Exercise 1

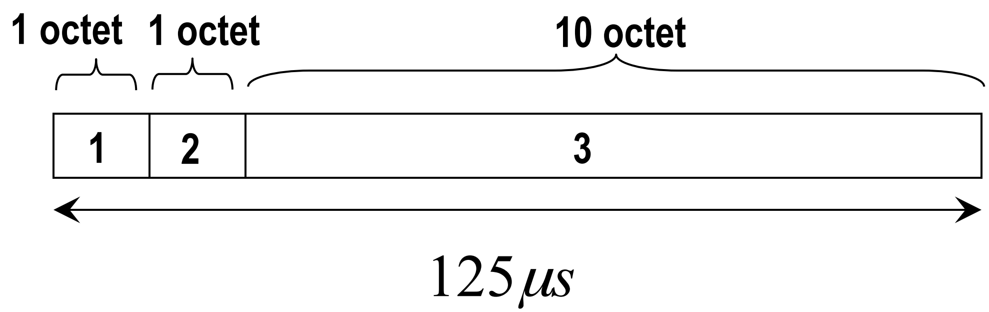
Two sources, each transmitting at 64 kbit/s, and another source transmitting at 640 kbit/s are multiplexed using Time Division Multiplexing (TDM).
Let us assume that multiplexing is performed at the level of a single octet (byte, 8 bit). You need to find:

1) the *structure* of the frame having minimal duration
2) the *duration* of such frame
3) the *transmission rate* of the multiplexer (expressed in kbit/s)

Answer to the same questions above (1, 2 and 3) in the case where multiplexing is performed at the level of a single bit (1 bit).

Exercise 1 - Solution

Structure of the frame (3 time slots, each one for each source) :



$$\text{Frame duration} = \frac{8\ bit}{64\ kbit/s} = 125\mu s$$

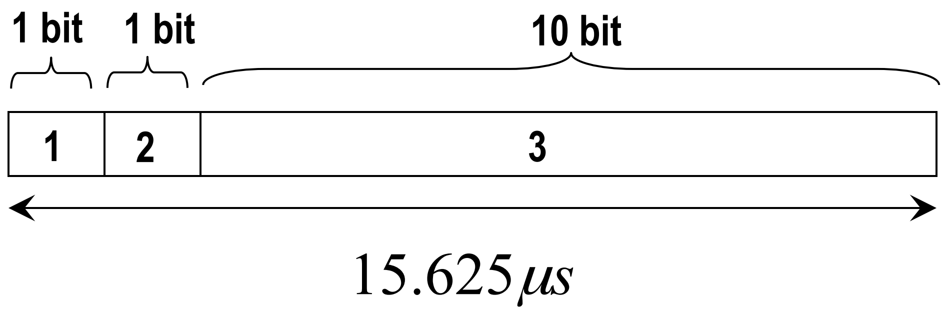
It's the time necessary for the slowest source (the one at 64 kbit/s) to accumulate the 8 bits necessary

$$\text{Transmission rate of the multiplexer} = \frac{12\ byte}{125\ \mu s} = 768\ kbit/s$$

Exercise 1 - Solution

If multiplexing is peformed at the level <u>**of a single bit**</u> **(1 bit).**

Frame structure :



Frame duration = $\dfrac{1\ bit}{64\ kbit/s} = 15.625 \mu s$

Transmission rate of the multiplexer = $\dfrac{12\ bit}{15.625\ \mu s} = 768\ kbit/s$

Exercise 2

A multiplexing system based on TDM is characterized by a frame composed of 10 Time Slots; in each time slot, 128 bits are transmitted. The system is used to multiplex 10 telephone channels, each of which has a transmission rate of 64 kbit/s.

You need to determine the *transmission rate* of the multiplexer and the *duration* of the frame.

Exercise 2 - Solution

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Solution. The transmission rate of the multiplexer is 640 kbit/s (10x64 kbit/s) and the frame duration is (128 bit / 64 kbit/s) = 2 ms.

Alternatively: the frame duration is the time necessary for a telephone source to accumulate the 128 bits necessary: 128/64=2 ms

Exercise 3

A cellular system utilizes a TDMA (Time Division Multiple Access) system for 100 telephone calls (100 channels), each of which transports voice encoded at 32 kbit/s. The cell radius is equal to 300 m, *timing advance* is <u>*not*</u> used, and we want the system to have en efficiency at least equal to 90%.

You need to determine:

- The *guard time* necessary in such system
- The size (expressed in bits) of the *TDMA burst* for each channel
  - (*burst* = number of bits transmitted for each source/ telephone call inside the slot which is reserved to it)
- The frame duration (in seconds)
- The transmission rate of the TDMA multiplexer

The speed of propagation of the signal is equal to 300000 km/s.

Exercise 3 - Solution

The propagation time τ is equal to **τ = 1 μs**, hence the guard time is equal to **2 μs**. The transmission burst must last at least for T, with **$T/(T+2\tau)=0.9$**, which gives **$T=18\tau$**. Therefore:

$\boxed{T = 18\ \mu s.}$

The frame duration D, with T=18μs is hence equal to D=100*(18+2)=2000 μs, hence $\boxed{D=2\ ms.}$

For each bit of each telephone call, the bits of each call/channel (the so called *burst*) are generated during the frame duration. Hence, the number of bits B of a burst is equal to $\boxed{B=32000 \times 0{,}002=64\ \text{bits.}}$

The B bits of each burst must be transmitted at a speed V (to be determined) such that T= 18μs are used. Hence, the transmission rate of the TDMA multiplexer is equal to $\boxed{V=64/18=3.555\ Mb/s}$