Università degli studi di Cagliari
Facoltà di Ingegneria
Dipartimento di Ingegneria Elettrica ed Elettronica
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École nationale supérieure d'électricité et de mécanique
Ingenérie des Systèmes Automatisés

Deterministic and probabilistic dependability assessments of a critical system

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Supervisori esteri:

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Prof. Nicolae Brînzei

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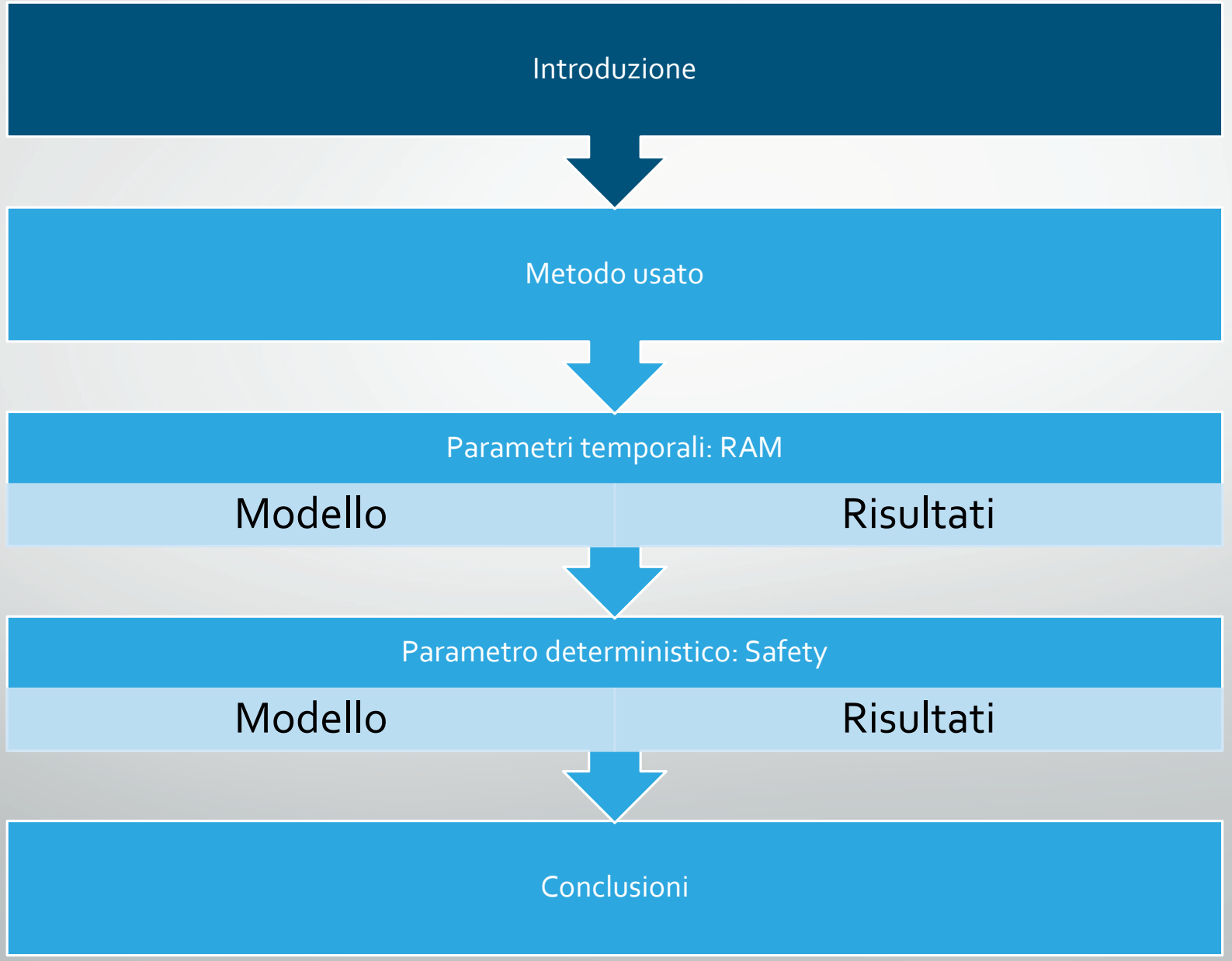
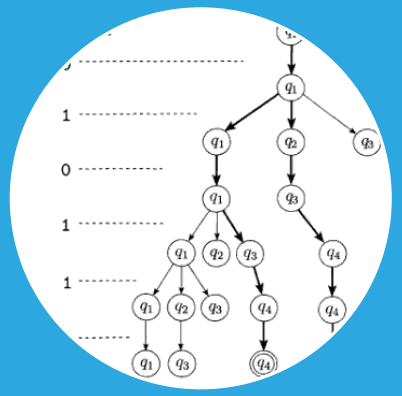
Outline


Introduzione
Metodo usato
Parametri temporali: RAM
Modello
Risultati
Parametro deterministico: Safety
Modello
Risultati
Conclusioni

Introduzione

Fidatezza

RAMS



Modello matematico

Automi

Model checking

LTL

Introduzione

Il caso studiato

Progetto APPRODYN

APProches de la fiabilité DYNamique pour modéliser des systèmes critiques

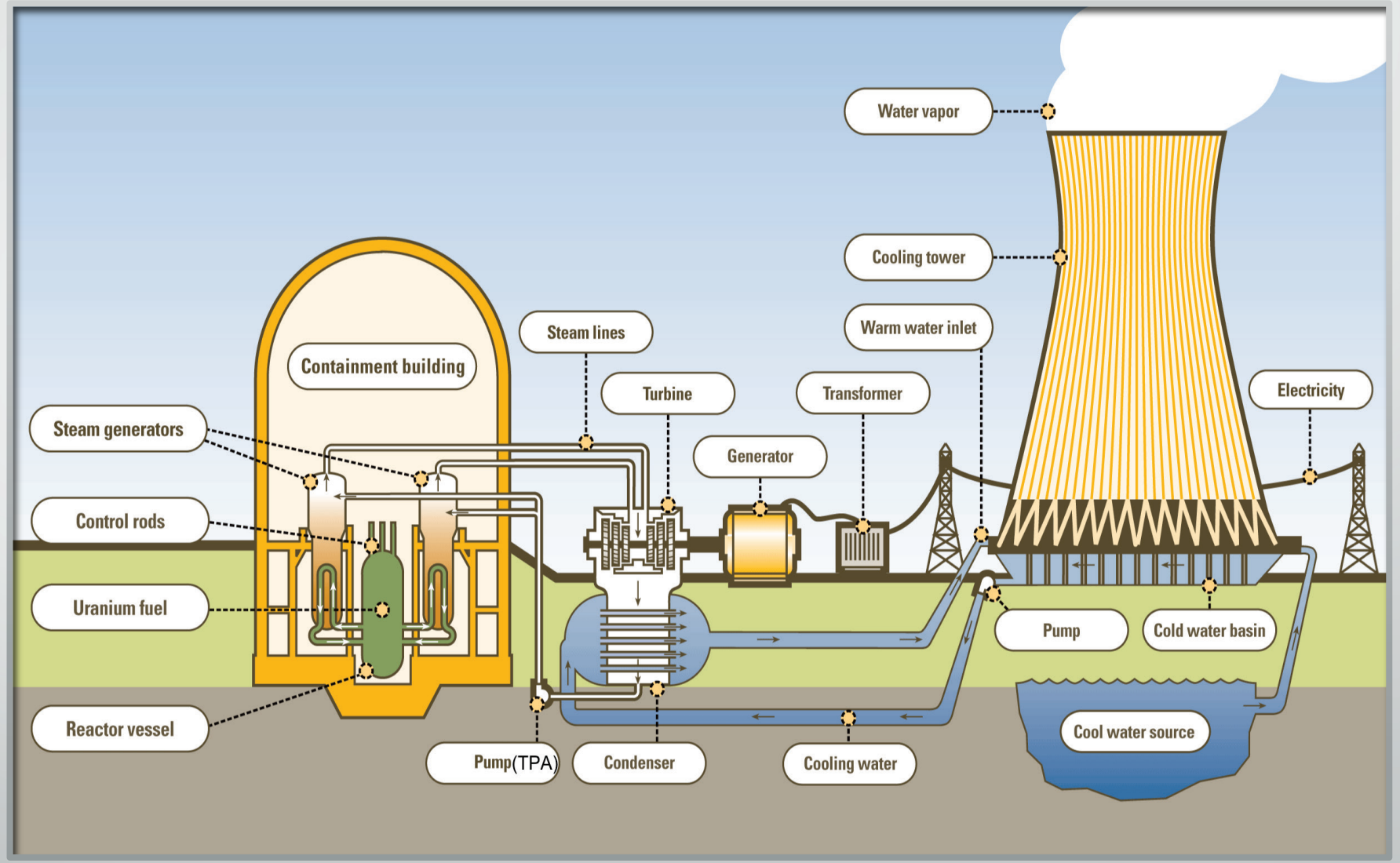


Fig.1 : Schema di una centrale nucleare ad acqua pressurizzata (PWR)

