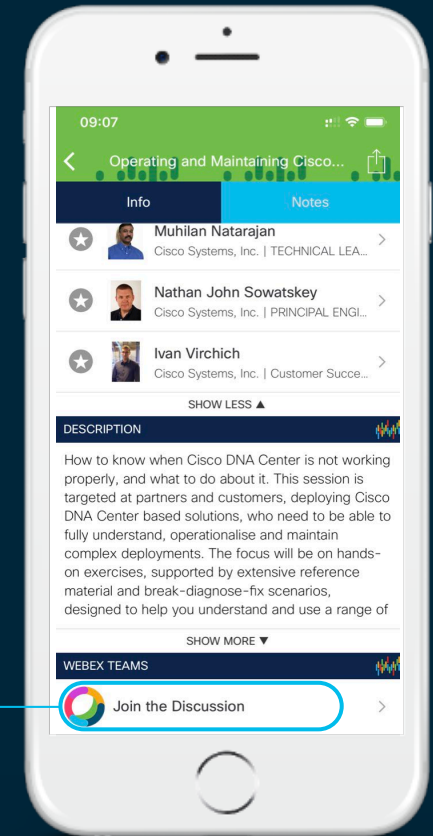# Cisco Webex Teams

Questions?
Use Cisco Webex Teams to chat
with the speaker after the session

How

1 Find this session in the Cisco Events Mobile App

2 Click "Join the Discussion"

3 Install Webex Teams or go directly to the team space

4 Enter messages/questions in the team space

Agenda

- New opportunities and new challenges with 5G

- Virtualization Options & Cloud-Native evolution

- Virtualization Challenges
  - Platform performance
  - Service Assurance

- Service Provider Transformation Requirements

New opportunities and new challenges with 5G

When did you start working on mobility?

I'm new to mobility

2G

3G

4G

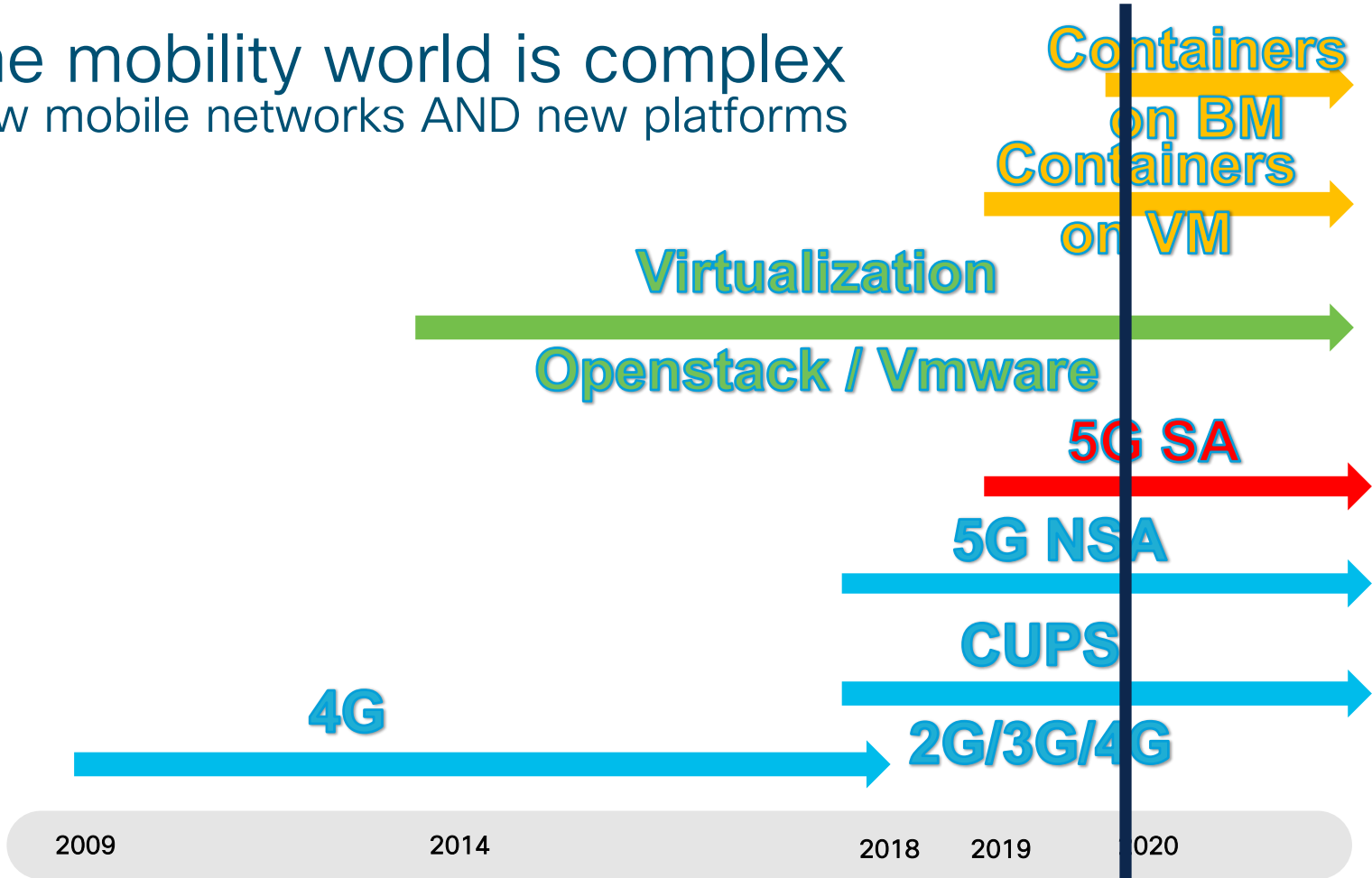# The mobility world is complex
New mobile networks AND new platforms

Containers on BM

Containers on VM

Virtualization

Openstack / Vmware

5G SA

5G NSA

CUPS

4G

2G/3G/4G

2009   2014   2018   2019   2020

Increased Network / Service Complexity

SGSN   GGSN

Transportation Autonomous Vehicles Automotive — IOT — Augmented Reality Virtual Reality — Smart City Traffic Management Emergency Services — Manufacturing Robotics — Tactile Internet — Health Fitness and Healthcare — Smart grid Utilites — Government — Smart Office

NSSF — AUSF — UDM — UDR — NEF — CHF — NRF — NWDAF

SEPP — SMSF — AMF — SMF — PCF — AF — BSF

Nnssf — Nausf — Nudm — Nudr — Nnef — Nchf — Nnrf — Nnwdaf

Nsmsf — Namf — Nsmf — Npcf — Naf — Nbsf — APIs (HTTP/JSON)

N1 — N2 — N4

UE — (R)AN NG- RAN, Fixed — N3 — UPF — N6 — DN

N9

N3IWF

5G Core architecture is very different
many new reference points and specifications

