ACI Layer 4-7 Policy-Based Redirect (PBR) Deep Dive and Tips

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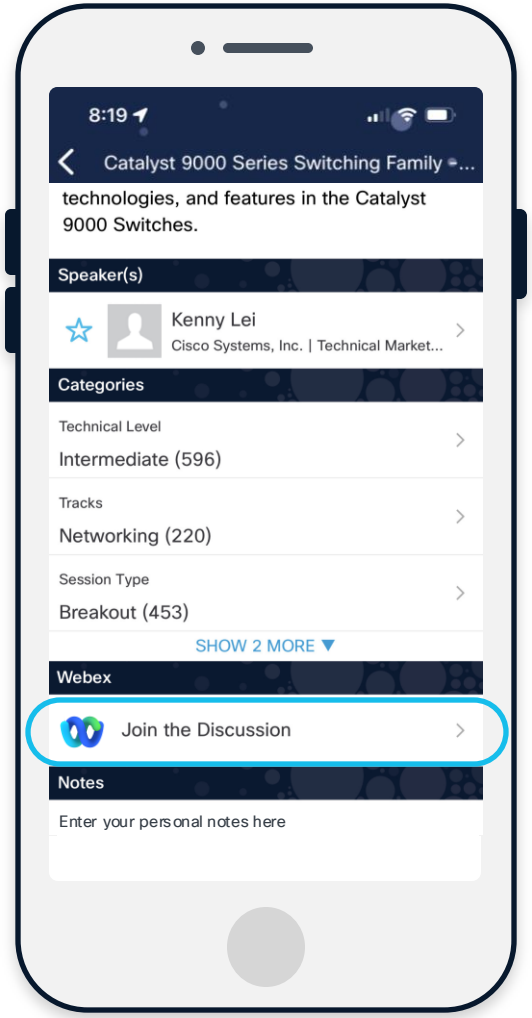


Session Objectives

- At the end of the session, the participants should be able to:
  - Understand ACI PBR use cases.
  - Understand how ACI PBR works.
  - Understand design considerations.
  - Understand ACI PBR for Multi-Site (New configuration workflow)
- Initial assumption:
  - The audience already has a good knowledge of ACI main concepts: VRF, BD, EPG, ESG, L3Out, Contract, Multi-Pod, Multi-Site, Remote Leaf etc.

- Note: This session uses ESGs mainly, but the PBR features are applicable to EPGs and uSeg EPGs.

Agenda

01 ACI PBR Use cases

02 PBR Forwarding and zoning-rules

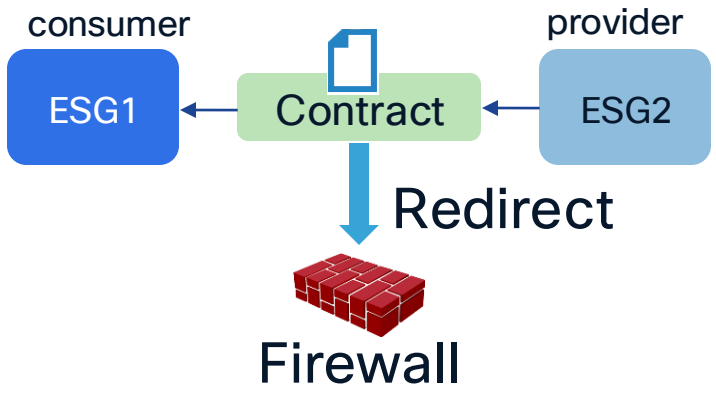
03 FAQs

04 Multi-location DC design

ACI PBR Use Cases

PBR (redirect) is one of the contract actions!

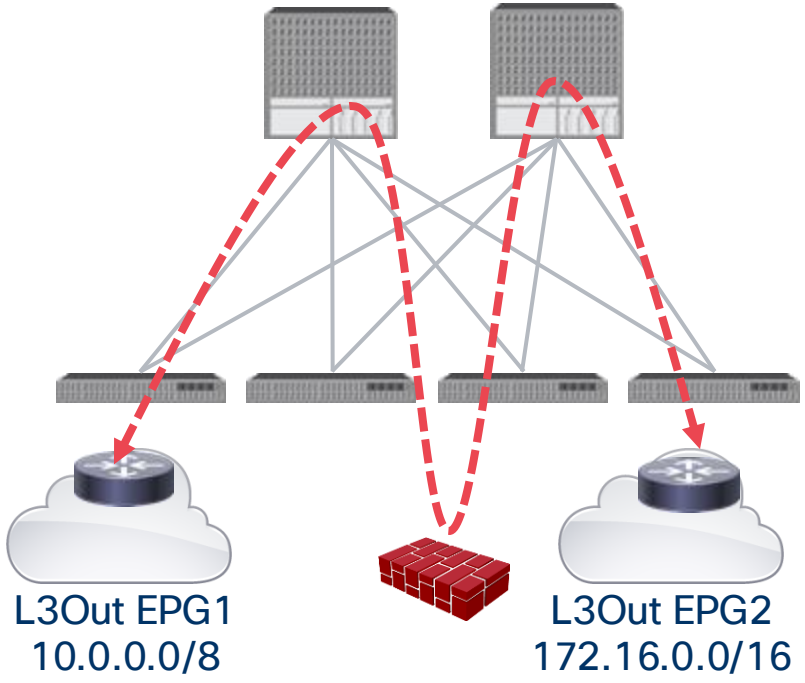
- Permit
- Deny
- Redirect
- Copy



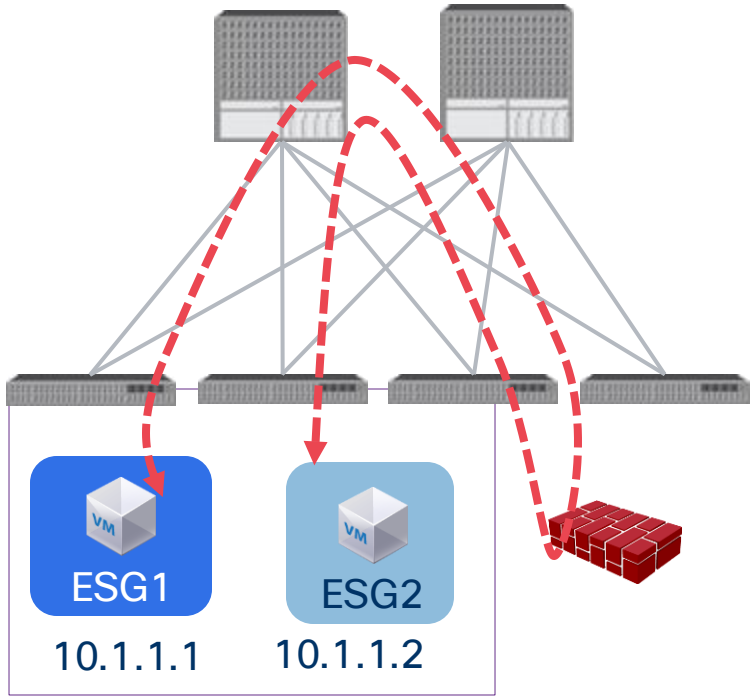
Where can we use PBR?

PBR is a contract action. It's based on source, destination EPG/ESG and filter matching.

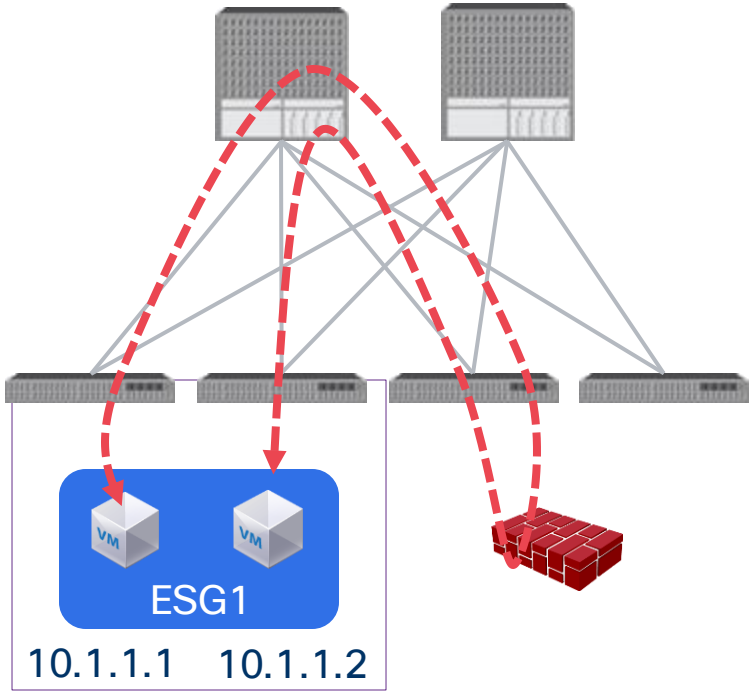
- Between EPGs or ESGs.
- Between L3Out EPGs.



- Between EPGs or ESGs in the same subnet.



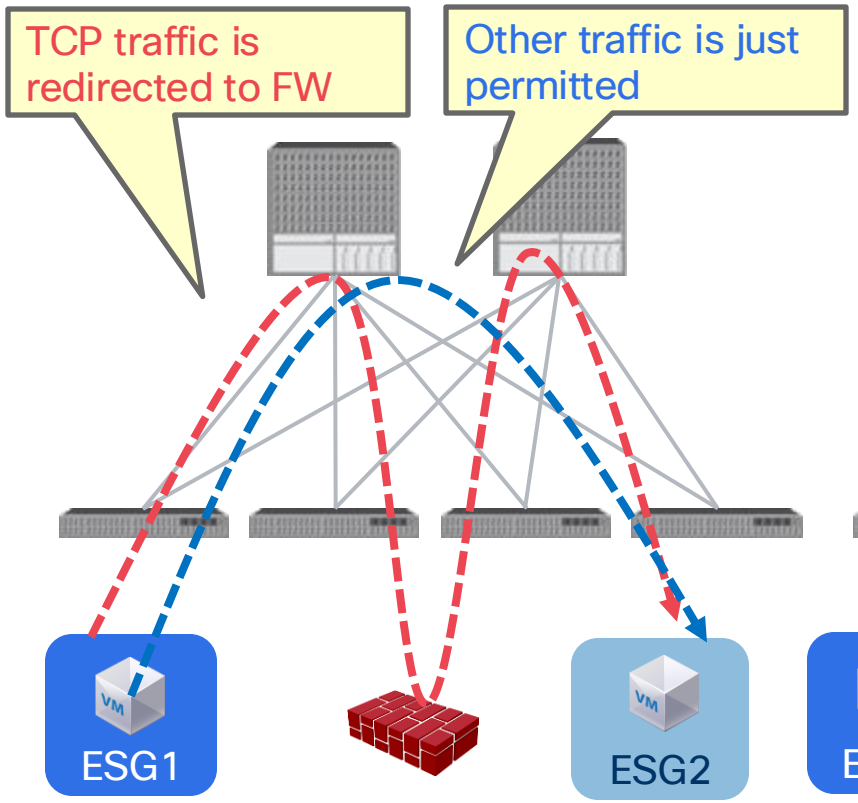
- Between endpoints in the same EPG or ESG.

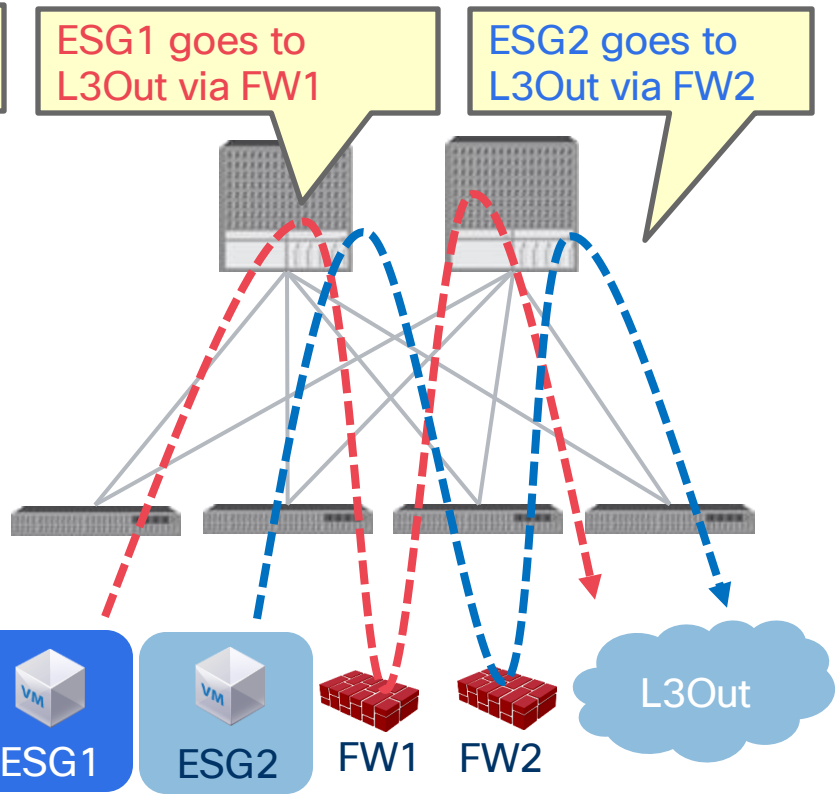


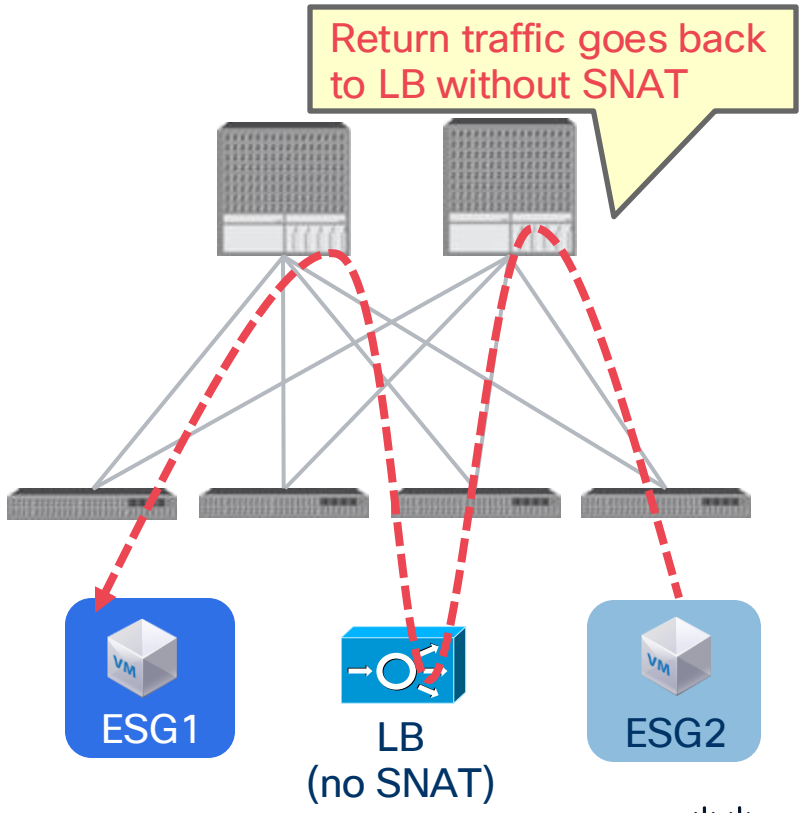
PBR use cases

PBR can be applied to each direction

- Inspect specific traffic
- Use different Firewall
- LB without SNAT (uni-directional PBR)



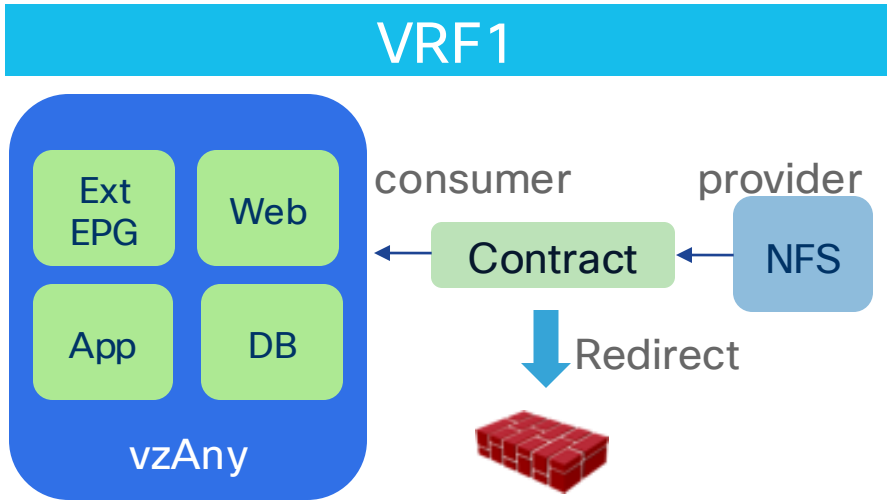


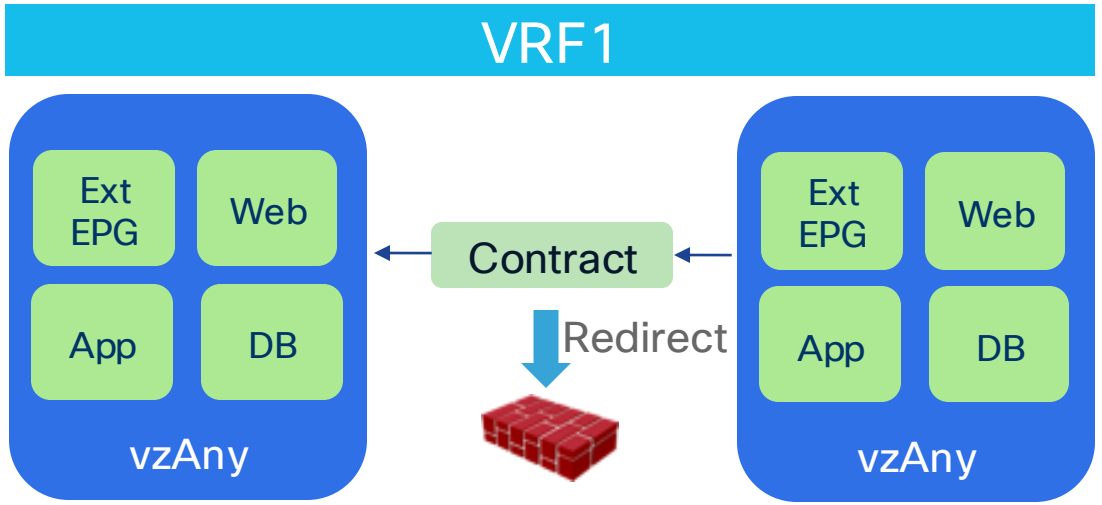


Important note

Please see
ACI Contract guide
for detail

- ACI must be Layer 3. (L2Out EPG is not supported)
- VRF must be in enforced mode. (PBR cannot be used in a VRF with unenforced mode)
  - If you want common permit or redirect rules in the VRF, you can use vzAny (All EPGs and ESGs in a VRF)
  - If you don’t need contract enforcement for specific EPGs/ESGs in the VRF, you can still use Preferred Group.



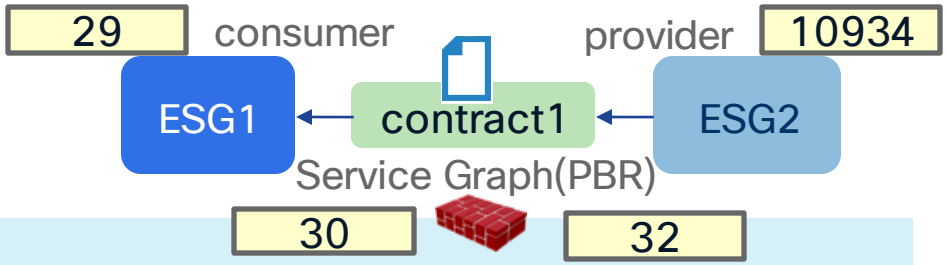


PBR
Forwarding and zoning-rules

Zoning-rules (1-node Service Graph)

- Without PBR (permit action)

```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+----------------+---------+---------+------------------+----------+----------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |      Dir       |  operSt |  Scope  |       Name       |  Action  |       Priority       |
+---------+--------+--------+----------+----------------+---------+---------+------------------+----------+----------------------+
<snip>
|    4157 |     29 |  10934 |       14 |         bi-dir | enabled | 2195459 | tenant1:contract1 |  permit  |    fully_qual(7)     |
|    4144 |  10934 |     29 |       14 | uni-dir-ignore | enabled | 2195459 | tenant1:contract1 |  permit  |    fully_qual(7)     |
+---------+--------+--------+----------+----------------+---------+---------+------------------+----------+----------------------+
```



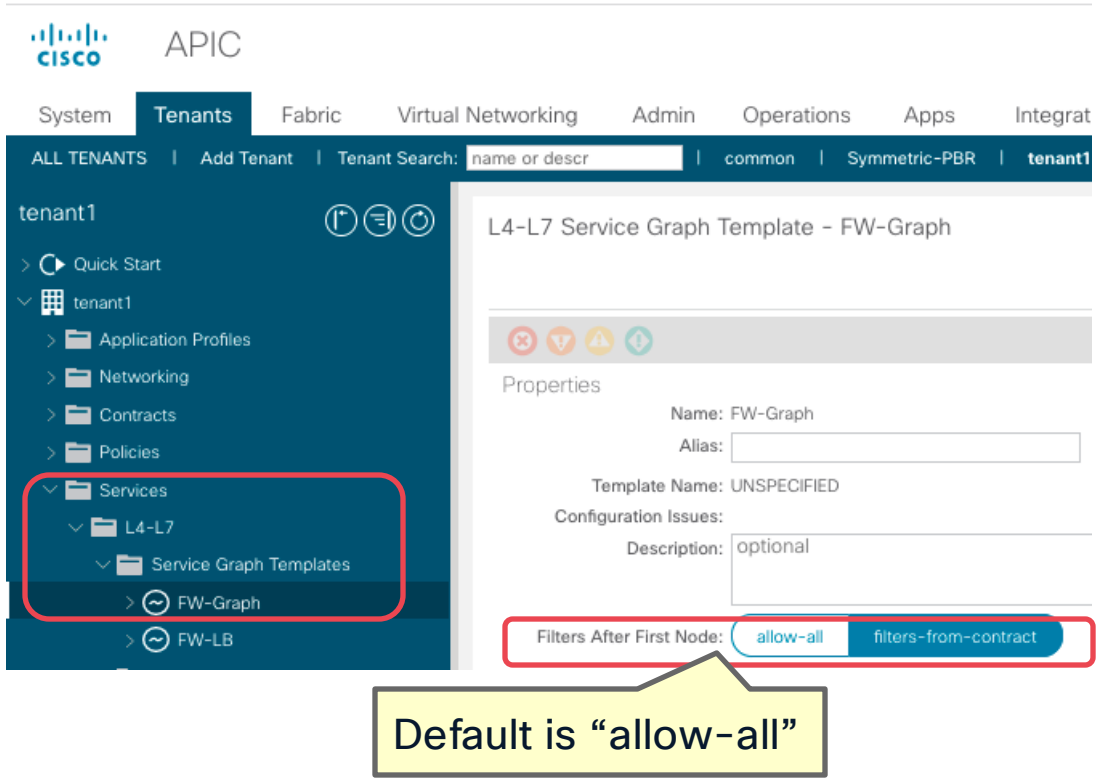
- With PBR (Service Graph)

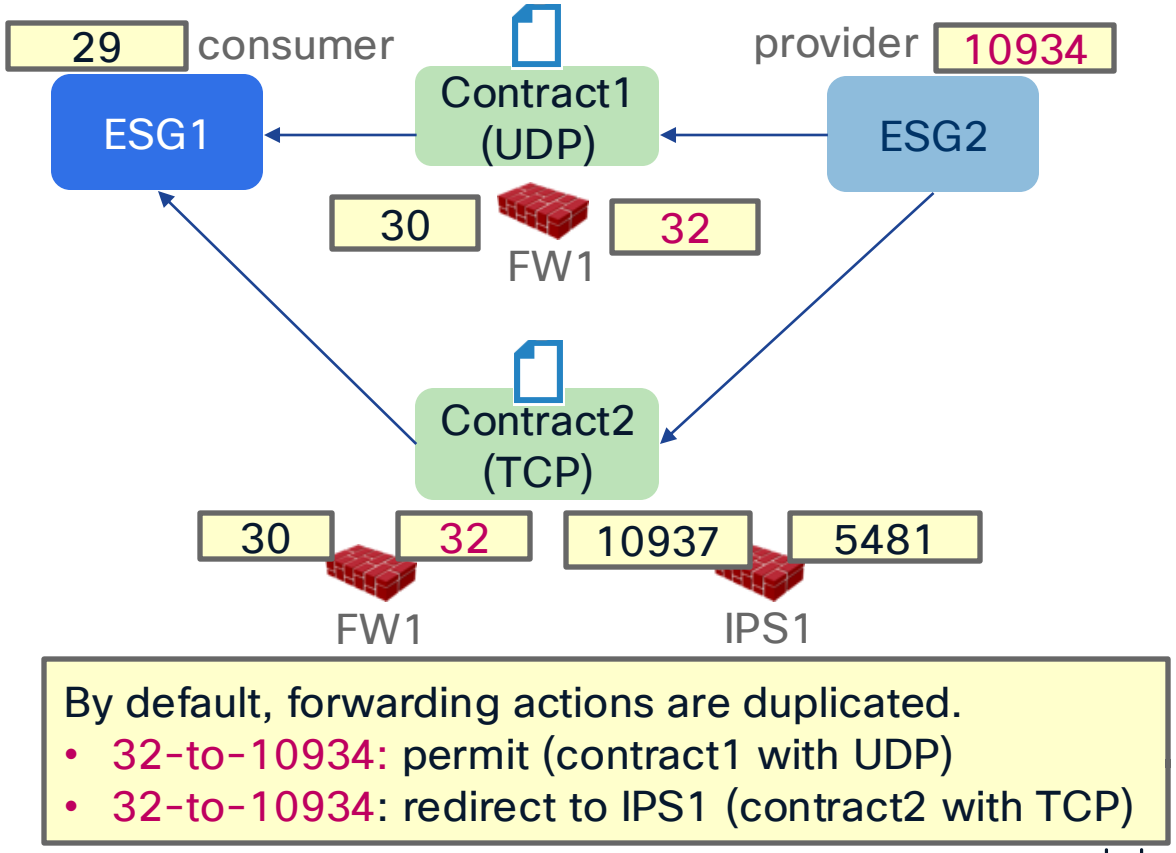
```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+----------------+---------+---------+------+------------------+----------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |      Dir       |  operSt |  Scope  | Name |       Action     |       Priority       |
+---------+--------+--------+----------+----------------+---------+---------+------+------------------+----------------------+
<snip>
|    4144 |     29 |  10934 |       14 |         bi-dir | enabled | 2195459 |      | redir(destgrp-11) |    fully_qual(7)     |
|    4157 |  10934 |     29 |       14 | uni-dir-ignore | enabled | 2195459 |      | redir(destgrp-12) |    fully_qual(7)     |
|    4140 |     32 |  10934 |  default |       uni-dir | enabled | 2195459 |      |       permit     |    src_dst_any(9)    |
|    4136 |     30 |     29 |       14 |       uni-dir | enabled | 2195459 |      |       permit     |    fully_qual(7)     |
+---------+--------+--------+----------+----------------+---------+---------+------+------------------+----------------------+
```

By default, unspecified default filter (any) is used for a zoning-rule entry without the consumer EPG.

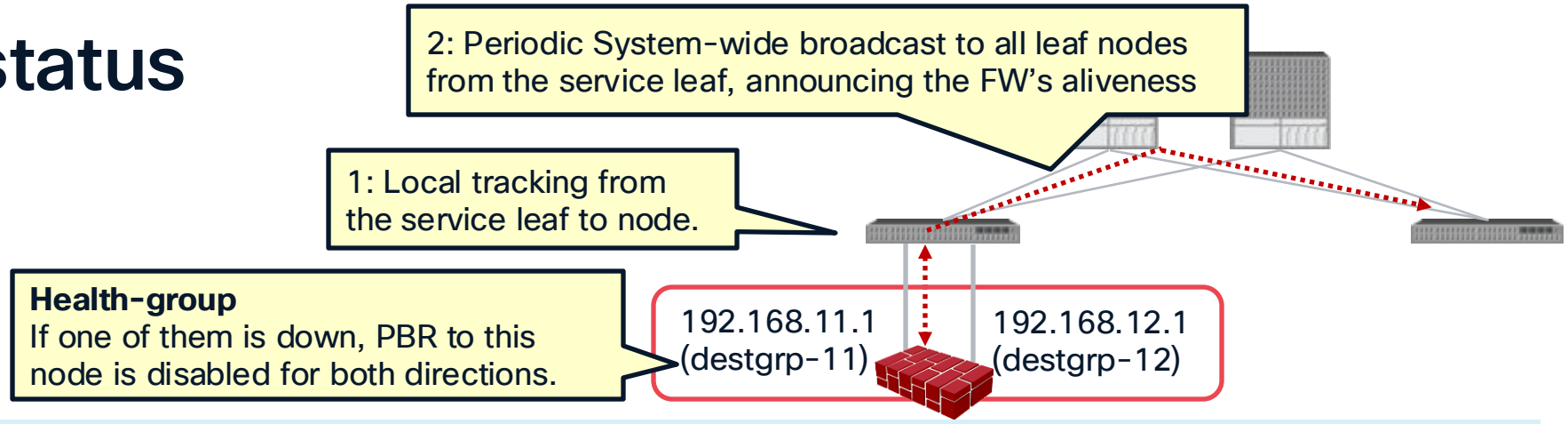
Filter-from-contract

- To use the specific filter in the contract, “filters-from-contract” needs to be checked.
- Use case: use a different forwarding action based on the filter.





