-5

1. True or False

T a. In stop and wait ARQ, the receiver always send an ACK frame each time it receives a frame with the wrong sequence number

F b. The BW x Delay product is the maximum # of bits/sec that can fill the "pipe"

mini ?

F c. In cable access, several users share the same cable. Hence Medium Access Control procedures are required on both the uplink and the downlink to prevent collisions.

T d. A web cache is both a server and as a client

F e. Web caching reduce the delay to all objects even those that are not cached

queue

F f. Two distinct web pages namely www.usc.edu/students.html and www.usc.edu/grades.html can be sent over the same persistent connection

T g. Each node, including hosts and routers, must have one and only one ARP cache, the purpose of which is to minimize the number of broadcast ARP request frames.

T h. The DNS server, a.k.a. as the resolver, maps a host name address to an IP address

T i. Statistical Multiplexing is more efficient when the Peak Rate is much higher than the average date rate.

F j. Both TCP and UDP provides one-to-one and one-to-many communications services. The difference is that TCP provides connection-oriented reliable service while UDP provides connectionless unreliable service.

F k. HTML protocol transfers files that make up pages on the world wide web

T T l. ARP is a protocol used to resolve the "next hop IP address" to its MAC address.

T T m. S&W ARQ Works well when propagation time is much less than transmission time

T T n. Private organizations "Intranets" that do not need an Internet connection can use the same network address as other public networks

T ~~F~~ T o. Applications using UNIX Sockets allow users to specify destination hosts by their names or IP addresses.

F F p. A DHCP server must be located on every network to assign IP addresses to DHCP clients on that network

T T q. If a computer has multiple Network Interface Cards, The DHCP process must occur separately over each interface to obtain a separate dynamically assigned IP address for each interface.

F ~~T~~ F r. Both TCP and UDP provides one-to-one and one-to-many communications services. The difference is that TCP provides connection-oriented reliable service while UDP provides connectionless unreliable service.

F F s. TCP is a reliable Transport layer Protocol. It guarantees delivery of messages to the application within a given period of time.

T ~~F~~ T t. UDP does not guarantee that you'll only receive the packet once. If you have badly configured networks, you can receive the same packet multiple times

F F u. A client computer on a shared network is assigned a ~~MAC~~ address and an IP address by the network administrator

F ~~T~~ F v. Server name resolution is done by using the address resolution protocol

ARP DNS

F T F w. An odd parity can detect all even number of errors but it can't detect odd number of errors

T T x. A Process X running in a server machine has a port number of 50. Two hosts A and B each send a UDP datagram to the Server with destination port #50. Both of these datagram will be directed to the same socket.

F T F y. To be able to recover the analog signal from its sample, the sampling period has to be at least twice the highest frequency component in the signal being sampled

T T z. To use a proxy server, the client must be configured to access the proxy instead of the target server.

F T aa. FTP requires a single TCP connection for data transfer

$\frac{T_p}{T_t} = 10$ $T_p = 10 \cdot T_t = 10 \cdot \frac{8}{10^6}$ $T_t = \frac{80}{10 \times 10^6} = \frac{8}{10^6}$ $\frac{8}{10^6} \times 3 \times 10^8$

Part 2: Quickies (every blank is worth 1 point)

no transmission for Ack

1. Consider a transmission link that uses the stop and wait protocol. The ratio of the propagation delay to the transmission time is 10. Frames are transmitted at a rate of 10 Mbps and each frame is 80 bits long. Bits propagate at the speed of light (3×10^8 m/sec)

   24000 $\frac{80}{10 \times 10^6} \times 10 \times 3 \times 10^8$

   a. The length of the link is 24000 meters

   b. The link efficiency (utilization) is 4.76 % 4.76

2. Three sources are multiplexed using FDM on a link that has a total bandwidth of 7900 Hz. The maximum bandwidth for each source if there must be a 200 Hz guard band between the channels is 2500 Hz 2500 $\frac{7900 - 2 \times 200}{3}$

3. You are designing a Go-Back-N sliding window protocol to be used over a 1 Mbps link from a ground terminal to a geosynchronous satellite at a distance of 30,000 Km. Each frame carry 1 Kbyte of data. The speed of light is 3×10^8 m/sec. It is desired to keep the "pipe" full. The minimum number of bits you need for sequencing the frames is ~~200~~ 5 bits.

