

GRUPPO TELECOM ITALIA

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Towards 5G

Challenges, Risks and Opportunities

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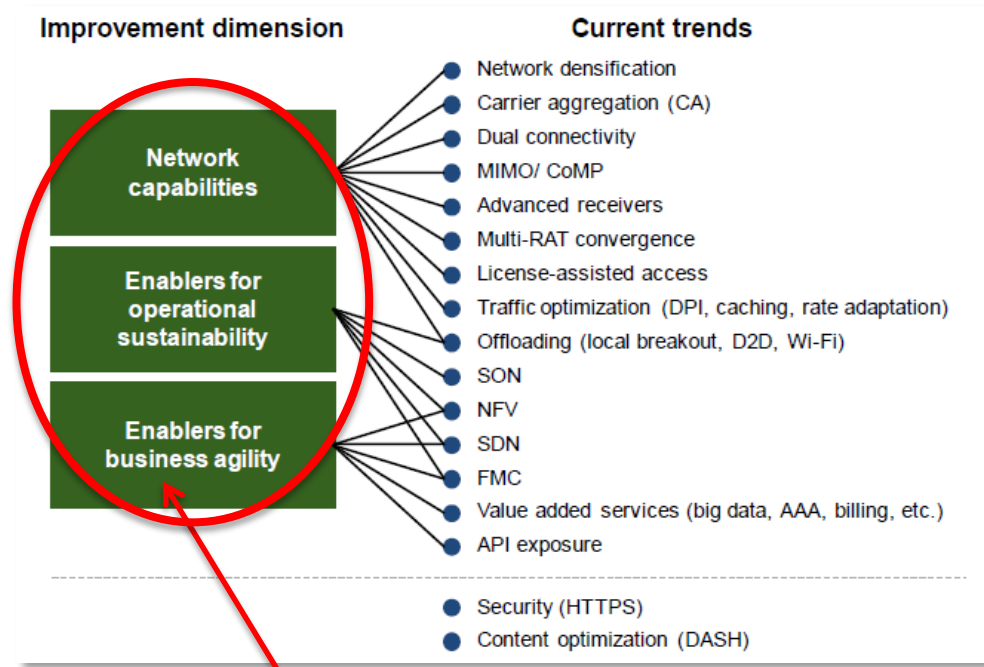
In a nutshell...

- ▶ Diffusion of ultra-broadband, performance advances in chipsets, (and, as such, in terminals, machines and in any ICT systems), tumbling hardware costs and a growing availability of Open Source software are creating the conditions for a **change of paradigm in Telecommunications**.
- ▶ In fact, the **rapid acceleration of innovation** in Telecommunications will bring to **automating processes, increasing flexibility and programmability of infrastructures**.
- ▶ Cloud and Fog Computing, Software Defined Networking (**SDN**) and Network Function Virtualization (**NFV**) are different facets of this evolutionary trend (**Softwarization**), accelerating the transition towards the **Digital Society and Digital Economy**.
- ▶ This trend is **lowering “thresholds” for new Players to enter**, thus creating new risks and opportunities, new roles and new value chains bringing towards **OPEX-centric biz models**.
- ▶ First concrete exploitations by 2020 through the deployment of **5G infrastructures**.

5G: more than... just «4G + 1»



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



Source: NGMN 5G White Paper (enabling technologies)

5G: more than... just «4G + 1»

- ▶ 5G will be more than a next step of “mobile” beyond 4G;
- ▶ 5G will become the “Nervous System” of the Digital Society and Economy:
 - ▶ a truly converged and dense telecommunication infrastructure, integrating deeply IT resources (e.g., processing and storage) with the Networks (radio, wireless and optics);
- ▶ Some expected distinguishing characteristics of 5G:
 - ▶ high flexibility (in Operations and processes);
 - ▶ ultra-low latency for “smart” connectivity;
 - ▶ “hooking” smart terminals, devices, machines, things, cars, drones and robots...with the processing and storage power available in the Cloud, and in the Network itself.

5G: a first step of the Softwarization in Telecommunications

- ▶ “Softwarization” is a crossing point of key technological trajectories:
 - ▶ pervasive diffusion of ultra-broadband;
 - ▶ IT HW performance increase (at lower costs);
 - ▶ growing availability of Open Source SW;
 - ▶ more and more powerful terminals and ... smart machines.
- ▶ “Softwarization” appears as a systemic trend in several forms, such as Cloud Computing, Edge-Fog Computing, SDN, NFV...
- ▶ L2-L7 network and service functions will look like “apps” and will be dynamically allocated onto a physical infrastructure, fully decoupled from above platforms;
- ▶ L1-L0 will be dynamically controlled with high flexibility.

