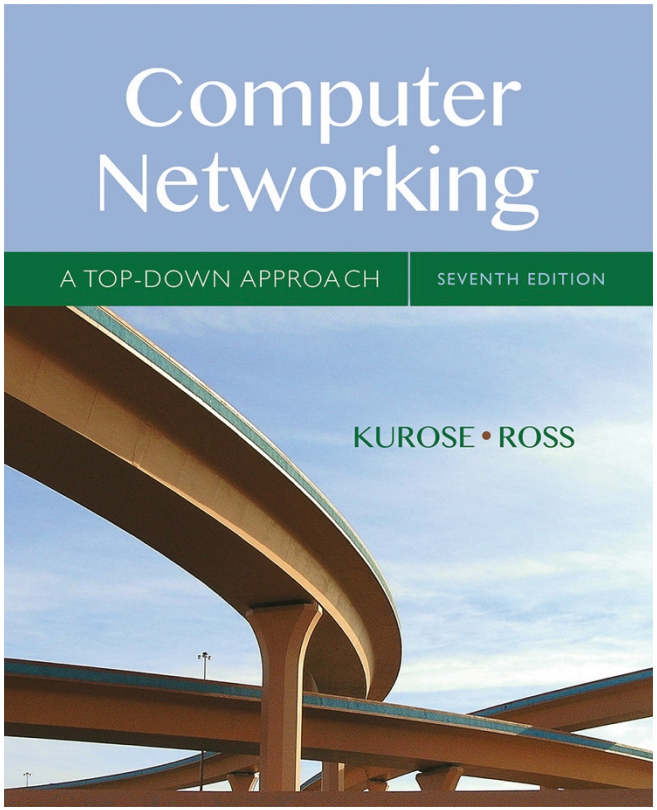
Introduction to TCP/IP I



7th edition
Jim Kurose, Keith Ross
Pearson/Addison Wesley
April 2016

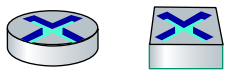
- essentially adapted from Kurose and Ross

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)

