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Local knowledge.

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Croatia

Demystifying ACI Security

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The Case for SDN

Applications All Around Us

...are the driving force of business that are being...

Rapidly developed and

Deployed at scale

...while requiring...

Frequent updates and

Highest Availability (SLAs)

Challenge for Infrastructure

...to keep up with the pace of change imposed on the:

- Network
- Security

...functions, while maintaining application:

- Capacity
- Resiliency
- Agility

Software-Defined Networking ...Comes to the Rescue

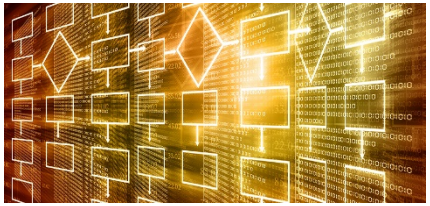
"...is an emerging architecture that is dynamic, manageable, cost-effective, and adaptable, making it ideal for the high-bandwidth, dynamic nature of today's applications. This architecture decouples the network control and forwarding functions enabling the network control to become directly programmable and the underlying infrastructure to be abstracted for applications and network services."

Source: www.opennetworking.org

What are the critical Security Functions in the DataCenter?

Defining SDN use case for DC security

Micro- Segmentation



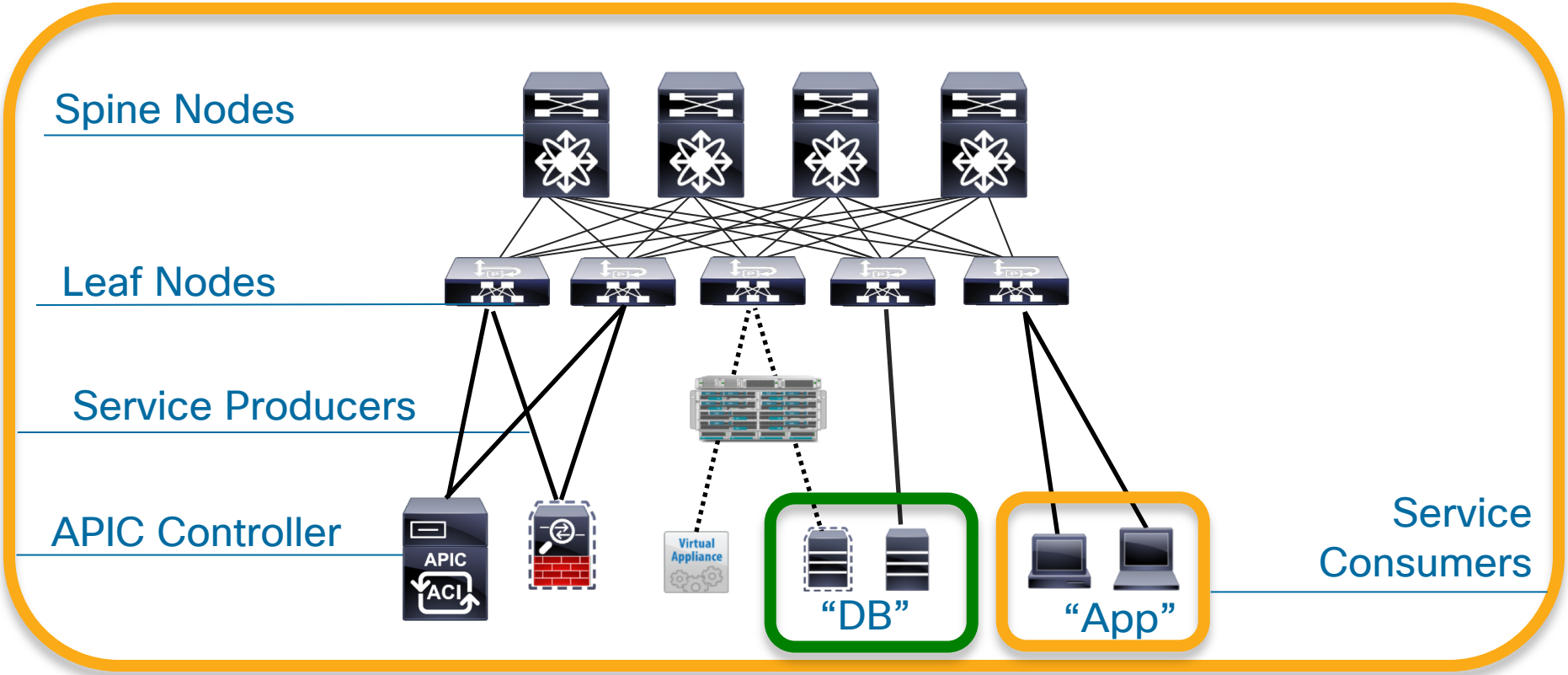
Programmability

Automatic Remediation

Embedding security policy within Application

Ease of Service Insertion

ACI Devices Role

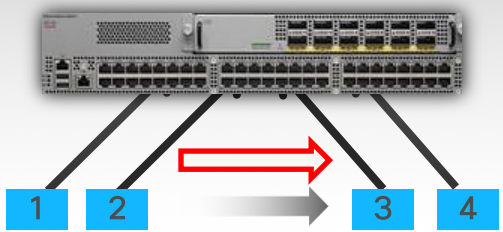


ACI Whitelist Policy supports “Zero Trust” Model

Whitelist policy = Explicitly configured ACI contract between EPG 1 and EPG 2 allowing traffic between their members

TRUST BASED ON LOCATION

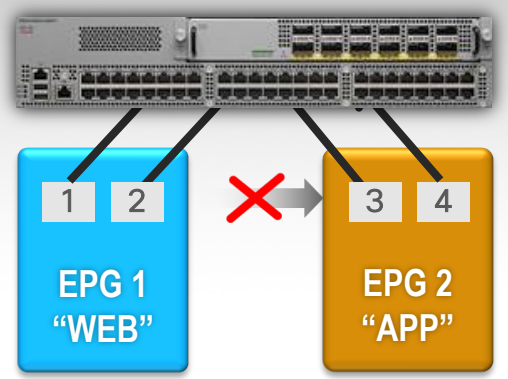
(Traditional DC Switch)



Servers 2 and 3 can communicate unless **blacklisted**

ZERO TRUST ARCHITECTURE

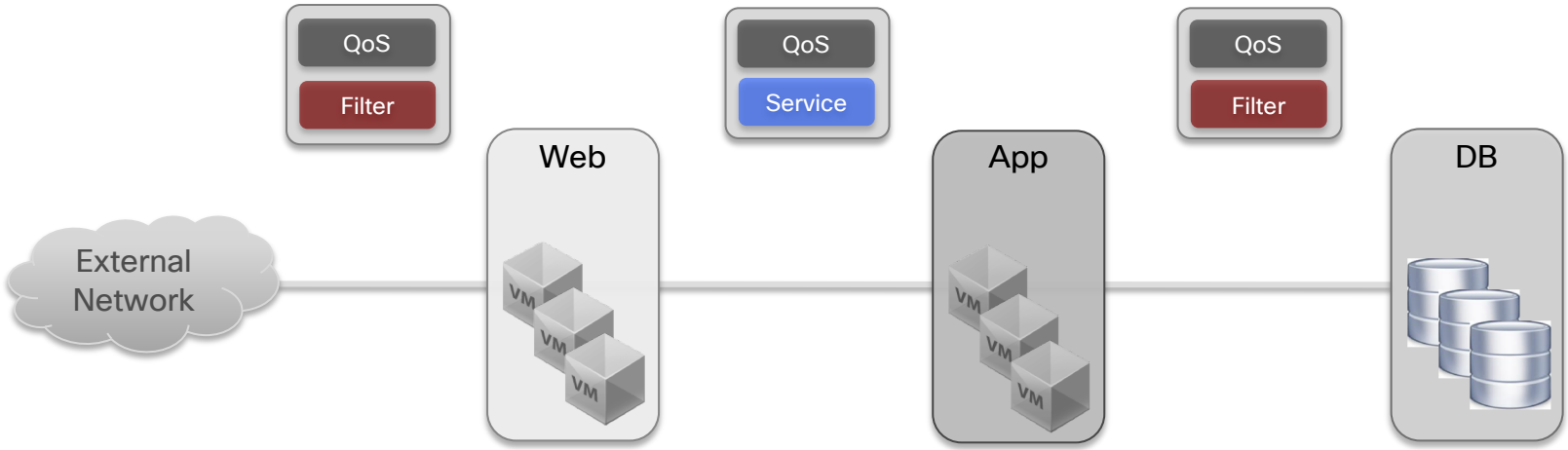
(Nexus 9K with ACI)



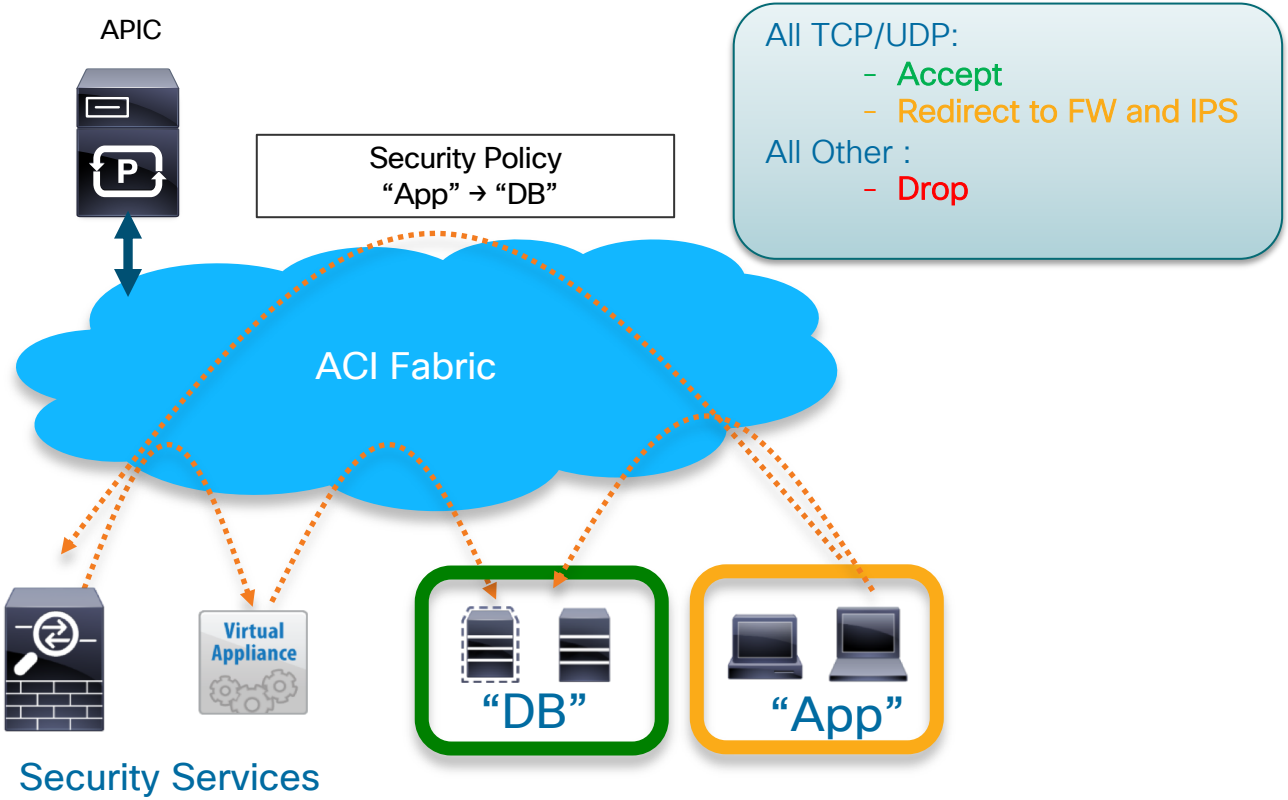
No communication allowed between Servers 2 and 3 unless there is a **whitelist policy**

The Heart of ACI

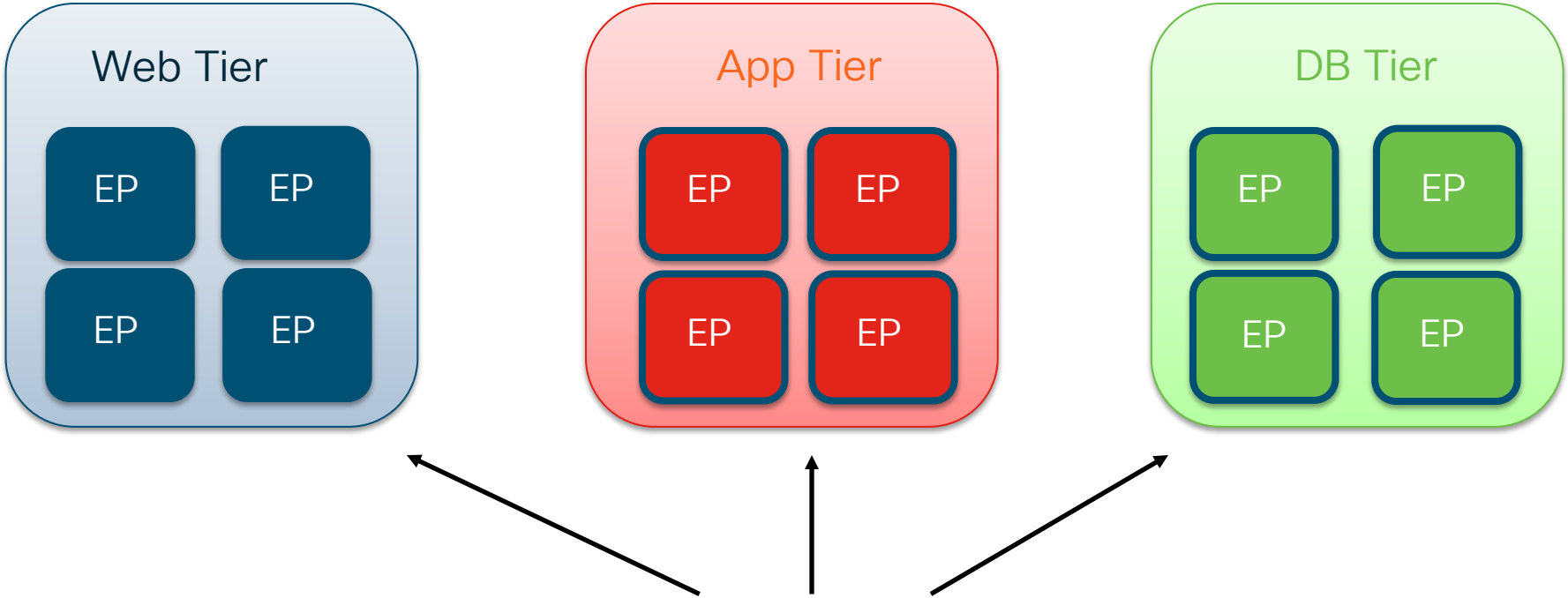
ACI uses a **policy based approach** that focuses on **the application**.



ACI Communication Abstraction

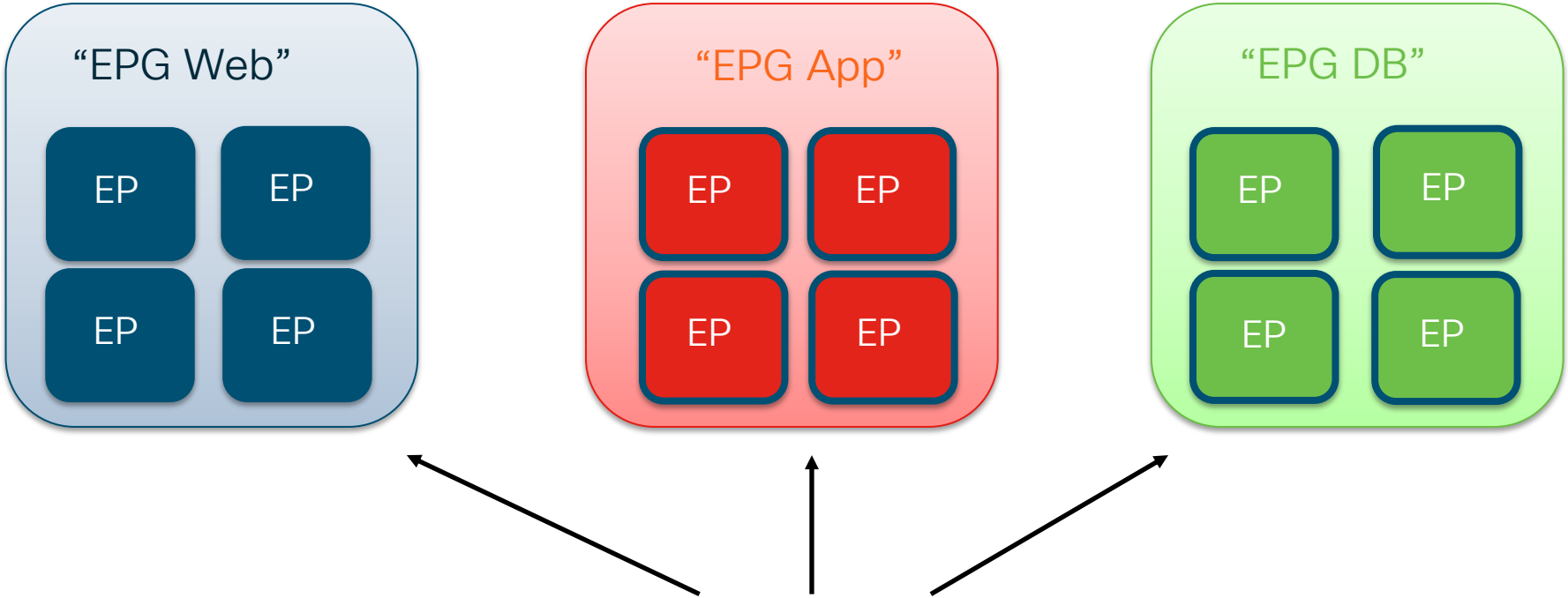


A Policy Based on Groups



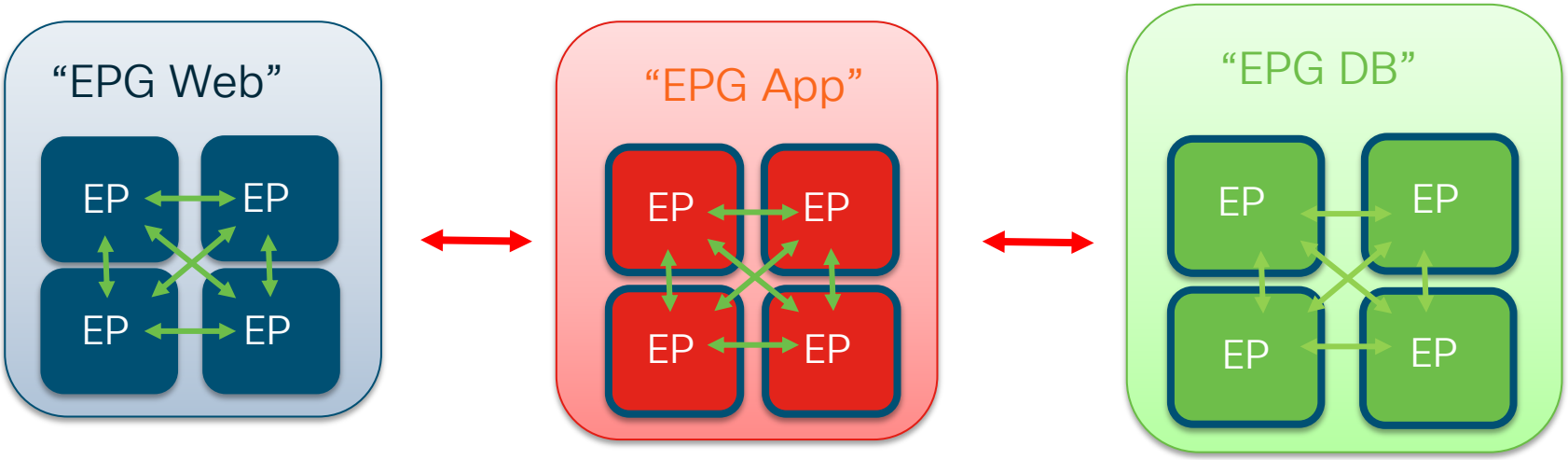
First, we need a way to identify and group together end points.

