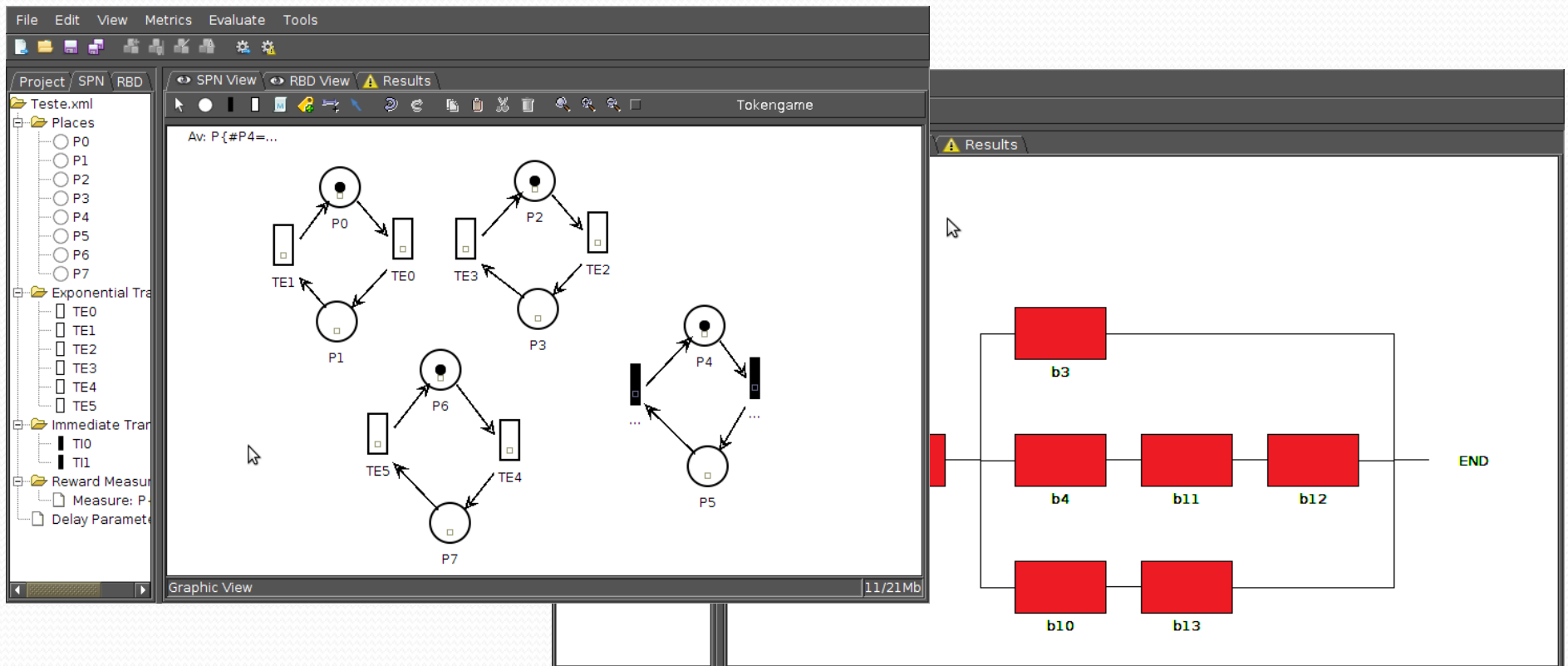


# Mercury Tool

A tool for dependability evaluation adopting RBD and SPN models

[www.modcs.org](http://www.modcs.org)



# MERCURY TOOL - FEATURES

- SPN Editor
  - Stationary Simulation
    - Standard Simulation (Availability)
    - Experimentation (evaluate different scenarios with same model)
  - Transient Simulation
    - Standard Simulation (Reliability)
- Token Game

# MERCURY TOOL - FEATURES

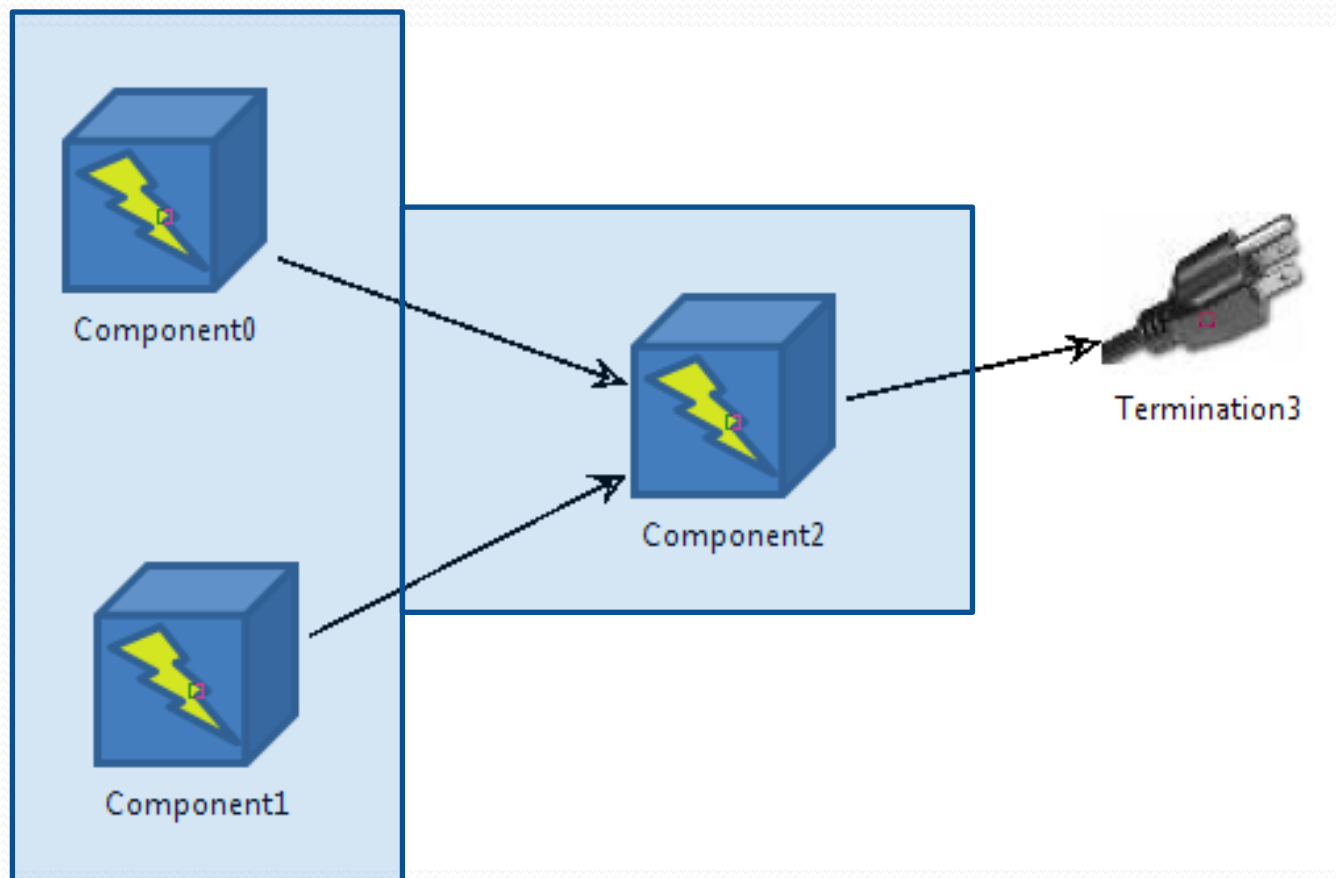
- RBD Editor
  - Standard Evaluation
    - Availability and Reliability
  - Reliability Importance
  - Experimentation
  - Bounds Evaluation

