**Course Summary**

What have we learned: a huge amount!
- principles
- practice
  ..... using Internet to motivate examples

**Chapter 1: Introduction**

Our goal:
- get "feel" and terminology
- more depth, detail *later* in course
- approach:
  - use Internet as example

Overview:
- what's the Internet
- what's a protocol?
- network edge
- network core
- Internet/ISP structure
- performance: loss, delay
- protocol layers, service models
- network modeling
Chapter 2: Application Layer

- conceptual, implementation aspects of network application protocols
  - transport-layer service models
  - client-server paradigm
  - peer-to-peer paradigm
- learn about protocols by examining popular application-level protocols
  - HTTP
  - FTP
  - SMTP
  - DNS
- web security
- programming network applications
  - socket API

Chapter 3: Transport Layer

- understand principles behind transport layer services:
  - multiplexing/demultiplexing
  - reliable data transfer
  - flow control
  - congestion control
- reliable multicast
- learn about transport layer protocols in the Internet:
  - UDP: connectionless transport
  - TCP: connection-oriented transport
  - TCP congestion control
Chapter 4: Network Layer

- understand principles behind network layer services:
  - forwarding
  - routing (path selection) - performance vs policy
  - dealing with scale
  - how a router works
  - NATs, IPv6
- instantiation in the Internet
- broadcast, multicast routing

Chapter 5: The Data Link Layer

- understand principles behind data link layer services:
  - error detection, correction
  - sharing a broadcast channel: multiple access
    - ALOHA (slotted and unslotted)
    - Ethernet
  - link layer addressing
- Ethernet switches
- link virtualization, brief introduction to ATM, virtual circuits
Chapter 6: Wireless & Mobile Networks

Wireless
- Wireless links, characteristics
- IEEE 802.11 wireless LANs ("wi-fi")
- Cellular Internet Access
  - architecture
  - standards

Mobility
- Principles: addressing and routing to mobile users
- Mobile IP
- Handling mobility in cellular networks
- Mobility and higher-layer protocols

Chapter 8: Network Security

- understand principles of network security:
  - cryptography and its many uses beyond “confidentiality”
  - authentication
  - message integrity
  - certificate authority

- security in practice:
  - firewalls
  - security in application, transport, network, link layers (WEP)
Chapter 7: Multimedia Networking

Principles
- making the best of best effort service
  - dealing with delay jitter and loss
- mechanism for providing QoS
  - e.g., leaky bucket, weighted fair queuing

Protocols and Architectures
- specific protocols for best-effort
  - e.g., RTP/RTCP, SIP

Networked Systems

[Diagram showing various networked systems such as Cellular Access Network, Public Switched Telephone Network, Wireless LAN, Mobile Adhoc Network, Sensor Network, Internet, Gateway, and Home Network.]
Networking Applications

- financial – stock trading, portfolio management
- social – voice communication, email, chat, telecommuting
- entertainment – games, music, video, surfing
- medical – telemedicine
- ...

networked systems indispensable part of not just global communication infrastructure but our daily lives

Q: Whither goest networking?

A: nobody knows!

General trends:

- ubiquity of communications
  - IP dialtone, IP: like electricity: it's everywhere!
  - network-capable appliances (e.g., IP toaster)
  - issues of scale important: 100's of millions of network-connected devices

- mobility important:
  - people move, need to communicate

- multimedia important:
  - it is how people communicate
Q: Whither goest networking?

- increasing link rates, but bandwidth not free in near future
  - increased # "users"
  - increased bandwidth requirements of enabled apps
- high bandwidth to home (DSL, cable modems) a major driver for future
  - games, VR, education, information, entertainment
  - merger of networking and telephony
  - broadcast entertainment (TV) and WWW
- security, reliability, management: critical concerns

Our Very Last Note Page!

- this course:
  - specific architectures, protocols
  - fundamental issues: APIs, reliable data transfer, flow/congestion control, routing, multiple access, addressing, security, multimedia networking
- remember: you learned it HERE!
Three parts
- Part 0 - Name and course number - 1 point
- Part 1 - about 26 questions (1 point each) + 1 bonus question (1 point)
- Part 2 - 3-4 questions based on the RSVP paper ~ 3 points (extra credit for cs5480)

Closed book, closed notes, you can bring calculators

Post midterm material (however, expected to know important midterm concepts especially TCPs loss recovery, timeout estimation, etc.)

Important Topics
- Chapter 4: BGP, Broadcast/Multicast Routing, Virtual circuits
- Chapter 5: Different types of medium access protocols, ALOHA, Ethernet protocols (derivations, numerical examples), Ethernet switches, MAC addressing
- Chapter 6: IEEE 802.11 protocol (understand CSMA/CA, SIFS/DIFS, RTS/CTS etc.), IP & cellular network mobility (indirect, direct routing, HA/FA/COA, HLR/VLR, handover), TCP performance over mobile wireless networks
- Chapter 7: Delay jitter, playout delays, loss concealment, RTP, SIP, WFQ, Token Bucket, delay guarantees
- Chapter 8: Cryptography - symmetric key, public key, hash functions, Authentication Protocols, Firewalls and Gateways, WEP, IEEE 802.11i
- Do not have to prepare the material taught by Prof. Patwari
- cs6480 - RSVP paper
Final Exam on 12/10/07
10:30 AM to 12:00 noon

Post Midterm book sections

- Chapter 4: 4.2, 4.3 (excluding 4.3.2), 4.5.1, 4.5.2, 4.6.1, 4.6.3, 4.7
- Chapter 5: 5.1, 5.2 (excluding 5.2.3), 5.3, 5.4, 5.5 (excluding Manchester coding), 5.6, 5.8 (excluding 5.8.2)
- Chapter 6: whole chapter
- Chapter 7: 7.1 (intro), 7.1.1, 7.1.2, 7.1.3, 7.3 (excluding 7.3.4 and 7.3.5), 7.4.1, 7.4.3, 7.5 (intro), 7.5.1, 7.5.2
- Chapter 8: Entire chapter excluding SNORT