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Network Service Orchestration: Getting Close to the Edge

CHIST-ERA – Intelligent Computation for Dynamic Networked Environments (ICoDyNE)

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“I’m playing all the right notes, but not necessarily in the right order”.

- Eric Morecambe (1926-1984)

EPSRC
Engineering and Physical Sciences Research Council

BT

Next Generation Converged Digital Infrastructure (NG-CDI)

http://www.ng-cdi.org

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UNIVERSITY OF CAMBRIDGE

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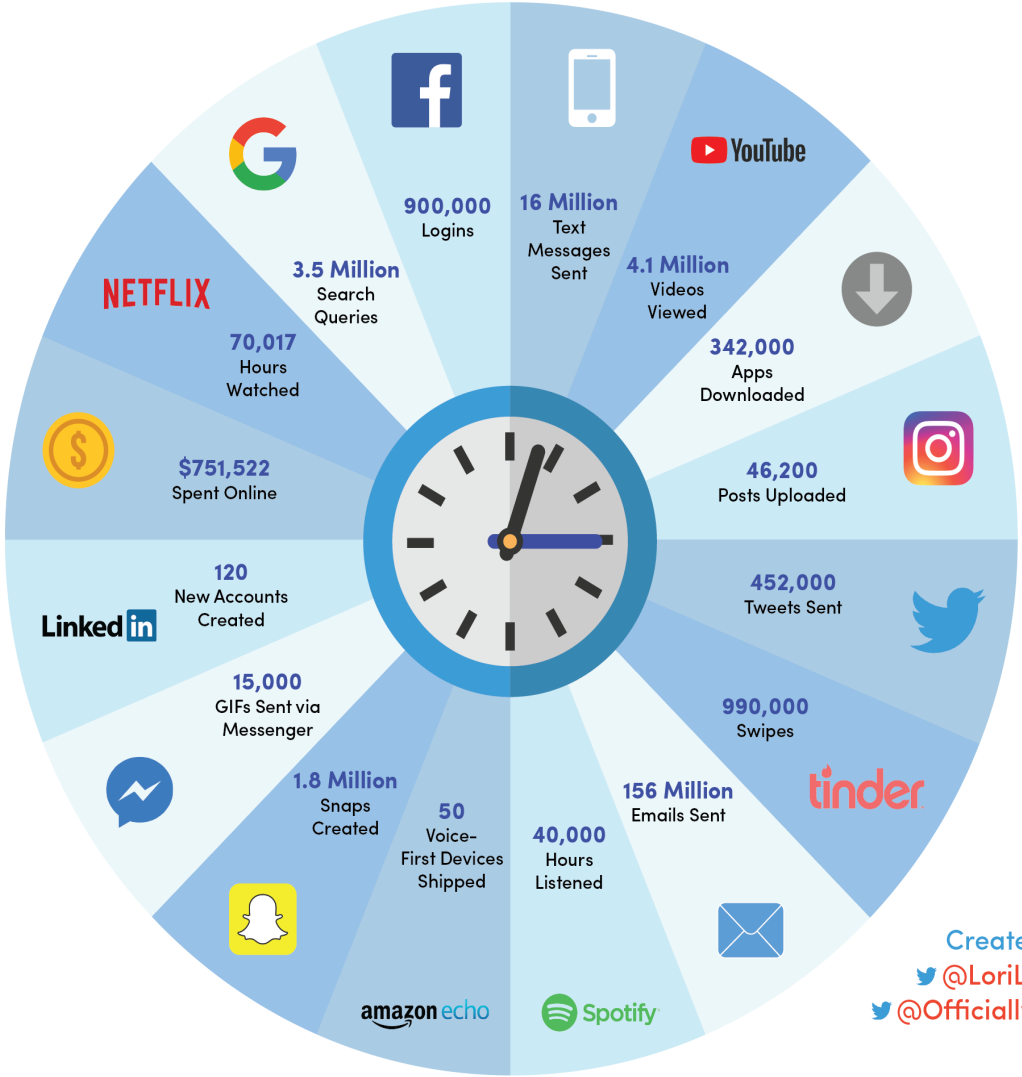
NG-CDI Objectives

- Developing a completely **new architecture** for digital infrastructures, composed of **highly- dynamic network functions** based on a micro-NFV approach that are collectively able to **adapt to the real-time requirements** of future digital services.
- Creating a new **autonomic framework** for digital infrastructure to equip the nodes of the infrastructure network with the ability to **understand** their state, **detect and diagnose** disruptions to service, and take **autonomous** actions.
- Implementing approaches for the **successful integration** of these technologies **within the business functions** with an aim to **improve service assurance** and organisational value.

An Internet Minute
2017

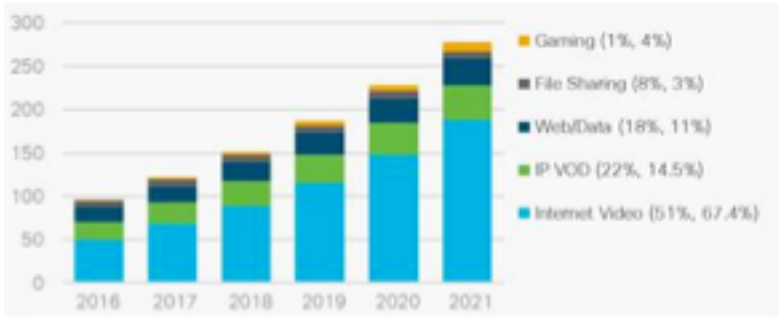


Created By:
@LoriLewis
@OfficiallyChadd

Service Challenges: Traffic Growth

- **Video**
  - Globally, IP video traffic was **73%** of all consumer Internet traffic in 2016 and will be **82%** by 2021
  - It would take an individual more than **5 million years** to watch the amount of video that will cross global IP networks **each month** in 2021
  - Consumer Video-on-Demand (VoD) traffic will nearly double by 2021. The amount of VoD traffic in 2021 will be equivalent to **7.2 billion DVDs** per month [1]

- **Mobile**
  - Mobile video traffic accounted for **60%** of total mobile data traffic in 2016
  - Mobile video will increase **9-fold** between 2016 and 2021
  - More than **three quarters** (78%) of the world's mobile data traffic will be video by 2021 [2]



Global consumer Internet traffic in Exabytes per month [1]

