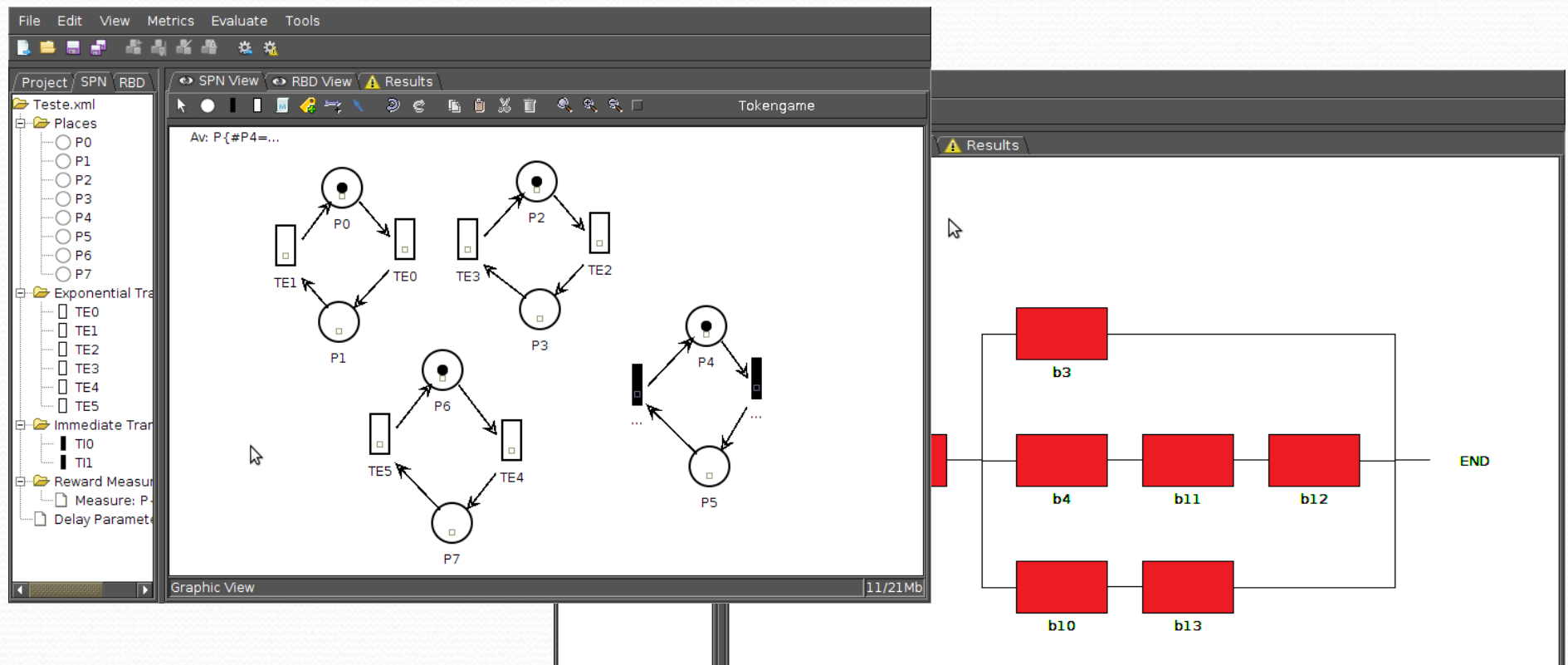


Mercury Tool

A tool for dependability evaluation adopting RBD and SPN models

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

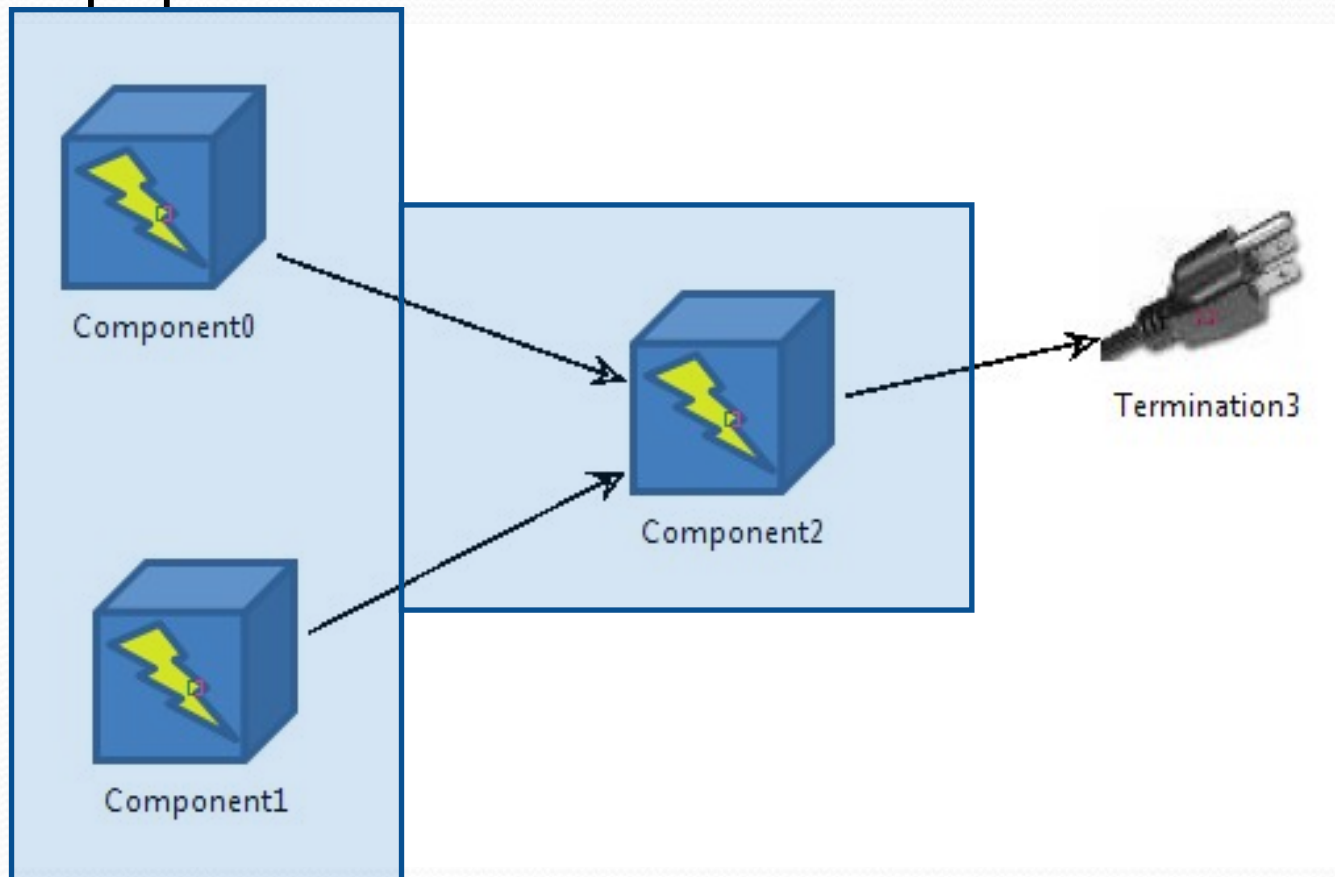
- RBD Editor
 - Standard Evaluation
 - Availability and Reliability
 - Reliability Importance
 - Experimentation
 - Bounds Evaluation
 - Logical & Structural functions

