Empowering New Services with Cisco SDN/NFV and ESP portfolio

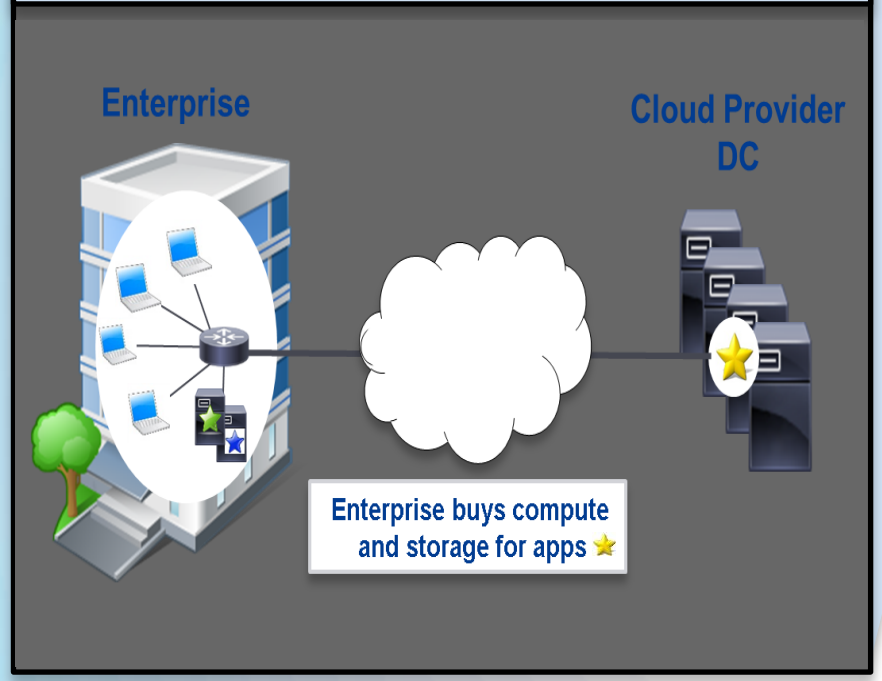
Khoo Boo Leng – GSP ASEAN Cross Architecture

October 8th 2015

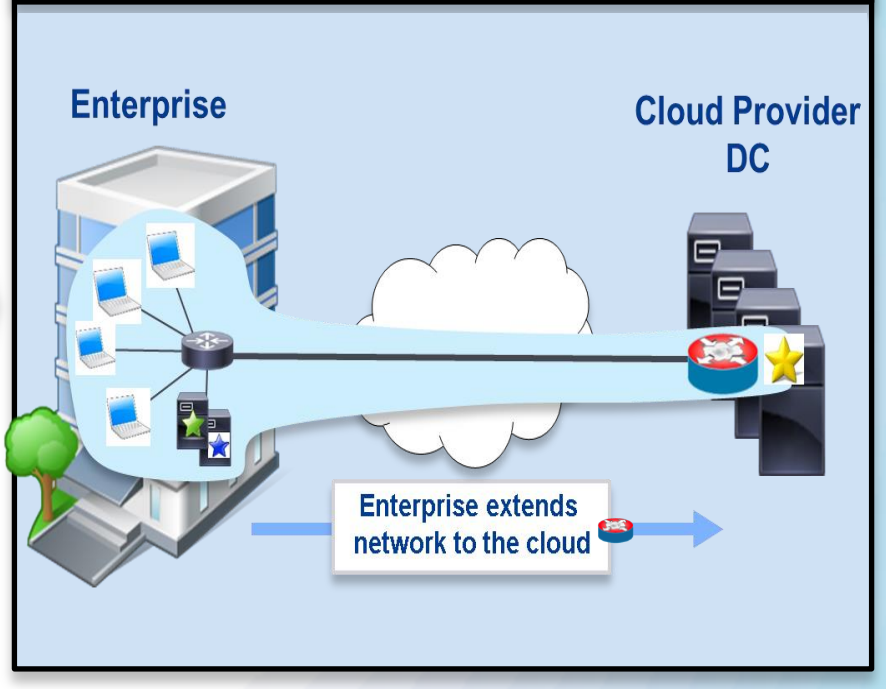
Enterprise Business Services Evolution

As Enterprises Move to Cloud, They Demand Same Networking Services from the Cloud as In Their DC

Before 2012: Enterprises want low cost compute and storage from the cloud

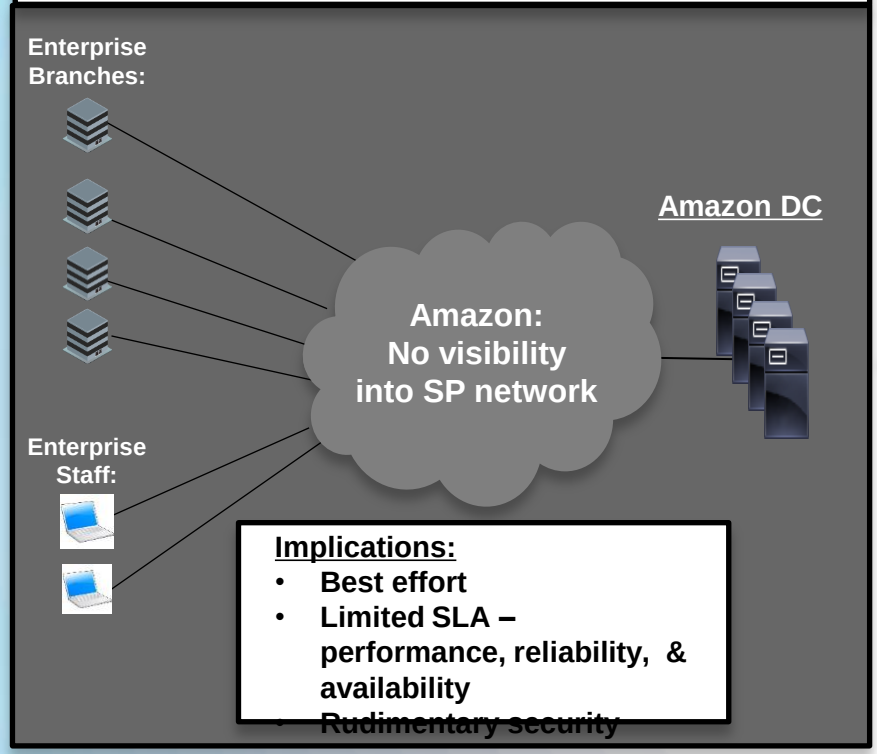


Now: Enterprises want networking services from their cloud



Service Providers' Unique NaaS Advantage: Their Network Infrastructure

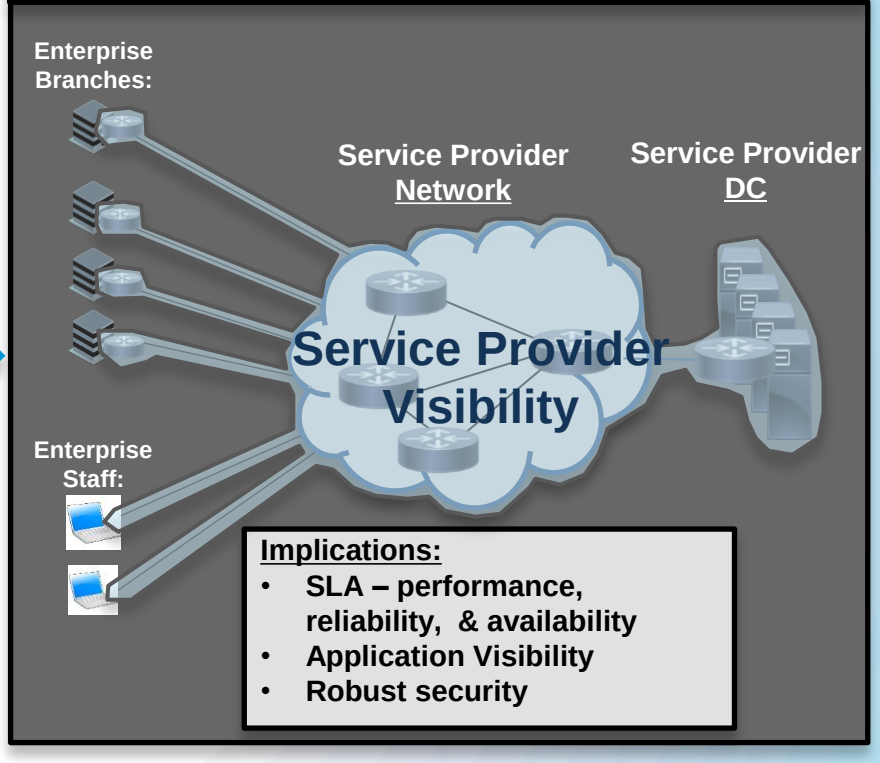
Amazon: Basic NaaS



Implications:

- Best effort
- Limited SLA – performance, reliability, & availability
- Rudimentary security

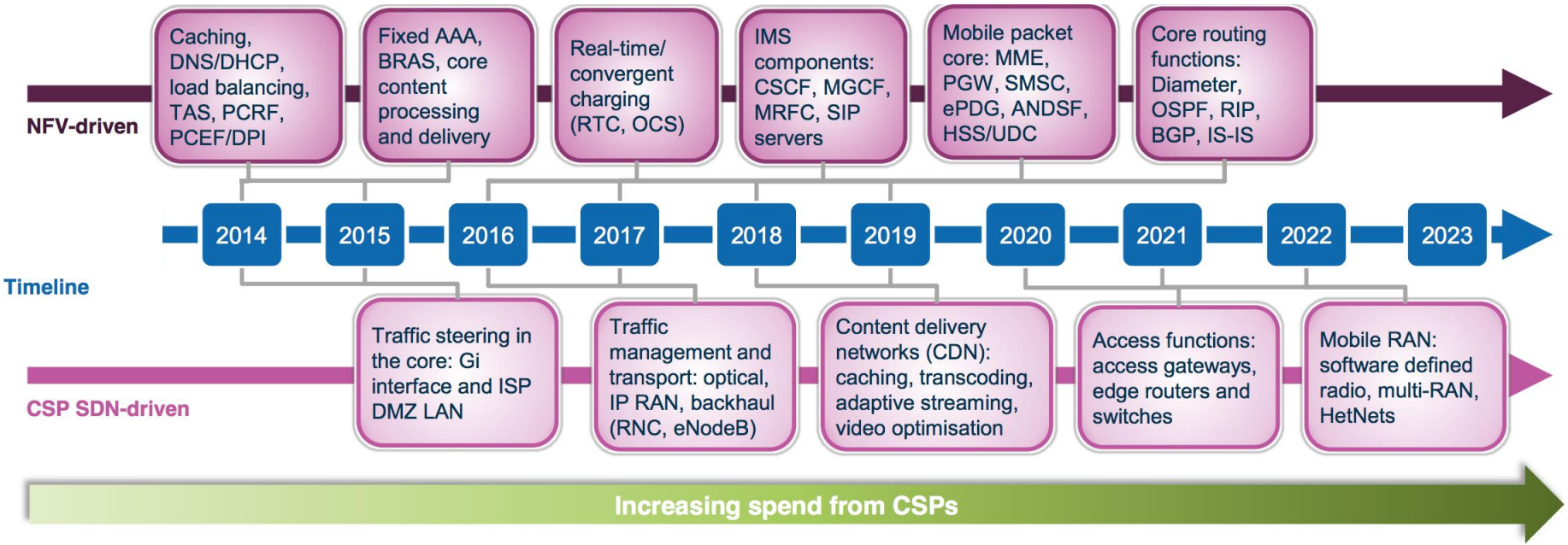
Service Provider: Differentiated NaaS



Implications:

- SLA – performance, reliability, & availability
- Application Visibility
- Robust security

SDN & NFV Trend Overview



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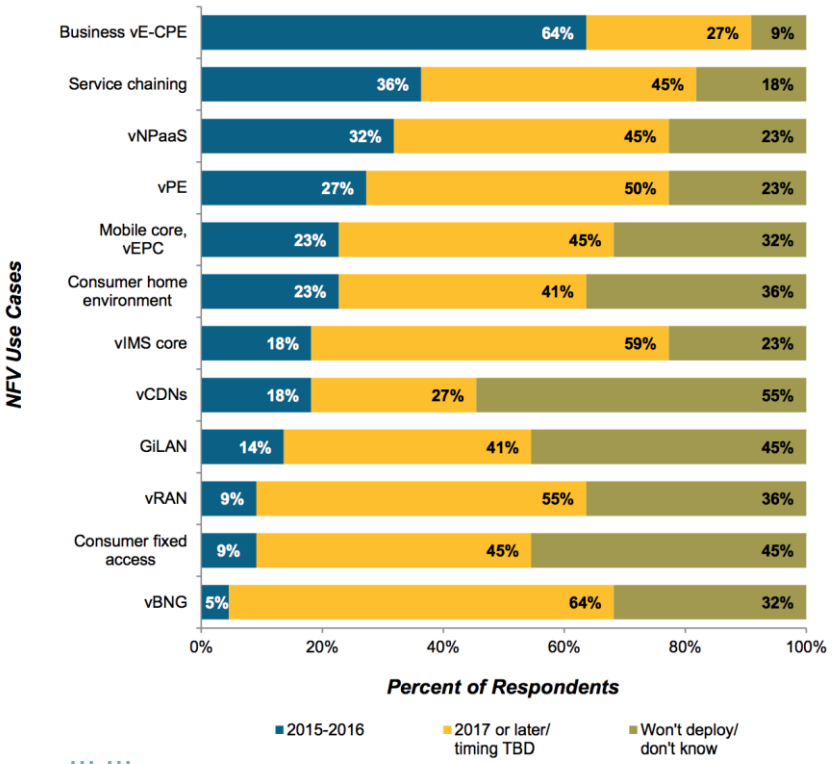
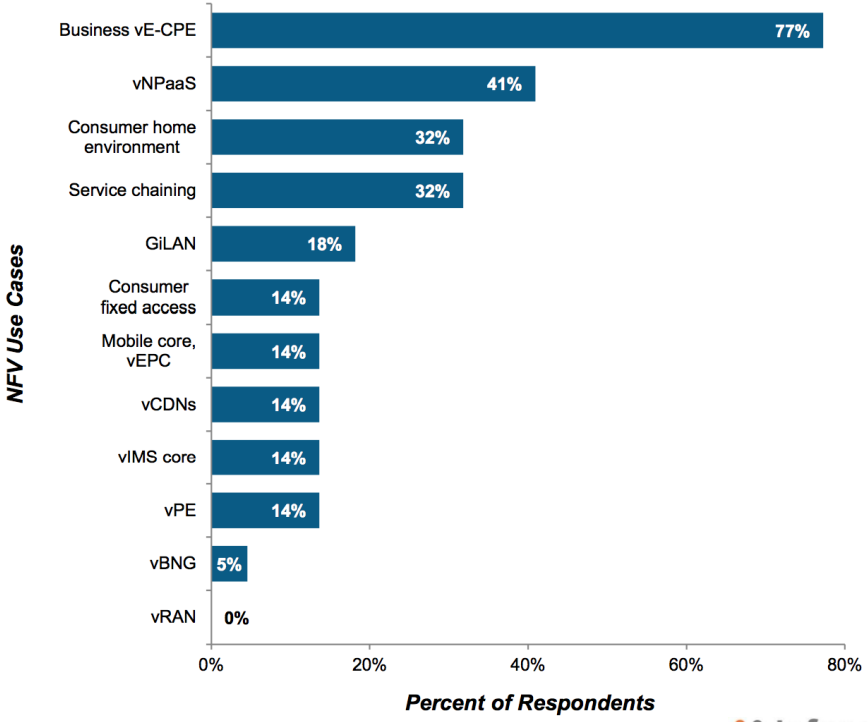
SDN & NFV Application Trend Overview

