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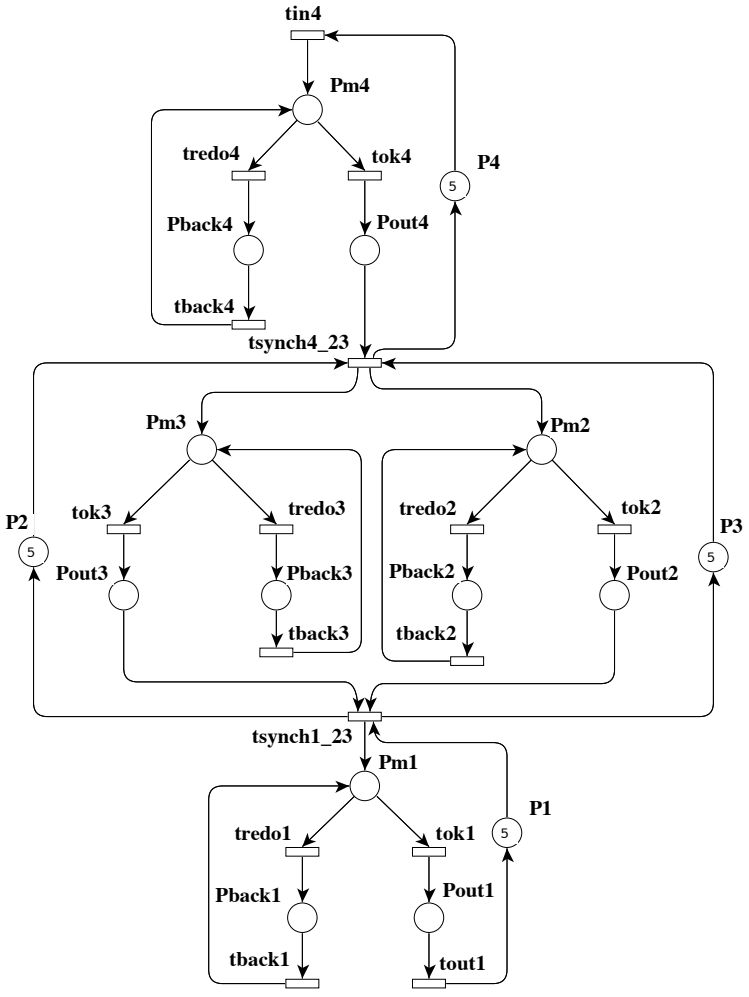
*This form is a summary description of the model entitled "Kanban" proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, unfolded P/T nets. Models are given together with property files (possibly, one per model instance) giving a set of properties to be checked on the model.*

## Description

This Petri net is extracted a benchmark used for SMART. It models a kanban system.




*Graphical representation for $N = 5$*

## References

http://www.cs.ucr.edu/~ciardo/SMART/

## Scaling parameter

| Parameter name | Parameter description | Chosen parameter values |
|---|---|---|
| N | The scale factor is a value that changes the initial marking of places P1, P2, P3 and P4 (M(P1)=M(P2)=M(P3)=M(P4)=N) | 5, 10, 20, 50, 100, 200, 500, 1000 |

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## Size of the model

Although the model is parameterized, its size does not depend on parameter values.

| | |
|---|---|
| number of places: | 16 |
| number of transitions: | 16 |
| number of arcs: | 40 |

## Structural properties

**ordinary** — *all arcs have multiplicity one* ..... ✔
**simple free choice** — *all transitions sharing a common input place have no other input place* ..... ✔ [a]
**extended free choice** — *all transitions sharing a common input place have the same input places* ..... ✔ [b]
**state machine** — *every transition has exactly one input place and exactly one output place* ..... ✘ [c]
**marked graph** — *every place has exactly one input transition and exactly one output transition* ..... ✘ [d]
**connected** — *there is an undirected path between every two nodes (places or transitions)* ..... ✔ [e]
**strongly connected** — *there is a directed path between every two nodes (places or transitions)* ..... ✔ [f]
**source place(s)** — *one or more places have no input transitions* ..... ✘ [g]
**sink place(s)** — *one or more places have no output transitions* ..... ✘ [h]
**source transition(s)** — *one or more transitions have no input places* ..... ✘ [i]
**sink transitions(s)** — *one or more transitions have no output places* ..... ✘ [j]
**loop-free** — *no transition has an input place that is also an output place* ..... ✔ [k]
**conservative** — *for each transition, the number of input arcs equals the number of output arcs* ..... ✔ [l]
**subconservative** — *for each transition, the number of input arcs equals or exceeds the number of output arcs* ..... ✔ [m]
**nested units** — *places are structured into hierarchically nested sequential units* [n] ..... ✘

