Translating Statecharts to behaviourally equivalent Timed Petri Nets

Matteo Guastella
matteo.guastella@student.uantwerpen.be

University of Antwerp

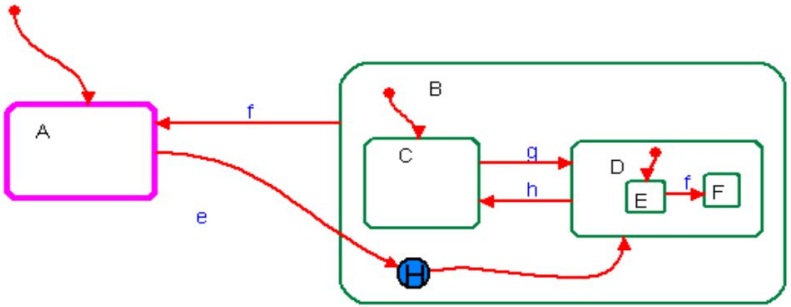
Contents

The Problem

- StateCharts:
  - easy to model complex system watching at the behaviour
- Petri Nets:
  - support the analysis of properties (reliability, safety, …)
  - hard to model complex systems
- We need both when we model complex system.
- Translating automatically StateCharts to Petri Nets can:
  - Improve the analysis of certain properties of the system
  - Maintain the modelling phase easy to do

StateCharts

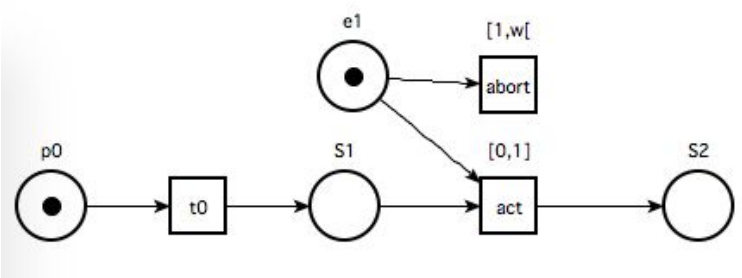
1. Nested states
   - OR-state, AND-state, basic states
2. Transitions can be triggered by
   - Events
   - Timeout events
3. Initial and current flags
4. History pseudo-state



D. Harel, H. Kugler, The Rhapsody Semantics of Statecharts (or, On the Executable Core of the UML), Springer Berlin Heidelberg, Berlin, Heidelberg, 2004, pp. 325–354

TPN

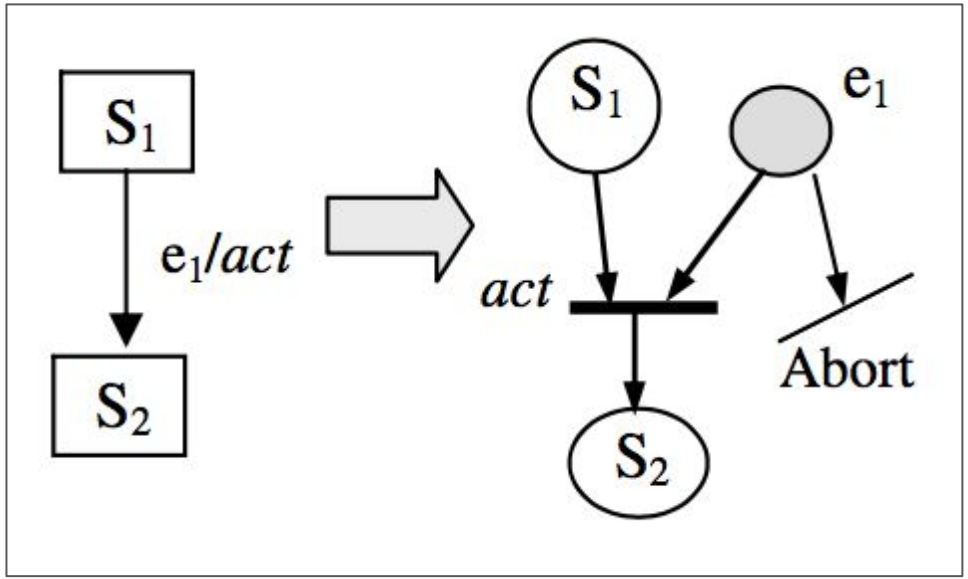
1. Only basic states (Places)
   - Flatten the model (Hammal paper)
   - Maintain hierarchy using multiple places
2. Transitions
   - Events as token in a places
   - Timed petri nets for timeout events
3. Tokens like initial and current flag
4. No concept of history
   - we need a particular pattern of places



Bernard Berthomieu, Louchka Popova-Zeugmann. Time Petri Nets: Theory, Tools and Applications. Xi'an, China, June 24, 2008. URL: http://www2.informatik.hu-berlin.de/~popova/tutorial.html

Transformation...some examples

Event transition

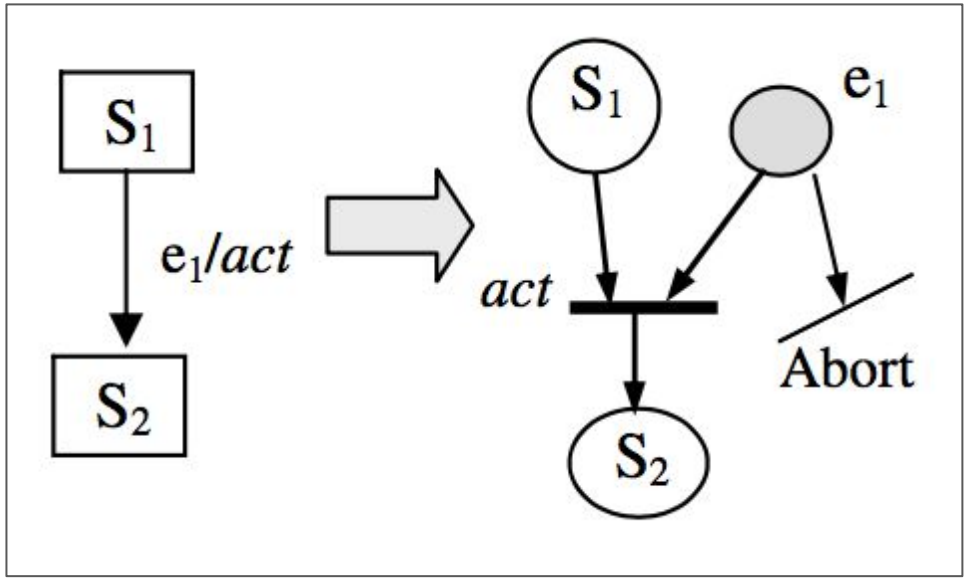


- A place for every state
- A place for every events
- Transition for actions
- Special transition abort

