COMP2322 Computer Networking

Homework 3

Author
Wang Yuqi
[redacted]

Lecturer
Dr. LOU Wei

BsC in Computer Science
Academic year: 2024/2025 Sem 2

Questions

Question 1

(2 points) UDP and TCP use 1's complement for their checksums. Suppose you have the following three 8-bit bytes: 01011011, 01100010, 01010110. What is the checksum value of these 8-bit bytes?

Question 2

(4 points) Consider transferring an enormous file of L bytes from Host A to Host B. Answer the following questions:

(a) Assume an MSS of 1500 bytes and the TCP sequence number field has 4 bytes. What is the maximum value of L such that TCP sequence numbers are not exhausted? (2 points)

(b) Assume that a total of 56 bytes of transport, network, and data-link header are added to each segment before the resulting packet is sent out over a 1 Gbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously. For the L you obtain in (a), find how long it takes to transmit the file. (2 points)

Question 3

(4 points) Consider that only a single TCP (Reno) connection uses one 150Mbps link which does not buffer any data. Suppose that this link is the only congested link between the sending and receiving hosts. Assume that the TCP sender has a huge file to send to the receiver, and the receiver's receive buffer is much larger than the congestion window. We also make the following assumptions: each TCP segment size is 1,500 bytes; the round-trip time of this connection is 500 msec; and this TCP connection always uses AIMD for congestion control (that is, it ignores slow start).

(a) What is the maximum window size (in segments) that this TCP connection can achieve? (1 point)

(b) What is the average window size (in segments) and average throughput (in bps) of this TCP connection? (2 points)

(c) How long would it take for this TCP connection to reach its maximum window again after recovering from a packet loss? (1 point)

Answers

Answer 1

$$\begin{array}{rr} & 01011011 \\ & 01100010 \\ + & 01010110 \\ \hline & 100010011 \\ \text{wrap} & = \quad 00010100 \\ \hline \text{invert:} & \quad 11101011 \end{array}$$

> **Answer:** The 8bit checksum is $(11101011)_2$

Answer 2(a)

Maximum number of Bytes = $2^{4\times 8} = 2^{32} = 4294967296$ Bytes

> **Answer:** $L = 4294967296$ Bytes ≈ 4.295 GB

Answer 2(b)

1. Number of Segments:

$$\left\lceil \frac{4294967296 \text{ Bytes}}{1500 \text{ Bytes/Segment}} \right\rceil = 2863312 \text{ Segments}$$

2. Total Transmission Size:

$$4294967296 \text{ Bytes} + 56 \text{ Bytes/Segment} \times 2863312 \text{ Segments} = 4455312768 \text{ Bytes}$$

3. Total Transmission Time:

$$\frac{4455312768 \text{ Bytes}}{1 \text{ Gbps}} = 35.642502144 \text{ sec}$$

> **Answer:** ETA = 35.642502144 sec

Answer 3(a)

1. Maximum Window Size in Bytes:

$$150\text{Mbps} \times 500\text{msec} = 75 \text{ Mbits} = 9375000 \text{ Bytes}$$

2. Maximum Window Size in Segments:

$$\left\lfloor \frac{9375000 \text{ Bytes}}{1500 \text{ Bytes/Segment}} \right\rfloor = 6250 \text{ Segments}$$

> **Answer:** Maximum window size = 6250 Segments

Answer 3(b)

1. Average Window Size:

$$\frac{3}{4} \times 6250 \text{ Segments} = 4687.5 \text{ Segments}$$

2. Average Throughput:

$$\begin{aligned} \frac{3}{4} \times \frac{W}{\text{RTT}} &= \frac{3}{4} \times \frac{9375000 \text{ Bytes}}{0.5 \text{ secs}} \\ &= 14062500 \text{ Byte/sec} \\ &= 112500000 \text{ bps} \end{aligned}$$

> **Answer:**
> Average window size = 4,687.5 Segments
> Average throughput = 112,500,000 bps = 112.5 Mbps

Answer 3(c)

1. After a packet loss, the window size will be halved.

$$\frac{6250 \text{ Segments}}{2} = 3125 \text{ Segments}$$

2. `cwnd` grows linearly (increment 1 every RTT):

$$3125 \text{ Segments} \times 0.5 \text{ secs} = 1562.5 \text{ secs}$$

> **Answer:**
> Time to reach maximum window size = 1562.5 seconds