Network Functions Virtualization (NFV)

An Introduction

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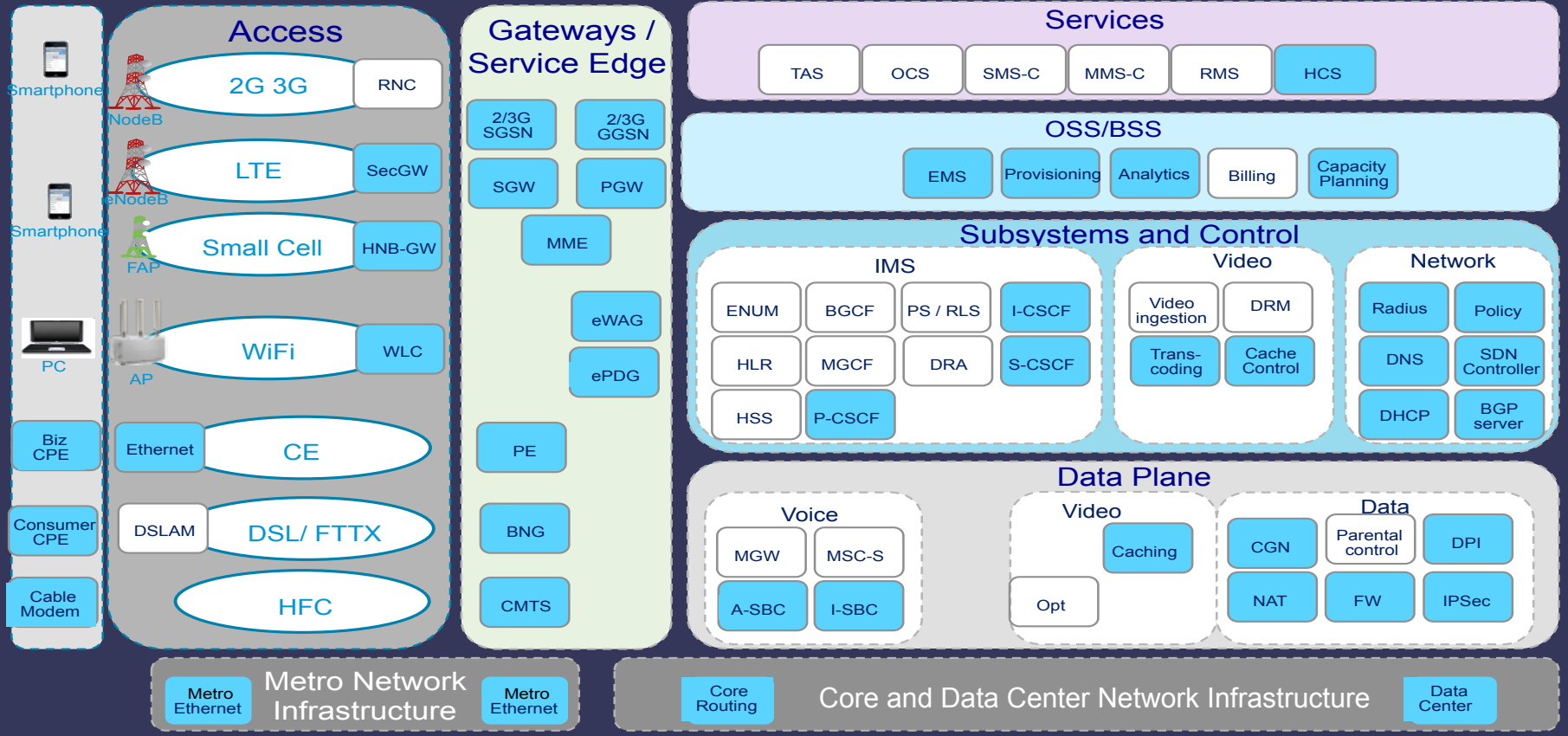
“Network Functions” in SP Network Architecture Landscape



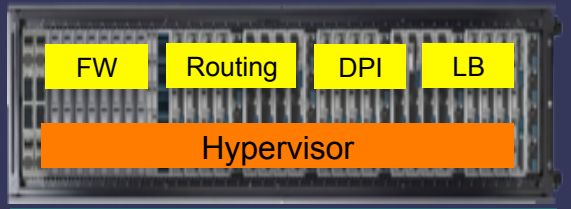
Virtualization of “Network Functions”

Existing Hardware / Appliance based Network Functions (NFs)

