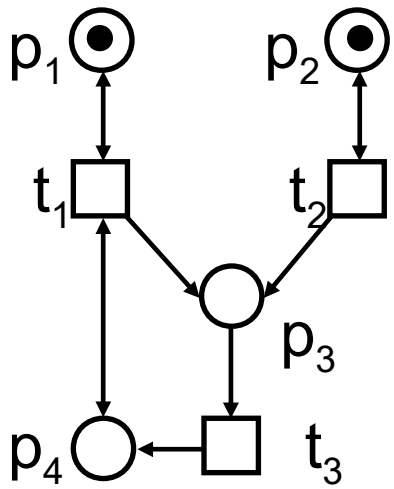
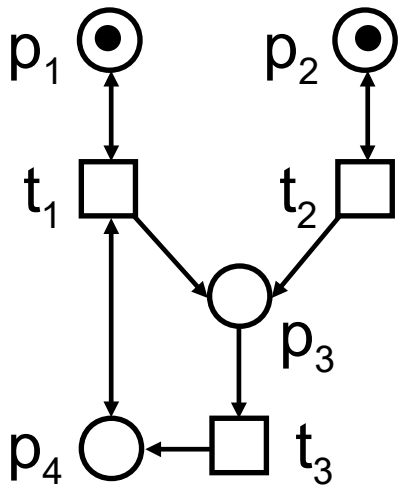
Konečné procesy pokrytia neohraničených Petriho sietí

- graf pokrytia



Konečné procesy pokrytia neohraničených Petriho sietí

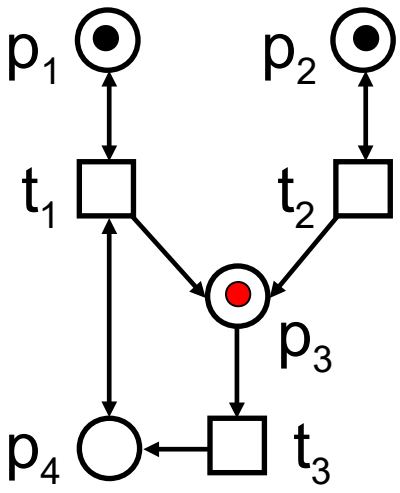
- graf pokrytia



(1,1,0,0)

Konečné procesy pokrytia neohraničených Petriho sietí

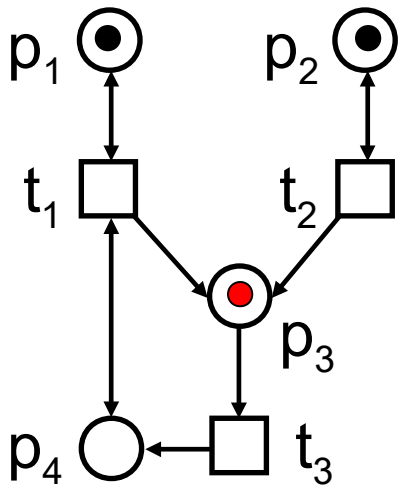
- graf pokrytia



$$(1,1,0,0) \xrightarrow{t_2} (1,1,1,0)$$

Konečné procesy pokrytia neohraničených Petriho sietí

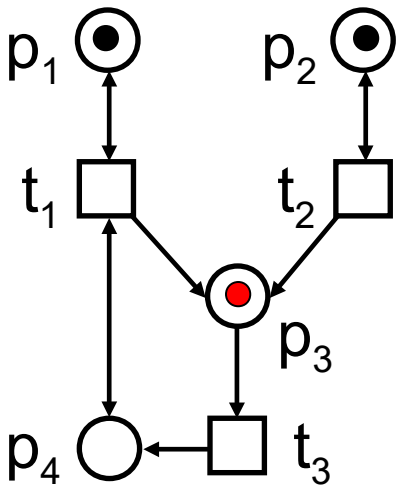
- graf pokrytia

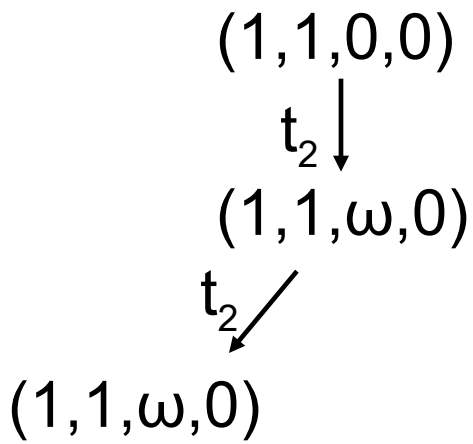


$$(1,1,0,0) \xrightarrow{t_2} (1,1,\omega,0)$$

Konečné procesy pokrytia neohraničených Petriho sietí

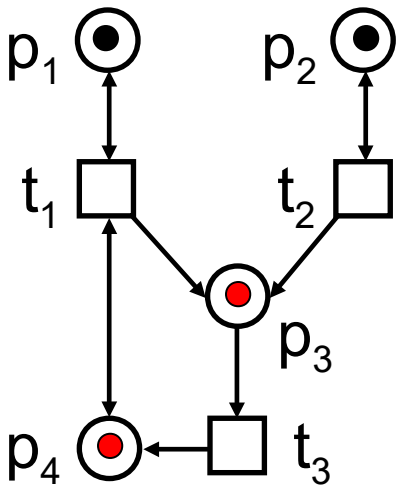
- graf pokrytia

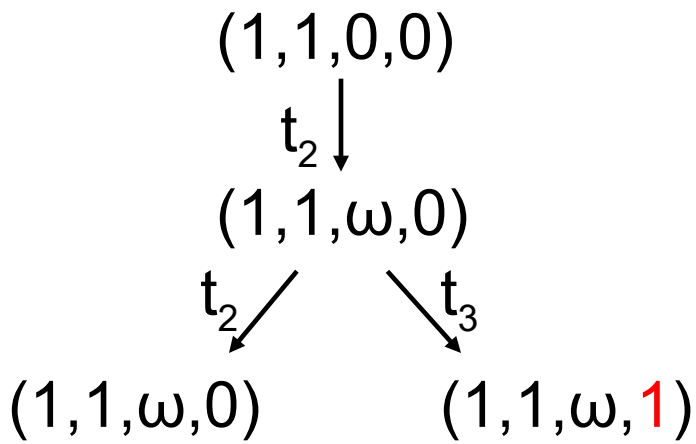




Konečné procesy pokrytia neohraničených Petriho sietí

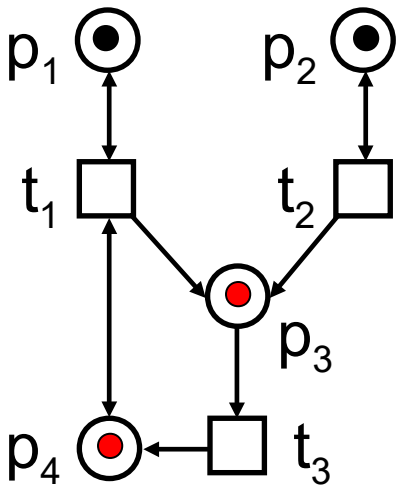
- graf pokrytia

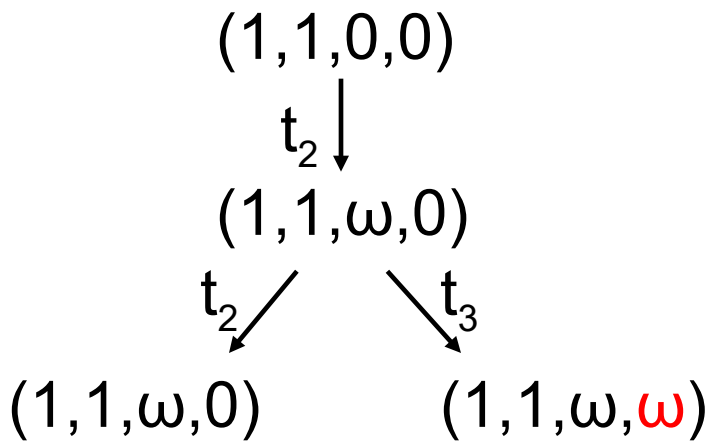




Konečné procesy pokrytia neohraničených Petriho sietí

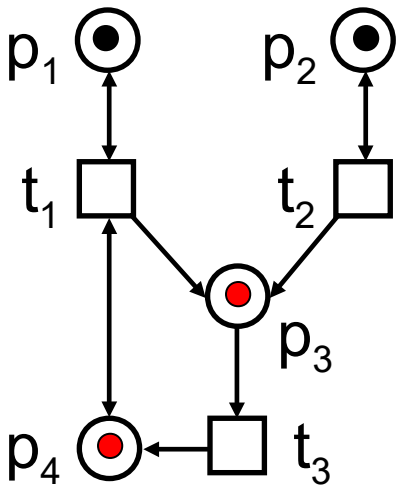
- graf pokrytia

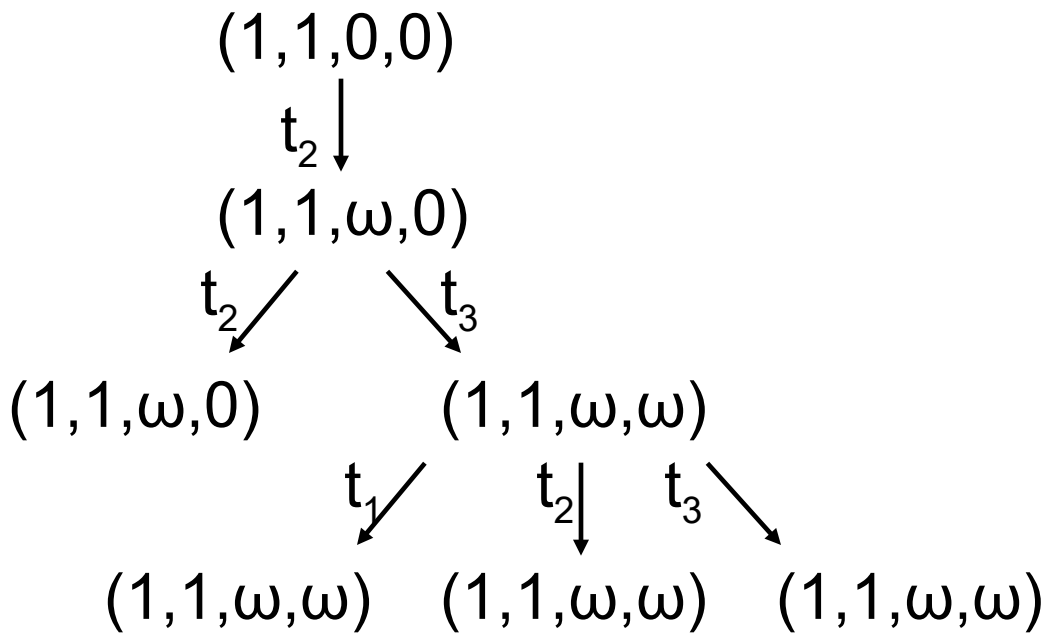




Konečné procesy pokrytia neohraničených Petriho sietí

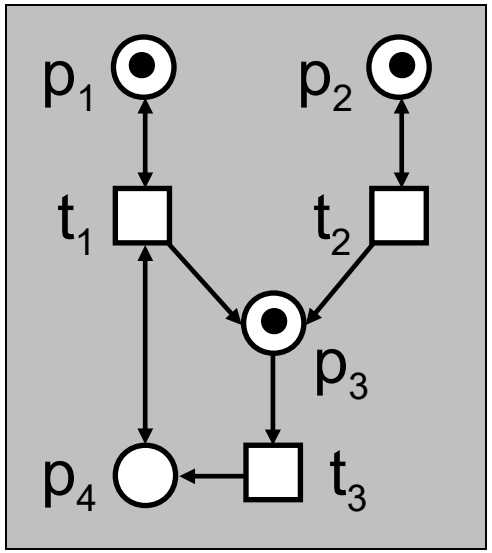
- graf pokrytia





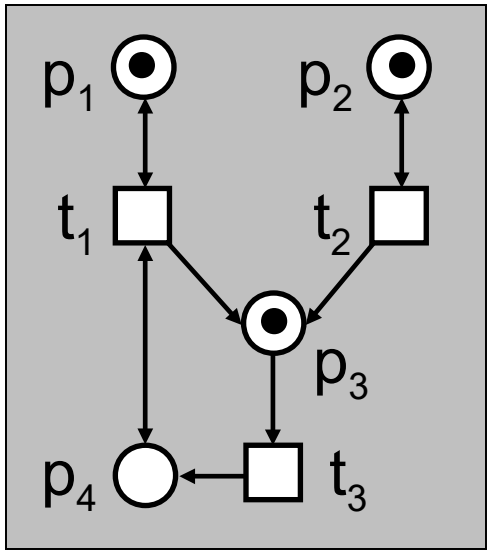
Konečné procesy pokrytia neohraničených Petriho sietí

- coverablity unfolding

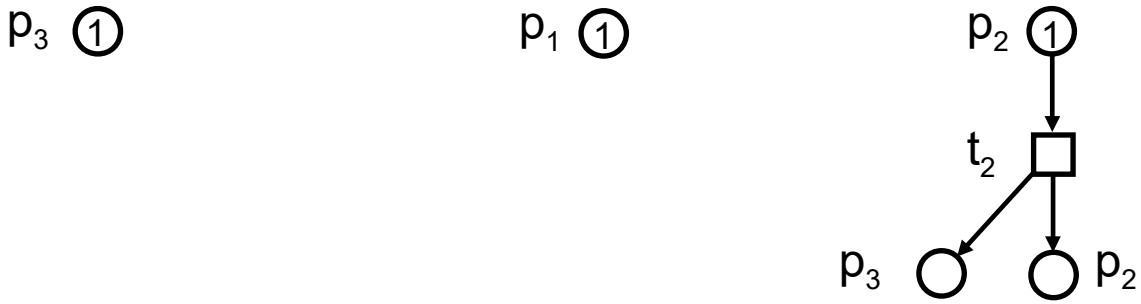


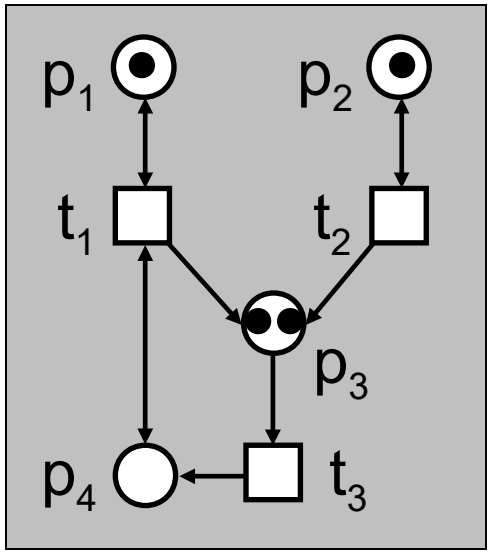
Konečné procesy pokrytia neohraničených Petriho sietí

p_3 1 p_1 1 p_2 1

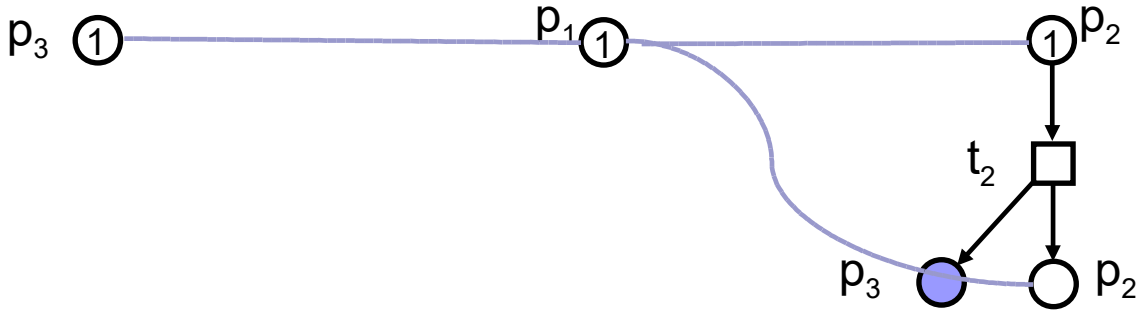


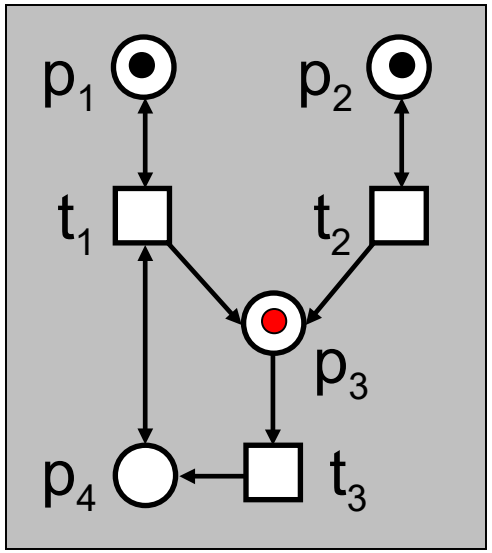
Konečné procesy pokrytia neohraničených Petriho sietí





Konečné procesy pokrytia neohraničených Petriho sietí





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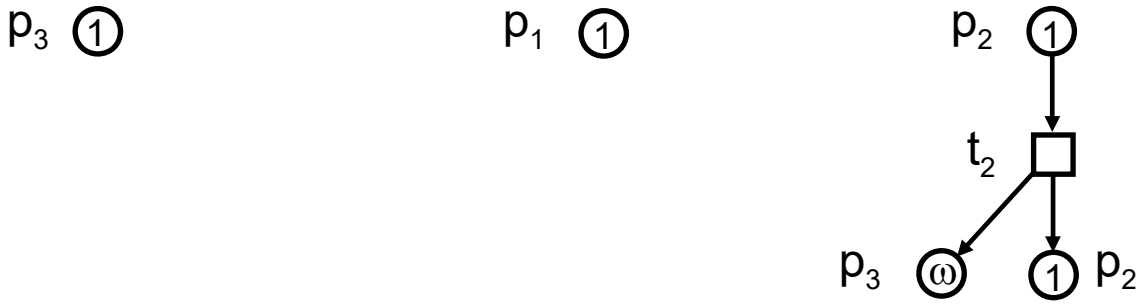
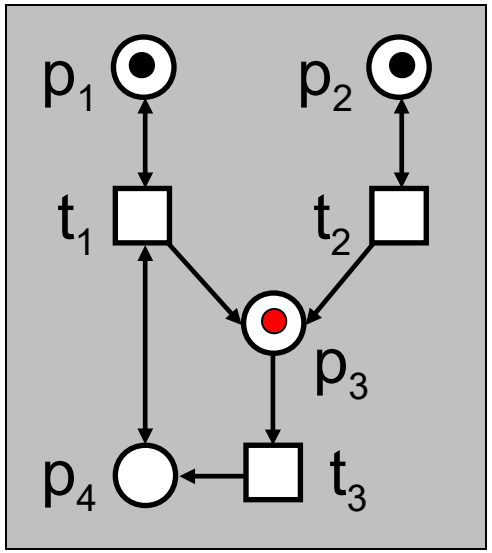
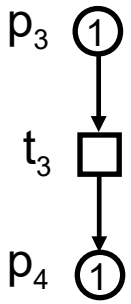
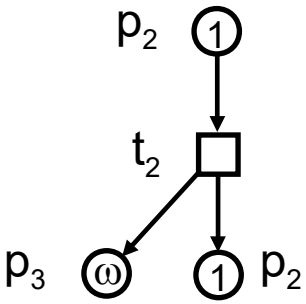
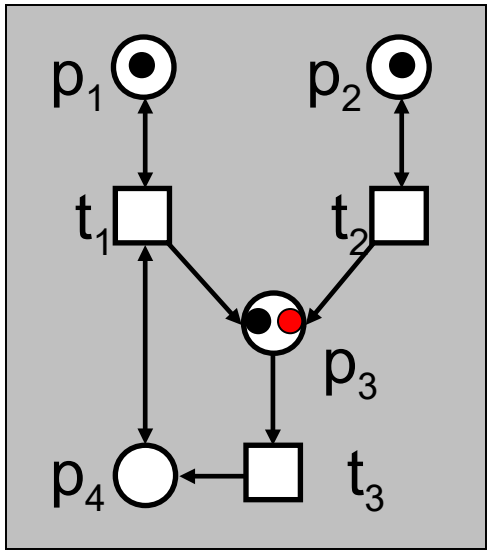




Konečné procesy pokrytia neohraničených Petriho sietí







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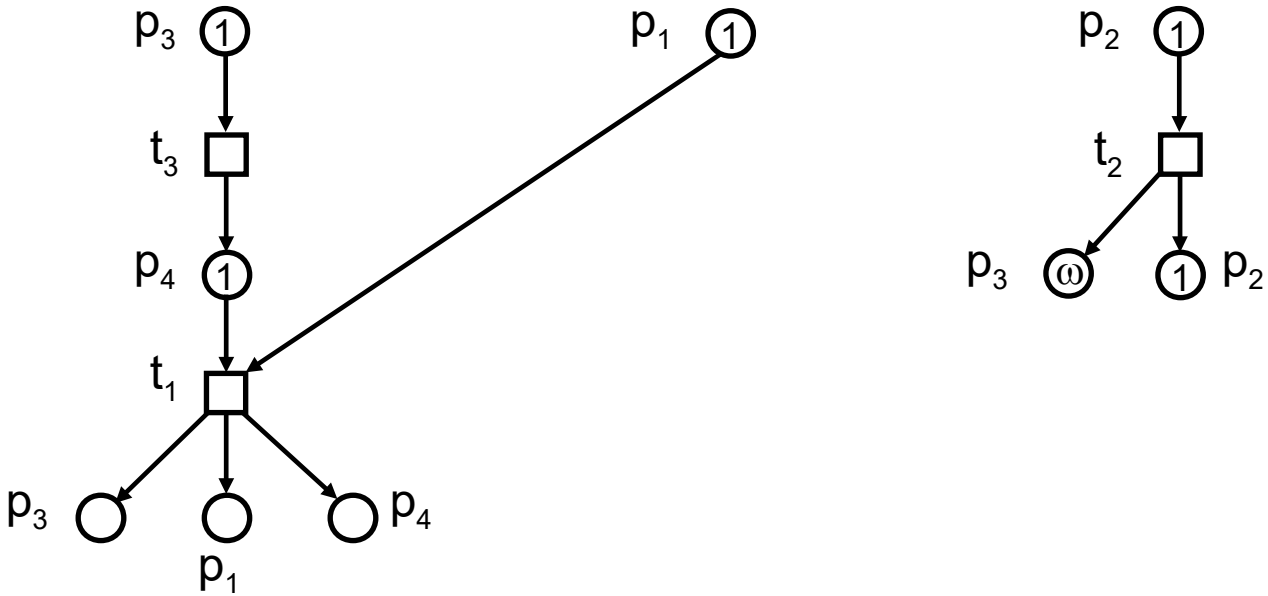

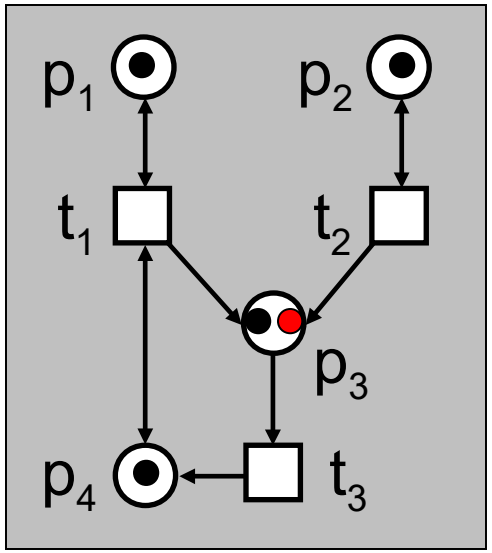

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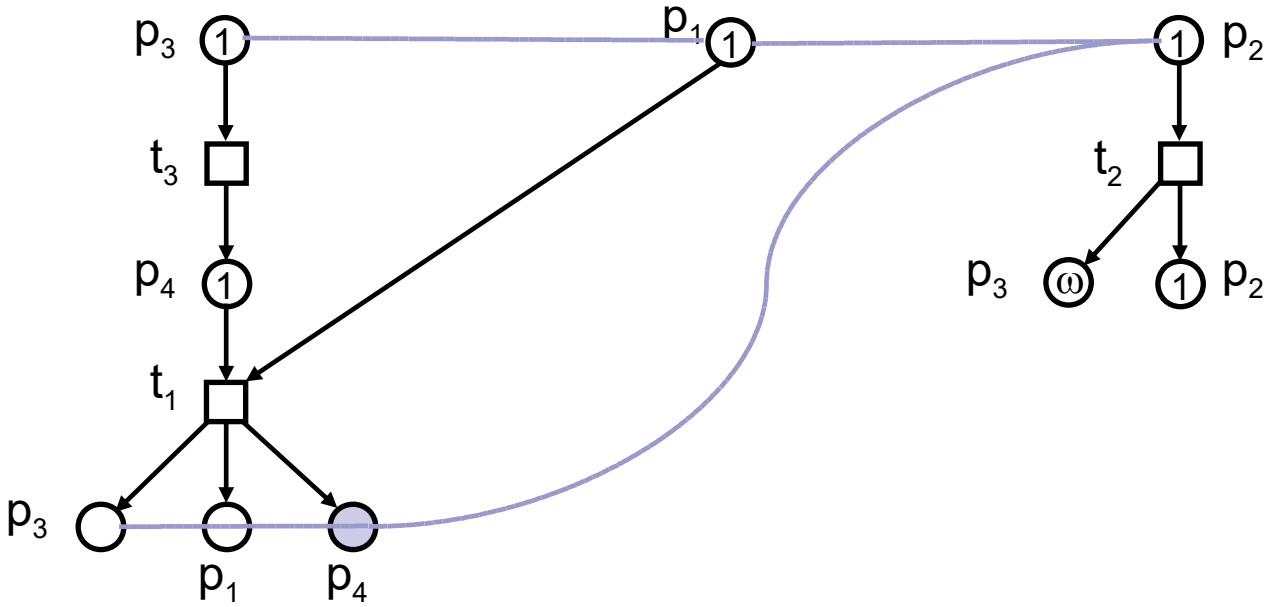

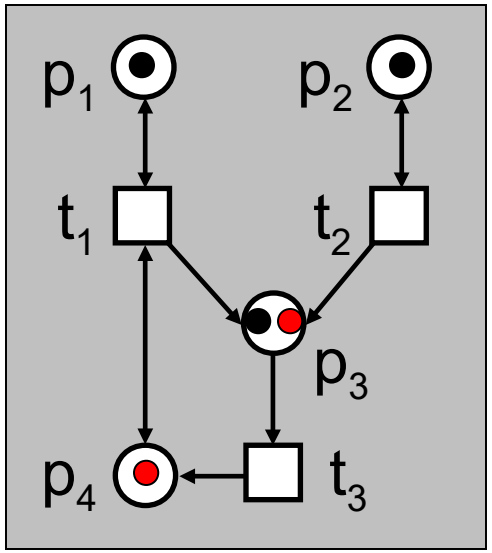

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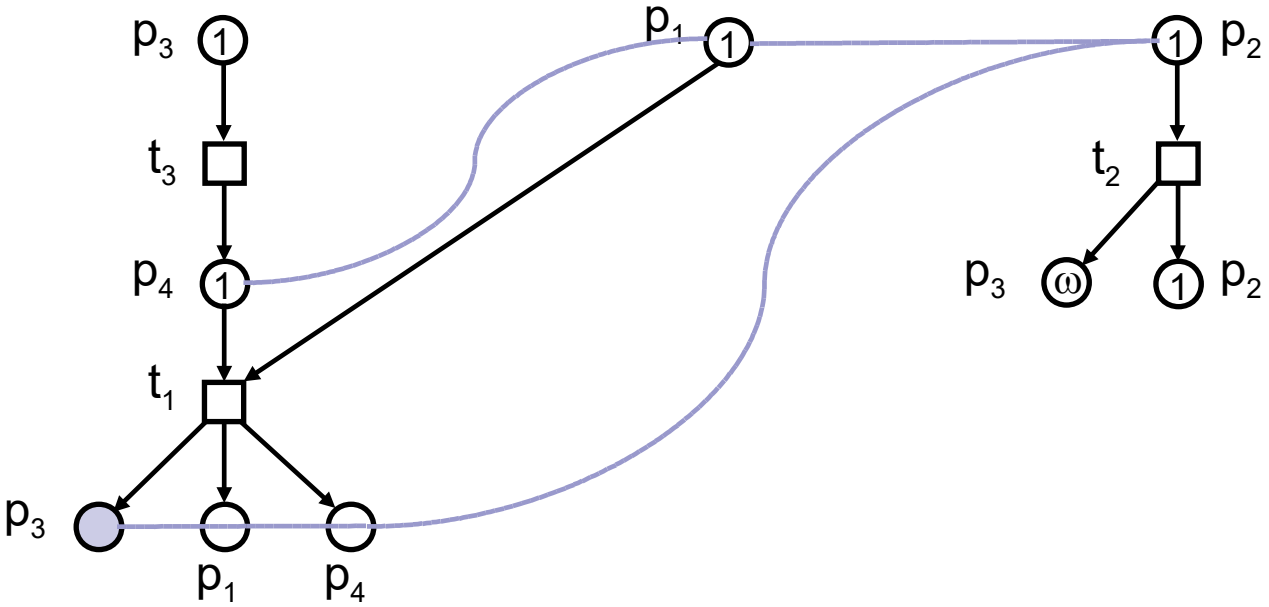
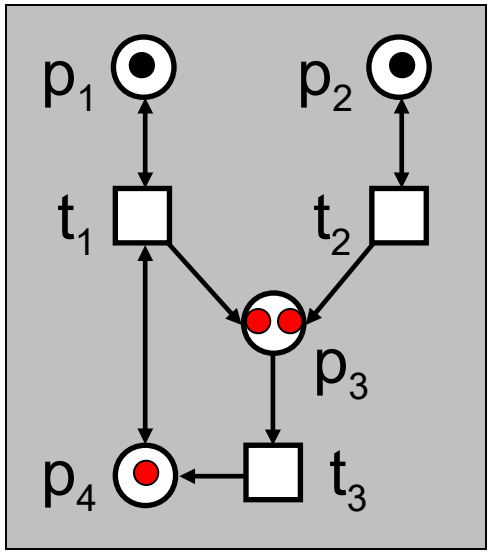
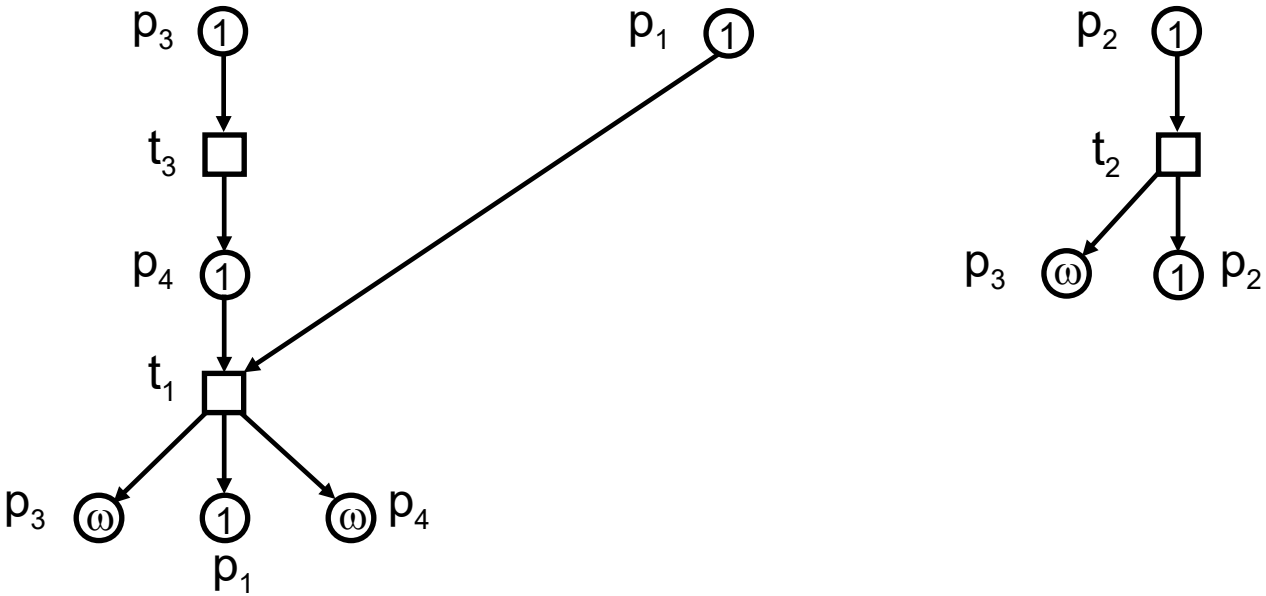
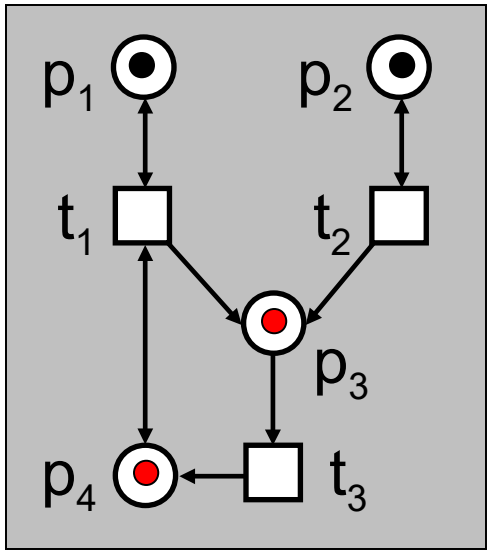


