



Network Protocols

Lecture 4



Review..

- Why layered model?
- TCP/IP Model (4-5 layers)
- OSI Model (7 Layers)
 - Application Layer 7
 - PresentationLayer 6
 - Session Layer 5
 - Transport Layer 4
 - Network Layer 3
 - Data Link Layer 2
 - Physical Layer 1

What is a Communication protocol?

- It is a **system of rules** that allow two or more entities of a communications system to transmit information via any kind of variation of a physical quantity.
- The protocol defines the rules syntax, semantics and synchronization of communication and possible error recovery methods.



Network Topology, architecture, and protocols

- Network **topology** defines how the “highway” is laid out. (star)
- Network **architecture** sets the rules of the road, such as how traffic gets on and off the highway. (ex. OSI)
- Network **protocols** define the expected behavior of drivers while using the highway.

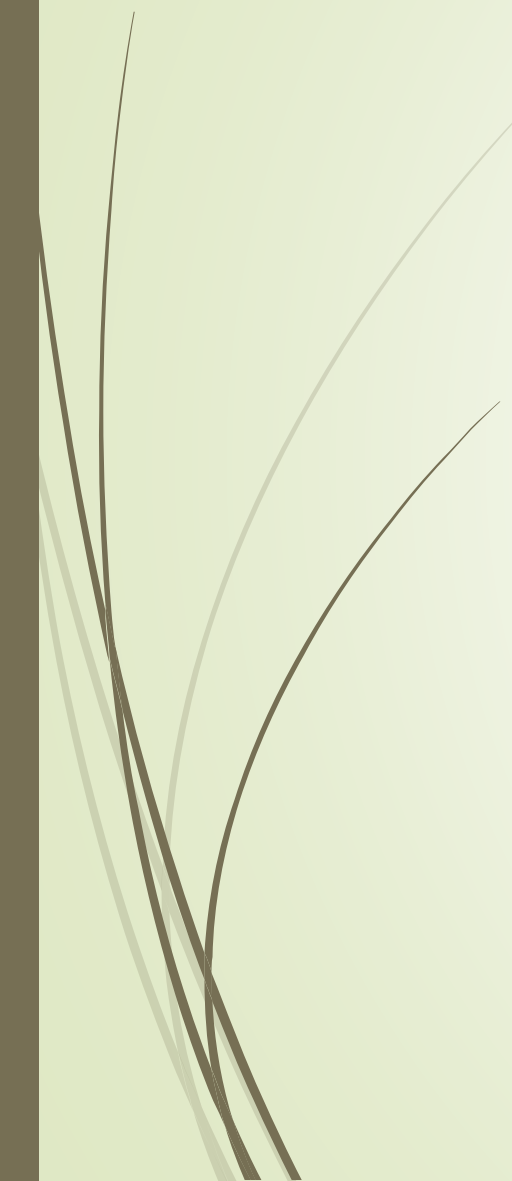


OSI models & Protocols

- Each **layer** is defined by a set of rules called protocols that specify how data is handled at that level.
- **Protocol suite/stack**: a set of compatible protocols used to communicate over a network (example: TCP/IP stack)
- A **connection-oriented** protocol: a rule that creates a virtual circuit connection with the destination node before a packet is transmitted (the dest. is ready to receive it).
- A **connectionless protocol**: transmits packets without first making a connection with the destination node. That is, packets are sent regardless of whether the destination node is ready to receive them.
- A **reliable protocol**: a protocol that acknowledges packets as they are being received.



What kind of rules the protocols specify?

- 
1. Data formats for data exchange.
 2. Address formats for data exchange
 3. Address mapping
 4. Routing
 5. Detection of transmission errors
 6. Acknowledgements
 7. Loss of information - timeouts and retries
 8. Direction of information flow
 9. Sequence control
 10. Flow control



Transmission Control Protocol/Internet Protocol (TCP/IP)

- TCP/IP is the **most widely** used protocol, and acts as the **Transport/Network** layer protocol.
- The TCP makes sure that the data is correctly **sized**, properly put in **packets**, and **sequenced** back in the right order upon receipt.
- The TCP, also known as a connection-oriented protocol, **links the Application layer to the Network layer**.

Layers and Protocols...