Step 1: Decouple software from underlying hardware

Step 2: Port it as a VM on x86 Server platform running as a Network Function

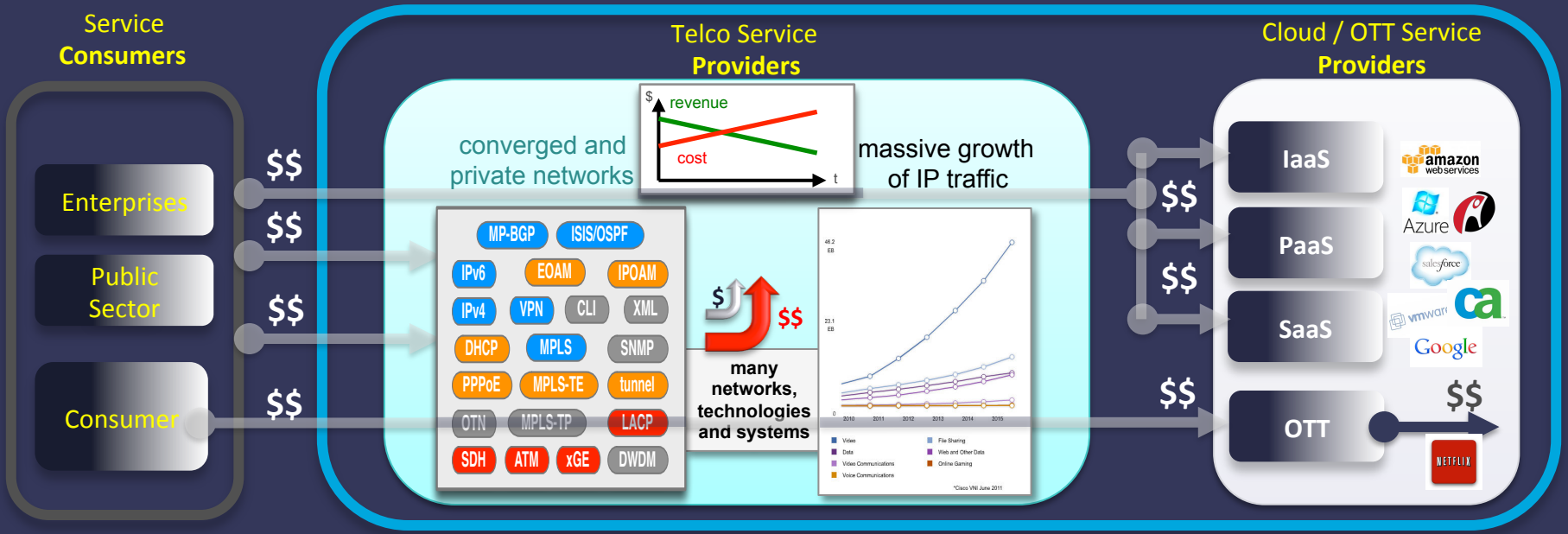
Virtualized NFs running as VM on x86 Server Platform



Ethernet Switches

Storage

Need to Understand SP Challenges to realize Why NFV



1. User Experience
2. Cloud Centric Consumption Models / Pay-as-you-go

1. Complex and silo'd networks
2. High cost to operate
3. Lack of agility, huge time required to create new services
4. Exponential growth of bandwidth

1. Lean & Agile OTT players with economies of scale
2. Highly-automated operations
3. Fast-paced innovation

SP’s Expectation from NFV

- NFV will help them to reduce cost (TCO)
- NFV will bring the much needed agility in the Service Creation & delivery process
- On-boarding a new service will be much easier with NFV
- SP’s can now afford to go wrong – decommissioning a failed service wont be expensive
- Services now can be scaled up and down elastically
- NFV will help drive more Openness and Standardization

Network Function Virtualization (NFV) Initiative

NFV = Transition of network infrastructure services to run on virtualised compute platforms – typically x86

- NFV – ***It is a Service Provider driven Initiative.***
  - Initiative announced at *"SDN and OpenFlow World Congress"*, Darmstadt, Oct 2012
  - Industry Specification Group (ISG) group within ETSI
  - Not defining standards -deliver white papers and liaising with standards bodies
  - First ETSI meeting was held in January, 2013
- Technically not related to SDN, conceptually different
  - But may utilize SDN concepts – Programmability, Orchestration
- Type of network function mostly determine where virtualization makes sense
  - Careful analysis is required on Network Function by Network Function

Key Factors To Determine Potential Virtualization Targets

1. Packet / Data Plane Performance Requirements
2. Control Plane Performance Requirements
3. Deviation from Standard Server build (e.g. interface type, density)
4. Economics of On-boarding if Virtualized
5. Power Efficiency requirement of the System
6. Development, Ease of Integration, Service Elasticity Needs

The Fundamental Electrical Building Blocks

General Purpose Processors (x86, ARM, PPC)

- Wide range of capabilities (including packet processing)
- Evolving multi-core capability (10+ processors per die)
- Support virtualization and easy to program

Network Processor Units (NPUs)

- Designed for flexible packet processing
- Multi-threaded (100s) / n/w acceleration / integrated memory
- Programmable in high level languages

