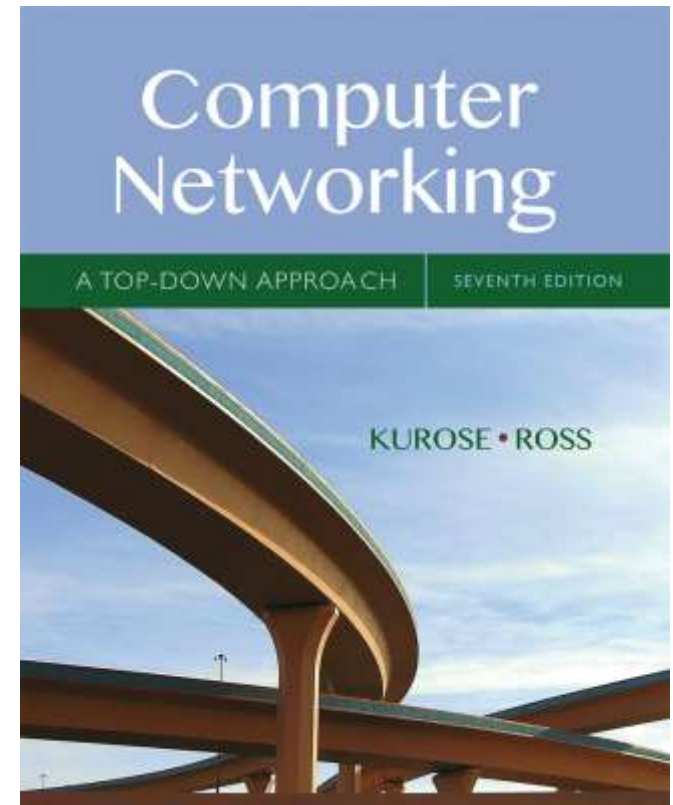


Introduction to TCP/IP I



7th edition

Jim Kurose, Keith Ross

Pearson/Addison Wesley

April 2016

- *essentially adapted from Kurose and Ross*

Network overview

The Internet: a “nuts and bolts” view



Billions of connected computing *devices*:

- *hosts* = end systems
- running *network apps*



Packet switches: forward packets (chunks of data)

