UNIVERSITAT POLITÈCNICA DE CATALUNYA
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Towards a representation of environmental models using Specification and Description Language

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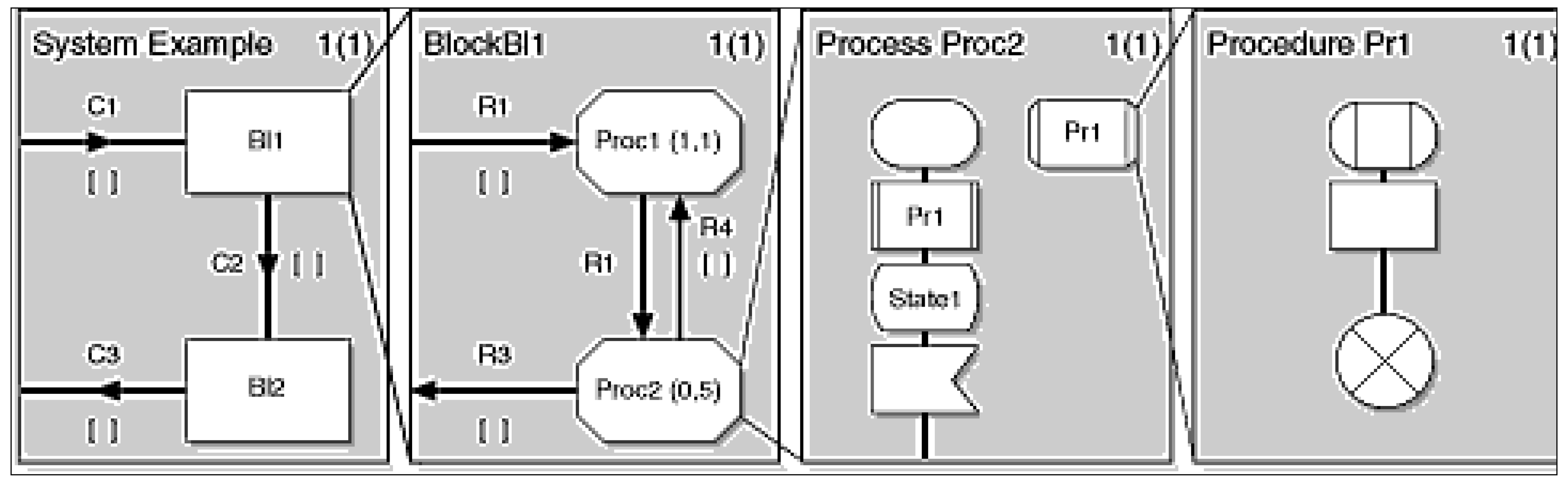
LiAM

To start

This poster explores how we can use Specification and Description Language (SDL) to represent environmental models. From the different phases of a simulation model construction, the formalization phase, sometimes is missed. This phase is needed in order to understand the model before any implementation.

Specification and Description Language

SDL [4] is a modern object oriented language that allows the definition of distributed systems. It has focused on the modeling of reactive, state/event driven systems, and has been standardized by the International Telecommunications Union in the Z.100.



The 4 levels of SDL diagrams: System, Block, Process and Procedure

Our cellular automaton generalization (mnCA^k)

Since the main concern in this kind of models is the representation of geographical information data, we need an structure able to contain all the information needed.

The multi n dimensional cellular automaton (mnCA) [5] is composed by m layers with n dimensions each one. It is defined over a mathematical topological space.

