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# Unit-2:
# Application Layer
# Part-2

**Prof. Maulik D Trivedi**
Computer Engineering Department
Darshan Institute of Engineering & Technology,
Rajkot
maulik.trivedi@darshan.ac.in
+91-9998265805

## Outline

- Principles of Computer Applications
- Web
- HTTP
- E-mail
- DNS
- Socket programming with TCP and UDP

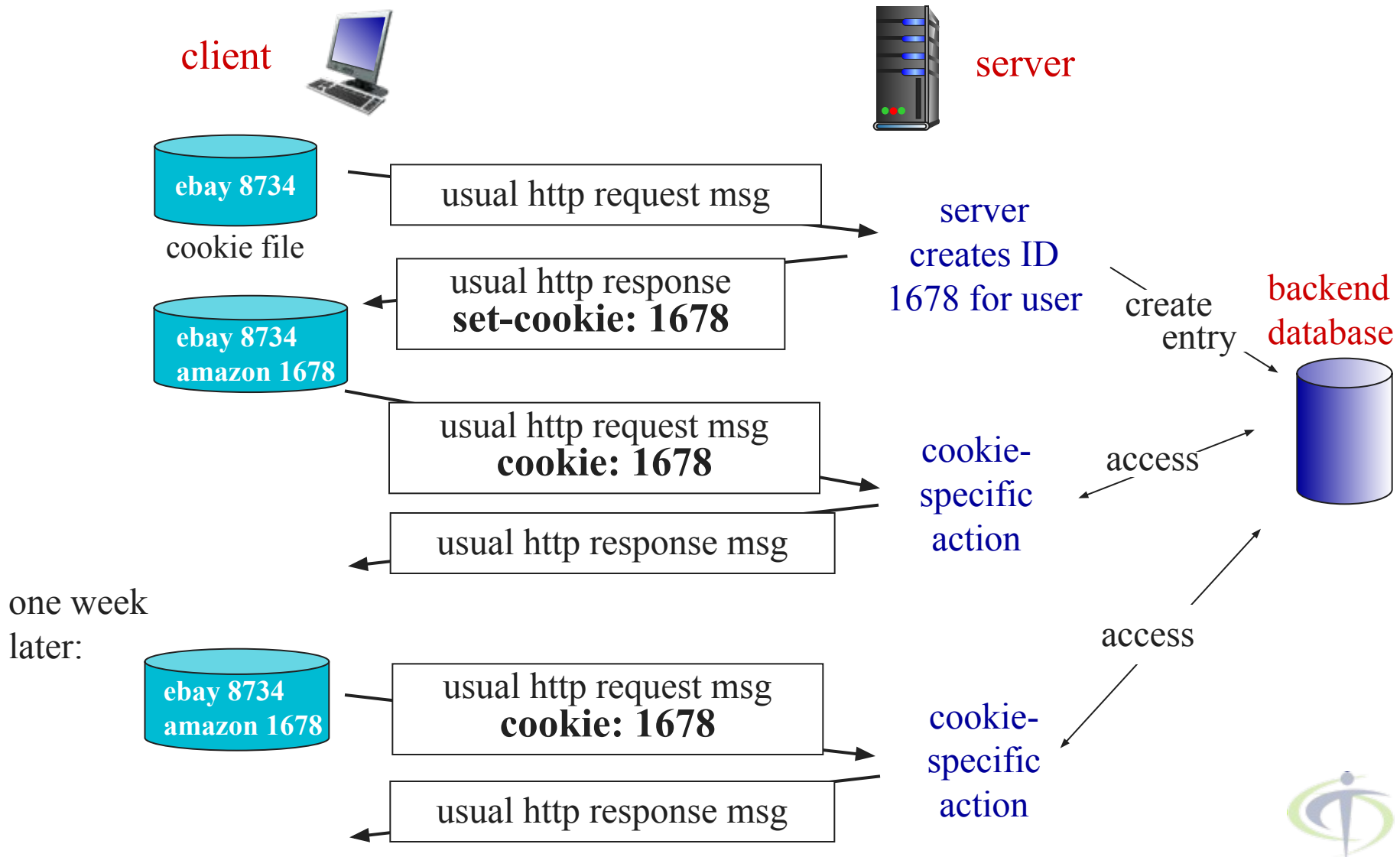
# User-Server interactions: Cookie

# User-Server interactions: Cookie

- A small text file that is stored in the user's computer either temporarily for that session only or permanently on the hard disk.
- Cookies provide a way for the Web site to recognize you and keep track of your preferences.
- The cookie technology has four components:
  1. A cookie header line in the HTTP response message
  2. A cookie header line in the HTTP request message
  3. A cookie file kept on the user's end system and managed by the user's browser
  4. A back-end database at the Web site

- **Use of Cookies**
  - **Authorization**
  - **Recommendations**
  - **Shopping carts**
  - **User session state (Web, Email)**

# Cookies - Example



# Web Caches (Proxy Server)

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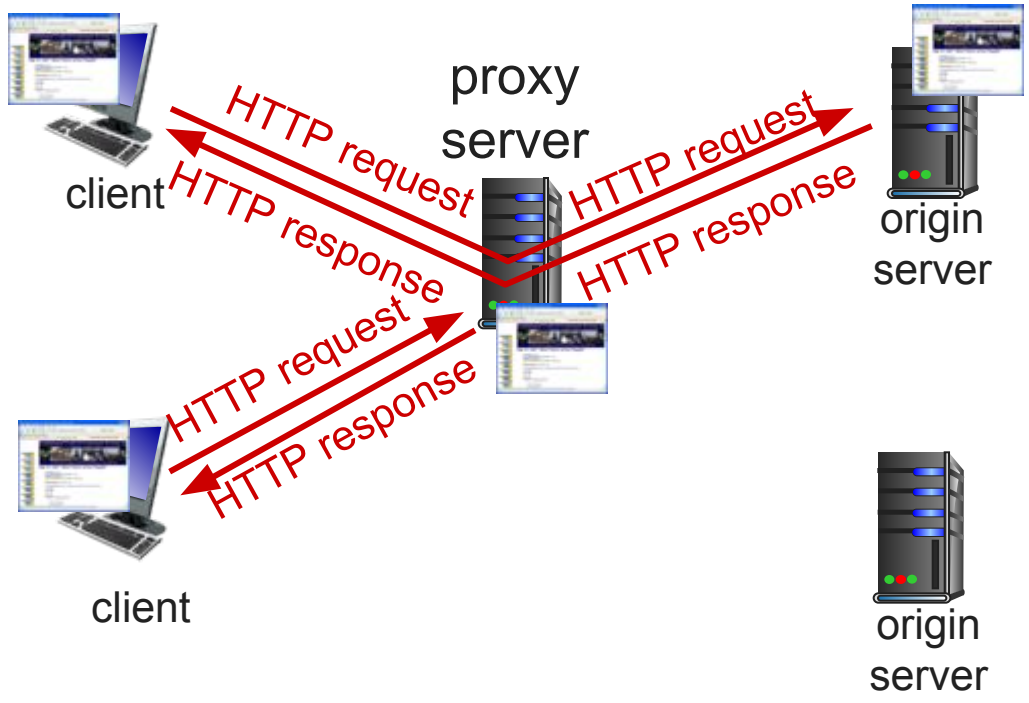
- It satisfies HTTP requests on the behalf of an origin Web server.
- The Web cache has its own disk storage and keeps copies of recently requested objects in this storage.