Fixed function ASICs

- Very low cost
- Integrated s/w, very efficient but relatively inflexible

All based on CMOS technology – All subject to Moore's Law

Characteristics of Network Elements

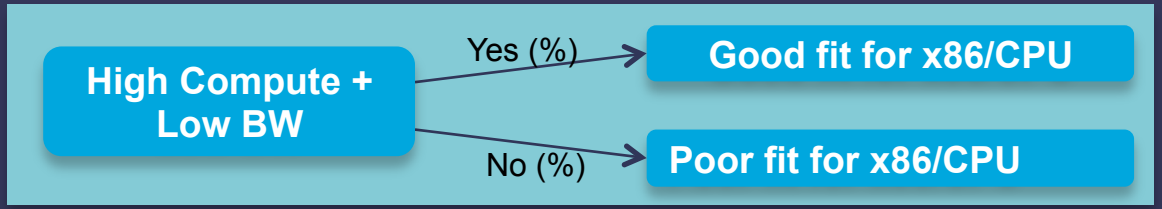
High Capacity Plumbing: (L0-3 : e.g. IPv4/v6, MPLS, VPNs, ACLs, optical devices …)

- High throughput / BW
- Many flows needing isolation, significant traffic management needed
- Stateless functions
- Mostly predictable traffic
- Interface-specific functions (2-stage forwarding)

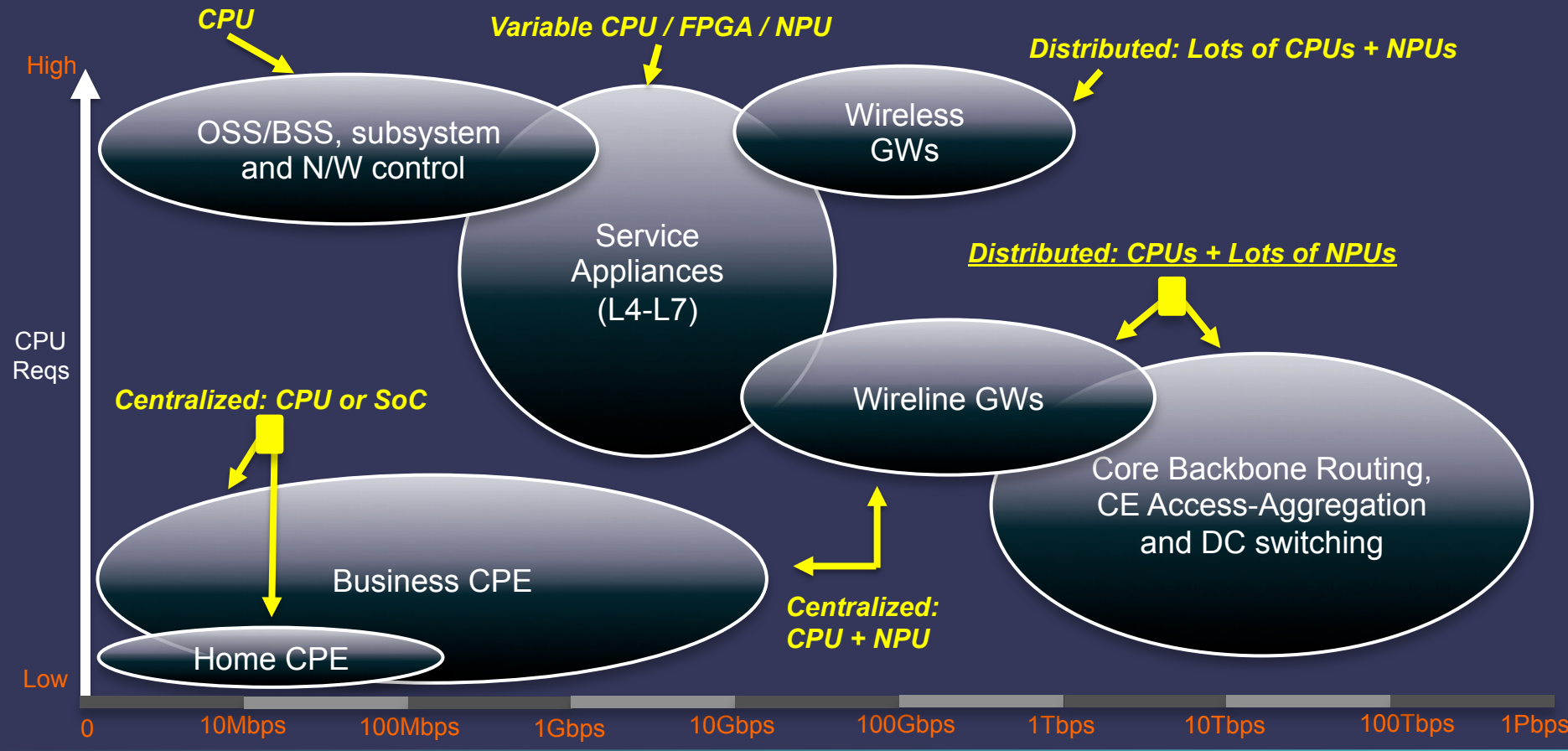
Low compute + High BW
➔ **Good fit for NPU**
➔ **Poor fit for x86/CPU**

