Last Class!

**Today:**
- what have we learned?
- where is the networking world going?
- final exam
- evaluation

Course Summary

*What have we learned: a huge amount!*

- Comprehensive view of field of Computer Networks
  - principles
  - practice

  ... using Internet to motivate examples
What did we do?

Introduction
- What is the Internet, protocol?
- network edge, core, access nets
- physical media
- delay, loss
- layers, service models
- Internet backbones, NAPs, ISPs
- history

Application Layer
- application-layer protocols
- the WWW: HTTP
- FTP
- email: SMTP, POP3, IMAP
- DNS
- Socket programming

What did we do?

Transport Layer
- services, principles
- multiplexing, demultiplexing
- UDP
- Principles of reliable of data transfer
- TCP
- Principles of congestion control
- TCP congestion control
What did we do?

Network Layer
- service model(s)
- routing principles
- hierarchical Routing
- IP protocol
- routing in the Internet
- what’s inside a router?
- mobility management

Link Layer, LANs
- introduction, services
- error detection, correction
- multiple access protocols
- LAN addresses, ARP
- Ethernet
- hubs, bridges and switches
- wireless: IEEE 802.11

Q: Where is Networking headed?

A: nobody really knows!

General trends:
- ubiquity of communications
  - IP dialtone, IP will be like electricity: it’s everywhere!
  - network-capable appliances (e.g., IP thermostat)
  - issues of scale important: 100’s of millions of network-connected devices
  - sensor networks
- mobility important:
  - people move, need to communicate
Q: Where is Networking headed?

- multimedia important:
  - it is how people communicate
  - QoS not a solved problem end-end
- high bandwidth to home (ADSL, cable modems) a major driver for future
  - games, VR, education, information, entertainment
  - merger of networking and telephony
  - broadcast entertainment (TV) and WWW
- security, and network management: critical concerns
- application-layer services: a network over the network: P2P, CDNs, etc.
- new architecture? on-going research

The Future: a broader CS view

1980 - 1995
computing communications

1995-2005
computing communications

2005 - ?
computing communications information processing
Remember Course Goals

- networking: will play a central role in computing, information processing
- this course:
  - specific architectures, protocols
  - fundamental issues: APIs, reliable data transfer, flow/congestion control, routing, multiple access, addressing, security, management
- remember: you learned it HERE!

Final Exam

- Network layer
  - Link State, Distance vector routing algorithm
  - Hierarchical routing
  - IP v4, v6 and Internet addressing
  - Internet routing protocols
  - Network address translation
  - Mobility management
  - Inside a router
Final Exam

- Data link layer
  - Service provided by data link layer
  - Multiple access protocols
  - Addressing and ARP
  - Ethernet, Hubs, Bridges, Switches
  - Wireless LAN

Evaluation
The End!