Introduzione

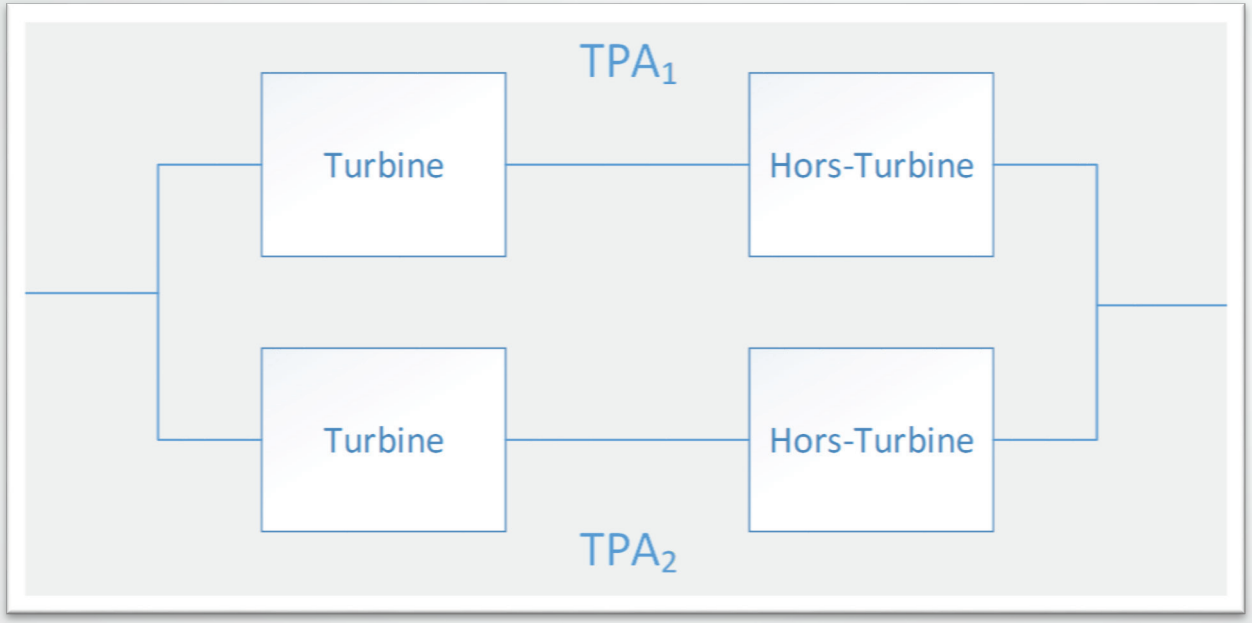


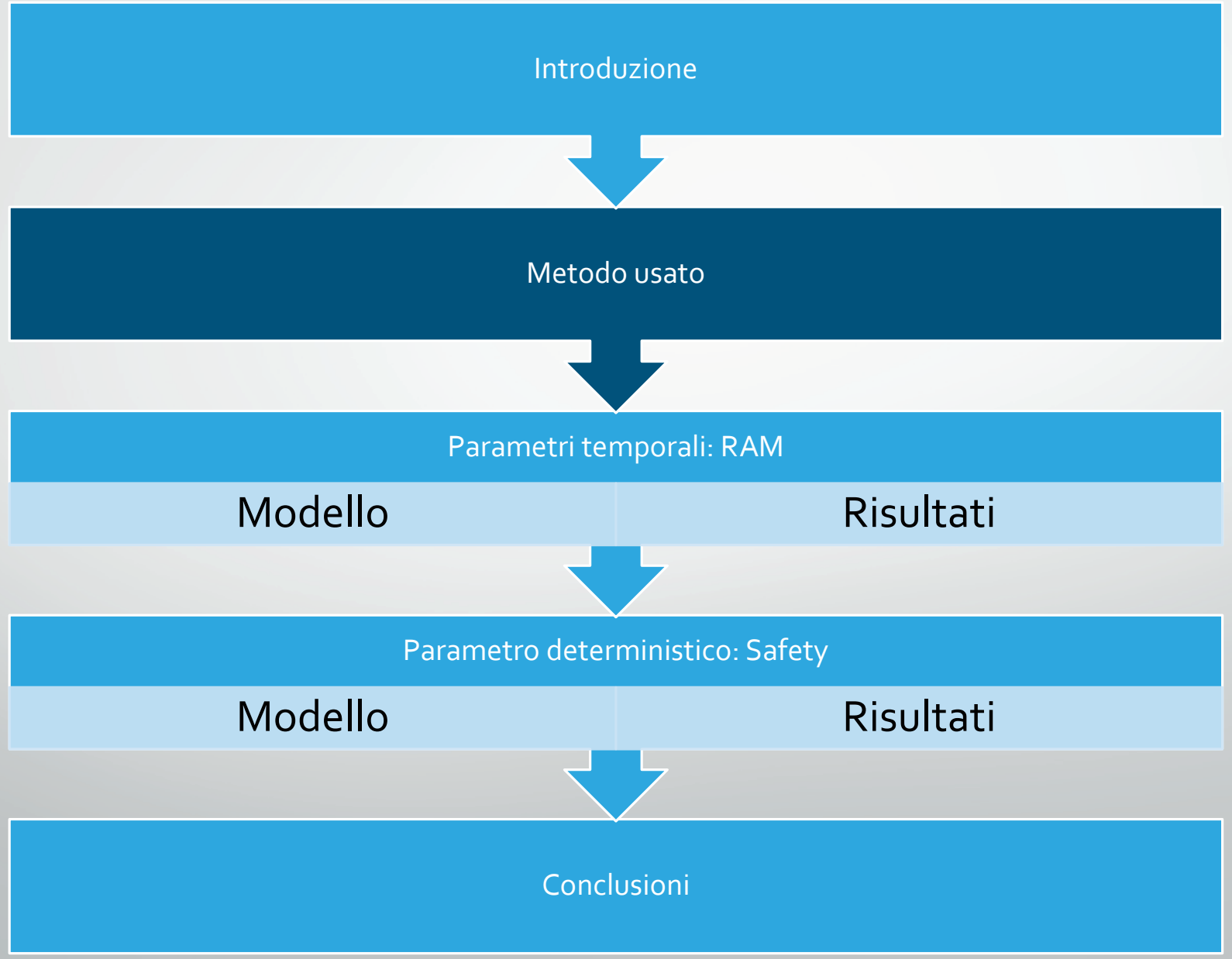
Fig.2: Diagramma di affidabilità del sistema

	λ_T [h]$^{-1}$	λ_{HT} [h]$^{-1}$	μ_T [h]$^{-1}$	μ_{HT} [h]$^{-1}$
TPA1	$1.47 \cdot 10^{-4}$	$1.46 \cdot 10^{-4}$	$5 \cdot 10^{-5}$	$4{,}17 \cdot 10^{-2}$
TPA2	$4.42 \cdot 10^{-4}$	$1.47 \cdot 10^{-7}$	$4{,}17 \cdot 10^{-3}$	$6.94 \cdot 10^{-3}$

λ: Tasso di guasto
μ: Tasso di riparazione

Tab.1: Parametri del sistema

Outline


Introduzione
Metodo usato
Parametri temporali: RAM
Modello
Risultati
Parametro deterministico: Safety
Modello
Risultati
Conclusioni

