Drivers - Agility is the prime reason to move to the Cloud

Major goals

Operator Telco Cloud motivation

- 13% Customer experience
- 16% New revenues
- 16% Fluctuating demand
- 25% Cost reduction
- 31% **Agility** Shorter innovation cycles

Agility in launching new services	**Operational Efficiency** via automation
Business Agility	Programmable & flexible architecture
	Scalability
	CAPEX Efficiency
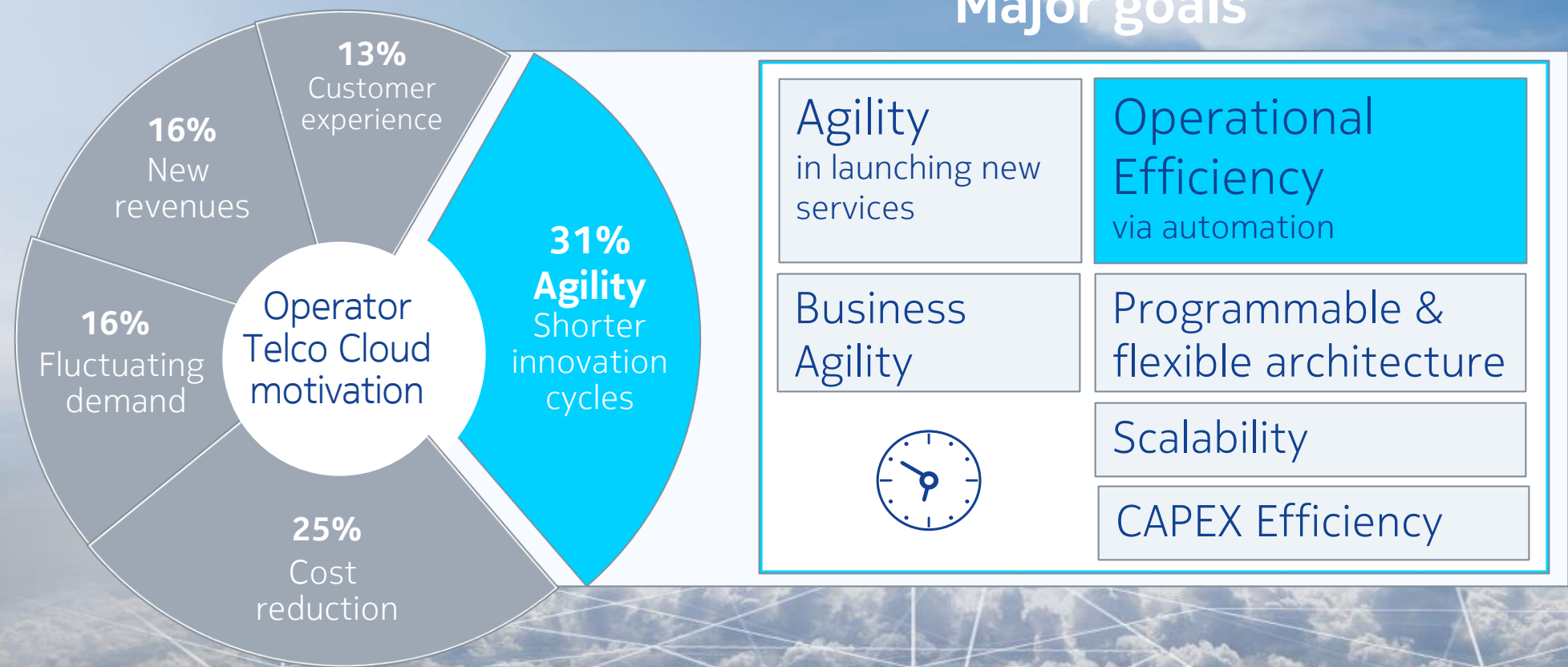
Operational efficiency & automation is the key for reaching agility and Cloud benefits

<Document ID: change ID in footer or remove> <Change information classification in footer>

"NFV is the largest transformation of carrier networks, ever" (IHS)

