

## Autonomic/Cognitive Management for the Future Internet (FI) era

*P.Demestichas*

*Emails: [pdemest@unipi.gr](mailto:pdemest@unipi.gr)*

*University of Piraeus*

*Department of Digital Systems*

*Telecommunication Networks and integrated Services*



- ❖ Requirements in the Future Internet era call for efficient/intelligent technologies, introducing benefits for user and the industry, e.g.,
  - Autonomic management of the infrastructure
  - New structures for accessing the Future Internet: operator-governed opportunistic networks and respective cognitive management systems
  - The basis includes the achievements in the area of autonomic/cognitive management of wireless technologies
- ❖ Research and standardization initiatives ongoing in FP7
- ❖ Evolution, validation and exploitation of FP7 results will require the realization of the vital steps in the FI PPP
- ❖ UPRC is interested in contributing to the FI PPP in the directions described above (through knowledge, know-how and research/experiment infrastructures)

# Legacy and Trends in the Wireless Access

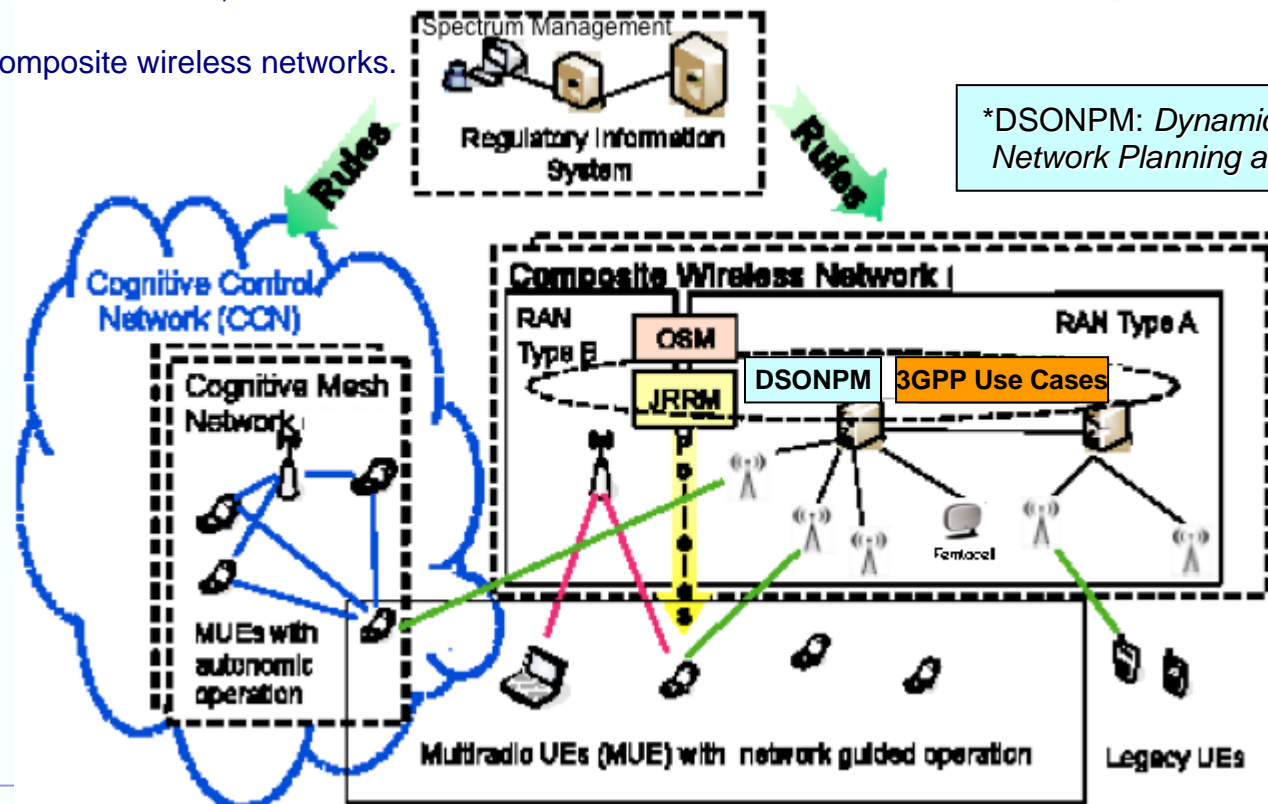


## Cognitive Control Network (CCN):

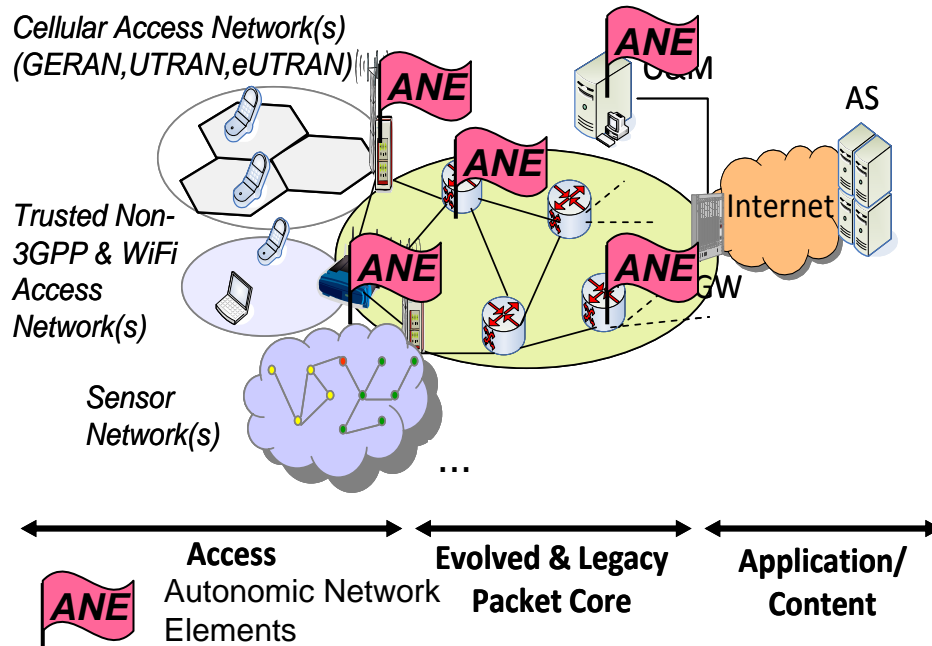
- Management relies on
  - Autonomic elements, operator governance, policies.
  - Cooperation protocols.
- Further challenges
  - Potentials for efficient FI application provision.
  - Improve resource utilisation and “green” footprints, reduce costs (total cost of ownership).
  - Bundle: spectrum management, secondary usage, routing, adhoc networks.
  - Standards (evolve ETSI TR102.683, IEEE Std 1900.4-2009).
