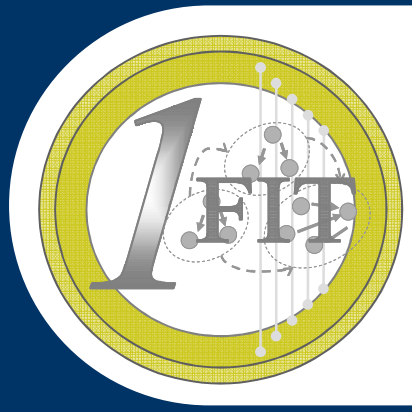

OneFIT – Heilmeyer questions

Opportunistic Networks and Cognitive Management Systems
for Efficient Application Provision in the Future Internet

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Heilmeyer Questions (1/2)

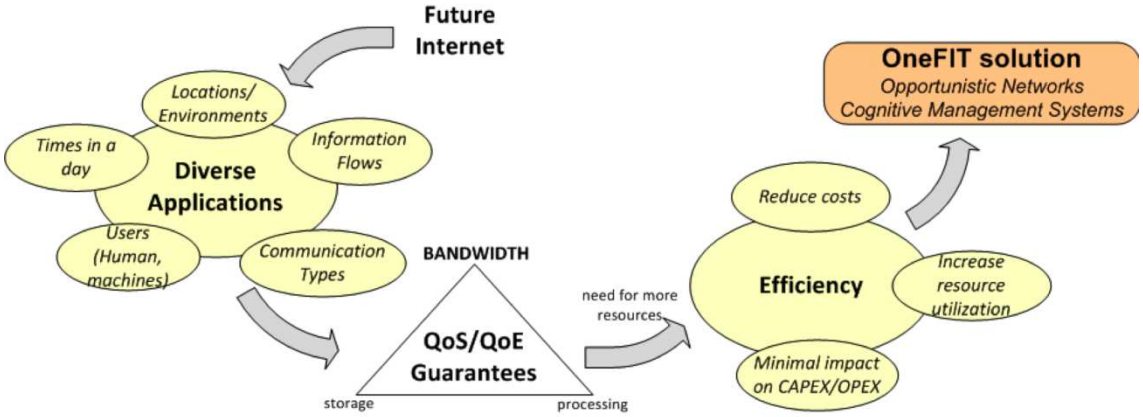
- What relevant problems does the project solve?
  - General aim: enhance application/service provisioning opportunities, higher cost efficiency
  - Problems addressed
    - Lack of coverage -> opportunistic network creation for infrastructure coverage extension
    - Congestion situations in wireless part -> opportunistic network creation for directing traffic to non-congested area
    - Improved QoE/QoS and resource usage when communication end-points are “closely” located
    - Cellular system inefficiencies -> opportunistic network creation for traffic aggregation and communication of fewer nodes with the infrastructure
    - Congestion situations in the backhaul -> opportunistic network creation for capacity exploitation
  - Solution
    - Operator governed opportunistic networks
    - Cognitive management systems for the opportunistic network and the infrastructure
    - Control channels for the cooperation of the cognitive management systems
  - Enhanced application provision
    - Service provision in cases of limited coverage and in the event of congestion situations
    - Higher QoE/QoS by resolving cellular network inefficiencies and exploiting “locality” of application and service provision
  - Efficiency
    - Better resource usage: higher spectrum utilization, lower transmission power
    - Improved spectrum utilization leads to higher capacity and therefore positively impacts the CAPEX
    - Lower transmission power leads to lower energy consumption, thus, lower OPEX
    - In general lower total cost of ownership (including cost of managing customer relations)
    - Management decisions and network operation with “green” footprint

Heilmeyer Questions (2/2)

