COSC264
Introduction to Computer Networks and the Internet

Introduction to Network Applications, Web and HTTP

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Outline

- Network applications
  - Network apps vs app. protocols
  - Application structure
- The Web
- HTTP

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The most popular network applications

- The Web
  - Search engine
  - E-commerce
  - Banking
  - News
  - Online video
  - Blog
- Email
- Instant messaging
  - Text/pic/sound
  - Video call
- Video conferencing/gaming

Other applications

- telnet
- File transfer (ftp)
- News group
- P2P file sharing

What is a network application?

- Programs that run on different end systems and communicate with each other over the network;
    - Web browser program in the user’s host;
    - Web server program in the web server host;

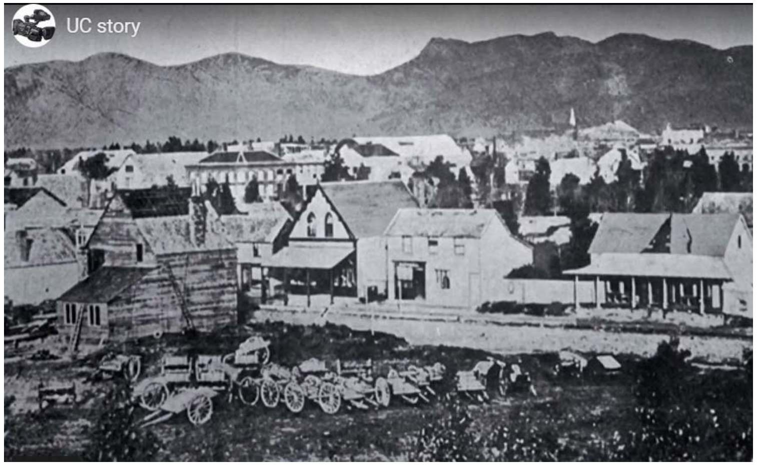
Network apps vs application protocols

- An application protocol is only one piece (a big one) of a network application.

Network app	Application protocol
Web (other pieces: HTML, web browsers, web servers)	HTTP (one piece of web, protocol)
Email	SMTP

Services an app needs

- Reliable data transfer
  - Email; instant messaging; file transfer, financial applications;
  - There are loss-tolerant applications though;
    - Multimedia applications



Bandwidth

- Rate
  - Internet telephony application
  - Many multimedia apps are bandwidth-sensitive;
- Elastic apps
  - Not strict with bandwidth;
  - Email; file transfer;

Timing

- Tight timing constraints
  - Interactive real-time apps: Internet telephony, virtual environments, teleconferencing, multiplayer games;
  - End-to-end delay: < 100s of ms;

Services provided by the Internet transport layer

TCP	**UDP**
Connected-oriented service	Connectionless service
Reliable transport service	*Unreliable data transfer service*
Congestion control (*NO guarantee of min transmission rate*)	*No congestion control*
Flow control	*No flow control*
No guarantee of delay	*No guarantee of timing*

The Internet has been hosting time-sensitive applications for many years!

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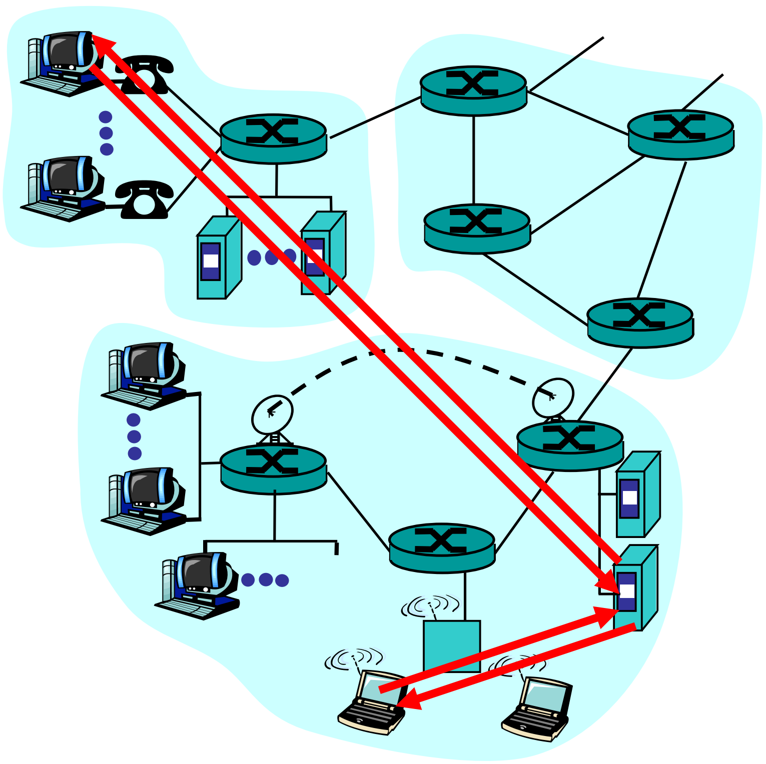
Application architectures