OSI model

Layer	Name	Example protocols
7	Application Layer	HTTP, FTP, DNS, SNMP, Telnet
6	Presentation Layer	SSL, TLS
5	Session Layer	NetBIOS, PPTP
4	Transport Layer	TCP, UDP
3	Network Layer	IP, ARP, ICMP, IPSec
2	Data Link Layer	PPP, ATM, Ethernet
1	Physical Layer	Ethernet, USB, Bluetooth, IEEE802.11



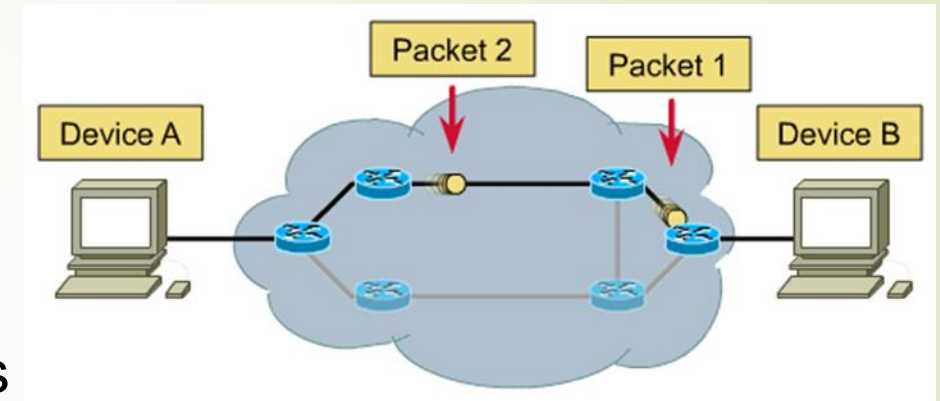
User Datagram Protocol (UDP)

- UDP is a **connectionless** protocol that operates at the **Transport layer**.
- This protocol does not have to open a connection with the receiver and it does not have to carry out any error correction (**unreliable**).
- UDP does not perform any checks to ensure the receipt of data, so it never carries out automatic retransmissions.

Transmission Control Protocol (TCP)

TCP supplies a virtual circuit between end-user applications.
These are its characteristics:

- Layer 4 protocol
- connection-oriented
- reliable
- divides outgoing messages into segments
- reassembles messages at the destination station
- re-sends anything not received
- reassembles messages from incoming segments.
- uses a field referred to as a **window** to define the number of octets that the sender is willing to accept



TCP Segment Header Format

Bit #	0	7	8	15	16	23	24	31
0	Source Port				Destination Port			
32	Sequence Number							
64	Acknowledgment Number							
96	Data Offset	Res	Flags		Window Size			
128	Header and Data Checksum				Urgent Pointer			
160...	Options							

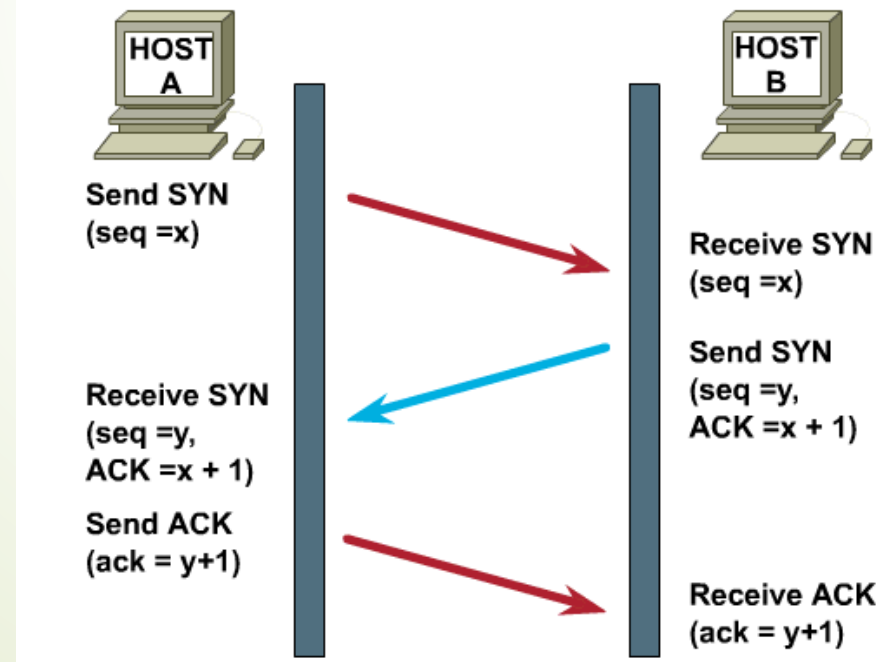
UDP Datagram Header Format

Bit #	0	7	8	15	16	23	24	31
0	Source Port				Destination Port			
32	Length				Header and Data Checksum			