Exhibit 2   NFV Hardware, Software, and Outsourced Services

Source: IHS

© 2017 IHS
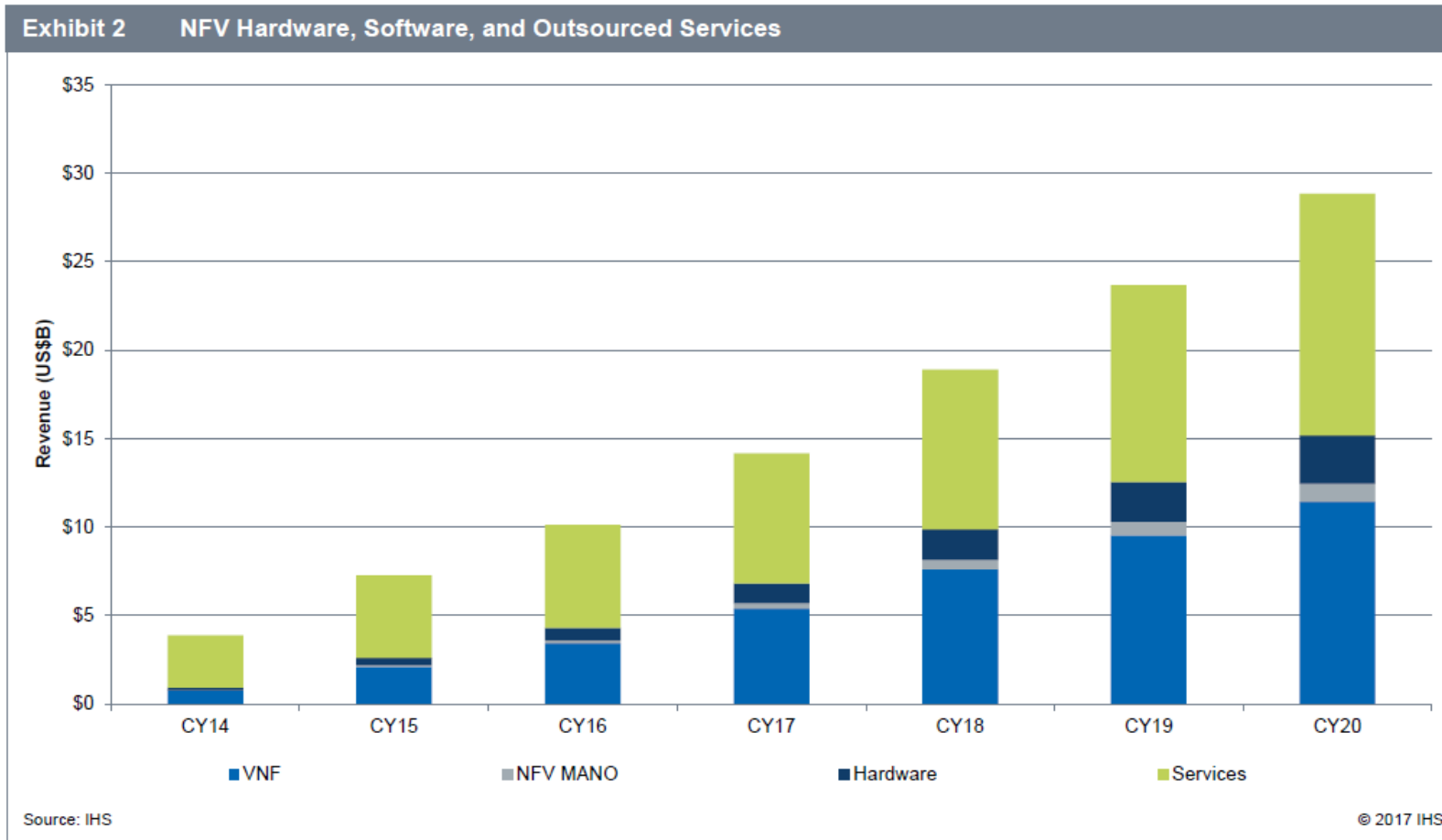
MANO is a necessary enabler for VNFs moving to the cloud.

Vendors' professional services are critical and completely necessary, because of NFV's maturity and the operator's evolving business & organizational practices.

Expertise in MANO and Services is differentiating.

Source: IHS (former Infonetics), NFV Hardware, Software and Services. Jan 2017.

MANO: Management and Orchestration. It controls resources and VNFs in the cloud, and deploys cloud-based services.

Confidential

NOKIA

NFV World Congress 2017: Realizing the agility of software-defined business through the Cloud - The cloud transformation domains

Evolve the network

Transforming network design

Converged offering for mobile, fixed, IP and optical networks, blending connectivity together

Connections for everyone and everything without compromises on quality.

