

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

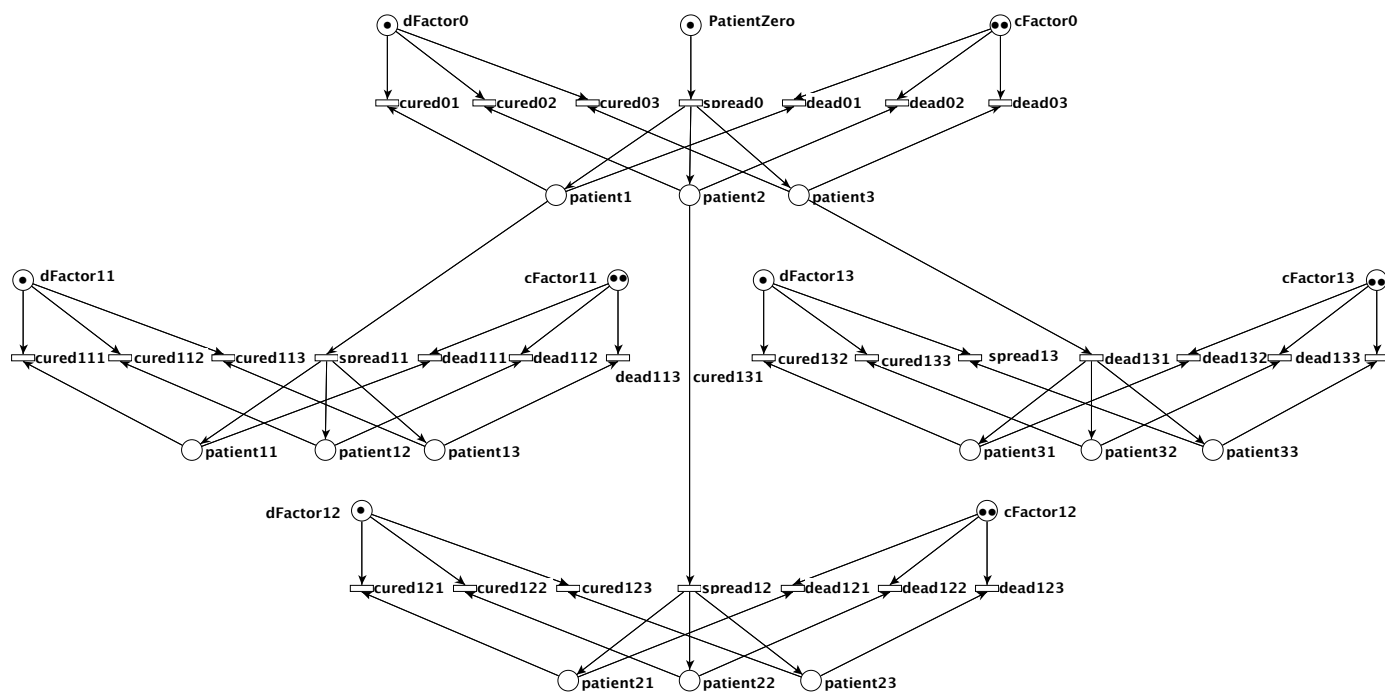
## Description

This Petri net models the simplified propagation of a contagious disease (from the point of view of a distributed system). It is based on a standard module describing a step where a given patient may either:

- propagate the disease
- die (according to an upper bound)
- cure himself (according to an upper bound)

In the two later cases, the disease does not propagate again.

*In April 2021, Pierre Bouvier provided a decomposition of ten instances of this model into networks of communicating automata. Each network is expressed as a Nested-Unit Petri Net (NUPN) that can be found, for each instance, in the "toolspecific" section of the corresponding PNML file.*



*Instantiation of this model for a spread factor of the virus ( $R_0$ ) of 3 (i.e. a patient contaminates 3 others), a death factor of 1 (i.e. at one stage,  $\frac{1}{3}$  of the patients may die) and a potential cure factor of 2 (i.e. at one stage,  $\frac{2}{3}$  of the patients may cure themselves); the analysis depth is 1 (one level of propagation of the disease)*

