COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING
Christophe Moy

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COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING

Christophe MOY
Professor
Centrale Supélec
IETR – UMR CNRS 6164
Head of Communications department

CEFIPRA Workshop, Hyderabad, India
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RESEARCH TEAM: SCEE

- Centrale Supélec is currently in 4 campuses
  - Châtenay Malabry (former Ecole Centrale Paris)
  - Gif-sur-Yvette (former Supélec)
  - Rennes (former Supélec)
  - Metz (former Supélec)

- Rennes campus
  - SCEE research team
    Signal, Communications and Embedded Electronics
  - Research activities are affiliated to IETR of CNRS (UMR 6164) – Institute of Electronics and Telecommunications of Rennes
RESEARCH TEAM

- SCEE research team
- Signal, Communications and Embedded Electronics
- 10 faculty members
- 15 PhD students / 1-2 post-docs

- International Chair during 2 years (2013-2014)
  - Prof. Honggang ZHANG
  - Zheijang University
  - Green radio communications
RESEARCH TOPICS OF SCEE TEAM

• Digital electronics
  • Multi-standard radio systems: apply SW principles to radio electronics
  • modeling approach of cognitive electronic systems, Model Driven Architecture (MDA), Model Based Design (MBD)
  • FGPA, partial reconfiguration of FPGA, design methodologies for complex HW/SW systems

• Radio-communications
  • Physical layer of wireless communication standards, OFDM, multi-carrier, Filter Bank modulations, synchronisation, PAPR – peak to average power ratio, etc.

→ Cognitive Radio approach, based on software radio
→ Towards Green Radio (energy efficiency for wireless communications)
APPLICATION EXAMPLES

• Benefit from cognitive radio in the radio domain
  • Legacy radio systems, especially in a multi-standard context
  • Dynamic spectrum allocation to mitigate spectrum scarcity
  • 5G
  • Sensor Networks
  • IoT – Internet of Things

Benefit from cognitive radio for other domains
  • Smart Grids
  • Smart Cities
  • Intelligent Transport Systems
  • Any Smart System indeed
COGNITIVE CYCLE

- Cognition requires
  - Sensors
  - Computing means for learning and decision making
  - Adapt the system to optimize its behavior

- What does it mean « optimize »?
  - Quality / cost / power consumption / etc.

- In our research
  ➔ making radio systems smarter
  ➔ also use wireless systems to make other systems smarter
TO MAKE A SYSTEM BECOME SMART OR BE SMARTER

- Brain smartness is not only a question of number of neurons
- It is (also/more?) a question of number of connections between neurons

Making a legacy system become smart/intelligent/cognitive means adding communication means between entities

- wireless communications are easier (mobile, can be added...)

- Prof. DHANDE this morning: « intercation Man/Machine/Information Digital manufacturing is about information transfer between
  - sensors and decision center
  - decision center and machine »

- Digital Manufacturing = « smart manufacturing »

COGNITIVE RADIO – Prof. Christophe MOY – Centrale Supélec - IETR
FROM RADIO TO COGNITIVE RADIO – ANALOGY WITH DIGITAL MANUFACTURING (?)

• Radio design has known a completely change of paradigm during these past 40 years
  ➔ maybe the same change that manufacturing is living today (?)
• Radio design has known a digital revolution
  • A lot of processing done by discrete electronic components before
  • Have turned to digital domain
  • And when possible to software executed on processors
  ➔ software radio
  ➔ This opened the door for cognitive radio
  • As soon as processing is executed on processor, you can easily change it and turn it intelligent while adding some artificial intelligence algorithms
  ➔ maybe the same change for digital manufacturing (?)
COGNITIVE RADIO TO MITIGATE SPECTRUM SCARCITY

• Radio spectrum is overloaded
• There is no more space for new radio applications
• A new way of using radio spectrum is necessary after 100 years

• Dynamic spectrum approaches, based on Cognitive Radio principles, are studied at research level and implemented in standards
  • Research: Opportunistic Spectrum Access (OSA)
    • Application for a better use of current ISM bands
    • Future radio standards
  • Standards: Licence Sharing Access (LSA)
    • ETSI RRS – I am participating to this standardization group which is the most pioneering standardization group in cognitive radio spectrum management worldwide
    • US is trying to fill the gap with ETSI RRS (PCAST)
OPEN TO COOPERATION

• Radio domain
  • Software defined radio approach for legacy radio systems: when several radio standards in the same systems (plane, car, robot, etc.)
  • Agile spectrum – get connected with most advanced standards in dynamic spectrum techniques (European ETSI RRS standard group)
  • 5G
  • IoT – Internet of Things
  • Sensor Networks
• Other domains requiring wireless communications: **high level modelling** (model-based design, Model Driven Architecture)
  • Smart Grids
  • Smart Cities
  • Intelligent Transport Systems
  • Digital manufacturing
PROJECTS OF THE TEAM CONNECTED TO DIGITAL MANUFACTURING

•

• Examples of industrial research
  • Orange: sensor networks based on cognitive radio

• Examples of current collaborative funded projects
  • European and international level
    • PHC (Hubert Currien funding for French-abroad collaboration) with Greece on Smart Grids
  • French level
    • SoGreen: Smart Grid to empower future cognitive communication networks
CONTACT ME

Prof. Christophe MOY
Centrale Supélec

christophe.moy@centralesupelec.fr