Transform the operations
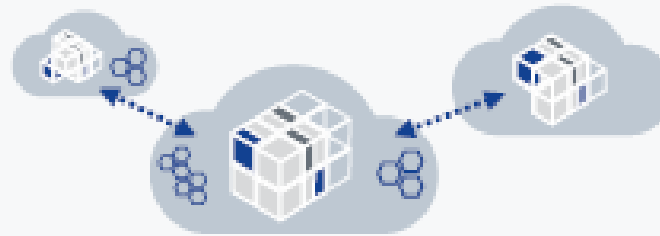
Enable cloud thinking. Networks that can think ahead.
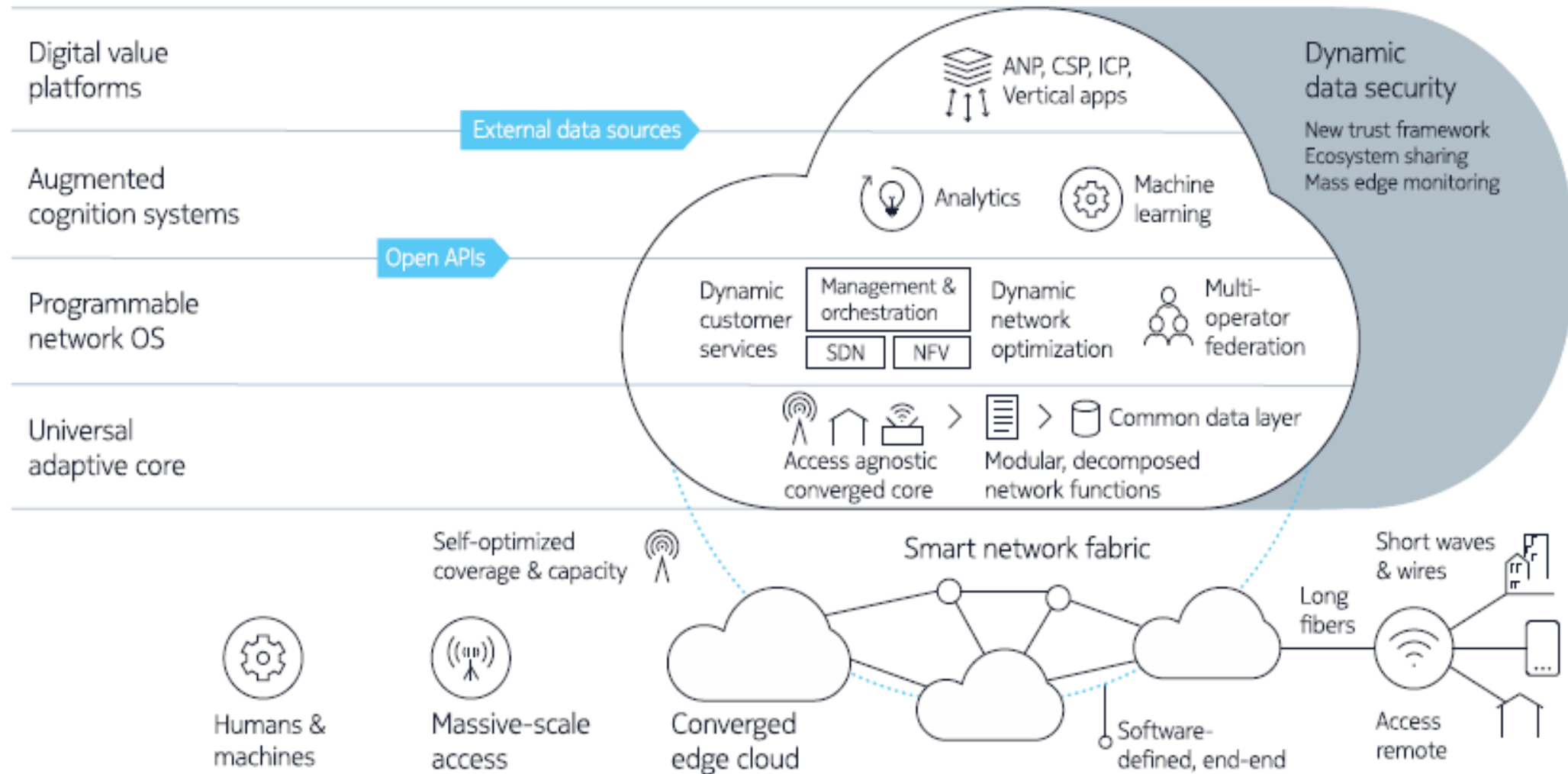
Combining intelligent analytics, automation, security and cloud technology.

