Automating Micro-Segmentation and Deploying Layer 4-7 Services in VXLAN EVPN Fabrics using Group Policy Option (GPO) and Nexus Dashboard

Max Ardica
Distinguished TME

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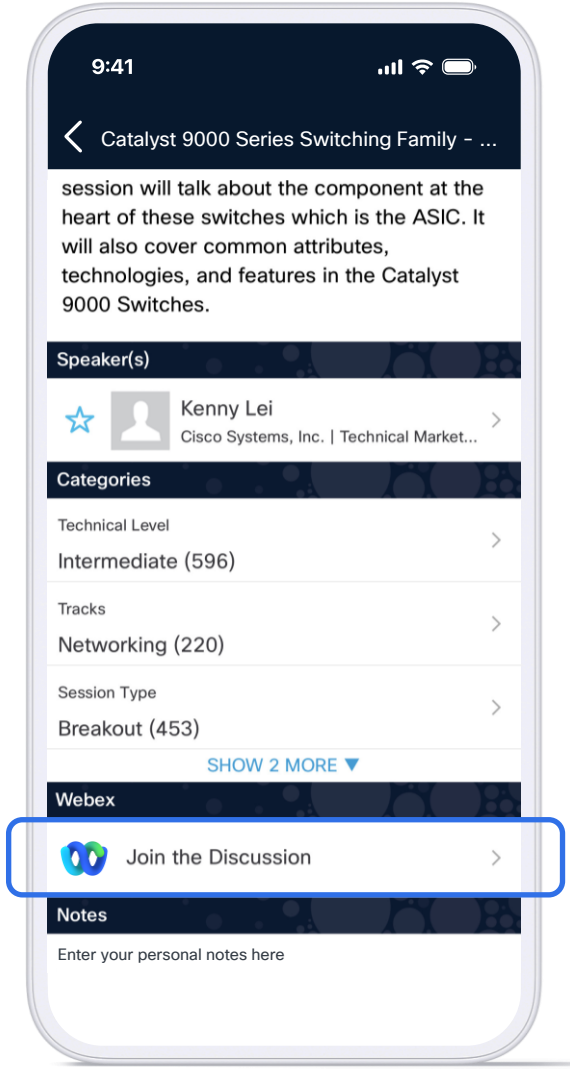

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Agenda

01 Introduction

02 Group Policy Option Origin

03 Group Policy Option Fundamentals

04 GPO Based Service Redirection

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Introduction

Group Policy Option

Enhancing Data Center Segmentation with Simplicity and Granularity

- Data Center security is important
- Threats are evolving, increasing and becoming more complex
- Enforce organization’s security standards by permitting only pre-approved traffic across and within every network segment
- Traffic enforcement needs to optimized. Design and configurations must be streamlined
- Newer capabilities have been introduced in recent NX-OS to expand the existing feature-set
  - Group Policy Option (GPO)
  - Service Redirection based on GPO

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Group Policy Option

Enhancing Data Center Segmentation with Simplicity and Granularity

GPO Standard

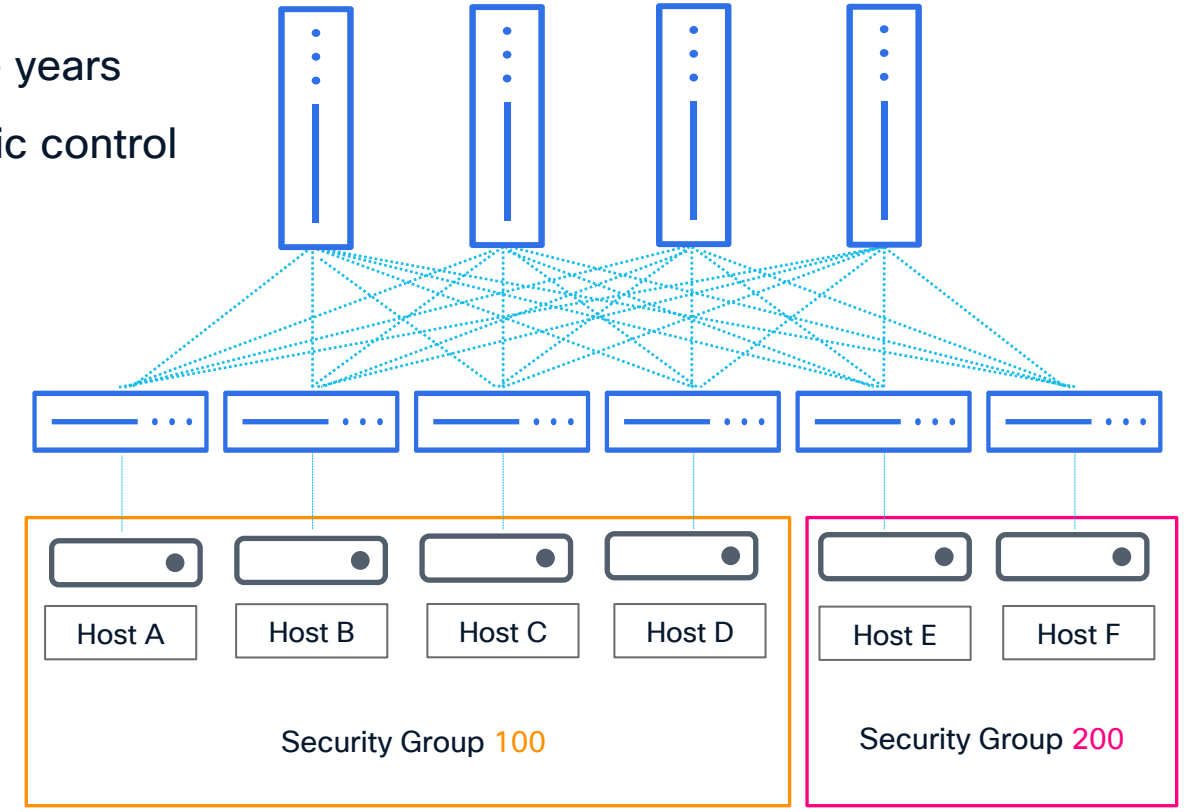
- First published in 2014, with many enhancements over the years
- Extension to VXLAN and EVPN that provide additional traffic control
- Backwards compatible

Grouping and Classification

- Classify endpoints into security-groups
- Based on IPs, MACs, VLANs and Ports

Enforcement for inter-group traffic

- Permit
- Deny
- Redirect



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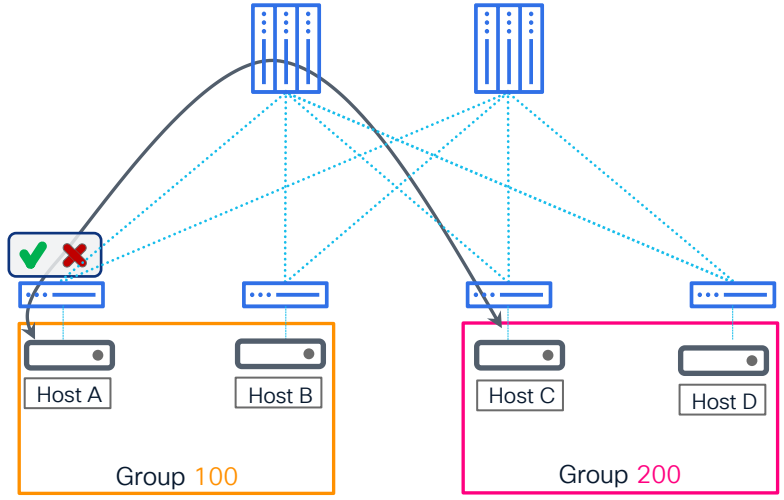
Group Policy Option

Main Use Cases

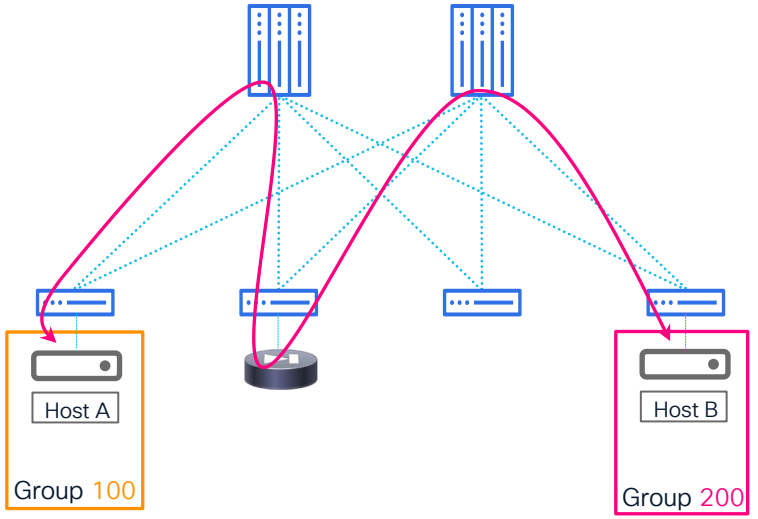
Segmentation

- Policies for macro and micro segmentation
- Control N/S and E/W traffic
- Granular filtering and better resource utilization



Service Redirection

- Easily insert service devices in the traffic path
- Traffic can be steered w/o touching routing tables or creating complex network designs



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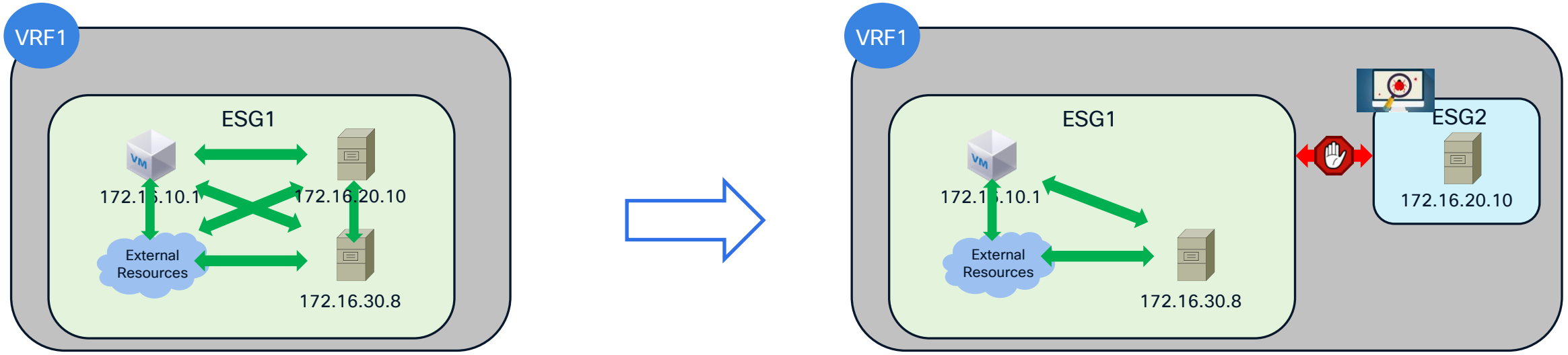
VXLAN GPO with NX-OS

Use Case - VRF as a Security Zone



- Creation of a single security group to classify endpoints connected to all the networks (internal and external) part of the same VRF
- Provides intra-VRF open connectivity

- Easy way to segment out specific endpoints that needs to get isolated (for example because they got compromised)

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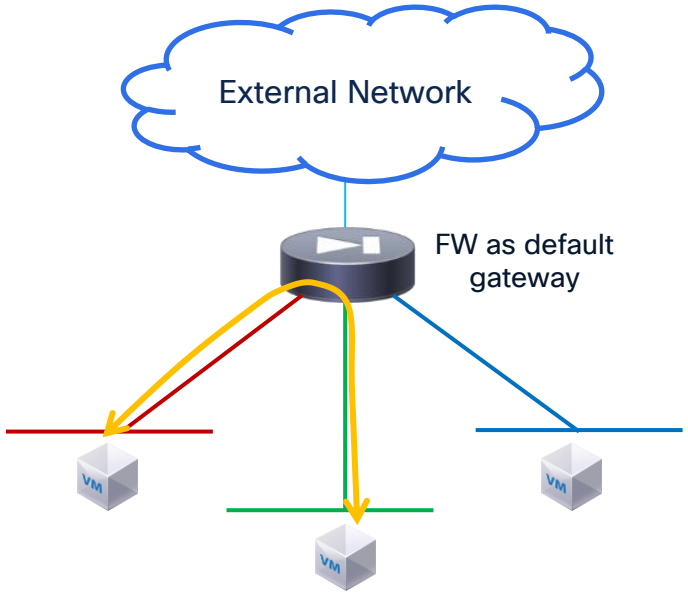
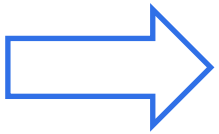
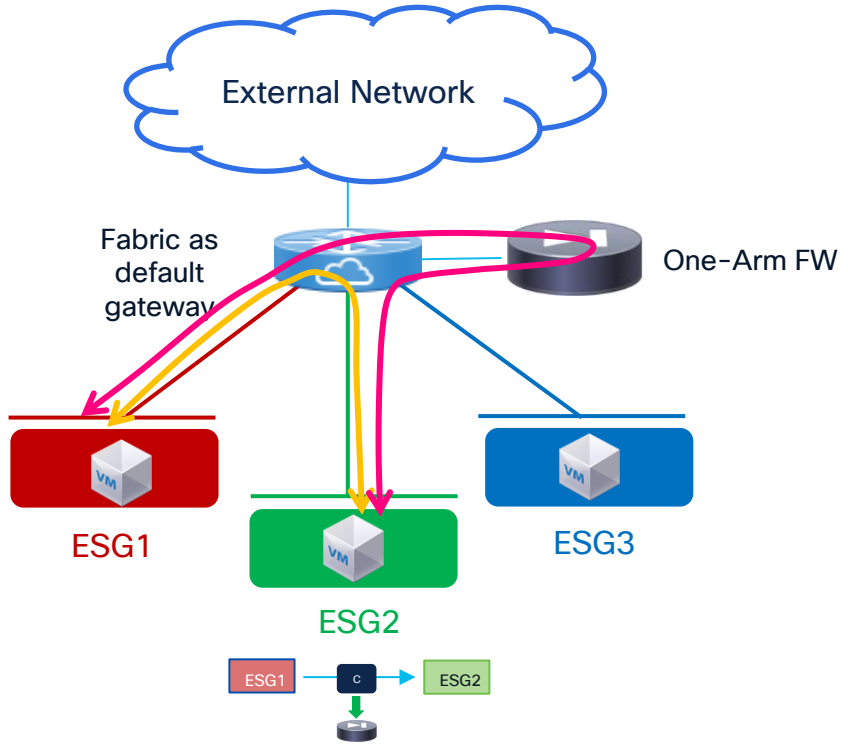
VXLAN GPO with NX-OS

Use Case - Subnet as a Security Zone







- Traditional design requires the deployment of a firewall as default gateway
- All inter-subnet flows are forced through the firewall, which may become a bottleneck

- Moving the default gateway function on the fabric
- Defining a separate ESG per subnet
- Redirect selective inter-subnet traffic flows only through the firewall, enforce policy or simply route at the fabric level for the rest of the flows

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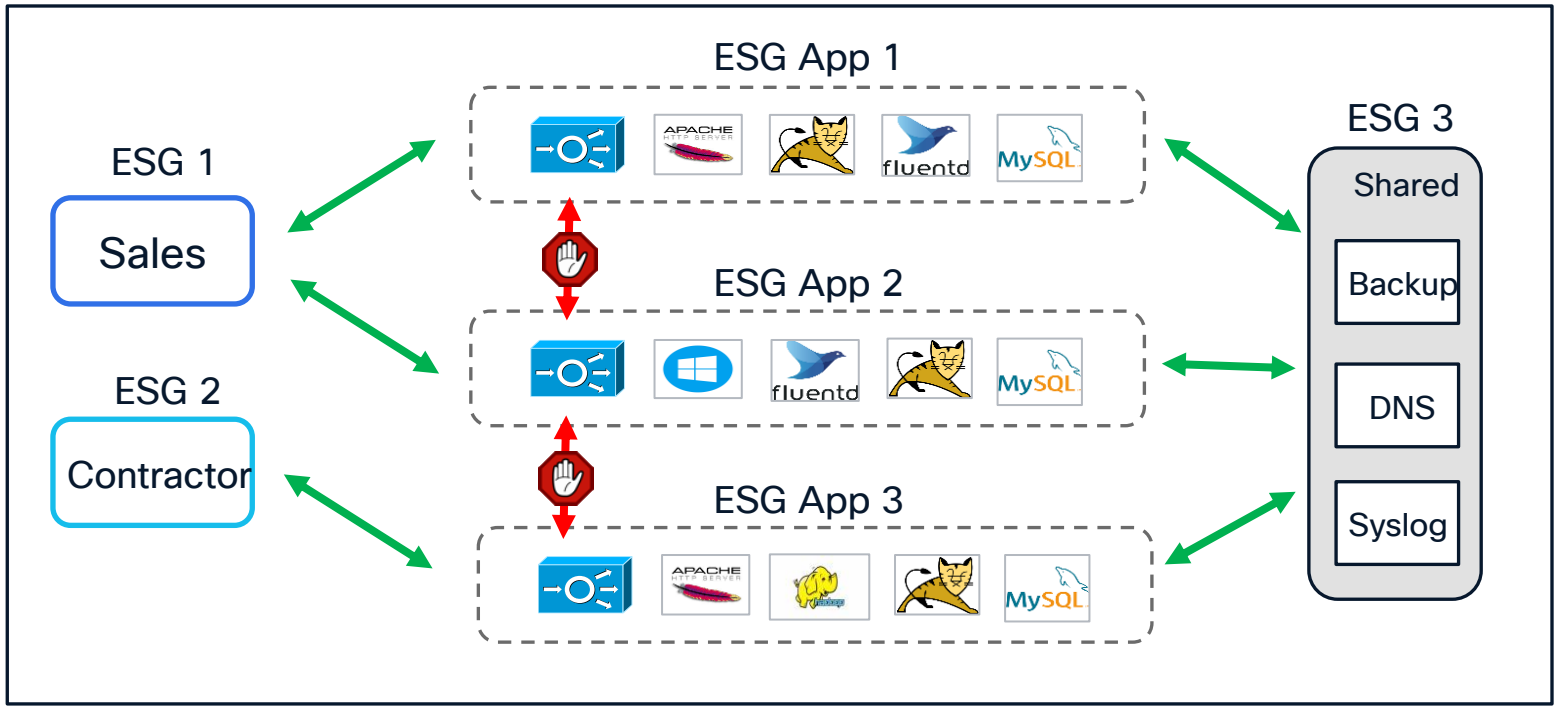
VXLAN GPO with NX-OS

Use Case – Application as a Security Zone



- Application as a security zone
- Does not require to know how the various components of the same application interact with each other
- Control communication between users and app, app to app and app to shared services

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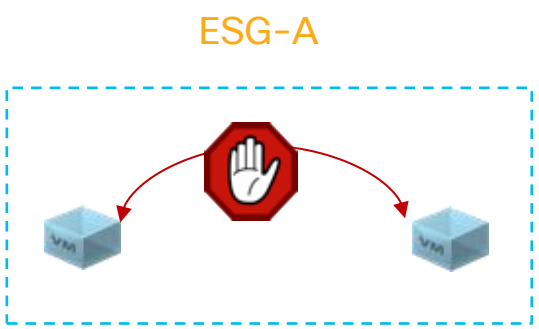
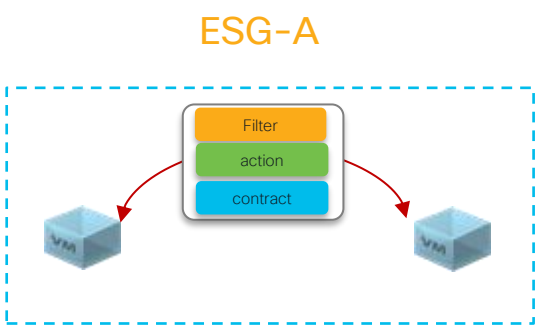
VXLAN GPO with NX-OS

Upcoming Use Cases*

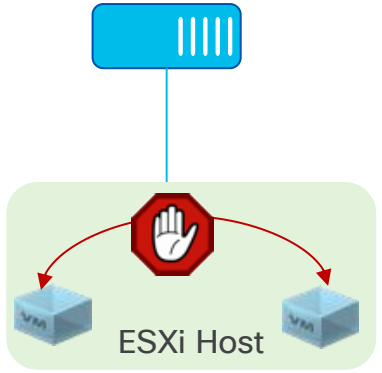
Intra-group Isolation



Intra-group Contract



Policy enforcement between endpoints connected to a common southbound Layer 2 switch (physical or virtual)



*Planned to be addressed in the 10.6(x) train

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Group Policy Option

Compatibility and Licensing

Licensing: Essentials

GPO introduced in NX-OS 10.4(3)F

- FX3, GX and GX2 platforms*
- Single and Multi Site** Fabrics

NX-OS 10.5(1)F introduced

- 9408 platform*
- Single Service Function Redirection in Single Fabrics

NX-OS 10.5(2)F introduced

- FX, FX2 and HX platforms*
- Multi Service Function Redirection in Single and Multi-Site** Fabrics
- IPv6 in Underlay

NX-OS 10.5(3)F introduced

- New Classifiers and ISSU support

*Min 24G RAM

**Multi-Site requires Advantage on BGWs

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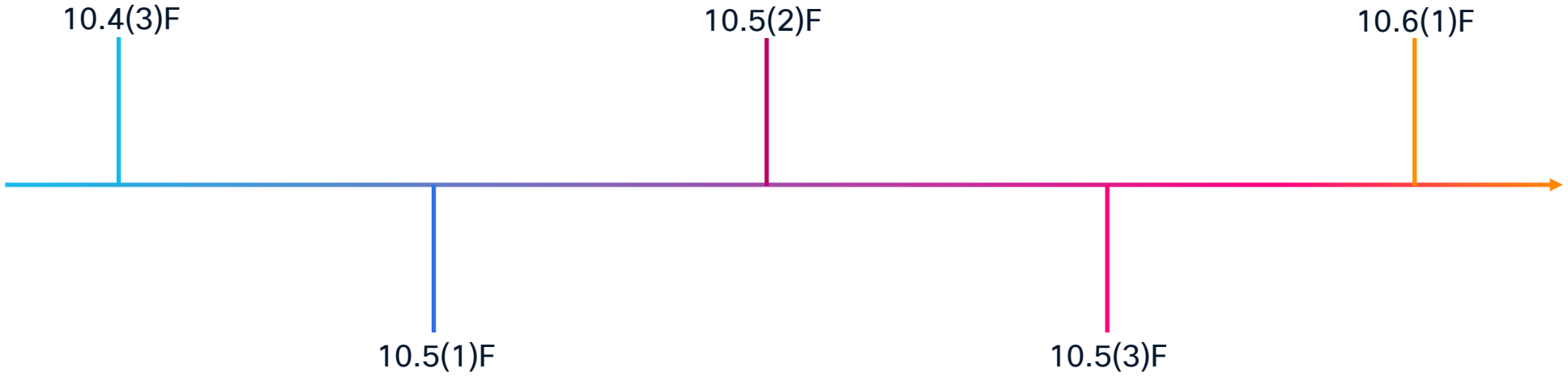
Group Policy Option

Feature Evolution

- Single and Multi-Site
- Supported Platforms: FX3, GX, GX2
- Classifiers: IP, VLAN
- Actions: Permit/Deny
- Single Site and Multi-Site

- Supported Platforms: FX. FX2, HX
- Actions: Redirection to Multi-Site
- IPv6 Underlay

- Classifiers: (Port,VLAN)
- MAC based micro-segmentation



- Supported Platforms: 9408
- Actions: Redirection to Single-Site

- Classifiers: MAC address
- ISSU Support
- N/S traffic via SR-MPLS

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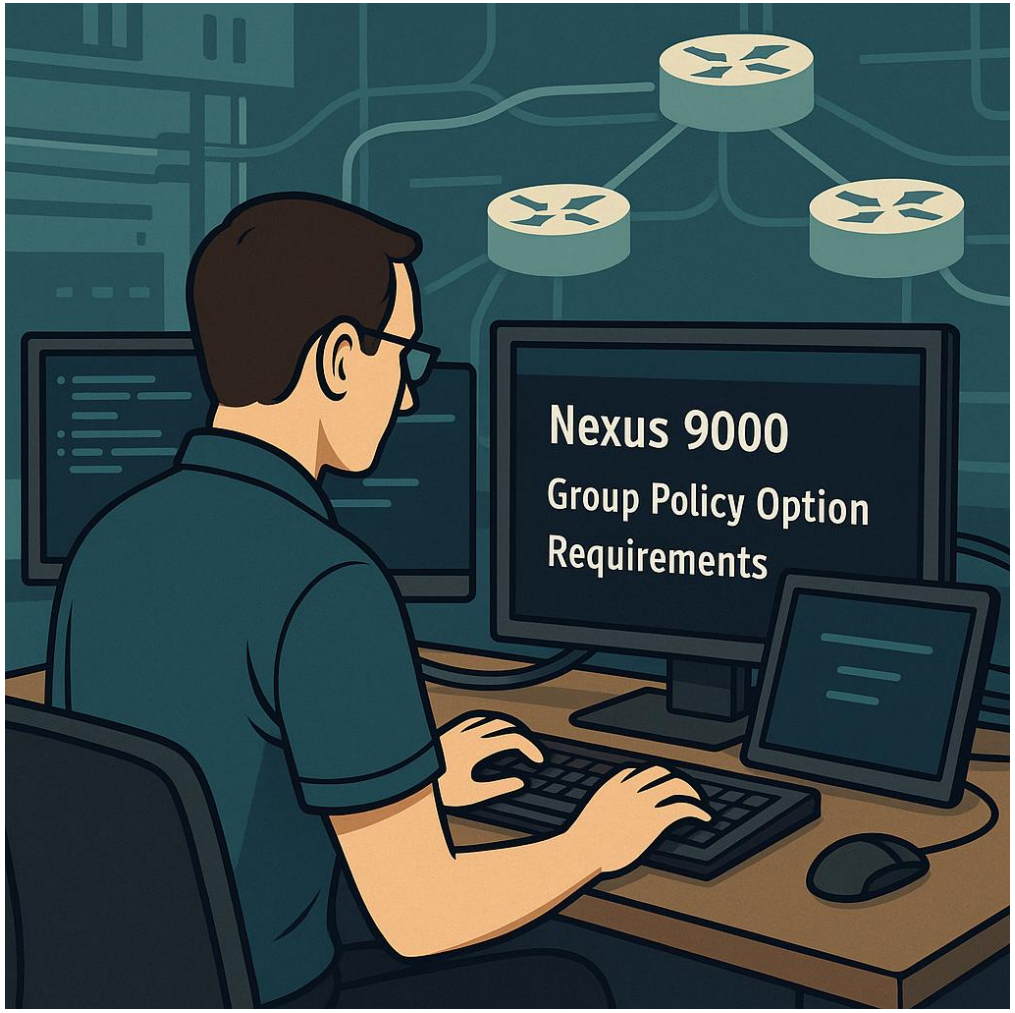
Group Policy Option

