Major Communicating Systems and Internet of Things

Track:

ELECTRONICS AND EMBEDDED SYSTEMS

Semester 7
Semester 8
OCENE Concentration

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Rennes Campus

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Semester 7

Engineering Challenge Term:
Smart Embedded Systems for Health:

- Automatic Control
- System modeling
- High energetic efficiency wireless communications

Challenge week: Smart system for personalized blood glucose control

2 or 3 elective courses[2] including:

Computer Architecture
The main objective of this course is to give students all necessary basic knowledge to understand how computers work. The design and building of microprocessors are major challenges for our society since they are omnipresent in our environment.

Common Core Cursus

- Project[1]
- Economics
- Humanities
- Engineering professional skills
- Languages

[1] the project will be included in the Smart and Secure Life project hub see below
[2] at least 5 elective courses should be validated during semester 7 and 8

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Semester 8

Engineering Challenge Term on Optimization:

Open choice between:

- Smart Grid and Energy Challenge
  - Renewable energy and micro-grids
- Digital Technology Serving the Human World
  - 2D – 3D Image and Sound Analysis

2 or 3 elective courses[2] including:

Radiocommunications

The objective of this course is to present the foundations of the radiocommunications, its basic principles and its applications to the world of telecommunications. At the end of this course, the students will be able to understand the current issues and evolutions related to the basic radio frequency architectures, the evolution over the different cellular generations, the IoT basis, and the main related services..

Common Core Cursus

- Project[1]
- Humanities
- Engineering professional skills
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Project Hub

Smart and Secure Life

"Since the democratization of the Internet, digital technology has emerged as one of the major challenges for the society. The proliferation of connected objects and interactions between systems opens up many perspectives in all scientific fields: **renewed energy management**, preservation of the environment, individualized health monitoring, etc. It requires designing and developing, among others, adapted communication systems, big data management systems, and **optimized decision-making algorithms**. Obviously, a big attention must also be paid to the security aspects.

These concerns are in the center of interests of the “Smart and Secure Life” hub in which digital sciences and technologies are at the service of society. It is a multidisciplinary center which draws on the skills of the four research teams on the Rennes campus. Projects can also emerge from student initiatives to respond to a concrete problem, with experienced supervision provided by the professors of the Rennes Campus, as it happened before. For instance, this past experience has resulted in the creation of "Immersive therapy", a start-up that exploits virtual and augmented reality in the medical domain."

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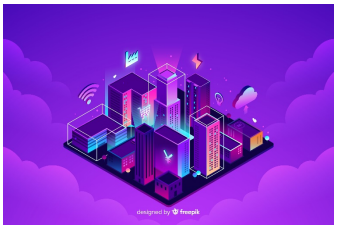

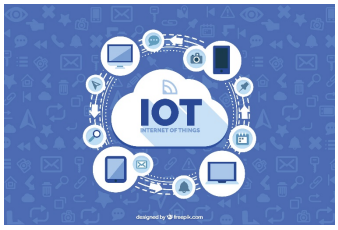

DOMINANTE SCOC
« SYSTÈMES COMMUNICANTS ET OBJETS CONNECTÉS »
SÉQUENCE DE DOMINANTE SD9

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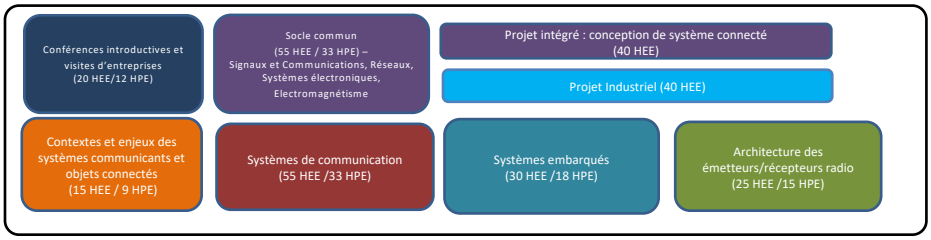
Séquence de dominante SCOC (SD9) / 200 HEE

The tracktrains architects and designers of complex heterogeneous, flexible, cooperative, high-tech communication and distributed intelligence systems.
The track sequence aims to give an overview of the different disciplines which will be deepened and broadened in the three mentions.



