SIMULATION MODELS FORMALIZATION

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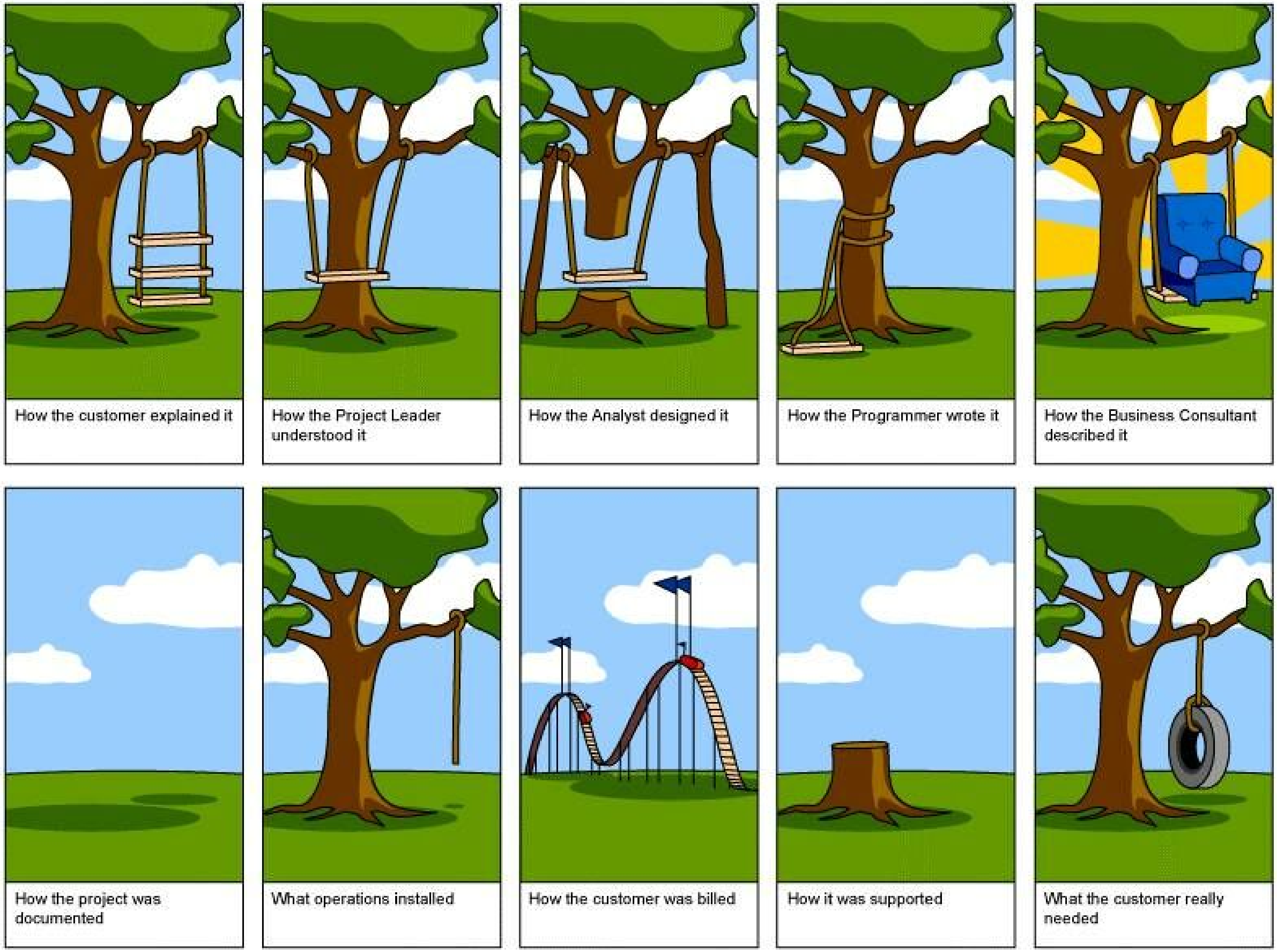
The need of a conceptual model


How the customer explained it
How the Project Leader understood it
How the Analyst designed it
How the Programmer wrote it
How the Business Consultant described it
How the project was documented
What operations installed
How the customer was billed
How it was supported
What the customer really needed

Hypotheses

- What is inside the model?
- Hypotheses
  - Systemic
  - Structural

Advantages of use a conceptual model

- Textual specification is less precise.
- Conceptual model have in a detailed manner, the dynamical relations between the different elements of the interest process.
  - Constitutes an specification by itself.
- Simplifies the dialog between the different parts that are involved in the project.
- Constitutes a representation of the simulation model independent of the selected tool used to build the model.

Conceptual model formalization

- Formalism must be **independent** from the simulation tools.
- The formalized model must **allow** some **analysis.**
  - To **determine relations** between components.

Conceptual model formalization

- Formalism ,must allow an easy transformation to the representations supported by the existing simulation frameworks.
  - Simplify the implementation process.
  - To evaluate alternatives.

Conceptual model formalization

- Some aspects of the model can be no specified, without causing problems in the transformation to other representations. MODULARITY
- The model must be defined in terms that **no constrain** its codification in a **particular mechanism** of simulation **clock update**.

