Model: Anderson
Type: P/T Net
Origin: Academic

since
MCC 2023

Sami Evangelista
sami.evangelista@lipn.univ-paris13.fr

This form is a summary description of the model entitled "Anderson" 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 PT net models Anderson's queue lock mutual exclusion algorithm for N processes.

The pseudo code of the algorithm is the following:

```
//  variables
constant int N := 4;
shared int next := 0;
shared enum slot {has_lock, must_wait} slot[N - 1] := { has_lock, must_wait, ..., must_wait};
local int my_place;

// code for a process p (p in [0..N-1])
01 loop {
02   noncritical_section;
03   my_place := fetch_and_inc(next)
04   if my_place = N - 1 then
05     atomic_add(next, - N)
06   fi
07   my_place := my_place % N
08   await slot[my_place] = has_lock
09   slot[my_place] := must_wait;
10   critical_section;
11   slot[(my_place + 1) % N] := has_lock
12 }
```

References

Shared-memory mutual exclusion: major research trends since 1986. Distrib. Comput., 2003. James H. Anderson and Yong-Jik Kim and Ted Herman

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
N	Number of processes competing	4, 5, 6, 7, 8, 9, 10, 11, 12

Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$N = 4$	105	200	752	7	1–6–26
$N = 5$	161	365	1380	8	1–7–32
$N = 6$	229	600	2280	9	1–8–43
$N = 7$	309	917	3500	10	1–9–49
$N = 8$	401	1328	5088	11	1–10–56
$N = 9$	505	1845	7092	12	1–11–63
$N = 10$	621	2480	9560	13	1–12–69
$N = 11$	749	3245	12540	14	1–13–86
$N = 12$	889	4152	16080	15	1–14–93

Model: Anderson
Type: P/T Net
Origin: Academic

since
MCC 2023

Sami Evangelista
sami.evangelista@lipn.univ-paris13.fr

Structural properties

ordinary — *all arcs have multiplicity one* .... yes
simple free choice — *all transitions sharing a common input place have no other input place* .... no [a]
extended free choice — *all transitions sharing a common input place have the same input places* .... no [b]
state machine — *every transition has exactly one input place and exactly one output place* .... no [c]
marked graph — *every place has exactly one input transition and exactly one output transition* .... no [d]
connected — *there is an undirected path between every two nodes (places or transitions)* .... yes [e]
strongly connected — *there is a directed path between every two nodes (places or transitions)* .... yes [f]
source place(s) — *one or more places have no input transitions* .... no [g]
sink place(s) — *one or more places have no output transitions* .... no [h]
source transition(s) — *one or more transitions have no input places* .... no [i]
sink transitions(s) — *one or more transitions have no output places* .... no [j]
loop-free — *no transition has an input place that is also an output place* .... no [k]
conservative — *for each transition, the number of input arcs equals the number of output arcs* .... yes [l]
subconservative — *for each transition, the number of input arcs equals or exceeds the number of output arcs* ..... yes [m]
nested units — *places are structured into hierarchically nested sequential units* [n] .... yes

Behavioural properties

safe — *in every reachable marking, there is no more than one token on a place* .... yes [o]
dead place(s) — *one or more places have no token in any reachable marking* .... no [p]
dead transition(s) — *one or more transitions cannot fire from any reachable marking* .... no [q]
deadlock — *there exists a reachable marking from which no transition can be fired* .... no [r]
reversible — *from every reachable marking, there is a transition path going back to the initial marking* .... ?
live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* .... ?

---

[a] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[b] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[c] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[d] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[e] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[f] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[g] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[h] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[i] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[j] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[k] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[l] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[m] stated by CÆSAR.BDD version 3.7 on all 9 instances (4, 5, 6, 7, 8, 9, 10, 11 and 12).
[n] the definition of Nested-Unit Petri Nets (NUPN) is available from `http://mcc.lip6.fr/nupn.php`
[o] safe by construction – stated by PNML2NUPN 3.2.0.
[p] stated by CÆSAR.BDD version 3.7 to be false on 2 instance(s) out of 9, and unknown on the remaining 5 instance(s).
[q] stated by CÆSAR.BDD version 3.7 to be false on 2 instance(s) out of 9, and unknown on the remaining 5 instance(s).
[r] stated by CÆSAR.BDD version 3.7 to be false on 2 instance(s) out of 9, and unknown on the remaining 5 instance(s).

generated on June 22, 2025

Size of the marking graphs

Parameter	Number of reachable markings	Number of transition firings	Max. number of tokens per place	Max. number of tokens per marking
$N = 4$	29,641 [s]	97,516	1	6 [t]
$N = 5$	689,901 [u]	2,784,245	1	7 [v]
$N = 6$	18,206,917	86,996,322	1 [w]	8 [x]
$N = 7$	538,699,029	?	1 [y]	9 [z]
$N = 8$	$\geq$ 1.13251e+08 [aa]	?	1 [ab]	10 [ac]
$N = 9$	$\geq$ 1.51217e+08 [ad]	?	1 [ae]	11 [af]
$N = 10$	$\geq$ 1.14121e+09 [ag]	?	1 [ah]	12 [ai]
$N = 11$	$\geq$ 8.47469e+09 [aj]	?	1 [ak]	13 [al]
$N = 12$	$\geq$ 8.42744e+08 [am]	?	1 [an]	14 [ao]

Other properties

- State property: at each reachable marking, there is at most one process in the critical section.

  $\sum_{i \in \{0..N-1\}, j \in \{0..N-1\}} cs_{i,j} <= 1$

- LTL property: there is infinitely often a process in the critical section.

  $[](<> (\sum_{i \in \{0..N-1\}, j \in \{0..N-1\}} cs_{i,j} == 1))$

---

[s] stated by CÆSAR.BDD version 3.7.
[t] number of initial tokens, because the net is conservative.
[u] stated by CÆSAR.BDD version 3.7.
[v] number of initial tokens, because the net is conservative.
[w] stated by PNML2NUPN 3.2.0.
[x] number of initial tokens, because the net is conservative.
[y] stated by PNML2NUPN 3.2.0.
[z] number of initial tokens, because the net is conservative.
[aa] stated by CÆSAR.BDD version 3.7.
[ab] stated by PNML2NUPN 3.2.0.
[ac] number of initial tokens, because the net is conservative.
[ad] stated by CÆSAR.BDD version 3.7.
[ae] stated by PNML2NUPN 3.2.0.
[af] number of initial tokens, because the net is conservative.
[ag] stated by CÆSAR.BDD version 3.7.
[ah] stated by PNML2NUPN 3.2.0.
[ai] number of initial tokens, because the net is conservative.
[aj] stated by CÆSAR.BDD version 3.7.
[ak] stated by PNML2NUPN 3.2.0.
[al] number of initial tokens, because the net is conservative.
[am] stated by CÆSAR.BDD version 3.7.
[an] stated by PNML2NUPN 3.2.0.
[ao] number of initial tokens, because the net is conservative.

generated on June 22, 2025