Data Centric Era

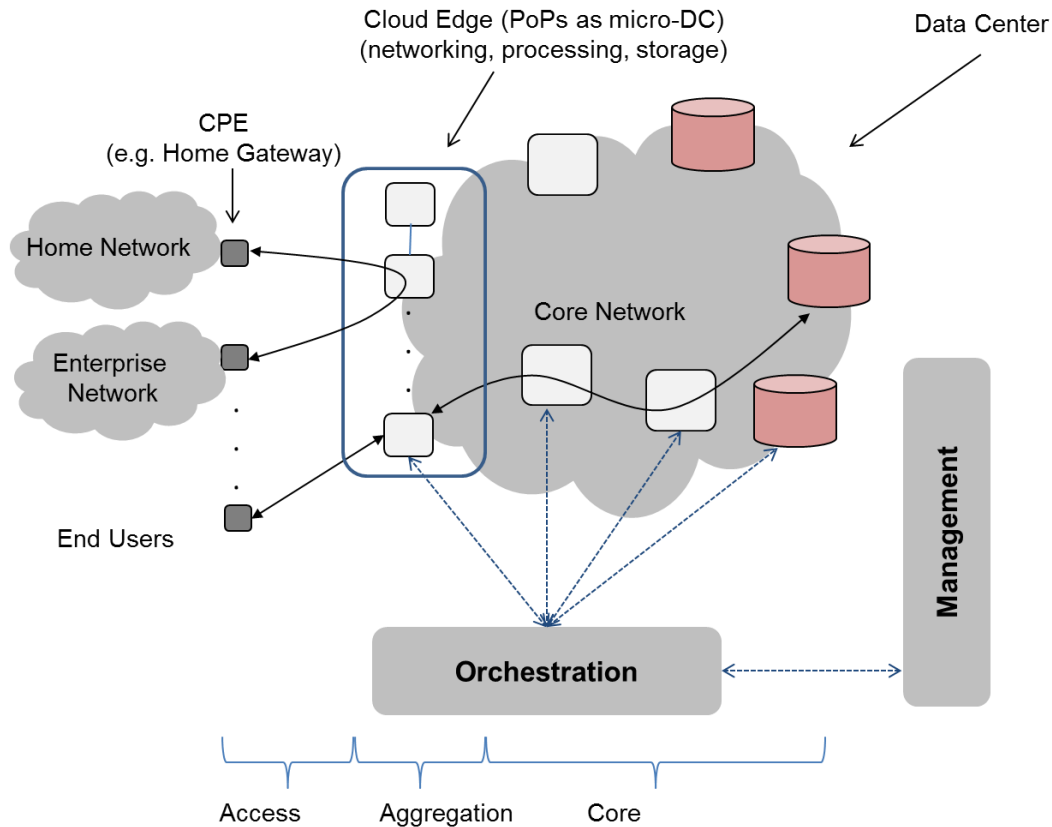
Impact of Softwarization: how 5G will look like ?

- ▶ Integrating deeper Networks and Clouds, at lower costs:
 - ▶ full virtualization allow executing network and service functions as “applications” on logical resources (e.g., VMs), dynamically allocated and moved on an underneath physical infrastructure, which is fully decoupled;
 - ▶ possibility of adopting IT-style operational processes (normally used for Data Centers such as dynamic allocation, migration and cloning of logical resources) also for the Network, or even up to the Users’ terminals (Edge/Fog Computing);
- ▶ Blurring the border between the Network/Cloud and “*what connects to it*”:
 - ▶ more and more powerful terminals will become capable of storing large data sets and and executing service components and functions even locally;
 - ▶ smart things, intelligent machines, Self-Driving Cars, etc. can become future “meta-terminals” for new ICT services.

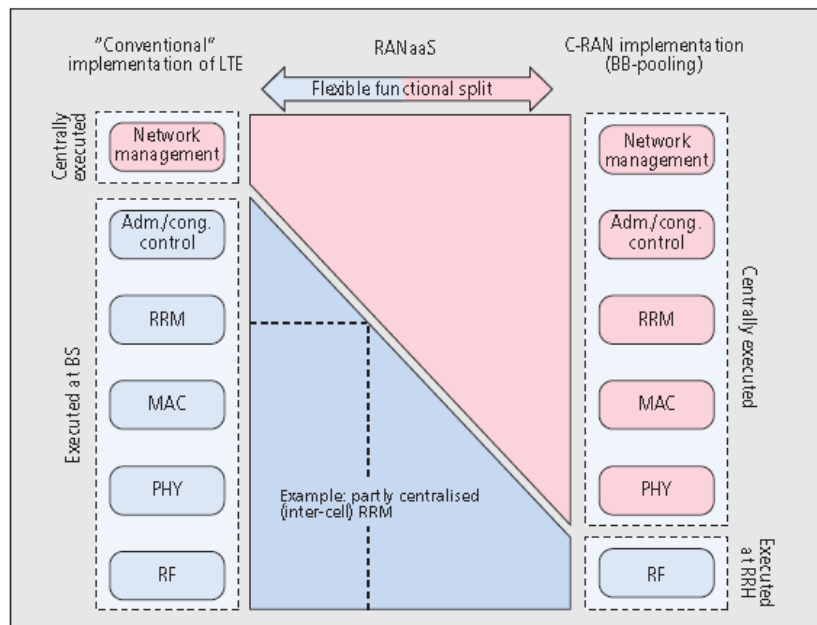
Impact of Softwarization: how 5G will look like ?

