Architecting Hybrid Multi-Cloud Infrastructures

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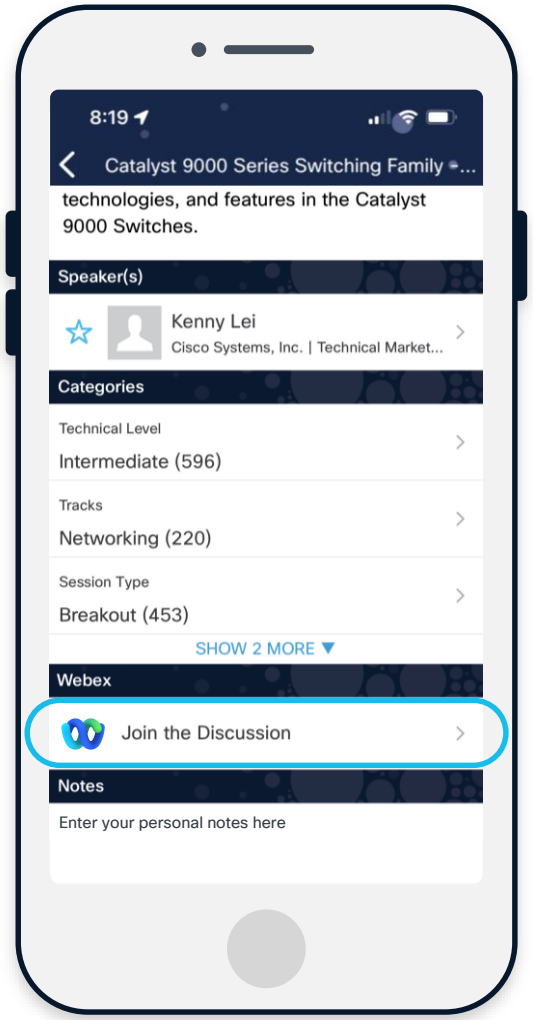


A little bit about David...

Cisco role: Distinguished, Solutions Engineer; Global Solutions Engineering.

Experience: My career @Cisco has spanned half of my life.

Fun fact 1: Written / published 4 books; 6 video series.

Fun fact 2: Enjoy the outdoors, music, working out, running.

Most Importantly: I am here for you!

Agenda

01 Current Challenges, Issues

02 Key Capabilities

03 Connecting Users+Devices+Things

04 Applications behind SD-WAN

05 Common Policy

06 Visibility / Day2 Operations

07 Summary

Session Focus Areas

Abstract

Cloud continues to be a major disruptor; customers have been on the Cloud Journey for several years.

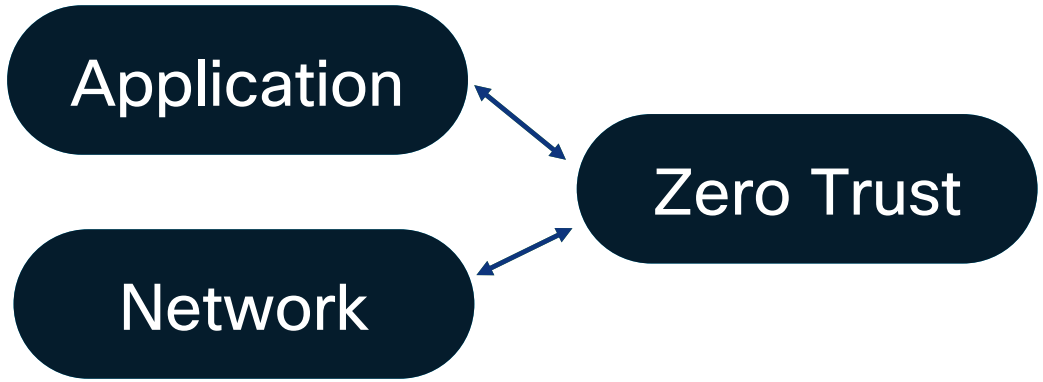
- Architectural trends impacting hybrid and multicloud infrastructures.
- Why private data centers and applications remain critical, even as applications and data move from traditional private data centers to public clouds.

How to:

- Address growing demands of users and applications being everywhere in a secure multi-cloud world.
- Help you optimize and understand traffic flows, operational efficiencies, and visibility in a multi-cloud world.

Goals of today's session

- Explore top challenges and discuss relevant use cases
- Provide a deeper understanding of current Cloud Networking deployment options
- Offer practical guidance on how best to deliver:
  - A consistent Cloud Networking, Segmentation, and Security solution
  - Visibility across entire solutions – including in-region, intra-region and inter-cloud connectivity options visibility



Taxonomy

- Hybrid-Cloud: Public Cloud and Private Cloud
- Multi-Cloud*: Hybrid-Cloud + 2 or more Cloud Providers (CSP)
- East / West Traffic Flows within (intra) across Cloud Regions/Branches
- North / South Traffic Flows across (inter) Clouds and on-prem Data Centers as well as user to app flows

I will be using AWS terminology but applies to other CSPs:

- IGW: Internet Gateway
- DX Gateway: Direct Connect Gateway
- TGW: Transit Gateway
- VPC: Virtual Private Cloud

*Multi-Cloud and Multicloud are used interchangeably in this session

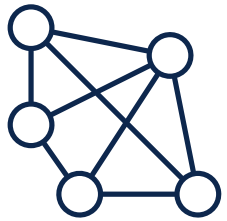
Cloud Terminology Matrix

For Your Reference

Area	AWS service	Azure service	GCP Service
Cloud virtual networking	Virtual Private Cloud (VPC)	Virtual Network (VNet)	Virtual Private Cloud (VPC)
NAT gateways	NAT Gateways	Virtual Network NAT	Cloud NAT
Cross-premises connectivity	VPN Gateway	VPN Gateway	Cloud VPN Gateway
DNS management	Route 53	DNS	Cloud DNS
DNS-based routing	Route 53	Traffic Manager	Cloud DNS
Dedicated network	Direct Connect	ExpressRoute	Cloud Interconnect
Load balancing	Network Load Balancer	Load Balancer	Network Load Balancing
Application-level load balancing	Application Load Balancer	Application Gateway	Global Load Balancing
Route table	Custom Route Tables	User Defined Routes	Routes
Private link	PrivateLink	Azure Private Link	Private Service Connect
Private PaaS connectivity	VPC endpoints	Private Endpoint	Private Service Connect
Virtual network peering	VPC Peering Transit Gateway	VNet Peering	VPC Network Peering
Content delivery networks	Cloud Front	Azure CDN	Cloud CDN
Network Monitoring	VPC Flow Logs	Azure Network Watcher	Network Intelligence Center

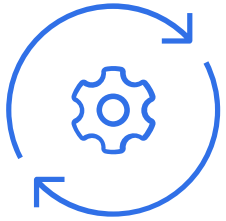
Current Challenges, Issues, Administration and Options

Challenges to solve

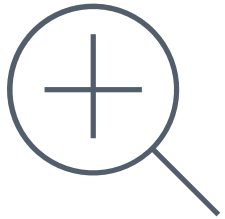


Network connectivity

Segmentation and security



Automation



Operations and visibility

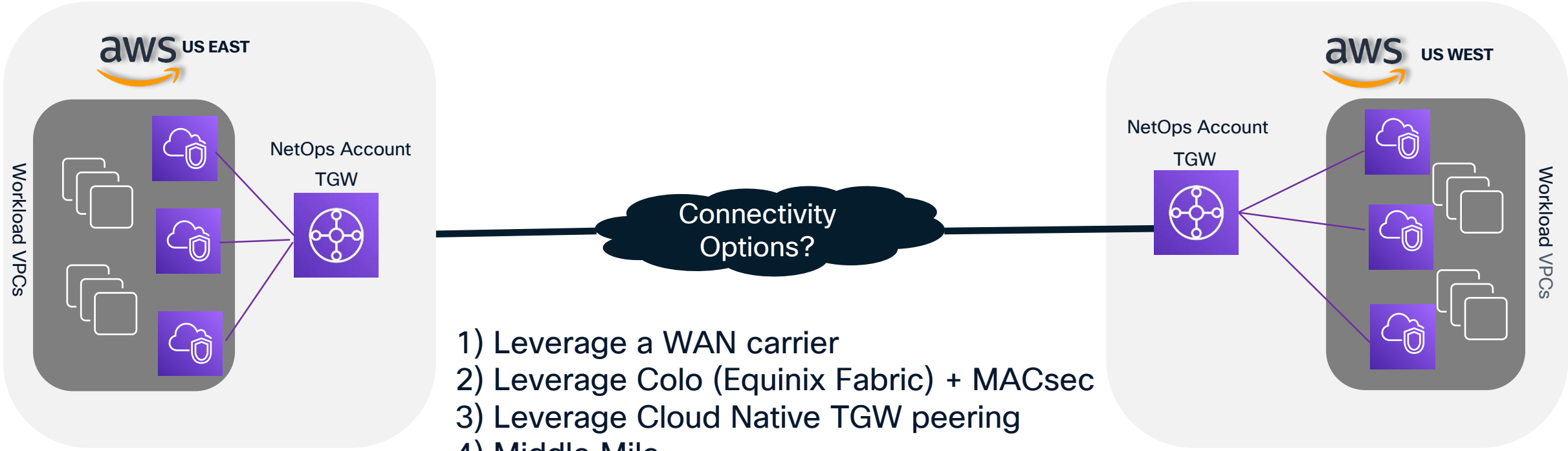
Need For Homogenous Experience Across Heterogenous Cloud Environments

Cloud Native Routing

- Intent: Reach 10.1.1.0/24 over all possible paths (ECMP) and Path Failure(s)
- Think of each Cloud as a distributed router
- How do we know about path failures?
- How do we have a backup path?
- ECMP?

Inter-Region Connectivity

Connectivity Options

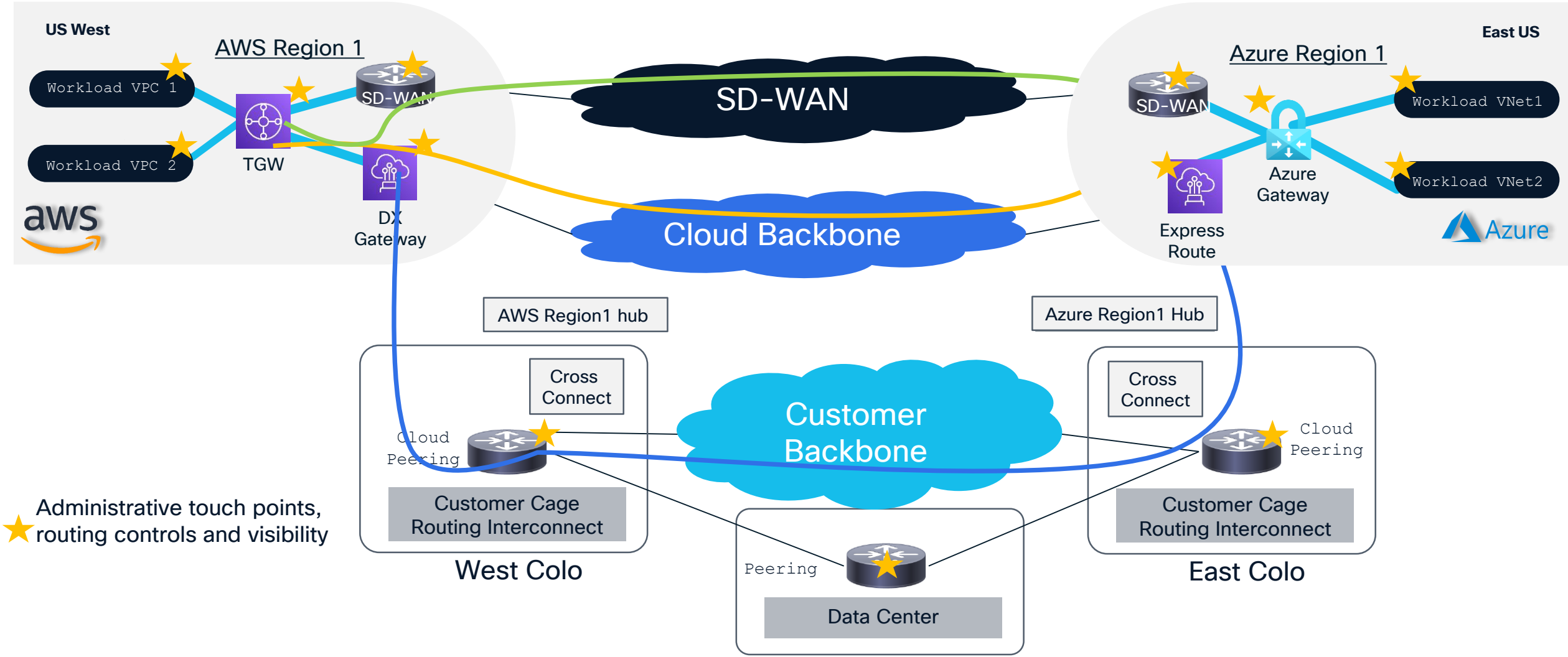


1) Leverage a WAN carrier
2) Leverage Colo (Equinix Fabric) + MACsec
3) Leverage Cloud Native TGW peering
4) Middle Mile
5) AWS Cloud WAN
6) Azure Virtual WAN

Customers are looking to build and create an environment they can switch out of easy (options) based on cost / pricing / charges.

Multi-Cloud Connectivity and Routing

Multiple Ingress/Egress



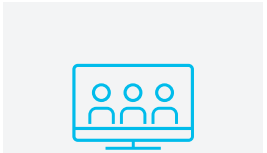
Questions to solve for:

- Which path did the traffic flow?
- Is ECMP possible?
- Failover?
- Path failure detection and re-routing to a new / backup path?
- What about visibility?

Let’s take a closer look...

Architecture

Secure Networking



Devices

Users

Things

Digital Resilience

AI Security

Zero Trust

Zero Trust Network Access

Infrastructure

webex by cisco

salesforce

Office 365

aws

Google Cloud

Azure

Data Center

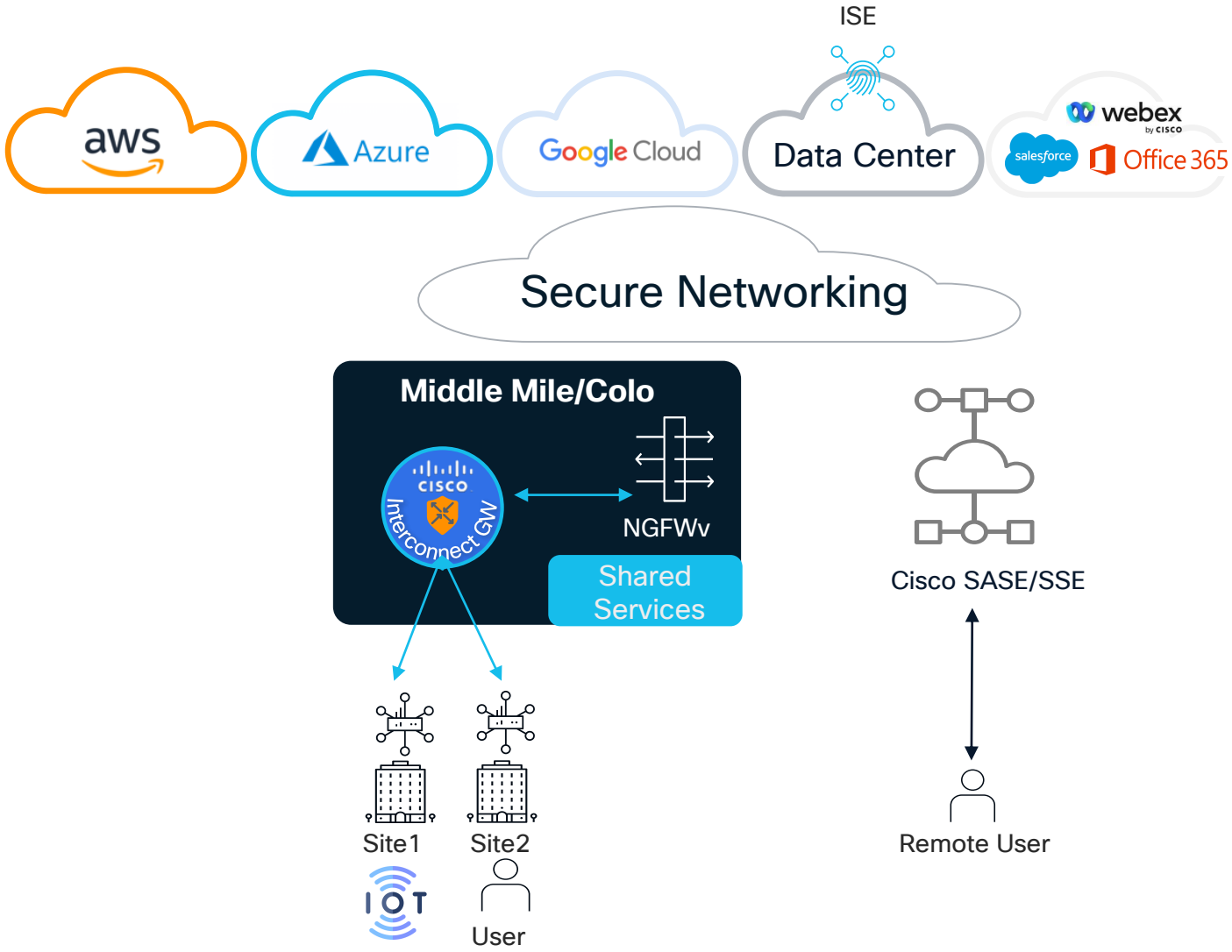
Key Capabilities

Taxonomy, a few more...

- NGFW: Next Generation Firewall
- ISE: Identity Services Engine
- SGT: Security Group Tag
- SASE: Secure Access Service Edge
- SSE: Security Service Edge
- SD-WAN: Software Defined WAN
- SDCI: Software Defined Cloud Interconnect
- CASB: Cloud Access Security Broker
- DLP: Data Loss Prevention
- ZTNA: Zero Trust Network Access

Topology

Automate branch, cloud and Data Center/Colo connectivity / security

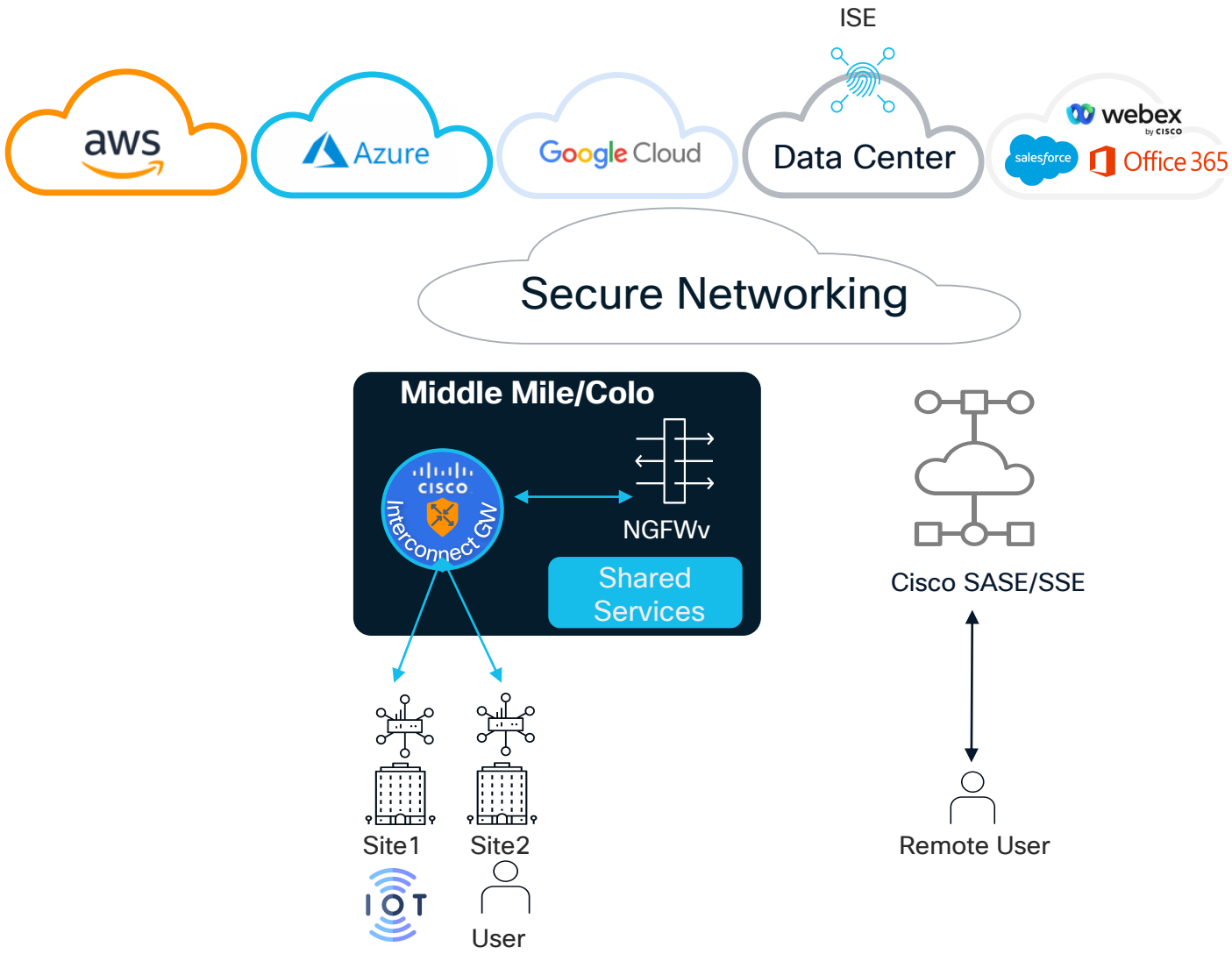


- Secure Remote Users / locations / sites
- IaaS / Saas / Internet / Private DC
- IoT Use-Cases
- Automation + Management + Visibility
- Segmentation (macro/micro)
- Policy Enforcement Points
- Common Policy

Middle Mile:

- Rely on more Internet Connectivity
- Discrete circuits connecting locations
- Consumption Options
- Optimize Traffic Flows
- Cloud Connectivity
- Remote location + Geo(s)

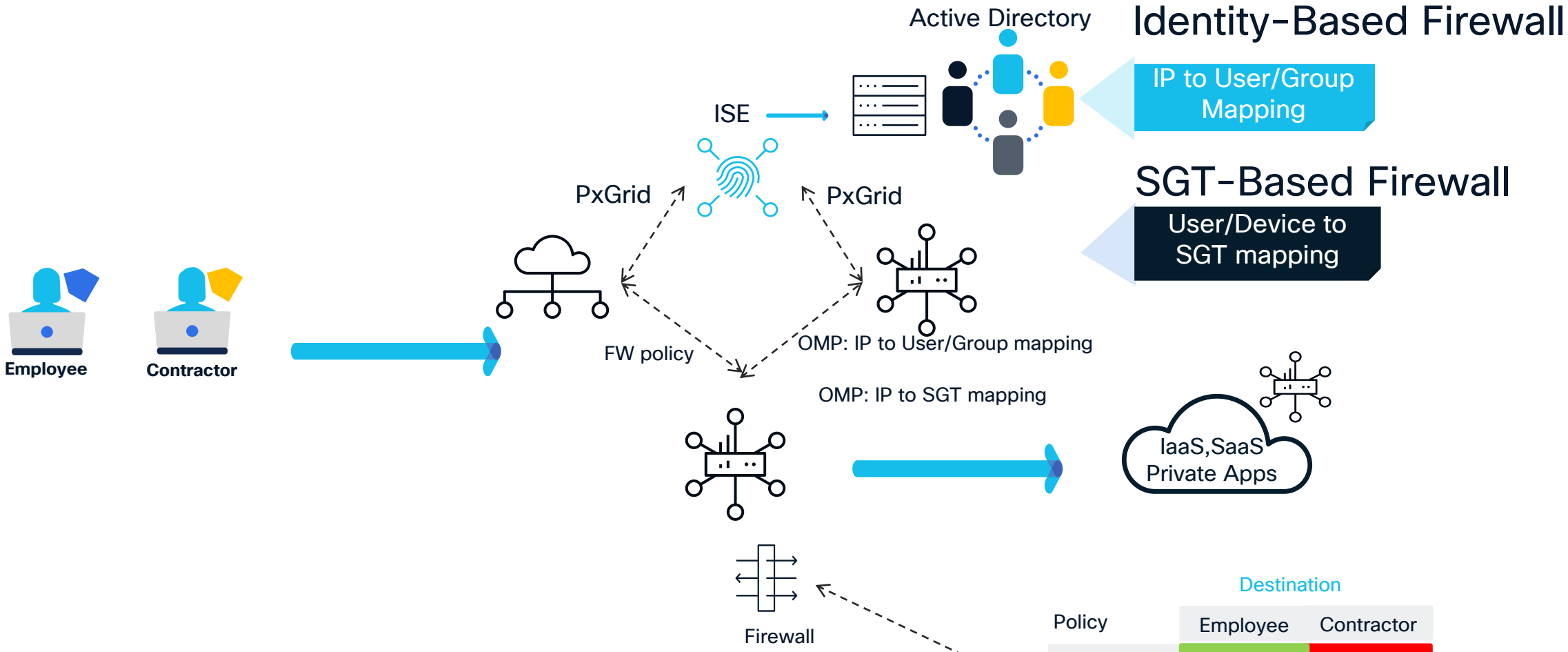
Capabilities: Site/User-to-Cloud



- SD-WAN + Firewall
  - Identity-Based Firewall
  - SGT-Based Firewall
- Stateful Firewall on cEdge
- Deployment Options:
  - **Base Firewall:** L3/L4
  - **Advanced Firewall:** Identity-based Firewall
  - **Advanced NGFW:** SGT-based Firewall
- Leverage on-prem ISE Investment Identity + ISE
- Ability to choose enforcement options
- Ability to carry + Enforce VRF and SGT end to end
- NGFW

Edge Firewall

Unified Security policy and intent



Source \ Destination	Employee	Contractor
Employee	Permit All	Deny All
PLC	Permit All	Deny All
Contractor	Deny All	Permit All

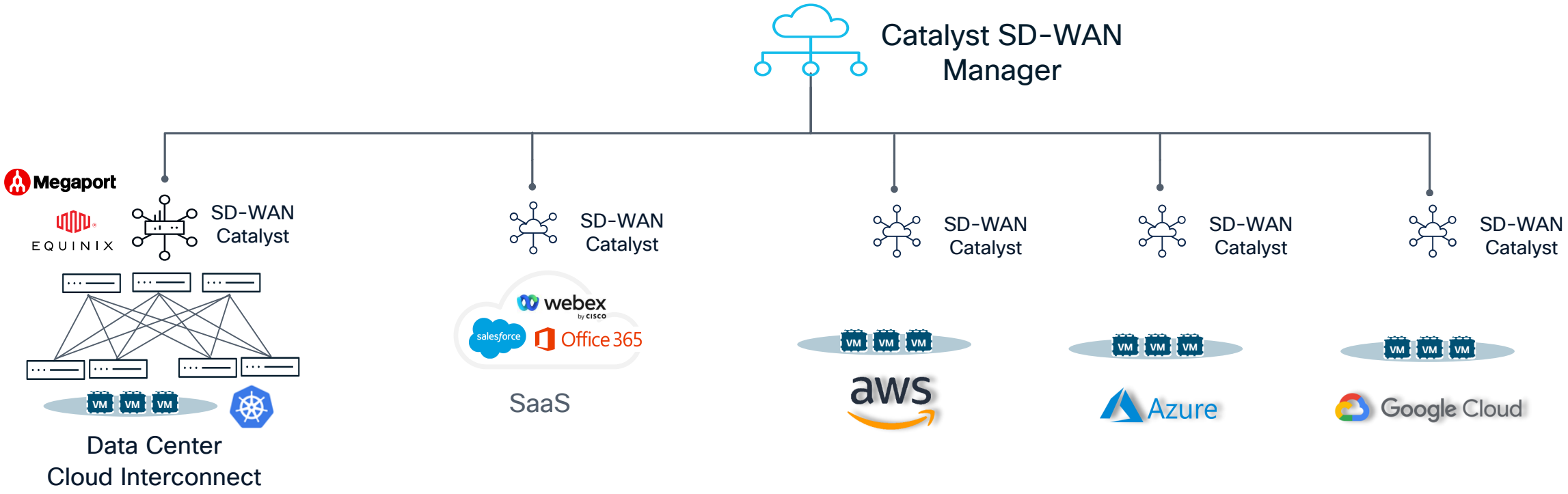
Granular Security Control at User/Group Level