Metodo usato

OBIETTIVI

Probabilistici

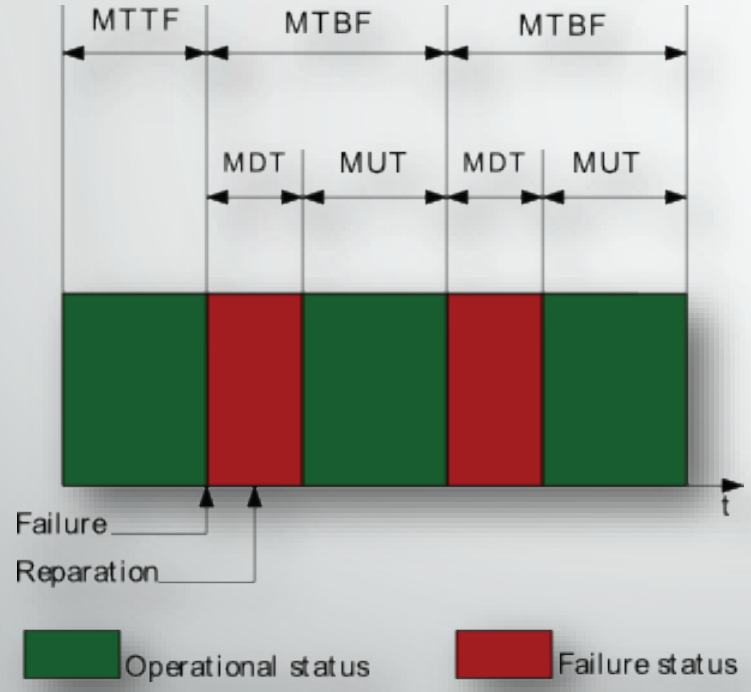


Fig.3 : Parametri associati alla fidatezza (RAM)

Deterministici

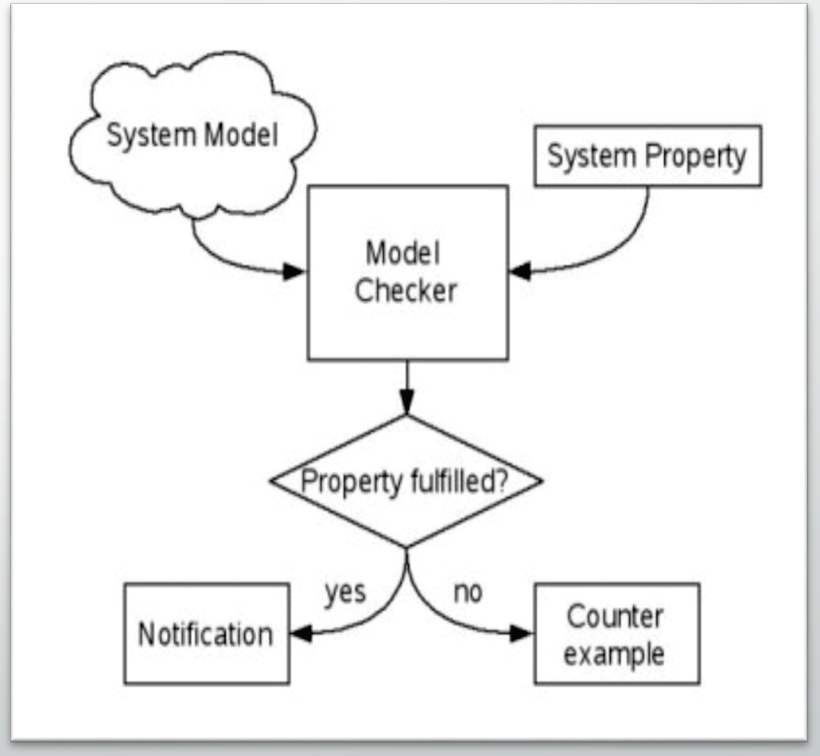


Fig.4 : Diagramma di funzionamento di un model checker

Metodo usato

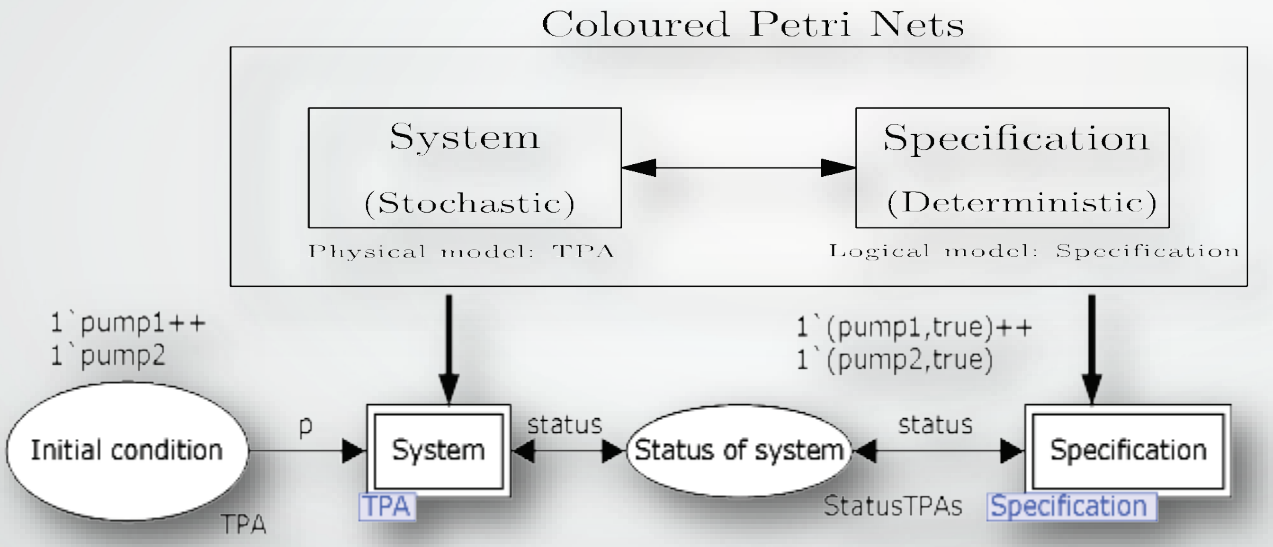
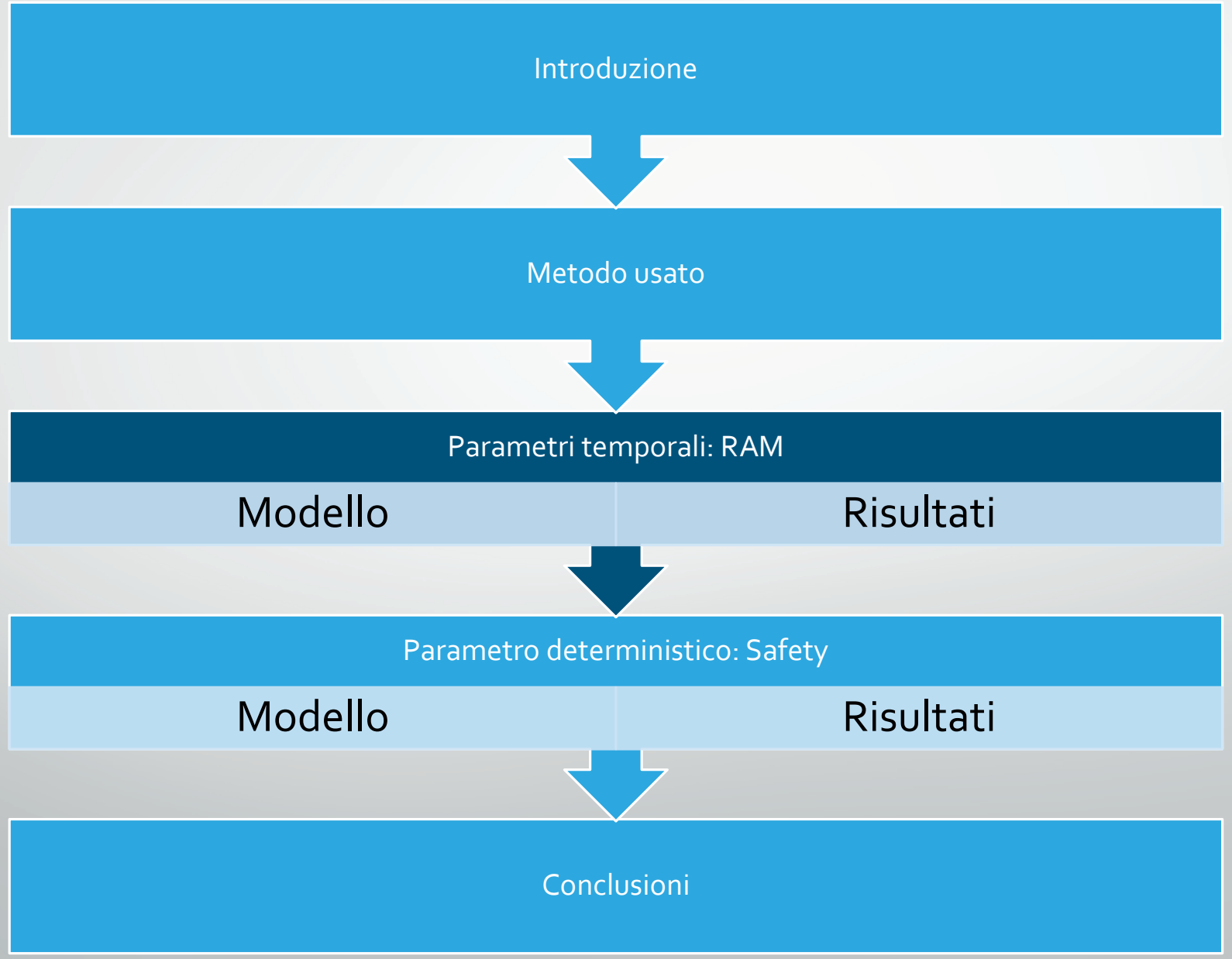


