

Fundamentals of Communication Networks

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

Host A transmits bursts of 10 packets to host B. Let X be the random variable that counts the number of lost packets in each burst. The Cumulative Density Function (CDF) of X is reported hereafter:

$$F_X(x) = \begin{cases} 5.9 \times 10^{-6}, & x < 1 \\ 1.4 \times 10^{-4}, & 1 \leq x < 2 \\ 0.0016, & 2 \leq x < 3 \\ 0.0106, & 3 \leq x < 4 \\ 0.0473, & 4 \leq x < 5 \\ 0.1503, & 5 \leq x < 6 \\ 0.3504, & 6 \leq x < 7 \\ 0.6172, & 7 \leq x < 8 \\ 0.8507, & 8 \leq x < 9 \\ 0.9718, & 9 \leq x < 10 \\ 1.0000, & x \geq 10 \end{cases} \quad (1)$$

- Compute the Probability Mass Function of X .
- Compute the probability that exactly one packet is lost in a burst.
- Compute the probability that more than 5 packets are lost.
- Show how to compute the Packet Error Rate for the link between A and B.

2. **Exercise (8 pts)**

A small enterprise purchases the IP address 131.175.128.0/19. Define an addressing plan to serve the following requirements:

- 1 subnet, 1000 host
- 2 subnets, 500 hosts each
- 3 subnets, 230 hosts
- 3 subnets, 100 hosts each
- 1 point to point link

3. **Exercise (6 pts)**

Host A establishes a TCP connection with host B. The capacity and propagation delay of link connecting A with B are: $C = 500$ kbps, $\tau = 5$ ms.

Assuming:

- MSS = 200 byte
- SSTHRESH = 1 kB
- RCWND = 2 kB
- ACK and control packets length = 20 byte
- headers length negligible
- bidirectional links

Compute the time needed to transfer a 10 kB file from A to B (from the connection setup to the reception of last ACK at A).

4. **Exercise (6 pts)**

Two hosts A and B are connected through a switch S. A is connected to Port 1 and B to Port 2. Let MAC-A and IP-A be the layer 2 and 3 addresses of A and MAC-B, IP-B the addresses of B. Host A transmits an IP packet to B and B replies to A with another IP packet.

- (a) Assuming that the forwarding tables of S is empty and the ARP tables of A and B are empty, indicate which packets are generated and transmitted in order to complete the exchange of packets. For each packet indicate the addresses included in the layer 2 (MAC) and layer 3 (IP or ARP) headers.
- (b) Indicate how the forwarding database of the switch changes after each packet.

5. **Question (4 pts)**

Given the network of switches indicated in the figure (link costs are indicated on each link), run the Spanning Tree Protocol and identify the root switch and the root ports (R), designated ports (D) and blocked ports (B) for all other switches. What is the main purpose of the spanning tree protocol?

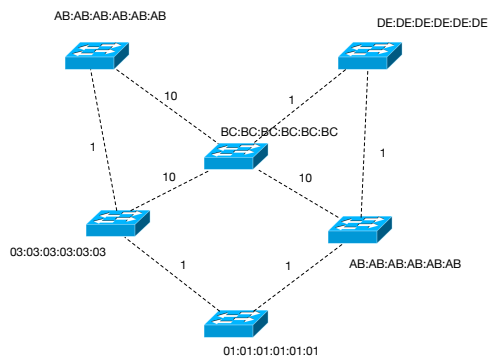


Figure 1: Network topology

6. **Questions (4 pts - each answer can be either TRUE or FALSE)**

In case the answer is FALSE, briefly explain why.

- T F The throughput achievable with slotted ALOHA is twice the one achievable with pure ALOHA
- T F Bellman-Ford shortest path algorithm is generally more efficient than Dijkstra's algorithm.
- T F The RCVWND field in TCP is used to avoid that a link becomes congested.
- T F NAT (Network Address Translation) devices translates hostnames into IP addresses.