Netzwerke AB01

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Aufgabe 1 - Vuong

Aufgabe 1.1

$$500 \text{ MB} \cdot 8 = 4000 \text{ Mb} \tag{1}$$

$$\begin{aligned}
\text{Transmission Time} &= \frac{\text{Packet Size}}{\text{Bandwidth}} && (2)\\
&= \frac{4000 \text{ Mb}}{50\text{Mb/s}} && (3)\\
&= 80s && (4)
\end{aligned}$$

Aufgabe 1.2

$$\begin{aligned}
\text{Throughput} &= \frac{\text{Packet Size}}{\text{Transmission Time}} && (5)\\
&= \frac{500 \text{ MB}}{80 \text{ s}} && (6)\\
&= 4 \text{ MB/s} && (7)
\end{aligned}$$

Aufgabe 2 - Mandy

Aufgabe 2.1

$$500 \text{ MB} \cdot 8 = 4000 \text{ Mb} \tag{8}$$

$$\begin{aligned}
\text{Transmission Time} &= \frac{\text{Packet Size}}{\text{Bandwidth}} && (9)\\
&= \frac{4000 \text{ Mb}}{50\text{Mb/s}} && (10)\\
&= 80 \text{ s} && (11)
\end{aligned}$$

Aufgabe 2.2

$$\begin{align}
\text{Propagation Delay} &= \frac{\text{Distance}}{\text{Signal Speed}} \tag{12}\\
&= \frac{600 \text{ km}}{200,000 \text{ km/s}} \tag{13}\\
&= 0.003 \text{ s} \tag{14}
\end{align}$$

Aufgabe 2.3

$$\begin{align}
\text{Total Time} &= \text{Transmission Time} + \text{Propagation Delay} \tag{15}\\
&= 80 \text{ s} + 0.003 \text{ s} \tag{16}\\
&= 80.003 \text{ s} \tag{17}
\end{align}$$

Aufgabe 3 - Mandy

Aufgabe 3.1

$$\begin{align}
\text{Data Rate/frame/user} &= 1 \text{ MB/slot} \cdot 2 \text{ slots/frame} \tag{18}\\
&= 2 \text{ MB/frame} \tag{19}\\
\tag{20}\\
\text{Data Rate/user} &= 2 \text{ MB/frame} \cdot 16 \text{ frames/s} \tag{21}\\
&= 32 \text{ MB/s} \tag{22}
\end{align}$$

Aufgabe 3.2

$$\begin{align}
\text{Total Data Rate} &= 1 \text{ MB/slot} \cdot 8 \text{ slots/frame} \cdot 16 \text{ frames/s} \tag{23}\\
&= 128 \text{ MB/s} \tag{24}
\end{align}$$

Aufgabe 3.3

$$\frac{32 \text{ MB}}{2 \text{ MB/frame}} = 16 \text{ frames} = 1 \text{ s} \tag{25}$$

Aufgabe 4 - Mandy

Aufgabe 4.1

$$\begin{aligned}
\text{Propagation Delay} &= \frac{\text{Distance}}{\text{Signal Speed}} && (26)\\
&= \frac{500 \text{ km}}{200,000 \text{ km/s}} && (27)\\
&= 0.0025 \text{ s} && (28)
\end{aligned}$$

Aufgabe 4.2

$$\begin{aligned}
1 \text{ Gbps } \cdot 1000 &= 1000 \text{ Mb/s} && (29)\\
\frac{1000 \text{ Mb/s}}{8} &= 125 \text{ MB/s} && (30)
\end{aligned}$$

$$\begin{aligned}
\text{Stored Data} &= \text{Propagation Delay } \cdot \text{ Data Rate} && (31)\\
&= 0.0025 \text{ s } \cdot 125 \text{ MBps} && (32)\\
&= 0.3125 \text{ MB} && (33)
\end{aligned}$$

Aufgabe 5 - Emily

Smoke signals are a communication method and people used them for gatherings, to warn people from danger and to transmit news. There are records of its use in cities, towers, castles and villages.

