CSC 435/524 Computer Networks
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Module - Transport Layer

1) What is the use of port number? Why can't process ids be used for port numbers?

2) Explain the difference between TCP and UDP with respect to the following:
a) Connectionless vs. Connection-oriented **b)** Use for real-time vs. delay-tolerant applications
c) Use for communication involving few messages vs. lengthy and/or critical communication
d) Use for unicast, multicast and broadcast communication **e)** Preserving message boundaries
f) Fragmentation in the source network **g)** Reliable, in-order delivery **h)** Full-duplex communication

3) Explain the 8 TCP flags that were discussed in the module and their use?

4) Explain how Explicit Congestion Notification works with the interaction of the source, destination and the routers through the IP header and TCP header.

5) What are the constituents of the pseudo header used in the checksum computation in the transport layer protocols? What is the purpose of the use of pseudo header?

6) What could be the minimum and maximum sizes for the UDP and TCP headers? Justify your answer.

7) Compute the Maximum Segment Size for a process running on the top of TCP/IP at a host whose underlying network MTU is 1470 bytes.

8) Explain the three different purposes of use of the TCP Options field that we discussed.

9) What are the three scenarios that could trigger the transmission of a segment? Explain.

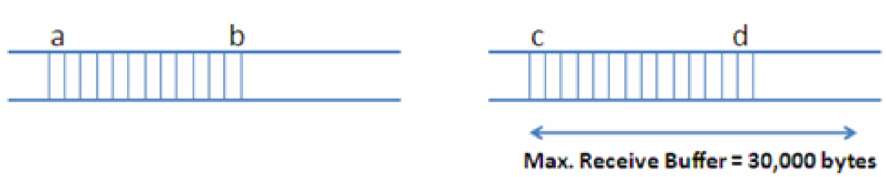
10) Briefly explain the 3-way handshake for TCP connection establishment.

11) What is the difference between flow control and congestion control?

12) What happens to the network throughput when you set the TCP timeout to be (i) far lower than the round trip time and (ii) far greater than the round trip time? Justify your answer.

13) The following are the sample round-trip times (Sample RTTs) for the acknowledgments or timeouts for a sequence of packet transmissions at the sender side: 150 ms, 300 ms, 250 ms, timeout, 400 ms, timeout and 700 ms. Compute the estimated timeout value at the end of each acknowledgment received or timeout incurred. Use Karl's simple retransmission algorithm (α =0.5).

14) Consider the status of a TCP connection at the source and destination as shown in the Figure and Table below. Let the Congestion Window size be 15,000 bytes. What would be the Effective Window Size (the amount of data that can be sent) by the source considering:



Source Process Destination Process

Notation	Description	Byte Sequence Number
a	Last Byte Acknowledged	20,000
b	Last Byte Sent	30,000
c	Last Byte Read	15,000
d	Last Byte Received	20,000

(a) Only Congestion Control
(b) Only Flow Control
(c) Both Flow Control and Congestion Control

15) Consider transmitting packets according to each of the following three congestion control algorithms:
(a) AIMD
(b) Slow Start
(c) Fast Recovery

The congestion control algorithm that works in units of packets and that starts each connection with a congestion window equal to one packet. Assume an ACK is sent for each packet received in-order, and when a packet is lost, ACKs are not sent for the lost packet and the subsequent packets that were transmitted. The lost packet and the subsequent packets have to be retransmitted by the sender.

For simplicity, assume a perfect timeout mechanism that detects a lost packet exactly 1 RTT after it is transmitted. Also, assume the congestion window is always less than or equal to the advertised window, so flow control need not be considered.
Consider the loss of packets with sequence numbers 7, 13, 20, and 25 in their first transmission attempt. Assume these packets are delivered successfully in their first retransmission attempt.
<u>Fill the following table to indicate the RTTs and the sequence numbers of the packets sent</u>. The sequence numbers of the packets sent range from 1 to 30.
<u>Compute the effective throughput achieved by this connection to send packets with sequence numbers 1 to 30</u>, each packet holds 1KB of data and that the RTT = 100ms.

RTT	Sequence Numbers of Packets Sent

16) You are hired to design a reliable byte-stream protocol that uses a sliding window like TCP. This protocol will run over a 100Mbps network. The RTT of the network is 100ms, and the maximum segment lifetime is 60 seconds. How many bits would you include in the *AdvertisedWindow* and *SequenceNum* fields of your protocol header?

17) Suppose TCP operates over a 1-Gbps link.
(a) Assuming TCP could utilize the full bandwidth continuously, how long would it take the sequence numbers to wrap around completely?
(b) Suppose an added 32-bit timestamp field increments 1000 times during the wraparound time you found above. How long would it take for the timestamp to wrap around?

18) Assume that TCP implements an extension that allows window sizes much larger than 64KB. Suppose that you are using this extended TCP over a 1-Gbps link with a latency of 100ms to transfer a

10-MB file, and the TCP receive window is 1MB. If TCP sends 1-KB packets (assuming no congestion and no lost packets):

- How many RTTs does it take until slow start opens the send window to 1 MB?
- How many RTTs does it take to send the file?
- If the time to send the file is given by the number of required RTTs multiplied by the link latency, what is the effective throughput for the transfer? What percentage of the link bandwidth is utilized?

19) Prove that # bits for the sequence number in a transport layer protocol header (designed for reliable, in-order delivery) has to be at least twice the # bits for the advertised window.

20) If the end-to-end delay from a source to destination is 100ms and the bandwidth of all the intermediate networks is 10Mbps, calculate the maximum number of bytes that can be sent from the source at any time.

21) Briefly explain the two techniques for fast retransmission discussed in class. What is the advantage of both these techniques over the Acknowledgment mechanism in the original TCP? Explain. New!!

22) What is meant by "keeping the pipe full" and "maximum segment lifetime"? If you are let to design a transport layer protocol, how would you choose the size of the Advertised Window and Sequence Number fields in the transport layer header? Derive (justify) your answer. New!!

23) What is the advantage of using the Selective Acknowledgment based fast retransmission compared to a Duplicate Acknowledgment based fast retransmission? New!!