GRUPPO TELECOM ITALIA

EAI International Conference on Software Defined Wireless Networks and Cognitive Technologies for IoT

Rome, 26th October 2015

A Global Operating System «from the Things to the Clouds»

How enabling X-as-a-Service

Antonio Manzalini
General Chair of IEEE SDN

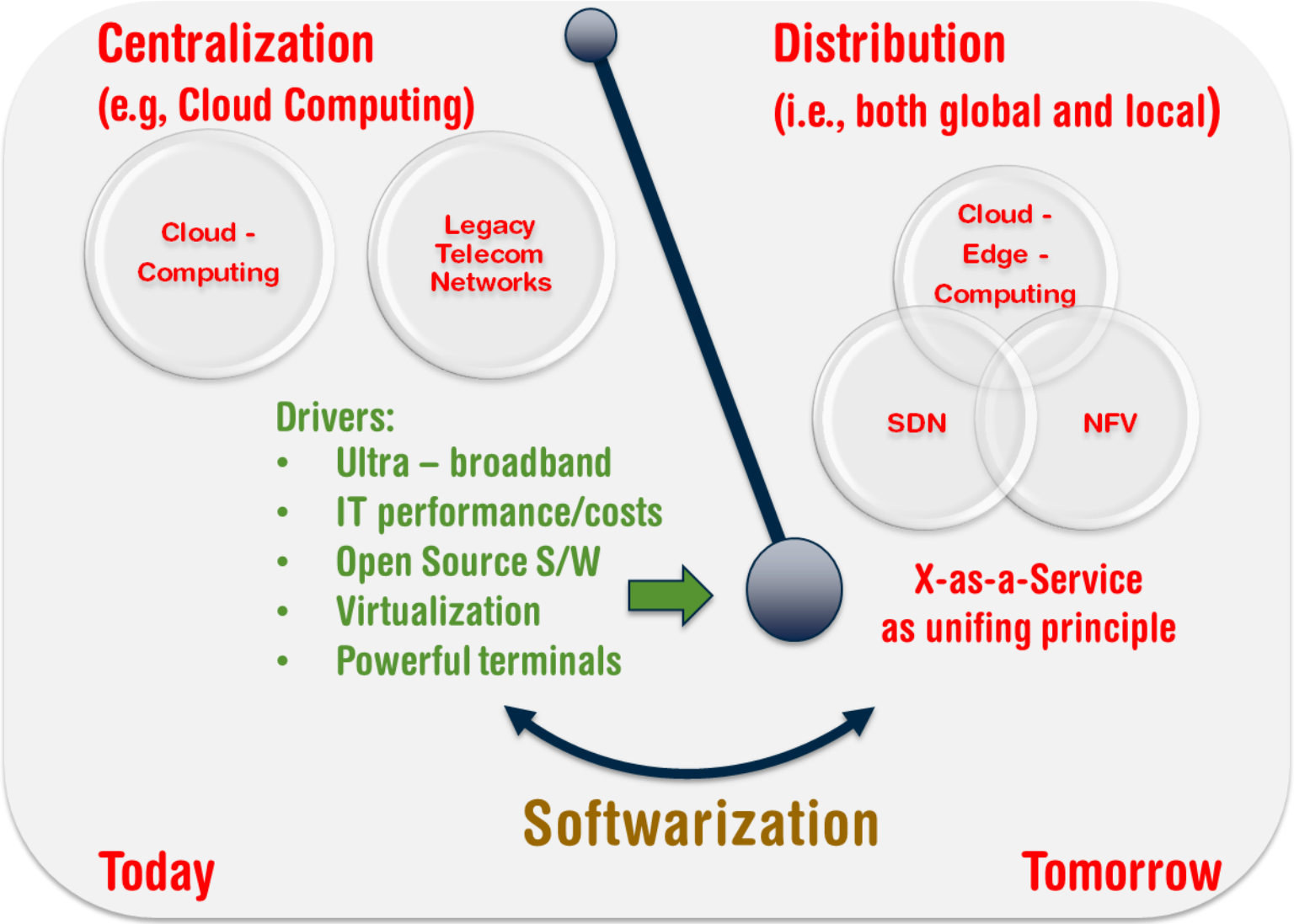
IEEE SOFTWARE DEFINED NETWORKS

TELECOM ITALIA | TIM

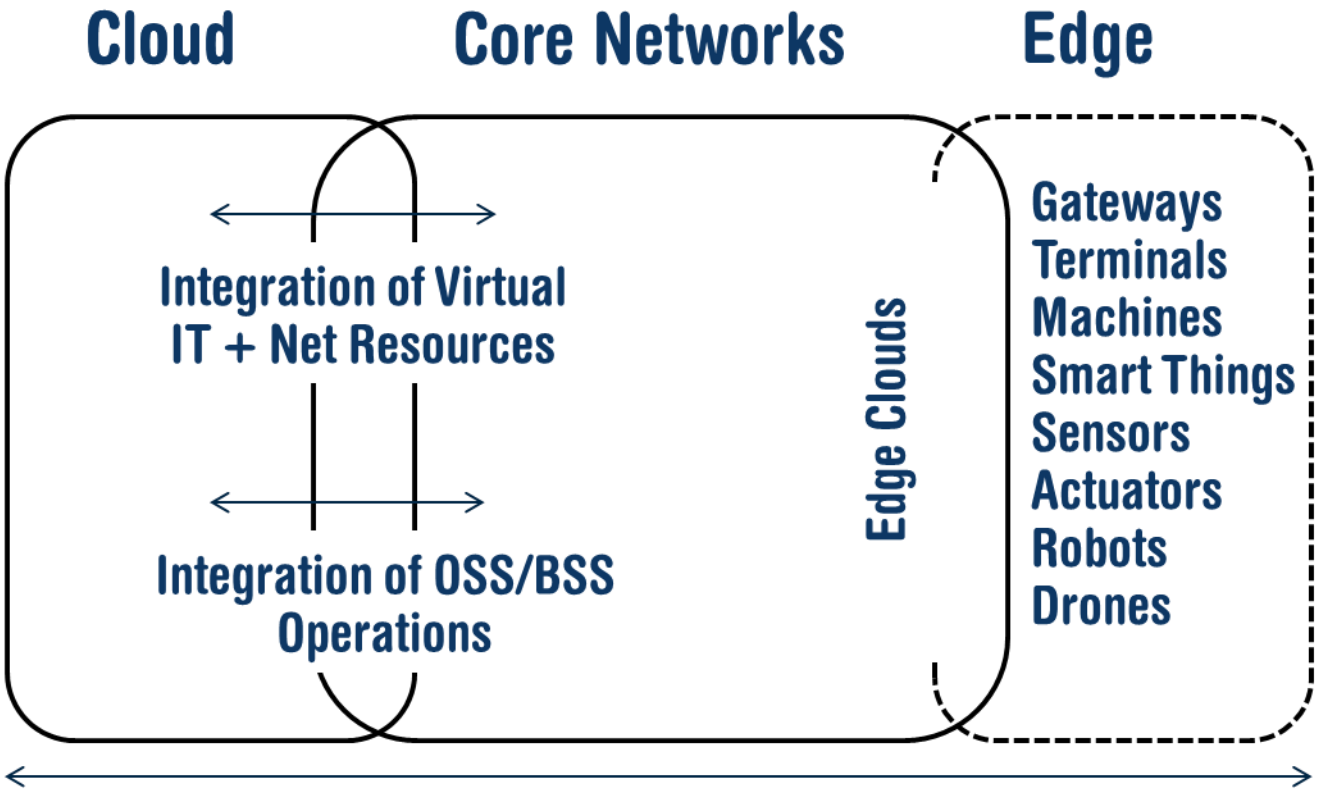
Abstract

- 5G will be decentralized computational and networking infrastructure entering deeply into our socio-economic reality. In the same way, metaphorically, a computer have operating system — dictating the way it works and provides services as a foundation upon which all applications are built — 5G will have an Operating System (i.e., the 5G OS) capable of operating (in coordination with the Management and Control systems) the 5G infrastructure as a flexible and highly adaptable virtual environment of logical resources, capable of executing any network functions and services as “applications”.
- Space-time dimensions of our Society and Economy will be morphed by the 5G faster access, larger bandwidth (increase of 2-3 orders of magnitude), lower latency (up to 1 ms).
- This will make the 5G as a “Nervous System”, the real and concrete techno-economic game changer, in fact it will allow: 1) integration of Cloud/IT and Networks resources thus achieving a fluid virtual environment executing any network function (e.g., L2-L7) and service as “applications” (on chains of logical resources, dynamically allocated and borderless moved on the underneath hardware of the 5G infrastructure); 2) blurring the border between the cloud, the network and what is connected to the network: terminals, devices, machines, smart things, drones robots will be seen as 5G nodes capable of providing end-Users with “any ICT service” (e.g., including Cognition-as-a-Service).

