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Cloud and DC Architecture Evolution for Service Providers

BRKSPS-2640

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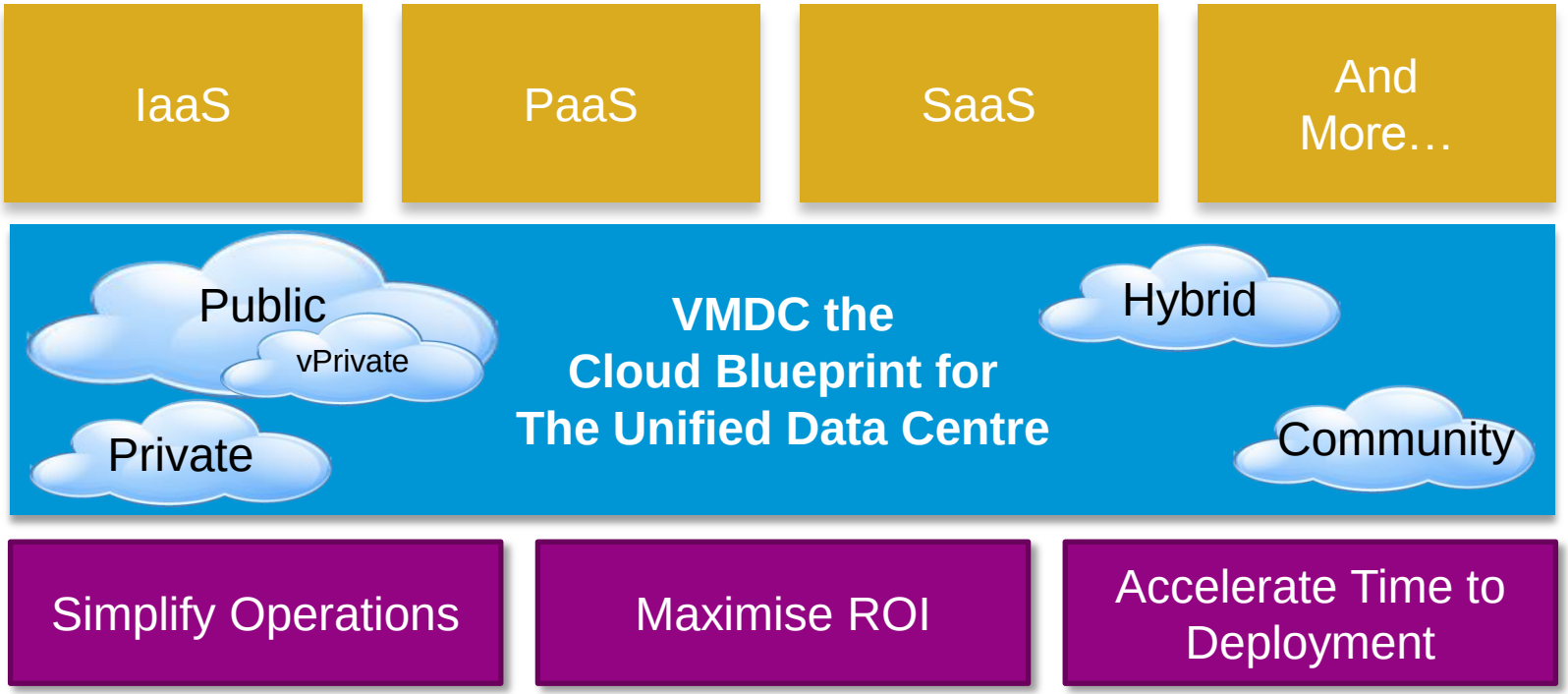
Agenda

- Traditional SP DC Architecture – VMDC
- Transition to Virtual Services Architecture
  - What is it and what are the advantages ?
  - CSR1000v and Use Cases
  - Cisco InterCloud – Hybrid Cloud Enabler
  - Cloud Orchestration Framework
- SDN / NfV in Multi-tenanted SP DC
  - Enabling Technologies and Elements (vPE and ESC)
  - Combining the benefits of DC and WAN
- Conclusion

Traditional SP DC Architecture

VMDC – Cloud Blueprint for the Unified Data Centre

Foundation for Cloud Applications and Services

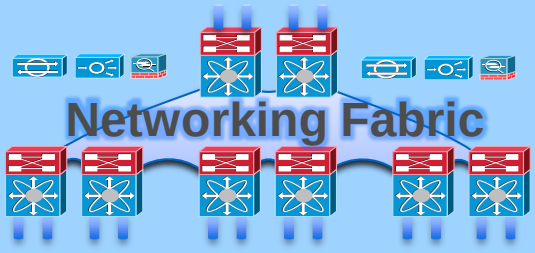


Virtualised Multiservice Data Centre

Inter-Data Centre Networking

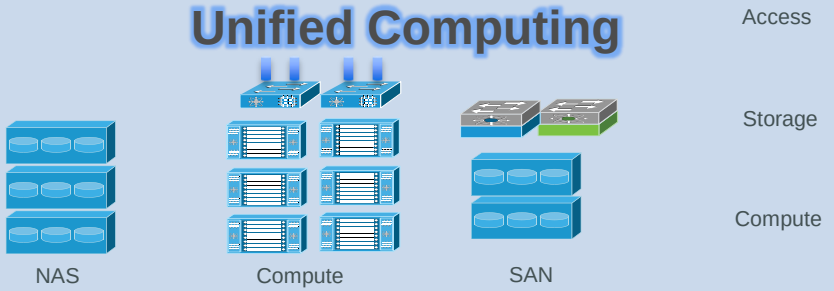
Unified Fabric and Data Centre Networking

Providing Network and Services Virtualisation



Unified Computing and Integrated Systems

Providing Server and Application Virtualisation

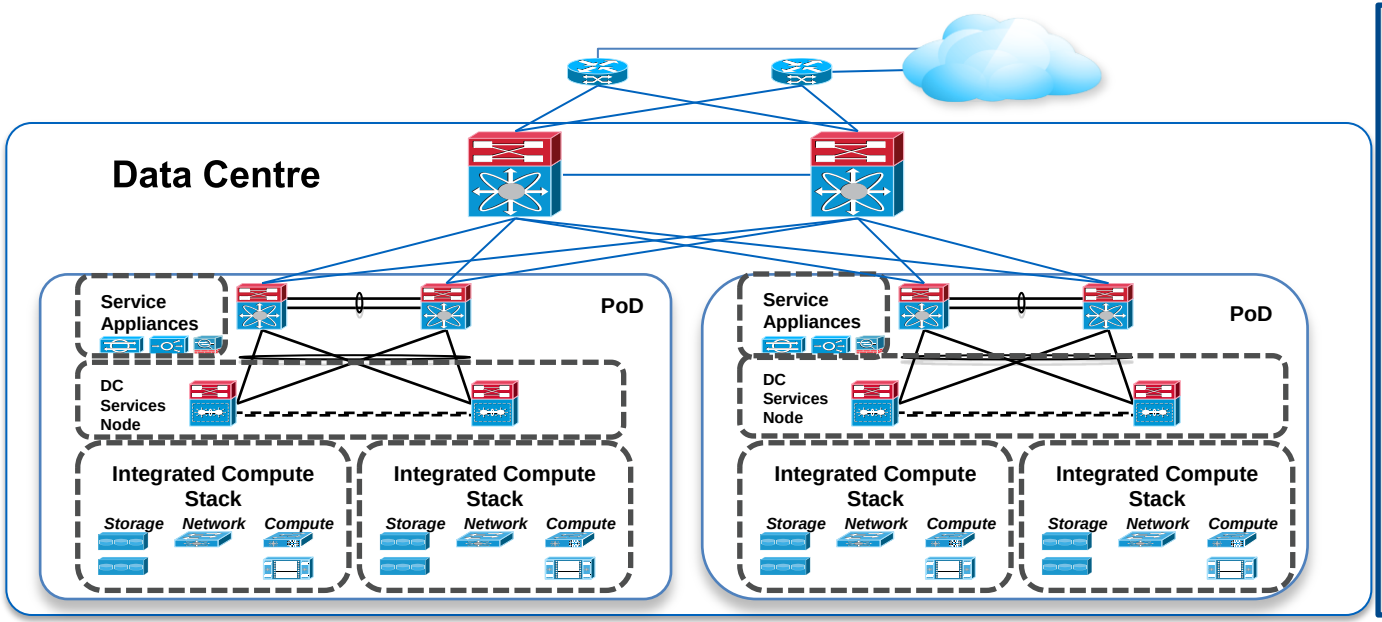


Cloud Service Management

- Business Support
- Provisioning Configuration
- Portability/ Interoperability

VMDC

The Challenge - Predictably Scale Data Centre



Key Factors to Consider

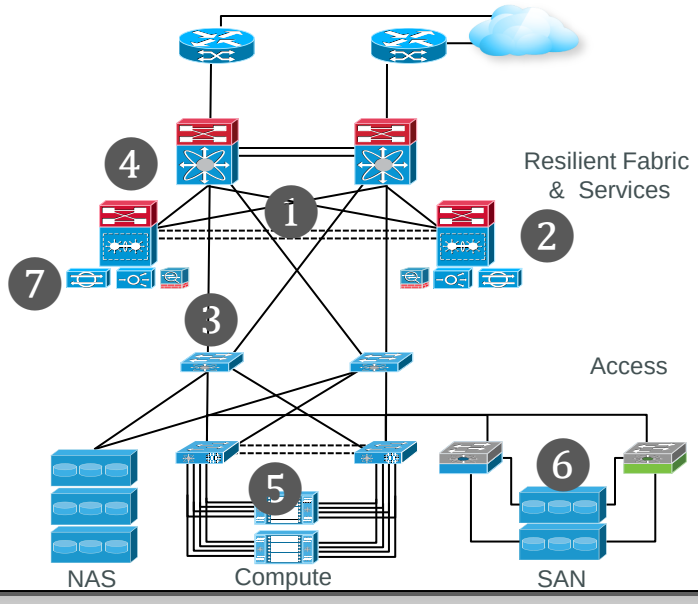
- **L2 Scale -** Virtual Machine Density, VMNics per VM, MAC Address Capacity
- Cluster Scale, ARP Table Size, VLAN scale, Port Capacity, Logical Failure Domains, L2 Control Plane
- **L3 Scale –** BGP Peering, HRSP Interfaces, VRF Instances, Routing Tables and Convergence, Services
- **Resource Oversubscription –** Network Compute and Storage Oversubscription, Bandwidth per VM

Benefits

- Optimise CAPEX savings while maintaining SLAs
- Predictable performance and scale based on building blocks
- Effective way to add separate application environments

The Challenge - Ensure High Availability

- **Redundant** end to end links, nodes and paths
- **L2 Redundancy** – ❶vPC+, ECMP, Port-Channels ❷ MEC, ❸MAC-pinning
- **L3 Redundancy** - ❹HSRP, NSF, NSR, LDP sync, MPLS graceful restart
- **Compute Redundancy** - ❺ UCS end host mode, (N1KV and MAC-pinning, Active/Standby Redundancy, Intra-Cluster HA)



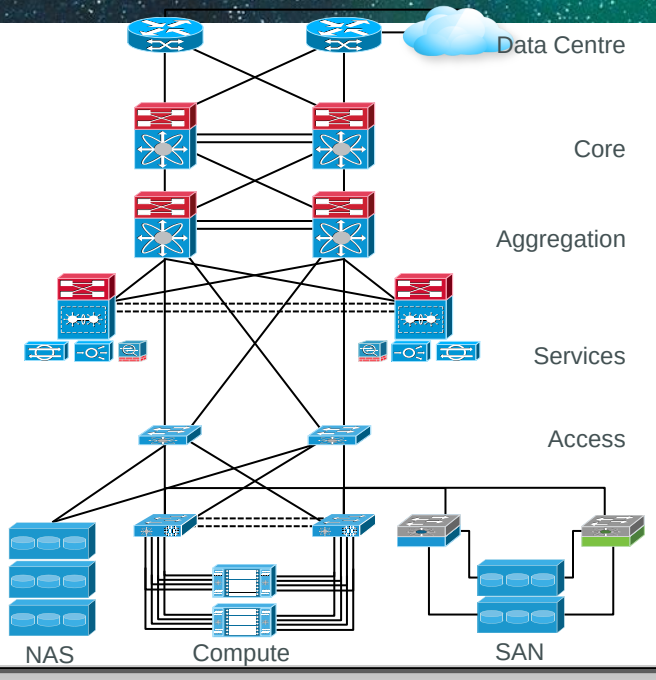
- **Storage Redundancy –** ❻FC port channeling, multi-pathing software from VMware or SAN vendor
- **Services Redundancy** – ❼ ASA, Load Balancer redundancy (port-channels, vPC, vPC+)
- **Routing Protocol Redundancy -** BGP, OSPF

Benefits

- Maximise infrastructure uptime
- Comprehensive end to end architecture

The Challenge - Service Levels and Multimedia Apps

- Define low latency traffic classes in the multimedia service tier (i.e., VoIP bearer and video conference) are characterised by three metrics - bandwidth, delay and availability.
- Support QoS across hybrid public/private domains



- **Traffic Classification and Marking -** It is a general best practice to mark traffic at the source-end system or as close to the traffic source as possible in order to simplify the network design.
- **Hierarchical QoS for Multi-Tenancy**
- **Queuing, Scheduling, and Dropping –** accounts for differences in queuing structures
- **Shaping and Policing**

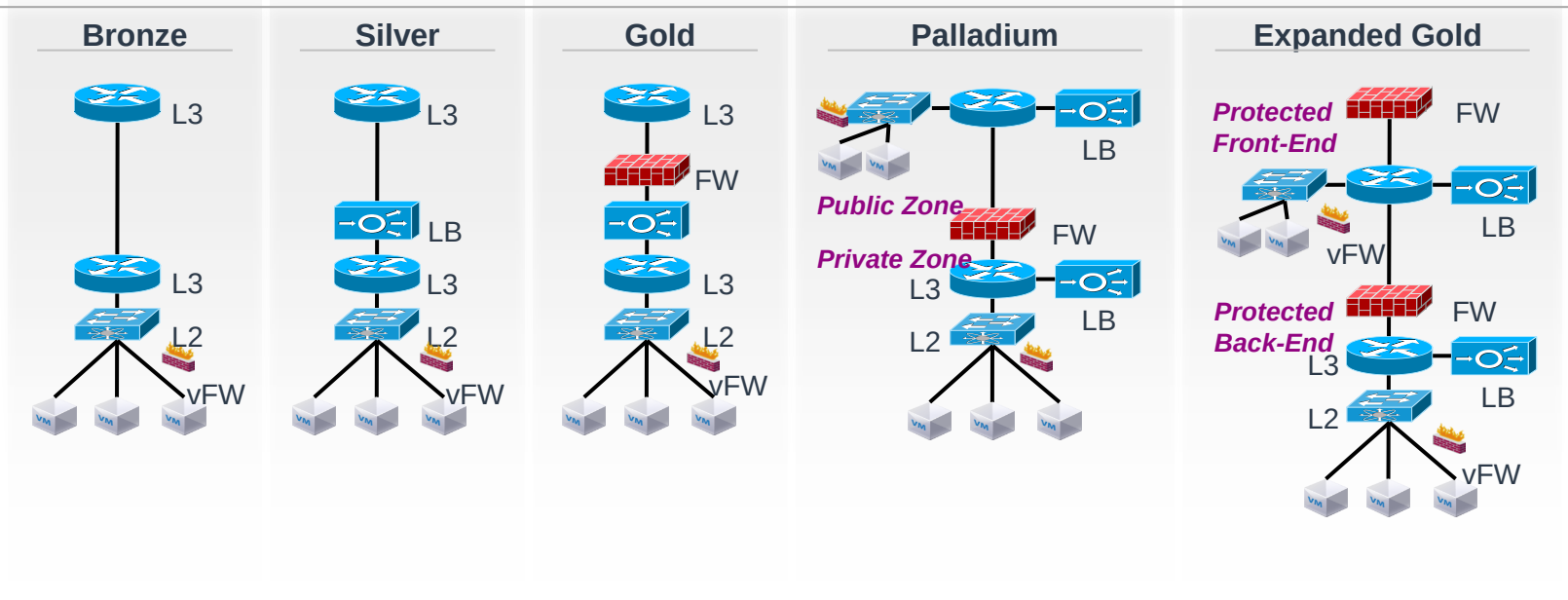
The Solution

- Quality of Service

Benefits

- Supports applications with differing latency requirements
- Provides end to end QoS
- Supports QoS across hybrid public/private domains

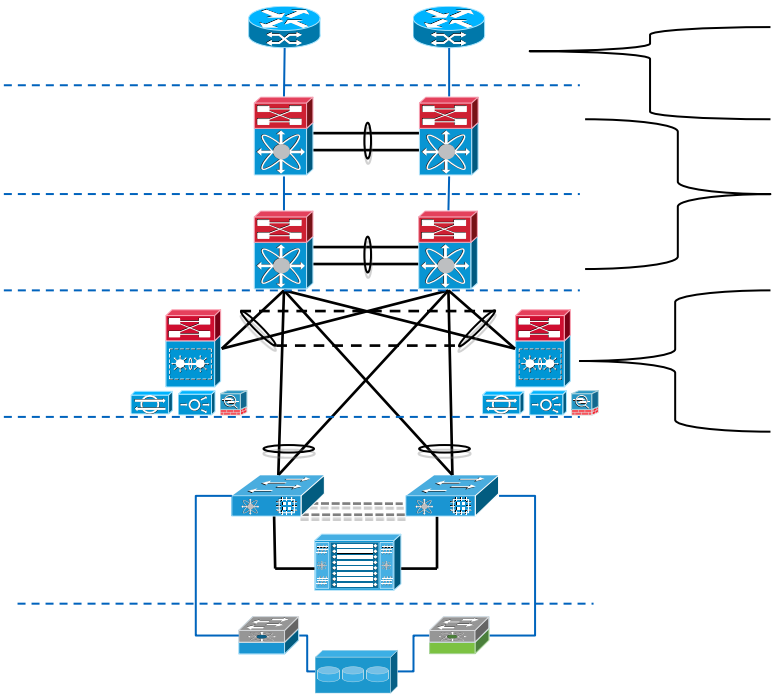
Cloud Consumer Models - Validated Tenancy Models



Benefits

- Quickly and securely onboard similar tenants
- Covers different levels of network services for a variety of needs
- Addresses varying security, QoS and other requirements
- Solutions available to automate the process

VMDC 2.2 PoD Construct



Component	SW Versions
ASR9000	XR 4.1.0
ASR1006	XE 3.4.0 15.1(3)S
Nexus 7010	NXOS 5.2.1
ASA5585-60X	8.4.2
ACE30	A 4.2.1
Cat 6509	IOS 12.2.33 SXJ
UCS 6140, B200	1.4(2b)
VSG	4.2(1)SV1(2) - VNMC: 1.2(1b)
Nexus 1000V	NXOS 4.2.1 SV1(1.4a)
VMware	vSphere 4.1 U1, ESXi
MDS9513	NXOS 5.0.4d

VMDC 3.0 with FabricPath

Simplified Network, Reducing Operating Expenses

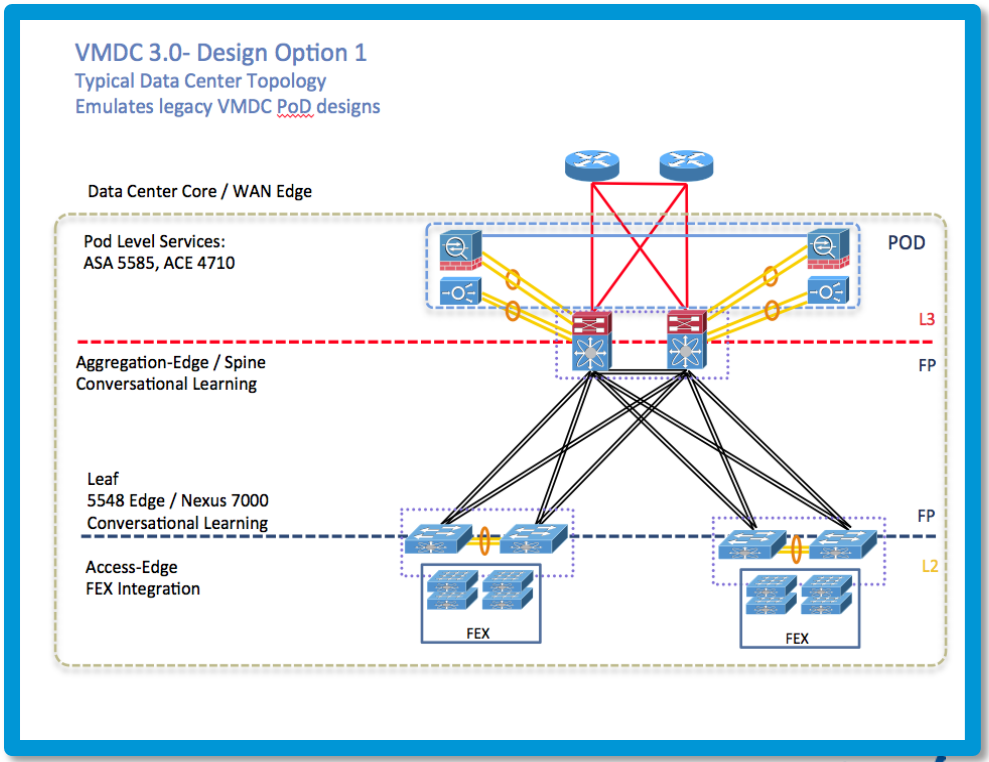
- Switch addresses are assigned automatically
- A single control protocol
- Easily expanded in a plug and play manner
- Non-FabricPath switches can still be without STP

Reliability Based on Proven Technology

- Cisco FabricPath is built on top of IS-IS
- Loop prevention and mitigation is available in the data plane

Efficiency and High Performance

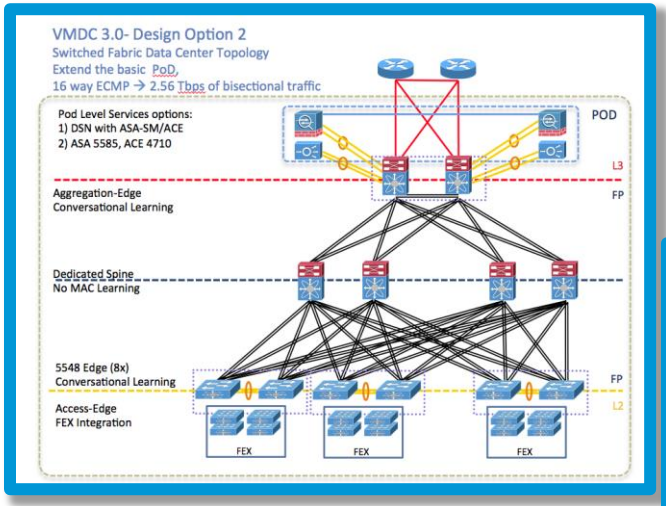
- 2.56 Tbps of bandwidth between switches
  (16-way ECMP combined with 16-port 10-Gbps PortChannels)
- Lower Latency than Spanning Tree based solution
- Cisco FabricPath enables massive scalability of the L2 domain

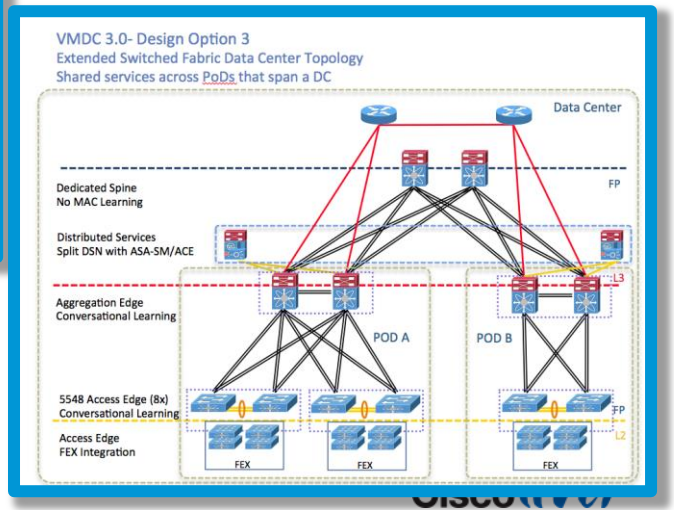


VMDC 3.0 with FabricPath
Design Options and Criteria

Design criteria included:

- Available FabricPath modules:
  - M1/F1 mixed VDC
  - M1/F2 split VDC
- VLAN scale: constrained by HSRP, GLBP
- MAC scale
- ARP learning rate
- Conversational MAC address learning
- Port Density
- Forwarding Paths
- Port-channel vs. single links
- VPC, VPC+ options
- QoS
- Distance (intra-PoD)





Private Cloud: Major Architectural Transitions

Addressing the need for Agility

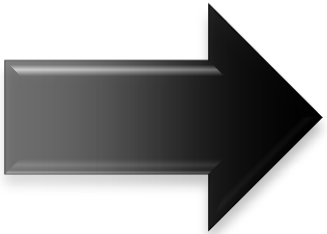
Deployed Architectures

Technologies:

- Physical services
- Fabric-based tenant segmentation
- L3 VPN to Aggregation
- Stovepipe orchestration

Characteristics

- Finite-scale
- Complex orchestration
- Limited flexibility and agility



Emerging Architectures

Enabling Technologies:

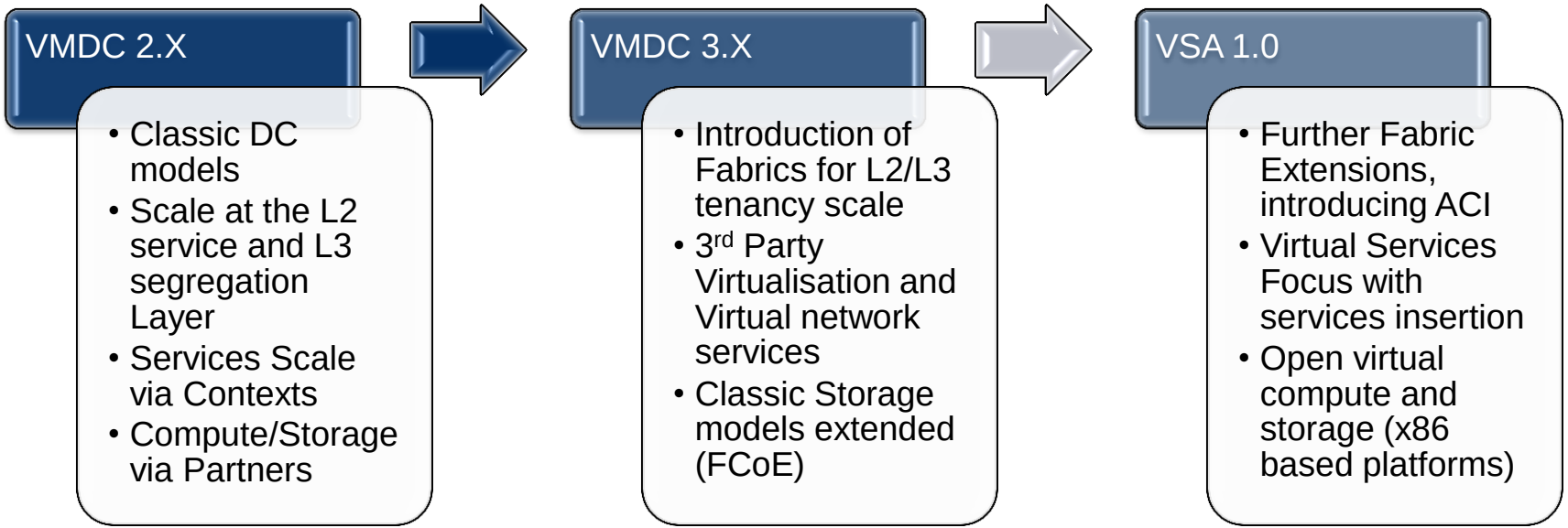
- Virtualised Services
- Overlay-based consumer segmentation
- Virtualised Routing
- Abstracted network orchestration

Characteristics

- High-scale
- Simplified orchestration
- Flexible and agile

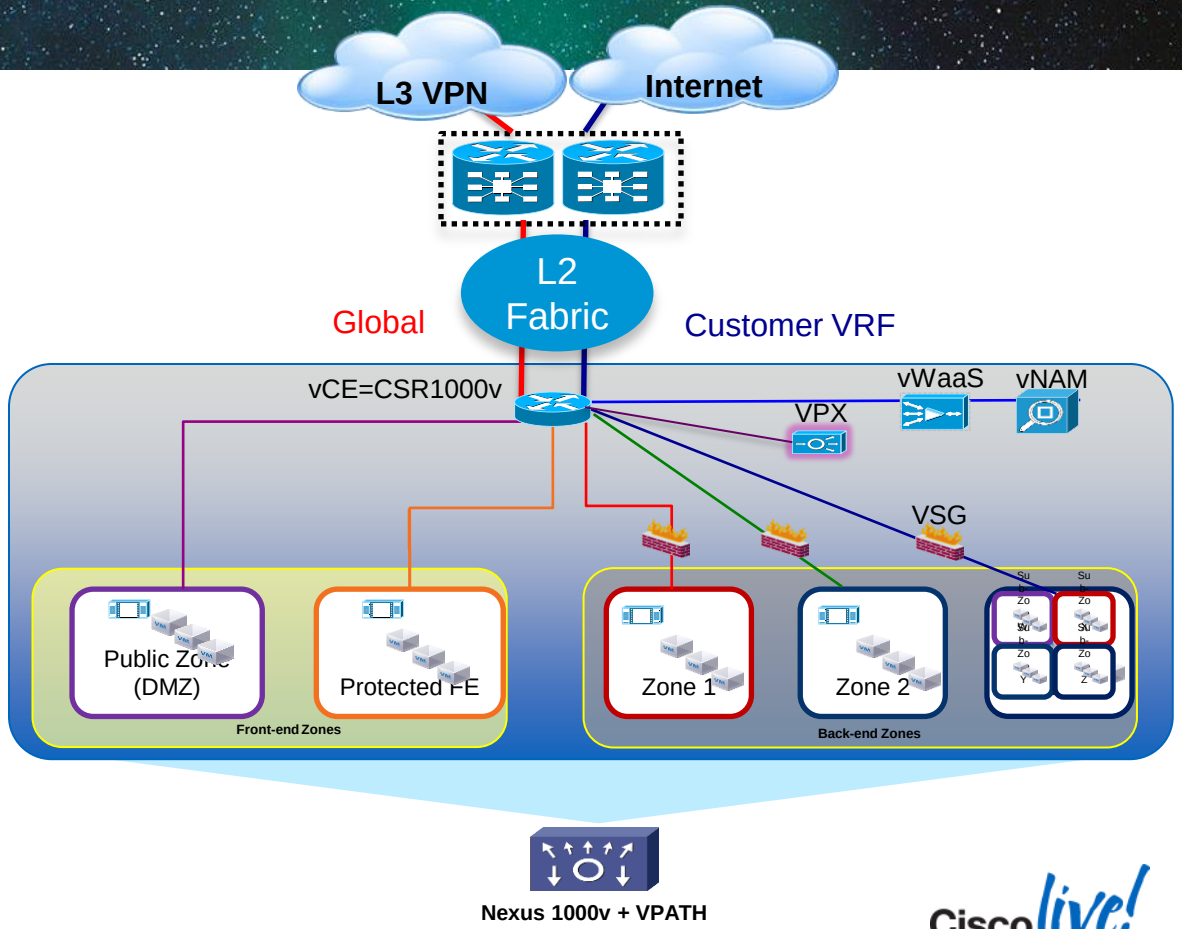
Transition to Virtual Services Architecture (VSA)

