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NfV and SDN Architecture and Use Cases for Service Providers

BRKSPG-2616

Rada Stanic

Consulting Solutions Architect

#clmel

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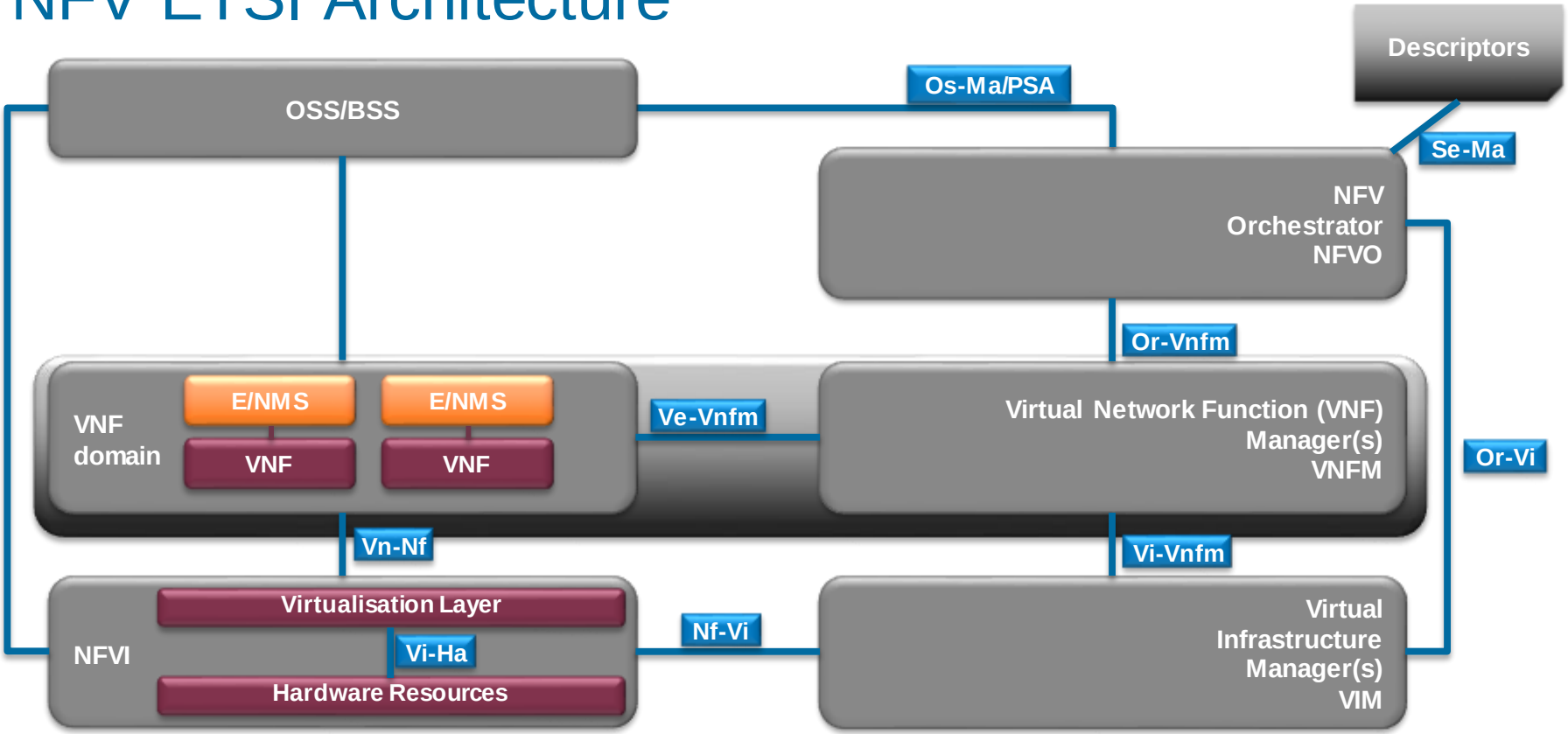
Agenda

- Introduction – What is NFV and Why Do SPs Need It ?
- “Standards” and “Open Source” Landscape
- Cisco’s Vision and Strategy for NFV
- NFV Use Cases
- Conclusion

Introduction – What is Network Function Virtualisation and Why Do SPs Need It?

NFV ETSI Architecture



http://www.etsi.org/deliver/etsi_gs/NFV/001_099/002/01.01.01_60/gs_NFV002v010101p.pdf

Four Phases of ETSI NFV Adoption

Φ0

- OSS based
- Managed through EMS
- Application is virtualised
- Possibly has a VNF-M
- No dependency between the application and the NFV-O

Φ1

- NFV-O based
- Application has own VNF-M
- VNF-M possibly manages application via EMS
- Application is virtualised

Φ2

- NFV-O based
- Application has own VNF-M
- Application is managed by VNF-M
- Application is virtualised

Φ3

- NFV-O based
- Application managed through Generic VNF-M
- Application is virtualised

An NFV Orchestration system has to be capable of handling any application that is in Φ1 through Φ3

Increasing Maturing of application and NFV system

Orchestration

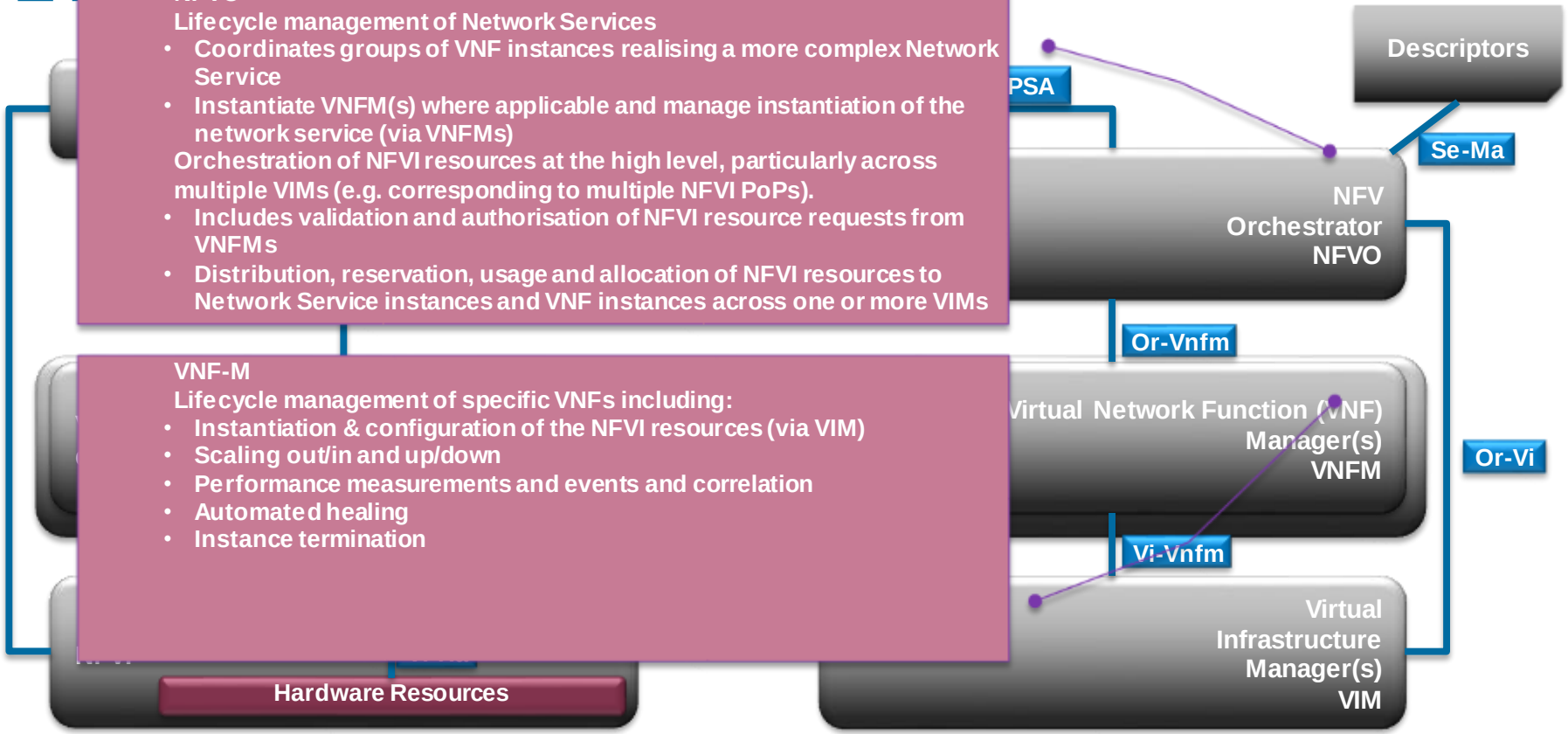
- Orchestration is a system providing the automated arrangement, coordination and management of complex DC infrastructure, middleware and application
- Essential intelligence for any virtualised solution
- Orchestration capabilities include:
  - Portal/UI, Northbound APIs
  - VNF onboarding and management
  - Rules engine
  - Service chaining control
  - System monitoring of health and utilisation (different metrics per different VMs)
  - Elasticity: adjusting resources (up- and down-scaling) to actual usage (“build and bill for use”)
  - Redundancy Capabilities
- The orchestration expected to be an open solution
  - Support for multi-vendor environment (VNFs, SDN, infrastructure, etc.)
  - Inclusion of open source SW
  - ETSI defining a reference architecture

ETSI NFV Architecture

NFVO
Lifecycle management of Network Services
- Coordinates groups of VNF instances realising a more complex Network Service
- Instantiate VNFM(s) where applicable and manage instantiation of the network service (via VNFMs)

Orchestration of NFVI resources at the high level, particularly across multiple VIMs (e.g. corresponding to multiple NFVI PoPs).
- Includes validation and authorisation of NFVI resource requests from VNFMs
- Distribution, reservation, usage and allocation of NFVI resources to Network Service instances and VNF instances across one or more VIMs

VNF-M
Lifecycle management of specific VNFs including:
- Instantiation & configuration of the NFVI resources (via VIM)
- Scaling out/in and up/down
- Performance measurements and events and correlation
- Automated healing
- Instance termination



ETSI NFV: The Need for SLA Management

NFV-O
Overall SLA mgmt
Resource Allocation
Descriptor mgmt

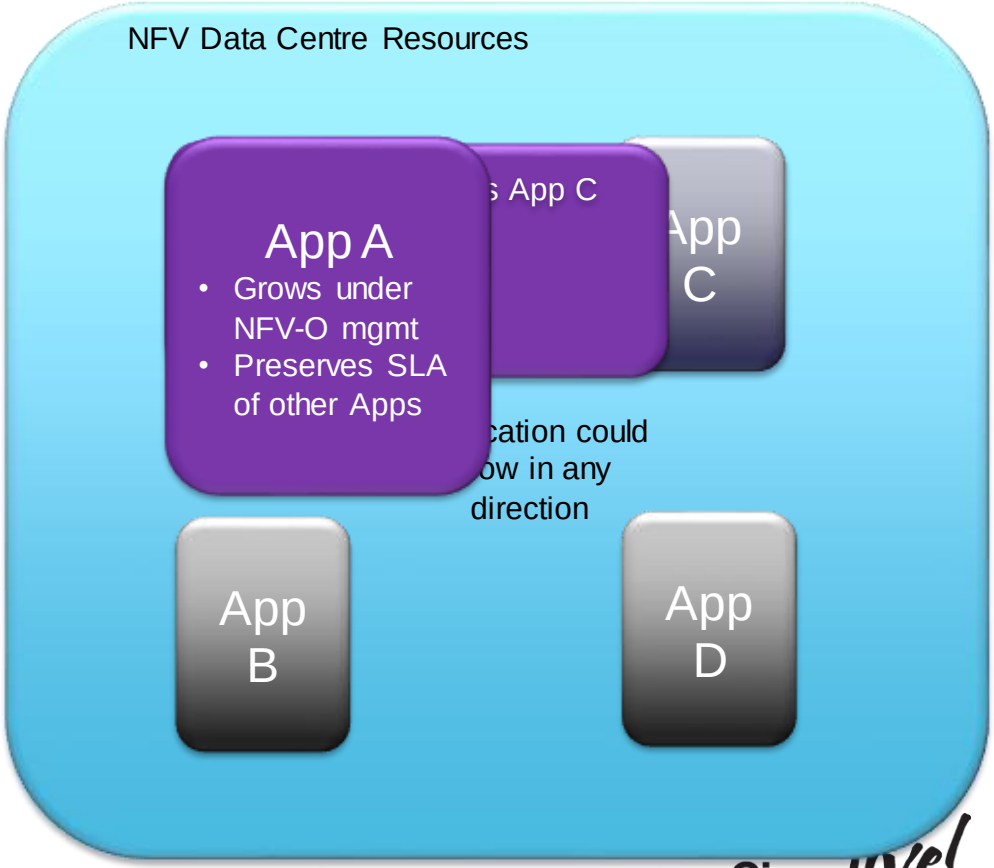
NFV Service Orchestration

VNFM
Application Lifecycle mgmt
Configuration mgmt

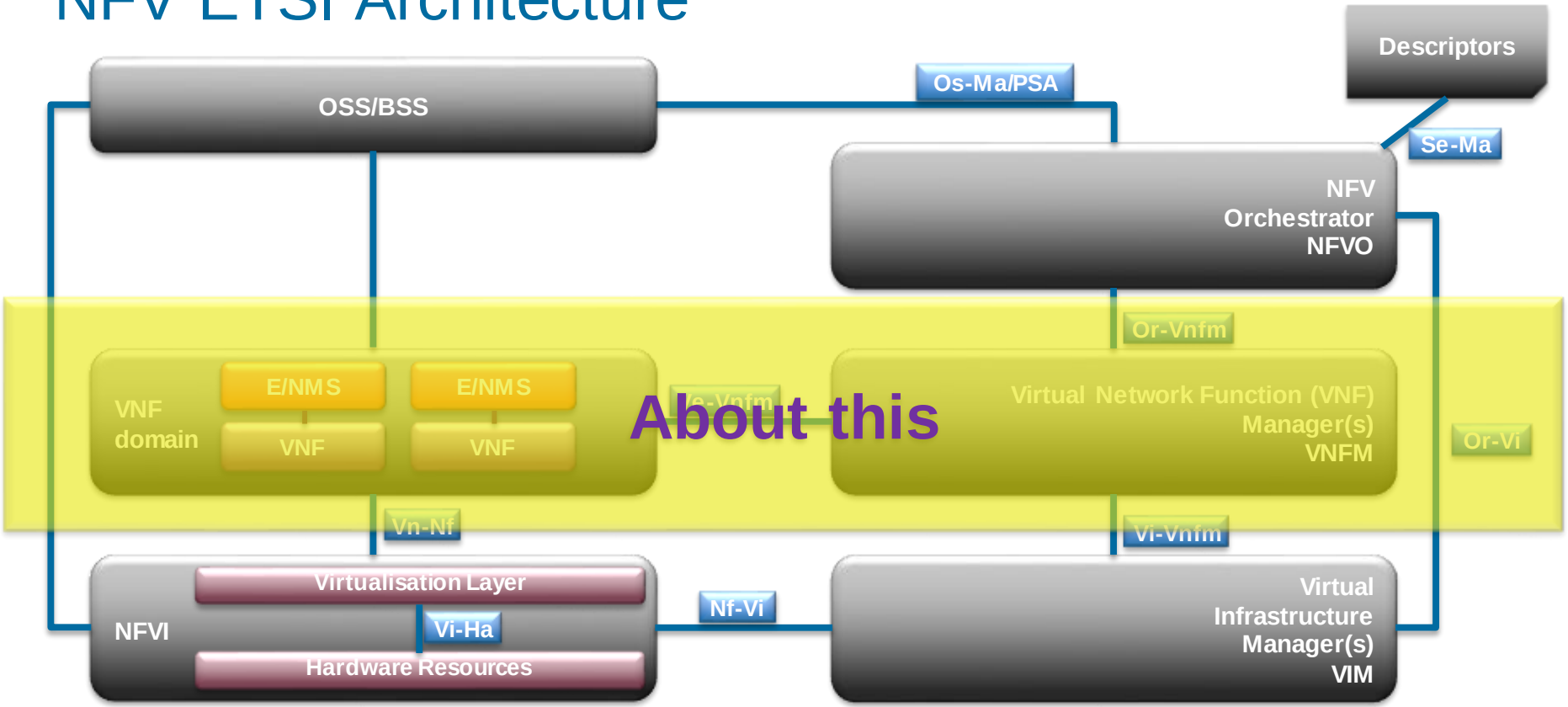
Application (VNF) Orchestration

VIM
Physical mgmt of Compute and Storage and Network

Infrastructure Orchestration



NFV ETSI Architecture



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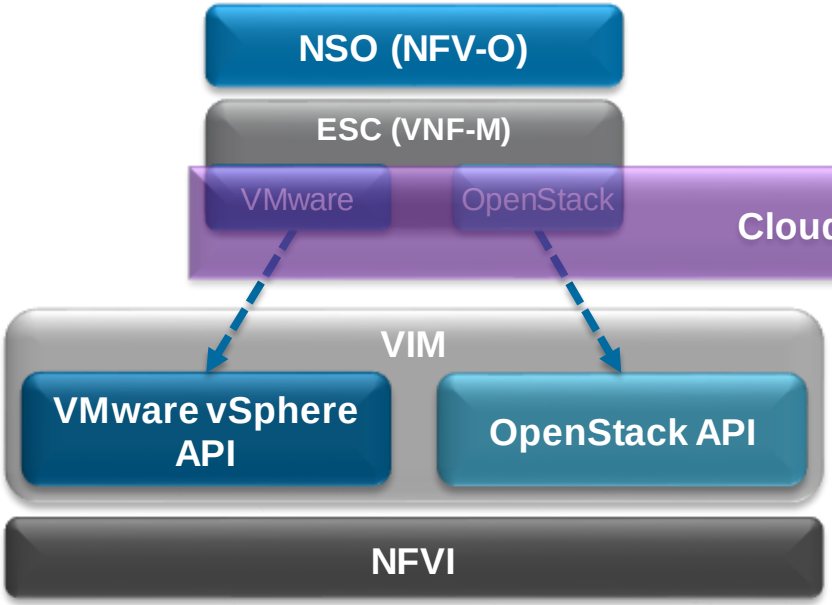
Multiple VNF-M

When composing complex VNF it is key to note that :

- Not all VNFs are at the same level of NFV maturity
  - The virtualised performance of the application is unknown or understated
  - Depends on the infrastructure (NFV-I)
  - The application performance choke points is uncertain or unknown
- Impact on the VNF-M
  - In the initial phases of NFV the VNF-M is tied closely to the VNF (the application)
  - Pragmatic approach is to have the VNF application vendor bring its VNF-M
- Impact on the NFV Orchestrator
  - Has to be able to operate with applications that are in all the possible phases (Φ1, Φ2, Φ3)
  - Multi VNF-M Capability

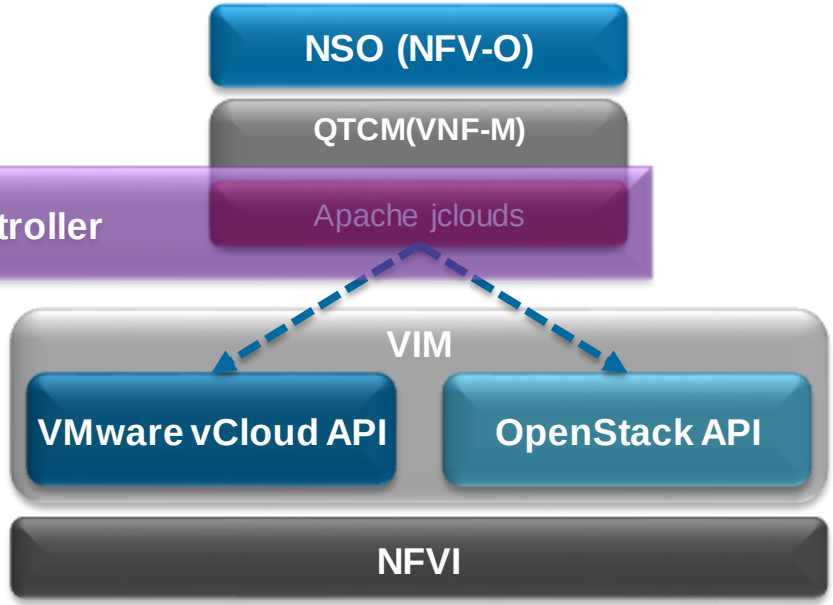
VNF-M Interface to VIM Layer

Elastic Services Controller (ESC)



- ESC direct connection to VMware/OpenStack APIs
- ESC provides light “multi-tenancy” for VMware NFVI

Quantum Telco Cloud Manager (QTCM)



- QTCM utilises Apache jclouds for VIM access
- VMware vCloud API used by Apache jclouds

