

This form is a summary description of the model entitled “MedleyB” 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 gathers a collection of NUPNs generated from two common protocols in distributed systems:

- the bully leader election [1]
- the two-phase commit [2]

These protocols were not implemented using traditional communication modes (e.g., unicast or broadcast), but reimplemented using “stigmergic” interaction as the substrate.

The models have been formally described in the LAbS high-level specification language for stigmergic systems. These LAbS descriptions have been translated automatically into LNT models using the SLiVER tool [3] [4]. The resulting LNT models have been translated to LOTOS automatically, and then to interpreted Petri nets using the CADP toolbox. A P/T net was then 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.

We kept only those NUPNs whose marking graph had more than 10^8 states, discarding other NUPNs that were considered too simple for the Model Checking Contest. We also discarded larger NUPNs whose corresponding PNML files were significantly larger than 100 Megabytes. This led to a collection of 13 NUPNs, which we ordered by increasing size of PNML files.

References

- [1] Hector Garcia-Molina. *Elections in a Distributed Computing System*. IEEE Trans. Computers 31, 1, pages 48–59, 1982. <https://doi.org/10.1109/TC.1982.1675885>.
- [2] Jim Gray. *Notes on Data Base Operating Systems*. In *Operating Systems, An Advanced Course*, LNCS 60, pages 393–481, Springer, 1978. https://doi.org/10.1007/3-540-08755-9_9.
- [3] Luca Di Stefano and Frédéric Lang. *Verifying Temporal Properties of Stigmergic Collective Systems Using CADP*. Proc. 10th International Symposium On Leveraging Applications of Formal Methods, Verification and Validation (ISoLA), LNCS 1306, pages 473–489, Springer, 2021. https://doi.org/10.1007/978-3-030-89159-6_29.
- [4] Luca Di Stefano and Frédéric Lang. *Compositional Verification of Stigmergic Collective Systems*. Proc. 24th International Conference on Verification, Model Checking, and Abstract Interpretation (VMCAI), LNCS 13881, pages 155–176, Springer, 2023. https://doi.org/10.1007/978-3-031-24950-1_8.

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
N	N is the instance number	from 1 to 13

Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$N = 1$	925	1037	2433	7	4-4-35
$N = 2$	1227	1472	4160	9	5-5-45
$N = 3$	1529	2131	8591	11	6-6-55
$N = 4$	829	2410	20118	13	7-7-59
$N = 5$	1831	3454	22350	13	7-7-65
$N = 6$	964	5535	65185	15	8-8-68
$N = 7$	2133	6753	67789	15	8-8-75
$N = 8$	1099	14556	216508	17	9-9-77
$N = 9$	2435	15948	219484	17	9-9-85
$N = 10$	1234	41201	720567	19	10-10-86
$N = 11$	2737	42767	723915	19	10-10-95
$N = 12$	1369	120590	2385506	21	11-11-95
$N = 13$	3039	122330	2389226	21	11-11-105

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) no ^(f)
source place(s) — one or more places have no input transitions yes ^(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 yes ^(k)
conservative — for each transition, the number of input arcs equals the number of output arcs no ^(l)
subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs no ^(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 ? ^(p)

^(a) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(b) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(c) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(d) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(e) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(f) from place 1 one cannot reach place 0.

^(g) place 0 is a source place.

^(h) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

⁽ⁱ⁾ stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(j) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(k) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(l) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

^(m) stated by CÆSAR.BDD version 3.7 on all 13 instances (13 values of N).

⁽ⁿ⁾ the definition of Nested-Unit Petri Nets (NUPN) is available from <http://mcc.lip6.fr/nupn.php>

^(o) safe by construction – stated by the CÆSAR compiler.

^(p) stated by CÆSAR.BDD version 3.7 to be false on 6 instance(s) out of 13, and unknown on the remaining 7 instance(s).

dead transition(s) — *one or more transitions cannot fire from any reachable marking*? ^(q)
deadlock — *there exists a reachable marking from which no transition can be fired*? ^(r)
reversible — *from every reachable marking, there is a transition path going back to the initial marking*? ^(s)
live — *for every transition t , from every reachable marking, one can reach a marking in which t can fire*? ^(t)

Size of the marking graphs

Parameter	Number of reach- able markings	Number of tran- sition firings	Max. number of tokens per place	Max. number of tokens per marking
$N = 1$	1.9004e+08 ^(u)	?	1	4
$N = 2$	3.47082e+10 ^(v)	?	1	5
$N = 3$	6.38825e+12 ^(w)	?	1	6
$N = 4$	8.43718e+12 ^(x)	?	1	7
$N = 5$	$\geq 1.13573e+15$ ^(y)	?	1 ^(z)	7
$N = 6$	6.34009e+14 ^(aa)	?	1	8
$N = 7$	$\geq 1.27746e+17$ ^(ab)	?	1 ^(ac)	8
$N = 8$	4.73316e+16 ^(ad)	?	1	9
$N = 9$	$\geq 1.97849e+19$ ^(ae)	?	1 ^(af)	9
$N = 10$	$\geq 3.45282e+18$ ^(ag)	?	1 ^(ah)	10
$N = 11$	$\geq 3.4097e+21$ ^(ai)	?	1 ^(aj)	10
$N = 12$	$\geq 1.66877e+20$ ^(ak)	?	1 ^(al)	11
$N = 13$	$\geq 4.31421e+23$ ^(am)	?	1 ^(an)	11

^(q) stated by CÆSAR.BDD version 3.7 to be false on 6 instance(s) out of 13, and unknown on the remaining 7 instance(s).
^(r) stated by CÆSAR.BDD version 3.7 to be true on 6 instance(s) out of 13, and unknown on the remaining 7 instance(s).
^(s) stated by CÆSAR.BDD version 3.7 to be false on 6 instance(s) out of 13, and unknown on the remaining 7 instance(s).
^(t) stated by CÆSAR.BDD version 3.7 to be false on 6 instance(s) out of 13, and unknown on the remaining 7 instance(s).
^(u) stated by CÆSAR.BDD version 3.7.
^(v) stated by CÆSAR.BDD version 3.7.
^(w) stated by CÆSAR.BDD version 3.7.
^(x) stated by CÆSAR.BDD version 3.7.
^(y) stated by CÆSAR.BDD version 3.7.
^(z) stated by the CÆSAR compiler.
^(aa) stated by CÆSAR.BDD version 3.7.
^(ab) stated by CÆSAR.BDD version 3.7.
^(ac) stated by the CÆSAR compiler.
^(ad) stated by CÆSAR.BDD version 3.7.
^(ae) stated by CÆSAR.BDD version 3.7.
^(af) stated by the CÆSAR compiler.
^(ag) stated by CÆSAR.BDD version 3.7.
^(ah) stated by the CÆSAR compiler.
^(ai) stated by CÆSAR.BDD version 3.7.
^(aj) stated by the CÆSAR compiler.
^(ak) stated by CÆSAR.BDD version 3.7.
^(al) stated by the CÆSAR compiler.
^(am) stated by CÆSAR.BDD version 3.7.
^(an) stated by the CÆSAR compiler.