Modular Nets and Object Nets: A Unifying View[1]

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Modular nets and object nets have been considered independently by two authors [Wik90], [Whi91], [Wik92], [Whi93]) using essentially the same basic idea but exploiting different methods and achieving different results.

In the given contribution, after a brief overview of the main ideas, proposals will be made to unify the terminology of both approaches on one hand and on the other hand to extend them to the case of nets with the strict firing rule.

Generally, we distinguish between two ways of construction of modular nets (MN):

First, an MN can be obtained from a set of given Petri nets (*net modules*, with certain nodes defined as input and output *ports*) by *composition*. Second, the structure of a given Petri net can be enhanced by decomposition into subnets (net modules) which are generated by the definition of certain nodes as input and output ports.

In both cases the construction procedure ensures that *conflicts* between transitions of the global net may arise only between those which are in one net module. This property of net modules (encapsulation of potential conflicts) is used to define them as a new type of locality in nets (next higher to places and transitions), and to characterize their external behaviour by an abstraction from its internal structure. This new type of net entities, achieved by encapsulation and concealment of net modules, has been called *object* and the nets composed of such entities *object nets* (ON).

Concerning the principle of abstraction, the approaches do differ fundamentally:

One approach, called *port logical system* [Whi93]), defines the abstraction from internal behaviour by so-called (input and output) *port formulae* and *net inference rules.* As a consequence, given a *link relation* for a set of net objects, the behaviour of a composite object net can be derived (composed) from port formulae, the net inference rules and the *link inference rules*. Thus, behavioural compositionality has been achieved for safe Petri nets with the usual "may"-firing rule.

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The other approach, *Markovian object nets* (MON), is aimed at a Markovian abstraction from the internal behaviour of net modules. It is assumed that the internal transitions of the net modules are governed by the "must"-firing rule and conflicts between sets of concurrently enabled transitions are solved according to given probabilities. Therefore, its behaviour is characterized by discrete-time Markov chains whose transition matrices may be obtained from net structure and given probabilities. Due to the fact that all conflicts which may arise in the corresponding Petri net are encapsulated by the net objects, they may be solved locally. Therefore, MONs allow a truly concurrent modelling and simulation.

It has been shown that MONs, in contrast to other stochastic net models, allow a unified quantitative and qualitative evaluation of distributed software systems [HVW93].

So far, the shape of net modules and objects has been strongly influenced by the weak firing rule for Petri nets. Thus, transitions are "tightly coupled" with their preplaces but not with their postplaces and therefore all input nodes of a net module or object are places and all output nodes are transitions.

If, on the other hand, the *strict firing rule* is applied (i.e. due to place capacities backward conflicts may arise), conflict clustering leads to a different shape of net modules. In this case all input and output nodes (ports) of net modules are transitions and the modules are connected with one another by places which have exactly one input arc and one output arc. As a consequence of the strict firing rule these places are "shared" between their predecessor and their successor modules.

This latter type of modules has been successfully applied in a practical project for hierarchical composition and decomposition of net models. The generalization of the MON approach to this case seems to be straightforward, whereas the applicability of the port logical system approach is still an open question.

References

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