Deployment of Micro-Segmentation in Cisco NX-OS VXLAN EVPN Fabrics with VXLAN Group Policy Option (GPO)

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BRKDCN-2933

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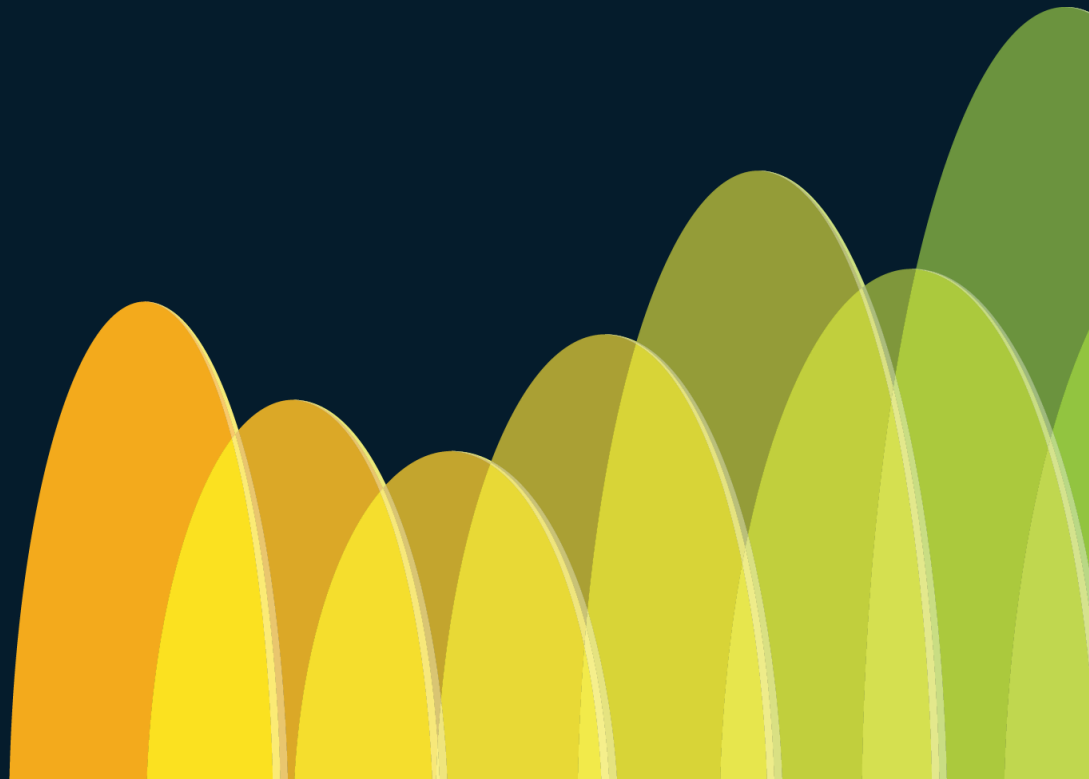
Agenda

- VXLAN GPO
  - Introduction
  - VRF Modes of Operation
  - Classification and SGACLs
  - The Value of the Control Plane
  - VXLAN GPO and Multi-Site
  - GPO Provisioning with Nexus Dashboard
- Secure Interconnection of Heterogeneous Fabrics

VXLAN GPO Introduction



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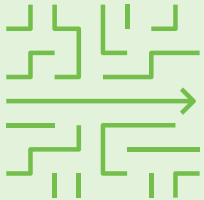
Hardware, Software and Licensing Support

Micro-segmentation is a network security technique that involves dividing a network into smaller, isolated segments to enhance security

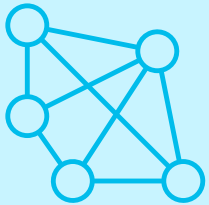
Unlike traditional network security approaches that rely on perimeter defenses, such as firewalls, micro-segmentation focuses on securing individual workloads or applications within the network

This approach provides granular control over network traffic, access permissions, and data protection within the data center

Why Micro-Segmentation?



Ability to segment east-west traffic



Smaller attack surface and better security

Auditing, compliance and conformance

Key Functions to Achieve Micro Segmentation

Endpoint Identity

Classify endpoints into groups:

- Network identity (IP/MAC/VLAN)
- Meta-data: VM attributes, labels, tags, etc.
- DNS

Policy Definition and Enforcement

Determine what policy to configure between groups:

- Default Permit vs Deny
- Redirect
- Policy simulation
- Dynamic vs. pre-defined

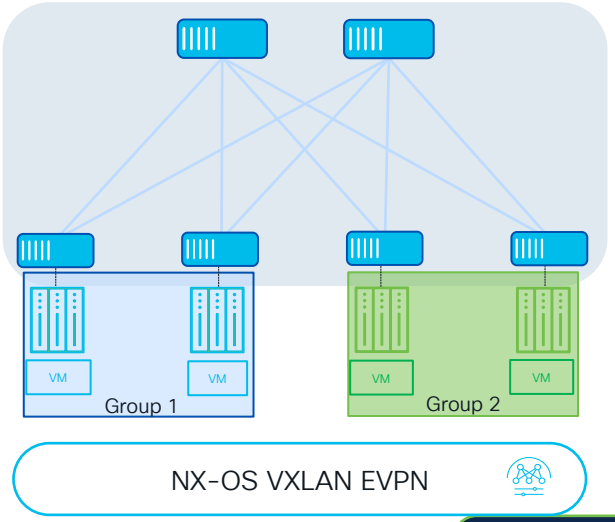
Verify and Refine

Verify policy enforcement, lifecycle management:

- Policy visibility
- Logging and log analysis
- Alerts, remediation
- Constant updates

VXLAN GPO with NX-OS

NX-OS 10.4(3)F



VXLAN GPO with NX-OS

- Group Policy Object carried in standard VXLAN header
- Decoupling network connectivity and security

Grouping

- Classify endpoints to create security groups
- Based on IP, VLAN, VM attributes, etc. across VRFs

Policy enforcement

- Create contracts/SGACLs between security groups
- Possible actions: permit, deny, redirect (service chaining)

Automation

- Automate using NDFC or Open APIs

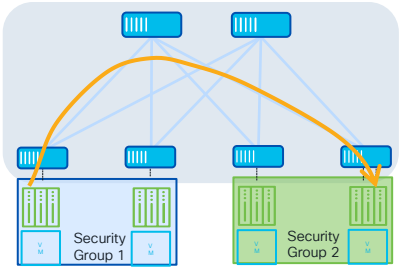
Benefits

Segment East-West traffic	Flexible security isolation	Reduce attack surface	Automate your way

VXLAN GPO with NX-OS
Main Use Cases

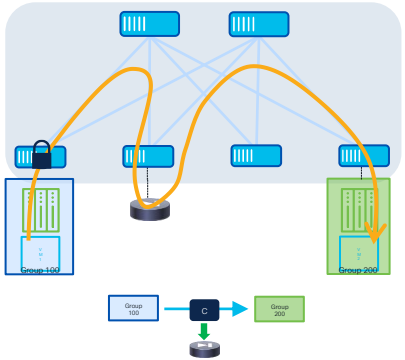
Creation of Security Zones

- VXLAN GPO allows to define policies for enforcing security policies (SGACLs) between security groups (SGs)
- SGACLs are a simpler, more flexible and more scalable policy enforcement mechanism compared to traditional ACLs
- Provides better control over the flow of network traffic (both east-west and north-south)

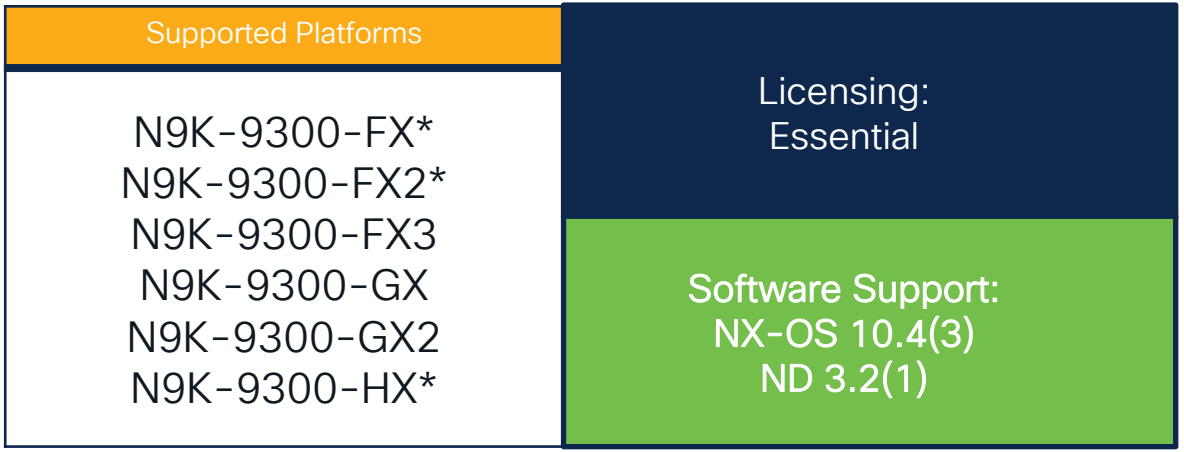


Service Chaining

- VXLAN GPO can be used to insert network services into a packet flow based on specific policy criteria
- Service chaining steers flows through the appropriate network services functions (such as firewalls, load balancers, or intrusion detection systems)



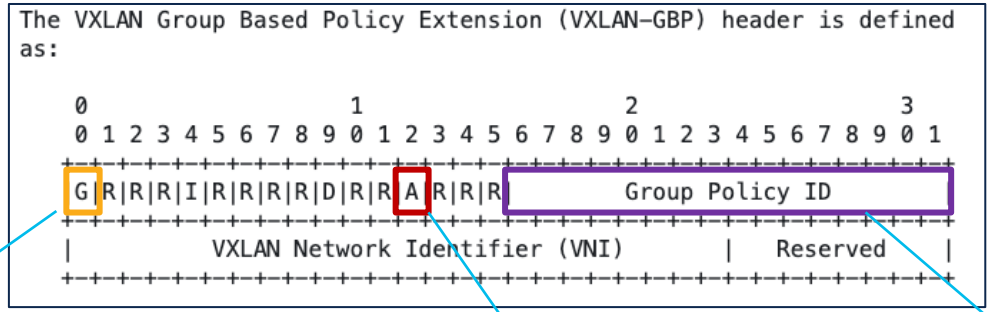
Hardware, Software and Licensing Support



*From NX-OS 10.5(2) version

VXLAN GPO with NX-OS
GPO Data-Plane Header

VXLAN GPO (VXLAN Group Policy Option) as originally defined in draft-smith-vxlan-group-policy



Group Based Policy Extension Bit

G = 1 indicates that the source Group membership is being carried within the Group Policy ID field

G = 0 indicates that the Group Policy ID is not being carried

Policy Applied Bit (only relevant when G=1)

A = 1 indicates that the group policy has already been applied to this packet (the policy MUST NOT be applied by a device when the A bit is set)

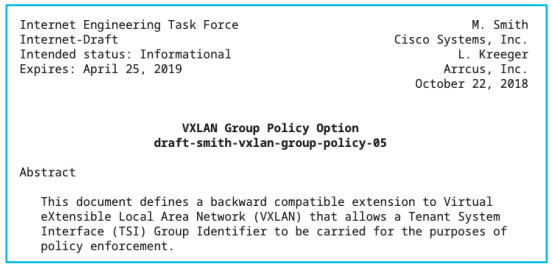
A = 0 indicates that the group policy has not been applied to this packet (the policy MUST be applied by a device when the A bit is set to 0 and the destination Group can be determined)

Group Policy ID (only relevant when G=1)

Security Group identifier

VXLAN GPO with NX-OS
Cisco GPO Control Plane Functionalities

Data Plane
(draft-smith-vxlan-group-policy)



Internet Engineering Task Force
Internet-Draft
Intended status: Informational
Expires: April 25, 2019

M. Smith
Cisco Systems, Inc.
L. Kreeger
Arrcus, Inc.
October 22, 2018

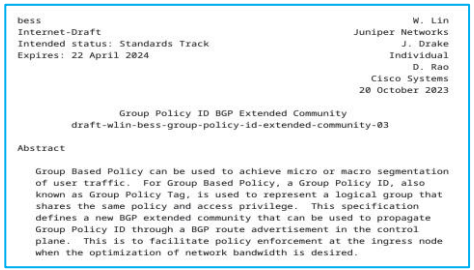
VXLAN Group Policy Option
draft-smith-vxlan-group-policy-05

Abstract

This document defines a backward compatible extension to Virtual eXtensible Local Area Network (VXLAN) that allows a Tenant System Interface (TSI) Group Identifier to be carried for the purposes of policy enforcement.

+

Control Plane
(draft-wlin-bess-group-policy-id-extended-community)



bess
Internet-Draft
Intended status: Standards Track
Expires: 22 April 2024

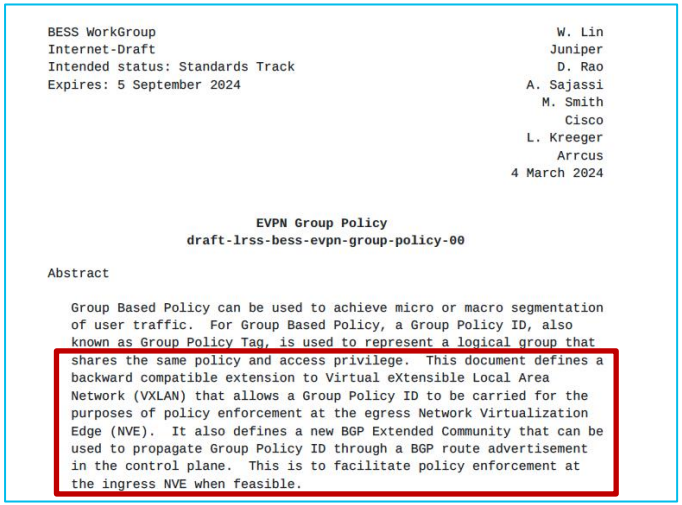
W. Lin
Juniper Networks
J. Drake
Individual
D. Rao
Cisco Systems
20 October 2023

Group Policy ID BGP Extended Community
draft-wlin-bess-group-policy-id-extended-community-03

Abstract

Group Based Policy can be used to achieve micro or macro segmentation of user traffic. For Group Based Policy, a Group Policy ID, also known as Group Policy Tag, is used to represent a logical group that shares the same policy and access privilege. This specification defines a new BGP extended community that can be used to propagate Group Policy ID through a BGP route advertisement in the control plane. This is to facilitate policy enforcement at the ingress node when the optimization of network bandwidth is desired.

Data Plane and Control Plane
(draft-lrss-bess-evpn-group-policy)



BESS WorkGroup
Internet-Draft
Intended status: Standards Track
Expires: 5 September 2024

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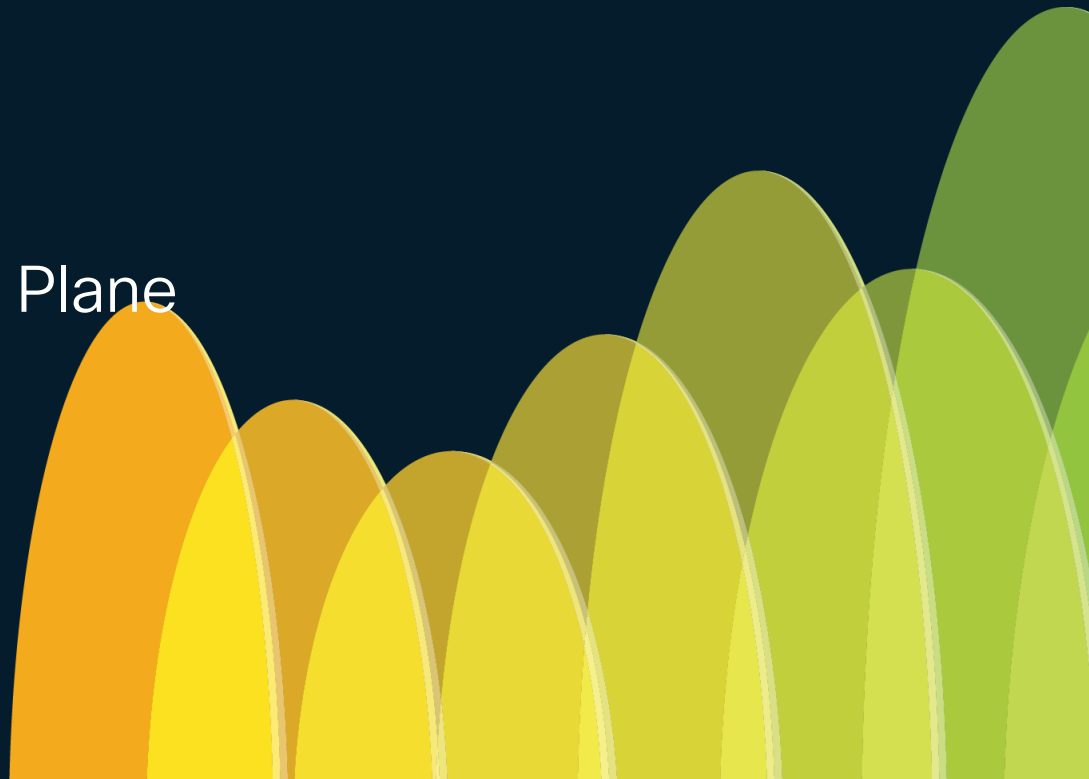
L. Kreeger
Arrcus
4 March 2024

EVPN Group Policy
draft-lrss-bess-evpn-group-policy-00

Abstract

Group Based Policy can be used to achieve micro or macro segmentation of user traffic. For Group Based Policy, a Group Policy ID, also known as Group Policy Tag, is used to represent a logical group that shares the same policy and access privilege. This document defines a backward compatible extension to Virtual eXtensible Local Area Network (VXLAN) that allows a Group Policy ID to be carried for the purposes of policy enforcement at the egress Network Virtualization Edge (NVE). It also defines a new BGP Extended Community that can be used to propagate Group Policy ID through a BGP route advertisement in the control plane. This is to facilitate policy enforcement at the ingress NVE when feasible.

VXLAN GPO
The Value of the Control Plane



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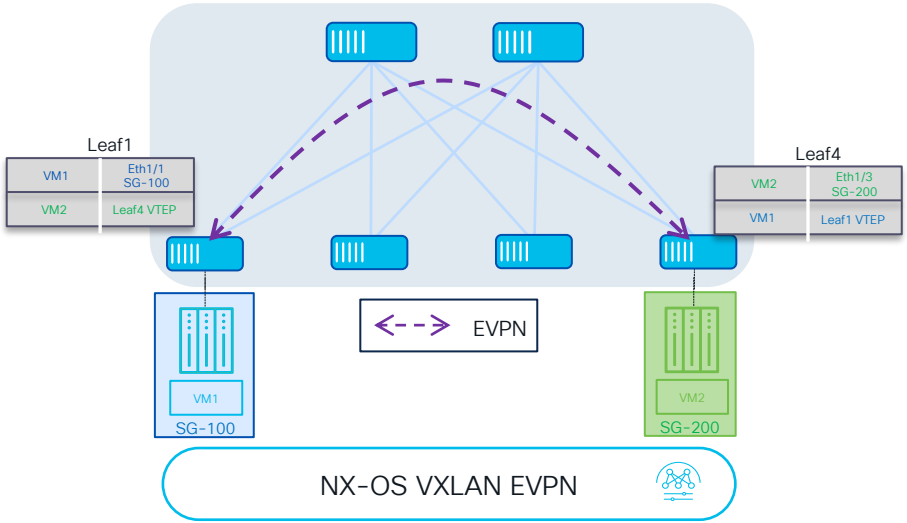
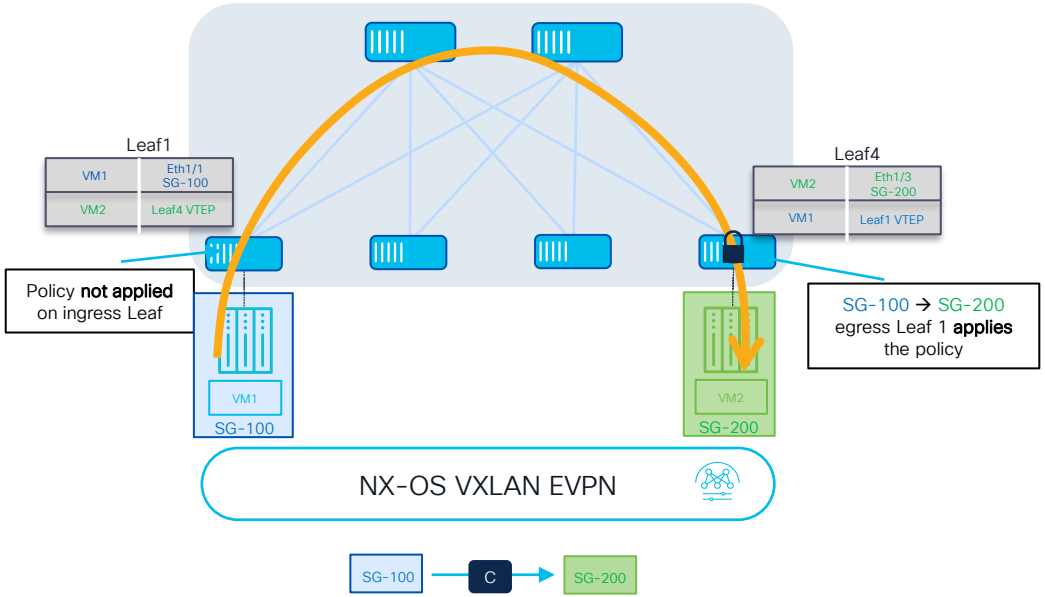
VXLAN GPO with NX-OS
Egress Enforcement Only Possible without SG Info in Control Plane