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:

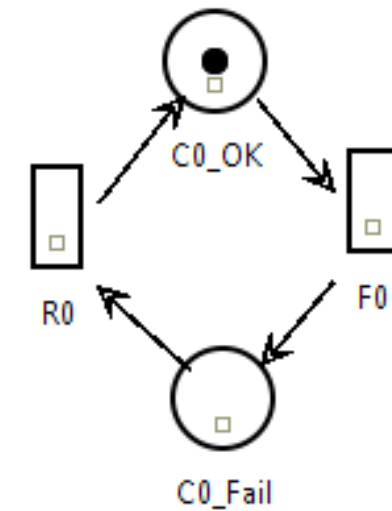
Component	MTTF (Hours)	MTTR (Hours)
Component0	1000	1
Component1	1000	1
Component2	1000	1

- Fail Condition

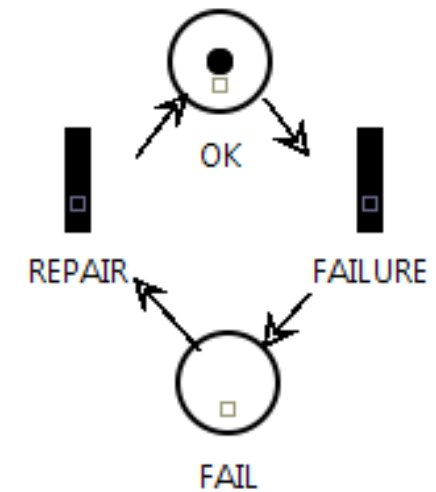
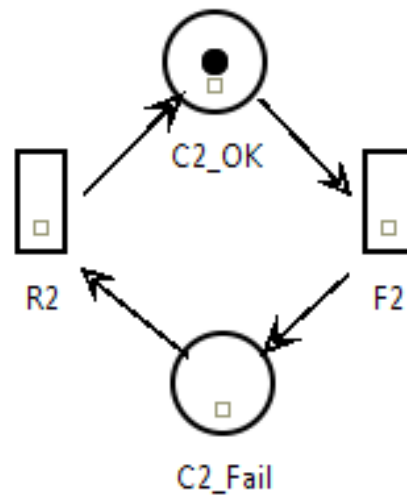
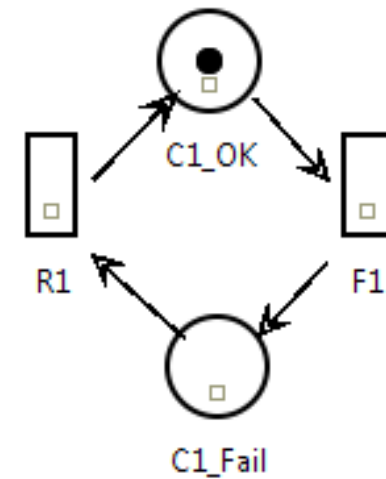
- If(**Component0 Fails** and **Component1 Fail**) or if(**Component2 Fail**) then the **system fails**