VMDC Evolution to VSA



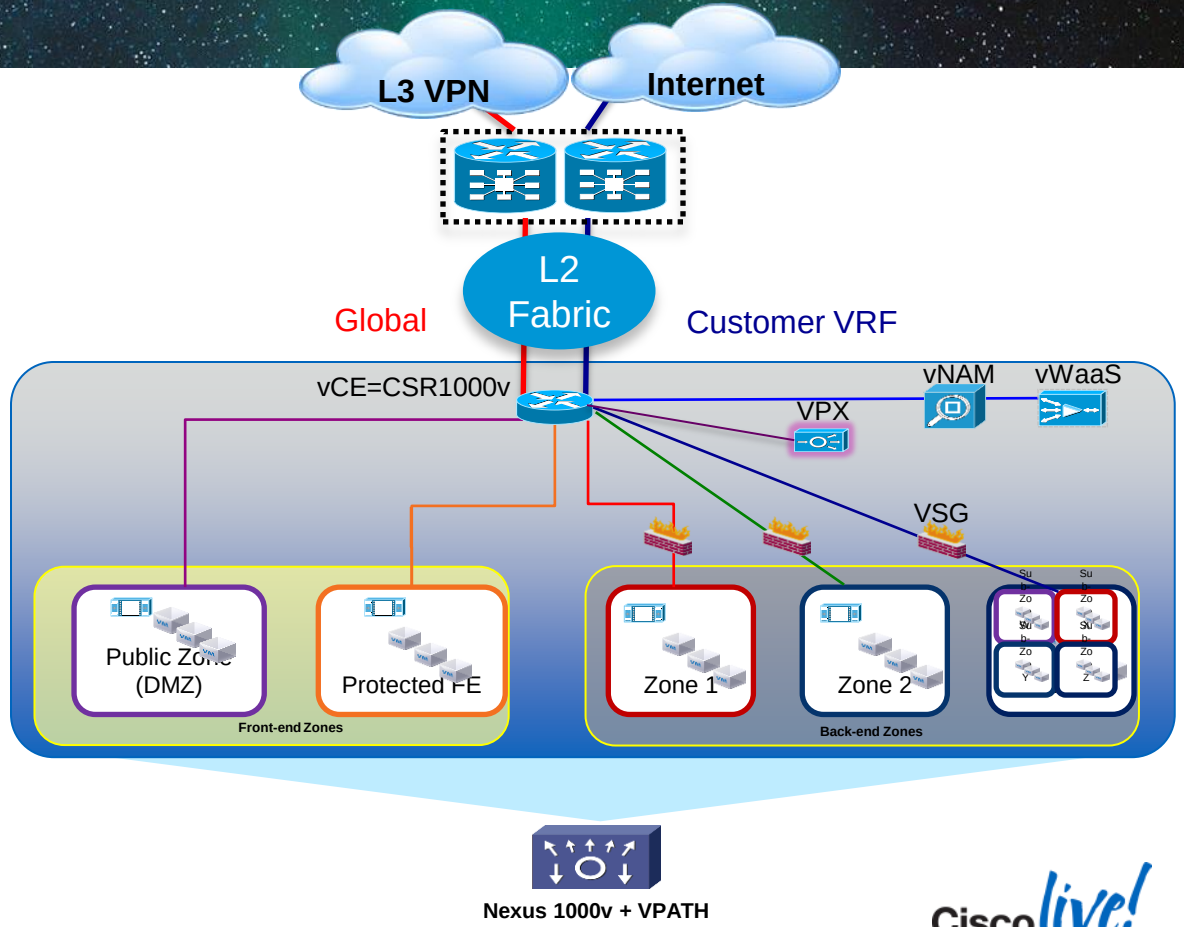
Virtual Services Architecture:
Architectural Highlights

- Overlay networking – VXLAN for scalable tenant segmentation and intra-DC L2 extension
- Virtual services – with single service instance per tenant
- RAAS – virtual router for tenant routing and zone-based firewalling
- Abstracted network control via Prime Network Services Controller

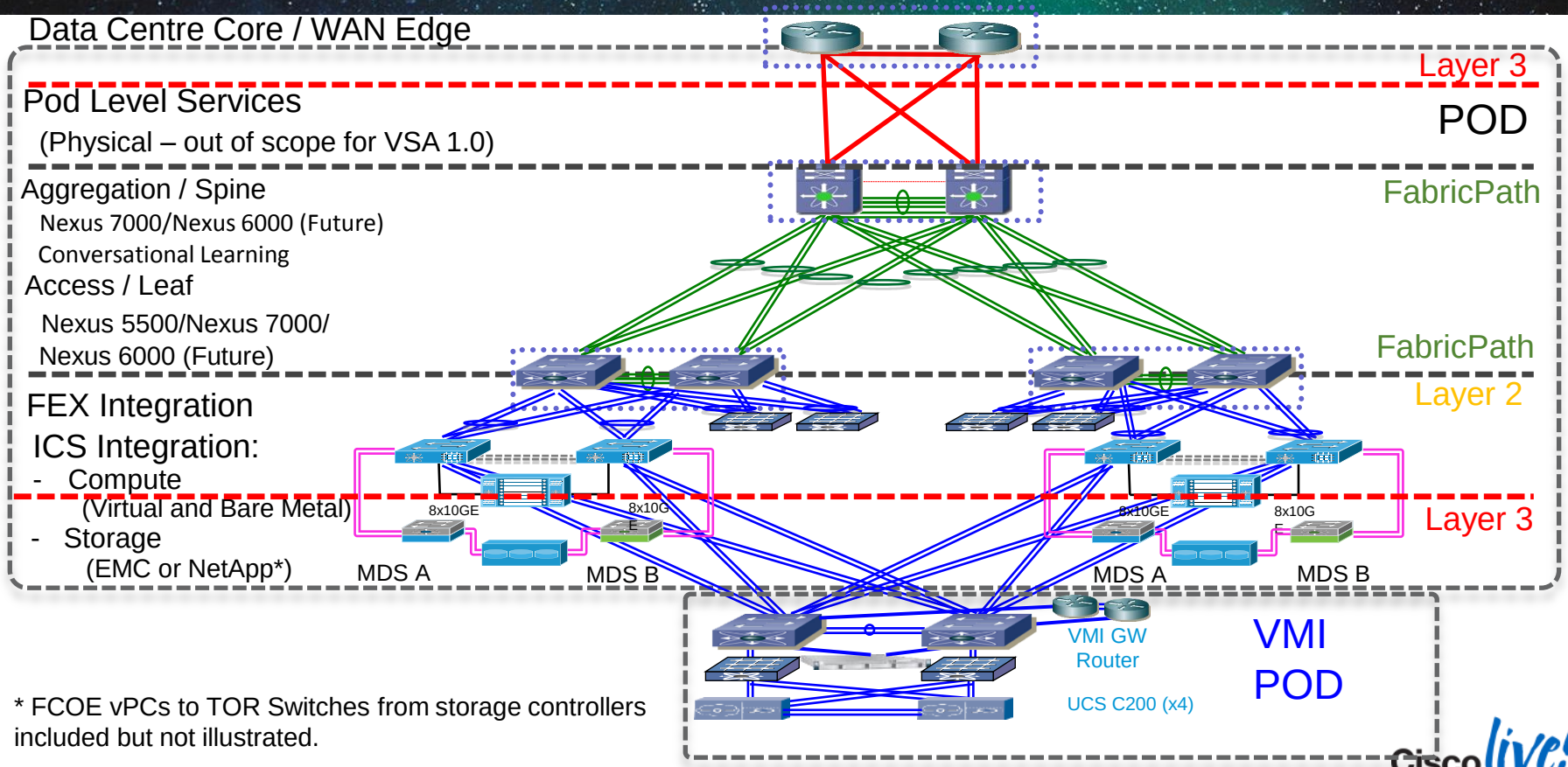


Virtual Services Architecture:
Architectural Highlights

- End to End differentiated SLA Support and Application Visibility
  - NBAR2 on CSR for application-based differentiation
  - Performance Agent on CSR for Round Trip Time reporting
  - vNAM Network Analysis
- Application Performance Tuning
  - vWaaS for end-to-end application optimisation

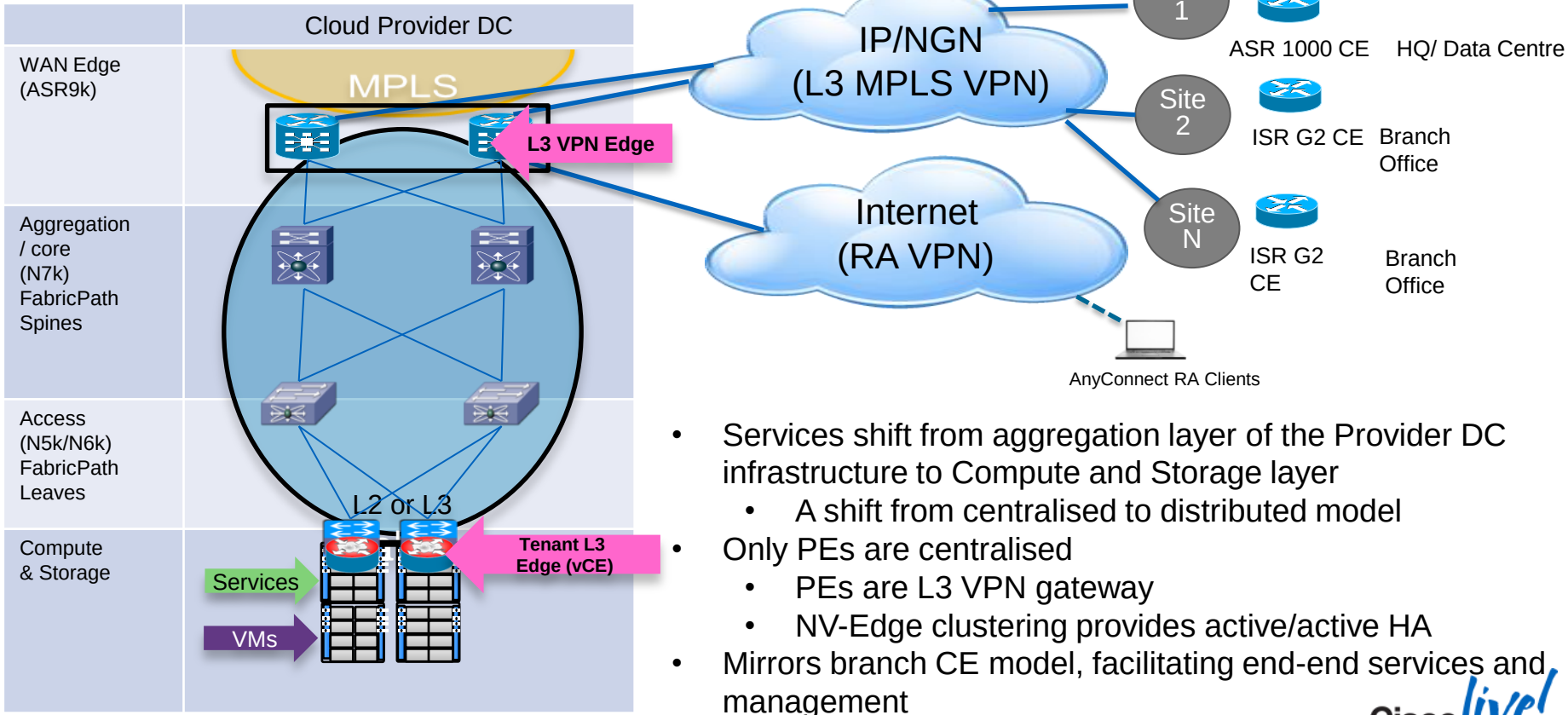


VSA 1.0 Intra-DC End to End Physical Topology



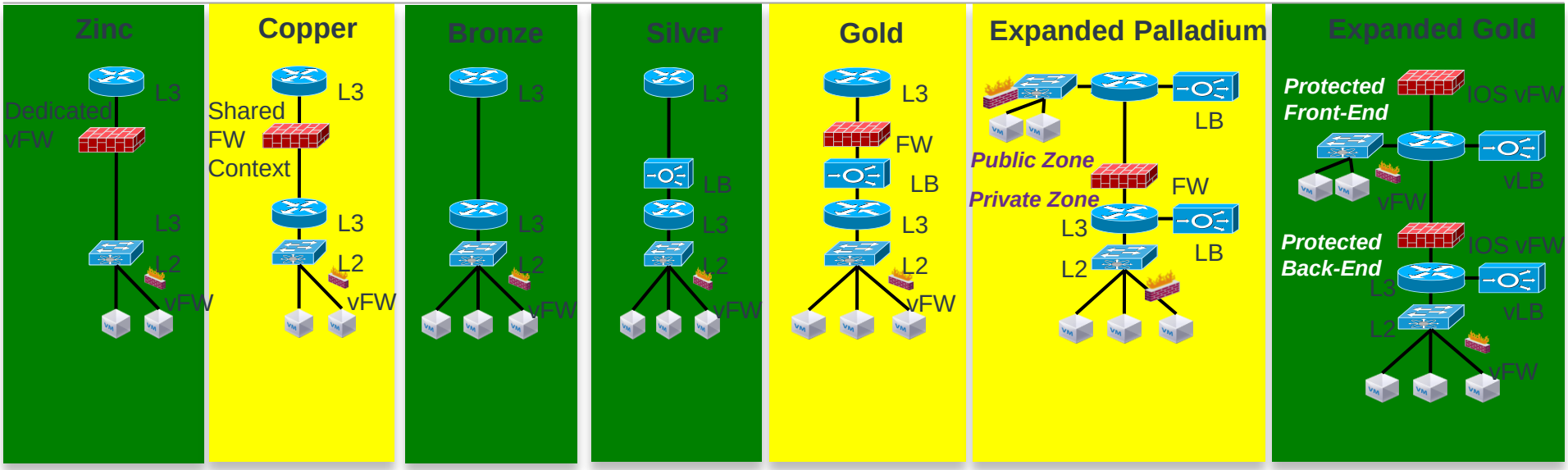
* FCOE vPCs to TOR Switches from storage controllers included but not illustrated.

End to End System View



- Services shift from aggregation layer of the Provider DC infrastructure to Compute and Storage layer
  - A shift from centralised to distributed model
- Only PEs are centralised
  - PEs are L3 VPN gateway
  - NV-Edge clustering provides active/active HA
- Mirrors branch CE model, facilitating end-end services and management

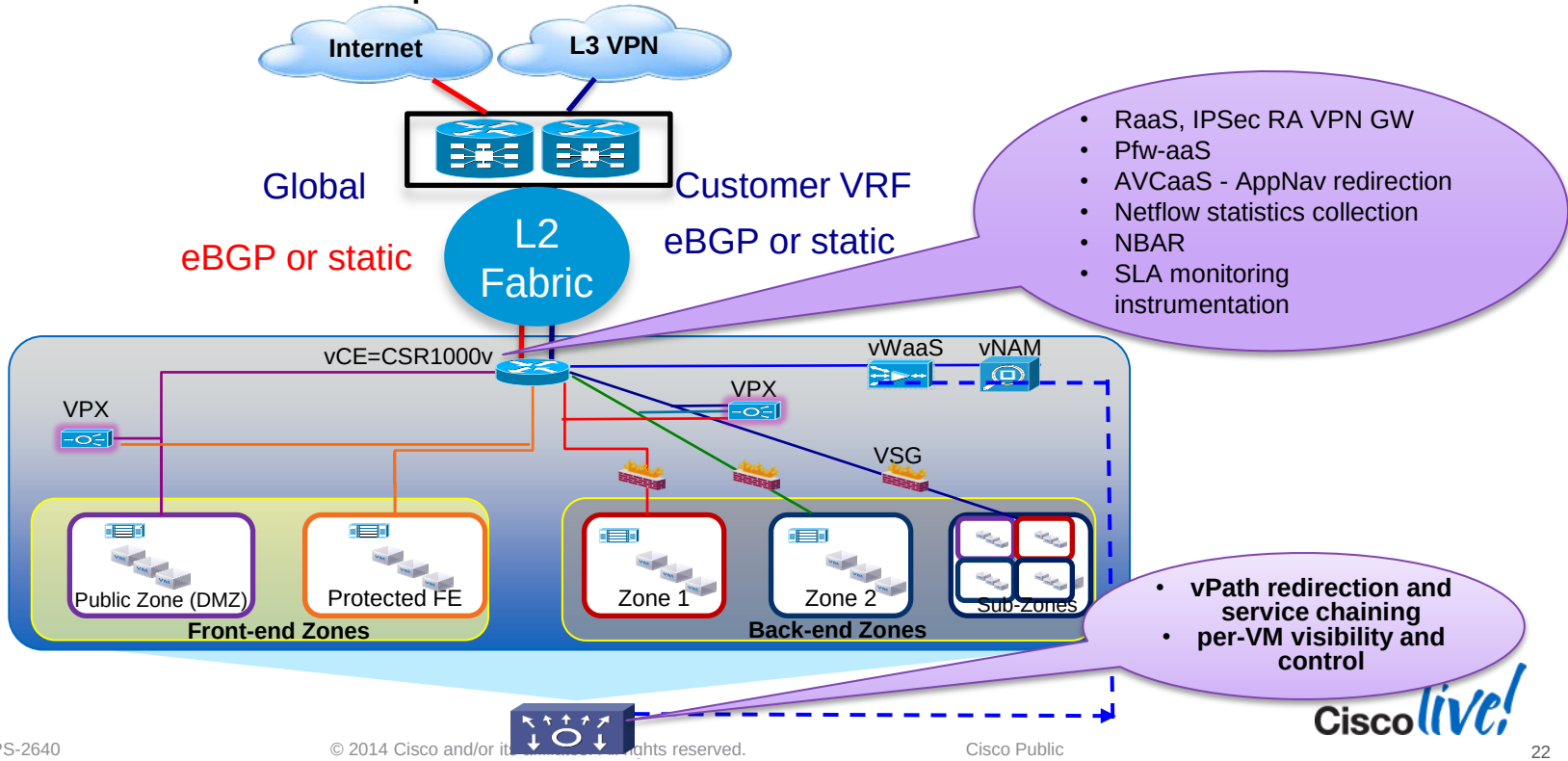
VSA – Supported Containers



- Predefined containers provide examples for different types of deployments
- Automated provisioning and management logic for each container type is pre-defined in the Management and Orchestration software

Expanded Gold Container

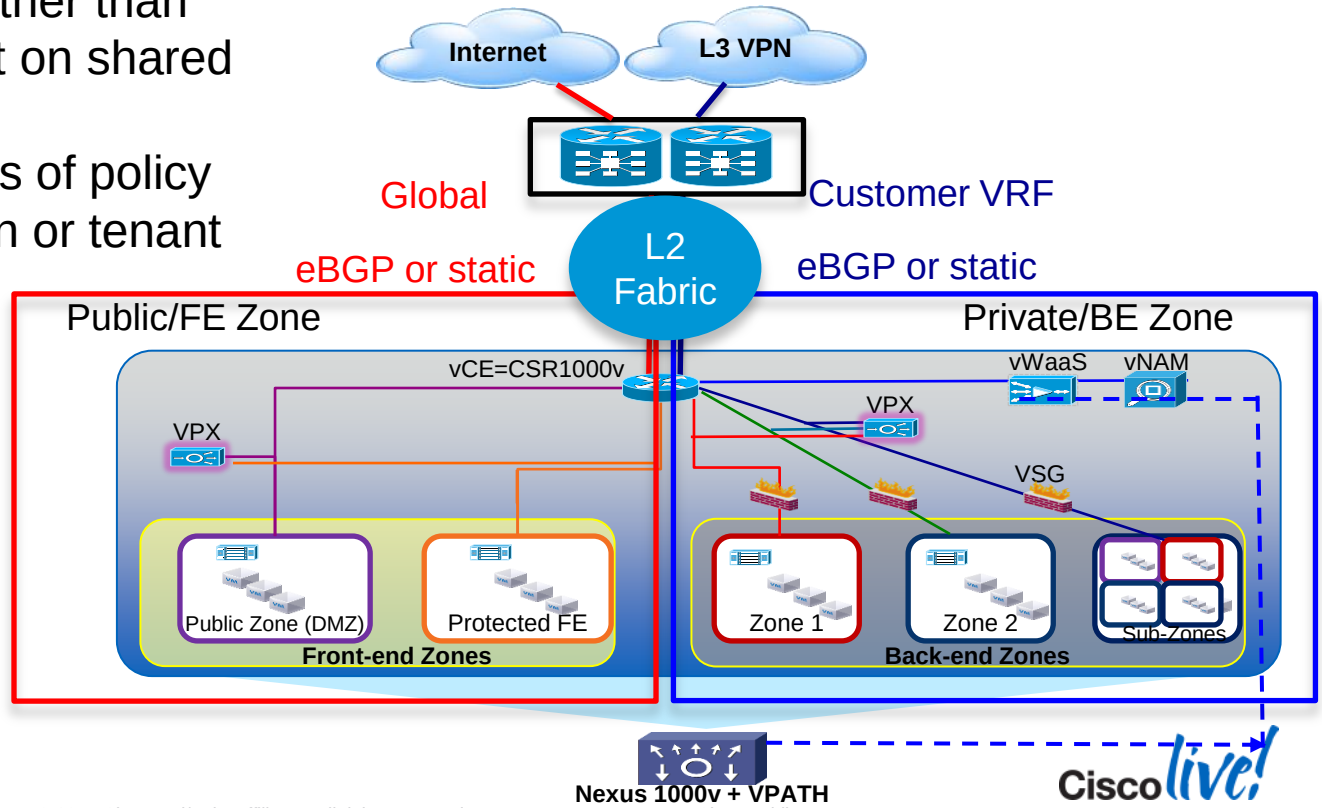
- Enterprise-class tiered application support with in-depth security.
- “All Virtual” network service implementation



Expanded Gold Container

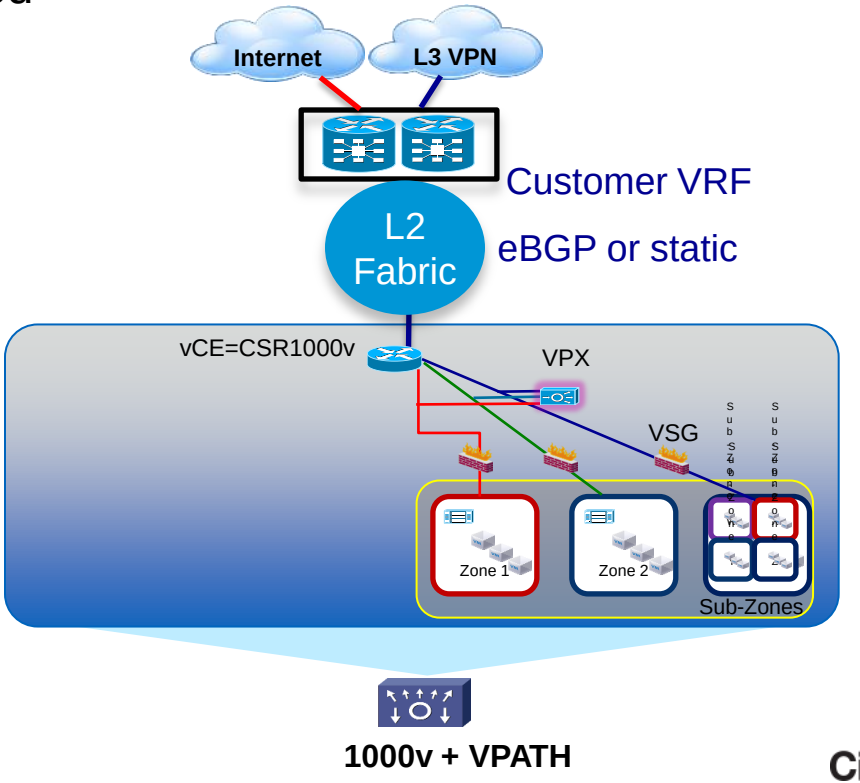
With CSR IOS Zone-based Perimeter Firewall

- Dedicated per-tenant, rather than dedicated logical context on shared physical firewall
- Greater flexibility in terms of policy administration (SP Admin or tenant user)
- Per-tenant granularity of policy control
- Zones based on logical interfaces



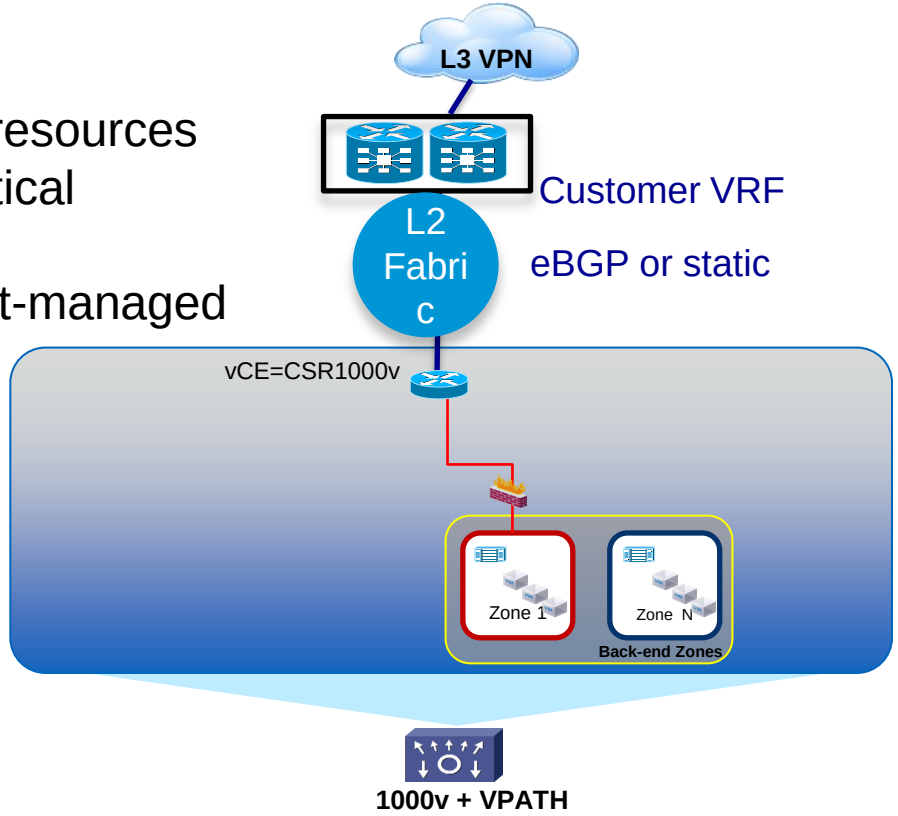
Silver Container

- Three routed segments for N-tiered application support
- Load balancer for application HA



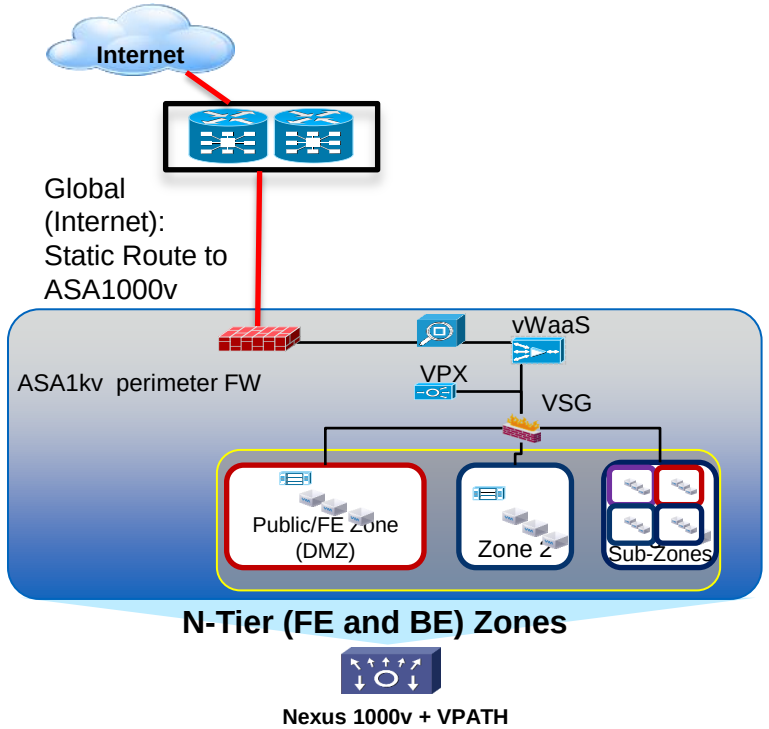
Sample Bronze Container

- Single routed segment
- Raw container for tenant resources
- Assumes less mission-critical applications
- Possible use case: tenant-managed network resources



Zinc Container

- At ASA1kv, 1 outside (statically routed) interface. Could be to L3 VPN but in this example, only the Internet/Public use case is shown, reserving the vCE model to the CSR
- 1 inside interface…single subnet with the VSG optionally providing N-tiered application zoning. As with any use of the VSG, there is the possibility to create sub-zones (for additional policy in front-end or back-end zones)
- vWaaS and vNAM are also options

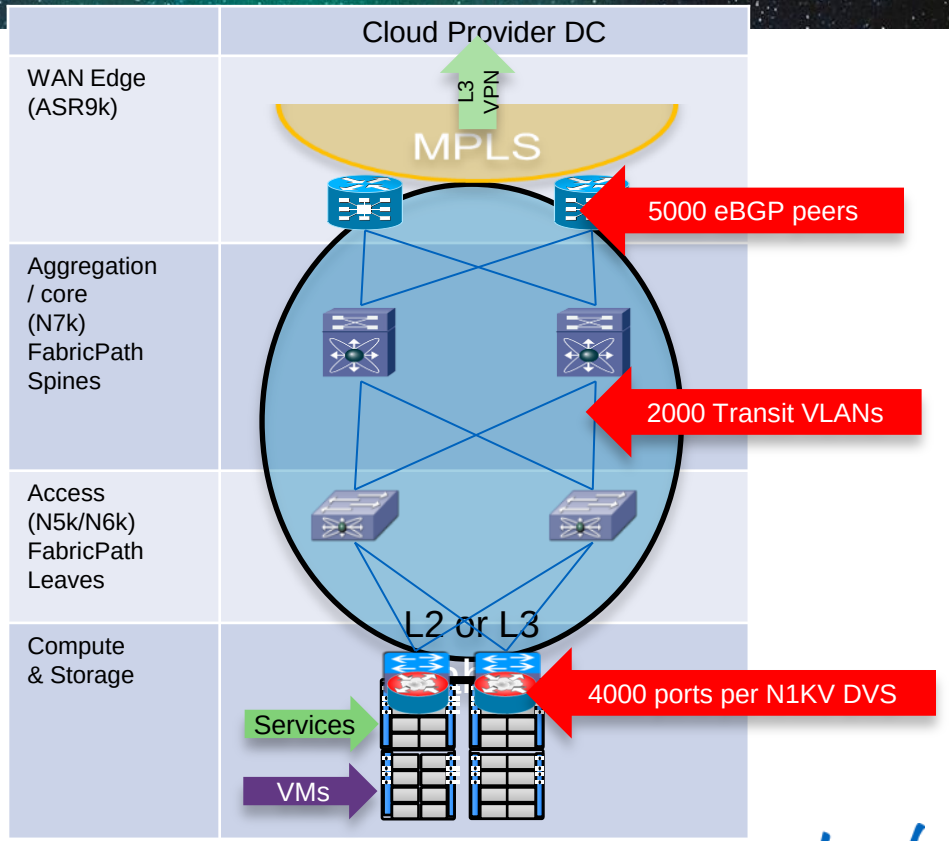


*Note: nested zones shown in Zone 3 simply as an example. In practice, these could apply to any zone per application or business requirements.