Context and Drivers: Softwarization of Telecommunications

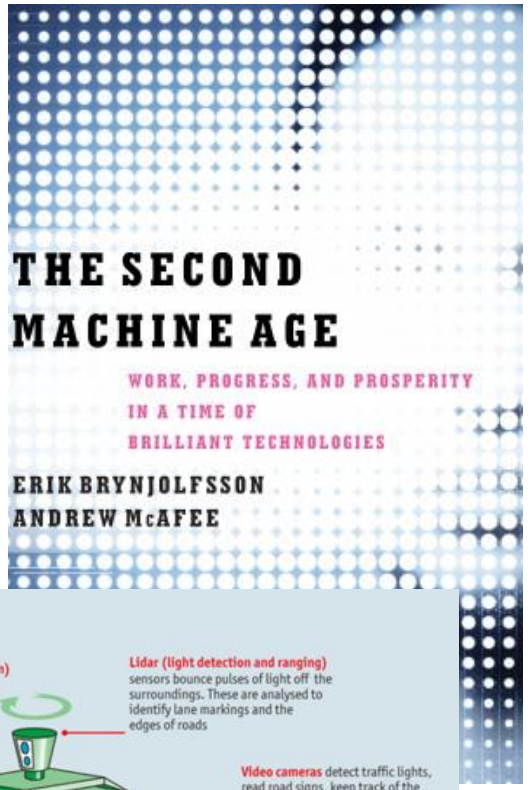


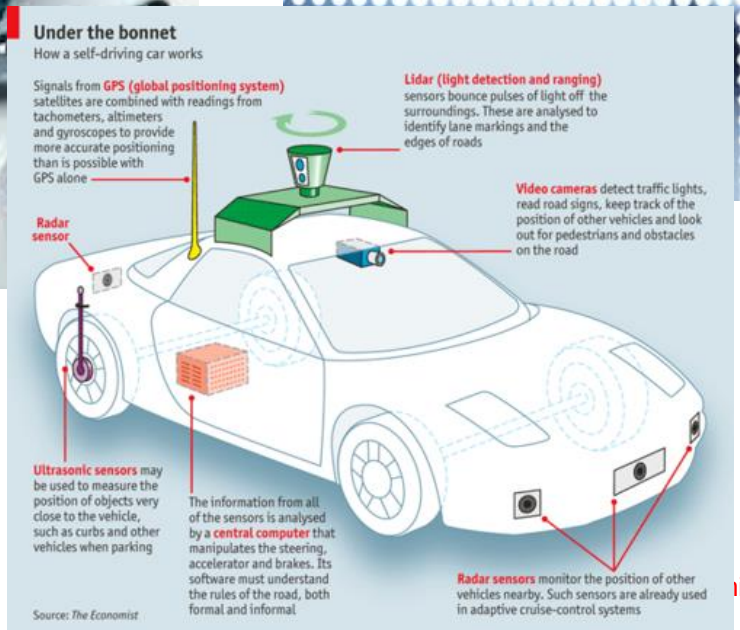
Context and Drivers:
Softwarization of Telecommunications



X-as-a-Service

“Future Smart-Terminals”

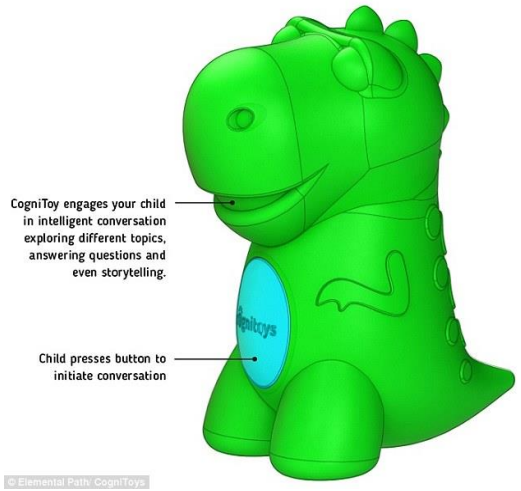


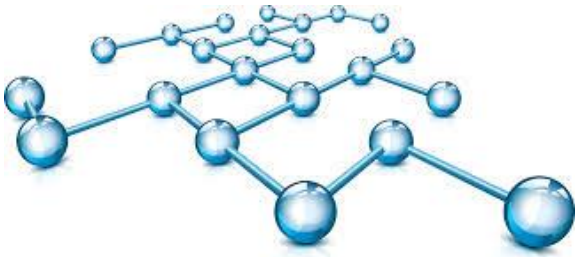


Today: ...just a cognitive toy

A cognitive toy connects to the IBM Watson‘ Cloud Supercomputer

- …responding to questions within a second…
- …and getting to know Users so to tailor contents of the answers



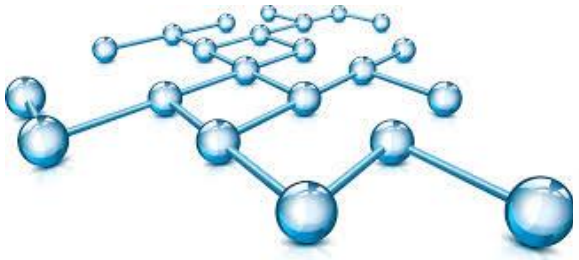


Cognitive Toy + Networks + Computing&Storage & Cognition

http://www.dailymail.co.uk/sciencetech/article-2957993/Now-s-smart-toy-Green-dinosaur-links-IBM-s-Watson-supercomputer-answer-child-s-questions.html