Its significance was shown especially during wars. Back then in China, soldiers were stationed at the Great Wall. Along that wall they had beacon towers with a certain distance between each other. The Chinese soldiers would send smoke signals from the top of said towers. By that action, guards within the walls were able to receive the warning and prepare for defense. Additionally, the color of the smoke would indicate the size of the intruder party. Transmitting the message that many enemies are approaching would be signaled through a single column of smoke. Therefore, two columns of smoke would mean the number of enemies is small.

Nowadays, smoke signals are rarely being used, due to the fact that they have been replaced by digital communication. Although they do serve their purpose in the military. Examples of its use would be to highlight an area for a helicopter to land or signaling an aircraft to target a certain area.

All in all, smoke signals played a big part in the past but unfortunately their use decreased overtime.

Aufgabe 6 - Emily

Unicast means sending data from its source to a destination. Which means there is one sender and one receiver involved.

Example: When I send an email. It is meant for only one specific email (receiver).

Broadcasting means data being transmitted at the same time by a single sender to many receivers. Receivers get the same data.

Example: Radio stations broadcast music, ads, news, etc. through radios to a wide audience. In this case the radio station being the single sender and radios being the multiple receivers.

Multicasting is similar to broadcasting. The difference is data being transmitted by a single sender to specific receivers.

Example: Live Streaming: A video is sent as a single multicast stream to all viewers who have subscribed to it.

Anycast means devices in different locations share one IP address. The sender reaches the nearest receiver.

Example: When you first start the game Valorant you will be routed to the nearest server based on your geographic position. It ensures that people from North America will be connected to the NA server and people from Korea will be connected to the Korea server.

Simplex mode is a one way only communication. The data travels from one way to another but is incapable of going the opposite way.

Example: Tv Broadcasting: The sender is reaching an audience but the audience cannot communicate with the sender.

Half-Duplex mode is a mix between Simplex and Full-Duplex. The sender can send and receive data but it is capped by one at a time. Which means there is a delay in communication.

Example: When you talk into a Walkie-Talkie you need to push a button to talk. During that time you cannot receive a message from the other person. After releasing the button you are able to do so.

Full-Duplex mode is a communication that goes both ways and takes place at the same time. There is no delay in communication if we are talking about the best case scenario, that is without interruptions.

Example: Phone calls: During phone calls you talk and receive sound from the other person with no wait.

Aufgabe 7 - Mandy

Chapter 1: Computer Networks and the Internet

In the following 7 problems, we are sending a 30 Mbit MP3 file from a source host to a destination host. All links in the path between source and destination have a transmission rate of 10 Mbps. Assume that the propagation speed is $2 * 10^8$ meters/sec, and the distance between source and destination is 10,000 km.

Aufgabe 7.1

1 Initially suppose there is only one link between source and destination. Also suppose that the entire MP3 file is sent as one packet. The transmission delay is:

- ✔ 3 seconds
- 50 milliseconds
- 3.05 seconds
- none of the above.

Correct.

$$
\begin{aligned}
\text{Transmission Delay} &= \frac{\text{Packet Size}}{\text{Transmission Rate}} && (34)\\
&= \frac{30 \text{ Mb}}{10 \text{ Mb/s}} && (35)\\
&= 3 \text{ s} && (36)
\end{aligned}
$$

Aufgabe 7.2

2 Referring to the above question, the end-to-end delay (transmission delay plus propagation delay) is

- 3 seconds
- ✔ 3.05 seconds
- 6 seconds
- none of the above

Correct.

$$
\frac{2 \cdot 10^8 \text{ m/s}}{1000} = 200,000 \text{ km/s} \tag{37}
$$

$$
\begin{aligned}
\text{Propagation Delay} &= \frac{\text{Distance}}{\text{Signal Speed}} && (38)\\
&= \frac{10,000 \text{ km}}{200,000 \text{ km/s}} && (39)\\
&= 0.05 \text{ s} && (40)
\end{aligned}
$$

$$
\text{End-to-End Delay} = 3.05 \text{ s} \tag{41}
$$

Aufgabe 7.3

3 Referring to the above question, how many bits will the source have transmitted when the first bit arrives at the destination.