# MERCURY TOOL - FEATURES

- Stationary Simulation
  - Simulate the model in order to evaluate the availability of the System.
  - Different scenarios in the same model can be evaluated adopting experiment feature.

# Example:

- Suppose a power infrastructure with two components in parallel and one in series, that provides energy to one given equipment.



# Example

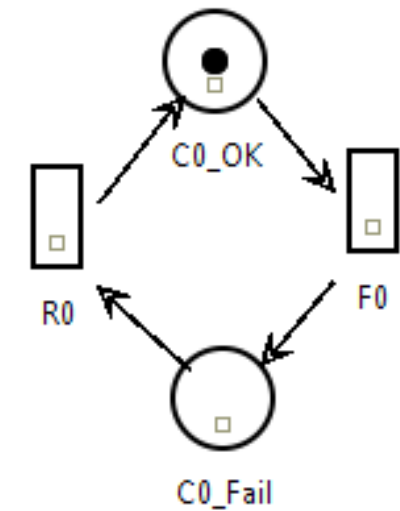
- Dependability Parameters:

Component	MTTF (Hours)	MTTR (Hours)
Component0	1000	1
Component1	1000	1
Component2	1000	1

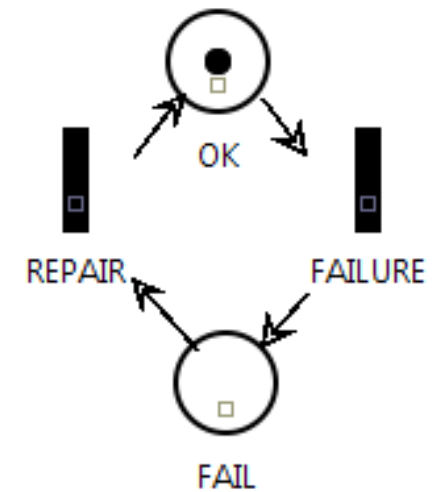
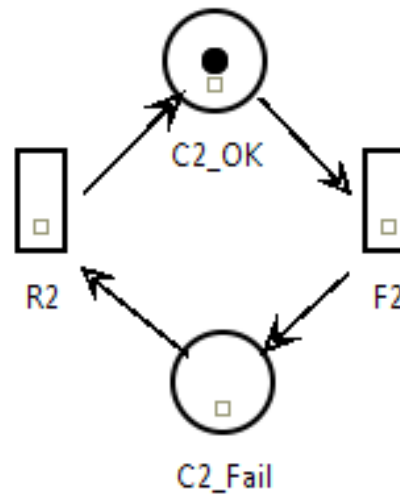
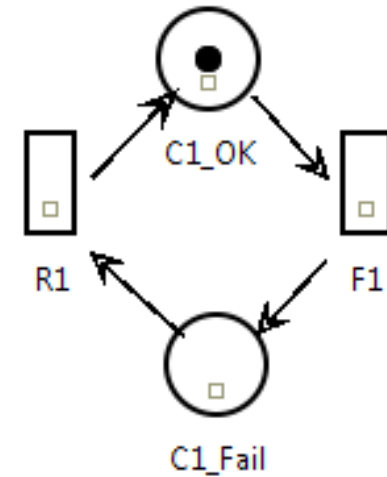
- Fail Condition
  - If(**Component0 Fails** and **Component1 Fail**) or if(**Component2 Fail**) then the **system fails**

# Example

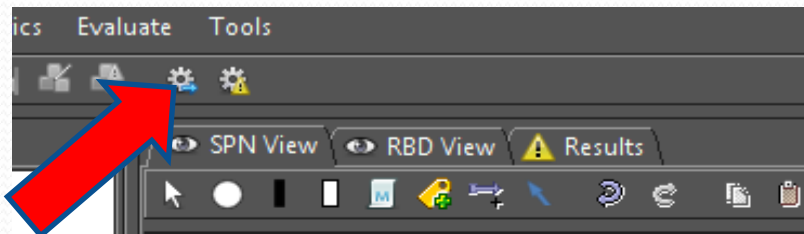
- SPN model



Av :  $P\{\#OK>0\}$



# Stationary Simulation



ons

```
SPN View RBD View Results
Result: 0.9989945651526129
Nines: 2.9976460666256988
Confidence Interval: [0.9989647476609412,0.9990243826442845]
Error %: 0.002984750138963997
Run size: 1000
Numer of Runs 50
Total Runs 50000
```



# Experiment different scenarios

- Different values of MTTF and MTTR can be associated to components and the user can change these values.
- For instance, the user can evaluate the availability considering different values of MTTF related to Component2