Tomorrow: …the Cognitive Society and Economy

Cognition, A.I., Deep Learning… on Actionable Data

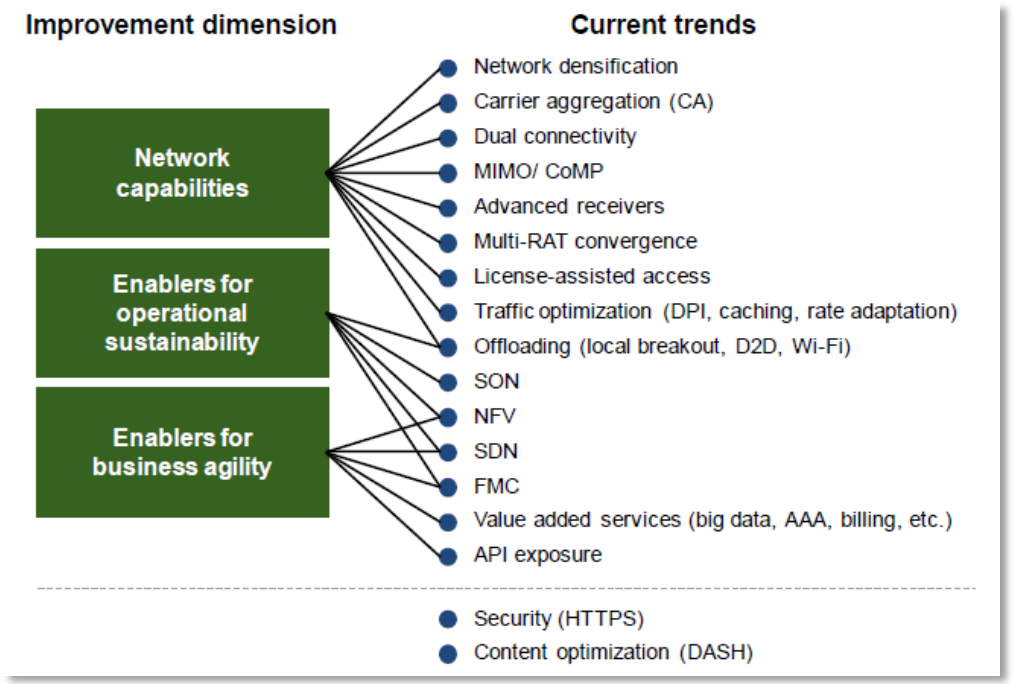


Future Smart Terminals + 5G + Computing&Storage

5G is disappering by embedding the «loop» into the reality

5G: a first exploitation of these new paradigms (5G is much more than «4G + 1»)

Source: http://5g-ppp.eu/about-us/

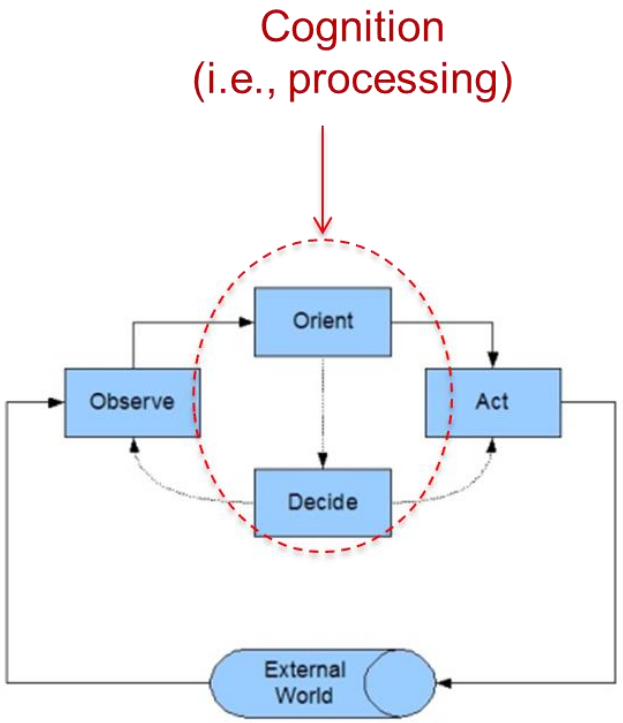


Source: NGMN 5G White Paper (enabling technologies)

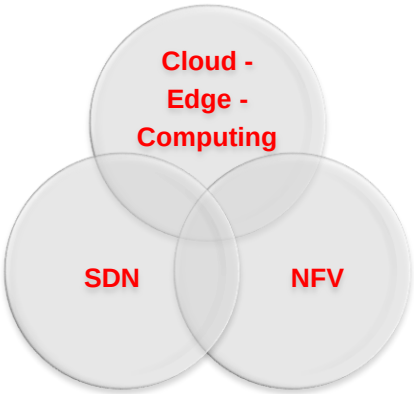
- **5G will become a dense and distributed Telecommunications-ICT infrastructure capable of integrating Communication, Storage and Processing resources "from the Things to the Clouds".**

5G: a first exploitation of these new paradigms (much more than «4G + 1»)

- 5G will have “nerve endings” up to the things and the “future smart-terminals” (e.g., autonomous machines, robots, drones, etc), becoming a sort of «nervous system».
- In fact, it will be possible embedding a «cognition loop» into reality:
  - sensing, collecting and storing (even locally) massive data sets (through terminals, smart things, intelligent machines);
  - transporting quickly huge sets of data (through high bandwidth and ultra-low low latency connections) where it is more convenient (allocation of virtual functions);
  - elaborating big data (Cloud and Edge/Fog Computing) to infer decisions for actuating/controlling local actions (pervasive machines).



Enabling technologies: SDN, NFV Cloud/Edge Computing

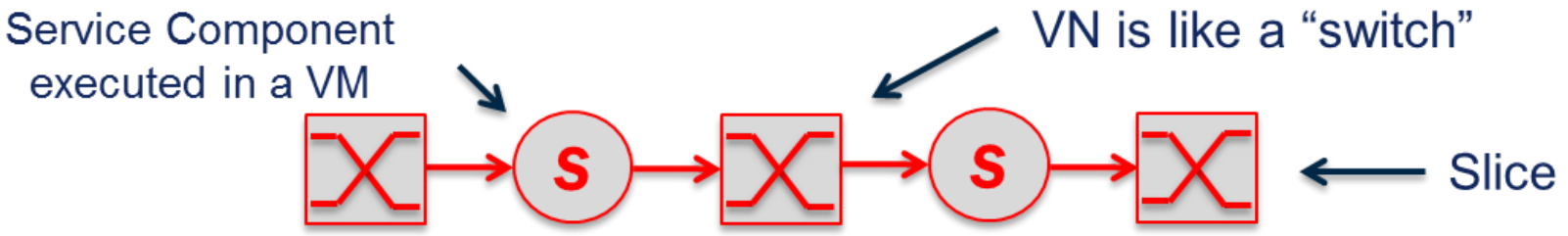


- Software Defined Networking (SDN)
  - separating Control Plane (S/W) and Data Plane (H/W)
    - a controller can be seen as an service (app.)
- Network Function Virtualization (NFV)
  - running functions in VMs on commodity IT servers
    - a network function can be seen as a service (app.)
- Scalable Cloud-Edge Applications and Services (Apps)
  - appls running on top of IT resources centralized and distributed
    - A CDN managing a caching can be seen as a controller
    - A proxy can be seen as a network function
- …distinction between Application - Controller - NFV to disappear under the same X-as-a-Service model/abstraction.

X-as-a-service

- A Slice is made of a set of Virtual Machines (VM) + set of Virtual Networks (VN)
  - Constraint-based VM allocation
  - VMs added and deleted over time
  - VNs provide service isolation and composition
- A VN is like a “switch” that fully connects all VMs in Slice
  - Private or Public (routable)
  - Closed or Open (available for multiple slices to join)
- Services are executed in one (or more) Slices

Services will become “units of orchestration”