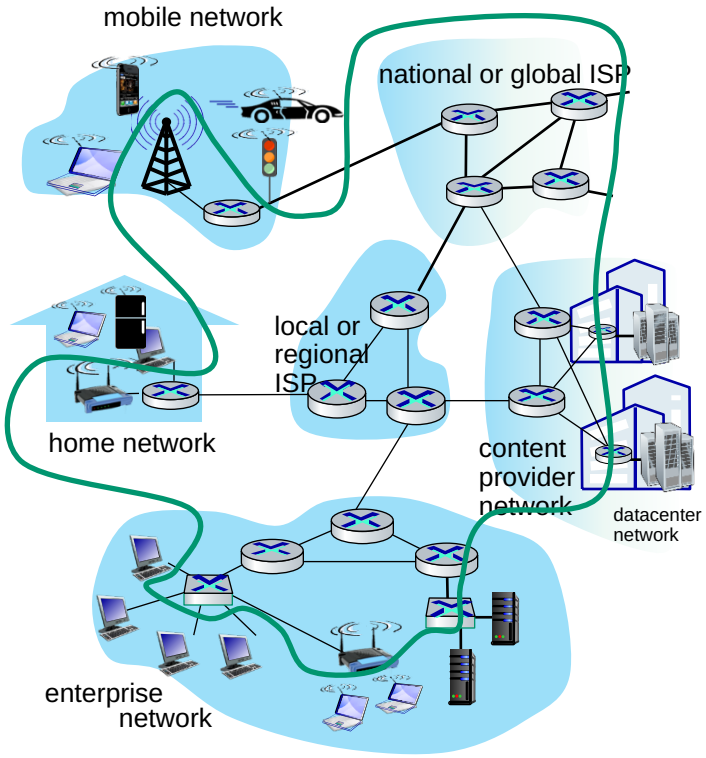
- *routers*, *switches*

Communication links

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

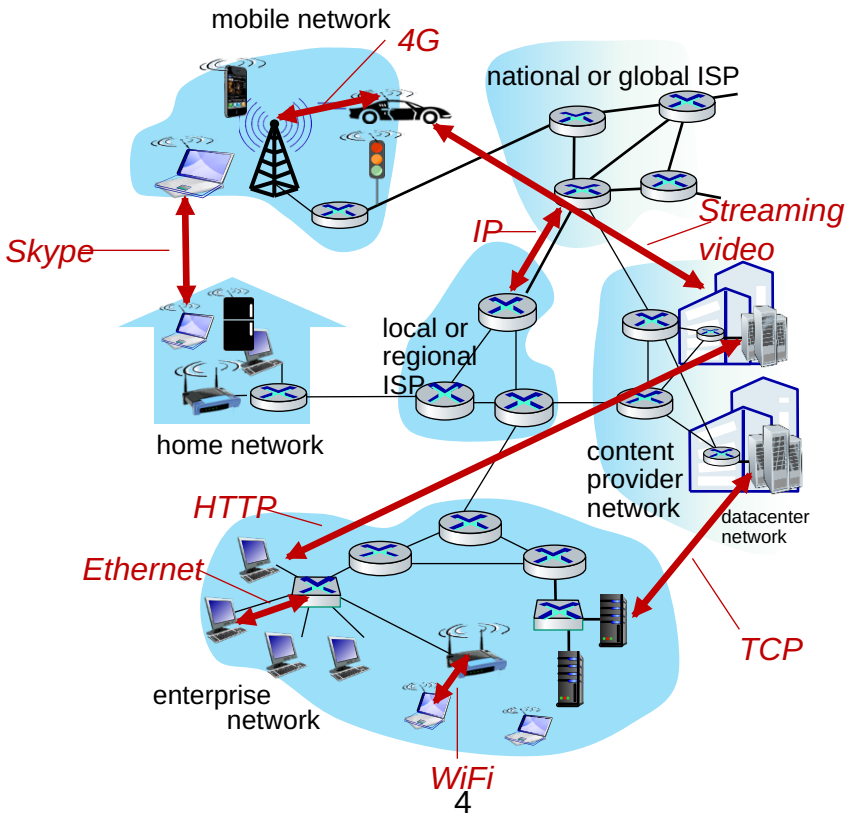
Network

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



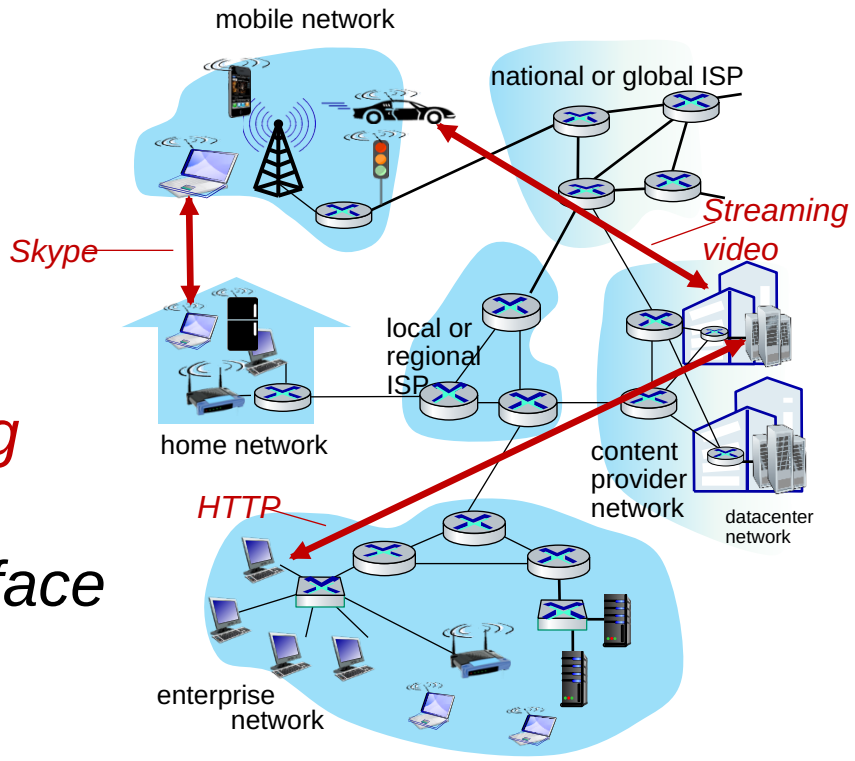
The Internet: a “nuts and bolts” view

- *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

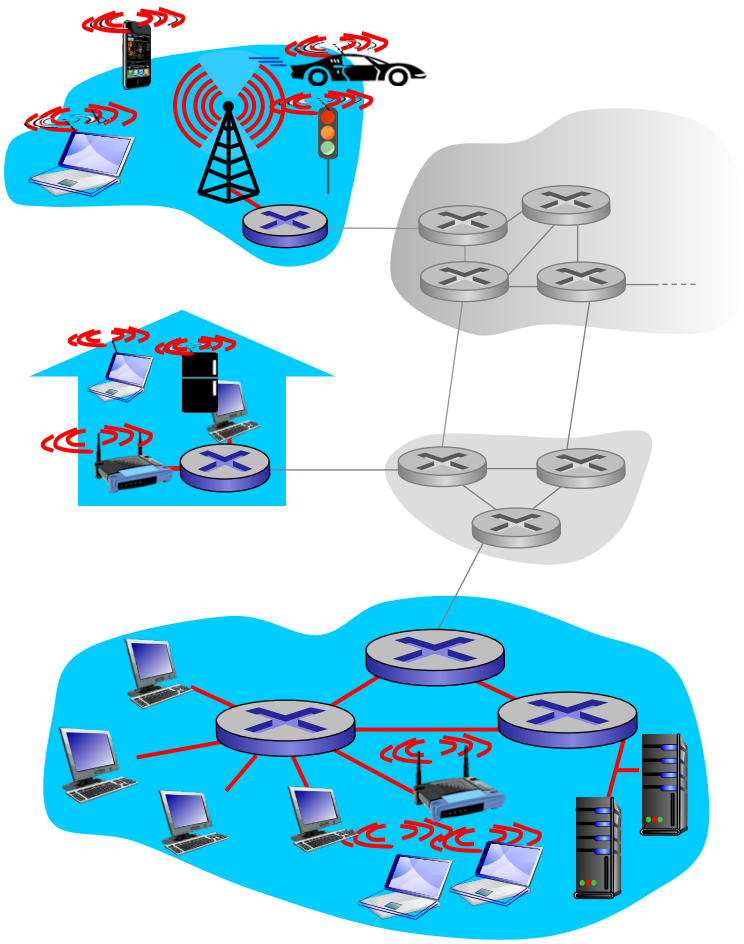
- provide services to applications:
  - Web, streaming video, teleconferencing, email, games, e-commerce, social media, …
- provide *socket programming interface*
  - *Sender invokes this interface to send/receive message to/from a remote host*