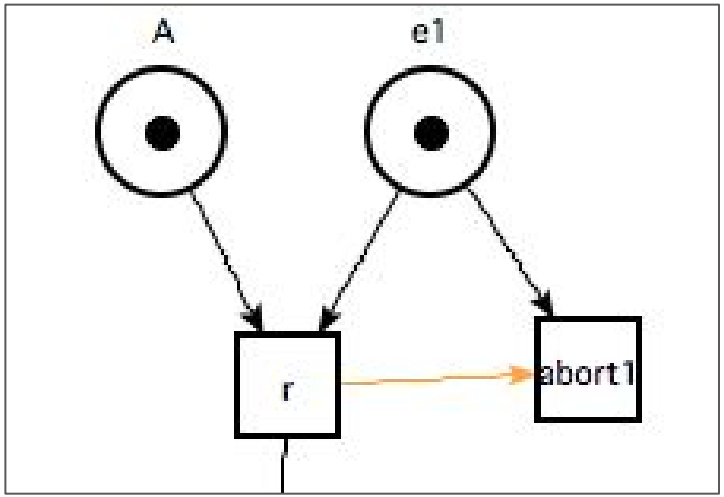
Y. Hammal, A Formal Semantics of UML StateCharts by Means of Timed Petri Nets, Springer Berlin Heidelberg, Berlin, Heidelberg, 2005, pp. 38–52.

Transformation...some examples

Event transition



We need priority between transitions:



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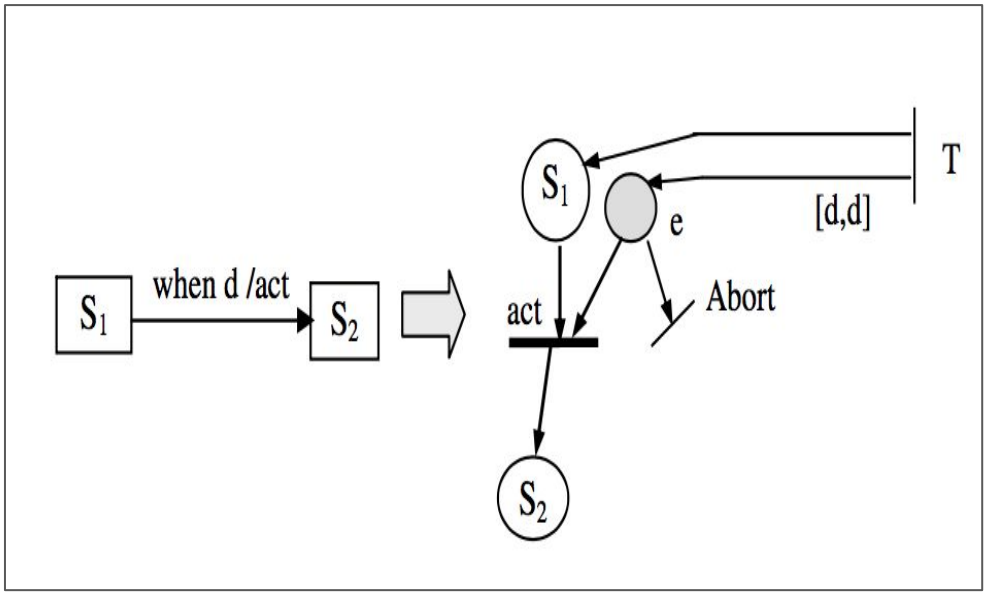
Transformation...some examples

Timed transition



- Transition T
- S1 immediately marked
- e marked after d time

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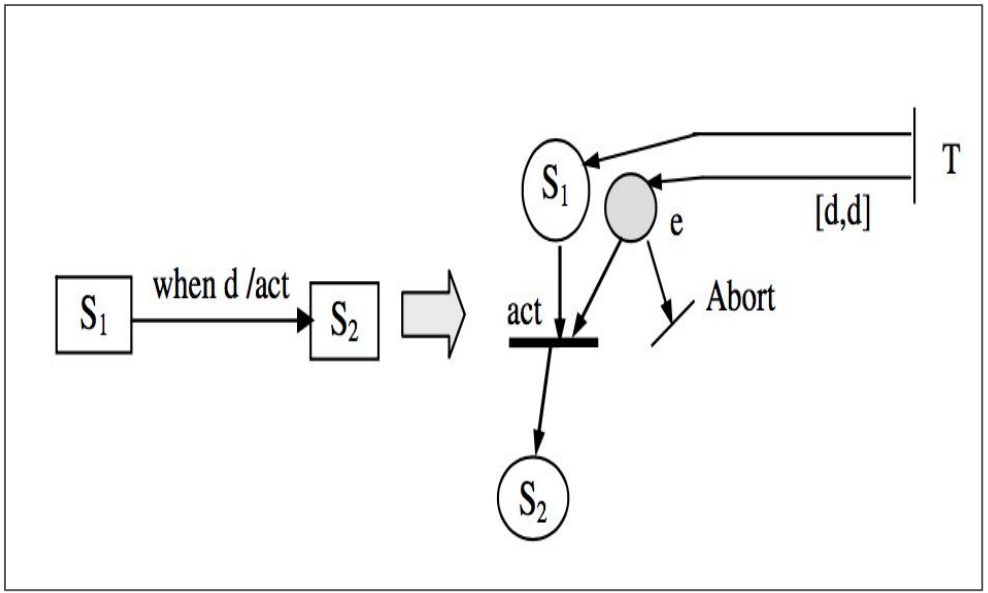
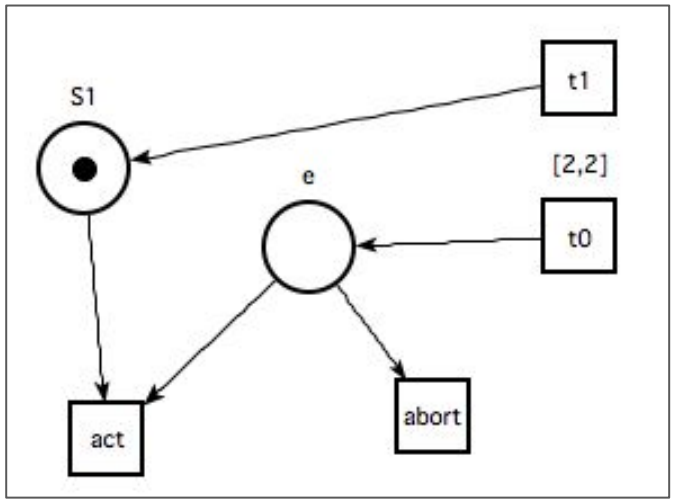
Transformation...some examples

