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This form is a summary description of the model entitled "FlexibleBarrier" 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 model describes a barrier algorithm that synchronizes several concurrent processes. The number of concurrent processes evolves dynamically over time. Between two successive synchronizations, processes can be killed or can fork new processes: all live processes have to be synchronized by the barrier. This algorithm is used in cooperative kernels, a novel technique that allows safe multitasking for irregular data-parallel algorithms on GPUs.

This collection of P/T nets was derived from an LNT model of the Flexible Barrier. Each instance was first translated to LOTOS, and then to an interpreted Petri net using the CADP toolbox. Finally, a P/T net was obtained by stripping out all data-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.

Each instance of the model is parameterized by the maximal number N of concurrent processes that synchronize on the barrier. Each instance is also parameterized by its version V, which specifies how the NUPN has been produced from the LOTOS specification. V is either equal to "a" if the NUPN has been generated *after* applying all the structural and data-flow optimizations of the CÆSAR compiler for LOTOS, or to "b" if the NUPN has been generated *before* these optimizations.

References

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
(N, V)	N is the maximal number of concurrent processes and V is the version defined above	$\{4, 6, 8, 10, 12, 14, 16, 18, 20, 22\} \times \{a, b\}$

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Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$N = 04, V = a$	51	88	309	7	2–6–19
$N = 04, V = b$	268	305	743	11	5–6–39
$N = 06, V = a$	75	154	599	9	2–8–27
$N = 06, V = b$	542	621	1533	15	7–8–60
$N = 08, V = a$	99	236	985	11	2–10–35
$N = 08, V = b$	920	1057	2627	19	9–10–76
$N = 10, V = a$	123	334	1467	13	2–12–43
$N = 10, V = b$	1402	1613	4025	23	11–12–94
$N = 12, V = a$	147	448	2045	15	2–14–51
$N = 12, V = b$	1988	2289	5727	27	13–14–111
$N = 14, V = a$	171	578	2719	17	2–16–59
$N = 14, V = b$	2678	3085	7733	31	15–16–140
$N = 16, V = a$	195	724	3489	19	2–18–67
$N = 16, V = b$	3472	4001	10043	35	17–18–159
$N = 18, V = a$	219	886	4355	21	2–20–75
$N = 18, V = b$	4370	5037	12657	39	19–20–177
$N = 20, V = a$	243	1064	5317	23	2–22–83
$N = 20, V = b$	5372	6193	15575	43	21–22–195
$N = 22, V = a$	267	1258	6375	25	2–24–91
$N = 22, V = b$	6478	7469	18797	47	23–24–214

Structural properties

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

[a] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[b] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[c] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[d] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[e] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[f] from place 1 one cannot reach place 0.
[g] place 0 is a source place.
[h] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[i] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[j] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[k] stated by CÆSAR.BDD version 2.7 to be true on 10 instance(s) out of 20, and false on the remaining 10 instance(s).
[l] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[m] stated by CÆSAR.BDD version 2.7 on all 20 instances (10 values of N × 2 values of V).
[n] the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.lip6.fr/nupn.php

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Behavioural properties

safe — *in every reachable marking, there is no more than one token on a place* ..... ✔ [o]
deadlock — *there exists a reachable marking from which no transition can be fired* ..... ? [p]
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* ..... ? [q]
live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* ..... ?