End Point Group



In the ACI model, we do this using the End Point Group (EPG).

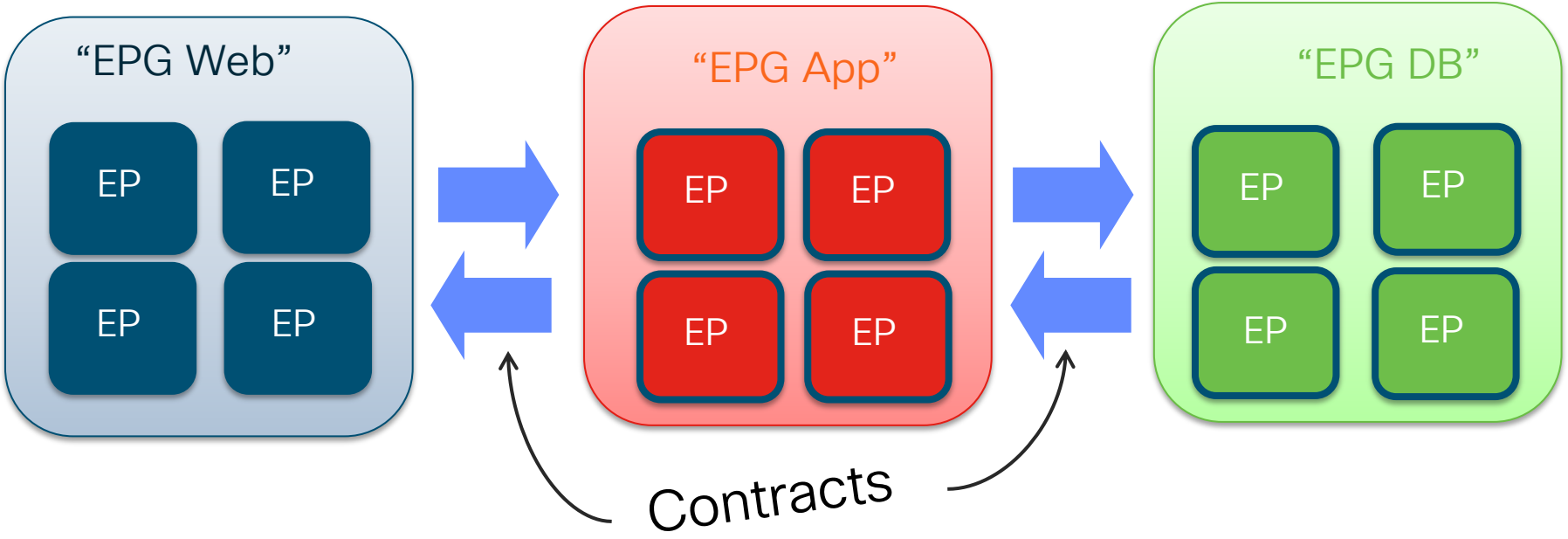
Endpoint Groups Communications



Devices within an Endpoint group can communicate, provided that they have IP reachability (provided by the Bridge Domain/VRF).

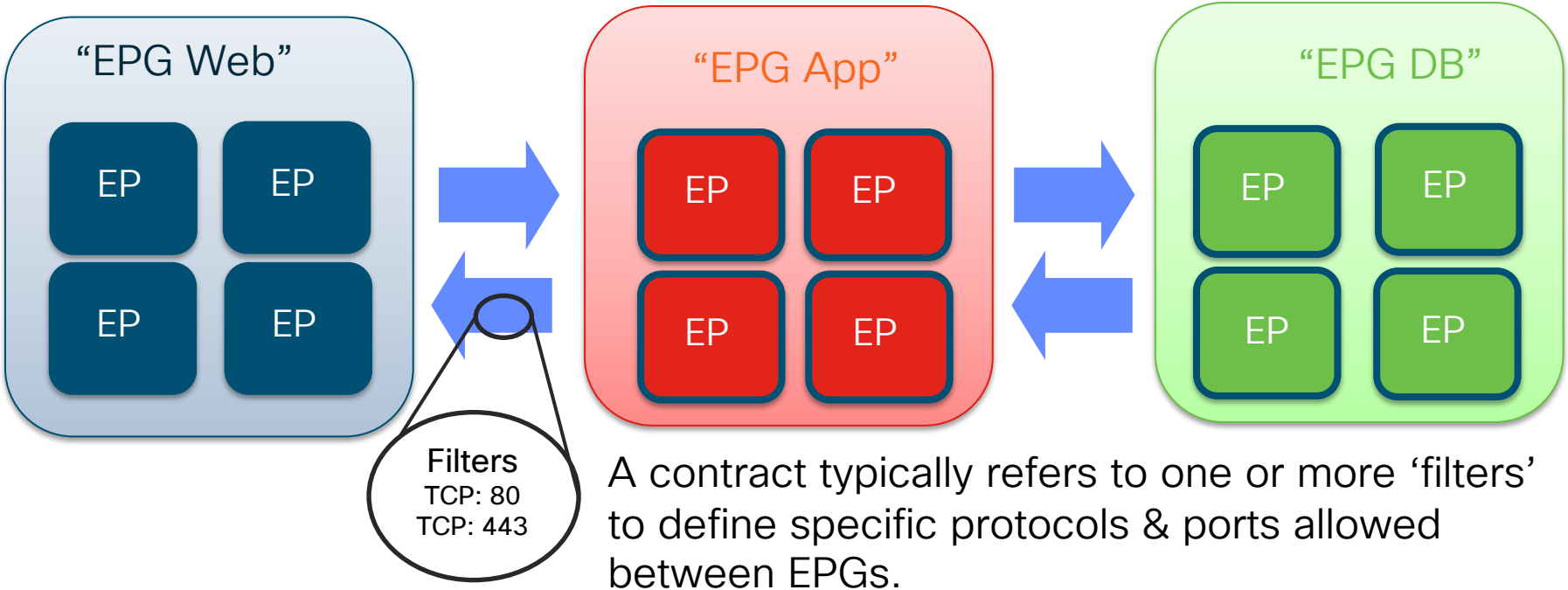
Communication between Endpoint groups is, by default, not permitted.

Contract



Once we have our EPGs defined, we need to create policies to determine how they communicate with each other.

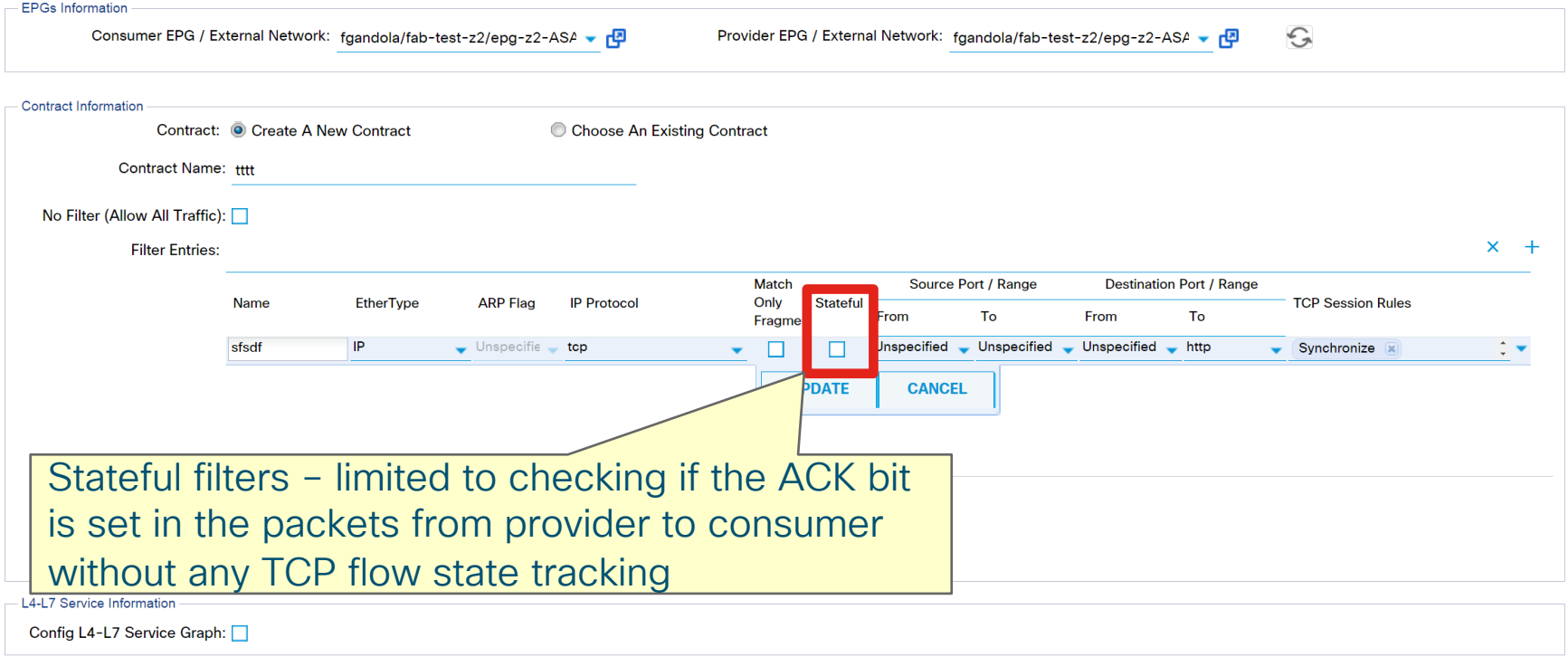
Contract : Kind of reflexive “Stateless” ACLs



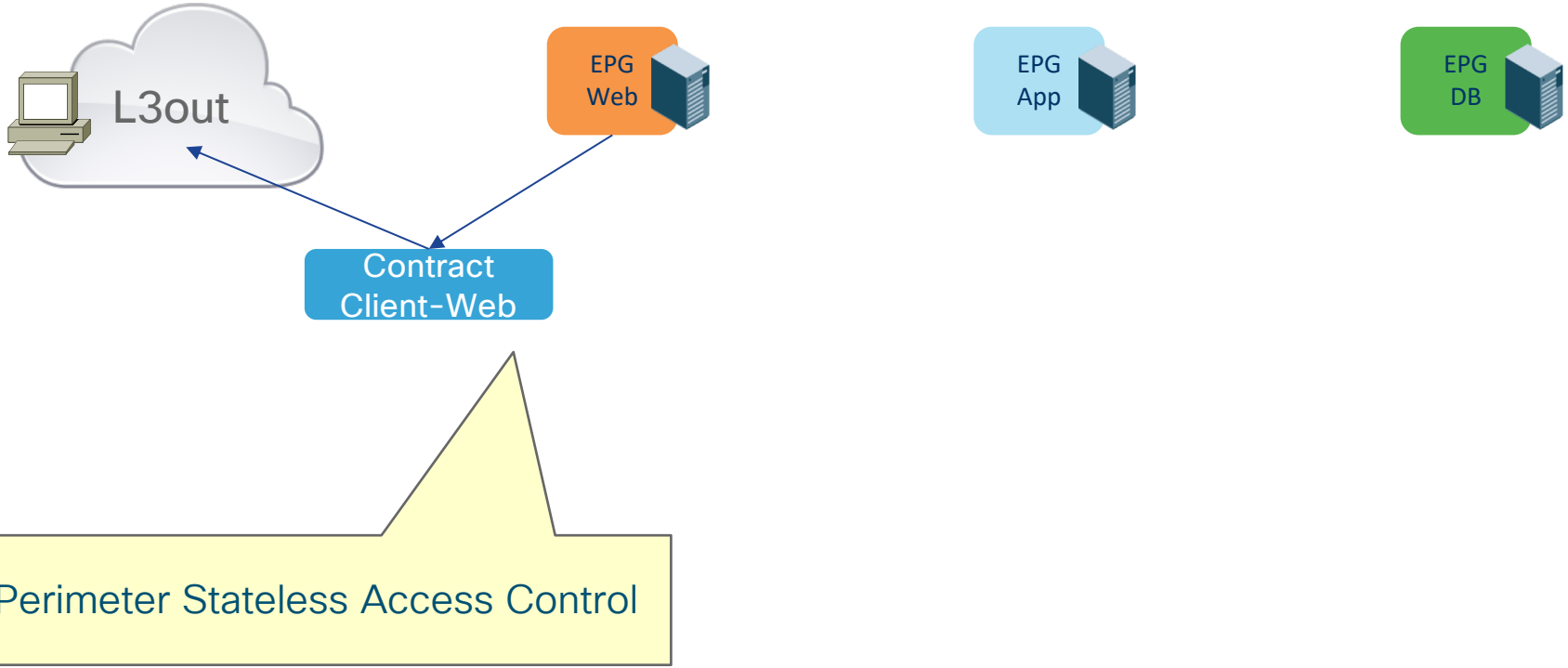
A contract typically refers to one or more ‘filters’ to define specific protocols & ports allowed between EPGs.

Create a Contract

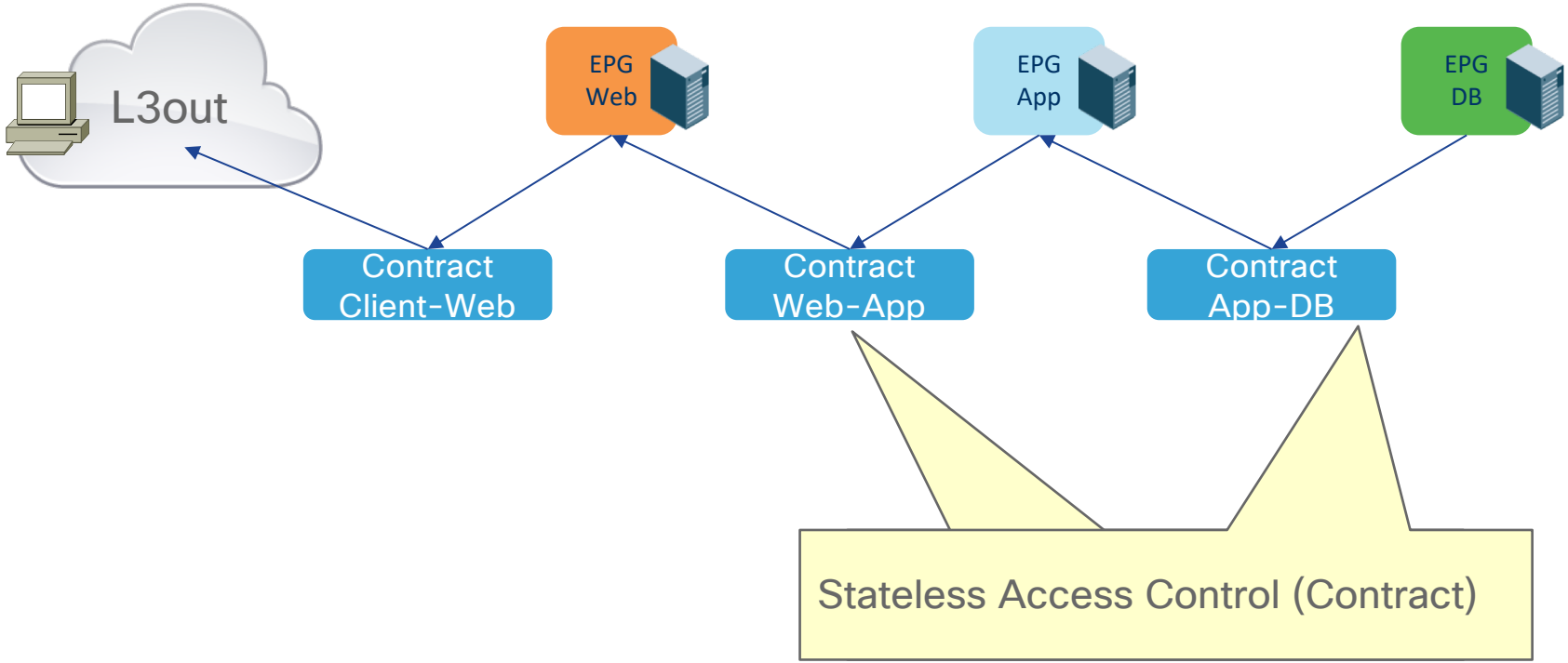
Config A Contract Between EPGs



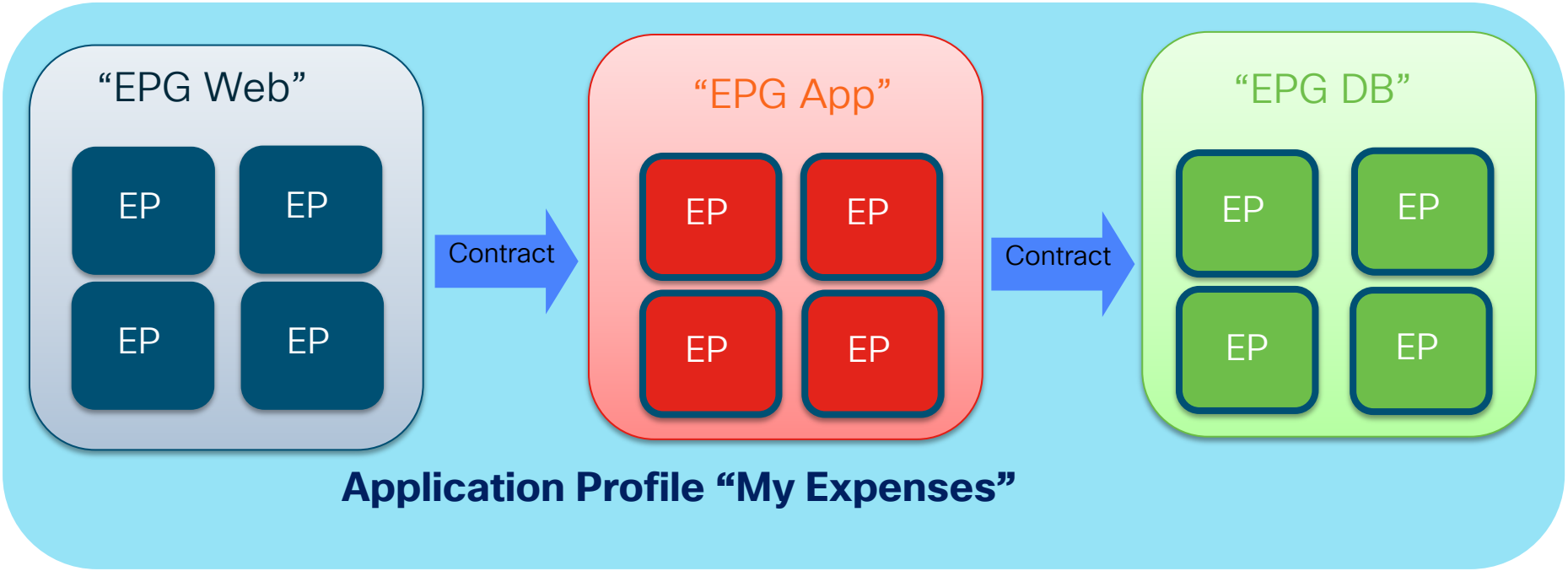
Access Control From Outside



Segmentation Using Contracts

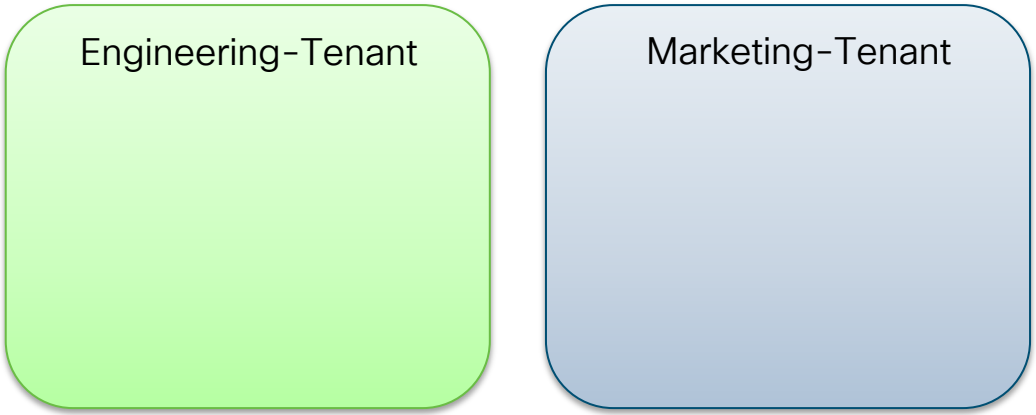


Application Profile



A collection of EPGs and the associated contracts that define how they communicate form an ***Application Profile***.