- What are the alternative solutions?
  - Complementary solution is planning of the infrastructure, in conjunction with self-x capabilities for dynamically finding the best reconfigurations
  - OneFIT enables higher flexibility in the situations that can be handled , and higher efficiency
  - Hybrid Networks: The possibility of extending ad-hoc networks with the support of infrastructure, has been considered as a way of improving the connectivity in large-scale ad-hoc networks
- What differentiates the project solution?
  - Efficient bundling of concepts like dynamic spectrum management, ad-hoc networks, social networks, etc., for realizing the concept of opportunistic networks
  - Operator governed opportunistic networks, in coordination with infrastructure, through the provision of policies, and information and knowledge on context and profiles
  - Several technologies are turned into an asset for the operator
- What are the barriers to the project solution?
  - Motivate users to join the opportunistic network for providing services to other users (of course those that engage in the service can be also served in the future)
  - Security (trust) and charging issues
- What are the business opportunities for the project solution?
  - Support of additional business scenarios
  - Enhanced QoE/QoS and service provision opportunities
  - Cost efficiency through improved resource usage

Backup Slides

Motivation for OneFIT



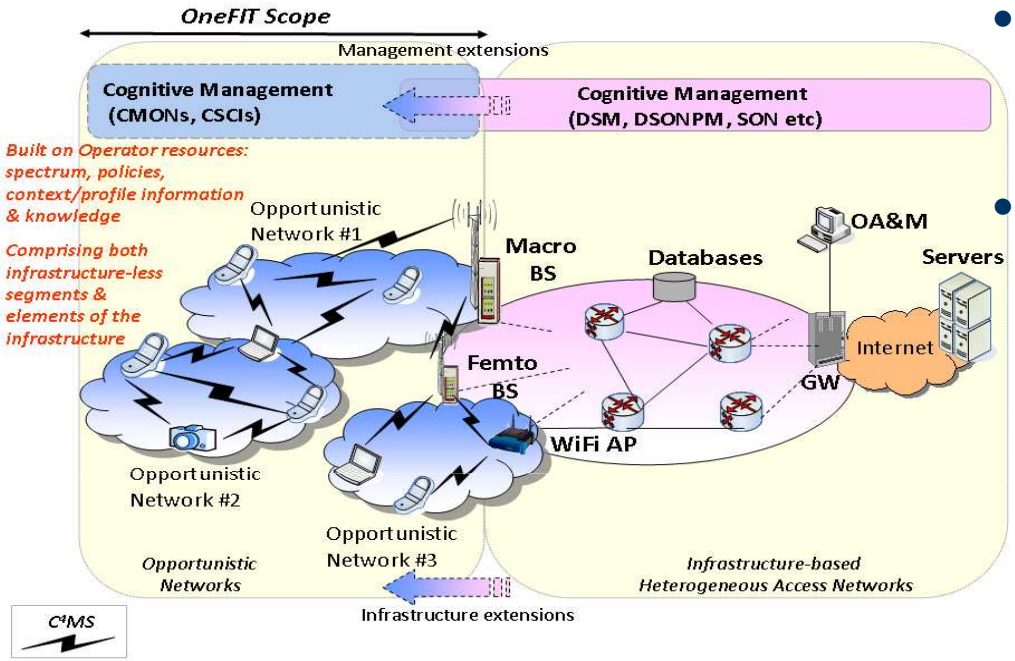
- <u>FI era requirements:</u>
  - Applications: numerous, diversified, often characterized by a "localized" interest
  - QoE/QoS
  - Increased need for wireless
  - Need for efficiency in application provision

- Applications
  - Growing interest for more application areas (FI penetrating every facet of our lives)
  - New applications/services built on the concepts of social networking, need smart devices and connectivity everywhere
  - Other applications including e.g. management of critical infrastructures, environment (eco-system) protection, product manufacturing, digital services each having own bandwidth and service provision requirements
- Diversification
  - Information flows, area and time of provision, end points can be users or machines, communication types
  - Quality of Service – Quality of Experience
  - Networks under stress for resources

❖ Efficiency in resource provision

- Worst-case based planning, leads to over-provisioning of resources in non-peak times.
- Intelligent resource management (e.g., spectrum reuse) is a solution, e.g., recent step is the addition of WiFi access points and femtocell nodes.
- User expectations increase and so do the resource requirements posed onto communication networks.
- Quest for further efficiency in resource provisioning.
- Efficiency coupled with: (i) the higher utilization of resources; (ii) energy consumption (iii) the reduction of the total cost of ownership, which will be assumed to comprise the operational expenditures (OPEX), capital expenditures (CAPEX), and costs associated with the management of customer relations.

