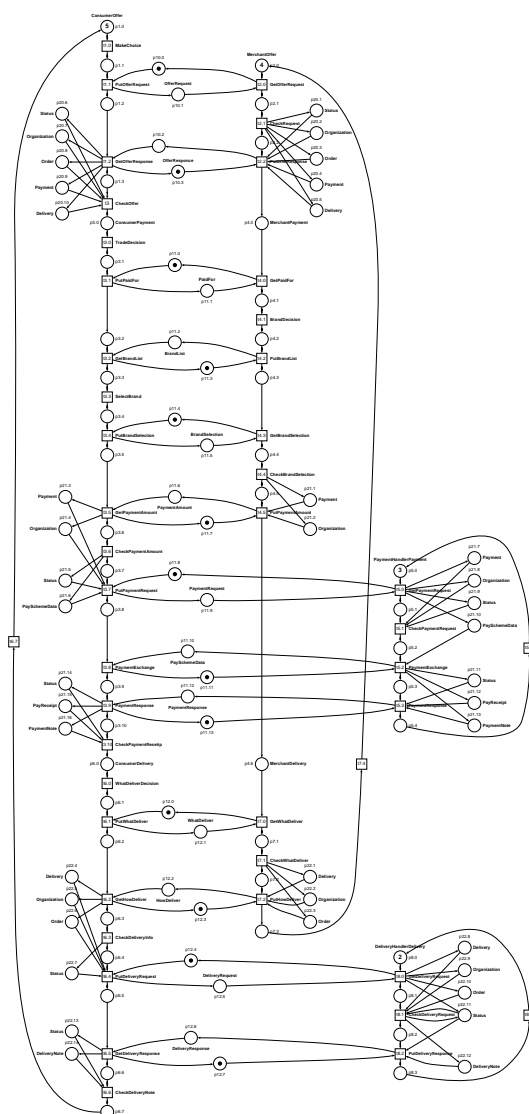


*This form is a summary description of the model entitled "IOTPpurchase" proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, unfolded P/T nets. Models are given together 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.



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

## 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
<i>CO, MO, PH, DH</i>	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

Although the model is parameterized, its size does not depend on parameter values.

number of places: 111  
 number of transitions: 45  
 number of arcs: 224

## Structural properties

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

## Behavioural properties

- safe** — *in every reachable marking, there is no more than one token on a place* ..... ? (o)
- deadlock** — *there exists a reachable marking from which no transition can be fired* ..... ✗ (p)
- reversible** — *from every reachable marking, there is a transition path going back to the initial marking* ..... ✓

(a) 2 arcs are not simple free choice, e.g., the arc from place “p-13F4-CD52-98” (which has 2 outgoing transitions) to transition “t-13F4-C885-8” (which has 5 input places).

(b) transitions “t-13F4-CCDD-83” and “t-13F4-C885-8” share a common input place “p-13F4-CD52-98”, but only the former transition has input place “p-13F4-CDDD-119”.

(c) 36 transitions are not of a state machine, e.g., transition “t-13F4-C875-5”.

(d) place “p-13F4-CD52-98” 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 “t-13F4-C885-8” is not loop free.

(l) 25 transitions are not conservative, e.g., transition “t-13F4-C875-5”.

(m) 13 transitions are not subconservative, e.g., transition “t-13F4-C875-5”.

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

(o) 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).

(p) Checked by the Tina <http://www.laas.fr/tina> tool version 3.3.0 as well as other behavioural properties..

**quasi-live** — for every transition  $t$ , there exists a reachable marking in which  $t$  can fire ..... ✓<sup>(a)</sup>  
**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
(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	?

<sup>(a)</sup> stated by [CESAR.BDD](#) version 2.2 on all 4 instances ((1, 1, 1, 1), (3, 3, 3, 3), (5, 4, 3, 2), (12, 10, 15, 17)).