True or False

T ~~F~~ a) In a virtual-circuit packet-switched network, a packet switch maintains state information for each connection passing through the switch.

F b) ADSL and cable modem access providers must install a modem in their offices for each individual subscriber unlike the case of dial-up connections where the modems are located at the user sites only

F c) An even parity can detect all even number of errors but it can't detect odd number of errors 10001

F ~~T~~ d) An "ARP request" is sent by device A to a specific device B located on the same network, to get the MAC address of B.

ARP request frame is broadcasted, ARP reply frame is unicasted

F e) Two distinct web pages say http://www.usc.edu/exam.html and http://www.ucla.edu/grade.html can be sent over the same persistent TCP connection

T f) A router is a node that can forward packets that are not explicitly addressed to it.

T g) A process C running in a server has a port number of 30. Two hosts A and B each send a UDP datagram to host C with destination port number 30. Both of these datagrams will be directed to the same socket.

T h) Two sockets form a bi-directional communications path between two applications

T i) In Statistical TDM, the number of time slots in each frame is less than the number of input lines to the MUX.

T j) 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.

T k) Applications using UNIX Sockets allow users to specify destination hosts by their names or IP addresses.

T ~~F~~ l) A DNS response is classified as un-authoritative if it comes from the cache memory of the local DNS server

F m) SMTP is a protocol that allows clients to retrieve their e-mails from their mail servers

F n) Longer frames suffer from longer propagation delays than shorter frames

F o) A connection-oriented iterative server can handle multiple clients simultaneously

T ~~F~~ p) The "Bind" call adds the local socket address to an already created socket

To make host name resolution scalable and centrally manageable, IP address mappings for FQDNs are stored on DNS servers , computers that stores FQDN-to-IP-address mappings. To enable the querying of a DNS server by a host computer, a component called the DNS resolver is enabled and configured with the IP address of the DNS server.

T q) A host that needs to map a name to an IP address would call a DNS client called a "Resolver".

F ~~T~~ r) In Go-Back-N ARQ, if the window size is 63 then the range of sequence number is 0 ~ 64

T s) DHCP is rarely used to assign IP addresses to servers as servers rarely move around.

T t) A server program, once it issues a passive open, waits for clients to request its services.

T ~~F~~ u) To use a proxy server, the client must be configured to access the proxy instead of the target server.

A Web cache—also called a proxy server—is a network entity that satisfies HTTP requests on the behalf of an origin Web server.

F v) On a single LAN, a host would use the MAC address of another host to determine whether the other host is located on the same network or not.

T w) The maximum allowable window size in selective reject protocol is 1/2 the sequence number space. 2^{m-1}

F ~~T~~ x) A UDP server serving 5 clients require 5 sockets where as a TCP server requires 6 sockets. UDP从头至尾都只有一个Socket，UDP根本没有destroy socket这个过程

T ~~F~~ y) Subnet mask is a mechanism used by a host to determine whether another host is on the same network or not.

digital signal

10k samples/s   4k samples/s   2k samples/s

10k · 5 = 50 kbps
4k · 5 = 20 kbps
2k · 5 = 10 kbps
} 80 kbps

Part 2: Quickies

a. We have 3 analog sources at 5KHz, 2KHz and 1KHz. Each source is sampled at the Nyquist rate and each sample is encoded into 5 bits. These sources are to be TDM with a series of digital sources, each generating traffic at a rate of 20 Kbps. The MUX rate is 160 Kbps. The number of digital sources that can be supported is 4

b. A signal is to be transmitted over a channel with bandwidth of 1 MHz. The Signal to Noise ratio on this channel is 20 dB. The maximum bit rate that can be reliably transmitted over this channel is ~~2.004~~ 6.658 Mbps.

dB的换算log以10为底，Shannon's Theorem里的log以2为底

$10 \log_{10} 100$

c. A channel has a bit rate of 5Kbps and a propagation delay of 20msec. Stop and Wait protocol is used. The channel is error free. The frame size that will result in 75% link utilization is ~~75~~ 600 bits

$$U = \frac{L/R}{RTT + L/R}$$

6

d. A 3000 Km T1 trunk is used to transmit 64 Bytes frames. The propagation delay is 6µsec/Km. It is desired to have the sender window size to be large enough to allow the sender to keep transmitting frames until the first Acknowledgement is received (the receiver is acknowledging each frame individually). The # of bits needed for frame sequencing is 7 bits

512 bits T_1 rate = 1.544 Mbps T_p = 0.018 s   RTT = 0.036 s

107.5625

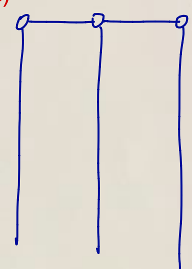
e. Bit stuffing procedure is performed on the following binary sequence: 11011111101111110110101. The T/x pattern is 110111110101111100110101

i) 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 + two small images (ignore all transmission times). The time (in terms of RTTs) elapsed from the time the user click on the link till the time the client receives the entire web page for each of the following is

