Lecture 25
Fall 2009
Wrap-up

Our Goals
- Engineering digital communication systems
  - Understanding key concepts
  - Exposing you to a range of important EECS ideas
- Across the different layers of the “stack”
  - Links, shared channels, multi-hop networks
  - Physical, link, network, and transport layers
- Across traditional “EE” and “CS” boundaries

Three Big Challenges
- Reliability
  - Communication is a notoriously hard problem; many things can go wrong
- Sharing
  - Dedicated links are impossibly expensive
- Scalability
  - Successful networks are large; large networks are successful (utility grows with size)

Approach
- Understand tools and techniques
  - Concepts and principles
  - Labs
  - Small problems
- Begin to understand trade-offs
  - The essence of all engineering systems
  - Science, art, or a mix?
  - Principles and tools matter, as do intuition and experience

Experimental Apparatus
- Analog Headset
- Workstation: Python/Numpy Streaming tools
- USB cable

Network Simulation
Reliability (1): Understanding Problems

- Challenge: Overcome wide range of faults
  - Inter-symbol interference, noise, bit errors, packet loss, buffer overflow, link failures, ...
- Digital abstraction
  - Key to enabling composition
  - Lab: Clock+data recovery, 8b/10b
- Inter-symbol interference
  - LTI, superposition, eye diagrams
  - Lab: unit-sample response, deconvolution
- Noise
  - Understanding Gaussians, PDFs, CDFs
  - Lab: measure, predict bit error rates

Reliability (2): Overcoming Problems

- Bit error detection + correction
  - Lab: interleaved block coding
  - Lab: Viterbi decoding of convolutional codes
- Packet loss
  - Lab: reliable transport protocols, sliding windows
- Link faults
  - Lab: routing around failures (distance vector and link-state protocols)

- Common theme: apply redundancy in creative ways

Sharing

- Challenge: Communication resources aren’t free or cheap
- Circuit v. packet switching (queues, Little’s law)
- Sharing a common medium (channel)
  - Lab: understanding frequency response; filters
  - Lab: frequency division multiplexing
  - Lab: Contention and time division MAC protocols (Aloha, CSMA, TDMA, exponential backoff)
  - Reducing amount of data sent: compression

Trade-Offs

- A number of techniques - how to apply them and make them work together?
- Reliability: apply redundancy in creative ways to build reliable systems out of unreliable components
- Sharing: reduce the amount of resources consumed
- Scalability: hide information, reduce amount of state to be managed

EECS Ideas

- Signals and systems
  - LTI, superposition, unit-sample response, frequency response, modulation
- Algorithms, centralized and distributed
  - Trellis decoding (Viterbi), shortest paths (Dijkstra), distance vector routing (Belman-Ford), compression (LZW, JPEG)
- Computer systems
  - Abstraction and modularity, layering, protocols, hierarchy
- Applied probability
  - Continuous-domain probability (density): reliability analysis
  - Discrete-domain probability: MAC protocol analysis
  - Basic queueing models: packet switch sharing analysis
- Methods: design, simulation, experimentation

Feedback

- Please give us your feedback
- HKN review form on web site → please complete this week!
- Anonymous tear-off sheet at end of Quiz 3
  - Please fill it out
- Email/talk to us any time
- Finish up remaining labs and checkoffs
Discussion

- Which activities worked well?
  - Lectures
  - Recitations
  - Labs: did they help understand material? Were they interesting?
  - Online psets: how effective?
  - Review problems

- Did we cover too much? Too little?

- Would you like to be an LA?