- 1 bit
- 30,000,000 bits
- ✔ 500,000 bits
- none of the above

Correct.

$$\begin{aligned}\text{Transmission Rate} \cdot \text{Propagation Delay} &= 10 \text{ Mbps} \cdot 0.05 \text{ s} && (42)\\ &= 0.5 \text{ Mb} && (43)\\ &= 500,000 \text{ bits} && (44)\end{aligned}$$

Aufgabe 7.4

4 Now suppose there are two links between source and destination, with one router connecting the two links. Each link is 5,000 km long. Again suppose the MP3 file is sent as one packet. Suppose there is no congestion, so that the packet is transmitted onto the second link as soon as the router receives the entire packet. The end-to-end delay is

- ✔ 6.05 seconds
- 6.1 seconds
- 3.05 seconds
- none of the above

Correct.

Transmission Delay per Link:

$$\begin{aligned}\text{Transmission Delay} = \frac{\text{Packet Size}}{\text{Transmission Rate}} &= \frac{30 \text{ Mb}}{10 \text{ Mb/s}} && (45)\\ &= 3 \text{ s} && (46)\end{aligned}$$

Propagation Delay per Link:

$$\begin{aligned}\text{Propagation Delay} &= \frac{\text{Distance}}{\text{Signal Speed}} = \frac{5,000\ \text{km}}{200,000\ \text{km/s}} && (47)\\ &= 0.025\ \text{s} && (48)\end{aligned}$$

Because there are 2 links:

$$\begin{aligned}\text{End-to-End Delay} &= \text{Total Delay} \cdot 2 && (49)\\ &= 6.05\ \text{s} && (50)\end{aligned}$$

Aufgabe 7.5

5 Now suppose that the MP3 file is broken into 3 packets, each of 10 Mbits. Ignore headers that may be added to these packets. Also ignore router processing delays. Assuming store and forward packet switching at the router, the total delay is

- 3.05 seconds
- ✔ 4.05 seconds
- 6.05 seconds
- none of the above

Correct.

$$\begin{aligned}\text{Transmission Delay/package/link} &= \frac{10\ \text{Mb}}{10\ \text{Mb/s}} && (51)\\ &= 1\ \text{s} && (52)\end{aligned}$$

The first package is sent to the first link in 1 s. From the router it is sent to its destination which adds another second. We also have to add 2x the propagation delay. Since there are two more packages we have to add 2 s. The propagation delays of these packages overlap with the earlier packet so we don't have to consider those.

$$\begin{aligned}\text{Total Delay} &= 1\ \text{s}\ + 1\ \text{s}\ + 0.05\ \text{s}\ + 1\ \text{s}\ + 1\ \text{s} && (53)\\ &= 4.05\ \text{s} && (54)\end{aligned}$$

Aufgabe 7.6

6 Now suppose there is only one link between source and destination, and there are 10 TDM channels in the link. The MP3 file is sent over one of the channels. The end-to-end delay is

- 300 microseconds
- 30 seconds
- ✔ 30.05 seconds
- none of the above

Correct.

Since we have to divide the 10 Mb/s equally to the 10 TDM channels if there are 10 users at the same time, they each get 1 Mb/s.

$$
\begin{aligned}
\text{Transmission Delay} &= \frac{30\ \text{Mb}}{1\ \text{Mb/s}} && (55)\\
&= 30\ \text{s} && (56)\\
\text{Total Delay} &= 30\ \text{s}\ + 0.05\ \text{s} && (57)\\
&= 30.05\ \text{s} && (58)
\end{aligned}
$$

Aufgabe 7.7

7 Now suppose there is only one link between source and destination, and there are 10 FDM channels in the link. The MP3 file is sent over one of the channels. The end-to-end delay is

- 300 microseconds
- 3 seconds
- ✔ 30.05 seconds
- none of the above

Correct.

FDM divides the 10 Mb/s equally from the start so it is the same as in 7.6.

$$
\begin{aligned}
\text{Transmission Delay} &= \frac{30\ \text{Mb}}{1\ \text{Mb/s}} && (59)\\
&= 30\ \text{s} && (60)\\
\text{Total Delay} &= 30\ \text{s}\ + 0.05\ \text{s} && (61)\\
&= 30.05\ \text{s} && (62)
\end{aligned}
$$

Aufgabe 8 - Emily

Aufgabe 8.1

1 Before sending a packet into a datagram network, the source must determine all of the links that packet will traverse between source and destination.

