



*TOMORROW
starts here.*

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Evolution of Service Provider Edge Architectures

BRKSPG-2051

Dan Clark, Network Consulting Engineer

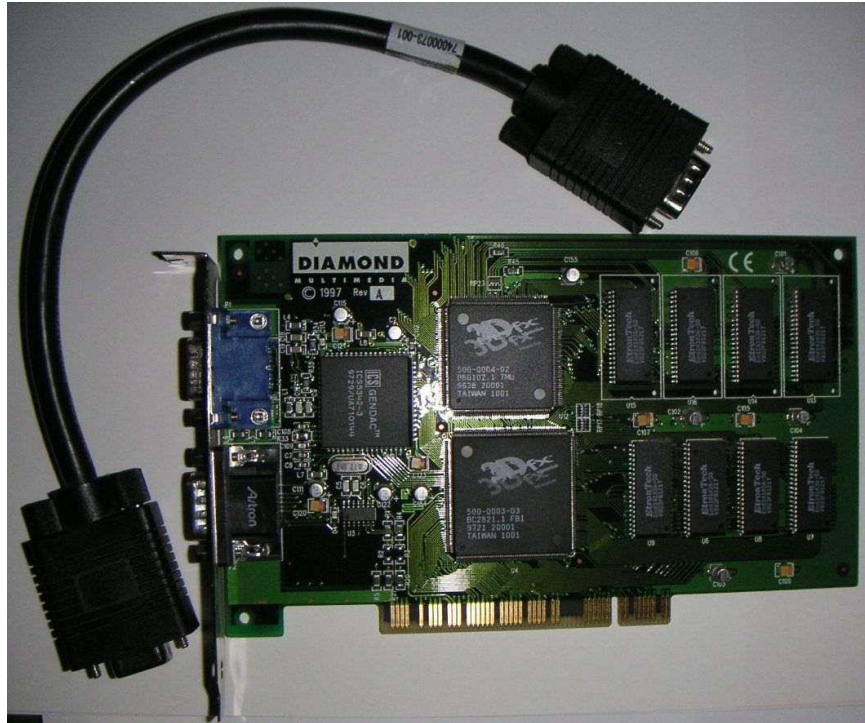
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Agenda

- Drivers for SP Edge Architecture Evolution
- Cisco Evolved Programmable Networks
- Virtualising Edge Network Functions
- Orchestrating NfV





A long-exposure photograph of a city street at night. The foreground is filled with vibrant, multi-colored light trails from moving vehicles, creating a sense of motion. In the background, a modern pedestrian bridge with blue lighting spans the street. Tall buildings with illuminated windows and storefronts line the street, and several flags are visible on the left side.

Drivers for SP Edge Architecture Evolution


What is Driving Service Provider Edge Evolution?

- Moving from IPNGN era to EPN
- Focus on end to end application delivery
- SP's desire to sell additional services to drive up revenue
- Customer consumption methods are changing
 - Customers looking for services “on tap”
- The classic motivator, OPEX reduction

Evolution of Residential Services

- Double-play and Triple-play are prevalent
- SP differentiation by
 - Access bandwidth
 - Multimedia content offerings (number of titles, HD/SD)
 - Value added services (e.g. security)
 - Mobility
- Service evolution focuses around
 - Increased bandwidth
 - .. For multimedia / OTT / Cloud applications
 - Mobility, seamless roaming, connected everywhere
 - Personalisation of subscriber services

What do our Enterprise Customers Care About?



Customer Challenges

Cost Reduction

- Doing more with less
- Resources for critical operations

Manageability

- Simplicity and Consistency
- Limited monitoring and diagnostics
- Node-by-node vs. holistic network management

Network Value

- Show me the value!
- Unused features
- Complex features

Service Agility

- Slow services rollout and scaling
- High costs and complexity for new services

Evolution of SP Enterprise Services

- Cheaper CPEs!
- Local loop bandwidth increase, from T1/E1 to DSL, Fibre and LTE
- Cloud Service Offerings
- Context-aware Security Services
- Increased Real-time applications
- BYOD
- Application Control and WAN Optimisation

So what is the goal?

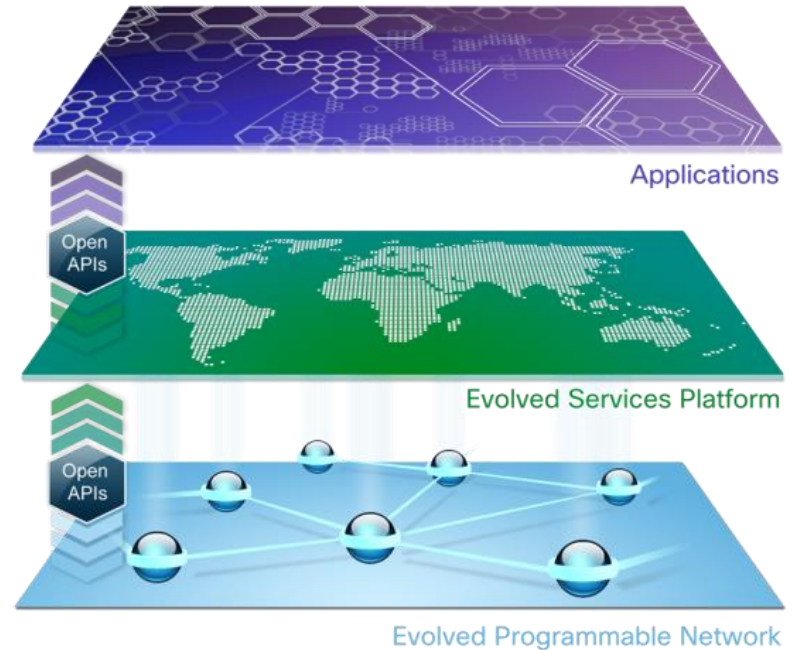
- Make it easier for customers to consume services!
- Decrease complexity
- Increase deployment speed
- Automate deployment and configuration

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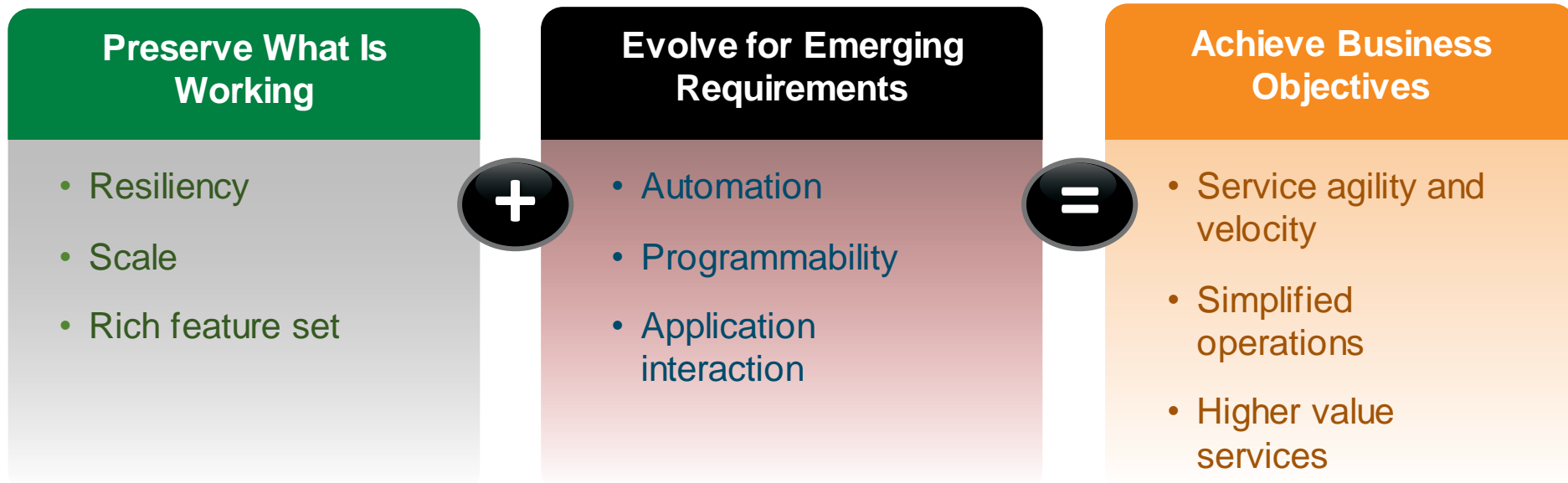
Cisco Evolved Programmable Networks

What is the Evolved Programmable Network?

