Description

This Petri net models a client/server application with NCLIENTS clients and NSERVERS servers. Communication from clients to servers is not reliable, with requests stored in a buffer of size BUFFERSIZE. Communication from servers to clients are reliable. A client send its message until it receives an answer.

The interesting point is that place RequestBuffer is not 1-bounded. This model can thus be used to assess how model checkers behave for colored non-safe nets.

Class
Client is 1..NCLIENTS;
Server is 1..NSERVERS;
Domain
Computation is <Client,Server>;
Var
  c in Client;
  s in Server;

```
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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>To set only one parameter, we set a parameter ( n ) and compute model parameters with: ( \text{NCLIENTS}=n^2 ), ( \text{NSERVERS}=n ), ( \text{BUFFERSIZE}=n )</td>
<td>2, 3, 4, 5, 7, 10</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>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{NCLIENTS}, \text{NSERVERS}, \text{BUFFERSIZE} )</td>
<td>1 + 3( \text{NCLIENTS} ) + ( \text{NSERVERS} ) + ( \text{BUFFERSIZE} )</td>
<td>3( \text{NCLIENTS} ) + ( \text{NSERVERS} ) + ( \text{BUFFERSIZE} )</td>
<td>8( \text{NCLIENTS} ) + 7( \text{NSERVERS} ) + ( \text{BUFFERSIZE} )</td>
</tr>
<tr>
<td>( n ) = 2</td>
<td>( n^3 + 3n^2 + n + 1 )</td>
<td>( 2n^3 + 3n^2 )</td>
<td>( 8n^3 + 7n^2 )</td>
</tr>
<tr>
<td>( n ) = 3</td>
<td>23</td>
<td>28</td>
<td>92</td>
</tr>
<tr>
<td>( n ) = 4</td>
<td>58</td>
<td>81</td>
<td>279</td>
</tr>
<tr>
<td>( n ) = 5</td>
<td>117</td>
<td>176</td>
<td>624</td>
</tr>
<tr>
<td>( n ) = 7</td>
<td>206</td>
<td>325</td>
<td>1175</td>
</tr>
<tr>
<td>( n ) = 10</td>
<td>498</td>
<td>833</td>
<td>3087</td>
</tr>
<tr>
<td>( n ) = 1311</td>
<td>2300</td>
<td>8700</td>
<td></td>
</tr>
</tbody>
</table>

Structural properties

- **free choice** — all (different) transitions with a shared input place have no other input place (a)
- **state machine** — every transition has exactly one input place and exactly one output place (b)
- **marked graph** — every place has exactly one input transition and exactly one output transition (c)
- **connected** — there is a undirected path between every two nodes (places or transitions) (d)
- **strongly connected** — there is a directed path between every two nodes (places or transitions) (e)
- **source place(s)** — one or more places have no input transitions (f)
- **sink place(s)** — one or more places have no output transitions (g)
- **source transition(s)** — one or more transitions have no input places (h)
- **sink transition(s)** — one or more transitions have no output places (i)
- **loop-free** — no transition has an input place that is also an output place (j)
- **conservative** — for each transition, the number of input arcs equals the number of output arcs (k)
- **subconservative** — for each transition, the number of input arcs equals or exceeds the number of output arcs (l)

Behavioural properties

- **safe** — in every reachable marking, there is no more than one token on a place (m)
- **deadlock** — there exists a reachable marking from which no transition can be fired (n)
- **reversible** — from every reachable marking, there is a transition path going back to the initial marking (o)

(a) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(b) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(c) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(d) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(e) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
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(h) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(i) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(j) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(k) stated by CÆSAR.BDD version 1.7 on all 6 instances (2, 3, 4, 5, 7, and 10).
(l) stated by CÆSAR.BDD version 2.0 on all 6 instances (2, 3, 4, 5, 7, and 10).
(m) stated by CÆSAR.BDD version 2.0 on all 6 instances (2, 3, 4, 5, 7, and 10).
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 = 2 )</td>
<td>7,424 ((o))</td>
<td>?</td>
<td>?</td>
<td>( \geq 8 ) ((p))</td>
</tr>
<tr>
<td>( n = 3 )</td>
<td>( 1.341 \times 10^9 ) ((q))</td>
<td>?</td>
<td>?</td>
<td>( \geq 15 )</td>
</tr>
<tr>
<td>( n = 4 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 24 )</td>
</tr>
<tr>
<td>( n = 5 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 35 )</td>
</tr>
<tr>
<td>( n = 7 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 63 )</td>
</tr>
<tr>
<td>( n = 10 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 120 )</td>
</tr>
</tbody>
</table>

\((o)\) computed by alpina and ITS-Tools at MCC’2013.

\((p)\) lower bound given by the number of initial tokens.

\((q)\) computed by alpina and ITS-Tools at MCC’2013.