Timed transition



Time interval: [min, MAX]



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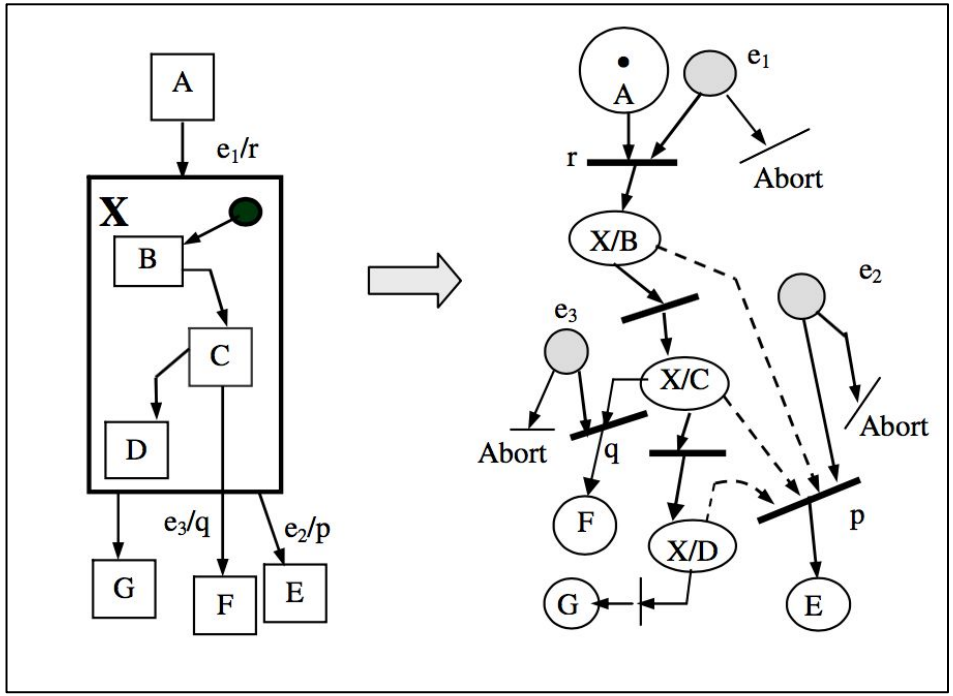
Transformation...some examples

Composite State



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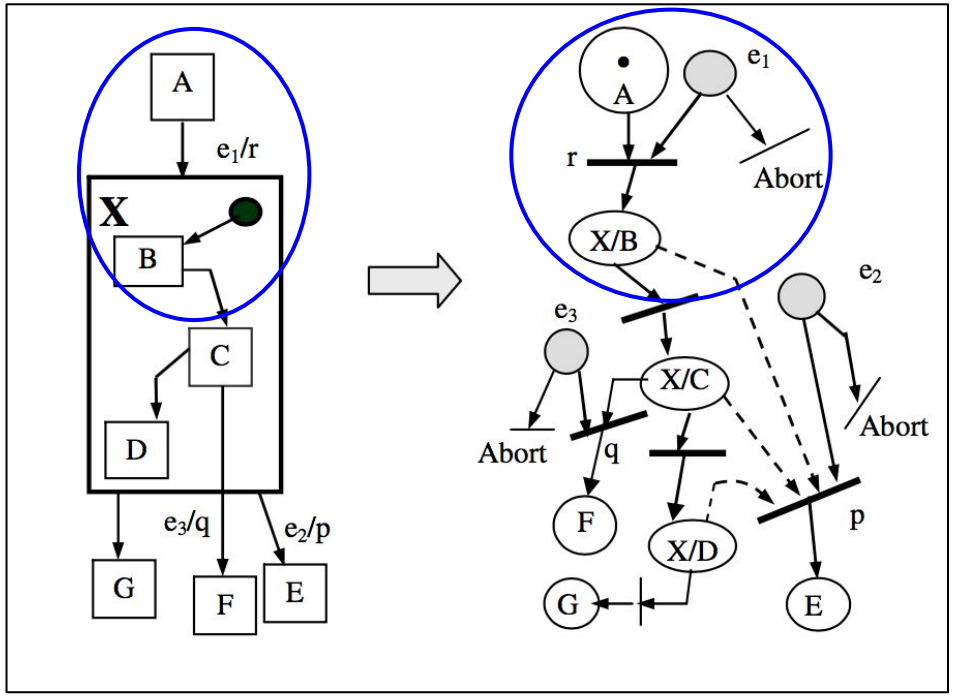

