NFV
– Myth, Hype & Reality

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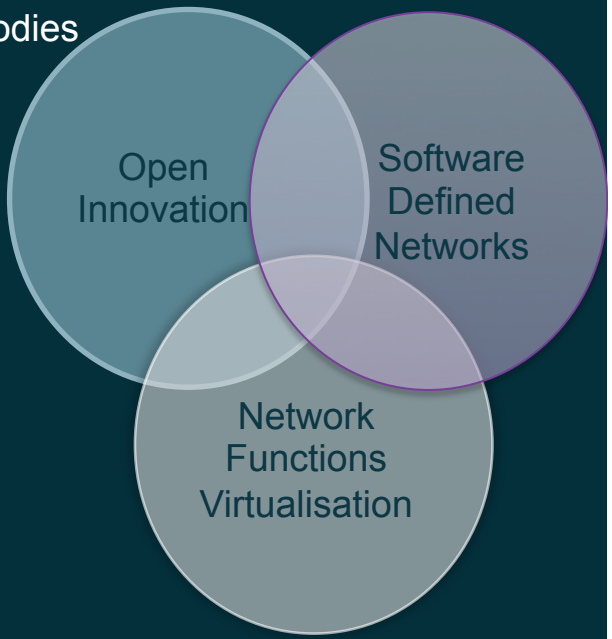
Agenda

- What is Network Functional Virtualization
- Components and challenges
- Use Cases

Network Function Virtualization

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

- NfV Initiative
  - Initiative announced at *"SDN and OpenFlow World Congress"*, Darmstadt, Oct 2012
  - Industry Specification Group (ISG) group within ETSI
  - Initiative should be a 2 year effort
  - Not defining standards -deliver white papers and liaising with standards bodies
  - First ETSI meeting was held in January'13
- Use of cloud technology to support network functions
  - Management, Control and Data plane components
- Not technically related to SDN
  - But may utilize SDN technology – APIs, Controllers
- Primarily an SP play today
  - Some interest from SP-like enterprises



Extract from "Network Functions Virtualisation – Introductory White Paper

Network Function Virtualisation
Terminology

- **NF: A Network Function (NF)** is a building block within an operator´s network infrastructure, which has well defined external interfaces and a well defined functional behaviour. In practical terms a Network Function is today often a network node
- **VNF: A Virtual Network Function (VNF)** provides exactly the same functional behaviour and interfaces as the equivalent Network Function, but is deployed in a **virtualised** environment
- **NFVI: The NFV-Infrastructure (NFVI)** is the totality of all hardware and software components which build up the environment in which VNF are deployed, managed and executed
- **NFVO: The NFV-Orchestrator (NFVO)** is a software to operate, manage and automate the distributed NFV Infrastructure. The Orchestrator has control and visibility of all VNF running inside the NFV-Infra

Network Function Virtualisation
Enablers, benefits and applications

- Enablers
  - Hypervisor and cloud computing technologies
  - Improving x86 h/w performance and scaling
  - Optimised packet processing SDKs and coding techniques, e.g. DPDK, Vector Processing
  - Network industry standardising on Ethernet
  - Network automation / orchestration
- Value Proposition
  - Reduction in CAPEX and OPEX
  - Faster service provisioning
  - Service agility
- Applications
  - Network Components
  - Network Services
  - Network Control Elements

Myth and Hype

- NFV removes the need for ‘Big Iron’ network devices
- Anything a physical network device can do, a VNF can do
- Just remove your physical device and replace with X86 + VNF
- Management is so much easier!

