Quality Of Service and MObility driven cognitive radio Systems

Requirements for a CR-system

Challenges compared to conventional wireless technology

Per H. Lehne[1], Dominique Noguet[2], Rohit Datta[3]
Ulrico Celentano[4], Vincent Mérat[5], Philippe Delahaye[5]
Gerhard Fettweis[3]

[1]Telenor Corporate Development, [2]CEA-LETI,
[3]Vodafone Chair, TU Dresden, [4]University of Oulu,
[5]Nec Technologies UK, Ltd.,

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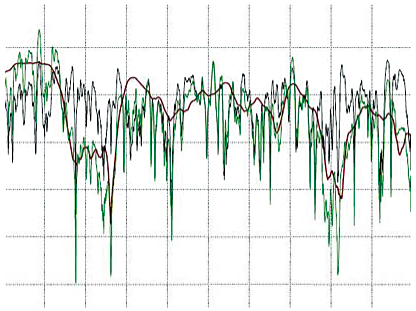
Introduction and background

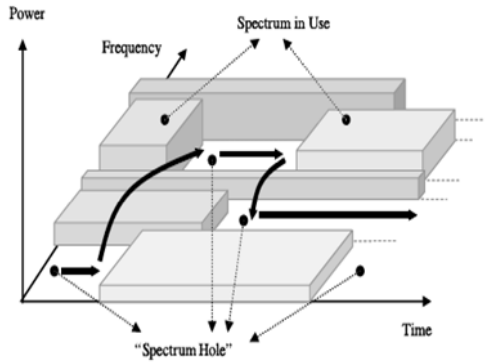
- The QoSMOS project:
  - Quality of Service and MObility driven cognitive radio Systems
    - A research project in EU's 7th framework program
    - Runs from 2010 – 2012 (3 years)
    - Lead by BT (UK) – 15 partners
- QoSMOS' focus is on mobile services and QoS, which introduces new challenges and possibilities, such as:
  - More dynamic frequency situation when moving
  - Handover with no dedicated spectrum
  - Handling of QoS when the frequency resource varies
  - QoS class can be linked to frequency choice and can be input to the spectrum management process

QoSMOS will research and develop the tools and techniques that allow opportunistic use of radio spectrum where users are moving, while receiving a managed QoS

Reliable services over unreliable resources?

- Wireless communications face a general challenge in that the medium is inherently unreliable with large link-quality variations:





- Additional challenges with CR:
  - Frequency planning must be ”instantenous”
  - Transceiver must be extremely agile
  - Co-existence is a key requirement
    - Not only primary users – also other opportunistic users

Regulatory situation

- Regulations for opportunistic spectrum access has just started
- Attention is on protection of incumbents
  - Transmitter power levels (power management)
  - Interference avoidance (sensing, geolocation)
  - Channel evacuation (response time)
- A general unpredictability of the spectrum availability
  - TV Whitespace has got the first attention
  - When do other bands follow?

Challenges (1)

- ***Keeping track of available spectrum***

- Stems from high level requirements on:
  - Incumbent users have the “right-of-way” (interference avoidance)
  - Other opportunistic users have the same “right” to shared access (Coexistence between systems)

- Has a direct influence on:
  - Radio Resource Management (RRM) now includes spectrum management (SM)
  - Mobility Management (MM) now includes spectrum mobility
  - Added new capabilities (use of databases, spectrum sensing)

Challenges (2)

- ***Providing QoS and mobility when access is opportunistic***

- An impossible combination?
  - Fair treatment among secondary users
    - Managing ”greedy” users
    - Common in cellular systems by imposing limits on throughput/download per user
  - Rethinking of QoS requirements for opportunistic users
    - Consider users’ expectations at large more than individual QoS metrics

- Has a direct influence on:
  - QoS policies
  - Mobility Management; quickly relocating users – spectrum mobility

