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*This form is a summary description of the model entitled "CO4" 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.*

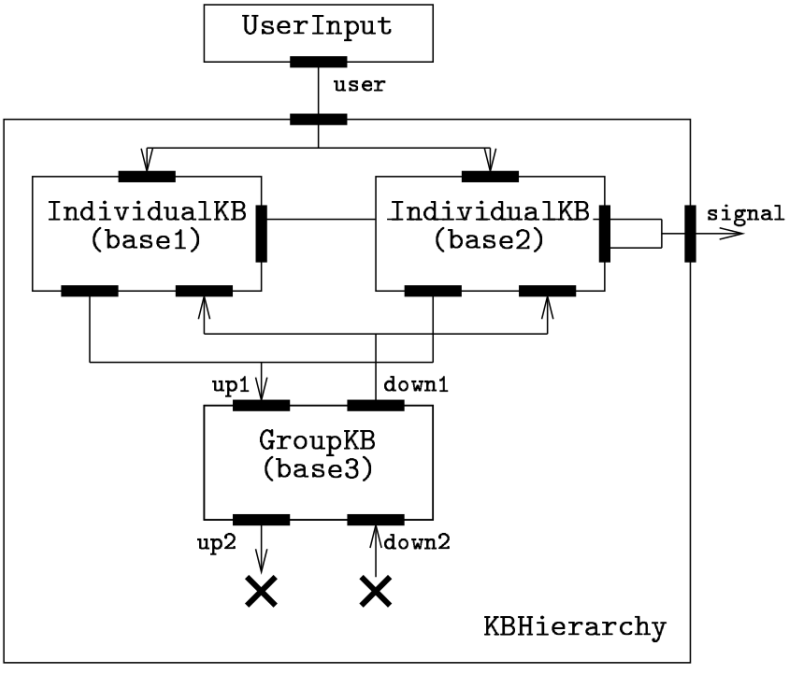
## Description

CO4 was a computer system dedicated to the incremental and concurrent building of a collection of knowledge bases organized as a tree. In this system, communication between CO4 entities follow a consensual decision protocol derived from peer-revieweing policies.

The CO4 system was formally described in LOTOS [1]. This description was later reformulated in LNT (*LOTOS New Technology*), a modern language that can be translated to LOTOS automatically.

Each LOTOS specification (either written by hand or generated automatically) was then translated to an interpreted Petri net 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 the NUPNs whose marking graphs had more than one million states, discarding other NUPNs that were considered too simple for the Model Checking Contest. This led to a collection of 21 NUPNs, which we ordered by increasing number of places.




*The CO4 distributed knowledge system*

## References

[1] Charles Pecheur. *Specification and Verification of the CO4 Distributed Knowledge System Using LOTOS*. Proceedings of the 12th IEEE International Conference on Automated Software Engineering (ASE'97), Incline Village, Nevada, USA, November 1997. Extended version available as INRIA Research Report RR-3259.

The source LNT and LOTOS files modelling the CO4 system are available from http://cadp.inria.fr/ftp/demos/demo_24.

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## Scaling parameter

| Parameter name | Parameter description | Chosen parameter values |
|---|---|---|
| $N$ | $N$ is the instance number | from 1 to 21 |

## Size of the model

| Parameter | Number of places | Number of transitions | Number of arcs | Number of units | HWB code |
|---|---|---|---|---|---|
| $N = 1$ | 89 | 295 | 1074 | 12 | 2–11–31 |
| $N = 2$ | 97 | 299 | 1113 | 12 | 2–11–32 |
| $N = 3$ | 97 | 306 | 1120 | 12 | 2–11–32 |
| $N = 4$ | 101 | 246 | 716 | 10 | 2–9–28 |
| $N = 5$ | 101 | 253 | 723 | 10 | 2–9–28 |
| $N = 6$ | 383 | 454 | 1016 | 11 | 5–6–31 |
| $N = 7$ | 384 | 456 | 1022 | 11 | 5–6–31 |
| $N = 8$ | 467 | 600 | 1596 | 15 | 5–8–44 |
| $N = 9$ | 467 | 634 | 1868 | 15 | 5–8–44 |
| $N = 10$ | 544 | 615 | 1338 | 11 | 5–6–32 |
| $N = 11$ | 545 | 617 | 1344 | 11 | 5–6–32 |
| $N = 12$ | 649 | 782 | 1960 | 15 | 5–8–45 |
| $N = 13$ | 649 | 816 | 2232 | 15 | 5–8–45 |
| $N = 14$ | 680 | 812 | 1822 | 15 | 6–8–45 |
| $N = 15$ | 833 | 1106 | 2980 | 21 | 7–11–65 |
| $N = 16$ | 837 | 1122 | 3052 | 21 | 7–11–66 |
| $N = 17$ | 967 | 1150 | 2568 | 17 | 7–9–54 |
| $N = 18$ | 979 | 1111 | 2420 | 15 | 6–8–47 |
| $N = 19$ | 1174 | 1447 | 3662 | 21 | 6–11–67 |
| $N = 20$ | 1178 | 1463 | 3734 | 21 | 6–11–68 |
| $N = 21$ | 1400 | 1583 | 3434 | 17 | 7–9–56 |