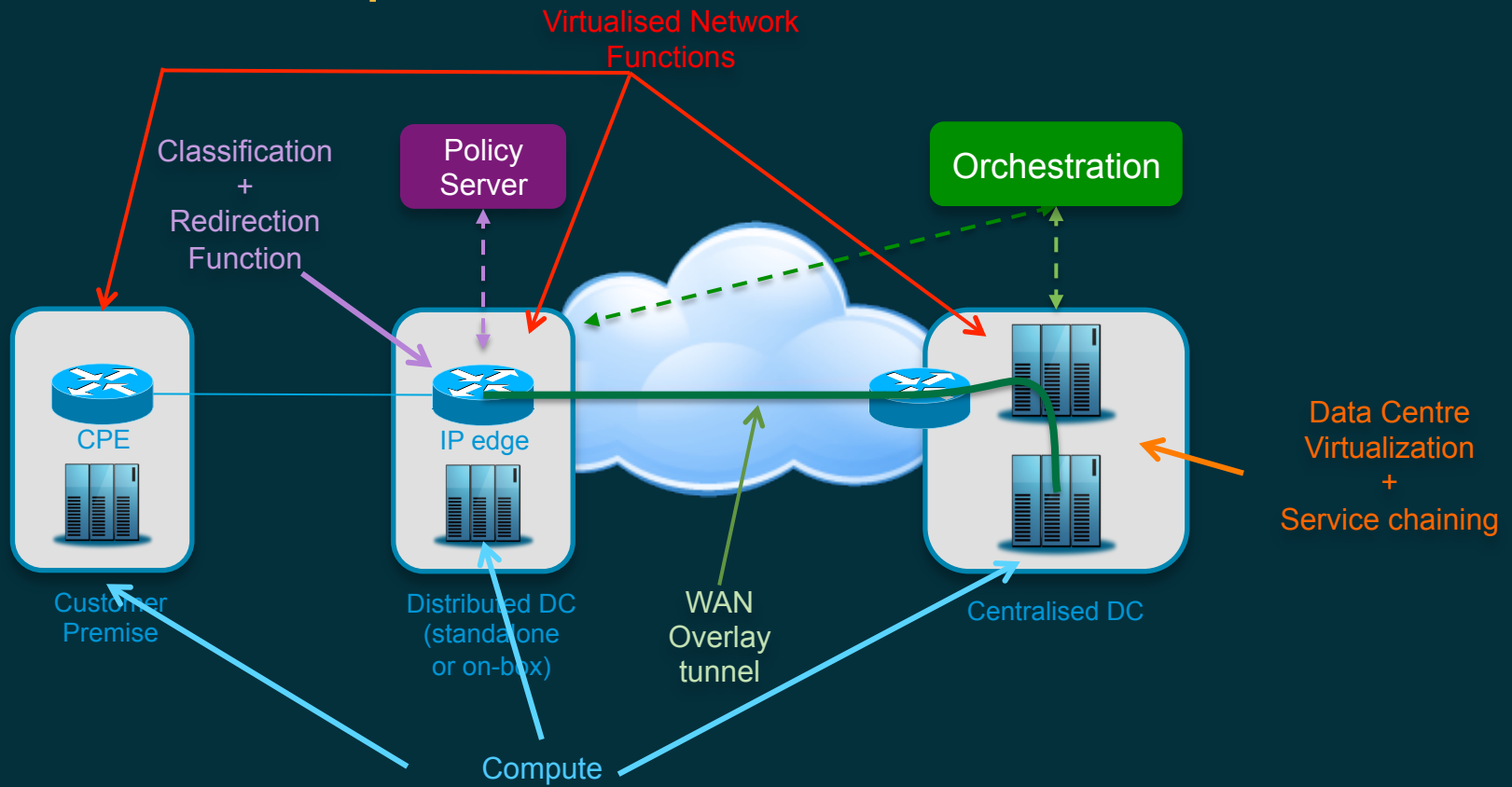
Reality?

If only it were that simple…

Components & challenges

More than simply virtualizing everything

Network Function Virtualization
Architectural Components



Required components and location of components will vary by use

- All use cases result in => Compute + VNFs + DC virtualization + Orchestration
- Re-direction use cases => Policy Server + WAN Overlay

Network Function Virtualization
The challenge

- Centralised vs. Distributed… Scale vs Management complexity
  - Centralized services – can run in centralised data centres – does it scale?
  - Distributed services – need to be distributed further out in the network – what is the management overhead?
- Control/Management plane vs. Data/User plane services
  - Control Plane Services – deal with signalling and management
    - Examples include DNS, OSS, DHCP, Route Reflector
  - Data Plane Services – forwarding/manipulation of user packets
    - Examples include DPI, NAT, CGN, BRAS, GiLAN services
- Redirected traffic vs. routed traffic service –> how the traffic gets to the service?
  - Redirected – a network device identifies a flow(s) and redirects it from its normal path
  - Routed – the traffic will naturally routed through the service

Virtual Network Function (VNF)
Criteria for evaluating virtualization

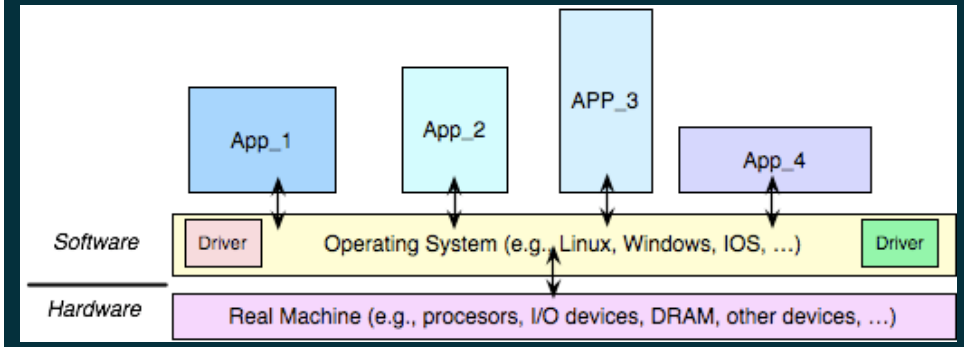
- VNF Definition : Provides exactly the same functional behaviour and interfaces as the equivalent Network Function, but is deployed in a virtualised environment
- Service Evaluation criterion:
  - Packet Performance
  - Infrastructure versus service
  - Deviation from ‘standard’ server builds
  - Economics / practicality of on-boarding service

