IT 4505
Section 3.4

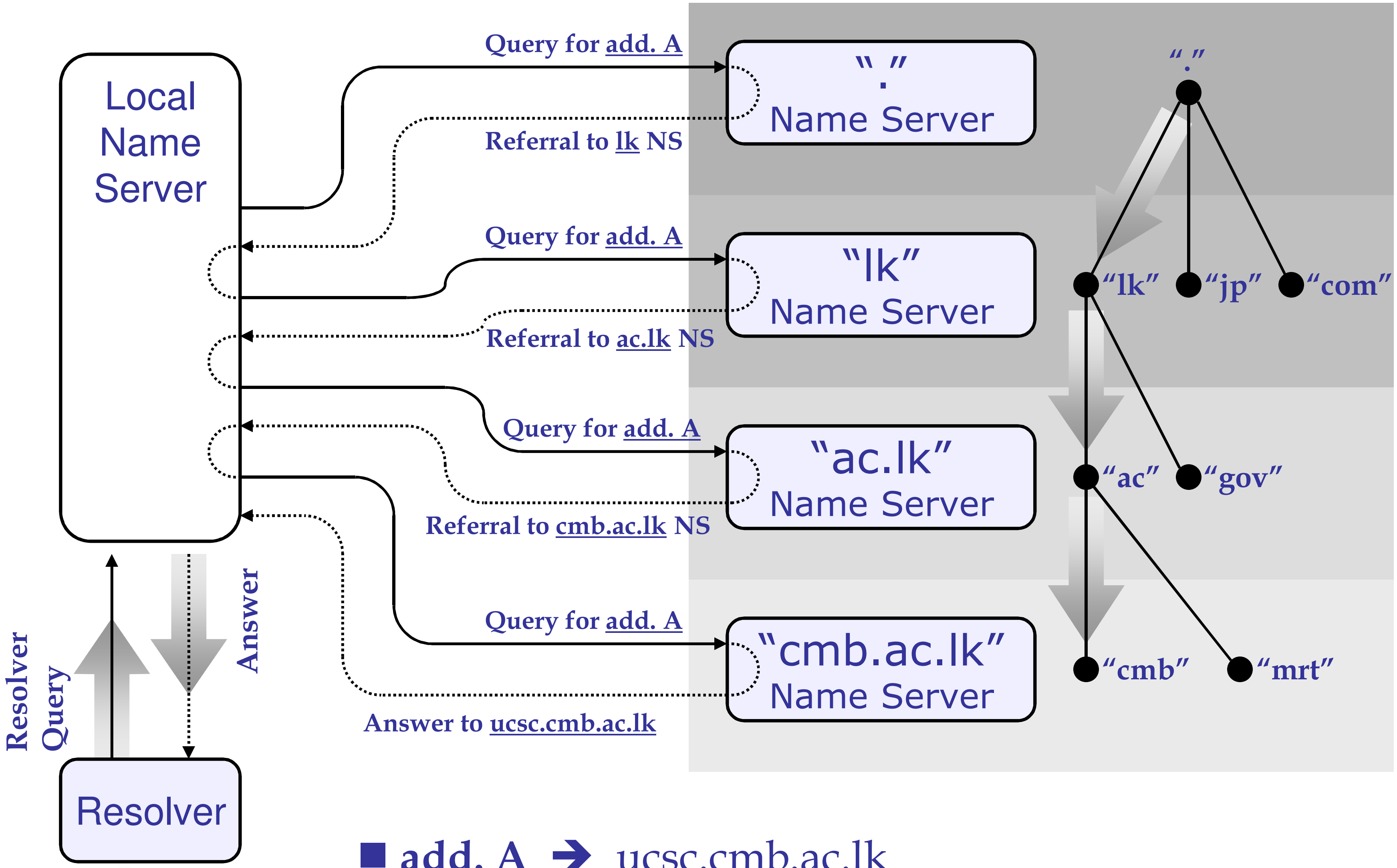
Application Layer Protocols

3.4.1 Domain Name System (DNS)

❑ **What is DNS ?**

- A database that is used by TCP/IP applications to map between hostnames and IP addresses
- Characteristics of DNS
  - o A hierarchical namespace for hosts and IP addresses
  - o A host table implemented as a distributed database
  - o A Client/Server system
- Components of DNS
  - o Namespace and Resource Record
  - o Name Server
  - o Resolver (Client)

