This form is a summary description of the model entitled “CircadianClock” 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

The abstract circadian clock model of Barkei and Leiber [BL00] shows circadian rhythms which are widely used in organisms to keep a sense of daily time. The stochastic Petri net of the circadian clock is based on the ODE model of [Vilar2002]. The bounded version of the net was used in [SH2009] and the unbounded version in [Rohr2010].

Graphical representation with parameter N. The left hand side represents the unbounded model from [Vilar2002]. It was made bounded using capacity places on the right hand side. The gray coloured transitions are logic/fusion transitions.

References


Scaling parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Parameter description</th>
<th>Chosen parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>initial number of tokens on places</td>
<td>1, 10, 100, 1000, 10000, 100000</td>
</tr>
</tbody>
</table>
Size of the model

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

- number of places: 14
- number of transitions: 16
- number of arcs: 58

Structural properties

- ordinary — all arcs have multiplicity one
- simple free choice — all transitions sharing a common input place have no other input place
- extended free choice — all transitions sharing a common input place have the same input places
- state machine — every transition has exactly one input place and exactly one output place
- marked graph — every place has exactly one input transition and exactly one output transition
- connected — there is an undirected path between every two nodes (places or transitions)
- strongly connected — there is a directed path between every two nodes (places or transitions)
- source place(s) — one or more places have no input transitions
- sink place(s) — one or more places have no output transitions
- source transition(s) — one or more transitions have no input places
- sink transition(s) — one or more transitions have no output places
- loop-free — no transition has an input place that is also an output place
- conservative — for each transition, the number of input arcs equals the number of output arcs
- subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs
- nested units — places are structured into hierarchically nested sequential units

Behavioural properties

- safe — in every reachable marking, there is no more than one token on a place
- deadlock — there exists a reachable marking from which no transition can be fired
- 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
- live — for every transition t, from every reachable marking, one can reach a marking in which t can fire

(a) 23 arcs are not simple free choice, e.g., the arc from place “p2” (which has 2 outgoing transitions) to transition “t10” (which has 2 input places).
(b) transitions “t10” and “t0” share a common input place “p2”, but only the former transition has input place “p11”.
(c) 12 transitions are not of a state machine, e.g., transition “t0”.
(d) 12 places are not of a marked graph, e.g., place “p2”
(e) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(f) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(g) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(h) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(i) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(j) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(k) 6 transitions are not loop free, e.g., transition “t10”.
(l) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(m) the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.12p6.fr/nupn.php
(n) stated by CÆSAR.BDD version 2.0 to be true for N = 1, and false on the remaining 5 instance(s).
(o) checked by Marcie on 2013-12-13; confirmed at MCC’2014 by Lola and Tapaal on 2 instances (N = 1 and N = 10).
(p) true for N = 1 and false for N > 1 – checked by Marcie on 2013-12-13.
(q) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(r) checked by Marcie on 2013-12-13.
## Size of the marking graphs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number of reachable markings</th>
<th>Number of transition firings</th>
<th>Max. number of tokens per place</th>
<th>Max. number of tokens per marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N = 1)</td>
<td>(128^{(1)})</td>
<td>(624^{(2)})</td>
<td>(N^{(3)})</td>
<td>(7^{(6)})</td>
</tr>
<tr>
<td>(N = 10)</td>
<td>(644,204^{(3)})</td>
<td>(6.7663E+6^{(3)})</td>
<td>(N^{(2)})</td>
<td>(52^{(4)})</td>
</tr>
<tr>
<td>(N = 100)</td>
<td>(4.2040E+10^{(ab)})</td>
<td>(4.9743E+11^{(ac)})</td>
<td>(N^{(ad)})</td>
<td>(502^{(ae)})</td>
</tr>
<tr>
<td>(N = 1000)</td>
<td>(4.0200E+15^{(ab)})</td>
<td>(4.8172E+16^{(ab)})</td>
<td>(N^{(ab)})</td>
<td>(5002^{(ab)})</td>
</tr>
<tr>
<td>(N = 10,000)</td>
<td>(400,200,040,004,000,200,004^{(aa)})</td>
<td>(N^{(ab)})</td>
<td>(N^{(ac)})</td>
<td>(50,002^{(ak)})</td>
</tr>
<tr>
<td>(N = 100,000)</td>
<td>?</td>
<td>?</td>
<td>(N^{(ad)})</td>
<td>(500,002^{(ai)})</td>
</tr>
</tbody>
</table>

\(^{(1)}\) confirmed at MCC’2014 by Marcie, PNMC, PNXDD, Stratagem, and Tapaal.
\(^{(2)}\) computed at MCC’2014 by Marcie.
\(^{(3)}\) confirmed at MCC’2014 by Marcie, PNMC, and Tapaal.
\(^{(4)}\) computed by Marcie on 2013-12-13; confirmed at MCC’2014 by Marcie, PNMC, PNXD, Stratagem, and Tapaal.
\(^{(5)}\) computed at MCC’2014 by Marcie.
\(^{(6)}\) confirmed at MCC’2014 by Marcie, PNMC, and Tapaal.
\(^{(7)}\) number of initial tokens, because the net is conservative.
\(^{(8)}\) computed by Marcie on 2013-12-13; exact value: 42040402004; confirmed at MCC’2014 by Marcie, PNMC, and PNXDD.
\(^{(9)}\) computed at MCC’2014 by Marcie.
\(^{(10)}\) confirmed at MCC’2014 by Marcie and PNMC.
\(^{(11)}\) number of initial tokens, because the net is conservative.
\(^{(12)}\) computed by Marcie on 2013-12-13; exact value: 40204040402004; confirmed at MCC’2014 by Marcie and PNMC.
\(^{(13)}\) computed at MCC’2014 by Marcie.
\(^{(14)}\) confirmed at MCC’2014 by Marcie and PNMC.
\(^{(15)}\) number of initial tokens, because the net is conservative.
\(^{(16)}\) computed by Marcie on 2013-12-13.
\(^{(17)}\) number of initial tokens, because the net is conservative.
\(^{(18)}\) number of initial tokens, because the net is conservative.

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