Network Services: (L4+ : e.g. DPI, vFW, CGN, DDOS, BNG, mobility, …)

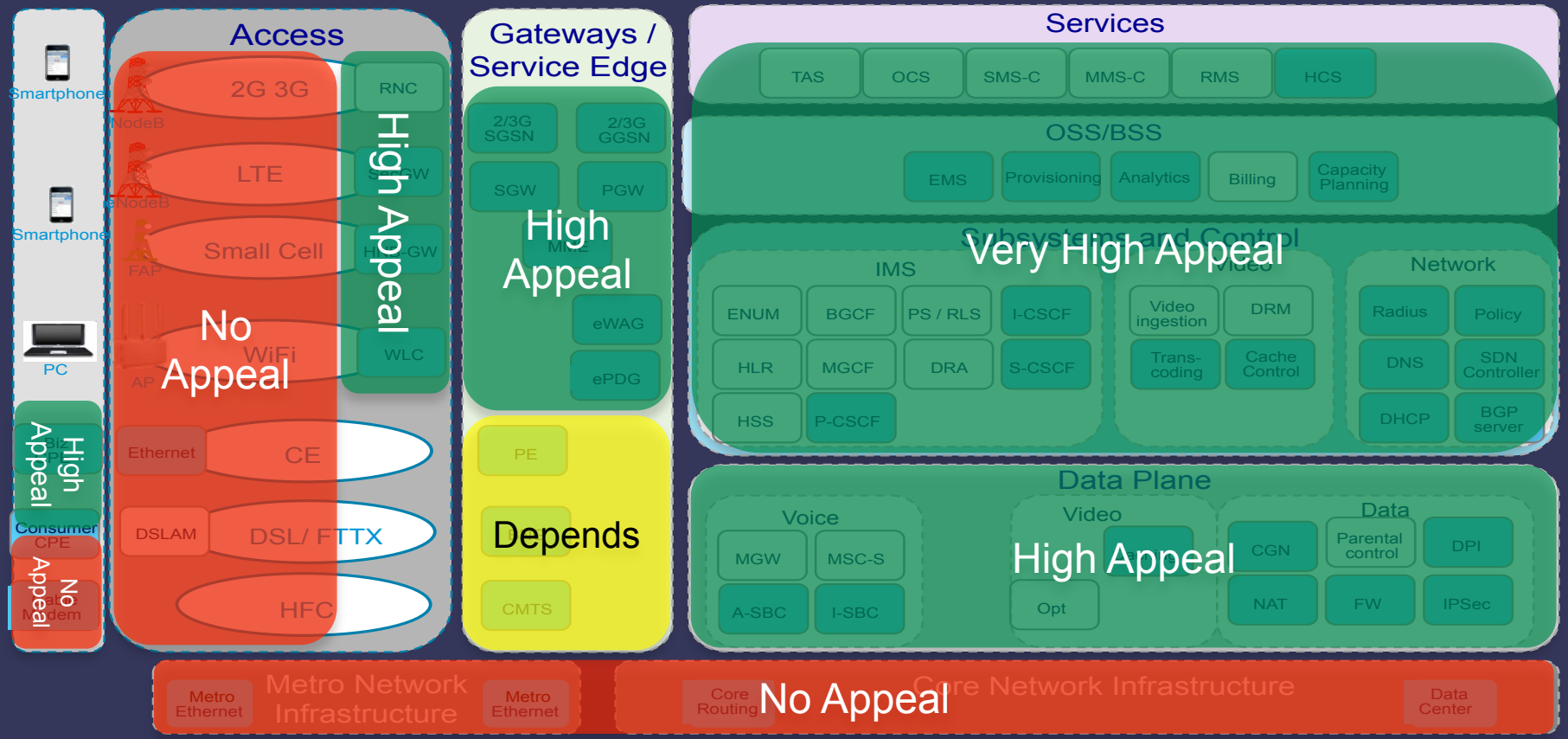
- Throughput - varies
- # of flows (traffic management) – varies
- Stateful functions
- Unpredictable traffic
- No i/f-specific functions



