2018-00681 - Pushing Low Power Wide Networks to Their Limits [PhD campaign]

Level of qualifications required : Graduate degree or equivalent
Fonction : PhD Position

About the research centre or Inria department

Grenoble Rhône-Alpes Research Center groups together a few less than 800 people in 35 research teams and 9 research support departments.

Staff is localized on 5 campuses in Grenoble and Lyon, in close collaboration with labs, research and higher education institutions in Grenoble and Lyon, but also with the economic players in these areas.

Present in the fields of software, high-performance computing, Internet of things, image and data, but also simulation in oceanography and biology, it participates at the best level of international scientific achievements and collaborations in both Europe and the rest of the world.

Other informations :
Agora team: https://team.inria.fr/agora/
CITI Laboratory: http://www.citi-lab.fr/
Herve Rivano: http://perso.citi.insa-lyon.fr/hrivano/
Oana Iova: http://perso.citi.insa-lyon.fr/oiova/

Mots-clefs: Internet of Things, Low-Power Wide Area Networks, Dense networks, LoRa, Sigfox, NB-IoT, Capacity, Performance

Context

The CITI laboratory, and Lyon at large, provides a fertile environment for high-quality research. CITI is an academic laboratory associated with INSA Lyon and Inria, which develops research activities bringing together computer science, networking, and digital communications to address the challenging issues related to the development of wireless, mobile, and connected devices (e.g., Internet of Things). The full cross-layer expertise that CITI acquired during the past ten years makes it a very original, challenging, and almost unique place in France.

AGORA is a young, diverse, and multicultural group working on mechanisms and protocols designed for the specific settings of the urban environment. With a background on optimization, stochastic geometry, cellular networks, and multi-hop wireless networks, the group has active collaborations with experts in transportation, air pollution, urbanism, economics, and robotics.

Lyon[1] is a very vibrant and international city, being voted France’s best city for students in 2017 by the student magazine l’Etudiant. With a wide diversity of sports activities, cultural events, outings, and excursions, Lyon offers everything for an unforgettable higher education experience.


Assignment

We live in a world where technology is advancing at a very fast pace. The current wireless scene includes a multitude of technologies that co-exist in the same environment. New long-range technologies (e.g., Sigfox[1], LoRa[2], NB-IoT[3]) manage to transmit small data packets over several kilometers, while consuming just a few mA. Due to the low price of these radio chips, and the simplicity of the network architecture, network operators around the world are deploying these new technologies, as it helps them avoid the classical multi-hop wireless networks that are expensive to build and maintain. However, if deployments continue at the current rate, it will considerably increase the density of devices, which will become very challenging both from a network
infrastructure and data collection perspectives. This thesis tackles the problem of how to create a reliable and energy efficient long-range network of millions of devices.

The thesis will include a study of the state of the art of Low Power Wide Area Networks (LPWANs), which will help the PhD student build up skills in this field, and improve her/his technical knowledge. Several papers describing these new technologies have been recently published, mostly focused on performance evaluation (how far can the communication between two device reach [4,5], what is the impact of temperature [6], what is their coverage [7], etc.), but also trying to model the capacity of LPWANs [8]. It is important to develop a critical sense while studying these papers, and carefully analyze the hypothesis that were made, how accurate the modes are, and which tools were used to evaluate them.

Main activities

The thesis will be focused on studying the effects of density in the specific case of LPWANs. One question that arises is what are the consequences of density on the existing protocols (e.g., LoRaWAN [9]), and on the shared resources (e.g., wireless channel). New protocols and algorithms could be defined in order to address the co-existence of millions of devices. The already existing models could be enriched in order to take into account the dense environmental conditions, or new models could be proposed.

One main point to take into consideration during the theses is the reliability of dense LPWANs. How can millions of devices communicate in a reliable manner, while keeping low energy consumption that will guarantee a lifetime of tens of years? Several methods can be considered, from simple retransmissions or costly acknowledgements, to more complex algorithms, such as intra-network coding, or spatial-temporal correlation of the collected data.

The PhD student is expected to build up technical skills, and evaluate his/her proposed solutions both in simulations and/or emulation, and on the experimental LPWAN testbed that is currently being deployed by the Agora team on the La Doua Campus in Lyon.

Bibliography


Skills

The candidate must possess a Master’s degree or an equivalent degree (e.g. engineering degree) in Computer Science or Telecommunications. Good mathematical background and wireless networking as well as practical skills with programming languages (e.g. C/C++, Java, Python), and fluent English are required.

The candidate should also have a willingness to address both theoretical and experimental aspects of the problem. Knowledge of the French language is not mandatory.

Benefits package

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

Remuneration

Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).