

- 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 μ s. 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

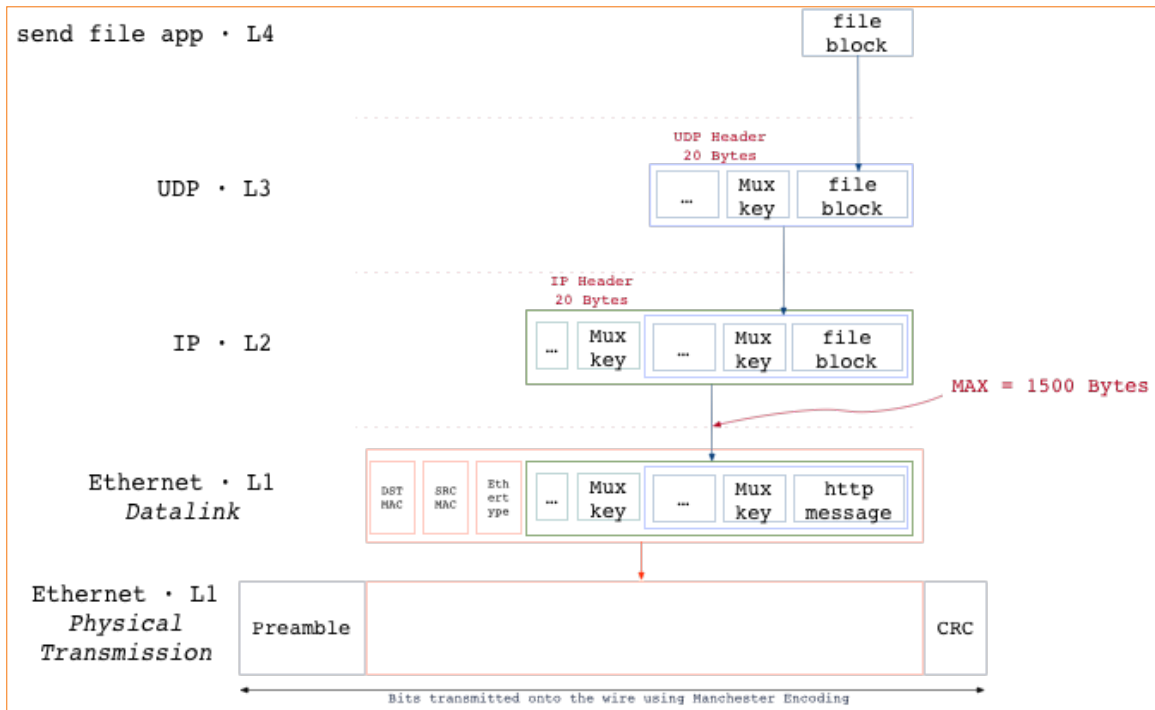


Figure 1. A file block being transmitted onto an Ethernet NIC

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).

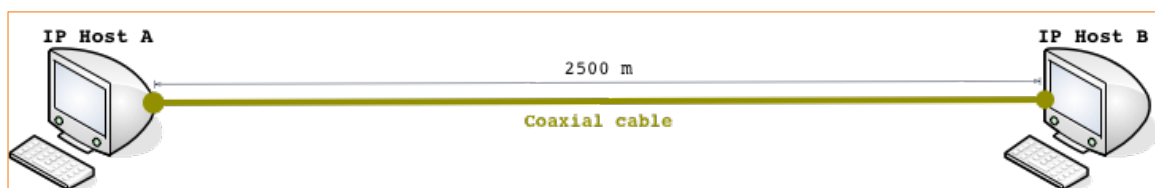


Figure 2. Hosts A and B directly connected

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 $1KB = 2^{10} B = \mathbf{1024 B} = 1024 \cdot 8 \frac{b}{B} = 8192b$, 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:

$$Total\ transfer\ time = N_{bit} \cdot T_t + T_p$$

$$Total\ transfer\ time = 8720\ b \cdot 100 \frac{ns}{b} + 25,6\ \mu s$$

$$Total\ transfer\ time = \mathbf{897,6\ \mu s}$$

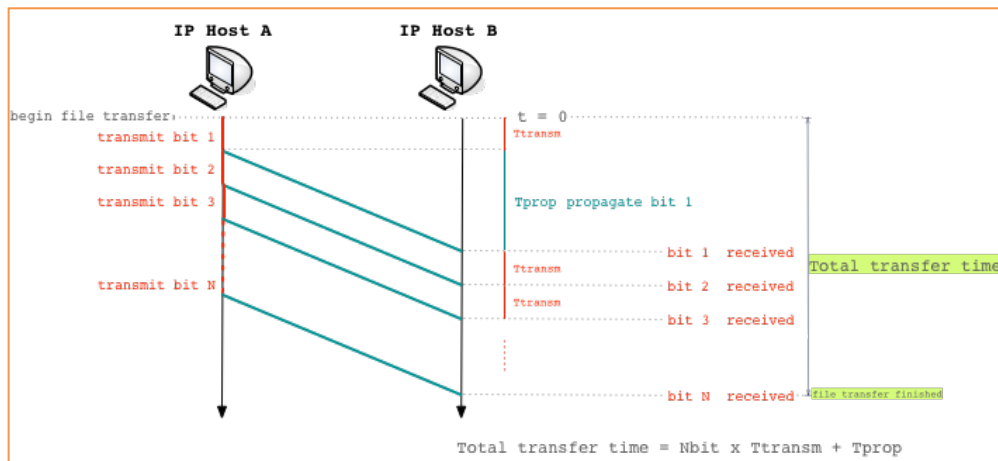


Figure 3. Concept of total transfer time -observe the formula.

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

- It's one of the multiplexing techniques on which packet switching networks are based
- It accepts a prefixed number of flows
- 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:
- It's used in networks with continuous traffic
 - If only one of the flows has data to send, that flow can use the full bandwidth available at the shared link
 - 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**. Option b is the correct response, in this sample question.*

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

- 24
- 32
- 36
- 18

This is a single-choice question (No capital M within brackets). Each network has a connectivity of $3 \cdot 2 = 6$; since we have 4 networks, the total connectivity is: $4 \cdot 6 = 24$. 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.