VSA 1.0 - Critical System Parameters

- Max. Tenants per PoD (ASR9k PE pair): 5000
- Tenancy Scale Validation Objective per PoD for 1.0: 2000*
  - 50 tenants configured in SUT compute layer
  - Simulated tenant sessions to stress the system end to end (at PE, transiting FabricPath, and in port capacity context at N1KV DVS)

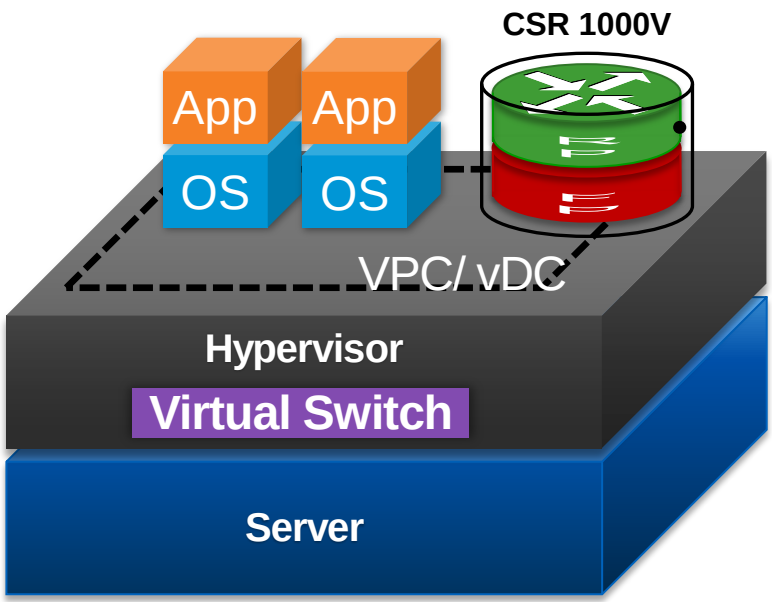
*Note: only 2000 max transit VLANs possible in NX-OS 6.1, per FabricPath domain. This number doubles to 4000 in NX-OS 6.2 (now shipping). 4000 to be validated in VSA 1.0.1.



CSR1000v and Use Cases

Cisco Cloud Services Router (CSR) 1000V

Cisco IOS Software in Virtual Form Factor



IOS XE Cloud Edition

- Selected Features of IOS XE primarily for Cloud Use Cases

Infrastructure Agnostic

- Server, Switch, Multi-Hypervisor *(ESXi, KVM, Xen, AMI)*

Single-tenant WAN Gateway

- Small Footprint *(reducing from 4 vCPU to 1)*, Low Performance

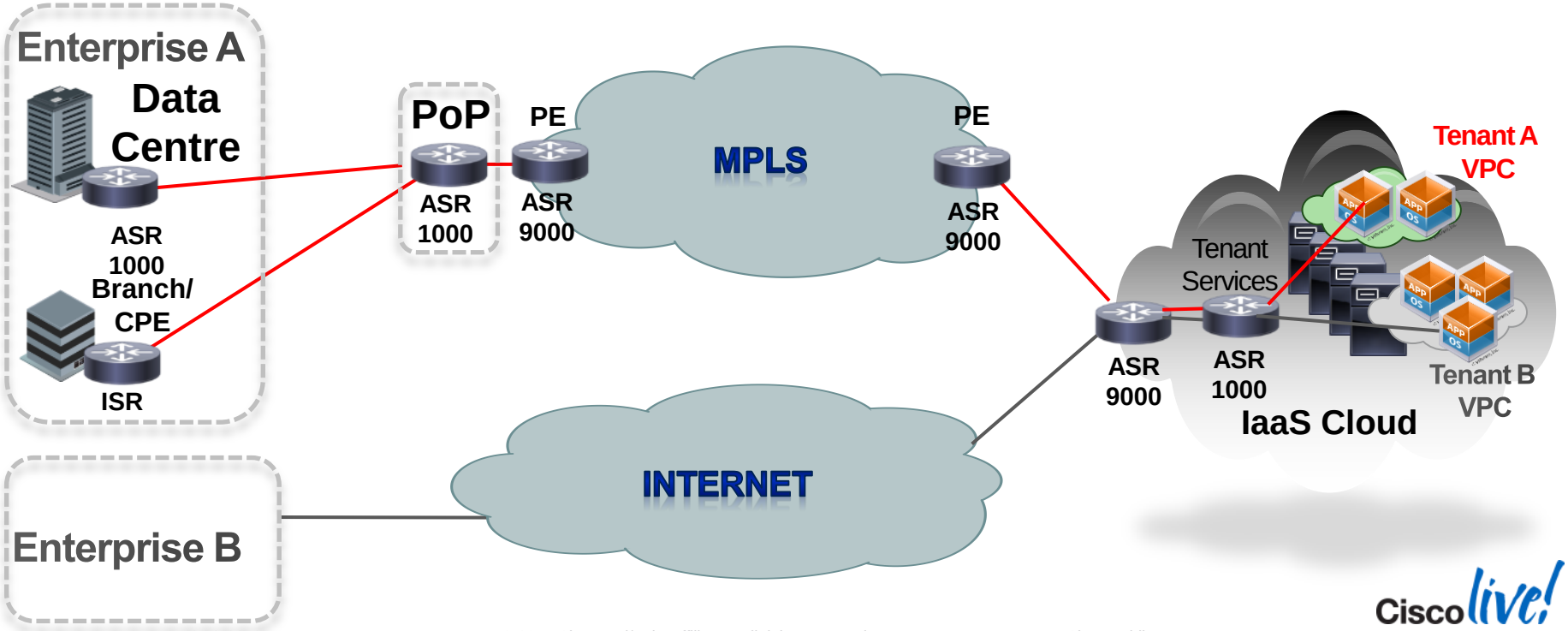
Term and Usage based Licenses

- Elastic Capacity *(10 Mbps to 1 Gbps* Throughput, 2 to 16 GB RAM)*

Programmability

- RESTful APIs *(leverages OnePK)* for Automated Management

The Current WAN Landscape



The Evolving WAN Landscape – with CSR 1000V

Phase 3 – CPE/

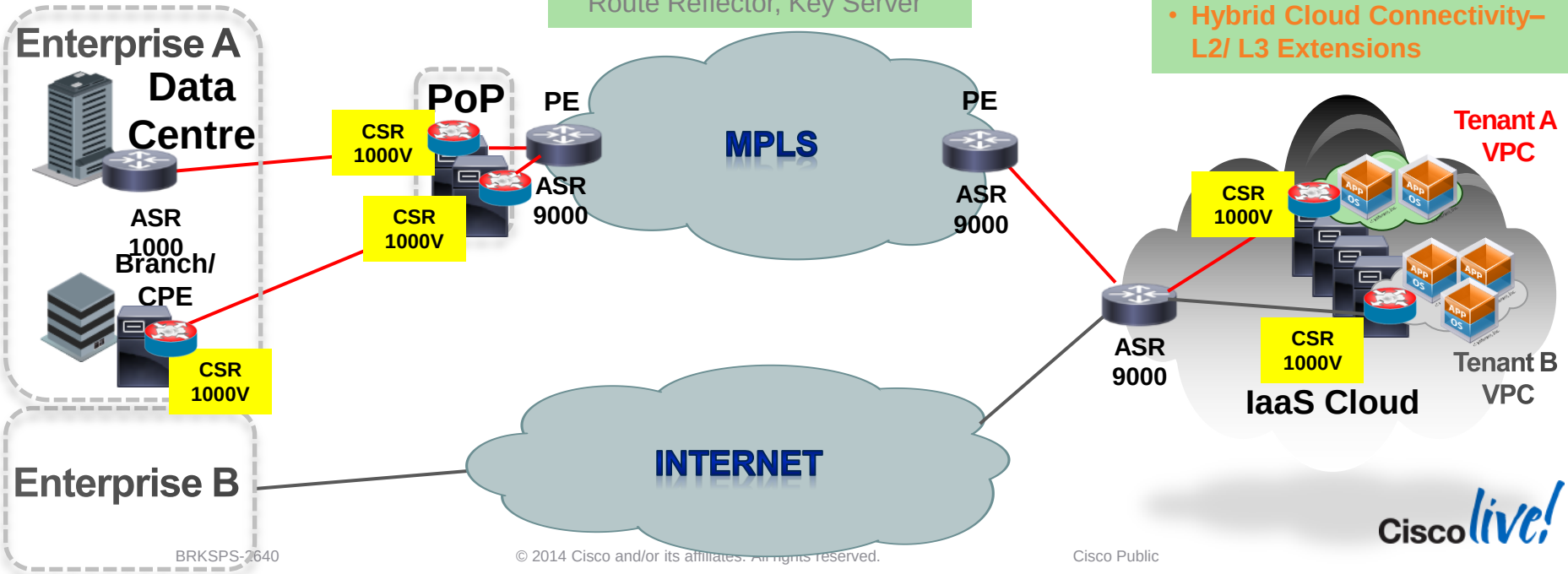
- vCPE/ NFV/ Branch-in-a-Box
- Lab

Phase 2 – SP Edge

- Network Services – VPN Gateway, vBRAS
- Control Plane Functions - Route Reflector, Key Server

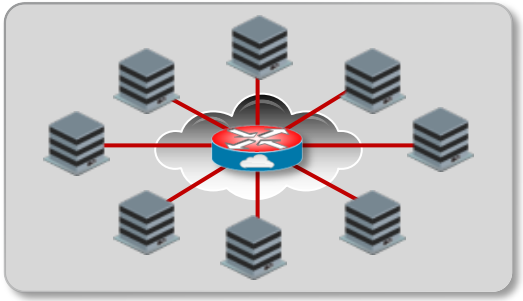
Phase 1 - Cloud

- Tenant Scale - vCE/ vPE
- Network Services - VPN Gateway, Control Point
- Hybrid Cloud Connectivity– L2/ L3 Extensions

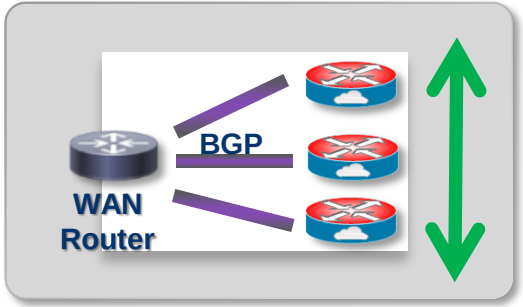


CSR 1000V Benefits

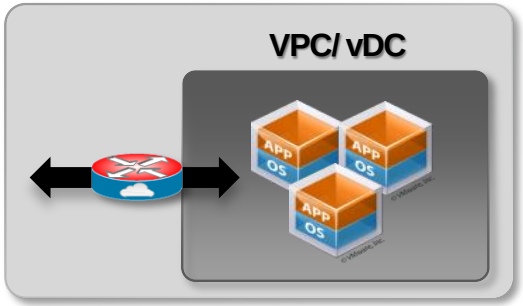
Any-to-Any Connectivity



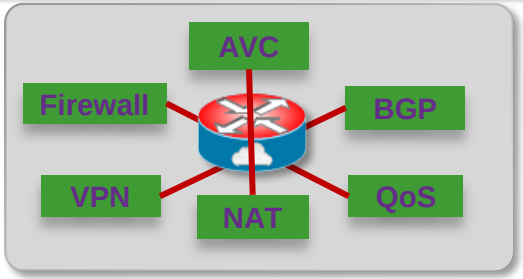
Tenant Scalability



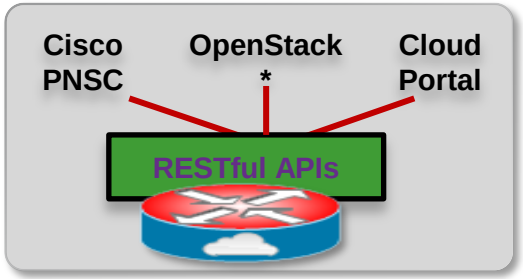
Traffic Redirection/ Control



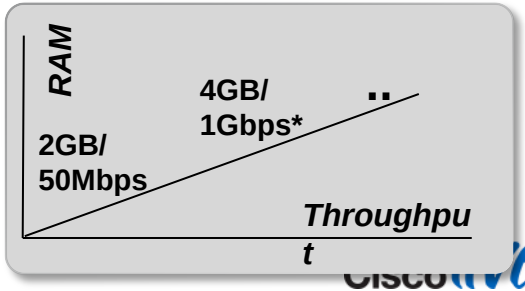
Integrated Services



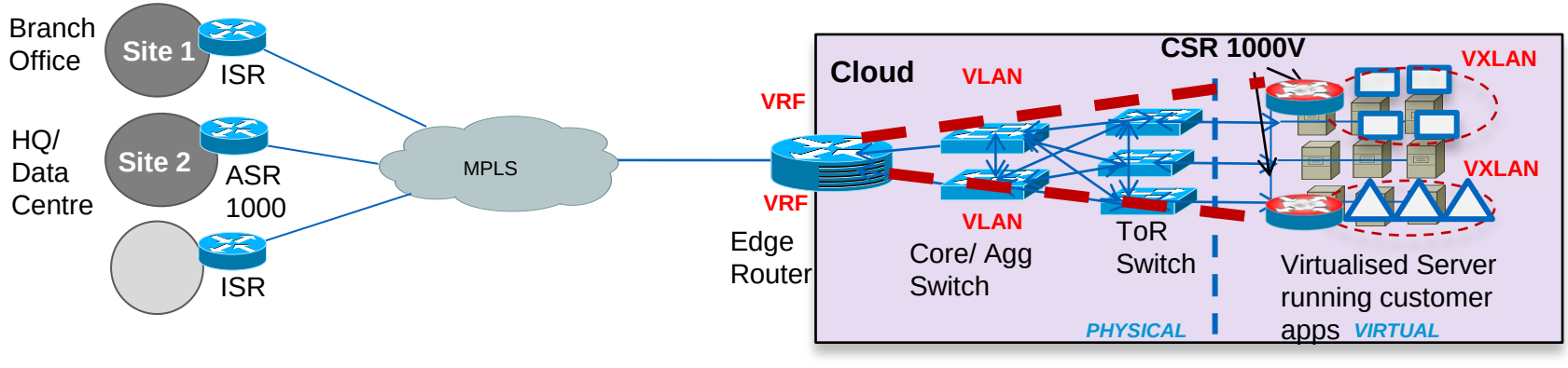
Programmability



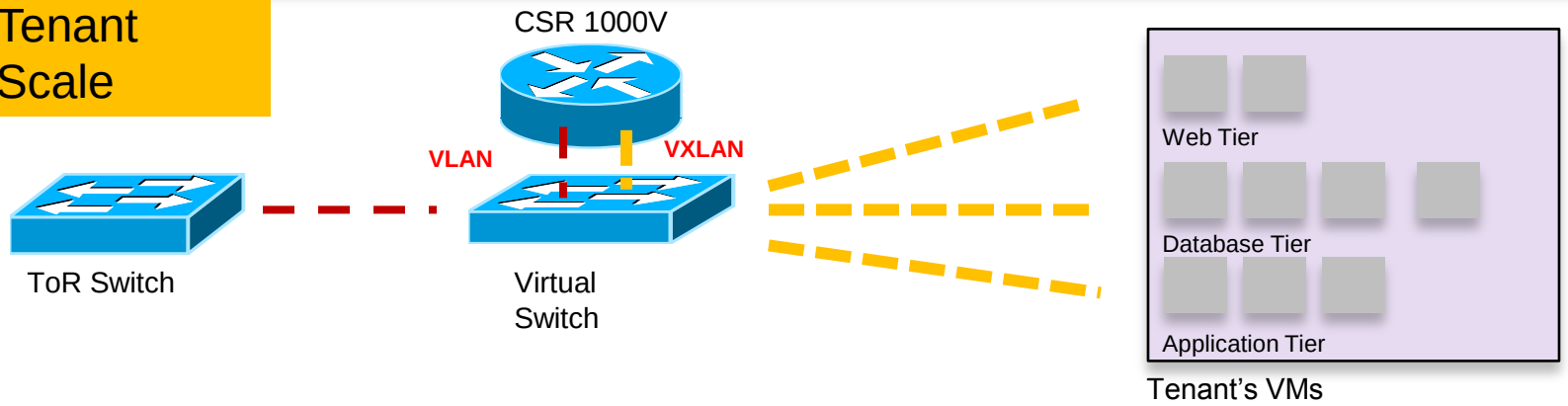
Licensing Elasticity



CSR as a VXLAN Gateway

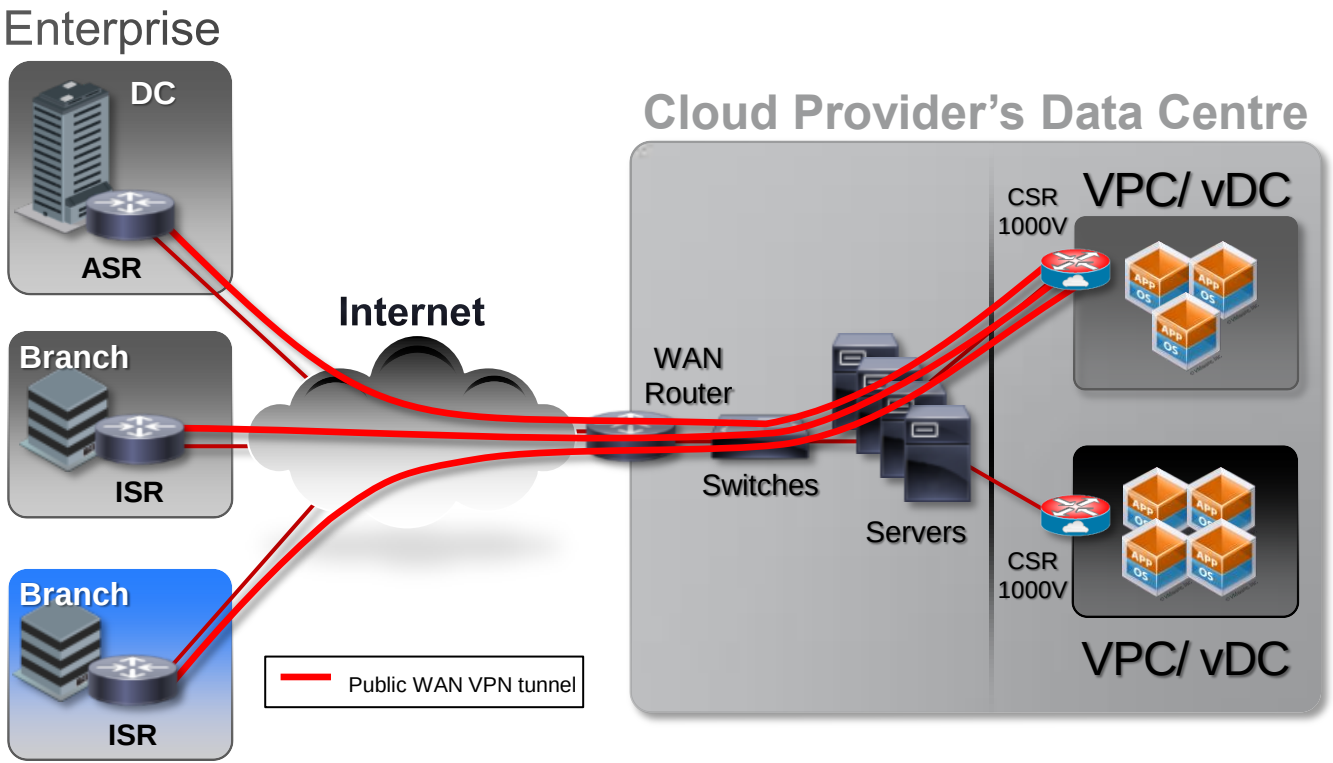


Tenant Scale



Secure VPN Gateway

Benefit: Scalable, Dynamic, and Consistent Connectivity with the Cloud



Challenges

- Inconsistent Security
- High Network Latency
- Limited Scalability

Solutions

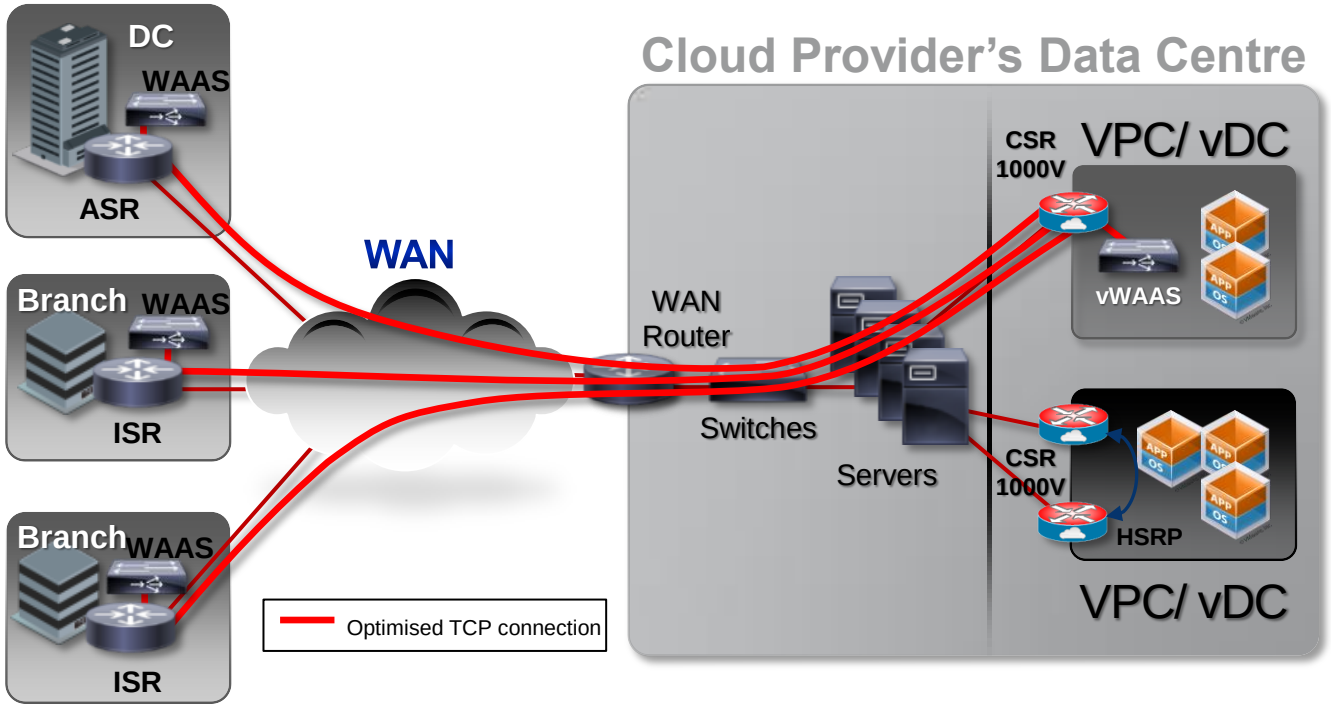
- IPSec VPN, DMVPN, EZVPN, FlexVPN
- Routing and Addressing
- Firewall, ACLs, AAA

Benefits

- Direct, Secure Access
- Scalable, Reliable VPN
- Operational Simplicity

Traffic Control and Management

Benefit: Comprehensive Networking Services Gateway in the Cloud



Challenges

- Response Time of Apps
- Resource Guarantees
- Resilient Connectivity

Solutions

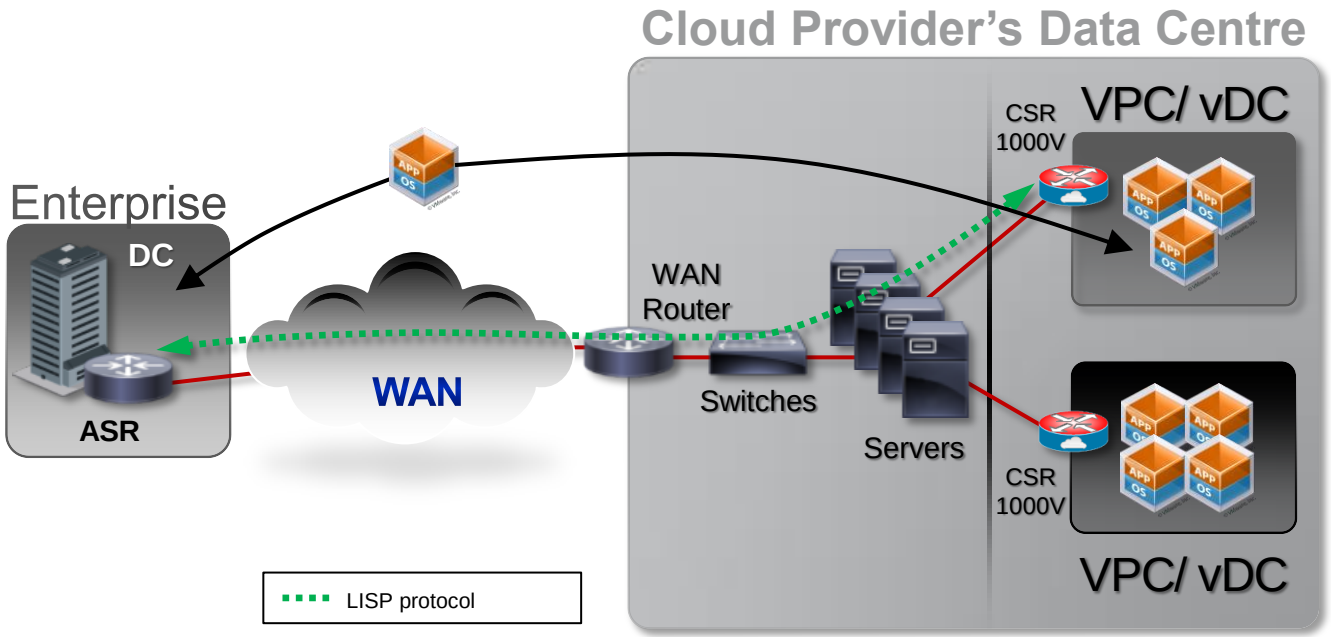
- AppNav for WAAS
- QoS Prioritisation
- HSRP VPN Failover