Fig.5: Rappresentazione gerarchica del sistema modellato

Outline


Introduzione
Metodo usato
Parametri temporali: RAM
Modello
Risultati
Parametro deterministico: Safety
Modello
Risultati
Conclusioni

RAM – Modello fisico

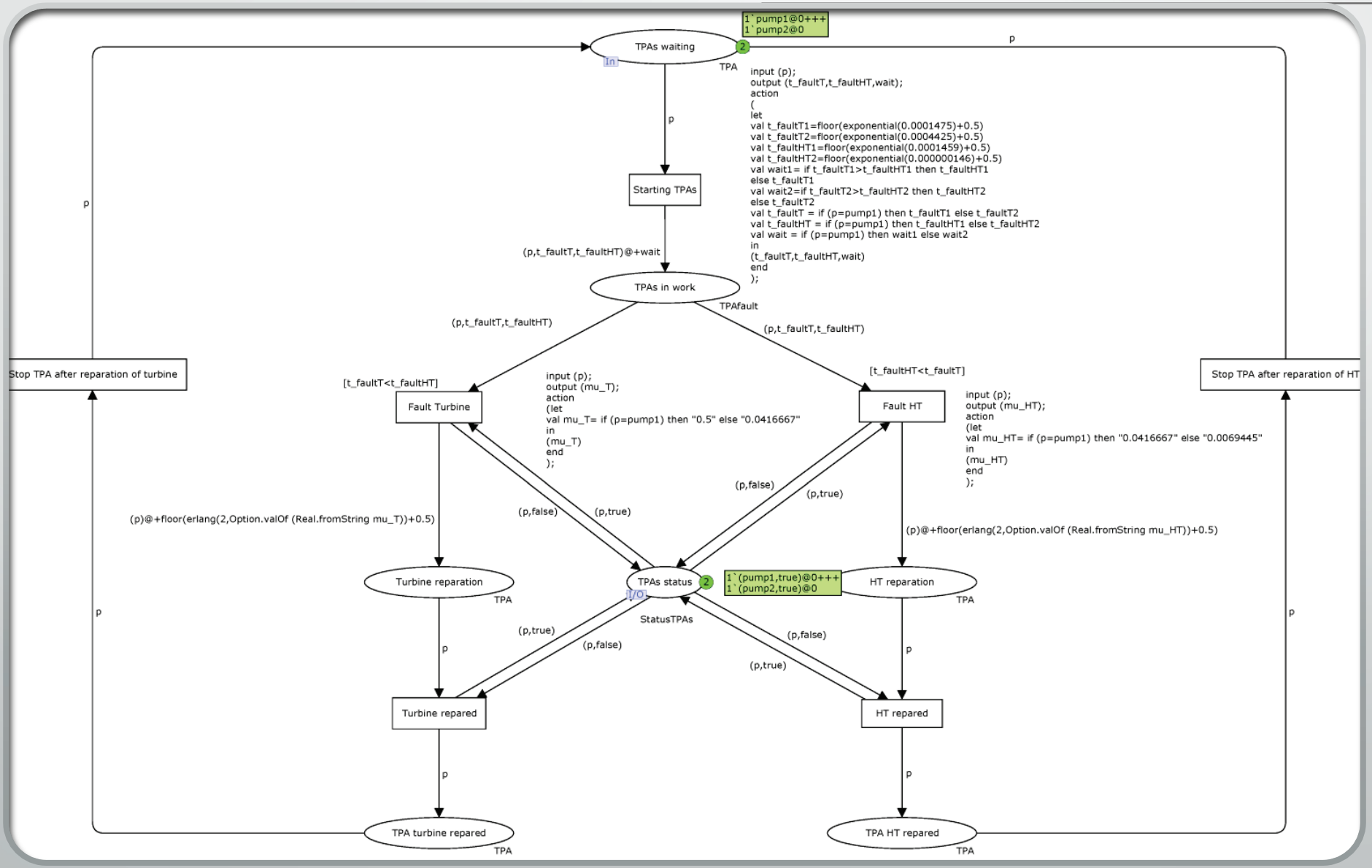


Fig.6: Rete di Petri Colorata, modello fisico

RAM – Modello fisico, dettagli

Calcolo guasto

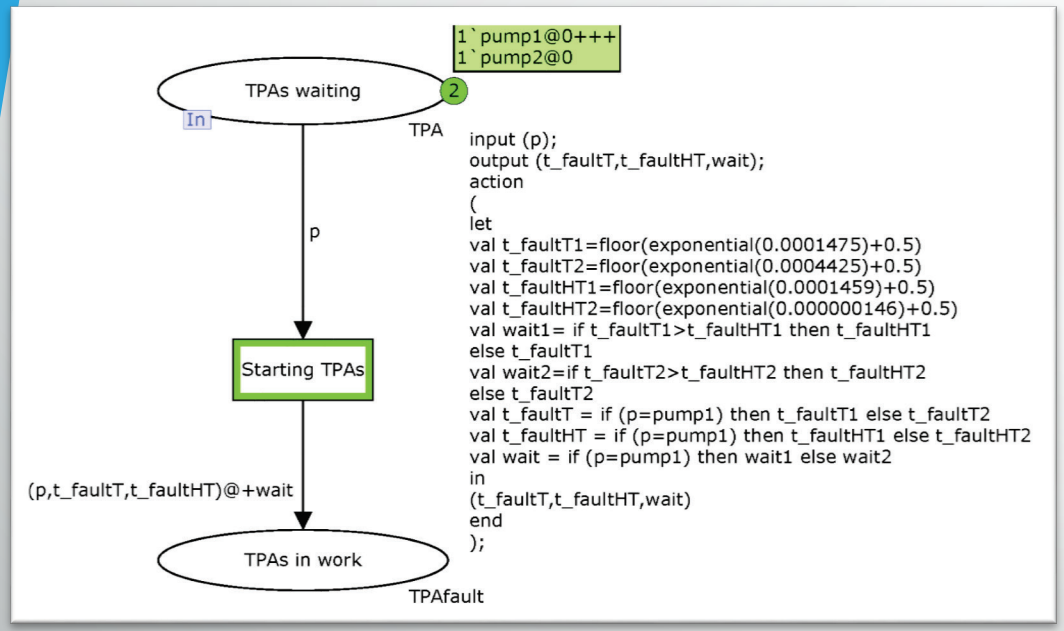


Fig.7: Particolare del modello fisico, avvio.

Calcolo riparazione

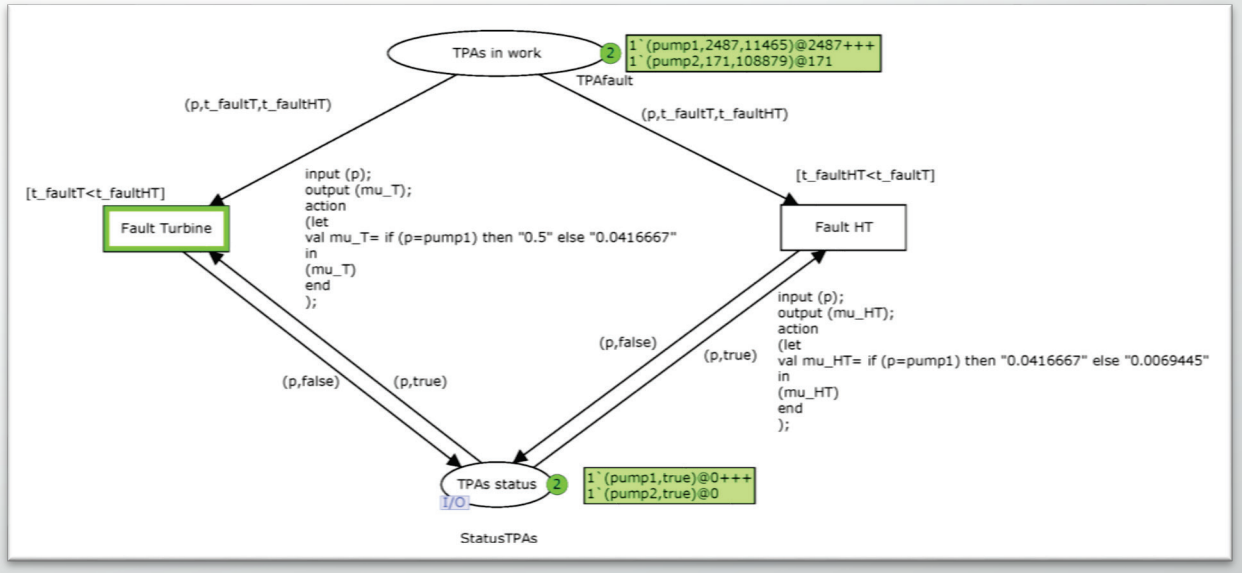


Fig.8: Particolare del modello fisico, guasto.