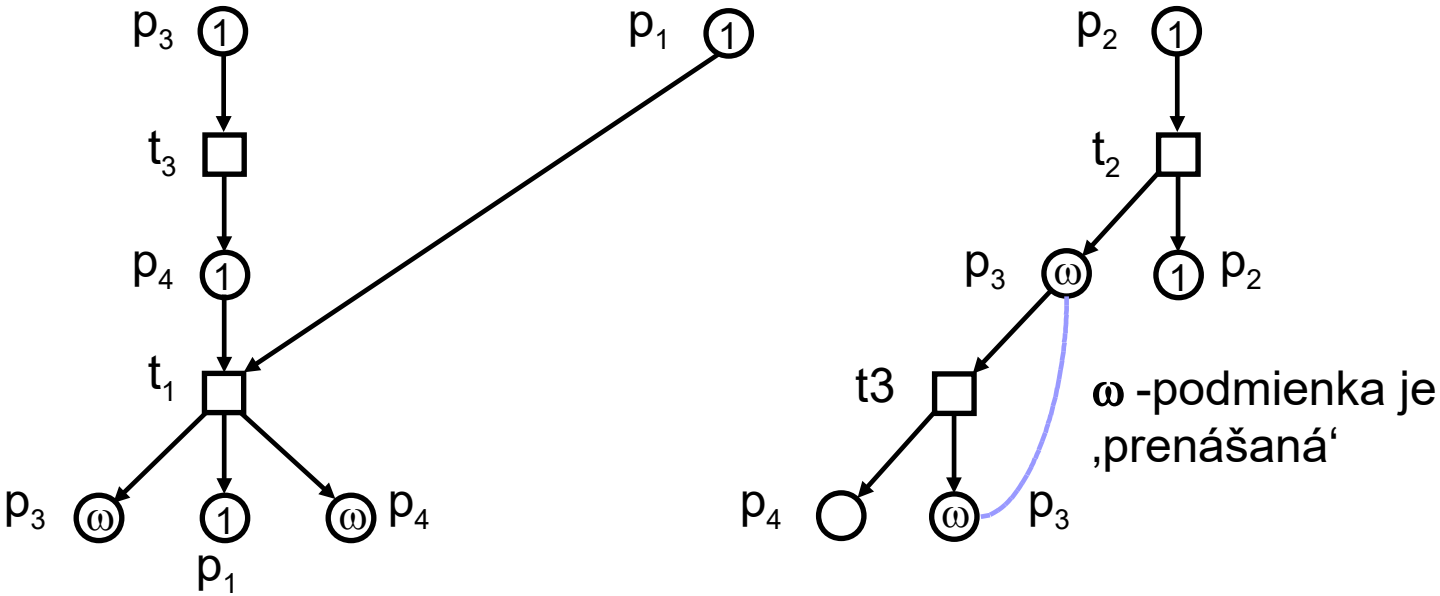


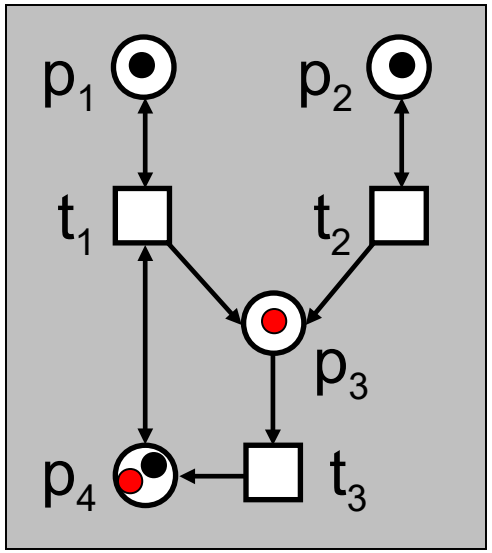
Konečné procesy pokrytia neohraničených Petriho sietí



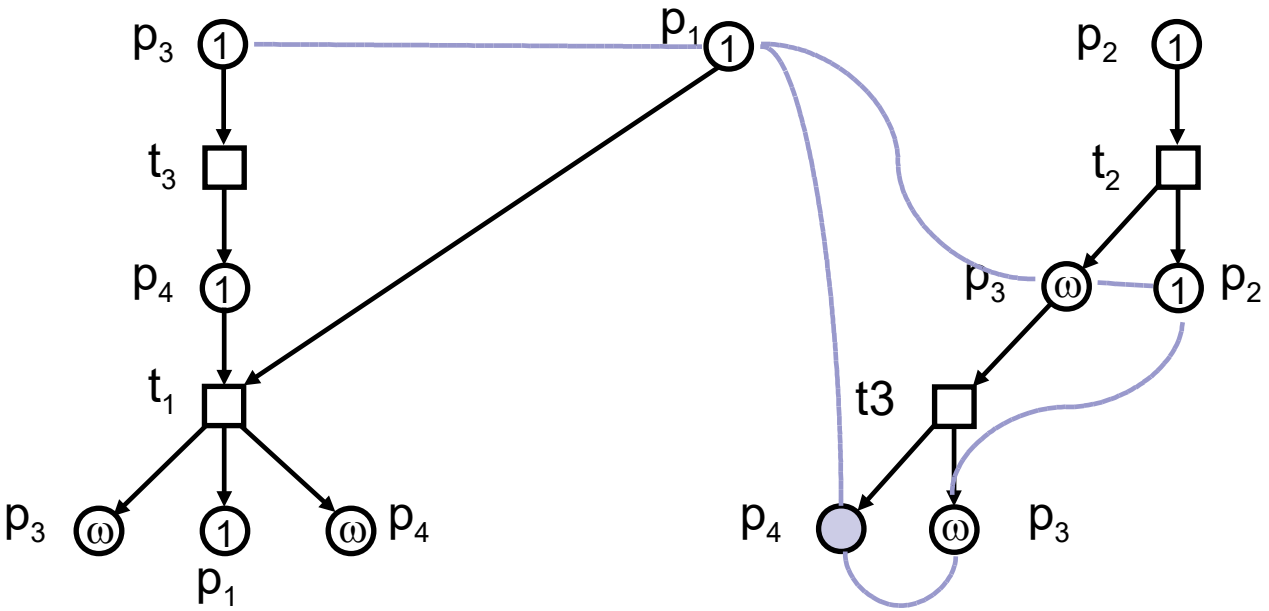


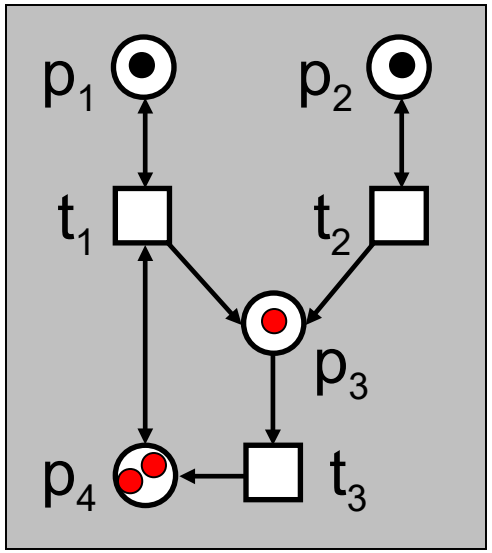
Konečné procesy pokrytia neohraničených Petriho sietí



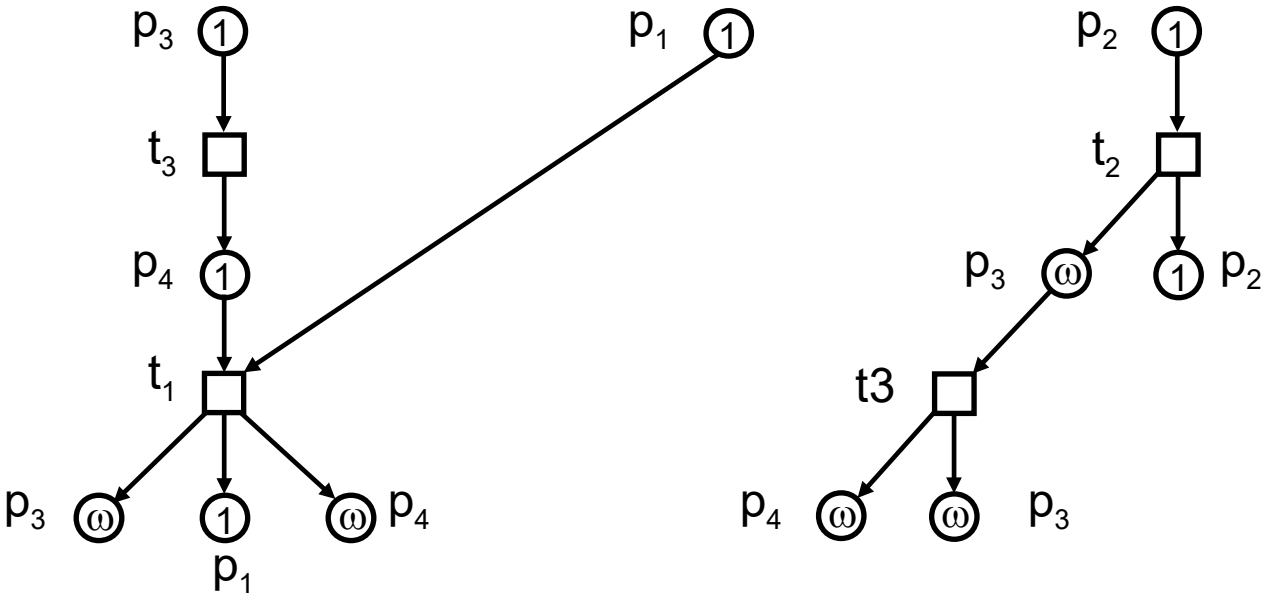


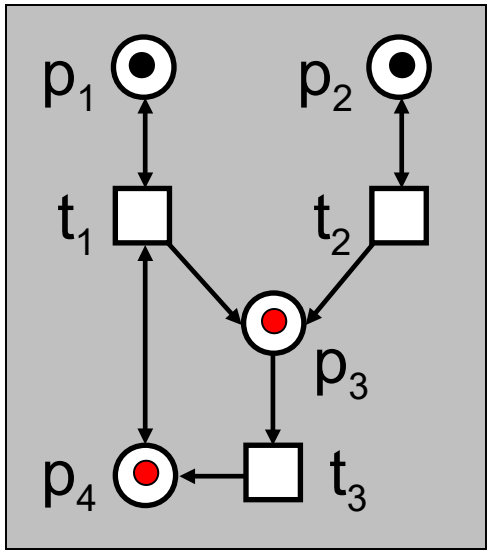
Konečné procesy pokrytia neohraničených Petriho sietí



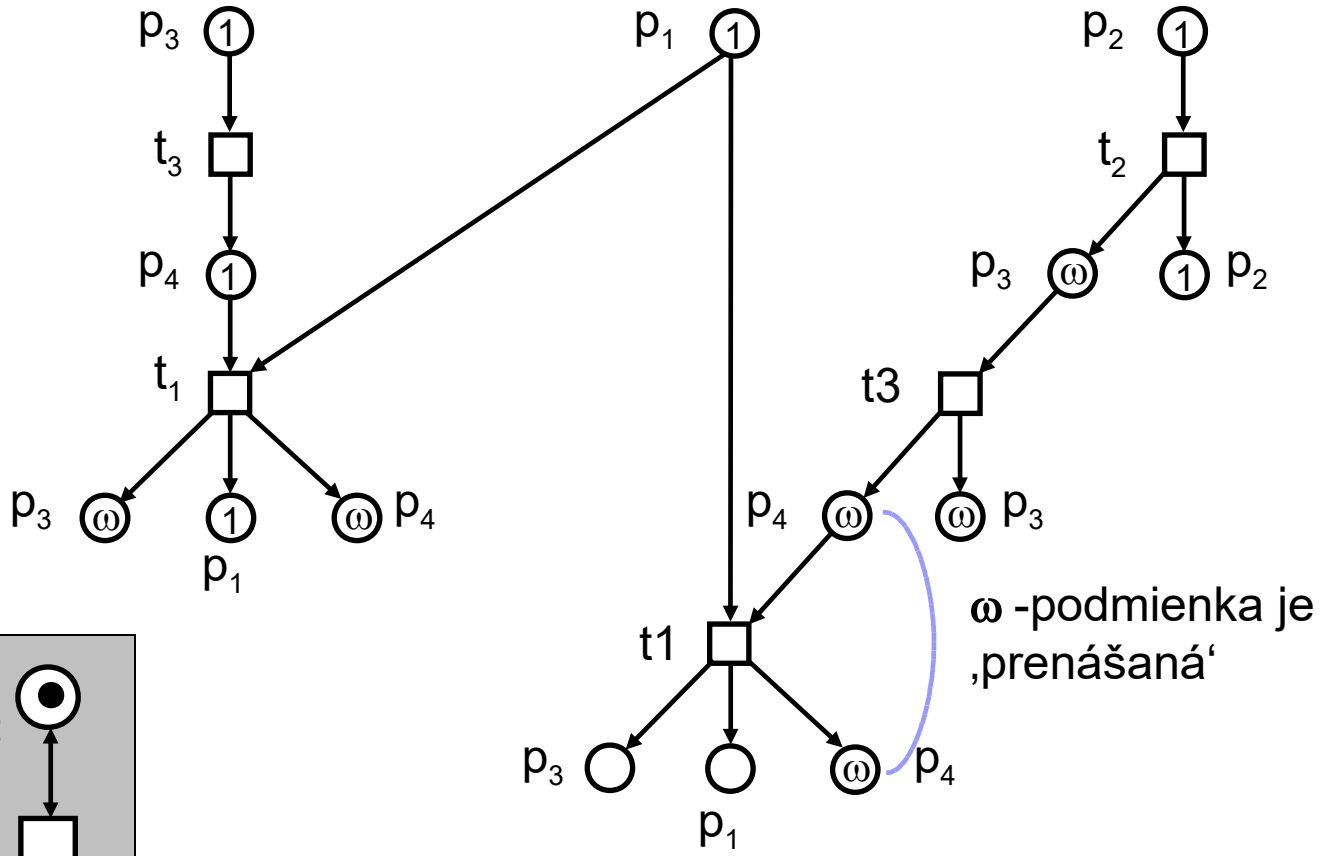


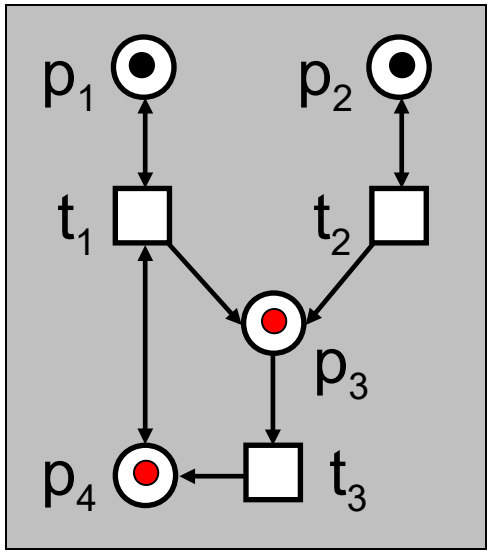
Konečné procesy pokrytia neohraničených Petriho sietí



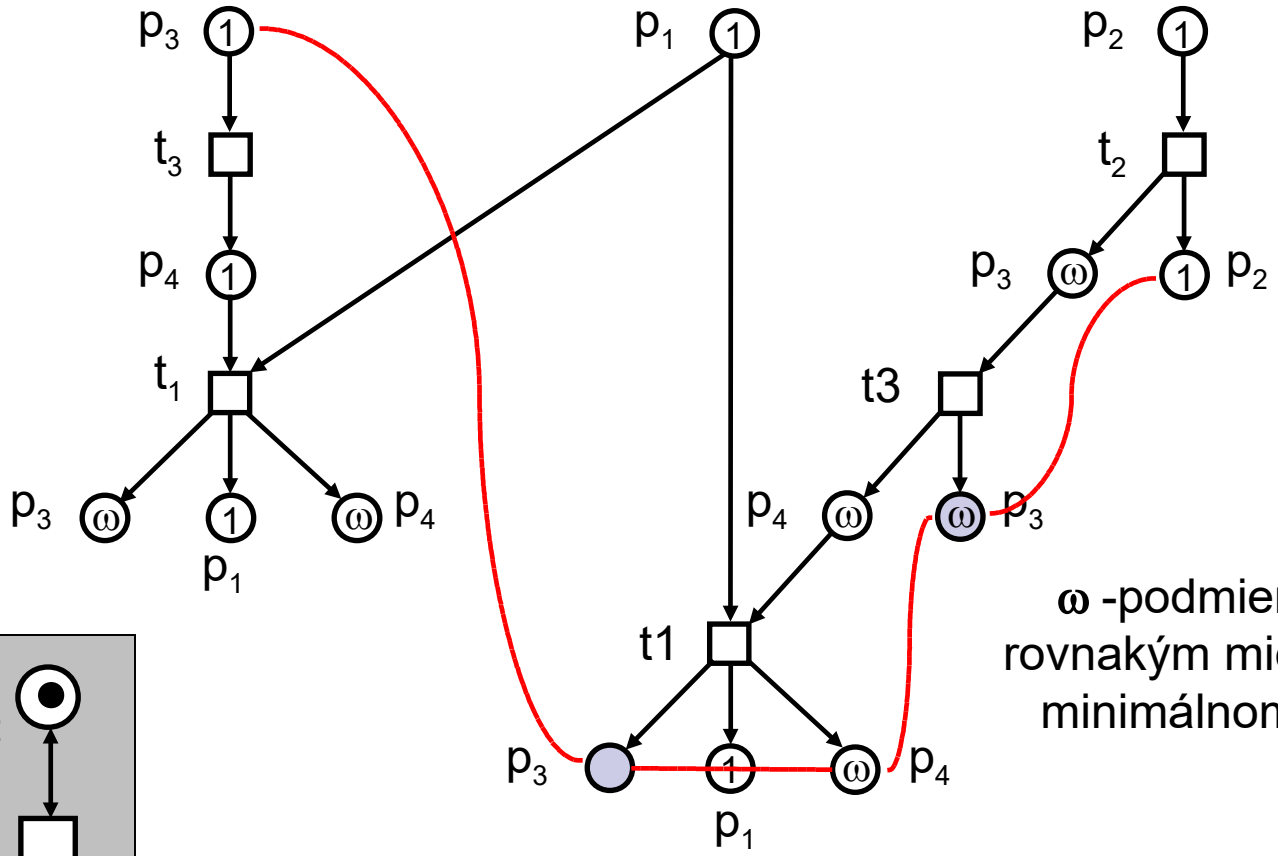


Konečné procesy pokrytia neohraničených Petriho sietí

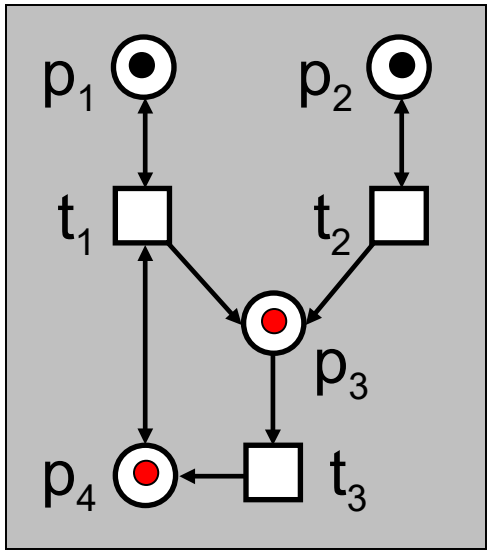




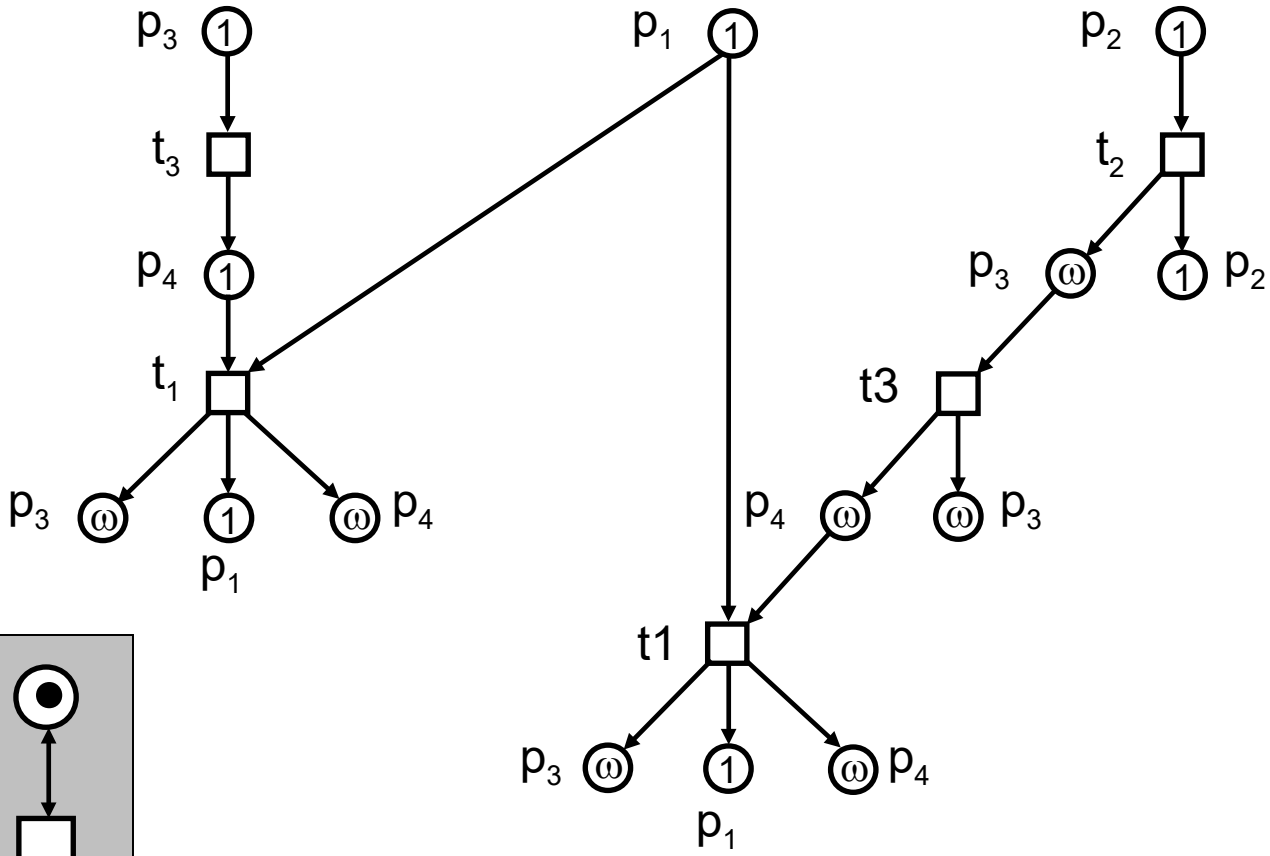
Konečné procesy pokrytia neohraničených Petriho sietí

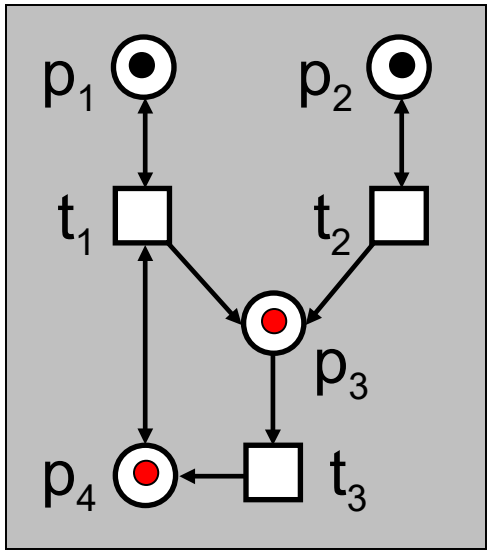


ω -podmienka s rovnakým miestom v minimálnom reze

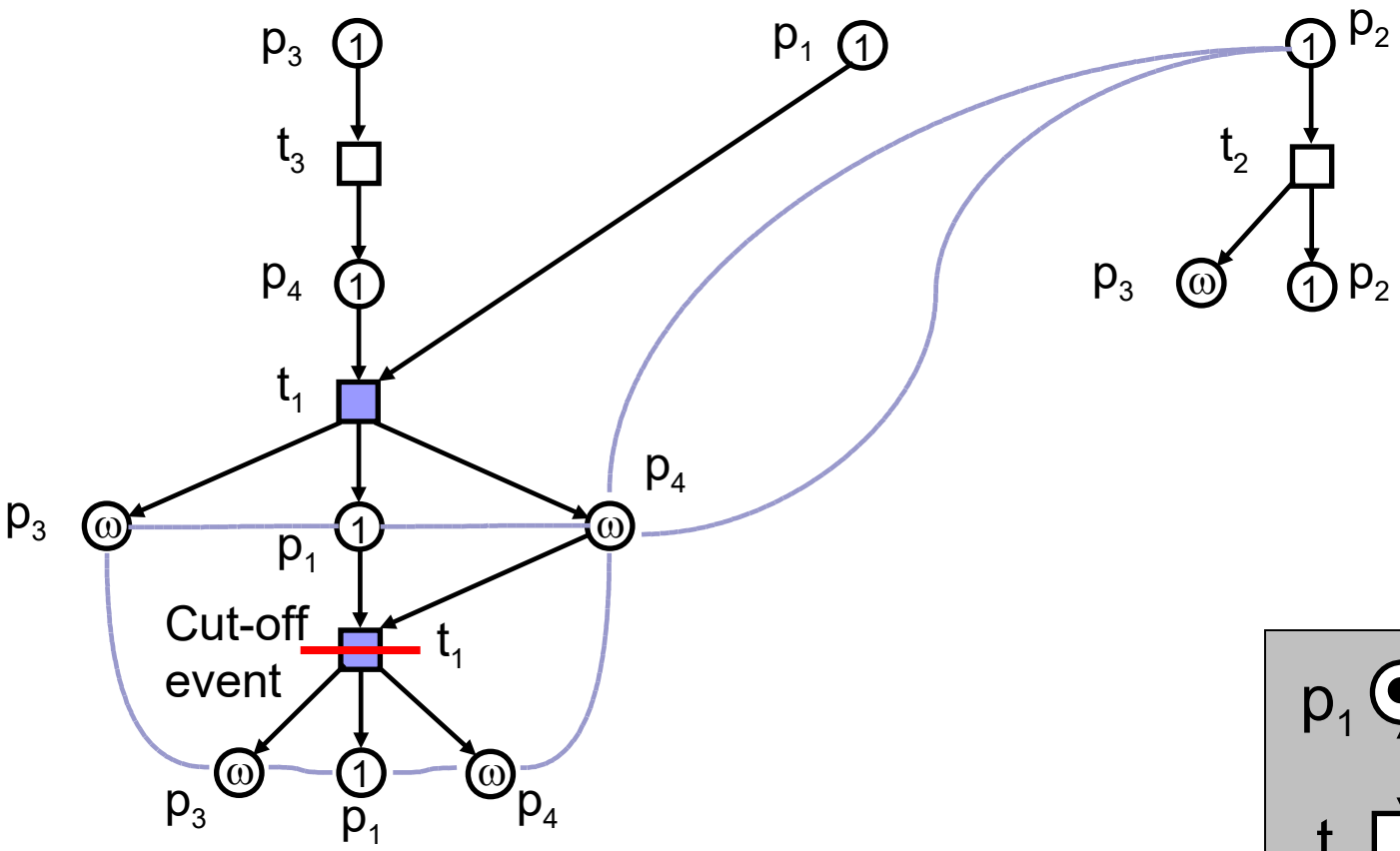


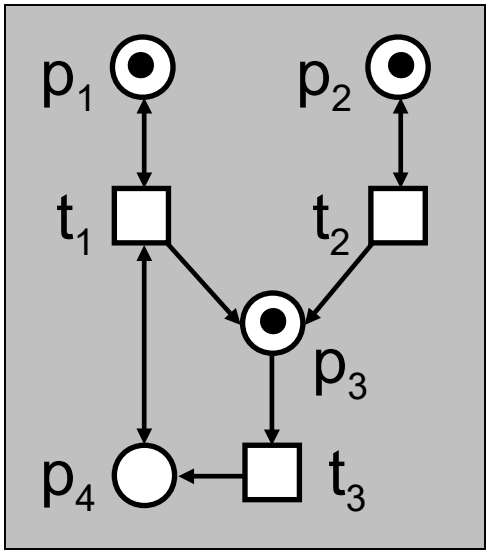
Konečné procesy pokrytia neohraničených Petriho sietí





Konečné procesy pokrytia neohraničených Petriho sietí





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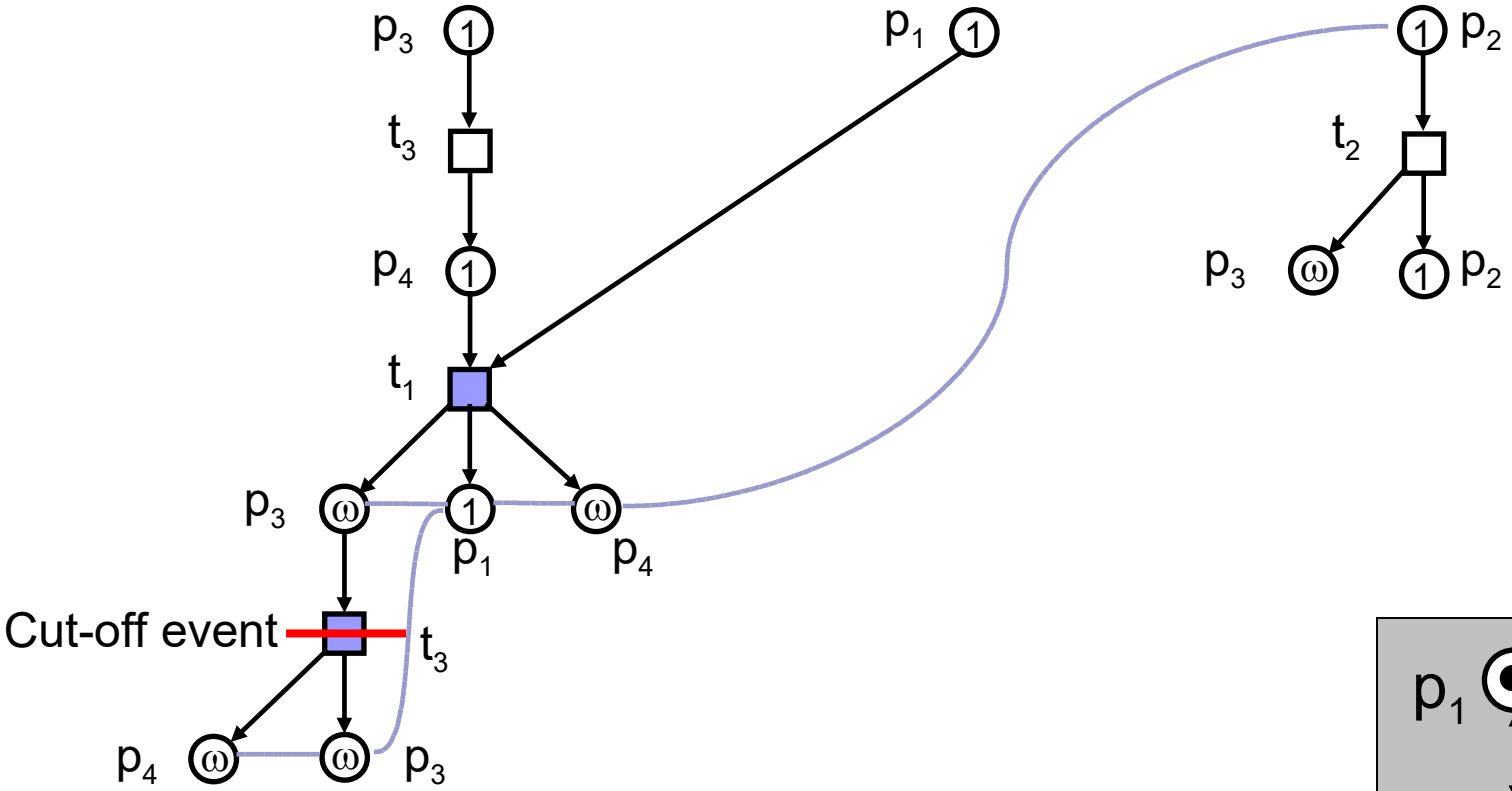