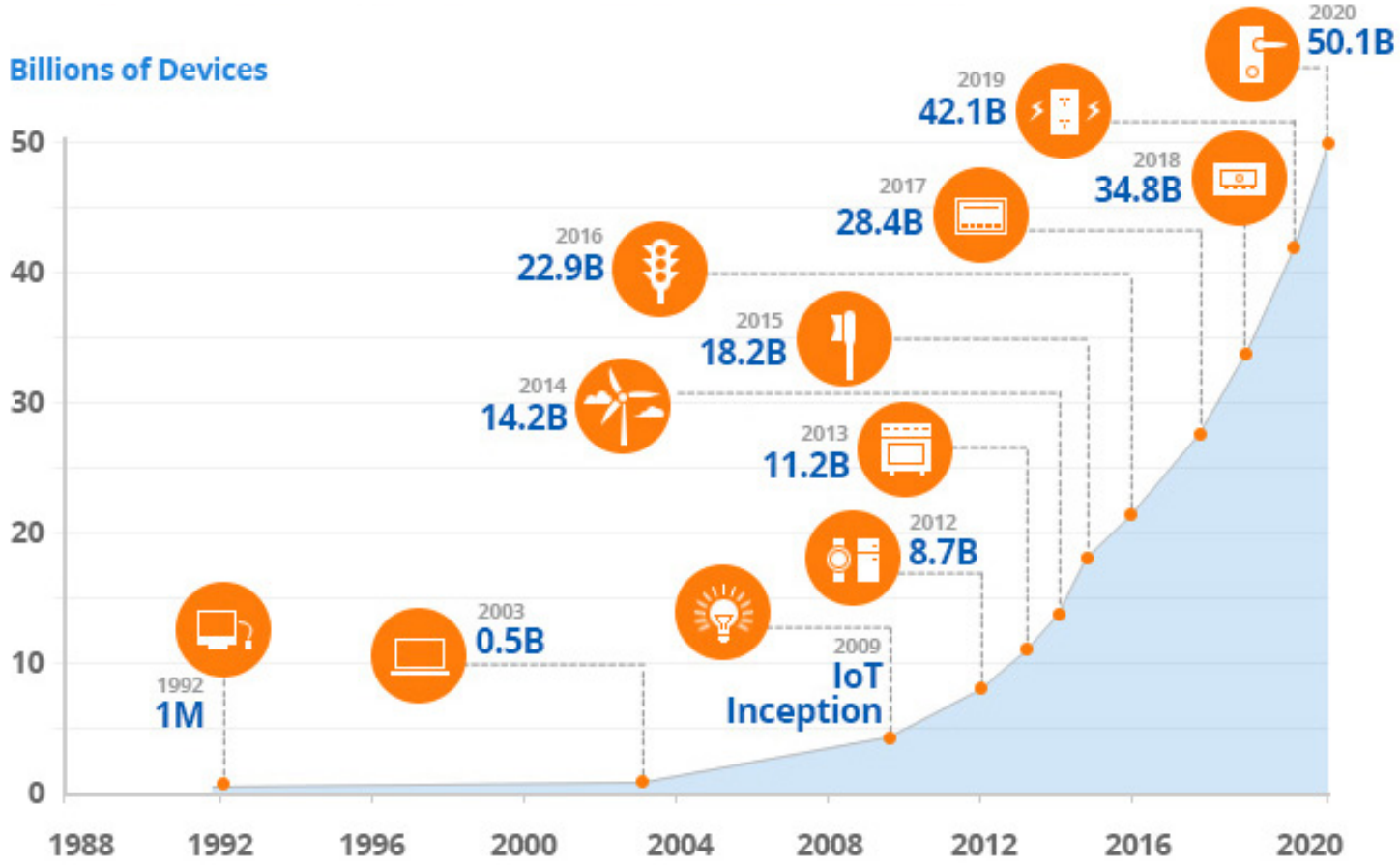
Mobile consumer Internet traffic in Exabytes per month [2]

[1] Cisco VNI (2017)

[2] Cisco VNI Mobile (2017)

*One exabyte is equivalent to one billion gigabytes, and one thousand petabytes

Service Challenges: Devices Connected (IoT)



Service Challenges: Reliability

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Debit cards

Visa admits 5m payments failed over a broken switch

IT meltdown affected millions across Europe, but Treasury committee is 'satisfied' with company's response

Patrick Collinson

Tue 19 Jun 2018 13.03 BST

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Cash beat Visa cards during an IT failure earlier in June when millions of payments in the UK and the rest of Europe failed for about 10 hours. Photograph: Alain Jocard/AFP/Getty Images

Visa has admitted that 5.2m transactions failed during its IT collapse earlier

most viewed in US

Image of sobbing toddler at US border: 'It was hard for me to photograph'

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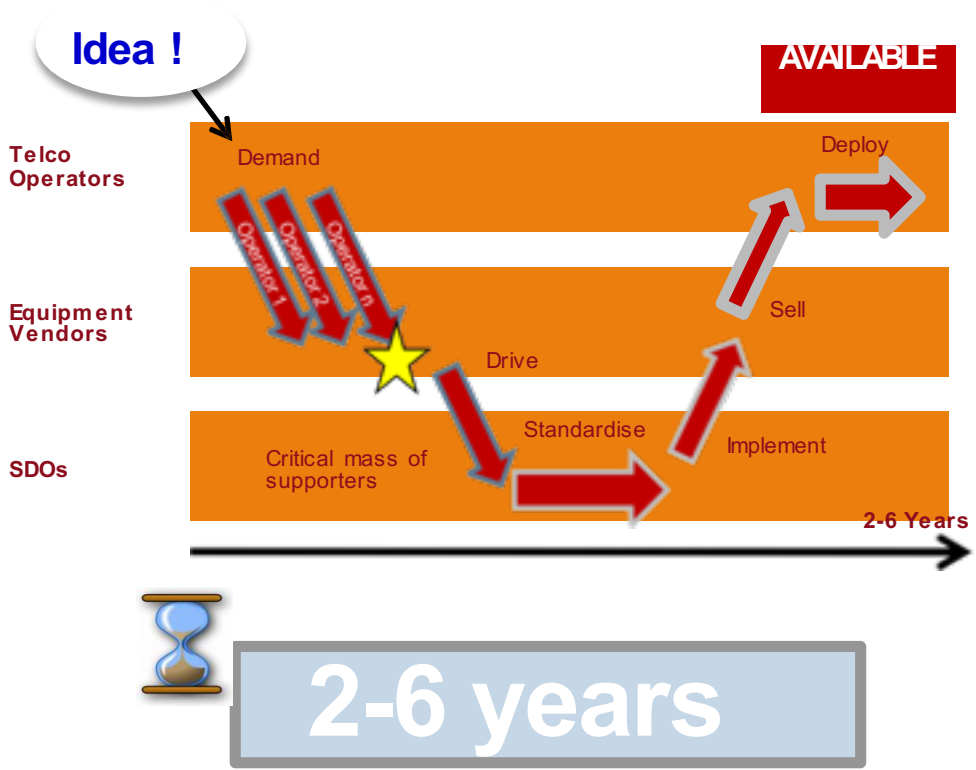
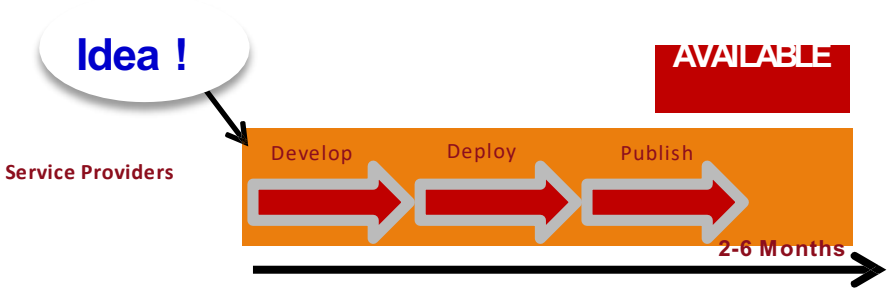
Innovation Cycles: Telecommunications



Innovation Cycles: Service Providers



2-6 months

Computer Industry: Server Evolution

Innovation!

