards Body



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Versions: 00 01 02

INTERNET-DRAFT
Intended Status: Informational
Expires: November 13, 2022

L. Krattiger, Ed.
A. Banerjee, Ed.
A. Sajassi
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R. Sivaramu
Cisco Systems

May 12, 2022

Multi-Site Solution for Ethernet VPN (EVPN) Overlay
draft-sharma-bess-multi-site-evpn-02

Abstract

This document describes the procedures for interconnecting two or more Network Virtualization Overlays (NVOs) via NVO over IP-only network. The solution interconnects Ethernet VPN network by using NVO with Ethernet VPN (EVPN) to facilitate the interconnect in a scalable fashion. The motivation is to support extension of Layer-2 and Layer-3, Unicast & Multicast, VPNs without having to rely on typical Data Center Interconnect (DCI) technologies like MPLS/VPLS. The requirements for the interconnect are similar to the ones specified in [RFC7209] "Requirements for Ethernet VPN (EVPN)". In particular, this document describes the difference of the Gateways (GWs) procedure and incremental functionality from [RFC9014] "Interconnect Solution for Ethernet VPN (EVPN) Overlay Networks", which this solution is interoperable to. This document updates and replaces all previous version of [SHARMA-MULTI-SITE].

Status of this Memo

This Internet-Draft is submitted to IETF in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at

Sharma, et al. Expires November 13, 2022 [Page 1]

- Internet Engineering Task Force (IETF) Request for Comment (RFC)
- Categorized as Informational
- Internet Draft since 2016
  - Currently in Version 3
  - Overall, 8 versions
- Updated and Maintained by BESS version of draft
  - draft-sharma-bess-multi-site-evpn
- Shipping since 2017

- Multi-Site (BESS version)
  - https://datatracker.ietf.org/doc/html/draft-sharma-bess-multi-site-evpn
- Pre-Cursor Draft (replaced by BESS version)
  - https://datatracker.ietf.org/doc/html/draft-sharma-multi-site-evpn

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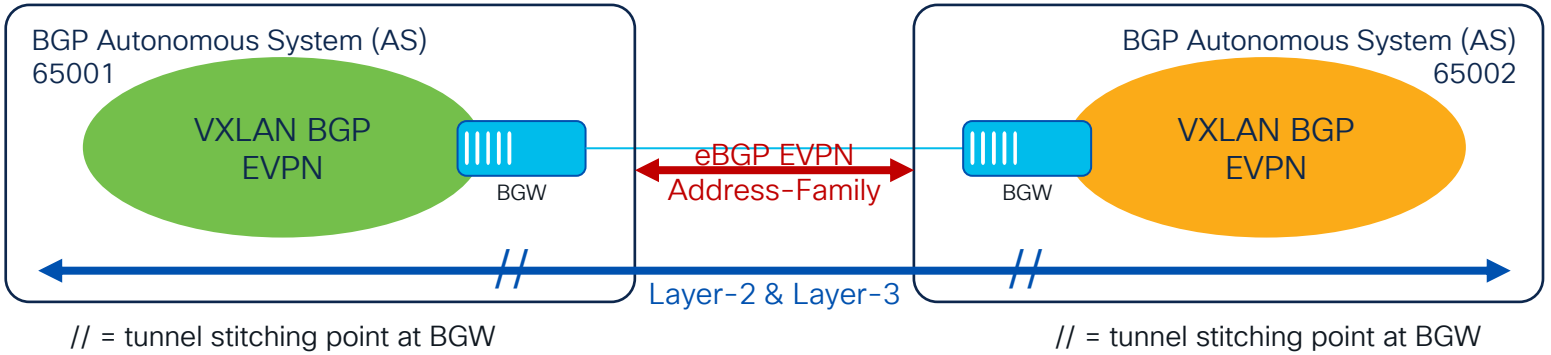
Multi-Site
By the Standards Body

- Multi-Site Solution for Ethernet VPN (EVPN) Overlay (draft-sharma-bess-multi-site-evpn)
- Interconnect Solution for Ethernet VPN (EVPN) Overlay Networks
- From the Abstract "*support extension of Layer-2 and Layer-3, Unicast & Multicast, VPNs*"



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RFC9014 and Multi-Site – Side by Side

	DCI-EVPN-Overlay (RFC 9014)	Multi-Site EVPN (draft-sharma-bess-multi-site-evpn)	
Interconnect	Integrated (1-Box), Decoupled (2-Box)	Integrated (1-Box)	
DCI Encap	VPLS, PBB-VPLS, EVPN-MPLS, PBB-EVPN, VXLAN	VXLAN	
Gateway Mode	Multipath PIP	Anycast VIP	Multipath PIP
ECMP	Underlay and Overlay	Underlay	Underlay and Overlay
EVPN RT-1	Consumed and Generated	None	Consumed and Generated
EVPN RT-2	Re-Originated with I-ESI	Re-Originated with ESI 0	Re-Originated with I-ESI
EVPN RT-3	Consumed and Generated	Consumed and Generated	Consumed and Generated
EVPN RT-4	Consumed and Generated	Consumed and Generated	Consumed and Generated
EVPN RT-5	ipvpn-evpn-interworking draft	Re-Originated	Re-Originated
Route Distinguisher (RD)	Separate RD for Intra and Inter DC	Separate RD for VIP and PIP	
Route-Target (RT)	Separate RT for Intra and Inter DC	Same RT for Intra and Inter DC	
VNI Allocation	Global and Downstream	Global and Downstream	
DF Election	Based on EVPN RT-4	Based on EVPN RT-4	
Identifier	I-ESI	I-ESI (= Site-ID)	
Split Horizon	Local Bias	Local Bias	
ESI-Type	Type 0 (Operator Managed)	Type 3 (MAC Based) or Type 5 (AS based)	
BUM Tree #	2, GW stitched (Intra and Inter DC)	2, GW stitched (Intra and Inter DC)	

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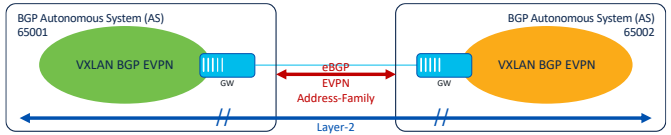
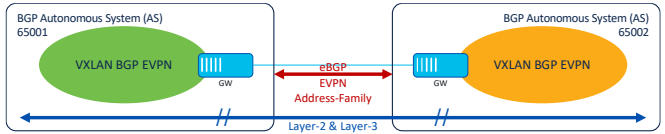
RFC9014 and Multi-Site – Side by Side
In a Nutshell





RFC 9014

Base Standard for Interconnecting EVPN
Defines the Layer-2 Stitching
Two Gateway Model
Multiple Encapsulations
Leverages Overlay and Underlay ECMP

Multi-Site

Extends RFC 9014 for Interconnecting EVPN
Describes Layer-2 and Layer-3 Stitching
Single Gateway Model (Two BGW* Model)
Focus only on VXLAN Encapsulation
Different ECMP model depending on BGW Model

*BGW – Border Gateway (BGW); Cisco's name for the VXLAN EVPN to VXLAN EVPN Gateway

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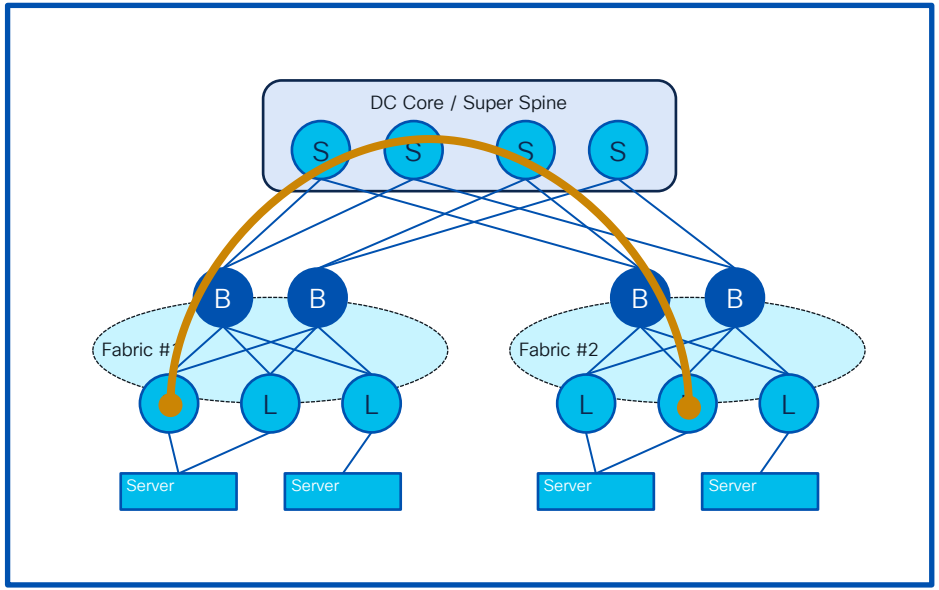
Multi-Site Functional Components and Use Cases

Use Case #1 – Compartmentalization



- Multiple Fabrics, single Data Center
  - Single or Multiple Data Halls
  - Within a Geographic Locations
- Control at BGW (Border Gateway)
  - Allows Extension of Layer-2
  - Allows Extension of Layer-3
  - Allows Extension of Layer-2 and Layer-3
  - Allows Traffic Control (BUM*)
  - Defines VNI allocation and stitching
  - Optimizes BUM* Replication

*BUM – Broadcast, Unknown Unicast, Multicast

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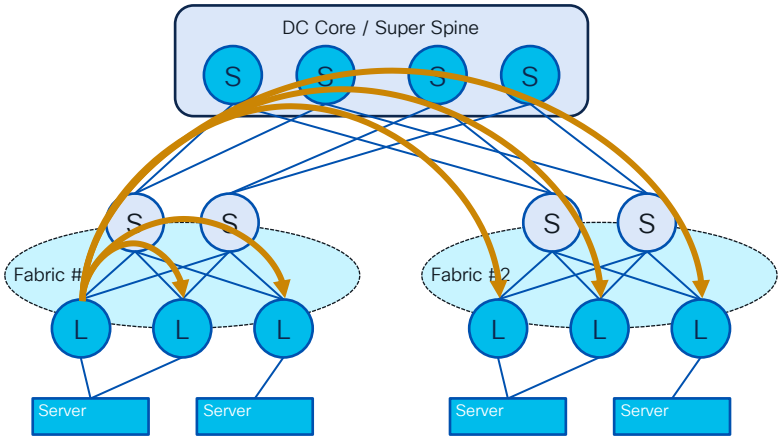
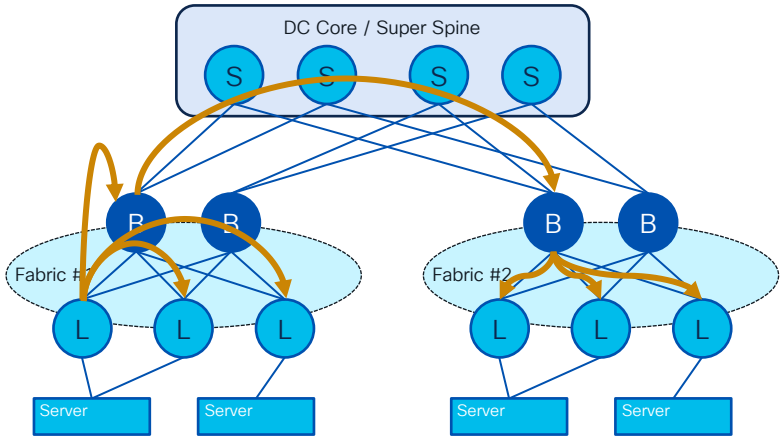
BUM Optimization
Use Case #1 – Compartmentalization

Single Fabric BUM with Ingress Replication



Single BUM Packet, 5x Replicated
3 Replication over DC Core / Super Spine (Between)
2 Replication for Fabric #1 (Local)