- Client-server
- Peer-to-peer (P2P)
- Hybrid of client-server and P2P

Client-server archicture



server:

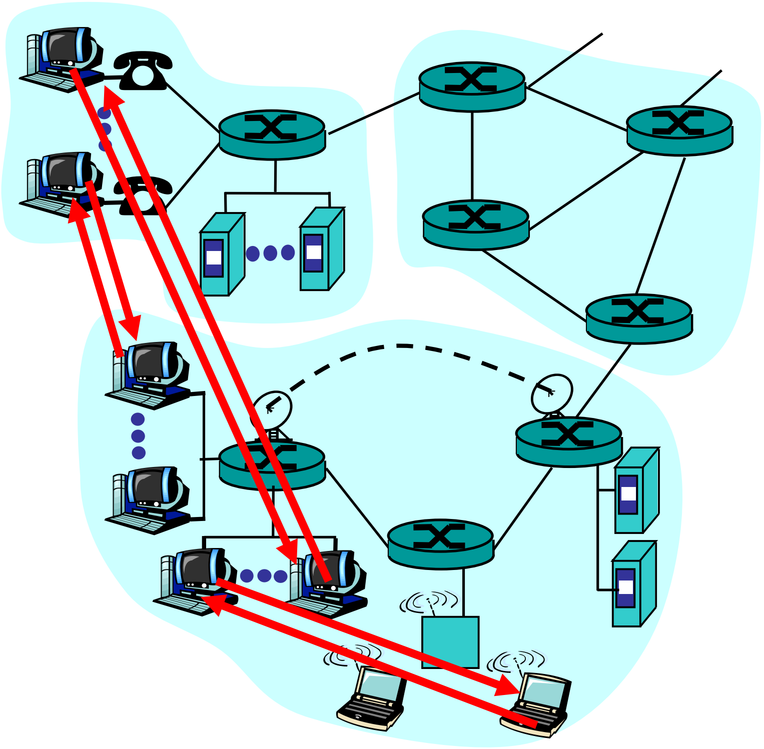
- always-on host
- permanent IP address
- server farms for scaling

clients:

- communicate with server
- may be intermittently connected
- may have dynamic IP addresses
- do not communicate directly with each other

Pure P2P architecture

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



Highly scalable

But difficult to manage

Hybrid of client-server and P2P

Napster

- File transfer P2P
- File search centralized:
  - Peers register content at central server
  - Peers query same central server to locate content

Instant messaging

- Chatting between two users is P2P
- Presence detection/location centralized:
  - User registers its IP address with central server when it comes online
  - User contacts central server to find IP addresses of buddies

