# Lecture 8: Overview of **Computer Networking** Slides adapted from those of

Computer Networking: A Top Down Approach, 5th edition. Jim Kurose, Keith Ross, Addison-Wesley, April 2009.

# KUROSE • ROSS

# <u>Roadmap</u>

- □ what's the Internet?
- □ network edge: hosts, access net
- □ network core: packet/circuit switching, Internet structure
- □ performance: loss, delay, throughput
- □ media distribution: UDP, TCP/IP

































# <u>Roadmap</u>

- □ what's the Internet?
- network edge; hosts, access net
- network core: packet/circuit switching, Internet structure
- performance: loss, delay, throughput in packet switching networks

□ TCP/IP



























## **Summary**

- Covered a "ton" of material!
- Internet overview
- □ network edge, core, access network
  - \* packet-switching versus circuit-switching
  - Internet structure
- □ performance: loss, delay, throughput
- □ layering, service models







# **Google Data Centers**

- □ Estimated cost of data center: \$600M
- Google spent \$2.4B in 2007 on new data centers





# Hybrid of client-server and P2P

#### Skype

- voice-over-IP P2P application
- centralized server: finding address of remote party:
- client-client connection: direct (not through server)

### Instant messaging

- chatting between two users is P2P
- centralized service: client presence detection/ location
  - user registers its IP address with central server when it comes online
  - user contacts central server to find IP addresses of buddies

2: Application Layer 39



# What transport service does an app need?

### Data loss

- some apps (e.g., audio) can tolerate some loss
- other apps (e.g., file transfer, telnet) require
  100% reliable data transfer

### Timing

some apps (e.g., Internet telephony, interactive games) require low delay to be "effective"

### Throughput

- some apps (e.g., multimedia) require minimum amount of throughput to be "effective"
- other apps ("elastic apps") make use of whatever throughput they get

### Security

□ Encryption, data integrity, ...

2: Application Layer 41

<u>Transport ser</u> apps	<u>vice requi</u>	<u>rements of co</u>	<u>mmon</u>
Application	Data loss	Throughput	Time Sensitive
file transfer	no loss	elastic	no
Web documents	no loss	elastic	no
real-time audio/video	loss-tolerant	audio: 5kbps-1Mbps video:10kbps-5Mbps	yes, 100's msec
stored audio/video	loss-tolerant	same as above	yes, few secs
interactive games	loss-tolerant	few kbps up	yes, 100's msec
instant messaging	no loss	elastic	yes and no
		2: A	pplication Layer 42

### Internet transport protocols services

#### **TCP** service:

- connection-oriented: setup required between client and server processes
- reliable transport between sending and receiving process
- □ *flow control:* sender won't overwhelm receiver
- congestion control: throttle sender when network overloaded
- does not provide: timing, minimum throughput guarantees, security

### **UDP service:**

- unreliable data transfer between sending and receiving process
- does not provide: connection setup, reliability, flow control, congestion control, timing, throughput guarantee, or security
- <u>Q:</u> why bother? Why is there a UDP?

2: Application Layer 43

	, .pp://di.off	layer protocol	transport protocol
	e-mail	SMTP IRFC 28211	ТСР
emote t	erminal access	Telnet [RFC 854]	TCP
<u> </u>	Web	HTTP [RFC 2616]	TCP
	file transfer	FTP [RFC 959]	TCP
stream	ing multimedia	HTTP (eg Youtube), RTP [RFC 1889]	TCP or UDP
Inte	ernet telephony	SIP, RTP, proprietary	
		(e.g., Skype)	typically UDP

### Next Lecture

- □ Media over IP
- Lab2 assigned later this week; due May 11th
  - Find your partner NOW (2-person group, email TA your group name + member names)
  - Build your own video compression/decompression system, use motion estimation
  - Apply different sets of packet loss & error patterns to your compressed video; observe the impact
  - Find ways to recover from errors and minimize media quality degradation
    - The top 5 groups will obtain extra 10% credit
  - Matlab or C/C++, must run on csil machines