- Next evolution of IP NGN
- Infrastructure layer of the programmable network
- Comprised of physical and virtual infrastructure
- Provides programmatic interface enabling automation and orchestration



Motivations for an Evolved Programmable Network



EPN 4.0 System Architecture Overview

Business Convergence

- Unified L3 VPN experience
- Seamless and Personalized BYOD remote access and VPN Access

Subscriber Service Convergence



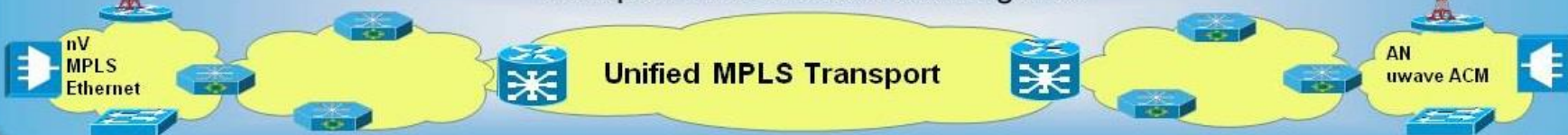
Consumer Convergence

- Unified Subscriber Experience

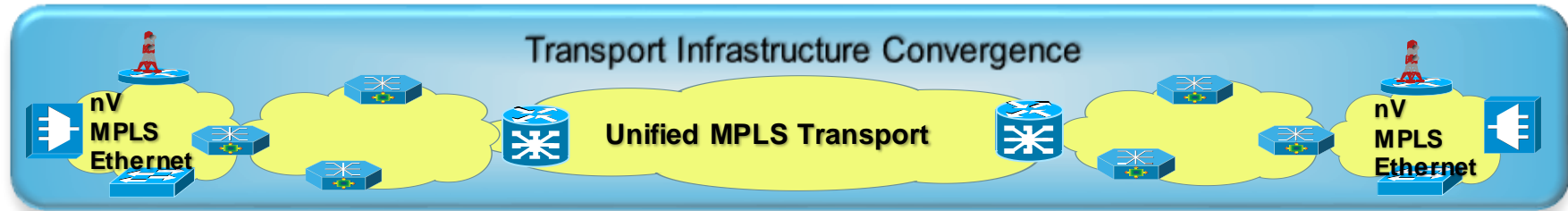
Service Infrastructure Convergence



Transport Infrastructure Convergence



Transport Infrastructure



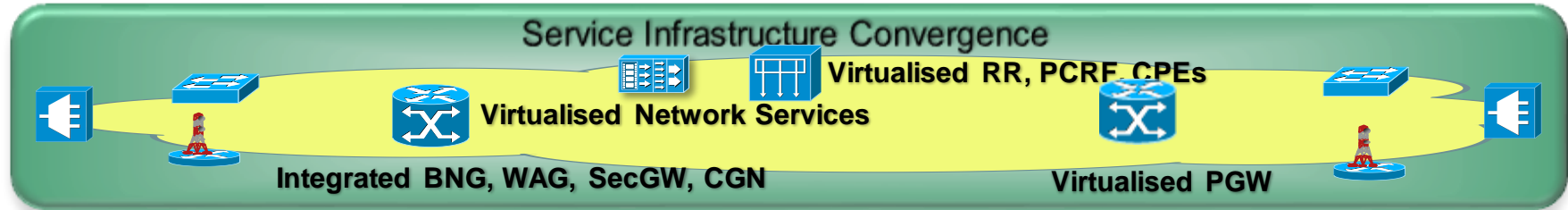
Enabled by Unified MPLS technology

Key Highlights

- Wireline and mobile transport services integration
- Multi access technologies support
 - Hybrid microwaves (P2P, rings), Ethernet Fibre (P2P, rings), network Virtualisation (nV)
 - L1/L2 and L3 access (IP/MPLS)
- Route Reflector function virtualisation
- Access Network Activation Automation
 - Autonomic Networking, Auto IP, EEM
 - Microwave Adaptive Code Modulation
- Multicast transport
 - mLDP and IP v4/v6 multicast
- Carrier class capabilities for HA, OAM and PM support

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Service Infrastructure



Key Highlights

- Fixed (BNG, MSE) and Mobile (WAG, SecGW) Service Edges optimal placement and integration with Transport Infrastructure
- Network Functions Virtualisation and Integration:
 - Integrated BNG, CGN, WAG, L2/L3 VPN Edge
 - Virtualised BNG, PGW, BRAS, vPE, vRR and vCPE
- Converged and Virtualised PCRF for Fixed, Mobile and WiFi Sessions
- Fixed and Mobile Service Edges with all Access Network Technologies: MPLS, Ethernet Ring, nV

Subscriber Services

Subscriber Service Convergence

Business Convergence

- Unified L3 VPN experience
- Seamless and Personalised BYOD remote access and VPN Access



Consumer Convergence

- Unified Subscriber Experience

Key Highlights

- Consumer Subscribers:
 - Unified subscriber experience
- Enterprise VPNs and BYOD Subscribers:
 - Unified and Personalised L3 VPNs experience over Fixed and Mobile Access
 - Personalised and billable SLAs
 - Covers: PE-CE routing, VPN routing topology, Access QOS and Security, VPN accounting
 - Seamless and Personalised remote BYOD access into Enterprise L3 VPN

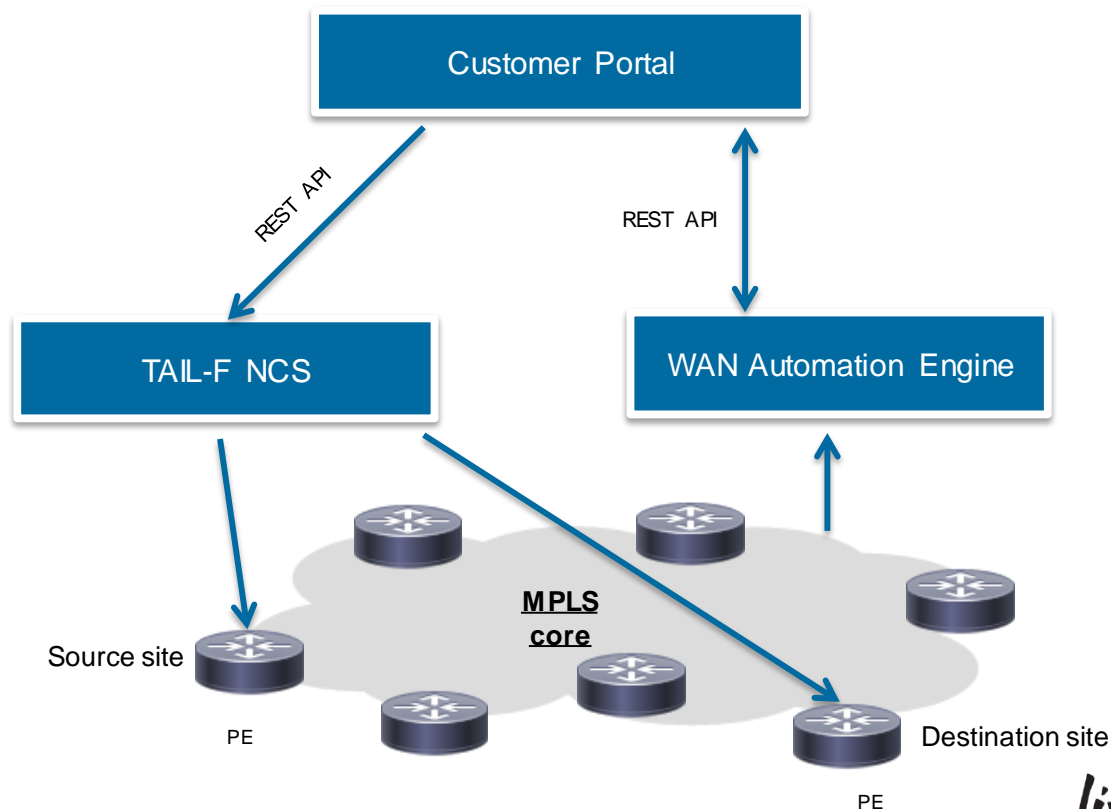
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A long-exposure photograph of a city street at night. The foreground is filled with vibrant, multi-colored light trails from moving vehicles, creating a sense of motion. In the background, a modern cityscape is visible with illuminated buildings and a pedestrian bridge spanning the street. The overall scene is a blend of urban architecture and dynamic light patterns.