Device Requirements

- Devices require minimum 24G of RAM
- Essentials License provides access to every GPO related functionality:
  - Basic enforcement
  - Redirection
- NX-OS requires some ad-hoc configs that will require a (single) reload:
  - Routing Template: system routing template-security-groups
  - SSD repartitioning: system flash sda resize extended
  - GPO feature: feature security-group



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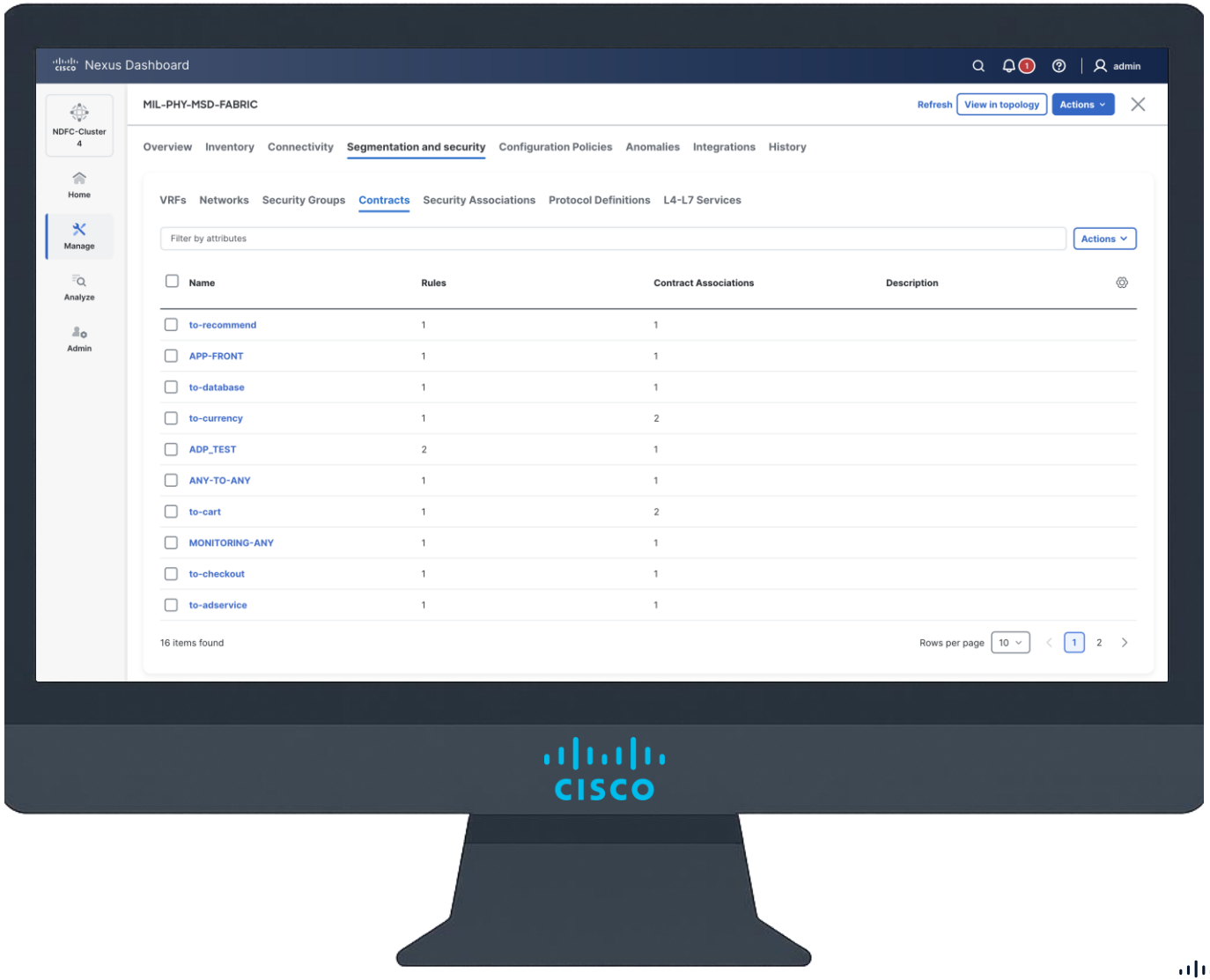
Group Policy Option

Controller Requirements

- Nexus Dashboard is highly recommended but optional
- Support for GPO added in ND 3.2
- Supports Single-Site and Multi-Site environments
- Seamless workflows to help administrators define the Data Center security posture
- Many enhancements will be added in upcoming versions



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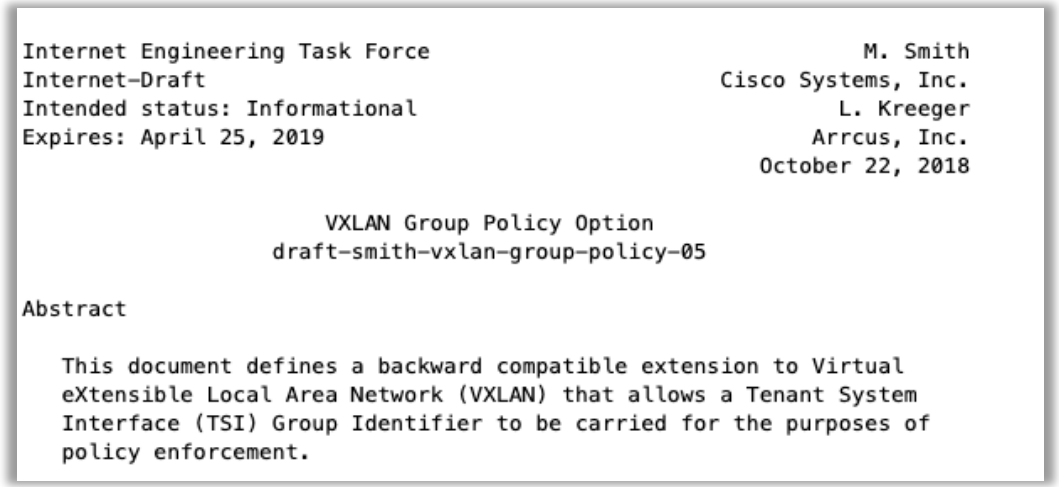
GPO Origin

Group Policy Option

Origin – IETF Drafts – Data Plane

- Originally defined in 2014, introduces backward compatible options to carry additional values in the VXLAN header
- Values include a Security Group Tag (SGT) and a few additional flags
- These values can be written and read by ingress and egress VTEPs to enforce security rules on overlay traffic
- Not widely adopted due to the lack of a related Control Plane
- No Control Plane = Inefficient use of fabric bandwidth

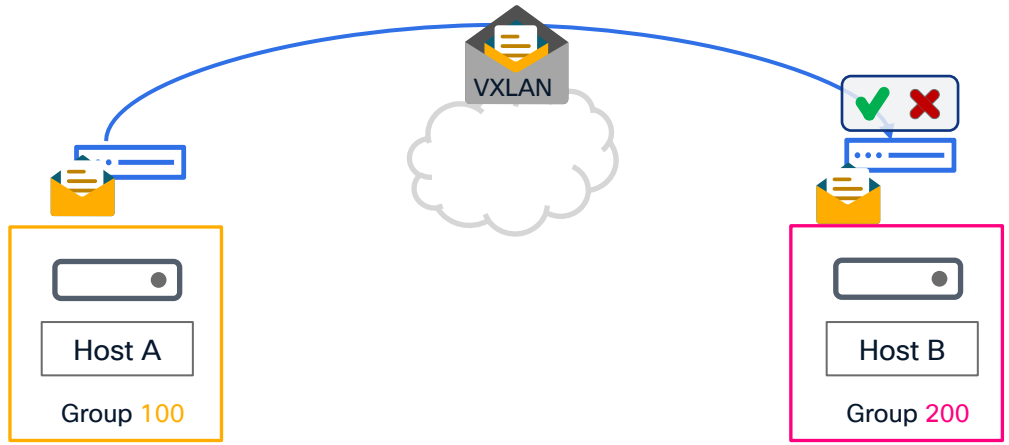


Internet Engineering Task Force — M. Smith
Internet-Draft — Cisco Systems, Inc.
Intended status: Informational — L. Kreeger
Expires: April 25, 2019 — Arrcus, Inc.
October 22, 2018

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.



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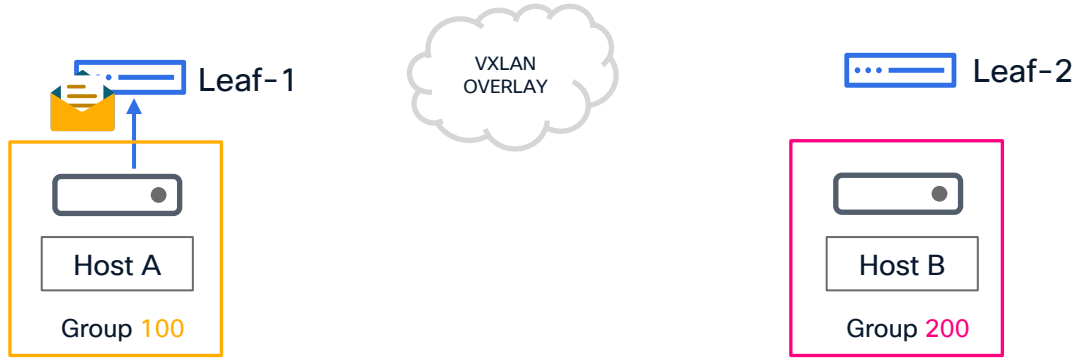
Group Policy Option

Origin – IETF Drafts – Data Plane

- Ingress leaf receives a packet that needs to be forwarded in the overlay



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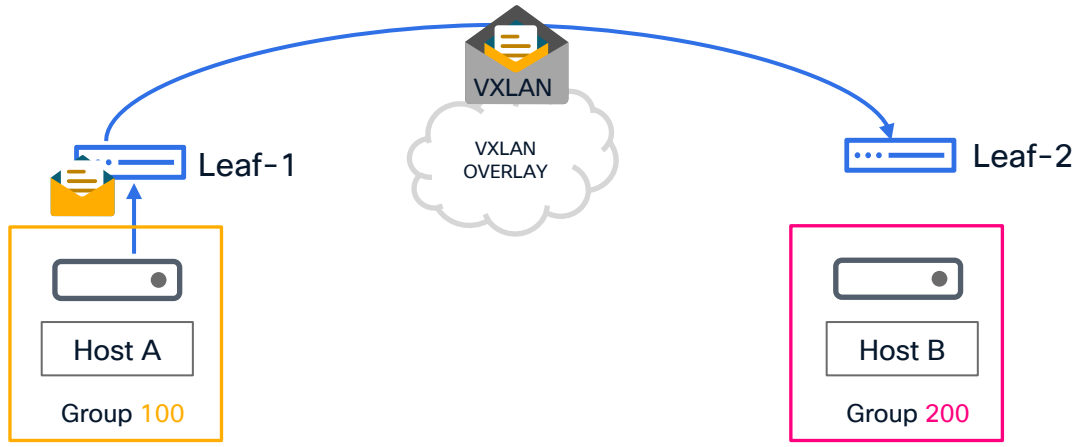
Group Policy Option

Origin – IETF Drafts – Data Plane

- Ingress leaf receives a packet that needs to be forwarded in the overlay
- Ingress leaf encapsulates the original packet into a VXLAN-GPO one and sends it to the egress VTEP



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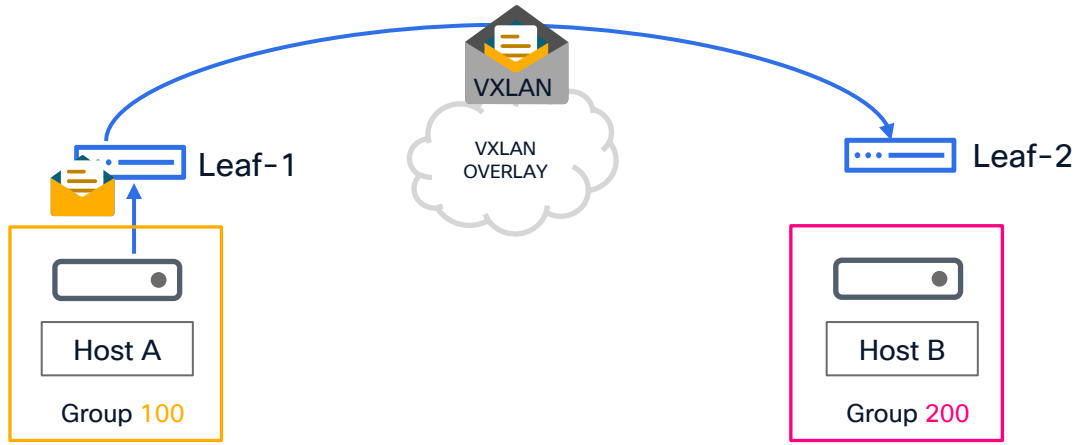
Group Policy Option

Origin – IETF Drafts – Data Plane

- Ingress leaf receives a packet that needs to be forwarded in the overlay
- Ingress leaf encapsulates the original packet into a VXLAN-GPO one and sends it to the egress VTEP
- Ingress Leaf is GPO aware, and has an SGT mapping for the source end-host
  - 1st bit (GBP Extension) = 1
  - SGT = 100
  - 12th bit (Policy Applied) = 0

```
Virtual eXtensible Local Area Network
 Flags: 0xc810, GBP Extension, VXLAN Network ID (VNI)
   1... .... .... .... = GBP Extension: Defined
   .... 1... .... .... = VXLAN Network ID (VNI): True
   .... .... .0.. .... = Don't Learn: False
   .... .... .... 0... = Policy Applied: False
   .100 .000 0.01 .000 = Reserved(R): 0x4010
 Group Policy ID: 100
 VXLAN Network Identifier (VNI): 2097152
 Reserved: 0
```



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Group Policy Option

Origin – IETF Drafts – Data Plane

- Ingress leaf receives a packet that needs to be forwarded in the overlay
- Ingress leaf encapsulates the original packet into a VXLAN-GPO one and sends it to the egress VTEP
- Ingress Leaf is GPO aware, and has an SGT mapping for the source end-host
  - 1st bit (GBP Extension) = 1
  - SGT = 100
  - 12th bit (Policy Applied) = 0
- VXLAN packet is received from egress VTEP who knows the destination end-host SGT
  - Policy can be applied there

```
Virtual eXtensible Local Area Network
 Flags: 0xc810, GBP Extension, VXLAN Network ID (VNI)
   1... .... .... .... = GBP Extension: Defined
   .... 1... .... .... = VXLAN Network ID (VNI): True
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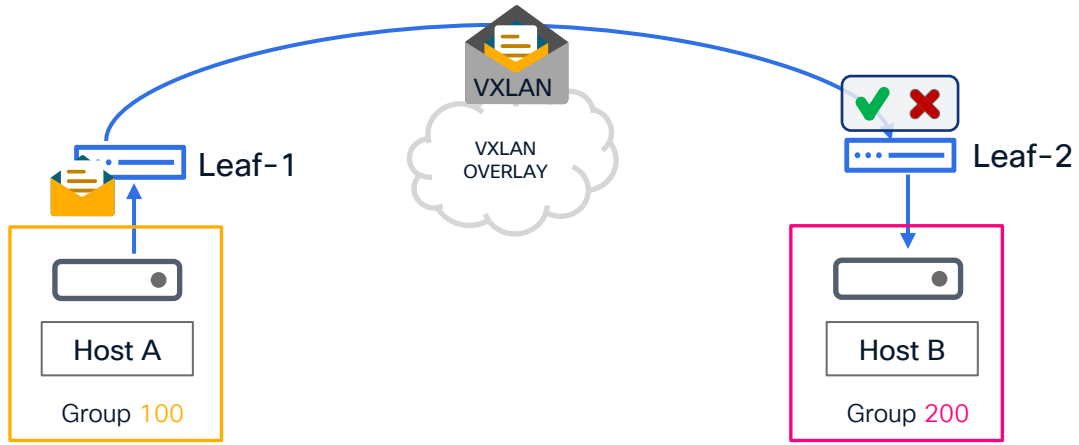

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Group Policy Option

Origin – IETF Drafts – Control Plane

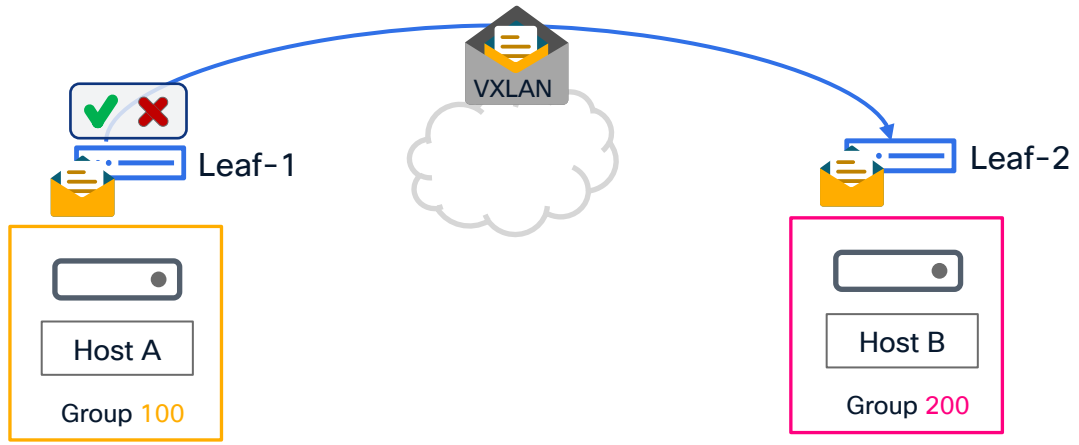
- Originally defined in 2022
- Defines an additional BGP extended community that can be appended to EVPN advertisements
- The extended community, which is set by the advertising VTEP to route types-[2-3-5], contains the SGT value
- Ingress leaf get to know the destination EP SGT and can enforce the traffic locally (data plane)
- The action is also signalled to the egress node so it can skip the policy enforcement (data plane)

bess W. Lin
Internet-Draft Juniper Networks
Intended status: Standards Track J. Drake
Expires: 22 April 2024 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.



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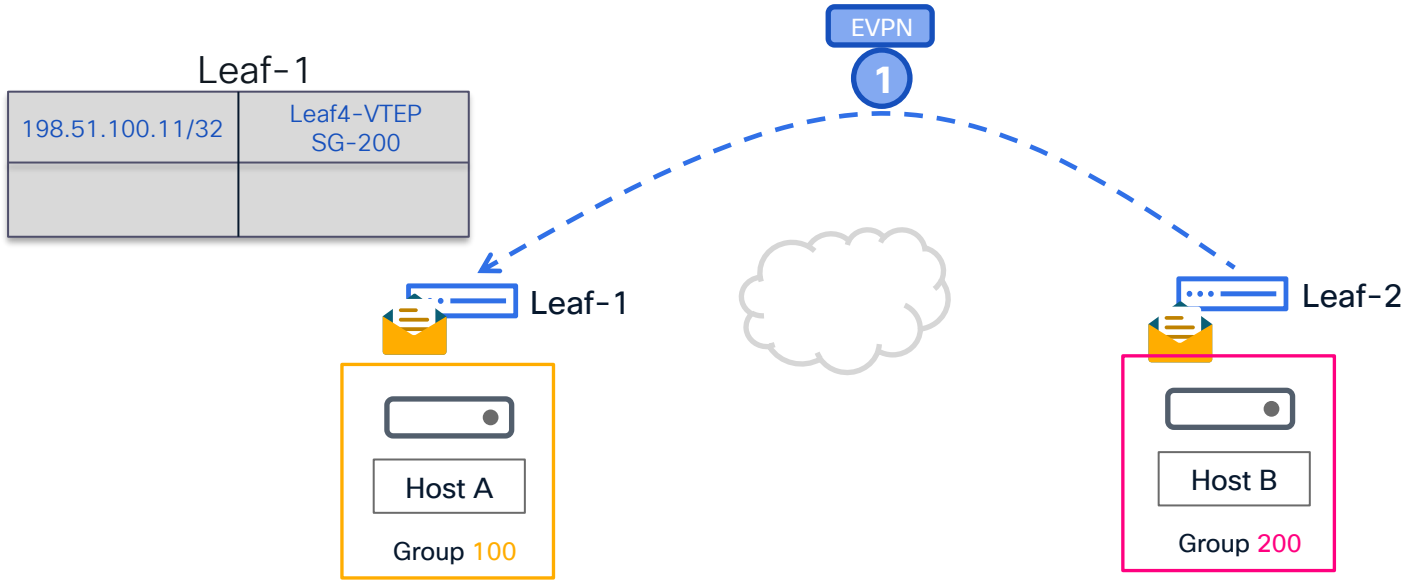
Group Policy Option

Origin – IETF Drafts – Control Plane - Flow

- When an endpoint or an external route is discovered, it gets redistributed in EVPN together with its SGT
- The propagation of such EVPN NLRI allows the remote VTEPs to learn about remote endpoints and routes together with their SGT

```
Path type: internal, path is valid, is best path
 Imported to 3 destination(s)
 Imported paths list: legacy_vrf L3-15002 L2-12112
 AS-Path: NONE, path sourced internal to AS
  172.20.21.3 (metric 3) from 172.20.20.2 (172.20.20.2)
    Origin IGP, MED not set, localpref 100, weight 0
    Received label 12112 15002
    Extcommunity: RT:65102:12112 RT:65102:15002 PCTAG:0:0:200
    ENCAP:8 MAC Mobility Seq:00:2 Router MAC:748f.c291.ac07
    Originator: 172.20.20.4 Cluster list: 172.20.20.2
```



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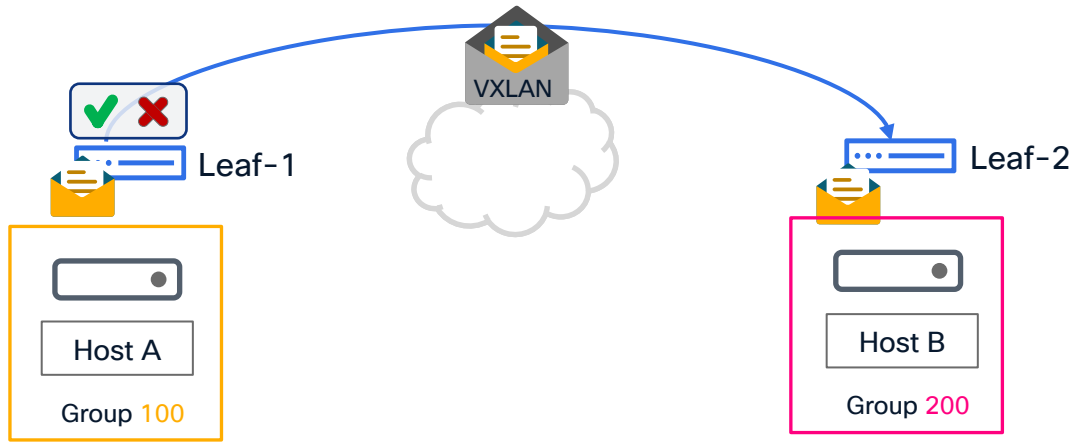
Group Policy Option

Origin – IETF Drafts – Control Plane - Flow

- When an endpoint or an external route is discovered, it gets redistributed in EVPN together with its SGT
- The propagation of such EVPN NLRI allows the remote VTEPs to learn about remote endpoints and routes together with their SGT
- (Data Plane) - Now the ingress leaf can immediately apply the policy
- If traffic is allowed, original packet will be encapsulated in a VXLAN-GPO packet
  - 1st bit (GBP Extension) = 1
  - SGT = 100
  - 12th bit (Policy Applied) = 1