- *routers, switches*

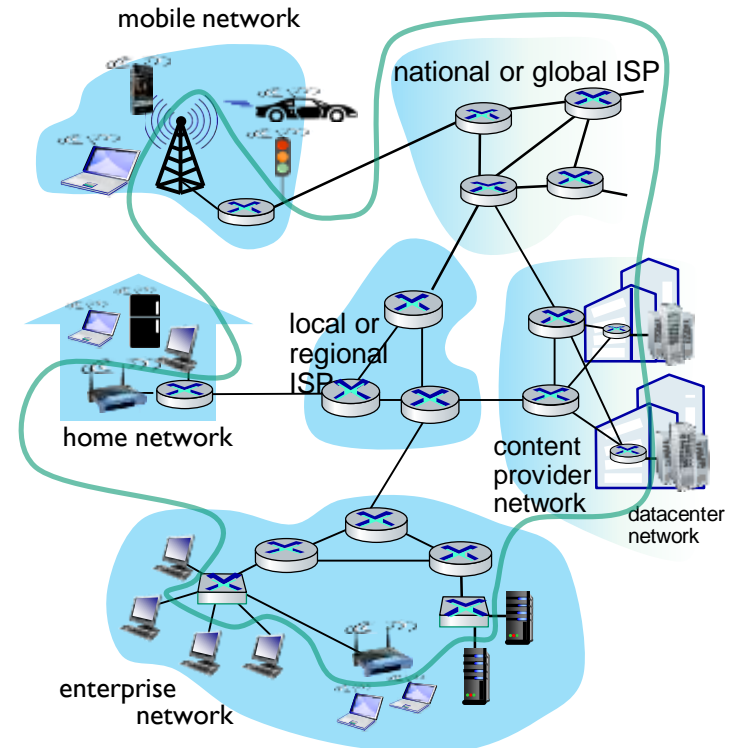
Communication links

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



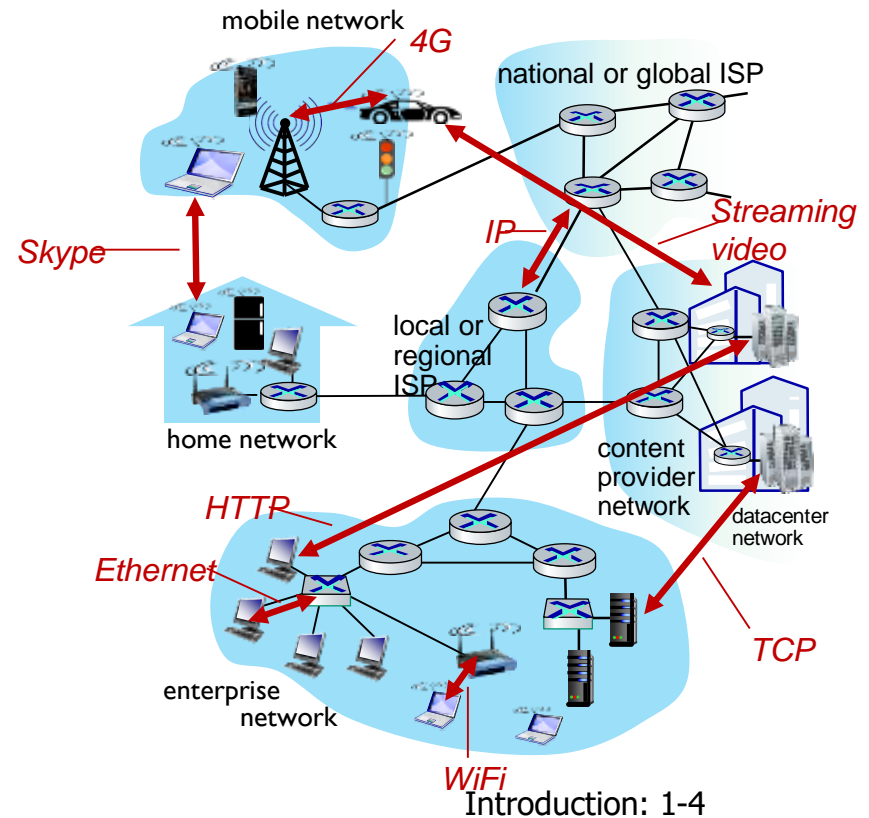
Network

- collection of devices, routers, links: managed by an organization



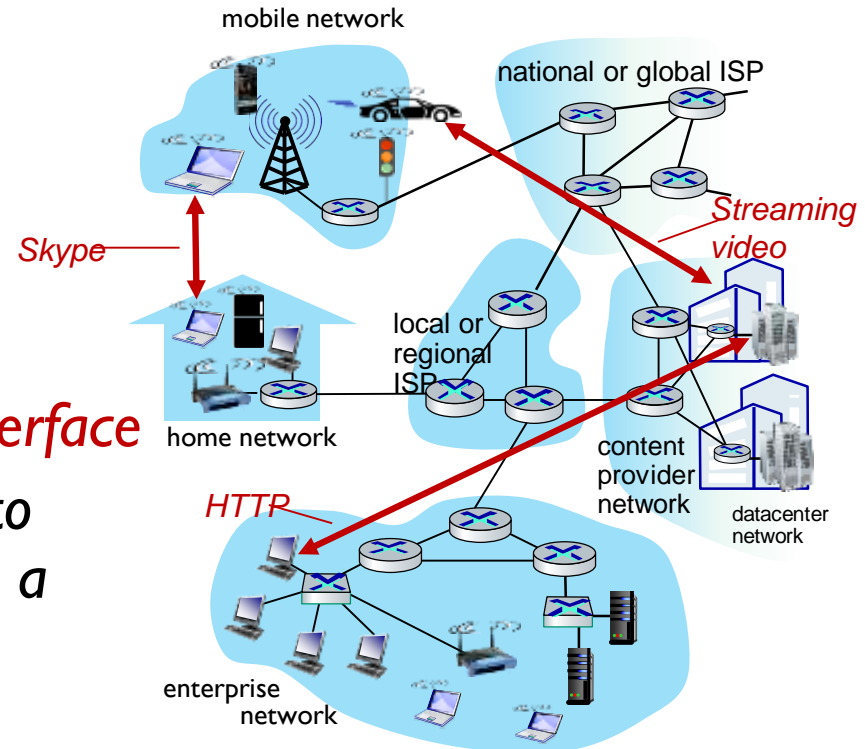
The Internet: a “nuts and bolts” view

- *Internet*: “network of networks”
- *protocols* are everywhere
 - control sending, receiving of messages
 - e.g., HTTP (Web), streaming video, Skype, TCP, IP, WiFi, 4G, Ethernet



The Internet: a “services” view

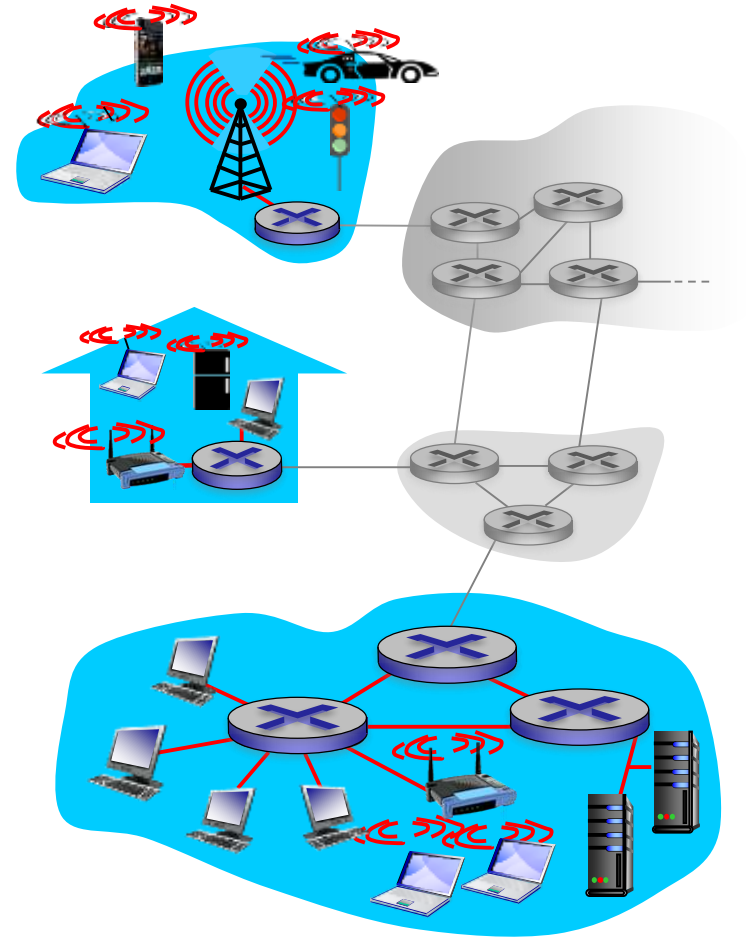
- provide services to applications:
 - Web, streaming video, teleconferencing, email, games, e-commerce, social media, ...
- provide *socket programming interface*
 - *Sender invokes this interface to send/receive message to/from a remote host*