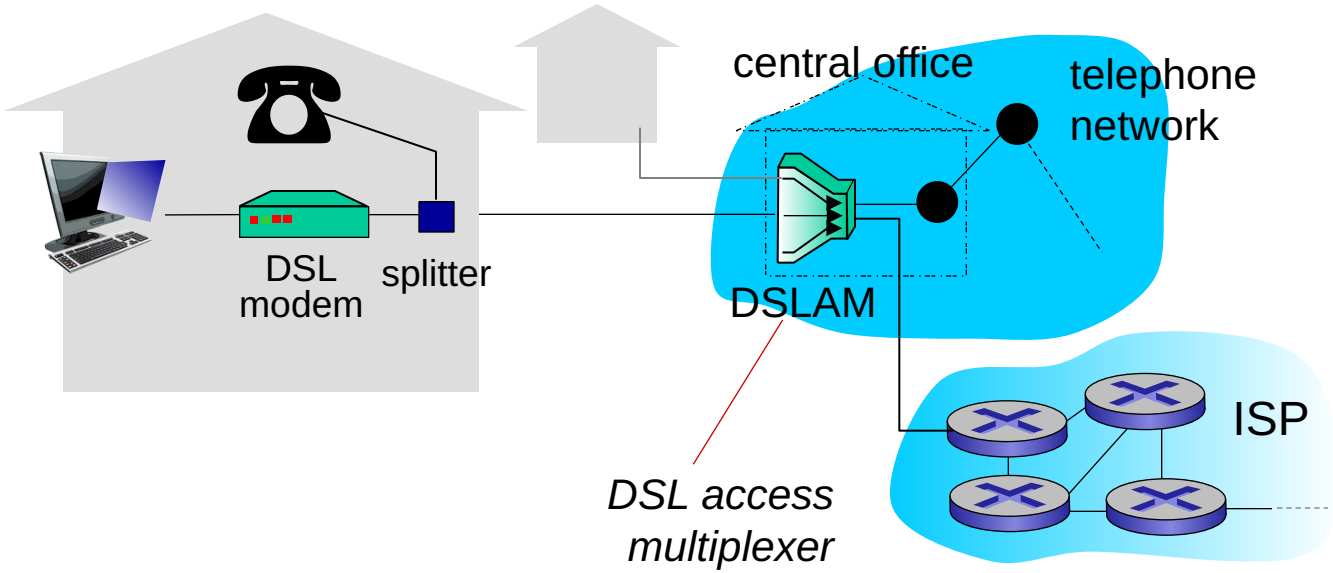
Access networks

Your connecting network

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

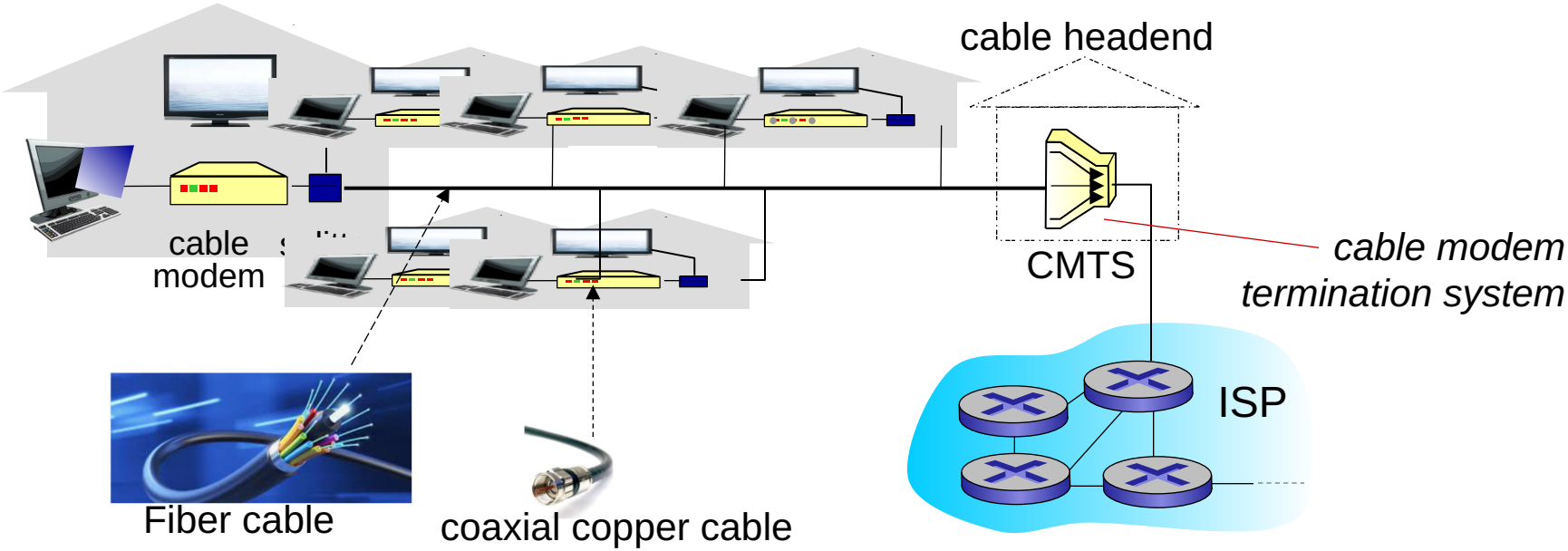


Access network: digital subscriber line (DSL)