Three-Way Handshake

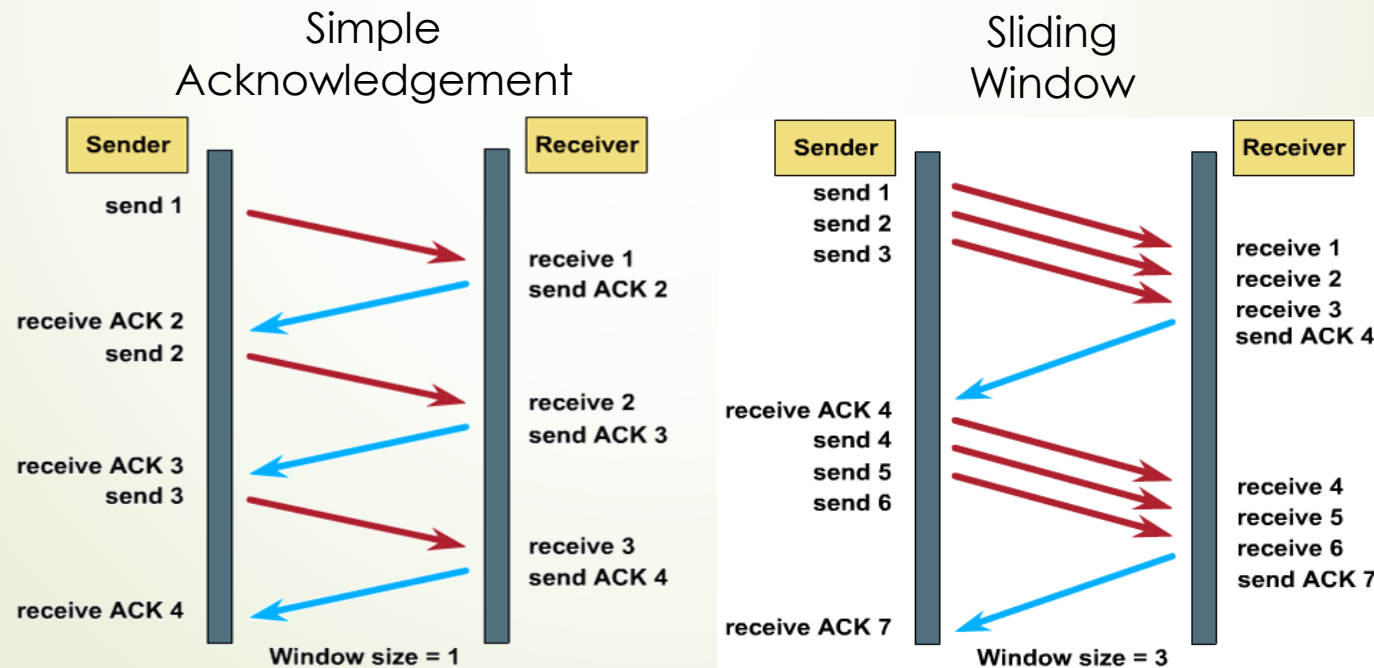
A *three-way handshake/open connection* sequence synchronizes a connection at both ends before the transferred data reaches the ends. The exchange of introductory sequence numbers, during the connection sequence, ensures that any data that is lost, due to problems that may occur later, can be recovered.

