



HAL
open science

COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING

Christophe Moy

► **To cite this version:**

Christophe Moy. COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING. CE-FIPRA/IFCPAR Workshop on Digital Manufacturing, Apr 2015, Hyderabad, India. hal-01151749

HAL Id: hal-01151749

<https://hal.science/hal-01151749>

Submitted on 13 May 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



CentraleSupélec

COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING

Christophe MOY

Professor

Centrale Supélec

IETR – UMR CNRS 6164

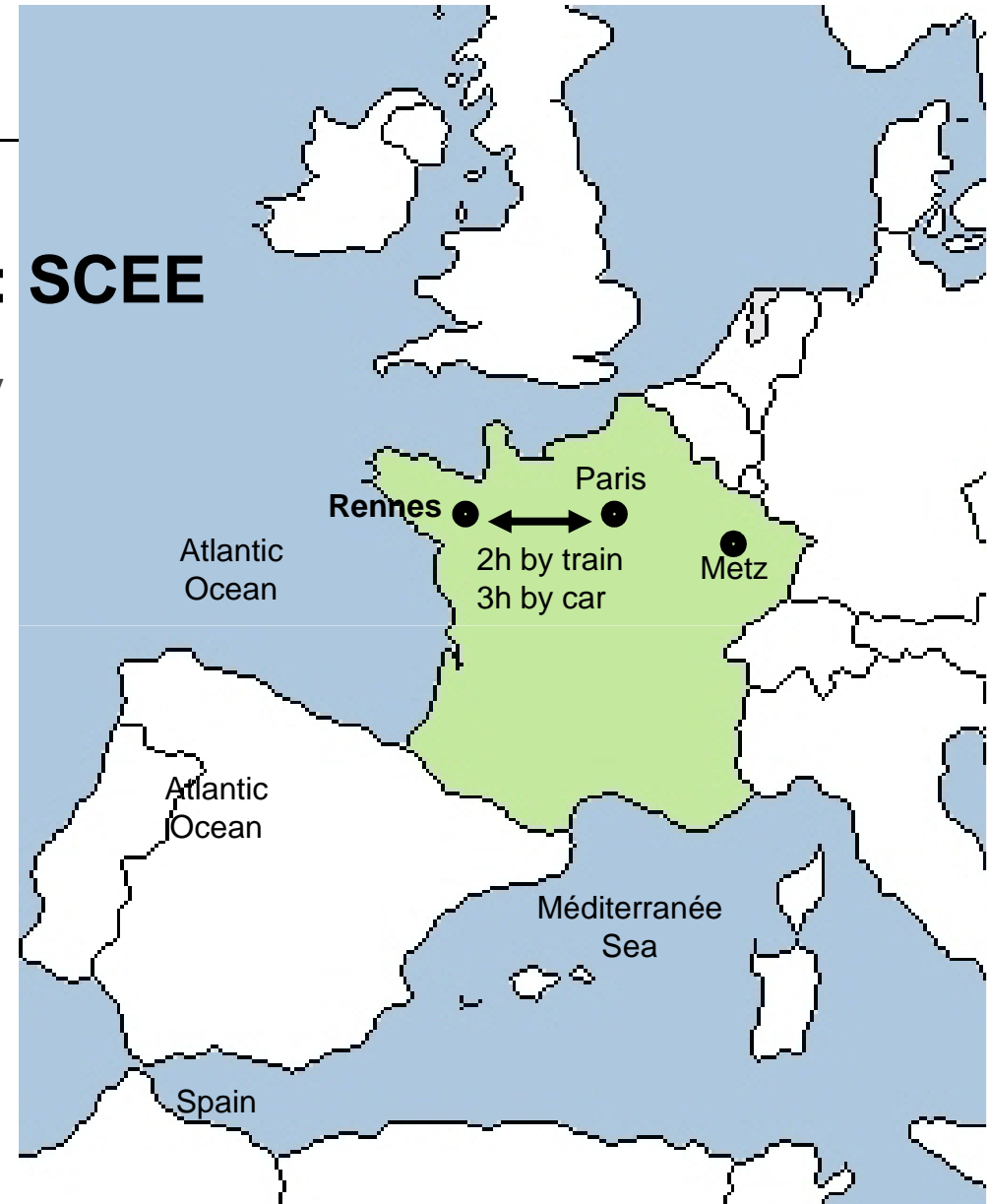
Head of Communications department

CEFIPRA Workshop, Hyderabad, India

12/04/2015

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** reasearch 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 reasearch 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**

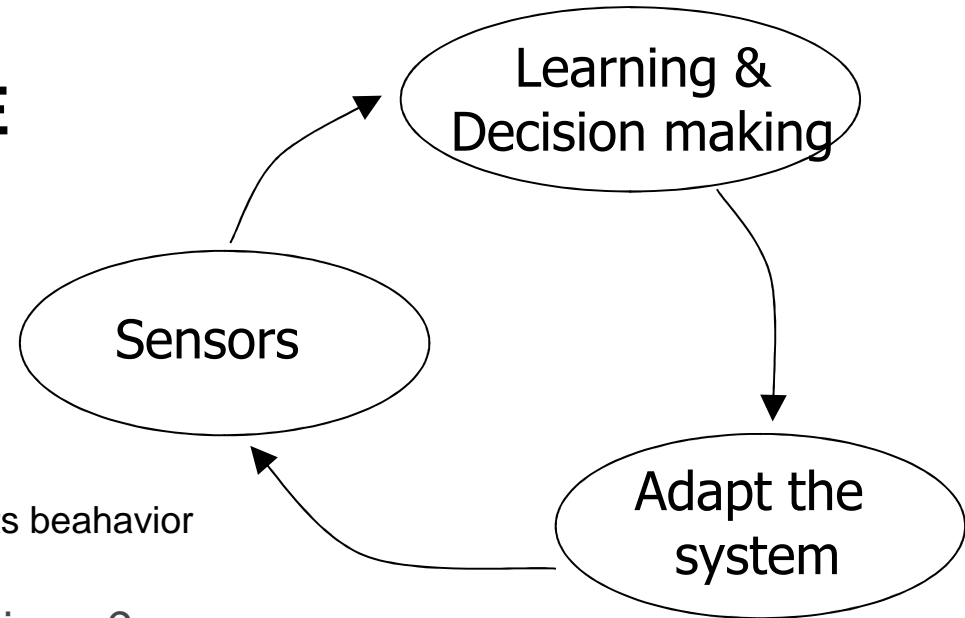
Benefit from cognitive radio for other domains

- 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...)

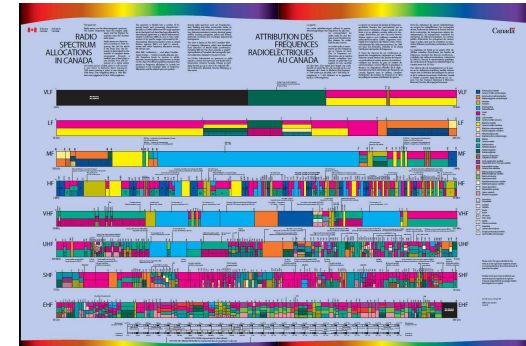
- Prof. DHANDE this morning: « intercation **Man/Machine/Information**
Digital manufacturing is about **information transfer** between
 - sensors and decision center
 - decision center and machine »
- **Digital Manufacturing = « smart manufacturing »**

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
 - Haved 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