WIRELESS WORLD RESEARCH FORUM®

Next Generation Communication Architectures and Technologies

Special Session on: Requirements and Technologies for the Next Generation of Mobile Communications

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University of Piraeus Research Center

ITU, 21 May 2013,
Geneva, Switzerland

Outline

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- Motivation and Vision
- Towards a 5G wireless world
- Intelligence
- Intelligence enablers
- Vertical markets/ Application areas
- Conclusions

Motivation & Vision

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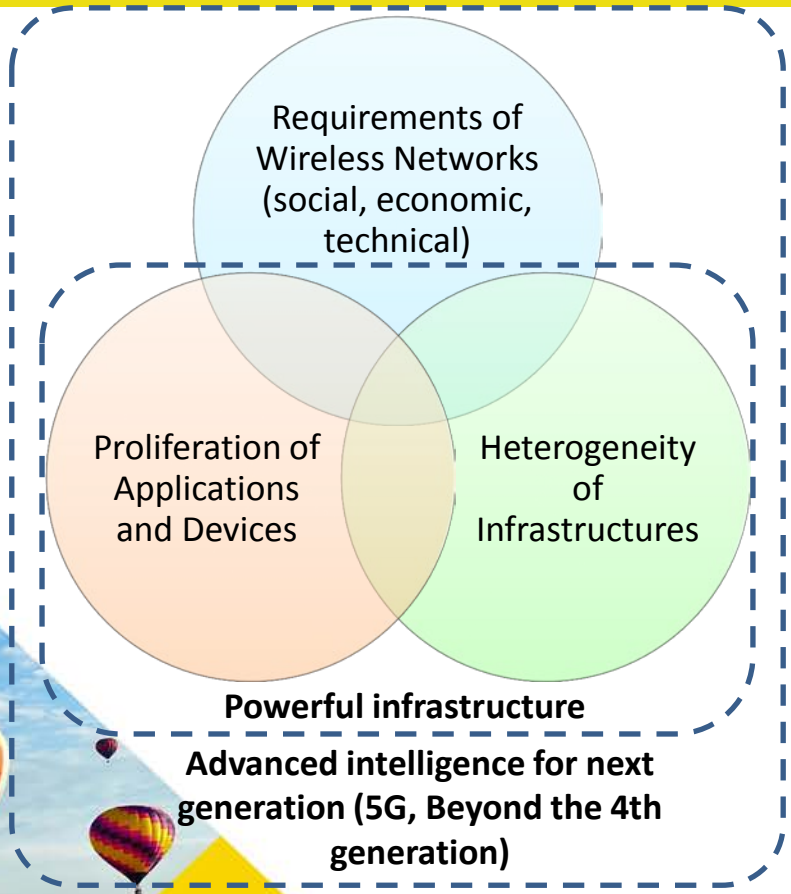

- Motivation and Vision
  - Embarked for the **next generation** (**5G**, beyond 4G) of wireless mobile broadband
  - Driving force: Requirements from **multiple perspectives**: Society; Environment; Economy; Users; Operators
  - Driving force: **Exploitation** of complex and **powerful infrastructures**
  - **Main message**: *Need for **advanced intelligence** for having the next generation wireless mobile broadband*

- Main topics
  - From requirements to architectures
  - Intelligence for managing
    - HetNets; Cloud-RANs; Knowledge; Cognitive Radio Networks, M2M/Cognitive IoT constructs
  - Intelligence enablers
    - Software-defined networks (SDN); Network Functions Virtualization (NFV)
  - Vertical market development
    - Smart Grids

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Towards a 5G world: technologies & objectives