# Experiment different scenarios

**Experiment Options**

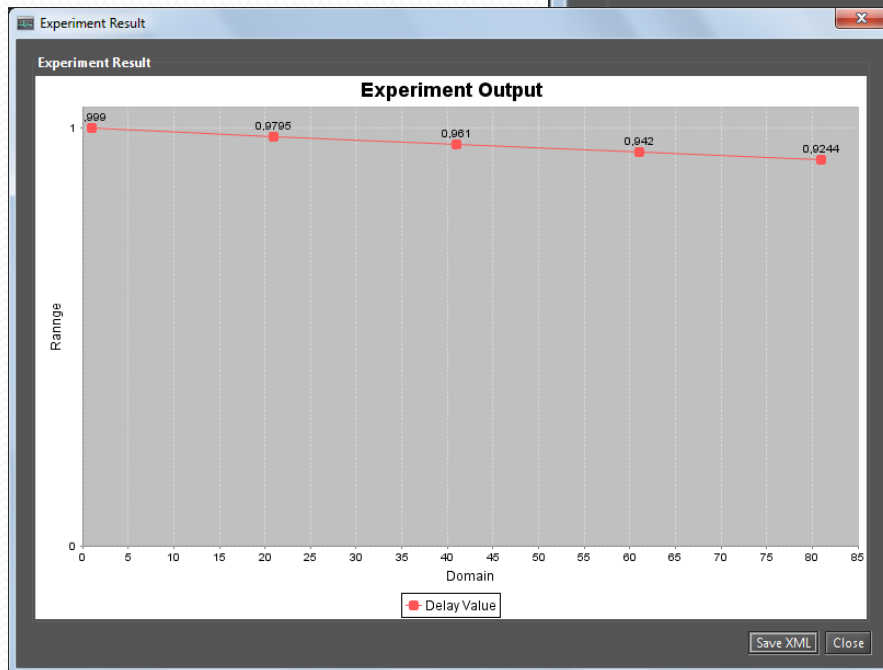
Options

Varying Parameter: MTTR\_C2: 1.0

Range Minimal Value: 1 Range Maximum Value: 100

Interval: 20

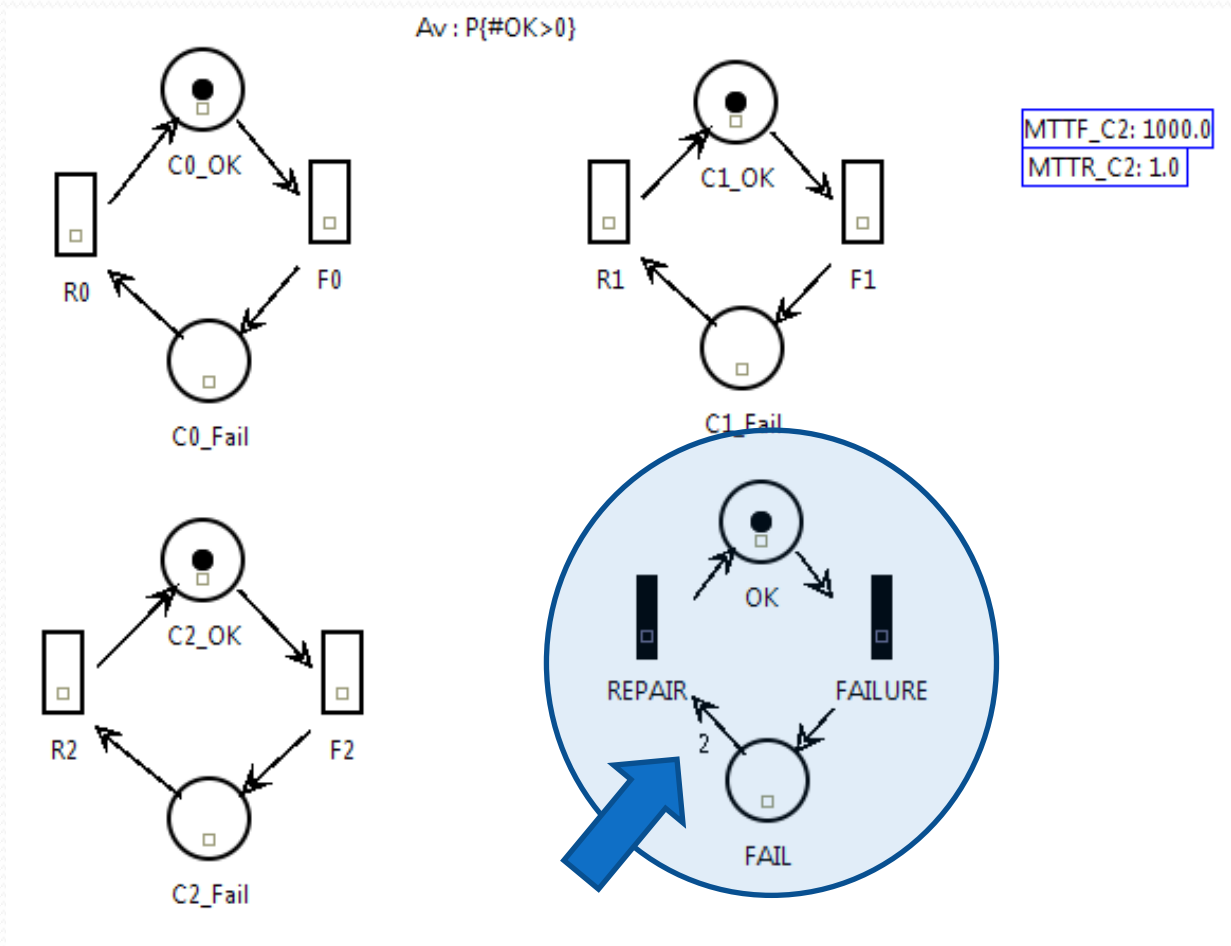
Cancel OK



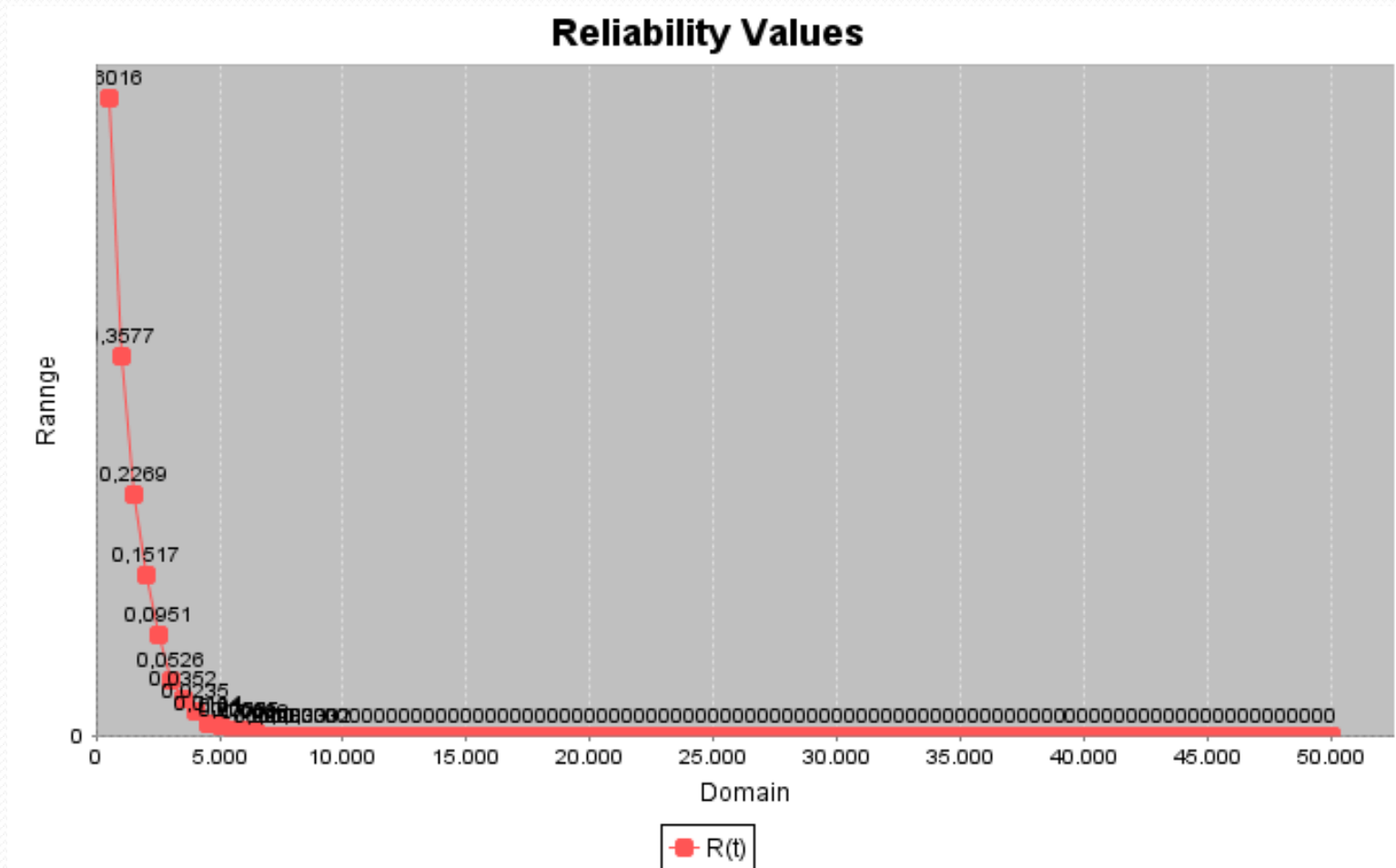
# Transient Simulation

- Calculate reliability adopting SPN simulation.
- To calculate reliability, repair activities are not allowed.
- A different SPN model must be considered to adopt Transient Simulation.