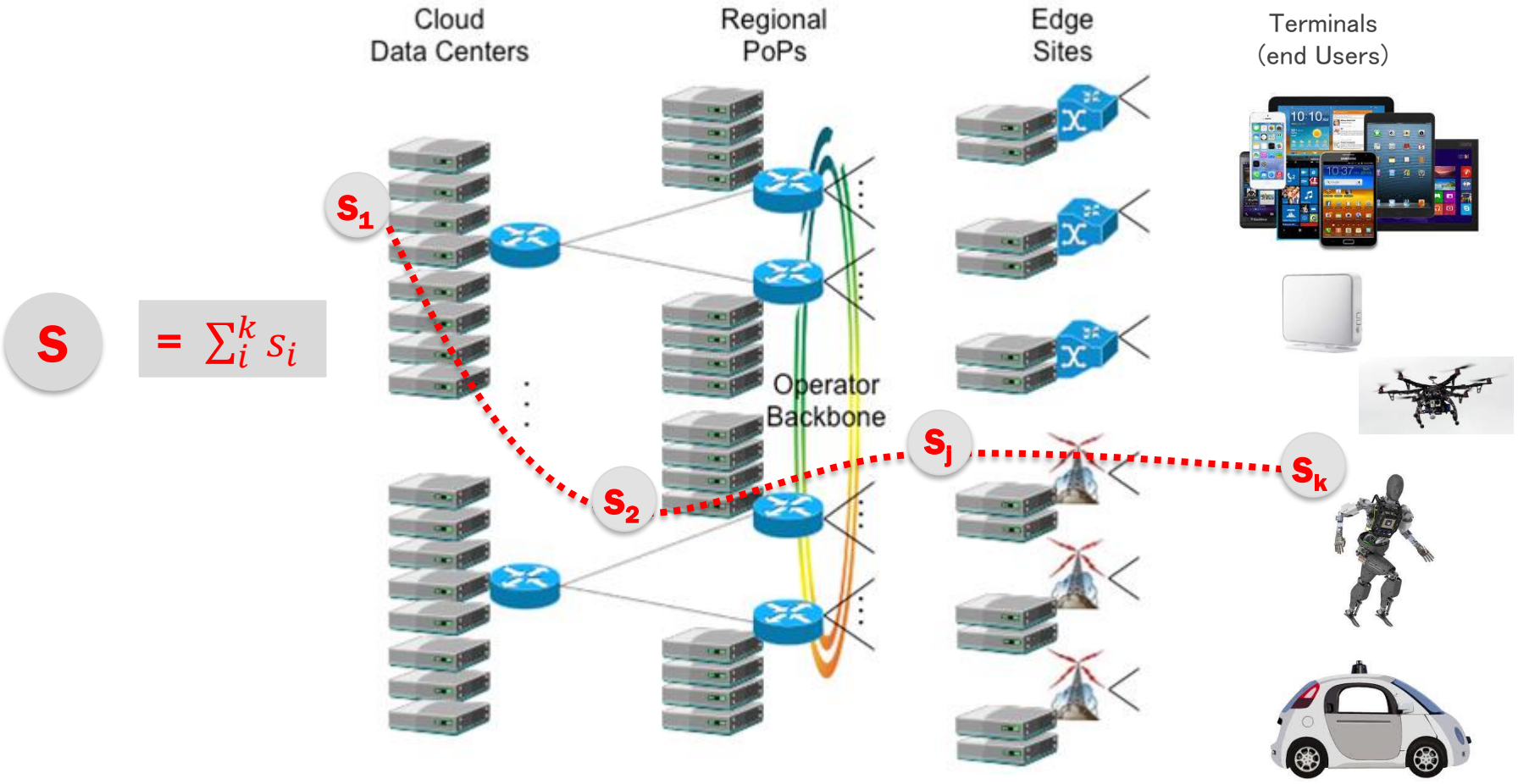
X-as-a-service

- Service
  - provides a function (both “global” and “local”)
  - exports APIs (e.g., REST)
  - available anywhere and anytime (location-time independent)
  - scalable, elastic, and resilient
  - runs in a set of VMs connected by one or more VN
  - build new services by composing with existing services

- Service unification is cutting across:
  - resources (Compute, Network, Storage)
  - the infrastructure (DC, WAN, Access/Edge, Terminals/Fog)
  - The service levels (IaaS, PaaS, SaaS)

Centralization vs Distribution: a trade-off is required

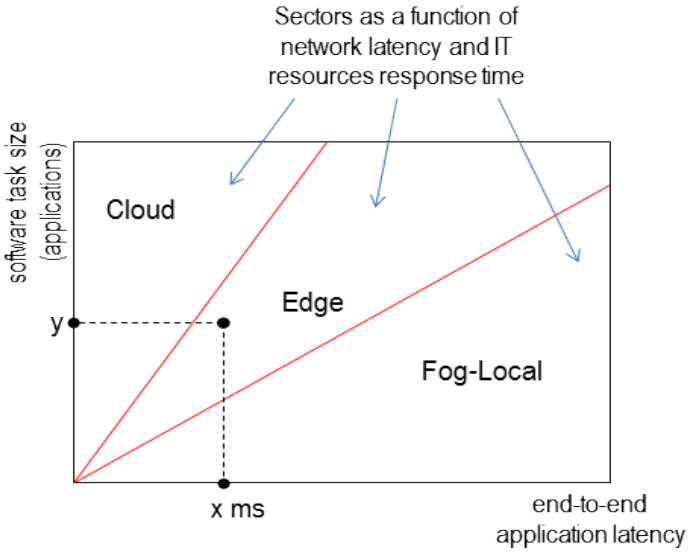
- Services can be seen as “chains” of service components (executed in VM, hosted in centralised vs distributed locations) and interconnected by VN



Example of instantiation in a typical Telco infrastructure

Centralization vs Distribution: a trade-off is required

- A «trade-off» has to be found between centralization and distribution of processing-storage aiming at meeting the service requirements;
- this «trade-off» depends on several factors:
  - software tasks dimensions and states;
  - IT response time and network latency (e.g., Return Trip Time - RTT);
  - availability of resources.
- Agile processes are required operating from the terminals, across the network, up to the Cloud/Edge Computing.



TI Patent Pending TEL1353.WO.P0 (July, 2015)

IT server – Users distance	Typical Network RTT
Less than 160 km	2 ms
800 – 1600 km	20 ms