```
Virtual eXtensible Local Area Network
  Flags: 0xc818, GBP Extension, VXLAN Network ID (VNI), Policy Applied
    1... .... .... .... = GBP Extension: Defined
    .... 1... .... .... = VXLAN Network ID (VNI): True
    .... .... .0.. .... = Don't Learn: False
    .... .... .... 1... = Policy Applied: True
    .100 .000 0.01 .000 = Reserved(R): 0x4010
  Group Policy ID: 100
  VXLAN Network Identifier (VNI): 2097152
  Reserved: 0
```



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Group Policy Option

Origin – IETF Drafts – Combined Data and Control Plane

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

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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

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

BESS WorkGroup
Internet-Draft
Intended status: Standards Track
Expires: 24 April 2025

W. Lin
Juniper
D. Rao
A. Sajassi
M. Smith
Cisco
L. Kreeger
Arrcus
J. Rabadan
Nokia
21 October 2024

EVPN Group Policy
draft-lrss-bess-evpn-group-policy-01

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.

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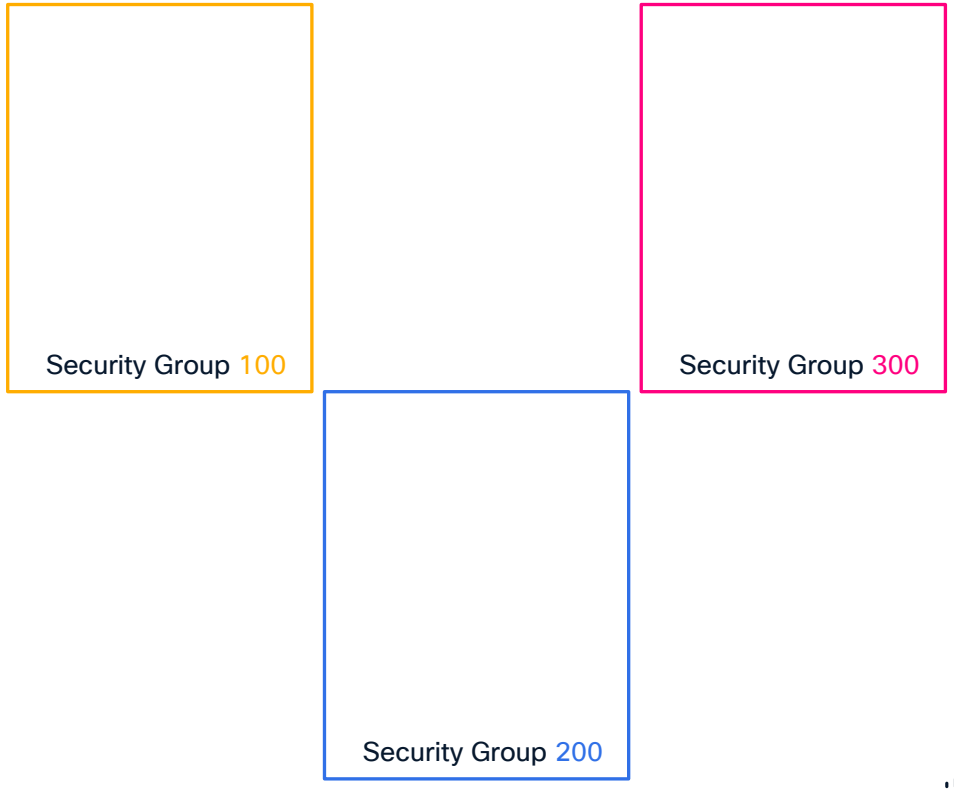
GPO Fundamentals

Group Policy Option Fundamentals

Group Definition

- Security Groups are containers that will include one or more end-hosts or networks with the same security requirements
- Security Groups must be configured with a 16-bit ID called Security Group Tag (SGT), reserved ranges:
  - 0 – 15
  - a_n=130+256·n [130, 386, 642...65410]
- IP traffic inside the same Security Group always allowed
- IP traffic across different Security Groups can be enforced
- Common reserved SGs:
  - 0 – for any non classified address, also refer to as “any”
  - 1 – for default type-5 routes of directly connected networks
  - 15 – prefixes learned from GPO unaware sites



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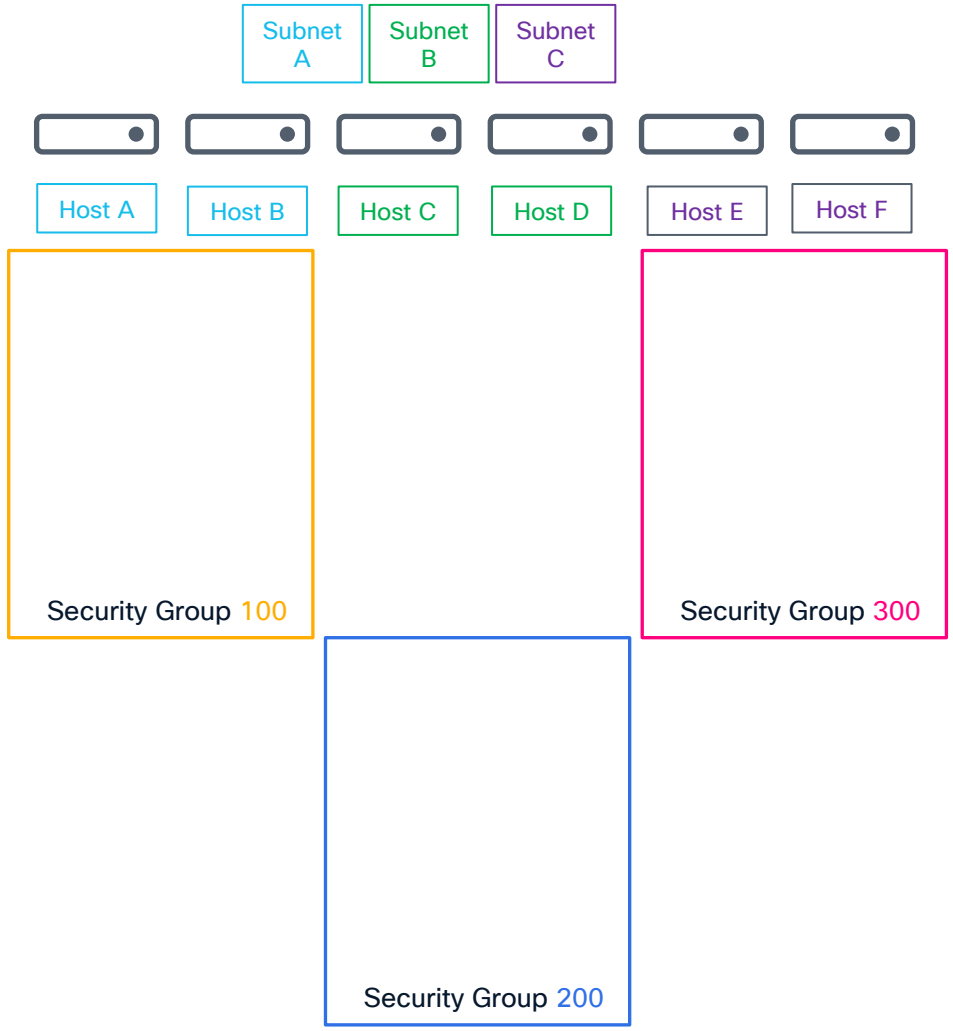
Group Policy Option Fundamentals

Endpoint Classification

- Classification, is done in CLI and depends on resource type
  - Connected Endpoints:
    - IP based classification
      - LPMs (including host-routes)
    - VLAN based classification
    - (Port,VLAN) based classification
    - MAC based classification
  - External Networks
    - IP Based Classification
      - LPMs



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Group Policy Option Fundamentals

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  - Connected Endpoints:
    - IP based classification
      - LPMs (including host-routes)
    - VLAN based classification
    - MAC based classification
  - External Networks
    - IP Based Classification
      - LPMs
- Endpoints in the same subnet can be mapped to different or same SGs
- Endpoint in different subnets can be mapped to the same SG

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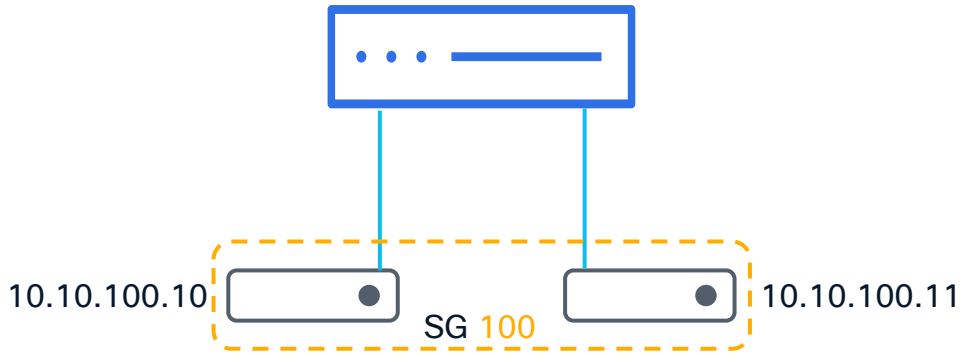
Group Policy Option Fundamentals

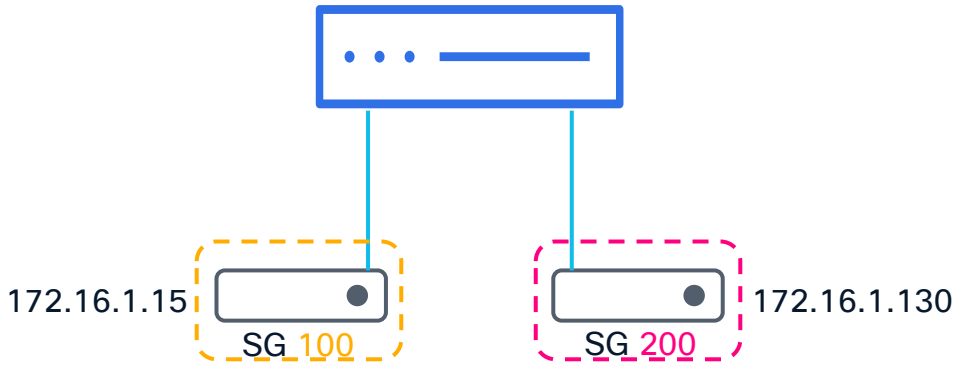
Connected Endpoint Classification – IP Based

Host Route Classifier




```
security-group 100 name MY_SG_1
  match connected-endpoints vrf my_vrf ipv4 10.10.100.10/32
  match connected-endpoints vrf my_vrf ipv4 10.10.100.11/32
```

LPM Classifier




```
security-group 100 name MY_SG_1
  match connected-endpoints vrf my_vrf ipv4 172.16.1.0/24
security-group 200 name MY_SG_2
  match connected-endpoints vrf my_vrf ipv4 172.16.1.128/26
```

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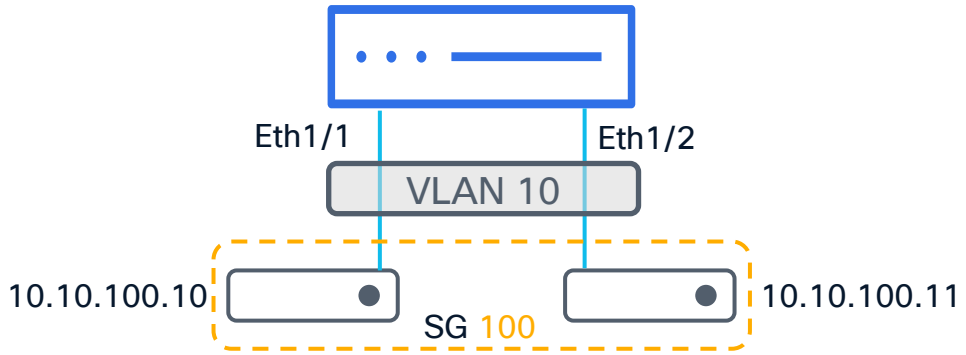
Group Policy Option Fundamentals

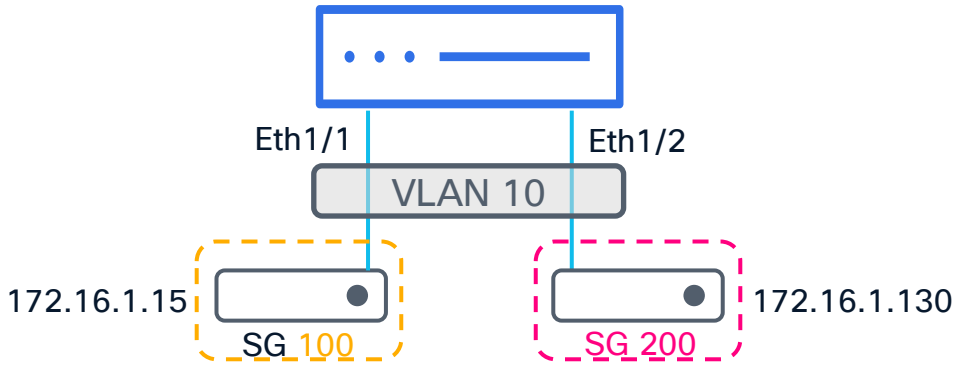
Connected Endpoint Classification – VLAN Based

VLAN Classifier




```
security-group 100 name MY_SG_1
  match vlan 10
```

(Port,VLAN) Classifier




```
security-group 100 name MY_SG_1
  match vlan 10 interface eth1/1
security-group 200 name MY_SG_2
  match vlan 10 interface eth1/2
```

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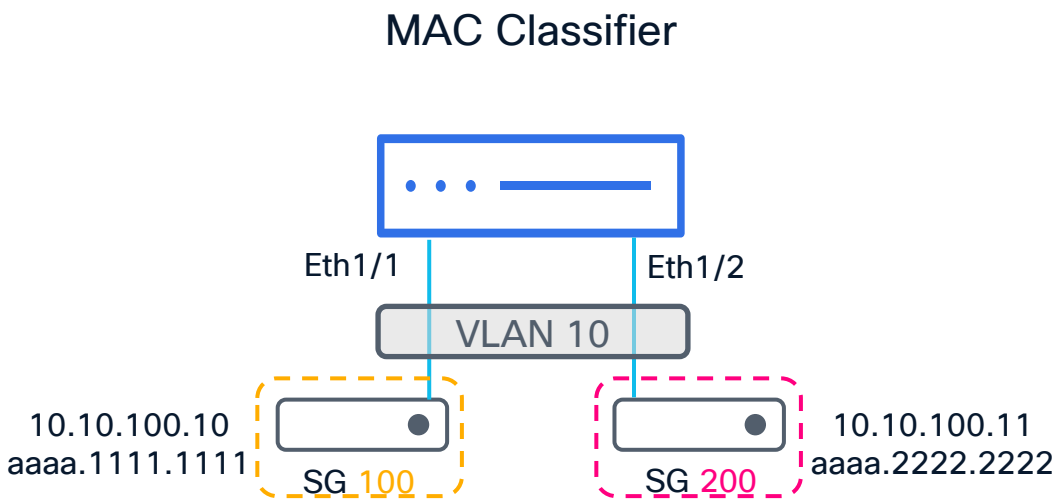
Group Policy Option Fundamentals

Connected Endpoint Classification – MAC Based




```
security-group 100 name MY_SG_1
  match vlan 10 mac aaaa.1111.1111
security-group 200 name MY_SG_2
  match vlan 10 mac aaaa.2222.2222
```

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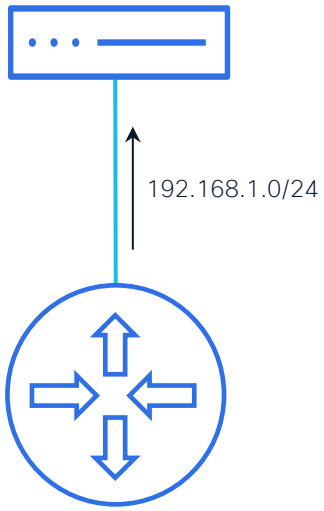
Group Policy Option Fundamentals

External Network Classifier



- External IPs or networks can be clasified into Security-Groups
- They can be learned via a dynamic protocol or programmed via static routes
- Classification is done at the border leaves and propagated to the fabric
- By default, security groups are attached to EVPN routes only when there's a classifier exactly matching the prefix or more specific than the prefix

```
security-group 200 name webclient
  match external-subnets vrf my_vrf ipv4 192.168.1.0/24
security-group 201 name appserver
  match external-subnets vrf my_vrf ipv4 192.168.1.101/32 route-inject
```

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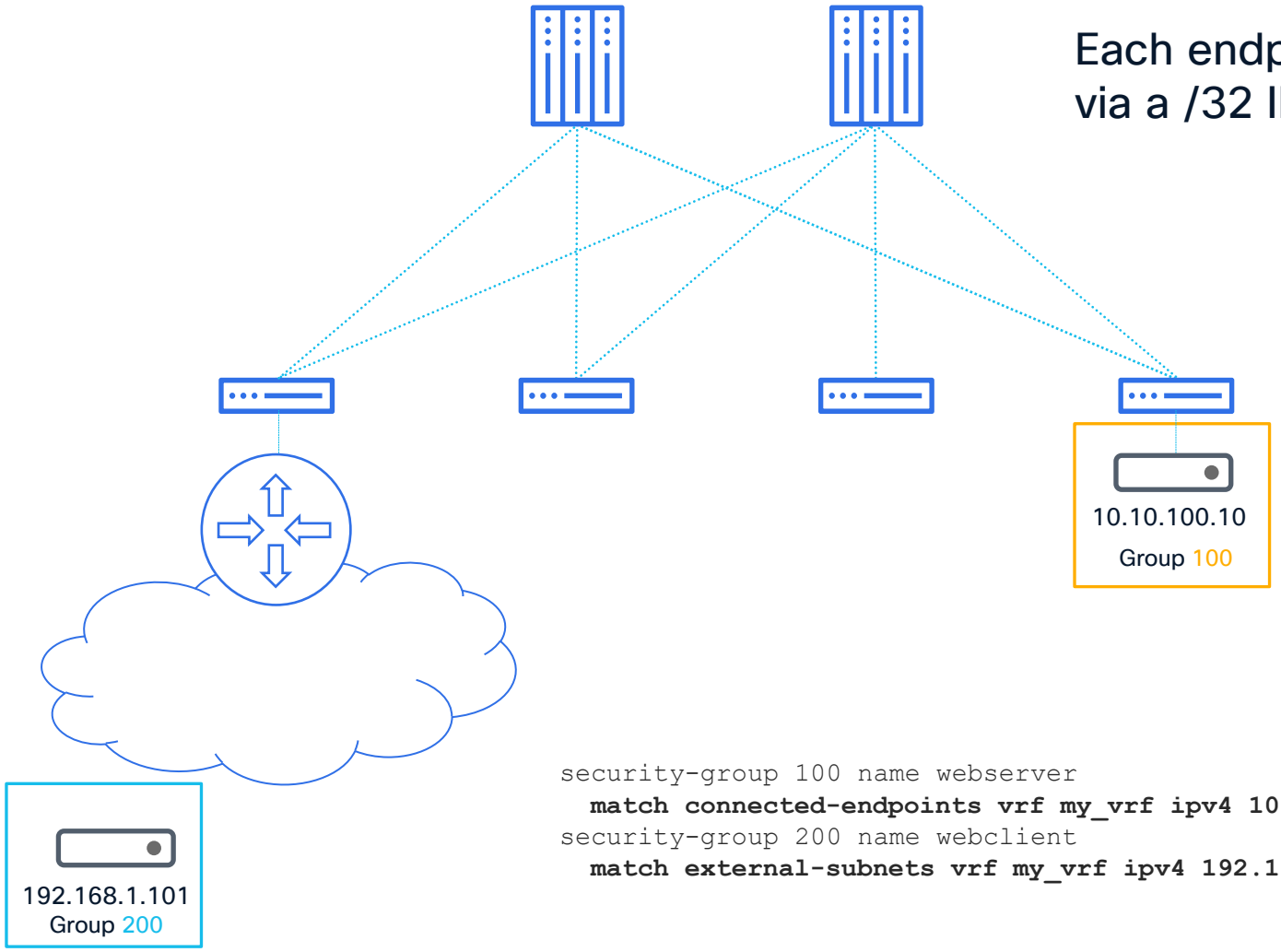
Group Policy Option Fundamentals

External Network Classifier – Broken Scenario



Each endpoint classification definition happens via a /32 IP address

```
security-group 100 name webserver
  match connected-endpoints vrf my_vrf ipv4 10.10.100.10/32
security-group 200 name webclient
  match external-subnets vrf my_vrf ipv4 192.168.1.101/32
```

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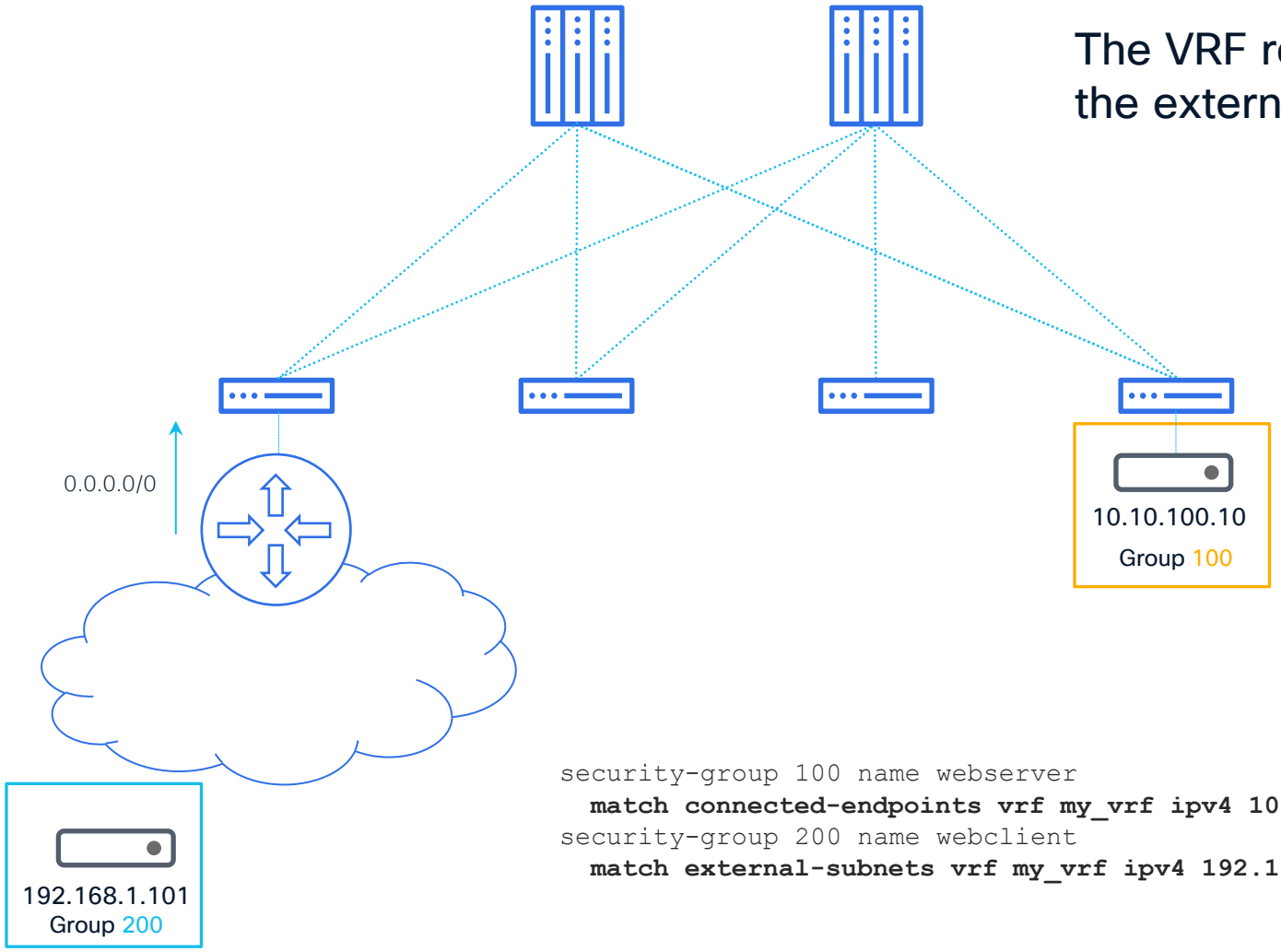
Group Policy Option Fundamentals

External Network Classifier – Broken Scenario



The VRF receives only the default route from the external router

```
security-group 100 name webserver
  match connected-endpoints vrf my_vrf ipv4 10.10.100.10/32
security-group 200 name webclient
  match external-subnets vrf my_vrf ipv4 192.168.1.101/32
```

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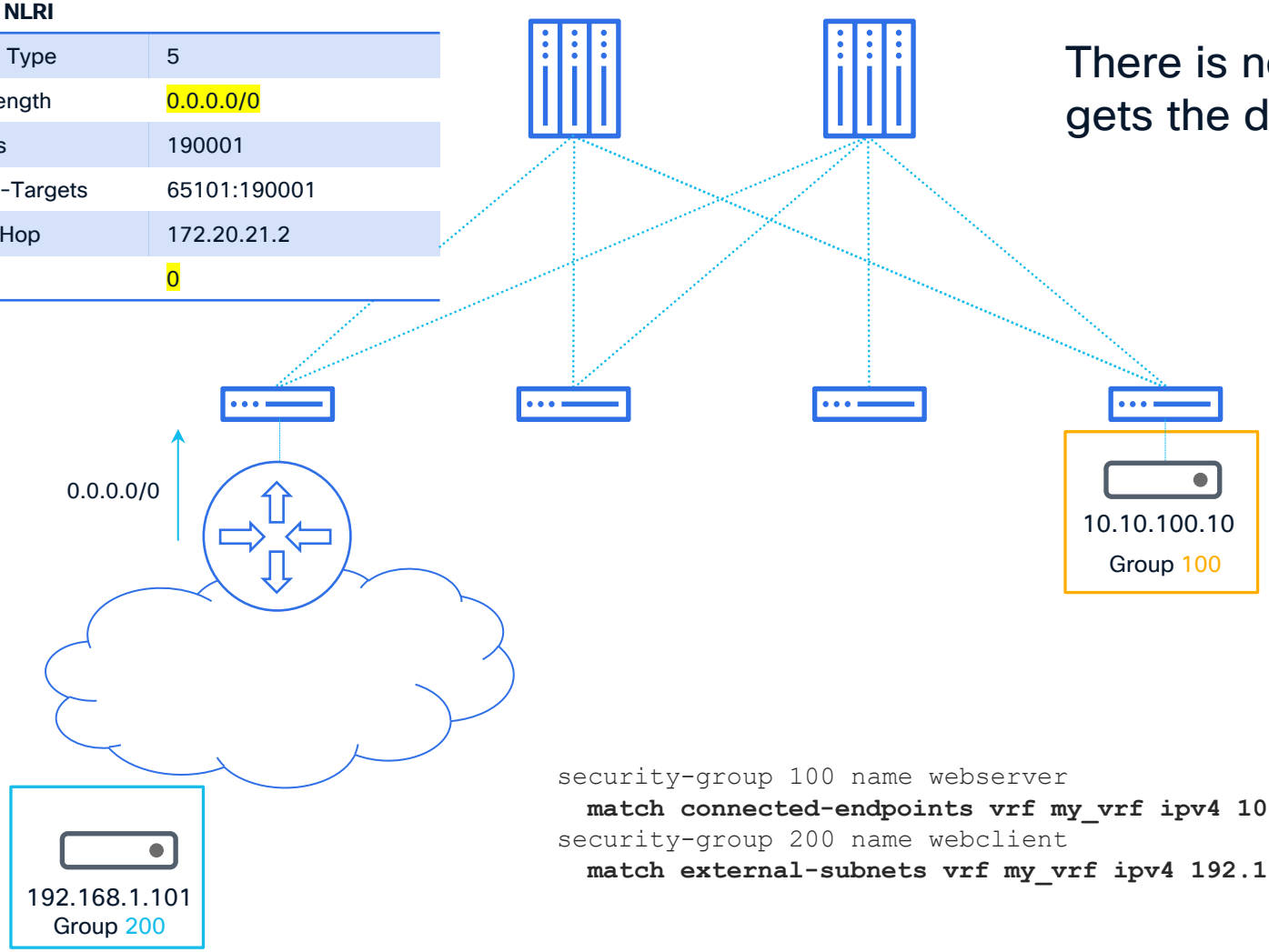
Group Policy Option Fundamentals

External Network Classifier – Broken Scenario

EVPN NLRI	
Route Type	5
IP / Length	0.0.0.0/0
Labels	190001
Route-Targets	65101:190001
Next-Hop	172.20.21.2
SGT	0



There is no classification for the 0.0.0.0/0, so it gets the default SGT 0