The representation is:

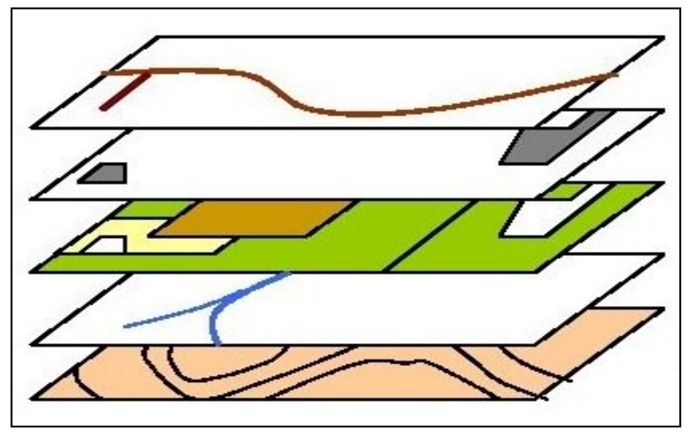
$$m:n-CA^k$$

where:

m: is the automaton number of layers.

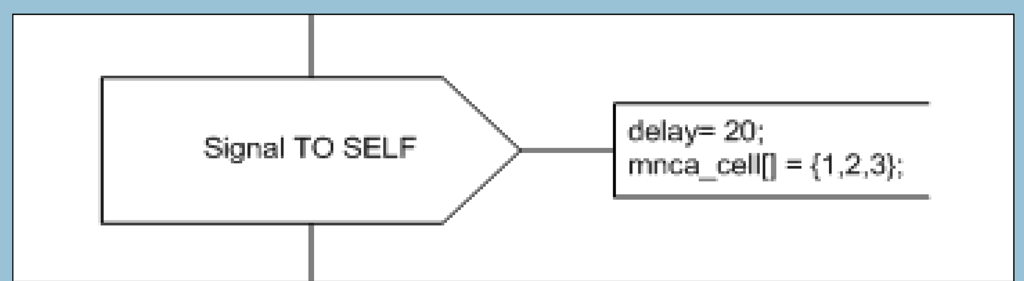
n: is the different layers dimension.

k: is the number of main layers (1 by default).



Our SDL extensions

In order to represent environmental models in SDL is needed to use some extensions. The first extension is used to deal with time since is one of the most important variables in this kind of models. The second is needed to manage with an mnCA.



Extensions to deal with time and multiple layer CA

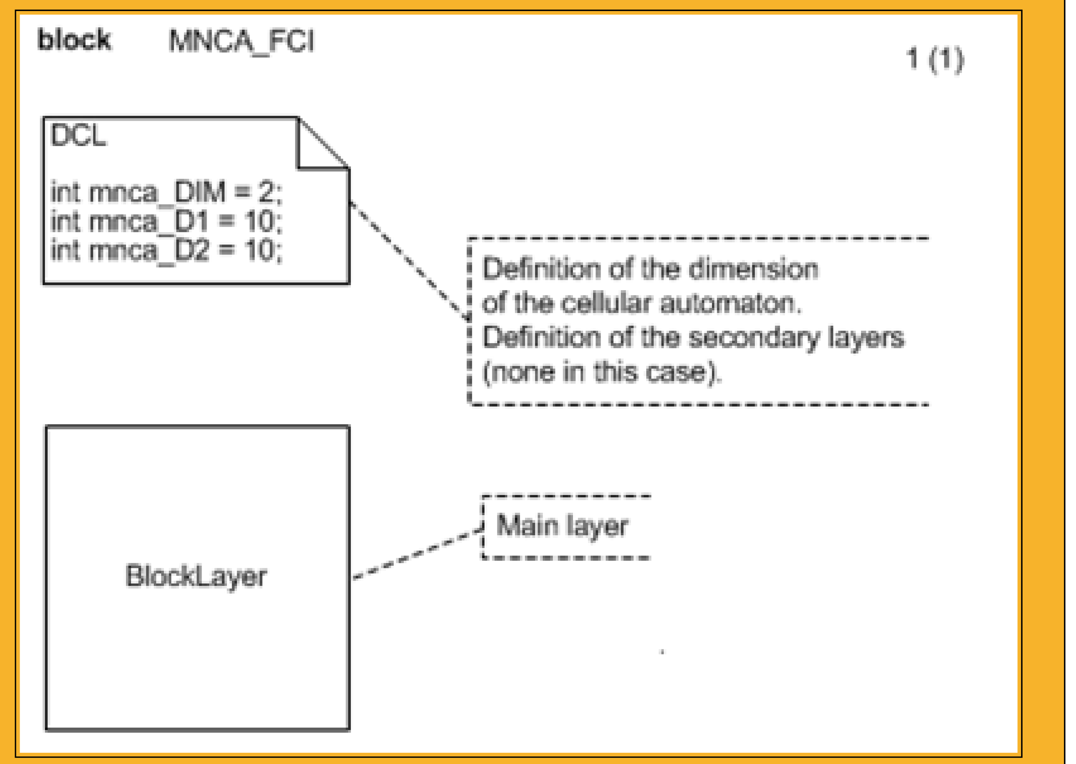
First, we set a delay to represent the time between sending and receiving the signal. This is helpful, for example, to represent the fire propagation time between two cells.