➢ **Introductory lectures and visits :** Introductory lectures present the engineering approach of complex connected systems and inter-systems. Round tables and visits present the challenges and needs of many business sectors such as transport, mobility, space, health, energy, cities, agriculture, telecommunications (eg Thales, Airbus , Orange, Bouygues, Nokia, EDF, Renault, etc.).

➢ **Teaching modules and projects :** The track modules provide the theoretical, technological, economic and legal foundations of communicating systems and connected objects.

A project integrating connected objects for applications like the factory of the future, transport or health will allow students to work on the design of a communicating object, then on the realization of a functional and operational demonstrator of connected object. to a network serving an application. This demonstrator will integrate electronics, communication, and data processing.

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Séquence de dominante SCOC (SD9) : teaching modules

- Contextes et enjeux des systèmes communicants interconnectés (15 HEE/9 HPE) :
  Strategic, economic, industrial, societal and human issues. Energy and environmental aspects.
  Legal aspects (digital law, data protection, resource management, new paradigms).

- Socle commun (55 HEE/33 HPE) : This course base aims to provide the basic concepts for communicating systems and connected objects by providing reminders and complements in communications and networks, in electronics and in electromagnetism, adapted to the diversity of the paths of the students entering the dominant (ST / electives). The TD will be declined according to the course of the students and the TP according to the mention chosen.

- Systèmes de communication (55 HEE/33 HPE) : This course deals with communication techniques, network architectures and processing architecture. It gives the foundations of the basic processing of a digital communication chain, access methods and data routing for different types of networks and applications. It addresses issues of quality of service, mobility, capacity, energy, reliability, security and resilience. It introduces the new paradigms of commincating systems (virtualization, mass densification, autonomy, intelligence…).

- Systèmes embarqués (30 HEE/18HPE) : Communicating objects require great computing power which can be embedded or distributed in a network. This course deals with major associated issues such as the distribution of processing, embedded OS, cyber security of components and systems while taking into account the methodologies for reducing energy consumption. Part of this teaching takes the form of a project aimed at putting into practice the various architectural design strategies on “Low Power System-on-Chip” type platforms.

- Architecture des émetteurs et récepteurs radio (25 HEE/15 HPE) : This course addresses the issues of radio transmission (spectrum management, noise, interference, disturbances, energy and power balance, range). It gives a vision of the architectures and chains of processing of transmitters / receivers (amplification, frequency transposition, modulation / demodulation, etc.) as well as the tools to model and design these treatments (microwave circuits) and manage performance compromises (linearity, efficiency, energy efficiency, weight, etc.) depending on the sector of application (space, telecommunications, IoT, health, etc.).

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Track OCENE
Objets Communicants et Electronique Embarquée (Rennes)

Image : Freepik.com

- **Goals** : The objects around you evolve according to two major forces: more abundant communications with their environment, and an intelligence offering them more autonomy. What knowledge of hardware and software architecture can be used to design such systems? And how, tomorrow, can you create the next generation of these systems by integrating the societal and environmental challenges they raise? Whether connected speakers, IoT, 5G, sensors for health, connected cities & agriculture, or autonomous vehicles and drones, the engineer of tomorrow must have solid skills in embedded systems , in intelligent radio, in artificial intelligence, and in security to respond effectively to these challenges. This is the aim of this mention, which is based on the 4 main pillars of communicating systems and intelligent connected objects: hardware, software, communications and AI.