- ▶ Reducing Costs;
- ▶ increasing flexibility and automation in the Operations:
 - ▶ Upper layers: L2-L7 network functions can be seen as “applications”;
 - ▶ Lower layers: all major hardware elements of an optical transport network can be dynamically controlled;
 - Two key dimensions to add this flexibility are spectral and spatial flexibility.
- ▶ creating new roles (e.g., Smart Connectivity Provider, Service Enabler...);
- ▶ enabling new service ecosystems in the Data Centric Era:
 - ▶ peer-to-peer video sharing, machine-to-machine, ultra-high definition video, interacting media-gaming, Internet of Things, Cloud Robotics... .

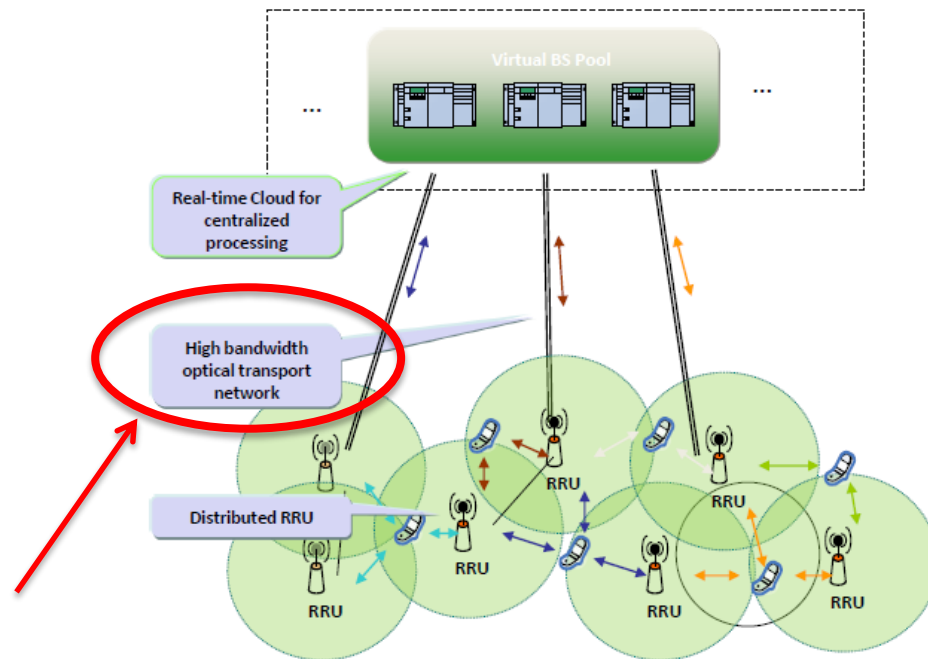
A network scenario



C-RAN

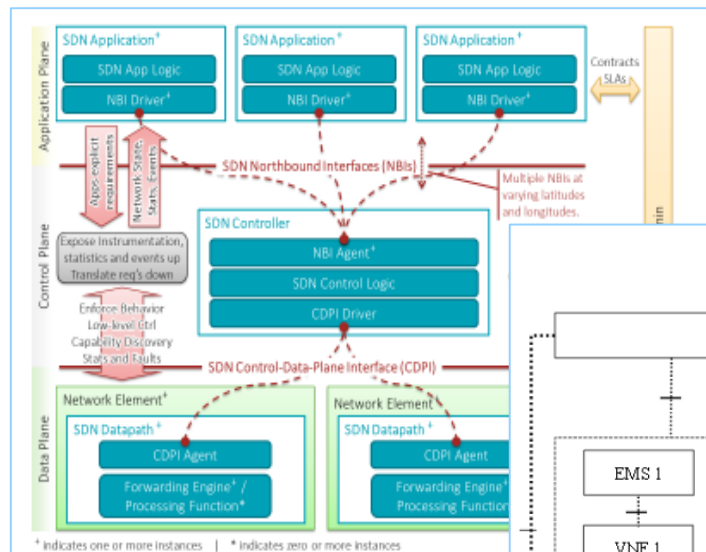


Flexible functional split.