Second, note that the signal is send to the same element (TO SELF). In order to distinguish between the different cells represented in the mnCA we are using the extension mnca_cell[ ]={cells} that defines the cells of the mnCA block that receives the signal.

Fibonacci function model

As a first example we represent CA that calculate the well known Fibonacci function.

This first level of the SDL diagrams, in this case, only contains a single block, representing the CA that implements the Fibonacci function. Next, we must define the structure of this m:n-CA^k cellular automata. First the number of cells (the dimensions), using the DCL (declaration block).



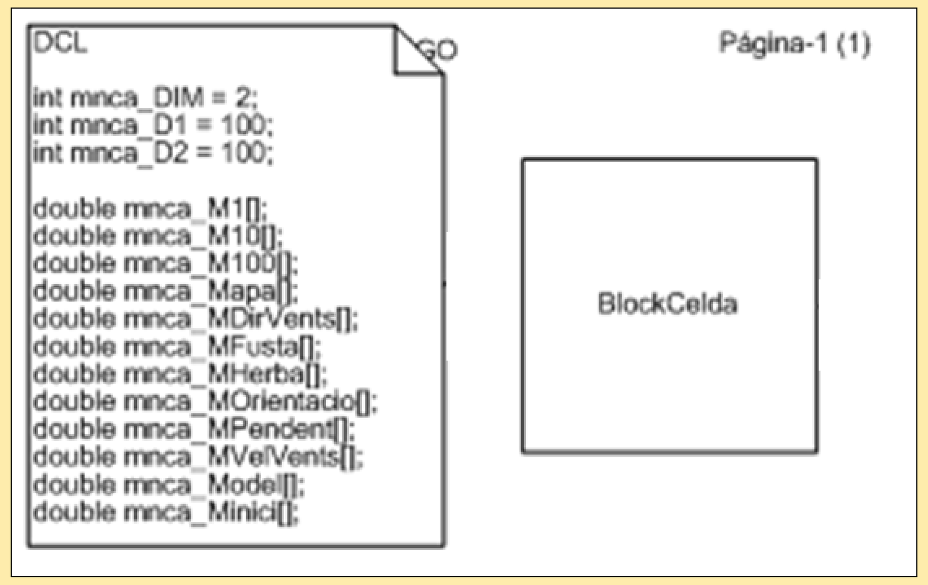
mnCA specification in SDL diagram

On this block, the mnca_DIM variable defines the number of dimensions of the CA, and mnca_D1 to mnca_Dn defines the size of each one of these dimensions. In that case we have a matrix (10x10) as is represented in the figure. *Evolution* function is defined in the *ProcessLayer*, to see its representation [8] can be consulted.