Cloud Controller

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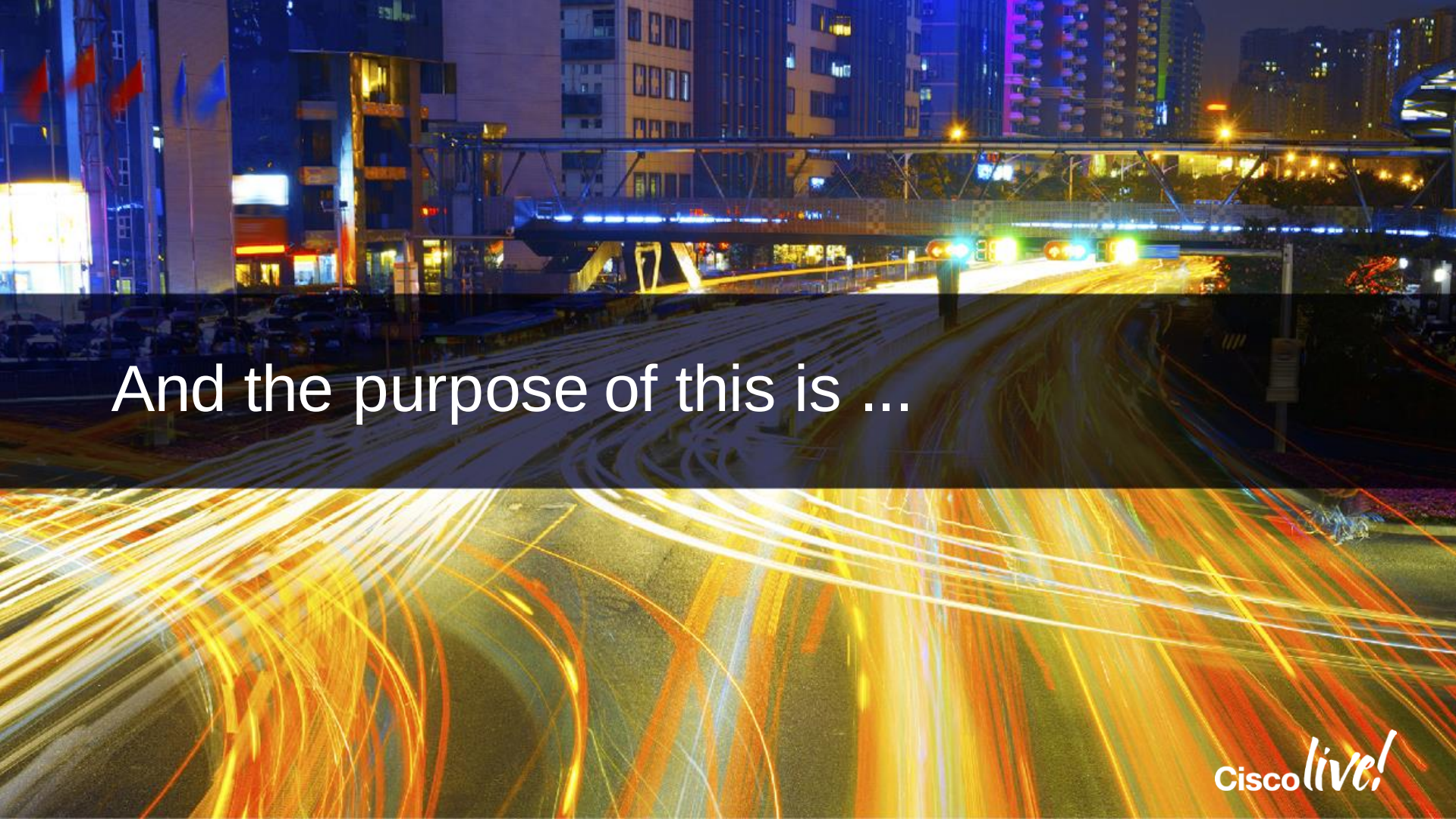
VNF Sample List …

Network Infrastructure, Gateways, Applications	Available CSR1Kv	Available IOS-XRv	Q3CY15 Sunstone vRouter	Available Nexus1000v	Available VTF (vPE-F)	Available vWAAS	Available vWLC	Available vNAM
	Available ASAv	Available vSourceFire	Available vESA	Available vWSA	Available vSCE	Available vNX-OS	Radar X-Star (vBNG Control Plane / NG XR Control Plane)	Radar vMX (Meraki)
	Available QvPC-SI (vEPC)	Available QvPC-DI (vEPC)	Available VDS-IS	Available Cloud DVR	Available Unified Comms Manager	Available Unified Contact Centre / CC Exp.	Available DDoS Radware Def. Pro / Arbor	Available MCE8K (Video Conferencing)
Management and Orchestration	Available DC Controller (XNC)	Available APIC-EM	Available ODL/CDL	Q1CY15 WAE	Available NCS	Q1CY15 ESC	Available APIC	Available Prime Service Catalog
	Available VTC	Q1CY15 NSO	Available Prime Network	Available Prime Performance Manager	Available Prime Network Registrar	Available Prime Optical	Available Prime Provisioning	Available Prime Infrastructure
	Available Intelligent Automation for Cloud	Available Prime Central	Available Prime Network Service Controller	Available Prime Fulfillment	Available Cisco Configuration Engine	Available Prime Analytics	Available CML (VIRL)	Available UCS Director
	Available Prime Access Registrar	Available Prime IP Express, Prime Home	Available Cisco Multicast Manager	Available CTCM (Stratos/Diadem)	Available Cisco Process Orchestrator	Available QvBN	Available Quantum Policy (BroadHop)	Available Tidal Enterprise Scheduler


And the purpose of this is ...

Traditional Physical Networks

- Shared resource supported many "service instances"
- Upfront procurement /purchase
- High Opex - difficult to automate or apply consistent policy
- Rigorous processes to maintain 99.999% uptime (change & release management)
- Easier to add a service than remove one (orphaned FW ACL rule)
- "Peak load" capacity planning model required
- Slow and expensive to create new **service-design** or add new **service-features**
- Operational "domaining" necessary to manage complexity – entrenched "silo'd" approach

Network Virtualisation: Enabling Business Outcomes

- Broad supplier choice - lower barrier to entry
- Granularity of features and x86 platform economics
- Software is easier to “model” and orchestrate
- Reduce OPEX through **automation** and policy-based service standardisation

- Reduce CAPEX through maximised capacity utilisation via intelligent service placement and highly automated resource capacity management
- Innovate at the service-design and service-feature layer
  - Create service designs quickly
  - Blend current capabilities and services with new components
- Service instantiation across multi-location, multi-vendor and mixed physical/virtual to enable current infrastructure to be leveraged while enabling transition to virtual
- Pay-as-you-go procurement

Standards and Open Source Landscape

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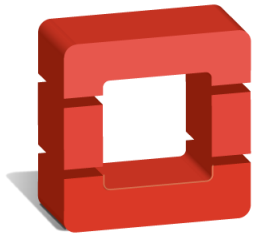
OpenStack



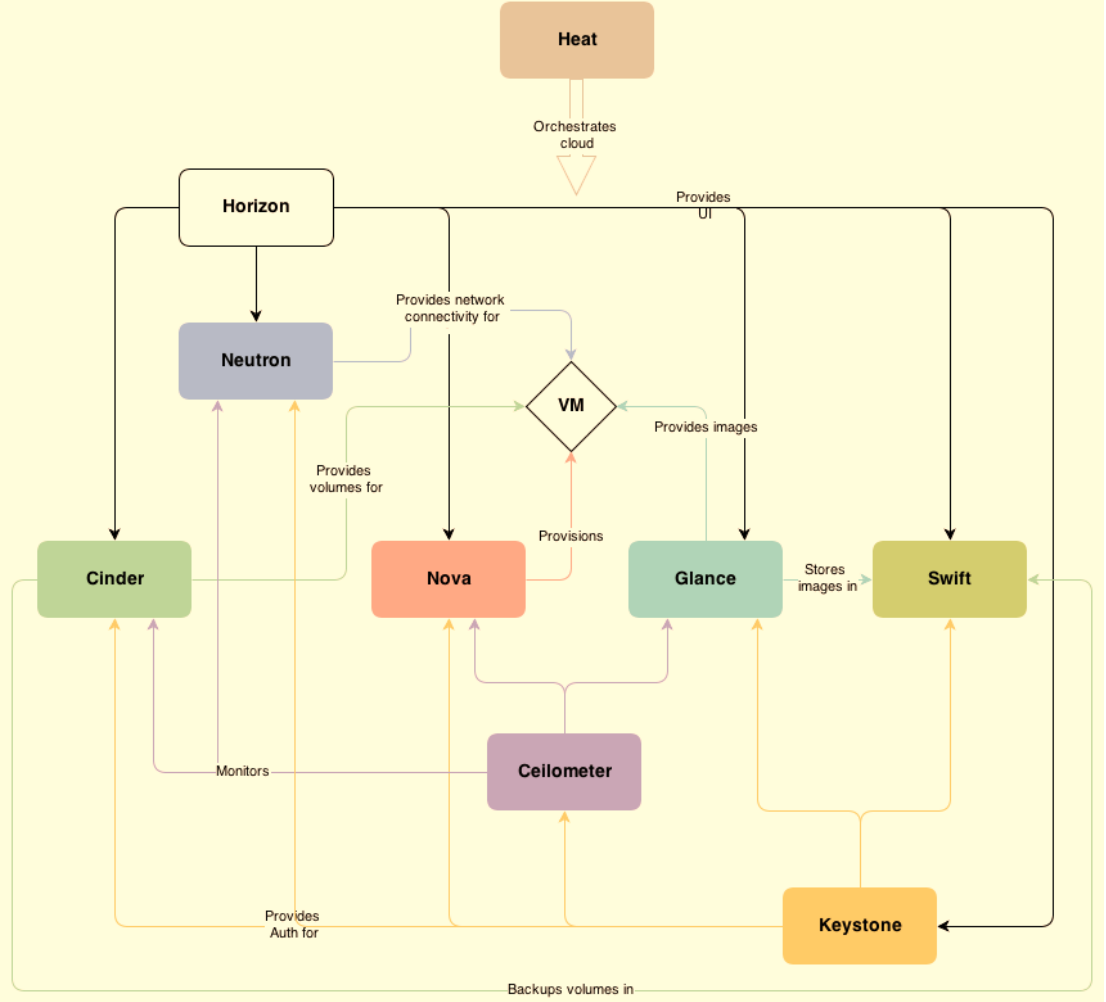
OpenStack is an Infrastructure As A Service (IaaS) cloud computing project

openstack™ = Cloud Operating System

"…provides a means to control (administer) compute, storage, network and virtualisation technologies…"

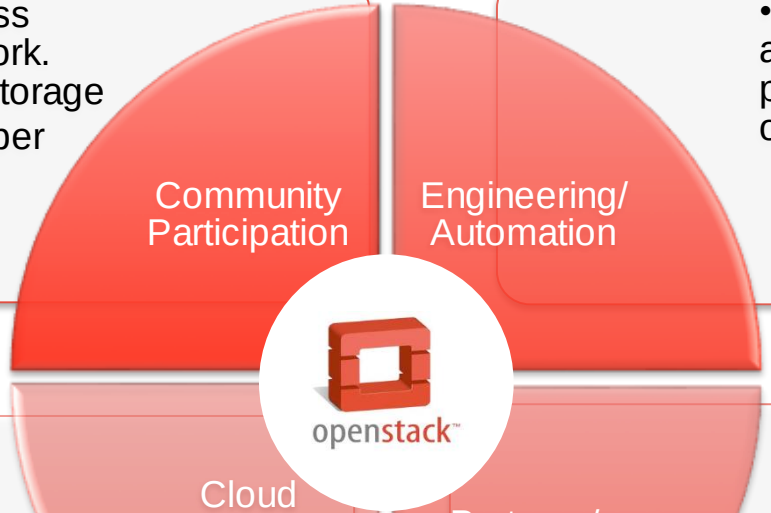
OpenStack

- Heat – Orchestration
- Horizon – Dashboard
- Neutron – Networking
- Cinder – Volume Storage
- Nova – Compute Service
- Glance – Image Service
- Swift – Object Storage
- Ceilometer – Telemetry
- Keystone – Identity Service



Cisco and OpenStack

- Code contributions across several services – Network. Compute, Dashboard, Storage
- Foundation Board member

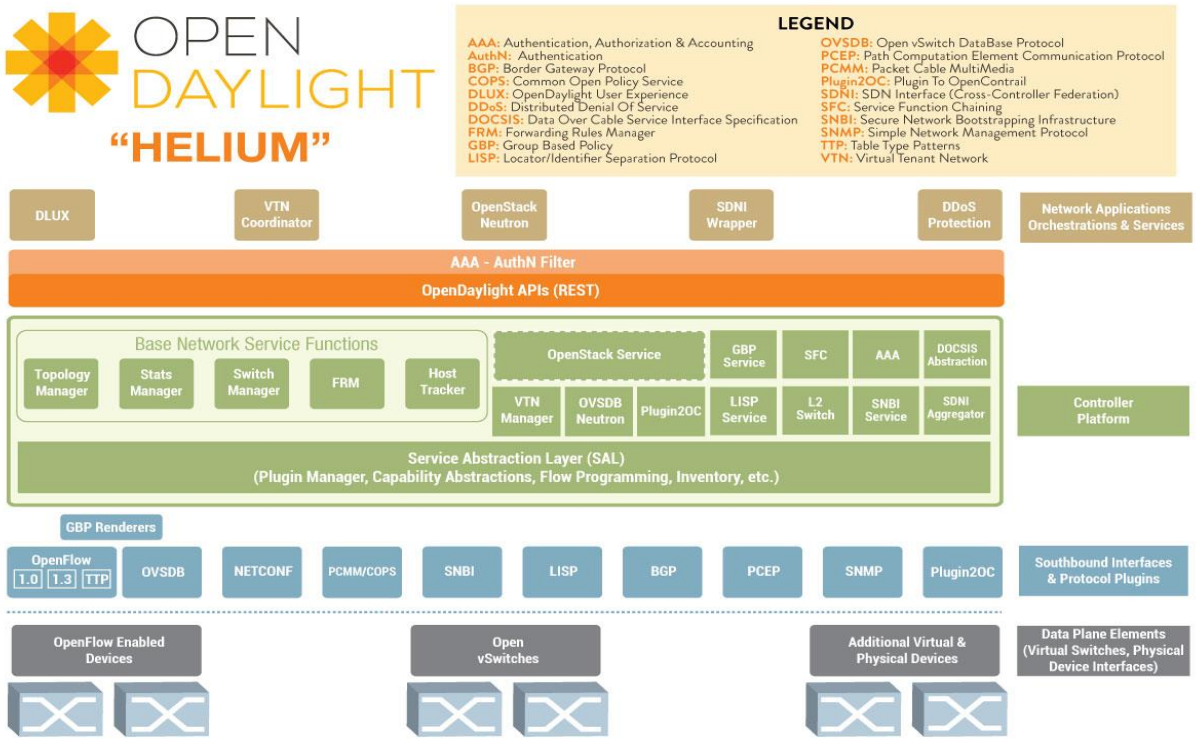


- Automation (Puppet) and architectures (HA) for production deployment and operational support
  - Neutron/Nova Plug-ins for Cisco product lines – Nexus, CSR, ACI, UCS

- OpenStack based Global Intercloud hosted across Cisco and partners data centres
- Cisco Webex Service running on OpenStack

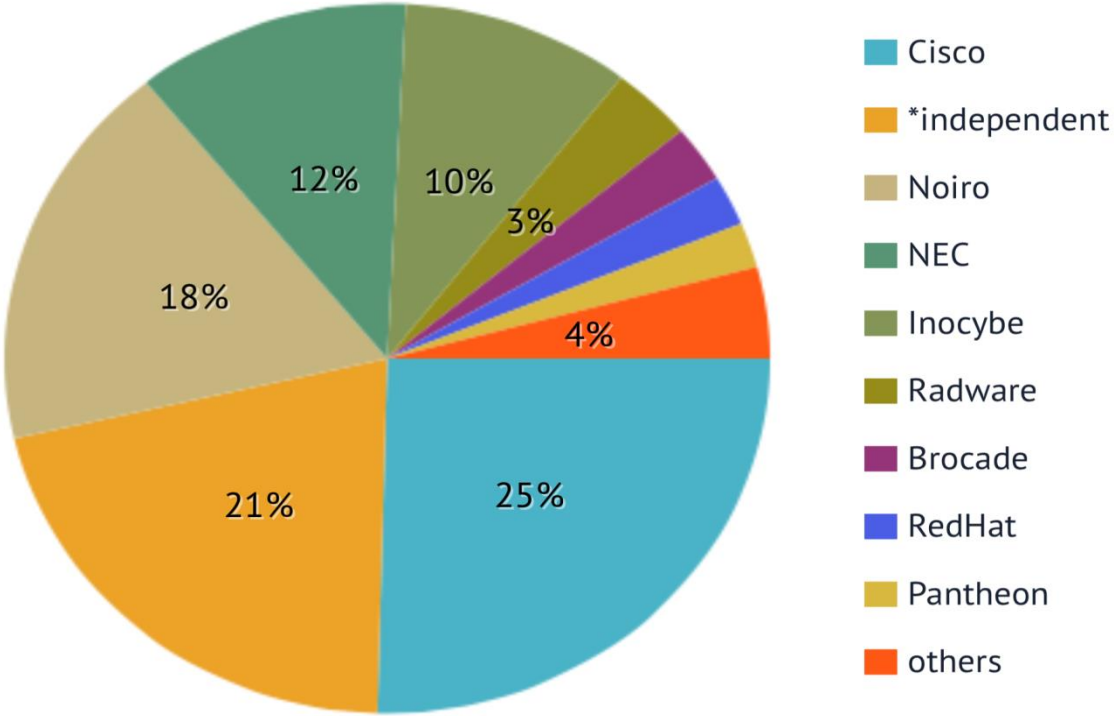
- Cisco Validated Designs for production deployments
- Work closely and jointly with customers to design and build their OpenStack environment

OpenDaylight Controller



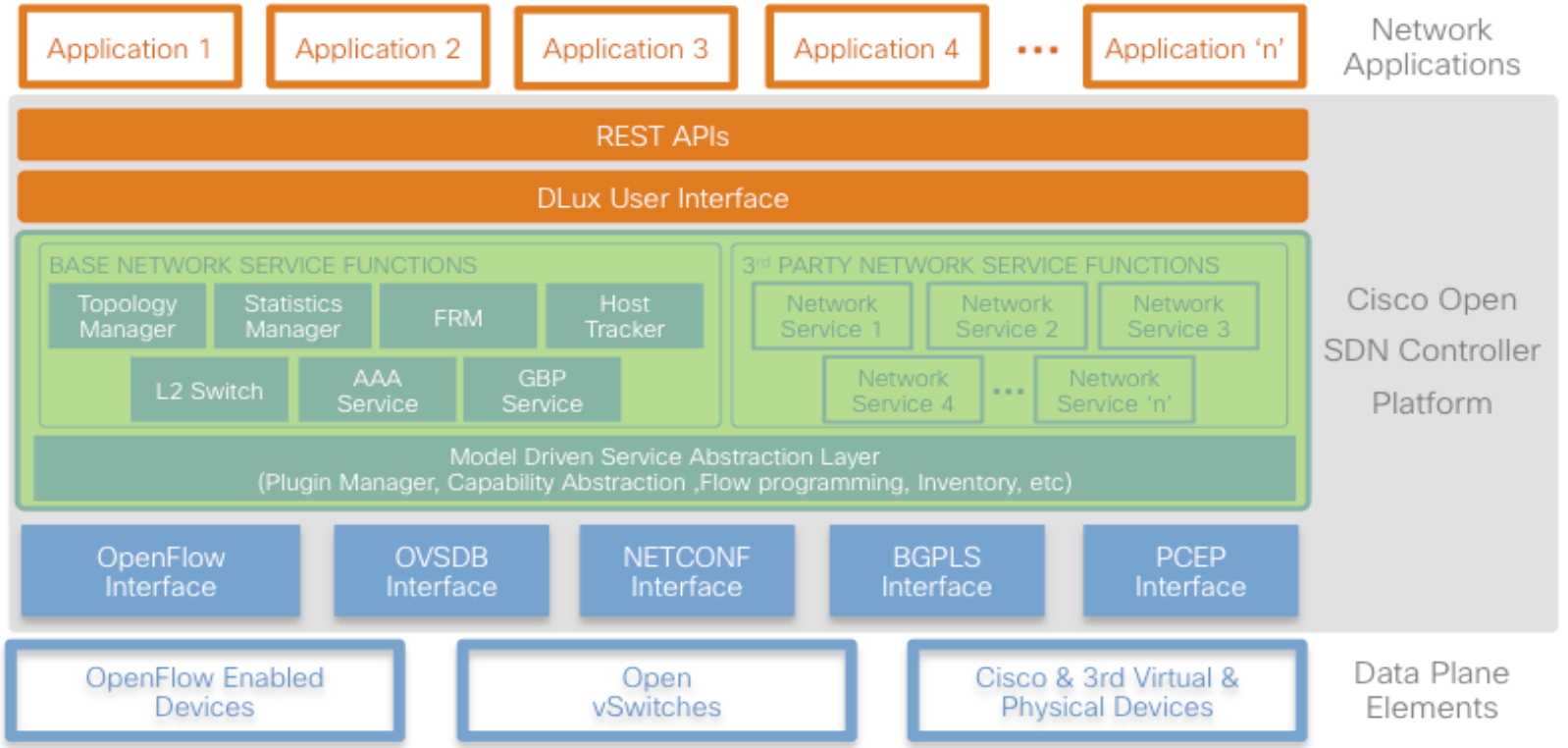
- Open platform for network programmability
- Enables SDN for networks at any size and scale
- New “Helium” release delivers new user interface and a much simpler and customisable installation process

