Network Function Virtualization (NFV) & App Hosting

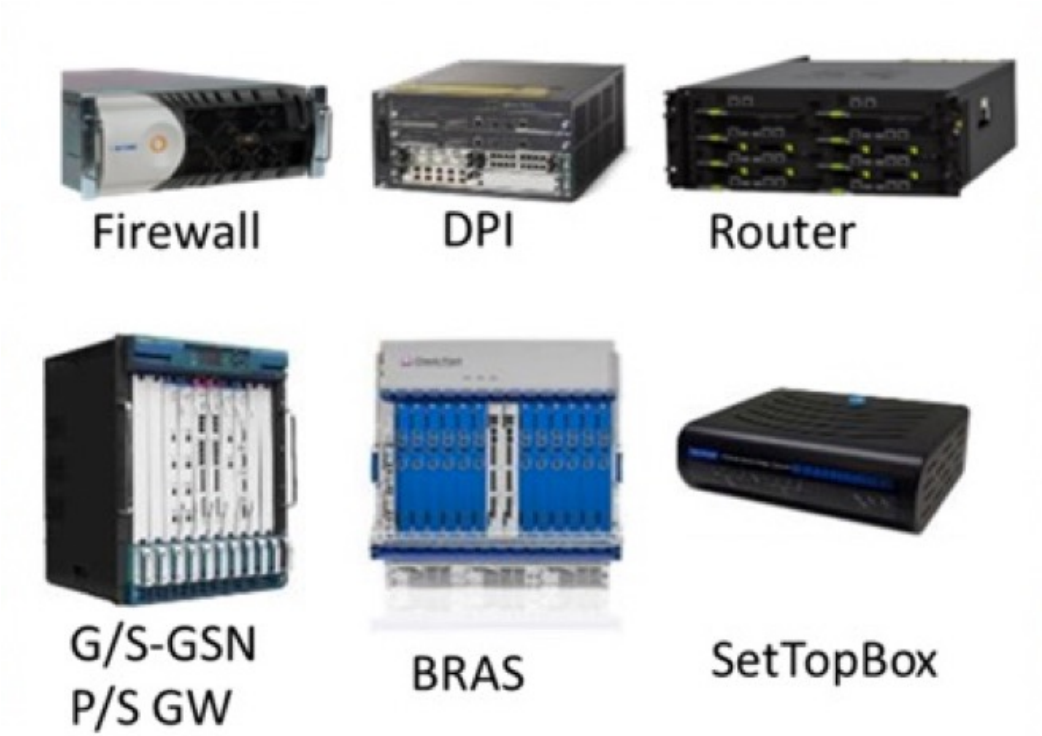
Aula Teórica nº13

2020/2021

Traditional Network Architecture

- **Initial Requirements:** minimum latency, loss; maximum throughput, availability
- HW systems built for very specific use cases
- Tightly coupled proprietary OS
- Perform only specific functions (fixed network function)
- Limited scalability: physical space and power limitations

Traditional Network Devices



- Specialized HW
- Proprietary Solutions
- High Cost
- Scalability Issues

Limitations of the traditional model (1/2)

- **Flexibility Limitations:** unable to meet fast-changing requirements => inefficient use of resources
- **Scalability Constrains:** if HW or SW limits are hit => upgrade of the device
- **Time-to-Market Challenges:** new requirements => re-evaluation of new equipment, redesign of the network, possibly new vendors for new needs => increases cost of ownership, longer timeline to offer new services to customers
- **Manageability Issues:** SNMP, Netflow, syslog… but could imply vendor-specific parameters

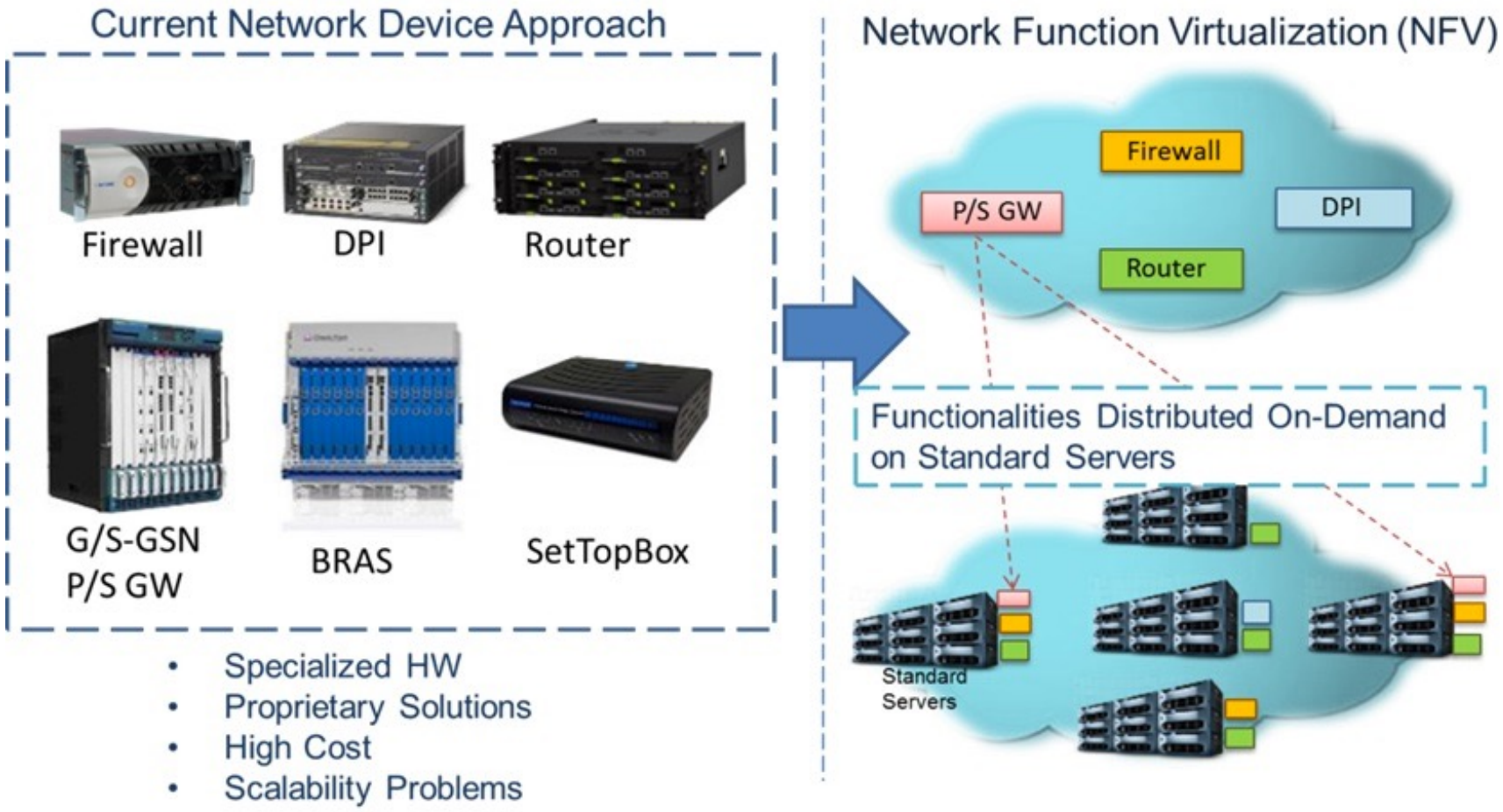
Limitations of the traditional model (2/2)

- **High Operational Costs:** highly trained teams for each vendor-specific system (tens to lock provider to vendors)
- **Migration Considerations:** on-site personnel to deply new HW, reconfigure physical connectivity, and upgrade facilities at the site
- **Capacity Over-Provisioning:** networks are built with excess capacity and are often more than 50% undersubscribed
- **Interoperability:** Some vendors implement new functionalities before they are fully standardized => implementation can become proprietary

Introducing NFV

- In data centers, the server virtualization is a proven technology (independent HW systems have mostly been replaced by virtualized servers running on shared HW)
- NFV expands this concept to include network devices
- It also allows the eco-system to provision, manage and monitor this virtualized network entities
- Example: replace a physical firewall appliance with a SW-based VM. Same FW functions, same OS, same look and feel… but on non-dedicated, shared, and generic HW
- Use commercial off the shelf (COTS) HW to provide the infrastructure for NFV

Network Functions Virtualization



Virtual Network Functions (VNFs)

VNF – Virtualized Network Function

- Meant to perfom a certain network function e.g. router, switch, firewall, load-balancer, etc. and a combination of these VNFs may be required to implement the complete network segment that is being virtualized (service chainning)
- Replaces a vendor’s specialized HW with systems performing the same function, yet running on a generic HW

Example: Cisco Firewalls

Cisco Firepower 4100 Series:

The industry's first 1RU NGFWs with 40-Gbps interfaces

Cisco Firepower 9300:

Ultra-high-performance NGFW, expandable as your needs grow

Cisco ASA 5500-X Series:

Models for branch offices, industrial applications, and the Internet edge

Firepower NGFWv:

The NGFW for virtual and cloud environments

Features	Cisco Firepower Model								
	NGFWv	2110	2120	2130	2140	4110	4120	4140	4150
Throughput: FW + AVC 1024B	1.2 Gbps	2.0 Gbps	3 Gbps	4.75 Gbps	8.5 Gbps	12 Gbps	20 Gbps	25 Gbps	30 Gbps
Throughput: FW + AVC + IPS (1024B)	1.1 Gbps	2.0 Gbps	3 Gbps	4.75 Gbps	8.5 Gbps	10 Gbps	15 Gbps	20 Gbps	24 Gbps
Maximum concurrent sessions, with AVC	100,000	1 million	1.2 million	2 million	3.0 million	9 million	15 million	25 million	30 million
Maximum new connections per second, with AVC	10,000	12,000	16,000	24,000	40,000	68,000	120,000	160,000	200,000
TLS (Hardware Decryption)	-	350 Mbps	450 Mbps	700 Mbps	1.2 Gbps	4.5 Gbps	7.1 Gbps	7.3 Gbps	7.5 Gbps
IPSec VPN Throughput (1024B TCP w/Fastpath)	-	750 Mbps	1 Gbps	1.5 Gbps	3 Gbps	6 Gbps	10 Gbps	13 Gbps	14 Gbps
Maximum VPN Peers	-	1500	3500	7500	10000	10000	15000	20000	20000

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- KVM
- VMWare
- AWS
- Azure

Hypervisor Cloud

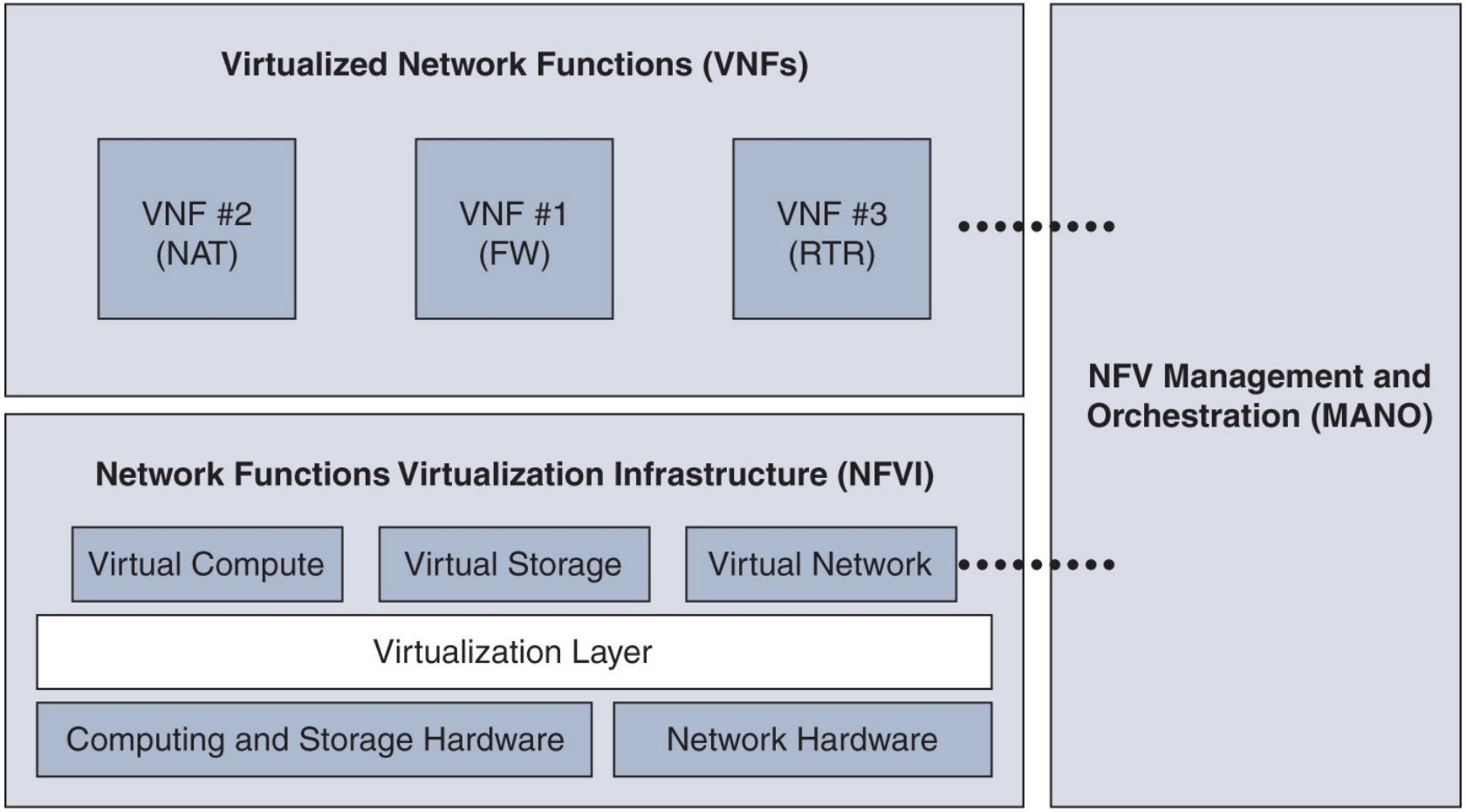
- vCPUs
- RAM
- Storage
- Networking

Resources Required

Management of NFV: Considerations

- multivendor implementations of VNFs
- managing the life cycles and interactions of these functions
- managing the HW resource allocations
- monitoring the utilization
- configuration of the VNFs
- interconnection of the virtualized functions to implement the service
- interaction with the billing and operational support systems
- Framework to allow the VNFs HW and the management systems to work seamlessly within well defined boundaries

High-Level ETSI NFV Framework



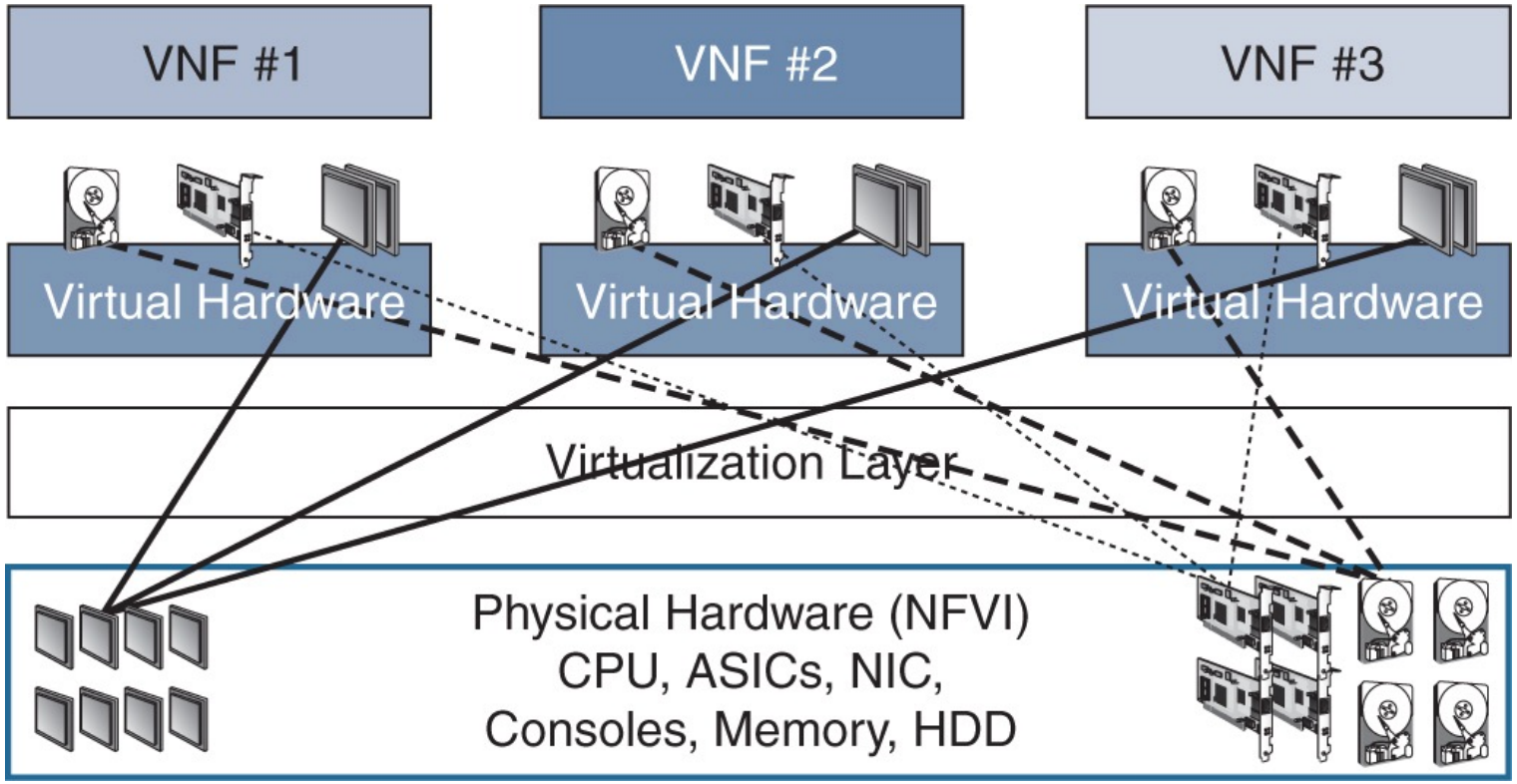
ETSI Framework Blocks

- **Network Functions Virtualization Infrastructure (NFVI) block:** HW to host the VMs, the SW to make virtualization possible, and the virtualized resources

