

Communication Networks

Prof. Laurent Vanbever

Exercise 3 – Transport Concepts

3.1 Reliable versus Unreliable Transport

In the lecture, you have learned how a reliable transport protocol can be built on top of a best-effort delivery network. However, some applications still use an unreliable transport protocol.

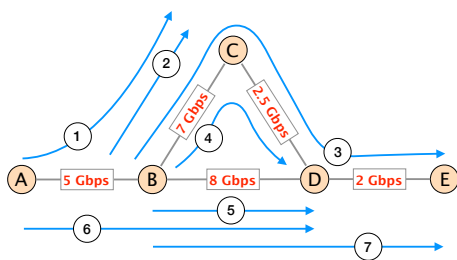
- a) What are the characteristics of best-effort and of reliable transport?
- b) What could be advantages of using an unreliable transport protocol?
- c) What type of applications are suitable to use unreliable transport protocols?
- d) As we will later see, the User Datagram Protocol (UDP) only provides unreliable transport. Assume you are forced to use a network which only supports UDP as a transport protocol. You must transmit an important document which eventually should be correctly transmitted. Do you see a way to implement some of the reliable transport mechanisms despite using UDP?

3.2 Negative Acknowledgments

In the lecture, we have mainly looked at transport protocols using (positive) Acknowledgments (ACKs). However, we could also use so called Negative Acknowledgments (NAKs or NACKs). In this case, the receiver is sending a NAK for every packet that *did not* receive. To detect lost packets, the receiver looks at the sequence numbers of all the received packets and sends NAKs for every missing sequence number. After receiving a NAK, the sender will retransmit the corresponding packet.

- a) Assuming a network with nearly no packet loss, what could be the main advantage of using NAKs?
- b) Assume now that the receiver will immediately send a NAK as soon as it detects a gap in the received packet numbers. E.g. for the following packet number sequence [4, 5, 7] the receiver would immediately send a NAK for packet 6. Can you see a problem with this implementation? How could you (partially) mitigate the problem?
- c) So far, NAKs look like a good alternative to (positive) ACKs. Nonetheless, TCP - the currently most-widely used transport protocol - is *not* using NAKs. There has to be a problem. Assume that the sender is transmitting 5 packets (with sequence number 1 to 5). Find at least two sequences of packet or NAK losses such that the **sender** wrongly assumes that the 5 packets were correctly received.

3.3 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				