Model: IOTPpurchase
Type: P/T Net
Origin: Academic

Abdulmalik Ahmad
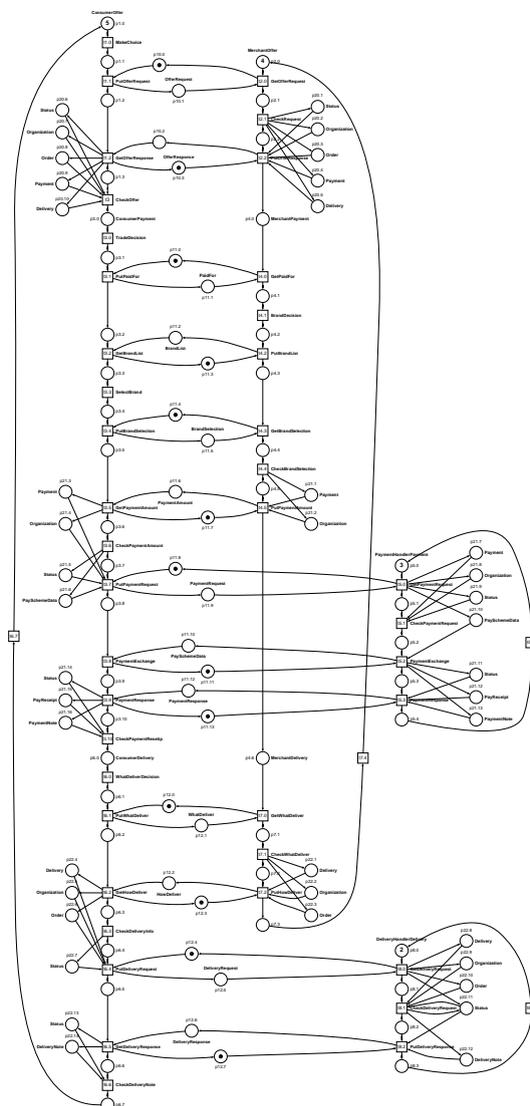aaltofa2000@gmail.com

This form is a summary description of the model entitled "IOTPpurchase" 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

The model specifies the Purchase Transaction of Internet Open Trading Protocol as described in [Z13]. It represents Offer, Payment, and Delivery Trading Exchanges, and reflects IOTP Message structure with distinct Trading Components according to RFC 2801.

In March 2020, Pierre Bouvier and Hubert Garavel provided a decomposition of the only one-safe instance of this model into a network of communicating automata. This network is expressed as a Nested-Unit Petri Net (NUPN) that can be found in the "toolspecific" section of the corresponding PNML file.

Graphical representation for $CO = 5, MO = 4, PH = 3, DH = 2$

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References

[Z13] Zaitsev D.A. Clans of Petri Nets: Verification of protocols and performance evaluation of networks, LAP LAMBERT Academic Publishing, 2013, 292 p.

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
CO, MO, PH, DH	CO is the number of ConsumerOffers; MO is the number of MerchantOffers; PH is the number of PaymentHandlers; DH is the number of DeliveryHandlers.	$(1, 1, 1, 1)$, $(3, 3, 3, 3)$, $(5, 4, 3, 2)$, $(12, 10, 15, 17)$

Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$(1, 1, 1, 1)$	111	45	224	23	1–22–45
$(3, 3, 3, 3)$	111	45	224	–	$--111$
$(5, 4, 3, 2)$	111	45	224	–	$--111$
$(12, 10, 15, 17)$	111	45	224	–	$--111$

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)* .... yes [f]
source place(s) — *one or more places have no input transitions* .... no [g]
sink place(s) — *one or more places have no output transitions* .... no [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* .... no [j]
loop-free — *no transition has an input place that is also an output place* .... no [k]
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] .... ? [o]

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[a] 2 arcs are not simple free choice, e.g., the arc from place "Status_p22_11" (which has 2 outgoing transitions) to transition "CheckDeliveryRequest_t8_1" (which has 5 input places).

[b] transitions "CheckDeliveryRequest_t8_1" and "PutDeliveryResponse_t8_2" share a common input place "Status_p22_11", but only the former transition has input place "Delivery_p22_8".

[c] 36 transitions are not of a state machine, e.g., transition "CheckBrandSelection_t4_4".

[d] place "Status_p22_11" is not of a marked graph.

[e] stated by CÆSAR.BDD version 2.2 on all 4 instances $((1, 1, 1, 1), 3, 3, 3, 3), (5, 4, 3, 2), (12, 10, 15, 17))$.

[f] stated by CÆSAR.BDD version 2.2 on all 4 instances $((1, 1, 1, 1), 3, 3, 3, 3), (5, 4, 3, 2), (12, 10, 15, 17))$.

[g] stated by CÆSAR.BDD version 2.2 on all 4 instances $((1, 1, 1, 1), 3, 3, 3, 3), (5, 4, 3, 2), (12, 10, 15, 17))$.

[h] stated by CÆSAR.BDD version 2.2 on all 4 instances $((1, 1, 1, 1), 3, 3, 3, 3), (5, 4, 3, 2), (12, 10, 15, 17))$.

[i] stated by CÆSAR.BDD version 2.2 on all 4 instances $((1, 1, 1, 1), 3, 3, 3, 3), (5, 4, 3, 2), (12, 10, 15, 17))$.

[j] stated by CÆSAR.BDD version 2.2 on all 4 instances $((1, 1, 1, 1), 3, 3, 3, 3), (5, 4, 3, 2), (12, 10, 15, 17))$.

[k] transition "CheckDeliveryRequest_t8_1" is not loop free.

[l] 25 transitions are not conservative, e.g., transition "CheckBrandSelection_t4_4".

[m] 13 transitions are not subconservative, e.g., transition "CheckBrandSelection_t4_4".

[n] the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.lip6.fr/nupn.php

[o] stated by CÆSAR.BDD version 3.3 to be true on 1 instance(s) out of 4, and false on the remaining 3 instance(s).

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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* ....no [q]
dead transition(s) — *one or more transitions cannot fire from any reachable marking* ....no [r]
deadlock — *there exists a reachable marking from which no transition can be fired* ....no [s]
reversible — *from every reachable marking, there is a transition path going back to the initial marking* ....yes
live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* ....yes

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
$(1,1,1,1)$	204	436	1	22
$(3,3,3,3)$	354,176	1,684,054	3	40
$(5,4,3,2)$	17,406,024	108,419,358	5	51
$(12,10,15,17)$	?	?	17	≥ 67 [t]

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[p] stated by CÆSAR.BDD version 2.2 to be true on 1 instance(s) out of 4, and false on the remaining 3 instance(s).

[q] stated by CÆSAR.BDD version 3.3 on all 4 instances $((1,1,1,1), 3,3,3,3), (5,4,3,2), (12,10,15,17))$.

[r] stated by CÆSAR.BDD version 2.2 on all 4 instances $((1,1,1,1), 3,3,3,3), (5,4,3,2), (12,10,15,17))$.

[s] checked by the Tina http://www.laas.fr/tina tool version 3.3.0 as well as other behavioural properties..

[t] lower bound given by the number of initial tokens.

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