GRIF | Petri module

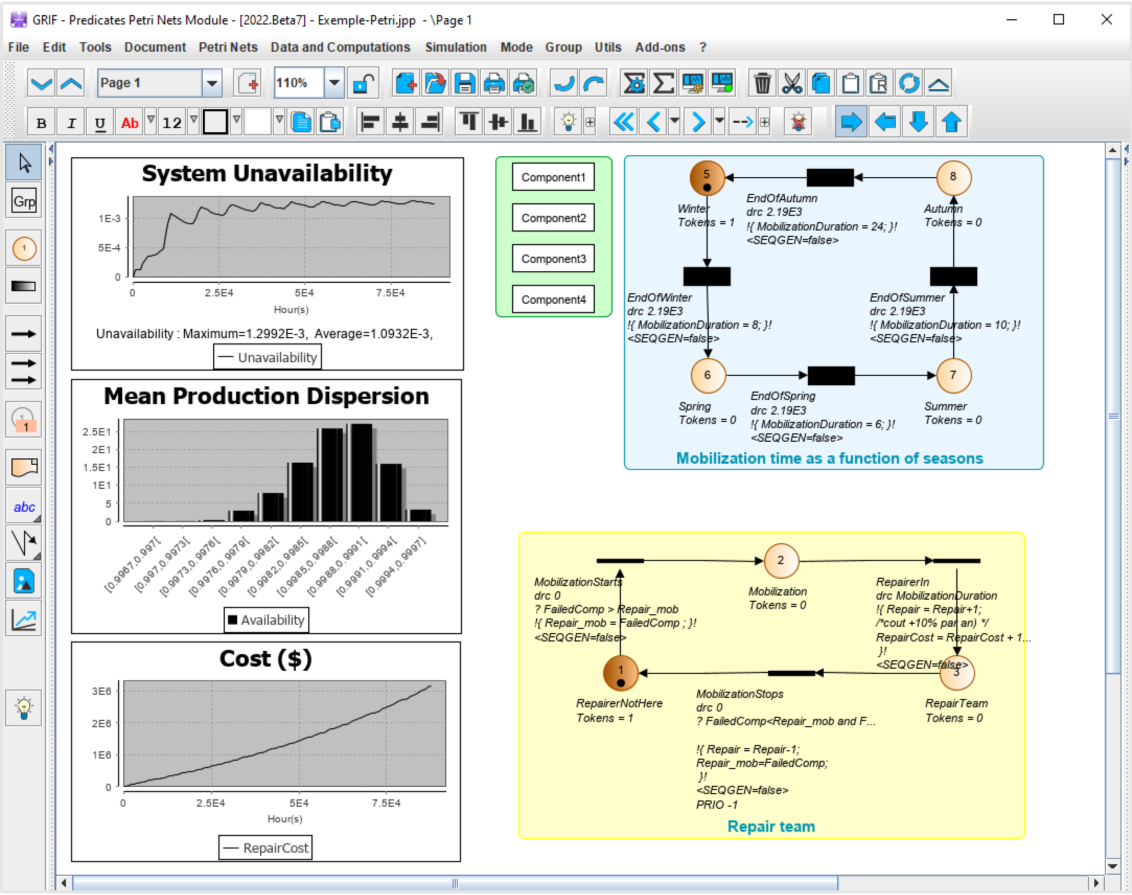
Technical sheet

To evaluate dynamic system performance using Stochastic Petri Nets with Predicates and Assertions

GRIF (GRaphical Interface for reliability Forecasting), a technology of TotalEnergies since the 80s, includes 3 packages and 12 modules allowing the user to choose the most appropriate modelling technique for the resolution of the studied system. Petri module is one of the four modules belonging to Simulation package.

Petri allows to model the behaviour of complex dynamic systems using stochastic Petri nets with predicates and assertions. All calculations are computed thanks to **MOCA-RP** (MOnte-CArlo – Petri Nets), TotalEnergies' high-speed computation engine, itself based, as its name suggests, on the Monte-Carlo simulation, which pushes back the boundaries of modelling.