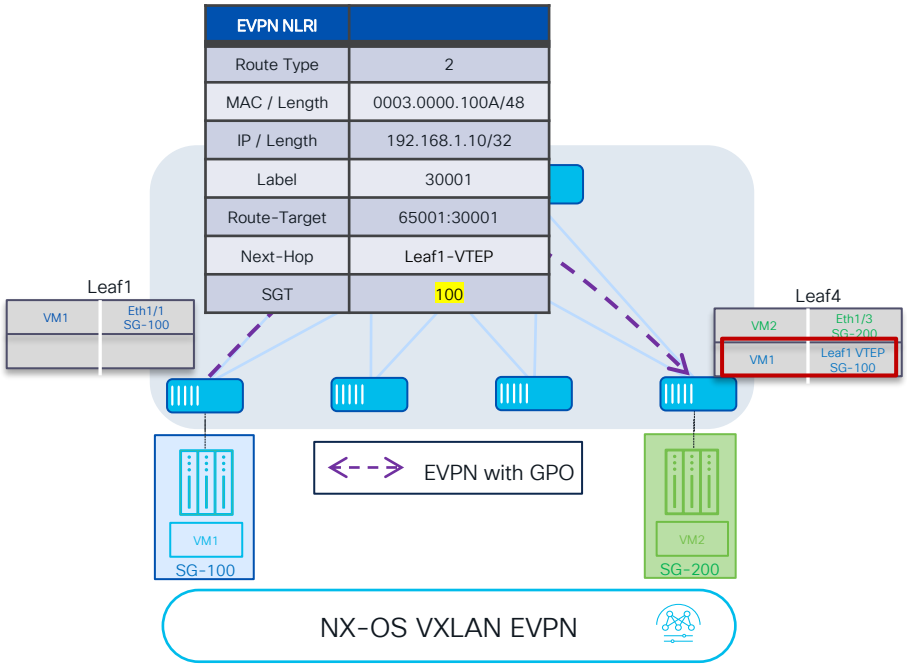
- Use of MP-BGP EVPN to propagate endpoints connectivity without policy information

VXLAN GPO with NX-OS
Egress Enforcement Only Possible without SG Info in Control Plane



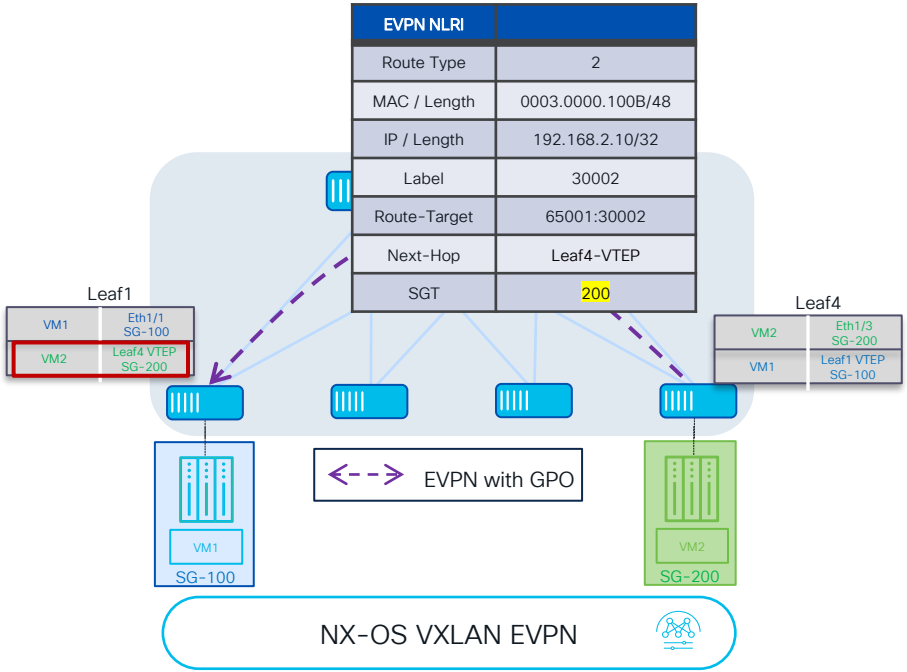
- Policy enforcement not possible on the ingress leaf node because missing info of the destination SG
- Egress leaf can apply the policy as the source SG is carried with the data packet

VXLAN GPO with NX-OS
Use of MP-BGP EVPN for Exchanging Security Tags



- Use of MP-BGP EVPN control plane to propagate endpoints connectivity and policy information inside the fabric
- The SGT information is propagated as a BGP extended community (Group Policy ID Extended Community)

VXLAN GPO with NX-OS
Use of MP-BGP EVPN for Exchanging Security Tags



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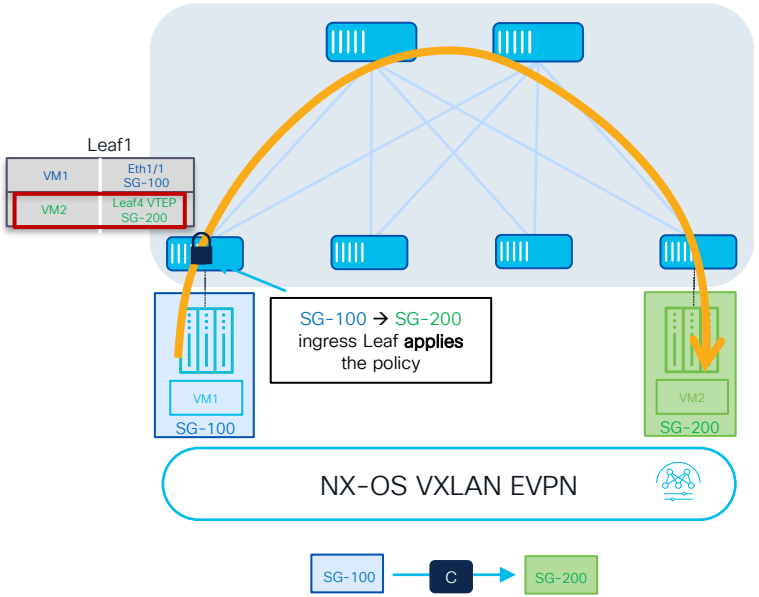
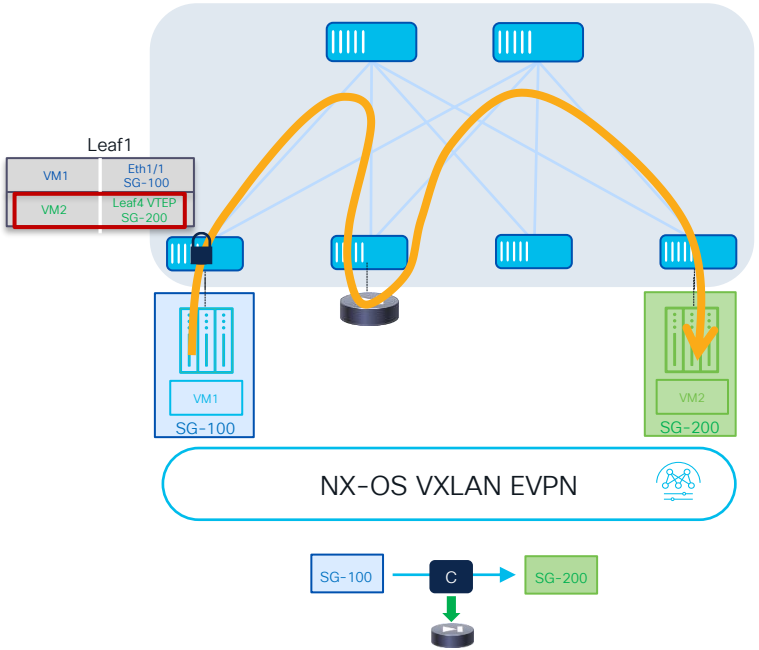
VXLAN GPO with NX-OS
Use of MP-BGP EVPN for Exchanging Security Tags



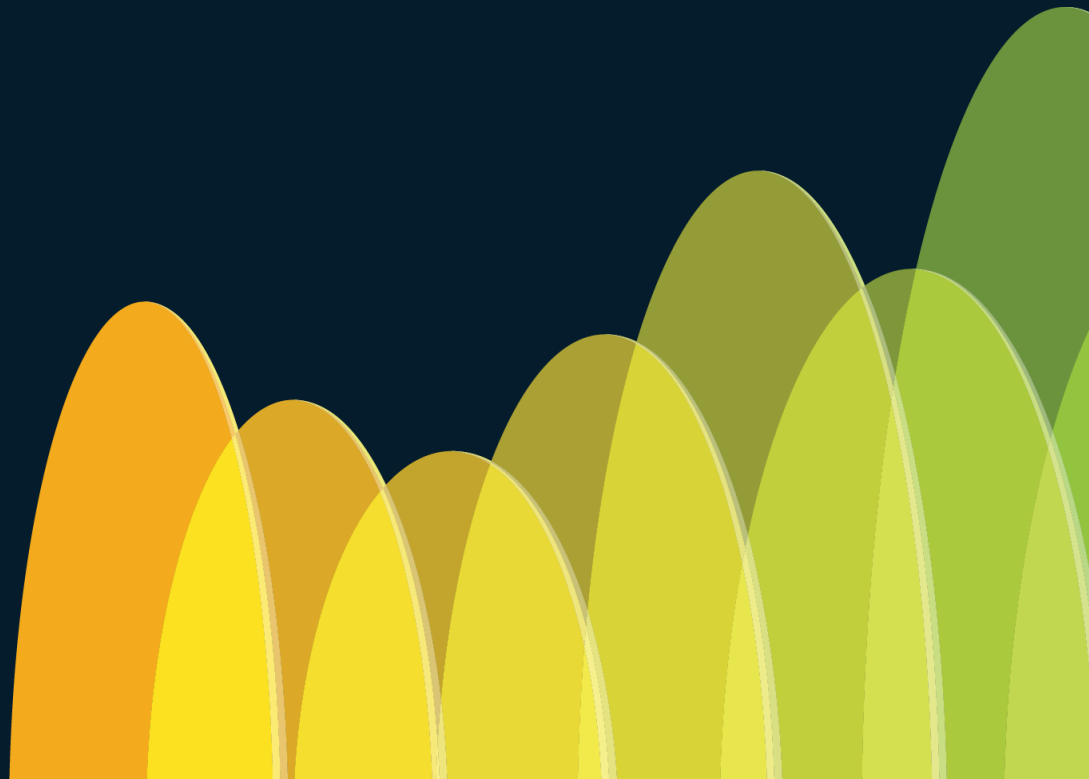
- Facilitate the enforcement of policy on the ingress leaf node (for both directions)
- Security Group Access Control Lists (SGACLs/contracts) enforced between groups

VXLAN GPO with NX-OS
Traffic Steering with Policy Based Redirection



- Policy Based Redirection capabilities to steer through one or more service devices (firewall, load balancers, etc.) traffic flows between different security groups
- Redirection to a Firewall service function with NX-OS 10.4(3)F
- Other use cases, including traffic stitching through multiple services, planned for NX-OS 10.5(x) release train

VXLAN GPO
VRF Modes of Operation



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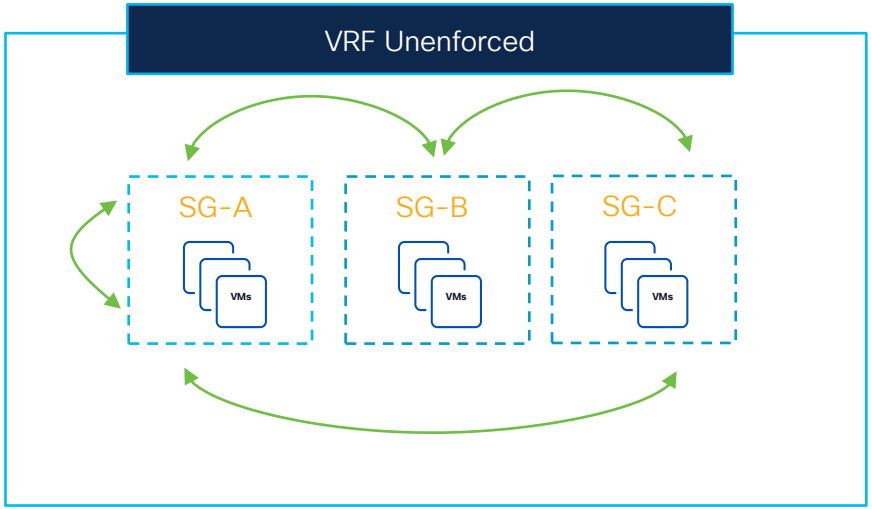
VRF Modes of Operation
VRF Unenforced

- Default VRF mode
- Can define Security Groups and associated rules to classify endpoints/prefixes in specific SGs
- SGACL contracts, even if configured, are not enforced in the VRF
- Not possible to verify if contracts applied between SGs are hit or not

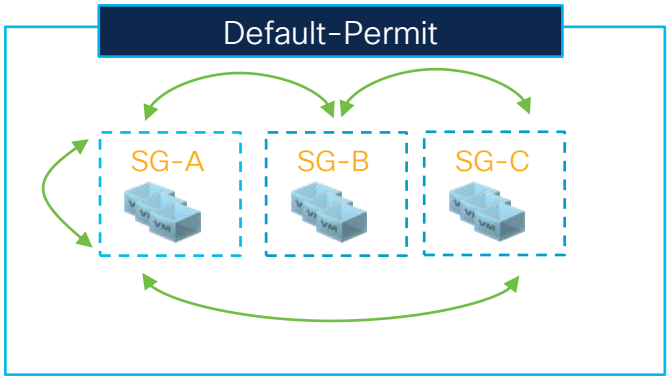


VRF Modes of Operation
VRF Enforced

Default-Permit Mode

- Open unicast communication between Security Groups (SGs) by default
- SGACLs must be applied to deny traffic between SGs
- Allows to verify if contracts applied between SGs are hit or not

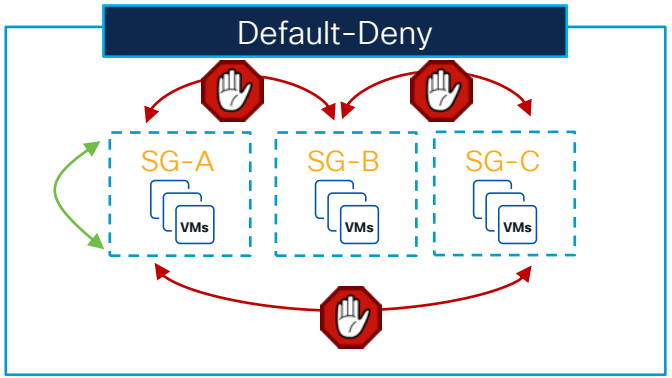
```
vrf context VRF1
  security enforce tag 17 default permit
```



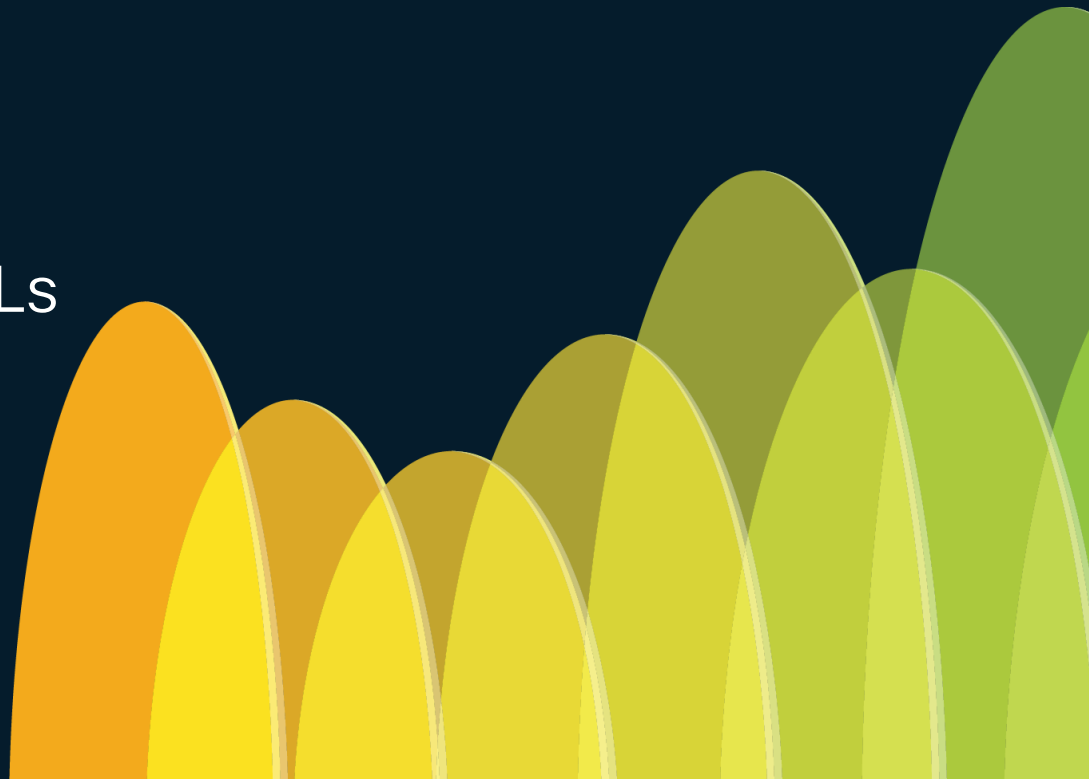
Default-Deny Mode

- No unicast communication between SGs by default
- SGACLs must be applied to allow traffic between SGs
- Zero Trust enforced

```
vrf context VRF1
  security enforce tag 17 default deny
```



VXLAN GPO
Classification and SGACLs



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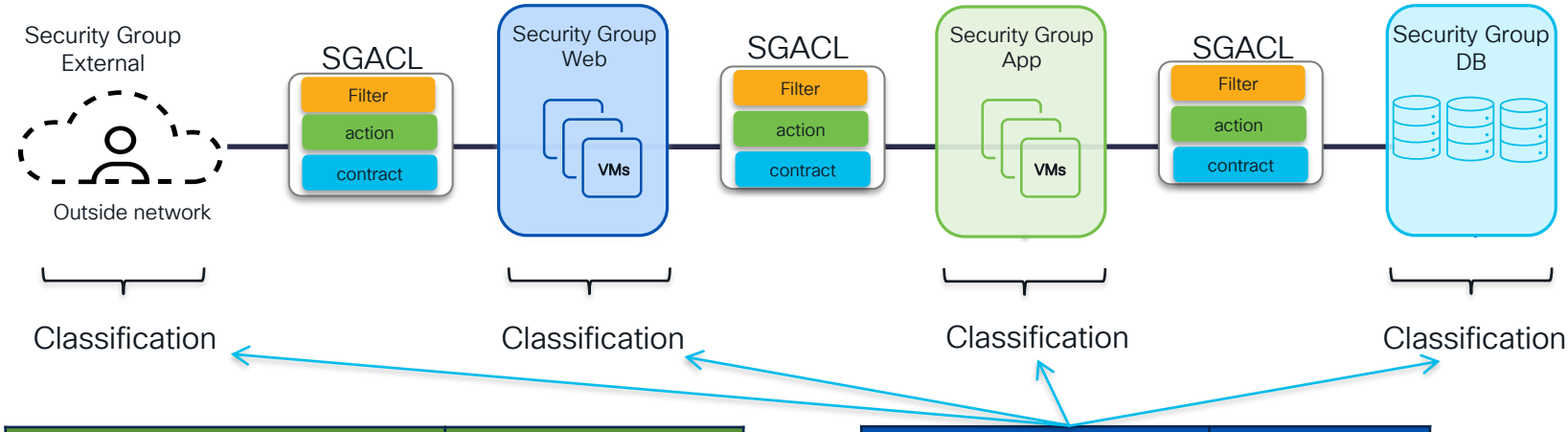
VXLAN GPO with NX-OS
Classification Criteria and SGACL Actions

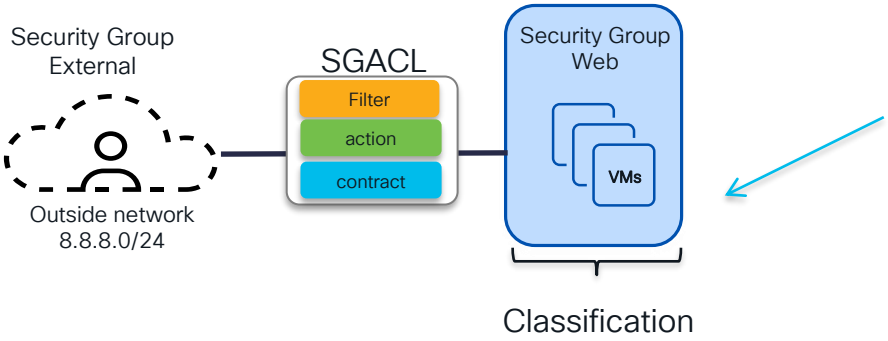


SGACL Action	NX-OS Version
Permit, Permit + Log	10.4(3)
Deny, Deny + Log	10.4(3)
Redirect (FW service only)	10.4(3)
Redirect (SLB, Service-Chain)	10.5(2)

Security Group Attributes	NX-OS Version
IP Prefix (internal & external)	10.4(3)
VLAN	10.4(3)
Port + VLAN	Roadmap
VM Tags/Attributes	Roadmap

Classification is done assigning a fabric-wide unique tag (valid range: 16-65535)

VXLAN GPO with NX-OS
Connected Endpoints Classification

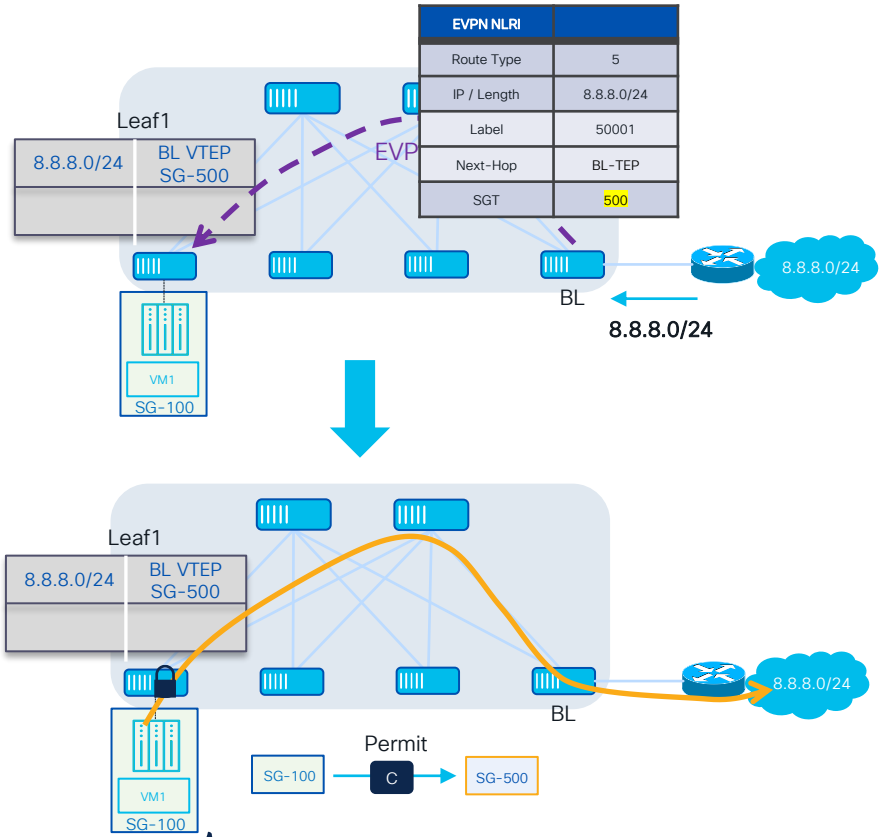


Classification on Compute Leaf Nodes

```
security-group 2000 name webserver
  match connected-endpoints vrf vrf1 ipv4 10.1.1.141/32
  match connected-endpoints vrf vrf1 ipv4 10.2.0.0/24
  match vlan 10
```