## 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* ..... ? [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* ..... ? [j]
**loop-free** — *no transition has an input place that is also an output place* ..... ? [k]

[a] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[b] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[c] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[d] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[e] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[f] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[g] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[h] stated by CÆSAR.BDD version 3.7 to be true on 16 instance(s) out of 21, and false on the remaining 5 instance(s).
[i] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[j] stated by CÆSAR.BDD version 3.7 to be true on 5 instance(s) out of 21, and false on the remaining 16 instance(s).
[k] stated by CÆSAR.BDD version 3.7 to be true on 16 instance(s) out of 21, and false on the remaining 5 instance(s).

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**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]
**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 reachable markings | Number of transition firings | Max. number of tokens per place | Max. number of tokens per marking |
|---|---|---|---|---|
| $N = 1$ | 1.42506e+06 [u] | ? | 1 | 11 |
| $N = 2$ | 2.39211e+06 [v] | ? | 1 | 11 |
| $N = 3$ | 4.97679e+06 [w] | ? | 1 | 11 |
| $N = 4$ | 1.10323e+06 [x] | ? | 1 | 9 |
| $N = 5$ | 1.4196e+06 [y] | ? | 1 | 9 |
| $N = 6$ | 1.18583e+06 [z] | ? | 1 | 6 |
| $N = 7$ | 1.45575e+06 [aa] | ? | 1 | 6 |
| $N = 8$ | 2.67576e+08 [ab] | ? | 1 | 8 |
| $N = 9$ | 2.66567e+08 [ac] | ? | 1 | 8 |
| $N = 10$ | 3.10497e+06 [ad] | ? | 1 | 6 |
| $N = 11$ | 3.8125e+06 [ae] | ? | 1 | 6 |
| $N = 12$ | 8.15089e+08 [af] | ? | 1 | 8 |
| $N = 13$ | 8.09205e+08 [ag] | ? | 1 | 8 |
| $N = 14$ | 2.10304e+09 [ah] | ? | 1 | 8 |
| $N = 15$ | $\geq$ 6.06741e+12 [ai] | ? | 1 [aj] | 11 |
| $N = 16$ | $\geq$ 7.06534e+12 [ak] | ? | 1 [al] | 11 |
| $N = 17$ | $\geq$ 2.42483e+11 [am] | ? | 1 [an] | 9 |
| $N = 18$ | 1.28681e+10 [ao] | ? | 1 | 8 |
| $N = 19$ | $\geq$ 1.08944e+13 [ap] | ? | 1 [aq] | 11 |
| $N = 20$ | $\geq$ 1.15888e+13 [ar] | ? | 1 [as] | 11 |
| $N = 21$ | $\geq$ 2.11466e+12 [at] | ? | 1 [au] | 9 |

[l] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 values of $N$).
[m] stated by CÆSAR.BDD version 3.7 on all 21 instances (21 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 true on 16 instance(s) out of 21, and false on the remaining 5 instance(s).
[q] stated by CÆSAR.BDD version 3.7 to be true on 16 instance(s) out of 21, and false on the remaining 5 instance(s).
[r] stated by CÆSAR.BDD version 3.7 to be true on 13 instance(s) out of 21, false on the remaining 2 instance(s), and unknown on the remaining 6 instance(s).
[s] stated by CÆSAR.BDD version 3.7 to be false on 13 instance(s) out of 21, and unknown on the remaining 8 instance(s).
[t] stated by CÆSAR.BDD version 3.7 to be false on 19 instance(s) out of 21, and unknown on the remaining 2 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 CÆSAR.BDD version 3.7.
[aa] stated by CÆSAR.BDD version 3.7.

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(ab) stated by CÆSAR.BDD version 3.7.
(ac) stated by CÆSAR.BDD version 3.7.
(ad) stated by CÆSAR.BDD version 3.7.
(ae) stated by CÆSAR.BDD version 3.7.
(af) stated by CÆSAR.BDD version 3.7.
(ag) stated by CÆSAR.BDD version 3.7.
(ah) stated by CÆSAR.BDD version 3.7.
(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.
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(as) stated by the CÆSAR compiler.
(at) stated by CÆSAR.BDD version 3.7.
(au) stated by the CÆSAR compiler.