

Network and Mobile Computing in the 20th Century and Beyond

COMP 1400

Memorial University

Winter 2015

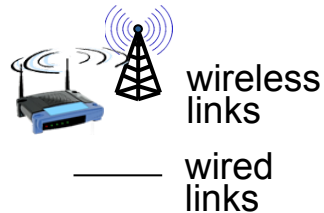
What's the Internet: "nuts and bolts" view



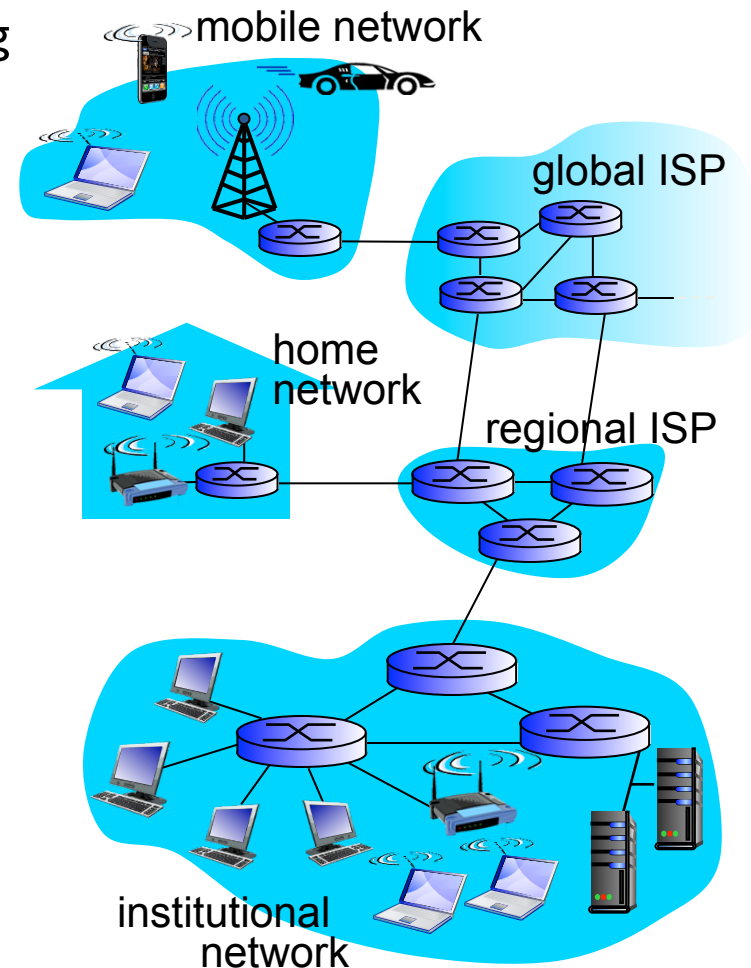
- millions of connected computing devices:
 - *hosts* = *end systems*
 - running *network apps*

❖ *communication links*

- fiber, copper, radio, satellite
- transmission rate: *bandwidth*



- ❖ *Packet switches*: forward packets (chunks of data)
 - *routers* and *switches*



“Fun” internet appliances



IP picture frame
<http://www.ceiva.com/>



Web-enabled toaster +
weather forecaster



Tweet-a-watt:
monitor energy use



Internet
refrigerator



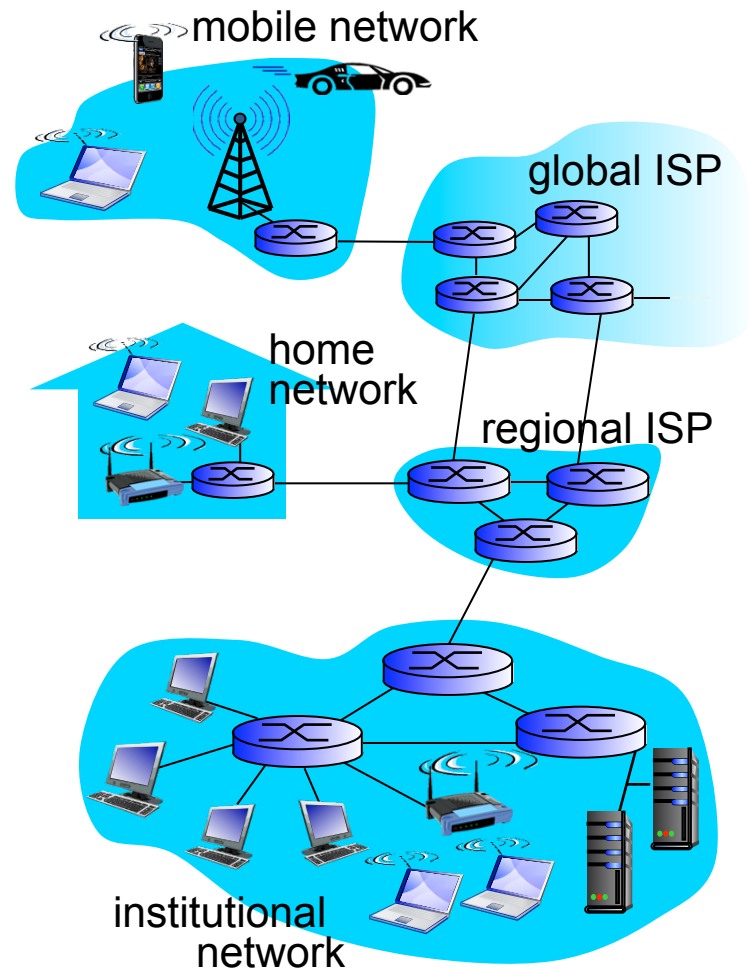
Slingbox: watch,
control cable TV remotely