- True
- ✔ False

Correct.

False, the network layer is in charge of the routes of the packet since every router decides by itself. Host knows where the package should go but doesn't "plan" it.

Aufgabe 8.2

2 Layers four and five of the Internet protocol stack are implemented in the end systems but not in the routers in the network core.

- ✔ True
- False

Correct.

True, there is no need for the other layers since the router is only there to forward packets.

Aufgabe 8.3

3 The Internet provides its applications two types of services, a TDM service and a FDM service.

- True
- False ✓

Correct.

False, the two types of services are UDP and TCP. TDM and FDM are services of circuit switching.

TCP is connection oriented and guarantees the delivery of application layer messages to the destination. It has flow control(sender/receiver speed matching) and when the network is congested, the source will slow down (congestion control).

UDP is connectionless and has no reliability, no flow control and no congestion control.

Aufgabe 8.6

6 Twisted-pair cooper wire is no longer present in computer networks.

- True
- False ✓

Correct.

False, twisted-pair copper wire is still commonly used, for example ethernet.

Aufgabe 8.7

7 Suppose 10 connections traverse the same link of rate 1 Gbps. Suppose that the client access links all have rate 5 Mbps. Then the maximum throughput for each connection is 100 Mbps.

- True
- False ✓

Correct.

False, throughput with multiple links is limited to the slowest link → 5 Mb/s.

Aufgabe 8.8

8 The acronym API in this textbook stands for “Advanced Performance Internet”.

- True
- ✔ False

Correct.

False, API stands for Application Programming Interface. It allows two systems/software applications to communicate with each other.

Aufgabe 8.9

9 Consider a queue preceding a transmission link of rate R. Suppose a packet arrives to the queue periodically every 1/a seconds. Also suppose all packets are of length L. Then the queuing delay is small and bounded as long as aL < R.

- ✔ True
- False

Correct.

True, if L is bigger than R then the queue of packets would keep growing until an overflow occurs where some packets are dropped.

Aufgabe 8.11

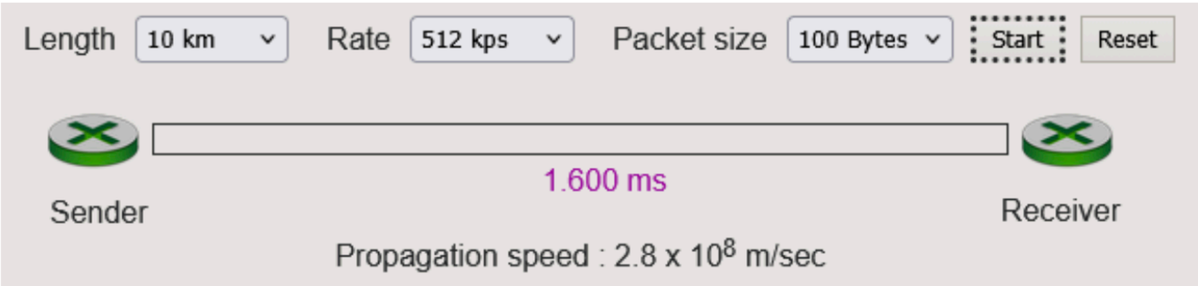
11 Ethernet is a popular residential Internet access technology.