- Entry transition associated with the initial state

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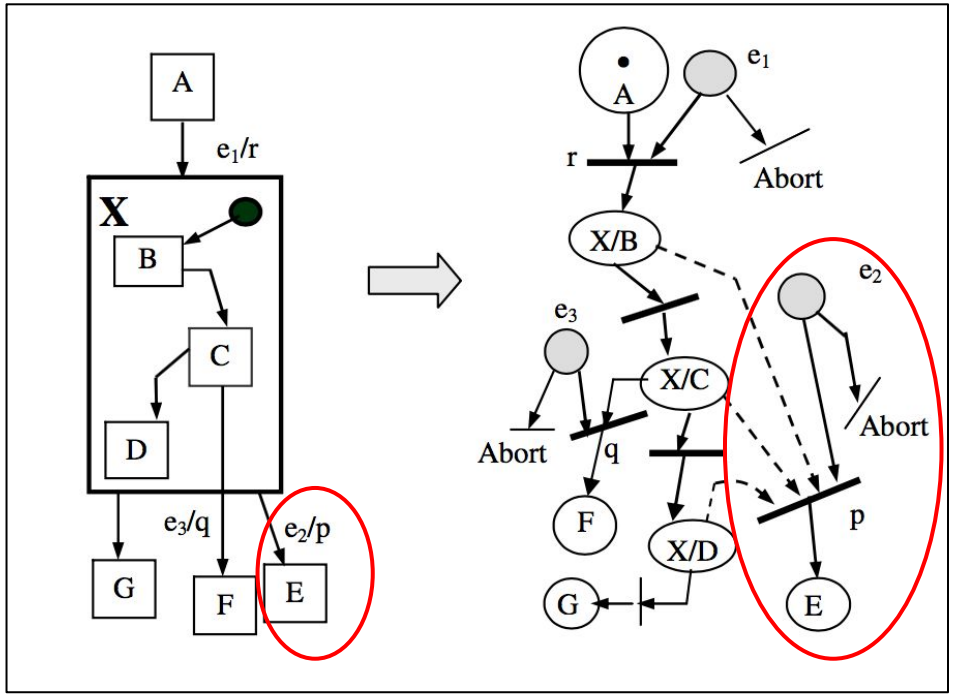
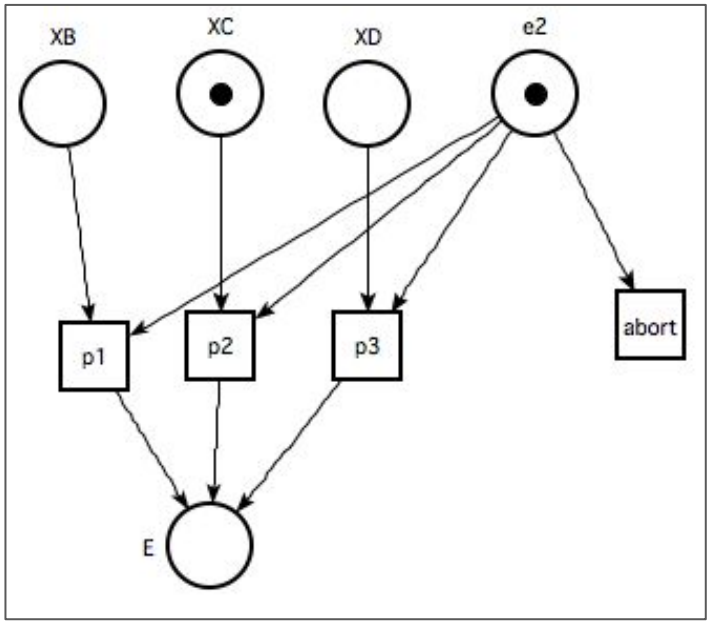
Transformation...some examples

Composite State



XOR arcs



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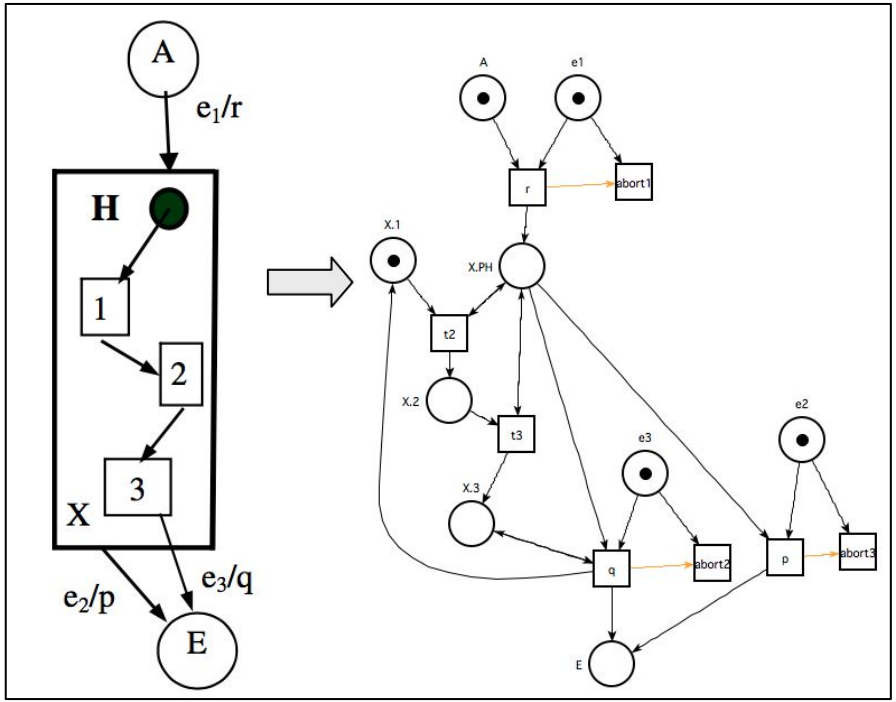
Transformation...some examples

History



- Special place PH createad
  - handle entry and exit transitions
- The initial state is marked with a token
- The memory of the last active configuration of the composite state is represented by the token that goes throw the states.

