Network Function Virtualization

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Why Cloud Networking Matters

The first light bulb was invented in 1879 marking the dawn of the electric era.

But making your own power was expensive and limited.

It was not until the power grid was established that electricity was broadly used.

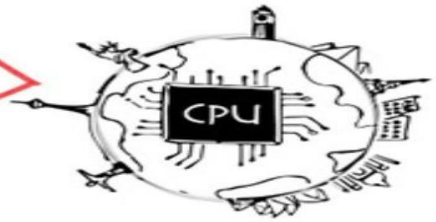
A similar thing happened with the telephone, which was invented in 1876.

For years, all calls had to be directly connected, which limited expansion and utility.

Worldwide phone systems and auto switching made broad telephony a reality.

Virtualized computing is going through a similar evolution. It's been around for a while but its utility was limited in scope and available to large organizations.

Cloud networking makes this computing capability available to everyone. We think the benefits will be profound!



What is NFV?

- **Network Functions Virtualization** (NFV) is a network architecture concept that proposes using IT virtualization related technologies to virtualize entire classes of network node functions into building blocks that may be connected or chained together to create communication services.

- Specification comes from ETSI that stands for European Telecommunications Standards Institute.

Objective of NFV

Classical Network Appliance Approach


Message Router


CDN


Session Border Controller


WAN Acceleration


DPI


Firewall


Carrier Grade NAT


Tester/QoE monitor


SGSN/GGSN

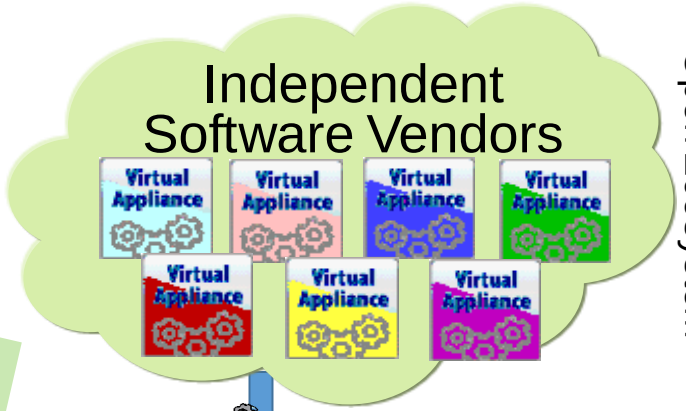

PE Router


BRAS


Radio/Fixed Access Network Nodes

- Fragmented, purpose-built hardware.
- Physical install per appliance per site.
- Hardware development large barrier to entry for new vendors, constraining innovation & competition.

Network Functions Virtualisation Approach



Competitive & Innovative Open Ecosystem


Orchestrated, automatic & remote install.


High volume standard servers


High volume standard storage


High volume Ethernet switches

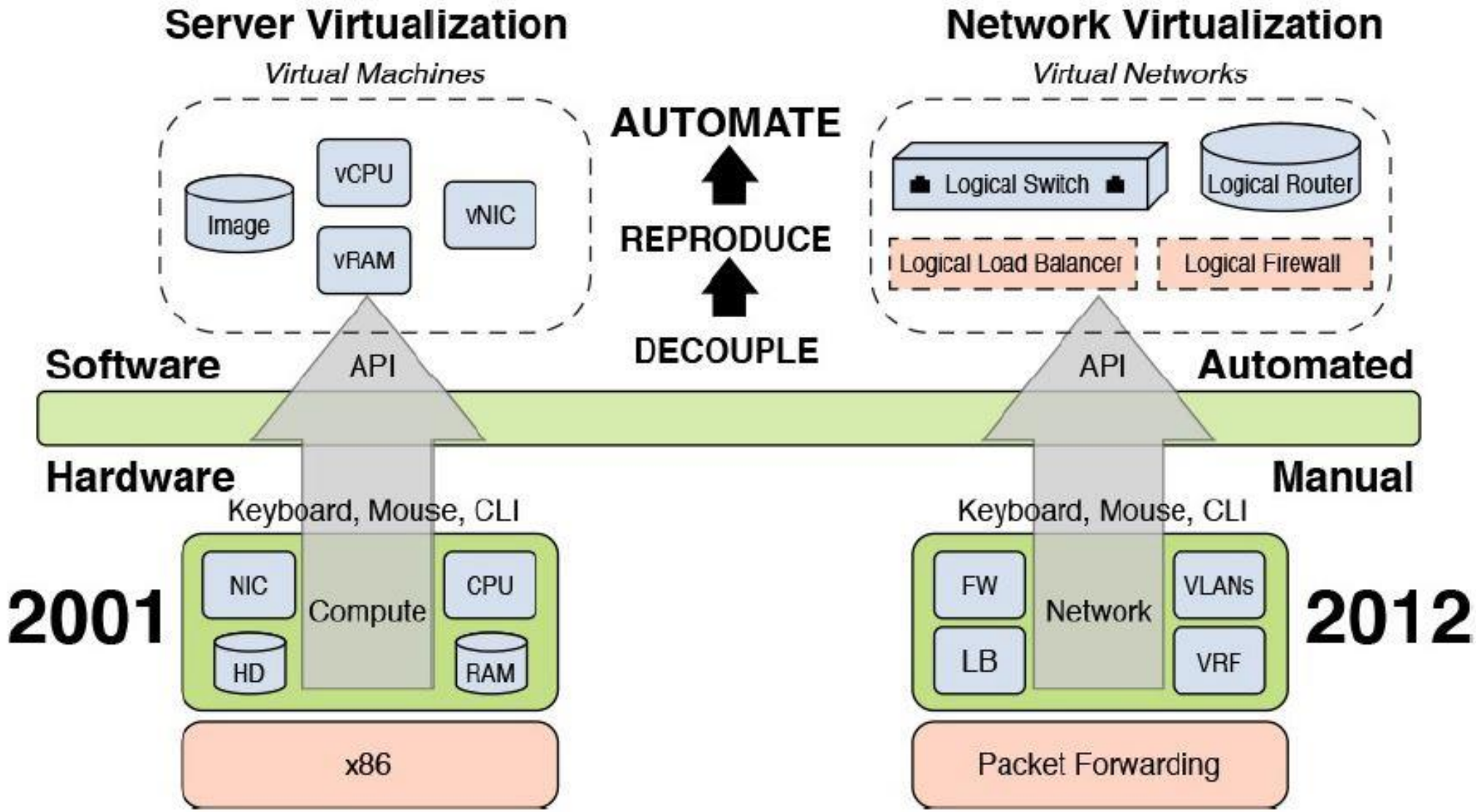
Anticipated Benefits of NFV

Architecture | CAPEX | OPEX

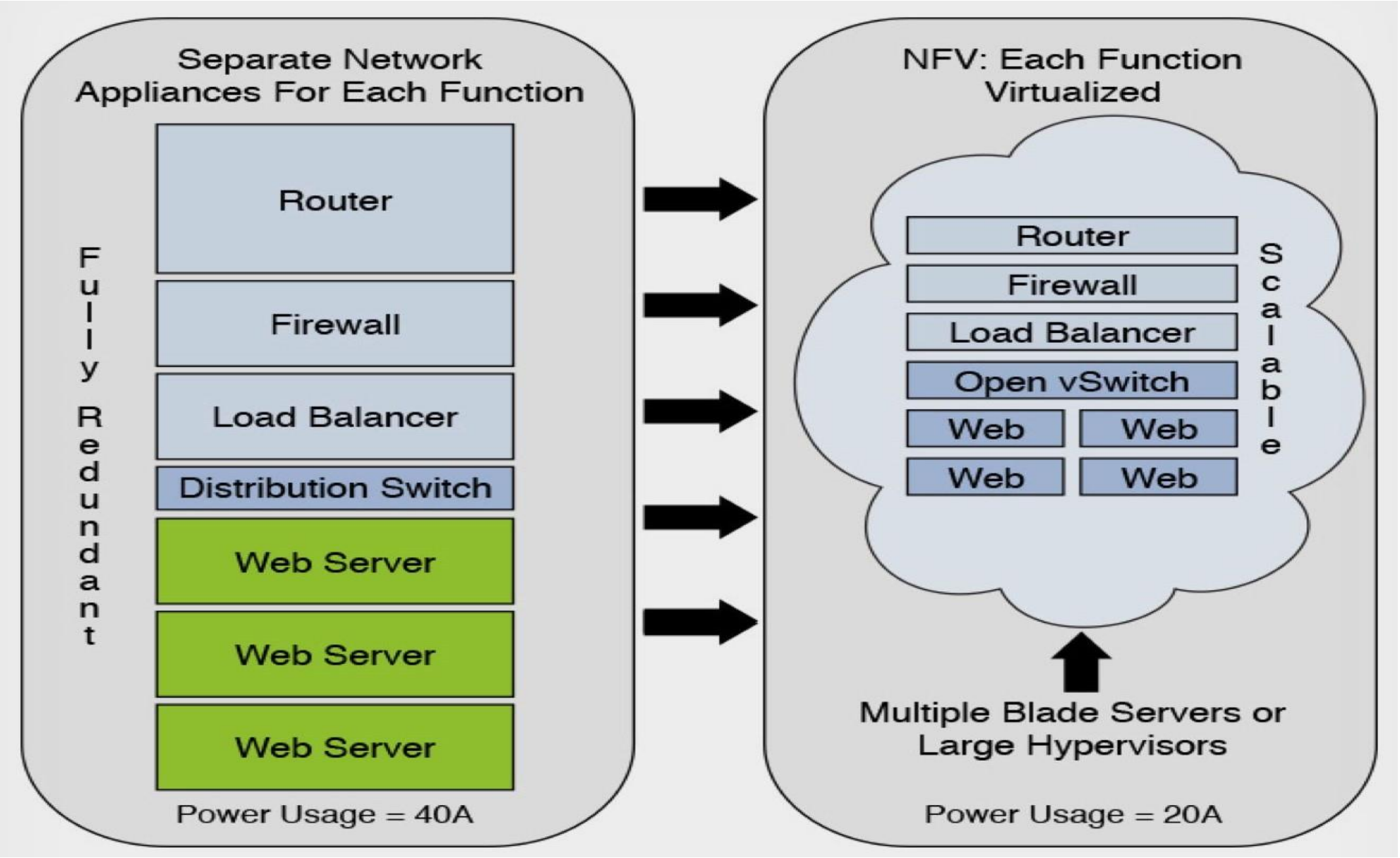
- **Architecture**
  - Reduced number of physical network elements to manage and deploy,
  - Service elasticity, agility (increased time to market)
- **Capital Expenses (CAPEX)**
  - Standard x86-based servers considered cheaper than routers/appliances,
  - Economies of scale (better resource utilization in large DCs)
- **Operating Expenses (OPEX)**
  - Automated network operations: reduces management requirements, branch visits
  - Reduced expenses such as power due to consolidation, efficiency

