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Chapter: 3
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Computer Networks
Assignment Chapter №3

Task 1. *1. 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. Suppose that the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. Give an example of bit errors in the bit string transmitted that will not be detected by the receiver.*

Solution. Append a "CRC" to the end of the msg if G(x) is of degree r, then append r 0s to end of the m msg bits. The new number is now $x^r M(x)$.
Divide this by G(x) modulo 2
Add the remainder to the $x^r M(x)$ modulo 2, The result is the checksummed frame to be transmitted T(x). This number is now divisible by G(x)

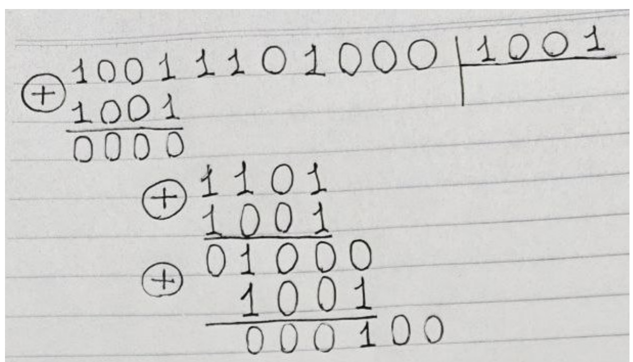

Fig. 1 - Calculating the CRC (Task 1)

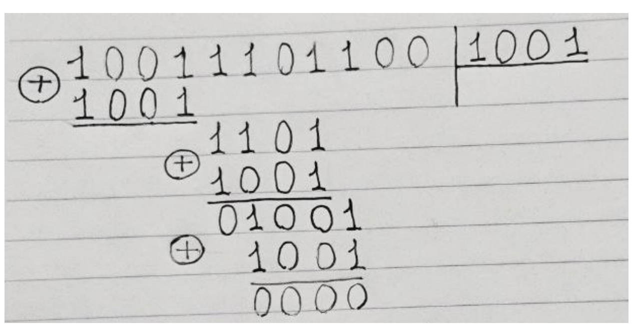

Fig. 2 - Checking (Task 1)

Another example in which errors are not recognized: 10010100100 □

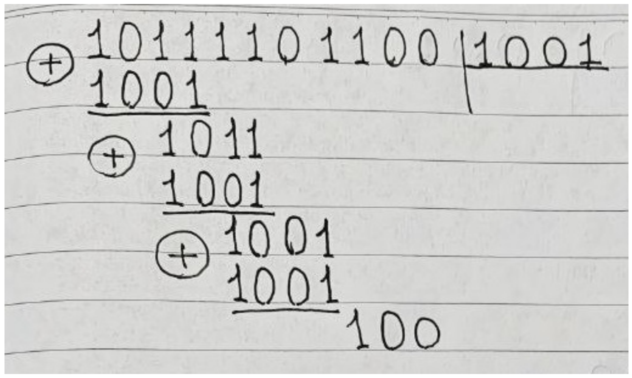

Fig. 3 - Invert bit (Simulating error) (Task 1)

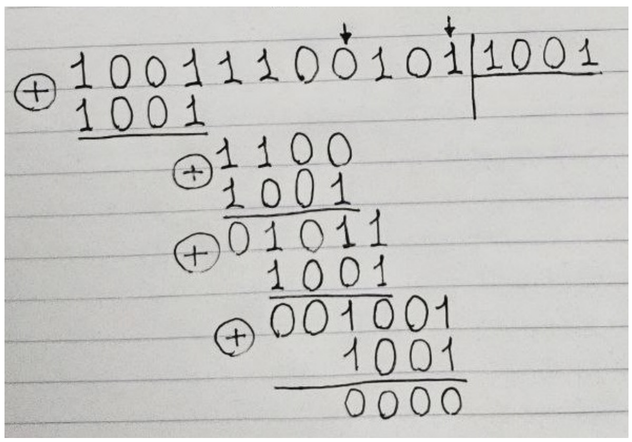

Fig. 4 - Example in which errors are not recognized (Task 1)

Task 2. *A channel has a bit rate of 4 kbps and a propagation delay of 20 msec. For what range of frame sizes does stop-and-wait give an efficiency of at least 50 percent?*

Solution. $U = \frac{T_{trans}}{T} = \frac{\frac{L}{R}}{2 \cdot T_{trans} + \frac{L}{R}}$
U - efficiency, L - frame size, R - bit rate (RTT $= 2 \cdot T_{trans}$)
$0.5 = \frac{\frac{L}{4000}}{2 \cdot 0.02 + \frac{L}{4000}}$
$0.5 \cdot (0.04 + \frac{L}{4000}) = \frac{L}{4000}$
$0.02 + \frac{L}{8000} = \frac{2 \cdot L}{8000}$
$\frac{2}{100} = \frac{L}{8000}$
L $=$ 160 bits $=$ 20 bytes (or more)

□

Task 3. *Suppose you are designing a sliding window protocol for a 1-Mbps point-to-point link to the stationary satellite evolving around the Earth at* 310^4 *km altitude. Assuming that each frame carries 1 kB of data, what is the minimum number of bits you need for the sequence number in the following cases? Assume the speed of light is* 310^8 *meters per second.*
(a) Receive Window Size = 1.
(b) Receive Window Size = Send Window Size

Solution. RTT (round-trip-time) $= \frac{3 \cdot 10^7}{3 \cdot 10^8} \cdot 2 = 0.2 sec$
PPS (packets per second) $= \frac{1Mbps}{1KB} = \frac{1000000}{1000 \cdot 8} = 125$
BD (Bandwidth-delay-product) = (Bandwidth) $\cdot$ (roundtrip delay) $= 125 \cdot 0.2 = 25$
SWS should be this large
a) if RWS = 1 => 25 + 1 = 26 sequence number => $2^5 > 26 > 2^4$ => 5 bits min
b) if RWS = SWS => 25 + 25 = 50 sequence number => $2^6 > 50 > 2^5$ => 6 bits min

□

Task 4. *Suppose that we run the sliding window algorithm with SWS = 5 and RWS = 3, and no outof-order arrivals. (a) Find the smallest value for MaxSeqNum. You may assume that it suffices to find the smallest MaxSeqNum such that if DATA[MaxSeqNum] is in the receive window, then DATA[0] can no longer arrive.*
(b) Give an example showing that MaxSeqNum 1 is not sufficient.
(c) State a general rule for the minimum MaxSeqNum in terms of SWS and RWS.

Solution. a) MaxSeqNum = SWS + RWS - 1 = 5 + 3 - 1 = 7
b) In part a) max seq number = 7. Sender sends first 6 frames 0, 1, 2, 3, 4, 5. The receiver receives all the frames but all ACK's are lost. Now the receiver is expecting 6, 0 (since sequence number wraps around, instead of 7 we have sequence number 0). After timeout, the sender sends 0, 1, 2, 3, 4, 5 again.
Receiver accepts frame 0 but it was the old incarnation instead of the new frame with sequence number 0
c) N = SWS + RWS - 1
Assume that the sequence numbers are 0 based.
Suppose a maximum sequence number = 3 means sequence numbers 0, 1, 2 and 3 can be used. □