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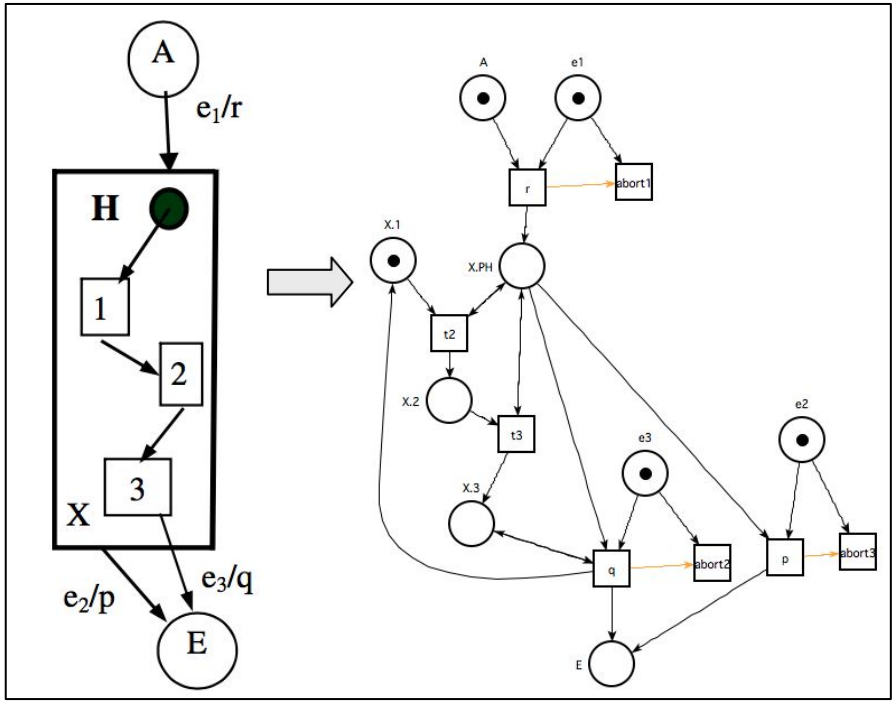
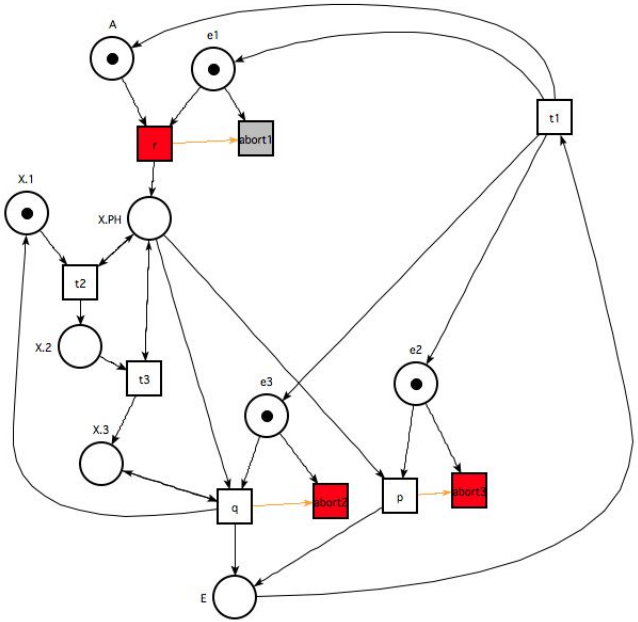


Steps



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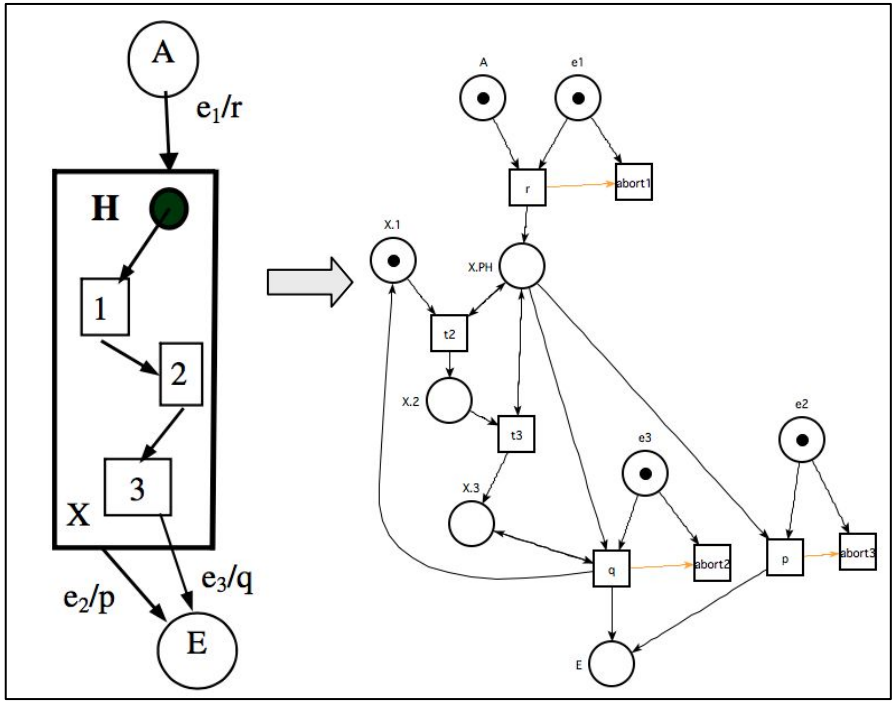