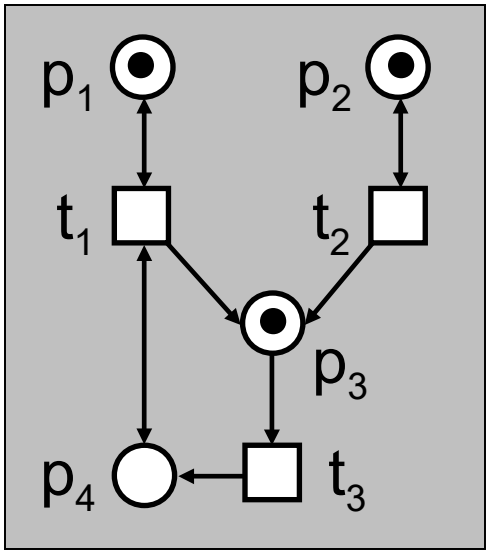

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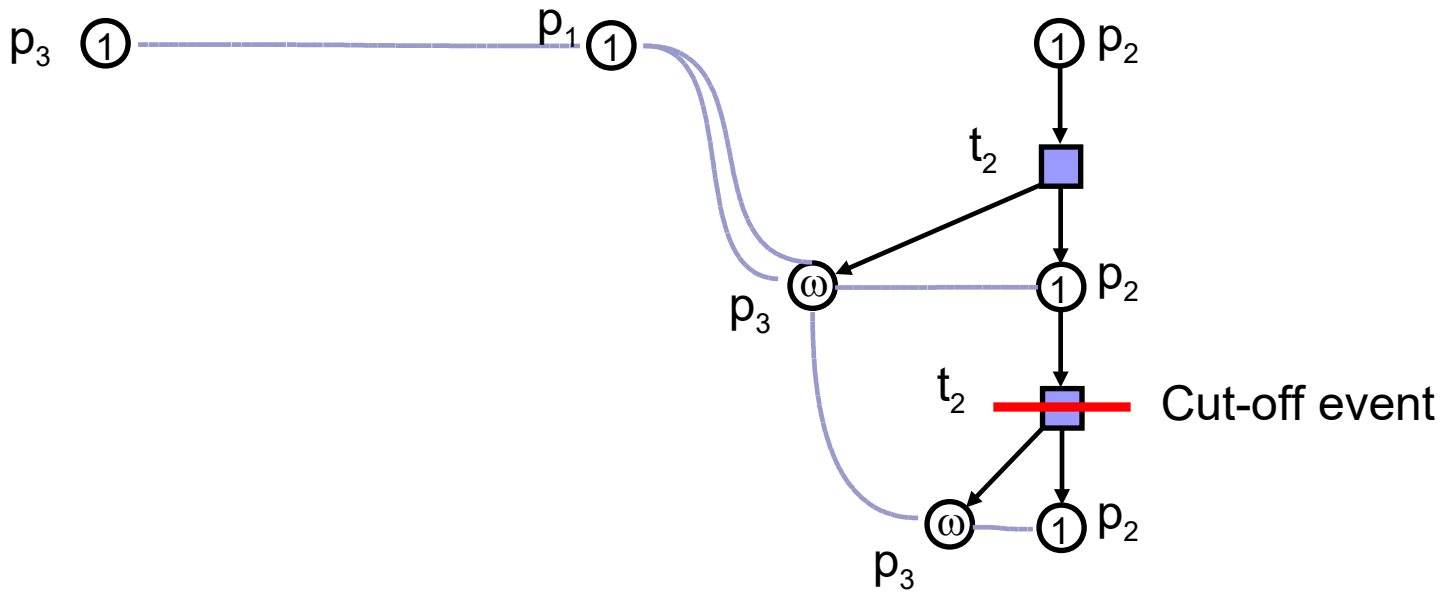
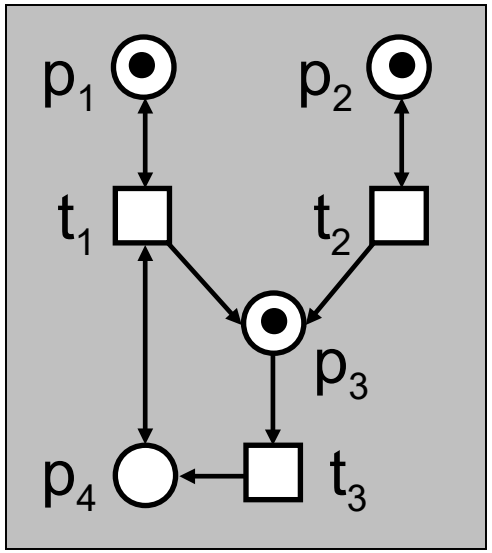
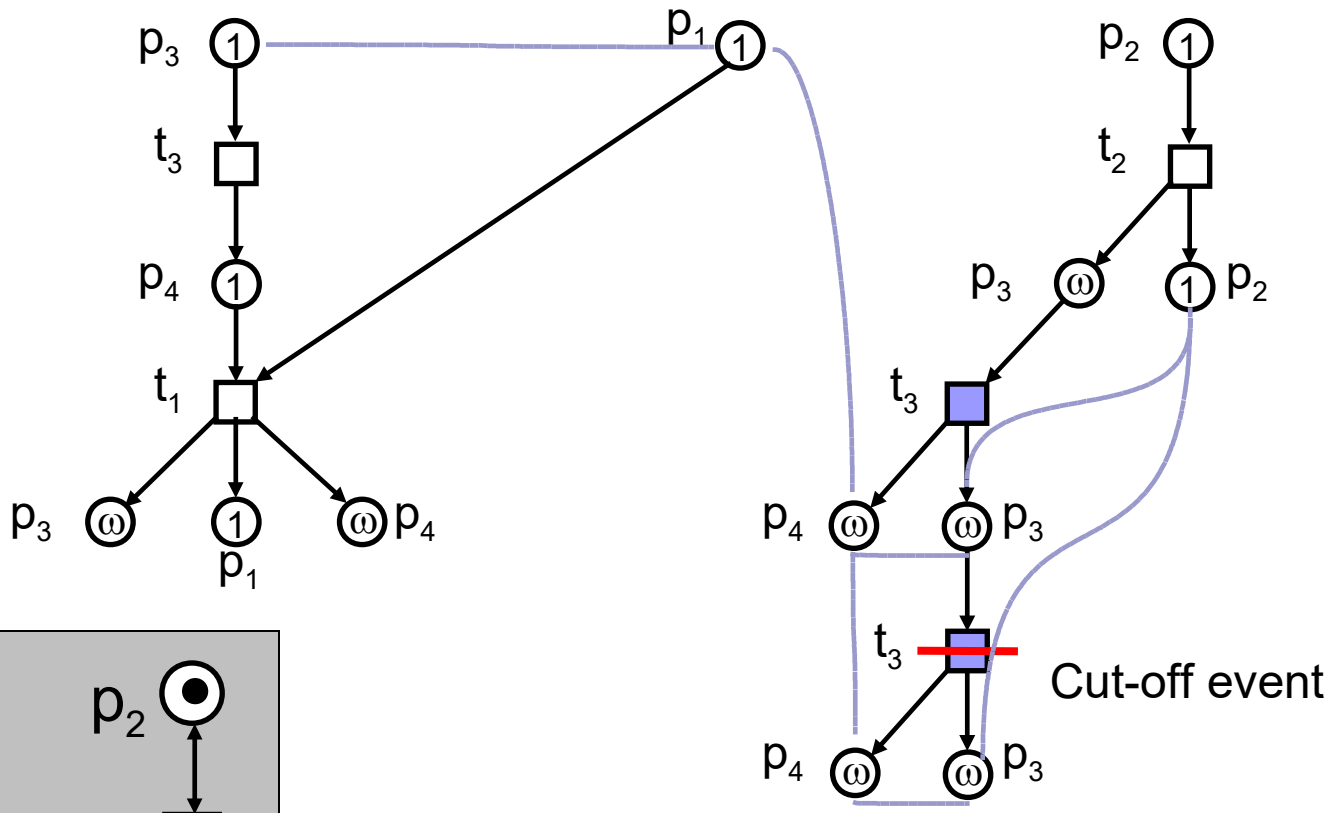
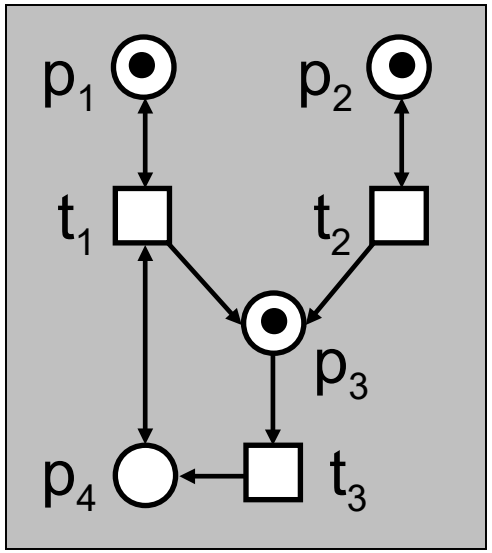
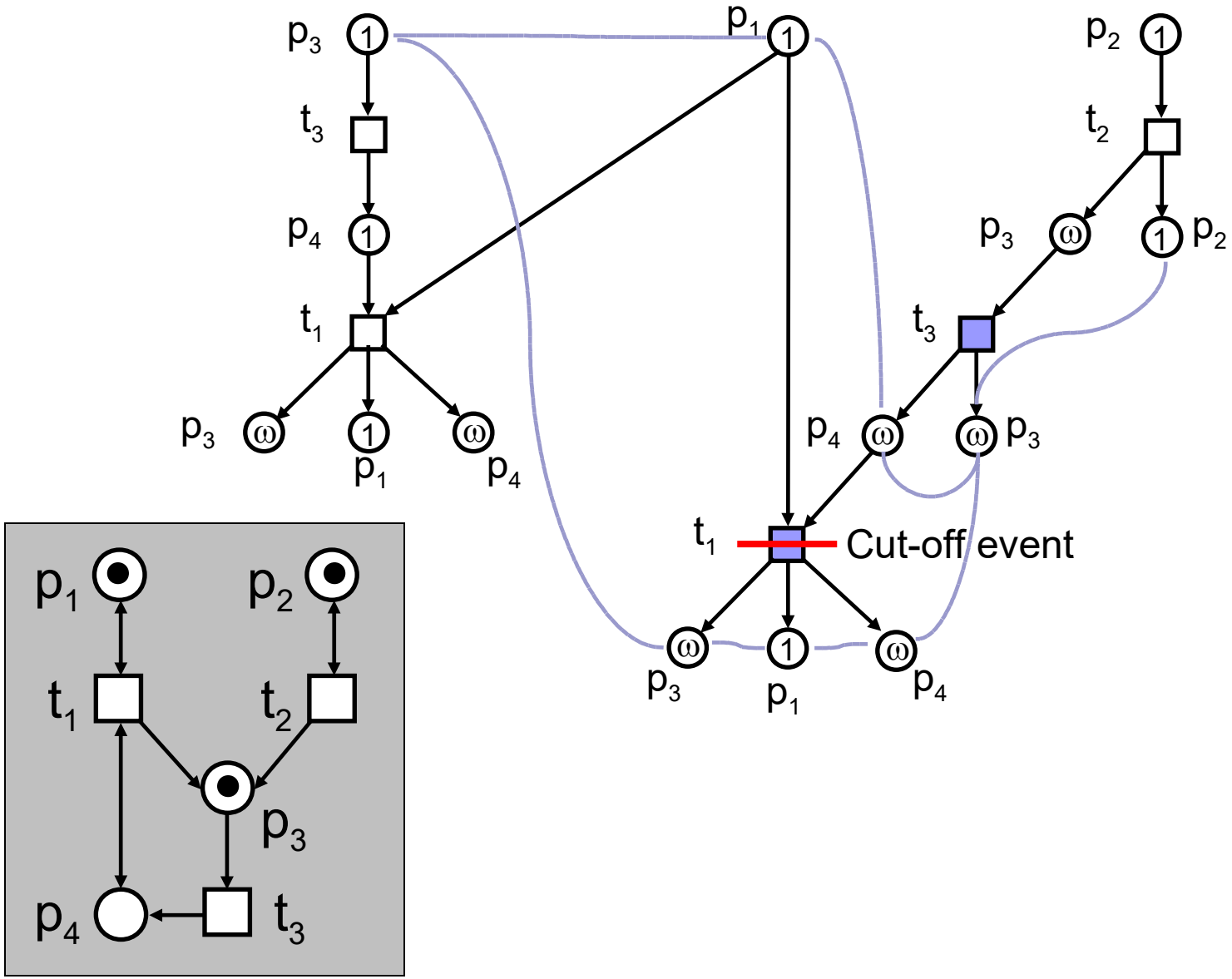




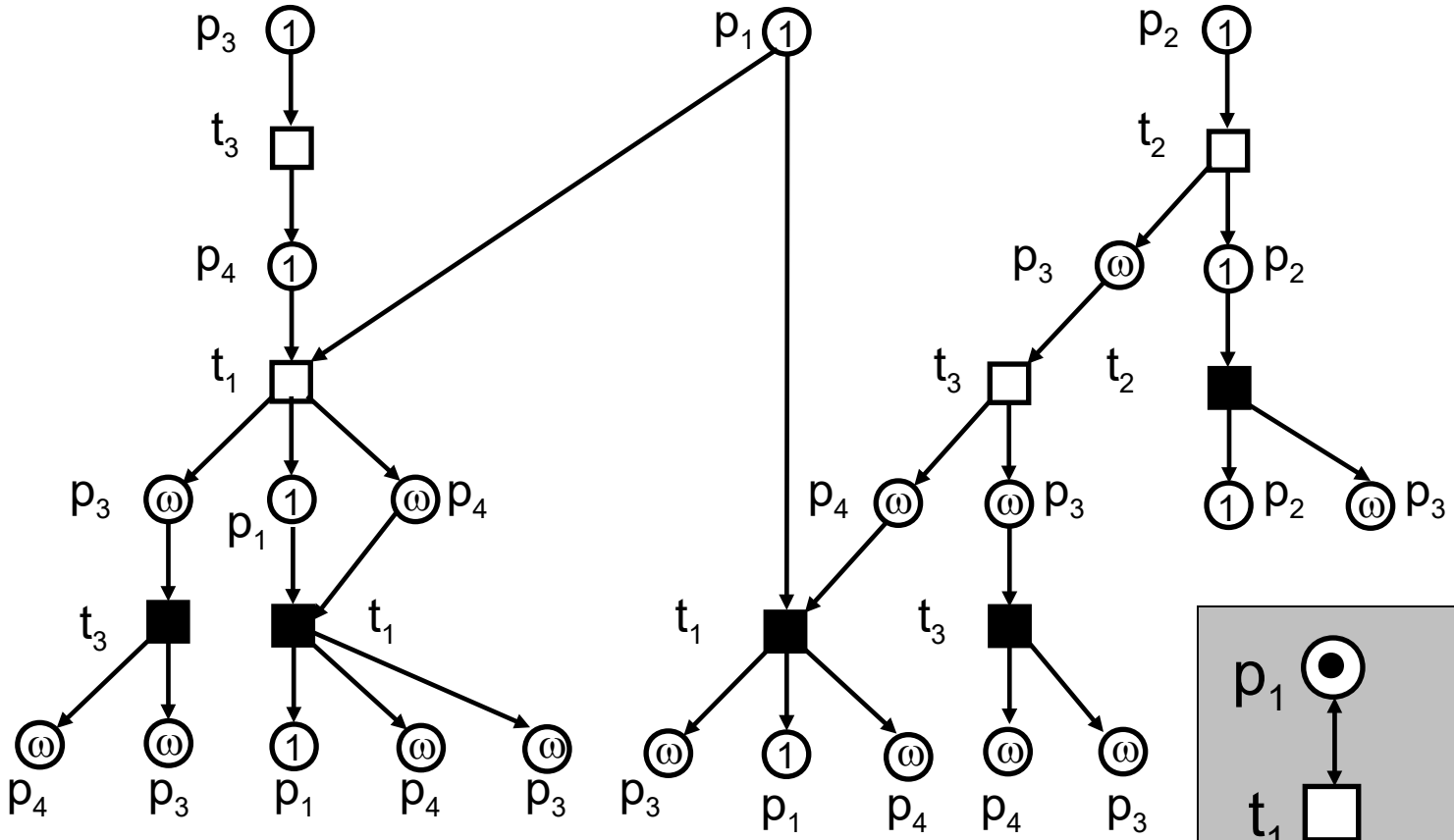
Konečné procesy pokrytia neohraničených Petriho sietí

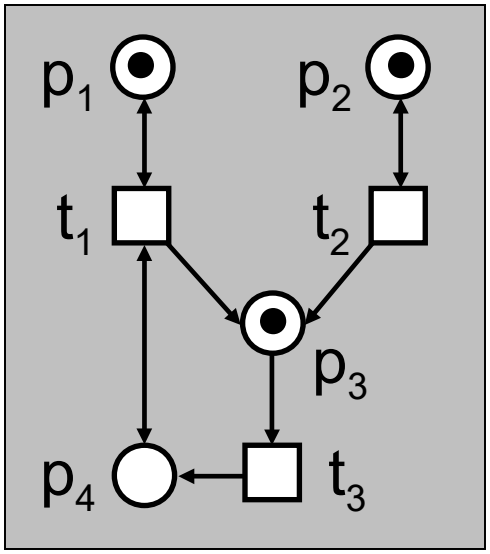




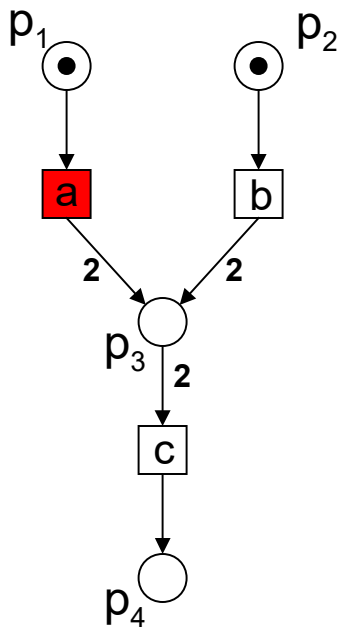

p3
1
t3
p4
1
t1
p3
ω
1
p1
ω
p4
p1
1
p2
1
t2
p3
ω
1
p2
t3
p4
ω
ω
p3
t1
Cut-off event
ω
p3
1
p1
ω
p4
p1
p2
t1
t2
p3
p4
t3

Konečné procesy pokrytia neohraničených Petriho sietí

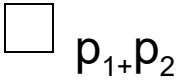




Kauzálna sémantika procesov Petriho sietí – token flows



Token flow 1



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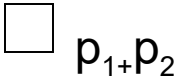
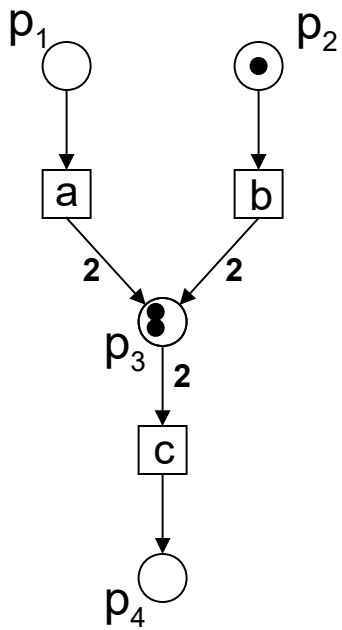


Kauzálna sémantika procesov Petriho sietí – token flows



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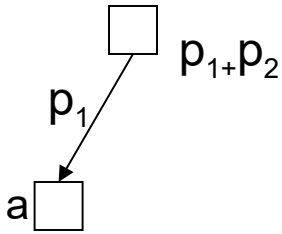
Token flow 1



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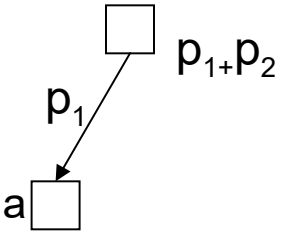
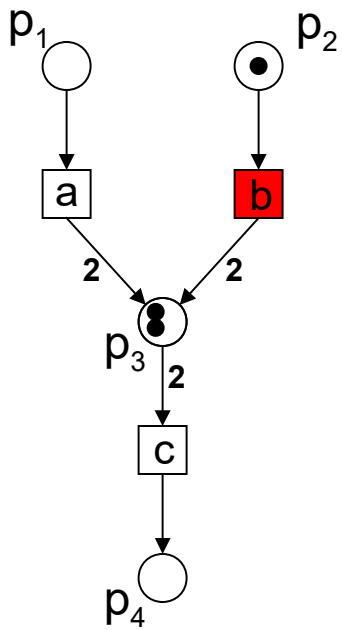


Kauzálna sémantika procesov Petriho sietí – token flows



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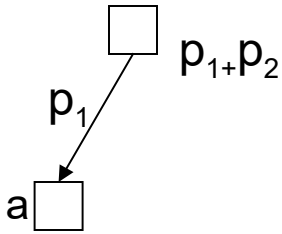
Token flow 1



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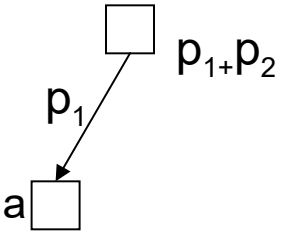
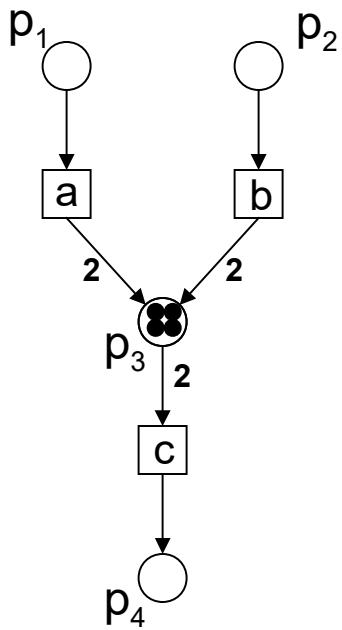


Kauzálna sémantika procesov Petriho sietí – token flows



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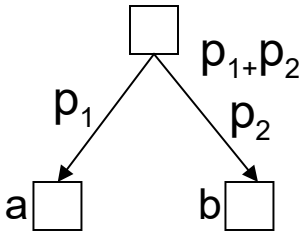
Token flow 1



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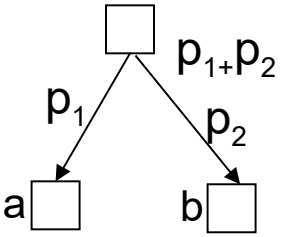
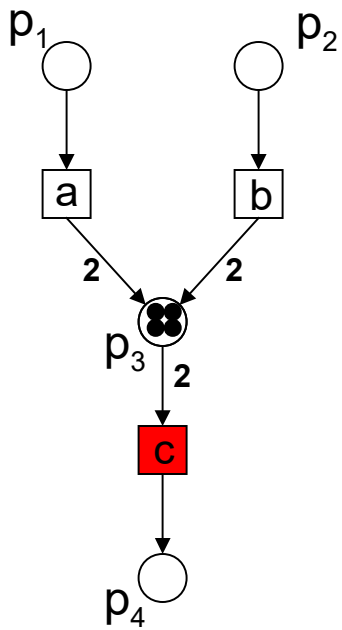


Kauzálna sémantika procesov Petriho sietí – token flows



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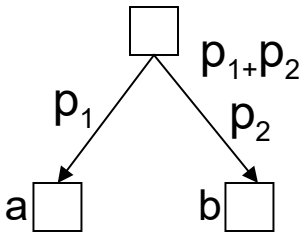
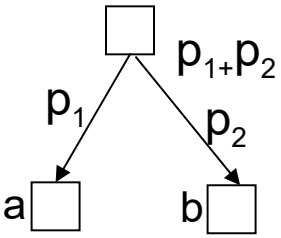
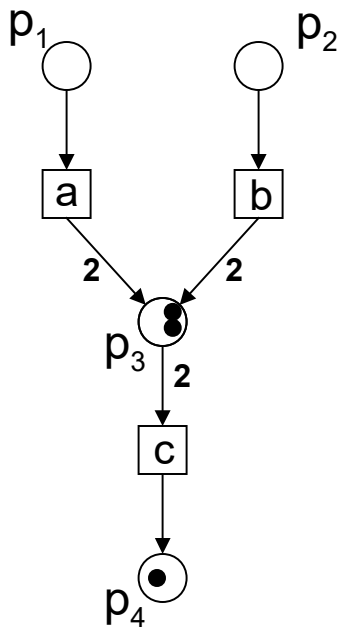
Token flow 1



Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows



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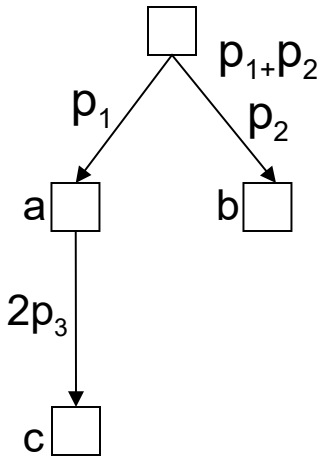
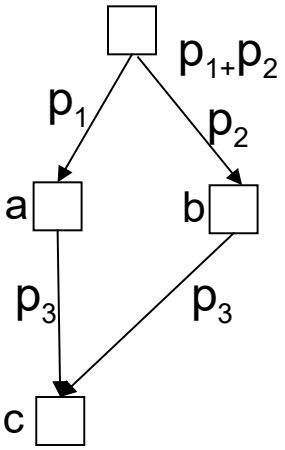
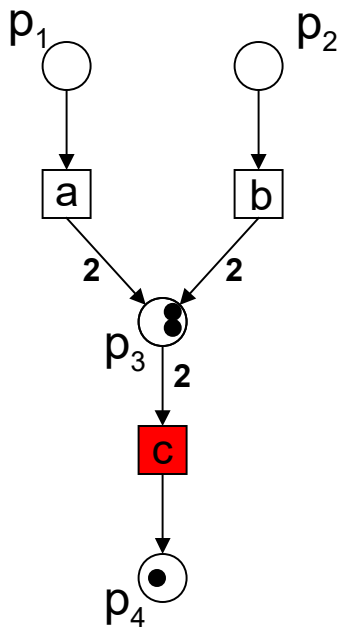
Token flow 1



Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows



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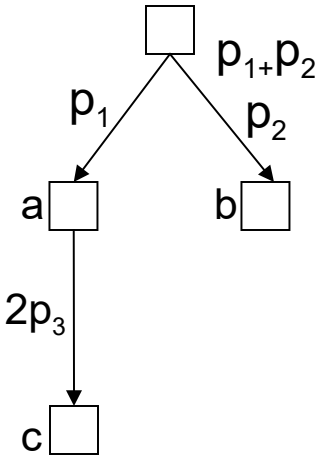
Token flow 1



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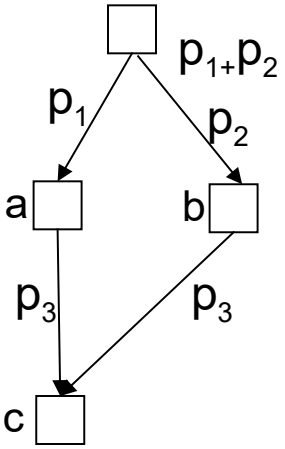
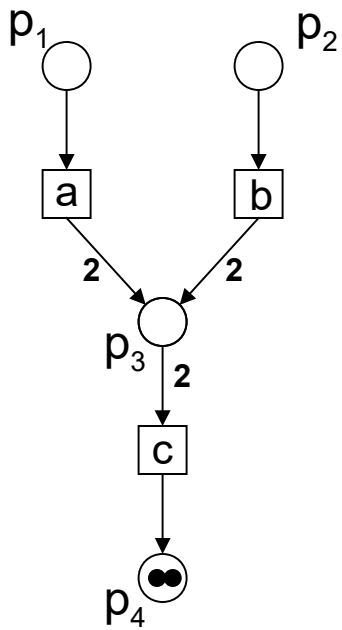


Kauzálna sémantika procesov Petriho sietí – token flows



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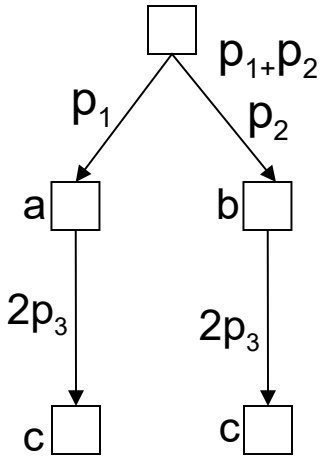
Token flow 1



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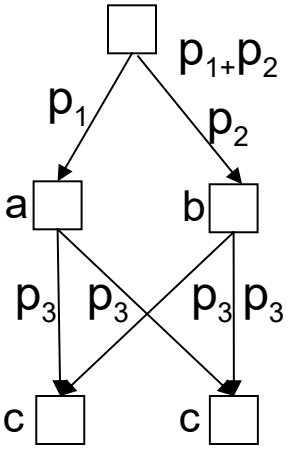
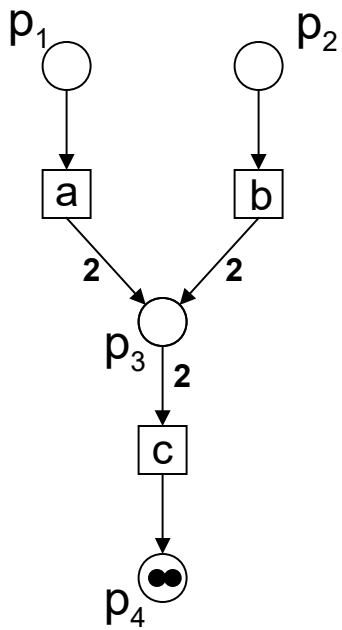


Kauzálna sémantika procesov Petriho sietí – token flows



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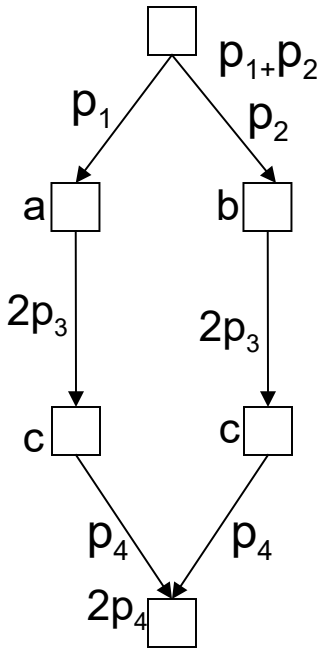
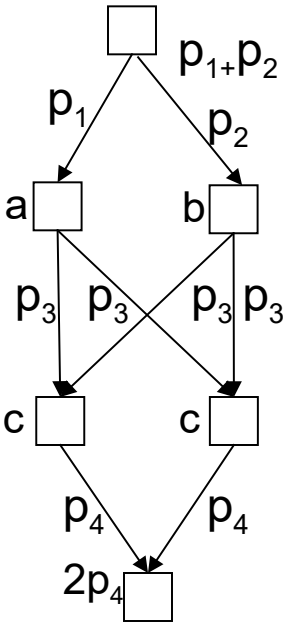
Token flow 1

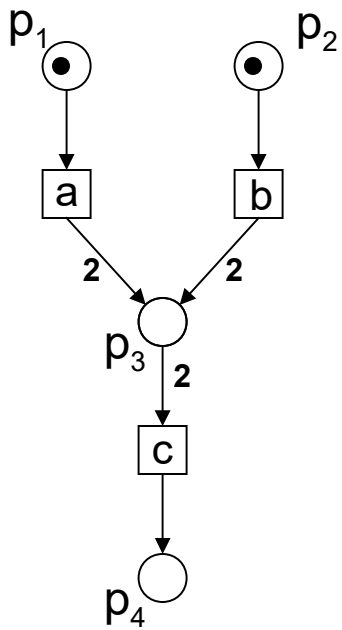


Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

Token flow je orientovaný acyklický graf s



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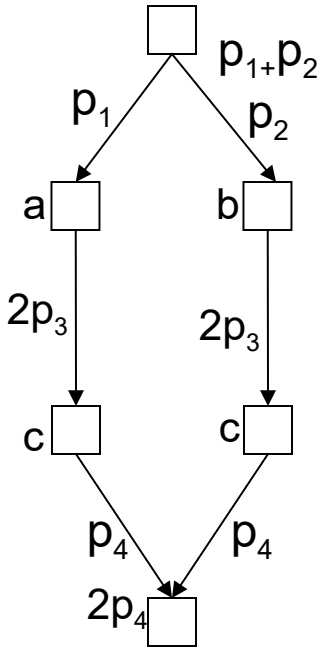
Token flow 1



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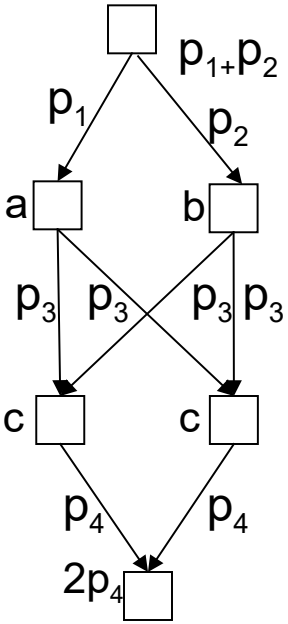
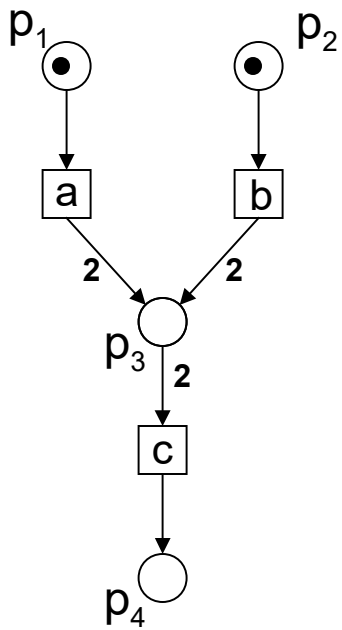


Kauzálna sémantika procesov Petriho sietí – token flows

Token flow je orientovaný acyklický graf s

- práve jedným vrcholom bez vstupných hrán (počiatočný vrchol)



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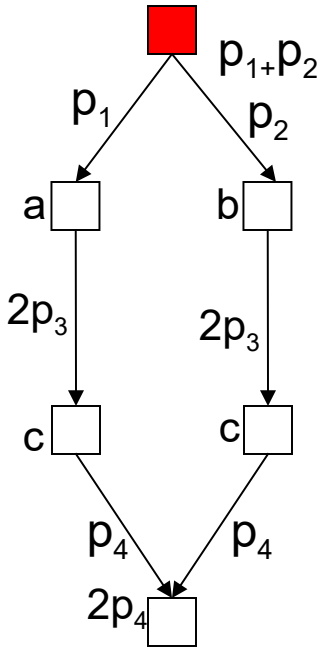
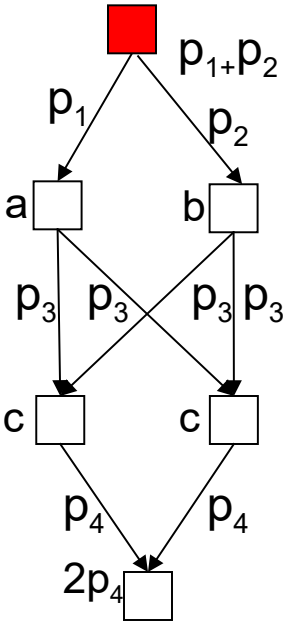
Token flow 1

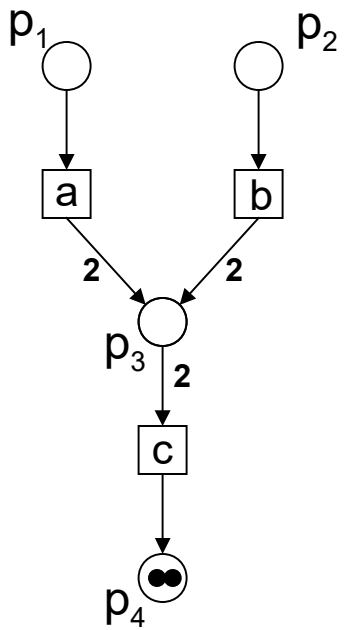


Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

Token flow je orientovaný acyklický graf s
- práve jedným vrcholom bez vstupných hrán (počiatočný vrchol)
- práve jedným vrchlom bez výstupných hrán (koncový vrchol)



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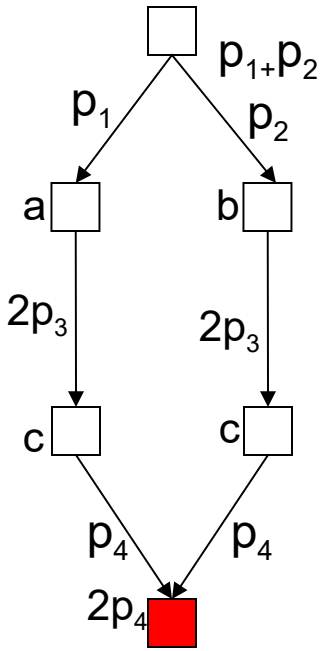
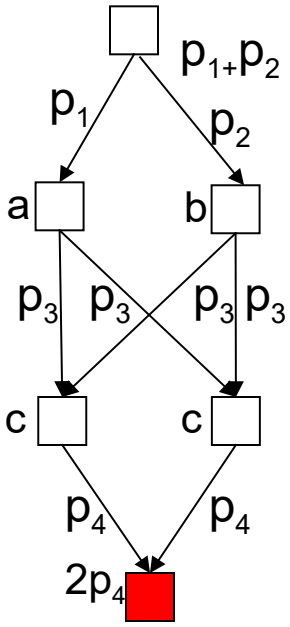
Token flow 1

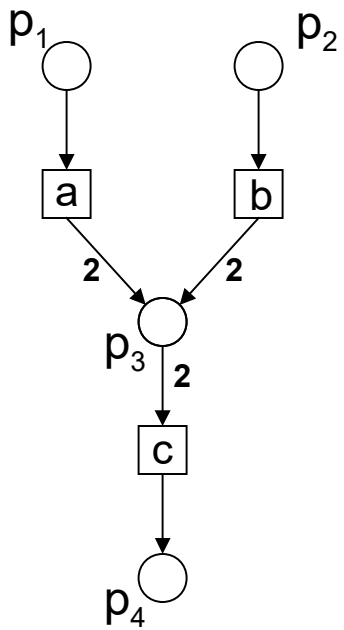


Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

Token flow je orientovaný acyklický graf s
- práve jedným vrcholom bez vstupných hrán (počiatočný vrchol)
- práve jedným vrchlom bez výstupných hrán (koncový vrchol)
- ostatnými vrcholmi označenými prechodmi siete



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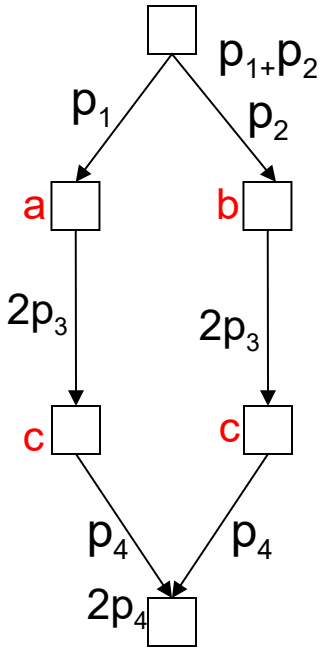
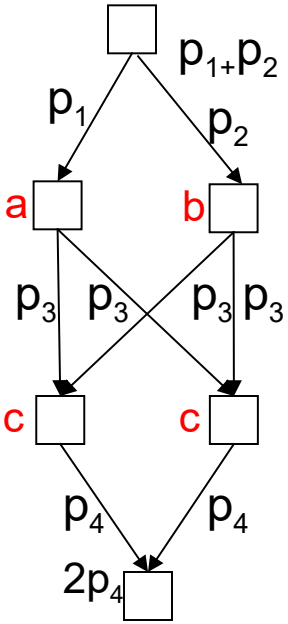
Token flow 1