# Transient Simulation



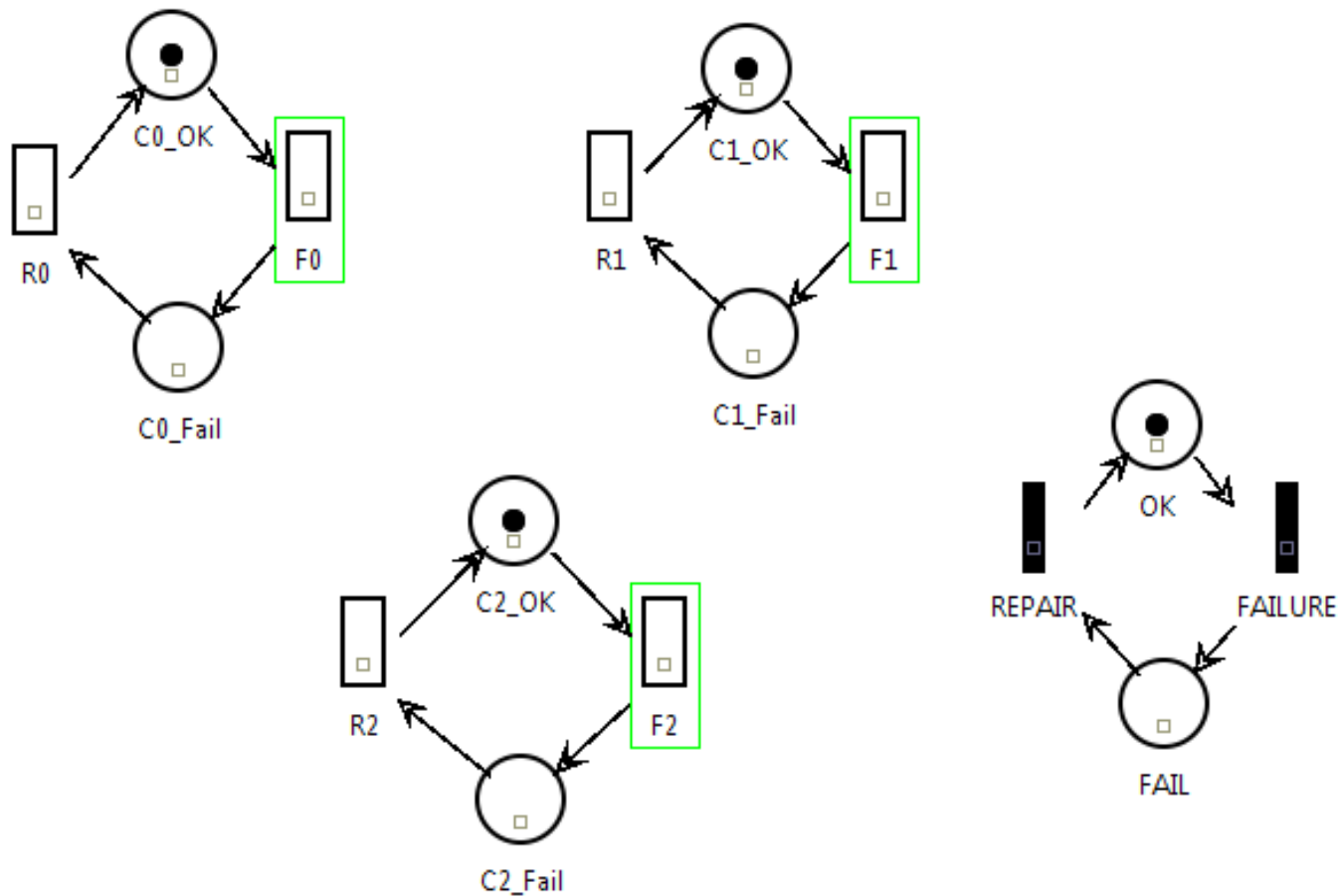
# Transient Results



# Token Game

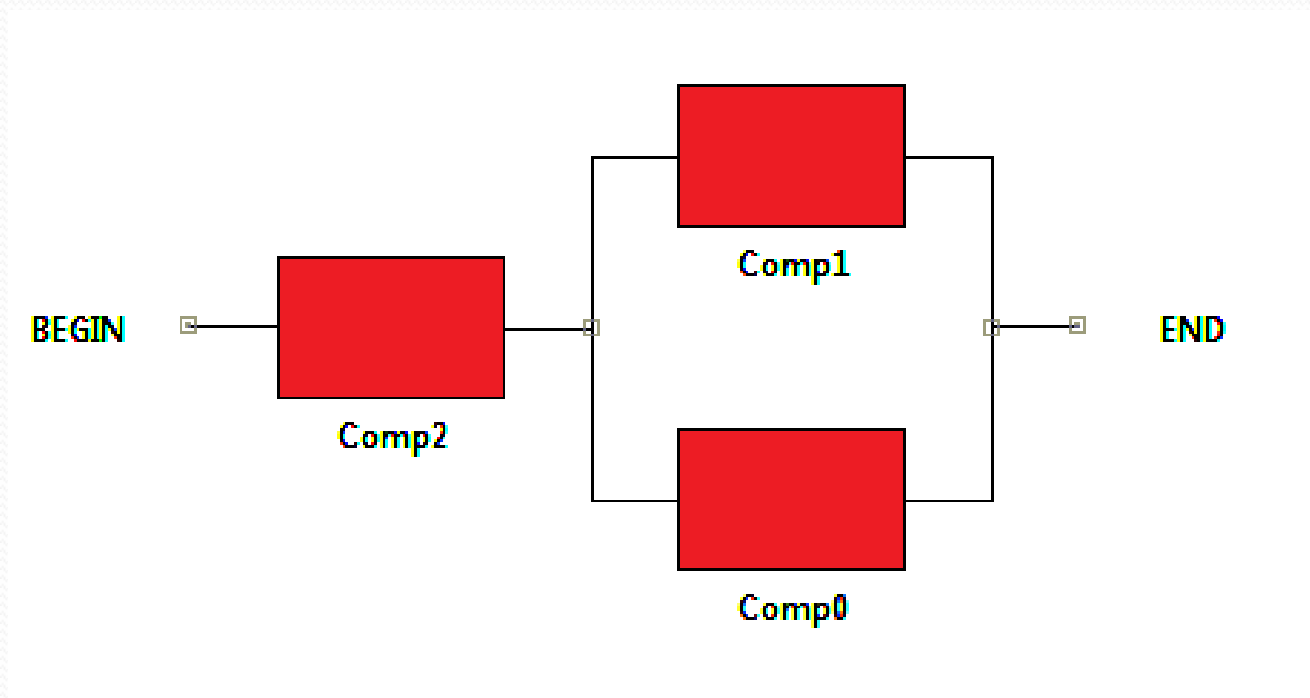
- Feature that allows users simulate/debug the behavior of Petri net model.