Tenants

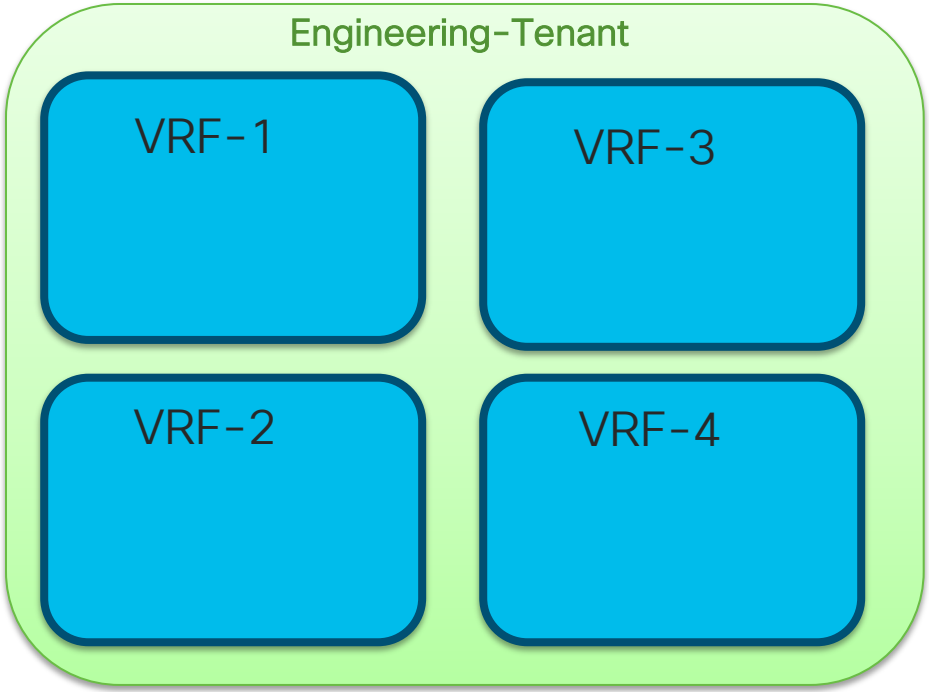


A Tenant is a container for all network, security, troubleshooting and L4 – 7 service policies.

Tenant resources are isolated from each other, allowing management by different administrators.

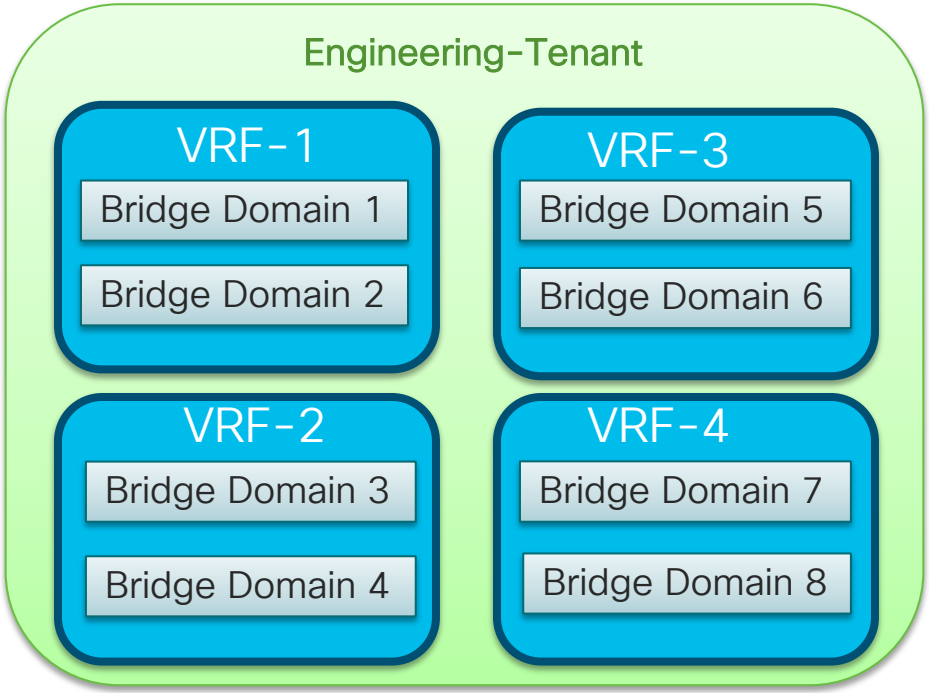
Tenants can provide traffic and RBAC isolation...

VRF aka Context aka Private Network



VRF(also called contexts) are defined within a tenant to allow isolated and potentially overlapping IP address space.

Bridge Domain: Not a VLAN but almost...

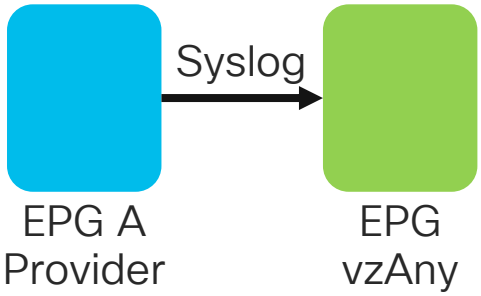


Within a private network, one or more bridge domains must be defined.

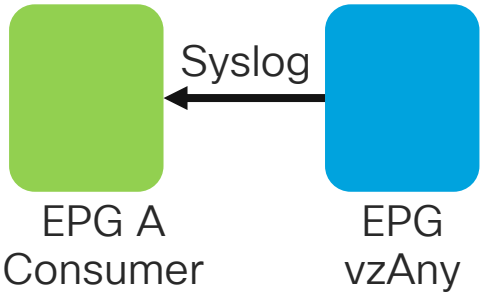
A bridge domain is a L2 forwarding construct within the fabric, used to constrain broadcast and multicast traffic

But what if I want all EPGs to be able to send syslog, query DNS, communicate with the AD, etc…?

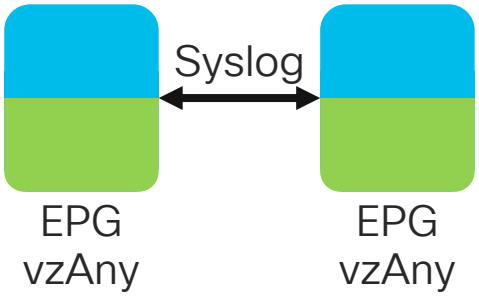
vzAny applies rules to all EPGs in a VRF



Any EPG can consume syslog that EPG A provides



EPG A can consume Syslog from any EPG in the VRF



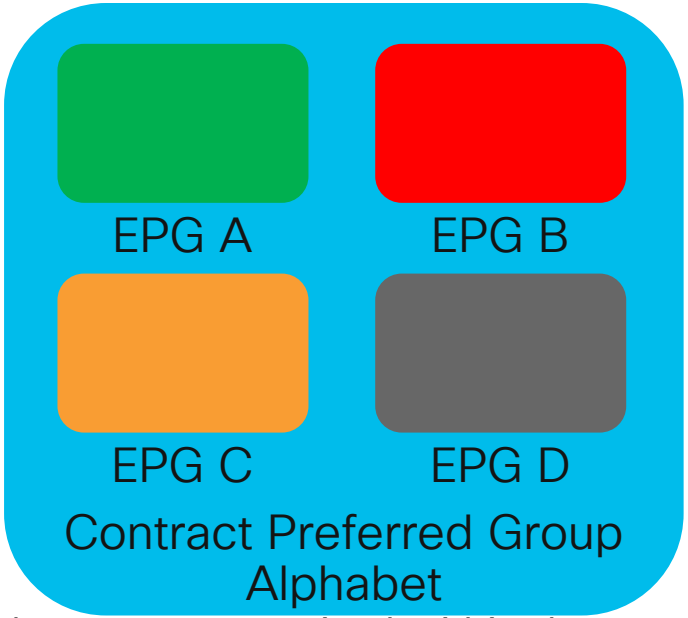
Any EPG in the VRF can consume or provide syslog

http://www.cisco.com/c/en/us/td/docs/switches/datacenter/aci/apic/sw/kb/b_KB_Use_vzAny_to_AutomaticallyApplyCommunicationRules_toEPGs.html#concept_F2BC3533BF984F1F88A18B712ED9C072

But what if I want some EPGs to communicate freely between themselves?

Contract Preferred Groups

Allow traffic between a group of EPGs



No contract required within the group

Contract required

http://www.cisco.com/c/en/us/td/docs/switches/datacenter/aci/apic/sw/kb/b_APIC_Contract_Preferred_Group.html

ACI Micro Segmentation

The ACI Micro Segmentation Toolbox

EPGs & Contracts
ACI Policy Model

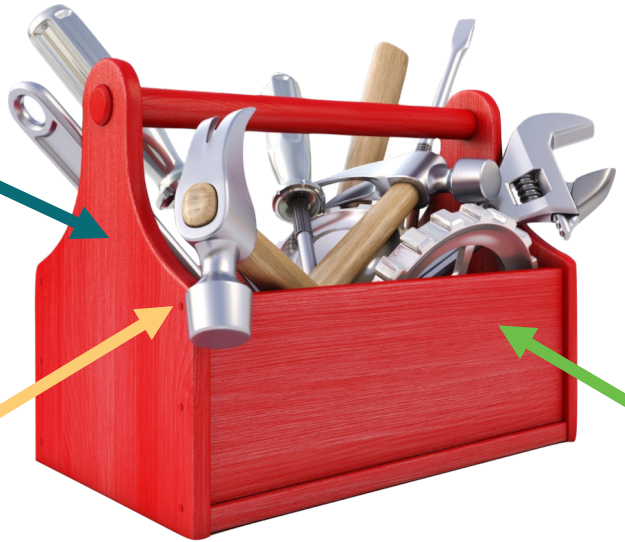
The ACI Micro Segmentation Toolbox

Intra-EPG isolation

- Functional equivalent to Isolated Private VLAN: **ALL endpoints in EPG are isolated from each other**
- Supported since ACI 1.2(2)
- Can be combined with Micro-segmented EPG

The ACI Micro Segmentation Toolbox

EPGs & Contracts
ACI Policy Model



Intra-EPG isolation

Intra-EPG Contracts

From 4.0 with Service Graph attached

The ACI Micro Segmentation Toolbox

Use of attributes to classify endpoints in a specific kind of EPG called µEPG

Network-based attributes: IP/MAC
VM-based attributes: Guest OS, VM name, ID, vnic, DVS, Datacenter

Does not create a Port Group on VMM (no vnic reassign)

Supported since ACI 1.1(1)

Micro-segmented EPGs with attributes

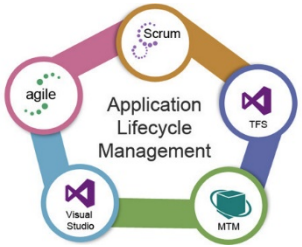
About Micro-segmented EPGs

- µSeg EPGs are not linked to a “Base” EPG (though virtual endpoints are still “attached” to their corresponding Port Groups):
  - They have their **own Bridge Domain** → Endpoints addressing must be taken into consideration in the design
  - They have their **own set of Contracts** → There is no contract inheritance from the “Base” EPG.
- Attributes are matched using an “OR” operator with a precedence order in case of conflict
  - **Any VM** in the VMM Domain & Tenant **matching an attribute** will be put in the µSeg EPG → Choose wisely the attribute(s) you want to match
  - In the last 2 case studies, **Custom Attributes** would be a natural choice

Use Cases

Securing infrastructure

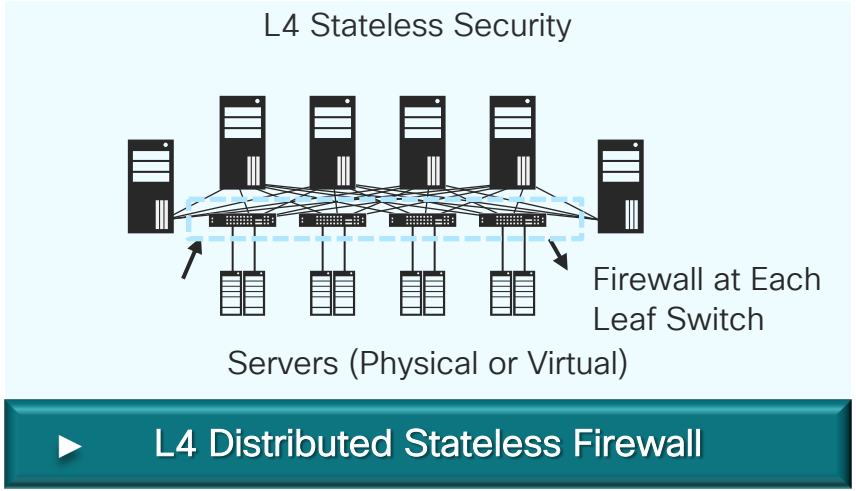
Quarantining compromised endpoints



Securing an application life cycle

Security Services

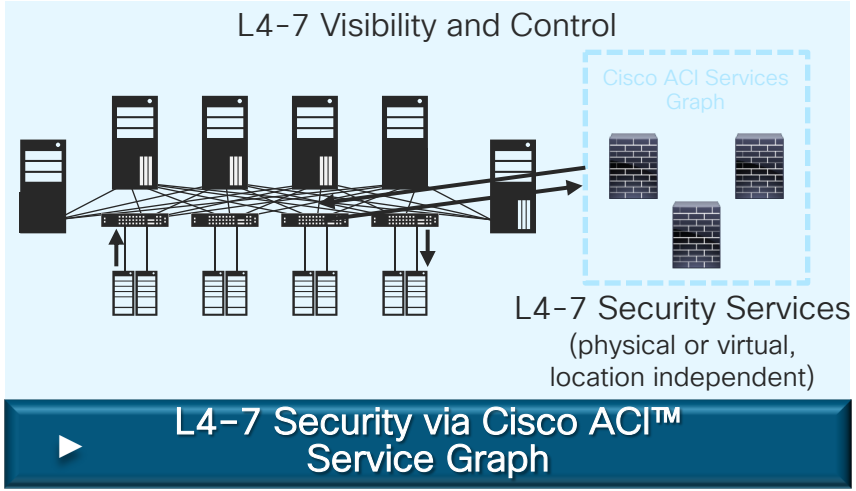
Cisco ACI Supports Flexible East-West Security Models



L4 Stateless Firewall Attached to Every Server Port

Line Rate Policy Enforcement

Policy Follows Workloads



Advanced Protection with NGFW, IPS/IDS, DDoS Services Insertion

Sizing at Scale: Can add ASA Cluster

L4-7 Security Policy Applied Consistently for Any Workload

Why Inserting Security Services ?

- **Stateless Segmentation** not sufficient for compliance
- More granular Access Control (i.e. user based)
- Dynamic protocol requiring **better inspection**
- **Better protection** and detection mechanisms

Cisco Security Portfolio Overview

Firewall/IPS/AMP

Firepower NGFW/NGIPS/AMP

ASAv, FMCv, NGFWv on Hypervisor

Cisco ASA

Analytics

StealthWatch

StealthWatch Cloud

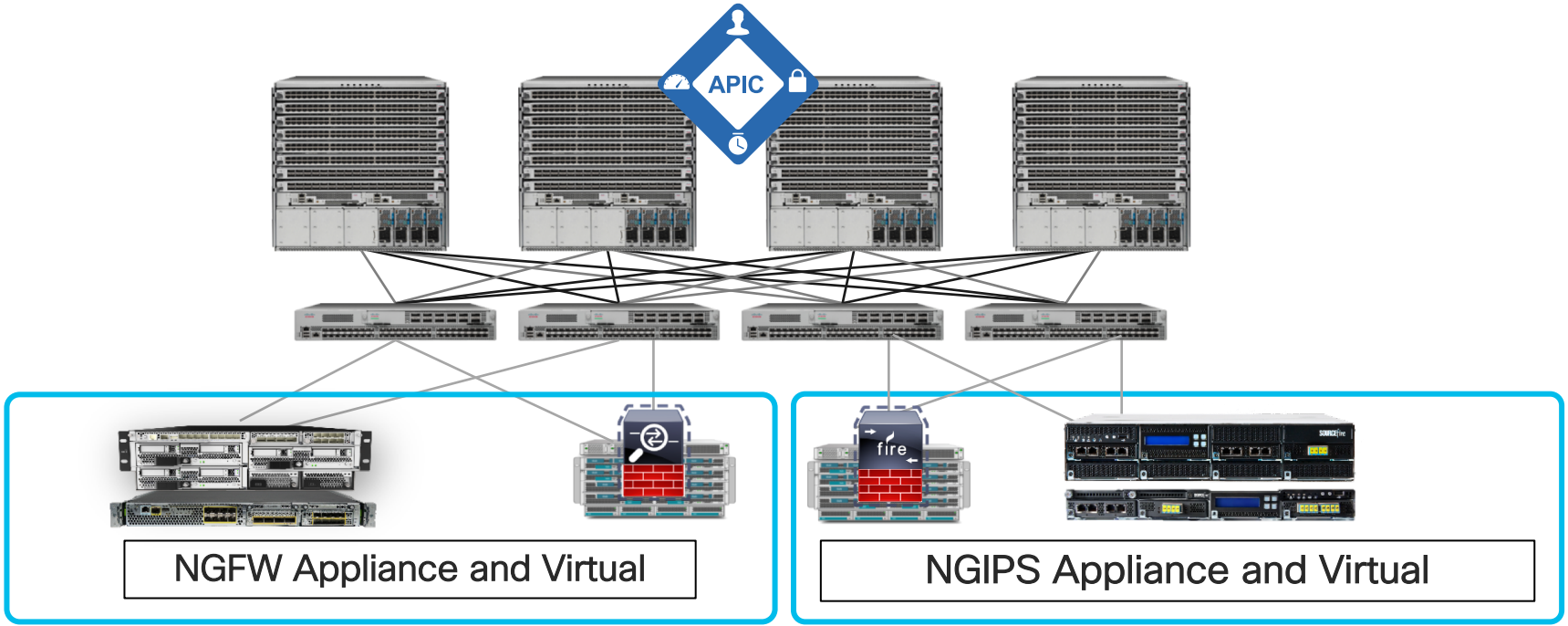
Cloud

ASAv, FMCv, NGFWv

AWS, Azure

Umbrella & CloudLock

Where to Connect Security Services in the Fabric ?



WE DON'T REALLY CARE !!!!