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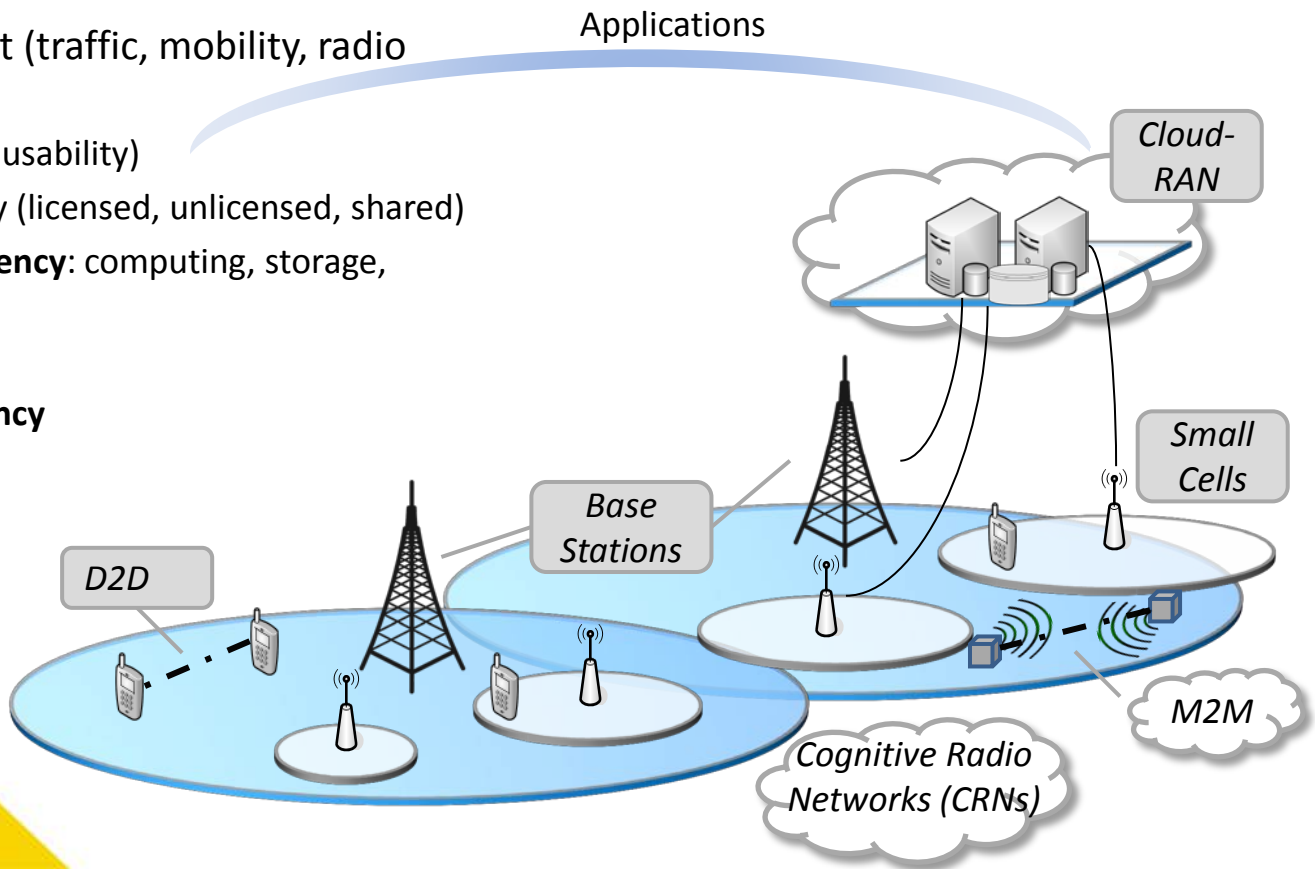
- Powerful infrastructures
  - Small cells/ Heterogeneous Networks
  - Multi-technology (mobile, WiFi)
  - Device-to-Device
  - Machine-to-Machine, Internet of Things
  - Cognitive Radio Networks
  - Diverse spectrum bands

- Multi-objective context (traffic, mobility, radio condition) handling
  - **QoE** (carrier grade, usability)
  - **Spectrum** efficiency (licensed, unlicensed, shared)
  - **Resource use efficiency**: computing, storage, communication
  - **Energy efficiency**
  - **Overall cost efficiency**



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Intelligence for heterogeneous networks

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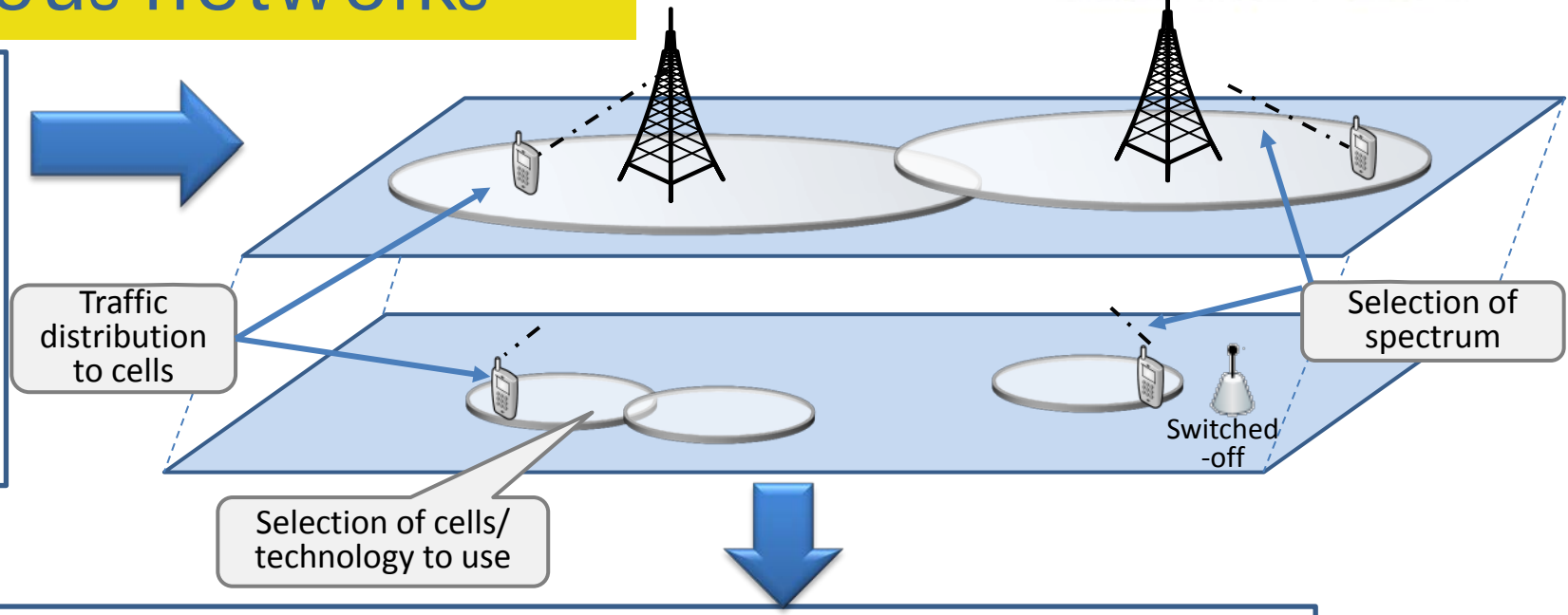
Input