- Endpoints internally connected to the fabric leaf nodes can be classified:
  - With host-level granularity (/32 or /128)
  - Using a less specific prefix, including a 0.0.0.0/0 ‘catch-all’ entry covering all the internal subnets in a VRF
- The “match vlan” option ensures that all traffic received from/destined to hosts in that VLAN on a given switch is classified to the SG
  - In the future it will be supported to match a VLAN tag with per-port granularity

VXLAN GPO with NX-OS
External Subnets Classification

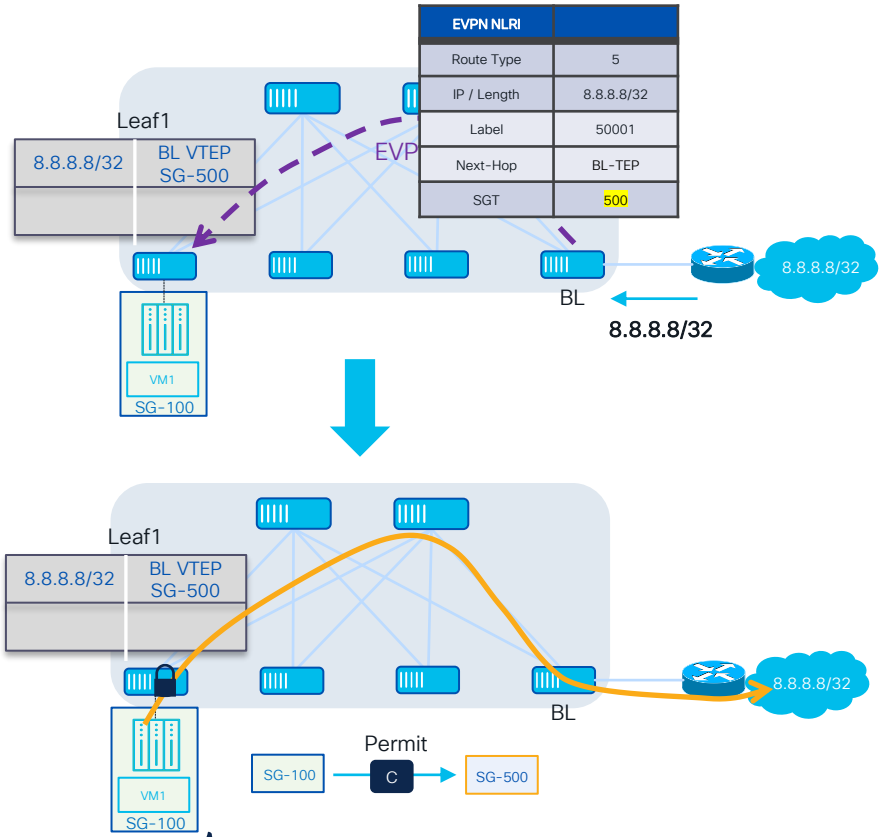


Classification on Border Leaf (BL) Nodes

```
security-group 500 name DNS
  match external-subnets vrf vrf1 ipv4 8.8.8.0/24
```

- The Border Leaf receives the 8.8.8.0/24 prefix **exactly matching** the classification subnet
- The 8.8.8.0/24 prefix is advertised into the fabric with the associated SG-500 tag
- Policy can be enforced between the endpoint in SG-100 and the external prefix based on the configured contract

VXLAN GPO with NX-OS
External Subnets Classification



Classification on Border Leaf (BL) Nodes

```
security-group 500 name DNS
  match external-subnets vrf vrf1 ipv4 8.8.8.0/24
```

- The Border Leaf receives the specific 8.8.8.8/32 prefix **covered** by the configured 8.8.8.0/24 classification subnet
- The 8.8.8.8/32 prefix is advertised into the fabric with the associated SG-500 tag
- Policy can be enforced between the endpoint in SG-100 and the external 8.8.8.8 destination based on the configured contract

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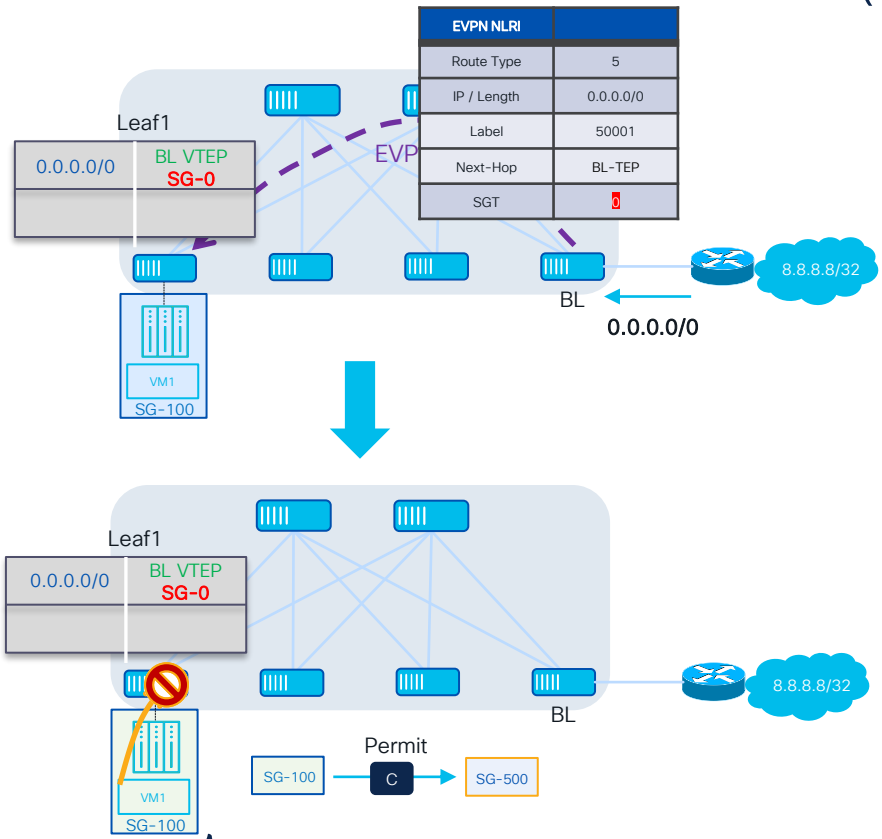
VXLAN GPO with NX-OS
External Subnets Classification (2)



Classification on Border Leaf (BL) Nodes

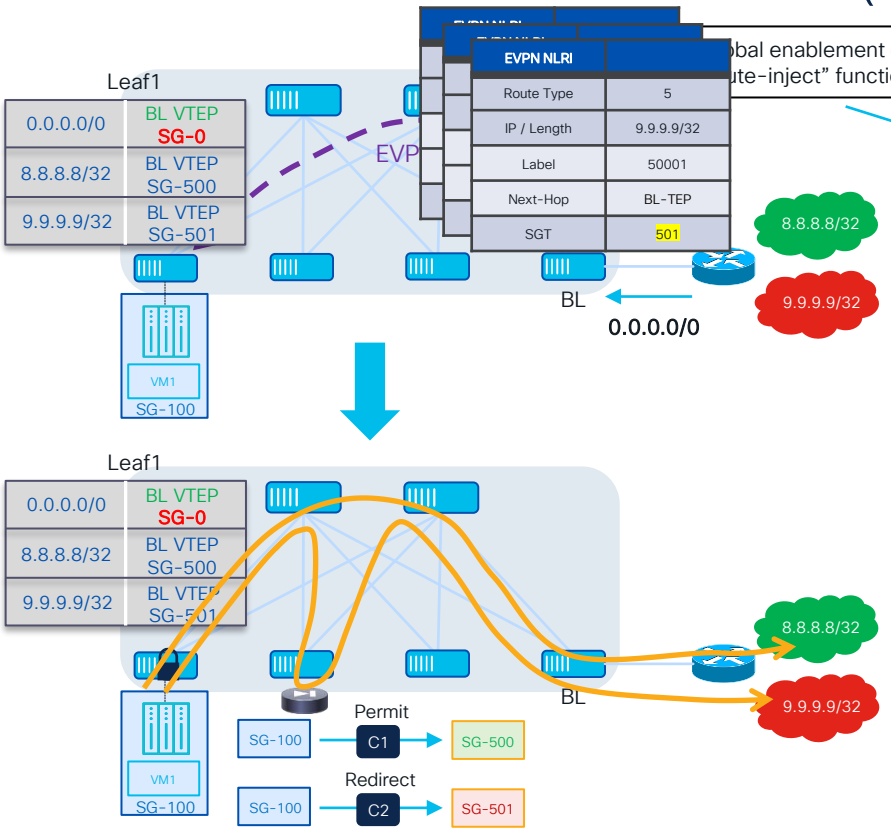
```
security-group 500 name DNS
  match external-subnets vrf vrf1 ipv4 8.8.8.8/32
```

- The Border Leaf receives the generic 0.0.0.0/0 prefix and only a more specific classification rule is configured on the Border Leaf node (8.8.8.8/32)
- The 0.0.0.0/0 prefix is advertised into the fabric with a special SG tag 0
- Policy enforced between the endpoint in SG-100 and the external prefix 8.8.8.8 is based on the specific VRF configuration (traffic is dropped assuming a ”default deny” VRF configuration, it is instead permitted with a “default permit” VRF configuration)

VXLAN GPO with NX-OS

External Subnets Classification (New Behavior)

NX-OS 10.5(2)F



Classification on Border Leaf (BL) Nodes

```
security-group external-subnets route-inject resolved community <ASN2:NN>
!
security-group 500 name DNS
  match external-subnets vrf vrf1 ipv4 8.8.8.8/32 route-inject
!
security-group 501 name webserver
  match external-subnets vrf vrf1 ipv4 9.9.9.9/32 route-inject
```

- Classification to specific security groups for external destinations (SG-500 and SG-501)
- If the BL node has reachability for those external prefixes (for example, because of a received 0.0.0.0/0 prefix), it advertises them into the fabric with the specific SG tags
- Different policies can now be properly enforced between the endpoint in SG-100 and the external destinations

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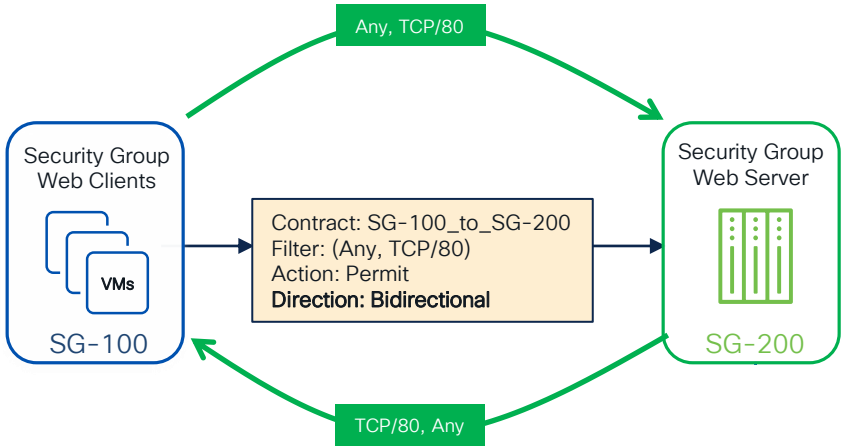
VXLAN GPO with NX-OS
Creation of Bidirectional SGACLs (Contracts)



Return rule automatically created

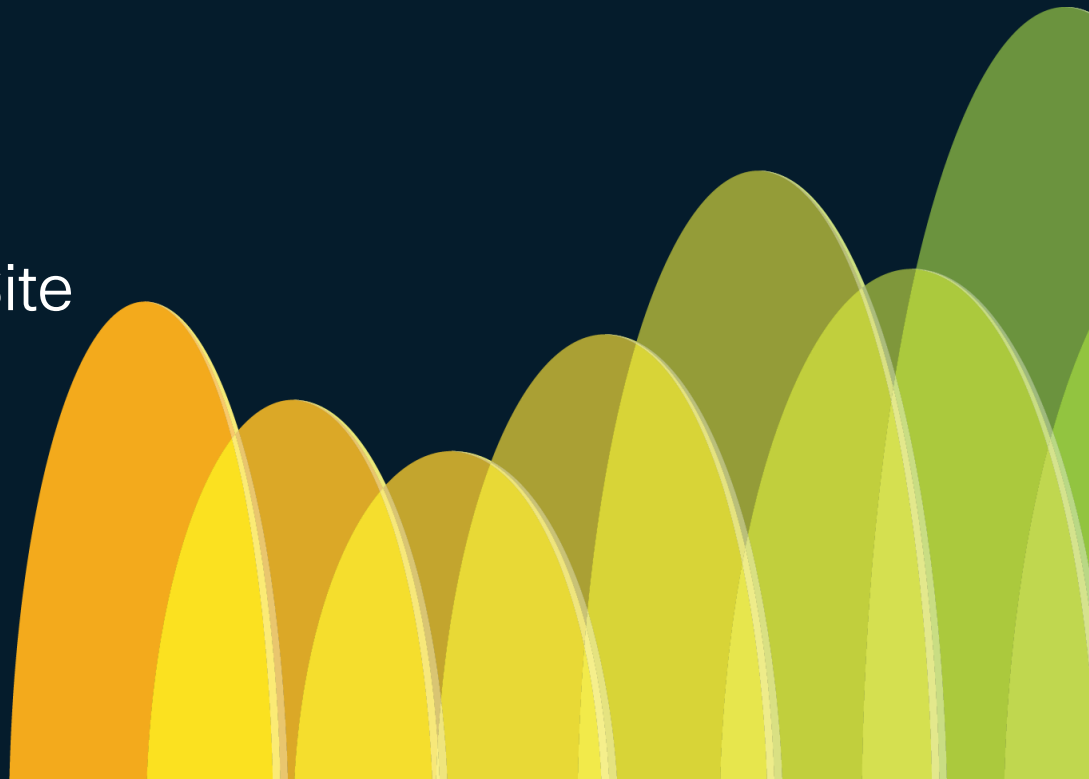
- When the VRF is enforced in “default deny” mode, communication between different SGs is denied in absence of contracts
- A contract has a name and one (or more) rules with an associated action (permit, deny, redirect, etc.)
- Each rule should be defined with “**Bidirectional**” direction, to ensure that two-way communication can be established (without requiring the definition of separate rules)

Rules

Direction	Action*	Protocol*	Match Summary
bidirectional	permit	http	IP TCP dport:80

VXLAN GPO

VXLAN GPO and Multi-Site



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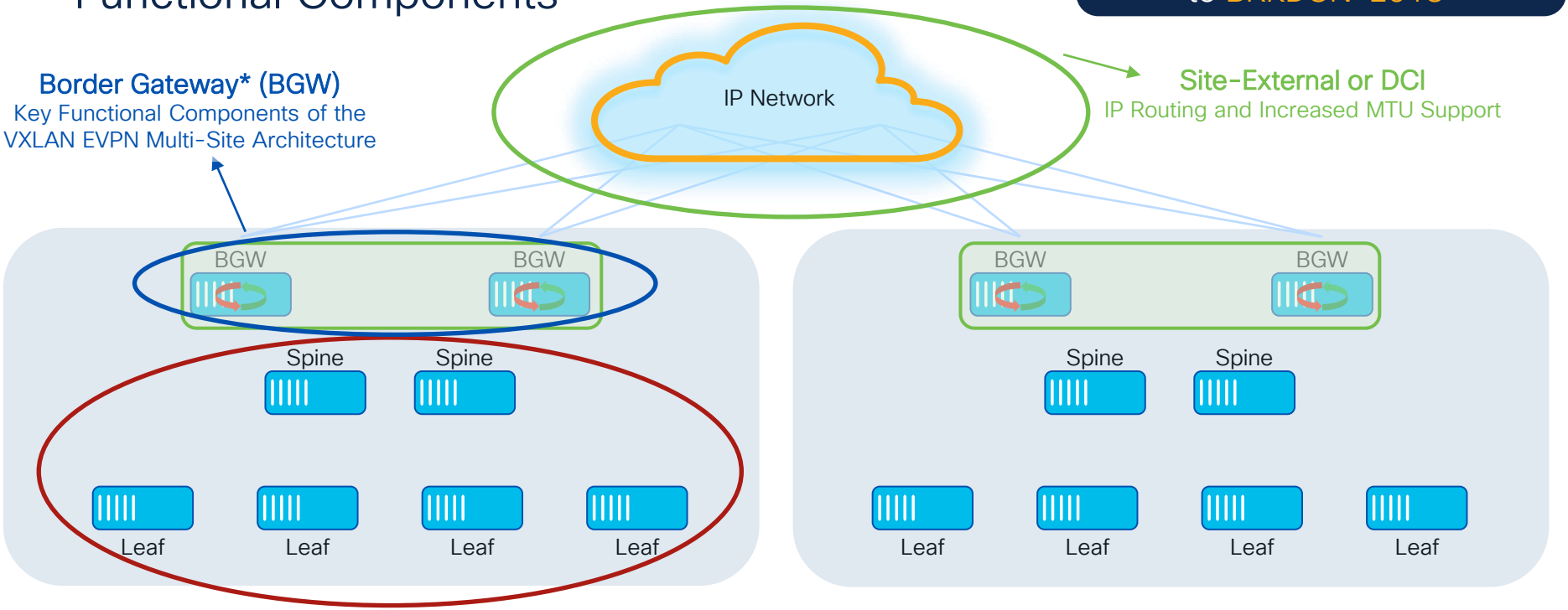
VXLAN EVPN Multi-Site
Functional Components

For More Information on VXLAN Multi-Site please refer to BRKDCN-2913

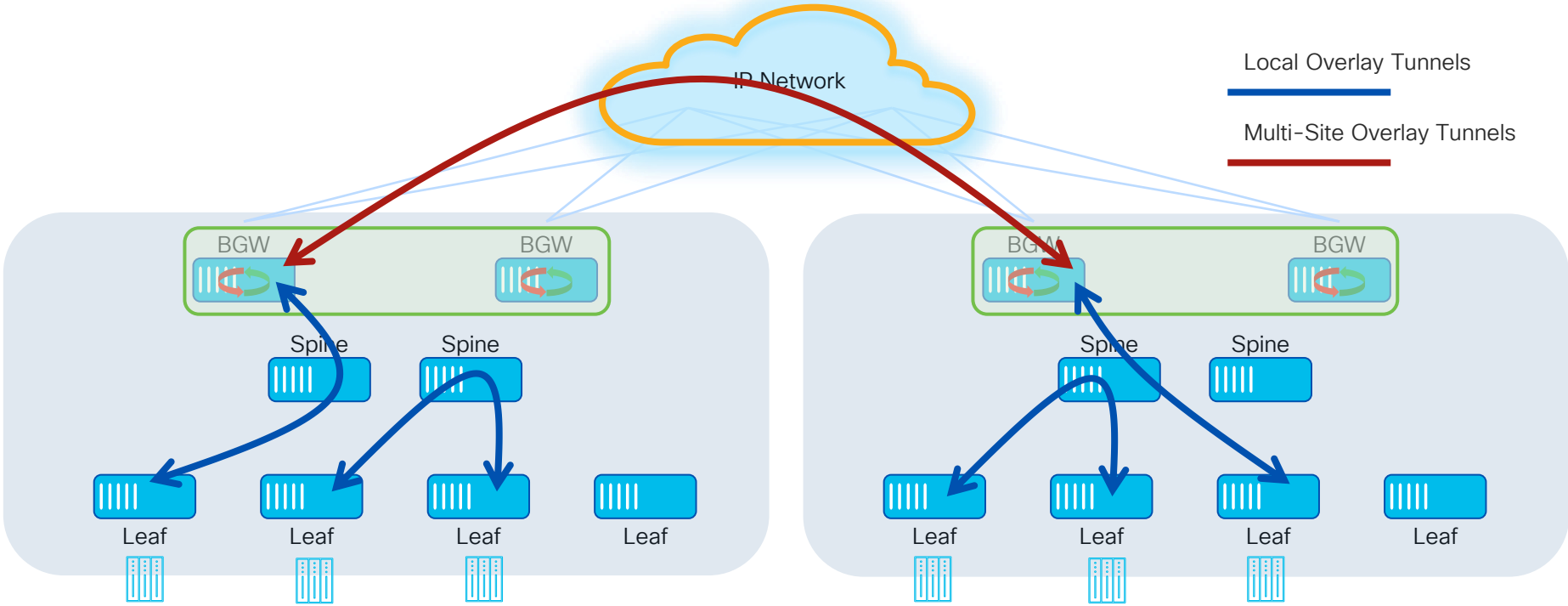
Border Gateway* (BGW)
Key Functional Components of the VXLAN EVPN Multi-Site Architecture



draft-sharma-bess-multi-site-evpn

*BGW and spine functions can coexist on the same physical devices

VXLAN EVPN Multi-Site
Hierarchical VXLAN Encapsulation



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

VXLAN GPO with Multi-Site
Deployment Considerations

- Anycast BGWs and vPC BGWs both support the Security Group feature
- All Security Group tags belong to a global namespace valid across multiple sites
  - Only **symmetric namespace** across fabrics is currently supported
- Connectivity and policy extension between “policy aware” sites but also with “policy unaware” fabrics
- Resources (internal endpoints or external prefix routes) in “policy unaware” sites are classified on the BGWs of “policy aware” sites as part of the same security group (“vxlan-evpn-sg” tag = 15)
  - The “vxlan-evpn-sg” reserved tag is allowed in contract’s CLI to apply security policies to traffic originated from (or destined to) policy unaware fabrics