RTT as a function of the distance IT Server - User

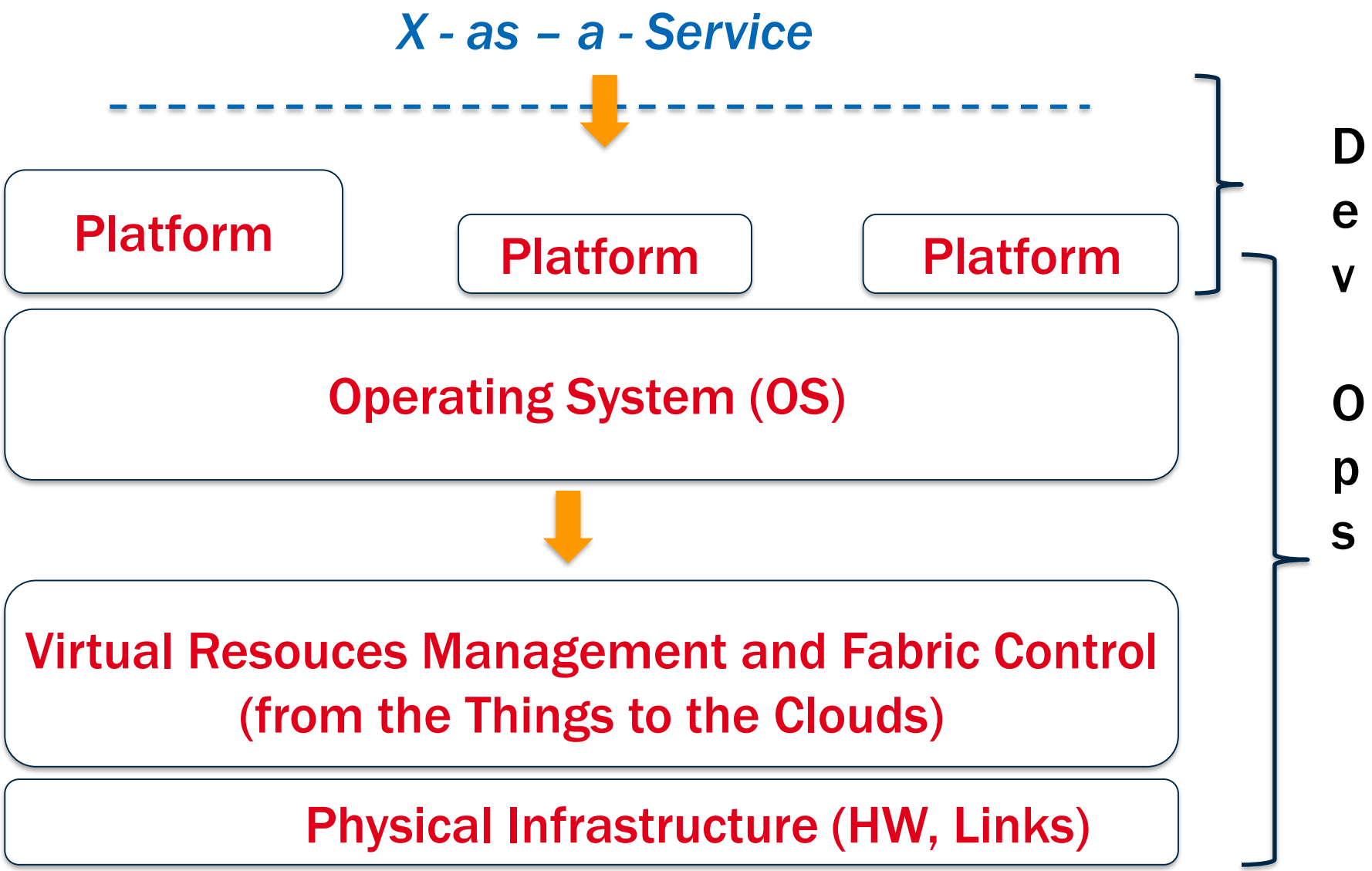
An OS for X-as-a-Service

- In computing, adoption of an Operating System facilitate program development by providing controlled access to high-level abstractions for computing hardware resources (e.g., memory, storage, communication) and information (e.g., files, directories);
- similarly, future Telecommunications infrastructures would strongly benefit from having a sort of Operating Systems;
- this Operating System would not manage the infrastructure itself, but it would the software framework and the APIs for supporting a broad spectrum of control and management applications, and services:
  - applications executed on the OS will perform the actual control and management tasks.

An OS for X-as-a-Service

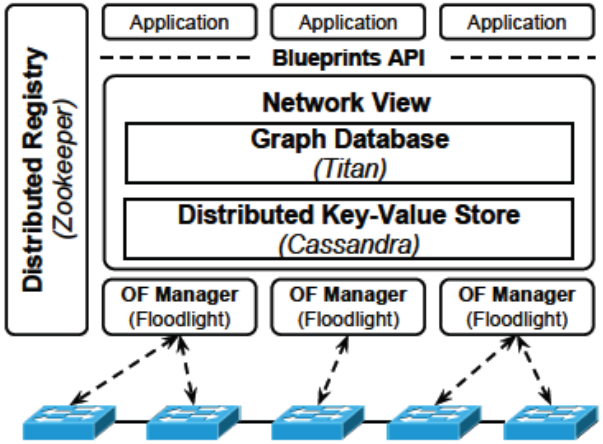
- In principle, an OS will make possible :
  - to program the Telecommunications-ICT infrastructure developing programs which are making use terms of high-level abstractions (not low-level configuration parameters);
  - to pursue a service unification under the X-as-a-Service abstraction:
    - resources (Compute, Network, Storage)
    - the infrastructure (DC, WAN, Access/Edge, Terminals/Fog)
    - The service levels (IaaS, PaaS, SaaS)

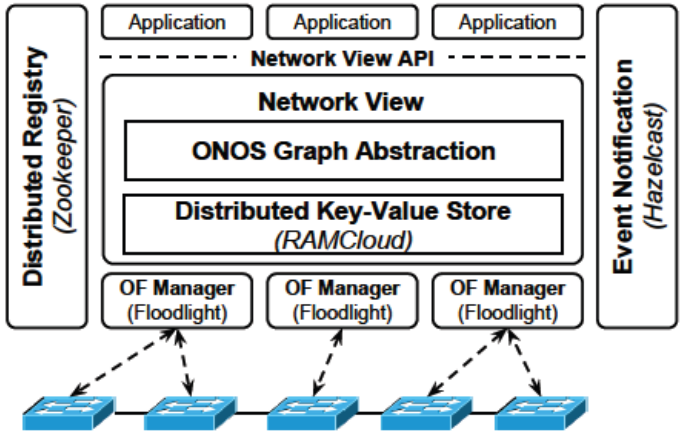
An OS for X-as-a-Service



Who does what: the ON.LAB «Open Network Operating System (ONOS)»

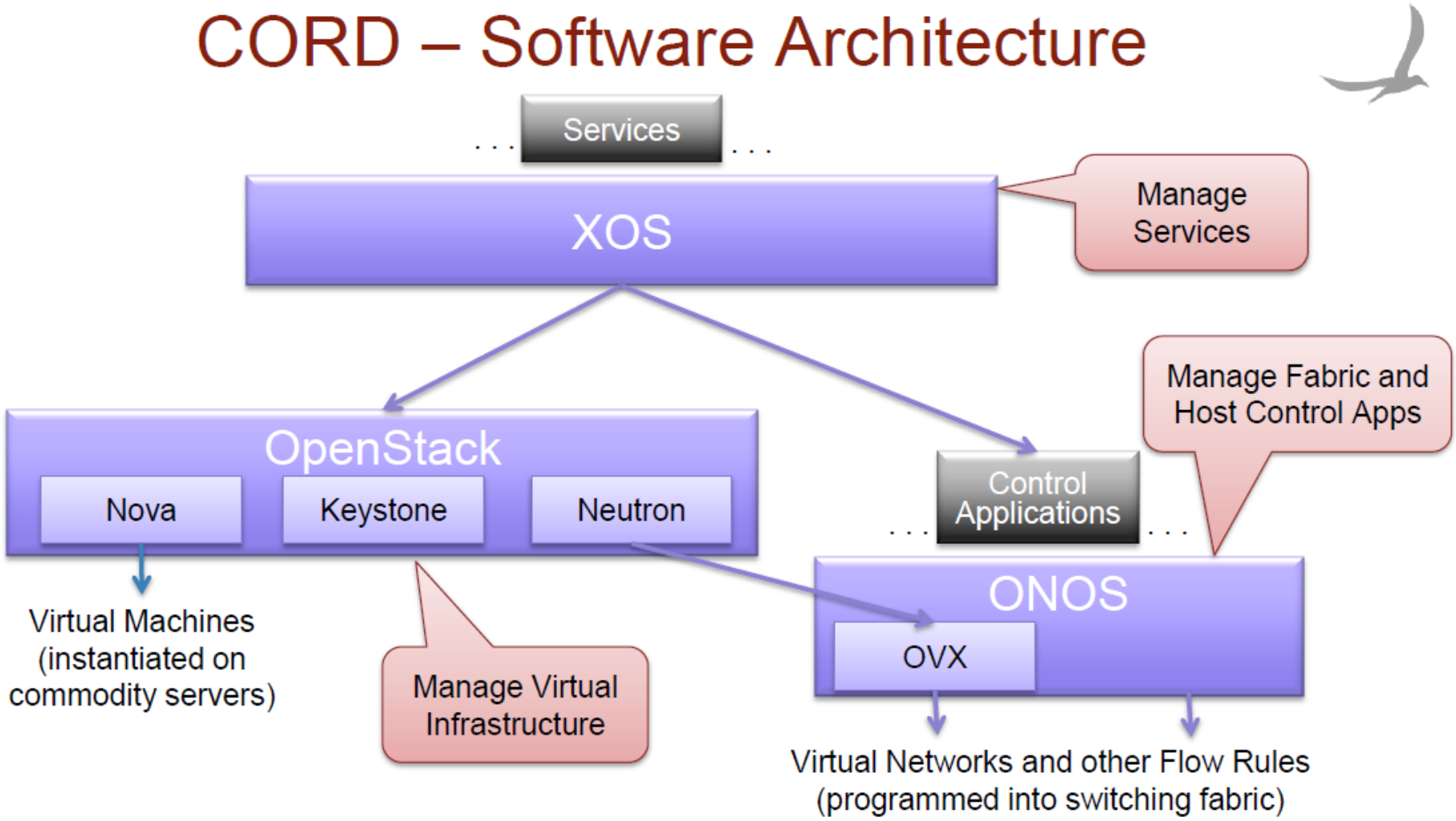
- ON.OS adopts a distributed architecture for high availability and scale-out in large production networks. It provides a global network view to applications, which is logically centralized even though it is physically distributed across multiple servers.
- Two main prototypes:
  - 1: focused on implementing a global network view on a distributed platform for scale-out and fault tolerance;
  - 2: focused on improving performance, notably event latency.