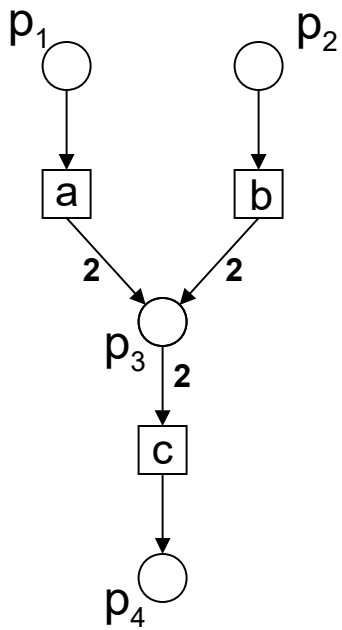


Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

Token flow je orientovaný acyklický graf s
- práve jedným vrcholom bez vstupných hrán (počiatočný vrchol)
- práve jedným vrchlom bez výstupných hrán (koncový vrchol)
- ostatnými vrcholmi označenými prechodmi siete
- hranami označenými multimnožinami miest (token flow funkcia)



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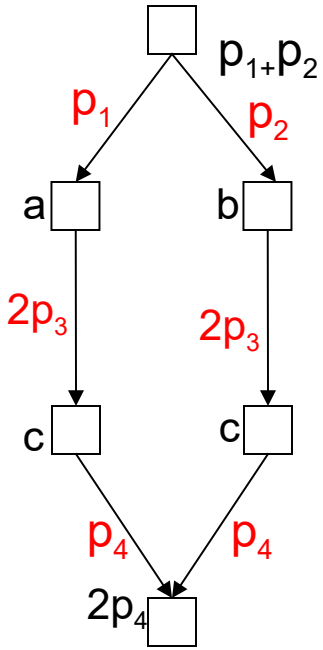
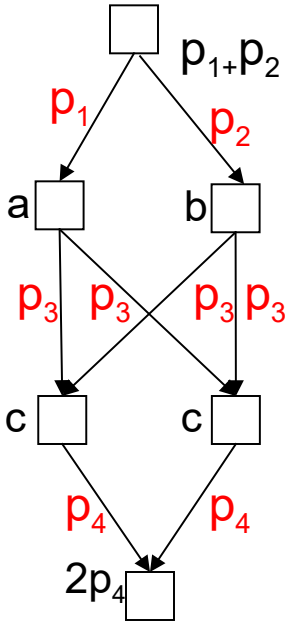
Token flow 1



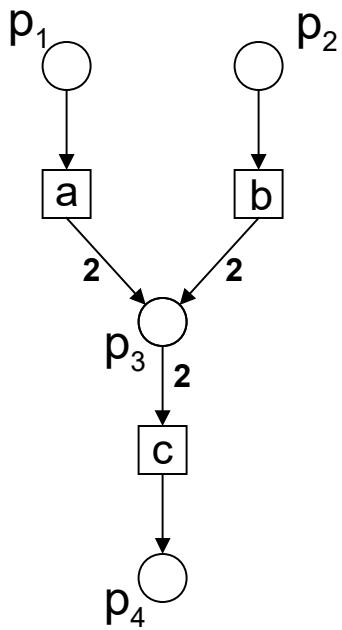
Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

Token flow je orientovaný acyklický graf s
- práve jedným vrcholom bez vstupných hrán (počiatočný vrchol)
- práve jedným vrchlom bez výstupných hrán (koncový vrchol)
- ostatnými vrcholmi označenými prechodmi siete
- hranami označenými multimnožinami miest (token flow funkcia)

pre ktorý platí:



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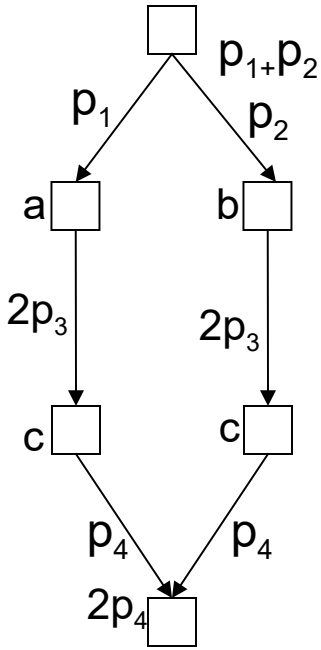
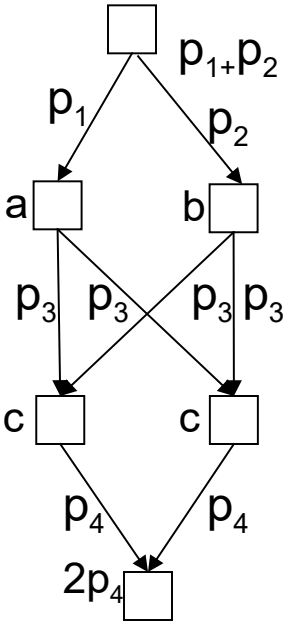
Token flow 1

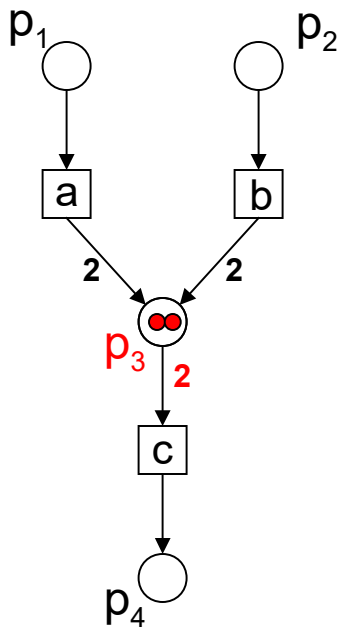


Token flow 2



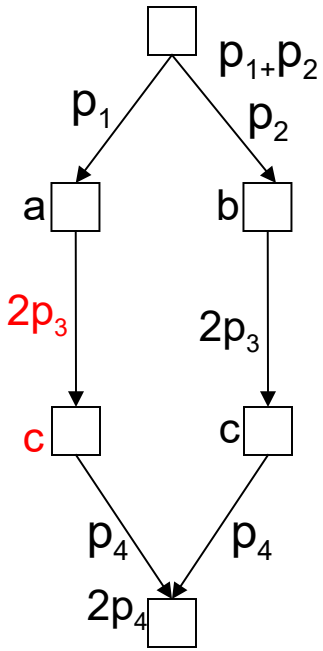
Kauzálna sémantika procesov Petriho sietí – token flows

Rovnosť vstupného toku - suma multimnožín na vstupných hranách vrcholu (vstupný tok) je rovná počtu značiek ktoré prechod označujúci vrchol skonzumuje

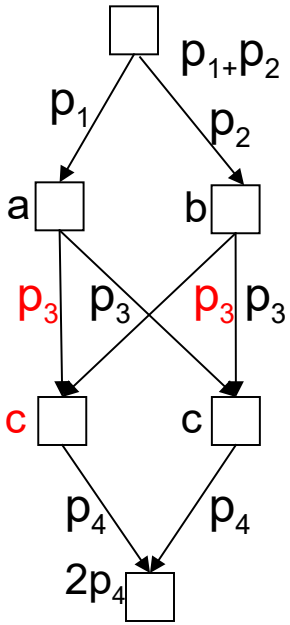


abcc

Token flow 1



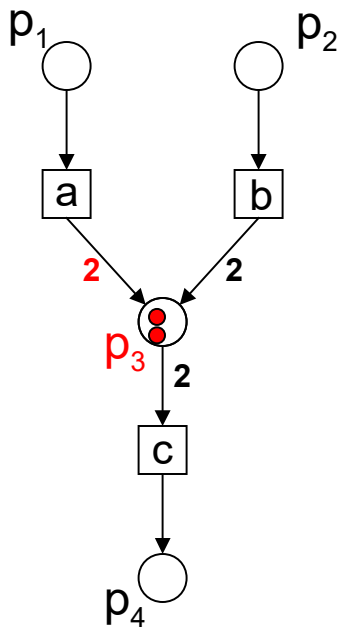
Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

Rovnosť vstupného toku - suma multimnožín na vstupných hranách vrcholu (vstupný tok) je rovná počtu značiek ktoré prechod označujúci vrchol skonzumuje

Rovnosť výstupného toku - suma multimnožín na výstupných hranách vrcholu (výstupný tok) je rovná počtu značiek ktoré prechod označujúci vrchol vyprodukuje



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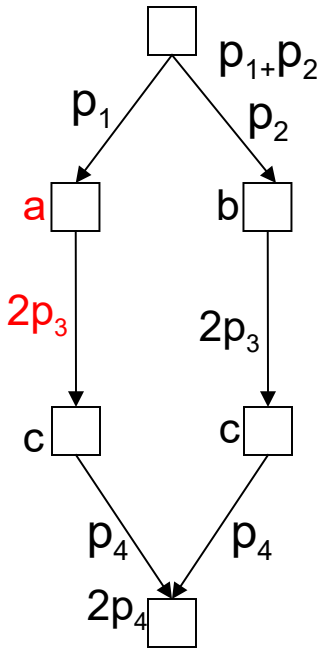
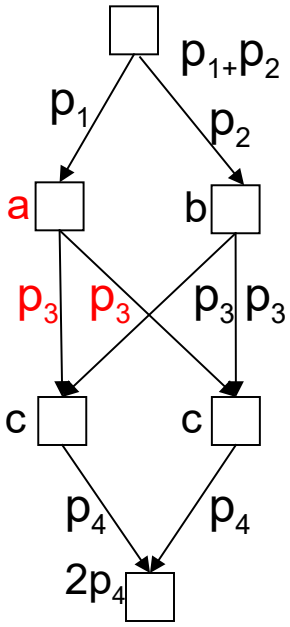
Token flow 1

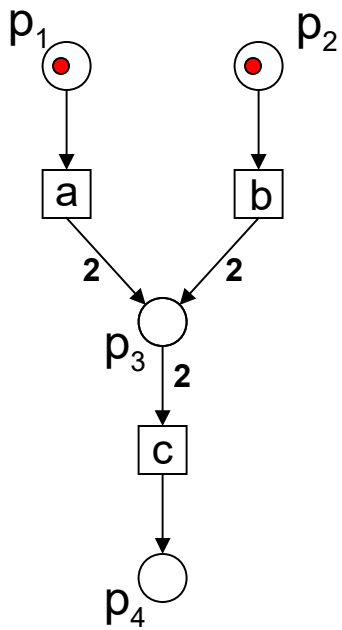


Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

výstupný tok počiatočného vrcholu reprezentuje počiatočné značkovanie



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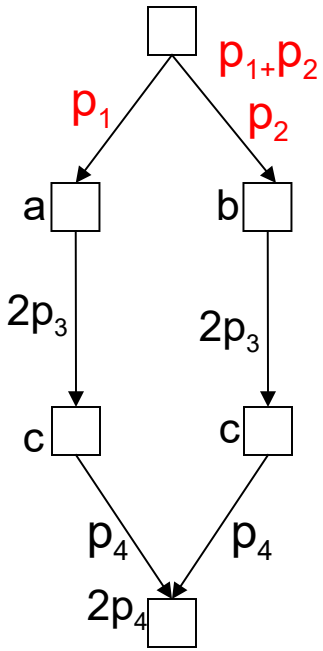
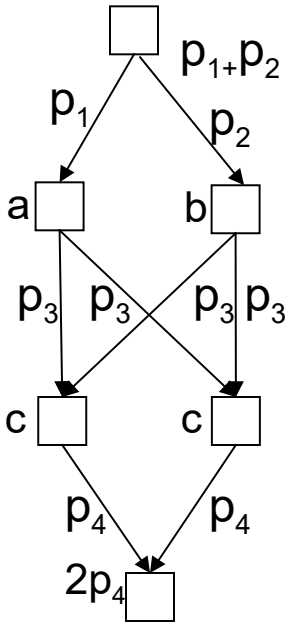
Token flow 1



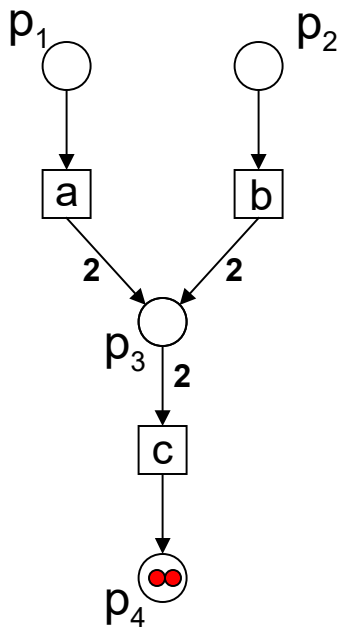
Token flow 2



Kauzálna sémantika procesov Petriho sietí – token flows

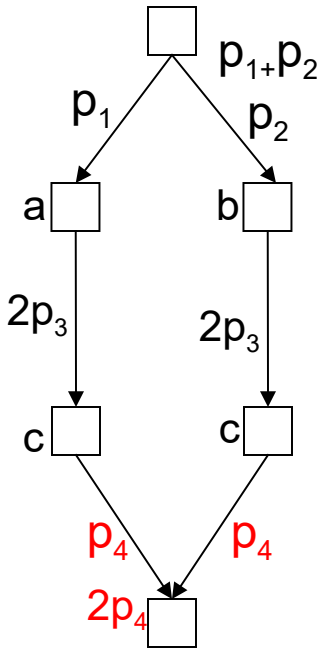
výstupný tok počiatočného vrcholu reprezentuje počiatočné značkovanie

vstupný tok koncového vrcholu reprezentuje dosiahnuté značkovanie

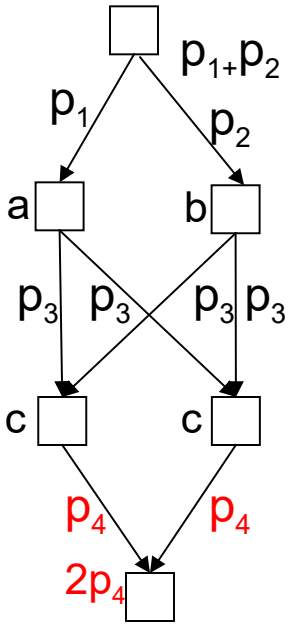


abcc

Token flow 1



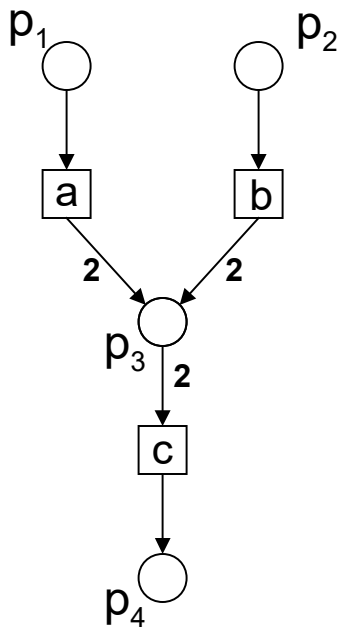
Token flow 2



Analýza uskutočniteľnosti nesekvenčných scenárov Petriho sietí pomocou token flows

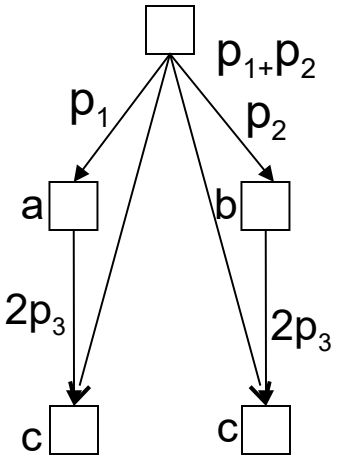
Neuvažujeme koncový bod, scenáre sú čiastočné usporiadania

Nepresahujúci výstupný tok - výstupný tok nepresiahne (nie je väčší ako) počet značiek ktoré prechod označujúci vrchol vyprodukuje

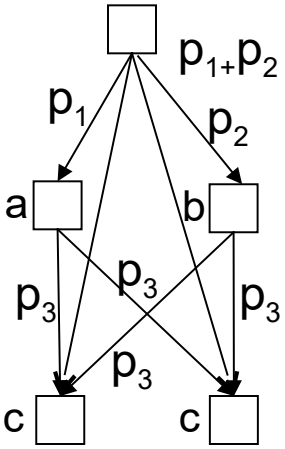


abcc

Token flow 1



Token flow 2



Algoritmus pre testovanie token flow
(pre sieť s fixným počiatočným značkovaním, fixné p)

Vstup: nesekvenčný scenár vo forme čiastočne usporiadanej multimnožiny prechodov, obohatenej iba o počiatočný vrchol (značkovanie)

Algoritmus pre testovanie token flow
(pre sieť s fixným počiatočným značkovaním, fixné p)

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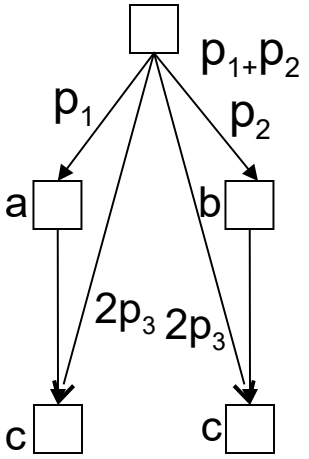
1.Vypočítaj token flow funkciu splňujúcu rovnosť vstupného toku



Algoritmus pre testovanie token flow
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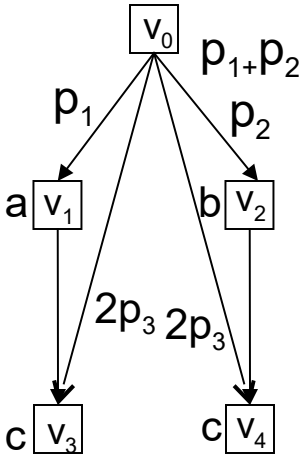
Vstup: nesekvenčný scenár vo forme čiastočne usporiadanej multimnožiny prechodov, obohatenej iba o počiatočný vrchol (značkovanie)

1. Vypočítaj token flow funkciu splňujúcu rovnosť vstupného toku
2. Priraď index vrcholom rešpektujúc poradie



Algoritmus pre testovanie token flow
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Vstup: nesekvenčný scenár vo forme čiastočne usporiadanej multimnožiny prechodov, obohatenej iba o počiatočný vrchol (značkovanie)

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3. Pre i = 0 až n

   Ak v_i má presahujúci výstupný tok vypočítaj novú token flow funkciu, ktorá
   - minimalizuje výstupný tok v_i
   - zachová rovnosť vstupného toku pre všetky vrcholy
   - zachová nepresahujúci výstupného toku pre vrcholy v_0 až v_{i-1}

Algoritmus pre testovanie token flow
(pre sieť s fixným počiatočným značkovaním, fixné p)

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Algoritmus pre testovanie token flow
(pre sieť s fixným počiatočným značkovaním, fixné p)

Vstup: nesekvenčný scenár vo forme čiastočne usporiadanej multimnožiny prechodov, obohatenej iba o počiatočný vrchol (značkovanie)

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    Ak má v_i presahujúci výstupný tok, vráť „scenár nie je uskutočniteľný“

4. Vráť „scenár je uskutočniteľný“

Procedúra minimalizácie

vypočítaj novú token flow funkciu, ktorá

- minimalizuje výstupný tok v_i
- zachová rovnosť vstupného toku pre všetky vrcholy
- zachová nepresahujúci výstupný tok pre vrcholy v_0 až v_{i-1}

Procedúra minimalizácie

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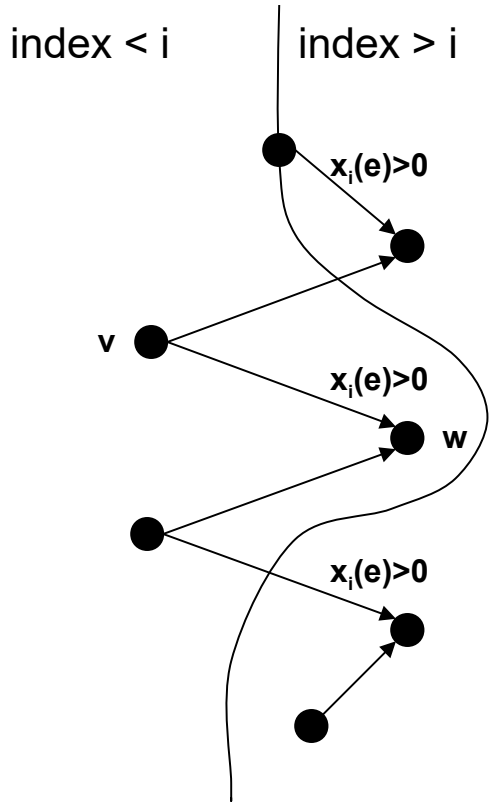
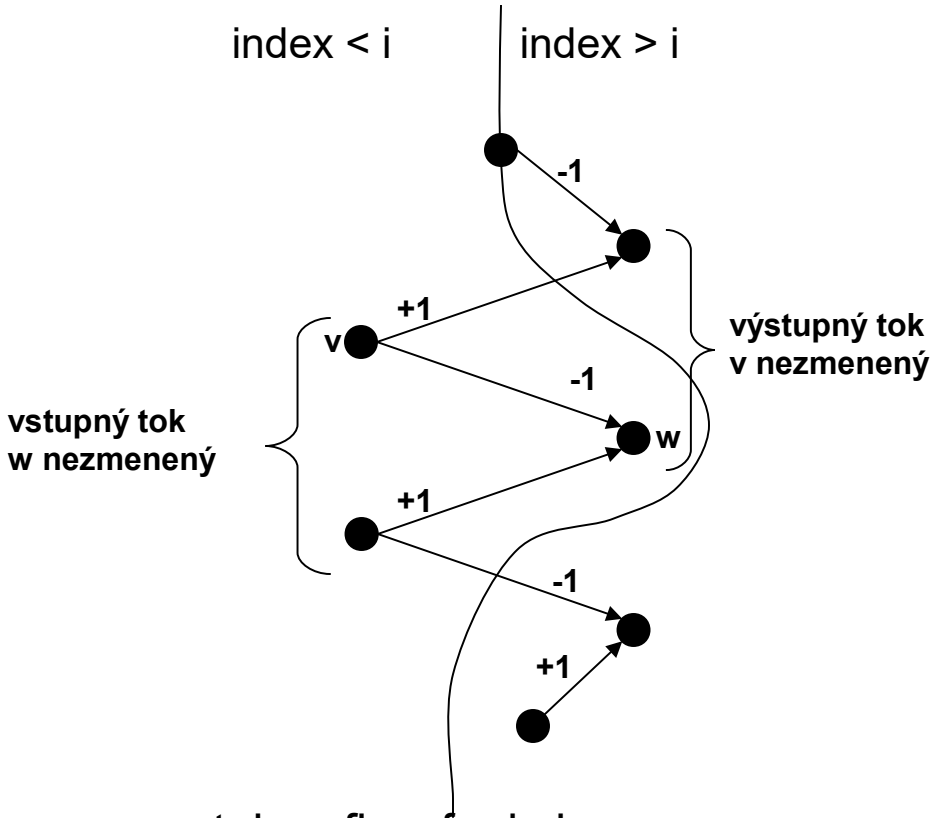
- zachová nepresahujúci výstupný tok pre vrcholy v_0 až v_{i-1}

Token flow znižujúca sekvencia 1



token flow funkcia x_i



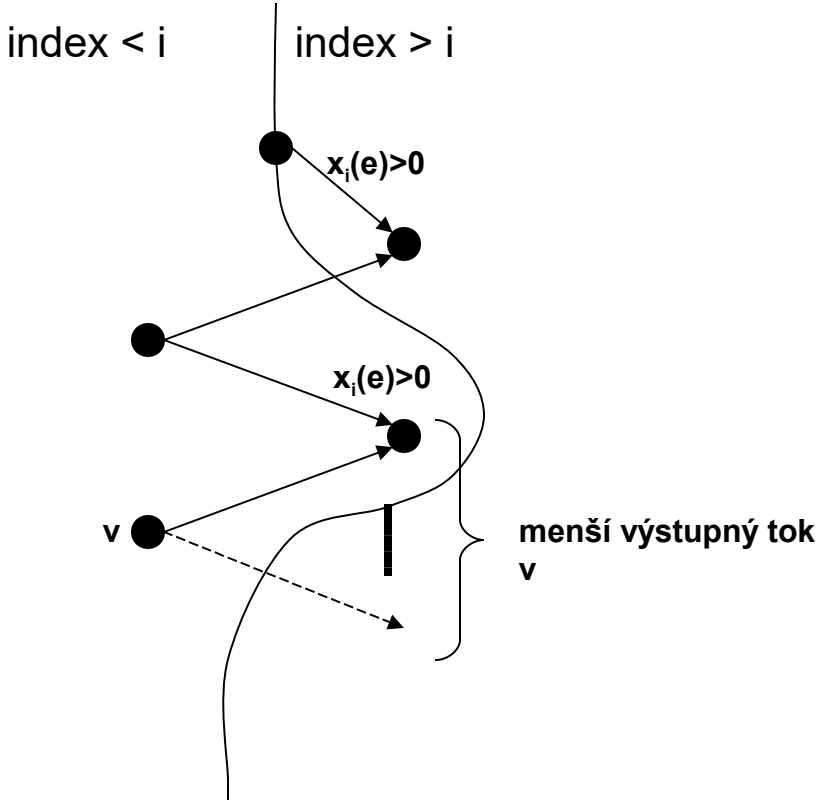
zmena token flow funkcie

Procedúra minimalizácie

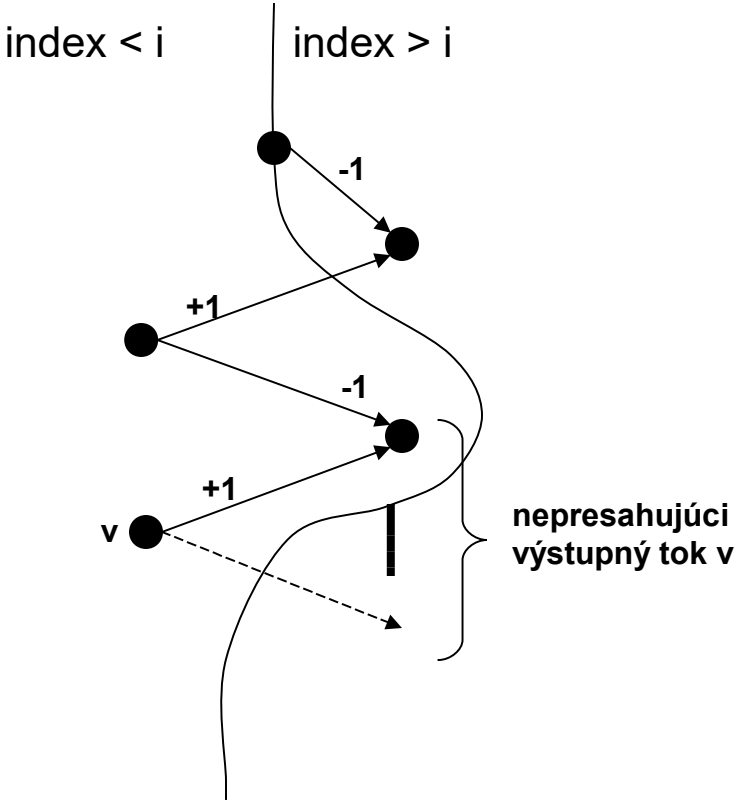
vypočítaj novú token flow funkciu, ktorá

- minimalizuje výstupný tok v_i
- zachová rovnosť vstupného toku pre všetky vrcholy
- zachová nepresahujúci výstupný tok pre vrcholy v_0 až v_{i-1}

Token flow znižujúca sekvencia 2

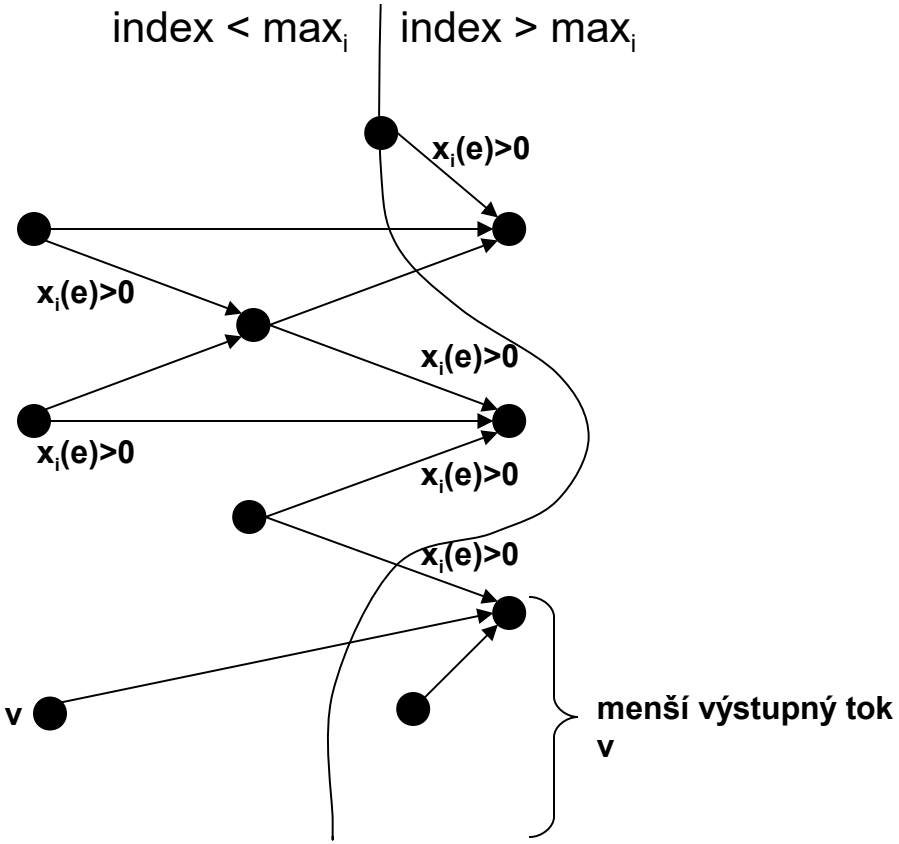


token flow funkcia x_i

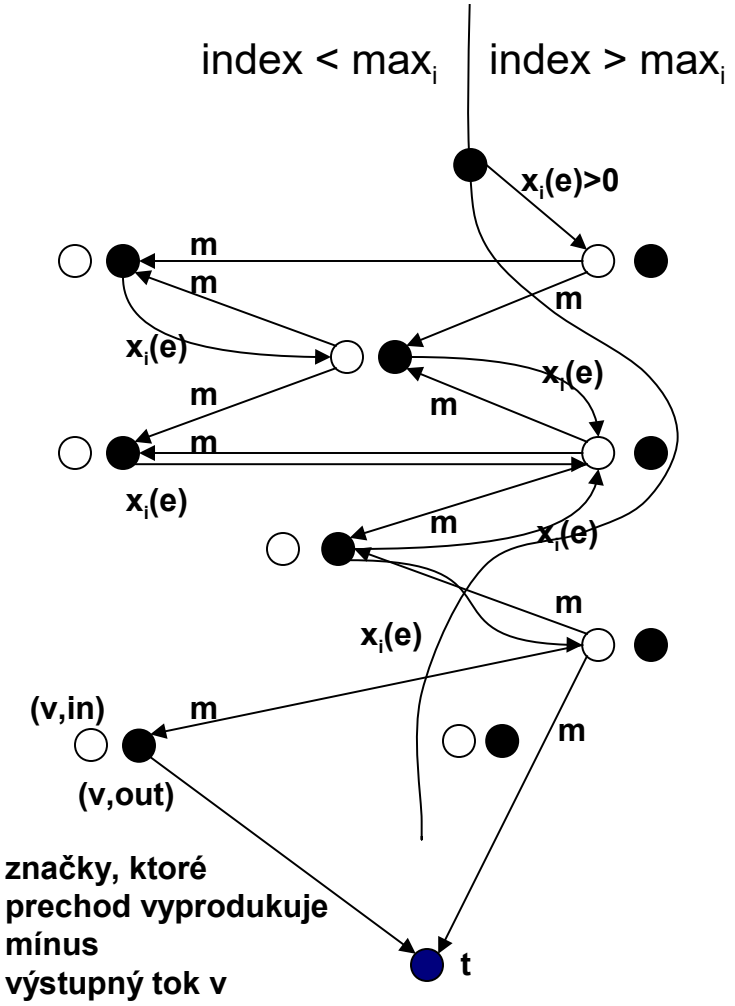


zmena token flow funkcie

Procedúra minimalizácie polynomiálna – Transformácia na problém maximálneho toku (max flow problem)

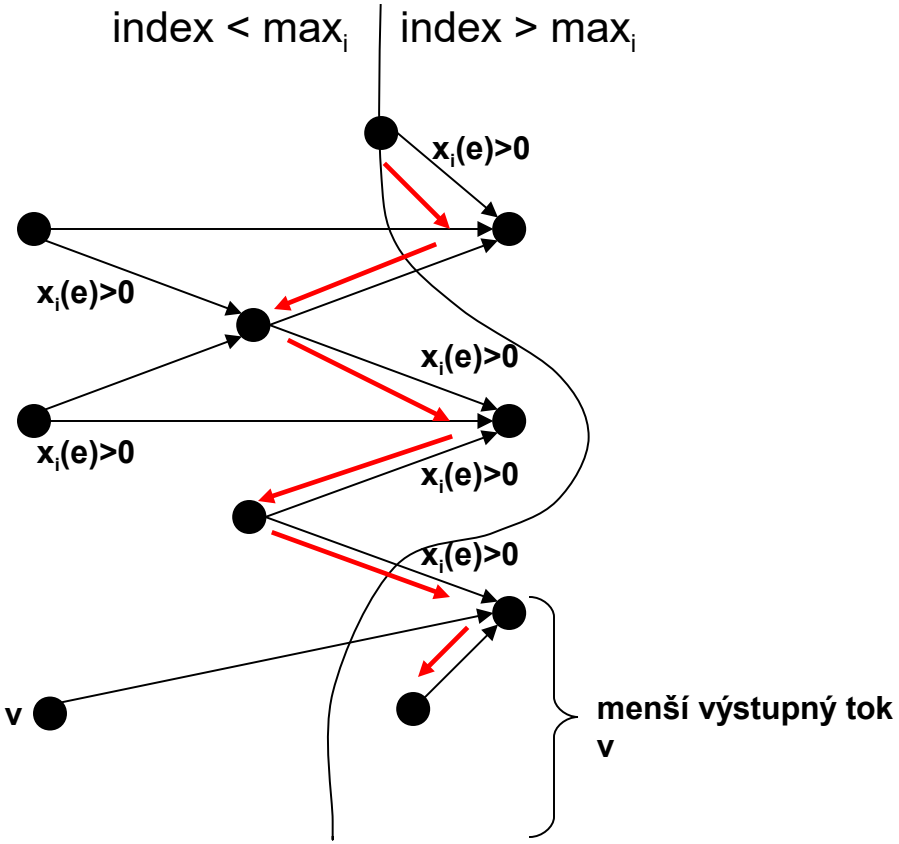


scenár

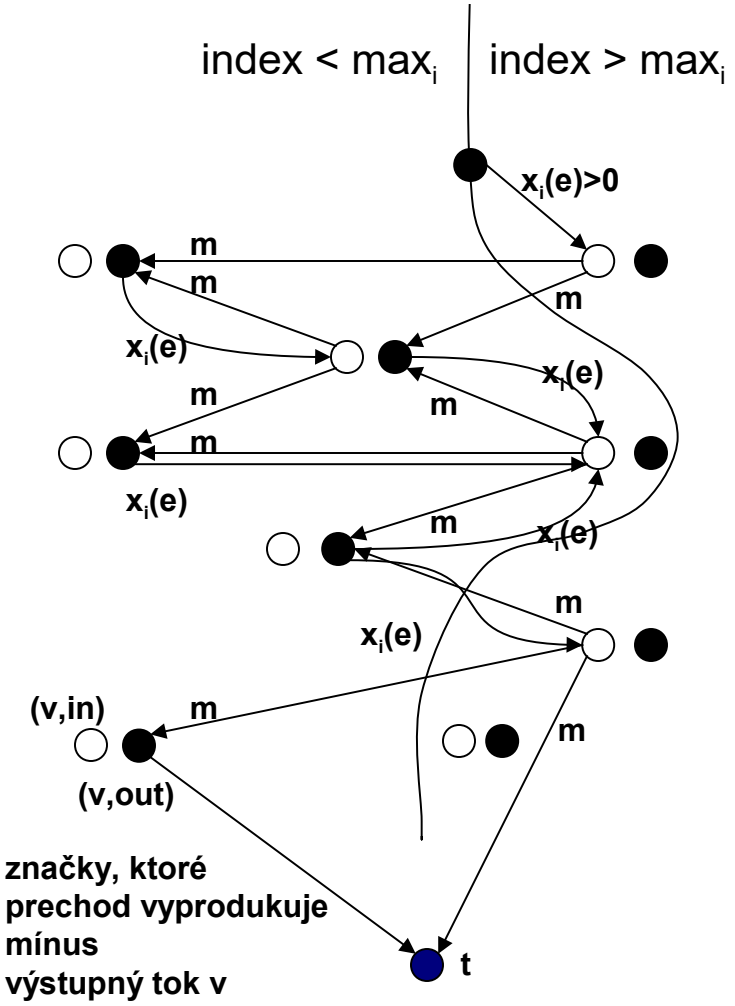


Flow Network

Procedúra minimalizácie polynomiálna – Transformácia na problém maximálneho toku (max flow problem)