```
security-group 100 name webserver
  match connected-endpoints vrf my_vrf ipv4 10.10.100.10/32
security-group 200 name webclient
  match external-subnets vrf my_vrf ipv4 192.168.1.101/32
```

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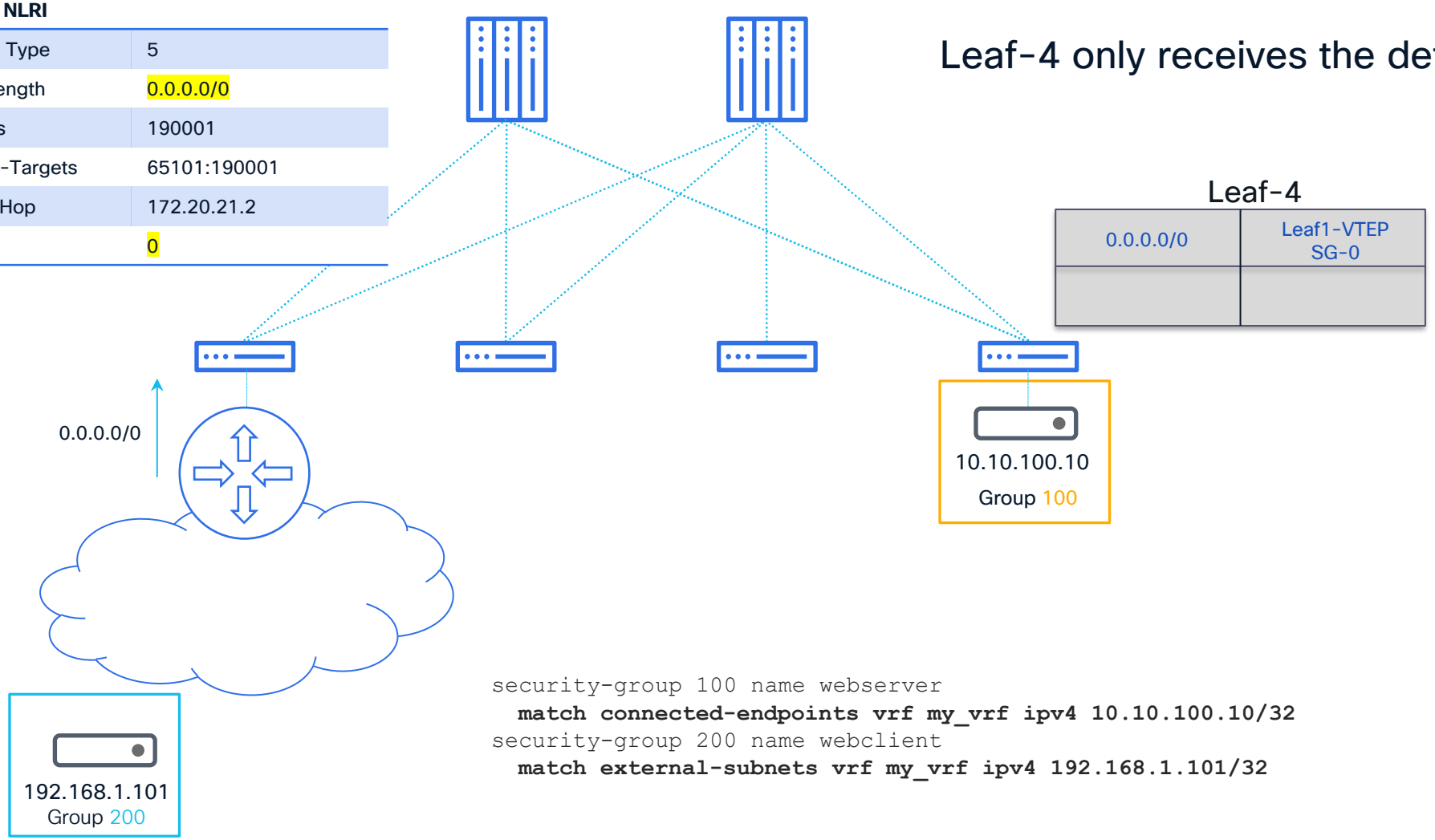
Group Policy Option Fundamentals

External Network Classifier – Broken Scenario

EVPN NLRI	
Route Type	5
IP / Length	0.0.0.0/0
Labels	190001
Route-Targets	65101:190001
Next-Hop	172.20.21.2
SGT	0



Leaf-4 only receives the default route with SGT 0

```
security-group 100 name webserver
  match connected-endpoints vrf my_vrf ipv4 10.10.100.10/32
security-group 200 name webclient
  match external-subnets vrf my_vrf ipv4 192.168.1.101/32
```

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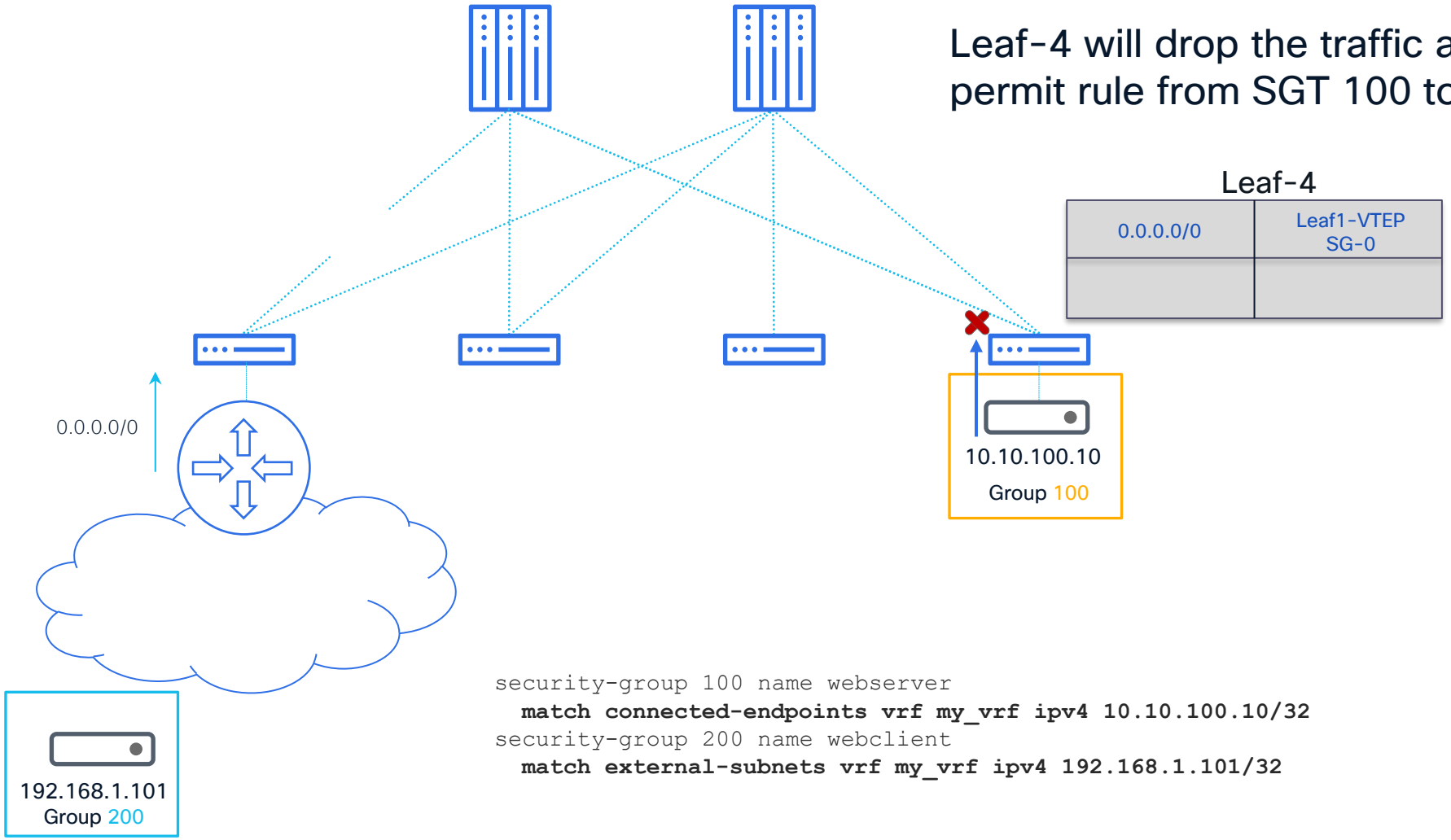
Group Policy Option Fundamentals

External Network Classifier – Broken Scenario




```
security-group 100 name webserver
  match connected-endpoints vrf my_vrf ipv4 10.10.100.10/32
security-group 200 name webclient
  match external-subnets vrf my_vrf ipv4 192.168.1.101/32
```

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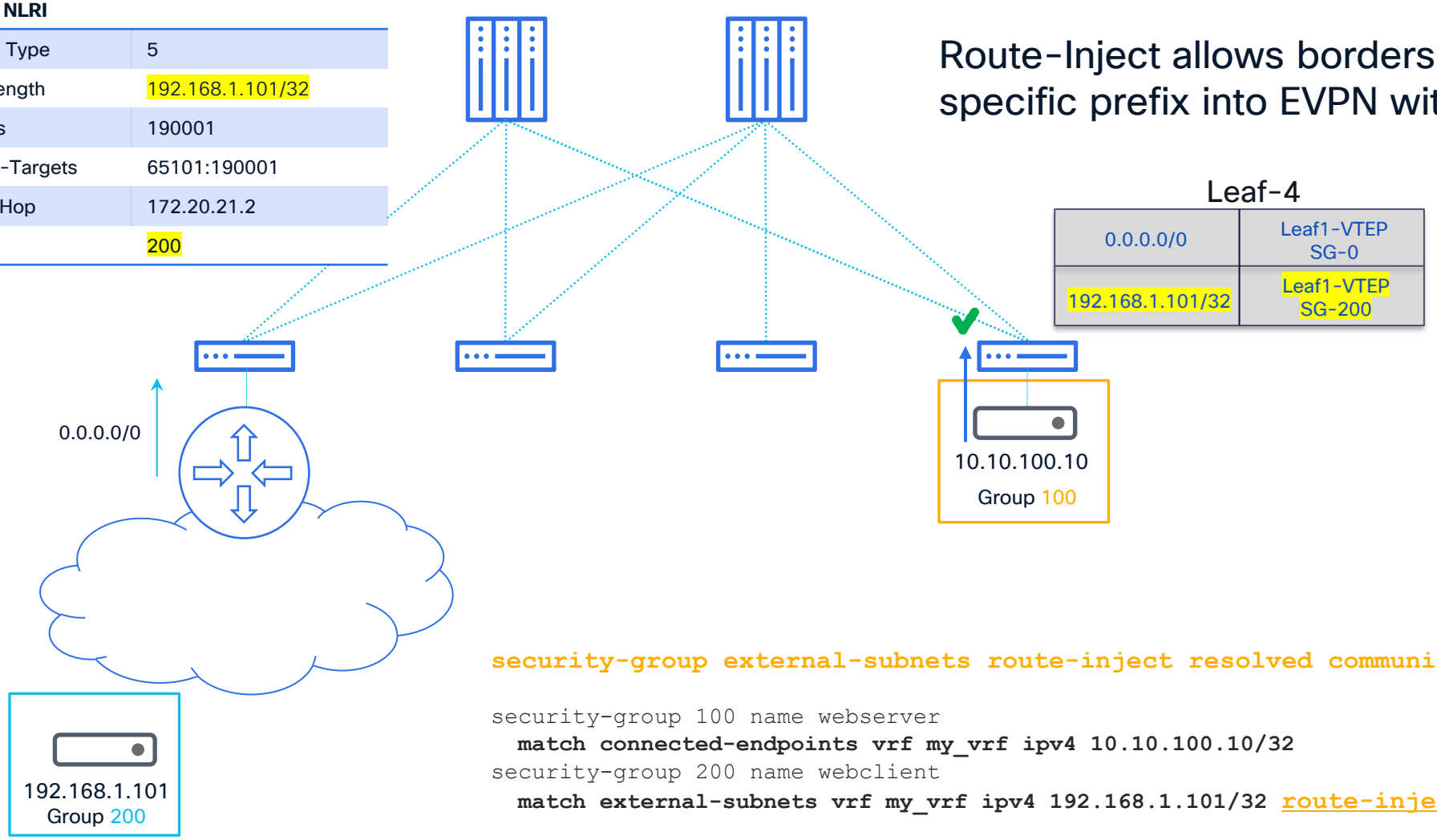
Group Policy Option Fundamentals

External Network Classifier – Route Inject to the Rescue!

EVPN NLRI	
Route Type	5
IP / Length	192.168.1.101/32
Labels	190001
Route-Targets	65101:190001
Next-Hop	172.20.21.2
SGT	200



Route-Inject allows borders to inject the more specific prefix into EVPN with the proper SGT

Leaf-4

0.0.0.0/0	Leaf1-VTEP SG-0
192.168.1.101/32	Leaf1-VTEP SG-200

```
security-group external-subnets route-inject resolved community 65101:999

security-group 100 name webserver
  match connected-endpoints vrf my_vrf ipv4 10.10.100.10/32
security-group 200 name webclient
  match external-subnets vrf my_vrf ipv4 192.168.1.101/32 route-inject
```

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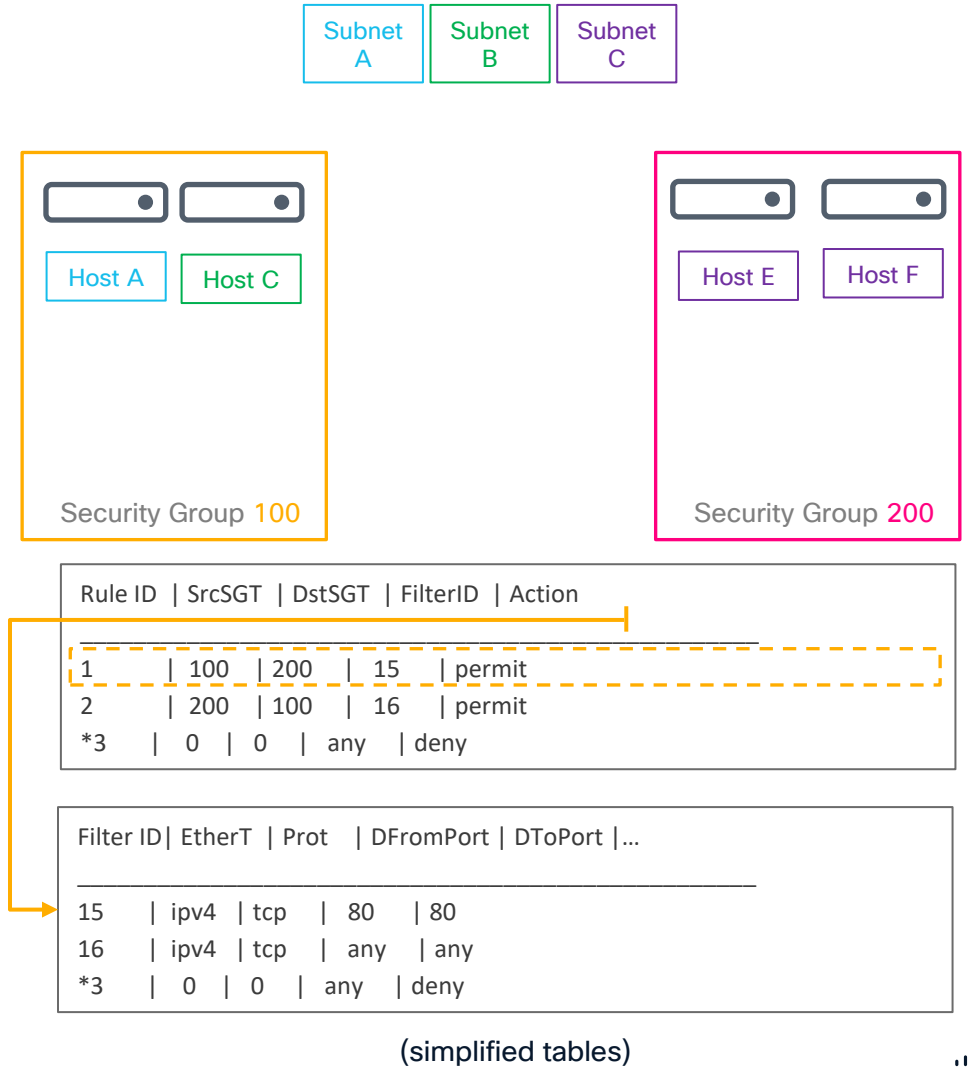
Group Policy Option Fundamentals

**Hidden Slide Follows

Traffic Enforcement

- Traffic enforcement is done by the VTEPs
- Every packet is evaluated in a security-rule table build based on configurations that contains records (SGACLs) to identify source and destination SGT and the conditions (protocol, ports, etc.)
- When a match is found then the correspondent action is applied
- When multiple matches are configured then a priority logic will be used for the tie break**
- If a 1:1 match is not found then a catch–all rule will be hit, the action in that case depends on configurations



(simplified tables)

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Group Policy Option Fundamentals

Traffic Enforcement – Contract priorities – Base Rules

In case of a ties the following logics will be used

1. Specific SGs win over Any
   i. SG-100 to SG-200
   ii. SG-100 to Any
   iii. Any to SG-100
   iv. Any to Any
2. More specific protocol rule win
   i. tcp.dst 80
   ii. tcp.src 80
   iii. tcp.any
   iv. IP
3. Action priority
   i. Deny
   ii. Redirect
   iii. Permit

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Group Policy Option Fundamentals

Traffic Enforcement – Filters

- SGACLs always match traffic between a source and a destination Security Group based on a filter
- Filters can include one or more entries that identify the traffic type. Valid options are:
  - IPv4/IPv6 carried protocol
  - TCP/UDP ports
  - TCP flags
  - DSCP
  - Fragments
- Filters are defined with “class-map type security” objects

```
class-map type security match-any TCP-PORT-80
 match ipv4 tcp dport 80

class-map type security match-any TCP-PORT-443
 match ipv4 tcp dport 443

class-map type security match-any MY-APP
 match ipv4 tcp dport 15000 to 15146

class-map type security match-any WEB-TRAFFIC-PORTS
 match ipv4 tcp stateful dport 443
 match ipv4 tcp stateful dport 80
 match ipv4 udp dport 443

class-map type security match-any MANAGEMENT
 match ipv4 tcp dport 3389
 match ipv4 tcp dport 22
```

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Group Policy Option Fundamentals

Traffic Enforcement – Policies

- Policies, or contracts/SG-ACLs, define the action that will be programmed on the hardware (filter):
  - Permit
  - Deny
  - Redirect to a Service function (or a *service-chain*)
- Multiple filters may be be included in a single policy each one with a different action
- Device can log and track hit counts when the log keyword is used
- Policies can be safely re-used, there is no risk to allow unintended traffic

```
policy-map type security VPN-CLIENTS-TO-ANY
 class TCP-PORT-80
  log
  service-chain WEB-CHAIN-SITE-1
 class MANAGEMENT
  permit
 class default
  log
  deny

policy-map type security ONLY-WEB-PORTS
 class WEB-TRAFFIC-PORTS
  log
  service-chain WEB-CHAIN-SITE-1
class default
  log
  deny
```

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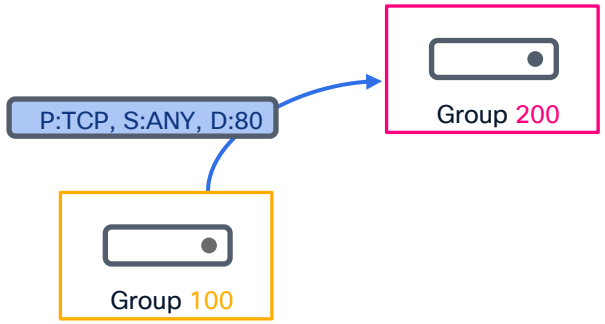
Group Policy Option Fundamentals

Traffic Enforcement – Associations

- Associations set the policy between a source and a destination SGT
- Multiple associations can be defined between the same S-SGT and D-SGT if they refer to a different policy
- Associations can be:
  - Unidirectional



vrf context my_vrf

security contract source 100 destination 200 policy ONLY-TCP-PORT-80 unidir

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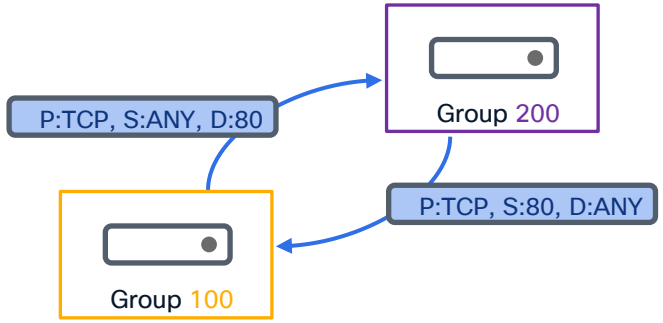
Group Policy Option Fundamentals

Traffic Enforcement – Associations

- Associations set the policy between a source and a destination SGT
- Multiple associations can be defined between the same S-SGT and D-SGT if they refer to a different policy
- Associations can be:
  - Unidirectional
  - Bidirectional (default)
- When an association is bidirectional the switch programs the hardware rule to allow the return traffic




```
vrf context my_vrf
  security contract source 100 destination 200 policy ONLY-TCP-PORT-80 bidir*
```

*default setting

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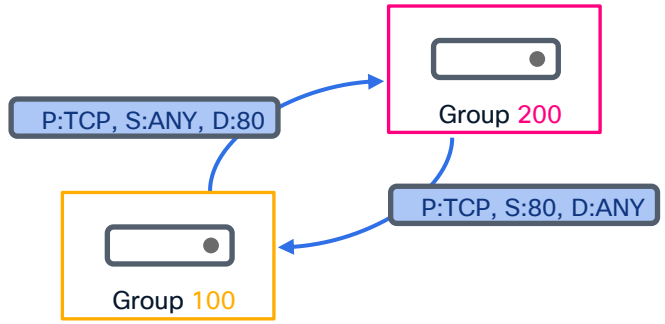
Group Policy Option Fundamentals

Traffic Enforcement – Stateful Filters and Bidirectional Rules

```
class-map type security match-any TCP-PORT-80
  match ipv4 tcp dport 80

policy-map type security CLIENTS-TO-WEB
  class TCP-PORT-80
  permit

vrf context my_vrf
  security contract source 100 destination 200 policy CLIENTS-TO-WEB bidir
```



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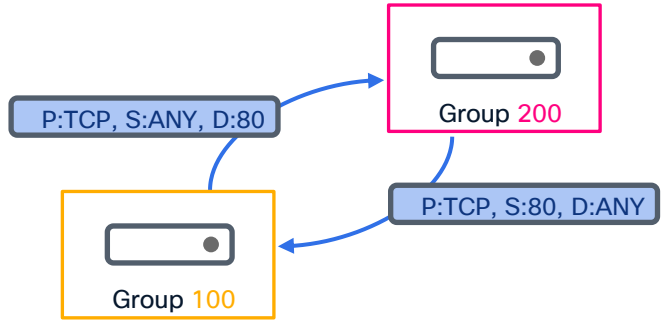
Group Policy Option Fundamentals

Traffic Enforcement – Stateful Filters and Bidirectional Rules

```
class-map type security match-any TCP-PORT-80
  match ipv4 tcp dport 80

policy-map type security CLIENTS-TO-WEB
  class TCP-PORT-80
  permit

vrf context my_vrf
  security contract source 100 destination 200 policy CLIENTS-TO-WEB bidir
```



Non Expected Traffic

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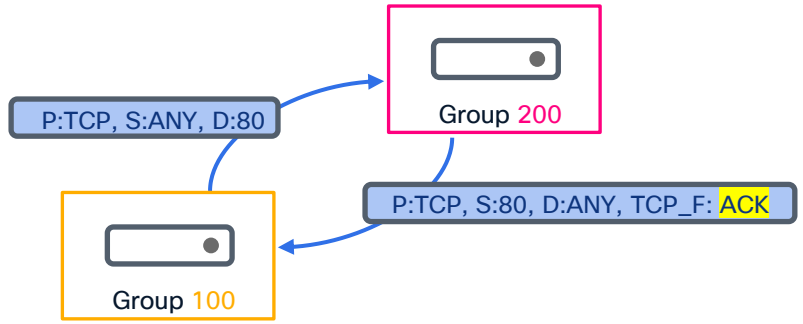
Group Policy Option Fundamentals

Traffic Enforcement – Stateful Filters and Bidirectional Rules

```
class-map type security match-any TCP-PORT-80
  match ipv4 tcp stateful dport 80

policy-map type security CLIENTS-TO-WEB
  class TCP-PORT-80
  permit

vrf context my_vrf
  security contract source 100 destination 200 policy CLIENTS-TO-WEB bidir
```



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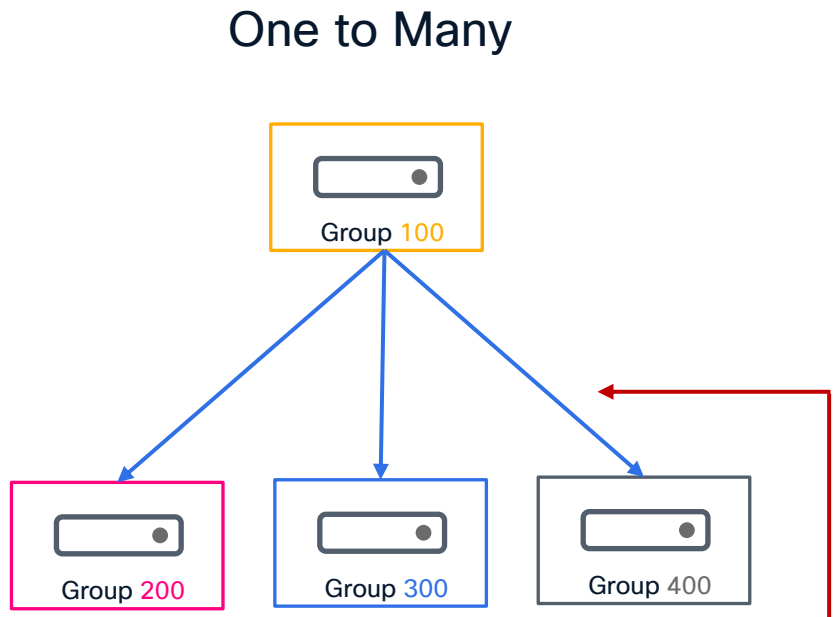
Group Policy Option Fundamentals

Traffic Enforcement – Associations with Any

- Associations can also be mapped to a special object defined with the **“any”** keyword
- **“Any”** represents all the security-groups part of a VRF
- This allows the administrator to define a single rule when the following communications are required:
  - One to many
  - Many to one
  - Many to Many
- In case of SGACL overlaps, the most specific wins
  - One to One
  - One to Many
  - Many to One
  - Many to Many




