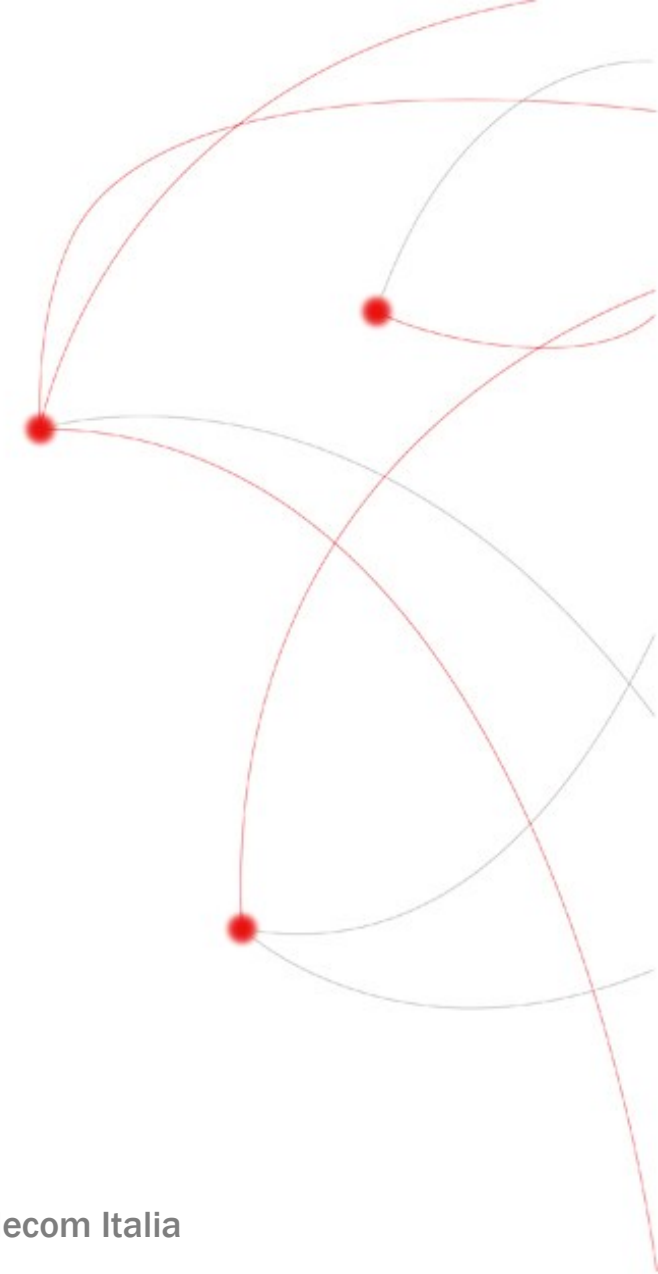


# Edge Softwarization

## A “Vision” of the Future

Antonio Manzalini

Innovation (Future Centre) - Telecom Italia

Commoditization of Services

OTTs

Competition vs Cooperation

How finding new revenues ?

Automation of OSS

Technology + Business Sustainability + Regulation

Traffic growth

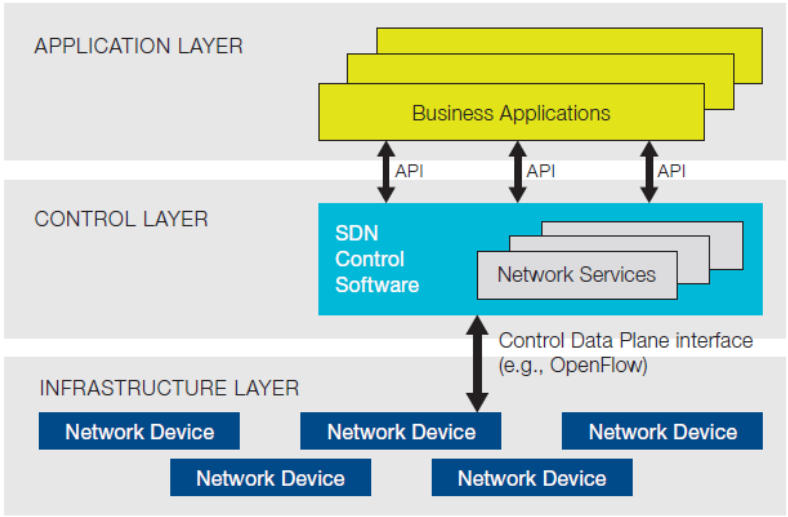
How reducing Capex and Opex ?