Modularity

- The capacity to describe the behavior of each subsystem, independent from the other subsystems that compose the model
  - Incremental design of the model.
  - Simplifies the verification and the validation of the model.
  - Each different stage → implementation stage.

Assure the Modularity

1. A module cannot access directly to the state of other modules or components.
2. A module must own a set of ports (input/output) to allow the interaction with the other parts of the model.

Conceptual models

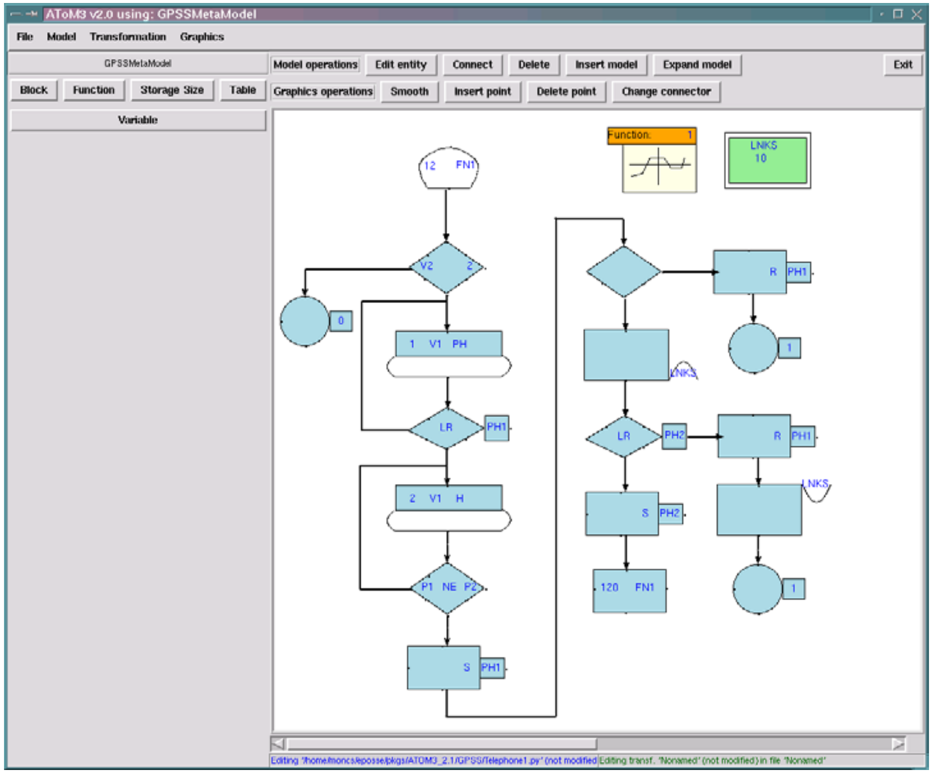
- Flow models.
- Queue networks.
- Petri nets
- Colored Petri nets.
- SDL language
- DEVS
- Causal and Forrester diagrams.

Working with different formal languages

- Three of the main mechanisms for doing this:
  - Meta-formalism.
  - Common formalism.
  - Co-simulation.
- Vangheluwe, H. L. (2000). DEVS as a common denominator for multi-formalism hybrid systems modelling. *IEEE International Symposium on Computer-Aided Control System Design* (pp. 129--134). IEEE Computer Society Press.

Meta-formalism

- A formalism that incorporates the different formalisms of the various sub models that makes up the system.
- ATOM3: http://atom3.cs.mcgill.ca/



Editing '/home/moncs/eposse/pkgs/ATOM3_2.1/GPSS/Telephone1.py' (not modified

Editing transf. 'Nonamed' (not modified) in file 'Nonamed'