High level solution description



- Anticipated benefits aimed by solutions:
  - Increased utilization of resources. In all cases there is the temporary assignment of spectrum to the opportunistic network
  - Lower transmission power levels, energy consumption, traffic load – larger Green footprints
  - Cost efficient handling of various situations including unexpected or not-frequently occurring events.
  - Value creation through the support of more (application provision, operation) scenarios.

- Solution Approach:
  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 Extensions of the infrastructure
  - Existing for a particular time interval, needed for application provision to users in most efficient manner
  - Comprise network elements of infrastructure and devices (envisaged in the Future Internet)
  - Context, profile, policy, knowledge-aware routing
- Cognitive management systems
  - Two types of systems are envisaged:
  - Cognitive system for management of opportunistic networks (CMONs)
  - Cognitive system for coordination with Infrastrucutre (CSCIs)
  - Need close cooperation between two networks
- Control Channels for the Cooperation (C^4MS)
  - Cooperation of cognitive management systems
  - Information definition, signalling flows, protocols (packet structures, exchange)

Mapping to wireless world (ETSI view)

Cognitive Control Network (CCN):

- *Management can rely on*

- Autonomic elements, operator governance, policies.
- Protocols for the cooperation in the CCN and with the CWN.

- *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 TR102.682, ETSI TR102.683, IEEE Std 1900.4-2009).
- Orchestration with composite wireless networks.

Composite wireless networks (CWN):

