SENDOIRA: study and demonstration of the Wireless Sensor Network aided Cognitive Radio concept

Cognitive Radio – Technology and Regulation workshop
Brussels, 28th January 2010
SENDORA project overview

- **Motivation:** radio spectrum is a scarce resource but is paradoxically **under-utilized** in some frequency bands

- **Objective:** develop a technology able to reuse the licensed but unused spectrum in an opportunistic manner, operating as secondary system in the considered bands

- **Challenge:** detect and use spectrum holes, without interfering harmfully with the licensed system, with fine granularity of allocation in time and frequency

- T0 = 1st January 2008

- Duration: 36 months

- Outcomes: 35 deliverables including proof-of-concept

- Effort: 576 PM
SENDORA concept consists in studying and developing a "Sensor Network aided Cognitive Radio" technology.
Benefits of the SENDORA approach

- The sensor network is an efficient means to:
  - identify “spectrum holes”
  - while protecting the primary systems

- Indeed, the sensor network allows to improve the protection of primary systems as it
  - improves primary users detection
  - and therefore allows fine interference management and resource allocation
    - As it allows to control the interference generated by the cognitive network

- Improvement of spectrum holes detection and interference control is performed by aggregating sensing information in an efficient way
SENDORA objectives

- Identify and analyse potential scenarios of use of the Wireless Sensor Network (WSN) aided Cognitive Radio technology

- Define and simulate WSN aided opportunistic access and dynamic resources allocation strategies for cognitive radios

- Design a flexible and reconfigurable architecture, and demonstrate through a proof-of-concept the WSN aided Cognitive Radio technology
SENDORA general implementation approach

Enabling techniques design:
- Sensing, Cognitive Actuation, WSN design
  ⇒ studies
  ⇒ interactions
  ⇒ implementations
  ⇒ simulations

Selection of SENDORA target application scenario
SENDORA system specifications
System demonstration specifications
System simulations
Recommended system definition
Dissemination

Techno-economical study
Radio platform adaptation
System demonstrations

+ + +
Selected target scenario

- Selected scenario: **Nomadic broadband access in urban and suburban areas**

- Scenario that was evaluated to both have high market potential and be the best solution for the service to provide

- In addition, a hybrid architecture is recommended with both an external sensor network and sensors integrated in the user terminals

- Mobile broadband will be a very important service for users and operators in the future

- Most users are stationary when needing mobile broadband, hence a nomadic service will be sufficient in most cases

- Cognitive radio can offer high bit rates and low costs

- Can be extended later towards mobility
SENDORA System Architecture

C = Centralized access capability
S = Sensing capability
A = Ad hoc capability

Primary Systems
Internet broadband access
Ad hoc broadband
Sensing information

Fusion centre
Internet
Ad hoc network
C,S
S
A,S,C
A,S
S
C,S
C
S
S
S
S
Main system requirements

- Common system requirements have been defined for the different parts of the system:
  - Regarding the Cognitive Network:
    Network topology (both centralized and ad hoc), Usage model (nomadic), Terminal types (laptop typically), Required capacity (DL: 5 Mbit/s, UL: 1.3 Mbit/s), Services and QoS (Internet Access, best effort), Operating Frequency range (<3GHz), Coverage (indoor and outdoor), Ranges (100m (ad hoc) to 1km (centralized)), Power (battery, dynamic power control)

  - Regarding the Wireless Sensor Network:
    Mobility (fixed infrastructure), Power (mains or battery), Communication (dedicated narrow licensed band), Coverage (area of cognitive operation), Detection probability of Primary communications (0.95)

  - Regarding the Primary Networks to consider:
    Considered Primary Technologies (WiFi, LTE, DTT, UMTS)
ttlee1  I think the requirement specifies "a narrow licensed band" while the assumptions table says 10 kHz.
ttle; 22/01/2010
Our objective is provide an advanced technology that is good for all actors in the ecosystem:
- End users
- Operators
- Manufacturers
- Regulation authorities
- …

An initial business case is currently studied:
- Based on a Joint Venture concept; common pool of primary spectrum resources, that will be utilized on a cognitive/SENDORA way by the Joint Venture to provide nomadic broadband
- SENDORA is an innovative and long term project, which means uncertain inputs to the business case calculations
- Preliminary results show possibilities for a profitable long term business
- Critical factors influencing profitability:
  - Sensor density
  - Sensor OPEX
  - The need for new site installations should be minimized
Objective: demonstrate dynamic spectrum allocation in a primary environment (OFDM waveform) by performing secondary cognitive operation providing optimized capacity to the secondary system without causing harmful interferences to the primary.
These demonstrations, together with the system simulations and techno-economical studies, will provide valuable inputs to feed the discussions on regulation aspects and evaluate, not only what is theoretically, but also technically and economically achievable.

SENDORA demonstrations are planned at Crowncom2010 and Future Networks Mobile Summit 2010. Final demonstration is planned at end 2010. Regulators are invited to participate to such events.

A joint workshop between SENDORA partners and Norwegian regulation (Norwegian Post and Telecommunication Authority) has been recently organized to address the “cognitive radio and regulation” topic.

Our goal is to receive a feedback on the proposed concept, adapt it to all actors’ needs, and provide valuable inputs through different means.
Open questions (1/3)

Regarding SENDORA approach

➢ What is your feedback regarding SENDORA Wireless Sensor Network aided Cognitive Radio concept in general?

➢ Do you think this approach would ease the regulation if the regulator could own the sensor network and provide himself the secondary system with transmission opportunities?

➢ What items would you like to see more deeply addressed in the project? What kind of outcomes would be of valuable interest for a regulator?
Open questions (2/3)

Regulation status regarding cognitive radio technologies

➢ Do you think that there will be a need for new regulation policies considering the current needs for wireless communications?
  ➢ At what term? 5 years? 10 years?

➢ What is your general feeling about dynamic spectrum allocation approaches? About the frequency bands sharing, with potentially primary and secondary usage?

➢ What are the current actions led by regulation authorities with respect to cognitive radio concept? Studies, proposals of new policies, …?
Open questions (3/3)

What will be decisive for the future adoption of cognitive radio technologies?

- What should be guaranteed in terms of system performance to allow the introduction of opportunistic systems in the wireless communications landscape?
- What band(s) could be opened in priority for large scale deployments and tests of such technologies?
- Cognitive operation requires a licensed narrow band for signalling: is it acceptable and where in the radio spectrum?
- How do you foresee the control of the coexistence of licensed users with opportunistic users in a same band? What constraints/requirements would you impose to guarantee a controlled systems coexistence?
Thanks for your attention!

More information on SENDORA @ www.sendora.eu