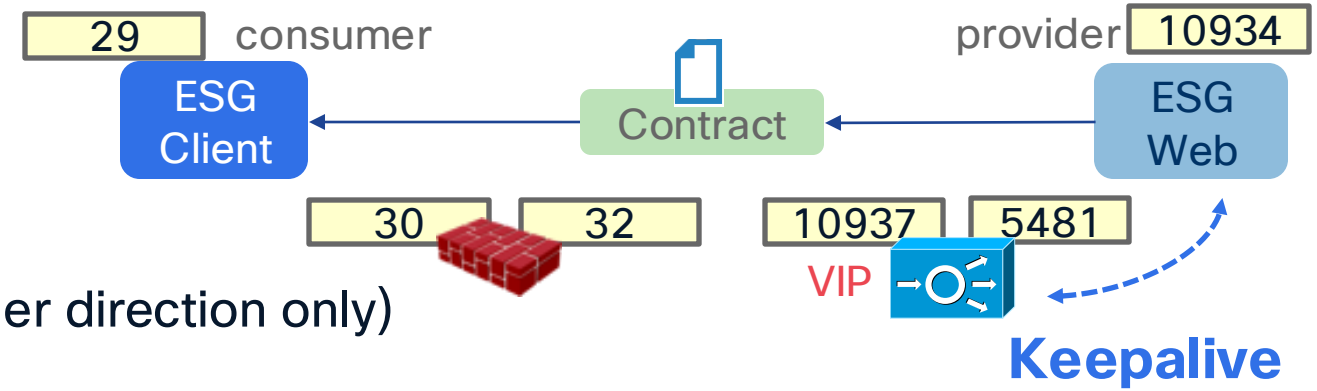
PBR destination status




```
Pod1-Leaf1# show service redir info
================================================================================================================================
LEGEND
TL: Threshold(Low)  |  TH: Threshold(High) |  HP: HashProfile  |  HG: HealthGrp  | BAC: Backup-Dest |  TRA: Tracking  | RES: Resiliency
================================================================================================================================
List of Dest Groups
GrpID Name            destination                              HG-name           BAC  operSt     operStQual      TL   TH   HP   TRAC RES
===== ====            ===========                              ==============    ===  =======    ============    ===  ===  ===  ===  ===
11    destgrp-11      dest-[192.168.11.1]-[vxlan-2195459]      tenant1::HG1      N    enabled    no-oper-grp     0    0    sym  yes  no
12    destgrp-12      dest-[192.168.12.1]-[vxlan-2195459]      tenant1::HG1      N    enabled    no-oper-grp     0    0    sym  yes  no


List of destinations
Name                                      bdVnid          vMac               vrf             operSt     operStQual      HG-name
====                                      ======          ====               ====            =====      =========       =======
dest-[192.168.11.1]-[vxlan-2195459]       vxlan-16678782  00:50:56:AF:6C:16  tenant1:VRF1    enabled    no-oper-dest    tenant1::HG1
dest-[192.168.12.1]-[vxlan-2195459]       vxlan-16121790  00:50:56:AF:DF:55  tenant1:VRF1    enabled    no-oper-dest    tenant1::HG1

List of Health Groups
HG-Name                                 HG-OperSt  HG-Dest                                                  HG-Dest-OperSt
=======                                 =========  =======                                                  ==============
tenant1::HG1                            enabled    dest-[192.168.11.1]-[vxlan-2195459]]                     up
                                                   dest-[192.168.12.1]-[vxlan-2195459]]                     up
```

Zoning-rules (2-nodes Service Graph)

- With Service Graph (PBR)
  - First node: FW (PBR for both directions)
  - Second node: LB (PBR for provider to consumer direction only)



- Consumer to provider direction
- Provider to consumer direction

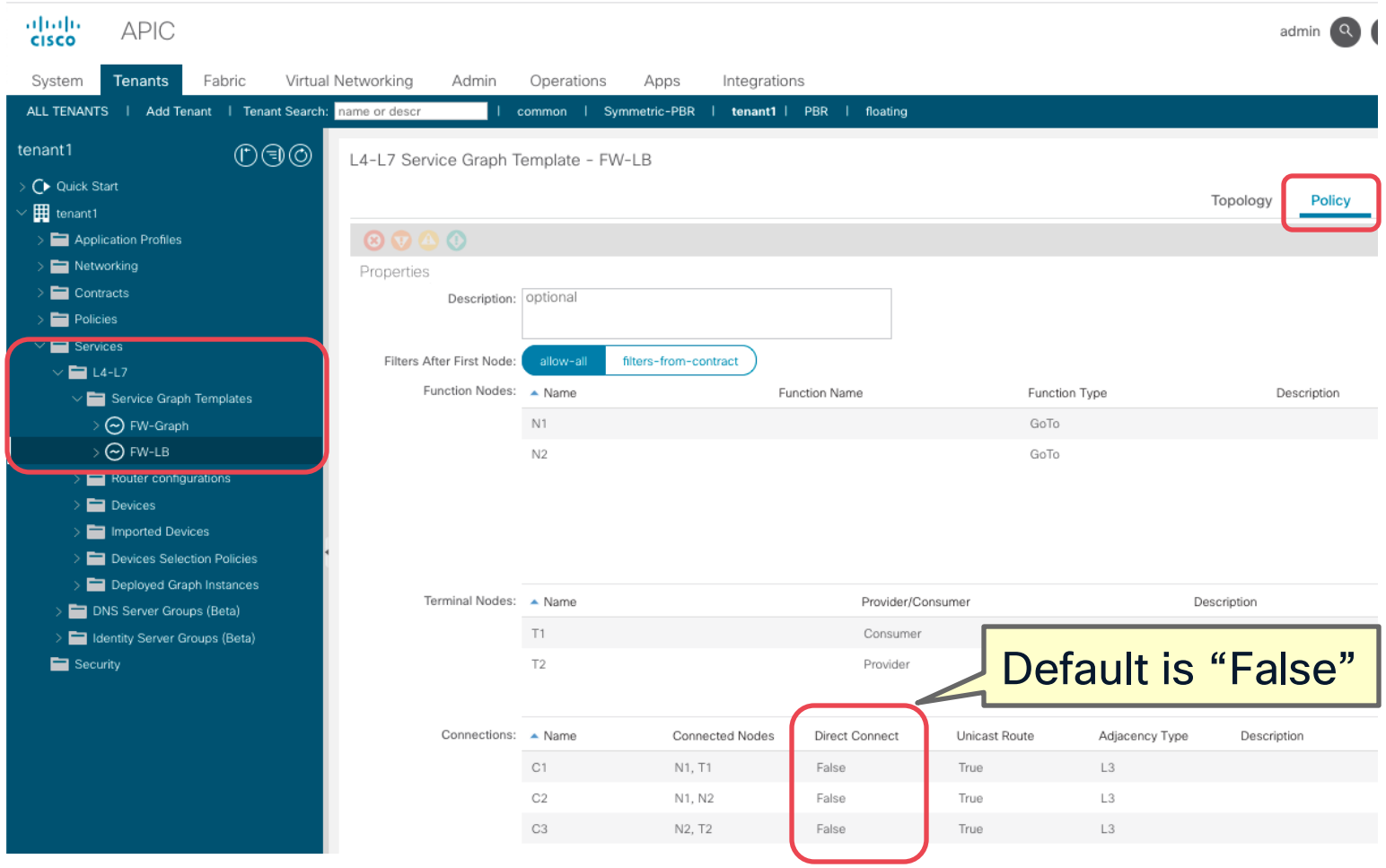
```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+----------------+---------+---------+------+------------------+---------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |      Dir       |  operSt |  Scope  | Name |       Action     |       Priority      |
+---------+--------+--------+----------+----------------+---------+---------+------+------------------+---------------------+
<snip>
|   4195  |   29   | 10937  |    14    |     bi-dir     | enabled | 2195459 |      | redir(destgrp-11) |    fully_qual(7)    |
|   4196  |   32   | 10937  | default  |    uni-dir     | enabled | 2195459 |      |       permit      |    src_dst_any(9)   |
|   4193  |  5481  | 10934  | default  |    uni-dir     | enabled | 2195459 |      |       permit      |    src_dst_any(9)   |
|   4198  | 10934  |   29   |    14    |    uni-dir     | enabled | 2195459 |      | redir(destgrp-17) |    fully_qual(7)    |
|   4181  | 10937  |   29   |    14    | uni-dir-ignore | enabled | 2195459 |      | redir(destgrp-12) |    fully_qual(7)    |
|   4194  |   30   |   29   |    14    |    uni-dir     | enabled | 2195459 |      |       permit      |    fully_qual(7)    |
+---------+--------+--------+----------+----------------+---------+---------+------+------------------+---------------------+
```

To permit traffic from the provider EPG to the LB (10934 to 5481), Direct Connect option must be enabled.

Direct Connect (False by default)

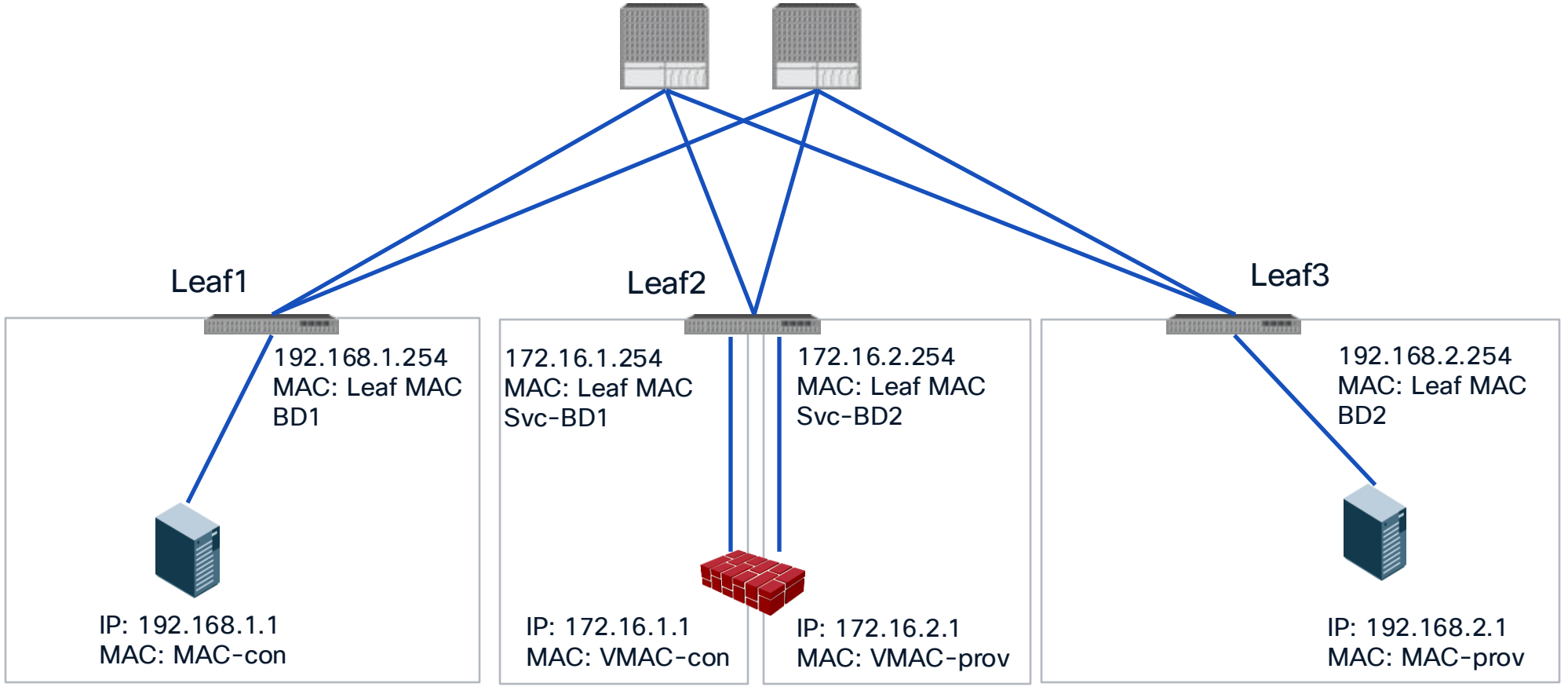
Direct Connect must be “True” for communication between the consumer/provider endpoint and the PBR destination.

- Tenant > Services > L4-L7 > Service Graph templates > Service Graph_NAME > Policy



How forwarding works

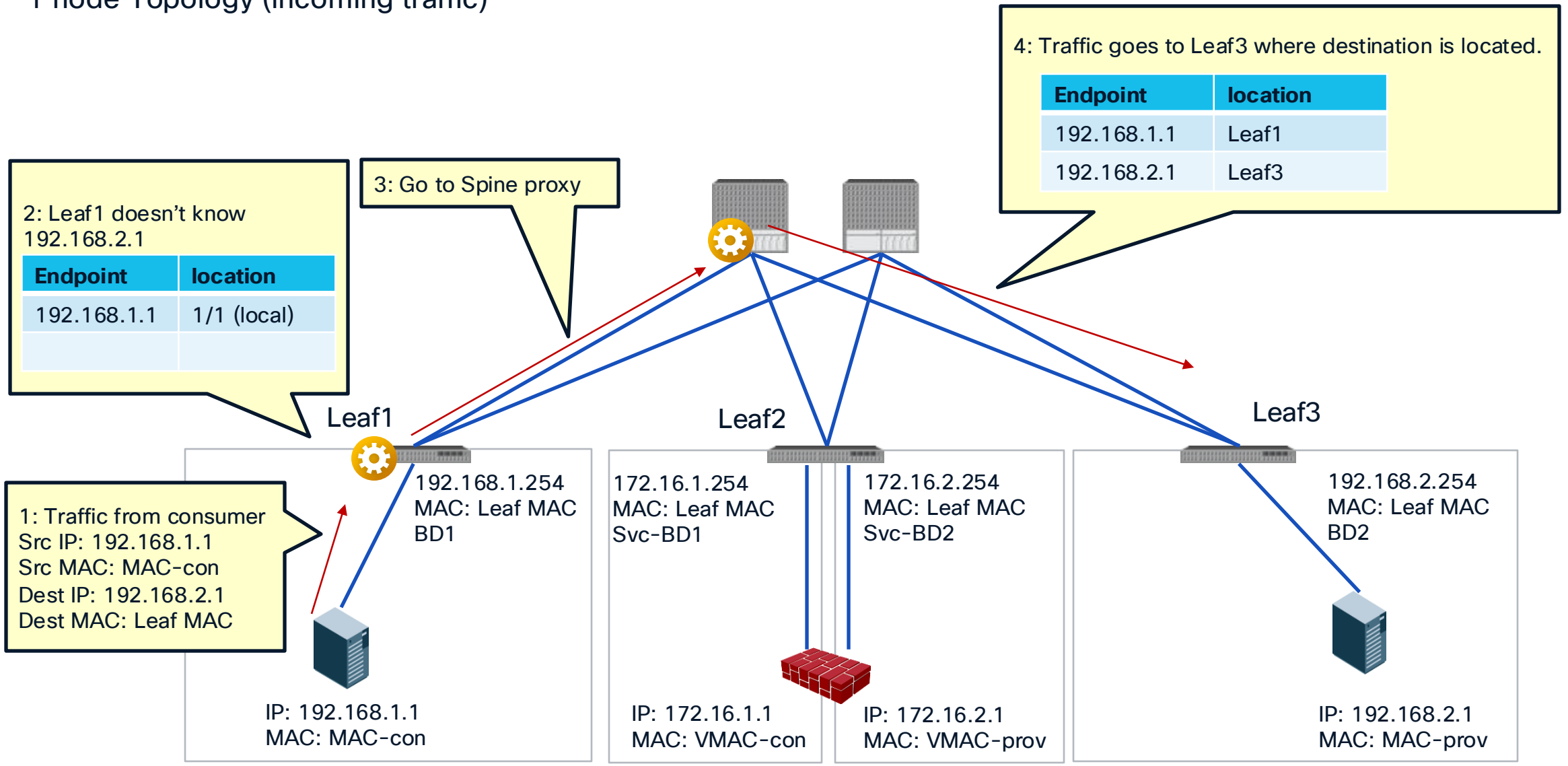
1 node Topology



How forwarding works

= VXLAN Encap/Decap

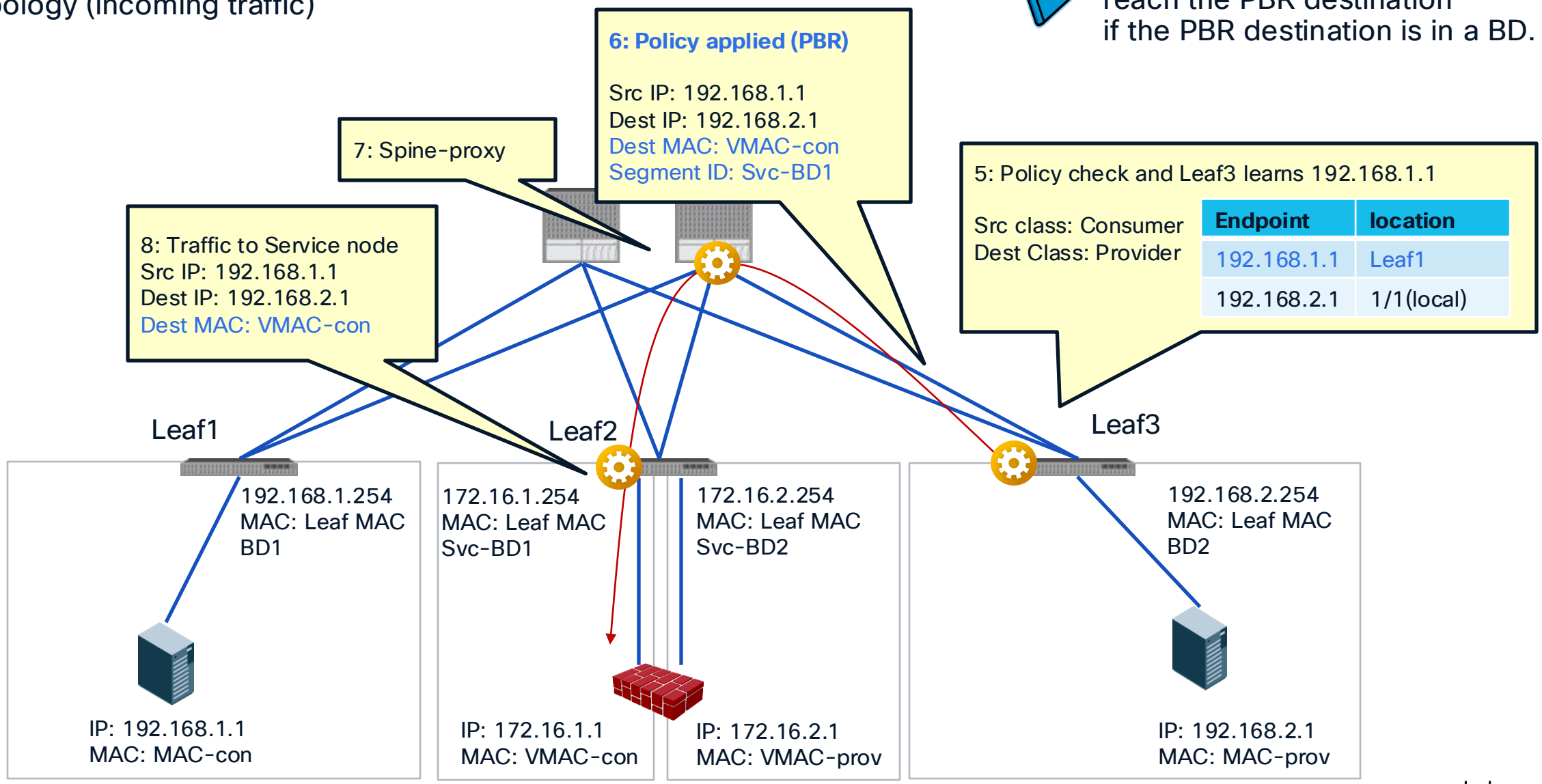
1 node Topology (incoming traffic)



How forwarding works

1 node Topology (incoming traffic)

Leaf applies policy.
It's always spine-proxy to reach the PBR destination if the PBR destination is in a BD.

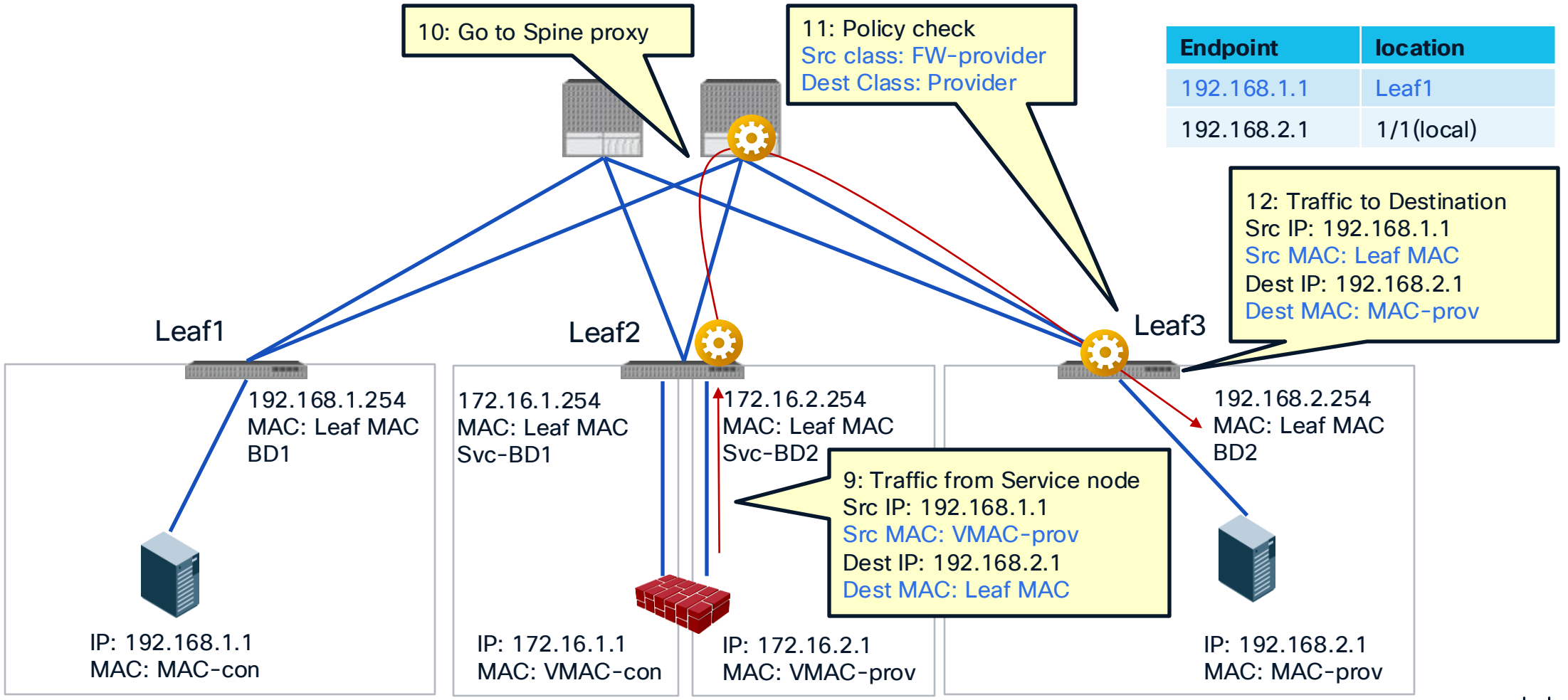


How forwarding works

1 node Topology (incoming traffic)

Dataplane IP learning is automatically disabled for the service EPG. (starting from 3.1)

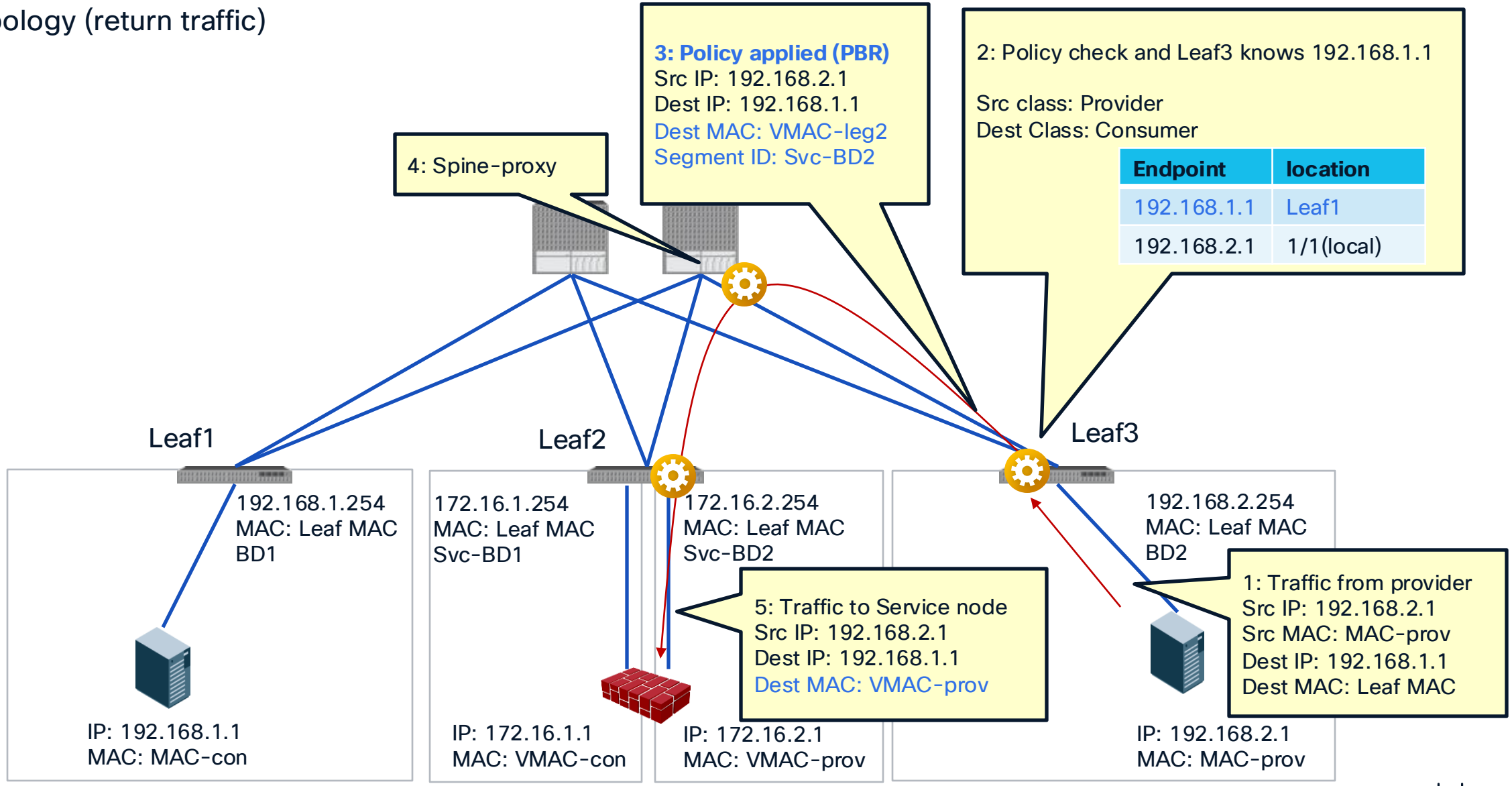
Leaf3 doesn't re-learn 192.168.1.1 here
Because of disable dataplane IP learning



Endpoint	location
192.168.1.1	Leaf1
192.168.2.1	1/1(local)

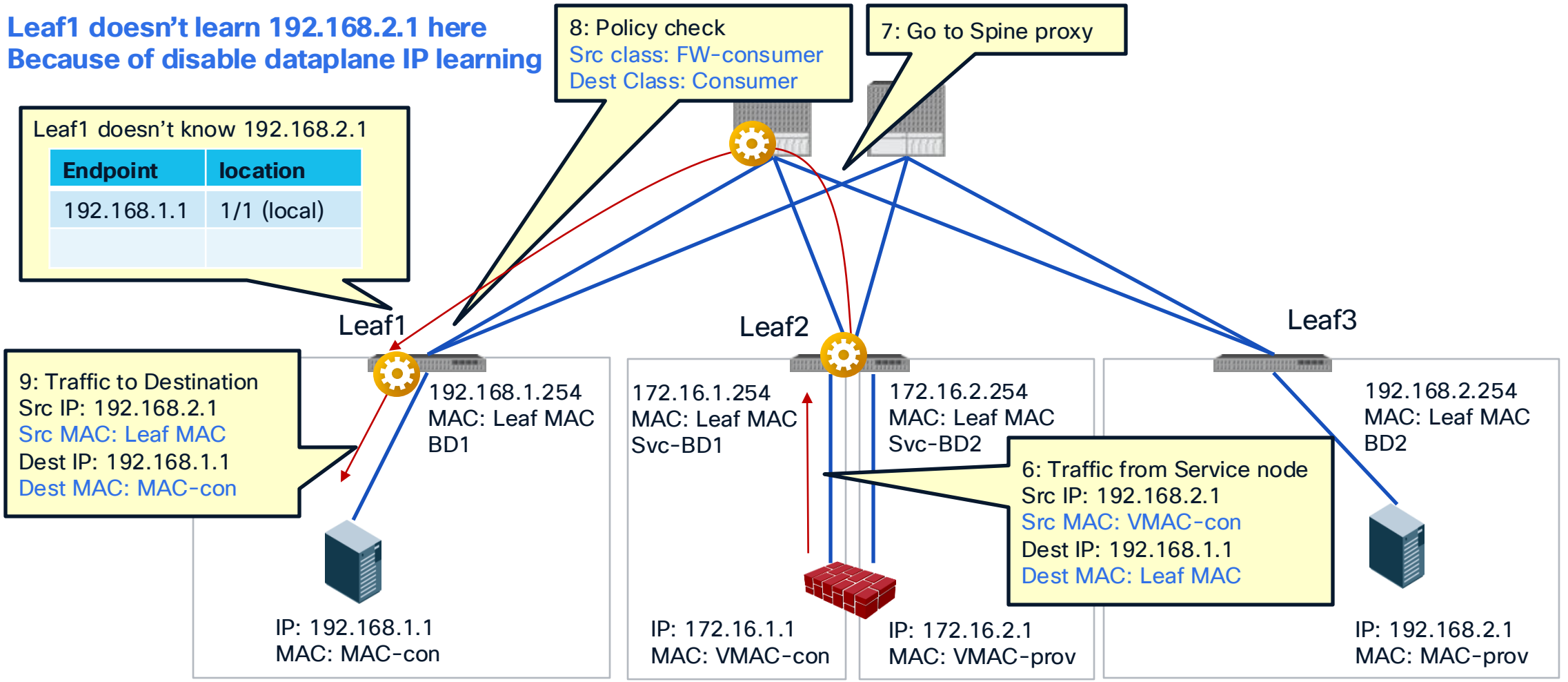
How forwarding works

1 node Topology (return traffic)



How forwarding works

1 node Topology (return traffic)



Where is the policy applied?