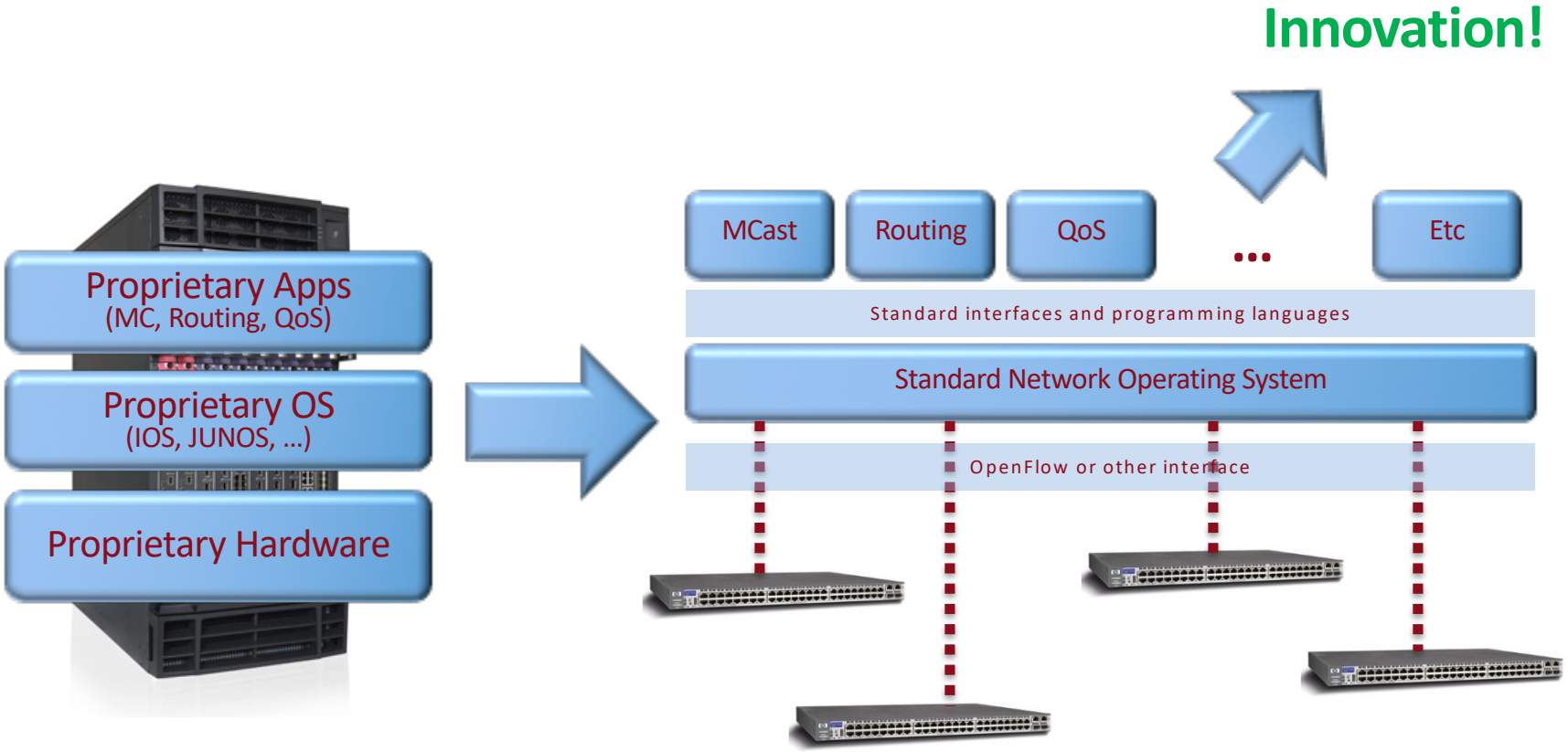
App ...

Standard interfaces and programming languages (Java, PYTHON, etc)

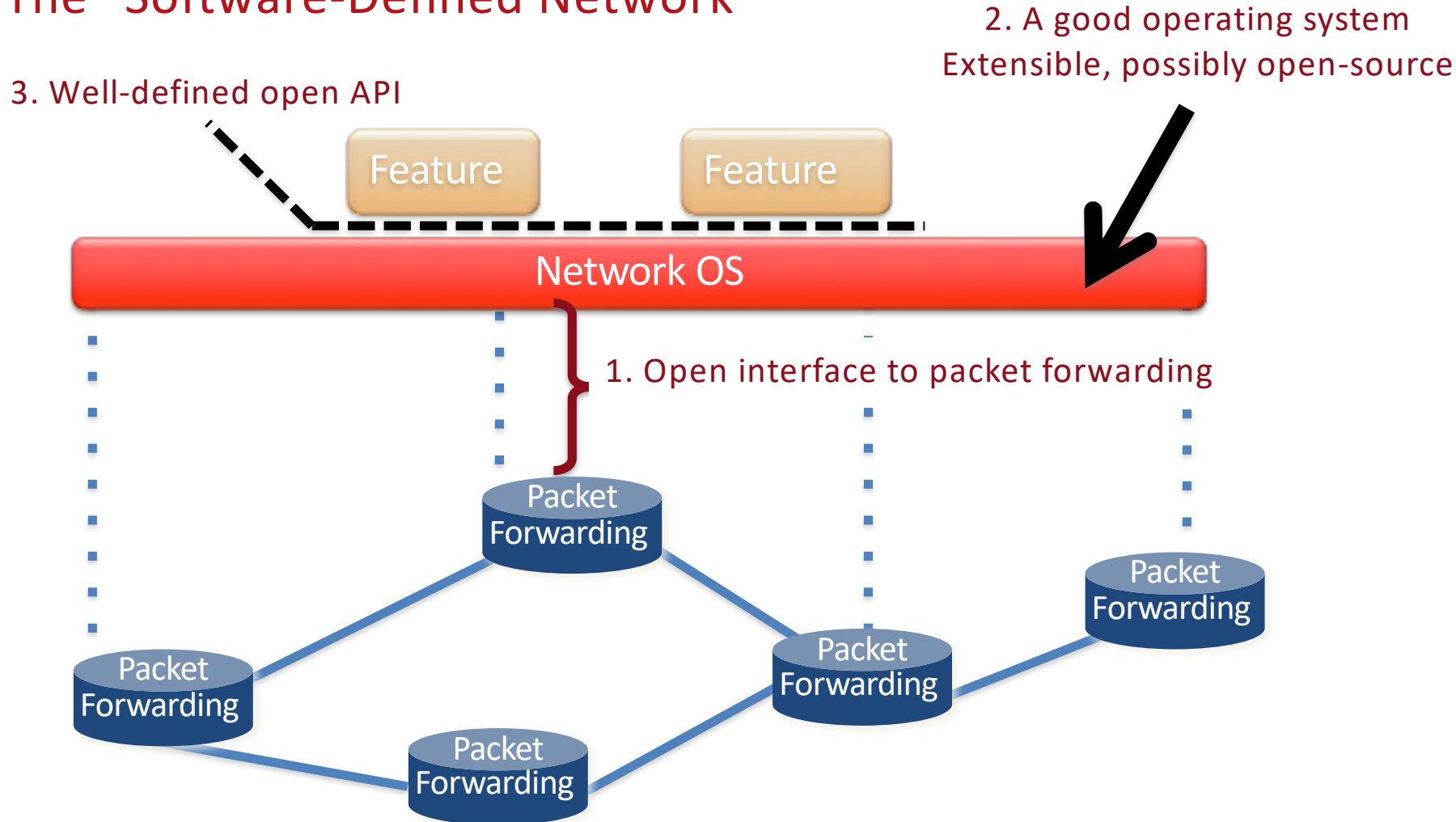
Standard Operating System (Linux, Windows, etc)

