1) The four sources of packet delay and the key factor(s) that affect each. (Section 1.4.1)

$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$

nodal processing : checks bit error and determines output link

queueing delay : time waiting at output link for transmission and depends on congestion level of router

transmission delay : (packet length(bits)) / (Link bandwidth(bps))

propagation delay : (length of physical link) / (speed (~$2x10^8$))

2) The name and function of each layer in the IP stack. (Section 1.5.1)

Application: supporting network applications • FTP, SMTP, HTTP

Presentation: allow applications to interpret meaning of data, e.g., encryption, compression, machine-specific conventions

Session: synchronization, checkpointing, recovery of data exchange

Transport: process-process data transfer • TCP, UDP

Network: routing of datagrams from source to destination • IP, routing protocols

Data link: data transfer between neighboring network elements • Ethernet, 802.111 (WiFi), PPP

Physical: bits “on the wire”

3) Define IP address, socket, and protocol, and describe their role in process communications. (Sections 1.1.3, 1.5.2, 2.1.2)

IP address: To receive messages, process must have identifiers like IP address and port numbers associated with process on host

Socket: process sends/receives messages to/from its socket

Protocol: Types of messages exchanged(request response). Rules for when and how processes send and respond to messages

4) The three primary protocols used for email. (Section 2.3)

1. (25)SMTP (simple mail transfer protocol): has a user agent(mail reader like outlook) and a mail servers which has a mailbox which contains incoming message, message queue of outgoing (to be sent) mail messages, and SMTP protocol client: sending mail server server: receiving mail server
   SMTP uses persistent connections and has multiple objects sent in multipart message

   SMTP: push
2. IMAP (Internet Mail Access Protocol): more features, including manipulation of stored messages on server. keeps all messages in one place: at server and allows user to organize messages in folders while keeping user state cross session
   stateful and can be used as a mail access protocol retrieve mail from servers
3. POP (Post Office Protocol): authorization, download is stateless and can be used as a mail access protocol retrieve mail from servers
4. (80)HTTP (hypertext transfer protocol): Clients sends HTTP request to server that replies with HTTP response and can be used for applications other than web browsing an example is Web-Based email.

5) Dedicated and shared access networks as discussed. (Section 1.2.1)

DSL

voice, data transmitted at different frequencies over dedicated line to central office

use existing telephone line to central office DSLAM

- data over DSL phone line goes to Internet
- voice over DSL phone line goes to telephone net

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

6) FDM(Frequency-division Multiplexing) and TDM(Time-Division Multiplexing). (Section 1.3.2)

FDM- frequency spectrum of a link is divided up among the connections established across the “link”.The “link” dedicates a frequency band of each connection for the duration of the connection. FDM is always transmitting

TDM- Time is divided into frames of fixed duration, and each frame is divided into a fixed number of time lots.

7) Throughput vs. bandwidth. (Section 1.4.4)

Throughput- rate (bits/time unit) at which bits transferred between sender/receiver
Instantaneous: rate at given point in time
Average: rate over longer period of time
Bandwidth(bits/sec)- Link transmission rate, aka link capacity

Bandwidth: is the maximum amount of data that can move from one point to another over a given amount of time.

Throughput: is the amount of data that actuality moves from one point to another over a given amount of time. Many things effect throughput may include protocol, data loss, latency, and others.

8) HTTP (non-persistent and persistent). (Section 2.2.2)

- Persistent has multiple objects through one TCP connect while non-persistent has multiple objects through multiple TCP connects

9) Web caching(proxy server) and its benefits. (Section 2.2.5)

Goal: satisfy client request without involving origin server
Benefits :
- Reduce response time for client request
- Reduce traffic on an institution’s access link

- Seven layers of ISO/OSI reference model

  Application, Presentation, Session, Transport, Network, Data link, Physical

- Persistent HTTP vs Non-persistent HTTP

  Persistent has multiple objects through 1 TCP connection while nonpersistent has multiple objects through multiple TCP connections

- DDoS define
  Distributed Denial of Service Series of attack on a network that renders the services

- Routing define
  Determines end to end path through network

- Ports
  HTTP:80, FTP 20/21, SMTP 25, DNS 53, TELNET 23, SSH 22
- Protocol that pushes messages
  SMTP
- FDM/TDM is **circuit** switching protocol
- Strategy for BitTorrent users to request missing chunks from peers:
  -at any given time, different peers have different subsets of file chunks
  -periodically, Alice asks each peer for list of chunks that they have
  -Alice requests missing chunks from peers, rarest first

- Protocol that PULLS messages
  HTTP
- Protocols defines the format, order of messages sent and received among network entities, and actions taken on messages transmission and receipt **true**
- SSL/TLS is implemented on application layer to support encryption **true**
- A web cache can always satisfy client request directly **False not always a web cache can serve either as a client or a server**
- HTTP request and response messages share the same format **False request has a request line and carriage return while response has a status line and the data**
- P2P is a Client/ Server model. **False P2P and Client/Server are opposing models**
-