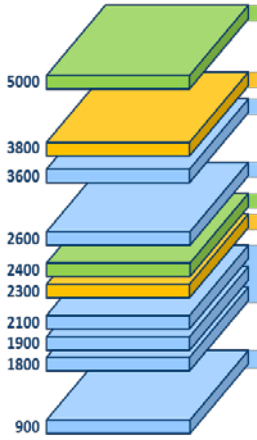
- Context of operation
  - Traffic
  - Mobility
  - Interference
- Policies
- Powerful infrastructure
  - Cells, Spectrum, Technologies



Output

- Optimal handling complex contextual situations
- **Distributed** solutions for **adaptive/predictive** network topology and resource allocation configurations:
  - **Selection of cells to operate from large sets:** Transceivers that will be involved in the handling of a situation (flexible cell layouts);
  - **Handling of many spectrum bands:** Selection of band, width that will be assigned to be operated by the transceivers (spectrum management);
  - **Cells of different technologies:** Handling the multi-technology aspect;
  - **Traffic distribution to cells:** Various time scales and degrees of distribution;
- Global optimality: QoE; energy efficiency; overall cost efficiency, etc.

Many bands of operation



Intelligence for managing Cloud-RANs

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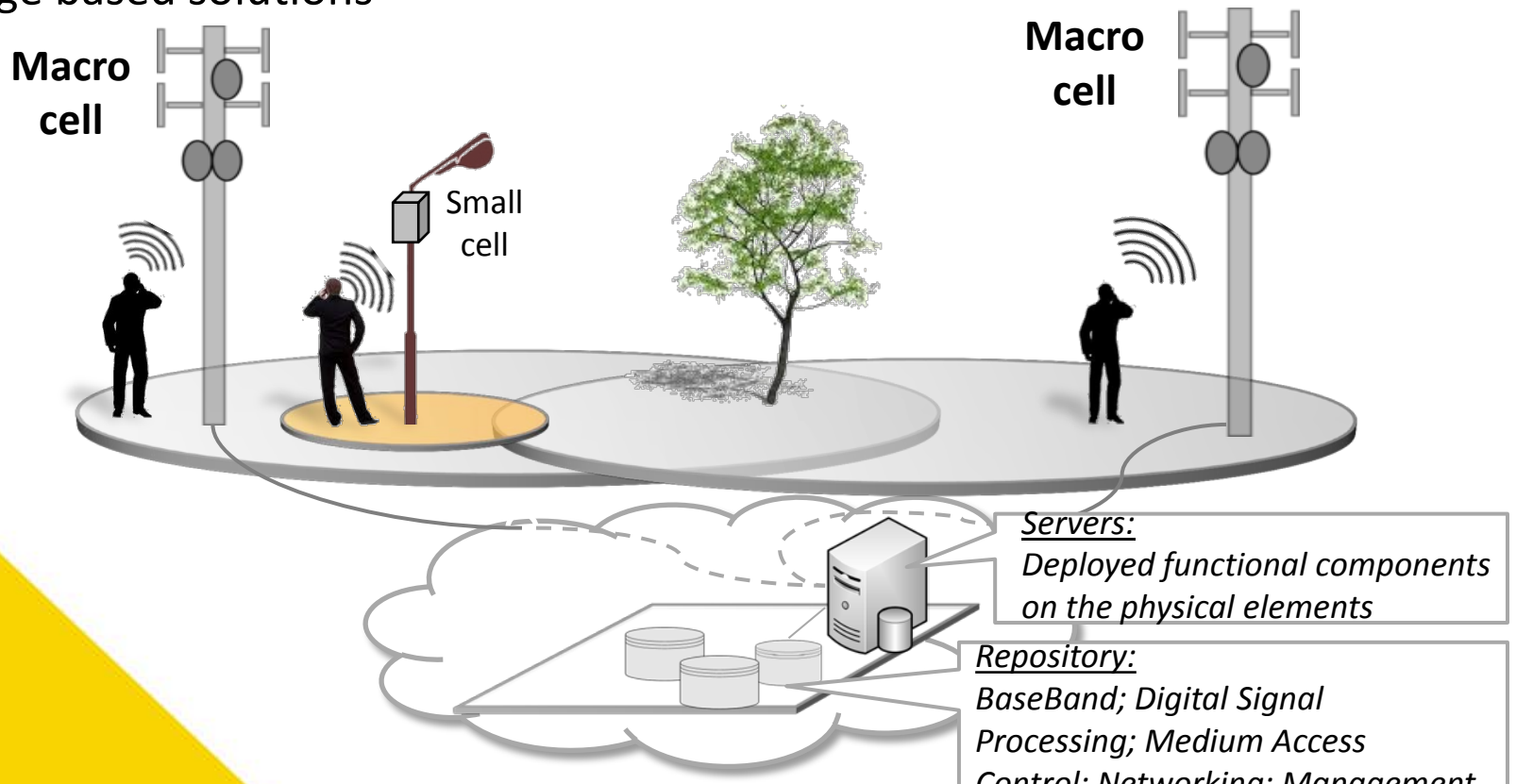
- Placement of very light transmission units – intelligence in the "core"
- Software components (system functionality) in repositories
- Dynamic software activation and deployment to various servers
- Smart management of available resources,
  - Given the context of operation find the physical elements that should be used, the allocation of functional elements to physical elements and the physical elements inter-connections
- Heuristic, knowledge based solutions