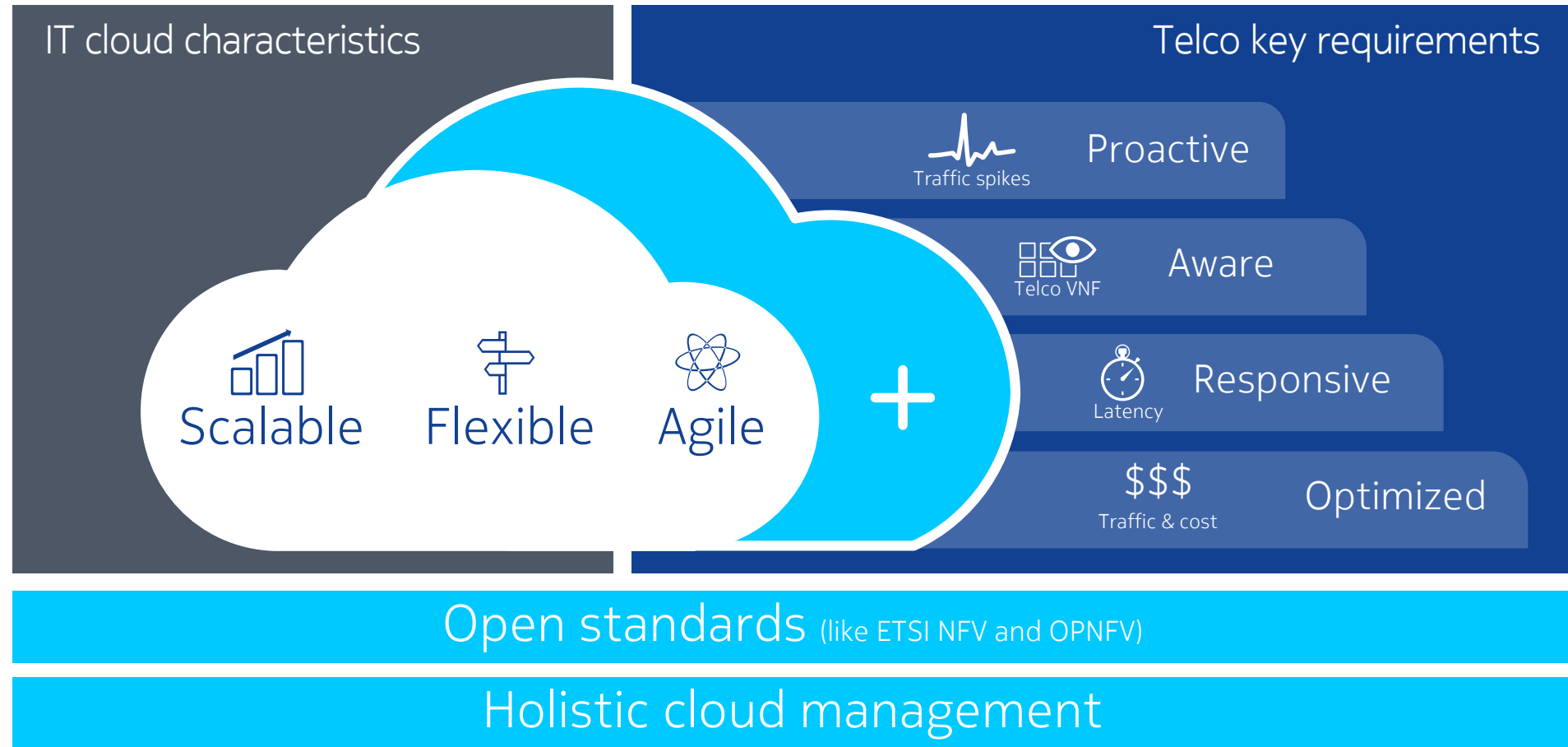Evolve processes, people and tools to leverage the cloud paradigm

Capture new business
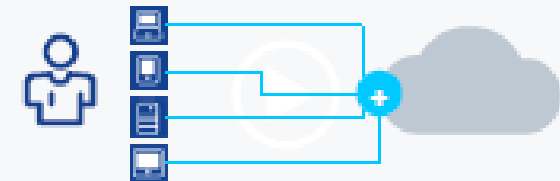
New business opportunities for enterprise and communication services providers

Open API's to unlock the network for innovation

Contextual applications to enter new markets with new business models.

NOKIA

Nokia Bell Labs Future X – a cloud based digital fabric

Digital value platforms

ANP, CSP, ICP, Vertical apps

External data sources

Dynamic data security

New trust framework
Ecosystem sharing
Mass edge monitoring

Augmented cognition systems

Analytics

Machine learning

Open APIs

Programmable network OS

Dynamic customer services

Management & orchestration

SDN   NFV

Dynamic network optimization

Multi-operator federation

Universal adaptive core

Common data layer

Access agnostic converged core

Modular, decomposed network functions

Self-optimized coverage & capacity

Smart network fabric

Short waves & wires

Long fibers

Humans & machines

Massive-scale access

Converged edge cloud

Software-defined, end-end

Access remote

NOKIA

Building the future together:
Open ecosystem for programmable world

CSP, IT, enterprise, and industry verticals

Open system interfaces and APIs

NOKIA

Standardization	Open HW & SW reference architectures	Open source software	Nokia ecosystem
3GPP	OPEN Compute Project	OPNFV · ONAP	
ETSI	TELECOM INFRA PROJECT	openstack. · onos	
IETF	Multi-access Edge Computing (MEC)	OPEN DAYLIGHT · vitrage	
ITU		Linaro · Open FastPath	
IEEE		LINUX FOUNDATION	