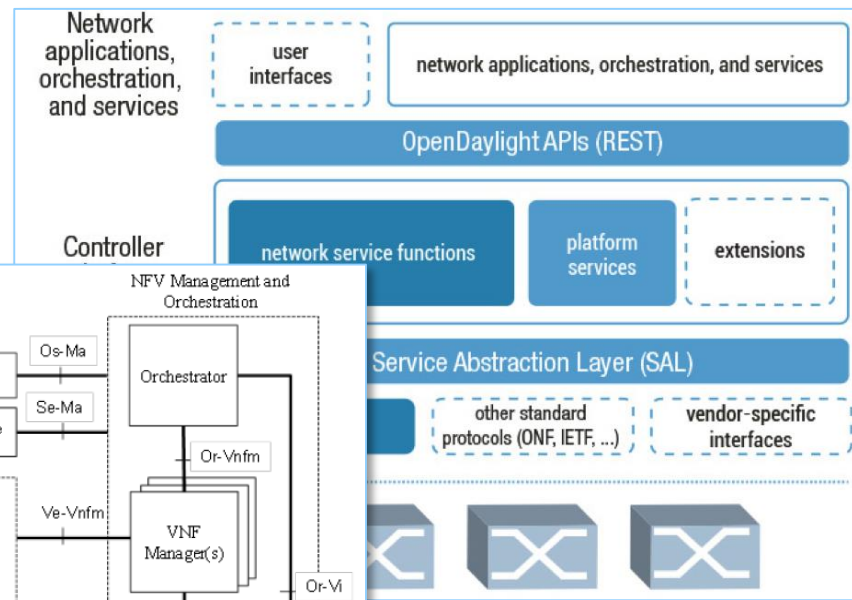


Source: Dr. Chih-Lin I "Softer RAN DEP-Management in a Software-Defined World", Keynote NOMS2014