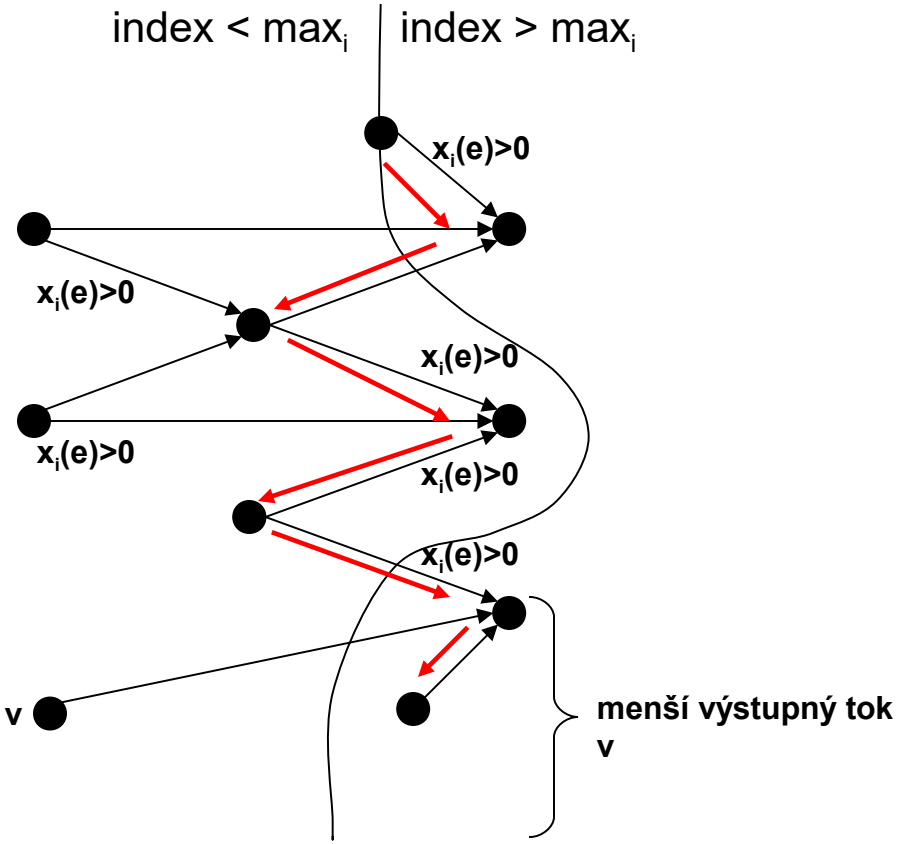


scenár

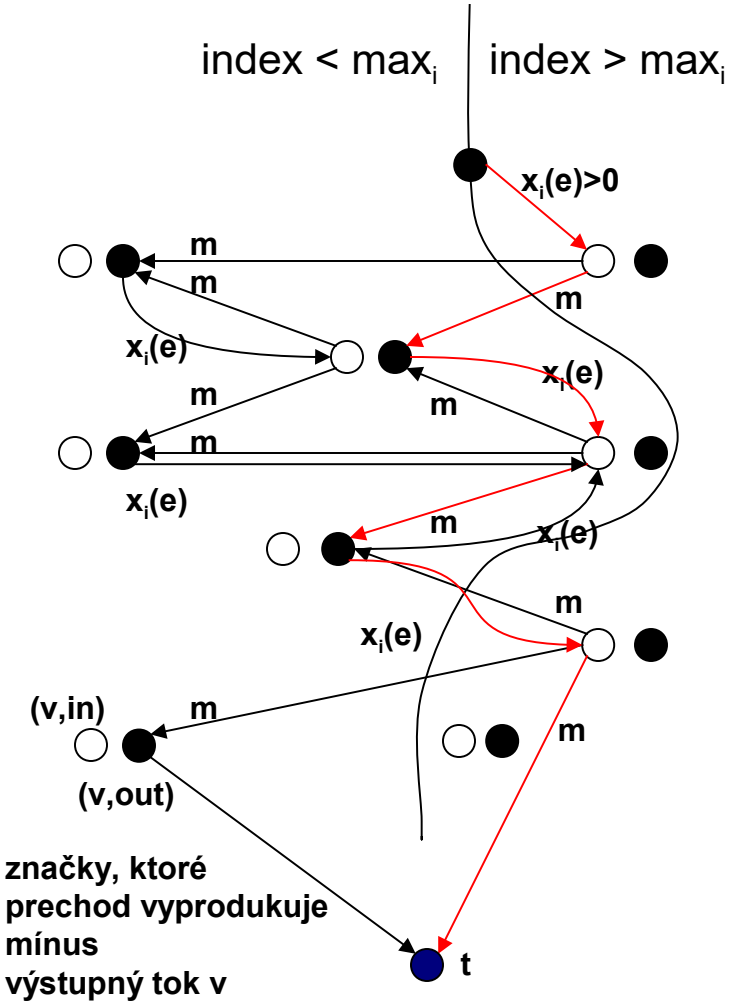


Flow Network

Procedúra minimalizácie polynomiálna – Transformácia na problém maximálneho toku (max flow problem)

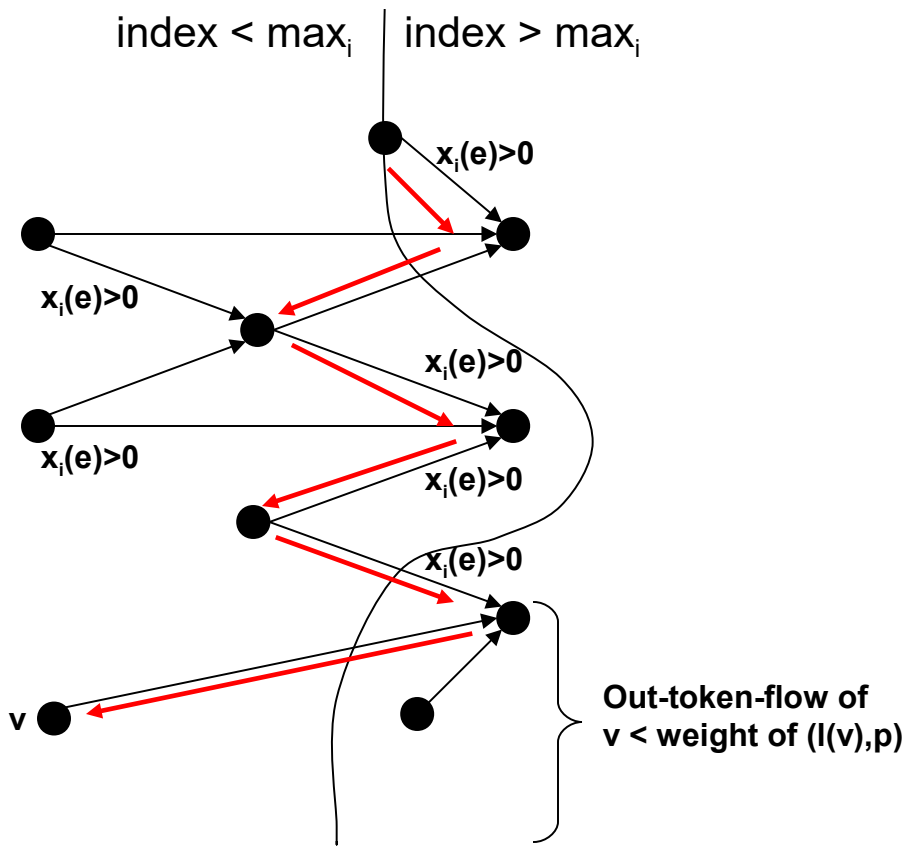


scenár

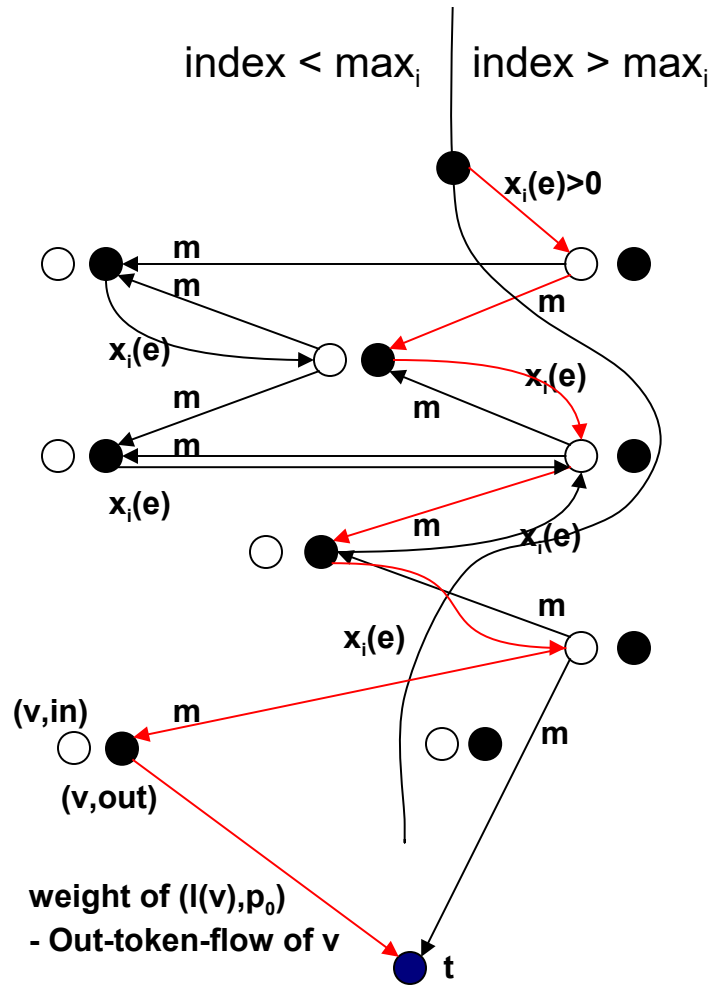


Flow Network

Minimizing procedure polynomial – translation into maximal flow problem in flow network



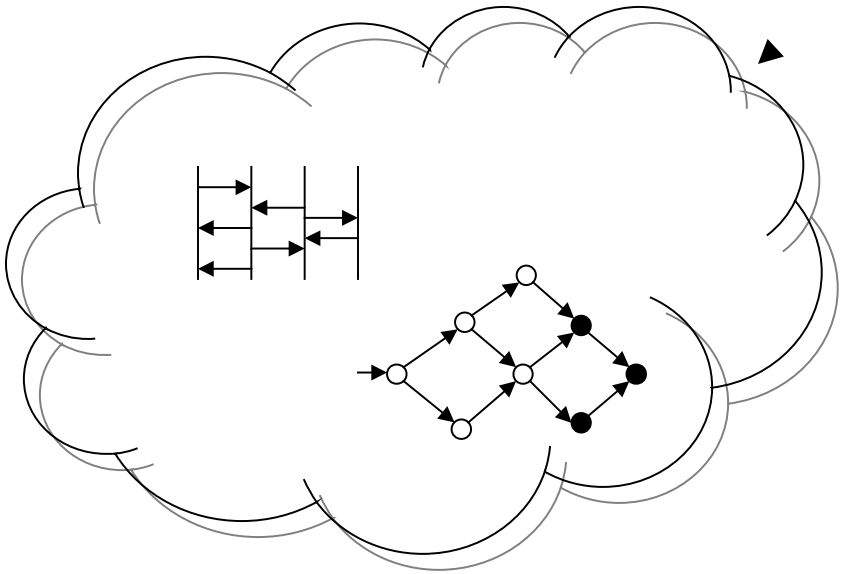
LPO

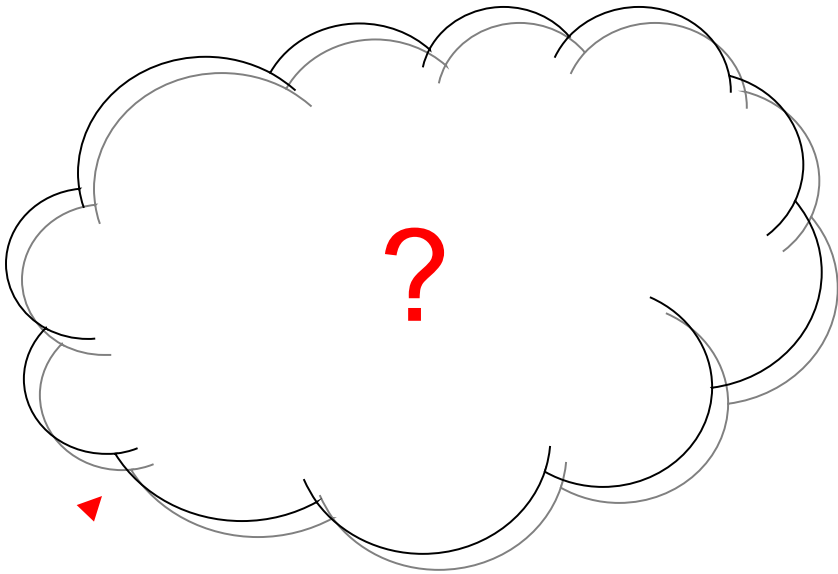


Flow Network

Identifikácia Petriho sietí zo záznamov správania a scenárov – syntéza pomocou token flows

generuje





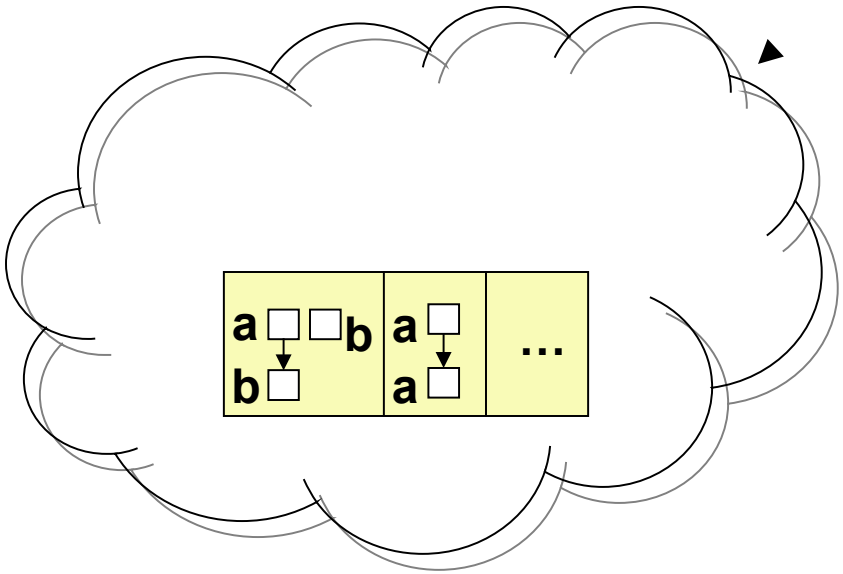
model správania

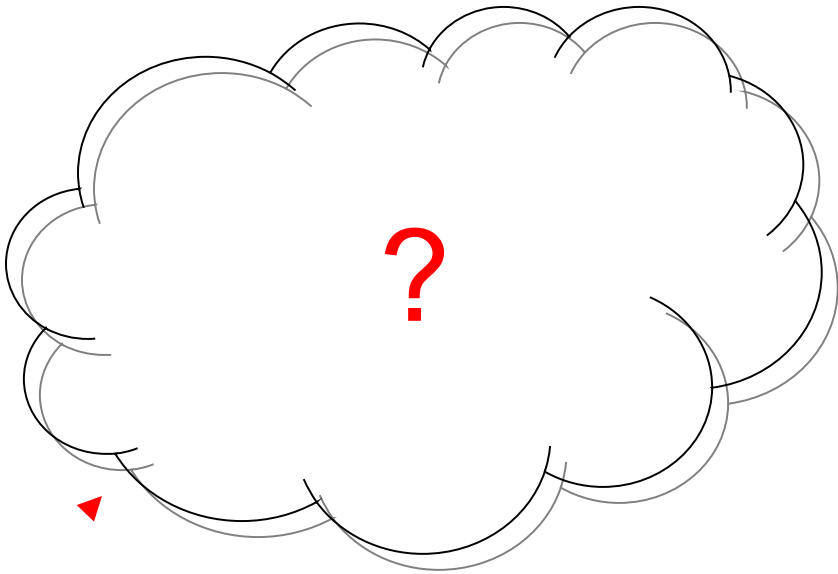
model systému

syntéza
identifikácia

Identifikácia Petriho sietí zo záznamov správania a scenárov – syntéza pomocou token flows

generuje

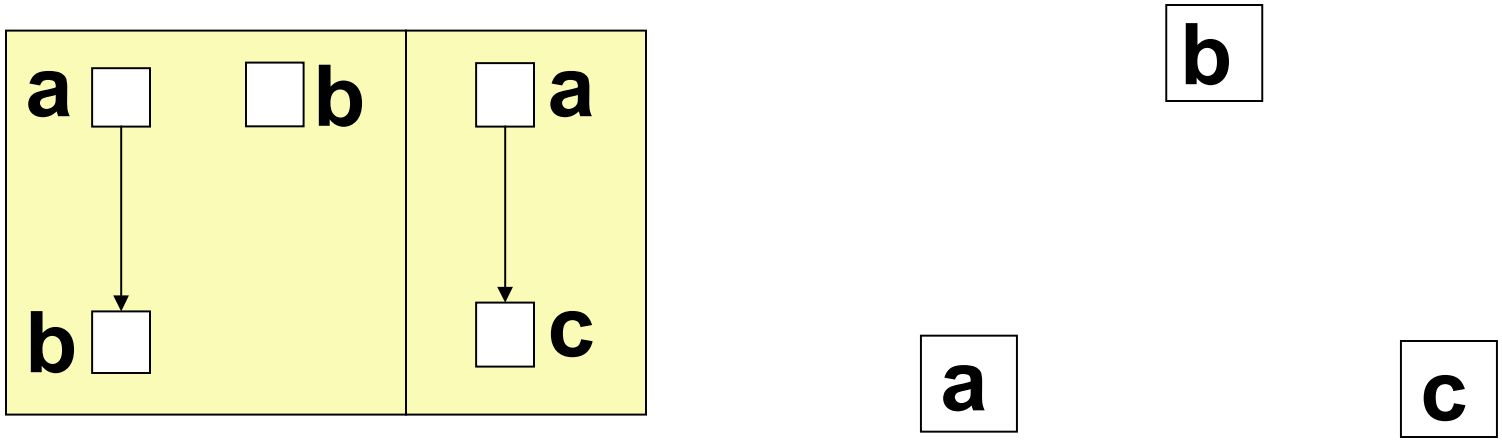




množina scenárov

Petriho sieť

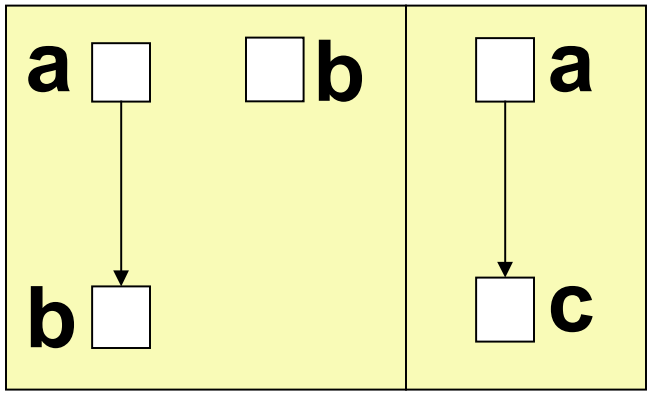
syntéza
identifikácia

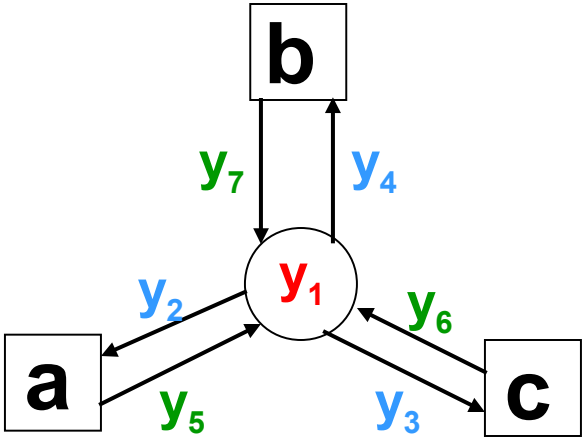


Začni z prázdnou množinou miest

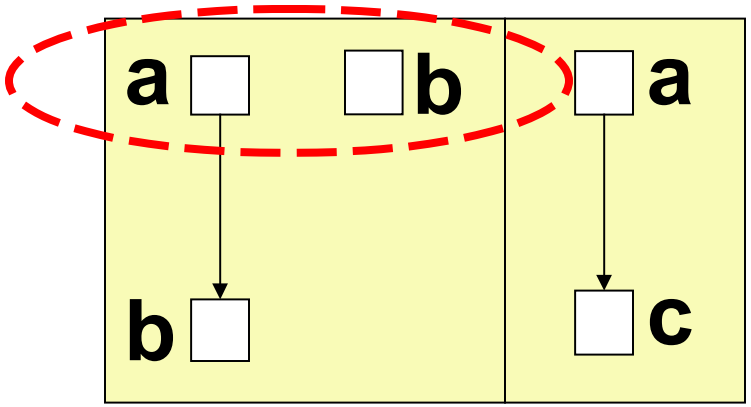
$p=(y_1,y_2,y_3,y_4,y_5,y_6,y_7)$

pre k prechodov (2k+1)-tica nezáporných celých čísel

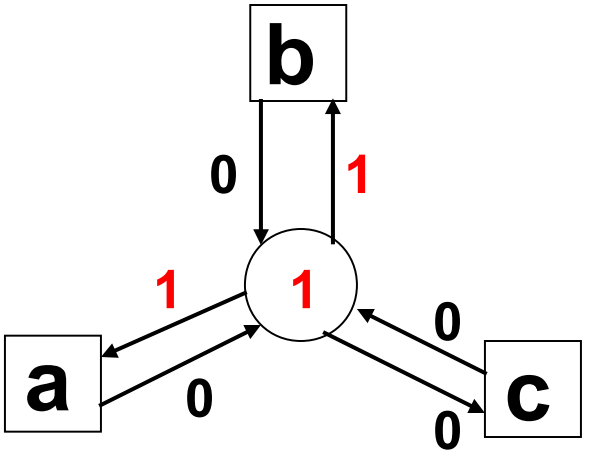




Pridaj miesta p tak aby sieť stále generovala scenáre



p neprípustné

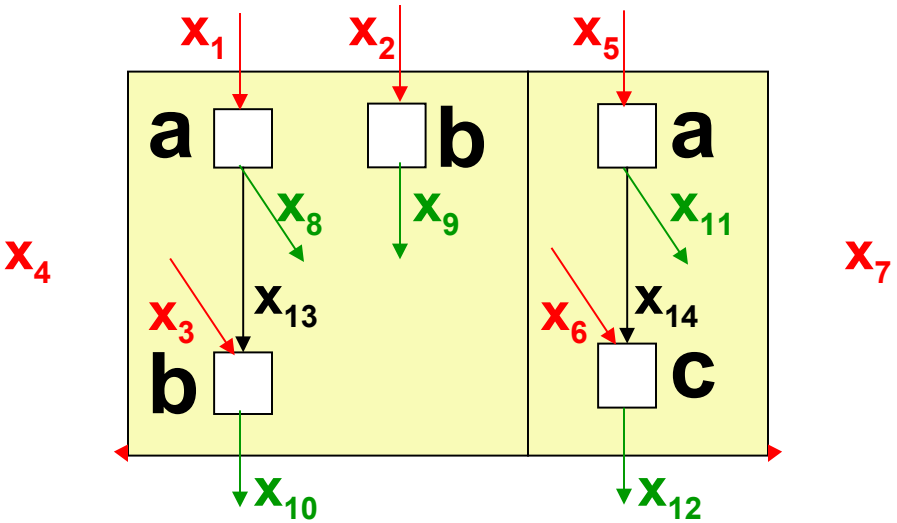


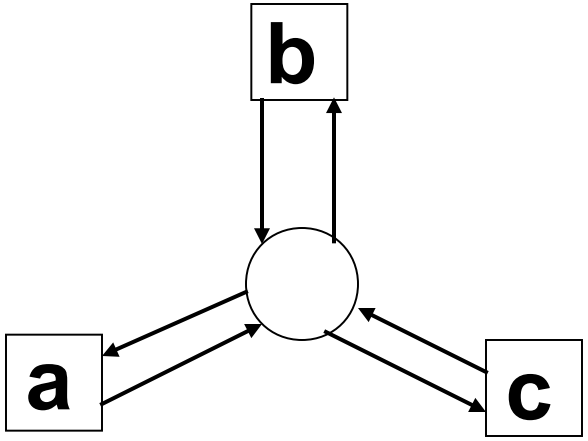
Pridaj miesta p tak aby sieť stále generovala scenáre

Špecifikuj distibúciu token flow

$x=(x_1,x_2,x_3,x_4,x_5,x_6,x_7,x_8,x_9,x_{10},x_{11},x_{12},x_{13},x_{14})$

n-tica nezáporných celých čísel





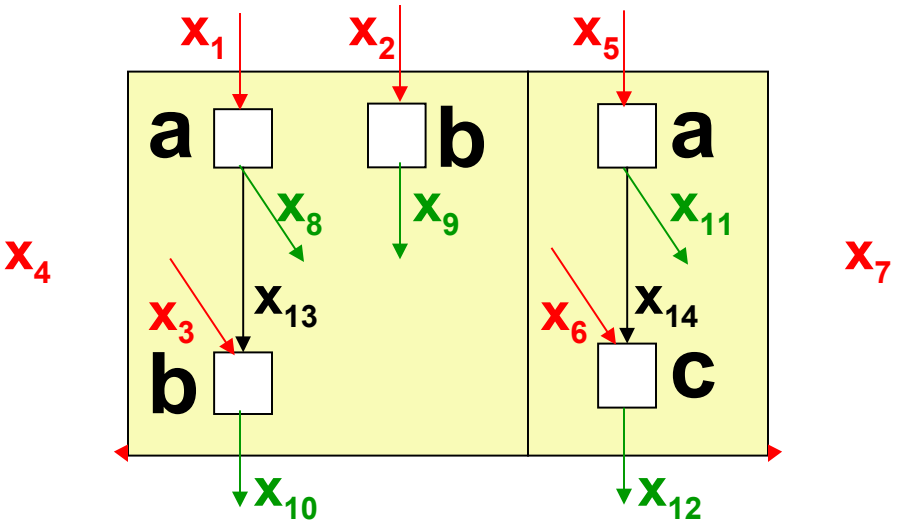
Značky skonzumované z počiatočného značkovania

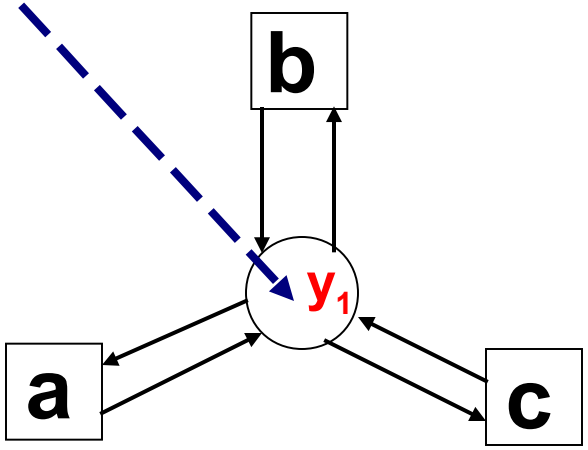
Značky vyprodukované spustením prechodu, ktoré boli skonzumované spustením nasledovného prechodu

Značky zostávajúce v finálnom značkovaní

Rovnaké počiatočné značkovanie scenárov

$$\overbrace{x_1+x_2+x_3+x_4}=\overbrace{x_5+x_6+x_7}$$





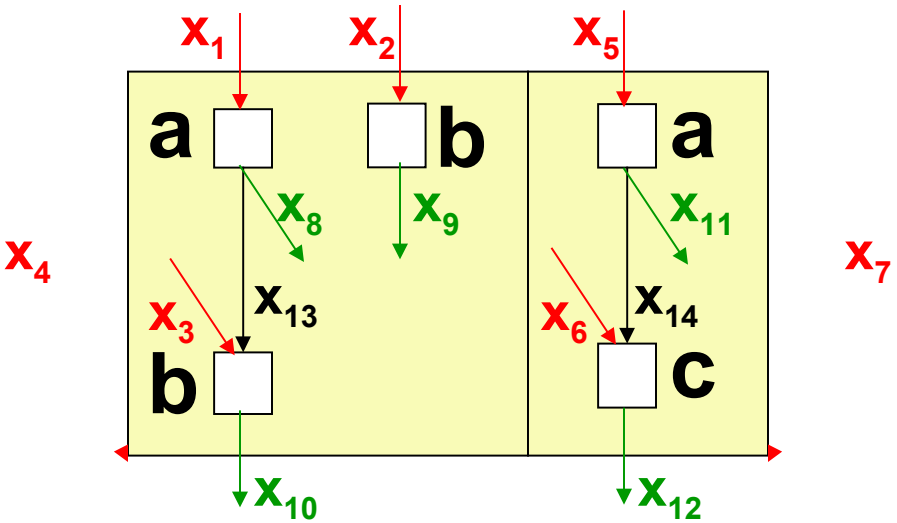
Značky skonzumované z počiatočného značkovania

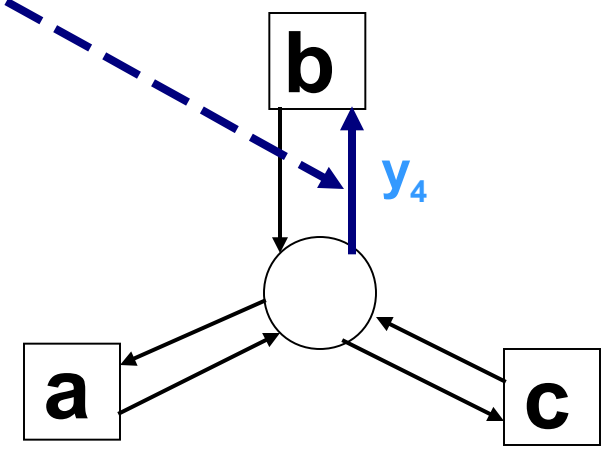
Značky vyprodukované spustením prechodu, ktoré boli skonzumované spustením nasledovného prechodu

Značky zostávajúce v finálnom značkovaní

Rovnaké prechody majú rovnaký vstupný tok

$$\overbrace{x_2}^{\text{vstupný tok}} = \overbrace{x_3 + x_{13}}^{\text{vstupný tok}}$$





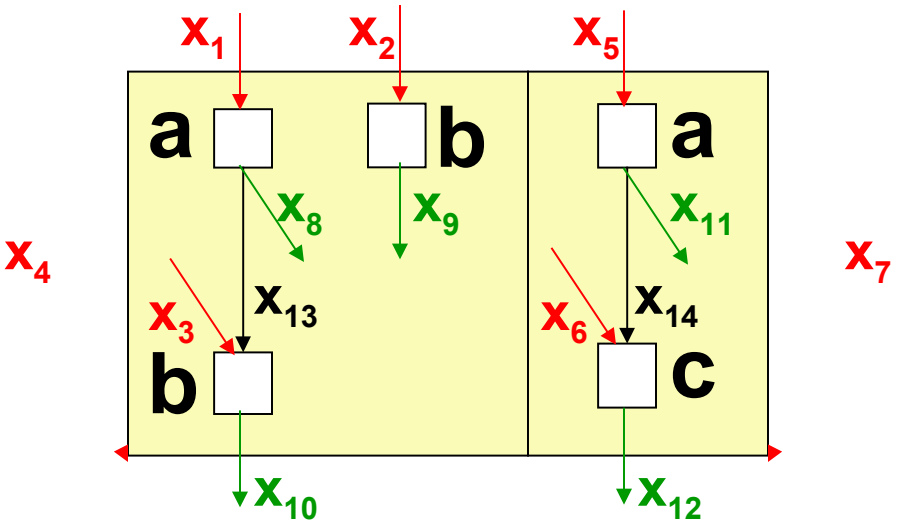
Značky skonzumované z počiatočného značkovania

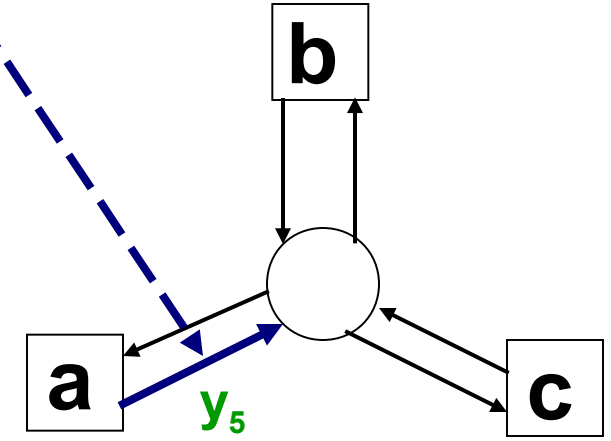
Značky vyprodukované spustením prechodu, ktoré boli skonzumované spustením nasledovného prechodu

