Tutorial Modelling Software-based Systems

...

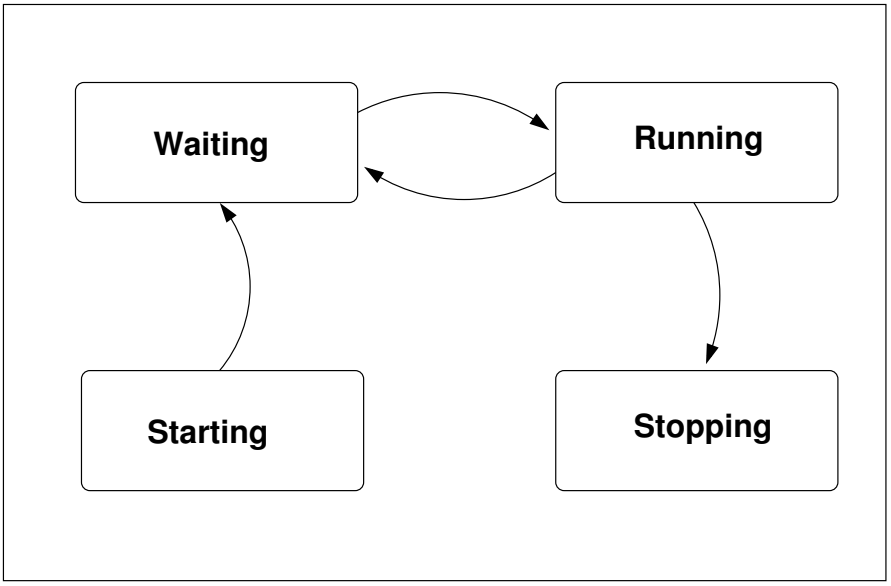
Tutorial 1 : Specifying a problem using the Eevent-B modelling language

Dominique Méry

24 septembre 2025

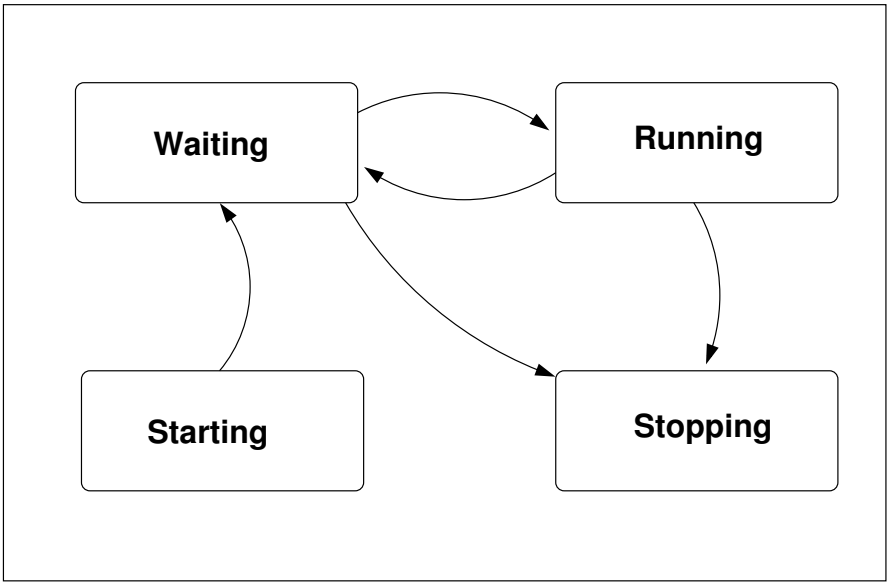
**Exercice 1** *ex1-tut1.zip*

*Express the following states machine using an Event B machines and check properties on the resulting models.*




**Exercice 2** *ex2-tut1.zip*

*Express the following states machine using an Event B machines and check properties on the resulting models.*




**Exercice 3** *(ex3-simple-tut.zip)*

*Soient deux ensembles A et B qui sont des parties de U.*

— *Ecrire un modèle Event-B qui utilise deux variables v et w deux sous-ensembles de A et B*

— *Ajouter une fonction partielle de A dans B.*
— *Définir un événement e1 qui transfert un élément de A dans B s'il n'est pas dans A.*
— *Définir un événement e2 qui crée un lien entre un élément de A et un élément de B.*