Deployment Timing for NFV Use Cases



Most Important NFV Use Cases for Revenue Generation



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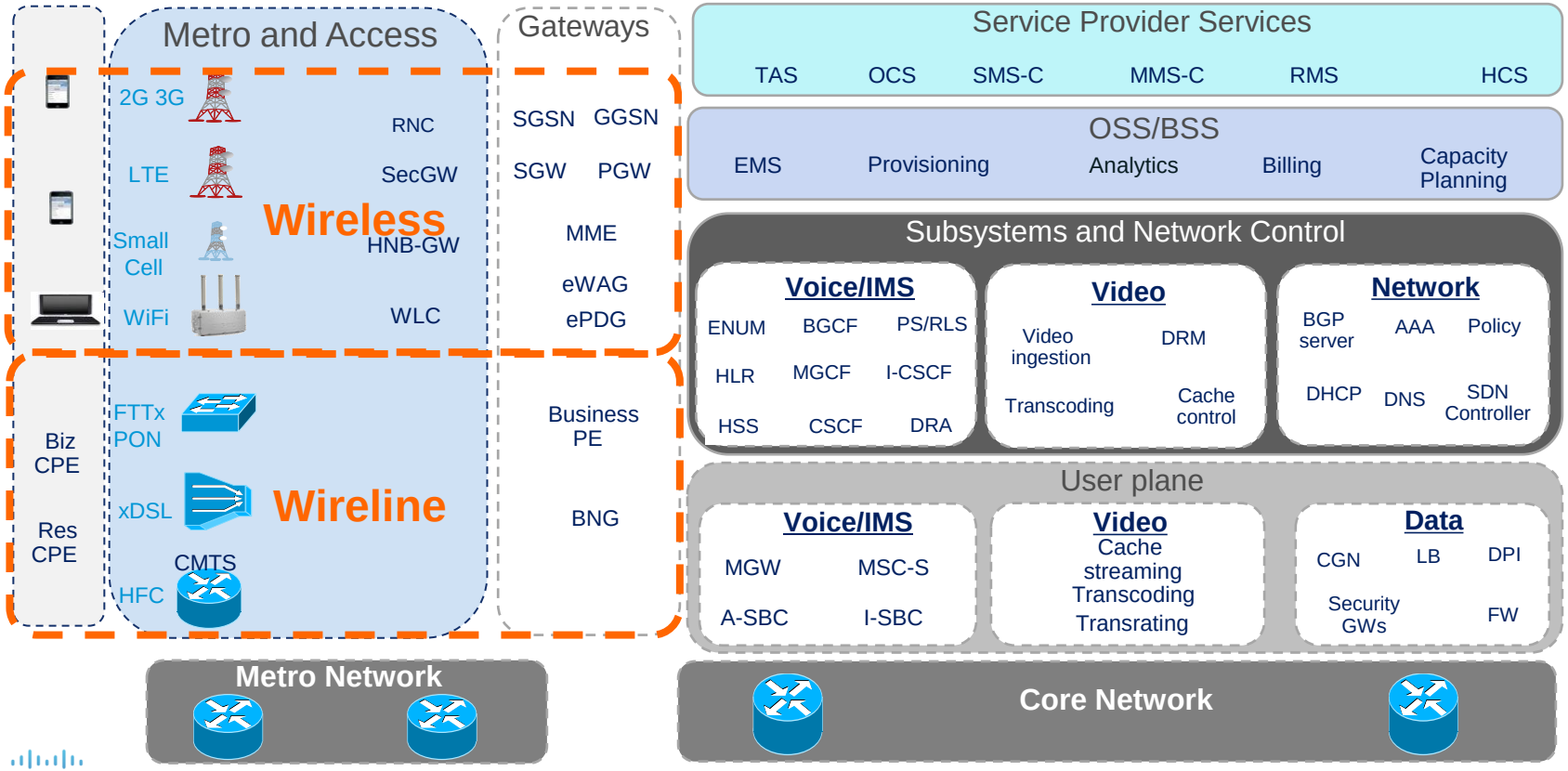
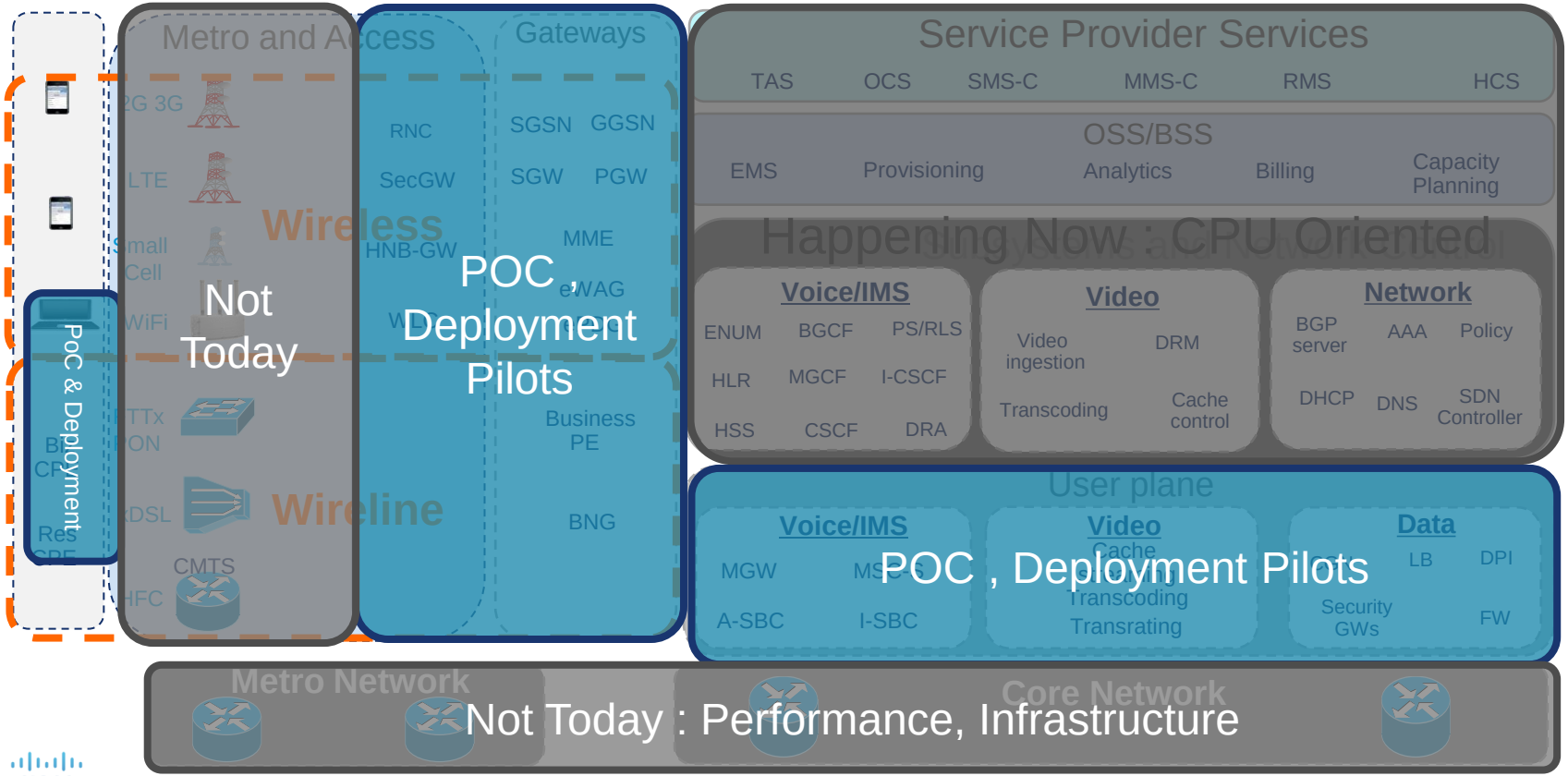
Service Provider Network Landscape



Service Provider Network Landscape

Virtualized Network Function Applicability



SDN & NFV Overview

SDN Address Network Transformation

Simplify

- Network Abstraction
- Packet Optical Convergence
- Centralized Intelligence

Automate

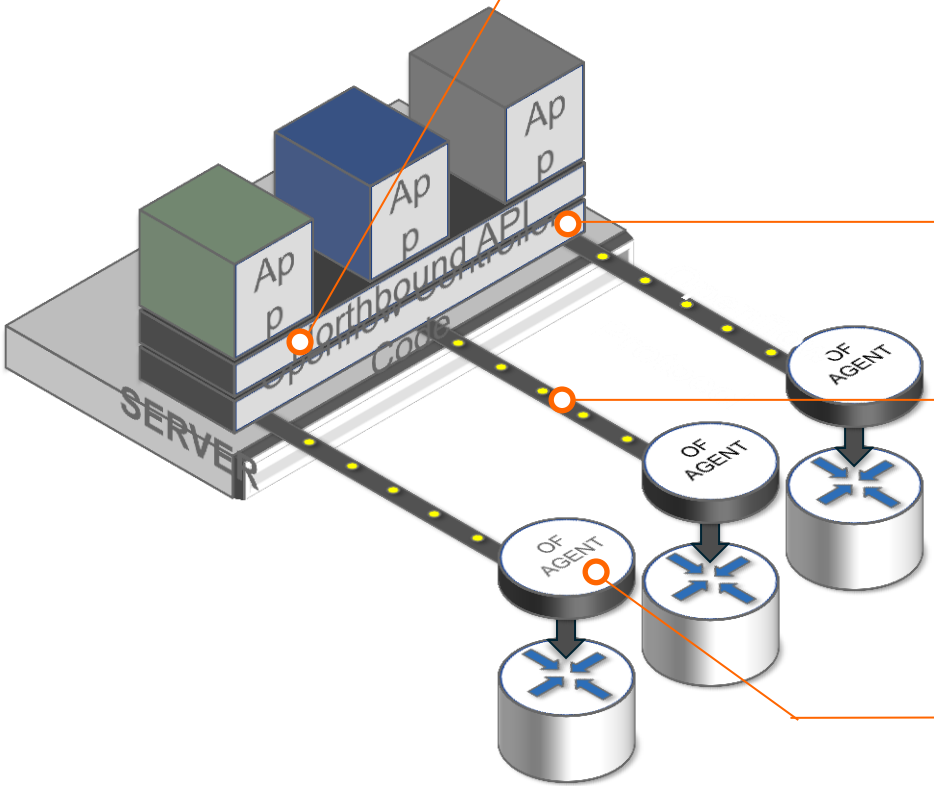
- ML-SDN
- Network Virtualization
- Autonomous Networking
- WAN Automation

Innovate

- Cross-domain service orchestration
- Flow through Provisioning
- Customer Self Service

OPEN NETWORK FOUNDATION

SDN Key Components



Northbound API

Applications Interface to Program the Network Element

OpenFlow Controller

Central Administration point for Network Element. Ex: POX, cisco XNC

OpenFlow Protocol

Mechanism for OpenFlow Controller to communicate with OpenFlow Agent

OF Agent

Runs on Network Element, receives instructions from Controller and Programs Flow tables

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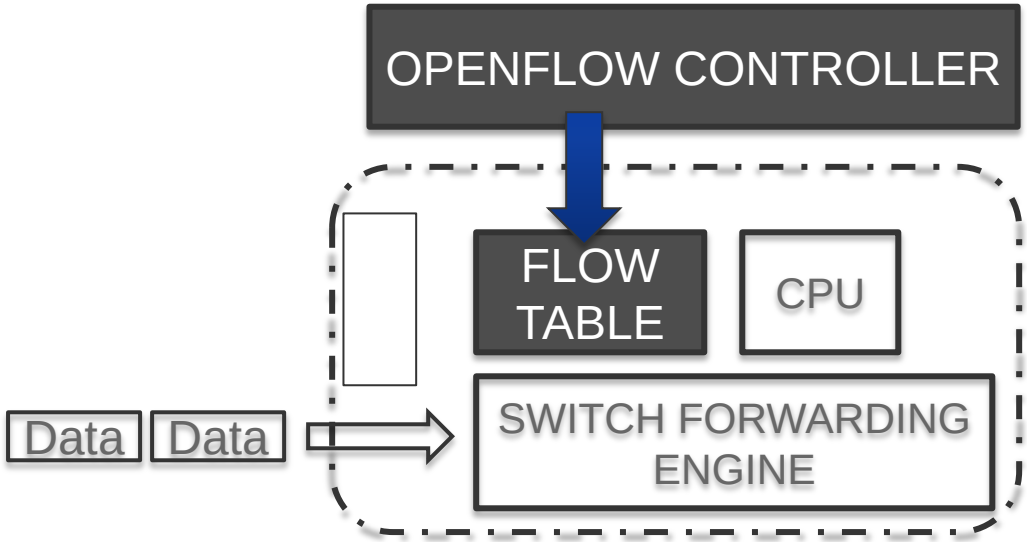
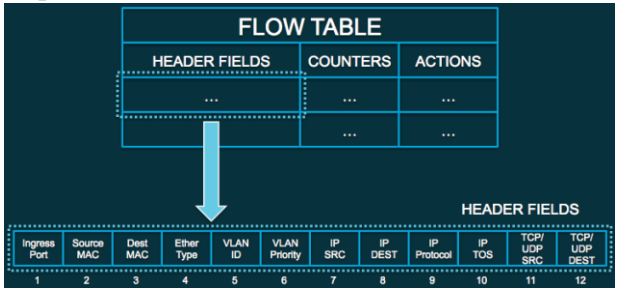
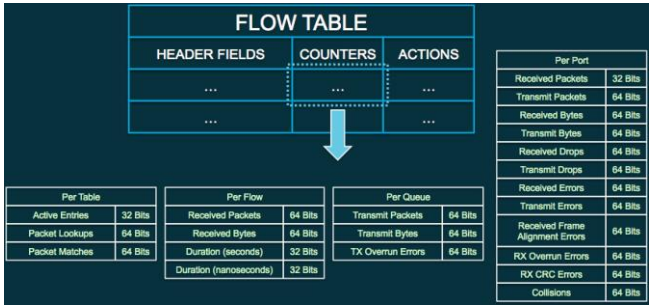
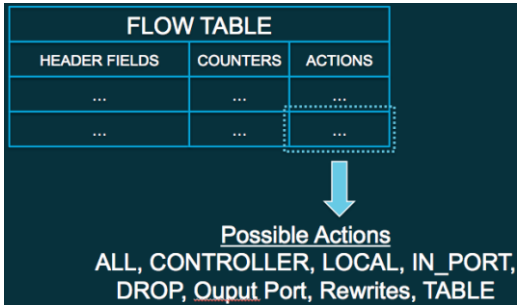
OpenFlow Protocol Principle



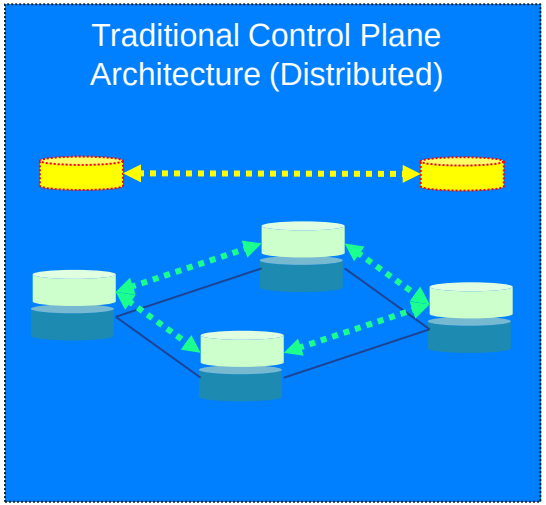


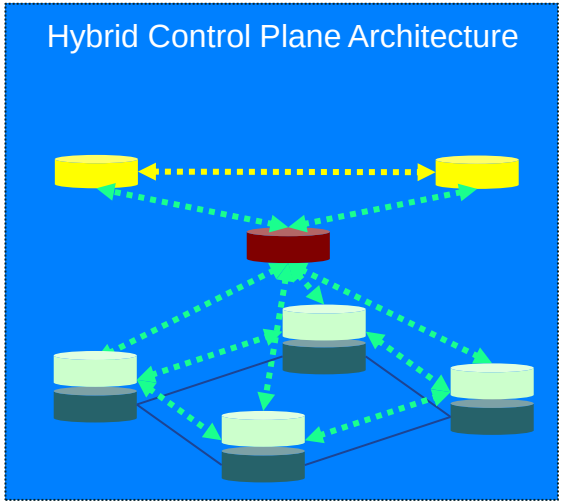


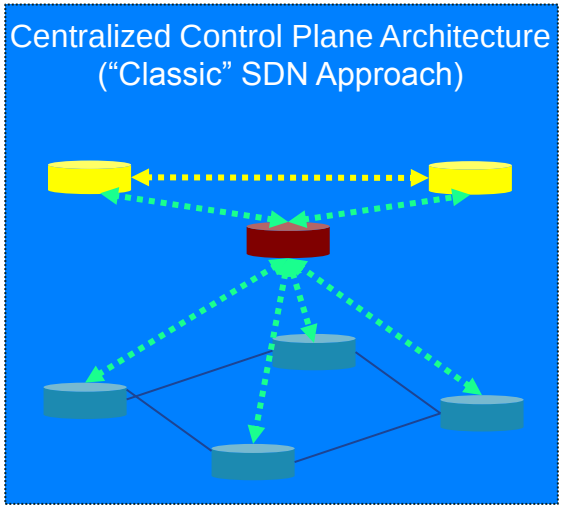


Brings out two models :
Reactive – as packets come in
Proactive – pre program

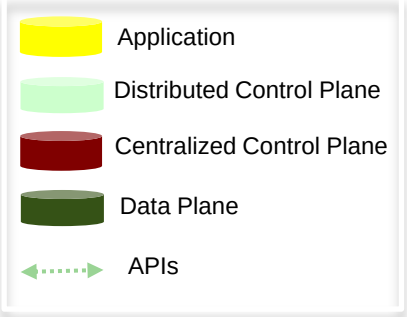
Service Provider **"Network Control Plane"** Architecture