Basic characteristics of processing devices

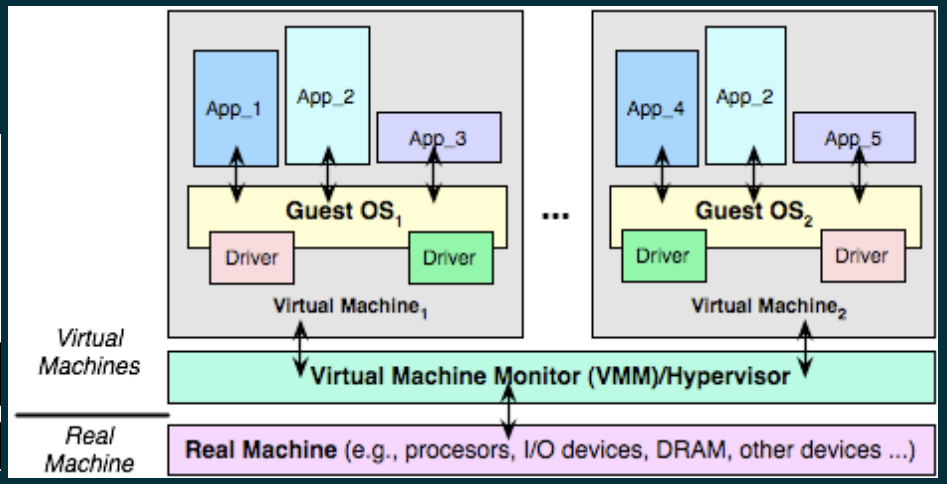
Characteristic	General Purpose CPU	Custom ASIC / NPU
Throughput (BW)	Low	High (10x)
Performance (pps)	Low	High (10x)
Power efficiency (Gbps/W)	Low	High
Integration	Low	High
Flexibility	High	Medium
System development cost & time	Low	High

General Virtual Machine Model

Bare Metal



Virtual Machine



- NFV Group looking for maximum flexibility
- **Compute Technology**
  - Hypervisor and 'Generic' Virtual Machines preferred – avoid custom device drivers
  - Bare metal acceptable – needed for performance reasons
- **NIC Mapping**
  - Major bottleneck for packet performance therefore focus of research
    - Pass-through and SR-IOV technologies

Characteristics of Network Elements

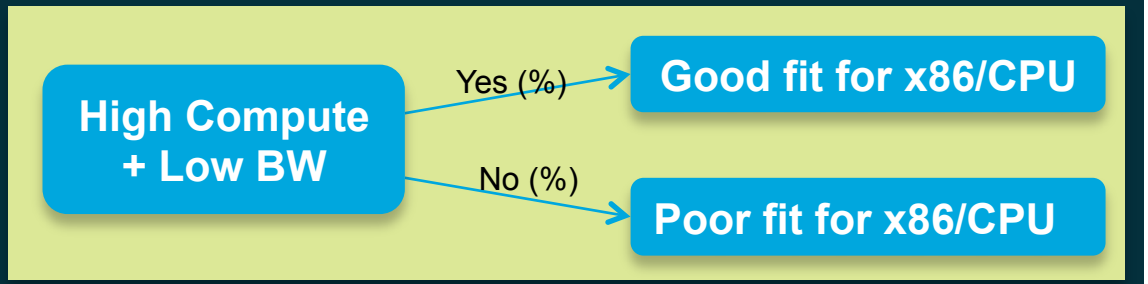
High Capacity Plumbing: (L0-3 : e.g. IPv4/v6, MPLS, VPNs, ACLs, optical)

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

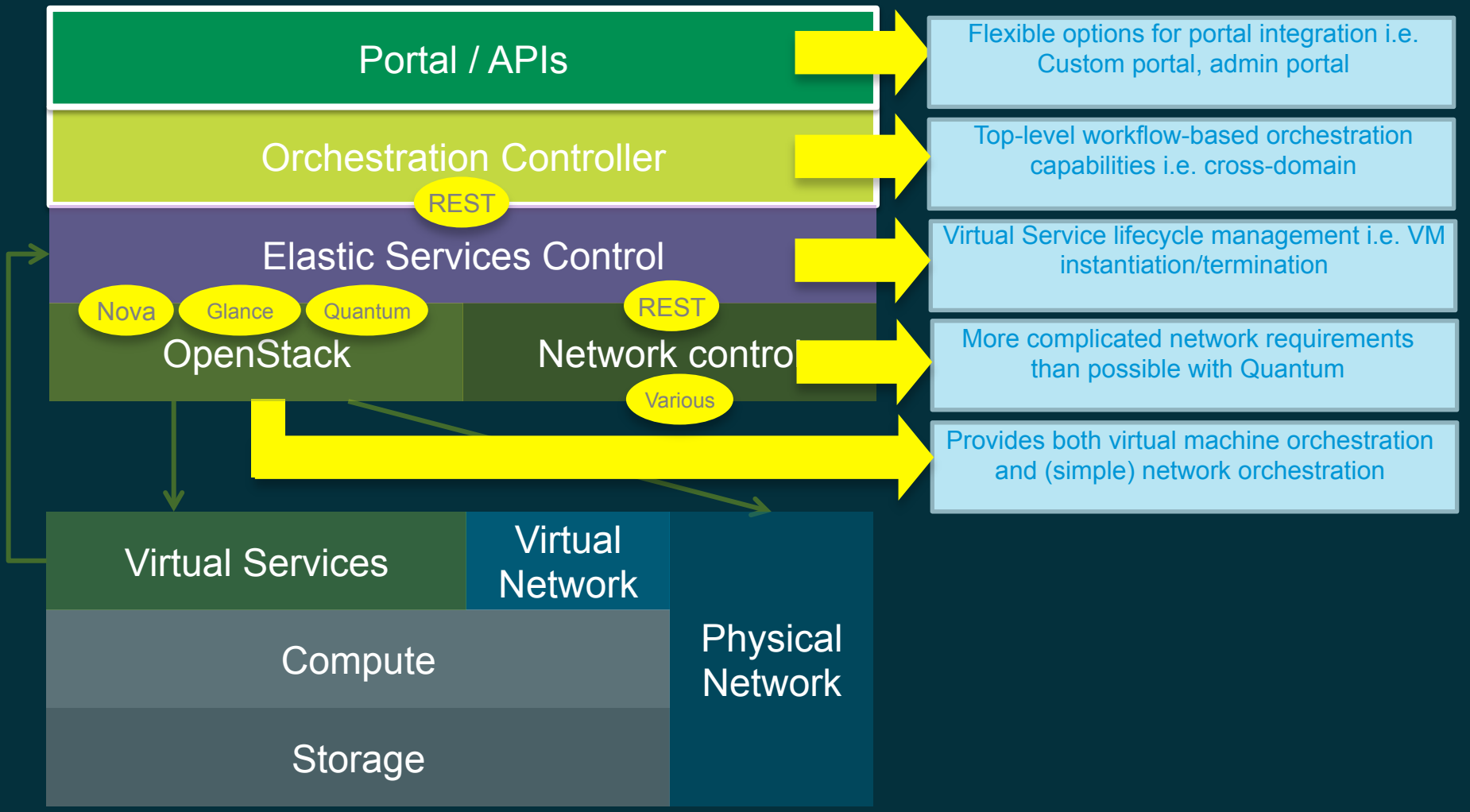
Low compute + High BW
➔ Good fit for NPU
➔ Poor fit for x86/CPU