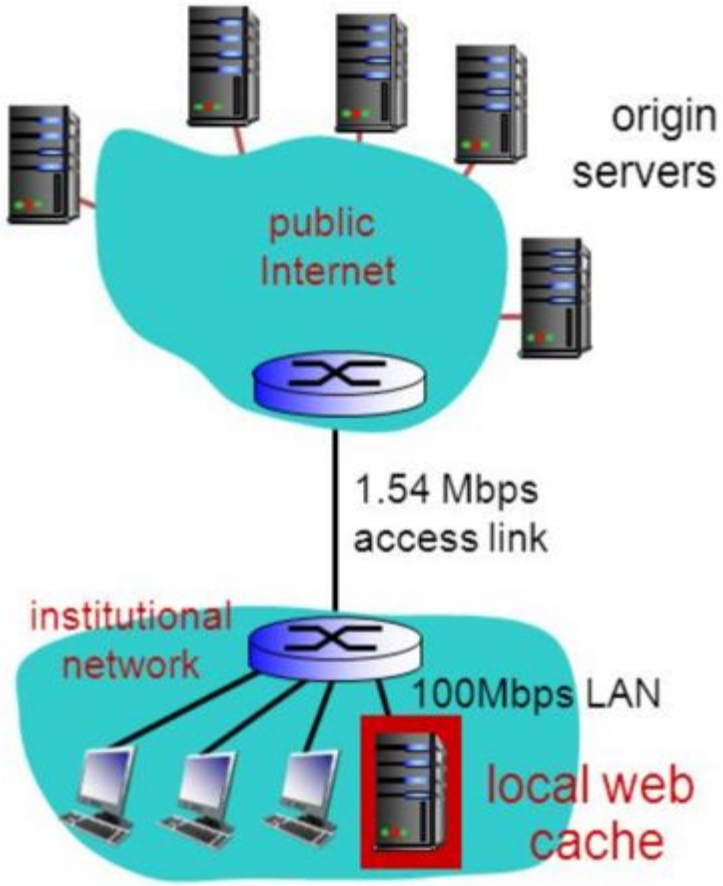


# Web Caches (Proxy Server) – Cont...

- A user's browser can be configured so, user's HTTP requests are first directed to the Web Cache.
- A browser sends all HTTP requests to cache.
- As an example, suppose a browser is requesting the object http://www.someschool.edu/campus.gif
- Object in cache returns to client browser.
- Otherwise cache requests object from origin server, then returns object to client browser.
- Reduce response time for client request.
- Reduce traffic on an institution's access link.
- Internet dense with caches: Insufficiency for content providers to effectively deliver content.

# Web Caches (Proxy Server) – Example

- Example: Institutional Network and Internet
- Reduce response time for client request.
- Reduce traffic on an institution's access link.
- Internet dense with caches: Insufficiency for content providers to effectively deliver content.



# FTP (File Transfer Protocol)

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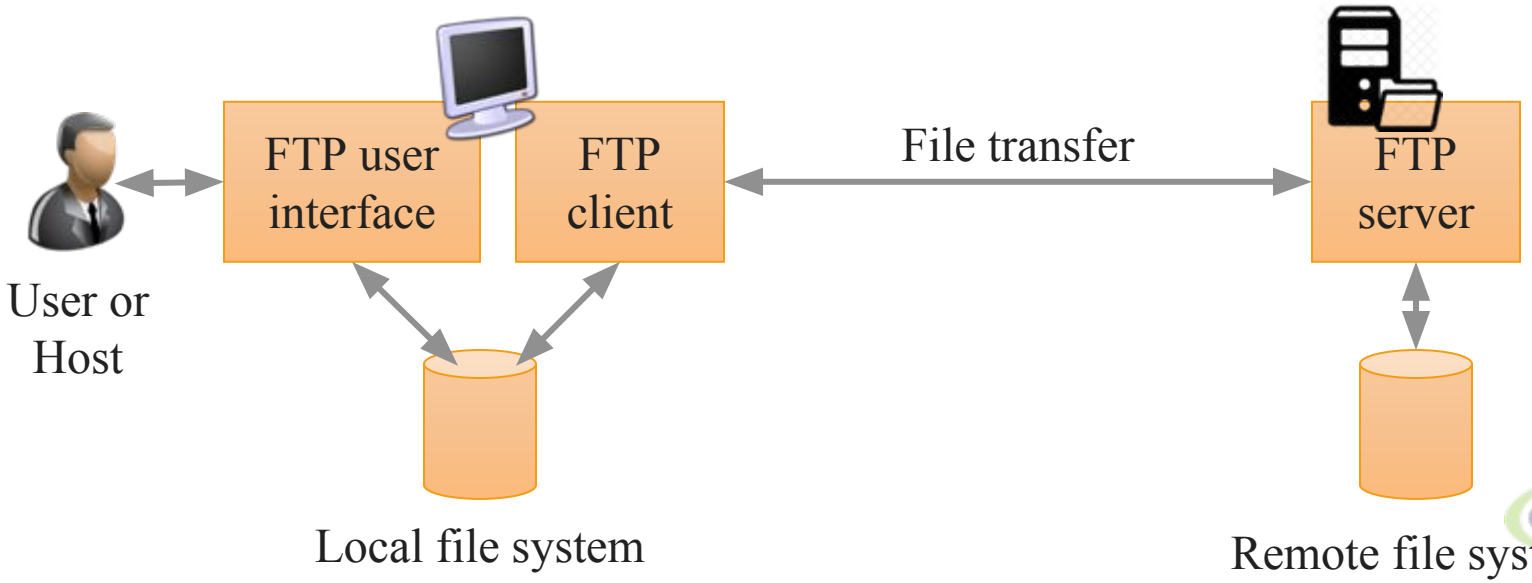
- File Transfer Protocol (FTP) is the commonly used protocol for exchanging files over the Network or Internet.
  - Example: Filezilla
- FTP uses the Internet's TCP/IP protocols to enable data transfer.
- FTP uses client-server architecture.
- FTP promotes sharing of files via remote computers with reliable and efficient data transfer.



