Last Class!

Today:
- what have we learned?
- where is the networking world going?
- question and answers
- questionnaires

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

Network Layer
- service model(s)
- routing principles
- hierarchical Routing
- IP protocol
- routing in the Internet
- what's inside a router?
## What did we do?

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

### Network Security
- introduction
- cryptography
- authentication
- integrity
- key distribution, certificates
- Firewalls
- secure email
- secure sockets
- IP sec
- 802.11 WEP

### Multimedia Networking
- application requirements
- making the best of best-effort service
- providing QoS in the network
- scheduling, policing
- Integrated Services
- RSVP
- Differentiated Services
What is the Internet?

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.

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**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!

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The End!