RAM – Modello fisico

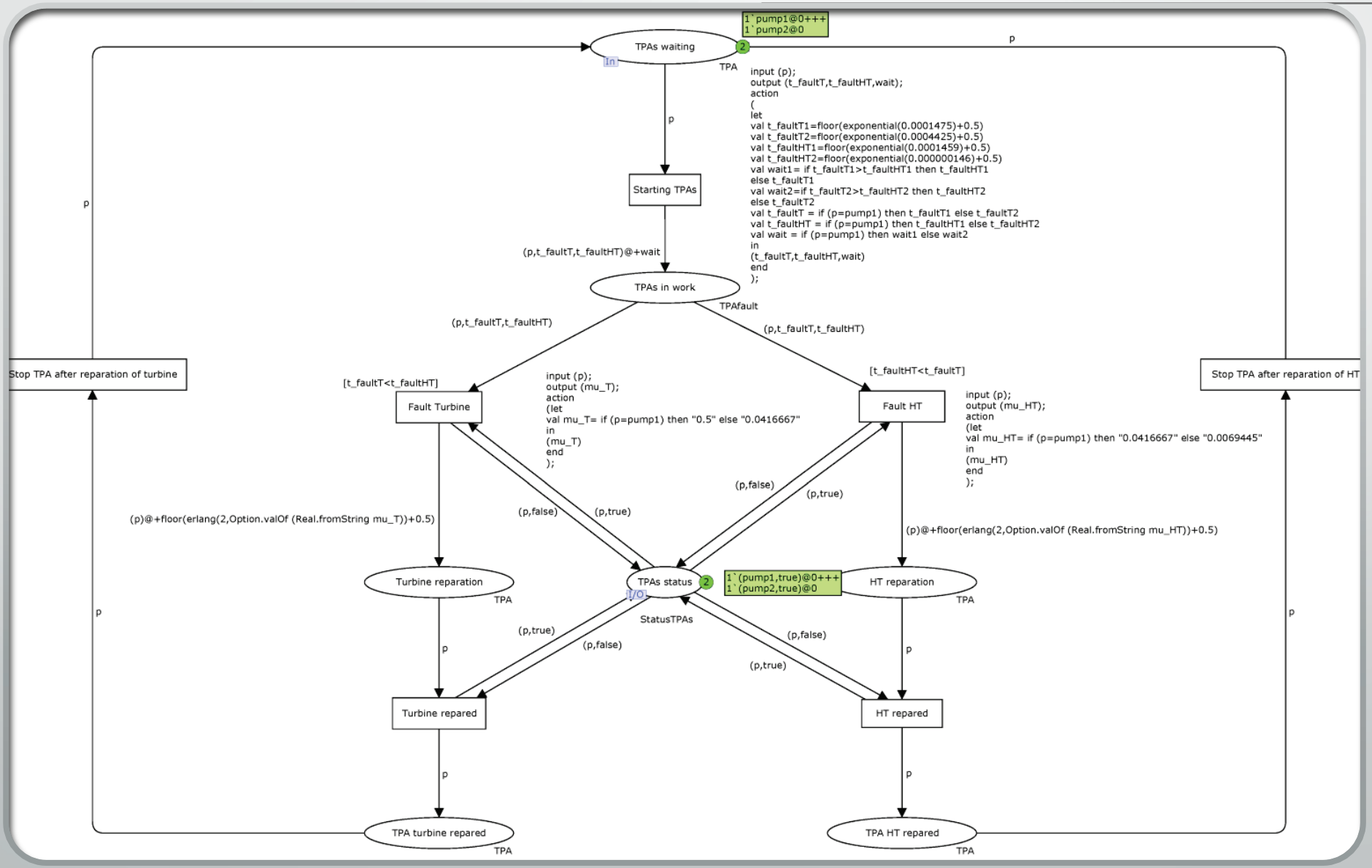


Fig.6: Rete di Petri Colorata, modello fisico

RAM – Modello del controllo

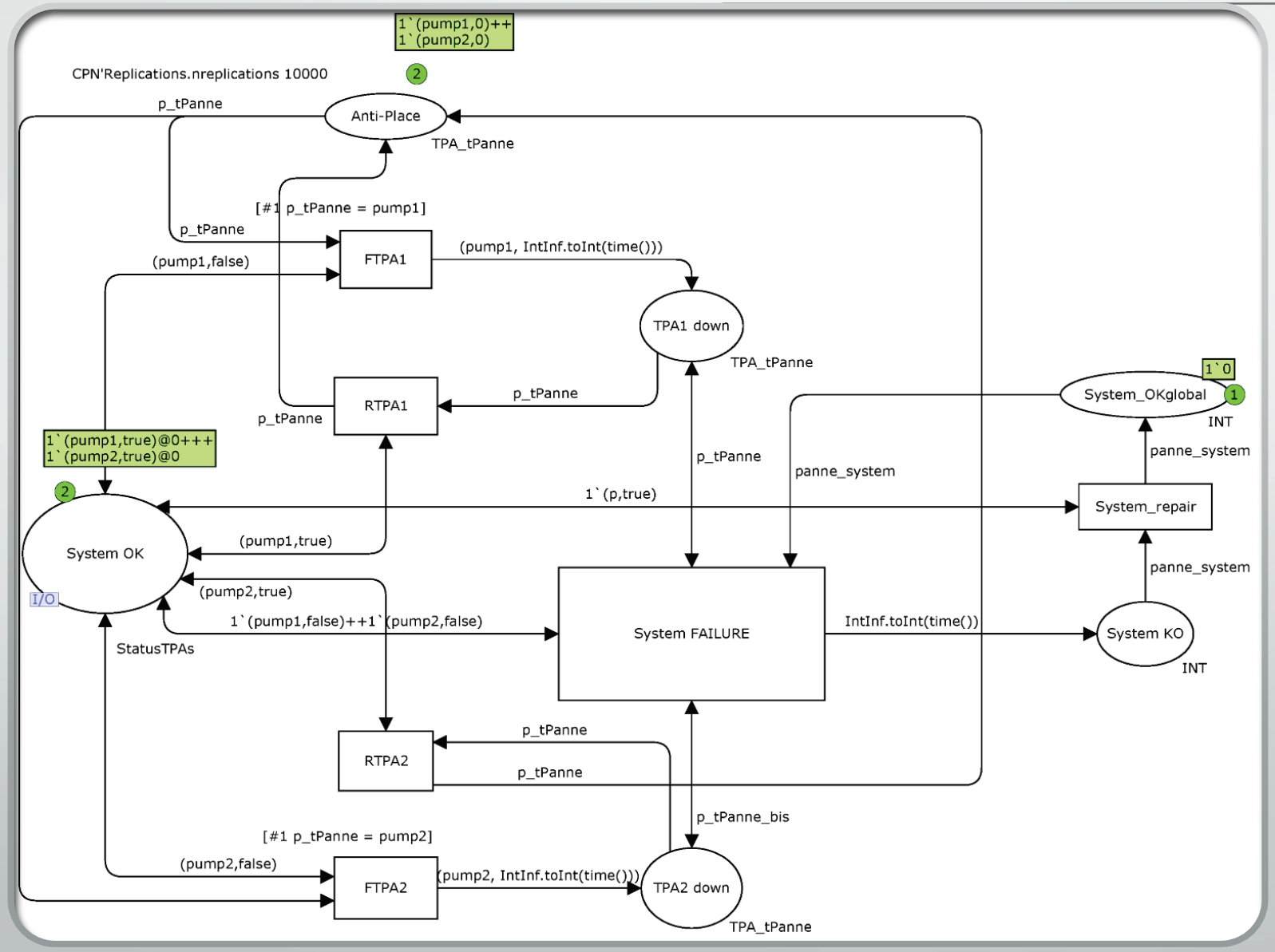
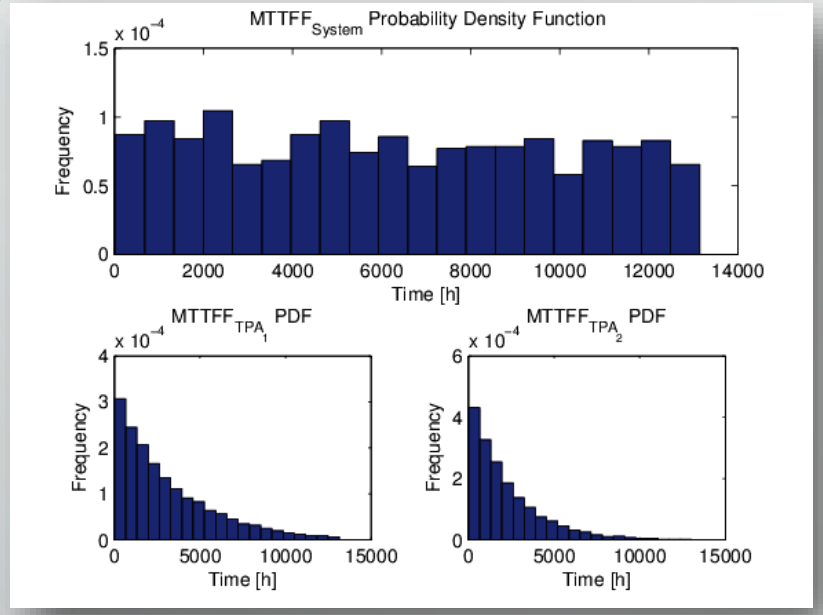