- The user runs the model according to the firing rules of SPN.
- Allows the user to analyze different situations, and assess their consequences.

# Token Game



# RBD Editor

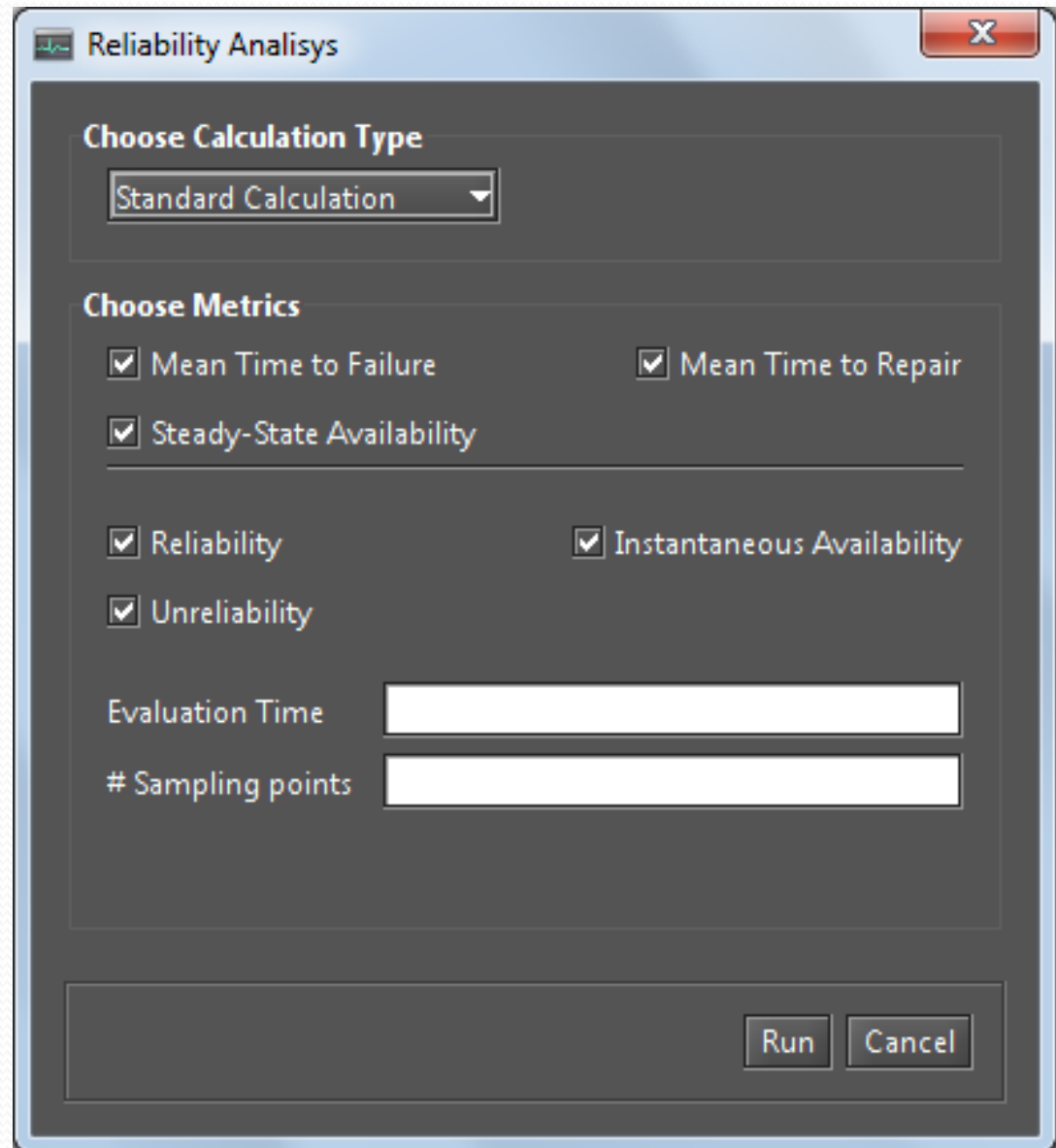
- Evaluate the model adopting Reliability Block diagram.