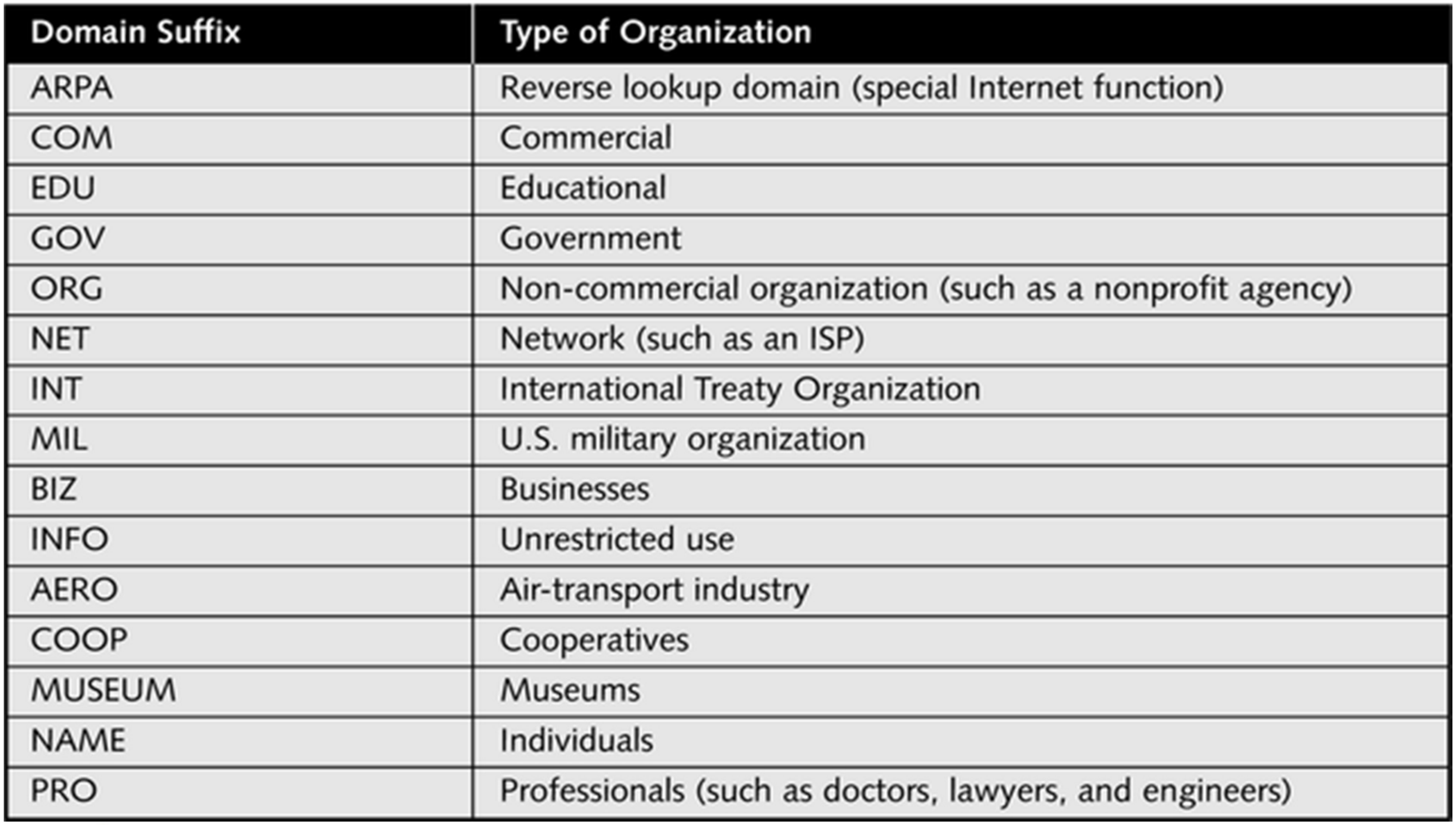
What is DNS? (con’t)



- add. A ➔ ucsc.cmb.ac.lk

What is DNS? (con’t)

- Top Level Domains



Domain Suffix	Type of Organization
ARPA	Reverse lookup domain (special Internet function)
COM	Commercial
EDU	Educational
GOV	Government
ORG	Non-commercial organization (such as a nonprofit agency)
NET	Network (such as an ISP)
INT	International Treaty Organization
MIL	U.S. military organization
BIZ	Businesses
INFO	Unrestricted use
AERO	Air-transport industry
COOP	Cooperatives
MUSEUM	Museums
NAME	Individuals
PRO	Professionals (such as doctors, lawyers, and engineers)