Intelligence for knowledge generation/management

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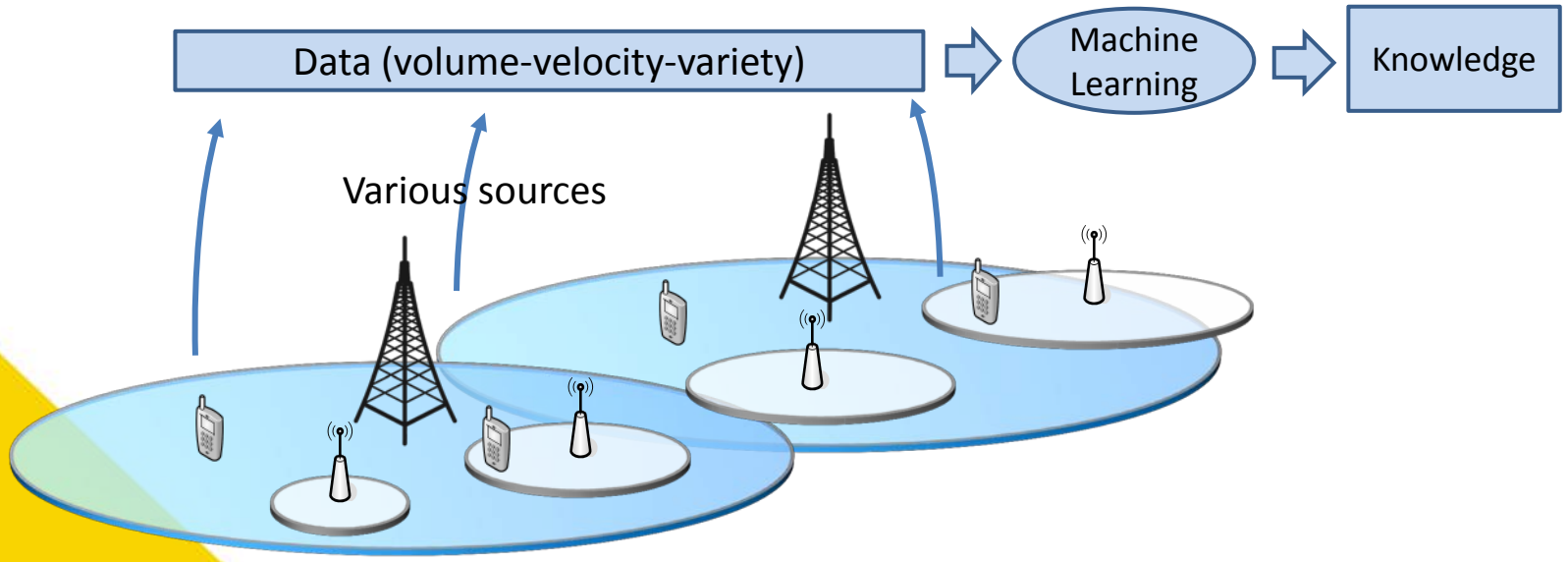
- Collection of data from various sources
  - Users, machines, network elements
  - Properties of velocity, variety, volume, etc.; analogies with big data
- Generation of knowledge
  - Supervised or unsupervised learning techniques
  - E.g., Self-Organizing Maps (SOMs) is an example of an artificial neural network that relies on unsupervised learning, in order to cluster/classify and eventually map a huge number of any type of data;
- Organization of knowledge
- Knowledge sharing



