

**Journée de la Fédération Charles Hermite  
Mercredi 12 décembre 2018, IECL Nancy.**

## **Modélisation mathématique et solutions pour la mobilité dans les réseaux sans fil**

**9h45 – 10h15 : Café d'Accueil**

**10h15 – 11h15 : Nicola Roberto Zema (LRI- Université Paris-Sud)**

An overview of multi-domain problems and solutions for controlled mobility in wireless networks

**Abstract:** The talk will describe a bird's eye view on the scientific problems related to Controlled Mobility in Wireless Networks. It will present what are the real problems, inherent for sets of communicating devices like UAVs or other robots, that embody a mobility that can be entirely controlled. In the talk, it will be proposed a taxonomy that classifies the different issues, present in literature, among a set of axes. These are chosen in respect to the varying disciplines and domains related to mobility in networks. The talk will first try to present what does it mean to consider a Mobility, in Wireless Networks, that is controllable and then illustrate what could be a set of urgent issues to be addressed in the field. It will then proceed to categorize the current scientific interests in a set of dimensions like the temporal scope, the degree of controllability and others.

**11h20 – 12h20: Marceau Coupechoux (LTCI – Telecom Paris Tech)**

Optimal Trajectories of UAV Base Stations

**Abstract:** In this presentation, we consider the problem of optimizing the trajectory of an Unmanned Aerial Vehicle (UAV) Base Station (BS). We consider a map characterized by a traffic intensity of users to be served. The UAV BS must travel from a given initial location at an initial time to a final position within a given duration and serves the traffic on its way. The problem consists in finding the optimal trajectory that minimizes a certain cost depending on the velocity and on the amount of served traffic. We formulate the problem using the framework of Lagrangian mechanics. When the traffic intensity is quadratic (single-phase), we derive closed-form formulas for the optimal trajectory. When the traffic map is divided in regions of quadratic traffic intensity (multi-phase) and time-varying, we propose an online algorithm based on Model Predictive Control (MPC). When the traffic intensity is bi-phase and time-independent, we provide necessary conditions of optimality and propose an Alternating Optimization Algorithm that returns a trajectory satisfying these conditions. Numerical results show how we improve the trajectory with respect to the MPC solution.

**12h20-13h45 : Pause déjeuner**

**13h45-14h45 : Arnaud Casteigts (LABRI – Université de Bordeaux)**

Finding and Exploiting Structure in Highly-Dynamic Networks

**Abstract:** Mobile entities like robots, drones, or vehicles can communicate directly with each other, inducing highly-dynamic networks where the communication links appear and disappear frequently (and sometimes unpredictably). While these networks may look chaotic at first glance, offering no evident structure to exploit in a protocol (or algorithm), it is often the case that they actually satisfy more subtle properties of a temporal nature. In other words, the dynamics of the network itself obeys a number of temporal constraints that one could use with benefits. In this talk, I will review a number of such properties that the networking and distributed computing communities have recently identified and successfully exploited. As much as possible, the talk will remain technology-insensitive, focusing instead on graph-theoretical properties and algorithmic ideas of wide applicability in the aforementioned technological contexts. The talk will conclude with an opening on collective movement synthesis, where temporal properties in the resulting network are satisfied by construction.

**14h50-15h50 : Anastasios Giovanidis (Lip6 – UPMC / CNRS)**

**Successful file transmission in mobile D2D networks with caches**

**Abstract:** In this talk, we will consider device-to-device (D2D) wireless networks, where user devices also have the ability to cache content. In such networks, users are mobile and communication links can be spontaneously activated and dropped depending on the users' relative position. Receivers request files from transmitters, these files having a certain popularity and file-size distribution. We will introduce a new performance metric, namely the Service Success Probability, which captures the specificities of D2D networks for the Poisson Point Process case of node distribution and both the SNR and SINR coverage model. Association can either be cache-aware or cache-unaware depending on information availability over cache inventories. We derive explicit expressions related to the defined performance metric using stochastic geometry analysis. We further extend the analysis from one-shot transmission to consecutive transmitter associations, where the receiver is allowed to profit from node mobility and gradually receive service by associating stepwise to nodes in its vicinity. It is illustrated that D2D communications considerably benefit from multiple consecutive associations, which can guarantee service completion especially in high mobility environments.

**15h50-16h15 : Pause café**

**16h15-17h15 : Jean-Philippe Georges, Francis Lepage, Vincent Lecuire (CRAN – Université de Lorraine)**

**Communications par réseaux de capteurs pour des systèmes en mobilité sur trajectoires connues**

**Abstract:** Parmi les systèmes mobiles ceux pour lesquels la trajectoire est connue est un cas fréquent. Des exemples dans l'industrie sont les navettes (camions, trains, conteneurs, ...) d'alimentation en matières premières ainsi que les chariots porte-produits dans les chaînes de fabrication, dans les transports publics sont les trains, bus et tramway et dans les loisirs sont les télésièges, les manèges et les circuits automobiles. La surveillance de ces mobiles peut avoir pour but la gestion temps réel de leur mission pour optimiser le service rendu, leur maintenance ou leur sécurité. L'Internet des objets est un concept qui s'applique bien à cette finalité. Dans ce cadre nous considérons l'usage des réseaux de capteurs comme technologie pour la collecte des informations sur les mobiles. Cette technologie est caractérisée par une courte portée des liaisons et par le relayage possible des transmissions par tout nœud du réseau créant ainsi un réseau sans infrastructure. Nous cherchons d'abord la topologie du réseau la mieux adaptée à la trajectoire du ou des mobiles en fonction de critères de performance. Puis nous focaliserons la présentation sur la conception d'un protocole de communication adapté aux systèmes mobiles liés parcourant ensemble la trajectoire et nous présenterons ses performances. L'application à un télésiège est en cours d'étude pour expérimentation réelle.

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