Microprocessors from Intel/AMD/etc

Networking Industry: SDN Potential



The “Software-Defined Network”

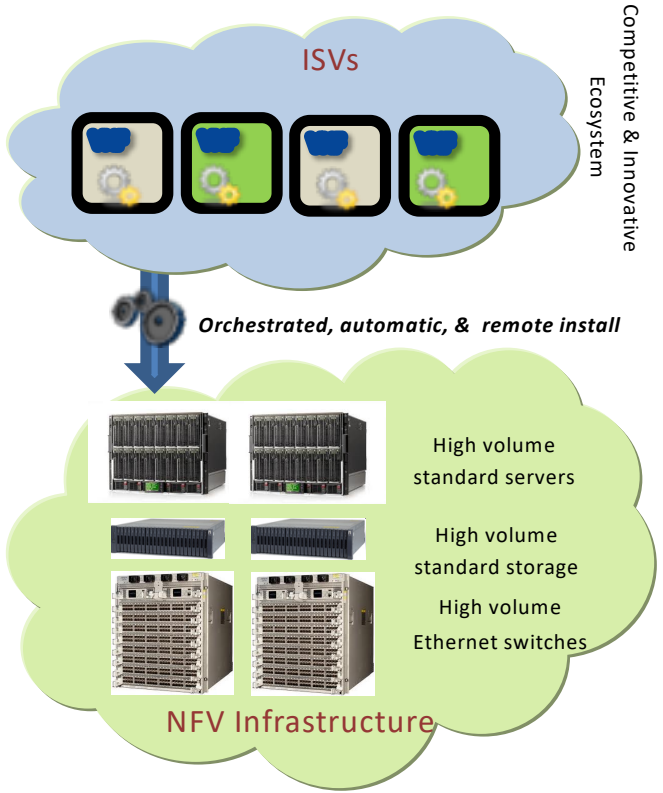


Network Functions Virtualisation

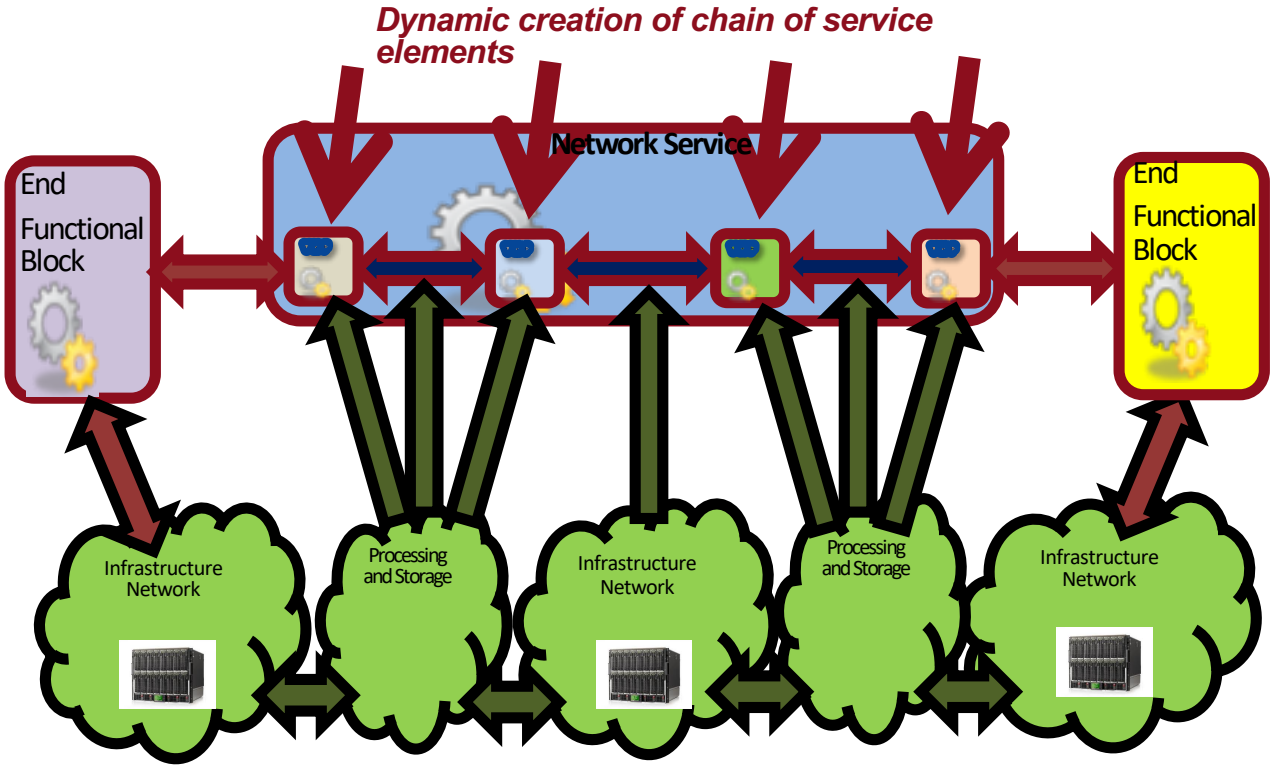
Classical Network Appliance Approach

- Fragmented non-commodity hardware.
- Physical install per appliance per site.
- Hardware development large barrier to entry for new vendors, constraining innovation & competition.