How taming complexity ?

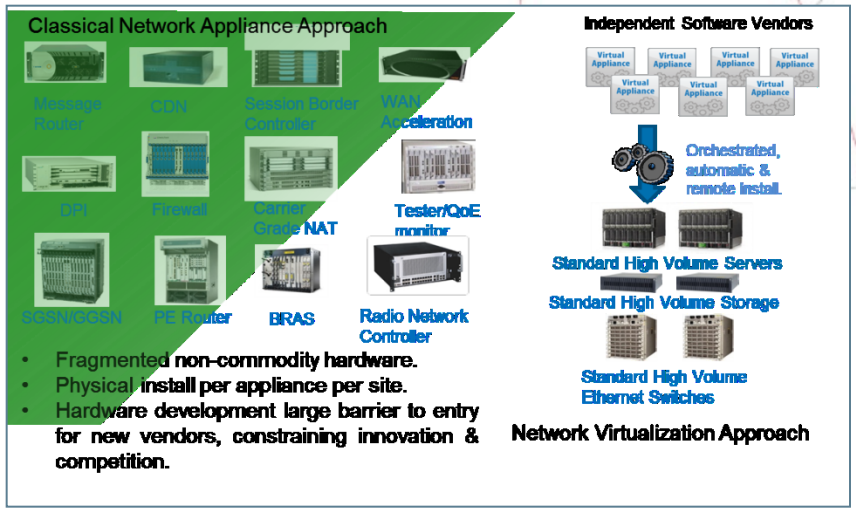
Sustainability ?

# … well known concepts

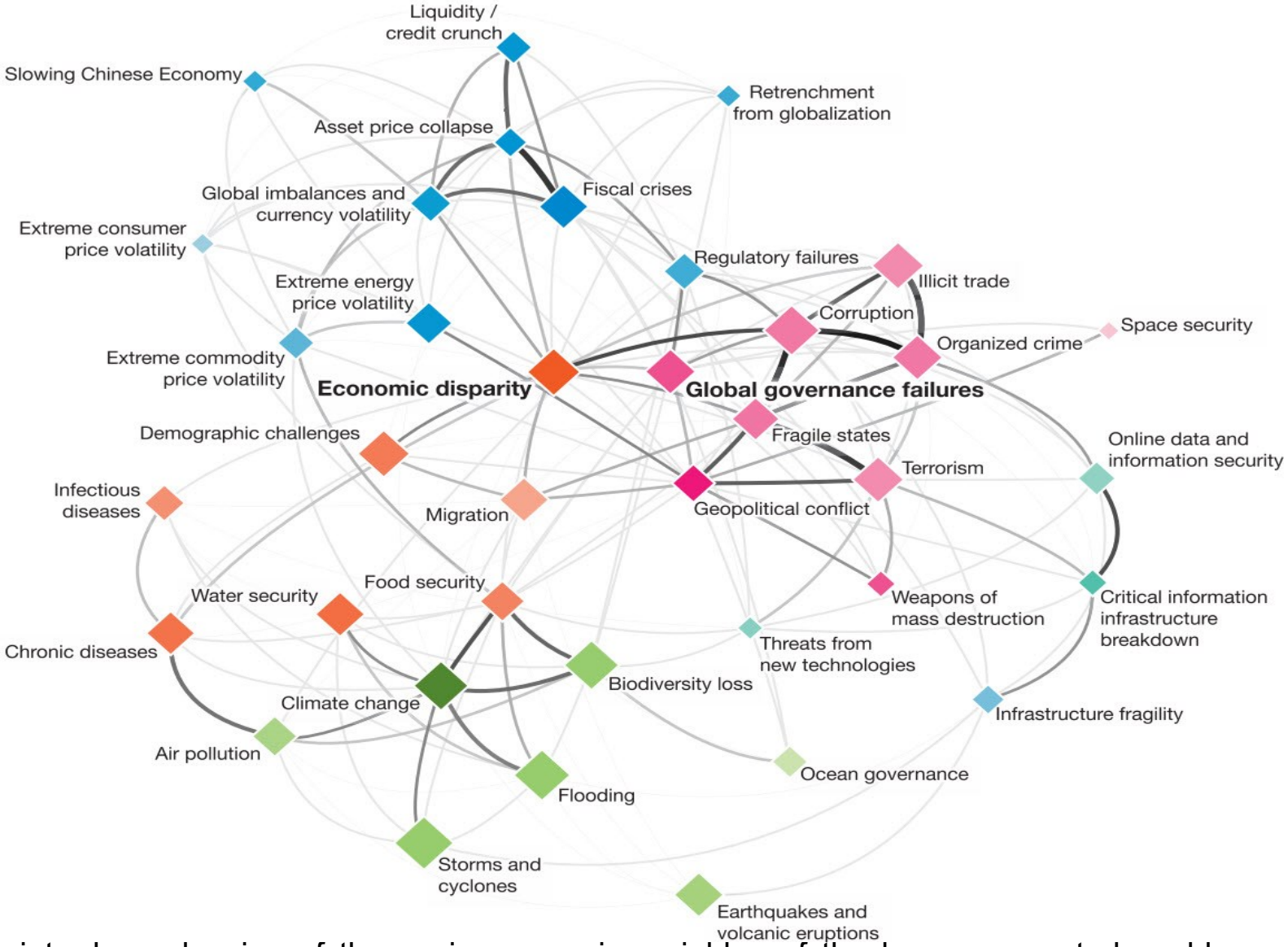
- **SDN: separation of Software (e.g., control plane) from Hardware (e.g. data plane, packets forwarding).**