Source: ON.Lab

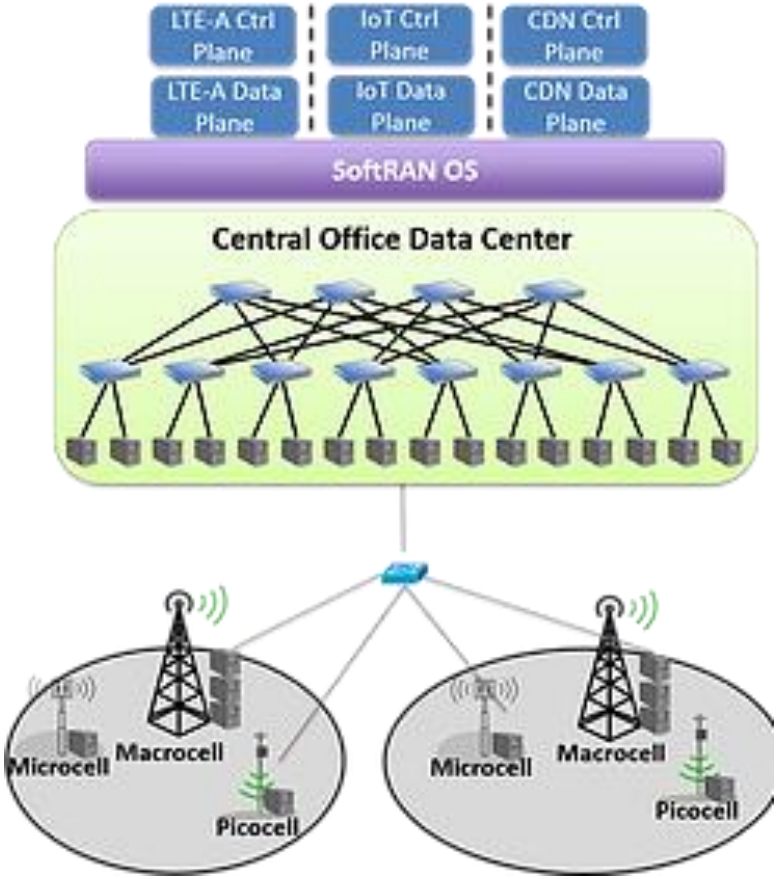
Who does what: the ON.LAB «CORD»



L. Peterson, "Central Office Re-architected as a Datacenter (CORD) Open Networking Lab - in collaboration with AT&T (ONS2015)"

Who does what: the Stanford «SoftRAN OS»

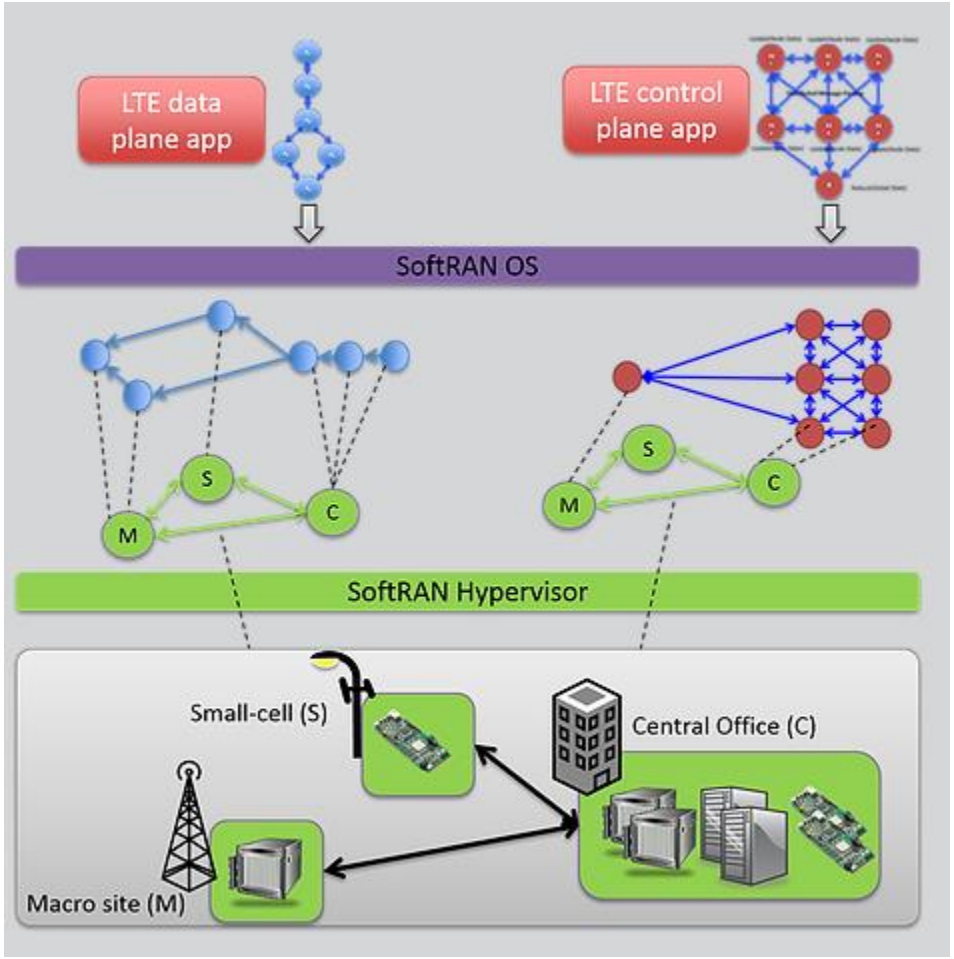
- SoftRAN model is turning the cellular network edge into a programmable DC spanning from the central office up to the RRUs.
- Provisioning services becomes equivalent to installing software apps onto an operating system.
- LTE, 5G will be just one services that can be deployed in SoftRAN.