```
vrf context my_vrf
  security con sou 100 dest any policy MANAGEMENT bidir
  security con sou any dest 500 policy BACKUP bidir
  security con sou any dest any policy FIREWALL-REDIRECTION bidir
```

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Group Policy Option Fundamentals

Traffic Enforcement – Associations with Any

- Associations can also be mapped to a special object defined with the **“any”** keyword
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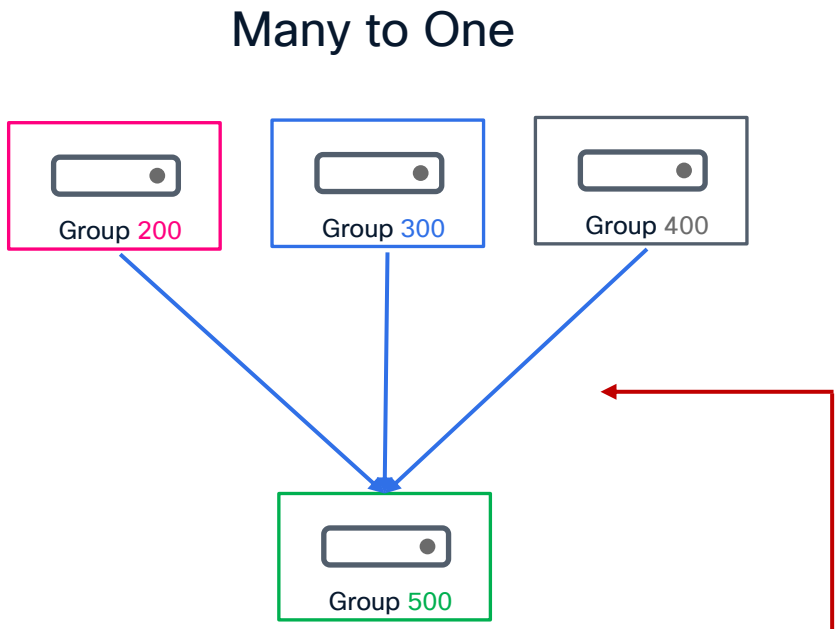
  - Many to One
  - Many to Many




```
vrf context my_vrf
  security con sou 100 dest any policy MANAGEMENT bidir
  security con sou any dest 500 policy BACKUP bidir
  security con sou any dest any policy FIREWALL-REDIRECTION bidir
```

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Group Policy Option Fundamentals

Traffic Enforcement – Associations with Any

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- **“Any”** represents all the security-groups part of a VRF
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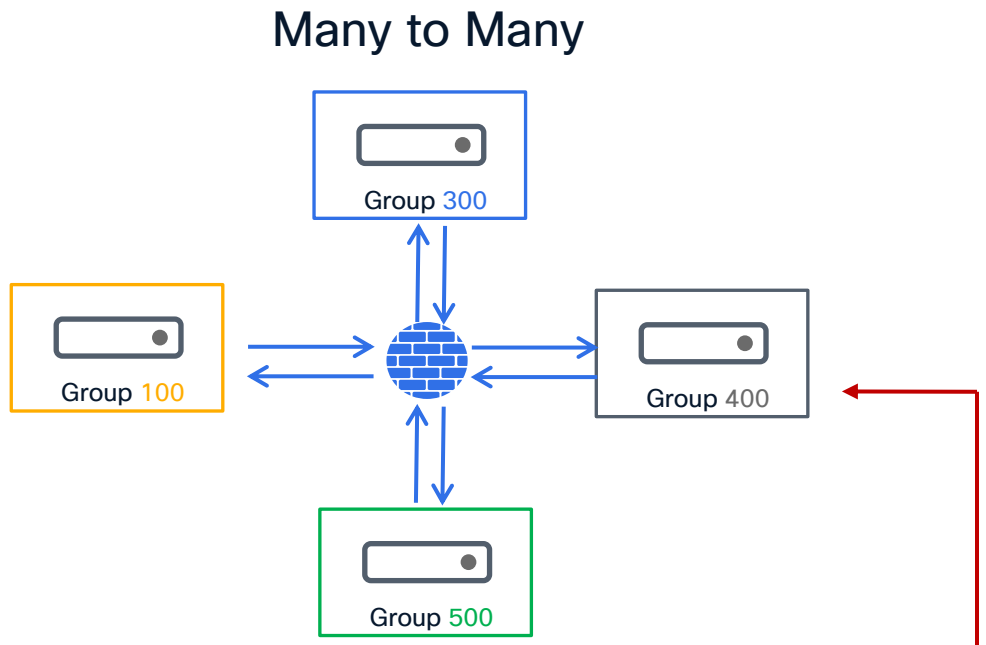
  - One to Many
  - Many to One
  - Many to Many




```
vrf context my_vrf
  security con sou 100 dest any policy MANAGEMENT bidir
  security con sou any dest 500 policy BACKUP bidir
  security con sou any dest any policy FIREWALL-REDIRECTION bidir
```

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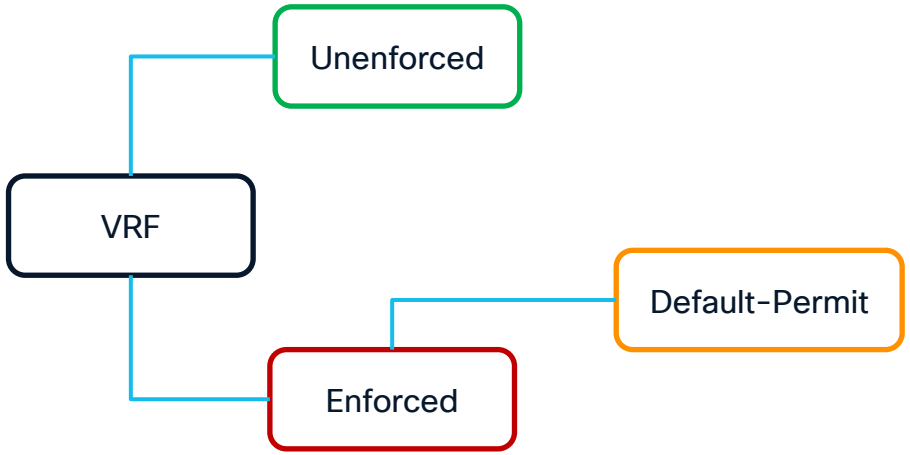
Group Policy Option Fundamentals

Traffic Enforcement – VRF Modes

- VRFs are the smallest atomic unit where traffic enforcement can be applied or denied
- They might be configured in 3 different options:
  - Unenforced: Classic behaviour, no policies
  - Enforced Permit: Block-List model, all traffic is allowed unless explicitly dropped
  - Enforced Deny: Allow-List model, all traffic is denied unless explicitly permitted
- Each VRF must be set with a default security tag for special classification, like BUM, multicast and for traffic that has not been categorized yet




```
vrf context my_vrf
  security enforce tag 13129 default permit
```

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Group Policy Option Fundamentals

Traffic Enforcement – VRF Modes

- VRFs are the smallest atomic unit where traffic enforcement can be applied or denied
- They might be configured in 3 different options:
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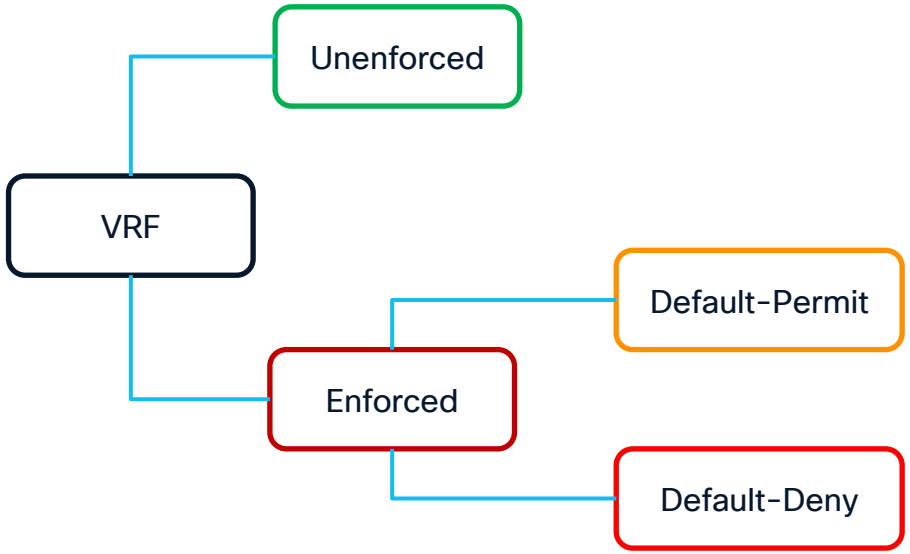
  - Enforced Permit: Block-List model, all traffic is allowed unless explicitly dropped
  - Enforced Deny: Allow-List model, all traffic is denied unless explicitly permitted
- Each VRF must be set with a default security tag for special classification, like BUM, multicast and for traffic that has not been categorized yet




```
vrf context my_vrf
  security enforce tag 13129 default deny
```

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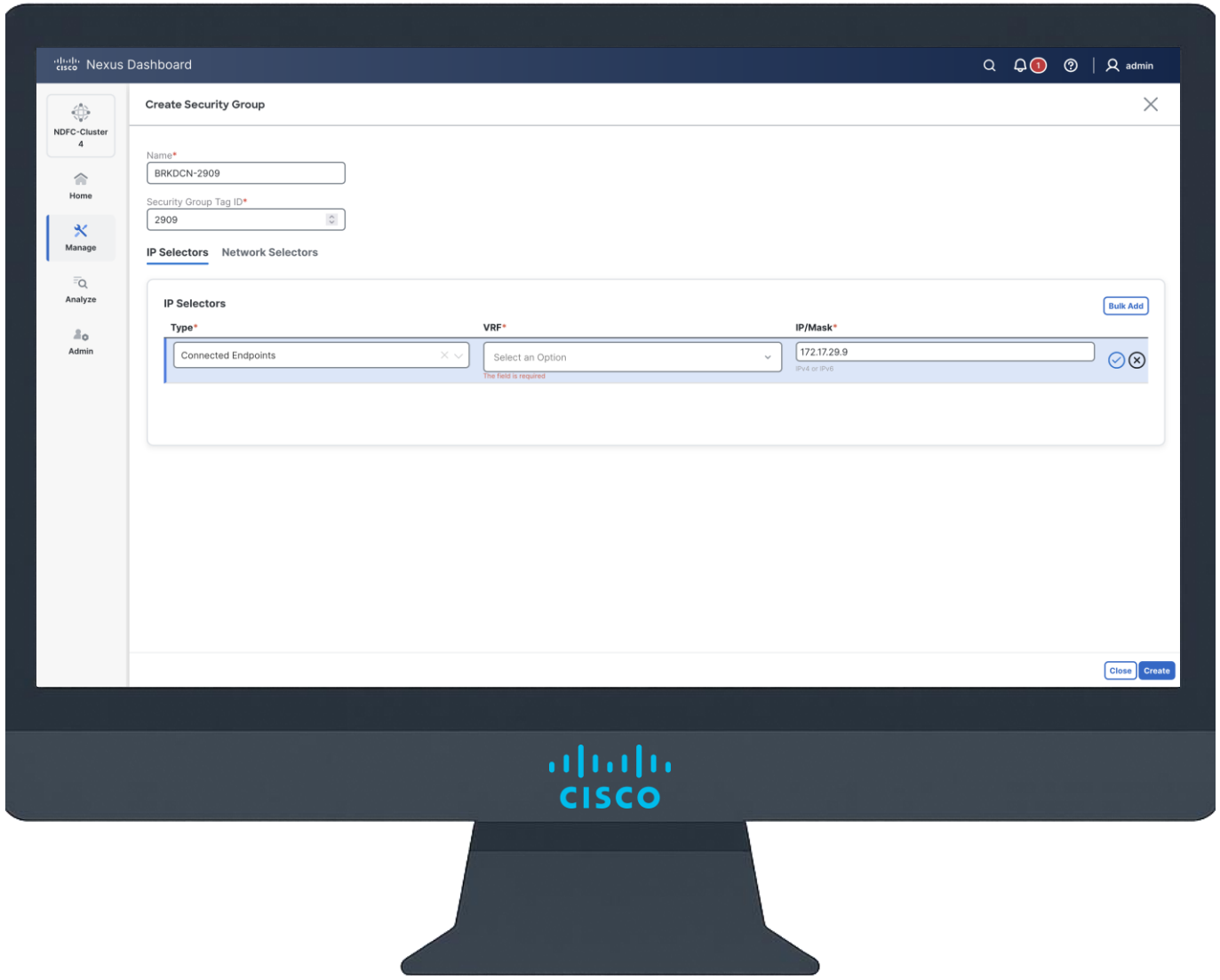
Group Policy Option Fundamentals

Nexus Dashboard Security Groups



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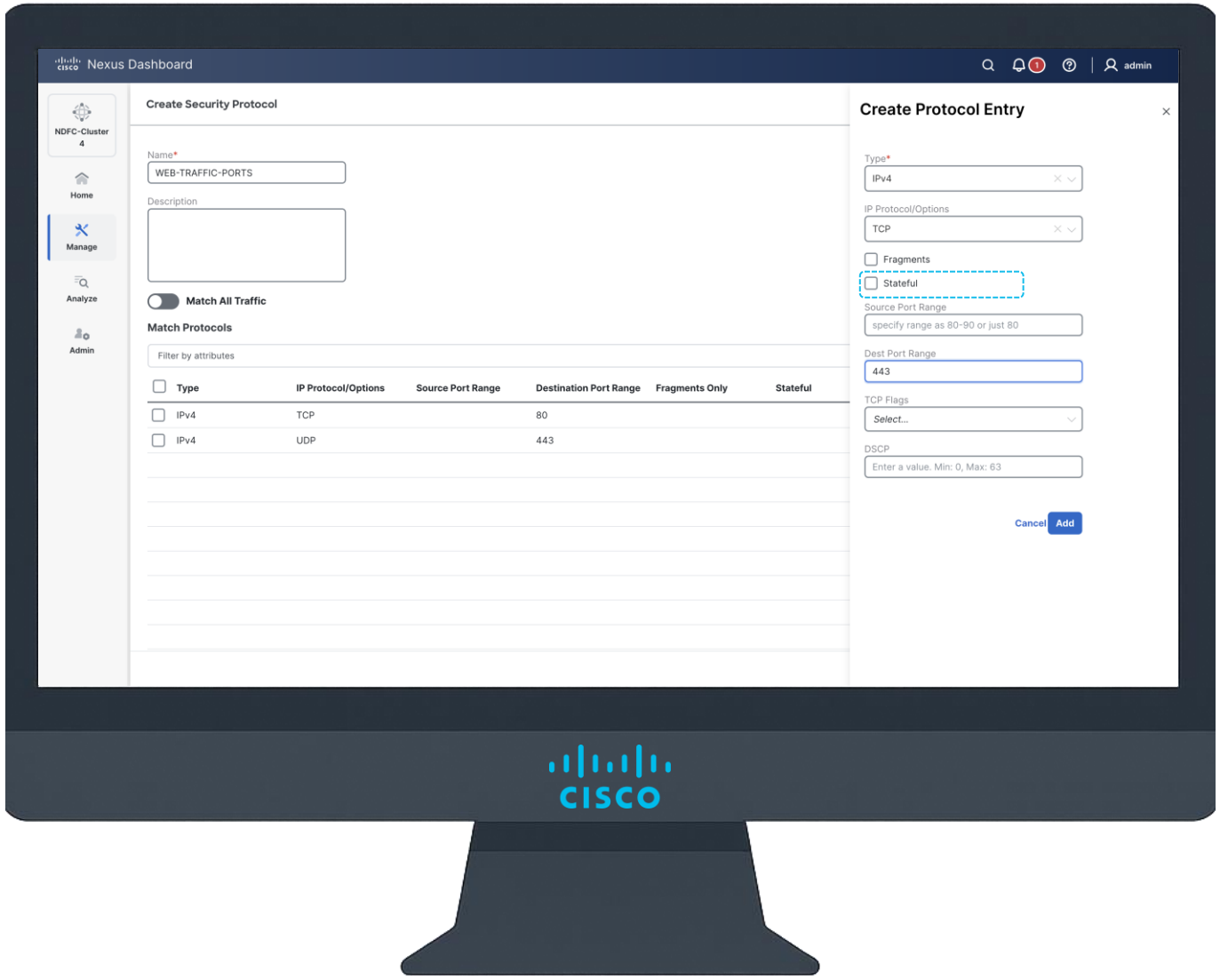
Group Policy Option Fundamentals

Nexus Dashboard Security Protocols



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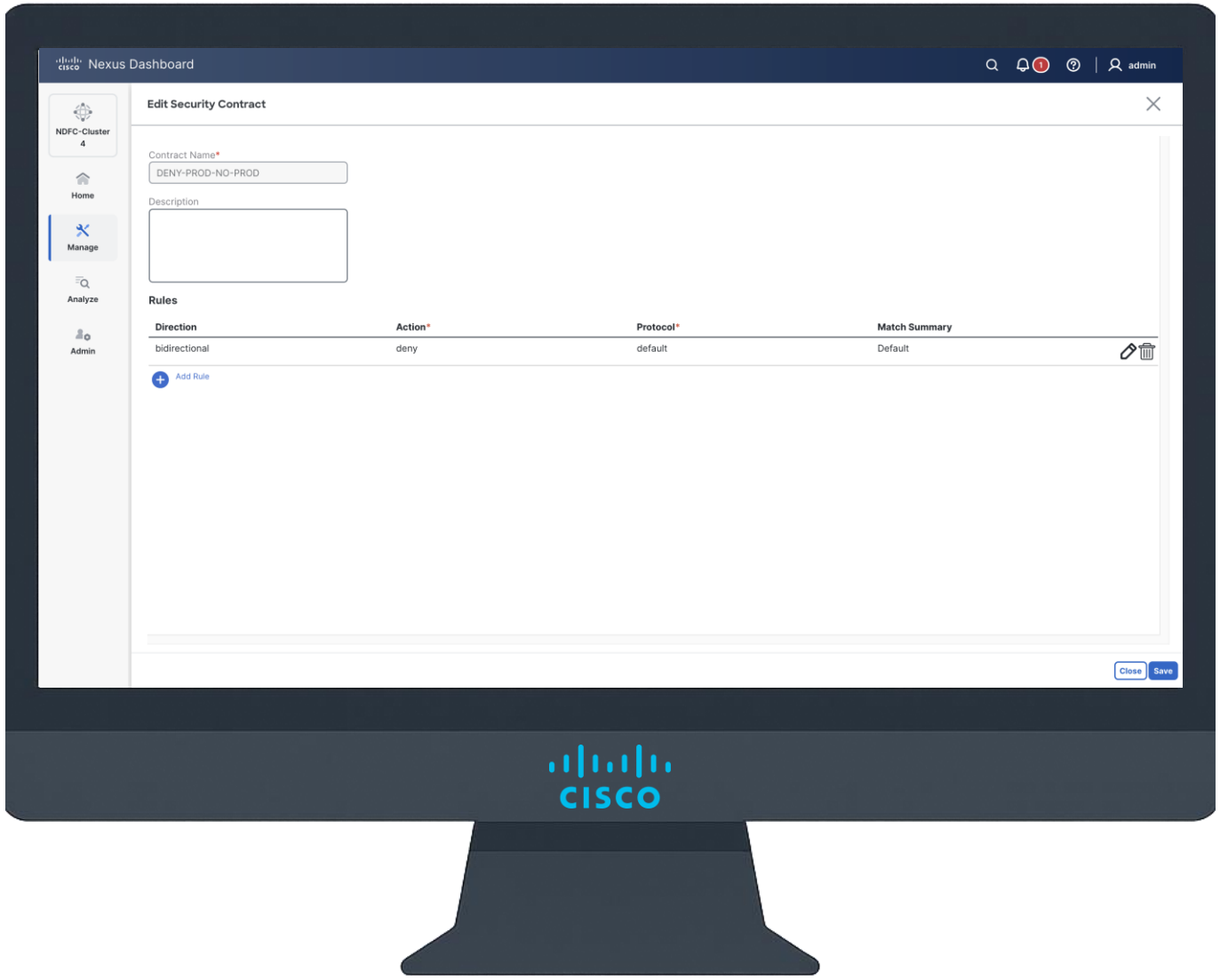
Group Policy Option Fundamentals

Nexus Dashboard Contracts



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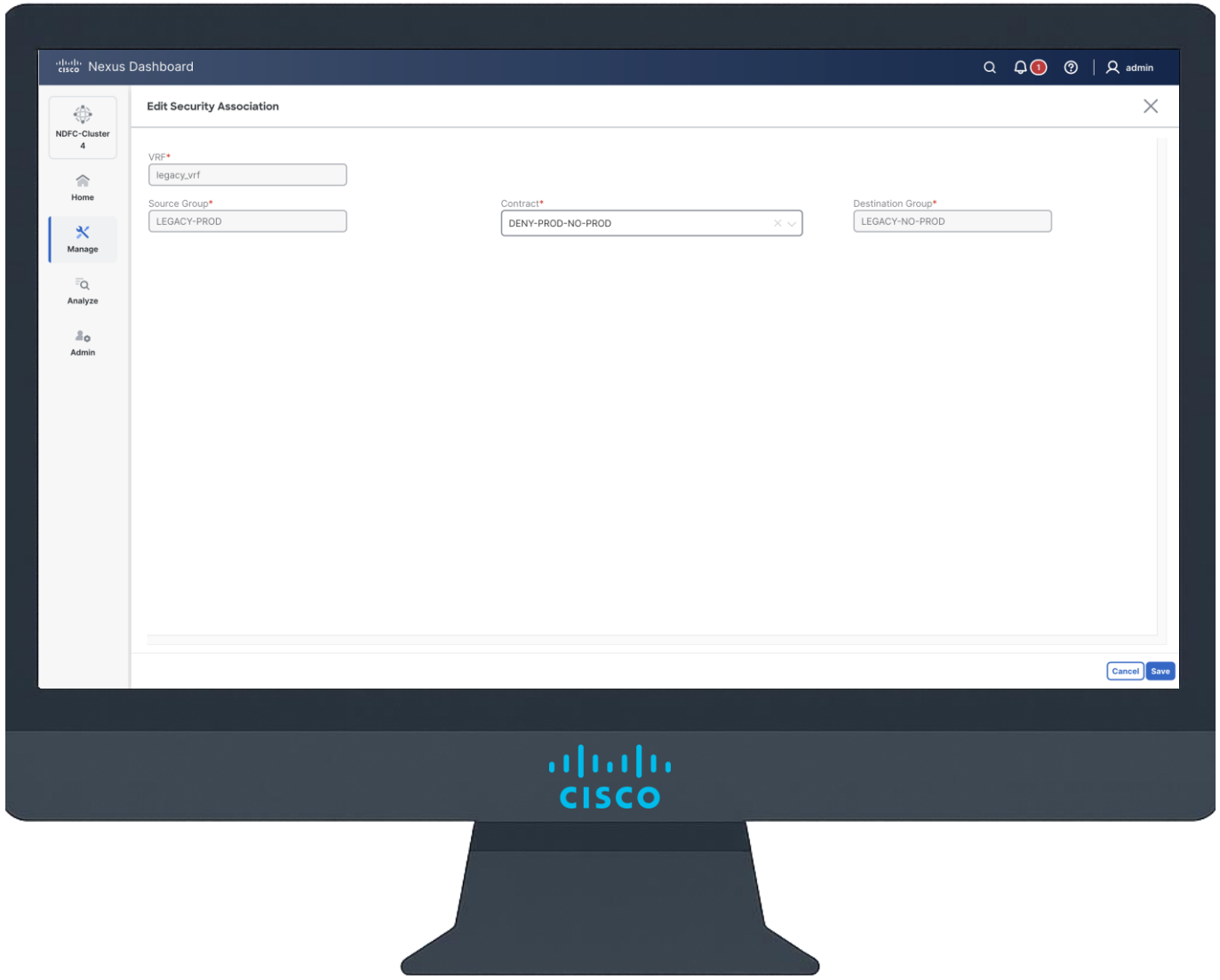
Group Policy Option Fundamentals

Nexus Dashboard Associations



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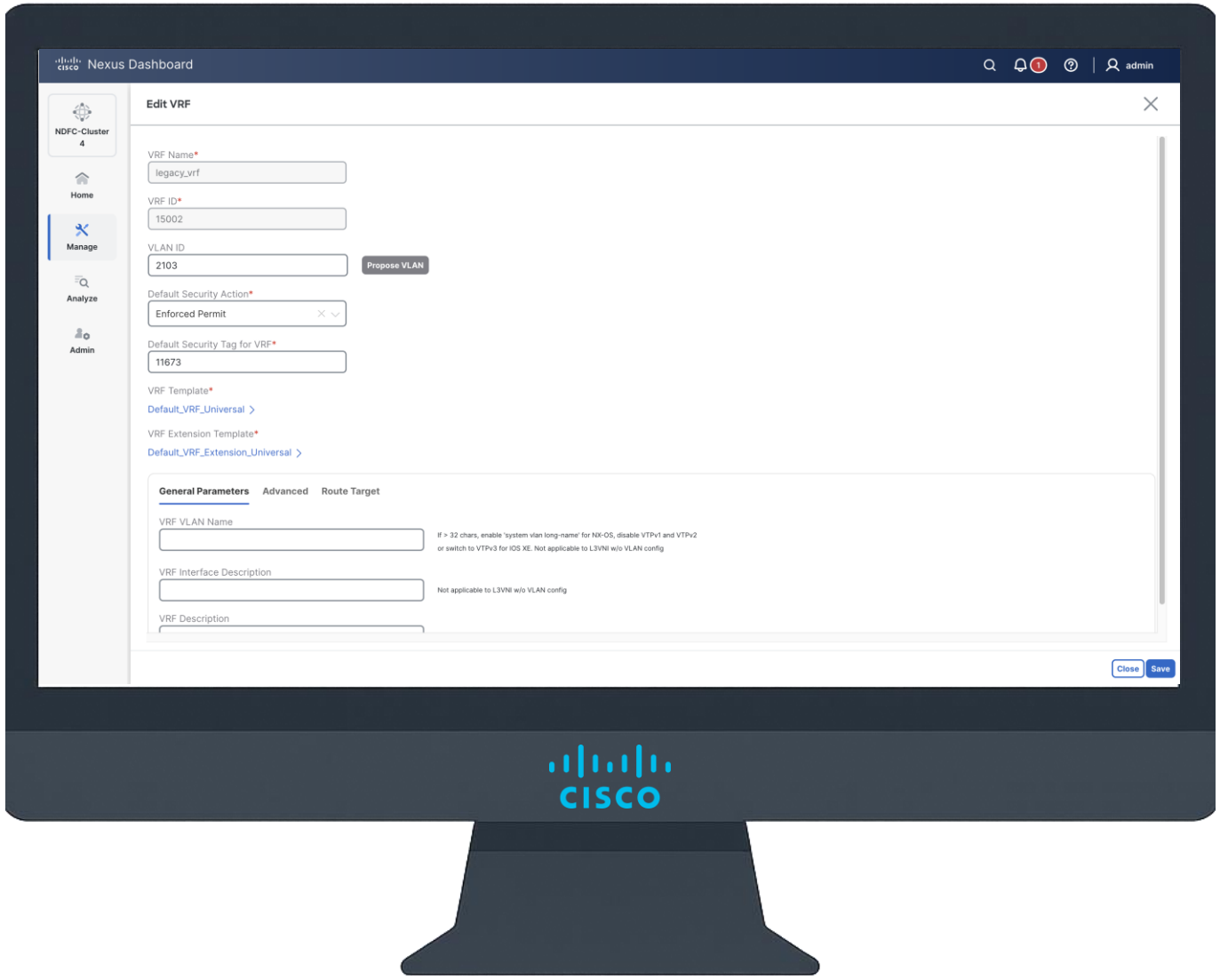
Group Policy Option Fundamentals

Nexus Dashboard VRF Settings



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Demo #1

GPO Based Service Redirection

Service Insertion

What is it and Why do we need it?

- Offload the traffic to a device connected to the fabric for additional processing
- Stateless ACLs might not be enough
- Companies' security policies might require advance traffic policies for some or all the traffic
- Security teams want to own the devices and the policies that inspect the traffic
- Redirection might also be used for other use cases:
  - NAT, CG-NAT
  - Load Balancing
  - TCP optimizers

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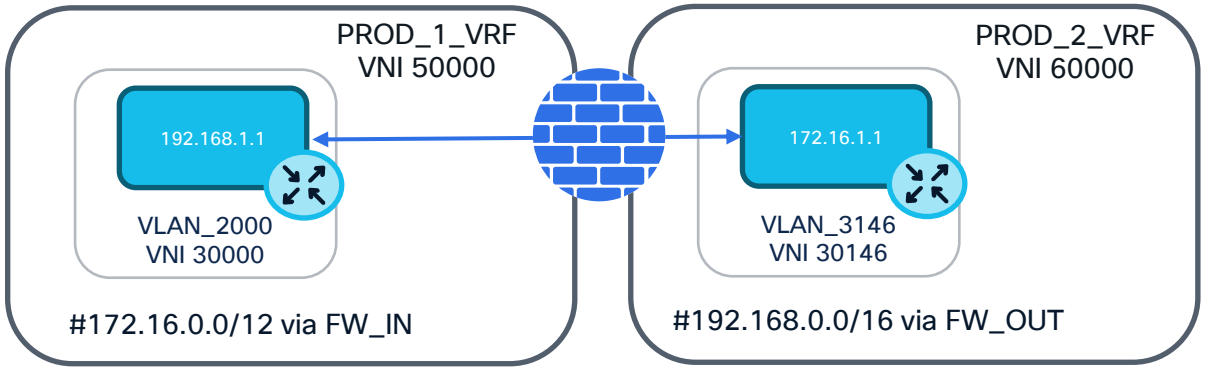
Service Insertion

Classic Service Insertion Methods

- Classic methods require traffic to be forwarded to the firewall device by trusting the next hops present in the Layer-2 and Layer-3 RIBs/FIBs → IP/MAC lookup only
- Valid for many use cases:
  - Firewall As Default Gateway
  - Firewall As Perimeter Device
- Introduce configuration complexities and/or sub-optimal performances
- Administrators are forced to disable or work around key fabric functions
  - Distributed Anycast Gateway (DAG) when firewall is used as default gateway
  - VRF Leaking with the perimeter firewall



Classic VRF Sandwich

https://www.cisco.com/c/en/us/td/docs/dcn/whitepapers/cisco-vxlan-multi-site-and-service-node-integration.html

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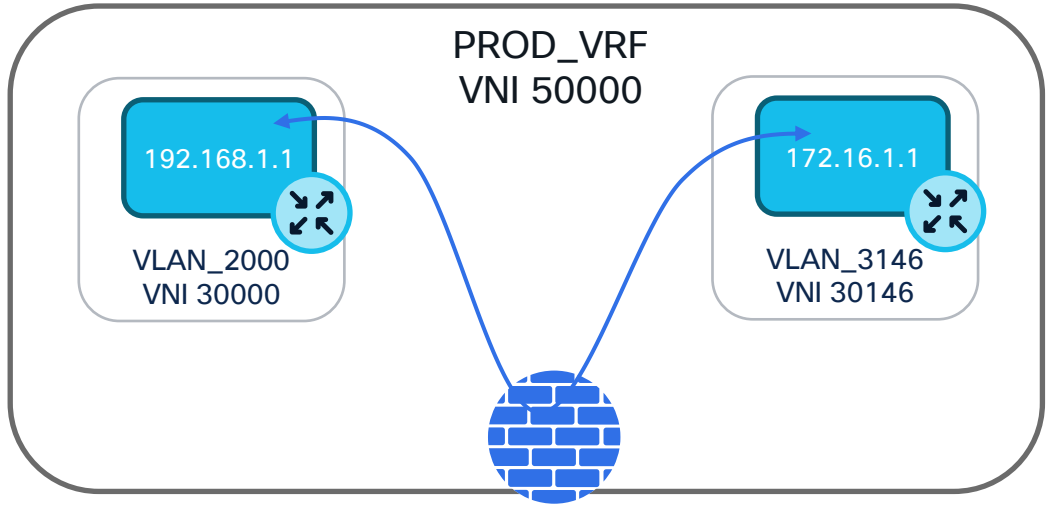
Service Insertion

Service Redirection Methods

- Redirection/Stitching methods reroute traffic through security devices based on defined policies, there is no need to influence Layer-2 and Layer-3 RIBs/FIBs
- NX-OS has multiple features that helps administrators under the ePBR umbrella term
  - Available since NX-OS 9.3(5)
  - Automated and simplified configuration
  - Ensures the symmetry will be maintained
  - Integrates with IP SLA
  - Supports IP access-list and now GPO



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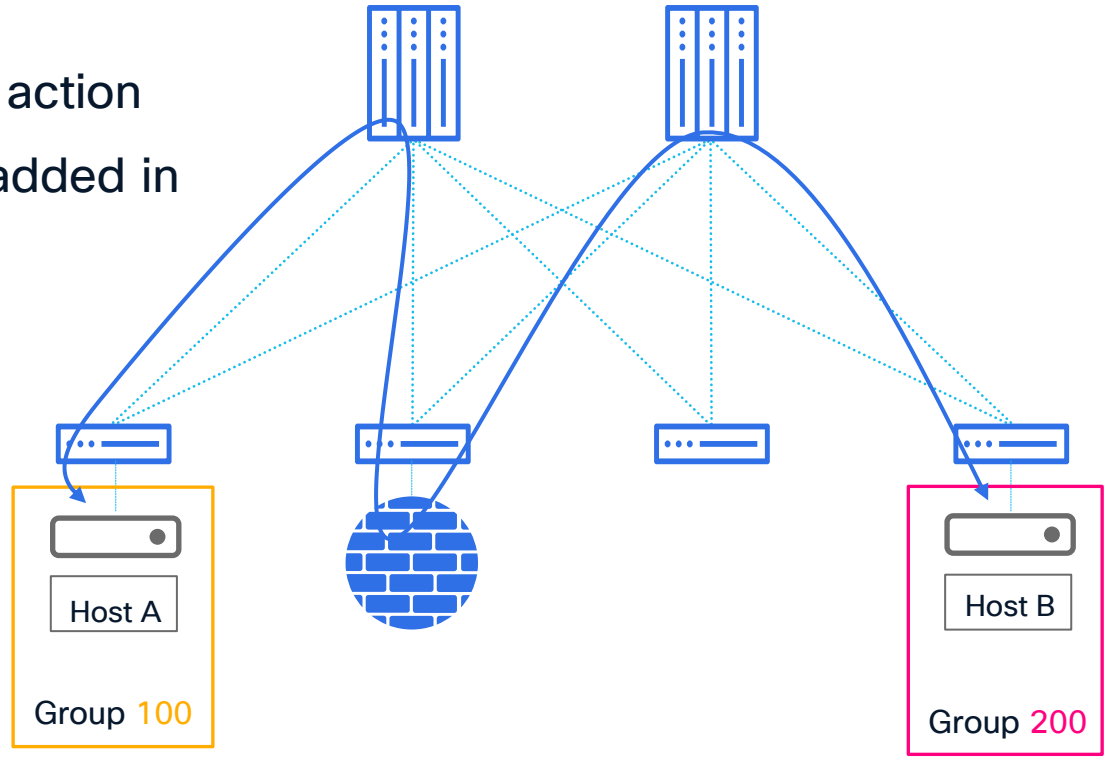
GPO Based Service Redirection

Highlights

- GPO Service Redirection support introduced in NX-OS 10.5(1)F
- Extends SGACL capabilities with the service-chain action
- Multi-Site and multi-node Service Chains support added in NX-OS 10.5(2)F
  - Maximum 5 Service Functions
- Redirection can happen for specific traffic flows
  - Granular match rules (filters)
- Not yet available in Nexus Dashboard (ND)
  - A workaround will be explored in the next demo



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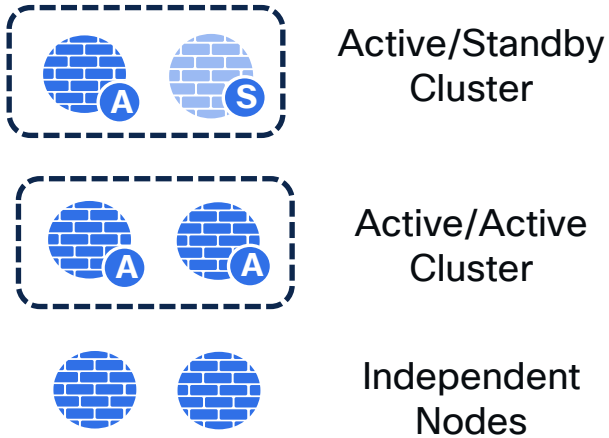
GPO Based Service Redirection

Terminology

Service Endpoint



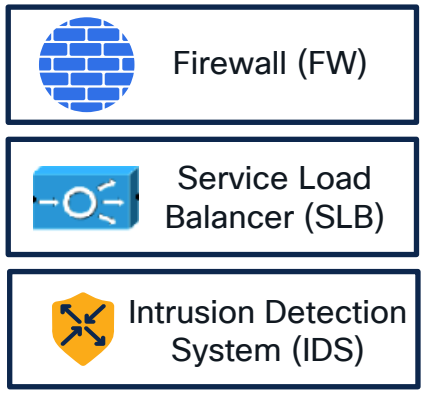
Active/Standby Cluster

Active/Active Cluster

Independent Nodes

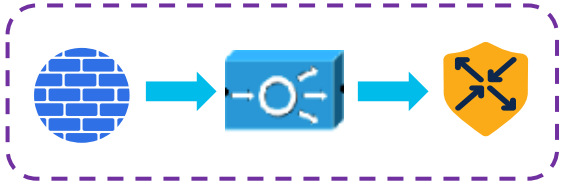
- Physical or virtual devices that handle the received traffic flows
- Can be deployed with different redundancy models (Active/Active, Active/Standby, Independent Nodes)

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-Chain



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

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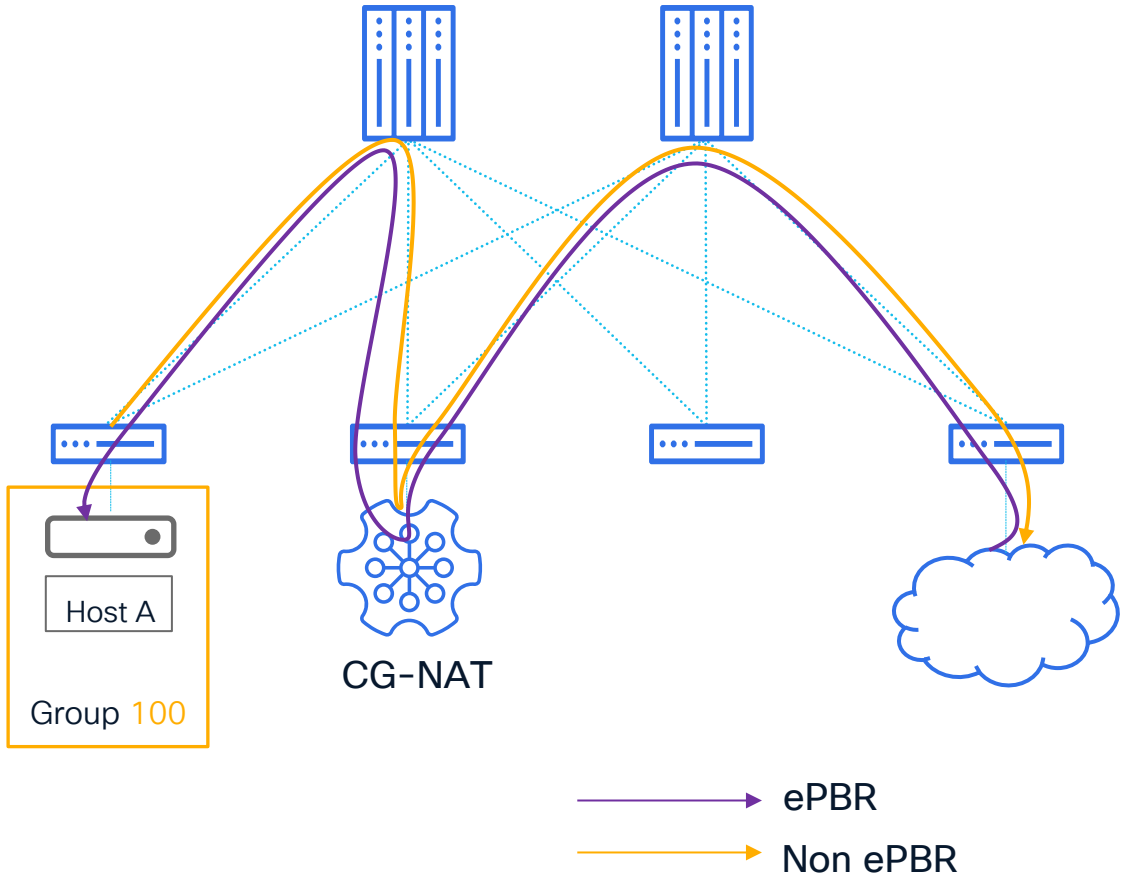
GPO Based Service Redirection

Service Endpoint

- Service Endpoints are networking devices that apply additional policies to the traffic
  - They can be Virtual or Physical
  - They can be standalone or deployed in clusters
- Depending on their function they might required different redirection rules
  - Device that do not apply any NAT rules like firewalls, IPS/IDS or TCP Optimizers
    - Redirection must be applied in both directions
  - Device that apply NAT rules like Load Balancers or CG-NAT devices
    - Redirection might be needed on one or both directions



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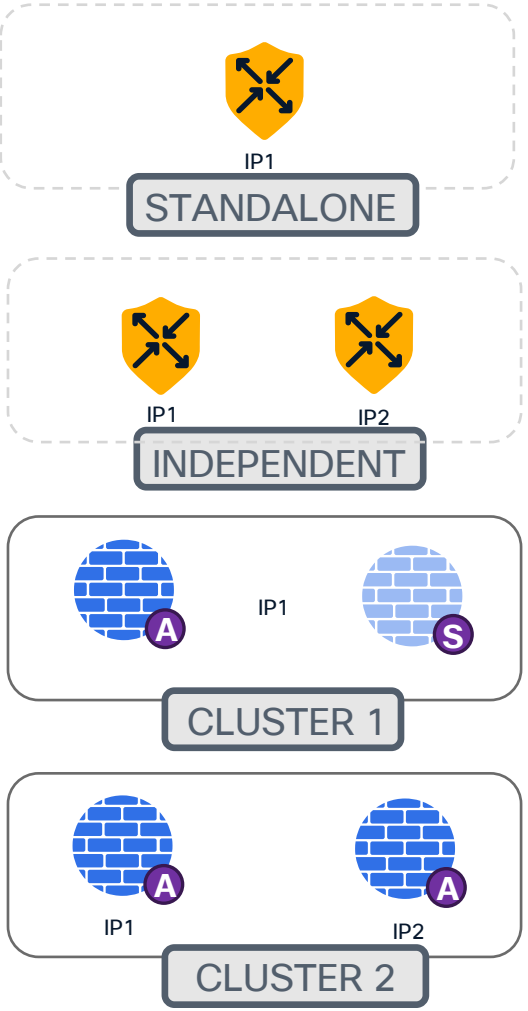
GPO Based Service Redirection

Service Endpoints and Service Functions



- Service Functions are logical groups of Service-Endpoints that enforce the same traffic policies
- Service Functions can contain one or multiple service endpoints
- They can be used to set the IP SLA monitoring, and they will take the device in and out of the pool based on their status
- Service endpoints implementing a specific Service Function must be classified in one (or more) ESGs