Programmable Networks Example

Programmable Networks in “Real” Life

- Customer Portal provides user interface where customer can order a bandwidth guaranteed LSP through the MPLS core
- WAE provides a ERO via demand calculation
- Tail-f pushes necessary configuration down the network



A long-exposure photograph of a city street at night. The background shows modern buildings with lit windows and a pedestrian bridge. The foreground is dominated by vibrant, multi-colored light trails from moving vehicles, creating a sense of motion and connectivity.

Virtualising Edge Network Functions

Network Functions Virtualisation (NFV)

Announced at SDN World Congress, Oct 2012

- AT&T
- BT
- CenturyLink
- China Mobile
- Colt
- Deutsche Telekom
- KDDI
- NTT
- Orange
- Telecom Italia
- Telstra
- Verizon
- *Others TBA...*

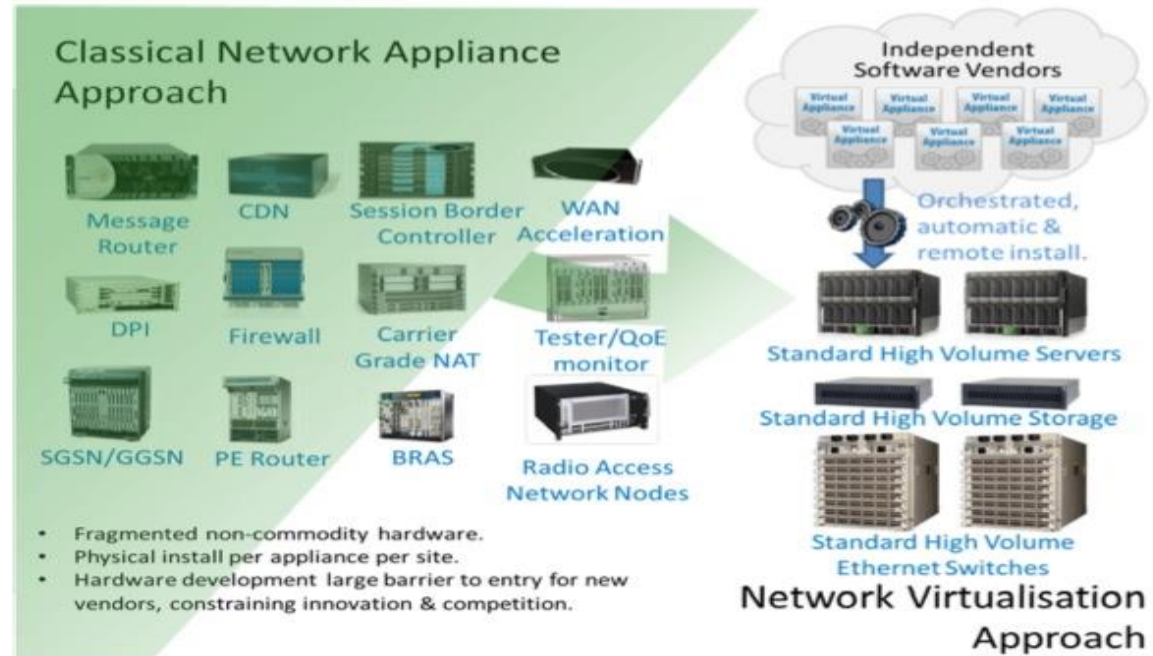


Figure 1: Vision for Network Functions Virtualisation

NFV as Defined by ETSI ISG

- NF - Network Function
- VNF - Virtualised Network Function
- NFVI - Virtualised Network Function - Infrastructure
- NFVO- Virtualised Network Function - Orchestration
- NS - Network service
- VA – Virtual Appliance

Overall Benefits of Virtualisation

1. Flexibility

- Placement of DCs (fully centralised, in PoPs)

- Virtual Machine mobility

- VM Capacity expansion bring-up/ tear-down of VMs

2. Run different images for different service

- Separate upgrade process

- Shorter certification cycles

- Option to deploy best-of-breed

3. Smaller failure domains

4. Opex savings due to automation / orchestration

X86 Compared to Network Processing Unit

Low

Bandwidth Requirement

High

High

Compute Requirement

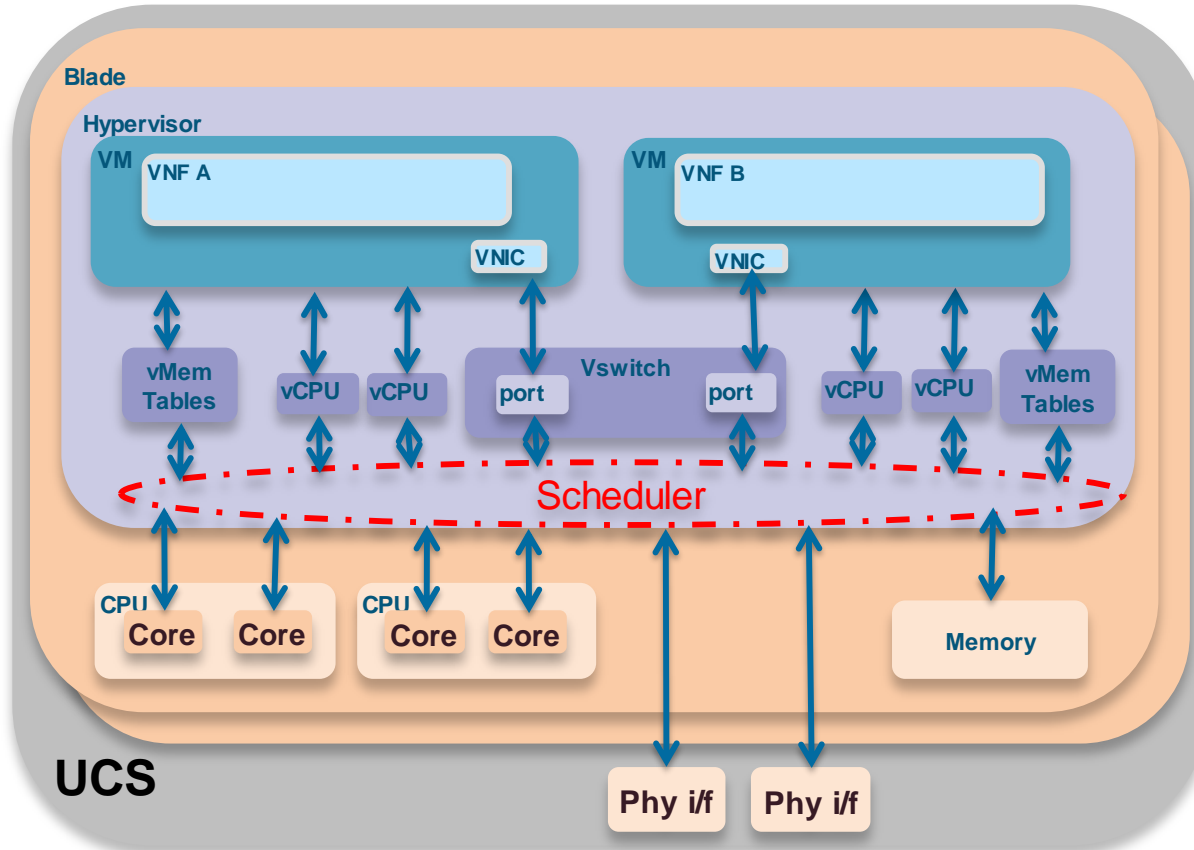
Low

- Network Services
 - L4-7
 - Stateful
 - Low to Medium throughput
 - RR, LNS, FW, DPI etc.
- Network Forwarding
 - L1-3
 - Stateless
 - High throughput
 - IPv4/v6 MPLS etc.