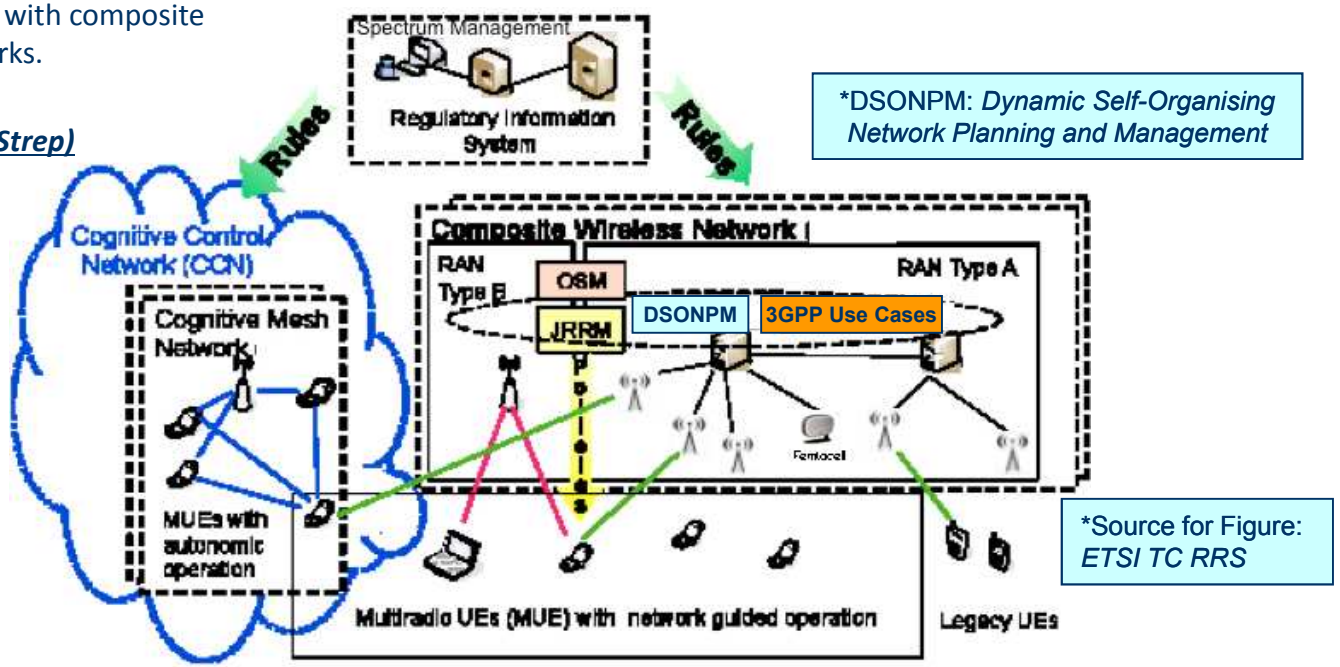
- *Management can rely on*

- 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.

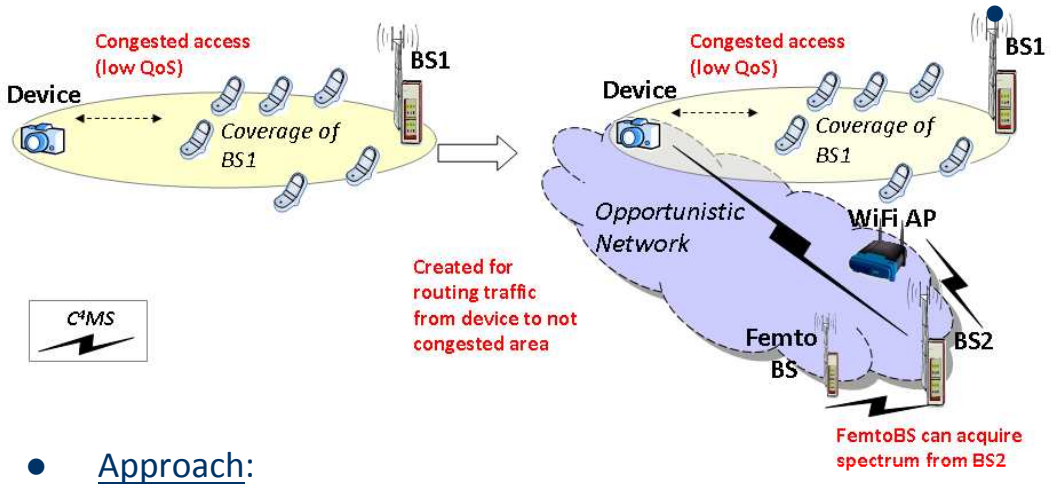
OneFIT scope (Strep)



*DSONPM: *Dynamic Self-Organising Network Planning and Management*

*Source for Figure: *ETSI TC RRS*

Architecture



- Approach:
  - *Business aspects*: *applications* and *scenarios*
  - *Functional and system architecture*
  - *Requirements* and *technical challenges* that have to be addressed by the opportunistic network, infrastructure and cognitive management systems: framed in this context is also the definition of *validation criteria*, in terms of resource utilization, green decisions,
- Architecture evolution
  - Basis: E3, FA of ETSI TC RRS, IEEE SCC41 WG P1900.4
  - High-level definition of functionality in the OneFIT system
  - Inter-working between functionalities (abstract), and opportunistic network, and infrastructure networks.
- Tangible outcome
  - Papers, contribution to ETSI TC RRS on evolved functional and system architecture

