

## Network Calculations

### Instructions

Answer the following questions in Hebrew or English. Use exact values for MB, KB, and Mbps. Assume a transmission is completed when the last bit arrives at the recipient.

### 1 File Transfer (8 points / 2 points each)

Calculate the total time required to transfer a 2.5MB file in the following cases, assuming an RTT of 160 ms and a packet size of 1 KB.

- (a) The bandwidth is 1.7 Mbps, and data packets can be sent continuously.
- (b) The bandwidth is 1.7 Mbps, but after we finish sending each data packet we must wait one RTT before sending the next.
- (c) The bandwidth is “infinite,” meaning that we take transmit time to be zero, and up to 15 packets can be sent per RTT.
- (d) The bandwidth is infinite, and during the first RTT we can send one packet ( $2^{1-1}$ ), during the second RTT we can send two packets ( $2^{2-1}$ ), during the third we can send four ( $2^{3-1}$ ), and so on.

### 2 Latency and Bandwidth (12 points)

Consider two computers which wish to communicate over a 100Mbps link with a 100ms RTT. One computer wants to send a file which is 50MB to the other. Assume that the transport protocol used (*e.g.* TCP) requires a  $2 \times RTT$  *handshake* before data can be sent.

- (a) (5 points) Calculate how long it will take to transmit and propagate the file. That is, the time from the start of the handshake until the last bit of the file reaches the recipient.
- (b) (7 points) Assume that the transport protocol breaks the file into 32KB packets and that each packet can be sent only after an ACK packet has been received from the recipient for the previous packet. Assume that the ACK packet is 28B (bytes) long. Ignoring processing delays (*i.e.* the recipient responds immediately after the last bit of the packet arrives and the sender begins the next packet immediately after the last bit of the ACK packet arrives) and assuming that no packets are dropped, calculate the total time that the transfer takes - from the time that the sender begins the handshake until the last ACK arrives at the sender.

Calculate your answers using the exact values for KB, MB, and Mbps.

### 3 Transmission Time (3 points)

How long does it take to transmit  $x$  MB over a  $y$ -Mbps link with a  $z$ ms RTT? Give your answer as a ratio of  $x$ ,  $y$ , and  $z$ . Consider the total time - transmission and propagation.

## 4 CRC (6 points / 3 points each)

Suppose we want to transmit the message 0110 1011 1111 and protect it from errors using the CRC polynomial  $x^3 + x^2 + 1$ .

- (a) Use polynomial long division to determine the message that should be transmitted. Write down the *entire message*.
- (b) Suppose the leftmost bit of the message is inverted due to noise on the transmission link. What is the result of the receivers CRC calculation? How does the receiver know that an error has occurred?

## 5 HDLC (4 points)

Suppose the following sequence of bits arrive over an HDLC link:

0110101111010111110100111111011001111110

Show the resulting frame after any stuffed bits have been removed. Indicate (1) any errors that might have been introduced into the frame and (2) any inclusion of the end sentinel.

## What to turn in

Turn in your submission for the above assignment including:

- Names of all students in the group
- Total number of hours spent on the assignment
- Date of submission
- All work, including calculations and graphs as appropriate

Turn in the above via email to [ise327@gmail](mailto:ise327@gmail.com), in person before the above date (or in my drawer in the Engineering School office, or via fax to 04-665-3661).

**Note:** Do not send work submissions to my personal email – use the course email ([ise327@gmail](mailto:ise327@gmail.com)).