NFV Approach

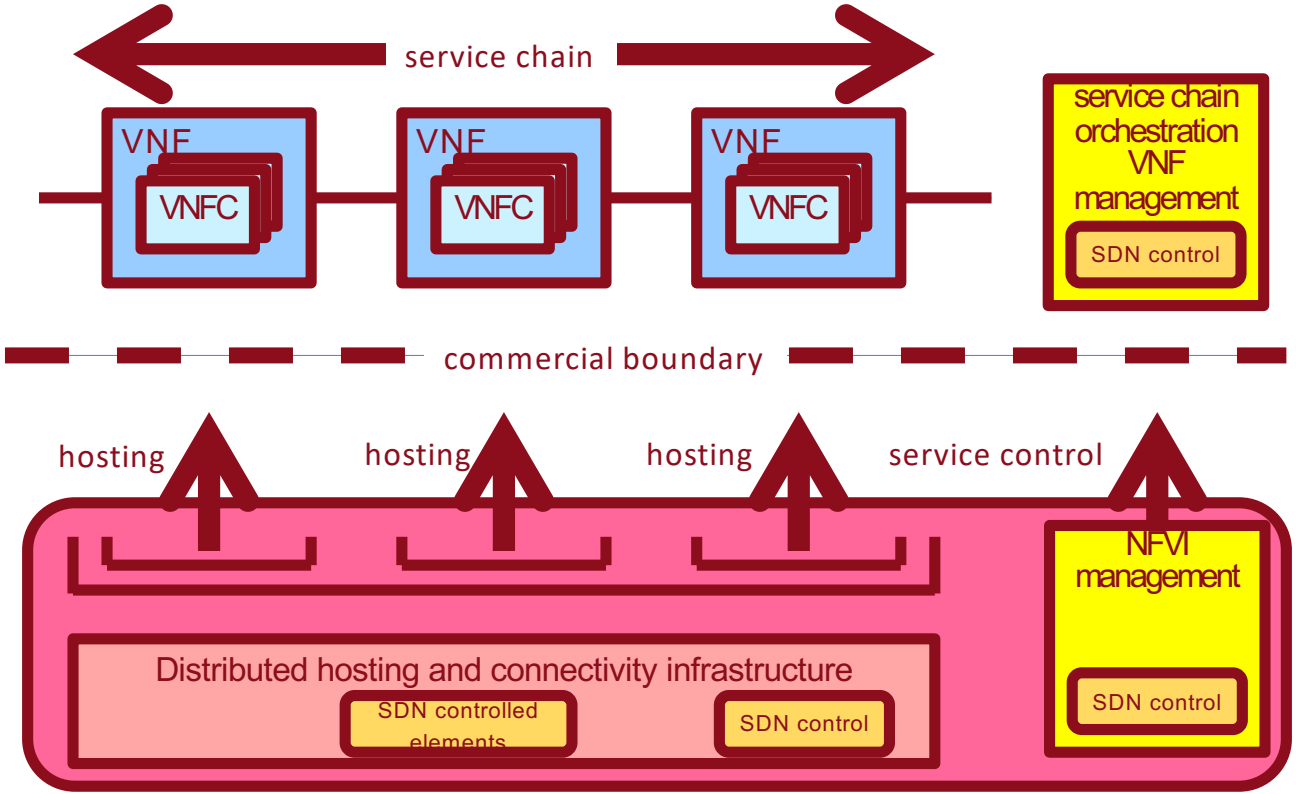


NFV Key Capability – Distributed Service

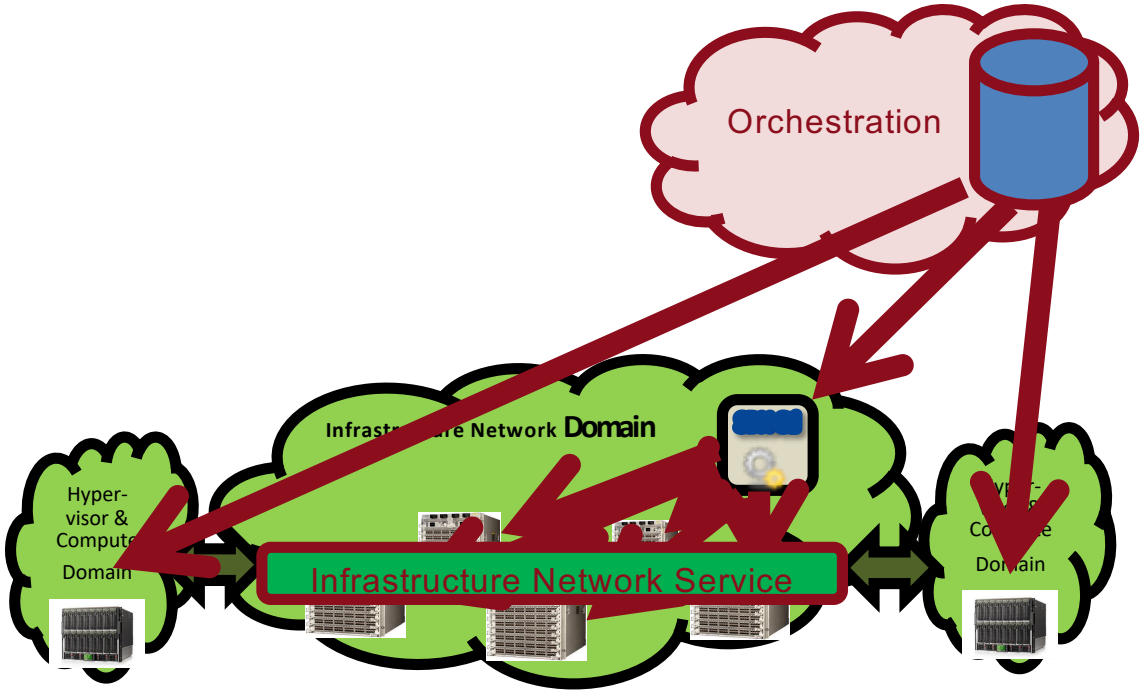


VNF = virtual network function

The network chain: new hosting environments?

