Transforming Network Infrastructures:
Key Technologies & Challenges

Athanassios Liakopoulos, TS Business Development Manager, EMEA

University of Piraeus, May 21st, 2015

Outline

- **Software Defined Networking**

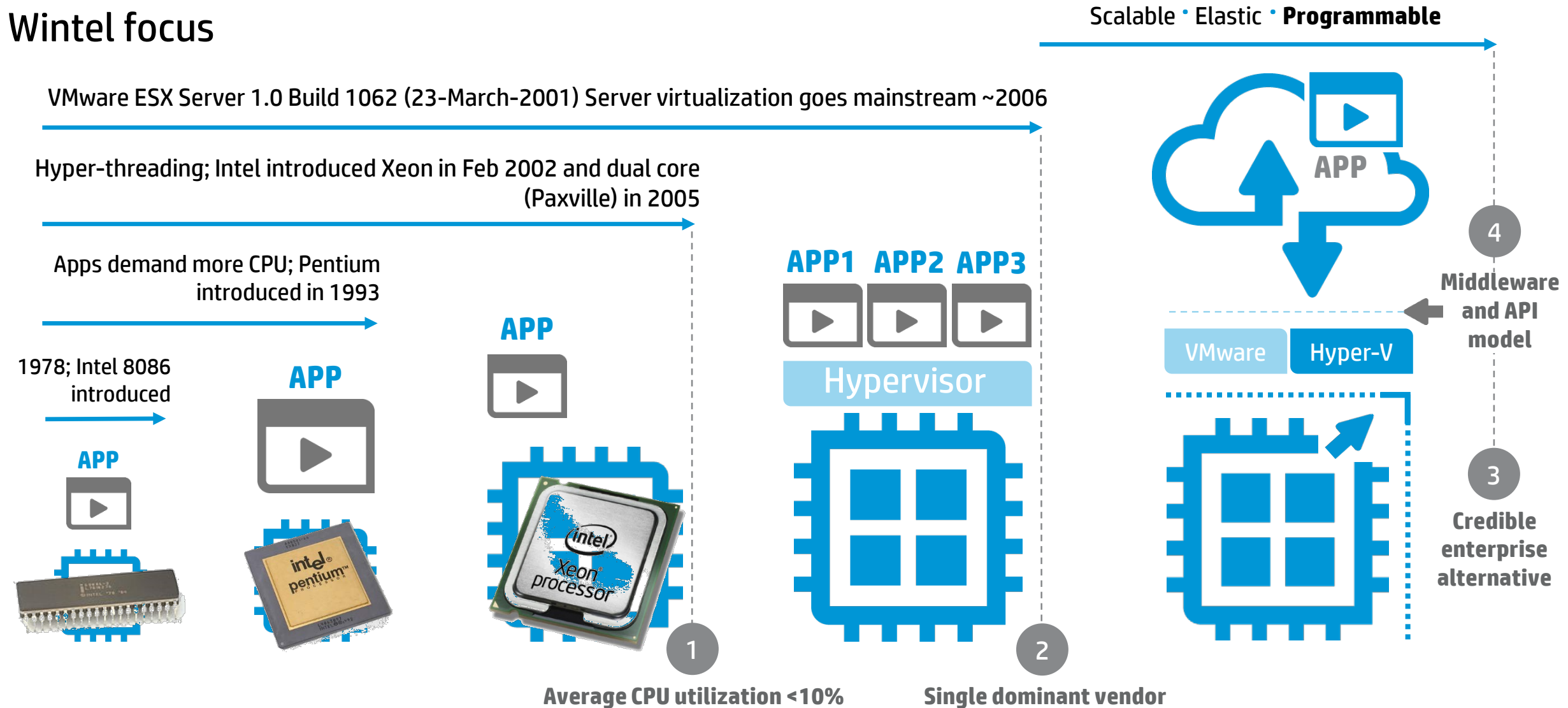- **Network Function Virtualisation**

- **Internet of Things**

Why network transformation is needed?

The compute trajectory in the datacenter

Wintel focus

Scalable • Elastic • **Programmable**

VMware ESX Server 1.0 Build 1062 (23-March-2001) Server virtualization goes mainstream ~2006

Hyper-threading; Intel introduced Xeon in Feb 2002 and dual core (Paxville) in 2005

Apps demand more CPU; Pentium introduced in 1993

1978; Intel 8086 introduced

APP

APP

APP

APP

APP1 APP2 APP3

Hypervisor

APP

VMware | Hyper-V

4

Middleware and API model

3

Credible enterprise alternative

1

Average CPU utilization <10%

2

Single dominant vendor

The storage trajectory in the datacenter
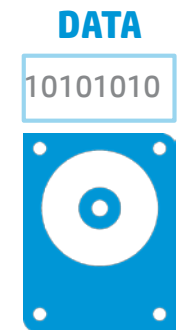
Coping with the data explosion

Converged storage – **Software defined storage**

Solid state drive goes enterprise and storage tiering improves performance

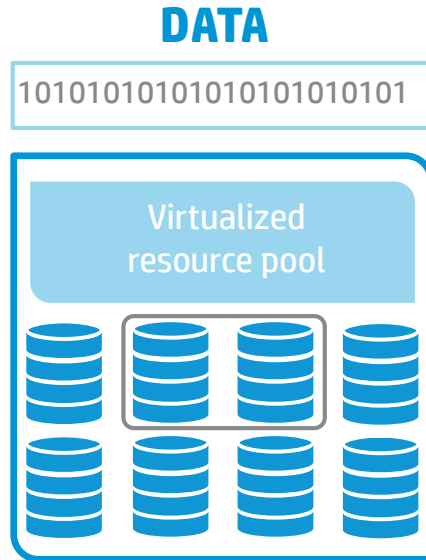Storage area networks with fibre channel connectivity & LUN's

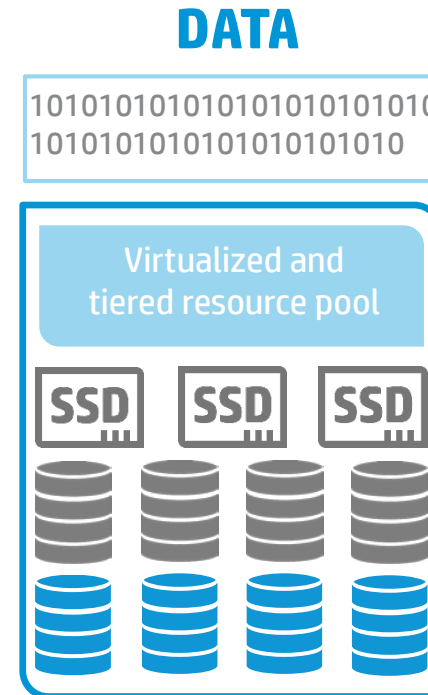Limited Sharing – SCSI, Ultra SCSI Connectivity, plus RAID

APP

Disk drives

4

Middleware and API model

DATA
10101010101010101010
101010101010101010

DATA
101010101010101010101

DATA
10101010101

Elastic virtualized and tiered resource pool

10101010101010101010
101010101010101010

DATA
10101010

Controller

Virtualized resource pool

Virtualized and tiered resource pool

SSD

SSD SSD SSD

SSD

1

Separation of control and data planes

2

Virtual storage

3

Human middleware

hp
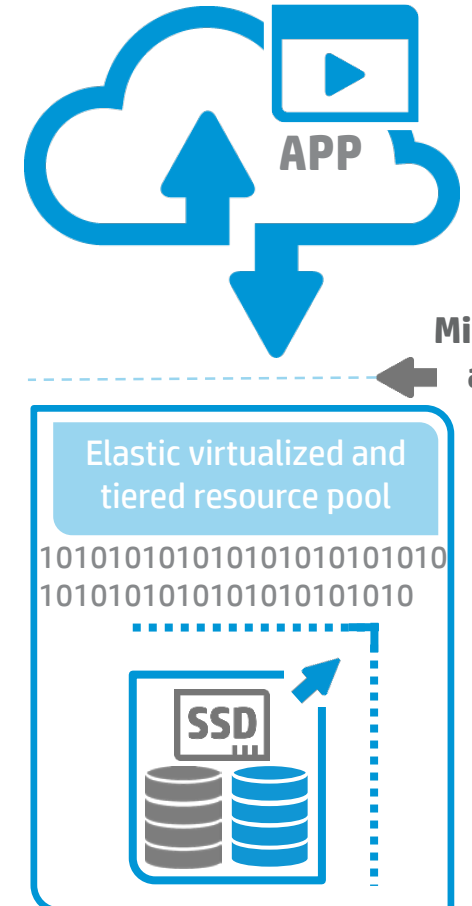
From networking to connectivity

Aligning the trajectory of change

Servers

1. X86 launch, increasing power then under-utilized
2. Virtualized compute through use of hypervisor
3. Competition inspired innovation – credible enterprise alternative
4. Cloud "ready" through middleware and API abstraction

Network

What path is networking taking?

Storage

1. Early separation of control and data plane
2. Implementation of virtual overlay model (LUN's)
3. Still too dependent upon human middleware
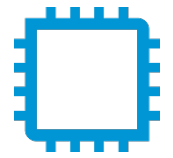4. Cloud "ready" through middleware and API abstraction

Todays network

Under-utilized and dependent upon human middelware – some virtual overlay

Servers

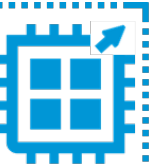1. X86 launch, increasing power then **under-utilized**
2. Virtualized compute through use of hypervisor
3. Competition inspired innovation – credible enterprise alternative
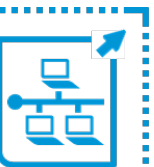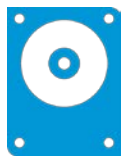4. Cloud "ready" through middleware and API abstraction

Network

Todays network
100G · VxLAN · NMS

➢ 100G provided for peak load / alternative to QoS
➢ VxLAN to provide scalable and stretchable VLANs (site to site)
➢ NMS to help alleviate manual CLI (human error)

Storage

1. Early separation of control and data plane
2. Implementation of **virtual overlay** model (LUN's)
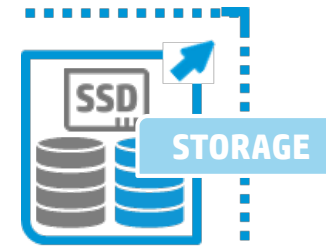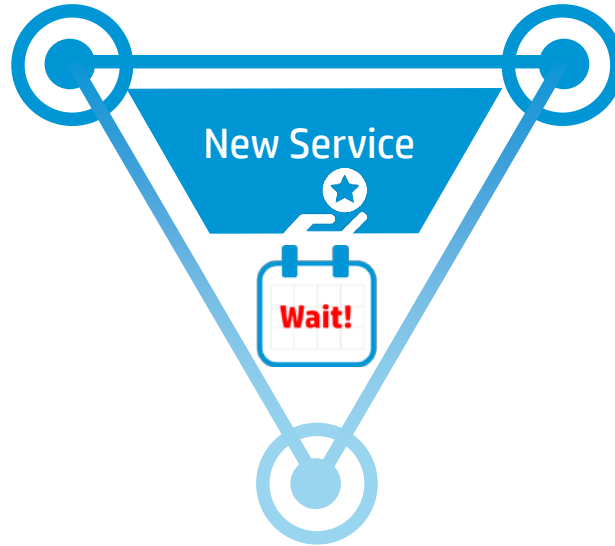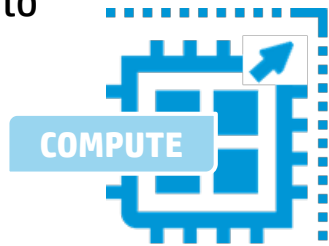3. Still too dependent upon **human middleware**
4. Cloud "ready" through middleware and API abstraction

Todays network

Unable to meet the needs of dynamic service delivery

- Compute power shifted to virtualization years ago
  "Speed of provision"

- Highly scalable and programmable
  "Dynamic"

COMPUTE

New Service

Wait!