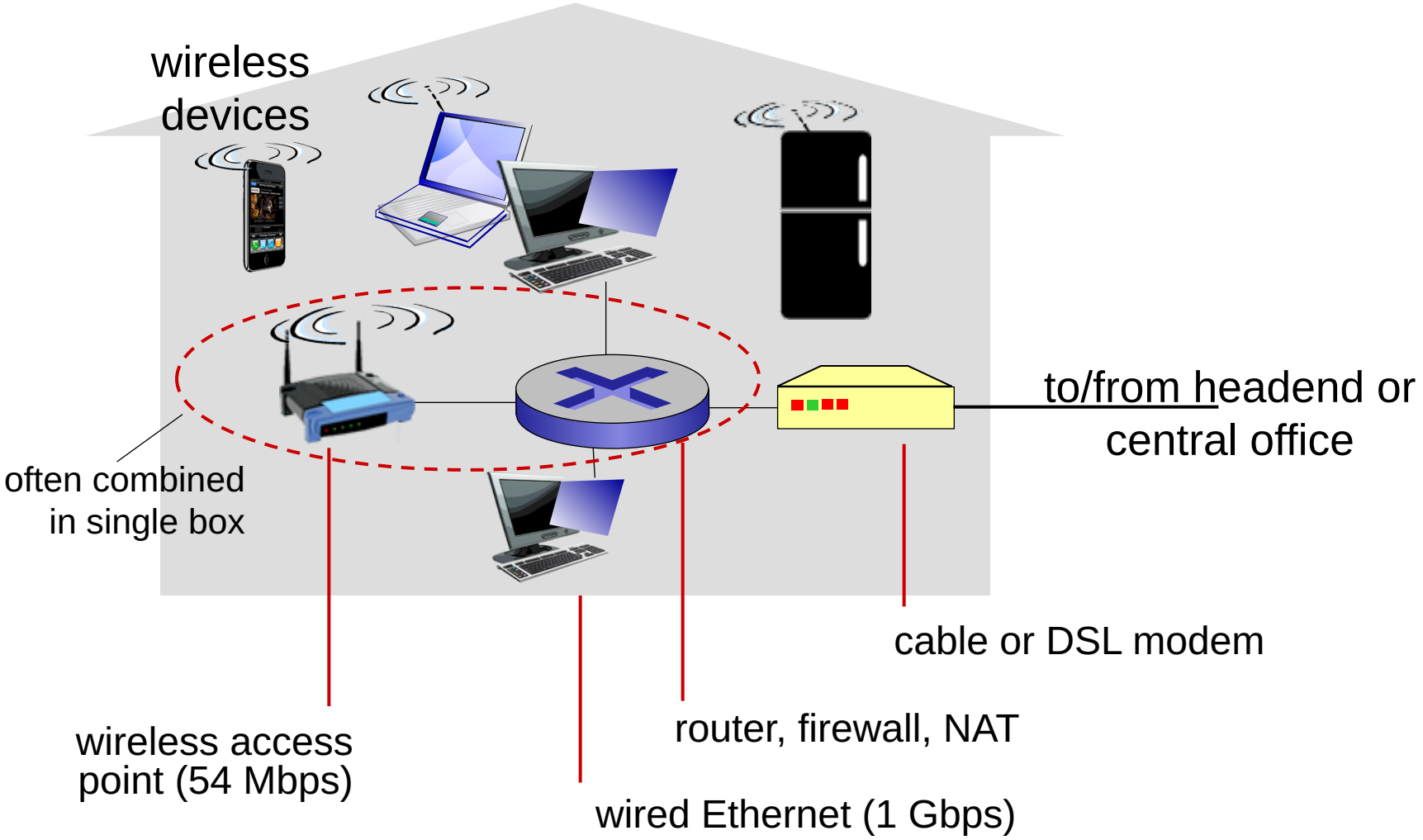
- use *existing* telephone line to central office DSLAM