Internet phones

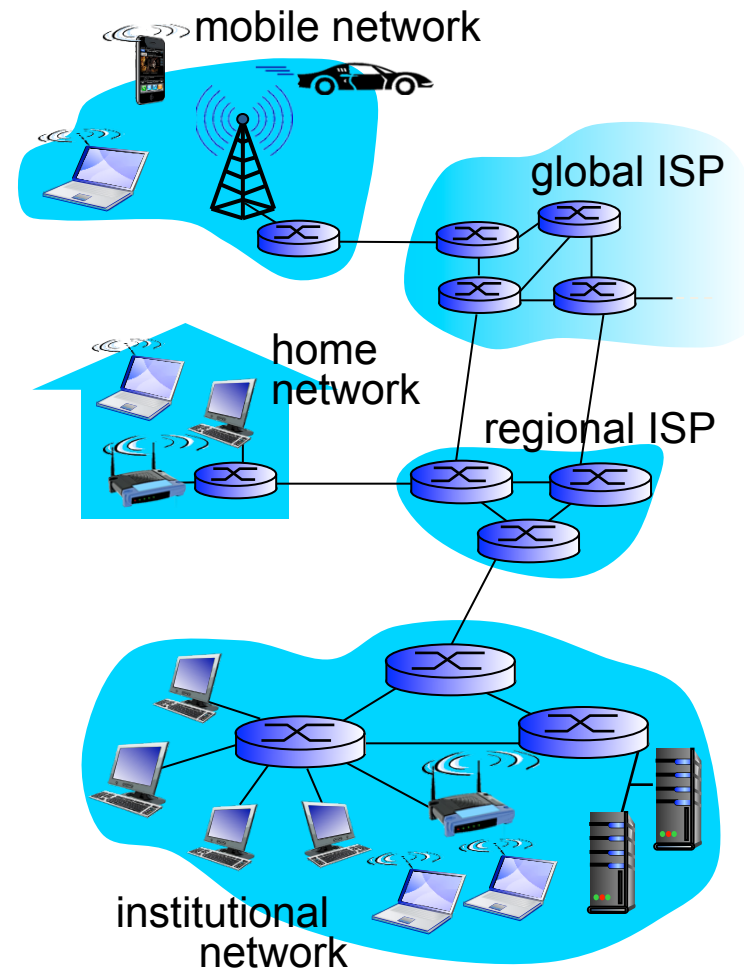
What's the Internet: "nuts and bolts" view

- *Internet: "network of networks"*
 - Interconnected ISPs
- *protocols* control sending, receiving of msgs
 - e.g., TCP, IP, HTTP, Skype, 802.11
- *Internet standards*
 - RFC: Request for comments
 - IETF: Internet Engineering Task Force



What's the Internet: a service view

- *Infrastructure that provides services to applications:*
 - Web, VoIP, email, games, e-commerce, social nets, ...
- *provides programming interface to apps*
 - hooks that allow sending and receiving app programs to “connect” to Internet
 - provides service options, analogous to postal service



What's a protocol?

human protocols:

- “what's the time?”
 - “I have a question”
 - introductions
- ... specific msgs sent
- ... specific actions taken when msgs received, or other events