Intelligence for M2M/IoT constructs

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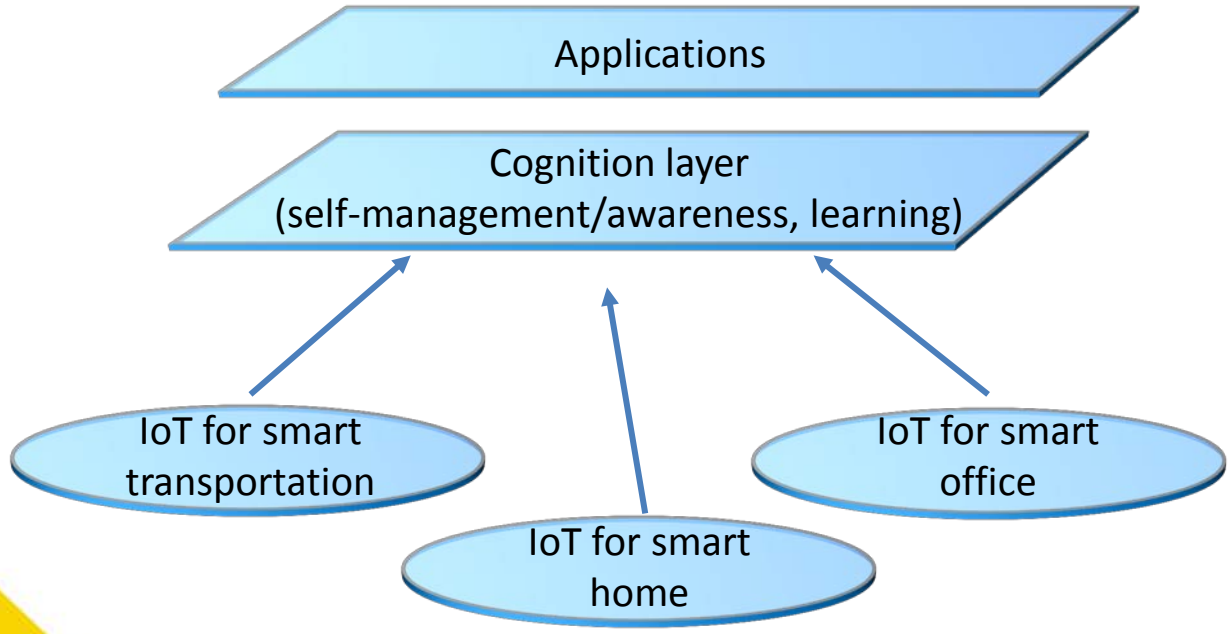
- A vast amount of objects in our ambience
  - Moving towards an Internet of Things (IoT)
  - Networking constructs encompassing various kinds of smart devices
  - Empowering the IoT domain through cognitive functionalities

- Intelligence for the efficient creation, deployment and management of objects/networks
- Reduced OPEX, QoE (time for service delivery, maintenance), energy consumption
- Service provision dynamically tailored to the needs of end users



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Intelligence Enablers: Software Defined Networking