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

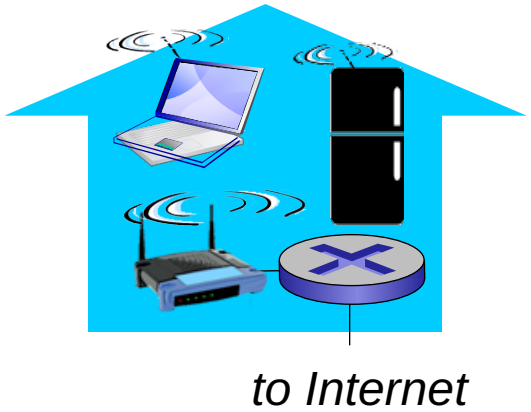


Wireless access networks

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

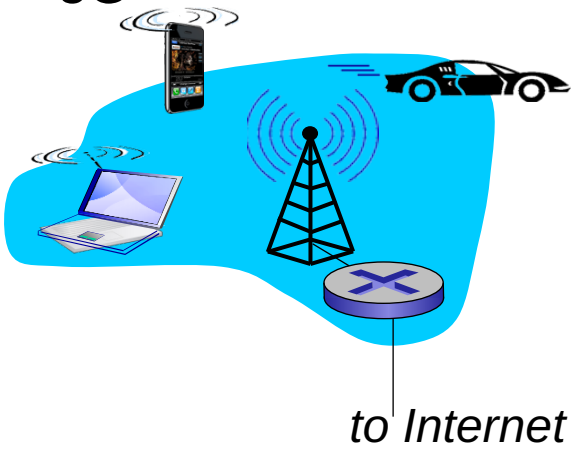
wireless LANs:

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



wide-area wireless access

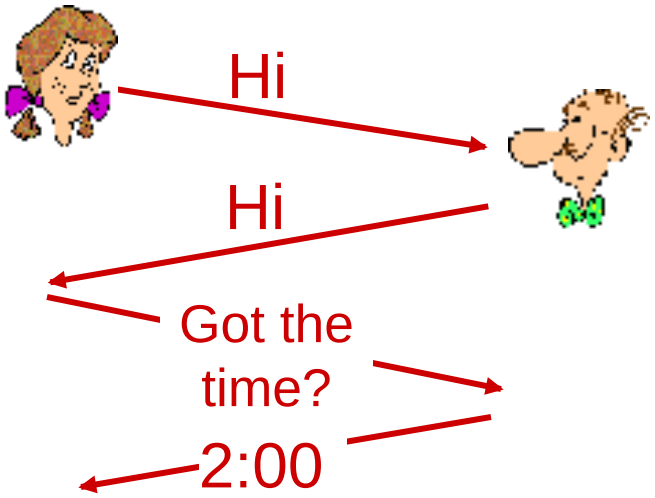
- provided by telco (cellular) operator, 10’s km
- between 1 and 10 Mbps
- 3G, 4G: LTE
- 5G



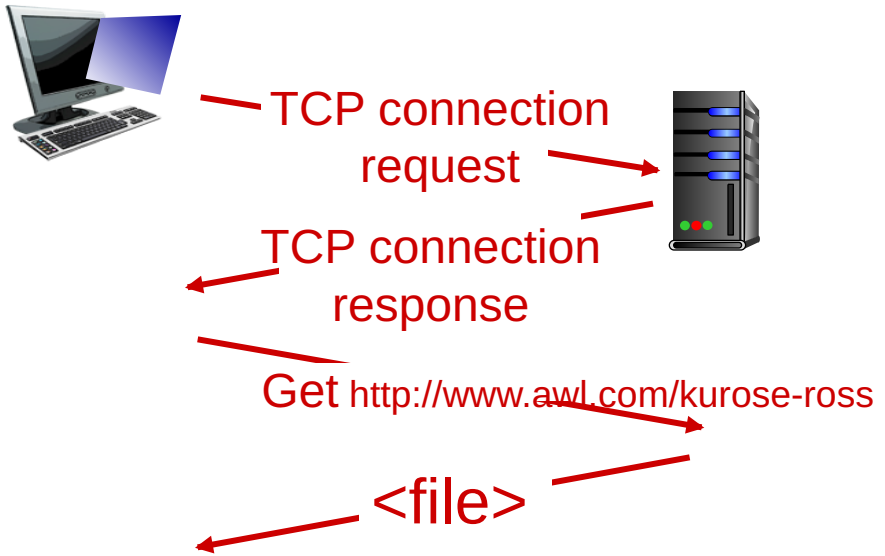
Internet protocol stack

What's a protocol?

a human protocol protocol:



a computer network



Q: other human protocols?

What's a protocol?

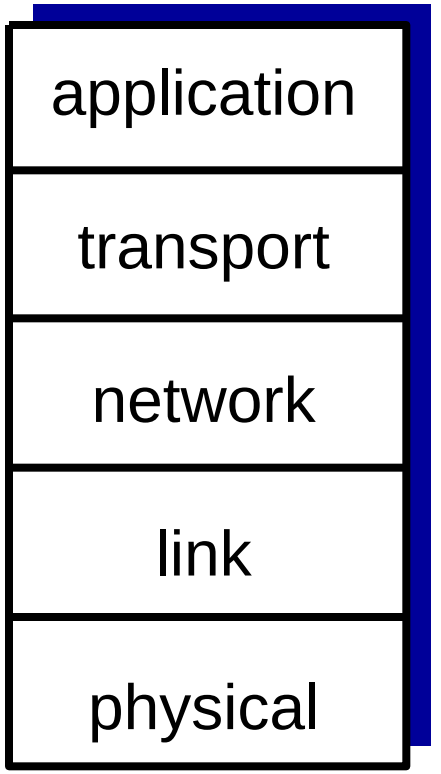
network protocols:

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

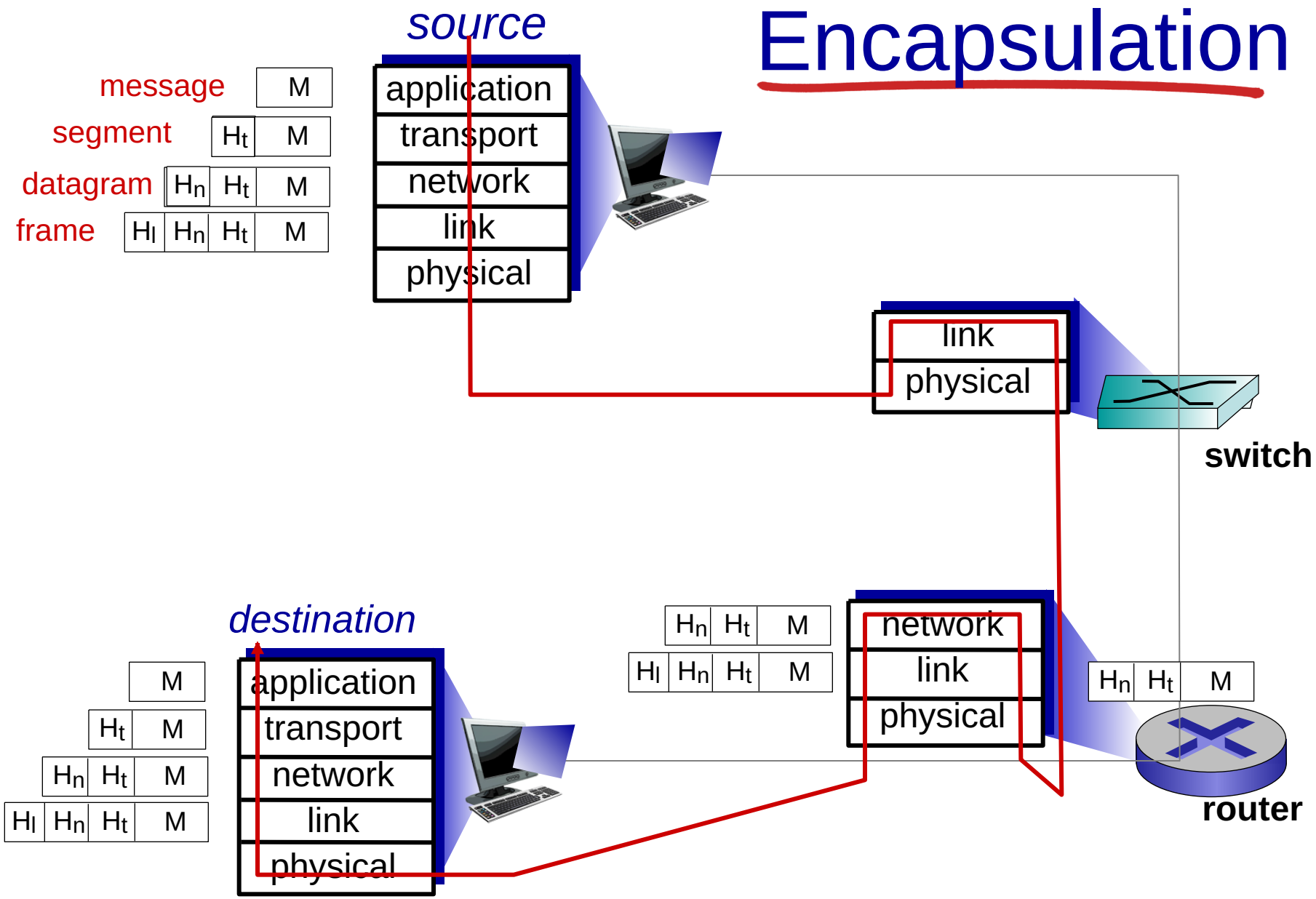
- *protocols define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt*

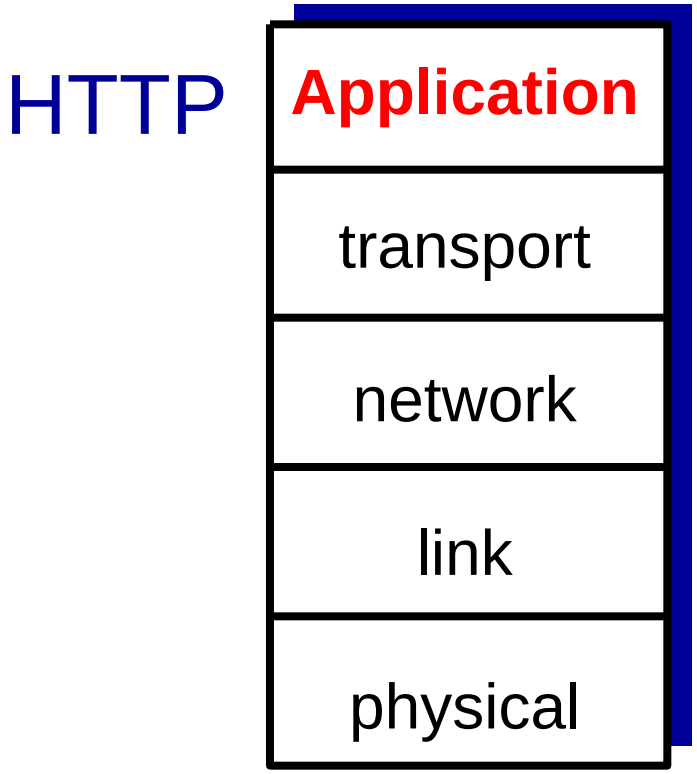
Internet protocol stack

- *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
Application
transport
network
link
physical

