Assignment #5

1. Suppose two hosts have a long-lived TCP session over a path with a 100ms round-trip time (RTT). Then, a link fails, causing the traffic to flow over a longer path with a 500ms RTT.



1. Suppose the router on the left recognizes the failure immediately and starts forwarding data packets over the new path, without losing any packets. (Assume also that the router on the right recognizes the failure immediately and starts directing ACKs over the new path, without losing any ACK packets.) Why might the TCP sender retransmit some of the data packets anyway?

答：有可能开始的重发计时比较小，小于500ms，新的链路导致了左边主机的计时器超时，然后重发。

还有可能在失效的链路上有正在传输的packet或者ACK，左边的主机没有接收到正确的ACK导致计时器超时或者接收到三个冗余的ACK，然后重发。

1. Suppose instead that the routers do not switch to the new paths all that quickly, and the data packets (and ACK packets) in flight are all lost. What new congestion window size does the TCP sender use? Why?

答：发送主机会将拥塞窗口的大小设为1，因为所有的ACK都丢失了会触发超时事件，超时事件发生的时候会将阈值减半同时重新开始慢启动过程。

2. Consider the following behavior of a TCP connection (using the congestion control algorithm we learned in class).

At time 0, a TCP sender initiates a connection. As soon as the connection is established, the TCP sender will begin sending data. The MSS is 1KB and RTT is 100 ms.

1. Assuming the connection does not lose any data or experience any timeouts, at what time will the sender’s congestion window be 16KB? (Assuming *threshold* is 32MSS)

答：初始的时候cwnd=1MSS，然后按照指数增长，1RTT的时候是1MSS，2RTT的时候是2MSS，3RTT的时候是4MSS，以此类推。cwnd到达16KB（16MSS）的时候，时间是5RTT，即500ms。

Right after the sender’s congestion window has reached a size of 16KB, a timeout occurs. After the timeout is detected, the sender continues sending more data over the established connection.

1. Assuming no additional packets loss or timeouts, how long (since the observed timeout) will it take for the congestion window to build to size 14KB?

答：16KB的时候发生了超时事件，那么cwnd会被置为1，然后threshold=16/2=8MSS。到达阈值前是指数增长，到达阈值前所花的时间为4RTT，即400ms的时候到达了阈值。到达了阈值之后开始线性增长，线性增长到14KB需要600ms，故总共需要400ms+600ms=1s。

1. While its congestion window is at 14KB, the sender receives triple duplicate acknowledgements for the same sequence number. How long after receiving the third duplicate acknowledgement will it take for the sender’s congestion window to be at least 9KB again?

答：收到三次重复的ACK会导致threshold减半，threshold=cwnd/2=7KB，拥塞窗口变为10KB，同时重传丢失的数据，然后进入快速恢复状态，在快速恢复状态下，如果收到了一个新的ACK，那么又会转到拥塞避免模式，此时cwnd=7KB。所以总共到达9KB需要100ms+200ms=300ms。

3. Consider a scenario with two hosts, Alice and Bob. A web server running on Alice is trying to send data to a browser on Bob. For each TCP connection, Alice’s TCP stack maintains a send buffer of 512 bytes and Bob’s TCP stack maintains a receive buffer of 1024 bytes. For simplicity, assume TCP sequence numbers began at 0 in this problem.

1) Bob’s stack received up to byte 560 in order from Alice, although its browser has only read up to the first 60 bytes. What will be the ***ACK#***and ***rcvr window size***in the TCP headers that Bob next sends to Alice?

答：发送ACK560，接收窗口大小1024-（560-60）=524字节

2) Later in the same connection, Alice’s congestion window is set to 1 MSS = 536 bytes and the advertised flow-control window from Bob is 560 bytes. The last ***ACK#*** that Alice received from Bob is byte 700, and the last byte that Alice sends to Bob is byte 900.

A) What is the smallest byte number that Bob will not accept?

答：超过剩余窗口大小的值不会被接收，所以能接收的最小字节序号为700+560=1260

B) Assuming that Alice doesn’t receive any more ACKs and her window does not change, what is the greatest byte number that Alice can send?

答：目前Alice未被确认的窗口大小为201字节，她的缓存大小为512字节小于拥塞窗口值，所以最多还能发512-201=311字节，最大的字节序号为311+700=1011

C) Again assuming that Alice doesn’t receive any additional ACKs, how many more bytes can the web server running on Alice write to its network socket before blocking?

答：最多能写311字节