What is DNS? (con’t)

❑ Namespace

- DNS namespace is a tree of “domains”
- Refers to the actual database of IP addresses and their associated names
- At the highest level of the hierarchy sit the **root servers**

❑ Zone

- A zone is a sub-tree of the DNS database that is administered as a single separate entity. It can consists of one domain or domain with sub-domains

What is DNS?   (con’t)

❑Resource Records (RR)

- •RRs contain the data associated with domain names

❑ Name Server

- •The server programs that store information about the domain name space

❑ Resolver (Client)

- •The programs that extract information from name servers in response to client requests

DNS: Basics

- ❑ Hierarchical namespace
- ❑ Distributed system – very few core servers
- ❑ Stores other information than simple hostname <-> IP mappings
- ❑ Request/response protocol

DNS: Architecture

- ❑ DNS servers are responsible for one or more domains of any level
- ❑ “Root servers” are maintained throughout the world (one is in Palo Alto) and are responsible for all of the top-level domains
  - When you register a domain, an entry for that domain is added to the appropriate root server
- ❑ Owners of each regular domain or subdomain maintain (or outsource) their own DNS servers containing the correct information

DNS: Domain servers

- ❑ What kind of records can be requested for a given domain?
  - Address translation
  - Caching information
  - Mail server information
  - Authoritative nameserver information
- ❑ How is this data requested?
  - Each record has a type and certain data associated with it – clients request records of a certain type from a server

3.4.2 Email – SMTP, POP, IMAP

SMTP - Simple Mail Transfer Protocol

- □ Basic protocol for email exchange over the Internet
- □ Fundamental difference between SMTP and FTP/TELNET is that it is NOT an interactive protocol
  - Messages are queued and spooled by SMTP agent
- □ Users interact with email application
  - E.g. Microsoft Outlook Express!
- □ Application interfaces with Message Transfer Agent
  - *Sendmail* on UNIX
  - Setup and configured by admins.
- □ SMTP specifies how MTA's pass email across the Internet
  - Also uses NVT commands

Simple Mail Transfer Protocol

- ❑ Client uses email application to construct and send messages
- ❑ Message is passed to mail spooler which is part of MTA
  - Application communicates with MTA via email transfer protocol
    - o Post Office Protocol (POP3) is common, but not very secure
- ❑ MTA's on remote systems listen for incoming mail on well known port (25)
- ❑ Messages are delivered in two parts – header and body
  - Header format has exact specification (RFC 822)
  - Body content types are specified by MIME

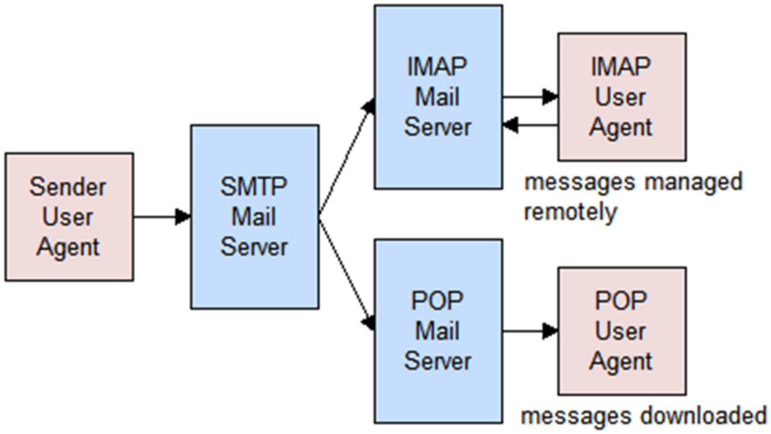
IMAP & POP

- **POP** (Post Office Protocol) - POP3 is a simpler protocol but supports fewer features and is less secure in typical usage

- **IMAP** (Internet Message Access Protocol) - IMAP is an improvement over an earlier final delivery protocol, **POP3**

- IMAP is One of the main protocols that is used for final delivery of messages**.**

- The mail server runs an IMAP server to use IMAP, that listens to port 143.



