

## ENS III – Activity 1.1

- How would you synchronize (using message passing) two computing systems communicated through a LAN? What precision will be achieved?

The simplest way to synchronize a pair of systems would be assigning the role of “director” to a computer, and this one will be in charge of sending periodic broadcast messages with its local time. Every computer will receive the message with the timestamp which must be used to set its local clock.

The implementation can be done executing remote objects in every computer and offering a method for updating the clock of its corresponding machine. The “director” machine would invoke the remote method of every computer in the network passing the current time. If the architecture used permits a mechanism for broadcast messages, this would be preferred instead of connecting with every machine individually because this would be too expensive.

The precision achieved depends on the network latency, if a machine receives a message indicating it must update the clock to 15:00, we would know that the real time (within the network) is between  $[15:00 - 15:00 + L]$  where  $L$  is the time spent by the message to arrive through the network to the computer.

- How would you synchronize (using message passing) a huge group of computers communicated through Internet? What precision will be achieved?

In a network as Internet, broadcasting messaging is not an option so we have to design a different model. We could think in a layer structure:

Layer 1: One computer acting as the “director”.

Layer 2: Group of privileged computers that can ask the director for current time.

Layer 3: Computers that ask to one or several computers of layer 2 for its current time.

The layer structure would form a taller or smaller tree depending on the number of layers, but a first approach would be done with just three of these.

In this situation we don't have a computer that sends periodically a message demanding a clock actualization, the mechanism is inverted and the computer clients are who ask for the current time periodically.

The implementation would be a remote object in every computer of Layer 1 and 2 (thinking in a 3-layers structure), implementing a method which return the current time.

The precision achieved will depend also on the net's latency, which obviously will be bigger than the first case (LAN connection). The third layer can ask to several computers of the layer two and average the results to get a more precise time.

NOTE: Another approach would be using P2P models for distributing the current time.

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