How to Insert Security Services

- Network Stitching ACI L2 Fabric
- Service graph insertion
  - Unmanaged
  - Managed with Device package
  - Managed Hybrid

Match the requirements and operation model of the DC and Security Team

Flexible Options for Services Insertion

ACI L2 Fabric

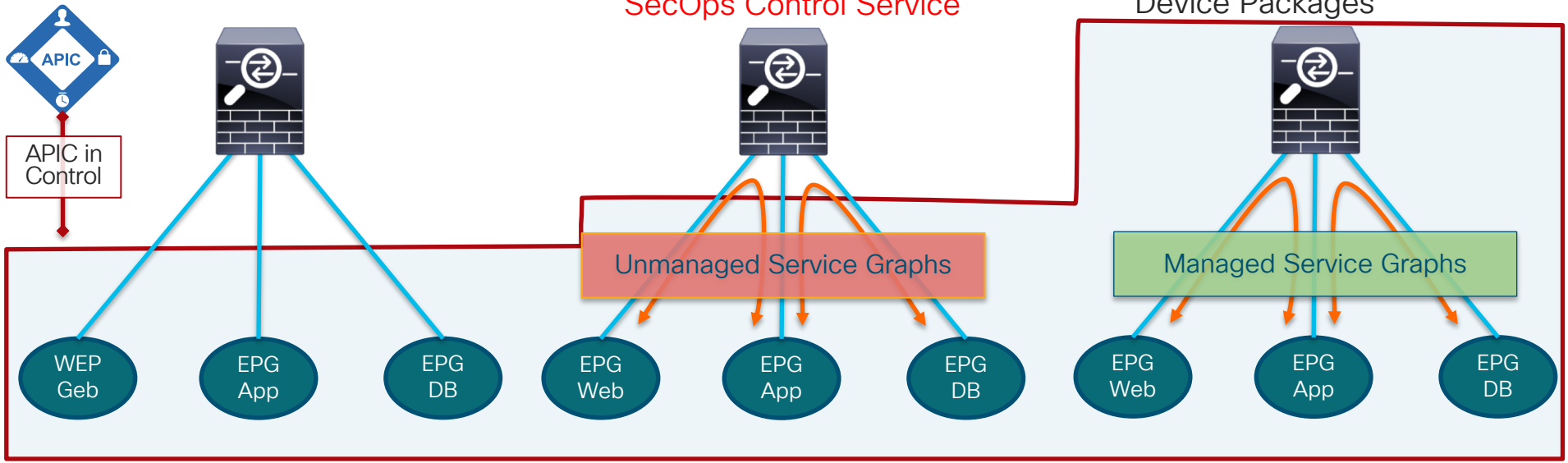
- APIC defines Tenants
- EPG is VLAN/Subnet

Service Graph No Package

- Fabric GW/Routing
- No Device Package:
  -Network Policy Mode
  SecOps Control Service

Service Graph Managed

- Orchestrate with Vendor:
  - Service Policy or
  - Service Manager
  Device Packages

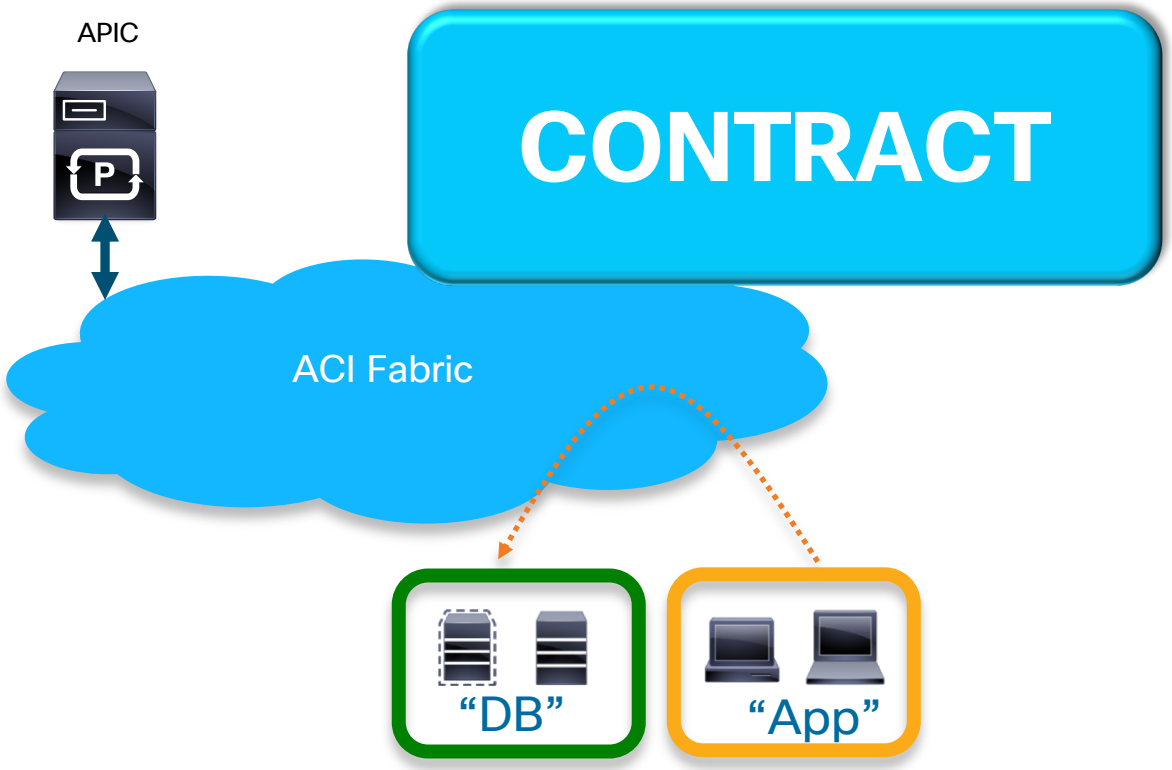


Service Graph technology was designed to automate and accelerate the deployment of L4-L7 sevices in the network

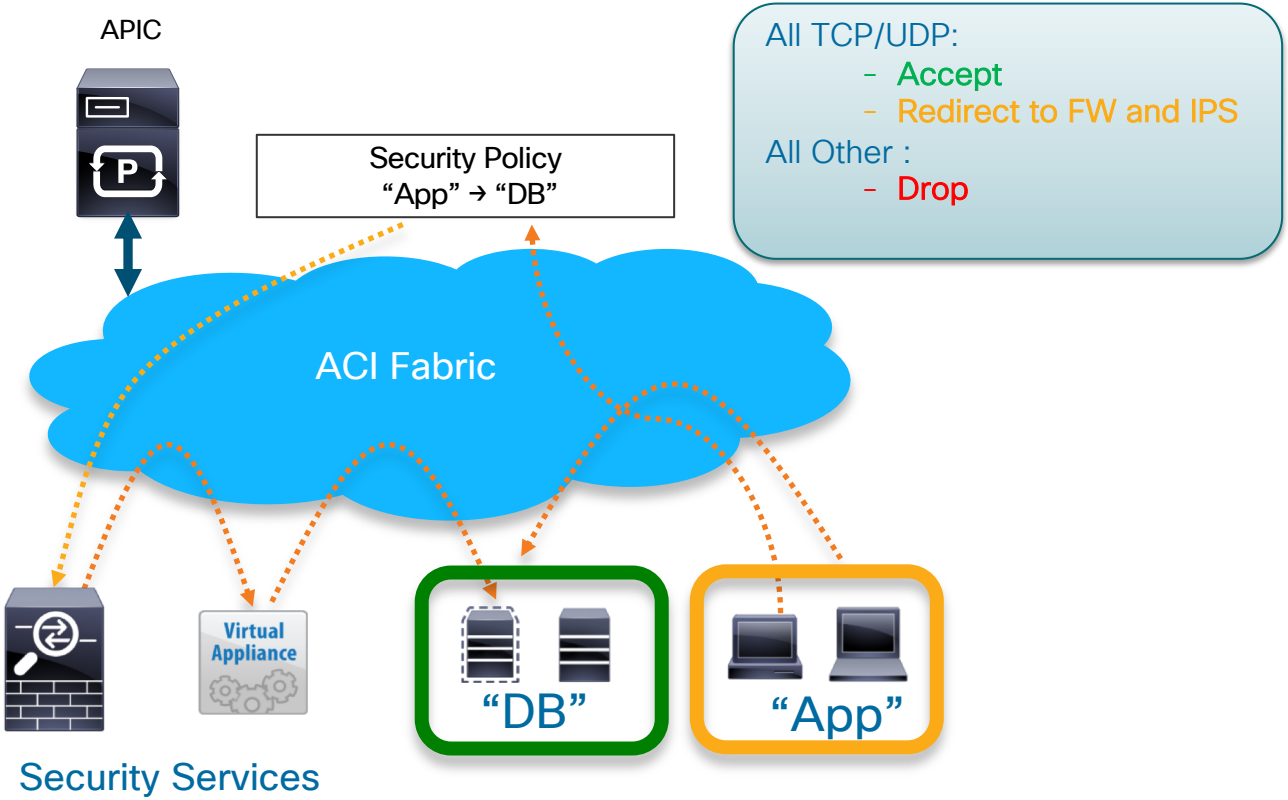
Why Use Service Graph ?

- Security is fully inserted to the Application as the service graph is an extension of the contract in the Application Profile
- Granular way to send traffic to the Security Service using the contract
- Configuration Templates
- Automation of the Network configuration both for Fabric and Security appliance (with Device Package)
- Statistics and health score automatically collected for the services
- Dynamic update of the ACLs based on End Point discovery in the EPG
- Insert several services seamlessly with Service Chaining

ACI Zero Trust Model

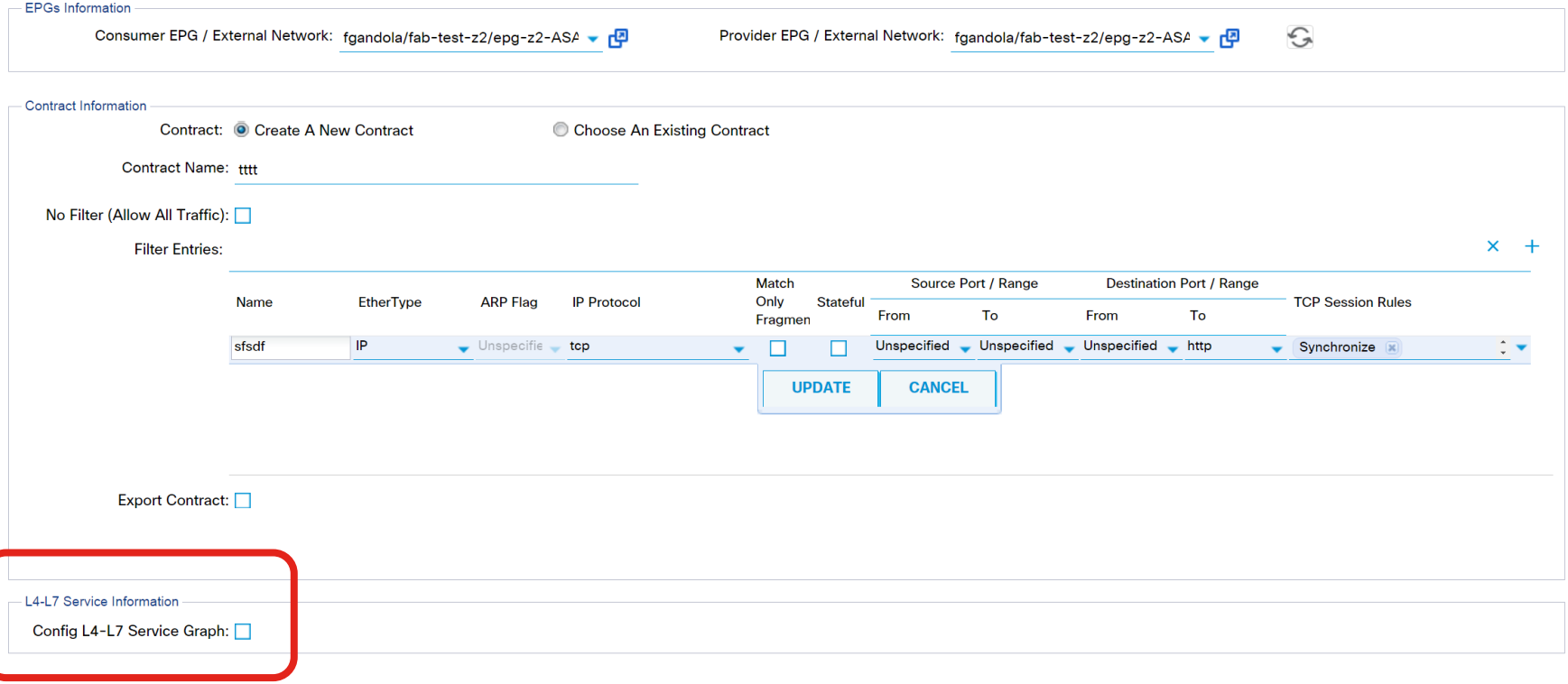


Build a Policy with Service Graph



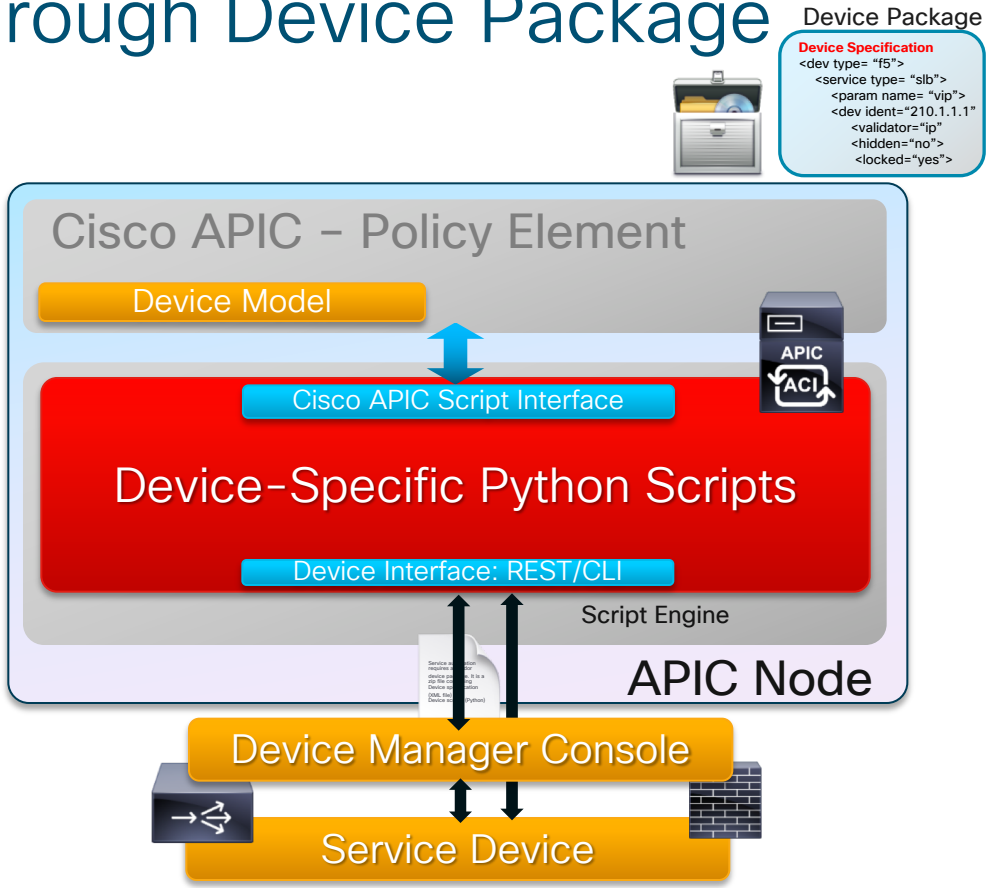
Add a Service graph to a Contract

Config A Contract Between EPGs

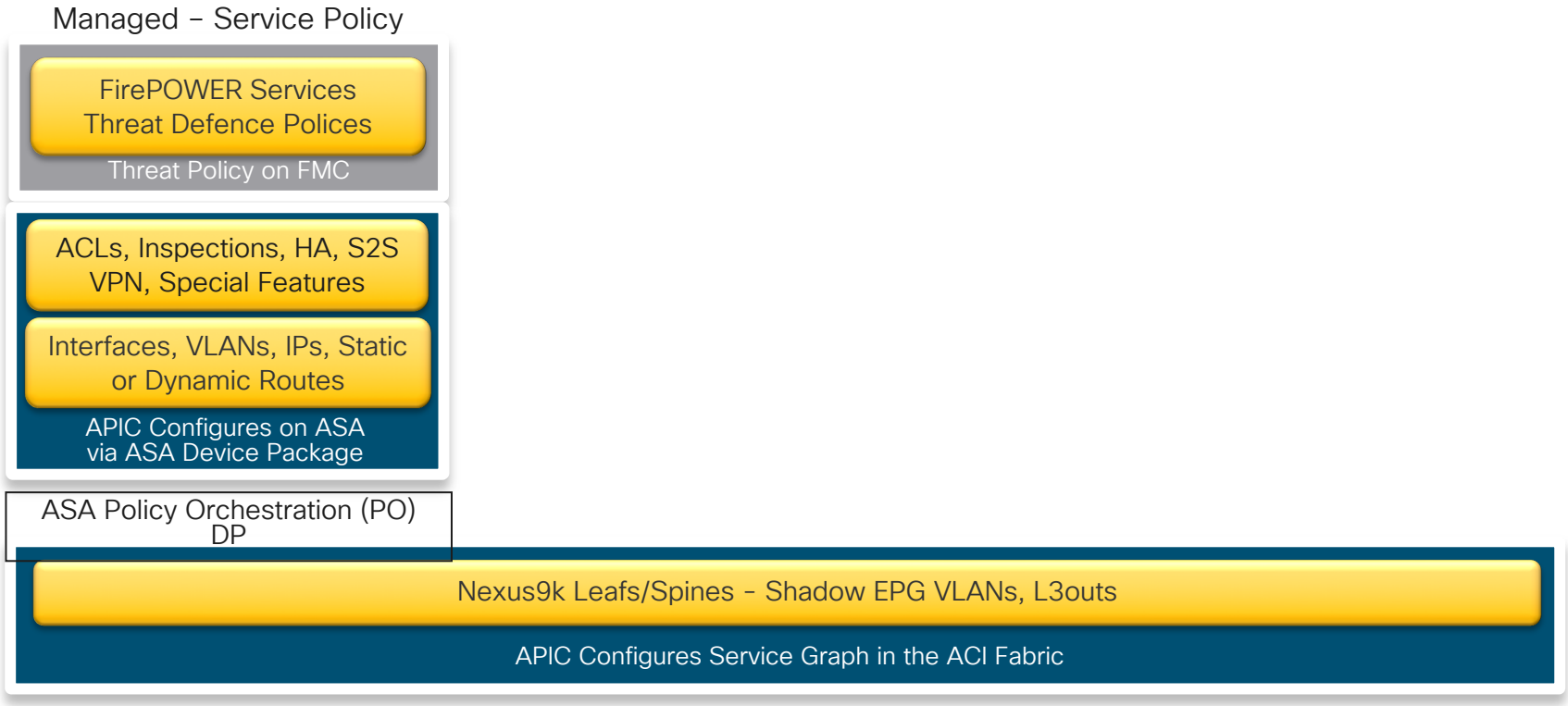


Service Automation Through Device Package

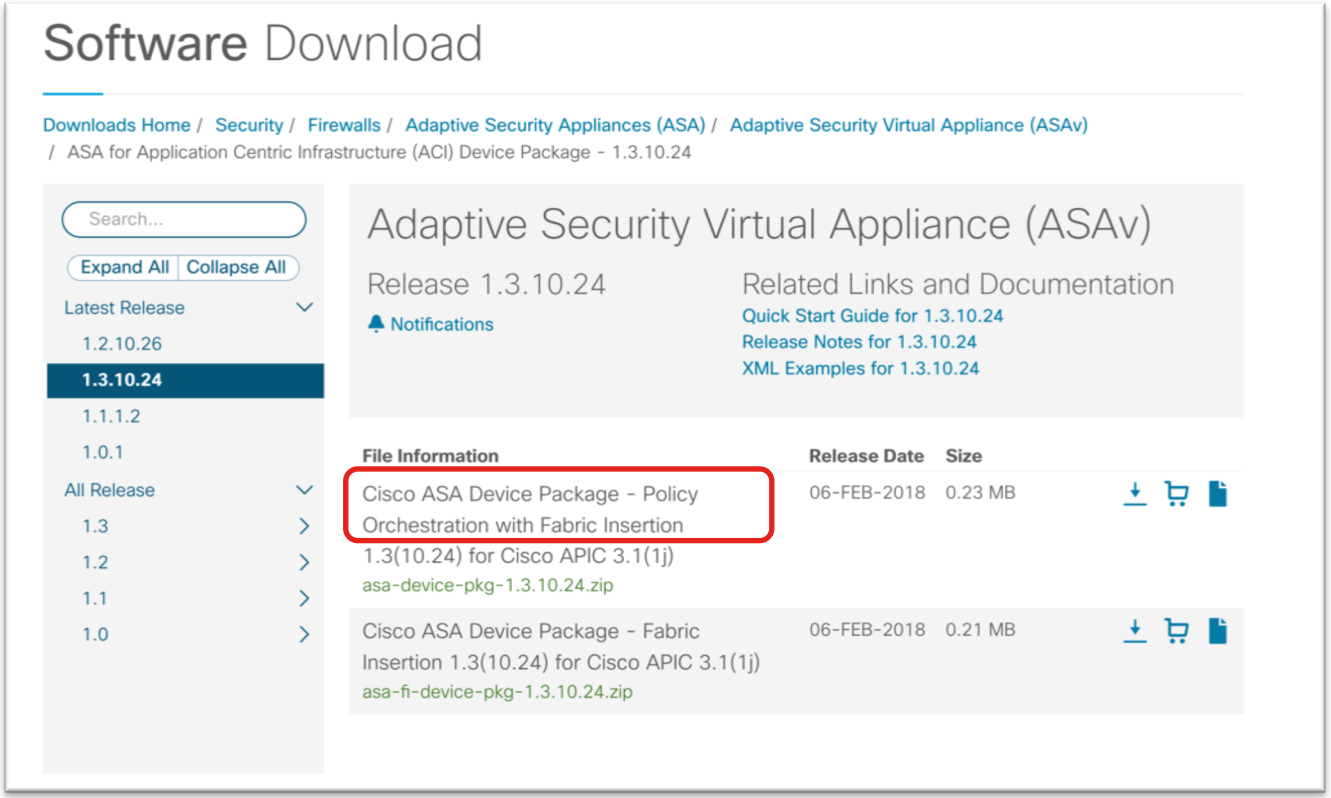
- Service automation requires a vendor device package. It is a zip file containing
  - Device specification (XML file)
  - Device scripts (Python)
- Cisco® APIC interfaces with the device using device Python scripts
- Cisco APIC uses the device configuration model provided in the package to pass appropriate configurations to the device scripts
- Device script handlers interface with the device using its REST or CLI interface