- Storage provision shifted to virtualization years ago
  "Speed of provision"

- Highly scalable and programmable
  "Dynamic"

STORAGE

➢ Cannot provision at the speed, scale and reach of cloud, mobility & big data

➢ Rigid and overprovisioned
  "Transformation needed to meet today's needs"

NETWORK

"Traditional network design practices do not adequately support the modern user. These design practices need to move beyond connecting the dots and sizing bandwidth."

Gartner, *28th March 2013*

Gartner®

Traditional networking holds up progress

Today's network challenges

Wait!

- Highly **static, over-provisioned** and underutilized
- Designed for **predictable demand**
- Segmented and time-shared connections
- Fragmented
- (Manual) **Configuration driven**
- Massive number of endpoints with wide range of connection types and duration
- Wide range of service requirements
- **Oblivious to application** requirements

Trajectory for tomorrows network

Solutions embedded in software innovation

Servers
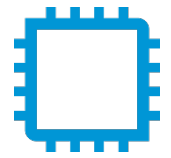
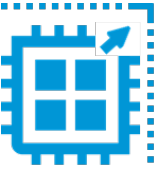**1** X86 launch, increasing power then under-utilized

2 **Virtualized** compute through use of hypervisor

3 Competition inspired innovation – credible enterprise alternative

4 Cloud "ready" through middleware and **API abstraction**

Network

➤ Network functions virtualization will virtualize physical network appliances / elements

➤ Software defined networking will allow the network to be orchestrated directly by the application

Tomorrows network

NFV **+** SDN
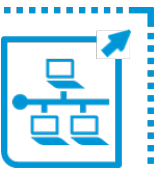
Storage
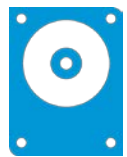
1 Early **separation of control and data** plane

2 Implementation of virtual overlay model (LUN's)

3 Still too dependent upon human middleware

4 Cloud "ready" through middleware and **API abstraction**

Tomorrows network

Complete the infrastructure trinity – enable business value

- Compute power shifted to virtualization years ago
  "Speed of provision"

- Highly scalable and programmable
  "Dynamic"

COMPUTE

New Service
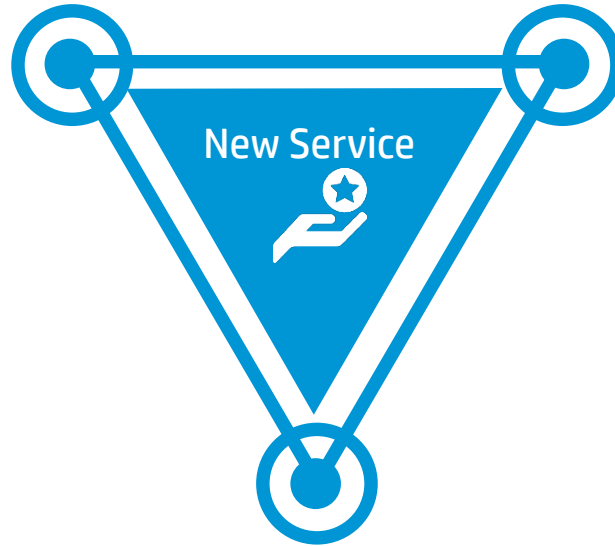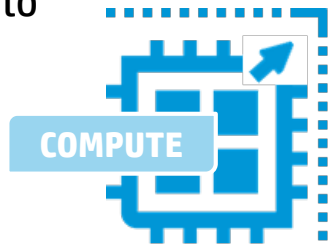
STORAGE

- Storage provision shifted to virtualization years ago
  "Speed of provision"

- Highly scalable and programmable
  "Dynamic"

NETWORK

- Overlay and physical network function shift to virtualization
  "Speed of provision"
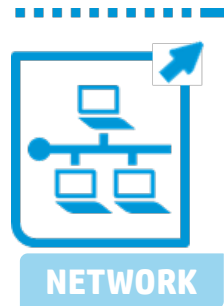
- Exposed API model and Open SDN eco-system enable programmable outcomes
  "Dynamic"

Software Defined Networking

"SDN: It's Not Something You Buy. It's an architectural approach, or model, not a product or a solution…"

Rohit Mehra - Vice President, Network Infrastructure IDC.

What is software-defined networking?

Definition from the Open Network Foundation

… In the SDN architecture, the control and data planes are decoupled, network intelligence and state are logically centralized and the **underlying network infrastructure is abstracted from the applications** …

Source: opennetworking.org

Scalable · Elastic · **Programmable**

APP1 APP2 APP3

VMware   Hyper-V

Data plane
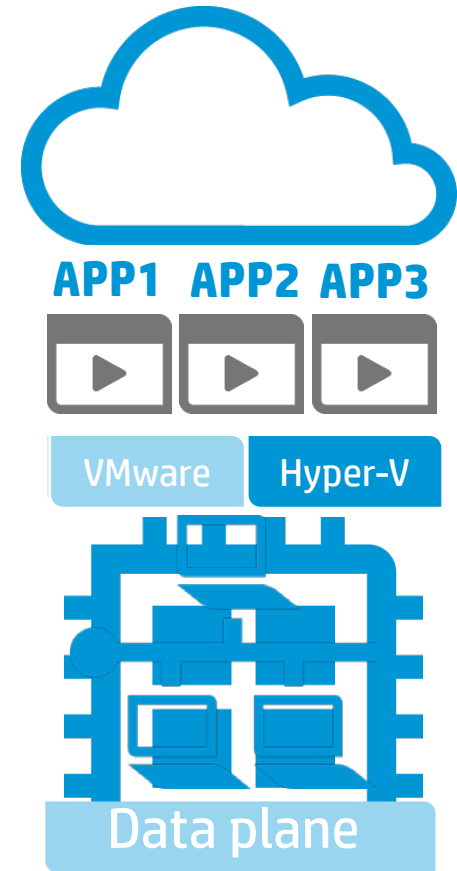
SDN in a Nutshell

- **Changes the way** that **organizations operate** their network infrastructures
  - Enables administrators to use high level applications for controlling the entire network
  - Traditional control (via routing protocols or L2 MAC forwarding) still possible

- **Separates** the network **control plane** from the network **data plane**
  - Control plane is moved to a central SDN controller while network devices retain locally the data plane
  - Control plane is manipulated via application program interfaces (APIs)

Application   Application

SDN Controller

Network virtualization

Decouple control logic

OpenFlow

Hardware abstraction layer

Hardware

SDN
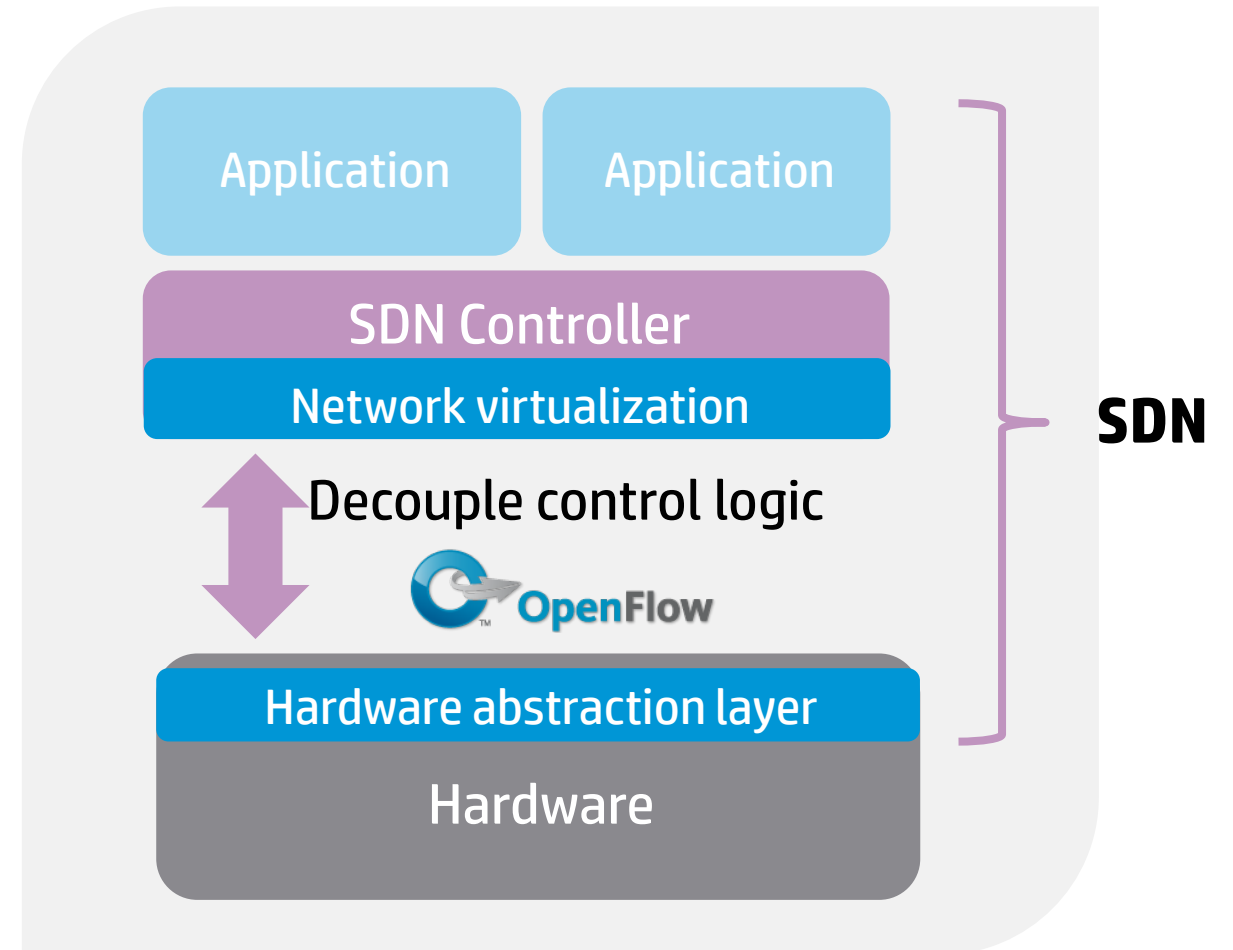
Evolution of Network Architectures

Innovation!
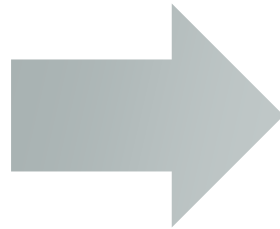
Network features (applications)

| MCast | Routing | QoS | ... | Apps | Apps |

Open interfaces and programming languages

Centralized Control Plane

Standard interfaces and control protocols

OS-Integrated Features

Proprietary OS

Proprietary Hardware

Standard "programmable" systems

HP SDN leadership winning industry awards

HP has the most innovative and complete SDN solution

SDN Architecture

Applications

SDN App Store
Powered by HP

Powered by HP
SDN SDK

Virtual Cloud	Load Balancing	Network Optimizer
Network Protector	Partner Apps	ConvergedControl