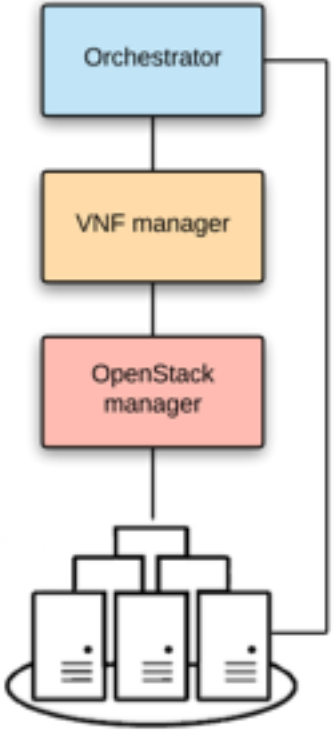


The key to achieving this: Service Orchestration

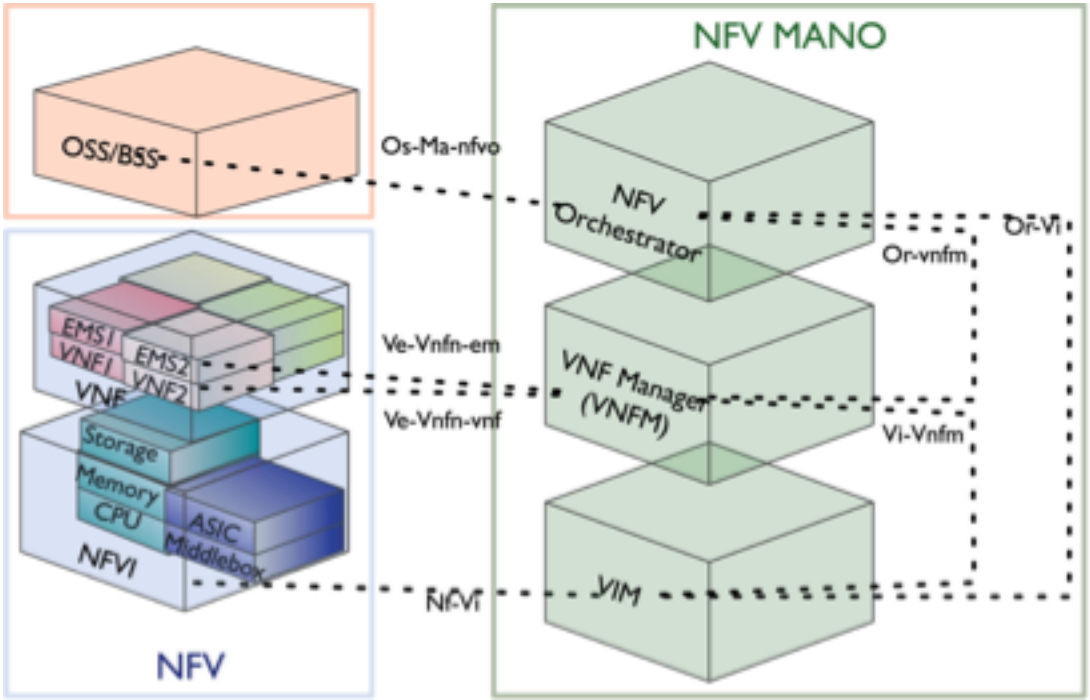


Service Orchestration –
aka. Management & Orchestration (MANO)

- A ***Service Orchestrator*** is a control system for the provision, management and monitoring of network services.
- Functional properties:
  - Coordination
  - Automation
  - Abstraction
- ETSI NFV MANO specification & Implementations
  - OpenBaton
  - Open Source MANO
  - OpenStack ++
  - OPNFV

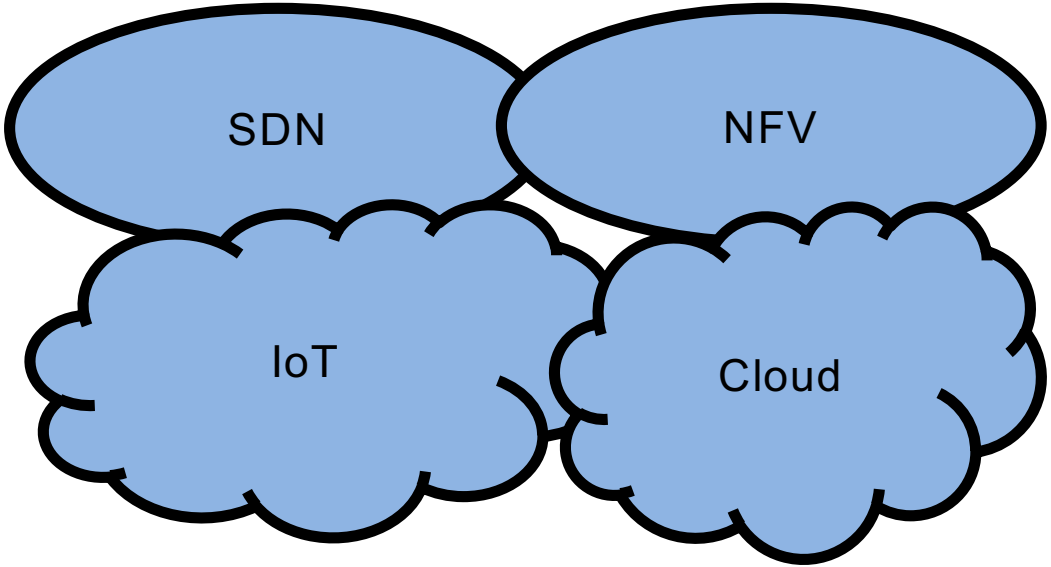


NFV Management and Orchestration (MANO)



Rotsos, C, King, D, Farshad, A, Bird, J, Fawcett, L, Georgalas, N, Gunkel, M, Shiomoto, K, Wang, A, Mauthe, AU, Race, NJP & Hutchison, D 2017, 'Network service orchestration standardization: a technology survey' *Computer Standards and Interfaces*, vol 54, no. 4, pp. 203-215. DOI: 10.1016/j.csi.2016.12.006

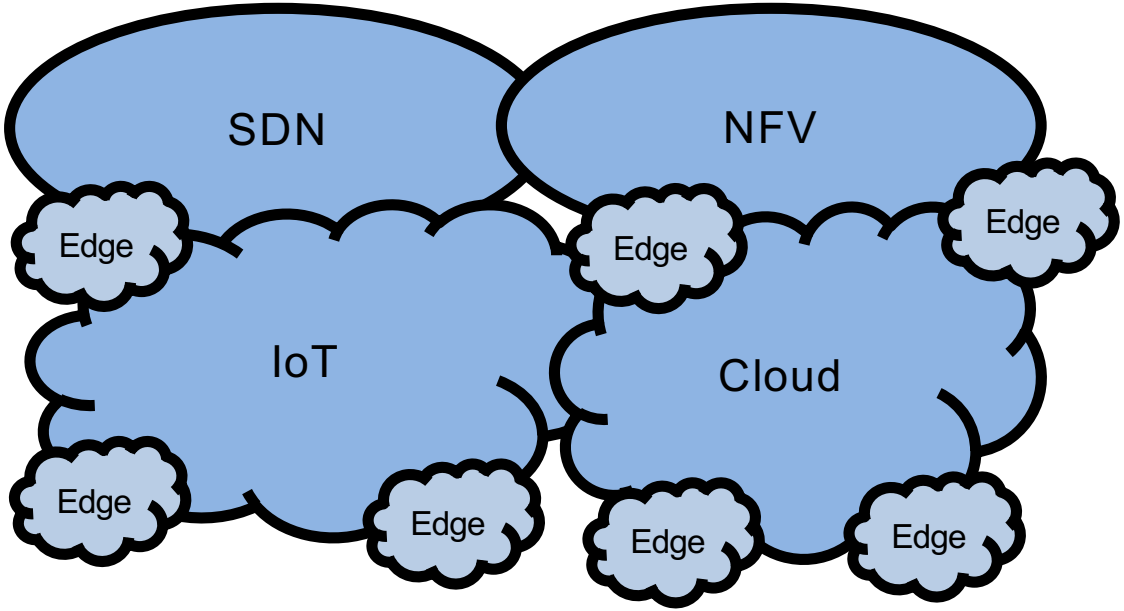
Objective: Automated creation, instantiation, and management of ICT services