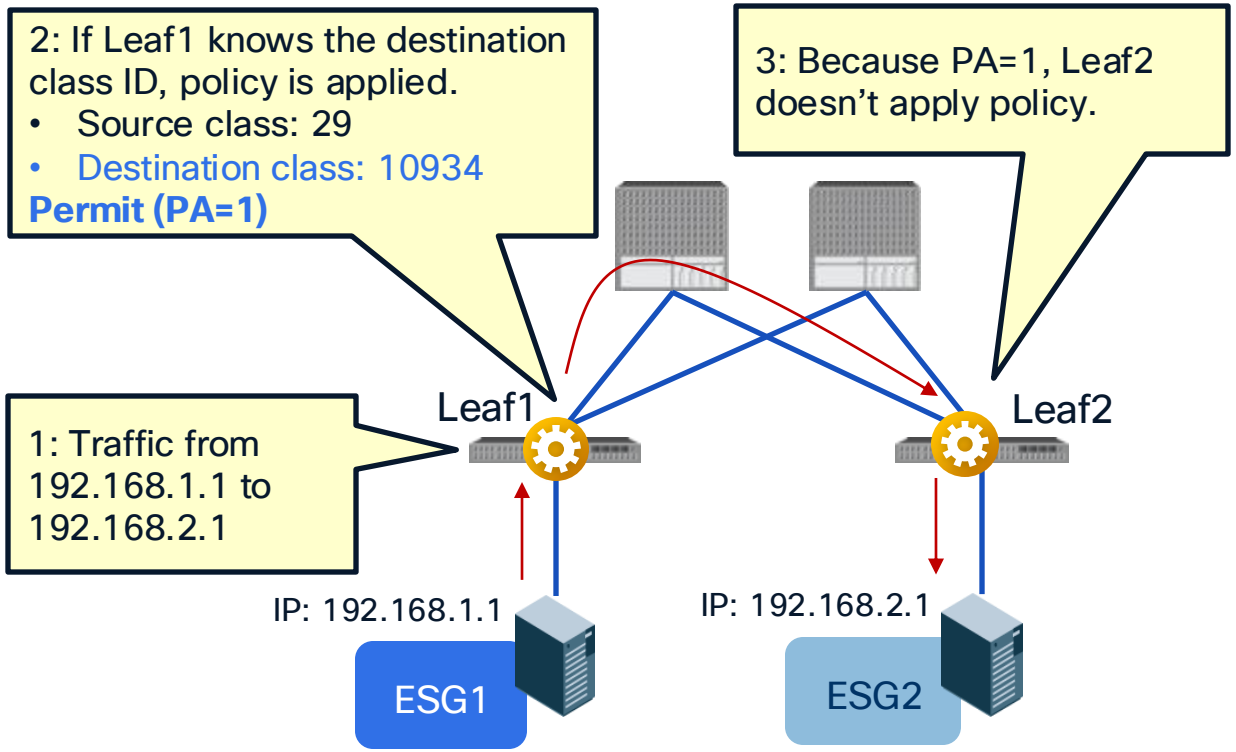
Please see ACI Contract guide for detail

Scenario	VRF enforcement mode	Consumer	Provider	Policy enforced on
Intra-VRF	Ingress/egress	EPG	EPG	• If destination endpoint is learned: ingress leaf • If destination endpoint is not learned: egress leaf
	ingress	EPG	L3Out EPG	Consumer leaf (non-border leaf)
	ingress	L3Out EPG	EPG	Provider leaf (non-border leaf)
	egress	EPG	L3Out EPG	Border leaf -> non-border leaf traffic • If destination endpoint is learned: border leaf • If destination endpoint is not learned: non-border leaf Non-border leaf-> border leaf traffic • Border leaf
	egress	L3Out EPG	EPG	
	Ingress/egress	L3Out EPG	L3Out EPG	Ingress leaf
Inter-VRF	Ingress/egress	EPG	EPG	Consumer leaf
	Ingress/egress	EPG	L3Out EPG	Consumer leaf (non-border leaf)
	Ingress/egress	L3Out EPG	EPG	Ingress leaf
	Ingress/egress	L3Out EPG	L3Out EPG	Ingress leaf

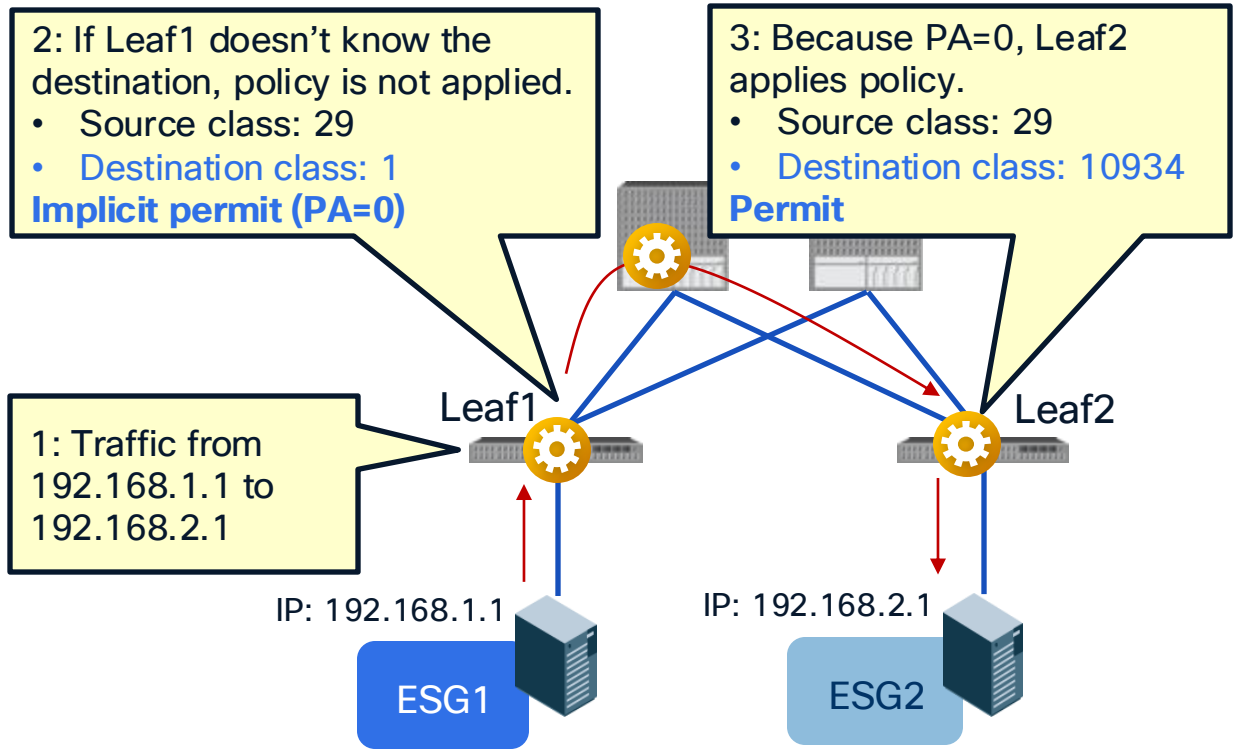
How ingress/egress leaf enforcement works?

Policy Applied (PA) bit

- Intra-VRF ESG-to-ESG egress leaf enforcement



- Intra-VRF ESG-to-ESG ingress leaf enforcement



Contract Priority

Look at your zoning-rule priority and then filter priority!

Please see
ACI Contract guide
for detail

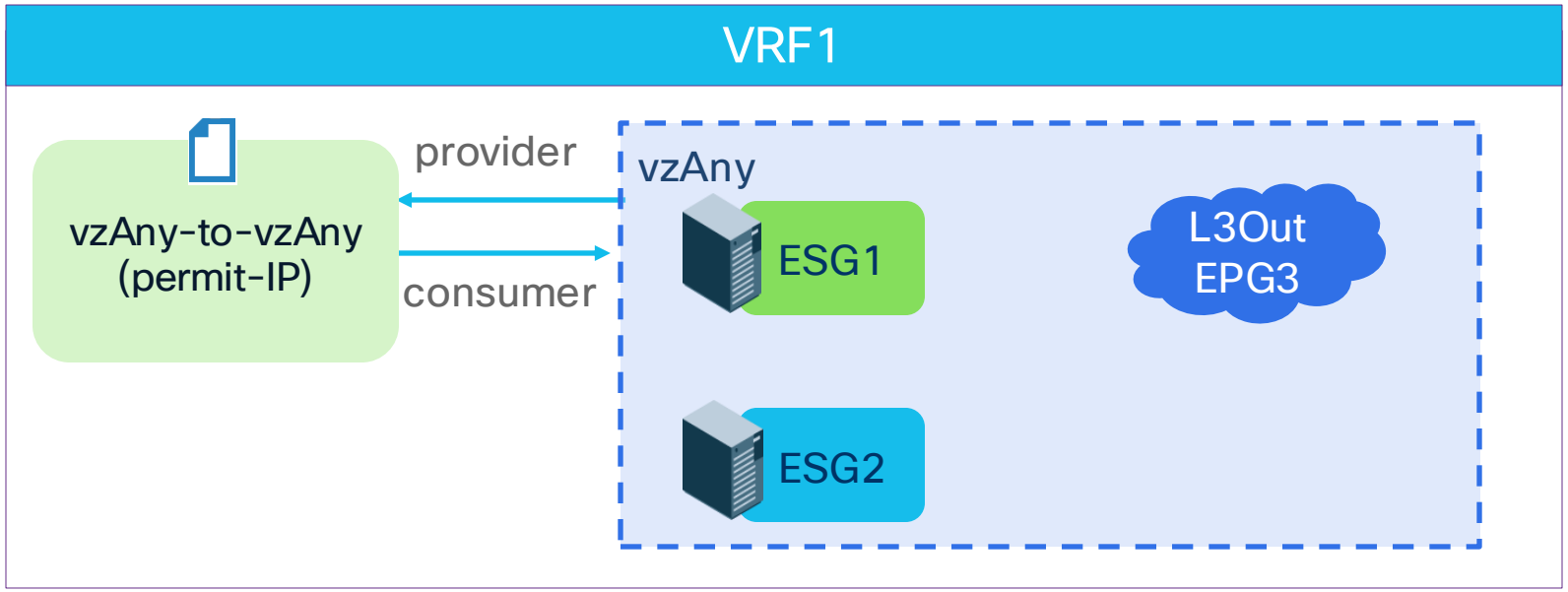
- More specific EPGs win over vzAny and preferred groups.
  - EPG-to-EPG wins over EPG-to-vzAny/vzAny-to-EPG that wins over vzAny-to-vzAny.
  - Specific source wins over specific destination. (EPG-to-vzAny wins over vzAny-to-EPG)

- Deny actions win. Specific protocol wins.
  - If the zoning-rule priority is the same, deny wins over redirect or permit action.
  - Between redirect and permit, a more specific protocol and a specific L4 protocol wins.

- More specific L4 rules win.
  - Specific filter wins over “any” filter.
  - Specific destination wins over specific source (“s-any to d-80” wins over “s-80 to d-any”)

Example 1

What's the forwarding action?

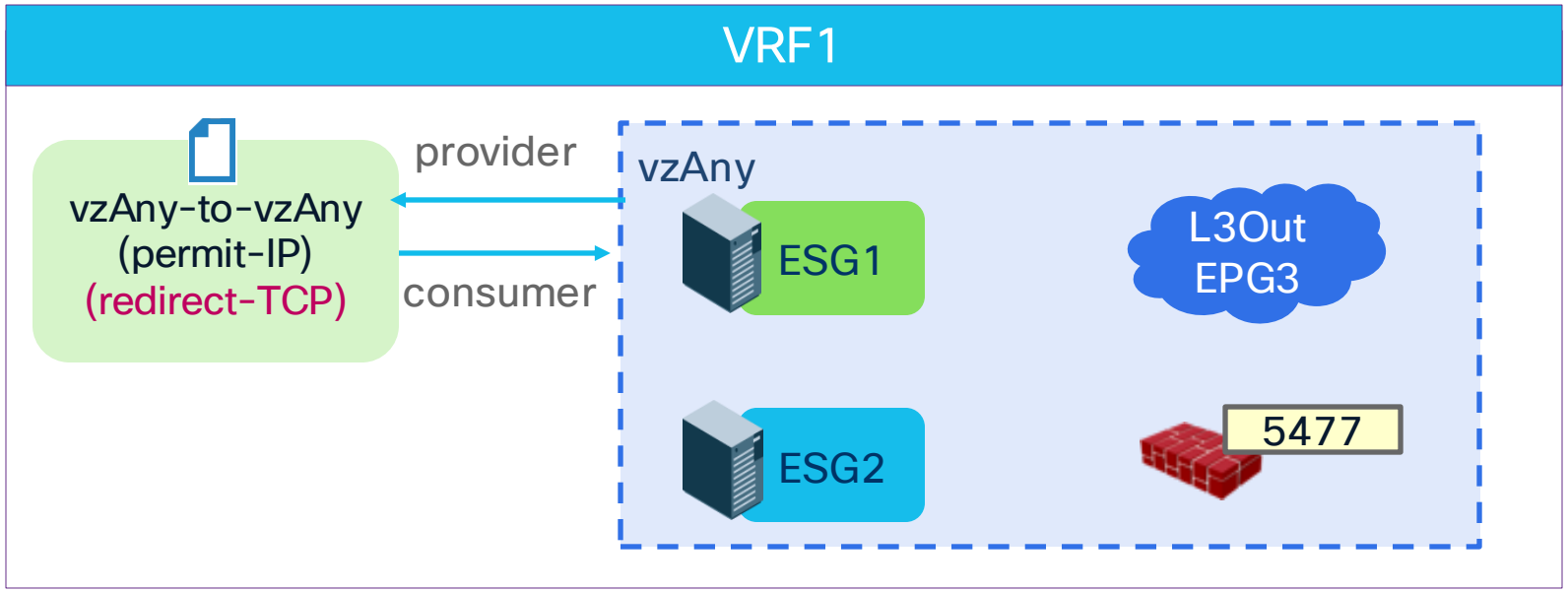


- ESG1-to-ESG2 (IP)
  - Permit
- ESG1-to-L3OutEPG3 (IP)
  - Permit
- ESG2-to-L3OutEPG3 (IP)
  - Permit

```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+---------+---------+---------+-------------------------+------------------+--------------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |   Dir   |  operSt |  Scope  |          Name           |       Action     |         Priority         |
+---------+--------+--------+----------+---------+---------+---------+-------------------------+------------------+--------------------------+
<snip>
|   4194  |   0    |   0    |    74    | uni-dir | enabled | 2195459 | tenant1:vzAny-to-vzAny  |      permit      |    any_any_filter(17)    |
+---------+--------+--------+----------+---------+---------+---------+-------------------------+------------------+--------------------------+
```

Example 2

What's the forwarding action?



- ESG1-to-ESG2 (TCP)
  - Redirect
- ESG1-to-ESG2 (UDP)
  - Permit

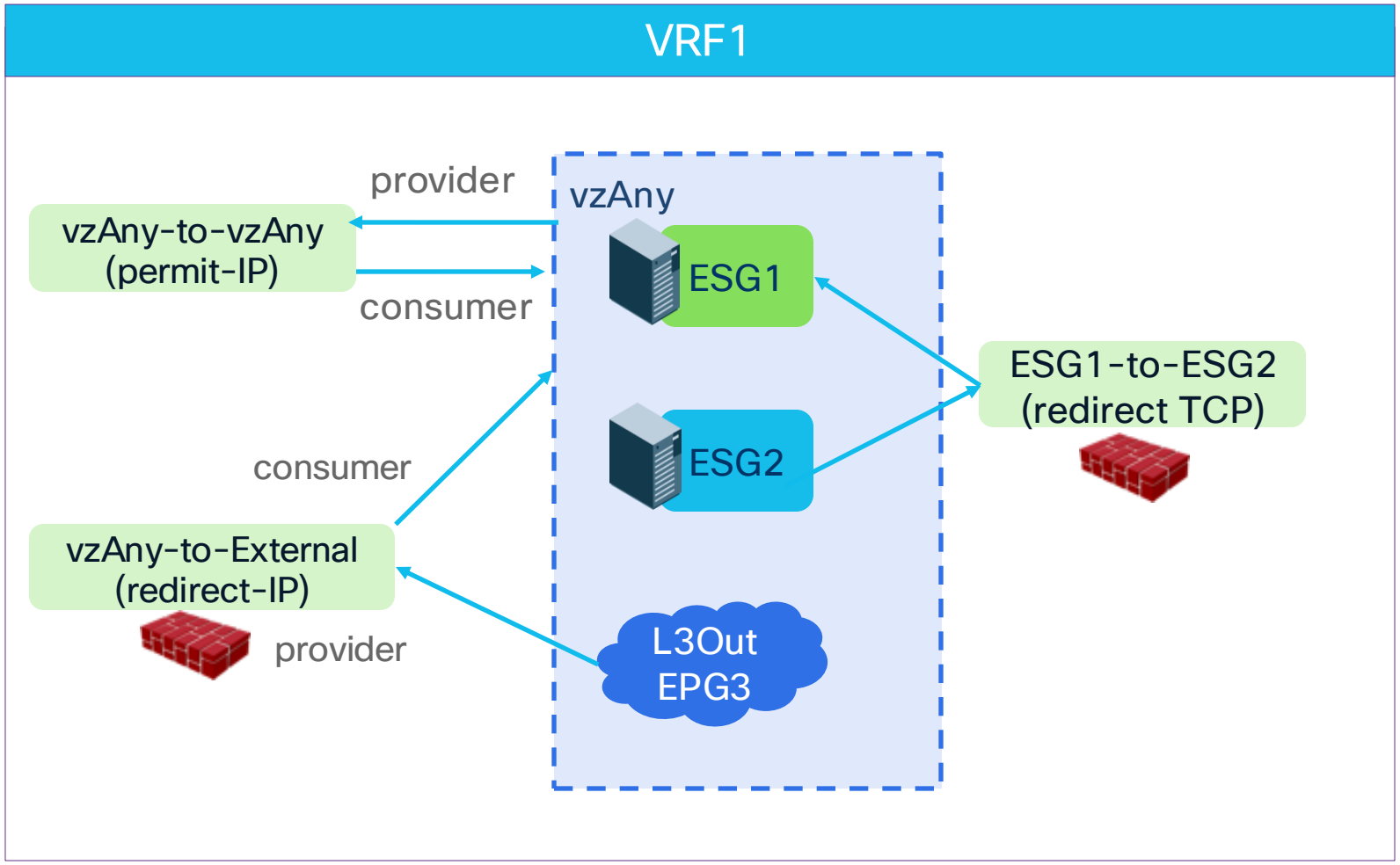
More specific L4 rules win though the zoning-rule priority is the same.

```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+---------+---------+---------+------------------------+--------------------+-------------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |   Dir   |  operSt |  Scope  |          Name          |       Action       |        Priority         |
+---------+--------+--------+----------+---------+---------+---------+------------------------+--------------------+-------------------------+
<snip>
|   4194  |   0    |   0    |    74    | uni-dir | enabled | 2195459 | tenant1:vzAny-to-vzAny |       permit       |    any_any_filter(17)   |
|   4248  |   0    |   0    |    14    | uni-dir | enabled | 2195459 |                        | redir(destgrp-20)  |    any_any_filter(17)   |
|   4186  |  5477  |   0    |    14    | uni-dir | enabled | 2195459 |                        |       permit       | shsrc_any_filt_perm(10) |
|   4193  |  5477  |   0    | default  | uni-dir | enabled | 2195459 |                        |       permit       |  shsrc_any_any_perm(11) |
+---------+--------+--------+----------+---------+---------+---------+------------------------+--------------------+-------------------------+
```

In this example:
- Filter ID 74: Permit-IP all
- Filter ID 14: Permit-TCP all

Example 3

What's the forwarding action?



- ESG1-to-ESG2 (TCP)
  - Redirect
- ESG1-to-L3OutEPG3 (IP)
  - Redirect
- ESG1-to-ESG2 (UDP)
  - Permit

Example 3

Why?

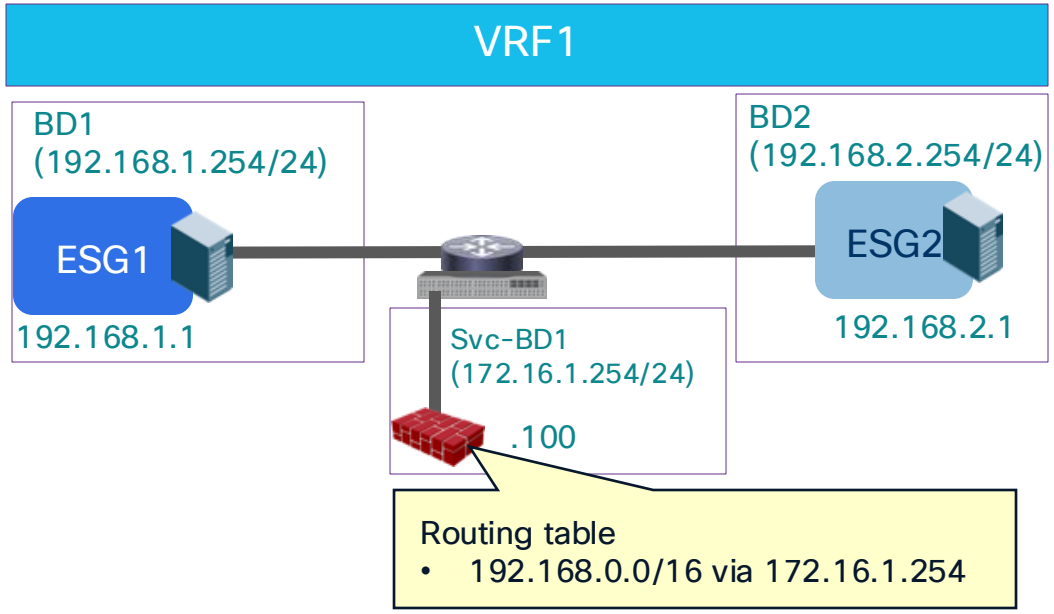
- ESG-to-ESG (priority 7) wins over External-to-vzAny/vzAny-to-External (priority 13 or 14) that wins over vzAny-to-vzAny (priority 17).

```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+----------------+---------+---------+-----------------------+-----------------+-------------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |      Dir       |  operSt |  Scope  |          Name         |      Action     |         Priority        |
+---------+--------+--------+----------+----------------+---------+---------+-----------------------+-----------------+-------------------------+
<snip>
|   4194  |   0    |   0    |    74    |    uni-dir     | enabled | 2195459 | tenant1:vzAny-to-vzAny |      permit     |    any_any_filter(17)   |

|   4172  |   0    | 32782  |    74    |    uni-dir     | enabled | 2195459 |                       | redir(destgrp-1) |   any_dest_filter(14)   |
|   4196  |  5477  | 32782  | default  |    uni-dir     | enabled | 2195459 |                       |      permit      |      src_dst_any(9)     |
|   4201  | 32782  |   0    |    74    |    uni-dir     | enabled | 2195459 |                       | redir(destgrp-1) |    src_any_filter(13)   |
|   4242  |  5477  |   0    |    74    |    uni-dir     | enabled | 2195459 |                       |      permit      | shsrc_any_filt_perm(10) |

|   4186  |   24   | 10936  |    14    |     bi-dir     | enabled | 2195459 |                       | redir(destgrp-1) |      fully_qual(7)      |
|   4193  |  5477  | 10936  | default  |    uni-dir     | enabled | 2195459 |                       |      permit      |      src_dst_any(9)     |
|   4209  |  5477  |   24   |    14    |    uni-dir     | enabled | 2195459 |                       |      permit      |      fully_qual(7)      |
|   4248  | 10936  |   24   |    14    | uni-dir-ignore | enabled | 2195459 |                       | redir(destgrp-1) |      fully_qual(7)      |

+---------+--------+--------+----------+----------------+---------+---------+-----------------------+-----------------+-------------------------+
```

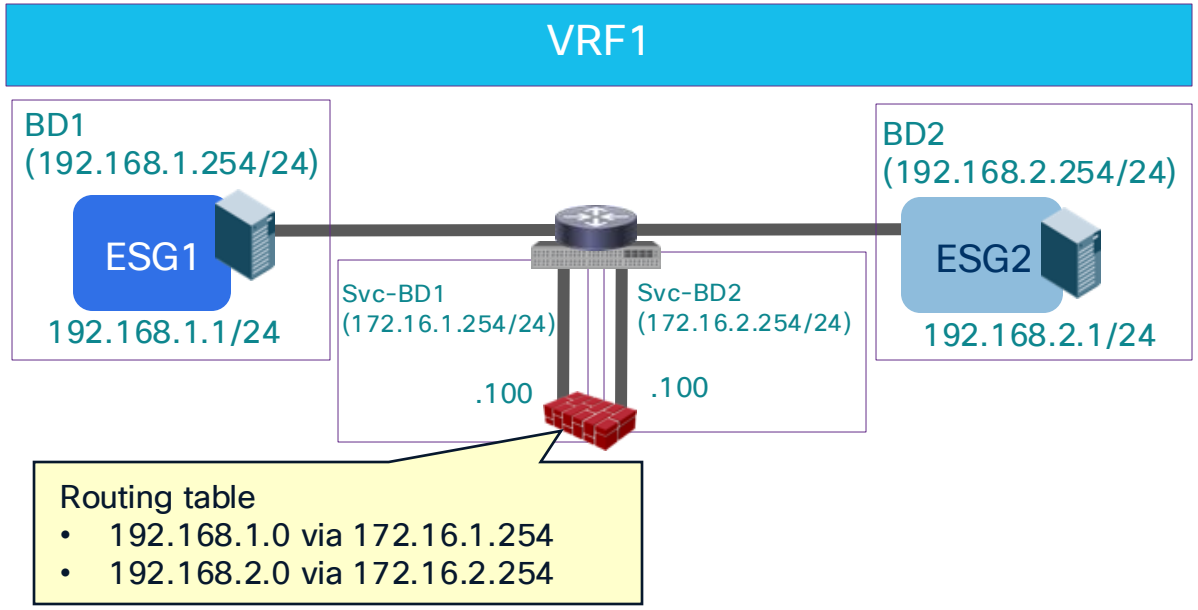
FAQs and advanced use cases

One-arm vs Two-arm?

