TECHNISCHE UNIVERSITÄT BERLIN
Fakultät IV – Elektrotechnik und Informatik
Fachgebiet Intelligente Netze
Julius Schulz-Zander
Susanna Schwarzmann, Marcin Bosk

5th Assignment: Network Protocols and Architectures, WS 20/21

Question 1: $(10 \cdot 4 = 40$ points) *TCP congestion window size*

Consider a TCP connection that uses **TCP Reno** as congestion control algorithm, which results in the congestion window sizes shown in Figure 2.

For simplicity, here we introduce the concept of *transmission round*: We assume that at the start of each round, TCP tries to send as many segments as the size of the congestion window. If it reaches threshold while sending, it stops sending, resets the congestion window to threshold, and waits for acks. Otherwise it sends the entire congestion window and then waits for acks. One transmission round is the time period between sending segments and receiving the corresponding acks. As an example, in the first transmission round, 4 segments are sent and 4 ACKs are received.

Remember that `Threshold` is the limit after which TCP switches from slow start to congestion avoidance.

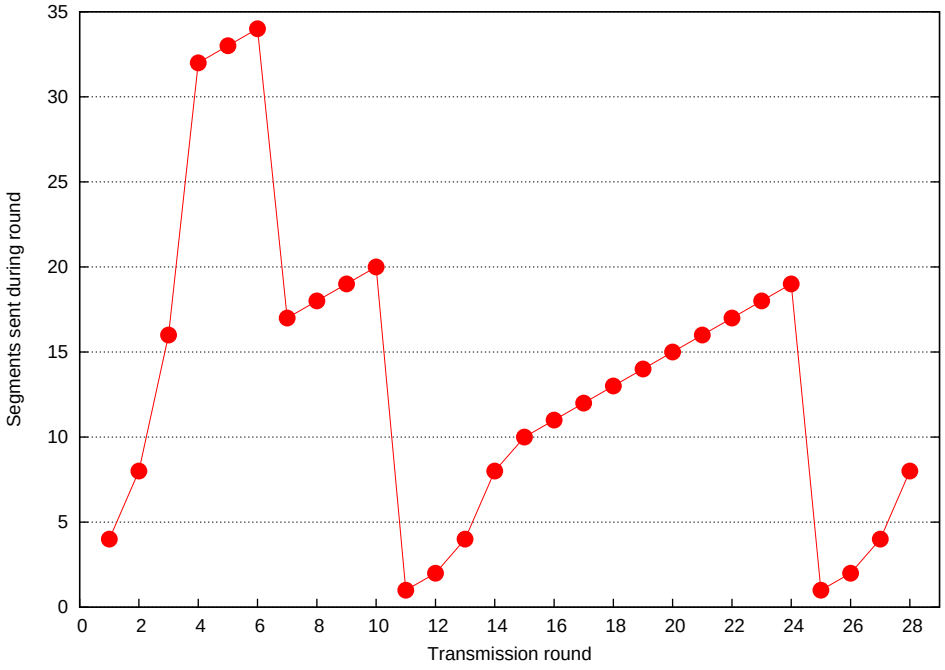

Figure 1: TCP window size as a function of time.

Answer the following questions. In all cases, you should provide a **short explanation** of your answer.

(a) What is the size of the window in the first transmission round?

(b) Identify the time intervals when TCP slow start is operating.

(c) Identify the time intervals when TCP congestion avoidance is used.

(d) After the 6th transmission round, is the segment loss detected by a triple duplicate acknowledgment or by a timeout?

(e) After the 10th transmission round, is the segment loss detected by a triple duplicate acknowledgment or by a timeout?

(f) What is the initial value of `Threshold` at the first transmission round?

(g) What is the value of `Threshold` at the 8th transmission round?

(h) What is the value of `Threshold` at the 12th transmission round?

(i) During which transmission round is the 30th segment sent?

(j) Assuming a packet loss is detected after the 28th round by the reception of a triple duplicate acknowledgement, what will be the values of the congestion window size and `Threshold`?

Question 2: (15 + 15 + 10 = 40 points) *TCP Bottlenecks*

Given is the situation in a network, which is shown in Figure 2. The drawn connections are saturated TCP flows, the total capacity of the links between hosts and routers are given in the illustration. Based on the principle of TCP, assume that the connections share the available capacities in a fair manner. The bandwidth a connection can consume is limited by the used link with the lowest capacity, i.e., the bottleneck. The bandwidth remaining on the links with more capacity (if available) is again split fairly.