- **NFV: virtualization of network functions (e.g. middle-boxes) for a dynamic allocation and execution on general purpose Hardware.**



# …in a dramaticallv new context




Systemic interdependencies of the socio-economic variables of the hyper-connected world we are living in (credit: World Economic Forum)

# …in a dramatically new context

New socio-economic drivers, impressive progress in ICT technologies, tumbling hardware costs and availability of open source software are accelerating the "network" innovation;

Softwarization is a key factor of this evolution:

- It will be possible to develop in software any functions, logics and methods capable of processing huge amount of data by using low cost powerful hardware;
- …but this has to be supported by ultra low latency networks !

Network Softwarization will bring to costs optimizations, to new services paradigms and it will require new business models.

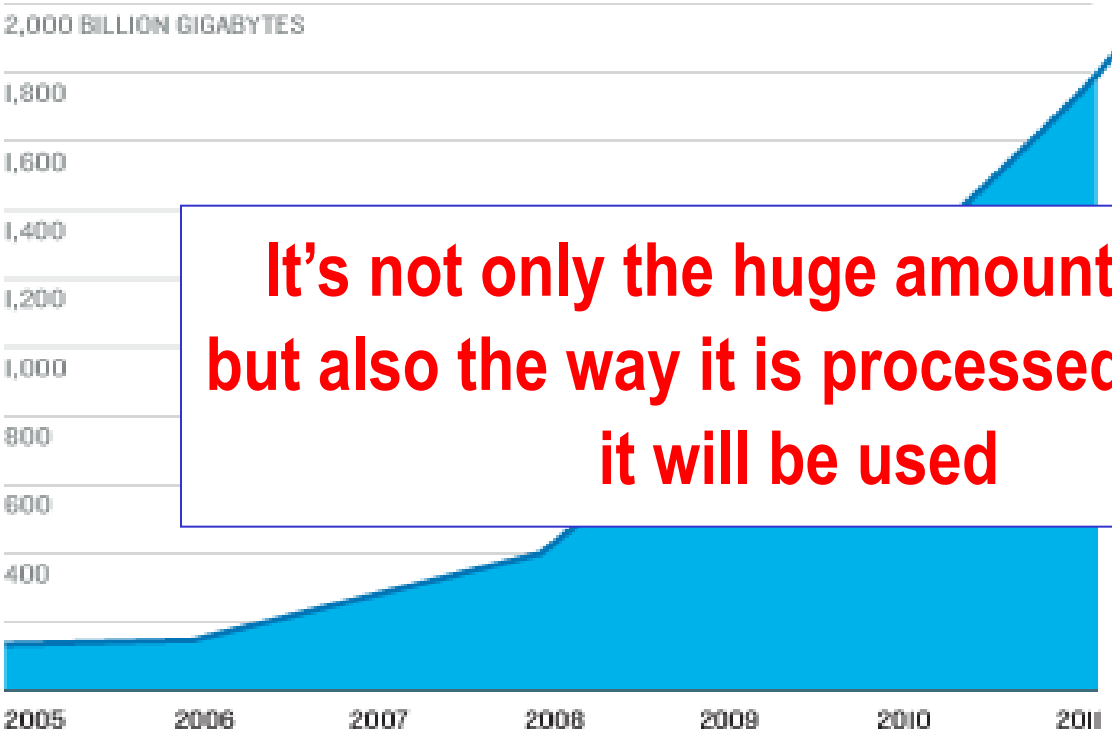
# A Data Tsunami is coming…

**65 billion**
Location-tagged payments made in the U.S. annually

