1. Calculate how much time it takes to transfer a 1KByte file from a host A to a host B assuming a direct connection. The requested time is to be understood as the time from the start of transmission of the first bit at host A to the instant in time where the last bit is successfully received by the receiver (Host B).

   Hosts A and B are connected with an Ethernet coaxial cable of 2500m in length. The resulting Rtt is 51.2 μs. The original Ethernet's transmission speed is 10 Mbps.

   Assume that the sending application at host A uses the following protocol stack: **UDP/IP/Ethernet**. Consequently, the file mentioned above will be encapsulated into a UDP datagram/IP packet/ etc. At this point, you might find it convenient to run through the encapsulation/multiplexing hierarchy as we explained it in the lectures. The involved **header sizes** follow:

   - Size of a UDP datagram header is 20 Bytes
   - Size of an IP packet header is 20 Bytes
   - The Ethernet header (Datalink layer, OSI) is comprised of
     - Dest. Address (DST MAC): 6 Bytes
     - Src. Address (SRC MAC): 6 Bytes
     - Ethertype: 2 Bytes
   - Max payload size that can be encapsulated into an Ethernet frame is 1500 Bytes
   - The Physical-layer Ethernet header has two sections:
     - Preamble: 64 bits
     - CRC: 32 bits

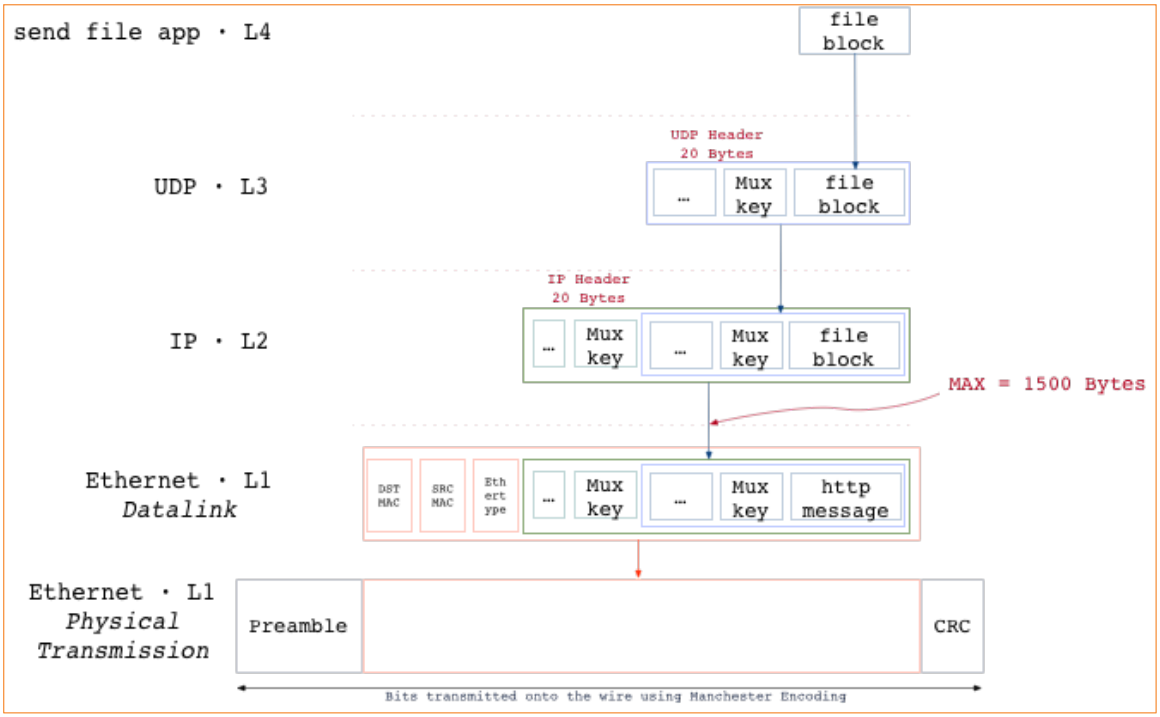

Figure 1. A file block being transmitted onto an Ethernet NIC

The problem statement requests that we calculate the time that it takes transferring the full Ethernet Physical frame from host A to host B assuming both hosts are directly connected (See Figure 2, below).

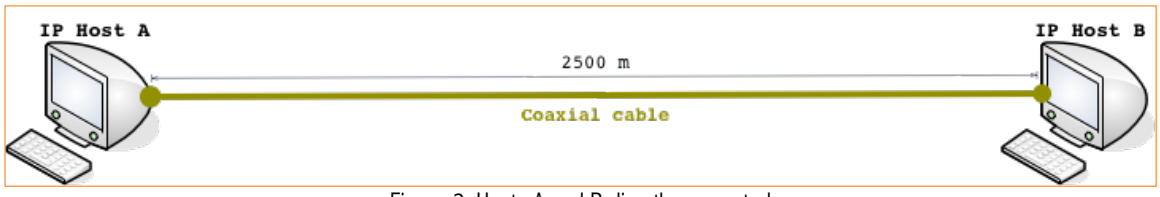

Figure 2. Hosts A and B directly connected

Conceptually, the transfer of a block of bits over a direct connection is depicted in Figure 3; it involves N_{bit} transmission times plus the propagation time (T_p) of the first bit. The geometry of the timing diagram will convince you that this is true: since the transmission time is much smaller than T_p, the transmission of a bit takes place at the same time the previous bit is being propagated. Let's check the precondition to this exercise, *i.e.,* that the Ethernet datalink accepts a maximum transfer unit (MTU) of 1500Bytes.