Multi-Site BUM with Ingress Replication



Single BUM Packet, 3x Replicated
1 Replication over DC Core / Super Spine (Between)
3 Replication for Fabric #1 (Local)
3 Replication for Fabric #2 (Local)

*BUM – Broadcast, Unknown Unicast, Multicast

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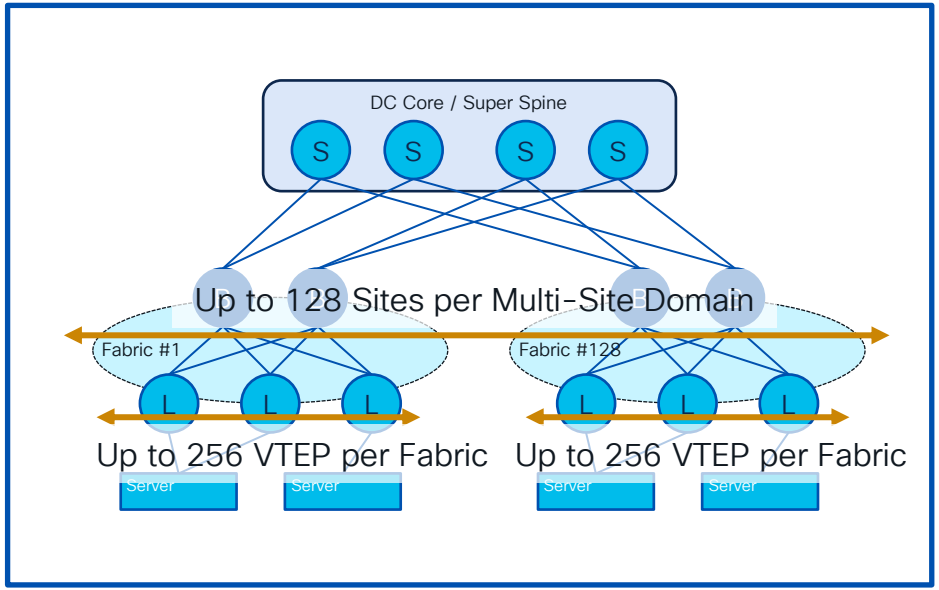
Use Case #2 - Scale



- Multiple Fabrics , single or multiple Data Center
  - Single or Multiple Data Halls
  - Within or between Geographic Locations
- Control at BGW (Border Gateway)
  - Reduces Remote VTEP Count
  - Expands VTEP scale
- Scale through Hierarchy
  - Multiply VTEP with Sites

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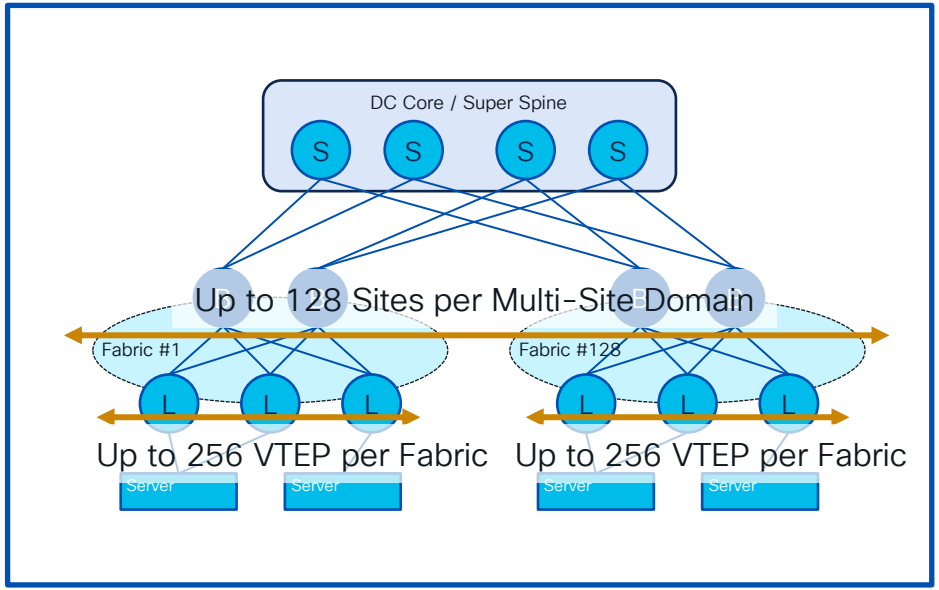
Use Case #2 - Scale



- Multiple Fabrics , single or multiple Data Center
  - Single or Multiple Data Halls
  - Within or between Geographic Locations
- Control at BGW (Border Gateway)
  - Reduces Remote VTEP Count
  - Expands VTEP scale
- Scale through Hierarchy
  - Multiply VTEP with Sites

32’768 VTEP to extend Layer-2 or/and Layer-3 segments to

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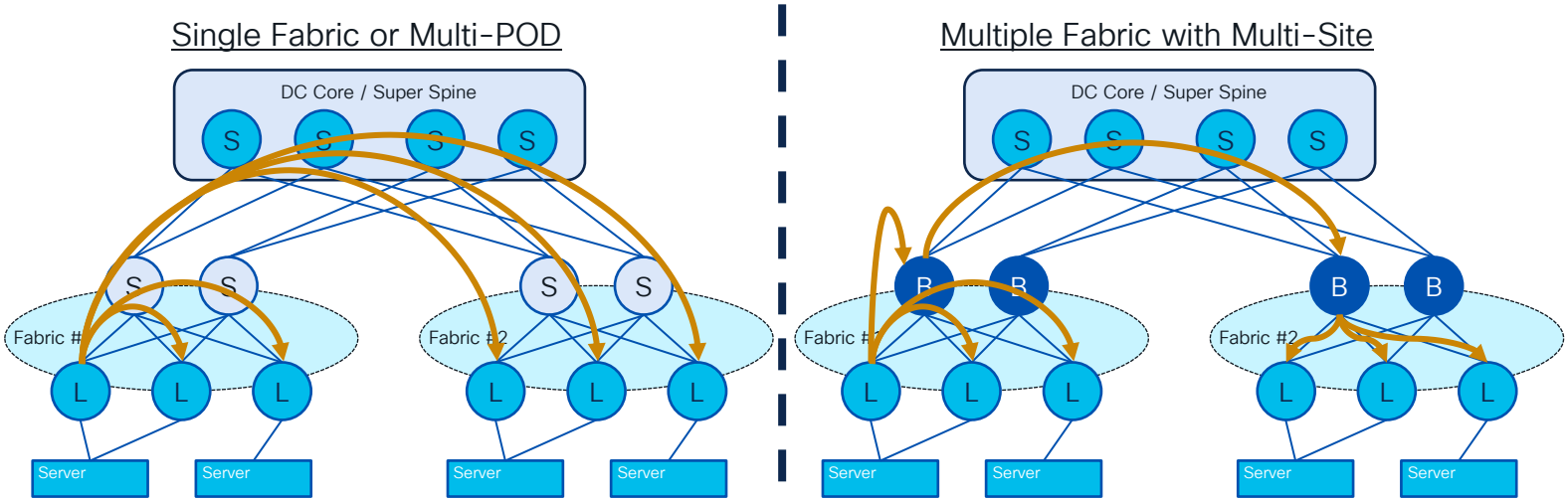
VTEP Scale
Use Case #2 – Scale



Leaf #1 sees every VTEP, 5 VTEP Peer
3 VTEP Peer for Fabric #2 (Between)
2 VTEP Peer for Fabric #1 (Local)

Leaf #1 sees only local VTEP, 3 VTEP Peer
1 VTEP Peer for Exit, BGW (Between)
2 VTEP Peer for Fabric #1 (Local)

*BUM – Broadcast, Unknown Unicast, Multicast

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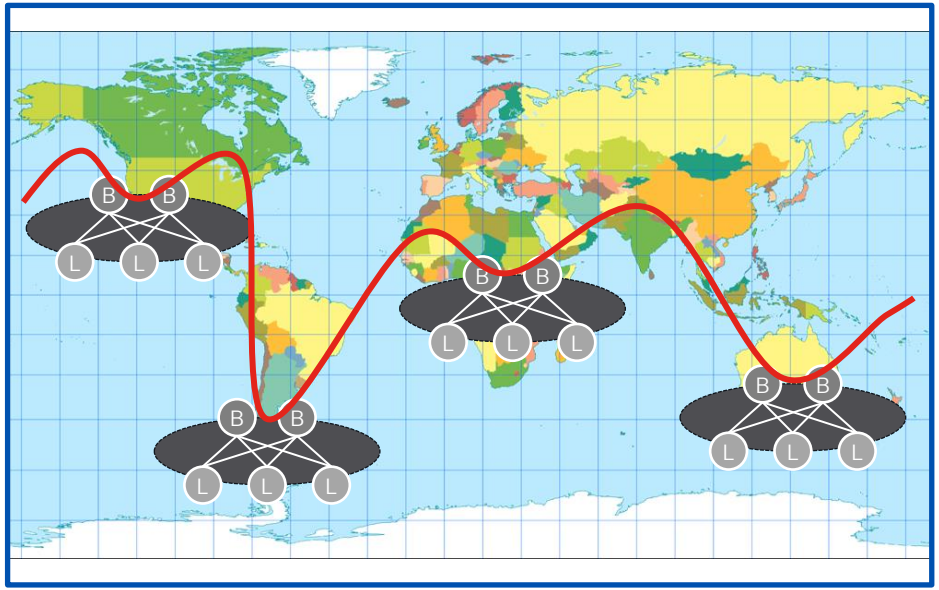
Use Case #3 – Data Center Interconnect (DCI)



- Multiple Fabrics, Geographically Dispersed
- Classic DCI Use Case
  - Allows Extension of Layer-2
  - Allows Extension of Layer-3
  - Allows Extension of Layer-2 and Layer-3
  - Allows Traffic Control (BUM*)
  - Defines VNI allocation and stitching
  - Optimizes BUM* Replication

*BUM – Broadcast, Unknown Unicast, Multicast

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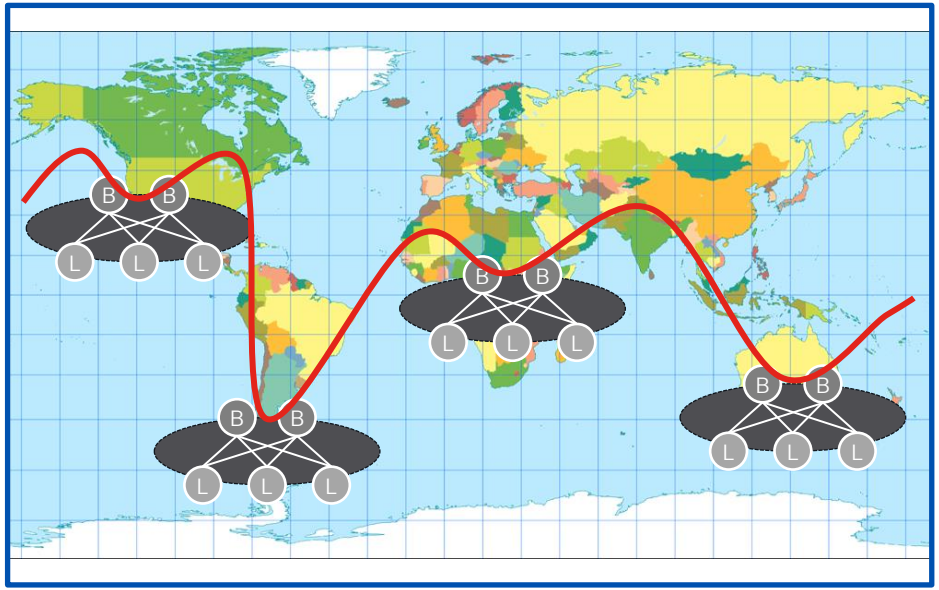
Use Case #3 – Data Center Interconnect (DCI)