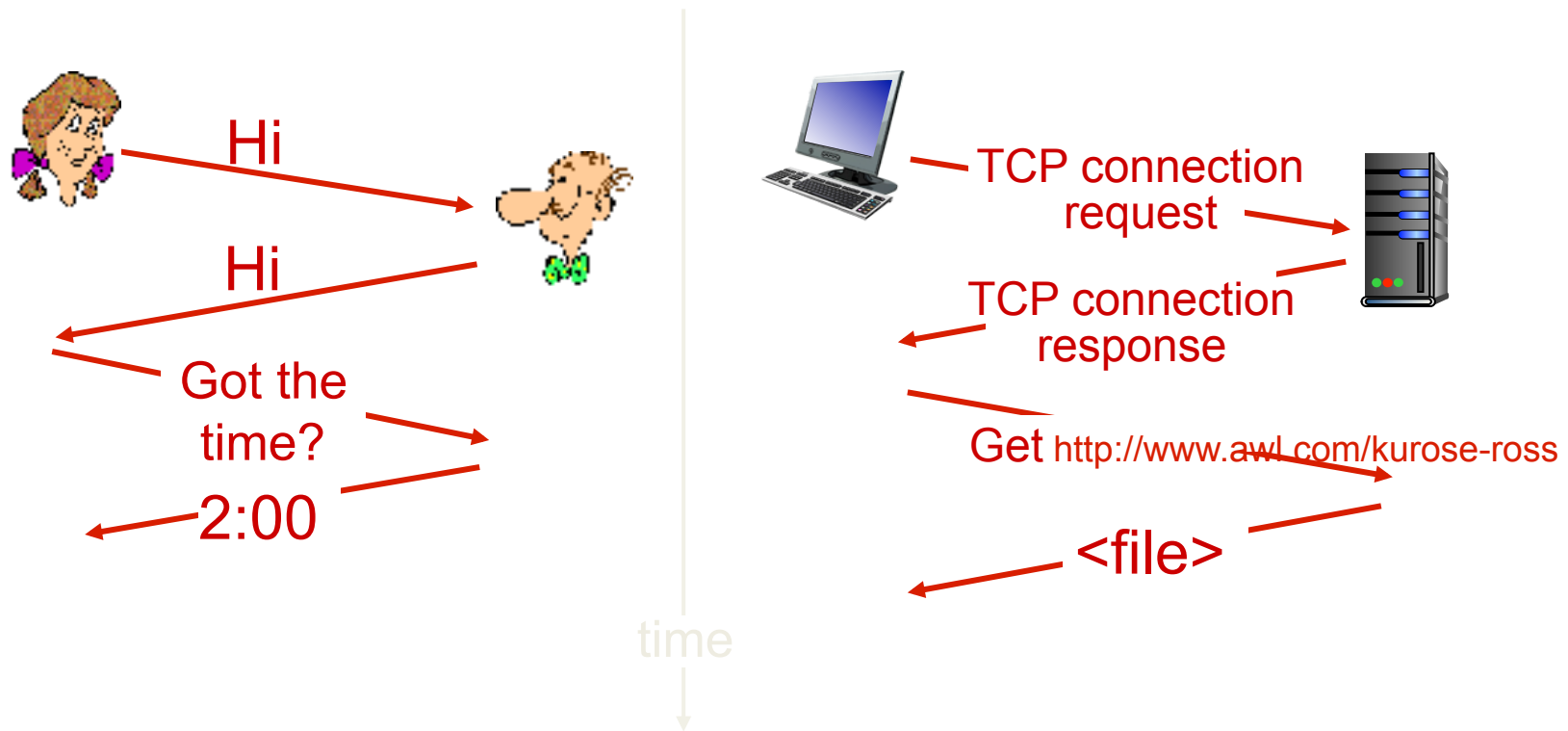
network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

What's a protocol?

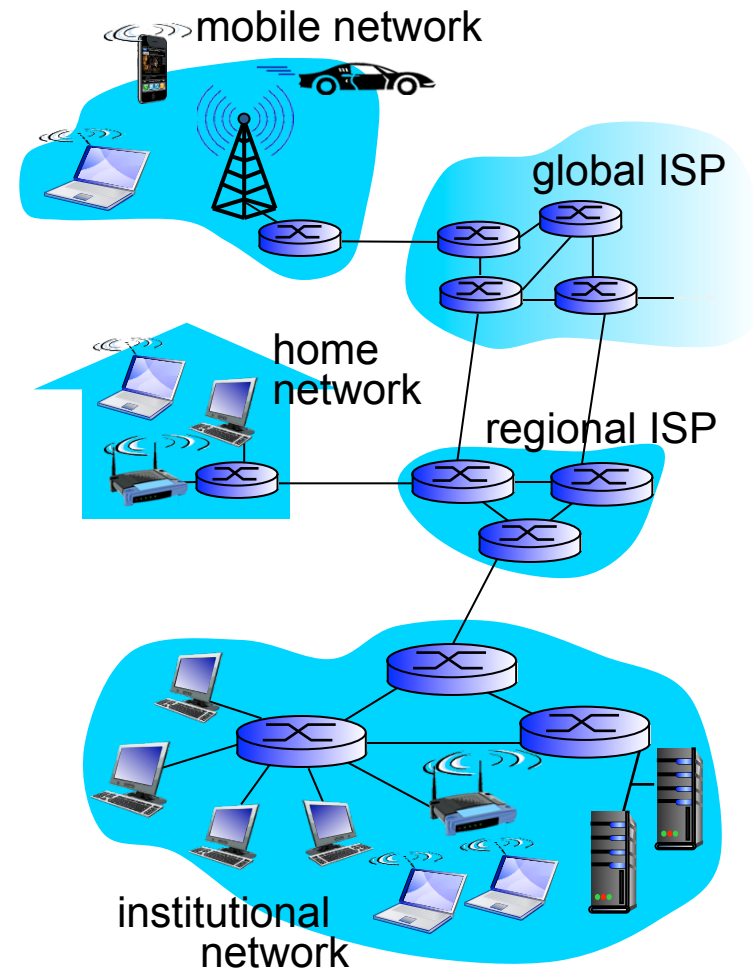
a human protocol and a computer network protocol:



Q: other human protocols?

