2019-01379 - PhD Position F/M [Sub - 2019] - Communication Protocols based on alternative paradigm for wireless mobile devices

Type de contrat : CEO de la fonction publique
Niveau de diplôme exigé : Bac + 5 ou équivalent
Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Inria Lille - Nord Europe Research Centre was founded in 2008 and employs a staff of 360, including 300 scientists working in sixteen research teams. Recognised for its outstanding contribution to the socio-economic development of the Nord - Pas-de-Calais Region, the Inria Lille - Nord Europe Research Centre undertakes research in the field of computer science in collaboration with a range of academic, institutional and industrial partners.

Contexte et atouts du poste

The INRIA FUN research group investigates solutions to enhance programmability, adaptability and reachability of FUN (Future Ubiquitous Networks) composed of RFID, wireless sensor and robotic networks. Limited resources, high mobility and high security level evolving in distrusted environments characterize the objects that compose FUN. They communicate in a wireless way. To be operational and efficient, such networks have to follow some self-organizing rules. Indeed, components of FUN have to be able in a distributed and energy-efficient way to discover the network, self-deploy, communicate, self-structure in spite of their hardware constraints while adapting the environment in which they evolve. For additional information on the FUN research group, please see http://team.inria.fr/FUN/

Context
Cooperation and coexistence of heterogeneous technologies and devices play a key role to realize ubiquitous and pervasive networks. Generally, the cooperation among heterogeneous devices is based on information acquired through the communication among the nodes. "Traditional" communication paradigms are based on link through electromagnetic fields waves (i.e. electromagnetic radiation), but alternative communication paradigms can be envisaged to improve efficiency, energy consumption and ubiquitous concept. For example, one can think to exploit the already available (to illuminate) LEDs that could be conveniently used to acquire useful information based on different emerging communication paradigm such as the VLC. A different communication paradigm could have inherent advantages in respect of the traditional approaches such as:

1) An environment where a "traditional" communication paradigm is difficult (e.g. environments too noisy with too many interferences);
2) Data rate could be higher than traditional communication (e.g. as in the case of the VLC paradigm);
3) The possibility to design and implement "smart" devices, that could adaptively select the best way to communicate based on their proper current status, the status of the neighbors and the surrounding conditions
4) The integration of mechanisms to make the communication system robust to attacks (e.g. Denial-of-Sleep attacks, eavesdropping).

Topic
The objective of this PhD course is to study and derive alternative communication paradigms among mobile devices. At the beginning, the PhD student will review the literature, by focusing on different and alternative (in respect of traditional techniques) communication paradigms. The candidate will be supported in the definition of the requirements of the system aimed at supporting a new communication paradigm. He will benefit from the background and expertise of the team in this context, acquired in the last years and that dealt with the implementation of two testbeds. The first one is concerning a VLC communication system where an Artificial Intelligence (AI) approach has been developed on top of the receiver (a photodiode) in order to manage control parameters to reduce the Bit Error Ratio (BER) [1] [2].

The other test-bed is implementing an indoor geo-localization system with a mobile user (i.e. the transmitter) that has to be geo-localized [3].

The final part of the doctoral program will be devoted to the design and implementation of a communication protocol based on a specific novel communication paradigm. The PhD candidate will be asked to analyze and identify some specific evaluation parameters, in order to define the goodness of the protocol and the critical issues in terms of security, by analyzing some specific types of attacks such as for instance Denial-of-Sleep attacks, eavesdropping. Moreover, a potential approach that could be explored would be the implementation of some machine learning techniques to be directly integrated in the devices, in order to develop effective, efficient and secure [4] cooperation mechanisms among the nodes.

Mission confiée

Under the direct responsibility of the supervisor, the candidate will be in charge to investigate alternative communication paradigms and develop a new communication protocol based on one of the selected paradigms for wireless mobile devices. Moreover, the candidate will be in charge to analyze and design coexistence solutions with preexisting communication techniques (e.g. WiFi, Bluetooth, etc.). The candidate will validate theoretical solutions through simulation and a proof-of-concept approach based on implementation on real devices.

Principales activités

Time Schedule

Year 1

M0-M3: The PhD student will spend 2-3 months to survey the state of the art in terms of alternative communication paradigms also regarding the type of security attacks in the context of the IoT networks.

M4-M8: Based on the analysis and study of the literature, the student will focus on a specific alternative paradigm and will design a novel communication protocol, in order to make mobile devices able to communicate in the most efficient and secure way. The candidate will need to study and individuate the limitations and the criticism of the specific communication protocol also under specific networks attacks.

M9 – M12: The candidate will study the specific application scenarios that could put the communication system in crisis (e.g. by individuating specific types of interference or condition where the communication fails).

At the end of the Year 1, the candidate should have acquired the theoretical background and knowledge to effectively design and develop communication techniques based on a different communication paradigm.

Year 2:

M13 – M18: Based on the communication protocols developed, the candidate will design and implement cooperation techniques among the mobile nodes.

M19-M24: The candidate will evaluate the results of the cooperation techniques both theoretically and by the means of simulation tools. Based on the communication protocols developed, the candidate will design and implement cooperation techniques among the mobile devices.

At the end of the Year 2 the candidate should have acquired the competencies to design and implement cooperation techniques based on a new communication paradigm and to individuate and recognize the limitations of a similar system.

Year 3:

M25 - M27: The candidate will revise the AI techniques available in literature and will individuate the most suitable solution to be applied to the novel communication system. The AI mechanism to be implemented has the main goal to make the device as smart as possible and then able to detect the best way to communicate (i.e. the selection of the most appropriate communication paradigm) based on both external environment and internal conditions.

M28-M36: The last six months will be devoted to the validation of the results achieved, both theoretically and via simulation, through the implementation of the AI techniques on the real robotic platform and to the evaluation of the performance in different scenarios and under different conditions.

At the end of the Year 3 the candidate should have acquired the competencies to propose AI approaches, specifically addressing two different communication paradigms (the new selected and the “traditional” one based on electromagnetic fields waves) that coexist in a unique device. He is also supposed to be acquired the capabilities to test the effectiveness of the system in a real scenario. He will be also asked to be able to create specific and critical scenarios in order to test the platform in “difficult” and critical situations.

Compétences

Skills

• Very good programming skills in C/C++/Python, Experience using Linux systems
• Ability to implement code on real devices
• The willingness to contribute to interdisciplinary scientific project
• In-depth interest in scientific problems and the motivation for independent and goal-oriented research

Required qualities

• Sense of organization, autonomy, rigor
• Teamwork taste
• Listening and communicating with non-technical contacts;
• Know write notes / reports
• Good knowledge of English

Required Diploma and experience: One among the following master or engineer degree is expected: Electrical, Electronic Engineer, Telecommunication Engineer, Computer Science, Informatics, or a related discipline.

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)
- Access to vocational training
- Social security coverage

Rémunération

1st and 2nd year: 1593.50€ Net monthly salary (after taxes)

3rd year: 1676.31€ Net monthly salary (after taxes)