- Multiple Fabrics, Geographically Dispersed
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  - Allows Extension of Layer-2
  - Allows Extension of Layer-3
  - Allows Extension of Layer-2 and Layer-3
  - Allows Traffic Control (BUM*)
  - Defines VNI allocation and stitching
  - Optimizes BUM* Replication

Works Within a Geographic Location – Works Between Geographic Locations

*BUM – Broadcast, Unknown Unicast, Multicast

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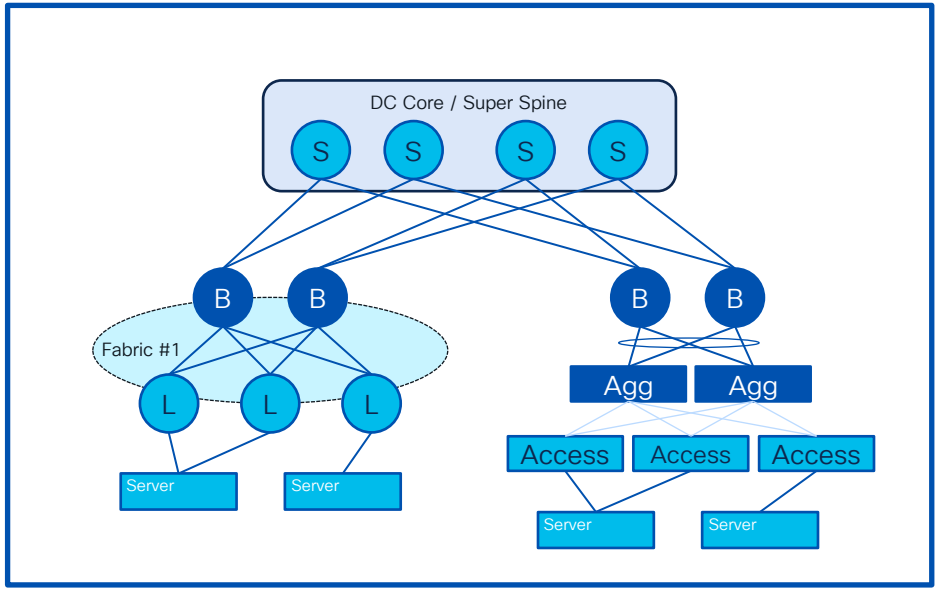
Use Case #4 – Integration with Legacy Networks



- Integrating Fabrics with Legacy Networks
  - BGW Frontends Legacy Network
  - BGW Frontends New Network
- Host Mobility and Migration
  - Provides Distributed Default Gateway
  - Allows Layer-2 Extension where needed
- Benefits from all Multi-Site functions
  - Layer-2, Layer-3 Multicast and Unicast VPNs between different Networks for Migration or Co-Existance

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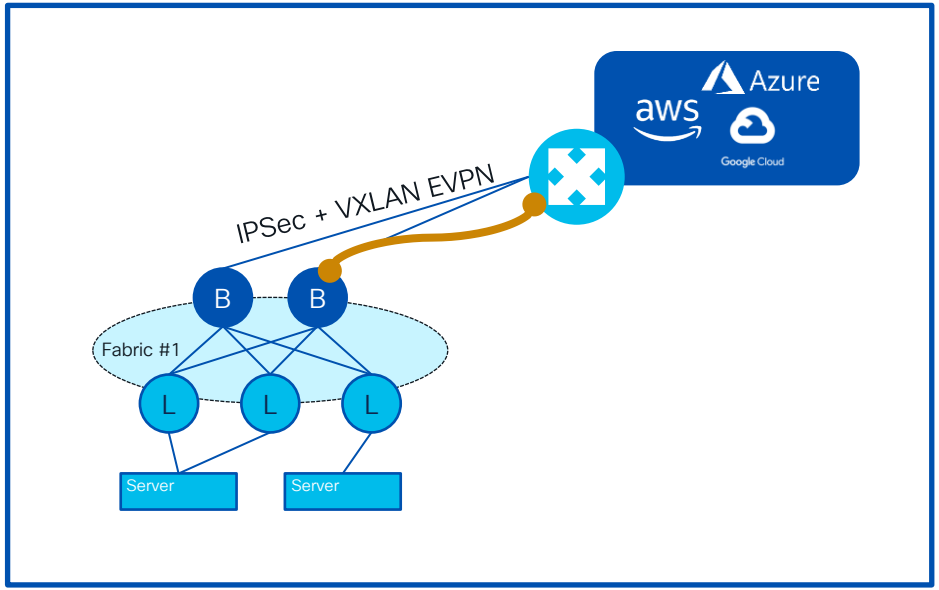
Use Case #5 – Hybrid Cloud Connectivity



- Extending from On-Prem to Public Cloud
  - Using BGW to terminate VXLAN EVPN Tunnel from Cloud
  - Transported via Internet or Direct Connect / Express Route
  - Encryption Optional (IPSec)
- Multi-Tenancy to the Cloud
  - Extends Layer-3 with VRF awareness
  - Multiple On-Prem VRF mapped or integrated with Virtual Cloud Instances (ie VPC or VNET)
- Leveraging Cisco Cloud Router
  - C8kv (Catalyst 8000 Virtual) in the Cloud as termination point
  - Replacing CSR1000v

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Multi-Site
A Deeper Look

As we Talk about Scale
Hardware Support

Minimum Hardware and Software Requirements for BGW (Border Gateway)	
Cisco Nexus Hardware	Cisco Nexus 9300 EX platform Cisco Nexus 9300 FX platform Cisco Nexus 9300 FX2 platform Cisco Nexus 9300 FX3 platform Cisco Nexus 9300 GX platform Cisco Nexus 9300 GX2 platform Cisco Nexus 9364C platform Cisco Nexus 9332C platform Cisco Nexus 9500 platform with X9700-EX line card Cisco Nexus 9500 platform with X9700-FX line card Cisco Nexus 9500 platform with X9700-GX line card
Cisco Nexus Software (NX-OS)	Cisco NX-OS Software Release 7.0(3)I7(1) or later*

*Check for Hardware Specific Support Releases

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As we Talk about Scale
Scalability Values as of NX-OS 10.2(3)F

Multi-Site Scale	
Number of Sites	128
Number of BGW per Site	6
Number of VTEP per Site (internal)	256

Border Gateway (BGW) Scale	EX	FX2	FX,FX3,GX,GX2	N9364C & N9332C
Number of Layer-2 VNI (VLAN)	3900			
Number of Layer-3 VNI (VRF)	2000			
MAC per BGW	92k			
IPv4 Host Routes per BGW*	450k	450k	1.1M	96k
IPv4 Network Routes per BGW*	450k	450k	1.1M	8k
IPv6 Host Routes per BGW*	24k	260k	620k	48k
IPv6 Network Routes per BGW*	200k	290k	620k	2k

*The values provided in these tables focus on the scalability of one particular Route scale at a time

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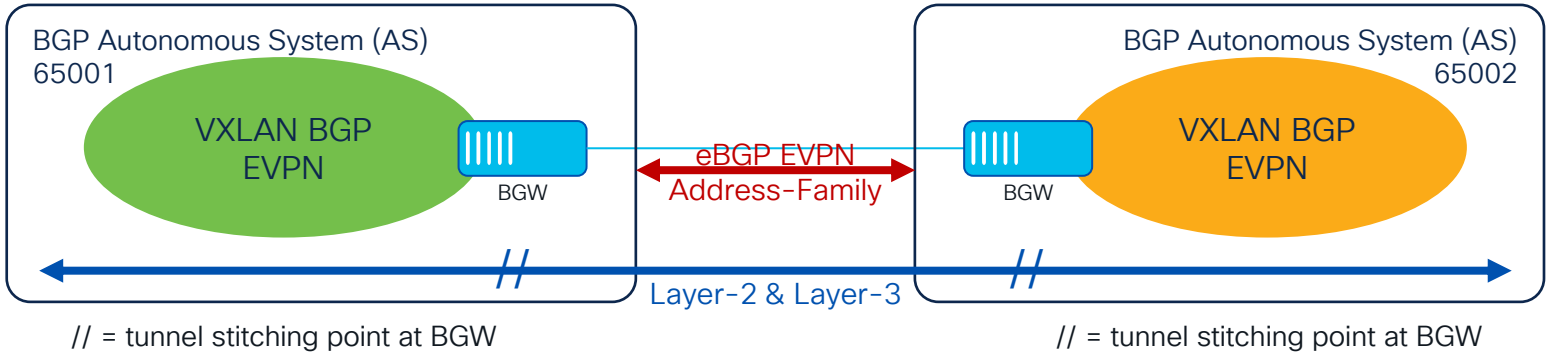
Some Notes on BGW and VXLAN Tunnels
Multi-Site

- Tunnels are Stitched at the BGW (Border Gateway)
- Intra Fabric Tunnel goes from Leaf to Leaf or Leaf to BGW
- Inter Fabric Tunnel goes from BGW to BGW



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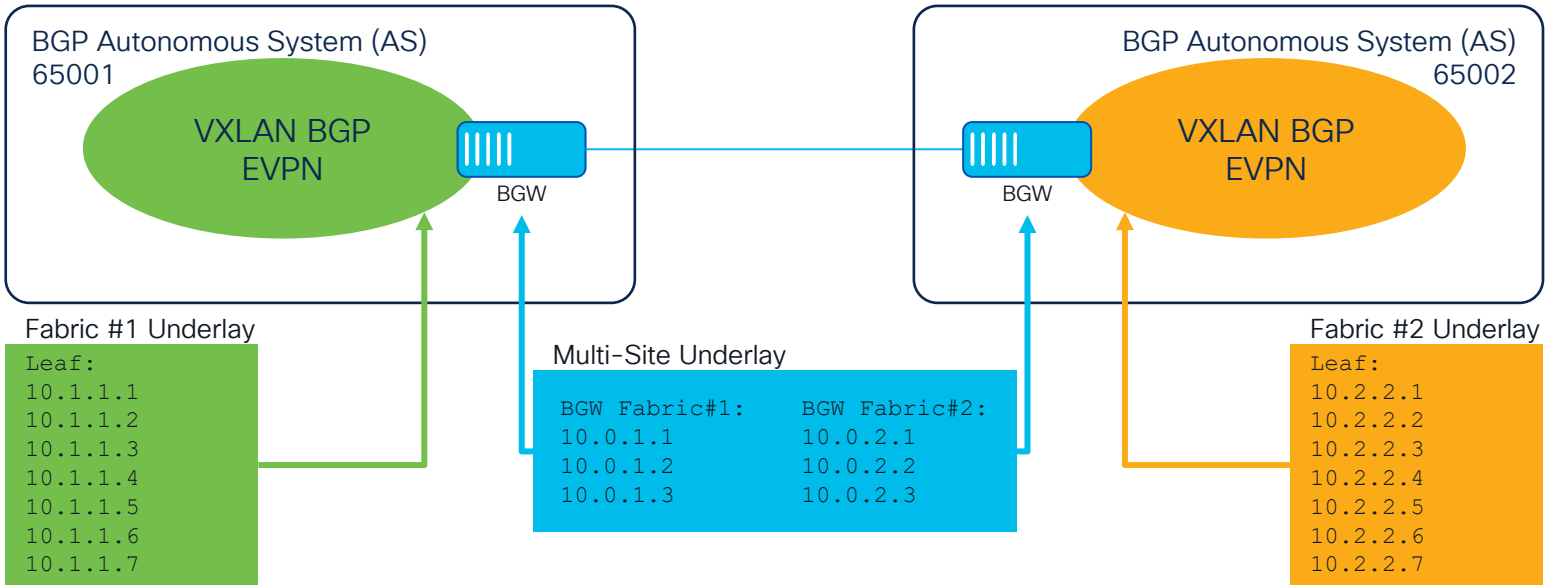
Some Notes on the Interconnect and Underlay
Multi-Site

