

Computer Networks

Homework 2

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27.3.2023

Problem 1:

A company has X PB of data it wants to move from Ljubljana to Koper. It decides to use the Amazon Snowmobile, pictured below, as the communication channel. The Snowmobile needs to travel a road of 107 km with a speed of 80 km/h and can carry all the data in one go.

- a) Find the data rate and latency of the (one-time) data transmission via Snowmobile.
- b) How much time in months would sending the data via a 40 Gb/s fiber optic cable take? What is the latency of sending a single bit over the cable, assuming the signal travels at 2/3 the speed of light in vacuum? Assume the road and the cable have the same length.

$$\text{data} = 53 \text{ PB} = 53 * 10^{15} \text{ B}$$

$$\text{distance} = 107 \text{ km} = 107 * 10^3 \text{ m}$$

$$\text{speed} = 80 \text{ km/h} = 80 * 10^3 \text{ m} / 3600 \text{ s} = 22.22 \text{ m/s}$$

- a) $\text{latency} = \text{distance} / \text{speed} = 107 * 10^3 \text{ m} / 22.22 \text{ m/s} = 4815 \text{ s}$
 $\text{data rate} = \text{data} / \text{latency} = 53 * 10^{15} \text{ B} / 4815 \text{ s} = 11.007 \text{ TB/s}$

Answer: The data rate of one-time transmission via Snowmobile is approximately 11 TB/s and the latency is 1h 20min and 15s.

$$\text{data rate fiber} = 40 \text{ Gb/s}$$

$$\text{speed fiber} = 2/3 * c = 2/3 * 3 * 10^8 \text{ m/s} = 2 * 10^8 \text{ m/s}$$

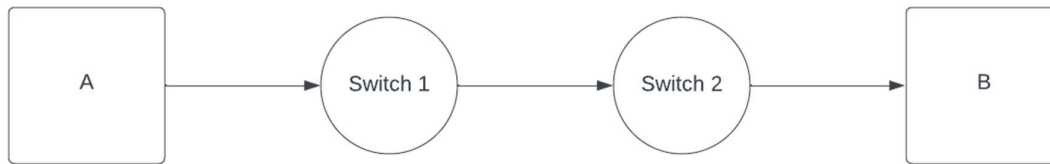
$$\text{distance fiber} = 107 \text{ km} = 107 * 10^3 \text{ m}$$

- b) $\text{time fiber} = \text{data} / \text{data rate fiber} = 53 * 10^{15} * 8 \text{ b} / 40 * 10^9 \text{ b/s} = 10.6 * 10^6 \text{ s} = 4.03 \text{ months}$
 $\text{latency fiber} = \text{distance fiber} / \text{speed fiber} = 107 * 10^3 \text{ m} / 2 * 10^8 \text{ m/s} = 535 \mu\text{s}$

Answer: Sending the same amount of data via a 40 Gb/s fiber optic cable would take about 4 months. The latency of sending a single bit over cable would take 535 microseconds.

Problem 2:

Find the latency, from first bit sent to last bit received, of sending a 2000 bit packet over a 10 Mbps link with two switching elements between the sender and the receiver. Both switching elements implement cut-through switching and forward a packet after reading its first 100 bits. Assume each section of the link introduces a propagation delay of 20 μ s.



data = 2000 b

data head = 100 b

data rate = $10 * 10^6$ b/s = 10 b/ μ s

propagation delay = 20 μ s = $2 * 10^{-6}$ s

time 1 (A to Switch 1) = propagation delay + data head / data rate = 20 μ s + 100 b / 10 b/ μ s = 30 μ s

time 2 (Switch 1 to Switch 2) = time 1 = 30 μ s

time 3 (Switch 2 to B) = propagation delay + data / data rate = 20 μ s + 2000 b / 10 b/ μ s = 220 μ s

latency = time 1 + time 2 + time 3 = 30 μ s + 30 μ s + 220 μ s = 280 μ s

Answer: The latency of first bit sent to last bit received is 280 microseconds.