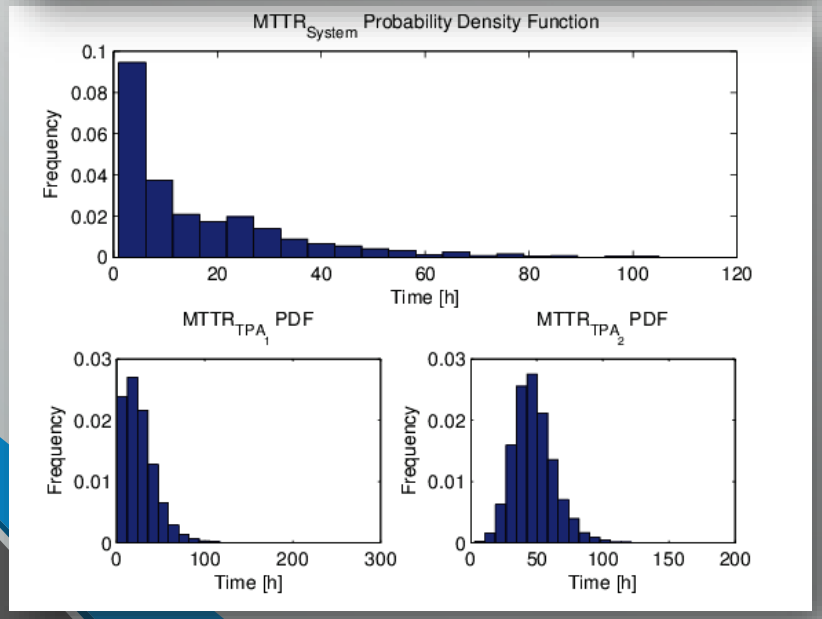
Fig.9: Rete di Petri Colorata, modello del controllo

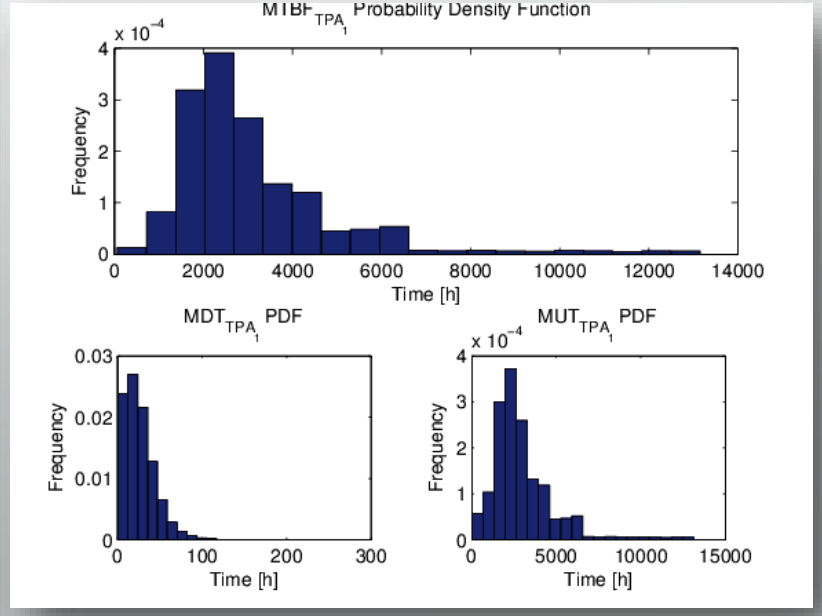
RAM - Risultati



Entità	MTTFF [h]	MTBF [h]	MTTR [h]	MUT [h]	MDT [h]
TPA_1	3111.7	3144.2	26.4	3020.1	26.4
TPA_2	2235.2	2259.2	48	2135.9	48
Sistema	6340.5	6312.8	16.4	6290.9	16.4

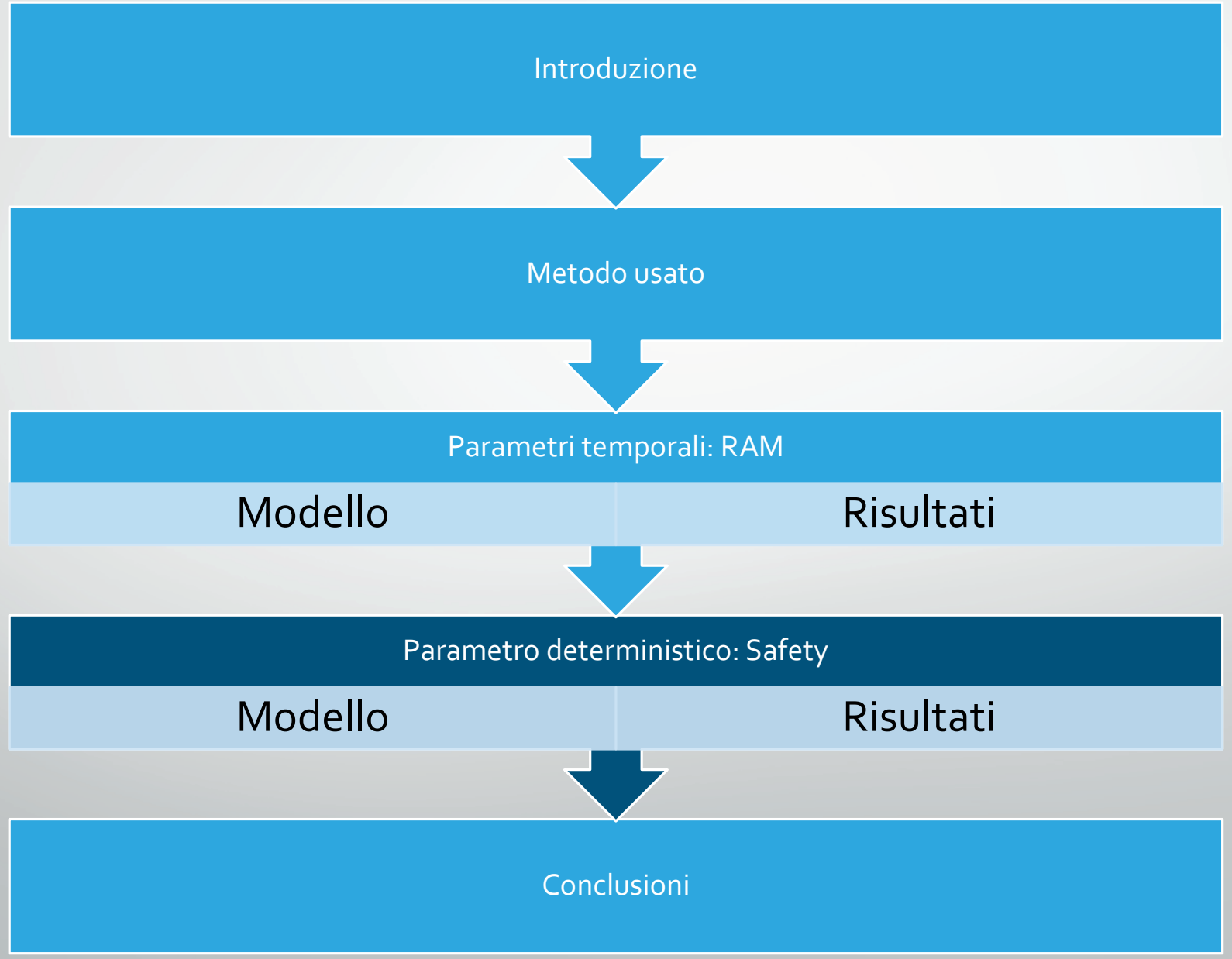
Tab.2: Risultati prestazionali





Varie figure, in alto a sinistra MTTFF, sotto MTTR, ed accanto un particolare della TPA_1