# FTP (File Transfer Protocol) – Cont…

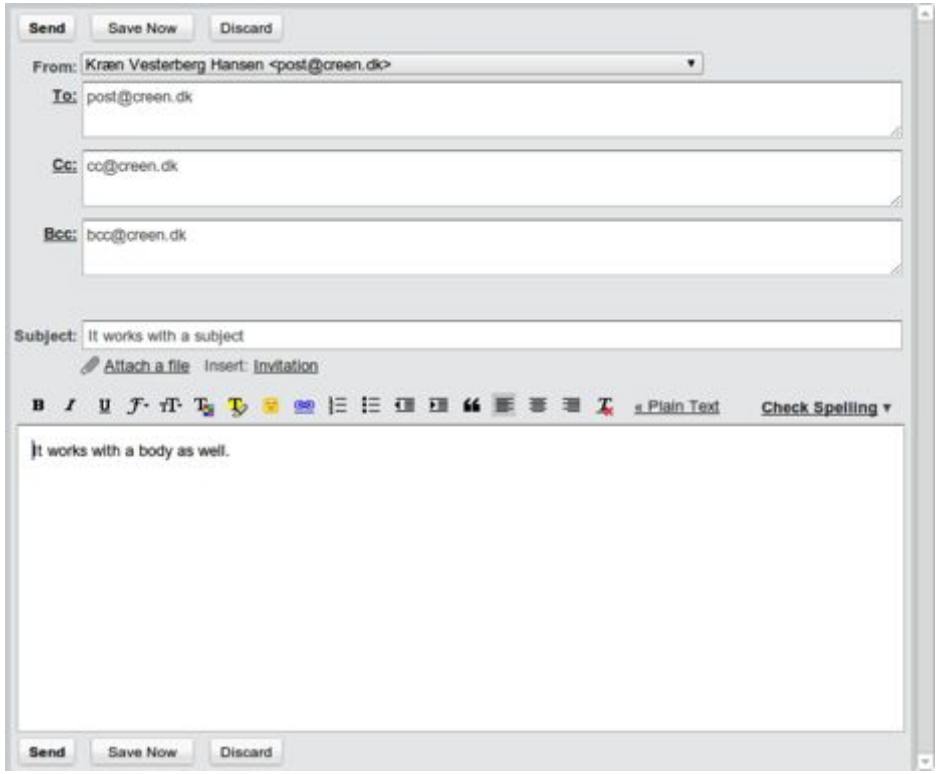
- FTP client connect FTP server at port 21 using TCP.
- FTP uses two parallel TCP connections to transfer a file,
- Control Connection: Used for sending control information between two hosts.
- Data Connection: To send a file.
  - Control Information like user identification, password, commands to change remote directory, commands to "put" and "get" files
- Client will browse remote file directory, sends commands over control connection.
- FTP server maintains "state" about user like current directory, earlier authentication.

# FTP (File Transfer Protocol) – Example

# Electronic Mail (Email)

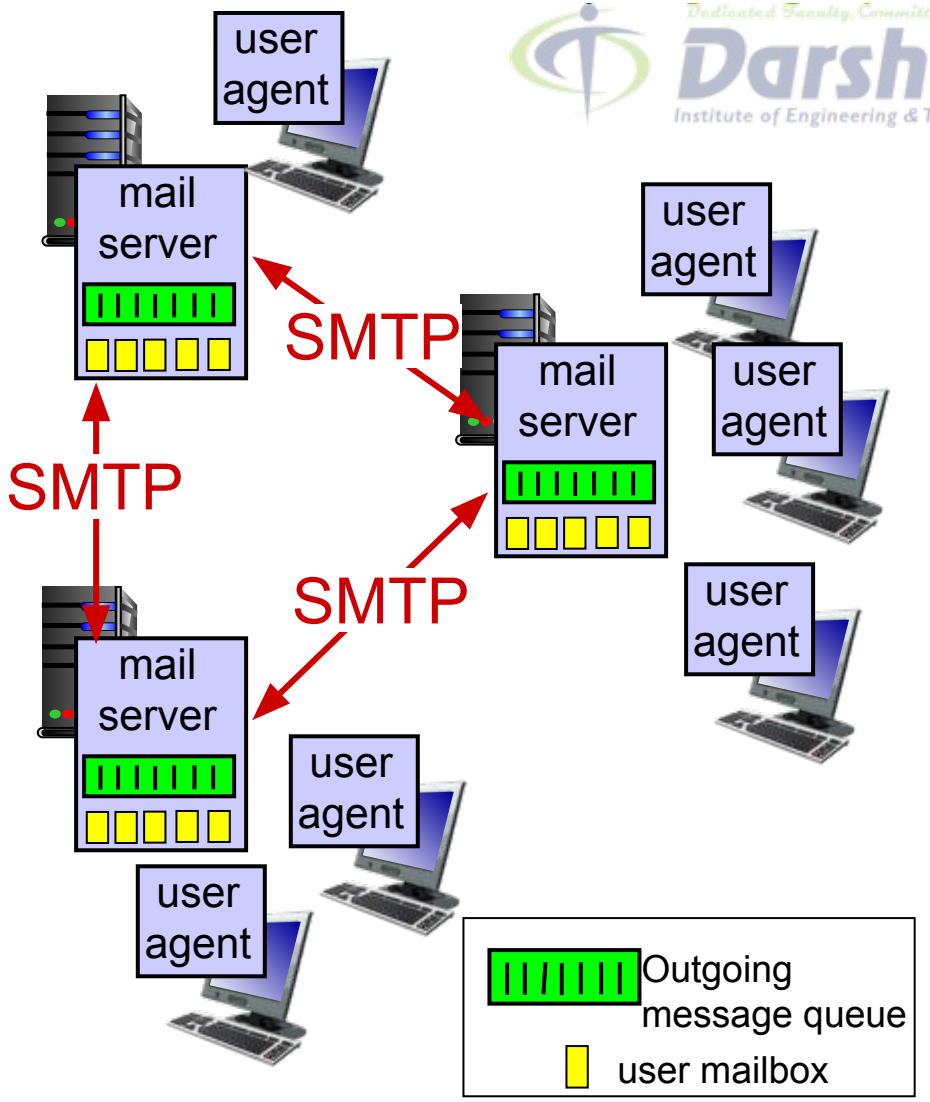
# Electronic Mail (Email)