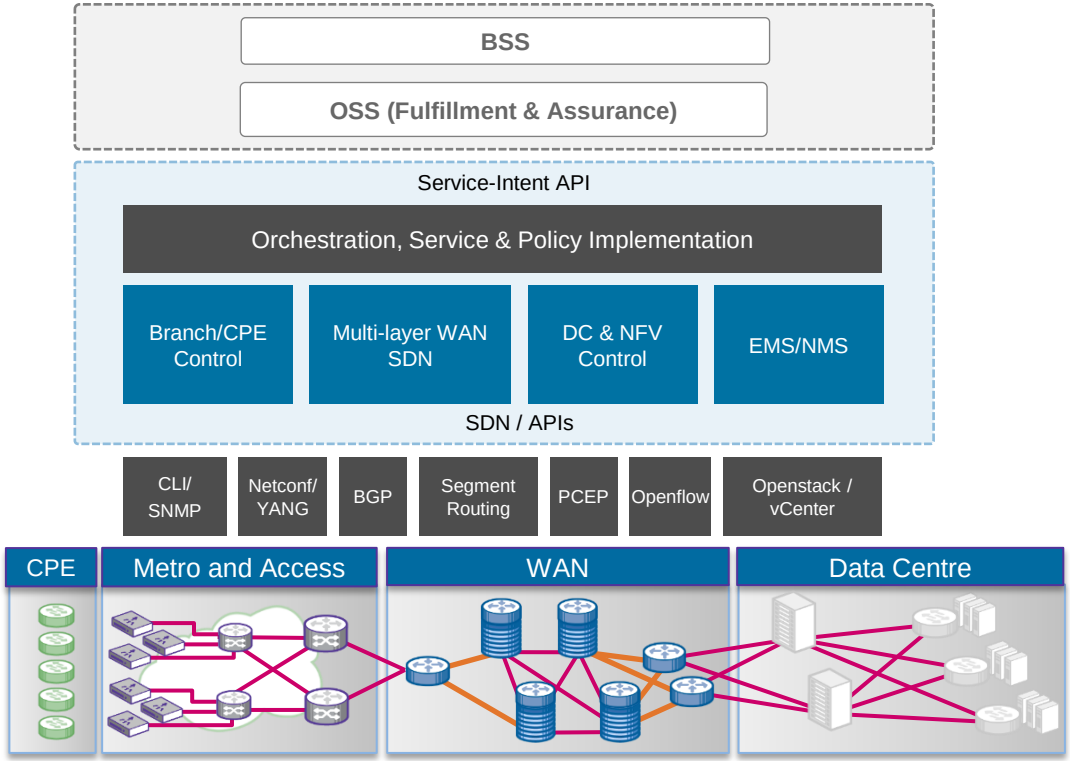




- Hybrid Control Plane → Existing distributed control plane + centralized CP function
  - Distributed Components – Functions tightly coupled to data plane
  - Centralized Components – Functions where abstraction is required
- Fully Centralized Control Plane → Where architecturally feasible and required for scale



SDN Protocol & API – High Level View



Multi Vendor End to End Management & Orchestration
(Physical & Virtual)

- Model driven, end-to-end service lifecycle and customer experience focus
- Seamless integration with existing and future OSS/BSS environment
- Loosely-coupled and modular architecture leveraging open APIs and standard protocols
- Orchestration across Multi-domain & multi-layer provides centralized policy and services across entire network

NFV Benefits

- Reduction of network elements to manage & deploy
- Service Elasticity
- Operational efficiencies through virtualization
- Reduced complexity for High Availability
- Automated network operations
- Capex reduction by deployment of standard x86-based servers
- Deployment of best-of-breed
- OPEX decrease by reduction of branch visits

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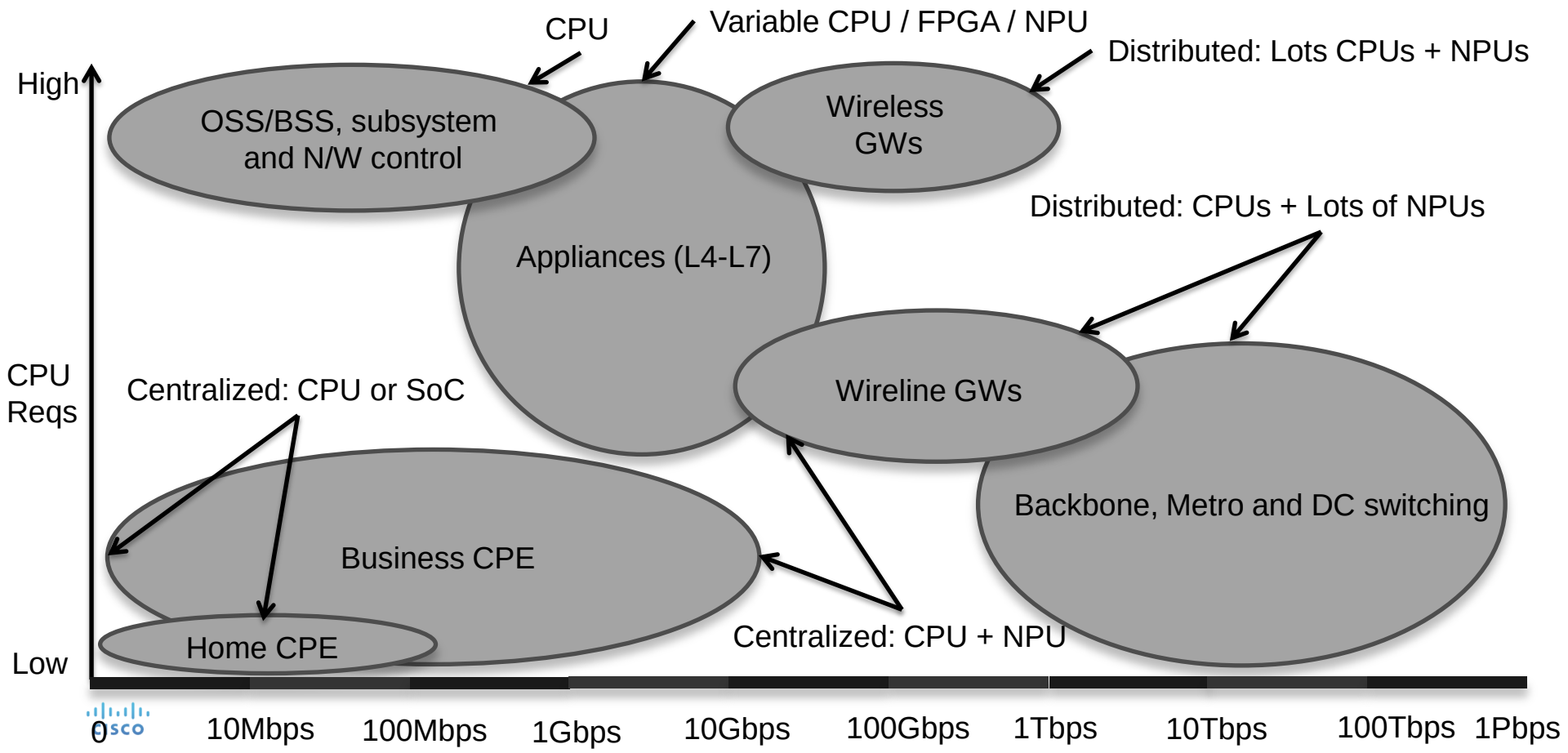
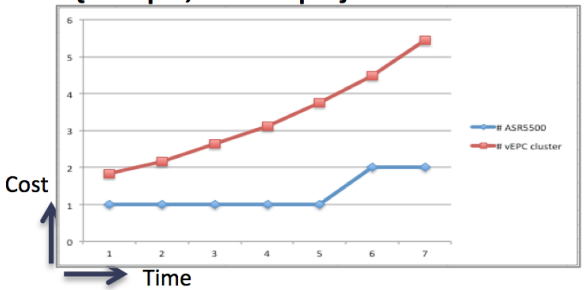
Network Virtualization Rules



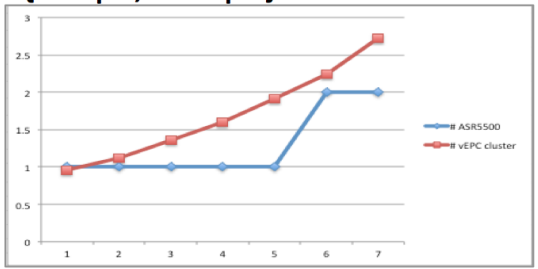
Virtualization vs Appliance

vEPC
ASR5500

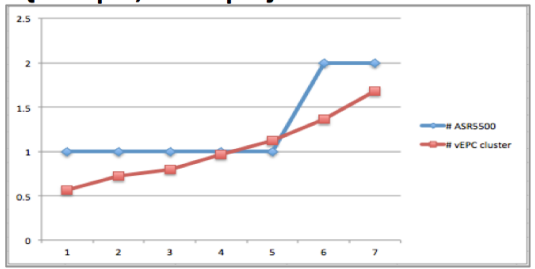
{10tps, 10Kbps}



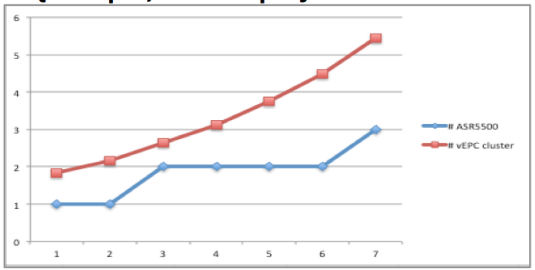
{10tps, 5Kbps}



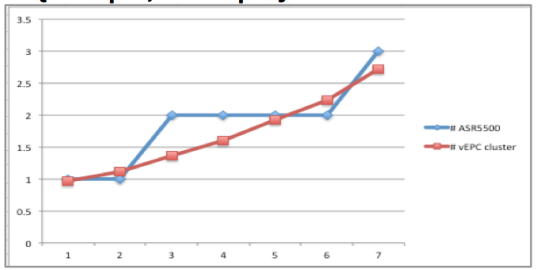
{10tps, 3Kbps}



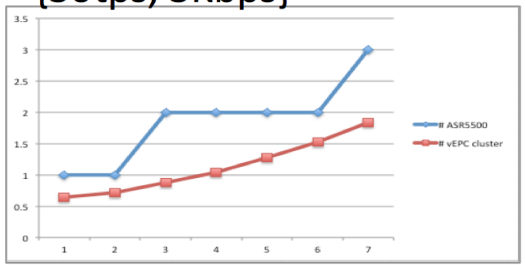
{30tps, 10Kbps}



{30tps, 5Kbps}

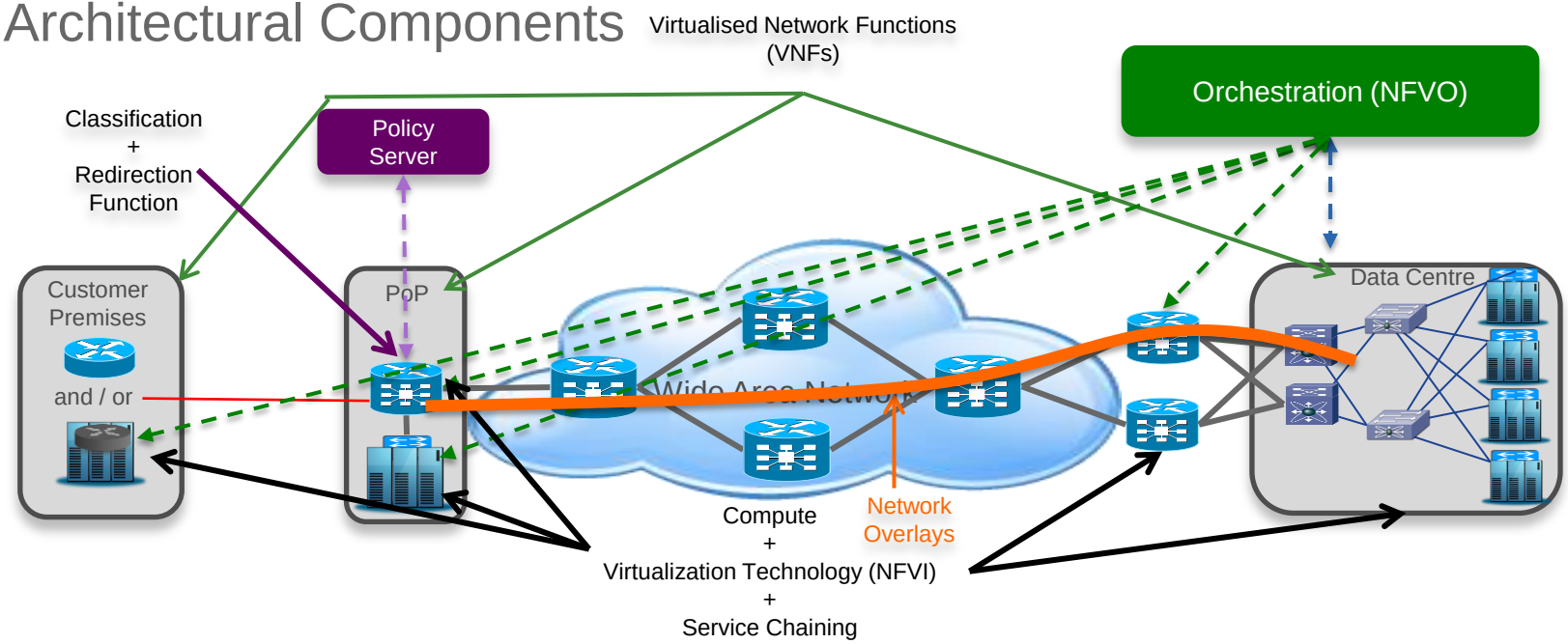


{30tps, 3Kbps}



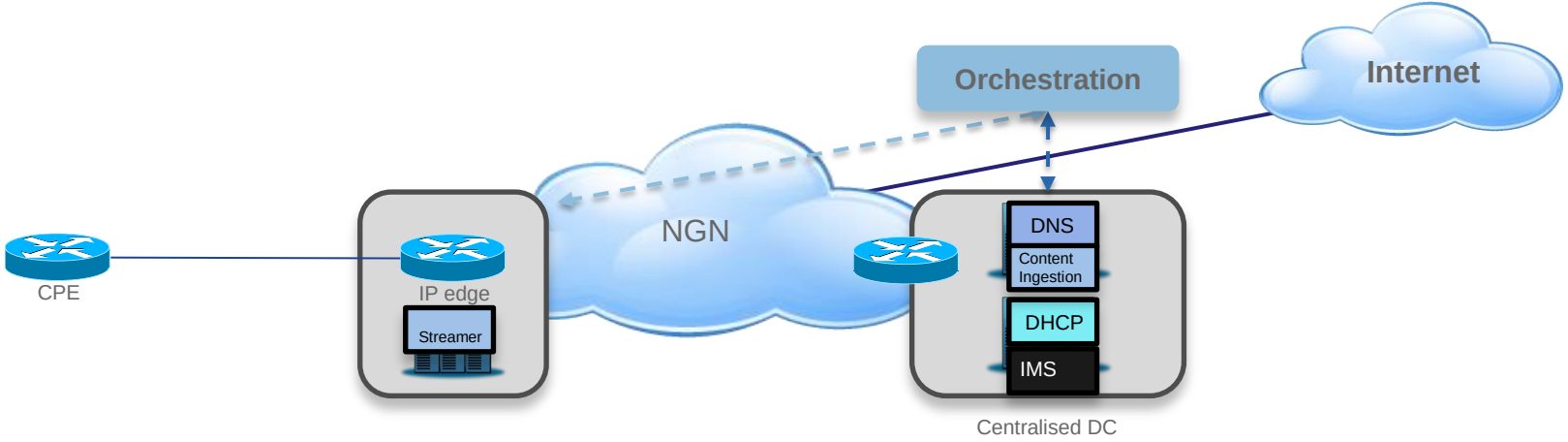
{Average TPS per session, Average throughput per session}

NFV vision
The Architectural Components



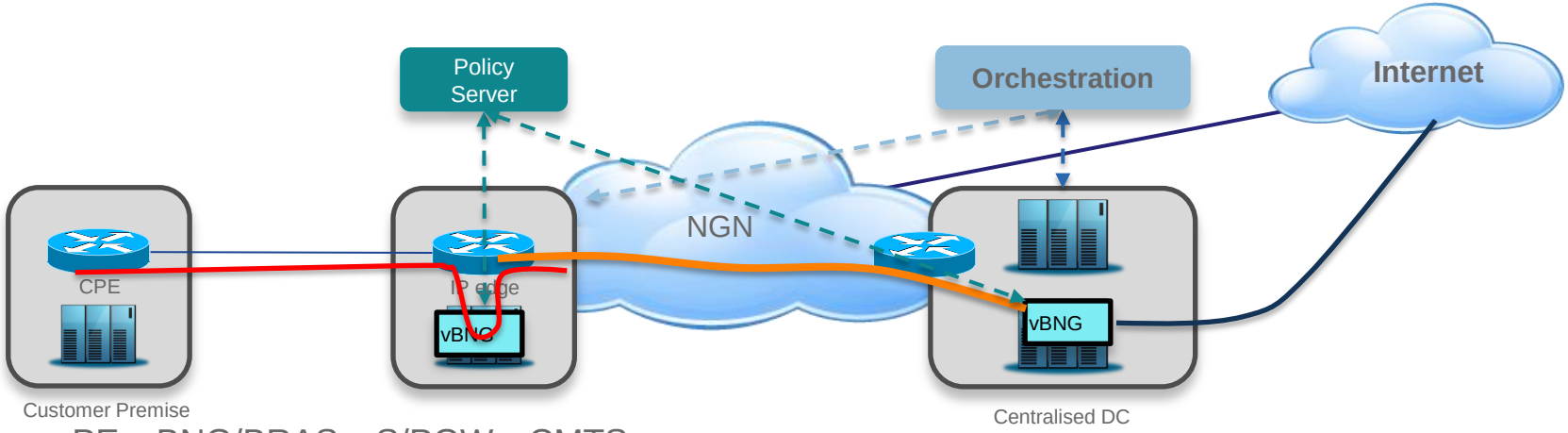
- Real : High capacity plumbing and high performance gateways
- Virtualized : CPU intensive functions, low – mid range packet processing functions
- Interaction required between the real and virtual network functions via orchestration
- All use cases ➔ Compute + VNFs + DC virtualization + Orchestration / Redirection use cases →Re-direction + Policy Server + WAN Overlay