TCP Three-Way Handshake/ Open Connection



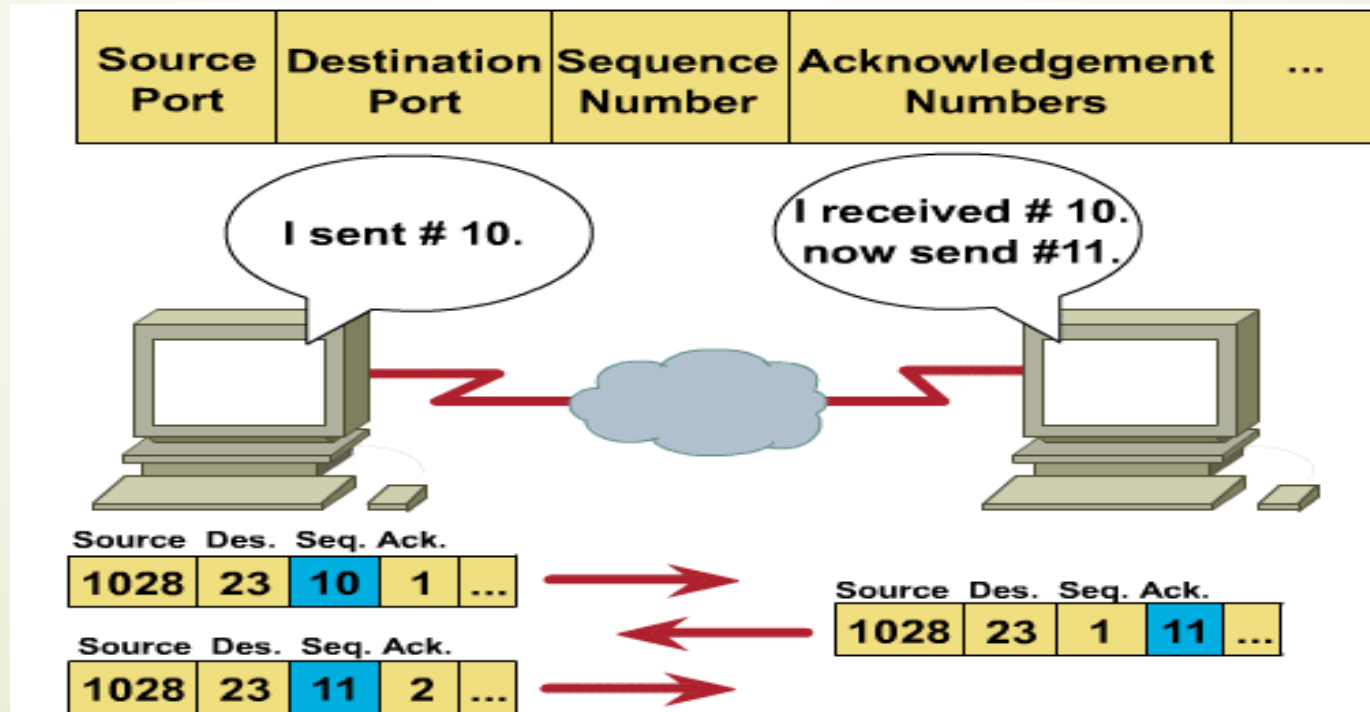
Simple Acknowledgment

Window size determines the amount of data that can be transmitted at one time before receiving an acknowledgement. After a host transmits the window-sized number of bytes, it must receive an acknowledgement before it can send any more messages. For example, with a window size of 1, each individual segment must be acknowledged before the next segment can be transmitted. This results in inefficient use of bandwidth by the hosts.



Sequence and Acknowledgment Numbers

TCP provides sequencing of segments with a forward reference acknowledgment. Each datagram is numbered before transmission. At the receiving station, TCP reassembles the segment into a complete message. **If a sequence number is missing in the series, that segment is re-transmitted.** Segments that are not acknowledged within a given time period result in re-transmission.