Source: http://www.softran.stanford.edu/#!technology/cgvz

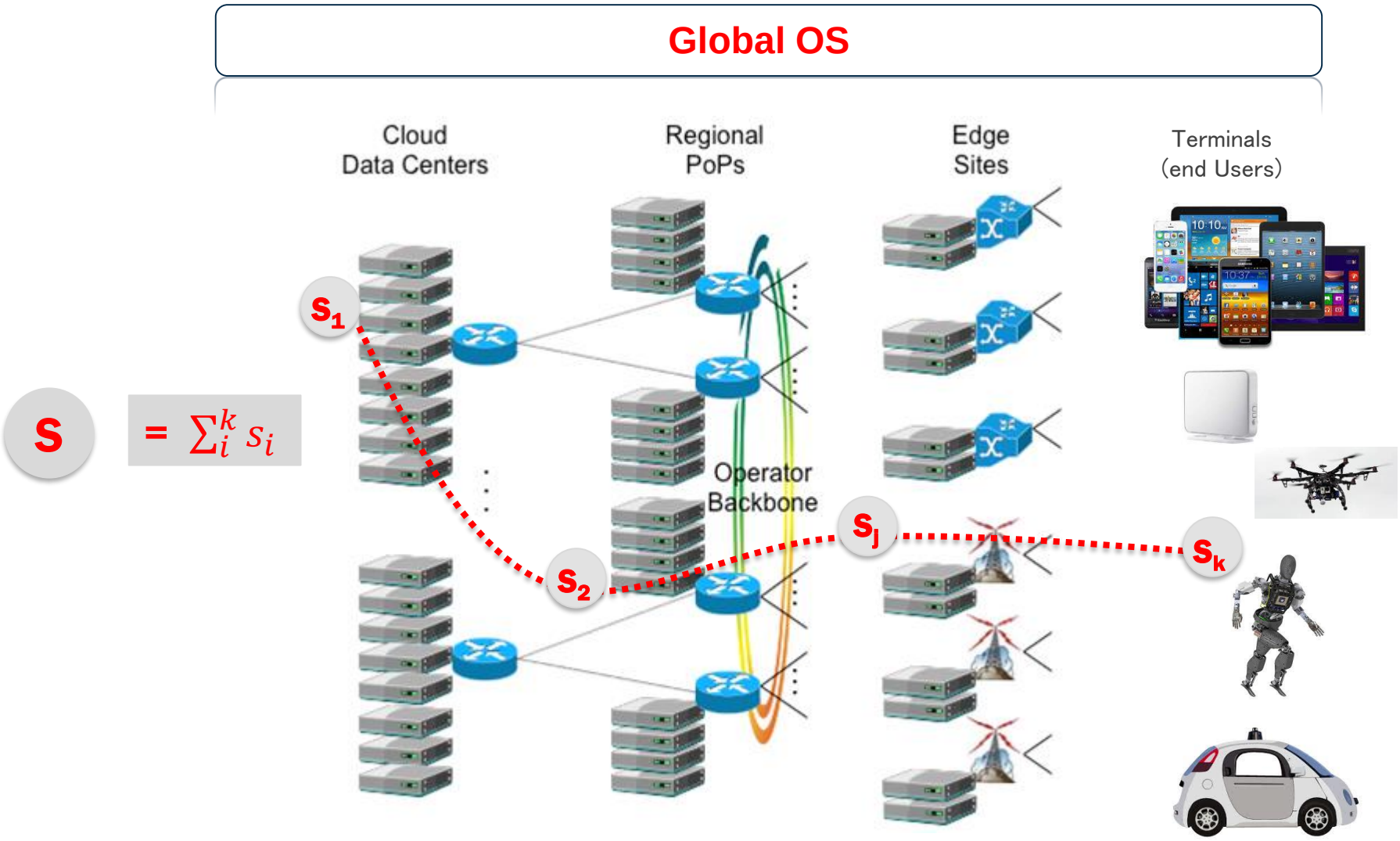
Who does what: the Stanford «SoftRAN OS»

- The OS will dynamically compile the service chains and allocated them onto computing/storage hardware at the central office and the cell sites.
- Whilst mapping of said service components and functions, throughput and e-2-e application latency requirements are met.
- OS, together with a sort of Hypervisor (handling virtualization of all resources), will allow deploying services on any available hardware (ranging from x86 and ARM to DSPs and GPUs…).

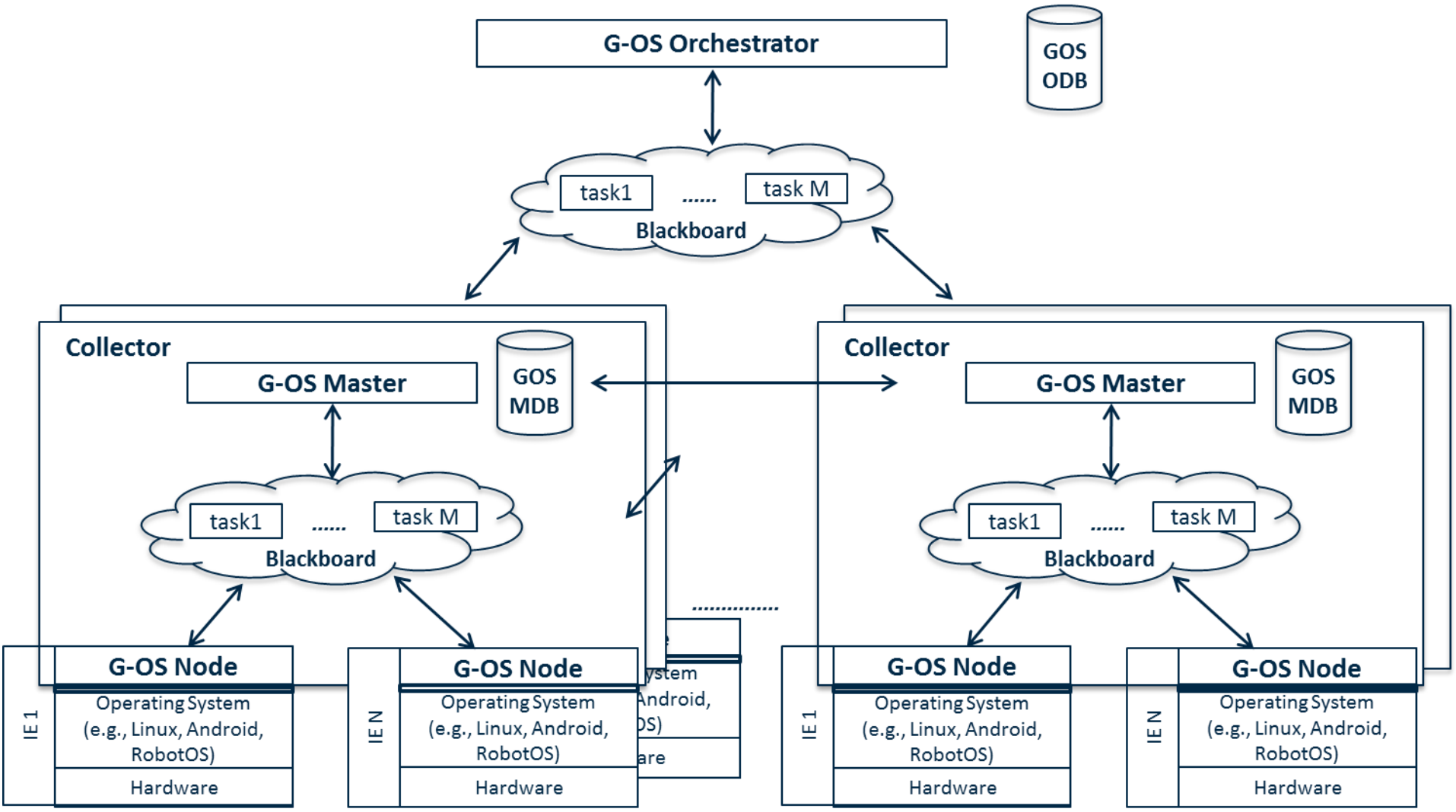


Source: http://www.softran.stanford.edu/#!technology/cgvz

Who does what: the TI G-OS «from Things to the Clouds»