**154 billion**
E-mails sent per day

**87%**
U.S. adults whose location is known via their mobile phone

## Digital Information Created Each Year, Globally




**2,000%**
Expected increase in global data by 2020

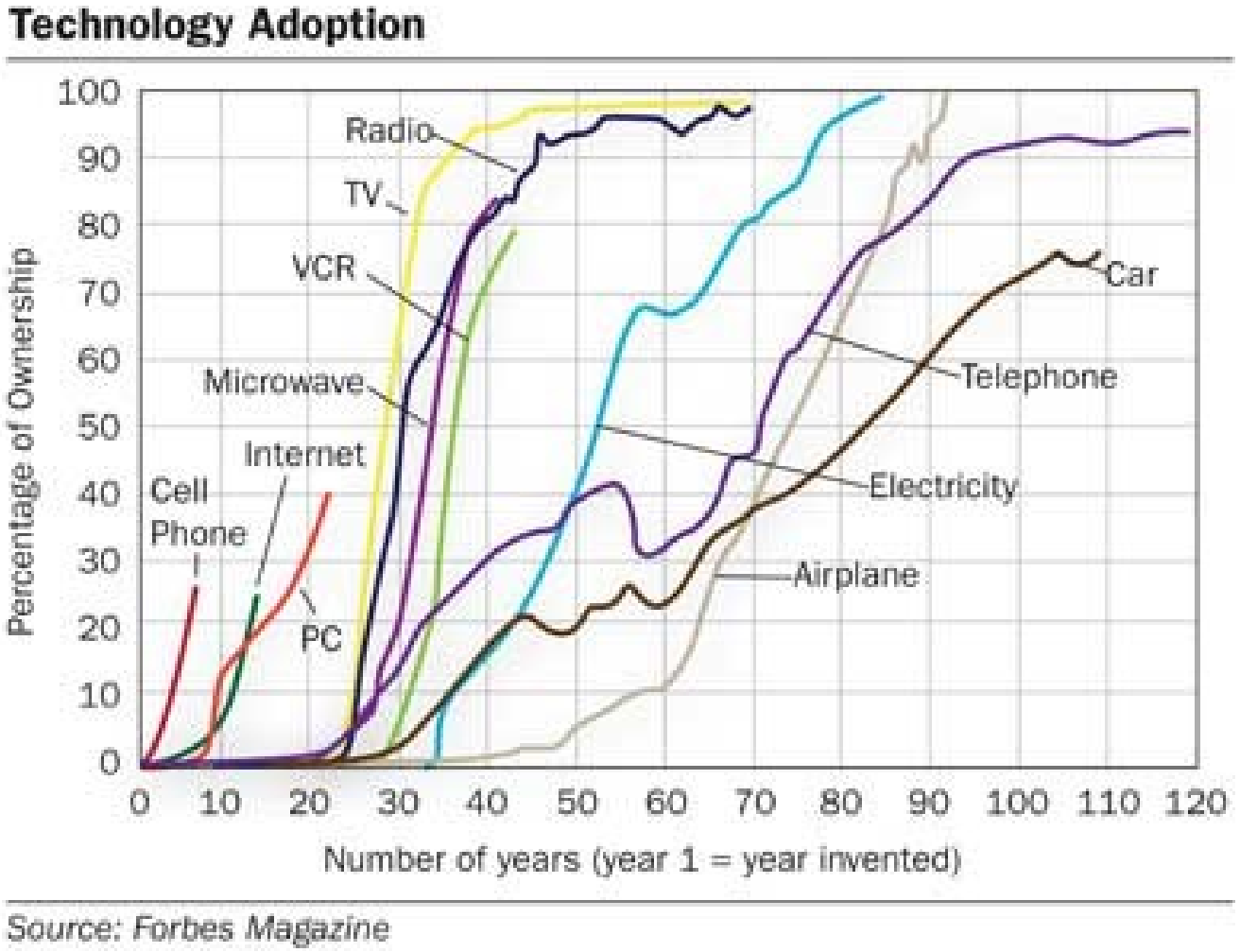
…bytes
…hotos stored
…k, per user

**75%**
Percentage of all digital data created by consumers

**It's not only the huge amount of data but also the way it is processed and how it will be used**

Sources: IDC, Radicati Group, Facebook, TR research, Pew Internet

# Technology adoption is accelerating…




**…cell phone took less than 10 years to reach 25% of the US population while the telephone took over 30 years…**

# Towards the Society and Economy of Knowledge…

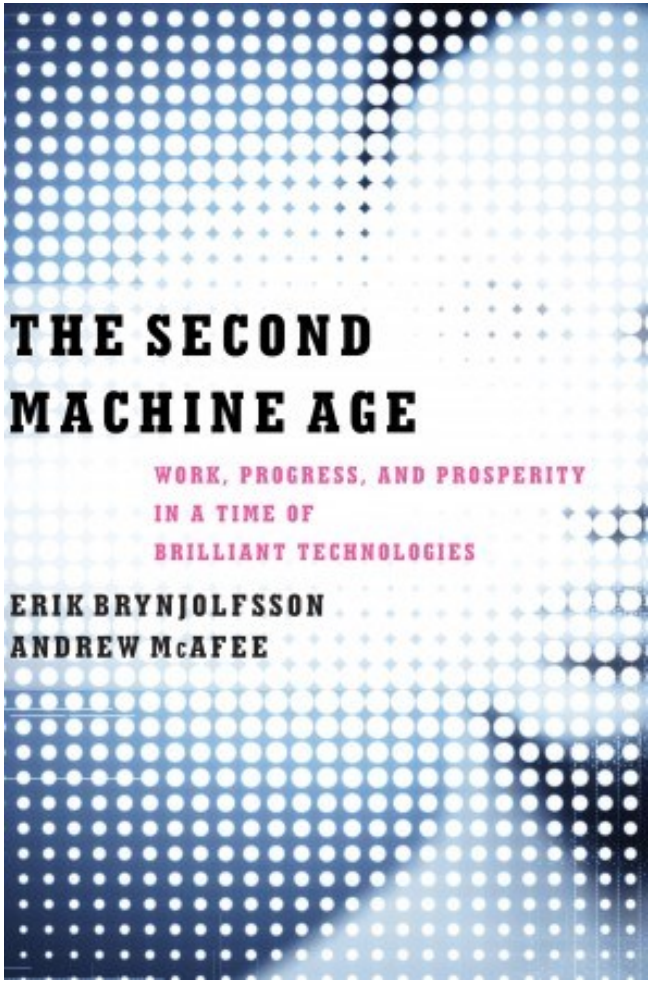
Data and information are reaching quickly any corner of the world…

… they are quickly processed, transformed in knowledge and used to actuate actions…

This is intelligence, i.e.,:

- processing and exchanging information to understand what's happening in the environment, to adapt to changes and to learn.
- **Bandwidth + Processing (Storage) !**

# The Age of Intelligent Machines is coming…




Advances of performance and decreasing costs of processing, high bandwidth networking and mass digitalization (Big Data) are creating the conditions for «intelligent machines» to be widely deployed and used.

http://www.washingtonpost.com/opinions/review-the-second-machine-age-by-erik-brynjolfsson-and-andrew-mcafee/2014/01/17/ace0611a-718c-11e3-8b3f-b1666705ca3b_story.html

# The Age of Intelligent Machines is coming…


http://www.technologyreview.com/featuredstory/526536/agile-robots/

# The Age of Intelligent Machines is coming…


http://online.wsj.com/news/articles/SB10001424052702304117904579501701702936522

## Google acquiring Titan
## Robot technology is part of the Google X division

# The Age of Intelligent Machines is coming…

## Use of Drones in Agriculture

# A new era is coming…

When intelligent machines will "flood the landscape of jobs", it will have a number of impacts:

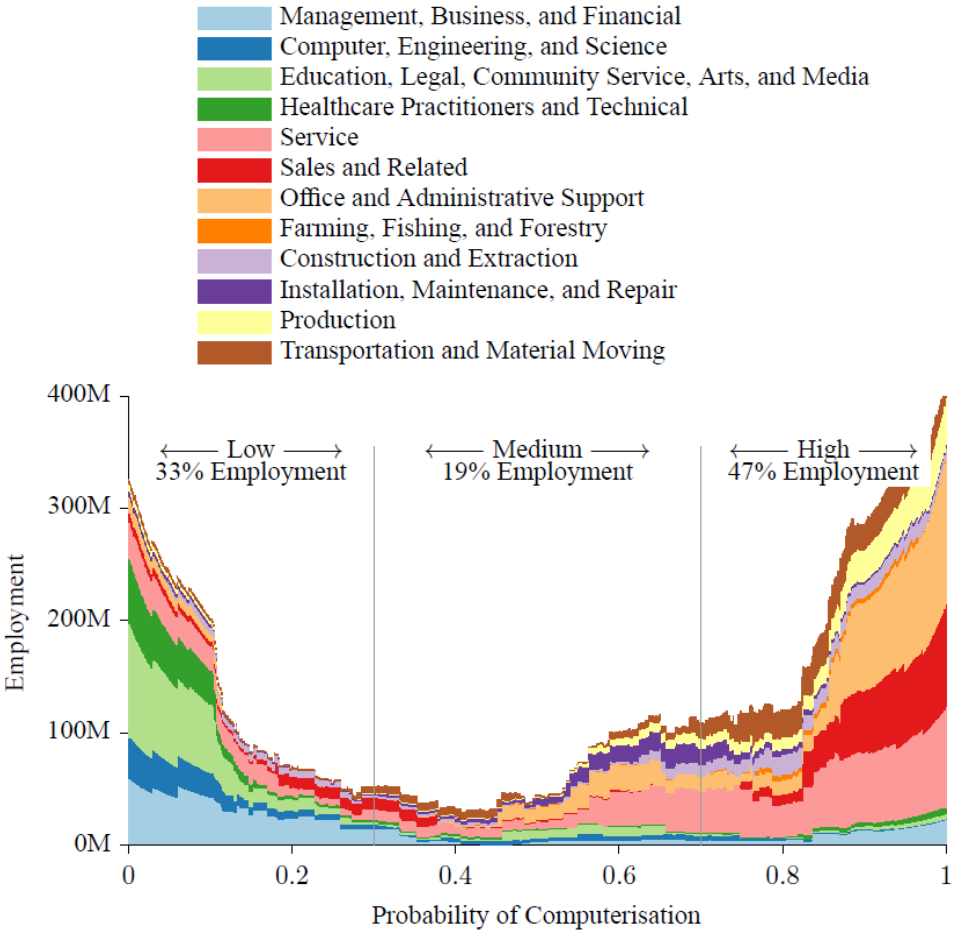
- increase of local production (micro - manufacturing);
- reduction of long distance transportation;
- "optimization" of most socio-economic processes;
- human labor costs will not move anymore the Industry.

This is not about "understanding" how human intelligence is working and replacing it, but…

…it is about deploying ultra low latency networks interconnecting huge amount of processing power !

# A new era is coming…

***"…as technology races ahead, low-skill workers will have to reallocate to tasks not-susceptible to "Computerization" – i.e., tasks requiring "creative and social intelligence".***






THE FUTURE OF EMPLOYMENT: HOW SUSCEPTIBLE ARE JOBS TO COMPUTERISATION?

http://www.futuretech.ox.ac.uk/sites/futuretech.ox.ac.uk/files/The_Future_of_Employment_OMS_Working_Paper_1.pdf

# A Vision of Future Networks…

Integrating of “IT and Network” resources;

blurring the distinction between the “Network” and what connects to it, i.e., the end-Users “Terminals”;

transforming the Edge (i.e., from the terminals to the local Edge PoP, or mini-Data Centers) into a virtual environment capable of supporting new service paradigms (e.g., Anything as a Service);

In this perspective, the capability of controlling the “latency” will represent a competitive advantage!

# A Vision of Future Networks…

## The rush to … minimizing the "latency":

- HTTP was not particularly designed for latency, so OTTs developed and used an application-layer protocol SPDY, for the web which greatly reduces latency;
- OTT (e.g., Google) are progressively moving "processing" towards the Users to reduce the "overall latency";
- AKAMAI Edge Computing is another example !