Connecting Users / Devices / Things to the Cloud

Multi-Cloud Networking: Catalyst SD-WAN Manager

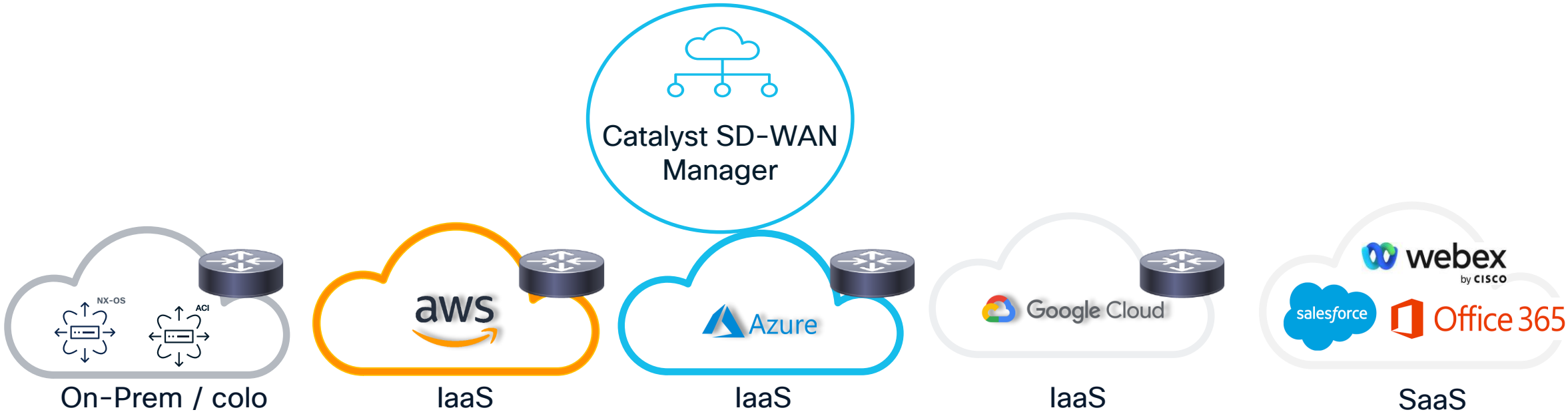
Multi-Cloud Networking

Automate connectivity & segmentation with full visibility across hybrid cloud



Automated connectivity and routing | Consistent security and segmentation | Single Point of Orchestration Visibility & Troubleshooting | Automated insertion of L4-7 services

Distributed Cloud Networking



- Catalyst SD-WAN Manager is highly resilient / available software defined controller
- Each Cloud is a distributed router
- Leverage SLA probes to monitor Cloud Objects / Path Selection

Personas

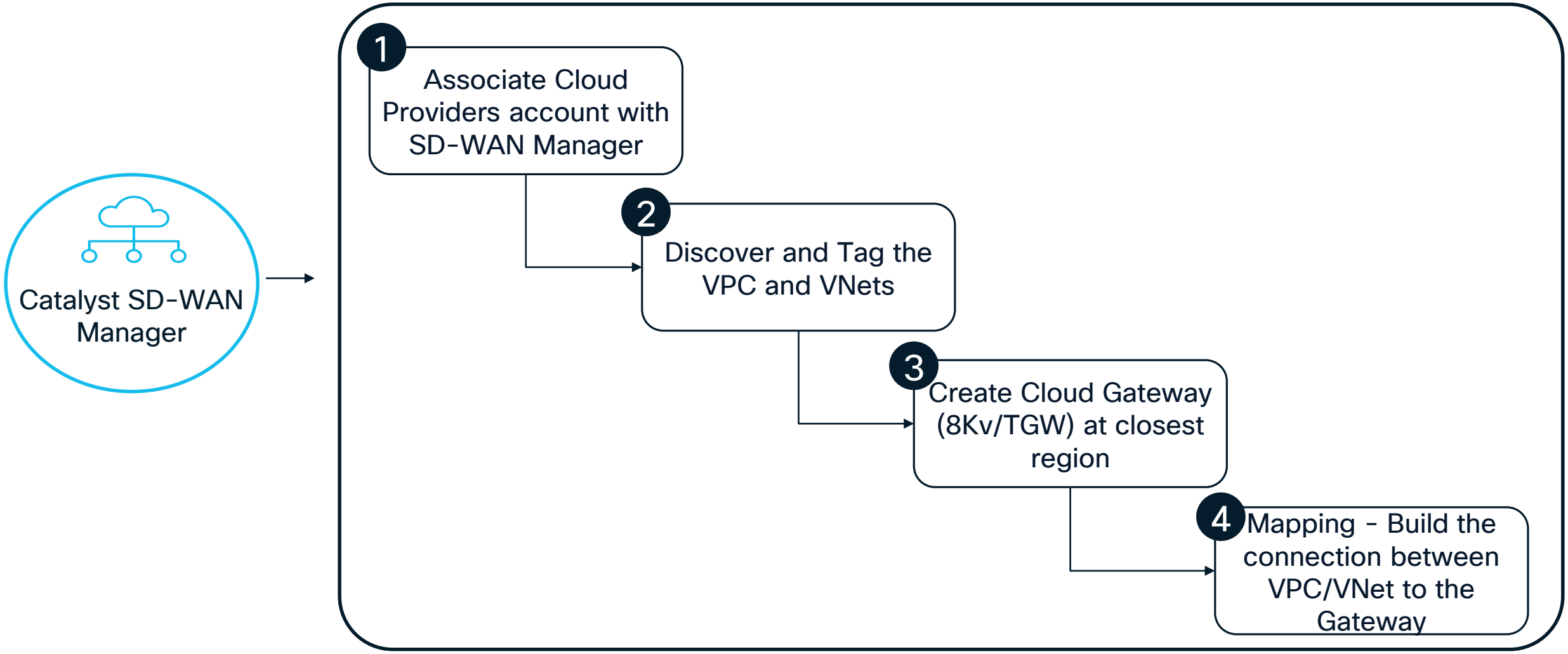
NetCloudOps
Account

CloudOps
Account

NetSecOps
Account
Ie. Firewall

Multi-Cloud Workflow

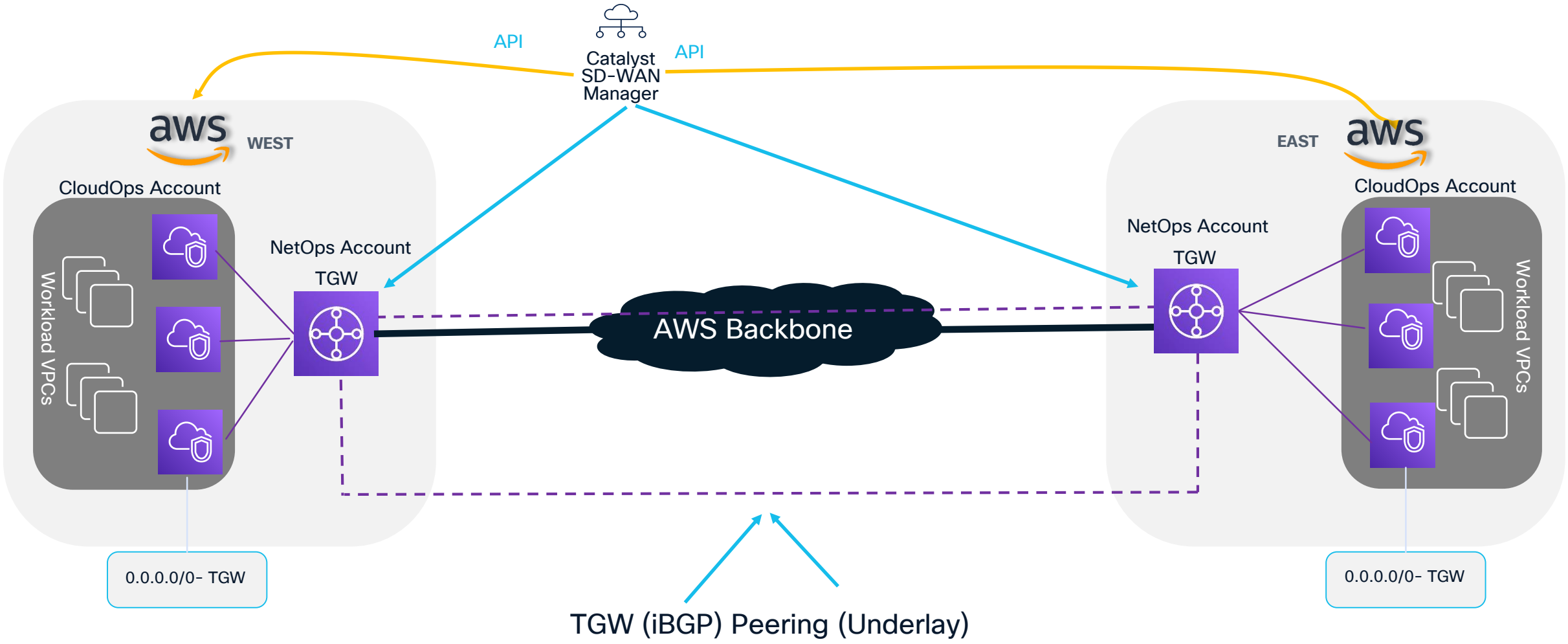
Secure Connectivity achieved in minutes



Integration and connectivity to AWS

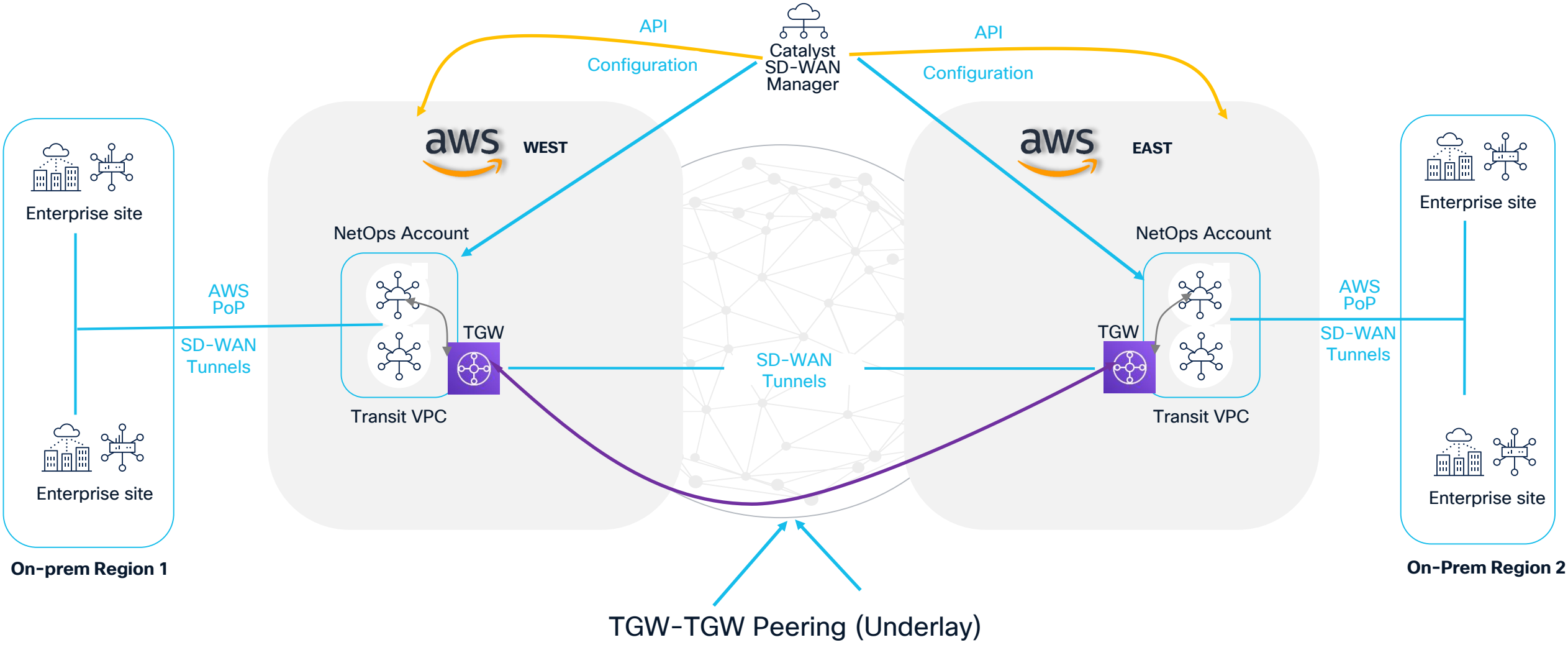
With TGW

AWS: Region-to-Region



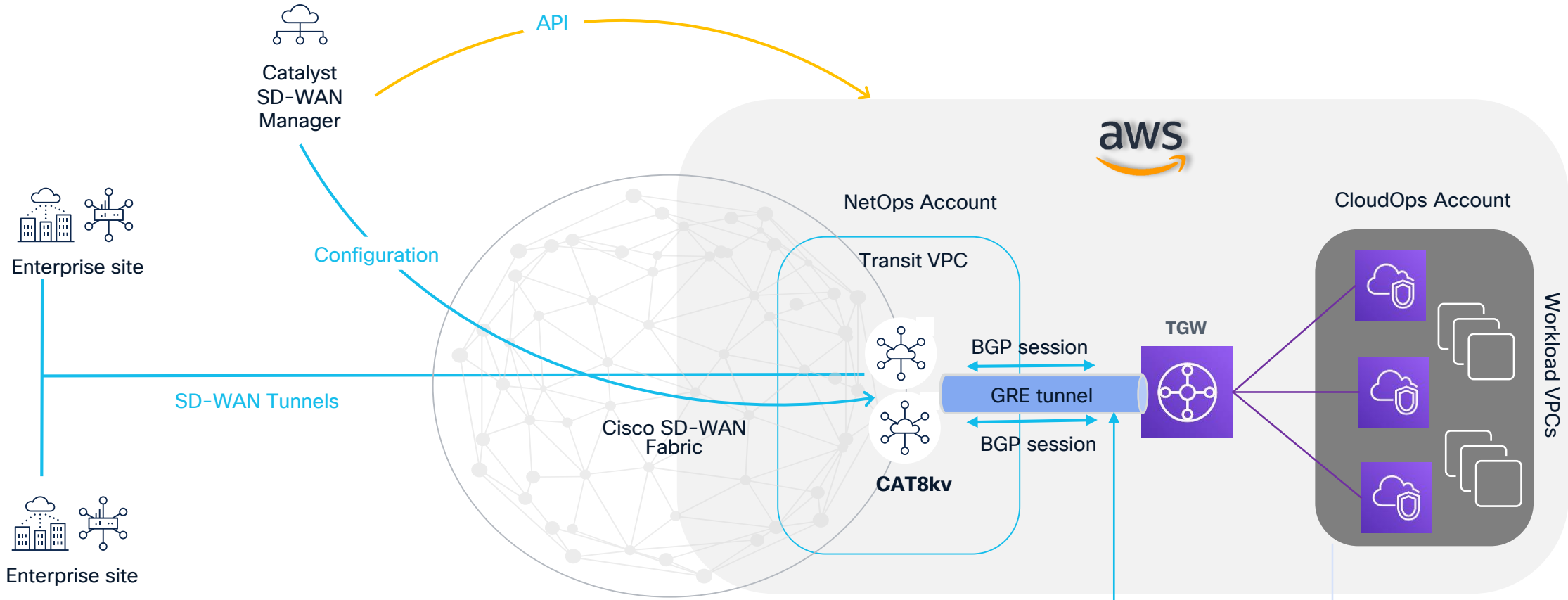
AWS: Site-to-Site

SD-WAN fabric across AWS Cloud global network



AWS: Site-to-Cloud

SD-WAN Native Integration using **GRE** (TGW Connect) between c8kvs within Transit VPC and Transit Gateway



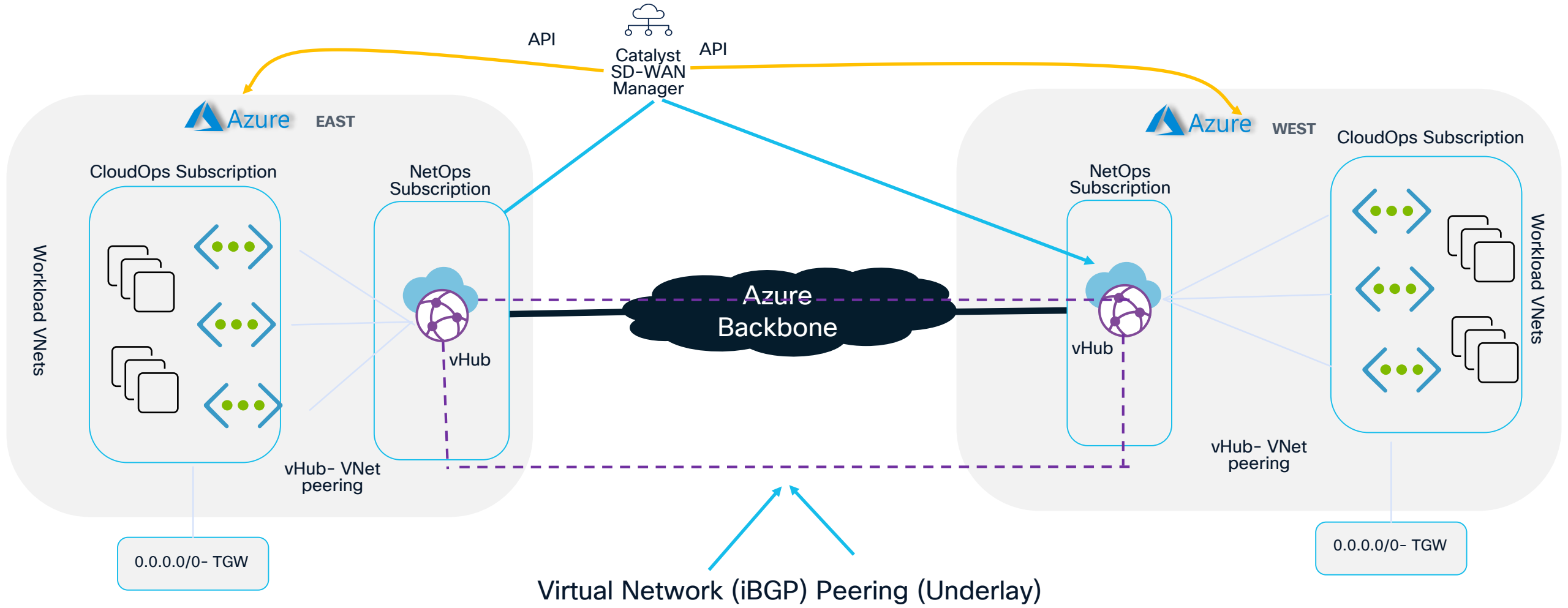
SD-WAN fabric **to** AWS Cloud workloads