OpenDaylight Helium Contributions

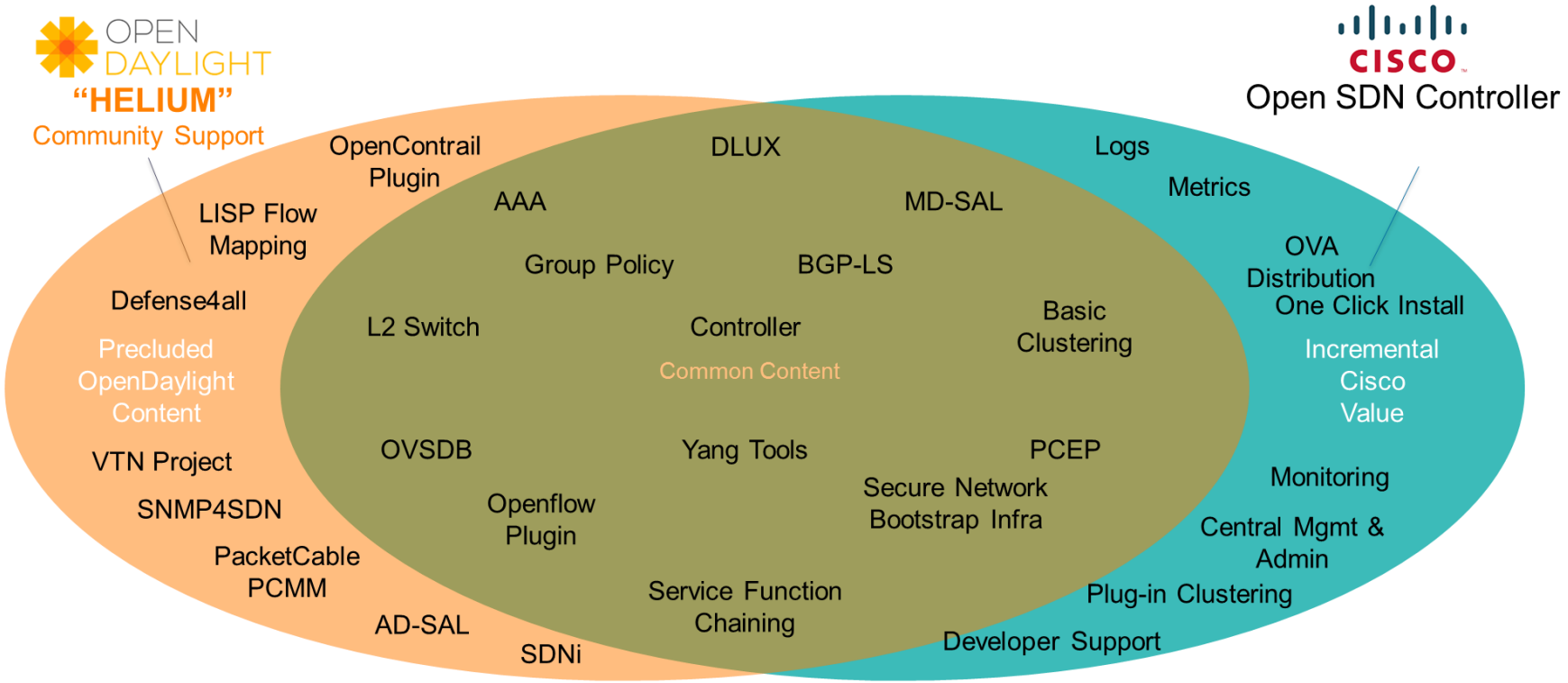


Source: http://spectrometer.opendaylight.org/?metric=loc

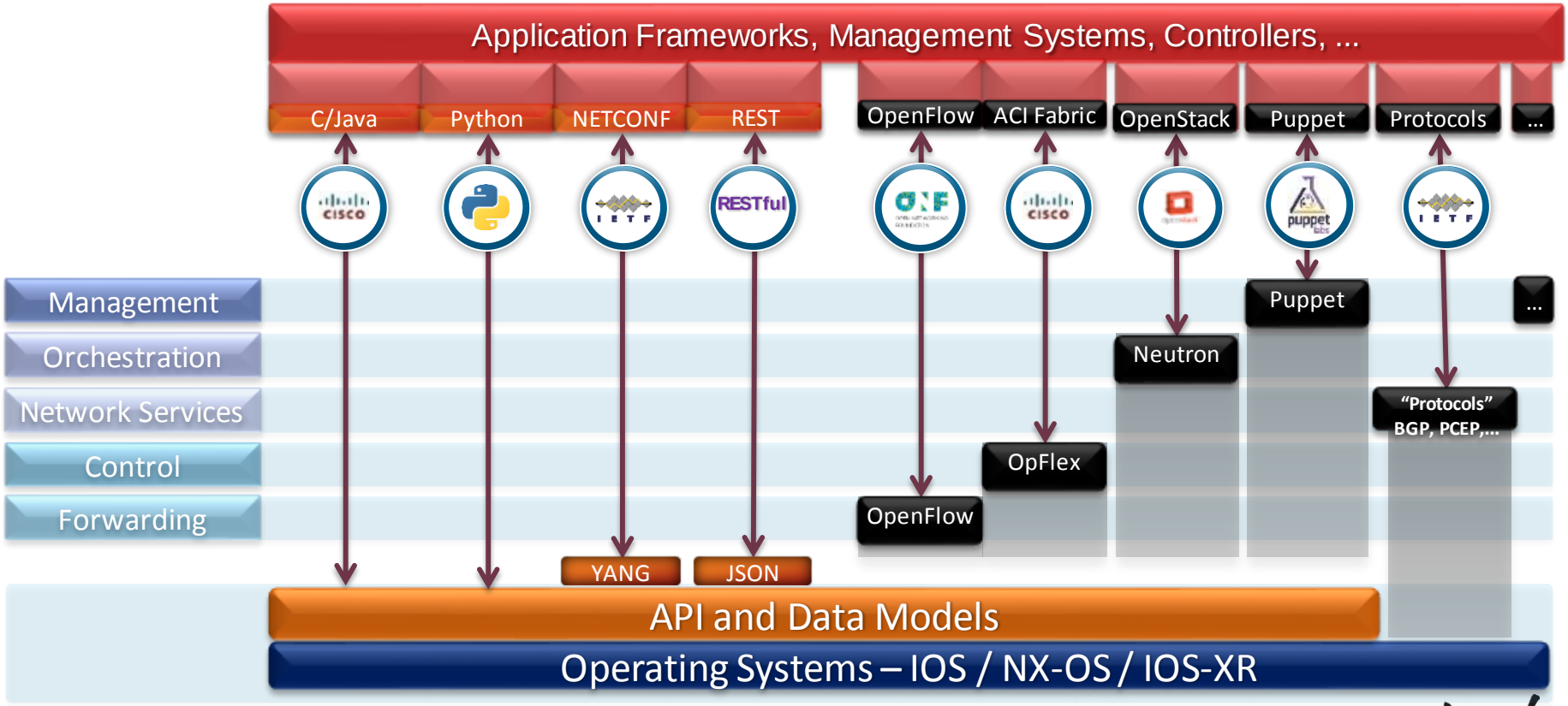
Cisco Commercial Distribution of OpenDaylight



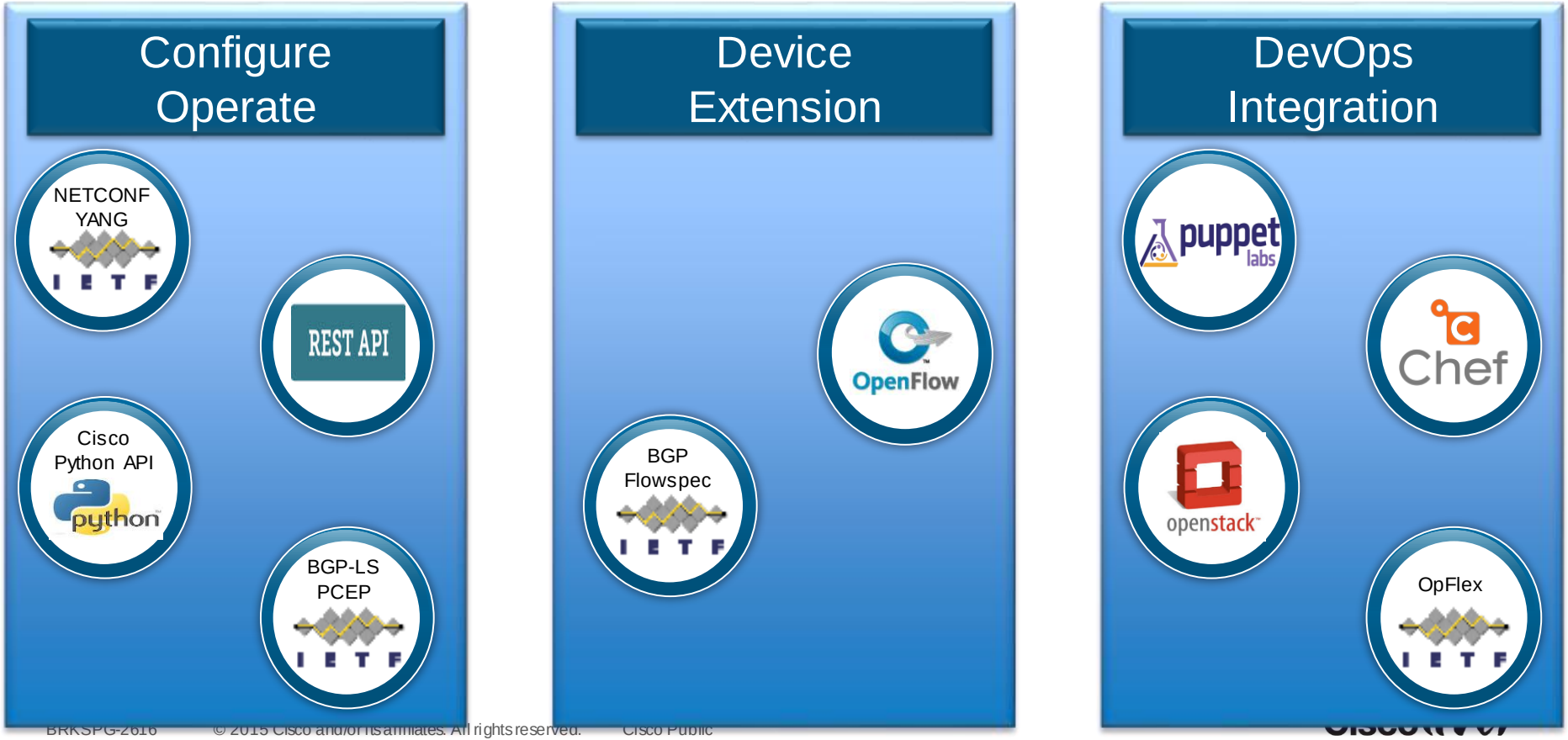
Open SDN Controller vs OpenDaylight Helium



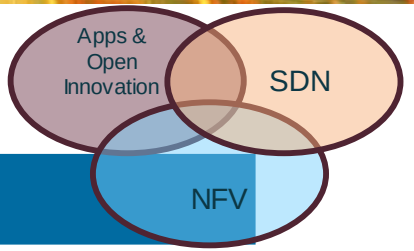
Device Programmability Options – No Single Answer!



Programmability Choice Driven By Use Case



NFV and SDN



Category	SDN	NFV
Why/what	Separation of control and data, centralisation of control and dynamic programmability of Network	Relocation of network functions from dedicated appliances to generic servers
Primary Verticals focus	Campus, data centre, cloud	Service Provider network
Hardware focus	Proprietary or commodity servers and switches	Commodity servers and switches
Initial Applications	Cloud orchestration and networking	Routers, firewalls, gateways, CDN, WAN accelerators, SLA assurance etc.
New Protocols	OpenFlow	None yet
Standards Body	Open Networking Forum (ONF)	ETSI NFV Working Group

Cisco's Vision and Strategy for NFV

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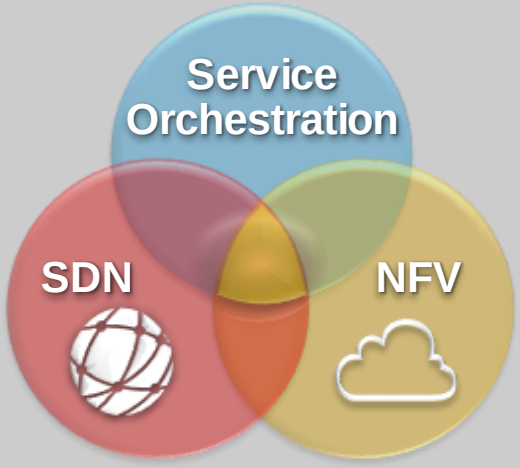
Fundamental Enablers of our SP Strategy and ESP



Orchestration
Automation, provisioning and interworking of physical and virtual resources

NFV
Network functions and software running on any open standards based hardware

SDN
Separation of control and data plane

Cisco Is Executing on Plan to Integrate All Three

Cisco NFV Solution Capability Summary

Service orchestration

- Multi-domain orchestration across compute, storage and network
- Data model driven design for service profile specification
- Customer facing service definition exposed via RESTFUL API

VNF Lifecycle management

- Elastic VM Lifecycle management to grow/shrink service on demand
- Supports horisontal and vertical scaling of VNFs (scale up/down, scale in/out)

Service Provisioning

- YANG based service models
- Supports flexible south bound device interfaces (CLI, SNMP, Netconf/YANG, REST)

Automated Network Control

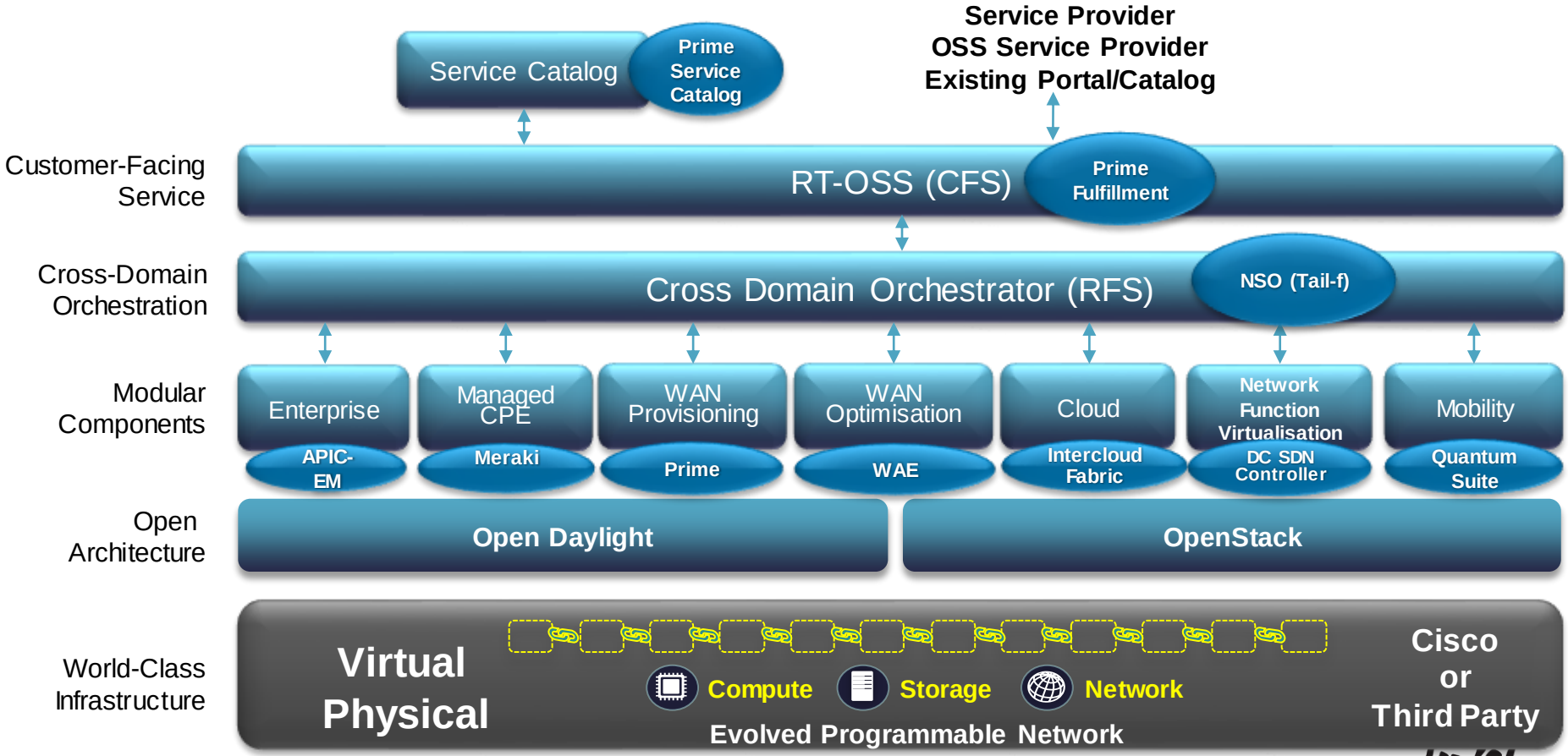
- Application driven network policy
- Supports rich network topologies and service chains
- Integrates cloud service with SP WAN (VPN/Internet)

Carrier-class performance and reliability

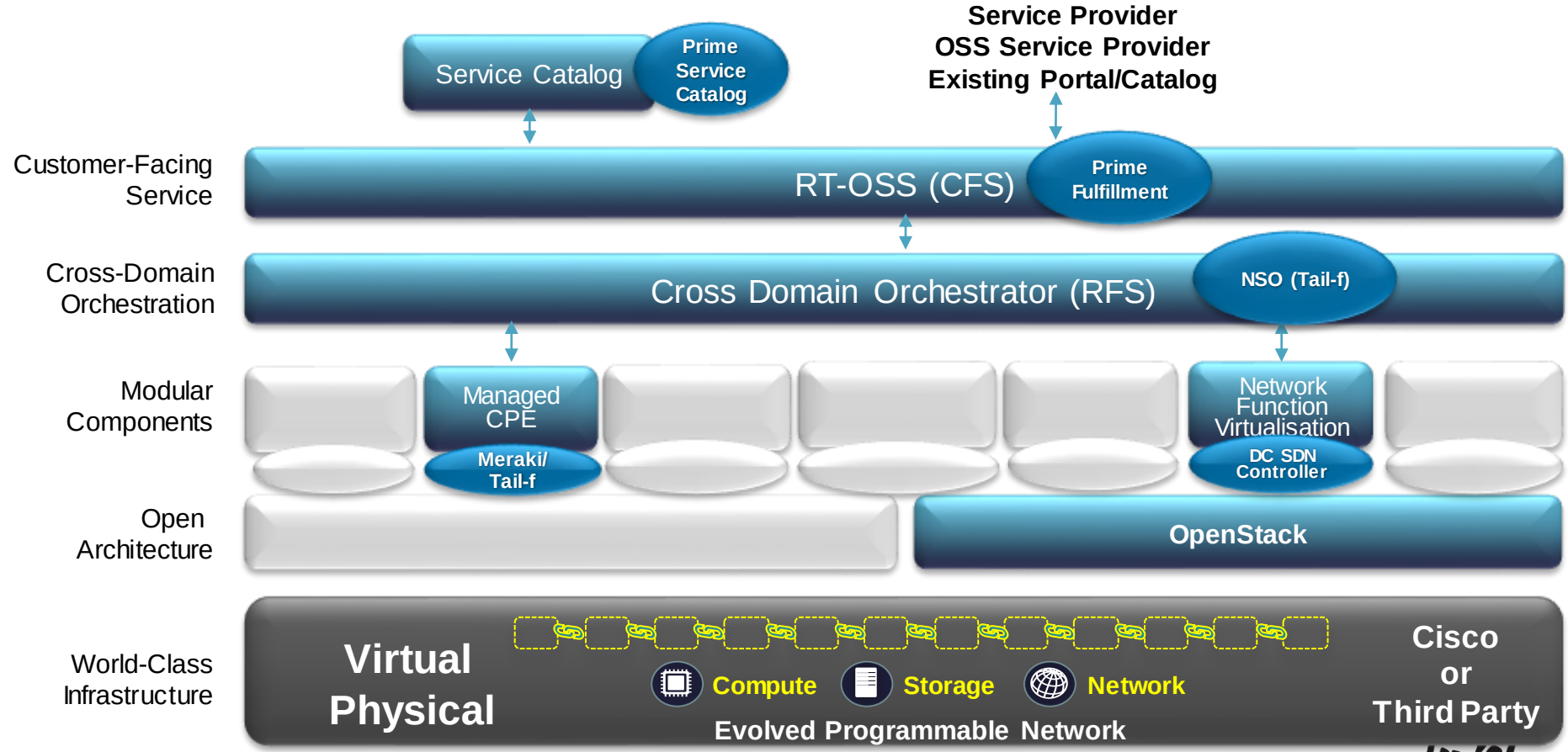
- High performance virtual data plane (10Gbps per core)
- High availability across infrastructure plane and service plane