  - Orchestration with composite wireless networks.

## Composite wireless networks (CWN):

- Management relies on
  - Self organizing network (SON) mechanisms: self-management/planning through DSONPM\*, 3GPP use cases.
  - (J)RRM: (Joint) Radio Resource Management.
  - DSM/FSM: Dynamic/Flexible Spectrum Management.
- Further challenges
  - QoE/QoS, cost efficiency (OPEX).
  - End-to-end perspective: evolution, intelligence embedding, federation for end-to-end optimality.
  - Validation: simulation, prototyping, experiments, trials, pilots.



# Autonomic Management of Infrastructure



## ❖ Requirements in FI era:

- Demanding situations in terms of Quality of Experience - Quality of Service, in order to support a wide range of applications, including video, voice, data flows
- Changing situations (potentially unpredictably)
- Efficiency in QoE and QoS provision in terms of total cost of ownership, e.g., OPEX, CAPEX, etc., decisions with "green" footprint
- Evolution of existing and emergence of new business models (roles and entities), in order to utilize new opportunities opened by the FI
- Coherence, convergence, stability, scalability

## ❖ Main direction:

**Autonomic network elements in infrastructure:**  
**behaviour determination based on**

- Context changes (alterations in environment or internal statu)
- Policies (rules), capabilities (profiles)
- Optimization mechanisms
- Knowledge, experience

## ❖ Intelligence evolution and deployment

- Distributed reactive/proactive adaptation based on knowledge
- Knowledge sharing for optimal operation of wireless segments
- Distributed traffic engineering in wireline segment

