# Softwarization: A Shift of Paradigm

NOMS 2014: SDNMO Workshop (9th May, Kracow)
Keynote Speech

Antonio Manzalini– Telecom Italia

TELECOM ITALIA

Software-defined * and Virtualization of Functions

- **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.

- They are known concepts… since decades, but today there are new techno-economic conditions…
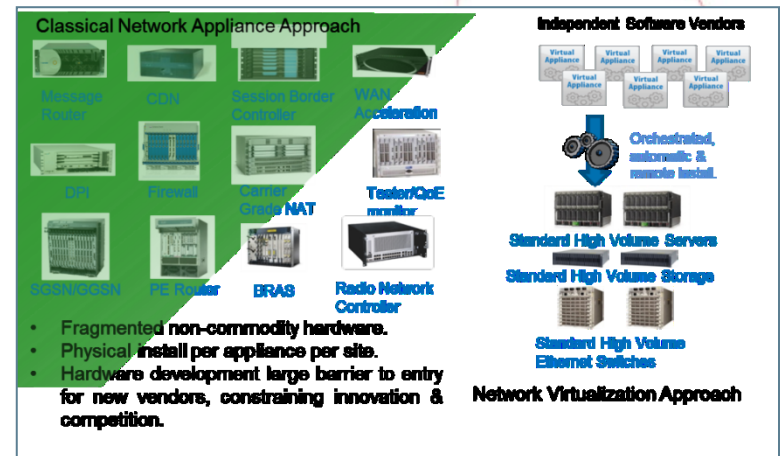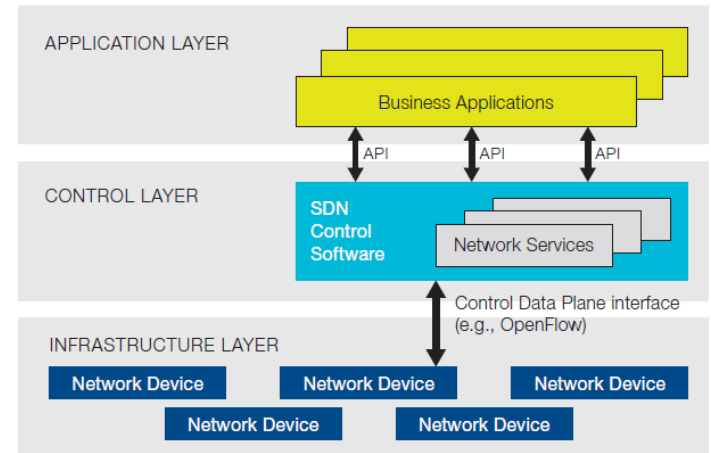
It's all about "Softwarization" !