```
security-group 10091 name FIREWALL-1
 type layer4-7
 match interface vlan 3101

epbr service FIREWALL-1-SITE-1
 vrf hyper_vrf
 security-group 10091
 probe icmp timeout 1 source-interface loopback98 frequency 2...
 service-end-point ip 172.17.91.101
 service-end-point ip 172.17.93.101
```

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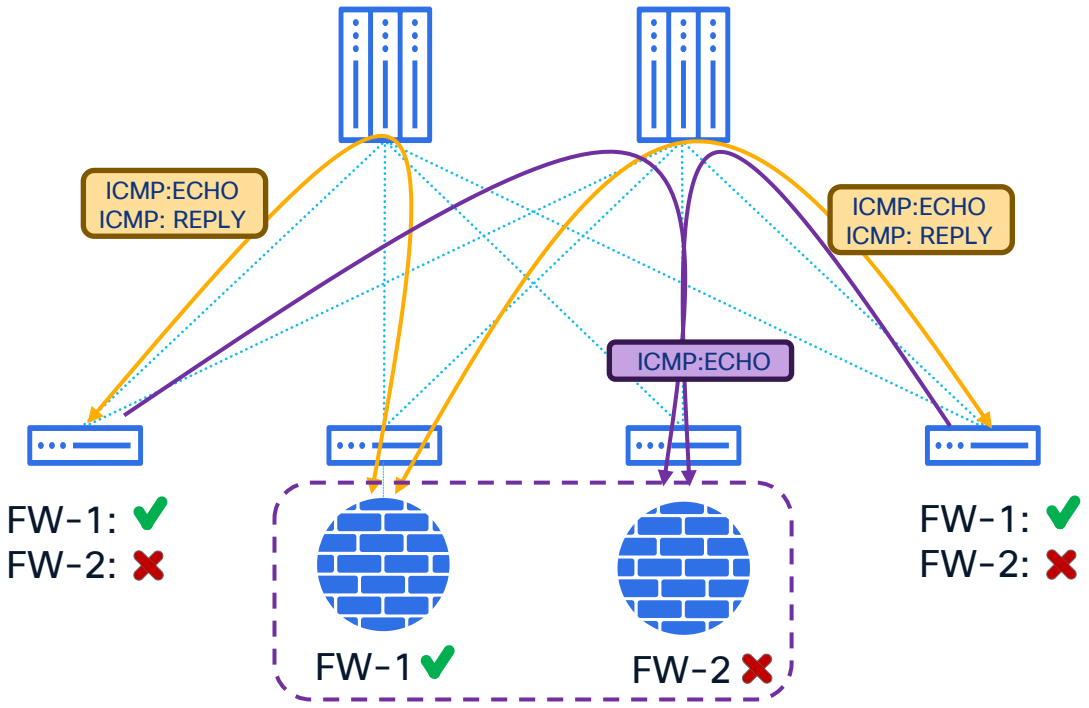
GPO Based Service Redirection

Service Function - Tracking



- Tracking the health of devices avoids blackholes
- All the VTEPs where the traffic is forwarded needs to track the status of the devices via loopbacks
- Unhealthy Service Endpoints must be excluded from the Service Function pool
- Probes can be configured with different protocols
  - ICMP, UDP, TCP, HTTP, DNS

```
epbr service FIREWALL-1-SITE-1
  vrf hyper_vrf
  security-group 10091
  probe icmp timeout 1 source-interface loopback98 frequency 2...
  service-end-point ip 172.17.91.101
  service-end-point ip 172.17.93.101
```

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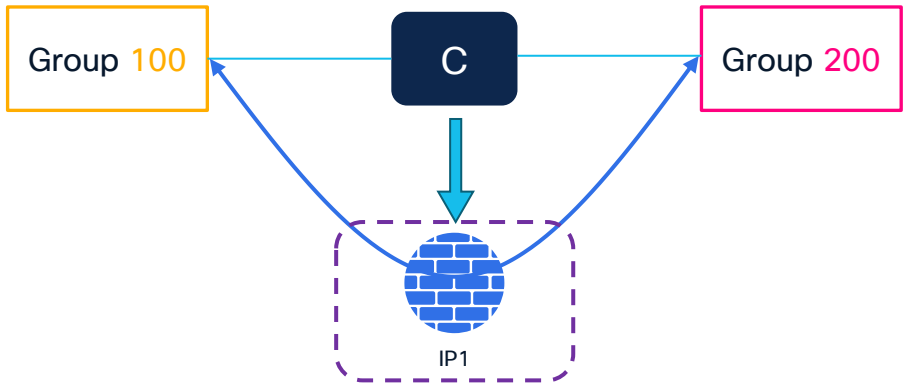
GPO Based Service Redirection

Service Chains - Single Function



- Service Chains allow us to define the traffic redirection rules
- When traffic is redirected to a service-chain it needs to cross all the functions listed there

epbr service-chain WEB-CHAIN-SITE-1

10 set service FIREWALL-1-SITE-1

action redirect

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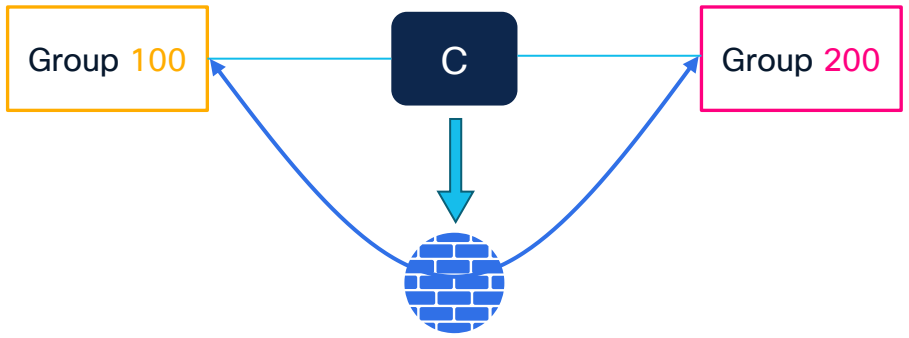
GPO Based Service Redirection

Service Chains - Single Function



- Service Chains allow us to define the traffic redirection rules
- When traffic is redirected to a service-chain it needs to cross all the functions listed there.
  - If a function is not UP, we can decide the action
    - Forward – Send the packet to the destination IP
    - Drop – Discard the packet
    - ~~Bypass~~ (not useful with single function service-chains)
- Single Function Service Chains have one step only

```
epbr service-chain WEB-CHAIN-SITE-1
 10 set service FIREWALL-1-SITE-1 fail-action drop
  action redirect
```

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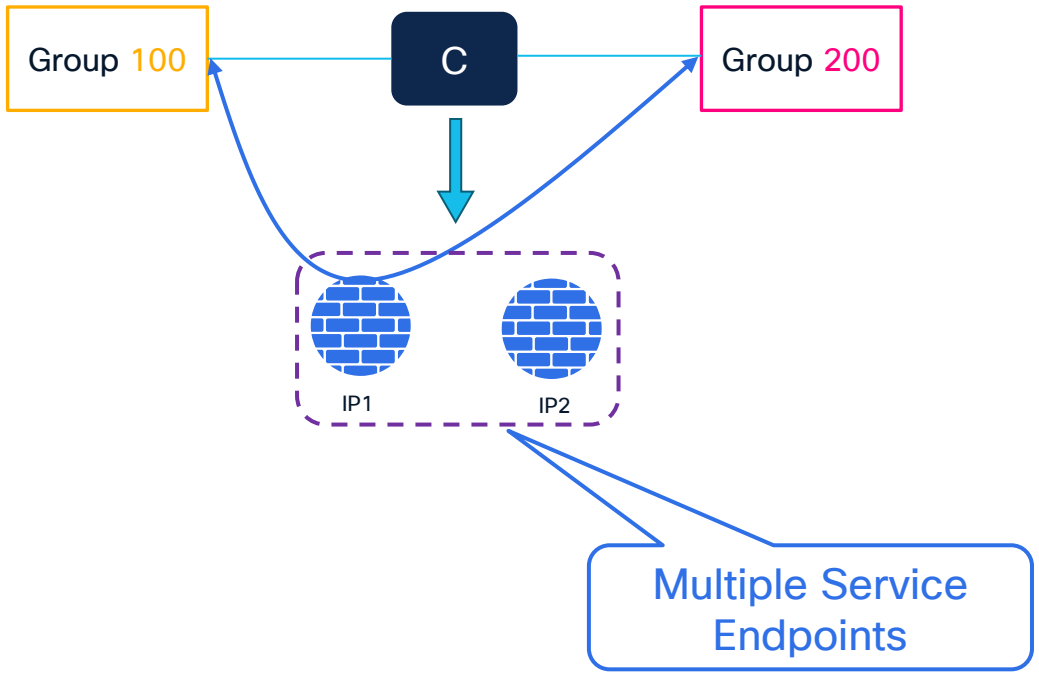
GPO Based Service Redirection

Service Chains - Single Function



- Multiple Service Endpoints for a function can be deployed in different ways
  - Cluster: Active/Active (cluster members with individual IPs)
  - Independent devices with synchronized policies
- Symmetry is always maintained
  - When multiple service endpoints, with different IP addresses, are defined inside a function, traffic in both directions is always sent to the same node (symmetric service redirection)

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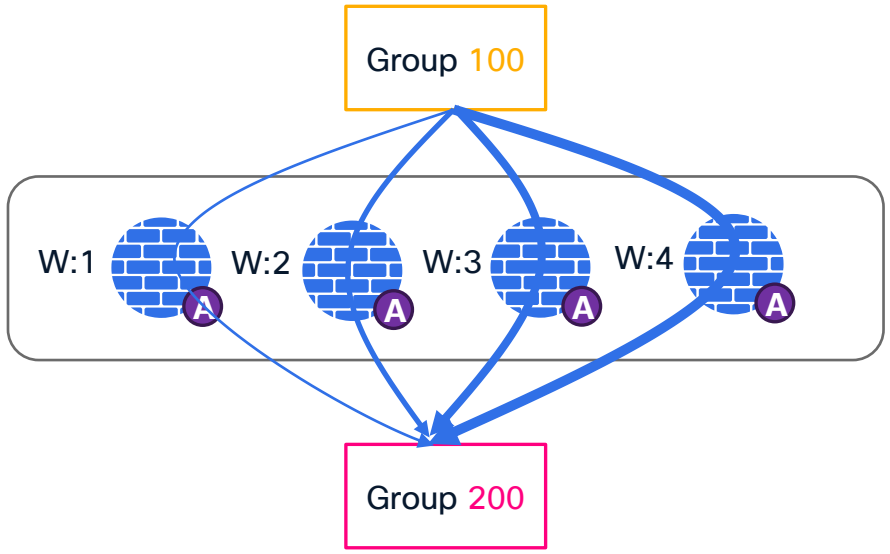
GPO Based Service Redirection

Service Chains – Load Balancing for a Single Function




