**Description**

Management of resources with the declaration of all resources to be used in a critical section. When process p enters a critical section (transition enter) it locks all the resources needed to be used in the critical section (4 max). Then, it can release a subset of these resources, max 2 at a time (and then stay in the critical section) or exit the critical section, thus releasing all the remaining resources it locks.

**References**

From a book on operating systems by Sacha Krakowiak. The model is presented and explained in the reference below:

### Scaling parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Parameter description</th>
<th>Chosen parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Cardinality of Proc and Res classes)</td>
<td>see description</td>
<td>((n, 2 \times n)) with (n \in {3, 5, 6, 7, 9, 10, 11})</td>
</tr>
</tbody>
</table>

### Size of the colored net model

- number of places: 5
- number of transitions: 7
- number of arcs: 29

### Size of the derived P/T model instances

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number of places</th>
<th>Number of transitions</th>
<th>Number of arcs</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n = 3)</td>
<td>33</td>
<td>4791</td>
<td>38652</td>
</tr>
<tr>
<td>(n = 5)</td>
<td>75</td>
<td>56105</td>
<td>492760</td>
</tr>
<tr>
<td>(n = 6)</td>
<td>102</td>
<td>136662</td>
<td>1226388</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  
- **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  

\(^{(a)}\) the net is not ordinary in all its 3 instances (3, 5, and 6).  
\(^{(b)}\) the net is not ordinary in all its 3 instances (3, 5, and 6).  
\(^{(c)}\) the net is not ordinary in all its 3 instances (3, 5, and 6).  
\(^{(d)}\) the net is not ordinary in all its 3 instances (3, 5, and 6).  
\(^{(e)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(f)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(g)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(h)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(i)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(j)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(k)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(l)}\) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).  
\(^{(m)}\) stated by PNML2NUPN 1.3.0 on all 3 instances (3, 5, and 6).  
\(^{(n)}\) the definition of Nested-Unit Petri Nets (NUPN) is available from [http://mcc.lip6.fr/nupn.php](http://mcc.lip6.fr/nupn.php)
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

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 = 3 )</td>
<td>6320 ( ^{(p)} )</td>
<td>116178 ( ^{(q)} )</td>
<td>4 ( ^{(r)} )</td>
<td>18 ( ^{(s)} )</td>
</tr>
<tr>
<td>( n = 5 )</td>
<td>1.0660E+8 ( ^{(t)} )</td>
<td>?</td>
<td>?</td>
<td>( \geq 15 )</td>
</tr>
<tr>
<td>( n = 6 )</td>
<td>2.5725E+10 ( ^{(o)} )</td>
<td>?</td>
<td>?</td>
<td>( \geq 18 )</td>
</tr>
<tr>
<td>( n = 7 )</td>
<td>8.5698E+12 ( ^{(u)} )</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>( n = 9 )</td>
<td>2.1185E+18 ( ^{(w)} )</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

\( ^{(o)} \) checked by the Crocodile tool in 2012, see reference 1; confirmed at MCC’2014 by GreatSPN, Lola, PNXDD, and Tapaal on one P/T instance \( (N = 3) \).  
\( ^{(p)} \) computed at MCC’2014 by GreatSPN, ITS-Tools, Marcie, and PNXDD; confirmed at MCC’2014 by GreatSPN on the colored net instance, and by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal.  
\( ^{(q)} \) computed at MCC’2014 by Marcie.  
\( ^{(r)} \) computed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal.  
\( ^{(s)} \) computed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal.  
\( ^{(t)} \) computed at MCC’2013 by ITS-Tools; confirmed at MCC’2014 by GreatSPN on the colored net instance.  
\( ^{(u)} \) computed at MCC’2013 by ITS-Tools; confirmed at MCC’2014 by GreatSPN on the colored net instance.  
\( ^{(v)} \) computed at MCC’2014 by GreatSPN on the colored net instance.  
\( ^{(w)} \) computed at MCC’2014 by GreatSPN on the colored net instance.