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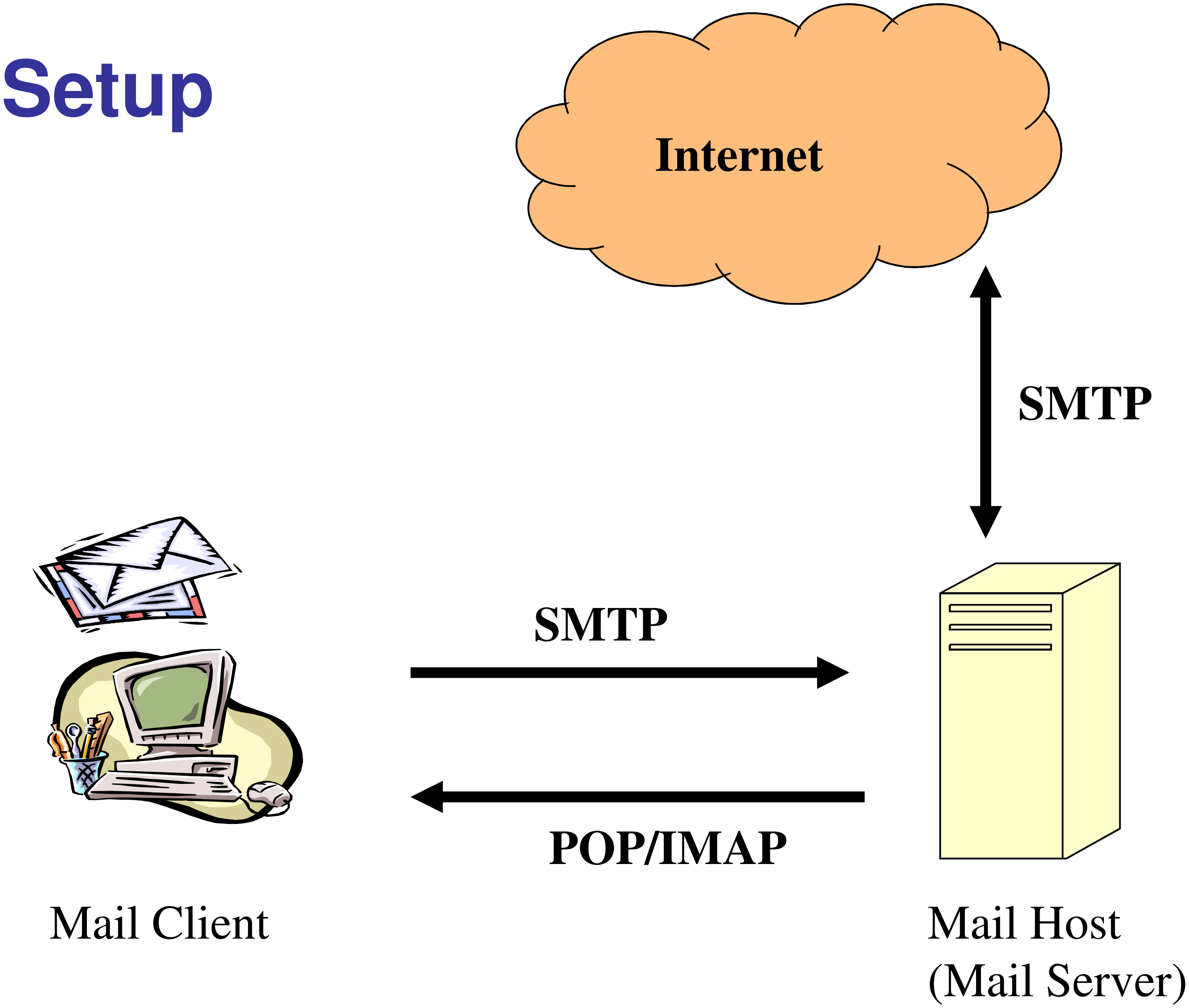
A Mail Setup


Internet
SMTP
SMTP
POP/IMAP
Mail Client
Mail Host
(Mail Server)

Email Exchange

There are **5** major parts involved in an email exchange

1. The user program
2. The server daemon (MTA)
3. The mailhost
4. A daemon for users to read mail from mailhost (MUA)
5. DNS

Email Exchange (Con't)

❑Mail server daemons: **sendmail**, **qmail, postfix**, **exim**, **mmdf, smail**, **zmailer** etc.