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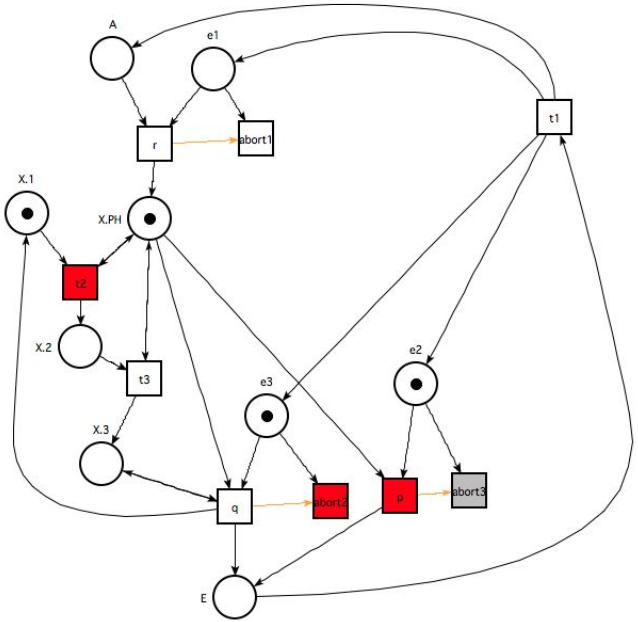

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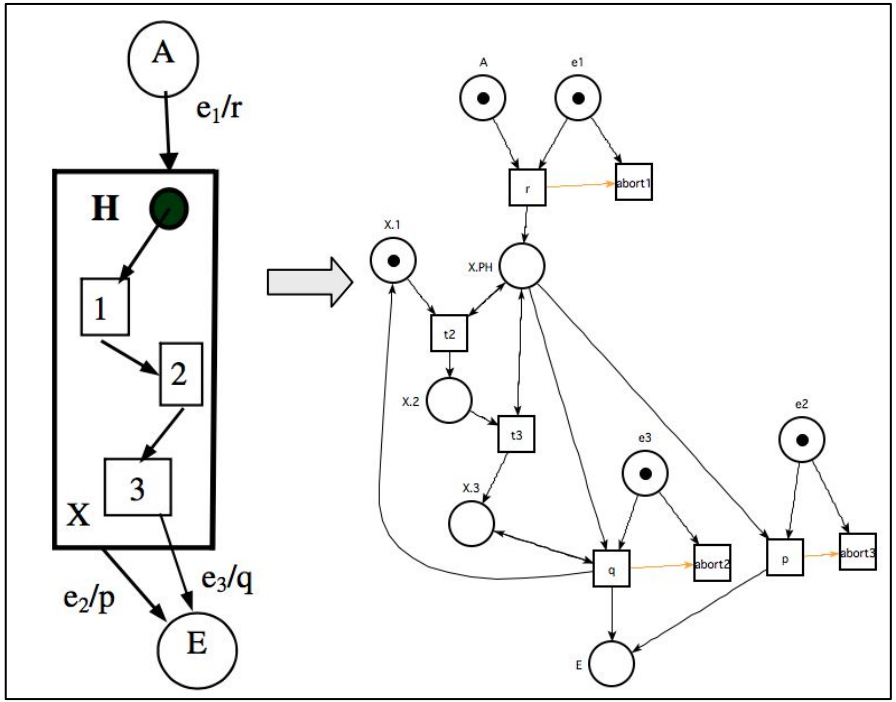

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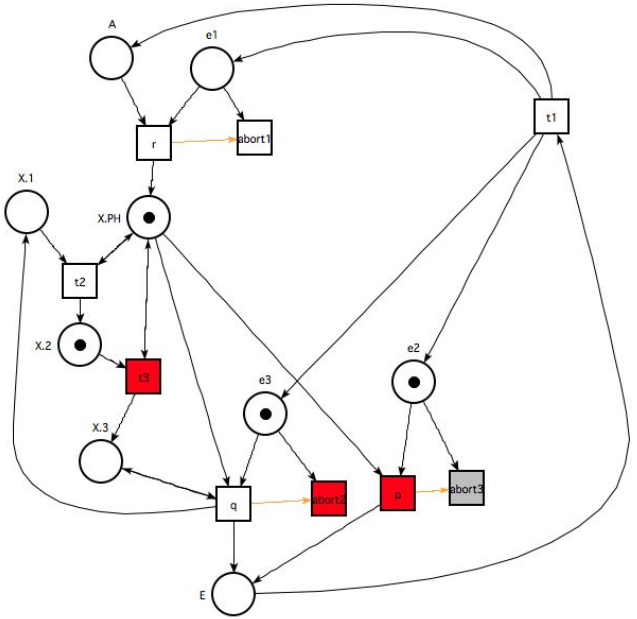

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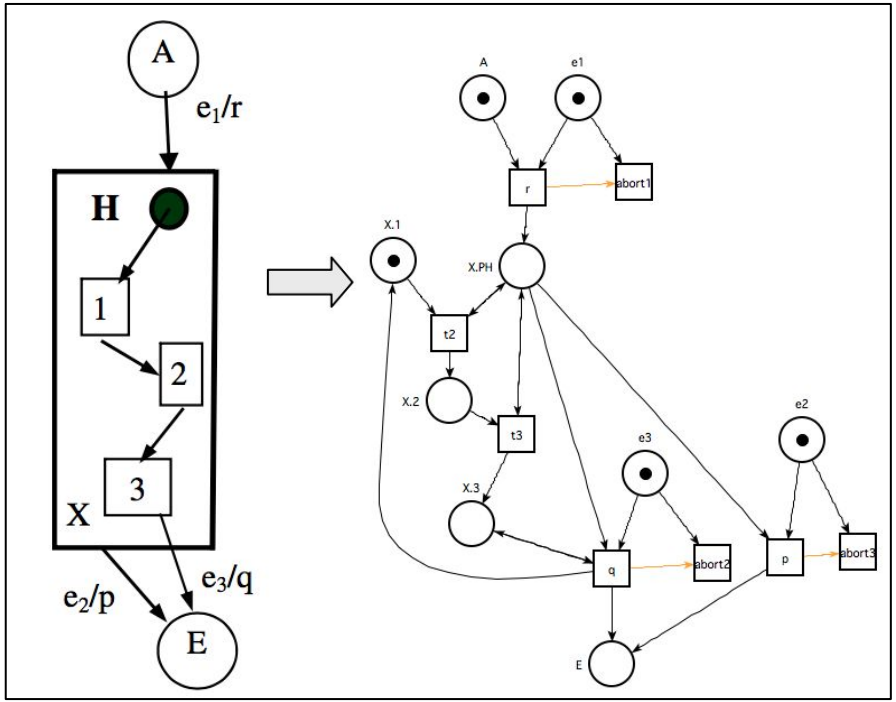