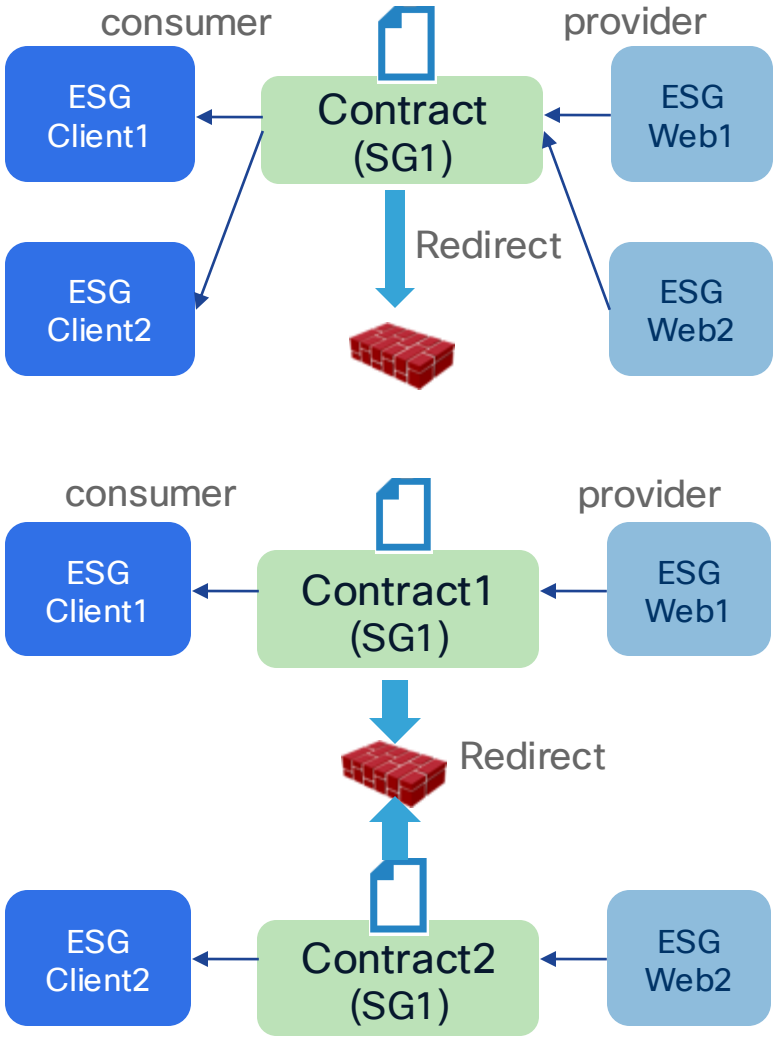
- One-arm
  - Simple routing design on service node.
  - One-arm must be used for intra-subnet or intra-EPG/ESG contract.
  - Some firewall doesn't allow intra-interface traffic by default.



- Two-arm
  - Need to manage routing design on service node.
  - Different security level on each interface.



Can we reuse same PBR destination multiple times?

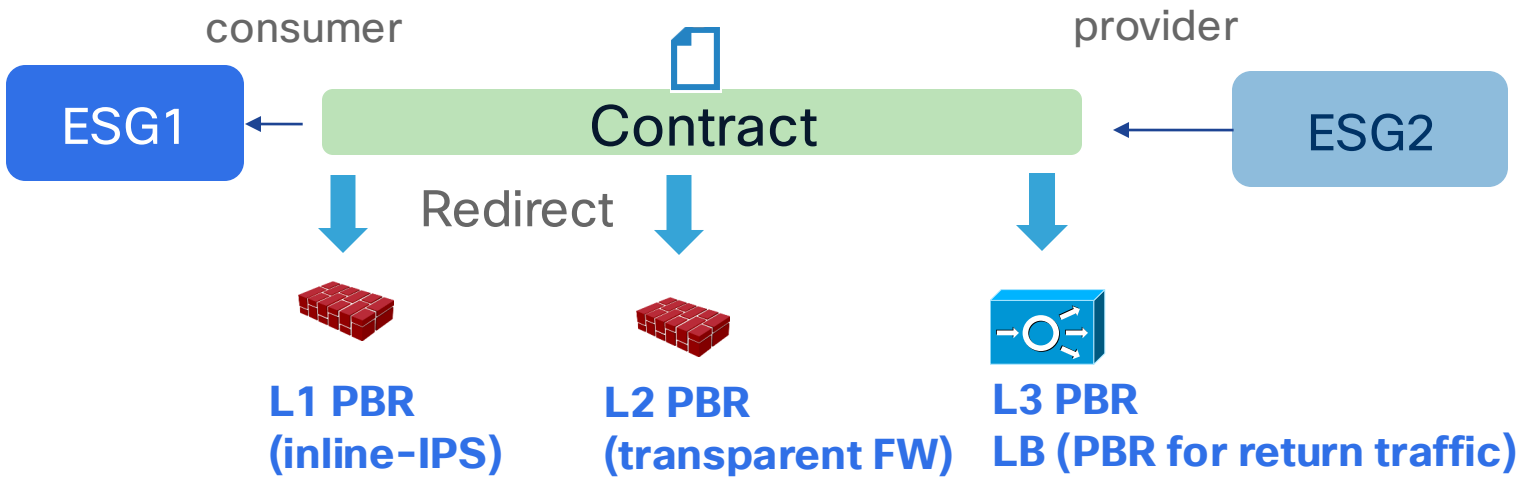


- Multiple consumer/provider ESGs/EPGs
- Multiple contracts can use the same PBR destination and Service Graph.

- Note
  - It could consume more TCAM resources if many EPGs consume and provide the same contract. The use of vzAny or ESG might be more efficient.
  - Depending on routing design, one-arm mode deployment may be required.

What types of devices can be PBR destinations?

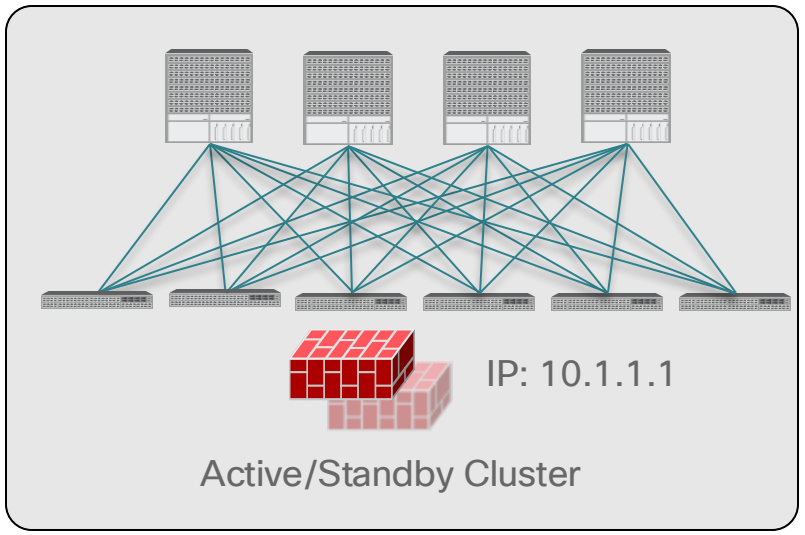
- Prior to ACI Release 5.0, a PBR destination must be an L3 routed device (L3 PBR).
- Starting from ACI Release 5.0, L1/L2 PBR is supported to insert L1/L2 devices.
  - Insert firewall without relying on BD/VLAN stitching.
  - L1/L2 service device BD must be dedicated BD that cannot be shared with other endpoints.
  - L1/L2/L3 PBR can be mixed in a service graph.



What are HA options?

One PBR destination IP
One Logical device with two concrete devices

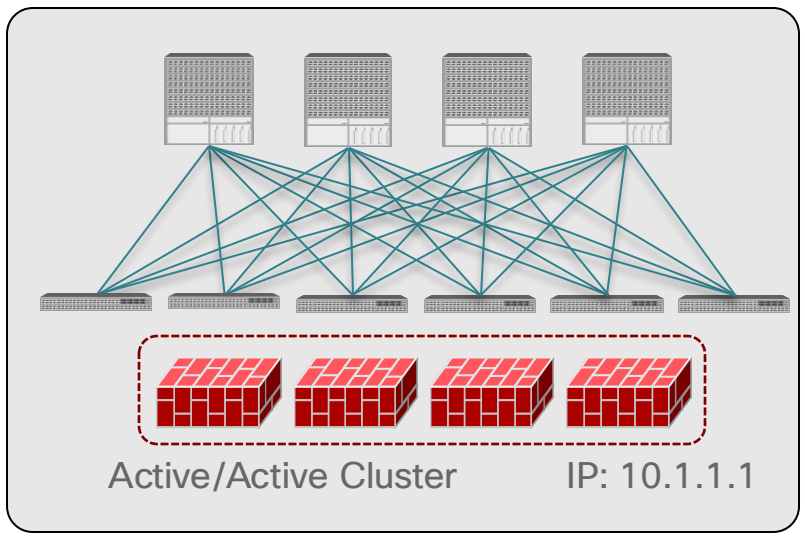
Active/Standby Cluster



- PBR is not mandatory
- The Active/Standby pair represents a single MAC/IP entry.

One PBR destination IP
One Logical device with one concrete device

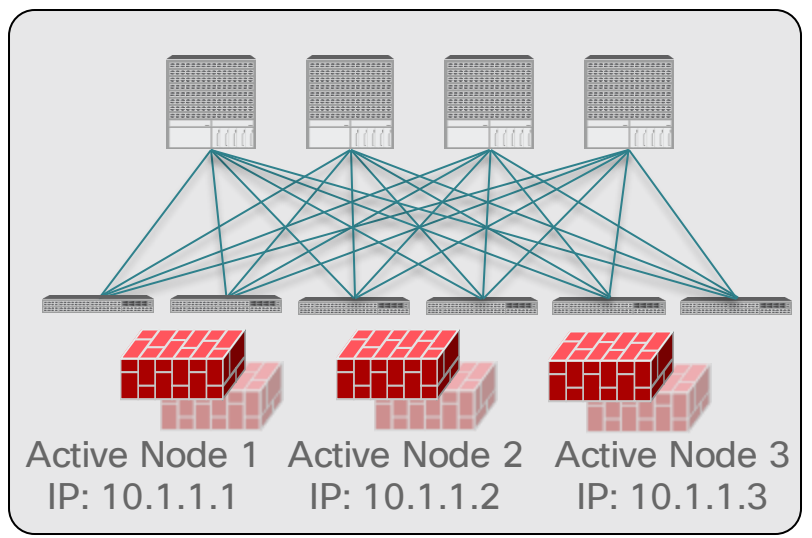
Active/Active Cluster ('Scale-Up' Model)



- PBR is required if the cluster is stretched across pods.
- The Active/Active cluster represents a single MAC/IP entry.
- Spanned Ether-Channel Mode supported with Cisco ASA/FTD platforms

Multiple PBR destination IPs (Symmetric PBR)
One Logical device with multiple concrete devices

Independent Active Nodes ('Scale-Out' Model)

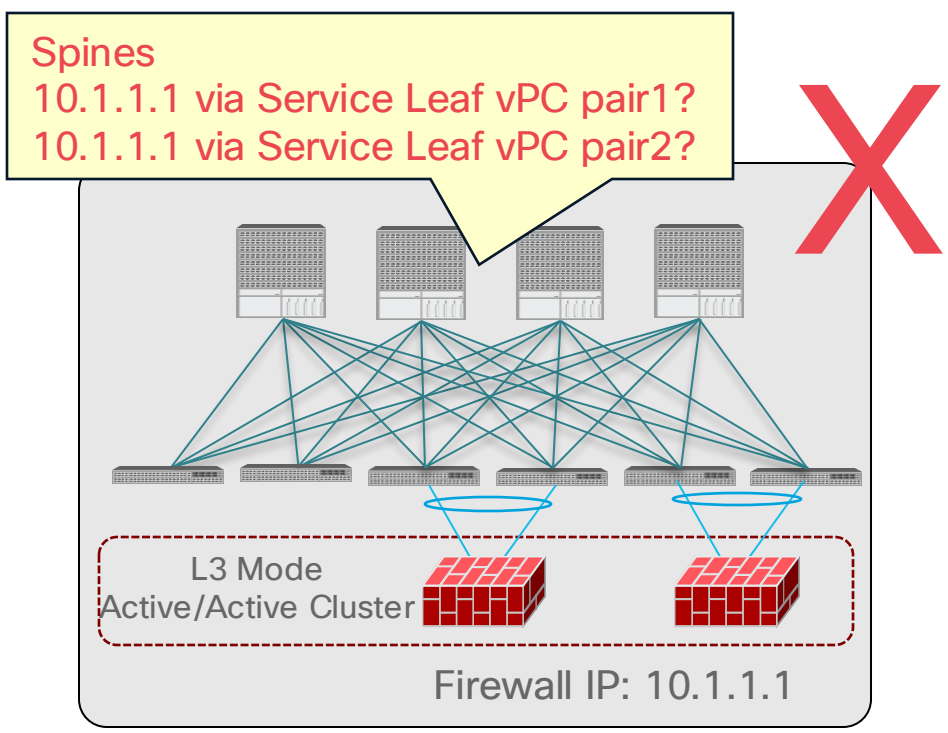


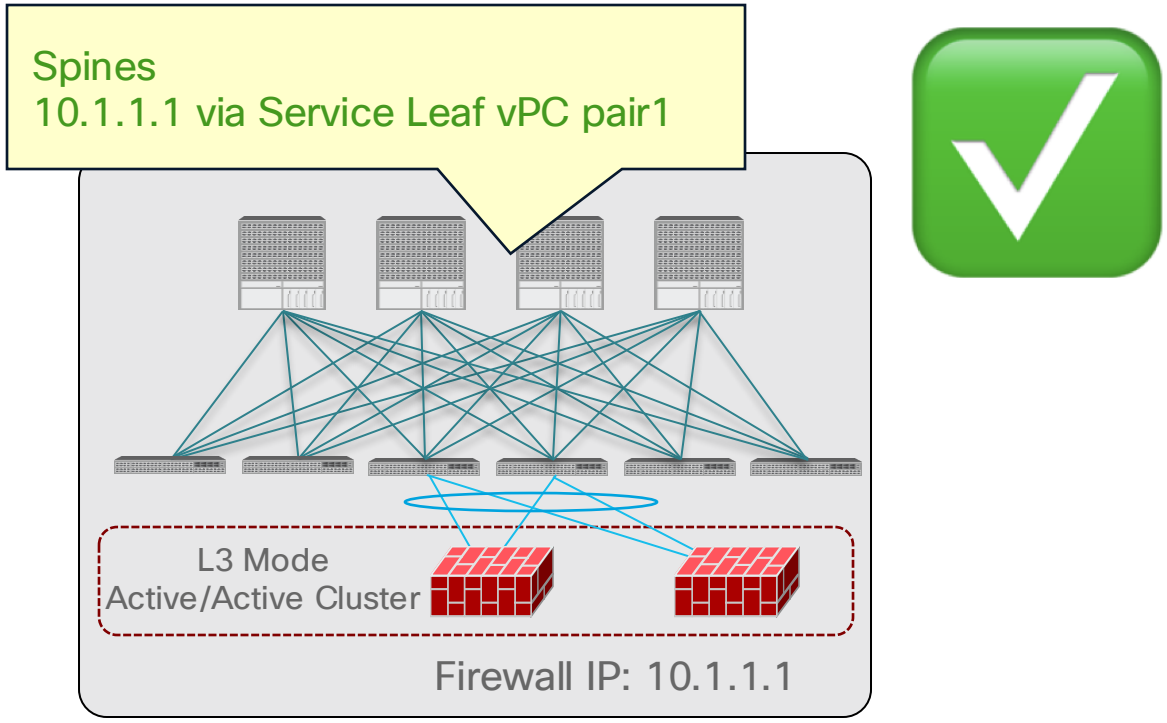
- PBR is required.
- Each Active node represent a unique MAC/IP entry.
- Use of Symmetric PBR to ensure each flow is handled by the same Active node in both directions

Active/Active cluster

One PC/vPC to all devices in the cluster

- Firewalls in the same cluster must be connected via the same PC/vPC in each pod. Otherwise, the same endpoint will be learned via different locations, which results in endpoint flapping.

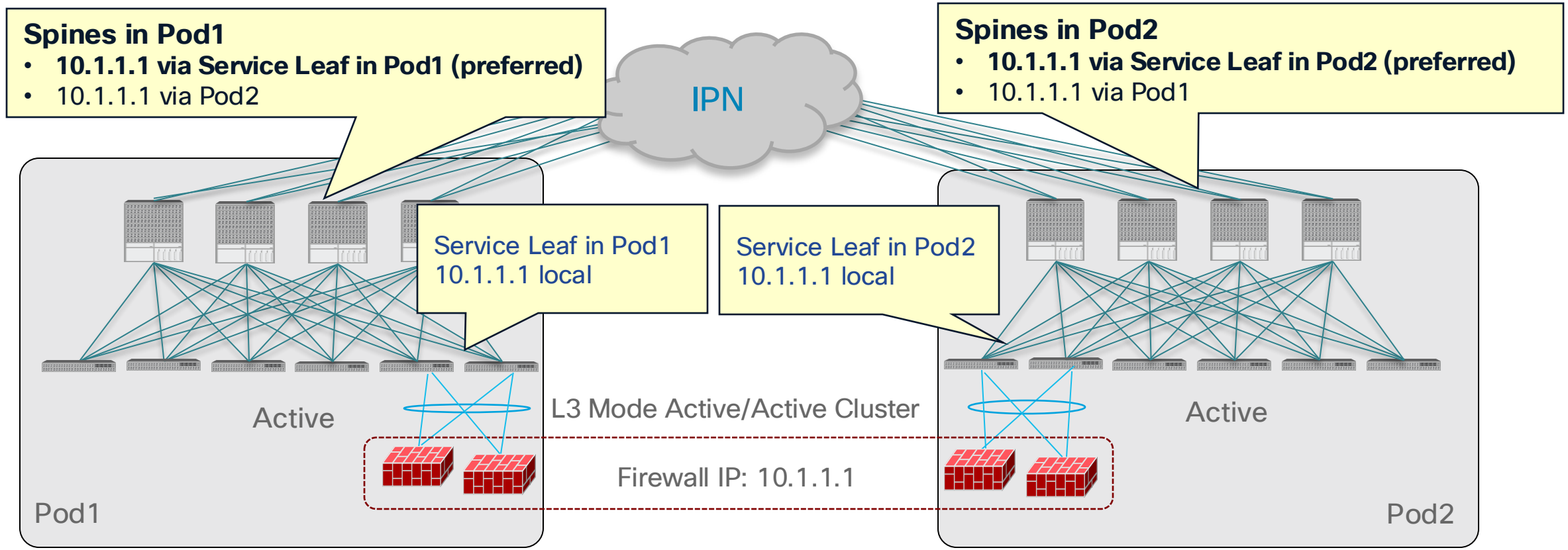




Active/Active cluster across pods

Anycast service

- For Multi-pod, Anycast service feature must be enabled.

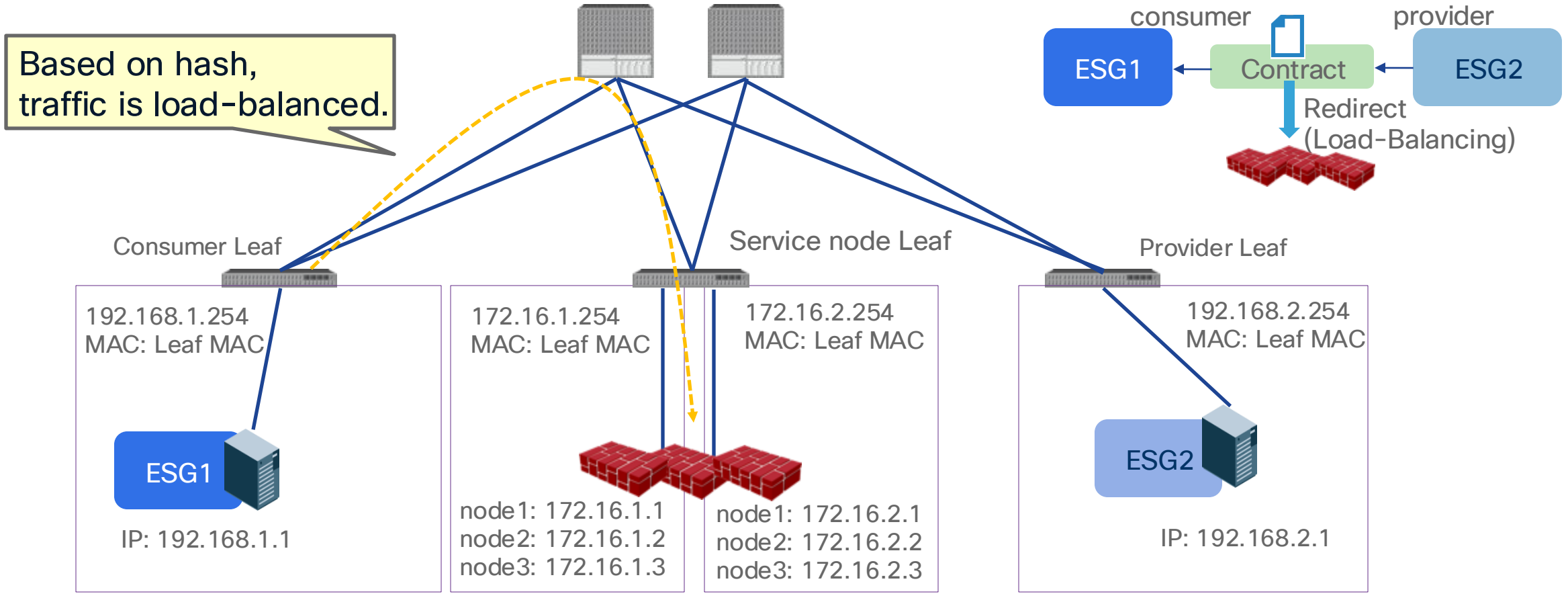


Independent Active Nodes

Symmetric PBR: Scale Firewall Easily

PBR destinations can be distributed across multiple leaf nodes.

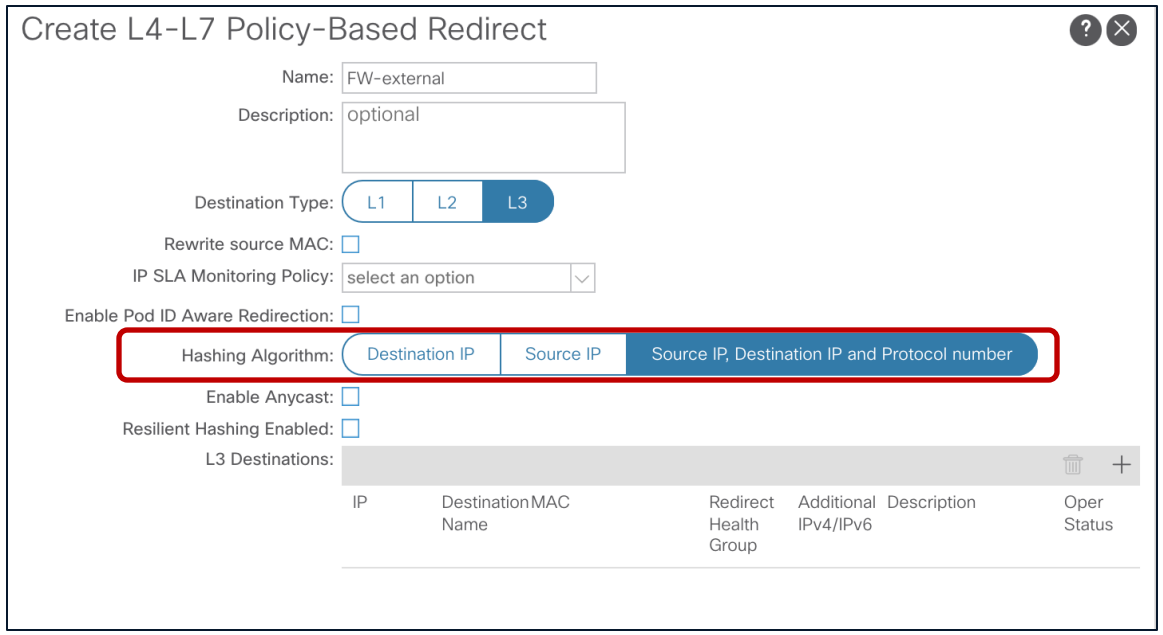
- Ensure incoming and return traffic go to the same firewall



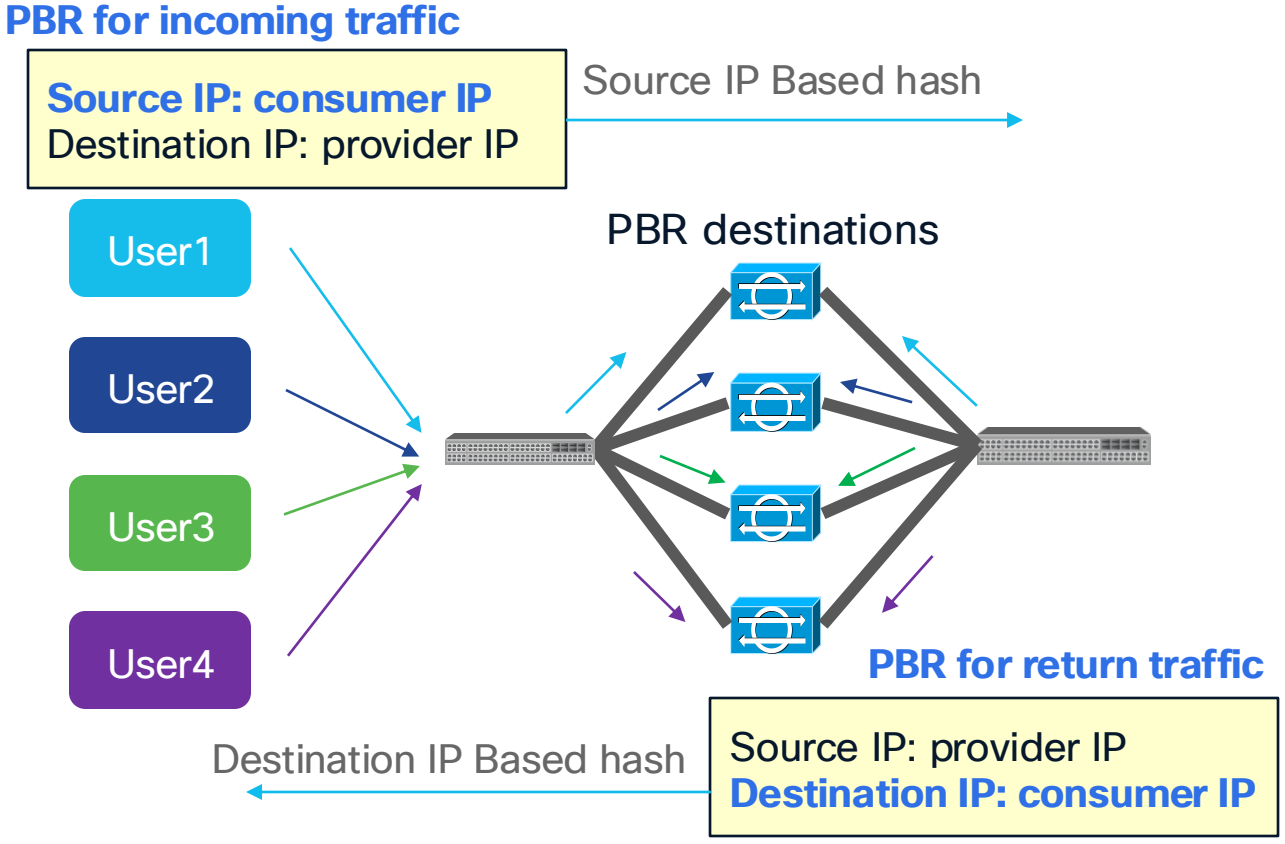
Independent Active Nodes

Symmetric PBR: Hash algorithm option

- Source IP, Destination IP and Protocol number (default)
- Source IP only
- Destination IP only

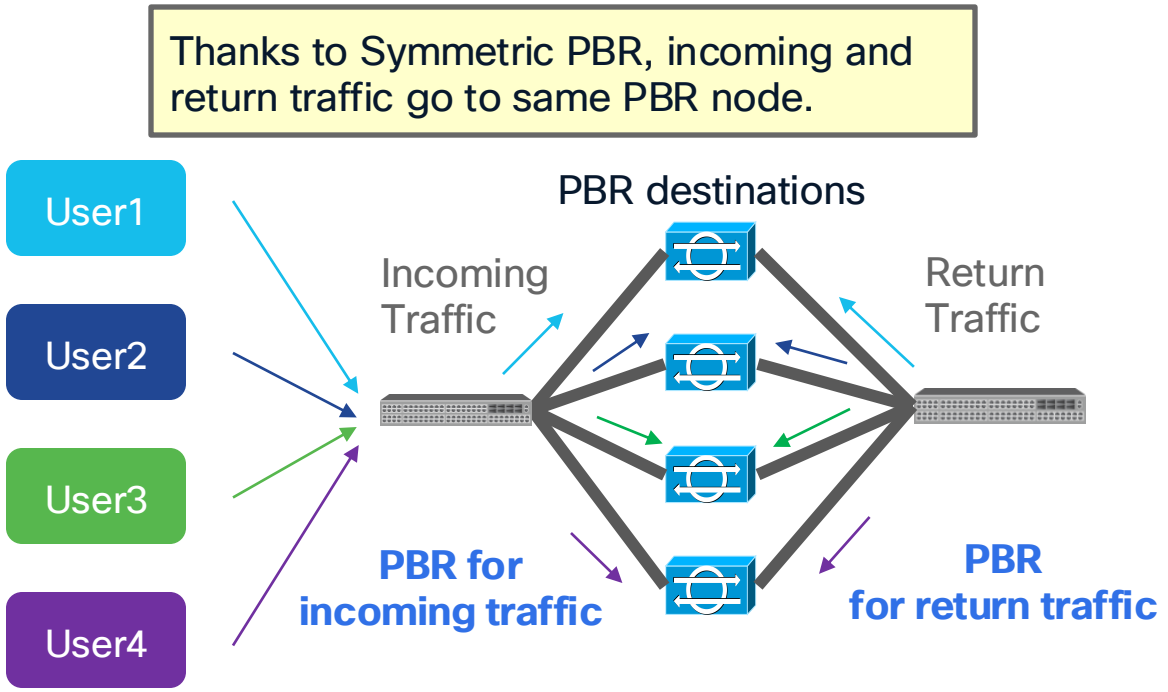


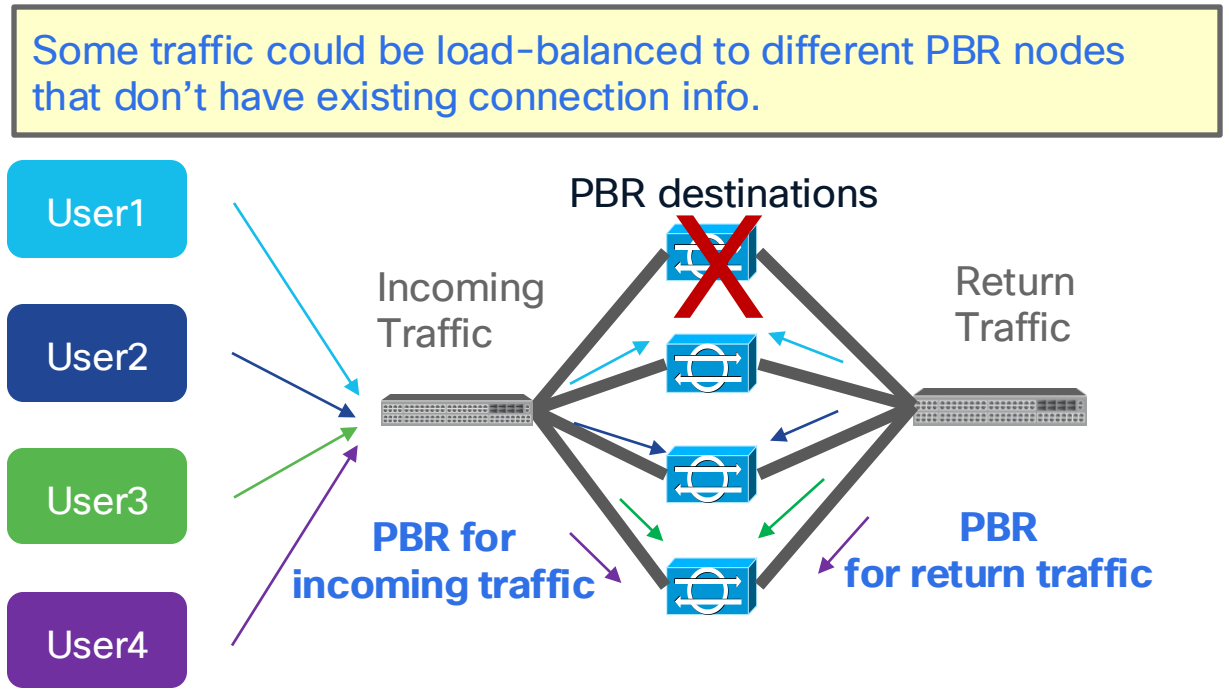
Example: same user (IP) will go through the same device



What happens if an L4-L7 device is down?