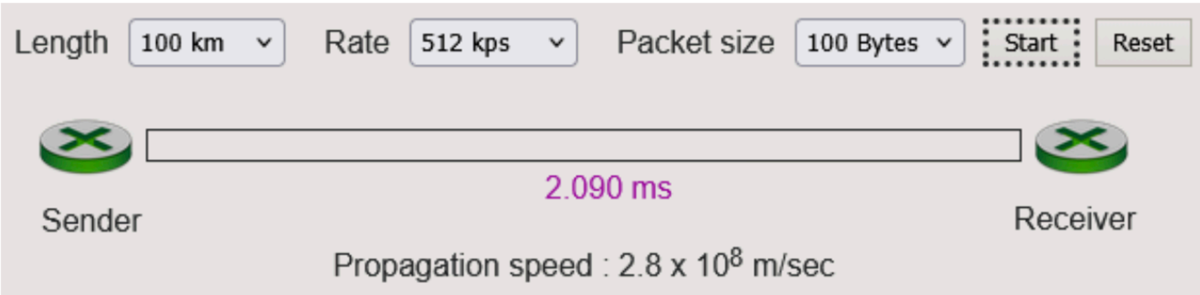
- True
- ✔ False

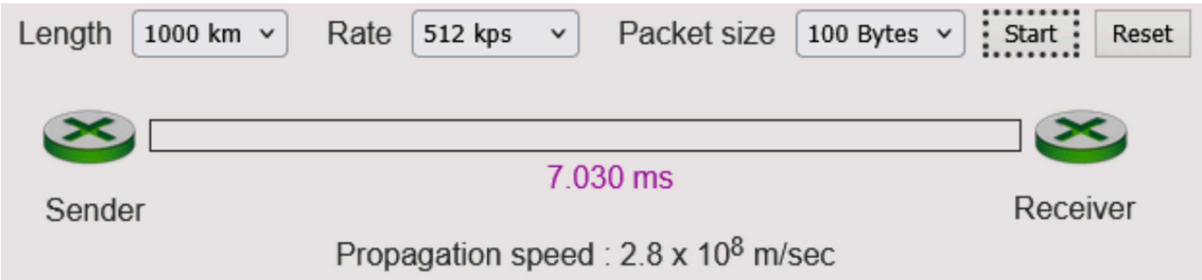
Correct.

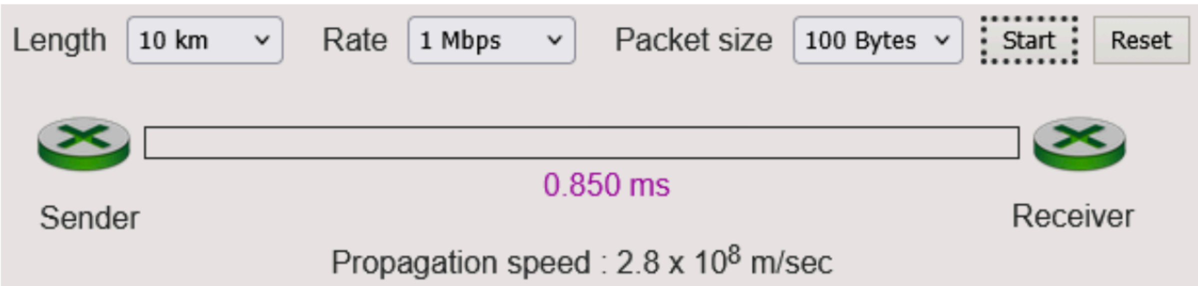
False, Ethernet is a technology for LANs. Popular residential Internet access technologies are DSL, fiber and cable internet.