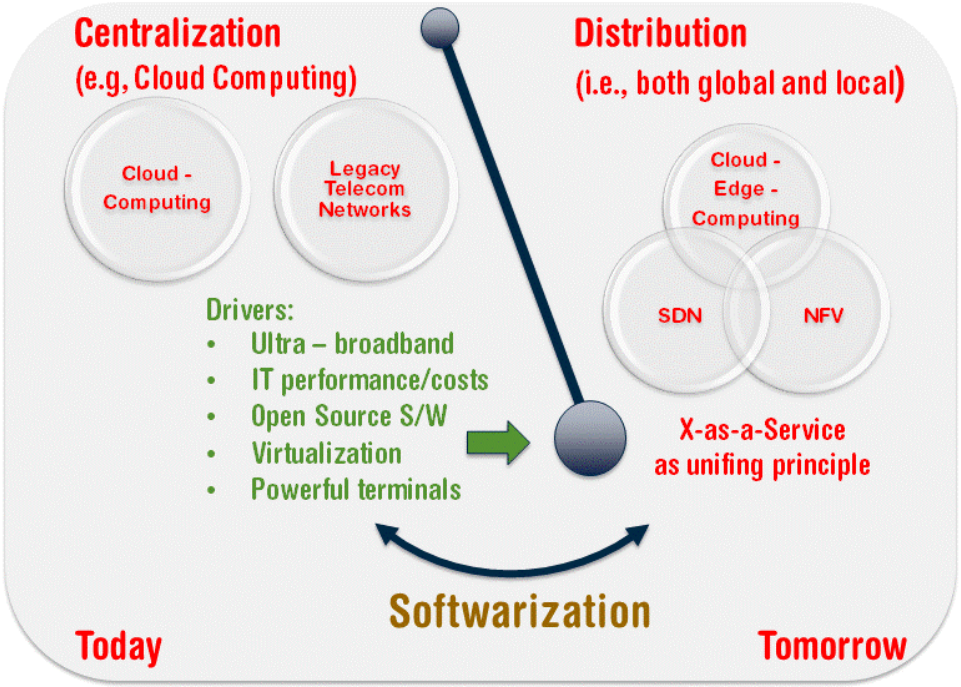


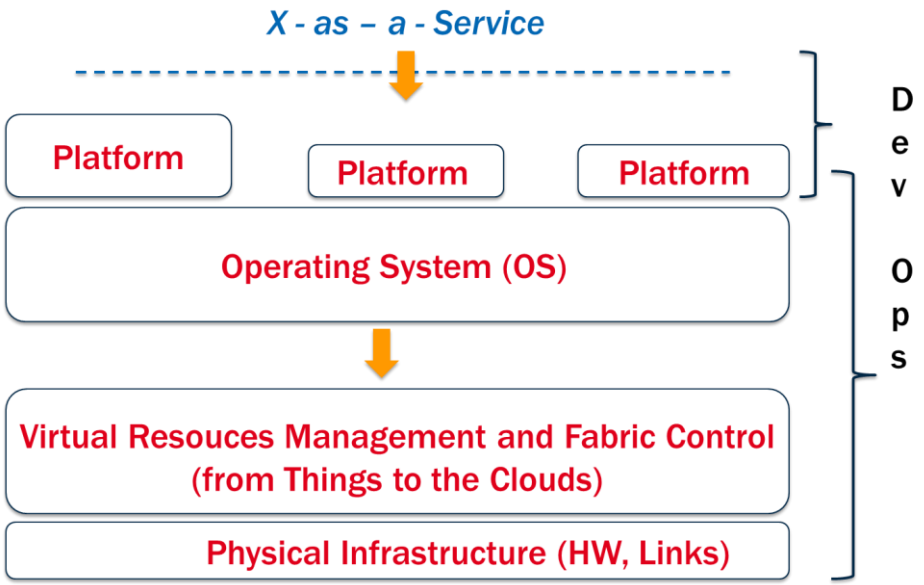
Who does what: the TI G-OS «from Things to the Clouds»



TI Patent TEL1353.WO.P0 (July, 2015)

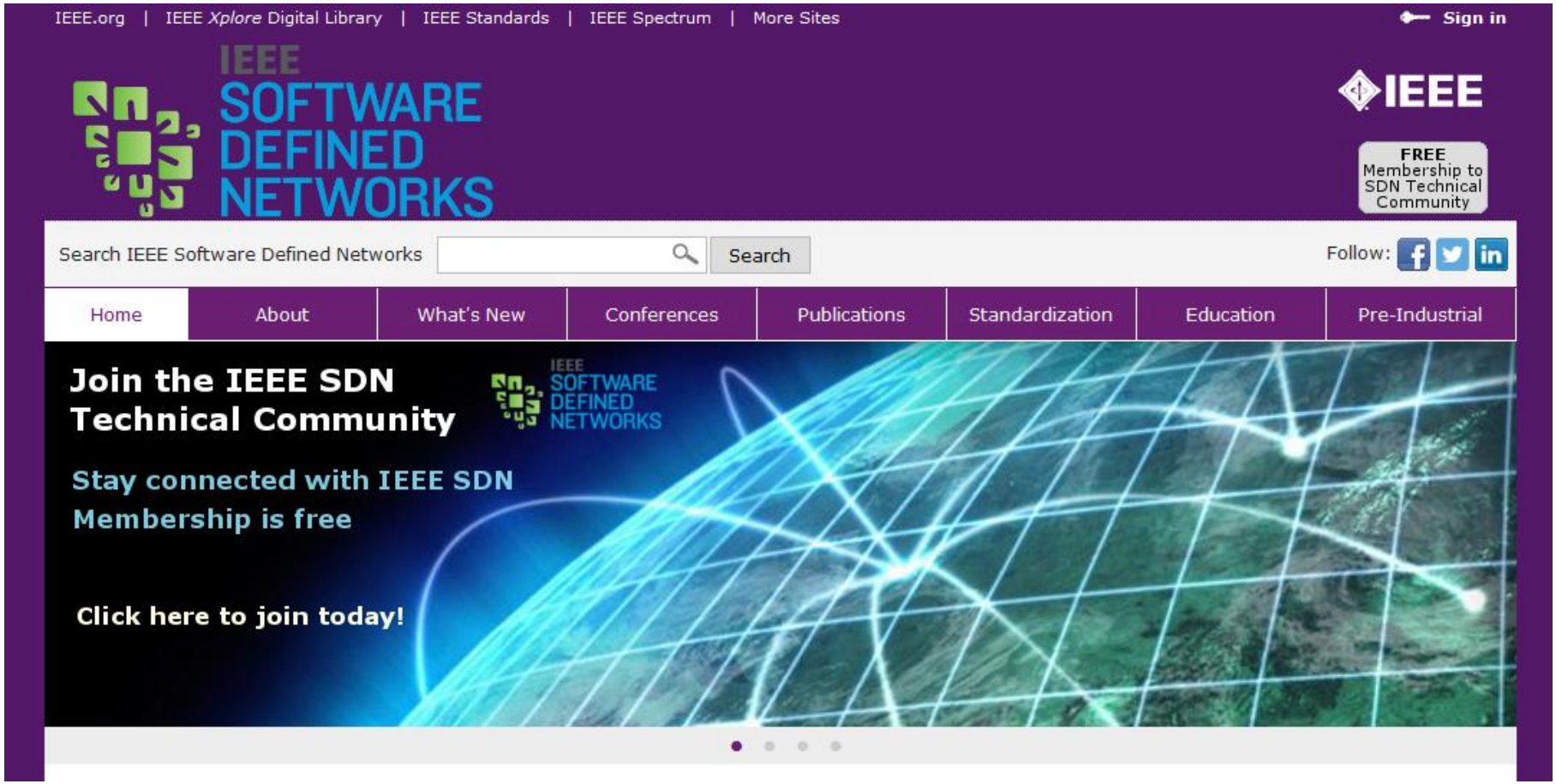
Conclusions





- Softwarization of Telecommunications is changing radically the concepts of network infrastructure and smart-terminals;
- SDN, NFV, Cloud-Edge are enabling technologies for 5G Softwarization;
- X-as-a-Service to overcome distinctions «without differences»;
- **An Operating System «from Things to the Clouds» is needed to exploit the disruptive innovation being brought by «Softwarization».**

IEEE SOFTWARE DEFINED NETWORKS



Join us!

Thanks !

http://ieee-sdn.blogspot.it/
https://twitter.com/a_manzalini
http://sdn.ieee.org/