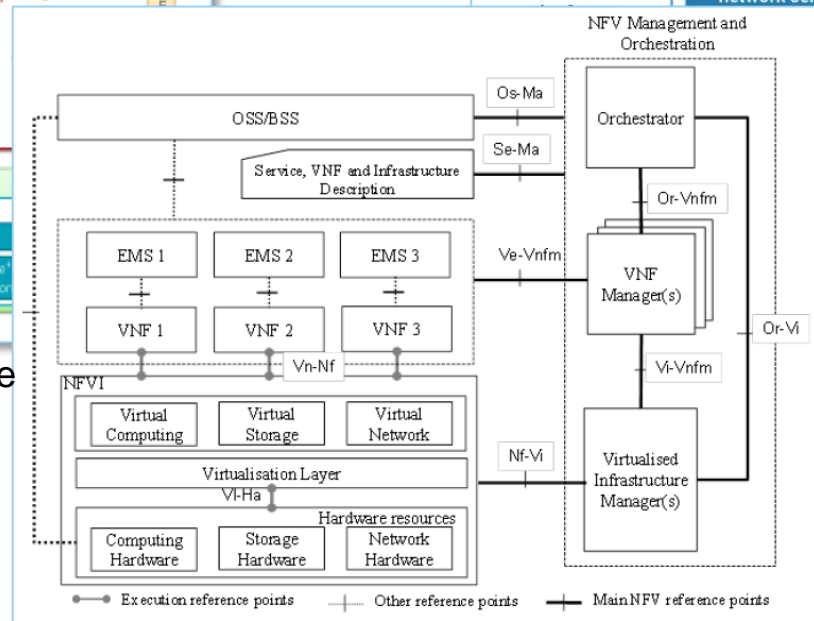
.... some reference architectures



SDN reference architecture

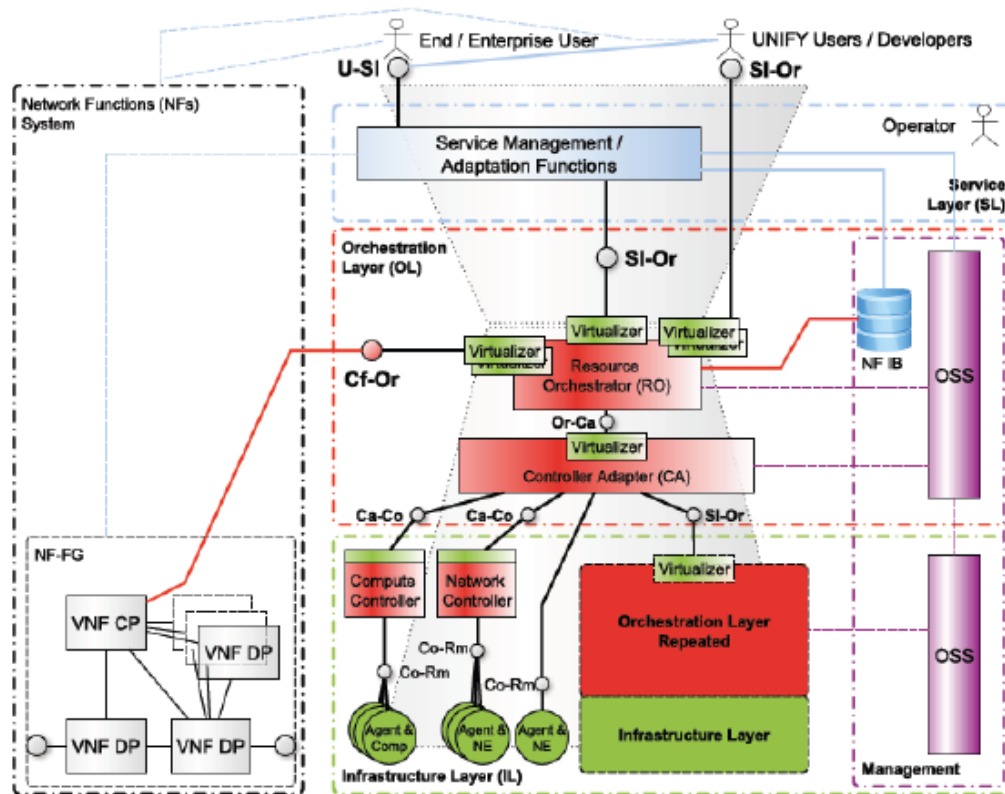


ODL reference architecture



NFV reference architecture

.... some reference architectures



UNIFY architecture

source: UNIFY D2.2



unifying cloud
and carrier networks

Major Service Providers:



Major Vendors:



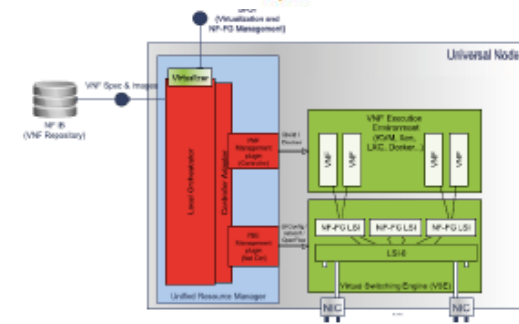
Universities:



Research Institutes:

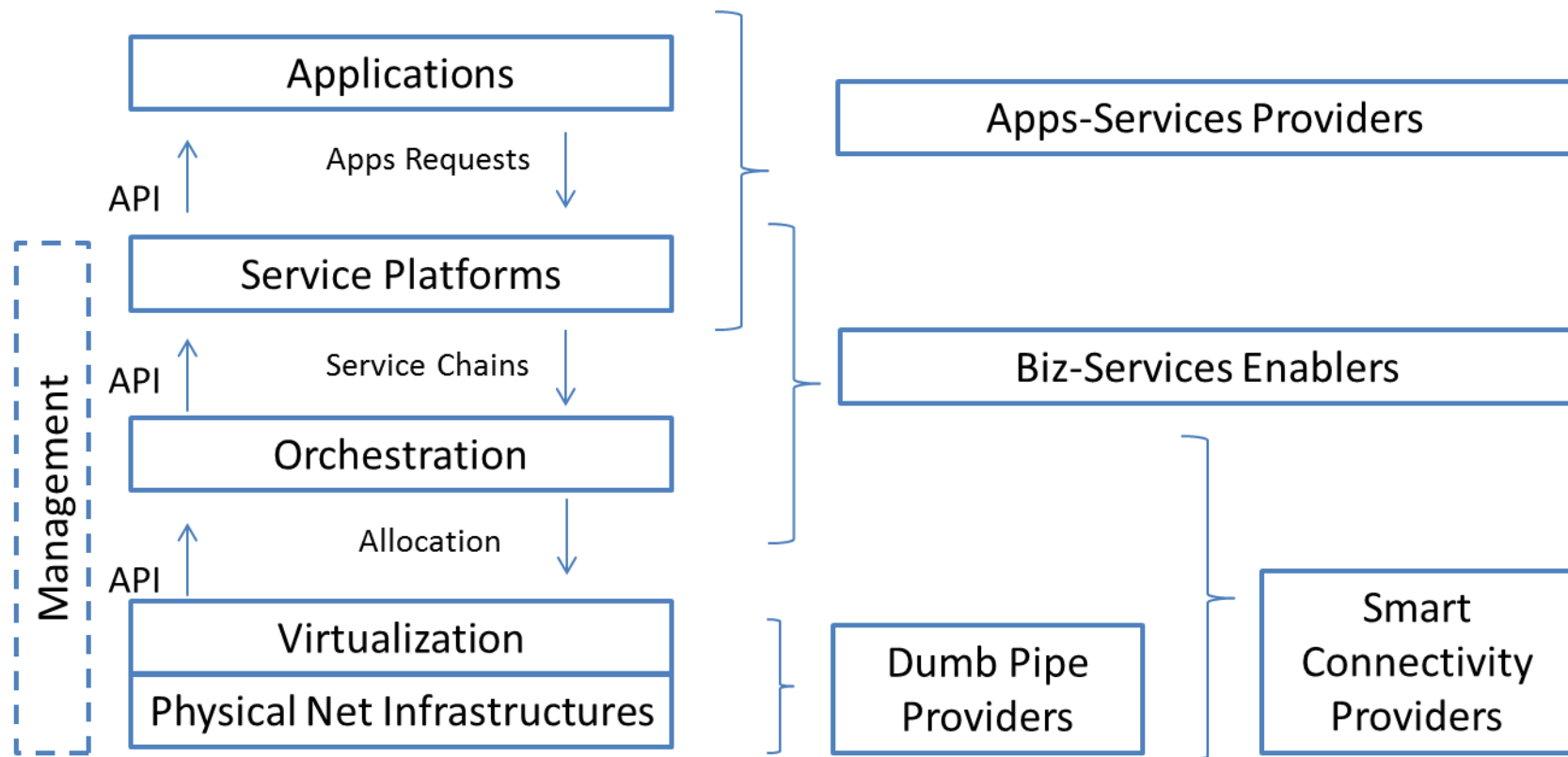


SMEs:

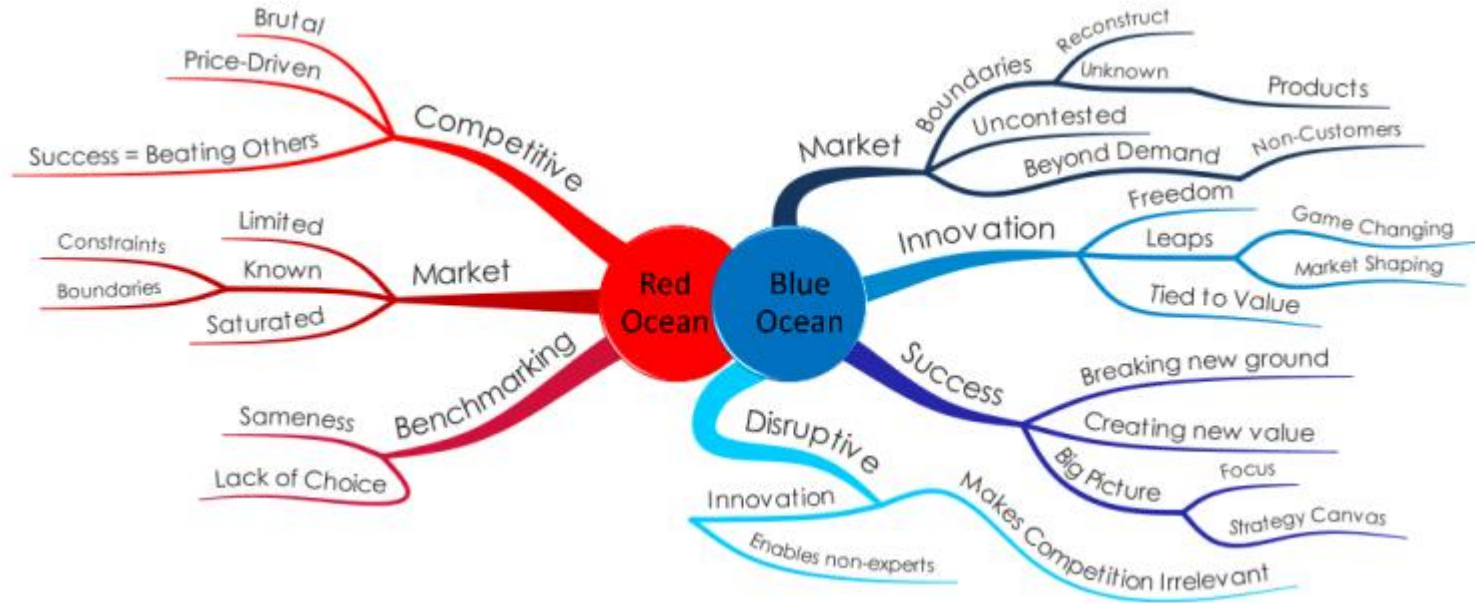


UNIFY Universal Node

... some reference architectures, interfaces and roles...