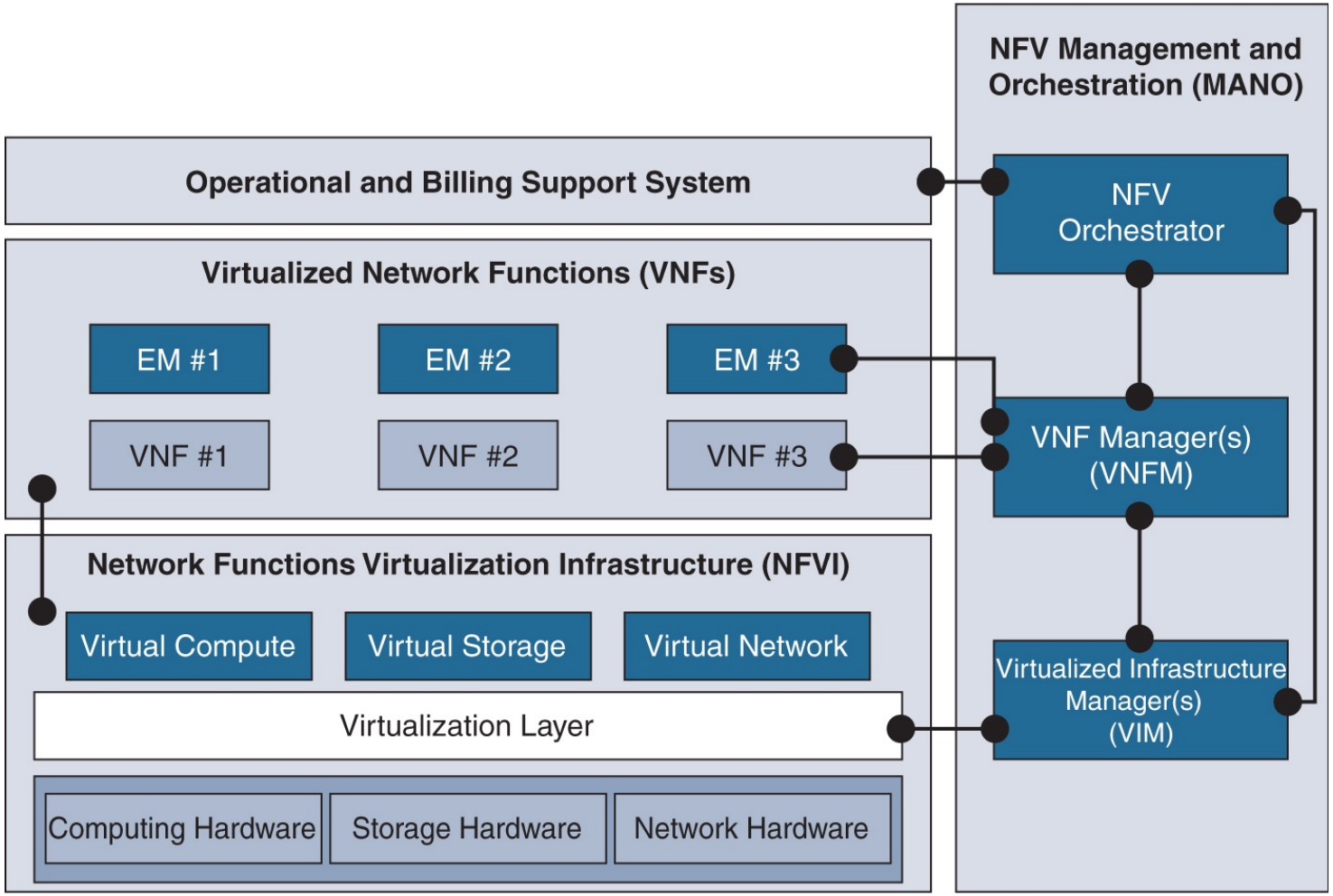
- **Virtualized Network Function (VNF) block:** The VNF block uses the virtual machines offered by NFVI and builds on top of them by adding the SW implementing the virtualized network functions.

- **Management and Orchestration (MANO) block:** MANO is defined as a separate block in the architecture, which interacts with both the NFVI and VNF blocks. The MANO layer manages all the resources in the infrastructure layer; in addition, this layer creates and deletes resources and manages their allocation of the VNFs.

Resource Allocations for VNFs



Low-Level View of the ETSI NFV Framework



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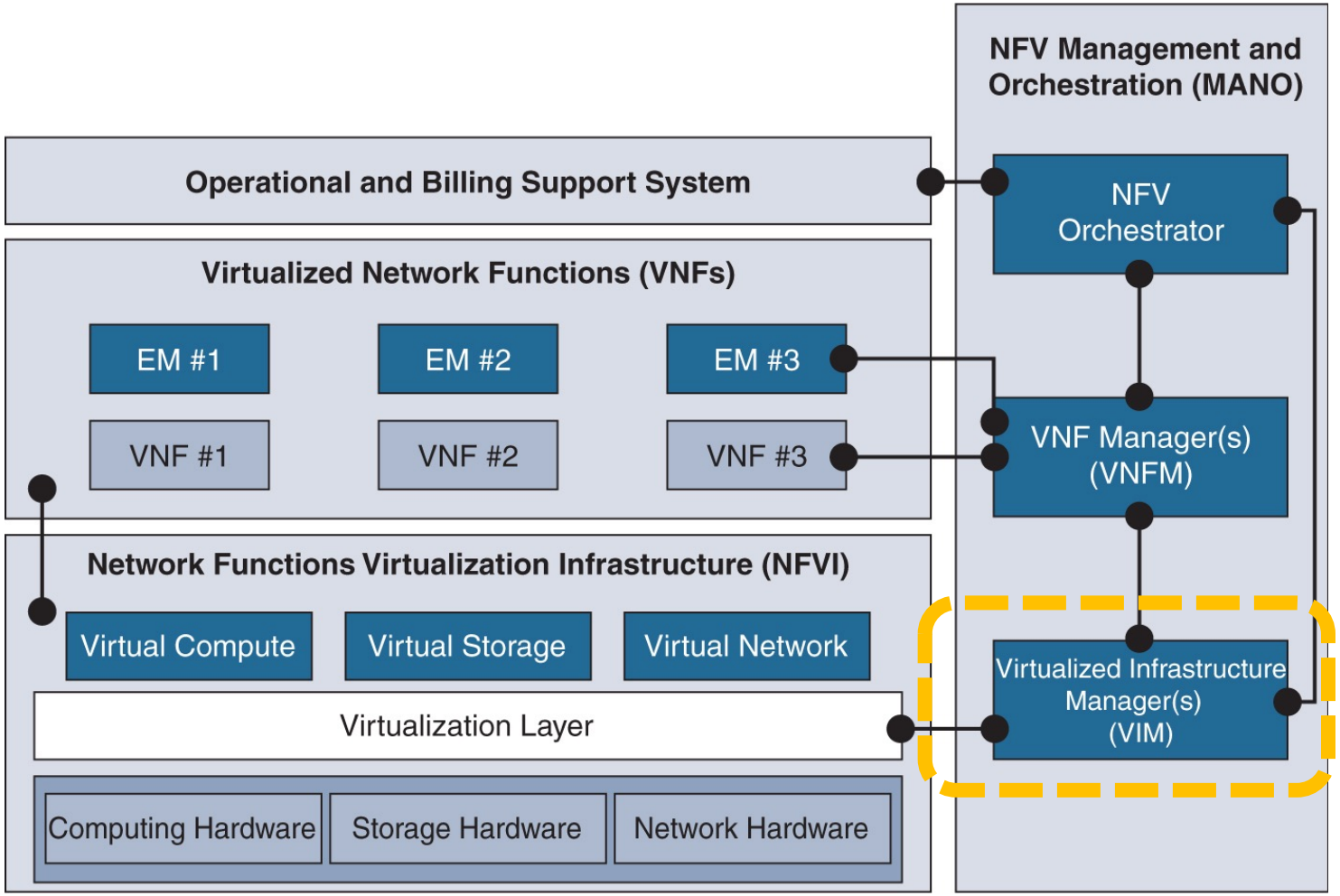