Note: There are no bottlenecks outside of the shown network.

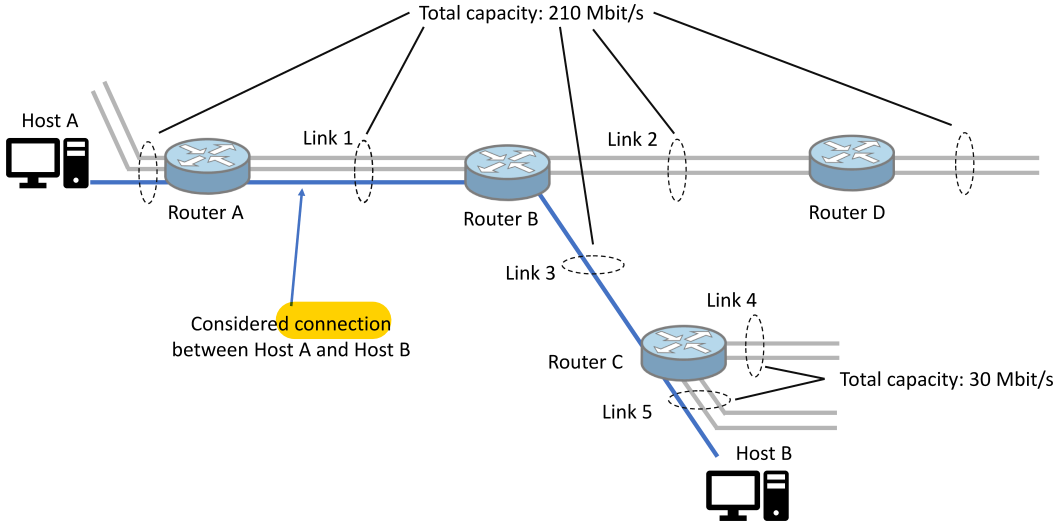

Figure 2: TCP Flows in the network

(a) Consider the blue highlighted connection. Which bandwidth will be provided to this connection? What are the implications for the other connections between Router A and Router B? **Explain your answers briefly.**

(b) Assume that we have the capability to modifiy the total capacity on Link 5. For the rest, all stays as before. How much bandwidth needs to be available on Link 5, so that the blue highlighted connection can obtain the highest possible bandwidth? **Briefly show how you calculated the bandwidth required on Link 5.** Why would an additional expansion of capacity on Link 5 not yield in a higher throughput? **Explain briefly.**

(c) What are the consequences of Link 5's expansion for the connections on Link 1? **Specify the changes in bandwidths on Link 1 for each connection and explain your answer briefly.**

Question 3: $(6 + 4 + 7 + 3 = 20$ points) *IP addresses on your computer*

On most Operating Systems, there are several ways to find out your own IP addresses. On the command line, the `ip address` command (or `ip a` for short) usually works on Linux and Mac OS, `ipconfig /all` usually works on Windows.

(a) Briefly describe the following special IP address types and their purpose (1-2 sentences):

(i) loopback

(ii) multicast

(iii) link-local

(b) Display **all IP addresses (IPv4 and IPv6)** that your computer currently has on **all its interfaces**[1] **on the command line.**

Include both the **command** that you used and the **output** of the command in your solution.

(c) For each address, answer the following questions:

(i) Is this an IPv4 or an IPv6 address?

(ii) Is this a loopback, a link-local, a multicast, a private/local unicast, or a global unicast IP address?

(iii) What subnet size is being used?

(d) Would you say that your current network supports IPv6? Why (not)?

What devices do you assume you can reach over IPv6: Hosts on the Internet, or only within your subnet?

Due Date: Wednesday, December 16th, 2020 11.59 pm (end of day)

- **As PDF files (no MS Office or OpenOffice files)**, uploaded via ISIS: `https://isis.tu-berlin.de/course/view.php?id=21979`
- Put the names and Student ID numbers (Matrikelnummer) of **all** your group members **and** the tutorial slot on your solution!

[1] This includes logical interfaces, such as the loopback interface.