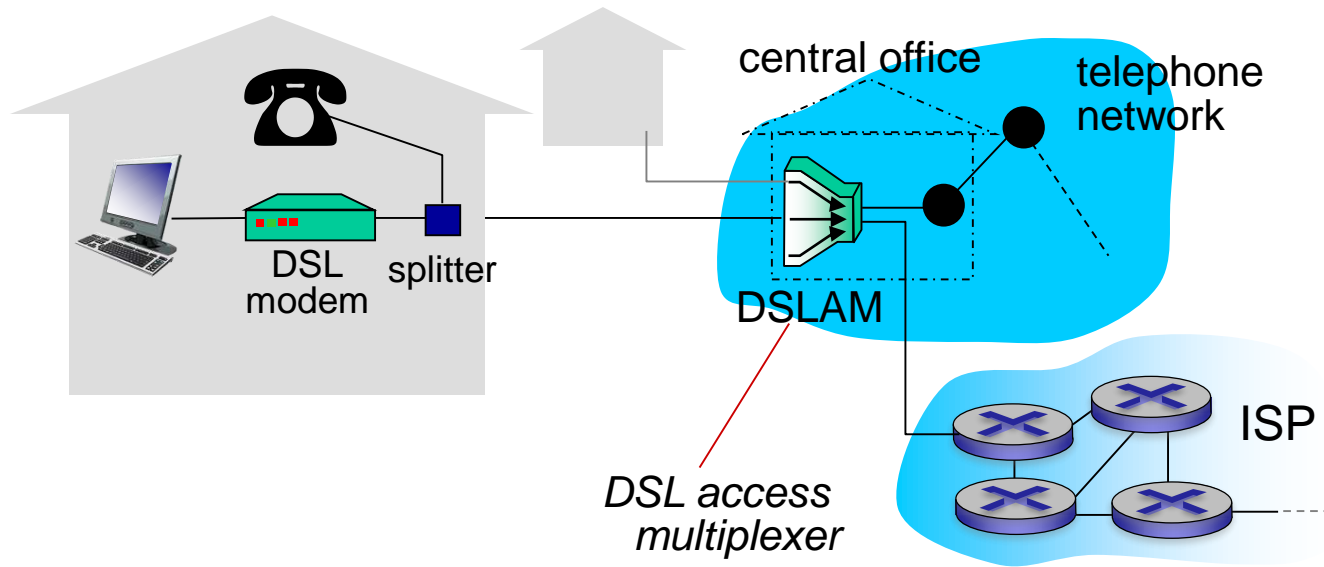
Access networks

Your connecting network

- residential access nets
- institutional access networks (school, company)
- mobile access networks