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

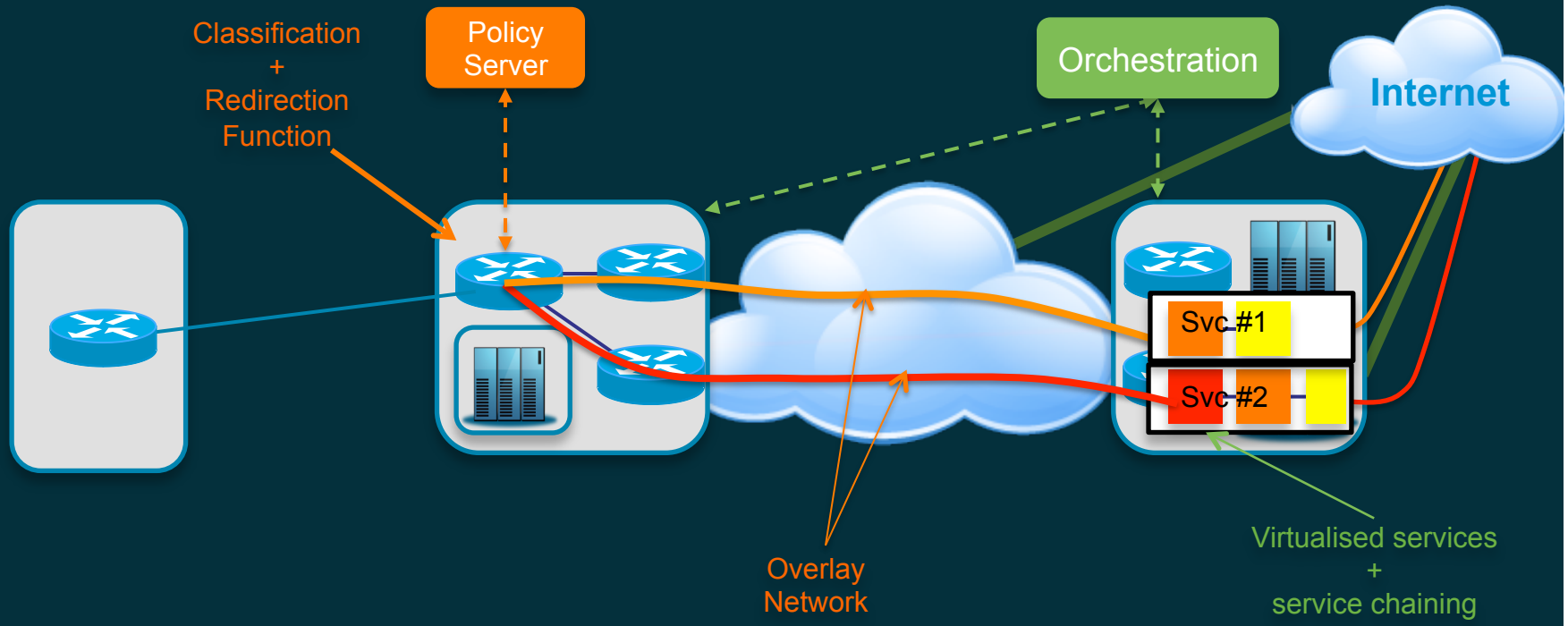
- Variable throughput
- Variable # of flows (traffic management)
- Stateful functions
- No interface-specific functions