## Scaling parameter

Parameter name	Parameter description	Chosen parameter values
$S, D, C, A$	$S$ , the spread factor (how many people are contaminated), $D$ , the number of potential deaths at each step of the propagation, $C$ , the number of potential cured patients at each step of the propagation, $A$ , the depth of the analysis (how many steps of the contamination are explored)	$\langle 2, 1, 1, 10 \rangle$ , $\langle 2, 1, 1, 12 \rangle$ , $\langle 3, 1, 1, 2 \rangle$ , $\langle 3, 1, 1, 4 \rangle$ , $\langle 3, 1, 1, 6 \rangle$ , $\langle 3, 1, 1, 8 \rangle$ , $\langle 4, 1, 1, 2 \rangle$ , $\langle 4, 1, 1, 3 \rangle$ , $\langle 4, 1, 1, 4 \rangle$ , $\langle 4, 1, 1, 6 \rangle$ , $\langle 8, 1, 2, 2 \rangle$ , $\langle 8, 1, 2, 4 \rangle$ , $\langle 16, 2, 4, 1 \rangle$ , $\langle 16, 2, 4, 2 \rangle$ , $\langle 16, 2, 4, 3 \rangle$

## Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$\langle 2, 1, 1, 10 \rangle$	8 189	10 235	22 517	6 143	1-6 142-7 438
$\langle 2, 1, 1, 12 \rangle$	32 765	40 955	90 101	24 575	1-24 574-29 758
$\langle 3, 1, 1, 2 \rangle$	66	91	208	54	1-53-63
$\langle 3, 1, 1, 4 \rangle$	606	847	1 936	486	1-485-575
$\langle 3, 1, 1, 6 \rangle$	5 466	7 651	17 488	4 374	1-4 373-5 184
$\langle 3, 1, 1, 8 \rangle$	49 206	68 887	157 456	39 366	1-39 365-46 664
$\langle 4, 1, 1, 2 \rangle$	127	189	441	107	1-106-123
$\langle 4, 1, 1, 3 \rangle$	511	765	1 785	427	1-426-494
$\langle 4, 1, 1, 4 \rangle$	2 047	3 069	7 161	1 707	1-1 706-1 978
$\langle 4, 1, 1, 6 \rangle$	32 767	49 149	114 681	27 307	1-27 306-31 659
$\langle 8, 1, 2, 2 \rangle$	731	1 241	2 993	-	-- 731
$\langle 8, 1, 2, 4 \rangle$	46 811	79 577	191 921	-	-- 46 811
$\langle 16, 2, 4, 1 \rangle$	307	561	1 377	-	-- 307
$\langle 16, 2, 4, 2 \rangle$	4 915	9 009	22 113	-	-- 4 915
$\langle 16, 2, 4, 3 \rangle$	78 643	144 177	353 889	-	-- 78 643

## Structural properties

<b>ordinary</b> — all arcs have multiplicity one .....	✓
<b>simple free choice</b> — all transitions sharing a common input place have no other input place .....	✗ (a)
<b>extended free choice</b> — all transitions sharing a common input place have the same input places .....	✗ (b)
<b>state machine</b> — every transition has exactly one input place and exactly one output place .....	✗ (c)
<b>marked graph</b> — every place has exactly one input transition and exactly one output transition .....	✗ (d)
<b>connected</b> — there is an undirected path between every two nodes (places or transitions) .....	✓ (e)
<b>strongly connected</b> — there is a directed path between every two nodes (places or transitions) .....	✗ (f)
<b>source place(s)</b> — one or more places have no input transitions .....	✓ (g)
<b>sink place(s)</b> — one or more places have no output transitions .....	✗ (h)
<b>source transition(s)</b> — one or more transitions have no input places .....	✗ (i)

- (a) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (b) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (c) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (d) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (e) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (f) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (g) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (h) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (i) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).