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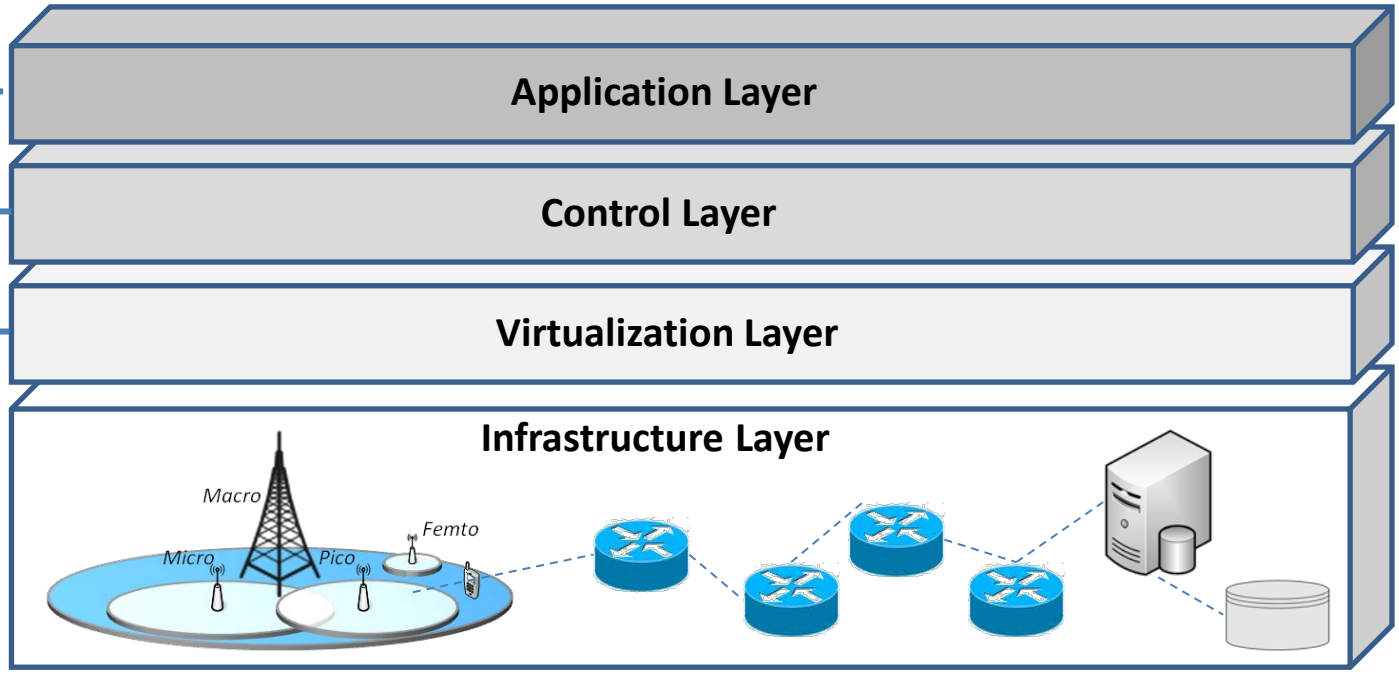
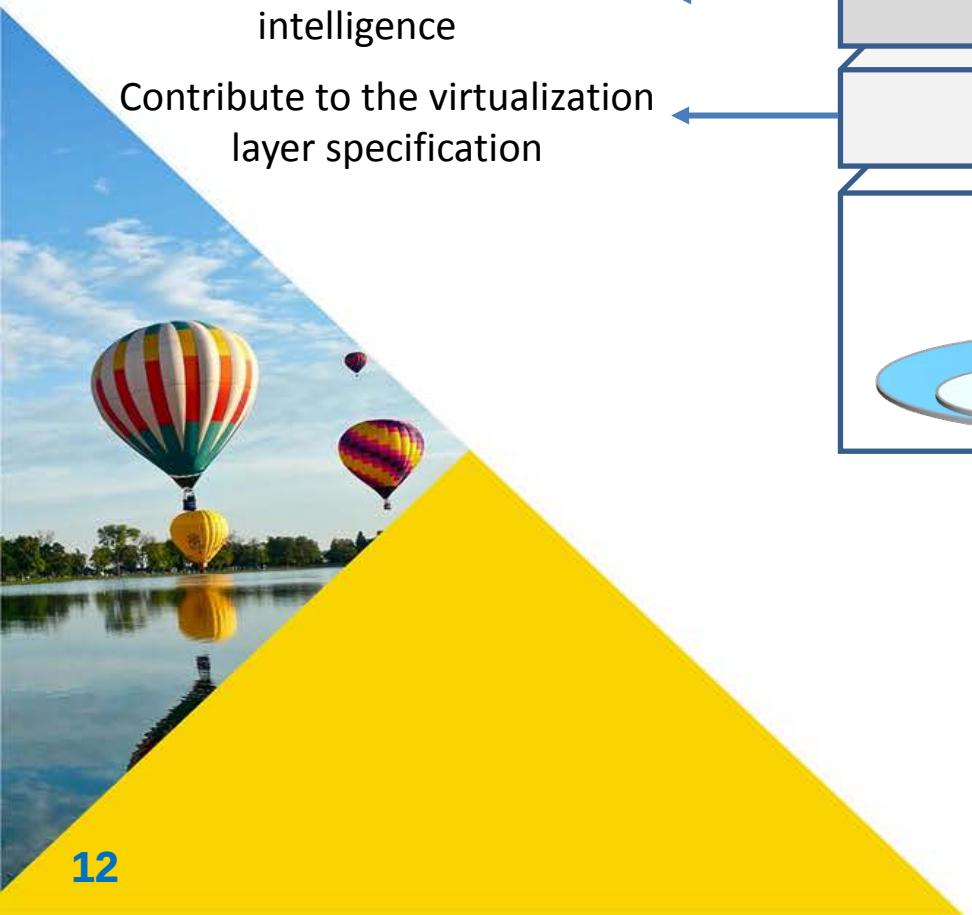
SDN applications for satisfying requirements/objectives from multiple/new perspectives

Influence the control layer with intelligence

Contribute to the virtualization layer specification





Intelligence Enablers: NFV (Network Functions Virtualization)

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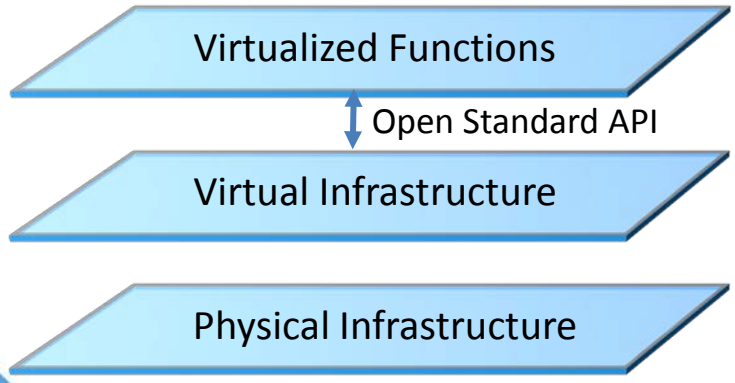