Network Function Virtualization
NfV Orchestration

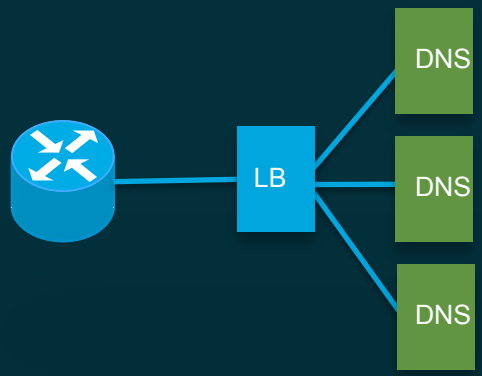


Service Redirector and Policy Server
Overall concept

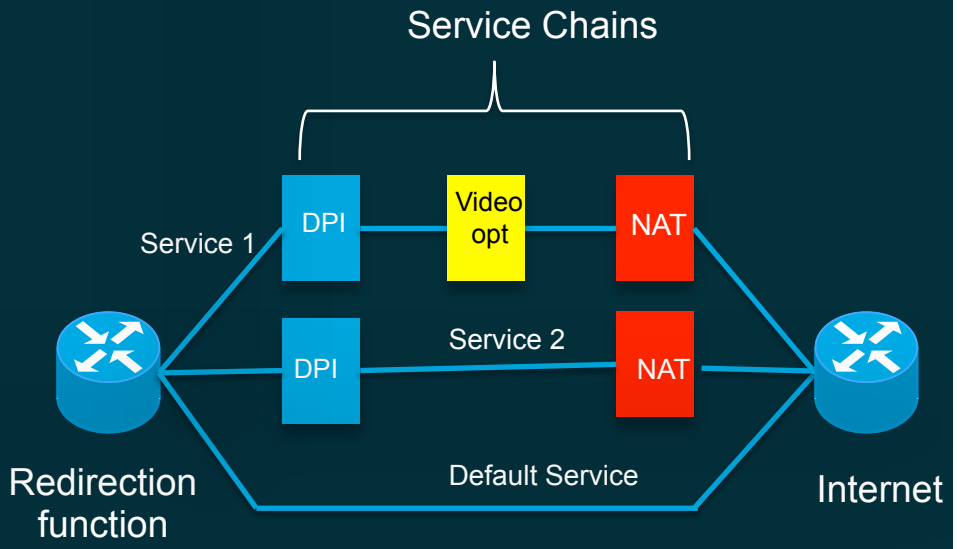


- Redirector overrides the default packet forwarding to re-directing user traffic to a services infrastructure
  - Typically lives close to the IP edge of the network, e.g. PE, BNG, P-GW, CMTs
- Under control of customer-aware policy function
- Primarily required for data plane services