Products
Solutions
Services
Security
Analytics
Automation

NOKIA

The (r)evolution into digital business with Nokia Cloud portfolio

Cloud-wise services

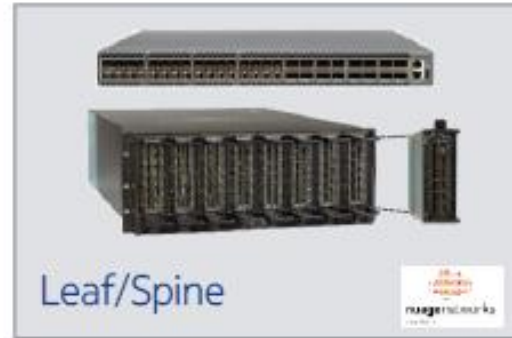Virtualized Network Functions (VNFs) & shared data layer

Software Defined Network (SDN)

Data center solutions

Management and Orchestration

Programmable IP & optical transport

Unparalleled performance for the cloud

Servers

Leaf/Spine

Storage

Racks

Nokia AirFrame Data Center Solution | Building Blocks

Hyperscale / Open Compute

Modular DC/Container DC

Accelerators

DC Services

NOKIA
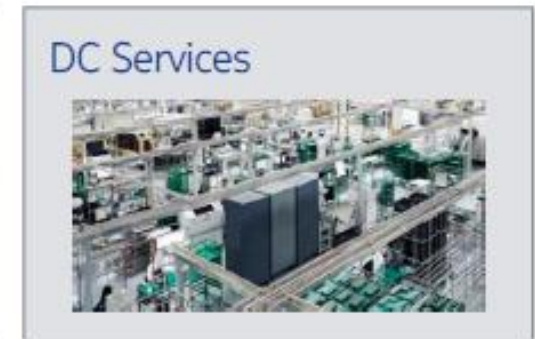
Open Compute for hyperscale efficiency
Industry-wide initiative to share datacenter specifications and best practices

Facebook started Open Compute Project (OCP) in 2011 to share and foster innovation for most energy efficient and economical datacenters

Today, many of world's biggest cloud/Internet companies are participating: Microsoft, LinkedIn, Apple, Bank of America…

OCP has brought up blueprints for compute, storage and networking that are derived directly from hyper-scale innovations

"Thanks to OCP and related efficiency work, Facebook is announcing that it has saved more than $2 billion in infrastructure costs over the course since 2011."
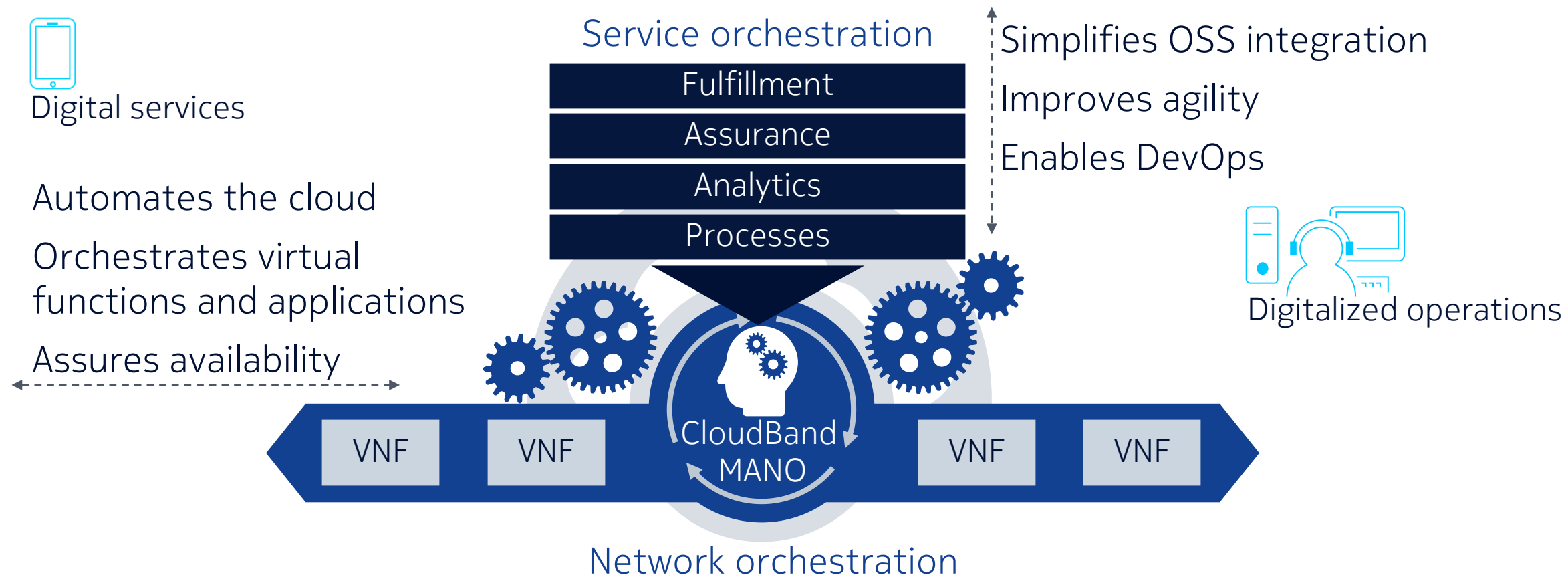
Facebook, March 2015