Control

Virtual Application Networks SDN Controller

Infrastructure

VXLAN, NVGRE

OpenFlow

10 Routers

Over 25 million ports across 50 Switches

6 WLAN APs

☑ 2014 Excellence In SDN
SDN ZONE
SOFTWARE-DEFINED NETWORK

Cloud innovation 2014 awards

innovation 2013 award
WINNER
SDN Solution

Networks deployed in
Minutes
vs. weeks

Helps customers react
80%
Faster to business apps

More than **30**
Partners in the ecosystem

hp

Network Optimiser for Microsoft Lync
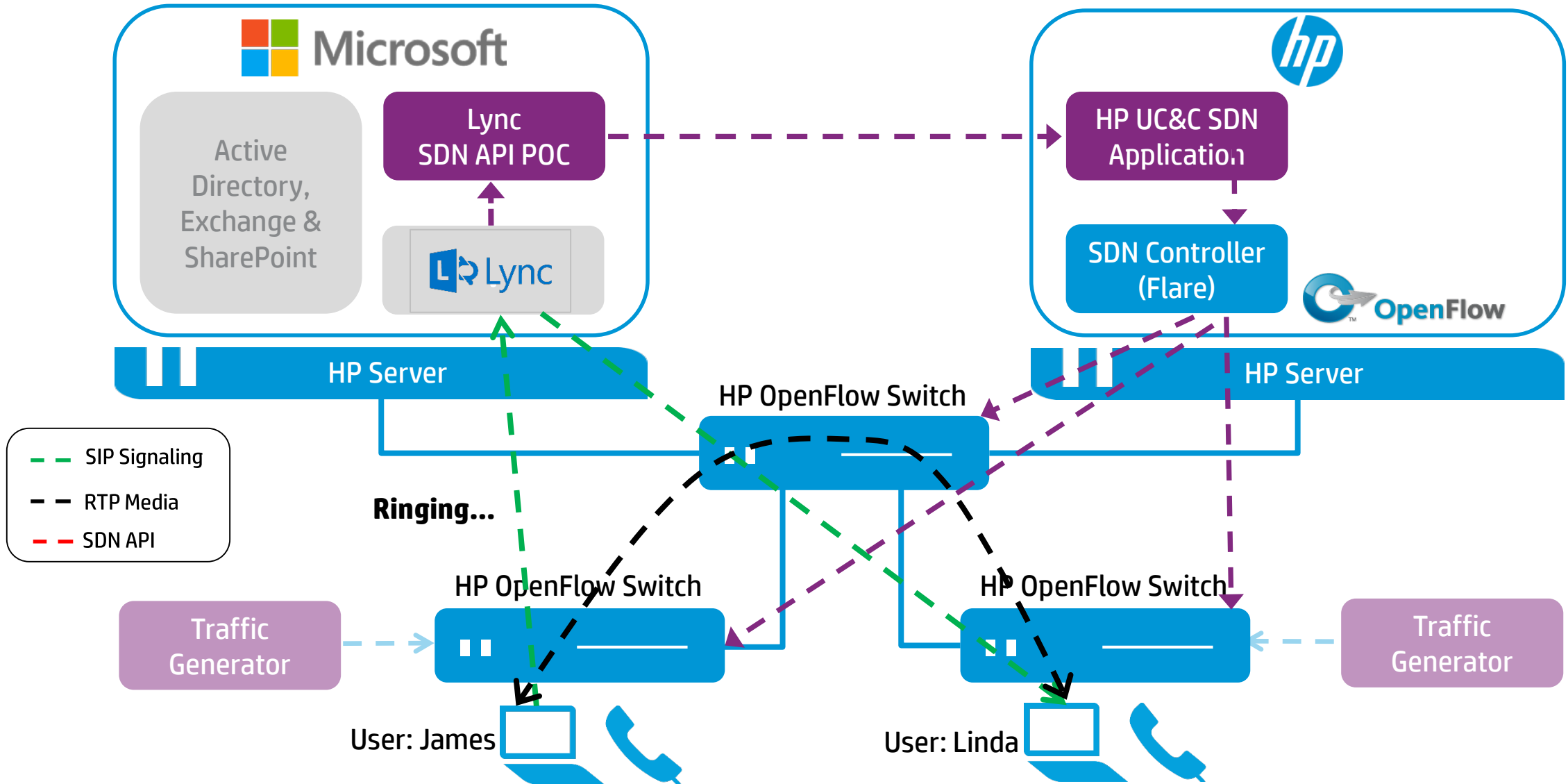
Open ecosystem delivered by HP SDK and SDN App Store

HP SDN App Store

"All product views are illustrations and might not represent actual product screens"
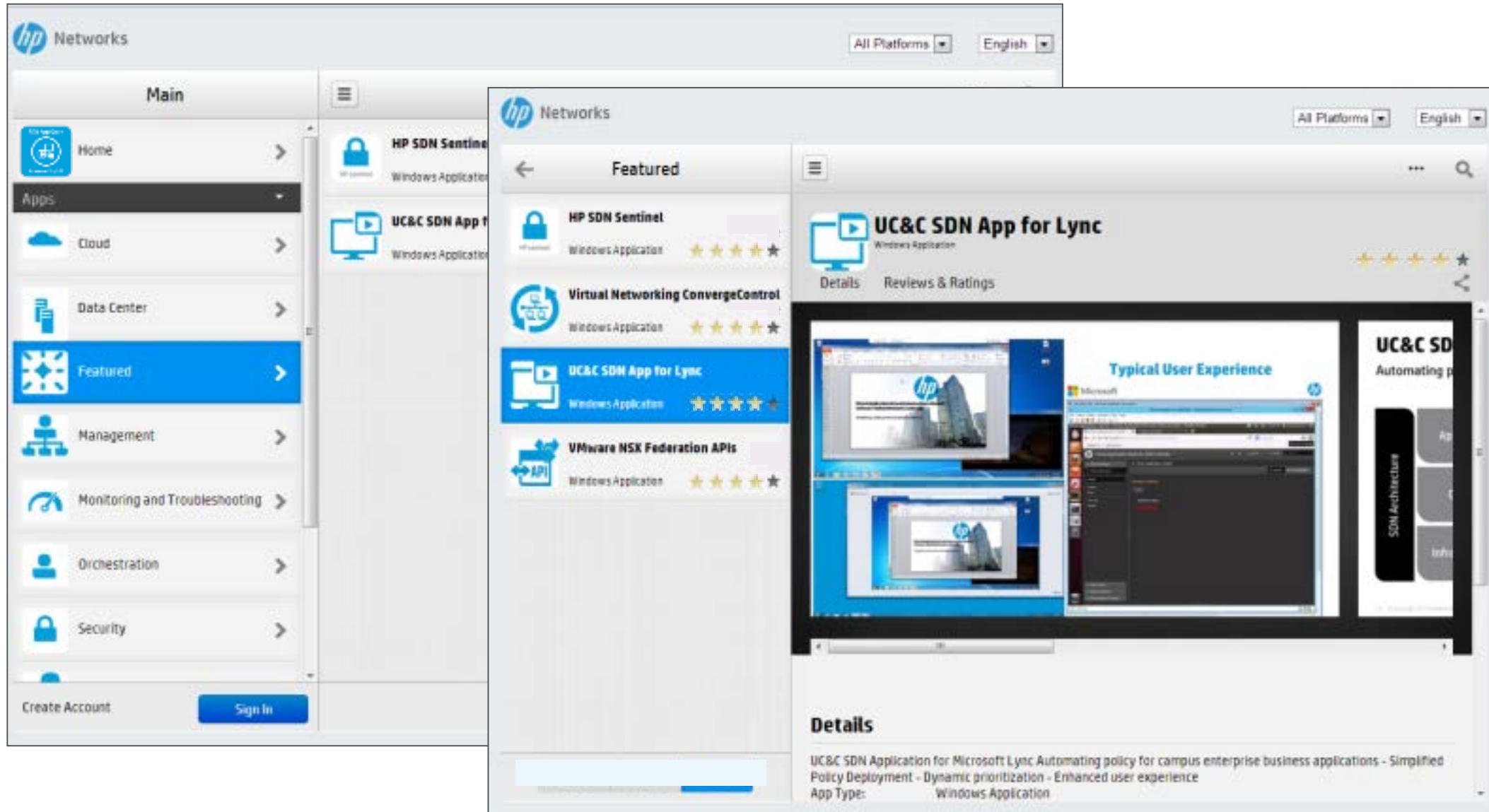
But NOT all vendors have the same approach..

SDN definition will always vary depending on who you ask

- Open SDN (Underlay)
- SDN via APIs
- SDN via Overlays
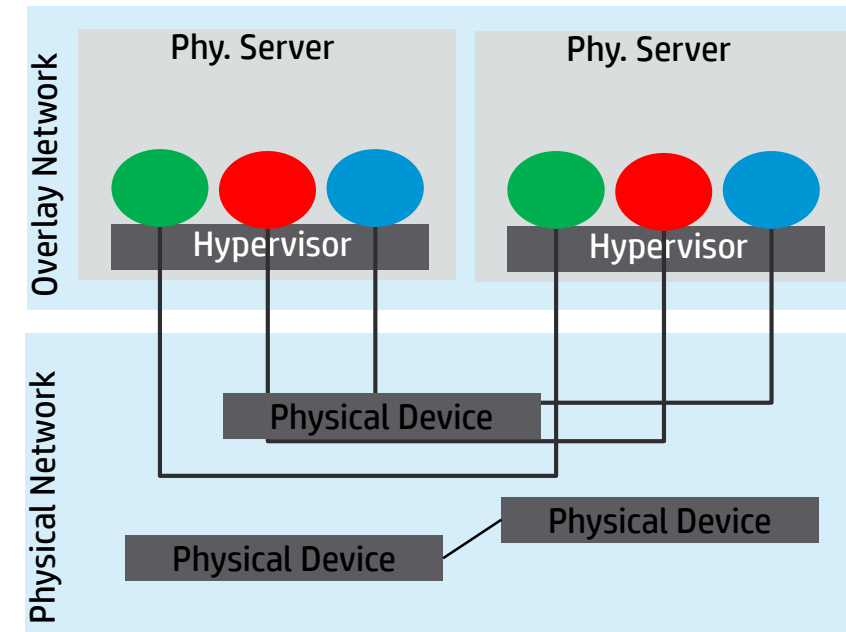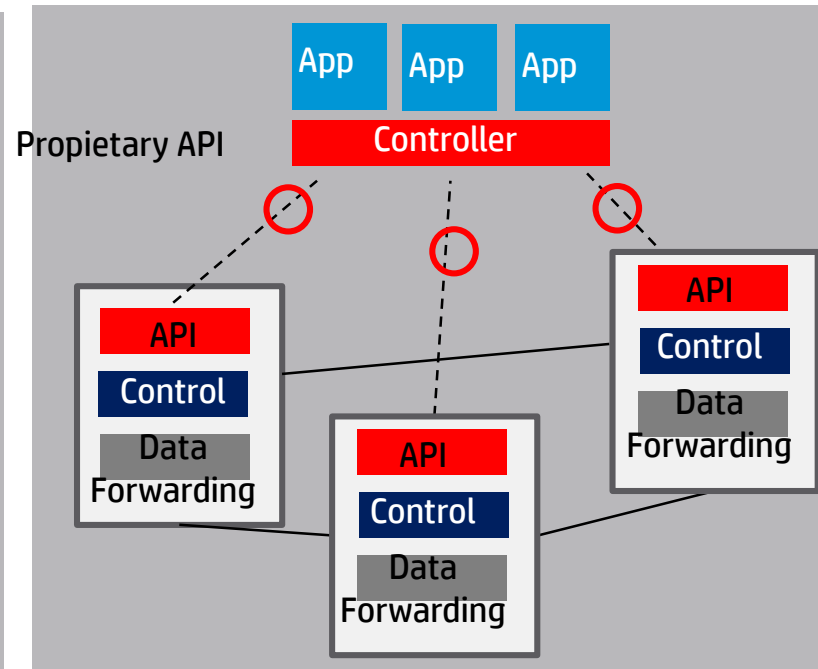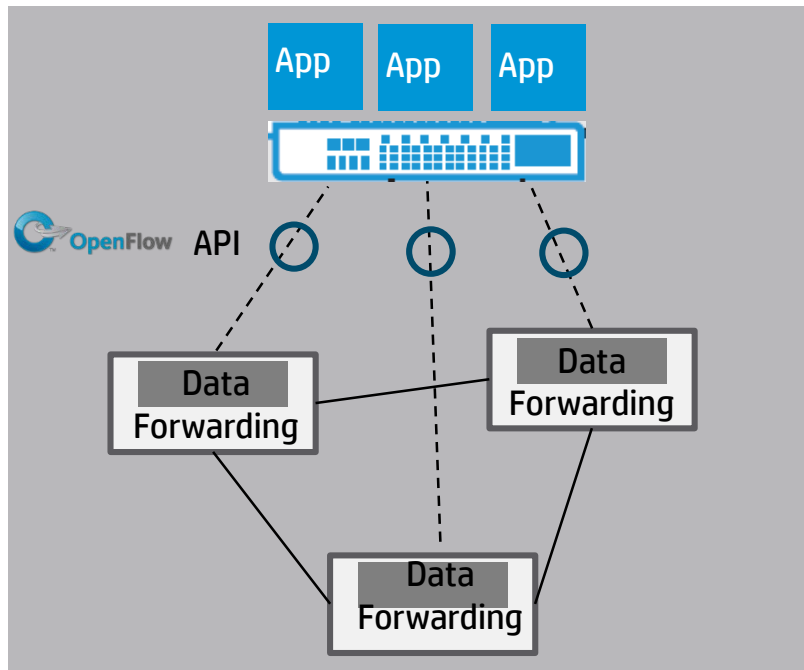
HP is taking this approach

