Coexisting Short Range Radio by Advanced Ultra-Wideband Radio Technology

Presenter: S. Zeisberg
Contributors: A.R. Biswas, H. Dunger, F. Berens (all EUWB)
The Reason for EUWB: **IMPACT**

- **ENABLING** application of UWB Radio by having a viable Regulation in place and efficient use of natural resource radio spectrum by introducing principles of cognitive radio (non-data-aided) in real existing regulation.

- **STRENGTHENING** major European Businesses by integrating UWB Radio Technology into their application scenarios: Transportation, Cellular, Automotive, Consumer Electronics (several major real live integration platforms).

- Enhancing **competition** & lowering market entrance barriers creating **INTERNATIONAL STANDARDS**.

- Enhancing **European Know-How** in UWB-RT and its application.
A Result of EUWB: **IMPACT NOW**

- **UWB is one of the first modern radio technology examples applying already Cognitive Radio Principles!** Because it was the only feasible way to regulate this new radio and therefore to enable **NEW MARKETs** → thanks to years and years of EU effort!

- **Cognitive Radio is a key phrase in today’s research** – mostly for designing completely new **radio systems and architectures (revolutionary approach!)**

- **However, Cognitive Radio is able for Enhancing Competition & Increase Spectrum Usage Efficiency already TODAY by applying Cognitive Radio Methods to existing Systems and applications** (UWB, GSM-R -- Smart-Metering, GSM-R -- RFID, WLAN – Radar, …)

- **Enhancing EU Know-How has started in practice!!!**
Coexistence **NOW** – using CR

- **UWB community around EU R&D major projects PULSERS and EUWB was providing the ground for new thinking in other Short Range Radio CEPT regulation activities ongoing already NOW!**
- **Cognitive Radio Methods!**

**Measurment Report**

**Feasibility Tests between E-GSM-R and UHF RFID**
at Kolberg, Germany, 25\(^{th}\) to 26\(^{th}\) June 2009

**Feasibility Tests between E-GSM-R and Low Duty Cycle SRD**
at Kolberg, Germany, 19\(^{th}\) to 20\(^{th}\) August 2009
EUWB in a nutshell

- Four **advanced research service** work packages
- Four **application integration** + 1 Tech. work packages
- Complete work package for **regulation & standardization**
Wireless Cabin and In-Flight Entertainment

- High speed broadband content download and/or streaming into IFE terminals system
- Next generation cabin management and communication
- Dynamic tracking of crew members, service & security staff, trolleys, special luggage etc. during operation, maintenance or emergency
- Monitoring and access control of security sensitive areas

Wireless Sensor Networks

- Sensor Based Maintenance
- Structural Health Monitoring
- System Health and Usage Monitoring
- Cabin Comfort Systems
Application: Aircraft

UWB technology benefits:
- Robust against multipath
- Multi-cell architecture (high freq. reuse)
- High data rates (>480Mbps / channel)
- Transceiver localisation
- Low power consumption

Advantages
- Eliminate cables
  - Weight reduction
  - Easier cabin layout reconfiguration
  - Easier maintenance

Open Issues
- Regulation, EMC
- Performance of UWB systems in aircraft environment
- Security against intrusion and jamming
- Reliability of fixed installed services
App-Ex: Disseminations and Cooperation

- **Typical example for EUWB cluster D & C:**
  - WP8a contribution for ICT Mobile Summit **Poster**
  - **Paper** at WPNC on Public Transport Application Scenario
  - **Paper** at WPNC on suitability of WiMedia MAC for PT scenario
  - **ETSI ERM TG UWB SRDoc** for airborne application -> CEPT WGFM FM47 → ECC WGSE SE24 → Draft Liaison Statement
  - Cooperation with Ellisys/Lecroy for WiMedia UWB measurements equipments

- **Typical example for EUWB service WP D & C:**
  - **Poster** Session at WCNC 2009 / WPNC 2010.
  - **Demo/Booth** contribution to ICT Mobile Summit 2009 /2010.
  - ICUWB 2009 **Paper** contributions
  - **patent ideas** created (under review).
WP8a: Next steps, open issues & risks

• Next steps
  – Integration of final demonstrator architecture
  – Implementation of WLP/WXP

• Open issues
  – HW platforms integration
  – Location and Tracking using WiMedia for ranging

• **Risks**
  – **Regulatory rules** still not allowing use of UWB devices in **public transport** (shortly to be solved) and **aircrafts** (open)
App-Ex 2: automotive Reliable Data Com

Wireless sensor to ECU data communication

Objectives

- Reliable data link between sensor and control unit
- Reduce cable harness complexity
- **Approach**
  - Channel propagation modeling
  - System simulation
  - Verification setup
  - Implementation
    - Automotive UWB frontends
    - Antenna concepts
- **ETSI + CEPT Challenge:** Equivalent protection by alternative mitigation: here mobility → smart tire
App-Ex 3: Home Theatre

Use multiband / multimode capability of the UWB HDR/VHDR platform to provide an intelligent, dynamic, wire-free multi-channel home audio experience.