Example

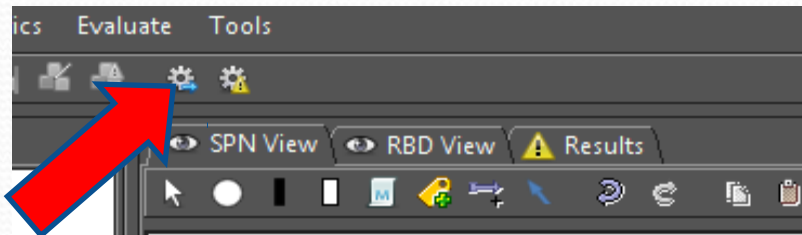
- SPN model



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



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

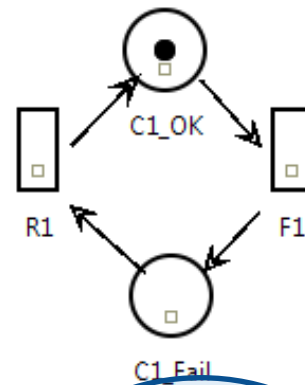
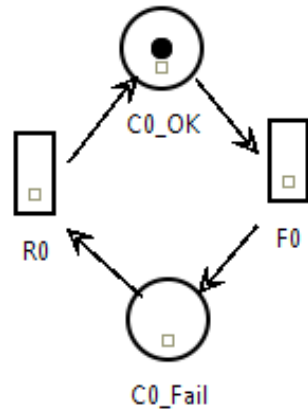


Transient Simulation

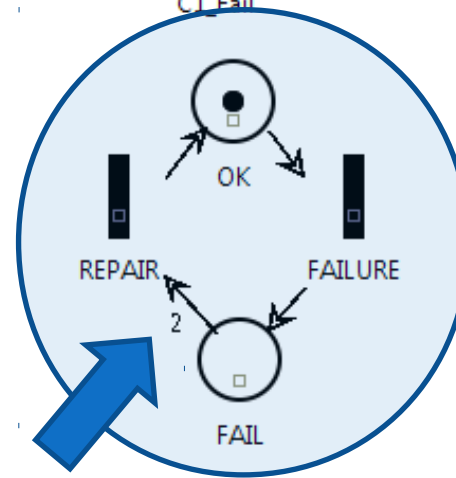
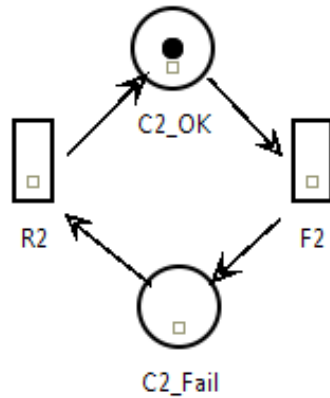
- Calculate reliability adopting SPN simulation.
- To calculate reliability, repair activities are not allowed.
- A different SPN model must be considered to adopt Transient Simulation.