One Touch Install

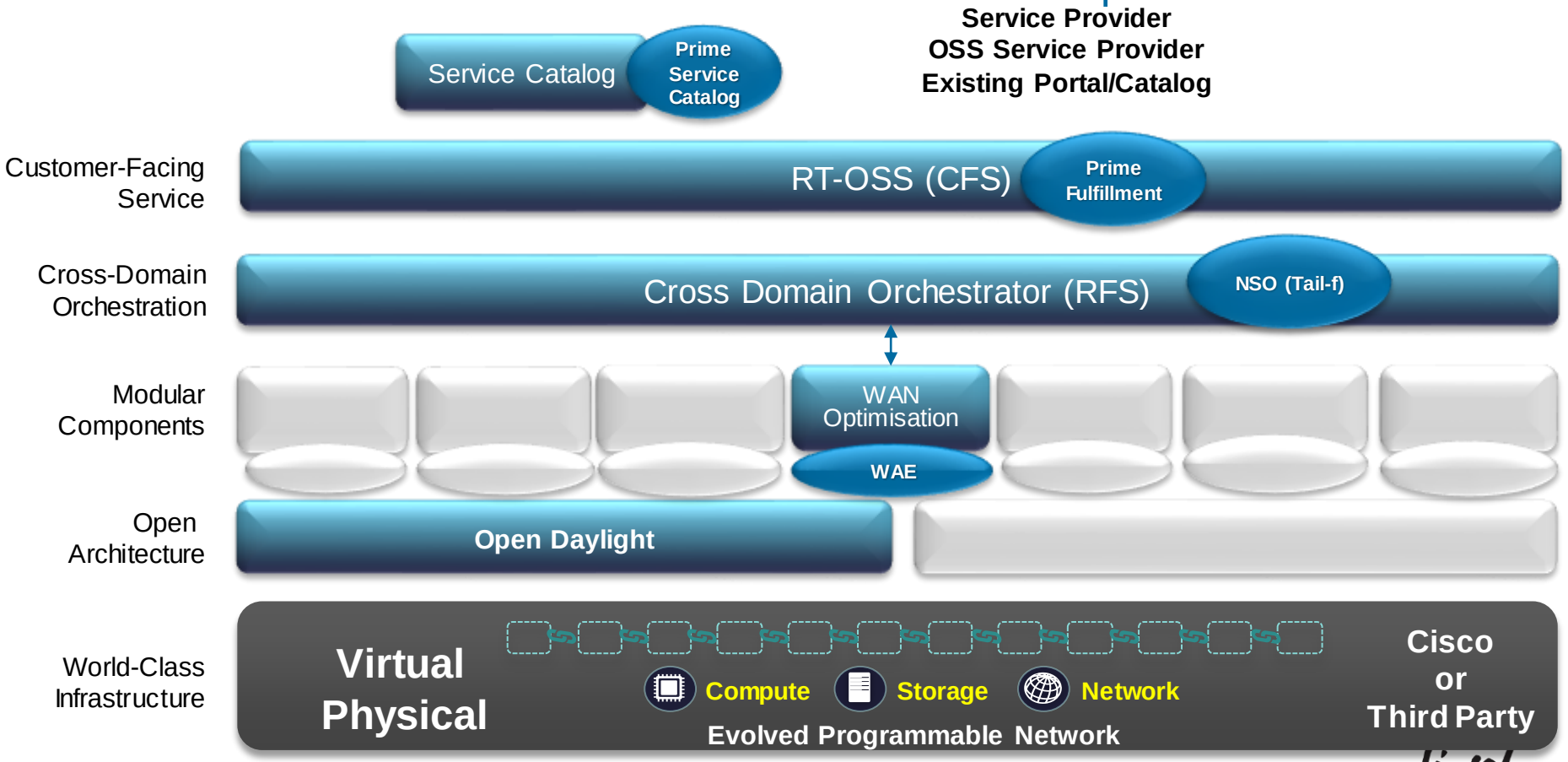
Cisco Evolved Services Platform – Modular Architecture



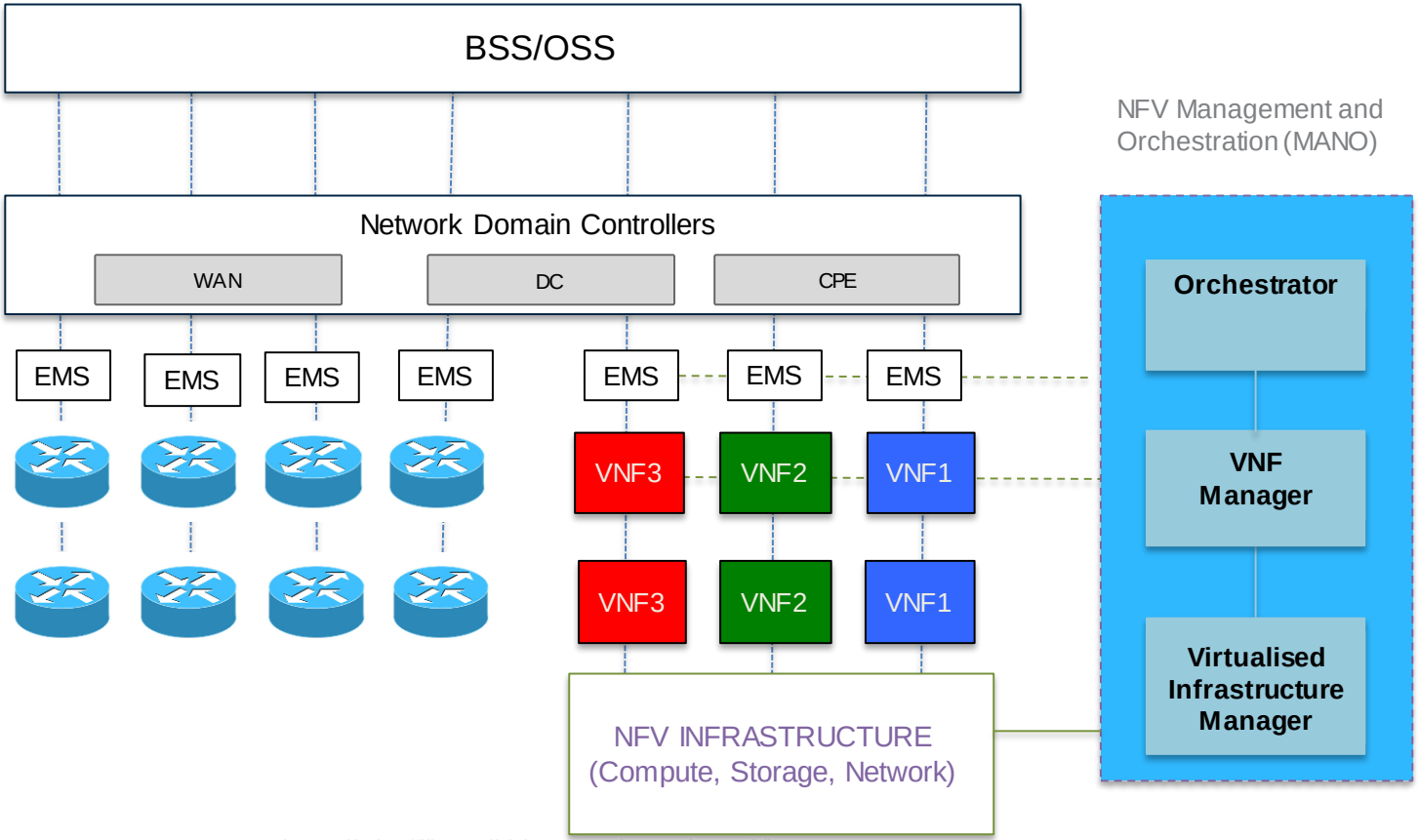
Modular Architecture for Virtualised Managed Services (vMS)



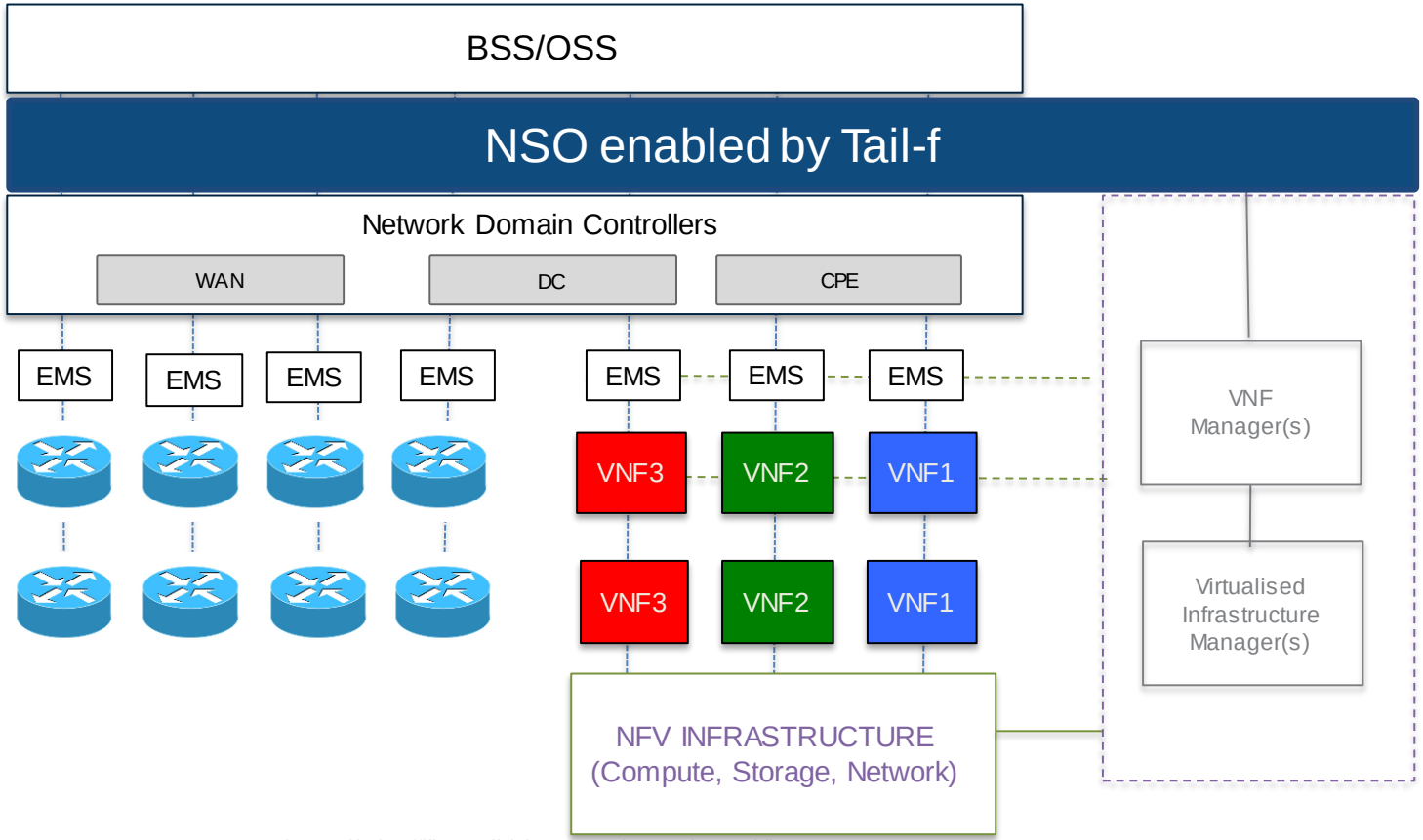
Modular Architecture for Service Provider Network Optimisation



Physical and Virtual Network Function Orchestration



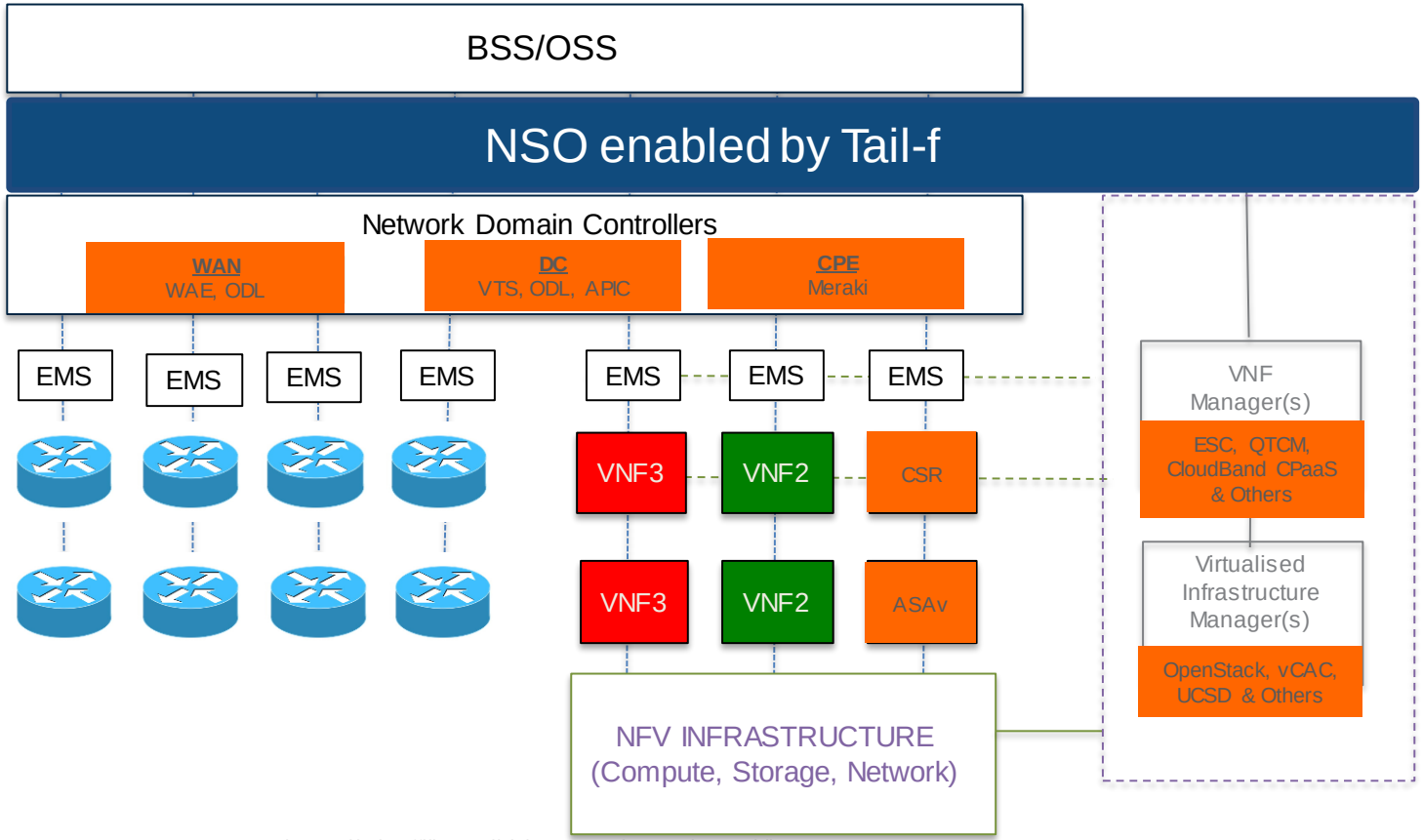
Integrated End-To-End Orchestration and Migration



VM Life-cycle
AND
Service Activation

Virtual
AND
Physical

Integrated End-To-End Orchestration and Migration



VM Life-cycle
AND
Service Activation

Virtual
AND
Physical

NFV Use Cases

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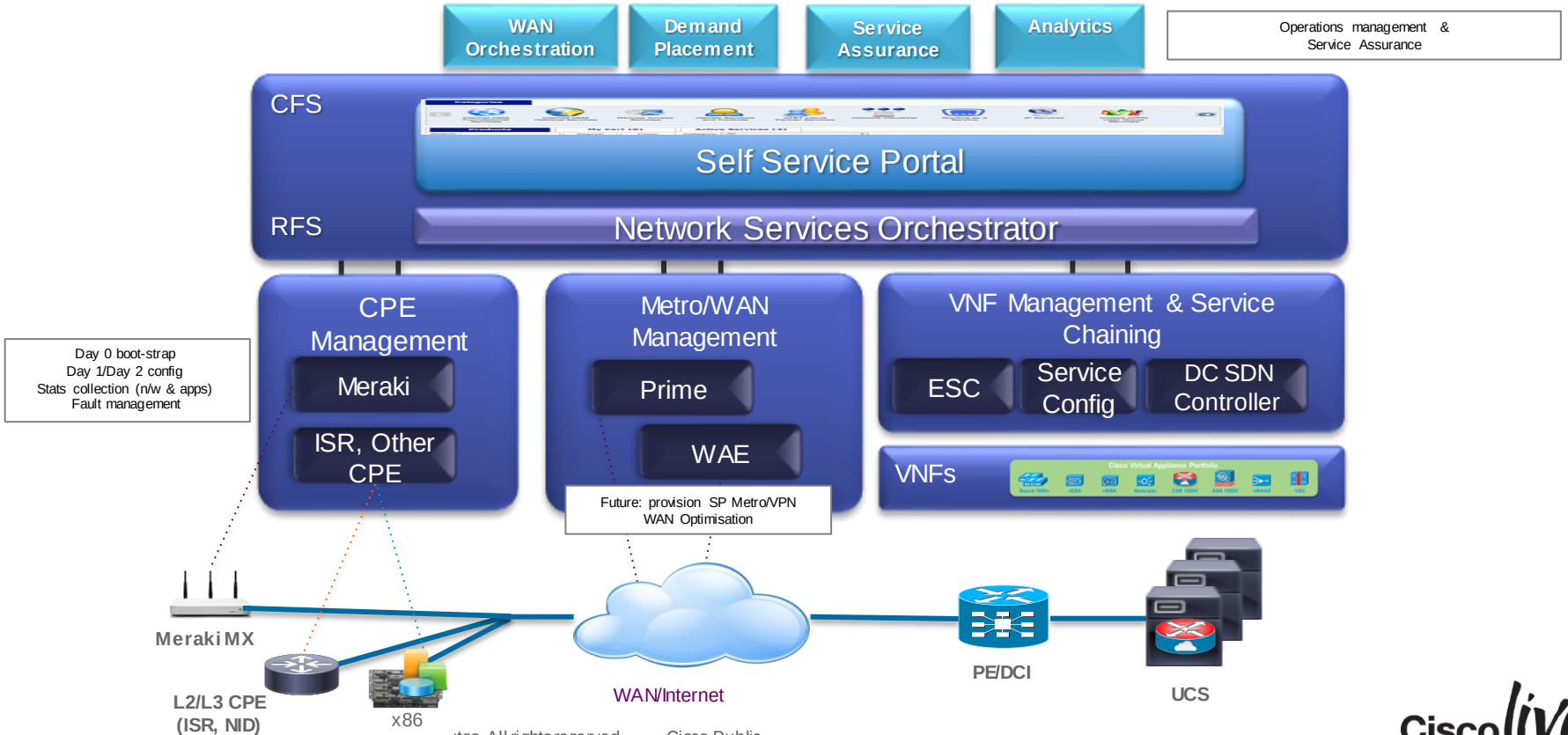
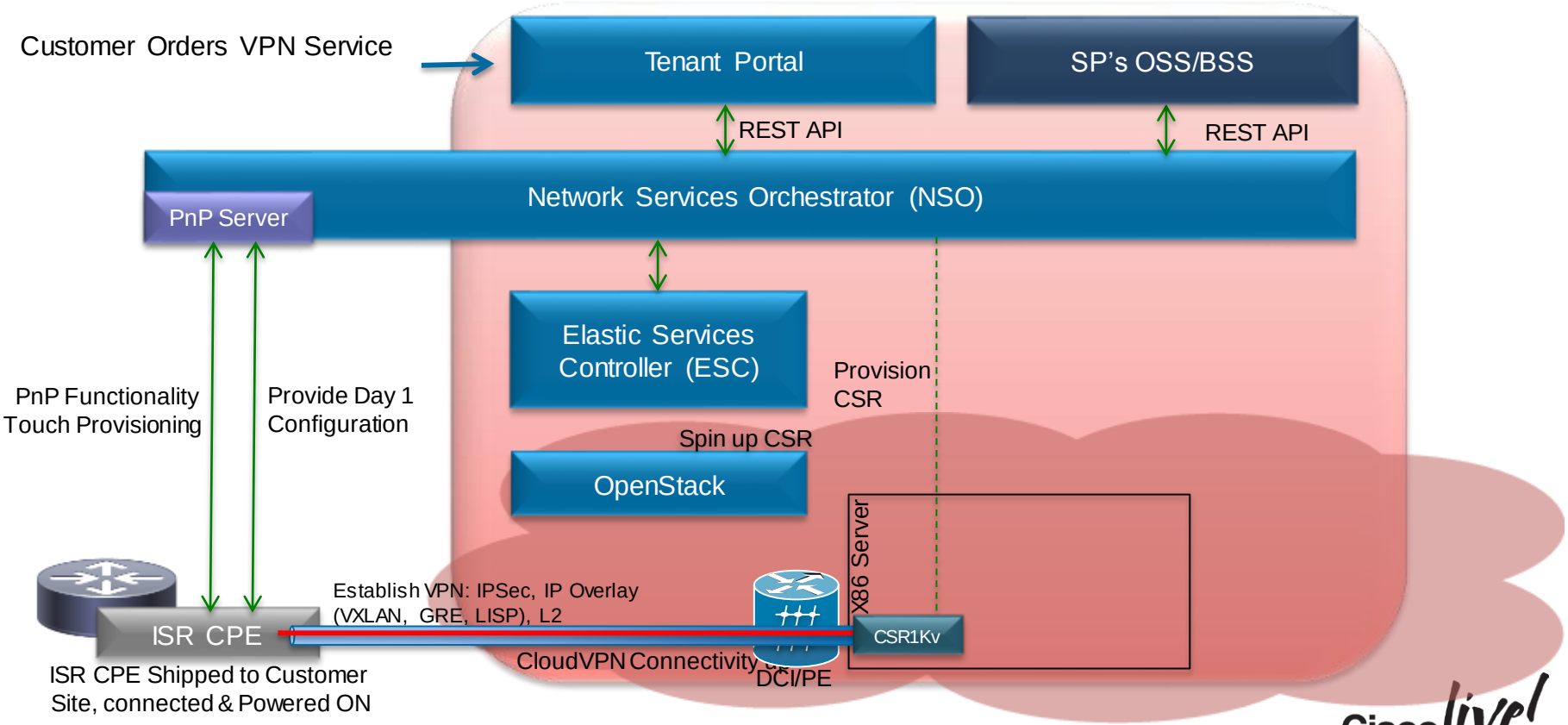
Use Cases