- Fabric #1 Underlay (VTEP, Point-2-Point, Loopback etc) is not aware of Fabric #2
- Each Fabric maintains their Unique Network Topology, Protocols and IP Addressing
- Only BGW IP Addressing must be Unique and Aligned between Sites



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Border Gateway Deployment Considerations

Multi-Site - A Deeper Look

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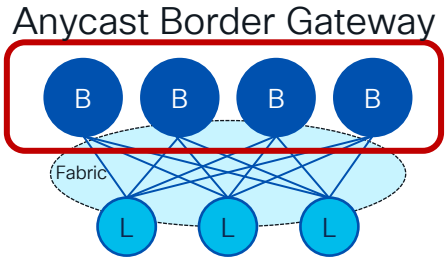
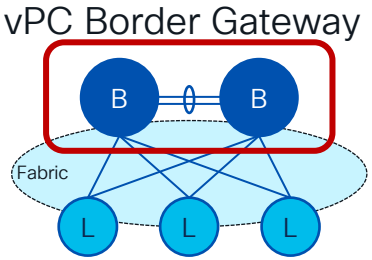
Border Gateways Deployment Considerations





- Border Gateways used for two main functions:
  - Interconnecting each site to the Inter-Site network (for East-West traffic flows)
  - Connecting each site to the external Layer 3 domain (for North-South traffic flows)
  - May also be used to connect endpoints and/or network service nodes (FWs, ADCs)
- Possible deployment models:
  - Anycast Border Gateways
  - vPC Border Gateways
- BGW function enablement in the VXLAN EVPN fabric:
  - BGWs on Leaf node (Border Gateway Leaf)
  - BGWs on Spine node (Border Gateway Spine)

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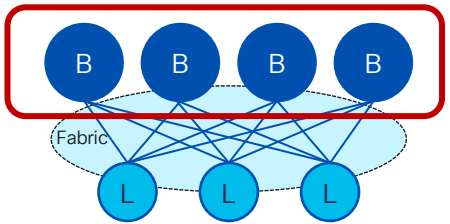
Anycast Border Gateway



Anycast Border Gateway

- Up to 6 Border Gateways
- Border Gateway
  - Deploying as a Leaf node – 7.0(3)I7(1)
  - Deploying as a Spine node – 7.0(3)I7(2)

- Two Mode of Operation:
  - Can Operate as Multi-Site Anycast BGW with VIP
    - Focuses on Scale and Convergence
    - Using Virtual IP (VIP) for Tunnel Stitching
    - Uses Overlay ECMP
  - Can Operate in RFC 9014 BGW Mode with PIP
    - Focuses on 3rd Party Interop
    - Using Primary IP (PIP) for Tunnel Stitching
    - Uses Underlay and Overlay ECMP

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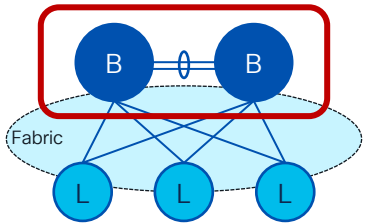
vPC Border Gateway



vPC Border Gateway

- Up to 2 Border Gateways
- Border Gateway
  - Deploying as a Leaf node – 9.2(1)

- Common Use Case
  - Legacy Network Integration or Migration
    - Provides Multi-Chassis Link Aggregation
    - Integrates with Ethernet and FabricPath
    - Hosts the Distributed Anycast Gateway
  - Attachment of Network Services
    - Dual-Attachment of Firewalls and ADCs
    - Acts like a vPC when it comes to Routing

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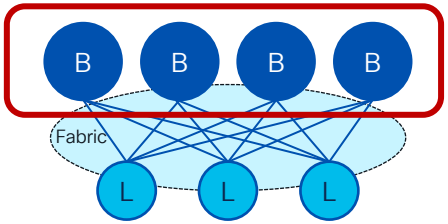
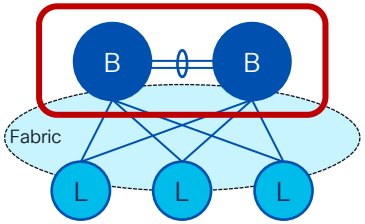
When to use what BGW



Anycast Border Gateway

- Up to 6 BGW
  - Shared Nothing
  - Simple Failure Scenarios
- Any Deployments
  - No End-Point or Network Services Connectivity on BGW
- Greenfield Deployments



vPC Border Gateway

- 2 BGW with physical vPC Peer-Link
- Small Deployments
  - End-Point or Network Services Connectivity on BGW
- Migration Use-Cases (Brownfield)
  - Classic Ethernet/FabricPath to VXLAN EVPN

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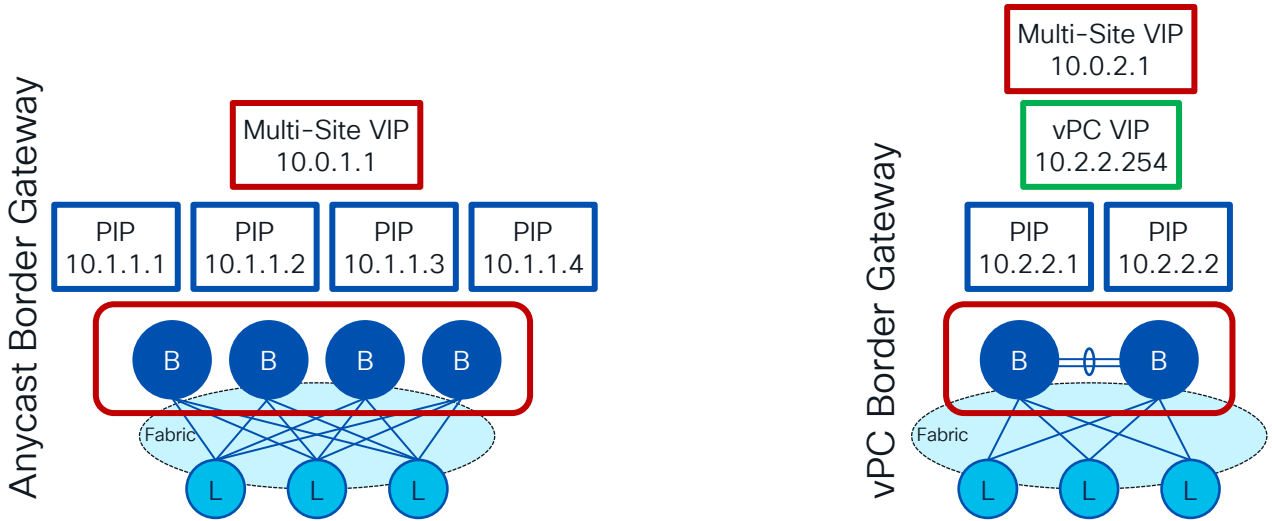
Details on the Different BGW

- Both Anycast and vPC Border Gateway needs to be configured with a common Multi-Site VIP address and an individual Primary IP (PIP) address
- vPC Border Gateways share a secondary IP address to be used as vPC virtual IP (vPC VIP)



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Control and Data Plane

Multi-Site - A Deeper Look

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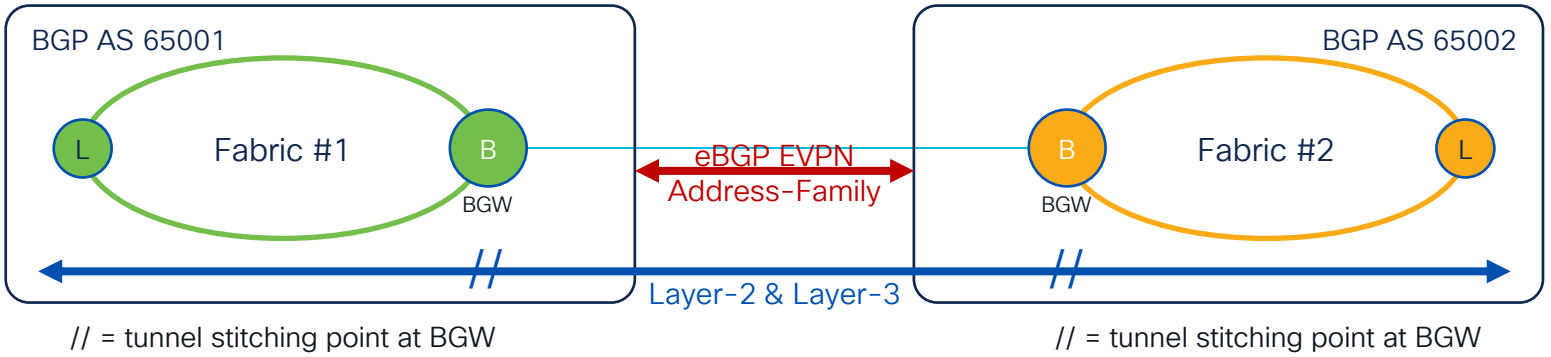
Control- and Data-Plane

- MP-eBGP EVPN for between Multiple Sites
- Leverages Natural BGP Next-hop behavior
  - VXLAN tunnel termination and re-origination
  - Loop protection (as-path attribute)
- Full mesh of MP-eBGP EVPN adjacencies between sites



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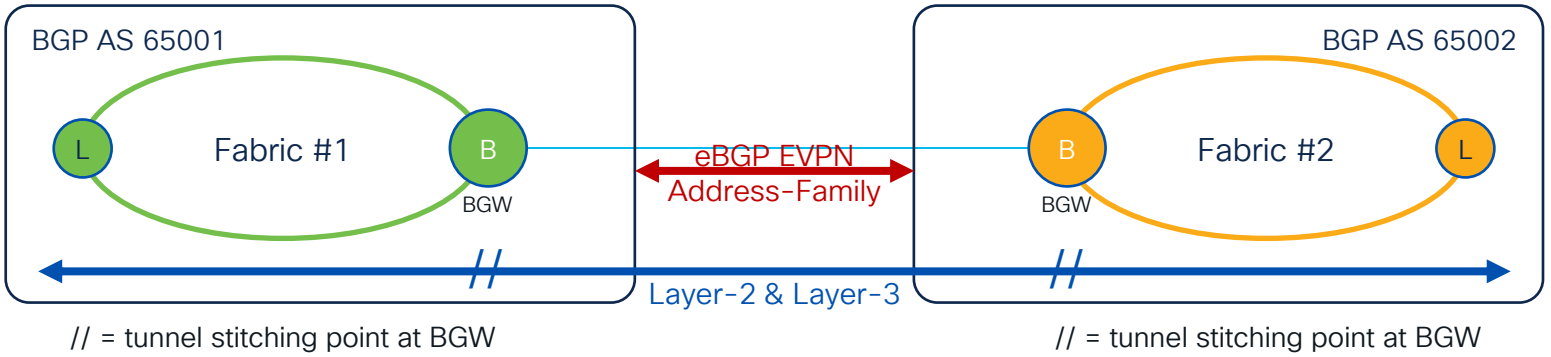
Control- and Data-Plane

- Two main options for underlay and overlay Control-Plane (CP) deployment
  - I-E-I (Recommended)
    - Within Fabric: IGP (OSPF, IS-IS) as underlay CP, iBGP as overlay CP
  - E-E-E*
    - Within and Between Fabrcis: eBGP for both underlay and overlay CPs



*For more information on why eBGP for both underlay and overlay CP is not a good idea:
https://learningnetwork.cisco.com/blogs/community_cafe/2017/10/17/the-magic-of-super-spines-and-rfc7938-with-overlays-guest-post