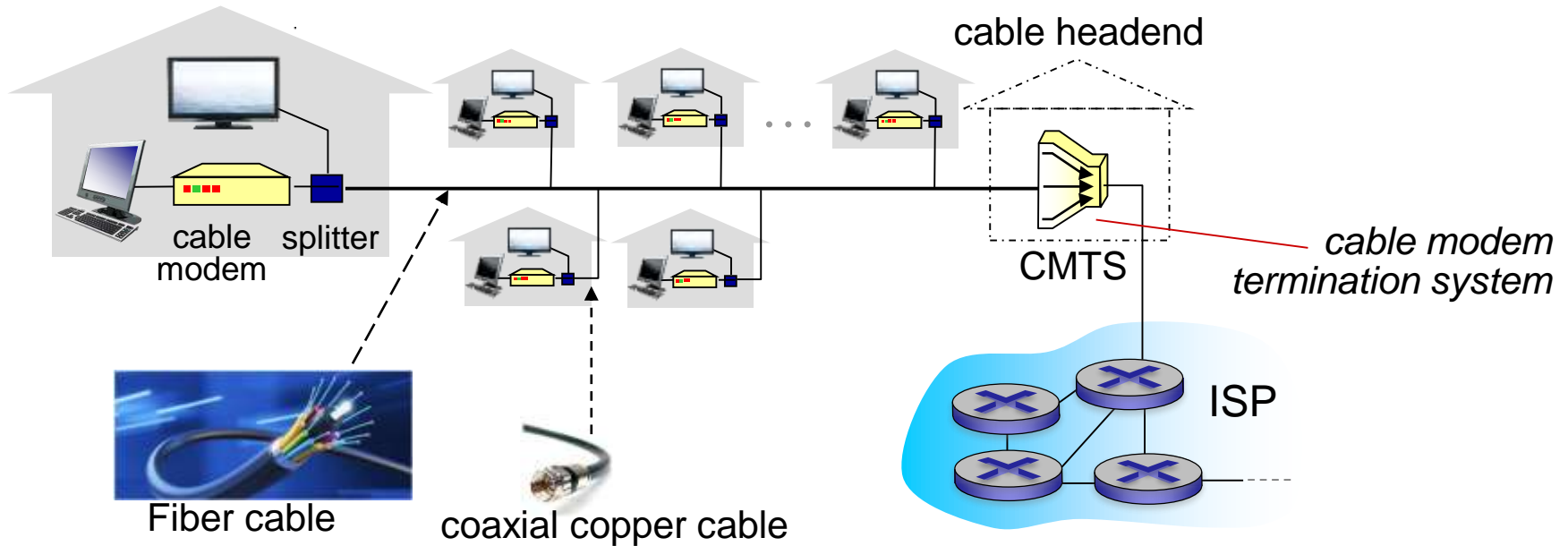


Access network: digital subscriber line (DSL)



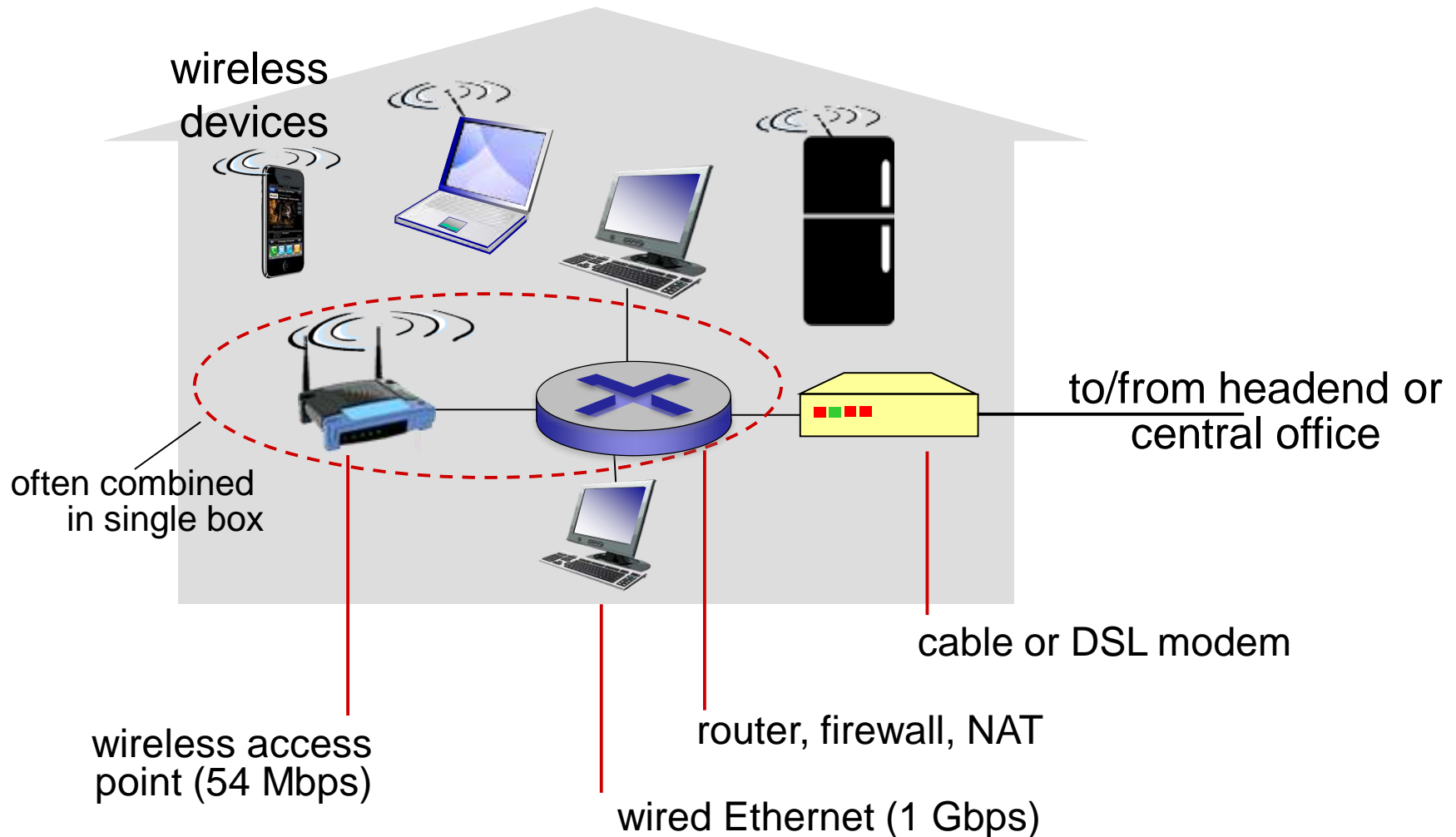
- use *existing* telephone line to central office DSLAM

Access network: cable network



- **network** of cable, fiber attaches homes to ISP router
 - homes *share access network* to cable headend
 - unlike DSL, which has dedicated access to central office