- 1500B – 20B (IP header) – 20 (UDP header) = 1460 B is the maximum amount of Bytes that our send file application can send in a single block
- Since the file size we are requested to send is $1\text{KB} = 2^{10}\text{ B} = \mathbf{1024\ B} = 1024 \cdot 8\frac{b}{B} = 8192\text{b}$, we can be sure that the transmitter will send the file in a single block.
- Observing Figure 1 (The multiplexing hierarchy upon transmission) we calculate the total number of bits transmitted (On the wire)

$$N_{bit} = file + UDP\ hdr + IP\ hdr + Ethernet\ Datalink\ hdr + Ethernet\ Physical\ hdr$$

$$N_{bit} = 8192\ b + 20B \cdot 8\frac{b}{B} + 20B \cdot 8\frac{b}{B} + 6B \cdot 8\frac{b}{B} + 6B \cdot 8\frac{b}{B} + 2B \cdot 8\frac{b}{B} + 64\ b + 32\ b$$

$$N_{bit} = 8192\ b + 160\ b + 160\ b + 48\ b + 48\ b + 16\ b + 64\ b + 32\ b$$

$$N_{bit} = 8720\ b$$

- The transmission time is the inverse of the transmission speed (10Mbps):
$T_t = \frac{1}{10Mbps} = \frac{1}{10 \cdot 10^6 \frac{1}{s}} = 0{,}1 \cdot 10^{-6}s = 100 \cdot 10^{-9}s = 100\ ns$
- The propagation time is half the Rtt: $T_p = \frac{Rtt}{2} = \frac{51{,}2\ \mu s}{2} = 25{,}6\mu s$
- Applying the formula in Figure 3 we obtain:

$$Total\ transfer\ time = N_{bit} \cdot T_t + T_p$$
$$Total\ transfer\ time = 8720\ b \cdot 100\ \frac{ns}{b} + 25{,}6\mu s$$
$$\mathbf{Total\ transfer\ time = 897{,}6\ \mu s}$$

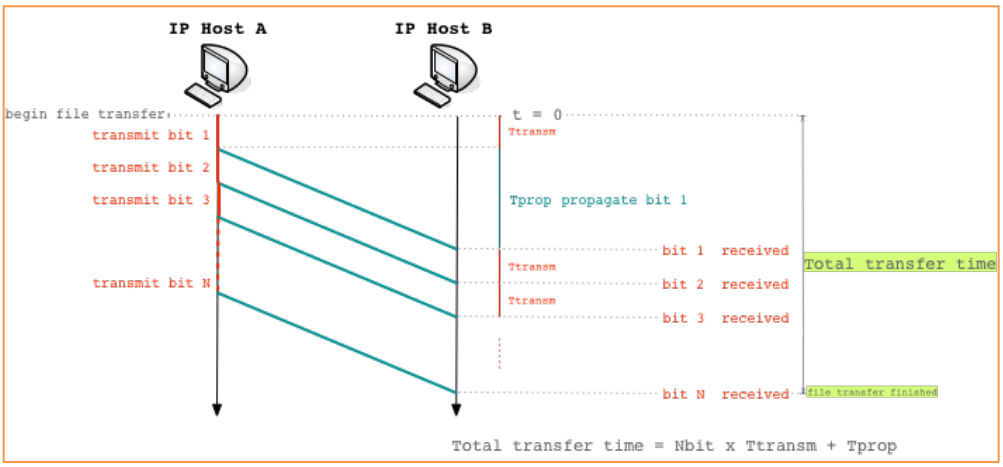

Figure 3. Concept of total transfer time -*observe the formula.*

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2. [M] Of the following statements about STDM (Synchronous Time Division Multiplexing), tick those that are true:

   a. It's one of the multiplexing techniques on which packet switching networks are based
   b. It accepts a prefixed number of flows
   c. If a flow has data available to send, then, the next quantum will not necessarily be used for transmitting a portion of them

This is a multiple-choice question (Observe the capital M within the brackets). In these questions, you are expected to tick ***at least one option.*** *b and c are the correct options in this sample question.*

3. Indicate which of the following statements about Statistical Multiplexing are true:

    a. It's used in networks with continuous traffic
    b. If only one of the flows has data to send, that flow can use the full bandwidth available at the shared link
    c. The maximum number of flows is limited

    *This is a single-choice question (No capital M within brackets). In these questions, you are expected to tick **at most one option.** Options b is the correct response, in this sample question.*

4. What is the connectivity of 4 unconnected networks, each one comprised of 3 hosts?

    a. 24
    b. 32
    c. 36
    d. 18

    This is a single-choice question (No capital M within brackets). Each network has a connectivity of 3 ·2 = 6; since we have 4 networks, the total connectivity is: 4 · 6 = 24. We will tick option a. You must include the calculations leading to the desired result in order to obtain the full credit.

5. [PR] What international institution is responsible for managing the allocation of MAC addresses?

    The indication [PR] means that this question is related to the concepts included in the PRactice labs. The IEEE (Institute of Electrical and Electronics Engineers) is the correct answer.