VPLMN | HPLMN

23.501, 23.502, 23.503: 5GC Stage 2

29.500, 29.501: SBA, Services
29.571: Data Types
33.501: Security

33.126/127/128: Lawful Intercept Stage 1/2/3
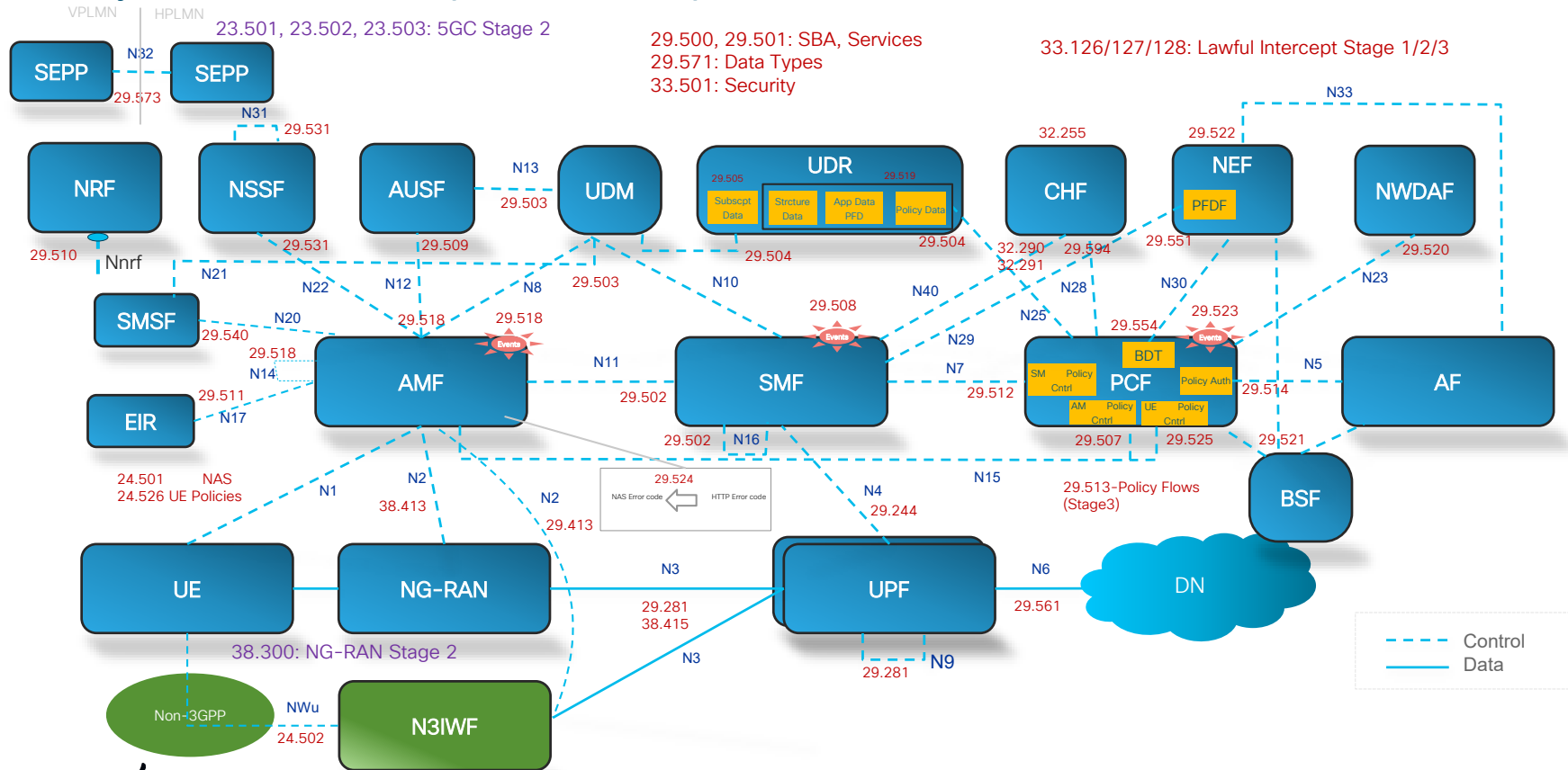
The SP as Digital Service Provider
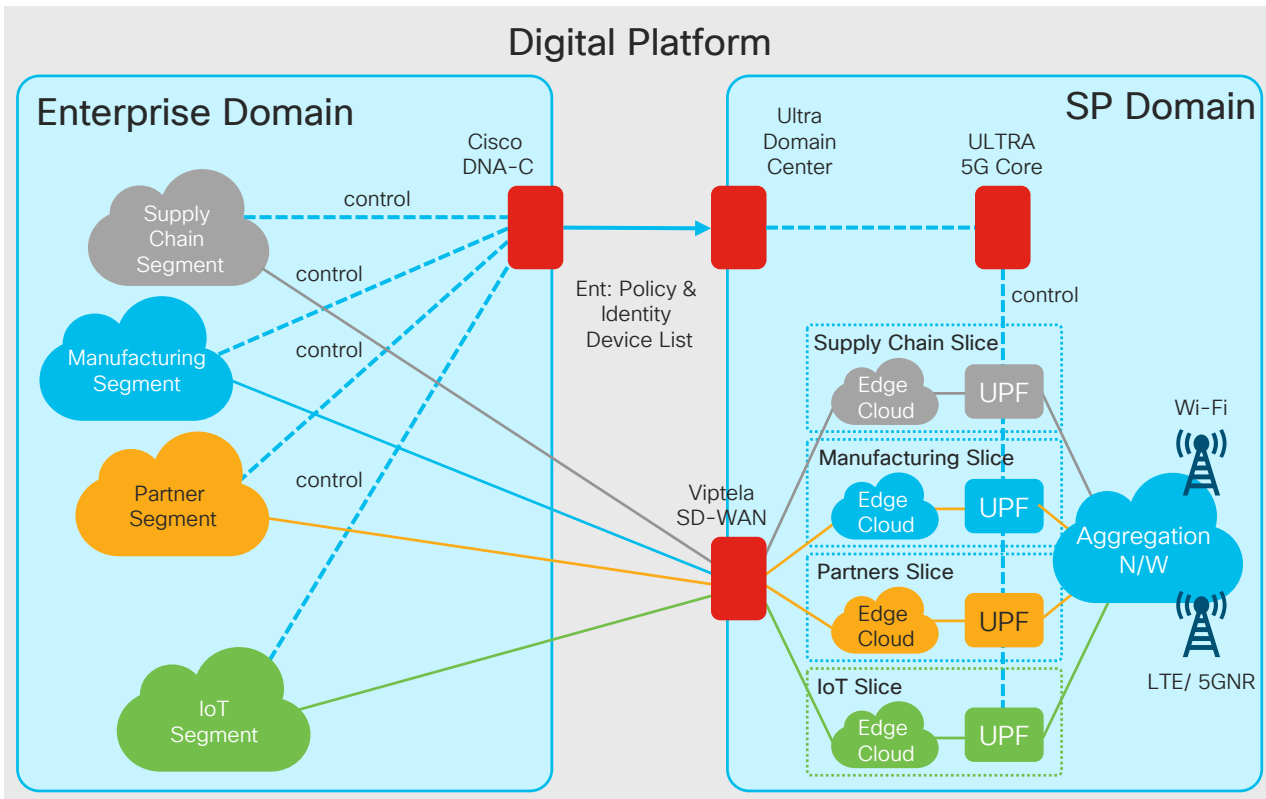
Enterprise Needs

Reach
- Extension of their network into the SP Domain

Control
- Over their devices and identities in the SP Domain
- Policies on security, identity and device

Multi Access
- Wi-Fi and 5G NR are complementary
- 5G NR–determinism
- Wi-Fi for enterprise ubiquity

SP Opportunity
- The SP can scale to serve multiples of such platforms

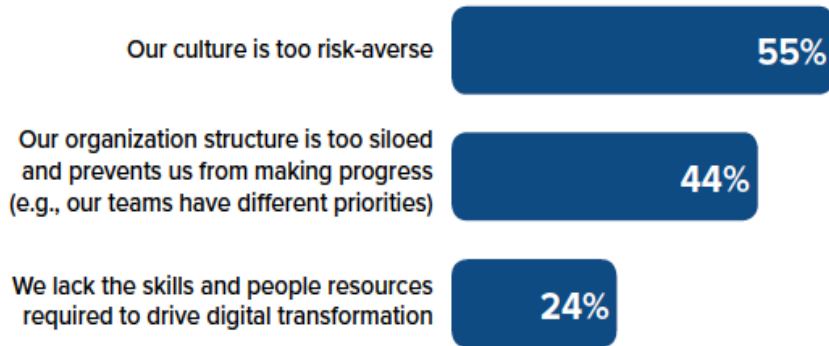# A history lesson about technology transitions

No more coal
New tracks

→

There are times when a technology and architecture shift are required: further incrementally optimizing the existing technology and product will not yield long term success

Are Service Providers ready for this?

Q. What are your top 3 challenges in meeting your Digital Transformation (DX) priorities?

- Our culture is too risk-averse — **55%**
- Our organization structure is too siloed and prevents us from making progress (e.g., our teams have different priorities) — **44%**
- We lack the skills and people resources required to drive digital transformation — **24%**

N = 400
Source: IDC SP Digital Readiness Survey, June 2018

From real RFQs:

"3000 APNs per chassis but it must be future proof i.e. "cloud native""

"Include all software enhancements of the future but max one upgrade per year"

"5G Standalone Architecture but don't ask to change billing system"

"Network slicing but also support the dozens of different corporate APN deployment models of the last 15 years"

"Any-G"

Are you ready for this?

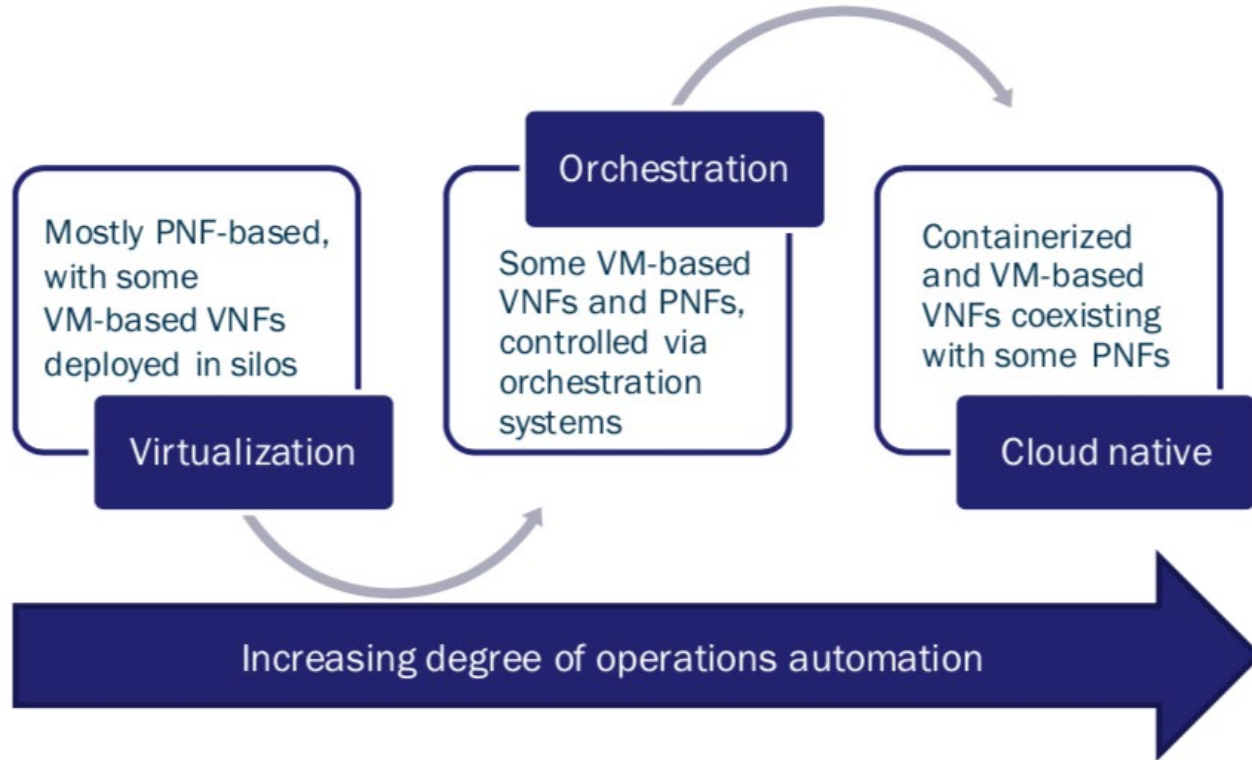## How is the Openstack networking service called?