Benefits

- Rich Portfolio of Network Features and Services
- Single Point of Control

DC to Cloud IP Mobility – Hybrid Cloud

Benefit: Simplified Application Deployment to the Cloud



Challenges

- Simple, Fast, Transparent Application Onboarding
- Consistency with DC

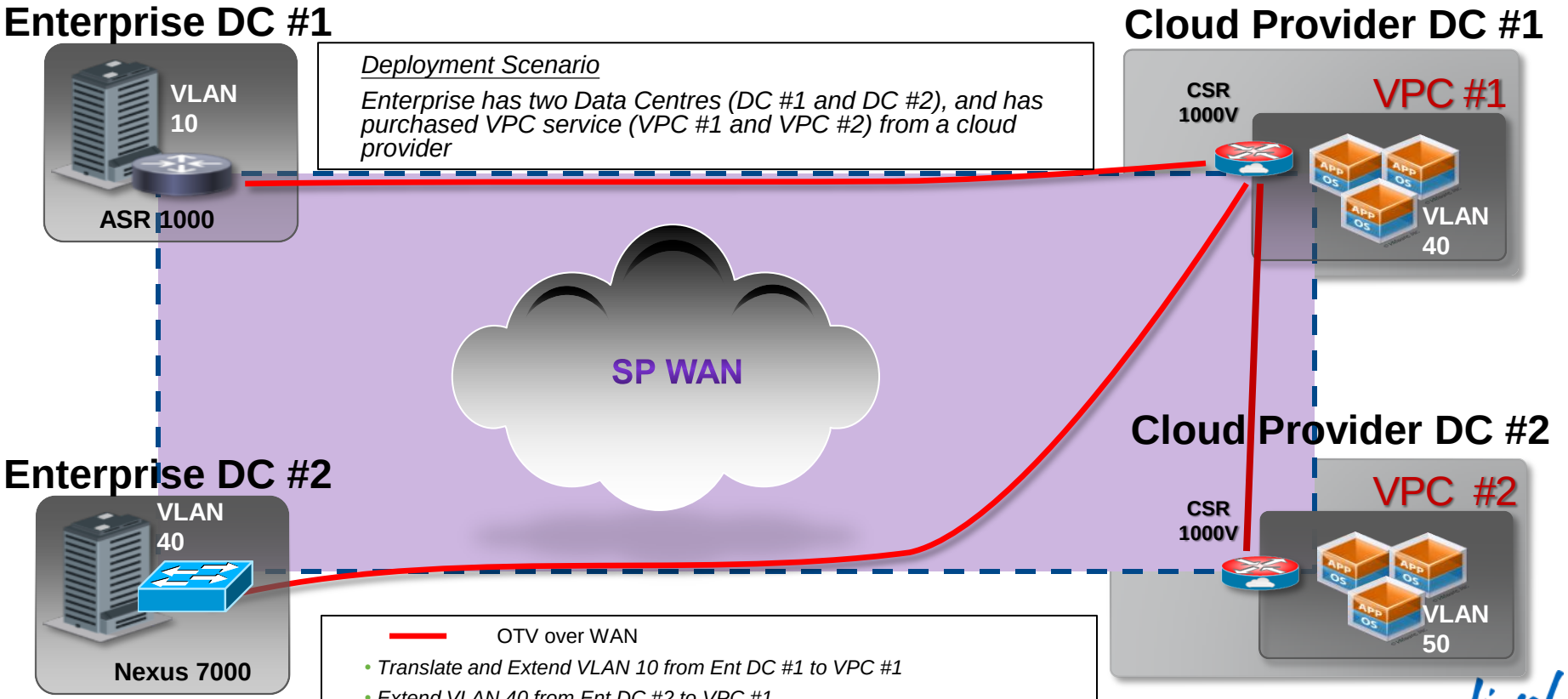
Solutions

- LISP for VM Mobility
- Routing
- NAT, DHCP

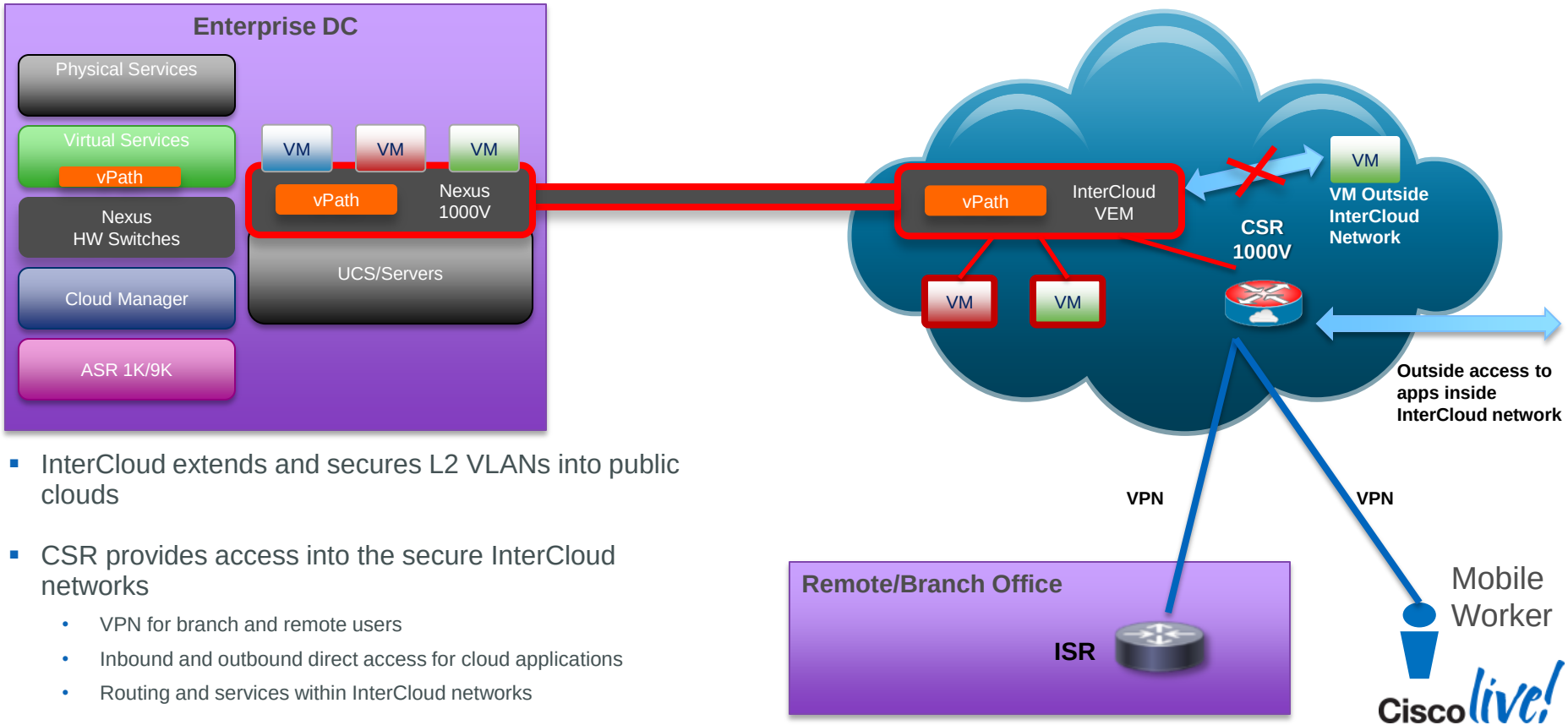
Benefits

- Simpler App Integration
- Dynamic infrastructure
- Consistent Management

DC to Cloud L2 Extension



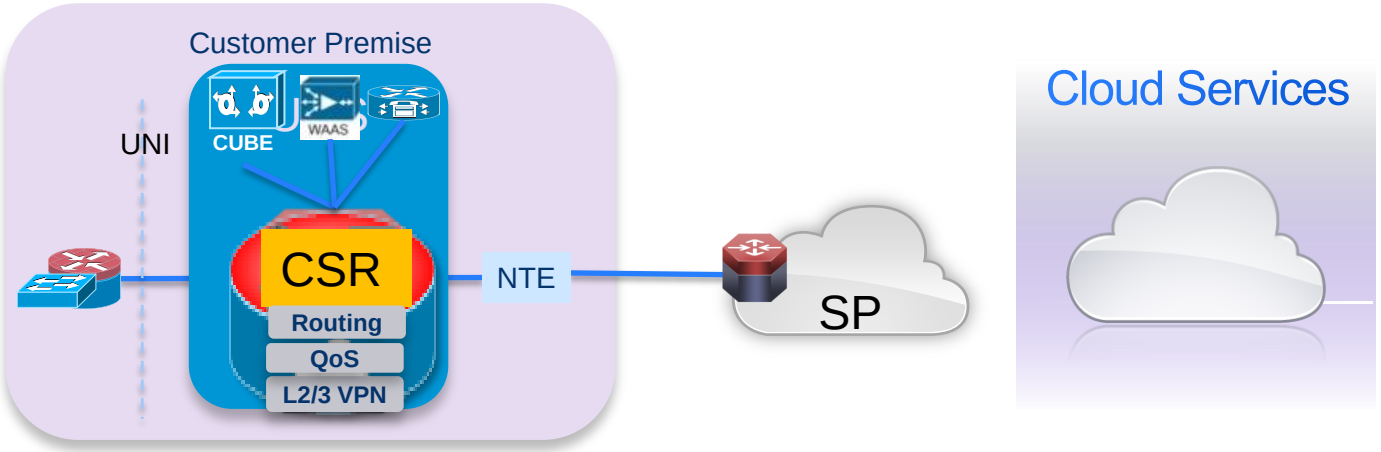
Nexus 1000V InterCloud + CSR – Hybrid Cloud



- InterCloud extends and secures L2 VLANs into public clouds
- CSR provides access into the secure InterCloud networks
  - VPN for branch and remote users
  - Inbound and outbound direct access for cloud applications
  - Routing and services within InterCloud networks

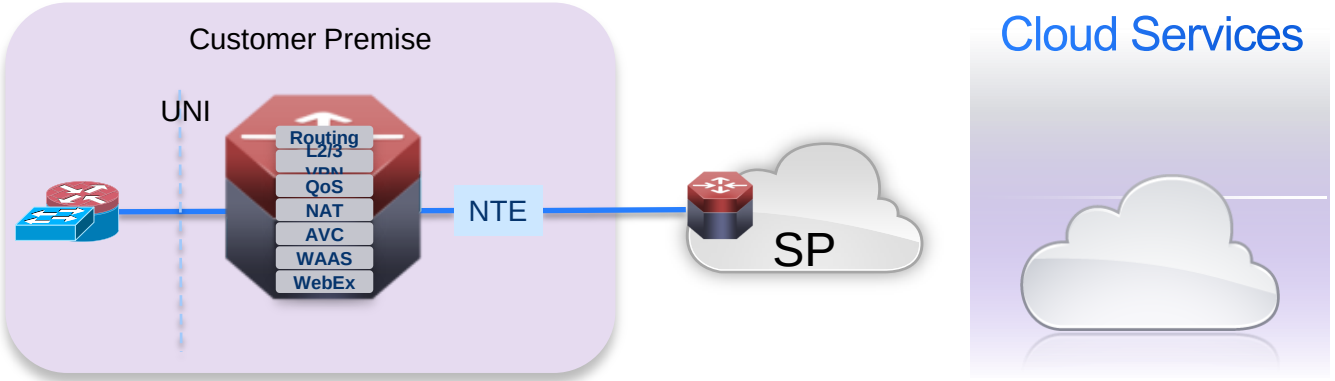
vCPE On-Premise – Enabling NfV

- L3 CPE functions delivered on a general purpose CPU platform (e.g. Cisco UCS)
- Local loop typically assumed to be Ethernet based
- Virtualised services (e.g. vWAAS, ASA 1000V) replace appliances for CPE functions



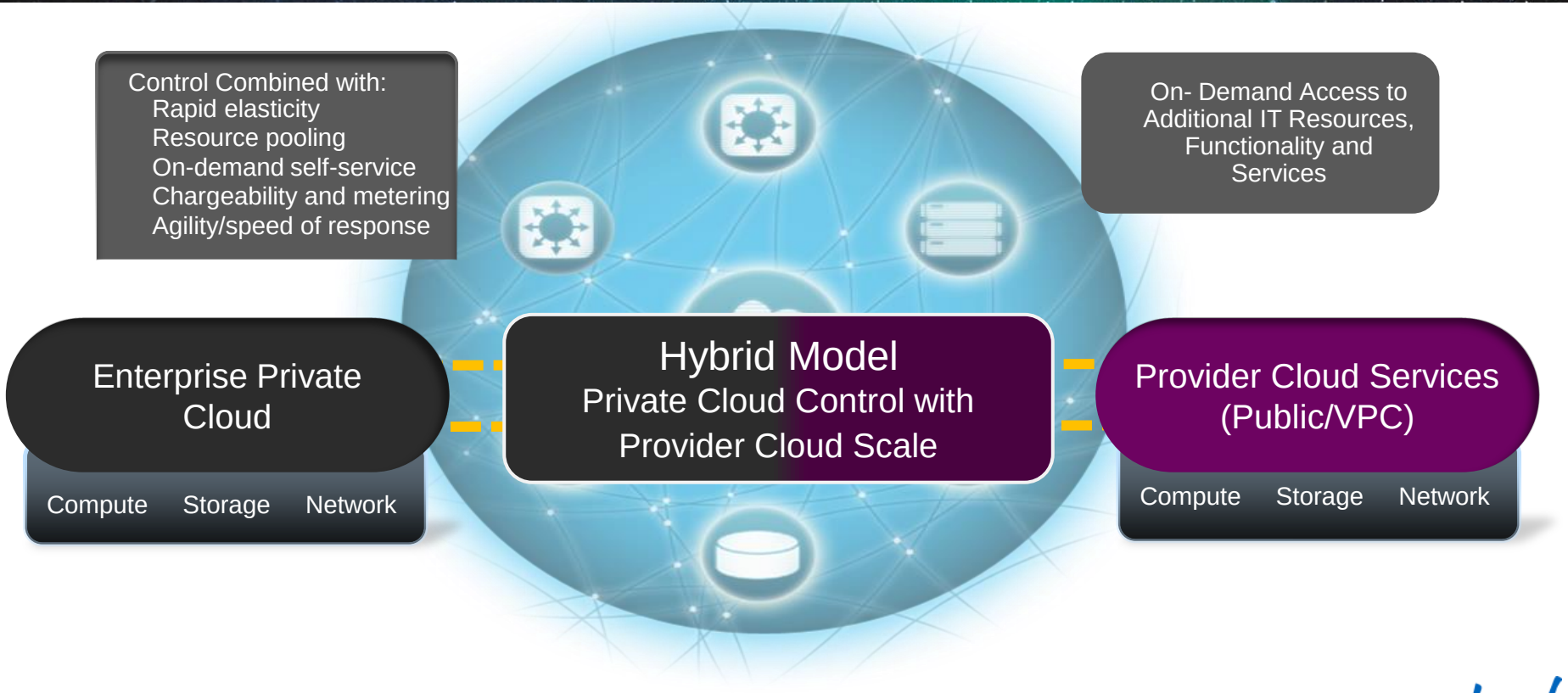
vCPE Off-Premise

- CPE functions moved into the SP PoP/ Cloud
- Off-premise CPE can be co-located in SP Edge PoP or centralised in Cloud DC
- L2 switches deployed on-premise

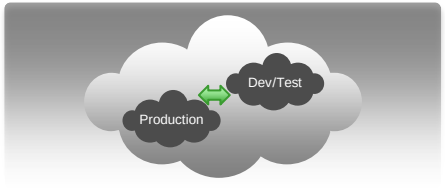


Cisco InterCloud – Hybrid Cloud Enabler

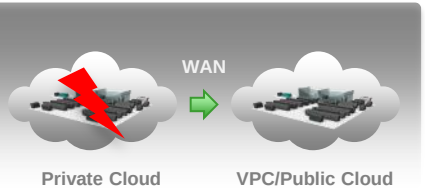
Hybrid Cloud Definition



InterCloud Supports Key Hybrid Cloud Use Cases



Common Peak Workloads



Dev/Test

Dev/Test Application across Private and Virtual Private Cloud

Bring Back Workload for Production Scale

Shadow IT Control

Providing Rapid Access to Hybrid Cloud Capacity

IT in Control of What and Where Applications Can Be Deployed

Capacity Augmentation

Bursting from Private Cloud to Virtual Private or Public Cloud for Peak Workloads

No Change to Application, Networking and Security

Disaster Recovery

Use Public Clouds for Backup and Disaster Recovery

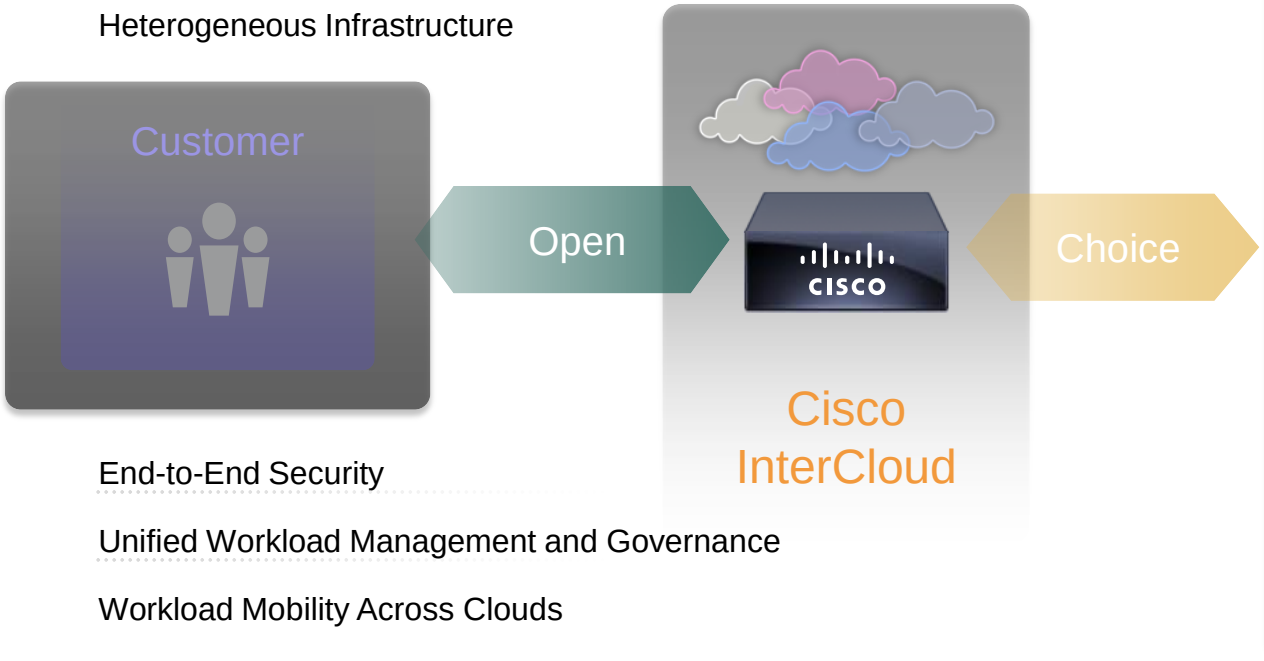
Securely Extend DC with Consistent Policies

Cisco's Hybrid Cloud Approach

No Vendor Lock-In

Any Hypervisor to Any Provider

Heterogeneous Infrastructure

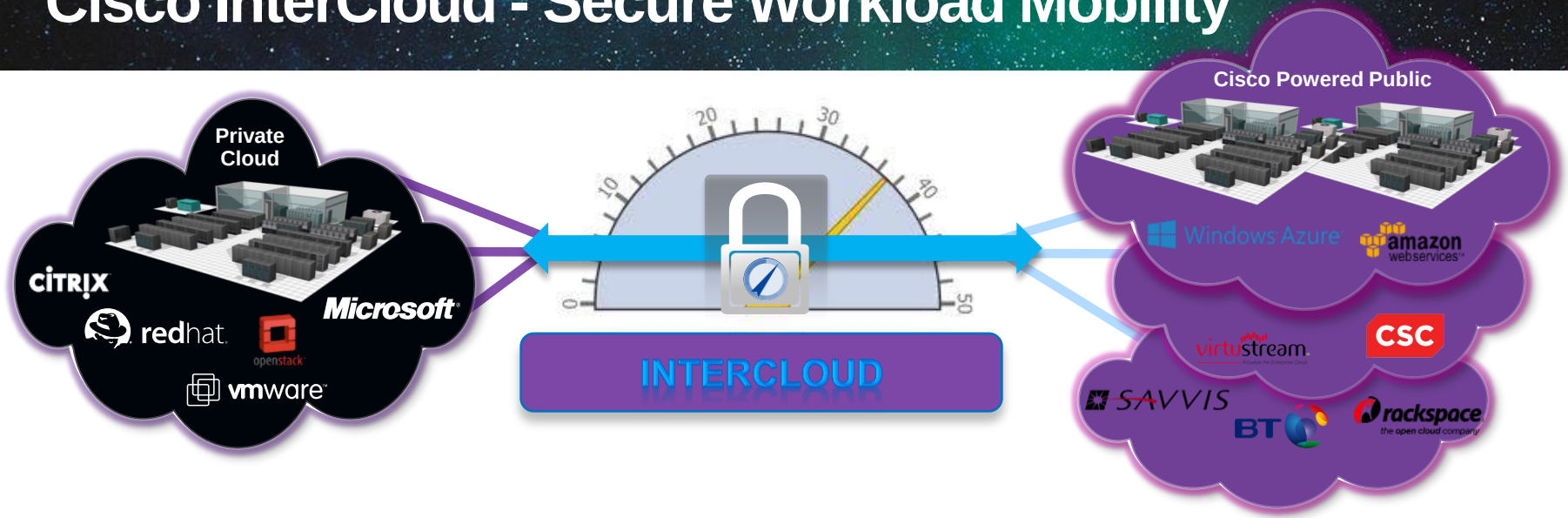


End-to-End Security

Unified Workload Management and Governance

Workload Mobility Across Clouds

Cisco InterCloud - Secure Workload Mobility

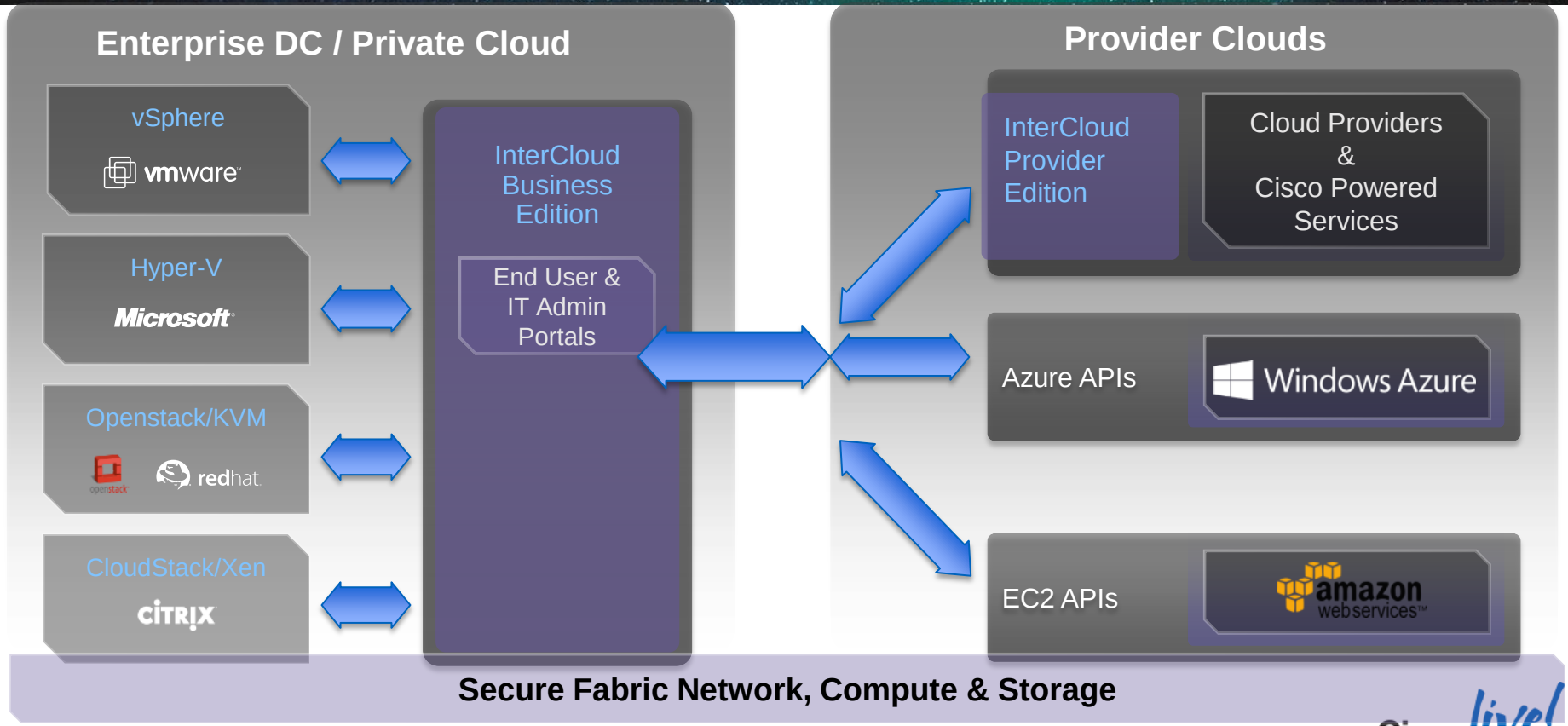


Open: Freedom to place workloads across heterogeneous Private and Public Clouds

Secure: Workloads in public clouds as a secure extension from private cloud

Bi-directional: Unified management and networking to move workloads across clouds

Cisco InterCloud Integration Models



Cisco InterCloud Value Proposition for Businesses

Choice Of Infrastructure to Meet Changing IT Requirements

Open

Heterogeneous On-Premises and Public Cloud Infrastructure

Multi-Cloud Support

Multi-Hypervisor Support

Protect Business Assets and Meet Compliance

Secure

Secure, Scalable Connectivity to Extend Private Cloud to Public Cloud

Consistent Policy Enforcement throughout the Hybrid Cloud

Workload Security in Public Cloud

Consistent Operations and Workload Mobility Across Clouds

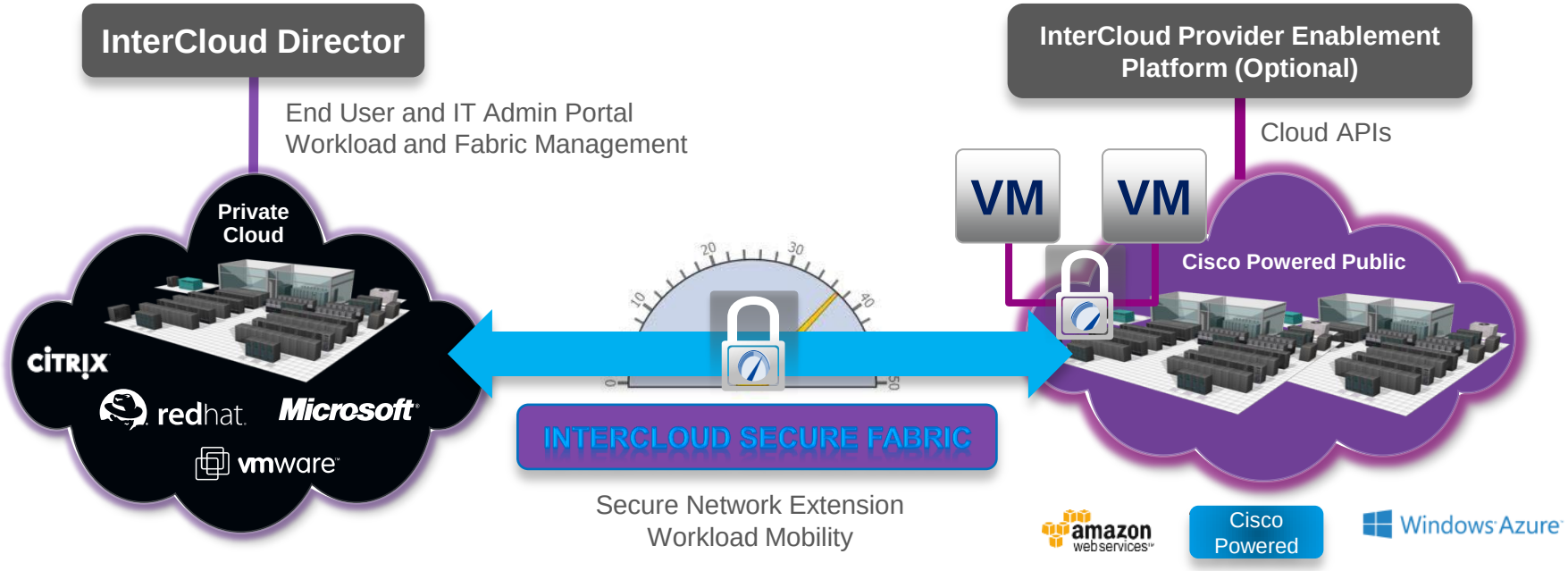
Flexible

Unified Hybrid Cloud Management for Users and IT Admins

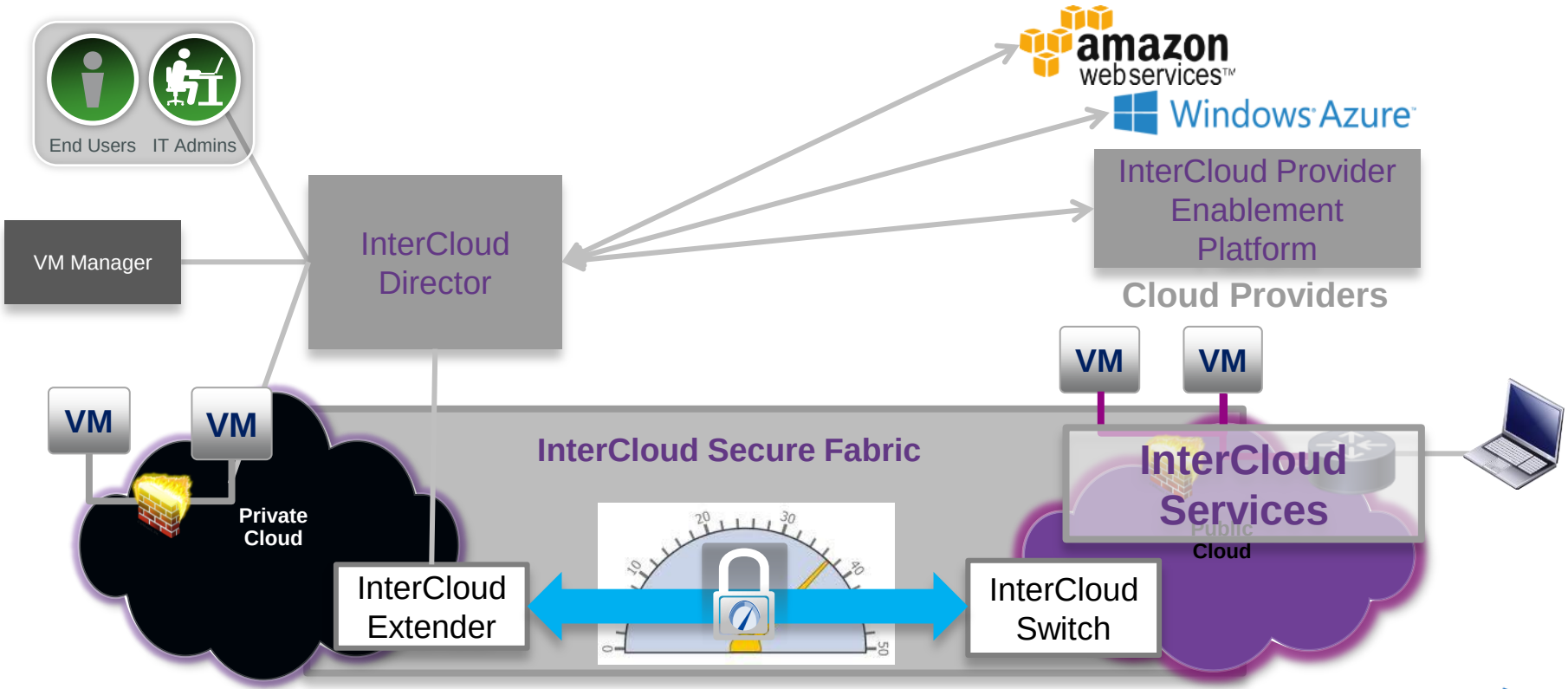
Workload Portability To and From Physical/Virtual/Hybrid Cloud