```
epbr service-chain SINGLE-FUNCT-CHAIN-SITE-1
 load-balance method src-dst-ipprotocol
 10 set service FIREWALL-1-SITE-2 fail-action drop
  load-balance method dst-ip
```

- Load Balancing is used when multiple Service Endpoints build a given Service Function
- Load Balancing hash might be calculated based on:
  - Source IP Address
  - Destination IP Address
  - Source, Destination IP Addresses and IP Protocol
  - Global configuration for the whole service-chain with possible override at the service function level
- Load Balancing uses resilient hashing
  - When a device fails, only the flows that were hashed to it will be re-hashed. The same happens when device comes back in the pool
- Two optional methods can be used and combined:
  - Weighted Load Balancing: unequally distributes the load over the different service endpoints
  - N+M Redundancy: Hot Standby devices ready to takeover the failed one(s)

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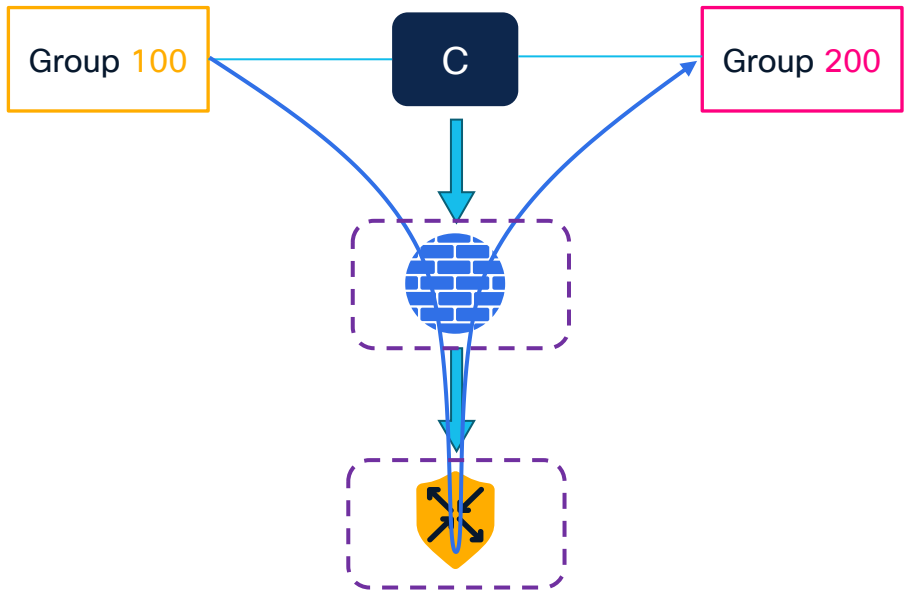
GPO Based Service Redirection

Service Chains – Multi Function



- Service Chains can contain multiple functions
- Each function is mapped to a sequence number that sets the order
  - Returning traffic will follow the order backwords
- If a function is not UP, we can decide the action
  - ~~Forward~~ – (cannot be used with multi function service-chains)
  - Drop – Discard the packet
  - Bypass – Redirect to the next function

```
epbr service-chain WEB-CHAIN-SITE-1
 10 set service FIREWALL-1-SITE-1 fail-action bypass
   action redirect
 20 set service IDS-1-SITE-1 fail-action drop
   action redirect
```

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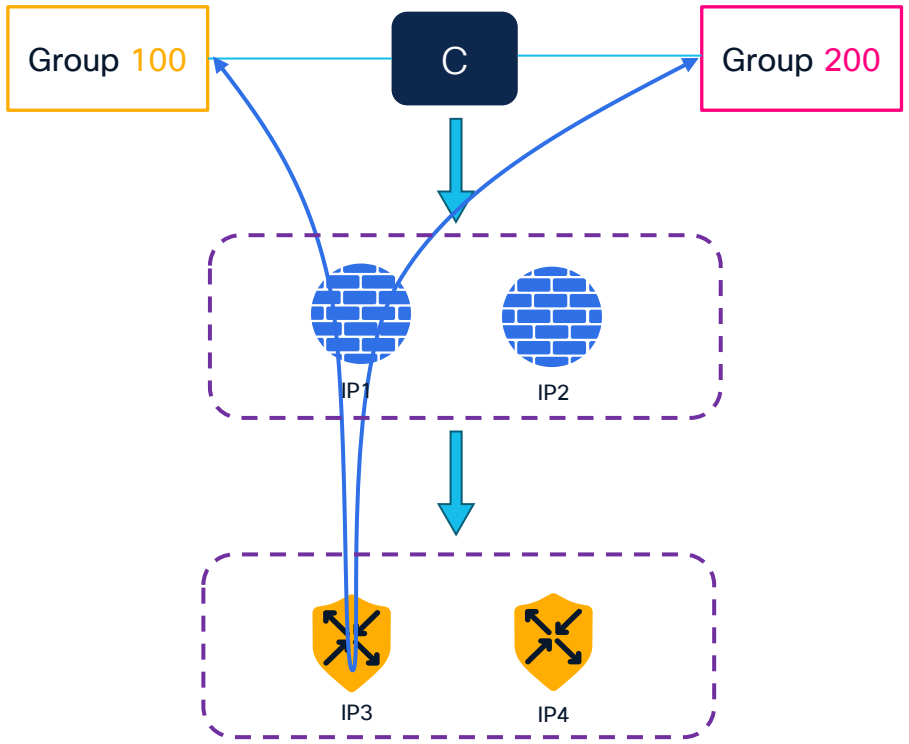
GPO Based Service Redirection

Service Chains – Multi Function



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```

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GPO Based Service Redirection

Multi-Site Highlights

- Multi-Site support added in NX-OS 10.5(2)F
- Works with single an multi function Service Chains
- Traffic hair-pinning is kept minimal in normal conditions
- Symmetry is always maintained, ensuring traffic returns to the same service cluster
  - Traffic can be intra-site; in this case the local Service Chain is used; Assuming that there is a local SC.
  - Traffic can be inter-site; in this case we will use a deterministic algorithm to pick the same chain for both direction
- Works when a site has no local Service Endpoints by design
  - Always consider the latency increase when redirecting to a different site
- All Service Endpoints in a Service Chain must be attached to the same site. **Mandatory!**
- If a function fails, the entire service-chain is considered as failed, the **failover-group** will be used
  - If the fail-action of the function is bypass, the above rule is relaxed

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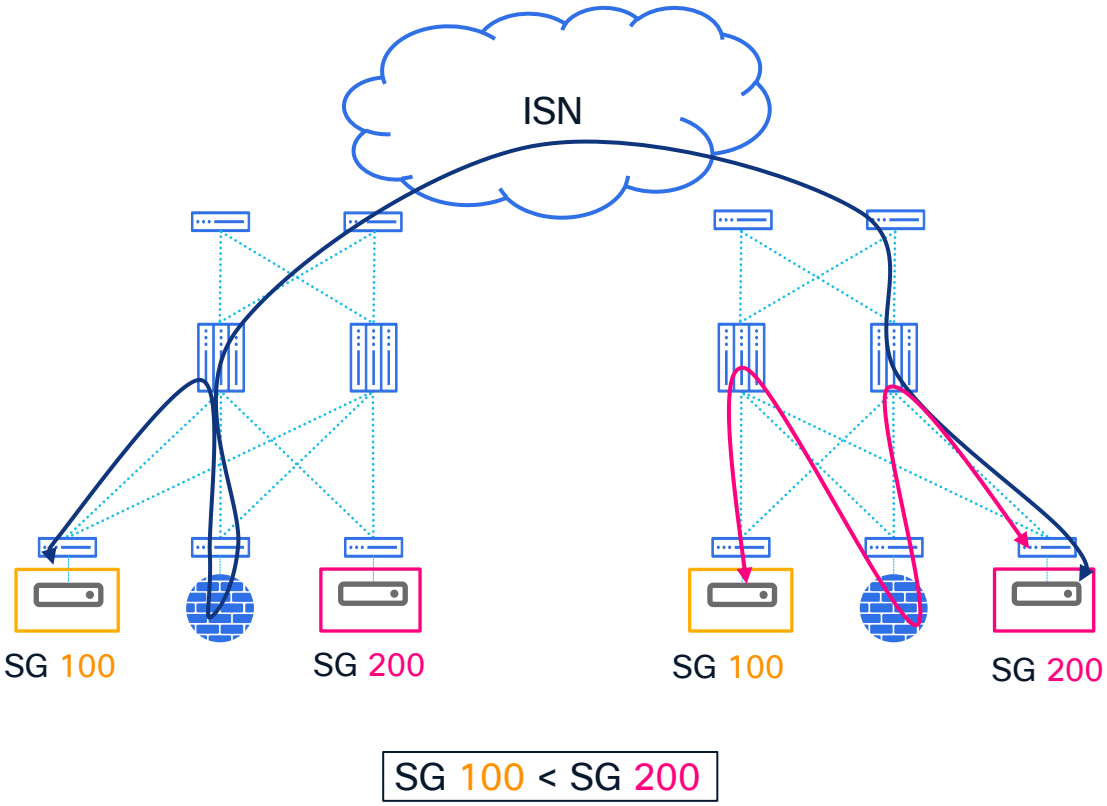
GPO Based Service Redirection

Multi-Site Highlights



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- Traffic hair-pinning is kept to minimal in normal conditions
- Symmetry is always maintained, ensuring traffic returns to the same service cluster
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  - Traffic can be inter-site: in this case we will use a deterministic algorithm to pick the same chain for both direction

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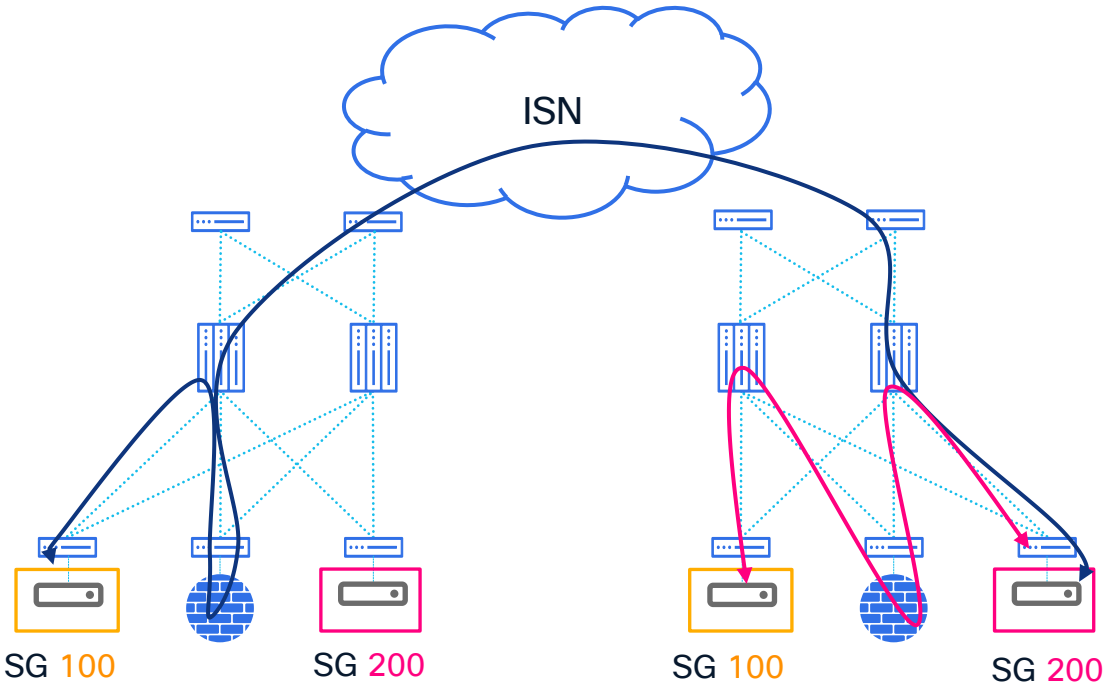
GPO Based Service Redirection

Keeping Intersite Redirection Symmetric



- Symmetricity in Service Chains is achieved by ensuring that data traffic use the Service Chain at either the source or destination site, known as site pinning
- If the Source Security Group Tag (S-SGT) is lower than the Destination Security Group Tag (D-SGT), VTEPs sends the traffic to local Service-Chain, provided it is operational
- Otherwise, VTEPs take in account the destination EP locality:
  - If destination EP is local then traffic is sent to the preferred Service-Chain, provided it is operational. At the end this must be considered intra-site traffic
  - If destination EP is remote, then traffic is forwarded by a permit rule towards the destination site. The first VTEP in the destination site (the BGW) will apply the redirect and send it to the preferred Service-Chain, provided it is operational

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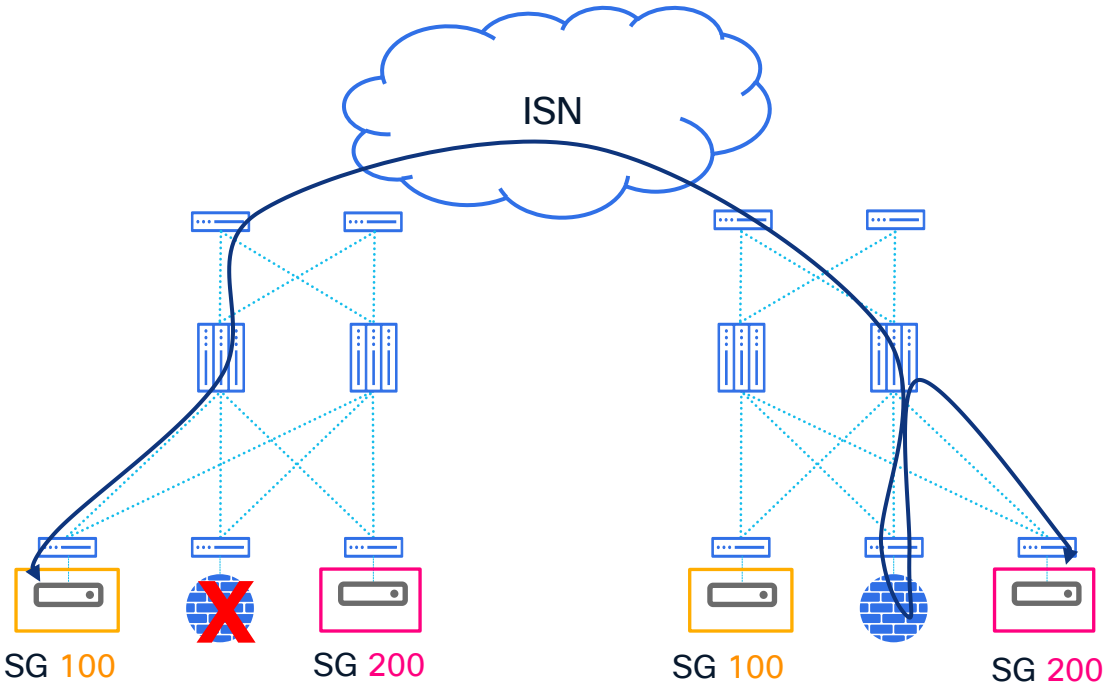
GPO Based Service Redirection

Keeping Intersite Redirection Symmetric



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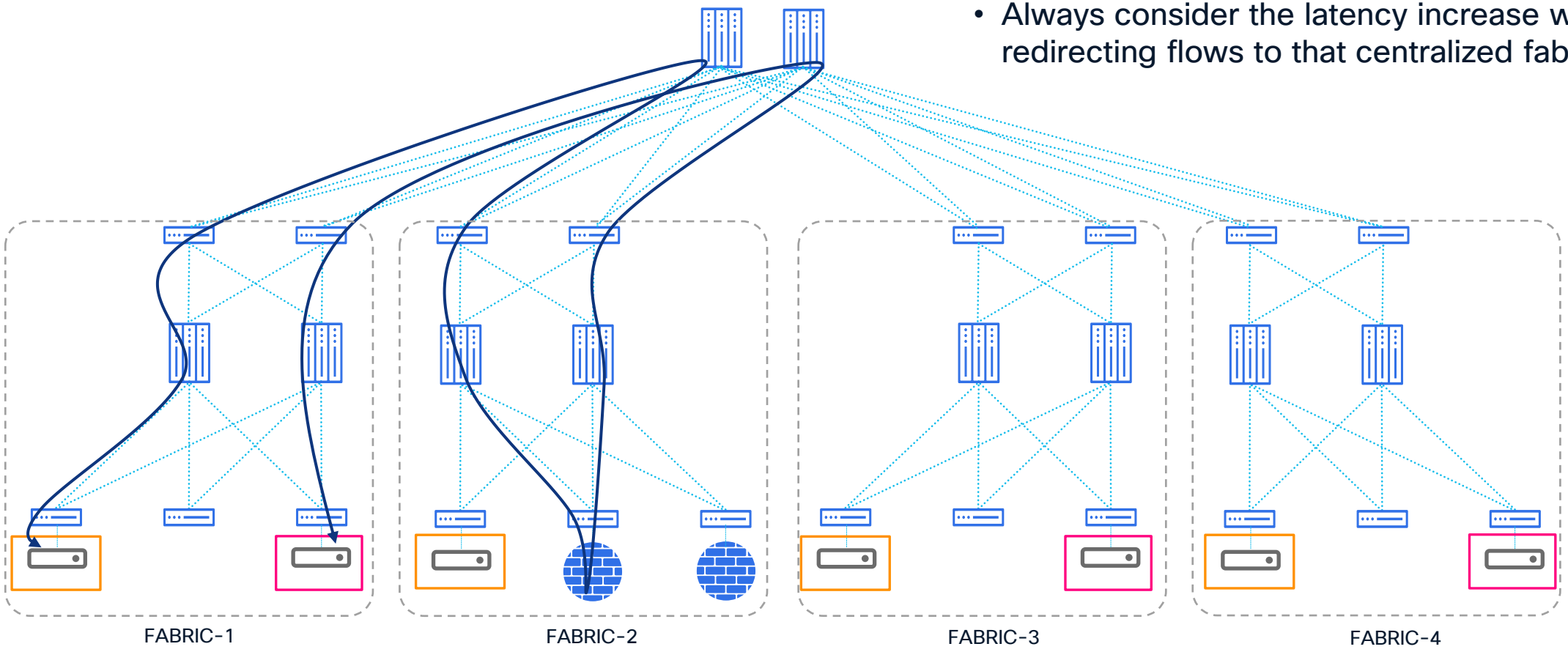
GPO Based Service Redirection

Centralized Service-Chain Deployment with Multi-Site

- A Service-Chain can be deployed only in a single fabric
  - Always consider the latency increase when redirecting flows to that centralized fabric



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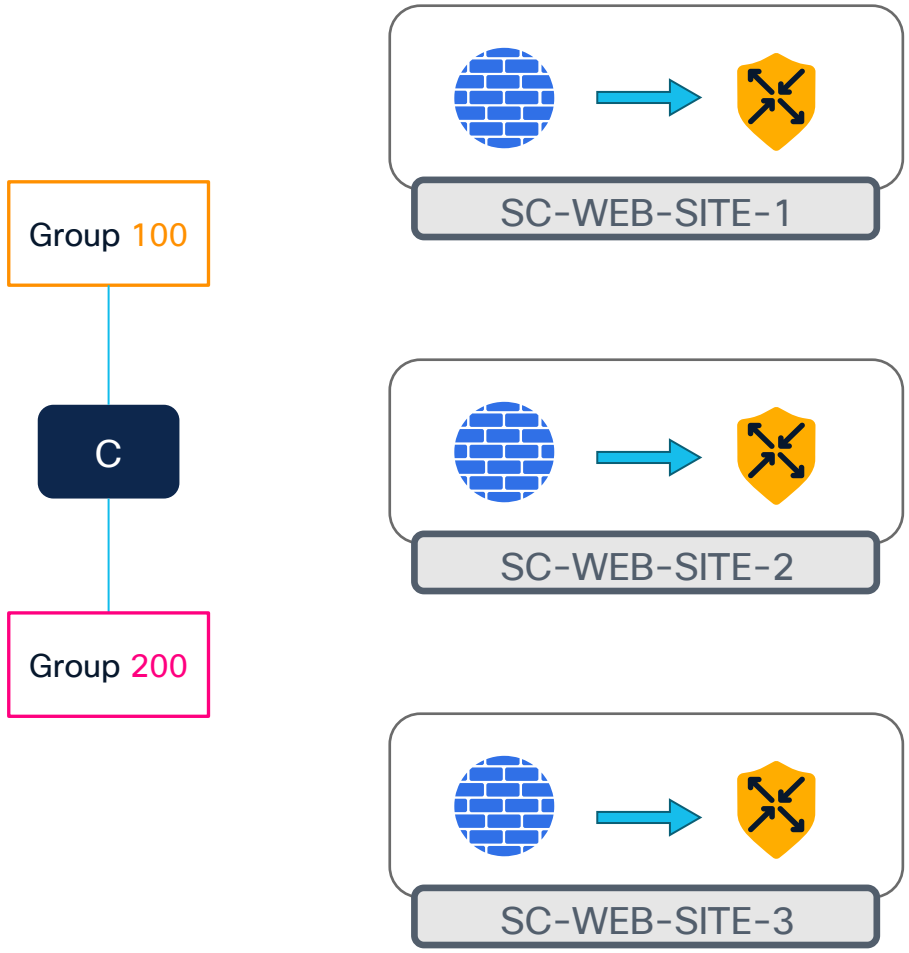
GPO Based Service Redirection

Multi-Site Service-Chain Redundancy



- Each redirection policy requires a favourite Service Chain
  - Can be deployed in the local fabric
  - Can be deployed remotely and reachable via the BGWs
- VTEPs in the same site must point to the same Service Chain
- Support configuration of backup Service Chains
  - When the primary Service Chain fails, the VTEPs will look at the Failover Group configuration containing the backup ones
  - Backups Service Chains are considered valid if they have the same number of functions. They must be configured everywhere
- Carefully design the redundancy, despite using a remote Service Chain as backup is technically possible, it might have a bad impact on the application

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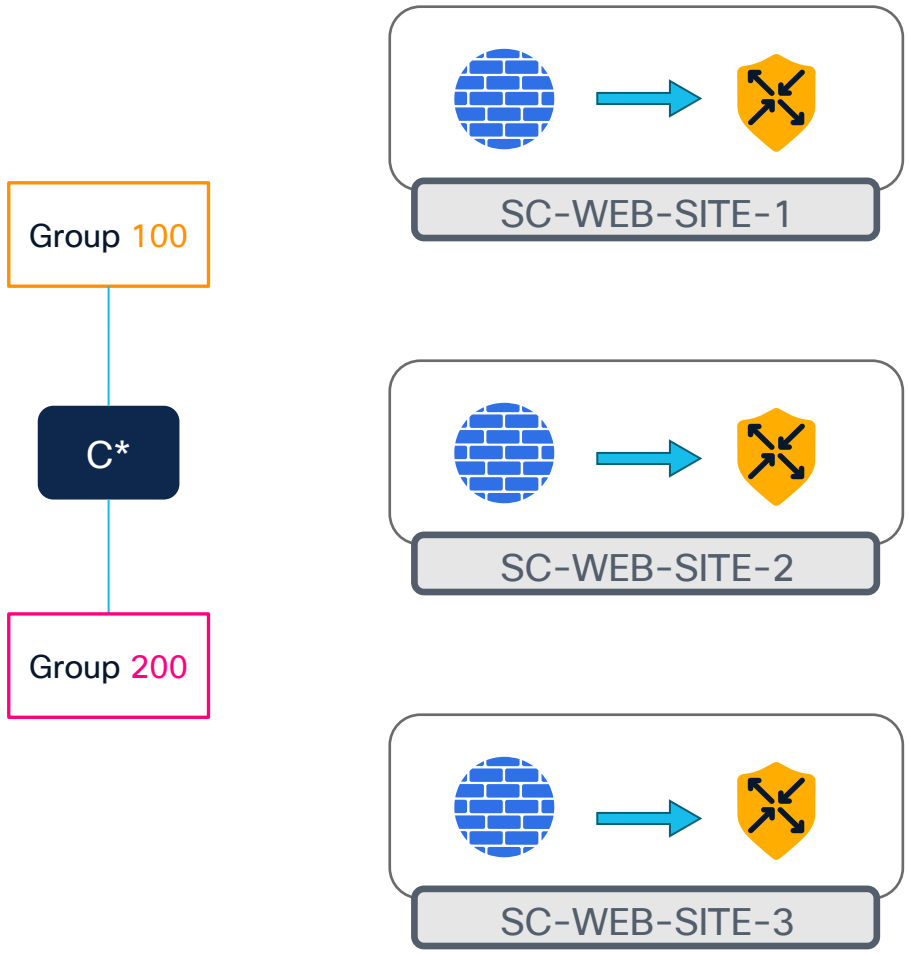
GPO Based Service Redirection

Multi-Site Service-Chain Redundancy



Configuration for Site-1 VTEPs

