“Virtualized network functions (VNFs) urgently need to be developed as **cloud-native** applications”

Doug Nassaur, Principal Technical Architect for AT&T’s Domain 2.0, Composable Telco Panel, Light reading

“With **virtual machines (VMs)** you get a lumpy and **slow-to-respond** system, but with **containers** you could **adapt more quickly**”

Peter Willis, Chief Researcher at BT, PARIS -- MPLS/SDN/NFV World Congress

“Biggest **NFV** challenge involves **transformation** of an organizational and cultural nature; moving to **DevOps**”

Niklas Sonkin, Sweden’s Tele2’s Chief operating officer, Light reading
The Evolving Network
5G - Finally The Bandwidth You Need
IOT - All Your Base Are Belong To Us

IoT is a huge opportunity

30 Billion
Connected devices in 2020

$2 Trillion Market

5G Driving IoT Growth

Connecting with Cellular

Secure
Scalable
Global Coverage
Service quality

Source: IDC
Need To Rethink Network Architectures
ETSI Network Function Virtualization Environment
Centralize And Distribute

Centralized control and distributed user planes moving services and applications closer to the edge

Meet high bandwidth/low latency requirements

Unlimited scale and Flexibility
Existing Network Architecture
Evolving Network Architectures
Need To Rethink Network Element Software Architectures
DON’T PANIC

ReThink ReBuild!
VNF Architectures - Where we are today? Monolithic

Virtual customer premises equipment (vCPE)
Today: VNFs and VNF Orchestration

- VNFs are pets
  - Monolithic VMs
  - Tightly Coupled
  - Stateful Persistent

- Virtual Infrastructure Manager (VIM)
  - Hardware dependent
  - Performance tuning
  - Scale Expensive
  - Centralized
  - Tedious updates
  - Redundancy Failover
VNF Architectures - Where we want to be?

Microservices

Remote site
- vDHCP
- vRouter

vCPE
- Host OS
- VIM
- NFVI

Central site
- Value Added Services
- SDN controller
- vFW
- vDPI

Enterprise users
- Branch Office

Customer A
- vRouter

Customer B
- vRouter

Host OS
- Hardware

VIM
- Host OS
- VIM
- NFVI

NFVI
- Hosting
- Carrier Network

Internet
Rethink VNFs and VNF Orchestration

VNFs are Cattle
- Microservice oriented containers
- Loosely Coupled
- Temporal Stateless

API First

Fail or Kill
- Replace

Scale-out
- Add/Remove

Loosely Coupled

Virtual Infrastructure Manager (VIM)
- Portable
- Distributed
- Composable
- Update & Reuse
- Elastic Scale
- Fault-Tolerant
- Recoverable
What is the Cloud-Native Telco?

Cloud-Native Architecture
- Containerized
- Microservices Oriented
- Dynamically Orchestrated

VNF “Cloud-Native” Attributes
- Composable & Disposable
- Recoverable
- Stateless

Cloud Native Telco
- Upgradable
- Resilience
- Performance
- Highly Scalable
- Programmable
- Robust Orchestration

MANO integration
Why Containers?
The Cloud Native Telco Transformation

Applications
- Monolith
- N-Tier
- Microservices

Infrastructures
- Datacenter
- Hosted
- Hybrid

Processes
- Waterfall
- Agile
- DevOps
## Containers Evolve VNF Development & Deployment

<table>
<thead>
<tr>
<th>Applications - VNFs</th>
<th>Infrastructure - VNF Orchestration</th>
<th>Process - VNF Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Apps+libraries-OS</td>
<td>● Containers are Linux</td>
<td>● Immutable images pushed to any platform</td>
</tr>
<tr>
<td>● Package Microservices</td>
<td>● Portable</td>
<td>● Smooth transition from Dev to Test to Ops</td>
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<tr>
<td>● Build quickly</td>
<td>● Fast instantiation</td>
<td>● Efficient Automation</td>
</tr>
<tr>
<td>● Faster time to market</td>
<td>● Scale-out</td>
<td>● Drives Continuous Integration and Continuous Deployment CI/CD</td>
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<tr>
<td>● Programmable API</td>
<td>● Higher Density</td>
<td></td>
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<tr>
<td></td>
<td>● Multi-tenancy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Updates and rollbacks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Secure reliable OS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● Signed image repos</td>
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</tbody>
</table>