Simple | Automated | Secure

Integration and connectivity to Azure

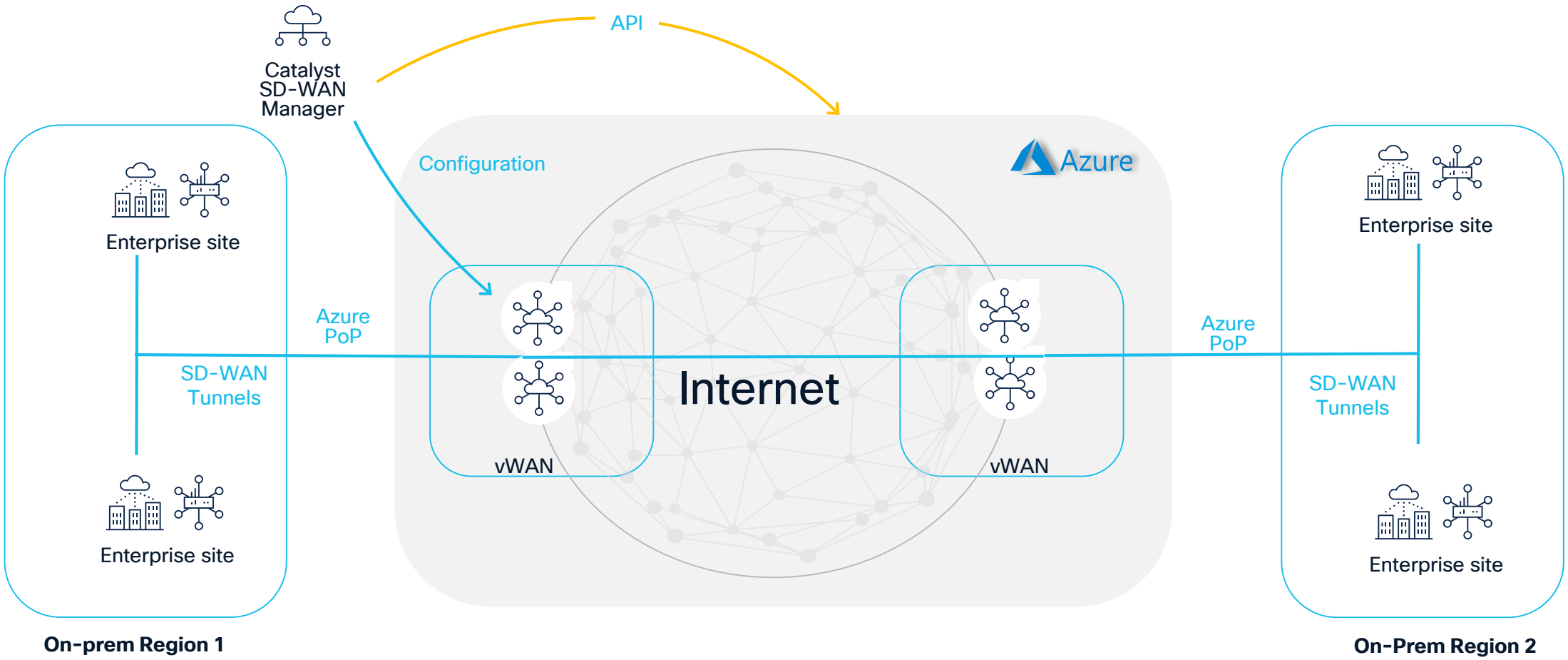
With vWAN/vHub

Azure: Region-to-Region

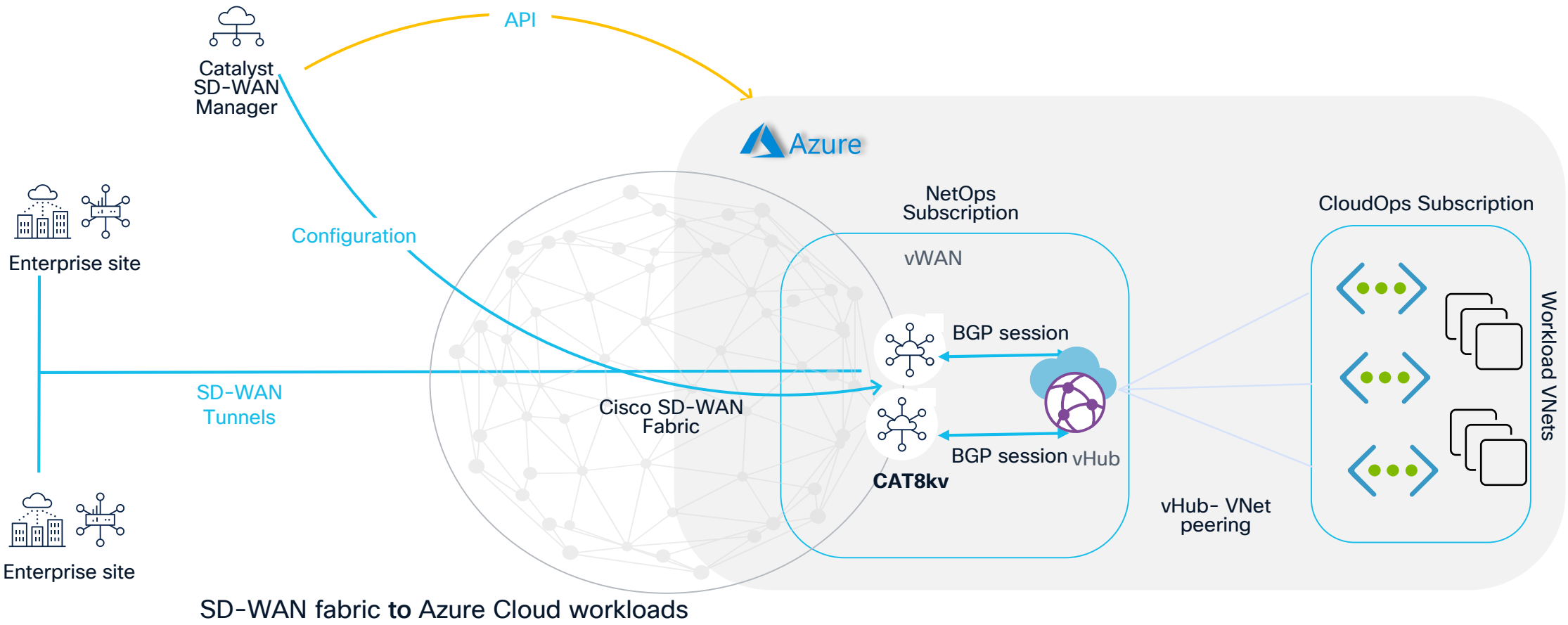


Azure: Site-to-Site

SD-WAN fabric across Azure global network



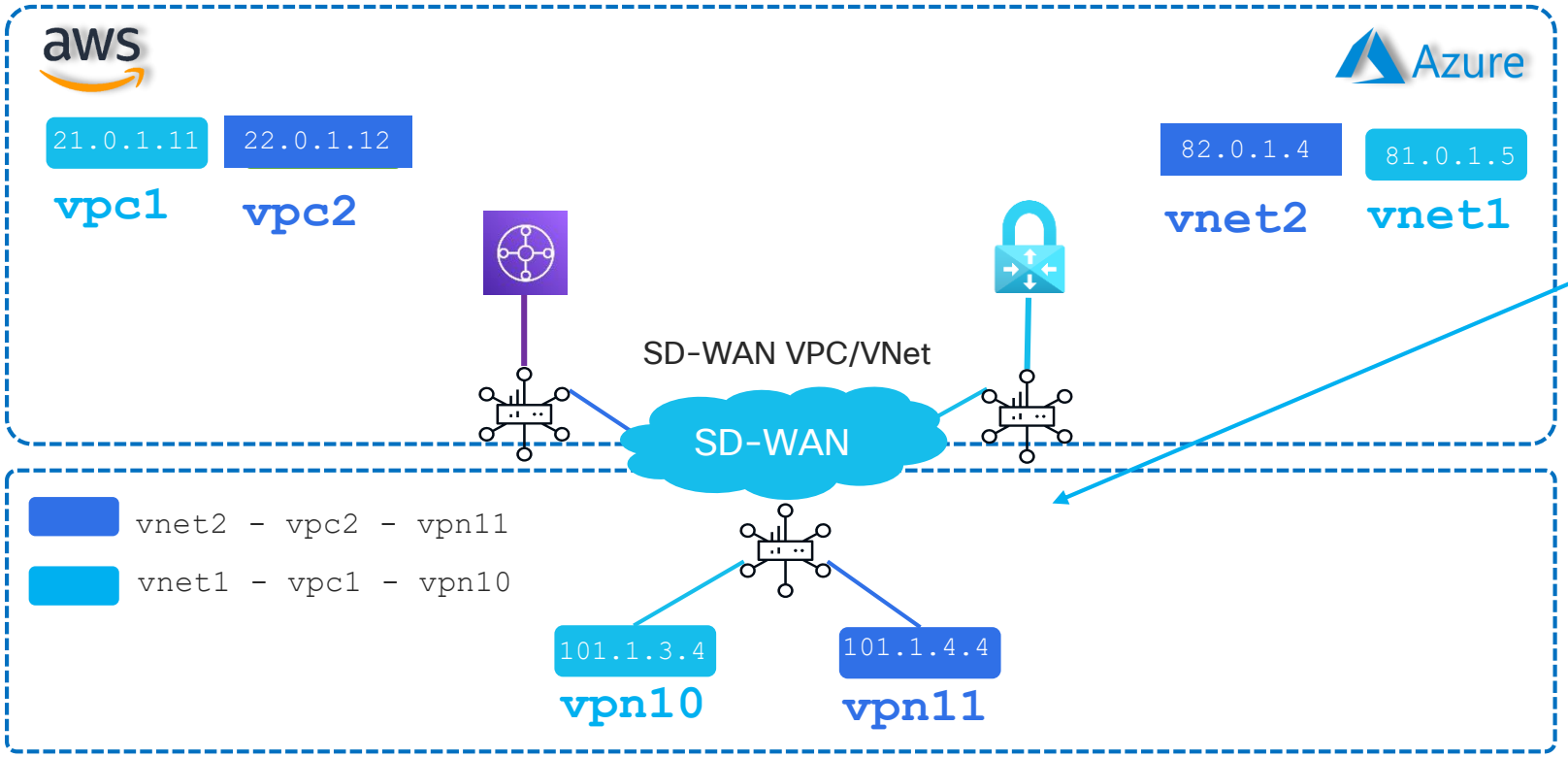
Azure: Site-to-Cloud



SD-WAN fabric to Azure Cloud workloads

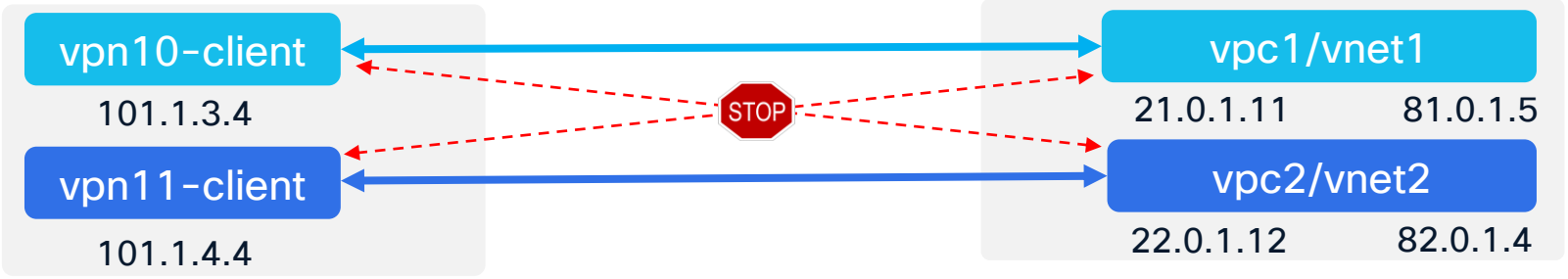
Simple | Automated | Secure

Segmentation with SD-WAN



1) SDWAN connectivity terminates at the Cat8ks for the different VRFs

2) VRF(s) are extended to the TGW/ Cloud WAN extended to the native VPCs

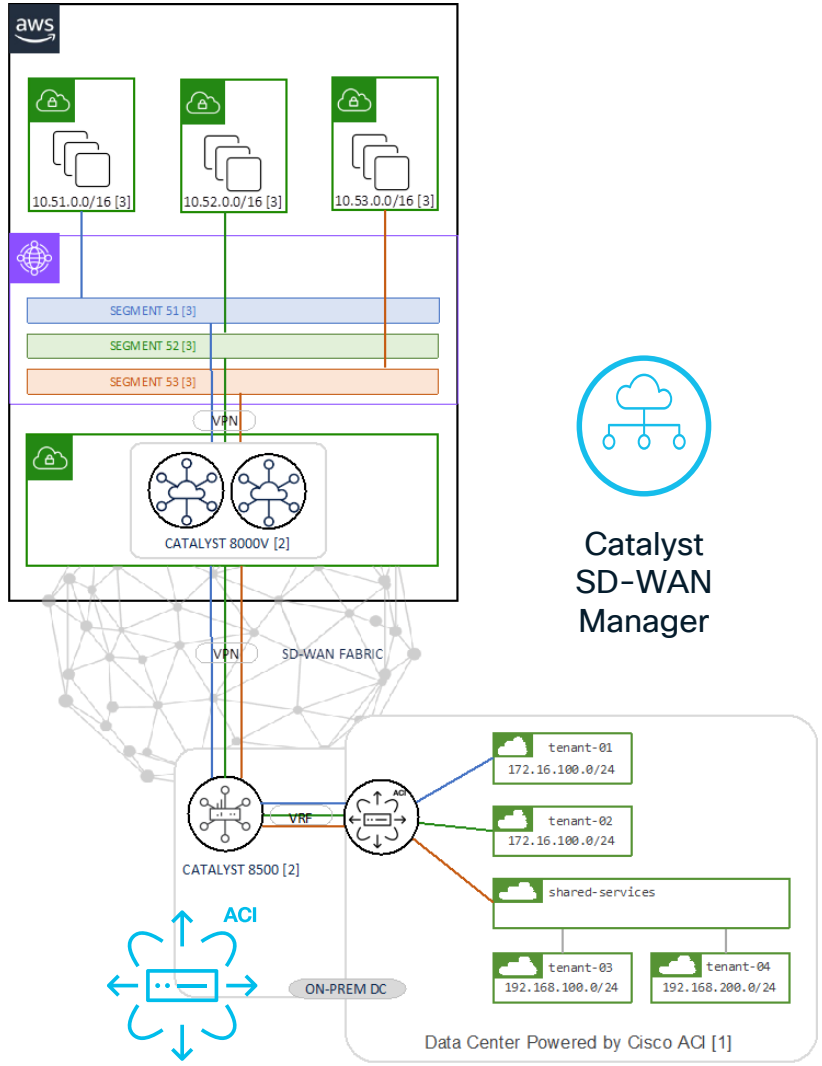


Catalyst SD-WAN + ACI to AWS Design Guide

Catalyst SD-WAN + ACI to AWS

Cloud OnRamp

- Hybrid Cloud Design and Best Practices: Catalyst SD-WAN extends SD-WAN architecture to connect datacenter workloads powered by ACI to public cloud applications through SD-WAN Cloud OnRamp. This enables secure, automated, and efficient hybrid cloud connectivity.
- Integrated Capabilities: The solution integrates multicloud, security, predictive operations, and enhanced network visibility within a Secure Access Service Edge (SASE)-enabled architecture, accelerating hybrid cloud adoption.
- Key Building Blocks: Includes ACI for tenant and VRF management, Catalyst SD-WAN for routed connectivity, and AWS infrastructure (e.g., Transit VPC, Transit Gateway) for cloud integration.



Cisco Catalyst SD-WAN Cloud OnRamp Connecting ACI to AWS Design Guide

Catalyst SD-WAN + ACI to AWS

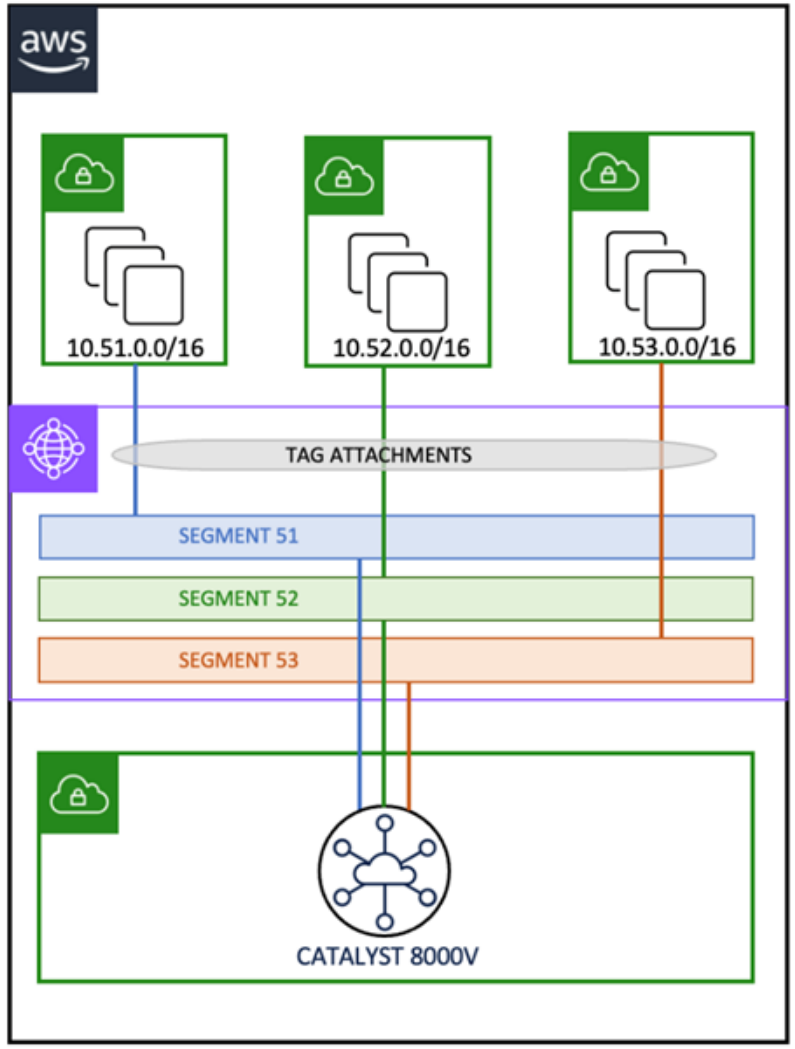
Cloud OnRamp

- The ACI tenant VRFs are mapped into SD-WAN VPNs on the Catalyst 8500 which is acting as the WAN Edge between the ACI Fabric and the SD-WAN Fabric.
- It connects to ACI border leaf nodes using Inter-AS option A (back-to-back VRF) on the service VPN side and connects to the SD-WAN Fabric.
- The SD-WAN Cloud OnRamp automation workflow will:
  - Discover and tag the virtual private cloud (VPC) in the public cloud
  - Create the cloud infrastructure (i.e., AWS TGW/Core Network Edge (CNE), Transit VPC) which connects all the VPCs
  - Create the SD-WAN Cloud Gateways which consist of a pair of Catalyst 8000V in the Transit VPC
  - Connect SD-WAN fabric the WAN Edge to the Cloud Gateway
  - Connect Cloud Gateway to the TGW/CNE
  - Map the connectivity between SD-WAN VPNs and VPCs, and VPCs to VPCs
  - The function and configuration of each SD-WAN building block are explained in detail in the Catalyst SD-WAN Building Blocks section.

Catalyst SD-WAN + ACI to AWS

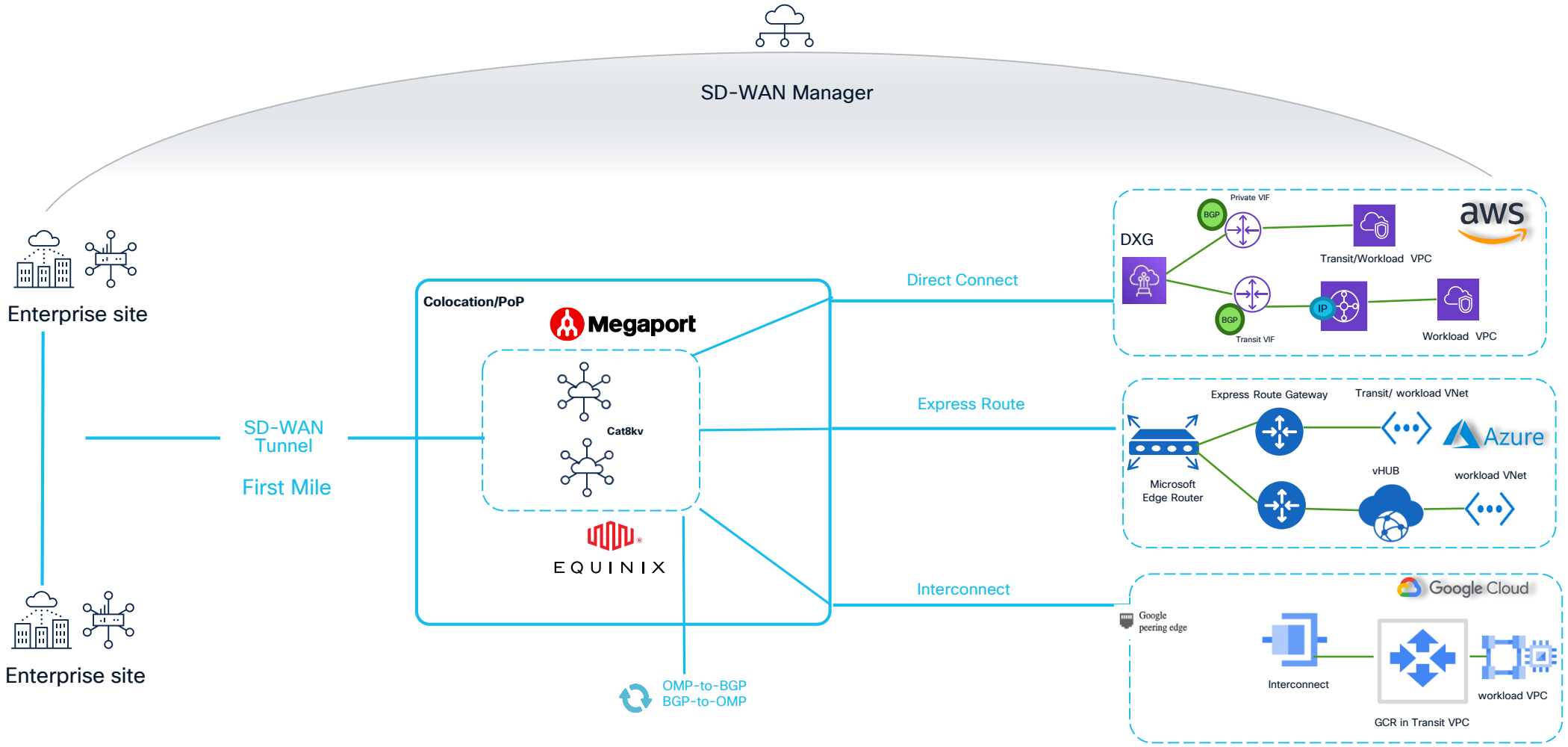
Cloud OnRamp

- Separate Cloud Accounts: Enterprises often use separate cloud accounts for networking, security, and development purposes. Catalyst SD-WAN supports discovering resources across multiple accounts via Catalyst SD-WAN Manager.
- Tag-Based Connectivity: Cloud resources are connected to the network using tags created in Catalyst SD-WAN Manager, which are associated with VPCs and used in a connectivity mapping table. These tags are also visible in the AWS console after VPN-to-VPC connectivity is established.
- Multi-Account Support: The design supports scenarios with one, two, or multiple AWS accounts, enabling flexibility for enterprises with varying cloud deployment structures.