Wildfire model

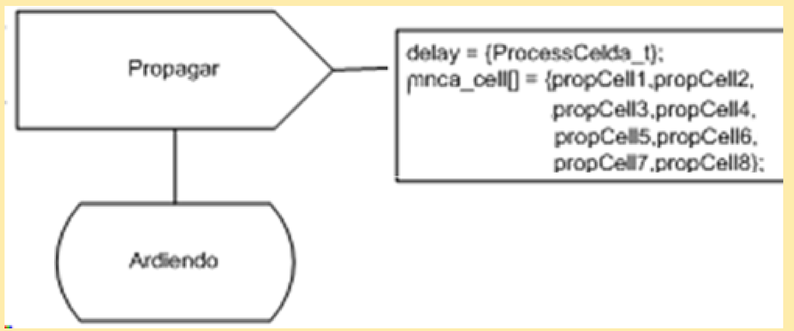
As a second example we show the first diagrams of a wildfire model. In that case we are following behave model to represent the fire spread [1].

It is interesting to remark that since in this model we need different layers we must define them on the DCL block on the mnca block.



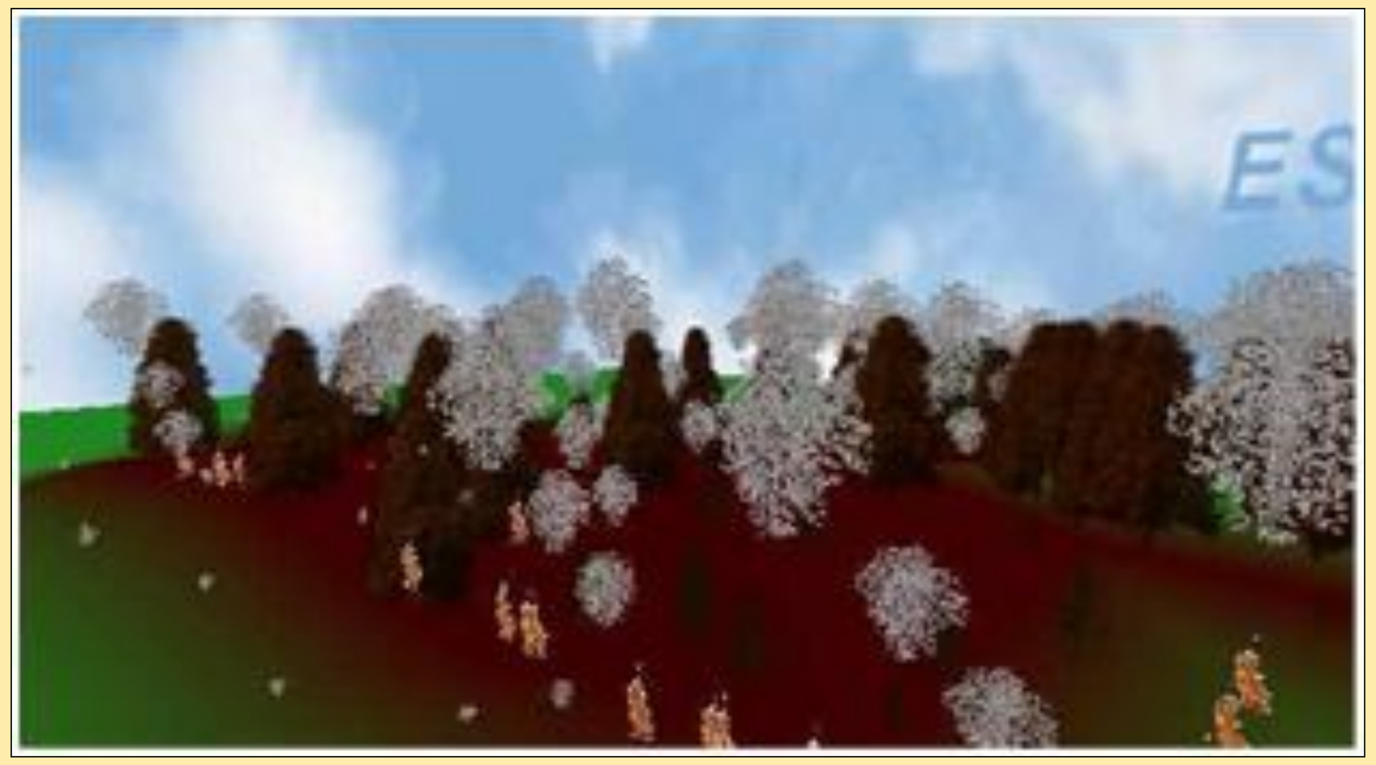
mnCA specification in SDL diagram

Inside the BlockCelda we can find the definition of the behavior of the model. The behavior is defined for one cell since it's the same for all main cells of the mnCA.