Use LT capability of the UWB LDR-LT platform to provide a wireless, reliable high-definition video streaming experience.

Detect and Avoid indoor WiMAX Terminals.
EUWB – Cellular (Terminal + BS)

- Provide **new means for convergence of NGNW** with ultra high speed short range wireless access inclusive local hybrid fixed/wireless systems by defining and validating interoperability in several heterogeneous scenarios.

- **Interoperation of integrated UWB/cellular terminals** seamlessly.

- **UWB in the fix to mobile convergence**, as a new access technology with its own particularities, for an “always-best connected” approach.

- **Interaction with NGMN** in which **heterogeneous radio access** is considered.

- **Exploration of the possibilities of integrate new services, based on UWB features** in future service platforms [IMS].
Cognitive Radio Motivation: Spectrum scarcity/inefficiency

- Wireless trends and current positions.
  - Need for new wireless technologies to support high data rate...
  - Need for more access to spectrum, but limited and already allocated...
  - Technology is helping but......

- Some say that:
  - "Scarcity is the most serious challenge facing the wireless industry today... and it is only going to get worse" (William Kennard, FCC Chairman, 2000)

- Other argue that:
  - "Scarcity is artificial; induced by regulation" (Ronald Couse, 1959)

- Frequency regulation
  - Need common language

- Measurement results say that:
  - Many spectrum bands are unused but some are heavily congested....

⇒ Spectrum sharing, primary/secondary, between operators, between RATs

Source: Richard Womersley, ATC Global Presentation, Helios/Chris Van Diepenbeek, IBBT
Objective for UWB to cover Cognitive Radio

- UWB systems spectrally overlapped with other radio systems
- Mutual interference expected in a few cases, but not in general!
- Impact on UWB solutions deployment

Future requirements of UWB systems

⇒ Need for coexistence with other radio systems
⇒ Meet worldwide regulation: automatically adopt the spectrum mask
⇒ Both LDR and HDR are in the same scenario: co-operation and coexistence
⇒ Need for intelligent techniques in order to detect systems to be protected ⇒ Non-Data-Aided Cognitive Radio (single or distributed, detection or data base, e.g. fixed UWB outdoor installations still not allowed basically because of Fixed Wireless Services ....)
Methods include short term and long term

- **Spectrum sensing**
  - Basic principle and requirements
  - Methods and model of spectrum sensing

- **Identification, classification and spatial distribution**
  - Identification of potential interferes
  - Classification of potential classification

- **Coexistence and mitigation techniques, cognitive pilot channel**
  - Detect and Avoid (DAA)
  - Scenarios of cognitive pilot channel
  - Requirements of CPC

- **Networking co-operation and negotiation**
  - Scenario of networking co-operation/negotiation
  - Requirement of networking co-operation/negotiation
Short Term CR Technique: Sensing

**Spectrum sensing**

- Spectrum sensing is one of important enabling techniques of the cognitive radio (CR)

- Spectrum sensing challenges at UWB systems
  - Long scanning time due to wide band
  - High energy consumption
  - Environment dynamic

- Need co-operation
Spectrum Sensing - next step: Co-Operative

Several nodes to share the spectrum sensing tasks and/or to share the knowledge acquired from primary systems.

Co-operative

- Partially co-operative
- Fully co-operative
Sensing example: Partially co-operative

- Co-operative sensing improves the detection performances, at the expense of increased control and management functionalities.
- Data fusion for co-operative sensing can be either soft decision based or hard decision based.
- Noisy reporting channel can be an issue in co-operative sensing.
- Figure shows the complementary receiver operating characteristics curves for co-operative sensing, with N number of sensing nodes.
CR related work packages in EUWB

- **WP9: Regulation and Standardisation**
  - Leader: **Hartmut Dunger, Robert BOSCH GmbH**
  - Time schedule: April 1st, 2008 – March 31st, 2011
  - Core activities in regulation/standardisation organisations related to Spectrum: CEPT ECC (TG3, WG SE, WG FM), ETSI (TGUWB, TG28, STF 350, RRS WP2, ...), IEEE (802.15.4a, 802.15), Alliances/Groups (WiMedia/ECMA TC48, Bluetooth SIG)

- **WP2: Cognitive UWB Radio and Coexistence**
  - Leader: **Abdur Rahim Biswas, CREATE-NET**
  - Time schedule: April 1st, 2008 – March 31st, 2011
  - Core activities in regulation/standardisation organisations related to Spectrum: ETSI RRS, COST (2010 subgroup on CR + new application for a separate action on CR)
WP9 – Regulation + Standardisation

- “UWB in the Public transport”, e.g. airborne UWB (WP8a).
  EADS (AIRBUS)
  Contribution to ETSI and CEPT for request on regulatory framework (ETSI TR 102 834 V0.0.4) because actual status: no UWB on board aircraft allowed.