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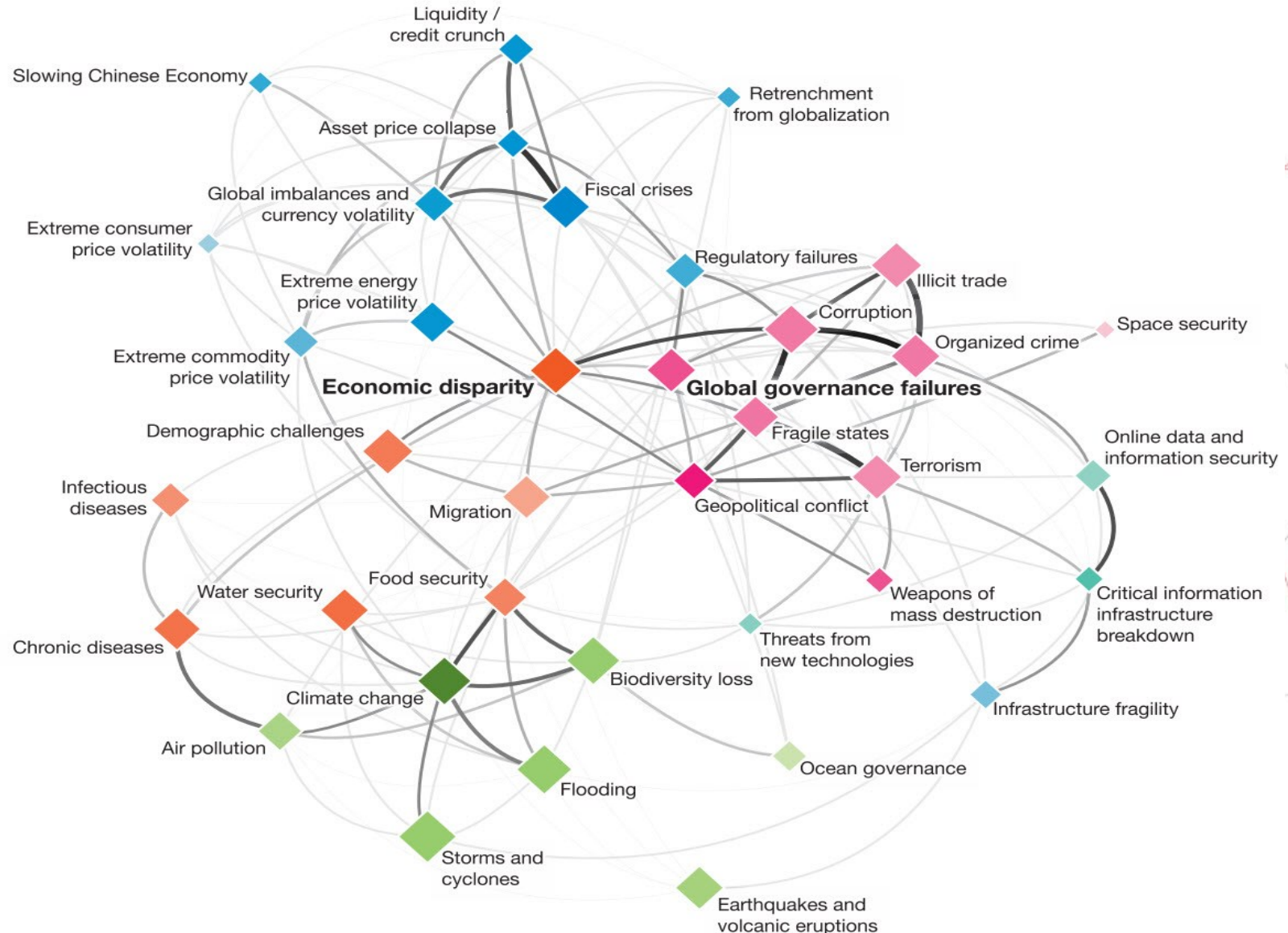
Systemic interdependencies of the socio-economic variables of the hyper-connected world we are living in (credit: World Economic Forum)

Data Tsunami

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 BILLION GIGABYTES
1,800
1,600
1,400
1,200
1,000
800
600
400

2005 2006 2007 2008 2009 2010 2011

2,000%
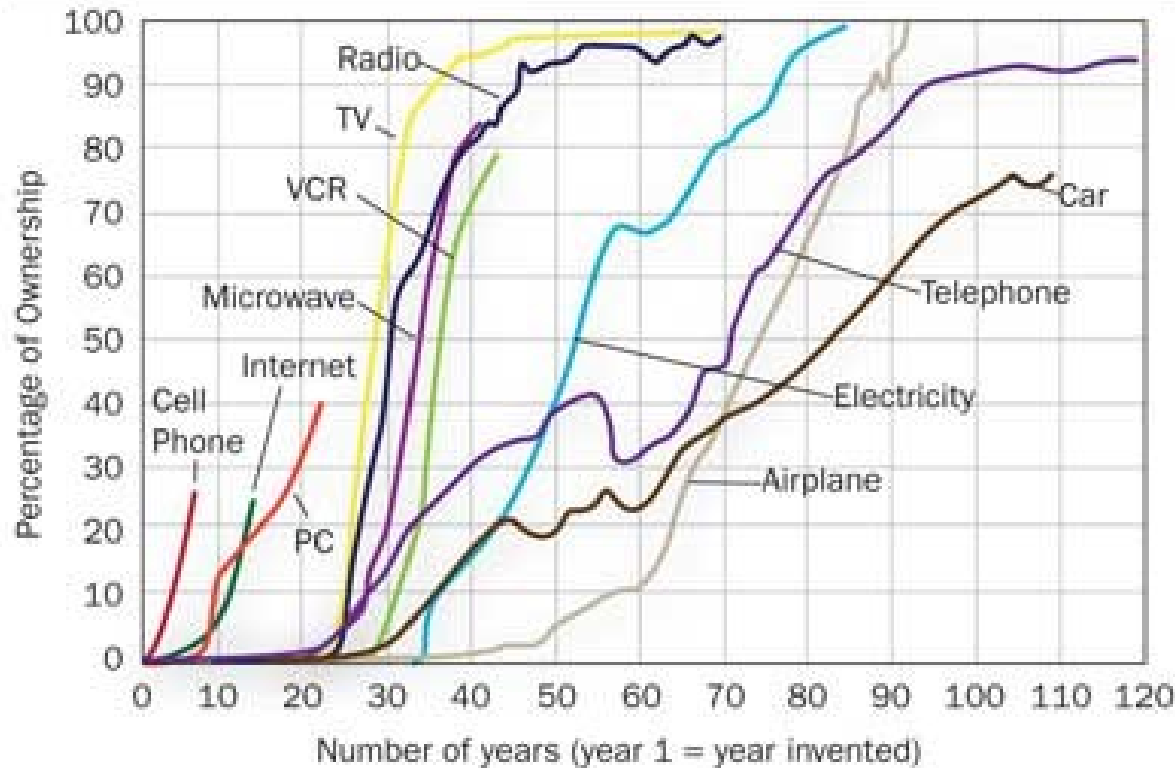Expected increase in global data by 2020

