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This form is a summary description of the model entitled "Cloud Deployment" 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

Distributed cloud applications consist of interconnected software components distributed over several virtual machines, themselves hosted on remote physical servers. In [1], a decentralized self-deployment protocol was presented, which was designed to automatically configure a set of software components to be deployed on different virtual machines. This protocol starts the components in a specified order, respecting important architectural invariants. This protocol supports virtual-machine and network failures, and always succeeds in deploying an application when a finite number of failures is assumed. This protocol was modelled using LNT, analyzed with the CADP toolbox, and implemented in Java.

This collection of P/T nets was obtained from automatically-generated LNT specifications of the protocol. Each LNT specification reflects a given software architecture to be deployed and generates all possible executions of the protocol for this architecture. Each LNT specification was 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 NUPN is parameterized by the number N of virtual machines used for the deployment. The NUPN is independent from other parameters of the architecture (such as the number of components, and the number of bindings, i.e., communication links between components) because these parameters are encoded as LNT data values.

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

[1] Xavier Etchevers, Gwen Salaün, Fabienne Boyer, Thierry Coupaye, and Noël De Palma. *Reliable self-deployment of cloud applications.* Proceedings of SAC 2014, pages 1331–1338. Available from https://hal.inria.fr/hal-00934042/en.

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
(N, V)	N is the number of components and V is the version defined above	$\{2, 3, 4, 5, 6, 7\} \times \{a, b\}$

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Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$N = 2, V = a$	69	174	821	11	3–9–26
$N = 2, V = b$	556	684	1987	17	6–9–52
$N = 3, V = a$	104	308	1611	15	3–13–37
$N = 3, V = b$	859	1152	4030	25	7–13–78
$N = 4, V = a$	141	475	2657	19	3–17–48
$N = 4, V = b$	1182	1824	8741	33	8–17–107
$N = 5, V = a$	180	675	3959	23	3–21–59
$N = 5, V = b$	1525	3132	24760	41	9–21–133
$N = 6, V = a$	221	908	5517	27	3–25–70
$N = 6, V = b$	1888	6804	91831	49	10–25–159
$N = 7, V = a$	264	1174	7331	31	3–29–81
$N = 7, V = b$	2271	19752	389666	57	11–29–185

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) .... ✔

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* .... ? (q)

(a) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 values of N × 2 values of V).
(b) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 values of N × 2 values of V).
(c) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 values of N × 2 values of V).
(d) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 values of N × 2 values of V).
(e) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 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 2.6 to be true on 6 instance(s) out of 12, and false on the remaining 6 instance(s).
(i) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 values of N × 2 values of V).
(j) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 values of N × 2 values of V).
(k) stated by CÆSAR.BDD version 2.6 to be true on 6 instance(s) out of 12, and false on the remaining 6 instance(s).
(l) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 values of N × 2 values of V).
(m) stated by CÆSAR.BDD version 2.6 on all 12 instances (6 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`
(o) safe by construction – stated by the CÆSAR compiler.
(p) stated by CÆSAR.BDD version 2.6 to be true on 6 instance(s) out of 12, and unknown on the remaining 6 instance(s).
(q) stated by CÆSAR.BDD version 2.6 to be false on 6 instance(s) out of 12, and unknown on the remaining 6 instance(s).

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quasi-live — *for every transition t, there exists a reachable marking in which t can fire* .... ? [r]

live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* .... ? [s]

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
$N = 2, V = a$	4807 [t]	?	1	9
$N = 2, V = b$	$\geq$ 8.48052e+10 [u]	?	1 [v]	$\in$ [2, 9] [w]
$N = 3, V = a$	190102 [x]	?	1	13
$N = 3, V = b$	$\geq$ 1.87983e+13 [y]	?	1 [z]	$\in$ [2, 13] [aa]
$N = 4, V = a$	7.09103e+06 [ab]	?	1	17
$N = 4, V = b$	$\geq$ 2.27706e+14 [ac]	?	1 [ad]	$\in$ [2, 17] [ae]
$N = 5, V = a$	2.4883e+08 [af]	?	1	21
$N = 5, V = b$	$\geq$ 2.96085e+16 [ag]	?	1 [ah]	$\in$ [2, 21] [ai]
$N = 6, V = a$	8.3047e+09 [aj]	?	1	25
$N = 6, V = b$	?	?	1 [ak]	$\in$ [2, 25] [al]
$N = 7, V = a$	2.6648e+11 [am]	?	1	29
$N = 7, V = b$	?	?	1 [an]	$\in$ [2, 29] [ao]

(r) stated by CÆSAR.BDD version 2.6 to be true on 6 instance(s) out of 12, and unknown on the remaining 6 instance(s).
(s) stated by CÆSAR.BDD version 2.6 to be false on 6 instance(s) out of 12, and unknown on the remaining 6 instance(s).
(t) stated by CÆSAR.BDD version 2.6.
(u) stated by CÆSAR.BDD version 2.6.
(v) stated by the CÆSAR compiler.
(w) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(x) stated by CÆSAR.BDD version 2.6.
(y) stated by CÆSAR.BDD version 2.6.
(z) stated by the CÆSAR compiler.
(aa) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(ab) stated by CÆSAR.BDD version 2.6.
(ac) stated by CÆSAR.BDD version 2.6.
(ad) stated by the CÆSAR compiler.
(ae) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(af) stated by CÆSAR.BDD version 2.6.
(ag) stated by CÆSAR.BDD version 2.6.
(ah) stated by the CÆSAR compiler.
(ai) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(aj) stated by CÆSAR.BDD version 2.6.
(ak) stated by the CÆSAR compiler.
(al) lower and upper bounds given by the number of initial tokens and the number of leaf units.
(am) stated by CÆSAR.BDD version 2.6.
(an) stated by the CÆSAR compiler.
(ao) lower and upper bounds given by the number of initial tokens and the number of leaf units.