ASA Device Package Opt 1: Policy Orchestration



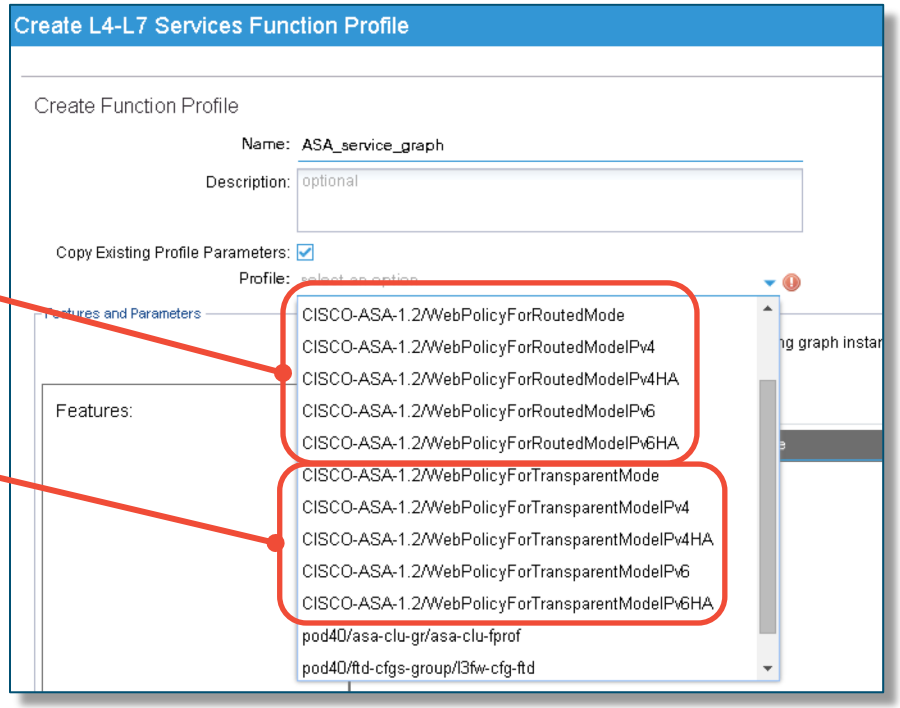
ASA PO & FI Device Package



ASA DP Built-In Profiles

Template for Routed ASA
Requires Entry of IP Addresses
HA needs Standby IP Entry

Template for Transparent ASA
Requires Entry of BVI IP Address
HA needs Standby IP Entry



Why Use Managed Service Graph ?

- Full Tenant orchestration with L4-L7 services
- ACL changes on the firewall can be offloaded to custom tools, using Northbound API
- Device package allows for very fast deployment of security
- APIC monitors the service health and validates configuration

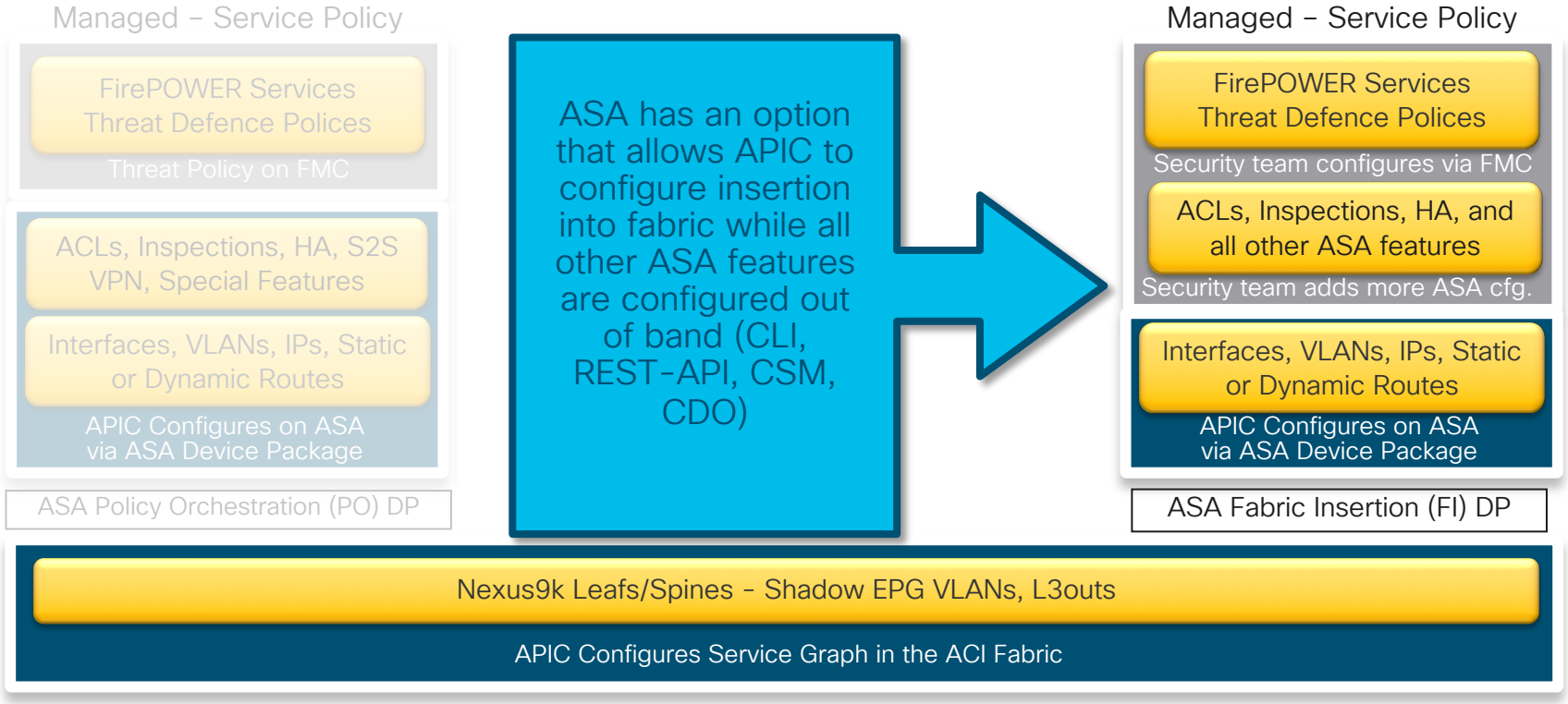
Why Use Unmanaged Service Graph ?

- Continuity of the SecOps management workflows and tools
- No device package available from a Vendor
- Quicker migration of security appliance configs and policies into ACI fabric
- Allow use of the full spectrum of product features, not just the features supported by the device package

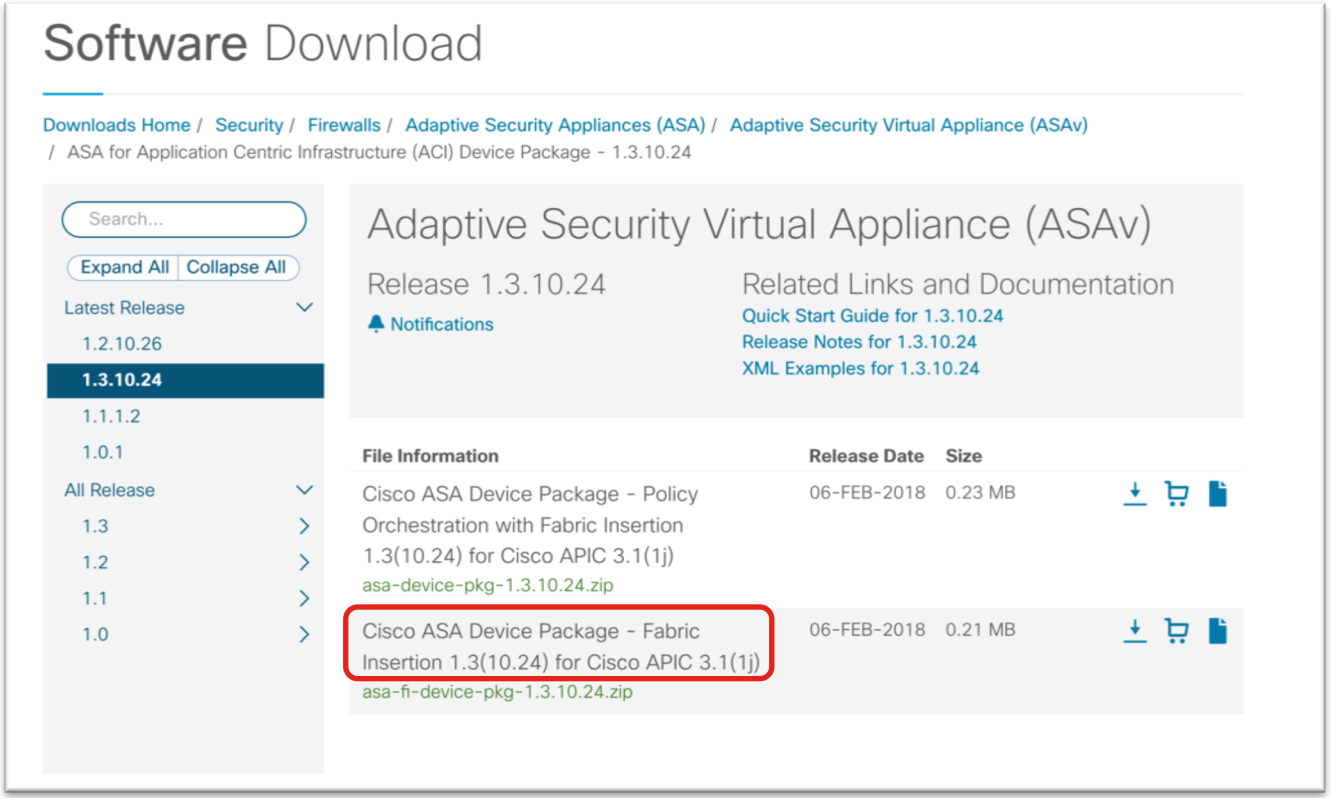
Service Graph Hybrid Managed

- Leverage the **network and interface configuration automation** from APIC with the Device Package
- Leverage the **External Security management solution** for the security team to create the security policy
- **Use the Service graph to tie together the policy and the network insertion**

ASA Device Package Opt 2: Fabric Insertion



ASA PO & FI Device Package



FTD Device Package Workflow

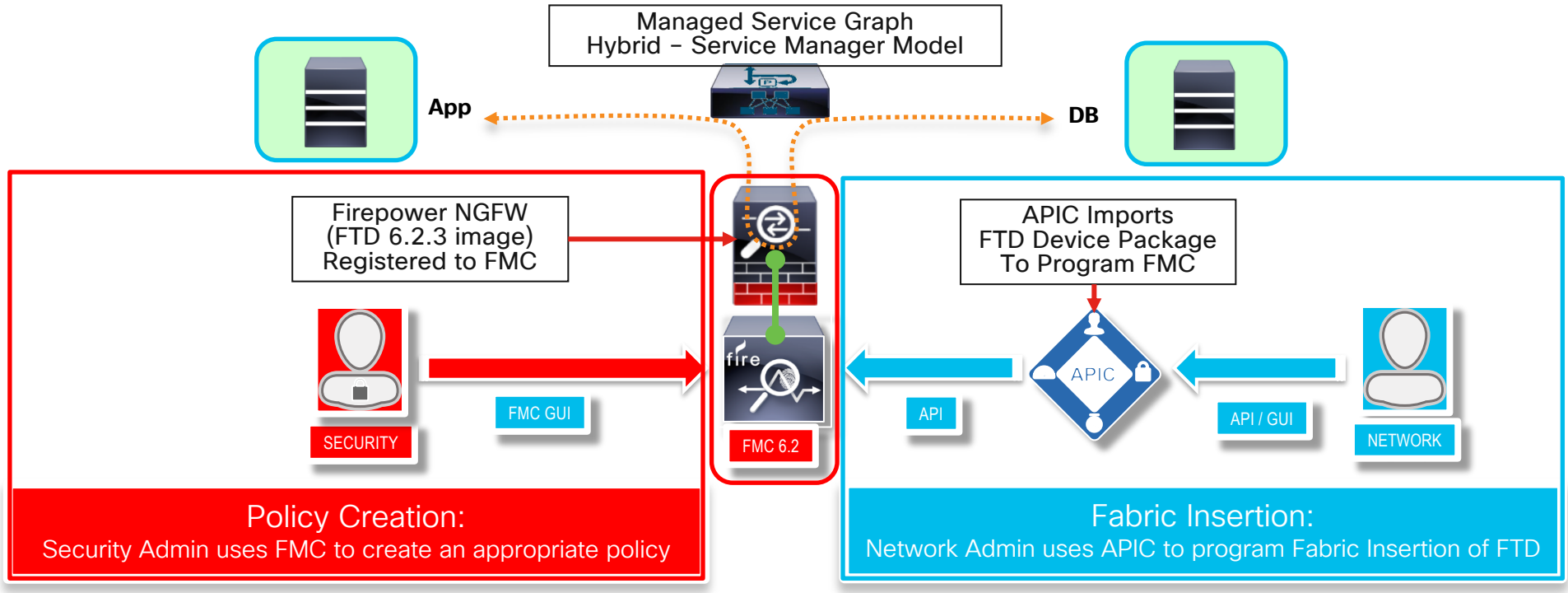
Existing Rule – Security Admin uses FMC to create an ACP Rule to be used with the new service graph. The rule includes allowed protocols, NGIPS, and AMP protections.

- Network Admin uses APIC to attach Security Zones to a given Rule, directing service graph traffic to an appropriate NGFW inspections.

New Rule – Network Admin uses APIC to create a new security Rule on FMC using the service graph. This is a Deny rule, preventing traffic flow until Security Admin gets a changes to update it.

- Security Admin uses FMC to update the new ACP Rule with an appropriate allowed protocol, NGIPS, and AMP policy. To prevent deletion of this rule on service graph detach, Security Admin can preserve configured security policy by updating ACP Rule comments.

FTD FI Device Package for ACI



FTD Device Package for ACI

1.0.1

- Cluster support
- Ether-Channel
- Static Routes

1.0.2

- HA support
- FTDv VLAN trunks
- FPR2100 support
- Dynamic EPG
- Enhance validation
- Suffix changes

1.0.3

- Routed
- Transparent
- NGIPS modes
- Interfaces/Zones
- Inline Pairs
- Attach Zones to ACP Rules

FTD Device Package for ACI – Version to Feature Comparison

FTD FI Device Package Version 1.0.3

APIC configures FMC 6.2.3, using REST-APIs to manage the following devices:

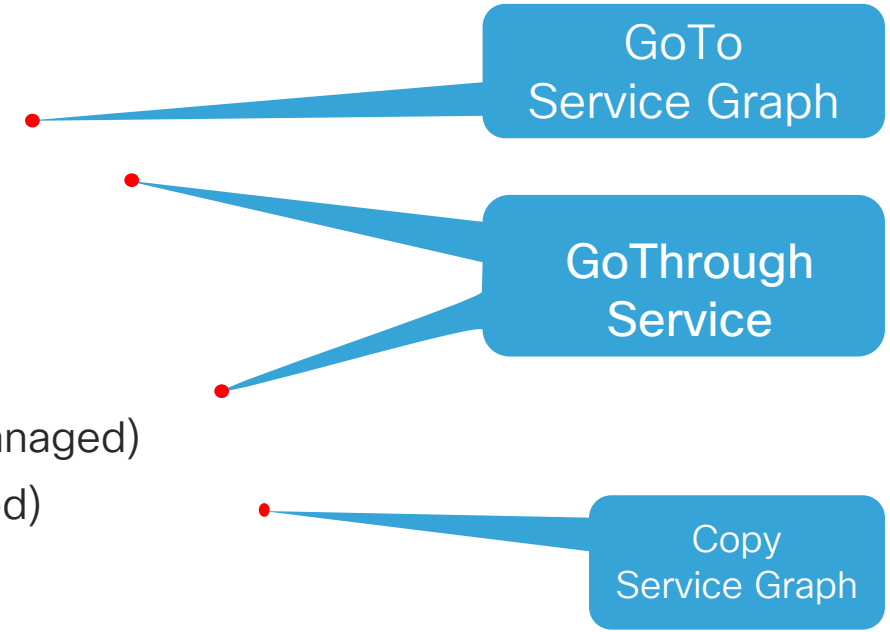
- Pre-registered FTD devices in either Stand-alone, HA or Cluster mode

APIC configures the following features:

- Interfaces in Routed, Switched, or Inline mode. Defines VLAN sub-interfaces (including Port-Channels) for Routed and Transparent firewall mode, including IRB. Static routes can be added under interface configuration.
- Security Zones, Interface Names, Inline Sets, as specified in function profile parameters. FMC names are prefixed with APIC Tenant and registered FTD device name. EPG learning feature is supported with FMC.
- Assignment of the Security Zones to pre-configured ACP Rule(s).