Adapted from: Network Functions Virtualization - Everything Old Is New Again. F5 White Paper. August 2013

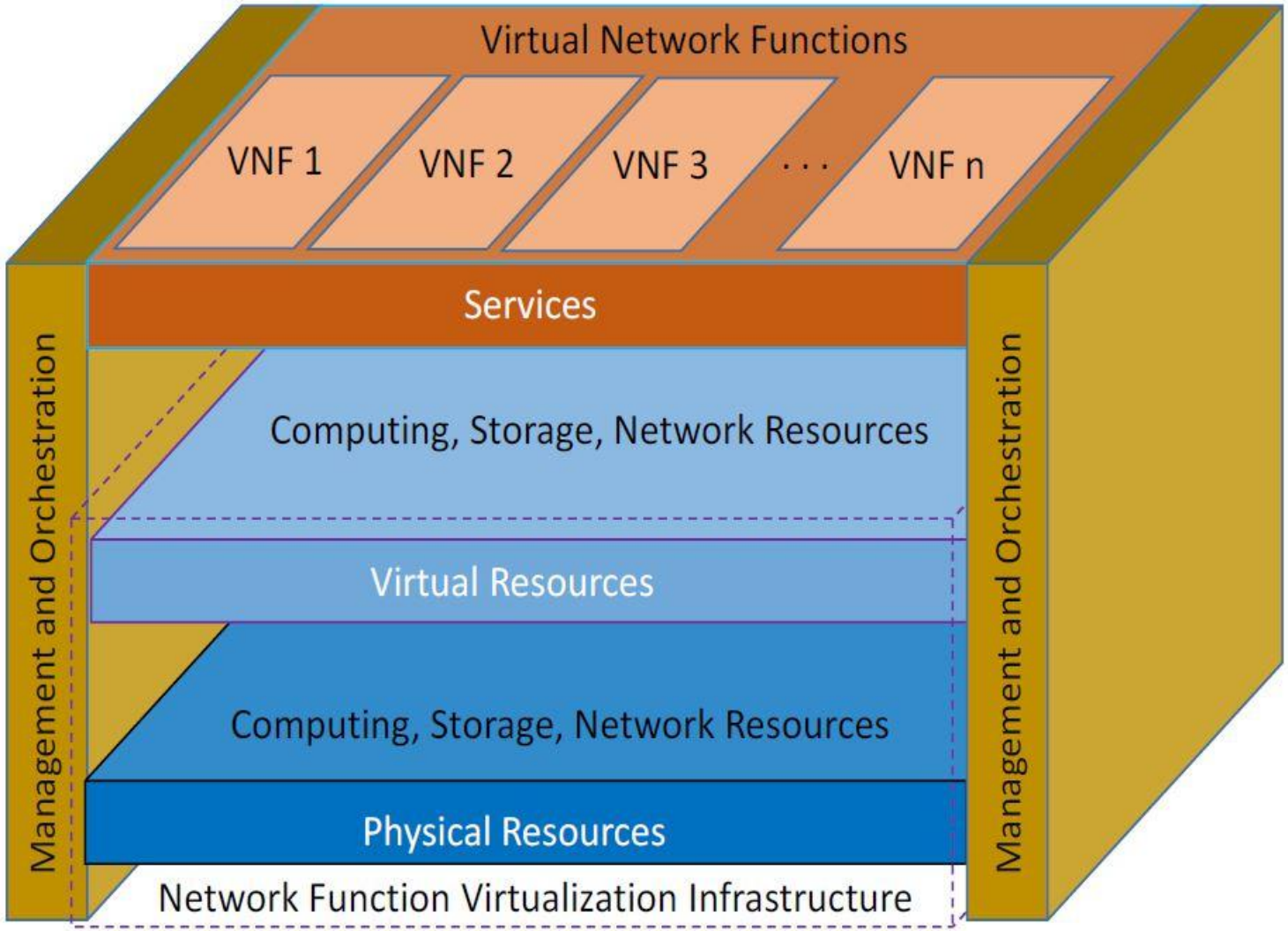
Server Virtualization vs Network Virtualization



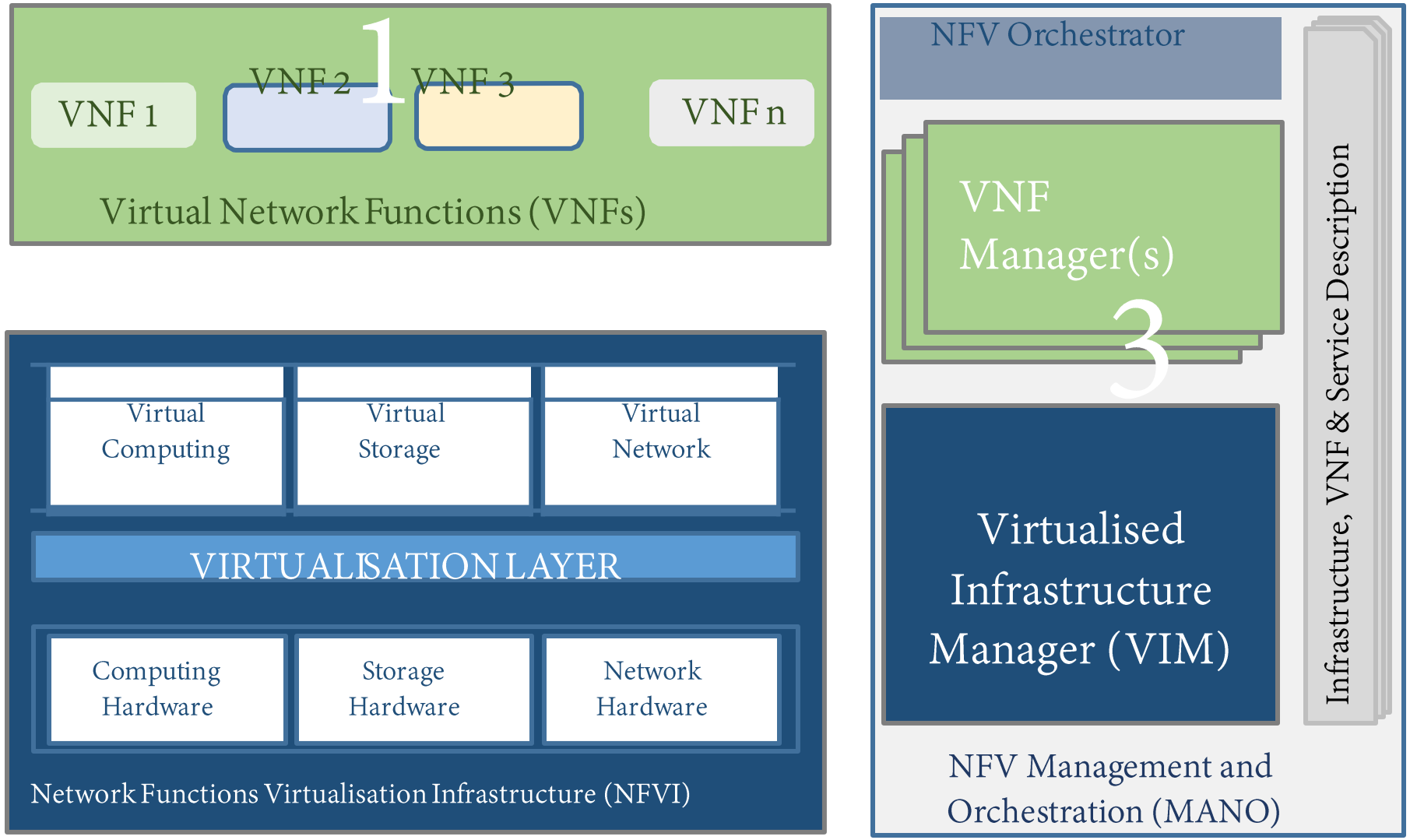
Benefits of Virtualization



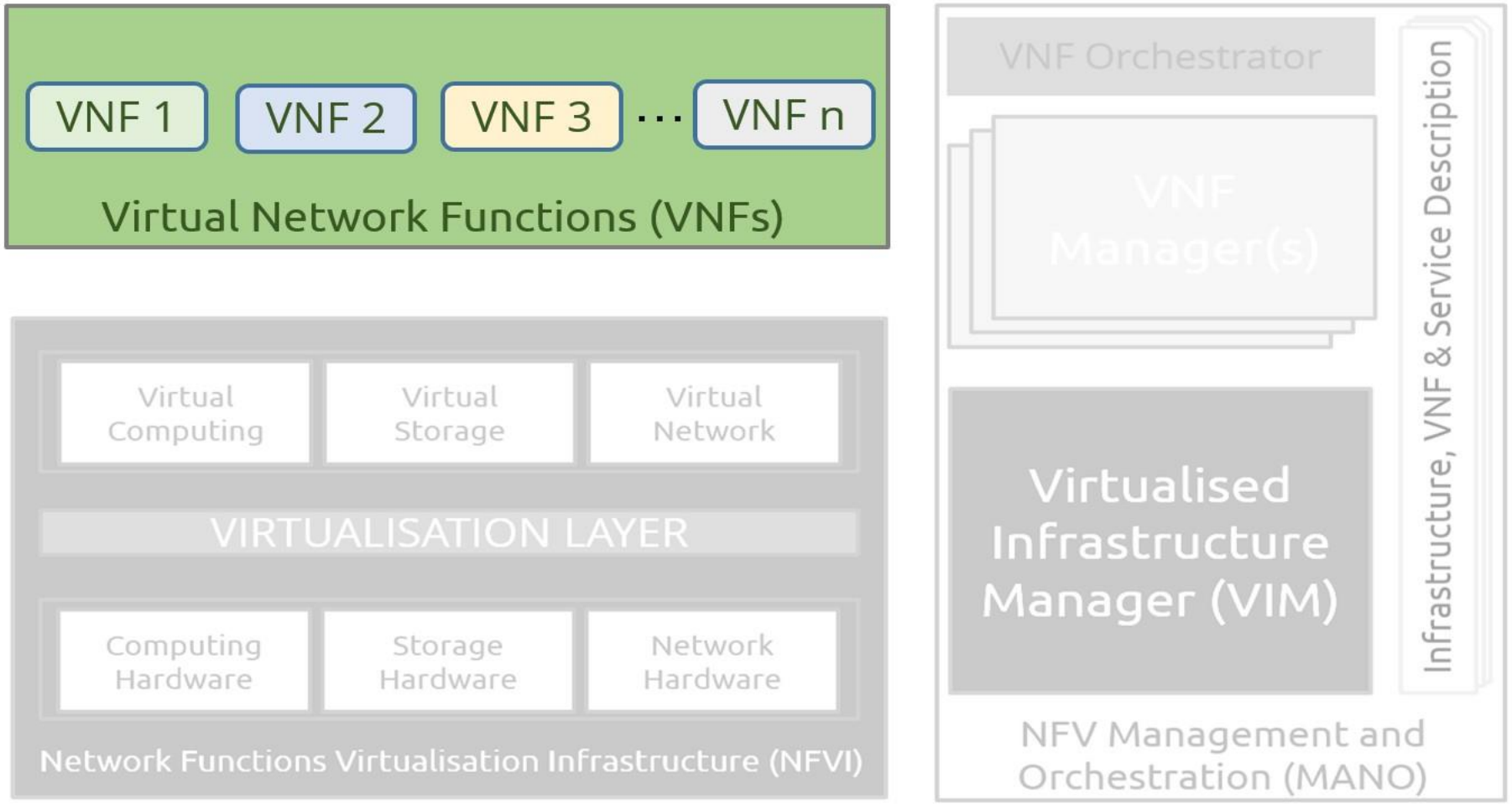
Network Function Virtualization Architecture