❑The server daemon usually has 2 function:

- looks after receiving incoming mail
- delivers outgoing mail

❑The server daemon does not allow you to read your mail. For this you need an additional daemon (**POP**, **IMAP**, etc).

❑The DNS and its daemon "**named**" play a large role in the delivery of email.

3.4.3 FTP - File Transfer Protocol

- ❑ This is the most basic file transfer application in the Internet
  - One of the original client/server applications run on the ARPANET
- ❑ Works on both Unix systems as well as non-Unix systems
- ❑ Allows for both file transfer and interactive access
- ❑ Requires authentication via user name and password
- ❑ Requires that a host system run an FTP server
  - Listens for incoming requests on a well known port (21)
  - Anonymous/Guest logins are common
- ❑ FTP is a two process model
  - Control process which communicates with peer control process
    - o These processes communicate commands/responses as well as port information
  - Data transfer process which actually transfers requested file

File Transfer Protocol Contd.

- ❑ Client control process connects to server control process
  - ftp ucsc.cmb.ac.lk
- ❑ The client also starts a data transfer process which listens on a local port
  - Communicates this port number to server via control process
- ❑ If client requests a file transfer, server initiates connection to client’s data transfer port
  - Server uses well known port for data transfer (20)
- ❑ Commands used by FTP are actually a subset of TELNET protocol NVT ASCII

Secure FTP

❑ SFTP is a program that uses SSH to transfer files.

❑ SFTP encrypts both commands and data, preventing passwords and sensitive information from being transmitted in clear over the network.

❑ It is functionally similar to FTP.

❑ There are two ways you can use SFTP: graphical SFTP clients and command line SFTP.

3.4.4 HTTP - Hyper Text Transfer Protocol

❑ Client can make requests

- GET for requesting a file from the server
- POST for submitting information to the server
- When it makes a request, the client also passes some client side descriptors to the server

❑ Server responds

- HTTP headers
- HTML document
  - o Text, JPEG, GIF, audio,Video etc.

❑ Browser implements client side of this service

❑ Web server implements server side of this service

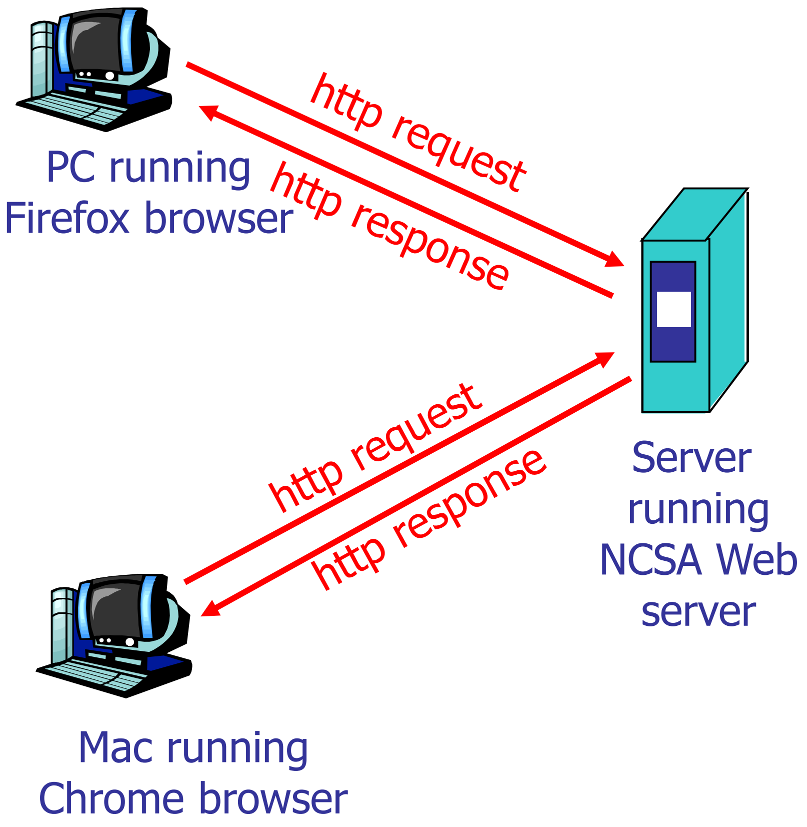
HTTP Request Methods

METHOD	DESCRIPTION
GET	Request to read a web page
HEAD	Request to read a web page’s header
PUT	Request to store web page
POST	Append to a named resource
DELETE	Remove the web page
TRACE	Echo the incoming request
CONNECT	Reserved for future forecast
OPTIONS	Query certain options