   $B \times D = 1 \times 10^6 \times \left(\frac{1000 \times 8}{1 \times 10^6} + 2\frac{3 \times 10^7}{3 \times 10^8} \right)$

4. Bit stuffing procedure is performed on the following binary sequence: 1101111110111110110101. The T/x pattern is 110111110101111100110101

   110111110101111100110101

5. The bit duration on a T1 line is 6.477×10^{-7} seconds 6.477×10^{-7} 1.544 Mbps

6. Suppose that Alice wants to send an email message to Bob. This will involve four entities: Alice's mail client (for email composition and sending), Alice's outgoing mail server, Bob's incoming mail server, and Bob's mail client (for email retrieval and viewing). The number of times SMTP Protocol is used is ~~4~~ 2

2RTT

7. Suppose within your web browser, you click on a link to obtain a web page. The IP address of the associated URL is cached in your machine (i.e. no need for DNS). Denote by RTT the round trip time between your machine and the server. Assume that the web page consists of a base HTML file + 4 images. The time (in terms of RTTs) it takes to download all objects (including the HTML file)

2RTT

a. Non Persistent http: 10 RTTs 10

b. Persistent http (without Pipelining): 6 RTTs 6

c. Persistent http with pipelining: 3 RTTs 3

d. Non-Persistent with 5 Parallel Connections: 4 RTTs 4

8. We have 4 information sources, two of which generate traffic at a rate of 200 bps each. The other two generate traffic at a rate of 150 bps each. They are to be multiplexed using multiple-slot (each slot supporting 1 bit), synchronous TDM. Each source is active 50% of the time. Ignore any synchronization bits.

14 700 bps

a. The length of the TDM frame is = 14 bits 14

b. The duration of the TDM frame is 0.02 sec 0.02

c. The TDM frame rate is 50 frames/sec 50

d. The multiplexed rate is 700 bps 700

e. The output of the multiplexor is applied to a QPSK modem. The signaling rate at the output of the modem is 350 Baud/second 350

2 bits

200	4
200	4
150	3
150	3

4	4	3	3

700 bps

1000
2000
6000

8 input sources.

9. Assume that you have ~~10~~ 8 input sources as follows: Four sources generates 1 Kbps (each), 75% of the time, Three sources generates 2 Kbps (each), 50% of the time and one source generates 6 Kbps, 25% of the time. A Statistical TDM with a link utilization of 80% is used. The required data rate at the output of the MUX is 9.375 K bps.

9375

$$\frac{4\times 1\times 75\% + 3\times 2\times 50\% + 6\times 25\%}{0.8}$$

10. A video signal is 5 MHz wide. It is sampled at the Nyquist sampling rate and then quantized using 32 levels and then encoded. The bit rate of the digital stream is 50 M bps

~~320M~~

$5M\times 2\times \cancel{32}$ $\log_2 32$

$100k = 4k\cdot\log_2(1+SNR)$

11. A channel with bandwidth of 4 KHz. It is desired to transmit data reliably at a rate of 100 Kbps over this channel. The minimum signal to noise ratio required is 75.257 dB

75.257

$C = 4k\log_2(1+SNR)$

$SNR = 2^{25}-1$

$SNR = 10\cdot\log_{10}(2^{25})$

$SNR = 10\cdot 25\cdot\log_{10}2$

12. A 32 Kbyte message is to be transmitted over a 2-hop packet network. The network limits the size of the packet to 2 Kbytes. The links are error free and each has speed of 50 Mbps. Each hop is 1000 Km long and the bits are transmitted at the speed of light of 2.5x108 m/sec. It will take 0.01344 seconds for the message to get from the source to the destination. Ignore processing and queuing delays.

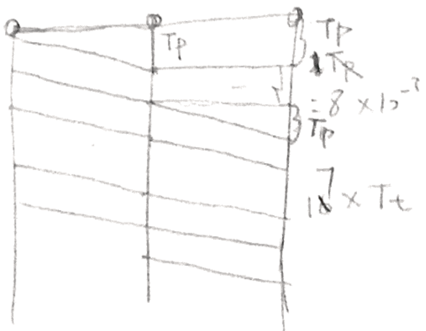
0.01344

13. A stream of 10 Mbps data rate is to be represented by a Manchester Line Code. The signaling rate is 20 M bauds/sec

$$T_t = \frac{2000\times 8}{50\times 10^6} = \frac{16}{50000} = 3.2\times 10^{-4}$$

$$T_p = \frac{1000000}{2.5\times 10^8} = 4\times 10^{-3}$$

$$17\times\frac{2000\times 8}{50\times 10^6} + 2\times\frac{1000}{2.5\times 10^8} =$$



