6.263J/16.37J Data-Communication Networks

3-0-9   Grad H

TR  1pm-2:30pm  32-124


Course description. Introductory course aimed at providing an analytic perspective to data networks with telephone networks and the Internet being primary applications. Basic tools for modeling and performance analysis will be taught accompanied by elementary, meaningful simulations. Insights will be developed for large networks by means of simple approximations. This self contained course will draw upon concepts from queueing and optimization.

Pre-requisite. Knowledge of basic probability (6.041/6.431) or instructor’s consent.

Grading policy. 4 home-works (20%), a mid-term (30%), and a final (50%).

Course Staff.

○ Instructor. Prof. Devavrat Shah, 32-D670, x34670, Email: devavrat@mit.edu.

○ Admin. Lynne Dell, 32-D664, x23679, Email: ldell@mit.edu.

Course text. Primarily, class notes by the Instructor. Additional reference texts are


Lecture schedule. The following is the lecture schedule.

• Introduction and fundamentals
  o [L1] Course logistics, History of communication, Overview and Little’s Law
  o [L2/L3] Markov chain, stationary distribution and balance equation, Geom/Geom/1 queue, M/M/1 queue, M/M/m/m queue, M/M/∞ queue.

• Telephone network and optimization
  o [L4] Loss network model, product form distribution, loss probability and Erlang’s formula, mean-field approximation for large network.
  o [L5] Elements of convex optimization

• Internet architecture: introduction
  o [L6] Packet switched (MUX effect), end-to-end philosophy, and layering
    physical (telephone, wireless, LAN, wired and optical); data (IP, routing);
    transport (TCP, UDP, congestion control); application (email, video, P2P);
    other architectural issues: security, QoS, provisioning.

• Physical layer: medium access protocols for wireless/(old)LAN
  o [L7] Slotted Aloha – 1/2e and 1/e results.
  o [L8] Slotted Aloha – mean-field model
  o [L9] Carrier Sense Multi Access (CSMA) protocol

• Physical layer: packet switched routers
  o [L10] Output queued switch architecture, Pollaczek Khinchine.
  o [L11,12,13] Input queued switch architecture, scheduling algorithm, fluid model and performance under overload.

• Physical layer: optical core architecture
  o [L14] Circuit-switched model and ‘burst’ switching

• Data layer: routing
  o [L15] BGP and shortest path algorithm
  o [L16] Ideal routing using flow level optimization model with cost inspired by PK formula; ‘selfish’ routing and relation to the ideal model, and correction.

• Data layer: congestion control
  o [L17] Windowed TCP, differential equation approximation, drop probability approximation under RED.
• [L19] Relation of TCP differential equation model and primal/dual algorithm; insights on design of ‘better’ congestion control; and overall routing, congestion control resource allocation.

• Algorithms inside the network: router algorithms


• Application layer, algorithms at the end-host