Proton

Electron

Neutron

Atom

Virtualization Options & Cloud-native Evolution

Network Virtualization Phases

Source: Analysis Mason, 2018

Early days of Virtualization
PNF –> VNF Migration

VM1 – Control Function (Active)	VM2 – Control Function (Standby)	VM3 – Service Function (Standby)	VM4 – Service Function (Demux)
Controller Tasks: VPN, Port, Session	Controller Tasks: VPN, Port, Session	SessMgr (standby) AAAmgr (standby)	
High Availability Tasks Resource Manager	High Availability Tasks Resource Manager	NPUsim	Demux processes
Hypervisor	Hypervisor	Hypervisor	Hypervisor

OAM ← "Internal" backplane → Traffic

Fabric interconnect

| Hypervisor	Hypervisor	Hypervisor	Hypervisor
NPUsim	NPUsim	NPUsim	NPUsim
SessMgr AAAmgr	SessMgr AAAmgr	SessMgr AAAmgr	SessMgr AAAmgr
VM5 – Service Function (Sessions)	VM6 – Service Function (Sessions)	VM7 – Service Function (Sessions)	VM8 – Service Function (Sessions)

Cisco VPC-DI (since 2014)

- Same software architecture as known already from dedicated legacy hardware platforms

- Hardware functions like NPU replaced by software

Adding management and orchestration
## Network Function Virtualization
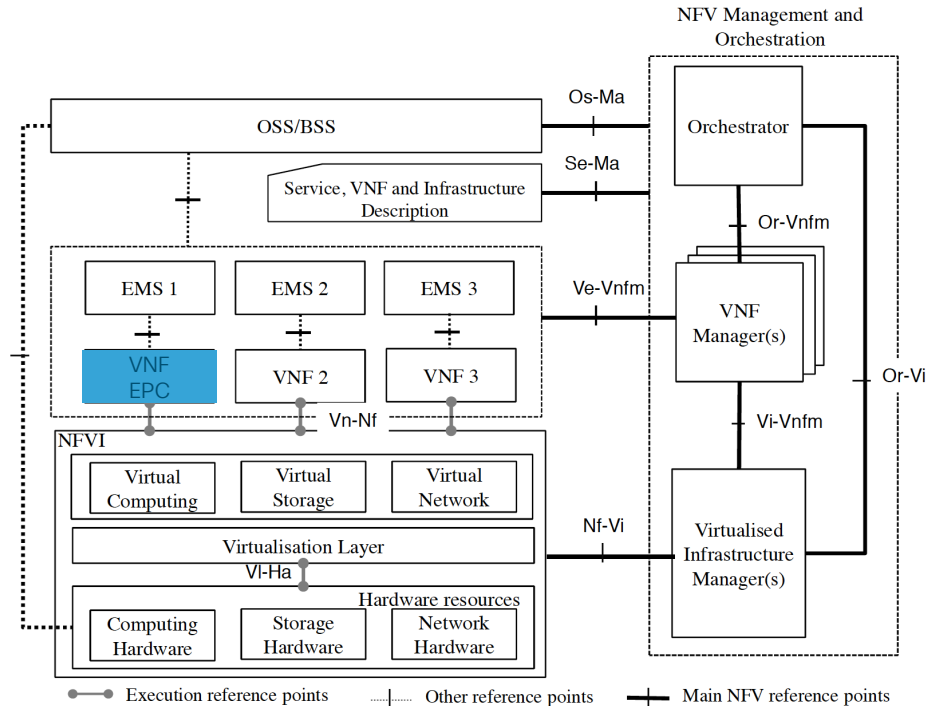
- ETSI Industry Specification Group (ISG) for NFV has defined a complete architecture framework

- Includes not only the Virtual Network Function (VNF), but also

  - a complete NFV Management and Orchestration Layer

  - a Virtualization Layer as part of the NFV Infrastructure

  - plus extensions to the OSS/BSS layer

NFV deployment models
Challenges and alternatives

DIY Focus
Fully Disaggregated

MANO	MANO	MANO
VNF	VNF	VNF	VNF

| Virtualization		Virtualization
Hardware	Hardware	Hardware
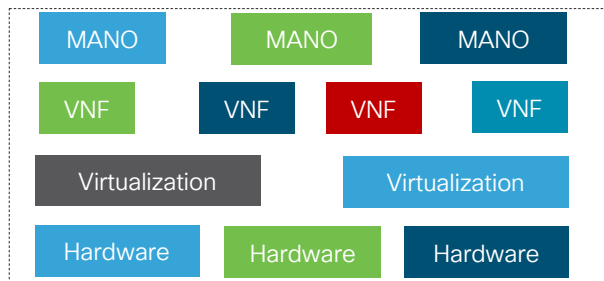
- Fully disaggregated approach
- Customer or SI integrates
- Customer assumes integration costs
- Customer triages problems

Many operators struggled for years with this model and few actually run network functions on their Telco cloud

Integrate Infrastructure Focus
Common & Horizontal NFVI

MANO	MANO
VNF	VNF	VNF	VNF

| Virtualization |
|----------------|
| Hardware |
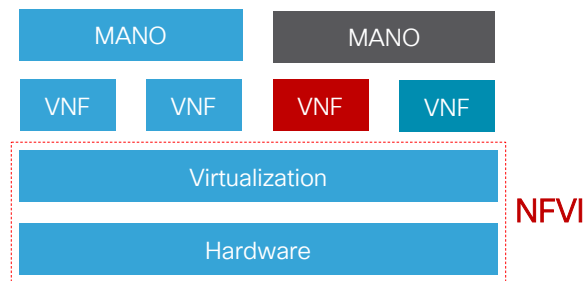
NFVI

- Common, horizontal carrier-grade NFV infrastructure for multiple use cases
- Pre-integrated, tested and validated NFVI with single point of ownership
- End to end support (aka Solution Support)

Several successful deployments (such as T-Mobile US running the largest virtualized packet core) using the "Ultra-M" model

CISCO Live!

Cisco solution for Mobility Telco Cloud
Codename "BlueStack"
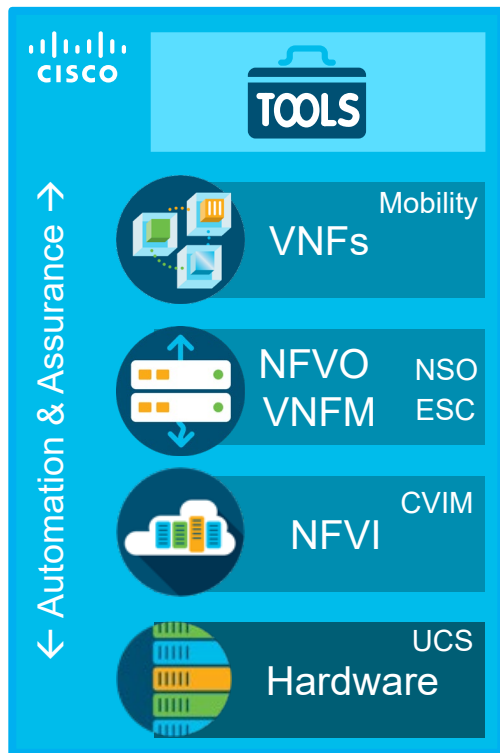
Objective