The importance of Open Standards

The breakdown of silos

HP Software-defined network leadership

| Open Network Foundation | OpenFlow Leadership | NFV Leadership | OpenStack Leadership |

Network Function Virtualisation

CSPs must transform

Old world manually driven: New world immediate self-serve

Cloud

Security

Mobility

Big Data

Advancing technologies

Growing OpEX & CapEx

CSPs must transform

Shifting landscape (OTT)

Exploding demands

$73 Billion
In lost revenues from OTT VoIP providers by 2020

$54 Billion
In lost SMS revenues by 2016

73% Increase
In OTT video services by 2016
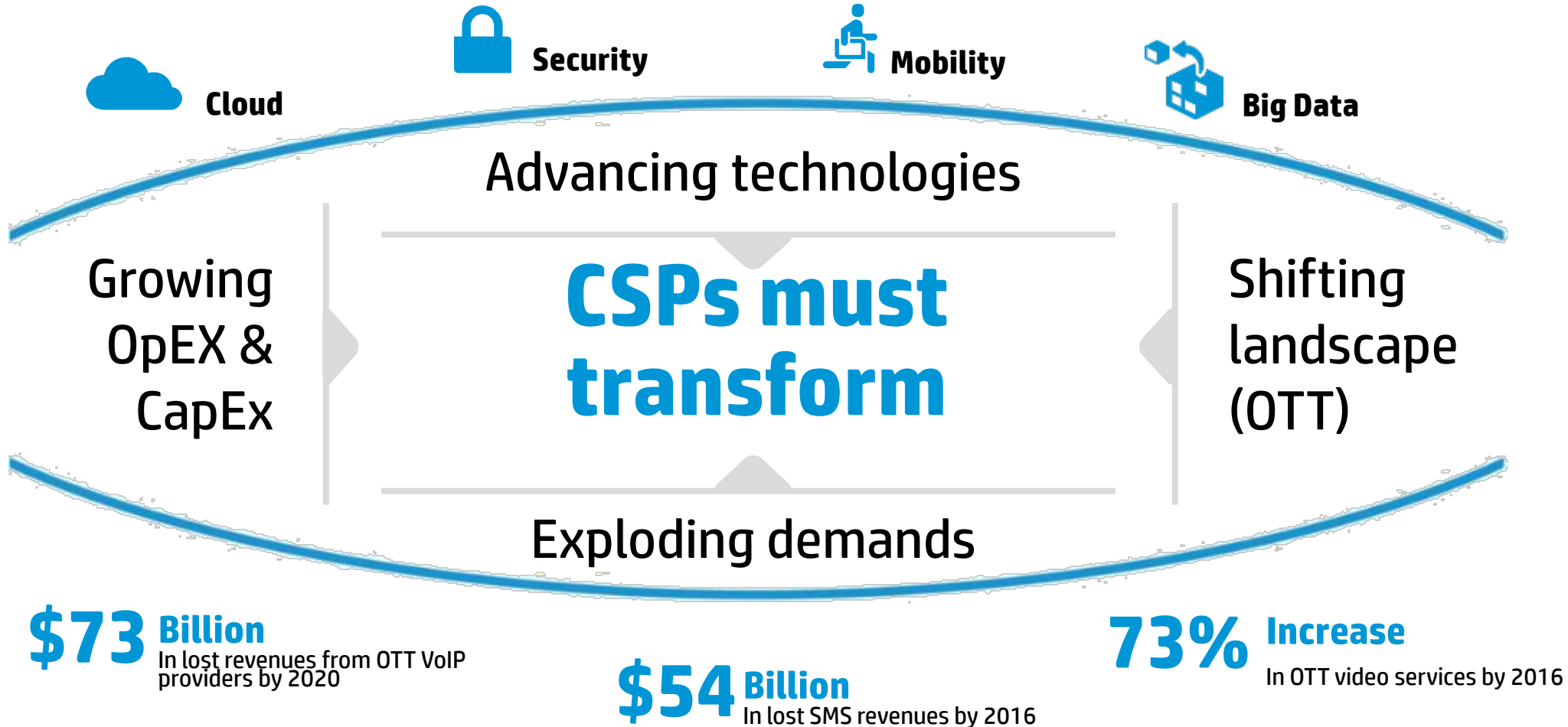
NFV – Why Now?

Change is not optional
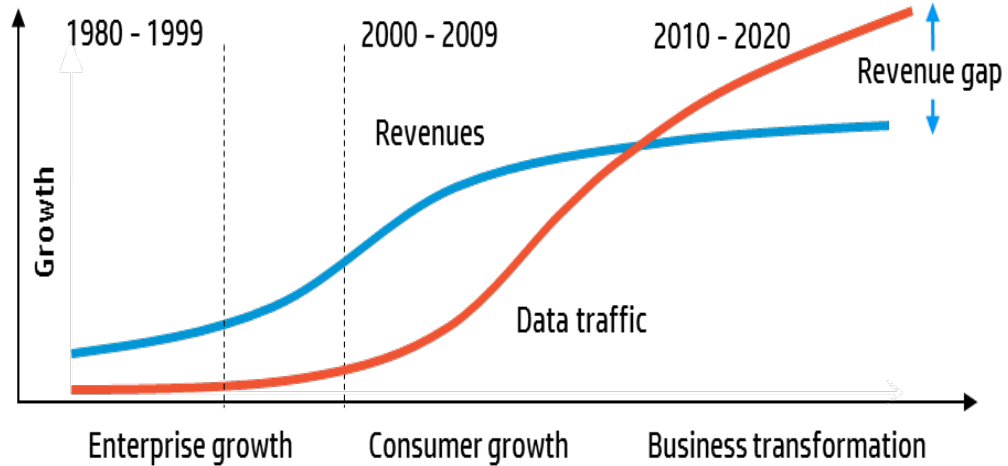
– **Market for Service Providers is transforming**
- Explosive bandwidth growth (46% CAGR) notably video
- Commoditisation from OTT players
- Near flat/decreasing revenue
- Current high cost of delivery in part through use of proprietary HW/SW platforms
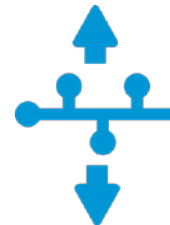
- **Improves OPEX**
  - Move from Telco opex model, to lower cost IT opex model

- **Lowers CAPEX**
  - Move from dedicated appliances to virtualization model based on IT technology

- **Accelerates Time to Market**
  - Deploy new software and new services quickly and easily (from months to _days_)

- **Accelerates Innovation via an Open Platform**
  - Broaden access to partners who can innovate not just NEPs but also start ups, ISV's…

- **Delivers Business Agility**
  - Rapidly scale up or scale down applications modify QoS, deliver new services faster

What is NFV ?

Message router

CDN

Session border controller

WAN acceleration

Intrusion prevention system

Firewall

Carrier grade NAT

Tester/QoE monitor

SGSN/GGSN

PE router

BRAS

RNC

Proprietary network appliances

Virtual function

Virtual function

Virtual function
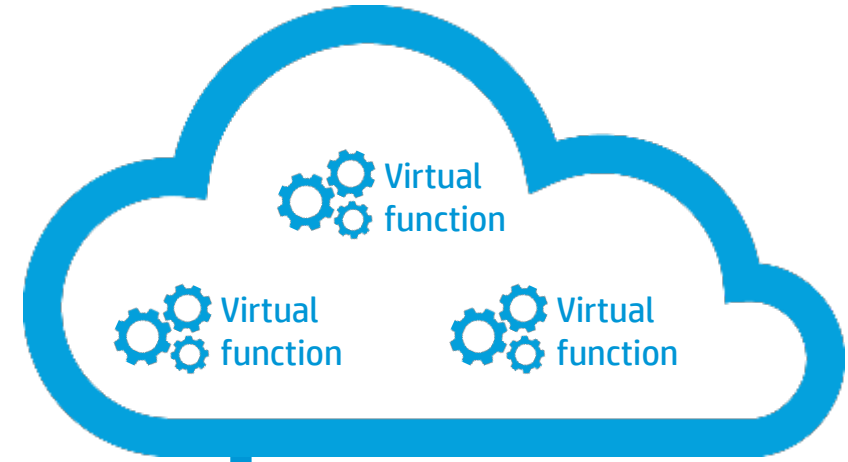
Orchestrated, automatic, and remote install

