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COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING

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CentraleSupélec

COGNITIVE RADIO: AN ENABLER FOR DIGITAL MANUFACTURING

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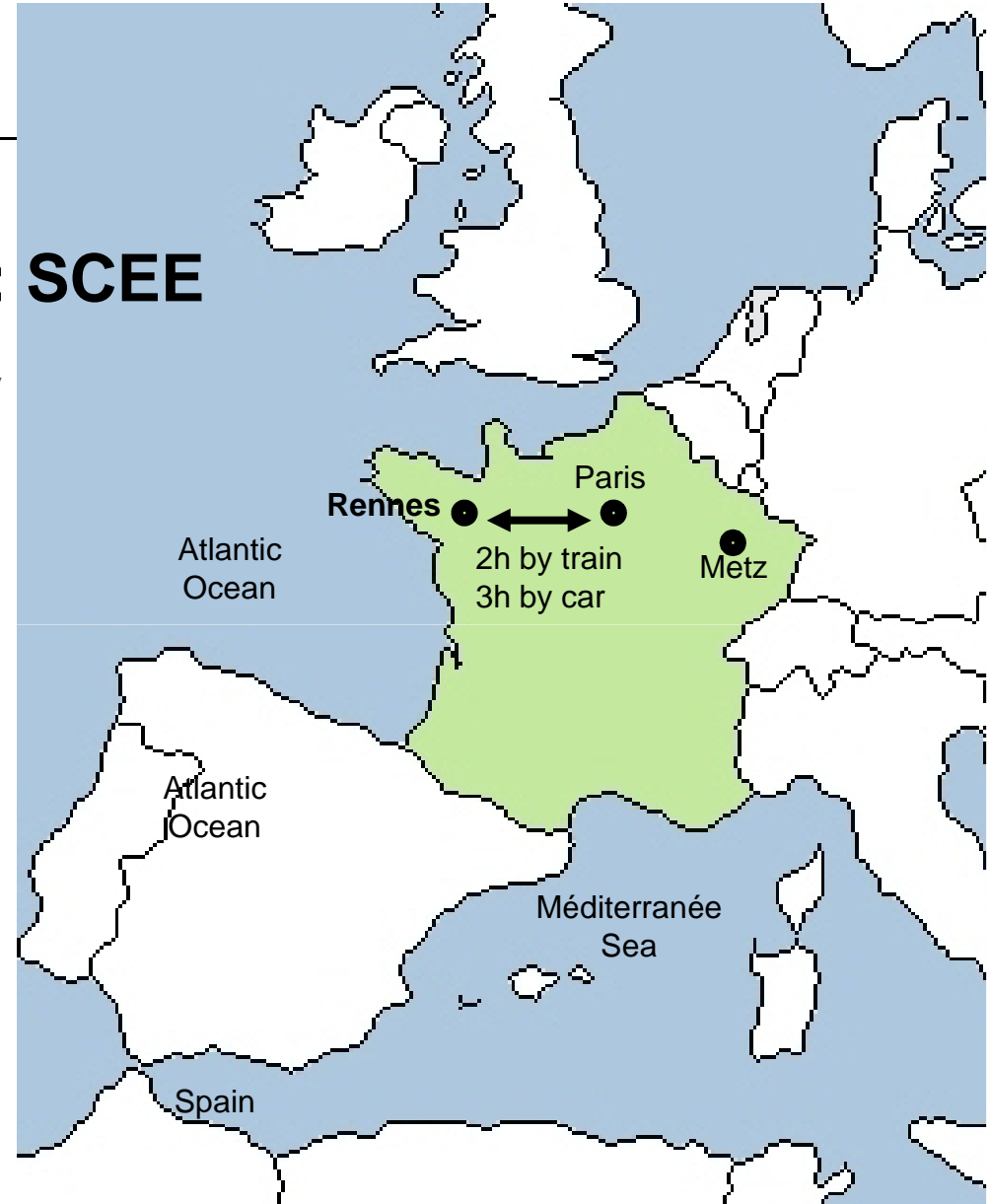
Head of Communications department

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**

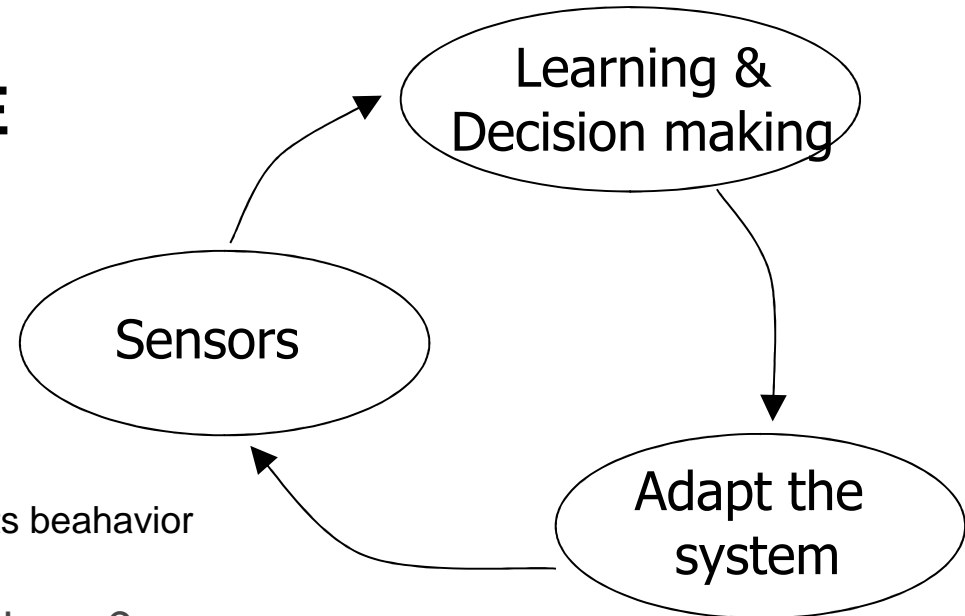
Benefit from cognitive radio for other domains

- 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...)

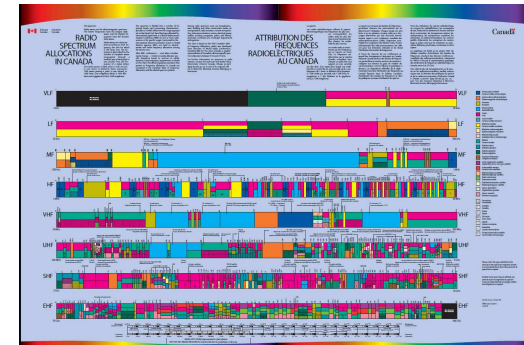
- Prof. DHANDE this morning: « intercation **Man/Machine/Information** Digital manufacturing is about **information transfer** between
 - sensors and decision center
 - decision center and machine »
- **Digital Manufacturing = « smart manufacturing »**

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 stds
 - 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

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- 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

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