$17\times T_t = 5.12\times 10^{-3}$

$17T_t + 2T_p$

-4

14. In the diagram below, nodes B, C, and D are sending messages to A with the indicated Source Port and Destination Port addresses. From this diagram, the number of Sockets A has opened is ~~4~~ (If all nodes are using UDP) and is ~~4~~ (if all nodes are using TCP)

887

5678

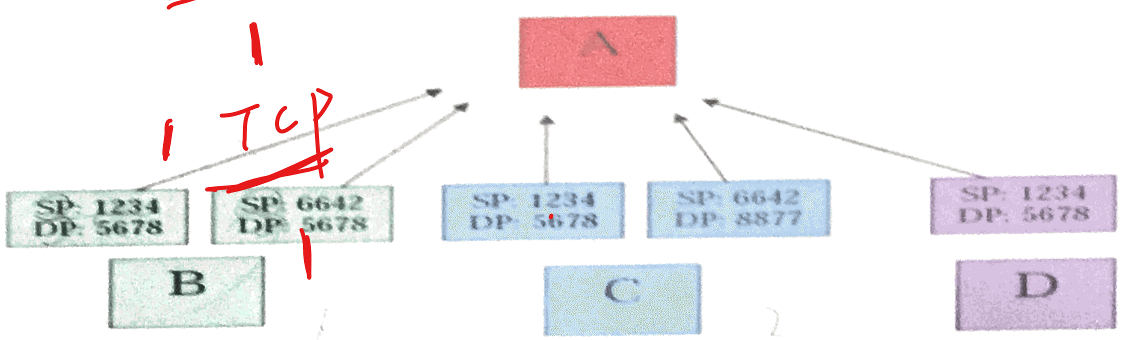
1 UDP

UDP

4

1 TCP

1 TCP



IP host
port App

3. An FCS error detection mechanism is used over a communications link. The message bit sequence is 1010111. An FCS generator pattern of 10010 is used to generate the FCS sequence.

a) How many FCS bits are generated? What are they? What is the transmitted bit sequence? Identify the FCS bits in that sequence. Show details of your work.

b) Now suppose the channel introduces the following a error pattern 10011011010. Will the receiver be able to detect the error? Prove your answer analytically.

c) Now suppose the received sequence is 11100001110. What will the receiver decide? Prove your answer

a) 4 bits of FCS are generated

a)

1011100

10010 | 10101110000

10010

001111

000000

11111

10010

0110010

010010

0010000

0010010

Remainder 0000

receiver cannot detect the error, because the remainder is 0, receiver will accept it.

transmitted bit sequence

10101111000

FCS bits

FCS

b)

1000101

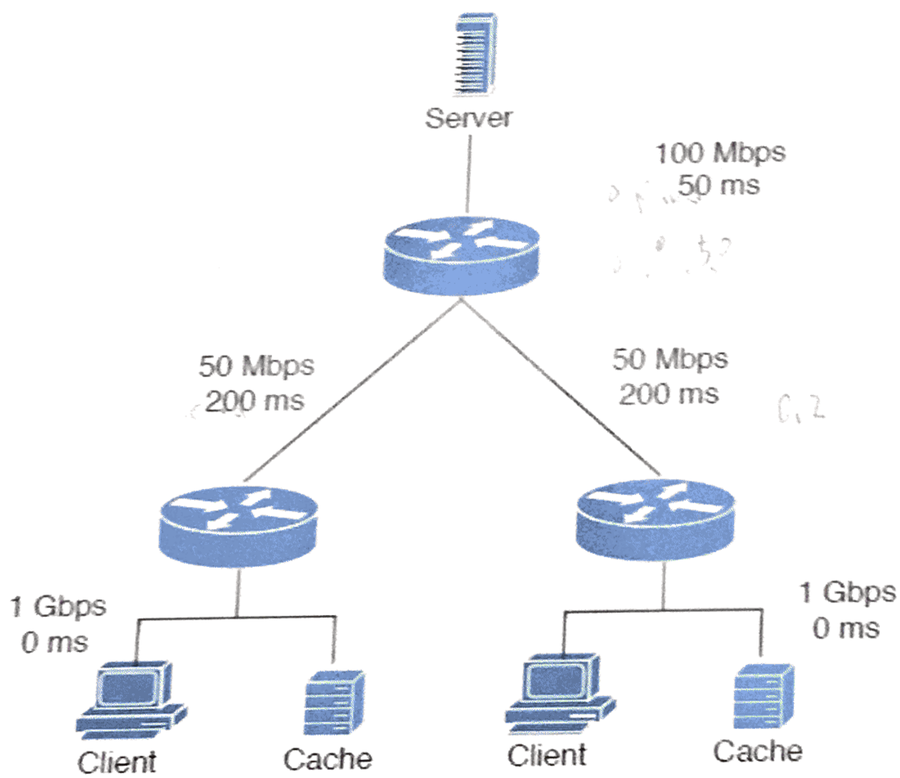
10010 | 10011011010

Because the remainder is 00000, ever cannot detect the error.