# RBD Editor

- Evaluate Model

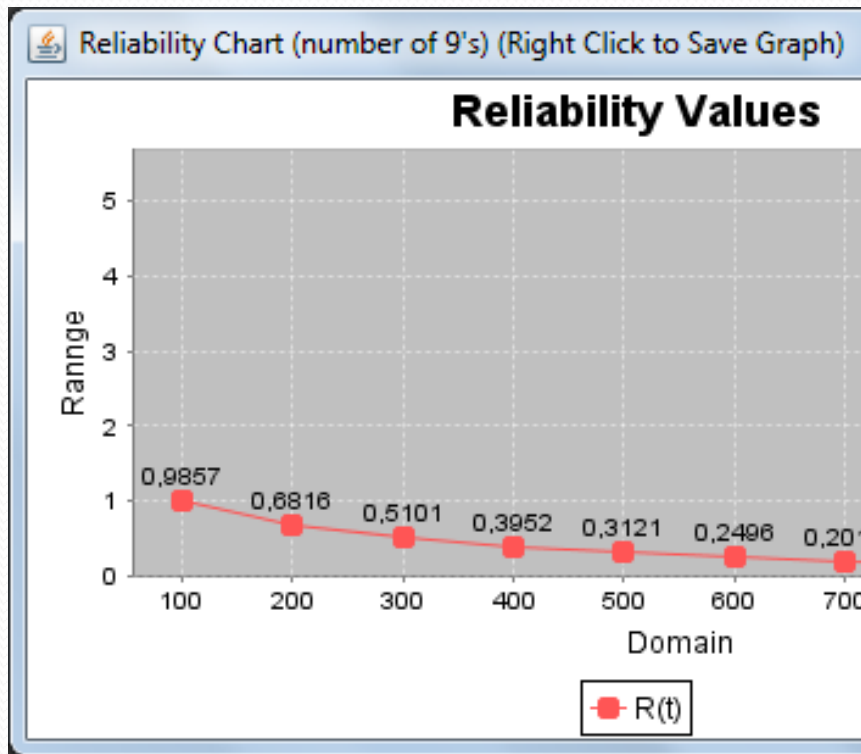


The screenshot shows a dialog box titled "Reliability Analysis" with a close button (X) in the top right corner. The dialog is divided into several sections:

- Choose Calculation Type:** A dropdown menu currently set to "Standard Calculation".
- Choose Metrics:** A section containing six checkboxes, all of which are checked:
  - Mean Time to Failure
  - Mean Time to Repair
  - Steady-State Availability
  - Reliability
  - Instantaneous Availability
  - Unreliability
- Evaluation Time:** A text input field.
- # Sampling points:** A text input field.
- Buttons:** "Run" and "Cancel" buttons located at the bottom right of the dialog.

# RBD Editor

- Results



### Textual Result

\*\*\*\*\* RBD Results \*\*\*\*\*

MTTF: 999.0009990009991  
MTTR: 1.0  
Availability: 0.9990000019950092  
Nines: 3.000000866422302

TIME	Reliability(9's)	Availability(9's)
100.0	0.9856613043607321	3.000000866422302
200.0	0.6815786365858836	3.000000866422302
300.0	0.5101168785370143	3.000000866422302
400.0	0.39519496724436887	3.000000866422302
500.0	0.31214006862300936	3.000000866422302
600.0	0.24956067781393076	3.000000866422302
700.0	0.2011681483855754	3.000000866422302
800.0	0.16309072987532214	3.000000866422302
900.0	0.13276372423583016	3.000000866422302
1000.0	0.10839759708103647	3.000000866422302

### Steady-State Results

Mean Time to Failure:

Mean Time to Repair:

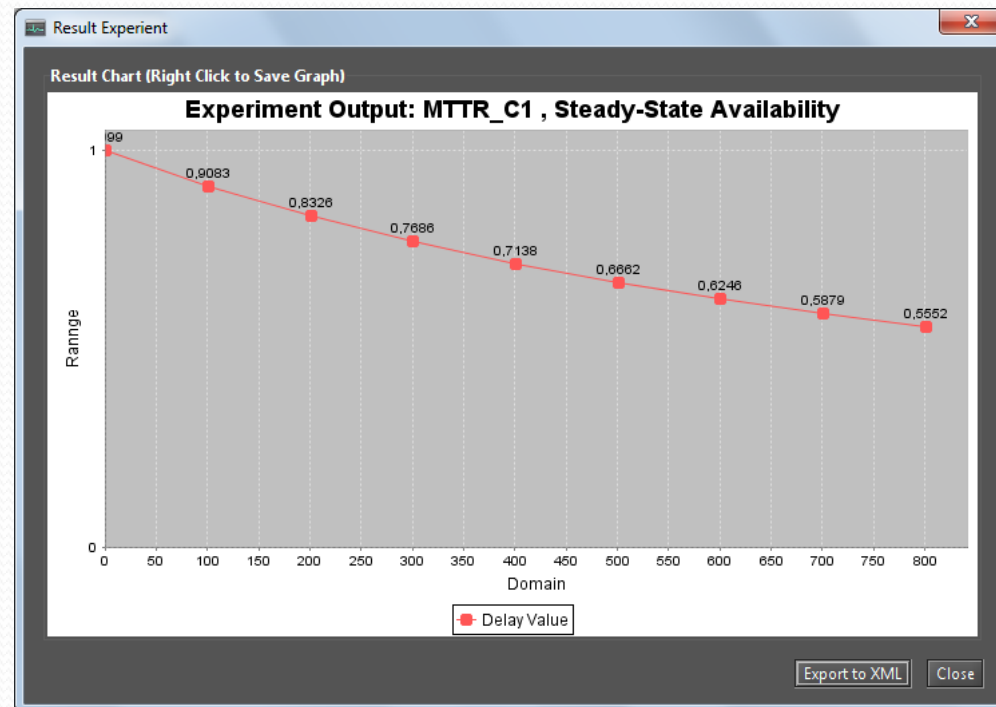
Steady-State Availability:

Availability(Number 9's):

Evaluation Time:

# RBD Editor – Experiment

- Experiment different scenarios also is included in the RBD editor.
- The user associate a label to MTTF/R and experiment the model.