- Deliver carrier grade "standardized" Cisco NFVI Telco Cloud with Cisco on Cisco Reference Architecture
- Onboard mobility VNFs followed by 3rd party VNFs
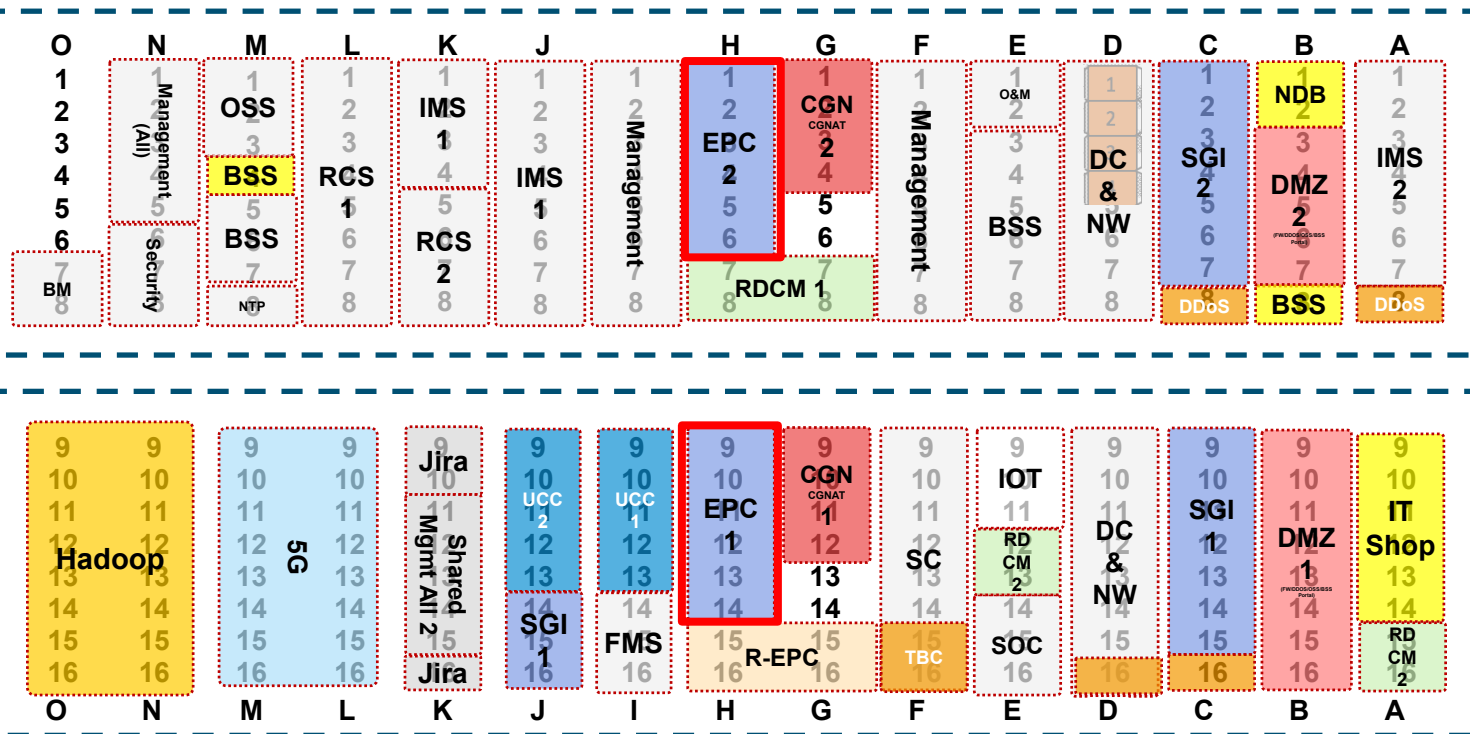- Drive down TCO, upgrade challenges and variations of stacks

Solving

- **Customer Problem:** SP forced to be the integrator
- **Cisco Problem:** Testing/Supporting many variants

Approach

- Solution owned by CX organization with support from multiple product teams
- Bundled price – including vEPC, H/W, Solution Support, CX Advanced Services, Automation
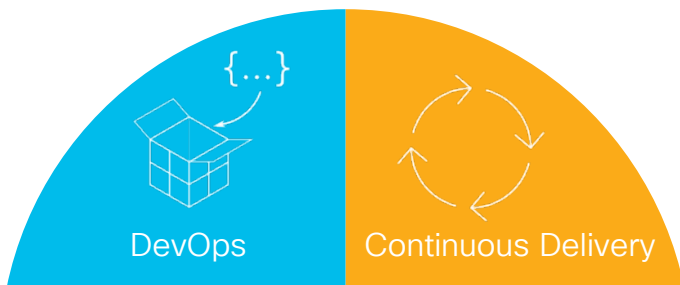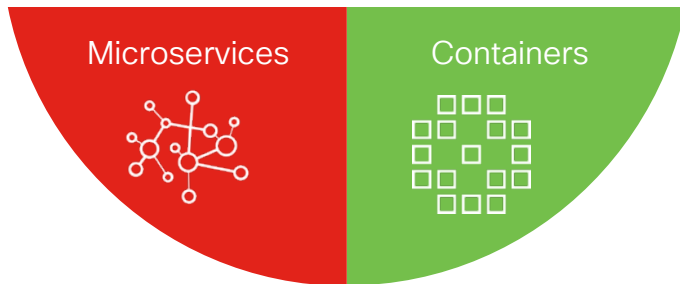
A reality check

- Dedicated racks per application
- No room to scale
- Space, power, cooling, connectivity etc. impact the data center design

120 racks

Cloud Native Principles

Cloud-Native

DevOps · Continuous Delivery · Microservices · Containers

Microservices

- Modular, loosely coupled software services
- Individually deployed and lifecycle managed

Containers

- Virtualization and management of Microservices
- Highly portable to different deployment targets

Continuous Delivery

- Automated integration, validation of containers

DevOps

- Automate and manage rapid deployments
- Isolate production changes and deploy once validated

Cloud Native Benefits

Lifecycle Automation — Automated instantiation and placement, upgrade, scale and recovery.

Multi-Cloud Portability — Mobile core disaggregation to the edge across public, private, and hybrid clouds.

Lightweight and Fast — Extremely fast startup times improves recovery and scaling event handling.

High Performance — Bypass the hypervisor overhead when deployed on bare metal. VPP based forwarding plane and vswitch.

Stateless Application Services — State services are separated from the application processing to simplify manageability.

Mobile Core Evolution

Cloud Native Design

N4   Nsmf

| Front end | Front end | Logging | Tracing |

Common Data Layer

| App Svc | App Svc | Data Store |
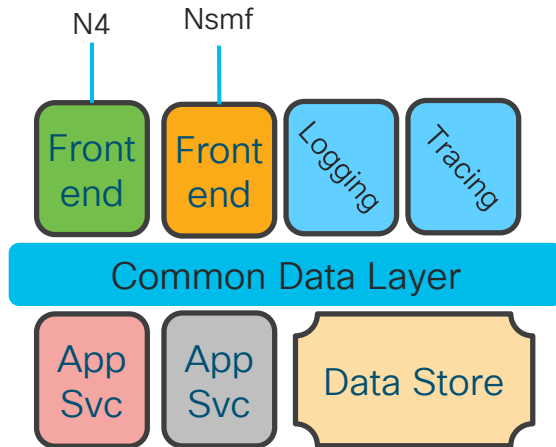
- ✓ Loosely-coupled Microservices
- ✓ Stateless Processing
- ✓ Common Capabilities
- ✓ Facilitating CI/CD

Kubernetes and Containers (CaaS)

- ✓ Lightweight and Fast
- ✓ Designed for Orchestration
- ✓ Portable
- ✓ Optimal resource utilization

Application Instrumentation

Grafana   JAEGER   KEEPALIVED

fluentd   Prometheus   Thanos   elasticsearch

HELM   NGINX   kibana   OPENTRACING
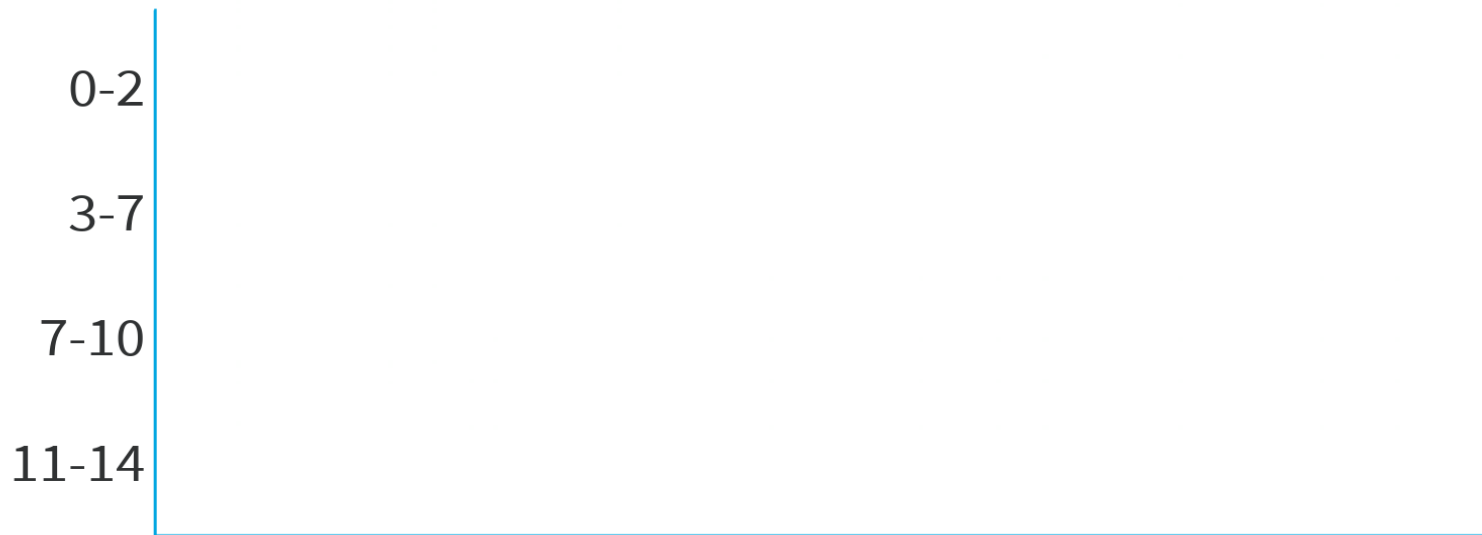
Istio   PROJECT CALICO   etcd

+

| Common Store | Ops-Center |

- ✓ Observability / Monitoring
- ✓ Configuration / SW MGMT
- ✓ Traffic Management
- ✓ Session Store

CISCO Live!