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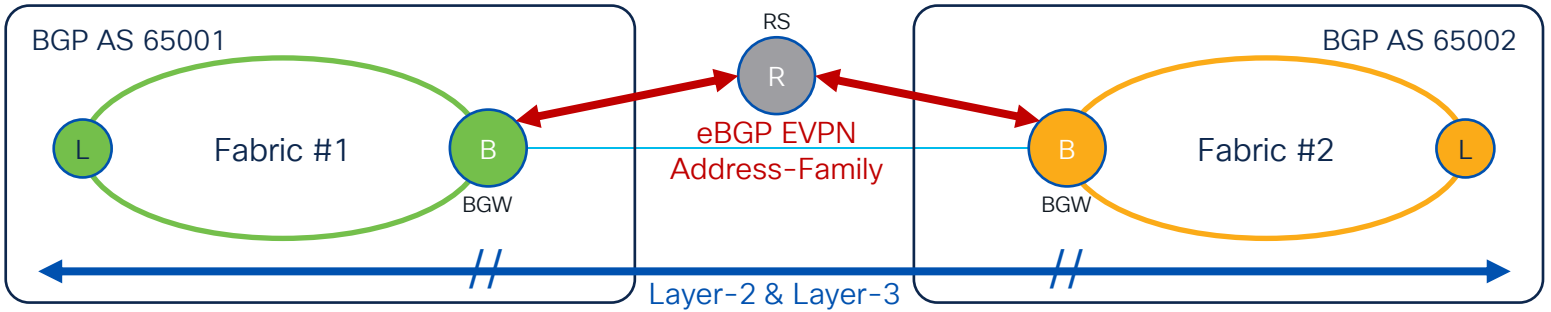
Control- and Data-Plane

- Full mesh of MP-eBGP EVPN adjacencies between sites
  - Recommended to deploy a couple of Route-Servers (RS) with 3 or more sites
- RS resides in a separate AS and only performs control plane functions
  - “eBGP Route-Reflectors”, IETF RFC 7947
- RS functions: EVPN routes reflection, next-hop-unchanged, route-target rewrite



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It all starts with a Network Device
The Dating Network - When Control- meets Data-Plane

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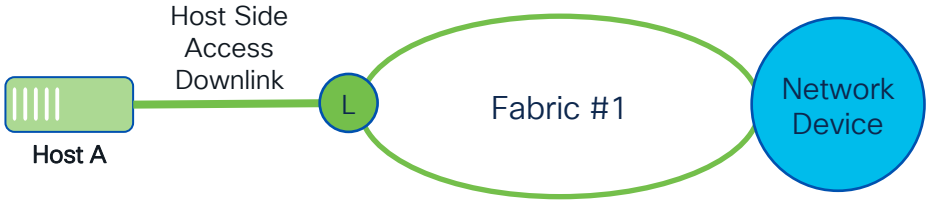
It all starts with a Network Device
The Dating Network - When Control- meets Data-Plane



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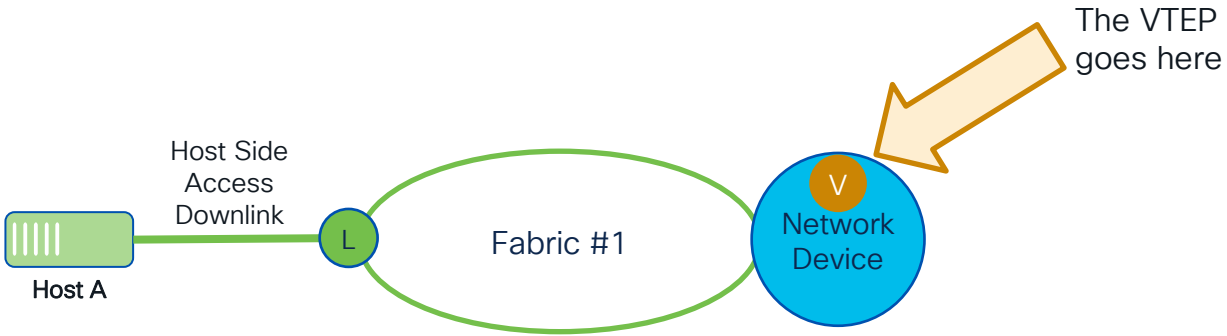
Making the Network Device an NVE
The Dating Network - When Control- meets Data-Plane



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Making the Network Device an NVE
The Dating Network - When Control- meets Data-Plane

Still a ...

Switch
Router
Network Device
or Edge Device

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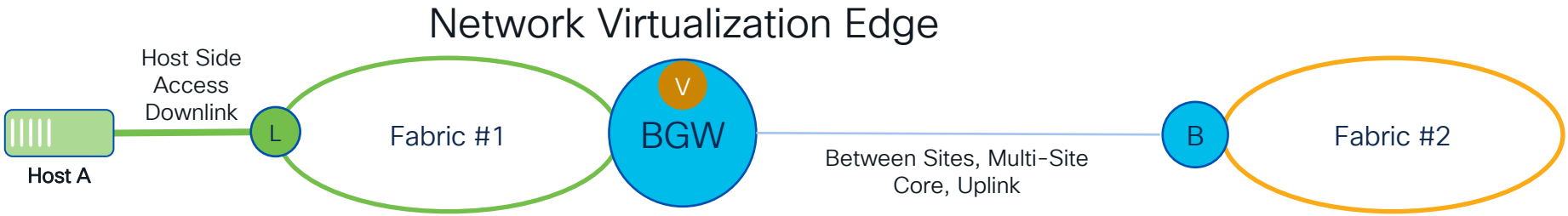
Expanding to the BGW – A “special” NVE
The Dating Network - When Control- meets Data-Plane



//

Stitching Point between
- Local VTEP (L)
- Remote VTEP (B)
- Individual VTEP in Fabric #2 are “hidden”

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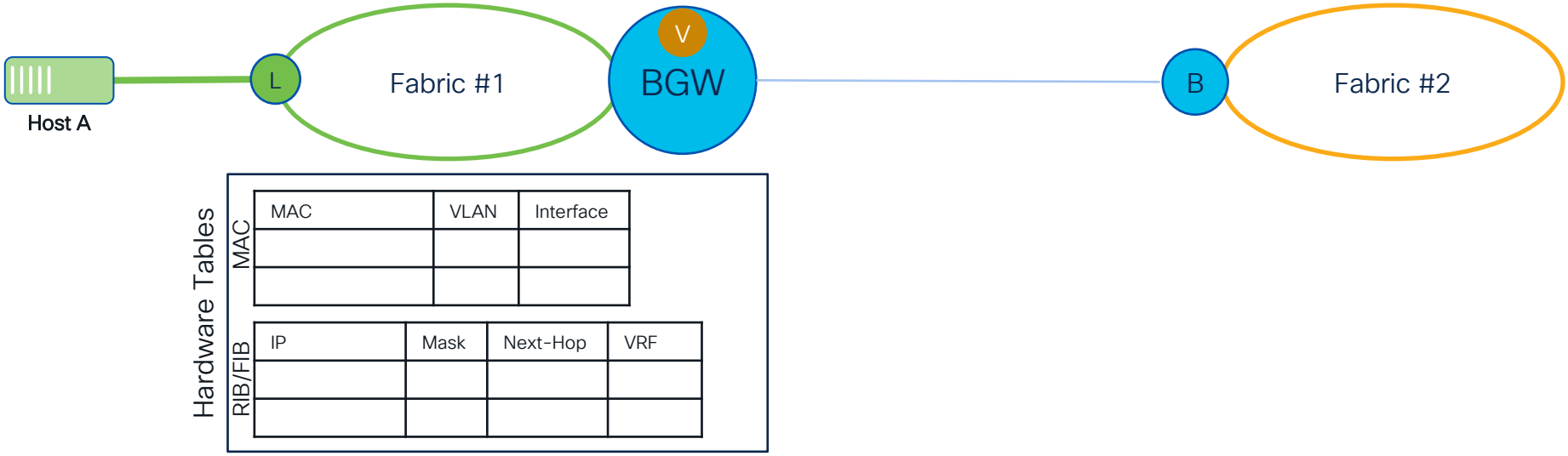
The BGW and Some Important Table
The Dating Network - When Control- meets Data-Plane



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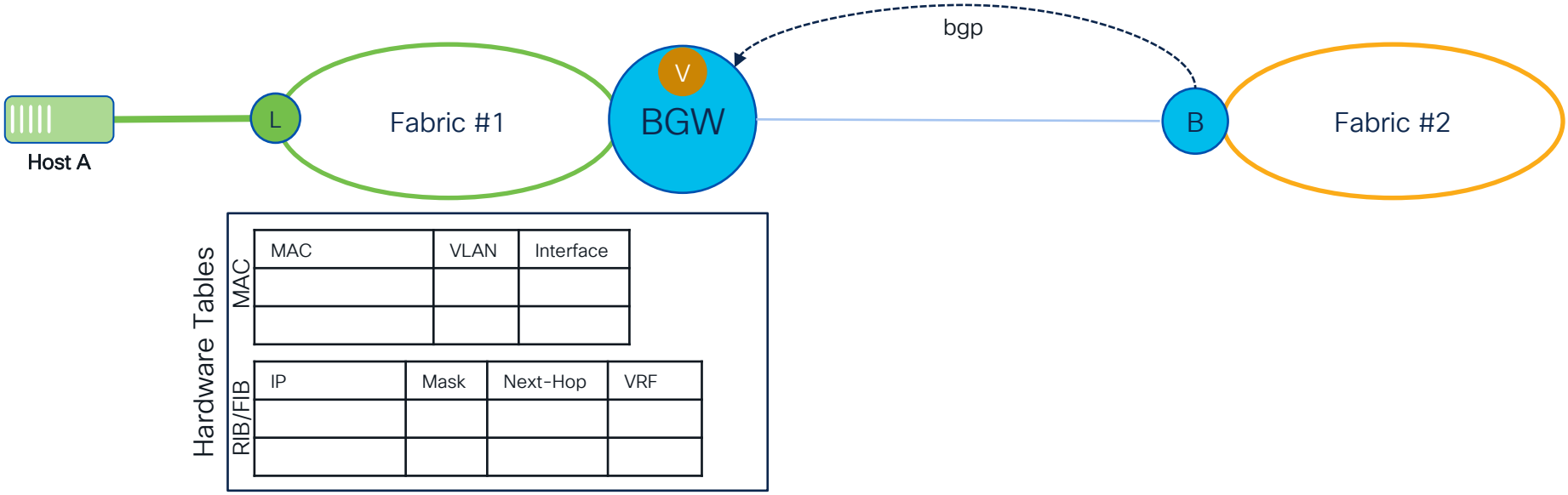
Always Remote Learning on a BGW
The Dating Network - When Control- meets Data-Plane



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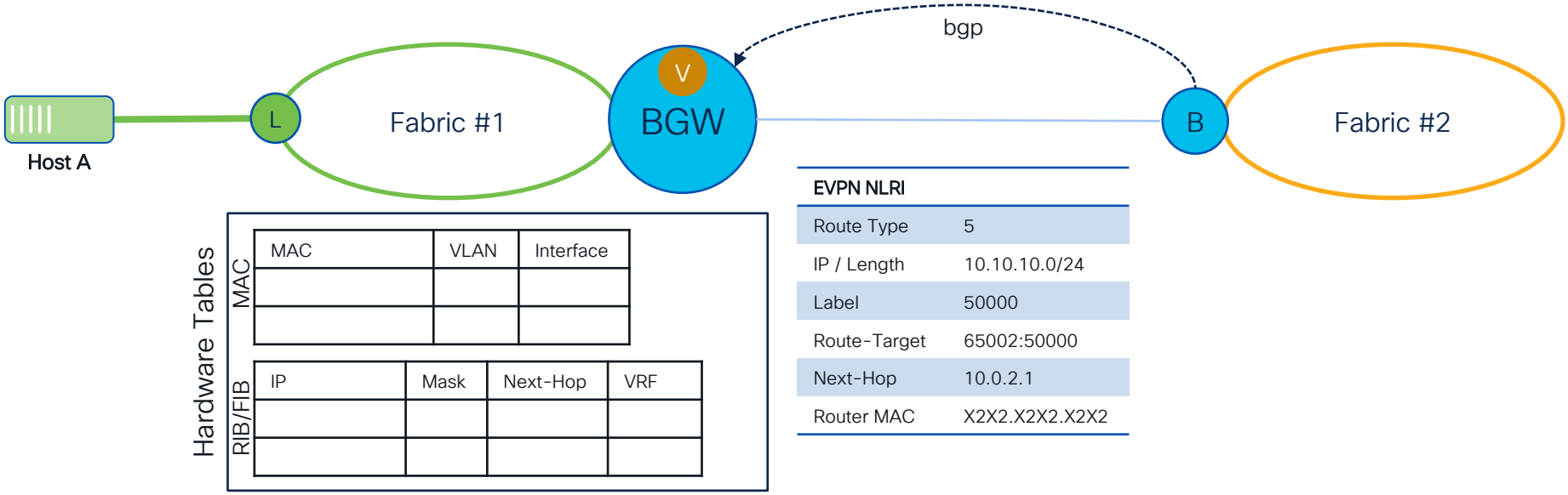
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



