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## ST5 – 62 – ENERGY INTELLIGENCE AND SMART BUILDING

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**Dominante :** GSI (Large Interacting Systems) and SCOC (Communicating Systems and Connected Objects)

**Langue d'enseignement :** French with specific modalities to allow the adaptation of students with a low level in French: all the materials are in English, the tutorials, the practical work as well as the integration teaching are provided in English. Support sessions in English are also scheduled.

**Campus où le cours est proposé :** Rennes

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### Engineering problem

Buildings must no longer be considered as simple consumers, but as true energy players, fully integrated into their ecosystems, and must be fully integrated into a renewed vision of society, where comfort and health are in harmony with energy management. To do this, we need to rethink the systems that make up the building, through new control functions and stronger interactions with the occupants. The "building" ecosystem is complex, because it is made up of a heterogeneous set of systems: local production, storage, supply, sale, and the various equipment, which must be coordinated for optimized management.

The engineer's challenges are first to analyze the needs and to specify the intelligent control systems. This design is based on the integration of control algorithms deployed on communicating systems to achieve an optimal compromise between technology - cost - efficiency, such as closed-loop performance, communication frequency and protocol, sensor autonomy and actuator lifetime.

### Advised prerequisites

None

**Context and issue modules :** This part is organized around several conferences that should give students the keys to understanding the major issues associated with this thematic sequence. Starting with the industrial issues: what are the needs of today and tomorrow, in terms of services and technologies: challenges and scientific obstacles. Then presentation of the difficulties encountered for the capture of heterogeneous data from which we can perform analyses and exploit these data.

Knowledge contributions will be given to understand the needs and the heterogeneity to be taken into account for the management of comforts (air



quality, thermal comfort, ...). Finally, a last intervention will present the "Research" point of view around intelligent buildings.

**Specific course (60 HEE) :** Students will be required to choose from one of the following two specific courses:

**Option 1:** *Energy-efficient communications*

**Brief description:** With a global electricity consumption of 6 to 10% corresponding to 4% of greenhouse gas emissions, ICST (Information and Communication Sciences and Technologies) must rethink the way they transmit, process and store data. The arrival of 5G (5th Generation mobile) and the explosion of connected objects (Internet of Things) suggest that the sector will continue to grow strongly in the coming years, making it all the more urgent to offer more environmentally friendly communications. The need for spectral efficiency (transmitting a given data rate in a given bandwidth) must then be combined with a strong energy efficiency constraint (transmitting while consuming as little as possible). This course provides training in digital communication concepts and tools for which energy efficiency is explicitly taken into account.

**Option 2:** *System architecture and modeling*

**Brief description:** Today's systems are increasingly complex. This complexity comes from the complexity of their structure and the interactions between the different components, the increase and the complexity of the exchanged data, the heterogeneity of concepts, substances, trades, standards, but also the human complexity (organization, ergonomics, psychology, sociology...). In order to better control this complexity, it is often necessary to rely on a modeling of the different artifacts of the system. This modeling allows, at different phases of the system's life, to better understand the needs it must meet, to structure its architecture, to make analyses in order to predict its behavior and thus to make a justified choice between several solutions. The different models constitute a common reference for the different parties involved in the design of the system. The objective of this course is to train students to model and structure a system architecture. Technological systems will be privileged with domains such as avionics, railways, industry, health, energy etc. Emphasis will also be placed on the ability to identify the characteristic performance attributes essential in the design, implementation, operation and management of complex systems.

**Challenge Week 1:** *Hierarchical management of thermal comfort*

**Associated partner:** Delta Dore (to be confirmed)

**- Location:** Rennes campus



- **Brief description** : The objective is to define a modular system, allowing the implementation of hierarchical control strategies between a local regulation of comfort per zone and a supervisor managing the intermittence of the occupation, the limitation of available power in order to minimize the consumption related to thermal comfort. The challenges induced by this project are the consideration of societal issues (human, comfort and energy efficiency), technical constraints (power limitation, ease of implementation and robustness of the solution) and the technologies allowing the implementation. The different groups will have to collaborate to address the different aspects of the project and to achieve a proof of concept.

### **Challenge Week 2:** *Remote control of thermal comfort*

**Associated partner:** Delta Dore (to be confirmed)

- **Location:** Rennes campus

- **Brief description** : In the context of thermal renovation, remote control solutions are often much more straightforward to deploy than solutions that require running new cables through the walls. The objective of this integration course is to realize the whole remote control system for the heating of several rooms. This realization requires the actual implementation of the communication system between the controller and the heating devices. Groups will compete to find the most relevant technological solution while integrating economic and ecological dimensions.