Transient Simulation

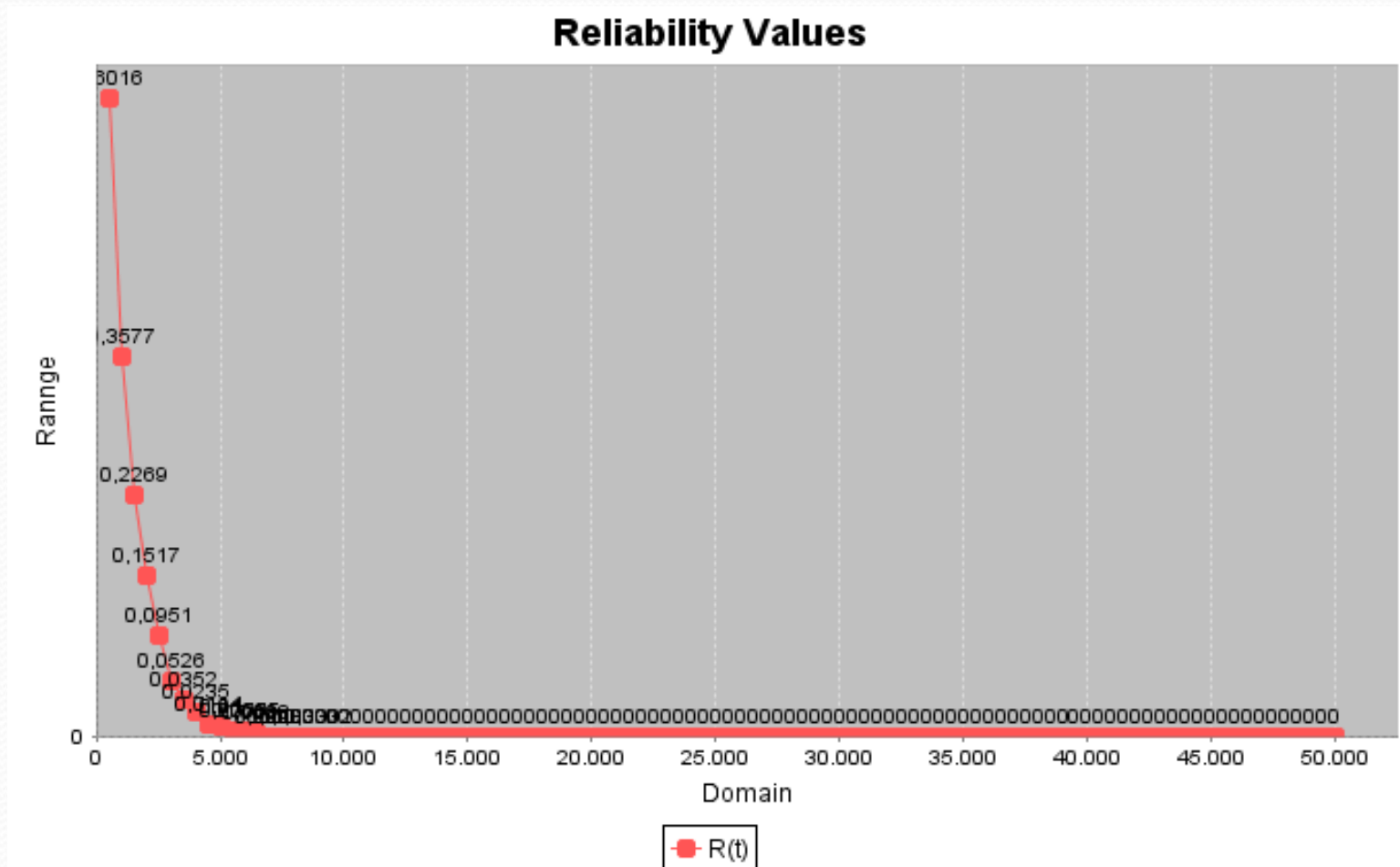
$A_v: P\{\#OK>0\}$



MTTF_C2: 1000.0
MTTR_C2: 1.0



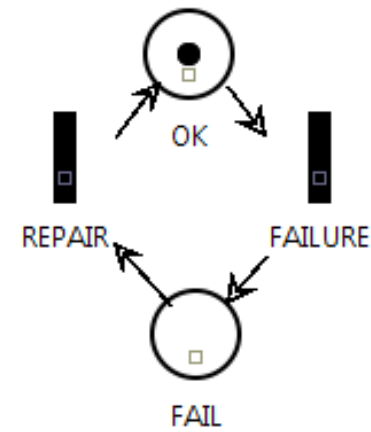
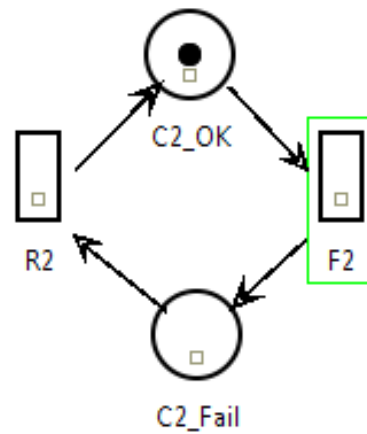
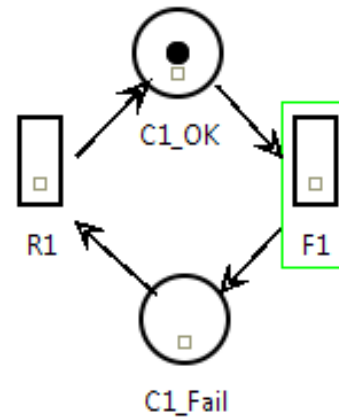
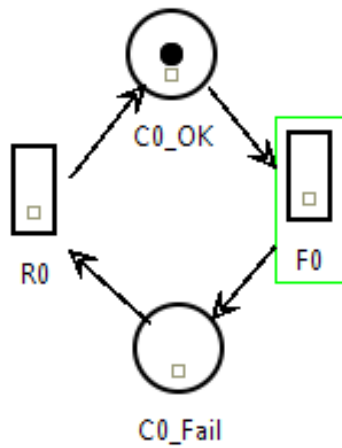
Transient Results



Token Game

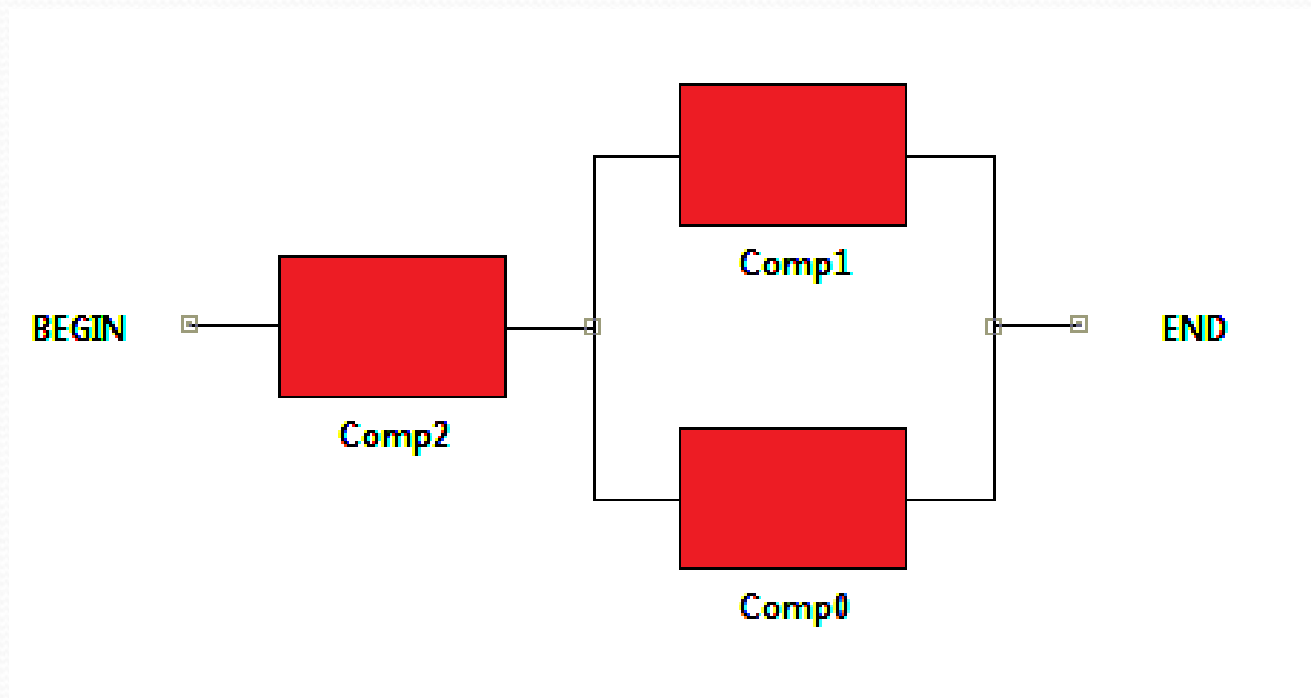
- Feature that allows users simulate/debug the behavior of Petri net model.
- The user runs the model according to the firing rules of SPN.
- Allows the user to analyze different situations, and assess their consequences.