Service Chaining and Virtual Network Overlays
Service Chain Definition



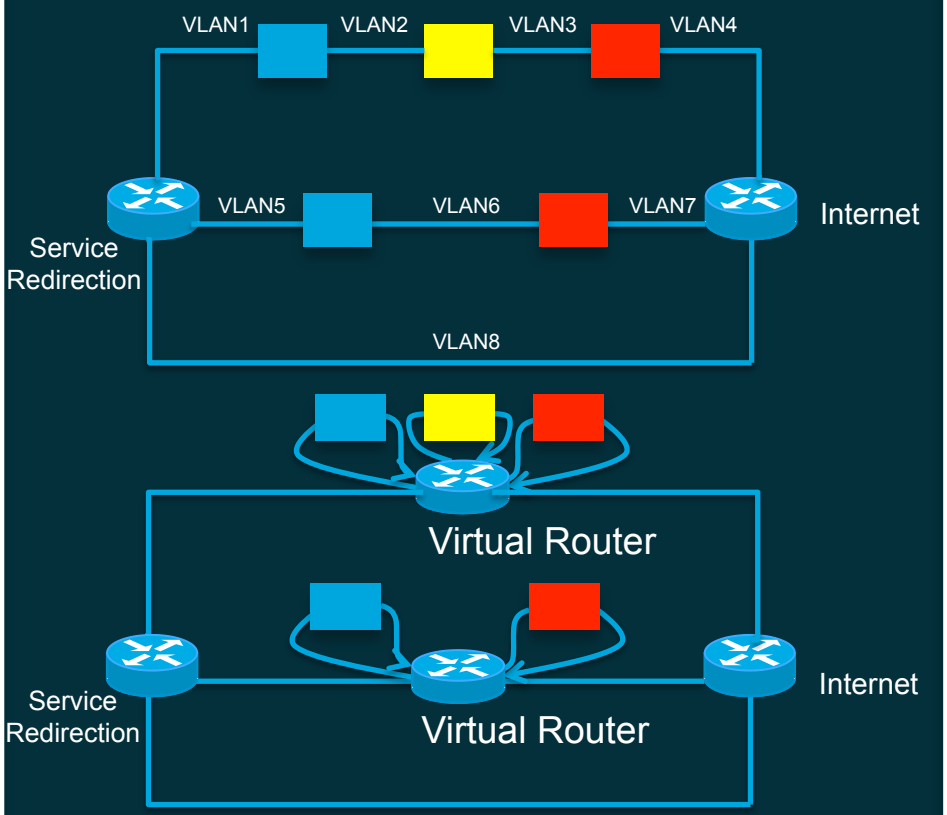
Simple Service Chains



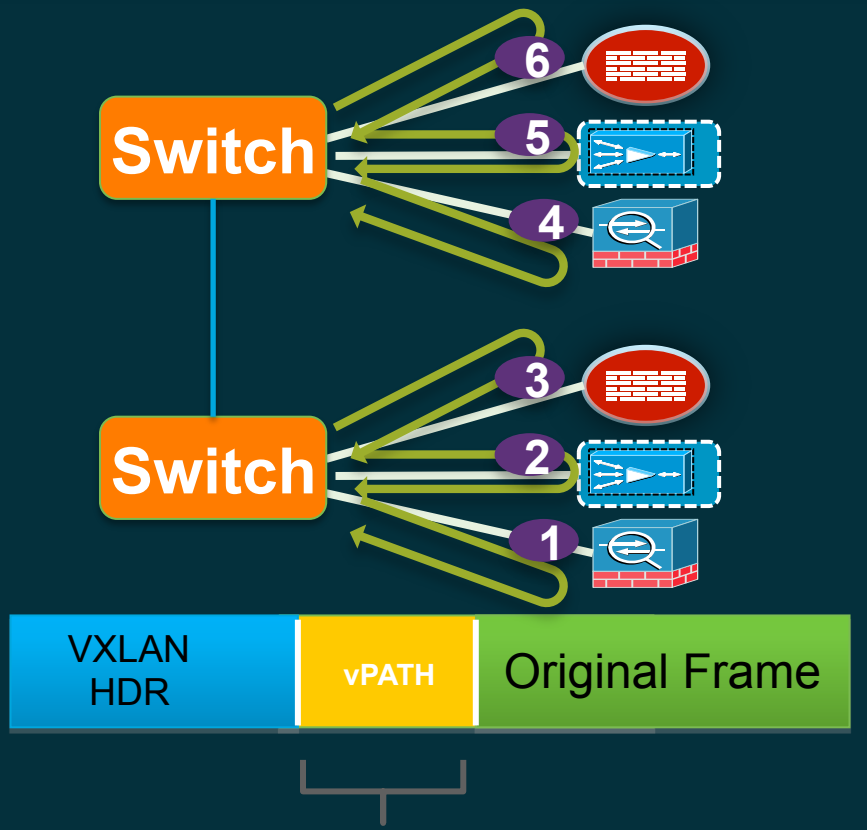
Complex Services and Service Chains

- How to steer traffic through a one or more service entities composed at SW speed?
  - Critical for non-routed data plane services
  - Important for control plane services
- Physical service path or carried in packet metadata?

Service Chaining and Virtual Network Overlays
Service Chain Technology



- Service ordering determined by n/w structure



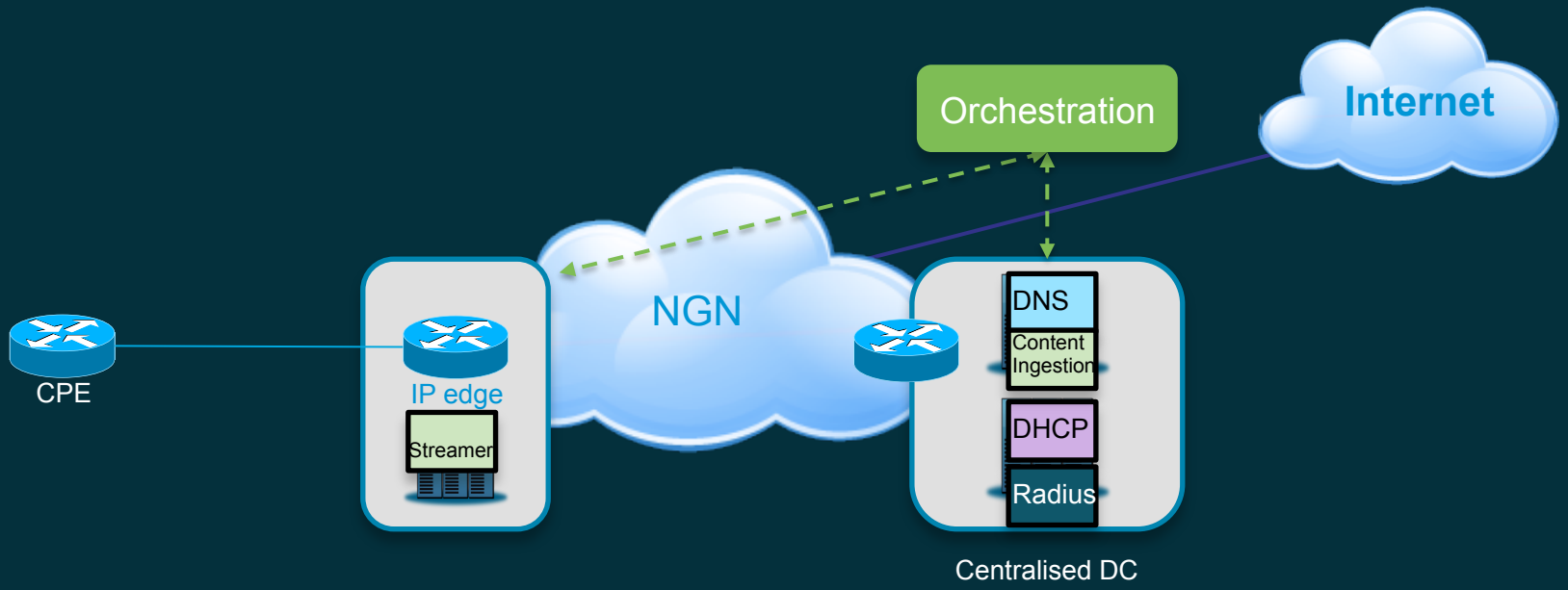
- Service ordering by info in user packet