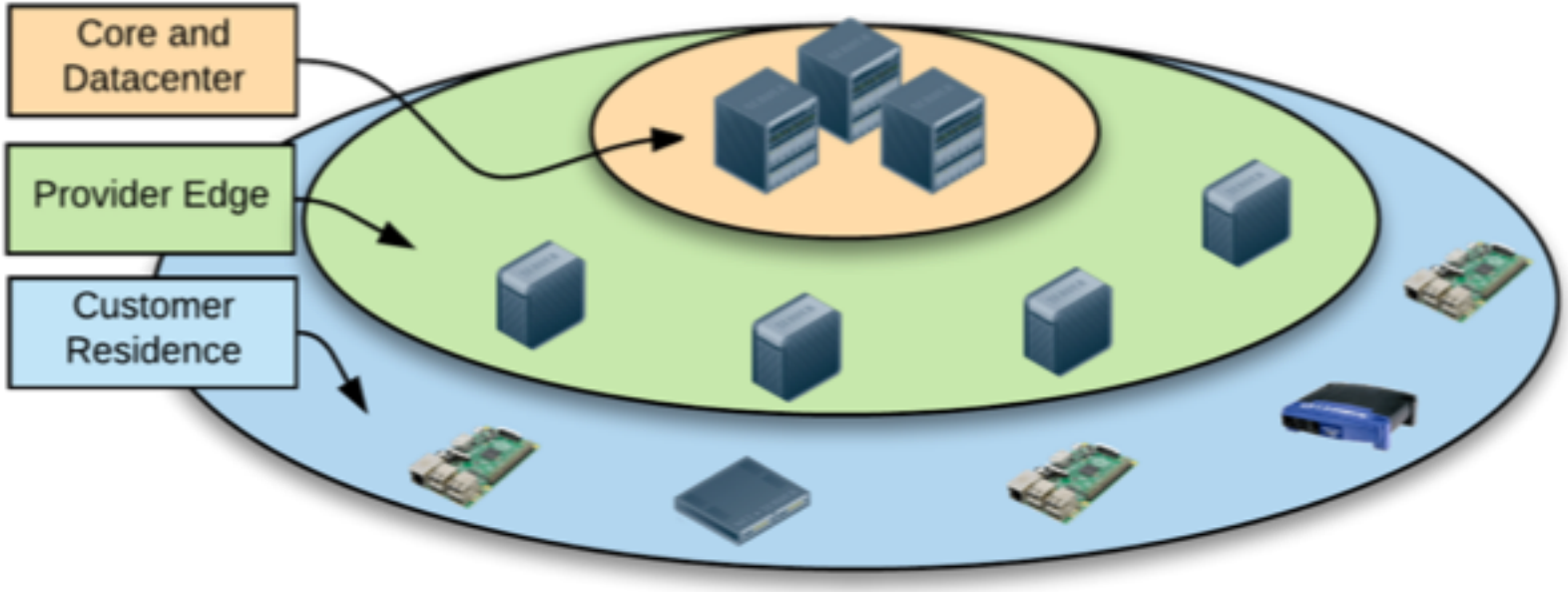

CAUTION
HEAVY
FOG


5G

Introducing the Edge



Or, to put it another way…



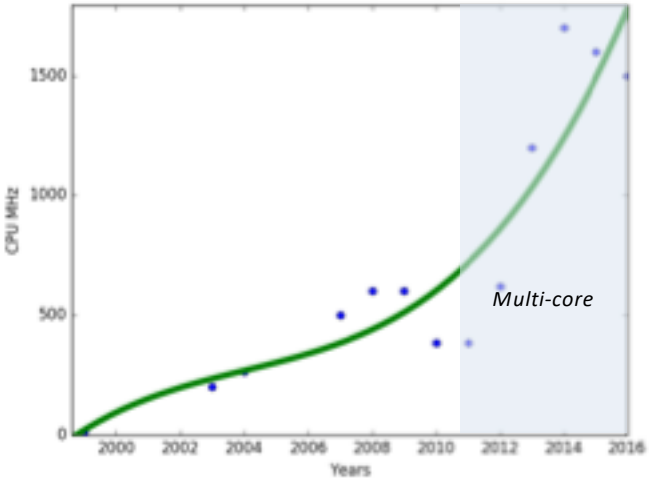
Potential of Fog/Edge Computing

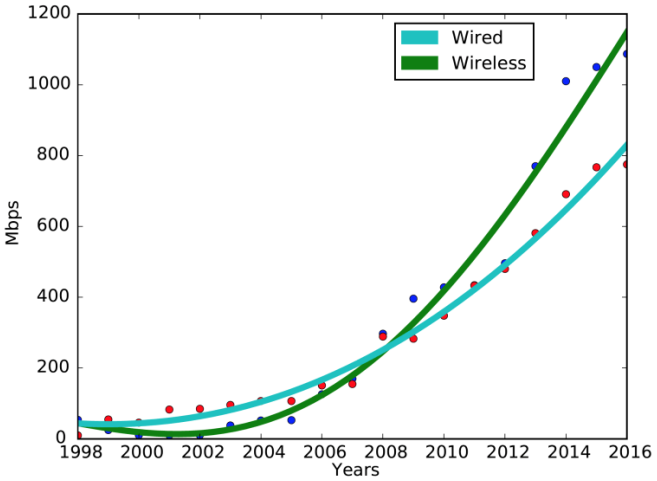
Increasing support for edge services

- NFV –> New edge services
  - QoE, caching, anomaly detection, mgnt.