Policy Based Workload Placement

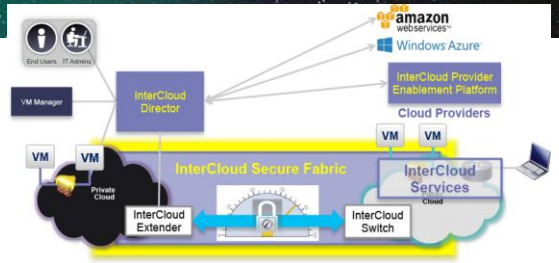
Cisco InterCloud Architecture



Cisco InterCloud Architectural Details

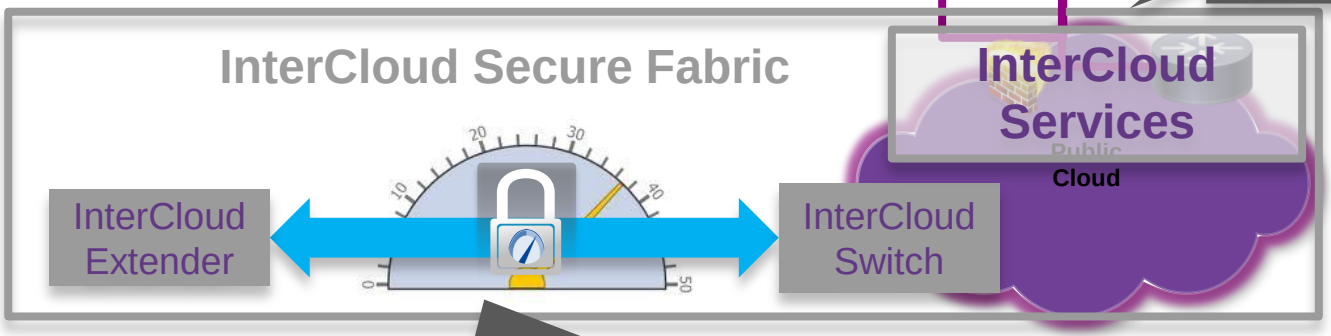


InterCloud Secure Fabric Key Features



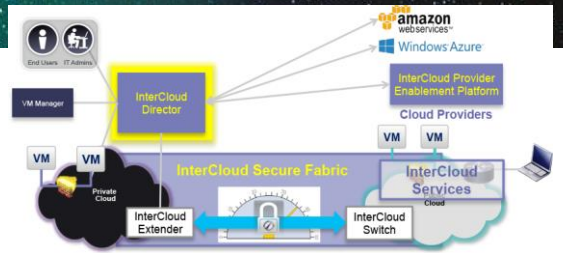
Flexible Application Reachability
Enterprise IP Address or Public IP Address

Consistent Network Policy
Cisco vPath Virtualised Network Services in Enterprise or Cloud



Secure Layer 2 Extension to Cloud
Extend VLAN with TLS Tunnel

Cisco InterCloud Director Features



End Users IT Admins

IT Broker
- Admin Portal
- Cloud Management based on Policy

Application-Centric
- End User Portal
- Physical, Virtual, Private and Public Clouds

VM Manager

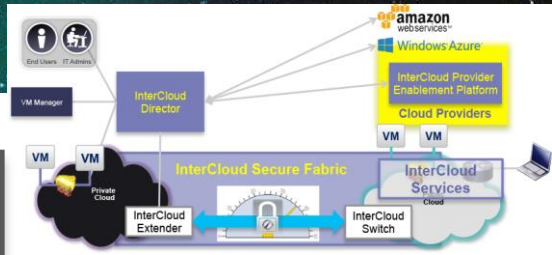
InterCloud Director

Open
- Open API for integration with other cloud management platforms

VM VM

Private Cloud

InterCloud Provider
Enablement Platform Features



Rapid Deployment
Enable Cloud Provider to Quickly Offer Hybrid Cloud Services

Open
API for Integration with Cloud Provider Management and Infrastructure

Interface with SP Management System or SP Portal

Open API

Interface with InterCloud Controller and Fabric

Cloud API

API Translation Logic

South Bound API

vCenter Adapter | vCloud Adapter | CloudStack Adapter | Others

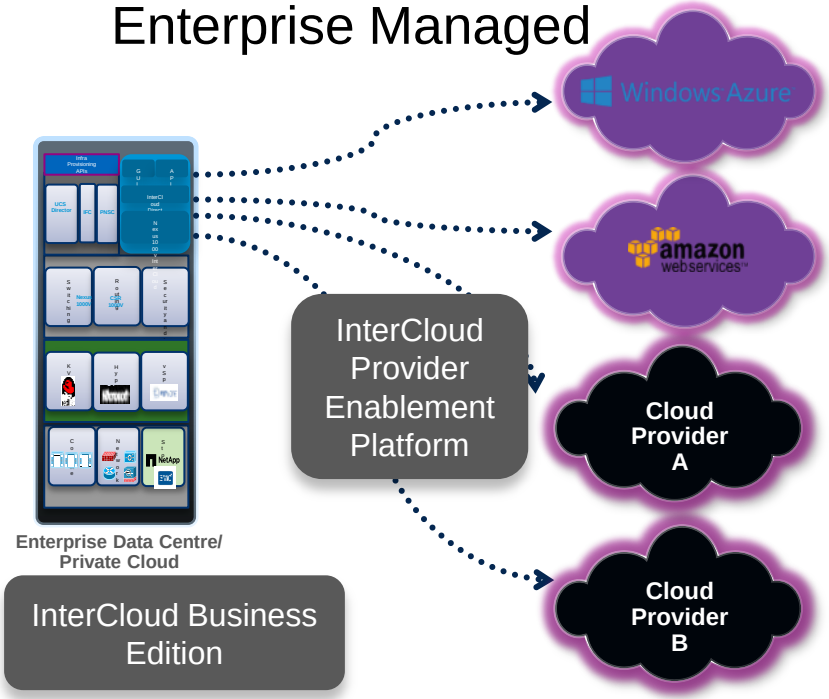
InterCloud Provider Enablement Platform

Cloud Providers

Flexible
Abstraction over Cloud Provider Infrastructure

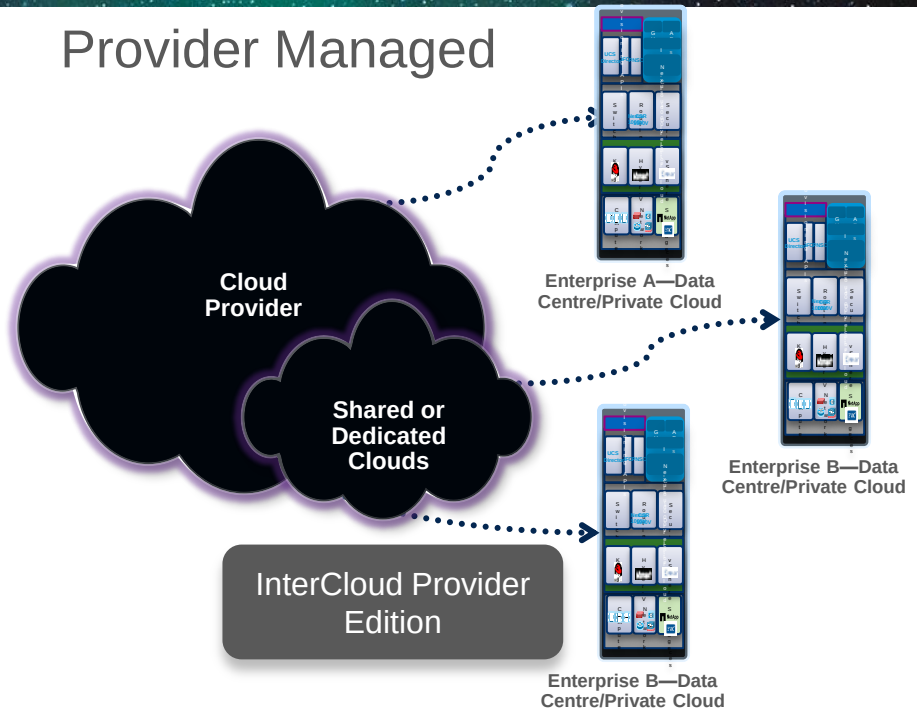
InterCloud Deployment Models

Enterprise Managed



- Enterprise procures and deploys software on-premise
- Choice of InterCloud enabled provider clouds
- No extra provider charge for InterCloud

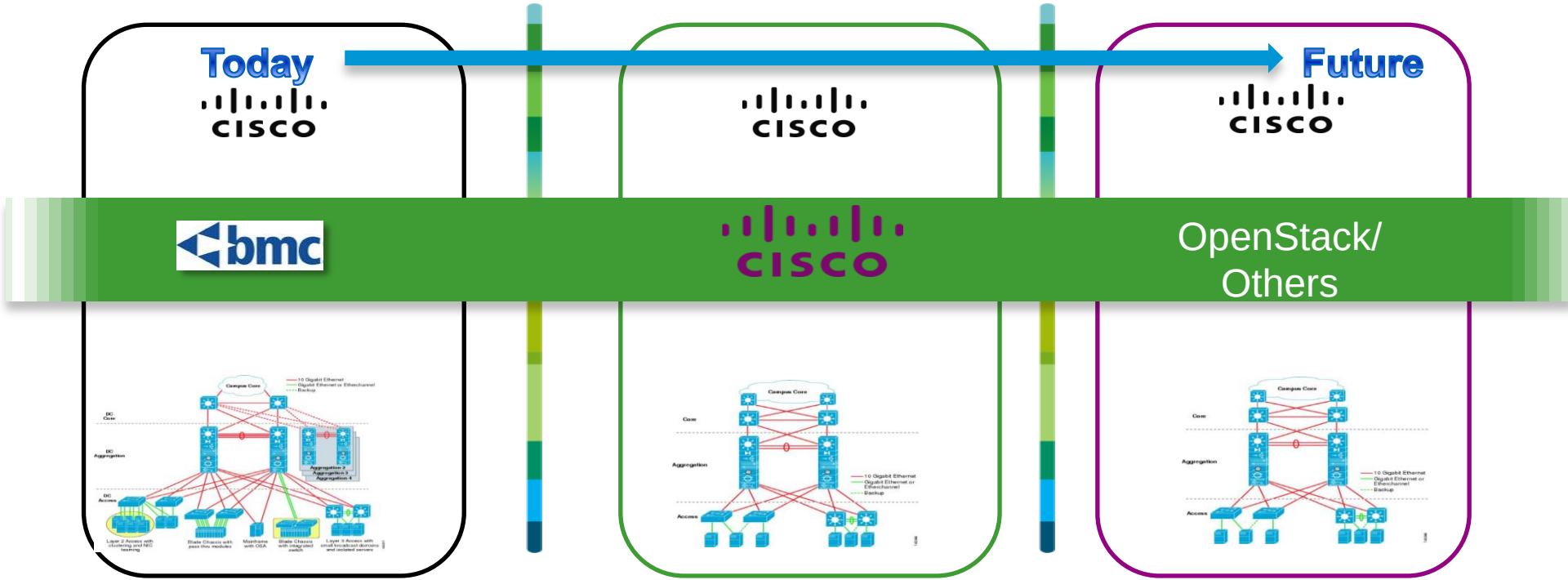
Provider Managed



- Provider procures and deploys software at enterprise
- Enterprise controls workload placement
- Enterprise pays provider for InterCloud service

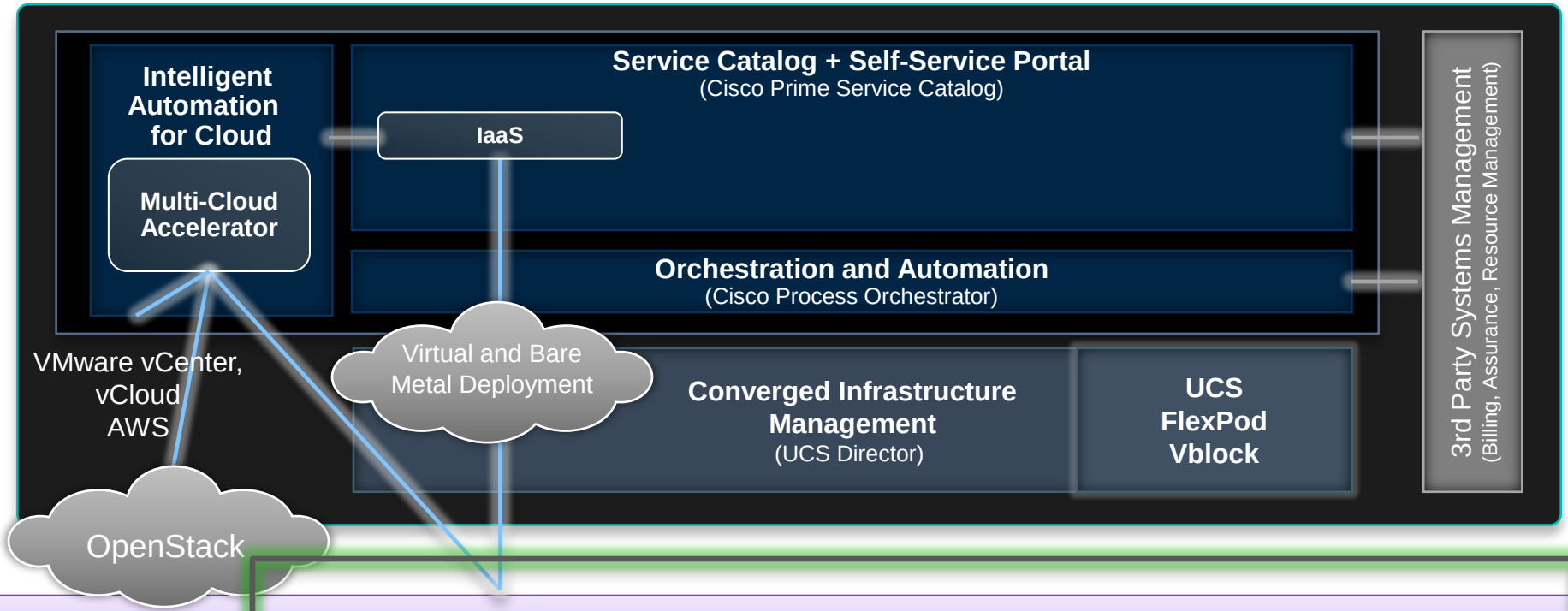
Cloud Orchestration Framework

Cisco Cloud Management Solutions



Intelligent Automation for Cloud 4.0

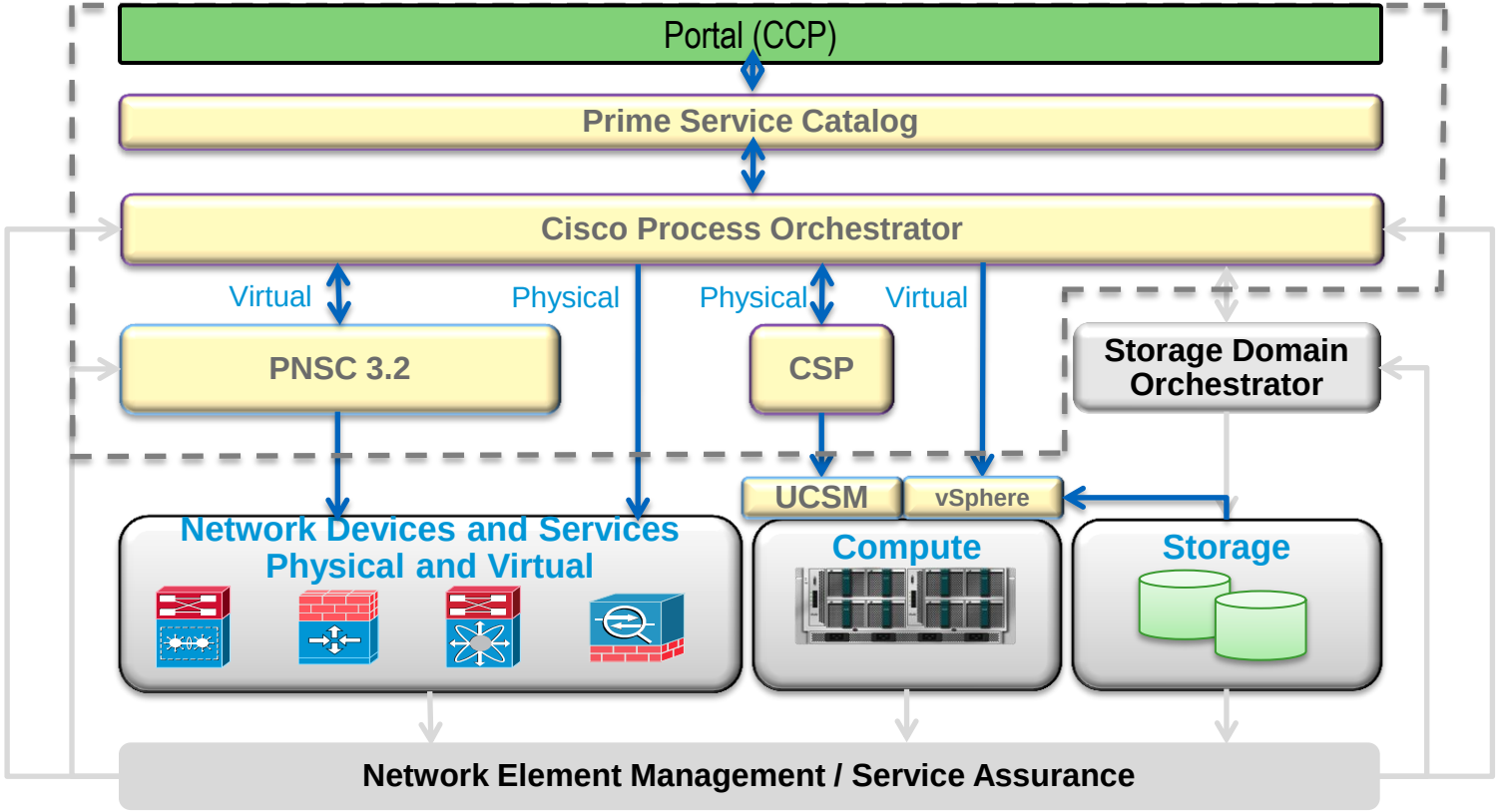
Network Automation for VSA



What's New in Cisco Intelligent Automation for Cloud 4.0 Beyond IaaS

- Integration with **CISCO UCS DIRECTOR** for virtual + physical infrastructure management
- New **SELF-SERVICE PORTAL AND SERVICE CATALOG** enhancements for IT as a Service
- **APPLICATION STACK ACCELERATOR PACK** for DevOps, with native Puppet + Chef support
- **HYBRID CLOUD** management support across Amazon, vCloud, and OpenStack
- **NETWORK SERVICES AUTOMATION** with Cisco Prime Network Services Controller
- Advanced **PRICING AND SHOWBACK** support for improved governance and control
- Enhanced multi-tenant and **MULTI-ORGANISATION** support for SPs and large enterprises

System Design Overview



IaaS/PaaS: What do End Customers Want?

Client #1

(requires IaaS services only)

"Give me the VMs and storage and I'll manage everything above the OS"

Client #2

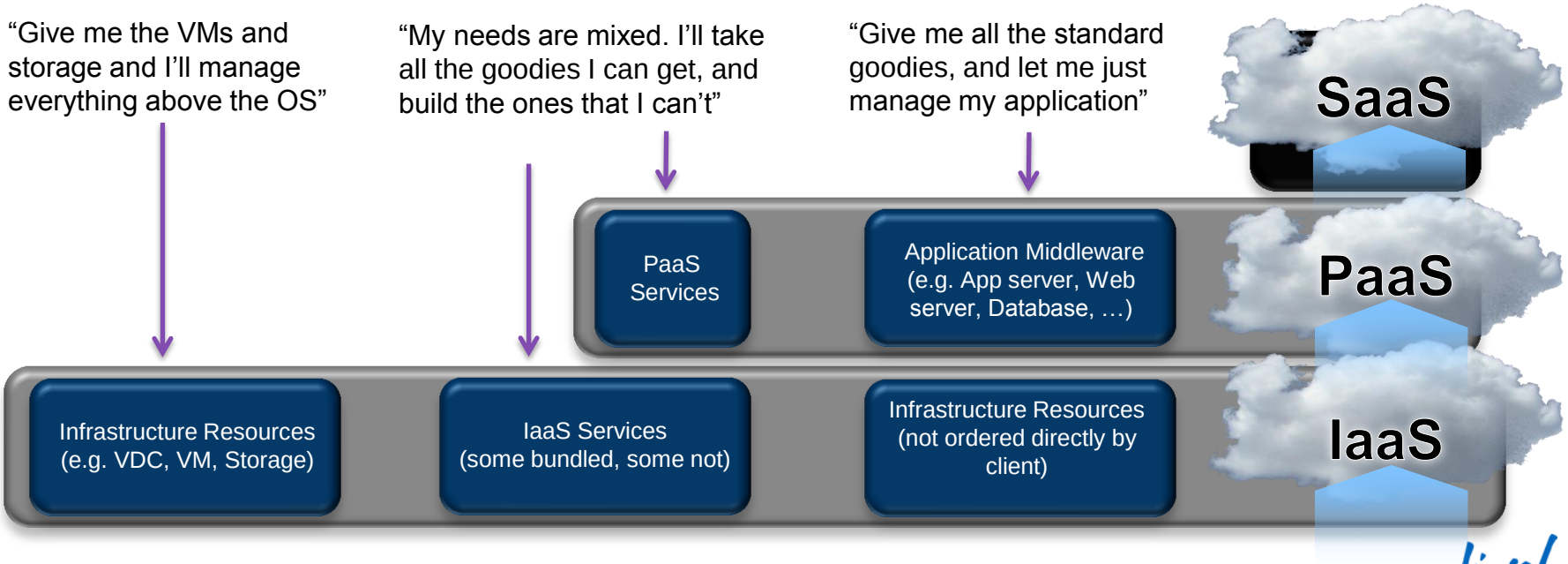
(requires IaaS & PaaS services)

"My needs are mixed. I'll take all the goodies I can get, and build the ones that I can't"

Client #3

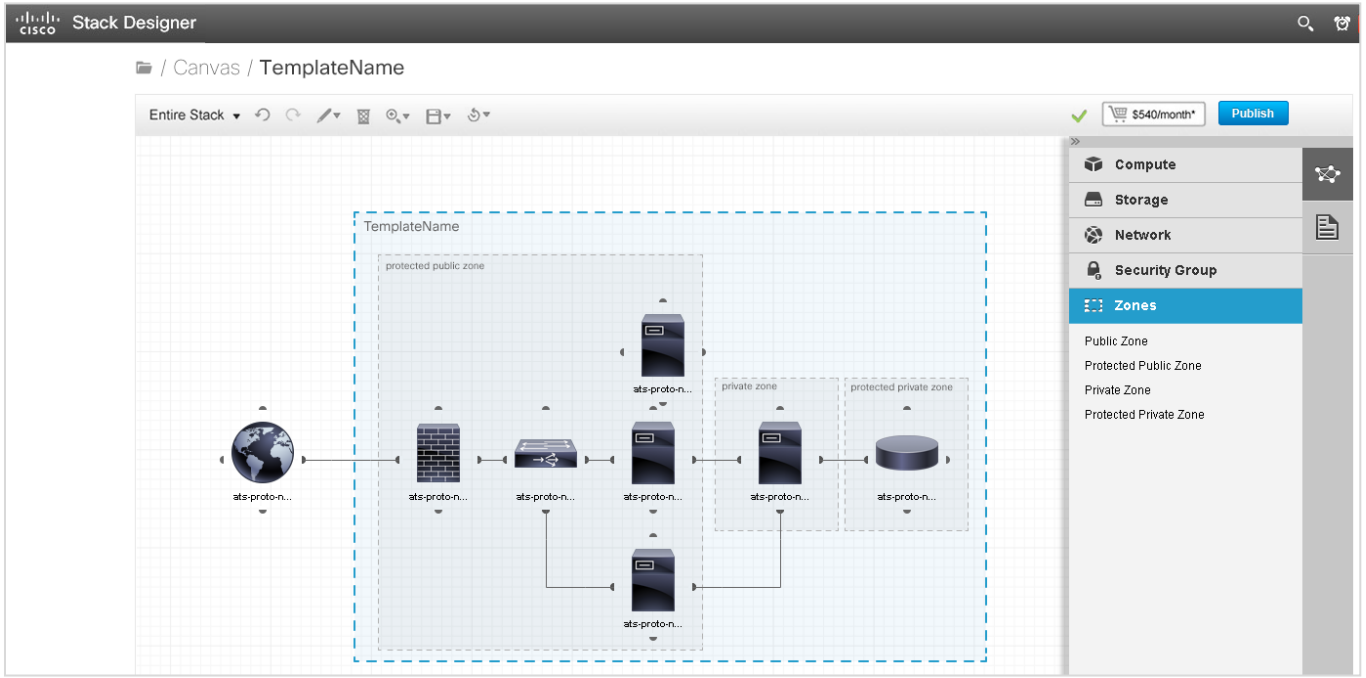
(requires PaaS services only)

"Give me all the standard goodies, and let me just manage my application"

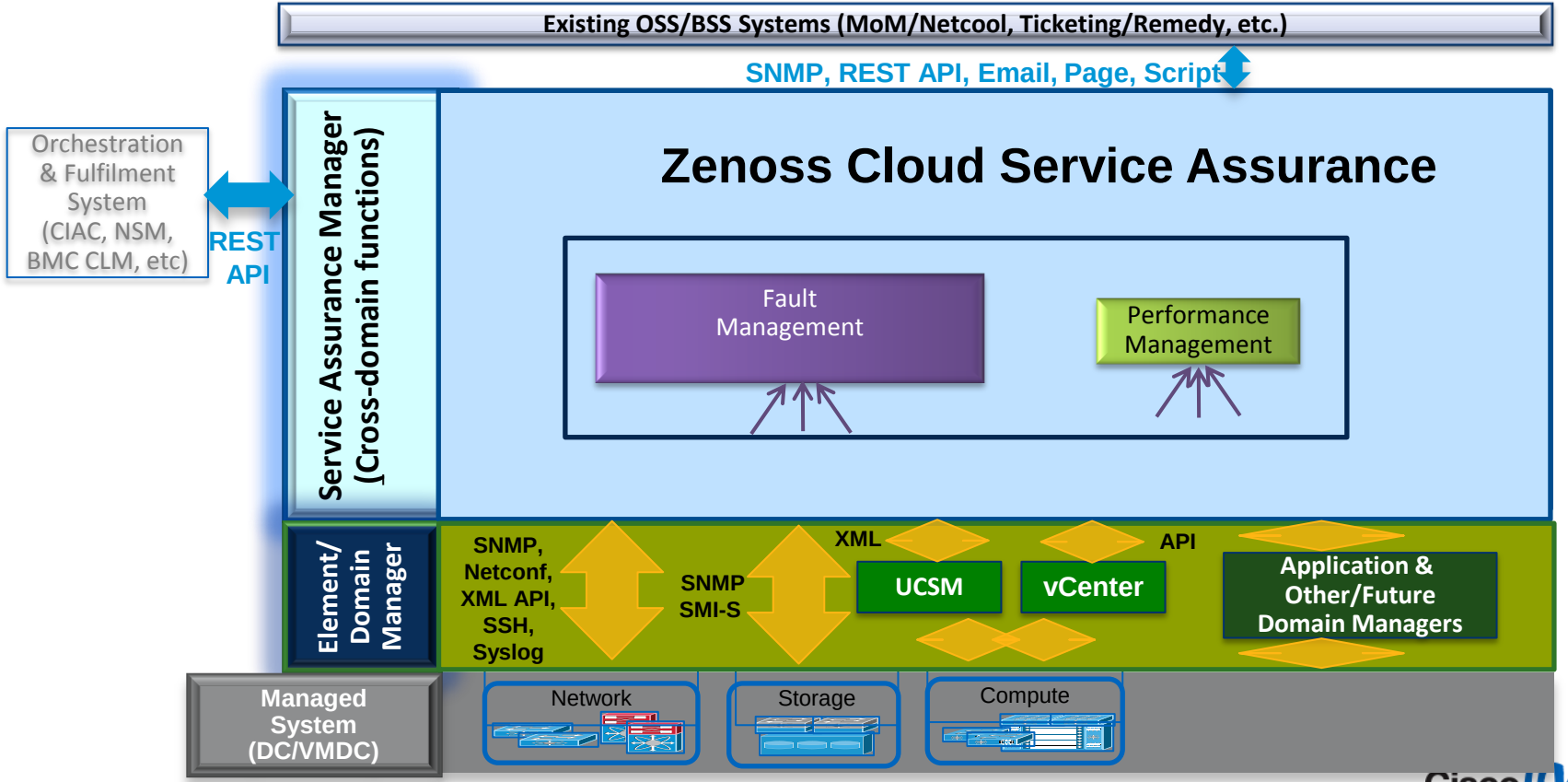


DevOps Solution Accelerator Stack Designer

- GUI-based configuration of complete application stacks
- TOSCA-based
  - Graphically describes interoperability of all application stack components
- Puppet or Chef codelets behind GUI icons



Cloud Service Assurance for VMDC - Architecture



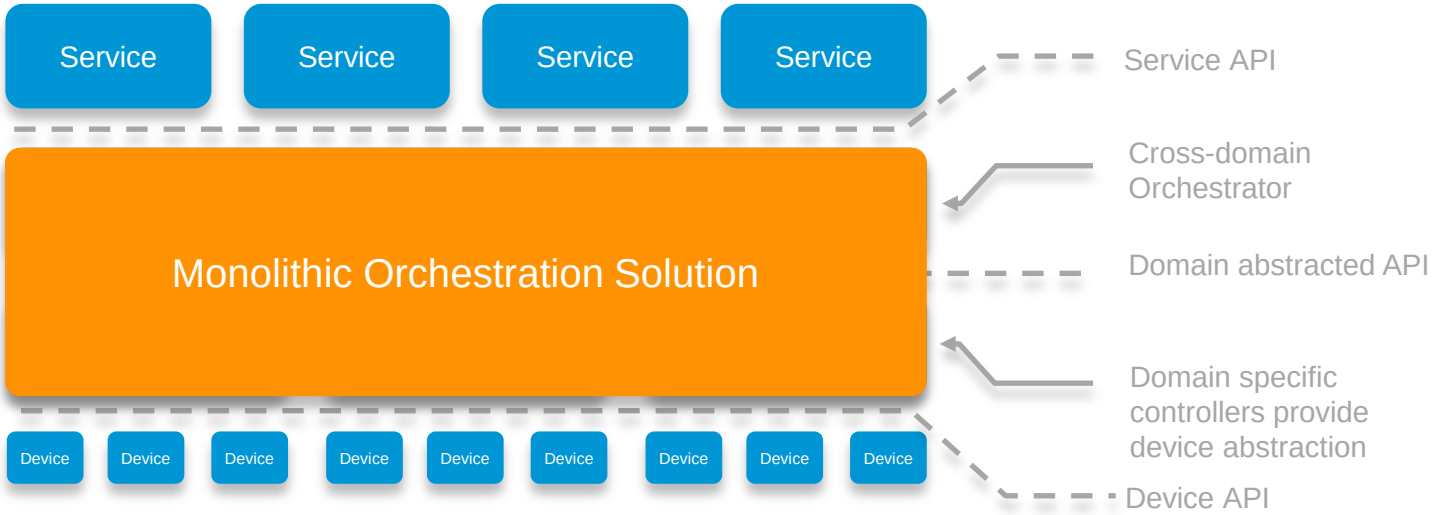
VMDC / VSA Benefits Summary

- VMDC is the Cisco validated reference architecture for Public/Private/Hybrid Cloud Infrastructure
- Multiple VMDC phases and tenancy models – evolving with new technologies/platforms and customer needs
- Multi-tenancy, service differentiation, tiered security services, virtualisation and automation are key for cloud deployments
- Cisco CVDs for cloud infrastructure, orchestration and assurance enable quicker adoption and deployment of complex technologies for end-end solutions
- Out-of-Box Orchestration support for different VMDC designs and tenancy models
- Use these as blueprint, change as necessary to design/deploy your own Clouds
- Do not over complicate Cloud Infrastructure designs – it will make Orchestration complex!