- Email is an asynchronous communication medium in which people send and read messages as convenient for them.
- Modern Email has many powerful features like:
  - A messages with attachments
  - Hyperlinks
  - HTML-formatted text
  - Embedded photos
- Email is fast, easy to distribute, and inexpensive.
- High level view of Internet mail system and its key components.
  - User agents
  - Mail servers
  - Simple Mail Transfer Protocol (SMTP)



# Email - Cont…

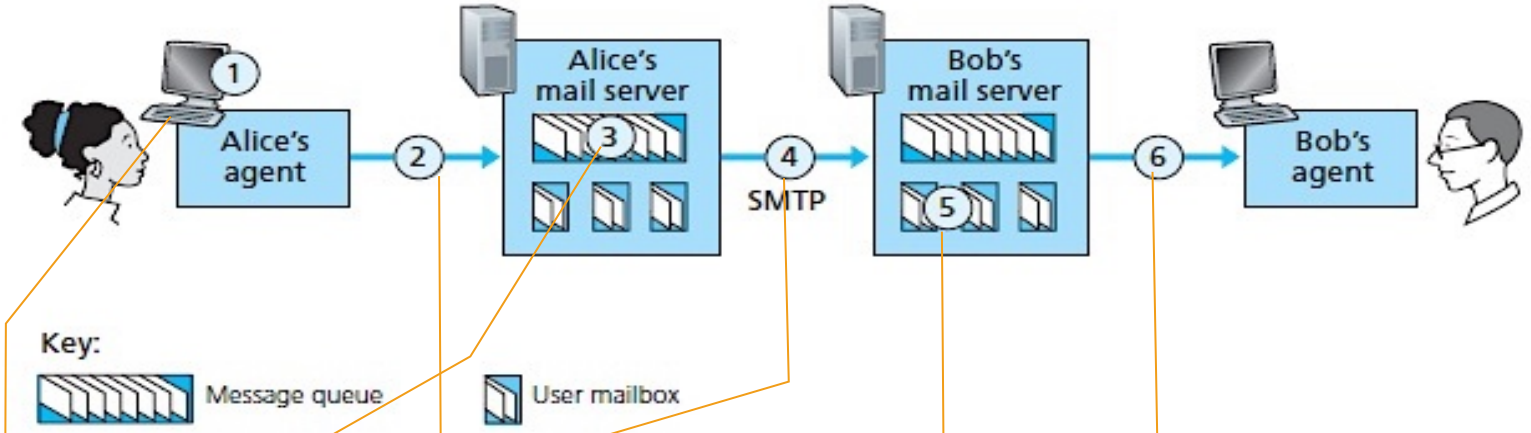
- User Agent
  - User agents allow users to read, reply to, forward, save, and compose messages.
  - E.g. Microsoft Outlook and Apple Mail.
- Mail servers:
  - A mailbox contains incoming messages for user.
  - A message queue of outgoing (to be sent) mail messages.
- SMTP
  - It is a principal application layer protocol between mail servers to send email messages.
    - client: sending mail to server
    - server: receiving mail from other different mail server



# SMTP

- Simple Mail Transfer Protocol used in sending and receiving e-mail.
- It use TCP to reliably transfer email message from client to server using port 25.
- It restricts the body (not just the headers) of all mail messages to simple 7-bit ASCII.
- SMTP does not use intermediate mail servers for sending mail.
- If receiving end mail server is down, the message remains in sending end mail server and waits for a new attempt.

# SMTP - Example




1. Alice uses user agent to compose message to computer@darshan.ac.in
2. Alice's user agent sends message to her mail server; message placed in message queue.
3. Client side of SMTP opens TCP connection with Bob's mail server.
4. SMTP client sends Alice's message over the TCP connection.
5. Bob's mail server places the message in Bob's mailbox.
6. Bob invokes his user agent to read message.

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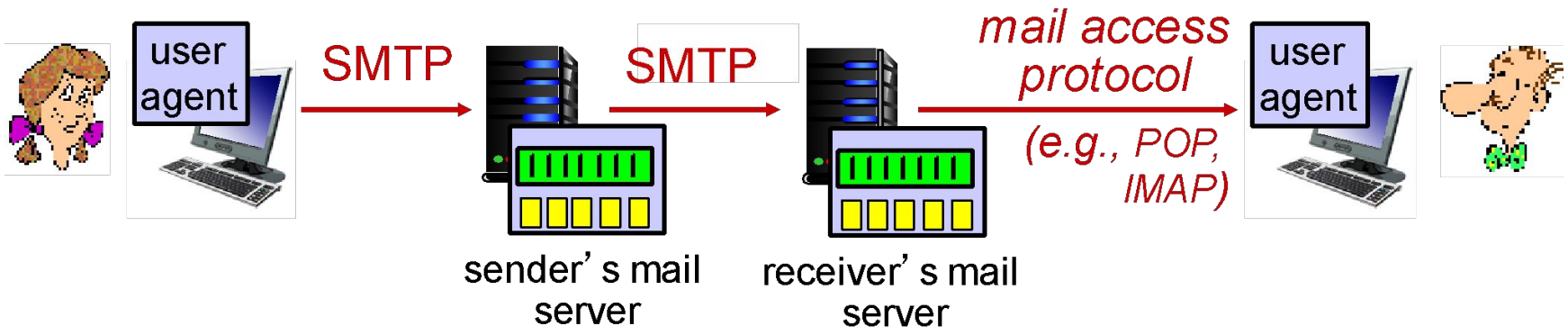
# Mail Access Protocols (POP3 and IMAP)




- POP3
  - Post Office Protocol – Version 3
- IMAP
  - Internet Mail Access Protocol
- A mail access protocol, such as POP3, is used to transfer mail from the recipient's mail server to the recipient's user agent.