- 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<sup>(n)</sup> ..... ? (o)

## Behavioural properties

- safe** — in every reachable marking, there is no more than one token on a place ..... ? (p)
- dead place(s)** — one or more places have no token in any reachable marking ..... ? (q)
- dead transition(s)** — one or more transitions cannot fire from any reachable marking ..... ? (r)
- deadlock** — there exists a reachable marking from which no transition can be fired ..... ? (s)
- reversible** — from every reachable marking, there is a transition path going back to the initial marking ..... ? (t)
- live** — for every transition  $t$ , from every reachable marking, one can reach a marking in which  $t$  can fire ..... ? (u)

## 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
$\langle 2, 1, 1, 10 \rangle$	?	?	1 <sup>(v)</sup>	6142
$\langle 2, 1, 1, 12 \rangle$	?	?	1 <sup>(w)</sup>	24574
$\langle 3, 1, 1, 2 \rangle$	9.16868e+09 <sup>(x)</sup>	?	1	53
$\langle 3, 1, 1, 4 \rangle$	4.5789e+89 <sup>(y)</sup>	?	1 <sup>(z)</sup>	485
$\langle 3, 1, 1, 6 \rangle$	?	?	1 <sup>(aa)</sup>	4373
$\langle 3, 1, 1, 8 \rangle$	?	?	1 <sup>(ab)</sup>	39365
$\langle 4, 1, 1, 2 \rangle$	9.93735e+19 <sup>(ac)</sup>	?	1	106
$\langle 4, 1, 1, 3 \rangle$	?	?	1 <sup>(ad)</sup>	426
$\langle 4, 1, 1, 4 \rangle$	?	?	1 <sup>(ae)</sup>	1706
$\langle 4, 1, 1, 6 \rangle$	?	?	1 <sup>(af)</sup>	27306
$\langle 8, 1, 2, 2 \rangle$	?	?	?	$\geq 220$ <sup>(ag)</sup>
$\langle 8, 1, 2, 4 \rangle$	?	?	?	$\geq 14044$ <sup>(ah)</sup>
$\langle 16, 2, 4, 1 \rangle$	1.21378e+35 <sup>(ai)</sup>	?	?	$\geq 103$ <sup>(aj)</sup>
$\langle 16, 2, 4, 2 \rangle$	?	?	?	$\geq 1639$ <sup>(ak)</sup>
$\langle 16, 2, 4, 3 \rangle$	?	?	?	$\geq 26215$ <sup>(al)</sup>

(j) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (k) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (l) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (m) stated by [CÆSAR.BDD](#) version 3.3 on all 15 instances (see all aforementioned parameter values).  
 (n) the definition of Nested-Unit Petri Nets (NUPN) is available from <http://mcc.lip6.fr/nupn.php>  
 (o) stated by [CÆSAR.BDD](#) version 3.5 to be true on 10 instance(s) out of 15, and false on the remaining 5 instance(s).  
 (p) stated by [CÆSAR.BDD](#) version 3.5 to be true on 10 instance(s) out of 15, and false on the remaining 5 instance(s).  
 (q) stated by [CÆSAR.BDD](#) version 3.3 to be false on 3 instance(s) out of 15, and unknown on the remaining 12 instance(s).  
 (r) stated by [CÆSAR.BDD](#) version 3.3 to be false on 3 instance(s) out of 15, and unknown on the remaining 12 instance(s).  
 (s) stated by [CÆSAR.BDD](#) version 3.3 to be true on 2 instance(s) out of 15, and unknown on the remaining 13 instance(s).  
 (t) stated by [CÆSAR.BDD](#) version 3.3 to be false on 2 instance(s) out of 15, and unknown on the remaining 13 instance(s).  
 (u) stated by [CÆSAR.BDD](#) version 3.3 to be false on 2 instance(s) out of 15, and unknown on the remaining 13 instance(s).  
 (v) this net is safe.  
 (w) this net is safe.  
 (x) stated by [CÆSAR.BDD](#) version 3.5.  
 (y) stated by libITS version 1.1.  
 (z) this net is safe.  
 (aa) this net is safe.  
 (ab) this net is safe.  
 (ac) stated by [CÆSAR.BDD](#) version 3.3.  
 (ad) this net is safe.  
 (ae) this net is safe.

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<sup>(af)</sup> this net is safe.

<sup>(ag)</sup> lower bound given by the number of initial tokens.

<sup>(ah)</sup> lower bound given by the number of initial tokens.

<sup>(ai)</sup> stated by libITS version 1.1.

<sup>(aj)</sup> lower bound given by the number of initial tokens.

<sup>(ak)</sup> lower bound given by the number of initial tokens.

<sup>(al)</sup> lower bound given by the number of initial tokens.