...vs strategies: Red and Blue Oceans



<http://www.blueoceanprinciples.com/why-blue-ocean/>

Red Ocean Scenario

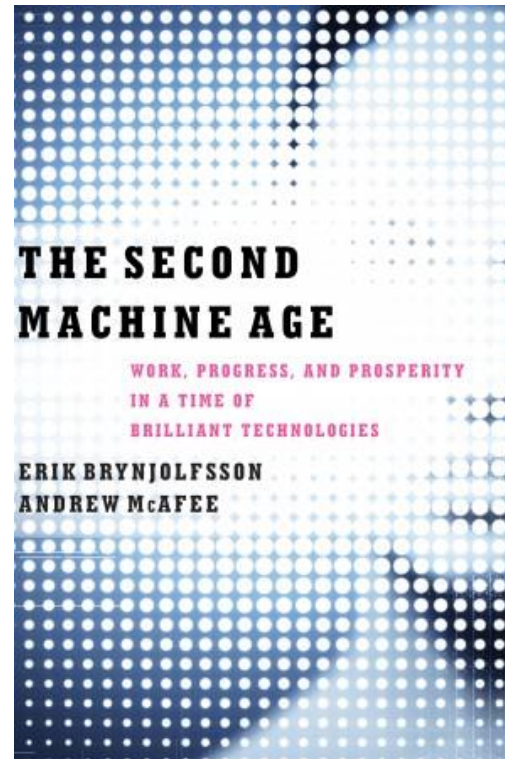
- ▶ Gradual exploitation of innovation (slow, continuity)
 - ▶ Smooth evolution of current Telecom infrastructures: e.g., introducing SDN and NFV starting from virtualizing some service functionalities.
 - ▶ Main challenges:
 - **interoperability of SDN-NFV with legacy systems, need of Standards** (traditional vendors lock-ins), need of **evolving the operational processes**, e.g. OSS/BSS, in order to cope with SDN-NFV (complicated, likely impossible).
 - ▶ Main benefits (and risks):
 - **potential savings in CAPEX and OPEX but** risk of jeopardizing said savings by the growing “complexity” and heterogeneity of the Telecom infrastructure;
 - **reducing (partly) the time to market but** it might be not-enough-short to cope with the market dynamics, and in view of competitors pursuing a blue scenario;
 - **enabling partial API-tization**: introducing programmability but processes are not flexible and fast enough to exploit full potential the APIs model opportunities.

Blue Ocean Scenario

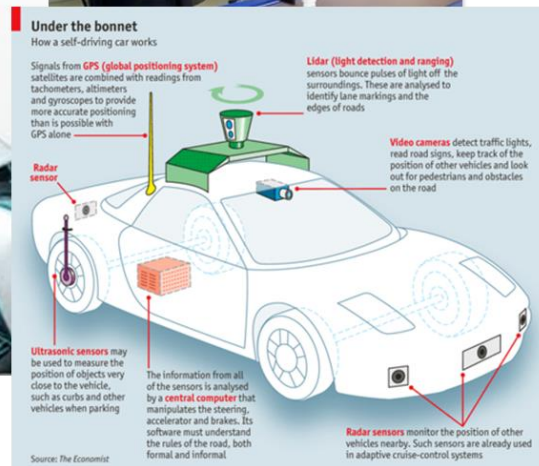
- ▶ Adopting innovation disruptively (fast, point of discontinuity)
 - ▶ ...downspiralling costs will allow competitors (e.g., Virtual or SD-Operators) to exploit “softwarization” much faster than in the former scenario.
 - ▶ Main challenges:
 - Virtual or SD-Operators will adopt a **virtualized infrastructure with IT-style operational processes** (a la OTT) dramatically shortening any time-to-market. **Markets will decide the “standard de facto”.**
Definition of new rules of competition and regulation.
 - ▶ Main benefits:
 - **de-perimetrization** of services: borderless operations in any country where it is possible to rent a physical infrastructure (virtual infrastructure *uploading*);
 - **servitization**: anything can be transformed in a “gate” to provide and access new ICT services and data (Internet of/with Things, pervasive robotics/machines);
 - **full API-tization**: processes are fast enough to allow Third Parties, Enterprises, residential Users (or even machines and pieces of software) to access and use APIs at various levels.

The Second Machine Age: a Blue Ocean Scenario ?

- ▶ *Global economy is on the cusp of a dramatic growth spurt driven by smart machines that finally take full advantage of **advances in computer processing, artificial intelligence, networked communication and the digitization of just about everything***
 - We'll be able to sense and collect massive data (by sensors, terminals, things);
 - To exchange quickly big sets of data (transported by optical and mobile networks with high bandwidth and low latency);
 - To elaborate big data (with Cloud/Edge and Fog Computing) in order to make decisions for actuating local actions (by any actuators)...
 - ...but this how “cognition” (nervous system) works !