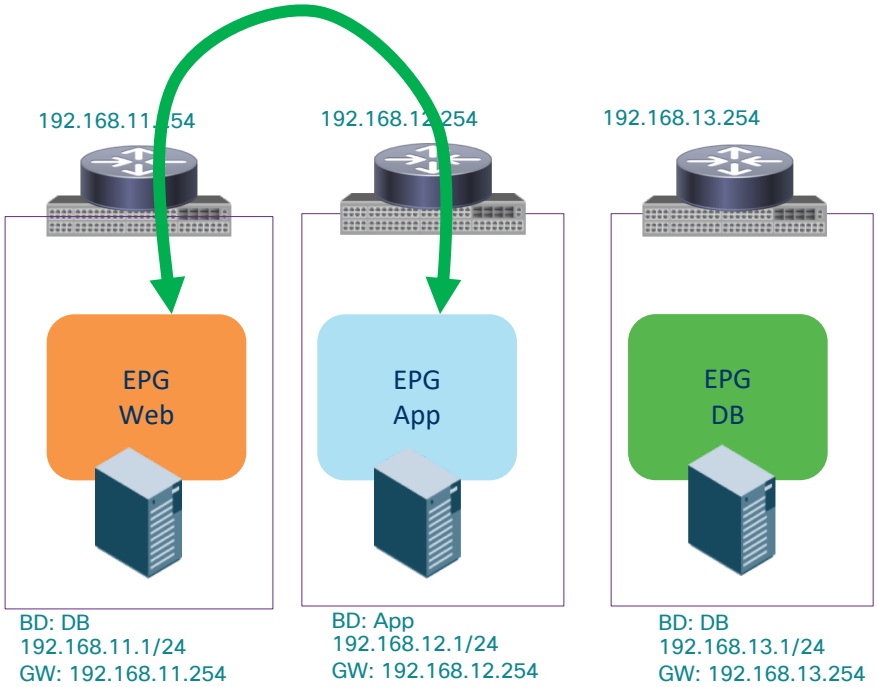
Matching FTD/ACI Deployment Modes

- Firewall Modes
  - Routed
  - Transparent
- NGIPS/IDS Modes
  - Inline (managed)
  - or Inline TAP (unmanaged)
  - Passive (unmanaged)



Security Service insertion using PBR

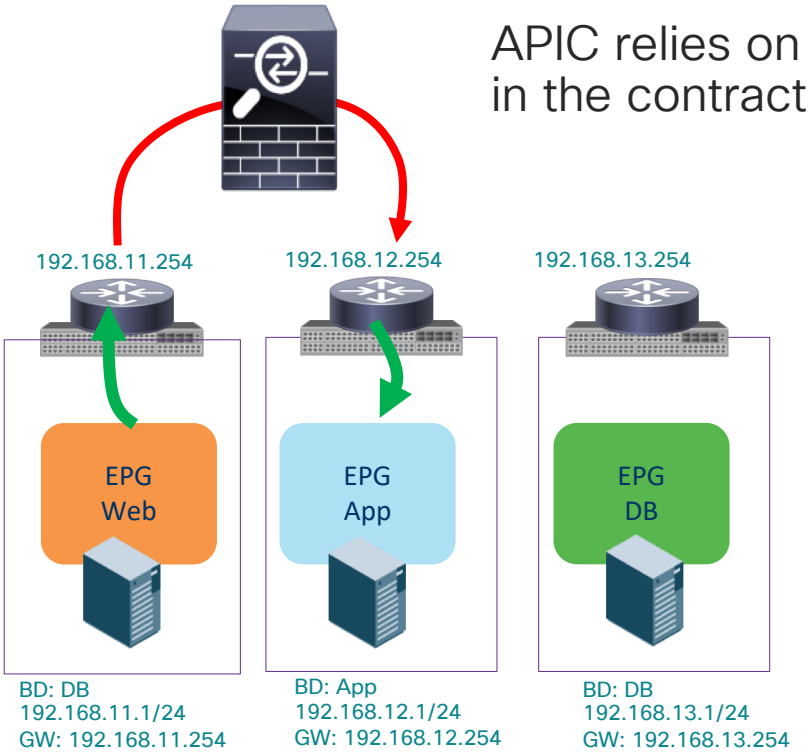
Policy Based Redirect is your Best Friend



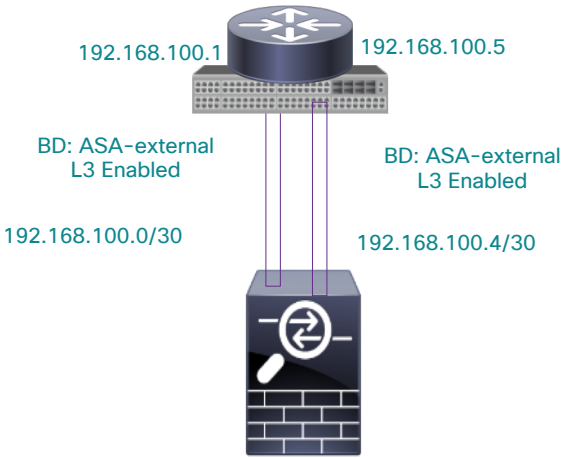
APIC relies on Routing to forward traffic from Server in EPG WEB to Server in EPB APP based on contract

Policy Based Redirect is your Best Friend

With PBR Service Graph

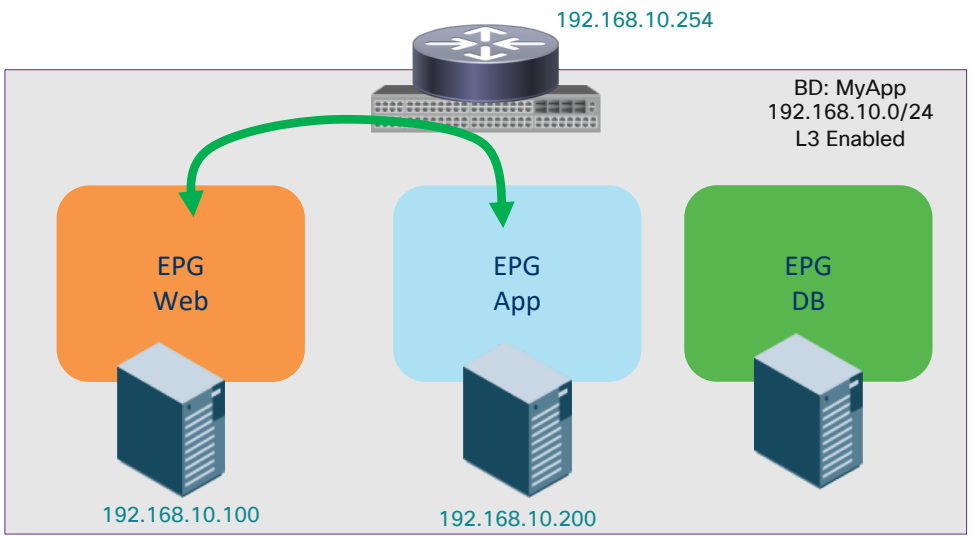


APIC relies on PBR to redirect the traffic defined in the contract to the Security Service



PBR for micro-Segmentation

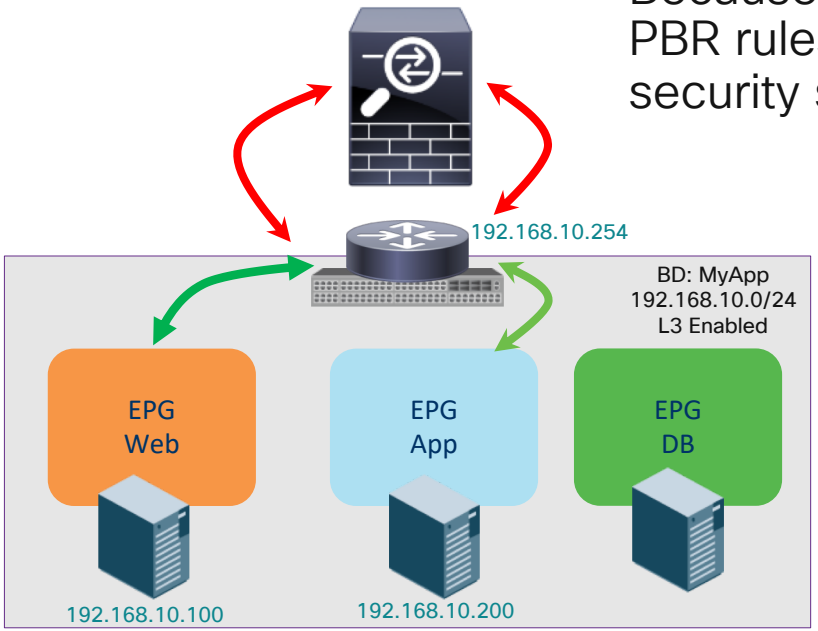
Based only on Contract



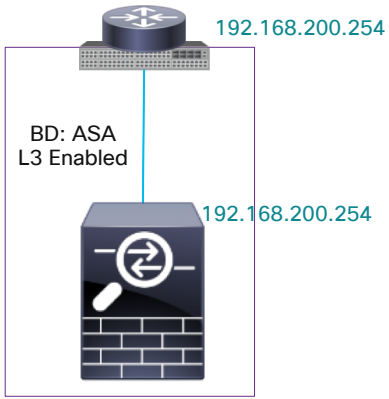
Because this is a communication between two End-Points in different EPG, the forwarding decision is made in the leaf switch

PBR for micro-Segmentation

Leveraging PBR



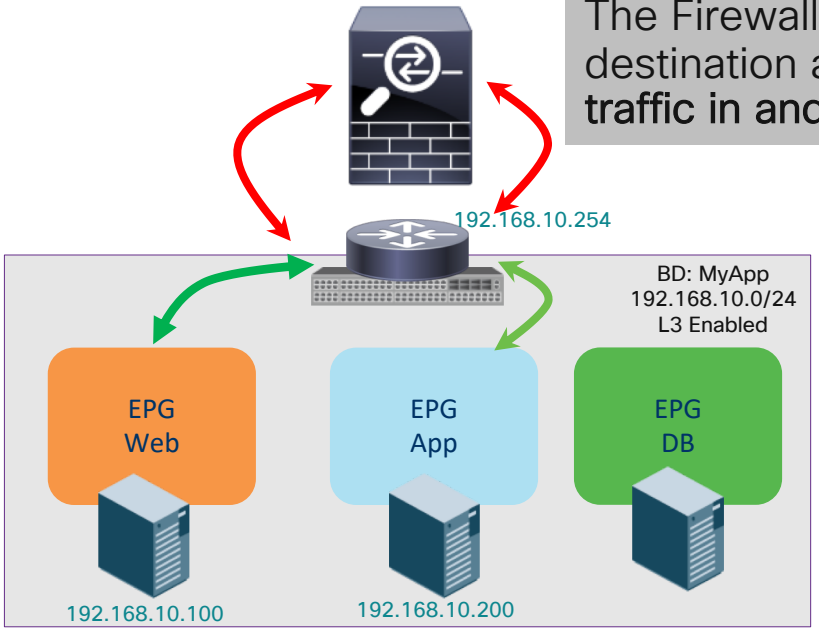
Because the traffic goes to Leaf Switch where PBR rules are enforced, traffic will be sent to the security service defined in the Service Graph.

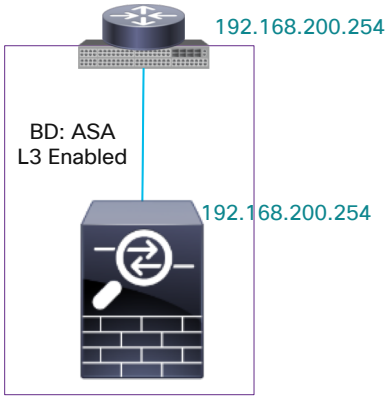


PBR for micro-Segmentation

Leveraging PBR

The Firewall must be in **ONE ARM** as source and destination are in the same Subnet. It must **allow traffic in and out via the same interface**.





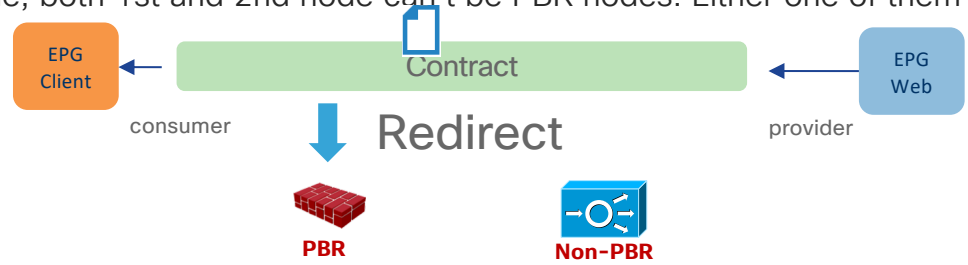
New features related to PBR ACI Version 3.2

- Multi-node PBR
- vzAny with PBR
- Resilient Hash PBR

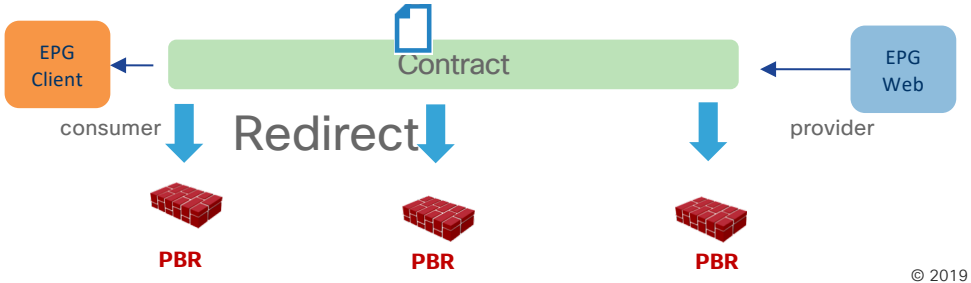
Multi-node PBR

ACI 3.2

- Prior to ACI 3.2: Concatenating PBR nodes was not supported.
  - For example, both 1st and 2nd node can't be PBR nodes. Either one of them can be.



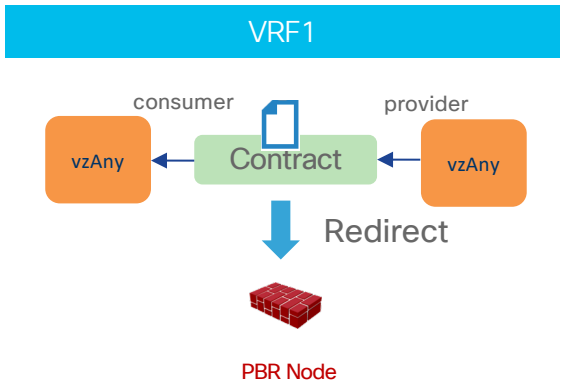
- ACI 3.2: Support more than 1 node PBR in a Service Graph. (up to 3 nodes)
  - We can mix PBR node and non-PBR node in same Service Graph

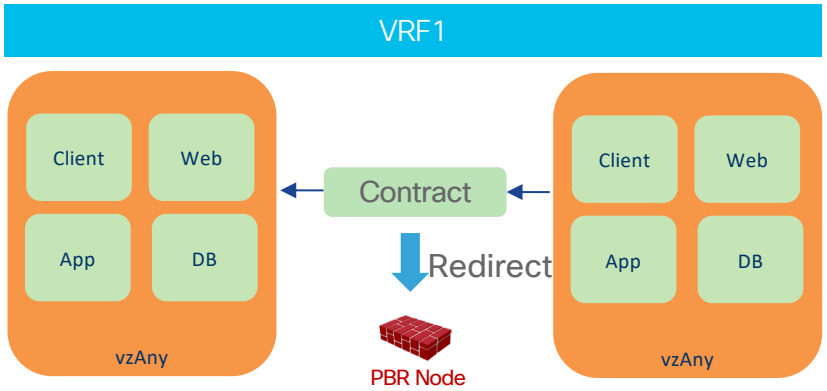


PBR with vzAny

ACI 3.2

- In ACI 3.2, PBW with vzAny (provider) is also supported.
- Use case: Insert Firewall everywhere.



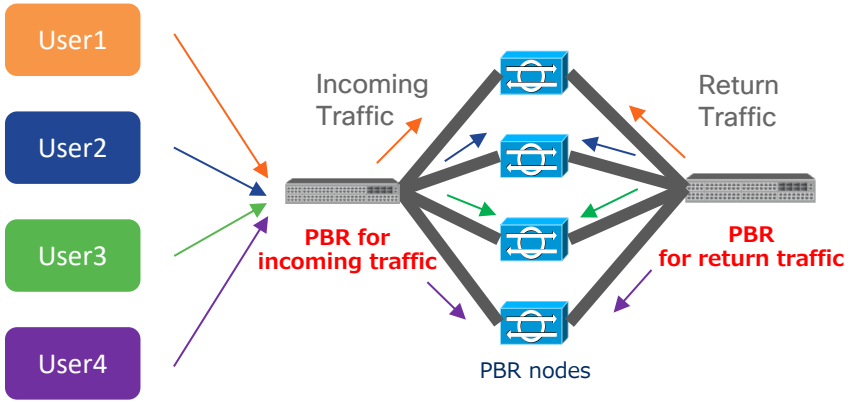


Resilient Hash PBR

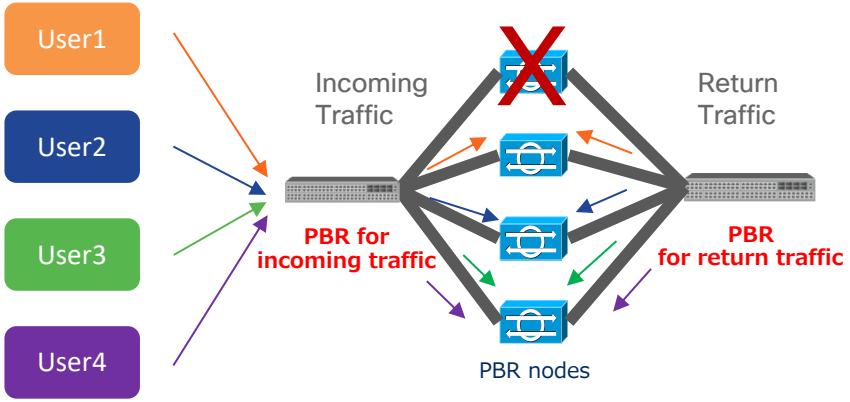
Before

- Symmetric PBR is supported today, but if one of the PBR nodes is down, traffic will be re-hashed. So existing connection having been going through available PBR nodes could be affected.

Thanks to Symmetric PBR, incoming and return traffic go to same PBR node.



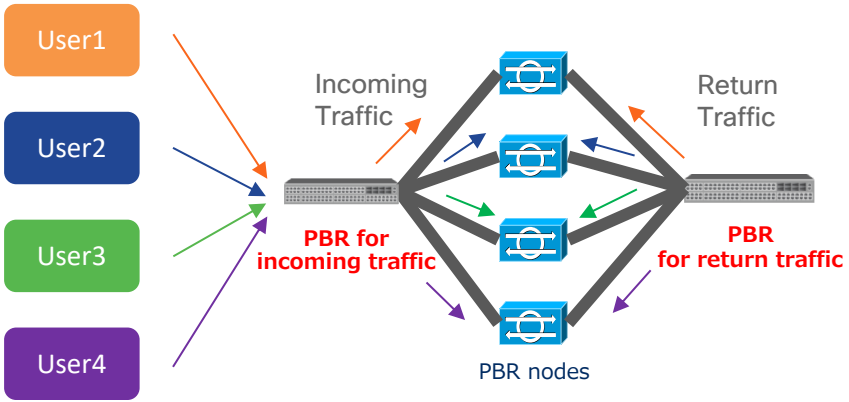
Some traffic could be load-balanced to different PBR nodes that don't have existing connection info.

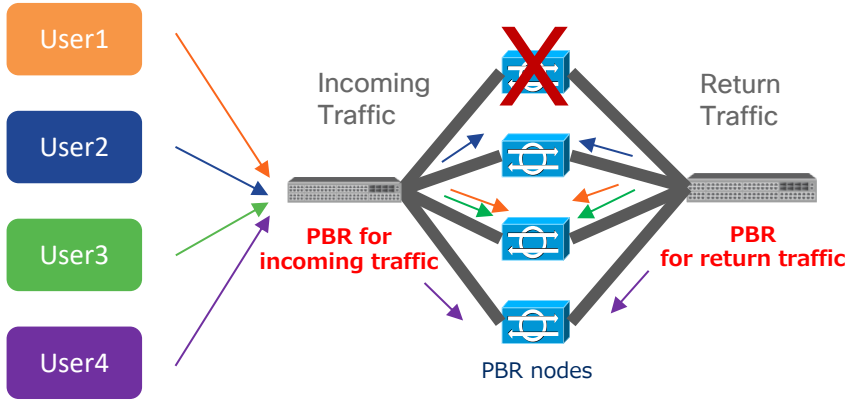


Resilient Hash PBR

ACI 3.2

- With Resilient Hash PBR, only the traffics that went though failed node will start using different PBR node.