Common formalism

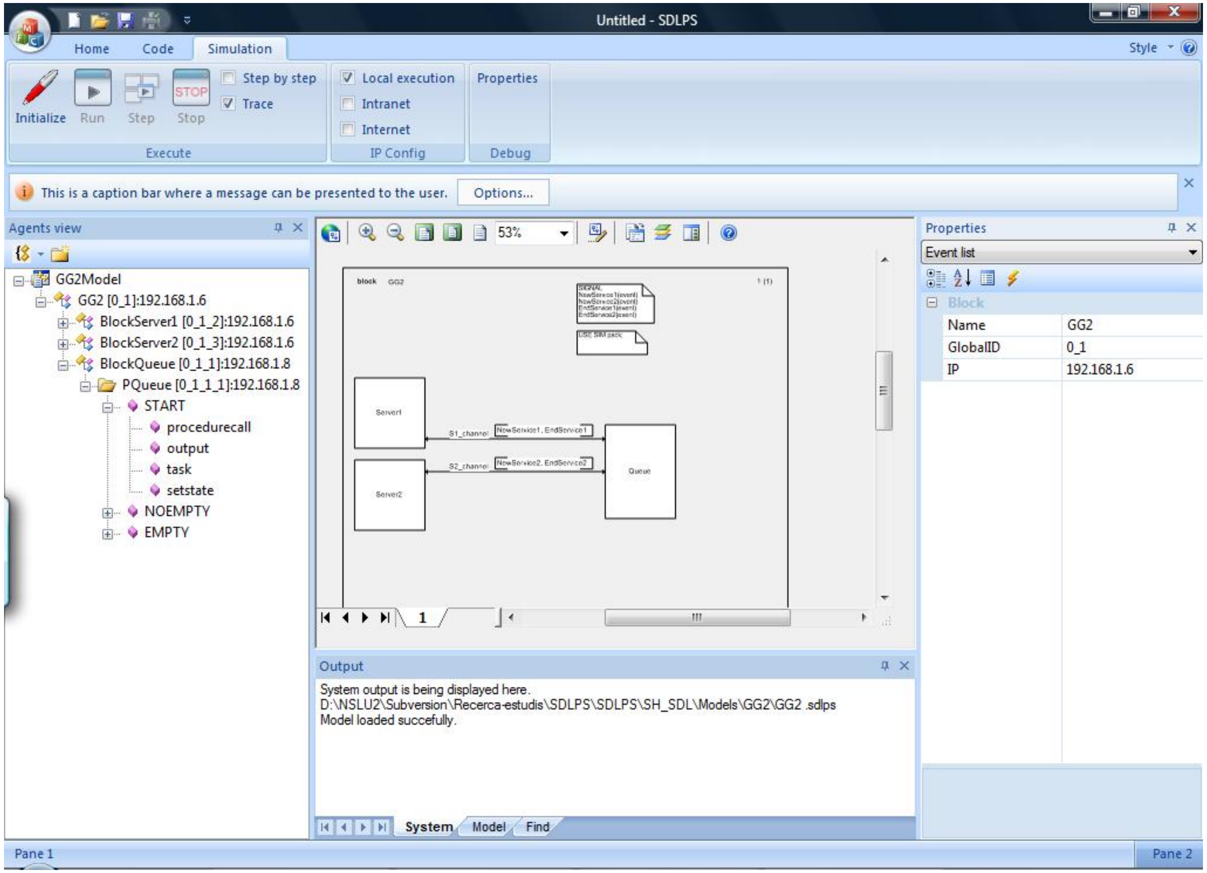
- A mechanism that converts all formalisms to a common formalism.
- Transforming algorithms from:
  - SDL→DEVS→Petri Nets…

Co-simulation

- Independent simulators that work together
- HLA: The **High Level Architecture** (**HLA**) is a general purpose architecture for distributed computer simulation systems. Using HLA, computer simulations can interact (that is, to communicate data, and to synchronize actions) to other computer simulations regardless of the computing platforms. The interaction between simulations is managed by a Run-Time Infrastructure (RTI).

Co-simulation with SDL

- We use SDLPS (on the practical sessions)