Outline


Introduzione
Metodo usato
Parametri temporali: RAM
Modello
Risultati
Parametro deterministico: Safety
Modello
Risultati
Conclusioni

Safety – Modello fisico

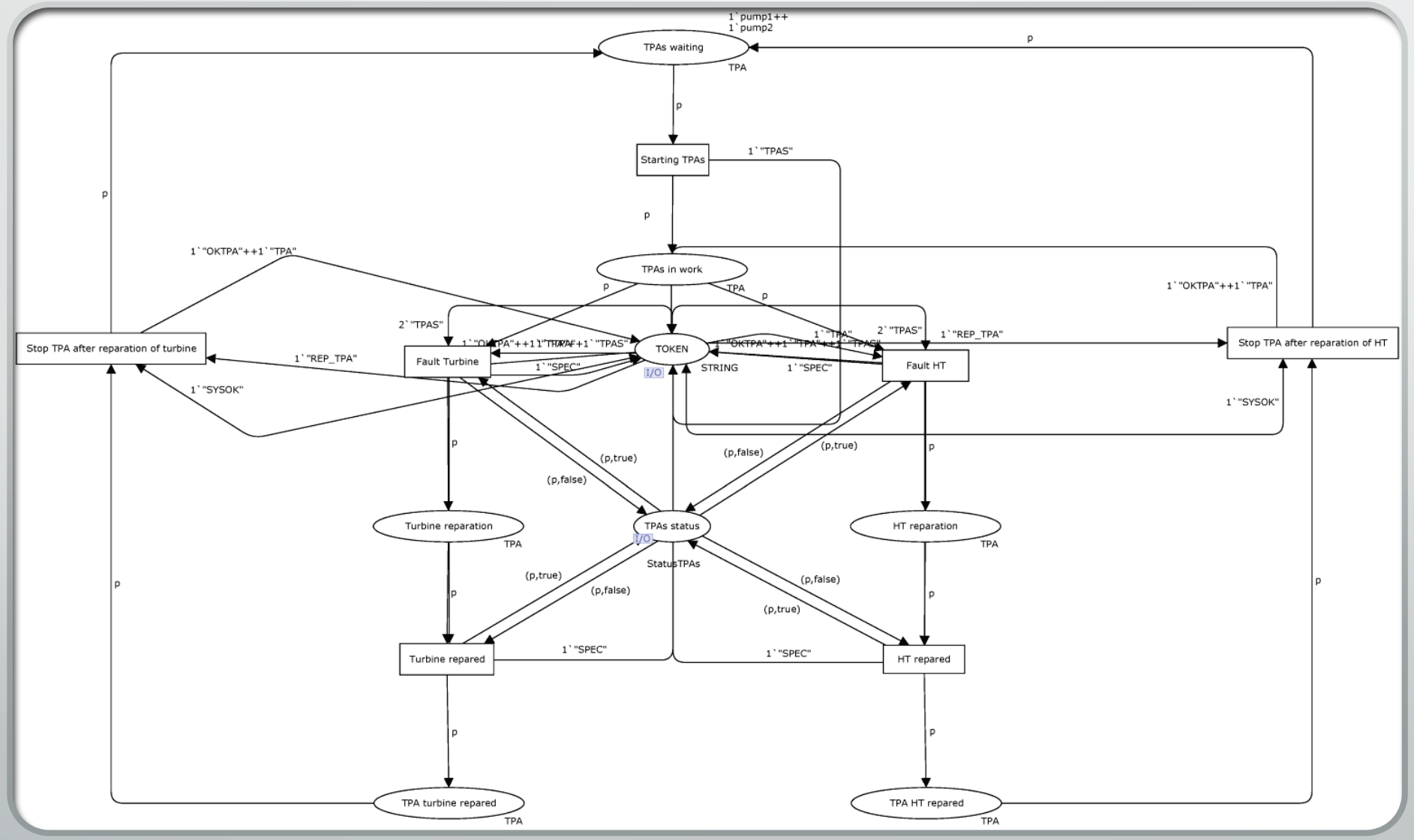


Fig.10: Rete di Petri Colorata deterministica, modello fisico

Safety – Modello del controllo

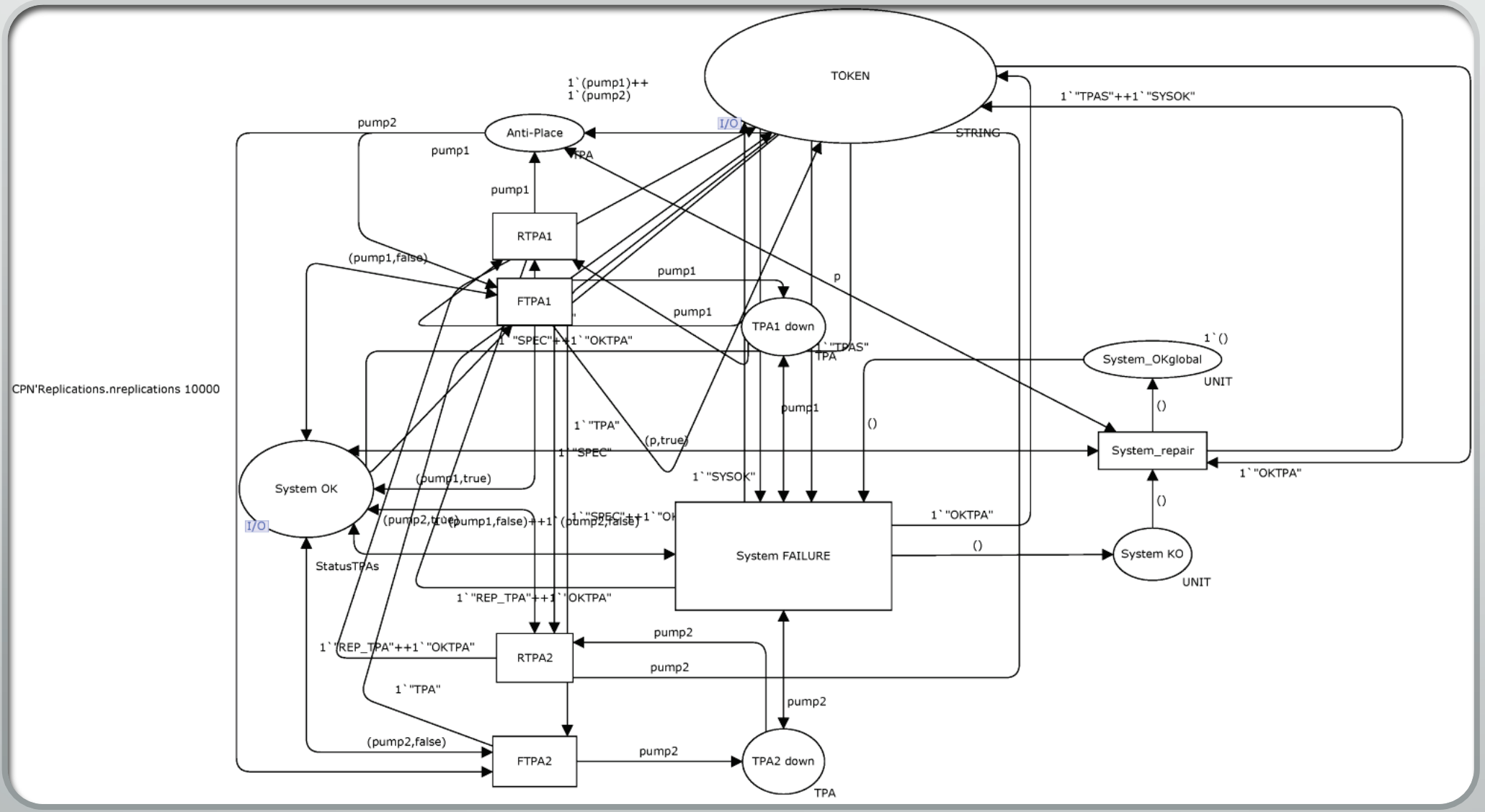


Fig.11: Rete di Petri Colorata deterministica, modello del controllo

Safety - Risultati

Spazio di stato :
72 nodi
100 archi

Formal model verification

CPN Tools

Old state space tool

Pros

- Implemented in CPN Tools GUI
- State space graph
- Text report
- CTL implemented
- Manual and support exist