## Behavioural properties

**safe** — *in every reachable marking, there is no more than one token on a place* ..... ✘ [o]
**deadlock** — *there exists a reachable marking from which no transition can be fired* ..... ✘ [p]
**reversible** — *from every reachable marking, there is a transition path going back to the initial marking* ..... ?
**quasi-live** — *for every transition t, there exists a reachable marking in which t can fire* ..... ✔ [q]
**live** — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* ..... ?

[a] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[b] stated by CÆSAR.BDD version 2.6 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[c] 2 transitions are not of a state machine, e.g., transition "tsynch1_23".
[d] 4 places are not of a marked graph, e.g., place "Pm3".
[e] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[f] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[g] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[h] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[i] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[j] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[k] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[l] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[m] stated by CÆSAR.BDD version 1.7 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).
[n] the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.lip6.fr/nupn.php
[o] in the initial marking, some places have several tokens (the number of which depends on $N$).
[p] confirmed at MCC'2014 by GreatSPN on 6 instances, by Lola on 4 instances, and by Tapaal on 3 instances.
[q] stated by CÆSAR.BDD version 2.0 on all 8 instances (5, 10, 20, 50, 100, 200, 500, and 1000).

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## Size of the marking graphs

| Parameter | Number of reachable markings | Number of transition firings | Max. number of tokens per place | Max. number of tokens per marking |
|---|---|---|---|---|
| $N = 5$ | 2.5464E+6 [r] | 2.4460E+7 [s] | 5 [t] | 20 [u] |
| $N = 10$ | 1.006E+9 [v] | 1.2032E+10 [w] | 10 [x] | 40 [y] |
| $N = 20$ | 8.0542E+11 [z] | 1.1012E+13 [aa] | 20 [ab] | 80 [ac] |
| $N = 50$ | 1.0426E+16 [ad] | 1.5612E+17 [ae] | 50 [af] | 200 [ag] |
| $N = 100$ | 1.7263E+19 [ah] | 2.6705E+20 [ai] | 100 [aj] | 400 [ak] |
| $N = 200$ | 3.1732E+22 [al]; confirmed at MCC'2014 by GreatSPN and PNMC | ? | 200 [am] | 800 [an] |
| $N = 500$ | 7.0860E+26 [ao] | ? | 500 [ap] | 2000 [aq] |
| $N = 1000$ | ? | ? | ? | 4000 [ar] |

[r] computed at MCC'2013 by Alpina, GreatSPN, ITS-Tools, Marcie, Neco, and PNXDD; confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal.
[s] computed at MCC'2014 by Marcie.
[t] computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.
[u] number of initial tokens, because the net is conservative.
[v] computed at MCC'2013 by Alpina, GreatSPN, ITS-Tools, Marcie, and PNXDD; confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, PNXDD, and Stratagem.
[w] computed at MCC'2014 by Marcie.
[x] computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
[y] number of initial tokens, because the net is conservative.
[z] computed at MCC'2013 by GreatSPN, ITS-Tools, Marcie, and PNXDD; confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, PNXDD, and Stratagem.
[aa] computed at MCC'2014 by Marcie.
[ab] computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
[ac] number of initial tokens, because the net is conservative.
[ad] computed at MCC'2013 by GreatSPN, ITS-Tools, and Marcie; confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Stratagem.
[ae] computed at MCC'2014 by Marcie.
[af] computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
[ag] number of initial tokens, because the net is conservative.
[ah] computed at MCC'2013 by GreatSPN, ITS-Tools, and Marcie; computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
[ai] computed at MCC'2014 by Marcie.
[aj] computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
[ak] number of initial tokens, because the net is conservative.
[al] computed at MCC'2013 by ITS-Tools.
[am] computed at MCC'2014 by GreatSPN and Marcie.
[an] number of initial tokens, because the net is conservative.
[ao] computed at MCC'2014 by PNMC.
[ap] computed at MCC'2014 by PNMC.
[aq] number of initial tokens, because the net is conservative.
[ar] number of initial tokens, because the net is conservative.