Značky zostávajúce v finálnom značkovaní

Rovnaké prechody majú rovnaký výstupný tok

$$\overbrace{x_{11}+x_{14}}=\overbrace{x_8+x_{13}}$$





Značky skonzumované z počiatočného značkovania

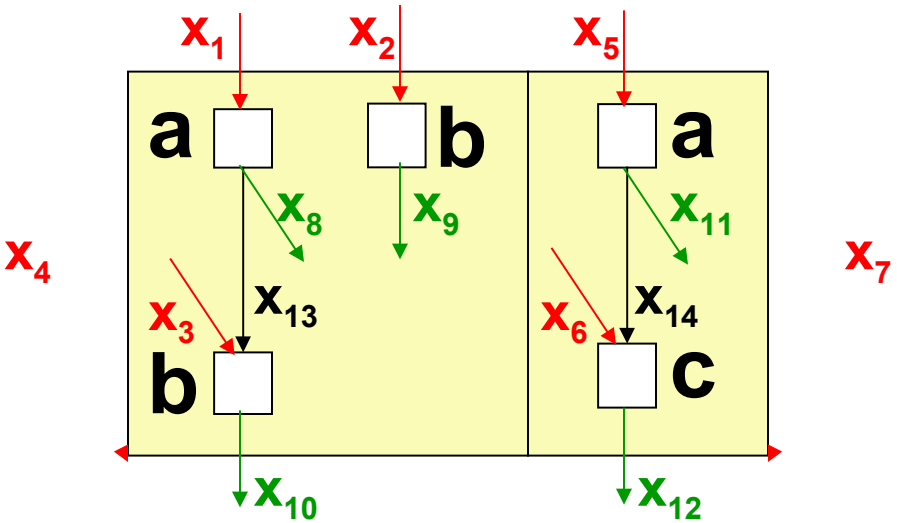
Značky vyprodukované spustením prechodu, ktoré boli skonzumované spustením nasledovného prechodu

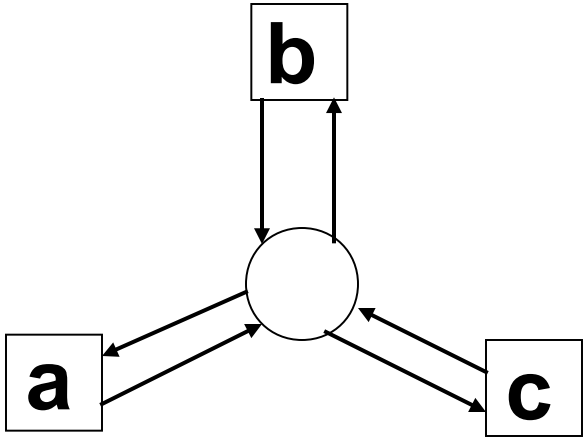
Značky zostávajúce v finálnom značkovaní

$$x_1+x_2+x_3+x_4 = x_5+x_6+x_7$$

$$x_2 = x_3+x_{13}$$

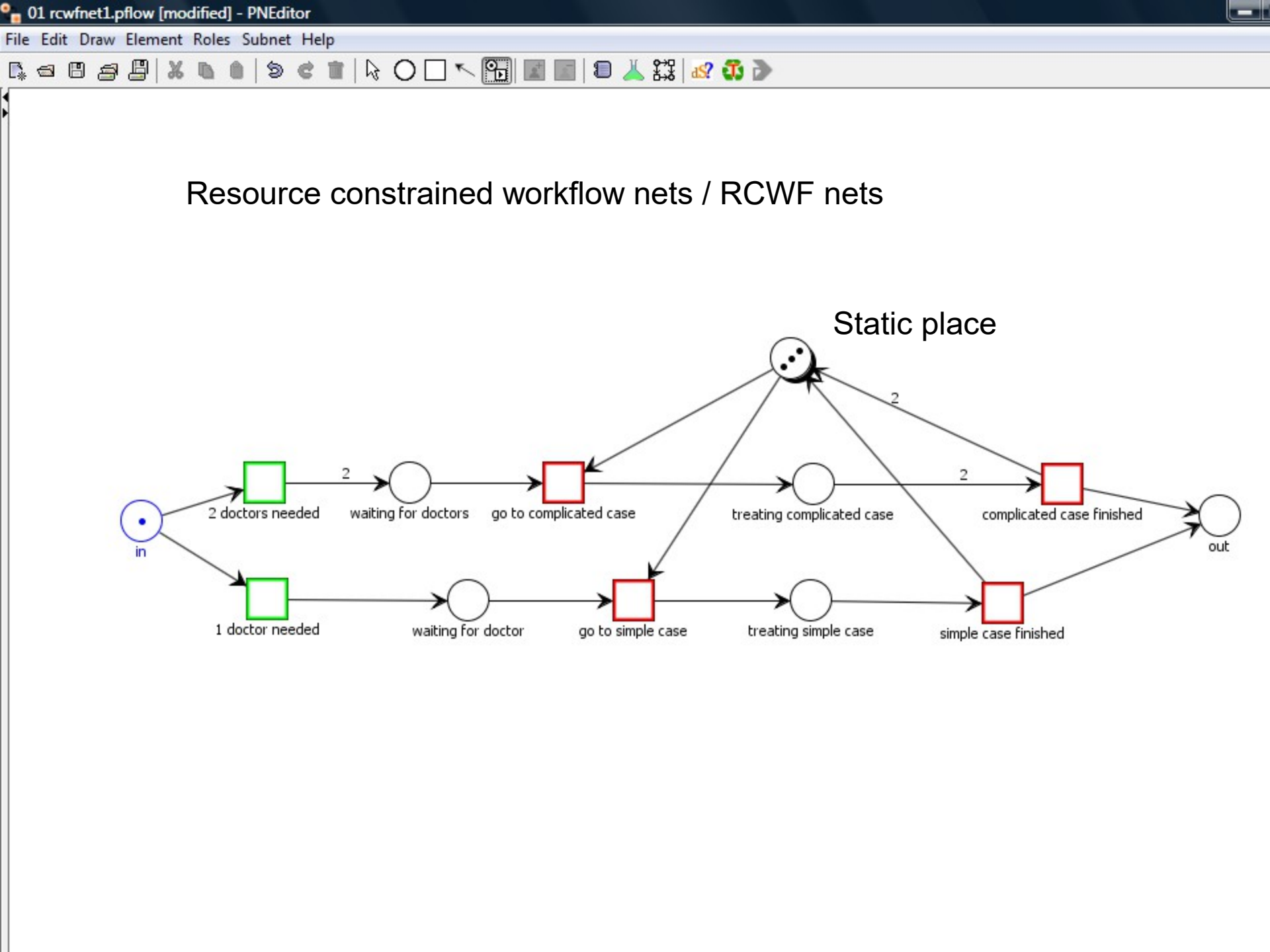
$$x_{11}+x_{14} = x_8+x_{13}$$





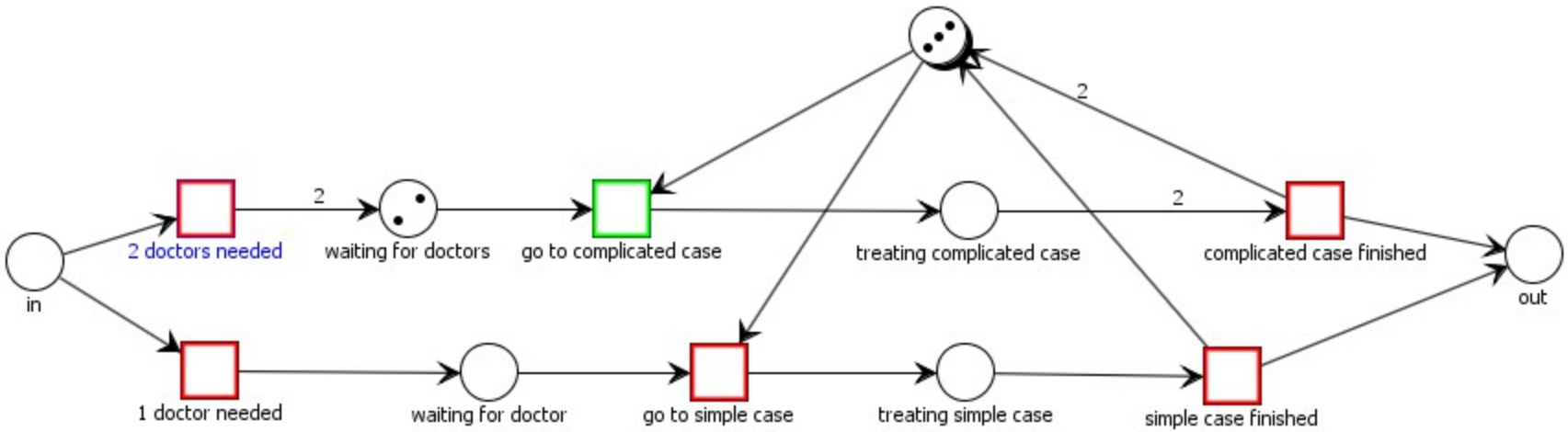
Nezáporné celočíselné riešenia homogénnej sústavy rovníc definujú miesta

Konečný počet prvkov bázy polyhedrálneho kužeľa


01 rcwfnet1.pflow [modified] - PNEditor
File Edit Draw Element Roles Subnet Help
Resource constrained workflow nets / RCWF nets
Static place
2
2
2
in
2 doctors needed
waiting for doctors
go to complicated case
treating complicated case
complicated case finished
out
1 doctor needed
waiting for doctor
go to simple case
treating simple case
simple case finished

01 rcwfnet1.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



01 rcwfnet1.pflow [modified] - PNEditor

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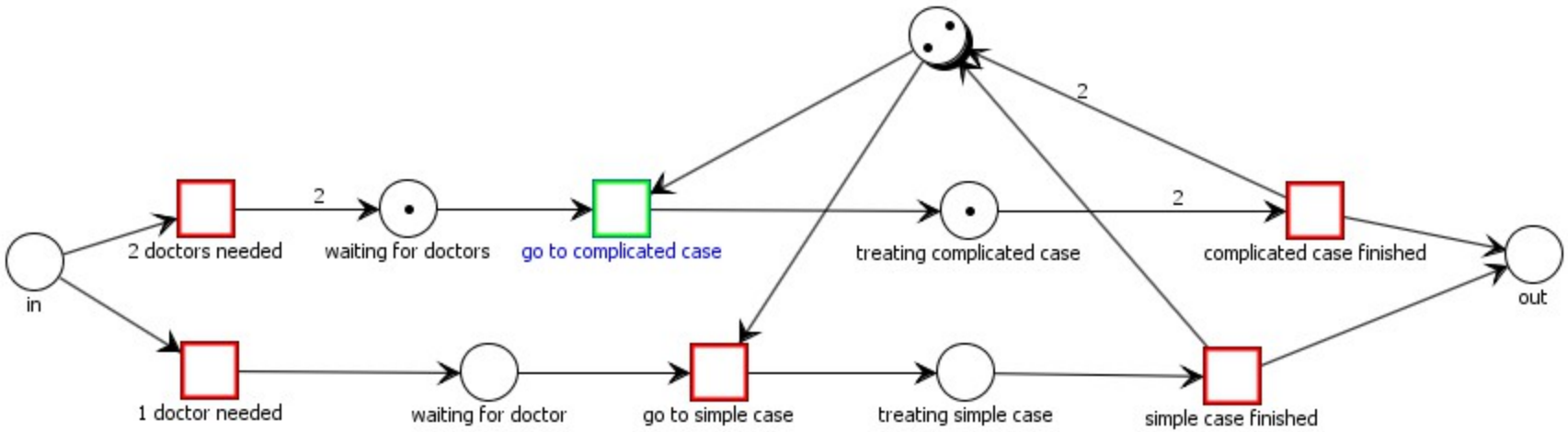
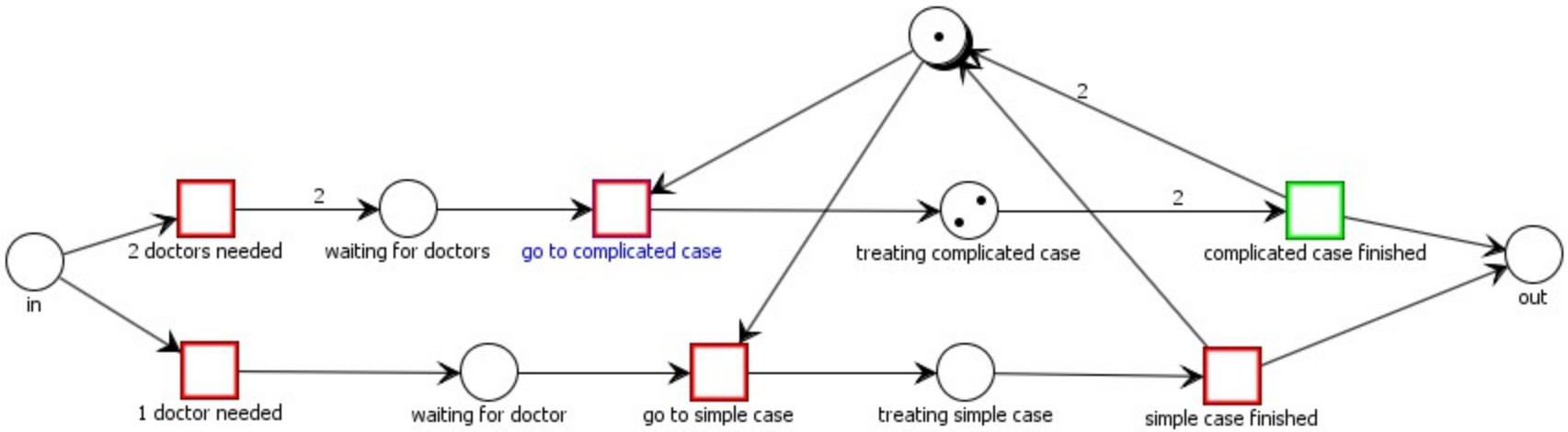


01 rcwfnet1.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



01 rcwfnet1.pflow [modified] - PNEditor

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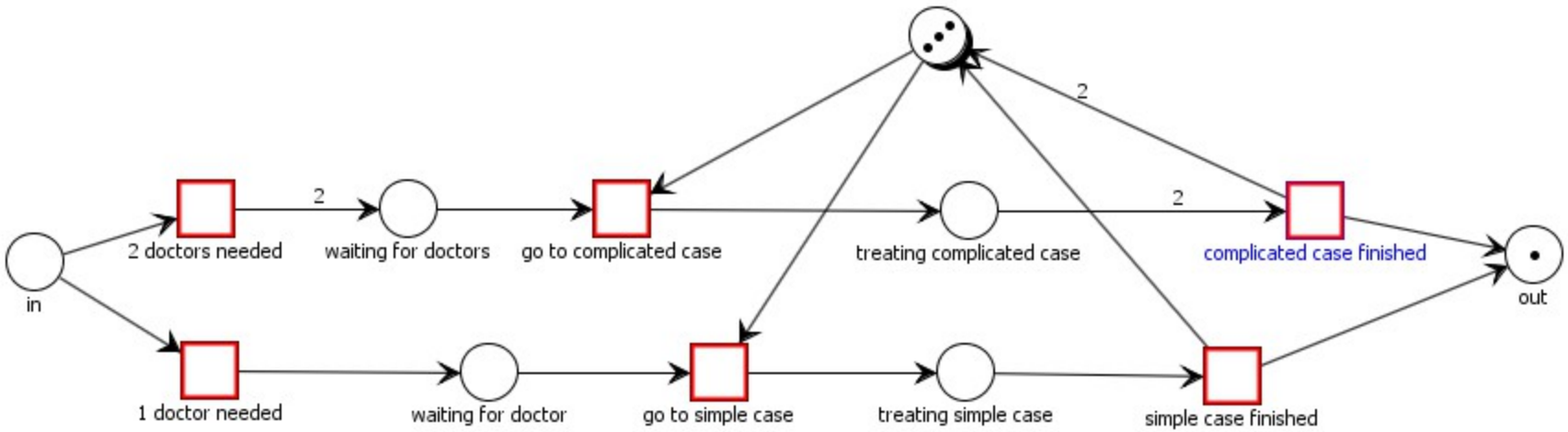
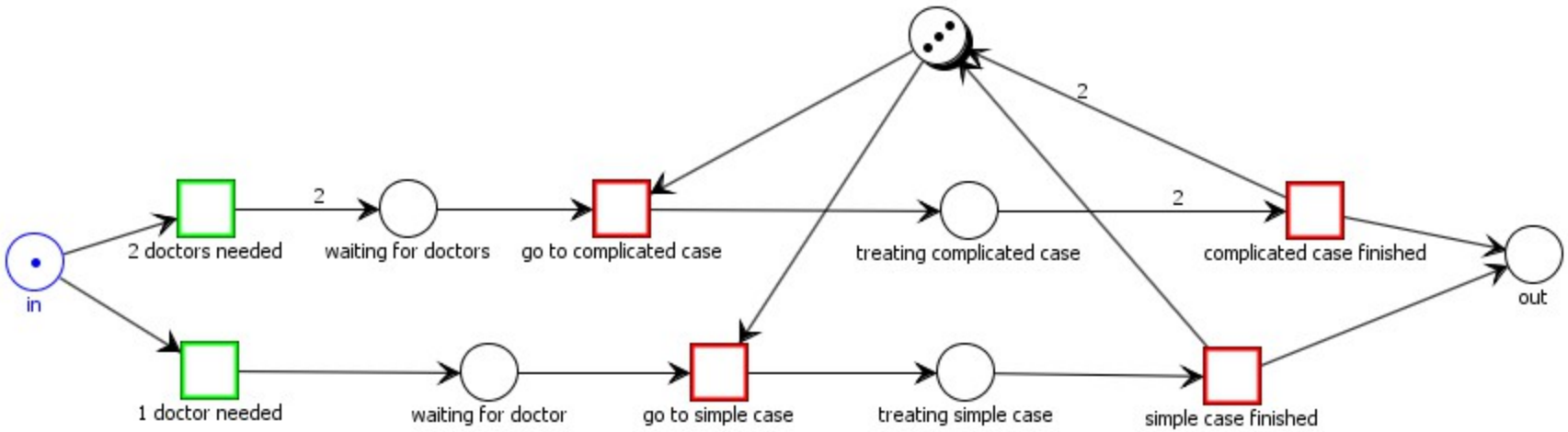


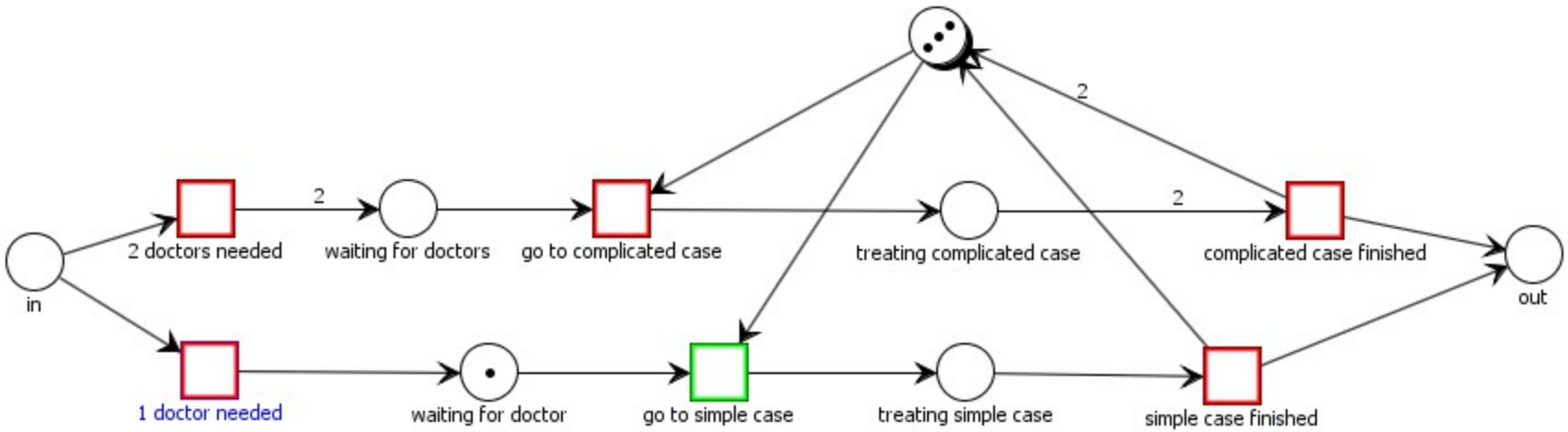
01 rcwfnet1.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



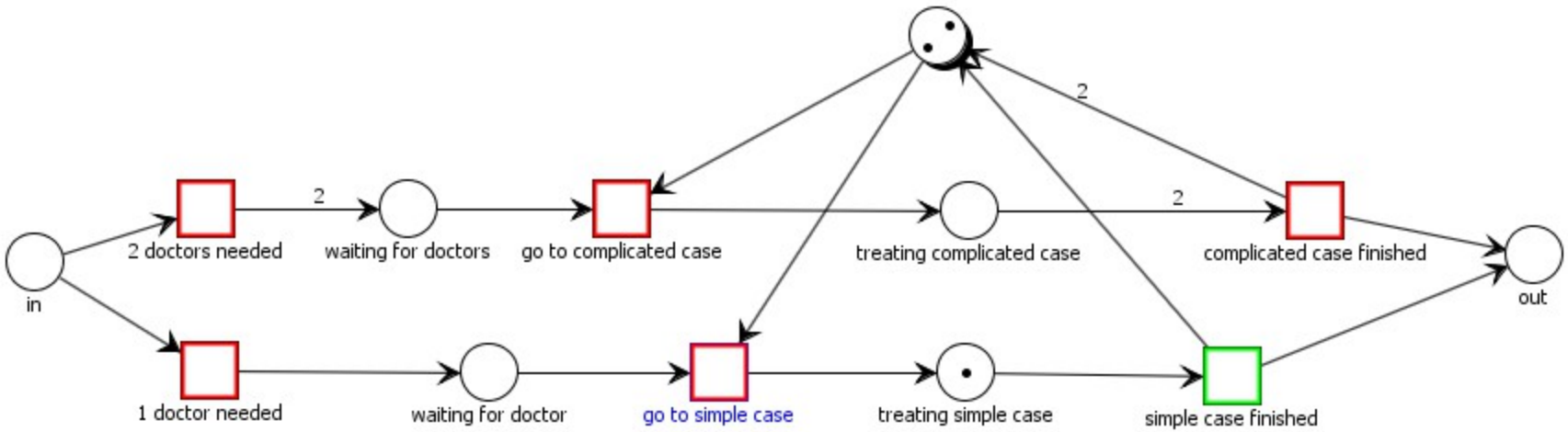
01 rcwfnet1.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



01 rcwfnet1.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



01 rcwfnet1.pflow [modified] - PNEditor

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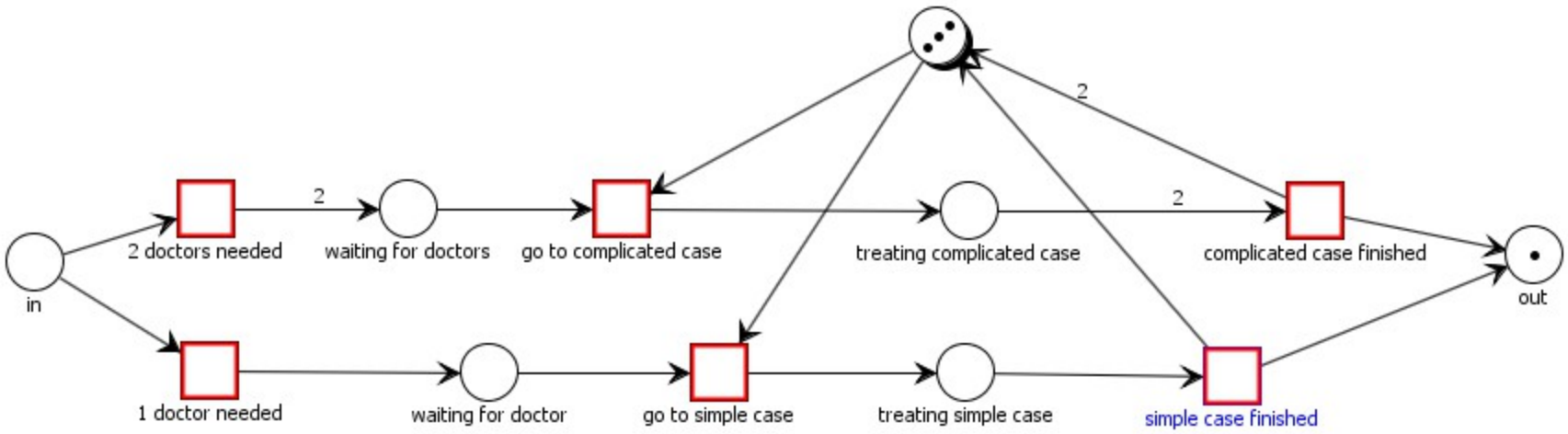
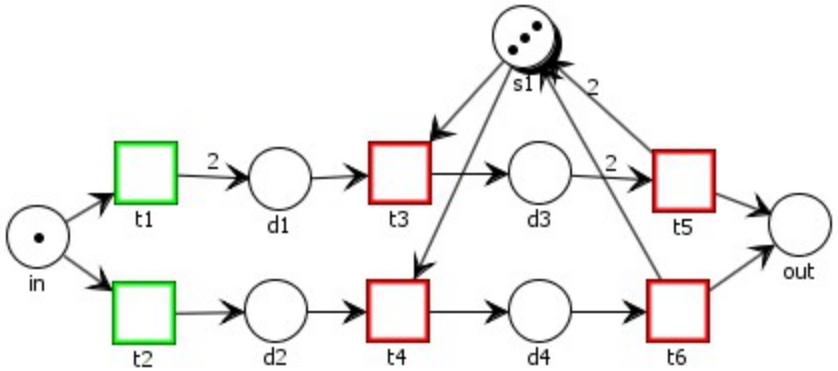


02 rcwfnet2.pflow - PNEditor

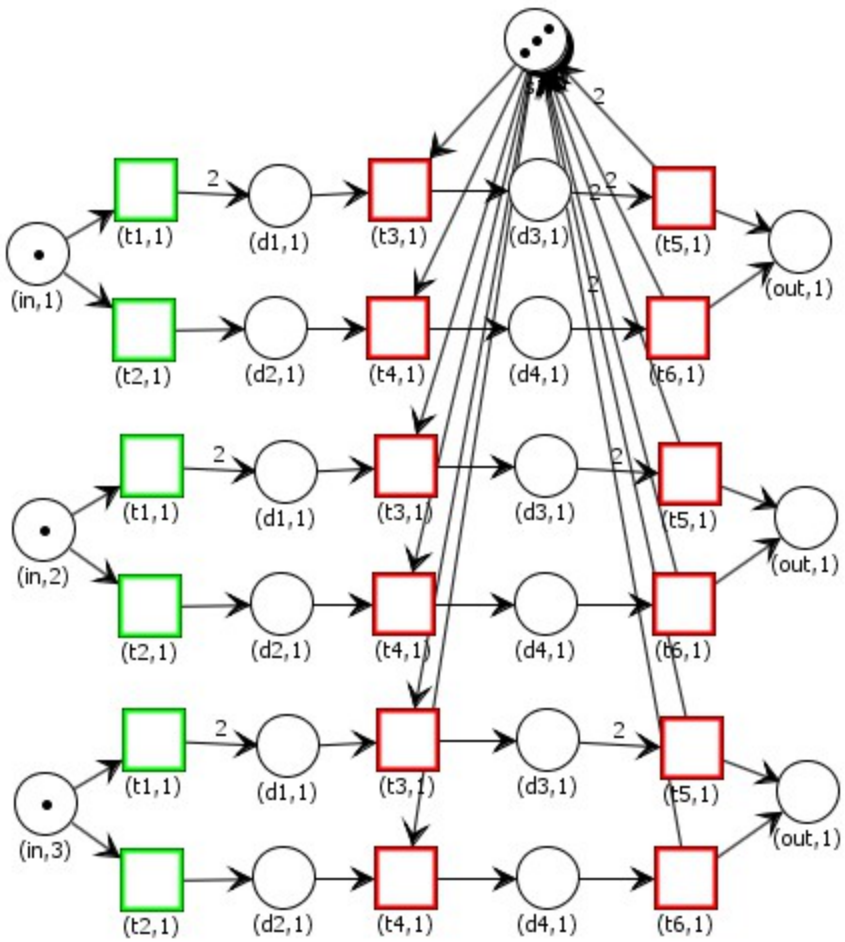
File Edit Draw Element Roles Subnet Help



runtime net of rcwfnet2 for 3 instances.pflow - PNEditor

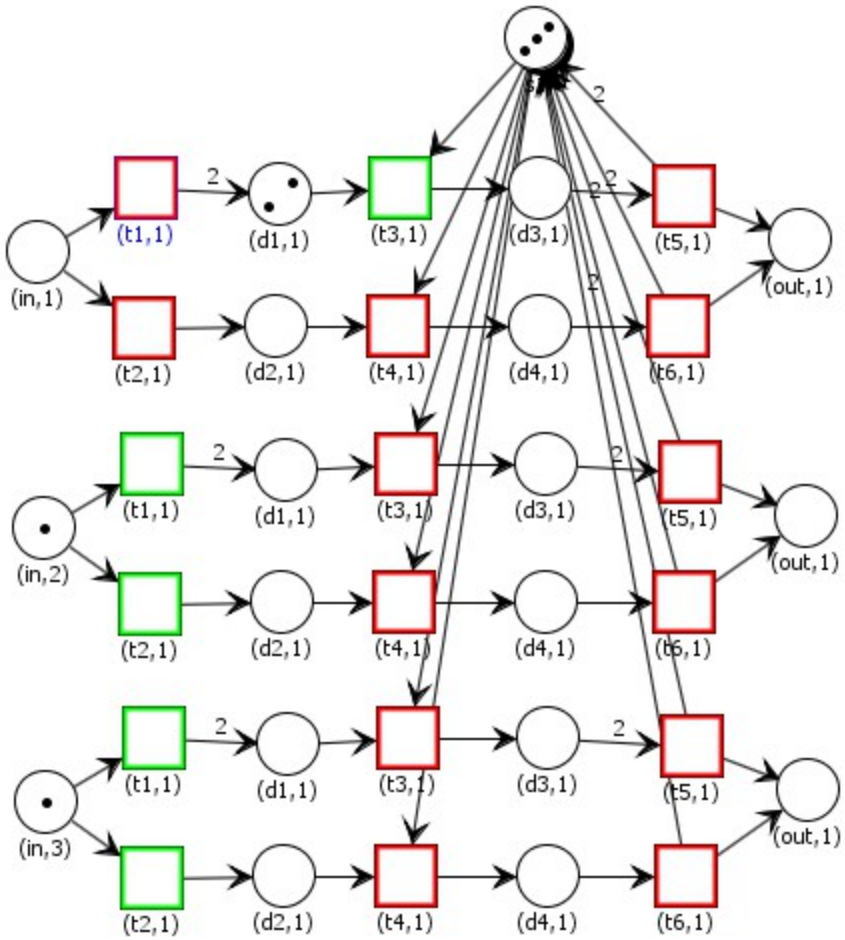
File Edit Draw Element Roles Subnet Help

Run time nets



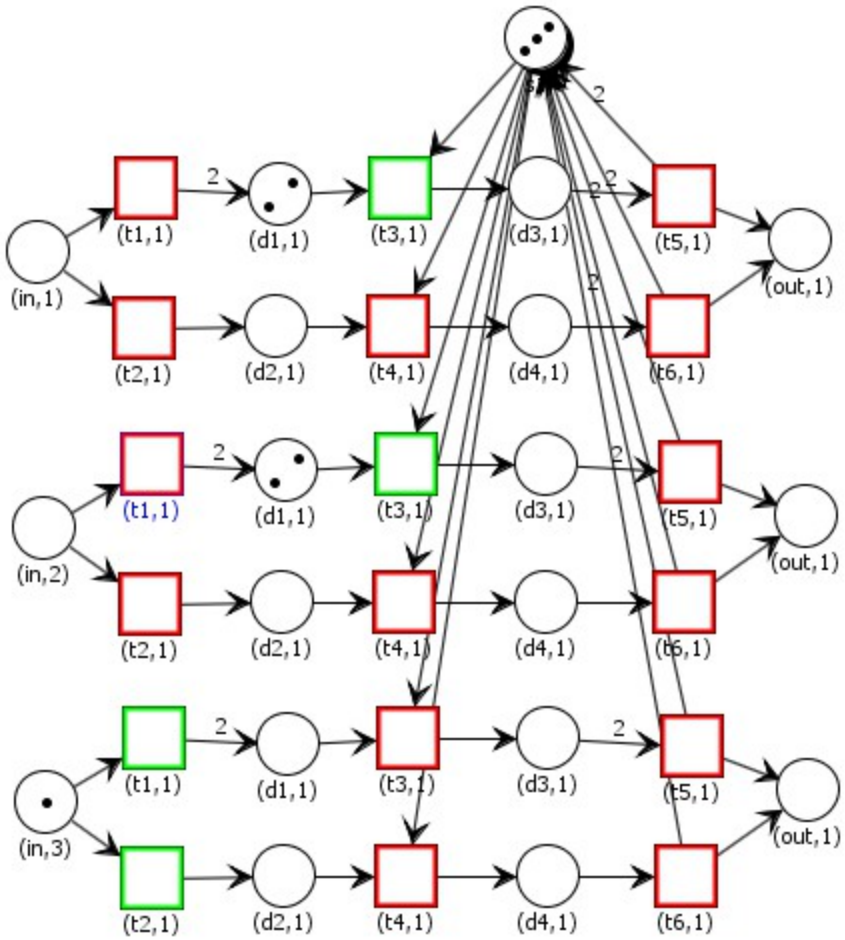
runtime net of rcwfnet2 for 3 instances.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



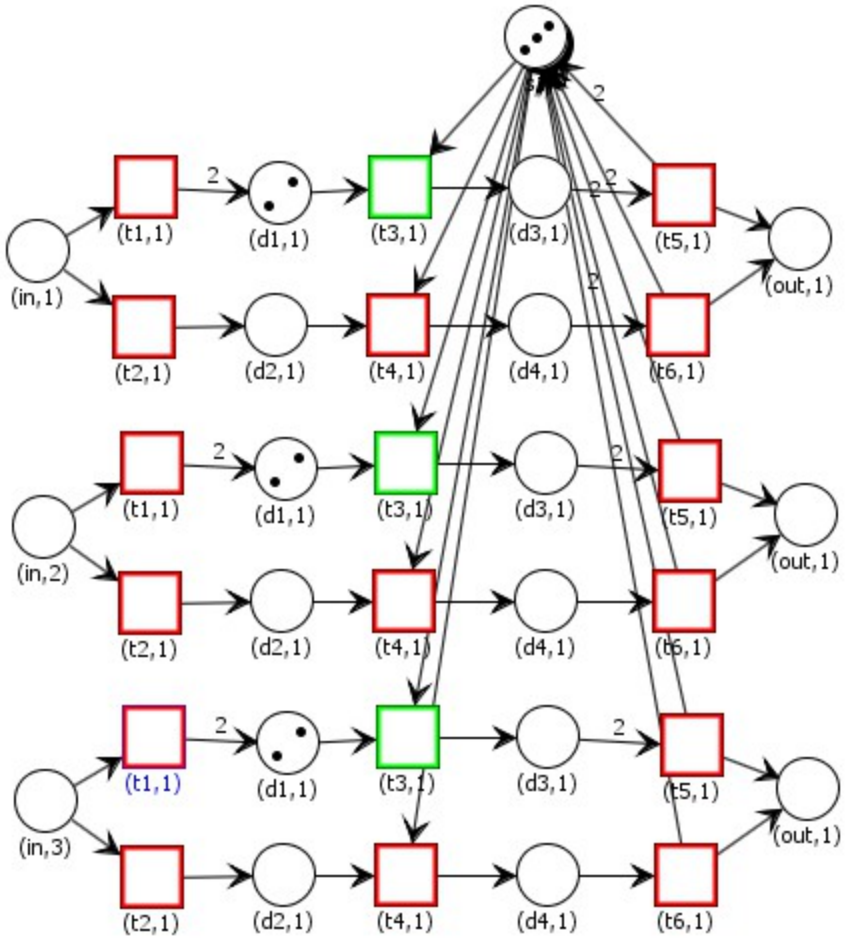
runtime net of rcwfnet2 for 3 instances.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



