Assignment # 2, EG-101

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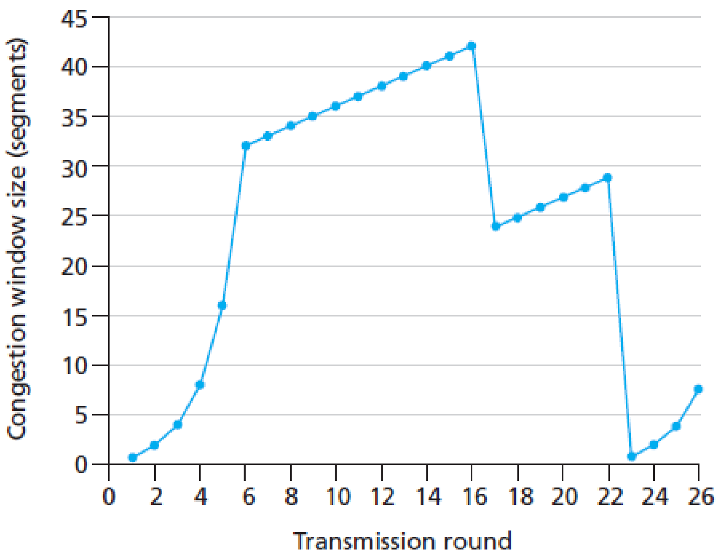
1. Consider a scenario in which Host A and Host B want to send messages to Host C. Hosts A and C are connected by a channel that can lose and corrupt (but not reorder) messages. Hosts B and C are connected by another channel (independent of the channel connecting A and C) with the same properties. The transport layer at Host C should alternate in delivering messages from A and B to the layer above (that is, it should first deliver the data from a packet from A, then the data from a packet from B, and so on).
    a. Design a stop-and-wait-like error-control protocol for reliably transferring packets from A and B to C, with alternating delivery at C as described above. Give FSM descriptions of the transmitter and receiver at A and C.
2. Consider the figure below. Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. **In all cases, you should provide a short discussion justifying your answer.**



    a. Identify the intervals of time when TCP slow start is operating.
    b. Identify the intervals of time when TCP congestion avoidance is operating.
    c. After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
    d. After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?

e. What is the initial value of ssthresh at the first transmission round? 'ssthresh' corresponds to the slow start threshold.
f. What is the value of ssthresh at the 18th transmission round?
g. What is the value of ssthresh at the 24th transmission round?
h. During what transmission round is the 70th segment sent?
i. Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh?
j. Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the ssthresh and the congestion window size at the 19th round?
k. Again suppose TCP Tahoe is used, and there is a timeout event at 22^{nd} round. How many packets have been sent out from 17th round till 22^{nd} round, inclusive?

3. Discuss the TCP CUBIC congestion control mechanism. How is it different from Reno/Tahoe? (**Note: Please limit your answers to 1 page only)**

4. Pre-reading required: '**Macroscopic Description of TCP Throughput**' of Section 3.7 of Kurose and Ross. In the period of time from when the connection's rate varies from W/(2 · RTT) to W/RTT, only one packet is lost (at the very end of the period).
   a. What is the average throughput of the connection?
   b. Show that the loss rate (fraction of packets lost) is equal to

$$L = \text{loss rate} = \frac{1}{\frac{3}{8}W^2 + \frac{3}{4}W}$$

   c. Use the result above to show that if a connection has loss rate *L,* then its average rate is approximately given by

$$\approx \frac{1.22 \cdot MSS}{RTT\sqrt{L}}$$

5. Consider a modification to TCP's congestion control algorithm. Instead of additive increase, we can use multiplicative increase. A TCP sender increases its window size by a small positive constant *a* (0 < *a* < 1) whenever it receives a valid ACK. Consider same set of assumptions as that in the question above.
   a. What is the average throughput of the connection?
   b. Find the functional relationship between loss rate *L* and maximum congestion window *W*.
   c. Argue that for this modified TCP, a TCP connection always spends the same amount of time to increase its congestion window size from *W/2* to *W*.