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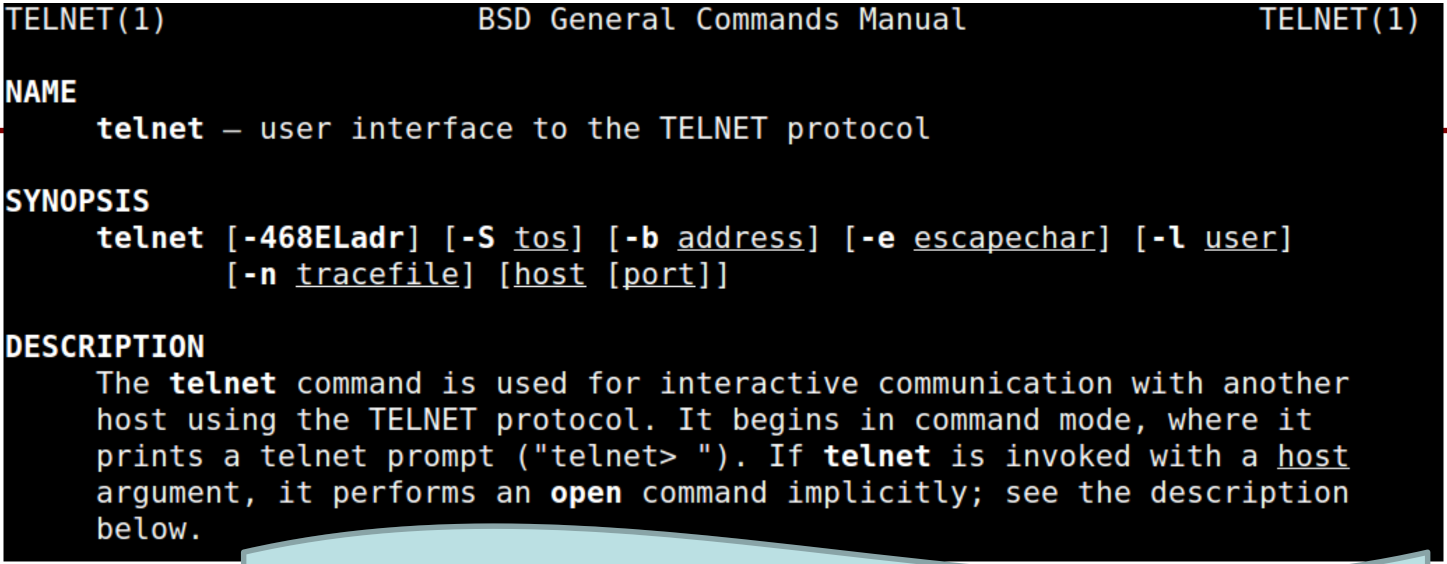
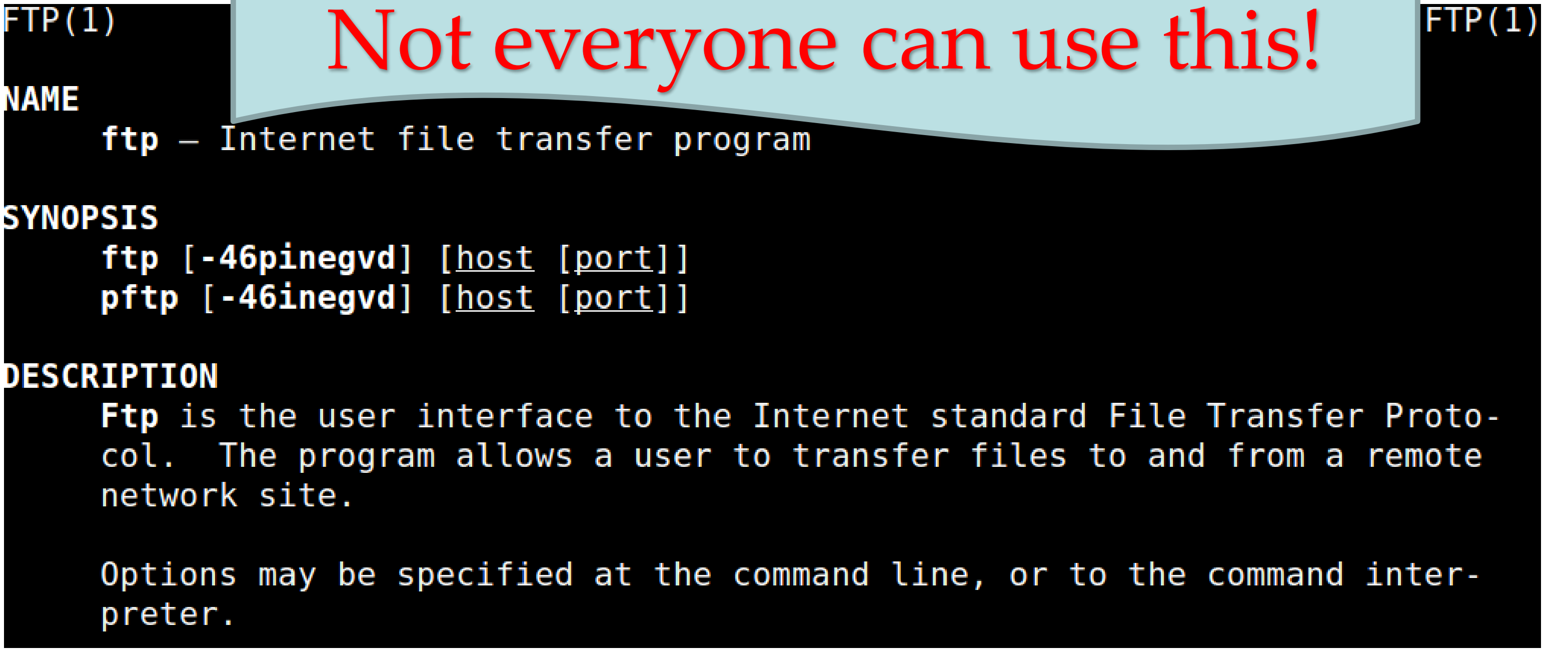
The Web

