02-Link Layer-PhysicalLayer

1. **Short Answer Questions**

    a. What's **encapsulation** as it applies to protocols. Briefly explain.
    b. Briefly explain the "**framing**" problem in the link layer and how PPP solves it.
    c. In an Ethernet, why does doubling the bit rate (if everything else remains the same) require halving the maximum cable length?
    d. In a token ring, a station must wait for the token to come around to it before sending. Why is it not possible for the station to sense the ring and then start transmitting if there is no traffic?
    e. Smarty Smart thinks that having a **minimum frame size is wasteful for Ethernet**. He proposes that the minimum frame size be reduced to 15 bytes, 14 bytes for the header and 1 byte for the payload. Explain why this may not be a good idea.
    f. In a broadcast channel, the link bandwidth is wasted due to multiple hosts trying to send at once and canceling each other's communication. A simple model of this problem is that time is divided into discrete slots. If a network has n hosts, and the probability of any single host trying to use a slot is p, **what fraction of slots are wasted** due to collisions?
    g. Explain the following terms: MTU, byte stuffing, bit stuffing
    h. Consider 4 hosts, A, B, C and D attached together using an **Ethernet hub** into a star topology. Assume that A is sending some data to B. Is it possible for C to send some data to D at the same time? Justify your answer.
    i. What's the "**type**" or "**protocolNo**" field in a Link Layer (LL) header used for? Do all LLs have to have a "**type**" field in their headers? If a protocol does NOT have this field, what is the implication?
    j. Consider a link layer that does **NOT** add error detection/correction bits to the end of its frames? What are the implications of this design?
    k. Why is it important for protocols configured on top **Ethernet** to have a **length** in their header indicating how long the message is?
    l. What's a MAC address. What is it used for?
    m. Briefly describe how Ethernet's Carrier Sense Multiple Access/Collison Detection (CSMA/CD) work? What's the advantage of CSMA/CD over CSMA?
    n. Briefly describe how channel partitioning MAC algorithms work. Also describe their advantages and disadvantages.
    o. Briefly explain the difference between serial and parallel communication. Which is preferred in long distance communication?
    p. Briefly explain the difference between synchronous and asynchronous communication. Which is preferred in long distance communication and why?
    q. Give a list of the 3 types of cables used in communication networks. Which cables do high speed Ethernet use?
    r. Briefly explain the difference between modulation and encoding.

2. Suppose you want to transmit the following 10-bit message "0100101100".

    a. Suppose you want to protect the message from errors using the CRC polynomial $x^4 + x^3 + x$. Use polynomial long division to determine the message that would be transmitted.
    b. Suppose you want to protect the message from errors using **two-dimensional odd** parity. Assume that the message is divided into 5-bit chunks for parity computation purposes. Determine the message that would be transmitted.

3. Suppose you want to transmit the following 12-bit message "110010011111".
    a. Suppose you want to protect the message from errors using a **checksum** by dividing the message into 4-bit chunks and performing 1s complement addition. Show the EDC bits that will be transmitted. Show your work.
    b. Suppose you want to protect the message from errors using **one-dimensional even** parity. Assume that the message is divided into 4-bit chunks for parity computation purposes. Determine the message that would be transmitted. Show the parity bits for each chunk.

4. Suppose you want to transmit the message 11011010 and protect it from errors using the CRC polynomial $x^3 + x^2 + 1$. Use polynomial long division to determine the message that would be transmitted. Assume no bit errors occur during transmission. How does the receiver know that the frame was received without any errors?

5. Suppose you want to transmit the message 11001001 and protect it from errors using the CRC polynomial x^3+1.
    a. Use polynomial long division to determine the message that would be transmitted.
    b. Suppose the leftmost bit of the message is inverted due to noise on the transmission link. What's the receiver's CRC calculation? How does the receiver know that an error has occurred?
    c. Describe the advantages and disadvantages of using a checksums instead of CRC for error detection and correction at the link layer?

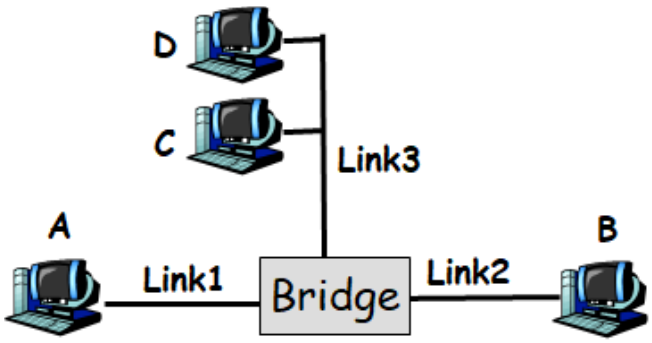
6. Suppose you want to transmit the following 4-byte message “0xfb 0x7e 0x7d 0xff” with 0xfb being transmitted first.
    a. Assume that the link layer uses byte-counting for framing and has a one-byte length field in the header. Show the bytes transmitted on the wire as hexadecimal numbers.
    b. Assume that the link layer uses byte-stuffing, using 0x7e as the frame delimiter and 0x7d as the escape character. Show the bytes transmitted on the wire.
    c. Assume that the link layer uses bit-stuffing, stuffing an extra 0 bit after 5 consecutive 1 bits. Show the bits transmitted on the wire clearly marking the stuffed bits. Recall that a link that uses bit-stuffing still uses 0x7e as the frame delimiter.

