Note: These answers are only reference answers. Other answers may also correct as long as you can provide reasonable explanations!

1. The following character encoding is used in a data link protocol:
   A: 01000111 B: 11100011 FLAG: 01111110 ESC: 11100000

Show the bits sequence transmitted (in binary) for the four-character frame:

A B ESC FLAG

when each of the following framing methods is used:

(a) Byte count.

(b) Flag bytes with byte stuffing.

(c) Starting and ending flag bytes with bit stuffing (each frame begins and ends with bit pattern 0x7E = 01111110)

Answer: The solution is

(a) 00000101 01000111 11100011 11100000 01111110

(b) 01111110 01000111 11100011 11100000 11100000 11100000 01111110 01111110

(c) 01111110 01000111 11**0**100011 111**0**00000 01111**0**10 01111110

2. A bit stream 10011101 is transmitted using the standard CRC method described in the text. The generator polynomial is $x^3 + 1$. Show the actual bit string transmitted.

Answer:

The frame is 10011101. The generator is 1001. The message after appending three zeros is 10011101000. The remainder on dividing 10011101000 by 1001 is 100. So, the actual bit string transmitted is 10011101100.

3. The distance from earth to a distant planet is approximately 9×10^{10} m. What is the channel utilization if a stop-and-wait protocol is used for frame transmission on a 64 Mbps point-to-point link? Assume that the frame size is 32 KB and the speed of light is 3×10^8 m/s.

Answer:

Link utilization $= (1/(1 + 2BD))$

BD = bandwidth-delay product / frame size

delay = $(9 \times 10^{10}) / (3 \times 10^8) = 300$ sec

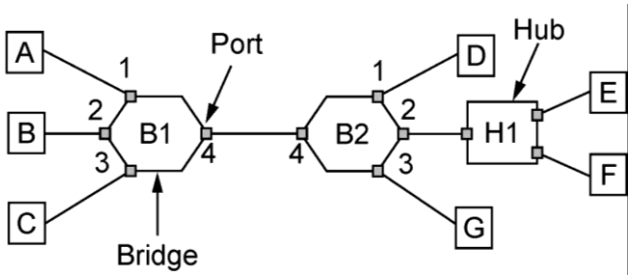
bandwidth-delay product = $64 \times 300 = 19.2$ Gbit

$BD = 19200000 / 256 = 75000$ frames.

So, link utilization is 6.67×10^{-4}%

4. Consider the extended LAN connected using bridges B1 and B2 as following

figure.



Suppose the hash tables in the two bridges are *empty*. List all ports on which a packet will be forwarded for the following *sequence of data transmissions*:

(a) A sends a packet to C.
(b) E sends a packet to F.
(c) F sends a packet to A.
(d) B sends a packet to C.
(e) D sends a packet to F.

Answer:

(a) B1: ports 2, 3, and 4. B2: ports 1, 2 and 3. (*Notes: in this answer, we only provide ports that forward the frame. Other ports may also receive the frame, e.g., port 4 on B2.*)
(b) B1: ports 1, 2 and 3. B2: ports 1, 3, and 4.
(c) B1: port 1. B2: port 4.
(d) B1: ports 1, 3 and 4. B2: ports 1, 2 and 3.
(e) B1 cannot hear the packet. B2: port 2.

5. How many frames per second can Gigabit Ethernet handle *at most*? Or how many frames can be transmitted per second for a Gigabit Ethernet NIC *at most*? Please give your answers for both cases when *carrier extension* and *frame bursting* are enabled respectively.
   Note: Suppose frames are transmitted back-to-back, and don't consider preamble and SoF bytes.

Answer:

The smallest Ethernet frame is 512 bits, so at 1 Gbps we get 1,953,125 or almost 2 million frames/sec. However, this only works when frame bursting is operating. Without frame bursting, short frames are padded to 4096 bits (i.e., carrier extension), in which case the maximum number is 244,140.