

# EE 4204 Computer Networks (Part 1)

Semester 2, 2020-21

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## TUTORIAL 2: PROBLEMS & SOLUTIONS

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# Problem 1

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- Problem:

Suppose that a certain communication protocol involves a per-packet overhead of 100 bytes for headers and framing. It is required to send 1 million bytes of DATA using this protocol. It is given that one data byte is corrupted and the entire packet containing it is thus lost necessitating retransmission of the lost packet. Give the total number of overhead+retransmitted bytes for packet data sizes of 5000 and 20000 bytes. Determine the optimal packet data size.



# Problem 1 (Contd.)

## ■ Solution

$P_1$	100	X
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$P_N$	100	X
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- Let X be the packet data size, O be the overhead+ retransmitted bytes, and N be the number of packets.
- Since there are 1 million data bytes, N is given by  $10^6/X$ . It is given that the overhead is 100 bytes per packet. The size of retransmitted packet (which was lost) is  $X+100$ .
- Therefore,  $O = N \times 100 + X + 100$
- $X=5000 \Rightarrow N = 200$ ; and  $O = 25100$  bytes
- $X=20000 \Rightarrow N = 50$ ; and  $O = 25100$  bytes
- The optimum value is obtained when  $dO/dX = 0$ .
- $O = 10^6/X \times 100 + X + 100 = 10^8/X + X + 100$
- $dO/dX = -10^8/X^2 + 1 = 0 \Rightarrow X = 10000$
- When  $X = 10000$  the number of overhead+retransmitted bytes is minimum as  $d^2O/dX^2 > 0$



# Problem 2

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- Problem:

- What signal-to-noise ratio is needed to put a T1 carrier on a 50 KHz line?

- Solution:

- Data rate of T1 carrier is 1.544 Mbps, i.e.  $C = 1.544 \text{ Mbps}$
- Bandwidth  $B = 50 \text{ KHz}$ .
- Using  $C = B \log_2(1+S/N)$ , we get  $C/B = 30.88$ .
- $S/N = 2^{30.88} - 1 = \text{about } 93 \text{ dB}$



# Problem 3

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- Problem:

- Assuming a framing protocol that uses bit stuffing, show the bit sequence transmitted over the link when the frame contains the following bit sequence (excluding flag bits):
- 11111111110011111011111101

- Solution:

- The transmitted bit sequence is given below. The stuffed bits are in bold and underlined.
- 11111**0**11111**0**0011111**0**1011111**0**101



# Problem 4

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- Problem:

- Assuming a framing protocol that uses byte stuffing. (i) Show the original data bytes extracted by the receiver upon receiving the following byte sequence (excluding flag bytes). (ii) What is the fraction of bandwidth wasted due to stuffing?
- 2B 7D 5D 7D 5D 5D 5E 7D 5E 0E 7D 5E

- Solution:

- The original data bytes extracted are:
  - 2B 7D 7D 5D 5E 7E 0E 7E
- Out of 12 bytes sent, 4 are overhead bytes due to stuffing. So, fraction of bandwidth wasted =  $4/12 = 1/3$



# Problem 5

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- Problem:

- A receiver receives a bit stream 11101010 including the CRC bits. Suppose that the divisor polynomial used is  $x^2+1$ , explain if the receiver detects any error.

- Solution:

- Dividing 11101010 by 101 using modulo-2 arithmetic gives a non-zero remainder (01).
- Therefore, the receiver detects the error.
- Carry out the division to obtain the remainder.

# Problem 5 CRC calculation