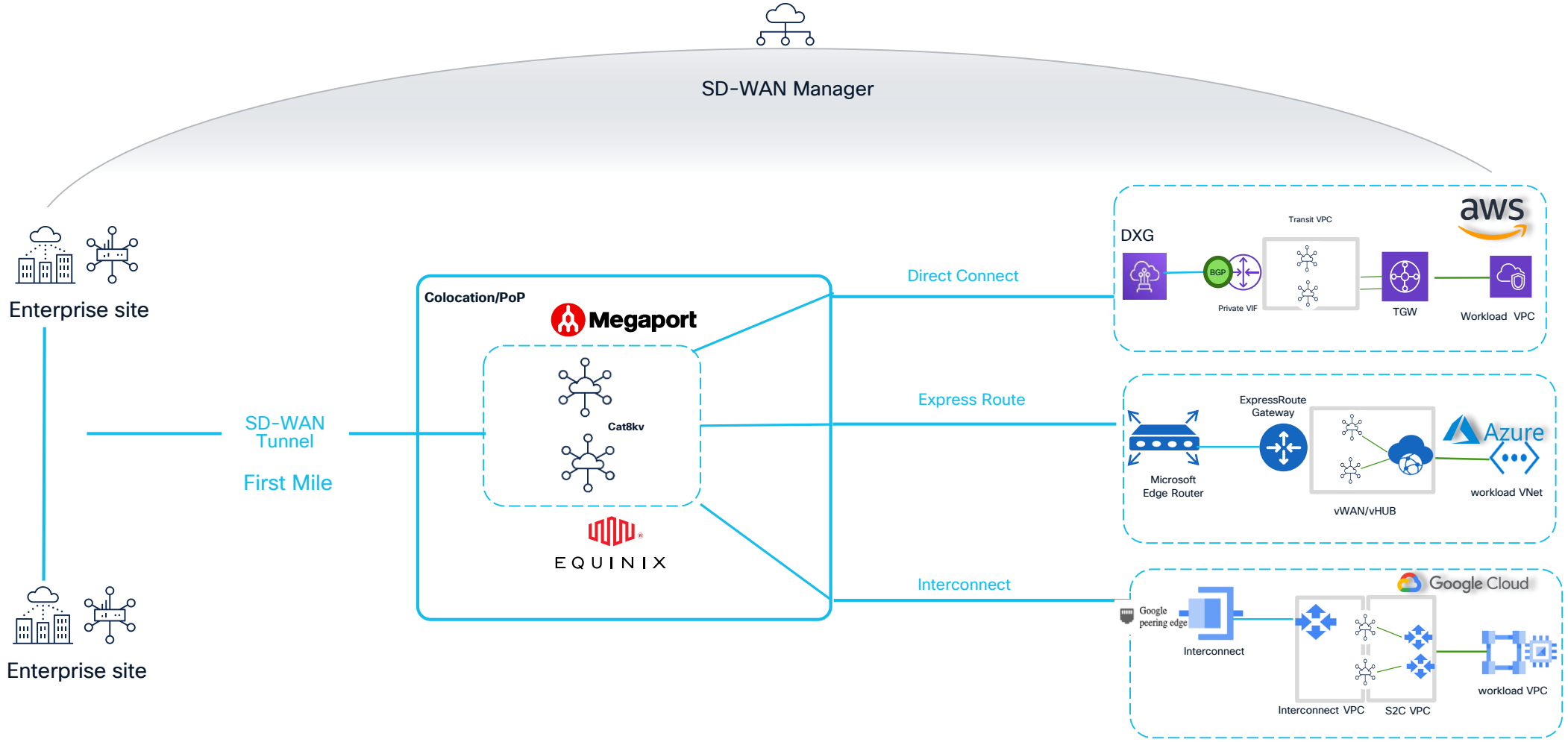
Middle Mile with Megaport & Equinix

Site-to-Multicloud- Megaport or Equinix



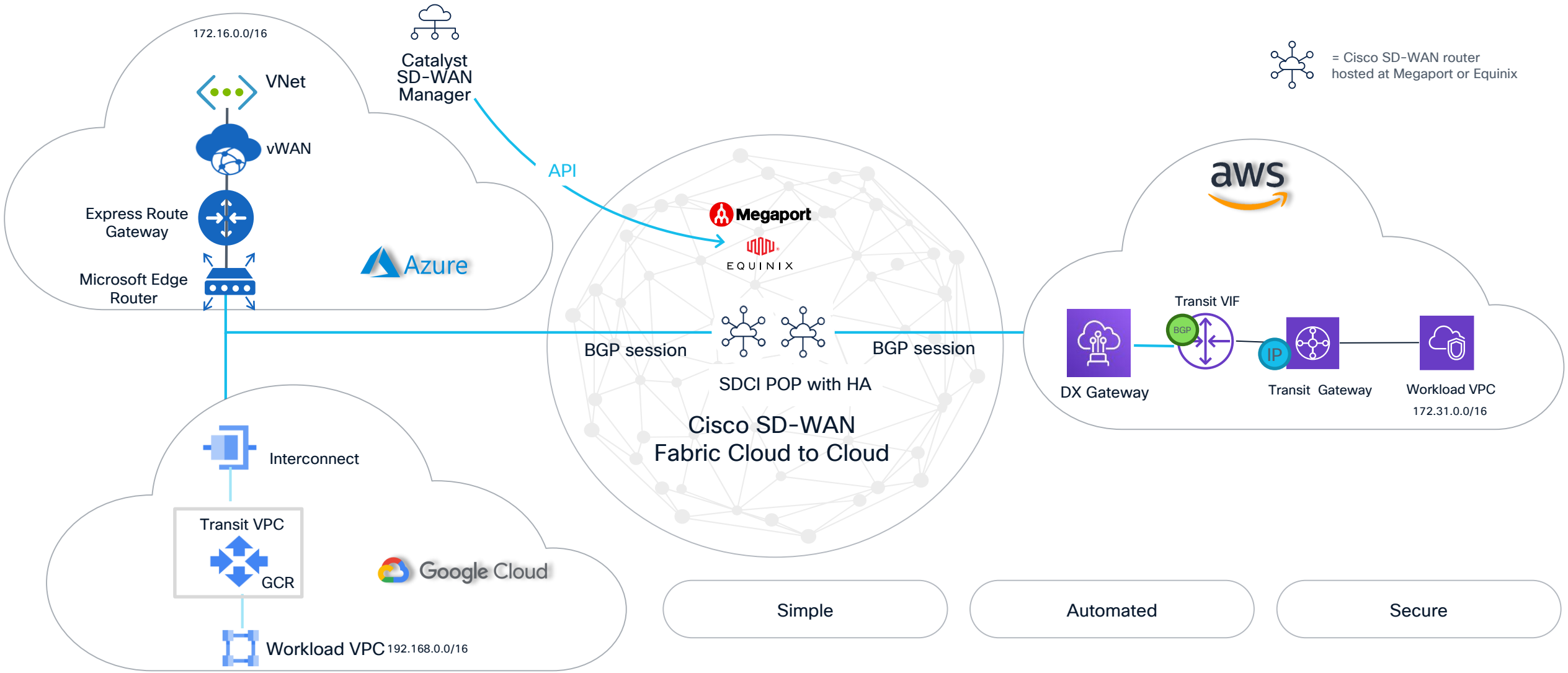
Site-to-Multicloud- Megaport or Equinix

Fully Encrypted



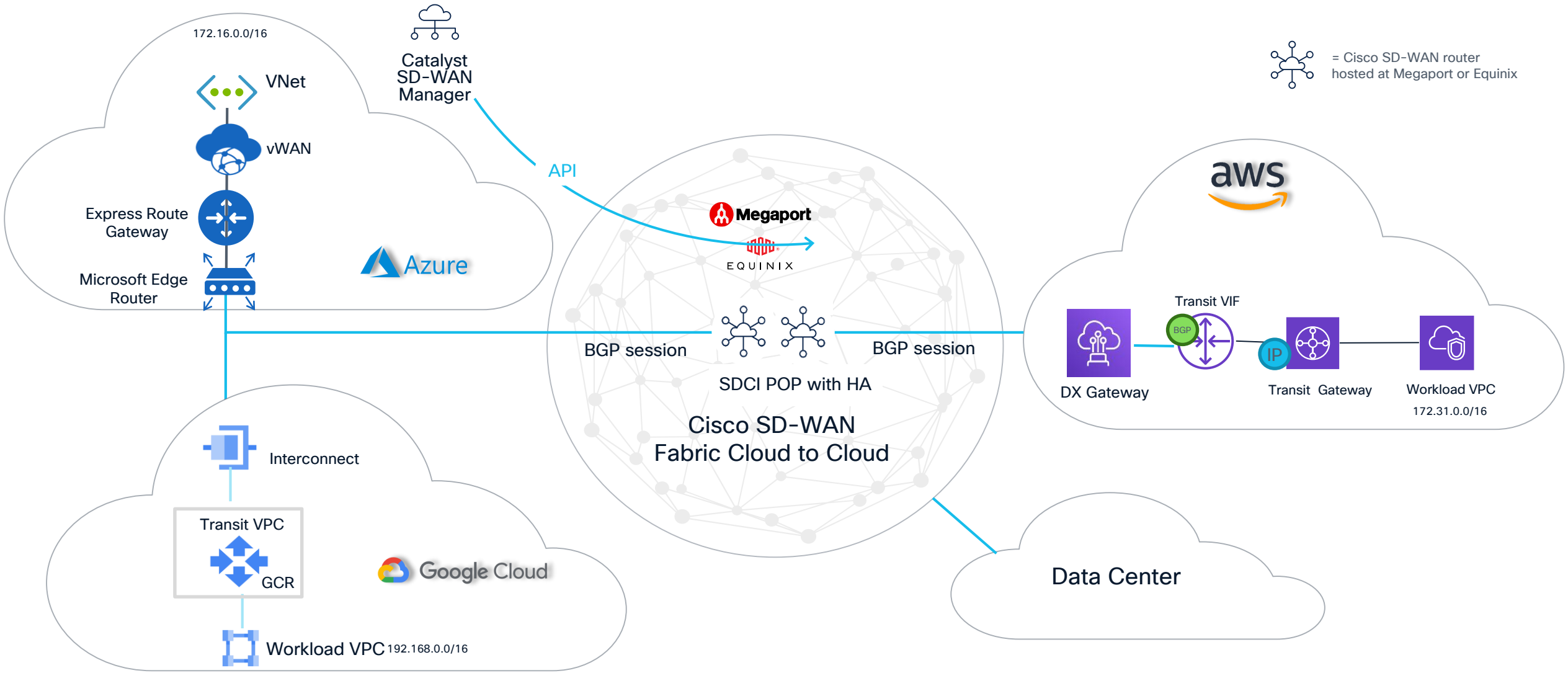
Cloud to Cloud: Private Connect

Megaport/Equinix



Cloud to Cloud: Private Connect

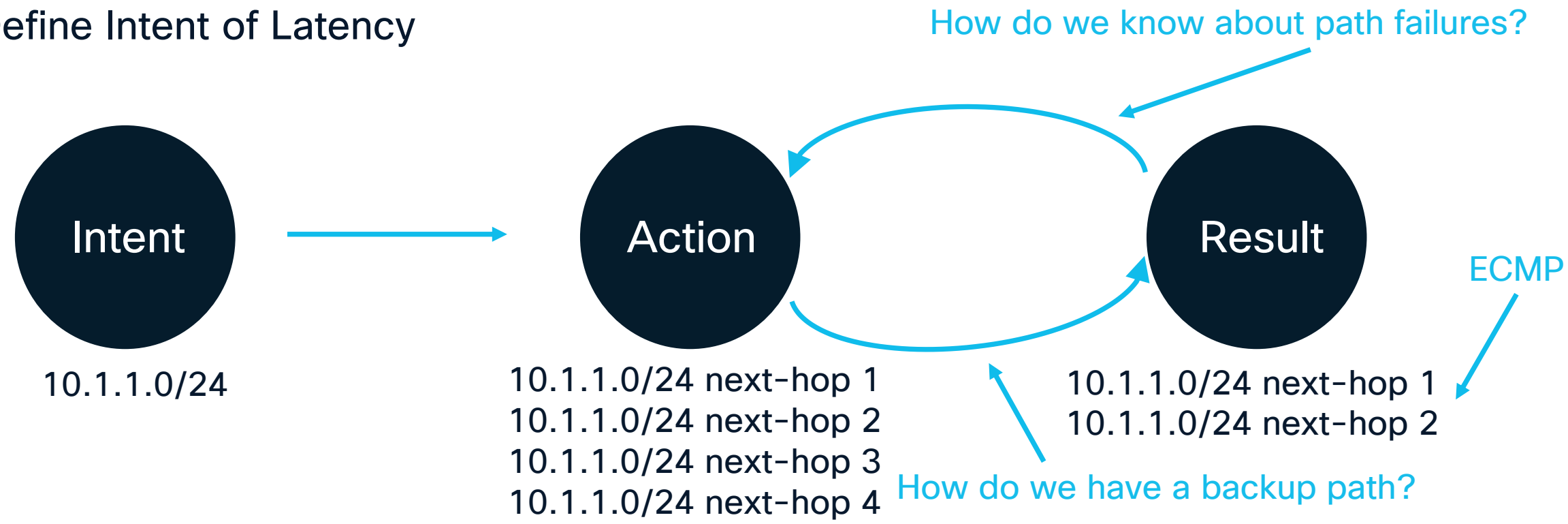
Megaport/Equinix



Automated with Cisco Catalyst SD-WAN Manager

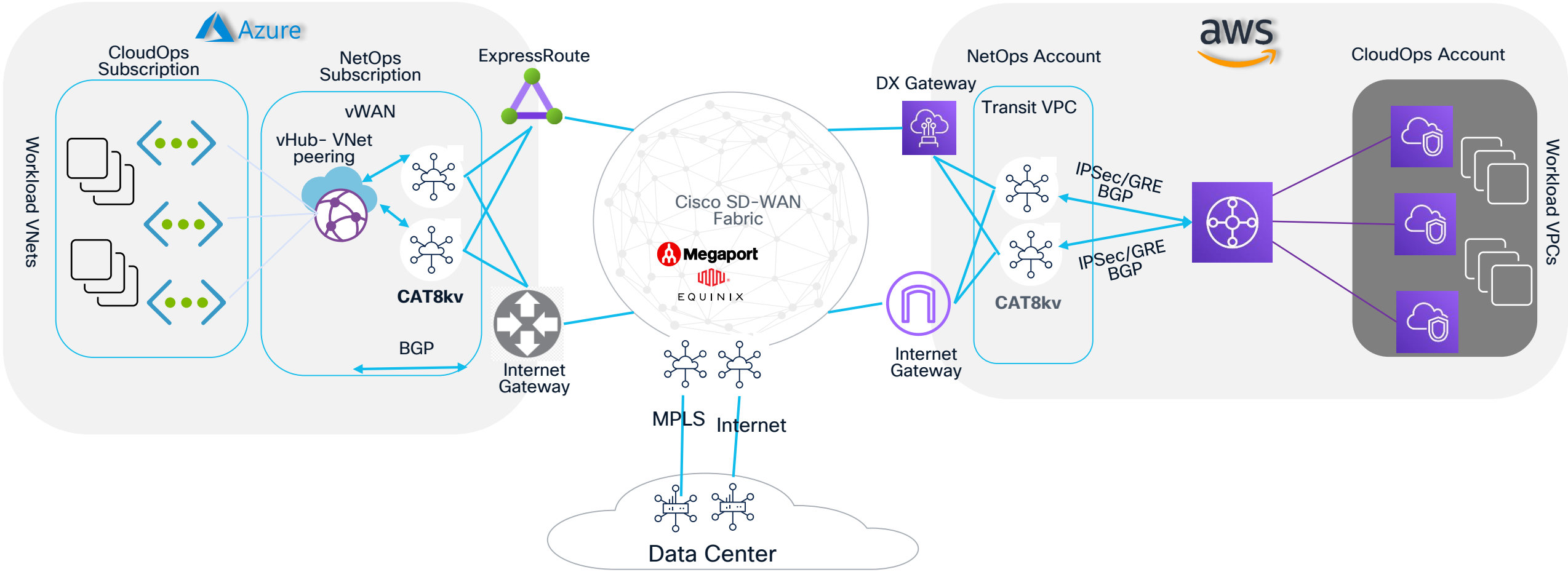
Cloud Networking with SD-WAN Manager

- Intent: Reach 10.1.1.0/24 over all possible paths (ECMP) and Path Failure(s)
- Administrator expresses the Routing Intent (NetOps / Cloud NetOps)
- Validation of reachability
- Define Intent of Latency



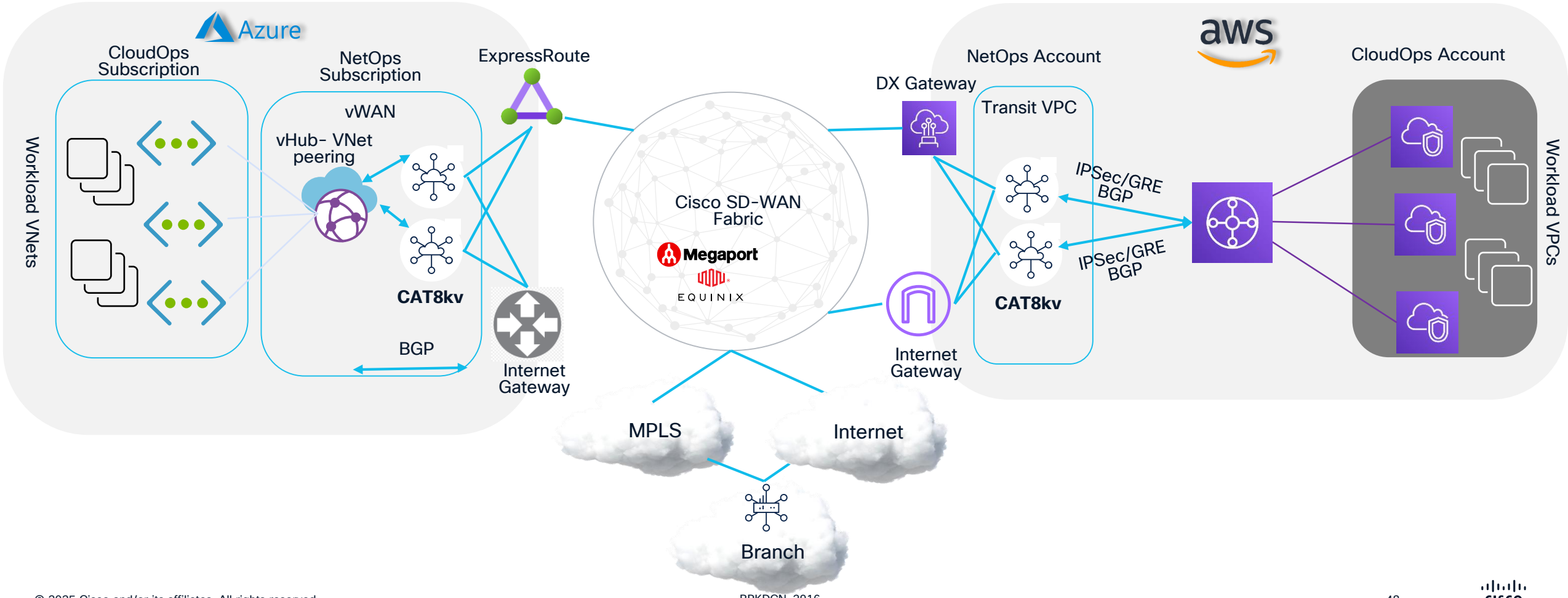
Cloud-to-Cloud

ECMP



Cloud-to-Cloud

ECMP



So where is the new perimeter?

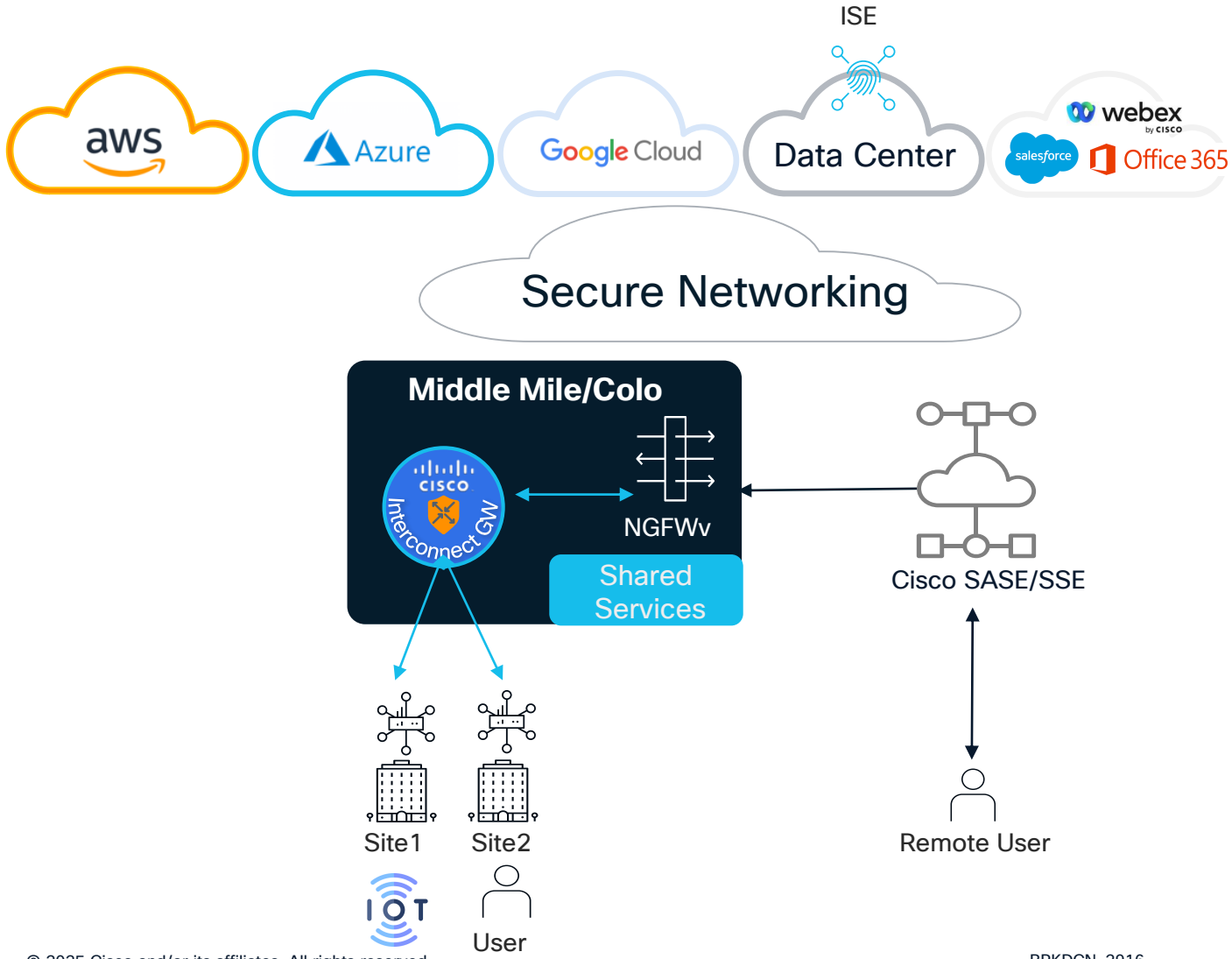
I define it as, wherever security controls and capabilities are to protect users/devices, things, applications and data; the security perimeter is everywhere.

Applications behind SD-WAN and Cloud Security Stack

Use-Cases

Use Case: Site/User-to-Cloud

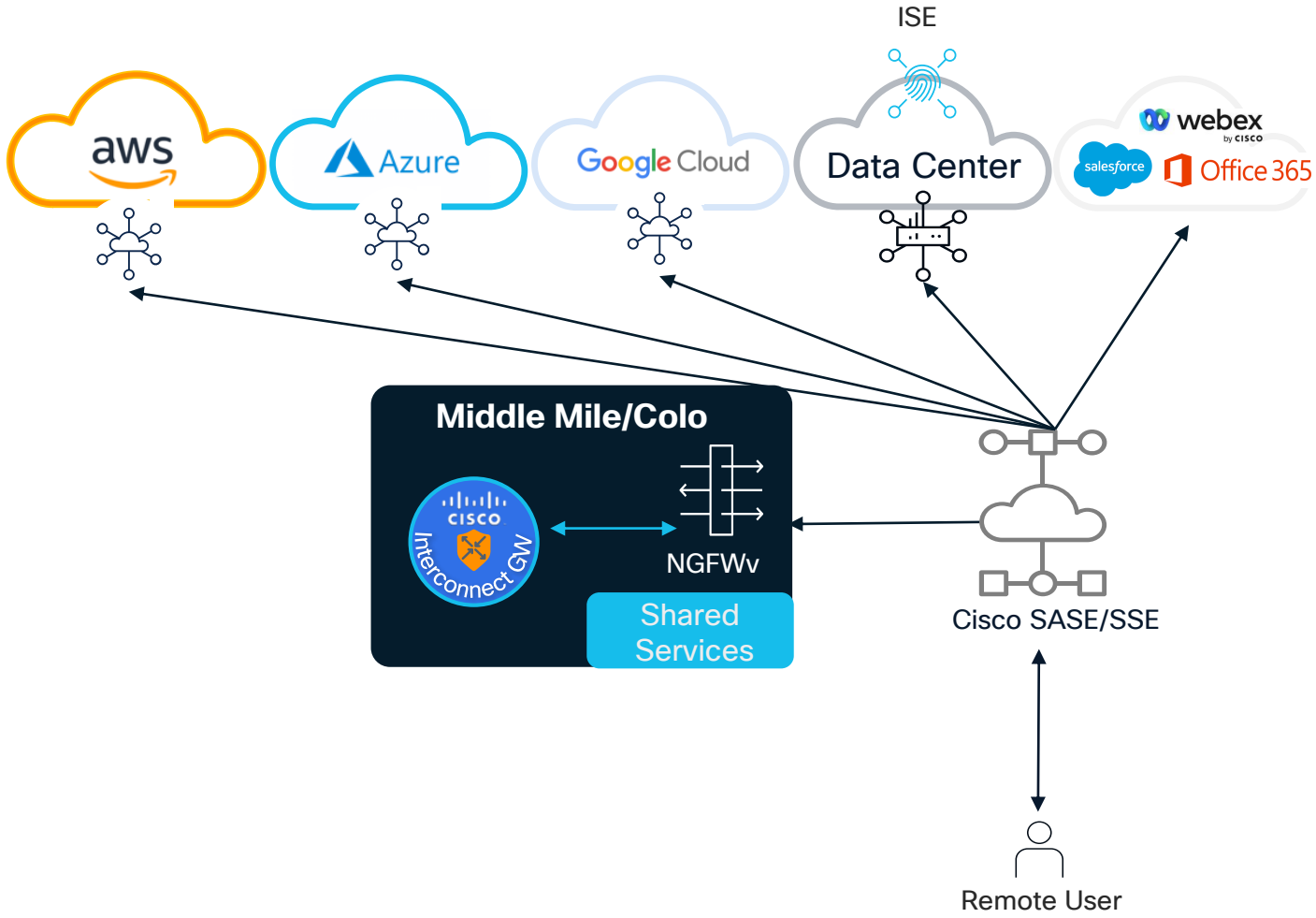
SASE/SSE



- Cloud Security for remote Users / Branch Users and IoT.
- Network automation + SASE/SSE (Secure Web Gateway (SWG), CASB/DLP, ZTNA, FWaaS)
- Capabilities: Ability to carry VRF and SGT end-to-end
- Ability to choose enforcement options
- Identity integration with on-prem ISE
- Selective Application Traffic and Internet Egress routed to SASE/SSE stack
- SASE Bypass/Direct Internet Access (DIA): Getting the right traffic to the right place- not every application can go through SASE. For example, Office365 no proxy/SWG.
- Least privilege access
- Cisco Security Cloud Control

Use Case: Site/User-to-Cloud

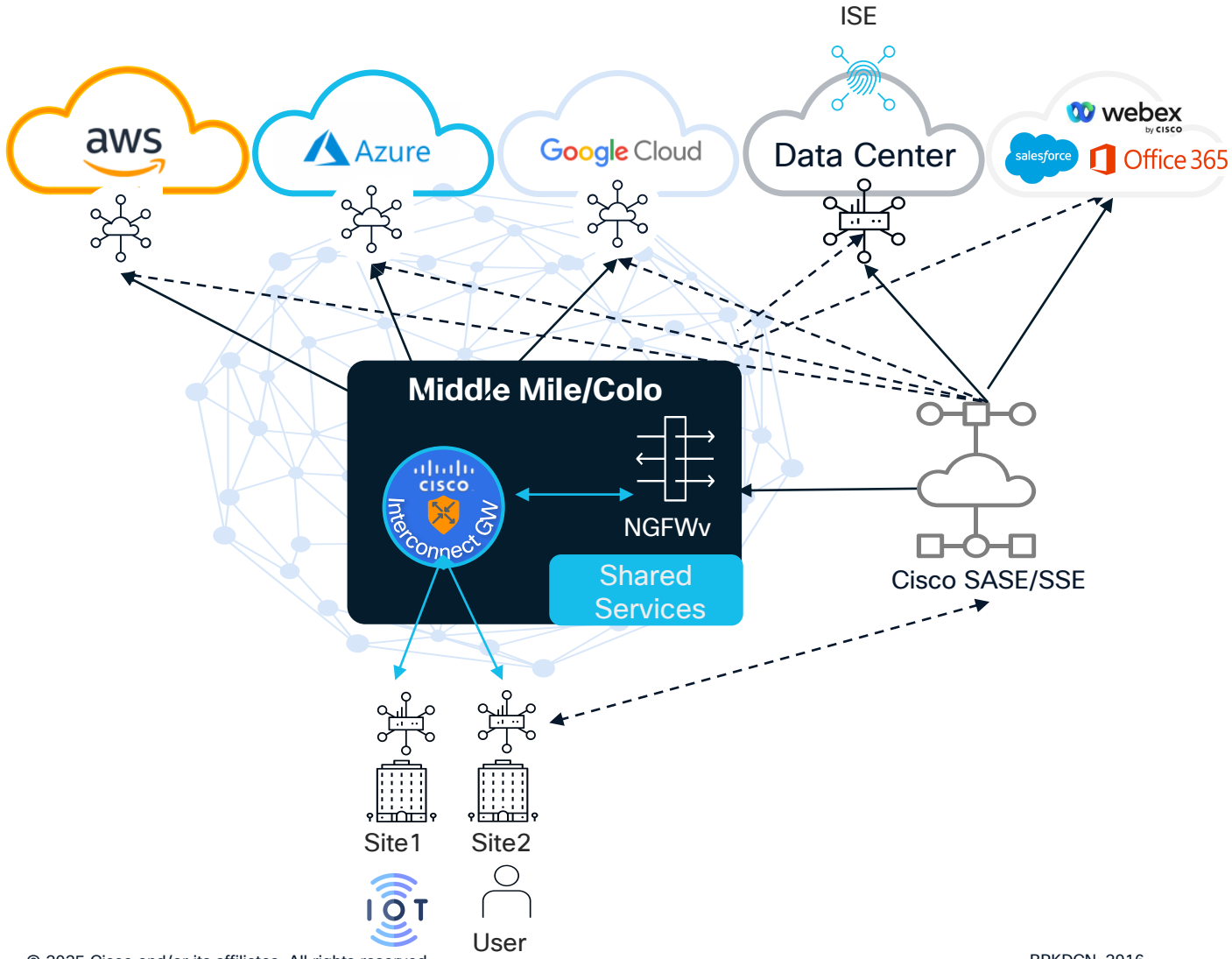
SASE/SSE - Remote User



- **Remote User to Internet**
  - Secure Client Web Module for DIA Security (DNS and Web SWG)
- **Remote User to SaaS Application**
  - SWG
  - DIA w/o Module (ie Webex or O365)
  - User Experience (ie API hook into WebEx Tenant and bypass)
  - DLP and CASB Controls (ie. upload only)
- **Remote User to Private**
  - Application in CSP
  - Application in Private DC
  - Application Middle Mile Shared- Services. Traffic goes through Secure Access First (FW/Inspection) PEP/IPS/Decryption/ZTNA FW
- **Three Different ways to get traffic into the SSE stack:**
  - Secure Client ZTNA module (per app tunneling / posture and auth)
  - Secure Client VPN module (traditional RA-VPN)
  - Clientless (browser) – unmanaged use-case

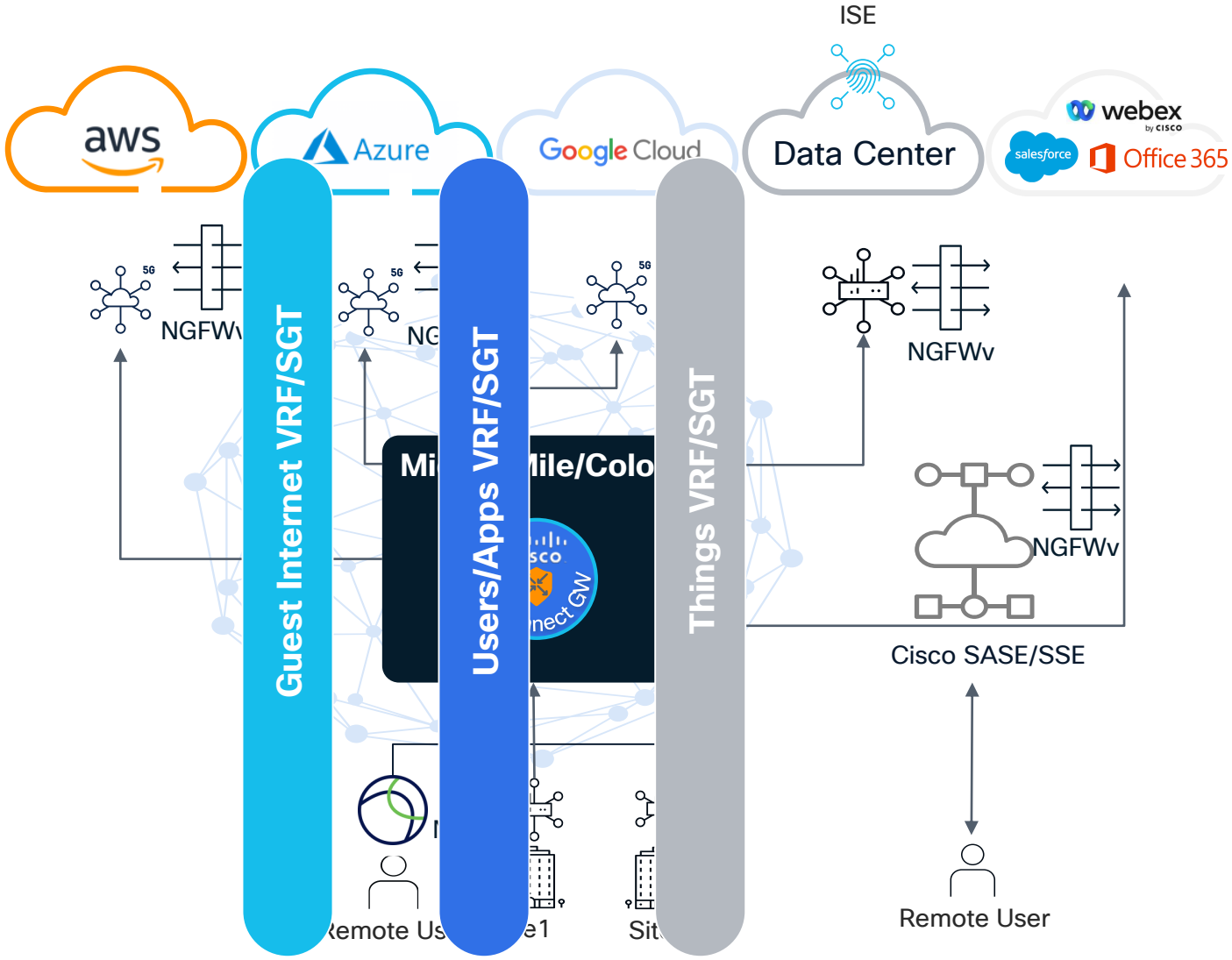
Use Case: Site/User-to-Cloud

SASE/SSE



- **Branch User/IoT to Internet/SaaS**
  - Catalyst/Meraki SD-WAN Optimized Routing
  - SSE Security Controls, Inspection and least-priv access
  - SD-WAN Security Capabilities
- **Branch User/IoT to Private App**
  - Catalyst/Meraki SD-WAN Optimized Routing (ie. DC via Middle-mile)
  - SSE Security Controls, Inspection and least-priv access
  - SD-WAN Security Capabilities
- **Identity Attribute Options:**
  - Azure-AD Username (SGT as well)
  - SGT Identity
  - VPN-ID (Ie. Acquisition/GuestNet)

End to End Segmented Traffic + Enforcement



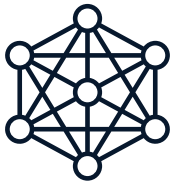
- Keep specific on its own “rail”
- VRF is ability to get traffic to the Firewall
- Micro-segmentation can also be applied
- Use Security Policy to x-connect “rail” to “rail” policy / communication

Resulting in:

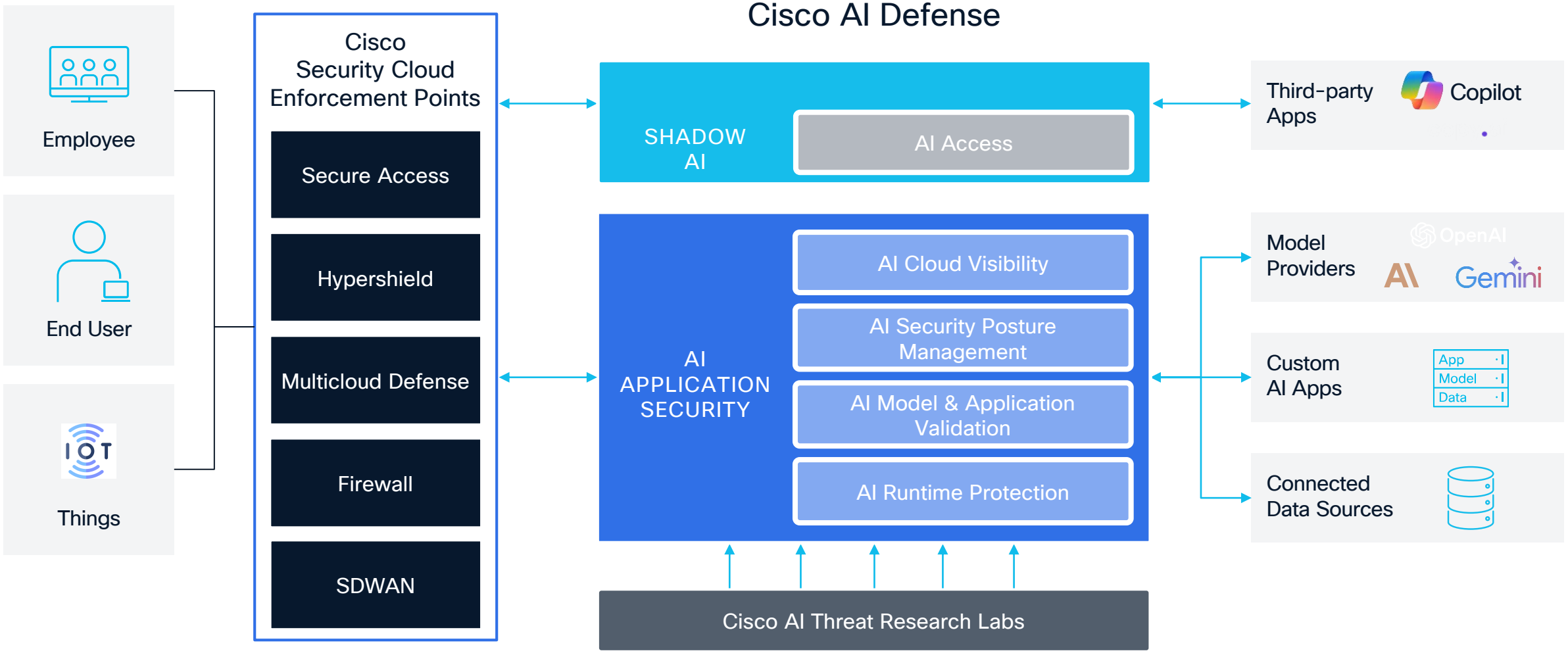
- Security Policies that are aligned user and group vs IP Addresses
- SD-WAN embedded security stack is now aware of user identity and apply policy.
- Identity Firewall capability provides granular access control based on user identity
- ZTNA trust assertion based on user and device context
- Trust based establishment