7. Consider a broadcast link L1 containing hosts A and B. Further consider another link L2 containing nodes C and D. Answer the following questions:
    a. Assume L1 and L2 are attached together with a **hub**. Does host A now need to compete with hosts C and D to gain control of the link? Why or why not? What's your answer if L1 and L2 are attached by a **bridge**?
    b. Assume L1 and L2 are attached together with a **bridge**. Assume A sends a packet to B immediately after the links are attached. Does the bridge forward the packet to link L2? Why or why not?
    c. Assume L1 and L2 are attached together with a **bridge**. Assume A sends a packet to B immediately after the links are attached. Further assume that B immediately replies back to A. Does the bridge forward the packet to link L2? Why or why not?

8. Some network applications are a better match for an Ethernet, some are a better match for an FDDI (token ring) network. Which network would be better match for a remote terminal application (e.g., Telnet) and which would be better for a file transfer application (e.g., FTP)? Give a general explanation

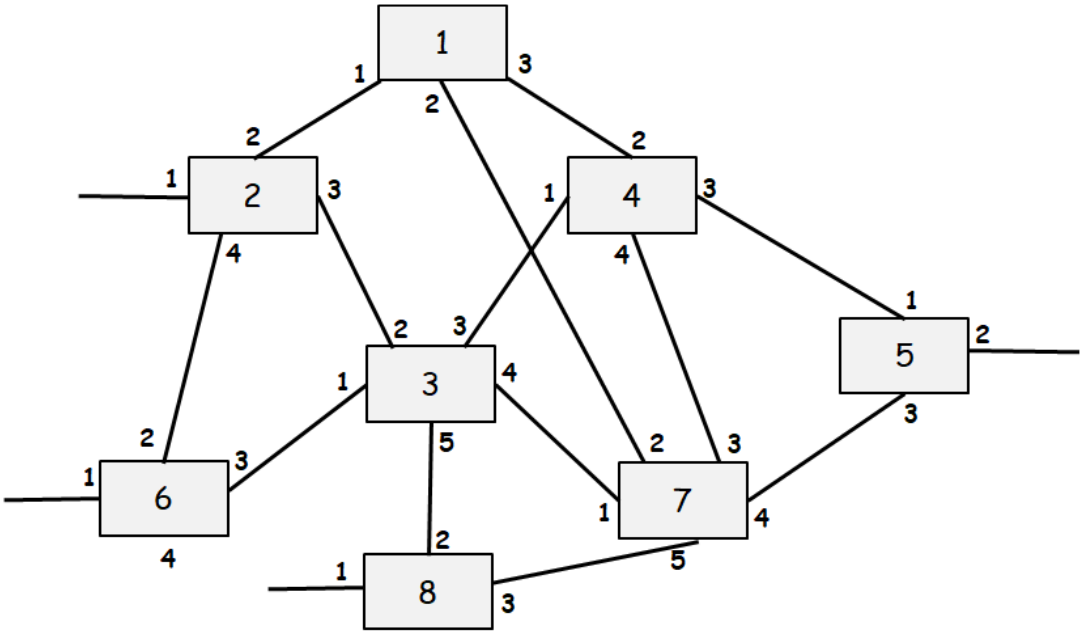
for what it is about each of these applications that suggest that one type of network is better match than the other?

9. Consider the following LAN consisting of 3 links attached by a **bridge**. For each of the following cases, describe which links does the bridge forward the packet to and show the bridge forwarding table after the packet is sent.



   a. A sends a packet to B.
   b. C sends a packet to B.
   c. A sends a packet to C.
   d. B sends a packet to D.
   e. C sends a packet to D.

10. Consider the following LAN consisting of 7 bridges numbered 1-7 with the given connections. Each interface of each bridge is also labeled starting with 1. Run Perlman's Spanning Tree Algorithm and for each interface of each bridge write down whether the interface is a "Root port (**R**)", a "Designated port (**D**)" or "Blocking Port (**B**)" in the tables given below. Finally, show the final spanning tree.



Bridge 1

Interface	Type
1	
2	
3	

Bridge 2

Interface	Type
1	
2	
3	
4	

Bridge 3

Interface	Type
1	
2	
3	
4	
5	

Bridge 4

Interface	Type
1	
2	
3	
4	

Bridge 5

Interface	Type
1	
2	
3	

Bridge 6

Interface	Type
1	
2	
3	
4	

Bridge 7

Interface	Type
1	
2	
3	
4	
5	

Bridge 8

Interface	Type
1	
2	
3	