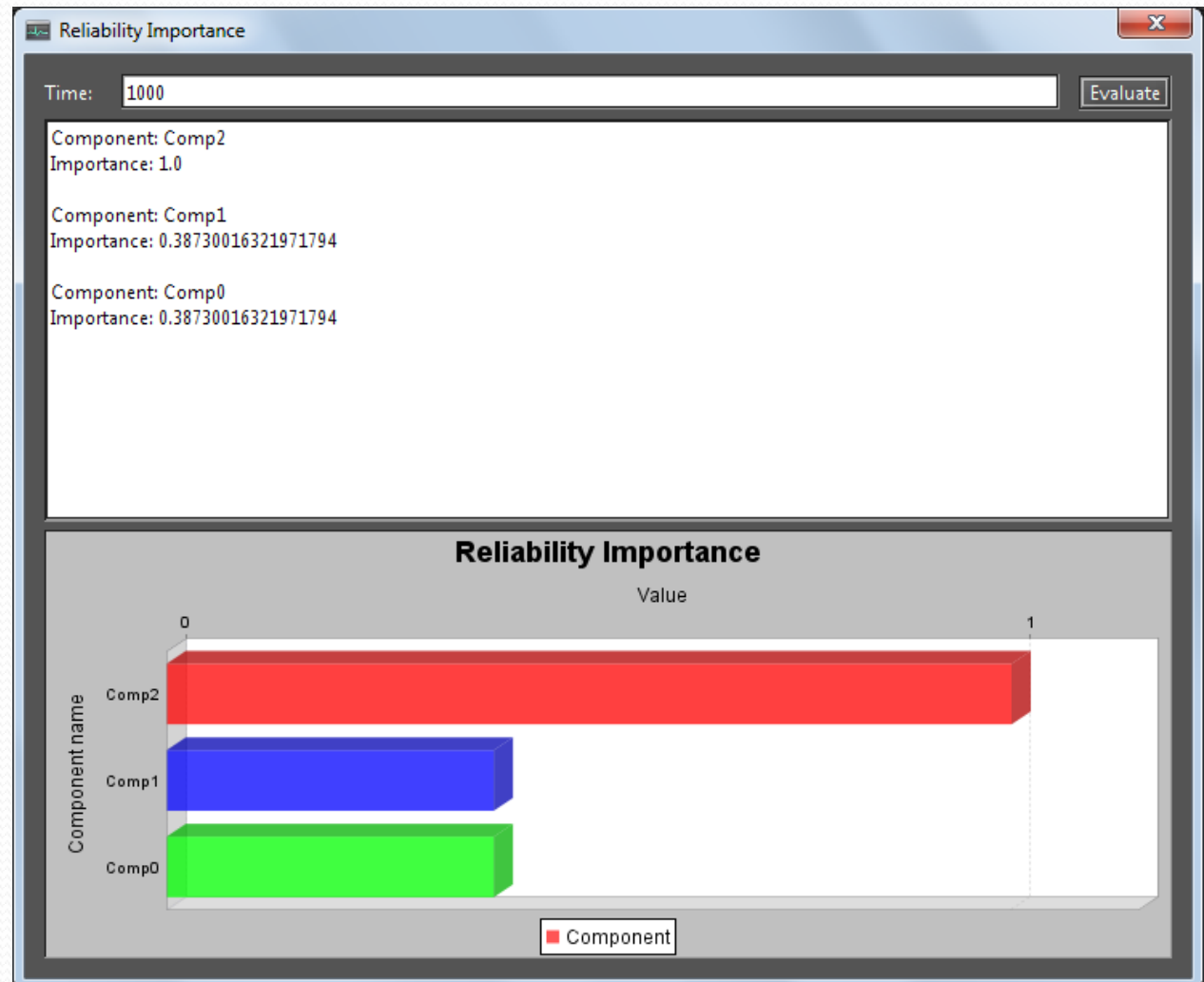


# RBD – Reliability Importance

- Reliability importance measures is one method of identifying the relative importance of each component in a system.
- One graph is presented to show the most important components in terms of reliability.
- Depends
  - Time
  - Structure
  - MTTF/R

