MODELING OF LARGE WIRELESS NETWORKS

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Objectives

The course is focused on the modeling of large wireless networks using random graph theory and stochastic geometry. These tools provide natural ways of defining and computing macroscopic properties of wireless networks which consist of a large collection of nodes executing some common protocol. The course will show how to perform various kinds of space and time averages which capture the key dependencies of the network performance characteristics (connectivity, stability, capacity, etc.) as functions of a relatively small number of parameters.

The course will be structured in 3 blocks:

I. Modeling of Medium Access Control;

II. Modeling of Routing Protocols;

III. Modeling of Overlay Networks.

The instructional objective is that students having completed the course be in a position to use the described methodology for research in e.g. cellular, mobile ad hoc or vehicular networks i.e. to develop new models coming from these networks and to analyze and optimize these networks.

Prerequisites

The course requires some basic knowledge on wireless networking, information theory, probability theory and stochastic processes. The main tools of the theory of stochastic processes to be used are Poisson point processes in the Euclidean plane. It is *not* required to have taken the Fall 2012 course SPACE-TIME STOCHASTICS (16964, 56549) to take this course.

I. Modeling of Medium Access Control

This part will develop the quantitative analysis of the main Medium Access Control protocols used in wireless networks. The main topics to be covered are:

- Interference in Large Wireless Networks;
- Coverage and Shannon Rates in Aloha Networks;
- Coverage and Shannon Rates in CSMA Networks;
- Coverage and Shannon Rates in Cellular Networks;
- Broadcasting in Vehicular Networks.

Various optimizations based on this quantitative analysis will be discussed.

II. Modeling of Routing Protocols

This will develop both qualitative and quantitative results. The most important qualitative results are in terms of phase transitions for infinite population models. The main topics to be covered are:

- Connectivity in Large Wireless Networks;
- Shortest Path Routing in Random Networks;
- Geographic Routing in Large Wireless Networks.

III. Modeling of Overlay Networks

This part will leverage the material covered in the two first parts and discuss more global architecture and design problems for overlay networks using wireless links. The topics to be covered will include:

- Network Information Theoretic Overlays;
- Cognitive Radio Overlays;
- Peer-to-Peer Overlays.

Material

The following material will be used in the course:

[BB] F. Baccelli & B. Blaszczyszyn, *Stochastic Geometry and Wireless Networks*, Vol. 1, 2, NOW Publishers, 2009.
pdf available at http://hal.inria.fr/inria-00403039 and http://hal.inria.fr/inria-00403040

[HG] M. Haenggi & R. K. Ganti, *Interference in Large Wireless Networks*, NOW Publishers, 2009.

[SKM] D. Stoyan, W. Kendall & J. Mecke, *Stochastic Geometry and its Applications*, John Wiley and Sons, second edition, 1995.

[WA] S. Weber, J. G. Andrews, *Transmission Capacity of Wireless Networks* NOW Publishers, 2012.

Evaluation

The evaluation will be based on:

- Assignments: 25%
- A first written midterm exam: 25%
- A second written midterm exam: 25%
- A research paper to read and present: 25%