- **vMS and Security**
- DC Orchestration
- WAN Orchestration
- Mobile Telco Cloud

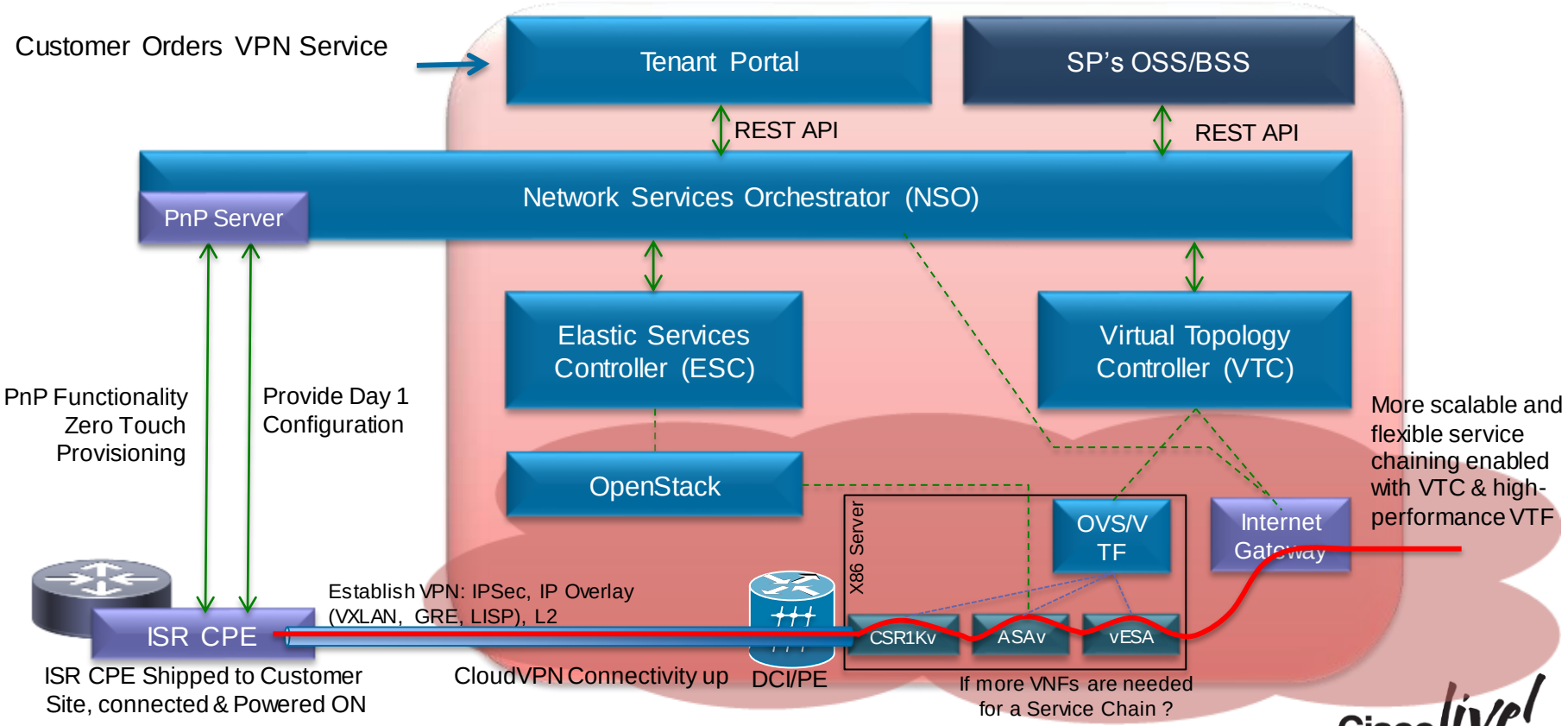
Reference E2E Functional Architecture for vMS



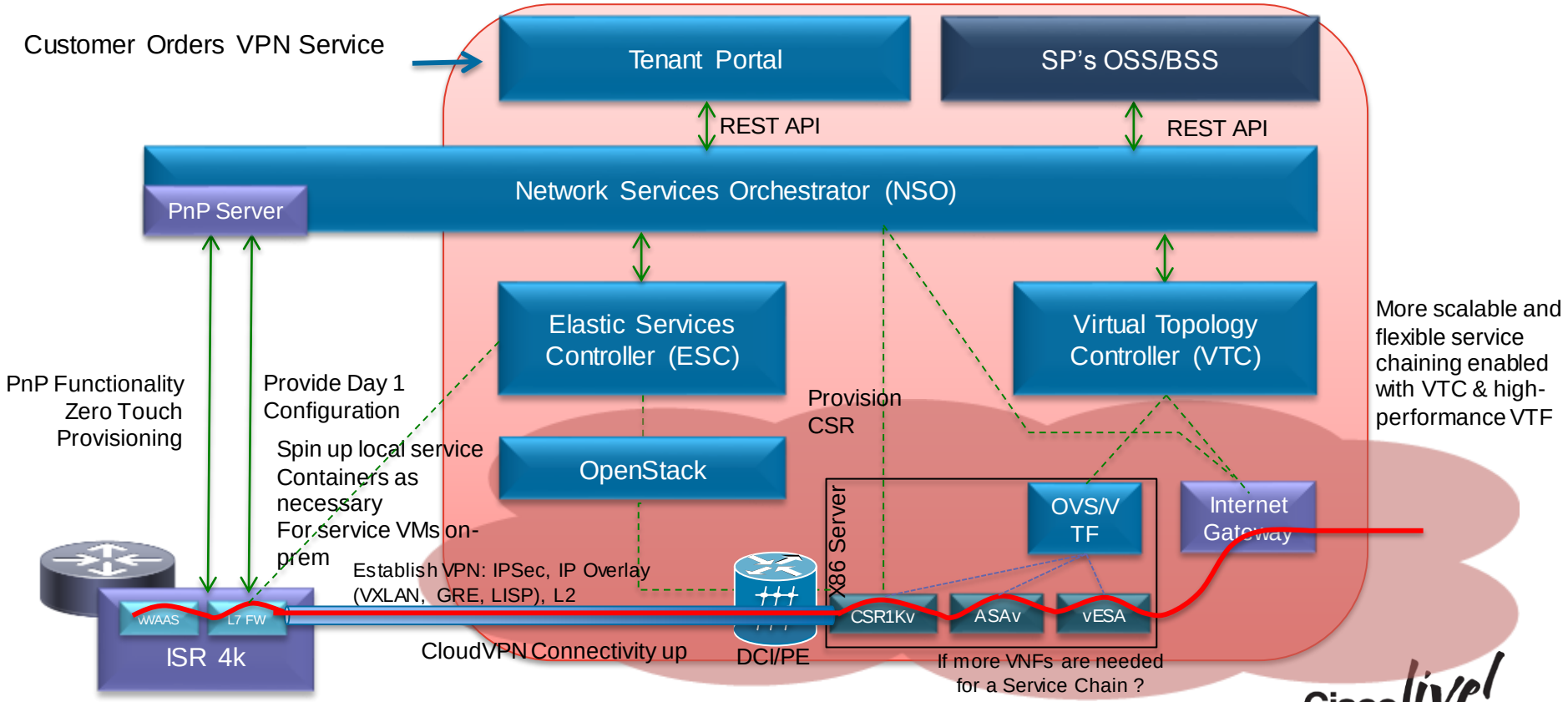
CloudVPN with ISR CPE Use Case



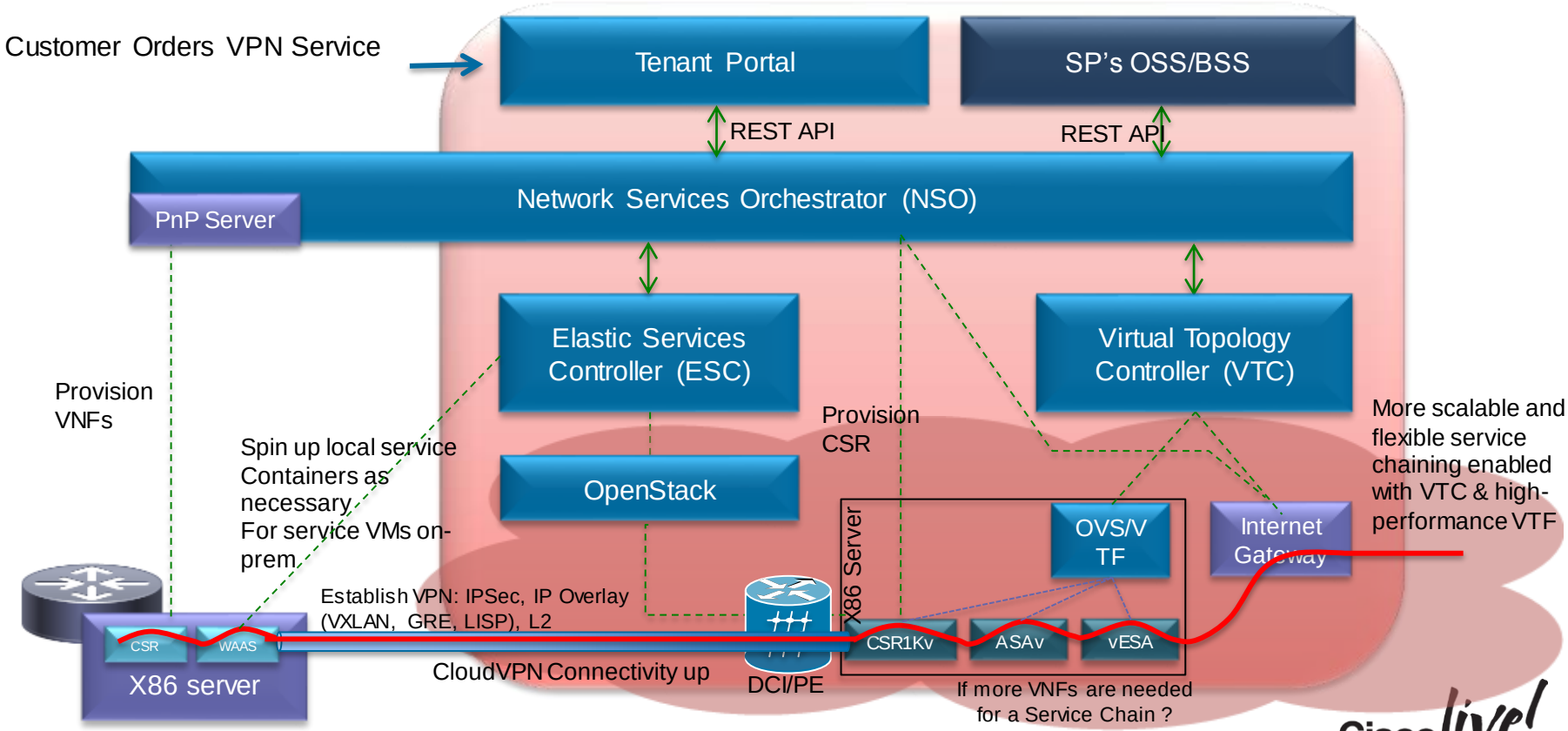
Adding VNFs in the Cloud



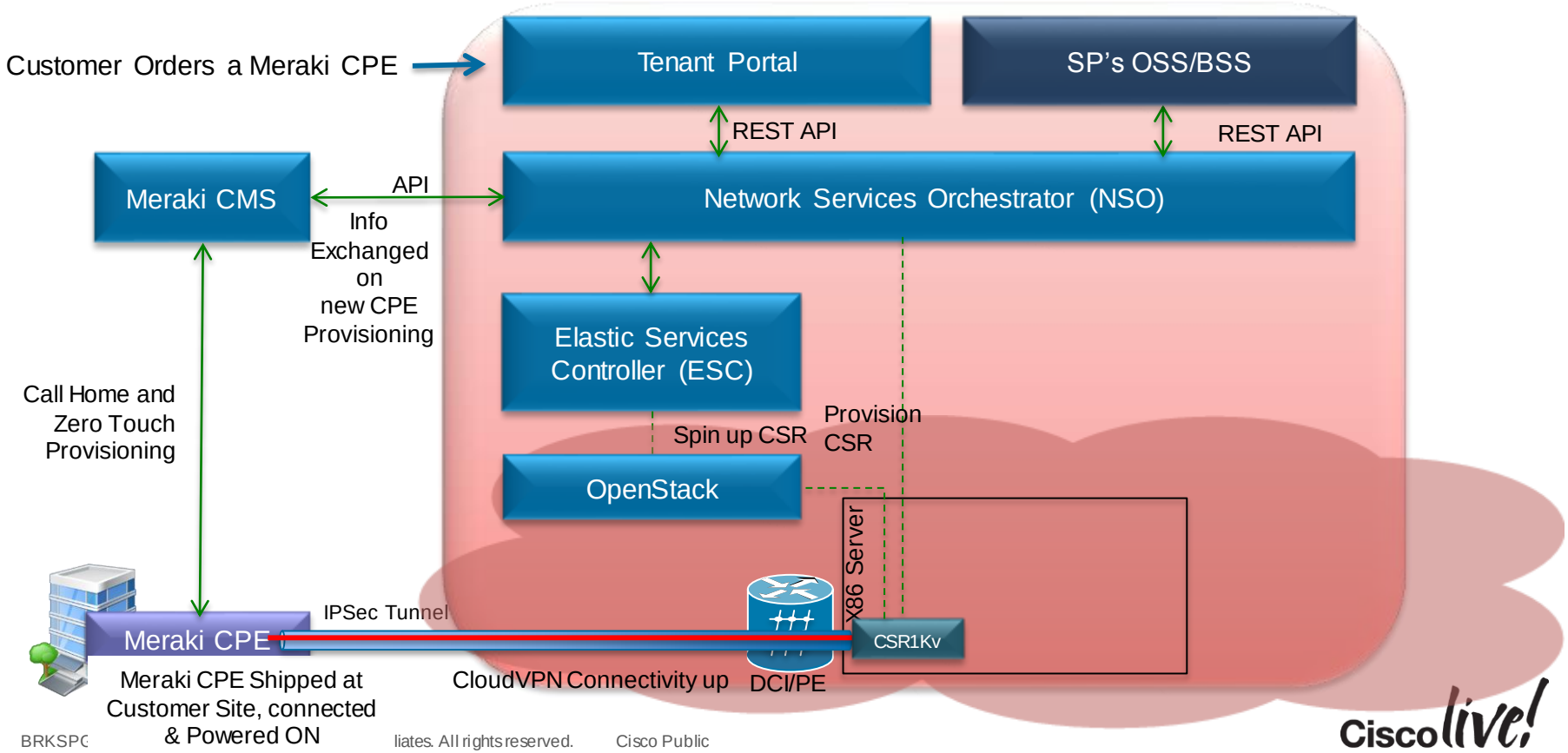
Managing On-premise NFV with ISR 4K



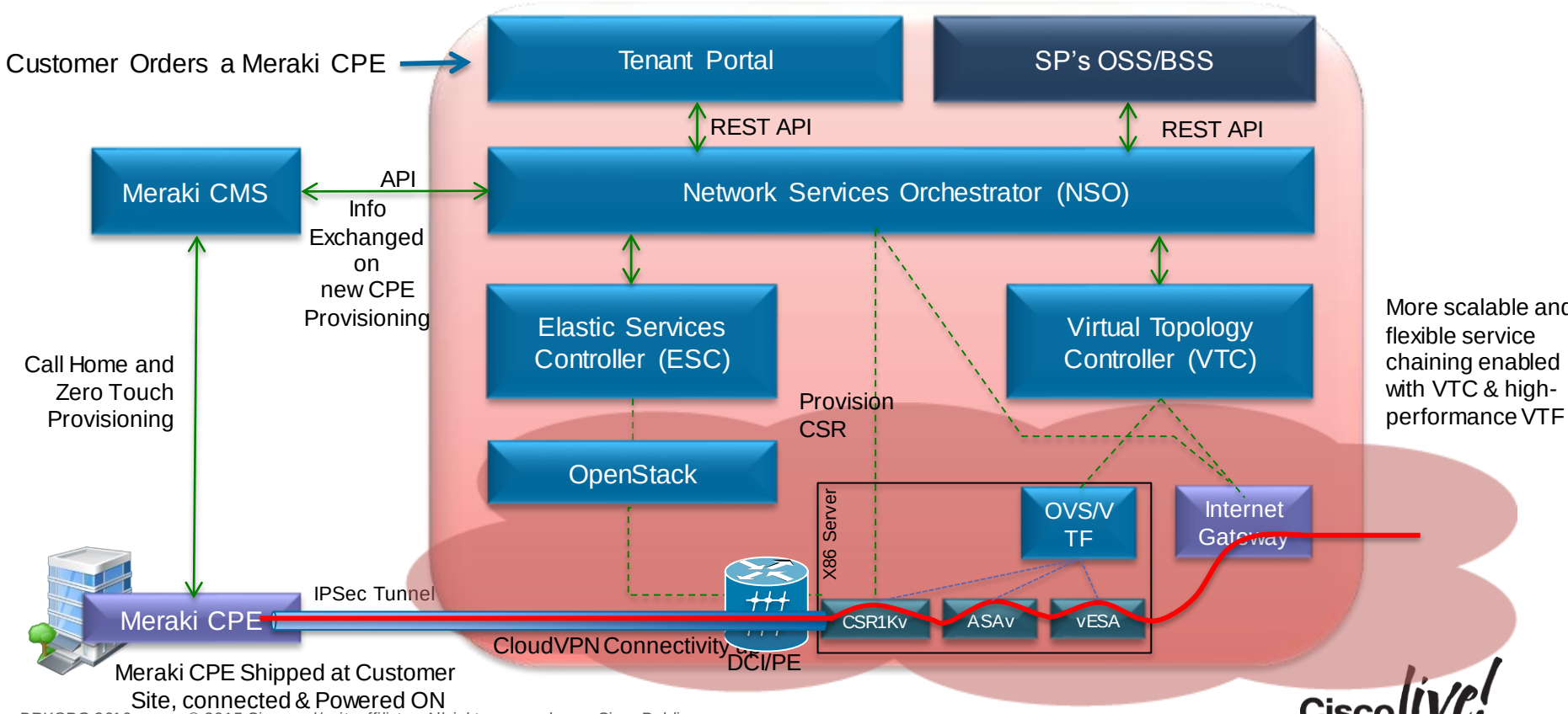
Managing On-premise NFV With Generic x86 Server