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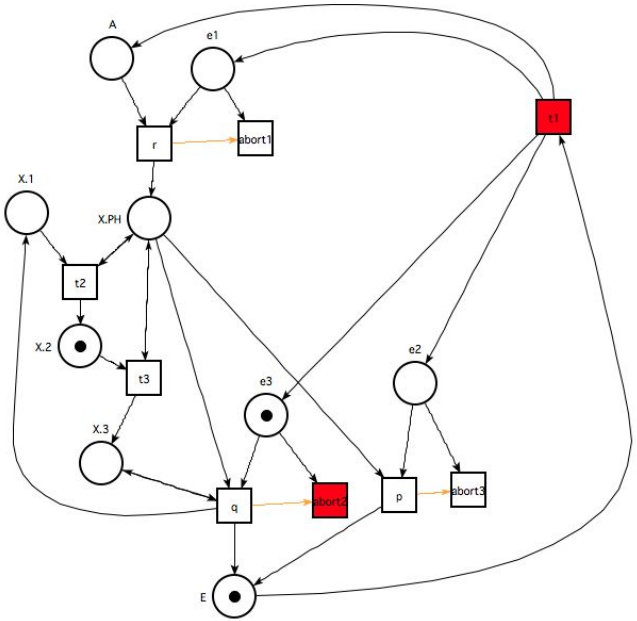

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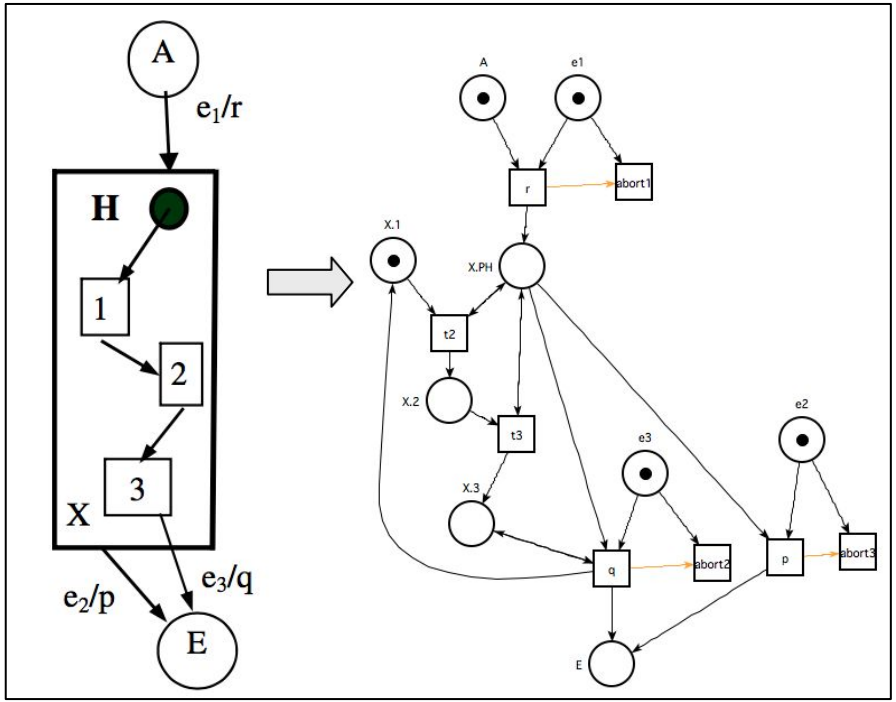

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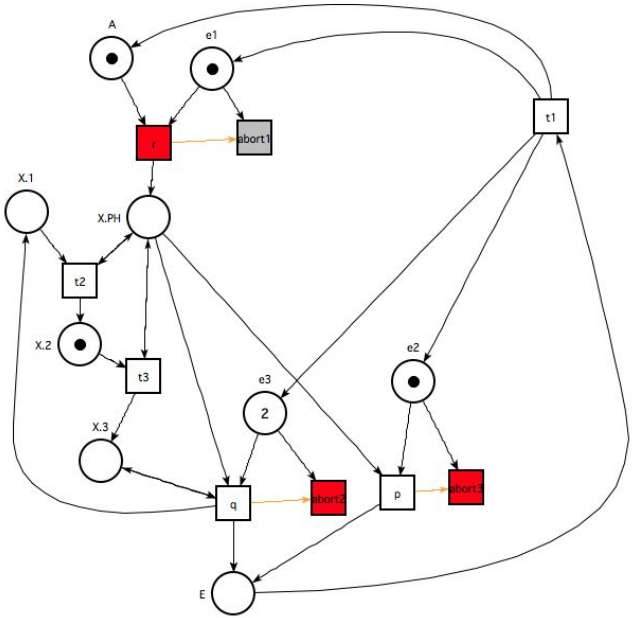