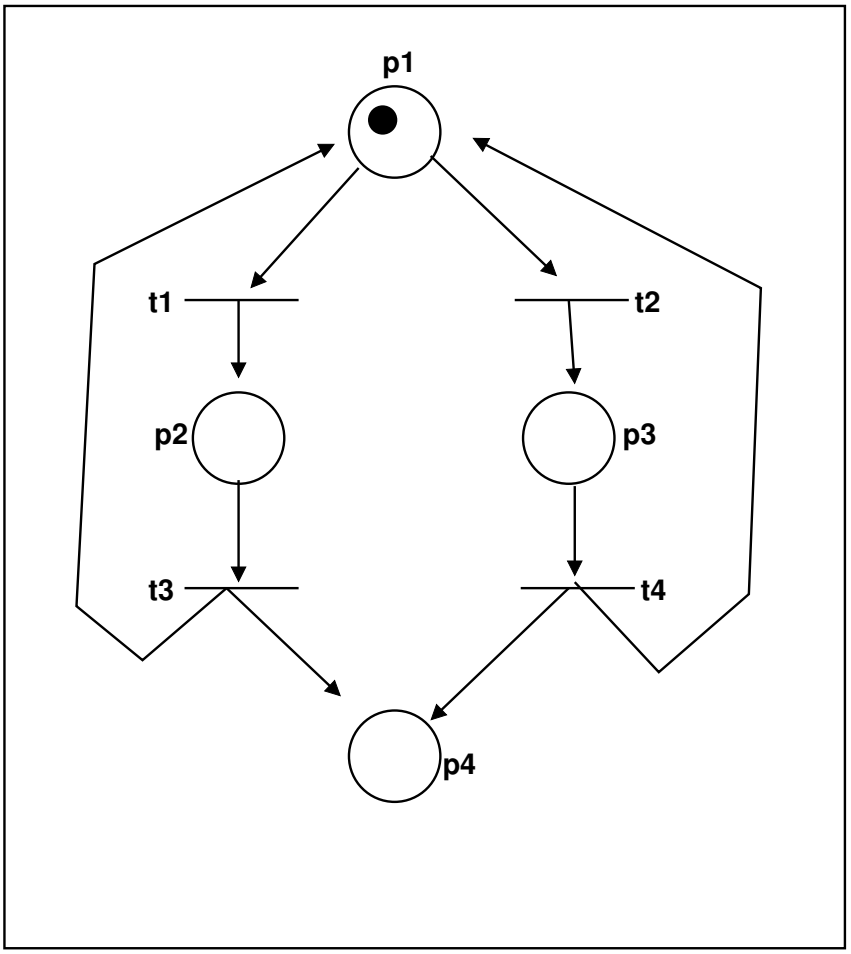
**Exercice 4** *ex4-tut1.zip*
*We consider a finite sequence of integers $v_1, \ldots, v_n$ where $n$ is the length of the sequence and is supposed to be fixed. Write an Event B specification modelling the computation of the value of the summation of the sequence $v$. You should define cerafully $v$, $n$ and the summation of a finite sequence of integers.*

**Exercice 5** *ex51-tut1.zip and ex52-tut1.zip*
*Express the following property in Event B :*
— *(ex51-tut1.zip) We assume to have p resources which may be shared by $n$ processes. If a process uses a given resource, the resource can not be used by another process. A process can use only at most one resource.*
— *(ex52-tut1.zip) We assume to have p resources which may be shared by $n$mcs processes. If a process uses a given resource, the resource can not be used by another process. A process can use possibly more than one ressoyrce. .*

**Exercice 6** *ex6-tut1.zip*
*A Petri net is a uple R=(S,T,F,K,M,W)*
— *S is a finite set of places.*
— *T is a finite set of transitions.*
— *$S \cap T = \varnothing$*
— *F is the flow relation : $F \subseteq S \times T \cup T \times S$*
— *K is expressing the capacity of each place :*
*$K \in S \to Nat \cup \{\omega\}$*
— *M is reprenting the initial marking of each place :*
*$M \in S \to Nat \cup \{\omega\}$ and satisfies the following condition $\forall s \in S : M(s) \leq K(s)$.*
— *W is the weight of each edge :*
*$W \in F \to Nat \cup \{\omega\}$*
*THe state of a Petri net R is defined by a set of markings :*
— *a marking M for R is a function from S to Nat $\cup \{\omega\}$ :*
*$M \in S \to Nat \cup \{\omega\}$ and it satisfies the condition $\forall s \in S : M(s) \leq K(s)$.*
— *a transition t of T is ready to fire for a marking M of R, if*
1. *$\forall s \in \{ s' \in S \mid (s',t) \in F \}$ :*
*$M(s) \geq W(s,t)$.*
2. *$\forall s \in \{ s' \in S \mid (t,s') \in F \}$ :*
*$M(s) \leq K(s) - W(s,t)$.*
— *$t \in T$ : $Pre(t) = \{s' \in S : (s',t) \in F\}$ and $Post(t) = \{s' \in S : (t,s') \in F\}$*
*The simulation of a Petri net is defined by a relation linking three elements : a marking $M$, a marking $M'$ and a transition $t$ as follows :*
— *the new marking M' is defined as follows from $M$ :*