Are you familiar with Open Source and Cloud Native?

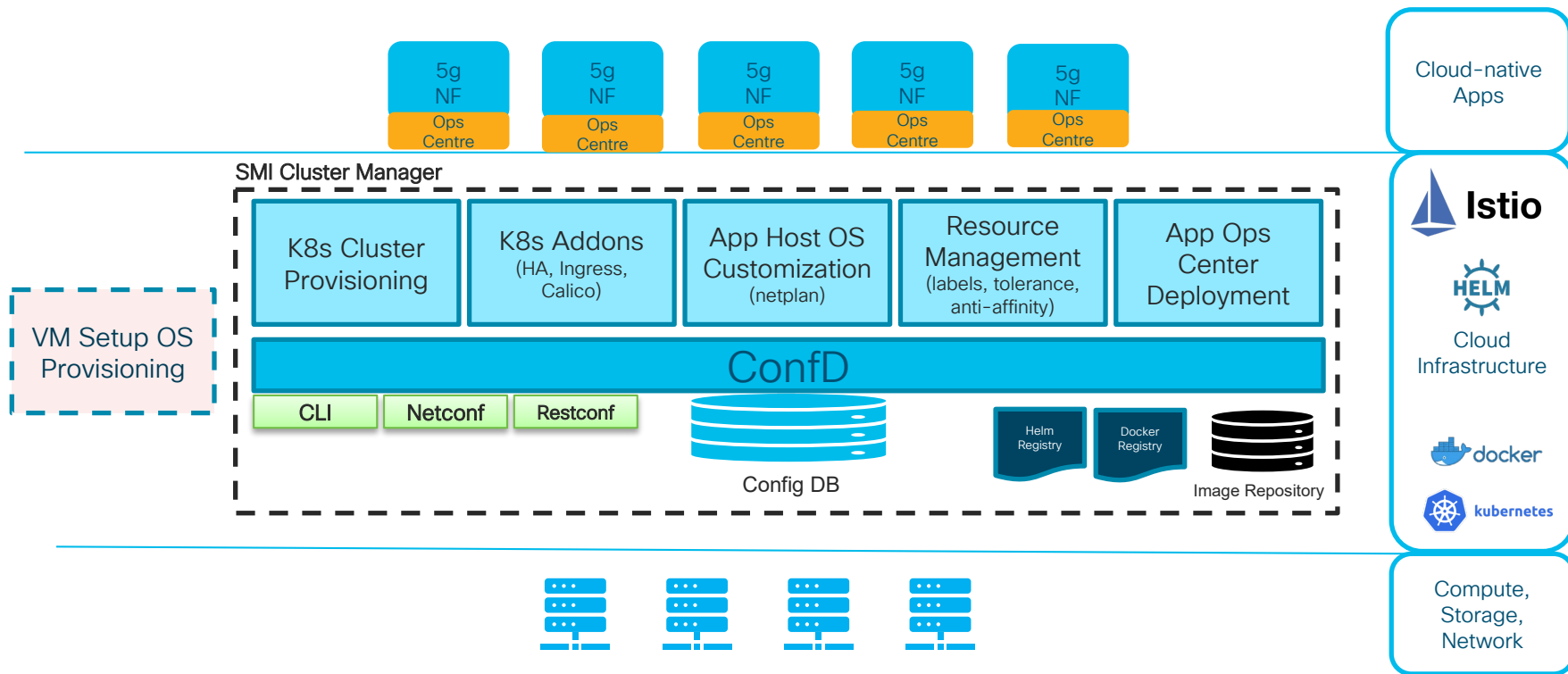## How many of the Open Source packages in the previous slide had you heard about before?

0-2

3-7

7-10

11-14

Subscriber Microservices Infrastructure
Keeping open source under control

Cloud-native Apps

5g NF	5g NF	5g NF	5g NF	5g NF
Ops Centre	Ops Centre	Ops Centre	Ops Centre	Ops Centre

SMI Cluster Manager

VM Setup OS Provisioning

K8s Cluster Provisioning	K8s Addons (HA, Ingress, Calico)	App Host OS Customization (netplan)	Resource Management (labels, tolerance, anti-affinity)	App Ops Center Deployment

ConfD

CLI Netconf Restconf

Config DB

Helm Registry Docker Registry

Image Repository

Istio

HELM

Cloud Infrastructure

docker

kubernetes

Compute, Storage, Network

CISCO Live!

Cloud Native Lesson Learned

Kubernetes Deployment

- Kubernetes Tuning
- Networking
- Storage
- Kubernetes Add-Ons

NF Management

- Air Gap Installation
- NF Install
- NF Configuration

Cloud Observability

- Metrics
- Alerts
- Logging
- KPIs

Platform and NF Lifecycle

- In Service Upgrades
- Canary Upgrade
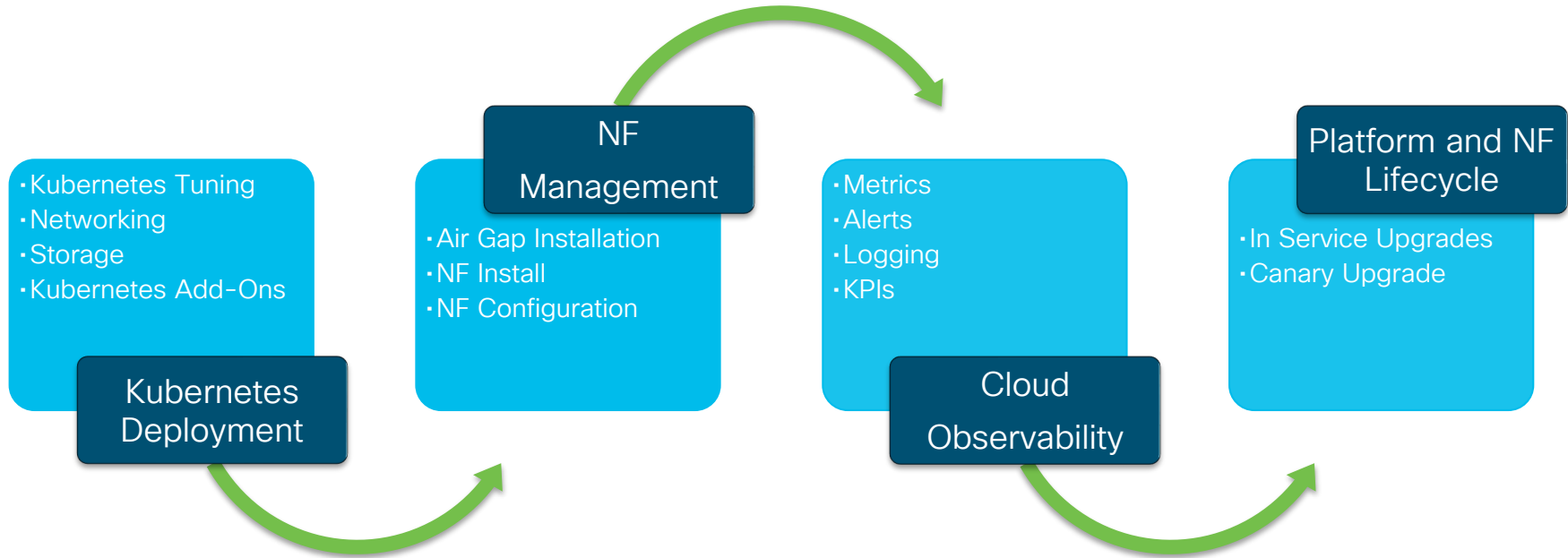
800+ Features in '19 -- GA in Jan '20 -- World-first deployment