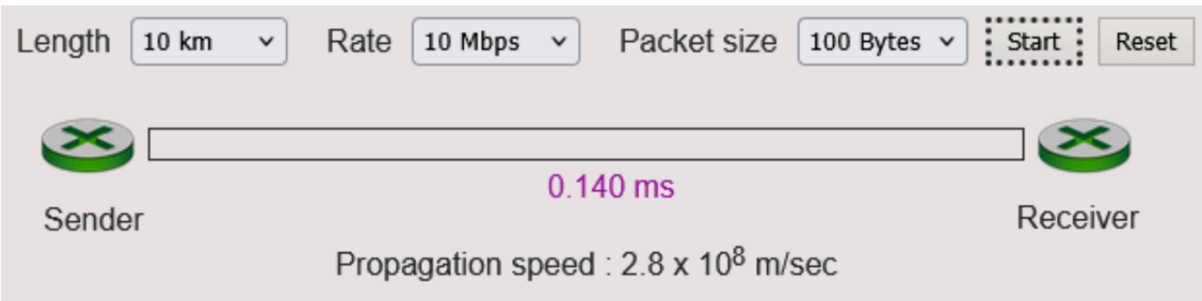
Aufgabe 9 - Vuong

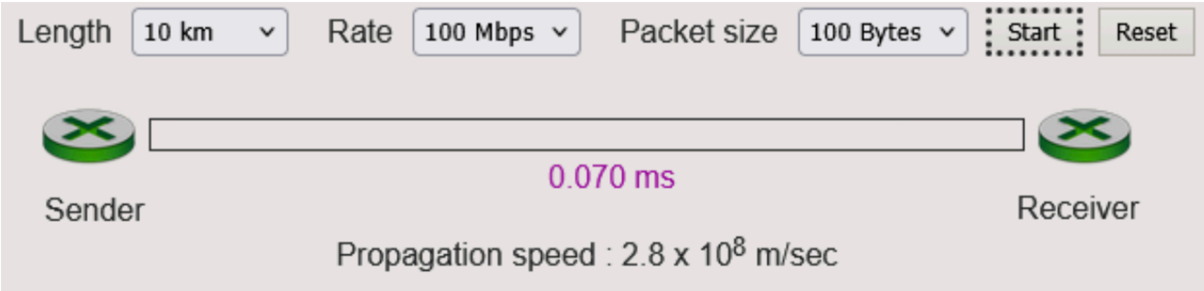


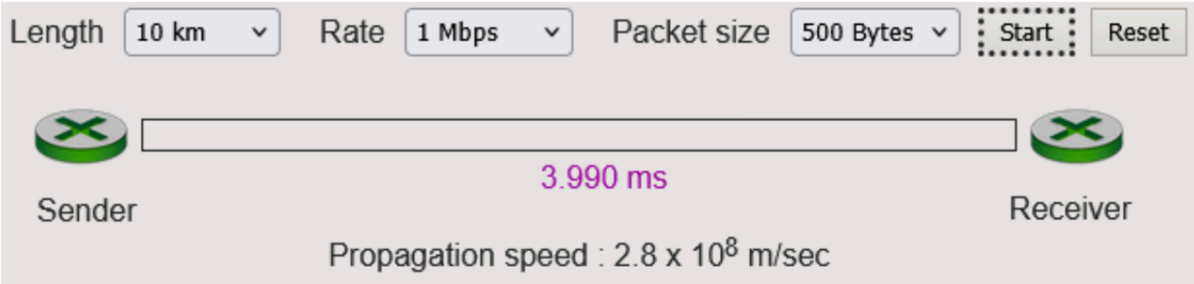


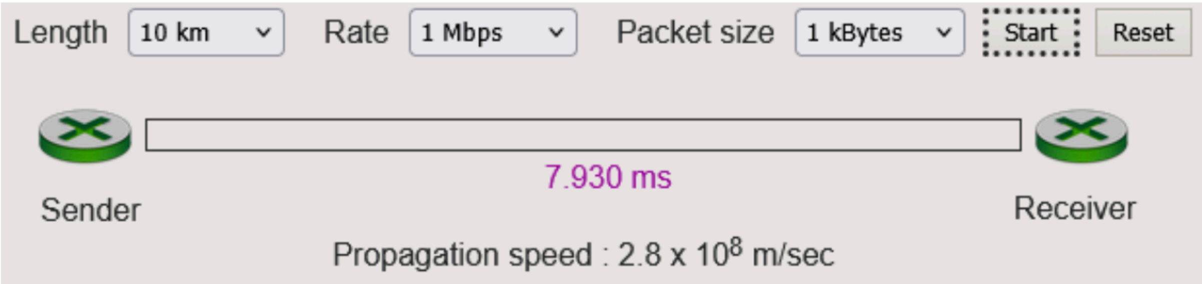


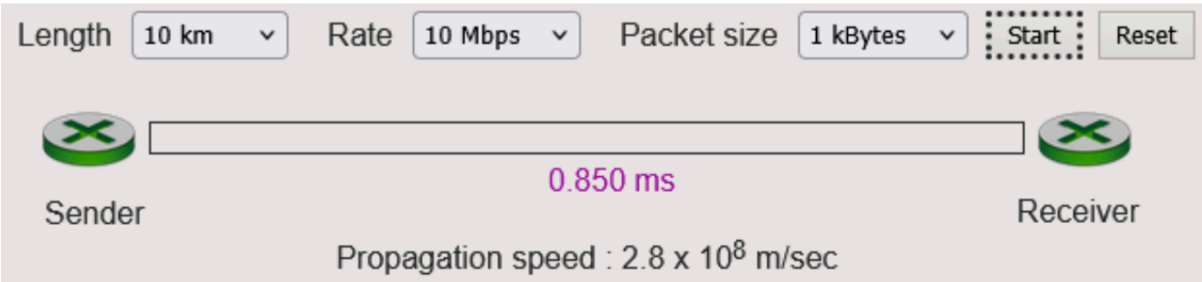


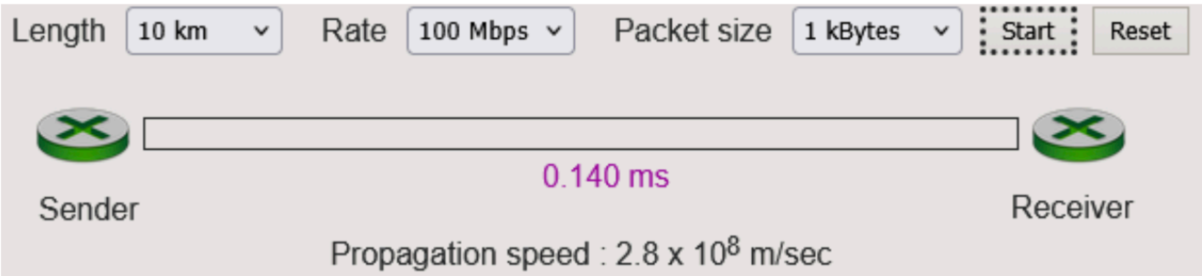










