EE 706: Communication Networks

Instructor: Saravanan Vijayakumaran
Indian Institute of Technology Bombay
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1. Suppose ten users want to share a channel using the Mini Slotted Alternating Priority (MSAP) protocol.
   (a) Suppose each user has a single frame to transmit, how many data transmission slots are required for the first user to complete his frame transmission under fixed, round-robin and alternating priorities? How many data transmission slots are required for the fifth user?
   (b) Answer the above question for the case when each user has five frames to transmit.
2. Generate subnetwork addresses and subnet masks to divide a single class C address 192.83.12/24 among four physical networks with 50 hosts each.
3. Suppose an IPv4 packet arrives at a router which is not capable of fragmentation, what are the fields in the IPv4 header which the router can possibly change? If the router is capable of performing fragmentation what are the fields which can possibly be changed?
4. Suppose a client wishes to establish a TCP connection with a server which is directly connected to it over a noisy link. Ignore the data link layer's ability to provide reliable communication for the moment. Can the TCP connection be established if
   (a) the link drops every odd-numbered segment which appears on it.
   (b) the link drops every even-numbered segment which appears on it.
   (c) the link drops every third segment which appears on it.
5. Suppose a client wishes to establish a TCP connection with a server which is directly connected to it over a noisy link. Ignore the data link layer's ability to provide reliable communication for the moment. Suppose the initial timeout duration used by the client and server is the same and its value is more than the round-trip time of the link (ignore processing delays). Assume that the client keeps trying to connect to the server until it succeeds. Draw the timing diagram of the TCP connection establishment mechanism if the first, second, third, and fifth segments which appear on the link are dropped. For each segment shown in the timing diagram, you should also show the TCP flags set, the value of the sequence number field, and the value of the acknowledgement field (if applicable).
6. TCP maintains three pointers into the receiver buffer to enable flow control through window advertisement: LastByteReceived, NextByteExpected and LastByteRead.

(a) Which of the following are valid scenarios if MaxReceiveBuffer is 2000 bytes? Calculate the value of AdvertisedWindow in each valid scenario.

   i. LastByteReceived = 1000, NextByteExpected = 2001, LastByteRead = 3000

   ii. LastByteReceived = 3000, NextByteExpected = 2001, LastByteRead = 1000

   iii. LastByteReceived = 1000, NextByteExpected = 1000, LastByteRead = 1000

   iv. LastByteReceived = 1000, NextByteExpected = 1001, LastByteRead = 1000

   v. LastByteReceived = 2500, NextByteExpected = 2001, LastByteRead = 1000

(b) Which of the above are valid scenarios if MaxReceiveBuffer is 1500 bytes? Calculate the value of AdvertisedWindow in each valid scenario.

(c) In the scenarios above which are valid, have the bytes arrived in order or out-of-order?

7. TCP maintains three pointers into the send buffer to enable flow control by calculating the maximum number of unacknowledged bytes which can be in transit: LastByteWritten, LastByteSent and LastByteAcked.

   (a) Which of the following are valid scenarios if AdvertisedWindow is 1000 bytes and MaxSendBuffer is 2000 bytes? Calculate the value of EffectiveWindow in each valid scenario.

      i. LastByteWritten = 2000, LastByteSent = 3000, LastByteAcked = 4000

      ii. LastByteWritten = 4000, LastByteSent = 3000, LastByteAcked = 2000

      iii. LastByteWritten = 2000, LastByteSent = 2000, LastByteAcked = 2000

      iv. LastByteWritten = 2000, LastByteSent = 2001, LastByteAcked = 2000

      v. LastByteWritten = 4500, LastByteSent = 3000, LastByteAcked = 2000

   (b) Which of the above are valid scenarios if AdvertisedWindow is 1000 bytes and MaxSendBuffer is 1500 bytes? Calculate the value of EffectiveWindow in each valid scenario.

   (c) In any of the scenarios above which are valid, does the send side TCP block the sending application?

8. Suppose the consecutive SampleRTTs on a connection are observed to be the following sequences of numbers (in seconds). Plot the value of EstimatedRTT using the equation $\text{EstRTT} = \alpha \times \text{EstRTT} + (1 - \alpha) \times \text{SampRTT}$ for $\alpha = 0.9$.

   (a) 2, 2, 2, 2, 2, 2

   (b) 10, 2, 2, 2, 2, 2

   (c) 1, 2, 3, 3, 2, 1

9. Plot the TCP congestion window at a TCP source as a function of time in the following scenarios. Suppose the initial size of the congestion window at time $t = 0$ is one segment and the following events are observed at a TCP source.

   - ACK for first segment sent arrives at time $t = 2$.
   - Cumulative ACK for second and third segments sent arrives at time $t = 4$.
   - Cumulative ACK for fourth, fifth, and sixth segments sent arrives at time $t = 7$.
   - Timeout waiting for ACKs of seventh segment sent occurs at time $t = 10$
   - ACK for all retransmitted segments arrives at time $t = 12$.

   Suppose the implementation of TCP congestion control at the source only contains the slow start and congestion avoidance algorithms (no fast recovery). Plot the congestion window as a function of time.