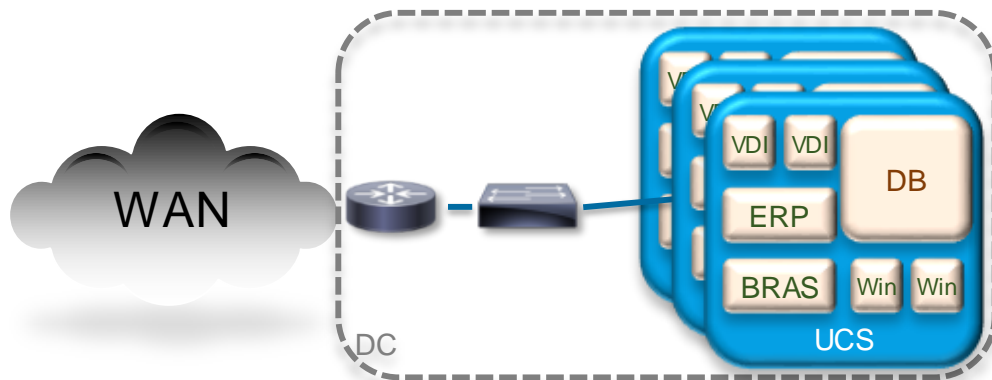
Overall Drawbacks of Virtualisation

- Scalability
 - A single hardware Edge system function is now replaced by multiple VMs
- Requirement to introduce stateful loadbalancer to scale
- Power consumption
- SLA guarantees when running on a hypervisor
- Systems integration when running on a hypervisor

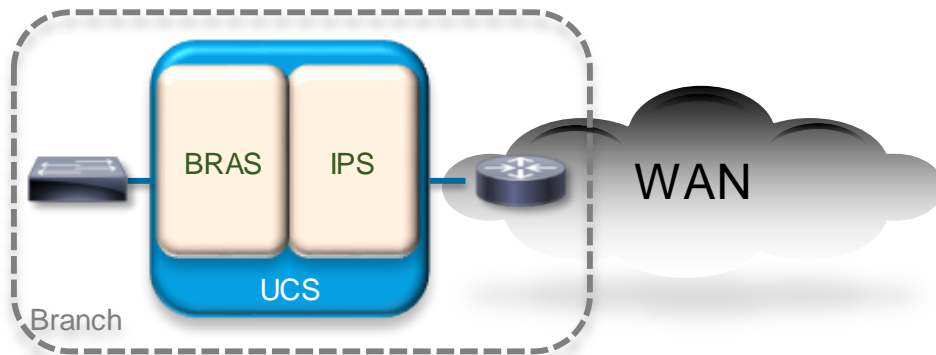
Virtualisation and Hypervisor Interactions



Differences Between Cloud and Branch NfV Use-Cases



- Focus on cloud orchestration and virtualisation features
- Mix of applications and VNFs may be hosted in the cloud
- Horizontal scaling -> smaller VM footprints
- Dynamic capacity & usage- / term-based billing



- Focus on replacing hardware-based appliances
- Typically smaller x86 processing capacity in the branch
- NfV applications (Firewall, NAT, WAAS..) may consume large proportion of available hardware resources
 - larger VM footprints
- Cloud orchestration and automation has to be distributed over all branches
 - integration with existing OSS desirable for migration

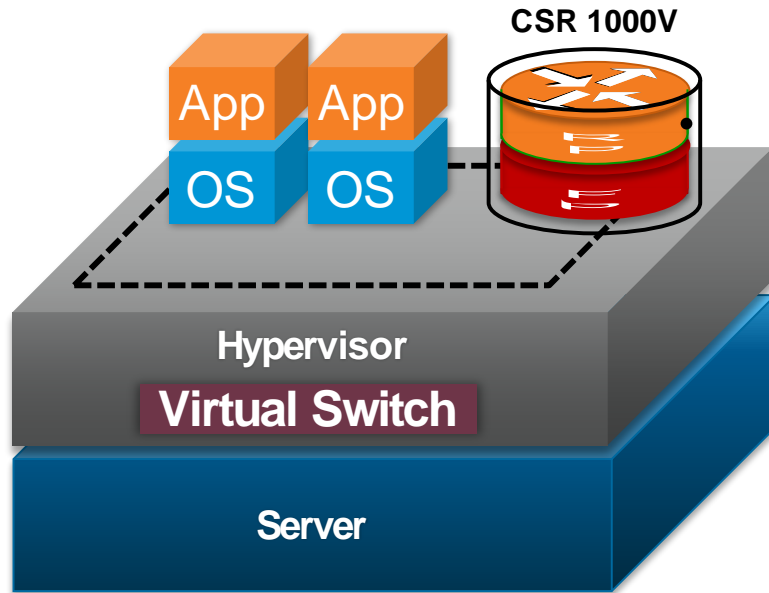
Virtual Appliance Options



- CSR1000v
- IOS-XRv
- ASAv
- QvPC
- And many more



Cisco CSR 1000V – Virtual IOS XE Networking



IOS XE Cloud Edition

- IOS XE features for Cloud and NFV Use Cases

Rich Network Services

- Routing, VPN, App Visibility & Control, DC Interconnect, and more
- Infrastructure Agnostic
- Server, Switch, Hypervisor

Single-tenant WAN Gateway

- Small Footprint, Low Performance

Perpetual, Term, Usage-based Licenses

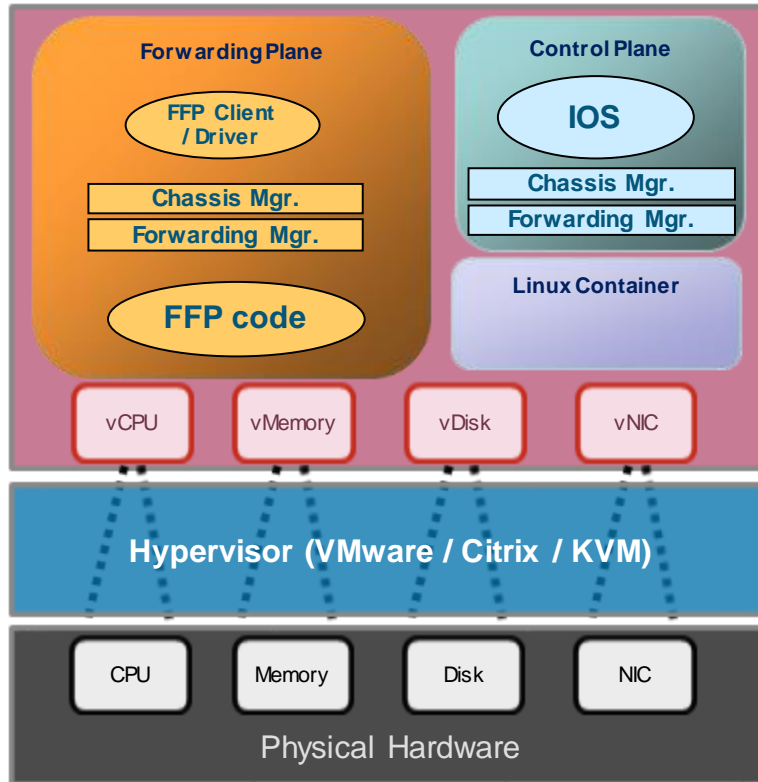
- Elastic Capacity (Throughput), and Feature Licenses

Programmability

- RESTful APIs for Automated Management

Rapid Deployment and Flexibility

Architecture (CSR 1000V) - Virtualised IOS XE



- Virtualised IOS XE
 - Generalised to work on any x86 system
 - Hardware specifics abstracted through a virtualisation layer
 - Forwarding (ESP) and Control (RP) mapped to vCPUs
 - Bootflash: NVRAM: are mapped into memory from hard disk
 - No dedicated crypto engine – we leverage the Intel AES-NI instruction set to provide hardware crypto assist.
 - Boot loader functions implemented by GRUB

NF Virtualisation with the CSR 1000v – SP Edge



- Want more on the CSR1k?
 - NFV Deployment using CSR1000v walk in lab

Why Move Services into the SP Network?

vCPE Example

Reduce costs, and consolidate by virtualising services.