- If one of the PBR nodes goes down, existing traffic flows will be rehashed. This could lead to the connection being reset.

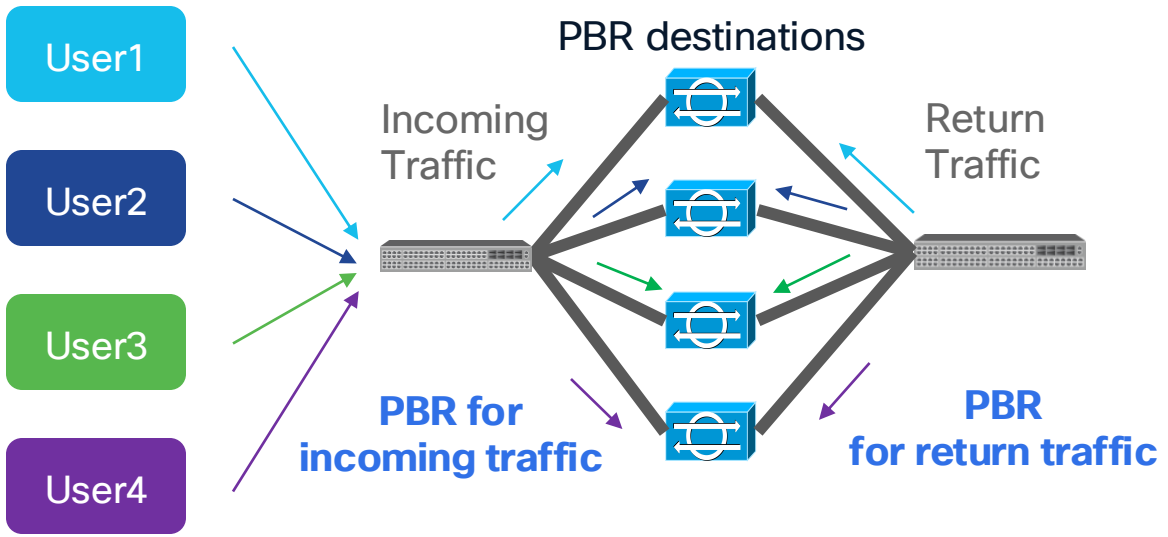


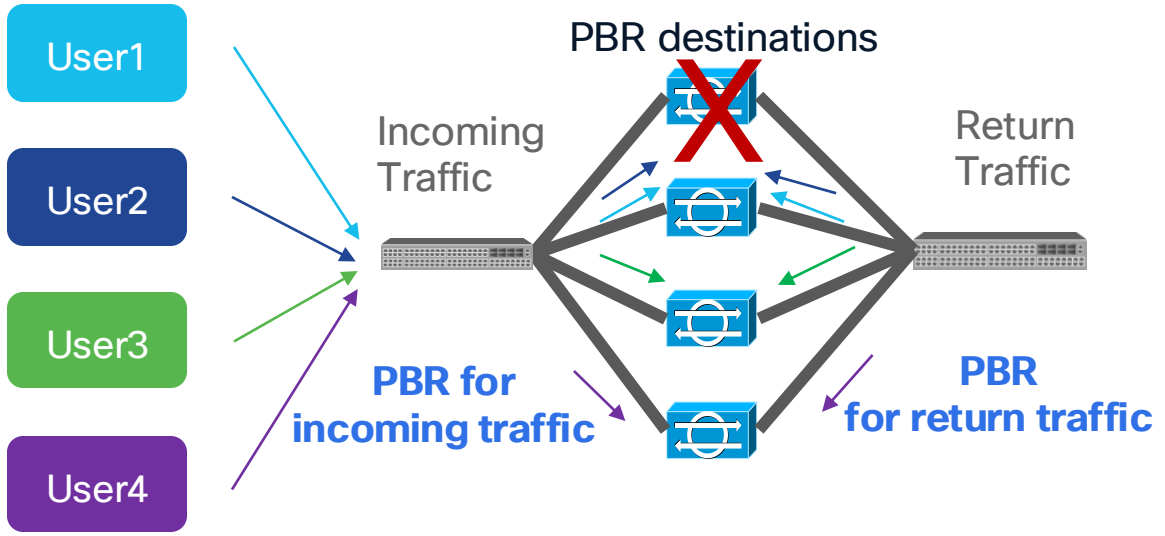


I want to minimize impact on the existing flow!

With Resilient Hash

- With Resilient Hash PBR, only the traffics that went through failed node will be rerouted to one of the available nodes.

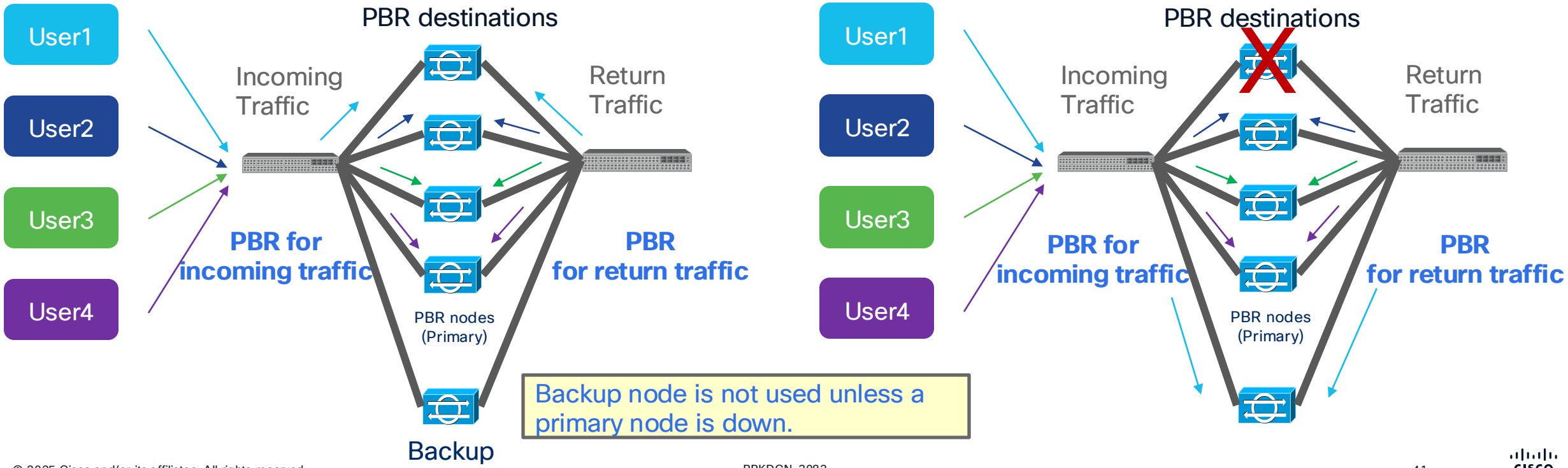




Can we use standby PBR destination?

Resilient Hash PBR with N+M backup

- As all the traffic that went through the failed node will go to one of the available nodes, capacity of the node is a concern. (The node would have doubled amount of traffic compared with usual)
- Instead of using one of the available primary nodes, a backup node in the group will be used. (N+M)

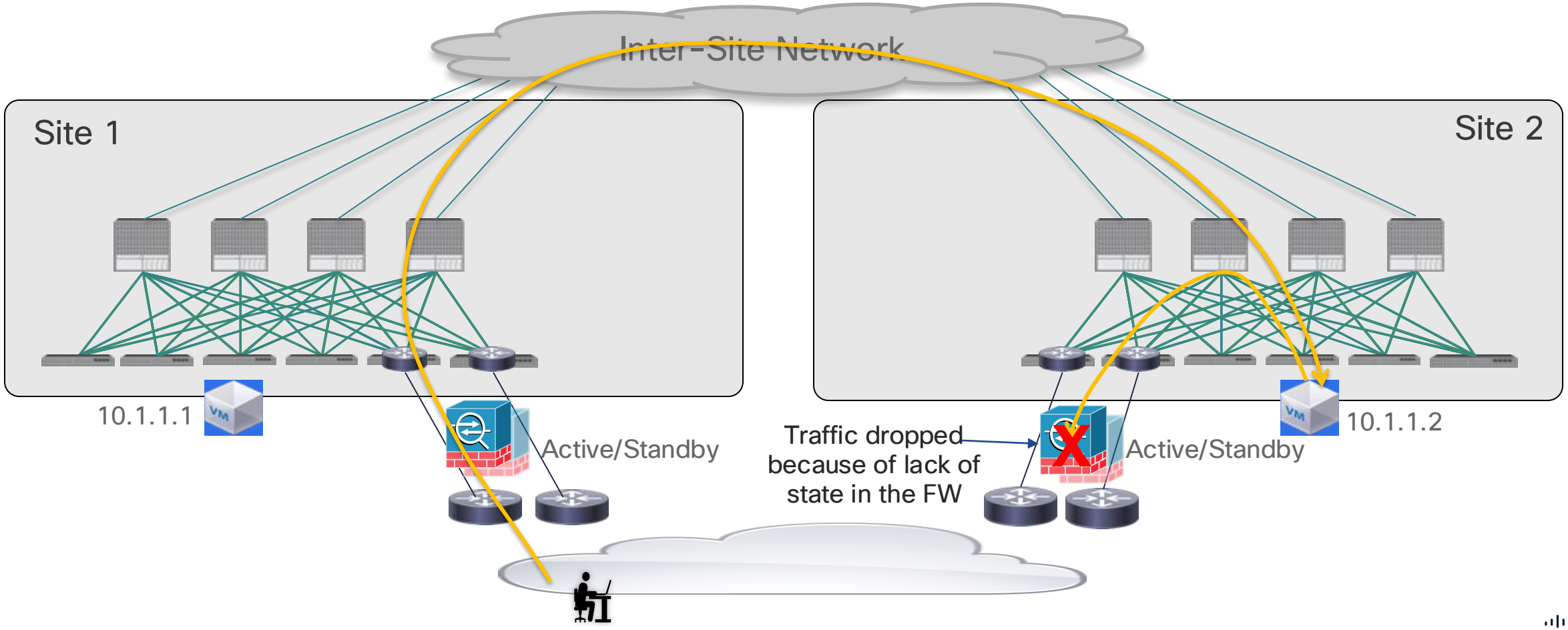


Multi-location Data Centers

Service insertion in multiple DC locations

What is the challenge of service insertion in multiple DC locations?

- Traffic Symmetricity is important



Multi-location Data Centers

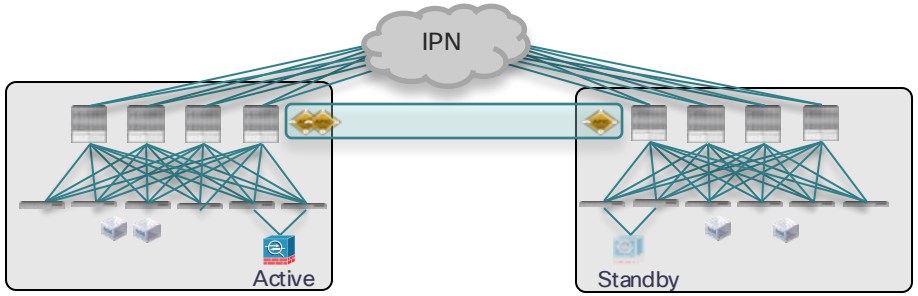
- Multi-Pod
- Multi-Site

ACI Multi-Pod

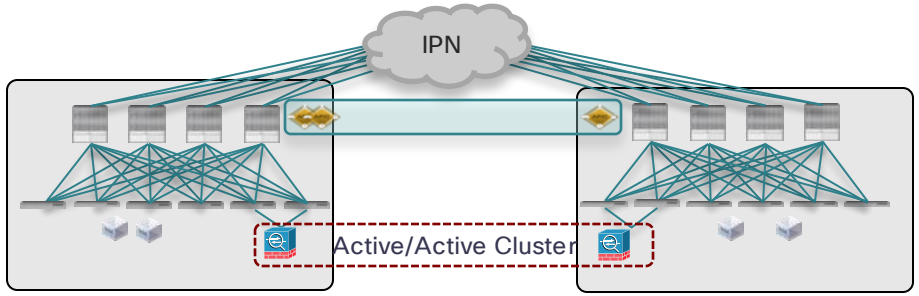
Design options

For your reference

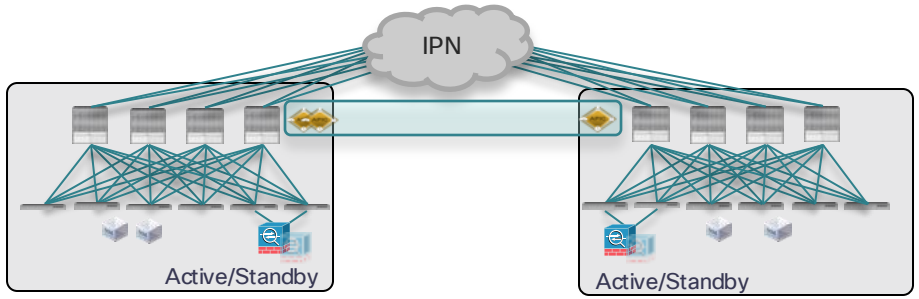
Typical options for an Active/Active DC use case



- Active and Standby pair deployed across Pods
- No issues with asymmetric flows



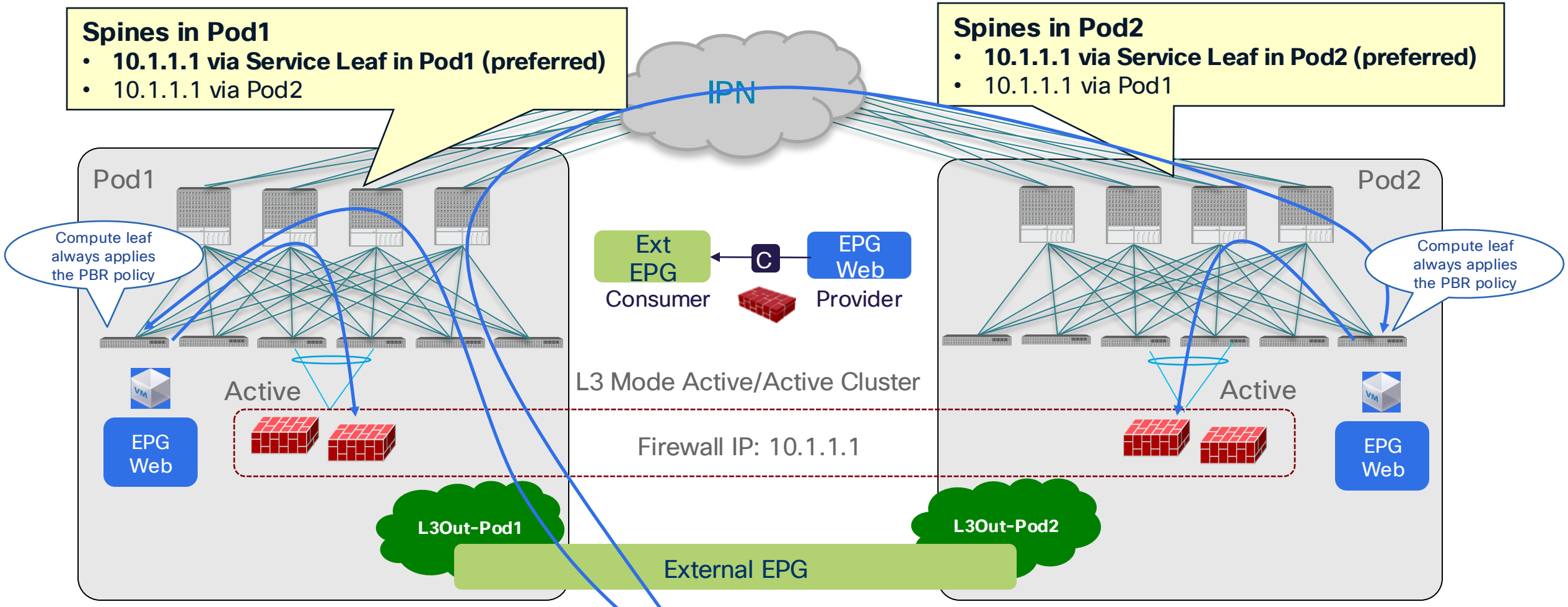
- Active/Active FW cluster nodes stretched across Sites (single logical FW)
- Requires the ability of discovering the same MAC/IP info in separate pods at the same time
- Supported from ACI release 3.2(4d) with the use of Service-Graph with PBR



- Independent Active/Standby pairs deployed in separate Pods
- Use of Symmetric PBR to avoid the creation of asymmetric paths crossing different active FW nodes

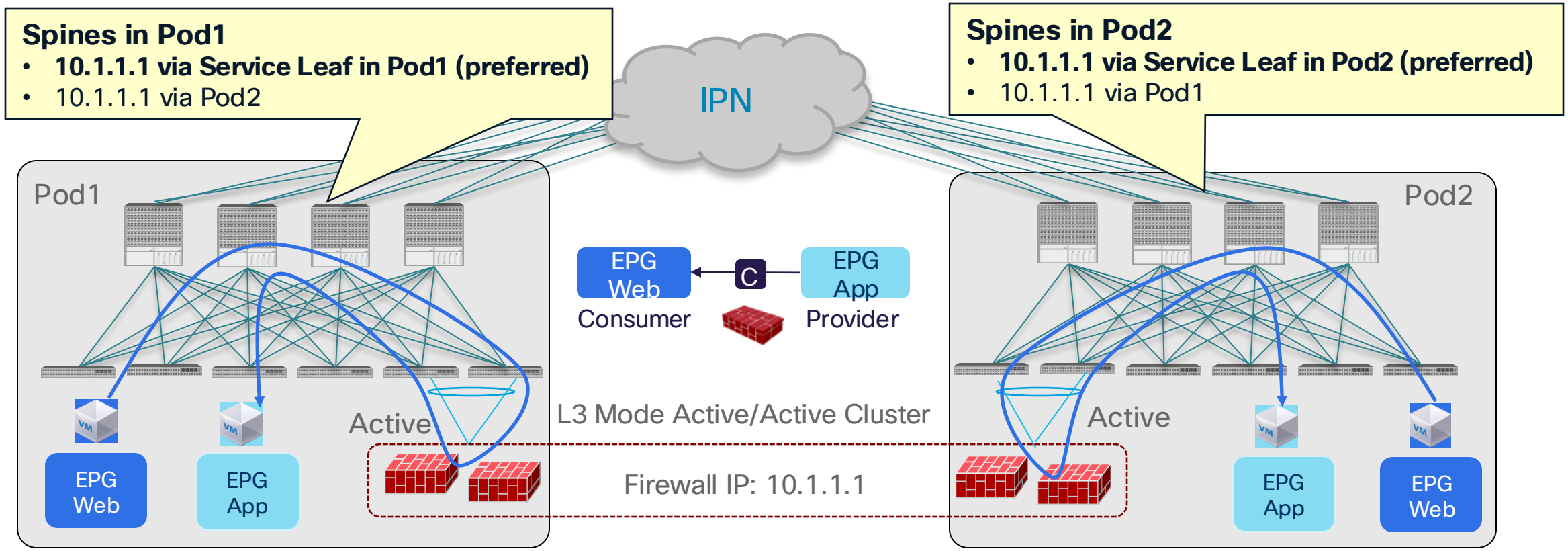
ACI Multi-Pod: Active/Active cluster across pods

North-South Traffic Flow



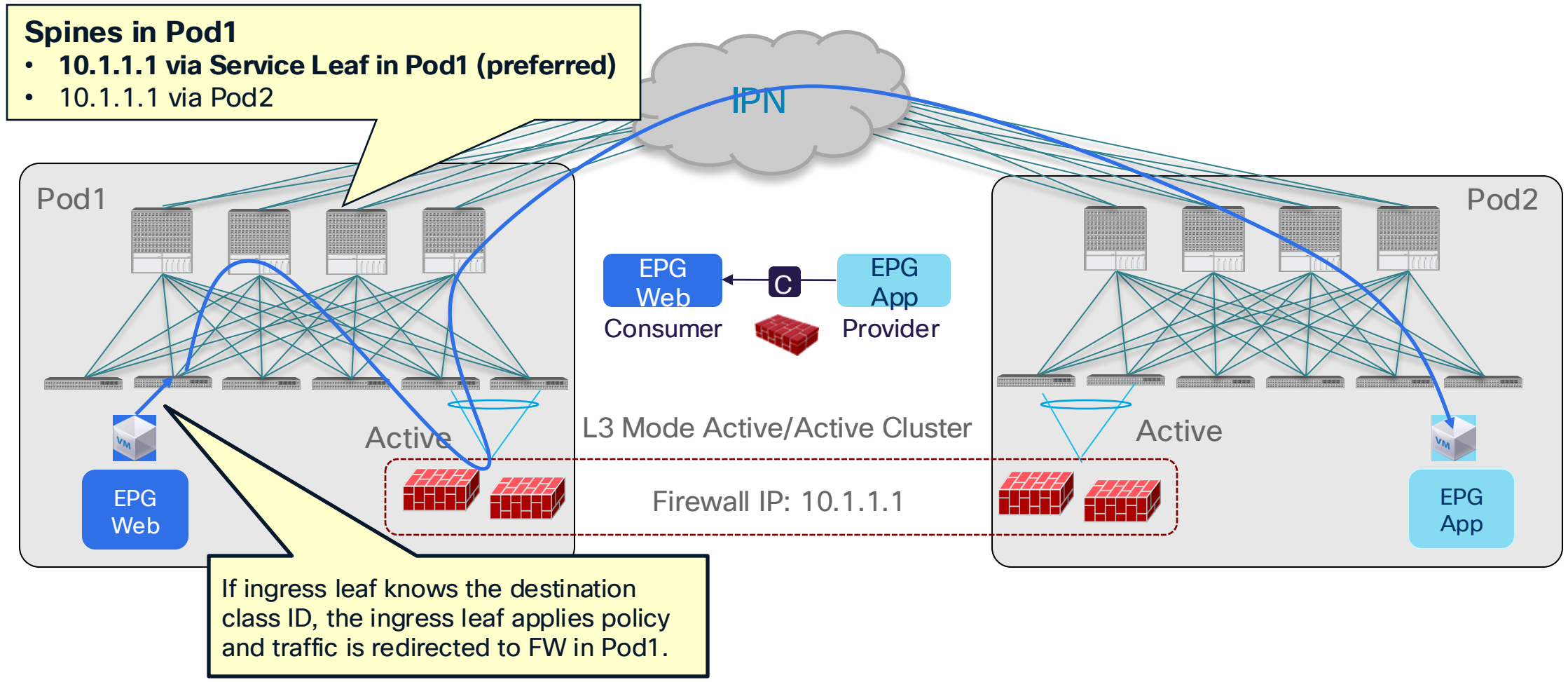
ACI Multi-Pod: Active/Active cluster across pods

East-West Traffic Flow (Intra-Pod)



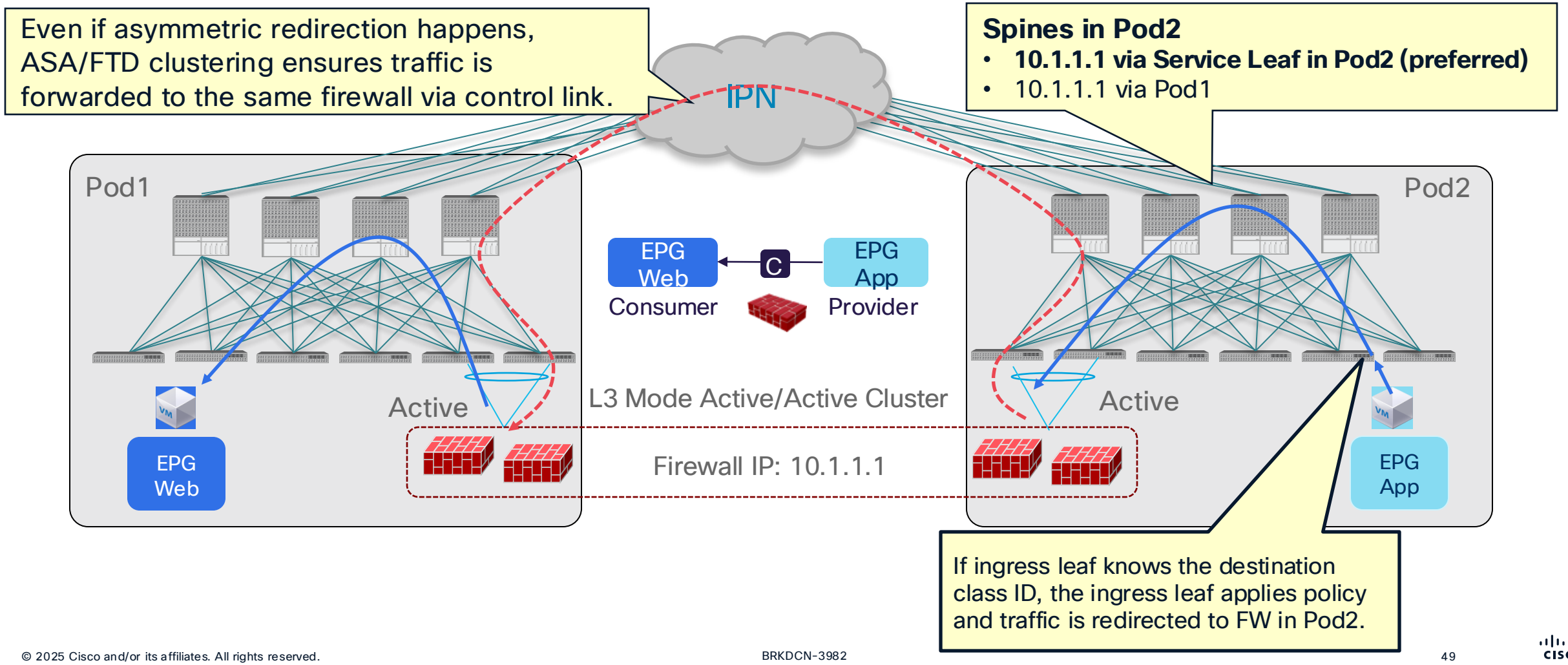
ACI Multi-Pod: Active/Active cluster across pods