# POP3 – Post Office Version 3

- POP3 is an extremely simple mail access protocol.
- With the TCP connection established, POP3 progresses through three phases: authorization, transaction and update.
- In authorization, the user agent sends a username and a password to authenticate the user.
- In transaction, the user agent retrieves messages, mark messages for deletion, remove deletion marks and obtain mail statistics.
- In update, after the quit command by client, ending the POP3 session; the mail server deletes marked messages.
- POP3 is designed to delete mail on the server as soon as the user has downloaded it.





# IMAP - Internet Mail Access Protocol

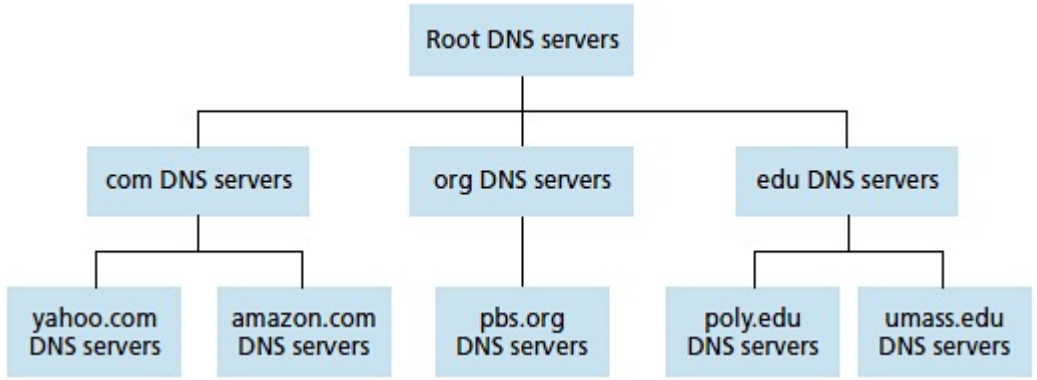
- To keeps all messages in one place: at server
- The recipient can then move and organize the message into a new, user-created folder, read the message, delete the message, move messages from one folder to another and so on.
- To allow users to search remote folders for messages matching specific criteria.
- Also permit a user agent to obtain components of messages, When low-bandwidth connection between the user agent and its mail server.
- In this case, user not to download all the messages in its mailbox, particularly avoiding long messages like an audio or video clip.

# DNS - Domain Name System

# DNS - Domain Name System


- It is an internet service that translates domain names into IP addresses.
- It is application-layer protocol. DNS service must translate the domain name into the corresponding IP address.
- In DNS system, If one DNS server doesn't know how to translate a particular domain name, it asks another one, and so on, until the correct IP address is returned.

# DNS - Example




- DNS client wants to determine the IP address for the hostname www.amazon.com
- The client first contacts one of the root servers, which returns IP addresses for TLD servers - top-level domain .com.
- Then contacts TLD servers, which returns the IP address of an authoritative server for www.amazon.com
- Finally, contacts one of the authoritative servers for www.amazon.com, which returns the IP address for the hostname www.amazon.com.

