MODELING OF LARGE WIRELESS NETWORKS

UT Austin ECE Course, Spring 2016 Semester

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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 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. The course will provide self contained material on the matter[1].

Contents

The course will contain the required mathematical foundations on Poisson point processes and three blocks of network modeling:

I. Modeling of Medium Access Control This part will develop the quantitative analysis of the main Medium Access Control protocols used in wireless networks using Poisson shot noise fields:

- 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;

Various optimizations based on this quantitative analysis will be discussed.

[1] It is *not* required to have taken the Fall 2015 class on Stochastic Geometry (M 393C, EE 381V, 53750) to take this class

II. Modeling of Routing Protocols This part will develop both qualitative and quantitative results. The most important qualitative results are in terms of percolation and phase transitions for infinite population models:

- 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:

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

References

The main reference will be:

[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

Here are other related references:

[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.

Grading

- Assignments: 33%
- Two midterm exam: 34%
- A research paper to read and present: 33%