☐ Step by step
☑ Trace

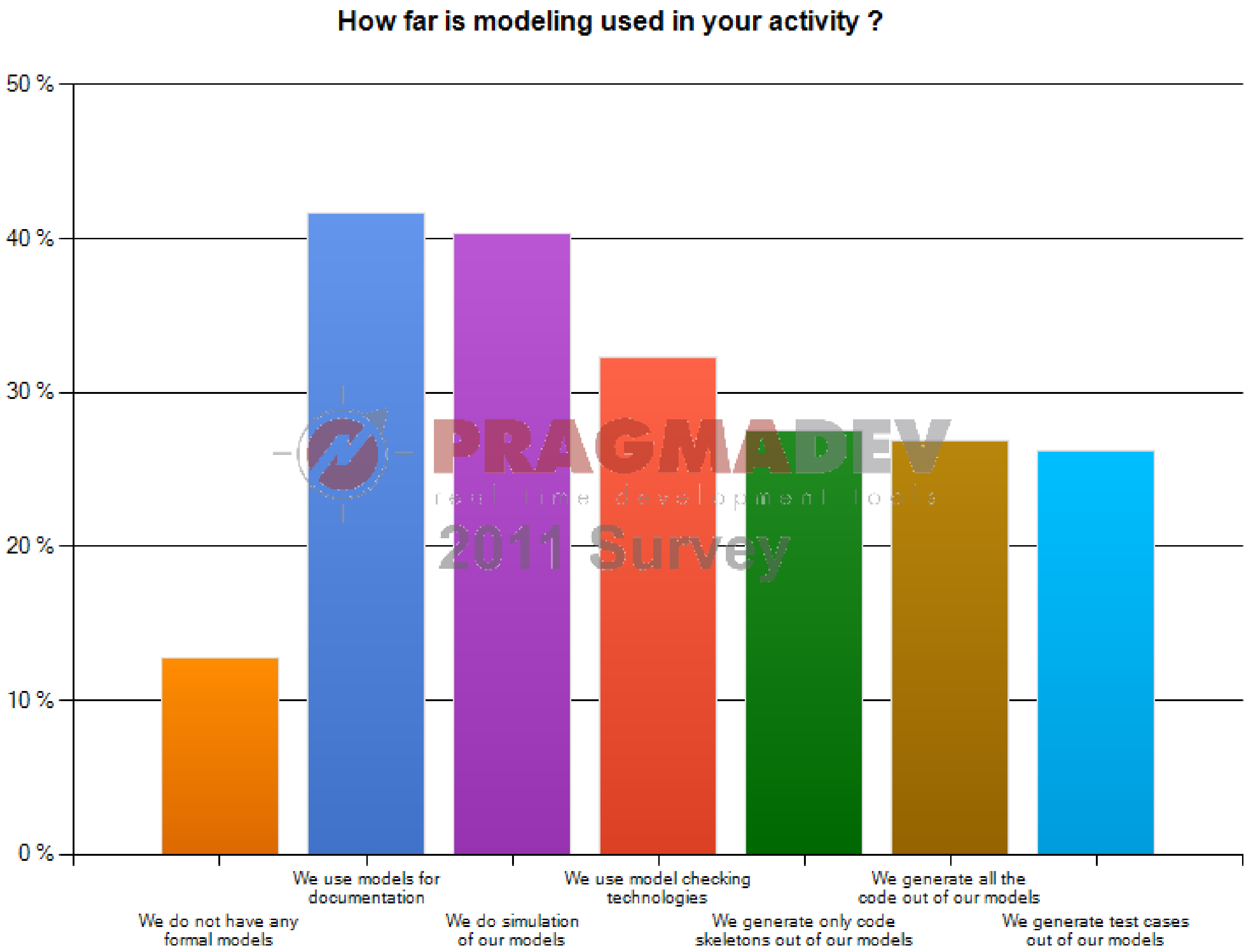
☑ Local execution
☐ Intranet
☐ Internet

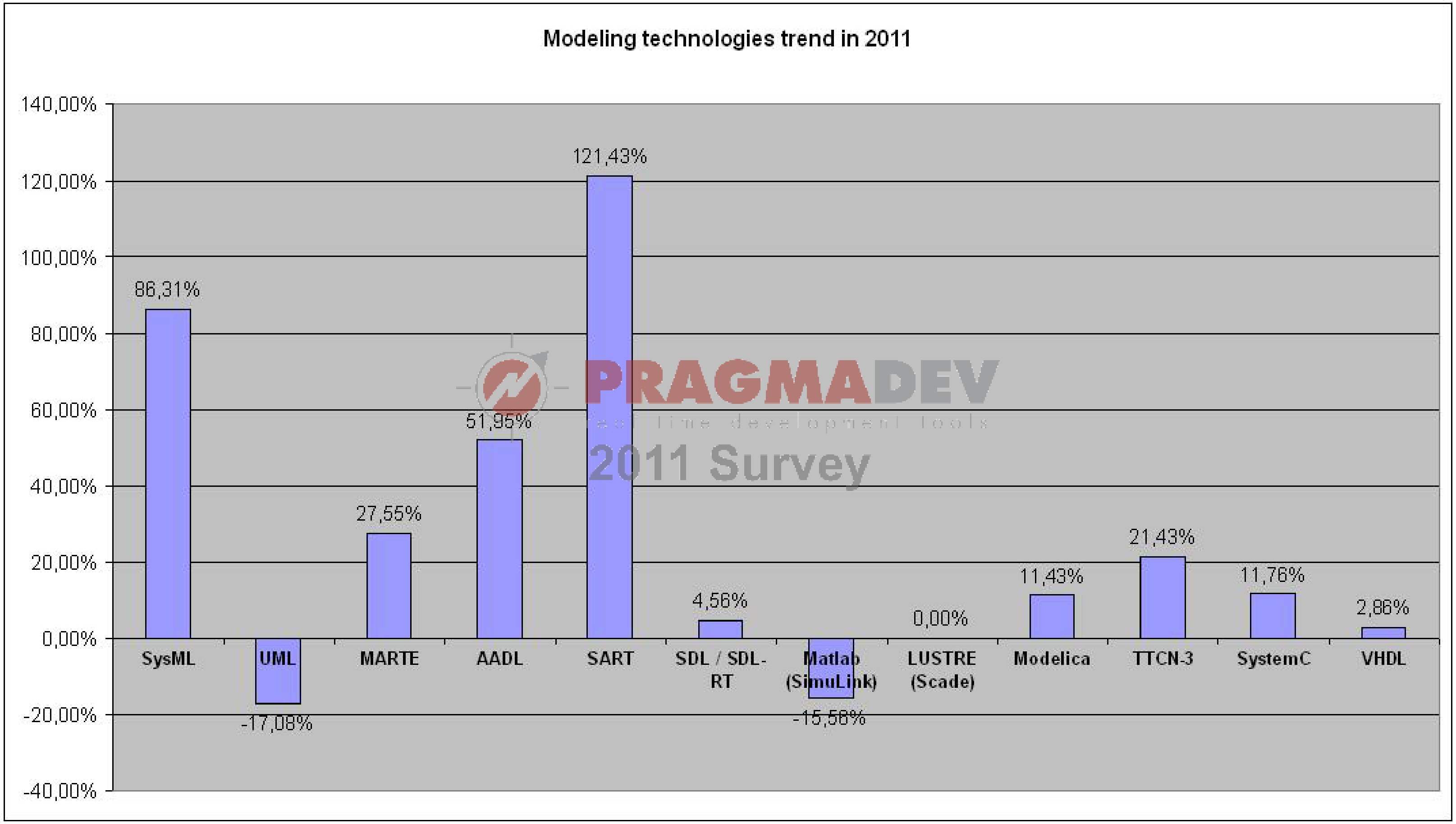
This is a caption bar where a message can be presented to the user. Options...