NfV High Level Use Cases

Use Cases

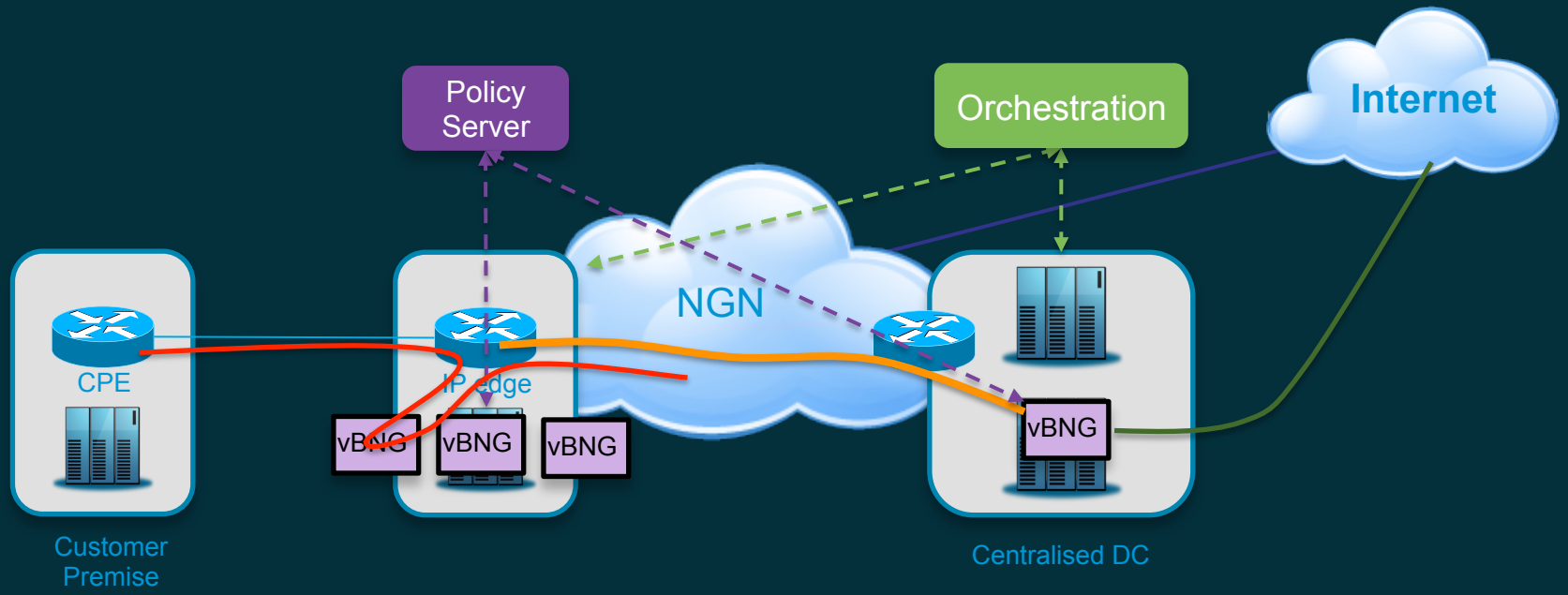
- Virtualized SP and 3rd party applications / appliances
- Virtualized gateways (PE, P-GW, BNG)
- Virtualized Mobile Services infrastructure

NfV use case:
Virtualized SP and 3rd Party applications / appliances



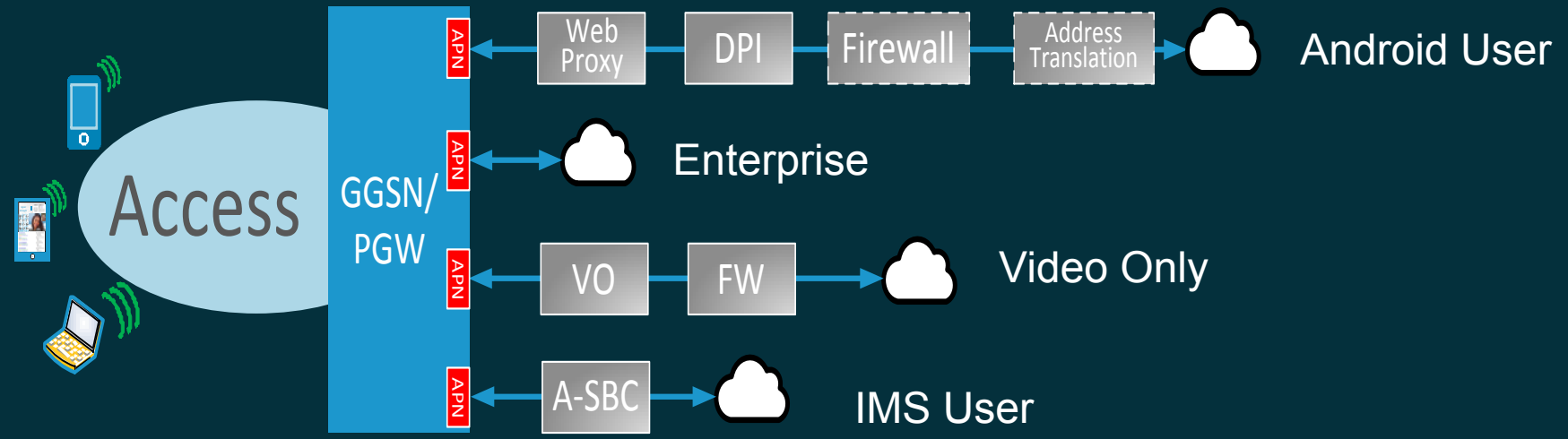
- SP **infrastructure** applications running on virtualized compute resources
  - Centralised or distributed
- Examples:
  - BGP Route-reflectors, Radius servers, Policy servers, DHCP servers, DNS, OSS / BSS, IMS subsystem components..
- Third party applications: Third party CDN and caching capabilities
- Very popular concept, already deployed by many SPs