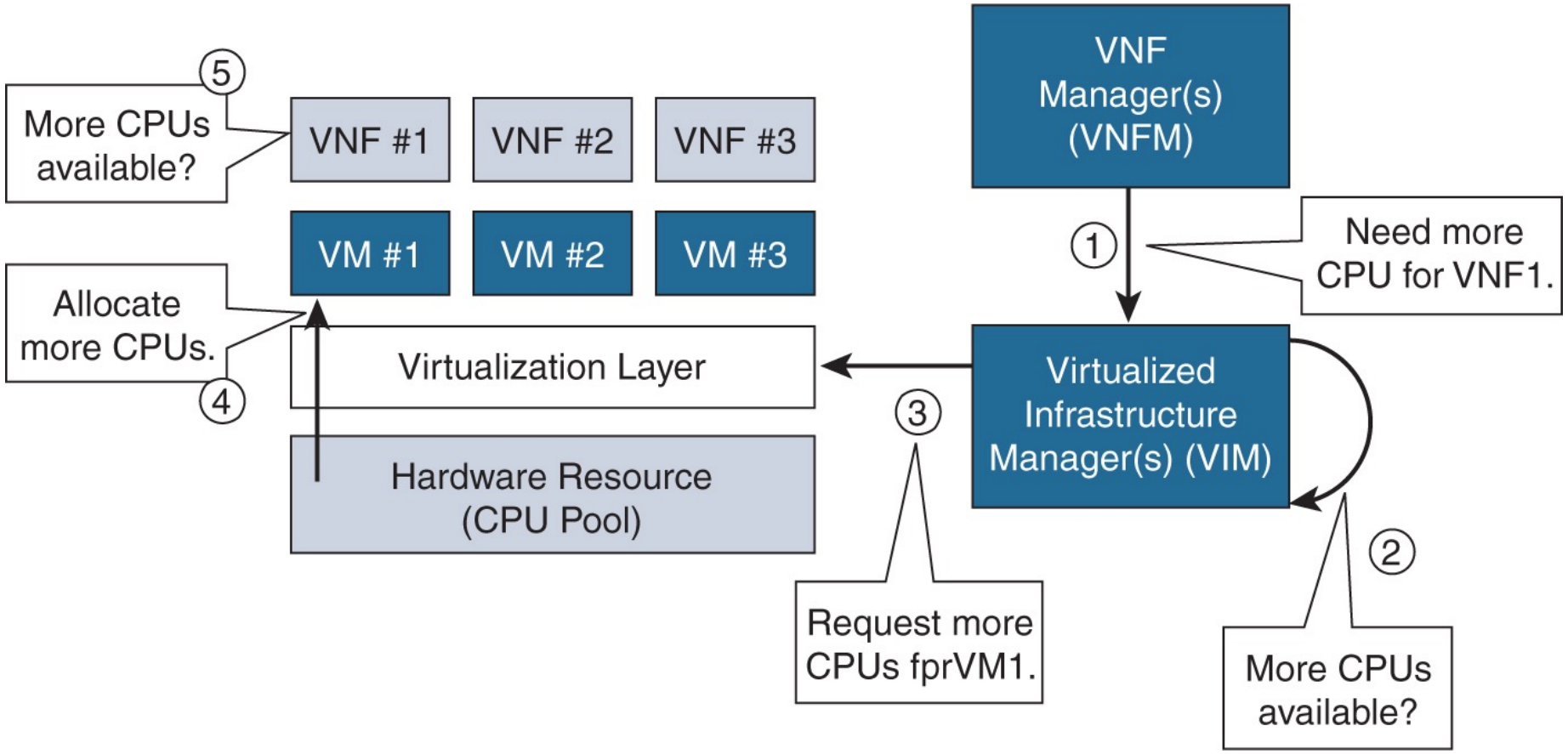
Openstack!

HW Resources

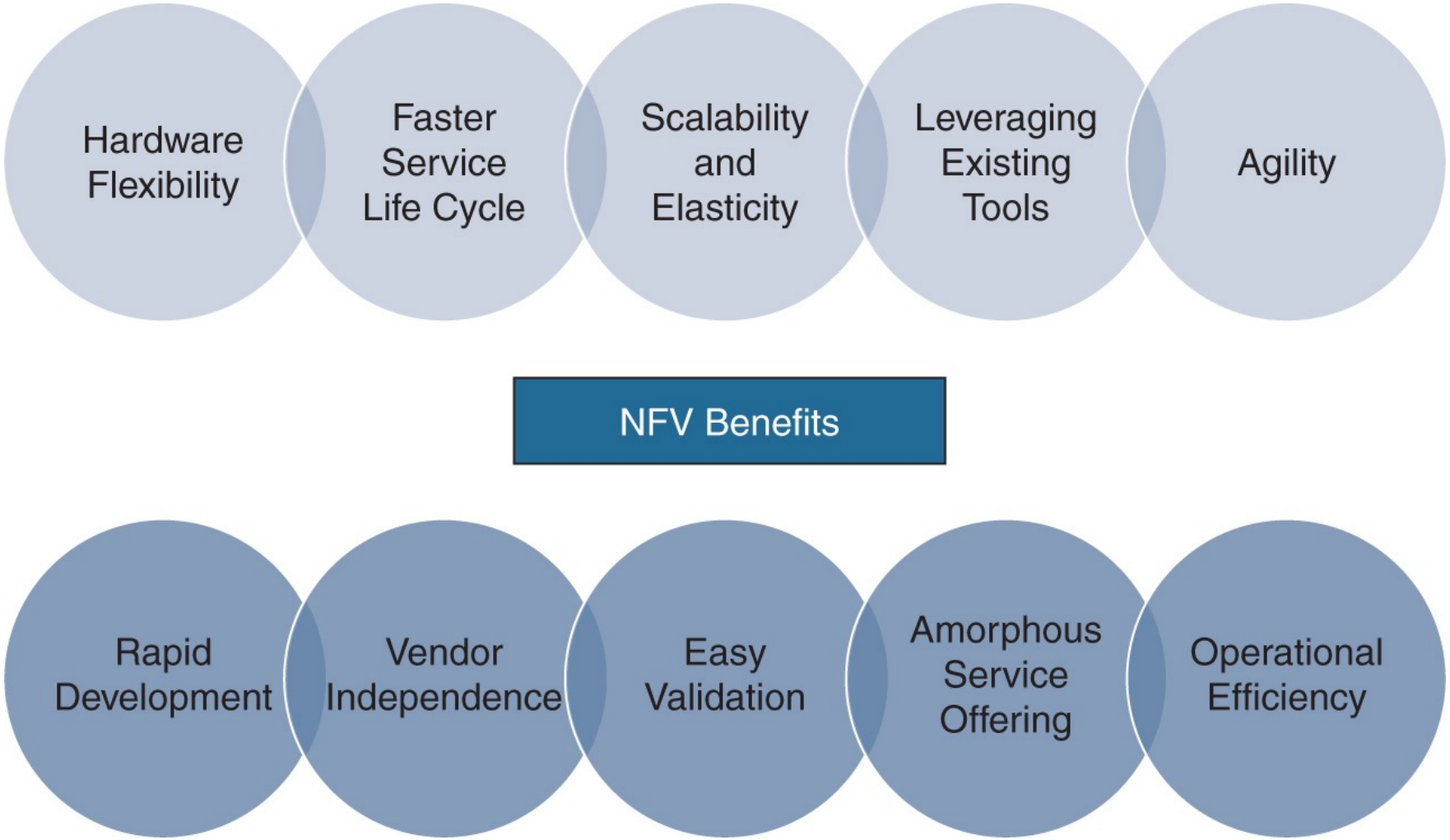
- **Computing HW:** includes both the CPU and memory. May be pooled between hosts using cluster-computing techniques
- **Storage HW:** storage can be locally attached or distributed with devices such as network-attached storage (NAS) or devices connected using SAN technologies
- **Networking HW:** comprises pools of network interface cards and ports that can be used by the VNFs

None of this HW is purposely built! COTS! The functional blocks can span and scale across multiple devices and interconnected locations