· · ·
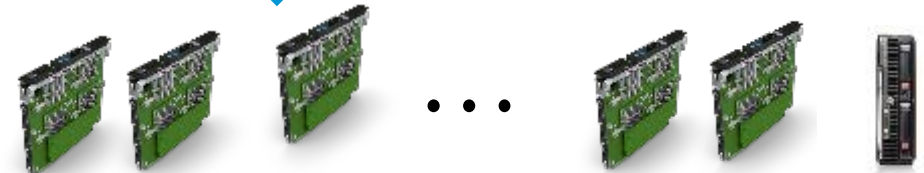
Pools of compute resources

Standard high volume servers, switches, and routers

Standard high volume storage

Enterprise vCPE Network Services

Traditional Appliance based Service Delivery

Branch Office

Factory

Fibre/Ethernet

Service Provider

ADSL
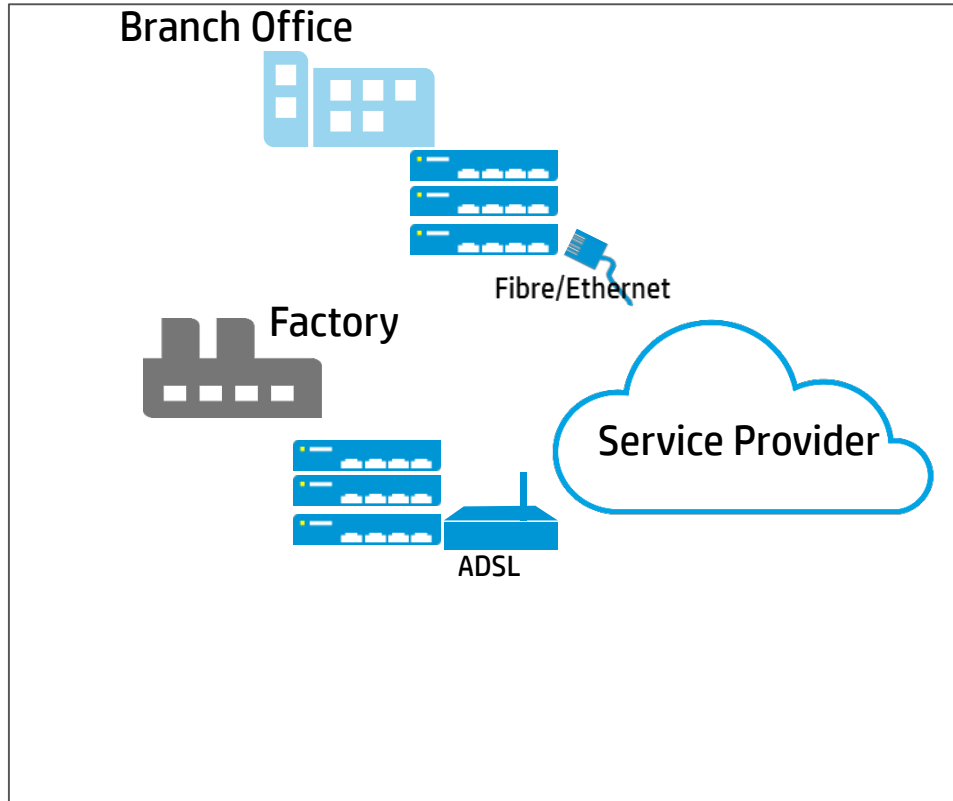
Virtualized Appliances based Service Delivery

Powered by HP Factory Express

Factory

vCPE

Fibre/Ethernet

Branch Office

Service Provider

vCPE

Fibre/Ethernet

VM   VM
Hypervisor
Server

Delivered with partners:
- **Checkpoint for FW**
- **Riverbed for WAN acceleration**

Branch Office

ADSL

vCPE
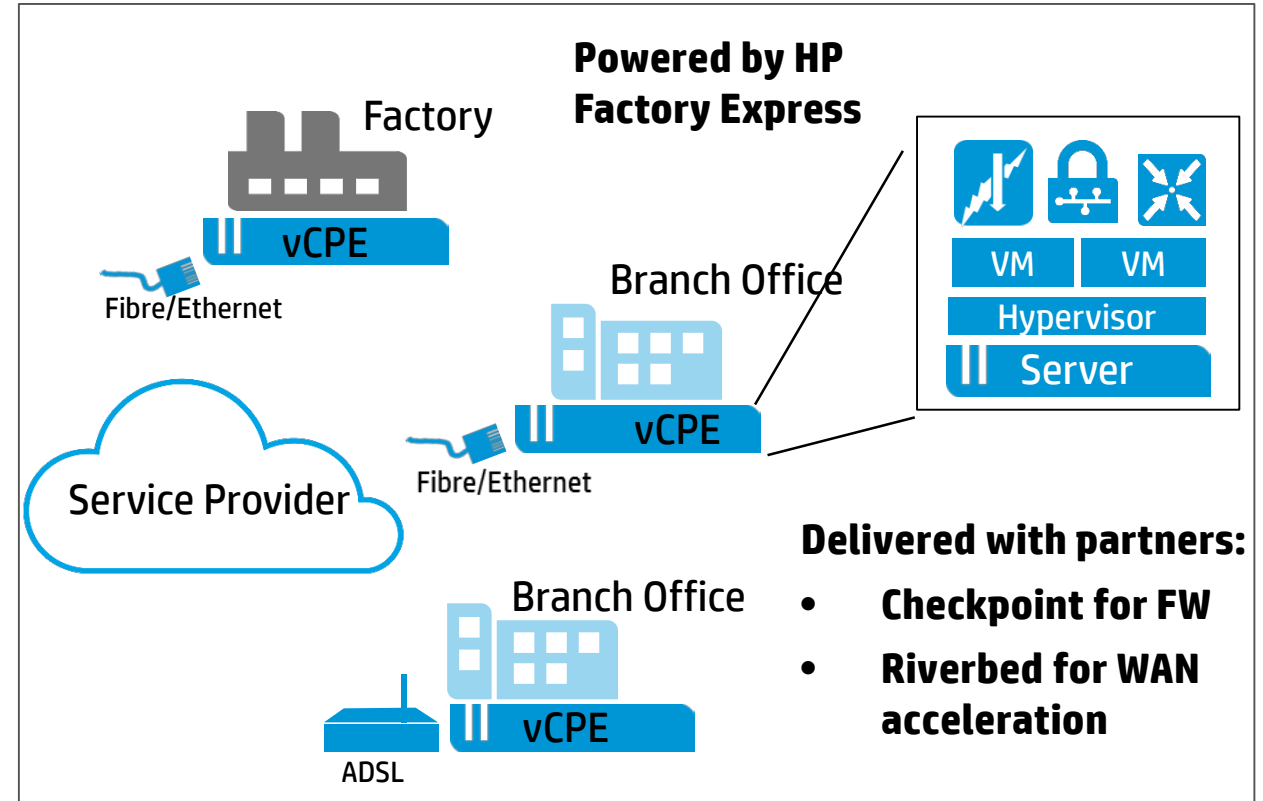
| Expand Service Scope | Improve Order to Bill time | Simplify Deployment | Ease Change management | Reduced CAPEX | Reduced OPEX |

Top NFV use cases

Solution	Description	Benefit of NFV
Virtual CPE consumer	Set top box, ADSL router	Opex reduction, SW download, colocation of applications on COTS
Virtual CPE enterprise	Enterprise Firewall, NAT, router on COTS, SW	Time to deploy (SW download) , flexibility (new features download), cost reduction
Virtual Appliance	Firewall, NAT, Isec, VPN, etc	Cost reduction (COTS), flexibility (SW download)
Virtual EPC (Evolved Packet Core)	Core LTE (MME, PDN GW, Serving GW)	Cost reduction (COTS), scalability
Virtual IMS	Mobile Network Element: CSCF, HSS, MRF, PCRF	Cost reduction, scalability (up & down), colocation
Virtual Base Station and Cloud RAN	BTS, RAN, small Cell on COTS and SW , VM	Cost reduction COTS, colocation of application (ie Radio, CDN) , controller in Cloud for multiple BTS (central mgt)
Applications	VAS (IVR, SMSC, MMSC...), CDN, DPI, OSS/BSS, etc	Opex reduction, SW download, colocation of applications on COTS

NFV Challenges for the CSP

NFV adoption is not an option, yet it is deeply transformational and risky for CSPs

Infrastructural

➢ Need Telco grade availability, performance and SLAs
➢ Telco network application readiness for virtualization
➢ Future proof architecture to cope with NFV uncertainty

Current Industry focus

Operational

➢ Integration within existing OSS/BSS environment
➢ How to maintain Customer and Services view correlated to underlying infrastructure
➢ Need Automation to enable NFV agility
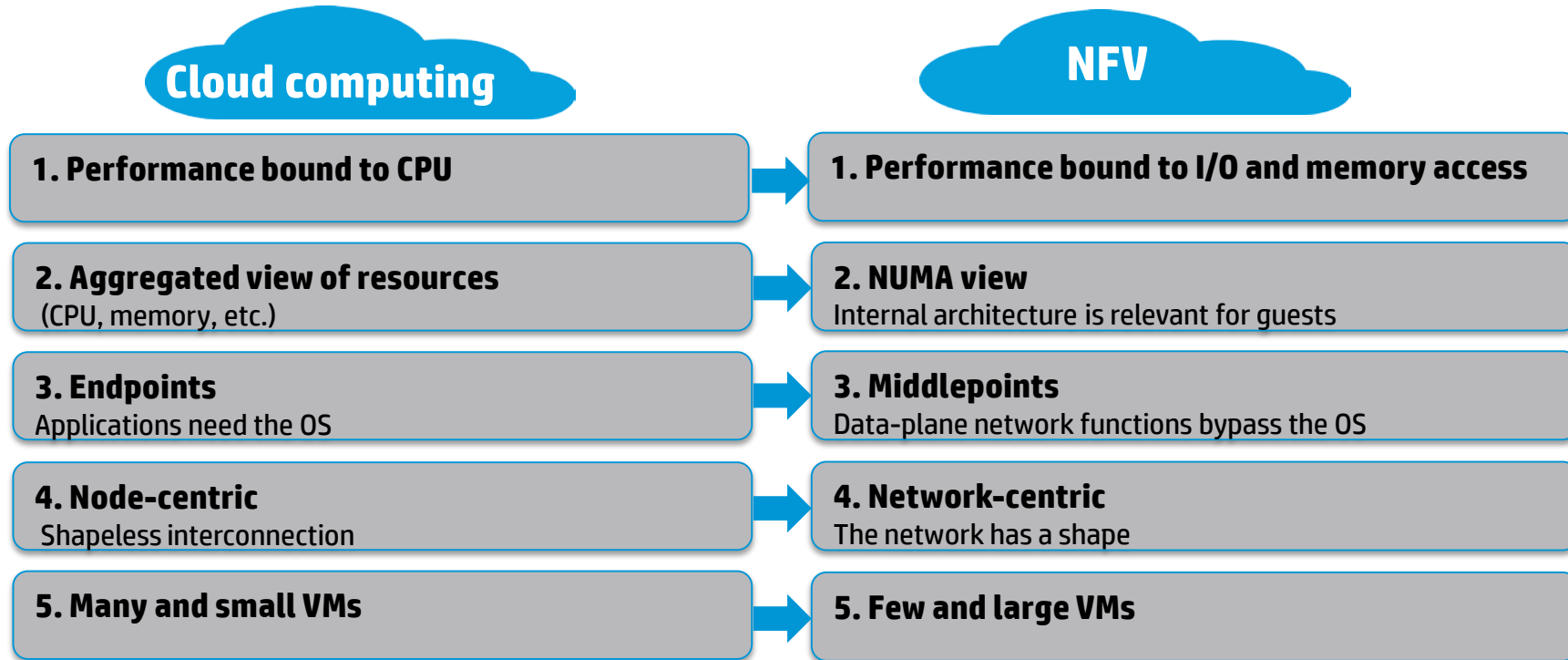➢ How to ensure reduced Operations costs while deploying NFV

Organizational

➢ Need for CIO and CTO to collaborate
➢ Need for new type of IT skills in the Network
➢ Purchase chain and projects/support engagement models will change

CSP needs to address these, too

Enterprise Cloud and NFV Cloud workloads

Cloud computing

NFV

Cloud computing	NFV
1. Performance bound to CPU	1. Performance bound to I/O and memory access
2. Aggregated view of resources (CPU, memory, etc.)	2. NUMA view — Internal architecture is relevant for guests
3. Endpoints — Applications need the OS	3. Middlepoints — Data-plane network functions bypass the OS
4. Node-centric — Shapeless interconnection	4. Network-centric — The network has a shape
5. Many and small VMs	5. Few and large VMs