NfV Use Case:
Virtualized SP / Applications / subsystems



- NFV transition well underway
  - Custom / Specialized h/w → Commercial off the Shelf (COTS) → Today: Virtualized solutions
- Examples: OSS/BSS, IMS, network control, video/collaboration, wireless/wifi, security application
- Onboarding can be an issue due to age and complexity of some OSS/BSS systems

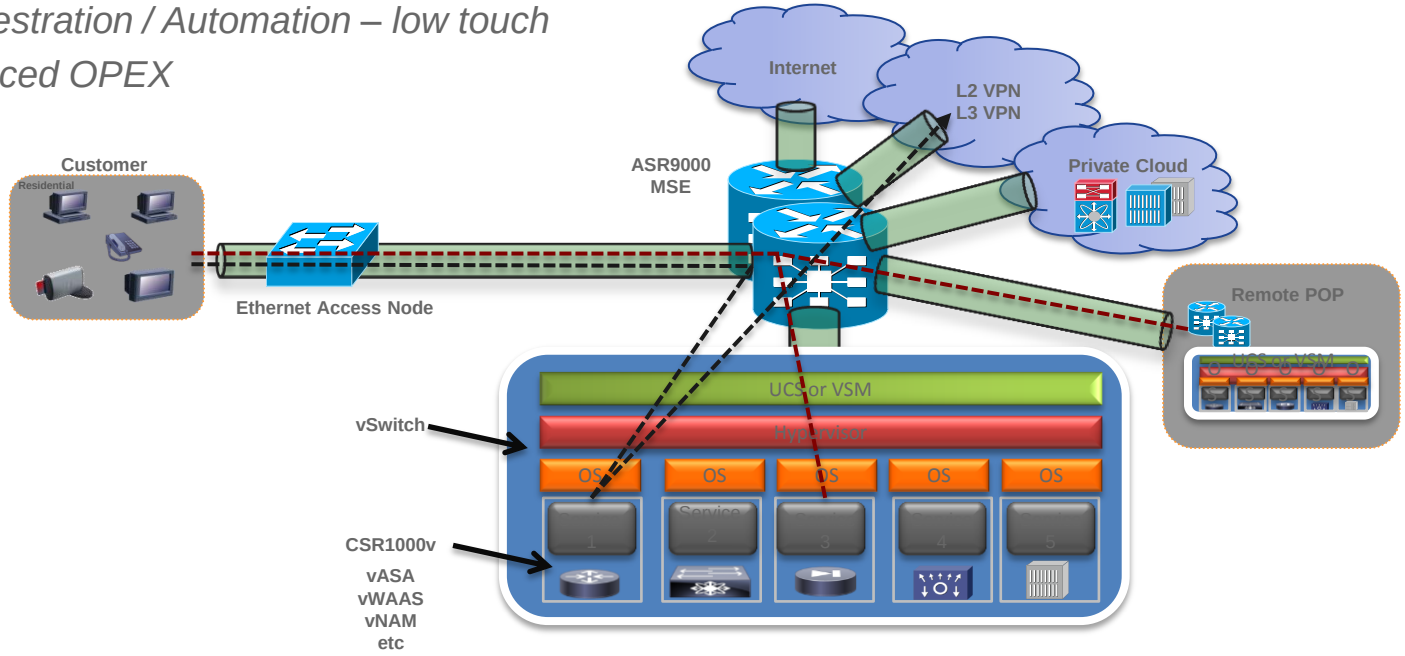
NfV Use Case:
Virtualized Edge Gateways



- vPE, vBNG/BRAS, vS/PGW, vCMTS
- Wide range of gateway architectures deployed
  - Regionalized: High subscriber / high capacity dedicated devices
  - Distributed: Gateway functionality integrated into metro infrastructure
- Cisco is complementing existing h/w gateway solutions with virtualized solutions
  - Pure virtualized solution based on CSR1000v
  - Splitting the subscriber control plane function from the data plane function

Virtualized Managed Services

- *Ethernet Based Backhaul*
- *Service Decoupled from Hardware*
- *Dynamic Service Insertion*
- *Orchestration / Automation – low touch*
- *Reduced OPEX*



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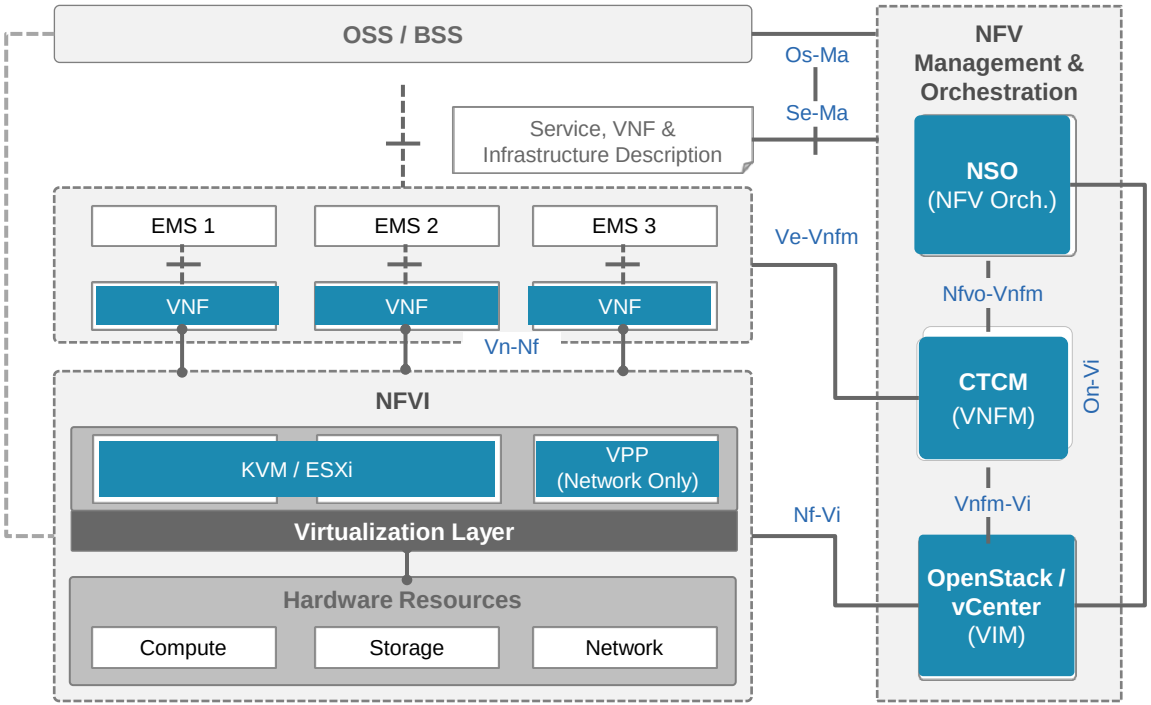
Nfv Infrastructure Orchestration & Implementation

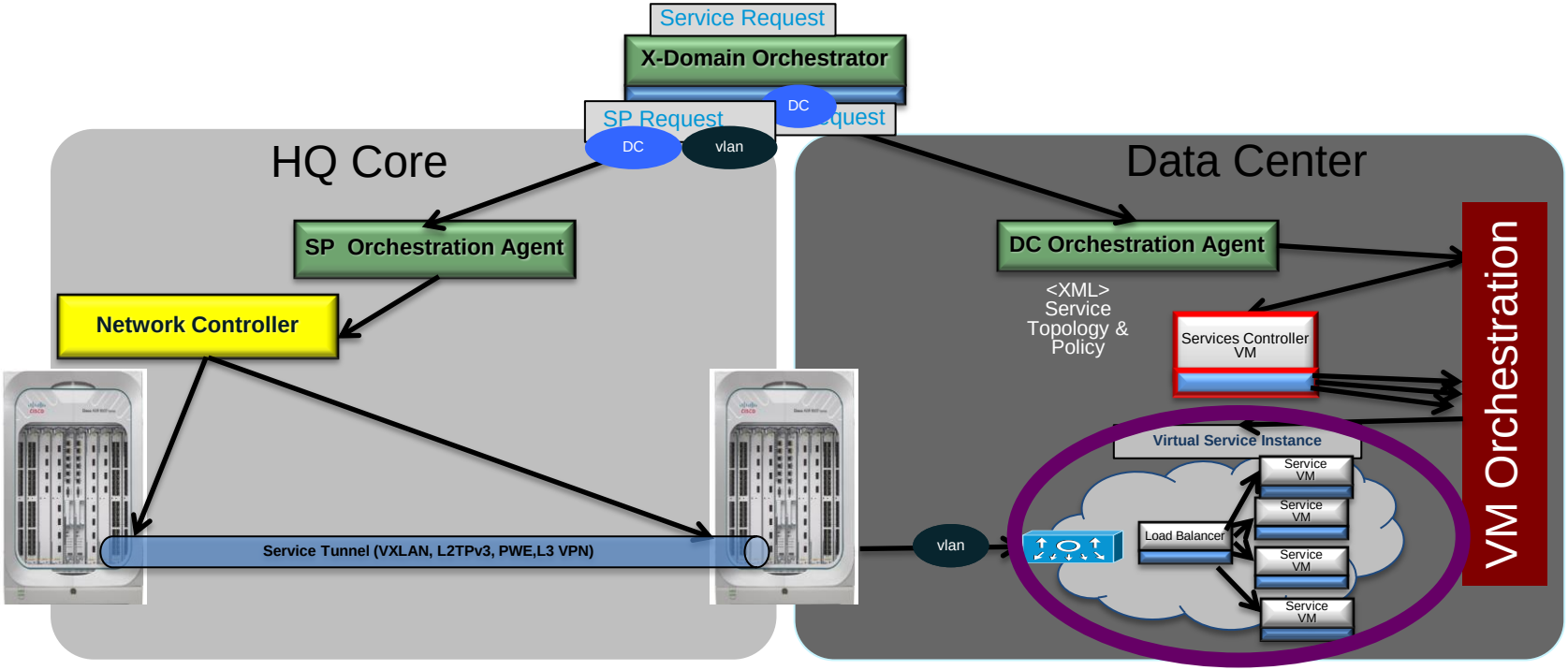
Cisco NFV Architecture Mapped to ETSI NFV Framework



- Modular architecture that conforms to ETSI NFV framework
- Model driven design for declarative NFV orchestration
- Supports Cisco and 3rd party VNF Managers
- Supports Cisco and 3rd party DC SDN Controllers
- Supports Cisco and 3rd party VNFs

X-Domain Orchestration

End to End Orchestration of Elastic Services



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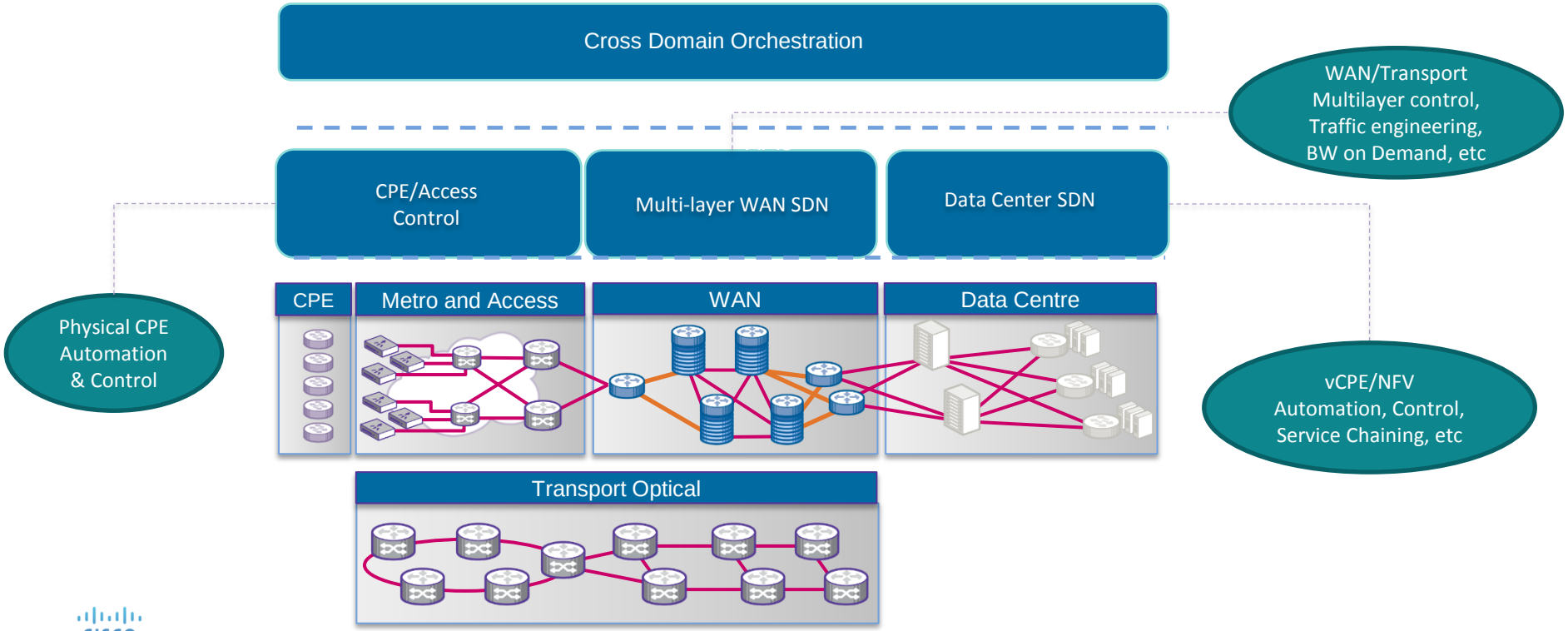
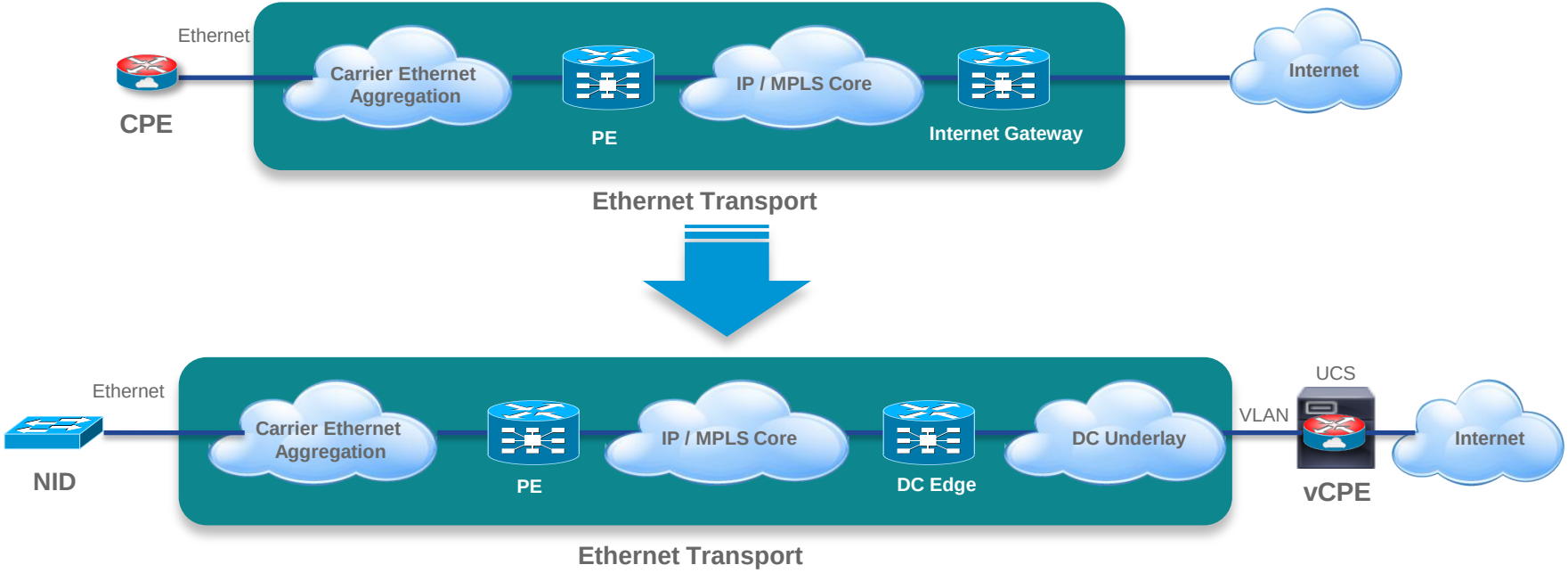
Addressing Cross Domain Service Enablement

Different problems that need to be solved in each domain



Virtual CPE Services

Evolution Of Enterprise Ethernet Services Architecture



Managed CPE Architecture Evolutions – Drivers & Motives

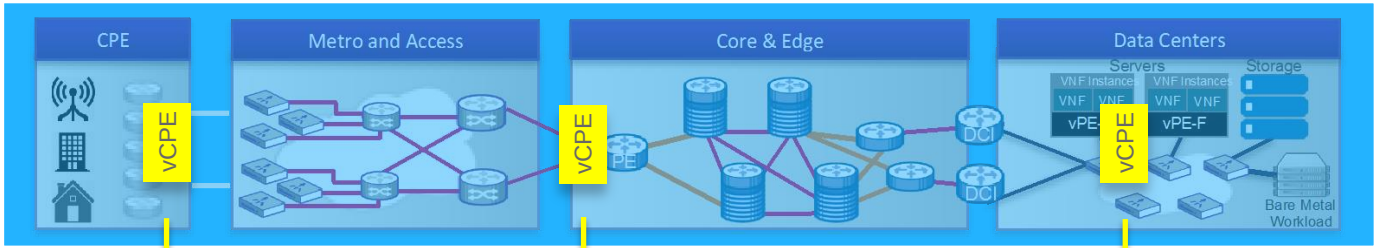
- Major drives – Virtualization, Programmability, SDN and Service Orchestration
- Customer motives that we are hearing behind considering this architecture
  - Reduction of truck rolls
  - Automated Provisioning
  - Better manageability of the customer premises equipment
  - Agile and on-demand service delivery
  - Ability to cross-sell and upsell more value added services on-demand
  - Consumption based pricing model
  - Reduce Total Cost of ownership (OPEX and CAPEX)
  - Faster time to revenue
  - Cloud based service delivery model
  - It is one of the initial NFV use case for some SP's

NIDs Requirement For Adoption Of vCPE Application

- To be inline with architecture changes for Virtualized CPE deployment
  - Layer 2 only access network to customer
  - Layer 2 NID is positioned as demarcation device and the only device installed at customer premises
- Access network options:
  - Metro BAU - Ethernet
  - HSBB - Ethernet
  - Ethernet in the First Mile – G.SHDSL (Ethernet)
  - Wireless (3G, LTE)
- Other requirements
  - Multi-queue SLG support – Layer 3 to Layer 2 (802.1p) Ethernet Priority marking
  - Wireless backup – Layer 3 technology
  - Ethernet Service Activation capability

vCPE – Implementation

Where it is located



SP's POP

1. Co-located with PE
2. Most common vCPE model
3. One vCPE per one or multiple customers
4. L2 / L3 traffic backhauled from customer premise

SP Central DC

1. At central DC
2. May not be common model
3. One vCPE per one or multiple customers
4. L2 / L3 traffic backhauled from customer premise

On Customer Premises

1. On-premises vCPE Running on x86 server
2. Helps retain most attributes of present architecture
3. More scalable from performance perspective, but difficult to manage

No where!