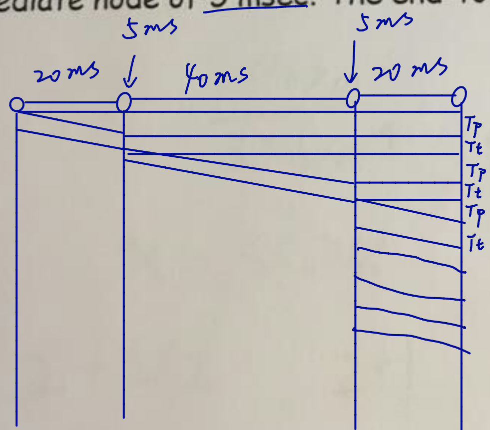
- Non Persistent http: 6 RTTs
- Persistent http with pipelining: 3 RTTs
- Non-persistent HTTP with parallel connections: ~~3~~ 4 RTTs

Shake hands + HTTP request + Shake hands + image request(2 requests at the same time)

j) 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 2.5×10^8 m/sec. It will take 0.01344 seconds for the message to get from the source to the destination. Ignore processing and Queueing delays. $T_p = 4 \times 10^{-3}$ $T_t = 3.2 \times 10^{-4}$



k) The number of hops separating two end hosts A and B is 3 with the middle hop twice as long as the other two. A message of 5 Kbits long is to be transmitted. The data rate on each link is 10 Kbps. The propagation delay over a short hop is 20 msec. Assume each Packet length is 1Kbits and a Queuing delay at each intermediate node of 5 msec. The end-to-end delay is 0.79 sec



$T_t = 0.1s$

5 packet

(ms)

$20 + 100 + 40 + 100 + 20 + 5 \times 100 + 10$

Part 3: Error Detection:

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) Suppose the channel introduces the following error pattern 00001101100, what will the receiver decision be? Show the details of your work.

c) Now assume that the receiver receives the pattern 11001101100. What will be his decision? Show the details of your work.

a) 4 bits

```
           1011100
10010 ) 10101110000
        10010
         01111
         00000
          11111
          10010
           11010
           10010
            10000
            10010
             00100
             00000
              01000
              00000
               1000
```

10101111000

b)
```
  10101111000
⊕ 00001101100
-------------
  10100010100
```

```
           1011000
10010 ) 10100010100
        10010
         01100
         00000
          11001
          10010
           10110
           10010
            01001
            00000
             10010
             10010
              00000
              00000
               0000
```

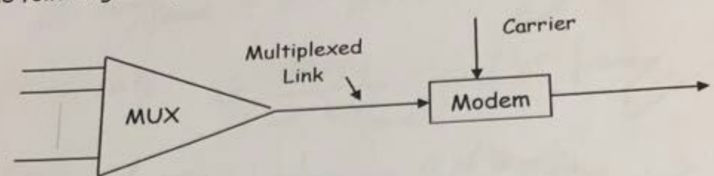
no error

c)
```
           1101011
10010 ) 11001101100
        10010
         10111
         10010
          01010
          00000
           10101
           10010
            01111
            00000
             11110
             10010
              11000
              10010
               1010
```

error detected.

Part 4: Resource Sharing

Consider the following multiplexer



Assume that you have ~~10~~ 6 input sources as follows:

15 Two sources generate 750bps (each), 75% of the time
12 One source generates 600bps, 50% of the time
10 Two sources generates 500bps bits/sec (each), 100% of the time
4 One source generates 200bps, 50% of the time

Case 1: Assume that the multiplexer is a synchronous TDM. What is the required data rate at the output of the MUX? What is the minimum number of time slots in such a frame and how are they assigned to each source? If each slot can support 8 bits, what is the frame duration? What is the frame rate? Assume that the modem is QPSK, what is the signaling rate at the output of the Modem?

Case 2: Now assume that the multiplexer is a Statistical TDM with a link utilization of 80%. What is the required data rate at the output of the MUX? Assume that the modem is 16-QAM, what is the signaling rate at the output of the Modem?

Case 1

MUX data rate = 3300 bps

750 bps 15 TS
600 bps 12 TS
500 bps 10 TS
200 bps 4 TS

66 TS 528 bits/frame

frame duration = 6.25 s

signaling rate = 1650 Baud/s

Case 2

3156.25 bps

789 bps

Part 5: Flow & Error Control

-6

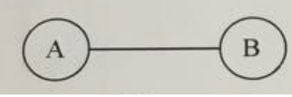
Consider a Data link that uses Selective Repeat request ARQ with a sending window size of 4. Suppose the transmission time of a frame is 1 second. Assume the one-way propagation delay is 0.5 seconds. Assume the acknowledgement frame transmission time is 1 second. Neglect processing delay. Assume station A begins with frame 0.