Capabilities	Standard OpenStack today	Functionality desired from carriers
Fault detection (Hardware/Virtualization Layer)	~1 Min.	Sub-second
Detection of failed VM's	~1 Min. or longer	Sub-second
Under Cloud Services failure detection	Approximately a min.	~10sec
vSwitch performance	1-2Gbps	Full Line Rate, with few cores
Network failure detection on compute nodes	Depends upon Linux Distro	50msec
Live Migration with SR-IOV & DPDK enabled functions	Currently no support	Fully supported

Internet of Things

The demands for digital ripple across every aspect of your enterprise

Value greater than the sum of individual parts
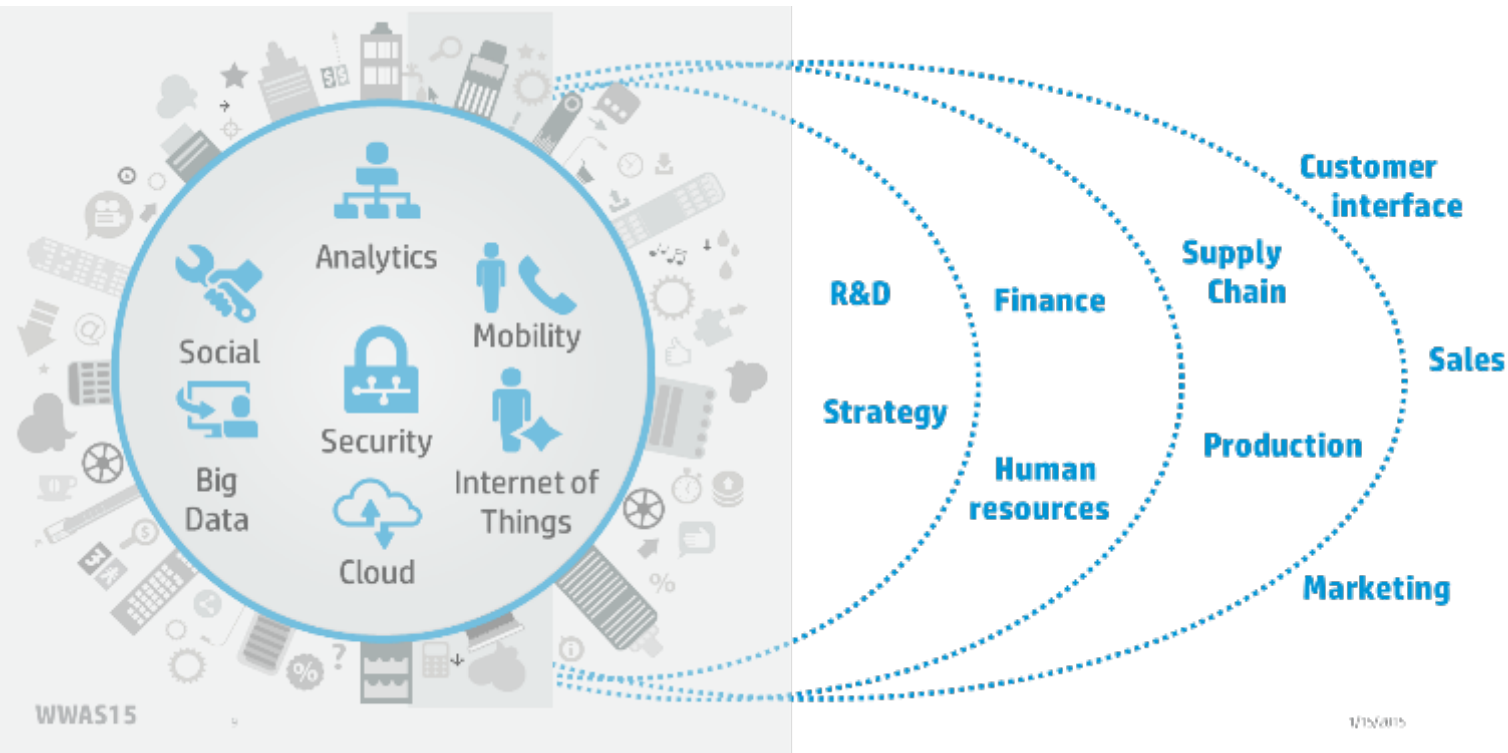
Globalization, technology innovation and the "instant consumer" are disrupting every industry
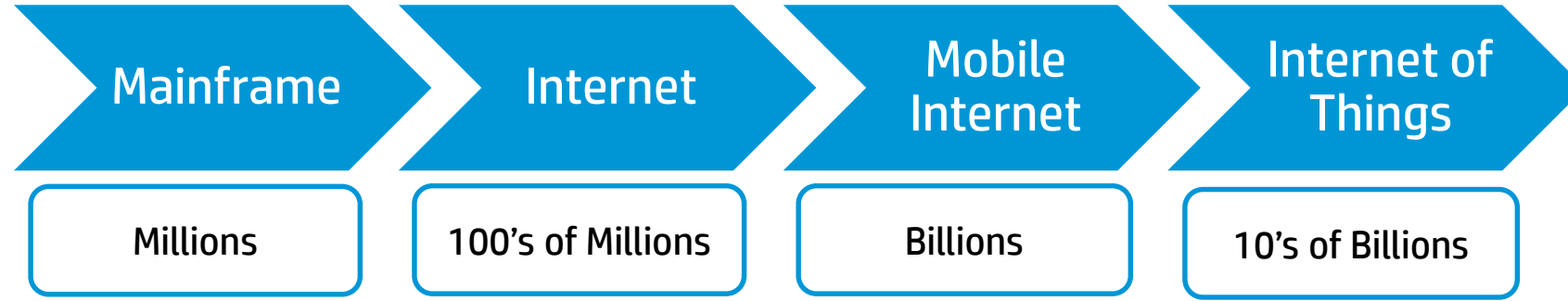
- New Commerce Models
- New Connectivity Models
- New Collaboration Models
- Data and Device Proliferation

'Things' connected to the internet – 50 billion by 2020

All expectations are huge

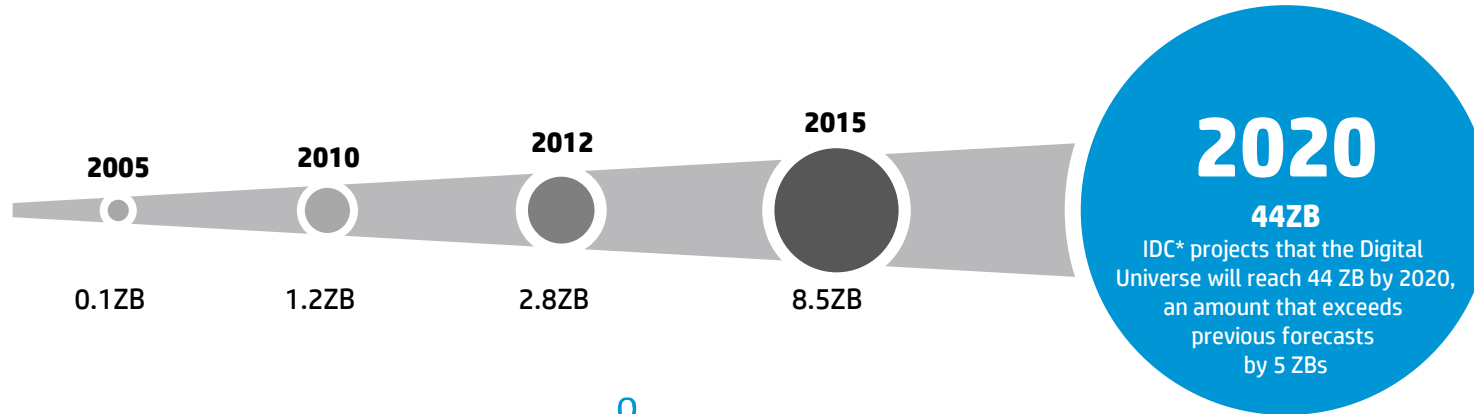| Mainframe	Internet	Mobile Internet	Internet of Things
Millions	100's of Millions	Billions	10's of Billions

A re-think of the architecture is required

– Today's Internet is not capable of connecting hundreds of billions of devices

– All devices will not attach to the network in the same way

…but at some point these devices will need to connect to the network

So, we must be prepared and ready to take advantage of this tidal wave

 WWAS15

Machine-generated data - 40% of the Digital Universe

Data must be unlocked and turned into meaningful info

2005 0.1ZB

2010 1.2ZB

2012 2.8ZB

2015 8.5ZB

2020 44ZB
IDC* projects that the Digital Universe will reach 44 ZB by 2020, an amount that exceeds previous forecasts by 5 ZBs

33x

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40% by 2020

33% of data in 2020 will contain useful information to enterprise
But only **0.5%** is currently analyzed

Machine-generated data is a key driver in the growth of the world's data
15x increase by 2020

Traditional Enterprise Data

Machine Data & Human Information

Dark Data

*EMC Digital Universe Study, with data and analysis by IDC, April 2014 IDC

 WWAS15

A definition - Internet of Things

Industry analyst's perspective

*"IoT is composed of technology-based connected solutions that allow businesses to gain **insights** that help **transform** how they engage with customers, deliver products/services, and run operations"*

– IDC *"Worldwide Internet of Things 2014-2020 Forecast: Forecast Update and Revenue by Technology Split"*
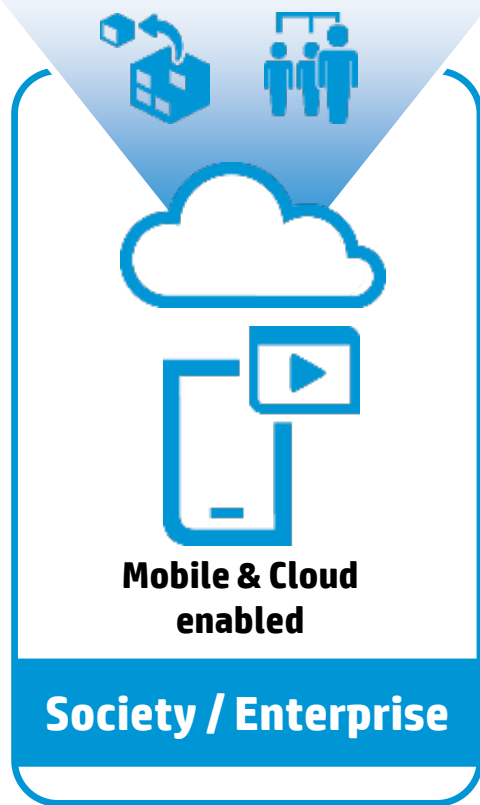(IDC #252330)

*"The Internet of Things (IoT) is the **network of dedicated** physical objects (things) that contain embedded technology to **sense** or **interact** with their internal state or external environment. The IoT comprises an **ecosystem** that includes things, communications, applications and data analysis."*

– Gartner *"The Internet of Things and Related Definitions "*
Oct 2014 ID: G00269832