- **Operators could transform their telephone exchanges in mini-DC !**

"Throughput = Window Size / RTT"

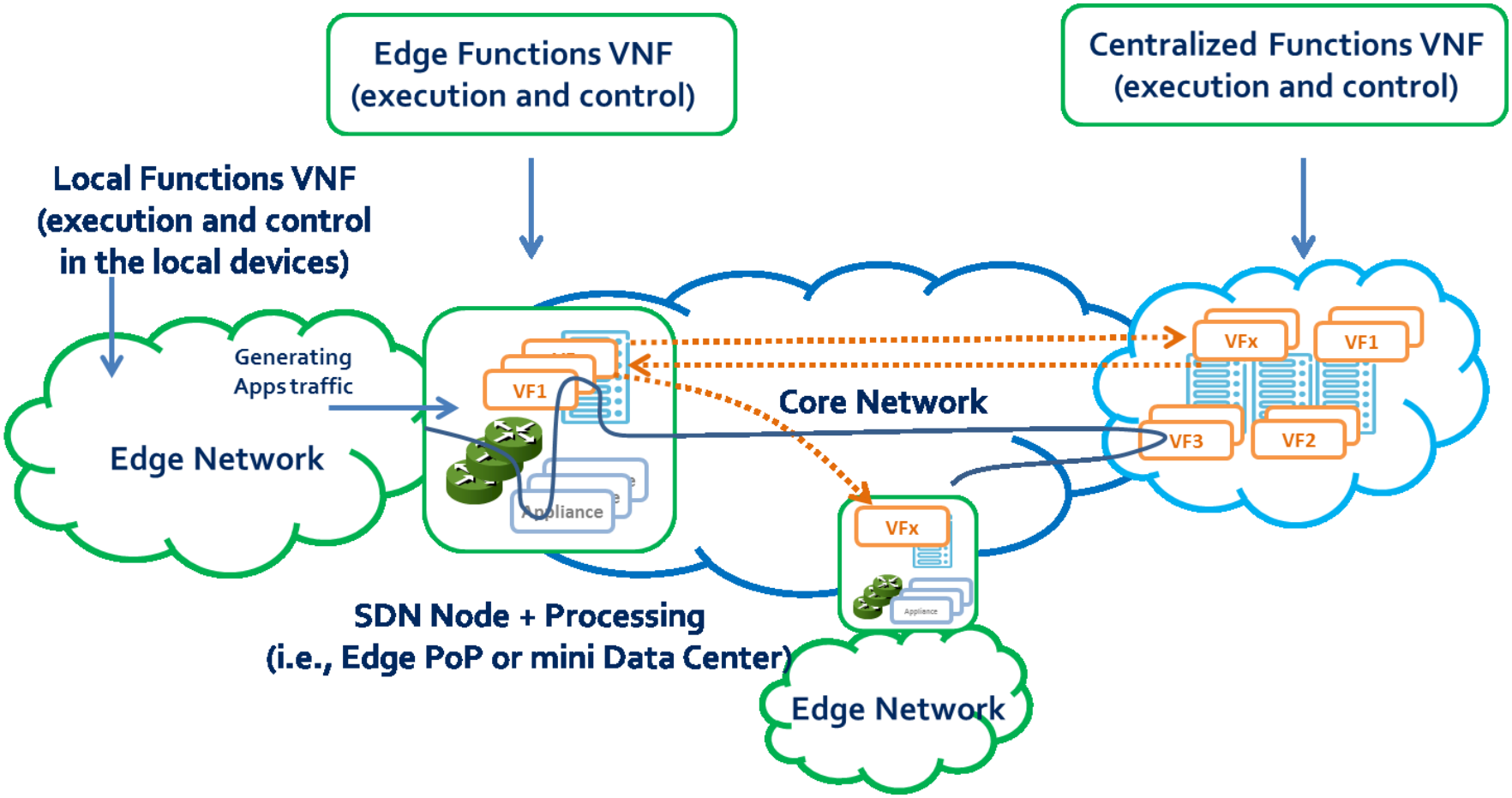
# A Vision of Future Networks…

A proper balance between centralization (cloud) and distribution (edge PoPs, or edge local devices) is required for minimizing the "overall latency" (composed by processing and storage response times and the network links latency);

in fact, the "overall latency" in elaborating big data related to VNF chains (in cloud or edge PoPs) should meet, for example, the "reaction times" requirements for:

- actuations (e.g. configurations of devices, specific actions for physical actuators, e.g. machines, cars, robots, etc…);
- highly interacting applications (e.g. interactive multi media gaming)…

# A Use Case




**What's the proper balance between centralization (cloud) and distribution (edge PoPs, or edge local devices) is required for minimizing the "overall latency" ?**