AI Applications

Cisco Security Cloud Control

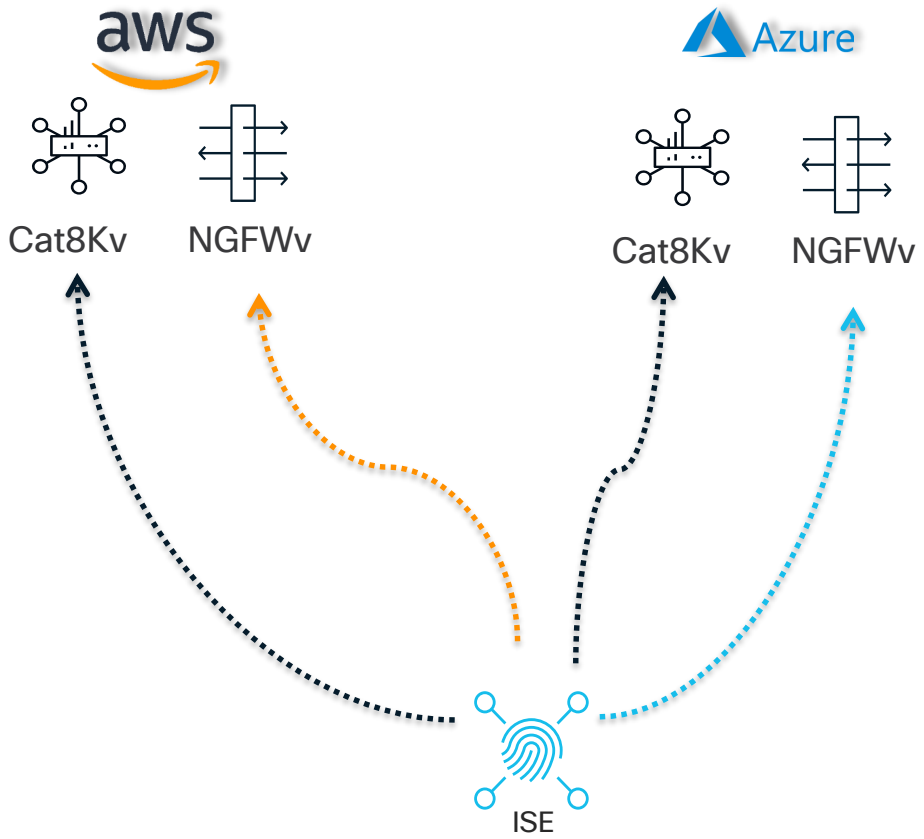


Security Cloud Control



Extending Policy to Public IaaS

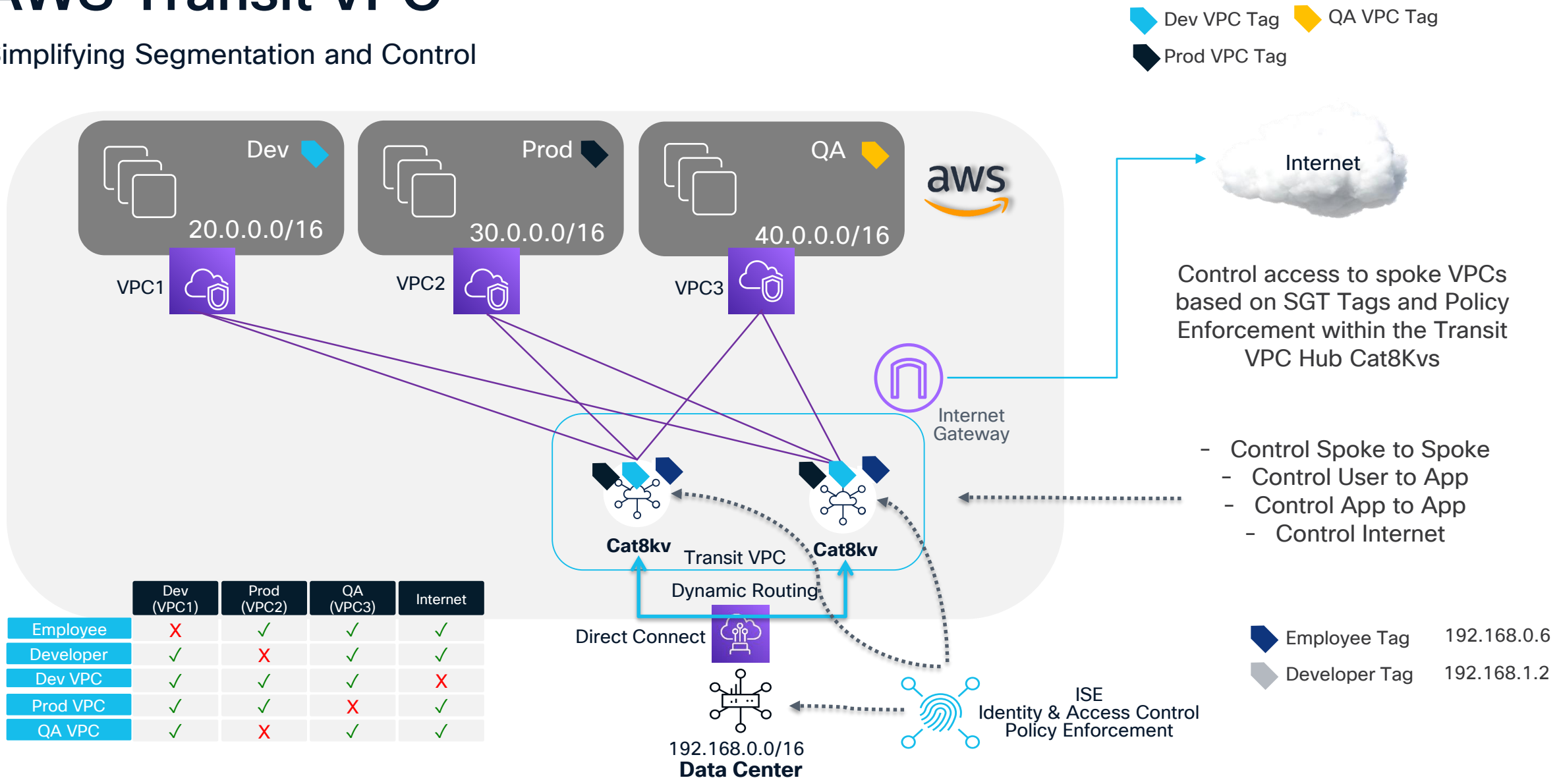
Enabling Group-based Policies



Leveraging SGTs and ISE controls on the Cat8Kv/NGFWv within the cloud transit environments.

AWS Transit VPC

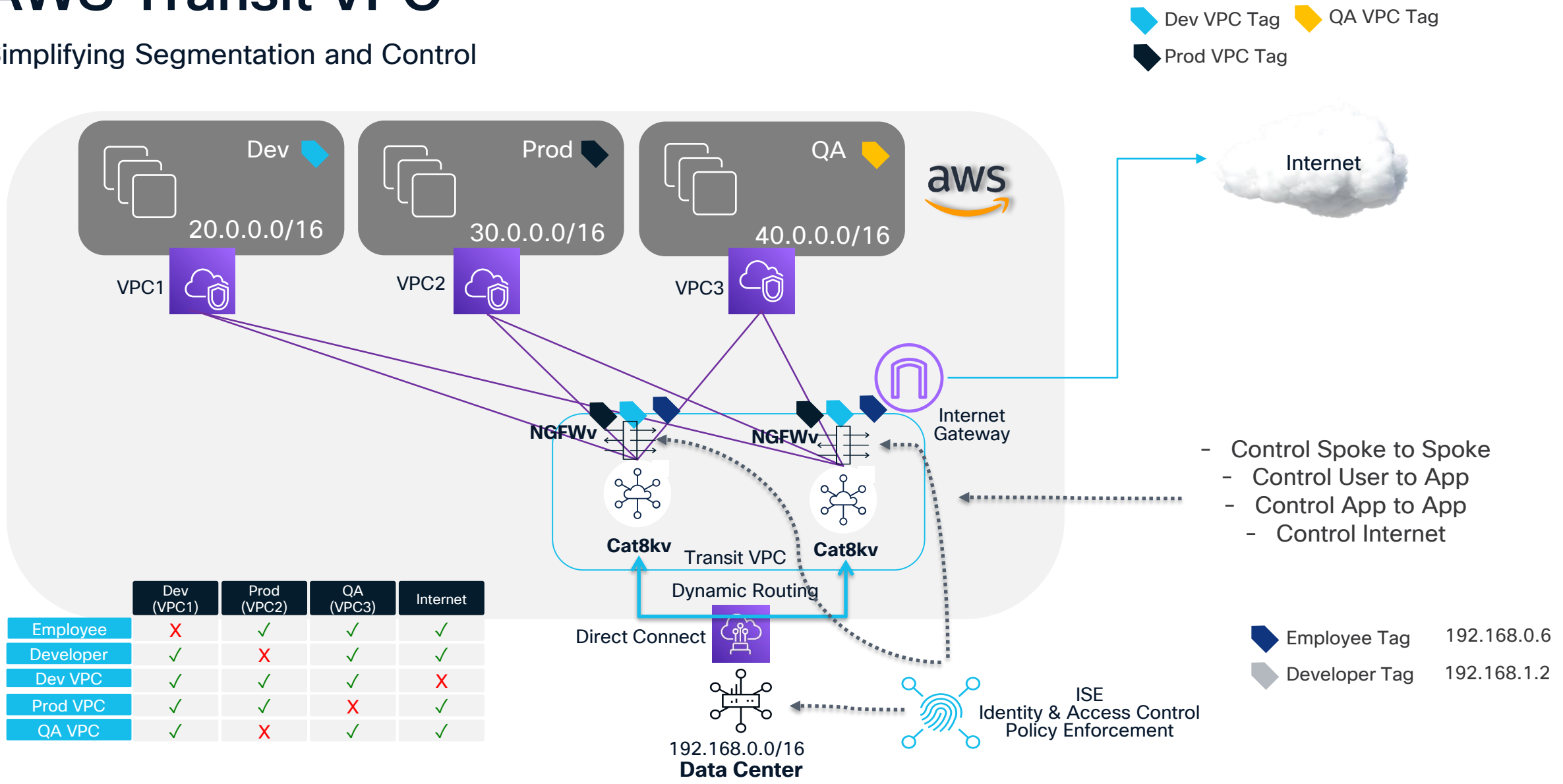
Simplifying Segmentation and Control



	Dev (VPC1)	Prod (VPC2)	QA (VPC3)	Internet
Employee	X	✓	✓	✓
Developer	✓	X	✓	✓
Dev VPC	✓	✓	✓	X
Prod VPC	✓	✓	X	✓
QA VPC	✓	X	✓	✓

AWS Transit VPC

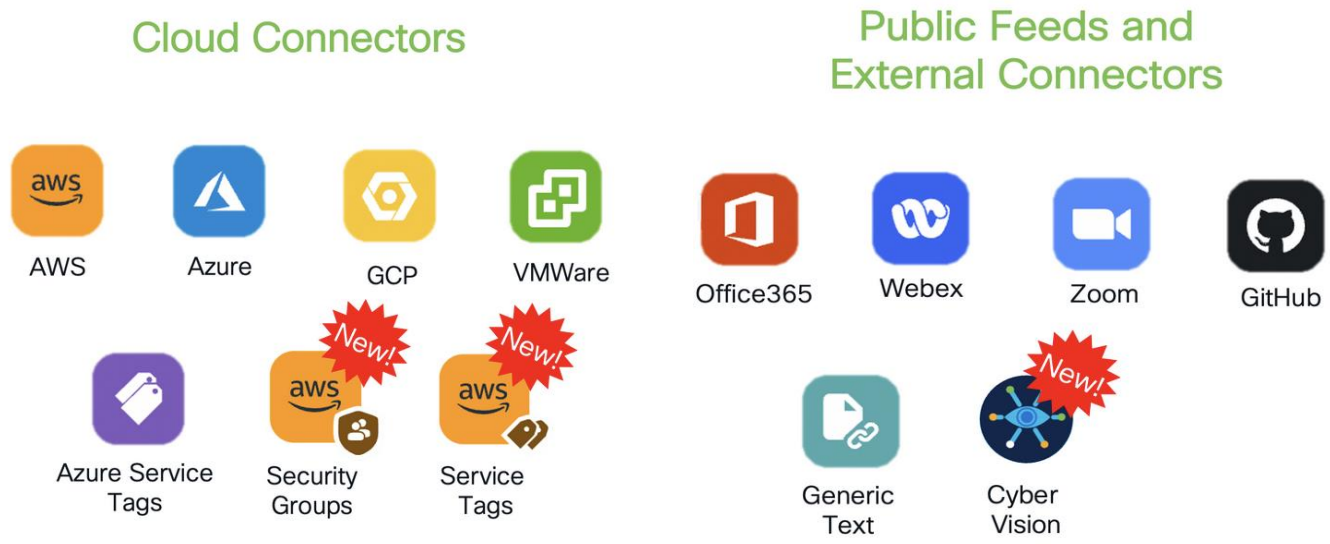
Simplifying Segmentation and Control

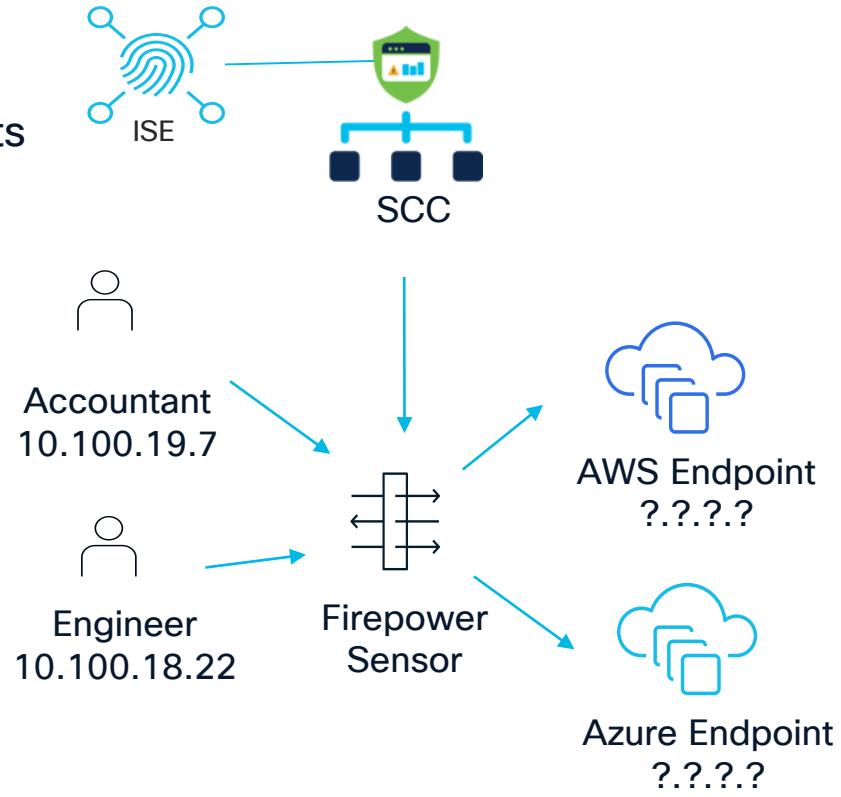


	Dev (VPC1)	Prod (VPC2)	QA (VPC3)	Internet
Employee	X	✓	✓	✓
Developer	✓	X	✓	✓
Dev VPC	✓	✓	✓	X
Prod VPC	✓	✓	X	✓
QA VPC	✓	X	✓	✓

Cisco Secure Dynamic Attributes Connector

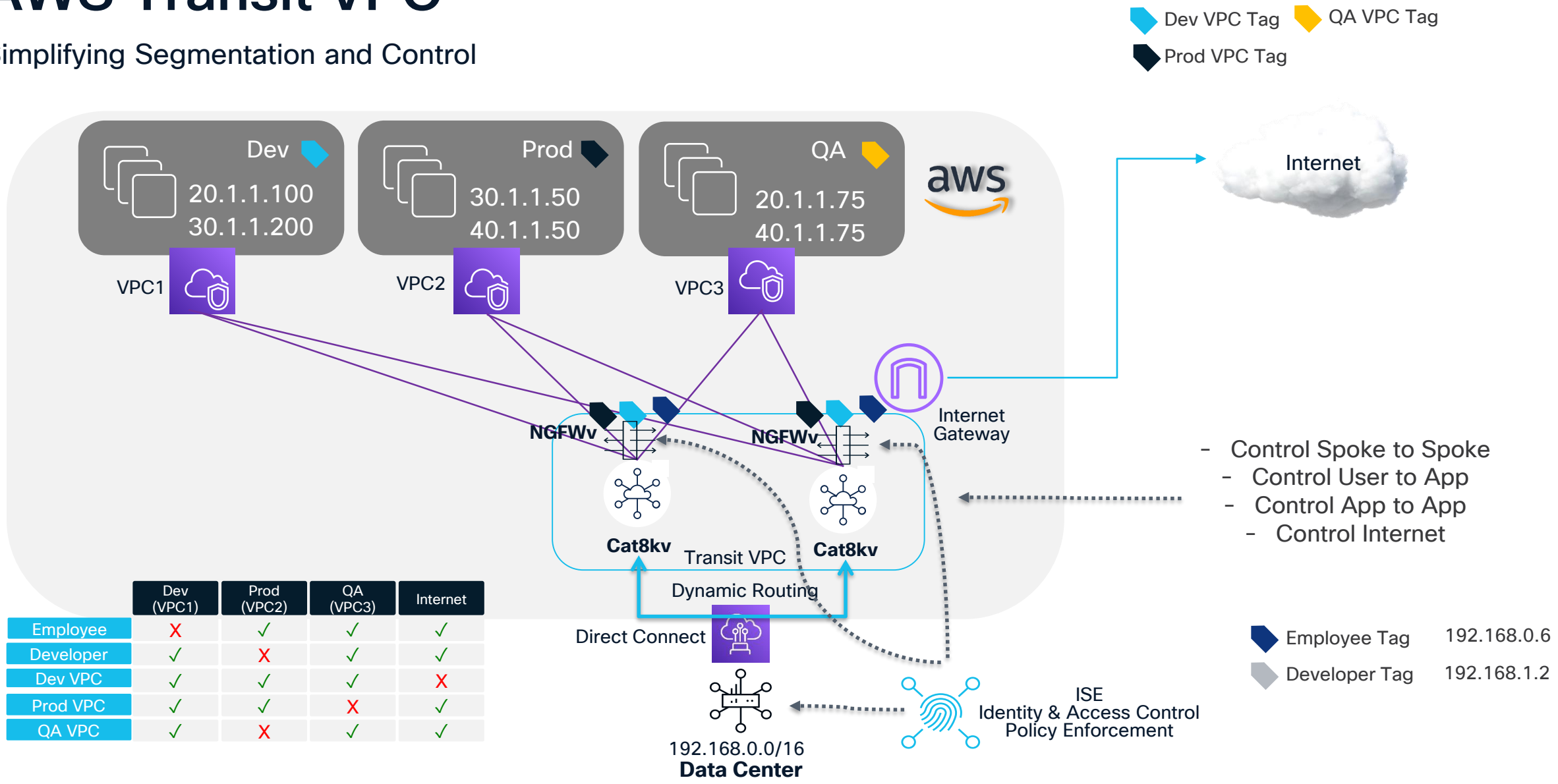
- Instead of manually defining the IP/Group mapping
- Gather attributes from dynamically changing cloud environments
- Subscribe to and pull dynamic IP feeds
- Ability to assign multiple IP addresses to multiple dynamic Firewall objects





AWS Transit VPC

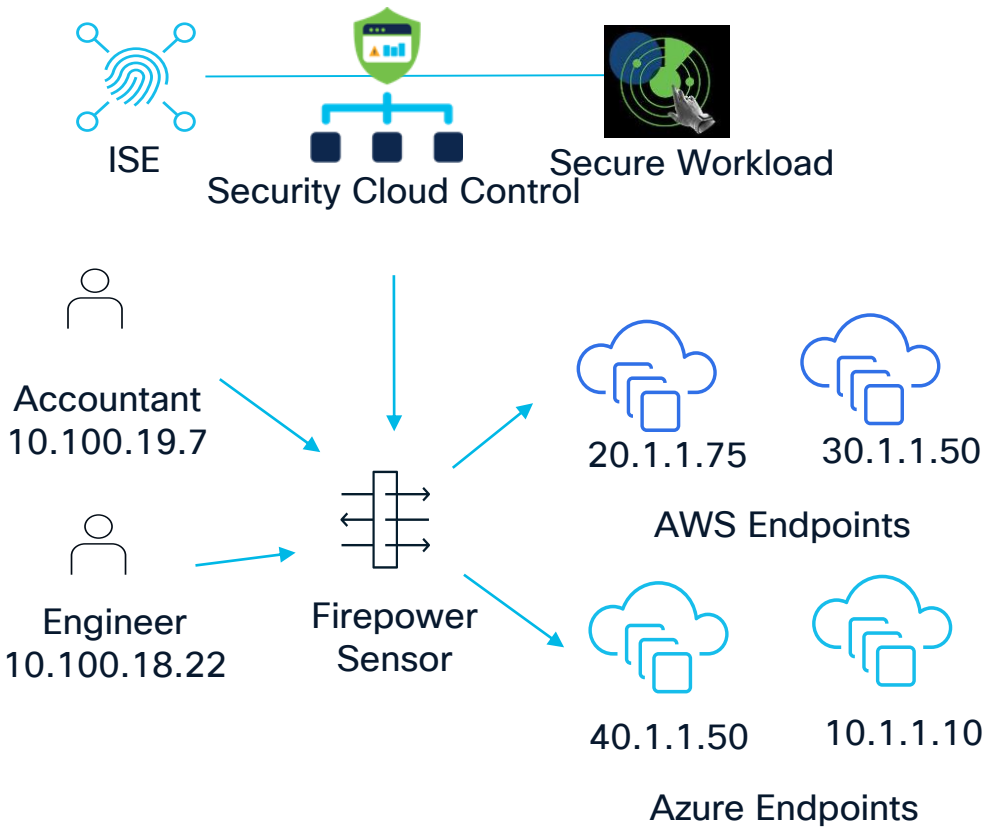
Simplifying Segmentation and Control



	Dev (VPC1)	Prod (VPC2)	QA (VPC3)	Internet
Employee	X	✓	✓	✓
Developer	✓	X	✓	✓
Dev VPC	✓	✓	✓	X
Prod VPC	✓	✓	X	✓
QA VPC	✓	X	✓	✓

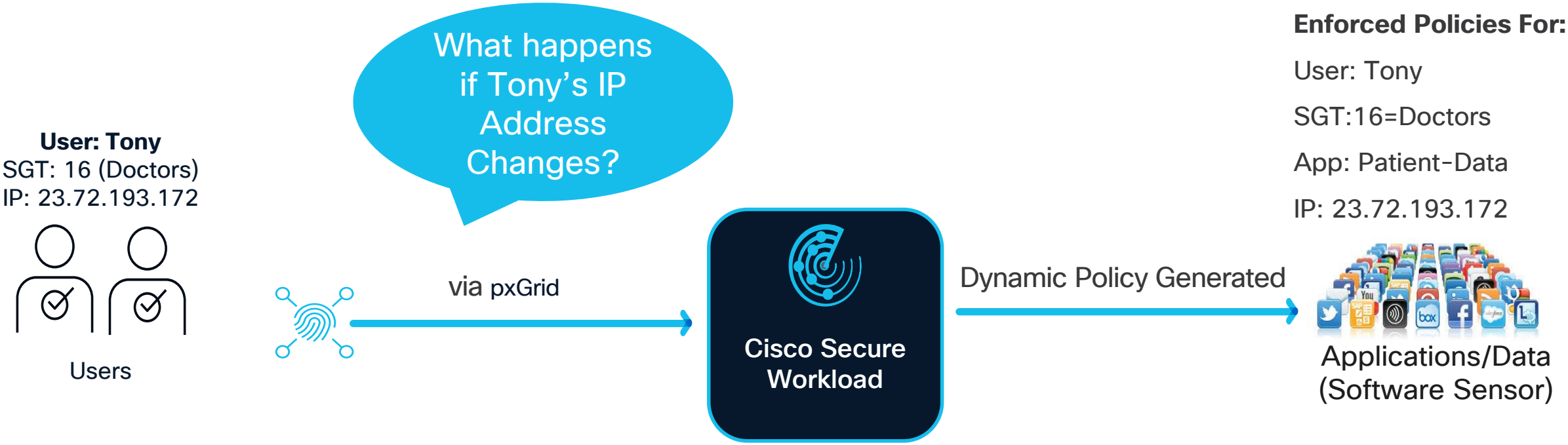
Cisco Secure Workload

- Segmentation policies enforcement at workloads
- Virtual Machines, Containers and Bare Metal
- Private and Public IaaS
- Prevent East / West lateral Movement
- Dynamic Policy
- Policy Enforcement
- Policy Visibility



Secure Workload with ISE

ISE Provides Identity to Secure Workload



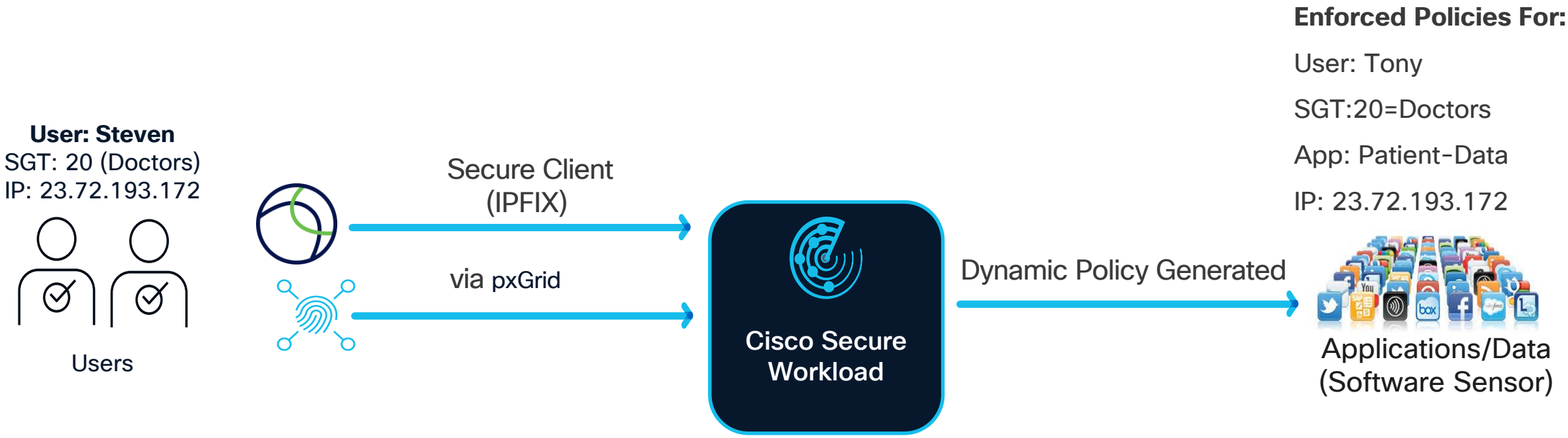
1) The sensor endpoint is sending Telemetry data
2) The endpoint also authenticates with ISE which notifies our identity repository via pxGrid.
3) Secure Workload merges the two streams and outputs dynamically generated policy.