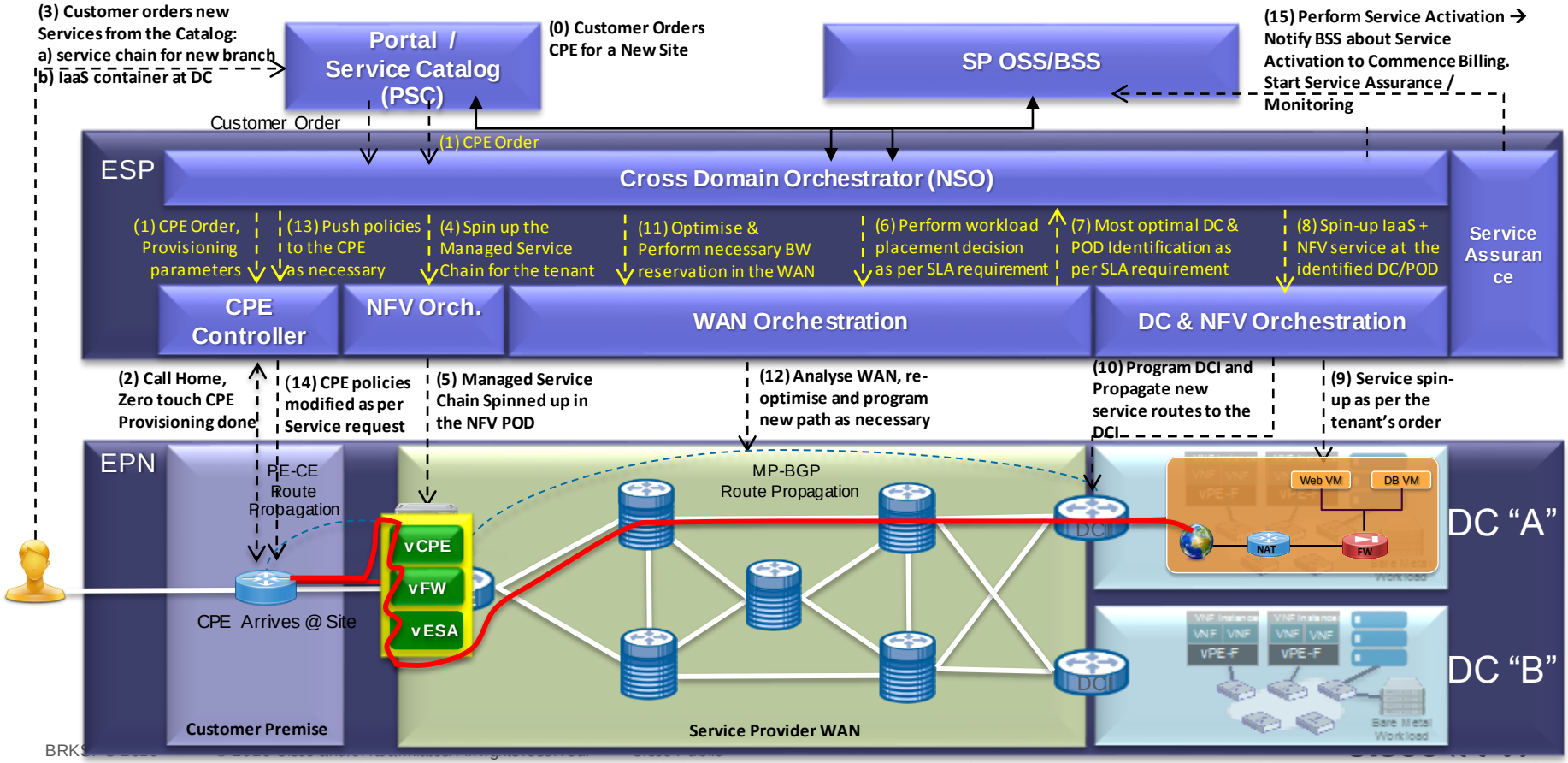
CloudVPN With Meraki CPE Use Case



Adding VNFs in the Cloud to the Meraki Service



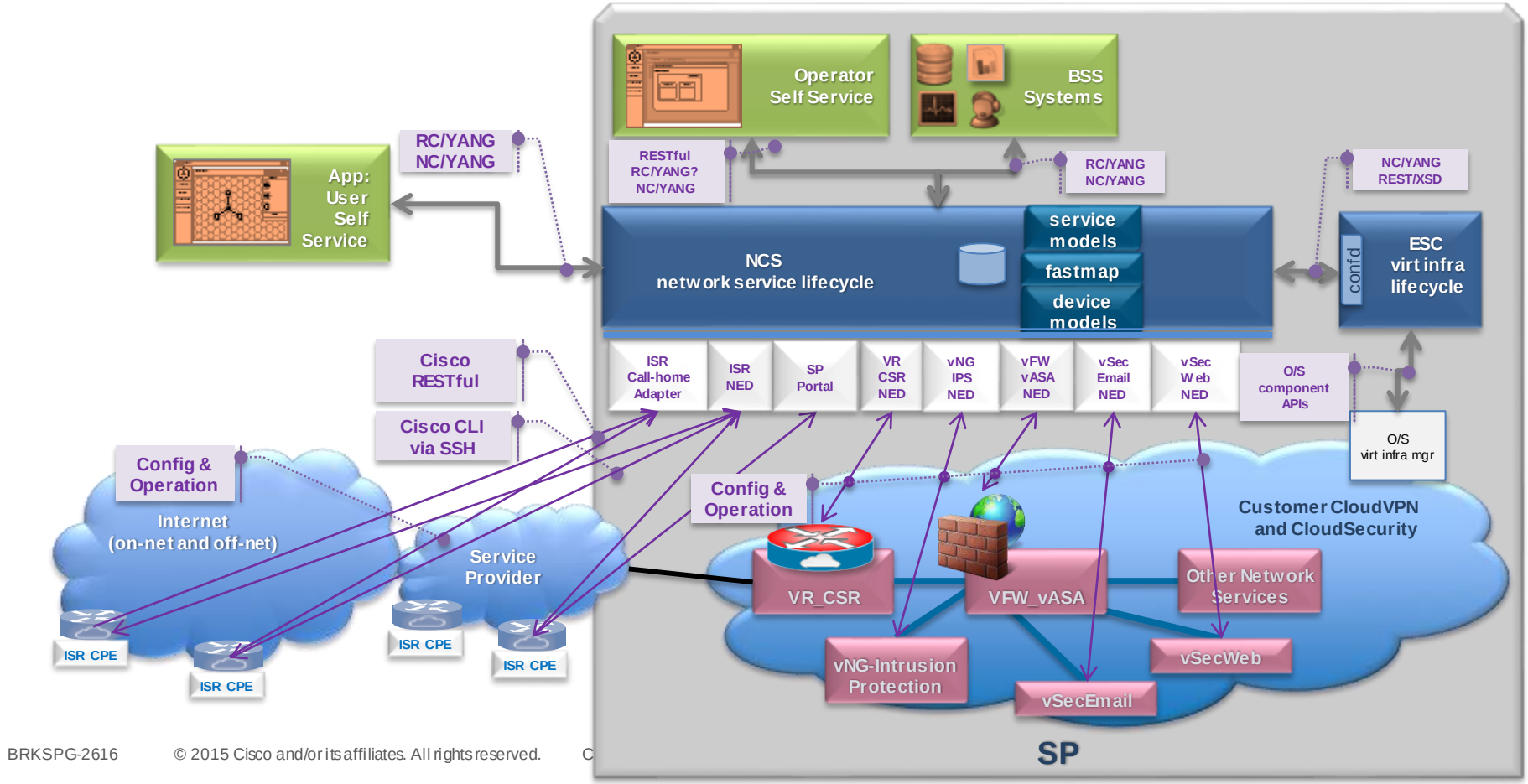
End-to-End Service Orchestration with ESP



Security as a Service and Threat Defence

- Security is all about two concepts - Visibility & Control
- Threats are mitigated as close to the source as possible
- Security services are dynamically chained together and instantiated to form a service chain to mitigate a specific threat and/or to provide a managed security service on distributed compute resources
- Threat defence provides a distributed capability to mitigate threats – targeted at the network, the Data Centre, the Cloud and the applications that they serve

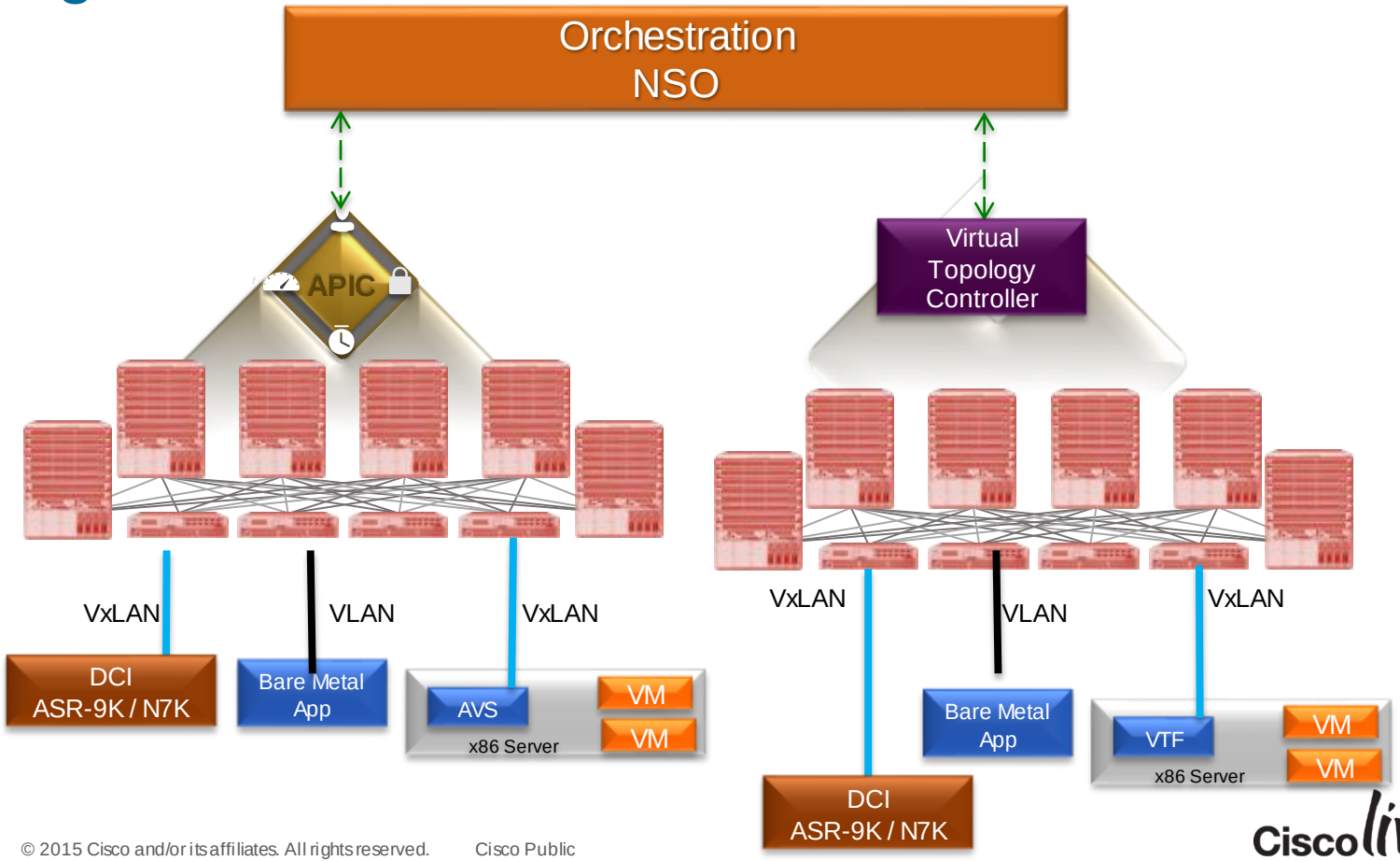
Service Delivery with Model Driven Real Time Automation