NFV Architecture in Details

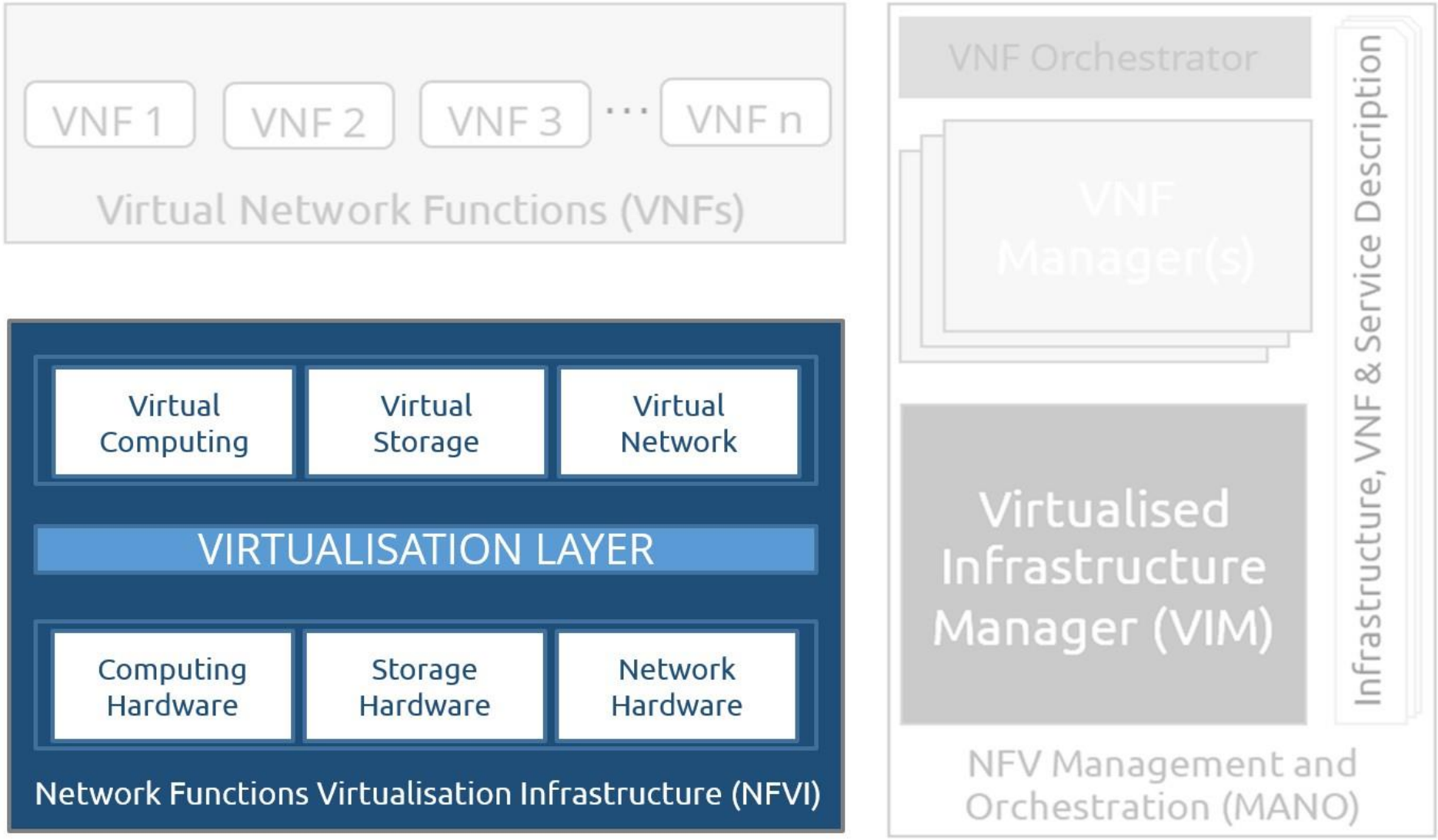


VNF (Virtualized Network Function)

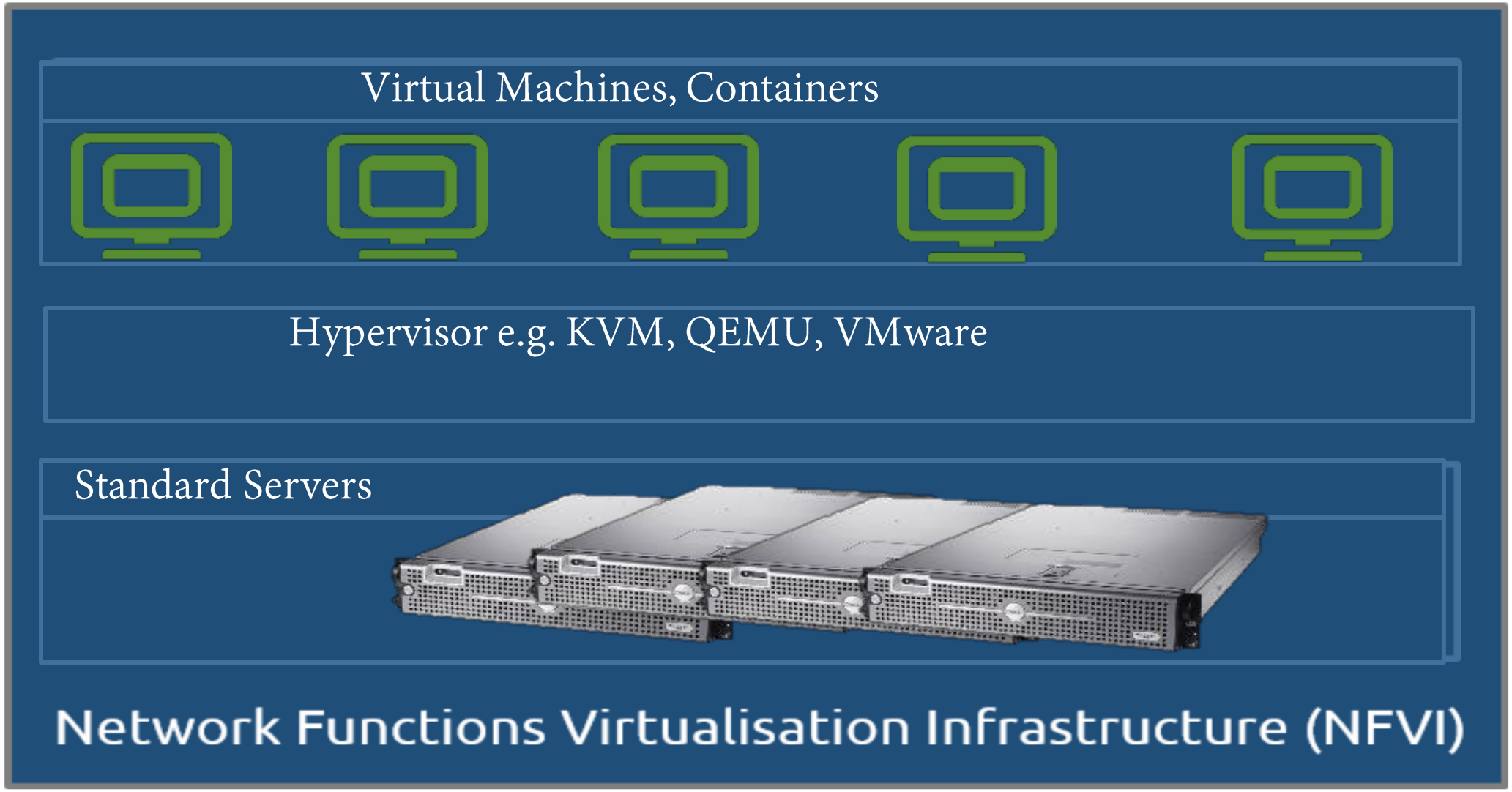


- A NF is an element within a network with well defined external interfaces and functional behavior e.g. DHCP, firewall
- VNF is an implementation of an NF that is deployed on virtual resources such as a VM
- A service is an offering provided by a TSP that is composed of one or more NFs.