Network Functions – Requirements & today's approaches



Mapping Back to the Service Provider Landscape



The Role of SDN and Orchestration

Partial list, just a few main ones are mentioned here

VM / VNF Lifecycle Management in End-to-end manner

Network Plumbing to orchestrate dynamic topologies

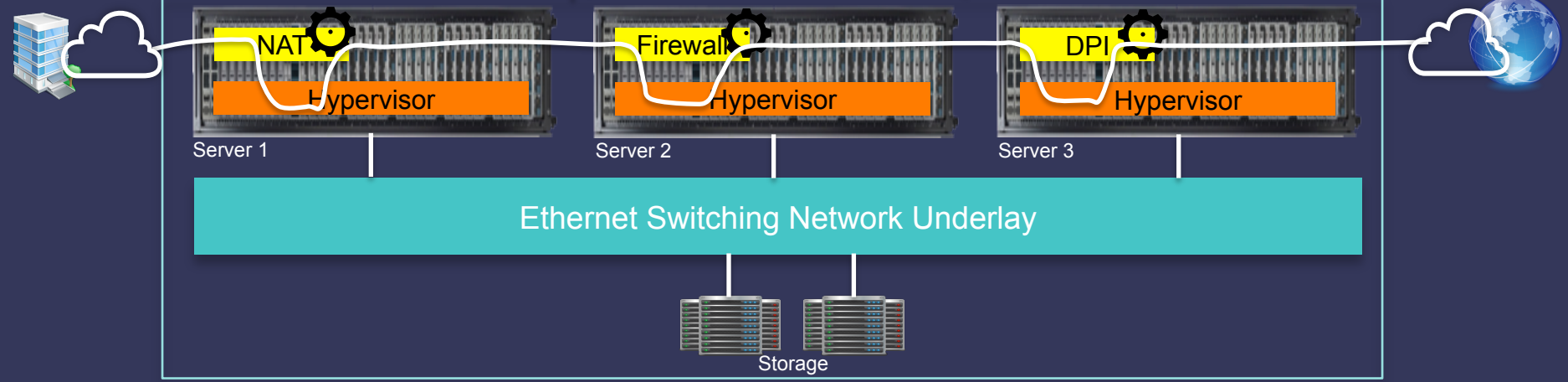