EVPN NLRI	
Route Type	5
IP / Length	10.10.10.0/24
Label	50000
Route-Target	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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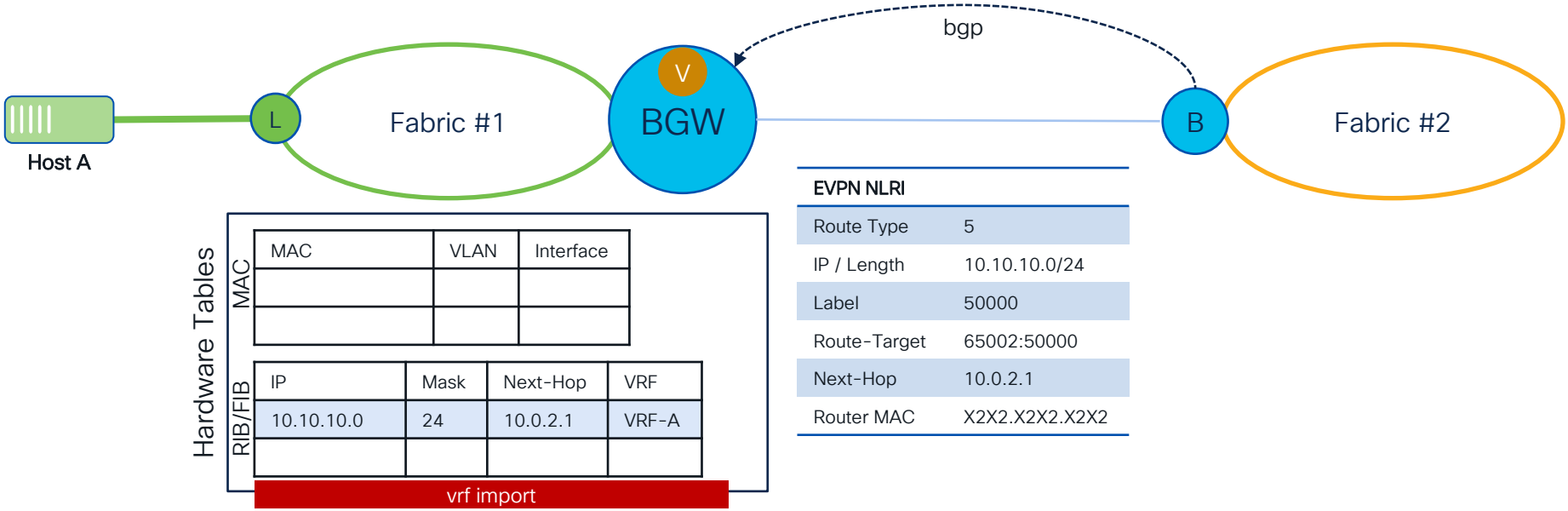
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



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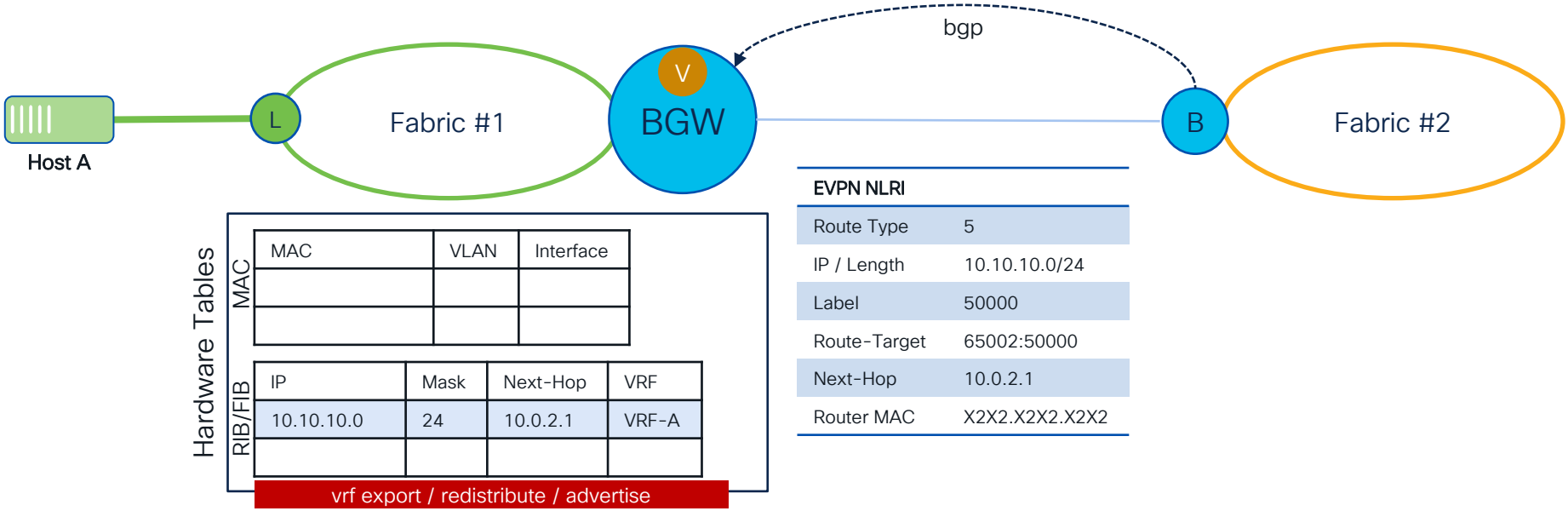
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



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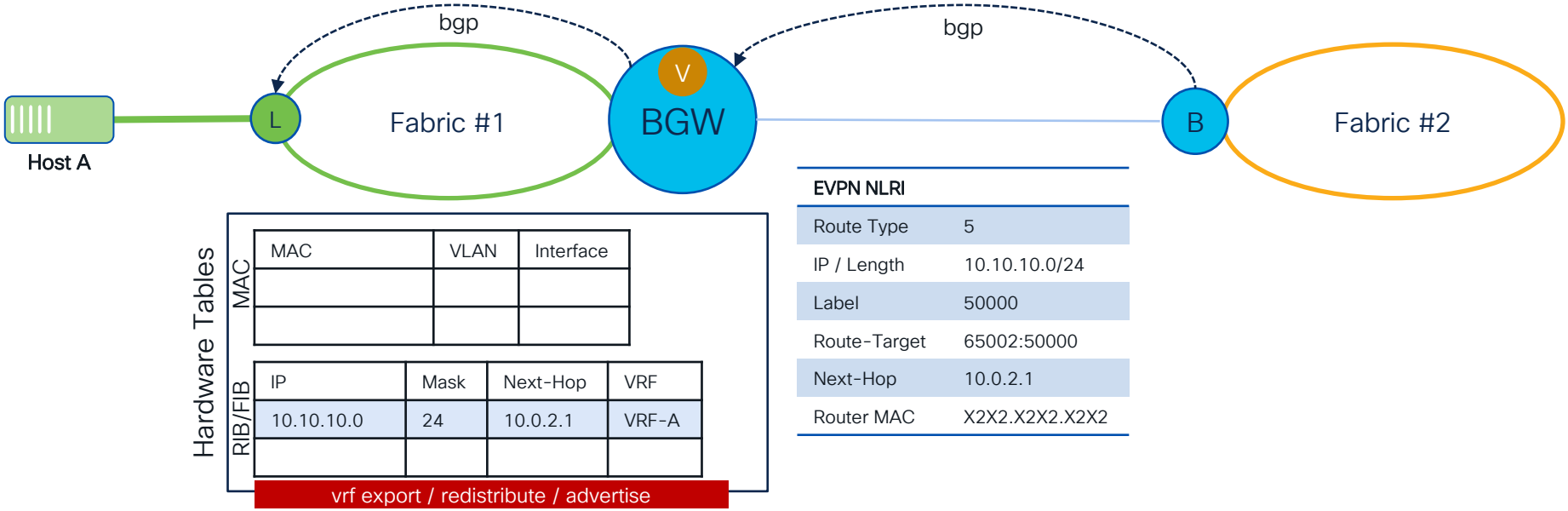
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



EVPN NLRI	
Route Type	5
IP / Length	10.10.10.0/24
Label	50000
Route-Target	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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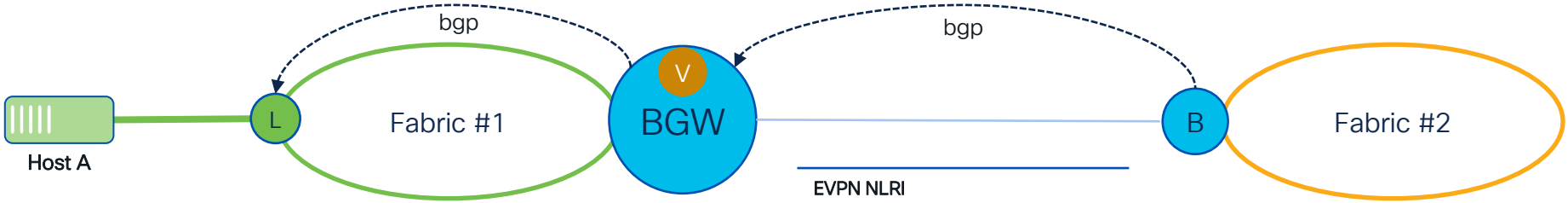
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



EVPN NLRI	
Route Type	5
IP / Length	10.10.10.0/24
Label	50000
Route-Target	65001:50000
Next-Hop	10.0.1.1
Router MAC	X1X1.X1X1.X1X1

EVPN NLRI	
Route Type	5
IP / Length	10.10.10.0/24
Label	50000
Route-Target	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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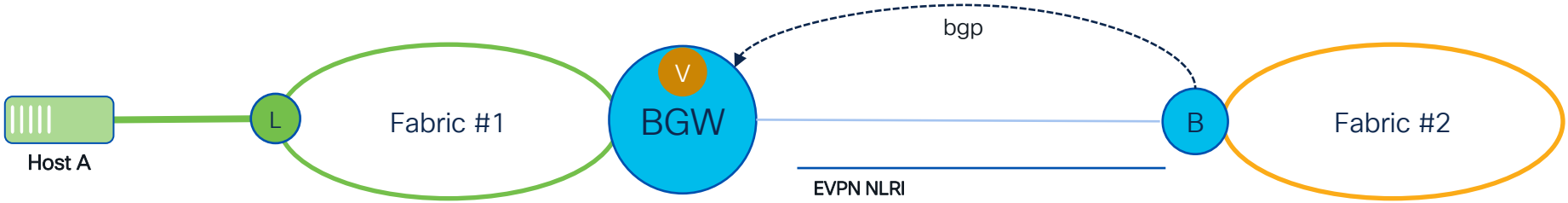
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