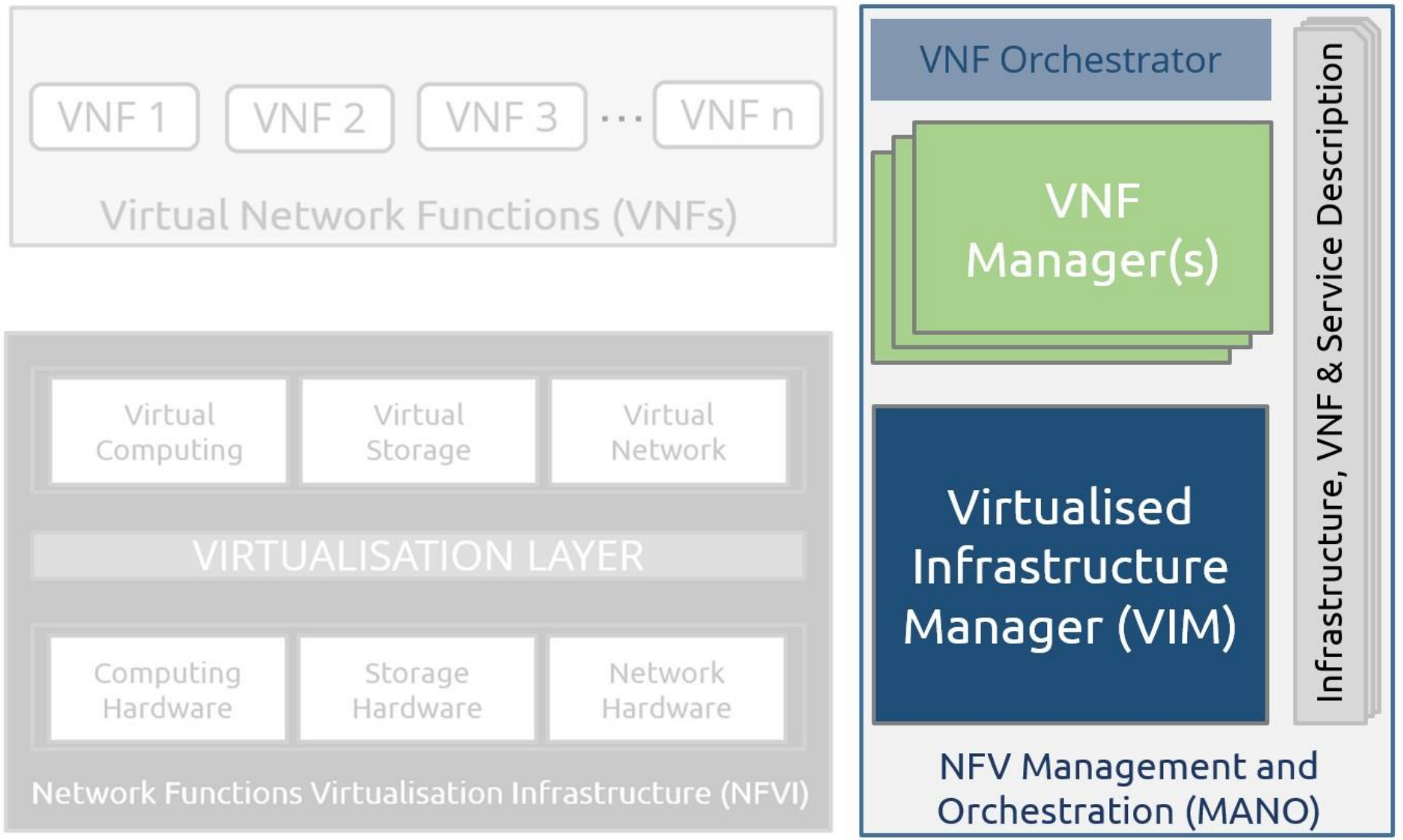
NFVI (NFV Infrastructure)



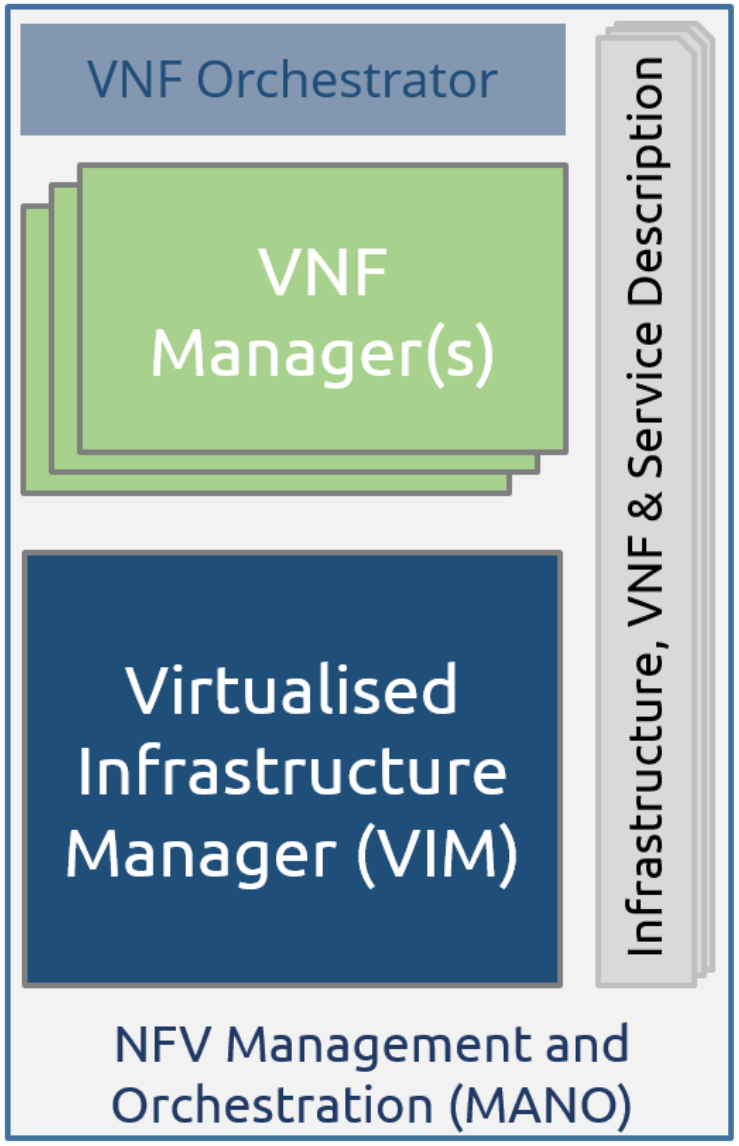
NFVI Components



NFV Mano


VNF 1
VNF 2
VNF 3
VNF n
Virtual Network Functions (VNFs)
Virtual Computing
Virtual Storage
Virtual Network
VIRTUALISATION LAYER
Computing Hardware
Storage Hardware
Network Hardware
Network Functions Virtualisation Infrastructure (NFVI)
VNF Orchestrator
VNF Manager(s)
Virtualised Infrastructure Manager (VIM)
Infrastructure, VNF & Service Description
NFV Management and Orchestration (MANO)

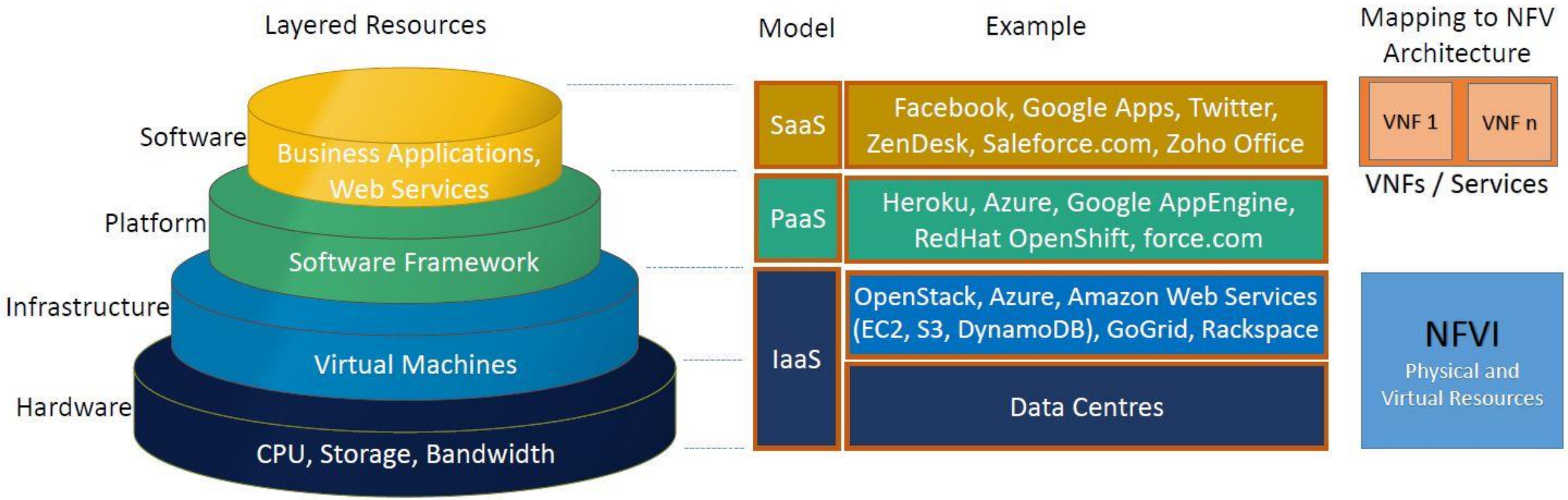
NFV Mano Explained



- Provides functionality required for the provisioning of VNFs, and the related operations, such as the configuration of the VNFs and the infrastructure these functions run on
- Orchestration and lifecycle management of physical and/or software resources that support the infrastructure virtualization, and the lifecycle management of VNFs,
- Databases that are used to store the information and data models which define both deployment as well as lifecycle properties of functions, services, and resources.