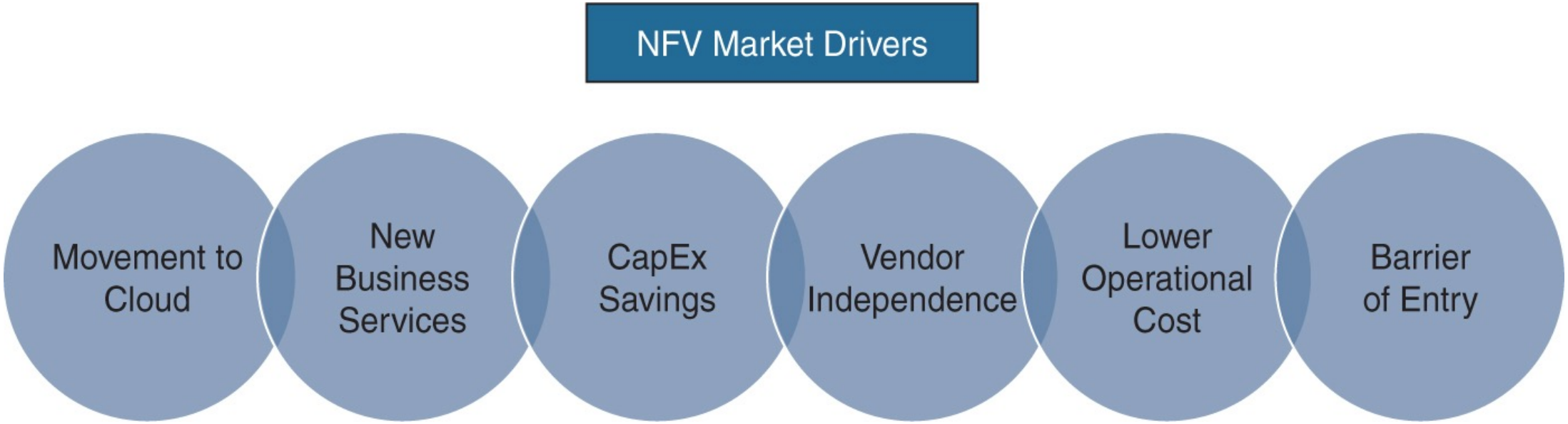
VNF-M Scaling Up VNF Resources



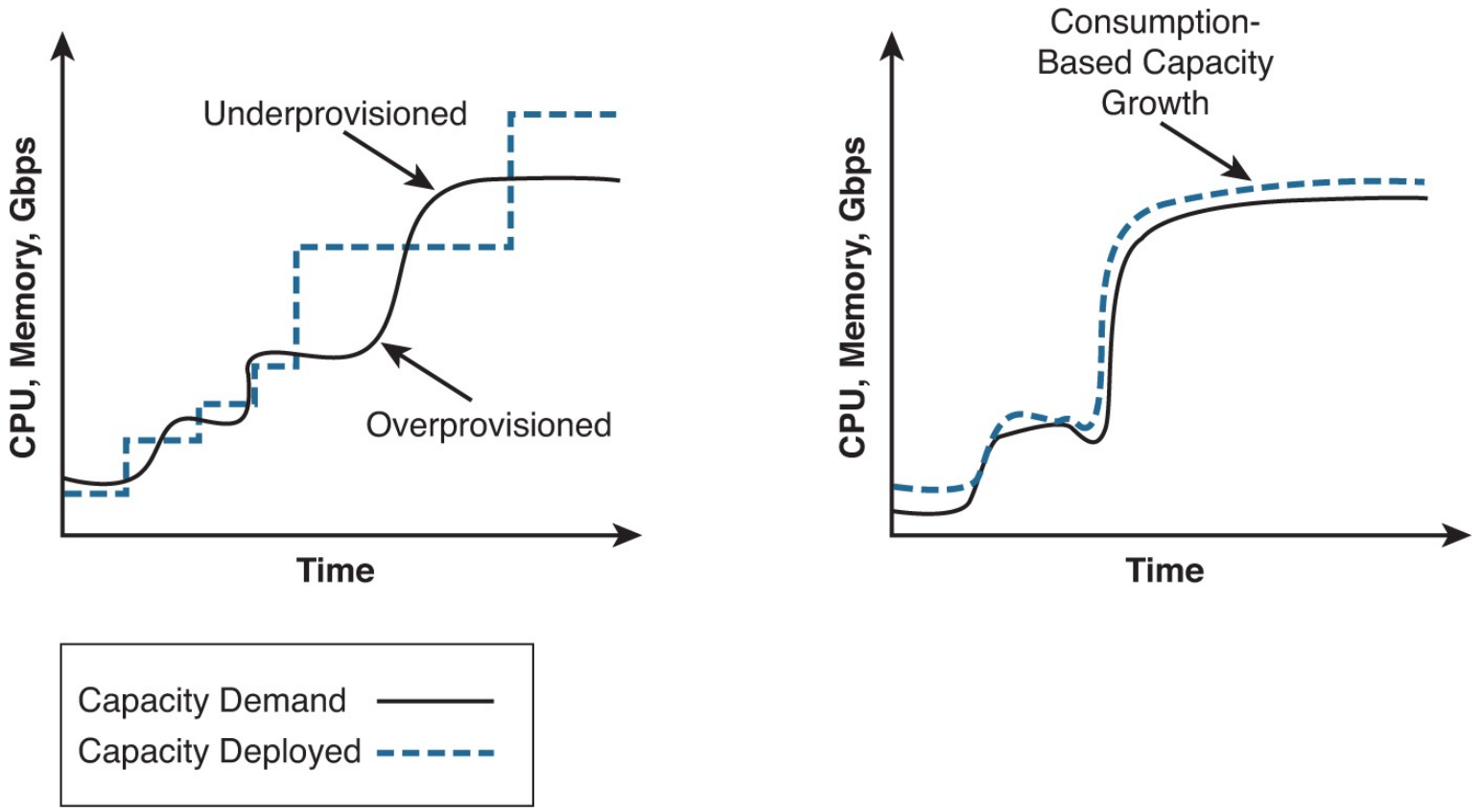
Benefits of NFV



NFV Market Drivers

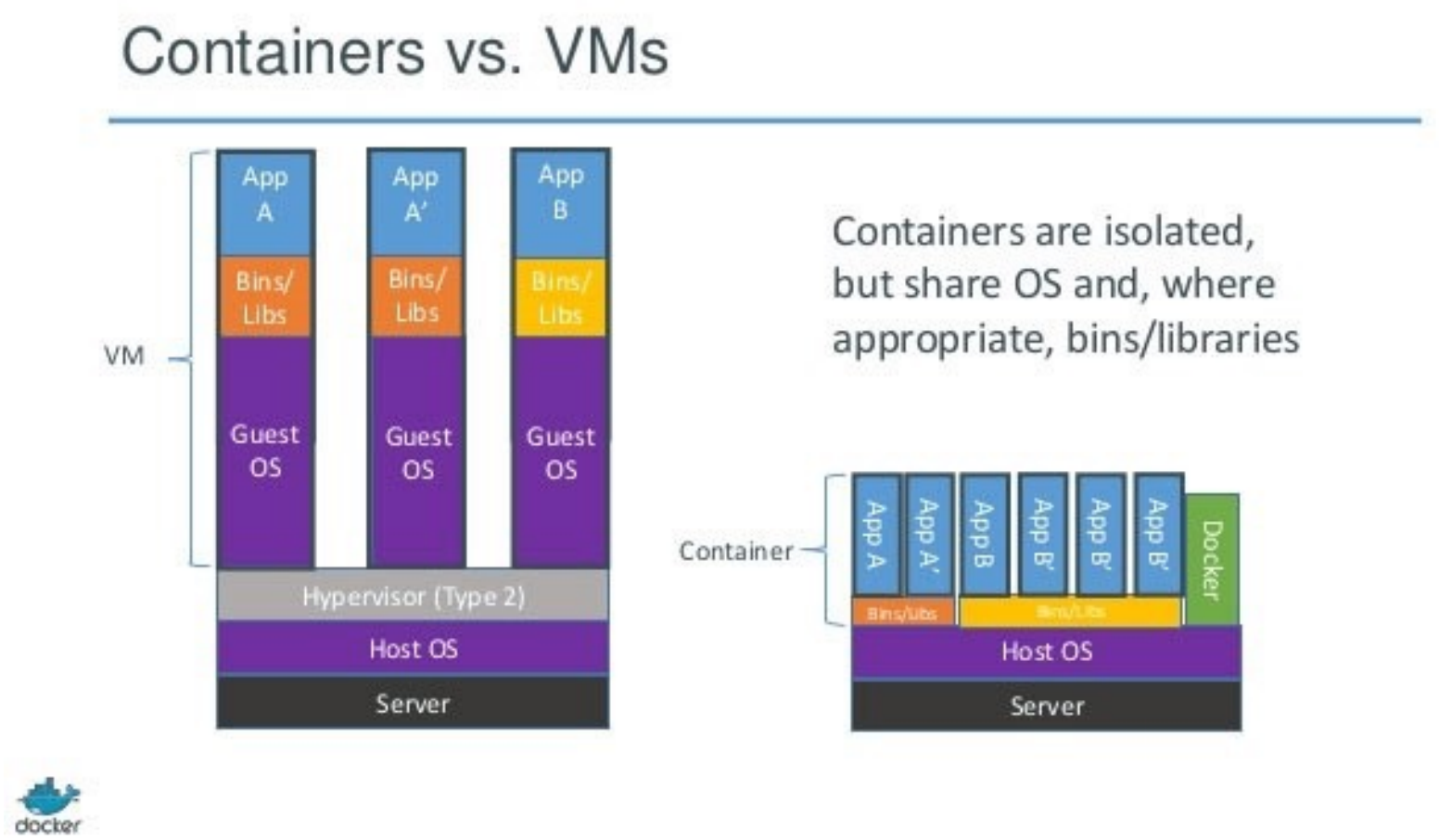


New Business Services

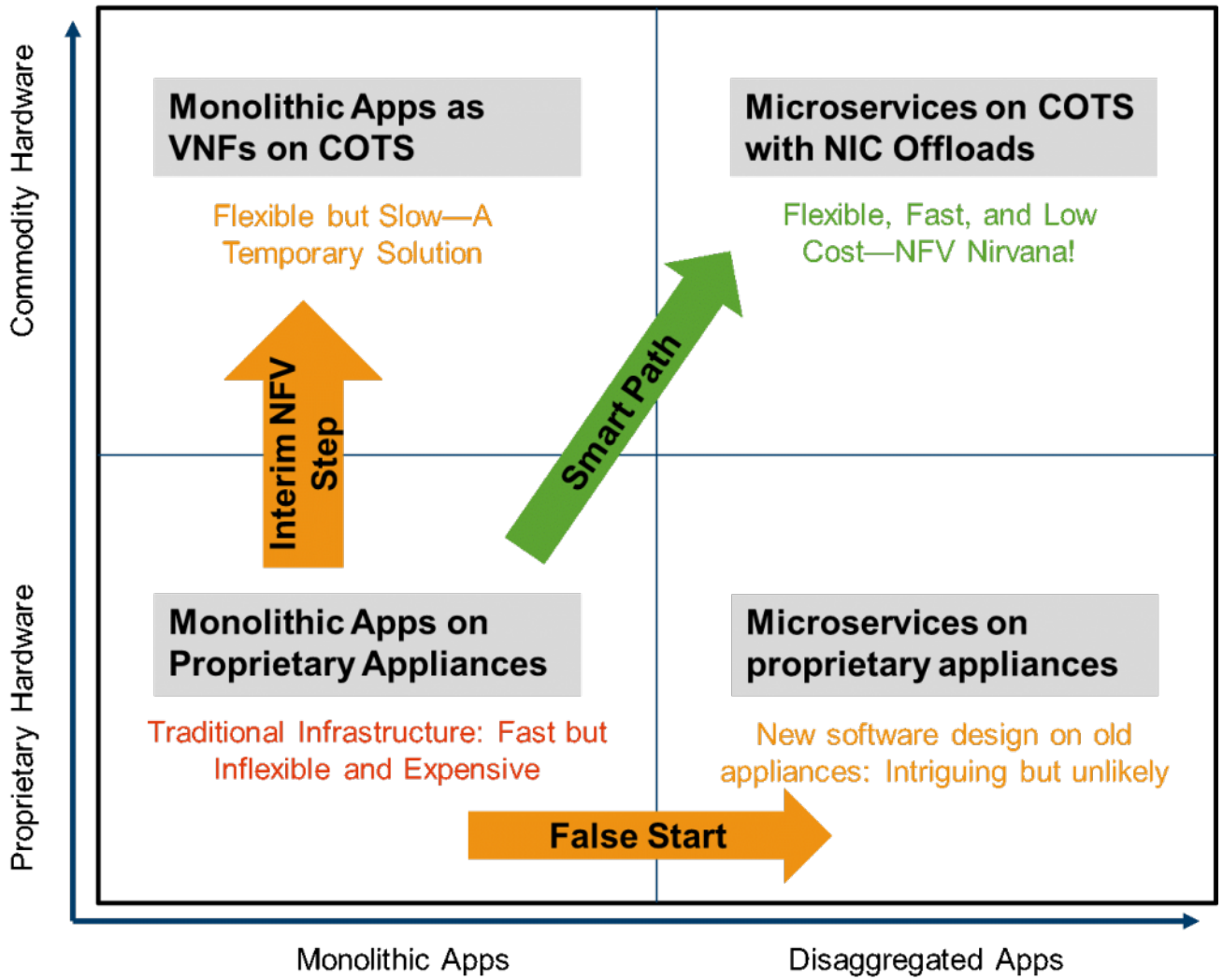


Consumption-Based Capacity Growth

Containers are the new Virtual Machine



Containers Make it Easy to Convert Legacy Appliances Into Microservices



Microservices vs “Plain Old” NFV

- Microservices means disaggregating the parts of a monolithic application into **many small parts** that can interact with each other and scale separately.