East-West Traffic Flow (Inter-Pod) incoming traffic



ACI Multi-Pod: Active/Active cluster across pods

East-West Traffic Flow (Inter-Pod) return traffic

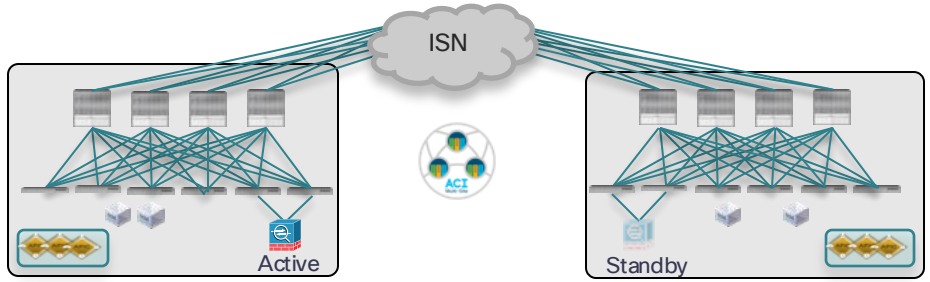


ACI Multi-Site

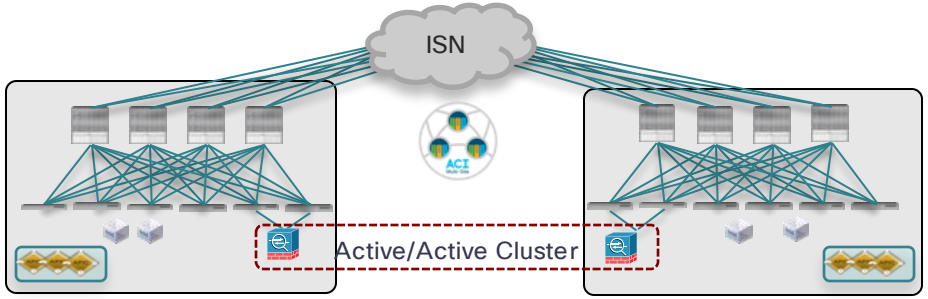
Design options

For your reference

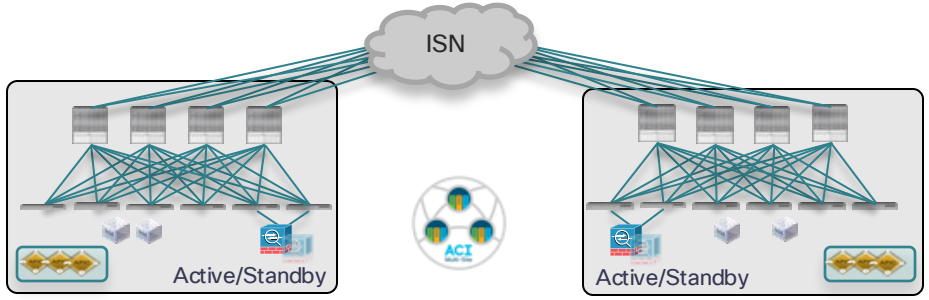
Deployment options fully supported with ACI Multi-Pod



- Active and Standby pair deployed across Pods
- **Limited supported options**



- Active/Active FW cluster nodes stretched across Sites (single logical FW)
- **Not supported**



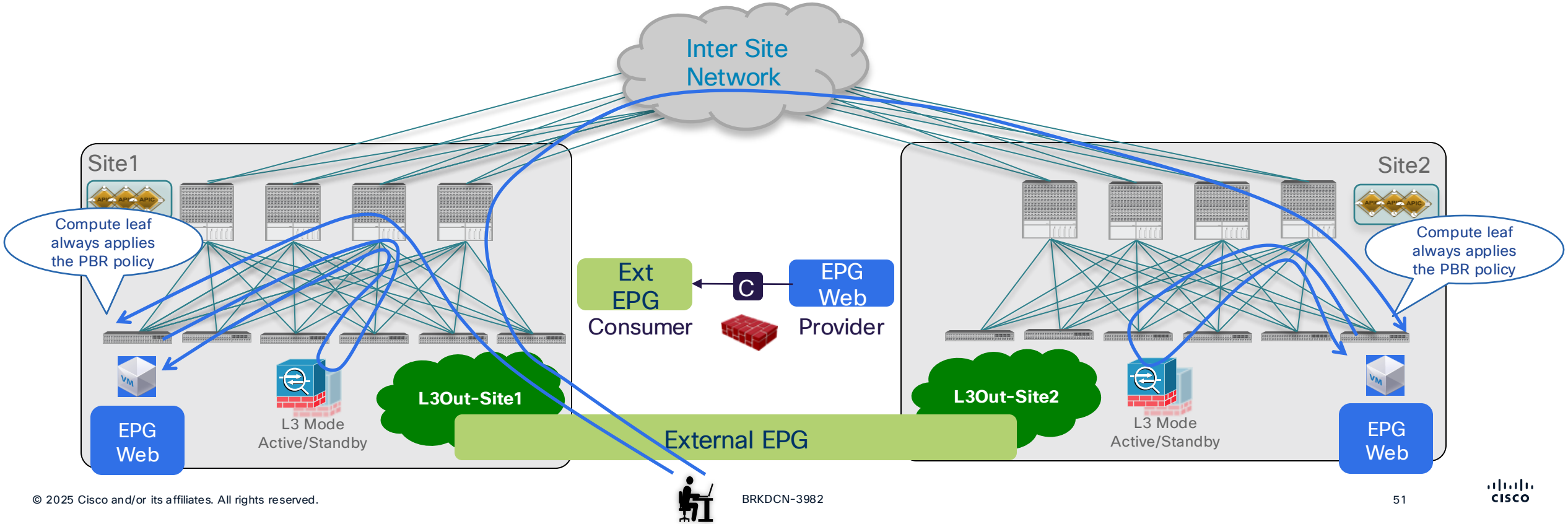
- **Recommended deployment model for ACI Multi-Site**
- Supported from 3.2 release with the use of Service Graph with Policy Based Redirection (PBR)

ACI Multi-Site: service nodes in each site

North-South Traffic Flow: compute leaf enforcement

Policy is always applied on the compute leaf

- North-South (L3Out-to-EPG) intra-VRF and inter-VRF contract with PBR
  - For inter-VRF contract, L3Out must be the provider.

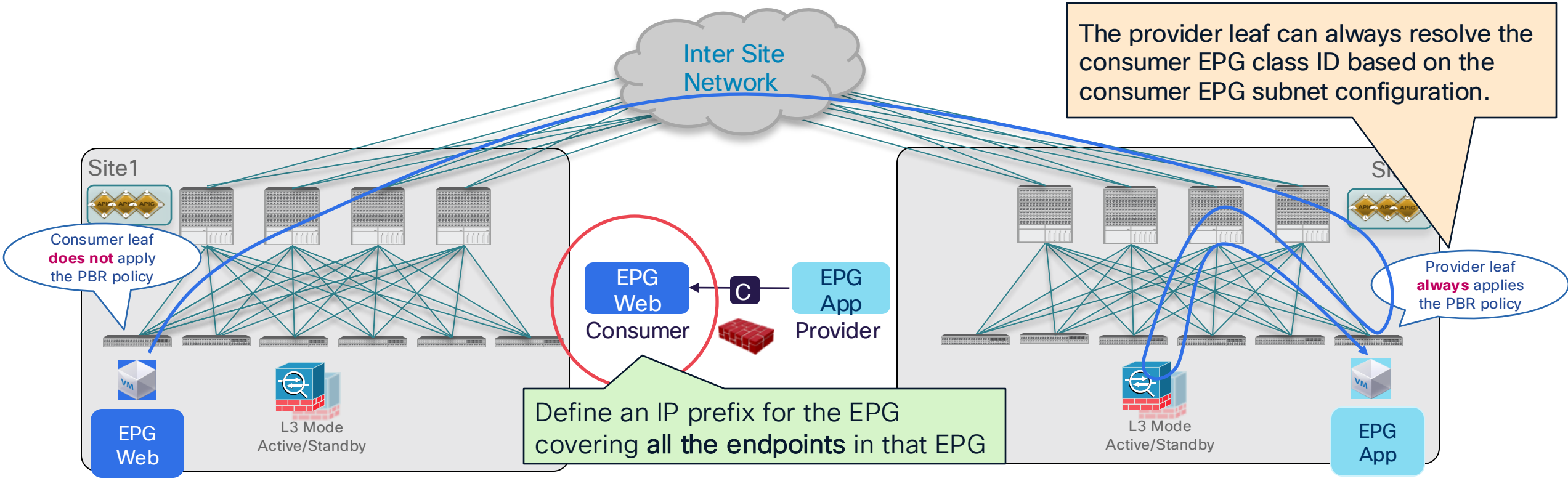


ACI Multi-Site: service nodes in each site

East-West Traffic Flow: provider leaf enforcement

Policy is always applied on the provider leaf

- East-West (EPG-to-EPG) intra-VRF and inter-VRF contract with PBR
  - The consumer EPG subnet must be configured, which means the design must be 1 BD subnet = 1 EPG (network centric).

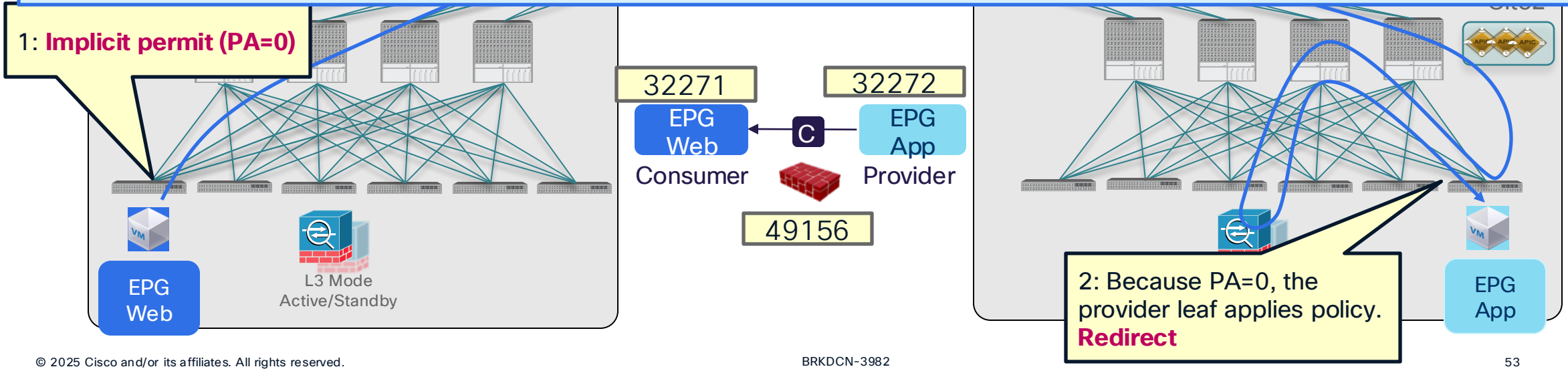


How to ensure the provider leaf enforcement?

Special rule for consumer-to-provider traffic

- redir_override: If the destination is NOT a local endpoint, the leaf doesn't apply policy (PA=0)

```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+----------------+---------+---------+------+----------------------------------+----------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |      Dir       |  operSt |  Scope  | Name |        Action                    |       Priority       |
+---------+--------+--------+----------+----------------+---------+---------+------+----------------------------------+----------------------+
<snip>
|   4144  | 32271  | 32272  |    14    |     bi-dir     | enabled | 2195459 |      | redir(destgrp-1),redir_override  |    fully_qual(7)     |
|   4157  | 32272  | 32271  |    14    | uni-dir-ignore | enabled | 2195459 |      | redir(destgrp-1)                 |    fully_qual(7)     |
|   4140  | 49156  | 32272  | default  |    uni-dir     | enabled | 2195459 |      |       permit                     |    src_dst_any(9)    |
|   4136  | 49156  | 32271  |    14    |    uni-dir     | enabled | 2195459 |      |       permit                     |    fully_qual(7)     |
+---------+--------+--------+----------+----------------+---------+---------+------+----------------------------------+----------------------+
```

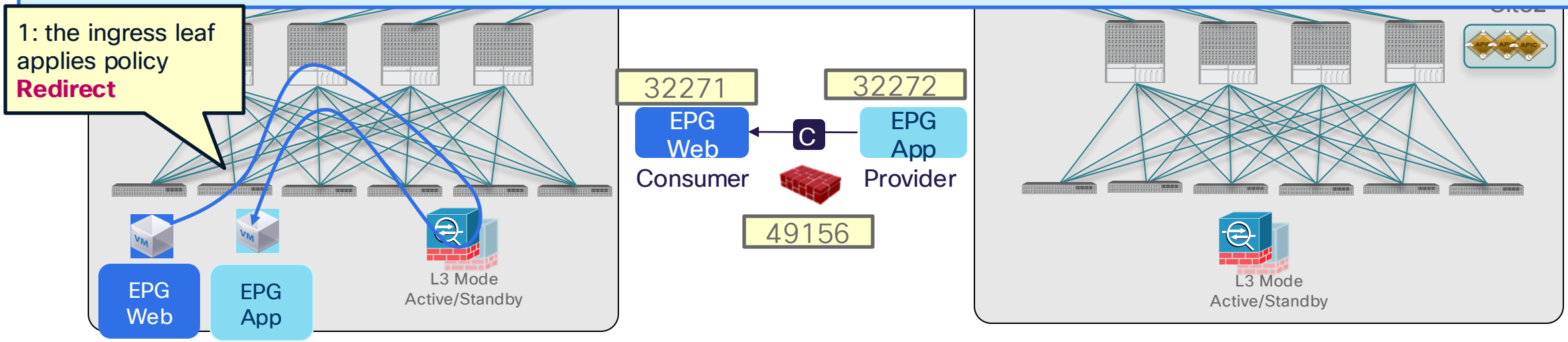


How to ensure the provider leaf enforcement?

Special rule for consumer-to-provider traffic

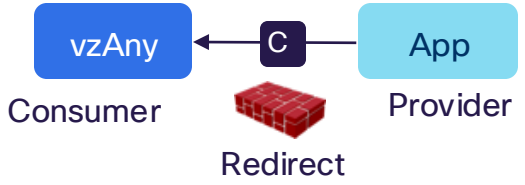
- If the destination is under the same leaf, the leaf applies policy.

```
Pod1-Leaf1# show zoning-rule scope 2195459
+---------+--------+--------+----------+----------------+---------+---------+------+----------------------------------+----------------------+
| Rule ID | SrcEPG | DstEPG | FilterID |      Dir       |  operSt |  Scope  | Name |          Action                  |       Priority       |
+---------+--------+--------+----------+----------------+---------+---------+------+----------------------------------+----------------------+
<snip>
|   4144  | 32271  | 32272  |    14    |     bi-dir     | enabled | 2195459 |      | redir(destgrp-1),redir_override  |    fully_qual(7)     |
|   4157  | 32272  | 32271  |    14    | uni-dir-ignore | enabled | 2195459 |      | redir(destgrp-1)                 |    fully_qual(7)     |
|   4140  | 49156  | 32272  | default  |    uni-dir     | enabled | 2195459 |      |       permit                     |    src_dst_any(9)    |
|   4136  | 49156  | 32271  |    14    |    uni-dir     | enabled | 2195459 |      |       permit                     |    fully_qual(7)     |
+---------+--------+--------+----------+----------------+---------+---------+------+----------------------------------+----------------------+
```



Multi-Site PBR Update

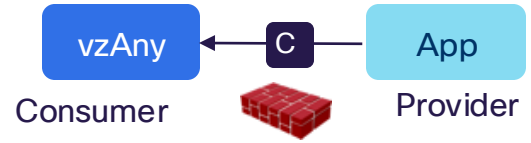
- vzAny-to-EPG
- vzAny-to-vzAny
- Configuration workflow



ACI Multi-Site vzAny-to-EPG PBR

NDO 4.2(3)/ACI 6.0(4)

Challenges



- How to keep traffic symmetric
  → Provider leaf enforcement

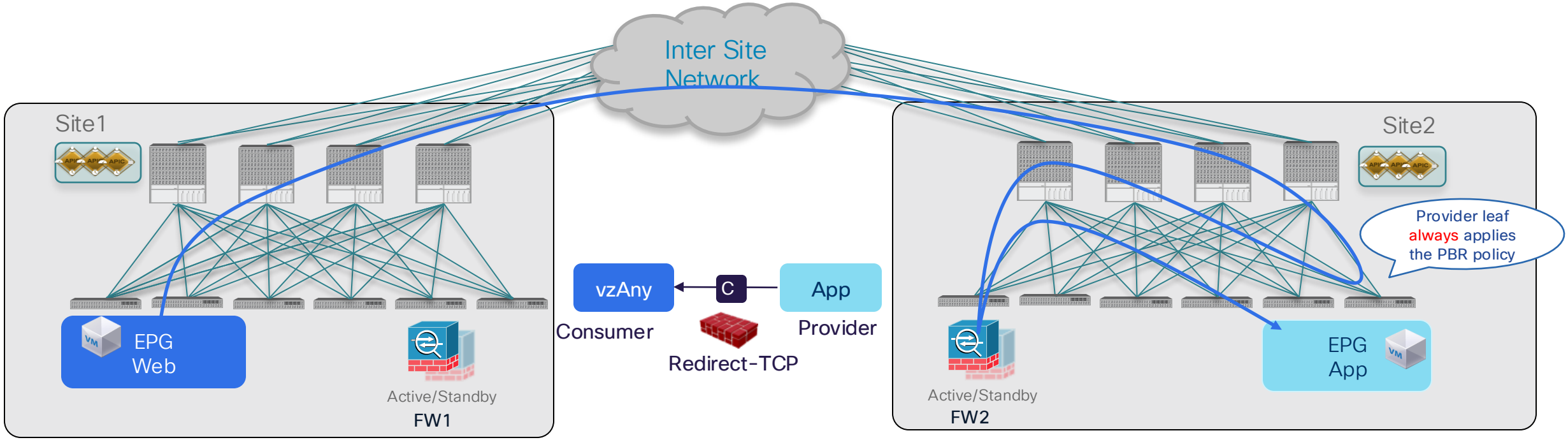
- How to ensure the provider leaf nodes can resolve destination class ID without EPG subnet.
  → Conversational learning

ACI Multi-Site vzAny-EPG PBR

NDO 4.2(3)/ACI 6.0(4)

Consumer to provider direction

- Provider leaf enforcement to keep traffic symmetric.

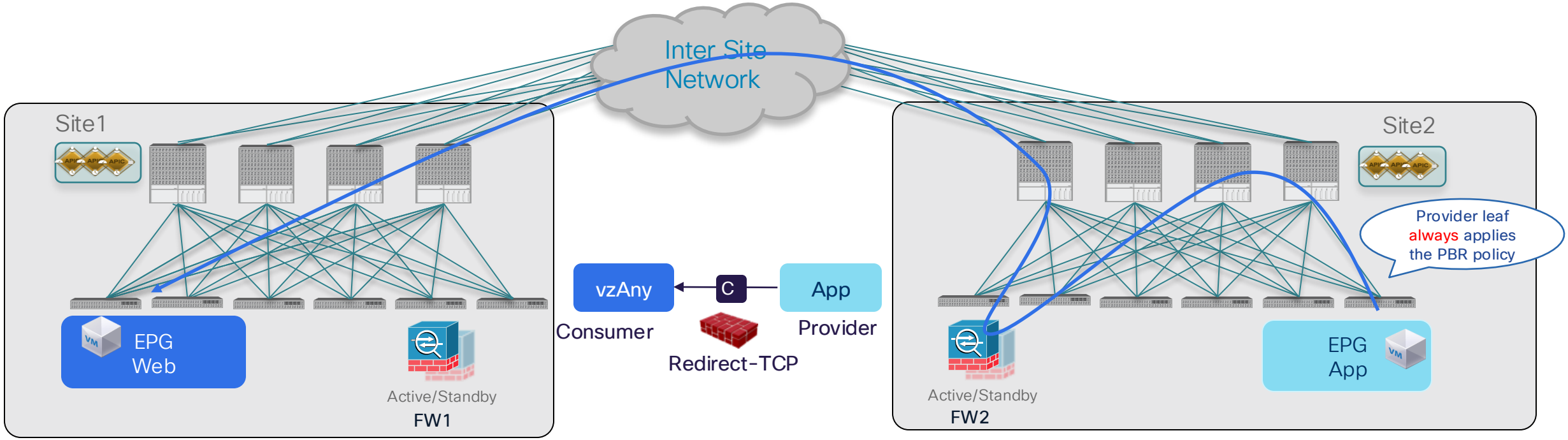


ACI Multi-Site vzAny-EPG PBR

NDO 4.2(3)/ACI 6.0(4)

Provider to consumer direction

- Provider leaf enforcement to keep traffic symmetric.

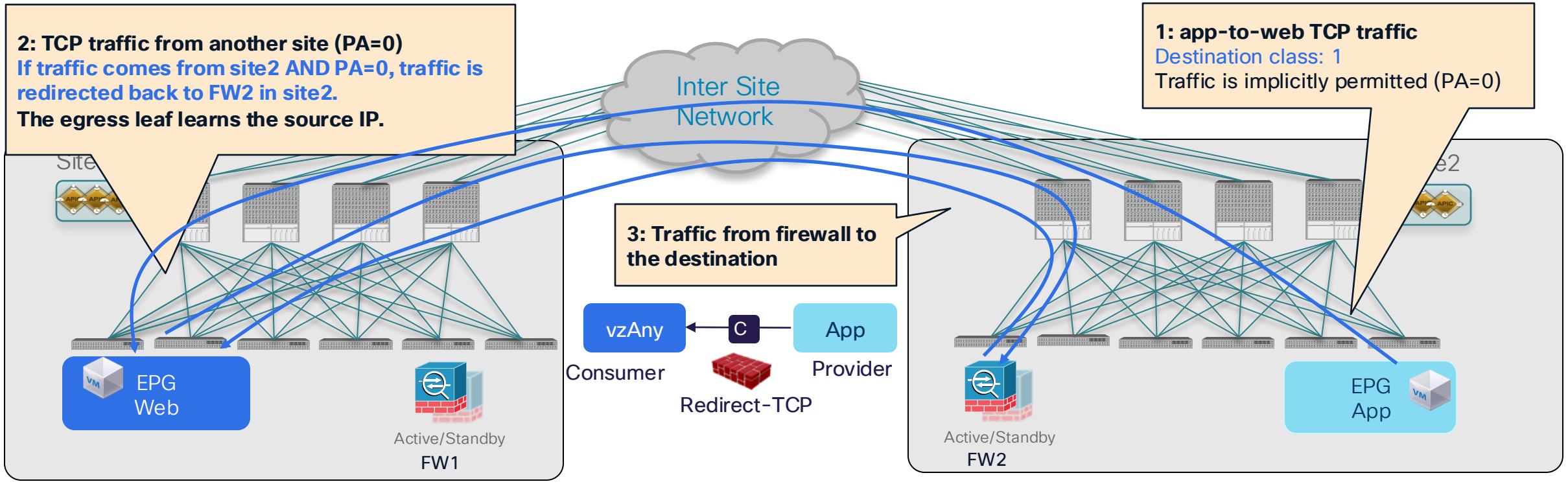


ACI Multi-Site vzAny-EPG PBR

NDO 4.2(3)/ACI 6.0(4)

What if the provider leaf doesn't know the consumer endpoint? (1/2)

- Force traffic inspected by the service device in the provider site

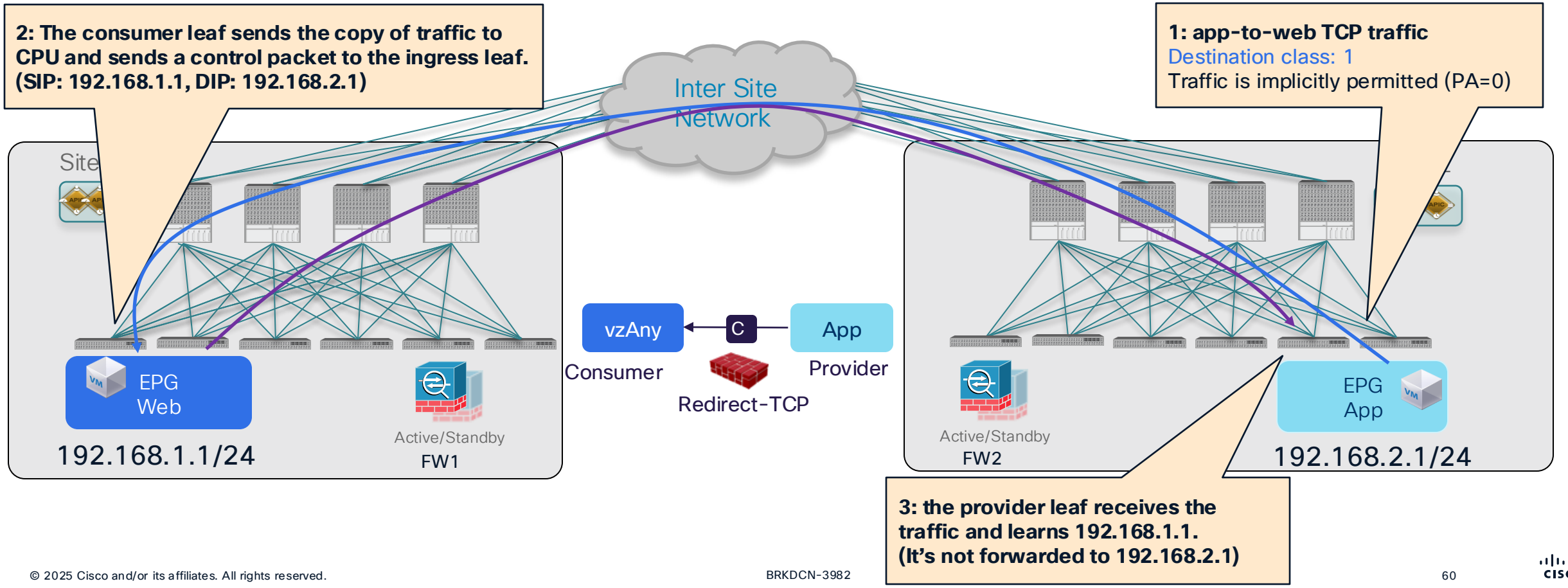


ACI Multi-Site vzAny-EPG PBR

NDO 4.2(3)/ACI 6.0(4)

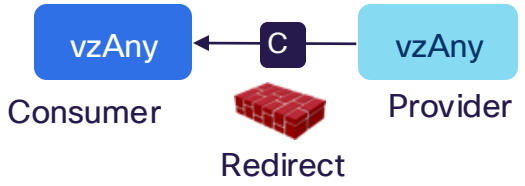
What if the provider leaf doesn't know the consumer endpoint? (2/2)

- Conversational Learning to get the ingress leaf learn the destination EP.



Multi-Site PBR Update

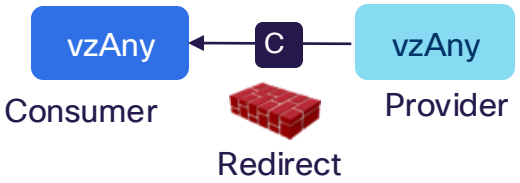
- vzAny-to-EPG
- vzAny-to-vzAny
- Configuration workflow



ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

Challenges



- How to keep traffic symmetric

  → redirect “inter-site” traffic in both source and destination sites.

  Note: If it’s intra-site traffic, redirect doesn’t happen twice.

- How to ensure the ingress leaf nodes can resolve the destination class ID without the EPG subnet.

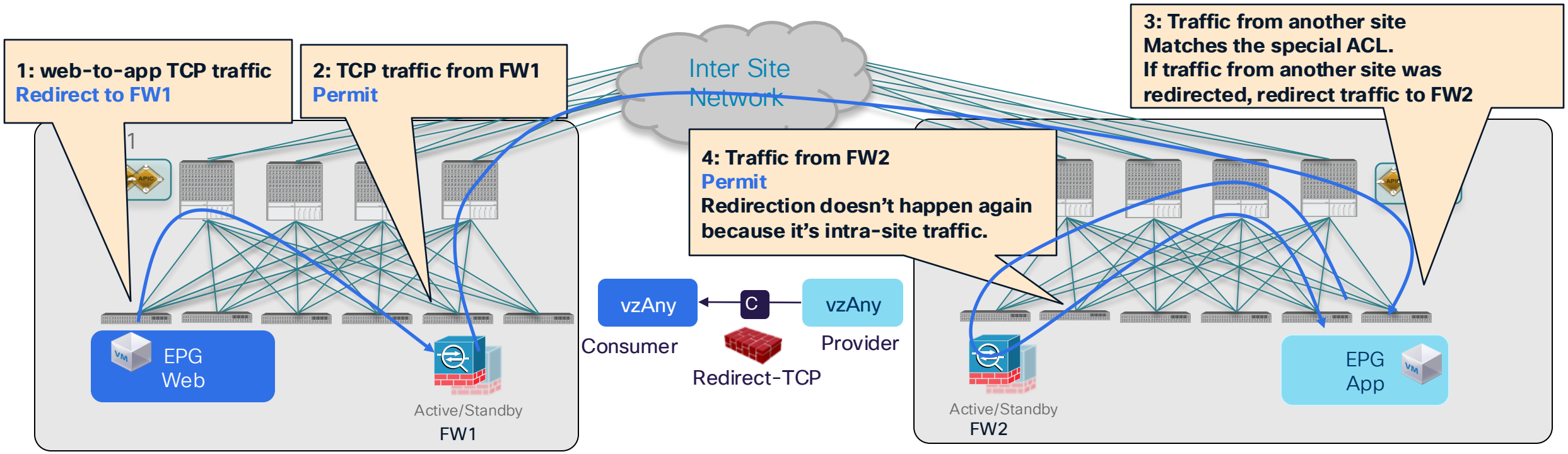
  → Conversational learning

ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

Consumer to provider direction

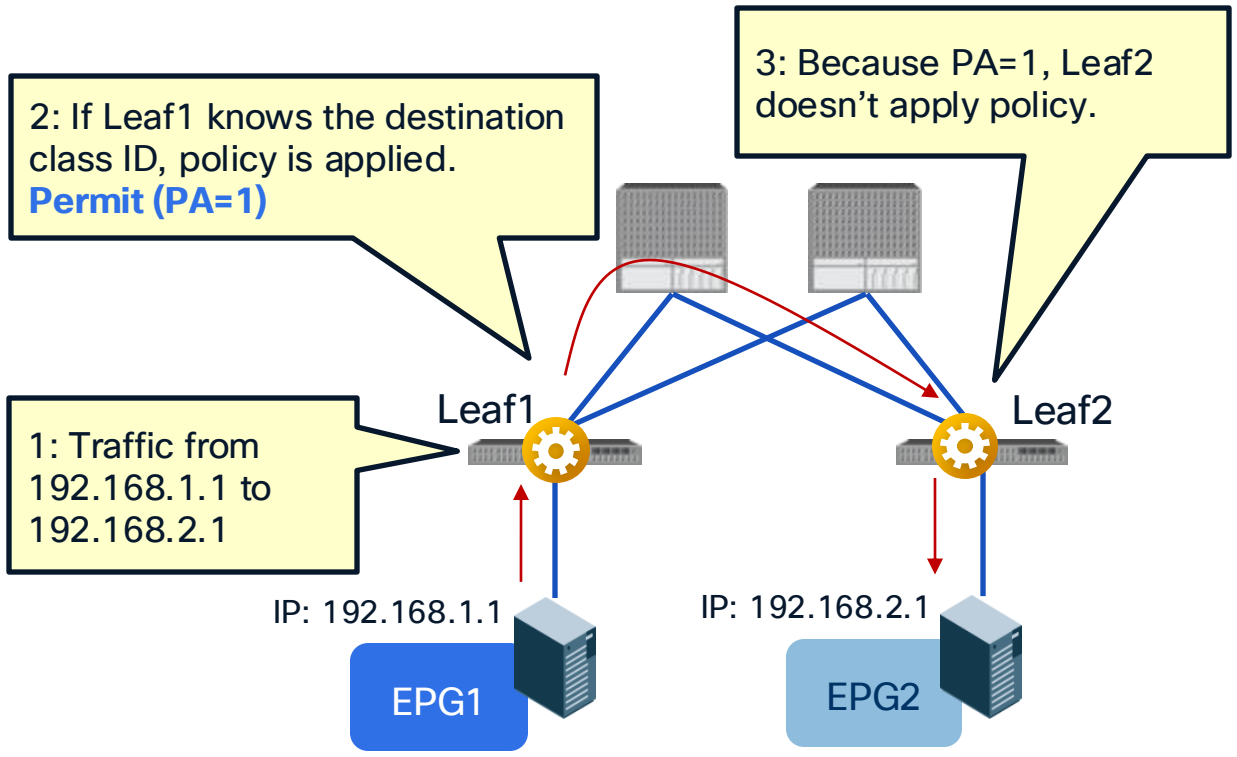
- Redirect “inter-site” traffic in both source and destination sites.