Increased device capabilities throughout

- Analysis of the CPE[1,2]
  - More capable ‘kickstarter’ CPEs
- Routers with line-cards
- NFV at the telephone exchange CORD[3]

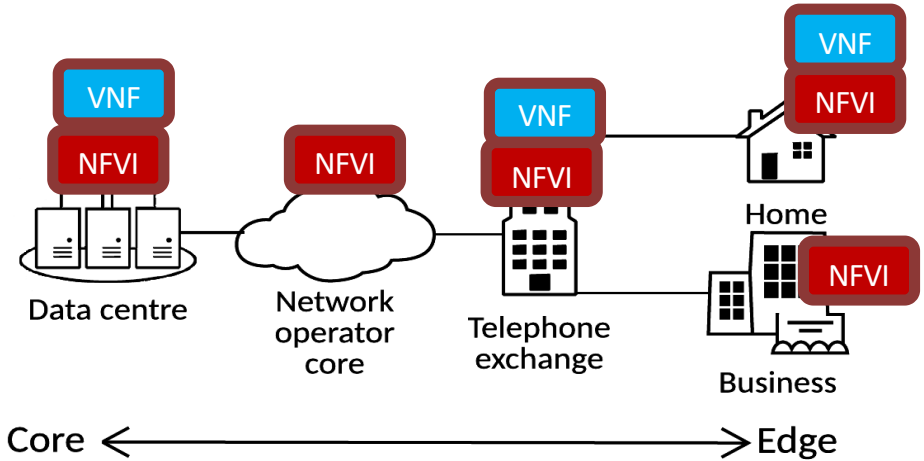




[1] More information about analysis at http://lyndonfawcett.com/analysis-of-the-cpe/
[2] Data source: https://wikidevi.com/wiki/Category:Wireless_embedded_system
[3] Al-Shabibi, A., and L. Peterson. "CORD: Central Office Re-architected as a Datacenter." *OpenStack Summit* (2015).

Integrating the Fog

- "Compute from Cloud to the end point"
- Benefits of Fog for NFV?
  - Low latency
  - Scalability
  - Privacy
  - Reduction of traffic to the core
  - Service with no Internet



[4] F. Bonomi, et al. Fog computing and its role in the internet of things. In Proceedings of the MCC workshop on Mobile cloud computing, 16. ACM, 2012.
[5] L. M. Vaquero and L. Rodero-Merino. Finding your Way in the Fog. ACM SIGCOMM Computer Communication Review, 2014.

Use Case: QoE in the Fog

Why?

- Target multiple households
- Low latency -> rapid change
- Reduce traffic to core

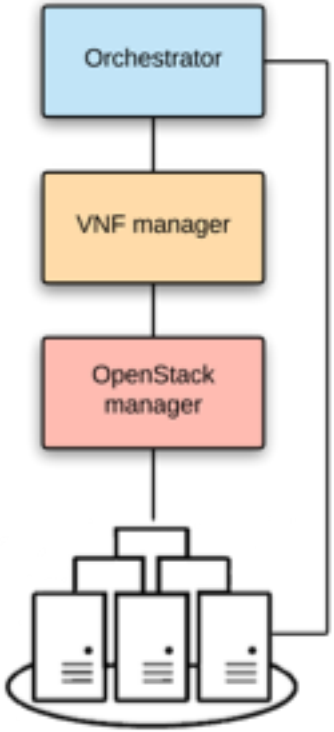
- Key focus:
  - Automatic location selection
  - Fog device discovery
  - Service migration in the Fog

[7] Example fairness application : Mu, M., Et al. “A Scalable User Fairness Model for Adaptive Video Streaming over Future Networks”, IEEE Journal on Selected Areas in Communications. 2016

Traditional MANO

Assumes homogenous environment

Assumes datacentre architecture



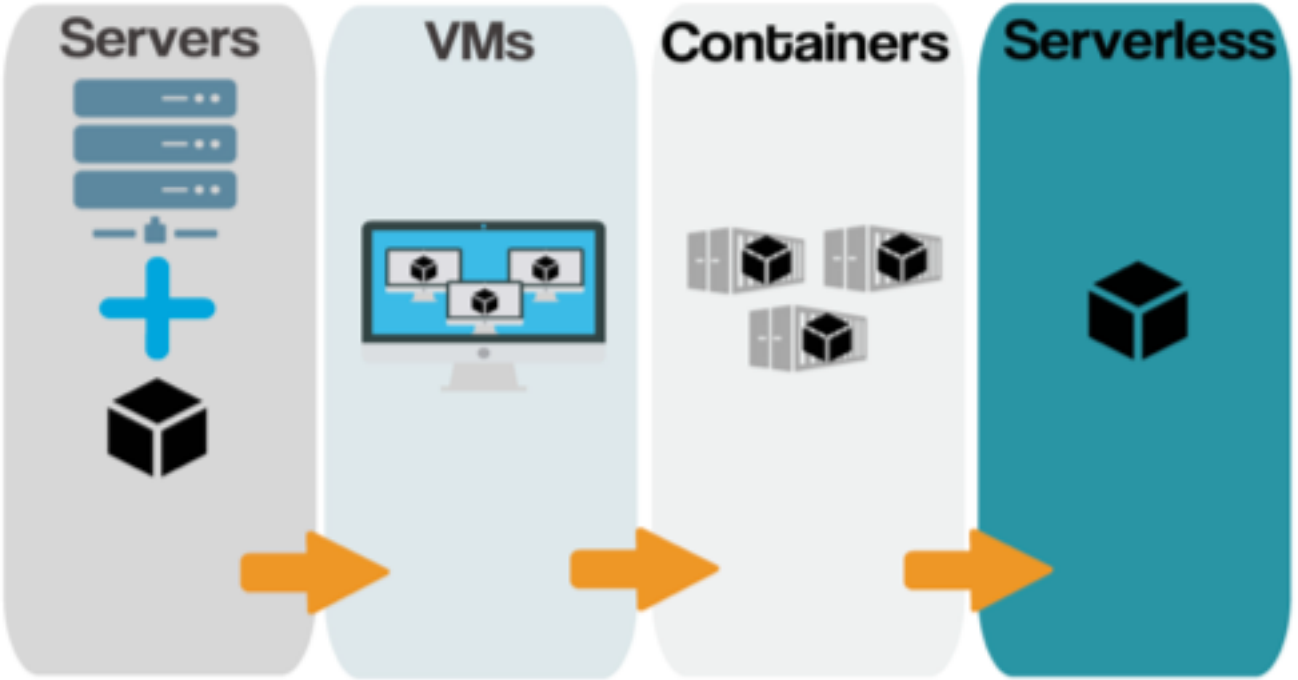
New challenges introduced by the Fog

- Reliability/volatility
- Location
- Capabilities
  - Architecture
  - RAM
  - CPU cores
  - Network I/O
  - Isolation methods

The Fog

The Cloud

How do we *build* and *develop* software for this new environment?



Where to place services? How to move them?

R Cziva, C Anagnostopoulos and D P Pezaros, "**Dynamic, Latency-Optimal vNF Placement at the Network Edge**", INFOCOM 2018.

What if things go wrong?

What if things go wrong?

- Detection and diagnostic methods to establish automated analysis and anomaly identification
- Working with data scientists to help inform decision-making and drive automation.

- “Provide the mechanisms to transfer raw data into effective actions”.

Finally, who is in control?

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Thanks for listening – any questions?

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