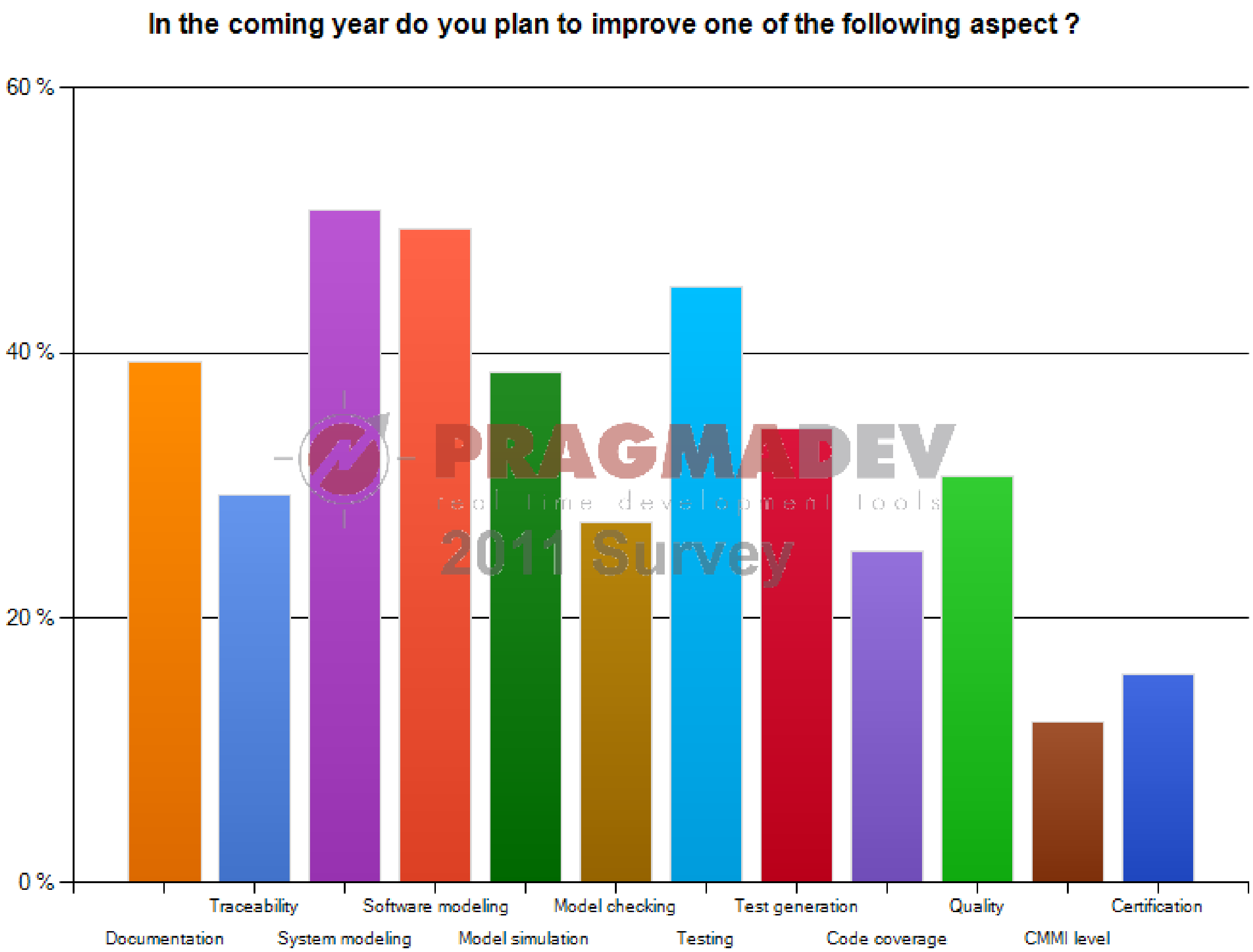
Name	GG2
GlobalID	0_1
IP	192.168.1.6

```
System output is being displayed here.
D:\NSLU2\Subversion\Recerca-estudis\SDLPS\SDLPS\SH_SDL\Models\GG2\GG2 .sdlps
Model loaded succefully.
```

Some data


How far is modeling used in your activity ?
50 %
40 %
30 %
20 %
10 %
0 %
We do not have any formal models
We use models for documentation
We do simulation of our models
We use model checking technologies
We generate only code skeletons out of our models
We generate all the code out of our models
We generate test cases out of our models
PRAGMADEV
real time development tools
2011 Survey