Cons

- No LTL implementation
- Limited CTL
- Difficult exploration of the state space

New state space tool (ASAP)

Pros

- LTL Model Checking
- Faster generation of state space
- State reduction techniques

Cons

- No GUI, no state space graph
- No documentation, limited support
- Uncommented source code
- SML code difficult to understand

ProM - Process Mining workbench

Pros

- Import CPN models
- LTL model checking with timed model

Cons

- Model checking made by a simulation trace, thus cannot ensure if the entire state space is checked

Fig.12: Le tecniche usate per la verificazione

Safety – Risultati - ASAP

TOY

- 3 nodi
- 4 archi

```
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                (2,{toy_model={broken=[()],init=[],work=[]}}),(),
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              NIL|]]}},()),(),())
 : unit MyDFSTraceExploration.storage * unit * unit
```

In figura, risultati di query in CPN Tool con ASAP

MODELLO

- 72 nodi
- 100 archi

```
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```
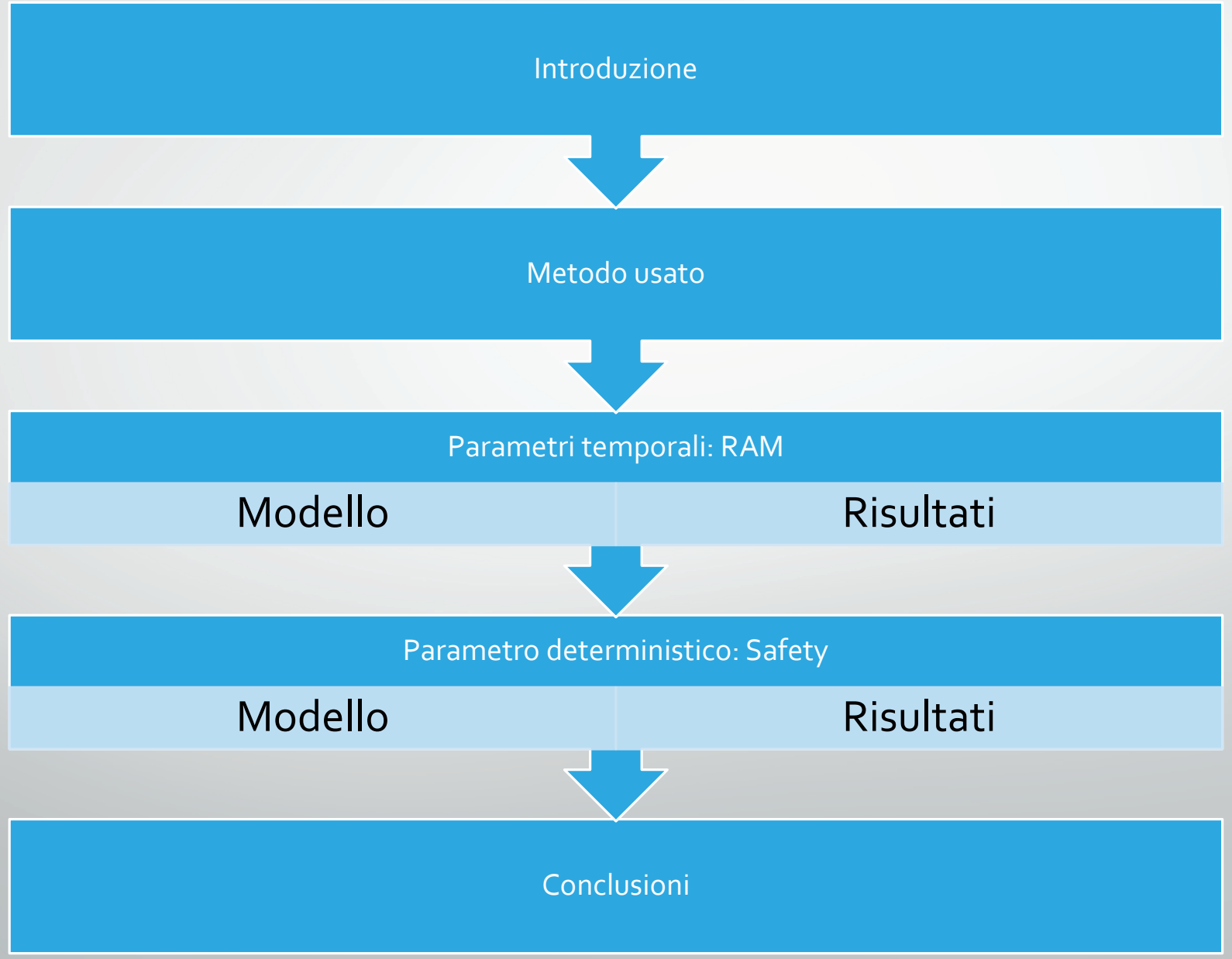

Outline


Introduzione
Metodo usato
Parametri temporali: RAM
Modello
Risultati
Parametro deterministico: Safety
Modello
Risultati
Conclusioni

Conclusioni

RAM

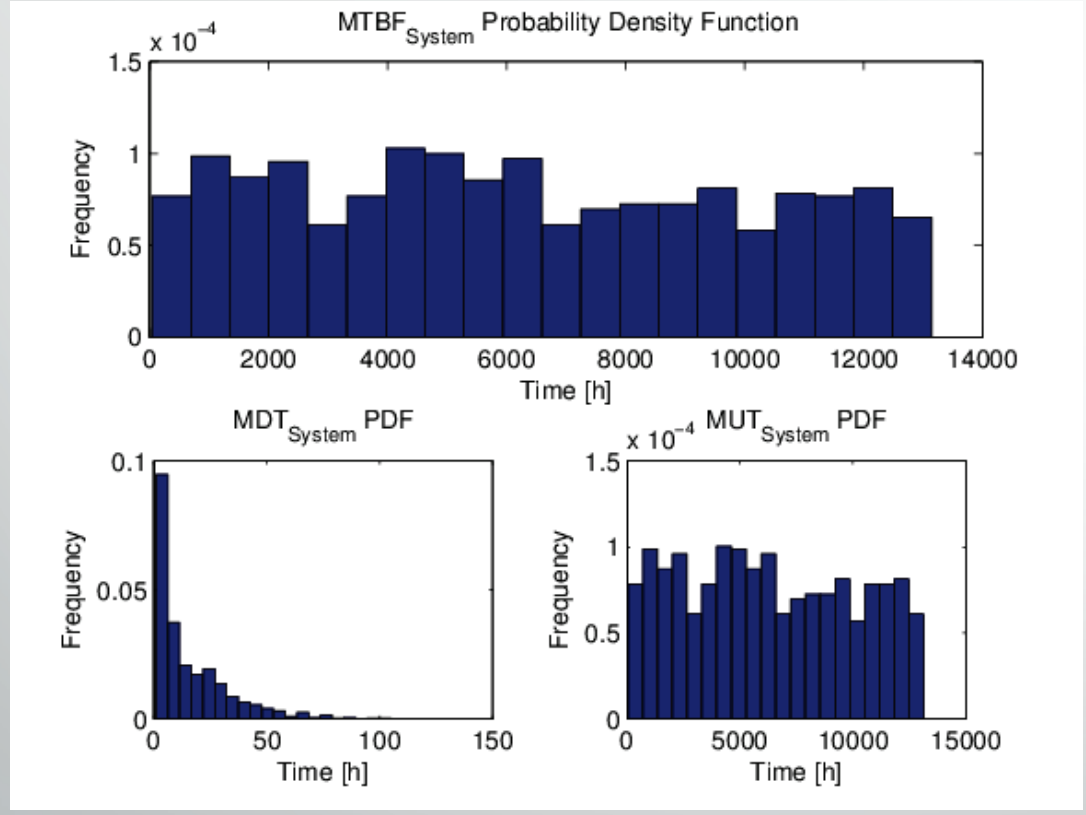


Fig.13: PDF del sistema

Safety

```
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                    NIL,...|]]}},()),(),())
: unit MyDFSTraceExploration.storage * unit * unit
```

Fig.14: Risultato query con ASAP

Don’t watch the clock; do what it does. Keep going.

Sam Levenson