- Suppose my legacy appliance **inspects packets**, **routes** them to the correct destination, and **analyzes suspicious traffic**.
- As we deploy more appliances, we get these three capabilities in the same ratio, even though one customer (or week, or day) might require substantially more routing and very little analysis, or vice versa.

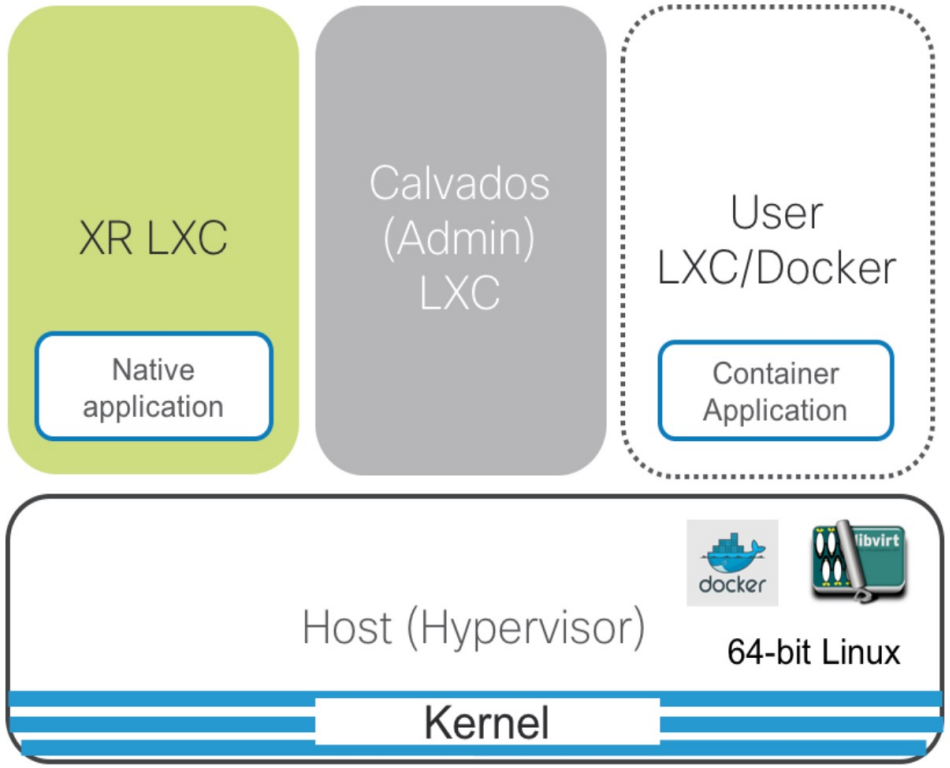
NFV moves network functions from dedicated appliances to COTS servers and microservices disaggregates monolithic functions into scalable components.