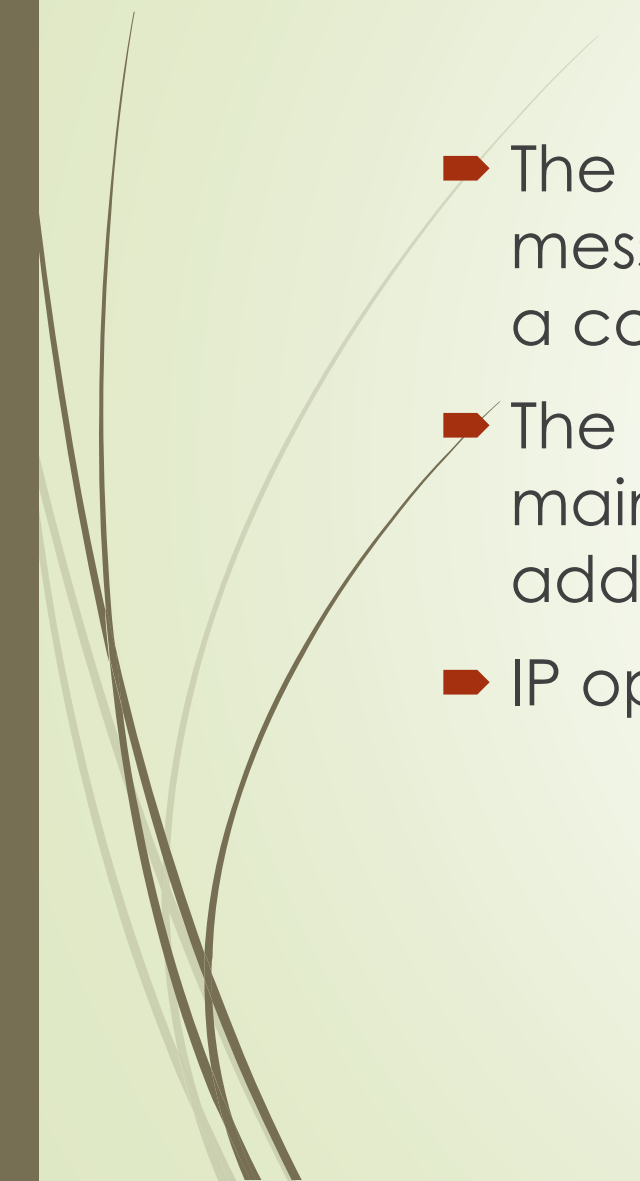


Network Layer protocols

- Network Layer:
finds a path to the destination and forwards packets along that path
- Difference between routing and forwarding
 - Routing is finding the path
 - Forwarding is the action of sending the packet to the next-hop toward its destination



Internet Protocol (IP)

- The IP is a set of rules that is concerned with sending a message to the correct address and is, therefore, called a connectionless protocol.
 - The IP is also responsible for the creation and maintenance of an addressing scheme, known as the IP address.
 - IP operates at the Network layer.
- 



IP addressing

- Each IP address is a unique 4-byte (or 32-bit) number, and each byte is separated by a decimal point.
- Composed of two parts: Network ID and Host ID
- Example of IP addresses : 171.64.20.23
- IP addresses can be used as static assignments to individual computers, or can be assigned dynamically (DHCP).

IP v6

- Is the most recent version of the Internet Protocol (IP)
- Pv6 is intended to replace IPv4
- IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion.
- Every device on the Internet is assigned a unique IP address for identification and location definition
- IPv6 is 128 bit address compared to 32bit IPv4