# DNS: A distributed - hierarchical database

- Root DNS Servers – Total 13

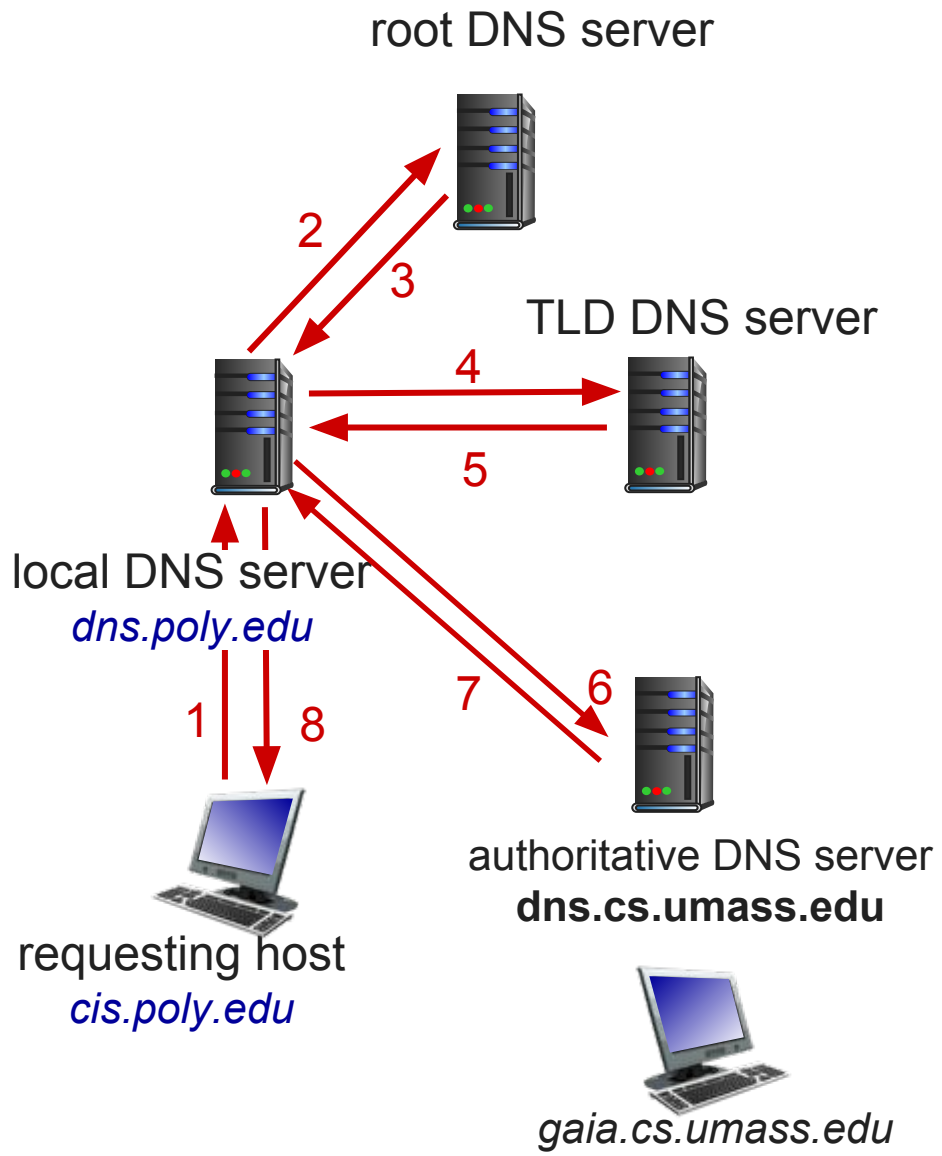
# DNS – Cont…

- Top-level domain (TLD) servers:
  - It is responsible for com, org, net, edu, aero, jobs, museums, and all top-level country domains, e.g.: uk, fr, ca, jp
  - Network Solutions maintains servers for .com TLD
  - Education for .edu TLD
- Authoritative DNS servers:
  - To organization's own DNS servers, providing authoritative hostname to IP mappings for organization's named hosts.
  - It can be maintained by organization or service provider.
- Local DNS name servers:
  - It does not strictly belong to hierarchy
  - when host makes DNS query, query is sent to its local DNS server.
    - It acts as proxy, forwards query into hierarchy.

# DNS - Example

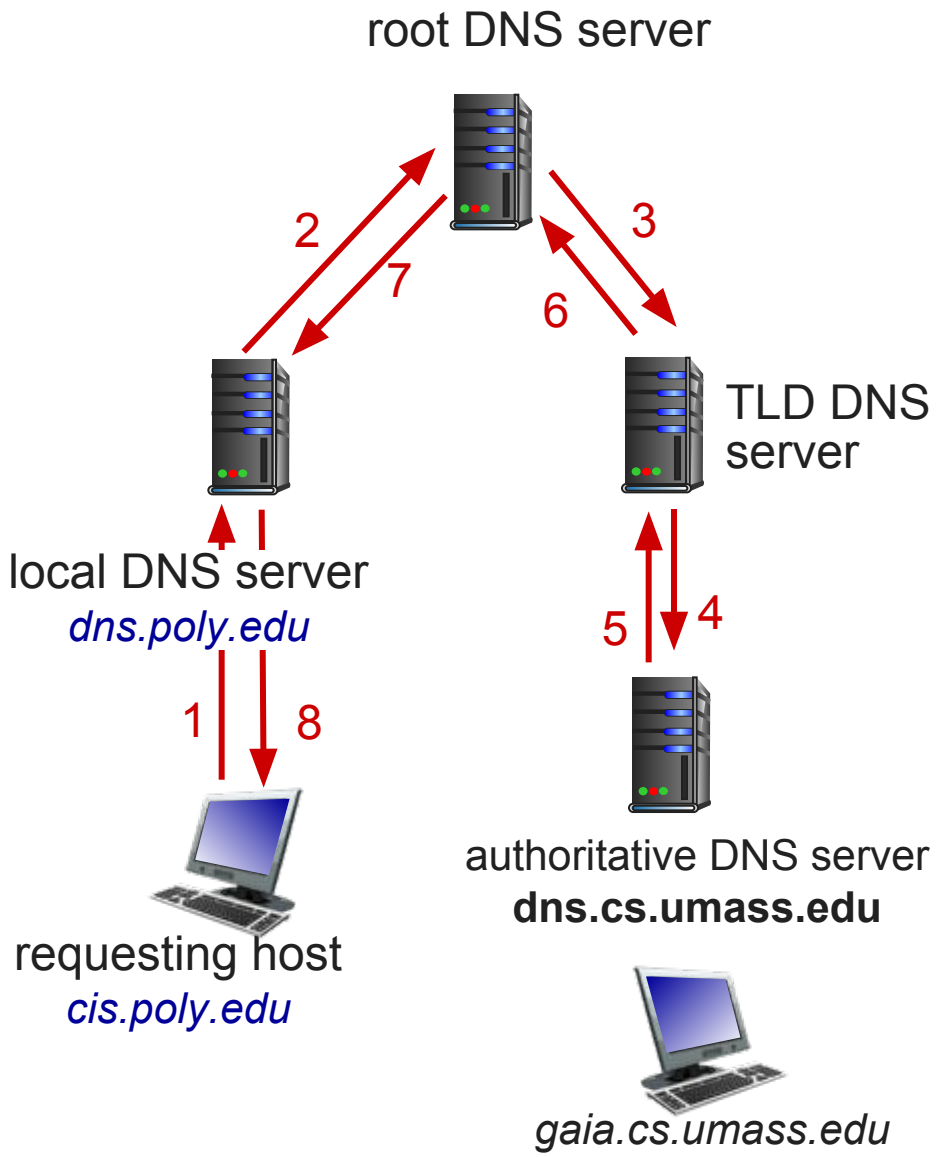
# DNS Name Resolution Example

- Iterated Query:
  - A host at cis.poly.edu wants IP address for gaia.cs.umass.edu



# DNS Name Resolution Example

- Recursive Query:
  - A host at cis.poly.edu wants IP address for gaia.cs.umass.edu



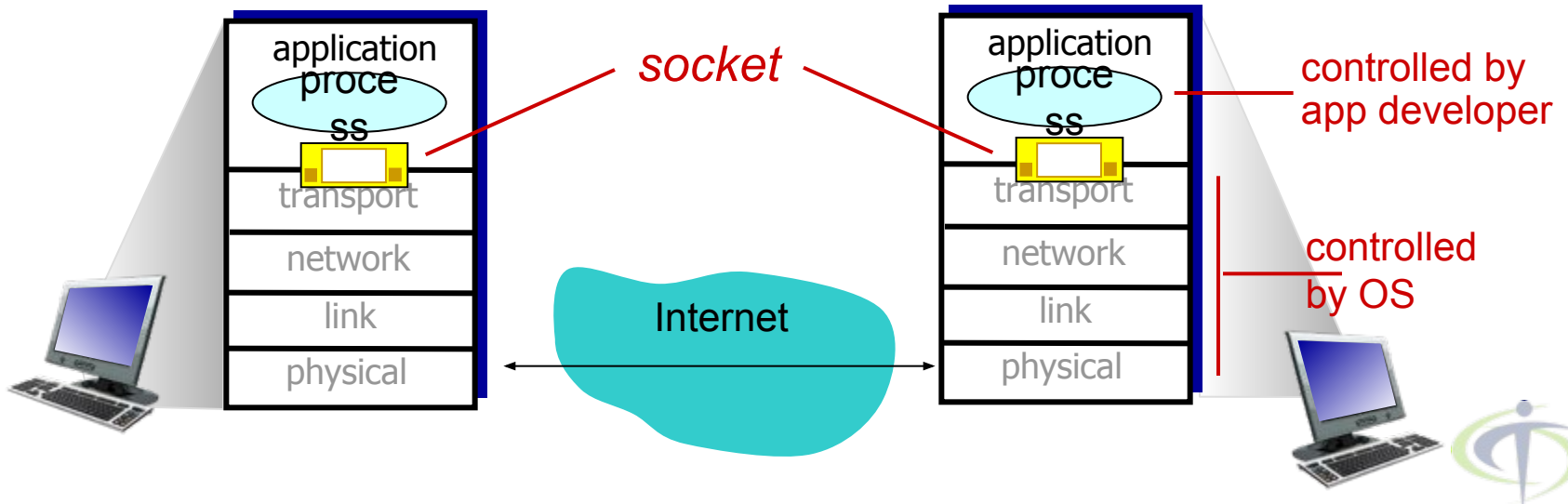
# DNS – Cont...