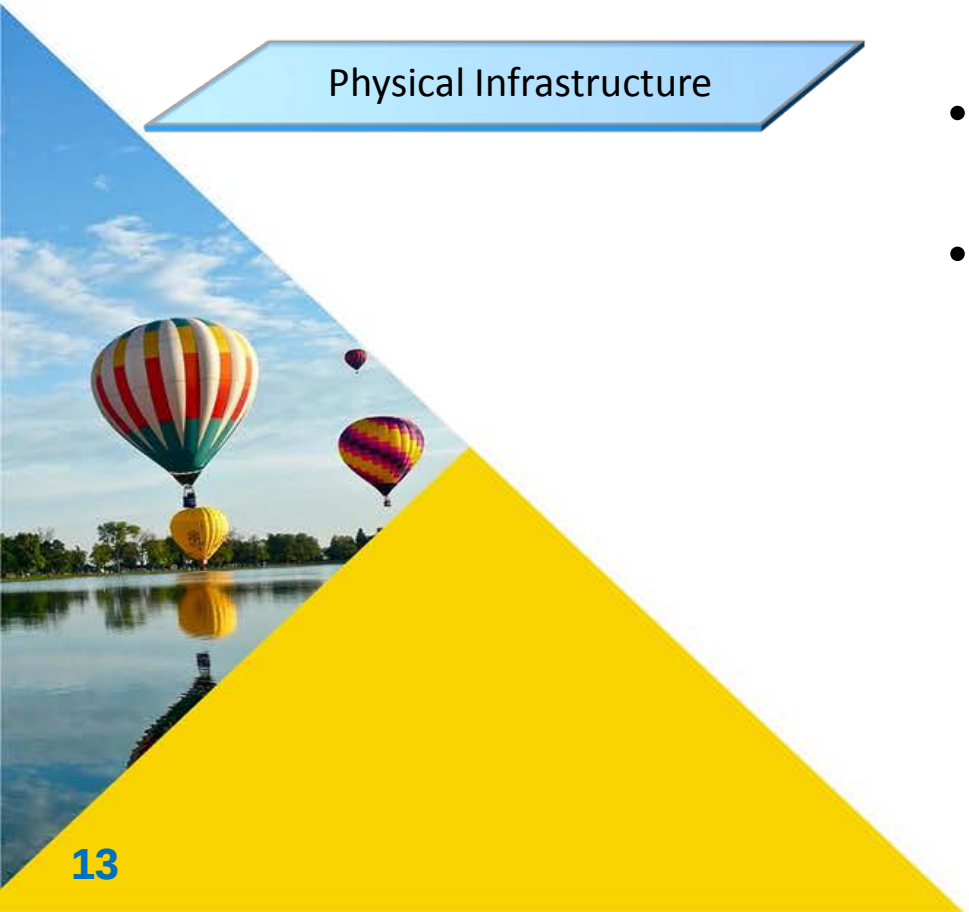

- NFV is based on cloud computing principles
  - High volume servers that will dynamically host the network functionality
  - Economies of scale achieved in the IT industry
  - Further goals: Reduced CAPEX, energy consumption
- Intelligence needed on how to manage (activate, deploy, cease) functionalities and physical elements
- Use the Forum (WGC, etc.) so as to complement momentum:
  - Research from academics combined with industrial forces that have started standardization

* Further info at: portal.etsi.org and 'NFV White Paper'

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Application of concepts in Smart Grids

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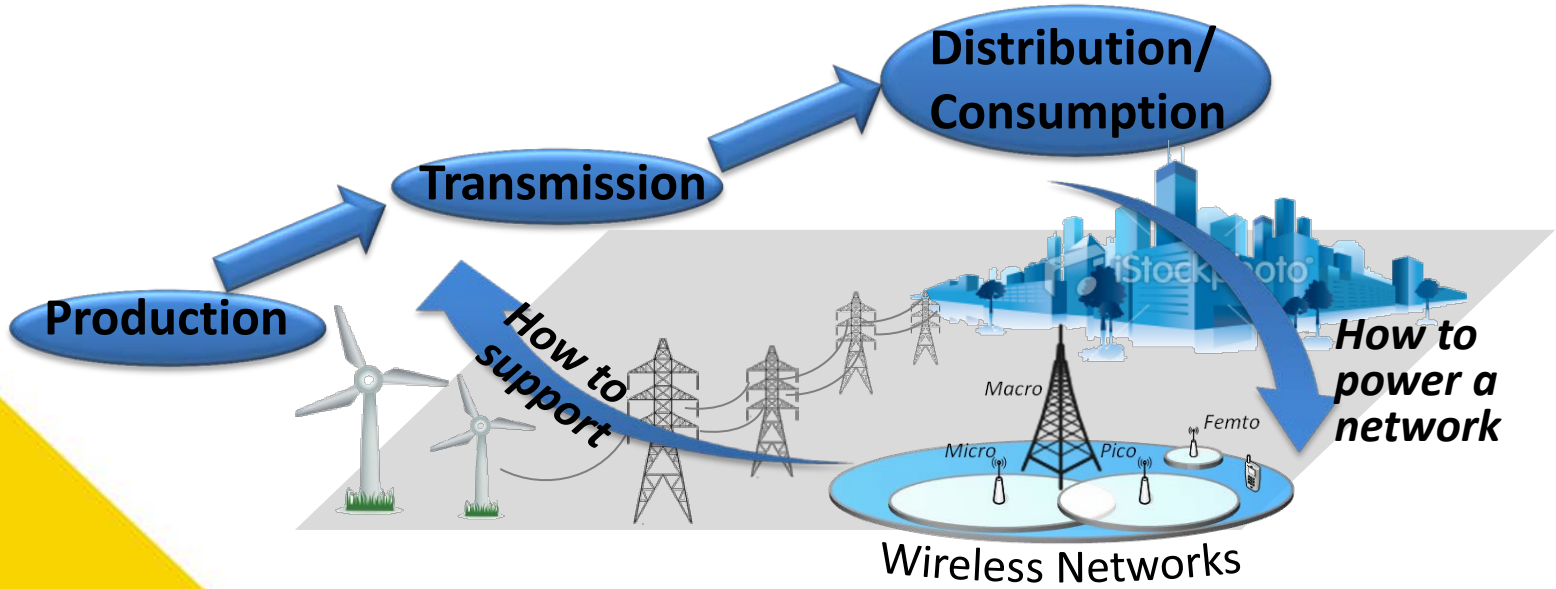
Joint Workshop between WWRF and IEEE SmartGridComm in Vancouver, Canada (October 2013)