111 Megabytes
Video and photos stored by Facebook, per user

75%
Percentage of all digital data created by consumers

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

Technology adoption is accelerating…

Technology Adoption

Percentage of Ownership vs Number of years (year 1 = year invented)

Radio, TV, VCR, Microwave, Internet, Cell Phone, PC, Car, Telephone, Electricity, Airplane

Source: Forbes Magazine

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

5

An Hyper Connected World accelerating Innovation…

Socio-economic drivers, progress in ICT technologies, tumbling hardware costs and availability of open source software are steering the evolution towards «Softwarization»

Softwarization:

- **it concerns to develop in software any functions, logics and methods capable of processing huge amount of data by being executed on (low cost) powerful hardware.**

This trend is not stoppable (as it's bringing to costs optimizations) and it's accelerating innovation in any Industry !

It's a pervasive "Intelligence"

Information is reaching very quickly any corner of the world and it can be very quickly processed to make decisions and actuations;

- related impacts/reactions can be even non linear and systemic (i.e., butterfly effect);

Intelligence (humans and ecosystems) is the capability of processing and exchanging information to understand what's happening in the environment, **to adapt to changes and to learn.**

Information, Intelligence and Knowledge

In this Hyper Connected world, still a main "control variable" of our "complex" economy is human attention, efforts and time, …

- humans are still the most productive part of current economy;
- industries are migrating where there are lower labor costs !

Softwarization will help creating a "pervasive intelligence" capable of reshaping the economy equation, by reducing human efforts in several jobs…(e.g. through "intelligent" machines, robots, drones…).

- This about implementing in intelligence in software and deploying it with Pervasive Computing and Ultra Low Latency Networks !

Impact of Softwarization

When **Intelligent Machines** will "flood the landscape of jobs", it will have a number of impacts:

- reduction of human efforts in jobs subjected to computerization, robotization …;

- increase of local production;

- reduction of long distance transportation;

- "optimization" of most socio-economic processes;

- human labor costs will not move anymore the Industry.