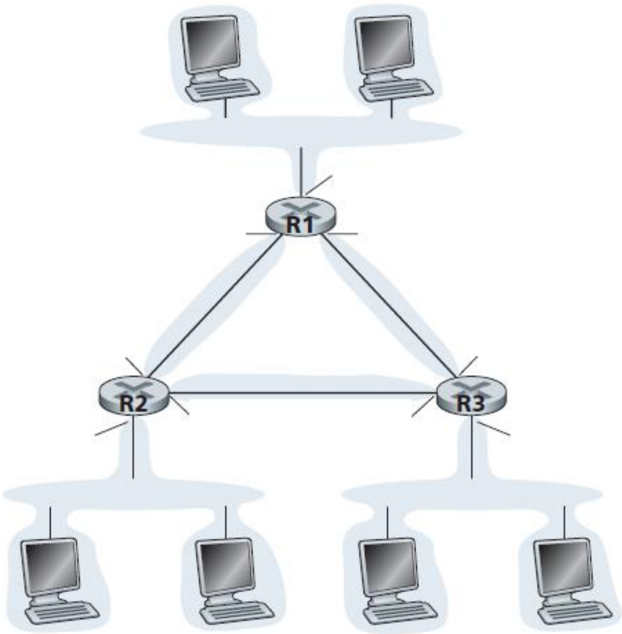
6. Explain count to infinity problem associated with DV algorithm with the help of a toy example. Also, discuss poisoined reverse technqiue employed to counteract with the above shortcoming via a numerical.

7. Consider a datagram network using 8-bit host addresses. Suppose a router uses longest prefix matching and has the following forwarding table:

Prefix Match	Interface
00	0
010	1
011	2
10	2
11	3

For each of the four interfaces, give the associated range of destination host and addresses and the number of addresses in the range

8. Consider the topology shown in Figure below. Denote the three subnets with hosts (starting clockwise at 12:00) as Networks A, B, and C. Denote the subnets without hosts as Networks D, E, and F.

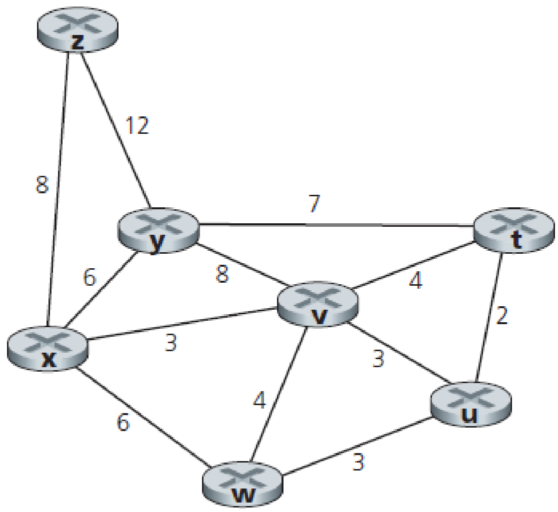


   a. Assign network addresses to each of these six subnets, with the following constraints: All addresses must be allocated from 214.97.254/23; Subnet A should have enough addresses to support 250 interfaces; Subnet B should have enough addresses to support 120 interfaces; and Subnet C should have enough addresses to support 120 interfaces. Of course, subnets D, E and F should each be able to support two interfaces. For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x – e.f.g.h/y. Justify your answers clearly.

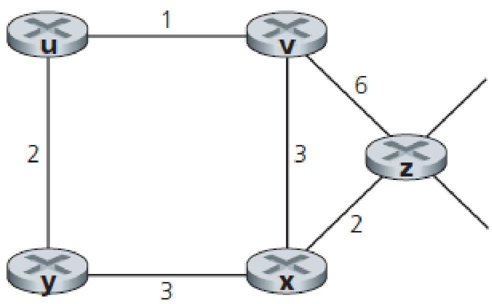
b. Using your answer to part (a), provide the forwarding tables (using longest prefix matching) for each of the three routers.

9. Consider the following network given in the figure below. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from
   a. Node *x* to all network nodes
   b. Node *v* to all network nodes.

   Illustrate all the intermediate steps clearly.



10. Consider the network shown below, and assume that each node initially knows the costs to each of its neighbors.



   a. Compute the distance tables after the initialization step and after each iteration of a synchronous version of the distance-vector algorithm and show the converged distance table entries at node *z*.
   b. Verify your answer by solving the same using Dijkstra's shortest-path algorithm to compute the routing table at Node *z*.