- Distributed database design is more preferred over centralized design to implement DNS in the Internet.
- A single point of failure: If the DNS server crashes then the entire Internet will not stop.
- Traffic volume: With millions of device and users accessing its services from whole globe at the same time.
- A Single DNS Server cannot handle huge DNS traffic but with distributed system its distributed and reduce overload on server.
- Distant centralized database: A single DNS server cannot be “close to” all the querying clients.
  - If it is in New York City, then all queries from Australia must travel to the other side of the globe, perhaps over slow and congested links cause significant delays.
- Maintenance: To keep records for all Internet hosts. it would have to be updated frequently to account for every new host.

# Socket Programming

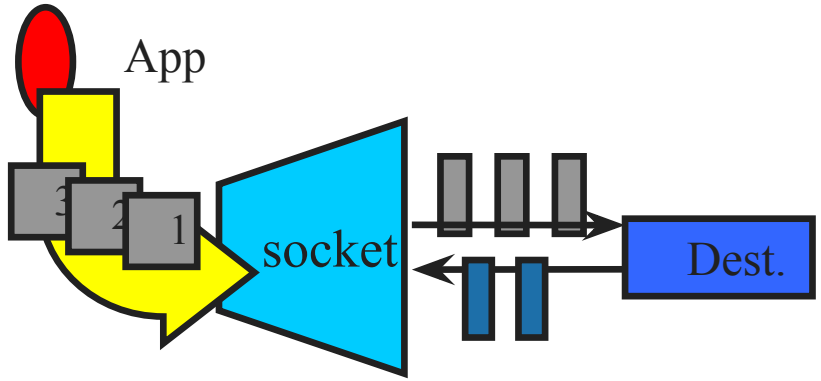
# Socket Programming

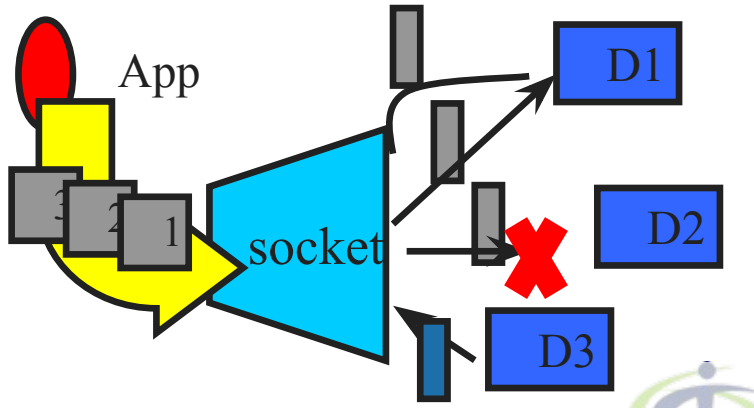
- Socket is interface between application and network.
  - An application creates a socket.
  - Two type of socket:
    - TCP Socket – Reliable Transmission
    - UDP Socket – Unreliable Transmission
- Once configured the application can pass data to the socket for transmission and receive data from the socket (transmitted through the network by some other host).