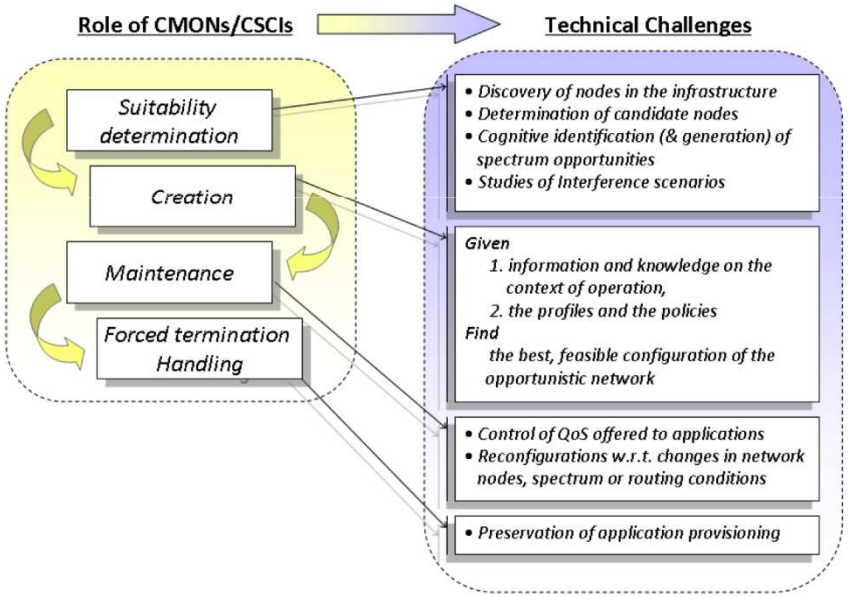
Scenarios (to be elaborated)

- Expanding the coverage of the infrastructure.
- Congested access to the infrastructure.
- Operator-governed cost-efficient localized application, service, content provision (i.e., when there is interest for the application/content within a portion of the area).
- Cost-efficient bridging of opportunistic networks with the outside world.

Applications

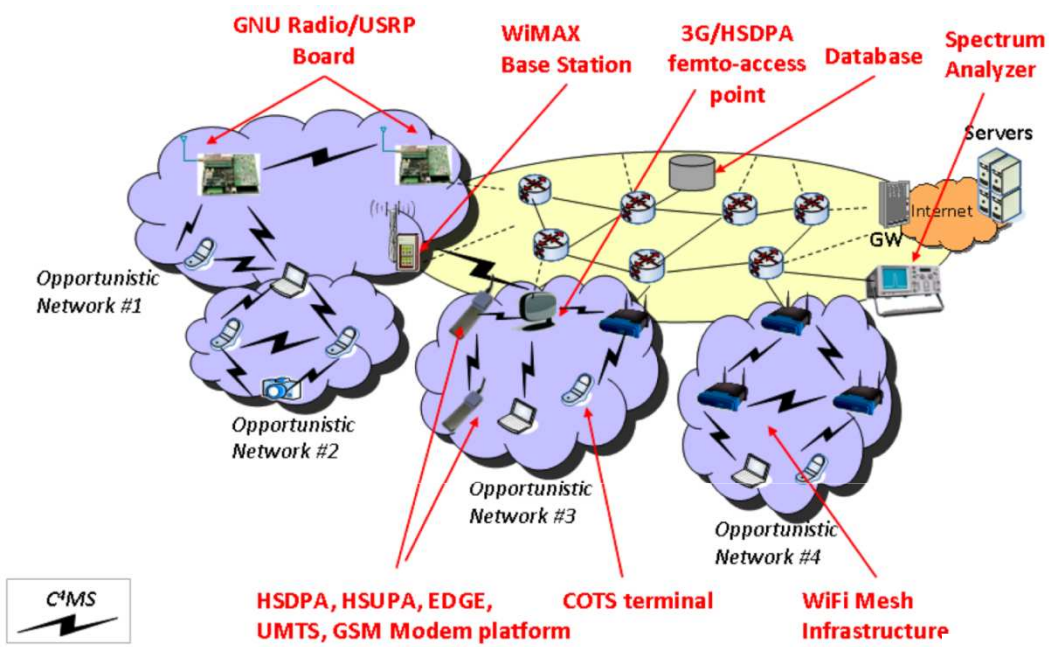
- SMS/MMS, instant messaging, voice chats etc. of users in a social network.
- Users in a social network, interested in a popular topic (relevant to a particular location/context), establish/join spontaneously a voice/video multi-conference.
- Seamless, automatic, self-configuration (identities, devices, call routing etc.), taking into account user profile (preferences, requirements, contacts), context and policies.
- Tag, share and record voice/video conversations and messages/chats, in real time. Discovery by users of this content
- Enabling users to record, comment, categorize and organize their past, present and future communications in social networks.