NfV use case:
Virtualized Edge Gateways



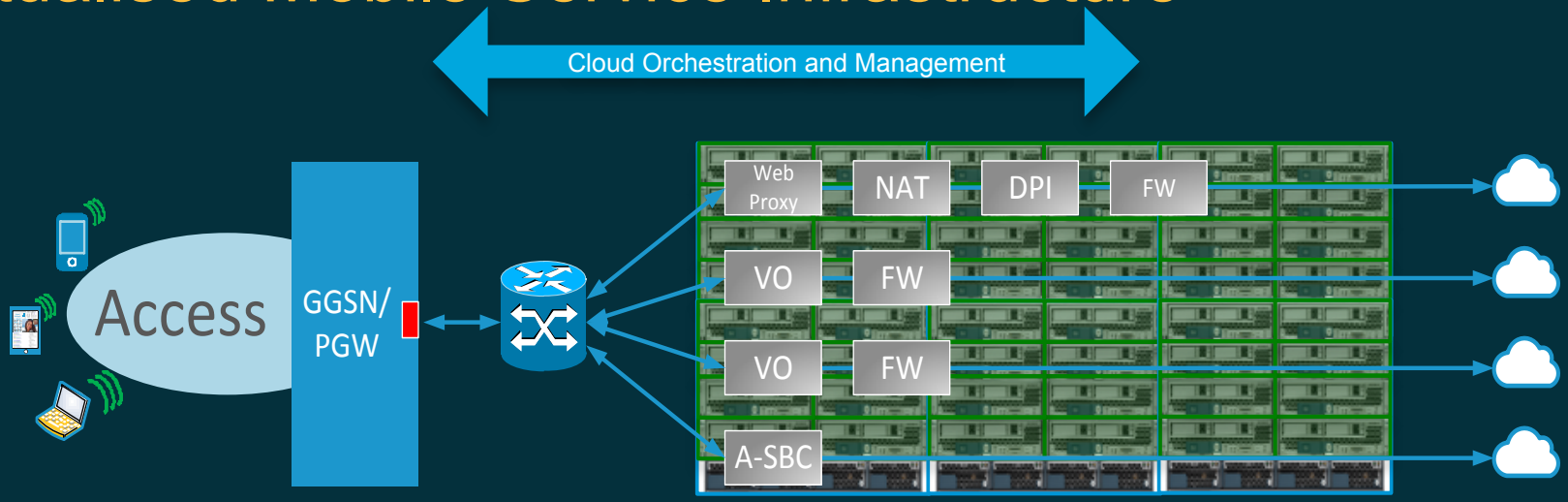
- Replacement of real IP Edge device with code executing on virtualized x86 platform
  - Examples BNG, CMTS, Mobile components…
- Two vBNG examples shown, many potential variations on theme
- Cost vs complexity
- Management scale challenge vs single-point of control

NfV use case:
Mobile Services Infrastructure



- Physical Appliances are complex to design because of mismatched capacities, diverse resiliency strategies, incompatible networking
- Re-configuration (adding capacity or adding an appliance) is also difficult
- No agility because the service chains are “hard-wired” to the APN and there is no programmability; reconfiguration requires manual operations

NfV use case:
Virtualised Mobile Service Infrastructure



- Simple reconfiguration of service chains via SDN and virtualization tools
  - ➔ better vertical scaling
  - ➔ horizontal scaling (adjusting capacity)
- Simplified cost model based on subscriber count + base cost of commodity hardware
- Need better solutions for fault tolerance and high availability based on hypervisor tools!

Summary

Network Function Virtualization
Research ideas

- Real performance of x86 running a full WAN routing/switching function
  - Large tables, ACL, QoS, policing
  - PPS, packet delay, packet loss under x86 and various hypervisors
- Impact and performance of hypervisors for applications
  - Low latency packet services
  - CPU QoS – not just packet QOS
- Orchestration techniques for NFV – absolutely key!
- What is the impact of NFV on n/w design?
- What are the real economics of NFV?

Network Function Virtualization

- Movement of Network functions to the cloud has significant potential
  - Control, services and data plane components
- NFV is not applicable to all network applications
  - Service functions ✔
  - High performance forwarding ✗
- NFV is an architecture rather than simply virtualizing functions

Thank you.