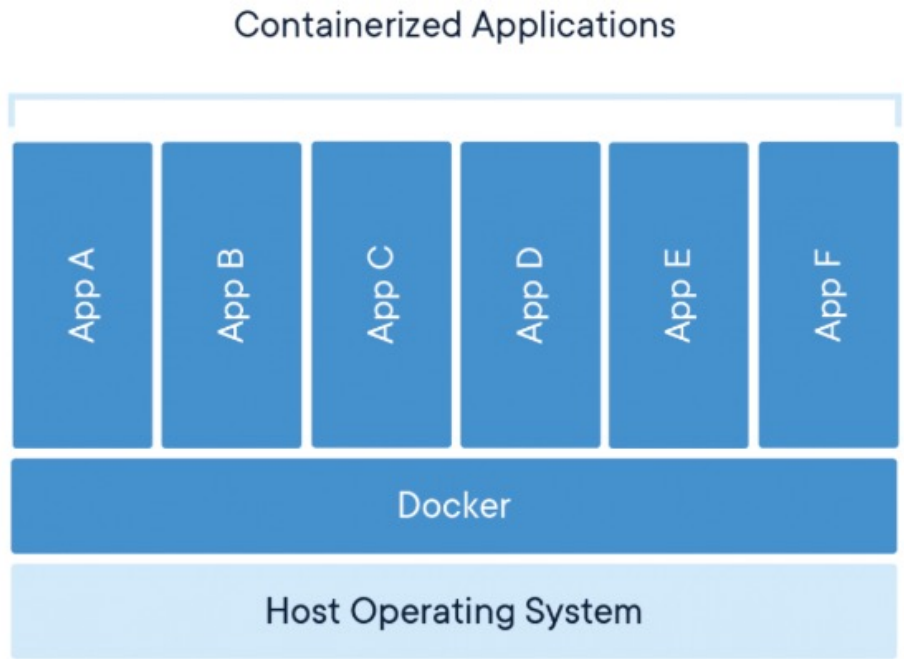
App Hosting in Routers

App Hosting in Routers for Far-Edge Computing

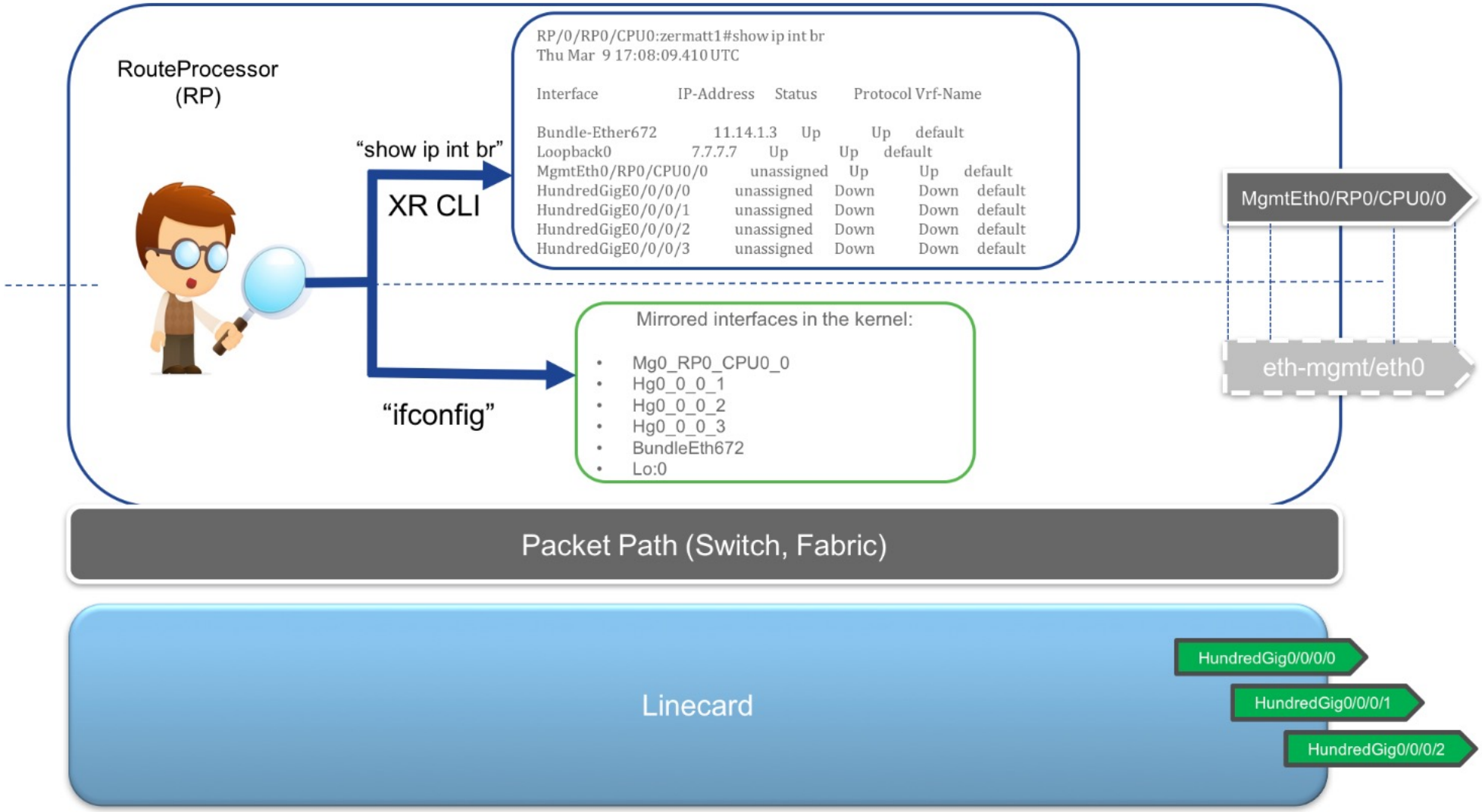
	N540-24Z8Q2C-SYS	N540X-ACC-SYS	NCS 5001/2-SE	NCS 55A1-36H-SE-S	55A2-MOD-SE-S NC55A2-MOD-SE-H-S	N540X-12Z16G-SYS N540-12Z20G-SYS	N540X-16Z4G8Q2C N540-28Z4C-SYS
Route Processor	4-core (1.5Ghz x86)	4-core (1.5Ghz x86)	8-core/12-core (2Ghz x86)	8-core (1.6Ghz x86)	8-core (2Ghz x86)	4-core (1.7GHz x86)	8-core (1.7GHz x86)
CPU Memory	32 GB	16 GB	32 GB / 64 GB	32 GB	32 GB	8 GB	8 GB
Disk Storage	128 GB SATA	128 GB SATA	64 GB SSD	128 GB SSD	128 GB SSD	32 GB eMMC	32 GB eMMC
Edge Compute (vCPU)	1-phy-core	1-phy-core	2-phy-core	2-phy-core	2-phy-core	1-phy-core	1-phy-core
Edge Compute (Memory)	4 GB	2 GB	4 GB	4 GB	4 GB	1 GB	1 GB
Edge Compute (Storage)	8 GB	8 GB	8 GB	8 GB	8 GB	1GB	1GB
App Hosting Matrix							
Bootstrap Srvr	✔	✔	✔	✔	✔		
Netrounds	✔		✔	✔	✔		
Cell Site Mon	✔	✔				✔	✔
Radware Dpro	✔						

LXC-Based Deployment
(Contemporary platforms like NCS55xx, NCS5xxx platforms)





What is exposed to Docker ?