The Web: the HTTP protocol

HTTP: hypertext transfer protocol

- ❑ Web’s application layer protocol
- ❑ client/server model
  - *client:* browser that requests, will receive and “displays” Web objects
  - *server:* Web server sends objects in response to requests
- ❑ http1.0: RFC 1945
- ❑ http1.1: RFC 2068


PC running Firefox browser
http request
http response
Server running NCSA Web server
http request
http response
Mac running Chrome browser

The http protocol: more

http: TCP transport service:

- ❑ 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"

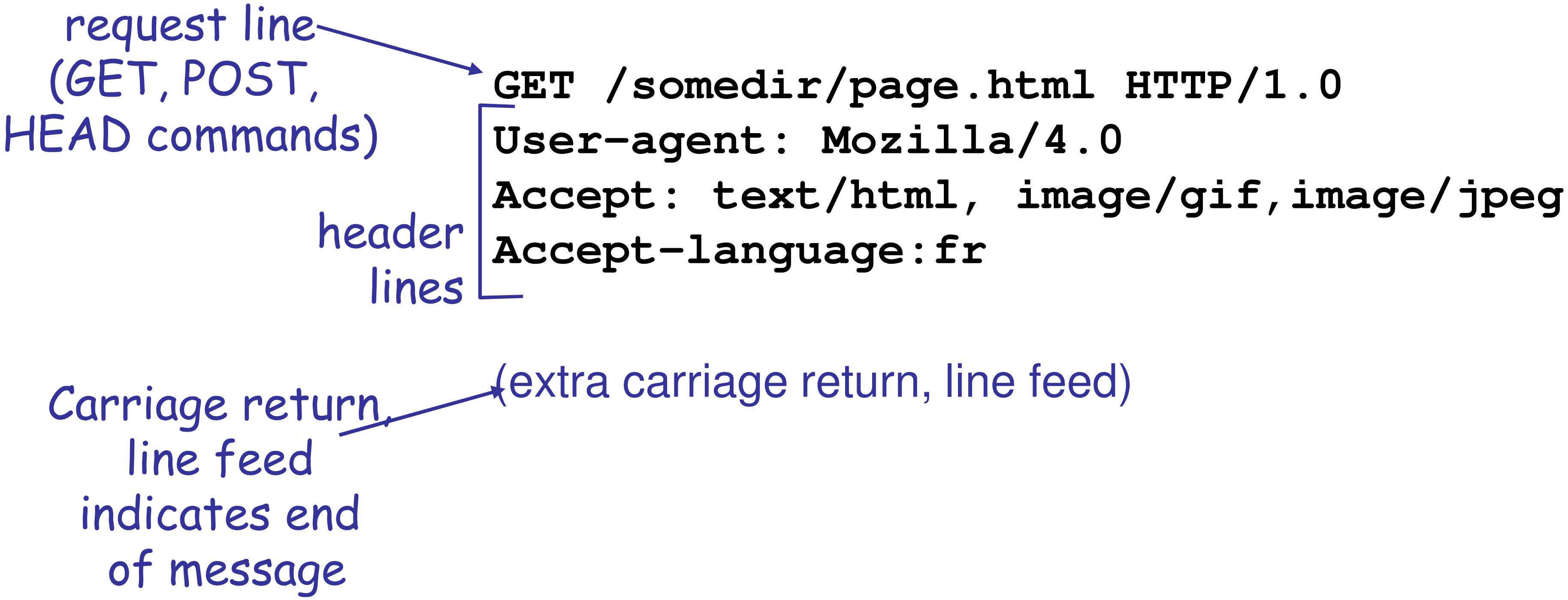
- ❑ server maintains no information about past client requests

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 message format: request

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



request line (GET, POST, HEAD commands)