1. Its not about vCPE → its about solving customers business problem
2. Example – Maraki + DSC, ISR-G2 + DSC models

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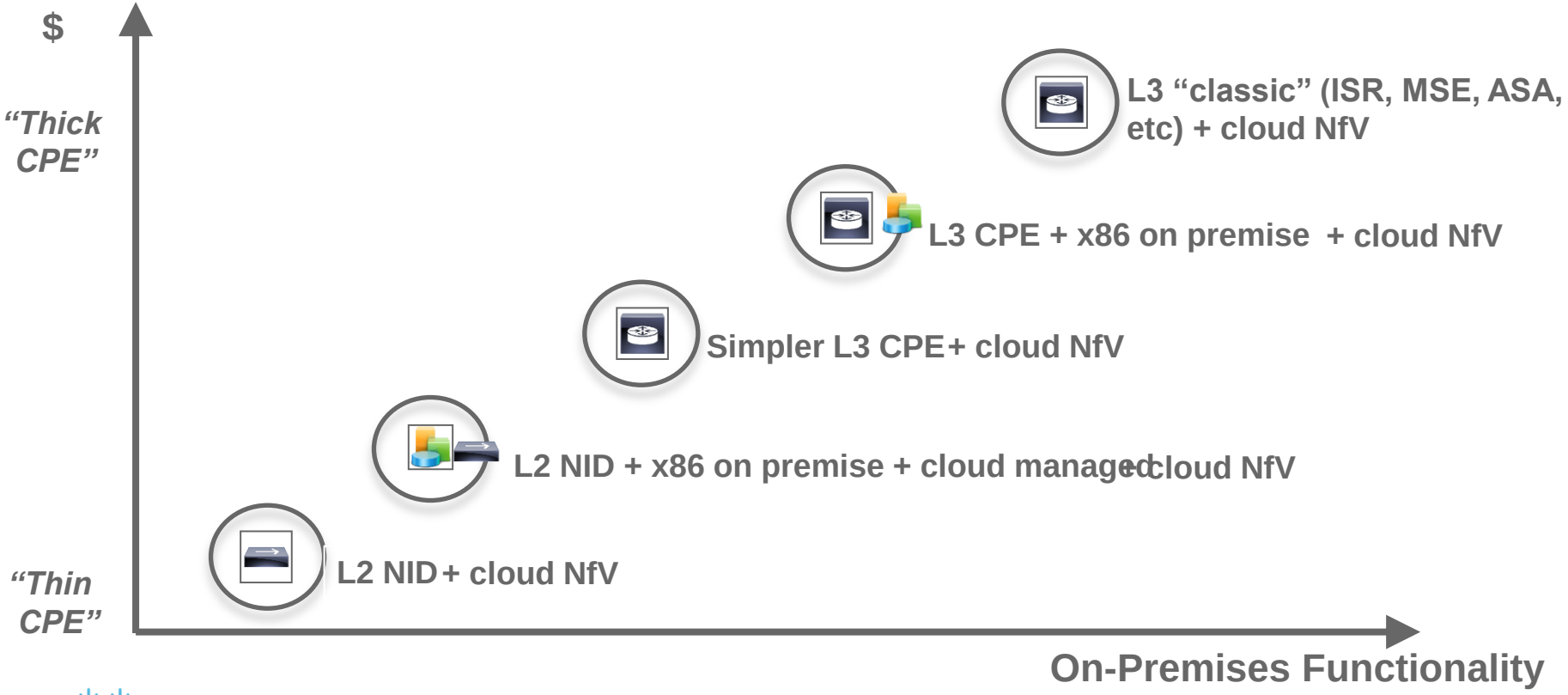
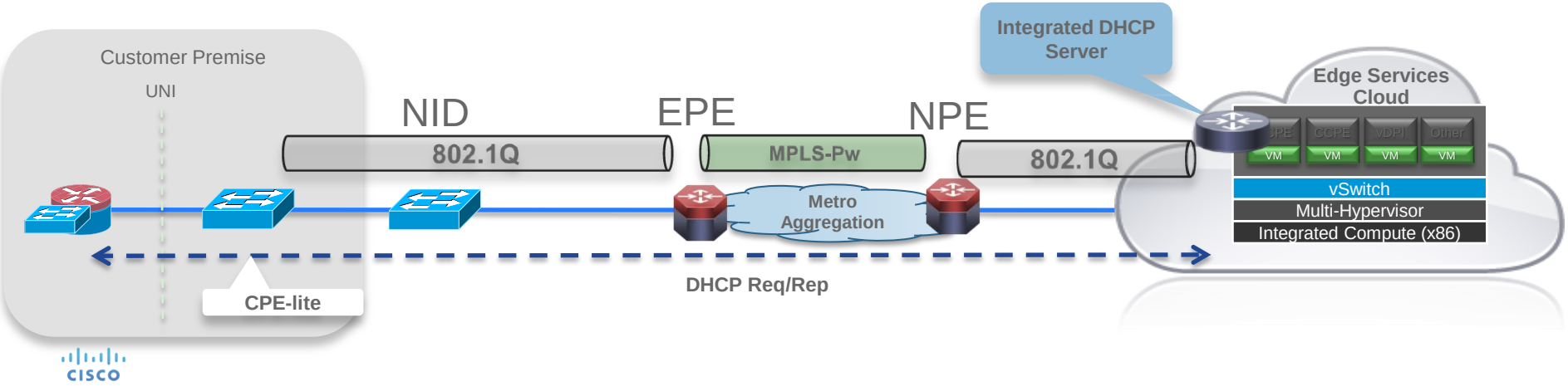
Managed CPE – One Size May Not Fit All



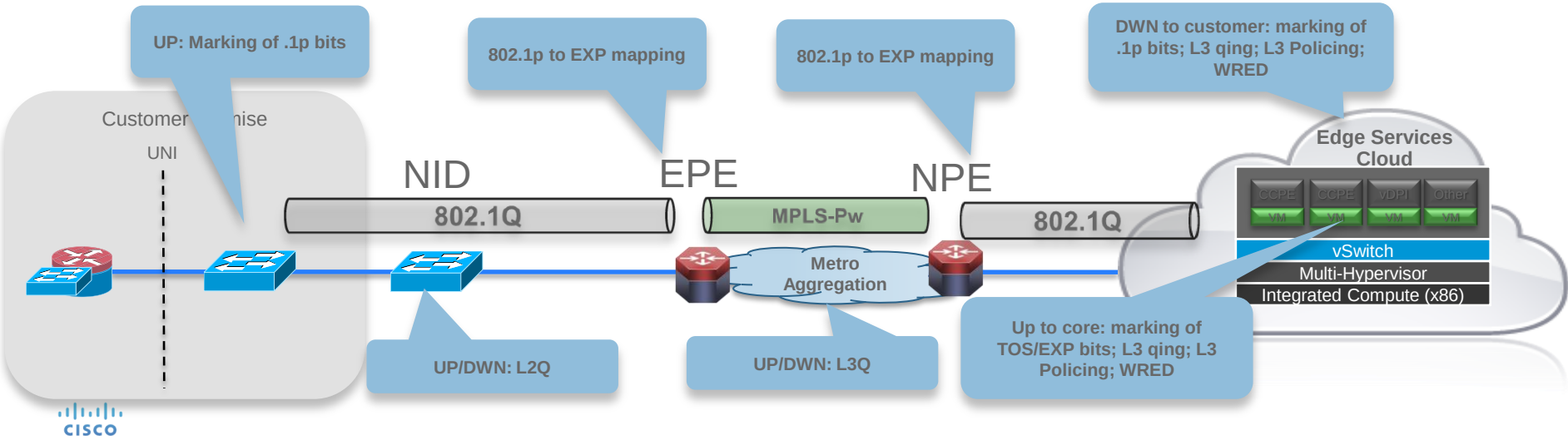
vCPE : IP Addressing & Routing Consideration

- IP Address assignment for hosts done by vCPE
  - vCPE has to redirect DHCP requests to the DHCP server
  - Could be offered out of the vCPE using integrated DHCP Server
  - Optional: customer operates a Router (with optional customer configured NAT)
- Traffic destined for the VPN tunneled to the CSR1000v, where it is routed to the destination (back to the customer premise for inter-subnet traffic)



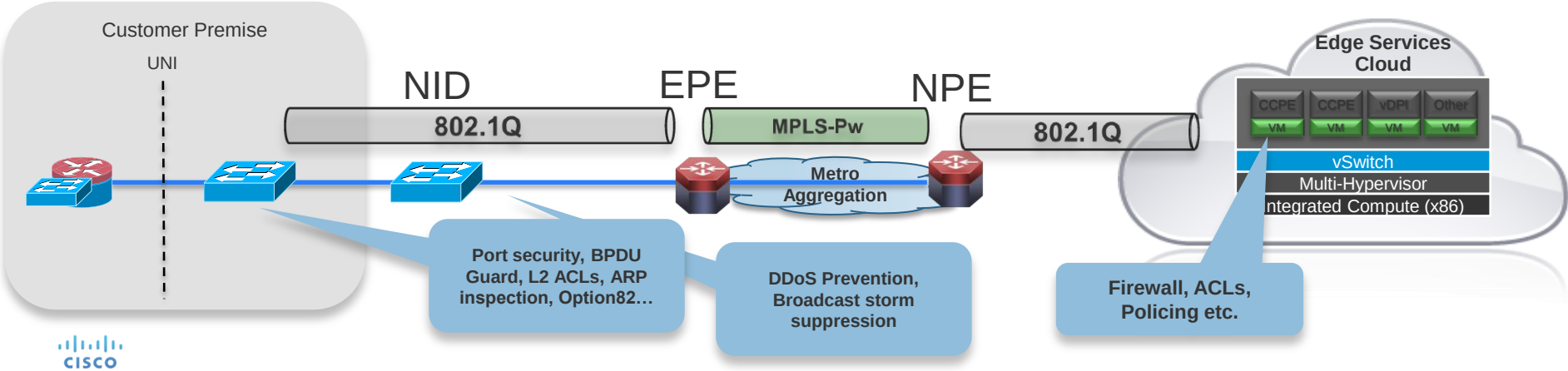
vCPE : QoS Consideration

- CPE-lite or NID: L2-Cos for traffic coming from the hosts into the L2 tunnel
  - Marking / re-marking of IEEE 802.1q bits according to the Metro Ethernet COS scheme
  - TM have to re-mark the MPLS EXP bits at the EPE for MPLS Pw Upstream transport
  - vCPE : downstream L3 QoS, either for core-facing traffic or for traffic returning to the customer premise

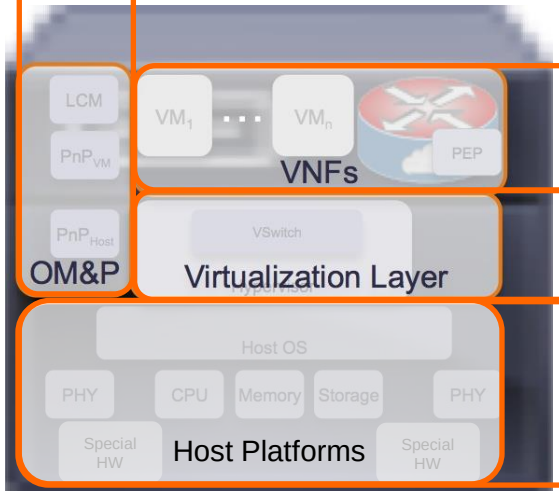


vCPE: Security Consideration

- Securing CPE-lite – L2 Security
  - Deploying limited physical ports,
  - Port security: Limiting MAC address tables / timers
  - BPDU Guard
  - L2 ACLs
  - ARP inspection
  - Option 82
- DDoS prevention and Broadcast Storm Suppression at the Metro Aggregation
- Traffic filtered by L3 in the vCPE



Virtual Branch High-Level Architecture Building Blocks



Interface to orchestrate, automate, and manage day 1, 2, N

(REST, NETCONF, SNMP)

Decoupled and elastically provisioned network services

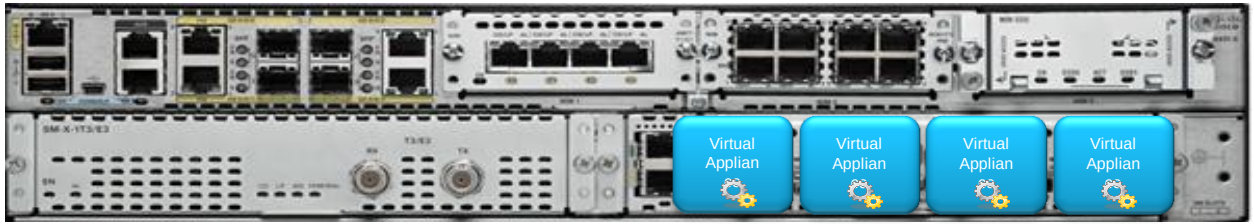
(AVC, FW/IPS, IPAM, Routing, WAN Opt, etc)

Provide container host for VNFs and abstract hardware

(KVM, ESXi, Xen, Hyper-V)

General Linux OS for platform support, deploy to generic COTS HW (UCS) , and leverage purpose built (CSX, 4K, etc.)

