This form is a summary description of the model entitled “Parking” 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 collection of P/T nets was derived from the formal specification of a car parking control system. The parking lot is divided into several areas. The accesses to each area are controlled by a set of PLCs (Programmable Logic Controllers), which monitor the availability in real-time, and direct cars entering the parking to the area with the highest availability if the requested area is fully occupied. For each area, there is one master PLC that supervises several so-called slave PLCs. The PLCs communicate via a MODBUS network and the whole system can be considered as a GALS (Globally Asynchronous, Locally Synchronous) system.

The parking system was formally described in GRL, a specification language dedicated to PLCs and GALS. Each GRL specification was automatically translated to LNT (LOTOS New Technology), then to LOTOS, and then to an interpreted Petri net using the CADP toolbox. Finally, a P/T net was obtained by stripping out all dataflow-related information (variables, types, assignments, guards, etc.) from the interpreted Petri net, leading to a NUPN (Nested-Unit Petri Net) model translated to PNML using the CÆSAR.BDD tool.

References


Scaling parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Parameter description</th>
<th>Chosen parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(M,S)$</td>
<td>$M$: number of master PLCs, $S$: number of slave PLCs</td>
<td>(1, 4), (2, 8), (4, 16), (8, 32), (4, 32), (8, 64)</td>
</tr>
</tbody>
</table>

Size of the model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number of places</th>
<th>Number of transitions</th>
<th>Number of arcs</th>
<th>Number of units</th>
<th>HWB code</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1, 4)</td>
<td>65</td>
<td>97</td>
<td>284</td>
<td>16</td>
<td>2–15–42</td>
</tr>
<tr>
<td>(2, 8)</td>
<td>137</td>
<td>201</td>
<td>593</td>
<td>33</td>
<td>2–32–87</td>
</tr>
<tr>
<td>(4, 16)</td>
<td>305</td>
<td>433</td>
<td>1289</td>
<td>73</td>
<td>2–72–193</td>
</tr>
<tr>
<td>(8, 32)</td>
<td>529</td>
<td>785</td>
<td>2329</td>
<td>121</td>
<td>2–120–321</td>
</tr>
<tr>
<td>(8, 64)</td>
<td>737</td>
<td>993</td>
<td>2993</td>
<td>177</td>
<td>2–176–449</td>
</tr>
</tbody>
</table>

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.

(a) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
(b) stated by CÆSAR.BDD version 2.6 on all 6 instances.
state machine — every transition has exactly one input place and exactly one output place .............................................. \( \times \) (c)
marked graph — every place has exactly one input transition and exactly one output transition .............................................. \( \times \) (d)
connected — there is an undirected path between every two nodes (places or transitions) .............................................. \( \checkmark \) (e)
strongly connected — there is a directed path between every two nodes (places or transitions) .............................................. \( \times \) (f)
source place(s) — one or more places have no input transitions .............................................. \( \checkmark \) (g)
sink place(s) — one or more places have no output transitions .............................................. \( \times \) (h)
source transition(s) — one or more transitions have no input places .............................................. \( \times \) (i)
sink transition(s) — one or more transitions have no output places .............................................. \( \times \) (j)
loop-free — no transition has an input place that is also an output place .............................................. \( \times \) (k)
conservative — for each transition, the number of input arcs equals the number of output arcs .............................................. \( \times \) (l)
subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs .............................................. \( \times \) (m)
nested units — places are structured into hierarchically nested sequential units \( \times \) (n)

Behavioural properties

safe — in every reachable marking, there is no more than one token on a place .............................................. \( \checkmark \) (n)
deadlock — there exists a reachable marking from which no transition can be fired .............................................. \( \checkmark \) (o)
reversible — from every reachable marking, there is a transition path going back to the initial marking .............................................. \( \times \) (p)
quasi-live — for every transition \( t \), there exists a reachable marking in which \( t \) can fire .............................................. \( \checkmark \) (q)
live — for every transition \( t \), from every reachable marking, one can reach a marking in which \( t \) can fire .............................................. \( \times \) (r)

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>(1, 4)</td>
<td>31745 ( ^{(t)} )</td>
<td>?</td>
<td>1 ( ^{(a)} )</td>
<td>15 ( ^{(c)} )</td>
</tr>
<tr>
<td>(2, 8)</td>
<td>4.5676E+09 ( ^{(v)} )</td>
<td>?</td>
<td>1 ( ^{(a)} )</td>
<td>32 ( ^{(f)} )</td>
</tr>
<tr>
<td>(4, 16)</td>
<td>8.44047E+21 ( ^{(z)} )</td>
<td>?</td>
<td>1 ( ^{(a)} )</td>
<td>72 ( ^{(ab)} )</td>
</tr>
<tr>
<td>(8, 32)</td>
<td>( \geq 5.71544E+44 ) ( ^{(ac)} )</td>
<td>?</td>
<td>1 ( ^{(a)} )</td>
<td>176 ( ^{(ae)} )</td>
</tr>
<tr>
<td>(4, 32)</td>
<td>3.67025E+32 ( ^{(al)} )</td>
<td>?</td>
<td>1 ( ^{(a)} )</td>
<td>120 ( ^{(ak)} )</td>
</tr>
<tr>
<td>(8, 64)</td>
<td>( \geq 6.2771E+65 ) ( ^{(ai)} )</td>
<td>?</td>
<td>1 ( ^{(a)} )</td>
<td>272 ( ^{(ak)} )</td>
</tr>
</tbody>
</table>

\( ^{(c)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(d)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(e)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(f)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(g)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(h)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(i)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(j)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(k)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(l)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(m)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(n)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(o)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(p)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(q)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(r)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(s)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(t)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(u)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(v)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(w)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.
\( ^{(x)} \) stated by CÆSAR.BDD version 2.2 on all the 6 instances.