Simple, stateless branch hardware. Ship it, plug it in, done!

Eliminate equipment silos at each site.

Increase managed network functionality, while reduced per-site costs.

Evolve/upgrade managed service offerings without changing CPE devices.

“Slim” cloud CPE hardware portfolio to fit branch locations.

Unified management spanning all branches.

- Not a replacement for entire CPE portfolio, but rather a complementary solution

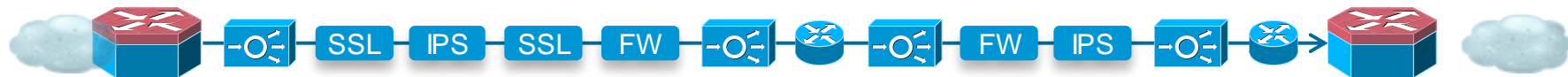
A long-exposure photograph of a city street at night. The foreground is filled with vibrant, multi-colored light trails from moving vehicles, creating a sense of motion. In the background, a pedestrian bridge spans the street, and modern buildings with lit windows and signage line the street. The overall scene is a dynamic urban environment.

Service Chaining

Service Chaining

- What is service chaining?
 - Linking functions to build a service
- Why does an SP care about service chaining?
 - Provide higher value, on demand services to your customers
- Defining the problem
 - To provide services elastically, we must leverage NFV

Motivation for Service Chaining



- Architectures for L4-7 services can be very cumbersome to operate
- Today: very complex configuration via switching / routing (PBR, routing knobs, VLAN stitching)
- Today: very static, scaling is a challenge.
- No way to share valuable information between the network and services, or between service functions
- Definition

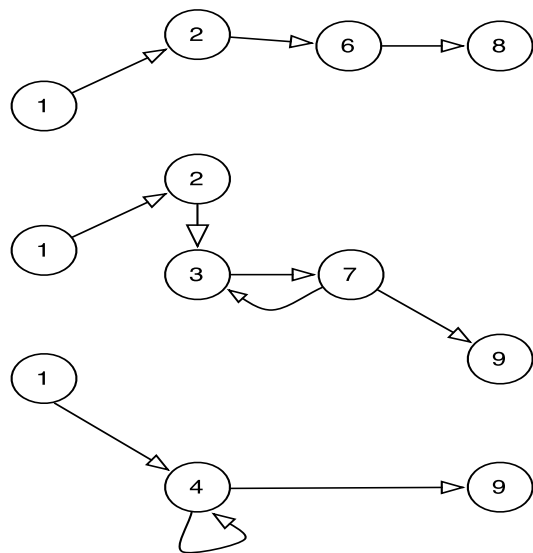
Service function: a function that operates on packets above and beyond forwarding (L4-L7 “services”)

Service Chaining: Steering traffic through more than one service function, i.e. apply multiple services to the traffic in a specific order

Service Chaining

- Service chaining is the broad term that describes delivering multiple service functions in a specific order
 - Decouples network topology and service functions
 - Supports dynamic insertion of service functions
 - Common model for all types of services
 - Enables the sharing of information between service functions
- Composed of data plane and control/policy planes
 - Overlay data plane → service path
 - Control and policy planes

Service Chaining and Graph Theory Representation



- The collection of service functions in a network form a graph
- Vertices: service functions
- Edges: overlay connectivity
- Sub-graphs define service chains from the overall service graph
- Service functions can be in more than one chain
- A service path is the specific instantiation of a service chain

Chain_1: S1→S2→S6

Path_n: instance(S1) → instance(S2) → instance(S6)

Service Chaining - Classification

- Classification node forms the start of a service chain
 - customer/network/service profile matching of traffic flows
- Defines what traffic enters which service path
- Variable granularity depending on requirements and platform capabilities
- Initial classification: starts a service path
- Subsequent classification(s): can alter a service path

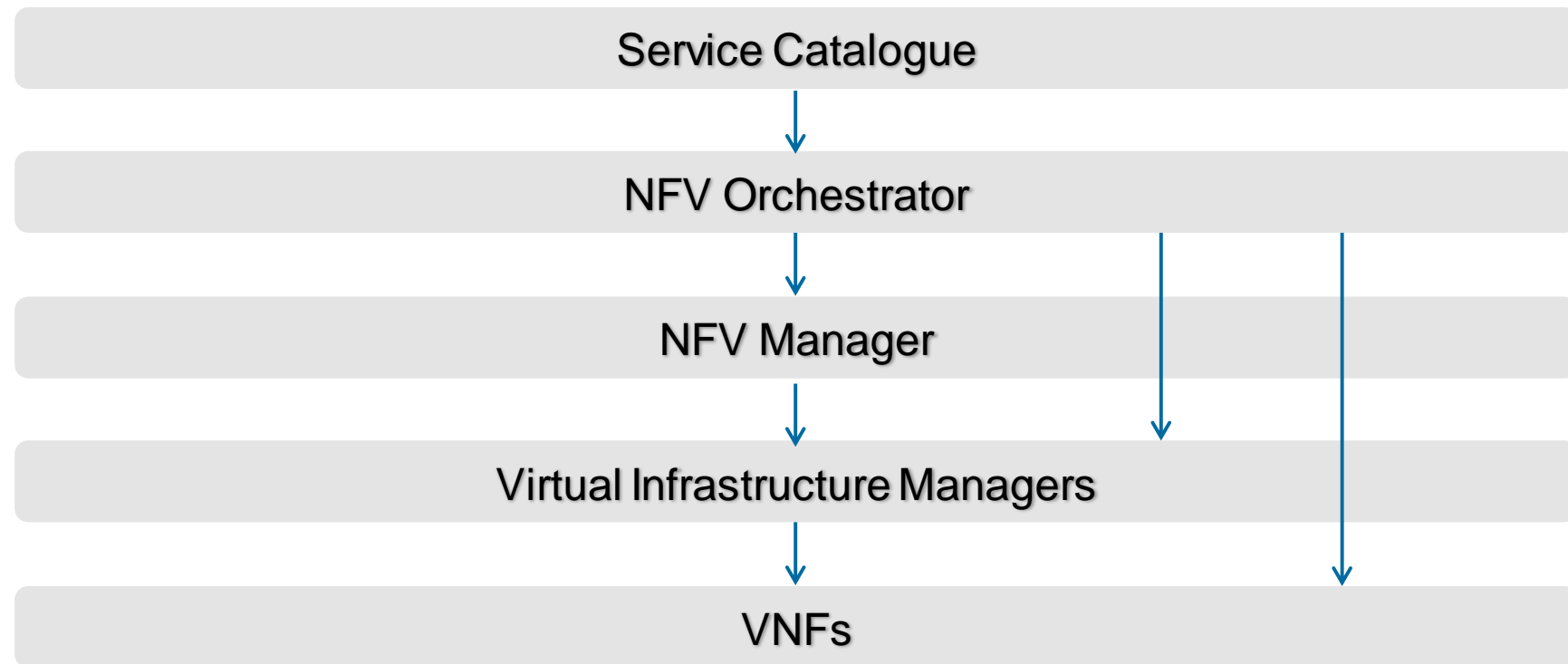
A long-exposure photograph of a city street at night. The background shows modern buildings with lit windows and a pedestrian bridge. The middle ground features a road with traffic lights and some vehicles. The foreground is dominated by vibrant, multi-colored light trails from moving vehicles, creating a sense of motion and energy.