ISR4K with integrated UCS E-Series Server

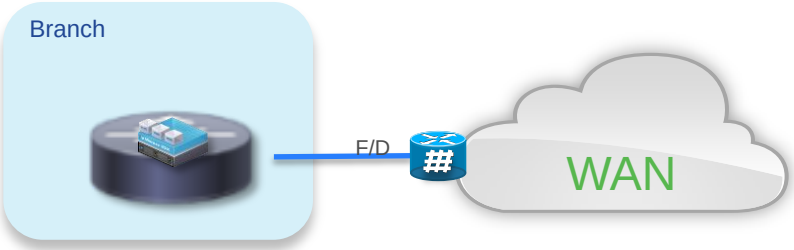


- + All-in-One Integration
- + On-Demand Services
- + Common Server Management Tools
- + Vendor Agnostic
- + Small Footprint

- + Rugged Core Network Platform with dedicated hardware
- + 7-Year Hardware Lifecycle
- + One Support Contract
- + Integrated WAN and Ethernet Switch
- + Integrated Services
- + Redundant HW & SW (VM and IOS)

Branch Virtualization – On Premise Options

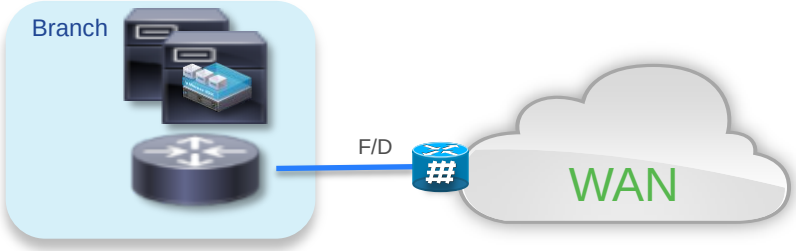
1



Router + integrated L4-7 services

- E.g. ISR + UCS-E
- Router performs transport functions
- Services (Firewall, WAAS..) virtualized on UCS-E
- Optional redundancy

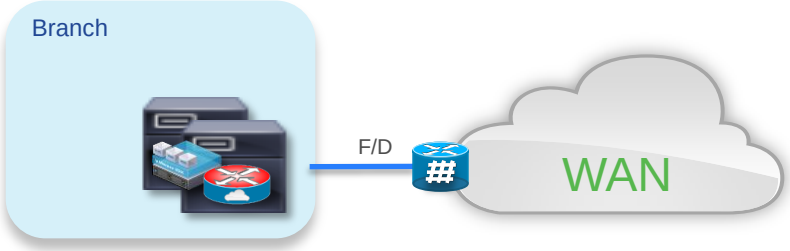
2



Router + virtualized L4-7 services

- Router performs transport functions (Routing, ACL, NAT, SNMP..)
- Services virtualized on external server
- Optional redundancy
- VNFs Could be multi-vendor (Best of breed)

3

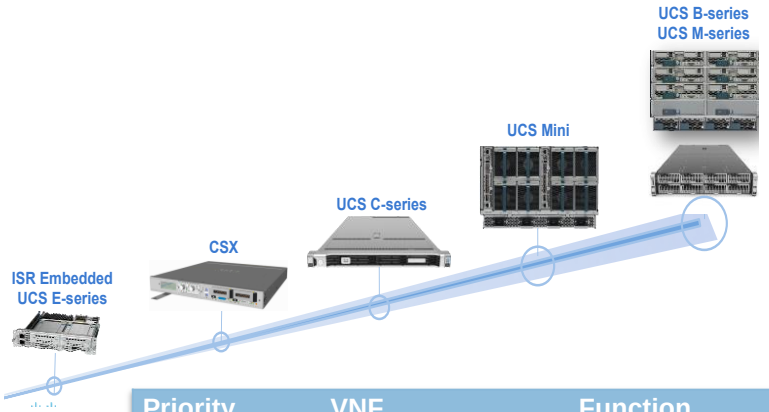


Fully virtualized Branch

- Physical router replaced by x86 compute
- Both transport and network services virtualized
- Optional redundancy
- VNFs could be multi-vendor (Best of breed)

Virtualizing Enterprise Branch Environments Solution Components

1. Multiple X86 compute form factors to fit all branch profiles
   - Including operating system to manage life-cycle of virtualized functions
   - Including plug-and-play functionality for automated branch and service instantiation
2. Virtualized network functions and appplications
   - Cisco VNF's - CSR, vWAAS. vASA, vDPI (NBAR/SCE) and more
   - 3rd party VNFs and applications (non VNF)
3. Orchestration – provision VNFs, service chaining, VM life cycle management & VNF service management
4. Fit into the IWAN Architecture and defined branch golden profiles
   - Small , medium, large - w/ the appropriate services
   - Hybrid, MPLS+DIA w/IWAN services



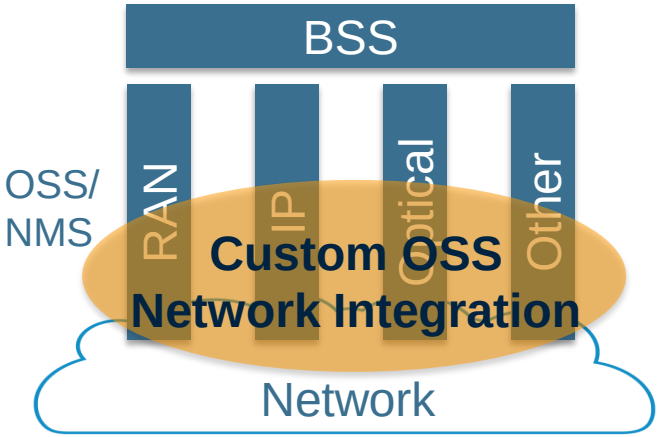
Priority	VNF	Function
1	CSR 1000v	L3-L7 integrated routing
2	vWaas	WAN optimization
3	Sourcefire	IPS/IDS
4	ASAv	Firewall
5	SRST	VoIP Call Control
6	Unity Cxn	VoIP Voicemail / AA
7	WSAv	Web security
8	vWLC	Wireless LAN controller
9	CUBE	SIP Trunking
10	CME	Call Processing

Orchestration
With
NSO tail f

Network Service Orchestration

Addressing Multi Domain & Vendors Elements

Today



- Hard-coded
- Domain specific
- Vendor lock-in
- HW based network functions

NFV

&

SDN

Tomorrow

Enter ***Network Service Orchestration***

- Service Agnostic
- Network Agnostic
- Model Driven

Orchestration describes the **automated** arrangement, coordination, and management of complex computer systems, middleware and services

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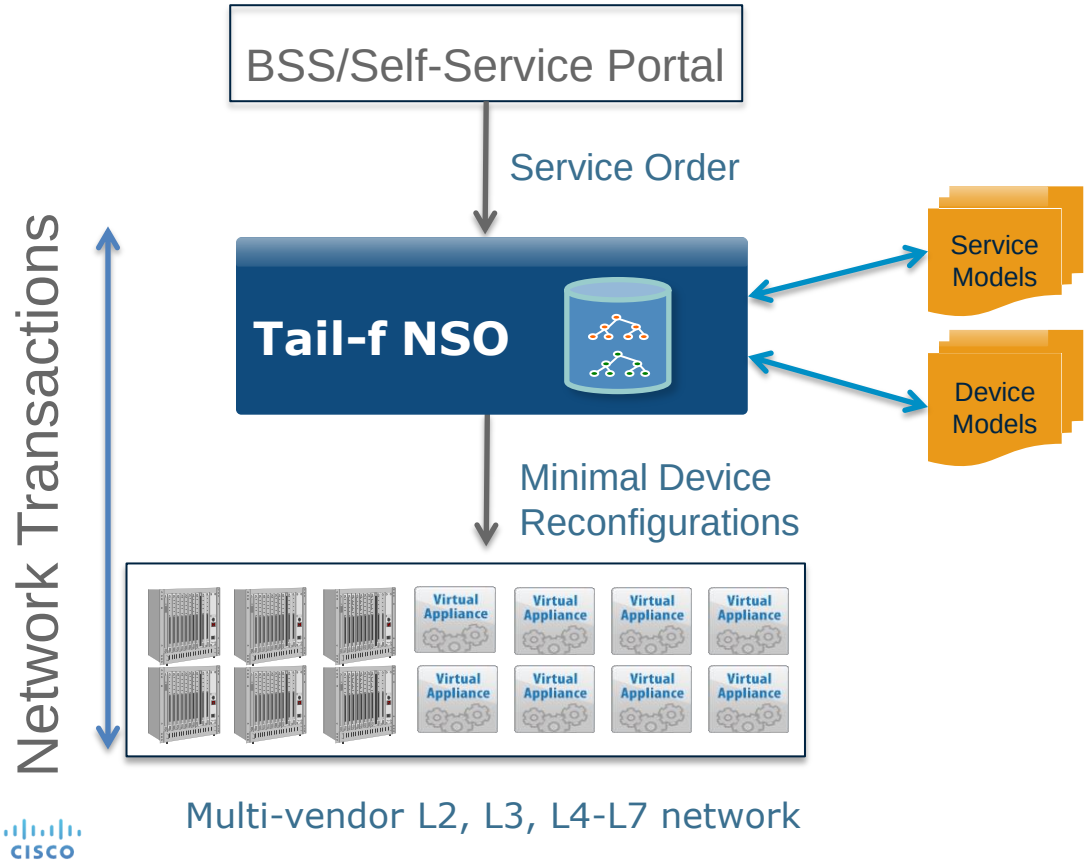
Model Driven Concept



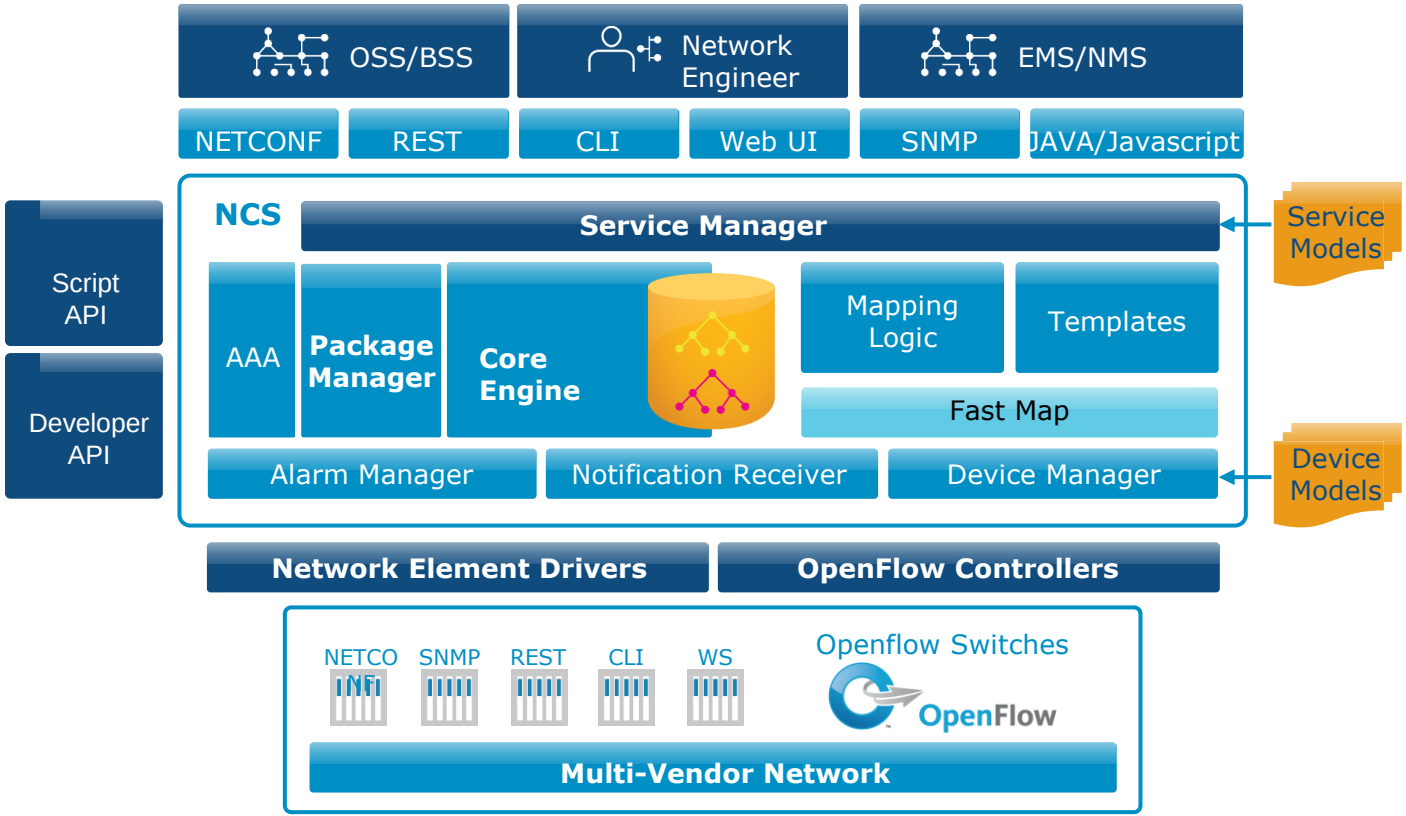
No hard-coded assumptions about
- network services
- network architecture
- network devices

Instead:
Data models written in YANG (RFC 6020)

Benefits:
- Service Agility
- Service Flexibility

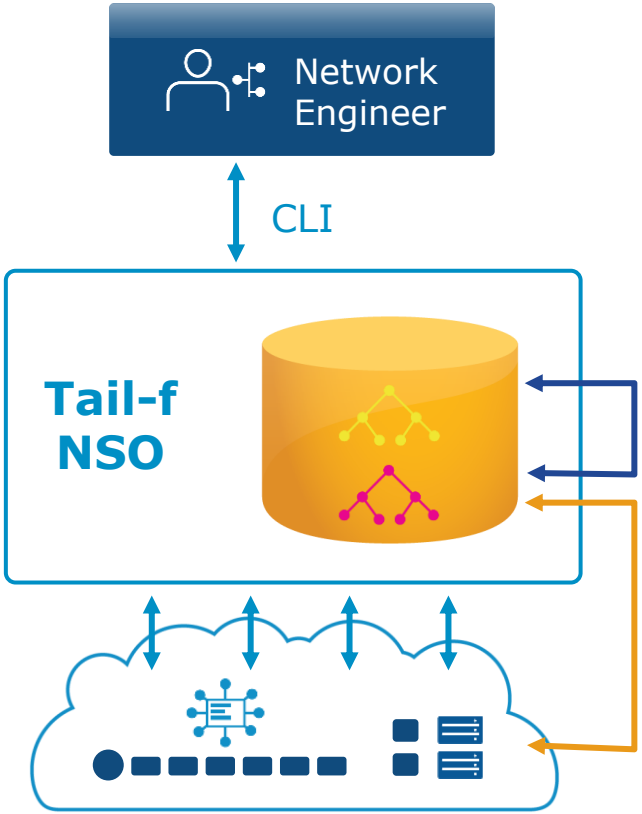
10x-100x improvement in TTM for new Services or Devices

NSO Architecture Overview



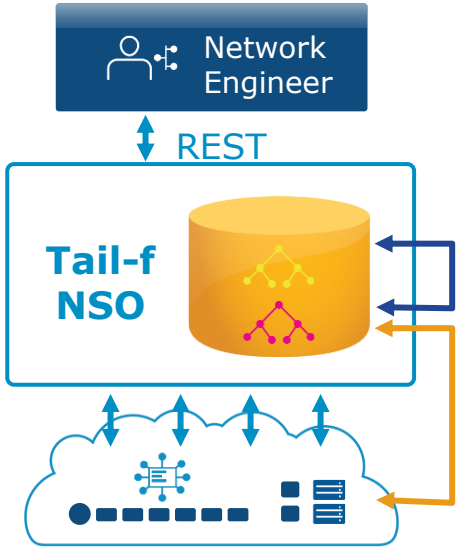
NSO CLI

- Service-aware
- Network-wide
- Juniper style
- Cisco XR style
- Powertool
- Helps keep the current domain experts
- Rich editing with tab-completion for commands, static elements and dynamic instances
- History, hints, help
- Extensible with custom/external commands, wizards



NSO REST

- **Relies on verbs of transport layer:**
  - **HTTP 1.1**
  - **GET : get resources**
  - **PUT : replace existing resource**
  - **POST : create resource**
  - **DELETE : delete resource**
  - **PATCH (RFC5789) : modify existing resource**
  - **HEAD, OPTIONS**
- **Stateless, client-server**
- **Hyperlinked, just like the web**
- **XML or JSON as data containers**
- **Links to available data-stores and operations**



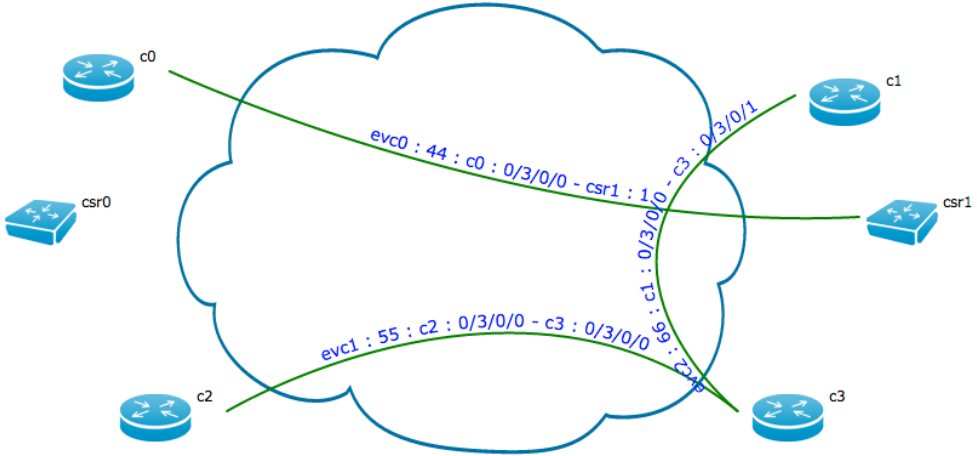
$curl –u admin:admin –s http://localhost:8008/api

- /api/running
- /api/candidate
- /api/operations
- /api/operational
- /api/rollback

Case Study: VPN Provisioning

Business Challenge:

Fast delivery of various types of VPNs (L2 and L3) and Carrier Ethernet 2.0 services for traffic separation in a dynamic, programmatic way.