✖ May not access employee data

✔ May access patient records

Secure Client (Any Connect)

Enterprise Policy Discovery



1) Secure Client Network Visibility Module (NVM) streams IPFIX to Secure Workload
2) The endpoint also authenticates with ISE which notifies our identity repository via pxGrid.
3) Secure Workload merges the two streams and outputs dynamically generated policy

✖ May not access employee data

✔ May access patient records

Security: In & Between the Clouds

Multicloud Defense

Personas

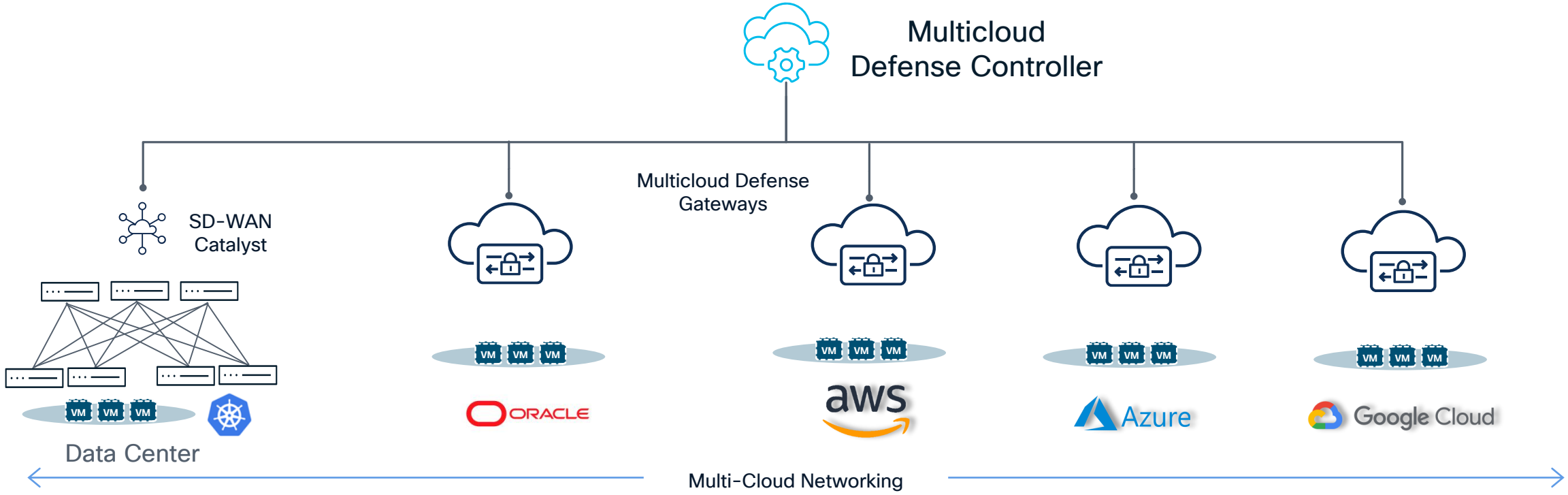
NetCloudOps
Account

CloudOps
Account

NetSecOps
Account
Ie. Firewall

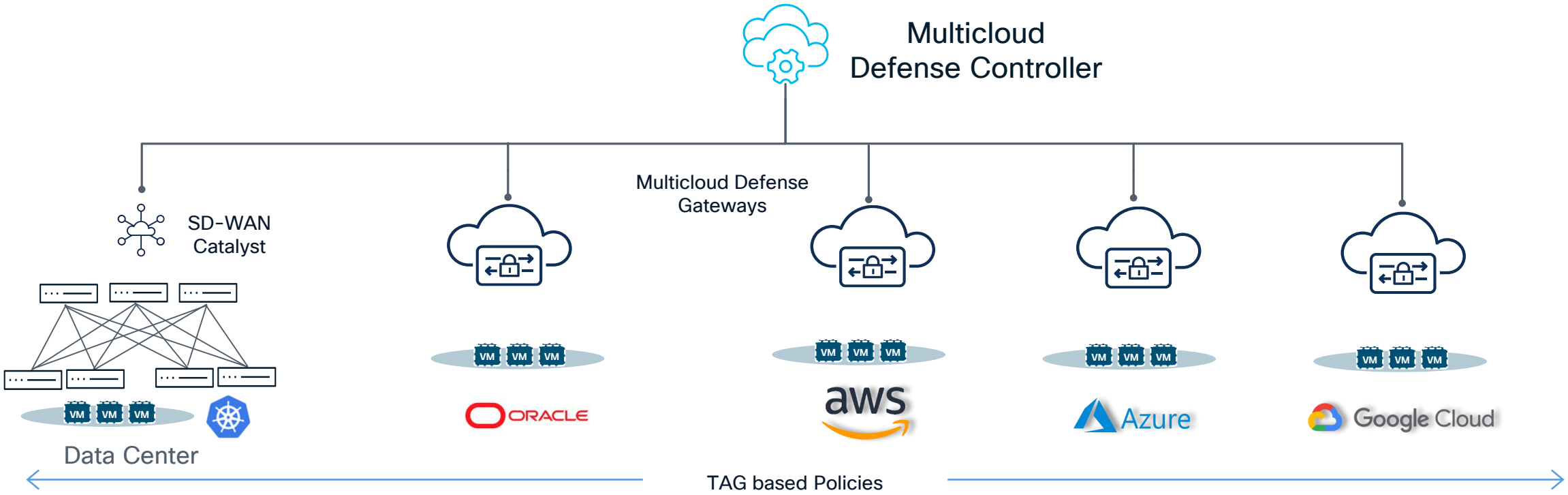
Multicloud Defense

Cloud networking, automation, and cloud-native network security controls



Dynamic Classification & Security Automation | Unified Security Policy | Segmentation (East/West) Ingress/Egress Protection | Auto-Scaling

Dynamic Unified Security Policy



Learn tags in real-time | Unified TAG-based Security Policies | Auto-Scaling

Dynamic Multicloud Policy

Construct Mappings

Multicloud Defense Gateways

Ingress Gateway

- Reverse Proxy
- TLS decrypt
- WAF – L7 DoS
- IDS / IPS
- Antivirus
- Geo IP
- Malicious IP

Egress Gateway

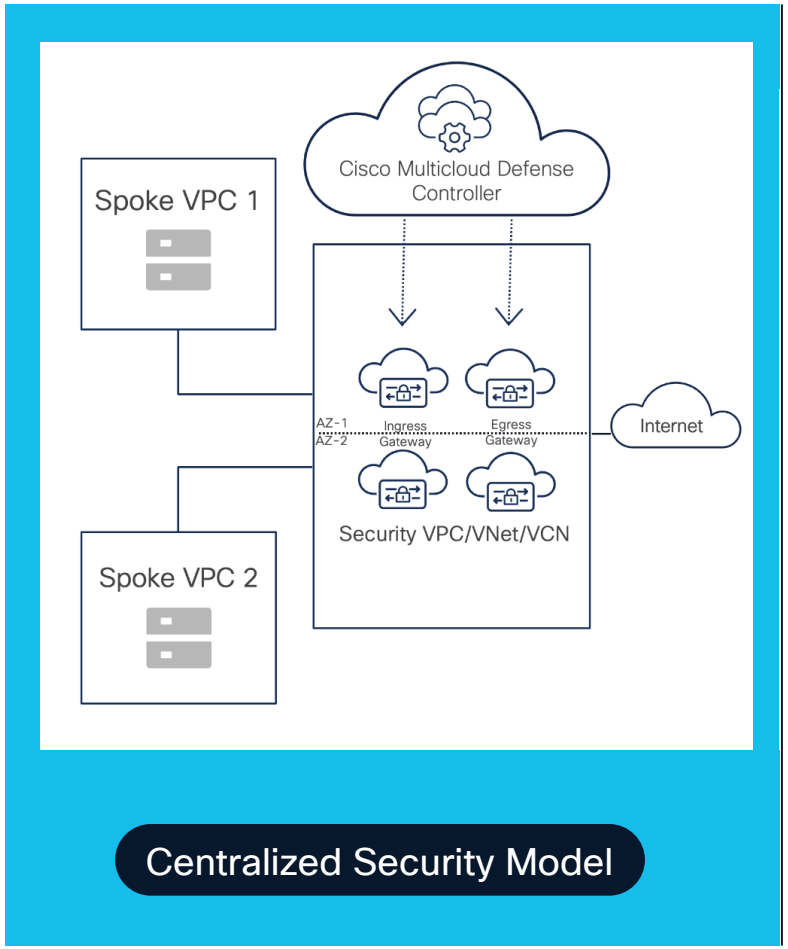
Egress

- URL filtering
- Forward proxy
- TLS decrypt
- FQDN filtering
- FQDN-based firewall policy
- DLP
- IDS / IPS
- Antivirus

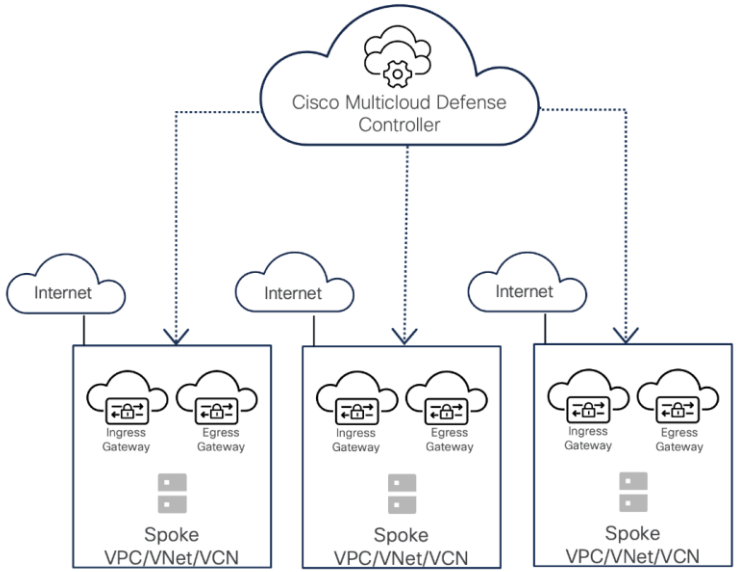
East/West

- FQDN filtering
- IPS / IDS
- Antivirus
- Segmentation
- FQDN-based firewall policy
- TLS decrypt

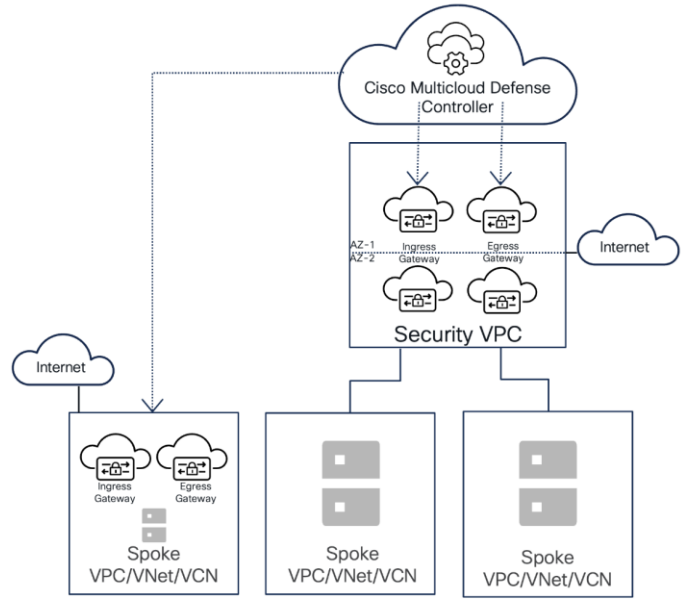
Security Models



Centralized Security Model



Distributed Security Model

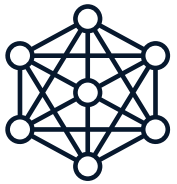


Combined Security Model

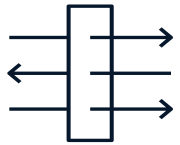
What is New?

Centralized Gateway Model

- Ability to add FTDv Gateway
- FTD Feature Set + Capabilities
- Common-Policy
- On-prem management for Cloud Security



Security Cloud Control

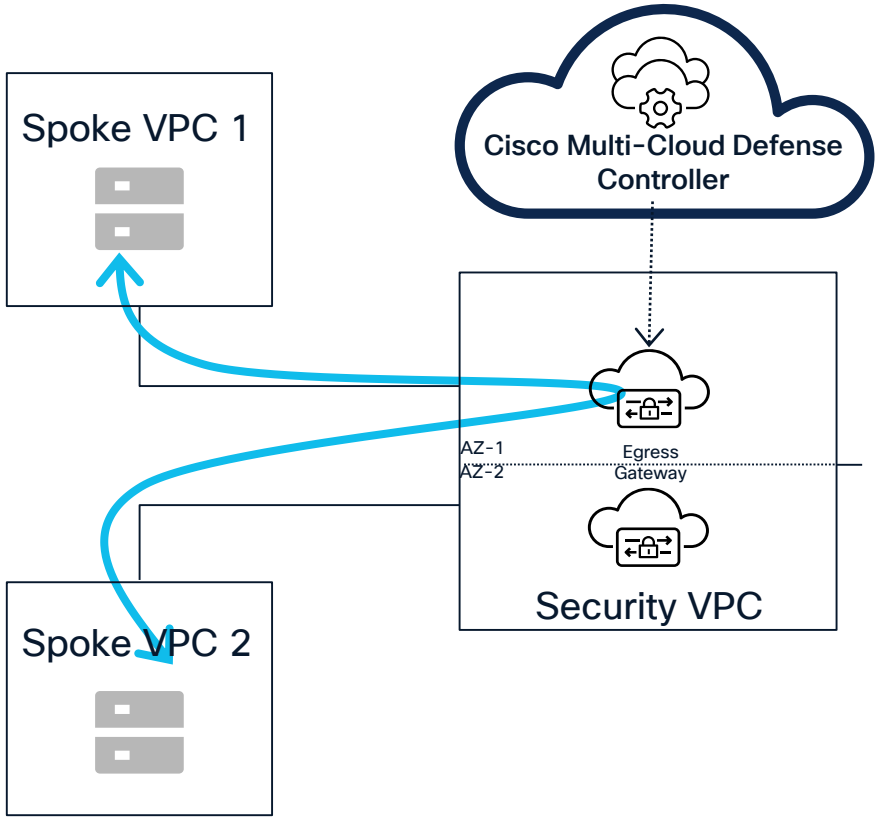


FTDv Firewall

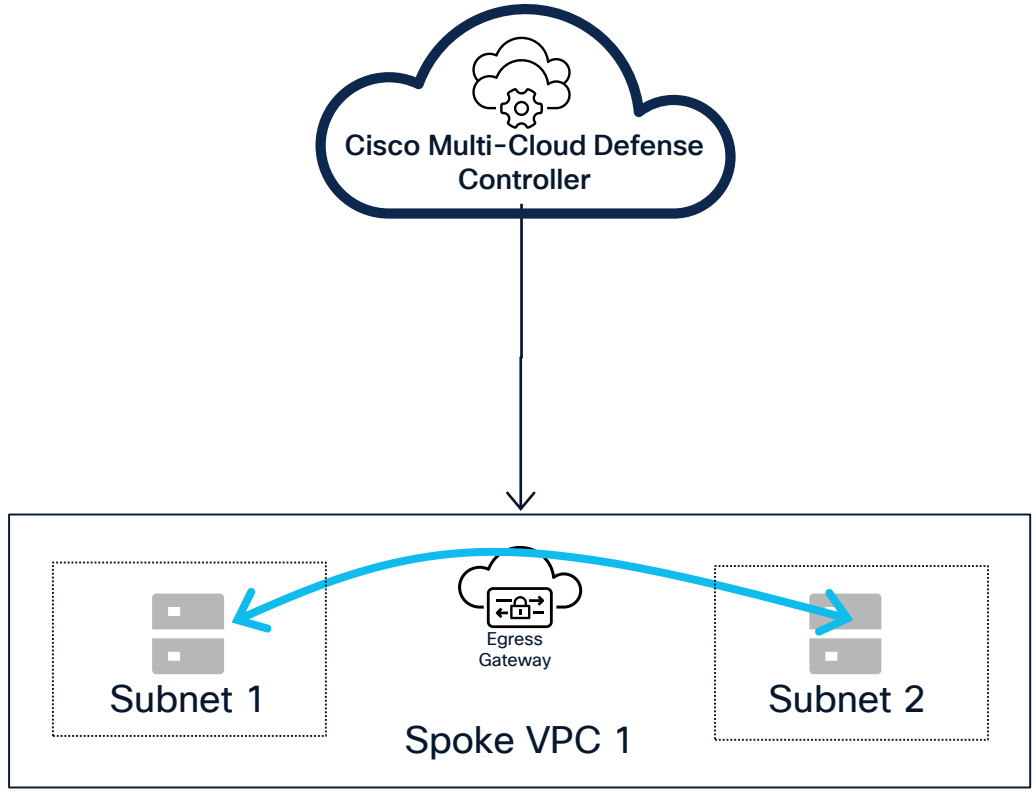
SDWAN | Secure Firewall | **Multicloud Defense** | Hypershield | Secure Workload | Secure Access | AI Defense

Segmentation

Use-case



Centralized Security Model
Inter VPC



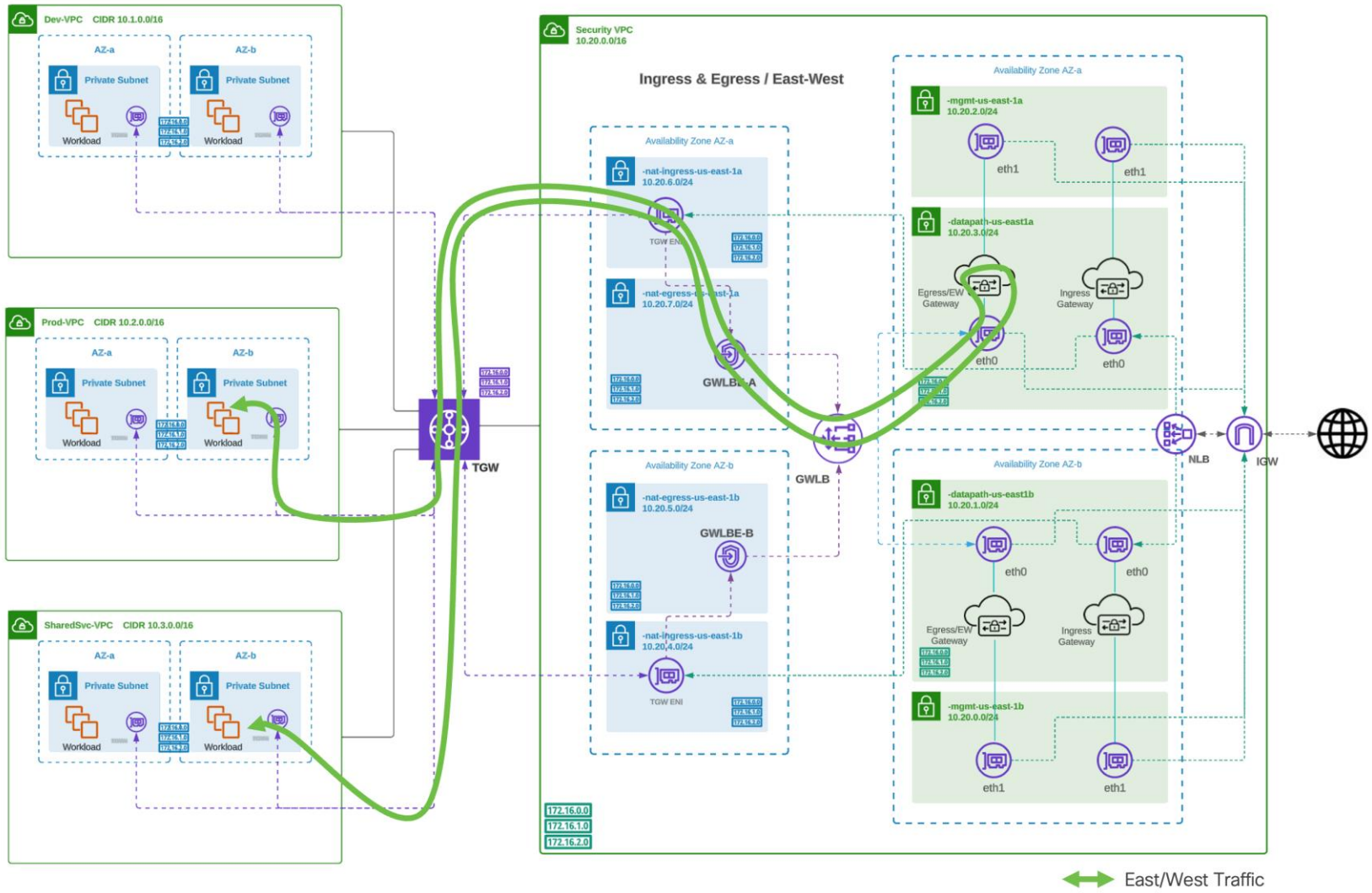
Distributed Security Model
Intra VPC

AWS Centralized

East-West Traffic Inspection (Inter-VPC)

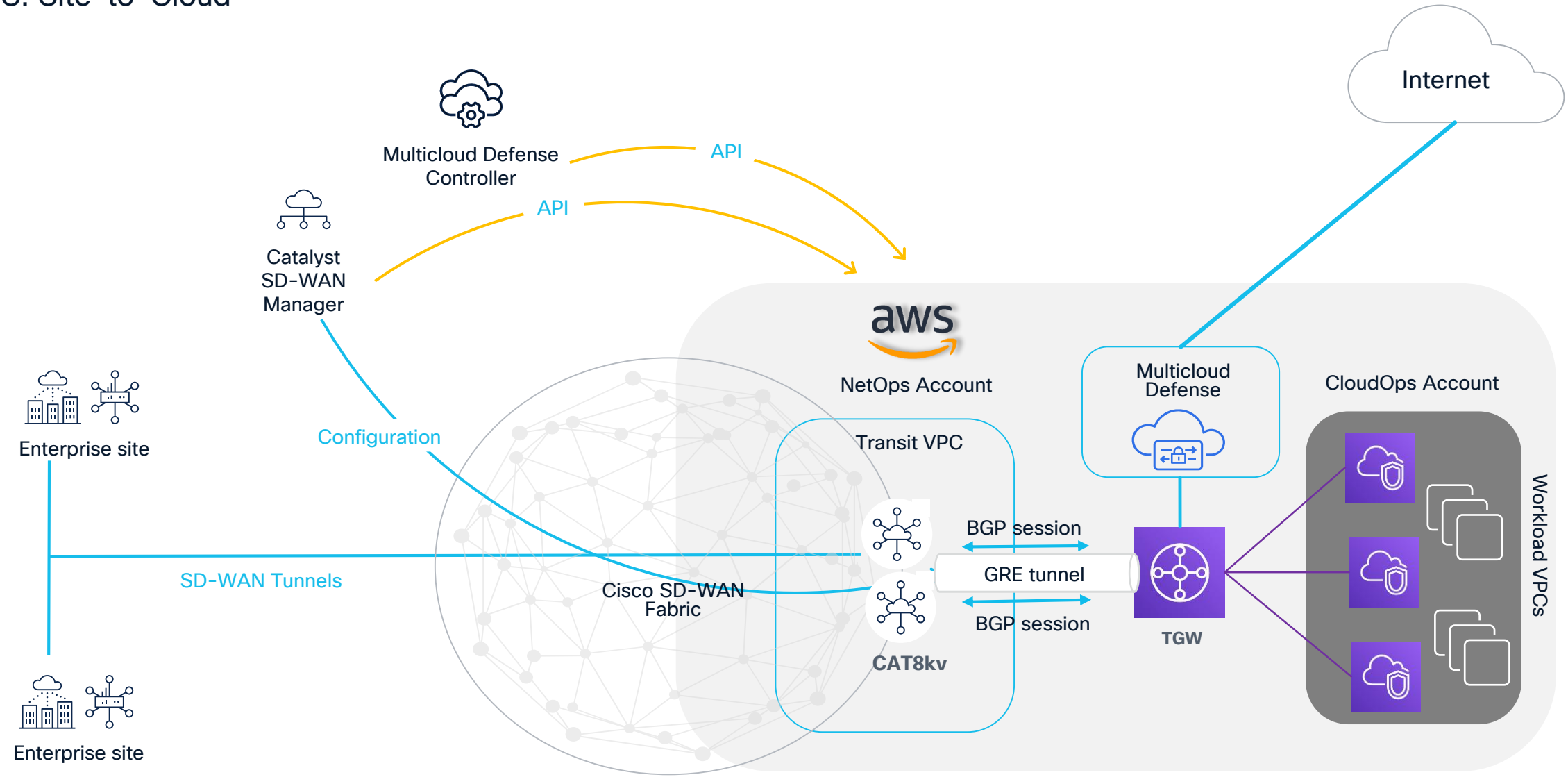
Controller simplifies orchestration

- Security VPC
- Multicloud Defense Gateways
  - Deployment
  - Insertion
  - Autoscaling
- AWS Transit Gateway
  - New or existing TGW
  - TGW attachment
- Traffic engineering (routing)
  - VPC subnet routing to TGW
- AWS Gateway Load Balancer for scalability