    WWAS15

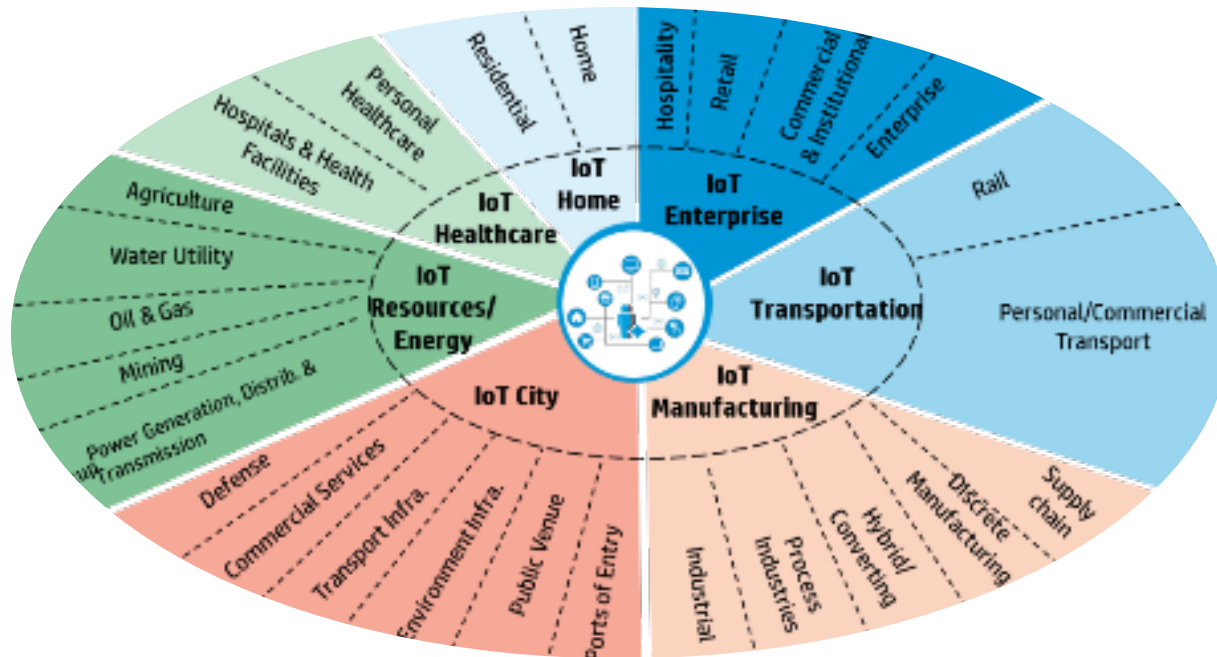# IoT is about Capturing Digital Moment

Creating Value from new Insights

Redefining the world of interactions

Mobile & Cloud enabled

Society / Enterprise

+

Things

=

Context aware
Seamless
Just-in time

Value creation

You need to pay attention – IoT has broad, broad Impact

IoT will take off – One use-case at a time

**Market forecasts vary widely,
but all point to a significant opportunity**

Some markets moving faster than others

- **Enablers** include:
  - Shrinking sensor footprint, power consumption, cost
  - Pervasive wireless, standardization of communication protocols
  - Low-cost cloud computing
  - Improved Ease of Use
  - Alignment with business need
  - Availability of complete solutions

**Require partnerships between
industrial IT and traditional IT**

     WWAS15

Internet of Things

Key functions and technologies of IoT

Key Functions
- Sense
- Collect
- Communicate
- Analyze
- Act

Key Technologies
- Sensors
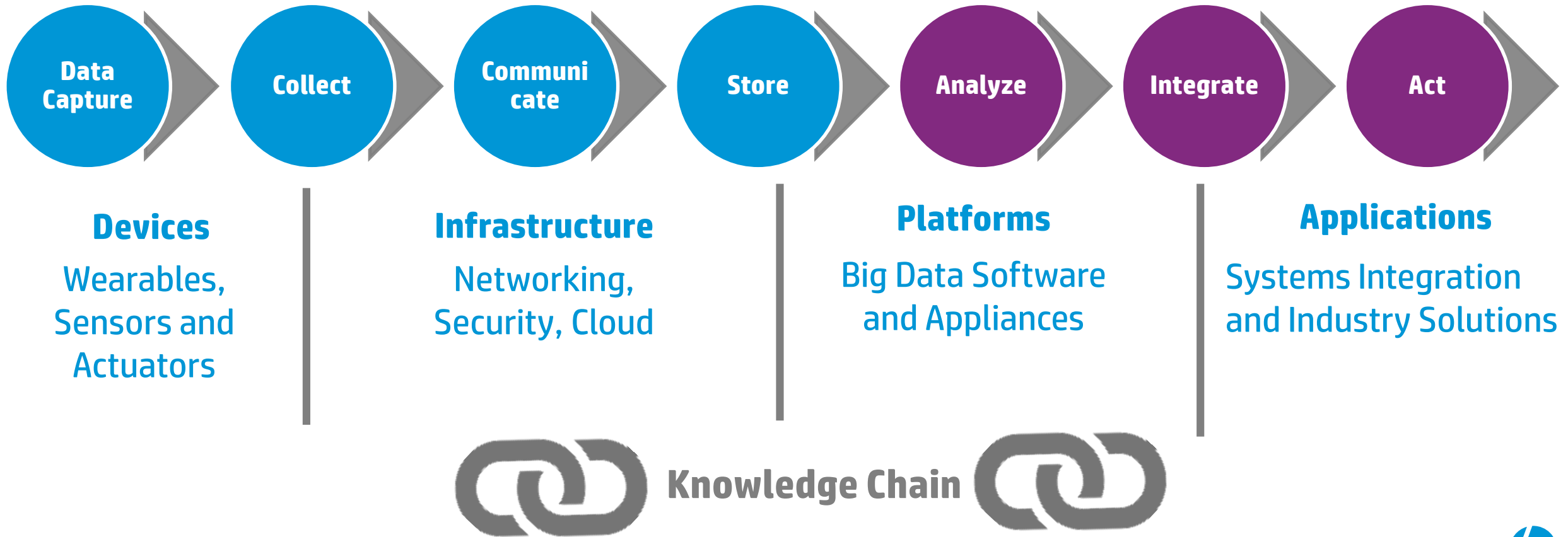- Networking
- Big Data
- Vertical Applications

Characteristics
- Heterogeneous
- Pervasive - Huge in numbers
- Decentralize control
- Autonomous
- CPU/Energy limited
- Wireless
- Situational awareness

WWAS15

IoT Functional Overview

It is NOT all about the device, Data is the new currency

| Data Capture | Collect | Communi cate | Store | Analyze | Integrate | Act |

Devices
Wearables, Sensors and Actuators

Infrastructure
Networking, Security, Cloud

Platforms
Big Data Software and Appliances

Applications
Systems Integration and Industry Solutions

Knowledge Chain

WWAS15

High Level Architectures for IoT

Use cases will drive different architectures

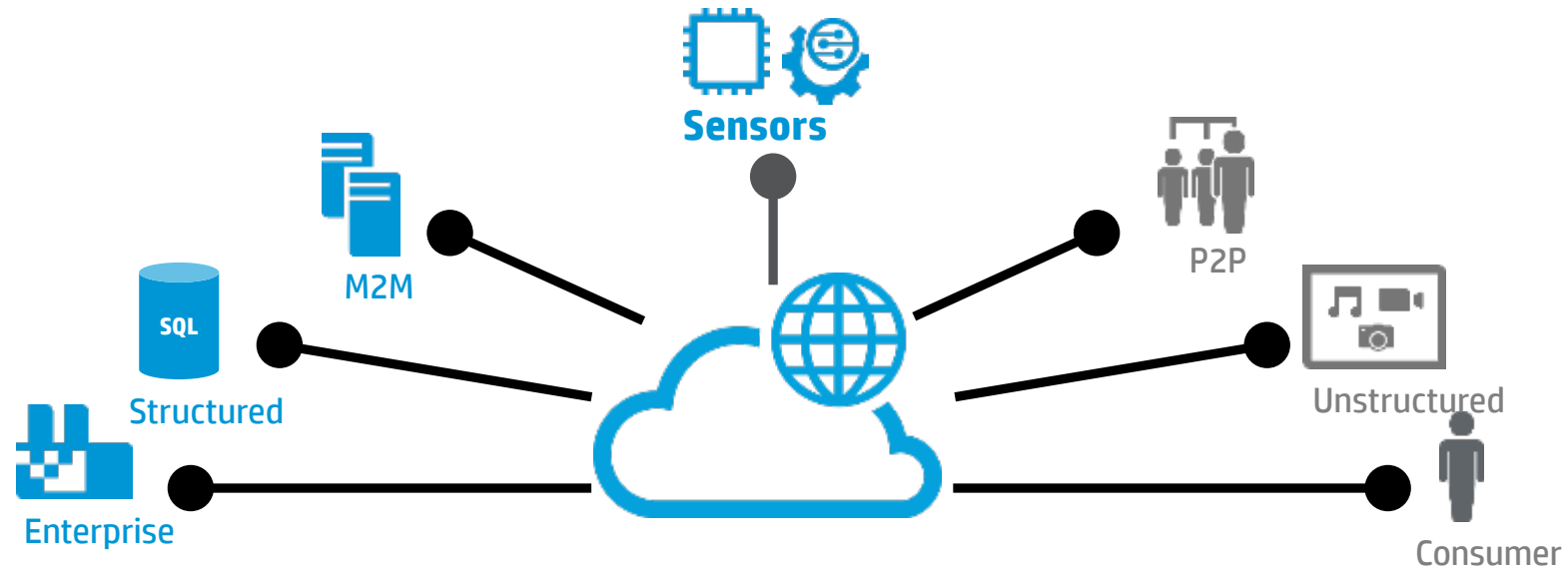- ## Thing/Device centric
  - "Direct" Thing/Device + Data + Analysis

- ## Gateway centric
  - "Dumb" Thing/Device + Gateway for Data aggregation + Analysis

- ## Cloud Centric
  - "Direct" or "Dumb" Thing/Device + Cloud/Enterprise data aggregation + analysis

No "one-size fits all"