Access network: home network

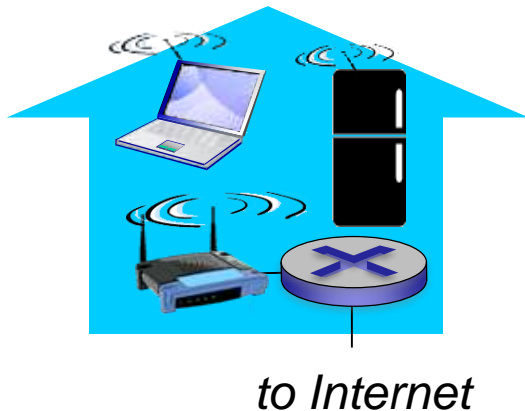


Wireless access networks

- shared *wireless* access network connects end system to router
 - via base station aka “access point”

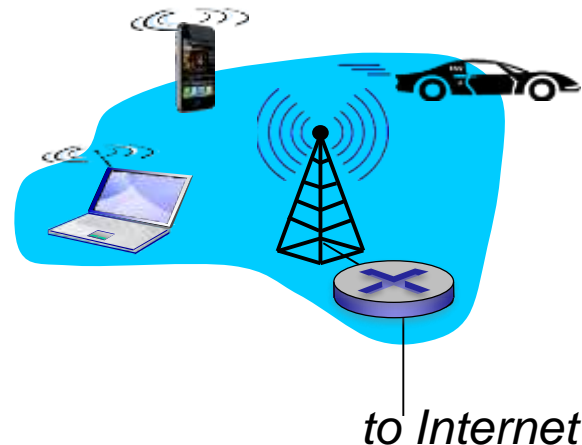
wireless LANs:

- within building (100 ft.)
- 802.11b/g/n (WiFi): 11, 54, 450 Mbps transmission rate



wide-area wireless access

- provided by telco (cellular) operator, 10's km
- between 1 and 10 Mbps
- 3G, 4G: LTE
- 5G

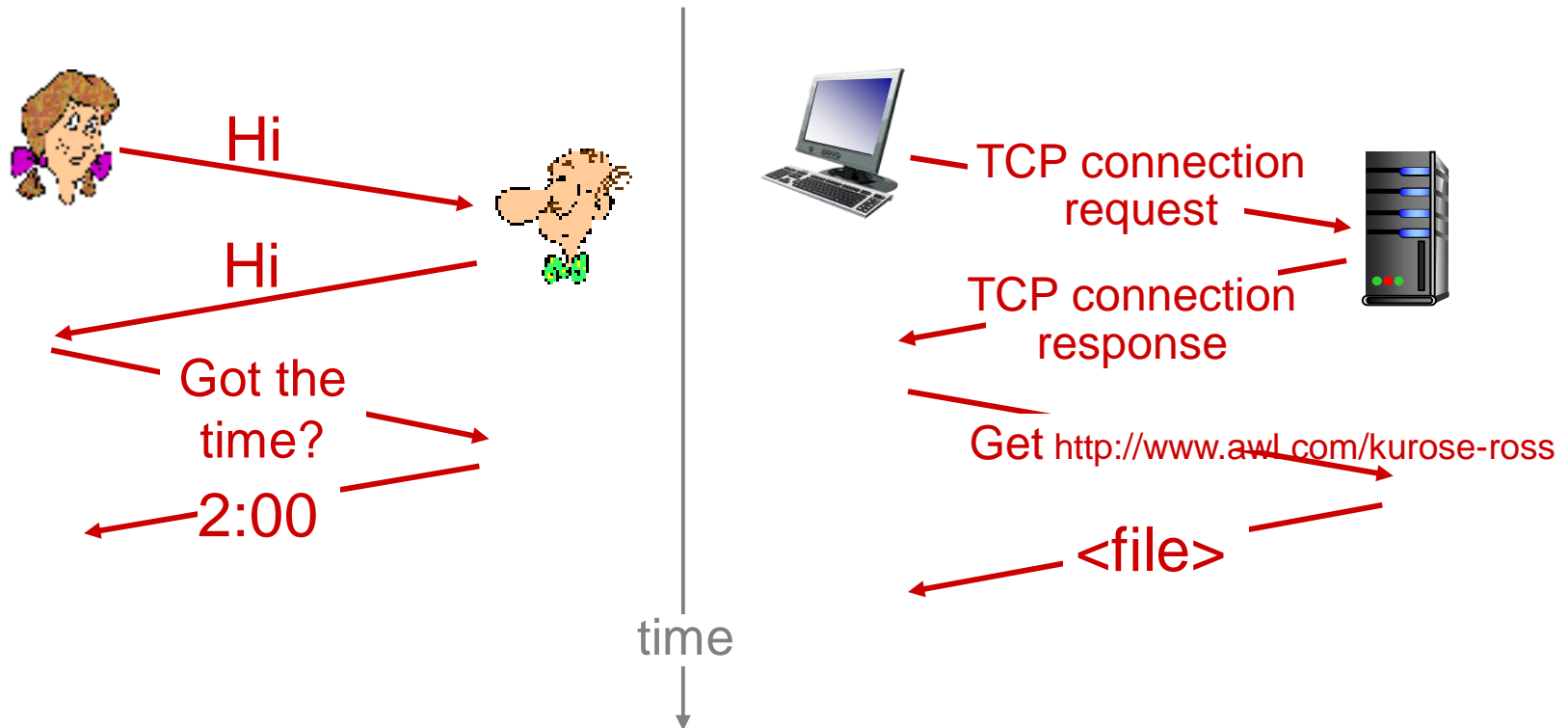


Internet protocol stack

What's a protocol?

a human protocol

a computer network protocol:



Q: other human protocols?