WWRF #31 Theme: Wireless-Enabled Smart Societies in the 2020's (Vancouver, Canada, October 2013)

- Use (evolve/port) intelligence for managing the Smart Grid
  - All segments: production, transmission, distribution, consumption
- Interconnection with wireless networks
- Maximising green footprint/ energy efficiency of wireless networks



Conclusions - Plan

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- Intelligence will be the key to the definition of the next generation of wireless/mobile broadband

- During WWRF #30 (passed) discussions on:
  - Self-Organizing Networks (e.g., UniverSelf; Semafour)
  - Cognitive IoT/M2M (iCore)
  - Cognitive Radio Networks
  - Smart Cities

- Future meetings contributions are planned on:
  - Intelligence enablers
  - Intelligence for HetNets, cloud RANs
  - Outcomes of initiatives: e.g., ICT ACROPOLIS (Advanced coexistence technologies for Radio Optimisation in Licenced and Unlicensed Spectrum); which is one of the influences of this talk

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Thank You!

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Acknowledgement

The talk has benefited and been influenced from discussions within the UniverSelf project (http://www.univerself-project.eu/), iCore project (http://www.iot-icore.eu/), and the ACROPOLIS Network of Excellence (http://www.ict-acropolis.eu/) which are funded from the European Community's Seventh Framework Programme (FP7/2007-2013).

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Backup Slides

Spectrum Sharing Strategies

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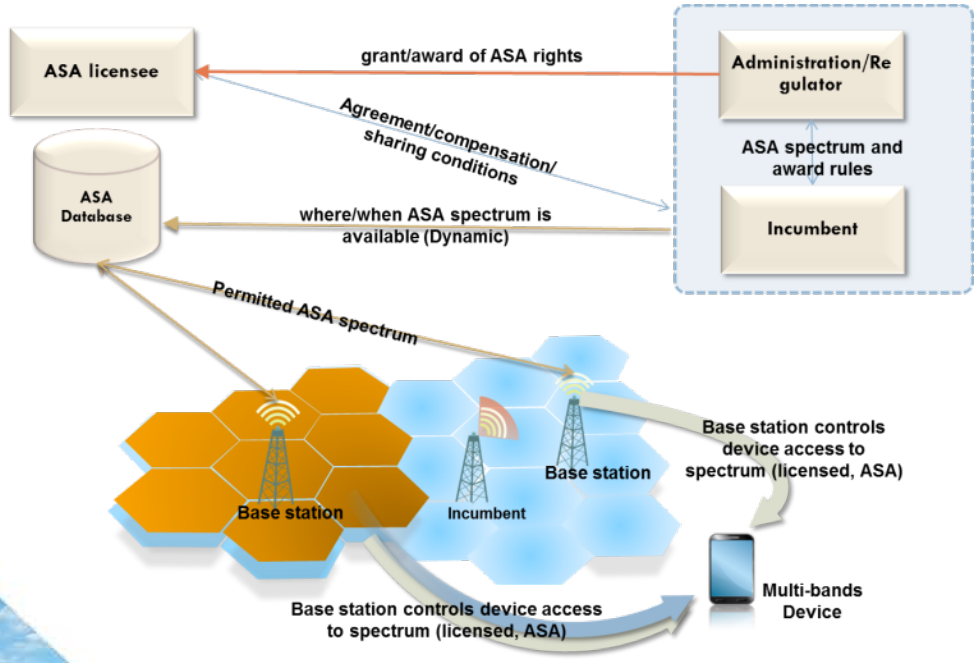

Source: Authorized Shared Access, Presentation at the WG FM – May 2011

- Licensed Shared Access (LSA)
  - The implementation of the LSA concept may take advantage of recent advances in cognitive technology, thus allowing sharing spectrum in a more dynamic way, utilizing frequency, location and time sharing bases
- Authorized Shared Access (ASA)
  - To Enable Timely Availability and Licensed Use of Harmonized Spectrum for Mobile with Predictable Quality of Service
- Collective Use of Spectrum (CUS)
  - Allowing spectrum to be used by more than one user simultaneously without requiring a license

Architectures and Functionality

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- Coordination of Autonomic Loops; Cognitive Loops; SONs
- Unification of Intelligent Mechanisms
- Knowledge Management: Extracting knowledge from big-data coming from wireless infrastructure
- Proactive optimizations
- Techno-economic criteria