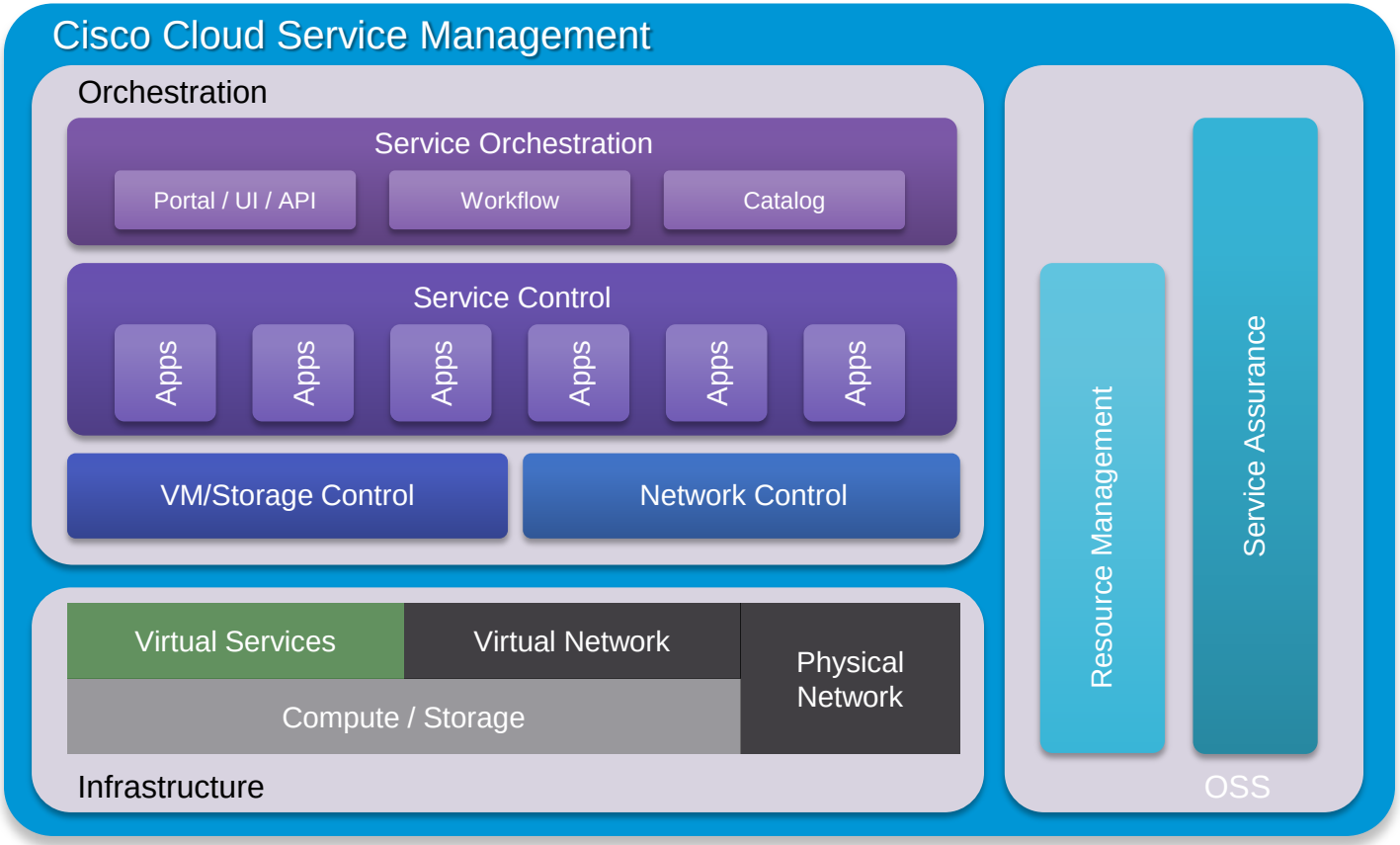
SDN / NfV in Multi-tenanted SP DC

Generalised Cloud Orchestration Model

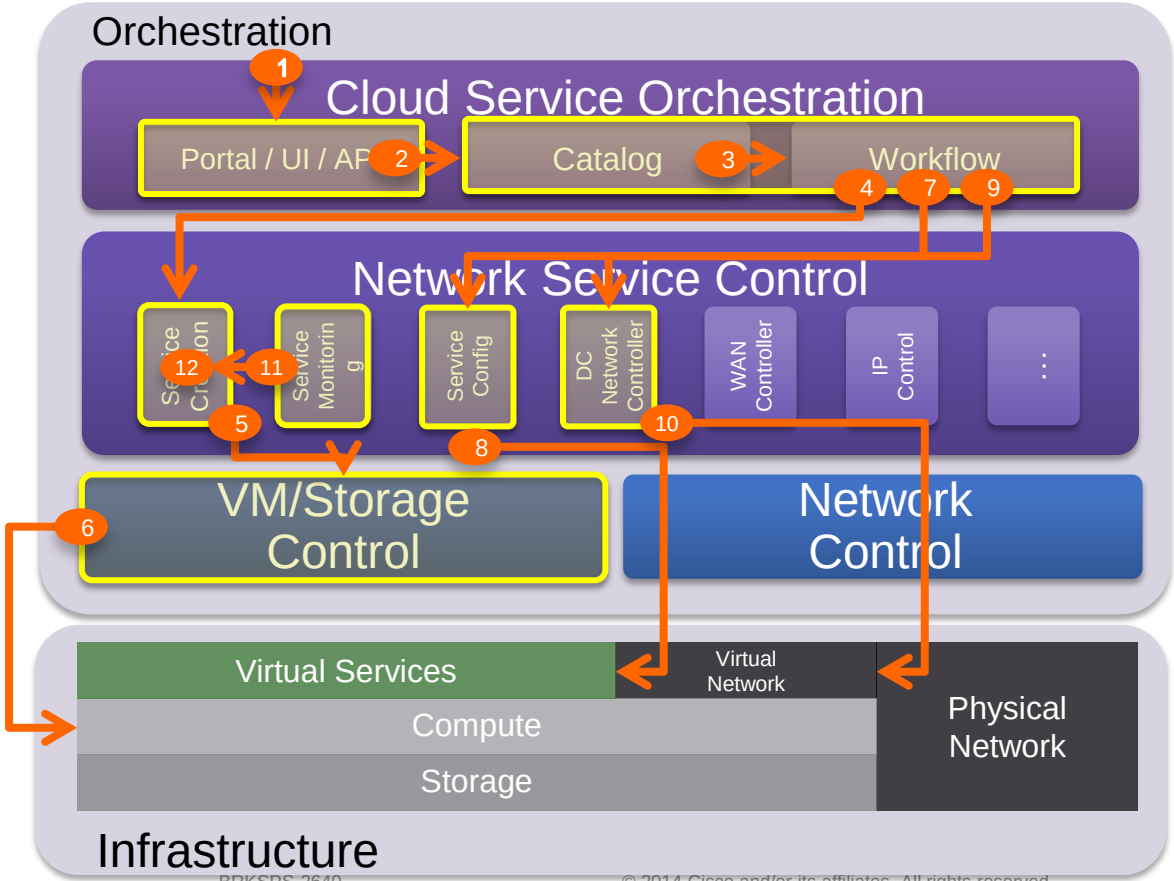
- From monolithic approach in the past …



Network Function Virtualisation
NfV Orchestration

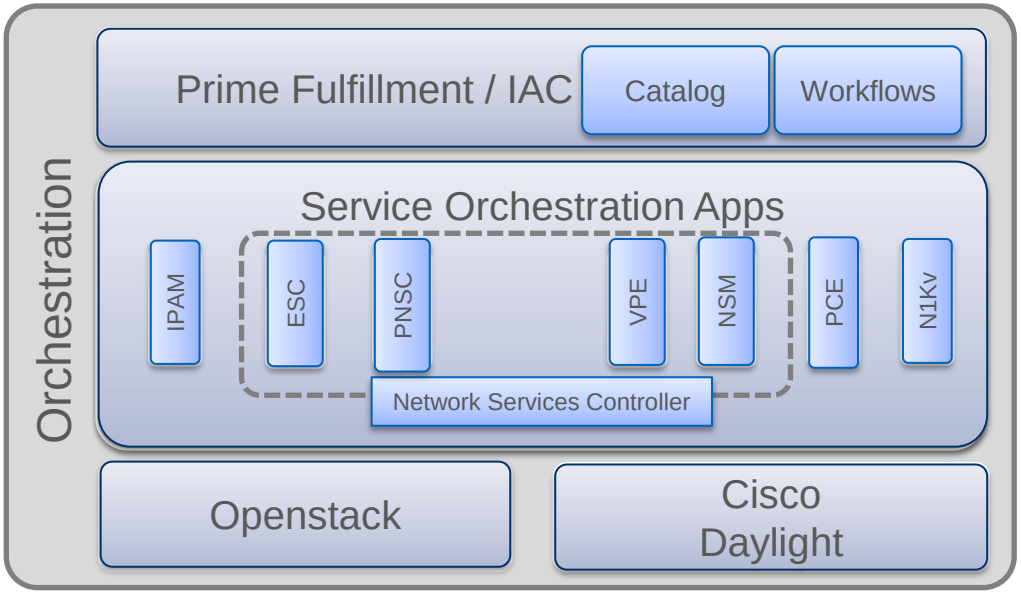


NfV Example Workflow



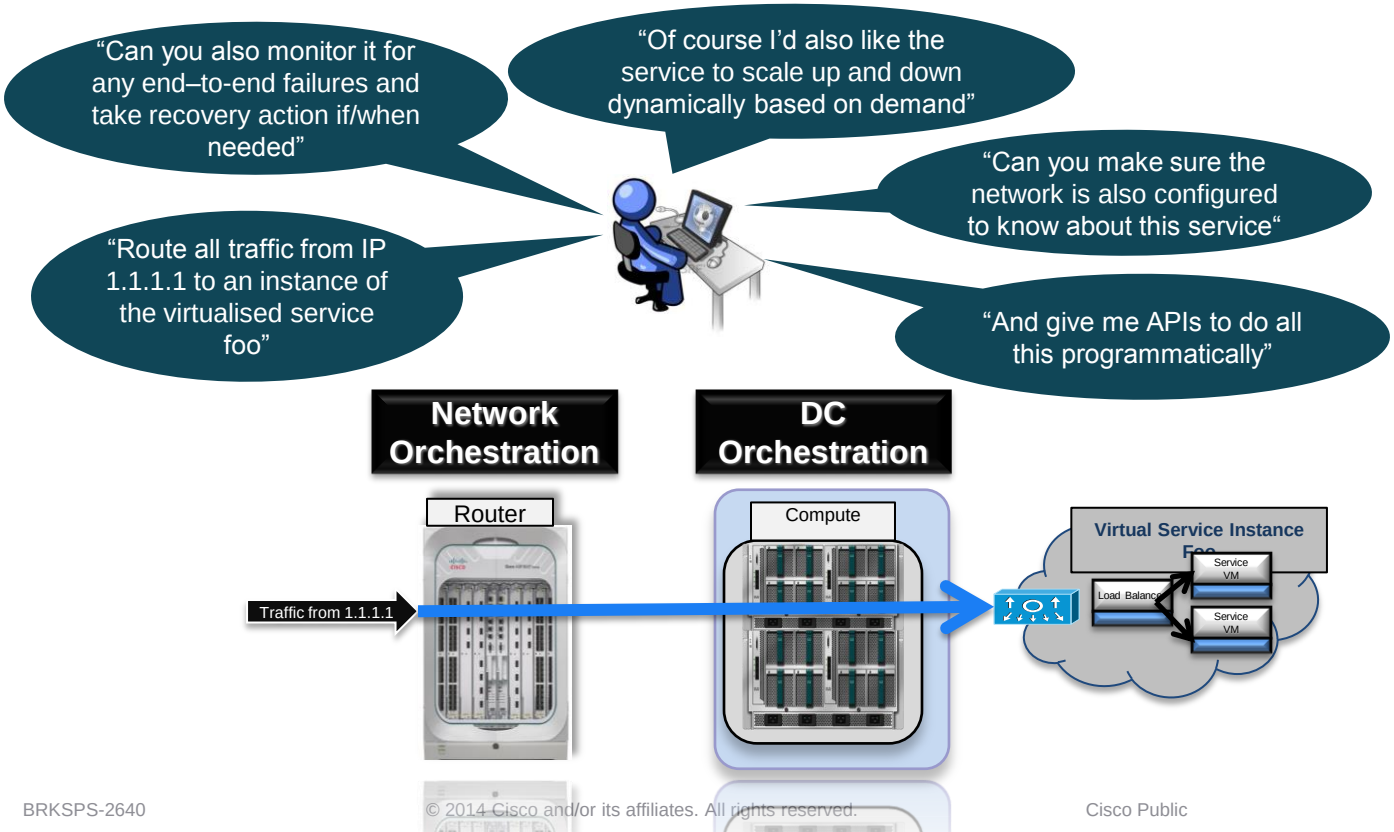
1. Request received
2. Catalog item
3. Defines workflow
4. Workflow calls Service Creation to set up service VMs
5. Service Creation calls to Openstack to set up VMs
6. Openstack sets up VMs
7. Workflow calls to Service Config function to set up services
8. Service Config configures services
9. Workflow calls DC network controller
10. DC network controller configures overlay network
11. Service monitoring tracks availability and performance of service
12. Service Creation manages service elasticity and high availability

Cisco Cloud Service Orchestration - Framework



Enabling Technologies and Elements (vPE and ESC)

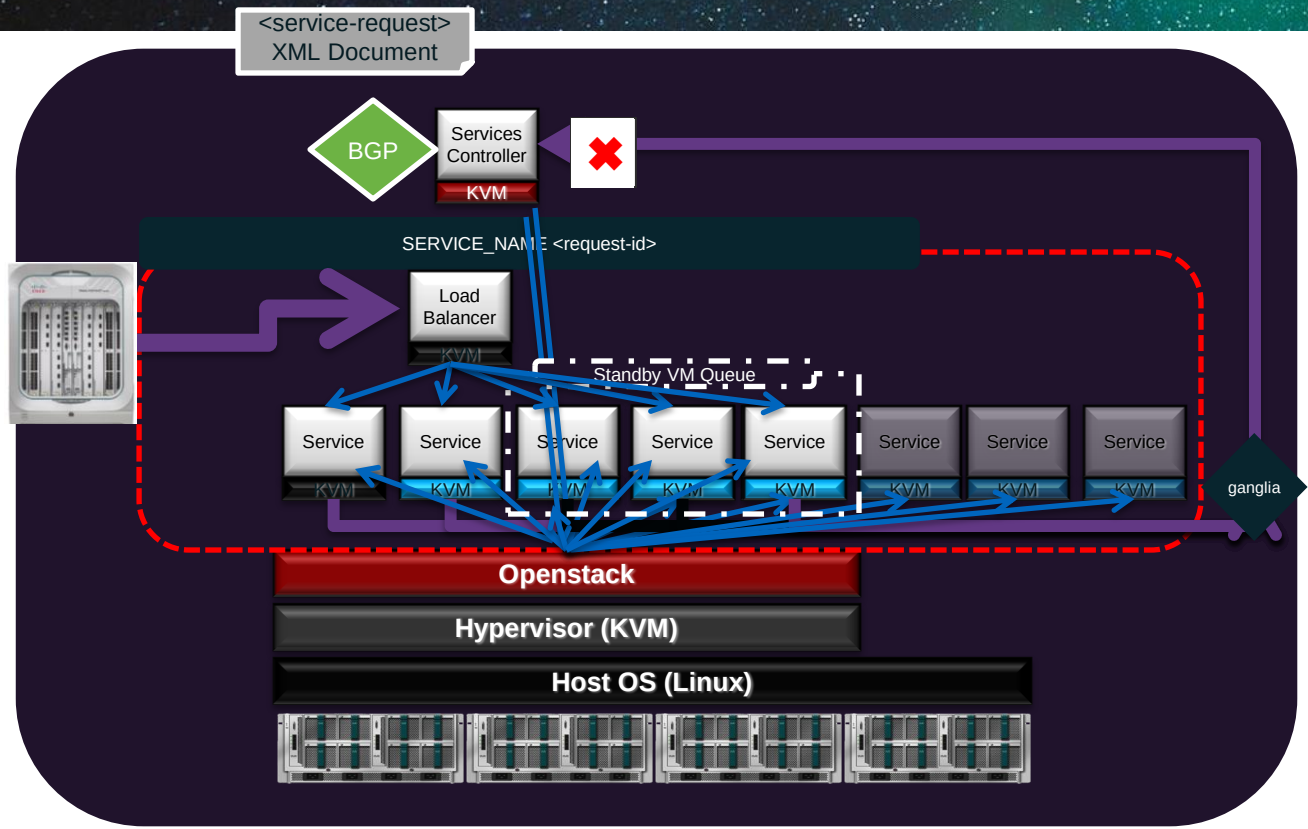
End-to-End Dynamic Provisioning and Monitoring of Virtualised Services



What Services?

.. Many familiar network services functions have already been developed for virtualised implementations

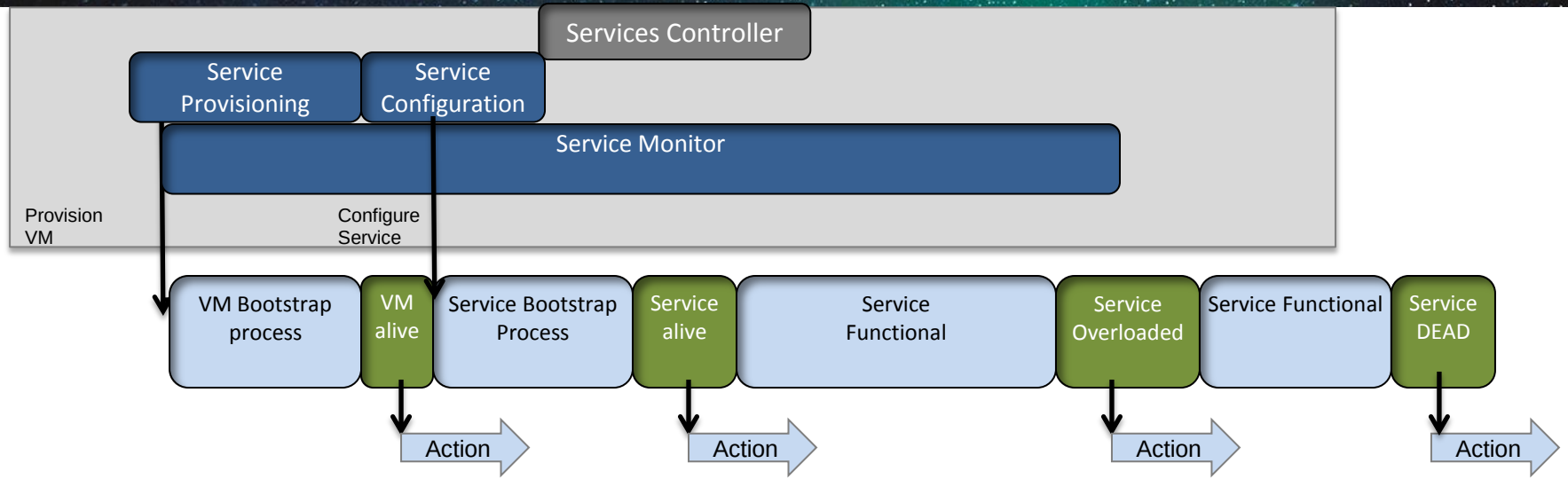
Elastic Services Controller - Example




```xml
<?xml version="1.0" encoding="UTF-8"?>
<service-request name="46-swire" version="1.1">
    //
    // This is the data that is passed down from the
    // GUI to the FEDC-Controller when a specific service
    // is being requested as part of the START_SERVICE call.
    //
    // The GUI provides the request-id of this request which it
    // will use to uniquely identify the service in the
    // fedc-controller-status XML returned from a GET_STATUS call
    //
    <parameter request-id="737448483823912"/>
    <parameter anycast-address="2607:f0d0:1000:51::1"/>
    <parameter internet-address="171.29.50.1"/>
    <parameter elastic-mode="true"/>
    <parameter min-instance="2"/>
    <parameter max-instance="10"/>
    <parameter standby-queue-depth="3"/>
    <parameter upper-threshold-load="75"/>
    <parameter lower-threshold-load="25"/>
</service-request>
```

1. <service-request> is generated and sent to the Services Controller which then creates the active VMs and hot-standby VMs
2. Service starts and reports application stats to the Service Controller STATUS=OK
3. Load increases and VMs are getting overloaded STATUS=OVERLOAD
4. Services Controller activates 3 of the “hot-standby” VM and adds them to the running service causing the load on all VMs to decrease below the threshold
5. The Services controller backfills the “hot standby” queue by booting 3 new VMs but not activating them

Service Lifecycle Management - Monitoring & Elasticity



List of Events

- VM Alive
- Service Alive
- Upper load threshold crossed
- Lower load threshold crossed
- Service Dead

List of Actions

- Notify (callback)
- Advertise Service
- Withdraw Service
- Restart VM
- Scale up (add a VM)
- Scale down (remove a VM)

Simple Rules

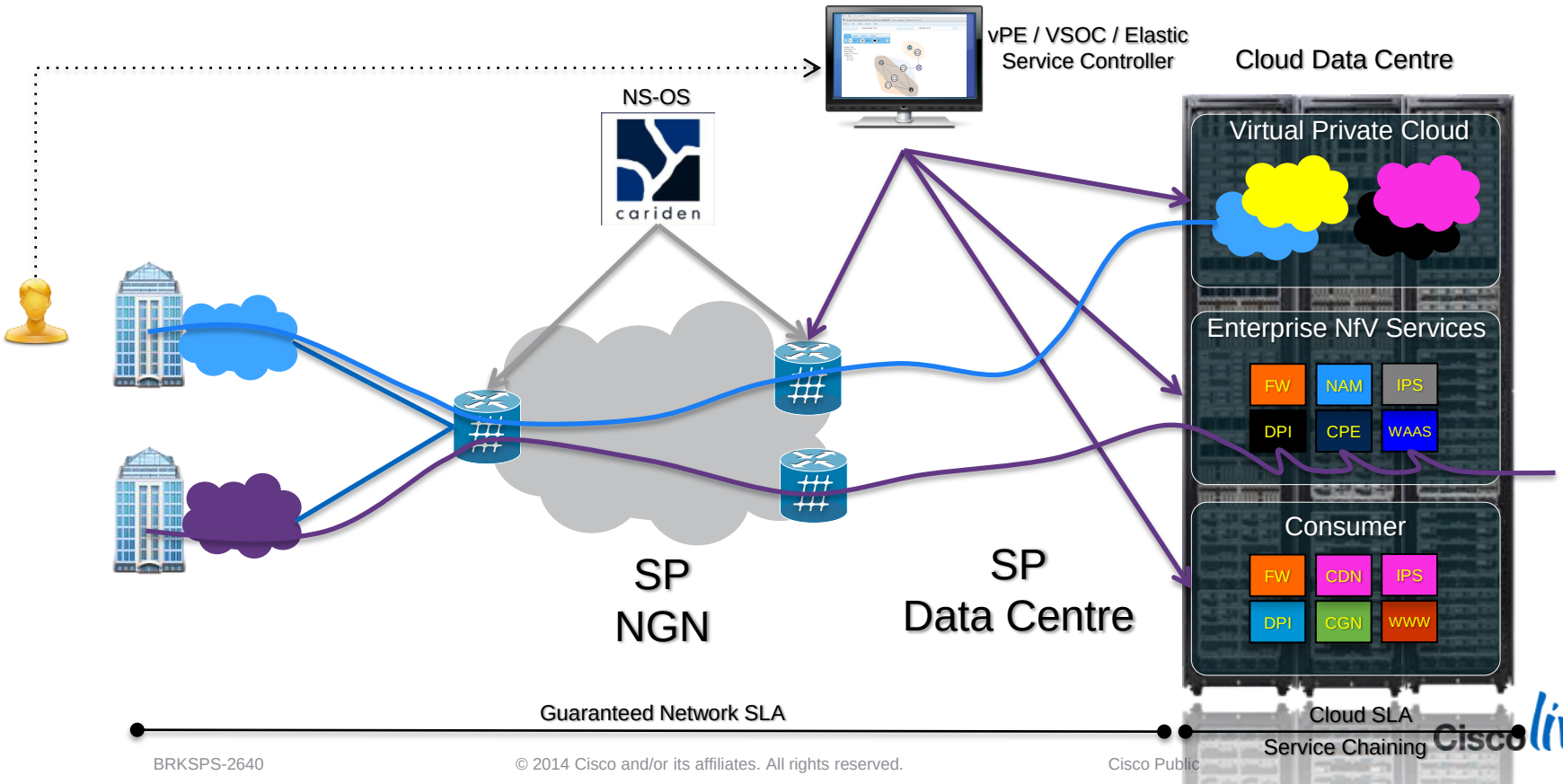
- Service Alive => advertise
- VM Dead => withdraw
- Upper load => scale up

Complex Rules

- Service Alive => Advertise, Notify
- Upper load => Scale up, Notify, Advertise
- Service Dead => Withdraw, Notify, Restart

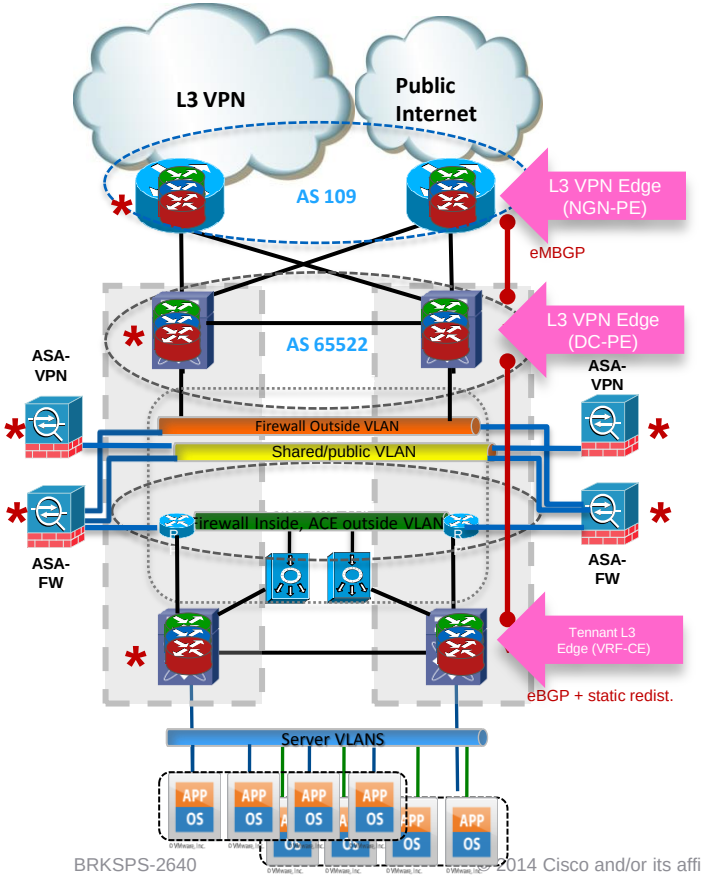
Service Provide Cloud Offering

Unique end-to-end Customer Experience

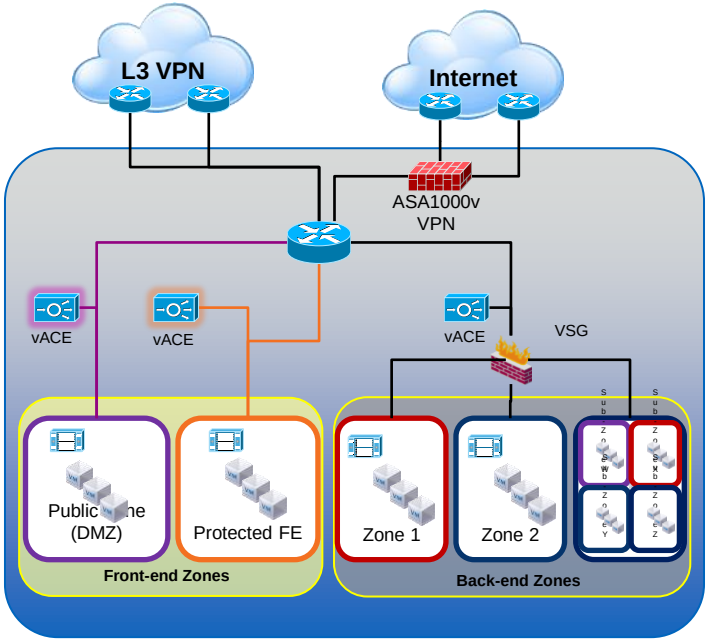


Data Centre Evolution

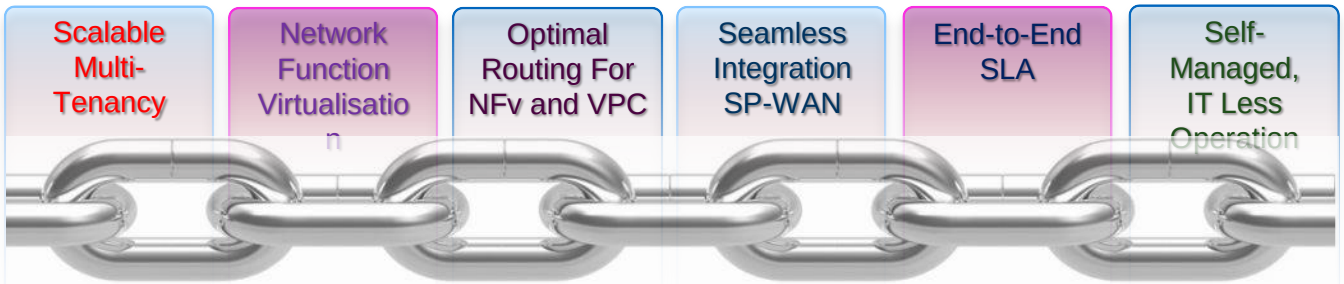
Traditional DC



vPE DC



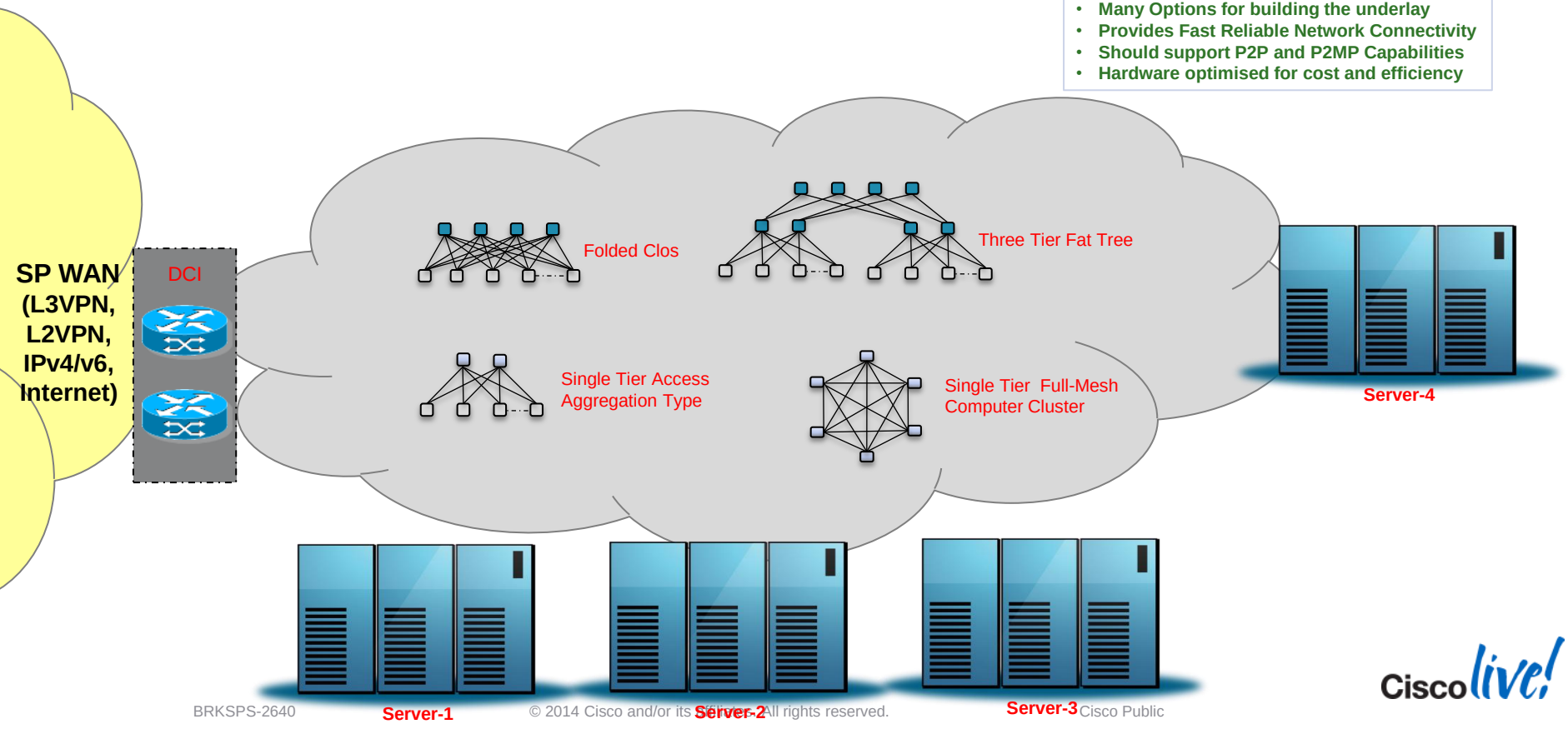
Solution Interdependencies
Need an Architectural Approach