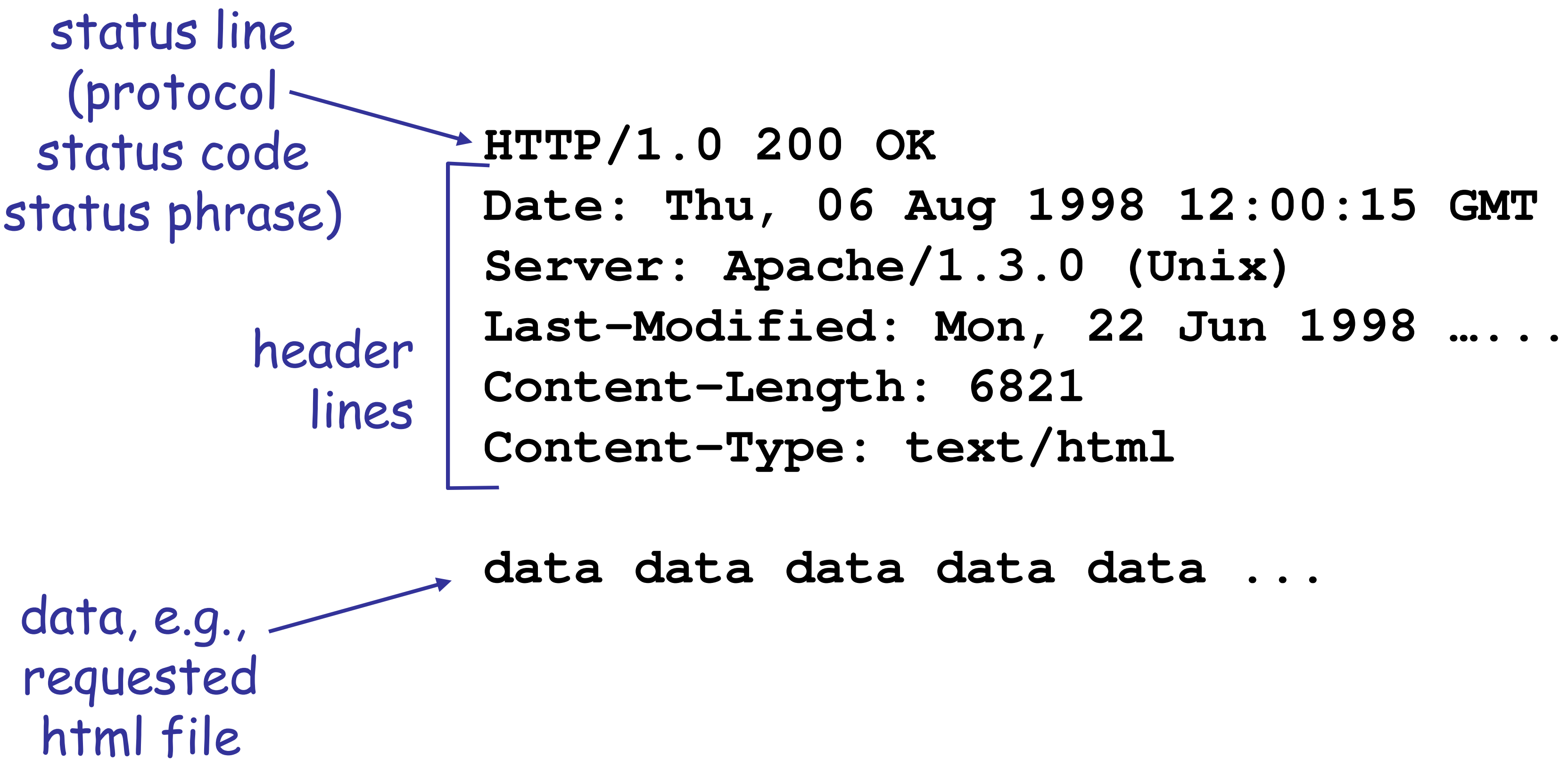
header lines

Carriage return, line feed indicates end of message

```
GET /somedir/page.html HTTP/1.0
User-agent: Mozilla/4.0
Accept: text/html, image/gif,image/jpeg
Accept-language:fr
```

(extra carriage return, line feed)

http message format: response



status line (protocol status code status phrase)

```
HTTP/1.0 200 OK
Date: Thu, 06 Aug 1998 12:00:15 GMT
Server: Apache/1.3.0 (Unix)
Last-Modified: Mon, 22 Jun 1998 …...
Content-Length: 6821
Content-Type: text/html

data data data data data ...
```

header lines

data, e.g., requested html file

http response status codes

200 OK

- request succeeded, requested object later in this message

301 Moved Permanently

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

400 Bad Request

- request message not understood by server

404 Not Found

- requested document not found on this server

505 HTTP Version Not Supported