**4 types of delay (63-65)**

**Processing Delay** – The time required to examine the packet’s header and determine where to direct the packet. The processing delay can also include other factors, such as the time needed to check for bit-level errors in the packet occurred in transmitting the packet’s bits from the upstream node to router A.

**Queuing Delay** – Is when the packet waits to be transmitted onto the link

**Transmission Delay** – Assuming the packets are first come first serve, the packet can be transmitted only after all the packets that have arrived before it has been transmitted. The amount of time it takes to push all the packet bits into a link.

**Propagation Delay** – Once a bit is pushed into the link, it needs to propagate to router B. The time required to propagate from the beginning of the link to router B is the propagation delay.

**IP Stack Layer (Page 79-81)**

**Application Layer** – Is where network applications and their applications-layer protocols reside. HTTP (Web document request and transfer), SMTP (Transfer of email and messages) and FTP (transfer of files between two end system) are some of the protocols that are part of the application layer.

**Transport Layer** – Transports application-layer messages between application endpoints. In the internet there are two transport protocols, TCP and UDP. TCP provides a connection-oriented service to its application and UDP provides a connectionless service to its application. TCP breaks long messages into small messages and provides a congestion control mechanism. UDP provides no reliability, no flow control, and no congestion control.

**Network Layer** – is responsible for moving network-layer packets known as datagrams from one host to another. If UDP and or TCP provide the address and port number to the destination, the network layer is the mailman delivering the message. The network layer includes IP protocol (Make sure you know what IP protocol does) and routing protocol that determines the routes that datagrams take between sources and destination.

**Link layer** – The network layer routes a datagram through a series of routes between the source and destination. To move a packet from one node (host or router) to the next node in the rout, the network layer relies on their services of the link layer. At each node, the network layer passes the datagram down to the link layer, which delivers the datagram to the next node along the route. Link layer protocols include Ethernet, WiFi, and the cable access network’s DOCSIS protocol. A datagram may be handles by Ethernet on one link and by PPP on the next link. The network layer will receive a different service from each of the different link-layer protocols. We’ll refer to the link layer packets as frames.

**Physical Layer** – While the job of the link layer is to move entire frames from one network element to an adjacent network element, the job of physical layer is to move the individual bits within the frame from one node to the next.

**Communication (Need to double check)**

**IP Address** – Consist of 4 bytes and has a rigid hierarchical structure. Shows where the host is located.

**Socket** – End systems attached to the internet provide a socket interface that specifies how a program running on one end system asks the internet infrastructure to deliver data to a specific destination program running on another end system.

**Protocol** – defines the format and the order of messages exchanged between two or more communication entities as well as the actions taken on the transmission and/or receipt of a message or other event

**Email Protocols (Page 151)**

**Post Office Protocol -** authorization download

**Internet Mail Access Protocol -** more features including manipulation of stored messages on server

**HTTP** –Gmail Hotmail yahoo

**Dedicated and Shared Access networks as discussed**

ATT vs Comcast

**FDM and TDM (Page 56)**

**FDM –** Frequency division multiplexing. Each circuit continuously gets a fraction of the bandwidth

**TDM –** Time division multiplexing. Each circuit gets all the bandwidth periodically during brief intervals of time

**Throughput vs Bandwidth (got it online)**

**Throughput** – is the actual amount of data that can be transferred through a network during a specified time period.

**Bandwidth** – is the maximum amount of data that can be transferred through a network for a specified period of time.

**HTTP – Non-persistent vs persistent (Page 130 - 131)**

**Non persistent** connections have some shortcomings. A brand-new connection must be established and maintained for each requested object. For each of these connections, TCP buffers must be allocated, and TCP variables must be kept in both the client and server. This can place a significant burden on the web server, which may be serving requests from hundreds of different clients simultaneously. Second each object suffers a delivery delay.

**Persistent** – the TCP connection stays open after sending a response

**Web caching and its benefits (Page 138)**

**Caching –** also called proxy server – is a network entity that satisfies HTTP requests on the behalf of an origin web server. Cache has its own disk storage and keeps copies of recently requested objects in this storage. Is both a server and client

Benefits – reduce the response time for a client request. Cache also reduce traffic on an institutions access link to the internet which means the institution does not need to upgrade bandwidth (saves money)