NOKIA

Why OCP hardware

- **OCP is designed to lower cost of infrastructure**
  - Vanity free design without any unnecessary components
  - Disaggregated rack level solution with common resources (e.g. power and storage)
  - Lower weight by removing unnecessary materials
  - Higher density, requiring less floorspace

- **OCP is designed to lower cost of operations**
  - Tool-less serviceability of hardware
  - Maintenance operations from the front enable strict hot aisle containment
  - Efficient cooling and higher operation temperature enabling low PUE (<1.1)

→ **Lower Total Cost of Ownership (TCO)**

NOKIA

CloudBand enables the transformation to NFV so that your customer can compete more effectively as a Digital Services Provider

Digital services

Automates the cloud

Orchestrates virtual functions and applications

Assures availability

Service orchestration

| Fulfillment |
| Assurance |
| Analytics |
| Processes |

Simplifies OSS integration

Improves agility

Enables DevOps

Digitalized operations

VNF   VNF   **CloudBand MANO**   VNF   VNF

Network orchestration

Confidential

NOKIA

ETSI NFV aligned portfolio
Open multi-vendor support

NFV MANO

OSS/BSS

Os-Ma-nfvo

NFV Orchestrator (NFVO)

Or-Vnfm

NS Catalog

VNF Catalog

NFV Instances

NFVI Resource

VNFs: Nokia's, partners' and competitors' RAN, IMS, EPC, Charging, Apps, etc.

EM

VNF

Ve-Vnfm-em

Ve-Vnfm-vnf

Vn-Nf

VNF Manager (VNFM)

Vi-Vnfm

NFV Infrastructure (NFVI)

Nf-Vi

Virtual Infrastructure Manager (VIM)

Or-Vi

HW: Nokia AirFrame, Dell or HPE.

CloudBand Network Director
Automates network services delivery, for rapid deployment of services

CloudBand Application Manager
Automates VNF lifecycle management in the cloud, for more efficient operation

CloudBand Infrastructure Software
Provides software infrastructure for performance, robustness, security and visibility

●━━ Execution reference points   ┤--Other reference points   ┤ Main NFV reference points

NOKIA

CloudBand products' flexibility creates more angles for you to win

Get started
Relatively static networks.

Just enough
Small VoLTE (Compact Core), or Network apps (Charging, SDM, DPI, etc.)

Whole stack
Complete cloud management (large VoLTE networks).
Example: 3UK

		CBND
	CBAM	CBAM
CBIS	CBIS	CBIS

Could be either.

CloudBand-led ...

Multivendor within MANO
Example: CBAM with Canonical VIM

Competitors' VNFs
"Complete cloud management" but in a competitors' network.