IPv4 Vs IPv6

➤ <https://www.youtube.com/watch?v=bNmnRvZW3HU>



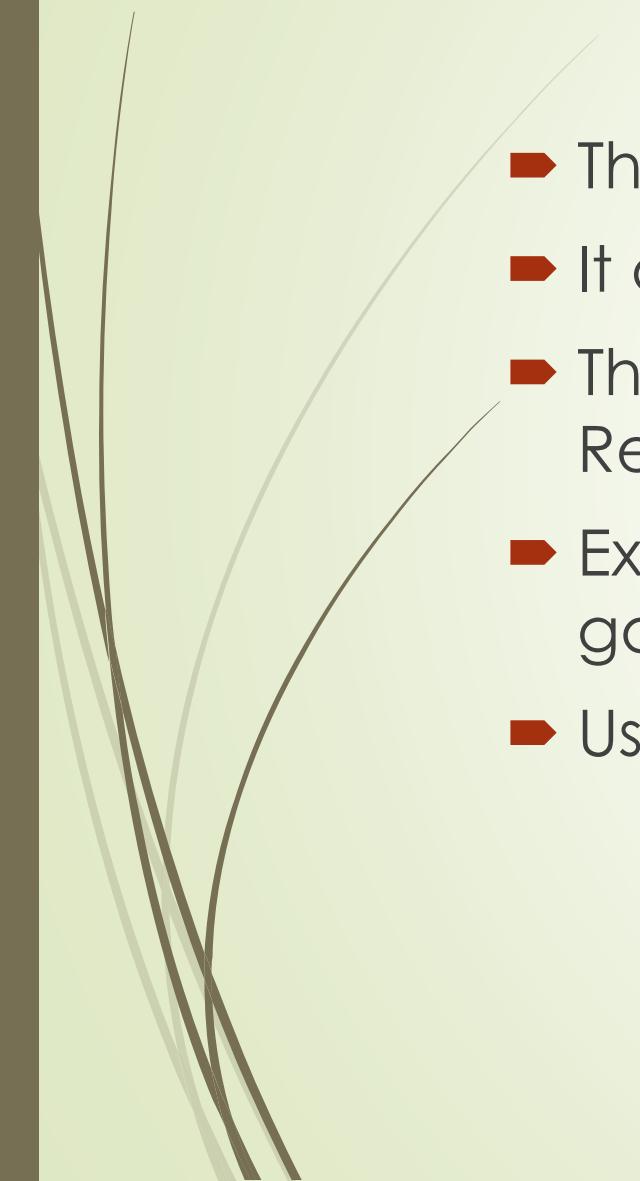


Some Application layer protocols

- DNS
- FTP
- HTTP
- SMTP
- POP3
- SSL

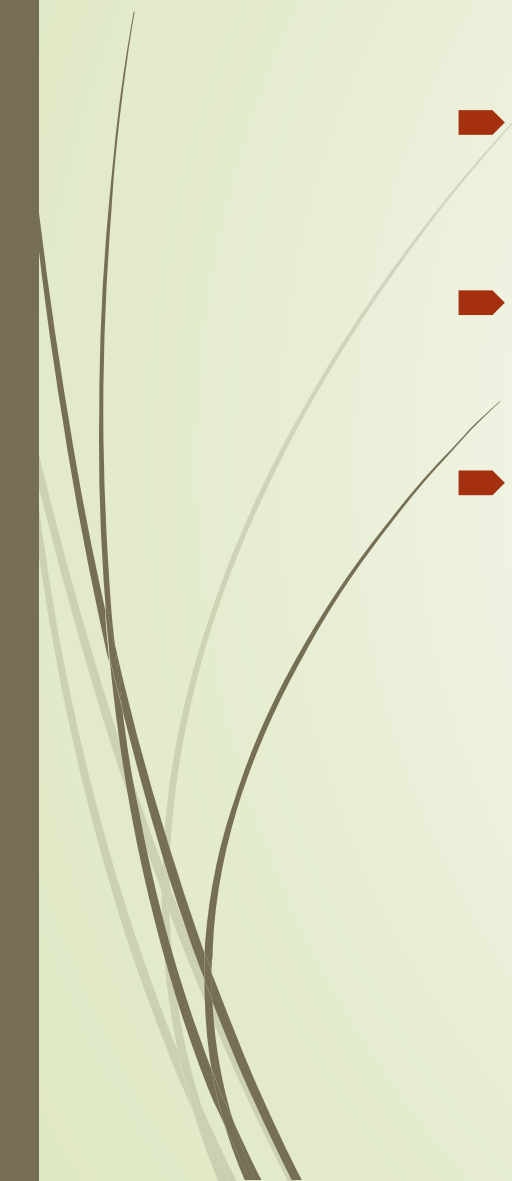


Domain Name Service (DNS) Protocol

- The DNS is used for locating resources on the Internet.
 - It operates at the Application layer.
 - The DNS server uses the IP address to link to the Uniform Resource Locator (URL) concerned.
 - Examples of domain names include com, net, org, edu, gov, and mil.
 - Uses port 53
- 




File Transfer Protocol (FTP)

- Used for the transfer of computer files between a client and server on a computer network.
 - It operates using a client at the Application layer and a server at the opposite end.
 - uses separate **control (port 21)** and **data (port 20)** connections between the client and the server
- 




File Transfer Protocol (FTP)

- Using FTP, a client can upload, download, delete, rename, move and copy files on a server
- Some FTP servers allow **anonymous** logins, while others require passwords and proper authentication (**login**).

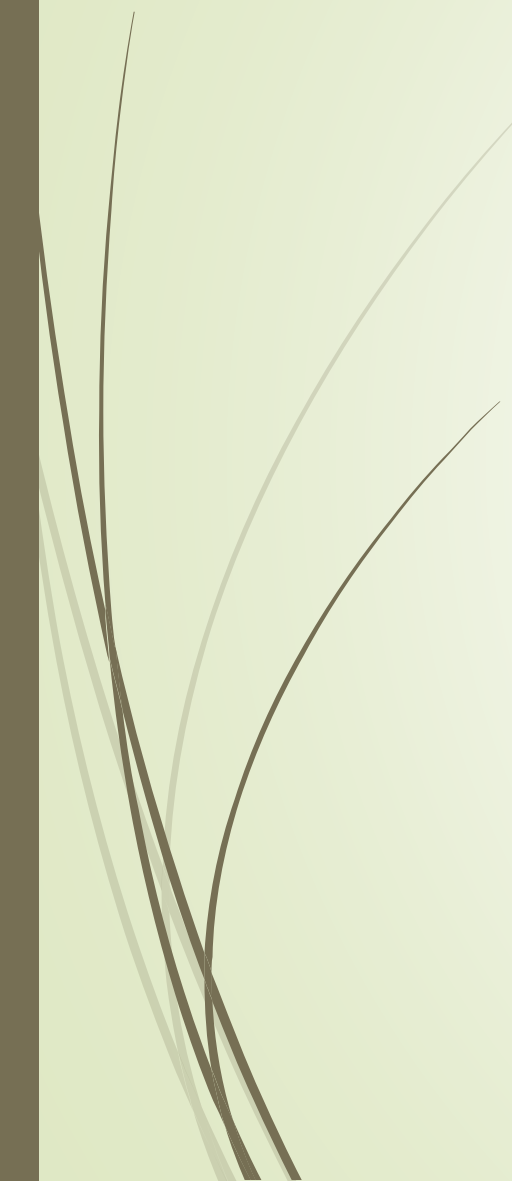


Simple Mail Transfer Protocol (SMTP)