A closer look at network structure:

- *network edge:*
 - hosts: clients and servers
 - servers often in data centers
- ❖ *access networks, physical media:* wired, wireless communication links
- ❖ *network core:*
 - interconnected routers
 - network of networks

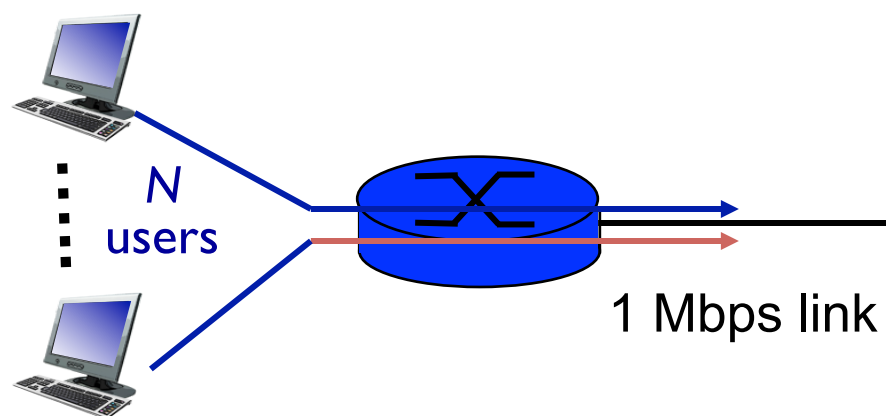


Packet switching versus circuit switching

packet switching allows more users to use network!

example:

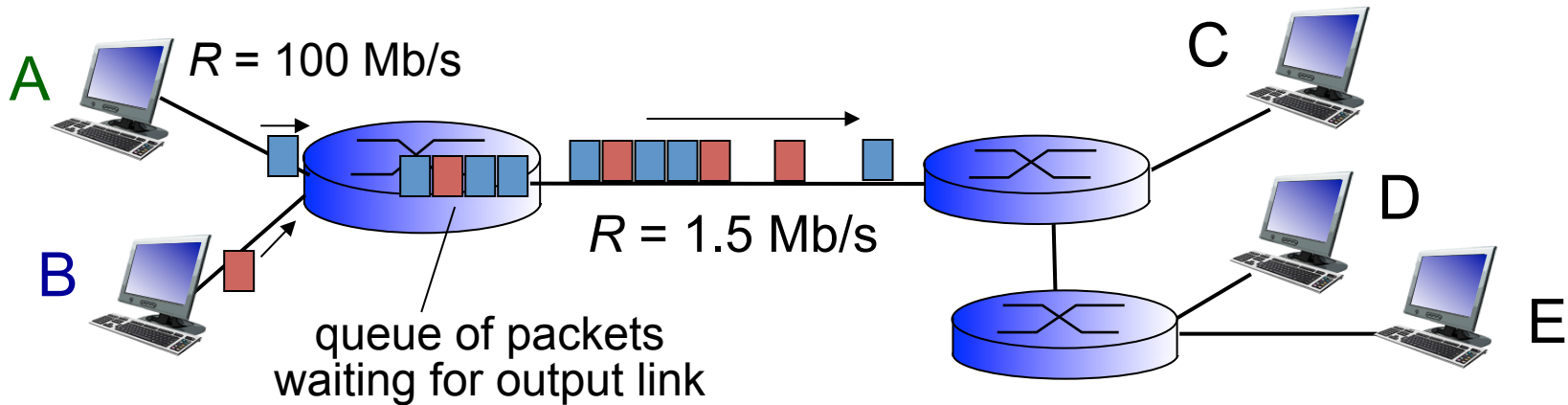
- 1 Mb/s link
- each user:
 - 100 kb/s when “active”
 - active 10% of time
- *circuit-switching:*
 - 10 users
- *packet switching:*
 - with 35 users, probability $>$ 10 active at same time is less than .0004 *



Q: how did we get value 0.0004?

Q: what happens if $>$ 35 users ?

Packet Switching: queueing delay, loss



queuing and loss:

- ❖ If arrival rate (in bits) to link exceeds transmission rate of link for a period of time:
 - packets will queue, wait to be transmitted on link
 - packets can be dropped (lost) if memory (buffer) fills up

Protocol “layers”

*Networks are complex,
with many “pieces”:*

- hosts
- routers
- links of various media
- applications
- protocols
- hardware, software

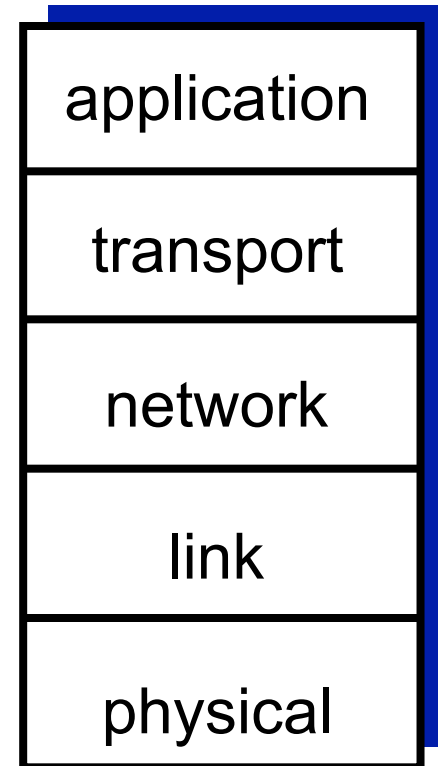
Question:

is there any hope of *organizing*
structure of network?