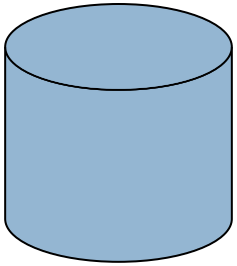

Modeling technologies trend in 2011
140,00%
120,00%
100,00%
80,00%
60,00%
40,00%
20,00%
0,00%
-20,00%
-40,00%
86,31%
-17,08%
27,55%
51,95%
121,43%
4,56%
-15,58%
0,00%
11,43%
21,43%
11,76%
2,86%
SysML
UML
MARTE
AADL
SART
SDL / SDL-RT
Matlab (SimuLink)
LUSTRE (Scade)
Modelica
TTCN-3
SystemC
VHDL
PRAGMADEV
real time development tools
2011 Survey


In the coming year do you plan to improve one of the following aspect ?
60 %
40 %
20 %
0 %
Documentation
Traceability
System modeling
Software modeling
Model simulation
Model checking
Testing
Test generation
Code coverage
Quality
CMMI level
Certification

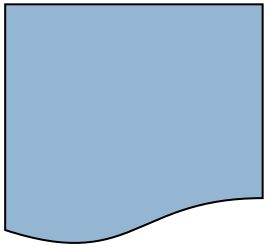
Flow models

Simulation models formalization

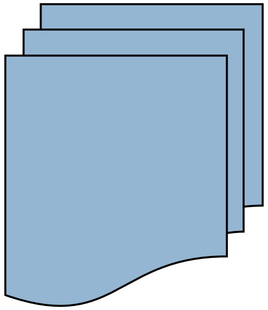
Flow models (data)



- □ Magnetic disc

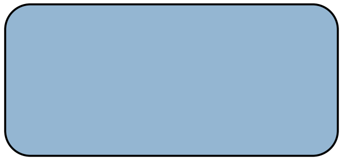


- □ Document

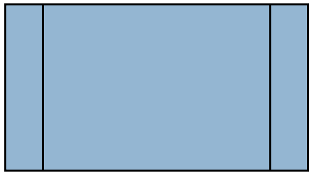


- □ Multiple document

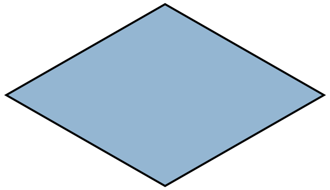
Flows models (Processes)



- State



- Process

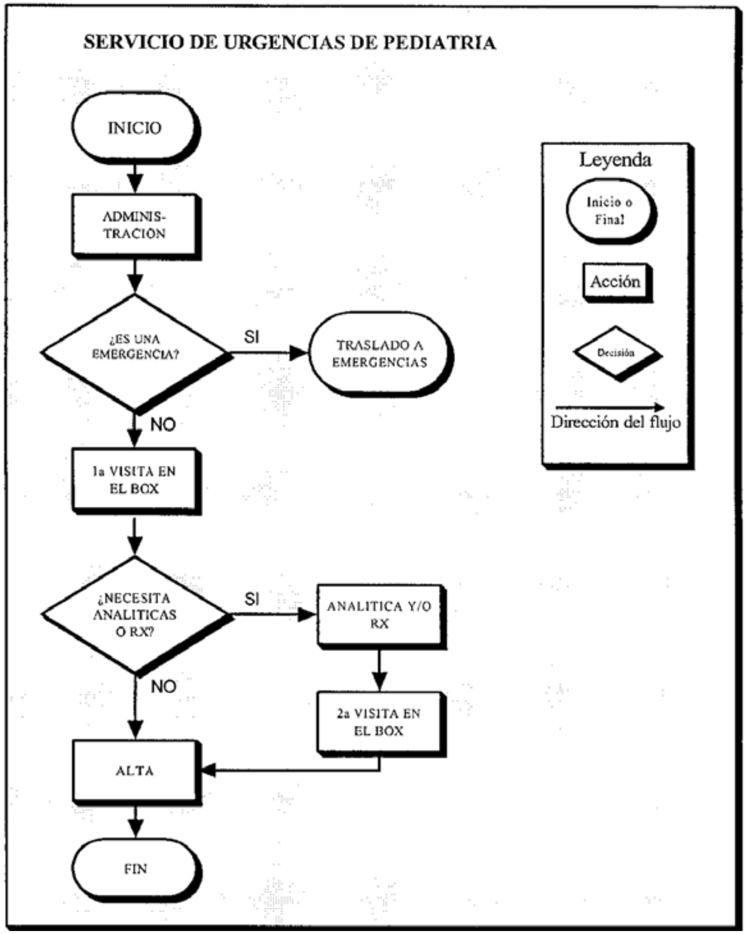


- Decision point

Pediatrics example

- Models a pediatrics example.
- If a new emergency arrives a special process takes cure of it.
- If X ray is needed, or blood analysis, is done in a second visit
- Finally the patient release the system.