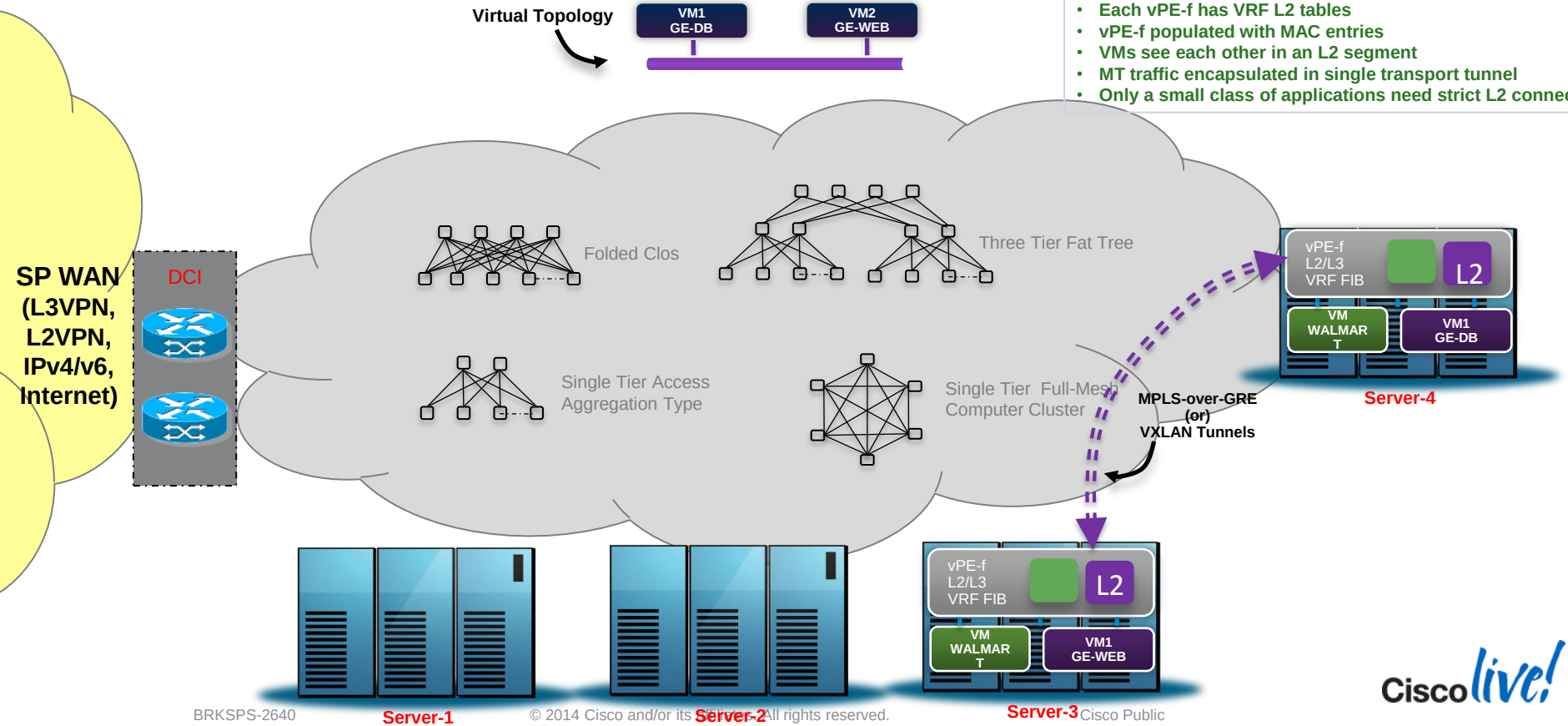
- Multiple ways of addressing each problem
- Interdependencies between options
  - One will impact another
- Need an architectural approach to solve the problem rather than point solutions

Data Centre Fabric – The Underlay Network

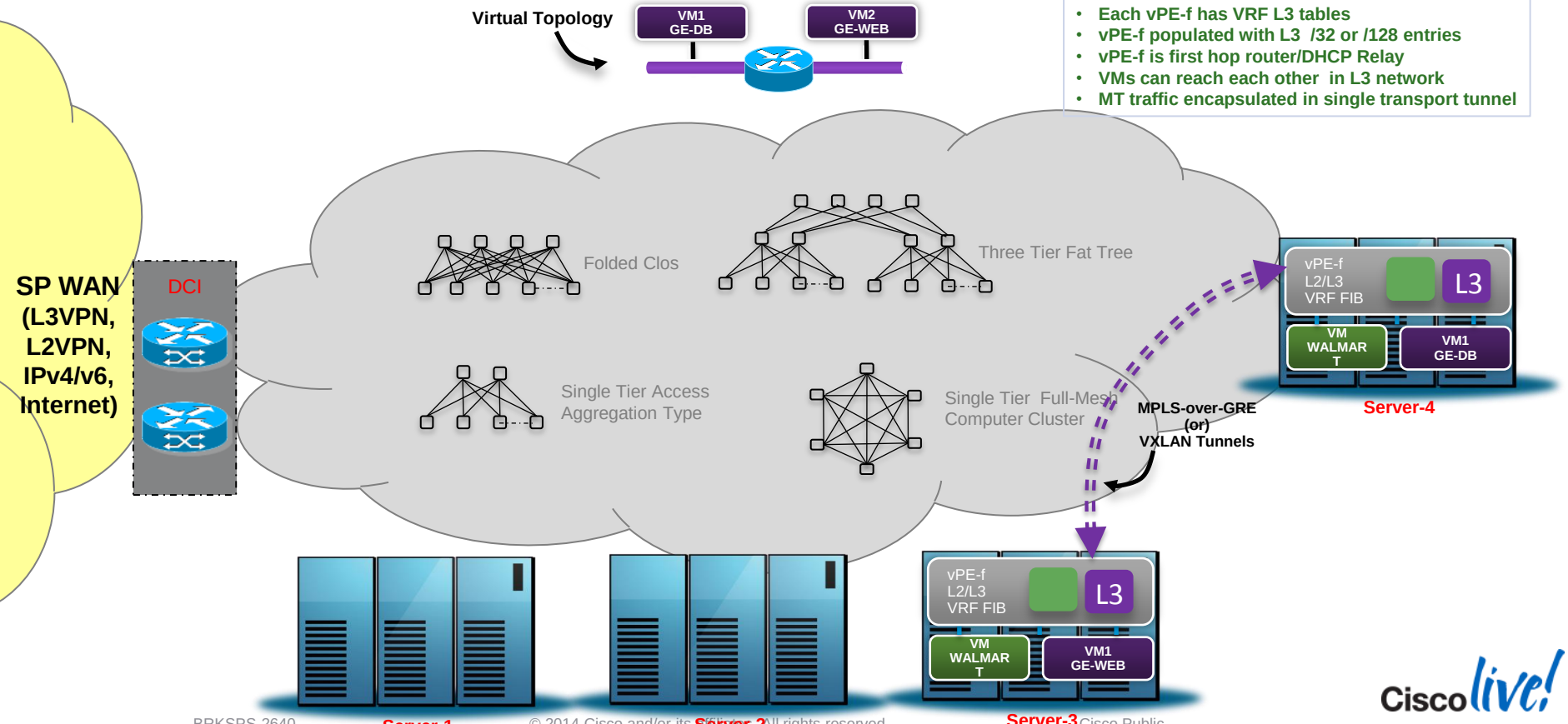
- Many Options for building the underlay
- Provides Fast Reliable Network Connectivity
- Should support P2P and P2MP Capabilities
- Hardware optimised for cost and efficiency



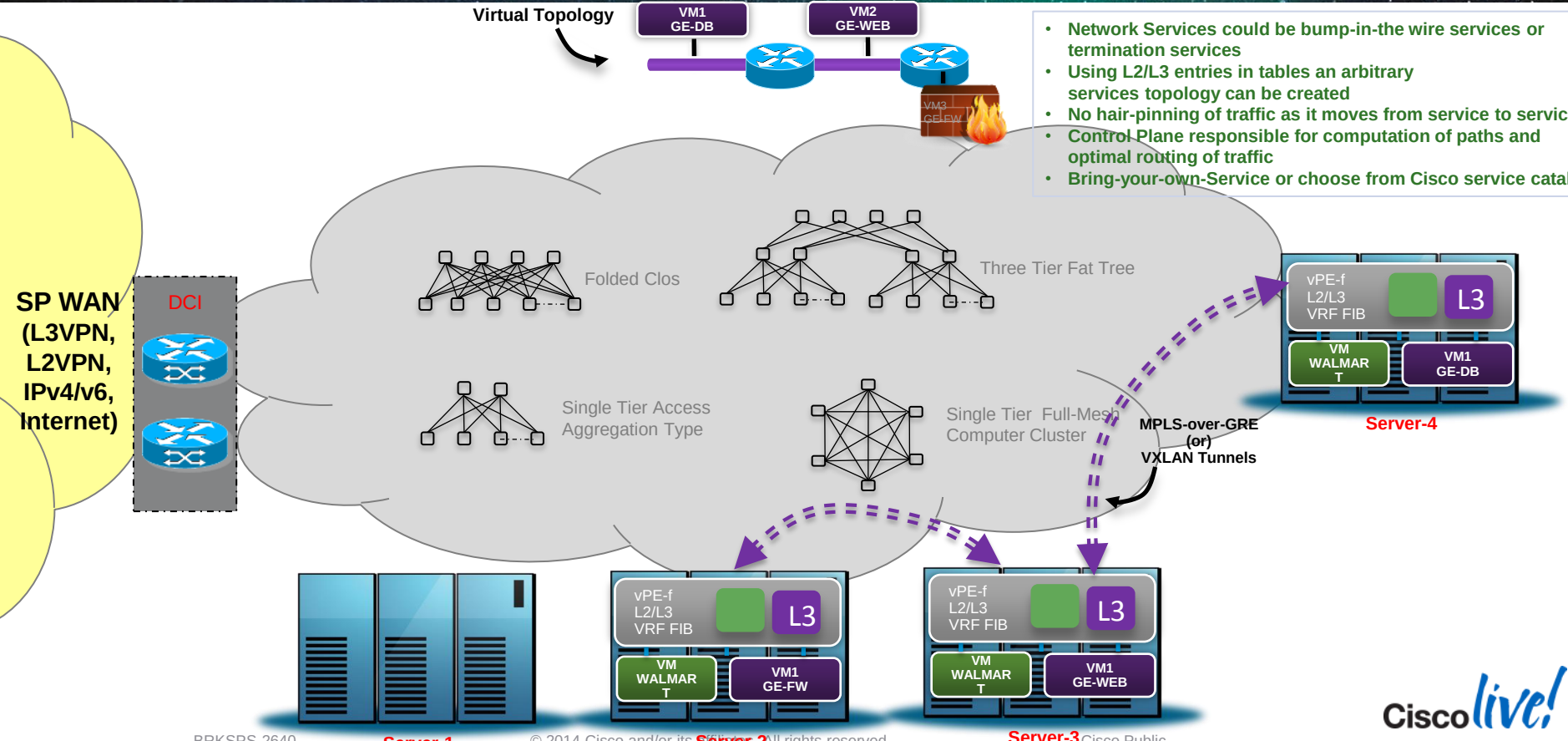
vPE Intra-Segment Forwarding



vPE Inter-Segment Forwarding

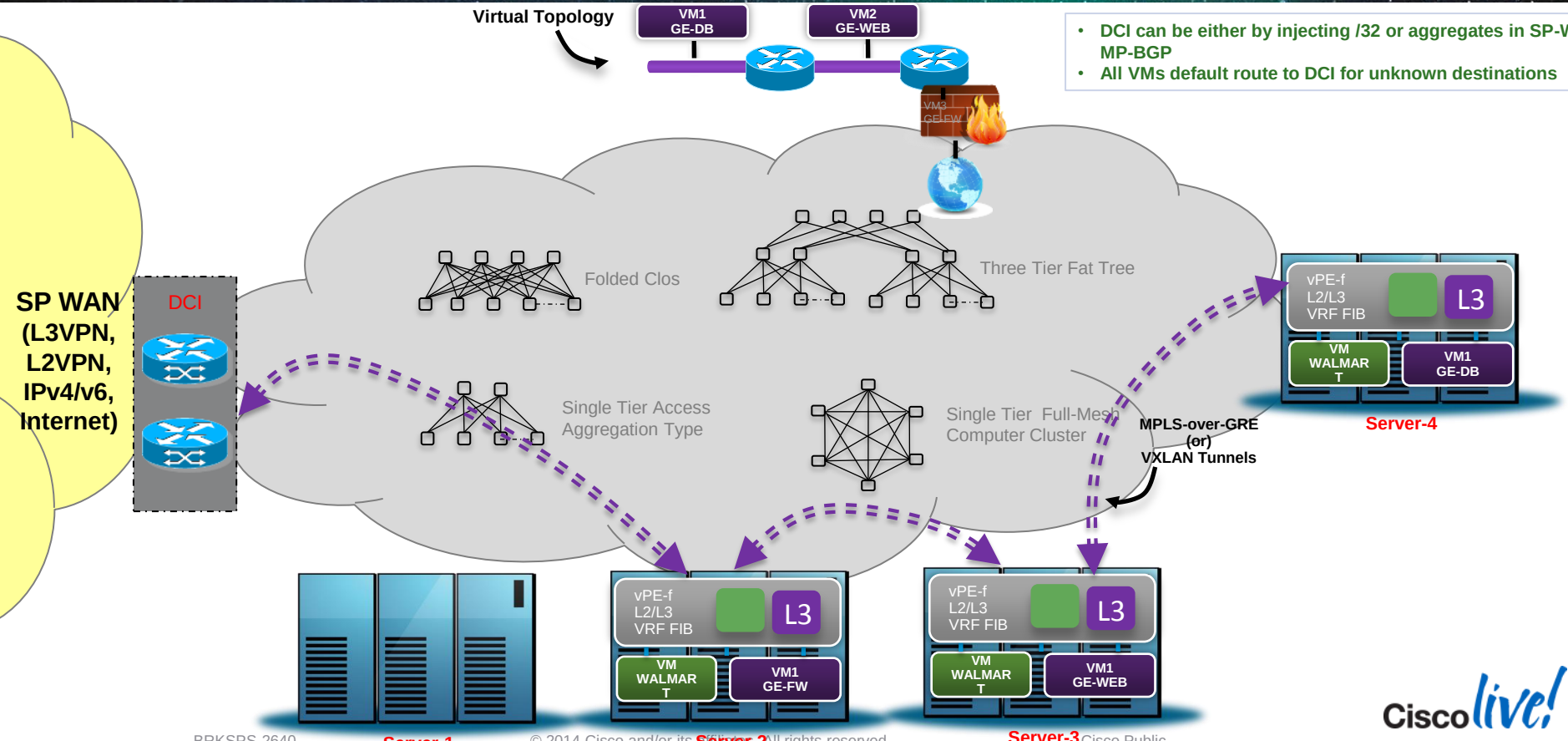


vPE Network Function Virtualisation



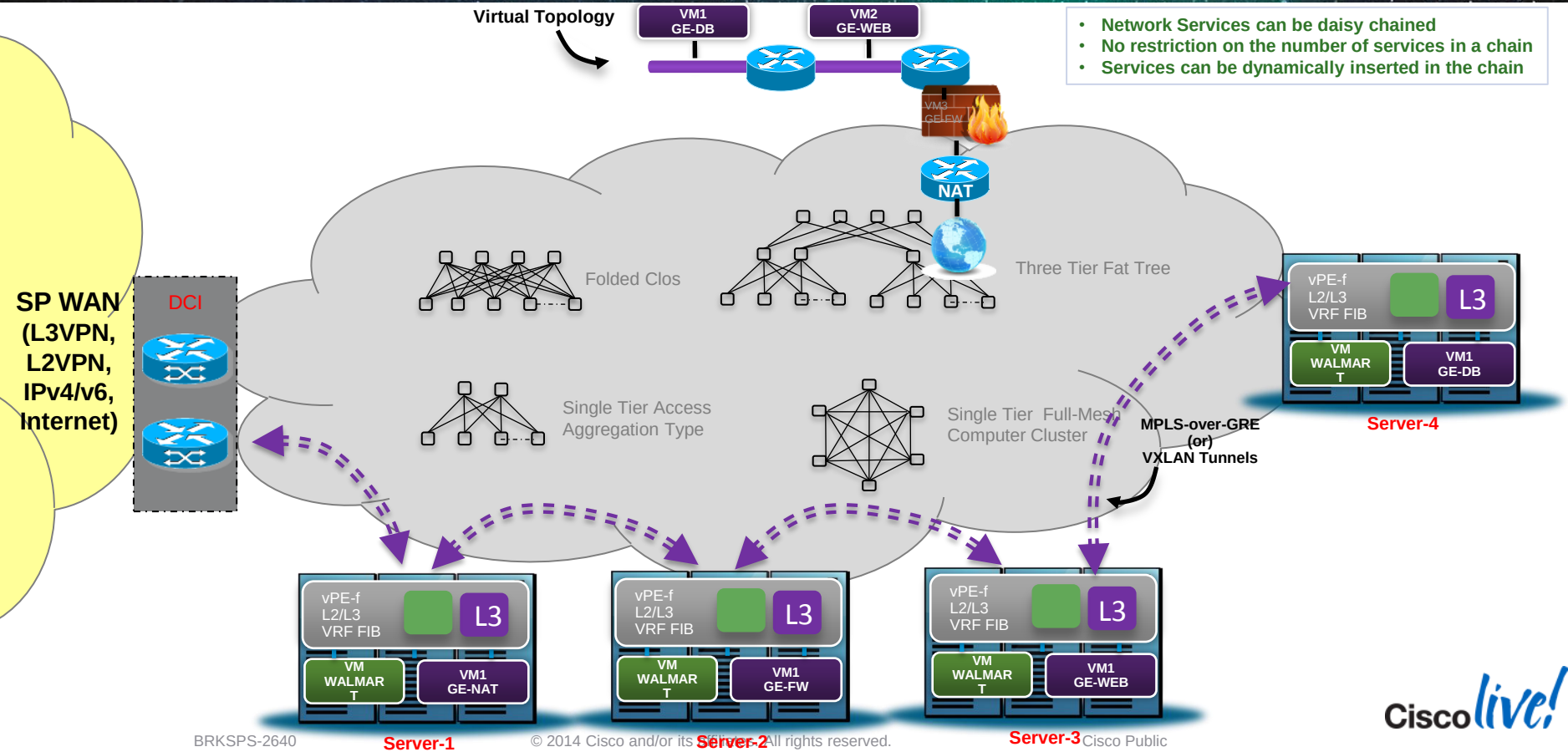
- Network Services could be bump-in-the wire services or termination services
- Using L2/L3 entries in tables an arbitrary services topology can be created
- No hair-pinning of traffic as it moves from service to service
- Control Plane responsible for computation of paths and optimal routing of traffic
- Bring-your-own-Service or choose from Cisco service catalog

vPE L3VPN, L2VPN & Internet Access

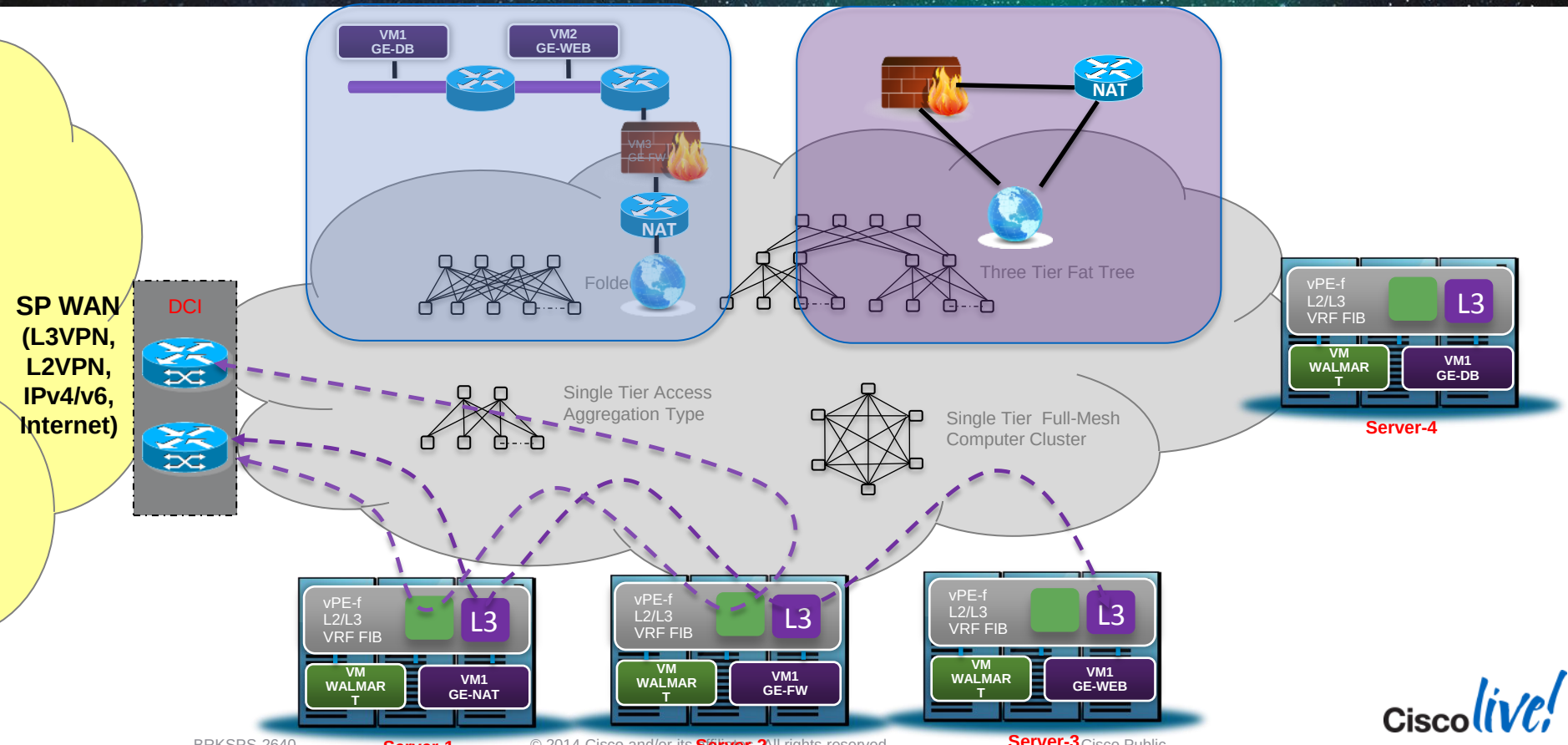


- DCI can be either by injecting /32 or aggregates in SP-WAN MP-BGP
- All VMs default route to DCI for unknown destinations