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:

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?

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 which is "lost". Calculate the throughput of the link assuming that station A has only those 6 frames to transmit

857.14 bit/s



Part 5: Name Resolution and Web Browsing

Consider the following configuration. Host A is located on LAN_1. A web Server X is located on LAN_2. Suppose that the user at host "A" types the URL of server X to download a given 1G-bit html file. Host A does NOT know the IP address of Server X. Host A is configured with the IP address of the local DNS server. Calculate the time elapsed from the moment user A enters the URL till the time the file is completely downloaded under the following assumptions:

a) DNS commands and http commands are so small compared to the file such that you can ignore their transmission times (ONLY)

b) The propagation delay within either LAN is negligible. The propagation delay from R_1 to R_2 is 100 msec. The propagation delay from anywhere in LAN_1 to any other site in the Internet (except LAN_2) is 500 msec.

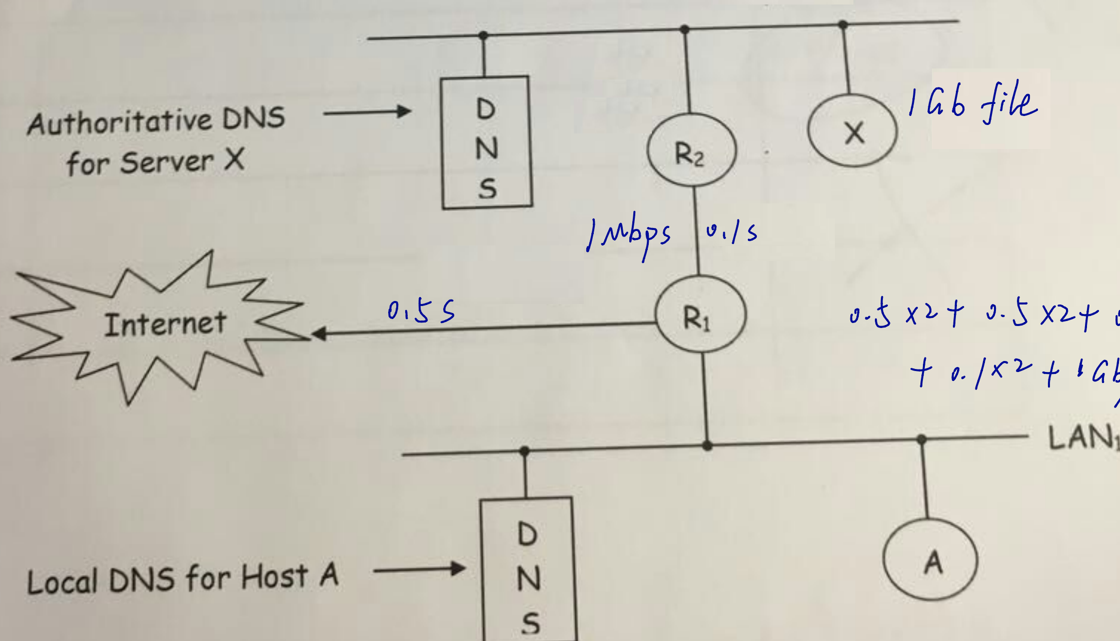
c) Each LAN operates at 1 Gbps. The link between R_1 and R_2 is 1 Mbps (in each direction)

d) The DNS is *iterative*

e) The authoritative DNS server is located at a Top Level Domain. Only the authoritative DNS server knows the IP address of Server X.

f) DNS runs over UDP where as http runs over TCP.

Create a table that identifies the steps taken (in order) along with the time required to accomplish each step.



$0.5\times2 + 0.5\times2 + 0.1\times2 + 0.1\times2 + 0.1\times2 + 1Gb/1Gb + 1Gb/1Mb + 1Gb/1Gb$

Step	Action	Delay(sec)
1	Host A contacts the the local DNS server	0
2	A's local DNS server contacts the Root Name Server	$0.5 \times 2 = 1s$
3	A's local DNS server contacts the Intermediate Name Server	$0.5 \times 2 = 1s$
4	A's local DNS server contacts the Authoritative DNS Server for Server X	$0.1 \times 2 = 0.2s$
5	The HTTP client of A initiates a TCP connection to Server X	$0.1 \times 2 = 0.2s$
6	The HTTP client of A sends a HTTP request to Server X and receives the response message from Server X	$0.1 \times 2 = 0.2s$
7	The Html file operated by LAN2	1Gb / 1Gbps=1s
8	The Html file transferred through the link between R1 and R2	1Gb / 1Mbps=1000s
9	The Html file operated by LAN1	1Gb / 1Gbps=1s
		Total delay: 1004.6s