On the left we show the aspect of the SEND signal that represents the propagation of the fire to other cells of the cellular automaton

Propagation of the wildfire.



3D Representation of the wild fire mnCA

SDLPS

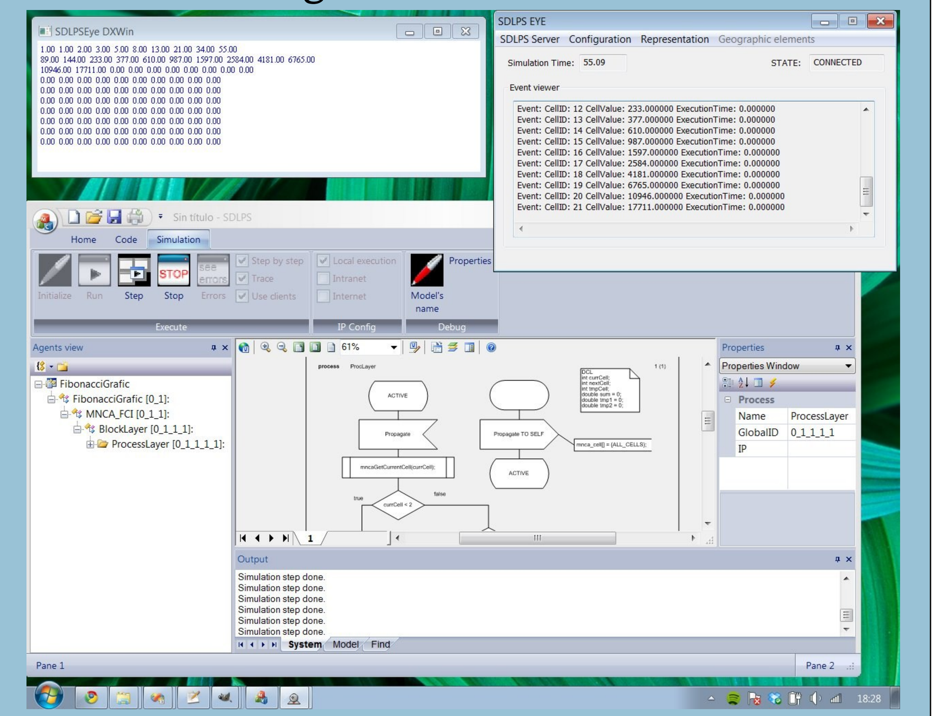
To implement our models we can use different existing tools that understand SDL language, like Cinderella or Telelogic of IBM. We develop our tool in order to improve the existing solutions adding some new capabilities:

i) Allow to work with the delaying signals and CA (as we explained in SDL Extensions).

ii) Allow to work with intelligent agents.

iii)Allow a distributed simulation of the models.

For these reasons we decide to implement our tool named SDLPS [7].



Example of use of SDLPS Aplication

Conclusions and future work

This poster shows how we can model environmental systems using Specification and Description Language. To do this the main concern is how model the behavior of CA graphically using SDL, and how to manage time. Two examples are quoted, a representation of a Fibonacci function over a cellular automaton, and the fire spread following the Behave model. Two proposed extensions to SDL are shown, one to manage time on the SDL signals and other to simplify the representation of the CA structures.

The future work is focused in the verification of the implemented structures on SDLPS and the use of this system on some ongoing real projects involving industrial models or other environmental models like snow avalanche configurations. The representation of those models in a 3D Virtual Reality it's also a working area of the project.

3D Representation of a snow avalanche configuration

References

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