Orchestrating NfV

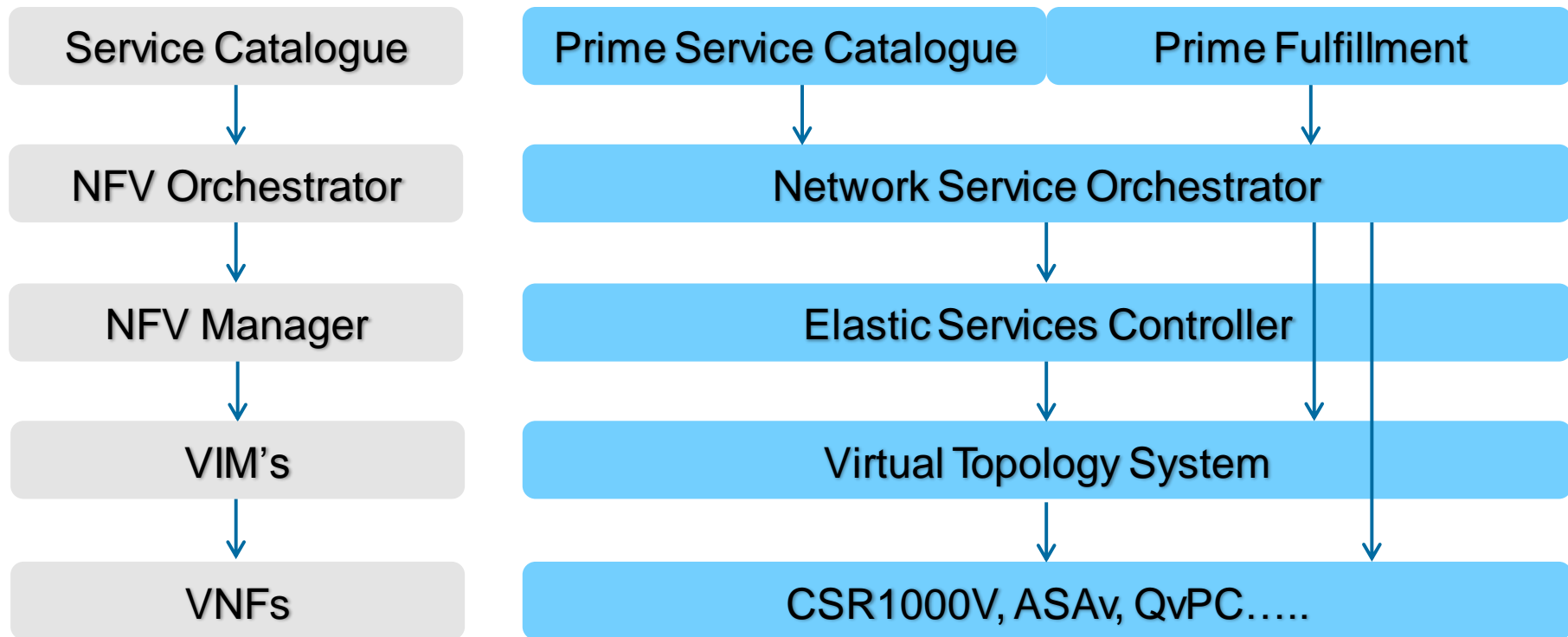
NFV Orchestration – Putting it all Together

- Remember our goals:
 - Reduced costs
 - Increase speed
 - Automate deployment and configuration
 - Make it easier for our customers to consume services

NFV Orchestration – The Concept

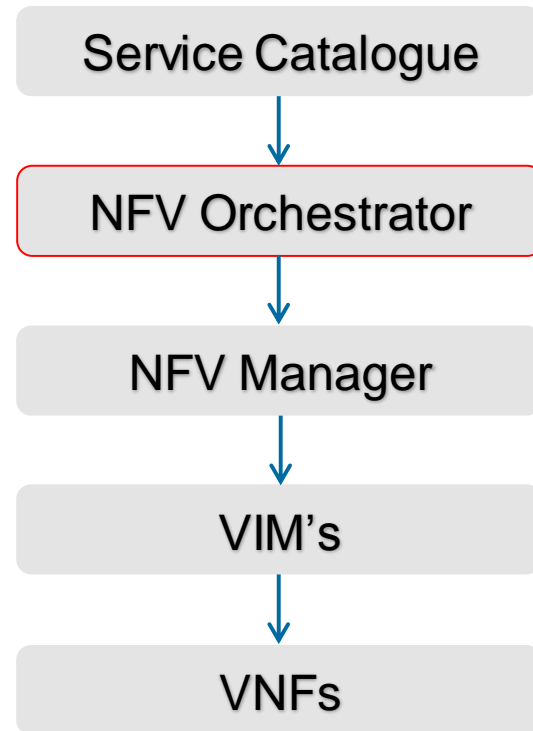


Cisco NfV Orchestration Solution



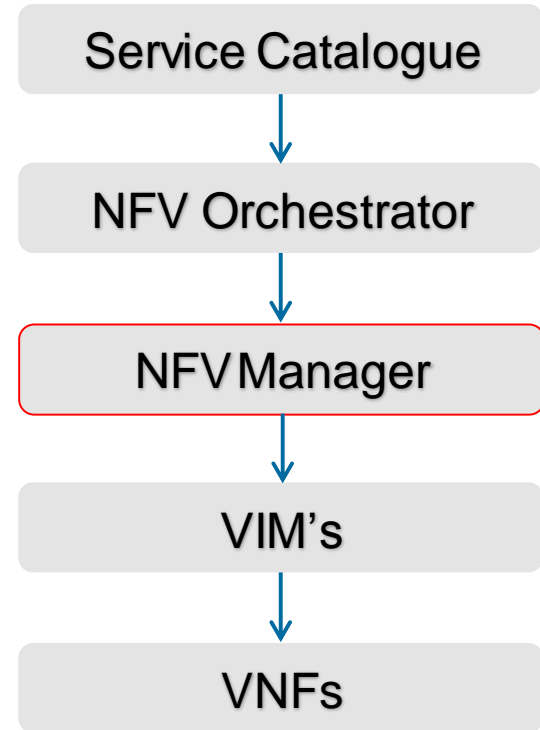
Network Services Orchestrator

- General Purpose Orchestrator
 - Physical, Virtual and Hybrid environments
- Part of the Evolved Services Platform
 - Utilises the EPN for underlying transport and service infrastructure
- Based on Tail-f's NCS platform
- Provides service lifecycle, service activation, monitoring to provide E2E service



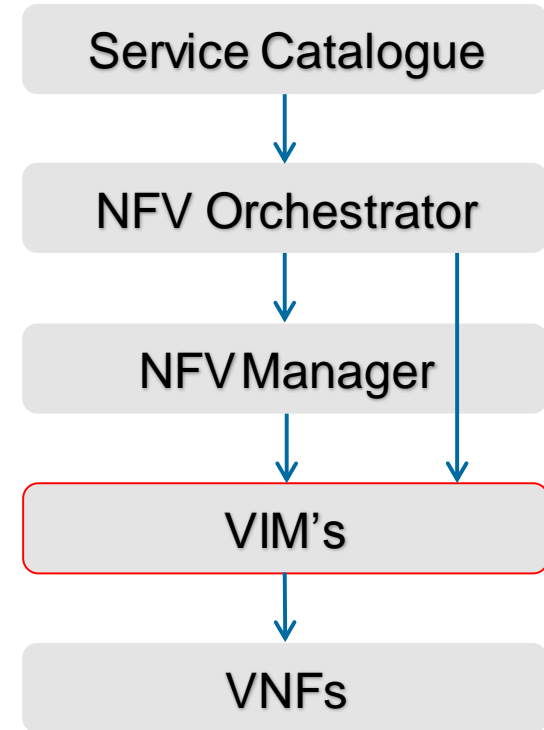
Elastic Services Controller

- Generic VNF Manager
 - Support for Cisco and 3rd party VNFs
- Dynamic Scale
 - Scale-up/Scale-down based on performance indicators
- Extensible
 - REST/SOAP support to provide interfaces for other components