Cloud Computing and NFV

Cloud computing is “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services)



Cloud Computing Service Models and their Mapping to Part of the NFV Reference Architecture

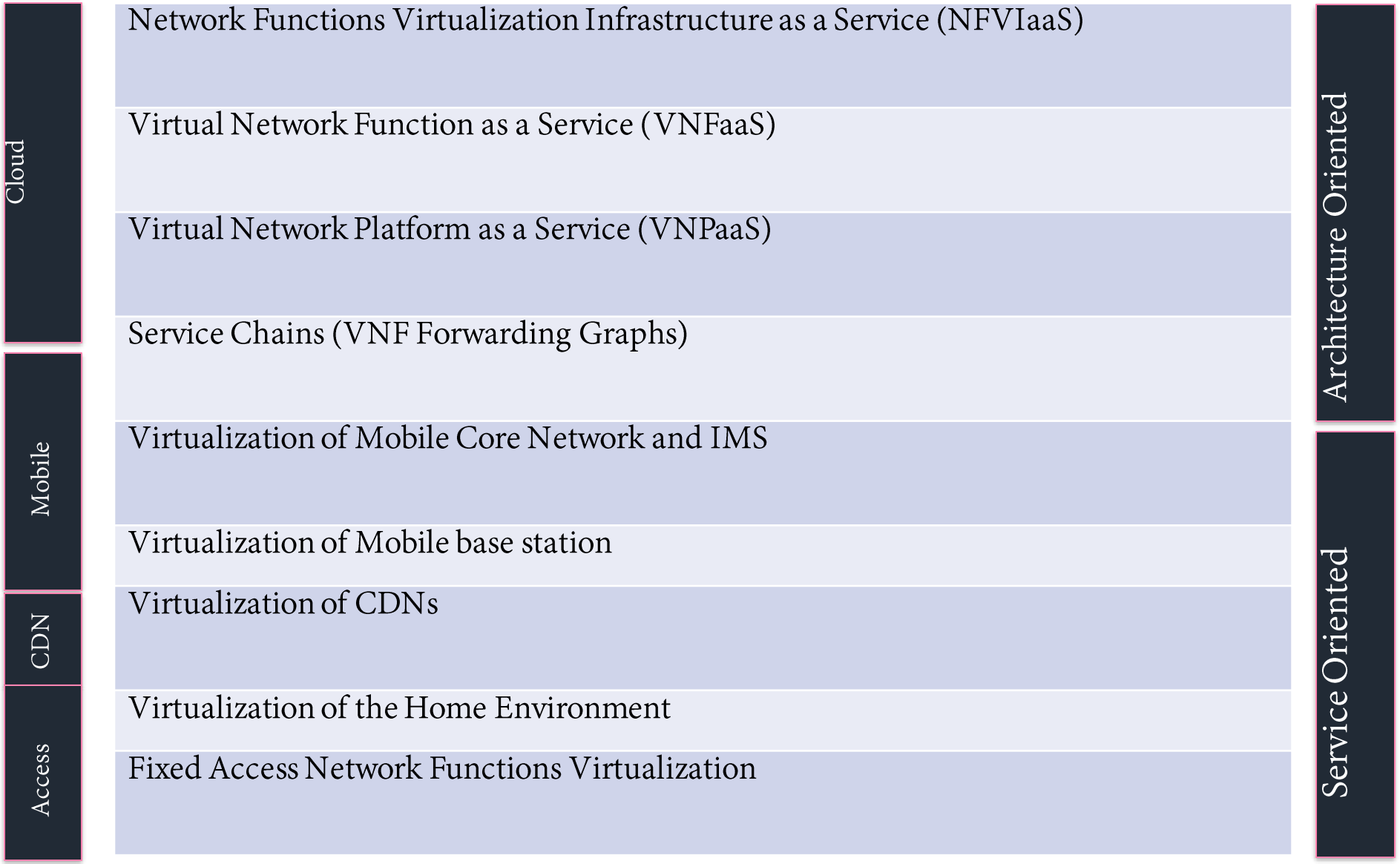
Cloud Computing vs NFV

	NFV	Cloud Computing
Approach	Service/Function Abstraction	Computing Abstraction
Formalization	ETSI NFV Industry Standard Group	DMTF Cloud Management Working Group
Latency	Expectations for low latency	Some latency is acceptable
Infrastructure	Heterogeneous transport (Optical, Ethernet, Wireless)	Homogeneous transport (Ethernet)
Reliability	Strict 5 NINES availability requirements	Less strict reliability requirements

NOT just transferring telecom network functions to the cloud

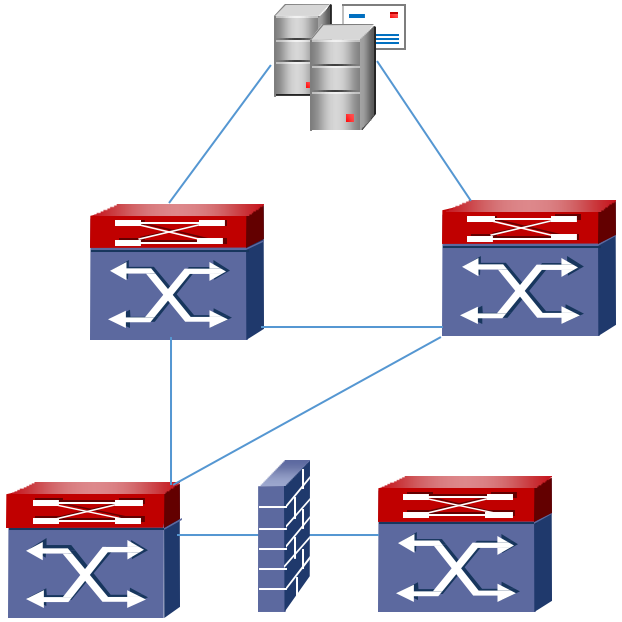
- Need for high availability for VNFs
  - Multi-tenancy: VNFs that deploy not just for a single customer but for a large number.
  - Interior network features like “virtual core routing” could be associated with a large-scale network virtualization application.

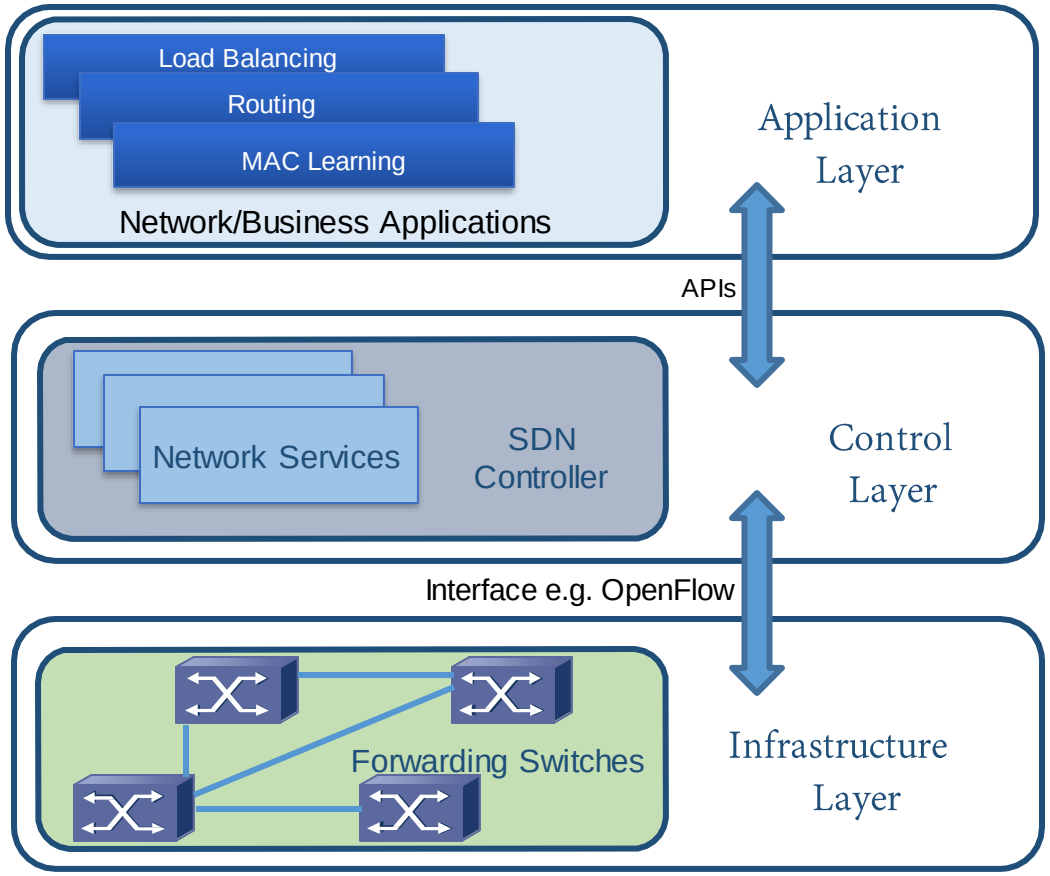
NFV Use Cases in Cloud Platform



Software Defined Networking (SDN)

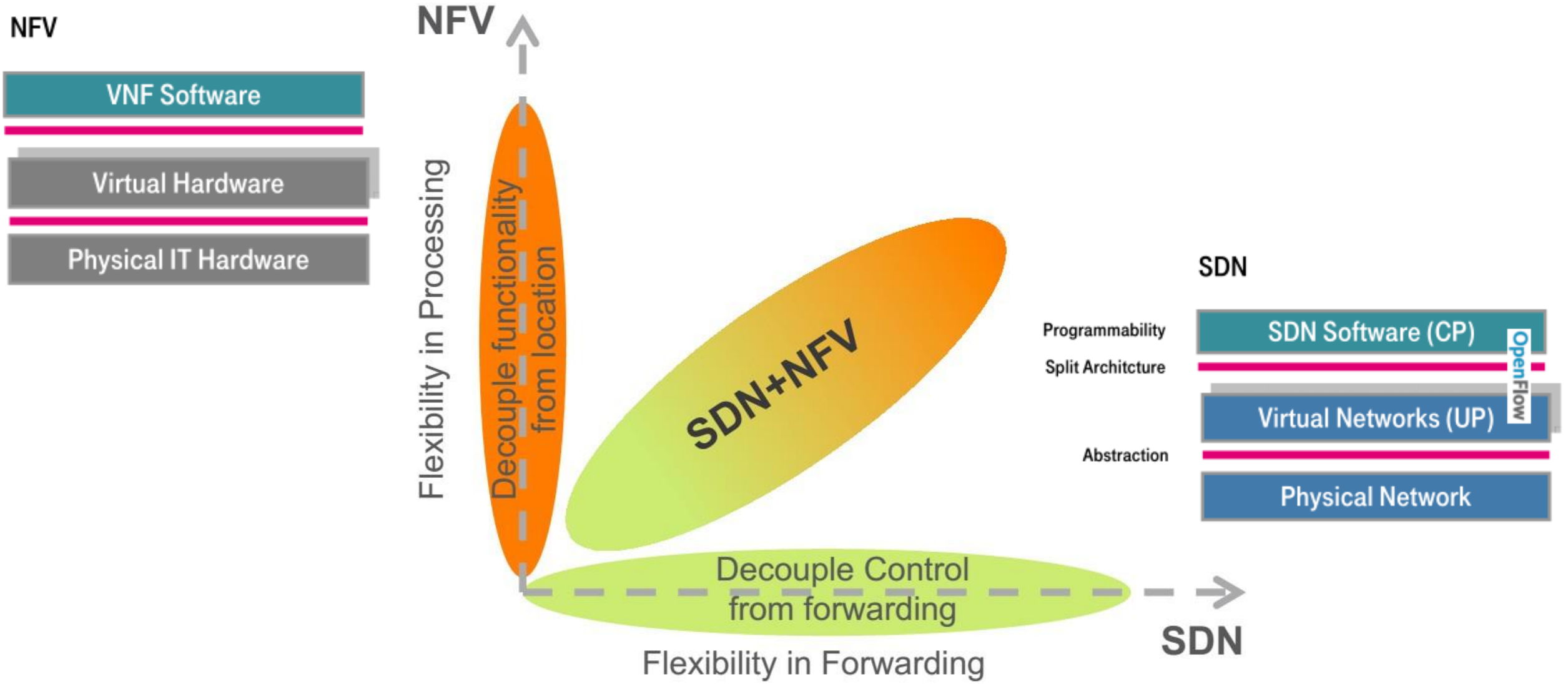
- SDN decouples the network control and forwarding functions.
- Allows network control to become directly programmable via an open interface