VXLAN GPO with Multi-Site

Policy Aware to Policy Aware Fabrics

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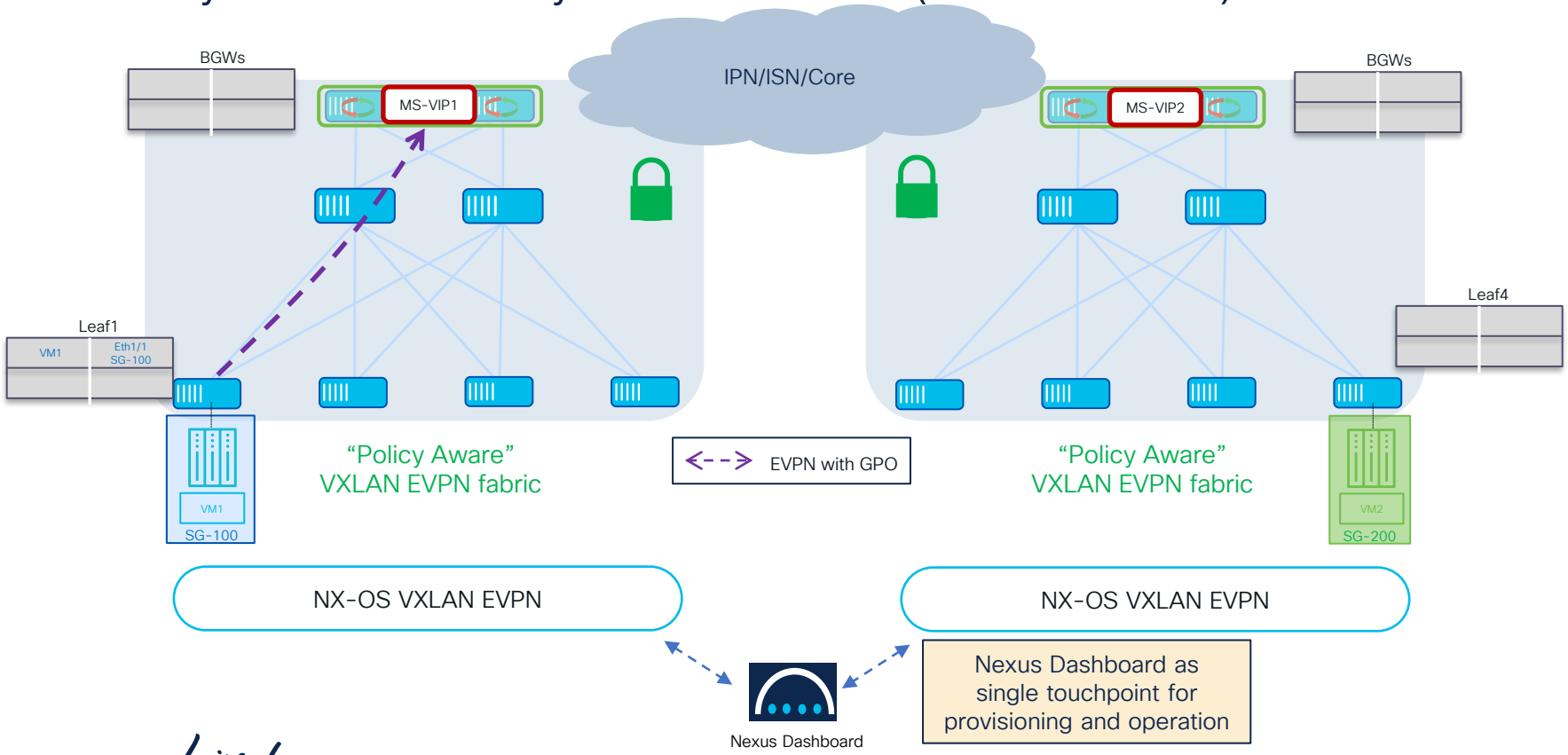
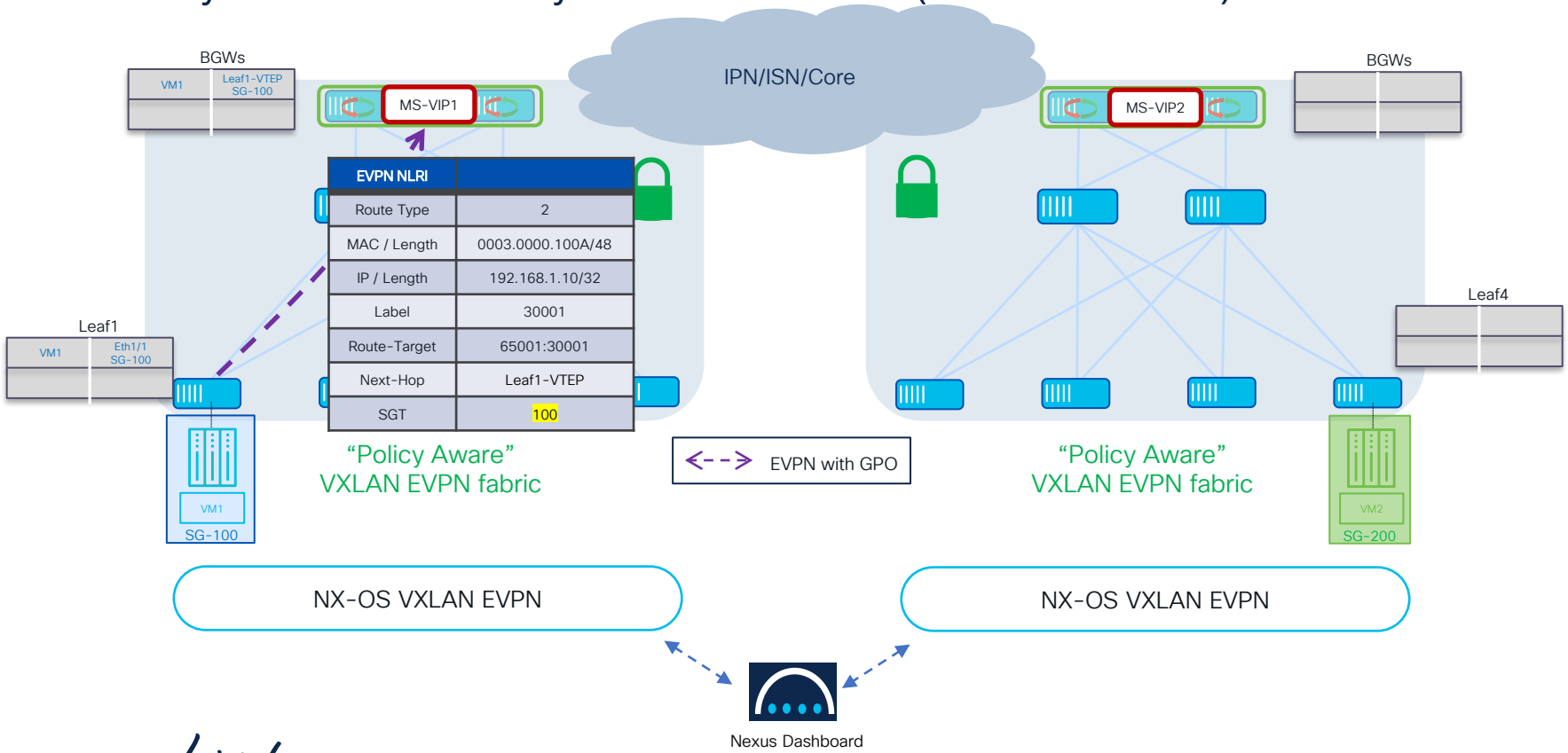
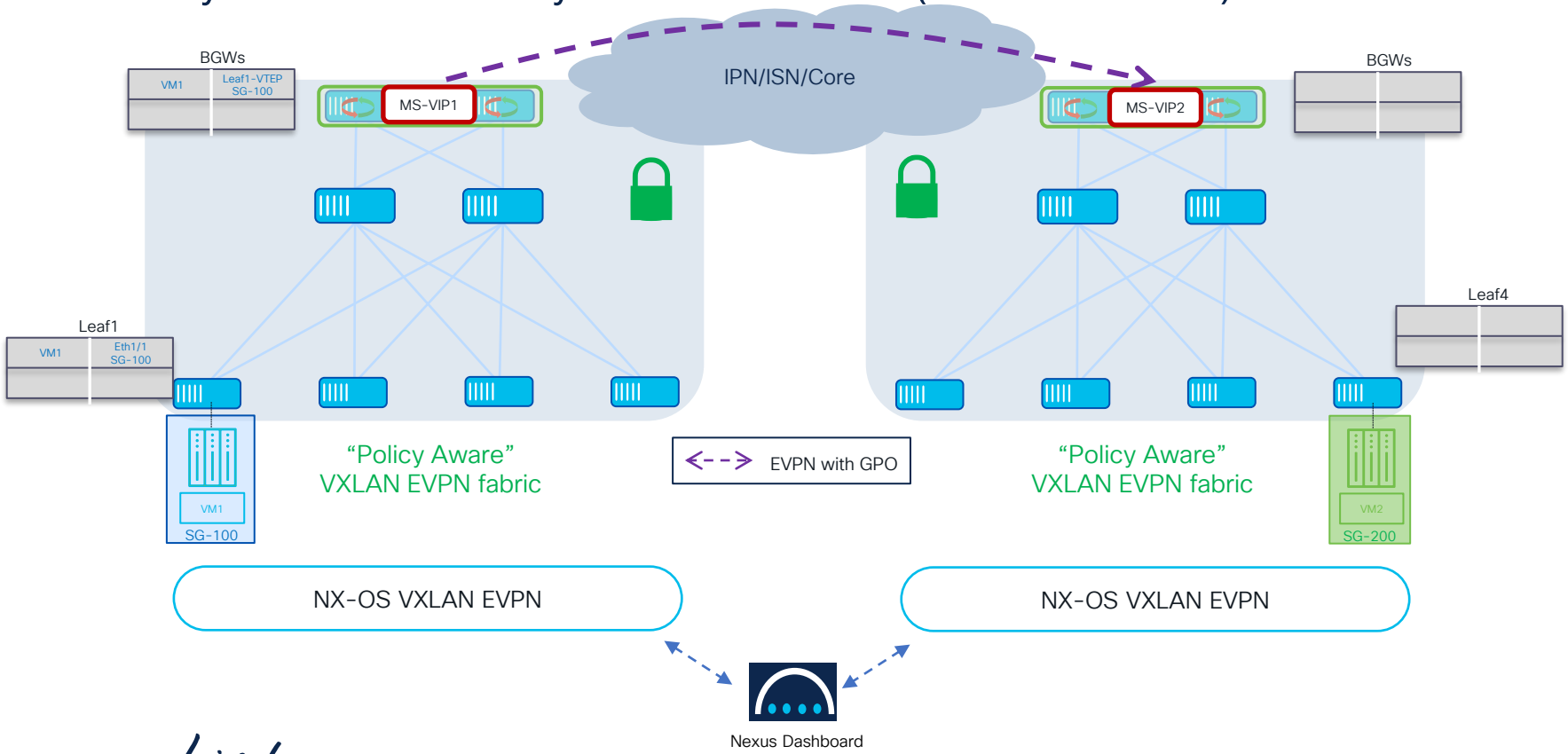
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



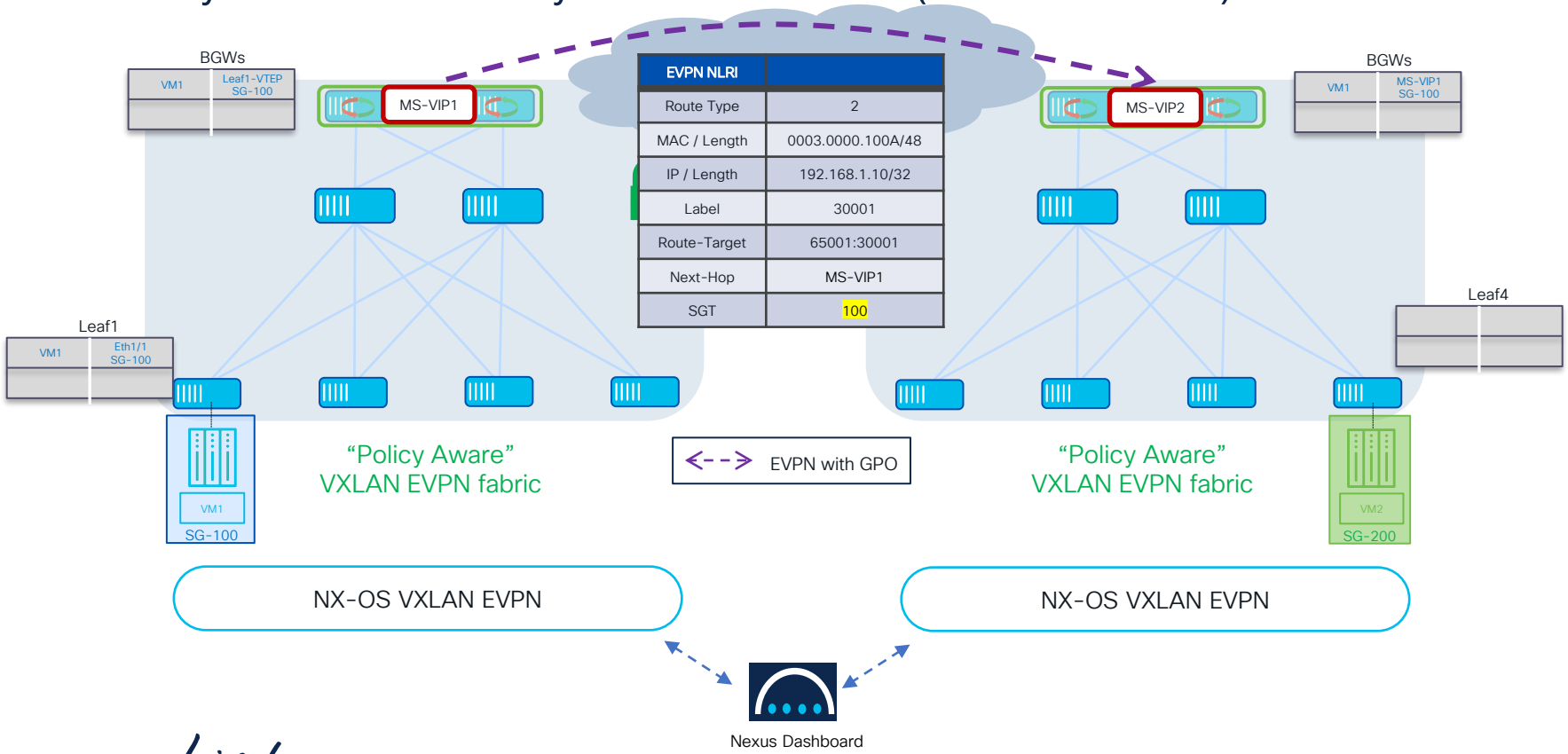
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



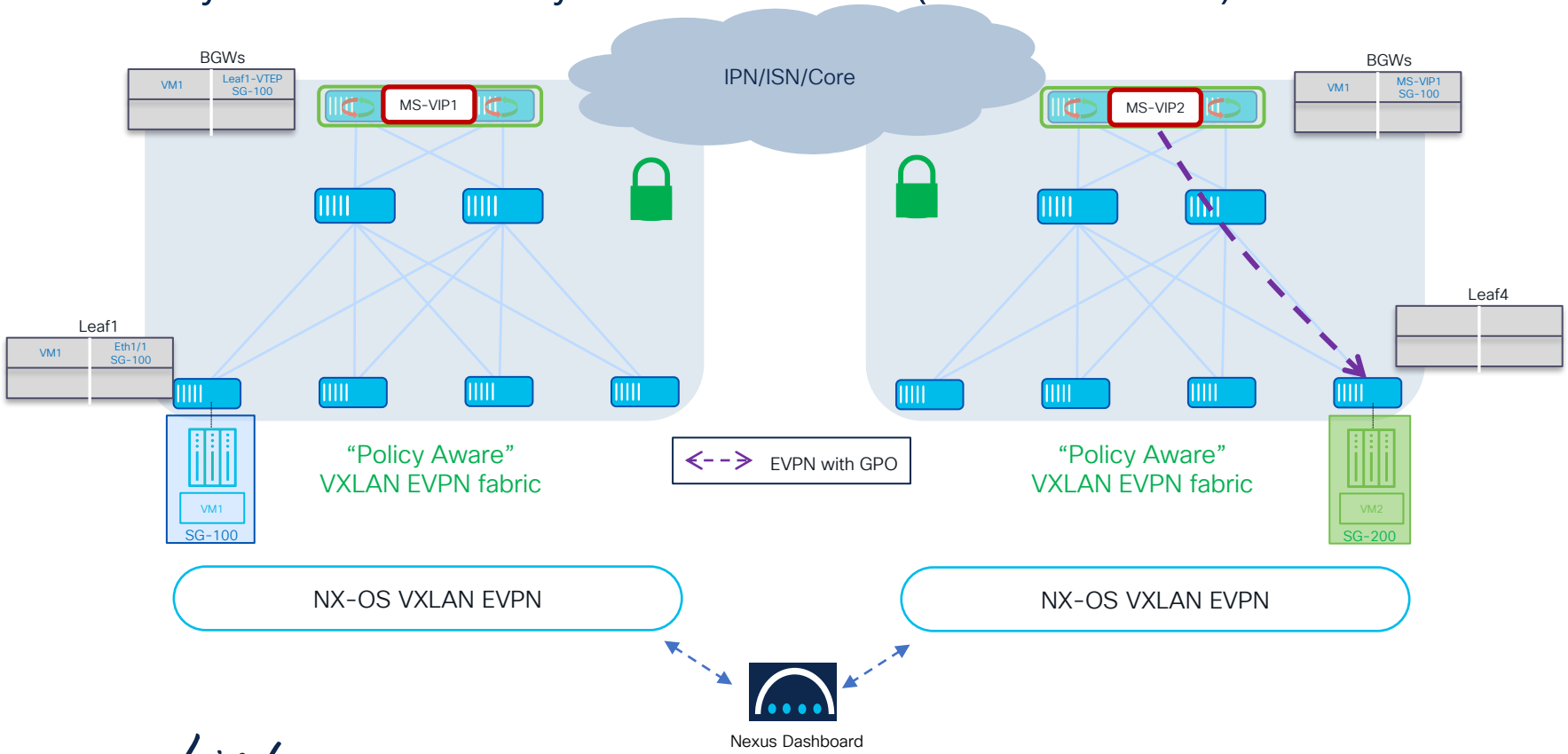
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