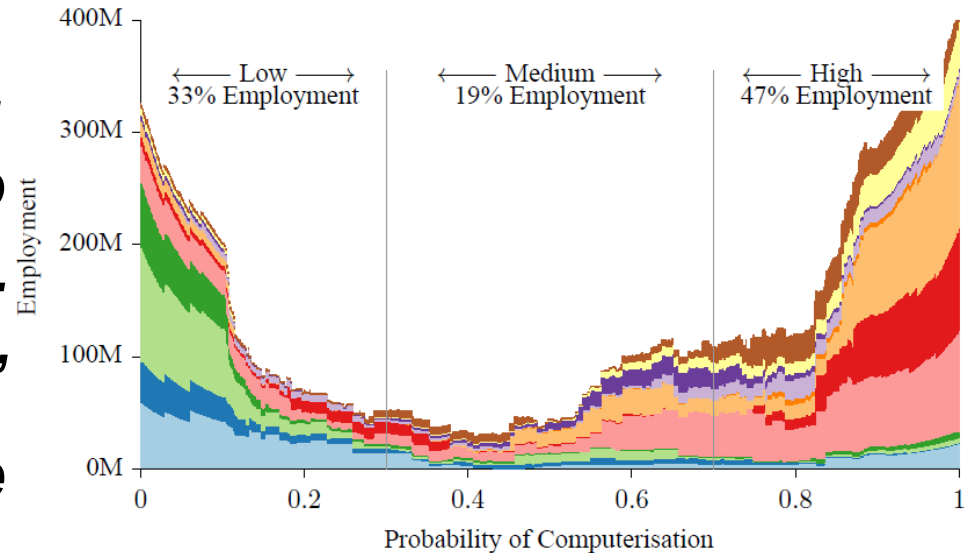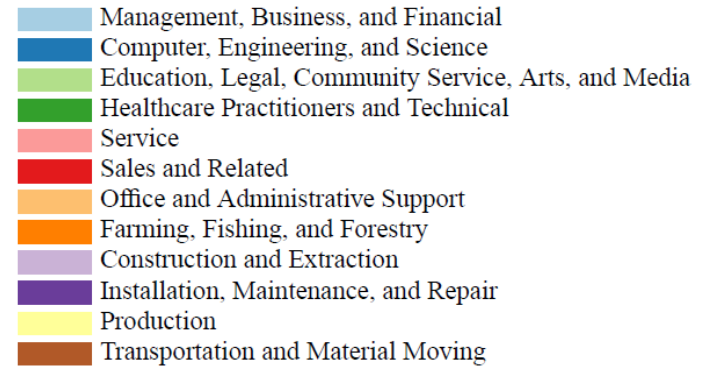A new (old) equation with four variables:

- Technology, Business Models, Regulation…and Acceptance !

9

Impact of Softwarization

High-skill workers on Softwarization are *needed !*

The other side of the coin:

"…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".

Legend:
- Management, Business, and Financial
- Computer, Engineering, and Science
- Education, Legal, Community Service, Arts, and Media
- Healthcare Practitioners and Technical
- Service
- Sales and Related
- Office and Administrative Support
- Farming, Fishing, and Forestry
- Construction and Extraction
- Installation, Maintenance, and Repair
- Production
- Transportation and Material Moving

Low 33% Employment — Medium 19% Employment — High 47% Employment

Y-axis: Employment (0M, 100M, 200M, 300M, 400M)
X-axis: Probability of Computerisation (0, 0.2, 0.4, 0.6, 0.8, 1)

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
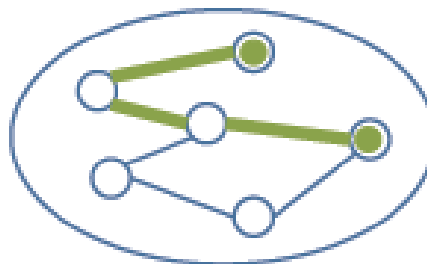
Industrial Mathematics…

To find and use systems and methods for playing with VMs:

- to allocate and move VMs so to meet service demands;
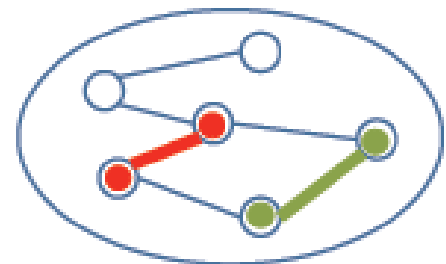
- to route the traffic across virtual links between VMs.

This is an "constraints optimization" problem: how allocating and migrating efficiently VMs while achieving close-to-optimal performance in executing software components (i.e., functions) ?
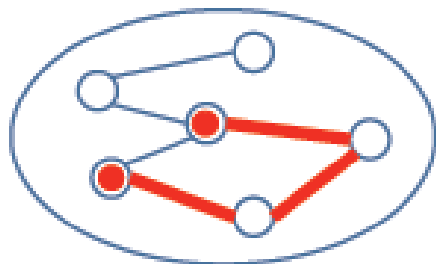
good placement bad routing;   good routing bad placement;   good placement and routing

Joe Wenjie Jiang et alii, "Joint VM Placement and Routing for Data Center Traffic Engineering"

11

A Vision of the Future…

networking, transmission

Core

Access

Data Centers (Cloud)
- **Computing for Glo*b*al Intelligence**

Edge Mini Data Centers
- **Computing for Glo*c*al Intelligence**

Robot As A Service
- **Sensors**
- **Actuators**
- **Computing for *Local* Intelligence**