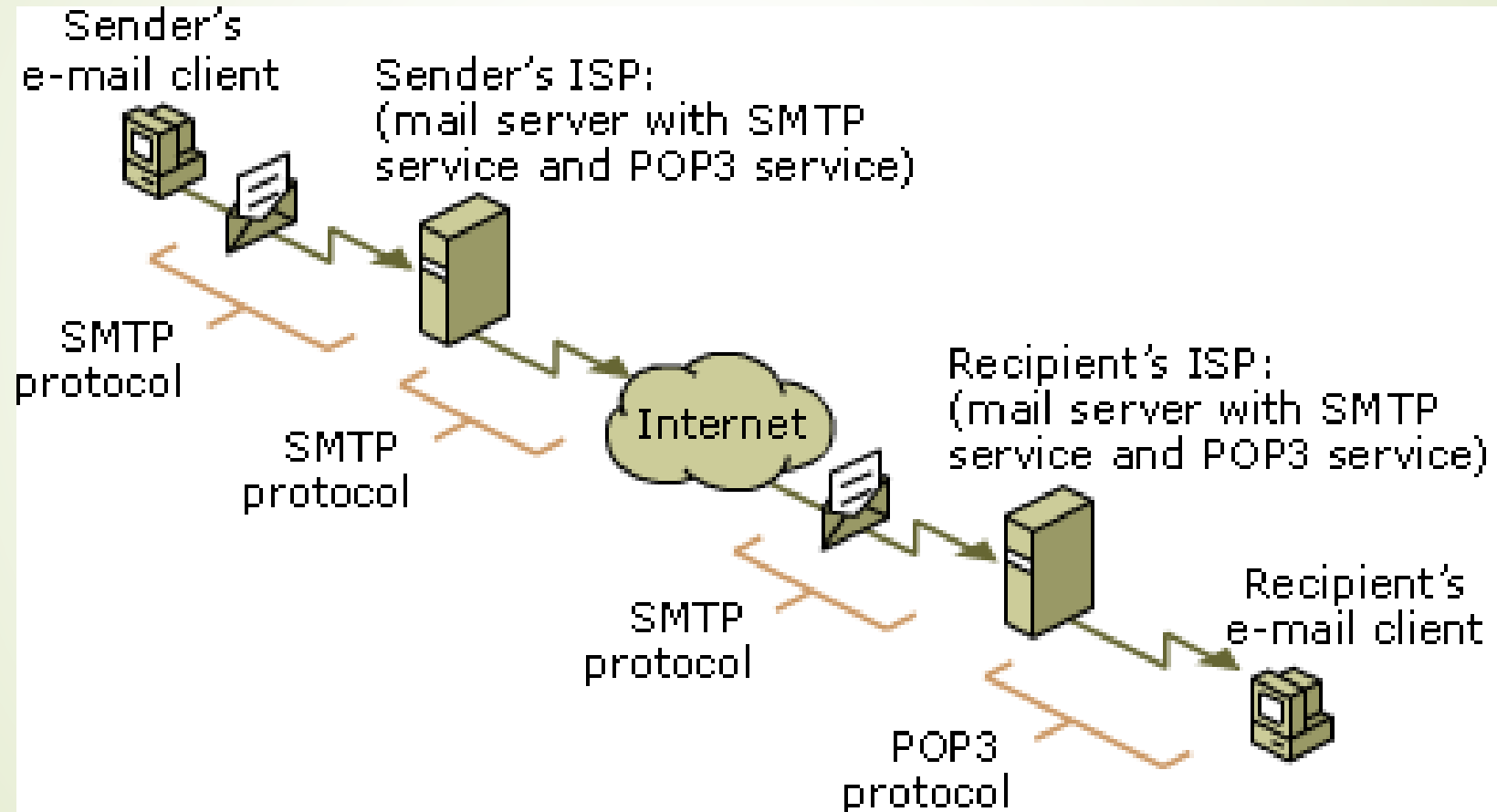
- SMTP is a set of rules that **regulates** the transfer of e-mail over the Internet.
- SMTP is a **delivery** protocol only
- For retrieving messages, client applications usually use either IMAP or POP3.
- SMTP communication between mail servers uses TCP **port 25**



Simple Mail Transfer Protocol (SMTP)

- Graphic or document attachments are handled by an SMTP extension called Multipurpose Internet Mail Extensions (MIME).
 - The MIME converts each attachment into a coded form, similar to text, for transfer over SMTP.
- 