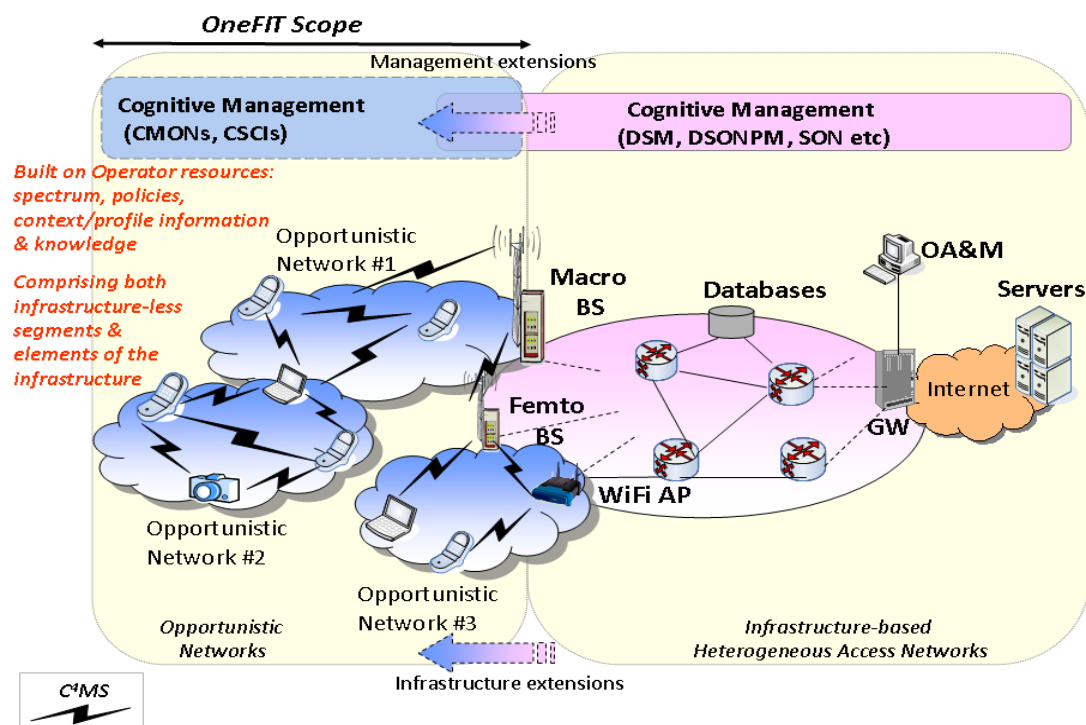
## ❖ System federation

- Good models for managing particular segments
- Federation of good models
- Interface definition and standardisation

## ❖ Validation

- Business drivers and criteria
- Simulation
- Prototyping, experiments, trials, pilots
- Generation of trust and certification

# New Structures for Accessing the Future Internet



## ❖ Requirements:

- Numerous diversified applications, social networking, prosumer concept -> applications with a "localized" interest
- Increased interest for wireless
- Efficiency in resource provision (utilization, "green", costs)
- Resolve potential congestion situations, expand infrastructure coverage when/where temporarily needed, efficiently offer localized applications and content

## ❖ Main direction:

**Opportunistic networks and cognitive management systems for efficient application provision in the Future Internet**

## ❖ Opportunistic networks

- Operator governed (through resources, policies, and information/knowledge)
- Coordinated with the infrastructure
- Comprise network elements of infrastructure and terminals (envisaged in the Future Internet)
- Building on: spectrum management, secondary usage, infrastructure-less networks, social networks
- Context, profile, policy, knowledge-aware routing

## ❖ Cognitive management systems

- Provide the means for feasibility determination, creation, maintenance, handling of forced terminations

## ❖ Control Channels for the Cooperation

- Information definition, signalling flows, protocols (packet structures, exchange)

# Conclusions



- ❖ **Requirements in the Future Internet era call for efficient/intelligent technologies**
  - **Autonomic management of infrastructures in the Future Internet context**
  - **New structures for accessing the Future Internet**
  - **In the areas above there is exploitation (among others) of advances made in the area of cognitive/autonomic management of wireless technologies**
- ❖ **Research and standardization initiatives ongoing in FP7 (placing EC in the foreground of the developments)**
- ❖ **Evolution, validation and exploitation of FP7 results will require further work and the essential steps to be done in the FI PPP**
- ❖ **UPRC is interested in contributing to the FI PPP in the directions described above, through knowledge, knowhow and infrastructures for experiments**



- ❖ **Legacy and trend in the Wireless World**
  - One of the foundations for the Future Internet
  - Autonomics/cognition have shown benefits when applied for the management of the technologies
  
- ❖ **Autonomic Management for the Future Internet**
  - End-to-end focus needs to be considered (wireless, wired, services)
  - Diverse and numerous devices have to be supported (PCs, PDAs, white, brown, cameras, sensors, actuators, things in our ambience)
  - Business requirements (drivers) need to be satisfied
  
- ❖ **Cognition for Enhanced Access to Future Internet**
  - Cognitive management for supporting new network structures
  - Feasibility determination, creation, maintenance, termination of opportunistic networks (governed by infrastructure)