Configuration Management of the VNFs

Integration with Other DC/POD And the WAN

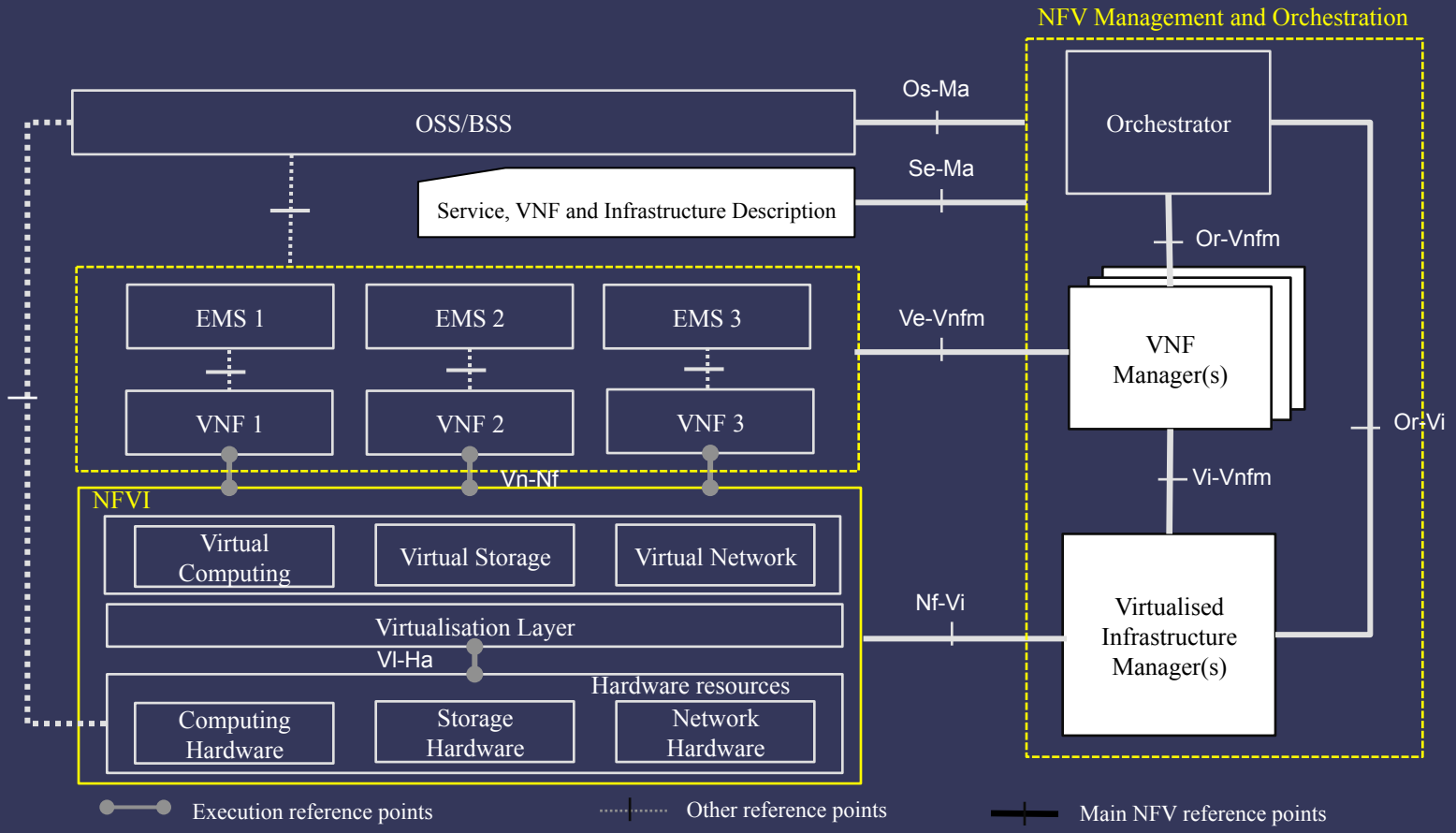
OAM, Assurance, Analytics

Orchestration and SDN Control Function

Standard APIs



NFV Reference Architecture from ETSI NFV ISG



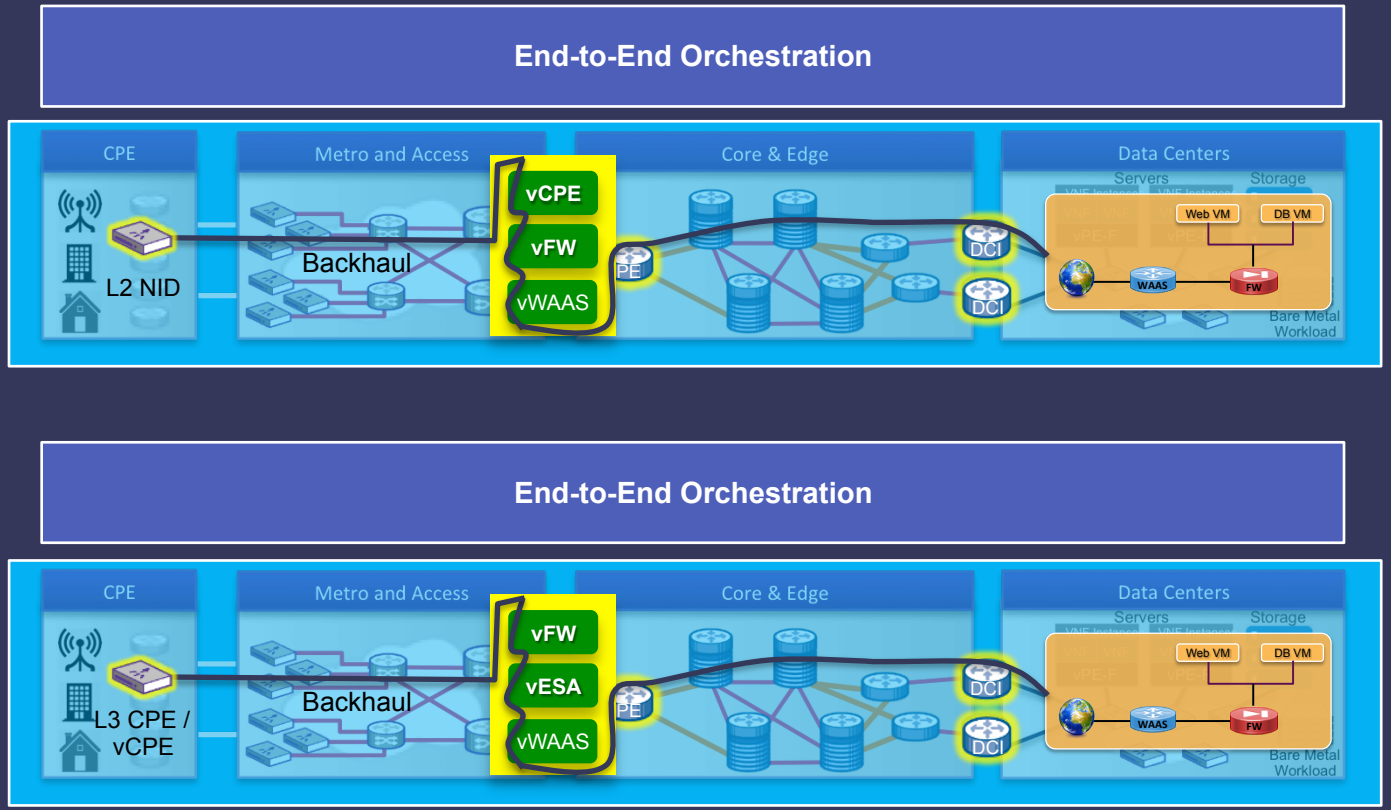
Major Service Providers Driving the ETSI NFV ISG