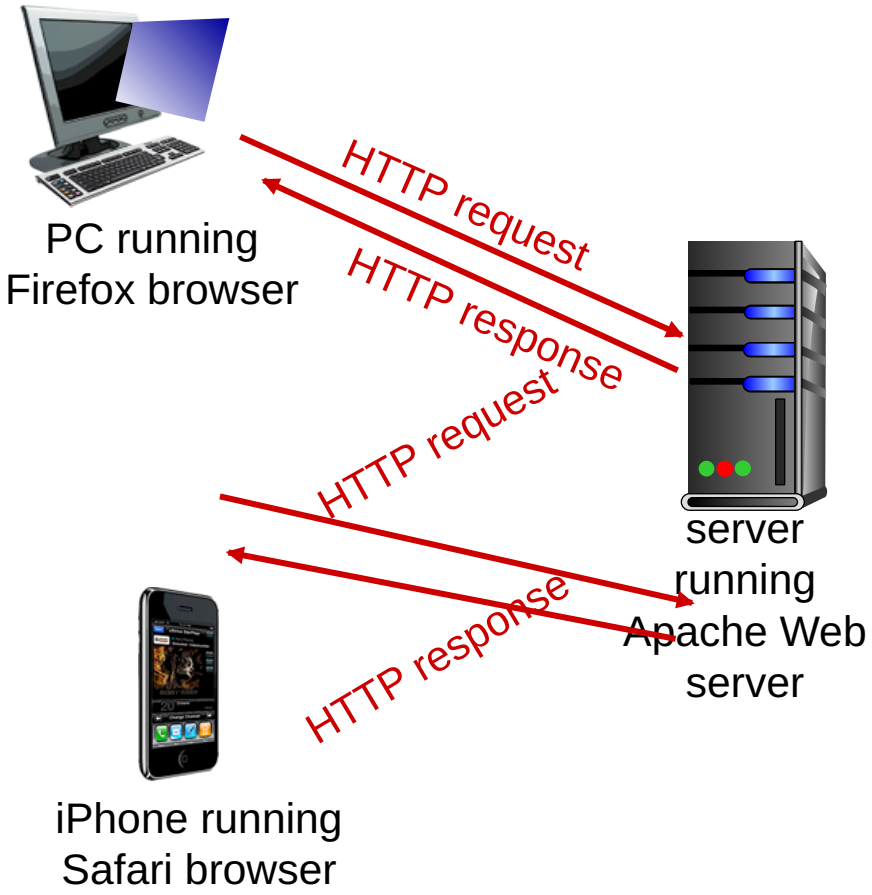
Web page

- 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.,

HTTP overview

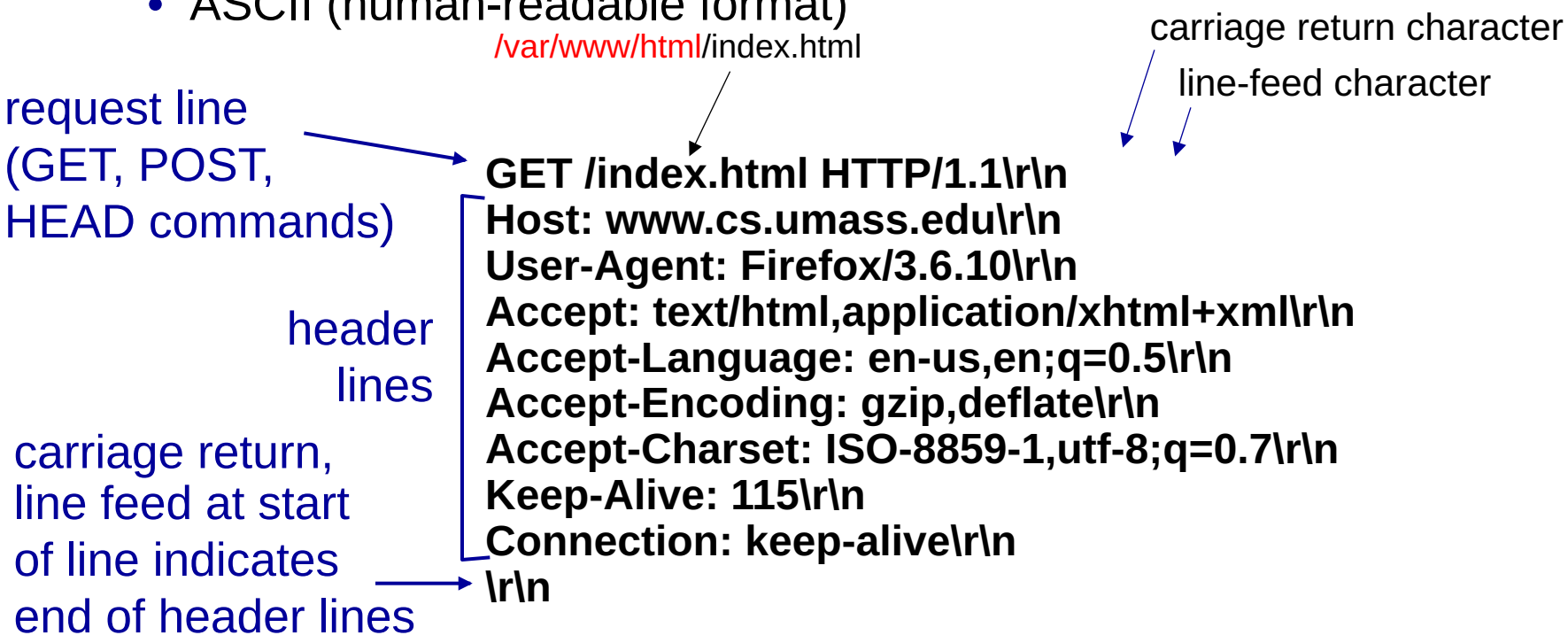
HTTP: hypertext transfer protocol