- Teaching methods: structuring the mention in four modules
  - For each module, 60% of courses and 40% of TD
  - For most modules, intervention by industrial partners. Vision on constraints and challenges of practical applications, links with theoretical foundations, business conferences
  - Project and / or IEC on all three sequences
  - Guided tours of partner sites

- **Ingénieurs formés** : Ingénieur R&D, Ingénieur Systèmes, Recherche, Conseil, Entrepreneuriat
- **Secteurs d’emploi (liste non exhaustive)** : Energie, Télécommunications, Transport ,Aéronautique et spatial, Robotique/Drones, Objets connectés, Santé
- **Compatibilité avec les Masters ISC et EEA sur Rennes**

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Track OCENE (Rennes)

Séquence 10 : Systems

(200 HEE enseignement + 80 HEE projet)

Séminaires d'introduction de mention (20 HEE/12 HPE) / Visite d'entreprise

Module 1 (70 HEE/42 HPE)	Module 2 (60 HEE/36 HPE)	Module 3 (50 HEE/30 HPE)
Conception de Systèmes	**Systèmes communicants**	**IA et traitement du signal**
▪ Architectures matérielles ▪ Plates-formes embarquées ▪ Conception/validation des systèmes	▪ Procédés de Transmissions ▪ Objets communicants	▪ Réseaux de neurones profonds ▪ IA et base de connaissance ▪ IA et traitement de séquences temporelles ▪ IA générative : réseaux GAN et VAE

- Partie Introductive (20 HEE) : Introduce the content of the mention, with conferences from industrial partners, emphasizing the consistency of the mention through industrial issues
- Module 1: Conception de Systèmes (70 HEE) : Hardware and software architectures, available technologies (FPGA, processors, platforms); on-board and real-time operating systems; design and validation methodology.
- Module 2: Systèmes communicants (60 HEE) : This module will present all the transmission schemes on the basis of current telecommunications systems, the key parameters to be optimized (energy efficiency, throughput, latency, reliability, security) and the consequences on the sizing of these systems; case studies of communicating objects (Internet of Things).
- Module 3: IA et traitement du signal (50 HEE) : After a rapid upgrade in the field of Machine Learning from artificial life (neuronal learning, Genetic algorithm, fuzzy logic ...), the main approaches currently used in AI will be studied in various fields (image, sound, text , strategy) so as to give students the opportunity to apply AI techniques in any field (financial analysis, telecom, hardware, signal processing, strategic games, etc.).

▪ **Examples of engineering issues dealt with:**

- Design and implementation of a video game on SoC (FPGA + Processor)
- Creation of a network of remote sensors (LoRaWAN + Cloud)
- Optimization of a real-time OS in a multi-core embedded environment (Soc FPGA)

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Track OCENE (Rennes)

Séquence 11 : Applications

(160 HEE enseignement + 120 HEE projet)

Module 4 (60 HEE/36HPE)	Module 5 (60 HEE/36 HPE)	Module 6 (40 HEE/ 24 HPE)
Electronique embarquée	**Télécommunications**	**Applications industrielles**
▪ Architectures reconfigurables ▪ Calcul embarqué intensif ▪ Cybersécurité des systèmes	▪ Réseaux et systèmes embarqués ▪ Radio intelligente	▪ - Objets communicants ▪ - IA Embarquée

- Module 4 : Electronique embarquée (60 HEE) : Advanced architectures: partial dynamic reconfiguration, intensive embedded computing (GPU, TPU); multi-core on-board platforms; confidentiality and security in electronic systems
- Module 5 : Télécommunications (60 HEE) : Learning and decision-making concepts for future telecommunications systems with the aim of making them more autonomous, more flexible and better able to manage the interoperability of networks. It will then be a question of approaching the foundations and implications of intelligent radio and its technological support, software radio.
- Module 6 : Applications industrielles (40 HEE) : Presentation of an application by an industrialist, definition of specifications and production in the form of a proof of concept; one of the 2 fields:
  - Communicating objects: At the end of this module, students will be able to size a network of communicating and autonomous objects.
  - Embedded AI: Implementation of AI techniques previously seen in different contexts such as audio / video / text analysis and synthesis.

▪ **Examples of engineering issues dealt with:**

- AI implementation in medical
- Opportunistic spectrum access by searching for available bands (smart radio)
- Autonomous vehicles, buildings, cities and smart agriculture, e-health
- Robot localization by SLAM and AI
- Human behavior analysis

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