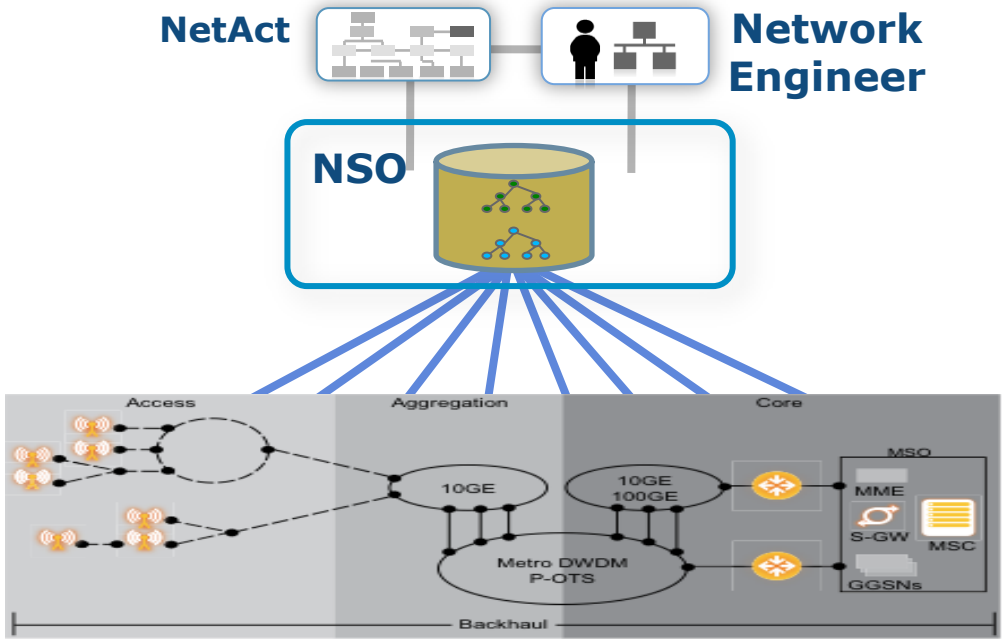


Business Outcomes with NSO:

- Automated provisioning of complex VPNs spanning 50,000+ devices from multiple vendors using network-wide, transaction-safe features
  - Juniper MX series core routers
  - Cisco for PE
  - Overture, Adtran and ADVA for CE
- Support for provisioning, updating and removing VPNs using minimal diffs
- Drastically reduced TTM
- API integration with customer self-service portal, OSS, and analytics systems

```
admin@ncs% set services service cust1 type eline evc evc1 ce-vlan 888
admin@ncs% set services service cust1 type eline evc evc1 endpoints c0 uni-interface TenGigE 0/3/0/4
admin@ncs% set services service cust1 type eline evc evc1 endpoints c3 uni-interface TenGigE 0/3/0/1
admin@ncs%
```

Network Provisioning Compliance Tool



Benefits with NSO:

- Network-wide CLI & Web UI
- Fine-grained, deep transaction-safe configuration changes with rollback across atomic change sets
- Engineers use NSO as a power-tool for new automated, paper free MOP process
  - Compliance
  - Technical review
  - Execution – with rollback
  - Post change compliance – with rollback
  - Service validation – with rollback
- Audit, Compliance and Reporting
  - Device groups to keep HA pairs in sync
- Backup and history
  - NSO export to offline database

Application Automation of IP service provisioning in mobile transport

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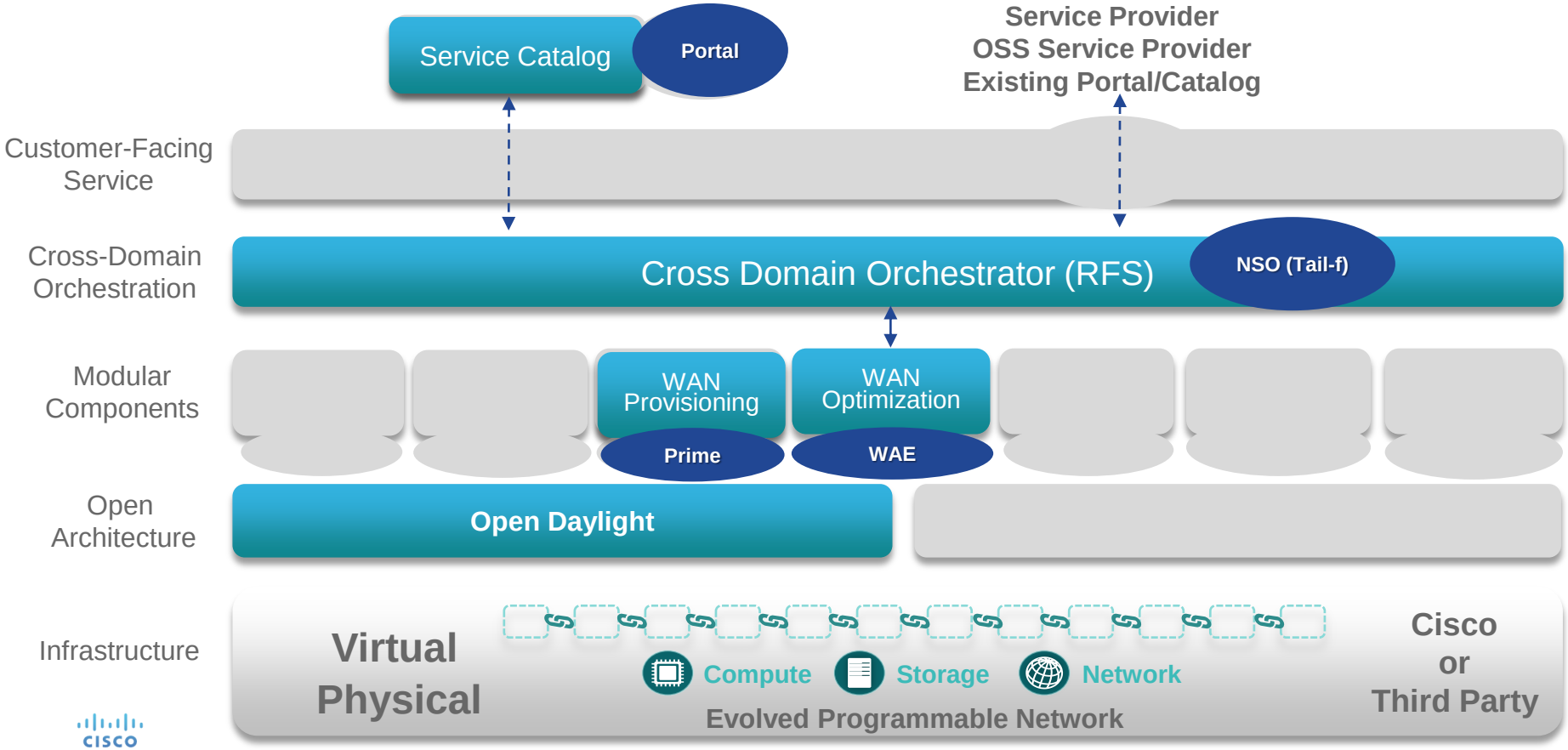
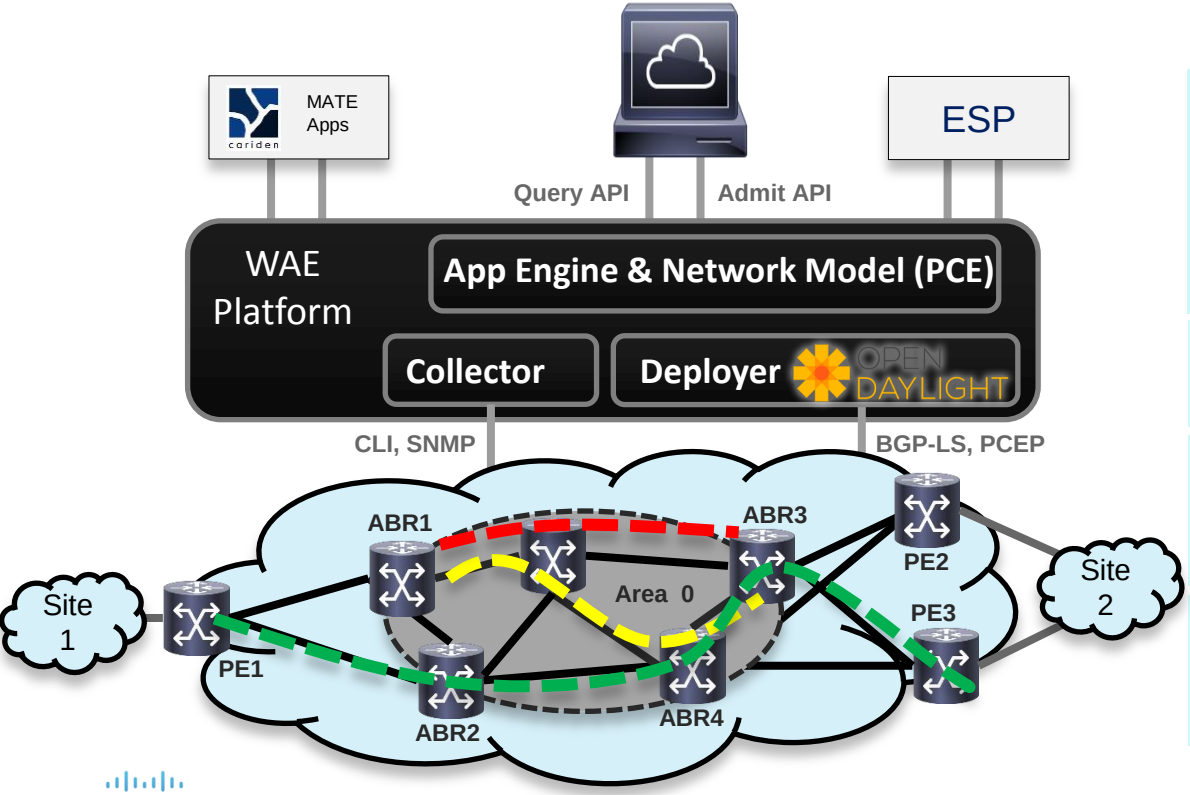
Architecture Implement Approach

SDN/NfV Architecture Framework
Exploration Phase 1 (Network Optimisation)



WAN Controller – WAE For Network Optimization



Description: SDN controller (WAN-Orchestrator) to compute dynamic/explicit path across the WAN to guarantee customer SLA (Bandwidth, Packet lost, Jitter, Backup…)

Business: SP to monetize the SP core, MPLS simplification

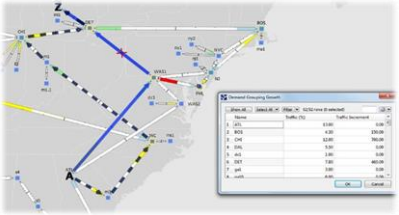
Platforms: ASR9K, CRS, NCS6000, Scapa, Quantum Wave Orchestration, 3rd party Routers (Juniper, ALU, Huawei)

SDN Elements: Open Day Light controller, BGP LS, Netflow, PCE-P, Segment Routing, NETCONF/YANG

Use Cases : Restoration & Path Re-route

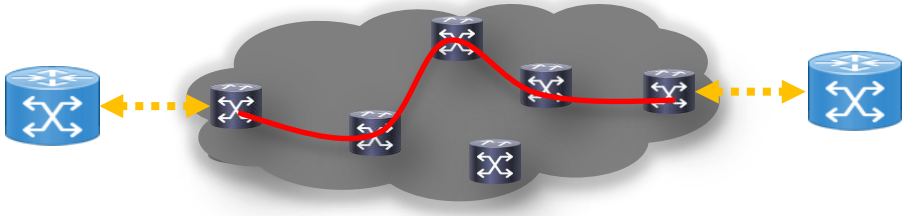
Multi-Layer Network Optimization

Global network view | Optimization across layers
15% interface savings



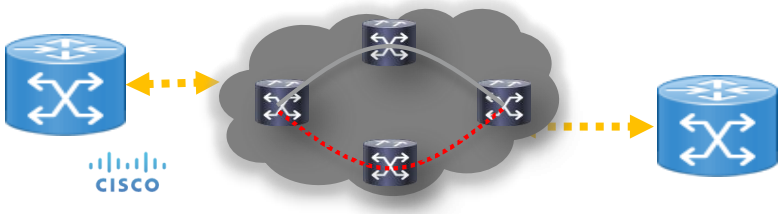
Multi-Layer Service Activation

Months to Minutes | Simple, focused applications
Constraint-based routing



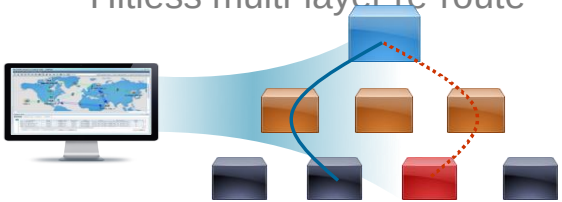
Multi-Layer Restoration

>40% Interface Savings | Zero Touches
Re-use stranded network assets



Coordinated Maintenance

Multi-layer service awareness | Months to Minutes
Hitless multi-layer re-route



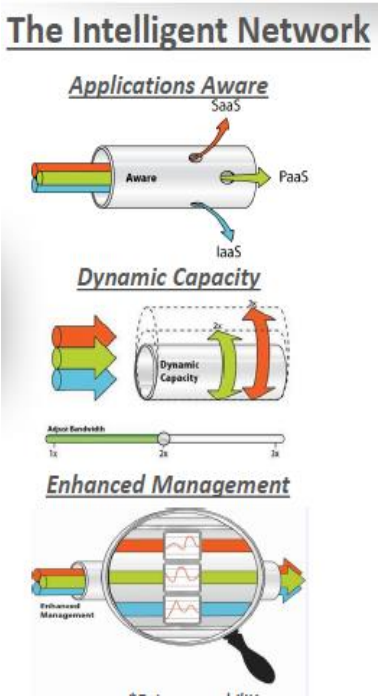
Dynamic Bandwidth On Demand

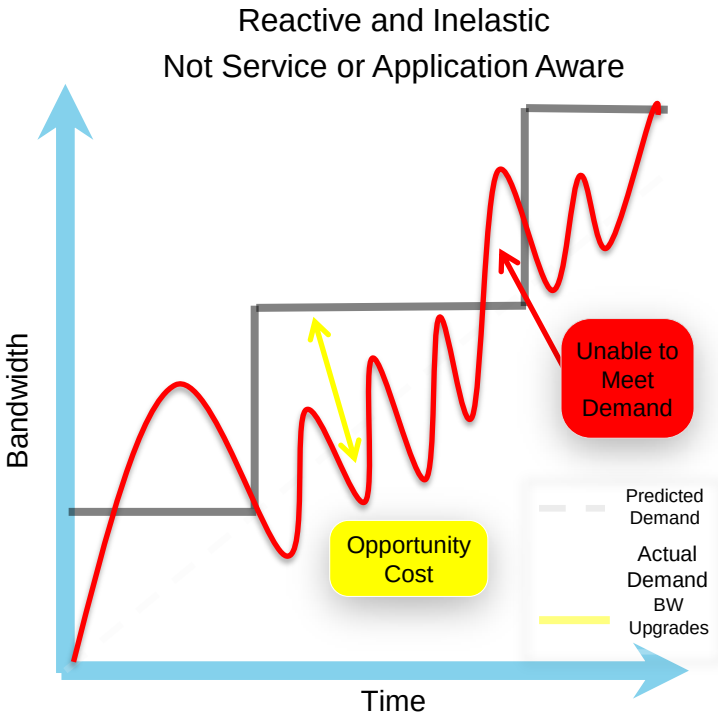
Dynamic Bandwidth on Demand

- Use only what you need
- For as long as you need it.
- Incrementally pay for what you use.
- No bandwidth management required.

Business Impact:

- Market Disruption
- Increase revenue per bit.
- Increase market differentiation.
- Lower OpEx.