Hardware Tables

MAC

MAC	VLAN	Interface

RIB/FIB

IP	Mask	Next-Hop	VRF

EVPN NLRI	
Route Type	2
MAC / Length	0003.0000.100B/48
IP / Length	192.168.1.12/32
Label1	30001
Label2	50000
Route-Target1	65002:30001
Route-Target2	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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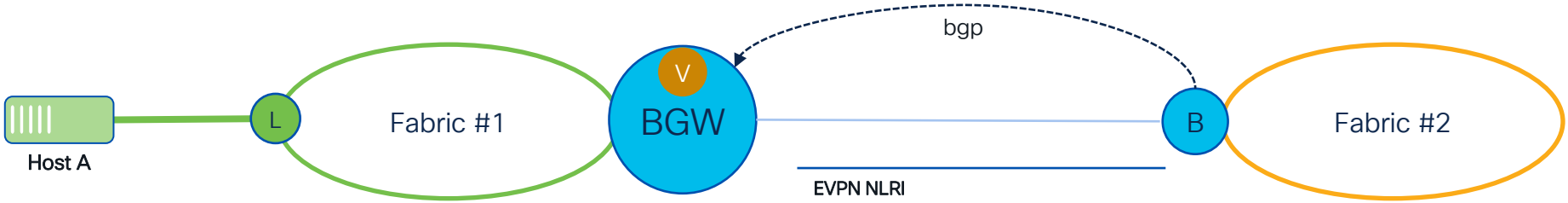
The Dating Network - When Control- meets Data-Plane



Hardware Tables

MAC

MAC	VLAN	Interface

RIB/FIB

IP	Mask	Next-Hop	VRF
10.10.10.0	24	10.0.2.1	VRF-A

EVPN NLRI	
Route Type	2
MAC / Length	0003.0000.100B/48
IP / Length	192.168.1.12/32
Label1	30001
Label2	50000
Route-Target1	65002:30001
Route-Target2	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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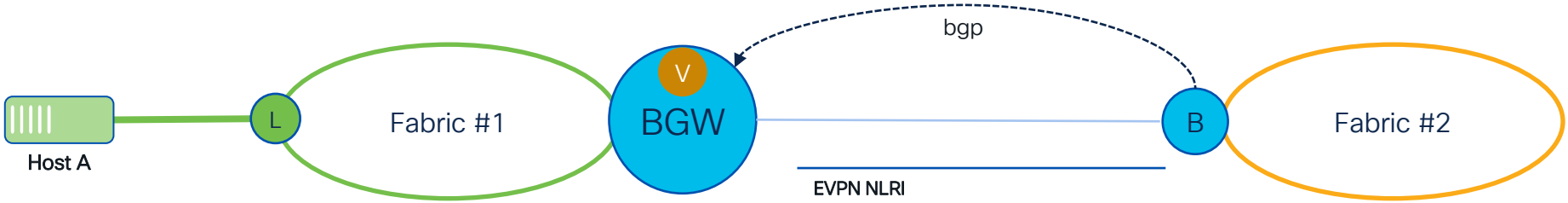
The Dating Network - When Control- meets Data-Plane



Hardware Tables

MAC

MAC	VLAN	Interface
0003.0000.100B	10	10.0.2.1

vrf import

RIB/FIB

IP	Mask	Next-Hop	VRF
10.10.10.0	24	10.0.2.1	VRF-A
192.168.1.12	32	10.0.2.1	VRF-A

vrf import

EVPN NLRI	
Route Type	2
MAC / Length	0003.0000.100B/48
IP / Length	192.168.1.12/32
Label1	30001
Label2	50000
Route-Target1	65002:30001
Route-Target2	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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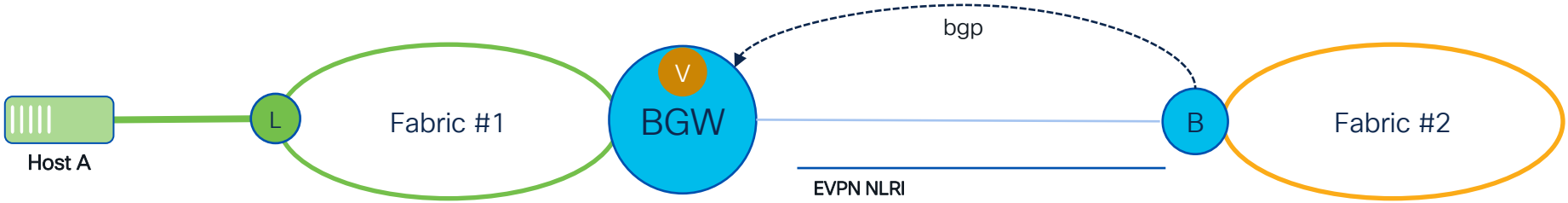
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



Hardware Tables

MAC

MAC	VLAN	Interface
0003.0000.100B	10	10.0.2.1

vrf export / redistribute / advertise

RIB/FIB

IP	Mask	Next-Hop	VRF
10.10.10.0	24	10.0.2.1	VRF-A
192.168.1.12	32	10.0.2.1	VRF-A

vrf export / redistribute / advertise

EVPN NLRI	
Route Type	2
MAC / Length	0003.0000.100B/48
IP / Length	192.168.1.12/32
Label1	30001
Label2	50000
Route-Target1	65002:30001
Route-Target2	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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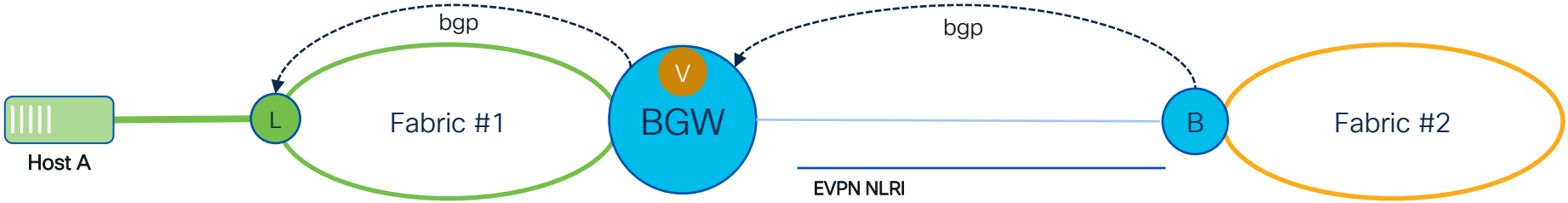
The Dating Network - When Control- meets Data-Plane



Hardware Tables

MAC

MAC	VLAN	Interface
0003.0000.100B	10	10.0.2.1

vrf export / redistribute / advertise

RIB/FIB

IP	Mask	Next-Hop	VRF
10.10.10.0	24	10.0.2.1	VRF-A
192.168.1.12	32	10.0.2.1	VRF-A

vrf export / redistribute / advertise

EVPN NLRI	
Route Type	2
MAC / Length	0003.0000.100B/48
IP / Length	192.168.1.12/32
Label1	30001
Label2	50000
Route-Target1	65002:30001
Route-Target2	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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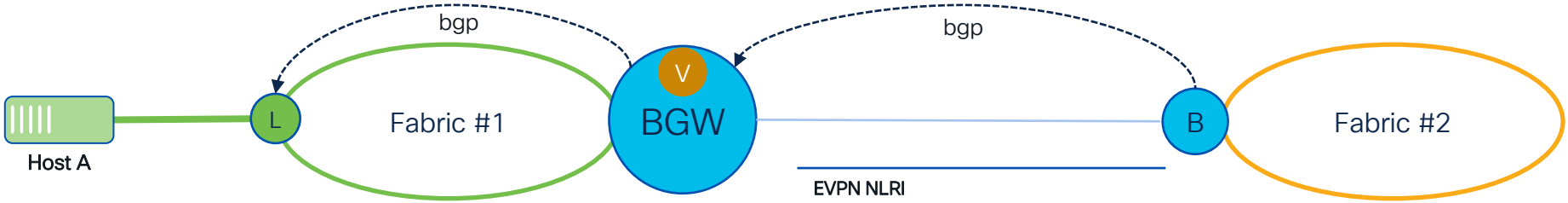
Remote Learning from Remote Fabric
The Dating Network - When Control- meets Data-Plane



EVPN NLRI	
Route Type	2
MAC / Length	0003.0000.100B/48
IP / Length	192.168.1.12/32
Label1	30001
Label2	50000
Route-Target1	65001:30001
Route-Target2	65001:50000
Next-Hop	10.0.1.1
Router MAC	X1X1.X1X1.X1X1

EVPN NLRI	
Route Type	2
MAC / Length	0003.0000.100B/48
IP / Length	192.168.1.12/32
Label1	30001
Label2	50000
Route-Target1	65002:30001
Route-Target2	65002:50000
Next-Hop	10.0.2.1
Router MAC	X2X2.X2X2.X2X2

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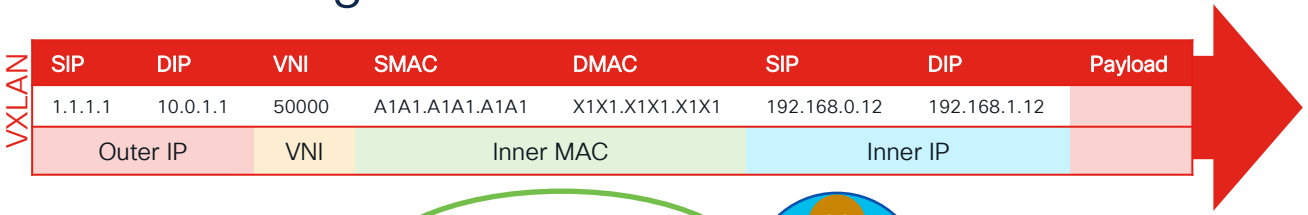
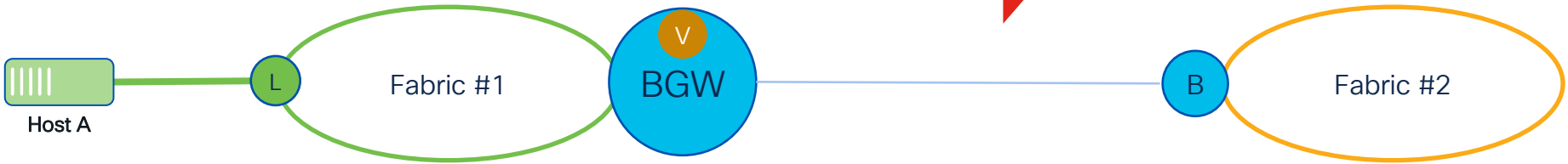
Routing from Local VTEP to Remote BGW

The Dating Network - When Control- meets Data-Plane





Hardware Tables

MAC

MAC	VLAN	Interface

RIB/FIB

IP	Mask	Next-Hop	VRF
192.168.0.12	32	1.1.1.1	VRF-A
192.168.1.12	32	10.0.2.1	VRF-A