Petri



Modelling and computations using the MOCA-RP engine:

– **Petri nets are easy to build** via **an intuitive graphic interface**. You **can create places, transitions, arcs and tokens and have access to all types of mathematical variables and logic operators (OR, AND, If-Then-Else, Min (), Max (), etc.)**. These variables represent indicators and can be used to act on the validation (Predicates) of transitions and can also be modified when firing transitions (Assertions).

GRIF
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Hardware requirement: Intel Core i3 or faster, 4 GB of free RAM, 1 GB of free space, no internet connection needed. **Software requirements**: Windows 10 or Linux or MacOS X with Java 11. **Licenses**: standalone with USB dongle or Floating licenses with Sentinel server. Installable, laptop.

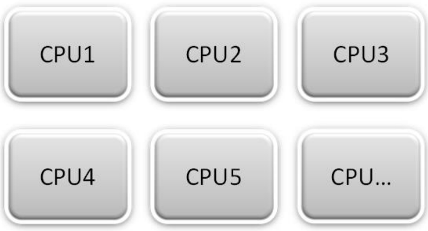
- **Once the system has been modelled, the MOCA-RP engine produces a number of results:**
    - Evaluation over a given period of any indicator created by the user.
    - Seven types of statistics available for each variable (mean over the calculation period, mean per time interval, variation frequency, etc.).
    - Analysis of the different values during the different simulated histories.
    - Transition firing frequency.
    - Sequences or minimal cut sets that lead to a specific event.
    - Mean sojourn time in each place and mean marking for each place, etc.

Because the module is so flexible, it can provide both standard dependability values (availability, reliability, etc.) and information about production systems (quantities produced, number of resources used, etc.).

Specificities and strengths:

- **User-friendliness:** The Petri module benefits from the hierarchical tree structure common to all modules of the Simulation package. A smart copy/paste feature improves modelling performance by connecting the data used by the selected part (or duplicating them depending on the user's decision) to existing data. Prefixing, suffixing, and renaming features are also available when objects of the Petri-Net are copied/pasted.

- **Model construction time:** The Petri module uses the graph tree structure common to all the modules, allowing users to create system subdivisions. Component prototypes can be created and stored in a library and reused either directly as Petri nets to easily create a larger Petri net, or as stochastic block diagrams in the BStoK, Petro or Flex modules.



- **Multi-core computing:** as in all the modules of the simulation package, calculations can be run simultaneously on several processors to radically reduce computation time. A high- performance computing plugin is also available for connections to supercomputers.

- **Power of expression**: The main advantage of stochastic Petri nets with Predicates and Assertions lies as much in their modelling power as in their ability to describe the dysfunctional sections (component failures) and working sections of an installation.
    - Because it has no theoretical limits of use, this module can be used for any system. It is possible to model strong dependencies among components with reconfigurations over time using deterministic or stochastic transitions: exponential, Weibull, triangular, uniform or any other law that may have been programmed.
    - Hybrid simulations can be run by linking MOCA-RP to a C++ code to define the physical properties of the system (temperature variation, propagation calculation, etc.).
    - Other data, such as priorities among different actions, intervention times, stock management, operating costs, or a change in policy after an event, can easily be included in this module.

- **Interactive simulation**: Petri module includes a step-by-step simulator, a key feature for checking/validating models. It helps ensure the accuracy of the model before computations are run. In addition to this initial purpose, the simulator is also used to explain system behavior and is a good training tool for helping people understand how it works.

- **The versatility of the Petri module means that it can be used in a wide variety of industrial sectors:** nuclear energy transportation, aerospace, oil and gas, etc.

Using data and results:

- Input data summarized in tables making it easier to check the quality of an entry.
- Possibility of automating calculations (batch run) and drawing variations for sensitivity analysis.
- Results are stored in the document and can be exported in a variety of formats (csv, XML, Excel, etc.).
- Results can be viewed as line graphs, pie charts or histograms.
- Vectorial printing in PDF format generates high-quality pictures but the files are small enough to be sent by e-mail even if the document contains hundreds of pages.
- External files (PDF certificates, system pictures, etc.) can be included in the document and be part of the full report.
- Interaction with the operating system: possibility of copying/pasting to or from word processing software, spreadsheets, or presentation tools.
- It has a **High-Performance Computing (HPC) plugin** for using the most powerful supercomputers.