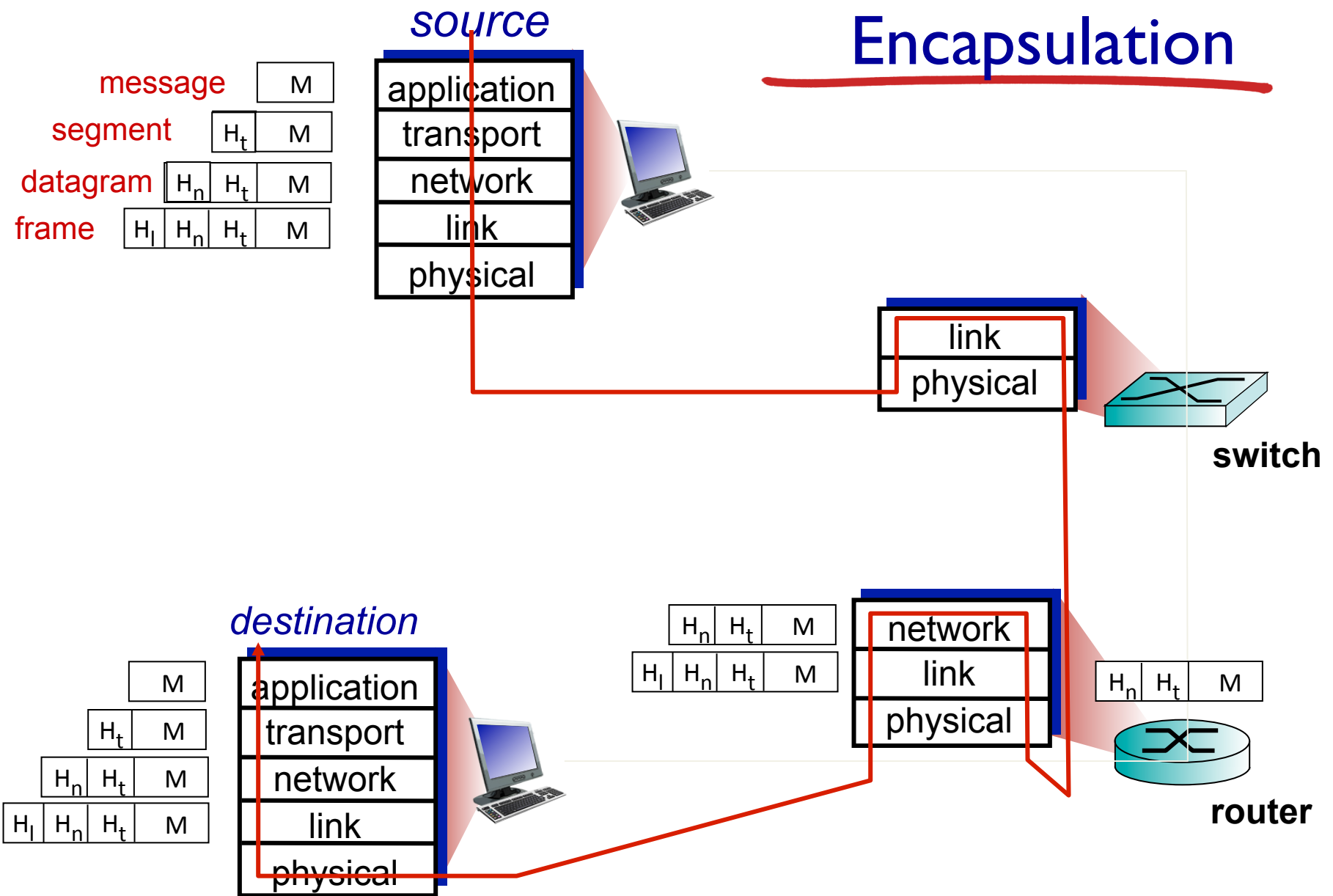
.... or at least our discussion
of networks?