Policy Based Redirect Requirements

- APIC must be v 2.0.1 or Higher
- The Service switch must be at least ‘-EX’ or more recent
- If not all the fabric is ‘-EX’, the Service switch must be dedicated to Services (i.e. no workload connected with the L4-7 services)

What about IDS ?

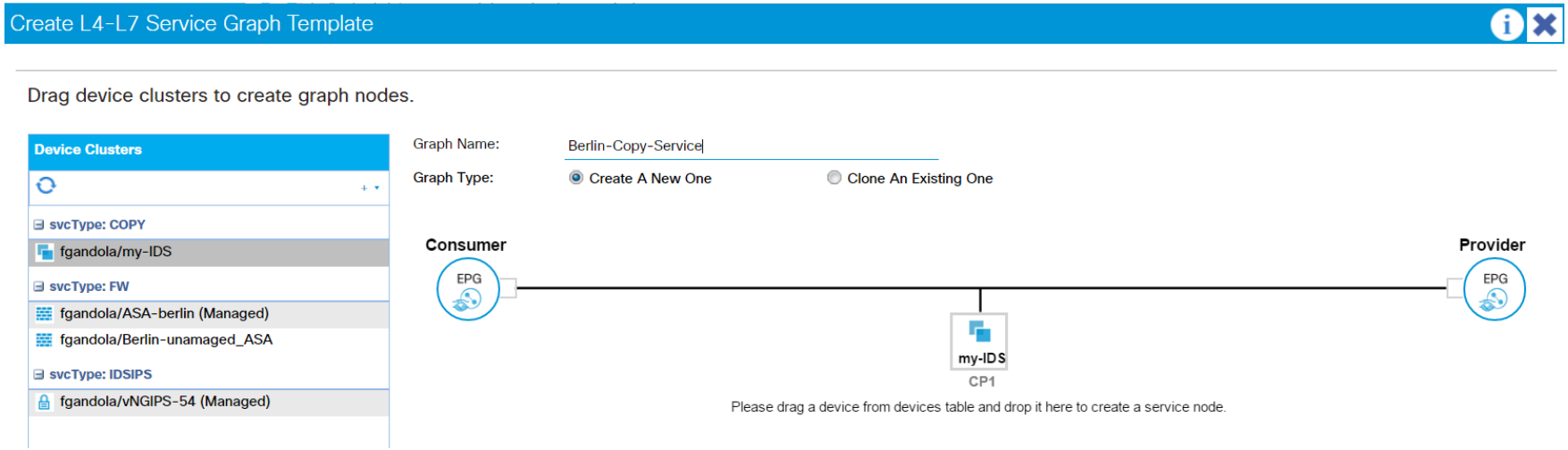
IDS Insertion in ACI

- Traditional Span mechanism based on EPG source/Destination
- NEW Copy Service :
  - Specific Service graph
  - As based attached to contract, leverage Subject for a more granular selection of traffic than SPAN
  - Require –EX leaf switch
  - Support only one device per copy cluster

Service Copy Configuration Steps

- Identify the source and destination endpoint groups.
- Configure the contract that specifies what to copy according to the subject and what is allowed in the contract filter.
- Configure Layer 4 to Layer 7 copy devices that identify the target devices and specify the ports where they attach.
- Use the copy service as part of a Layer 4 to Layer 7 service graph **template**.
- Configure a device selection policy that specifies which device will receive the traffic from the service graph. When you configure the device selection policy, you specify the contract, service graph, copy cluster, and cluster logical interface that is in copy device.

Copy Service : Service Graph Template



https://www.cisco.com/c/en/us/td/docs/switches/datacenter/aci/apic/sw/1-x/L4-L7_Services_Deployment/guide/b_L4L7_Deploy_ver211/b_L4L7_Deploy_ver211_chapter_01101.html#id_28562

Threat Protection with IPS

Cisco Firepower Threat Defense Features

Cisco Firepower Threat Defense Full Feature-Set - NGFW

- L2-L7 Firewall with L3 (Routed), L2 (Transparent IRB or Inline-NGIPS) Modes
- Scalable CGNAT, ACL, Dynamic Routing, Fail-to-Wire I/O modules
- Application Inspection, PKI for Site-to-Site VPN, Onbox Manager
- Inter-chassis cluster, FlexConfig, REST-APIs, Packet Tracer/Capture
- NSS Leading Next-Gen IPS - SourceFIRE
- Comprehensive Threat Prevention, L7 Application Visibility and Control
- Security Intelligence (C&C, Botnets, IP, DNS, etc.), Threat / Risk Reports
- Blocking of Files by Type, Protocol, and Direction, Protocol Rate Limiting
- Access Control: Enforcement by Application and User AD integration
- Switch, Routing, NAT Options, and ISE PxGRID integration
- URL Filtering, Malware Blocking, Continuous File Analysis
- Malware Network Trajectory, User-based IOCs, URL lookup
- AMP public & private cloud with ThreatGrid, FMC-ThreatGrid APIs
- Firepower Management Center (fka. FireSIGHT or Defense Center)

Automation

Dynamic Update to EPG Object-Group

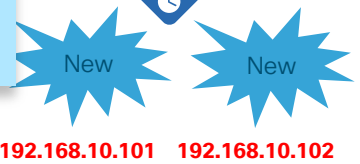
APIC dynamically detects new endpoint, ASA subscribes to attach/detach event, and ASA device package automatically adds EPs to object-group

2: APIC create object-group for the EPG.

3: APIC add new endpoints to object-group (192.168.10.101, 192.168.102)

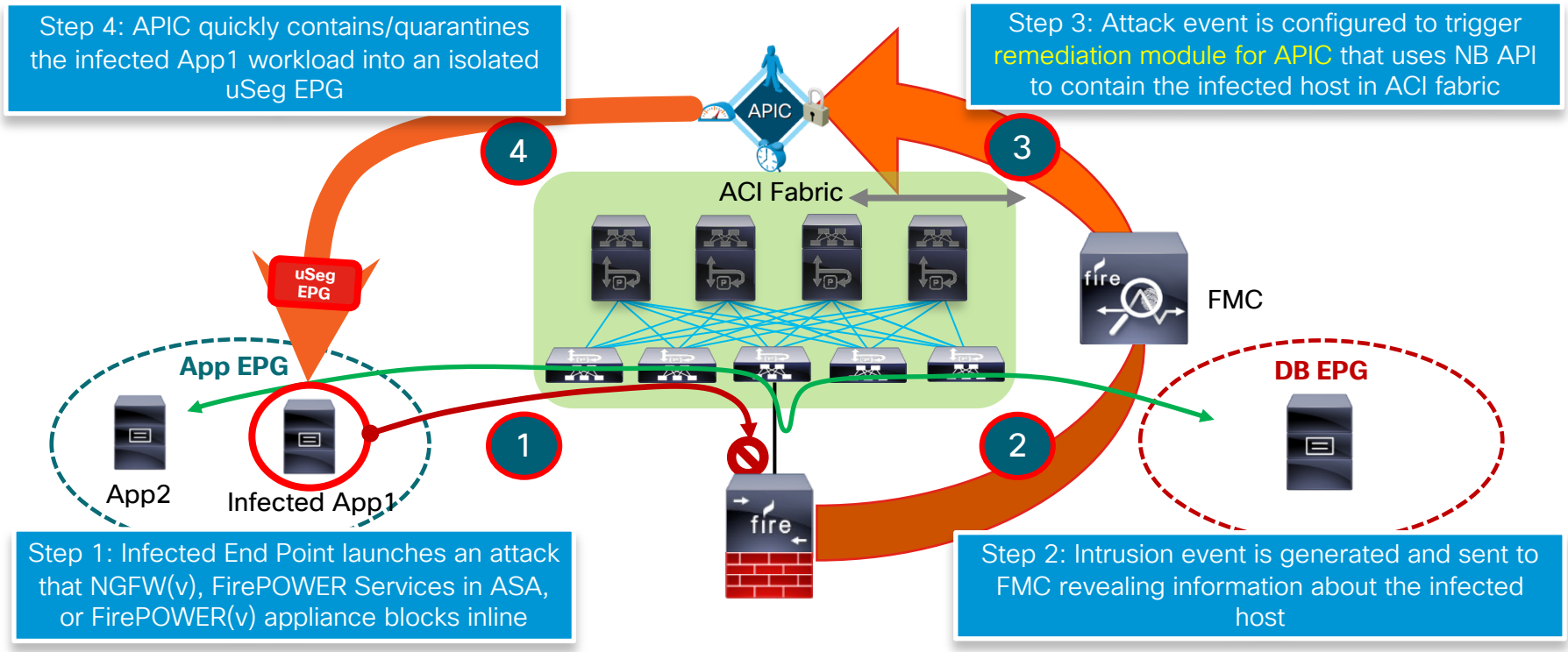
```
object-group network __$EPG$_pod37-aprof-app
 network-object host 192.168.10.101
 network-object host 192.168.10.102

access-list access-list-inbound extended permit tcp any object-group __$EPG$_pod37-aprof-app eq www
```



1: Enable “Attachment Notification” on function connector internal.

FMC to APIC Rapid Threat Containment

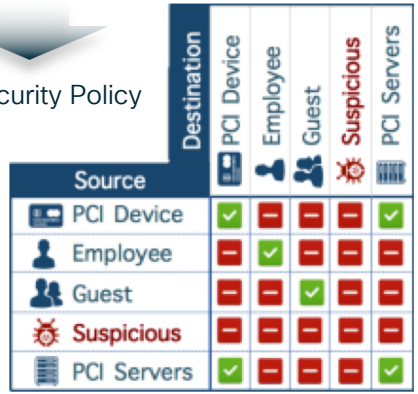


TrustSec

with TrustSec

Traditional Security Policy

TrustSec Security Policy



Security Control Automation

Simplified Access Management

Improved Security Efficacy

Software Defined **Segmentation**

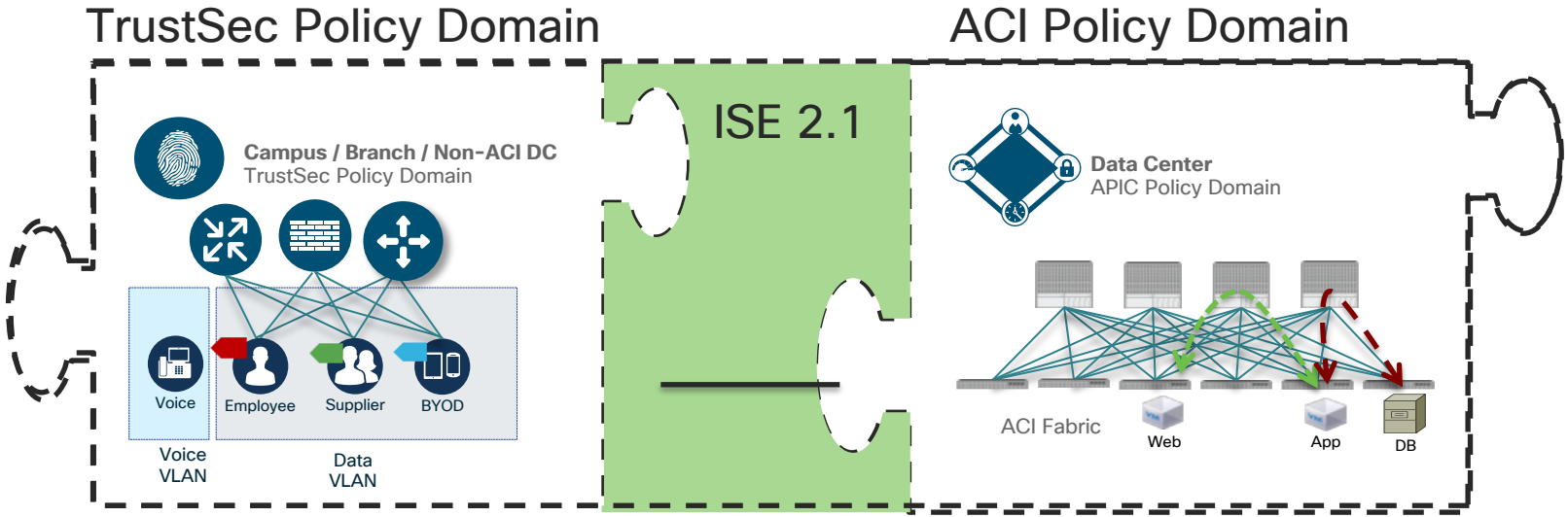
Network Fabric

Switch Router Wireless DC FW DC Switch

Flexible and Scalable Policy Enforcement

Enabling Group-Based Policies across the Enterprise

- Cohesive security policy
- Simplified security management
- End-to-End segmentation



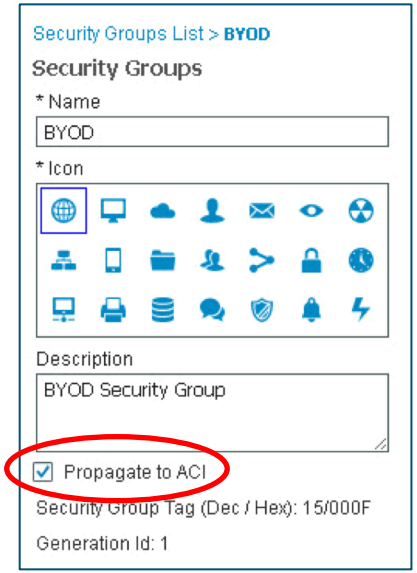
TrustSec Security Groups Provisioned in ACI

ISE Dynamically provisions TrustSec Security Groups in ACI Fabric

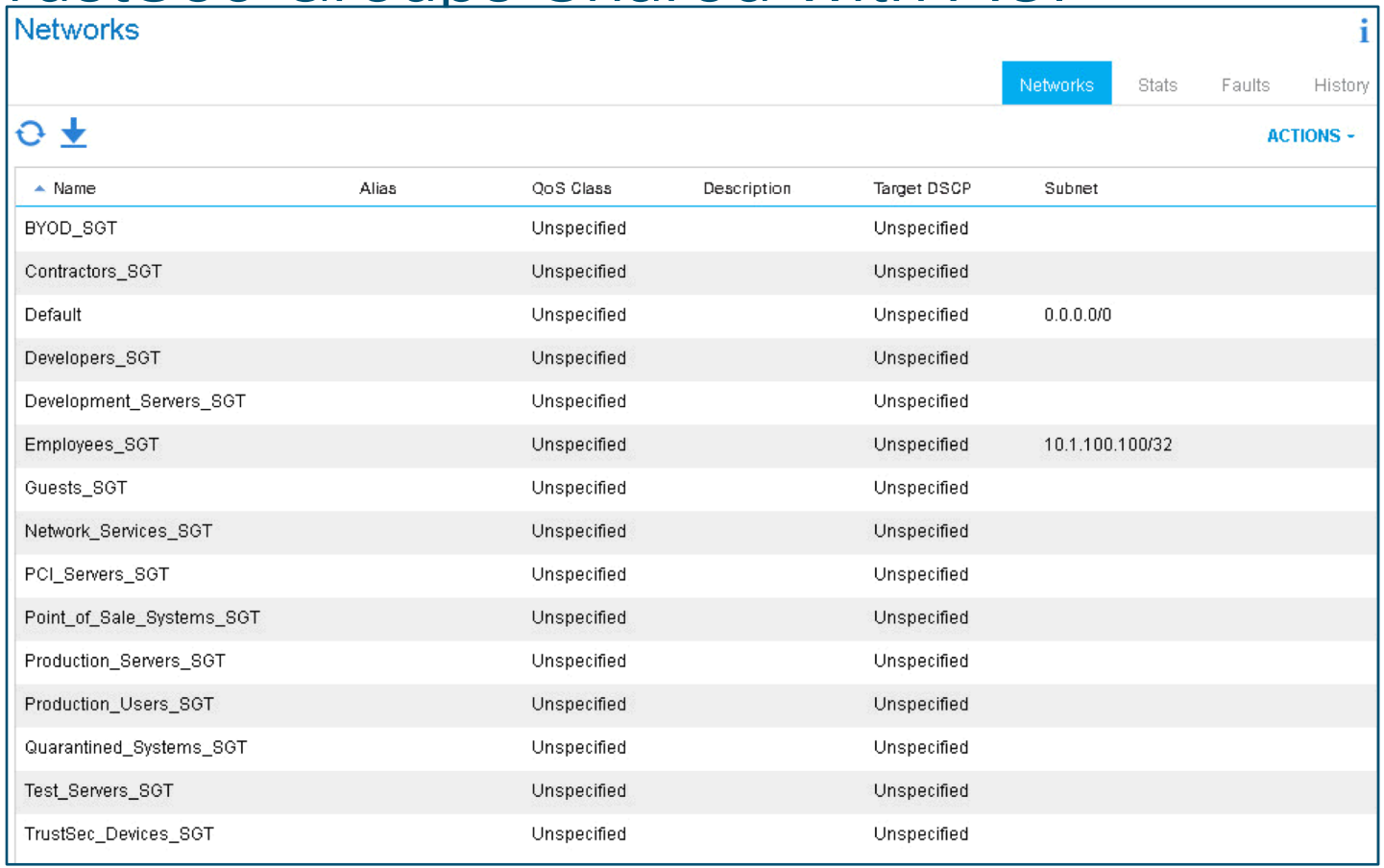
Max: 200 Security Groups
Up to 4000/32 mappings (gen1)
Up to 10K/32 mappings (gen2) (-EX)