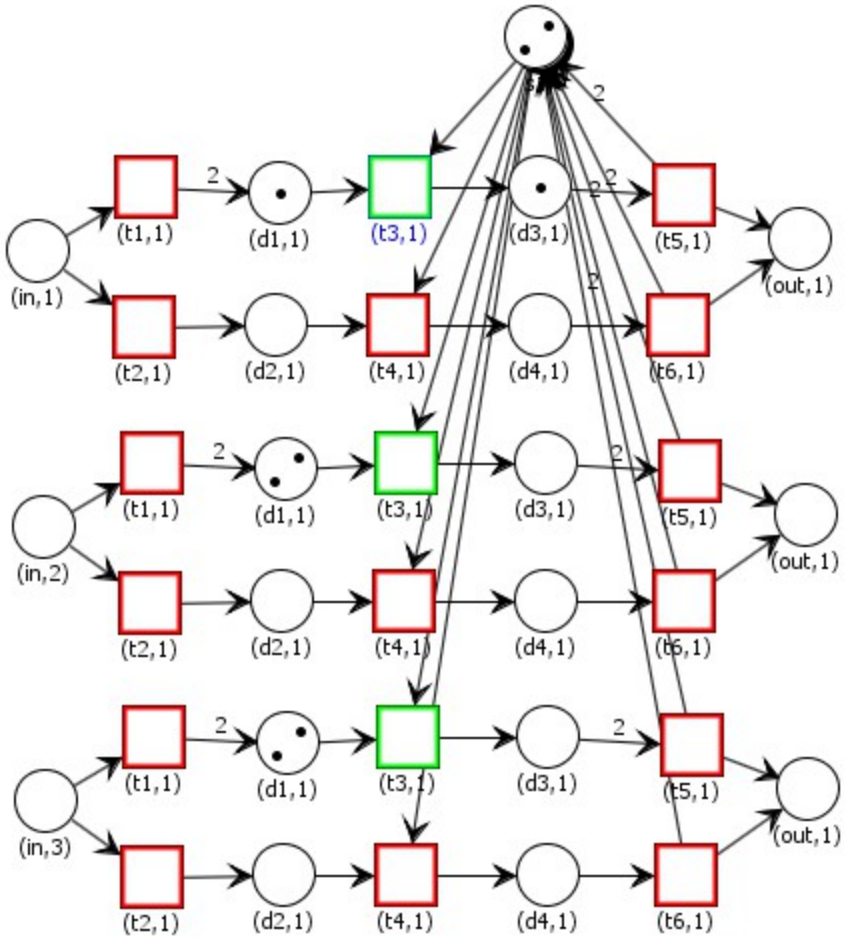
runtime net of rcwfnet2 for 3 instances.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



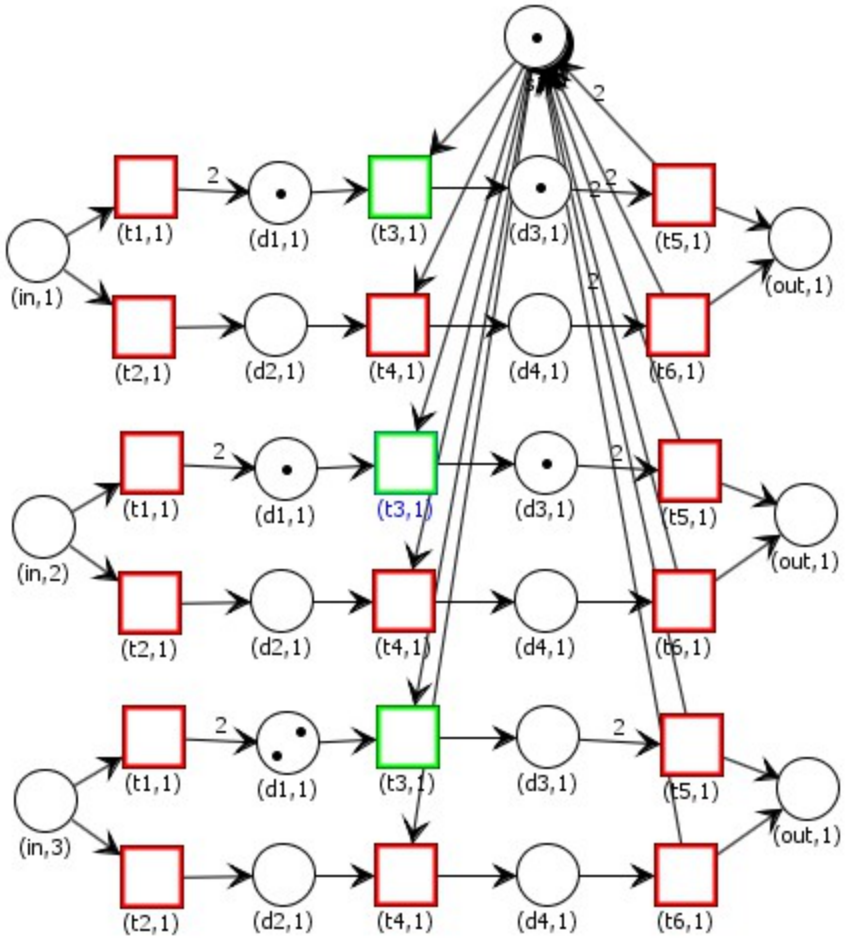
runtime net of rcwfnet2 for 3 instances.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



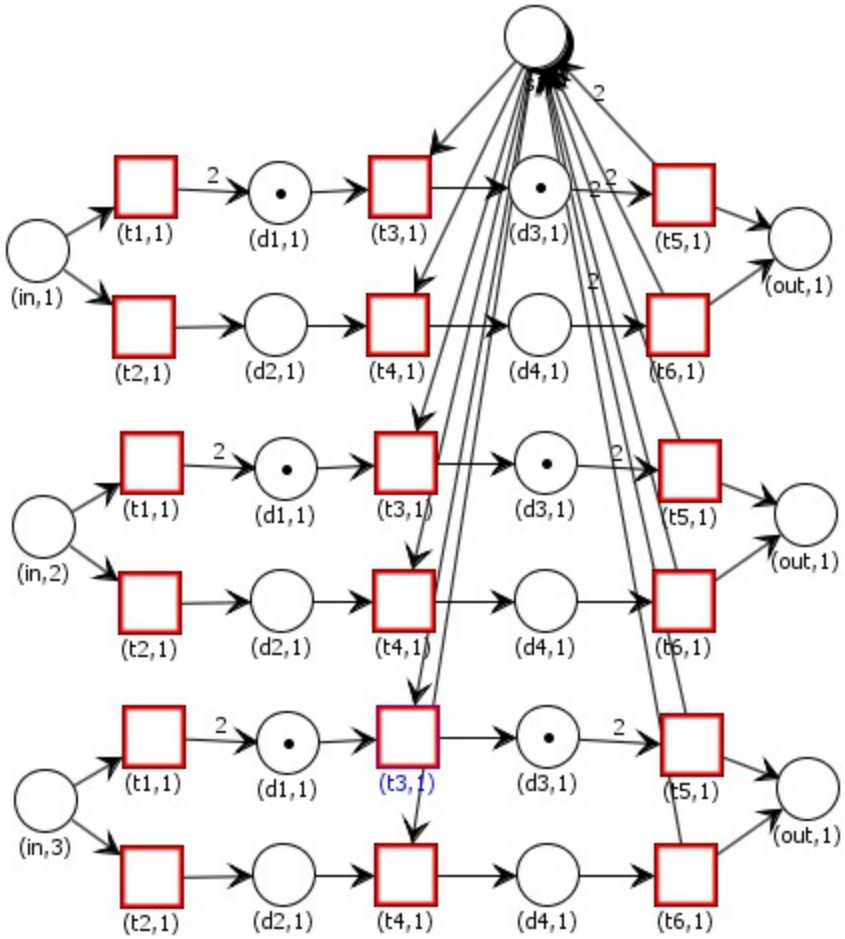
runtime net of rcwfnet2 for 3 instances.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



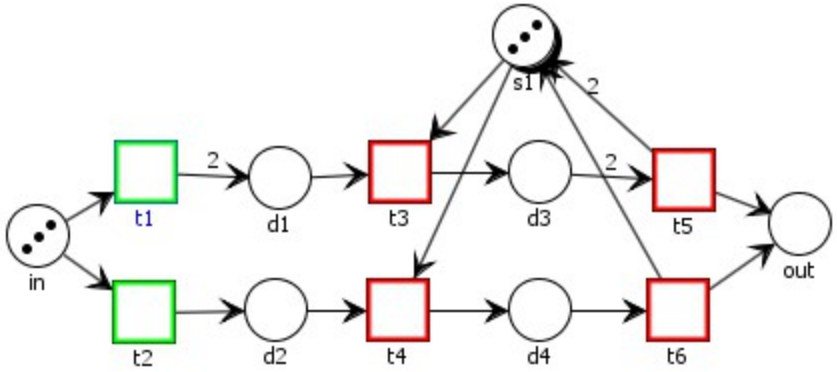
runtime net of rcwfnet2 for 3 instances.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



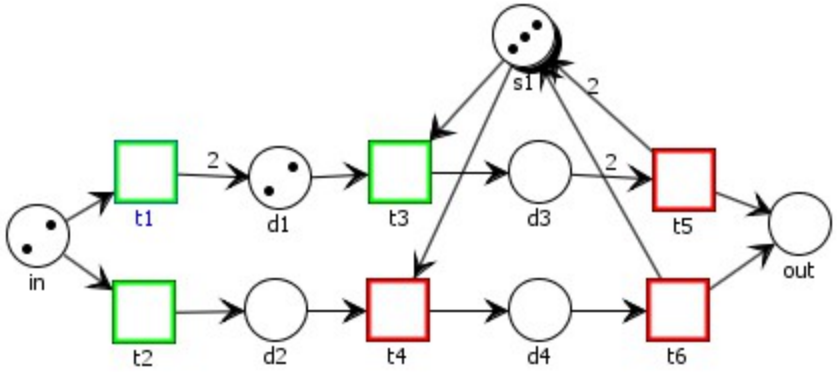
rcwfnet2 non detecting instance deadlock.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



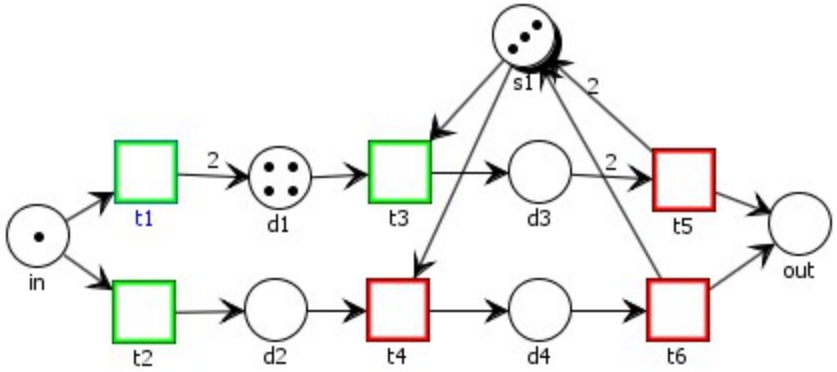
rcwfnet2 non detecting instance deadlock.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



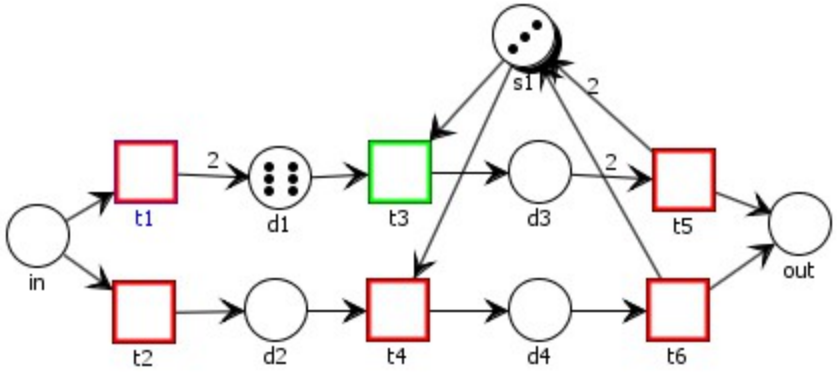
rcwfnet2 non detecting instance deadlock.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



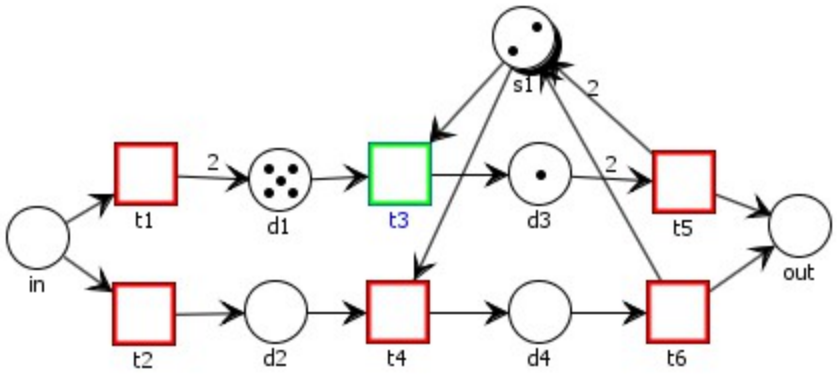
rcwfnet2 non detecting instance deadlock.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



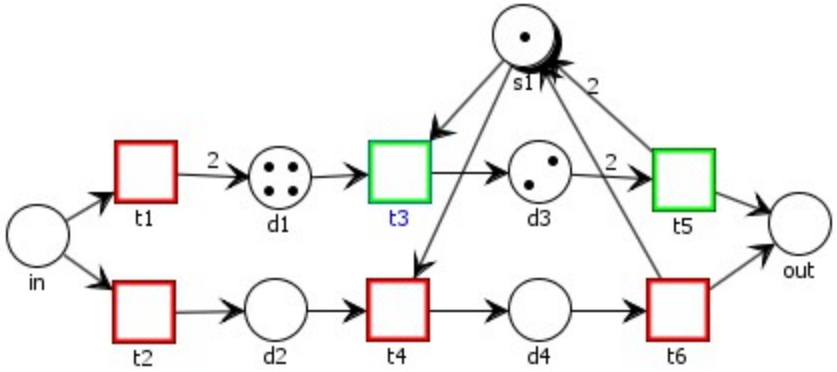
rcwfnet2 non detecting instance deadlock.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



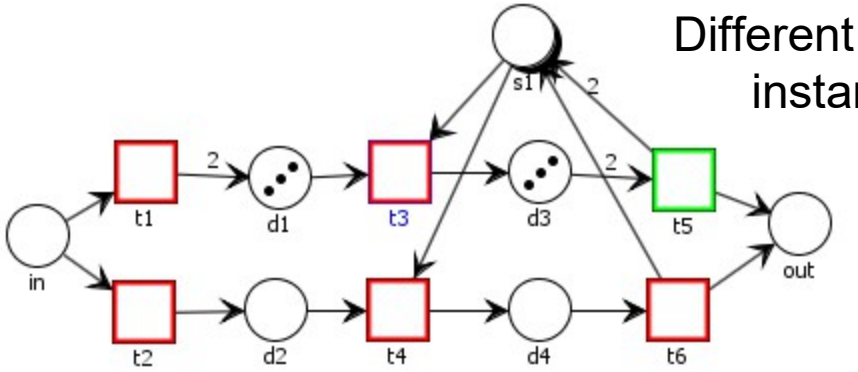
rcwfnet2 non detecting instance deadlock.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



rcwfnet2 non detecting instance deadlock.pflow [modified] - PNEditor

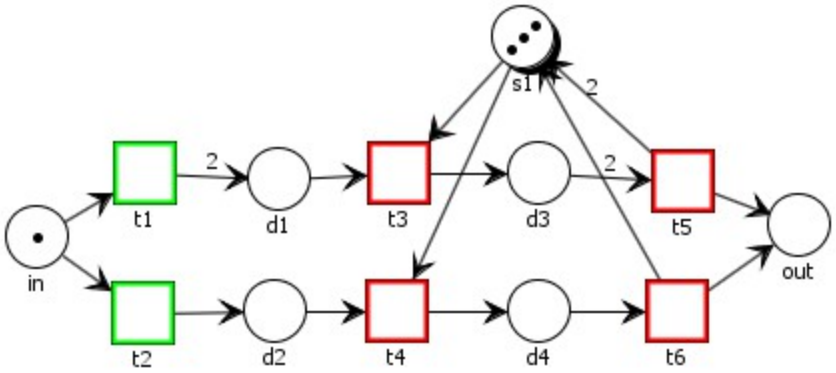
File Edit Draw Element Roles Subnet Help



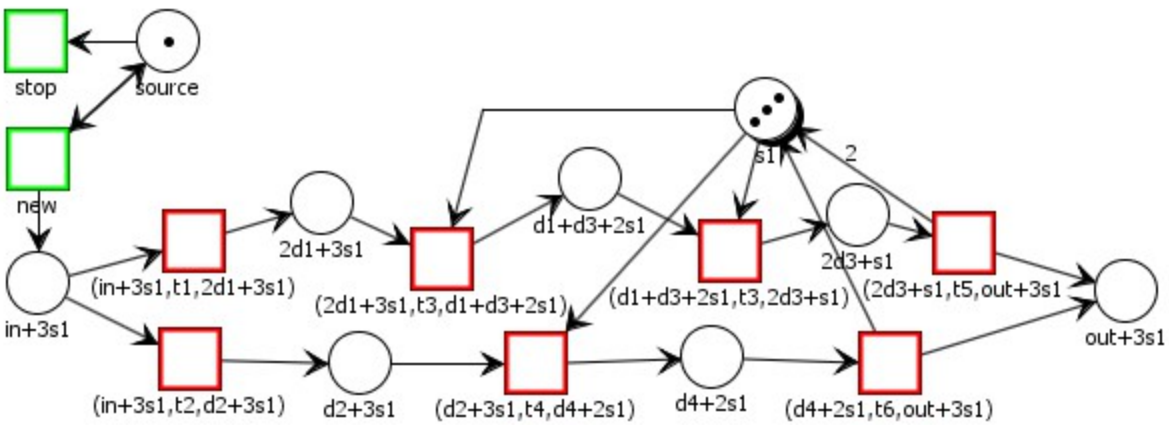
Different instances mixed – existing instance deadlock not found

transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help

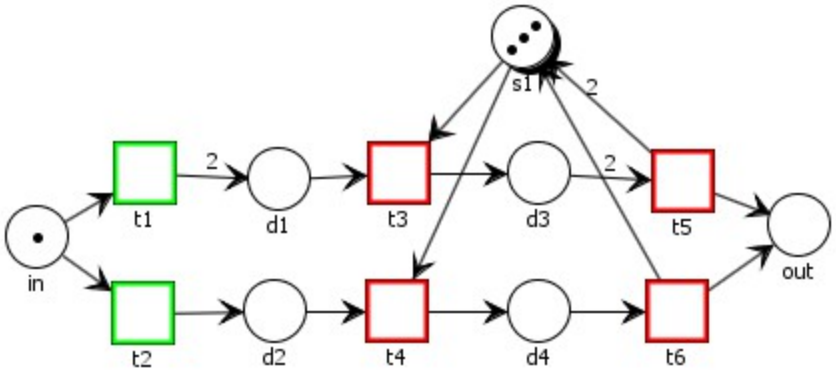


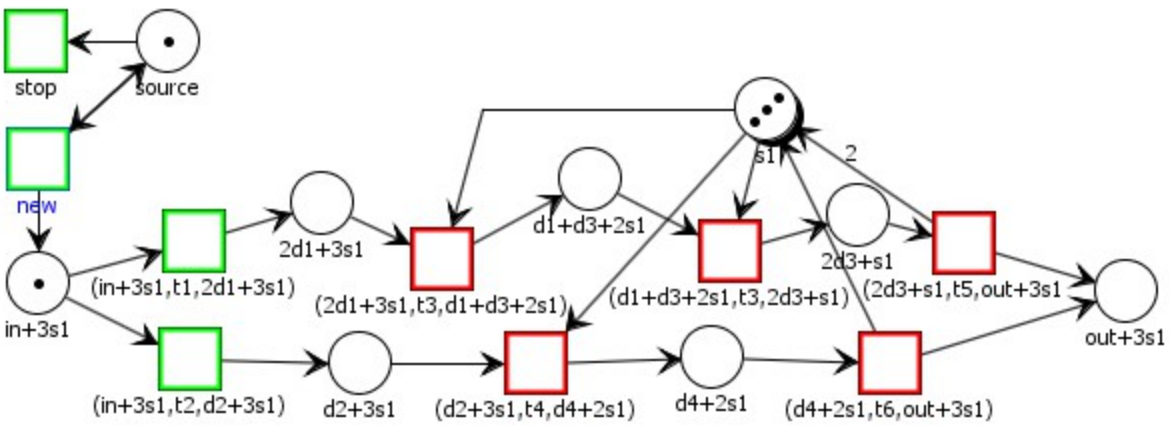
Transformed net



transformed rcwfnet2.pflow [modified] - PNEditor

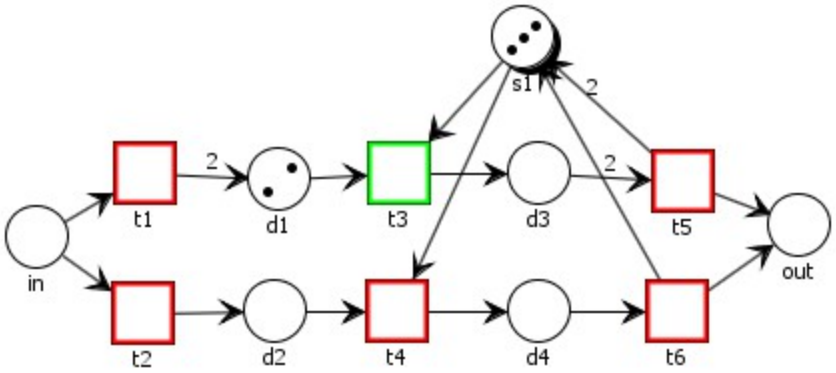
File Edit Draw Element Roles Subnet Help

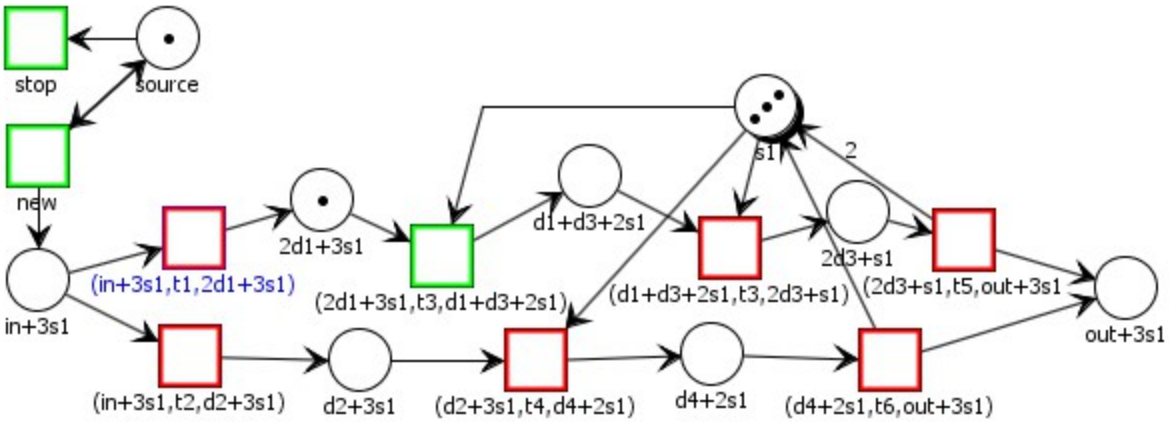




transformed rcwfnet2.pflow [modified] - PNEditor

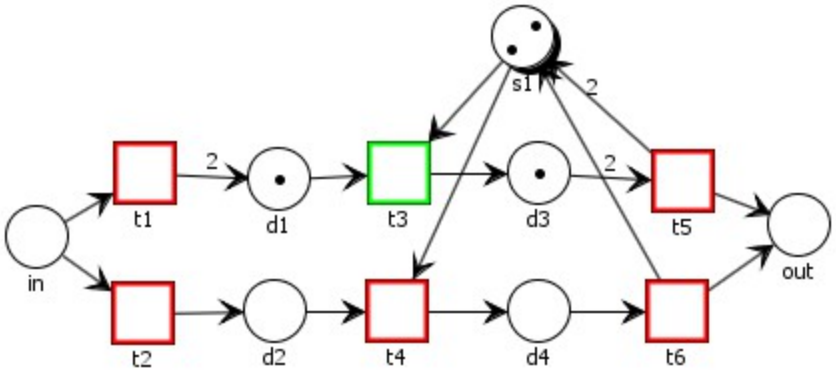
File Edit Draw Element Roles Subnet Help

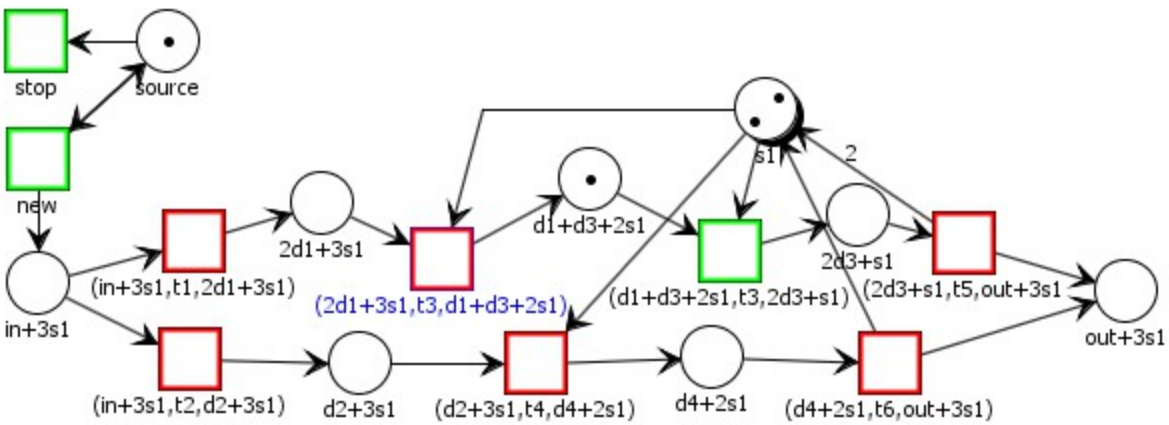




transformed rcwfnet2.pflow [modified] - PNEditor

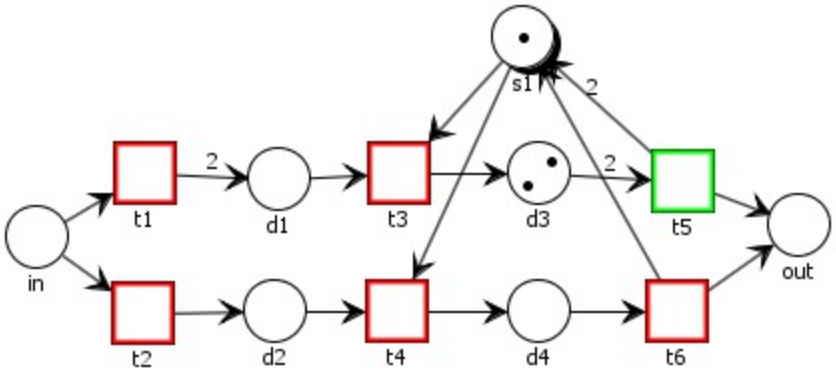
File Edit Draw Element Roles Subnet Help

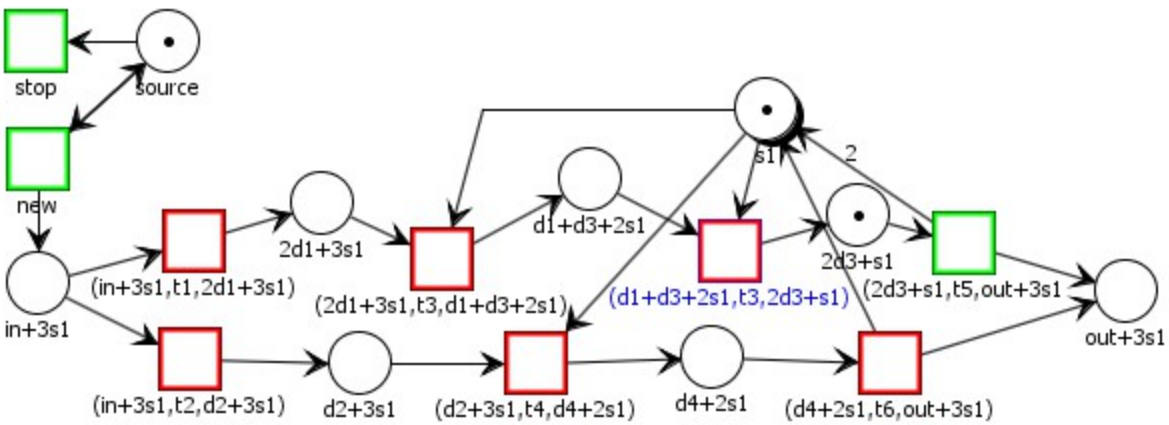




transformed rcwfnet2.pflow [modified] - PNEditor

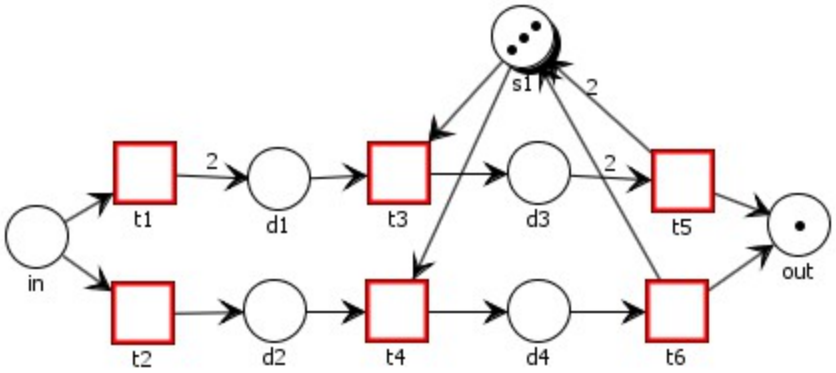
File Edit Draw Element Roles Subnet Help

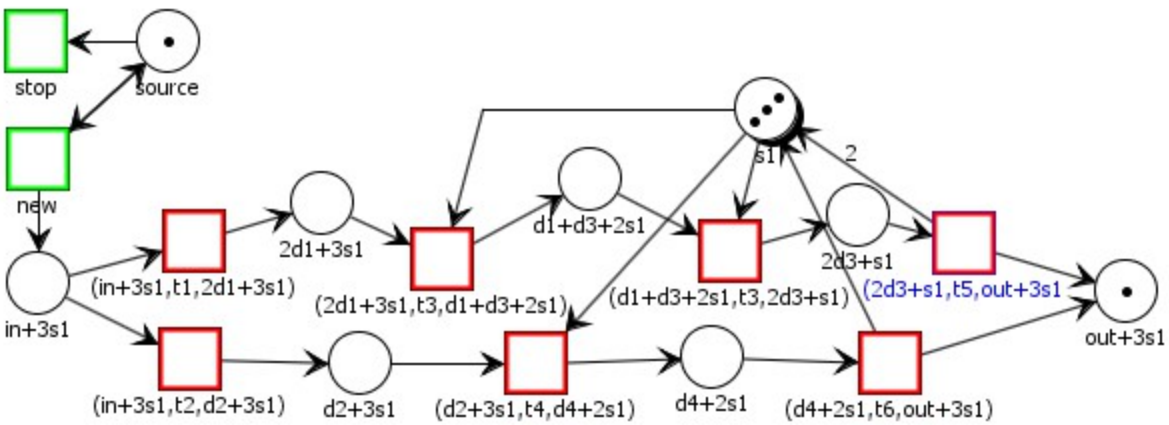




transformed rcwfnet2.pflow [modified] - PNEditor

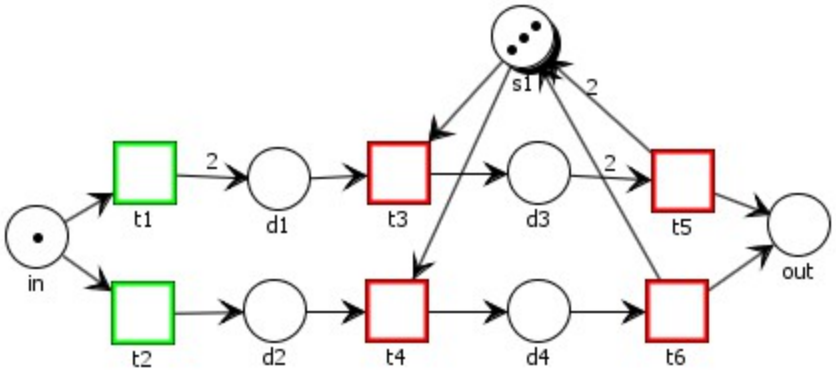
File Edit Draw Element Roles Subnet Help