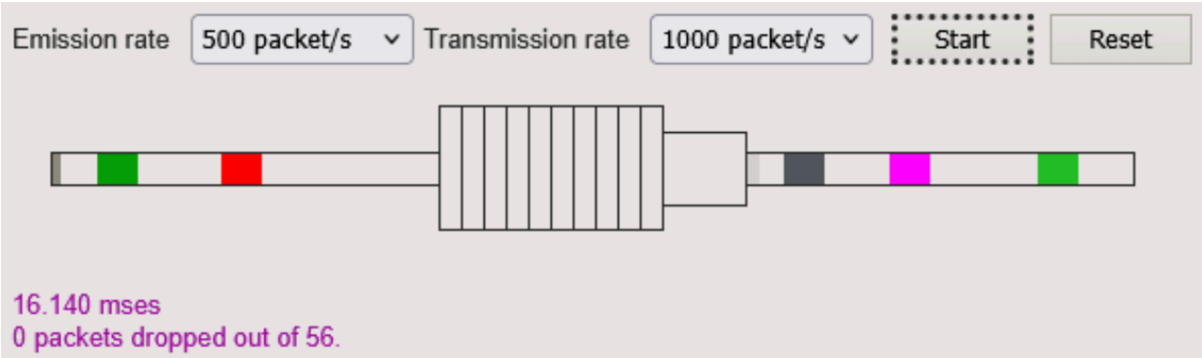


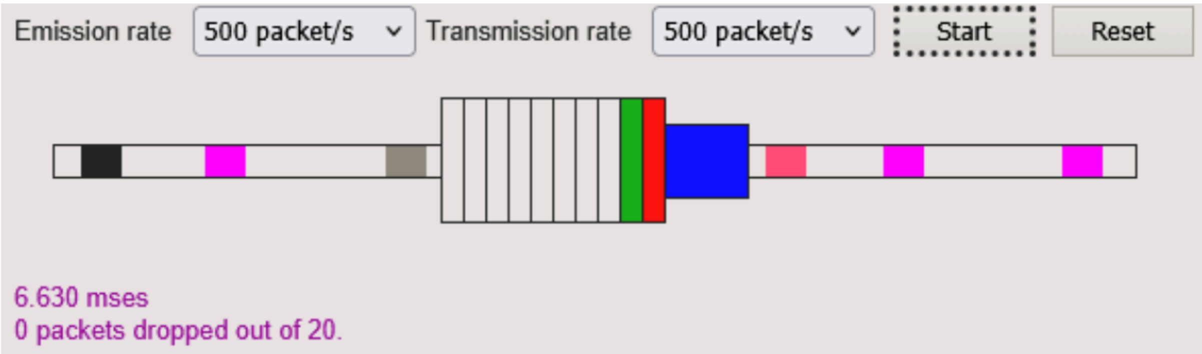
We tested different combinations of link length, data rate and packet size. During the simulation, we could see that there are two types of delays.