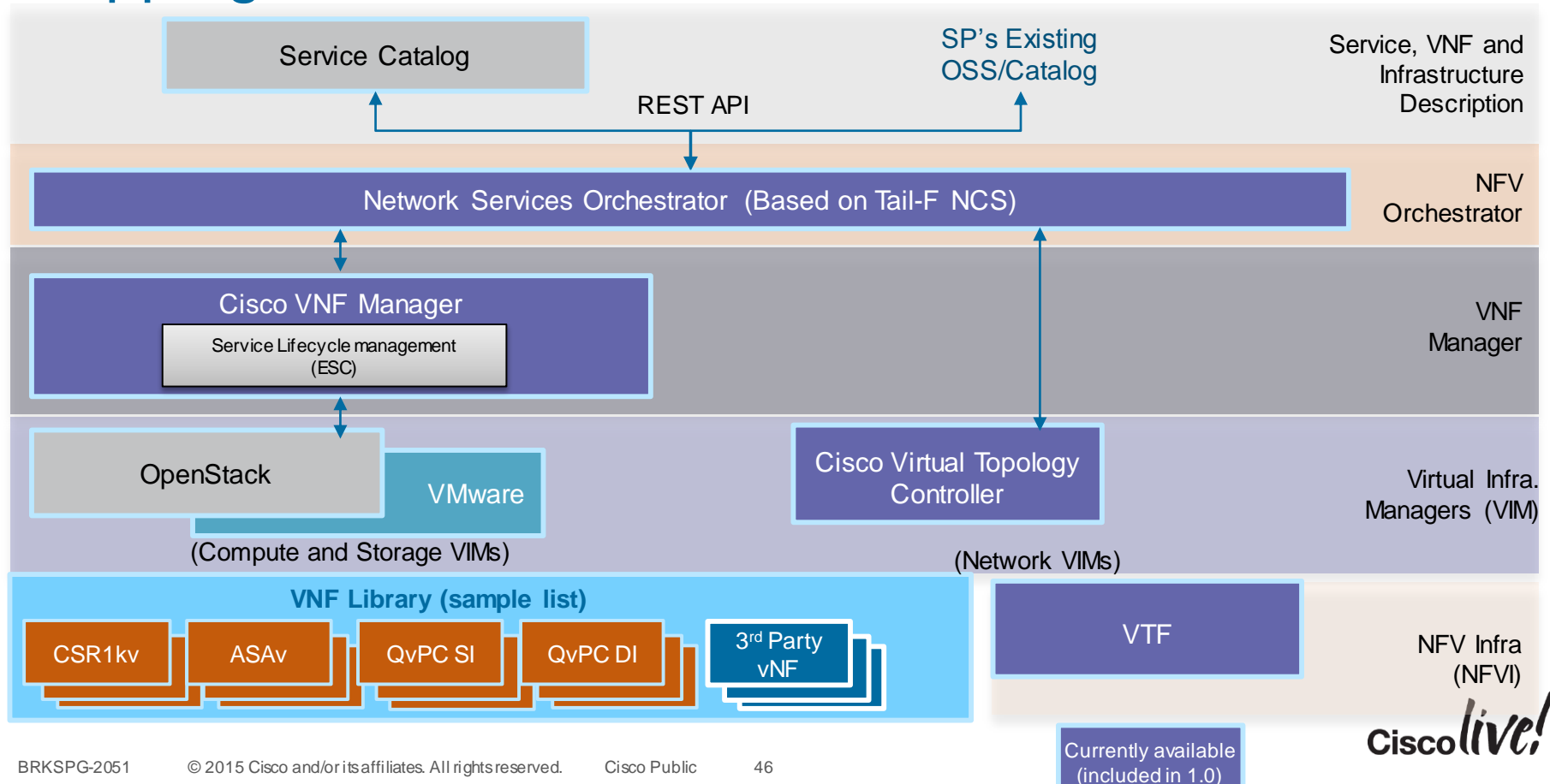


Virtual Topology System

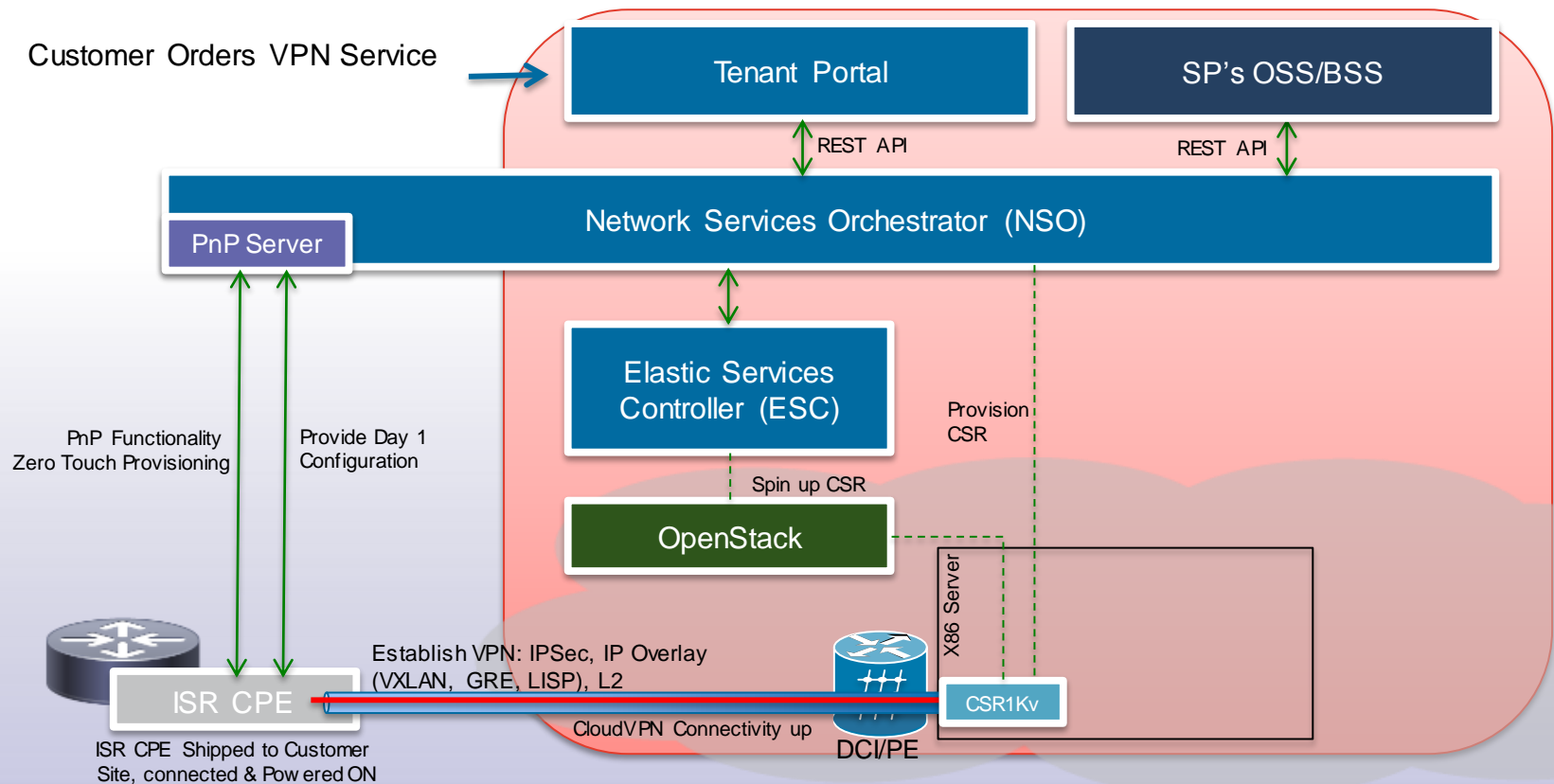
- Comprised of two components
 - Virtual Transport Controller
 - Virtual Transport Function
- VTC
 - Routing Controller based on XRv
- VTF
 - Lightweight software forwarding plane
 - Runs once per server
 - Unique forwarding instance created per tenant
 - Optimised forwarding for x86