Distributed Control and Middleboxes (e.g. Firewall, Intrusion Detection, etc.) in Traditional Networks Vs Logical Layers in a Software Defined Network

SDN & NFV Network Flexibility

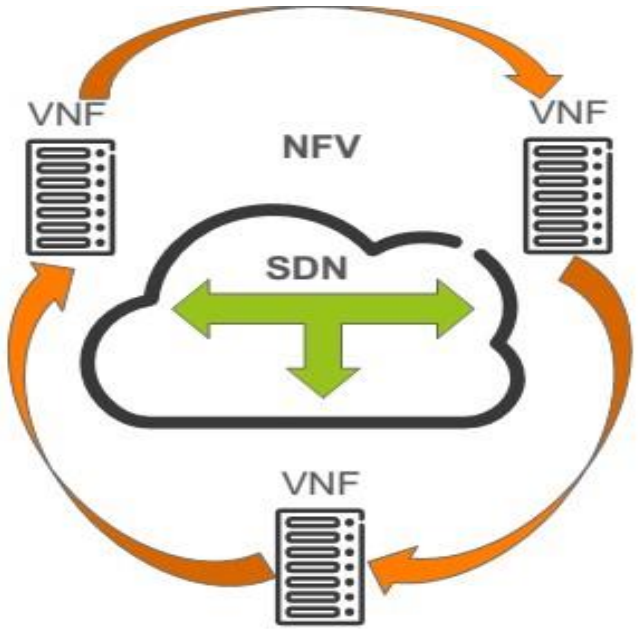


Sources: Ahmad Rostami, Ericsson Research (Kista): http://www.itc26.org/fileadmin/ITC26_files/ITC26-Tutorial-Rostami.pdf and Uwe Michel, T-Systems

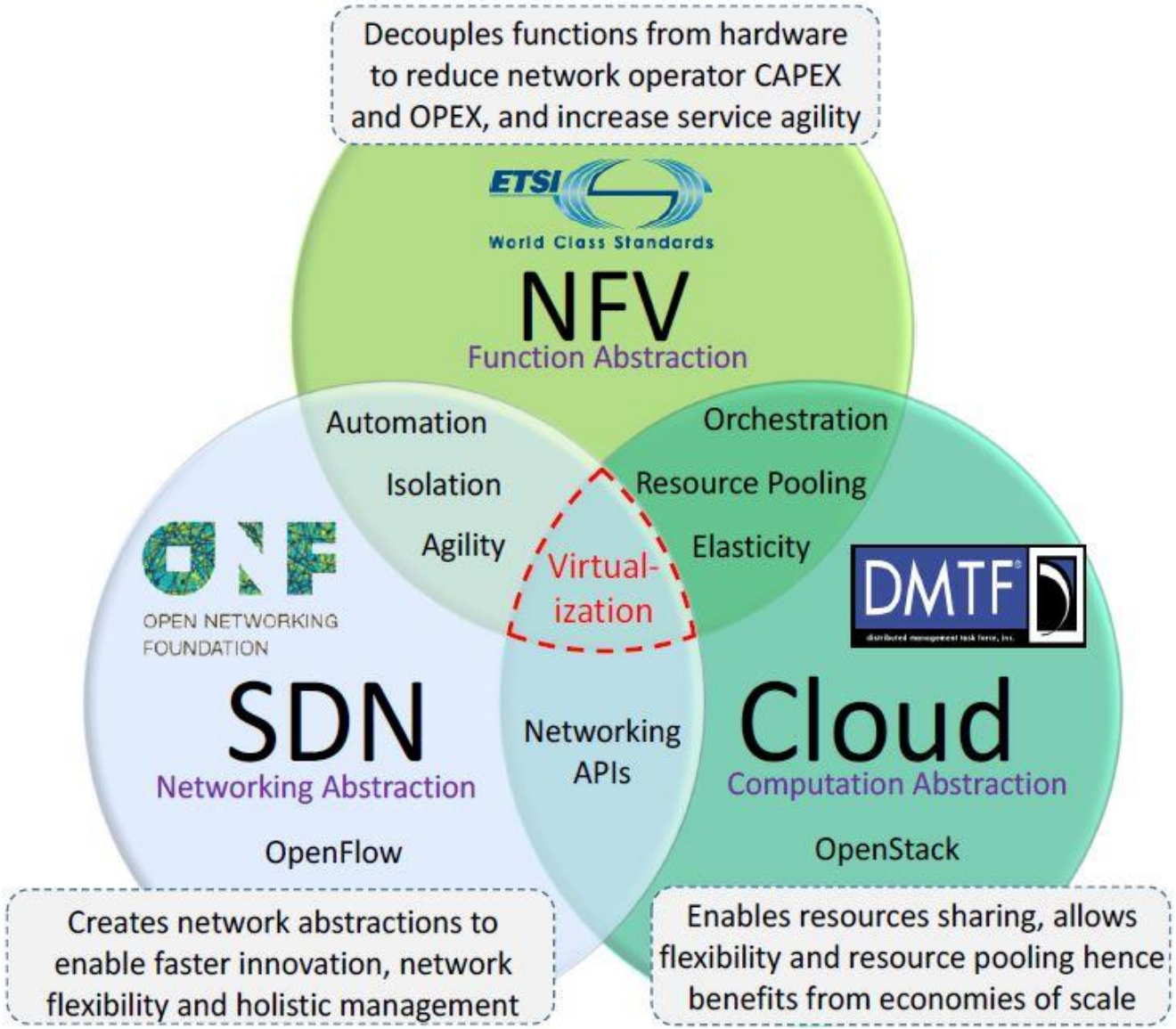
NFV vs. SDN

	NFV	SDN
Approach	Service/Function Abstraction	Networking Abstraction
Formalization	ETSI	ONF
Advantage	Promises to bring flexibility and cost reduction	Promises to bring unified programmable control and open interfaces
Protocol	Multiple control protocols (e.g SNMP, NETCONF)	OpenFlow is de-facto standard
Applications run	Commodity servers and switches	Commodity servers for control plane and possibility for specialized hardware for data plane

- NFV and SDN may be highly complimentary
- NFV differs from the virtualization concept as used in the SDN architecture