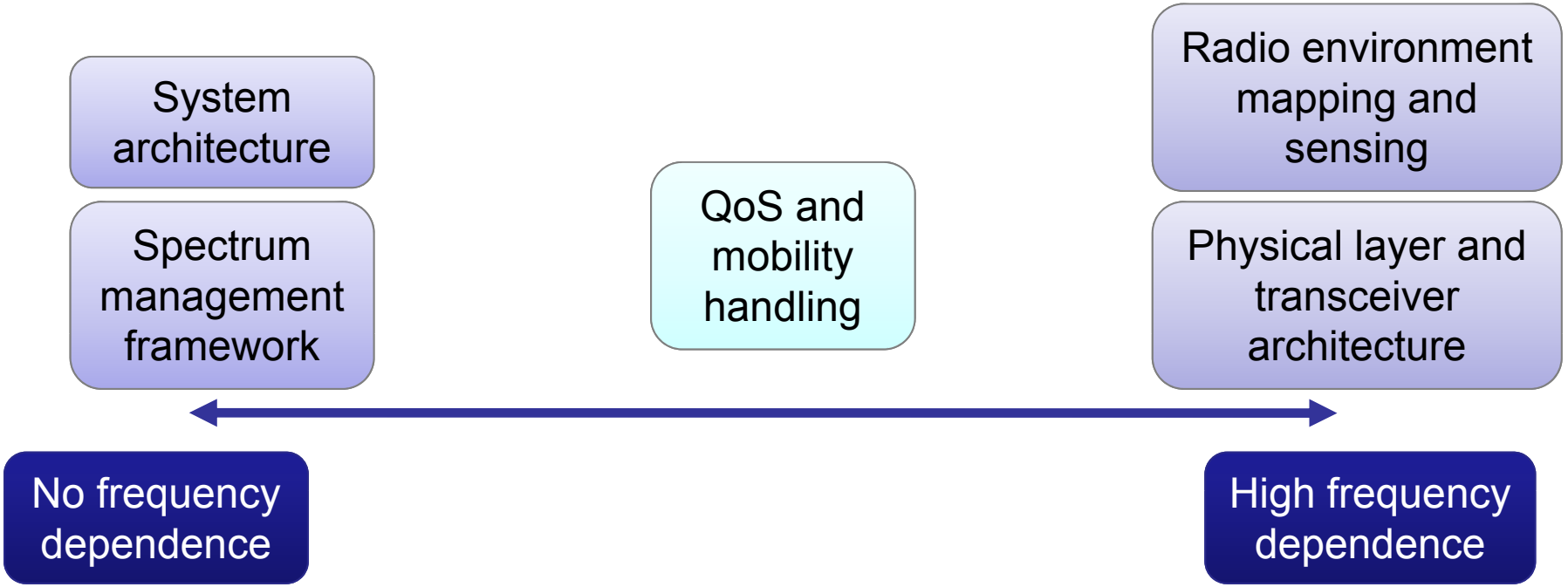
Setting requirements: The QoSMOS approach

- Frequency flexibility
  - Distinction between frequency-dependent and frequency-independent part of the system.

- Requirement categories addressing:
  - System operations and performance
  - Flexibility and scalability

- Responding to the challenges

The QoSMOS approach:
Frequency flexibility



The QoSMOS system is the complete set of functions and modules which is being specified and designed in the project.
A QoSMOS realization is an implementation of those functions and modules of the complete QoSMOS system which is necessary to fulfil the requirements (functional, regulatory, performance) of operation under the constraints of a certain scenario and region.
A QoSMOS deployment is the delivery, installation, and testing of the QoSMOS realization in order to put it in operational state.

The QoSMOS approach:
Requirements categories

Business, user and service related requirements	• Competitiveness
System operation related requirements	• Regulatory compliance
Performance related requirements	• Technical performance
Architecture and complexity related requirements	• Flexibility and scalability

The QoSMOS approach:
System operations

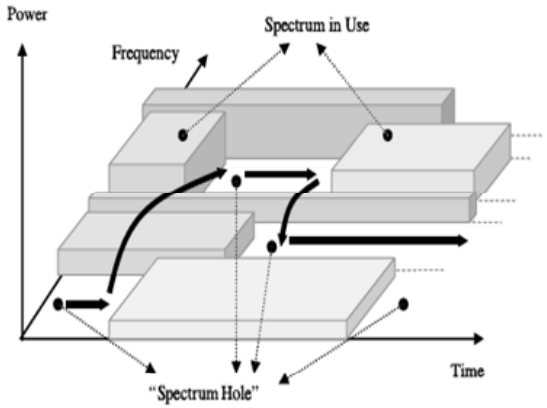
- Regulatory compliance
  - Co-existence
  - Context awareness (sensing, geolocation)
  - Underlay and interweave spectrum sharing
  - Interference avoidance and incumbent protection

- Before setting an opportunistic transmission
  - Detect any incumbent system presence
  - Guarantee that the coverage area of the secondary system do not include any incumbent victim device
- When the opportunistic transmission is set
  - Track the potential apparition of an incumbent signal
  - Escape from the band whenever this situation occurs

