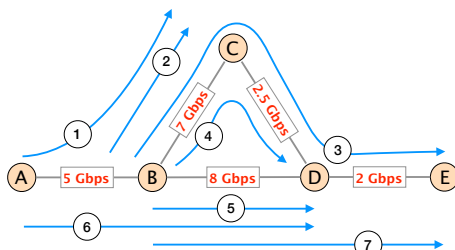


## Communication Networks

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### Exercise 4 - Transport Concepts II

#### 4.1 Fairness

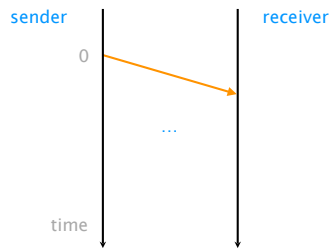


A network with shared links and 7 flows.

Consider the network on the left consisting of 5 nodes (A to E). Each link has a maximal bandwidth indicated in red. 7 flows (1 to 7) are using the network at the same time. You can assume that they have to send a lot of traffic and will use whatever bandwidth they will get. Apply the max-min fair allocation algorithm discussed in the lecture to find a fair bandwidth allocation for each flow. You can use the table below. In the top row, indicate which link is the current bottleneck. The other rows contain the corresponding bandwidth distribution for each flow.

Bottleneck link					
Flow 1 A - B - C					
Flow 2 B - C					
Flow 3 B - C - D - E					
Flow 4 B - C - D					
Flow 5 B - D					
Flow 6 A - B - D					
Flow 7 B - D - E					

## 4.2 Reliable Transport (Exam Style Question)



How long would a transfer take?

Consider a Go-Back-N sender and receiver directly connected by a 10Mbps link with a propagation delay of 100 milliseconds. The retransmission timer is set to 3 seconds and the window has a length of 4 segments.

Draw a time-sequence diagram (see left) showing the transmission of 10 segments (each segment contains 10 000 bits). An ACK is transmitted as soon as the last bit of the corresponding data segment is received. The size of an ACK is very small, that means they have an negligible transmission delay.

- Draw the time-sequence diagram for the case where there are no losses.
- Draw the time-sequence diagram for the case where the 3rd and the last segment are lost once.

## 4.3 Understanding Go-Back-N's Behavior (Exam Style Question)

Assume you have a Go-Back-N (GBN) sender and receiver. The receiver acknowledges *each* data segment with a cumulative ACK which indicates the next expected data segment. Furthermore, it saves out-of-order segments in a buffer. The sender and receiver buffer can contain four segments each. The time-out period is much larger than the time required for the sender to transmit four segments in a row.

- The sender wants to transmit 10 data segments (0,...,9) to the receiver. Assume that *exactly* one segment is lost. How many segments has the sender to transmit in the best (resp. worst) case? For each case, indicate which segment was lost.
- Once again, the sender wants to transmit 10 data segments (0,..., 9) to the receiver. This time, assume that exactly one ACK is lost. How many segments has the sender to transmit in the best (resp. worst) case and which ACK was lost?

- c) Assume the sender just transmitted segments 4, 5, 6 and 7 and is now waiting for ACKs from the receiver. It receives three times an ACK with number 4. Therefore, it cannot remove segments from its buffer and eventually the timeout is reached. Following the GBN protocol, the sender will retransmit all four segments.

A friend of yours explains that she improved her GBN algorithm so that, in the case above, the sender would just retransmit data segment 4 (instead of all four segments). She tells you that, quite often, she would then get an ACK with number 8 back (all four packets were successfully transmitted).

Can you explain why your friend believes that only data segment 4 was missing? Under which network conditions would the proposed improvement *not* work (assuming you still get three times an ACK with number 4)?