How to identify traffic was redirected?

Policy Applied (PA) bit

- PA bit (2 bit): Source Policy (SP) bit and Destination Policy (DP) bit



	SP	DP	Behavior
PA=1	1	1	The egress leaf doesn't apply policy because policy was applied.
PA=0	0	0	The egress leaf should apply policy because policy is not applied yet.

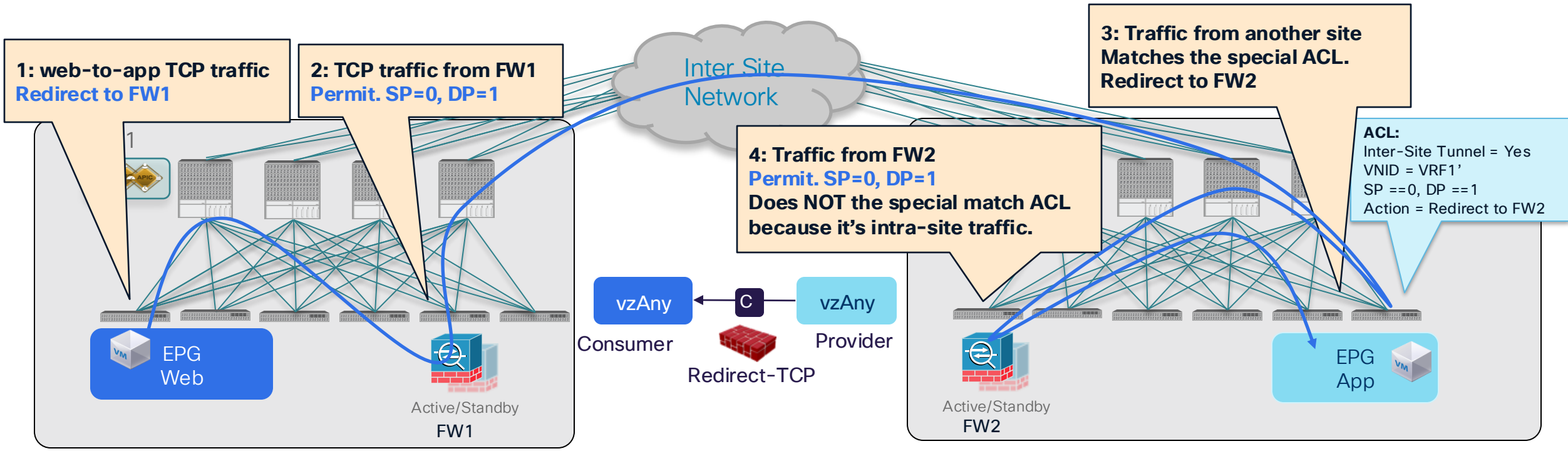
"SP=0, DP=1"
is used for traffic from service EPG to indicate traffic needs to be redirected again

ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

Consumer to provider direction

SP=0, DP=1
for traffic from
the service EPG

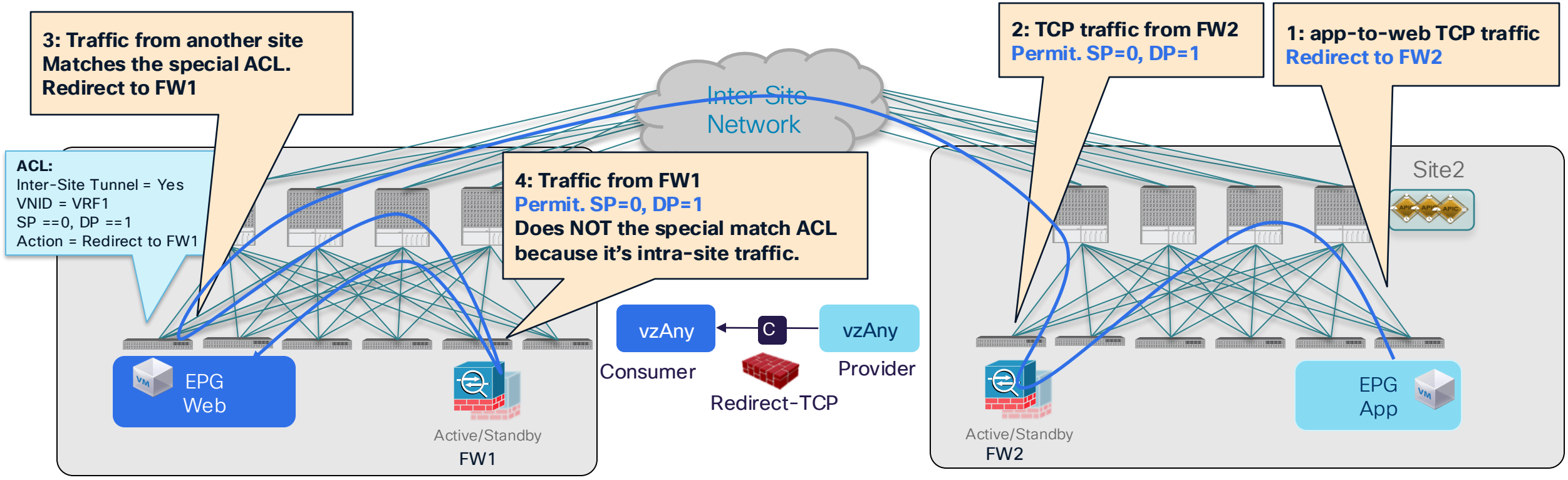


ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

Provider to consumer direction

SP=0, DP=1
for traffic from
the service EPG

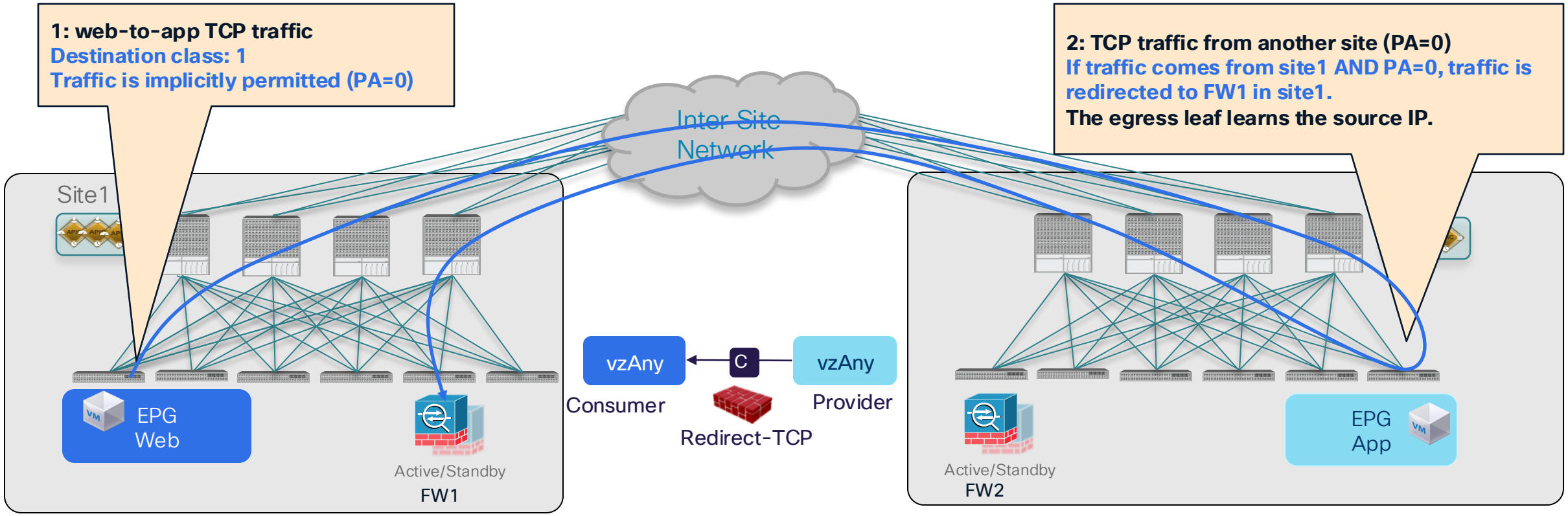


ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

What if the ingress leaf doesn't know the destination class ID (1/3)

- Force traffic inspected by the service device in the source site.

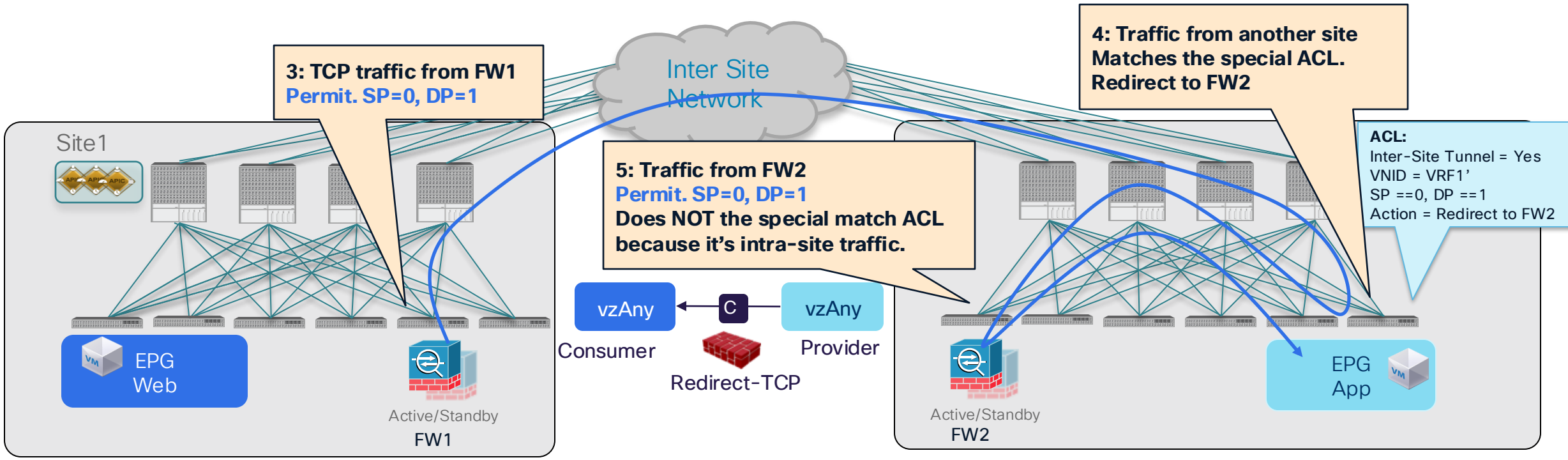


ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

What if the ingress leaf doesn't know the destination class ID (2/3)

- Force traffic inspected by the service device in the destination site

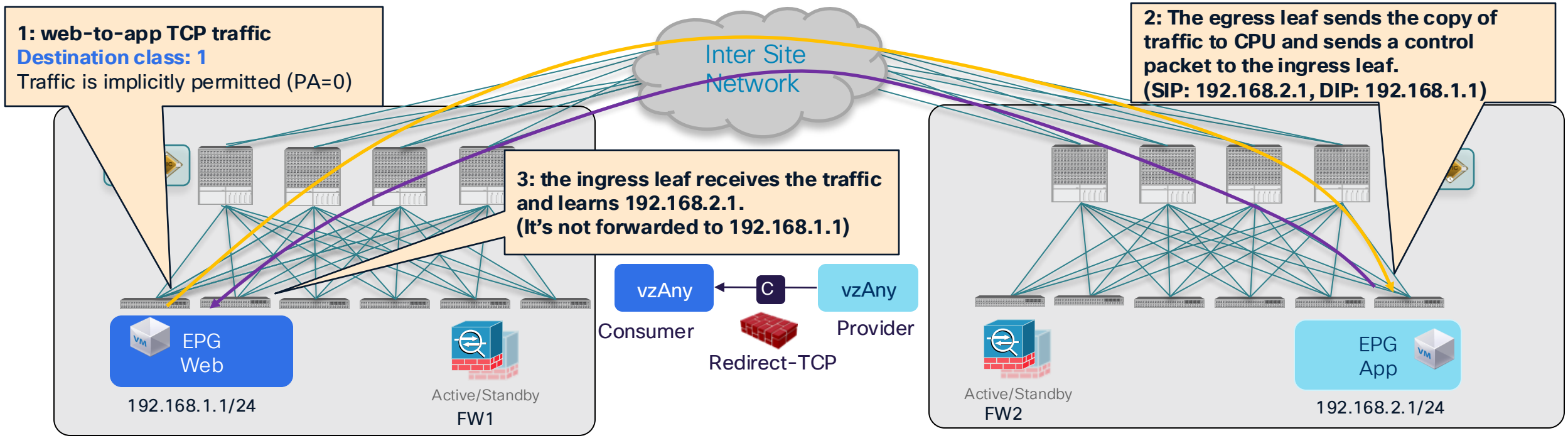


ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

What if the ingress leaf doesn't know the destination class ID (3/3)

- Conversational Learning to get the ingress leaf learn the destination EP.

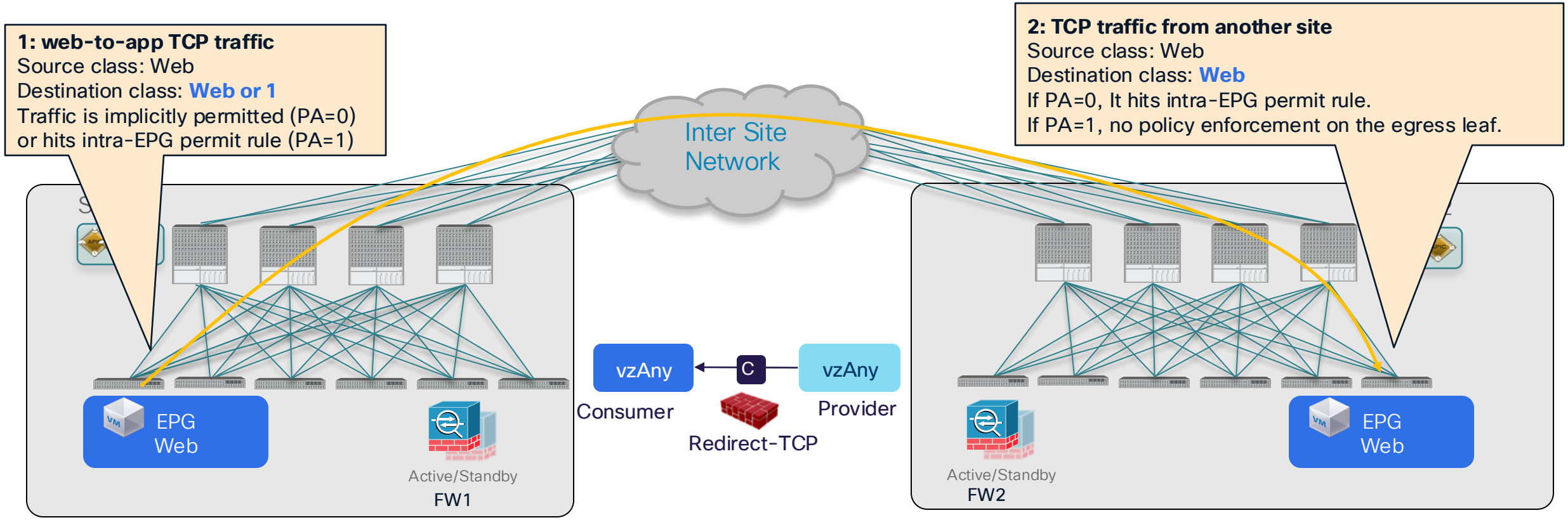


ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

Intra-EPG traffic

- Intra-EPG permit rule (priority 3) wins over vzAny-to-vzAny rule (priority 17).

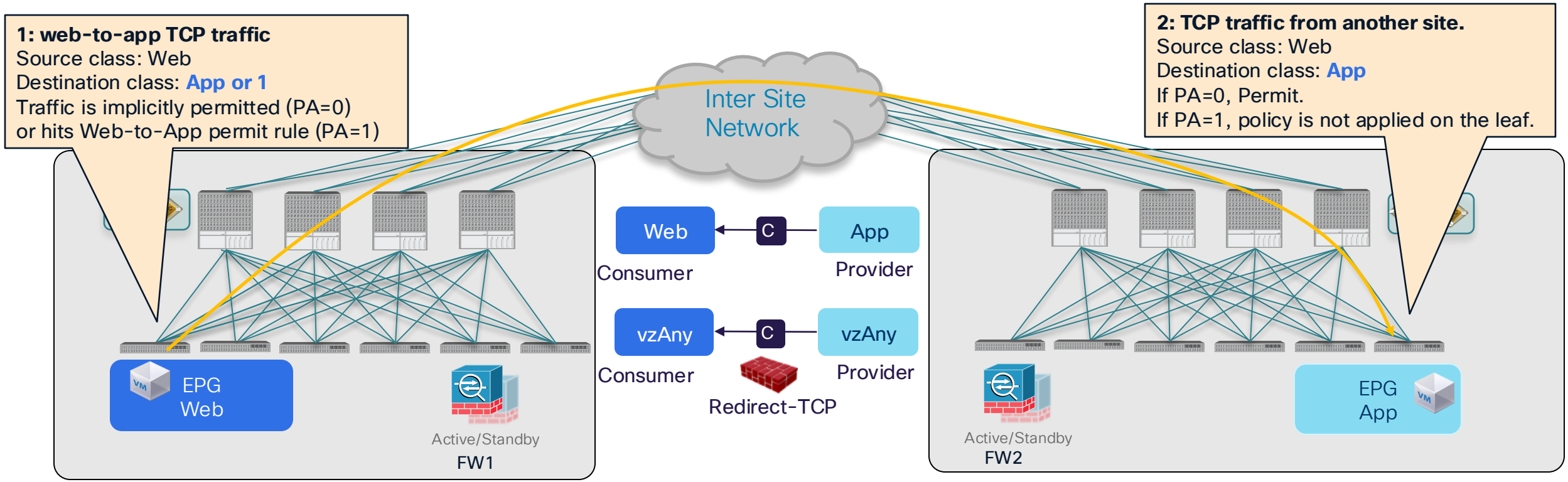


ACI Multi-Site vzAny-to-vzAny PBR

NDO 4.2(3)/ACI 6.0(4)

Bypass firewall for specific EPG-to-EPG traffic

- EPG-to-EPG permit rule (priority 7 or 9) wins over vzAny-to-vzAny rule (priority 17).



ACI Multi-Site

vzAny PBR and L3Out-to-L3Out PBR

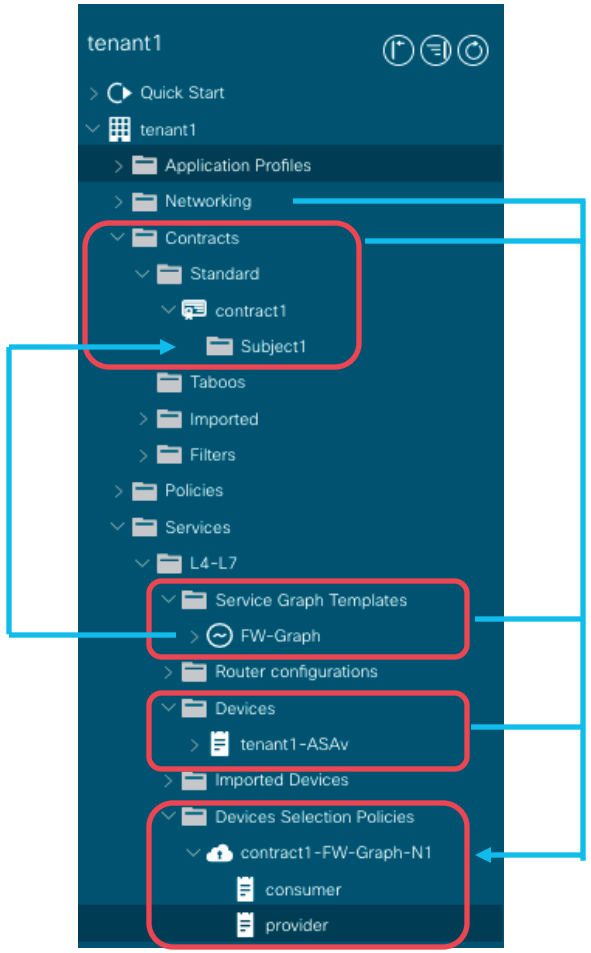
	vzAny-to-vzAny	vzAny-to-EPG	vzAny-to-L3Out	L3Out-to-L3Out
Redirection	Both sites	Site for the specific EPG	Both sites	Both sites
Service node	One-node One-arm	One-node One-arm Starting from 6.1(3) Two-node Two-arm	One-node One-arm	One-node One-arm
VRF	Intra-VRF	Intra-VRF	Intra-VRF	Intra-VRF and Inter-VRF

- No need to configure EPG subnets.
- By configuring specific EPG-to-EPG permit contract, firewall can be bypassed.
- Each site needs to have PBR destination with decent high availability within the site.
- ESG with PBR is not supported in Multi-Site (6.1(4) roadmap)

Multi-Site PBR Update

- vzAny-to-EPG
- vzAny-to-vzAny
- Configuration workflow

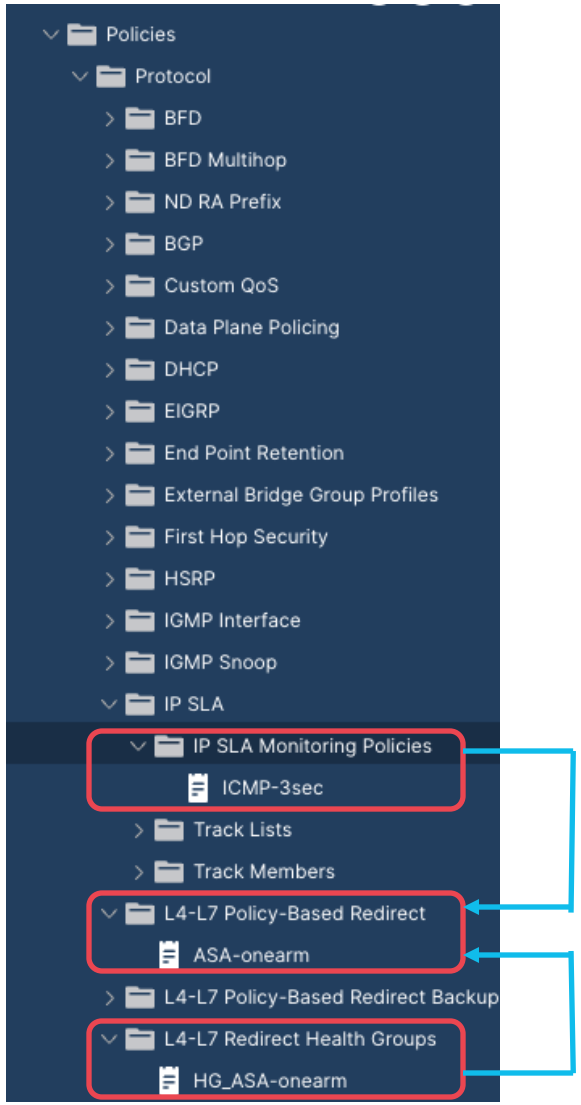
Recap: Configuration for Service Graph



- Contract
- Service Graph template
  - Service Graph template is attached to a contract subject
- L4-L7 Device
  - Physical domain (static path) or VMM domain (VM name and interfaces)
  - Cluster interfaces
- Device Selection Policy
  - It's based on
    - Contract name
    - Service Graph template name
    - Node name in the Service Graph

Recap: Configuration for PBR

PBR requires additional configurations



- L4-L7 PBR Policy
  - PBR destination IP (and MAC)
  - PBR related options (hash option, resilient hash etc)
  - Tracking configuration (IP-SLA, Health-group)
- IP-SLA policy (optional)
  - Protocol: ICMP/TCP/HTTP/L2Ping
  - Interval etc
- L4-L7 Redirect Health-group (optional)

Multi-Site L4-L7 configuration

Previous and new L4-L7 Configuration steps

Existing configuration steps are still available.

- Previous L4-L7 configuration steps: APIC local config + NDO config

APIC config (each site)

APIC Admin

1. Configure Tracking options (optional)
   - IP-SLA policy
   - Health-Group
2. Create a PBR policy
3. Create a L4-L7 Device

NDO config

NDO Admin

1. Create a Service Graph template
2. Attach the Service Graph template to a contract
3. Select the cluster interface, BDs and PBR policies required for Device Selection Policy on APIC

- New L4-L7 configuration steps: NDO config ONLY

NDO config

NDO Admin

1. Configure an IP-SLA policy (optional)
2. Configure a Service Device template
3. Insert the Service Device to a contract

vzAny-to-vzAny PBR configuration Example (Video)

Tenant Templates :: Cisco | vSphere - Site1-FW-1 - Su | Site1-FW-1 | Site2-FW-2 | APIC (10.51.89.2) | APIC (10.51.89.112)

Not Secure https://10.51.89.77/mso/configure/tenantTemplates/application

- Overview
- Operate
- Configure
- Admin

Configure / Tenant Templates

Tenant Template

Refresh | Audit Logs

Applications | L3Out | Monitoring Policies | Service Device | Tenant Policies

Filter by attributes

Add Schema

Name	Templates	Tenants	Policies
Max-Schema	4 4	1	18
ServiceChaining	1 1	1	13

10 Rows

Page 1 of 1 1-2 of 2

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Current date and time is Friday, January 19, 01:54 PM (GMT+9)

Give your feedback

Conclusion

Summary

- How ACI PBR works, use cases and design tips
- Flexible traffic redirection
  - Redirect specific traffic based on contract.
  - Intra-subnet and intra-EPG/ESG redirection
  - Any-to-Any, Any-to-EPG/ESG redirection
- Scale easily
  - Symmetric PBR with tracking and resilient hash
  - PBR destinations can be L1/L2/L3 devices anywhere in the fabric
- Multi-Location Data Centers
  - Multi-Site vzAny PBR is available!
  - New L4-L7 configuration workflow on NDO
  - Multi-Site ESG PBR will be available in 6.1(4)
- For more information, please check ACI PBR white paper!