Gateways   Cloud / Internet   Enterprise

Apps   **Data**   **Analytics**

Security / Privacy

    WWAS15
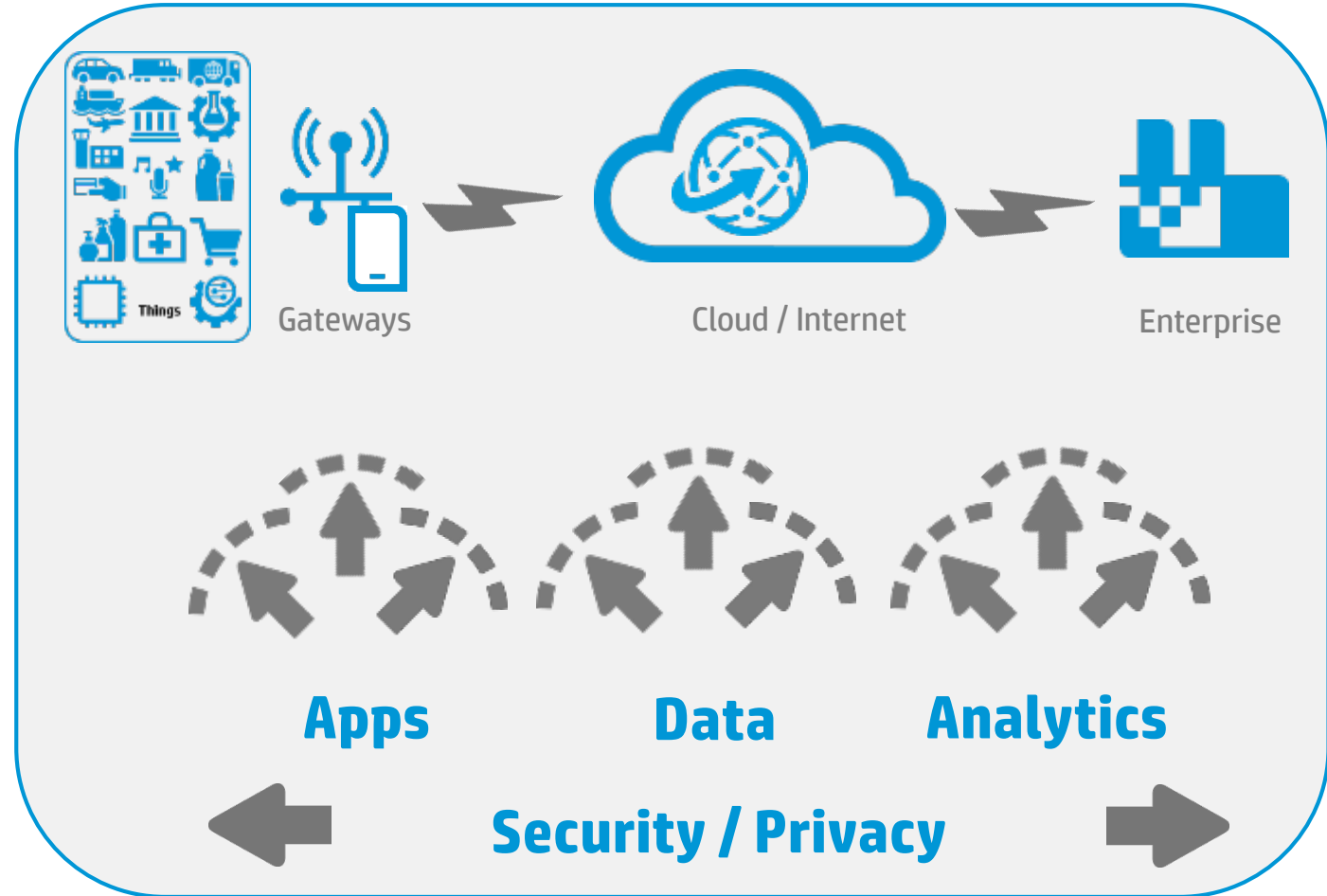
Information is knowledge

Dynamic Intelligence

Sensors

M2M

SQL

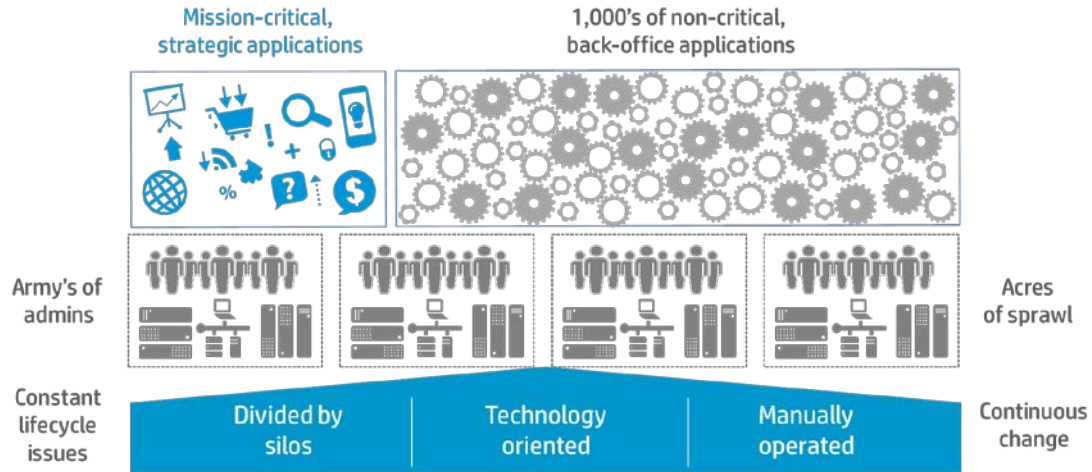Structured

Enterprise

P2P

Unstructured

Consumer

Big Data / Big Insights

Connected Intelligence / Intelligently Connected

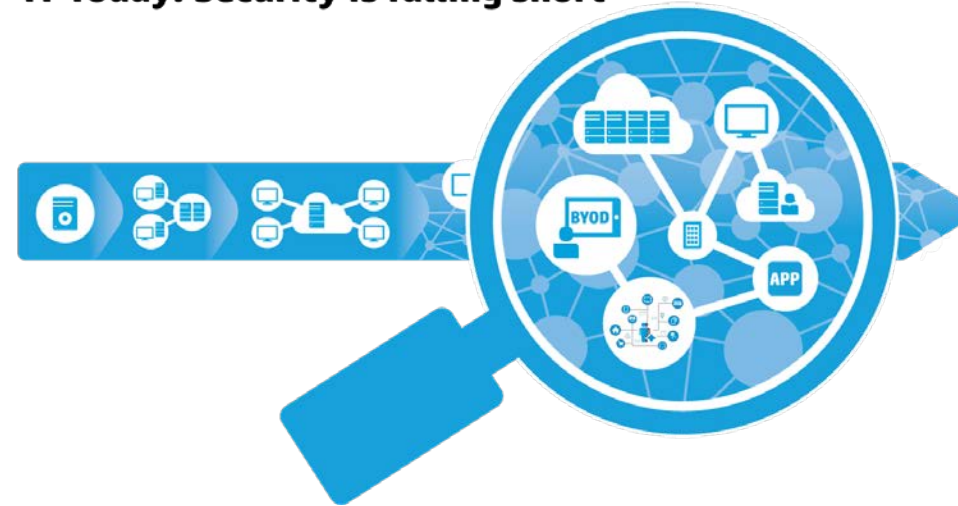"to turn information into a force multiplier and drive new business value"

   WWAS15

IoT Challenges

Complexity - a barrier to IT responding

Mission-critical, strategic applications

1,000's of non-critical, back-office applications

Army's of admins

Constant lifecycle issues

Divided by silos | Technology oriented | Manually operated

Acres of sprawl

Continuous change

IT Today: Security is falling short

Lack of Standards

IoT vendors are jumping into this space by simply adding connectivity to their devices with no thought about security or analytics!
HP's Internet of Things State of the Union Study, revealing that
70 % of the most commonly used IoT devices contain serious vulnerabilities

Conclusions

IT Transformation

Redefining the world of interactions

UNIVERSAL ACCESS TO PEOPLE **APP**LICATIONS **DATA** & **THINGS**

Mobility

Big Insights

Connectivity

TRANSFORM Your IT INFRASTRUCTURE into **BUSINESS** **ENABLED** CONNECTIVITY

Key Takeaways

- Transformation is about **value creation** – from rigid network to agile network connectivity

- **SDN** - focus less on managing infrastructure and more on quality of business experience

- **NFV** – increase business agility by bringing IT skills to Network

- **IoT** - value resides in the information produced and the actions taken as a result

- Transformation is always a **multi-dimensional challenge**

Embrace new technologies

Resources

- [SDN Whiteboard (video)](#)
- [Software-defined networking (business white paper)](#)
- [Network functions virtualization (technical white paper)](#)
- [Internet of Things Research Study](#)
- [HP SDN Development Centre](#)

Networking/IT & Business Skills

- Switching & Routing, SDN/OpenFlow/ODL, Wireless, Security, Data Center Interconnection, ADC/Load balancer
- 3-tier application architectures, (private/hybrid/public/managed) cloud, virtualisation & OpenStack
- OPNFV, Orchestration, BSS/OSS, BigData, DevOps, Converged Systems
- Strategic & Tactical Planning
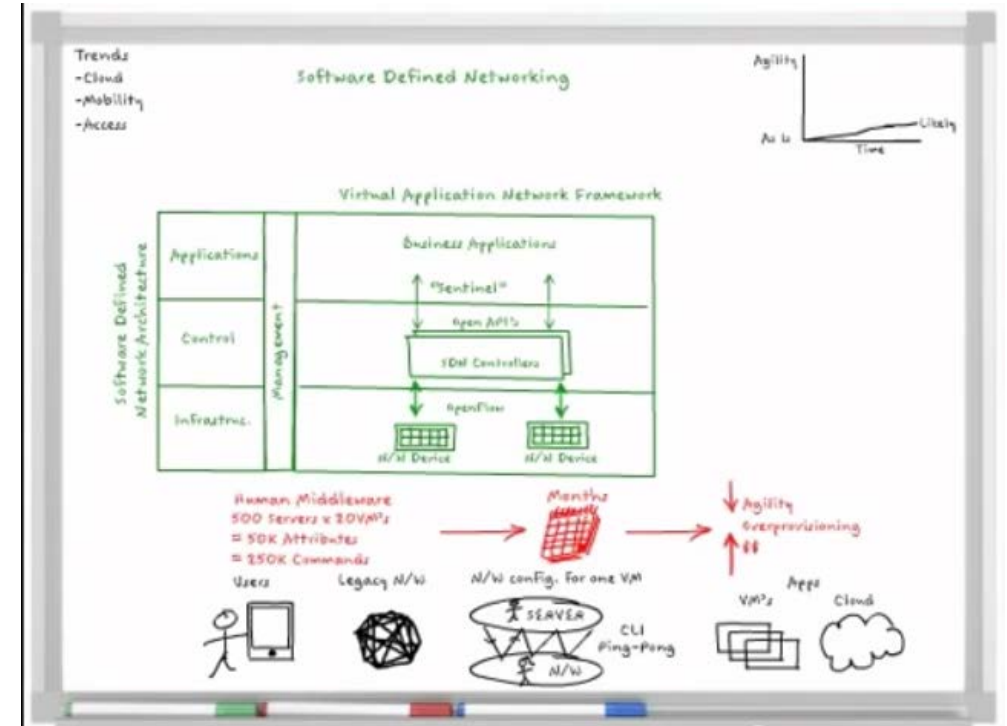
2nd EMEA SDN Symposium for Universities

Lisabon, July 1-2 2015

Overview

Register

HPSDN4Unis

We held the 1st, very successful, EMEA SDN Symposium for Universities in Lancaster, UK back in November 2014. After 2 days of interactive discussions and presentations focused on the future of SDN in the Research & Education sector, sharing some best practices in that area by the Ballarat Grammar School, Australia and Lancaster University, we are proud to propose the 2nd EMEA SDN Symposium for Universities.

This time you will have the opportunity to hear the views of **market analysts**, the importance of **open standards**, best practices around **SDN development** including **SDN Apps** from industry and academic **experts**. We will also plan to cover topics such as **funding and research** opportunities, **case studies** from independent software vendors **(ISVs)** and existing customers who have already deployed production networks benefiting from an **SDN architecture**.

EMEA SDN Symposium for Universities video

Call for Abstracts

Event Organisers invite researchers and key stakeholders to actively participate to the 2nd SDN Symposium. There are to possibilities; either to present your SDN research activities via a short presentation or to build your SDN demo in the exhibition area. You need to submit short abstract (up to 250 words) for the thematic areas below:

- New architecture models
- SDN applications (incl. security, load balancing, traffic engineering, VPNs, etc)
- SDN use cases in campus environment
- Inter-domain SDN Services & Federation
- SDN Deployment Experiences & Best Practices
- Testing & Monitoring SDN infrastructures
- Intersection of SDN & Network Function Virtualisation (NFV)

h41112.www4.hp.com/test/sdn-symposium/pages/event-overview.html

Thank you

Athanassios Liakopoulos

Technology Services

EMEA Business Development Manager