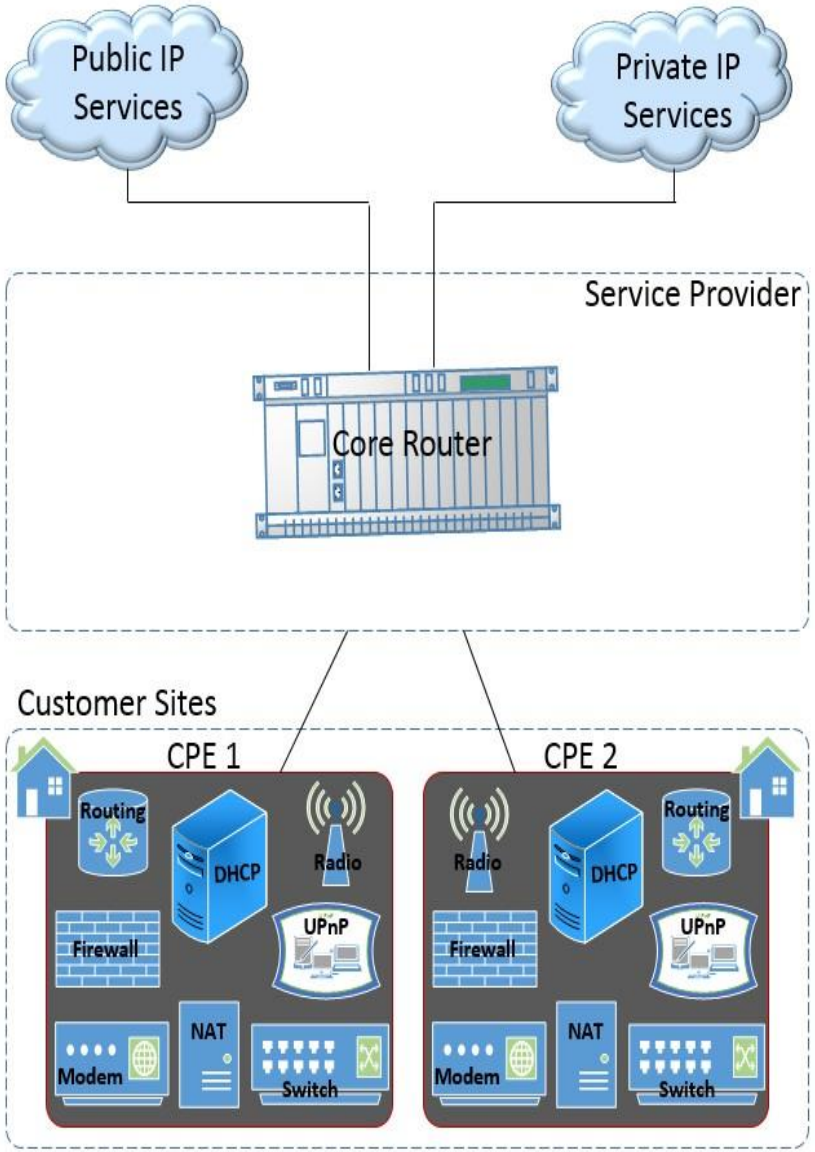
Relationship between SDN, NFV and Cloud

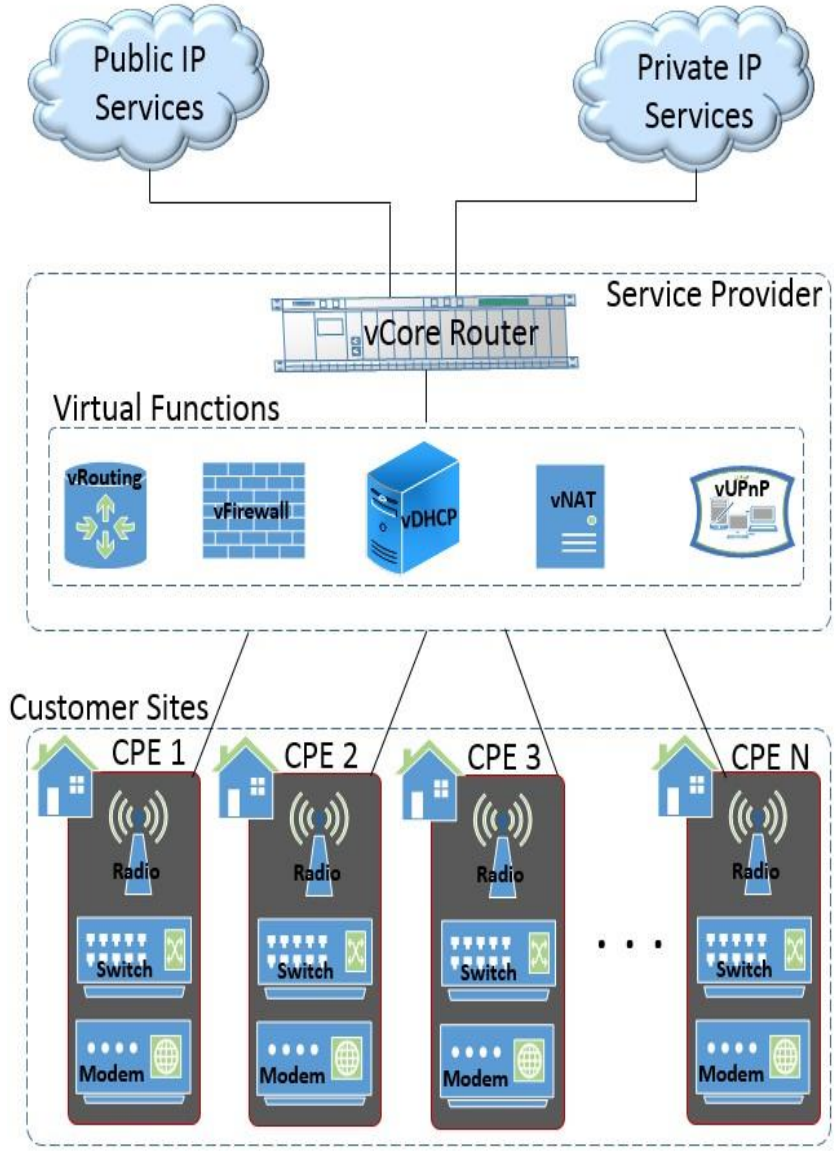


Fields of Application (examples)

- Application-level optimisation: CDNs, Cache Servers, Load Balancers, Application Accelerators
- Mobile networks: HLR/HSS, MME, SGSN, GGSN/PDN-GW, Base Station, EPC
- Home environment: home router, set-top-box
- Security functions: Firewalls, intrusion detection/protection systems, virus scanners, spam protection
- Tunnelling gateway elements: IPSec/SSL VPN gateways
- Traffic analysis/forensics: DPI, QoE measurement
- Traffic Monitoring, Service Assurance, SLA monitoring, Test and Diagnostics
- NGN signalling: SBCs, IMS
- Converged and network-wide functions: AAA servers, policy control and charging platforms
- Switching elements: BNG, CG-NAT, routers

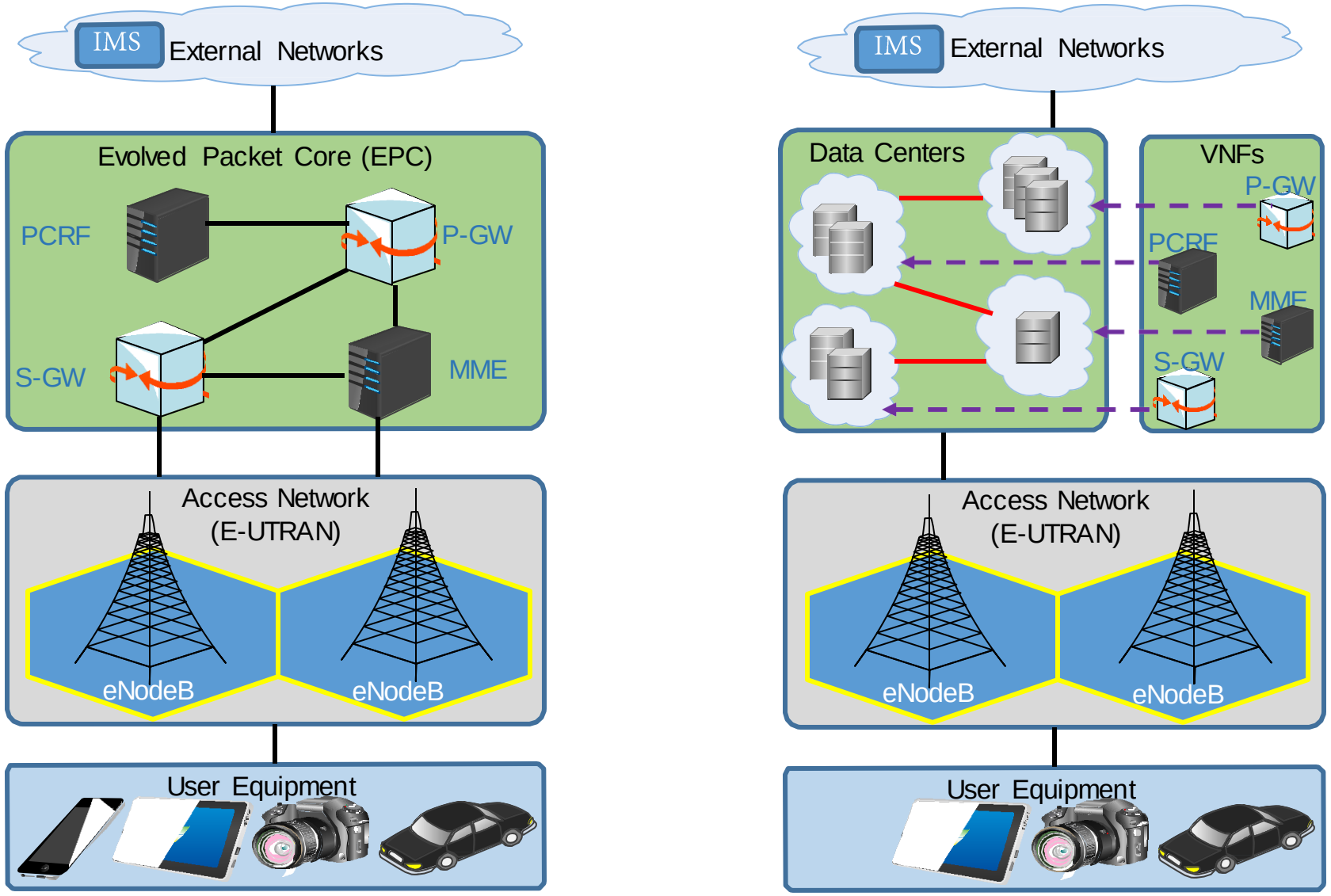
Virtualized CPE (Customer Premises Equipment)





Source: Rashid Mijumbi, Joan Serrat, Juan Luis Gorricho, Niels Bouten, Filip De Turck, Raouf Boutaba, "**Network Function Virtualization: State-of-the-art and Research Challenges**". IEEE Communications Surveys and Tutorials. First Quarter, 2016.

Virtualized EPC (Evolved Packet Core)



