Problems: Ethernet

1. What is the smallest size of an Ethernet frame? What is the largest size of an Ethernet frame?

2. What is the ratio of useful data to the entire frame for the smallest Ethernet frame? What is the ratio for the largest frame?

3. One of the Ethernet standards is called 10Base5. It uses a bus topology and the data rate is 10 Mbps. The speed of propagation in a 10Base5 cable is 2/3 of the speed of light. How long in meters is a bit on a 10Base5 Ethernet?

4. The maximum length of a 10Base5 cable is 500 meters. How long does it take for a bit to travel from the beginning to the end of the network? Ignore any propagation delay in the equipment

5. Using the data in Exercise 4, find the maximum time it takes for a sender to detect a collision. The worst case occurs when data are sent from one end of the cable and the collision happens at the other end. Remember that the signal needs to make a roundtrip.

6. Why do you think that an Ethernet frame should have a minimum data size?

7. Using the data in Exercises 4 and 5, find the minimum size of an Ethernet frame for collision detection to work properly.

8. How long time does it take to create the smallest frame in a 10Base5 Ethernet?

9. A 10 Mbps Ethernet is sometimes said to perform well if the average offered load is no larger than 30% of the network capacity. If the load is larger, the collisions will be so frequent that too much time is spent on collisions, which in turn will result in large queueing delays in the connected computers. Now take a 100 Mbps Ethernet with the same length of the bus as in the 10 Mbps Ethernet examples and with the same offered load, i.e. 30%. Would the proportion of lost time compared to efficient time, be larger or smaller than in the case for the 10 Mbps network?

10. Given the same scenario as in Exercise 9. In order to show the same value regarding the proportion of lost time, how much shorter should the 100 Mbps Ethernet be compared to the 10 Mbps Ethernet?

11. The CSMA/CD protocol is a so-called contention protocol. When does it perform best compared to controlled access protocols (like Token Ring), during low loads or during high loads?

12. Below is an Ethernet-II frame, see lecture notes (slides). The Preamble, Start Frame Delimiter and CRC fields have been removed in the frame below. Two digits represent one byte; e.g. 2E is one byte. The four left-hand side digits (including the colon) and the dashes are *not* parts of the frame.

```
0000:  08 00 20 7c 94 1c 00 00 - 39 51 90 37 08 00 45 00
0010:  00 3e 36 00 00 00 80 11 - da 4f 82 eb 12 7f 82 eb
0020:  12 0a 04 01 00 35 00 2a - ee 6a 00 01 01 00 00 01
0030:  00 00 00 00 00 00 06 67 - 65 6d 69 6e 69 03 6c 64
0040:  63 02 6c 75 02 73 65 00 - 00 01 00 01
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(a) To which MAC-address is the frame addressed?

(b) From which MAC-address does the frame come?

(c) Give an explanation for the remaining field in the Ethernet-II header (PDU Type/Length field).

Solutions: Ethernet

1. Smallest size: 64 bytes (18 bytes header, 46 bytes data)
   Largest size: 1518 bytes (18 bytes header, 1500 bytes data)

2. Ratio of useful data for the smallest packet: $\frac{46}{64} = 0.72$, and for the largest: $\frac{1500}{1518} = 0.99$.

3. Because the sending station must be able to sense a potential collision before the entire frame is sent. Otherwise, in the case of collision, the frame will be discarded in the false belief that the frame has been successfully received by the destination.

4. We assume a propagation speed of $\frac{2}{3} \cdot c$, and use $s = v \cdot t$. The bit length is

$$s = 1 \cdot 10^{-7} \cdot \frac{2}{3} \cdot 3 \cdot 10^8 = 20m.$$

5. Again make use of $s = v \cdot t$;

$$t = \frac{500}{\frac{2}{3} \cdot 3 \cdot 10^8} = 2.5\mu s.$$

6. Worst case means that data has to traverse the entire cable twice (time to collision + time to detection) before the collision is sensed. Thus the requested time is $2 \cdot 2.5\mu s = 5\mu s$.

7. The minimum size is $\frac{2 \cdot 500}{8 \cdot 1 \cdot 10^{-7} \cdot \frac{2}{3} \cdot 3 \cdot 10^8} = 6.25$ bytes.

8. Smallest frame size = 64 bytes = $64 \cdot 8$ bitar. Hence $t = \frac{64 \cdot 8}{10 \cdot 10^6} = 51.2\mu s$.

9. Denote by x the length of the cable. The two LANs will have an equal time to detection (of collision), $t_d = \frac{x}{0.6 \cdot c}$, dependent only on the propagation speed. A packet of length y will however be transmitted in $t_{10} = \frac{y}{10 \cdot 10^6}$ seconds in the 10Mbps LAN, and only in in $t_{100} = \frac{y}{100 \cdot 10^6}$ seconds in the 100 Mbps LAN. The proportion of lost time over effective time will thus be 10 times larger for the 100 Mbps LAN.

10. 10 times shorter.

11. CSMA/CD performs best during low loads. The following scenario is probable during a too high load: A station sends a packet and senses that it collides. It backs off a certain time. As we have a high load, several other stations experience the same thing. They all back off. When their individual backoff times have expired, they attempt to use the medium again. There is now a large probability of new collisions, as several station were previously forced to back off. Practically none gets to send. In the meantime the content of the outbuffer of each station grows, imposing an even higher load.

12. The first 6 bytes is the destination address, 08 00 20 7c 94 1c, the following 6 bytes is the source address, 00 00 39 51 90 37, whereas the consecutive 2 bytes is the PDU Type/Length Field. Everything is written in hexadecimal code so the 08 00 of the PDU Type/Length Field means $8 \cdot 16^2 = 2048$ in decimal notation. $2048 > 1536$ so this field indicates a particular type (not length) of the PDU data. Since the maximum length of an Ethernet frame data is 1500 the limits for the type value (here denoted V) is set acording to

    - $V \leq 1500$: specifies the length of the data
    - $V \geq 1536$: specifies a type of frame
    - $1500 < V < 1536$: undefined