- “UWB in the automotive Environment” (WP8b), BOSCH
  will likely be covered by the EN 302 500 (loc. Tracking) and EN 302 500 (communic.)

- “UWB in the Home Entertainment” (WP8c), PHILIPS
  will likely be covered by the EN 302 065

- “UWB in Heterogeneous Access Networks” (WP6), TELEFONICA
  will likely be covered by the EN 302 065

- “Cognitive Radio and Coexistence” (WP2), CNET
  Ongoing standardisation work in ETSI Technical Committee

- WP9 leader represents the European (CEPT) SRD strategy on the ITU WP 1B in Seoul in March (UWB is an agenda item on WRC 11)

- UWB applications will become part of the ERC/REC 70-02
WP9: Disseminations and Cooperation

- "Introduction of the EUWB consortium and their RRS activities”, ETSI RRS#2, 06/08
- “Cognitive Pilot Channel (CPC): a Data Aided Coexistence and Mitigation Technique for UWB Systems”, ETSI RRS WG3 2008
- 01_08: EUWB CPC Application Scenarios and Concept & Motivation, RRS3#1, 09/08
- 01_09: Cognitive Pilot Channel Presentation, RRS3#1 Meeting, 18-09-2008
- 02_13: TR of CPC-v003_Extension proposed by EUWB, RRS3#2 meeting, 11/08
- “Comments on the Draft ECC report 120” on the technical requirements for UWB DAA devices to ensure the protection of radiolocation in the bands 3.1-3.4 GHz and 8.5-9
- "Cognitive Radio Vision within European FP7 Projects “ 1st CEPT WS
- Walter, EUWB and UCELLS, “Experimental Analysis of 3.5 GHz WiMAX 802.16e Interference in WiMedia-defined UWB Radio Transmissions”, VTC 2009-Spring
- “Cognitive Pilot Channel: RAS Contribution in ETSI RRS WG3” 2nd EC Concentration Meeting, October, 2008, Brussels
- “Proposal for RAS conference on Regulation and Standardization”, 3rd EC Concentrated Meeting, February, 2009, Brussels

**Organization of special sessions and conferences:**

- A special session on Cognitive Reconfigurable Radio Systems and Networks at ICT Event Lyon, May 2008
- Special sessions at 2009 European Reconfigurable Radio Technologies Workshop and Product Exposition, April 2009, Spain.
- The requirements of Cognitive Radio in the Field of Standardization at CROWNCOM 09, Hannover
- A special session on Spectrum without Boundaries in ICT mobile summit, 09
- Active participation on > 30 meetings of ETSI and CEPT in technical committees and subgroups by member of EUWB
generate studies for impact analysis between UWB on board aircraft and terrestrial and space based radio services

further proof validity of mitigation techniques in other SRDs to expand application areas of UWB

Improve the acceptance of UWB technology inside the traditional radio service community to avoid effort-consuming EC-decisions: ECC decisions should be sufficient → first success → SE24 instead of extra PT

Allocating European industry and administration member for a progressive CEPT standpoint on UWB and SDR (both on WRC11 agenda) in 2009 and 2010.

With a regulatory framework is nothing to lose, but a lot to win (it is more often a political then a technological challenge) .......... Cognitive Techniques are Topic!
EUWB’s intention for RAS cluster:

- EUWB wanted to be and is active in RAS to:
  - **disseminate information** about UWB activities related to EUWB to any interested EC project (RAS) partner
  - **request (technical) information about other radio systems / other projects expertise** (e.g. to support coexistence investigations, with BWA such as WiMax, LTE, avionics radar, …) → recent co-operation with WALTER
  - Commit to provide resources for **RAS administration** (co-chair by Sven, CI group co-chair by Rahim)

- EUWB wanted to exploit RAS in particular:
  - to **harmonize spectrum regulation strategy** and tactic with other UWB related projects
  - to **prepare common activities for CEPT and ETSI** (meeting inputs, public consultations, ..) → AoI
  - to **prepare a white paper** towards European administrations towards WRC’11 and beyond → AoI