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
$N = 04, V = a$	20737 [r]	?	1	6
$N = 04, V = b$	$\geq$ 3.66789e+08 [s]	?	1 [t]	$\in [2, 6]$ [u]
$N = 06, V = a$	2.98598e+06 [v]	?	1	8
$N = 06, V = b$	$\geq$ 4.63158e+10 [w]	?	1 [x]	$\in [2, 8]$ [y]
$N = 08, V = a$	4.29982e+08 [z]	?	1	10
$N = 08, V = b$	$\geq$ 2.87705e+13 [aa]	?	1 [ab]	$\in [2, 10]$ [ac]
$N = 10, V = a$	6.19174e+10 [ad]	?	1	12
$N = 10, V = b$	$\geq$ 1.14075e+17 [ae]	?	1 [af]	$\in [2, 12]$ [ag]
$N = 12, V = a$	8.9161e+12 [ah]	?	1	14
$N = 12, V = b$	$\geq$ 6.12466e+20 [ai]	?	1 [aj]	$\in [2, 14]$ [ak]
$N = 14, V = a$	1.28392e+15 [al]	?	1	16
$N = 14, V = b$	$\geq$ 3.04107e+15 [am]	?	1 [an]	$\in [2, 16]$ [ao]
$N = 16, V = a$	1.84884e+17 [ap]	?	1	18
$N = 16, V = b$	$\geq$ 2.19392e+17 [aq]	?	1 [ar]	$\in [2, 18]$ [as]
$N = 18, V = a$	2.66233e+19 [at]	?	1	20
$N = 18, V = b$	$\geq$ 1.51447e+19 [au]	?	1 [av]	$\in [2, 20]$ [aw]
$N = 20, V = a$	3.83376e+21 [ax]	?	1	22
$N = 20, V = b$	$\geq$ 1.00937e+21 [ay]	?	1 [az]	$\in [2, 22]$ [ba]
$N = 22, V = a$	5.52061e+23 [bb]	?	1	24
$N = 22, V = b$	$\geq$ 6.53756e+22 [bc]	?	1 [bd]	$\in [2, 24]$ [be]

[o] safe by construction – stated by the CÆSAR compiler.
[p] stated by CÆSAR.BDD version 2.7 to be false on 10 instance(s) out of 20, and unknown on the remaining 10 instance(s).
[q] stated by CÆSAR.BDD version 2.7 to be true on 11 instance(s) out of 20, and unknown on the remaining 9 instance(s).
[r] stated by CÆSAR.BDD version 2.7.
[s] stated by CÆSAR.BDD version 2.7.
[t] stated by the CÆSAR compiler.
[u] lower and upper bounds given by the number of initial tokens and the number of leaf units.
[v] stated by CÆSAR.BDD version 2.7.
[w] stated by CÆSAR.BDD version 2.7.
[x] stated by the CÆSAR compiler.
[y] lower and upper bounds given by the number of initial tokens and the number of leaf units.
[z] stated by CÆSAR.BDD version 2.7.
[aa] stated by CÆSAR.BDD version 2.7.
[ab] stated by the CÆSAR compiler.
[ac] lower and upper bounds given by the number of initial tokens and the number of leaf units.
[ad] stated by CÆSAR.BDD version 2.7.
[ae] stated by CÆSAR.BDD version 2.7.
[af] stated by the CÆSAR compiler.
[ag] lower and upper bounds given by the number of initial tokens and the number of leaf units.
[ah] stated by CÆSAR.BDD version 2.7.
[ai] stated by CÆSAR.BDD version 2.7.
[aj] stated by the CÆSAR compiler.
[ak] lower and upper bounds given by the number of initial tokens and the number of leaf units.
[al] stated by CÆSAR.BDD version 2.7.
[am] stated by CÆSAR.BDD version 2.7.
[an] stated by the CÆSAR compiler.

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(ao) lower and upper bounds given by the number of initial tokens and the number of leaf units.
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(aq) stated by CÆSAR.BDD version 2.7.
(ar) stated by the CÆSAR compiler.
(as) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(at) stated by CÆSAR.BDD version 2.7.
(au) stated by CÆSAR.BDD version 2.7.
(av) stated by the CÆSAR compiler.
(aw) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(ax) stated by CÆSAR.BDD version 2.7.
(ay) stated by CÆSAR.BDD version 2.7.
(az) stated by the CÆSAR compiler.
(ba) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(bb) stated by CÆSAR.BDD version 2.7.
(bc) stated by CÆSAR.BDD version 2.7.
(bd) stated by the CÆSAR compiler.
(be) lower and upper bounds given by the number of initial tokens and the number of leaf units.