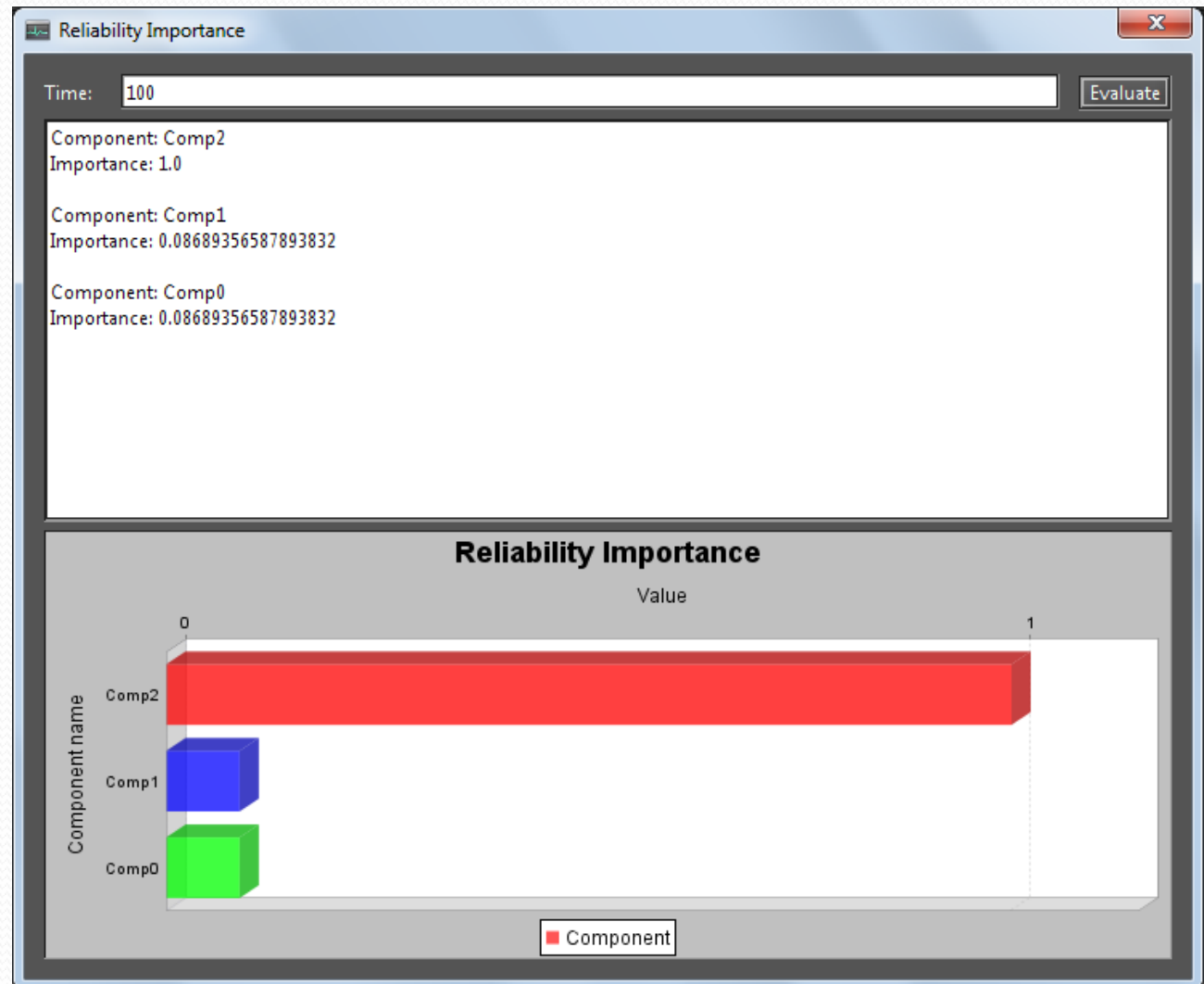
# RBD – Reliability Importance

- At 1000 hours



# RBD – Reliability Importance

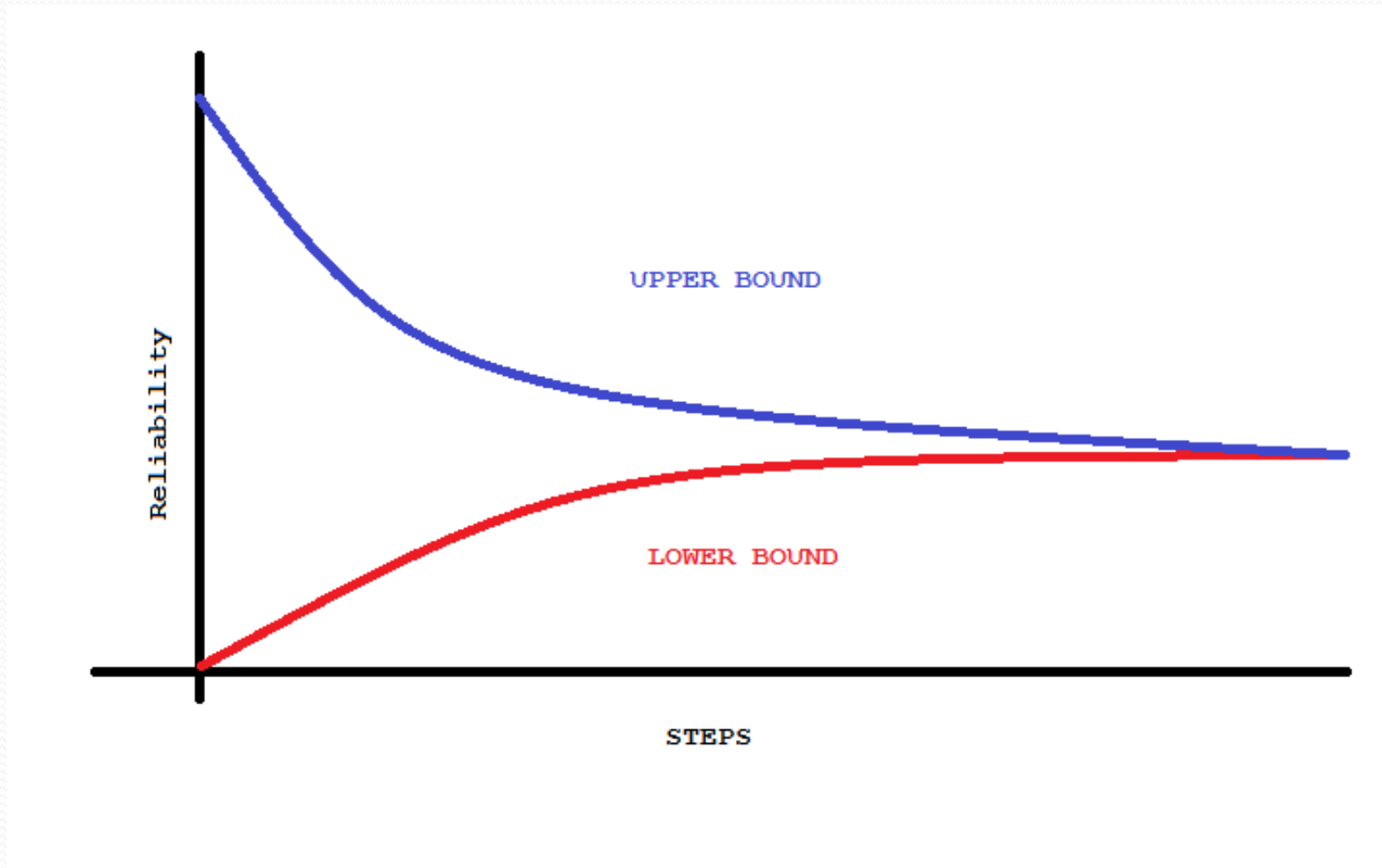
- At 100 hours



# RBD Bounds Evaluation

- Adopted to evaluate large systems.
- Calculate the Upper and Lower bounds of RBD model
- The accuracy is selectable by the user.

# RBD Bounds Evaluation





# RBD Bounds Evaluation

The screenshot displays the 'RBD Bounds Analysis' application window. At the top, the 'Metrics' section has four checked checkboxes: 'Stead State Availability', 'Instantaneous Availability', 'Reliability', and 'DownTime'. Below this is a 'Time' input field and three buttons: 'Get Initial Values', 'Run Iterations', and 'Cancel'. A tabbed interface shows 'Stead State Availability' as the active tab. Under this tab, there are two rows of data: 'Upper: 0.9803921568627451' with a spinner set to '5' of '5' iterations, and 'Lower: 0.9573346540339104' with a spinner set to '6' of '6' iterations. The main area contains a table titled 'Availability Stead State Iterations Results' with two columns: '++ Upper Values +' and '++ Number of nines +'. The table lists five steps for both upper and lower values, showing a decreasing trend in the number of nines as the iteration number increases.

Step	Upper Value	Number of nines
1	0,980392156863	1,707570176098
2	0,961168781238	1,410818978413
3	0,960208572665	1,400210482255
4	0,960207614374	1,400200023331
5	0,960207539364	1,400199204671

Step	Lower Value	Number of nines
1	0,957334654034	1,369924728396
2	0,959245501647	1,389824448220
3	0,959249248407	1,389864376868
4	0,960205626683	1,400178330186
5	0,960207535621	1,400199163820
6	0,960207539364	1,400199204671

# MERCURY

- High Level Editors can be included in Mercury and these models can be translated to SPN/RBD.