- 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

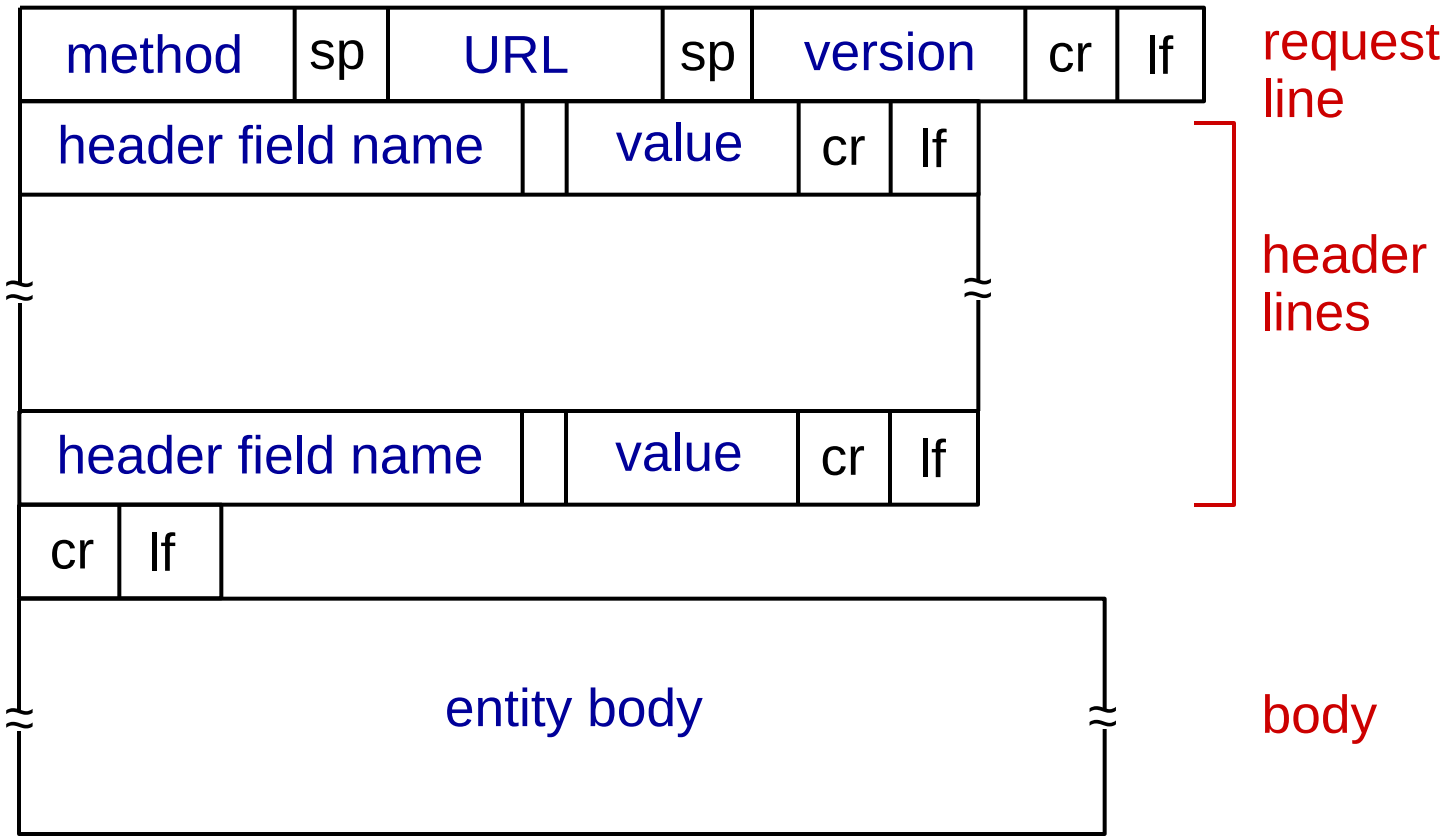


HTTP request message

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



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.