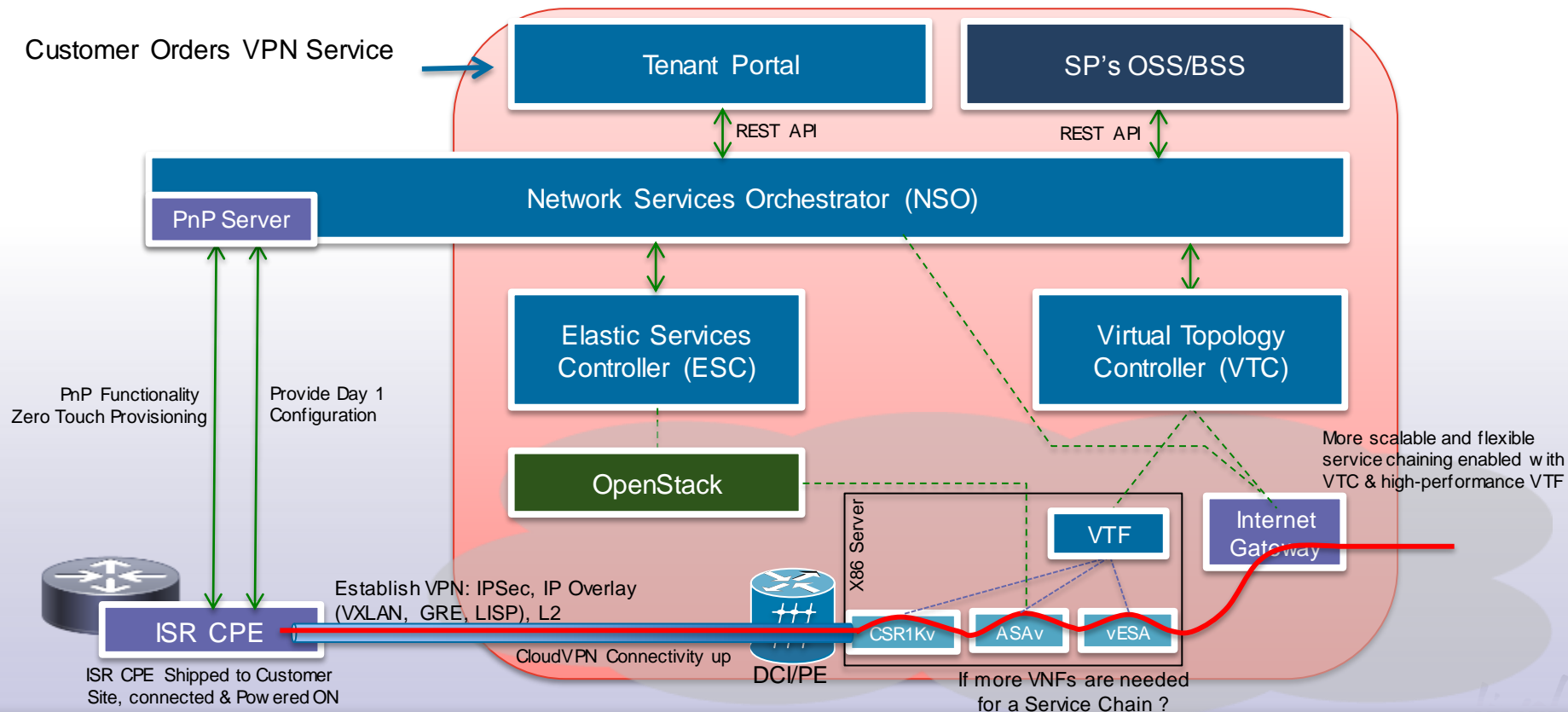
Mapping Architecture to ETSI NFV Framework



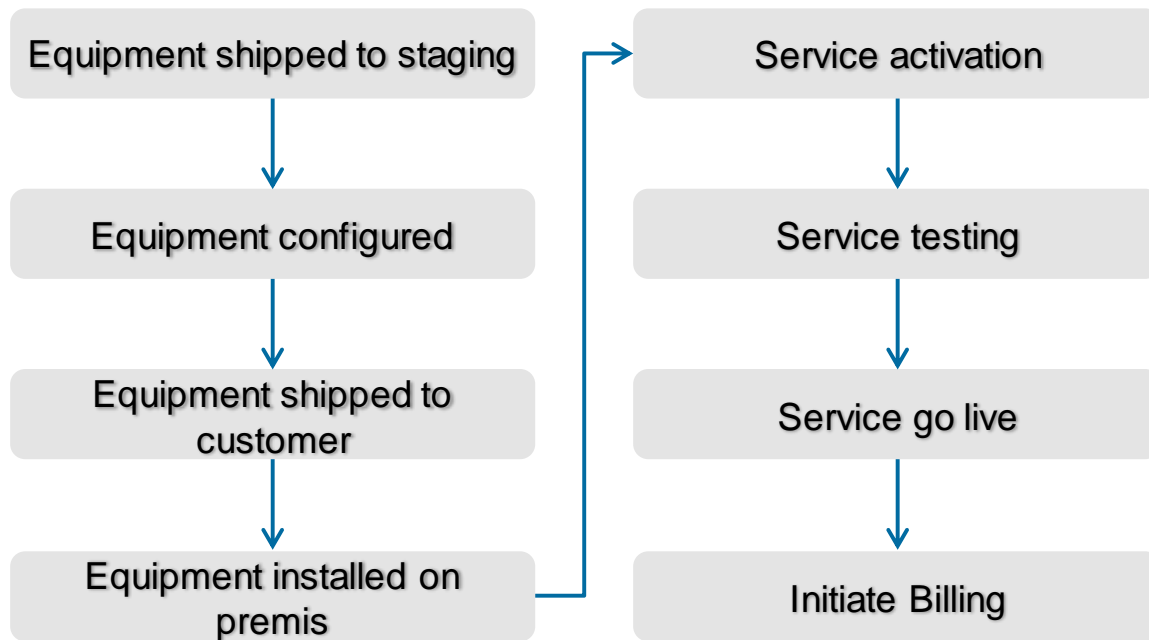
CloudVPN with ISR CPE Use Case



Adding VNFs in the Cloud



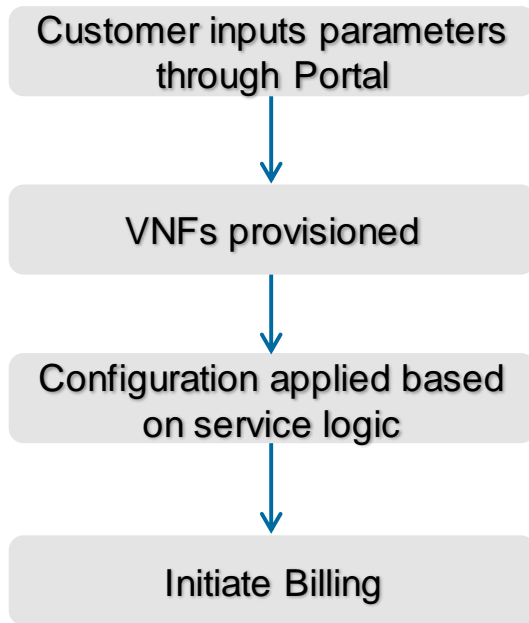
The Changing Landscape for SPs and Services – The Old



- Many steps to deploy service
- Multiple points of possible delays
- E2E delivery measured in weeks.....

The Changing Landscape for SPs and Services

– The New



- Customer inputs their parameters directly, validation done on input
- VMs deployed dynamically
- E2E delivery measured in minutes.....

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Summary

Summary

- Drivers for SP Edge Evolution
- Cisco Evolved Programmable Networks
- Virtualising Edge Network Functions
- NFV Orchestration

Key Takeaways

- SPs need to tackle opposing forces:
 - Need for CAPEX and OPEX reduction
- SP customer buying habits changing, require elastic services
- Evolution towards a unified MPLS Transport
- Flexible services placement enabled by EPN
- Network Function Virtualisation rapidly maturing
- Orchestration systems like Cisco ESP essential



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- dCloud Labs
- Meet the Expert 1:1 meetings

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