- Until 1990s the Internet was mainly used by researchers, academics and university students.



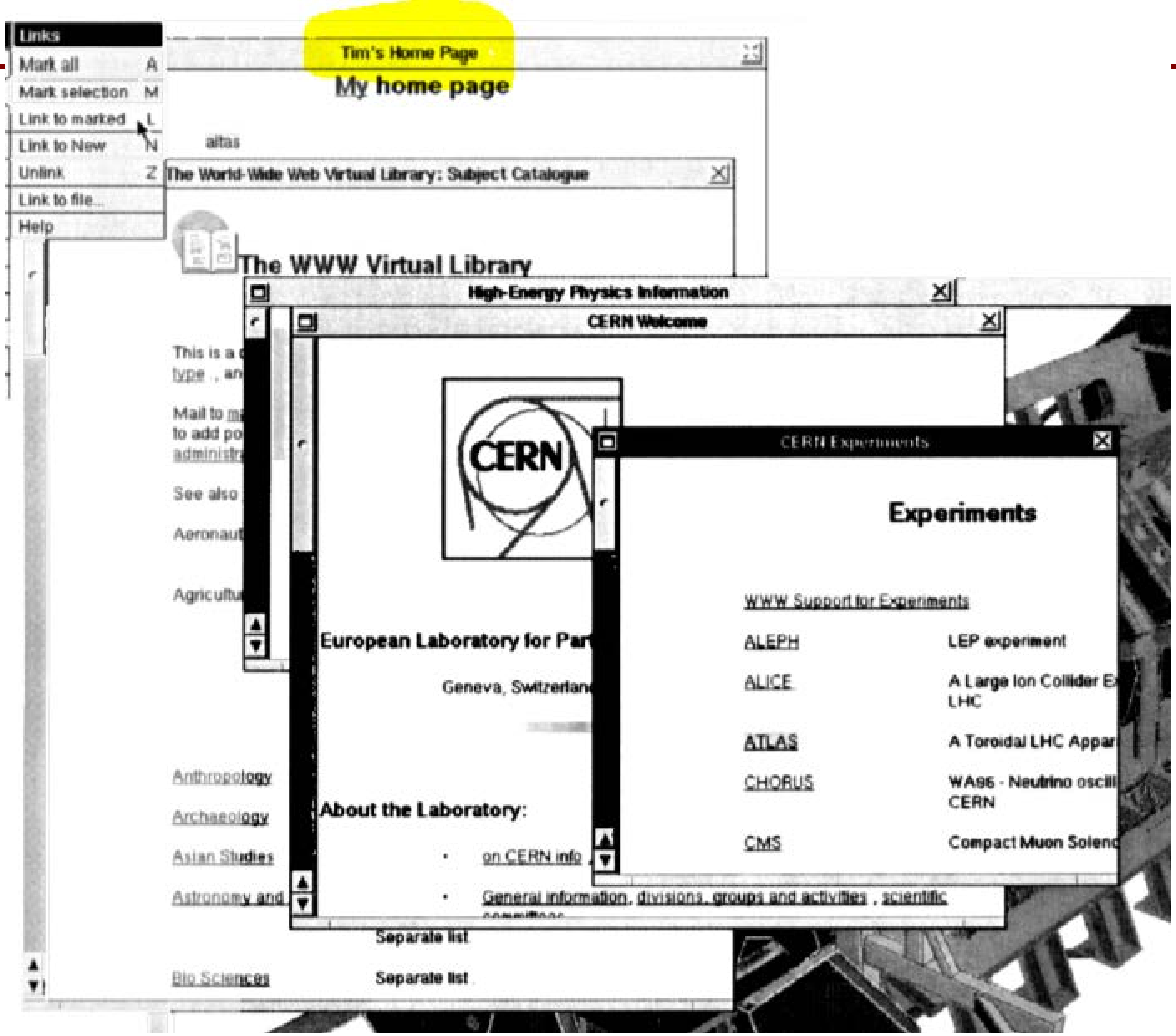
```
TELNET(1)                 BSD General Commands Manual                TELNET(1)

NAME
     telnet — user interface to the TELNET protocol

SYNOPSIS
     telnet [-468ELadr] [-S tos] [-b address] [-e escapechar] [-l user]
            [-n tracefile] [host [port]]

DESCRIPTION
     The telnet command is used for interactive communication with another
     host using the TELNET protocol. It begins in command mode, where it
     prints a telnet prompt ("telnet> "). If telnet is invoked with a host
     argument, it performs an open command implicitly; see the description
     below.
```