Token Game



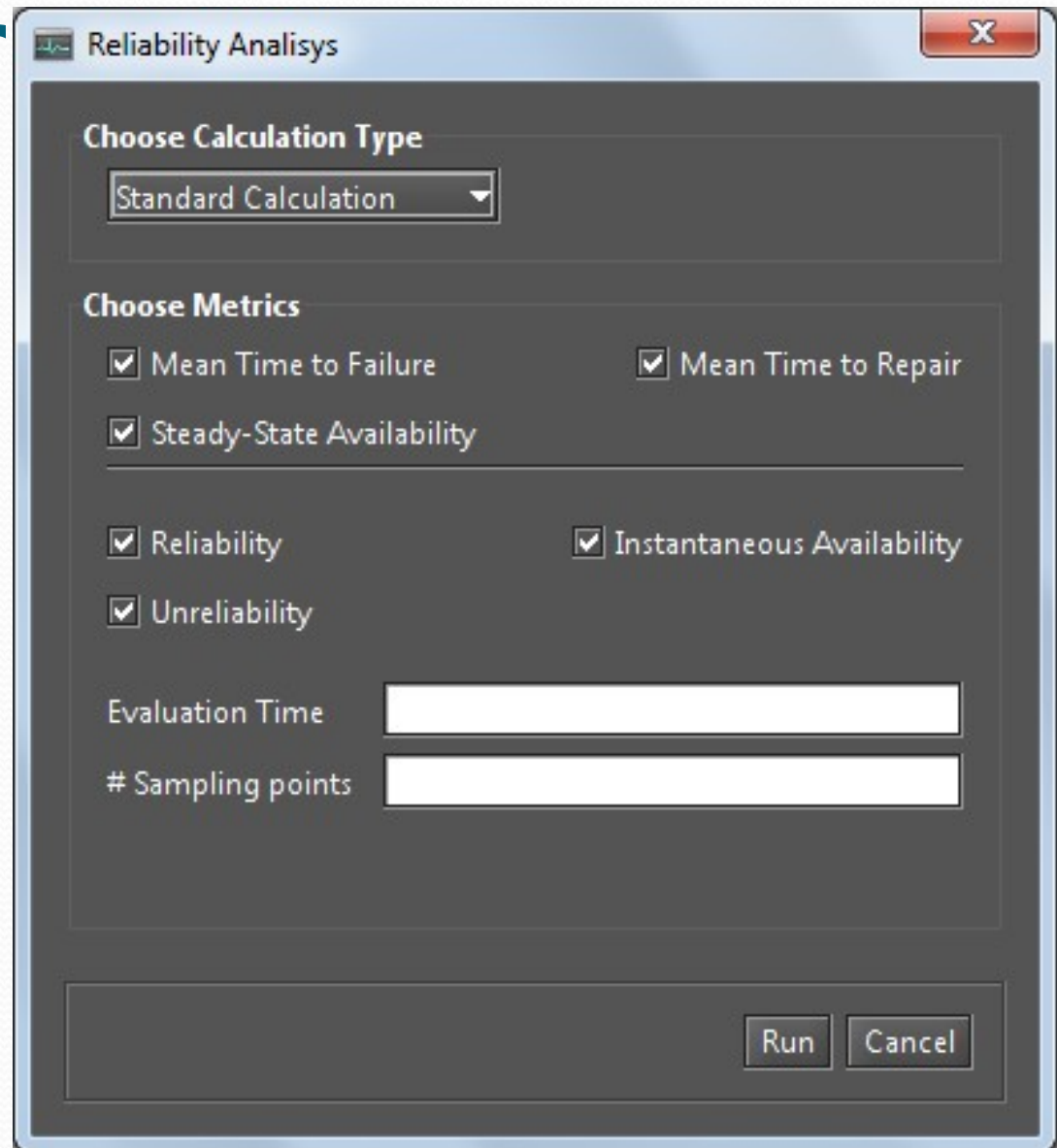
RBD Editor

- Evaluate the model adopting Reliability Block diagram.