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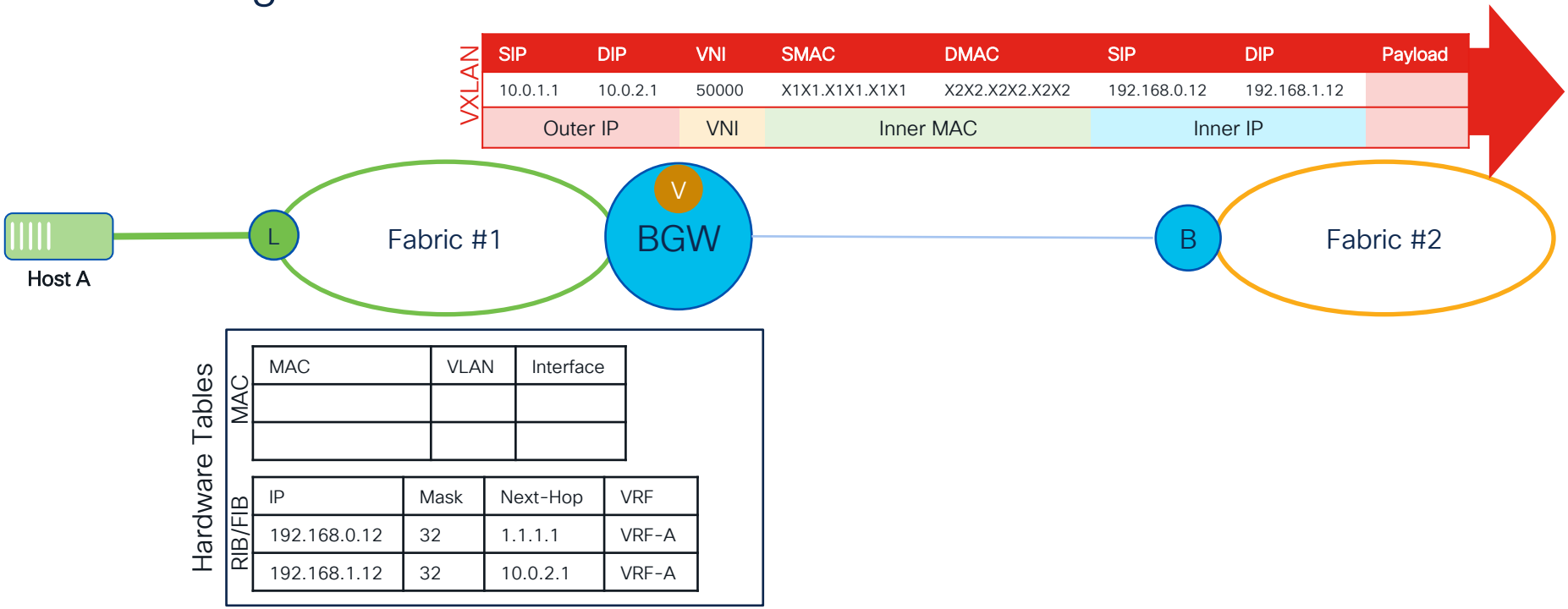
Routing from Local VTEP to Remote BGW

The Dating Network - When Control- meets Data-Plane



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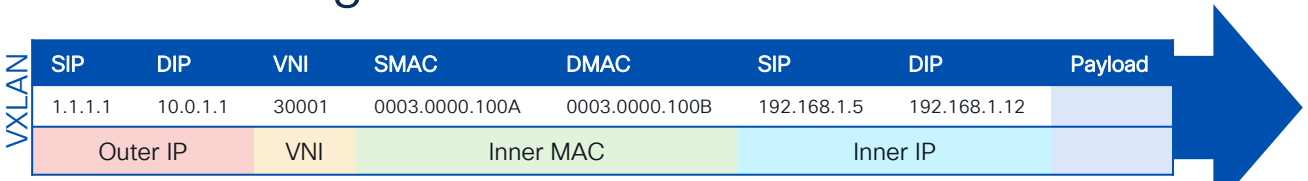
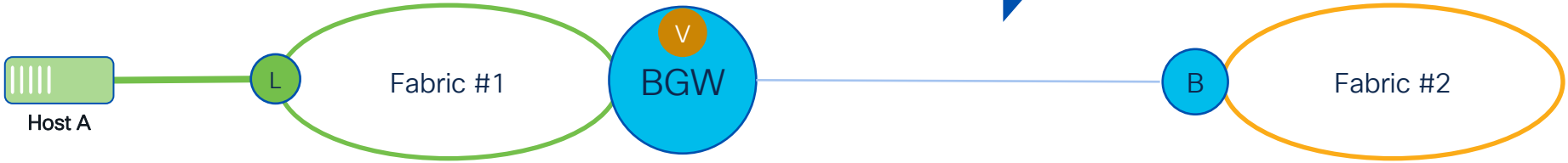
Bridging from Local VTEP to Remote BGW

The Dating Network - When Control- meets Data-Plane





Hardware Tables

MAC

MAC	VLAN	Interface
0003.0000.100A	10	1.1.1.1
0003.0000.100B	10	10.0.2.1

RIB/FIB

IP	Mask	Next-Hop	VRF
192.168.1.5	32	1.1.1.1	VRF-A
192.168.1.12	32	10.0.2.1	VRF-A

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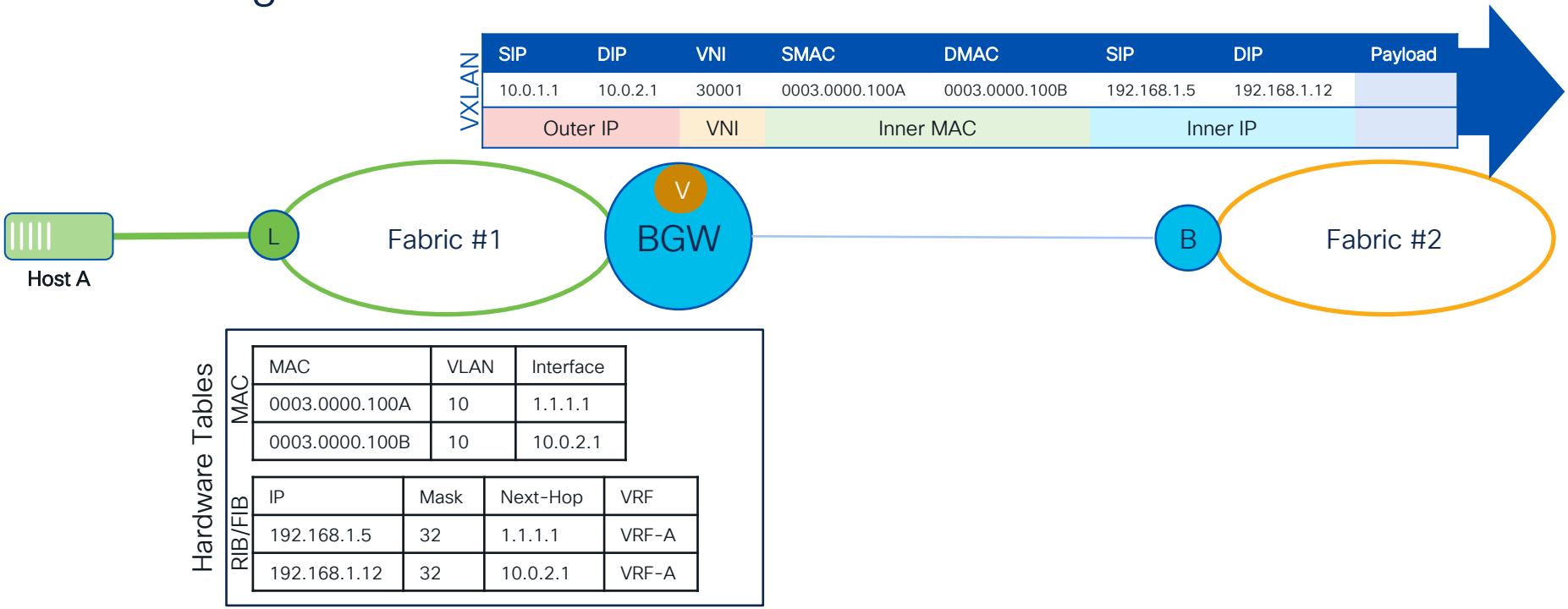
Bridging from Local VTEP to Remote BGW

The Dating Network - When Control- meets Data-Plane



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Conclusion

Conclusion

#1

Border Gateway (BGW)

A Gateway (GW) to stitch multiple VXLAN BGP EVPN domains
Provides Control- and Data-Plane separation
Extends Layer-2 and Layer-3 with Control
Allows to Scale beyond any Fabric Scale
Facilitates Multi-DC and Multi-Pod Use-Cases
More than just a Data Center Interconnect (DCI)

#2

VXLAN BGP EVPN Multi-Site

A Simple add or drop-in
First introduced in September 2017 – proven and deployed
A Solution combining EVPN DCI Overlay (RFC9014) and IPVPN-EVPN interworking (draft-ietf-evpn-ipvpn)
Provides Layer-2 and Layer-3 extension
Wide Hardware Support
Flexible Deployment Option - Not just for VXLAN Fabrics

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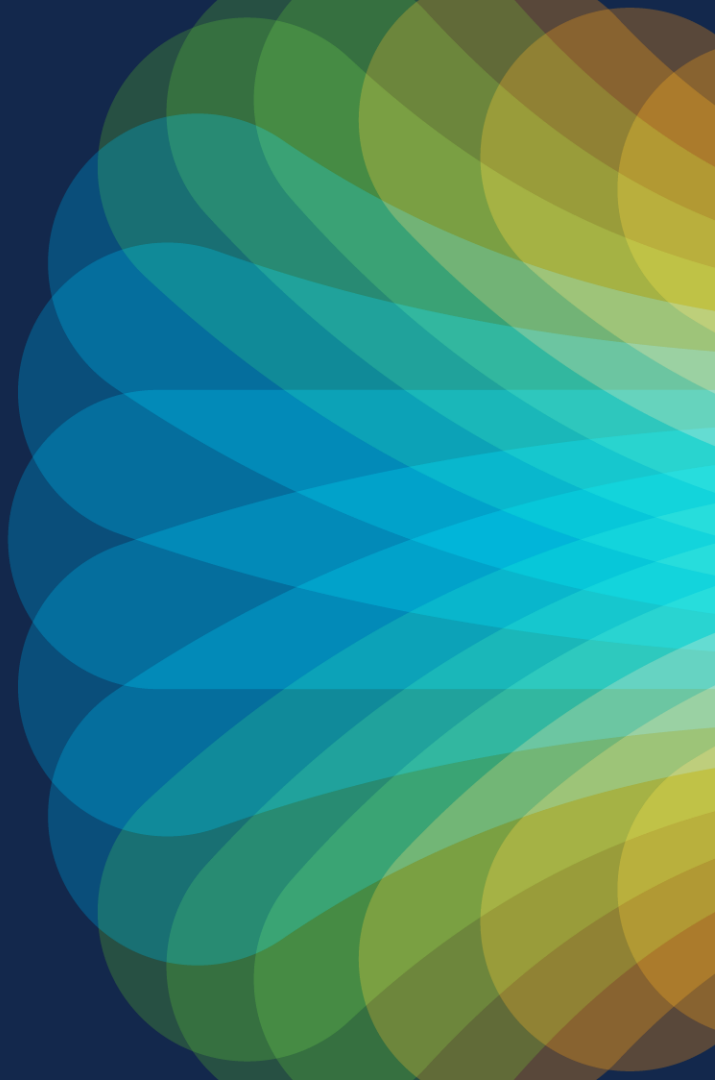
The bridge to possible

Thank you



Resources – Cisco NX-OS

- VXLAN EVPN Multi-Site Design and Deployment White Paper
  - https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/white-paper-c11-739942.html
  - Supported since NX-OS 7.0(3)I7(1) – EX, FX, FX2, FX3, GX, GX2
- NextGen DCI with VXLAN EVPN Multi-Site Using vPC Border Gateways White Paper
  - https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/whitepaper-c11-742114.html
  - Supported since NX-OS 9,.2(1) – EX, FX, FX2, FX3, GX, GX2

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Resources – IETF

- draft-sharma-bess-multi-site-evpn – Multi-Site Solution for Ethernet VPN (EVPN) Overlay (Layer-2 and Layer-3)
  - https://datatracker.ietf.org/doc/html/draft-sharma-bess-multi-site-evpn
- RFC 9014 – Interconnect Solution for Ethernet VPN (EVPN) Overlay Networks (Layer-2 only)
  - https://datatracker.ietf.org/doc/html/rfc9014
- draft-ietf-bess-evpn-ipvpn-interworking – EVPN Interworking with IPVPN (Layer-3 only)
  - https://datatracker.ietf.org/doc/html/draft-ietf-bess-evpn-ipvpn-interworking

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