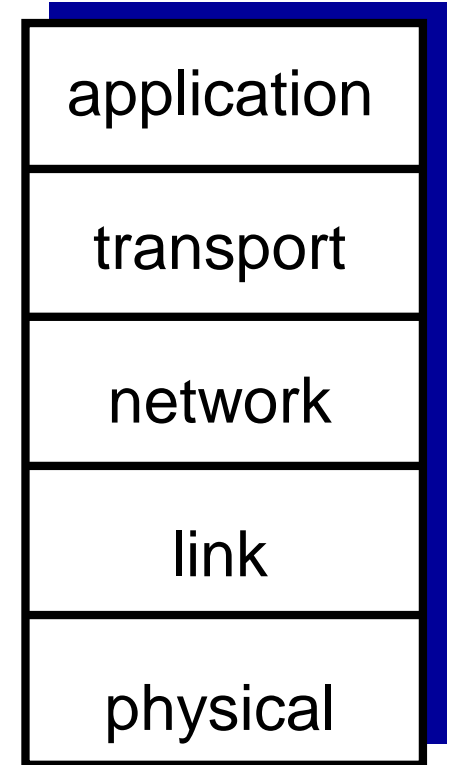
What's a protocol?

network protocols:

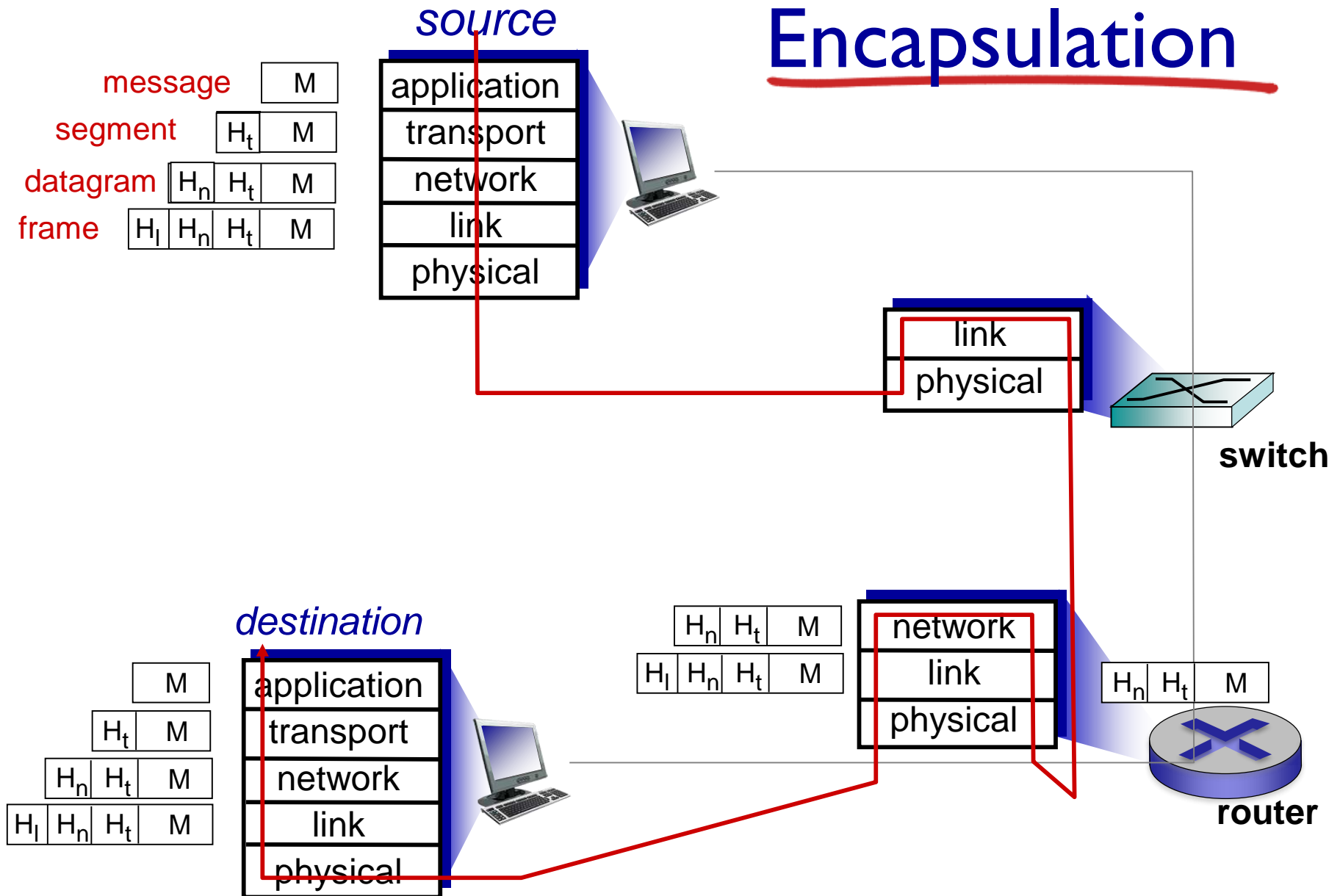
- machines rather than humans
- all communication activity in Internet governed by protocols
- *protocols* define *format, order* of *messages sent and received* among network entities, and *actions taken* on message transmission, receipt