Cognitive management systems – Control channels for cooperation



- Suitability determination (Suitability of opportunistic network approach).
  - Node/infrastructure discovery
  - Identification of candidate nodes
  - Identification and generation of spectrum opportunities from the infrastructure side,
  - Interference scenarios resulting from the opportunistic networks.
- Opportunistic network creation.
  - Selection of the optimal, feasible configuration of the opportunistic networks.
  - Configuration includes the selection of participant nodes, spectrum and routing pattern.
- Opportunistic network maintenance.
  - How to control QoS offered to the applications served by opportunistic networks?
  - Reconfiguration actions in the case of alterations in the node status, and the spectrum and routing conditions.
- Handling of forced terminations of the opportunistic network.
  - Preservation of applications as much as possible, even when the opportunistic network has to be terminated before the data session ends.

Validation



- Hardware platform
  - 3G/HSDPA femto-access point (NTUK).
  - WiMAX and WiFi access points (UPRC).
  - WiFi Mesh infrastructure (UNS). “Access” type, using 802.11b/g, “interconnecting” or “gateway” type using 802.11a. ArrowSpan’s MeshAP3800.
  - GNU board/USRP (UNIS, UPC).
  - COTS mobile terminals (UPC, implemented as GNU boards) and PDAs (UPRC).
  - 2G/3G modem platform (IFX).
  - Spectrum analyzer, database (UPC).

- Tangible outcome:
  - Prototype platform realizing the system architecture and supporting the scenarios of WP2
  - Integration of algorithms (WP4) and interfaces and protocols (WP3) into the platform
  - Integration of Future Internet class of services, focusing on social networking and prosumer related applications, services and micro-services
  - Experiments and fine tuning of OneFIT systems based on results
  - Papers on the benefits and the validation of the OneFIT solutions

- Management platform
  - Discovery procedures and algorithms by ALUD
  - Candidate node determination by UPRC
  - Spectrum opportunity identification by UPRC , ALUD and UPC
  - Opportunistic network creation and reconfiguration by NTUK, UPC and UPRC (spectrum selection functionality), and TCF and UNS (routing pattern selection).
  - Forced termination handling by UPRC.
  - Exploitation of findings from off line studies

Consortium, WPs, outputs

Participant organization name	Part. short name	Country
University of Piraeus Research Center	UPRC	Greece
Alcatel-Lucent Bell-Labs Deutschland	ALUD	Germany
Telefónica Investigación y Desarrollo S.A. Unipersonal	TID	Spain
Thales Communications S.A.	TCF	France
Infineon Technologies AG	IFX	Germany
NEC Technologies	NTUK	United Kingdom
VTT Technical Research Centre of Finland	VTT	Finland
EIT+ Wrocław Research Centre	EIT+	Poland
The University of Surrey	UNIS	United Kingdom
Universitat Politecnica de Catalunya	UPC	Spain
University of Novi Sad – Faculty of Technical Sciences	UNS	Serbia
Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen	BNetzA	Germany

- WP Structure:
  - WP1: Management
  - WP2: Business aspects, requirements, architecture
  - WP3: Control channels for the cooperation of the cognitive management systems
  - WP4: Algorithms
  - WP5: Integration, experiments, validation
  - WP6: Dissemination, Standardization, Regulation, Exploitation, Training

Objective	Concrete output
Architecture	Standards (**RRS**), prototype
Algorithms	Papers, prototype, IPR
C^4MS	Standards (**RRS**), prototype
Validation	Prototype platform encompassing algorithms and interfaces
Dissemination	Papers, standards, regulation