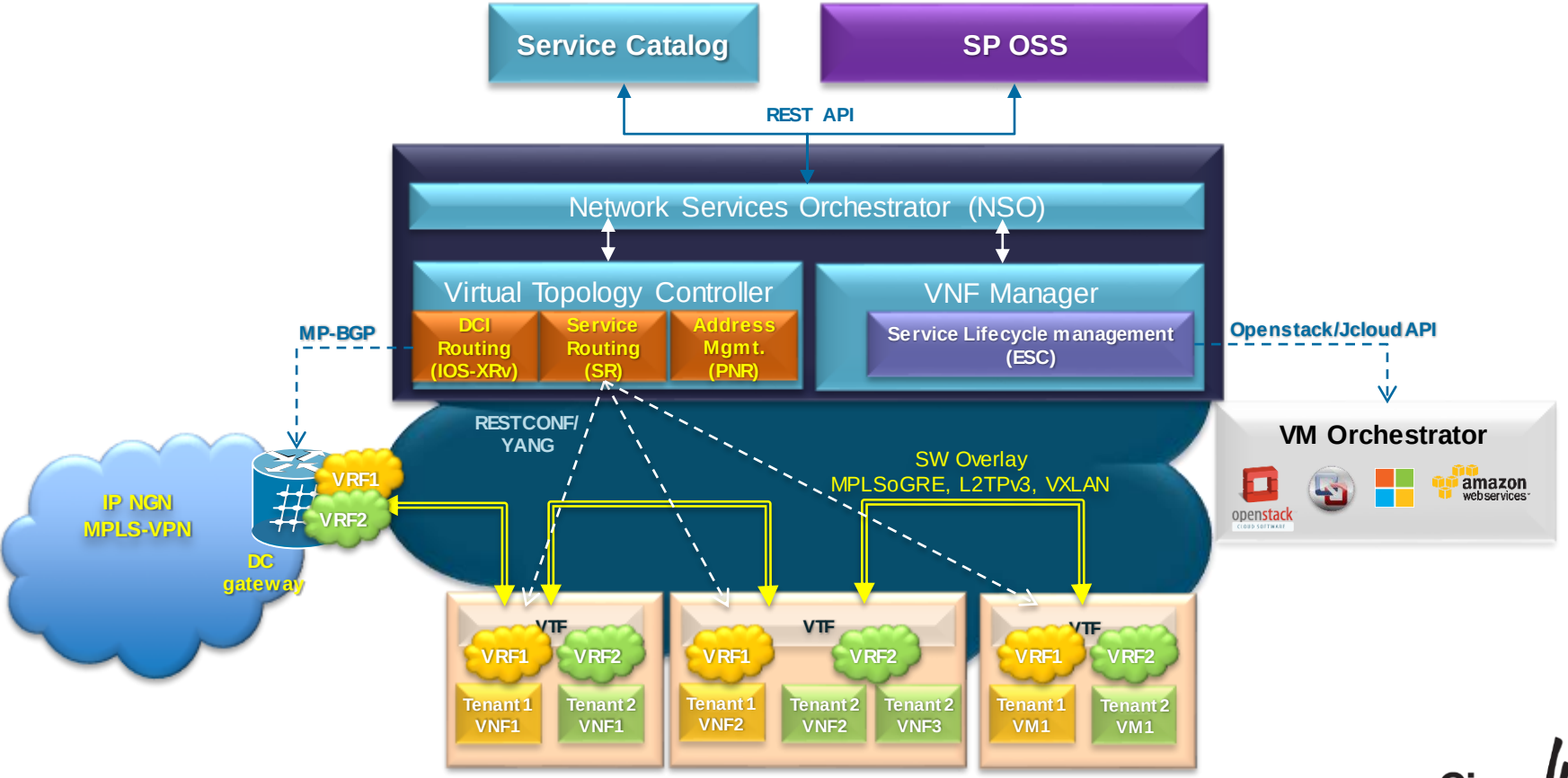
Use Cases

- vMS
- **DC Orchestration**
- WAN Orchestration
- Mobile Telco Cloud

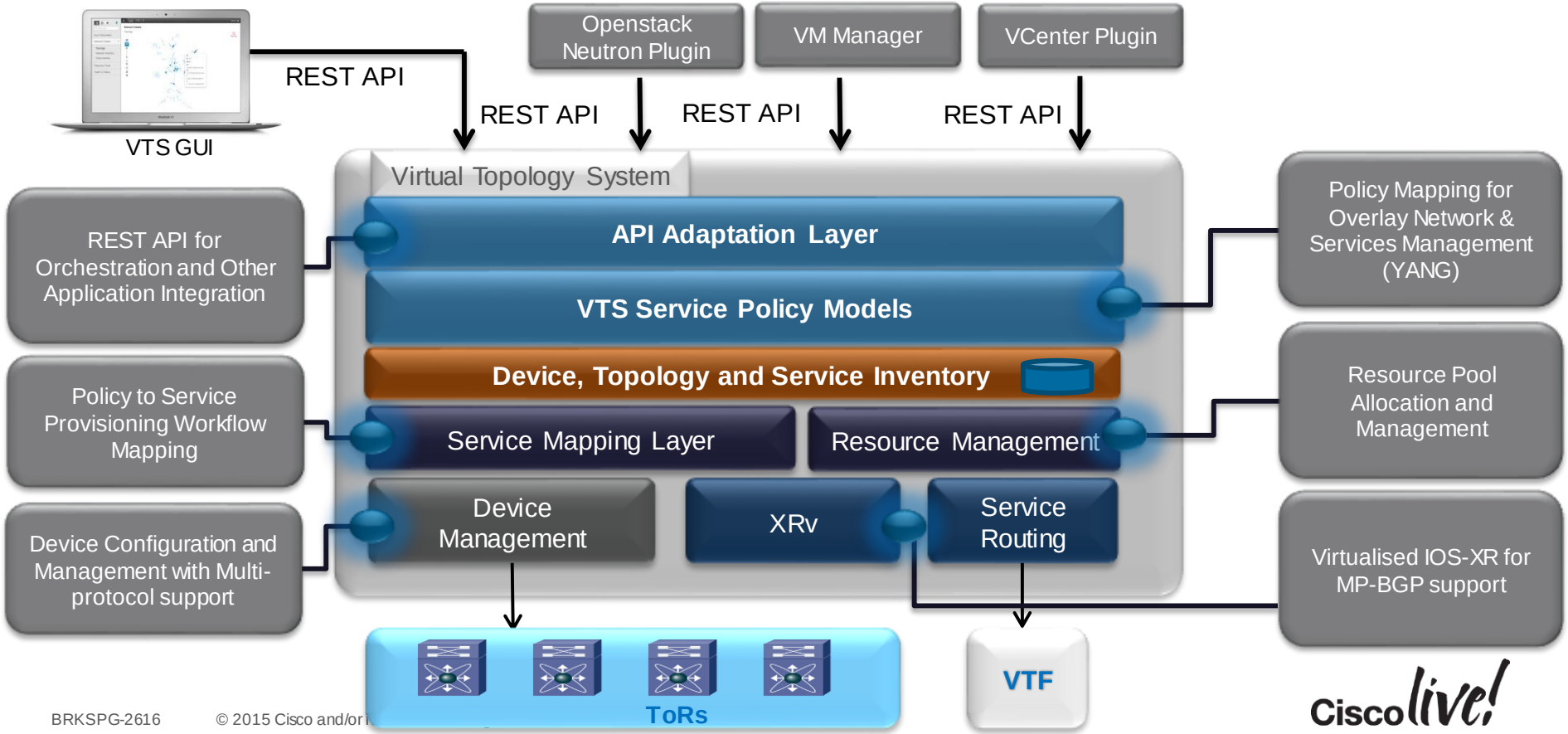
ACI Integration



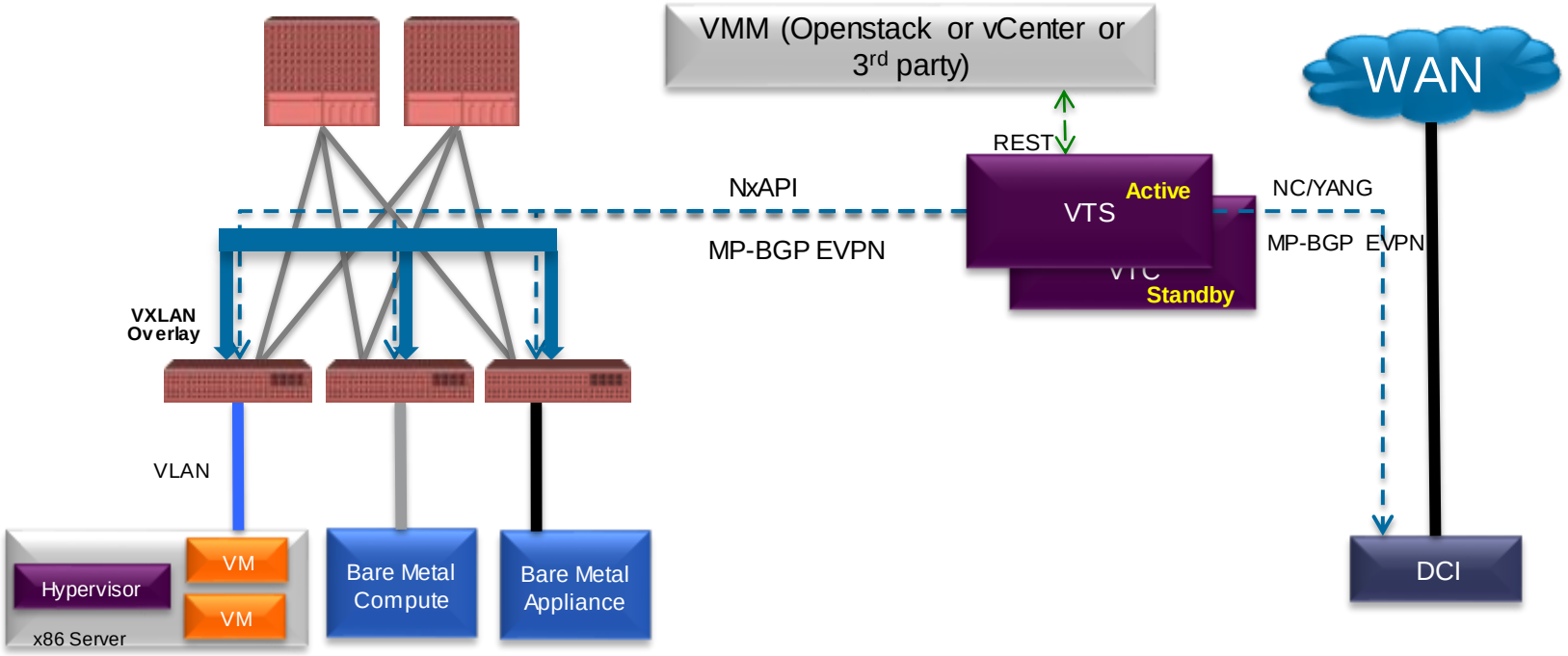
NFV Service Chaining



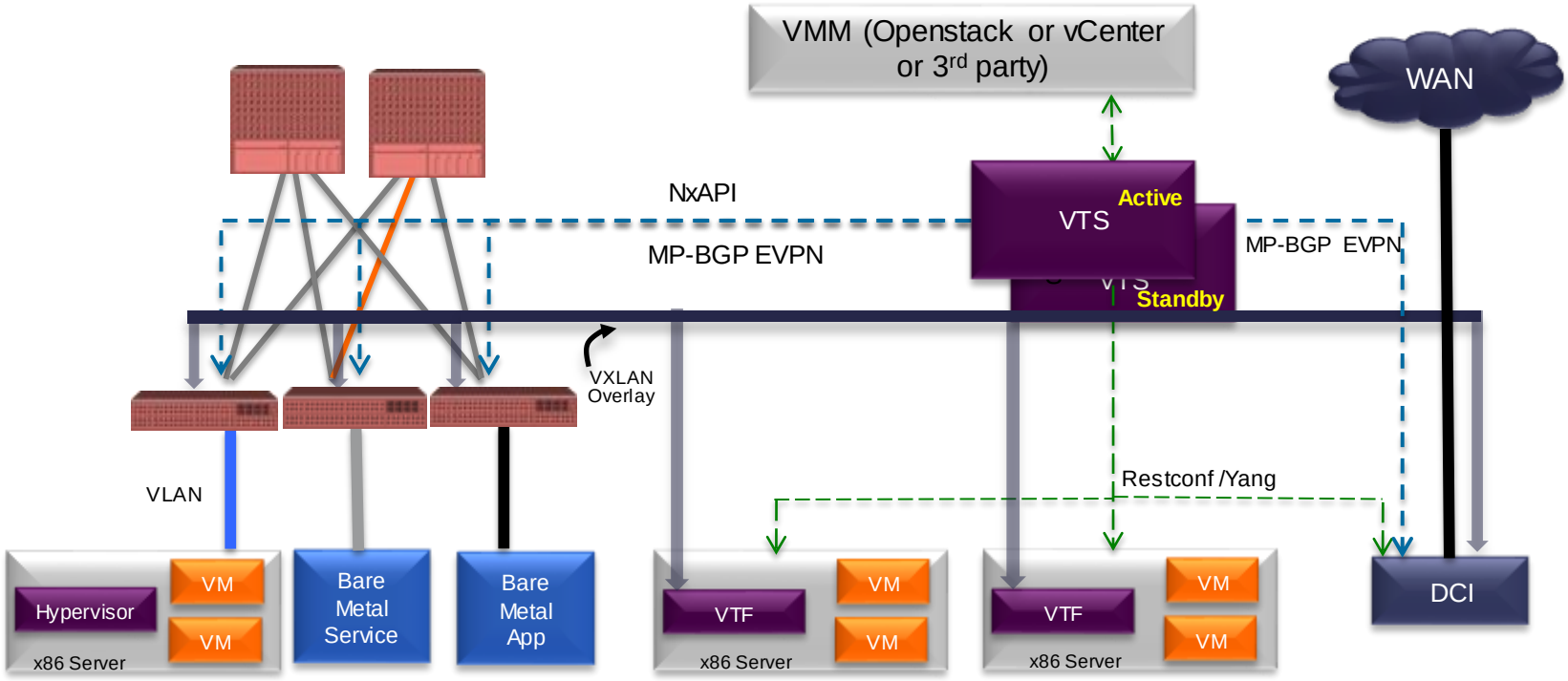
VTS Architecture Evolution



VTS 1.5 - EVPN Based VXLAN Overlay Network



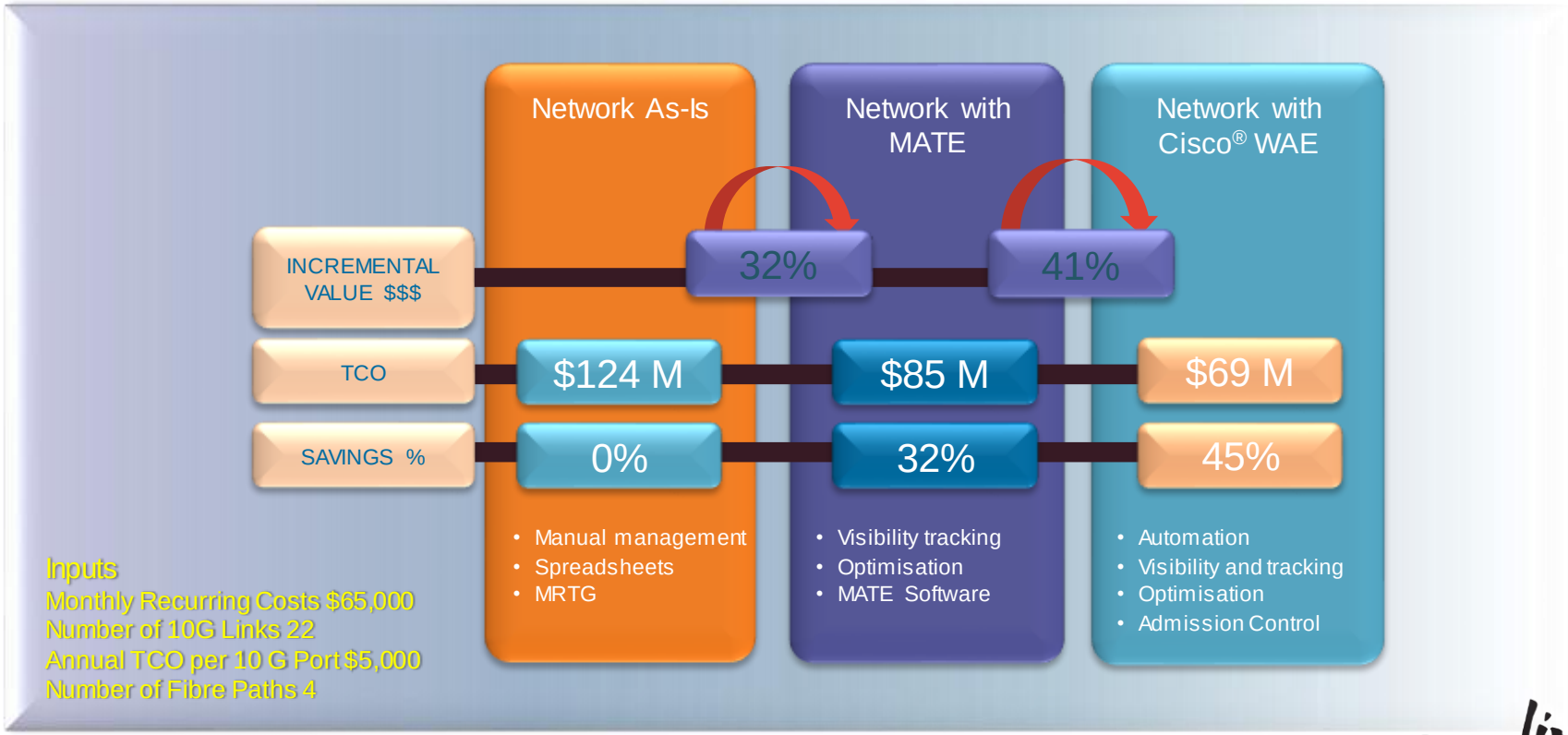
VTS 2.0 - EVPN Based VXLAN with P2V integration



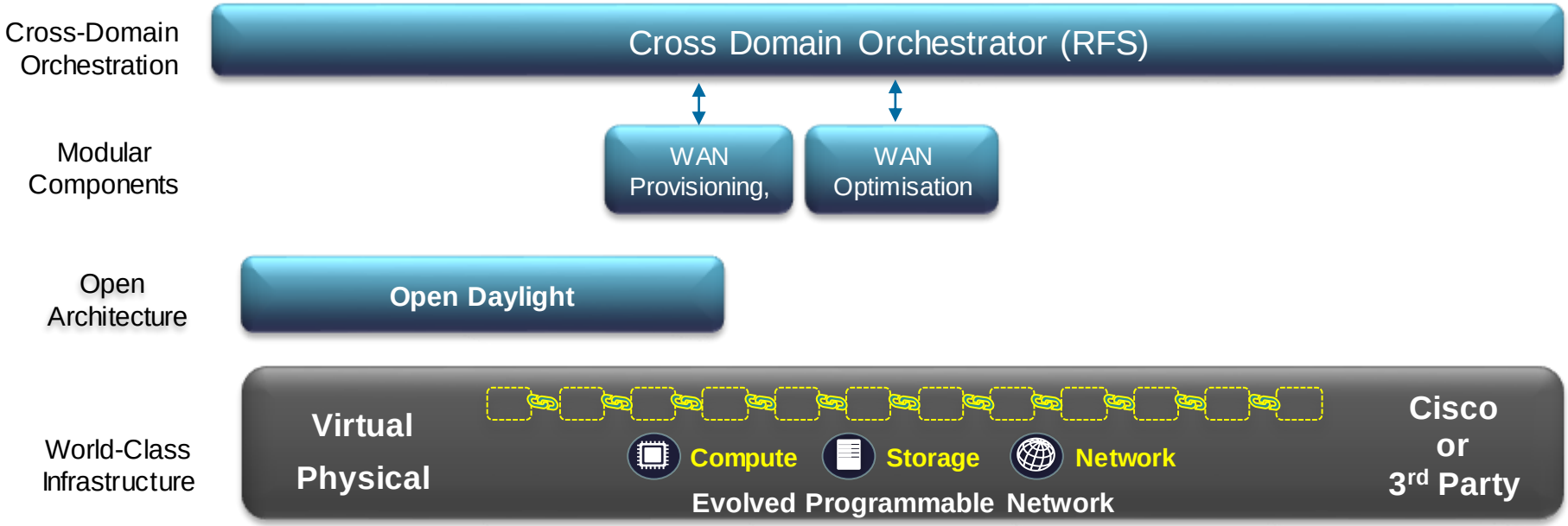
Use Cases

- vMS
- DC Orchestration
- **WAN Orchestration**
- Mobile Telco Cloud

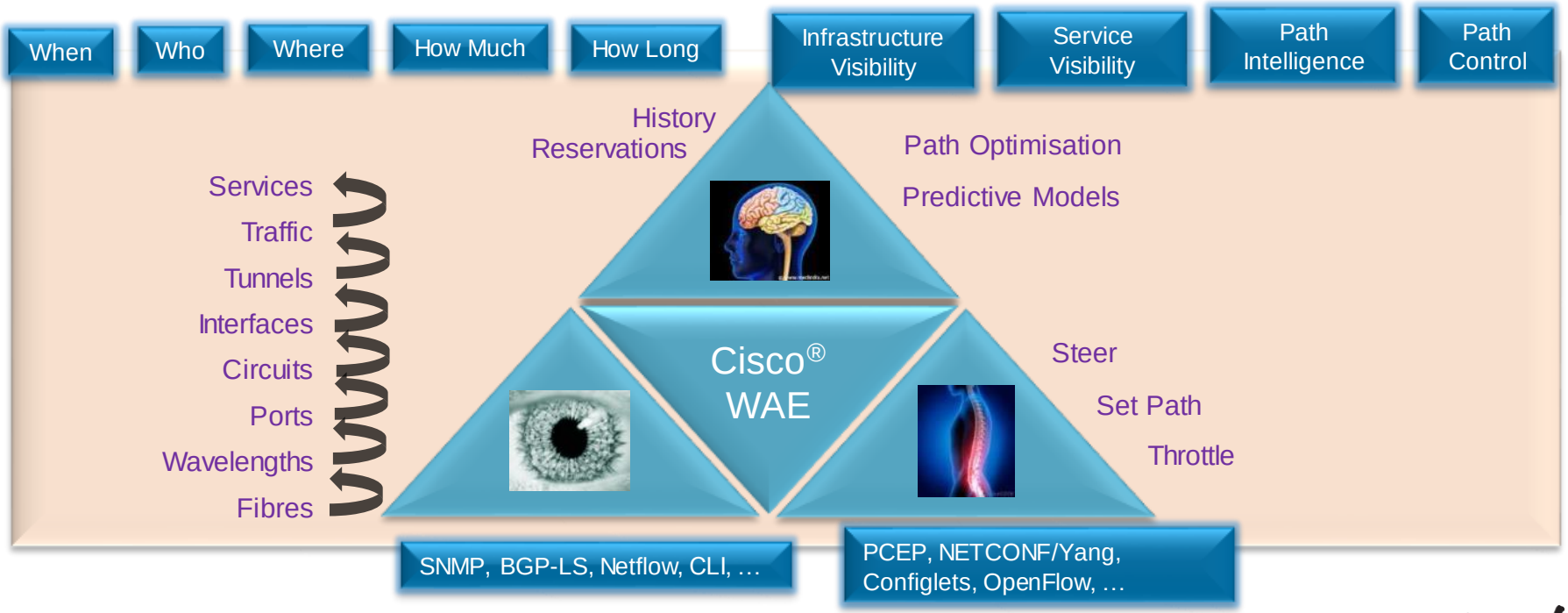
Gradual Adoption Path



Modular Architecture for Service Provider Network Optimisation



WAN Automation Engine



Use-Case: Tunnel Load Balancing

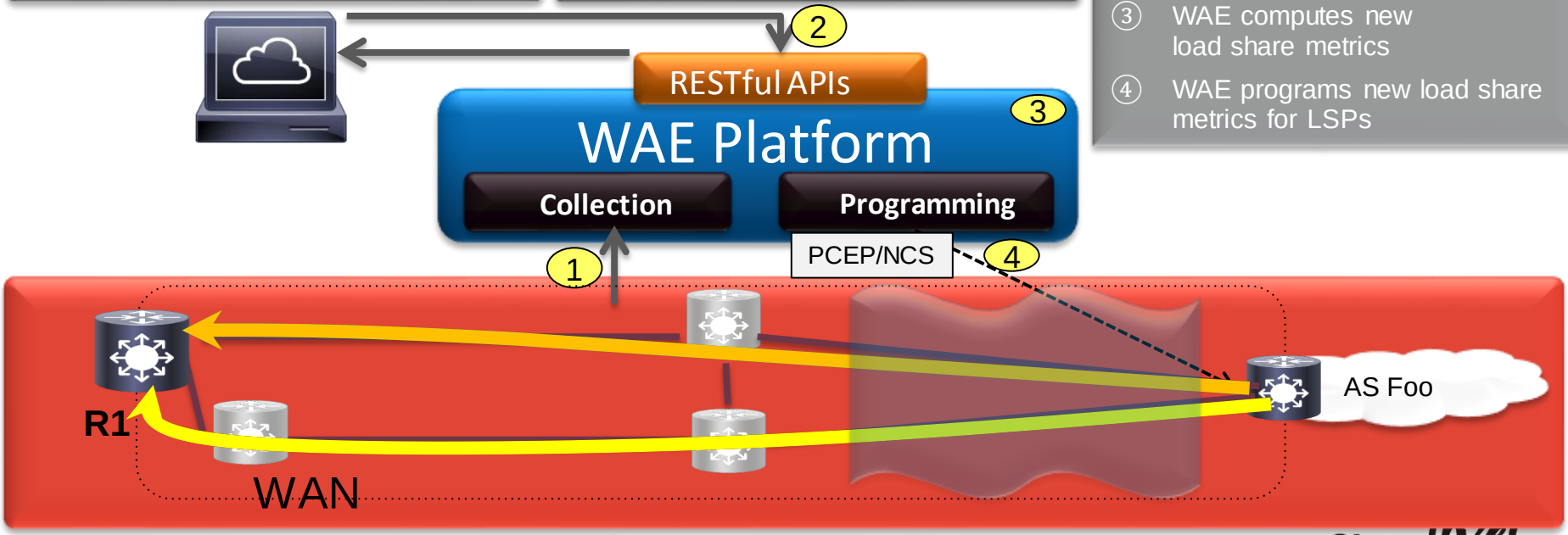
Problem:

SP needs to efficiently use expensive resources (high cost links).

Solution:

The most expensive network resources are fully optimised by WAE assigning best load share metrics.

1. Network conditions reported to collector, accessible to App
2. App determines LSP imbalance and requests WAE to recalculate LSP load share metrics
3. WAE computes new load share metrics
4. WAE programs new load share metrics for LSPs

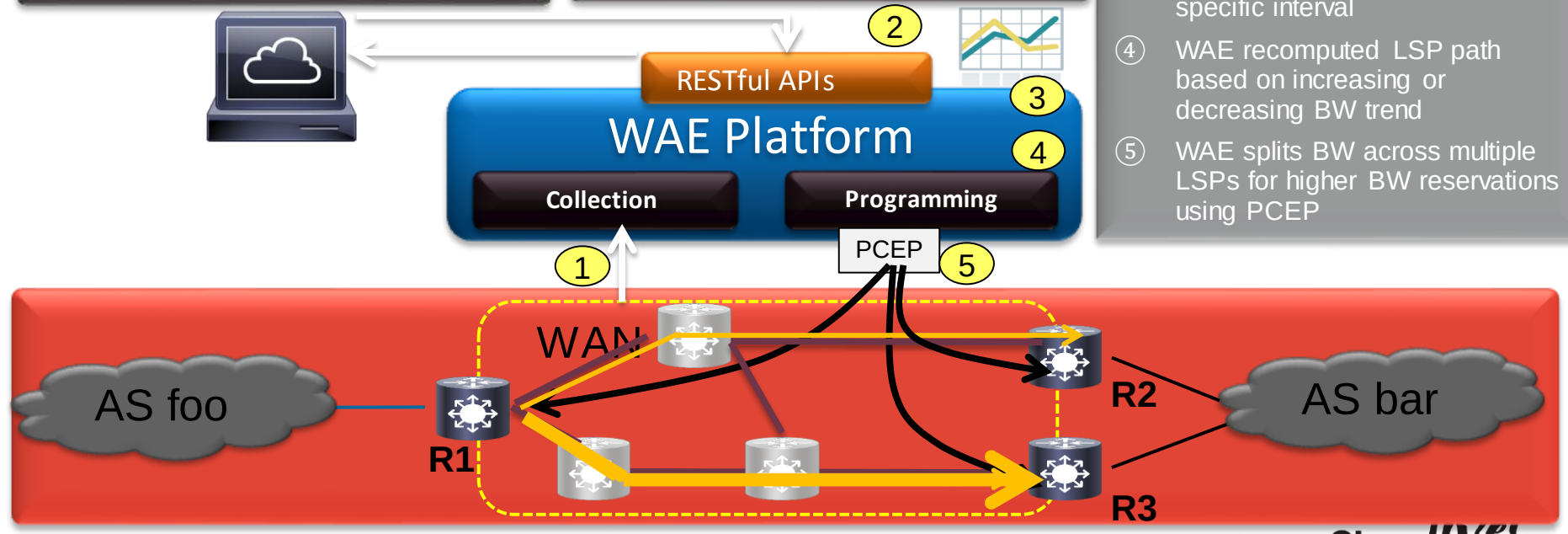


Use Case: Network Auto-bandwidth

Problem: LSPs inefficiently use BW reserving too much or lagging behind the required amount. Need to dynamically set thresholds needed for LSP aggregation & splits

Result: Using TE Manager with the WAE dynamically manages LSP BW

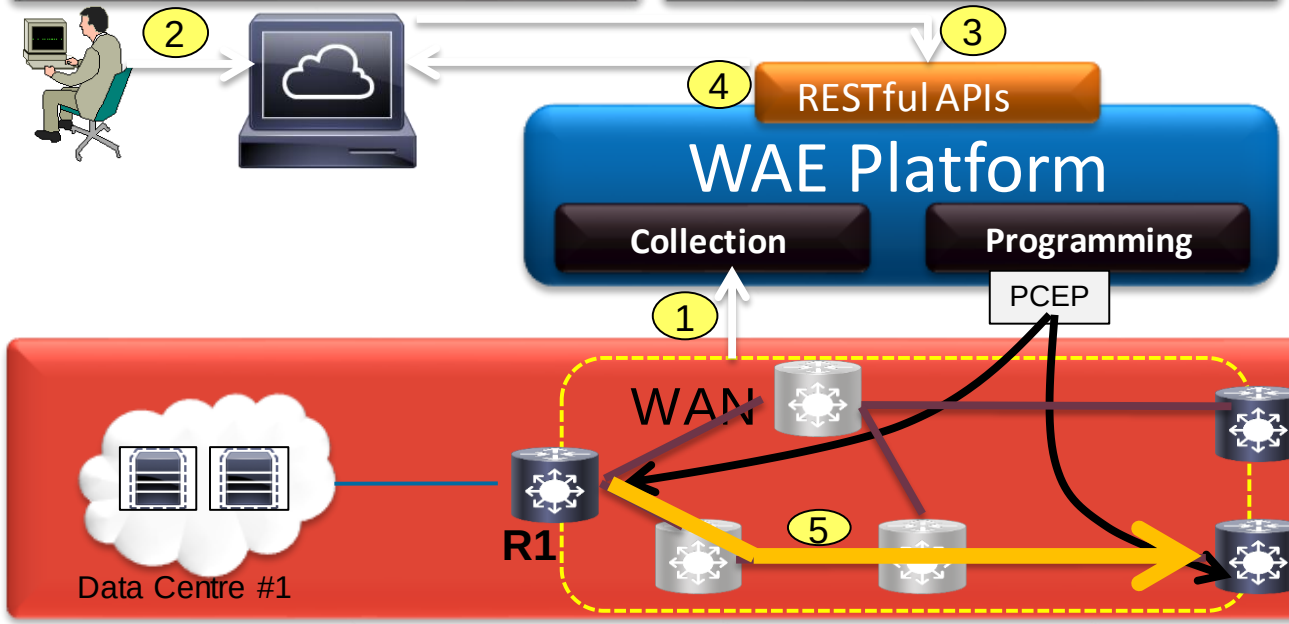
1. Network conditions reported to collector, accessible to App
2. App requests dynamic BW adjustment by WAE
3. WAE monitors BW usage over a specific interval
4. WAE recomputed LSP path based on increasing or decreasing BW trend
5. WAE splits BW across multiple LSPs for higher BW reservations using PCEP



Use-Case: Bandwidth Calendaring

Problem: Enterprise customer uses self-service portal to request BW between Data Centres in San Francisco and LA

Result: At the predetermined time, WAE places the demand on the network (using either IGP or MPLS TE)