Internet protocol stack

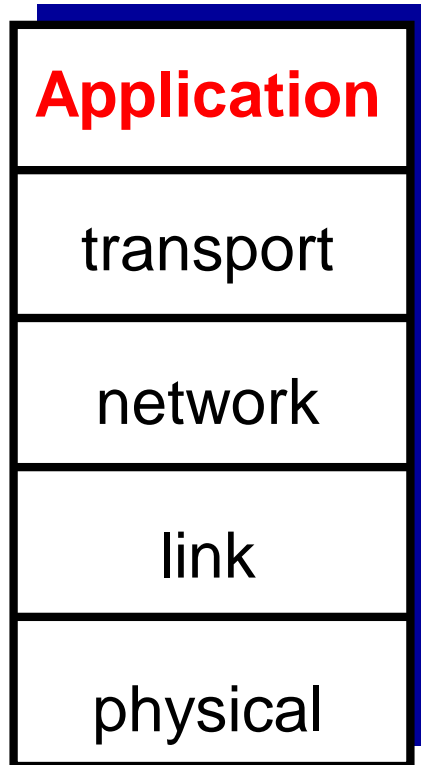
- *application*: supporting network applications
 - FTP, SMTP, HTTP
- *transport*: process-process data transfer
 - TCP, UDP
- *network*: routing of datagrams from source to destination
 - IP, routing protocols
- *link*: data transfer between neighboring network elements
 - Ethernet, 802.111 (WiFi),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



Encapsulation



HTTP



Web page

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

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

host name

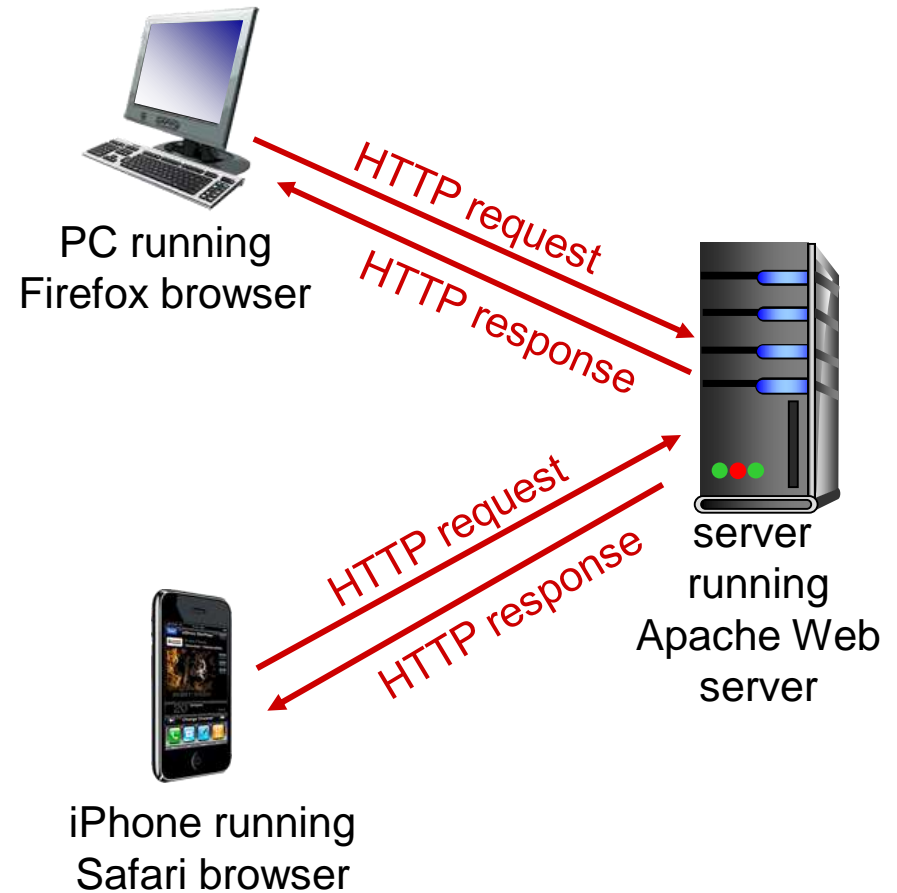
path name

`/var/www/html/someDept/pic.gif`

HTTP overview

HTTP: hypertext transfer protocol

- Web's application layer protocol
- client/server model
 - **client**: browser that requests, receives, (using HTTP protocol) and "displays" Web objects
 - **server**: Web server sends (using HTTP protocol) objects in response to requests



HTTP request message

- two types of HTTP messages: *request, response*
- **HTTP request message:**
 - ASCII (human-readable format)

request line
(GET, POST,
HEAD commands)