```
epbr service-chain SERVICE-CHAIN-WEB-SITE-1
  mode multisite failover-group SERVICE-CHAIN-WEB-FOVER
  10 set service FIREWALL-SITE-1 fail-action bypass
  20 set service IDS-SITE-1 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-2
  10 set service FIREWALL-SITE-2 fail-action bypass
  20 set service IDS-SITE-2 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-3
  ... [same but pointing to site 3 Service Functions ]

epbr failover-group SERVICE-CHAIN-WEB-FOVER
 service-chain SERVICE-CHAIN-WEB-SITE-2 preference 2
 service-chain SERVICE-CHAIN-WEB-SITE-3 preference 1
```

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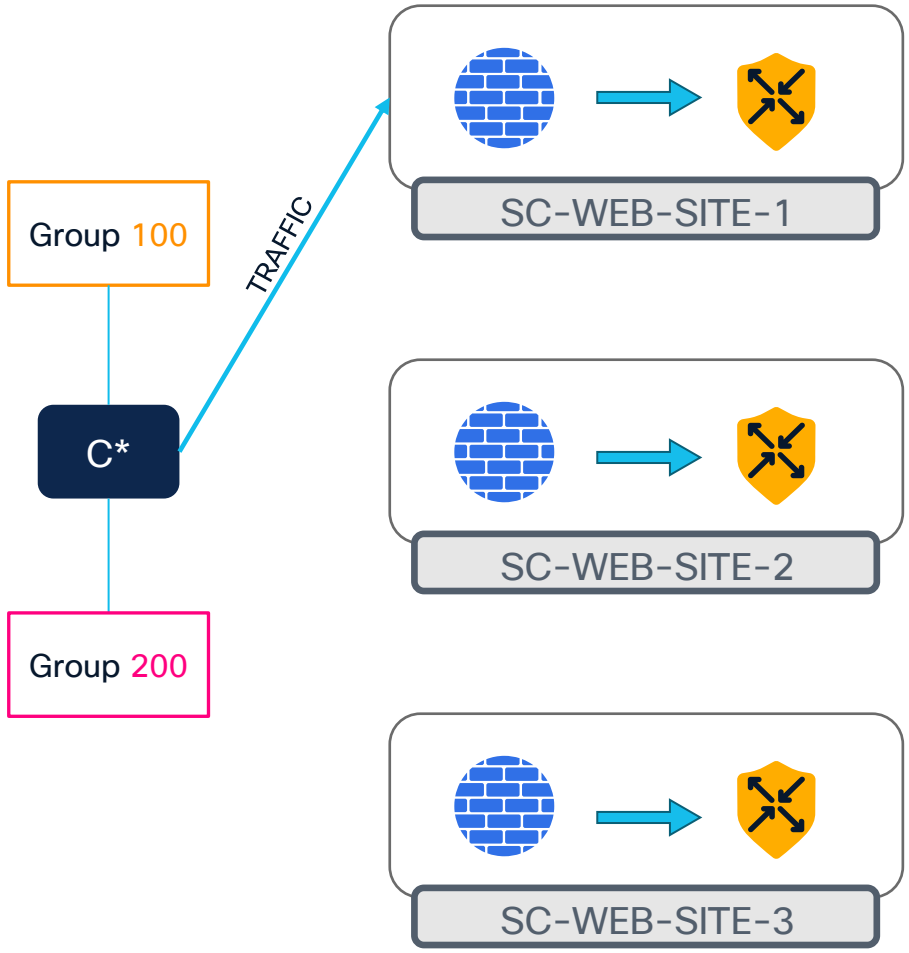
GPO Based Service Redirection

Multi-Site Service-Chain Redundancy



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epbr service-chain SERVICE-CHAIN-WEB-SITE-1
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  20 set service IDS-SITE-1 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-2
  10 set service FIREWALL-SITE-2 fail-action bypass
  20 set service IDS-SITE-2 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-3
  ... [same but pointing to site 3 Service Functions ]

epbr failover-group SERVICE-CHAIN-WEB-FOVER
 service-chain SERVICE-CHAIN-WEB-SITE-2 preference 2
 service-chain SERVICE-CHAIN-WEB-SITE-3 preference 1
```

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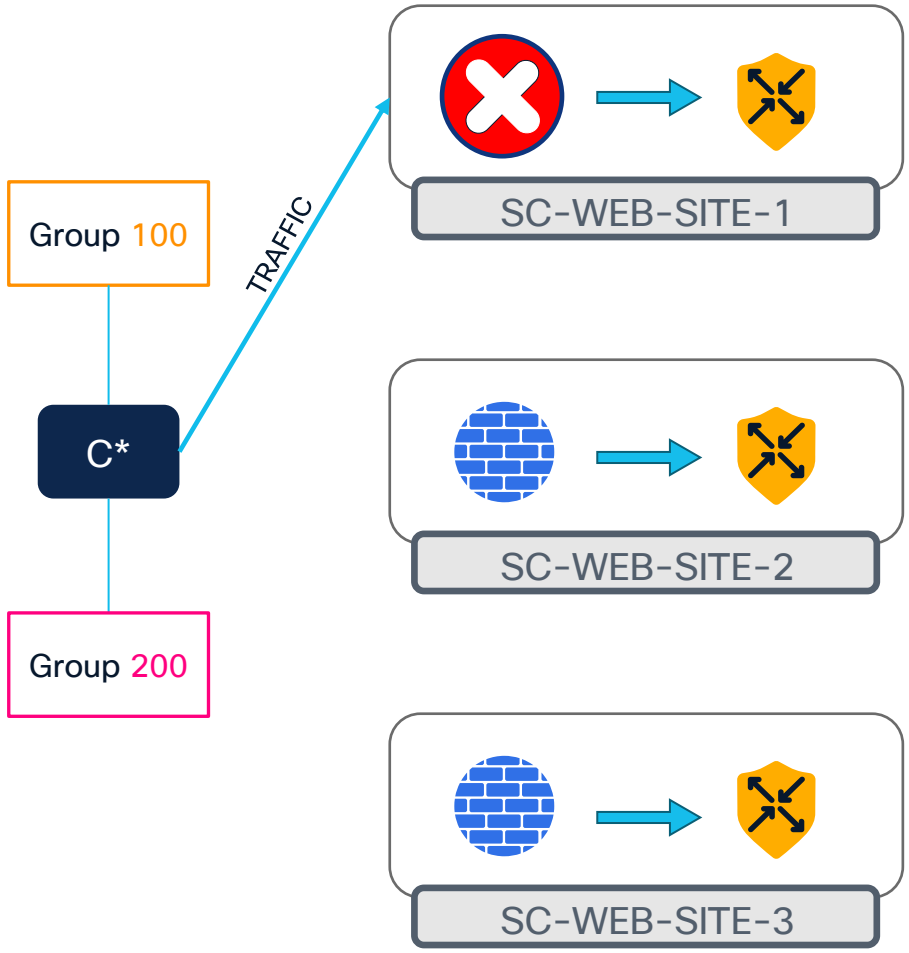
GPO Based Service Redirection

Multi-Site Service-Chain Redundancy



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  20 set service IDS-SITE-1 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-2
  10 set service FIREWALL-SITE-2 fail-action bypass
  20 set service IDS-SITE-2 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-3
  ... [same but pointing to site 3 Service Functions ]

epbr failover-group SERVICE-CHAIN-WEB-FOVER
 service-chain SERVICE-CHAIN-WEB-SITE-2 preference 2
 service-chain SERVICE-CHAIN-WEB-SITE-3 preference 1
```

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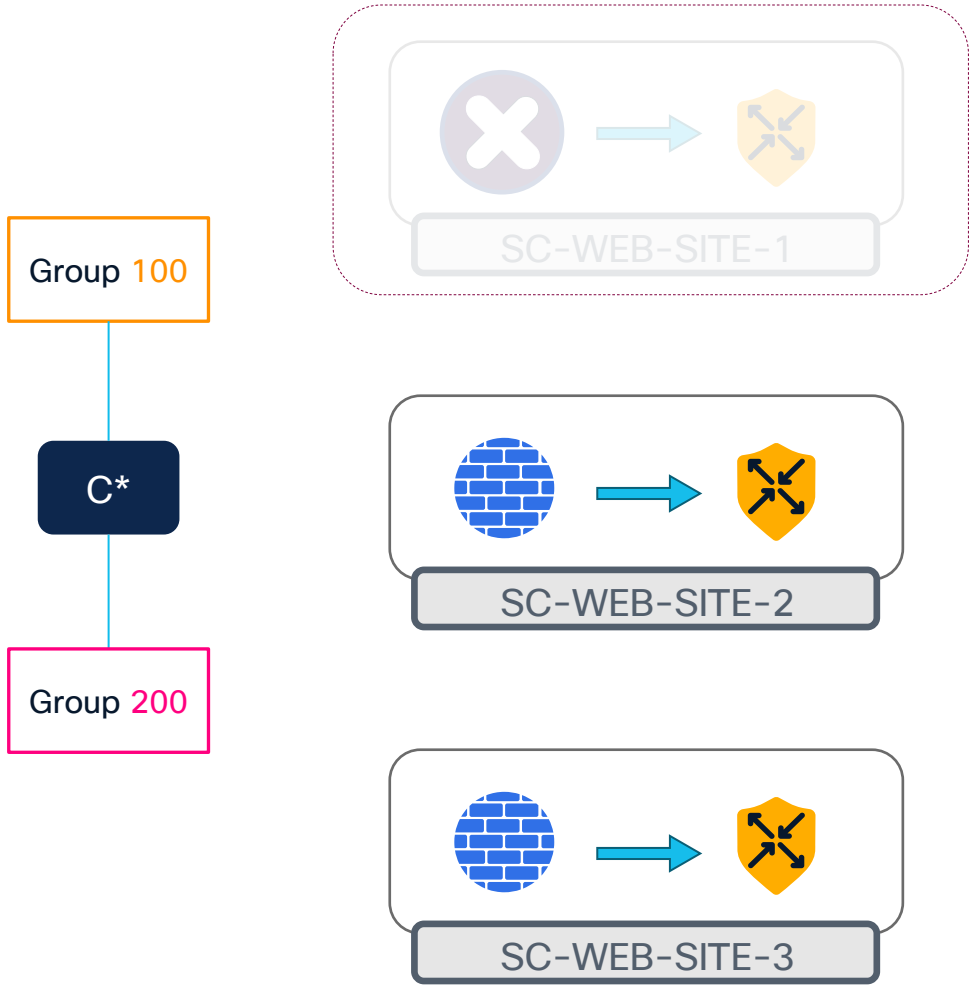
GPO Based Service Redirection

Multi-Site Redundancy



Configuration for Site-1 VTEPs

```
epbr service-chain SERVICE-CHAIN-WEB-SITE-1
  mode multisite failover-group SERVICE-CHAIN-WEB-FOVER
  10 set service FIREWALL-SITE-1 fail-action drop
  20 set service IDS-SITE-1 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-2
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  20 set service IDS-SITE-2 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-3
  ... [same but pointing to site 3 Service Functions ]

epbr failover-group SERVICE-CHAIN-WEB-FOVER
 service-chain SERVICE-CHAIN-WEB-SITE-2 preference 2
service-chain SERVICE-CHAIN-WEB-SITE-3 preference 1
```

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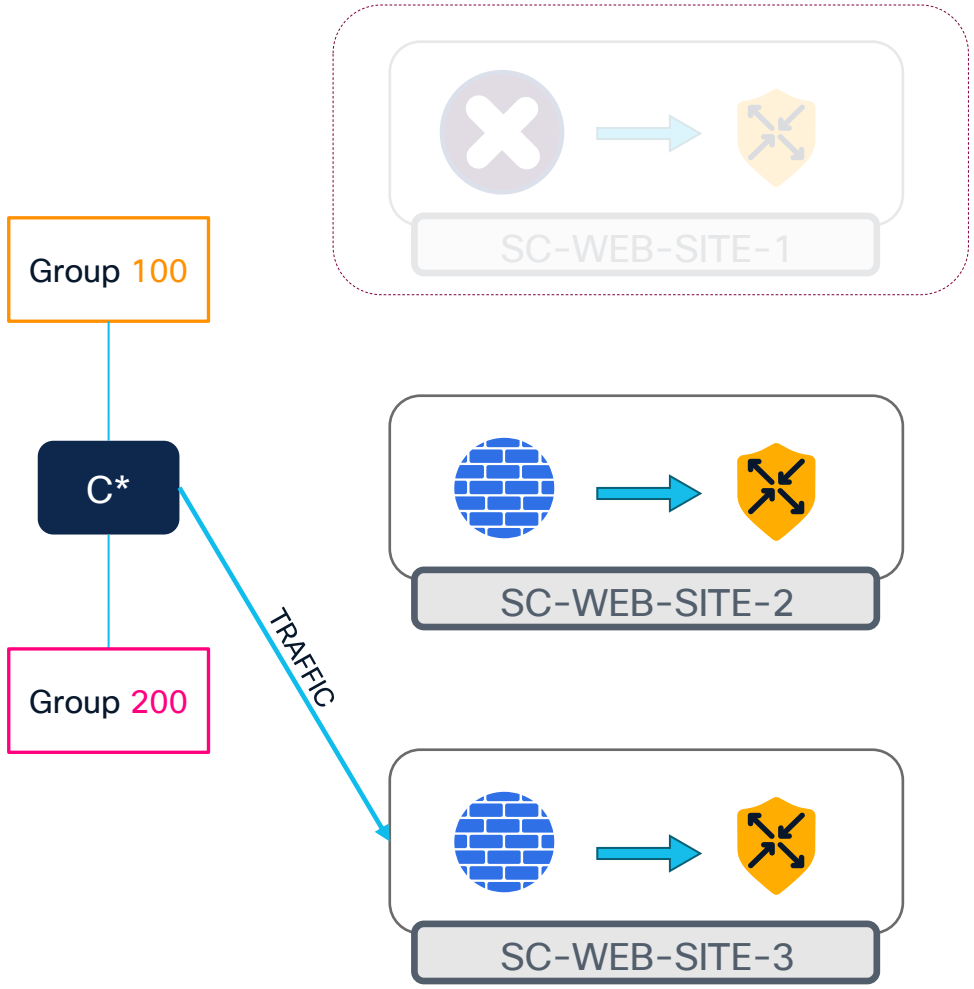
GPO Based Service Redirection

Multi-Site Redundancy



Configuration for Site-1 VTEPs

```
epbr service-chain SERVICE-CHAIN-WEB-SITE-1
  mode multisite failover-group SERVICE-CHAIN-WEB-FOVER
  10 set service FIREWALL-SITE-1 fail-action drop
  20 set service IDS-SITE-1 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-2
  10 set service FIREWALL-SITE-2 fail-action bypass
  20 set service IDS-SITE-2 fail-action drop

epbr service-chain SERVICE-CHAIN-WEB-SITE-3
  ... [same but pointing to site 3 Service Functions ]

epbr failover-group SERVICE-CHAIN-WEB-FOVER
 service-chain SERVICE-CHAIN-WEB-SITE-2 preference 2
 service-chain SERVICE-CHAIN-WEB-SITE-3 preference 1
```

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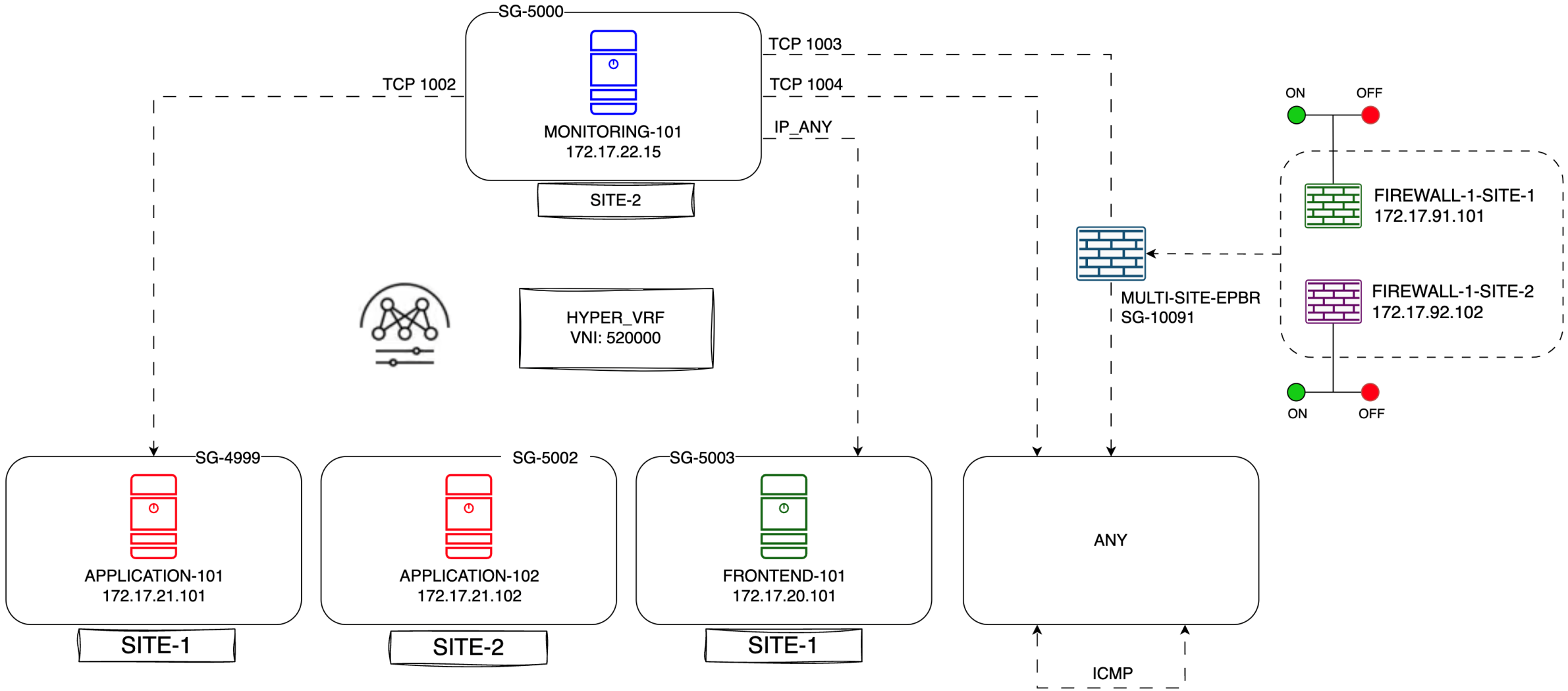
Demo #2

Demo 2

Topology



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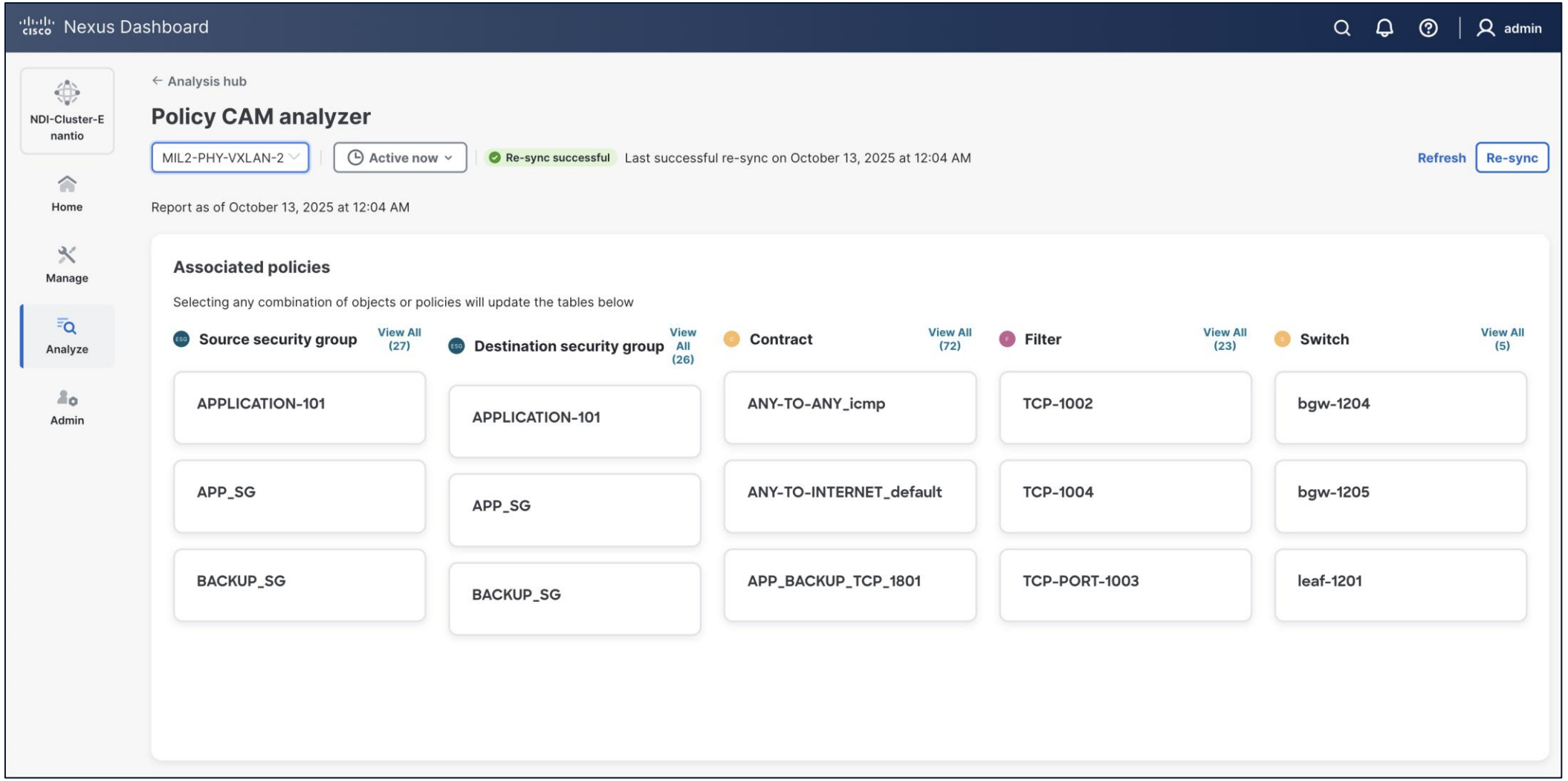
Verification

Policy CAM Analyzer



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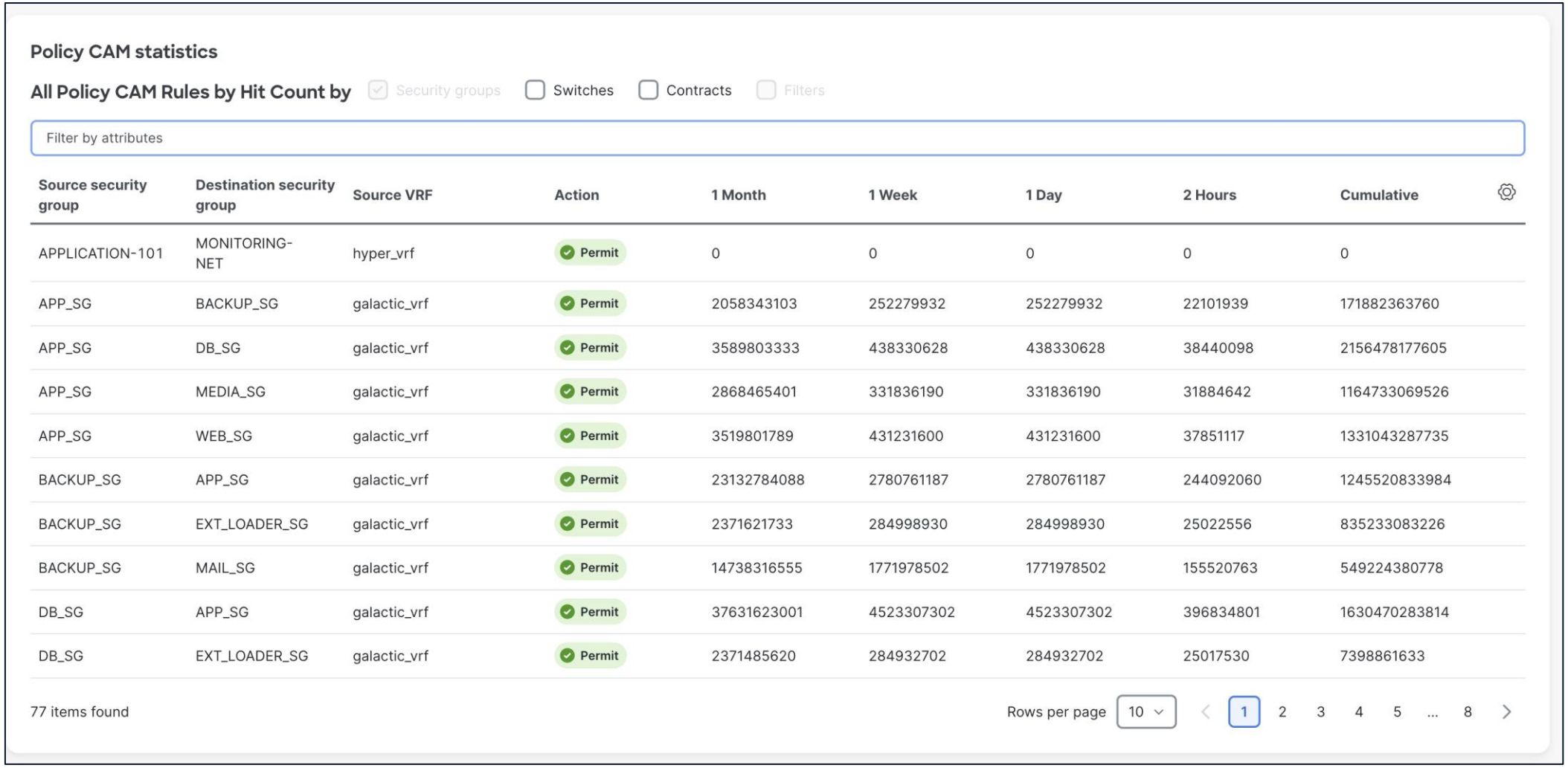
Verification

Policy CAM Statistics



Policy CAM statistics

All Policy CAM Rules by Hit Count by ☑ Security groups ☐ Switches ☐ Contracts ☐ Filters

Filter by attributes

Source security group	Destination security group	Source VRF	Action	1 Month	1 Week	1 Day	2 Hours	Cumulative
APPLICATION-101	MONITORING-NET	hyper_vrf	Permit	0	0	0	0	0
APP_SG	BACKUP_SG	galactic_vrf	Permit	2058343103	252279932	252279932	22101939	171882363760
APP_SG	DB_SG	galactic_vrf	Permit	3589803333	438330628	438330628	38440098	2156478177605
APP_SG	MEDIA_SG	galactic_vrf	Permit	2868465401	331836190	331836190	31884642	1164733069526
APP_SG	WEB_SG	galactic_vrf	Permit	3519801789	431231600	431231600	37851117	1331043287735
BACKUP_SG	APP_SG	galactic_vrf	Permit	23132784088	2780761187	2780761187	244092060	1245520833984
BACKUP_SG	EXT_LOADER_SG	galactic_vrf	Permit	2371621733	284998930	284998930	25022556	835233083226
BACKUP_SG	MAIL_SG	galactic_vrf	Permit	14738316555	1771978502	1771978502	155520763	549224380778
DB_SG	APP_SG	galactic_vrf	Permit	37631623001	4523307302	4523307302	396834801	1630470283814
DB_SG	EXT_LOADER_SG	galactic_vrf	Permit	2371485620	284932702	284932702	25017530	7398861633

77 items found

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Conclusions

Summary

New Security Options for VXLAN EVPN Fabrics

- We just discovered new functionalities that can greatly enhance the security in your Data Center networks
- Group Policy Option:
  - With dynamic classification and grouping of connected endpoints and external networks
  - Remediates persistent security gaps in legacy, migrated environments
  - Essential for new secure greenfield deployments
- Service Redirection with GPO:
  - Easily design and configure the integration between GPO and ePBR service redirection
  - Flexibly map the flows that need to be sent to external devices for additional policies
- Available on standalone NX-OS and NDFC*
  - Automation can be achieved in both environments
  - Automation can integrate external data sources and/or logics

*GPO Service Redirection workflows: future NDFC

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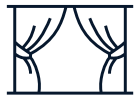

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Thank you

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