Resource Allocation in Communication Networks

Instructor: Lei Ying, lei.ying.2@asu.edu

Class Schedule: 3pm-4:15pm, Tuesday and Thursday

Course Description

Traditionally, communication networks analysis has primarily meant a purely queueing theoretic viewpoint. Lately, this view has undergone a radical change and there is need to view a communication network architecture as a slow time-scale, control-theoretic solution to a large-scale distributed optimization problem. This approach will show a student why the layered architecture is a natural by-product of the desire to design a fair and stable system. This course will also demonstrate the important role of distributed algorithms, probabilistic methods, queueing theory and stochastic processes in designing algorithms.

Prerequisite

EEE 459 and EEE 480, or equivalent. Basic understanding of optimization will also be useful. Required mathematical background will be introduced in class when needed.

Major Topics

1. Convex optimization and network utility maximization

2. Layering as optimization decomposition: A cross-layer design approach in multihop wireless networks

3. Scheduling in wireless networks

4. Peer-to-peer networks

Weekly Schedule

Week 1: Introduction to resource allocation in communication networks

Week 2: Convex optimization (one lecture), Lyapunov stability (one lecture)

Week 3: Network utility maximization (Kelly's formulation)

Week 4: Algorithms for resource allocation: primal algorithm

Week 5: Introduction to duality, dual algorithm, and primal-dual algorithm

Week 6: The Internet congestion control protocol: TCP Reno, TCP Vegas

Week 7: The Internet congestion control protocol: TCP Illinois, adaptive virtual queue algorithm for active queue management

Week 8: Stability of delayed differential equation, network stability under feedback delays

Week 9: Introduction to layering as optimization decomposition, stochastic stability, Foster-Lyapunov theorem

Week 10: Scheduling in packet switches

Week 11: Scheduling in wireless networks

Week 12: Throughput-optimal routing and scheduling in multihop wireless networks

Week 13: Peer-to-peer networks

Week 14: The classic gossip process

Week 15: Probability results: Chernoff bound, balls-and-bins argument, Poisson heuristic

Week 16: Capacity of ad hoc wireless networks (Gupta and Kumar's result)

Textbook

R. Srikant and Lei Ying, "Communication Networks: An Optimization, Control and Stochastic Networks Perspective". The book draft will be distributed in class.

Course Assessment (tentative)

Homework (60%), final report (20%), final presentation (20%)