Flows models



Flows models (best)

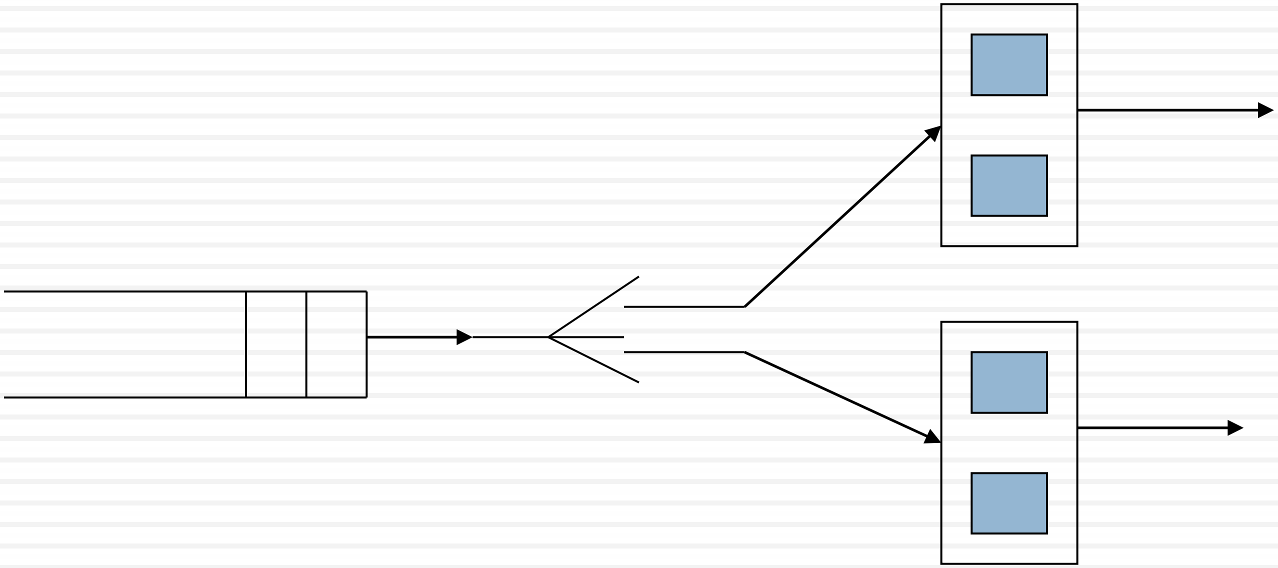
- Simple
- Allows to describe the system faster.

Flows models (worse)

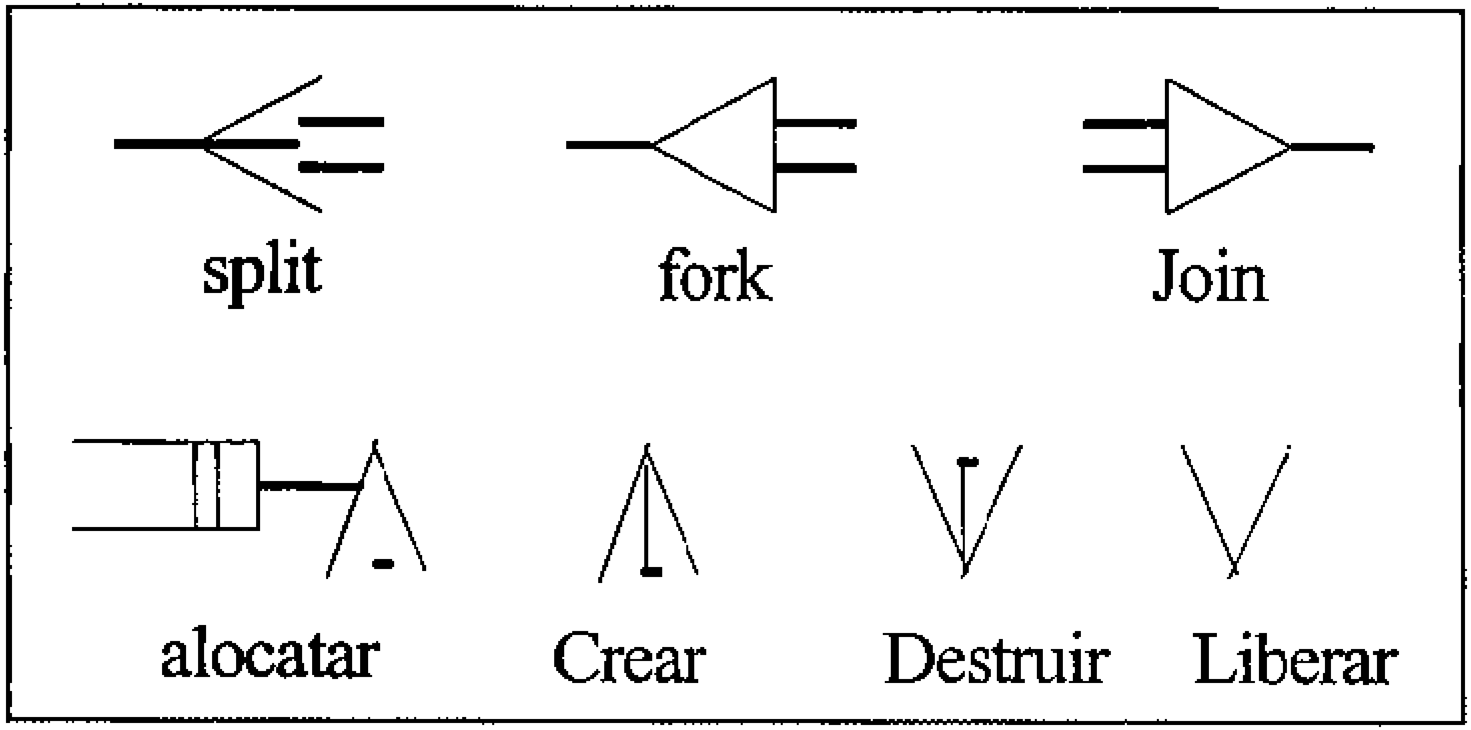
- No description about the implementation.
- No description about the events.
- Is not calculable.
- Not structured methodology, not specific of the OR.

