EE 60554: Communication Networks

Instructor: Prof. Martin Haenggi, 274 Fitzpatrick, `mhaenggi@nd.edu`
Lecture: TH, 9:30–10:45pm, DBRT 208
Text: Dimitri Bertsekas and Robert Gallager, *Data Networks* (2nd Ed., 1992), Prentice Hall
Available at `http://www3.nd.edu/~mhaenggi/ee60554/BG/`
Thomas G. Robertazzi, *Computer Networks and Systems: Queueing Theory and Performance Evalution*, 3rd Ed., Springer, 2000.
Jean-Yves Le Boudec and Patrick Thiran, *Network Calculus*, Springer, 2001.

Motivation and Course Objective

Modern communication networks are one of the most complex systems where the reliability and efficiency of the components play a very important role. For a good understanding of the dynamic behavior of these systems one has to construct mathematical models that describe the stochastic service of randomly arriving requests. *Queueing theory* is one of the most commonly used mathematical tool for the performance evaluation of such systems. Alternatively, packet arrivals and departures may be modeled deterministically, especially if a network has to strictly meet certain delay requirements. In this case, *network calculus* is the tool of choice for the modeling and analysis.

The focus of the class is to present the basic methods for the analysis of single queues and simple networks, using both queueing theory and network calculus. The main goal is to develop an understanding how models can be constructed and how they are analyzed. It is assumed that the student has been exposed to a first course in probability theory.

Course Outline

The course consists of three parts, which take about 1/6, 1/2, and 1/3 of the lecture time.

- Review of the OSI model, TCP/IP, UDP/IP, IPv6, and Internet applications (e-mail, web).
- Fundamentals of Markov systems, queueing models and theory (M/M/1 and extensions), stochastic traffic modeling. Little's theorem and Jackson networks.
- Network calculus: Min-plus algebra applied to network analysis. Arrival and service curves, min-plus convolution, sub-additive functions, rate functions, backlog, virtual delay, burst tolerance and leaky buckets.

Grading

Six homework assignments (10%), two midterm exams (25% each), a project (10%), and an oral final exam (30%).

Additional References

- James Kurose and Keith Ross, *Computer Networking—a Top-Down Approach Featuring the Internet*, 5th Ed., Addison-Wesley, 2010.
- James Norris, *Markov Chains*, Cambridge Series in Statistical and Probabilistic Mathematics, Cambridge University Press, 1997.