* Partial List

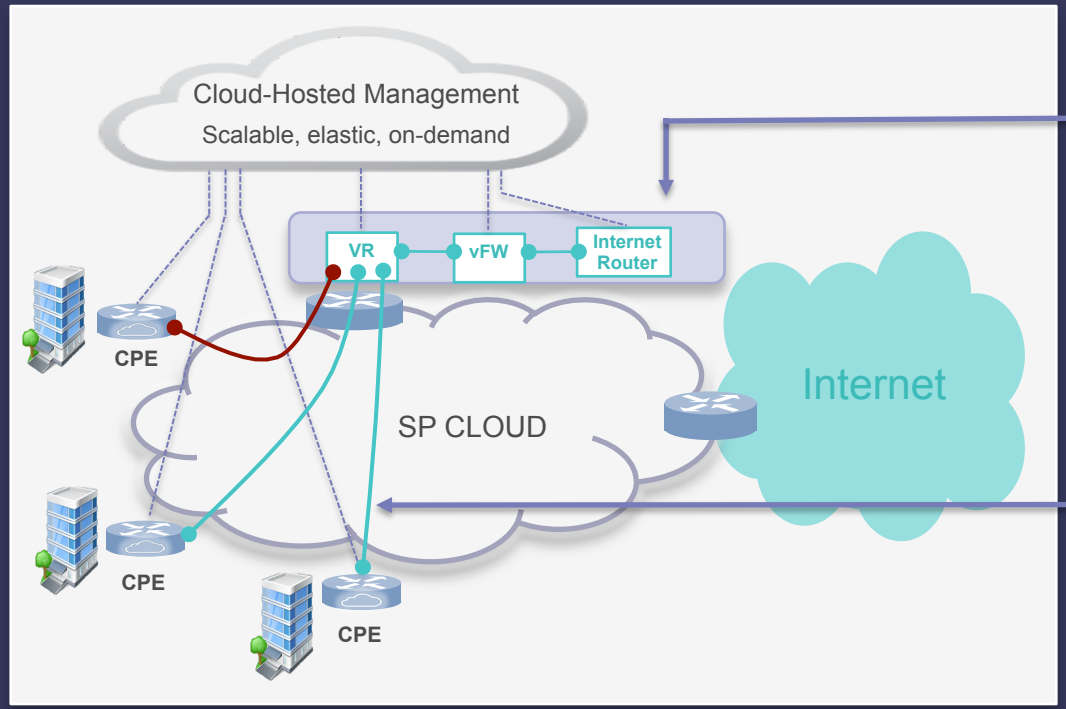
NFV Use Cases

- Simple ones – Virtualized Route Reflector
- Virtualized CPE for Business VPN services
- Virtualized Mobile Packet Core
- Virtualized Managed Services (CPE, FW, UTM…..)
- Virtualized Home CPEs
- Virtualized Gateways (BRAS, BNG, mobile gateways, Wi-Fi gateways)
- ….

Business VPN vCPE + Managed Service Chain



Business VPN CPE in a Overlay Transport Model



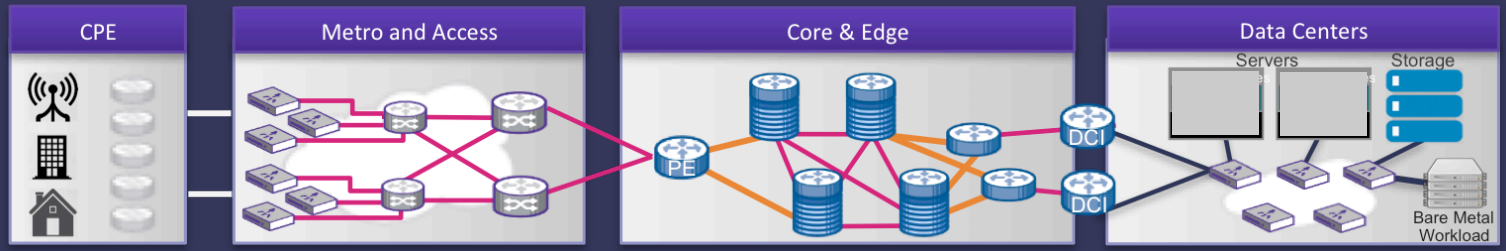
Cloud IPVPN with FW and Remote Access to Internet

- vFW with NAT and Policy
- vFW with IPSec/SSL Remote Access including Remote End-Host posture verification

Overlay Packet Tunnels

- Keyed IPv6 tunnels - mesh, hub&spoke;
- IPSec tunnels – mesh, hub&spoke if keyed IPv6 tunnels not supported;