TrustSec Groups represented as External EPGs

TrustSec Groups Shared with ACI

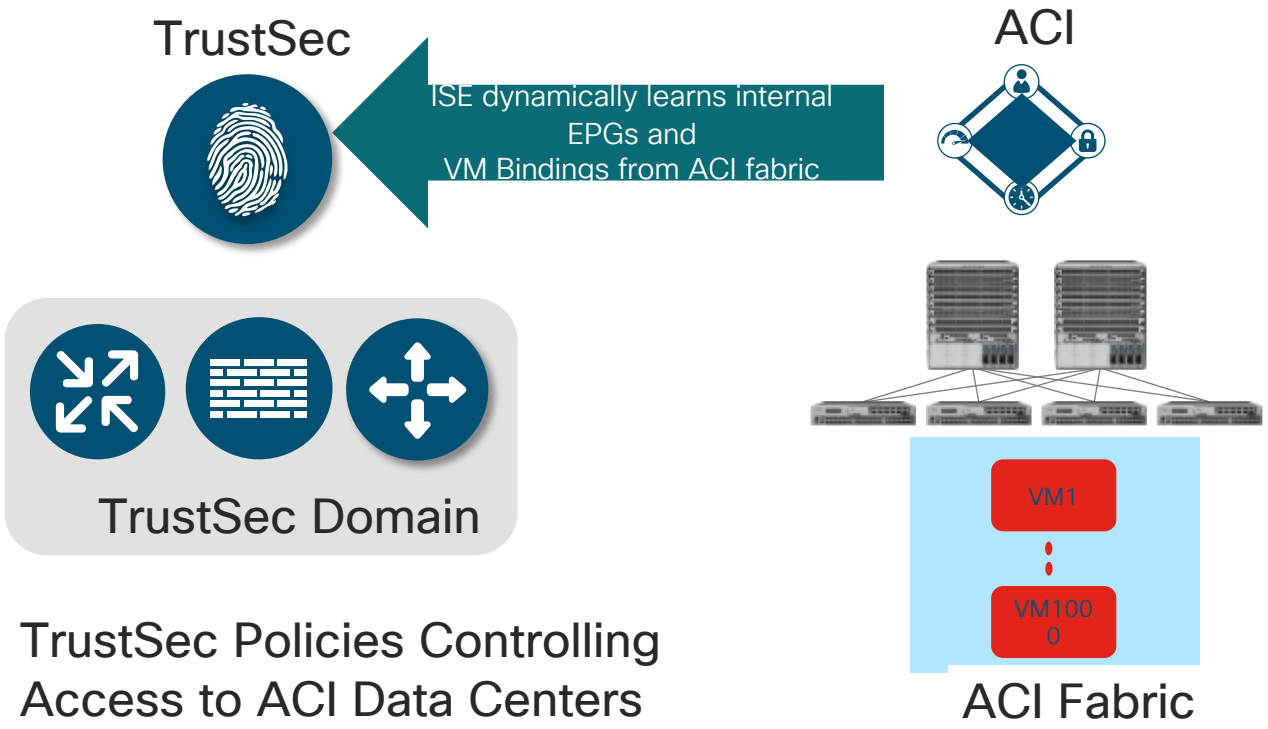


TrustSec Groups Shared with ACI



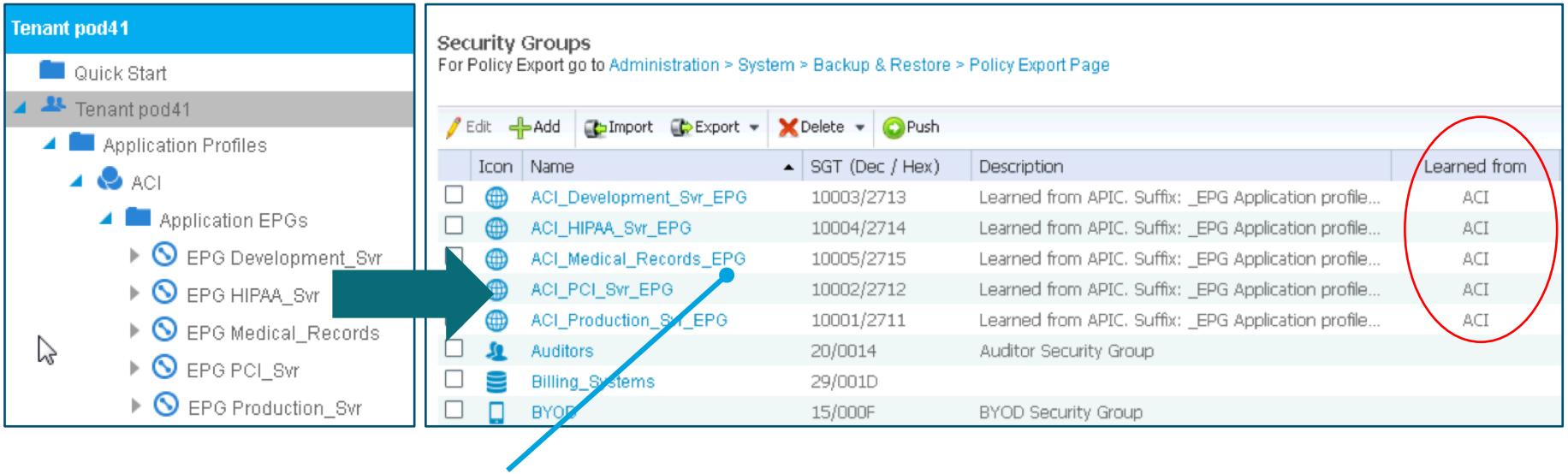
Name	Alias	QoS Class	Description	Target DSCP	Subnet
BYOD_SGT		Unspecified		Unspecified	
Contractors_SGT		Unspecified		Unspecified	
Default		Unspecified		Unspecified	0.0.0.0/0
Developers_SGT		Unspecified		Unspecified	
Development_Servers_SGT		Unspecified		Unspecified	
Employees_SGT		Unspecified		Unspecified	10.1.100.100/32
Guests_SGT		Unspecified		Unspecified	
Network_Services_SGT		Unspecified		Unspecified	
PCI_Servers_SGT		Unspecified		Unspecified	
Point_of_Sale_Systems_SGT		Unspecified		Unspecified	
Production_Servers_SGT		Unspecified		Unspecified	
Production_Users_SGT		Unspecified		Unspecified	
Quarantined_Systems_SGT		Unspecified		Unspecified	
Test_Servers_SGT		Unspecified		Unspecified	
TrustSec_Devices_SGT		Unspecified		Unspecified	

Sharing Application Context to TrustSec Policies



TrustSec Policies Controlling Access to ACI Data Centers

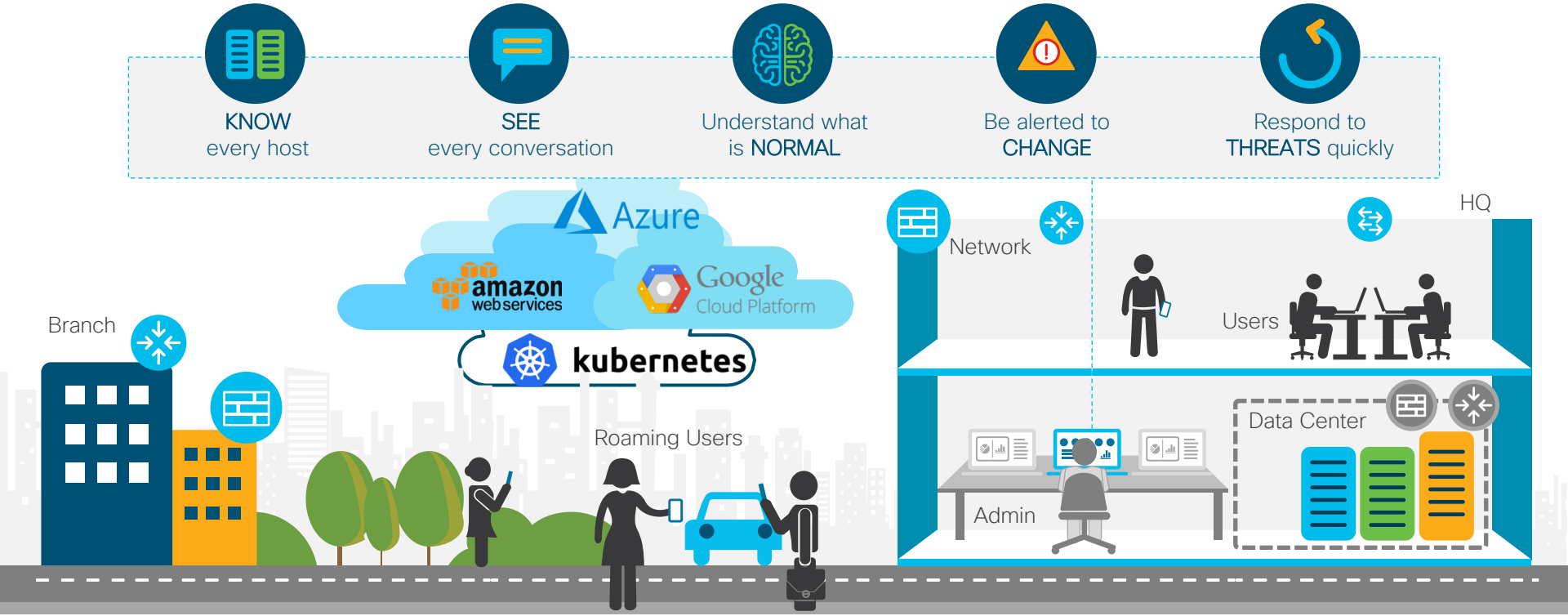
Sharing ACI Endpoint Groups to TrustSec



- EPG suffix added to Security Group name
- IP-SGT bindings from ACI can be propagated over SXP TrustSec devices and to pxGrid peers

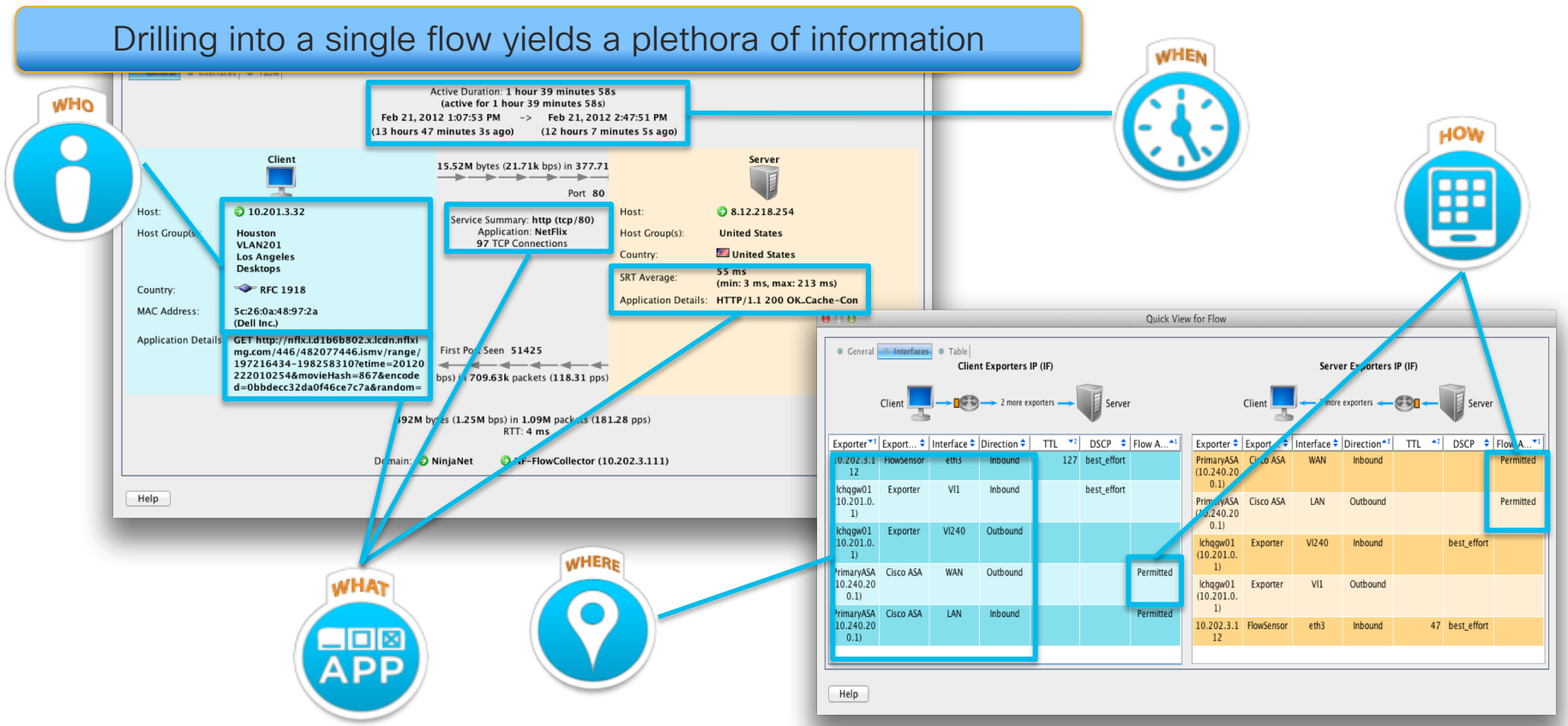
StealthWatch

Effective security depends on total visibility



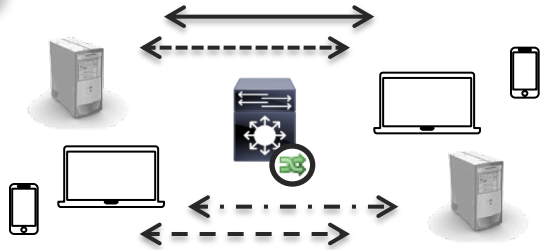
Cisco CTD Solution: Providing Scalable Visibility

Drilling into a single flow yields a plethora of information



Flow-based Anomaly Detection

1



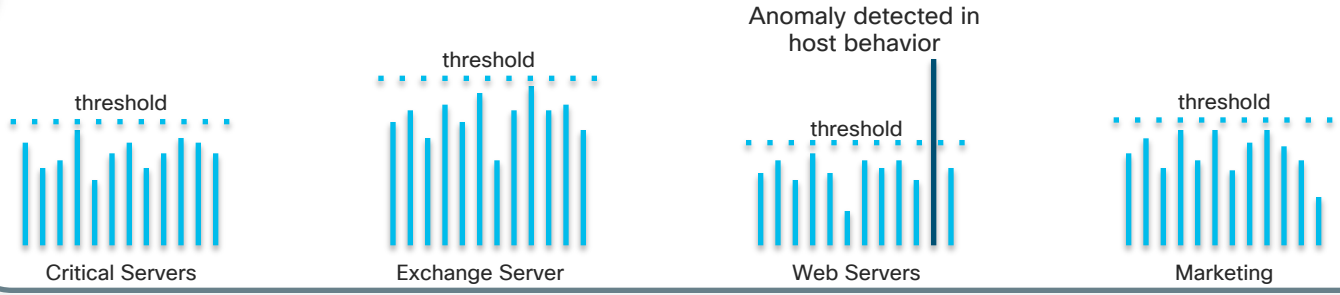
Collect & Analyze Flows

2

- # Concurrent flows
- Packets per second
- Bits per second
- New flows created
- Number of SYNs sent
- Time of day
- Number of SYNs received
- Rate of connection resets
- Duration of the flow
- Over 80+ other attributes

Establish Baseline of Behaviors

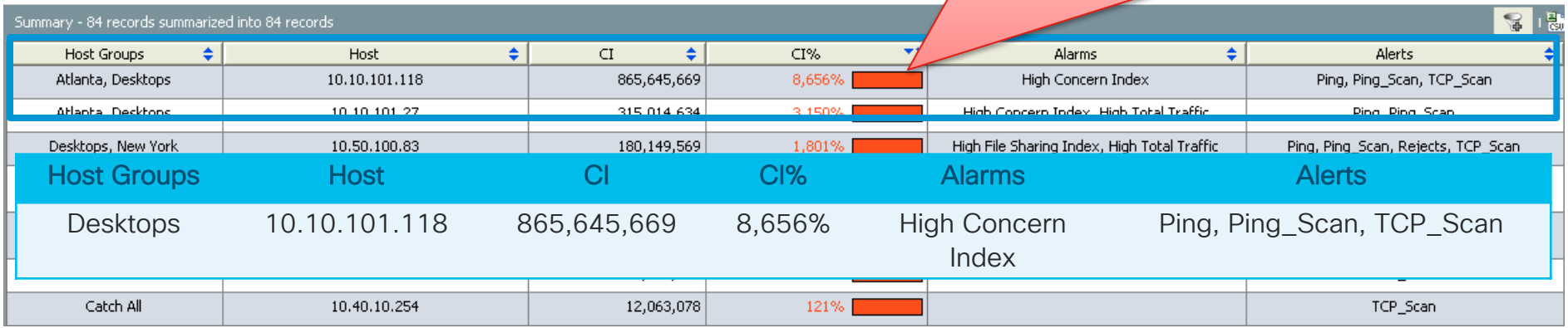
3



Alarm on Anomalies & Changes in Behavior

Behavior-Based Attack Detection

High Concern Index indicates a significant number of suspicious events that deviate from established baselines



Host Groups	Host	CI	CI%	Alarms	Alerts
Desktops	10.10.101.118	865,645,669	8,656%	High Concern Index	Ping, Ping_Scan, TCP_Scan

It Can :

- **Detect Sophisticated and Persistent Threats.** Malware that makes it past perimeter security can remain in the enterprise waiting to strike as lurking threats. These may be zero day threats that do not yet have an antivirus signature or be hard to detect for other reasons.

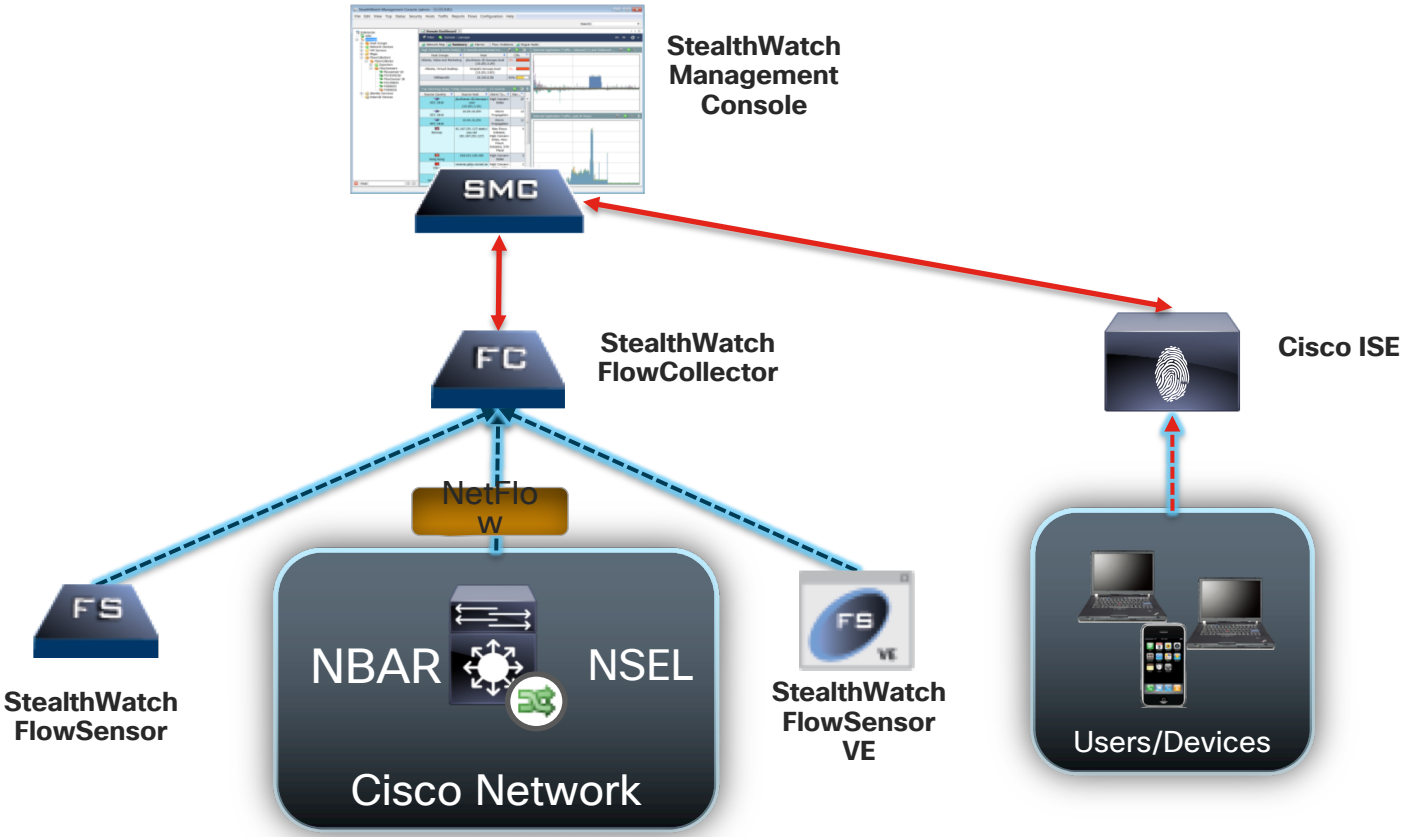
- **Identify BotNet Command & Control Activity.** BotNets are implanted in the enterprise to execute commands from their Bot herders to send SPAM, Denial of Service attacks, or other malicious acts.

- **Uncover Network Reconnaissance.** Some attacks will probe the network looking for attack vectors to be utilized by custom-crafted cyber threats.

- **Find Internally Spread Malware.** Network interior malware proliferation can occur across hosts for the purpose gathering security reconnaissance data, data exfiltration or network backdoors.

- **Reveal Data Loss.** Code can be hidden in the enterprise to export of sensitive information back to the attacker. This Data Leakage may occur rapidly or over time.

StealthWatch Solution Components



How do I send Traffic to my FlowSensor ?

How Send Traffic to my FlowSensor ?

- Traditional Span mechanism based on EPG Source/Destination
- NEW Copy Service :
  - Specific Service graph
  - As based attached to contract, leverage Subject for a more granular selection of traffic than SPAN
- Require –EX leaf switch
- Support only one device per copy cluster

In Conclusion

- ACI helps tackling DC Security Challenges by :
  - Integrating security in the Application
  - Accelerating security deployment
  - Automating security insertion

- Cisco Security helps better protect your DC by :
  - Providing leading edge technologies
  - Integrating smoothly in ACI architecture
  - Providing a full security framework


CISCO