VXLAN GPO with Multi-Site
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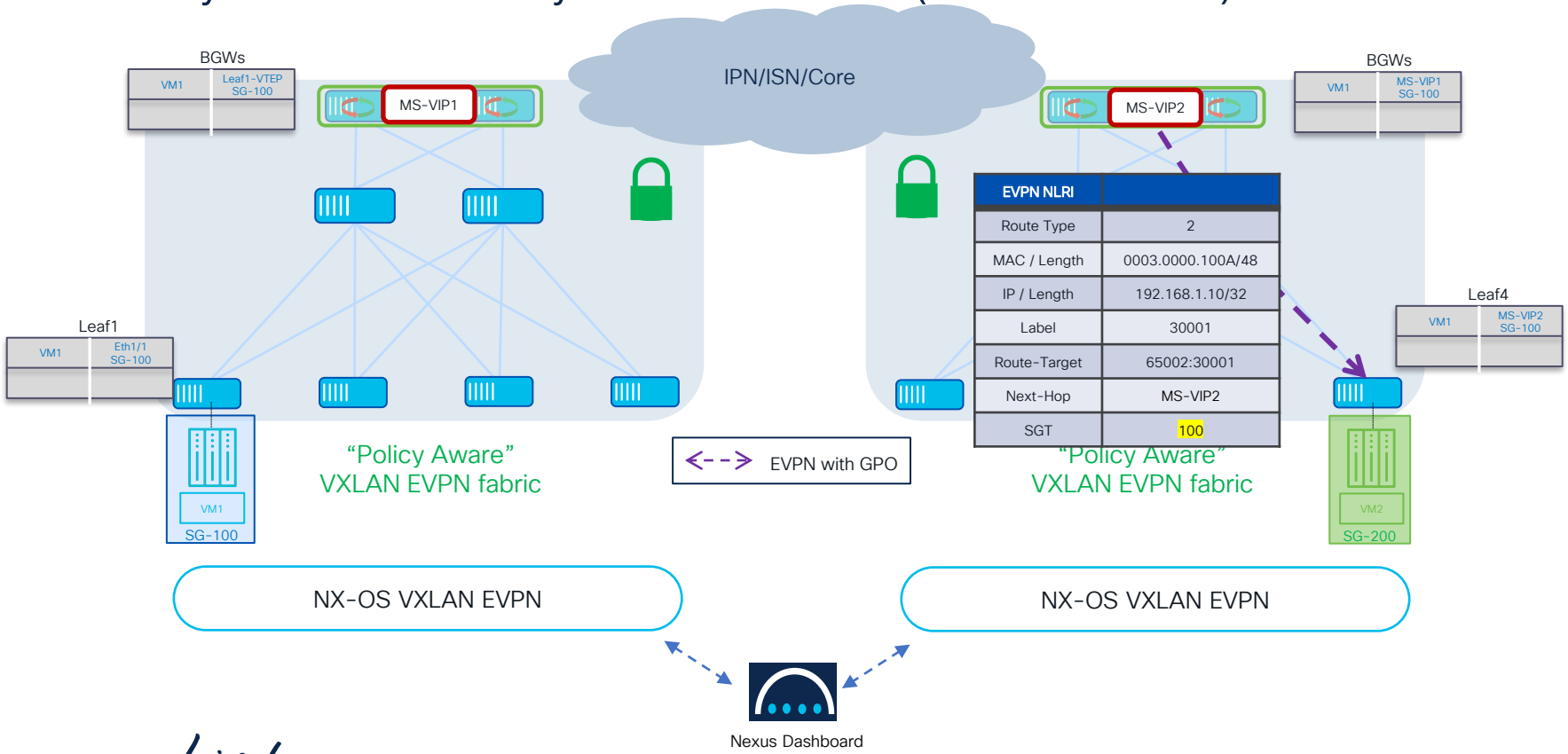
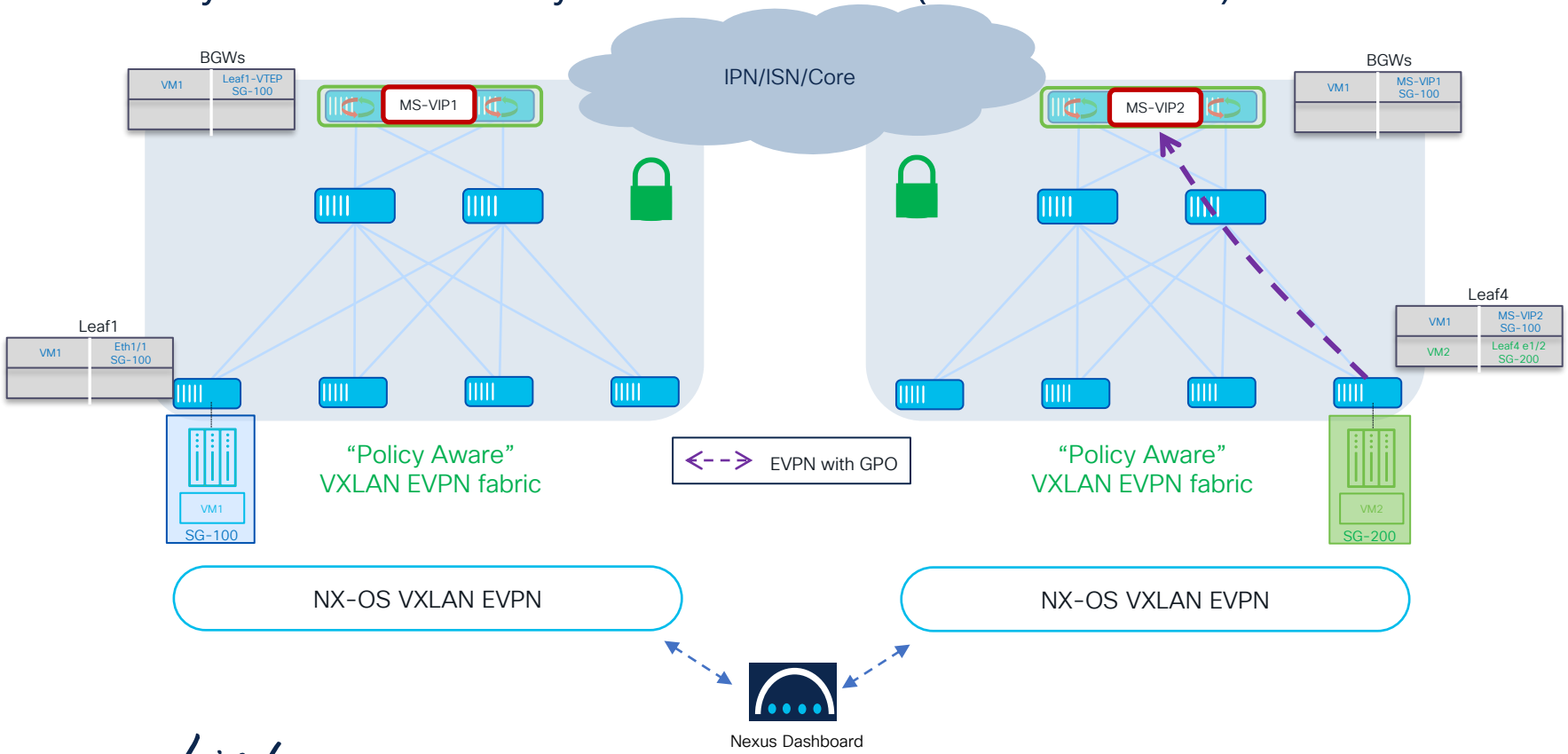
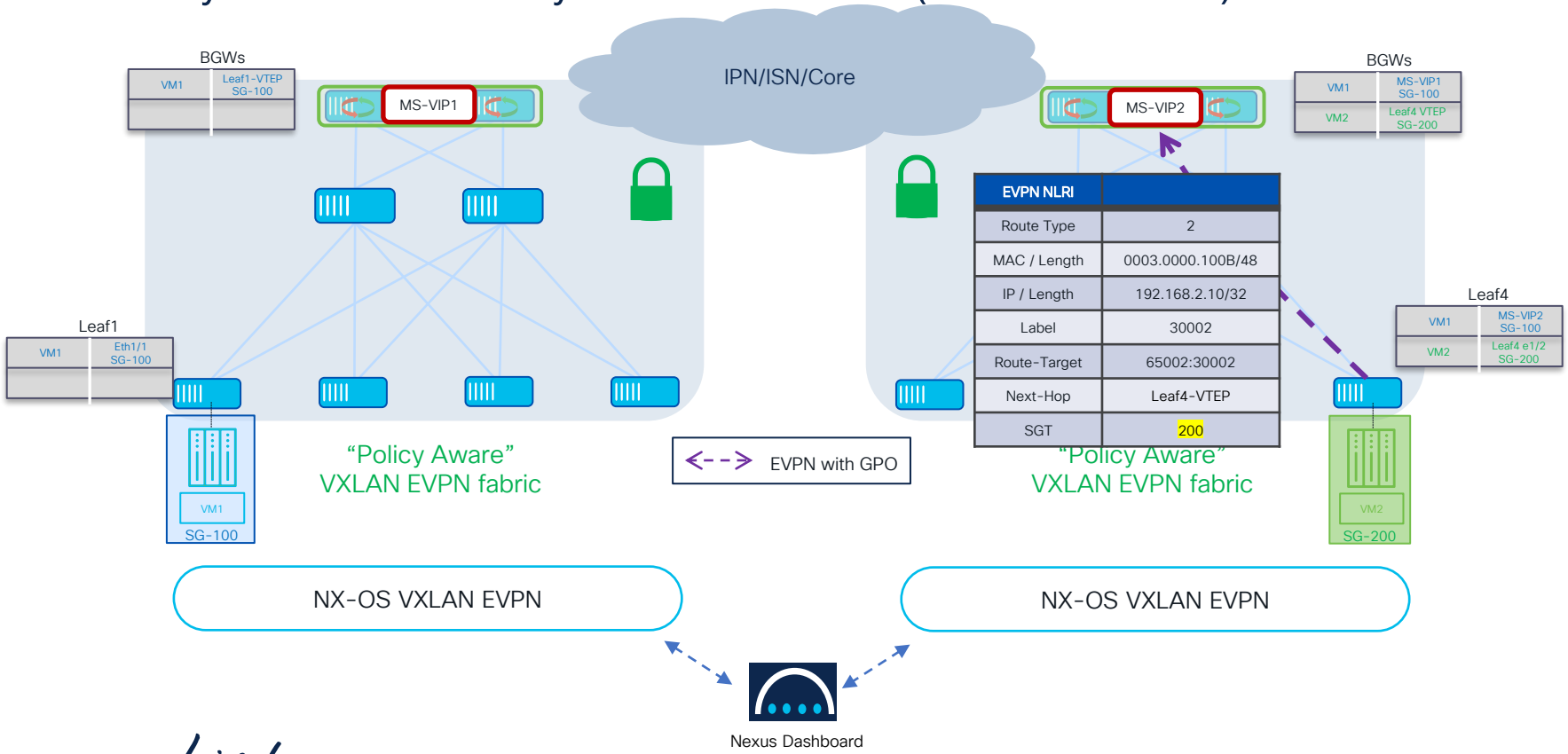


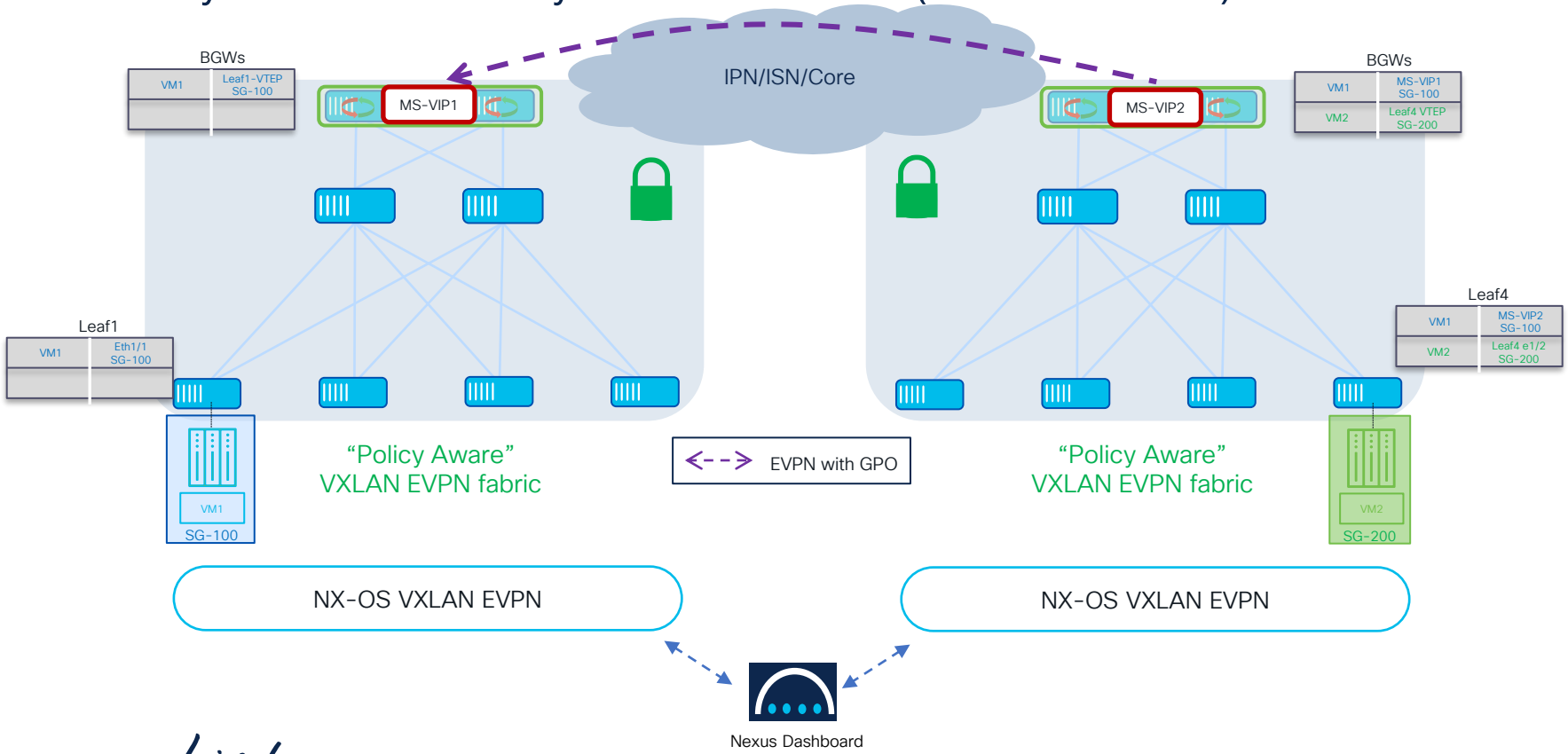
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



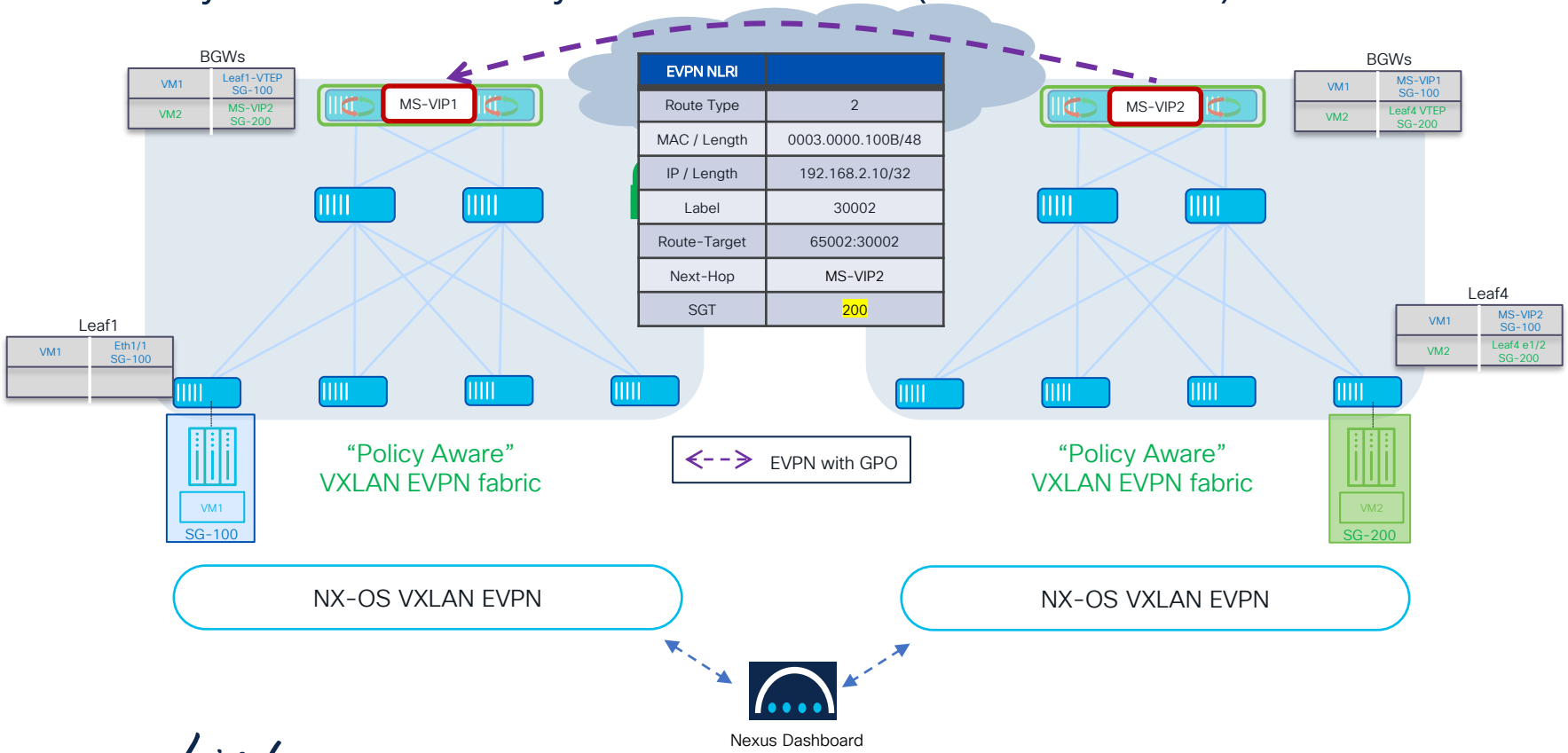
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



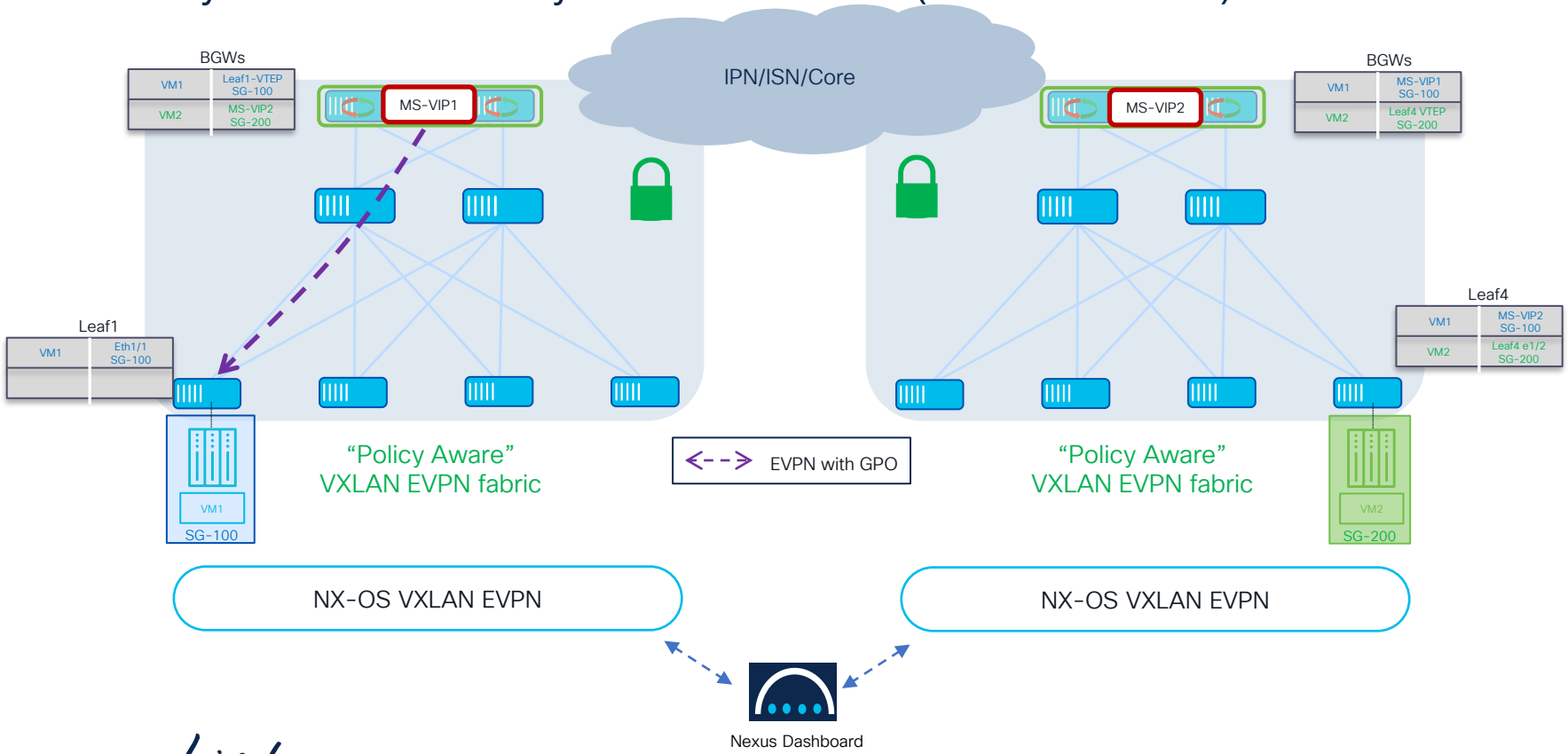
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



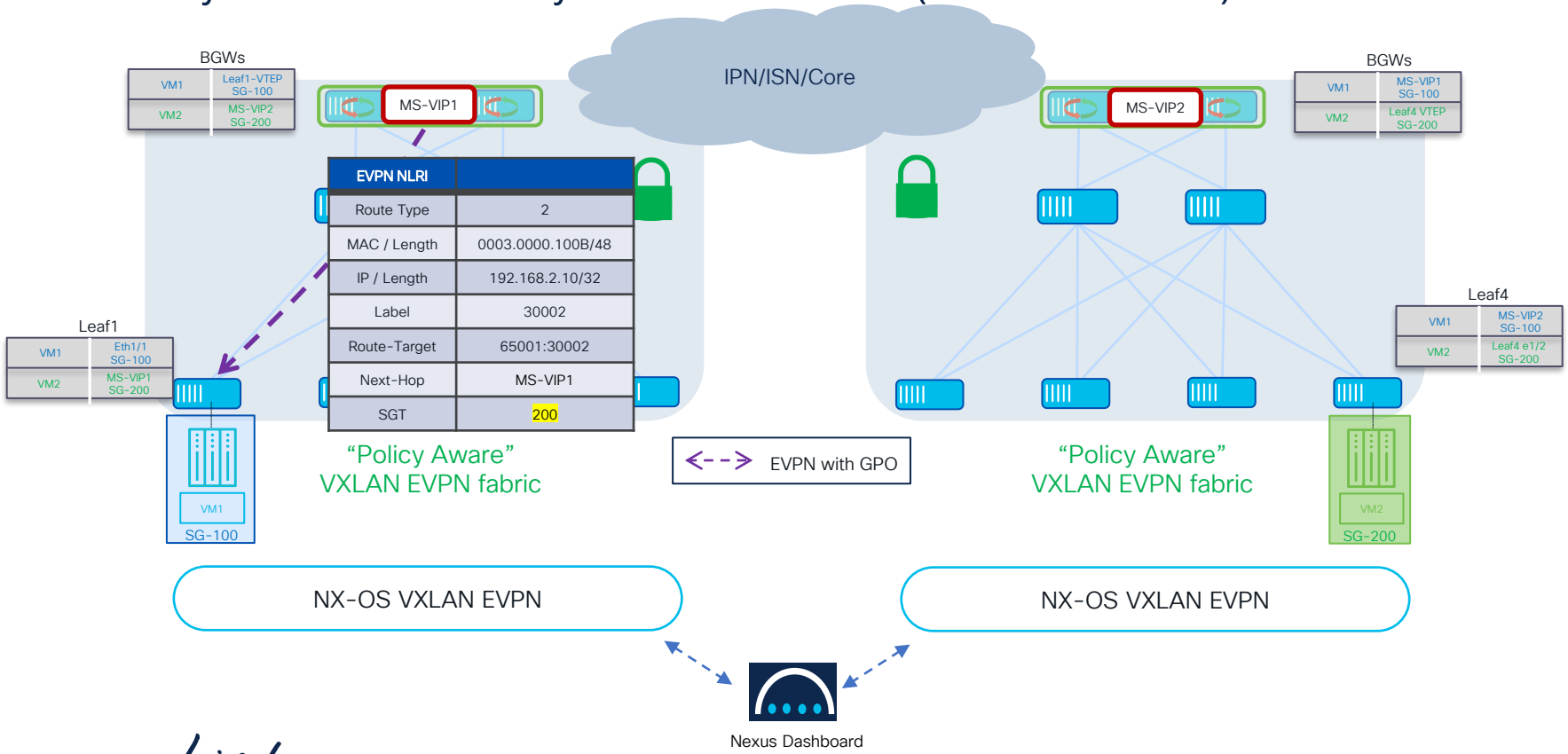
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



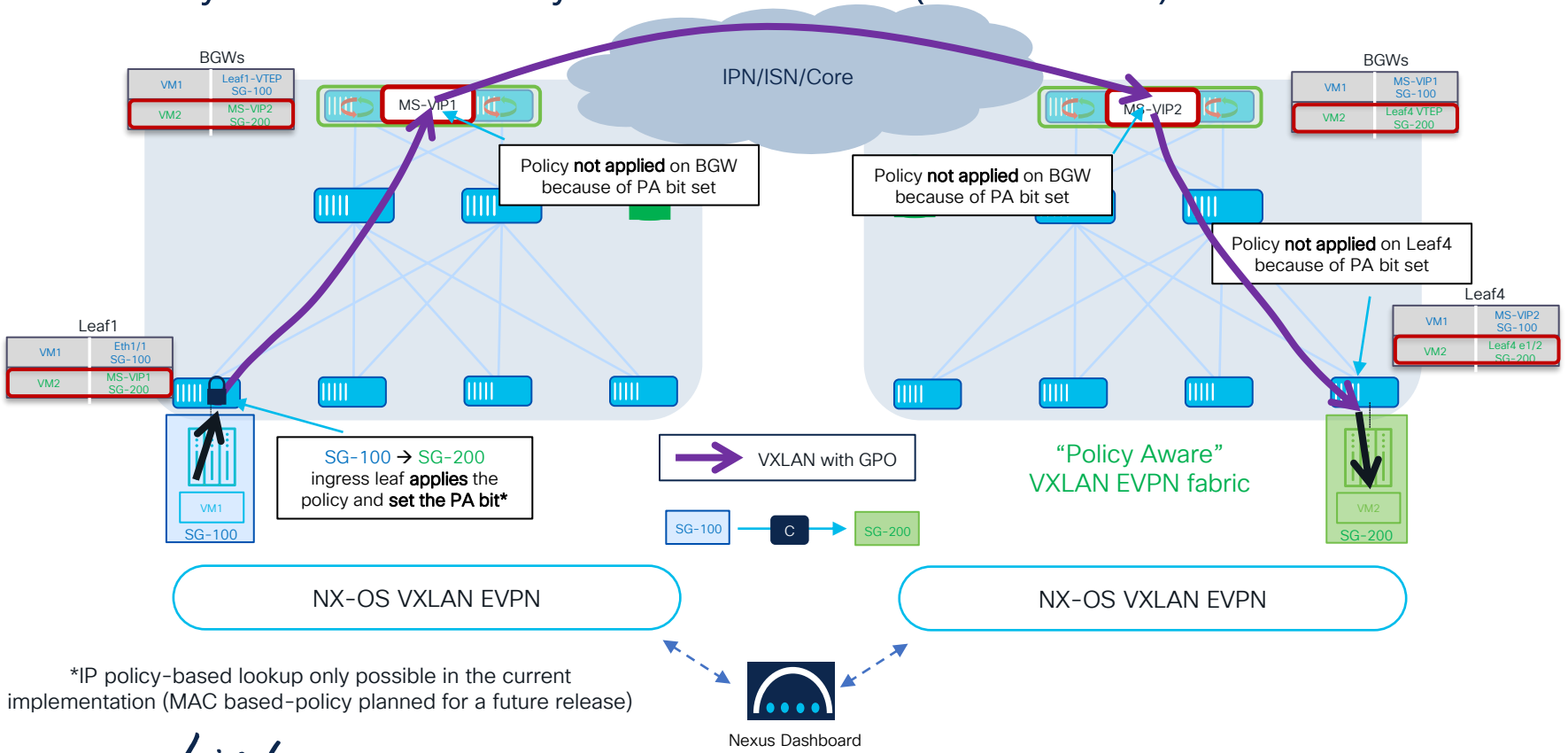
VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)



VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Control Plane)

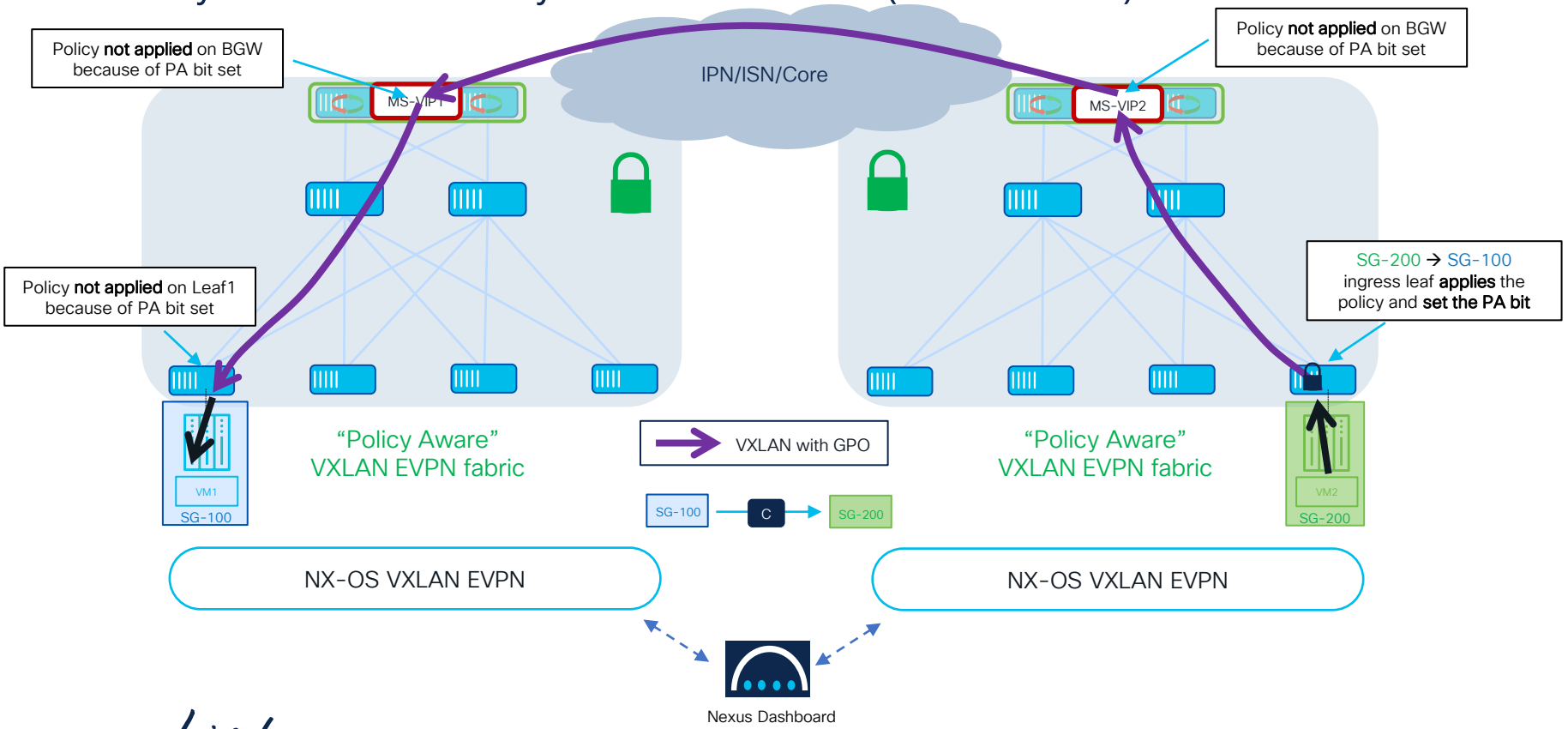


VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Data Plane)



*IP policy-based lookup only possible in the current implementation (MAC based-policy planned for a future release)

VXLAN GPO with Multi-Site
Policy Aware to Policy Aware Fabrics (Data Plane)



VXLAN GPO with Multi-Site

Policy Aware to Policy Unaware Fabrics

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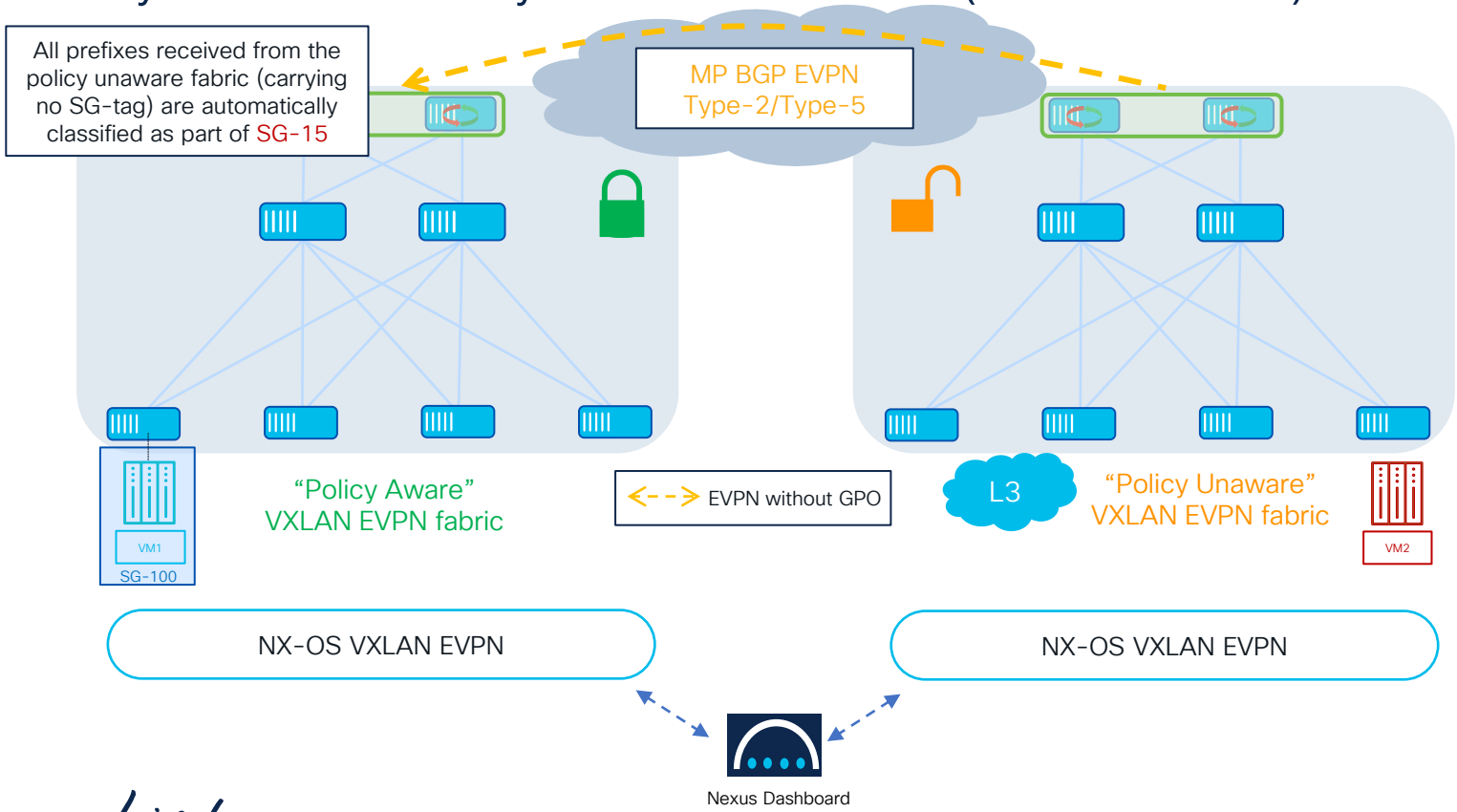
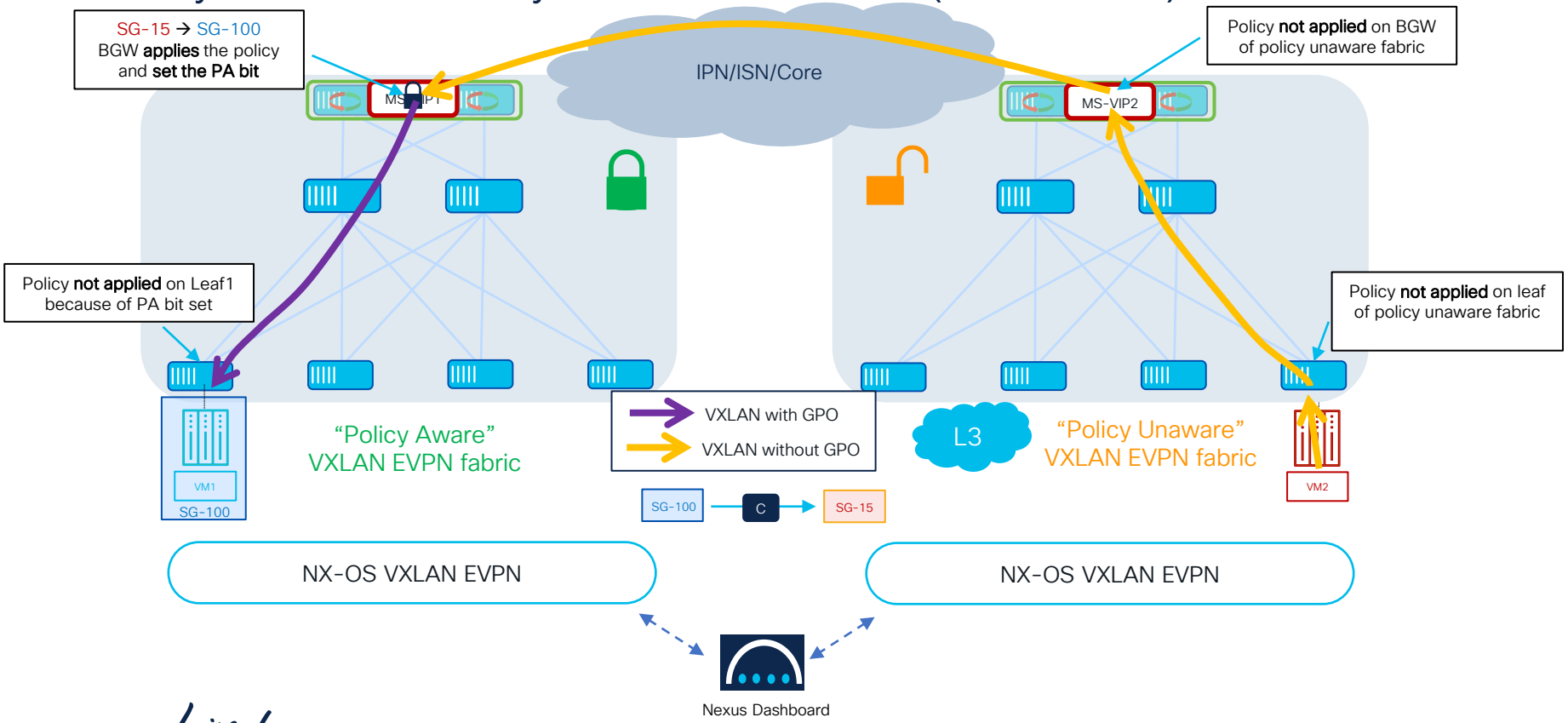
VXLAN GPO with Multi-Site

Policy Aware to Policy Unaware Fabrics (Control Plane)

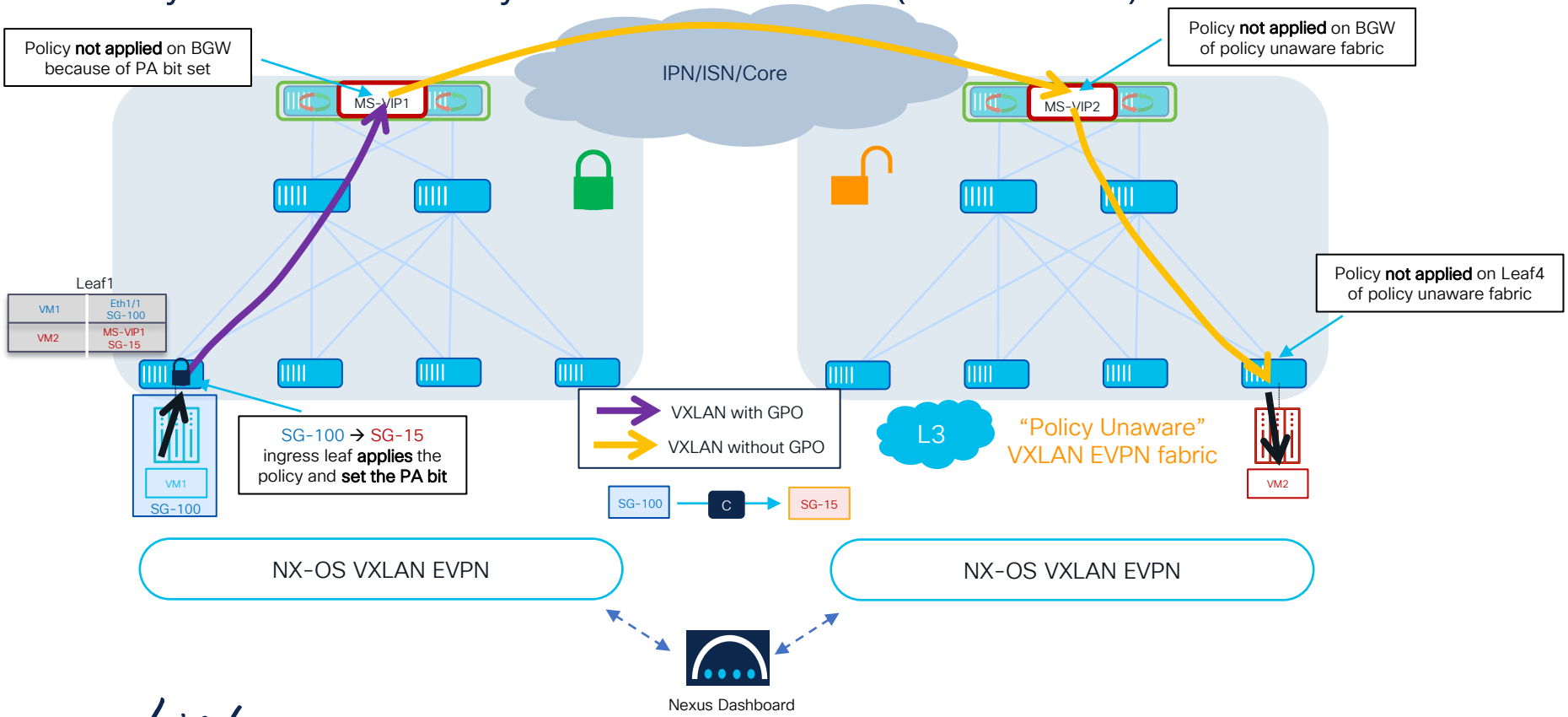


VXLAN GPO with Multi-Site

Policy Aware to Policy Unaware Fabrics (Data Plane)



VXLAN GPO with Multi-Site
Policy Aware to Policy Unaware Fabrics (Data Plane)



VXLAN GPO with Multi-Site

Service Redirection

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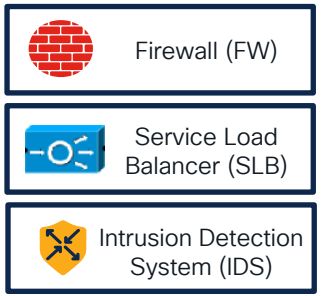
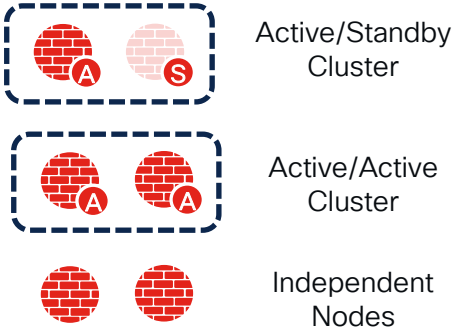
VXLAN GPO with Multi-Site
Service Integration Terminology

Service Function



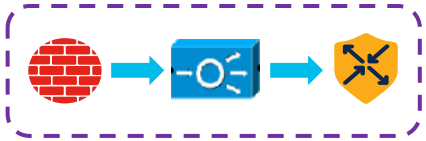
- An entity that includes one or multiple service endpoints (service devices)
- Service devices of the same type implement the same logical function

Service Endpoint



- Physical or virtual devices that handle the received traffic flows
- Can be deployed with different redundancy models (Active/Active, Active/Standby, Standalone Nodes)

Service-Chain

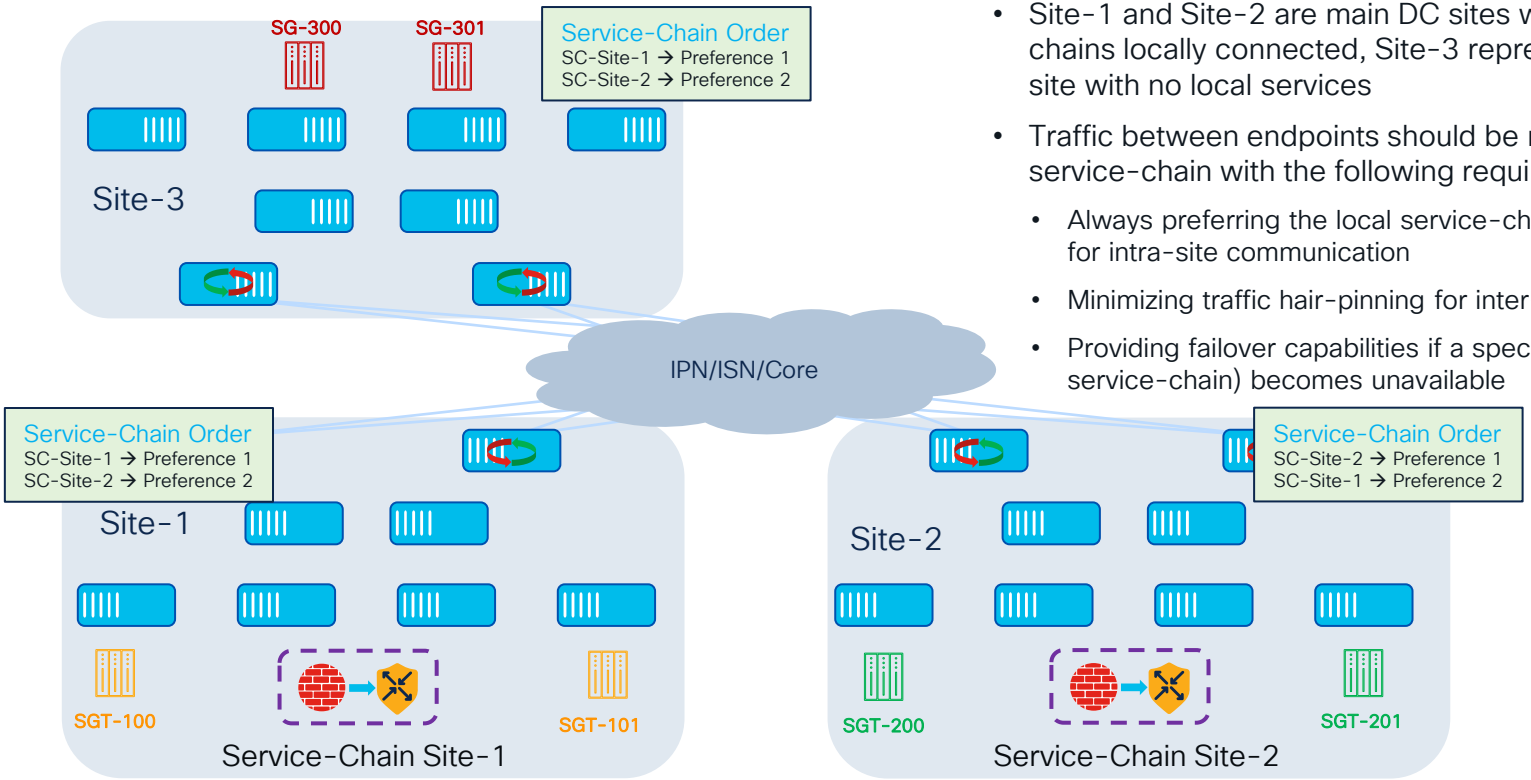


- A group of ordered Service Functions traffic flows will need to traverse
- Service-chain configuration provides options to test the reachability and eventually skip a failed function