Not everyone can use this!



```
FTP(1)                                                                   FTP(1)

NAME
     ftp — Internet file transfer program

SYNOPSIS
     ftp [-46pinegvd] [host [port]]
     pftp [-46inegvd] [host [port]]

DESCRIPTION
     Ftp is the user interface to the Internet standard File Transfer Proto-
     col.  The program allows a user to transfer files to and from a remote
     network site.

     Options may be specified at the command line, or to the command inter-
     preter.
```

- Started by Tim Berners-Lee in 1989.
  - Telephone (1870s); radio (1920s)/TV (1930s);
  - Email and the Web;



Tim's Home Page

My home page

altas

The World-Wide Web Virtual Library: Subject Catalogue

The WWW Virtual Library

This is a
type , an

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See also

Aeronaut

Agricultu

Anthropology

Archaeology

Asian Studies

Astronomy and — Separate list

Bio Sciences — Separate list

High-Energy Physics Information

CERN Welcome

CERN

European Laboratory for Par

Geneva, Switzerlan

About the Laboratory:

- on CERN info
- General information, divisions, groups and activities, scientific committees

CERN Experiments

Experiments

WWW Support for Experiments

ALEPH	LEP experiment
ALICE	A Large Ion Collider Ex LHC
ATLAS	A Toroidal LHC Appar
CHORUS	WA95 - Neutrino oscill CERN
CMS	Compact Muon Solen

- On-demand service!
- HTTP (HyperText Transfer Protocol) is at the heart of the Web.

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  - Overview
  - Non-persistent HTTP and persistent HTTP
  - HTTP messages

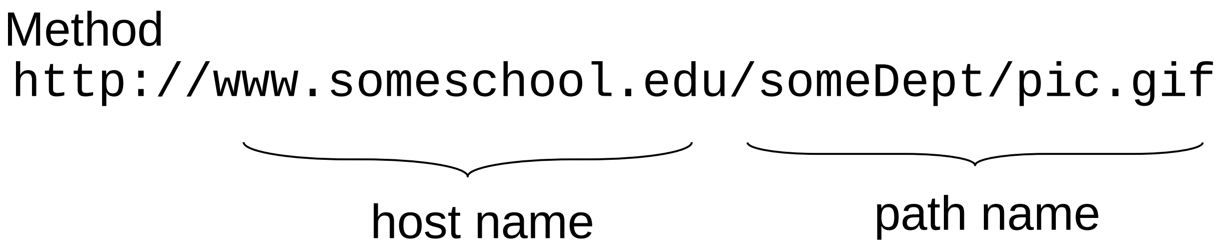
HTTP overview

HTTP: hypertext transfer protocol

- Web’s application layer protocol
- HTTP /1.0: RFC 1945
- HTTP /1.1: RFC 2068/2616/7230
- HTTP /2: RFC 7540
- HTTP /3: Introduced in *26 September 2019*.

