flows under steady-state regime or full buffer conditions. But future IoT networks will require wireless communication protocols have been essentially optimized for high rates data transmission over unreliable and low latency channels. Such protocols must be more specifically dedicated to ultra reliable and low latency communications (URLLC) required for haptic services, impose extremely reactive protocols, which require new PHY/MAC and MAC optimization, measure and estimation techniques. The keys to success

The candidate should have earned an MSc degree, or equivalent, in one of the following field: information theory, signal processing, electrical engineering, applied mathematics.

He/she should have a strong background in probabilities and information theory as well as in signal processing for wireless communications. He/she can easily manipulate algebra and mathematical analysis, convex or non convex optimization, measure and estimation theory.

He/she is willing to confront theory to experimental results and for such, the candidate is able to program and to conduct experimentation on software radio platforms.

The objective of this PhD is to propose a comprehensive theoretical framework and to develop new collaborative coding techniques adapted to this new paradigm.

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be rather transient with bursty communications. Therefore, our objective is to design on-the-fly protocols allowing any radio node to transmit almost instantaneously a short packet of information in the network, to one or several destinations, avoiding complex synchronization, scheduling and coordination. This kind of communication is a key issue for future 5G (and beyond) communications in order to control vehicles, drones, robots and any other non-human things in real time.

The optimization of URLLC IoT protocols thus requires to reshape almost completely the communication protocol stack to balance latency and reliability with side constraints such as energy efficiency or computational complexity.

The key elements for these communications are to reduce drastically the needs for synchronization, signalling and detection issues. The packet should be encoded such that all these steps can be performed jointly to avoid costly and long headers to be transmitted.

The proposed approach will rely on estimation theory and hypothesis testing techniques to design new optimal techniques to transmit very short packets (typically less than 100 bits) in a multi-user scenario. The key issue for such problem is to increase diversity at the receiver: multi-antennas reception, opportunistic relaying, joint transmission, multi-user detections are fundamental techniques that have to be reshaped in the context of small packets.

We will take care about the multi-objective framework: increasing reliability should not be done at a high price in terms of complexity or energy efficiency.

The candidate will leverage on recent results in information theory and on hypothesis testing to establish new performance bounds and to derive some fundamental trade-offs (e.g. energy-reliability, latency-reliability, energy-capacity,...), leading to the characterization of optimal multi-user transmission schemes in the Bayesian sens.

This framework will help to design new distributed coding techniques including opportunistic cooperation and relaying. The performance of the proposed algorithms will be confronted to the theory, validated by simulation and experimentally assessed on the plateform FIT/CorteXlab.

Some references relative to this topic:


Skills

Technical skills and level required:

- theoretical background: probability and statistics, algebra, functional analysis, optimization theory, signal processing.
- specialization in one of these fields: estimation theory, measure theory, information theory, coding.
- programming: familiar with Matlab, Python or C/C++ languages.
- experience in GNU radio programming is not mandatory but would be appreciated.

Languages:

- English: read/write/speak fluently.
- French is optional.

Relational skills:

- Strong autonomy, innovation, ideas.
- Like to collaborate, to confront ideas.
- Open mind.

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities
Remuneration

Gross income: 1982€ the 1st and 2nd year; 2085€ the 3rd year.