VXLAN GPO with Multi-Site
Service Redirection Deployment Considerations

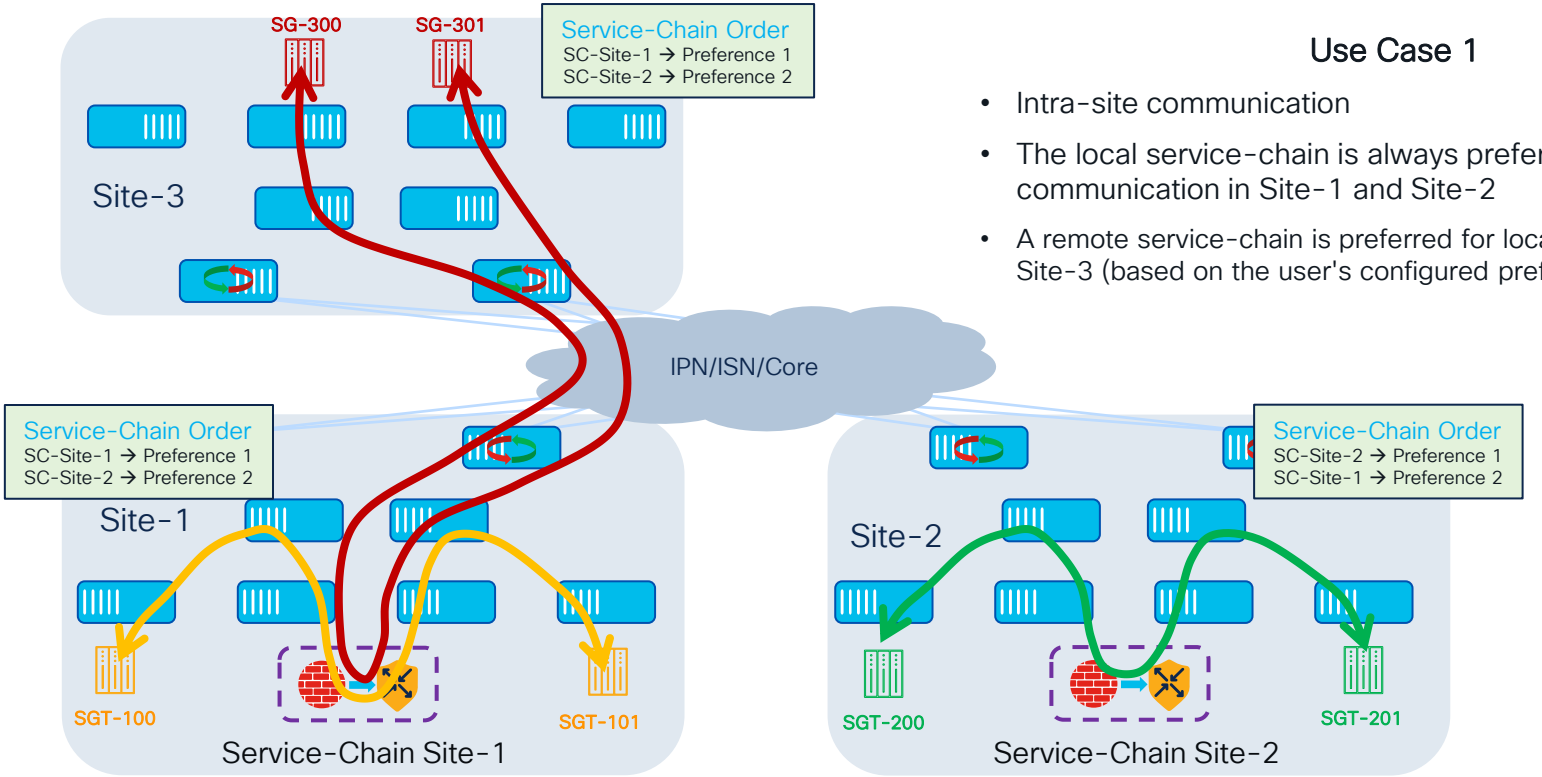
- Intra-fabric GPO Service Redirection support introduced in NX-OS release 10.5(1)F
- Multi-Site and service-chains support added in NX-OS release 10.5(2)F
- Service-chains can be deployed in different sites, but all the service devices building each service-chain must be connected in the same site
  - Symmetry is always maintained, ensuring both legs of a given traffic flow traverse the same service-chain
- Administrators can define failover groups and set priorities for service-chains deployed in multiple sites
  - Probing enabled from each leaf node to determine the health of the service devices
  - Failover function used when the service-chain locally deployed in a site fail
  - Also used by design when a site has no local service-chain deployed

VXLAN GPO with Multi-Site
Service Redirection Topology



- Site-1 and Site-2 are main DC sites with service-chains locally connected, Site-3 represents a remote site with no local services
- Traffic between endpoints should be redirected to the service-chain with the following requirements:
  - Always preferring the local service-chain (if available) for intra-site communication
  - Minimizing traffic hair-pinning for inter-site flows
  - Providing failover capabilities if a specific site (or service-chain) becomes unavailable

VXLAN GPO with Multi-Site
Service Redirection Intra-Site Flows

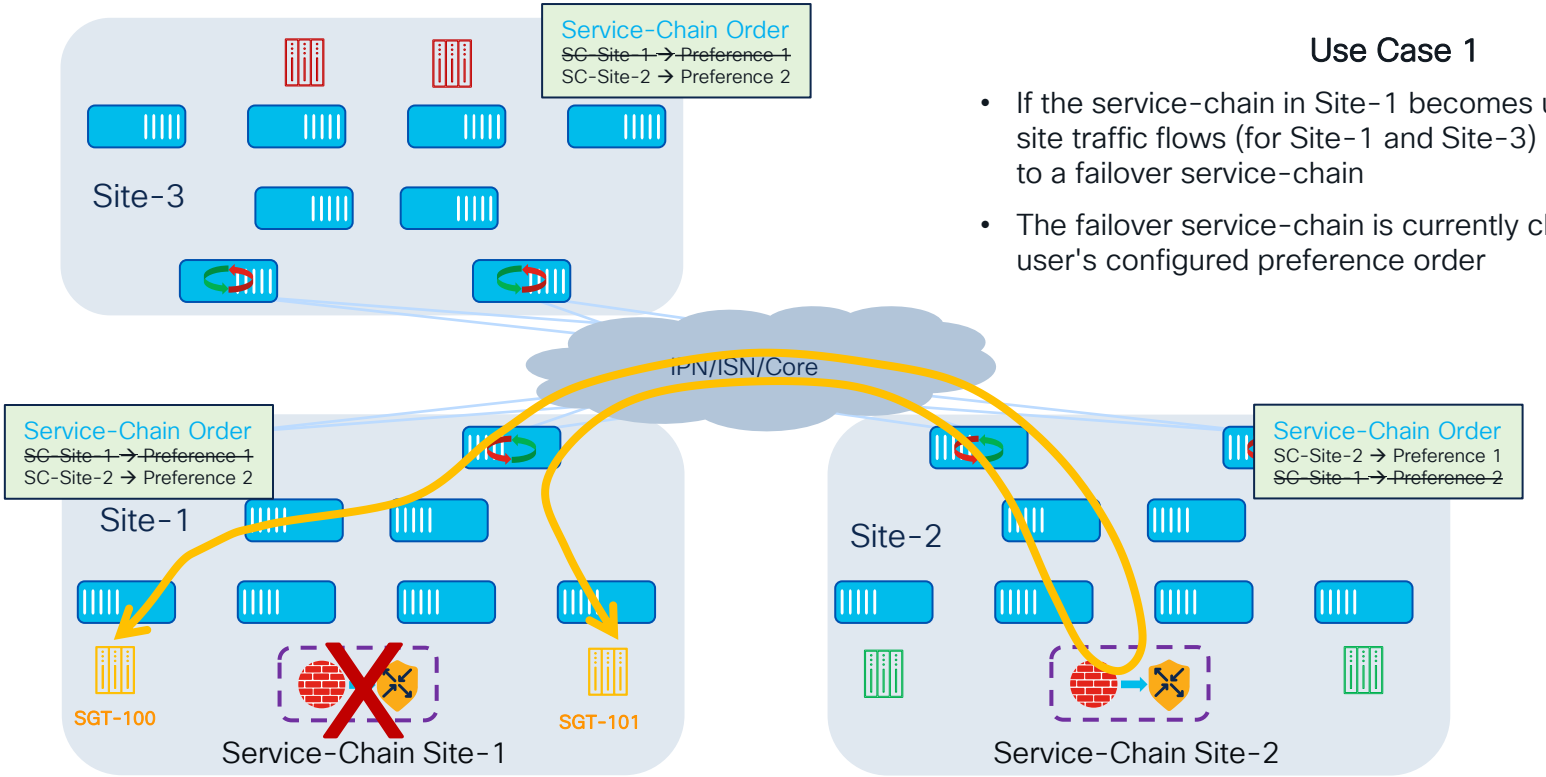


Use Case 1

- Intra-site communication
- The local service-chain is always preferred for local communication in Site-1 and Site-2
- A remote service-chain is preferred for local communication in Site-3 (based on the user's configured preference order)

VXLAN GPO with Multi-Site

Service Redirection Intra-Site Flows – Failure Scenario

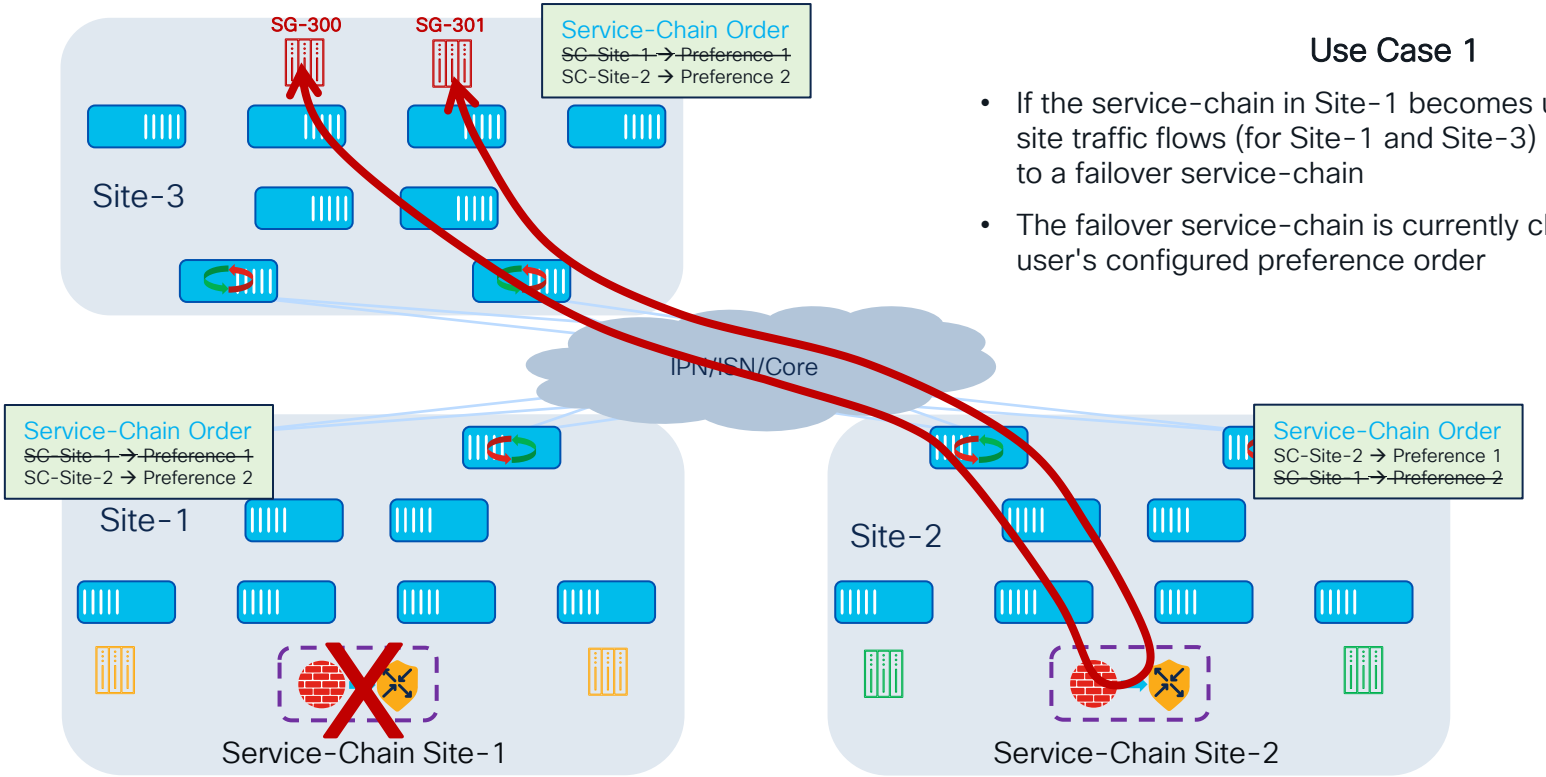


Use Case 1

- If the service-chain in Site-1 becomes unavailable, intra-site traffic flows (for Site-1 and Site-3) can be redirected to a failover service-chain
- The failover service-chain is currently chosen based on the user's configured preference order

VXLAN GPO with Multi-Site

Service Redirection Intra-Site Flows – Failure Scenario



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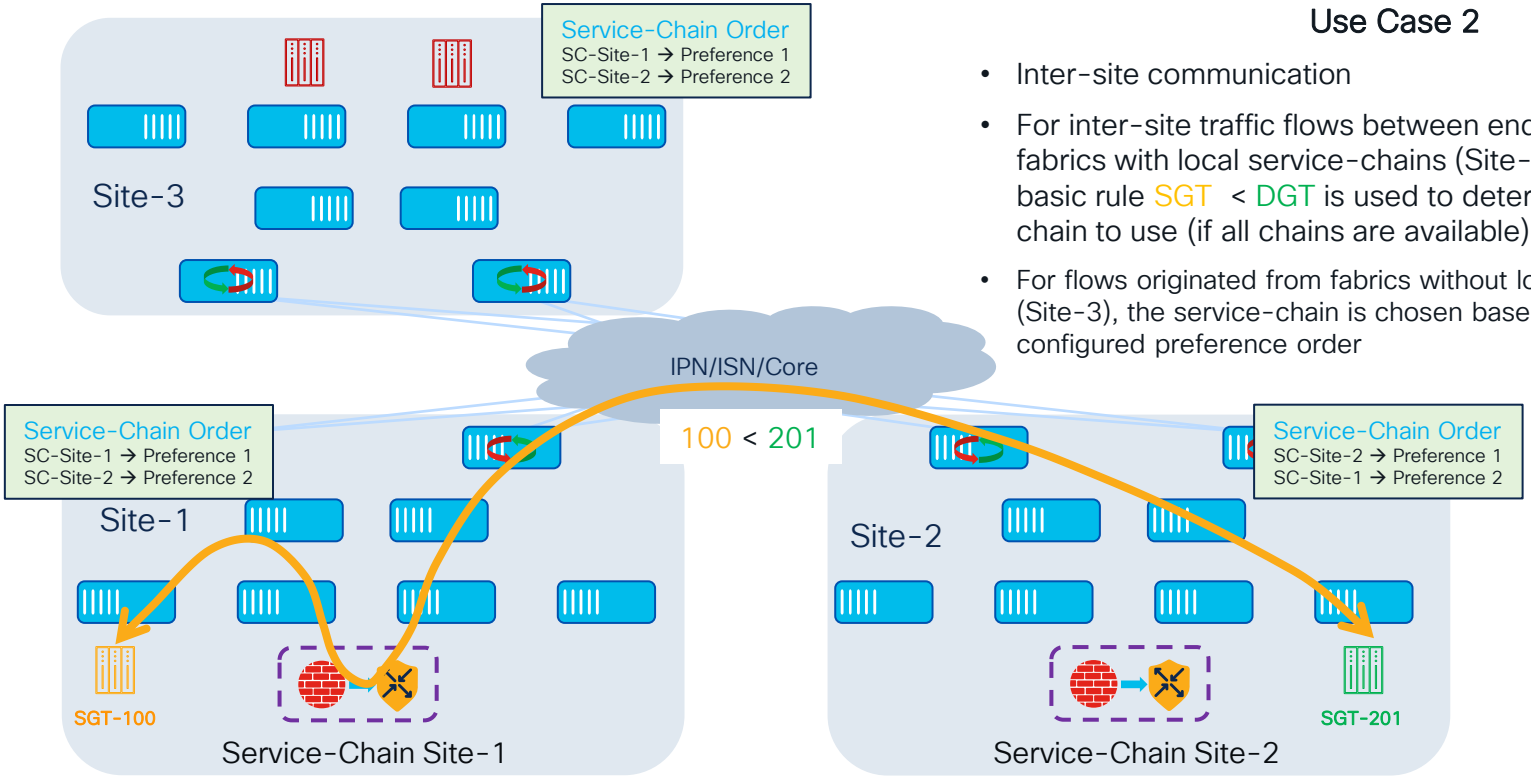
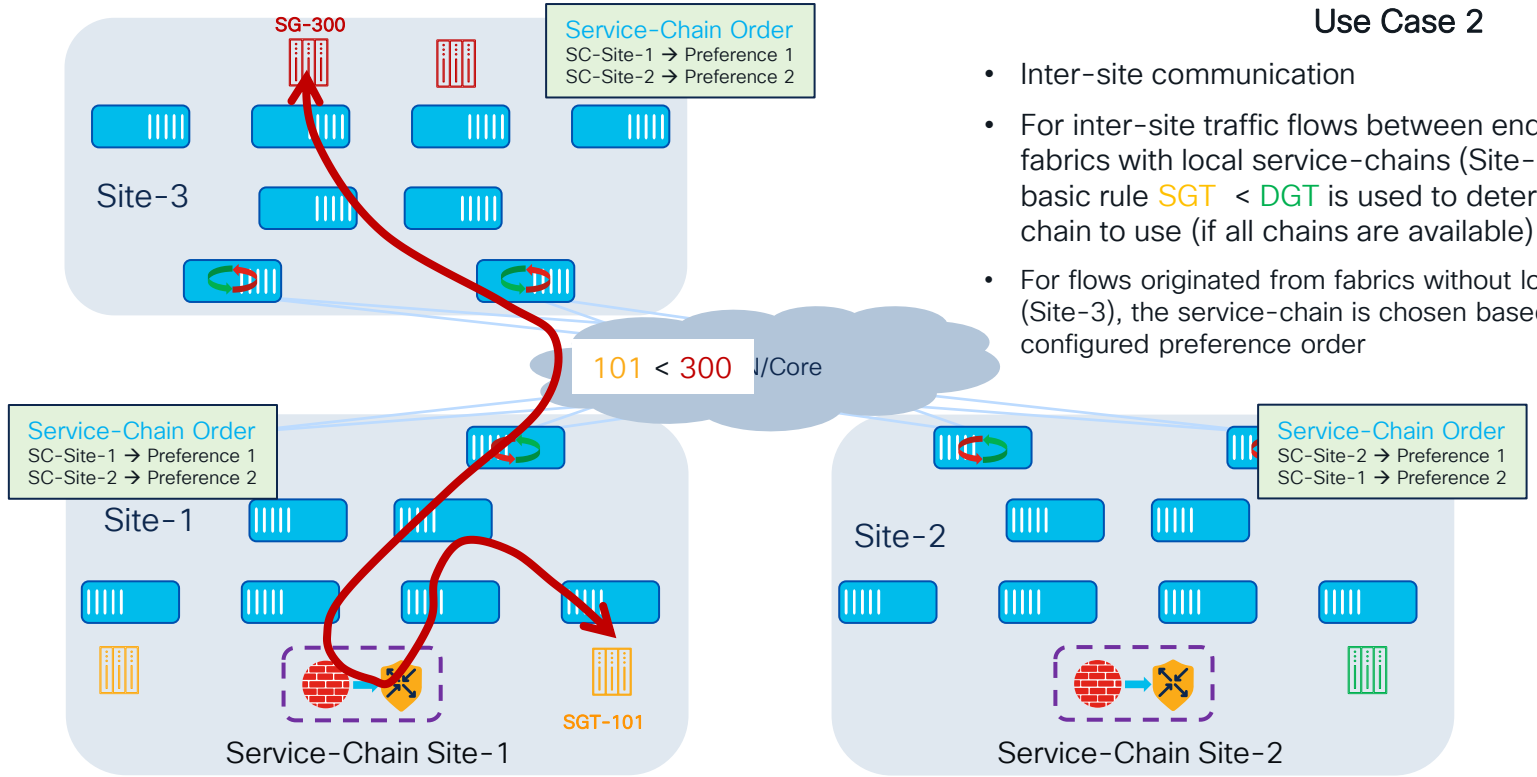
VXLAN GPO with Multi-Site
Service Redirection Inter-Site Flows



Use Case 2

- Inter-site communication
- For inter-site traffic flows between endpoints part of fabrics with local service-chains (Site-1 and Site-2), the basic rule SGT < DGT is used to determine the service-chain to use (if all chains are available)
- For flows originated from fabrics without local service-chain (Site-3), the service-chain is chosen based on the user's configured preference order

VXLAN GPO with Multi-Site
Service Redirection Inter-Site Flows



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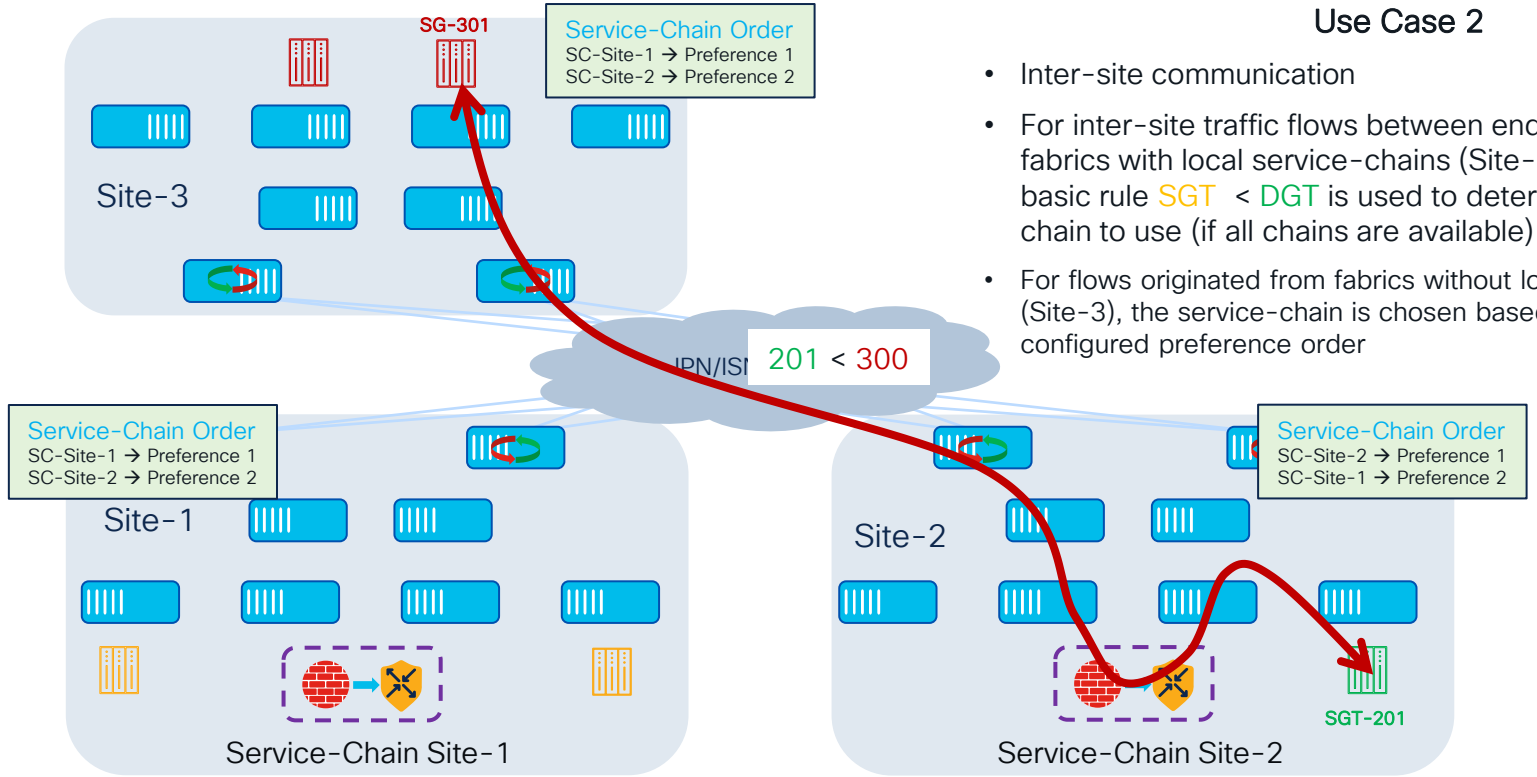
VXLAN GPO with Multi-Site
Service Redirection Inter-Site Flows