Internet protocol stack

- **application:** supporting network applications
 - FTP, SMTP, HTTP
- **transport:** process-process data transfer
 - TCP, UDP
- **network:** routing of datagrams from source to destination
 - IP, routing protocols
- **link:** data transfer between neighboring network elements
 - Ethernet, 802.111 (WiFi), PPP
- **physical:** bits “on the wire”



Encapsulation



Web and HTTP

Web has been the most important application on the Internet

- *web page* consists of *objects*
- object can be HTML file, JPEG image, Java applet, audio file,...
- web page consists of *base HTML-file* which includes *several referenced objects*
- each object is addressable by a *URL*, e.g.,

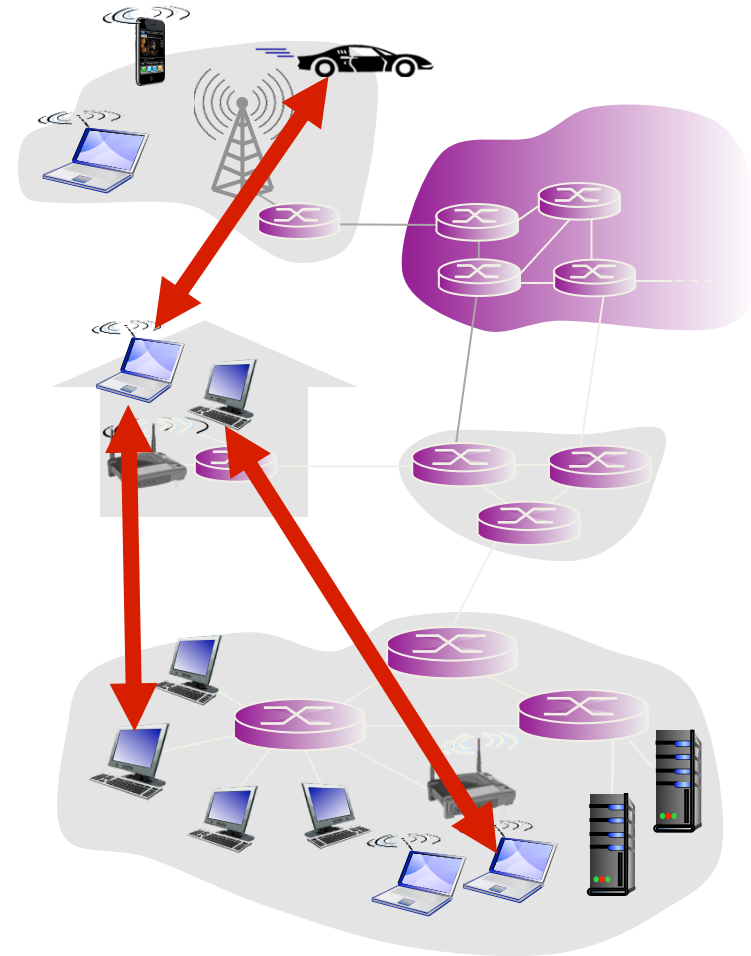
<code>www.someschool.edu/someDept/pic.gif</code>	
 host name	 path name
- carried by the HyperText Transfer Protocol

P2P applications

- *no* always-on server
- arbitrary end systems directly communicate
- peers are intermittently connected and change IP addresses

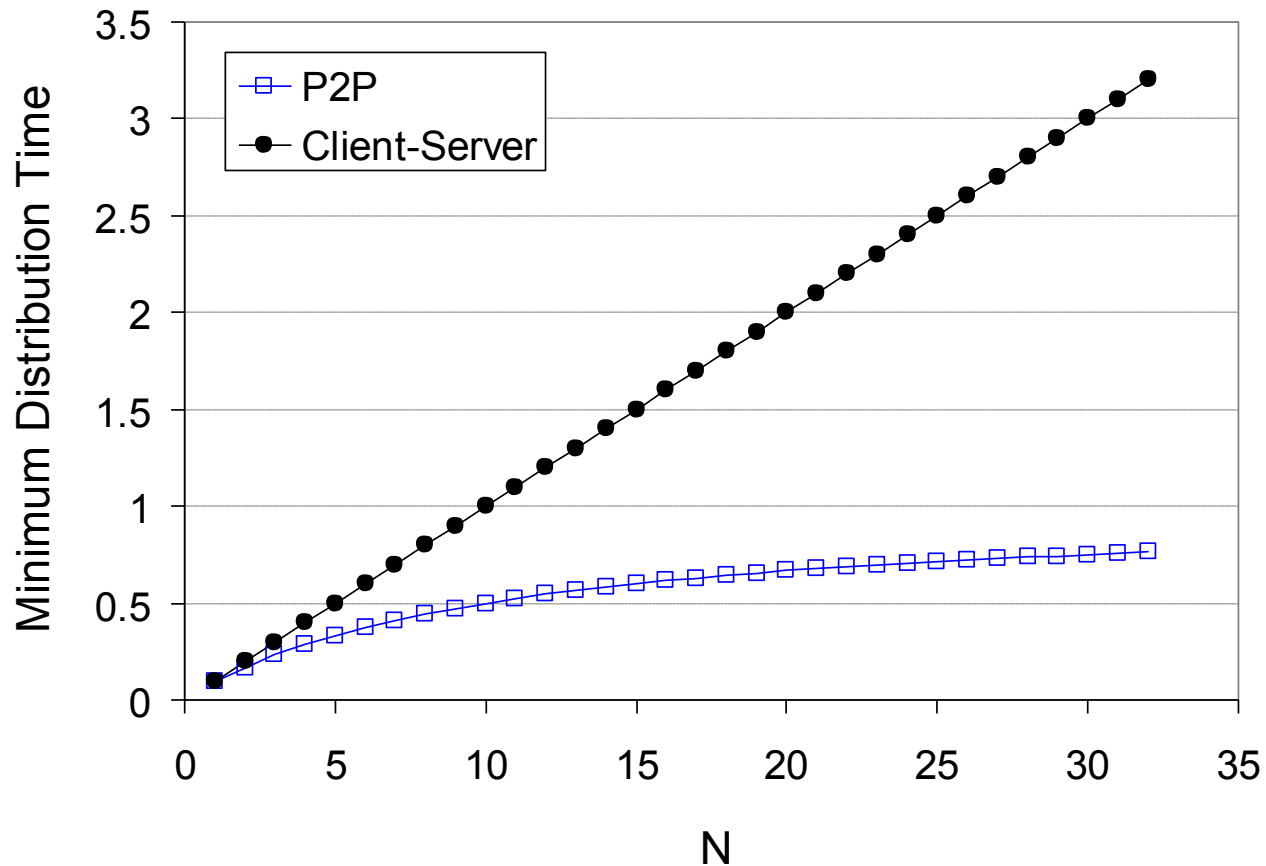
examples:

- file distribution (BitTorrent)
- Streaming (KanKan)
- VoIP (Skype)



Client-server vs. P2P: example

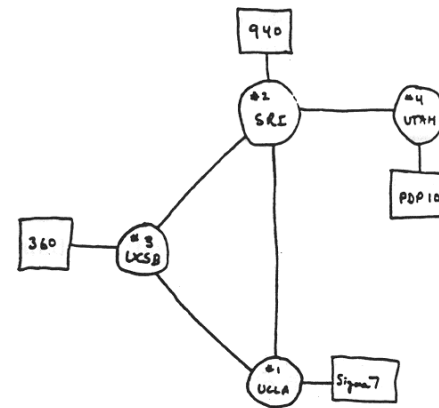
client upload rate = u , $F/u = 1$ hour, $u_s = 10u$, $d_{min} \geq u_s$



Internet history

1961-1972: Early packet-switching principles

- **1961:** Kleinrock - queueing theory shows effectiveness of packet-switching
- **1964:** Baran - packet-switching in military nets
- **1967:** ARPAnet conceived by Advanced Research Projects Agency
- **1969:** first ARPAnet node operational
- **1972:**
 - ARPAnet public demo
 - NCP (Network Control Protocol) first host-host protocol
 - first e-mail program
 - ARPAnet has 15 nodes



THE ARPA NETWORK

Internet history

1972-1980: Internetworking, new and proprietary nets

- **1970:** ALOHAnet wireless network in Hawaii
- **1974:** Cerf and Kahn - architecture for interconnecting networks
- **1976:** Ethernet at Xerox PARC
- **late 70' s:** proprietary architectures: DECnet, SNA, XNA
- **late 70' s:** switching fixed length packets (ATM precursor)
- **1979:** ARPAnet has 200 nodes

Cerf and Kahn' s internetworking principles:

- minimalism, autonomy - no internal changes required to interconnect networks
- best effort service model
- stateless routers
- decentralized control

define today' s Internet
architecture

Internet history

1980-1990: new protocols, a proliferation of networks

- **1983:** deployment of TCP/IP
- **1982:** smtp e-mail protocol defined
- **1983:** DNS defined for name-to-IP-address translation
- **1985:** ftp protocol defined
- **1988:** TCP congestion control
- new national networks: CSnet, BITnet, NSFnet, Minitel
- 100,000 hosts connected to confederation of networks

Internet history

1990, 2000's: commercialization, the Web, new apps

- early 1990's: ARPAnet decommissioned
- 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)
- early 1990s: Web
 - hypertext [Bush 1945, Nelson 1960's]
 - HTML, HTTP: Berners-Lee
 - 1994: Mosaic, later Netscape
 - late 1990's: commercialization of the Web
- late 1990's – 2000's:
 - more killer apps: instant messaging, P2P file sharing
 - network security to forefront
 - est. 50 million host, 100 million+ users
 - backbone links running at Gbps

Internet history

2005-present

- Over a billion hosts
 - More smartphones and tablets
- Aggressive deployment of broadband access
- Increasing ubiquity of high-speed wireless access
- Emergence of online social networks:
 - Facebook: over one billion users
- Service providers (Google, Microsoft) create their own networks
 - Bypass Internet, providing “instantaneous” access to search, email, etc.
- E-commerce, universities, enterprises running their services in “cloud” (eg, Amazon EC2)



Radio Shack AMERICA'S TECHNOLOGY STORE



PRESIDENTS' BIRTHDAY SALE!

DON'T DELAY!