Queue networks

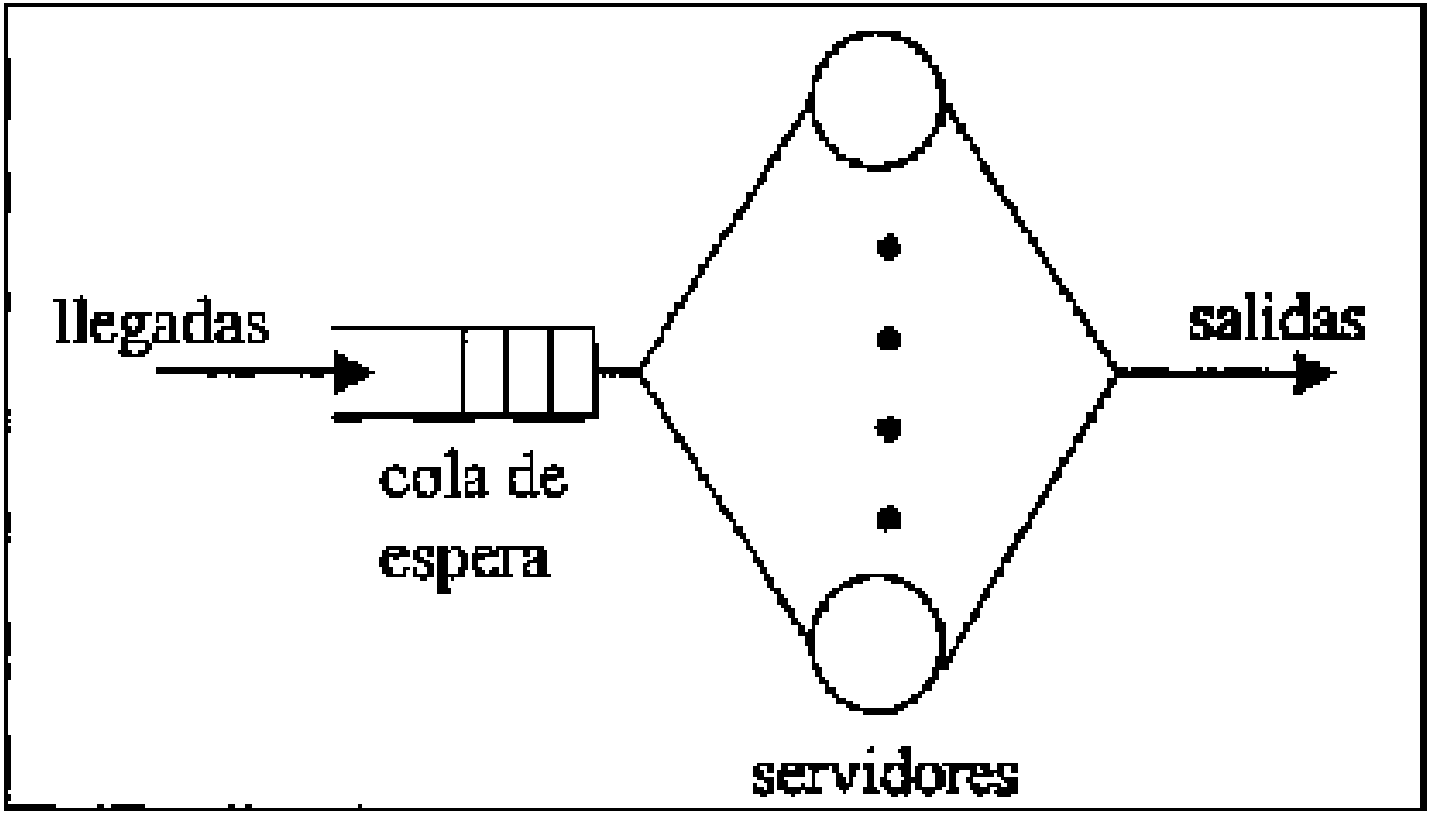
Simulation models formalization



Queue networks



Queue networks (M|M|S)



Queue networks (best)

- Simple
- Allows to understand the system faster.
- Specific to describe queue models.

Queue networks (worse)

- No description about the implementation.
- Do not describe too much about the events management.
- Is not always calculable.
  - Some models can be calculated following the queue theory.