header
lines

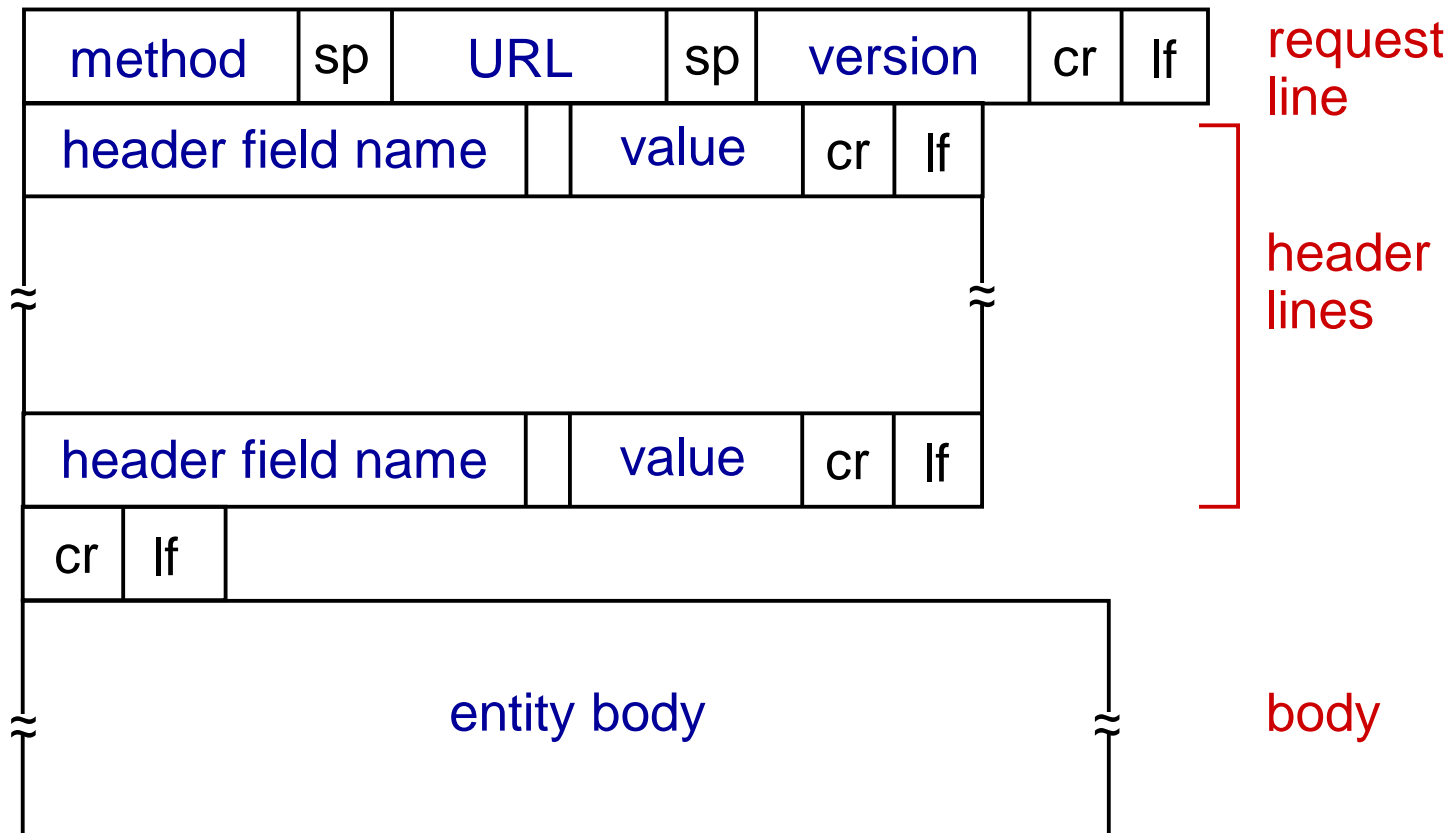
carriage return,
line feed at start
of line indicates
end of header lines

```
GET /index.html HTTP/1.1\r\n
Host: www.cs.umass.edu\r\n
User-Agent: Firefox/3.6.10\r\n
Accept: text/html,application/xhtml+xml\r\n
Accept-Language: en-us,en;q=0.5\r\n
Accept-Encoding: gzip,deflate\r\n
Accept-Charset: ISO-8859-1,utf-8;q=0.7\r\n
Keep-Alive: 115\r\n
Connection: keep-alive\r\n
\r\n
```

/var/www/html/index.html

carriage return character
line-feed character

HTTP request message: general format



HTTP response message

status line
(protocol
status code
status phrase)

header
lines

data, e.g.,
requested
HTML file

```
HTTP/1.1 200 OK\r\n
Date: Sun, 26 Sep 2010 20:09:20 GMT\r\n
Server: Apache/2.0.52 (CentOS)\r\n
Last-Modified: Tue, 30 Oct 2007 17:00:02
GMT\r\n
ETag: "17dc6-a5c-bf716880"\r\n
Accept-Ranges: bytes\r\n
Content-Length: 2652\r\n
Keep-Alive: timeout=10, max=100\r\n
Connection: Keep-Alive\r\n
Content-Type: text/html; charset=ISO-8859-
1\r\n
\r\n
data data data data data ...
```

HTTP response status codes

- status code appears in 1st line in server-to-client response message.
- some sample codes:

200 OK

- request succeeded, requested object later in this msg

301 Moved Permanently

- requested object moved, new location specified later in this msg (Location:)

400 Bad Request

- request msg not understood by server

404 Not Found

- requested document not found on this server

505 HTTP Version Not Supported

DNS: domain name system

people: many identifiers:

- SSN, name, passport #

Internet hosts, routers:

- IP address (32 bit) - used for addressing datagrams
- “name”, e.g., www.yahoo.com - used by humans

The need to translate host name to ip address.

Domain Name System:

- name server
 - Resolve the name to ip address translation
- *DNS is an application-layer protocol:*
 - executed between host (your computer) and name servers to *resolve* names/ipaddress translation
 - Your host starts the DNS query at local DNS server.
 - We will go to the details in the future.