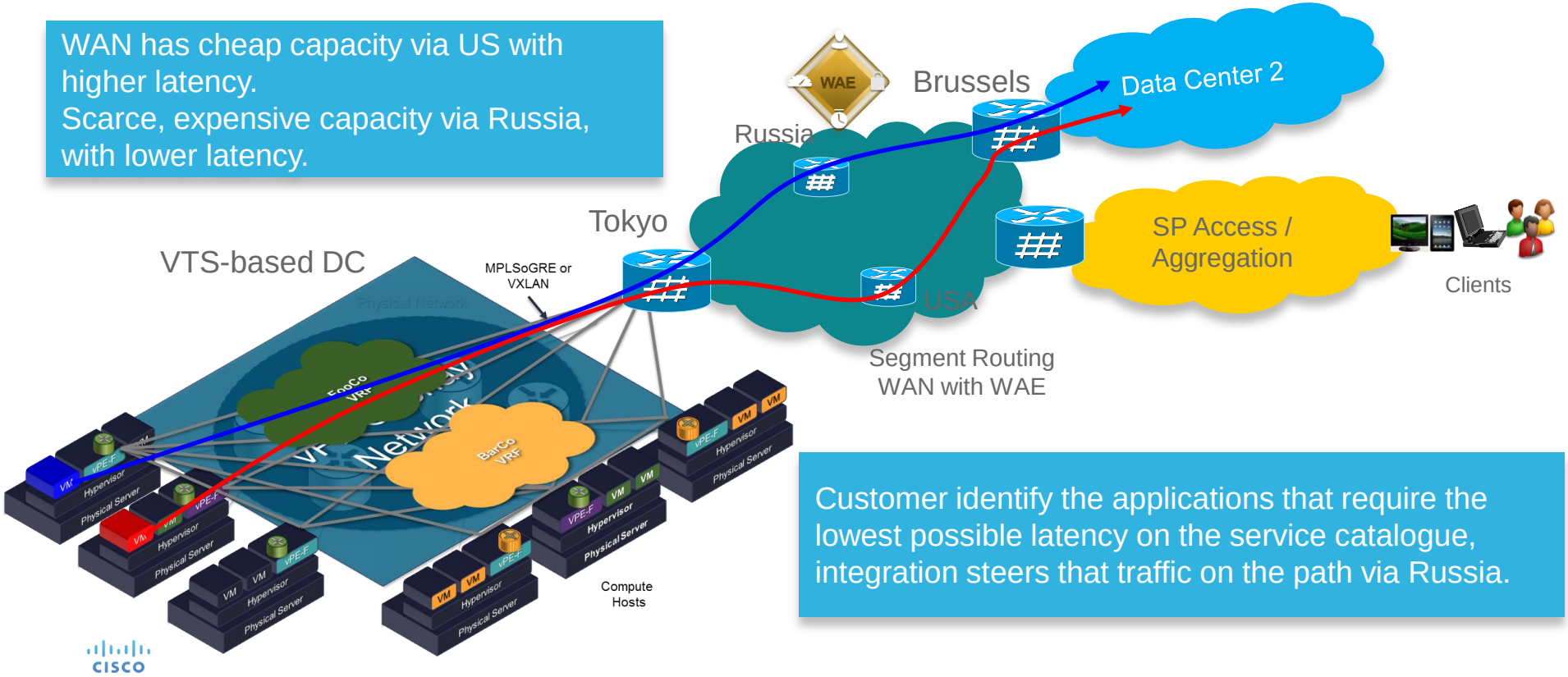
Segment Routing Across WAN and DC

Application requires the lowest latency path in the WAN

Low Latency SR TE

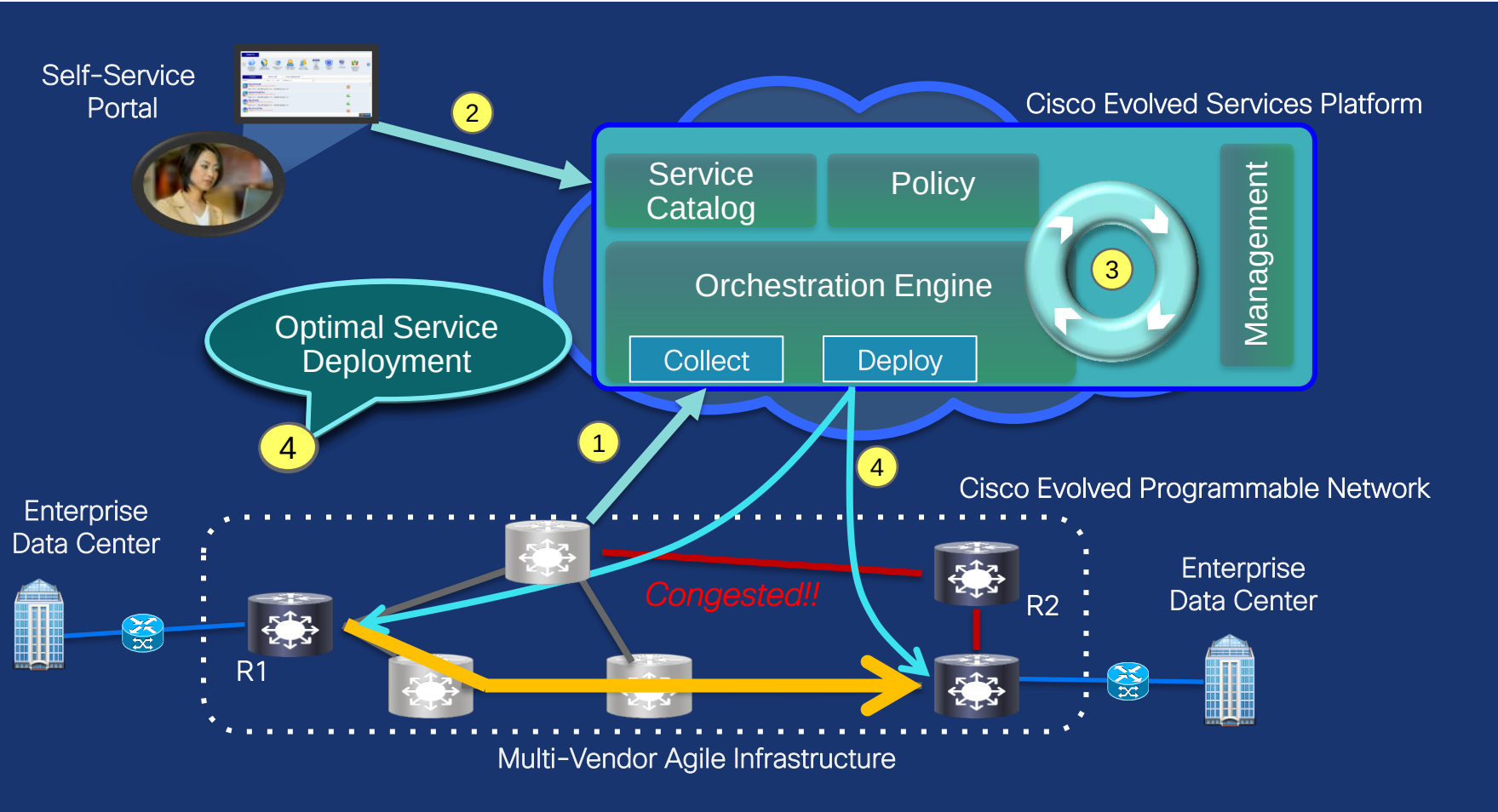
High BW SR TE

WAN has cheap capacity via US with higher latency.
Scarce, expensive capacity via Russia, with lower latency.

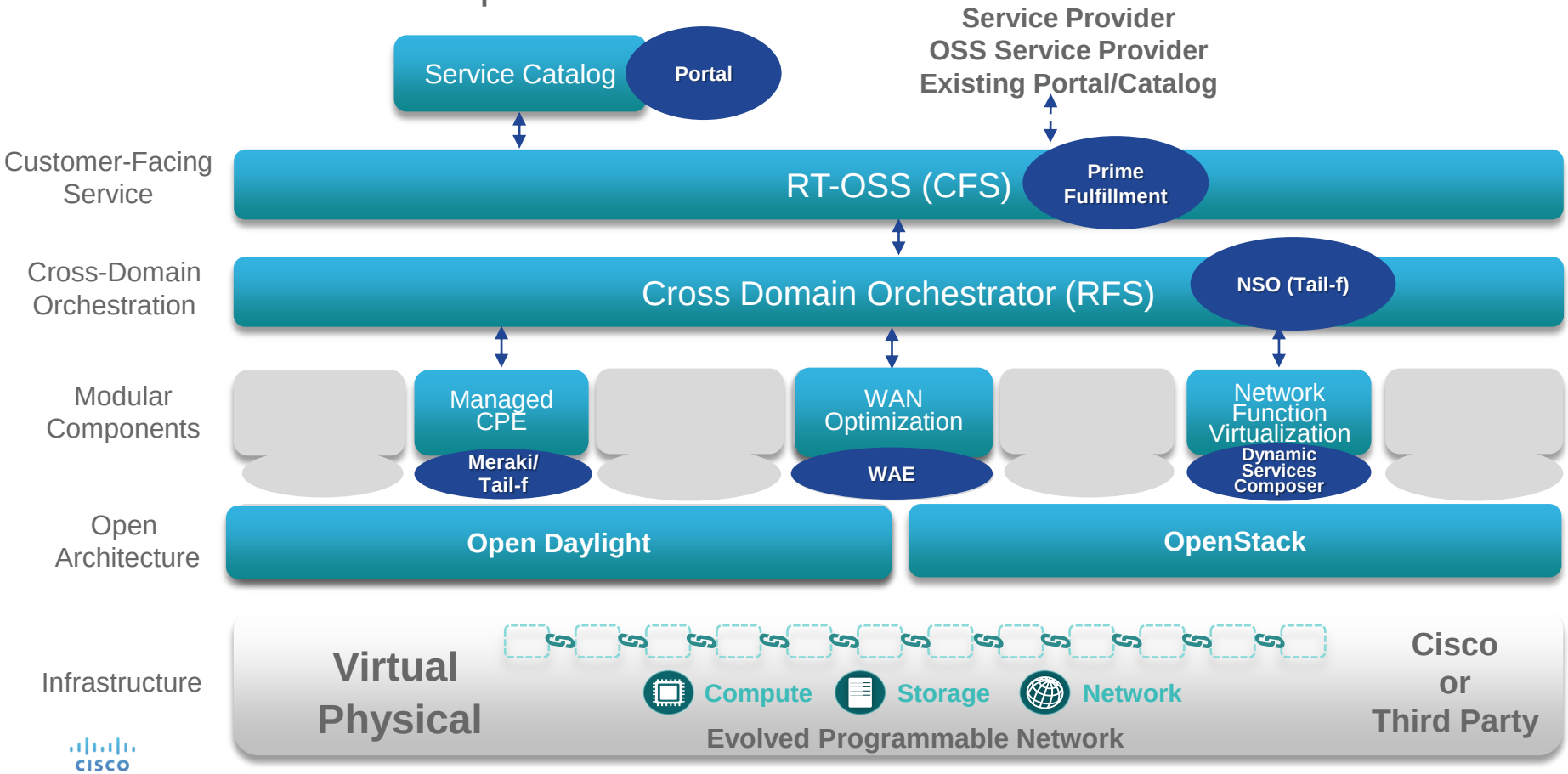


Customer identify the applications that require the lowest possible latency on the service catalogue, integration steers that traffic on the path via Russia.

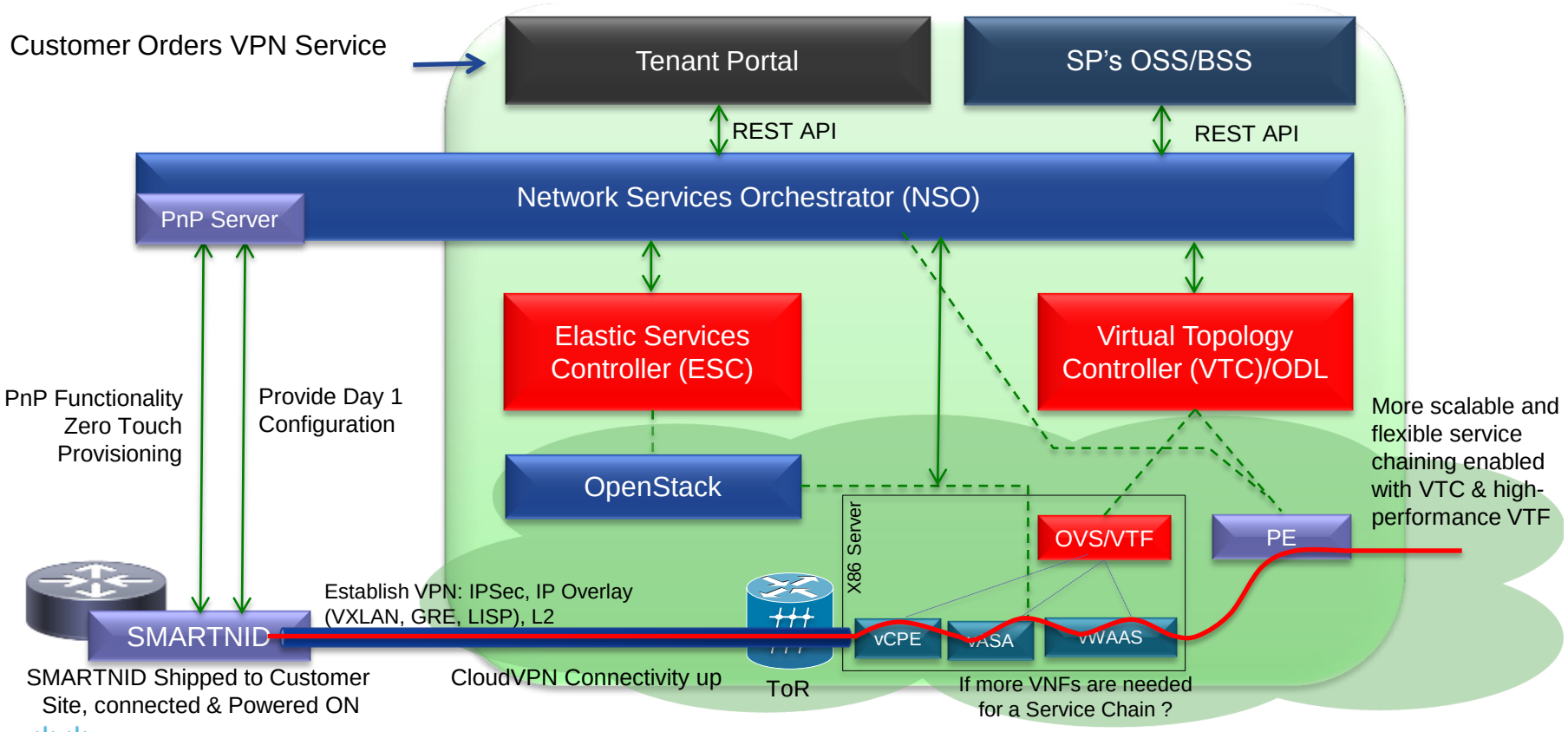
BOD & Calendaring – Enables New Classes of Service



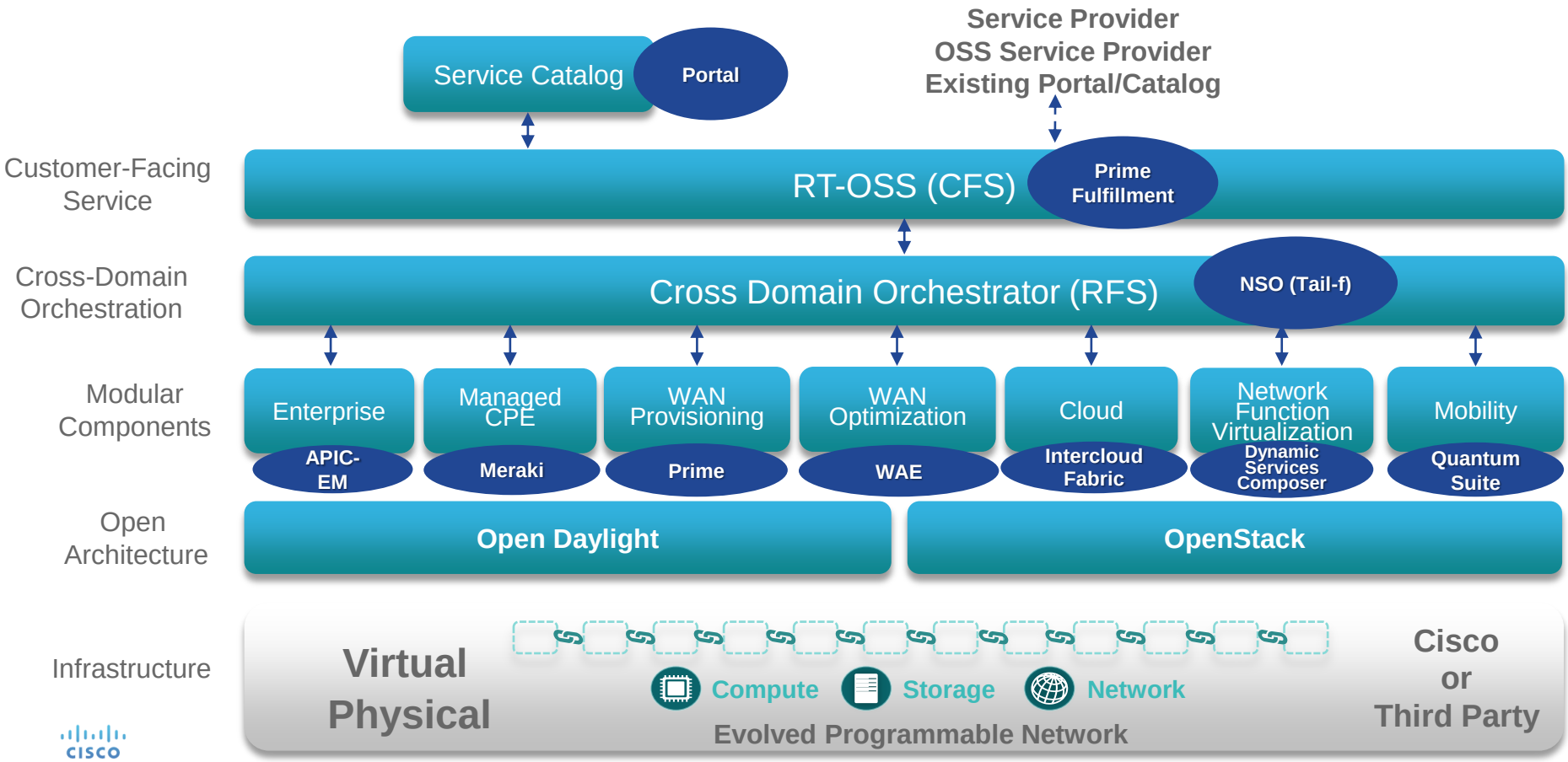
SDN/NfV Architecture Framework
Exploration Phase 2 : vCPE & vBranch



vCPE & vBranch Solution



End State Architecture



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TOMORROW starts here.