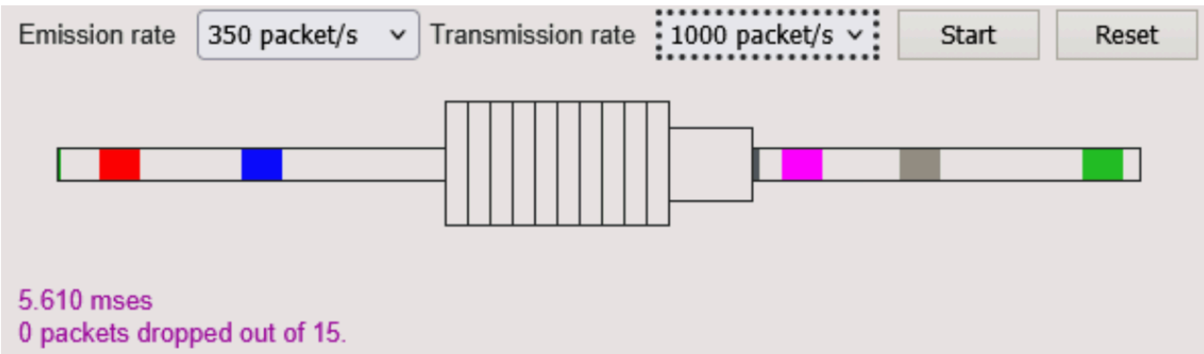
The **Propagation Delay** only depends on the distance between the sender and the receiver. The longer the link, the longer it takes for the signal to arrive. The propagation speed stays constant at $2.8 \cdot 10^8$ m/s. Changing the data rate or the packet size doesn't affect this delay.

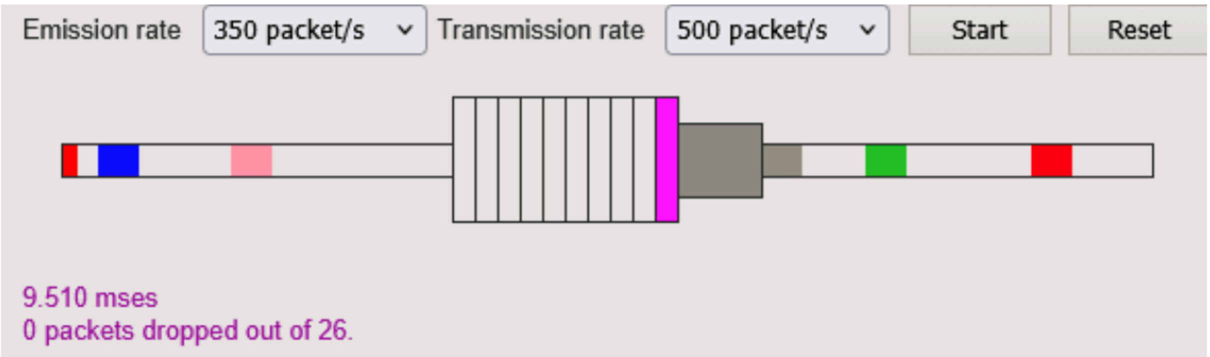
The **Transmission Delay** depends on the packet size and the transmission rate. Larger packets or a slower link take more time, while smaller packets or higher data rates are faster.

Aufgabe 10 - Vuong









We tested six different combinations of emission rate (how many packets are sent per second) and transmission rate (how many packets can be processed or forwarded per second).

When the emission rate ≤ transmission rate, all packets are transmitted successfully and no packets are dropped.

When the emission rate > transmission rate, packets start to queue up in the buffer because they arrive faster than they can be sent. Once the buffer is full, overflow occurs and some packets are dropped.