NFVO overlay
Existing deployment, now needs NFV Orchestration, due to growing capacity or use-cases.
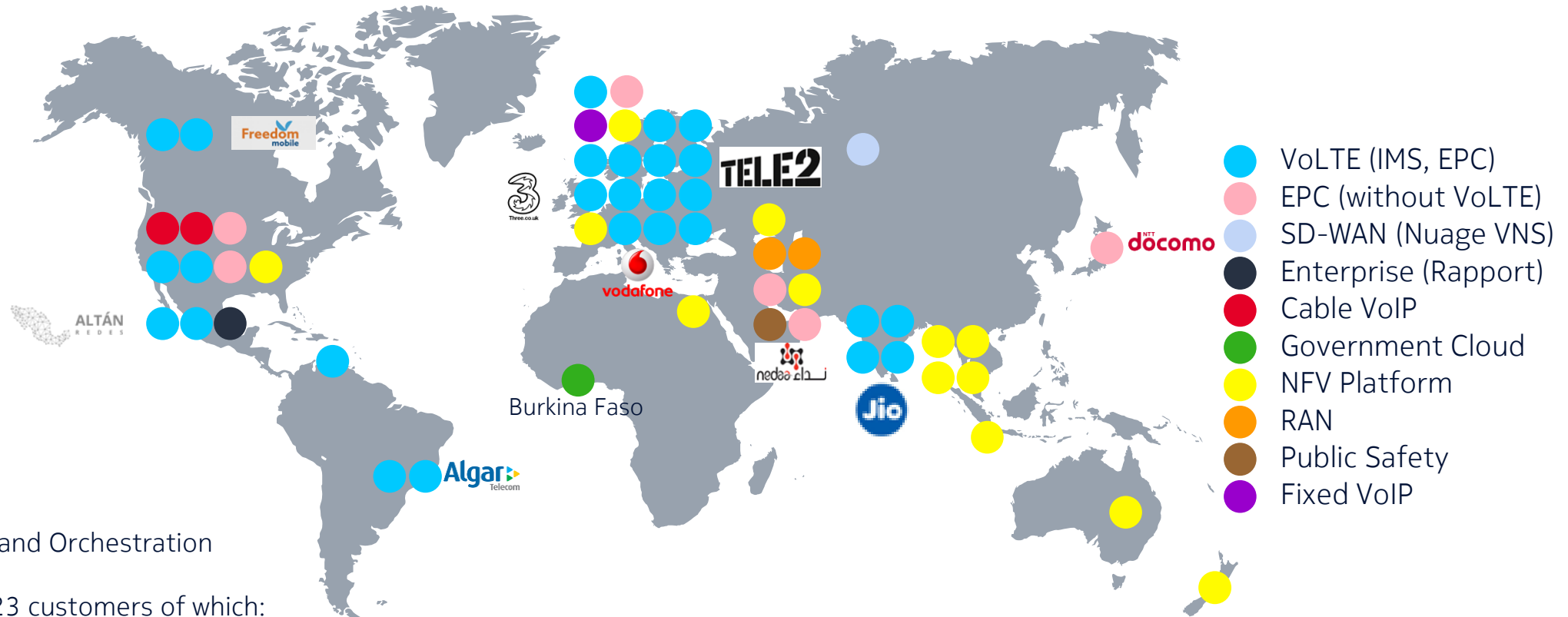Examples: emerging opportunity.

IT use-case
Telco also wants to use CBIS to manage their IT cloud infrastructure, and NFVO to orchestrate it.

Multivendor within MANO	Competitors' VNFs	NFVO overlay	IT use-case
NFVO CBND	CBND	CBND	CBND
VNFM CBAM	CBAM	VNFM	
VIM/NFVI CBIS	CBIS	VIM / NFVI	CBIS

© Nokia 2017

Nokia-internal

NOKIA

Nokia CloudBand commercial references for MANO
Doubled over 12 months since launching the new CloudBand