$$M'(s) = \begin{cases} M(s) - W(s,t), & \text{si } s \in Pre(t) - Post(t) \\ M(s) + W(t,s), & \text{si } s \in Post(t) - Pre(t) \\ M(s) - W(s,t) + W(t,s), & \text{si } s \in Pre(t) \cap Post(t) \\ M(s), & \text{sinon} \end{cases}$$

*We consider the following Petri net :*




**Question 6.1** *Translate this Petri net in Event B.*

**Question 6.2** *Express safety properties that you can discover from the diagram.*

**Exercice 7** *(ex7-tut1.zip)*
*Nous considérons le modèle suivant.*

*MACHINE* $M1$
***VARIABLES***
$x$
***INVARIANTS***
...
*EVENTS*
EVENT *INITIALISATION*
***BEGIN***
$act1 : x := -10$
***END***
EVENT *evt1*
***WHEN***
$grd1 : x \geq -1$
***THEN***
$act1 : x := x+1$
***END***
EVENT *evt2*
***WHEN***
$grd1 : x \leq -1$
$grd2 : x \geq -44$
***THEN***
$act1 : x := x-1$
***END***
*END*

*On considère plusieurs cas pour l'invariant.*

---

**Question 7.1** *(M1)*

$inv1 : x \in \mathbb{Z}$
$inv3 : x \leq -1$

*Est-ce que toutes les conditions de vérification sont prouvées par le prouveur de l'application Rodin ? Expliquez clairement pourquoi elles sont prouvées ou non.*

**Question 7.2** *(M2)*

$inv1 : x \in \mathbb{Z}$
$inv3 : x \leq -3$

*Est-ce que toutes les conditions de vérification sont prouvées par le prouveur de l'application Rodin ? Expliquez clairement pourquoi elles sont prouvées ou non.*

**Question 7.3** *(M3)*

$inv1 : x \in \mathbb{Z}$
$inv4 : -45 \leq x \wedge x \leq -10$

*Est-ce que toutes les conditions de vérification sont prouvées par le prouveur de l'application Rodin ? Expliquez clairement pourquoi elles sont prouvées ou non.*

**Question 7.4** *(M4)*

$inv1 : x \in \mathbb{Z}$
$inv3 : x \leq -3$
$inv4 : -45 \leq x \wedge x \leq -10$
$inv2 : x \leq -1$

*Est-ce que toutes les conditions de vérification sont prouvées par le prouveur de l'application Rodin ? Expliquez clairement pourquoi elles sont prouvées ou non.*

**Exercice 8** *ex8-tut1.zip*
*A semaphore $s$ is a shared variable accessible by two operations : $P(s)$ and $V(s$. Informally, we can describe the effect of these two operations as follows :*

- *$P(s)$ is testing if the value of $s$ is greater than $0$ and is not equal to $0$. Il the value of $s$ is 0, the process which is executing $P(s)$ is inserted in a queue.*
- *$V(s)$ is increasing the value of $s$ by one, if the queue is non empty. If the queue is non empty, the first waiting process of the queue is awaken and becomes a lively process.*

*Using the Event B modelling features, describe a system using the primitives.*

**Exercice 9** *ex9-tut1.zip*
*We assume that two $n \times n$ matrices of boolean values are given : $A$ and $B$.*
*Write an Event B specification modelling the multiplication of the two matrcices.*

**Exercice 10** *(ex10-1-tut1.zip and ex10-2-tut1.zip )*
*A system is used to sum two numbers x0 and y0 by adding one unit to a variable z. It includes an incx2z event which decreases the value of x by one and increases the value of z by one, and an incy2z event which decreases y by one and increases z by one. The overall process stops when the two variables x and y are zero.*
*Write a model in Event-B for the syste.*