# RT&D Agenda

- **Key areas will include:**
  - **How achieving Ultra Low Latency and Edge Mobility;**
  - **How managing and orchestrating virtual entities;**
  - **How finding the right balance global vs local "intelligence" (Cloud, Edge up to end-Users devices and premises);**
  - **Standardizing of interfaces for interoperability;**
  - **How ensuring Security and Privacy;**
  - **How pursuing sustainable Open Source Software models;**
  - **Developing New Business Models and Ecosystems;**
  - **Education and Development of new skills and jobs.**

# Conclusions

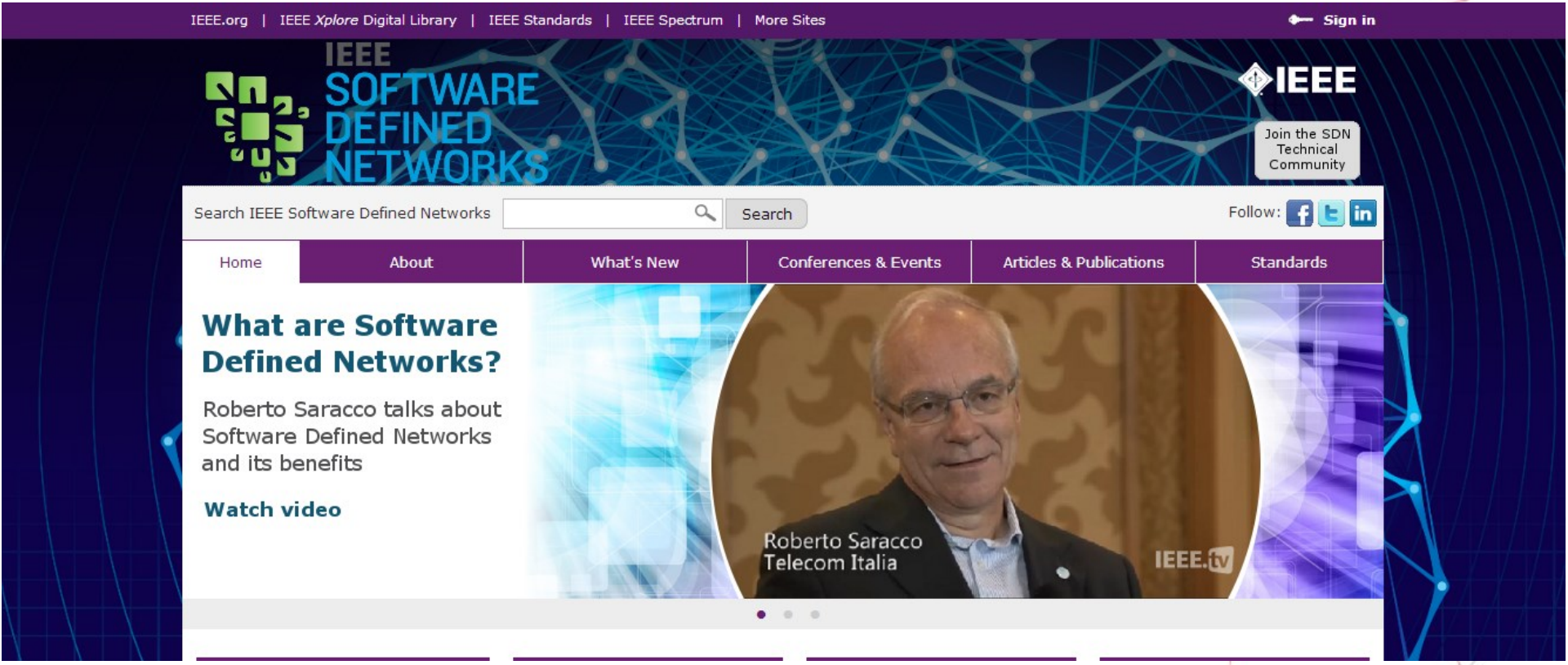
Some “innovations” (e.g., tools) are capable of changing everything:

- Hunting to Agriculture economy
- Agriculture to Industry economy
- …today the Knowledge economy ?


The new “tool” will be the “huge amount of processing power interconnected by and ultra low latency networks”;

New service paradigms by combining:

- Sensing;
- Computing – Communicating;
- Acting.




**IEEE SDN Initiative has a number of committees of Experts to explore and develop conferences, education modules, standards, publications, proof of concept and to boost the pre-industrial adoption of SDN.**

**http://sdn.ieee.org/**

**If you interested, please join us !!**

# Thank you
# Arrivederci !

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