C -4

c)

4. Consider the scenario shown in Figure below in which a server is connected to a router by a 100Mbps link with a 50ms propagation delay. Initially this router is also connected to two routers, each over a 50Mbps link with a 200ms propagation delay. A 1Gbps link connects a host and a cache (if present) to each of these routers and we assume that this link has 0 propagation delay. All packets in the network are 20,000 bits long.



a. What is the end--to--end delay from when a packet is transmitted by the server to when it is received by the client? In this case, we assume there are no caches, there's no queuing delay at the routers, and the packet processing delays at routers and ~~nodes are~~ all 0.

$$\frac{20000}{100M} + \frac{20000}{50M} + 50ms + 200ms + \frac{20000}{1\times10^9}$$

$= 250.62ms$

50mbps

b. Here we assume that client hosts send requests for files directly to the server (caches are not used in this case). What is the maximum rate at which the server can deliver data to a single client if we assume no other clients are making requests?

c. Again we assume only one active client but in this case the caches are on and behave like HTTP caches. A client's HTTP GET is always first directed to its local cache. 65% of the requests can be satisfied by the local cache. What is the <u>average</u> rate at which the client can receive data in this case? 65% × 1Gmbps + 35% × 50mbps = 667.5mbps

d. Now clients in both LANs are active and the both caches are on (similar to c). 65% of the requests can be satisfied by the local caches. What is the average rate at which each client can receive data? 667.5mbps

e. Now consider Figure shown below where the network has been extended by two additional LANs, and all LANs are connected via 25 Mbps links and the throughput of the server link is only 80Mbps. In all four LANs 60% of the requests can be satisfied by the local caches. What is the <u>average</u> rate at which each client can receive data? Comment on your results

(a) $T_{t_{S-R}} = \dfrac{20000 \text{ bits}}{100 \times 10^6 \text{ bps}} = 2 \times 10^{-4}$ s

$T_{t_{R-R}} = \dfrac{20000 \text{ bits}}{50 \times 10^6 \text{ bps}} = 4 \times 10^{-4}$ s

$T_{t_{R-C}} = \dfrac{20000 \text{ bits}}{1 \times 10^9 \text{ bps}} = 2 \times 10^{-5}$ s

$T_{total} = T_{t_{S-R}} + T_{t_{R-R}} + T_{t_{R-C}} + 0.05 + 0.2$

$= 0.25062$ s

-2

(b) min (100 Mbps, 50 Mbps, 1 Gbps)

that is 50 mbps

(c). 65% of requests are 1 Gbps

35% of requests are 50 mbps

$65\% \times 10^9 + 35\% \times 50 \times 10^6 = 667.5$ mbps

(d) it still the same in (c).

the shared link between server and router is 50 mbps.

So, average rate is $65\% \times 10^9 + 35\% \times 50 \times 10^6$

$= 667.5$ mbps

(e) The shared link rate between server and router becomes 20 mbps, and this is the max rate of which server can deliver data.

average rate

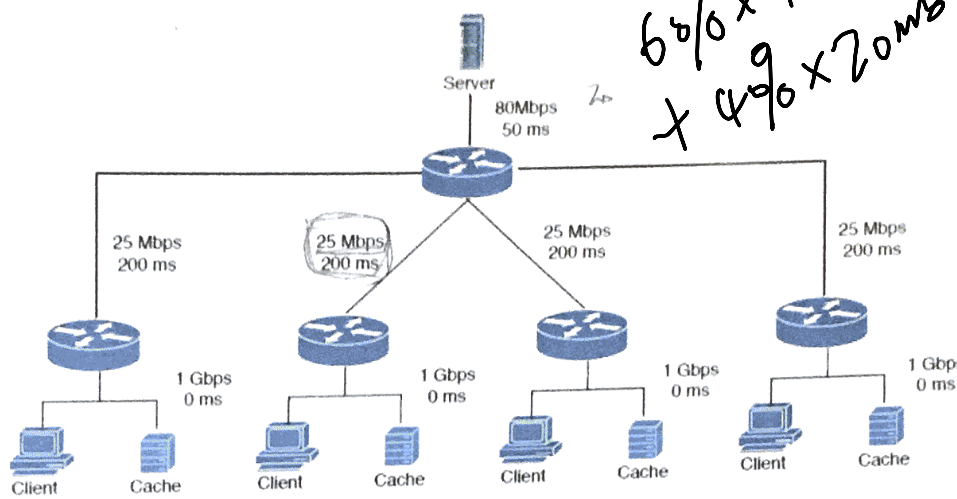
$60\% \times 10^9 + 40\% \times 20 \times 10^6 = 608$ mbps