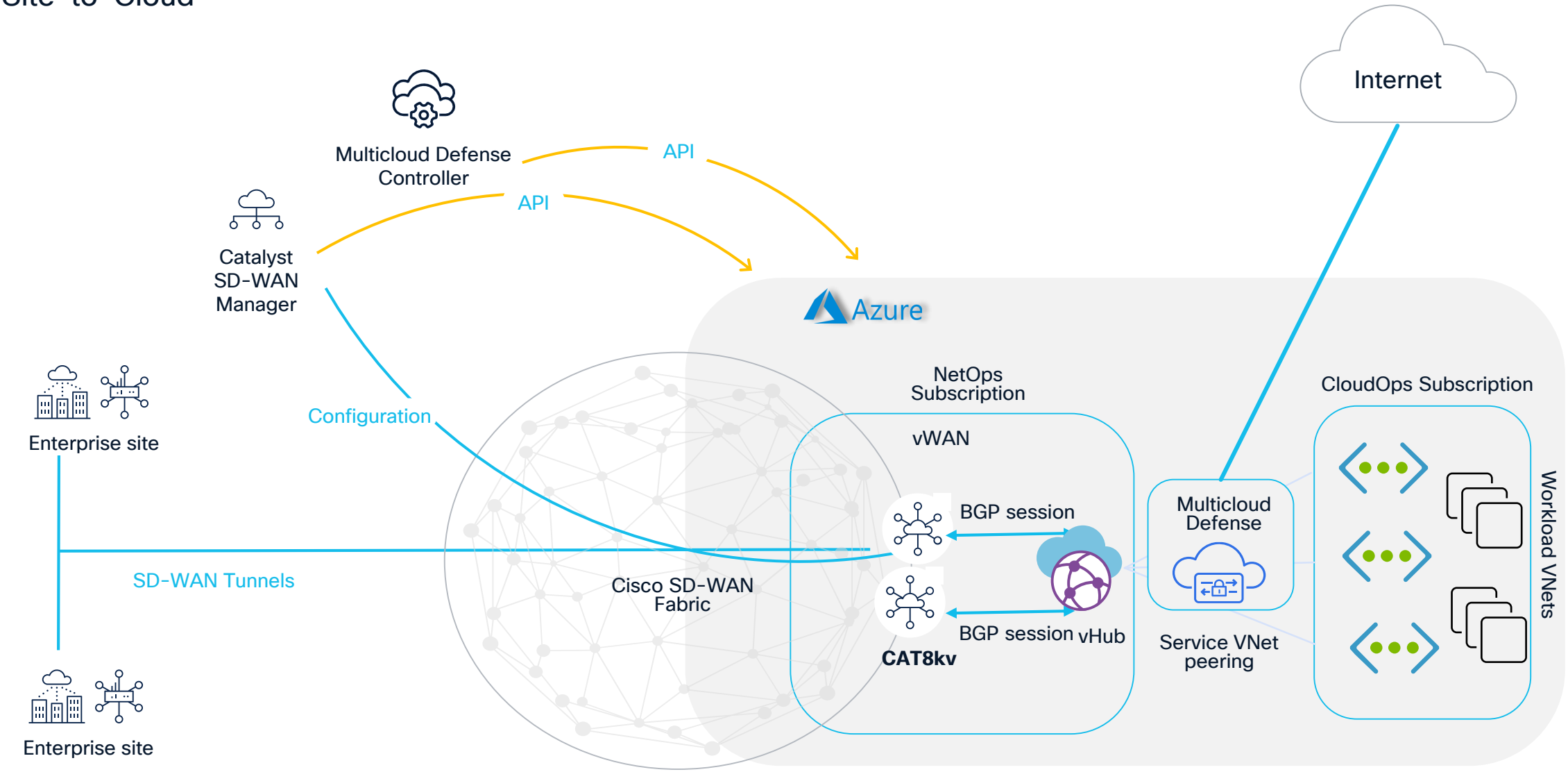
SDWAN + Multi-Cloud Defense

AWS: Site-to-Cloud

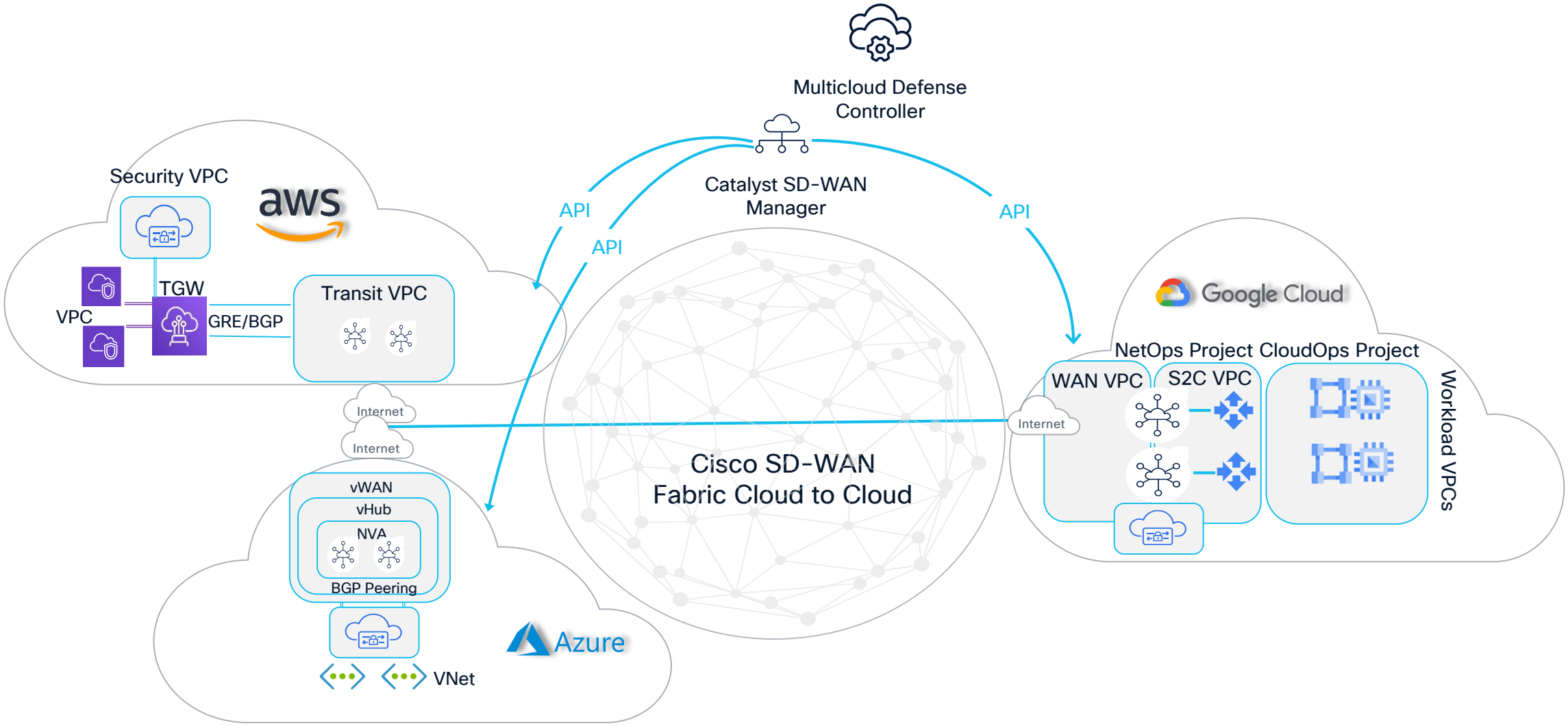


SDWAN + Multi-Cloud Defense

Azure: Site-to-Cloud

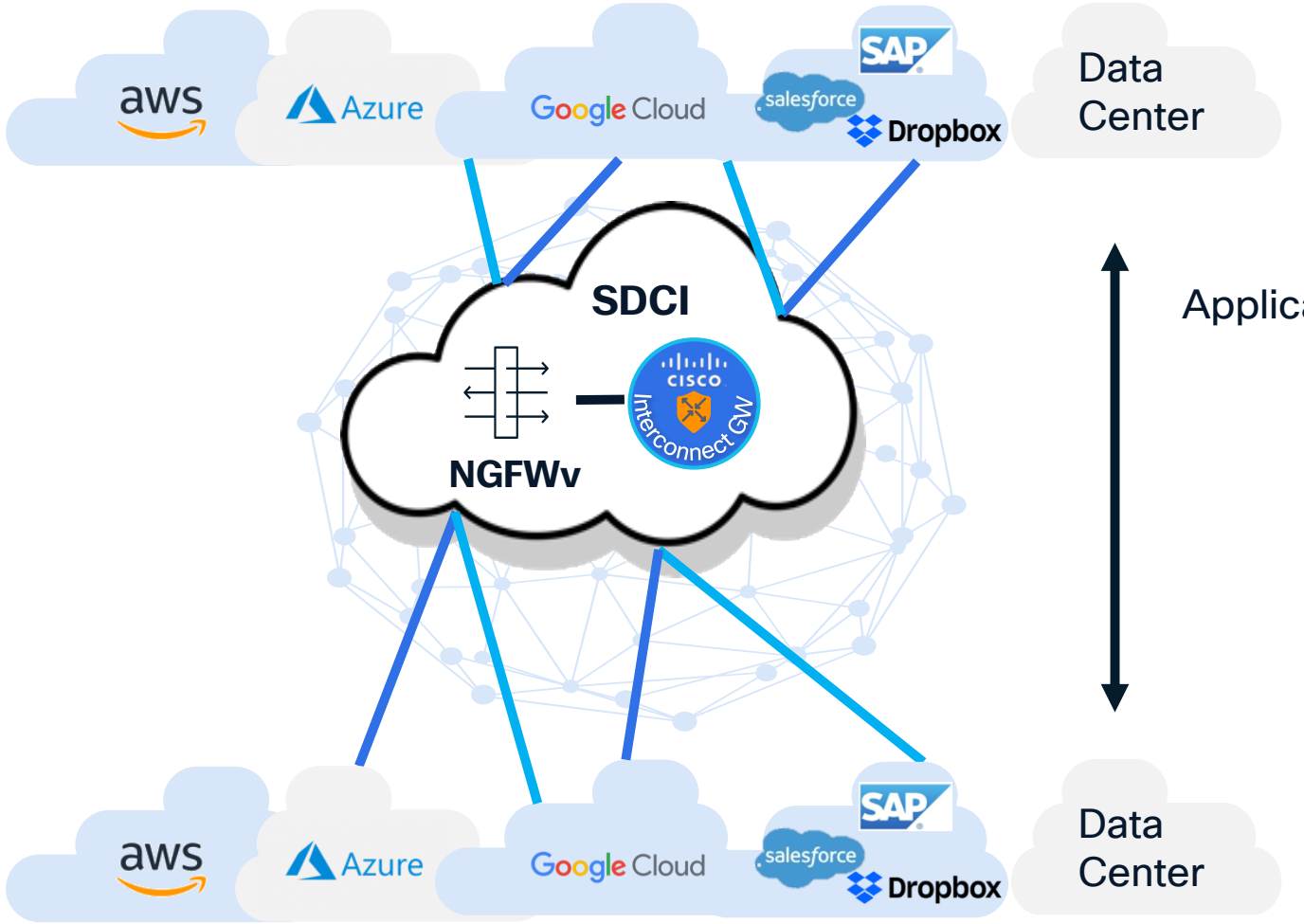


Security Stack Insertion in the Cloud



Transparently secures Application-to-Applications

SD-WAN + NGFWv + MCD



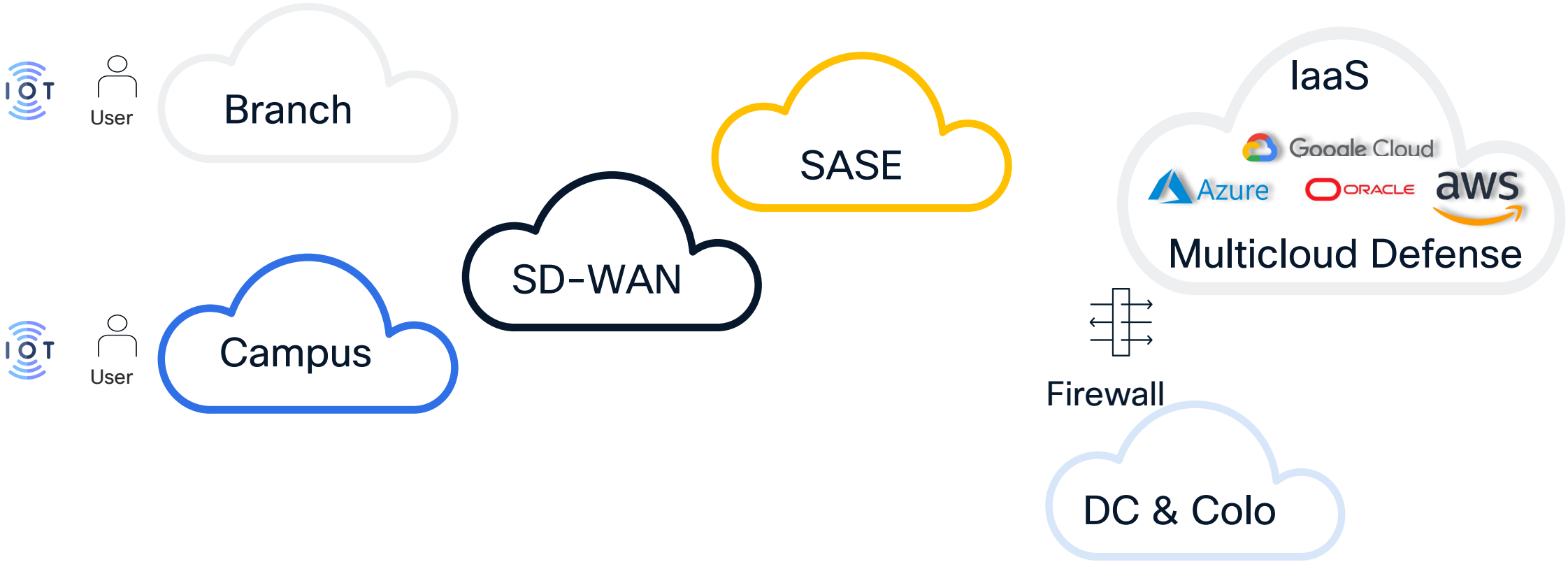
Application to Application

- Web to Database
- Auto-scaled Application
- Container Applications
- Cloud to Cloud
- Cloud to on-prem Data Center
- API to API via HTTPS

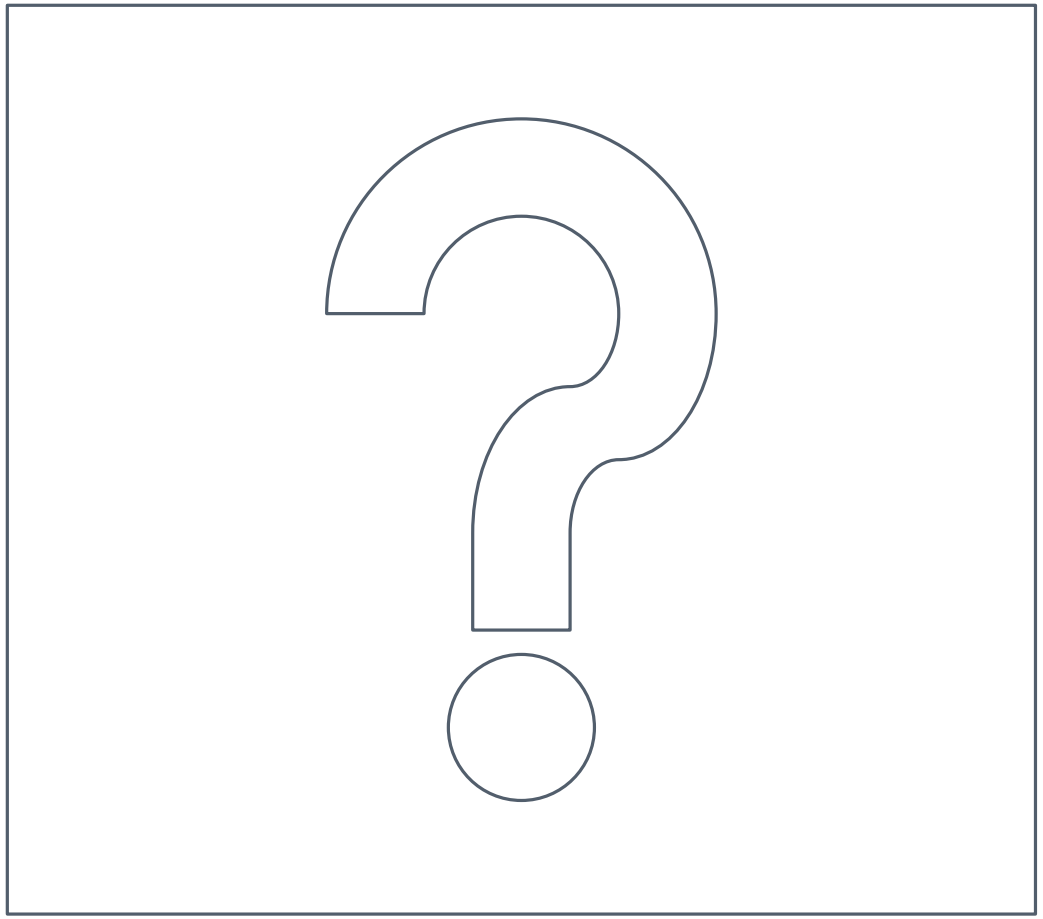
Private Transport
Public Transport

Common Policy

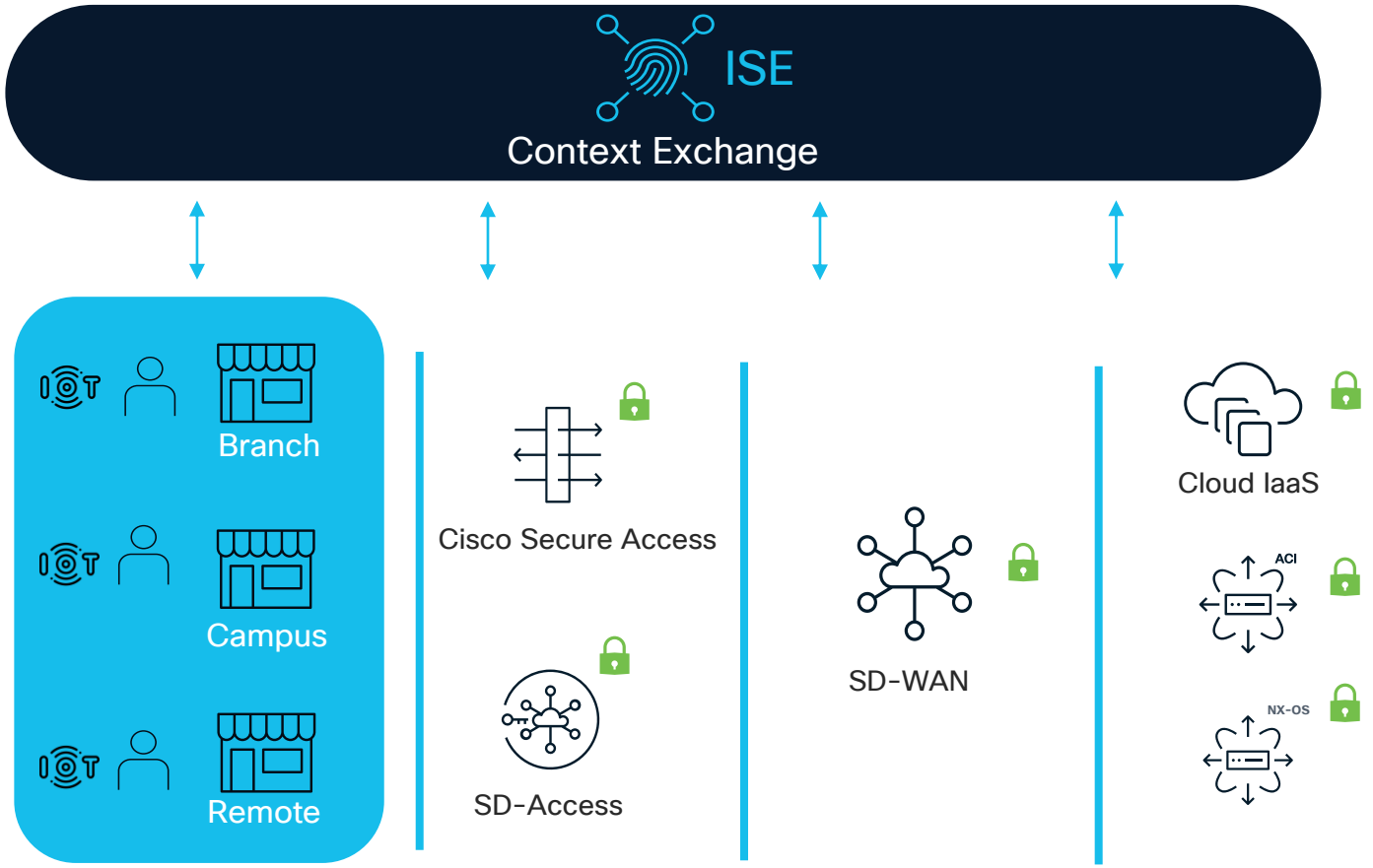
We talked about...



How do we bring all of this together?



Common Policy



Policy Enforcement Points:
Consistent Policies

Build context in its local domain and store it as standard security group tags (SGT).

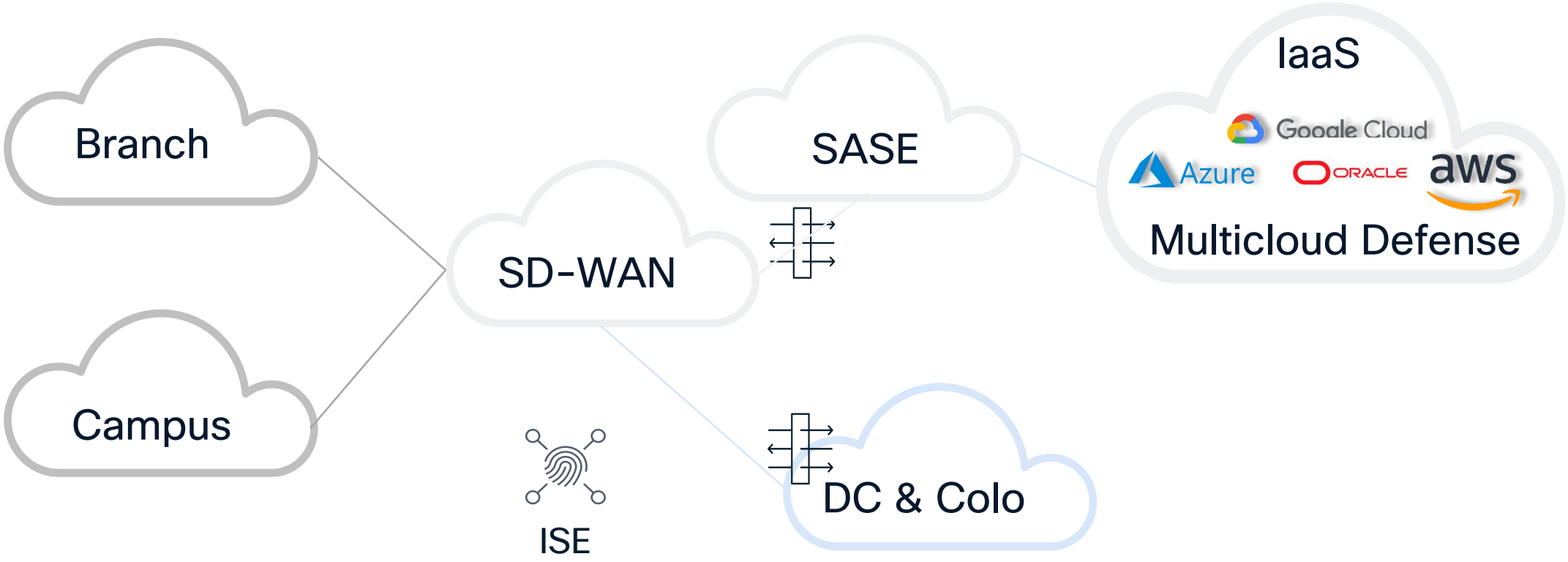
Share context everywhere, across networking and security domains.

Enforce consistent SGT-based policies; enable simple and unified policy experience.

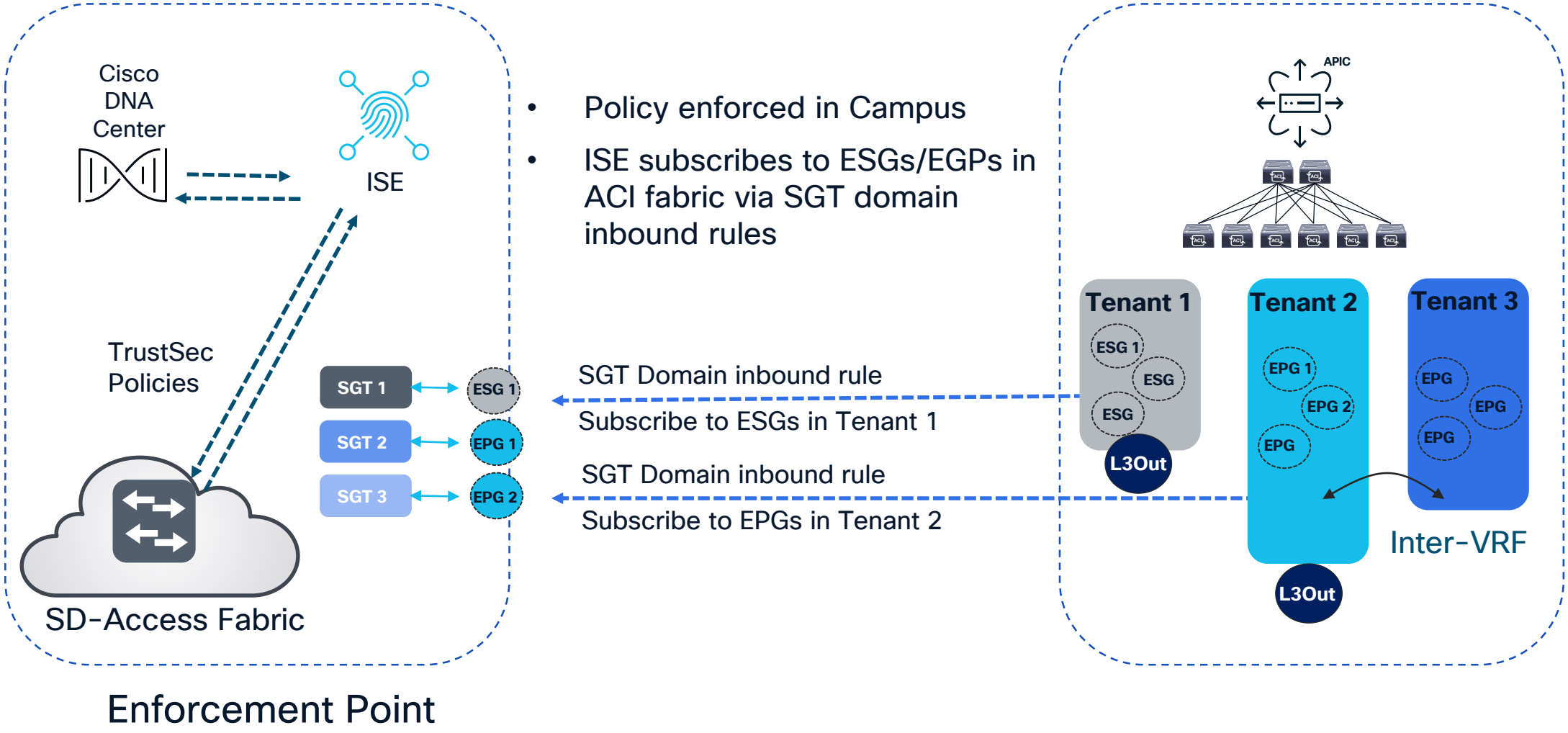
- Context-aware policies for on-prem app and cloud workloads for multiple enforcement points
  - Leveraging existing investments in ISE, Catalyst & Nexus Switching & Catalyst Center