All-Weather Stereo
Cut 34% 1188
Reg. 17.95
Realistic STEREO-MATE® AM/FM personal receiver shrugs off sand, water. #13-142. Requires extra batteries. See Radio Shack.



AM/FM Clock Radio
30% Off 1388
Reg. 19.95
Chromatonic™-261 clock radio's compact size cuts rightstand clutter. #12-1368. See Radio Shack.



In-Ear Stereo Phones
HALF PRICE! 788
Reg. 15.95
Realistic® in-ear phones weigh just 0.6 ounce! With carry pouch. #33-977. See Radio Shack.



Micro-Thin™ Calculator
39% Off 488
Reg. 7.95
Radio Shack EC-413 is almost the size of a credit card! Solar powered. #46-493. See Radio Shack.

3-DAY SPECIALS ABOVE GOOD SATURDAY THRU MONDAY ONLY!

0% INTEREST!

**NO PAYMENTS UNTIL MAY!
NO DOWN PAYMENT!**

HURRY! OFFER ENDS TUESDAY FEBRUARY 19

*See Radio Shack Store for details. Offer requires purchase of \$100 or more. Payment & fee by you. See listing for financing. An interest period may sometimes be added to a finance charge of up to 2.9% APR on all equipment monthly finance charges. Refer to your Radio Shack Account Agreement.

COME IN AND TAKE ADVANTAGE OF THESE OTHER FANTASTIC VALUES!

INTRODUCTORY SPECIAL!



Save \$670
\$1599

Low As \$10 Per Month • Reg. Separate Items 2269.65

- 286-Based PC Compatible
- Color Monitor
- 20MB SmartDrive™ Hard Drive
- Easy-to-Use 10-in-1 DeskMate® Software #25-4623/1043/1045/1338

BONUS PACKAGE

- Lotus Spreadsheet For DeskMate
- DeskMate Q&A Write
- Quicken
- 2-Button Mouse



Mobile Cellular Telephone
Save \$100
\$199*

Low As \$10 Per Month • Reg. 299.00

*Requires one activated and minimum phone contract with Radio Shack Cellular phone service. Some areas prohibited by state or local ordinance. Offer good in CA, HI, IL, IN, MI, NY and in the District of Columbia. © 1992.



Deluxe Portable CD Player
Save \$40
159.95

Low As \$10 Per Month • Reg. 199.95

Realistic® CD-3250 has 16 selector memory. Headphones extra. #43-507.



Tiny Dual-Superhet Radar Detector
Save \$60
79.95

Reg. 139.95

Road Patrol™ XX* detector lets you drive with confidence. Detects X and K-band tones. #22-101.



Compact 10-Channel Desktop Scanner
Save \$30
99.95

Low As \$10 Per Month • Reg. 129.95

Realistic® PRO-57 lets you catch the news as it happens! Hear police, fire, rail, military, lots more. #30-108.



VHS Camcorder
Save \$100
\$799

Low As \$20 Per Month • Reg. 899.00

Realistic Model 102 includes video light for indoor shooting. 2-tap battery. With accessories. #14-803.



Mobile CB With Channel Controls on Mike
HALF PRICE! 49.95

Reg. 99.95

Realistic TRC-430 lets you get highway info or help—you'll never have to drive "alone." #22-104.



Our Easiest-to-Use Phone Answerer
Cut 17%
49.95

Reg. 59.95

DUPHONE™ TAD-241 answerer is ready to use—just plug it in. Has built-in announcement. #43-365.



3-Way Speaker With Massive 15" Woofer
Save \$110
149.95

Each • Low As \$10 Per Month • Reg. 259.95

Optimus Match Two® system pumps out bass you can feel. 4" horn tweeter, 5" midrange. #43-433.



20-Memory Speed-Dial Phone
Cut 33%
29.95

Reg. 44.95

Radio Shack ET-292 Ten-Fone® is ideal for home or office. Tone-dialer. 10-line. #43-381. #299. #43-382.



Handheld Voice-Actuated Cassette Tape Recorder
40% Off
29.95

Reg. 49.95

Realistic CTR-85 makes an excellent "totobaker" for students, secretaries or executives. #14-1006.

Check Your Phone Book for the Radio Shack Store or Dealer Nearest You

*Radio Shack, Realistic, and Duphone are registered trademarks of Radio Shack Electronics Corporation. © 1992. All rights reserved. Prices subject to change without notice. See store for details. **PRICES APPLY AT PARTICIPATING STORES AND DEALERS.**

Radio Shack

Radio Shack Electronics Corporation
10000 Westpark Drive
Dallas, Texas 75243
© 1992 Radio Shack Electronics Corporation

Most Major Credit Cards Welcome

Now and beyond

- Computers in your pocket, on your wrist and face
- Machine to machine
- Environment monitoring through the crowd
- Healthy life styles and medical research
- Ubiquitous computing
 - Ambient intelligence

“The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.”

Mark Weiser

Chief Scientist, Xerox PARC

The Computer for the 21st Century

Scientific American

September 1991