A central challenge in the development of the Internet of Things (IoT) and cyber-physical systems (CPSs) arises from the fact that sensors that are deployed all over the physical system (infrastructure) depend on local energy sources, often batteries or energy harvesting systems. This battery dependency becomes a critical issue when the systems are deployed in hard-to-reach locations, e.g., remote geographical areas, concrete structures, human bodies, or disaster/war zones. An effective remedy is using energy harvesting technologies. Specifically, energy can be harvested from different ambient sources such as light, vibrations, heat, chemical reactions, physiological processes, or the radio frequency (RF) signals produced by communications systems.

Among all choices, RF signals stand as a solid alternative for energy harvesting in the IoT and CPSs. From this perspective, sensors, actuators and other network components might harvest energy from the surrounding wireless communications. More interestingly, the transmission of information can be performed in such a way that the energy transmission task is invigorated. This is essentially the key idea of a new paradigm in communications: simultaneous information and energy transmission (SIET), which is at the core of the development of CPS and the IoT in 6G communications systems [2].

In the context of the IoT and CPSs, using SIET faces two critical challenges: (i) Ultra low tolerance to latency (delay) in communications; and (ii) Very high need of reliability in terms of error-decoding probability and energy-shortage probability.

Latency is one of the major challenges due to the sensitivity of the CPSs to the communication delays. Such sensitivity stems from the fact that after any change in a CPS, there exists a very narrow time-window during which the CPS must respond to the change and dynamically adapt its operations. Such adaptations are crucial for avoiding failures or disruptions in the physical system.

Reliability is another central challenge in CPS due to implications of any communication error. In applications in which human lives are at risk, such as autonomous vehicles, remote surgery, etc., CPSs must operate under high reliability constraints.

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NASSIET introduces a theoretical framework for analyzing SIET in a non-asymptotic block-length regime. That is, the underlying assumption is that the transmission takes place during a finite period, which leads to strictly positive DEP and the ESP. This new framework builds upon the existing results on the fundamental limits of information transmission in the non-asymptotic block-length regime (c.f. [11]), as well as on some preliminary results obtained by the Principal Investigator on non-asymptotic SIET [12].


Principales activités
The overarching goal of this thesis is to address foundational questions pertinent to the reliable and resilient operation of communication systems whose objective is the simultaneous transmission of information and energy within a context of ultra low latency and high reliability. Two particular scenarios are studied: (a) Point-to-point Channels; and (b) Multiple access channels.

Compétences
Candidates are expected to have a strong background in mathematics. Abilities in algorithm design and computer programming are also essential. Previous knowledge on information theory, game theory and signal processing is desirable. The candidate must have a provable level of written and spoken English. Skills in French language are not required.

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Avantages
- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Rémunération
Gross monthly salary for the first and second year: 1982€
Gross monthly salary for the third year: 2085€