COMP90007 Internet Technologies
Week 4 Tutorial

Semester 2, 2018

Question 1

The following character encoding is used in a data link protocol:

A:	`01000111`	B:	`11100011`
FLAG:	`01111110`	ESC:	`11100000`

Show the bit sequence transmitted (in binary) for the four-character frame payload *A B ESC FLAG,* when each of the following framing methods are used:

(a) Character count

(b) Flag bytes with byte stuffing

(c) Starting and ending flag bytes, with bit stuffing

Answer:

```
1. 00000101 01000111 11100011 11100000 01111110
       5        A        B      ‘ESC’    ‘FLAG’
2. 01111110 01000111 11100011 11100000 11100000 11100000 01111110 01111110
     FLAG       A        B       ESC     ‘ESC’     ESC     ‘FLAG’    FLAG
3. 01111110 01000111 110100011 111000000 011111010 01111110
     FLAG       A         B       ‘ESC’    ‘FLAG’     FLAG
```

Question 2

The following data fragment occurs in the middle of a data stream for which the algorithm as described in the lecture is used:byte-stuffing

A B ESC C ESC FLAG FLAG D.

What is the output after stuffing?

Answer:
After stuffing we get:
A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D.

Question 3

One of your classmates, Lancelot, has pointed out that it is wasteful to end each frame with a flag byte and then begin the next one with a second flag byte. One flag byte could do the job as well, and a byte saved is a byte earned. Do you agree?

Answer: If you could always count on an endless stream of frames, one flag byte might be enough. But what if a frame ends (with a flag byte) and there are no new frames for 15 minutes? How will the receiver know that the next byte is actually the start of a new frame and not just noise on the line? The protocol is much simpler with starting and ending flag bytes.

Also, If there is a long delay then the receiver will not know for a long time whether or not the frame has ended

Question 4

A bit string, `0111101111101111110`, needs to be transmitted at the data link layer.

What is the actual string transmitted across the physical transmission medium, assuming bit stuffing is used?

Answer:
The output is `011110111110011111010`.

Question 5

- Suppose that a message 1001 1100 1010 0011 is transmitted using Internet Checksum (4-bit word). What is the value of the checksum?

Answer: To obtain the checksum, we need to calculate the ones complement of the ones complement sum of the words. The ones complement sum is same as sum modulo 24 and adding any overflow of high order bits back into low-order bits:

0011 + 1010 = 1101

1101 + 1100 = 1001 + 1 = 1010

1010 + 1001 = 0011 + 1 = 0100.

So, the Internet checksum is the ones complement of 0100, or **1011**.

Question 6

Data link protocols almost always put the CRC in a trailer rather than in a header. Why?

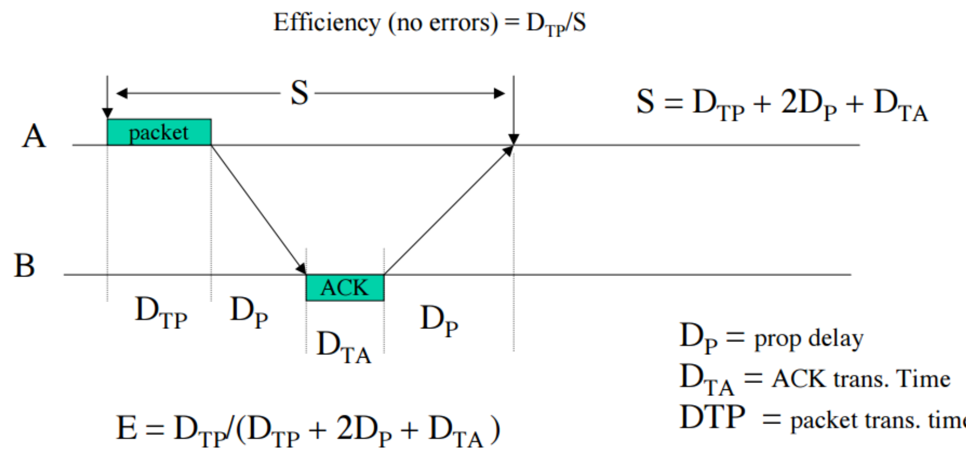
Answer:
The CRC is computed during transmission and appended to the output stream as soon as the last bit goes out onto the wire. If the CRC were in the header, it would be necessary to make a pass over the frame to compute the CRC before transmitting. This would require each byte to be handled twice – once for checksumming and once for transmitting. Using the trailer cuts the work in half.

Question 7

A channel has a bit rate of 4 kbps and a propagation delay of 20 ms. For what range of frame sizes does stop-and-wait give an efficiency of at least 50 percent?

Answer:
Efficiency will be 50% when the time to transmit the frame equals the round trip propagation delay.

At a transmission rate of 4 kbps, 40 ms will transfer 160 bits. For frame sizes greater than 160 bits, stop-and-wait is reasonably efficient.



$0.5 <= D_{TP}/(D_{TP} + 2D_P + D_{TA})$
$0.5D_{TP} + D_P <= D_{TP}$
$0.5D_{TP} >= D_P$
$D_{TP} >= 2D_P >= 40$ ms $\rightarrow$ 160 bits

Question 8

A 100 km long cable runs at the T1 data rate (i.e. 1.544 Mbps).

The propagation speed in the cable is 2/3 the speed of light in a vacuum. How many bits fit in the cable?

Answer:
The propagation speed in the cable is: $2/3 \times c = 2 \times 10^8$ m/s
So a 100 km cable will be filled in: $(100 \times 10^3) / (2 \times 10^8) = 500$ μs
Therefore, knowing the data rate: $1.544 \times 10^6 \times 500 \times 10^{-6} = 772$ bits on the cable