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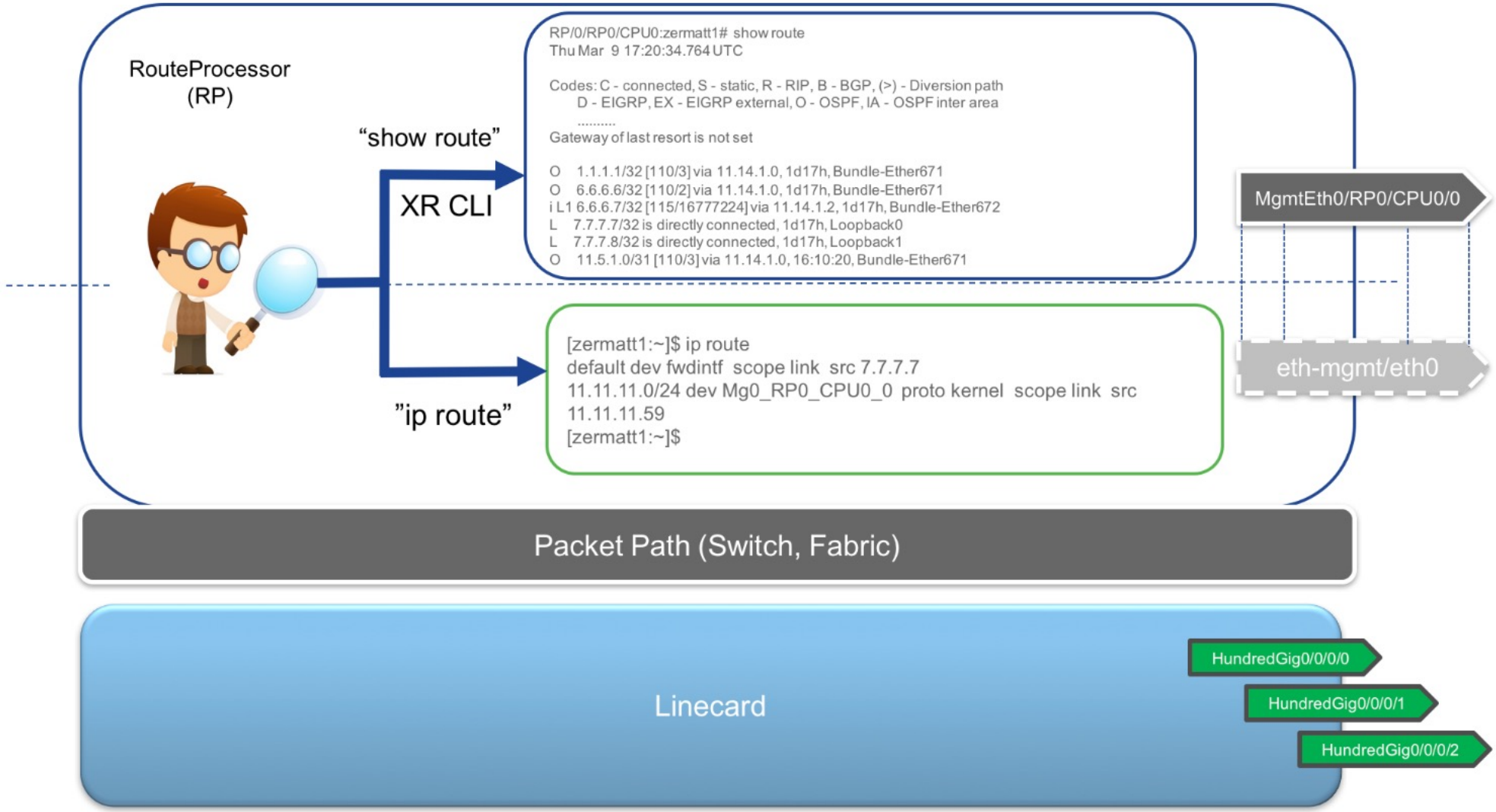
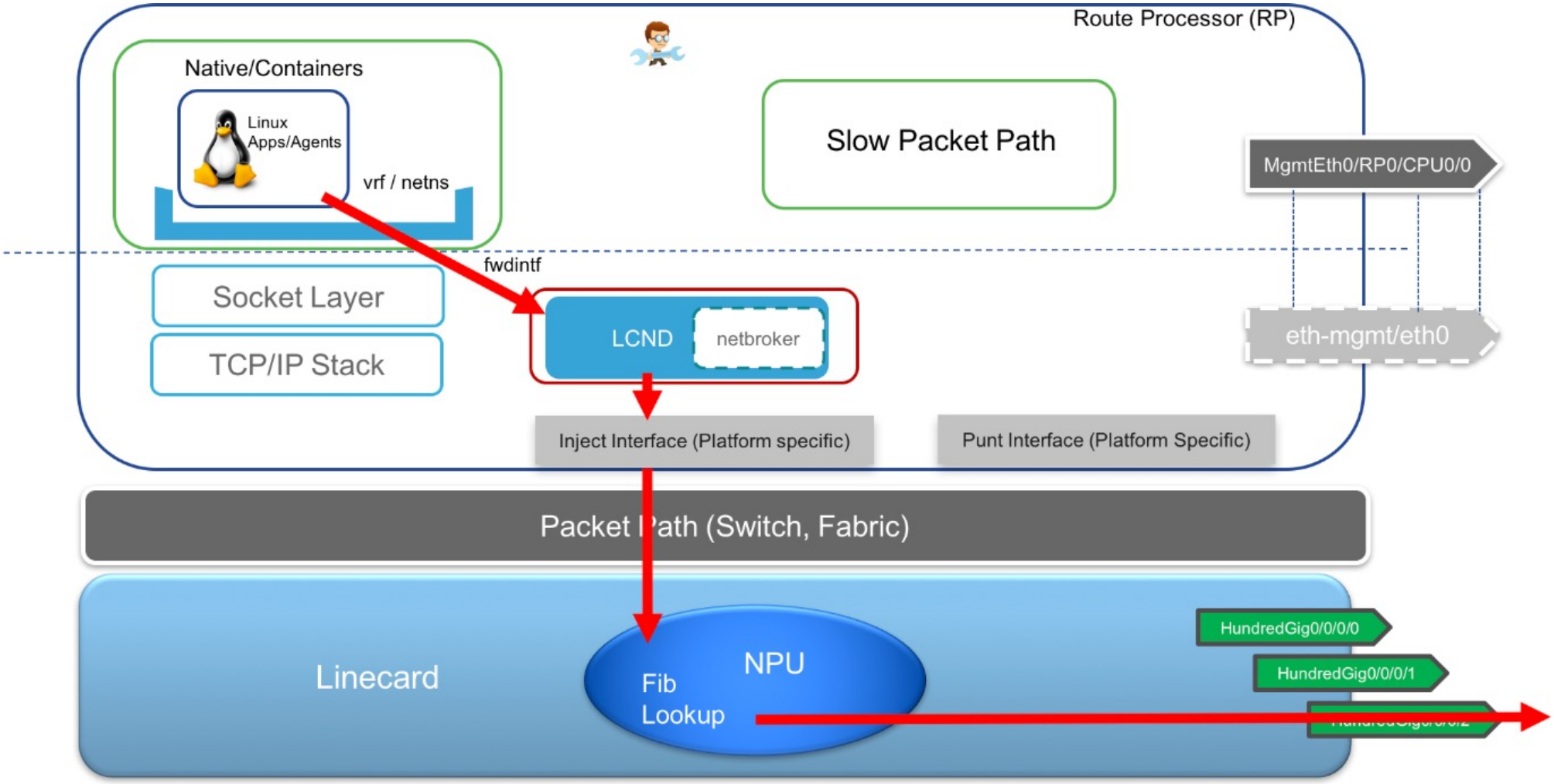
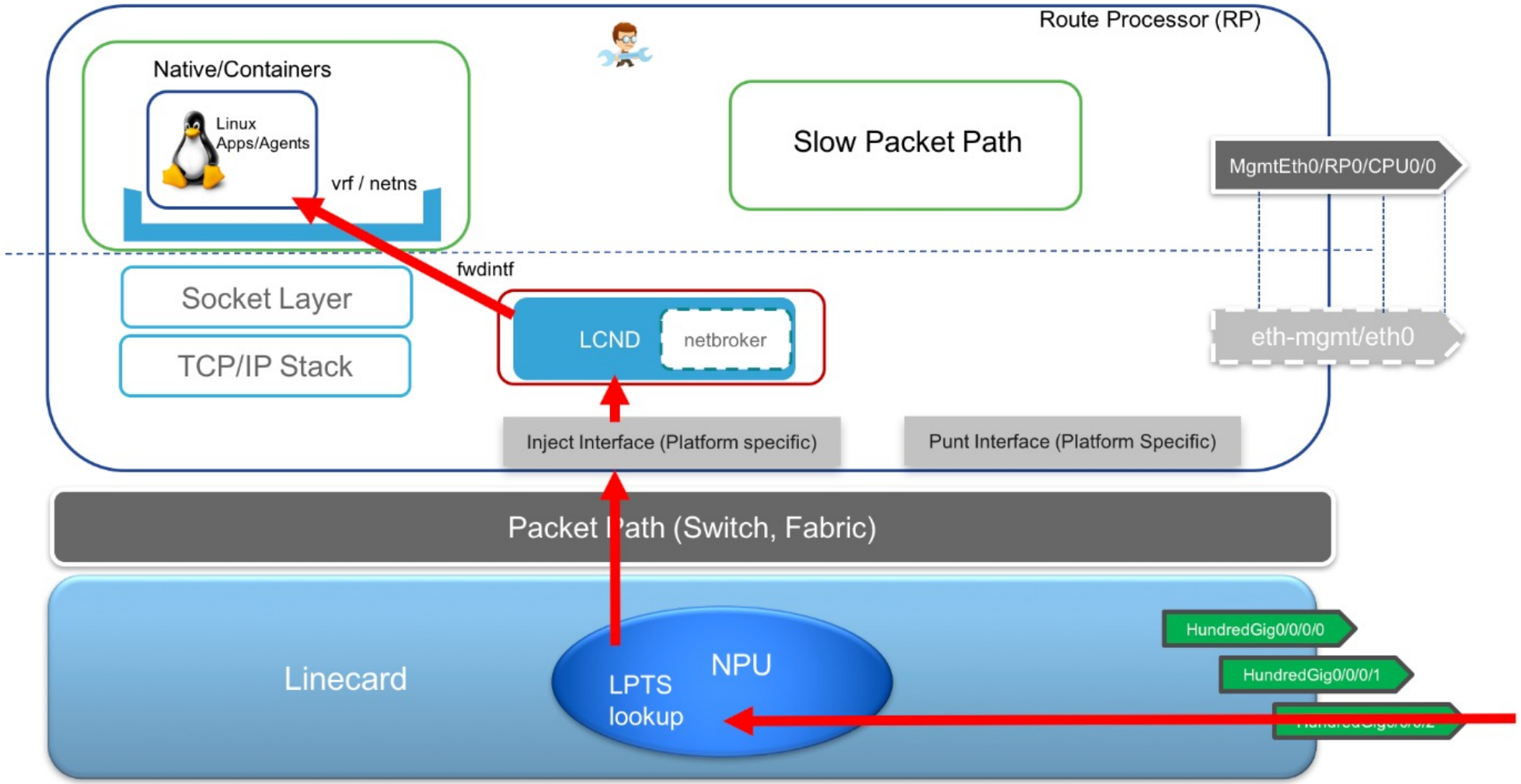


Packet TX from Docker



Packet RX to Docker ?



Use Cases

Applications	Business Outcomes	Areas
Bootstrap Server	Automated device onboarding, reduced truck rolls	Minimum Touch, Lower Opex
Out- of- band Access	Alternate management access to remote devices	
Cell Site Monitoring	Environmental visibility and decision making at remote locations	Infra Monitoring
Mobility DDoS solution	Better / quicker DDOS mitigation	
Telemetry Collection & Analysis	Distributed, scalable solution to network/device visibility & analysis	Infra Testing
Telemetry via gRPC & output Kafka data	Avoid deploying telemetry collectors	
Service Activation/Assurance	Distributed Service Testing & SLA Monitoring without additional HW	
Video Quality Monitoring	Deep Neural Network to generate Video KPIs & monitor user QoE	Enterprise Services
Video Quality Enhancement	Lower caching requirements	
Video BW reduction using fingerprinting	Massively reduce uplink video bandwidth by using latest AI tech	
Emergency Notification System	Smart City Application to monitor Environmental & Security hazards	
vOLT ų Radisys	Market disruption with SD- PON / vOLT	vOLT