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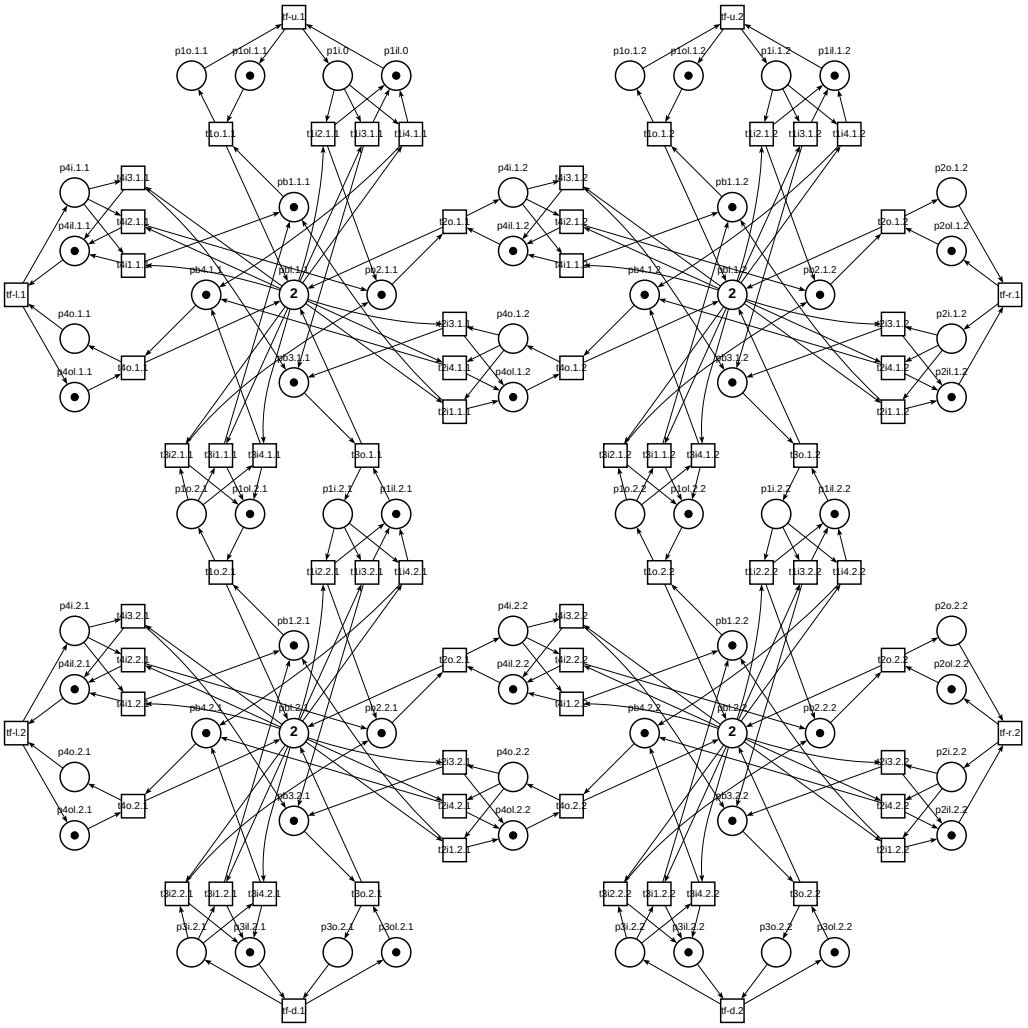
This form is a summary description of the model entitled "SquareGrid" proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, unfolded P/T nets. Models are given together with property files (possibly, one per model instance) giving a set of properties to be checked on the model.

Description

Square communication grid model is composed of nodes which represent data communication equipment (DCE) implementing packet forwarding. Each DCE has four ports, situated on sides of a unit size square, which work in full-duplex mode. Data terminal equipment (DTE) is attached on the borders. Each DTE receives and sends packets.



Graphical representation for $k = 2, p = 1, b = 2$

References

1. Zaitsev D.A., Zaitsev I.D., Shmeleva T.R. Infinite Petri Nets as Models of Grids (pp. 187-204). Chapter 19 in Mehdi Khosrow-Pour (Ed.) Encyclopedia of Information Science and Technology, Third Edition (10 Volumes). IGI-Global: USA, 2014.

2.Shmeleva T.R., Zaitsev D.A., Zaitsev I.D. Analysis of Square Communication Grids via Infinite Petri Nets. Transactions of Odessa National Academy of Telecommunication, no. 1, 2009, p. 27-35.

3. A C program that generates $k \times k$ grid can be downloaded from http://daze.ho.ua/tinaz.zip

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Scaling parameter

Parameter name	Parameter description	Chosen parameter values
k, p, b	k – number of rows and columns (square grid consists of $k \times k$ DCE nodes and $4 \cdot k$ DTE nodes attached on the borders of a square); p – number of packets in each section of internal buffer; b – avaliable size of internal buffer. p and b define initial marking and do not affect the model structure.	$k = 2, 4, 8, 10, 13$, with $p = k/2$ and $b = k$

Size of the model

Parameter	Number of places	Number of transitions	Number of arcs
k	$P = 13 \cdot k^2 + 8 \cdot k$	$T = 16 \cdot k^2 + 4 \cdot k$	$A = 64 \cdot k^2 + 16 \cdot k$
$k = 2$	68	72	288
$k = 4$	240	272	1088
$k = 8$	896	1056	4224
$k = 10$	1380	1640	6560
$k = 13$	2301	2756	11024

Structural properties

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

[a] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[b] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[c] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[d] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[e] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[f] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[g] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[h] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[i] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[j] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[k] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[l] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[m] 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* ..... ✗ [n]
deadlock — *there exists a reachable marking from which no transition can be fired* ..... ✓ [o]
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* ..... ✓
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
$k = 2$	?	?	?	≥ 48 [p]
$k = 4$	?	?	?	≥ 272 [q]
$k = 8$	?	?	?	≥ 1824 [r]
$k = 10$	?	?	?	≥ 3440 [s]
$k = 13$	?	?	?	≥ 6981 [t]

Other properties

Model is $4 \cdot p + b$ bounded – the sum of tokens in DCE internal buffer places. Model is P/T-invariant for any natural k as proven in [1,2].

[n] stated by CÆSAR.BDD version 2.2 on all 5 instances ($k = 2, 4, 8, 10, 13$).
[o] proven in [1,2]; checked by the Tina `http://www.laas.fr/tina` tool version 3.3.0 as well as other behavioural properties for small values of parameter k.
[p] lower bound given by the number of initial tokens.
[q] lower bound given by the number of initial tokens.
[r] lower bound given by the number of initial tokens.
[s] lower bound given by the number of initial tokens.
[t] lower bound given by the number of initial tokens.