9.1 General Communication Systems

- Draw the "Shannon-Weaver Communication System" diagram and label the components.
- For each component, describe what it does and how it is affecting the information through the process of communication.

9.2 Weird Communication System

You are transmitting data using quantum coupled 24-side dices. The system works quite easy: If you roll a dice, your friend's dice will show the same side (which is the "symbol"). Rolling a die and detecting which side is on top takes 2 seconds.

- How many bits do you need to map each symbol to a different bitstring?
- How many bits of information does one symbol carry?
- For now assume that you can encode 4 bit in one symbol. What is your data rate?
- How many sides should the die have to achieve 64kbps?
- What would be a better way to increase the data rate?

9.3 Marathon Telecommunications

Remember the Marathon runner from the first lecture. Our goal is to use his running activity to achieve a similar data rate to your home DSL connection (16Mbit/s). He is still running moderate pace of 5min/km for the complete distance of 42km.

- Which size should the hard disk he carries have to achieve the aforementioned data rate?
- Now assume he carries a 16 GB USB stick. Would it be possible for him to achieve the data rate, e.g. by using a bicycle?

9.4 Delays

You are sending packets with maximum size 1500 byte over 1Gbit cables (rate: 1Gbps) with length 1km. The optical fibre operates with speed of light as $(2 \cdot 10^8 \frac{m}{s})$ The responding server takes 1ms to process your order and sends packets with the same size back.

- How large is your transmission delay?
- What is the propagation delay using the optical fibre?
- How long is the RTT measured by your application?

9.5 Web Performance

You download a website with one HTML file (size: 12kB) which contains links to 5 JPG images (size: 100kB each). You have a 16Mbps Internet connection and the one-way-trip time is 10ms. Processing is done instantly ($D_s = 0s$). Teardown is not considered (while closing, you already open the next connection).

- How long does it take until the complete page is loaded using non-persistent connections?
- How long using persistent connections?

9.6 Pipelining Utilization

You are running a pipelining protocol over a channel with RTT 100ms and your goal is to achieve a utilization of 100%. Packets have a size of 1500 Byte, the data rate is 1 Mbps.

- How many packets do you have to send in sequence (before awaiting an ACK) to achieve this goal?