

Titre de la thèse – PhD Title:

Proactive service-based resource management for CCAM applications.

Collaboration- Partnership: *IMT Atlantique / SRCD*

IMT Atlantique : Campus Brest Nantes Rennes

Laboratory : IRISA

École doctorale : SPIN 3MG

Financement - Funding: PIEEC Orange



IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

Context:

IMT Atlantique, internationally recognised for the quality of its research, is a leading general engineering school under the aegis of the Ministry of Industry and Digital Technology, ranked in the three main international rankings (THE, SHANGHAI, QS). Located on three campuses, Brest, Nantes and Rennes, IMT Atlantique aims to combine digital technology and energy to transform society and industry through training, research and innovation. It aims to be the leading French higher education and research institution in this field on an international scale. With 290 researchers and permanent lecturers, 1000 publications and 18 M€ of contracts, it supervises 2300 students each year and its training courses are based on cutting-edge research carried out within 6 joint research units: GEPEA, IRISA, LATIM, LABSTICC, LS2N and SUBATECH.

The proposed thesis is part of the research activities of the team: EASE (Enable Affordable Smart Environment) and of the laboratory IRISA (<http://irisa.fr>) and the department SRCD (Système Réseaux, Cybersécurité et Droit du numérique). The scientific activities of this department are related to networks and telecommunications.

The IRISA EASE research group aim to ease development, deployment, evolution and maintenance of pervasive applications in complex environments with a strong focus on smart cities and smart agriculture. We are especially interested in cooperative autonomy applied to autonomous vehicles. We develop a comprehensive set of new interaction models and we are interested in new communication technologies that could support such local ephemeral interactions. 5G-V2X is one of these technologies. The project takes place in a larger project (<https://www.cnrs.fr/en/pepr/pepr-dacceleration-5g>) launched by the French government in order to responds to the challenges of 5G and the networks of the future.

Scientific and technological context:

V2X (Vehicle to Everything) technology is pivotal in reducing road accidents, offering real-time communication among vehicles and infrastructure to enhance situational awareness and prevent collisions, aligning with the European Union's strategy to improve road safety and move towards a vision of zero road fatalities. Indeed, in order to decrease fatalities on roads while maintaining efficiency, vehicles will have to cooperate together and with roadside infrastructure using V2X communication technologies. Several technologies are in competition to gain access to the 5 GHz ITS bands, and other mass-market communication technologies could be used in order, for example, to cooperate with other devices (smartphone). The ITS (Intelligent Transportation Systems) communication architecture has to evolve to allow the cohabitation of multiple incompatible communication technologies and their unavoidable evolutions.

In the context of V2X communication, the team is interested in the way information is exchanged to enhance the various involved devices (vehicles, smartphone, roadside equipment, ...) making decisions. Awareness information is to be broadcast by all allowed to use reserved channels. In this context, the development of 5G-V2X offers many opportunities introducing a new V2X mode ready to operate in the 5 GHz ITS band with a fully decentralized access control (mode 2).

Radio resource allocation typically ensures fairness among users and/or prioritization based on the service class. This operating principle requires oversizing the radio resources allocated to the most demanding service classes. In the case of CCAM (Cooperative, connected and automated mobility), a large number of critical services can coexist on a limited resource, leading to occasional overloads of the 5G resources allocated to this type of service.

Expected contributions of the thesis:

The objective of this work is to design a service-based radio resource management method that ensures communications meet the service's time constraints while adopting a frugal approach. By ensuring that the most important and urgent information is transmitted first, it is possible to avoid increasing the capacity allocated to this type of service. The definition of the importance of a given piece of information depends on the service logic related to CCAM. For example, depending on the complexity of the situation, a vehicle may request confirmation of its own perception as it prepares to cross an intersection. This will require a form of real-time cooperation between the vehicle and the network, which must be studied, particularly to find the right level of

(de)centralization of the underlying resource allocation process. The levers that can be mobilized to distribute the demand relate to the service logic (criticality of the information, time constraints, ability to anticipate demand, ability to manage unavailability), as well as the possibility of mobilizing other means of exchange.

Profil du candidat – Required skills:

- Network architecture and protocols
- 4G and ideally 5G technologies (3GPP)
- Simulation, Implementation of a platform with OpenAir Interface.
- Standard soft skills for a doctoral thesis (imagination, precision, tenacity, listening, team spirit)
- Fluent English

Plan de travail – Work Plan:

- Skill development: 3GPP standard (5G), V2X communication technologies, ITS services
- Identification of target services and associated priority levels
- Prototype of a centralized allocation mechanism dependent on geography
- Prototype of a decentralized (local) allocation mechanism
- Consideration of anticipation in resource allocation
- Evaluation/validation of the proposed mechanisms in the project's use cases
- Existing platforms will be supplemented to carry out preliminary developments and experiments.

Candidature – Application:

To apply for this position, please send a detailed application including a cover letter, an up-to date CV, transcripts of grades and reference letters will be addressed to: Jean-Marie Bonnin (jm.bonnin@imt-atlantique.fr)

Renseignements complémentaires - Additional Informations :

- Date de fin de candidature - Application deadline : April 30th 2024
- Date de démarrage de la thèse - Start date : September-October 2024
- Durée du contrat - Contract duration: 36 months
- Localisation - Location :
 - IMT Atlantique, campus de Rennes, 2 rue de la Chataigneraie, 35510 Cesson Sévigné
 - The thesis will be in IMT Atlantique (campus of Rennes) premises and bound to IRISA Lab (<https://www.irisa.fr/>).
 - The doctorale school is SPIN: <https://ed-spin.doctorat-bretagne.fr/fr/lecole-doctorale>
- Contact(s): jm.bonnin@imt-atlantique.fr