

## Data Transmission in the Fourth Dimension.

**Abstract.** Alice wants to send an arbitrary binary word to Bob. We show here that there is no problem for her to do that with only two bits. Of course, we consider here information like a signal in  $4D$ .

### Introduction.

We present here some method (that we call  $4D$ ), taken from [1] for a new kind of data transmissions (with no use of strange quantum physics's phenomenons) that enables to save energy. We will see that under some technical assumptions, this method can also be faster than the classical method. The main paradigm over this work is :

$$TIME = INFORMATION$$

The first basic idea is the following : every (finite) binary information  $M$  can be coded by two bits and time. How to do that ? Well, this word  $M$  represents some information but also a positive number  $n$ . Let us fix a constant  $C$  which is known by the transmitter (Alice) and by the receiver (Bob). First Alice sends a bit (for start) and she starts a chronometer. At some instant  $t < n + C$ , she begins to send a second bit (for stop) and when the chronometer indicates  $n + C$ , she stops this second bit transmission.

For his part, Bob waits for a signal. When he receives a signal that he recognizes to be a bit, he waits for the decreasing front of this bit and then starts a chronometer. Then, he waits for a signal that corresponds to a second bit. He waits again for the decreasing front of this signal and stops the chronometer.

Reading the number  $m$  on his chronometer, Bob can deduce from  $m = n + C$  and his knowledge of  $C$ , the integer  $n$  that he converts in base 2. He obtains the initial message  $M$ .

For an interlude, assume now that one can measure time with an arbitrary real precision. Under this assumption, every finite or infinite information could be sent with two bits and moreover...in bounded time, say in at most 3 seconds! How ? A finite binary word can be completed with zero's to an infinite binary word. Now, every infinite binary word represents also a positive real number  $x$ . There exists an invertible injective mapping  $i : \mathbb{R}^+ \mapsto [0..2]$  :

$$i(x) = \begin{cases} x & \text{if } 0 \leq x < 1 \\ 1 + 1/x & \text{if } x \geq 1 \end{cases}$$

In a similar way than before, Alice sends a high bit signal, waits and sends a second bit signal such that the measurable interval corresponds to  $C + i(x)$  seconds where  $C$  is a known constant. Then Bob can deduce  $x$  from his chronometer and so the initial message  $M$ .

The possible conclusions of this remark are :

optimistic (or naïve ?) : one can code every information with at most 1 second.

pessimistic (or realistic ?) : there exists a limit to the measure of time.

The latter remarks seems to be in adequation with the speed limit of light. However, speed depends on time but also space. Hence speed could be limited by a limit on space but not on time....

## Comparisons.

Let's come back in the real life world. First, let us fix some parameters and assumptions :

- by "unit of time", we mean the least interval of time  $\delta$  that can be measured.
- another key point is that usually, channels of transmission are submitted to noises. Hence in order to recognize a bit signal from this noise, a bit signal must be well formatted. In consequence, in actual architectures, a bit signal must have a minimal duration in order to be recognizable in that noise. Let us denote  $B$ , the minimal duration of a bit signal (in the previous units of time). In general, one can consider that  $B \approx 100$  (and even  $B \approx 1000$ ).
- From the previous model of transmission, one can immediately deduce a necessary condition :  $C > B$  and we will fix  $C \approx B$ . Hence, for the instant  $t < n + C$  when Alice begins her second bit, we will have  $t \leq n + C - B \approx n$ .
- Denote  $E$  the energy used to produce a bit.

What do we mean by a chronometer ? That can be a shift register using for instance  $JK$  flip flops.

What about the transmission in that way of a 64 bits word. Since

$$2^{64} = 18446744073709551616$$

it would be not realistic to wait about  $10^{20}$  units of time for the transmission of a 64 bits word. The solution is to cut such a word in smaller parts, for instance in 8 sub-words of 8 bits. The transmission of 64 bits will then consist in the successive transmissions of eight words of 8 bits. Moreover, one can sequentialize the transmission of successive intervals with the following method : a "stop bit" can be used as a "start bit" for the next information :

This idea generalizes the fact that one word can be sent with two bits. Here,  $k$  words can be sent with  $k + 1$  bits.

## Conclusion.

In conclusion, we have seen some advantages for this  $4D$  method in order to save energy but also time for data transmissions. One can expect to save a factor 8 in energy and a factor 2 in time.

Observe also that the  $4D$  transmission method does not need two kinds of bits signals but only one : the method only uses for instance high level bits. Hence, the voltage used for transmissions can be divided by two.

This  $4D$  method can be adapted for spatial transmissions via satellites with a synchronization management.

The principal possible difficulty for this  $4D$  transmission method comes from the fact that clocks of transmitter and receptor are usually asynchronous and each one can be submitted to variations and/or the transmission speed on the channel can also change. Here are some possible solutions :

- take a unit of time large enough for absorbing these variations.
- use sometimes a synchronization protocol : the transmitter sends his own unit of time between two signals. The receptor converts this value in his own unit and will use this factor for the future conversions.

Since this  $4D$  method is at a very low level, one could expect to use it for networks, even for internet. This method is a technical system for a transmission between one point and another in a graph.

However, an optimal application for this  $4D$  method seems to be in the architecture of computers. Why not use this for a new kind of data BUS ? In that case, the transmitter and receptor both share a common clock. Observe also that of course, this  $4D$  method can be used for parallel transmissions seeing them like serial transmissions on multi channels :