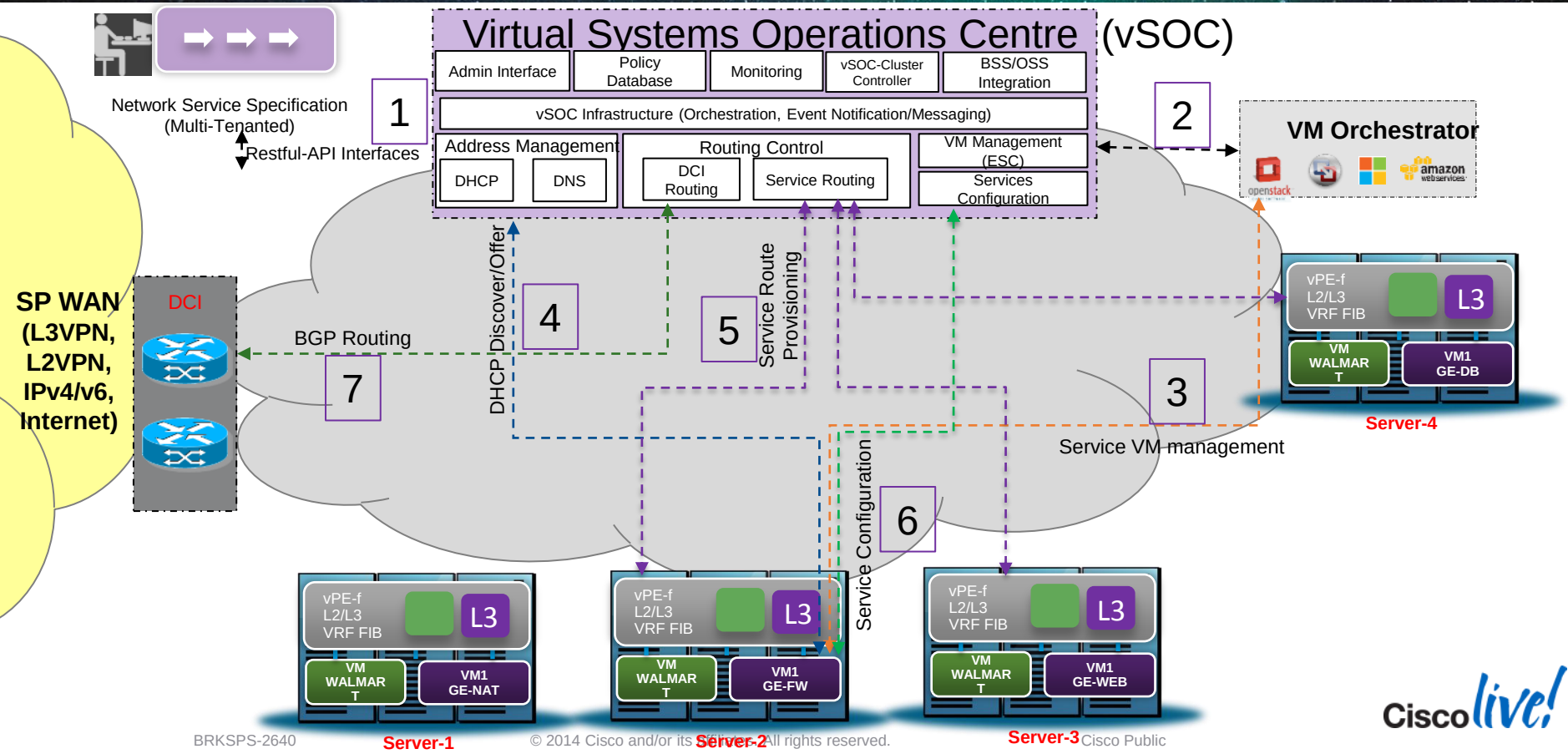
vPE Services in a Chain



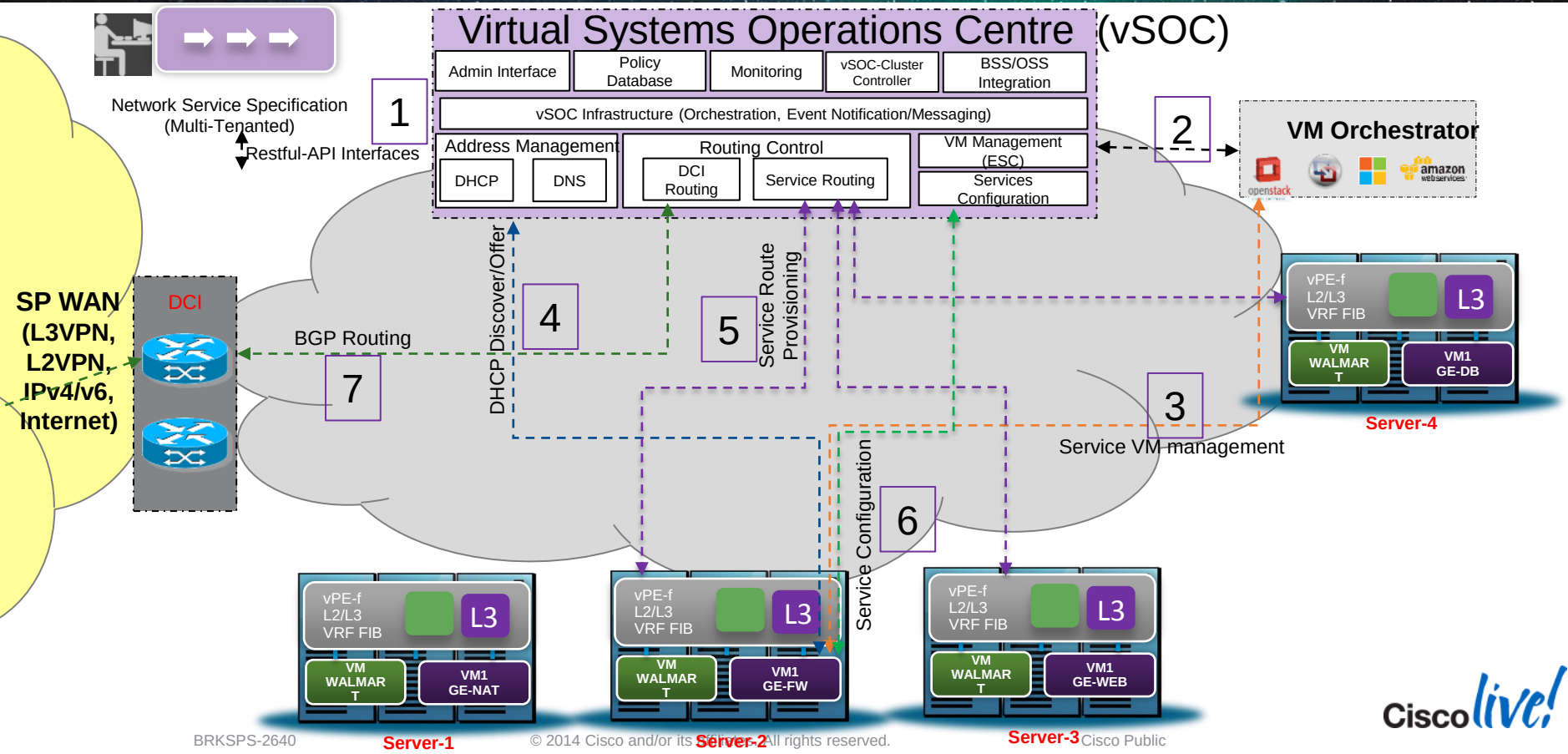
vPE Multi-Tenancy, Varied Topologies



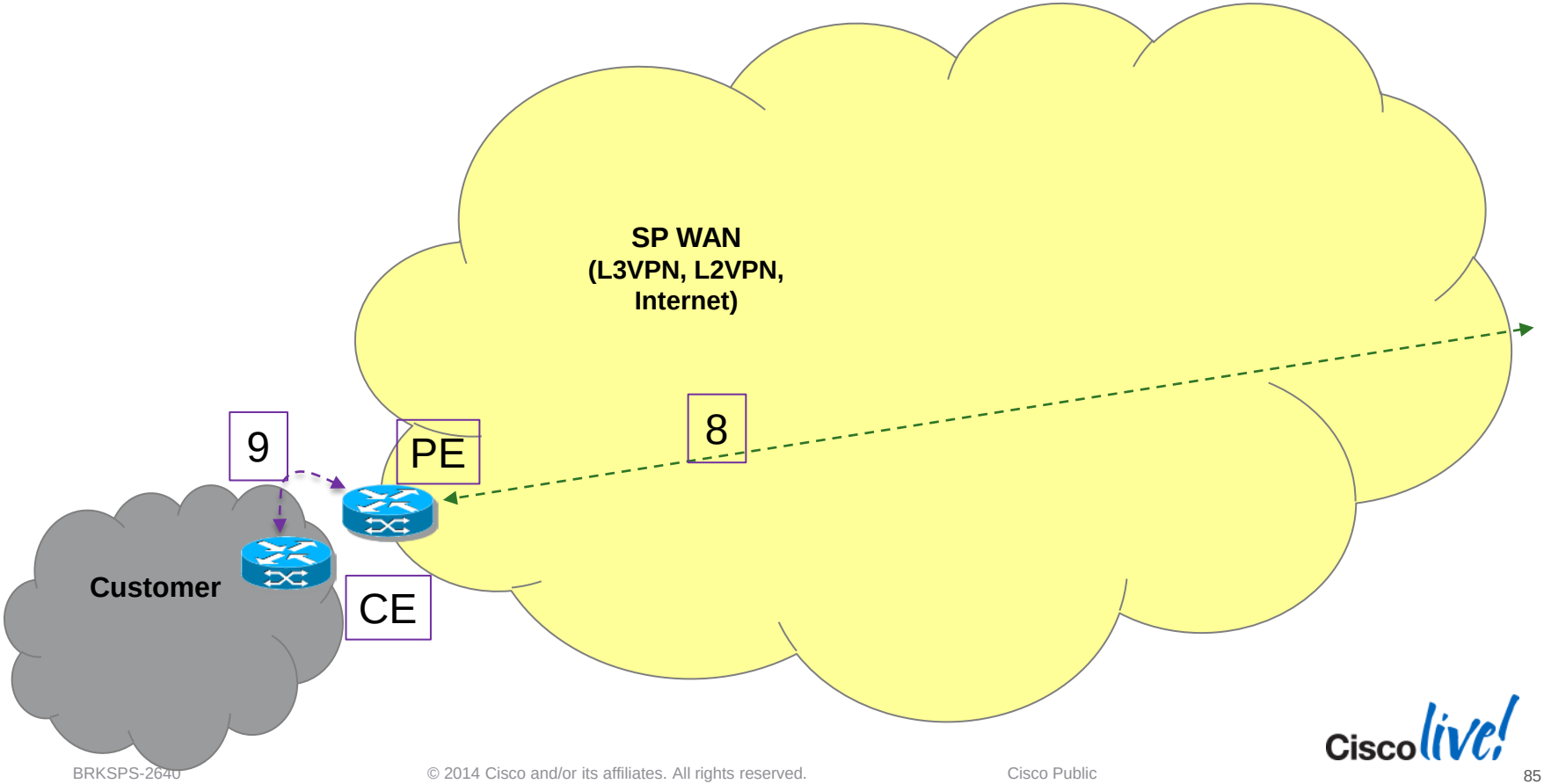
vPE Control Components



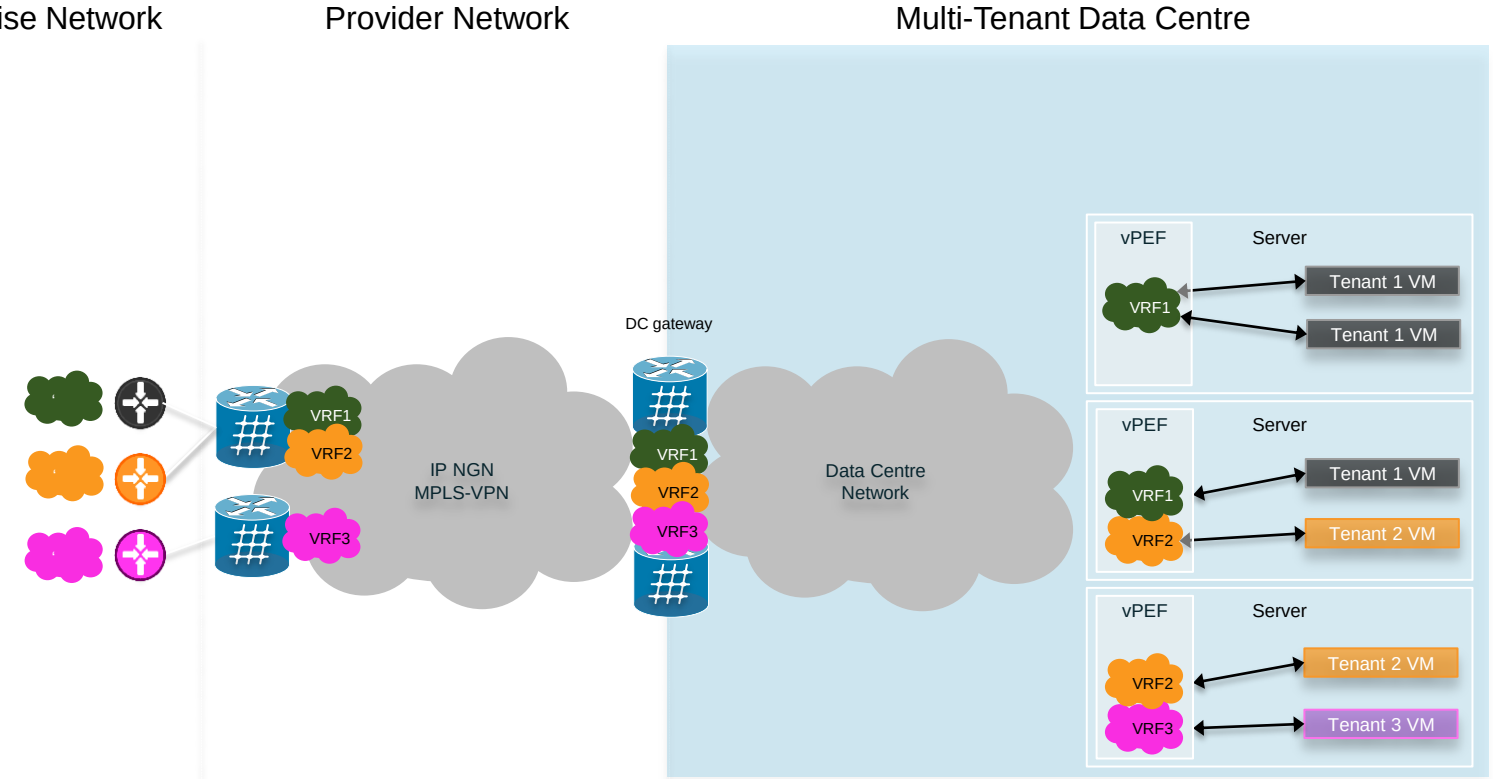
vPE Control Components



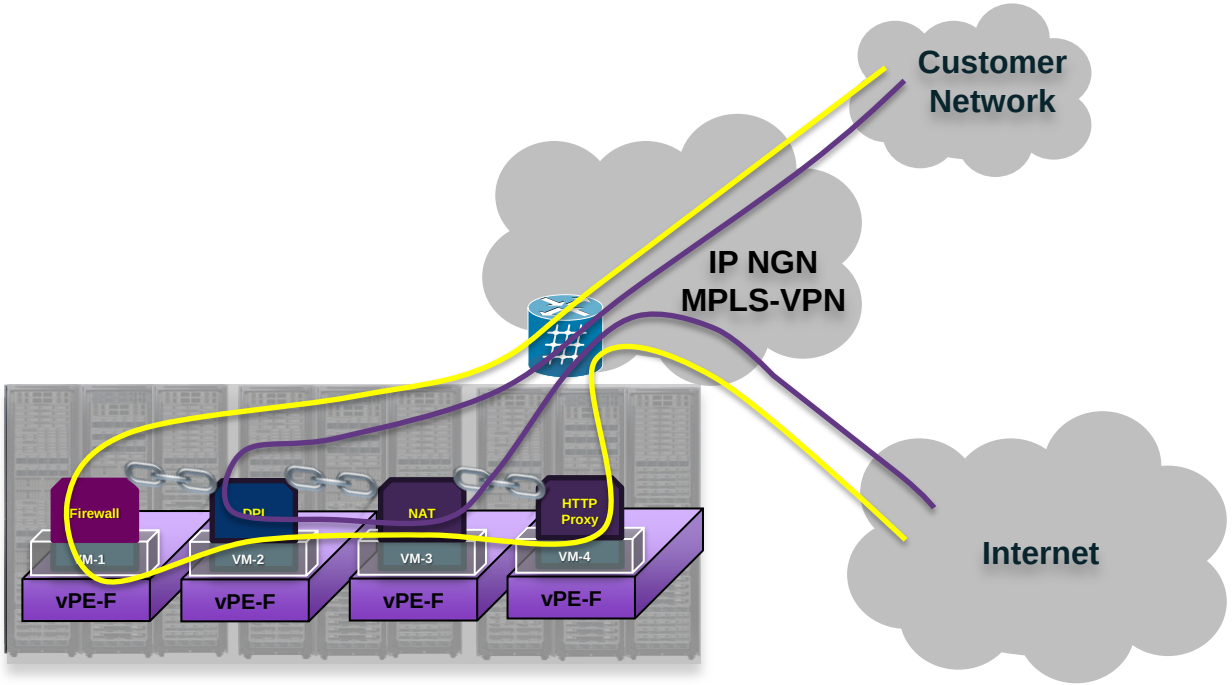
BGP Signalling in the WAN



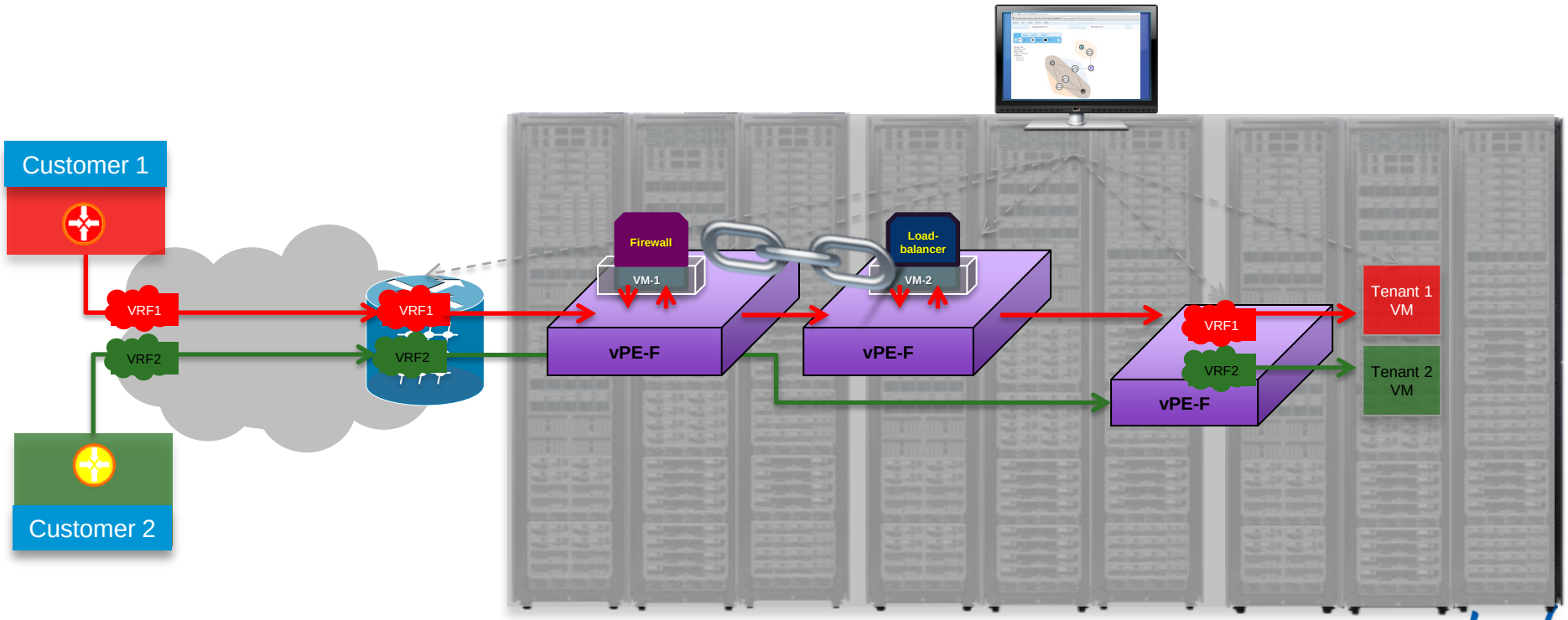
Use Case 1: IaaS / Virtual Private Cloud



Use Case 2: NFV & Services Chaining



Use Case 3: Combined VPC and NFV Service Chaining



Components of Cisco vPE Solution

vSOC	Virtual Systems Operations Centre (vSOC) Extensible Service Orchestrator
vPEF	Virtual PE Forwarder (vPEF) Light weight forwarding element per Server
NfV Services	vASA, CSR1000v for NAT and DPI & RaaS, GI-LAN future
DC WAN Gateway	ASR9k, Nexus 7k - Physical PE (DC WAN Gateway)

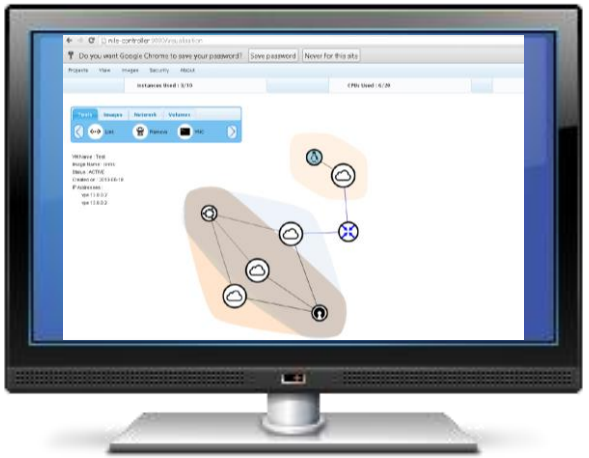
vPE-F Vector Path Processing (VPP)

Underlying Technology Differentiator

- vPE-forwarder is based on Cisco's VPP technology
- What is Vector Packet Processing?
  - Highly optimised packet processor for general-purpose CPUs
  - Very fast
    - Constructs super frames of packets and processes them in one shot - exploits temporal locality of application flows. Benefits from I-cache, D-cache hits.
    - Direct PCI pass-through allows send/receive packets with zero operating system overhead
    - near line rate processing on 10G interfaces
  - 64-bit, multi-threaded
  - Portable
  - VPP is a user space process - fault protected & easy upgrades
  - Multi-tenant forwarding contexts for IPv4 and IPv6
  - Shipping on several Cisco products (ASR 9000)
- Complete forwarding stack (as opposed to Intel DPDK developer framework)

vSOC User Experience

- Single portal for customers to login and provision their network and application VMs
- Each customer can create multiple topologies
- Traffic for a topology could come from Internet, existing L3VPN network, L2VPN network
- Topology composed of multiple zones
- Inter zonal traffic subjected to one or more services (FW, NAT, DPI, Load Balancer)
- Ability to provide pre-packaged end application services such as Web Server, Video Server, Mail Server, Database Servers, Hadoop Cluster, etc
- Design template library and custom network topology templates for provisioning ease.
- BYOS – Ability for customers to bring their own service appliances



Cisco vPE Key Solution Highlights

End to end Solution offering from Cisco

Based on Open, standards-based interfaces

Highest performance virtual forwarder

Virtual forwarder in a VM isolates network failure domain from compute

Overlay architecture independent of underlying fabric

Self Service model and automated network config enables zero touch provisioning

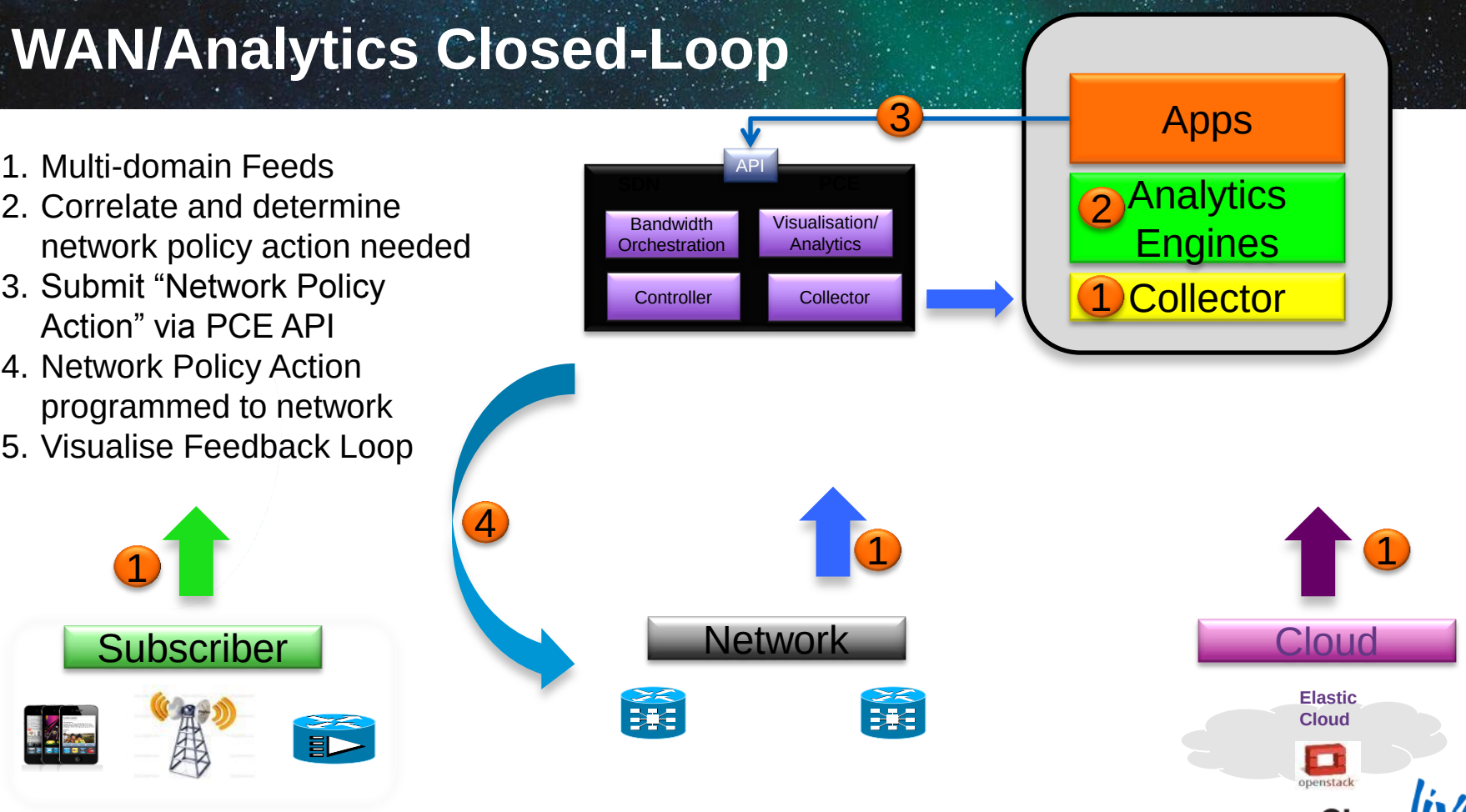
Service configuration integrated with Solution

Elastic Services Management

Combining the Benefits of DC and WAN

WAN/Analytics Closed-Loop

1. Multi-domain Feeds
2. Correlate and determine network policy action needed
3. Submit “Network Policy Action” via PCE API
4. Network Policy Action programmed to network
5. Visualise Feedback Loop



WAN Orchestration
Bandwidth Calendaring

PCE & Demand Engineering, ESC

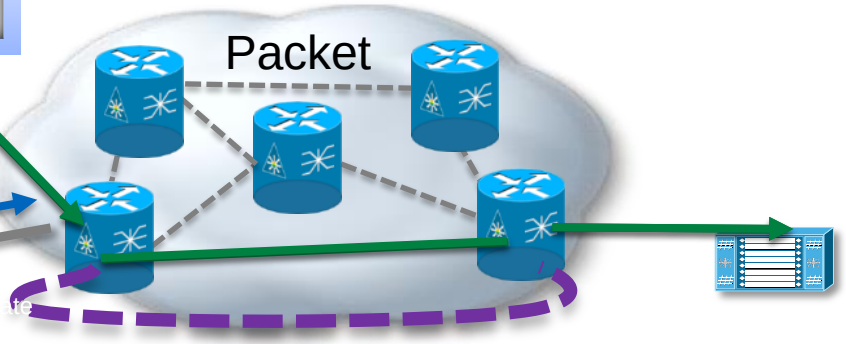
1 BW Calendaring App provides UI to end user. End user requests connectivity between locations with BW requirement and calendar interval

Bandwidth Calendaring Application

Bandwidth Orchestration

Data Collection

Network Programming



3 a User requests connection with defined BW characteristics to DC service A from location attached to Router D for specific Calendar period

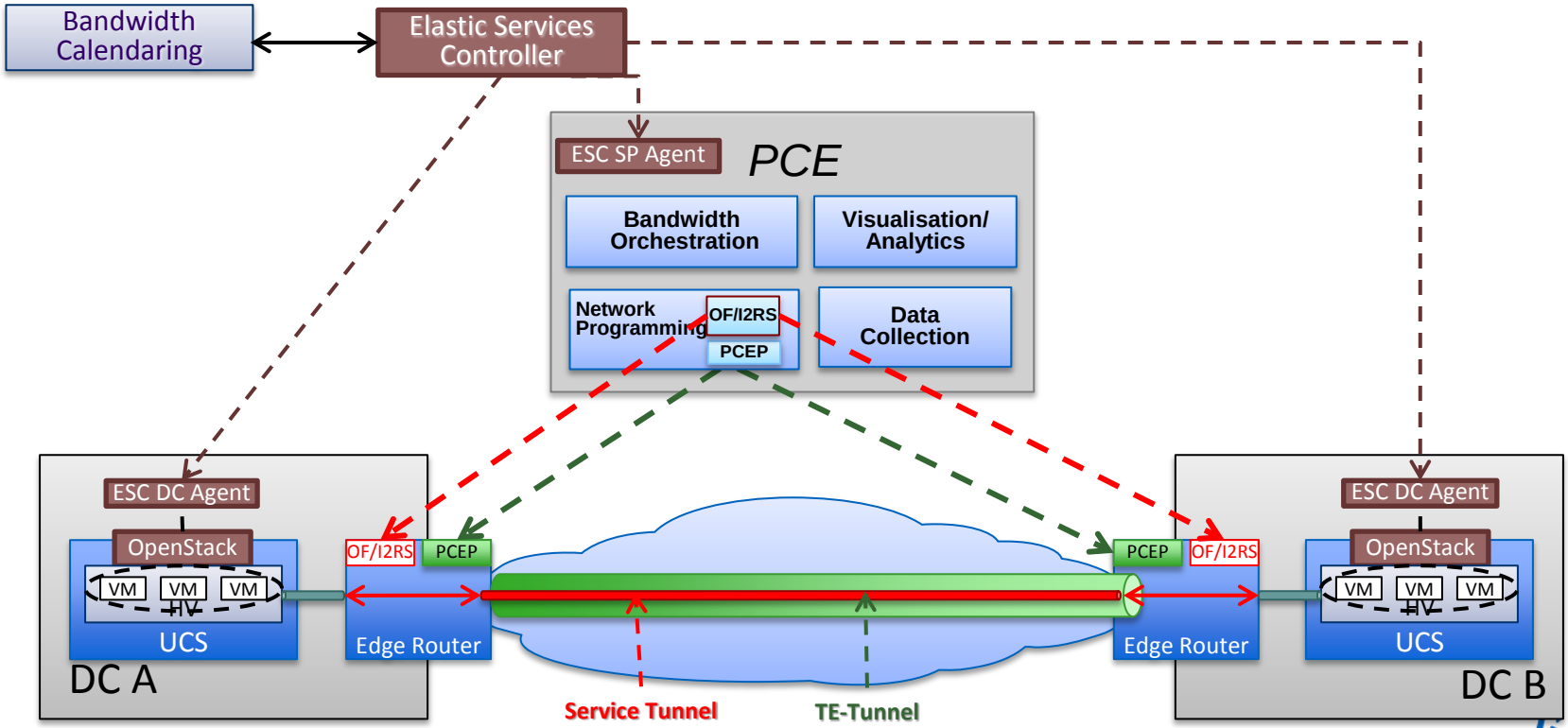
5 BW calendaring confirms request to end user and tracks reservation to ensure Service is available at the required Calendar interval

2 WAN Orchestration controller collects topology, state and utilisation info from packet network

3 b On behalf of user, BW Calendaring App requests a Network path to DC Service A from location attached to Router D

4 WAN Orchestration controller discovers available resources and calculates optimal path and returns result to the app

Bandwidth Calendaring: Example DCI



Elastic Cloud Services (NfV)
Dynamic Scaling of Bandwidth and Services

PCE & Demand Engineering, ESC, Openstack, NfV

1

2

3

4

Service Orchestration

Services Controller

ESC

Cloud orchestration

WAN orchestration

Security
Web FWs
NAC/Compliance
DDoS Scrubbers

DC/Cloud #1

WAN

Security
Web FWs
NAC/Compliance
DDoS Scrubbers

DC/Cloud #2

1	Request is made to instantiate Security Service at multiple DC/Cloud locations
2	ESC Requests from Cloud Orchestration VM instances and network connectivity to run the Security service
3	ESC requests from WAN orchestration network path to carry flows requiring Security services to nearest DC/Cloud
4	ESC monitors service instances and based on policy decides when to spin up additional capacity per service DDoS – As attack traffic increases spin up additional scrubbers in both DCs

Conclusion

- Demand for greater operational efficiencies, quick tenant onboarding and new services will drive “Virtual Services Architecture” adoption
- “Hybrid Cloud” as a service will be the key enabler for the broader cloud adoption
- SDN and NfV adoption will be driven by specific use cases
- Key architectural principles must be open, modular and extensible
- Orchestration and automation will be the key enabler for successful cloud based services

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