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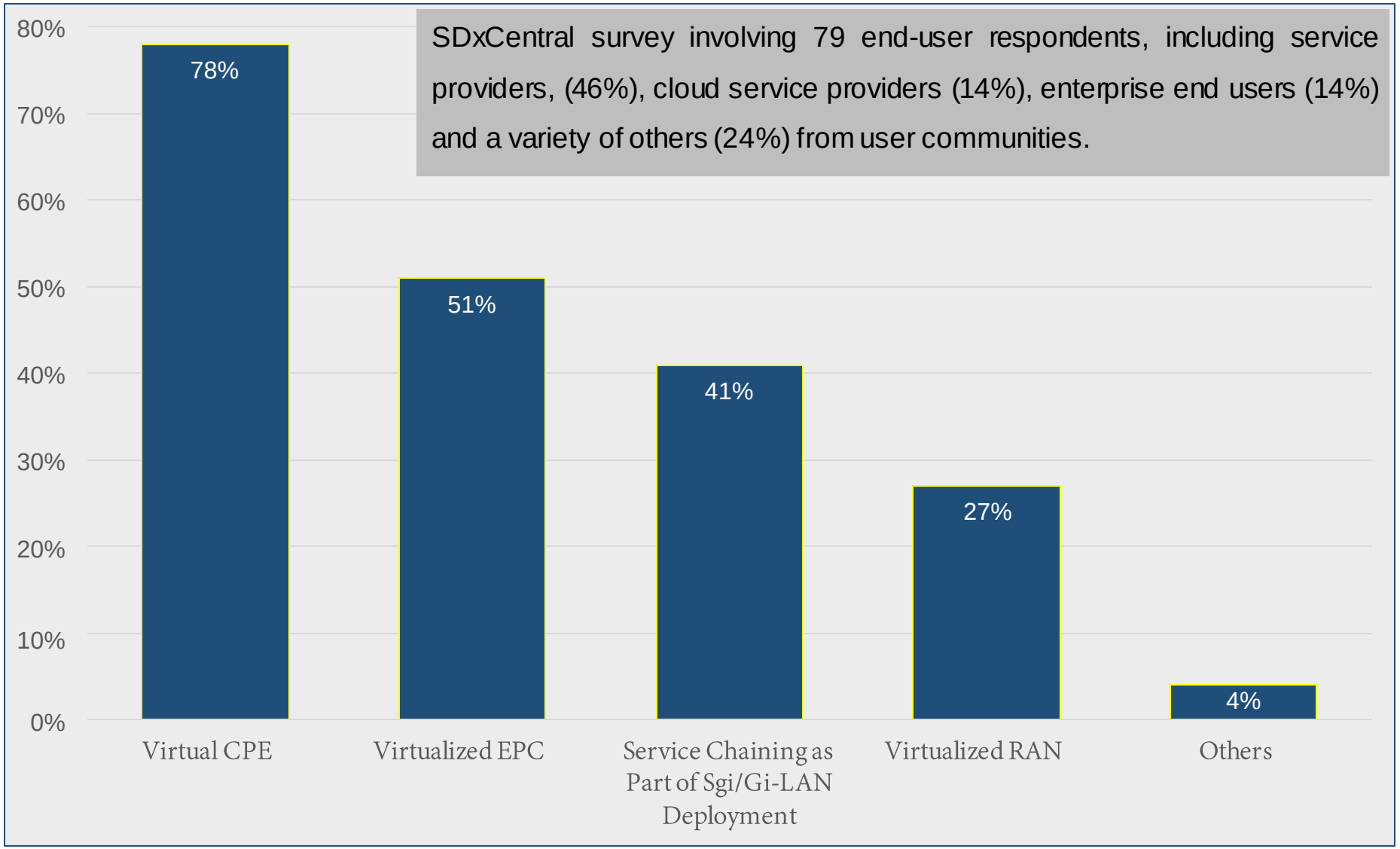
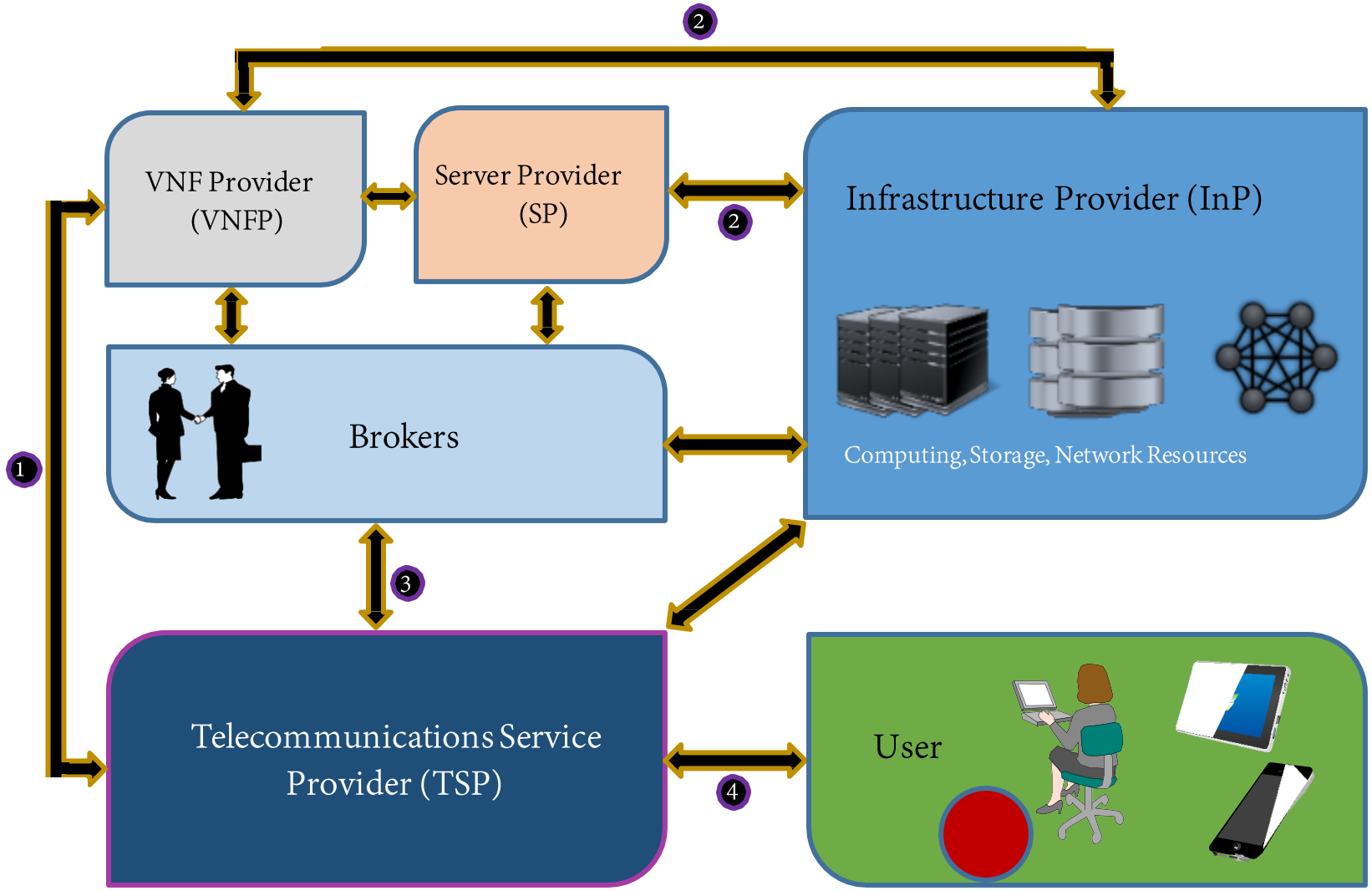
Ranking of the NFV Use Cases



Data source: sdxcentral.com

Business Model of NFV



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OPNFV

- Open source collaborative project founded and hosted by the Linux Foundation, and composed of TSPs and vendors.
- Introduced in September 2014 as an outgrowth of the ETSI NFV Industry Specification Group (ETSI NFV ISG).
- Includes participation of leading end users to validate OPNFV meets the needs of user community

OPNFV Objective

- Develop an integrated and tested open source platform that can be used to build NFV functionality,
- Accelerate the introduction of new products and services
- Contribute and participate in relevant open source projects
- Ensure consistency, performance and interoperability among open source components
- Establish an ecosystem for NFV solutions based on open standards and software to meet the needs of end users
- Promote OPNFV as the preferred platform and community for open source NFV

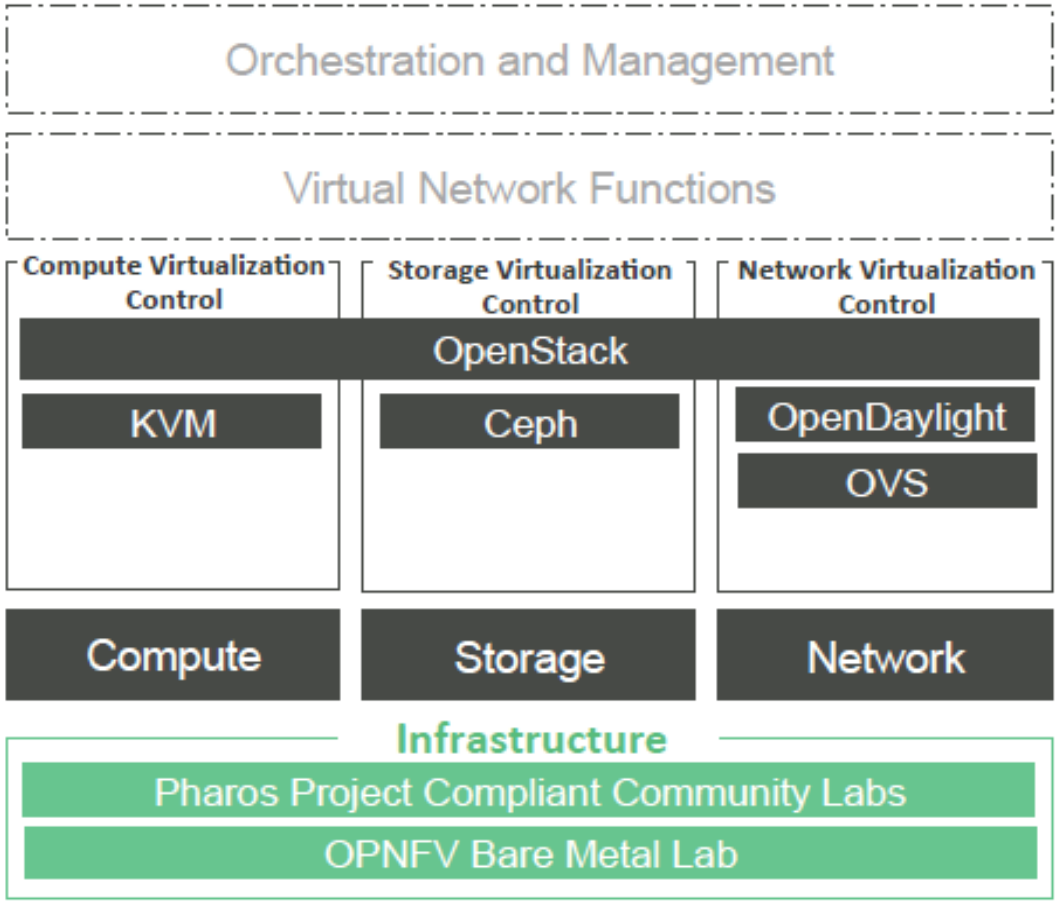
Objective is to establish a carrier-grade integrated open source reference platform that may be used to validate multi-vendor interoperable NFV solutions.

OPNFV Membership

https://www.opnfv.org/about/memberslist as of April 14th 2016

OPNFV Arno Released on June 4, 2015

- Initial build of the NFV Infrastructure (NFVI) and Virtual Infrastructure Manager (VIM) components of ETSI NFV architecture.
- Baseline foundation to enable continuous integration, automated deployment and testing of components necessary to build an NFV platform from upstream components such as OpenDaylight, OpenStack, Open vSwitch, Ceph & KVM.
- Aimed at exploring NFV deployments, developing VNF applications, or NFV performance and use case-based testing.



[10/01/2015] Arno SR1: Designed to address known issues in the initial release for incremental stability and improved predictability.

What are the grand challenges?

- High performance virtual appliances
- Isolation/coexistence
- Management solutions
- Fault tolerance
- Vendor independence/multi-vendor

References

1) Rashid Mijumbi, Joan Serrat, Juan Luis Gorricho, Niels Bouten, Filip De Turck, Raouf Boutaba, "**Network Function Virtualization: State-of-the-art and Research Challenges**". IEEE Communications Surveys and Tutorials. First Quarter, 2016.

2) Rashid Mijumbi, Joan Serrat, Juan Luis Gorricho, Steven Latre, Marinos Charalambides, Diego Lopez, "**Management and Orchestration Challenges in Network Function Virtualization**". IEEE Communications Magazine. January 2016.

3) ETSI, "NFV - Update White Paper," Oct 2013, http://portal.etsi.org/NFV/NFV_White_Paper2.pdf

4) ETSI, "Architectural Framework," Oct 2013 http://www.etsi.org/deliver/etsi_gs/nfv/001_099/002/01.01.01_60/gs_nfv002v010101p.pdf

5) ETSI, "NFV Use Cases," http://www.etsi.org/deliver/etsi_gs/nfv/001_099/001/01.01.01_60/gs_nfv001v010101p.pdf

Thank You