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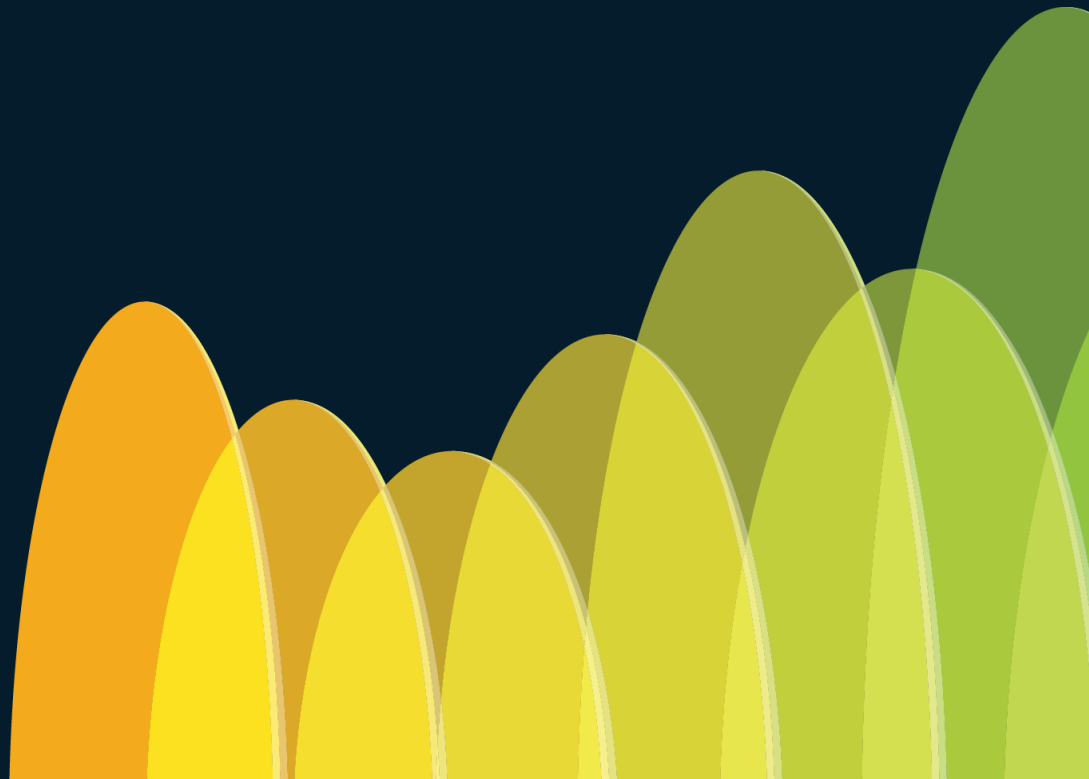
Secure Interconnection of Heterogeneous Fabrics



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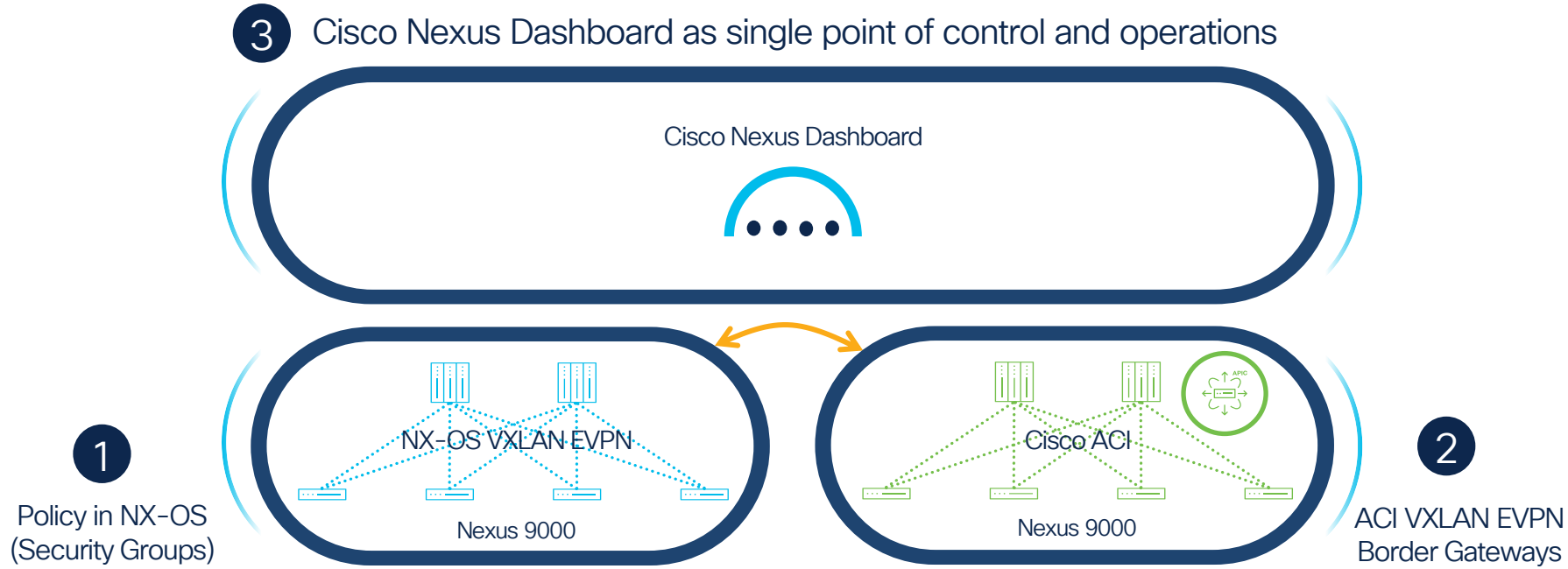
Open NEtworking Fabric Experience

Evolve multiple DCN fabrics into a single user experience to deliver consistent use cases

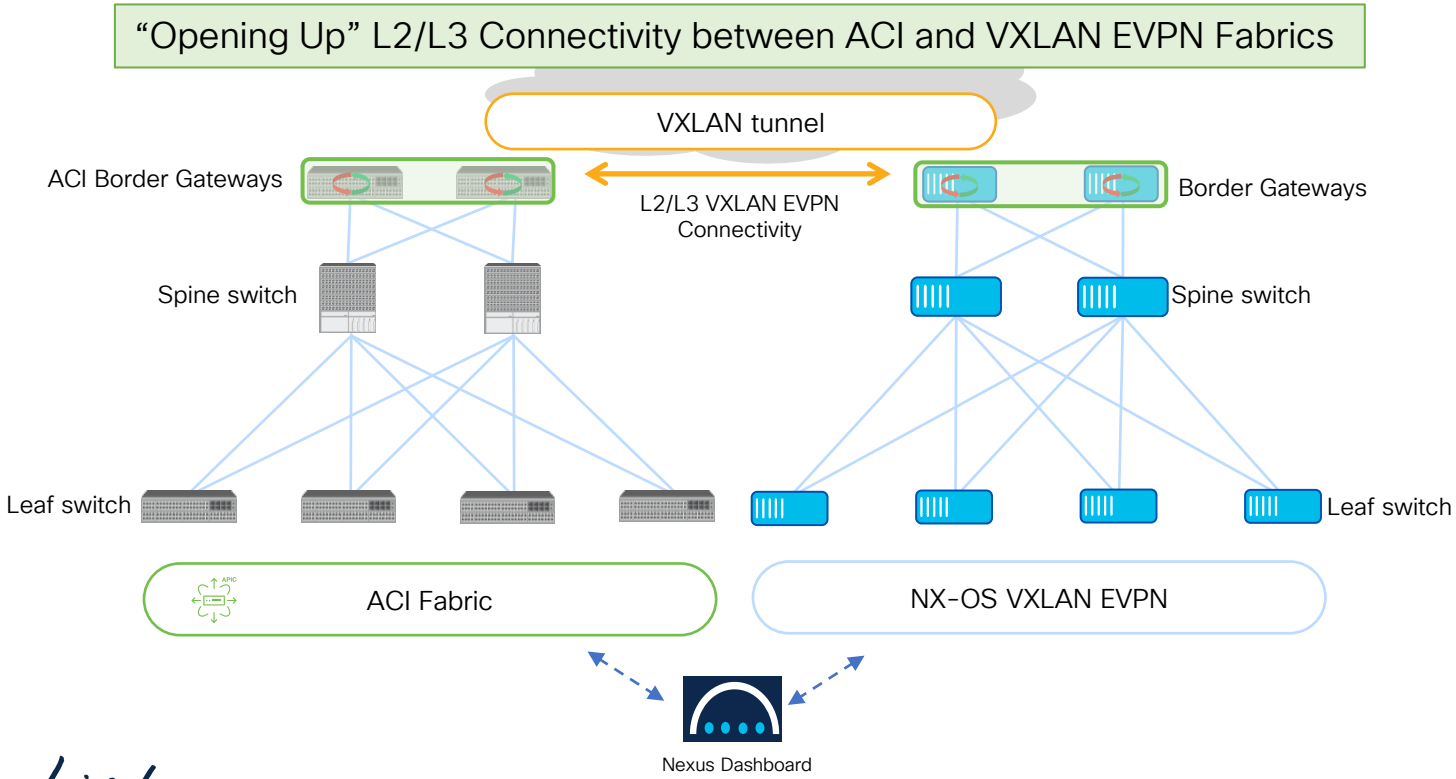
Nexus ONE Fabric Experience – Overview



Different fabric architectures | Same outcome with common experience

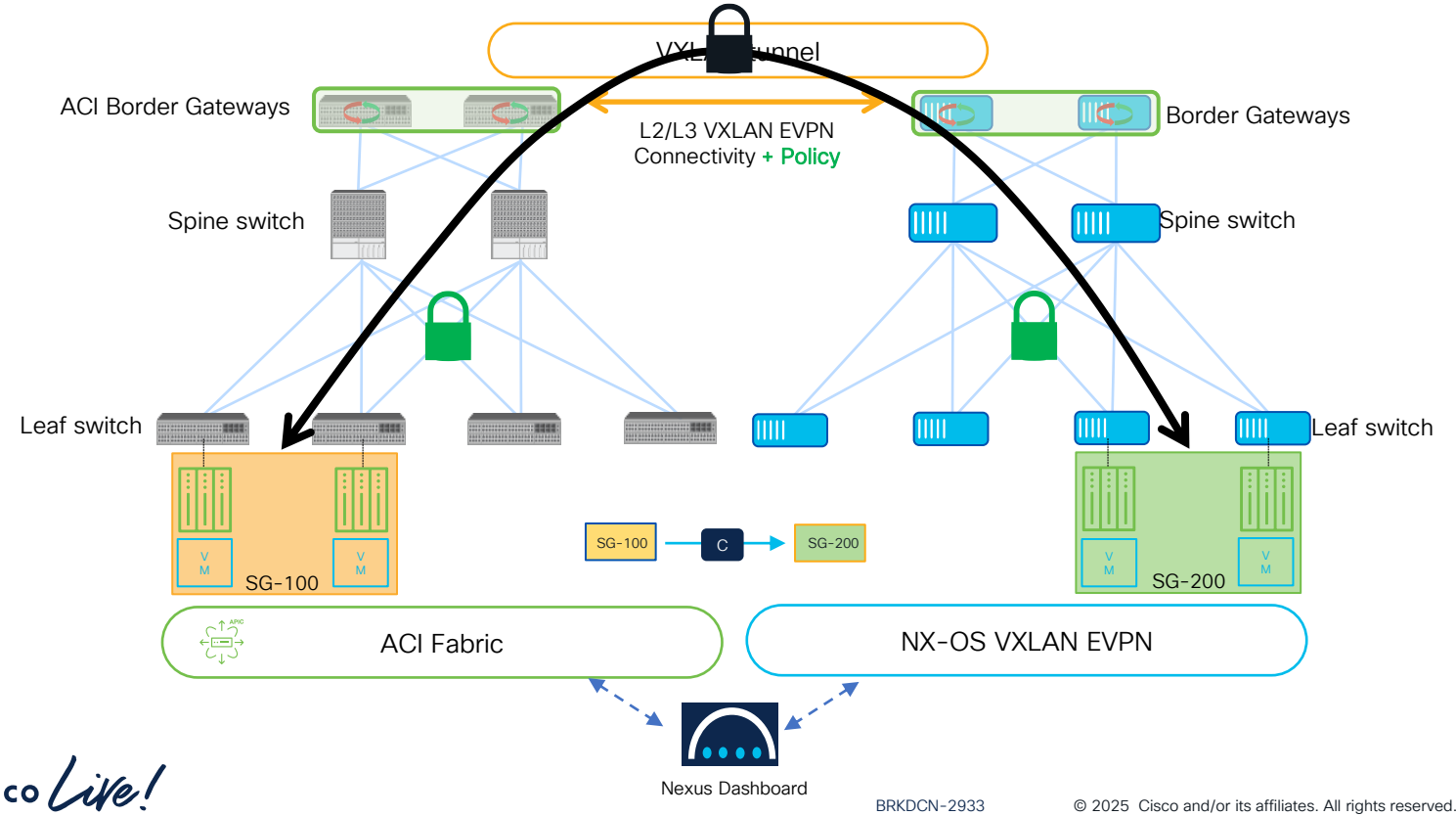
Heterogeneous Fabrics
Introducing ACI Border Gateways

For More Information on ACI BGWs please refer to BRKDCN-2634

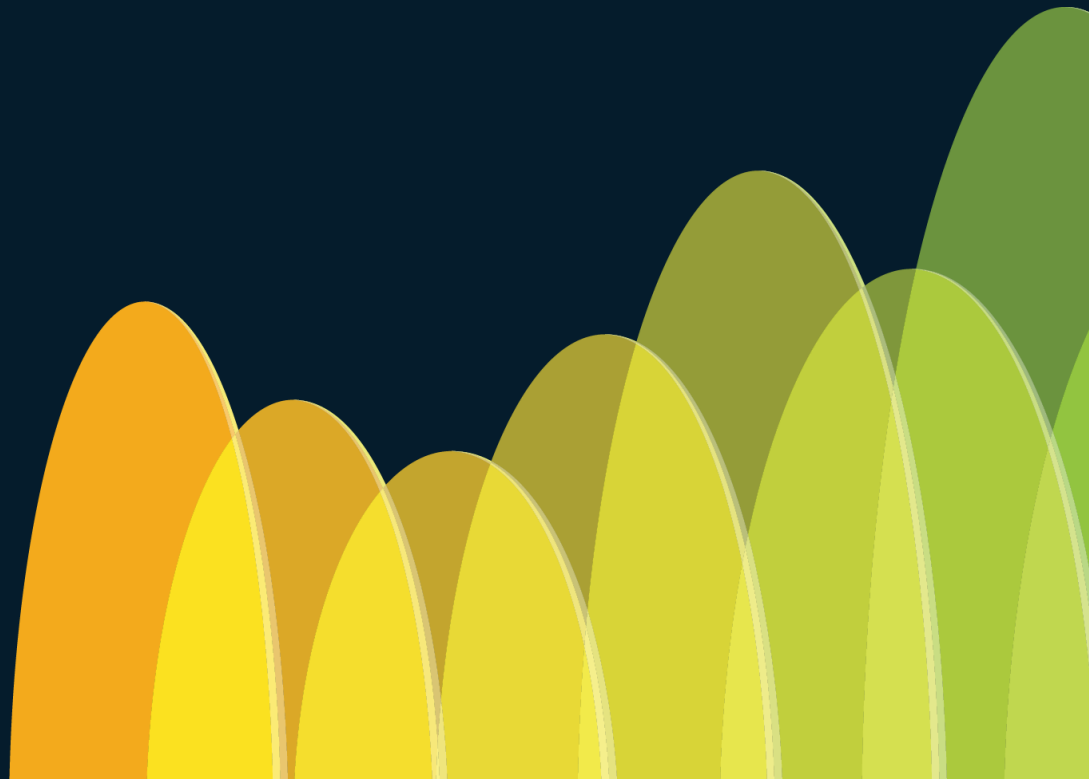


Heterogeneous Fabrics
Policy Enforcement End-to-End

ACI 6.1(4)
NX-OS 10.5(3)



Conclusions



Conclusions

- The introduction of GPO in VXLAN EVPN fabrics provides policy enforcement and redirection capabilities between different secure groups
- The GPO functionalities are available for a single VXLAN EVPN fabric or also for multiple fabrics part of a Multi-Site domain
    - A mix of policy-aware and policy-unaware can be part of the same Multi-Site domain
- Nexus Dashboard (Fabric Controller) is the single pane of glass allowing to provision and operate a GPO-enabled infrastructure
- Cisco ONE Fabric Experience aims to seamlessly and securely interconnect and operate a mix of heterogeneous fabrics (ACI and VXLAN EVPN)

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Wednesday
10:30am –11:30am

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Smart, Secure, Seamless: Transforming Experiences with Next-Generation Networking

Level 2
Room 204

Harness a Bold New Era: Transform Data Centre and Service Provider Connectivity

Level 2
Room 203

Securing User to Application and Everything in Between

Level 2
Melbourne Room 2

Unlocking Digital Resilience through Unified Observability

The HUB
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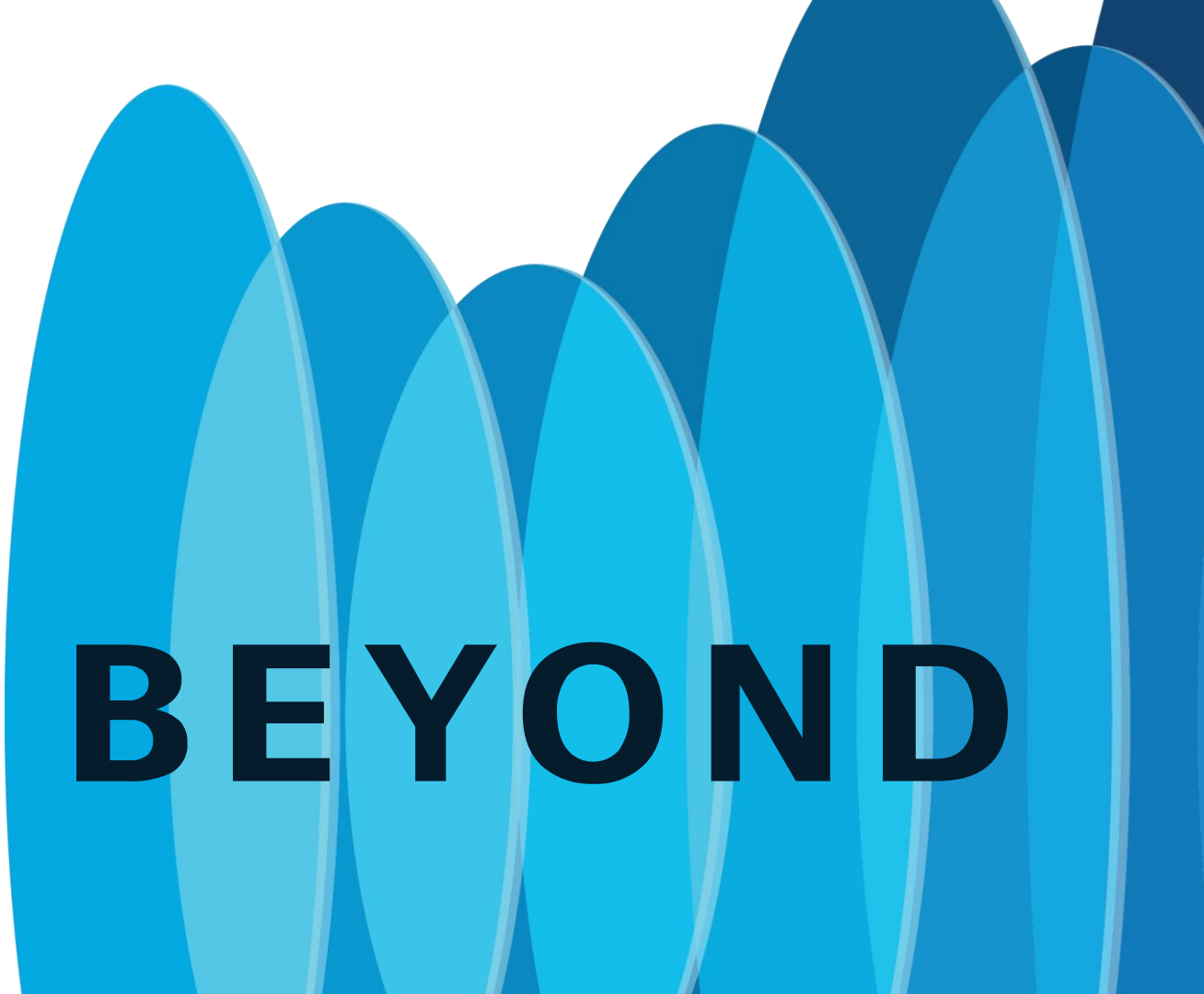

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