Fundamentals of Communication Networks

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1. **Exercise (6 pts)**:

   A string composed of 4 bits is transmitted over a channel characterized by a bit error probability $p = 0.05$.

   (a) Compute the probability mass function (pmf) of the discrete random variable $X = \{$number of bits correctly received$\}$

   (b) Compute the expected value and the variance of X

2. **Exercise (6 pts)**

   In the network illustrated in Figure 1, host A transmits to B a file of 2 kB. Suppose that the communication takes place with a Stop-And-Wait protocol with a timeout of 25ms, packets of 200 bytes and end-to-end acknowledgments of negligible size. Assume that R1 operates with a store-and-forward strategy and all queues are empty.

   (a) Compute the total transfer time for the file and the actual end-to-end transmission rate in case of no errors.

   (b) Repeat the computation at point (a) assuming that the third packet is lost.

   (c) Repeat the computation at point (a) assuming a Go-Back-N protocol with optimal window size and no errors.

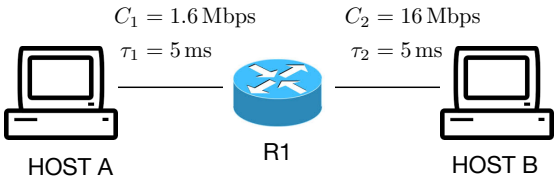

Figure 1: Network topology

3. **Exercise (6 pts)**

   An organization is given the following IP addressing space: 165.107.140.0/22. The organization needs to divide the network in the following subnets:

   - 1 subnets with at least 500 hosts
   - 1 subnet with at least 60 hosts
   - 5 subnets with at least 35 hosts

- 2 point-to-point links

Define an addressing plan for the network and indicate for each subnet: IP address, netmask, direct broadcast address and maximum number of hosts.

4. **Exercise (6 pts)**
   Between two hosts A and B a TCP connection is established with the following parameters:
   - MSS: 200 bytes
   - SSTHRES: 4 kB
   - RCWND: 8 kB

   (a) Calculate the time taken to transfer a file of 6kB from A to B (including the time needed to set up the connection), assuming that the channel is characterized by a capacity of 1Mbps and a propagation time $\tau = 10$ms and that ACK lengths are negligible.

   (b) Draw the evolution of the CWND assuming that at t = 129.62ms the RCWND changes to 10 MSS

5. **Question (4pts)**
   A layer 2 device (bridge) has three ports (Port 1, 2 and 3) and the following forwarding table:

Table 1: Forwarding Table

MAC Address	Output Port
MAC-A	Port 1
MAC-B	Port 1
MAC-C	Port 2
MAC-D	Port 1

   For each of the following scenarios, describe the behaviour of the bridge (forwarding port and new)

   (a) A frame is received on port 1 with source MAC-B and destination MAC-A

   (b) A frame is received on port 3 with source MAC-E and destination MAC-A

   (c) A frame is received on port 2 with source MAC-C and destination MAC-F

   (d) A frame is received on port 2 with source MAC-B and destination MAC-A

6. **Questions (4 pts - each answer can be either TRUE or FALSE)**
   In case the answer is FALSE, briefly explain why.
   - [T] [F] In RIP, each router transmits its distance vectors to all routers in the network.
   - [T] [F] The efficiency of a Stop and Wait protocol increases as the propagation delay increases.
   - [T] [F] Flow control in TCP is performed through the RCWND field.
   - [T] [F] FTP performs data transfer and control on a single persistent TCP connection.