Requirement: Ultra Low Latency to get milliseconds of reaction time

12

A Vision of the Future…

L2-L7 Software

Centralized Intelligence

Edge Intelligence

Processing

Storage

Bandwidth

L0-L1 Hardware
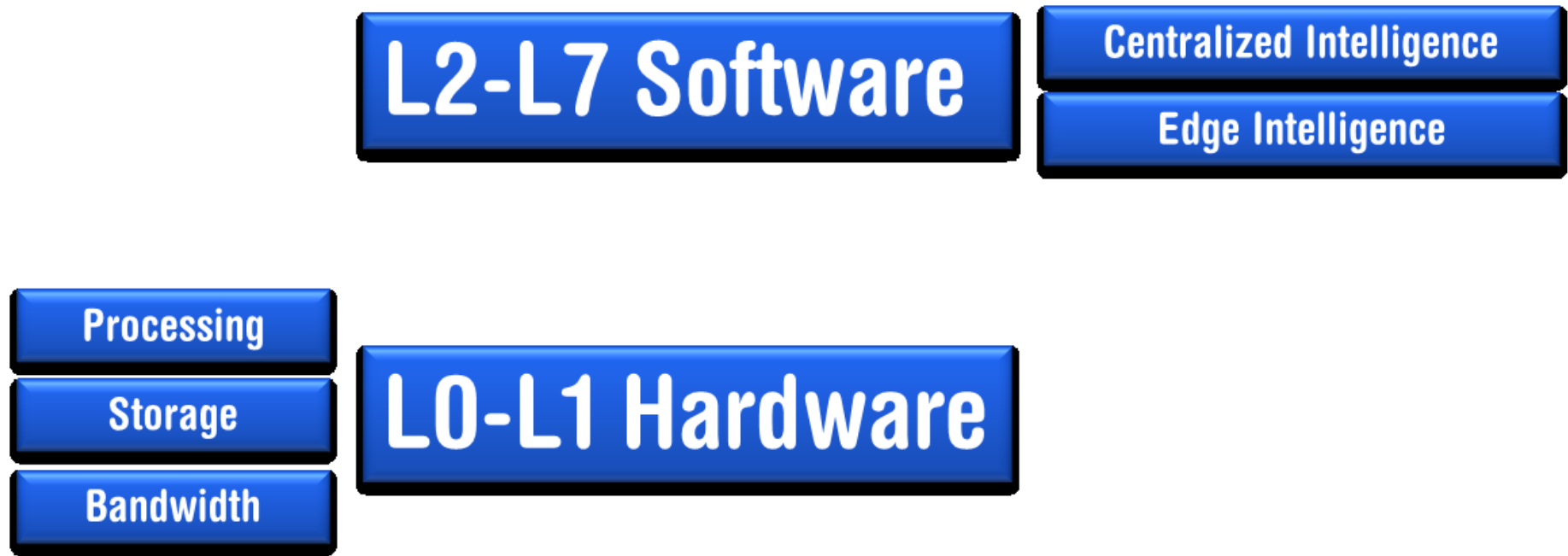
How managing physical resources, virtual network functions and services … and the "intelligence" ?
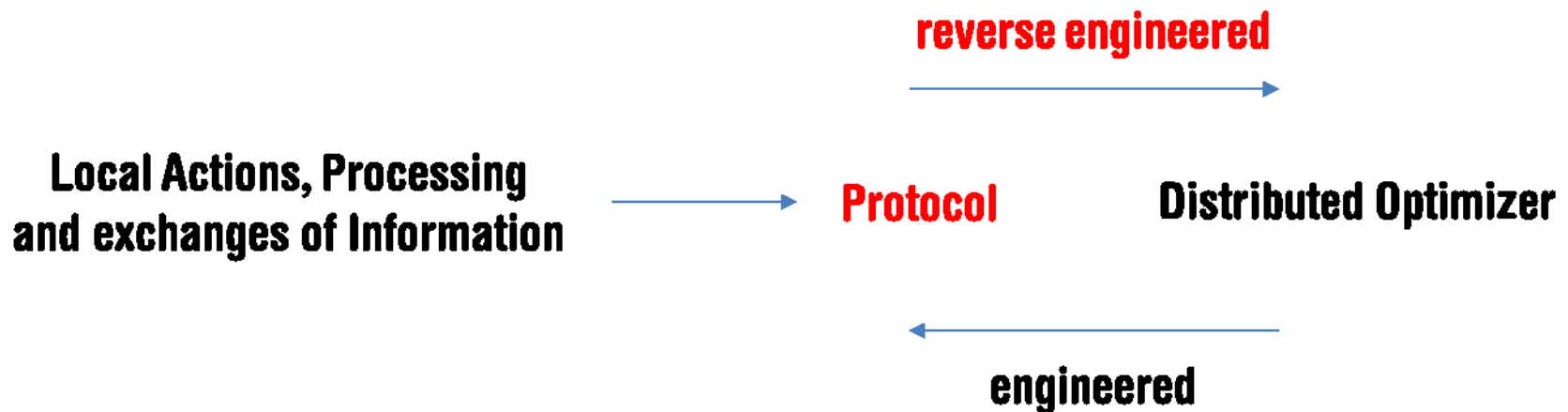
13

