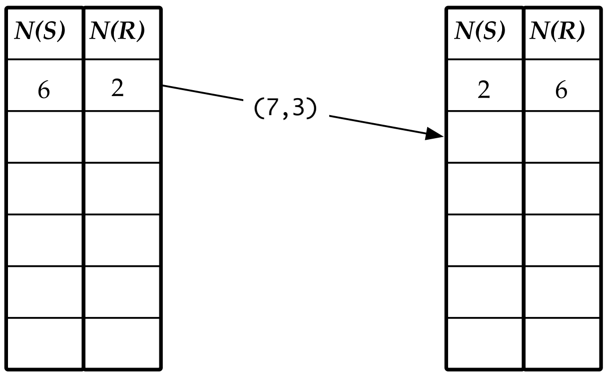
Ex. 6-1: HDLC

1. Which techniques for error detection/correction and frame boundary indication are used in HDLC?

2. Due to efficiency, HDLC employs piggy-backed acknowledgements. Explain!

3. Consider the following example: Station A sends 3 data packets to Station B starting with sequence number 6. Subsequently, B sends 2 data packets to A starting with sequence number 2. Assume that HDLC uses a sliding window with 3-bit sequence numbers. Let $N(S)$ and $N(R)$ be the sending resp. receiving counter. Note that in HDLC the next expected packet number is requested instead of acknowledging the last sequence number. Complete the following diagram:



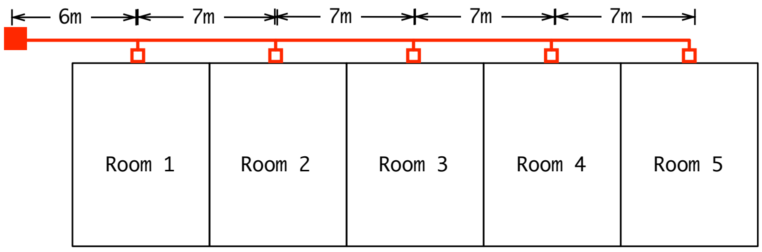
4. HDLC uses a sliding window protocol for flow control with size 7. Assume that Station A and Station B are connected by a $10 \cdot 10^6$ Bps link. The speed of light can be assumed to be 300.000 km/s. The distance between both station is 10.000 km. Consider a frame size of 5000 Bit including a header of size 100 Bit. Each packet is acknowledged by the receiver separately. The processing time of packets as well as the size of ACKs can be neglected.

   - What is the net performance achieved by the protocol?
   - Which window size is at least necessary to achieve the maximal net performance?
   - Assuming a window size of 127, what is the frame size to achieve the best capacity utilization?

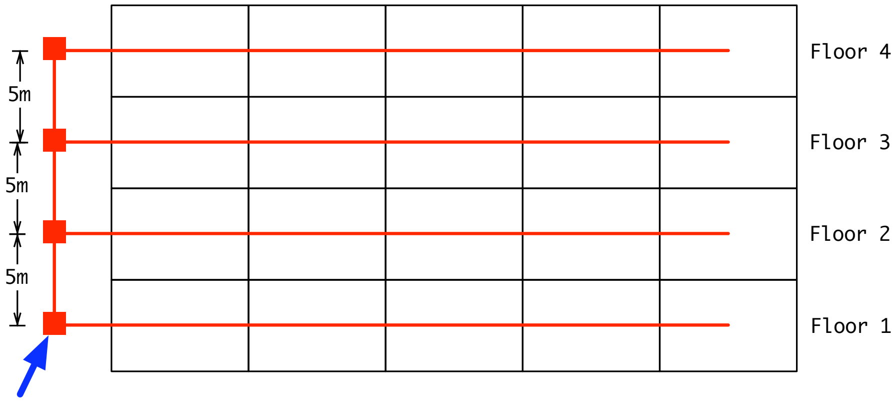
Ex. 6-2: Topology

As a corporate CIO you are employed with the task of supervising the cabling in a new building sketched below.

Bird's view of one Floor



Side view of the building



As you know, there are different possible topologies to do networking with, e.g., star, tree, and bus. Considering that the blue arrow points to the point where the telco lines enter the building, i.e., the "start" of the network. Also consider that you need in average 3meters of cabling from the network wall plugs to the work stations.

Compute the rough amount of cable you need to connect one work station per room considering the following topologies:

- Bus Topology, Bus ends in wall plugs. No Switching.
- Star Topology, with switch at blue arrow.
- Tree Topology, with switch at every floor, every switch connected to switch at floor zero.

Now consider the failure propability of the cable to be p_c^f in $\left[\frac{\text{failures}}{\text{minutes}\cdot\text{meters}}\right]$ and the failure probability of a switch to be p_s^f in $\left[\frac{\text{failures}}{\text{minutes}}\right]$. Give a formula for the failure probability per minute for each of the network setups described above.

Ex. 6-3: ALOHA and Friends

Ex. 6-3.1: Pure ALOHA

Consider a channel using pure Aloha that is shared by a user group of size N. The available data rate is 56.000 Bit/s. Each station would like to send a 1000 Bit frame every 100 seconds on average. However, retransmissions should not be considered. Compute N such that the throughput will be maximized. *Hint: See Chapter 4.2.1 in (Tanenbaum, Computer Networks).*

Ex. 6-3.2: Slotted ALOHA

Measuring a slotted Aloha channel with an infinite number of stations shows about 10% of all slots are empty.

1. Calculate the channel utilization G (total number of attempted transmissions per frame time).
2. Calculate the data throughput.
3. Is the channel under- or overloaded?

Ex. 6-3.3: Ethernet

1. Why does Ethernet require a minimum packet length?
2. Consider a network with two stations linked by several repeaters. The distance between both stations is 2.5 km. The data rate is $10 \cdot 10^6$ Bit/s, the propagation delay is $2 \cdot 108$ m/s. What is the minimum packet length for that case?