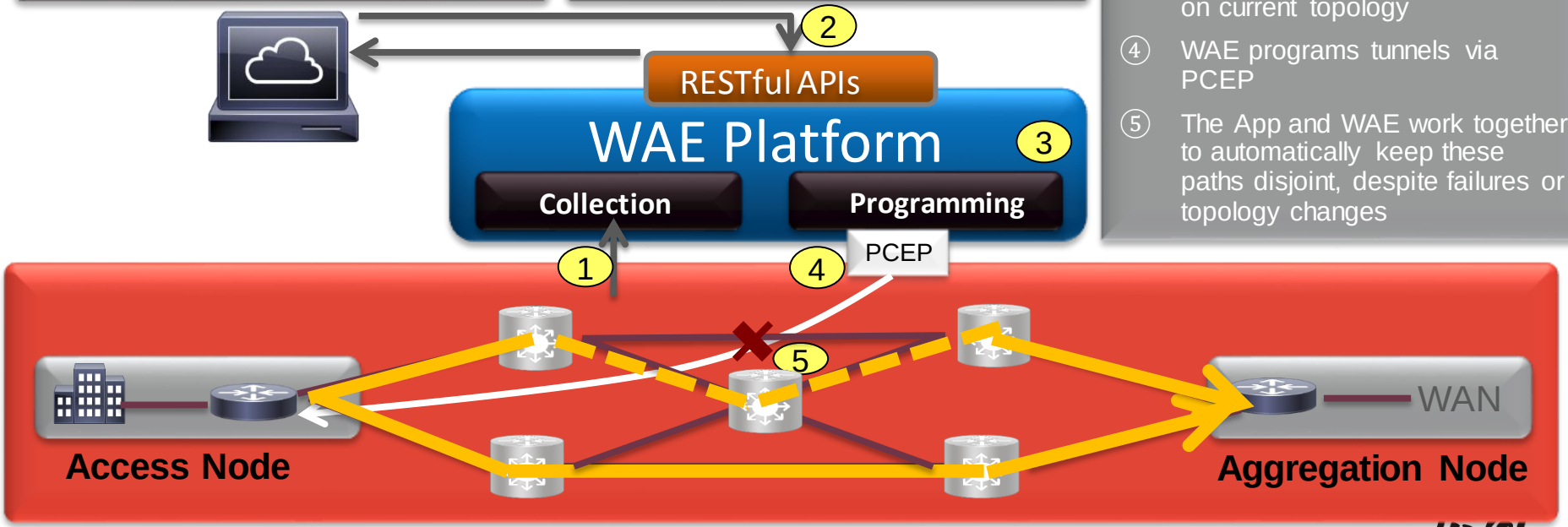
1. Network conditions reported to collector consistently
2. Customer requests DC #1 – DC #2 bandwidth at Future Date
3. Demand admission request: <R1-R3, B/W, Future Date>
4. WAE returns booking confirmation as Future Date nears
5. On Future Date NS-OS places customer demand on IGP or explicit path (TE tunnel)

Use Case: Policy-Based Path Planning

Problem: A service provider needs to provision disjoint LSPs from access to aggregation router, even across failures

Result: WAE ensures LSP paths remain disjoint

1. Network conditions reported to collector, accessible to App
2. App requests disjoint LSPs from access to aggregation router
3. WAE computes new LSPs based on current topology
4. WAE programs tunnels via PCEP
5. The App and WAE work together to automatically keep these paths disjoint, despite failures or topology changes



Use-Case: TE Metric Optimisation

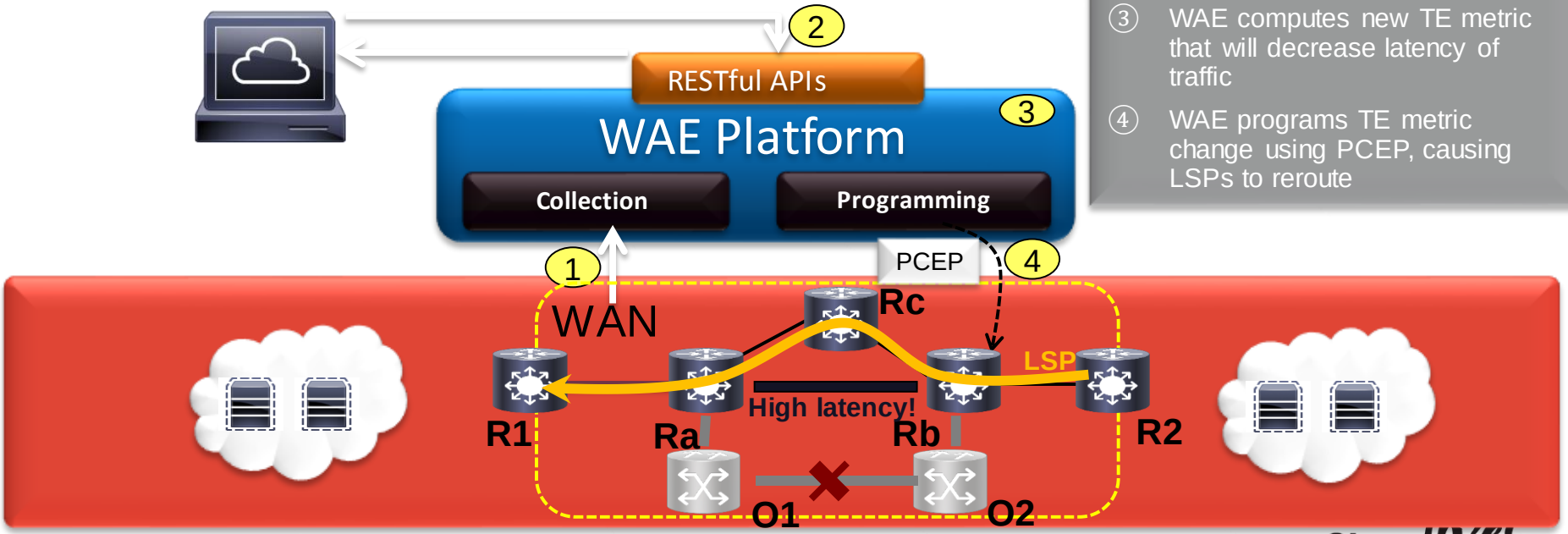
Problem:

A service provider needs to ensure low latency for high priority traffic, even in the event of a fibre cut

Solution:

WAE assigns new TE metrics based on measured latency, thereby routing LSPs according to lowest latent paths

1. Real-time data collection reveals latency at L3 accessible to App (caused by fibre cut / optical failover)
2. App requests TE Metric change on L3 circuits routed over L1 link
3. WAE computes new TE metric that will decrease latency of traffic
4. WAE programs TE metric change using PCEP, causing LSPs to reroute



Use Case: Data Centre Workload Placement

Combine DC and Network knowledge

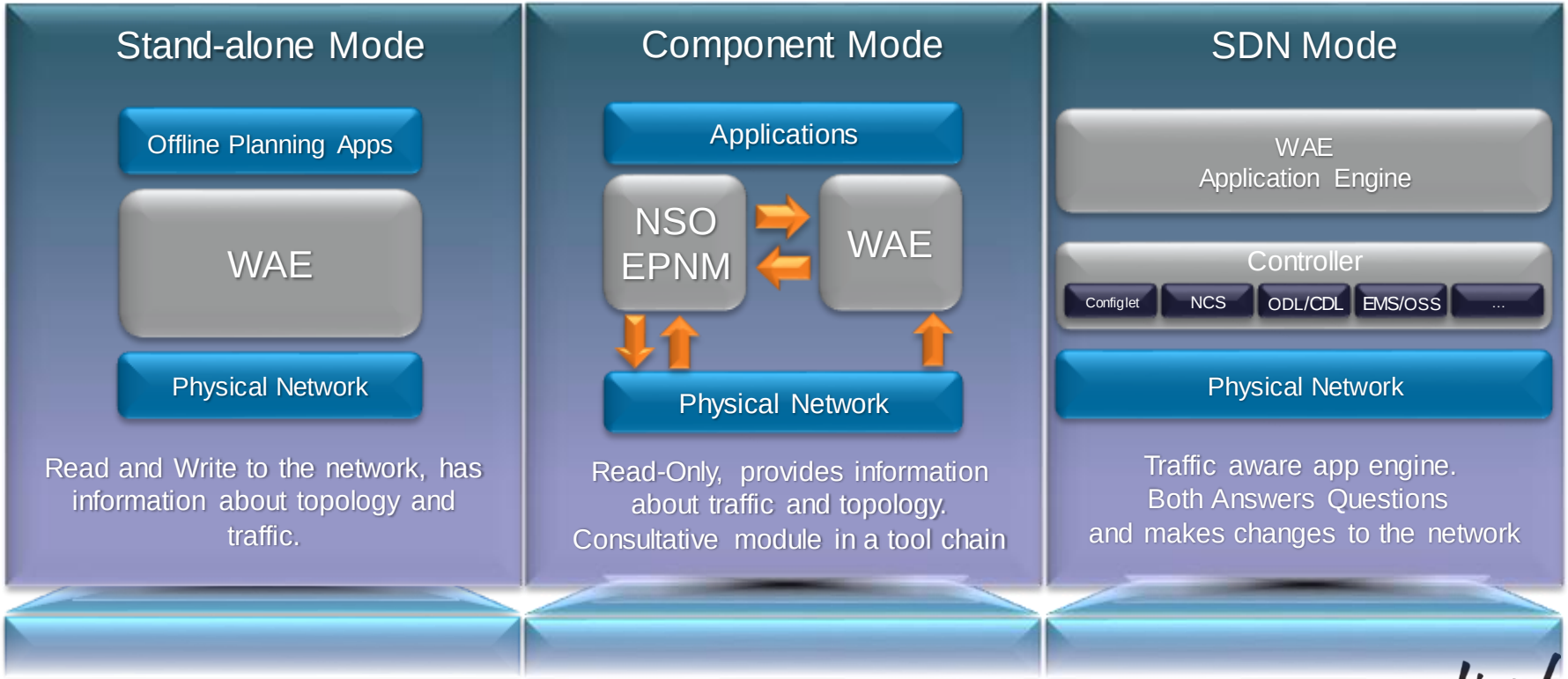
Scenario

Intelligently place workload into a data centre within my network so I can optimise load placement.

Outcome

App that queries both systems and produces a set of Intelligent options to optimise load placement that guarantee SLA, allocate sufficient resources, optimise network utilisation, minimise latency

WAE Modes of Deployment



Use Cases

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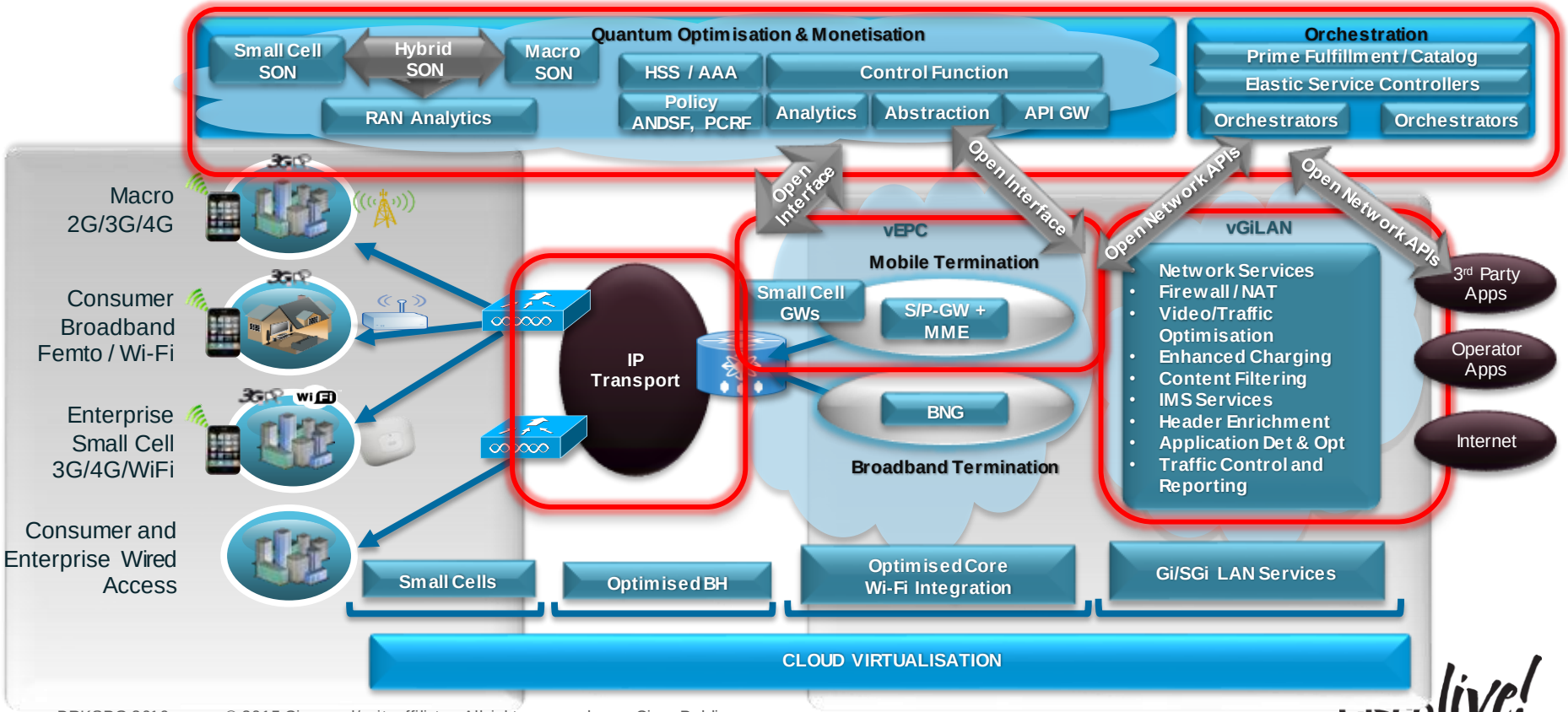
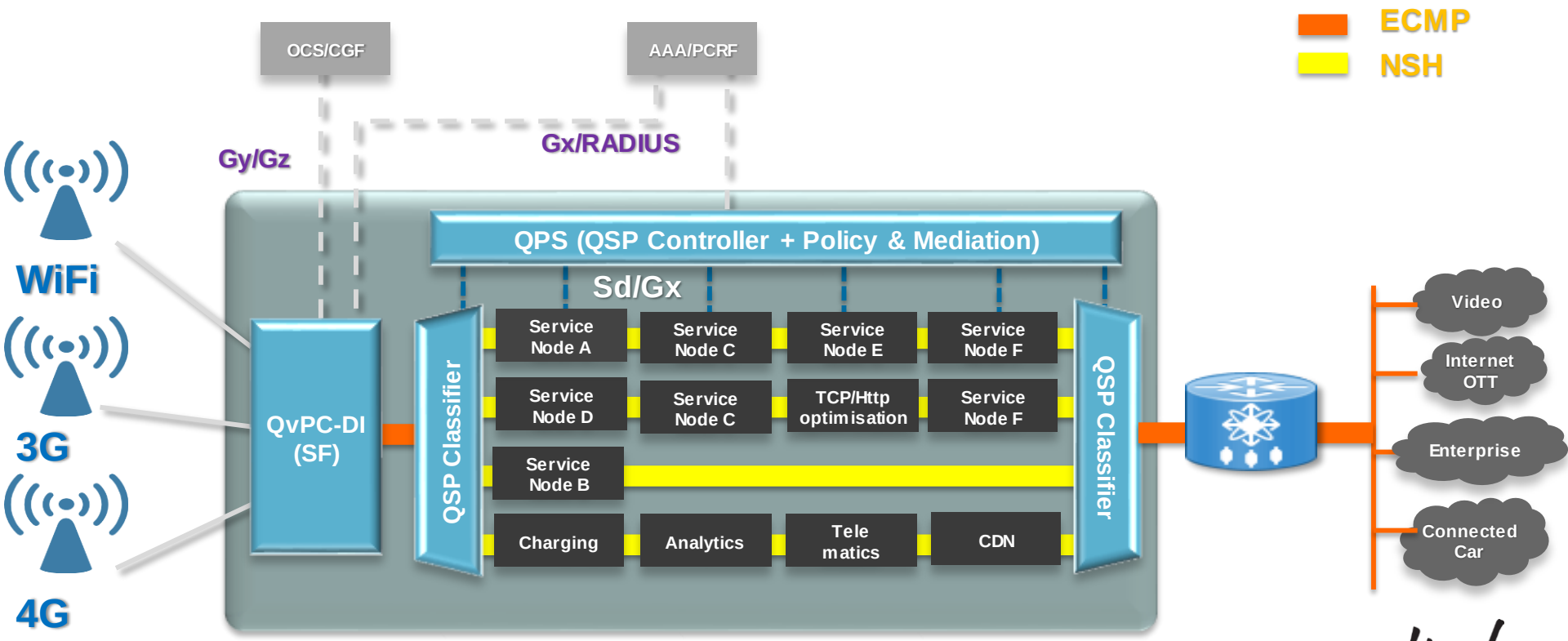
SDN and NFV in Mobility



Virtualised Gi LAN Service Chaining

Software Defined Service Enablement in Mobile Networks



Conclusion

- There are compelling cost and business agility benefits to NFV based NW services – all SP and many enterprises are exploring implementations
- NFV presents more complex management requirements
- Cisco has an industry leading multi-vendor Service Orchestration platform that we are expanding to address MANO lifecycle requirements
- Open source efforts such as OpenStack, ODL will be key enablers
- A standards based approach (e.g. ETSI) is key to ensuring vendor choice and interoperability
- It is not just about SDN or NFV or Cloud, it is all three combined that will deliver new agile, self-provisioned services, better Opex models and lower Capex

Cisco Live – SP Program

	Tues March 17th	Wed March 18th	Thurs March 19th	Fri March 20th
Breakfast			SP Breakfast Roundtable with Cisco's VP of Government Affairs Dr Robert Pepper – SP hub @ Hilton	
Lunch		Cloud Roadshow lunch - SP hub @ Hilton	EPN Roadshow lunch – SP hub @ Hilton	
Sessions	**Walk In Self Paced (WISP) Labs (all week):** LABSP-1002 - Configuring ELAN services **AND** LABSP-1001 - NFV Deployment using CSR1000v	**1.00pm – 2.30pm** BRKSPM-2003 - Optimising SP networks with WAN Automation Engine **2.45pm – 4.15pm** BRKSPM-2013 - High Density WiFi for Large Public Venues **4.30pm – 6.00pm**: BRKSPG-2617 - The Evolved Service Provider: Accelerating a New Class of Carrier Cloud Services	**2.45pm -4.15pm**: BRKSPG-2051 - Evolution of Service Provider Edge Architectures **4.30pm – 6.00pm**: BRKSPG-2618 – SP Security with BGP FlowSpec	**8.45am – 10.45am** BRKSPG-2644 - OpenStack for Service Providers and Enterprise
Evening		GSP customer reception and Emirates stadium tour		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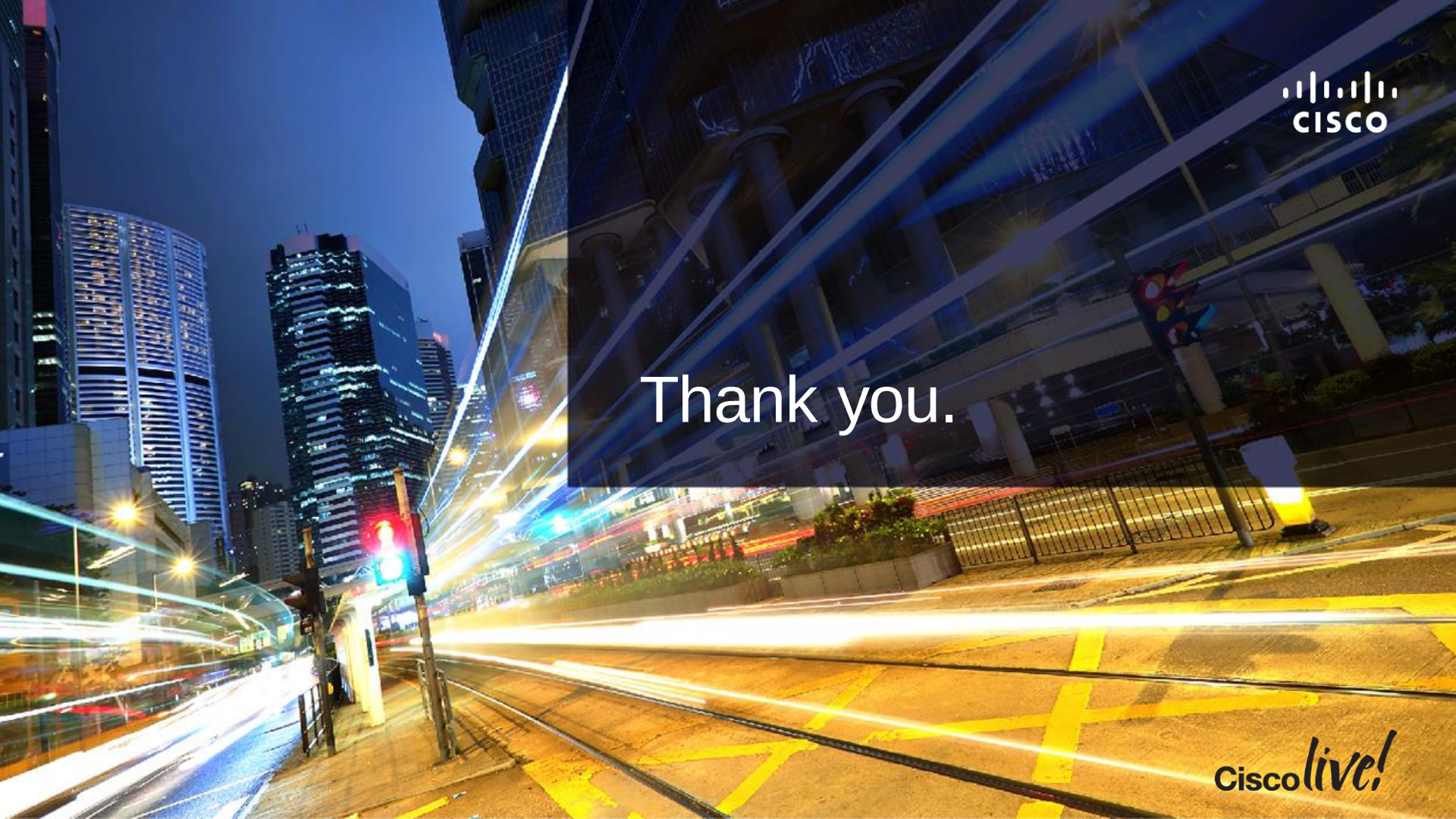
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