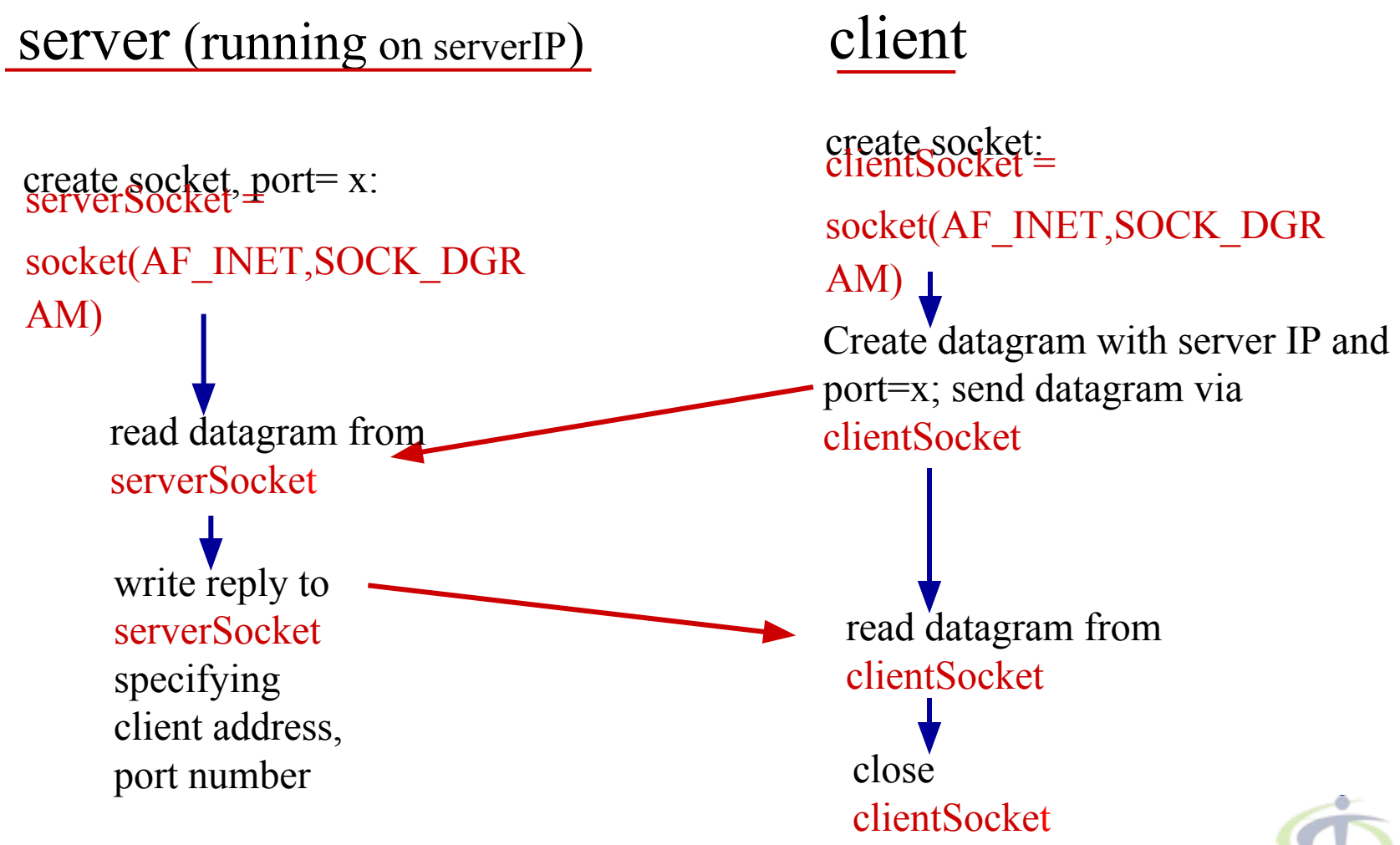
# Type of Socket

- SOCK_STREAM
  - E.g. TCP
  - Reliable delivery
  - In-order guaranteed
  - Connection-oriented
  - Bidirectional
- SOCK_DGRAM
  - E.g. UDP
  - Unreliable delivery
  - No order guarantees
  - Connection-less
  - Unidirectional

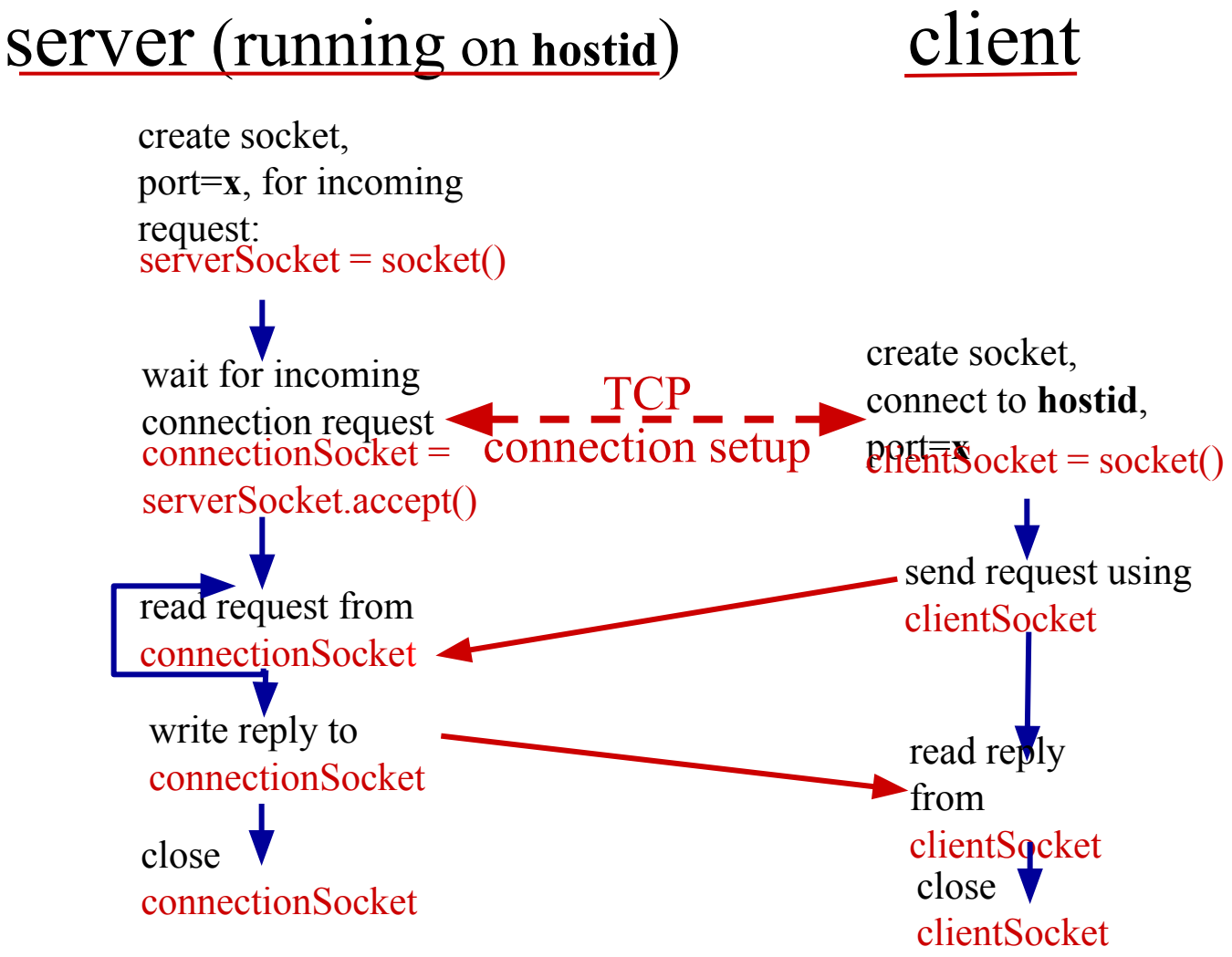


# Client-Server socket interaction: UDP



# Client-Server socket interaction: TCP



# Outline - Summary

- Principles of Computer Applications
  - Browser, Web Server, Email, P2P Applications etc…
- Application Layer (TCP – UDP Services)
- Web (Web Pages – Objects like html, jpeg, mp3, etc…)
- HTTP (TCP connection, port-80, persistent & non-persistent conn.), Request & Response Message format, Cookies, Web caches, FTP, Port-21
- E-mail (User agent, Mail Server, SMTP port - 25), POP3, IMAP
- DNS (Domain names to IP Address), hierarchy structure
- Socket programming with TCP and UDP (TCP – Sock_Stream, UDP – Sock_DGram)

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# *Thank You*

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