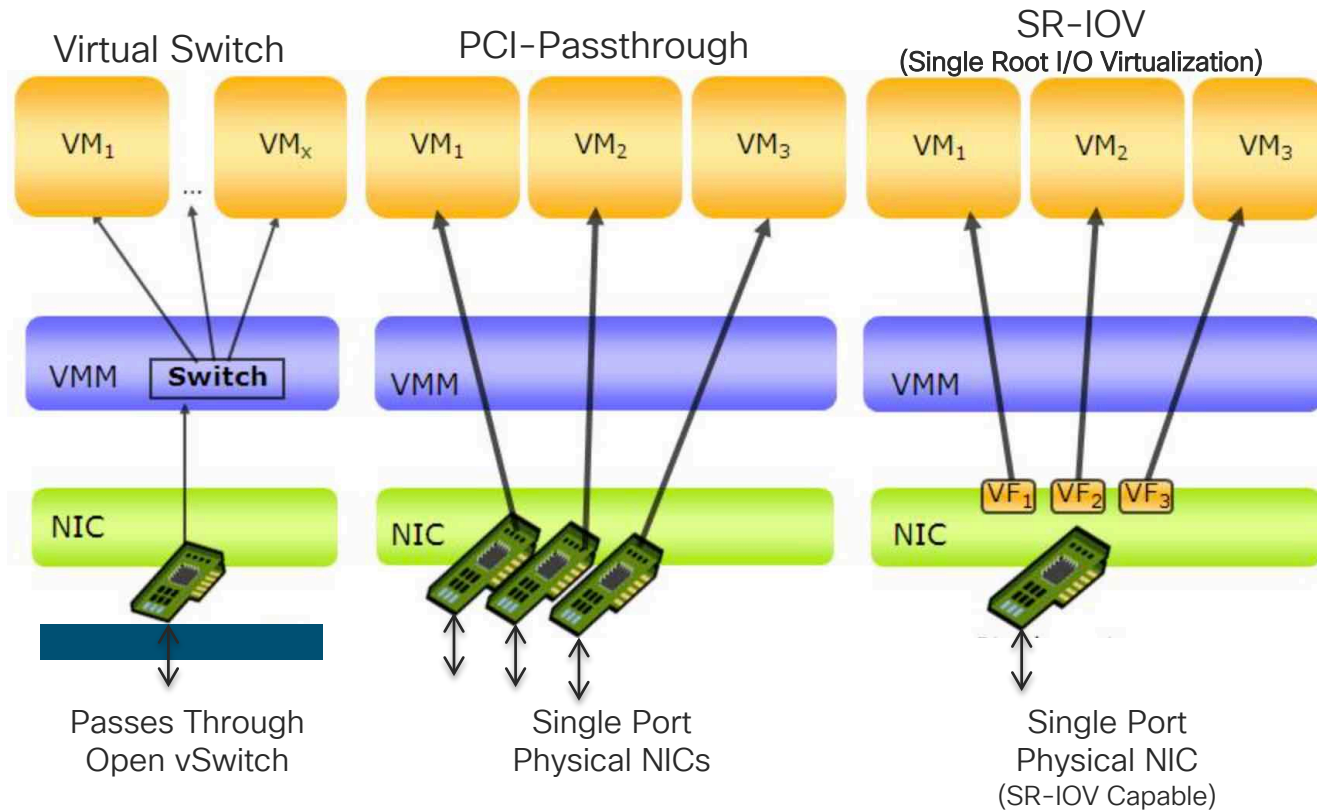# Virtualization Challenges

Platform performance
and Service Assurance

Many permutations for virtualized deployments

Variable	Description	Variants	Count
N(EXGW)	Number of VNF Gateway Functions	PGW, SGW, ePDG, MME	4
N(MANO)	Number of NFV-O MANO Environments	HP NFVD, ECM, NetCracker, RHEL Tacker HEAT, NSO/ESC	5
N(VIM)	Number of Virtual Infrastructure Managers	OpenStack Mercury, Ubuntu OpenStack, vSphere	3
N(HWCPU)	Number of hardware compute combinations	UCS-B, USC-C, HP C7000, HP DL360, Dell 630	5
N(HWNIC)	Number of hardware network combinations	Intel Niantic/Fortville/RRC (10 GbE/40 GbE/100 GbE), Cisco VIC	4
N(DPDK)	Number of DPDK modes	DPDK SR-IOV, DPDK PCI-PT, DPDK vSwitch + VHOST-user	4
N(EPA)	Number of hardware EPA attributes	Huge Pages, vCPU Pinning, IOMMU, DDIO	4

Examples above result in 19,200 different combinations

Impossible to test and measure performance for all

cisco Live!

I/O mechanisms

Virtual Switch

PCI-Passthrough

SR-IOV
(Single Root I/O Virtualization)

Passes Through
Open vSwitch

Single Port
Physical NICs

Single Port
Physical NIC
(SR-IOV Capable)

- PCI-Passthrough is not recommended because it requires a physical interface per virtual port

- SR-IOV achieves best performance because it accesses virtual ports on physical NIC

- Virtual switch provides the most flexibility but is slower

Data Plane Development Kit (DPDK)

DPDK-accelerated OVS with DPDK enabled VNFs
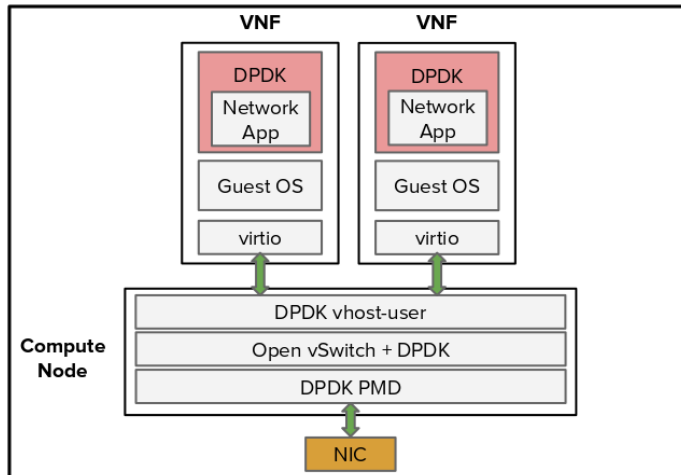
SR-IOV with DPDK enabled VNFs
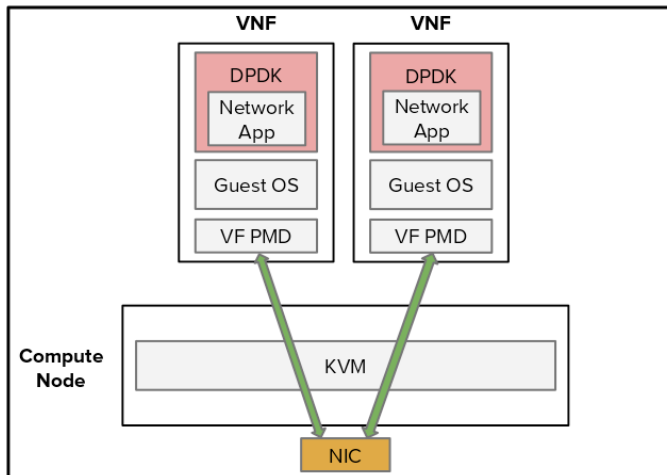
- DPDK can be used inside the VNF application (now the default for Cisco VPC) and in the virtual switch (e.g. OVS+DPDK)

- Key concept is the Poll Mode Driver (PMD): continuously scan the NIC for new packets instead of waiting for interrupt
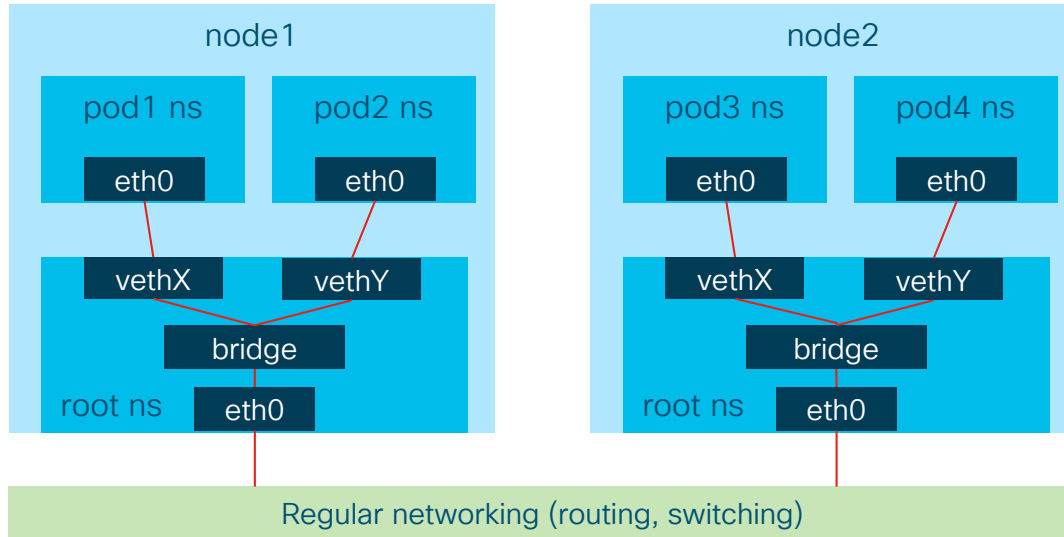
Compute Optimizations

