Ex. 8-1: Selective Repeat

(see winter term 99/00) The transmission of a data frame (packet) with n bits shall happen via selective repeat, i.e., the recipient confirms each correctly received data frame by an acknowledgement (ACK) at once. If the recipient discovers a transmission error, he discards the packet. The sender waits a certain amount of time for the ACK and then repeats the transmission.

1. What is the probability that a packet is transmitted incorrectly and discarded by the recipient, if the probability of inverting one single bit is p?
2. How long is the time t for transmitting a single packet with n bits if the delay between sender and recipient is δ and the transmission rate is r $\left[\frac{\text{Bit}}{\text{s}}\right]$?
3. How long does the transmission of a packet take if only the second transmission is successful? What is the probability of this occurrence?
4. Let T be a random variable that measures the total time of a single packet transmission, i.e., the time it takes until a packet is received successfully. First, draw the probability tree that depicts the different sending cases. Then, compute the expected value $E(T)$ of T.

Hints:

$$\sum_{i=0}^{\infty} q^i = \frac{1}{1-q} \qquad |q| < 1$$

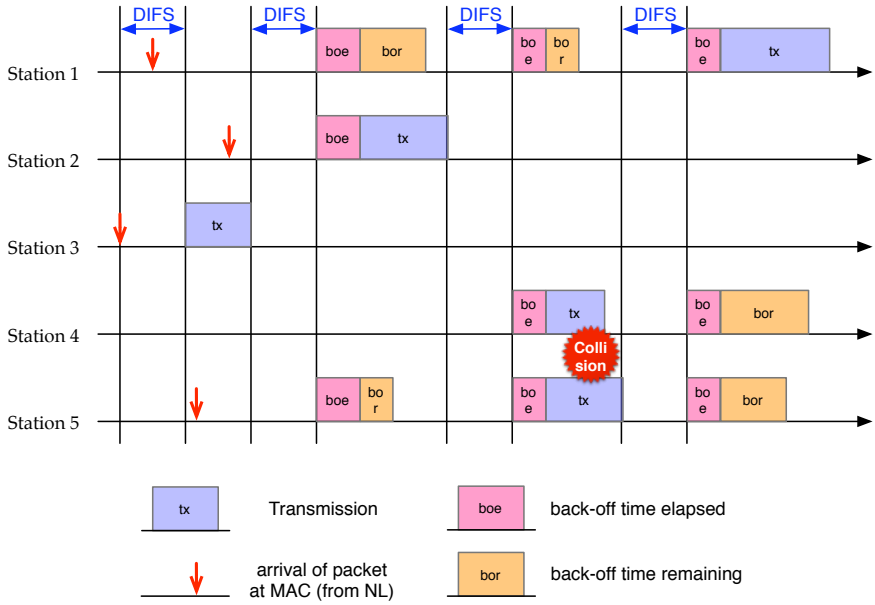
$$\sum_{i=0}^{\infty} i q^i = \frac{1}{(1-q)^2} \qquad |q| < 1$$

$$E(T) = \sum_{\forall t \in \{T\}} t p(t)$$

where $p(t)$ is the probability of t as an event of T.

Ex. 8-2: Wireless LAN

Consider the following situation in an 802.11 network:

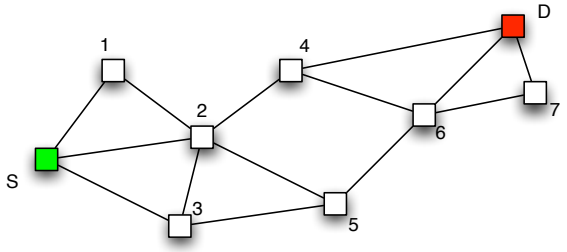


1. In which mode of operation is this network in?
2. Why is the start of the back-off timers delayed by DIFS?
3. How is the back-off timer determined? Explain this considering station 1?
4. Why are collisions still possible? How does a station act after a collision occurs, particularly regarding its back-off time?

Ex. 8-3: Virtual Circuit vs. Datagram

Ex. 8-3.1: Example

Assume a packet-switched wired network with the following topology:



The maximum packet payload is 2′000 bytes. Unique node identifiers are 32 bits. The system can support up to 4096 connections. All nodes know the complete topology and route optimizing a shortest-path metric.

Describe a data transfer of 8′500 bytes from S to D. Also give the minimum packet size for every packet exchange. Do this both for a virtual-circuit and a datagram system.

Ex. 8-3.2: Questions

Which of the two implementation alternatives (virtual circuits vs. datagrams) is more advantageous considering the following criteria? Discuss!

Criteria	**Virtual Circuit**	**Datagram**
Complexity of connection establishment		
Complexity of addressing		
Complexity of routing		
Complexity of congestion control (transport layer)		
Complexity of order recovery (transport layer)		
Complexity within the routers		
Error-Proneness		

Ex. 8-3.3: Big-Oh Complexity

Compare virtual-circuit and datagram networks regarding the asymptotic complexity of and in Big-Oh notation. Assume the following input parameters:

- C : Number of connections
- V : Number of nodes (vertices)
- E : Number of links (edges)
- L : Average path length
- P : number of packets

Give the $O()$ complexity of packet size, router computation cost, and router memory consumption.