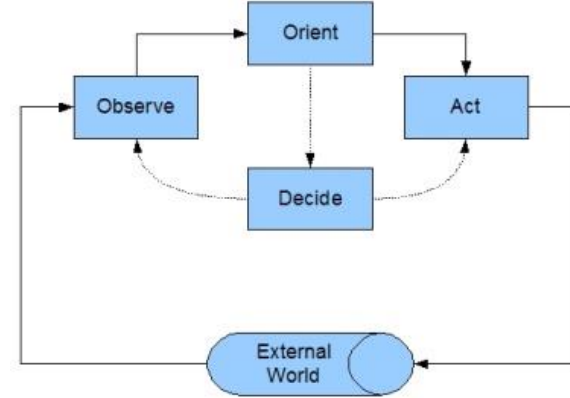
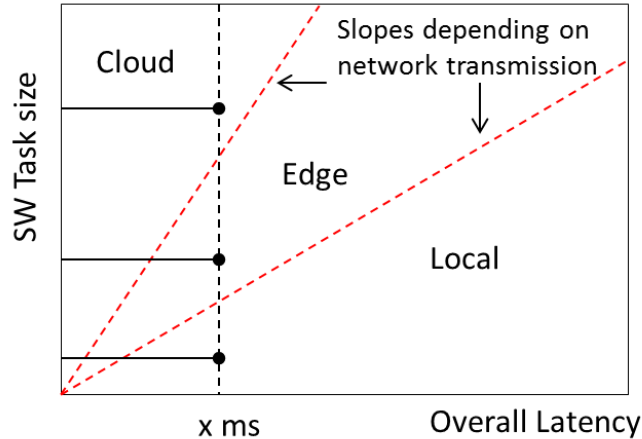


Telecommunication terminals of the future...



Sources: The Economist

«end-to-end» latency: a key factor of success



- ▶ Minimising the end-to-end latency, whilst optimising the use of resources, implies dynamic allocation and move (orchestration) of virtual functions;
- ▶ high flexibility and automation in the Operations is also required.

How the Telecommunications ecosystem will change ?

- ▶ Competition moving from a CAPEX-oriented models (e.g., based on physical infrastructure) to an OPEX ones (e.g., virtualised functions):
 - ▶ the threshold for new Competitors is lowering: new “fully virtual” Operators to enter the market, as less investments will be required (they can rent physical resources from Infrastructure Providers);
- ▶ Voice commoditization, “services packaging” and...cognition:
 - ▶ voice telephony is likely to become just another OTT service...or
 - ▶ telecoms services to become increasingly packaged with other services and made available through a variety of access connectivity services;
 - ▶ new service models are to appear (e.g. Cognition as a Service).

How the Telecommunications ecosystem will change ?

- ▶ Changes in the Telecommunication ecosystem:
 - ▶ Potential emergence of new roles for Operators (e.g., Smart Connectivity Provider, Service Enabler, etc.)
 - ▶ OTT are advantaged: they master the SW and they are in the middle of a set of relationships (working with customer equipment manufacturers and their retailers);
 - ▶ Some telecoms equipment suppliers are repositioning as principally software supply companies: a significant shift in business model:
 - the sale of software licencing has many differences to the sale of equipment !

Conclusions

- ▶ 5G will be a first exploitation of SD-Infrastructure (SDI);
- ▶ Softwarization will not be limited to decoupling SW from the HW, also it will bring to “virtualization” of resources CPU, memory and network functions:
 - ▶ this will help overcoming the “ossification” of legacy infrastructures, both in terms of technology layering and vertical partitioning in “silos”;
- ▶ Agenda:
 - ▶ A unifying functional model (e.g., cross-layer) for SD-I;
 - Abstractions, functional modules, interfaces...
 - ▶ Standardization of interfaces;
 - ▶ Automated Operations;
 - ▶ New Open Ecosystems.



The screenshot shows the IEEE Software Defined Networks website. At the top, there is a navigation bar with links to IEEE.org, IEEE Xplore Digital Library, IEEE Standards, IEEE Spectrum, and More Sites. A 'Sign in' button is located on the right. The main header features the IEEE Software Defined Networks logo and a 'Sign in' button. Below the header is a search bar with the text 'Search IEEE Software Defined Networks' and a 'Search' button. To the right of the search bar are social media links for Facebook, Twitter, and LinkedIn. A navigation menu below the search bar includes links to Home, About, What's New, Conferences, Publications, Standardization, Education, and Pre-Industrial. The main content area has a large banner with the text 'Join the IEEE SDN Technical Community', 'Stay connected with IEEE SDN Membership is free', and 'Click here to join today!'. A red arrow points to the 'Sign in' button in the top right corner.

Arrivederci !

A decorative wavy line that starts as a red curve on the left and transitions into a blue curve on the right, spanning the width of the slide.

<http://ieee-sdn.blogspot.it/>

https://twitter.com/a_manzalini

<http://sdn.ieee.org/>