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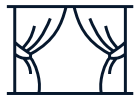

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Appendix:
- Useful Links
- NDO Configuration UI

Useful Links

- Cisco Application Centric Infrastructure Policy-Based Redirect Service Graph Design White Paper
  - https://www.cisco.com/c/en/us/solutions/data-center-virtualization/application-centric-infrastructure/white-paper-c11-739971.html
- Cisco ACI Contract Guide
  - https://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/white-paper-c11-743951.html
- Service Graph Design with Cisco ACI (Updated to Cisco APIC Release 5.2) White Paper
  - https://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/white-paper-c11-2491213.html
- ACI Fabric Endpoint Learning White Paper
  - https://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/white-paper-c11-739989.html

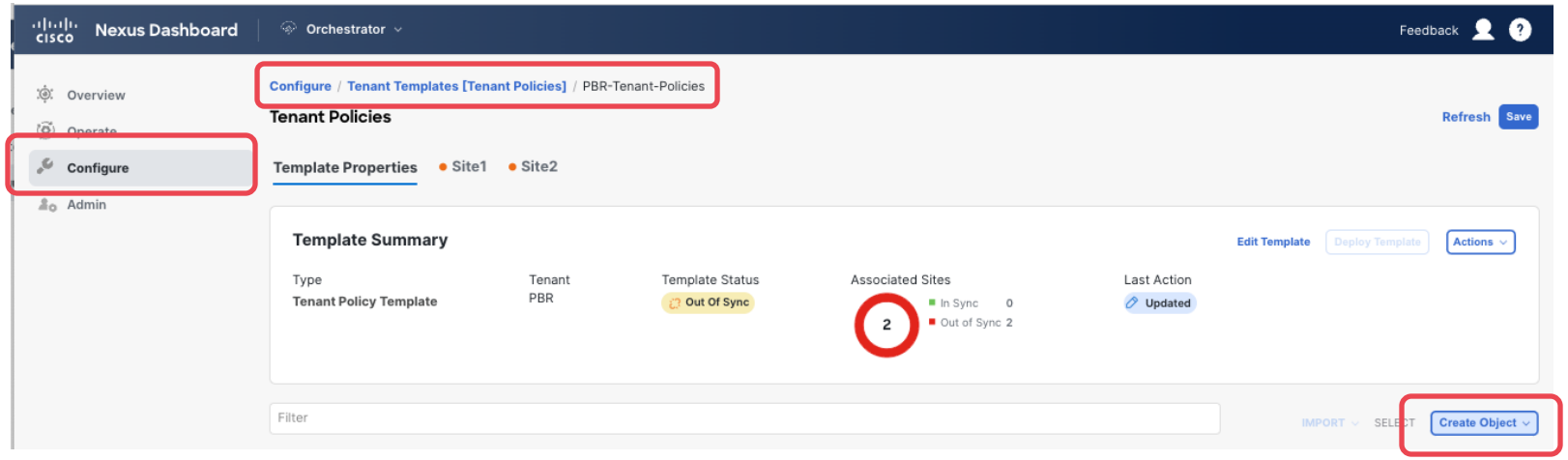
Useful Links

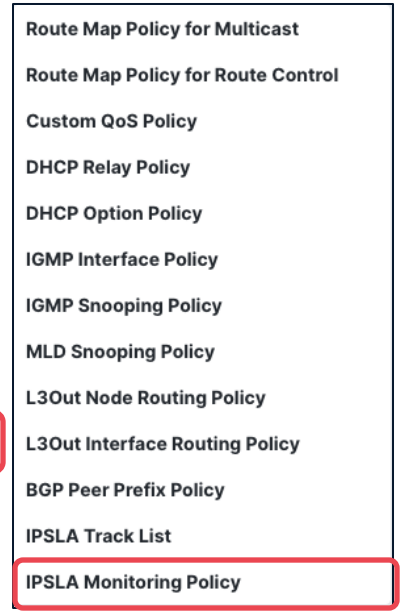
- Cisco ACI and F5 BIG-IP Design Guide White Paper
  - https://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/white-paper-c11-743890.html
- Cisco ACI Multi-Pod and Service Node Integration White Paper
  - https://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/white-paper-c11-739571.html
- Cisco ACI Multi-Site and Service Node Integration White Paper
  - https://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/white-paper-c11-743107.html
- ACI Multi-Site/Multi-Pod and F5 BIG-IP Design Guide
  - https://www.cisco.com/c/en/us/solutions/collateral/data-center-virtualization/application-centric-infrastructure/aci-multi-site-pod-f5-ip-design-guide.html

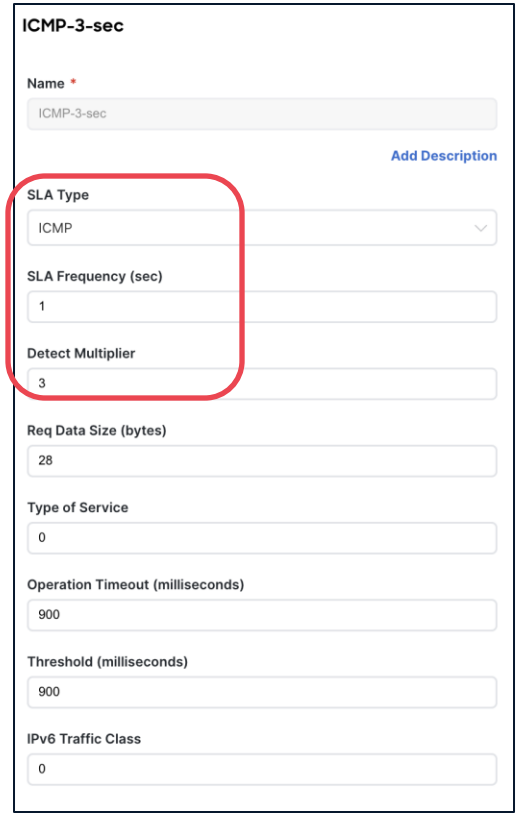
Multi-Site L4-L7 configuration

1: Configure an IP-SLA policy (optional)

- Tenant Policy Template
  - NDO -> Configure -> Tenant Template -> Tenant Policies
  - -> Create Object -> Create an IPSLA Monitoring Policy



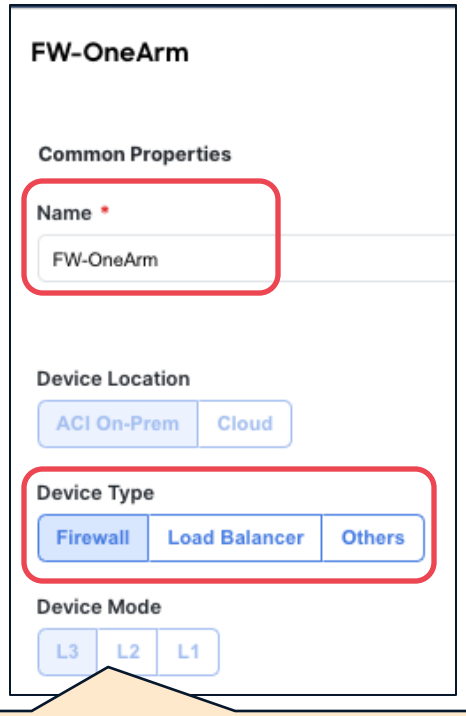




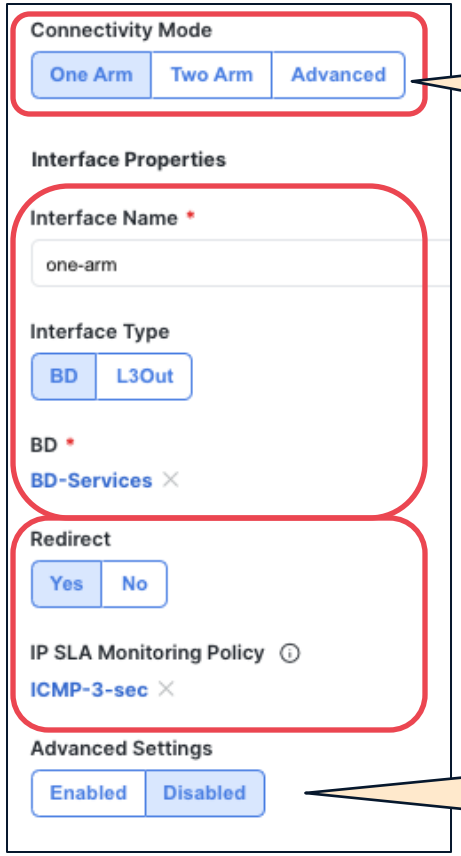
Multi-Site L4-L7 configuration

2: Configure a Service Device template (1/2)

- Service Device template: PBR policy + L4-L7 device network config at one
  - NDO -> Configure -> Tenant Template -> Service Device -> Create Service Device Template



Options that are not applicable are automatically grayed out. For example, if it's L1/L2 PBR, Device Type must be "Others"



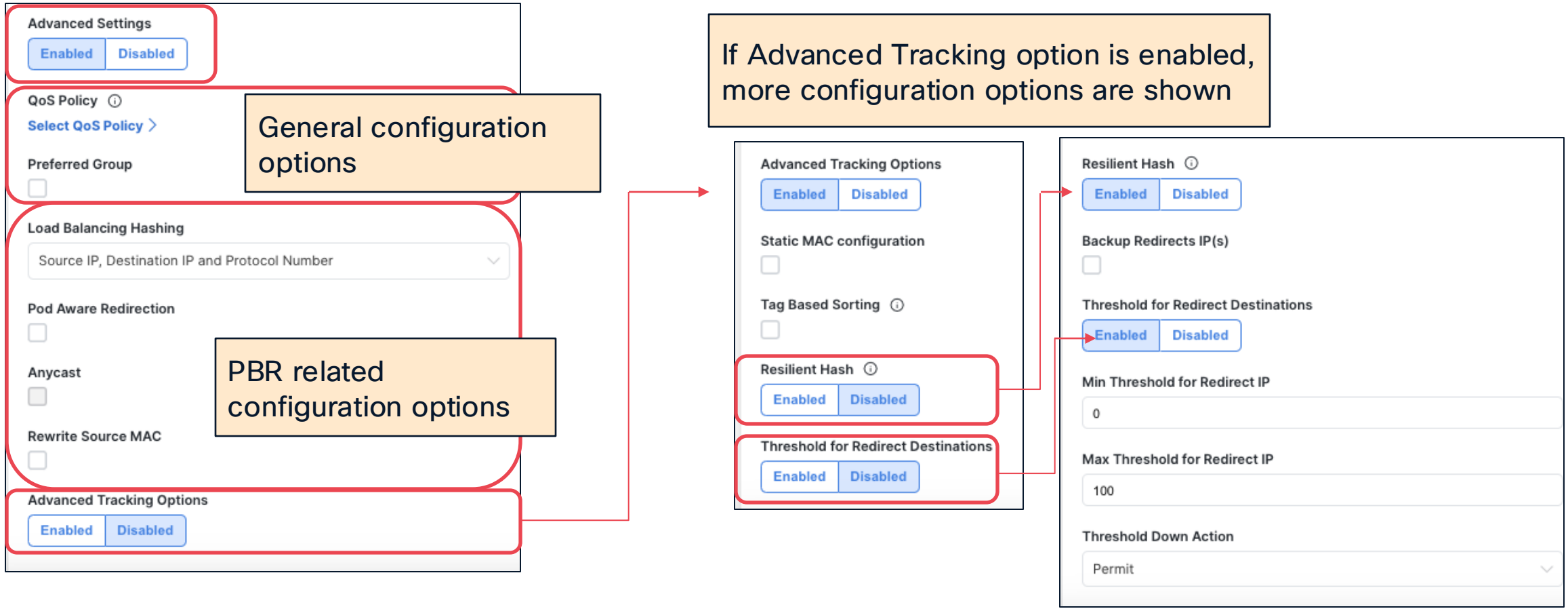
If it's Two Arm or Advanced, a table will show up and then each interface configuration can be done by clicking the pencil icon

By default, other configuration options are hidden

Multi-Site L4-L7 configuration

2: Configure a Service Device template (2/2)

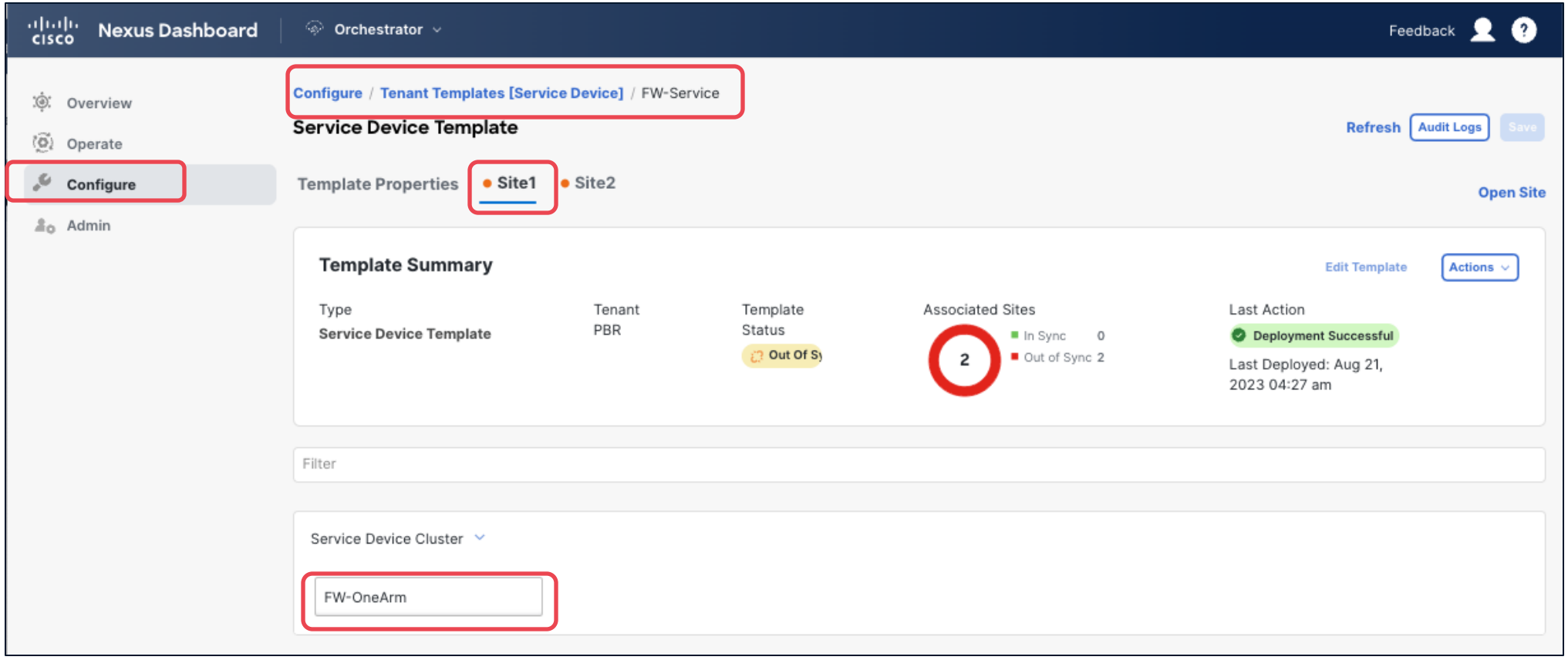
- New workflow hides Advanced configuration options unless it's required.



Multi-Site L4-L7 configuration

2: Configure a Service Device template for site level (1/3)

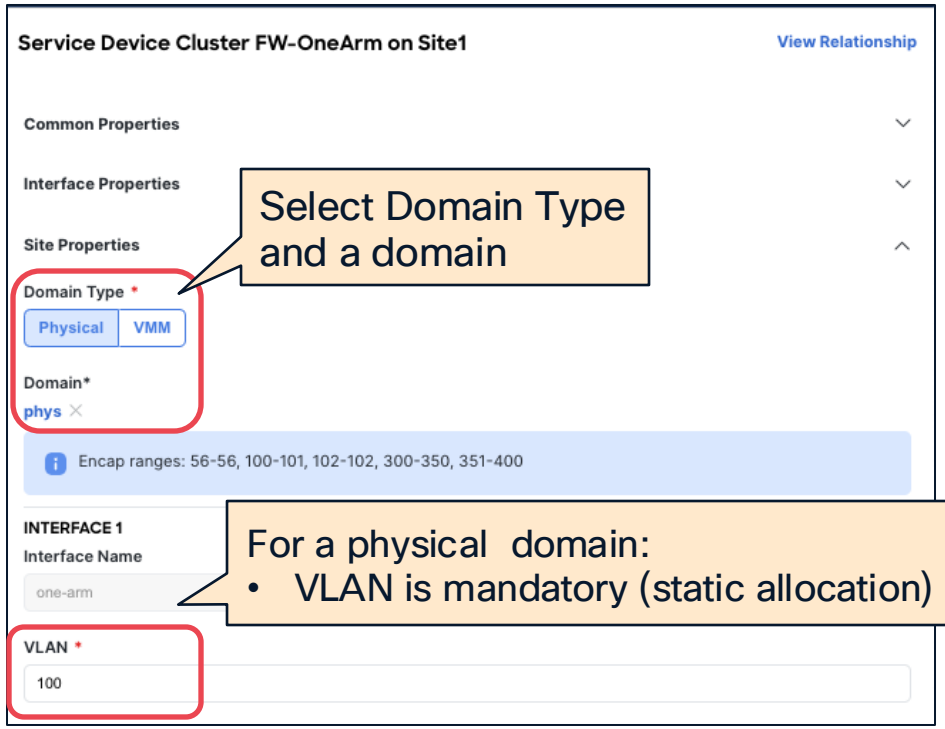
- Domain (physical or virtual domain) configuration is per site configuration.
- Select a site -> Select the Service Device Cluster



Multi-Site L4-L7 configuration

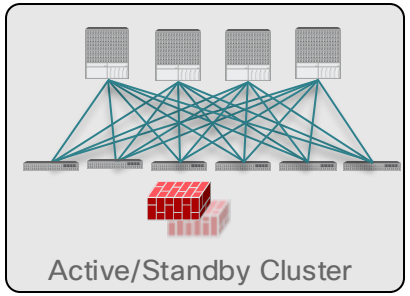
2: Configure a Service Device template for site level (2/3)

- Physical domain



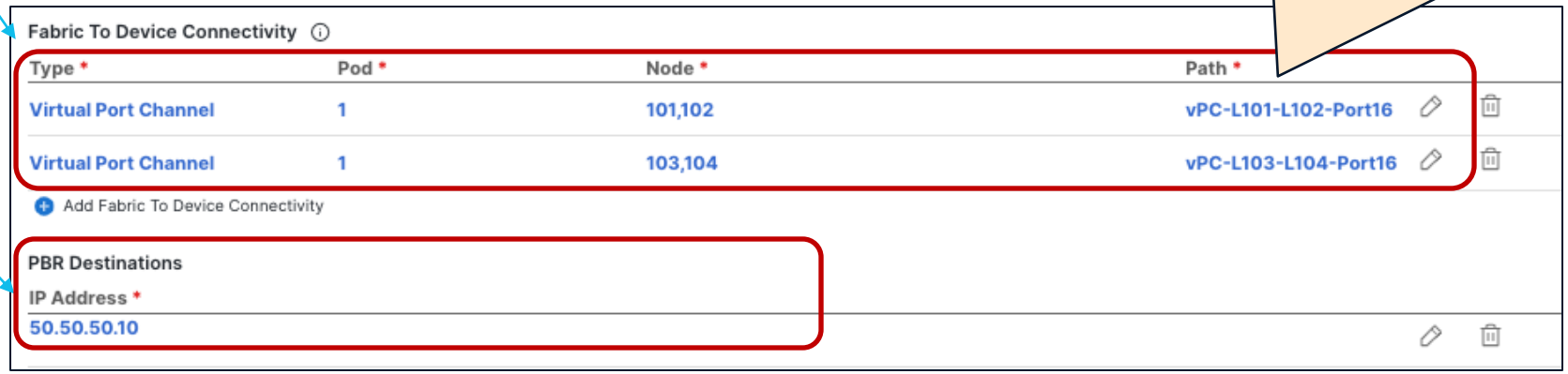
Select Domain Type and a domain

For a physical domain:
- VLAN is mandatory (static allocation)



Specify the interfaces connected to FW nodes (Active/Standby mode)

For a physical domain:
- Two Interfaces connected to the Active/ Standby service devices (static path)

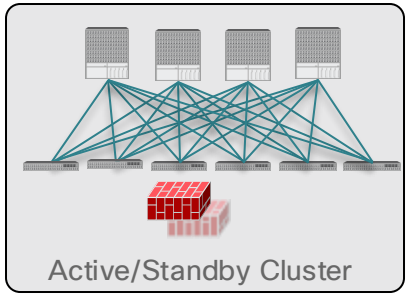


Specify the single IP address identifying the logical cluster

Multi-Site L4-L7 configuration

2: Configure a Service Device template for site level (3/3)

- VMM domain



Service Device Cluster FW-Cluster on Site1 — View Relationship

Common Properties

Interface Properties

Site Properties

Domain Type * Physical | VMM

Domain* vDS-Site1

Encap ranges: 50-60, 100-110, 300-399, 480-480, 800-900

Trunking Port Enabled

Promiscuous Mode Enabled

INTERFACE 1

Interface Name one-arm

VLAN

Enhanced LAG Option LAG1

Select Domain Type and a domain

For a VMM domain:
- VLAN is not mandatory (dynamic allocation). If VLAN ID is specified, the VLAN ID must be part of a static VLAN range
- Enhanced LAG

Specify the FW VMs (Active/Standby mode)

Specify the single IP address identifying the logical cluster

VM Information*

VM Name*	VNIC*
vCSA-7-Site1/ASAv-Pod1	Network adapter 2
vCSA-7-Site1/ASAv-Pod2	Network adapter 2

Add VM Information

PBR Destinations

IP Address *

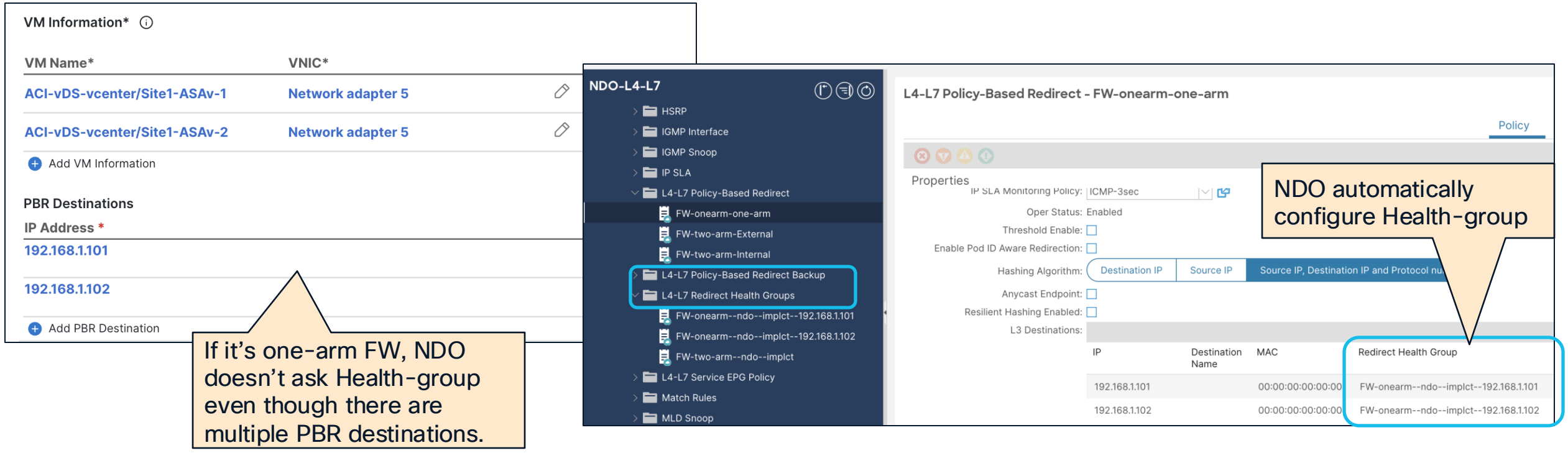
50.50.50.10

For a VMM domain:
- VM Name and its interface
- PBR destination IP (If IP-SLA tracking is enabled, MAC configuration is not required

Multi-Site L4-L7 configuration

Note:

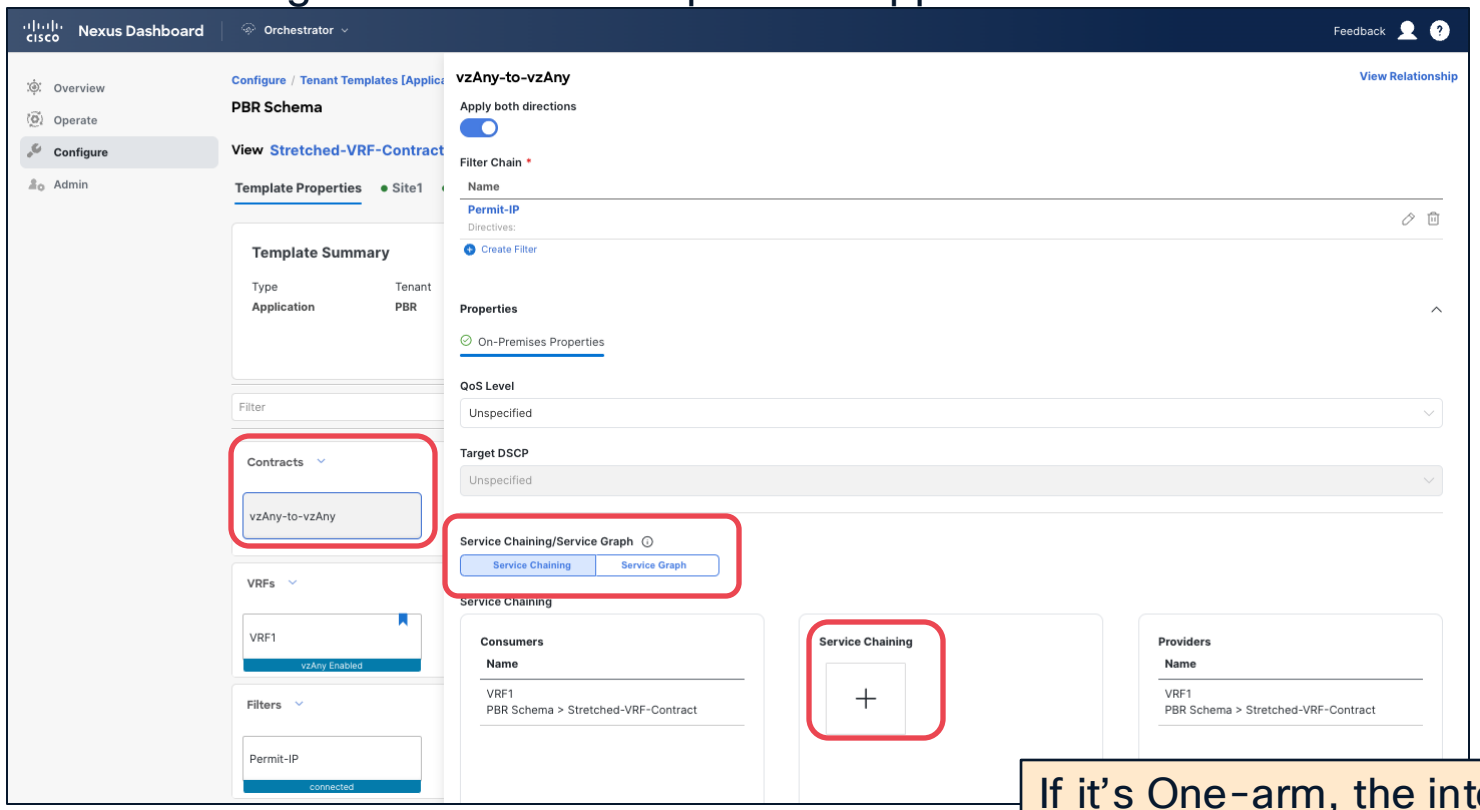
- New workflow doesn't ask you some configuration options if they are not required. For example:
  - If tracking is enabled, NDO doesn't ask PBR destination MAC.
  - NDO doesn't ask Health-group configuration unless it's required.

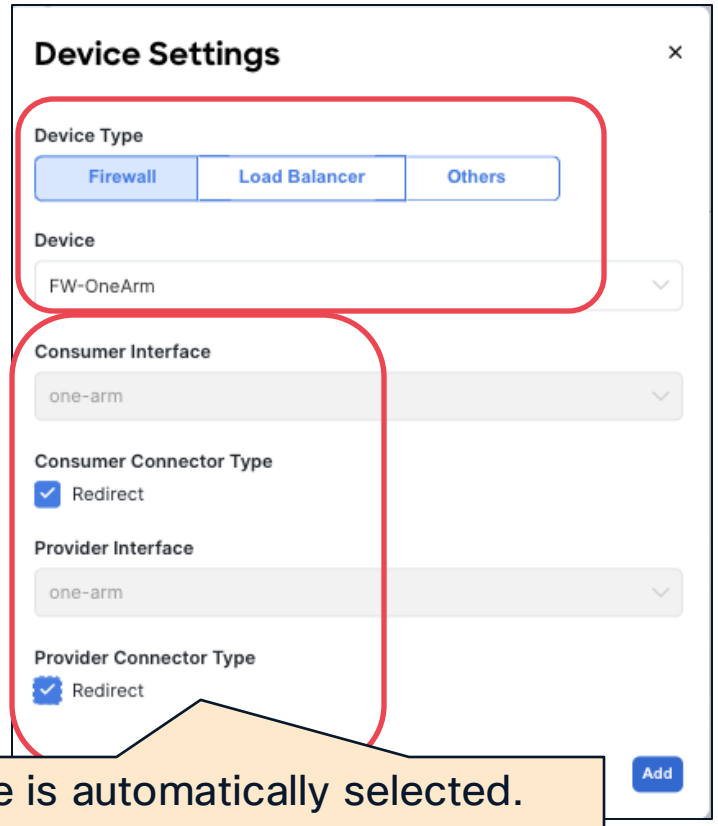


Multi-Site L4-L7 configuration

3: Insert the Service Device to a contract

- Just select which device you want to insert!
- NDO -> Configure -> Tenant Template -> Applications -> Select the Schema





If it's One-arm, the interface is automatically selected.
Redirect can be enabled/disabled at each interface

Multi-Site L4-L7 configuration

Optional: required configuration for vzAny PBR

- Enable “L3 Multicast” and “Site-aware Policy Enforcement Mode” on the VRF