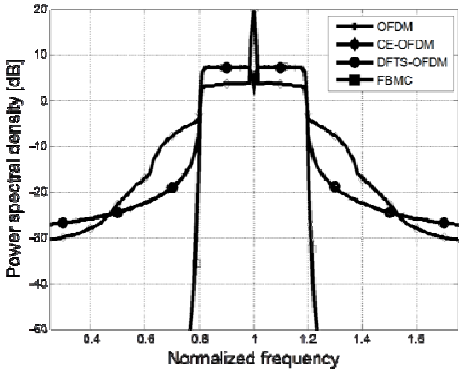
- FCC and CEPT has defined requirements for this in the TVWS

The QoSMOS approach:
Performance

- Technical requirements
  - Managed QoS (traffic classes, interworking, priority, service re-start)
  - Mobility (user and terminal, *spectrum* mobility)
  - Spectrum utilization (out-of-band radiation, spectrum efficiency)

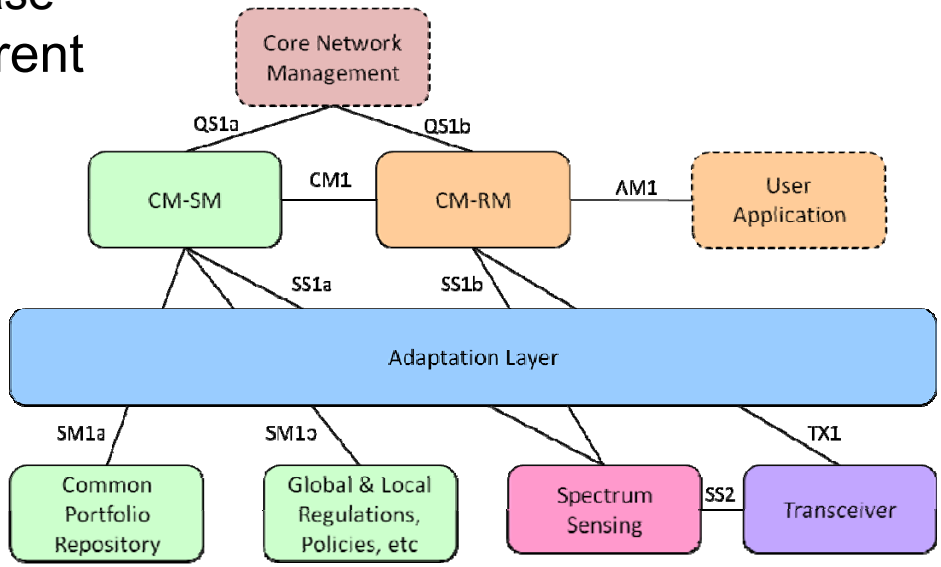


  - Ability to detect incumbents (means, sensitivity)
  - Ability to adapt transmitted power (power management)
  - Ability to leave the band when incumbents switch on (response time)



The QoSMOS approach:
Flexibility and scalability

- Interfaces
  - Interworking with other opportunistic systems
  - Geolocation database
  - Regulations and policies database
- QoSMOS can be based on different RATs
  - Targeting different scenarios
  - Exchange of control data
  - Measurement reports
- Flexible architecture
  - Different scenarios
  - Distribution of decision making functions (centralized vs decentralized)
- Scalability
  - A high number of terminals and network nodes



The QoSMOS approach:
Responding to the challenges

Challenge:	**1: Keeping track of spectrum**	**2: QoS and Mobility by OSA**
Frequency flexibility	X	
Spectrum sensing; support and performance	X	
Geo-location; accuracy and interfaces	X	
Context-information; collection and response	X	
Logical common channel	X	X
Regulation and policy information	X	X
QoS interworking	X	X
User, terminal and spectrum mobility		X
Physical and spectrum handover support	X	X

Conclusions

- Two major challenges:
  - Keeping track of spectrum
  - Providing managed QoS and mobility
- Calls for additional functionality and flexibility:
  - Spectrum sensing
  - Geo-location
  - Additional interfaces
- The QoSMOS system requirement addresses these challenges through the system requirements

Where to get more info

- D1.2 “QoSMOS consolidated scenarios”
- D1.4 ”QoSMOS consolidated system requirements”
- D2.2 “System architecture options for the QoSMOS system”
- And much more at www.ict-qosmos.eu