RBD Editor

- Evaluate Model

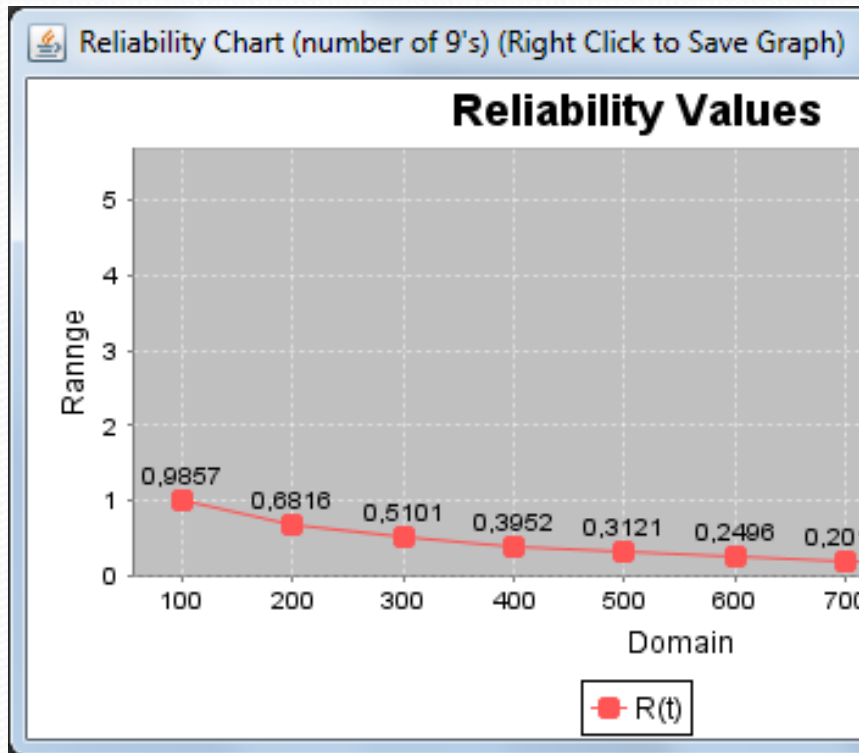


The screenshot shows a dialog box titled "Reliability Analysis" with a close button (X) in the top right corner. The dialog is divided into several sections:

- Choose Calculation Type:** A dropdown menu currently set to "Standard Calculation".
- Choose Metrics:** A section containing six checked checkboxes:
 - 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:

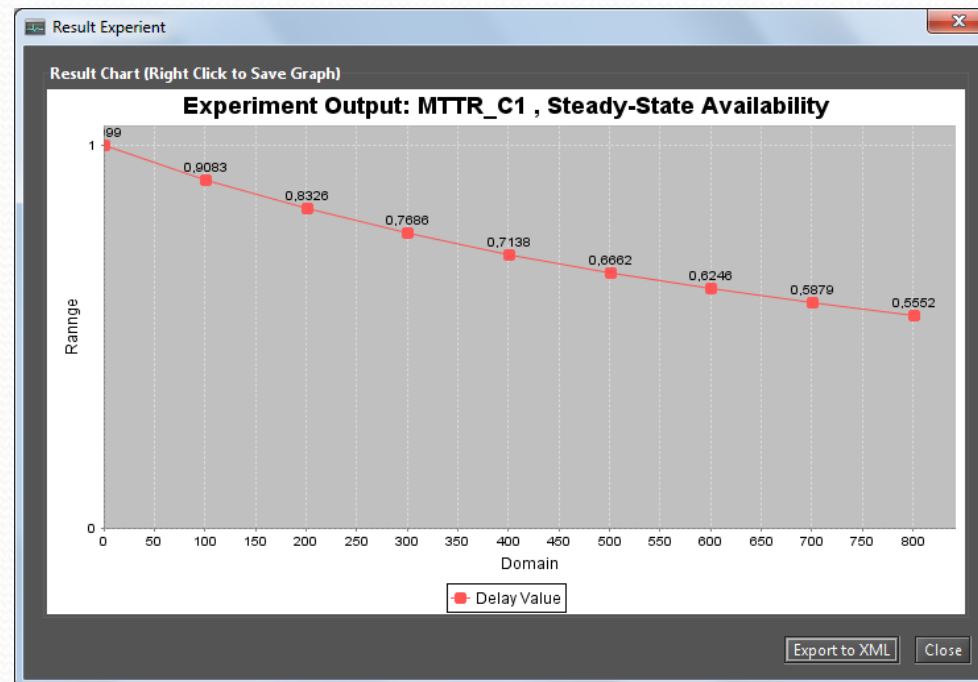
Steady-State Availability:

Availability(Number 9's):

Evaluation Time:

RBD Editor – Expirement

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

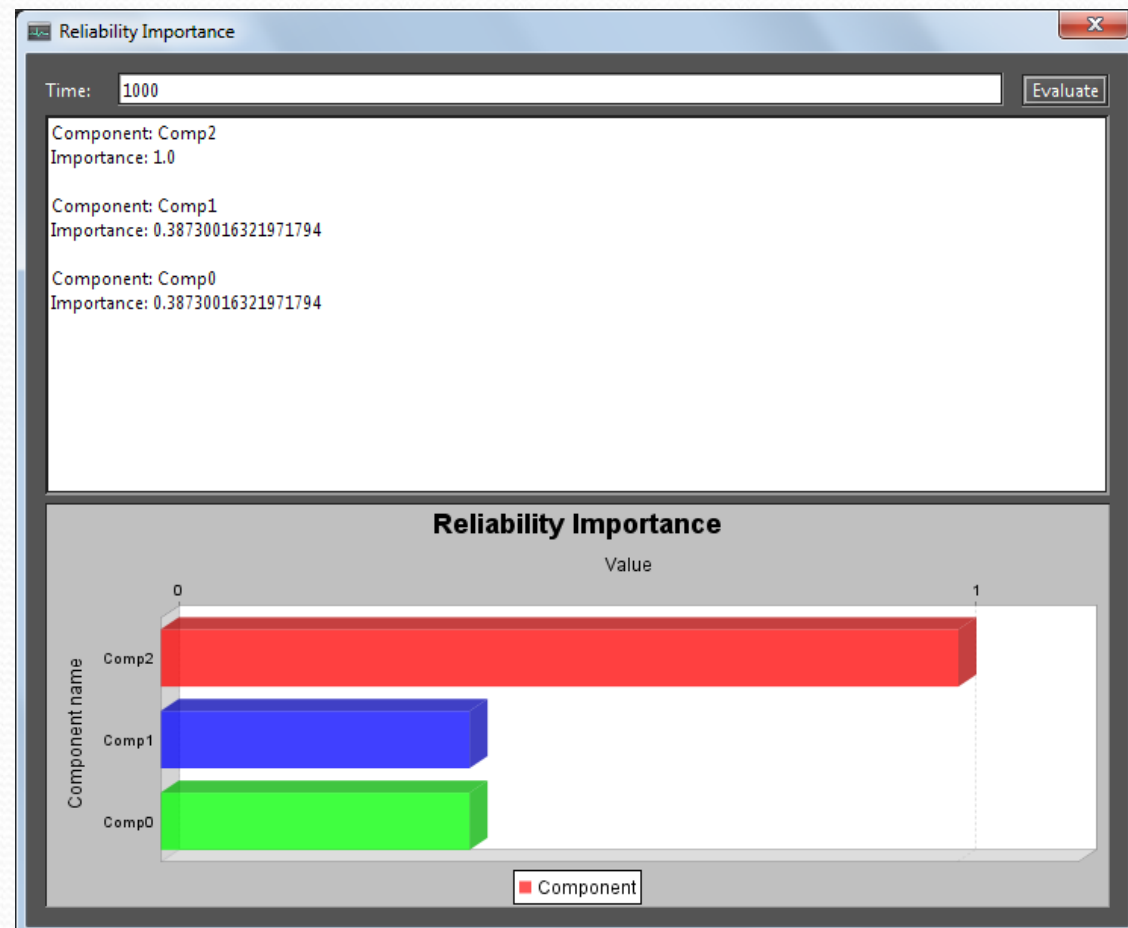


RBD - Reliability Importance

- 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

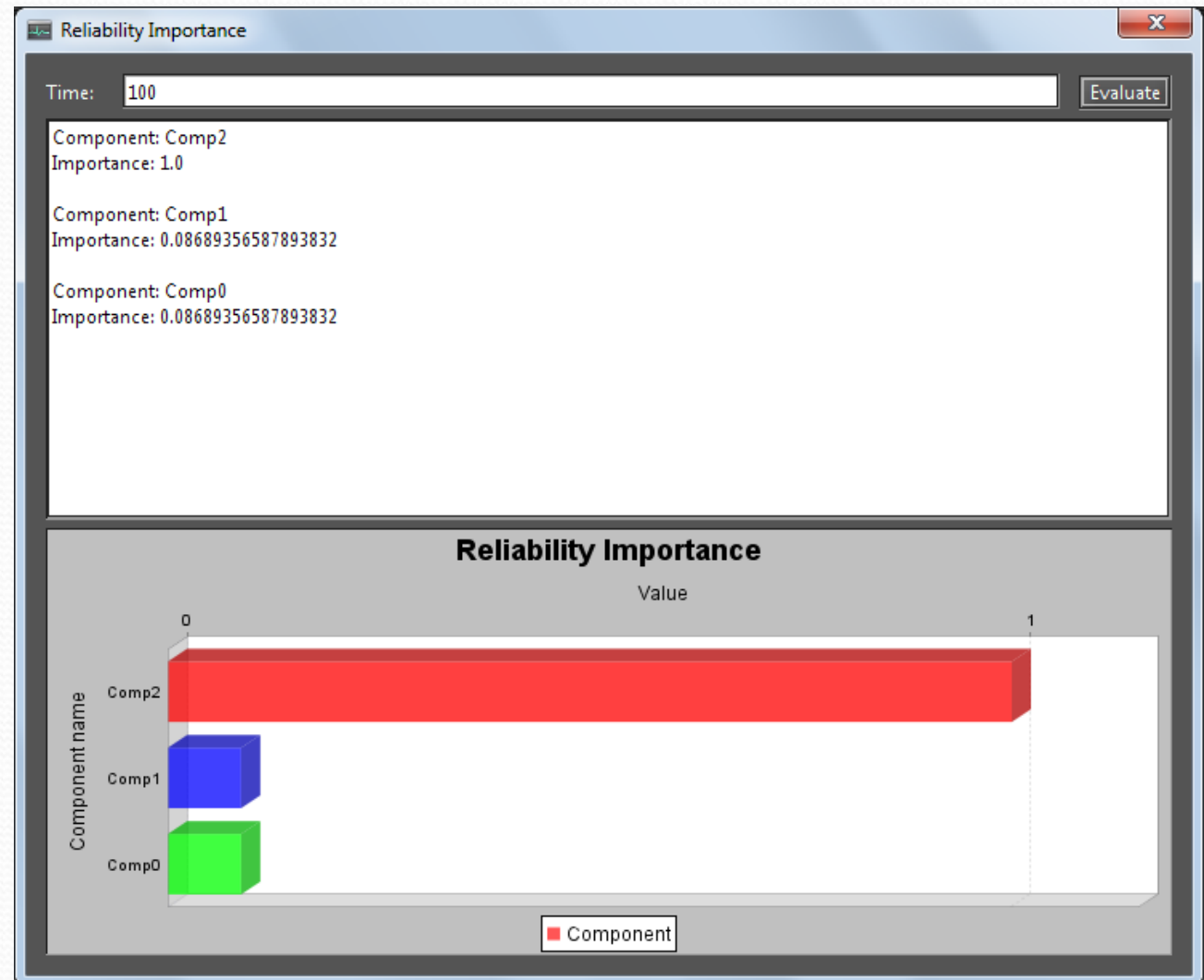
RBD - Reliability Importance

- 1000 hours



RBD - Reliability Importance

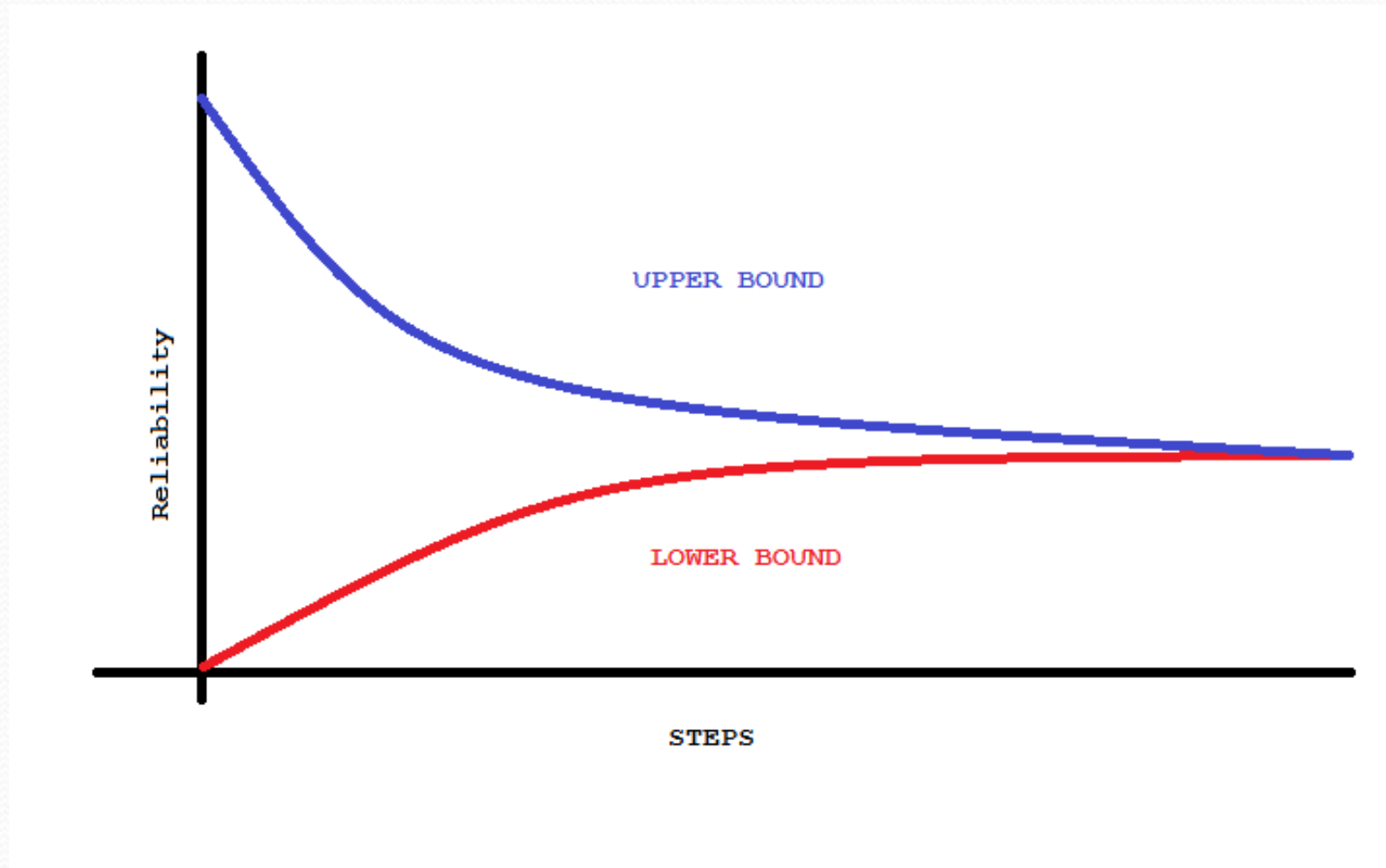
- 100 hours



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' software window. At the top, the 'Metrics' section has four checked options: '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'. The main content area is divided into tabs: 'Stead State Availability', 'Instantaneous Availability', 'Reliability', and 'Downtime'. The 'Stead State Availability' tab is active, showing 'Upper: 0.9803921568627451' and 'Lower: 0.9573346540339104'. It also includes spinners for 'Iterations' (set to 5) and 'of' (set to 5) for the upper bound, and another spinner for 'Iterations' (set to 6) and 'of' (set to 6) for the lower bound. The bottom section, titled 'Availability Stead State Iterations Results', contains two columns of data. The left column lists 'Upper Values' and 'Lower Values' for steps 1 through 5. The right column lists 'Number of nines' for steps 1 through 6.

Step	Upper Value	Lower Value	Number of nines
Step 1	0,980392156863	0,957334654034	1,707570176098
Step 2	0,961168781238	0,959245501647	1,410818978413
Step 3	0,960208572665	0,959249248407	1,400210482255
Step 4	0,960207614374	0,960205626683	1,400200023331
Step 5	0,960207539364	0,960207535621	1,400199204671
Step 6		0,960207539364	1,400199204671

MERCURY

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