Common Policy

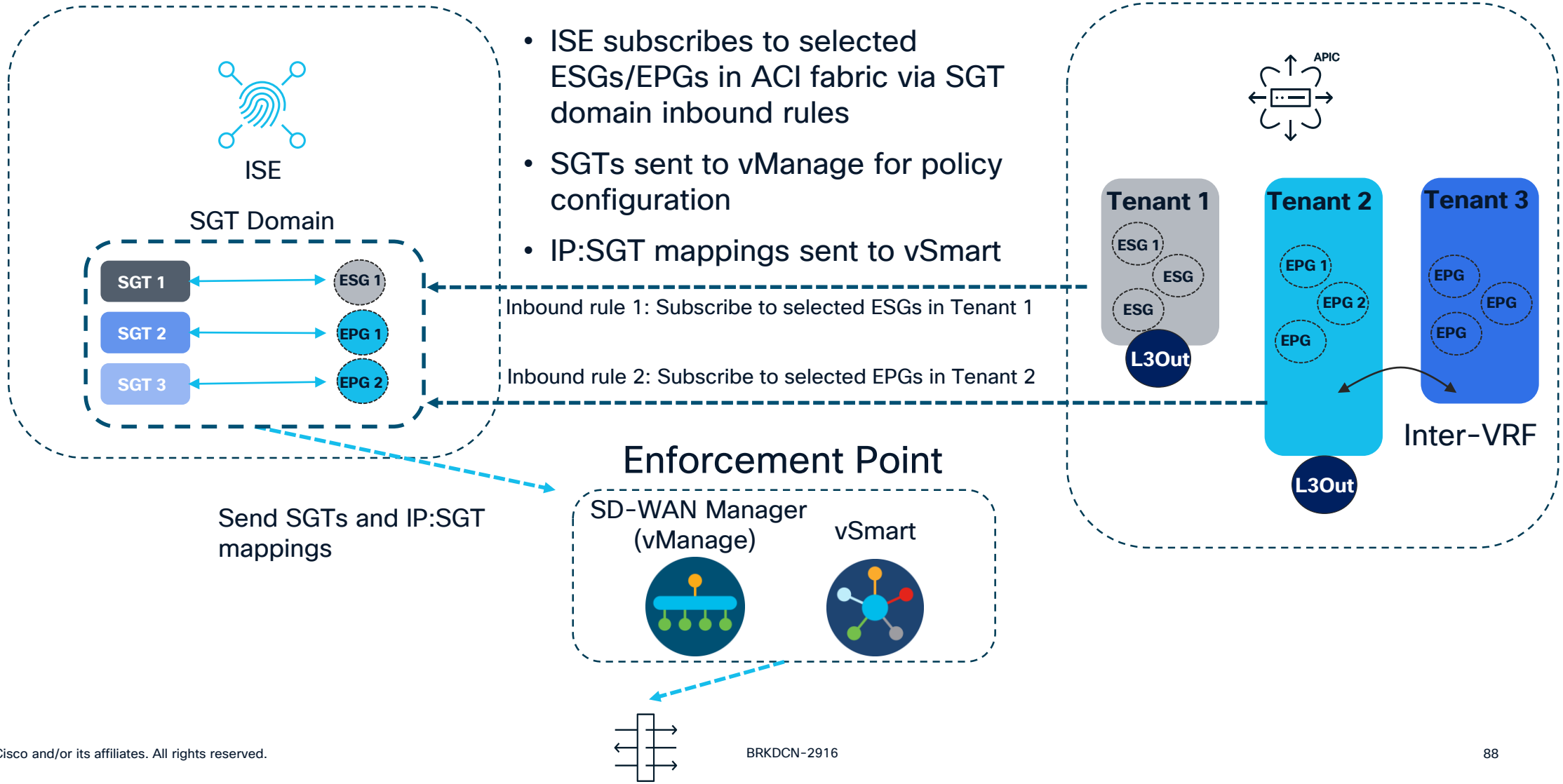
Use Cases



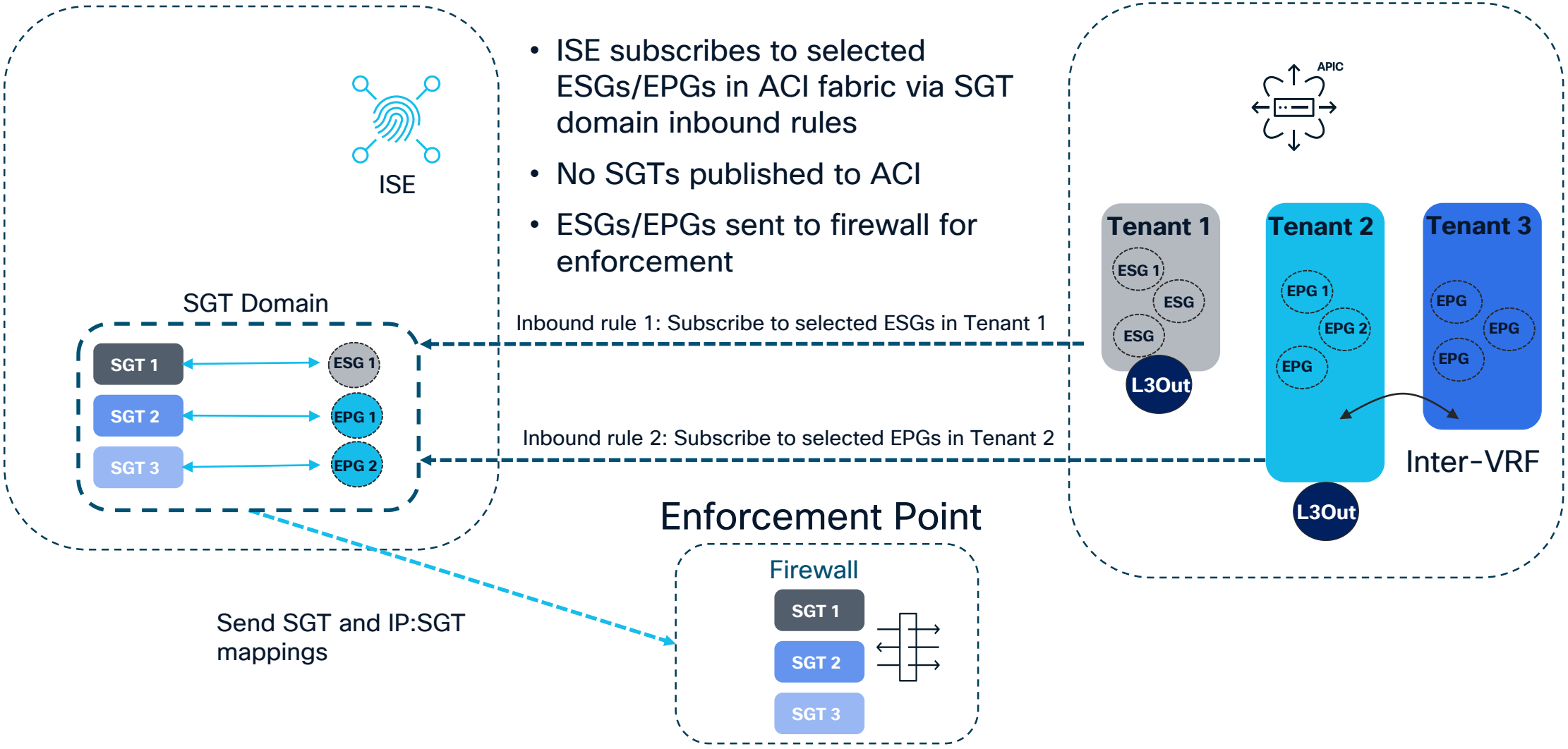
Use Case: Policy Enforcement in Campus



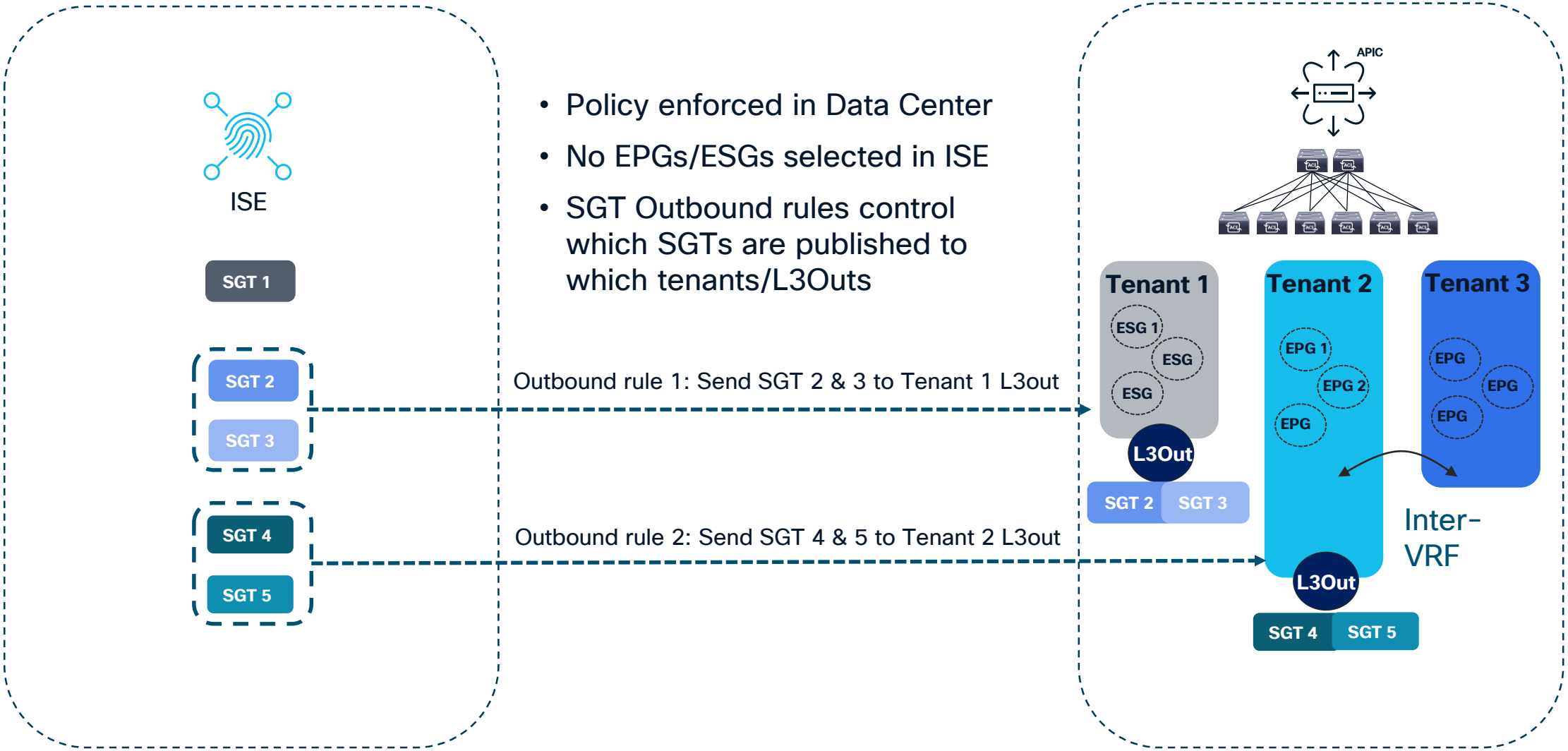
Use Case: Policy Enforcement in SD-WAN



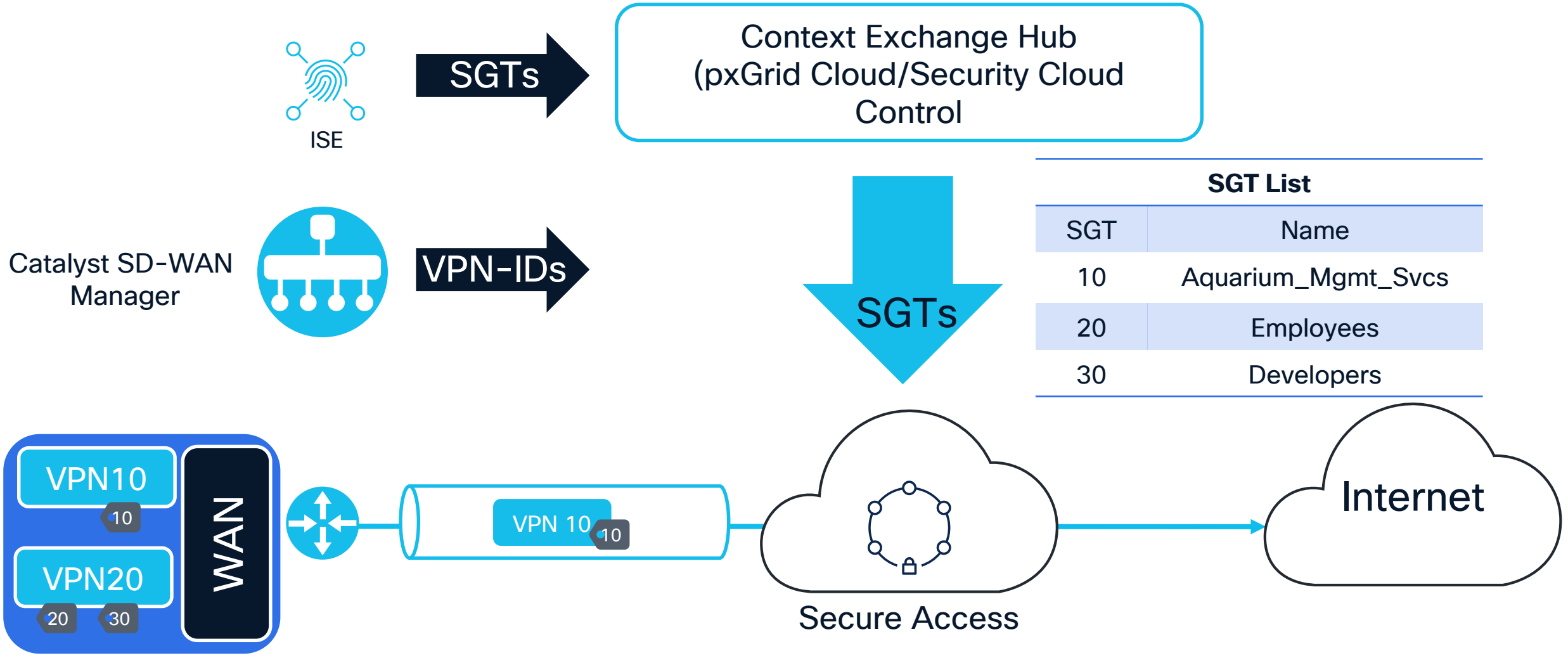
Use Case: Policy Enforcement in Firewall



Use Case: Policy Enforcement in Data Center



ISE / SD-WAN / Secure Access Integration

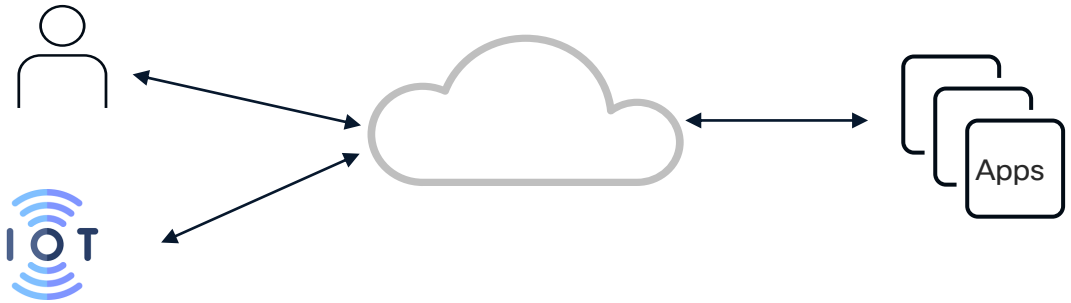


Common Policy

Bringing it all together

Micro-Segmentation

- VXLAN GPO allows the user to define policies for micro-segmentation.



Service Chaining

- VXLAN GPO can be used to insert network services into a packet flow based on specific policy criteria.

Inside each use case is the ability to apply policy for Micro-Segmentation and/or Service-Chaining

Hybrid ZTNA

Devices

Users

Things

Application
(CASB/HTTPS)

Network
(NGFW/IPS)

webex by CISCO
salesforce
Office 365

aws

Google Cloud

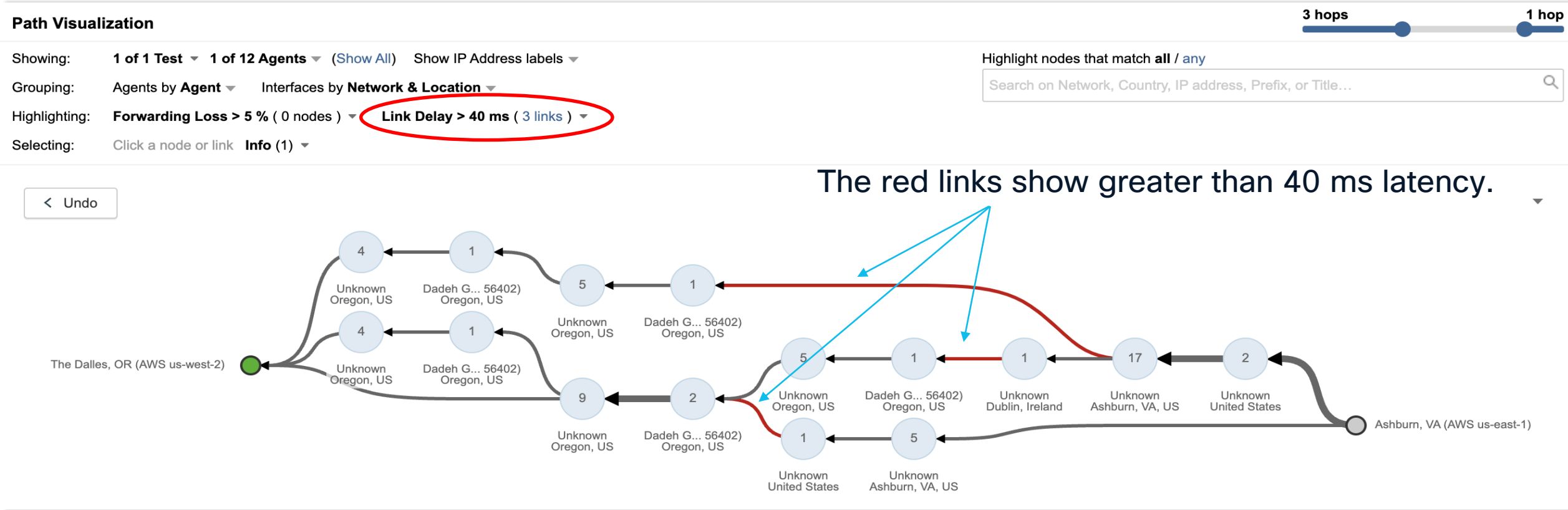
Azure

Data Center

Visibility

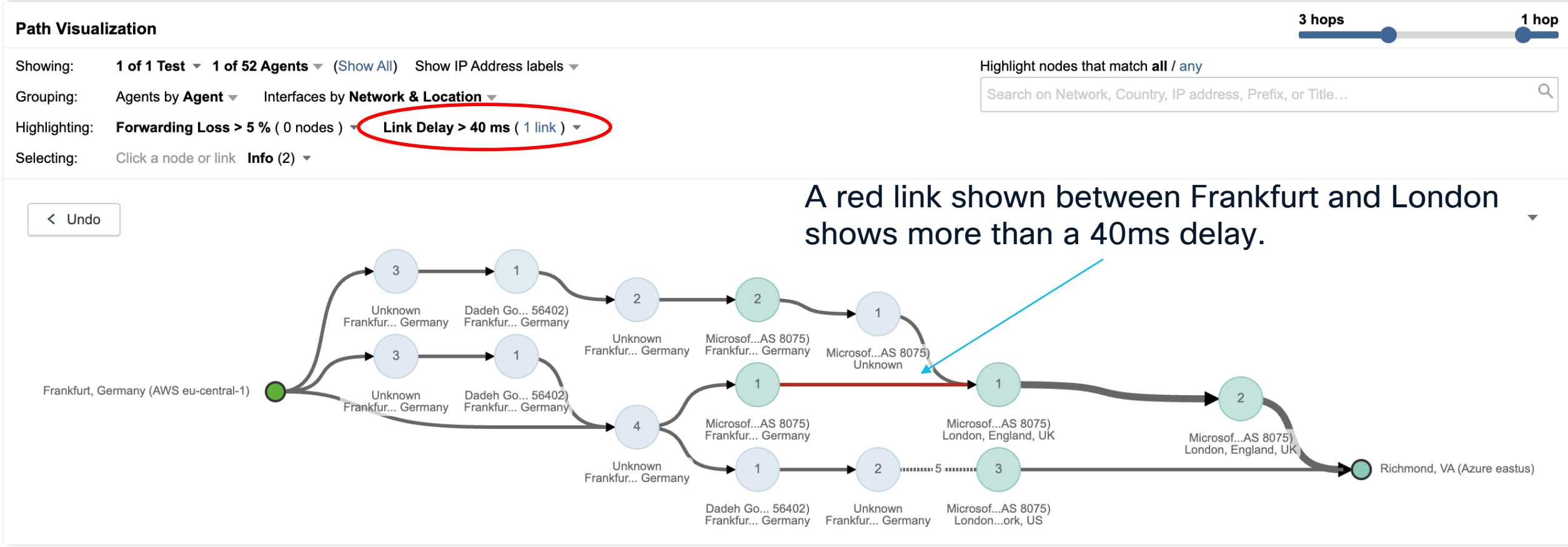
Visibility: AWS Inter Region

Thousand Eyes: Dallas, TX to Ashburn, VA



Visibility: AWS/Azure Inter Cloud

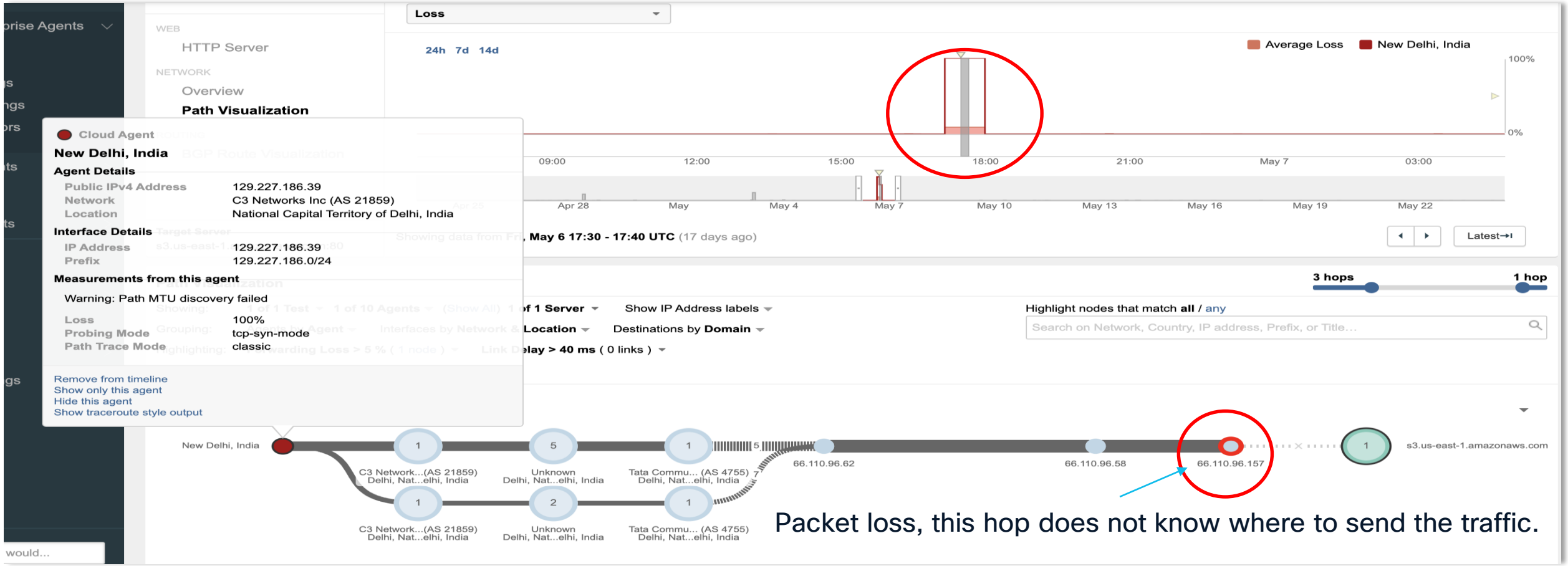
Thousand Eyes – Frankfurt, Germany AWS to Richmond, VA US Azure



- Provider-to-provider path analysis w/ direct peering relationships.
- Traffic from AWS through an intermediate provider but still gets on the Azure backbone before leaving Frankfurt

Visibility: AWS/Azure Inter Cloud

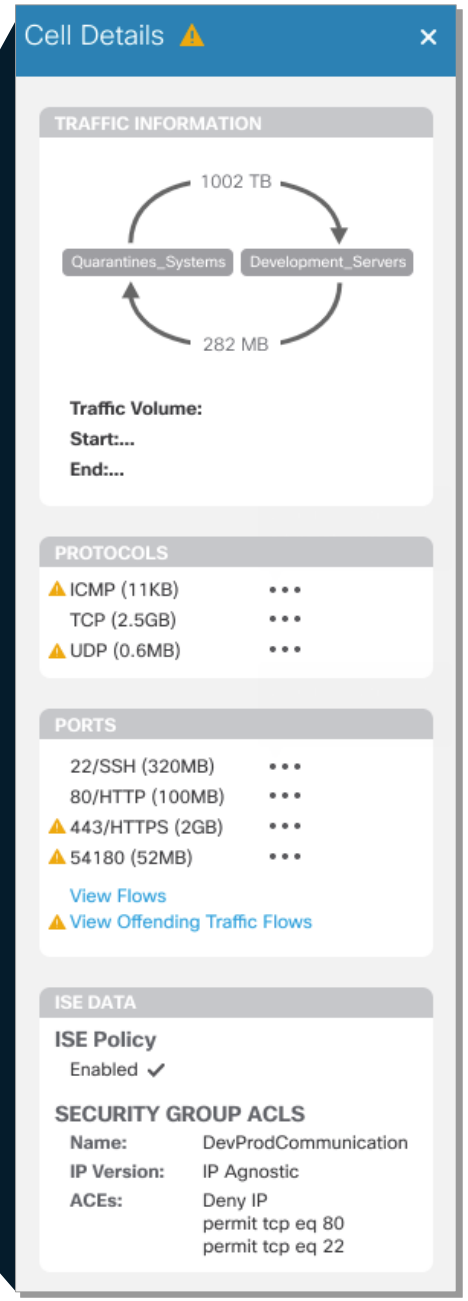
Thousand Eyes – End user perspective from New Delhi to S3 Service



Depicted above is the loss of service, source of loss and time of outage.

Secure Network Analytics

Trusted ISE Policy – Near Real Time Network Telemetry



Digital Resilience

1 **Foundational Visibility**

2 **Guided Insights**

3 **Proactive Response**

Digital Resilience: Proactive intelligence, predictive recommendations, and automated remediation for Infrastructure, Security and Applications.

Finally, what About Infrastructure as Code?

https://registry.terraform.io/namespaces/CiscoDevNet

https://galaxy.ansible.com/cisco

Summary

Outcomes

1. As users / devices / things / applications and data are everywhere; common policy simplifies and automates for the customers Enterprise
2. Security Cloud Control extend security perimeter and enforcement
3. Common Policy to simplify policies for users / devices / things + on-prem app and cloud workloads for multiple enforcement points
4. Digital resilience allows security detections, investigations and remediation to become much faster; reducing the customer impact

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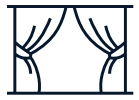
Earn 100 points per survey completed and compete on the Cisco Live Challenge leaderboard.

Level up and earn exclusive prizes!

Complete your surveys in the Cisco Live mobile app.

Continue your education



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