Université Lille Nord de France
Pôle de Recherche et d'Enseignement Supérieur

Ecole doctorale régionale Sciences Pour l'Ingénieur Lille Nord-de-France - 072

Titre Thèse	Large scale IoT experimentation for smart cities	
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Financement prévu	Contrat Doctoral Etablissement	ULille ☐ UPHF ☐ Centrale Lille ☐ Yncrea ☐
	Région – Autre ☐	Contrat de recherche ☐ Préciser :
Financement acquis ? ☒	Contrats de Recherche ☒ Préciser Nano2022 (ST)	Autre ☐ Préciser

Résumé du sujet :

The smart city, the connected man, the environmental monitoring ... so many applications that need to retrieve information via communicating objects. The number of such objects continues to grow and this is accompanied by a massive increase in wireless transmissions, a heterogeneity of deployed systems and the great variability of environments (in space, in time). Moreover, for energy reasons, the protocols to access the radio resource must be reduced to their minimum (grant free access, Non-Orthogonal Multiple Access - NOMA). A major consequence is the increased impact of interference. Future networks will then face two challenges: robustness and adaptability, with a strong energy constraint and lifespan. In particular, interference will not present the traditional Gaussian behavior generally assumed in IoT / M2M heterogeneous networks but will have a more impulsive behavior [1,2]. This impulsivity will have a major impact on future networks that it is important to understand, especially for short packets for which one or more strong pulses can drastically degrade performance [3]. This impact remains difficult to determine. If theoretical approaches (such as stochastic geometry for example) attempt to provide answers [4], the results of experiments are sorely lacking in order to optimize the radio links. Moreover, it is difficult to conceive satisfactory experiments in a laboratory environment since a large number of nodes and a variety of protocols must be deployed and evaluated in an environment that changes over time.

The objectives of the project are to design a hardware/software receiver architecture, robust to non-Gaussian (or Gaussian) interference that we will deploy in places of life. We are targeting a specific location, representative of smart cities: Lilliad learning center in Lille University. The goal is to define transmission and reception strategies that are both energy efficient and robust in the context of IoT, i.e., for sporadic transmissions and interference that can sometimes behave differently from the traditional Gaussian noise. In particular the design of the receivers and the numerical treatments allowing to implement the non-linearities necessary for the optimal reception will be studied, based on a 28nm FD-SOI technology in conditions of energy efficiency. The gain control and the response of the low noise amplifier can be adapted, the saturations of the amplifier naturally impacting the very nature of the interference.

[1] M. Egan, L. Clavier, M. de Freitas, L. Dorville, J.M. Gorce and A. Savard, "Wireless Communication in Dynamic Interference", IEEE GLOBECOM 2017, Singapore 4-8 Dec. 2017

[2] E. Soret, L. Clavier, G.W. Peters, F. Septier, I. Nevat, "Modeling interference with alpha-stable distributions and copulae for receiver design in Wireless Communications", 61st World Statistics Congress, 16-21 July 2017, Marrakech

[3] V. Dimanche, A. Goupil, L. Clavier, G. Gellé, "On detection method for soft iterative decoding in the presence of impulsive interference", IEEE Commun. Lett., 18, 6 (2014) 945-948

[4] De Freitas M., Egan M., Clavier L., Goupil A., Peters G.W., Azzaoui N., "Capacity bounds for additive symmetric α-stable noise channels", IEEE Trans. Inf. Theory 63, 8 (2017) 5115-5123.