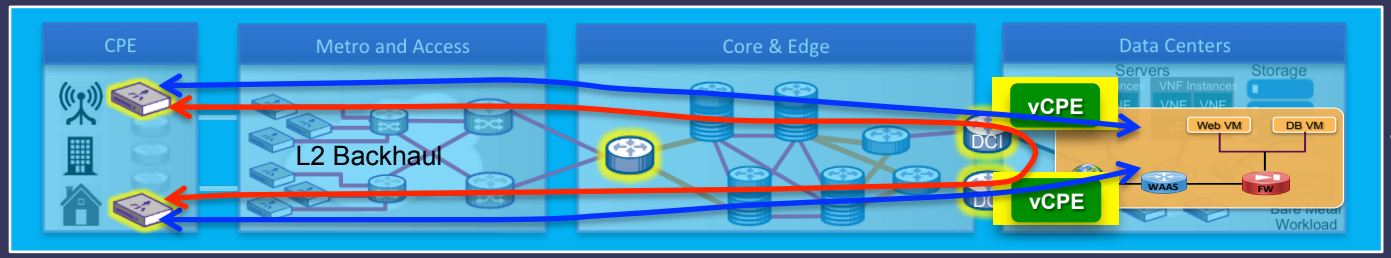
Where to Place the VNFs ?



- Candidate location types in the network –
  - Centralized Data Centers → Easier to manage
  - Fully Distributed – POP's, Edge / Anchor Points / Peering locations → Higher scale & performance
  - Hybrid – Mix of the above
- Some factors that may need to be considered here –
  - The Use Case to deploy the VNFs
  - Cost of transporting traffic across core
  - Network Architecture / design
  - Chance of Sub-optimal routing, impact on SLA (e.g. delay)
  - Management Ease vs. Scalability

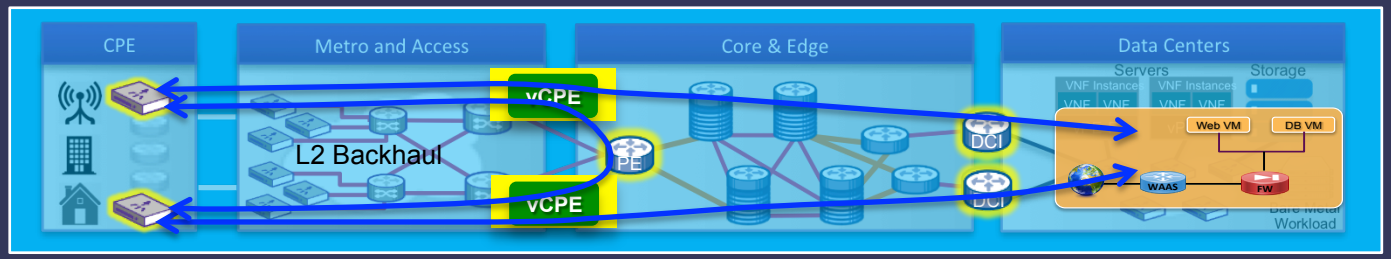
Use Case Example – vCPE for Business VPN

Centralized



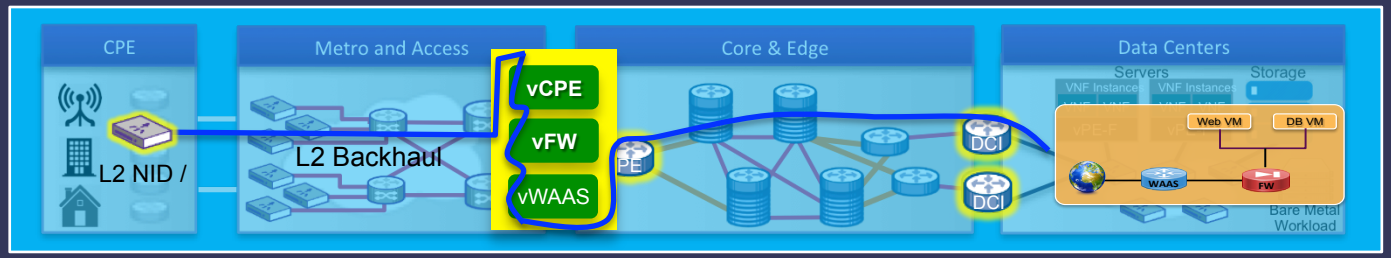
Higher Traffic Across Core
Sub-optimal routing
Higher e2e delay

Distributed



Better performance / scale
More Complex to manage

Distributed with Service Chain



Better performance / scale
More Complex to manage

NFV – How to build / Augment Operations skillsets

- Most existing technologies, protocols and associated skills is equally required
- On top of that, there is a need for acquisition of New Skills
  - x86 Server Virtualization
  - Virtualization on Linux (and KVM/QEMU) Environment
  - Cloud Orchestration System – OpenStack
  - Virtual Switches – OVS, Snabbswitch, Netmap/VALE, Vendor Specific
  - SDN Controllers – OpenDayLight, Vendor Specific
  - Device Programmability and APIs – NETCONF, Yang, RESTCONF, REST APIs, OF….
  - Service Function Chaining – specially NSH (Network Service Header)
  - Network based Virtual Overlay transport – VXLAN, MPLSoGRE/UDP, LISP, L2TPv3…..
  - Management, Orchestration, OSS Fundamentals
  - …..

Thank you.