Web page

- Web page consists of objects
- Object can be HTML file, JPEG image, audio file,…
- Web page consists of base HTML-file which includes several referenced objects
- Each object is addressable by a URL
- Example URL:



Method

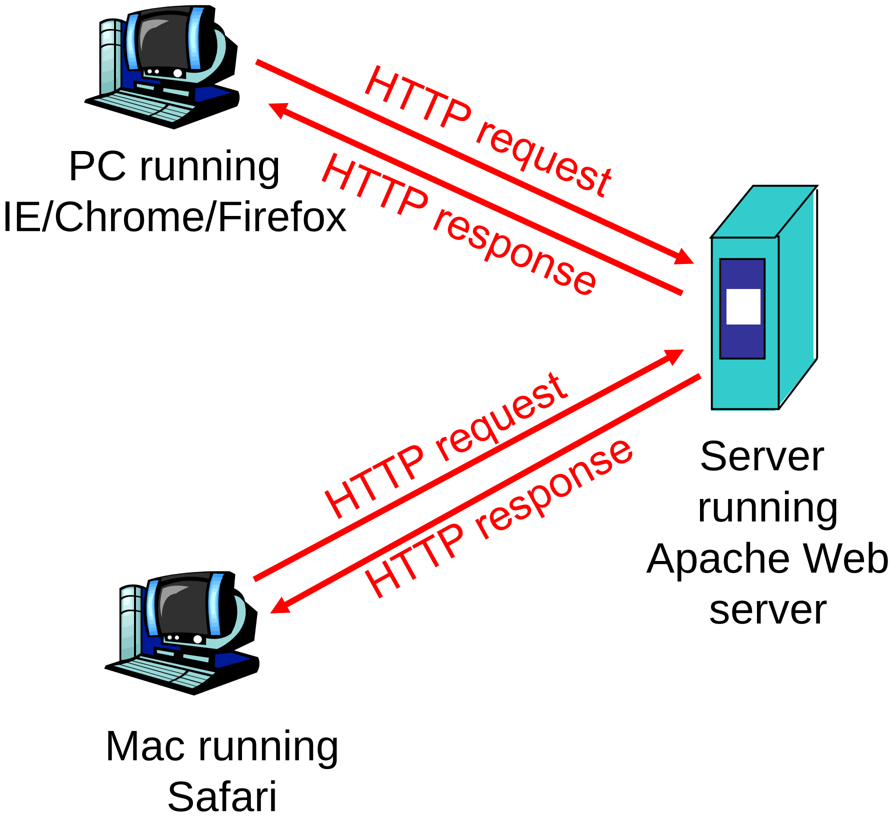
`http://www.someschool.edu/someDept/pic.gif`

host name

path name

client/server model

- *client:* browser that requests, receives, “displays” Web objects
- *server:* Web server sends objects in response to requests



HTTP overview (continued)

Uses TCP:

- client initiates TCP connection (creates socket) to server, **port 80**
- server accepts TCP connection from client
- HTTP messages (application-layer protocol messages) exchanged between browser (HTTP client) and Web server (HTTP server)
- TCP connection closed

HTTP is "stateless"

- server can work without maintaining any information about past client requests.

aside

Protocols that maintain "state" are complex!

* past history (state) must be maintained

* if server/client crashes, their views of "state" may be inconsistent, must be reconciled

HTTP connections

Nonpersistent HTTP

- At most *one object* is sent over a TCP connection.
- HTTP/1.0 uses nonpersistent HTTP

Persistent HTTP

- Multiple objects can be sent over single TCP connection between client and server.
- HTTP/1.1 uses persistent connections in default mode

References

- [KR3] James F. Kurose, Keith W. Ross, *Computer networking: a top-down approach featuring the Internet*, 3rd edition.
- [PD5] Larry L. Peterson, Bruce S. Davie, *Computer networks: a systems approach*, 5th edition
- [TW5] Andrew S. Tanenbaum, David J. Wetherall, *Computer network*, 5th edition
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Acknowledgements

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  - Prof Aleksandar Kuzmanovic's lecture notes for CS340,Northwestern University, https://users.cs.northwestern.edu/~akuzma/classes/CS340-w05/lecture_notes.htm