Examples of each:
- apps) customer example...deployed much faster, etc.
- infrastructure) standing up 1000 new instances
DevOps for Accelerated VNF Development: CI / CD

- Self Provisioning
- Environment Standardization
- Auto Scaling
- Centralized Ops Management

- DEV
- QA
- INT TEST
- PROD

CONTINUOUS DELIVERY

- IDE
- Configuration Management
- Continuous Integration
- Monitoring

- Product Manager
- Developers
- Test Engineers
- Operations Personnel

NEW SERVICE FEATURE IDEA

VNF FEATURE

CYCLE TIME
Challenges
Key Challenges for Cloud-Native VNFs

- Datapath Performance
- Container Network Provisioning
- Orchestration and integration with ETSI Architecture
  - VNF Orchestration
  - Multi-site Orchestration
- Adopting the DevOps Mindset
Datapath Performance
Datapath Acceleration Today

DPDK VNF with SR-IOV
Single-Root IO Virtualization

Hardware Dependencies to the NIC
minimum CPU overhead
ToR for switching

DPDK VNF with
Open vSwitch + DPDK
(data plane development kit)

DPDK - Direct IO to NIC or vNIC
Performance tuning
vSwitch features
Evolution of Datapath for Containers

VNF in VM

Container VNFMus

Container VNFMus1

Container VNFMus2

Application

DPDK

vNIC

vNIC

Bridge IPC, macvlan, vlan trunk, ipvlan/ afinetns

VNF containers in VM

vNIC

vNIC

Overlay Mgmt

OVN, Kuryr

SR-IOV

Host OS

VF

vNIC

vNIC

QEMU KVM

vswitch

OVS br-int

OVS br-tun

SR-IOV

vNIC

vNIC

Overlay Mgmt

OVN, Kuryr

User space

Kernel space

VNF Container
Microservices

Internet

User space

QEMU KVM

vswitch

OVS br-int

OVS br-tun

SR-IOV

vNIC

vNIC

Overlay Mgmt

OVN, Kuryr

Host OS

VF

vNIC

vNIC

Evolution of Datapath for Containers
Container Network Provisioning
Container Network Provisioning

Central Site
- Management VNF-μs
- Control plane VNF-μs
- OVS-DPDK
- VXLAN
- VLAN

Remote Site
- Data Plane VNF-μs
- OVS-DPDK
- DPDK
- VLAN
- VXLAN
- DPDK

Management traffic
Control-plane traffic
Data-plane traffic
Internet
Hybrid VNFs - VMs And Containers Will Co-exist

- Optimum resource usage
- Robust orchestration - Needs coordination between VM and Container schedulers/orchestrators
- Reuse networking services Firewall, Router, Load Balancer
Distributed NFV vCPE

Branch Office and Central office distributed VNFs

VNF Orchestration needed at all sites

Source: ETSI Use case
http://www.etsi.org/deliver/etsi_gs/nfv/001_099/001/01.01.01_60/gs_nfv001v010101p.pdf
Putting It Together - Managed Containerized CPE

- **OpenShift 3**
- Kubernetes
- Containerized Microservices
- Runtime and Packaging Format
- Atomic Registry
- Automation
- Networking
- Cluster Services
- Storage

**Enterprise SDN**

**VTEP**

**DPDK**

**VIM**

**NFVO**

**VNF-M**

**Carrier’s Software Defined Infrastructure**

**Managed Containerized CPE**

**CO/Micro Data Center**

**Data Center**
Adopting the DevOps Process
Pets versus Cattle
Are you Ready?

Cloud Native Telco

- Performance
- Elastic Scale
- Containers
- Microservices
- Orchestration
- DevOps
- CI/CD
- Resilience
- Upgradability
Demo Time!
Thank-you