- Configure NUMA for fast local memory access for CPUs

- Enable huge pages for fast memory searches

- Pin the vCPUs to physical CPU cores/threads

NUMA → Huge Pages → CPU Pinning
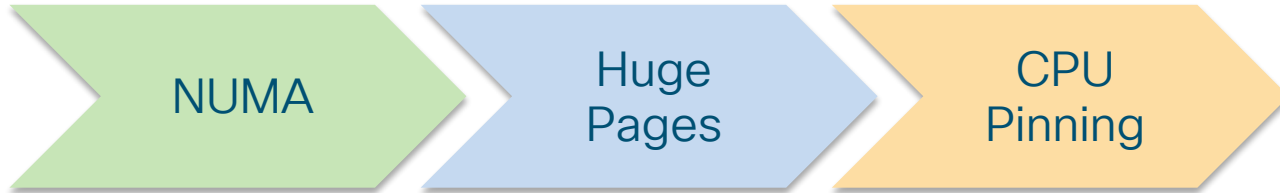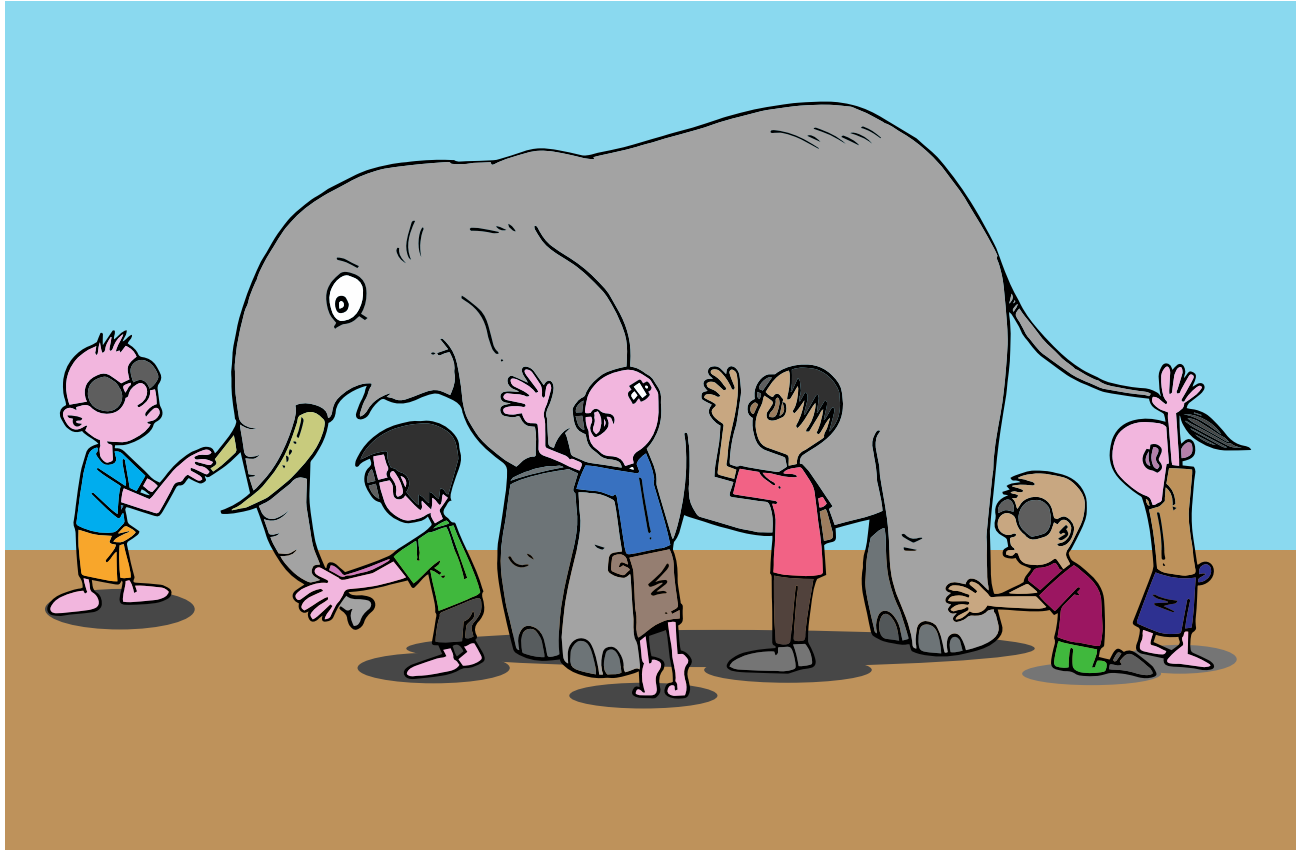
New challenges with containers
Kubernetes networking model

- Single IP address per pod does not fit network function model (packets in and out on different interfaces)

- "Multus" is possible alternative but has limitations

- SR-IOV into a container requires "privileged mode" i.e. a container can access all host devices (security concern)

Eventually this will be addressed but phased approach using VMs is suggested

The Service Assurance Challenge

Service Assurance in a Cloud-Native Environment

Probes and Tracing

CLI / NetConf Yang API

Data Store ◄── Trace output ── SMF

Visualization

3rd Party Collector

UPF

40G NIC

Session Manager-U

Trace Service

Packet Copy

VPP

40G NIC   40G NIC
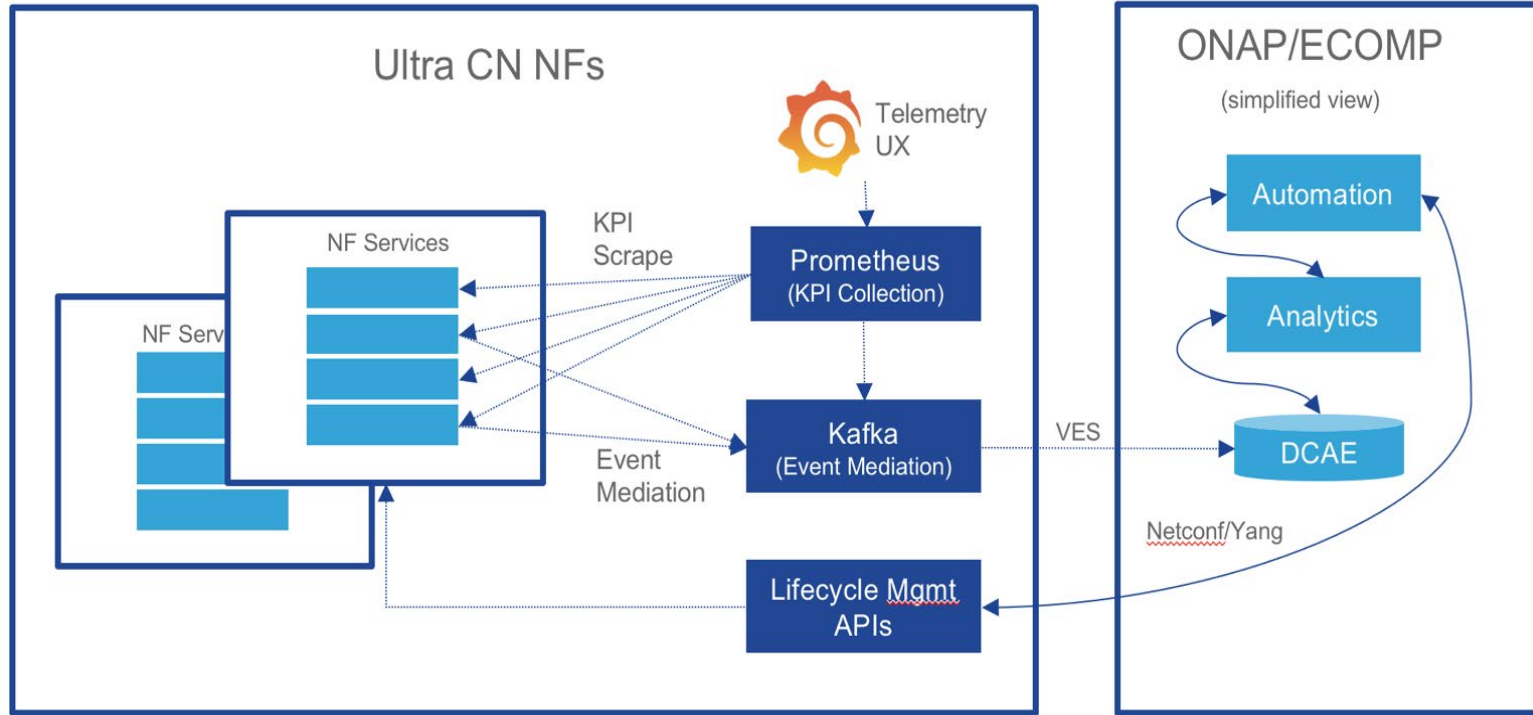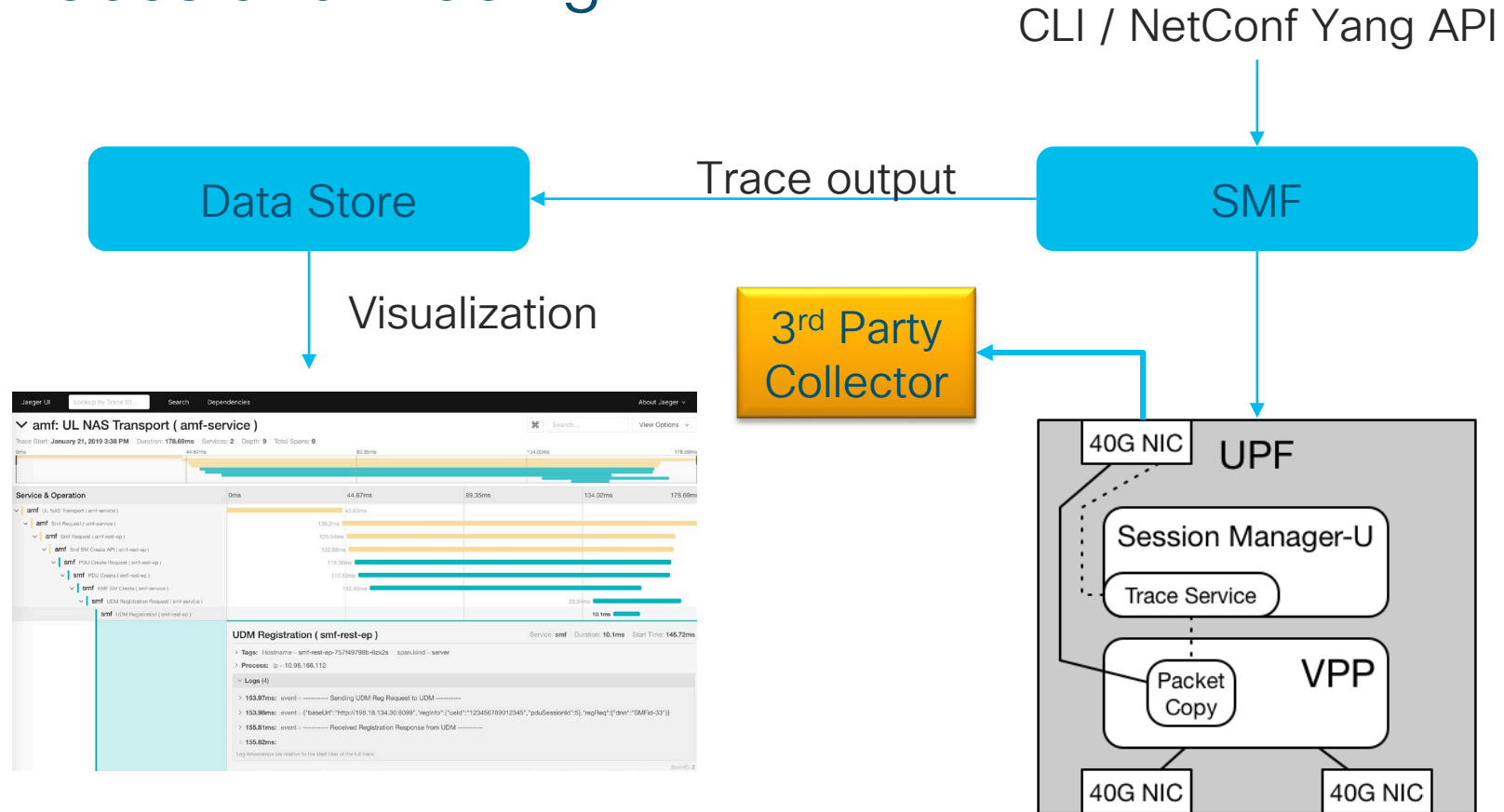
Automated Upgrades