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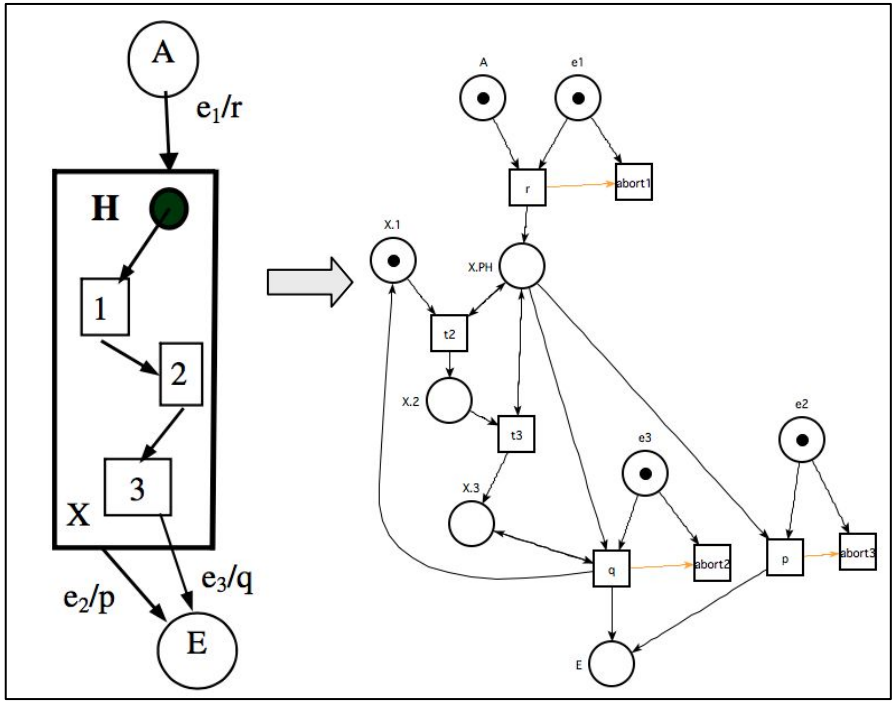

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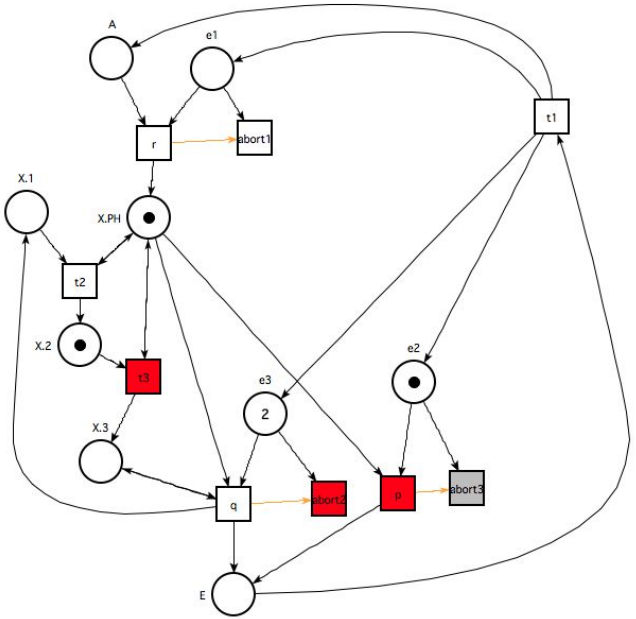

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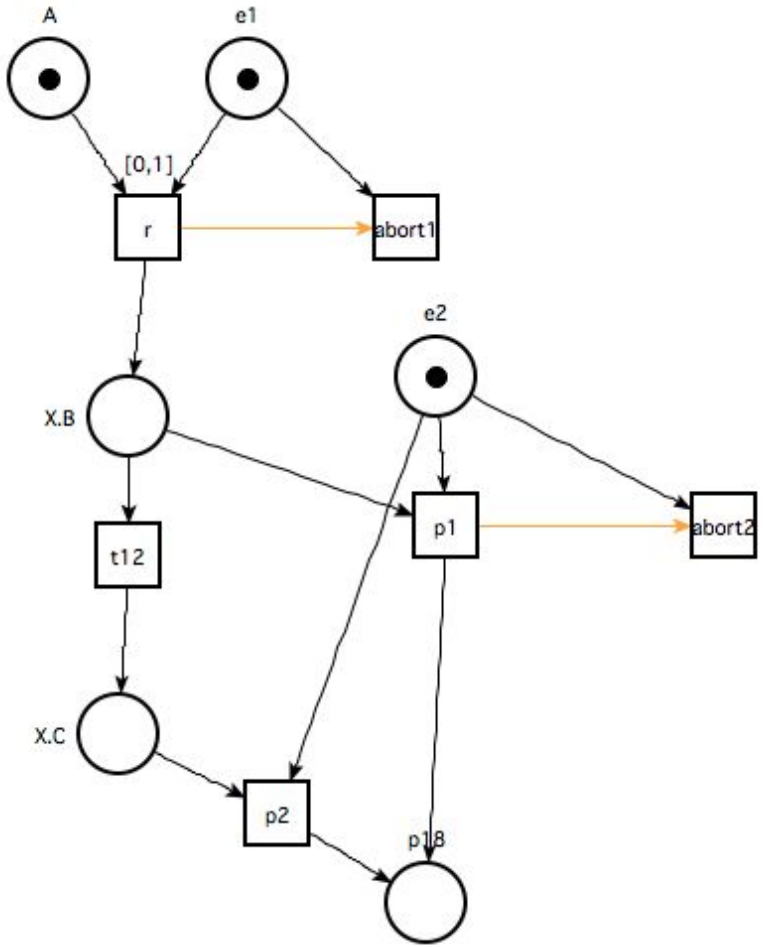
TINA toolbox

- Create Timed Petri Nets
  - Timed transitions
  - Priority between arcs
- Support analysis of TPN
- Possibility of import/export in a textual format (.tpn)

```
tr abort1 [0,w[ e1 ->
tr t12 [0,w[ {X.B} -> {X.C}
tr abort2 [0,w[ e2 ->
tr p1 [0,w[ {X.B} e2 -> p18
tr r [0,1] e1 A -> {X.B}
tr p2 [0,w[ e2 {X.C} -> p18
pl e1 (1)
pl A (1)
pl e2 (1)
pr r r > abort1
pr p1 p1 > abort2
net PN1
```



http://projects.laas.fr/tina/

Project Goals

- Definition of TPN meta-model in AToMPM
- Model Transformation between SC and TPN
- Exporting TPN for TINA analysis
- Verify the correctness of the transformation making a test suite of SC and corresponding TPN (manually generated) and verify if they are the “same”.

Questions?