Comment: When the number of users increases, the average data rate decreases

caching irrelevant

comment on caching

$60\% \times 1\text{Gbps}$
$+ 40\% \times 20\text{mbps} = 608\text{mbps}$



Work Sheet#5

Framelength = 1000 bits

5. Consider a Data link that uses Go-Back-N ARQ with a sending window size of 4. Suppose the transmission time of a frame is 1 second. Assume the one-way propagation delay is 0.5 seconds. Assume the acknowledgement frame transmission time is 1 second. Neglect processing delay. Assume station A begins with frame 0. The Timeout for each frame is 2 seconds (The timer starts at the **end** of the transmission of each frame)

Draw the frame-exchange-timing diagram for the following sequence of events. Be sure to label each data frame and ACK frame with a sequence number for the following two cases:

$\frac{6000}{8} = 750bps$

a) Station A sends 6 frames in a row, starting at t=0. Assume all frames are received with no errors. Calculate the throughput of the link assuming that station A has only those 6 frames to transmit. Clearly illustrate how could A be sending 6 frames in a row if his window size is 4?

$\frac{6000}{11} = 545.455$

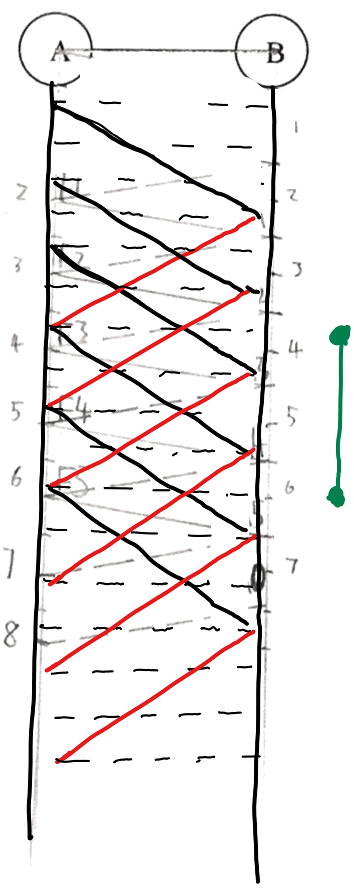
b) Station A sends 6 frames in a row, starting at t=0. All frames are received without errors, except the frame with a sequence number 3 (i.e. F_3) which is "lost". Calculate the throughput of the link assuming that station A has only those 6 frames to transmit

(a)

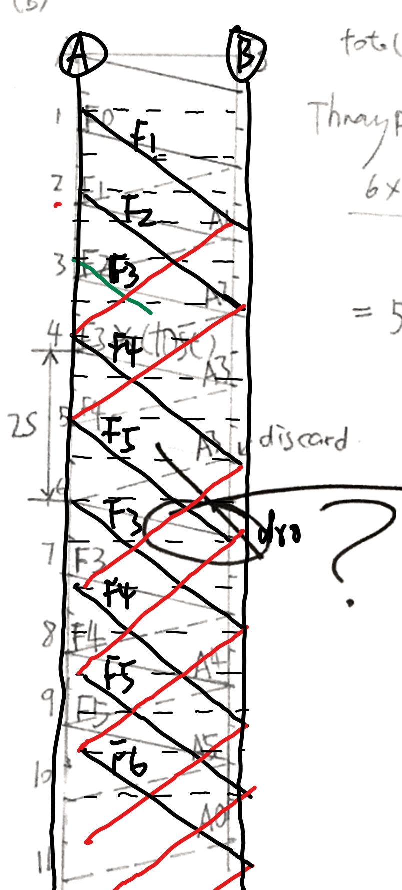
Total time is 8 s

$$\text{Throughput} = \frac{6\times 1000 \text{ bits}}{8\,s} = 750 \text{ bps}$$

when the sender receive one acknowlegement, he can slide one window, so he can send 6 frames in a row.



(b)



total time is 11 s

$$\text{Throughput} = \frac{6\times 1000 \text{ bits}}{11\,s} = 545.455 \text{ bps}$$