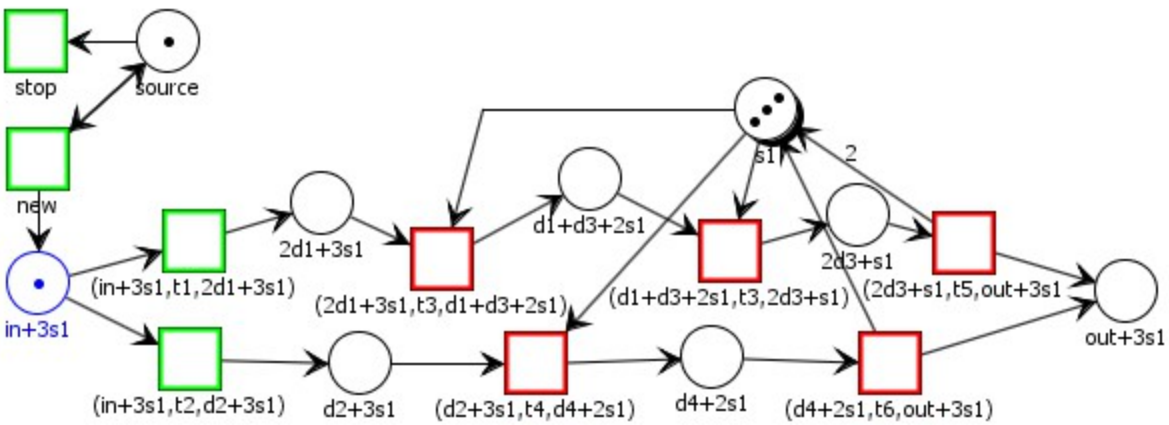




transformed rcwfnet2.pflow [modified] - PNEditor

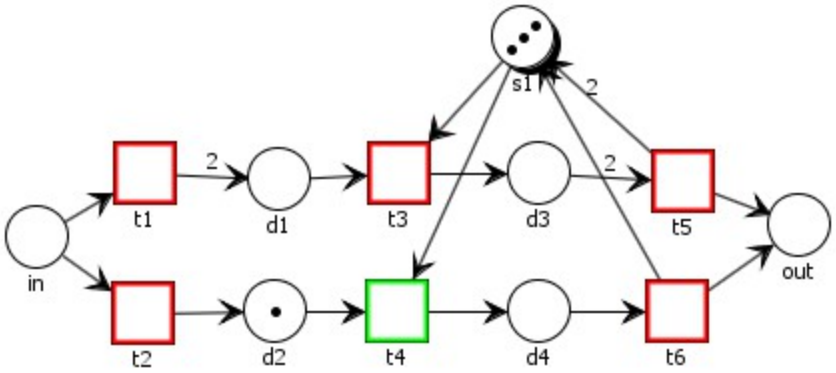
File Edit Draw Element Roles Subnet Help

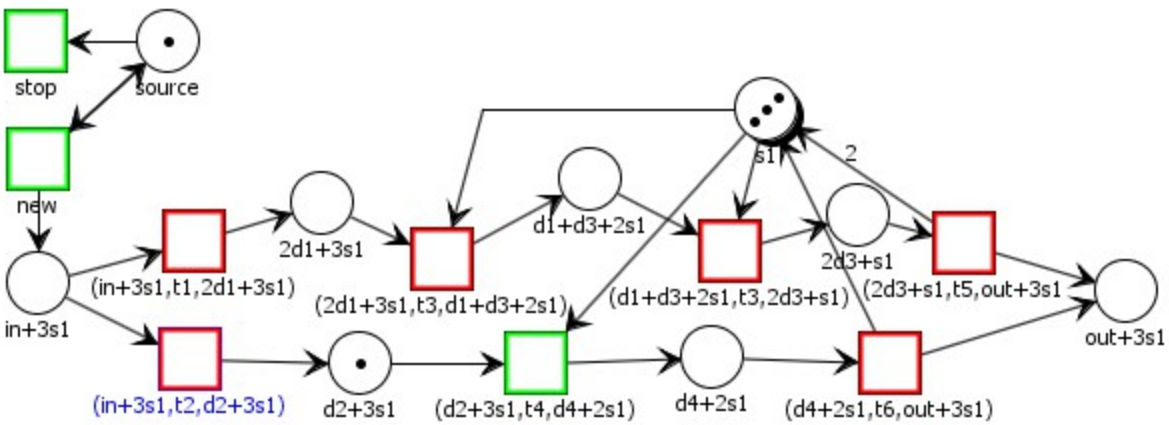




transformed rcwfnet2.pflow [modified] - PNEditor

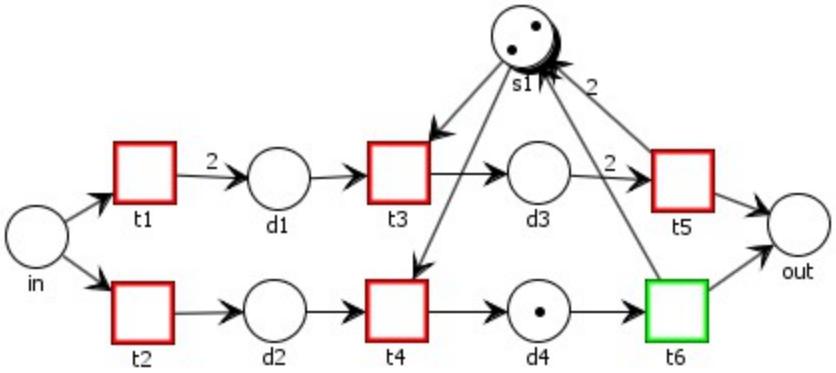
File Edit Draw Element Roles Subnet Help

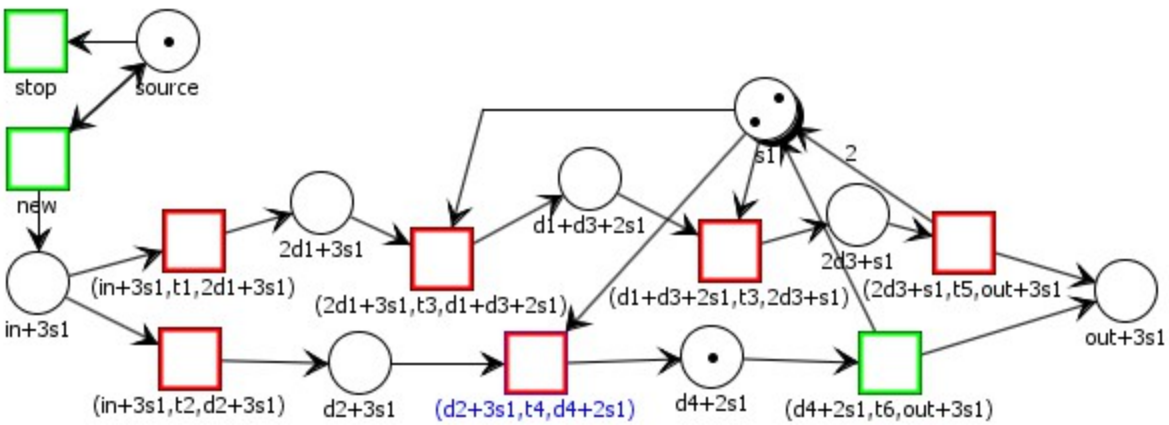




transformed rcwfnet2.pflow [modified] - PNEditor

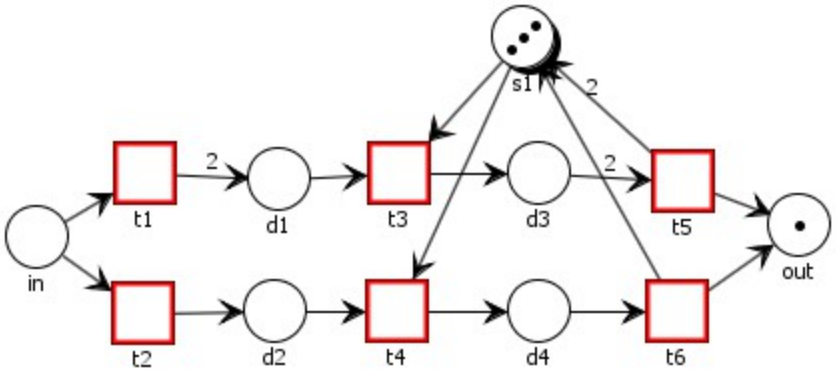
File Edit Draw Element Roles Subnet Help

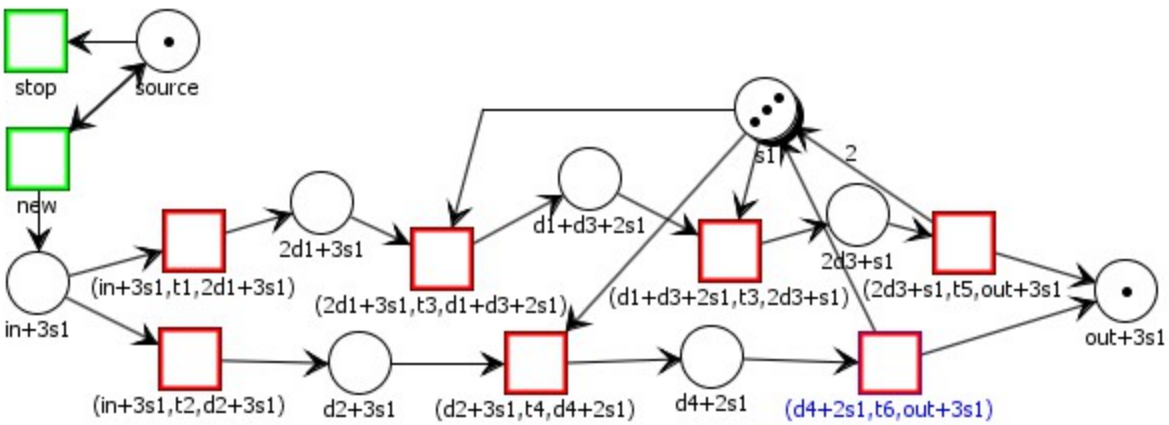




transformed rcwfnet2.pflow [modified] - PNEditor

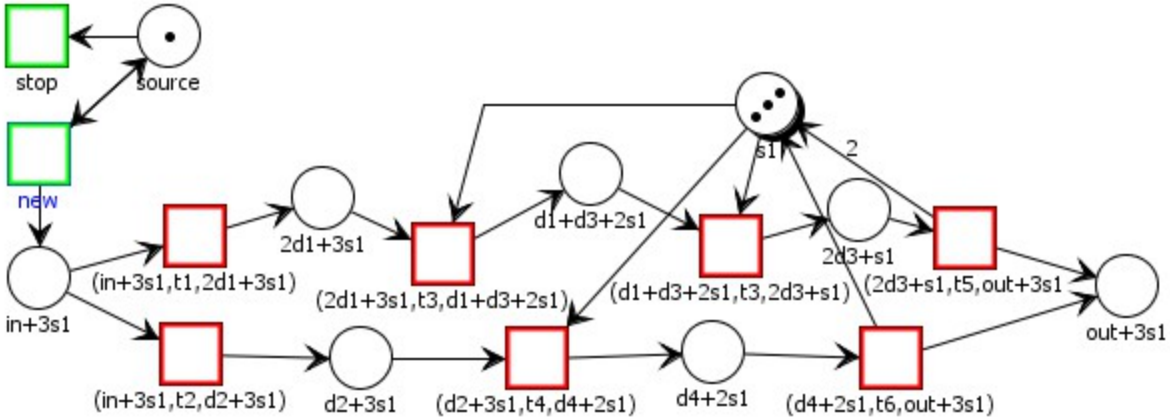
File Edit Draw Element Roles Subnet Help





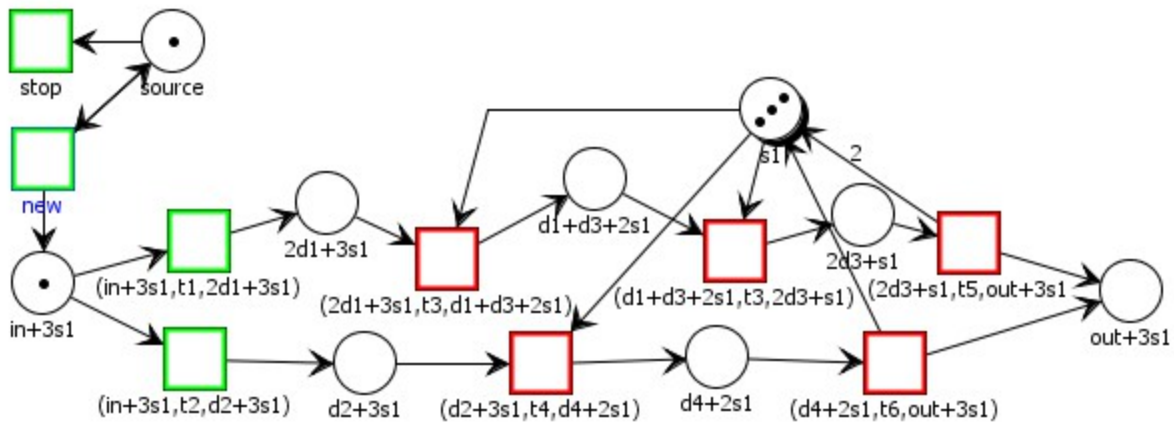
transformed rcwfnet2.pflow - PNEditor

File Edit Draw Element Roles Subnet Help



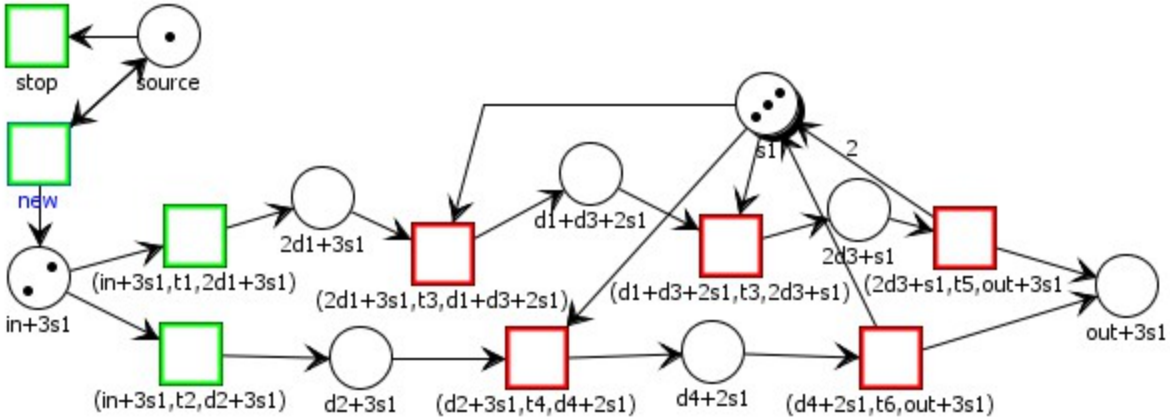
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



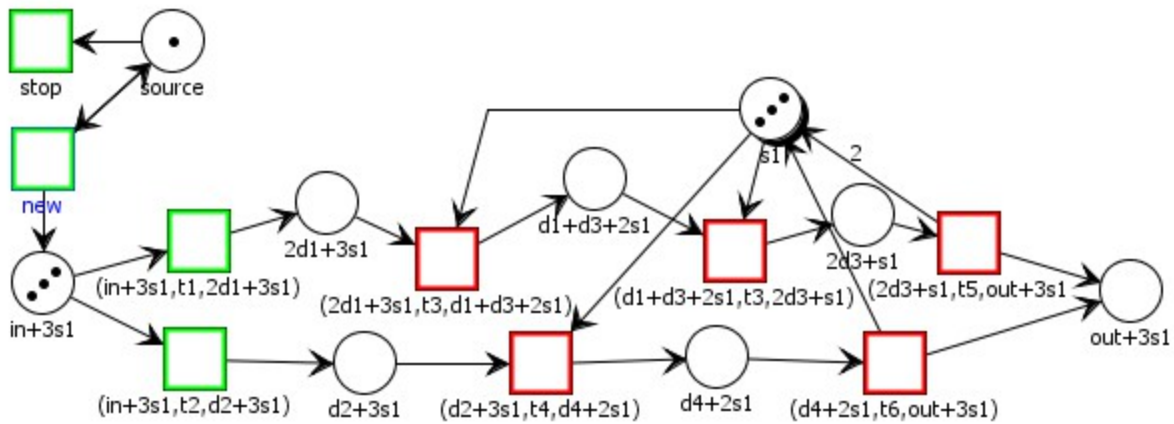
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



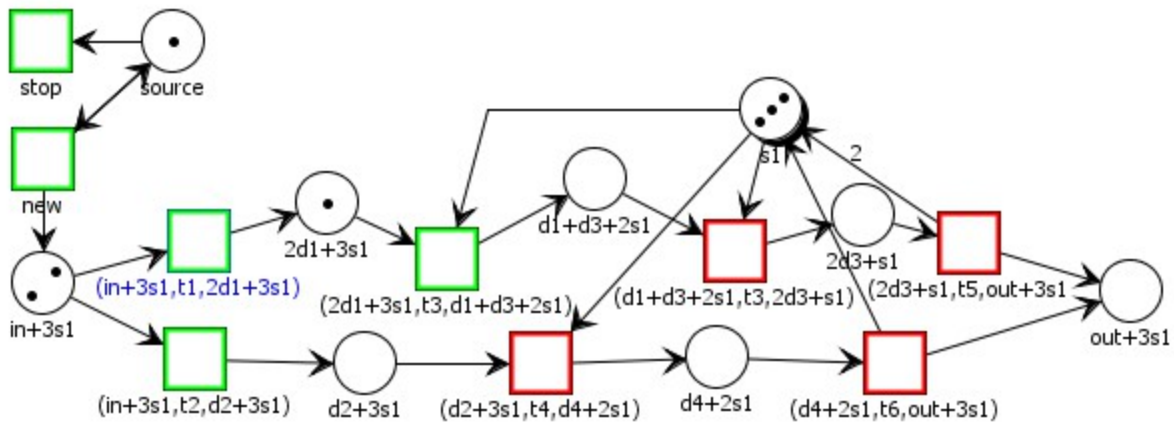
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



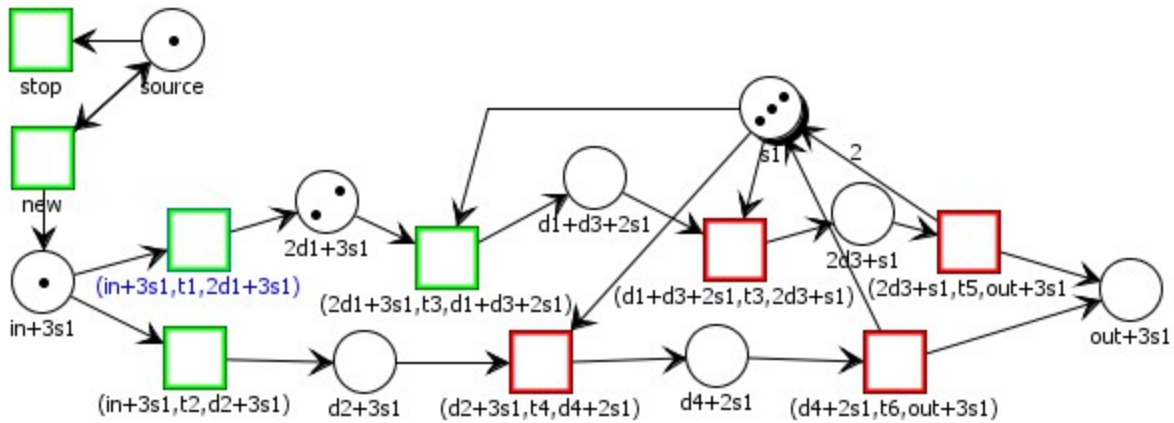
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



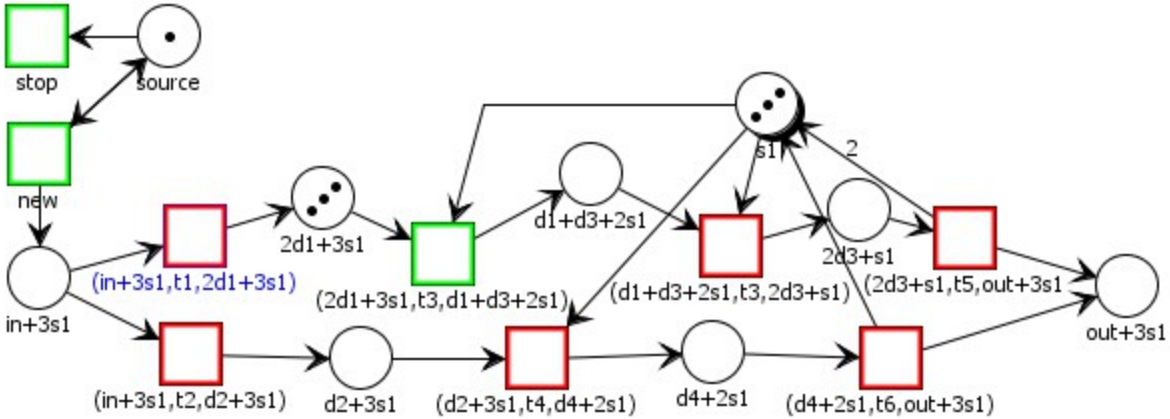
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



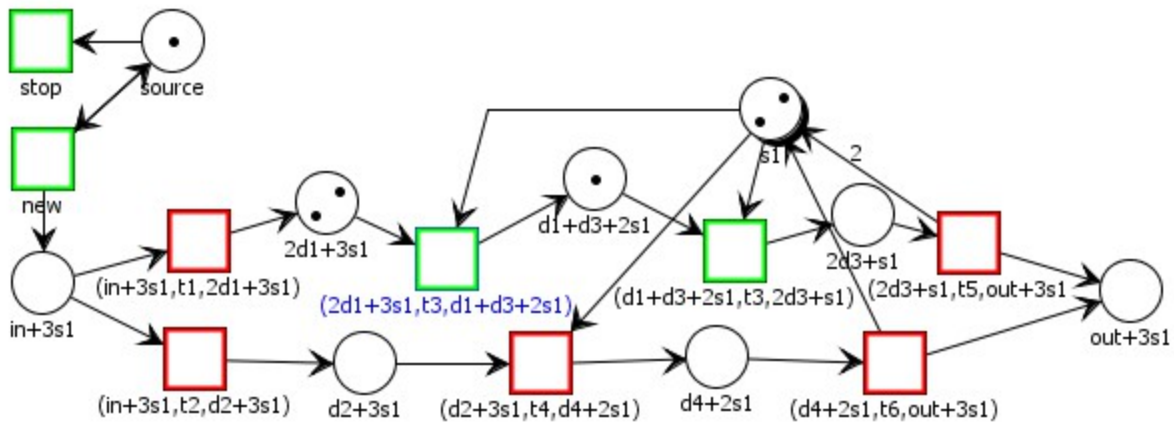
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



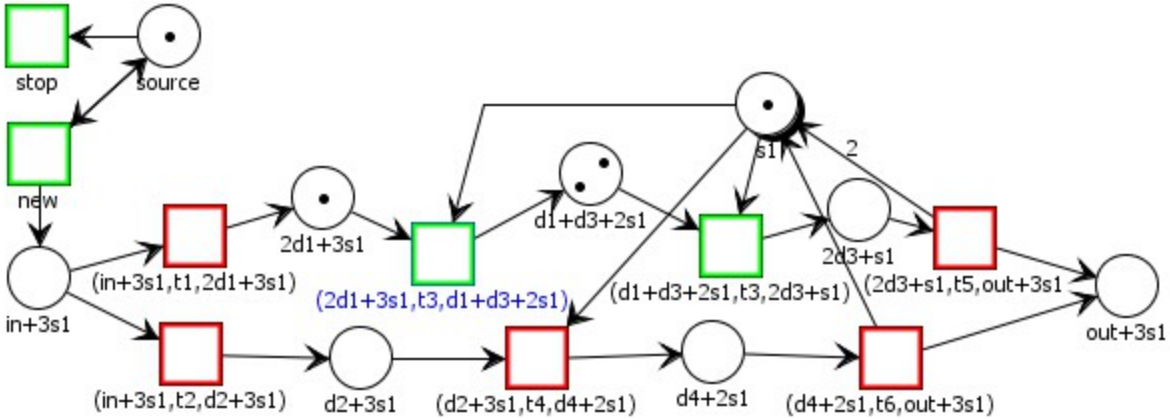
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



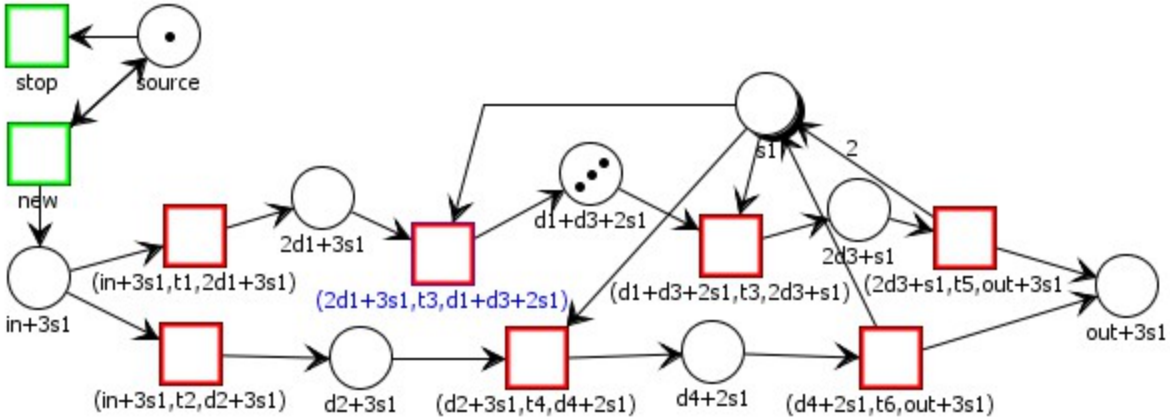
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



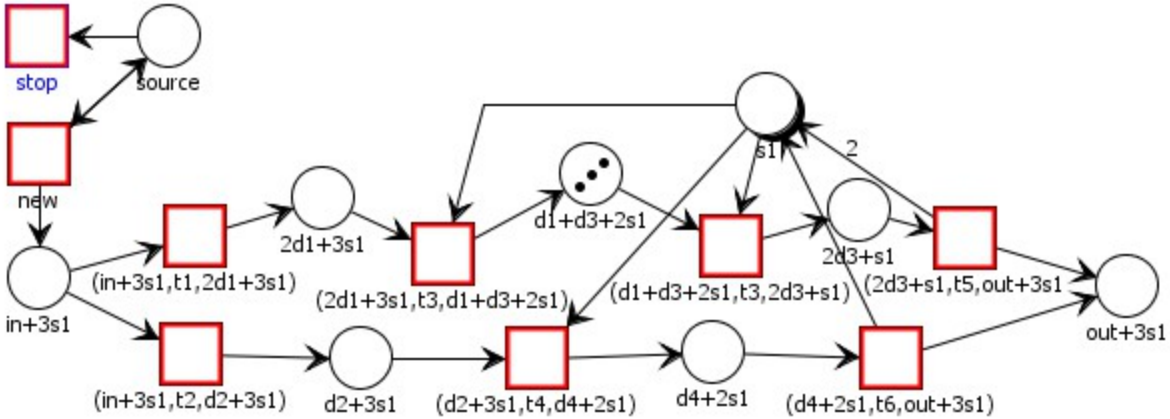
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help

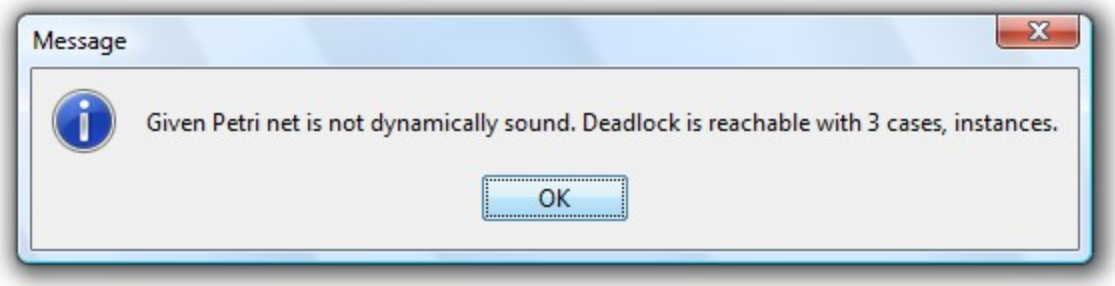


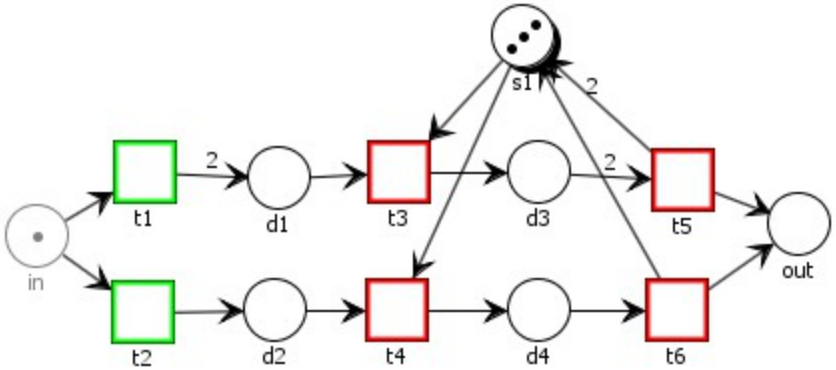
transformed rcwfnet2.pflow [modified] - PNEditor

File Edit Draw Element Roles Subnet Help



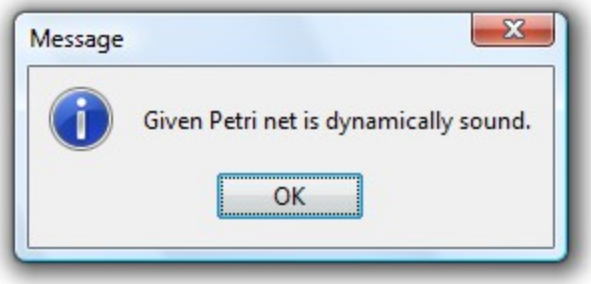
Edit Draw Element Roles Subnet Help

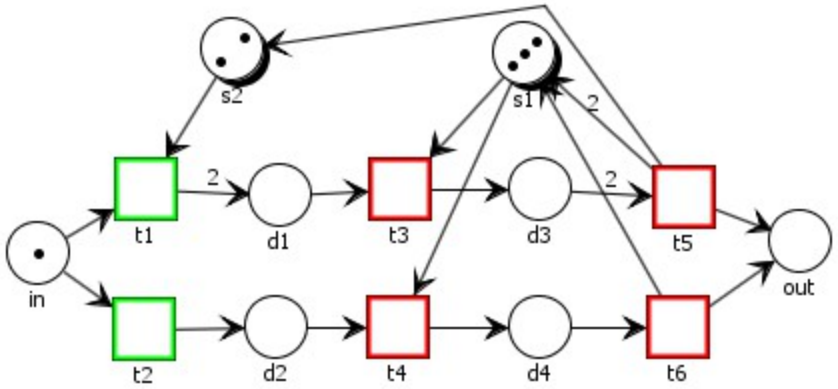




corrected rcwfnet2.pflow - PNEditor

File Edit Draw Element Roles Subnet Help





rcwf net with dangerous place without recovering transition.pflow - PNEditor

File Edit Draw Element Roles Subnet Help

Roles

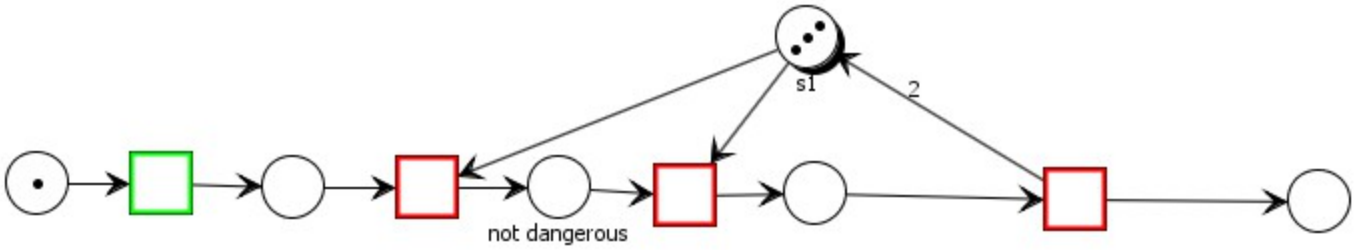
prijem (2)

lekar na izbe (4)

Message

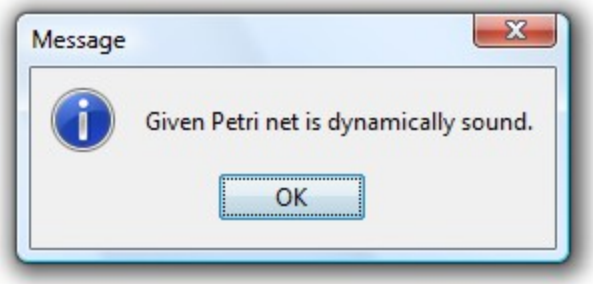
Given Petri net is not dynamically sound. Deadlock is reachable with 3 cases, instances.

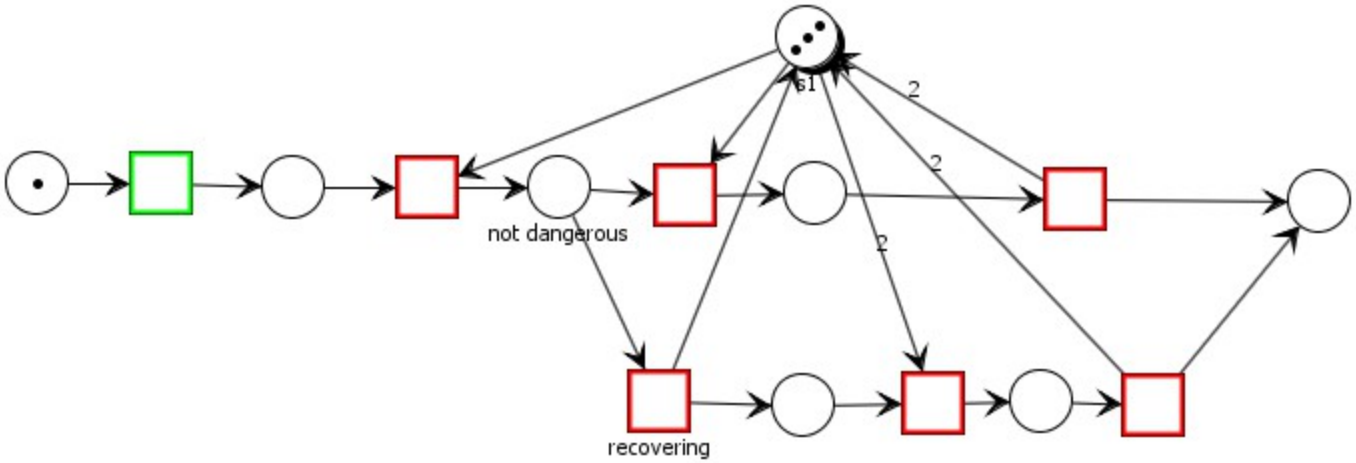
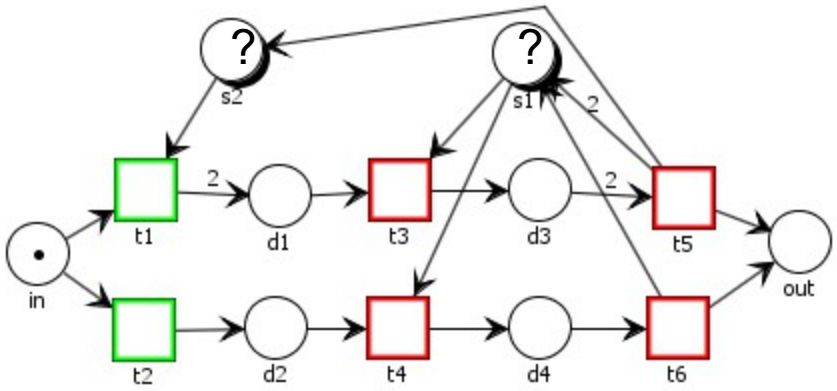
OK



rcwf net with no dangerous place and recovering transition.pflow - PNEditor

File Edit Draw Element Roles Subnet Help





m(s2) < m(s1) ⇔ no instance deadlock
m(s2) >= m(s1) ⇔ instance deadlock for m(s1) instances