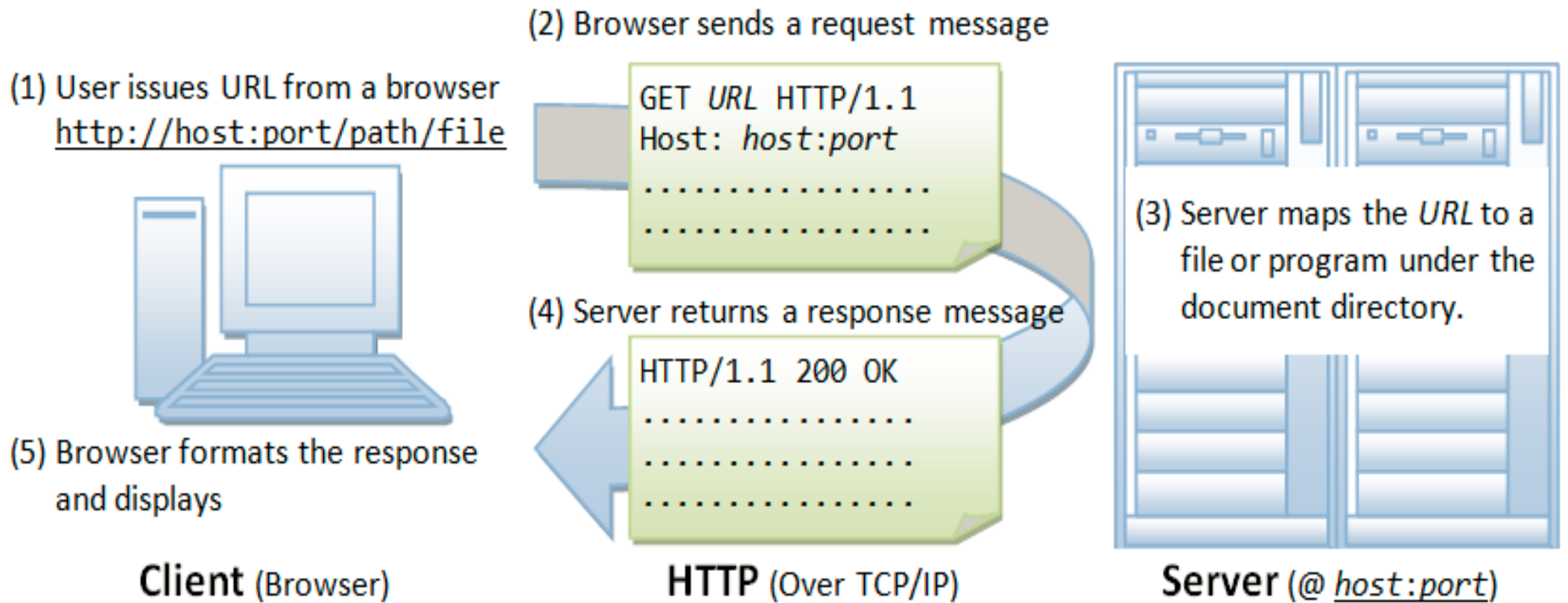
SMTP illustration



Hypertext Transfer Protocol (HTTP)


- Application protocol for distributed, collaborative, and hypermedia information system
- HTTP is a **pull protocol**, the client pulls information from the server (instead of server pushes information down to the client).
- HTTP functions as a request-response protocol in the client-server computing model.
- stateless protocol. In other words, the current request does not know what has been done in the previous requests.
- Http uses port 80

HTTP functionality





HTML

- HyperText Markup Language (HTML): a language that uses embedded tags to describe how a document is to be displayed in a browser and how it is to be linked to other documents.
- 

HTML Example

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta http-equiv="X-UA-Compatible" content="IE=Edge"/>

  <meta charset="utf-8"/>

  <title>htu-university</title>

  <meta name="generator" content="Wix.com Website Builder">

  <meta name="fb_admins_meta_tag" content=""/>
  <link rel="shortcut icon" href="https://static.parastorage.com/client/pfavico.ico" type="image/x-icon"/>
  <link rel="apple-touch-icon" href="https://static.parastorage.com/client/pfavico.ico" type="image/x-icon"/>
  <script type="text/javascript">
    var santaBase = 'https://static.parastorage.com/services/santa/1.2764.29';
    var clientSideRender = true;
```

Post Office Protocol v3 (POP3)

- standard protocol for receiving e-mail
- Periodically, you (or your client e-mail receiver) check your mail-box on the server and download any mail, probably using POP3
- delete mail on the server as soon as the user has downloaded it.
- POP can be thought of as a "store-and-forward" service.