55

Legend:
- VoLTE (IMS, EPC)
- EPC (without VoLTE)
- SD-WAN (Nuage VNS)
- Enterprise (Rapport)
- Cable VoIP
- Government Cloud
- NFV Platform
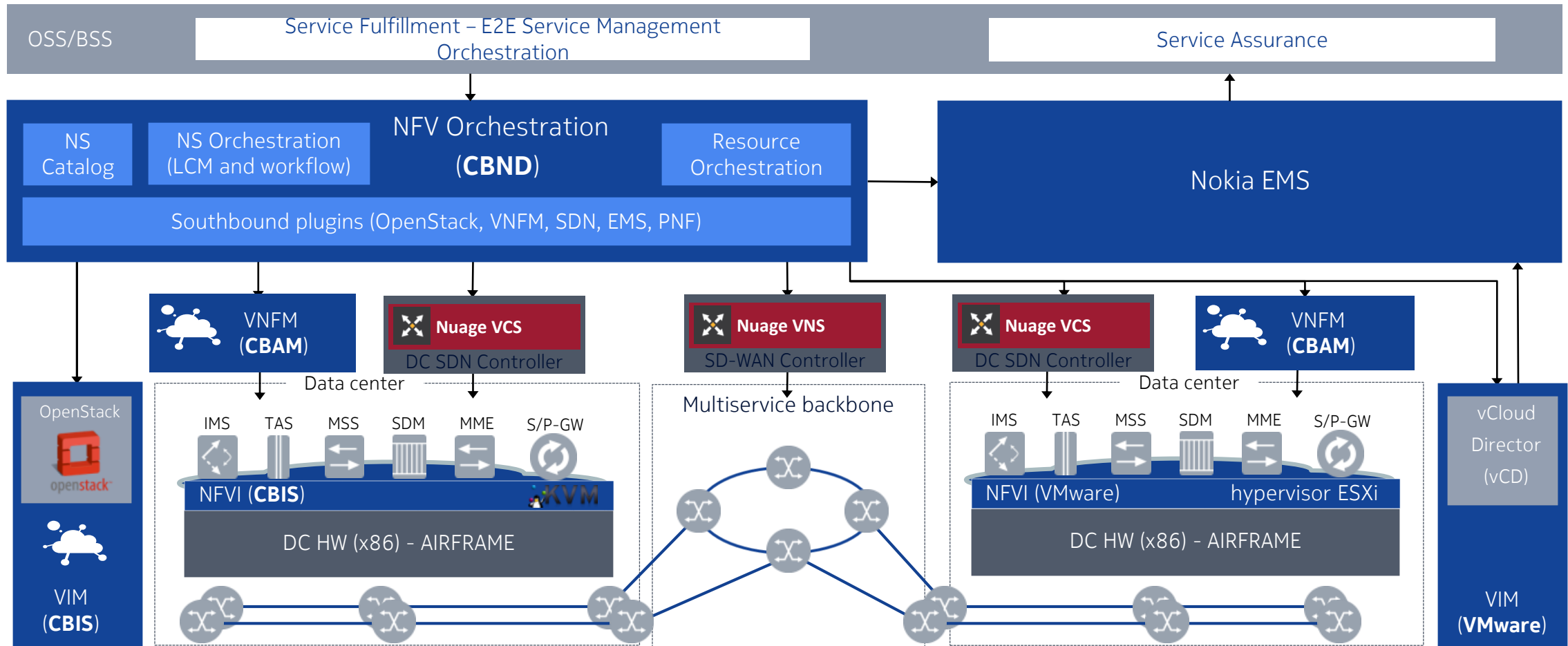- RAN
- Public Safety
- Fixed VoIP

MANO: Management and Orchestration

New CloudBand has 23 customers of which:
- 21 CloudBand Infrastructure Software (VIM)
- 19 CloudBand Application Manager (VNFM)
- 9 CloudBand Network Director (NFVO)

NOKIA

Nokia OSS MANO Solution Architecture
Nokia offering in case Nokia requested to build a Cloud Core from scratch

OSS/BSS

Service Fulfillment – E2E Service Management Orchestration

Service Assurance

NFV Orchestration (CBND)

| NS Catalog | NS Orchestration (LCM and workflow) | | Resource Orchestration |

Southbound plugins (OpenStack, VNFM, SDN, EMS, PNF)

Nokia EMS

VNFM **(CBAM)**

Nuage VCS
DC SDN Controller

Nuage VNS
SD-WAN Controller

Nuage VCS
DC SDN Controller

VNFM **(CBAM)**

OpenStack
openstack

VIM **(CBIS)**

Data center

IMS   TAS   MSS   SDM   MME   S/P-GW

NFVI **(CBIS)**   KVM

DC HW (x86) - AIRFRAME

Multiservice backbone

Data center

IMS   TAS   MSS   SDM   MME   S/P-GW

NFVI (VMware)   hypervisor ESXi

DC HW (x86) - AIRFRAME

vCloud Director (vCD)

VIM **(VMware)**

© Nokia 2016

NOKIA

3 UK
End to End solution for Full Core

"Three carries 35% of mobile data traffic in the UK today. The cloud core network will enable us to scale even further and continue to offer great value and service innovation to our customers. The agreement with Nokia will help us to continue delivering the UK's most reliable network."
Graham Baxter, Chief Operating Officer of Three UK

Drivers for customer

- Single future proof platform for all core applications
- Reduce dependency on hardware
- Highly flexible and scalable architecture

Nokia proposition/ offering

- Data Center Services based on the Cloud Design Center
- Consulting services for their cloud evolution
- Architectural flexibility to add DC in any layer without impacting network operability
- Highly resilient and highly redundant physical HW and network architecture
- Pre-integrated end to end core solution

- Single vendor (Cloud IMS, EPC, NFVI, MANO)
- Rapid deployment, scaling & upgrades
- Full mobile cloud core (IMS, TAS, SBC, SDM, EPC, Messaging) deployed on AirFrame and CloudBand, and NetGuard security products.
- Full range of services Transformation consulting, Data Center Services, Systems Integration, Managed Services and Care

NOKIA