Manual Software Upgrades

STEP 01
Manual MOP execution

STEP 02
Mass upgrade impacting all sessions

STEP 03
Verify to see if everything went ok

STEP 04
If it fails, begin rollback of software

TOO MANY ADMINS

HIGHLY RISKY

COMPLEX OPERATION

Automated, Incremental Upgrades

Instantiate a new VNF instance with the upgraded software

Direct a small portion of the subscribers/sessions to the upgraded VNF

2%

Monitor the upgraded VNF & verify key KPIs

Incrementally add more sub. / sessions to the upgraded VNF
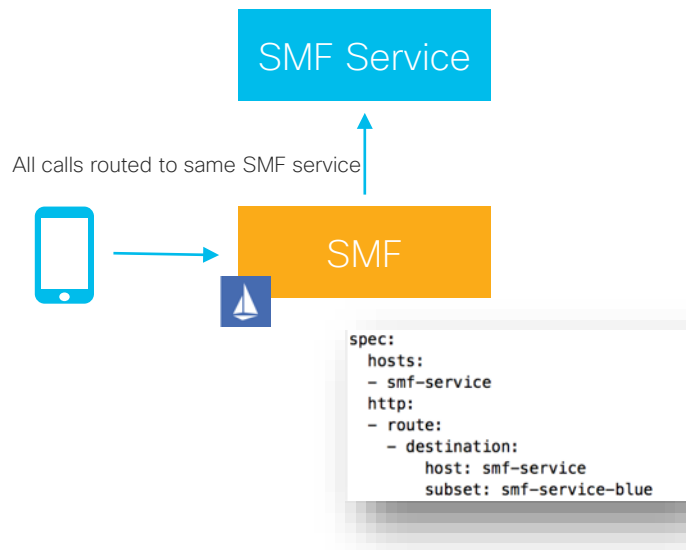
Canary

Retire original VNF instance once all sub. have been migrated

Canary Upgrade Example
SUPI Hash Based Routing

Default Behavior

Canary Rule Injected

SMF Service

SMF Service

SMF Service

All calls routed to same SMF service

SUPI Hash Prefix = 3

SUPI Hash Prefix != 3

SMF

SMF

```
spec:
  hosts:
  - smf-service
  http:
  - route:
    - destination:
        host: smf-service
        subset: smf-service-blue
```

```
spec:
  hosts:
  - smf-service
  http:
  - match:
    - headers:
        supi_hash:
          prefix: "3"
    route:
    - destination:
        host: smf-service
        subset: smf-service-green
  - route:
    - destination:
        host: smf-service
        subset: smf-service-blue
```

Selective routing of calls is done using ISTIO intelligent service mesh

SP Transformation Requirements

SP Transformation Requirements in the Virtualized World

- Skills gap running the platform

- Changing people's paradigm
  - Clouds are very different to traditional telco!

- Getting silo'd groups to work together

- Getting a consistent deployment process and post deployment customizations

Is your organization ready for CI/CD?

How often do you perform network upgrades?

Never touch a
running system

Once per year

Twice per year

Once per quarter
or more

Service Provider transformation
Changing network software and configurations

Today

- Software is only updated once a year
  - Although vendors are releasing software with new features and big fixes now almost monthly, operators are still not prepared to upgrade more than once a year
  - Software is tested for weeks and months in a lab

- Any change is done very carefully
  - Network freezes prevent any changes for months
  - Even smallest configuration changes are done in maintenance windows at night

Alternative

- Implement automation pipelines to automatically receive new software updates and perform initial testing

- Use Canary testing approach to validate new software and any changes in the field

- Improve system resiliency to tolerate failures instead of trying to avoid them

Service Provider transformation
Vendor integration and procurement

Today

- Vendor selection cycles are way too long:
  - Many of the larger operators went through multiple rounds of vendor selections with durations of 12–18 months; from RFQ preparation to deployment this easily meant two years where technology changed significantly

- 5 year horizon is far too long for TCO calculation and contract commitment
  - Many aspects required for price calculation change significantly (Hardware, optimization technologies, software enhancements)
  - Vendor landscape and political selection criteria may change significantly

Alternative

- Adding VNFs to an existing Telco cloud environment is much simpler than installing hardware
  - Vendor products can be compared and tested (e.g. for performance) under same conditions
  - Vendors need to prove that all product promises can actually be fulfilled

- Pricing can be made much more flexible (per month/day/hour instead of buying perpetual licenses)

Service Provider transformation
Capacity planning

Today

- Throughput performance is a key marketing and decision factor
  - "Gigabits" per subscriber (nice for demos but who needs that?)
- RFQs demand hardware dimensioning even though
  - Forecasts may change
  - Hardware platforms will change
  - Architectures may change
  - Call models have impacts but very few inputs are given or are reliable

Alternative

- Consider all the other scenarios where number of sessions, transaction rates etc. are more important than just throughput
- Consider call model impacts
- Test the performance of different vendors in lab environment instead of relying on a theoretical RFQ dimensioning
- Use real production data to extrapolate capacity needs once deployed

The bridge to possible
Rakuten and Cisco Customer Experience

Conclusion

Conclusion

- Traditional network appliance based infrastructure unsuitable for the future

- A Telco Cloud is required to meet SP goals around network agility, flexibility, efficiency, and scalability

- The move to Telco Cloud is a journey. Virtualization of network functions is a first step towards a cloud-native architecture ready to be provisioned, ported across Clouds

- Continuous Automation across all domains key to delivering on the benefits of the Telco Cloud environment

- The shift to cloud- and software-led networking requires that Service Providers reskill and adjust their processes / organisation

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Enjoy **"Running with the 5G Bull"** immersive demo

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Complete your online session survey

- Please complete your session survey after each session. Your feedback is very important.

- Complete a minimum of 4 session surveys and the Overall Conference survey (starting on Thursday) to receive your Cisco Live t-shirt.

- All surveys can be taken in the Cisco Events Mobile App or by logging in to the Content Catalog on ciscolive.com/emea.

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