This form is a summary description of the model entitled “Permutation admissibility in multistage interconnection networks” 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 model describes a $8 \times 8$ stages shuffle-exchange network. In order to ease readability, the net components are grouped in columns similar to the way the switches are arranged in stages. Thus, whole net is represented as a cascade of columns alternating in type of the components being either place or transition. Transitions occur column-wise from the leftmost to the rightmost and in columns from the topmost to the bottommost. It can be easily seen that no token can visit a place more than once. Direction of the arcs indicates the flow of tokens through the net.

Here, we consider the scaling parameter $N$ as a multiplier for the initial marking in places $\text{in}(x)$ and $\text{c5}$. The figure shows the model when $N = 1$.

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>Multiplier for the marking of places $\text{in}(x)$ and $\text{c5}$</td>
<td>1, 2, 5, 10, 20, 50</td>
</tr>
</tbody>
</table>

Size of the model

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

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

Behavioural properties

safe — in every reachable marking, there is no more than one token on a place .......................................................... X
deadlock — there exists a reachable marking from which no transition can be fired .......................................................... X
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 ..........................................................?

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(a) the net is not ordinary in all its 6 instances (1, 2, 5, 10, 20, and 50).
(b) the net is not ordinary in all its 6 instances (1, 2, 5, 10, 20, and 50).
(c) the net is not ordinary in all its 6 instances (1, 2, 5, 10, 20, and 50).
(d) the net is not ordinary in all its 6 instances (1, 2, 5, 10, 20, and 50).
(e) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
(f) from place “aux16,0” one cannot reach place “in4,6”.
(g) there exist 9 source places, e.g., place “in4_5”.
(h) there exist 64 sink places, e.g., place “out7,1”.
(i) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
(j) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
(k) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
(l) stated by PNML2NUPN 1.3.0 on all 6 instances (1, 2, 5, 10, 20, and 50).
(m) stated by PNML2NUPN 1.3.0 on all 6 instances (1, 2, 5, 10, 20, and 50).
(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 Helena on all 6 colored instances, and by Lola and Tapaal on all 6 P/T instances.
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>52,537 ($q$)</td>
<td>54,600 ($r$)</td>
<td>1 ($s$)</td>
<td>9 ($t$)</td>
</tr>
<tr>
<td>$N = 2$</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>≥ 18</td>
</tr>
<tr>
<td>$N = 5$</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>≥ 45</td>
</tr>
<tr>
<td>$N = 10$</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>≥ 90</td>
</tr>
<tr>
<td>$N = 20$</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>≥ 180</td>
</tr>
<tr>
<td>$N = 50$</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>≥ 450</td>
</tr>
</tbody>
</table>

$q$: Computed by Alpina, and ITS-Tools at MCC’2013; confirmed at MCC’2014 by Helena on the colored net instance, and by GreatSPN, Marcie, PNMC, PNXDD, and Tapaal on the P/T net instance.

$r$: Computed at MCC’2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.

$s$: Computed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal on the P/T net instance.

$t$: Computed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal on the P/T net instance.