A Vision of the Future…

Three levels of intelligence:

- **automatic behavior: achieved with fast pre-defined rules for self-configuration in predefined contexts; it could be designed, for example, by means of simple and fast automatic rules;**

- **autonomic behavior: a capability responsible for local self-adaptation and it is achieved by exploiting unsupervised learning capabilities. The layer could be designed, for example, by introducing reinforcement learning and cognitive algorithms;**

- **self-organized global behavior: a behavior achieved through orchestrating local control points.**

Industrial Mathematics…

Example: TCP/IP can be seen as an example of distributed optimizer whose objective is to maximize the sum of utility functions (bit rates) with constraints on resources

reverse engineered

→

Local Actions, Processing and exchanges of Information → **Protocol** **Distributed Optimizer**

←

engineered

Global-Local Optimisers executed with Pervasive Computing and Ultra Low Latency Networks !

When milliseconds will make the difference…

… Softwarization will start by the Edge Networks

- **accumulation of processing and storage resources;**

- **migration of "intelligence" towards the End-Users;**

- **an effective for enabling ICT ecosystems, by addressing socio-economic "problems" (i.e., the fabric of Society);**

  - **lowering the threshold for new Players to enter the edge arena;**

  - **new forms of competition and collaboration among Players;**

  - **new value chains and new business models;**

- **Leaving more time for a smooth "softwarization" of the core**

When milliseconds will make the difference…

Core Networks

- potential reductions of CAPEX and OPEX

  - …need to test the performance

- convergence of IT and Networks nodes and systems

  - …big impact on operations processes

- standardization of interfaces

  - … a plethora of Standards de Facto

- interoperability with legacy equipment

- development of high-skill jobs for mastering the software

When milliseconds will make the difference…

1. **Integrating profoundly Cloud/IT resources and Carriers' Networks:**

   • **distributed virtual platforms executing any network function (e.g., L4-L7 or even L2-L7) and services as "applications" (on VMs, dynamically allocated and moved on general purpose HW);**

2. **Blurring the distinction between the "Carriers' Network" and what connects to it, i.e., the End-Users "Terminals":**

   • **any devices, machines, smart things, robots, drones…will look like nodes (at the edge) providing the End-Users with "any services".**

Research Agenda

- **Key areas will include:**

  - **New Management and Orchestration approaches integrating abstractions of processing, storage and networking;**

  - **Developing and controlling "intelligence" into End-Users devices, machines, smart things…drones, robots;**

  - **Standardization of interfaces for interoperability;**

  - **Addressing Security and Privacy;**

  - **Developing New Business Models and Ecosystems;**

  - **How pursuing Open Source Hardware and Software;**

  - **Education and Development of new skills.**

Conclusions

Commoditization

Competition

Reducing time to market

Automation

How finding new revenues ?

…Transition to Economy of Knowledge

Traffic growth

How reducing Opex ?

**How taming complexity ?**

Sustainability

Conclusions

Only rare "innovations" are capable of changing everything:

- Hunting to Agriculture economy

- Agriculture to Industry economy

- …towards Knowledge economy ?

Softwarization is the new "tool" to implement and manage machine intelligence, via pervasive computing and ultra low latency networks:

- Sensing

- Computing - Communicating

- Acting
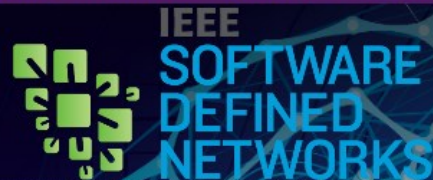
The first step towards civilization

from "2001: A Space Odyssey

The IEEE SDN Initiative formed committees to explore and develop conferences, education modules, standards, publications, proof of concept and pre-industrial adoption of SDN.

Please join us !!

22

Thank you
Arrivederci !

antonio.manzalini@telecomitalia.it