TINA - a tool for analyzing paths in TPNs

Louchka Popova-Zeugmann
Sebastian Marek

Humboldt-Universität zu Berlin, Institut für Informatik,
Unter den Linden 6, D-10099 Berlin, e-mail: {popova,markek}@informatik.hu-berlin.de

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Abstract

One of the most adequate ways of modeling and analyzing concurrent systems with an infinite state space is given by the theory of Petri nets. For studying systems in which local time dependencies between actions are relevant, a large variety of time dependent Petri nets have been defined and widely applied. In the following, Time Petri Nets (TPNs) introduced by Merlin [2] will be considered.

TPNs are classical Petri nets in which to each transition t a time interval $[a_t, b_t]$ is additionally assigned, where a_t and b_t are relative to the time which t was last enabled. When t becomes enabled it can not fire until a_t time units have elapsed, and it must fire no later than b_t, unless t is disabled by the firing of another transition. Firing a transition takes no time. Thus, the basic idea of this kind of time dependent Petri nets is as following: when a transition becomes enabled it may (in general) not fire at once but only during a certain time interval, and at the end of that interval, firing is compulsory. However, if the interval is not bounded above then the second characteristic, the obligation to fire, disappears.

In general, there is no relation between the behaviour of a TPN and its skeleton (i.e. the the net structure without time restrictions). Thus, choosing time intervals does not only determine the quantitative behaviour of the net, but may also be critical for its qualitative aspects. For systems which are modelled with TPNs an analysis can be done in order to improve their reliability (cf. [1]).

Conversely, the question arises: under which time restrictions prescribed qualitative and/or quantitative properties can be fulfilled. In [3] it is shown, that in a given Petri Net (PN) time intervals can be computed for each transition such that

- a given transition sequence which is enabled in the PN remains enabled in the TPN and
- a feasible branch in the PN becomes non-feasible in the TPN.

To solve these problems without actually calculating state spaces one can use methods of linear programming (cf. [3]).

TINA - time INA (cf. [4]) - is a tool for

- editing a TPN as a pnt-file
- solving the following problems with respect to a given transition sequence α in a TPN existing as a pnt-file:
  1. assuring that the sequence can be executed
  2. assuring that prescribed deadlines for the given sequence are met,
  3. assuring that prescribed minimal time duration of the sequence is observed,
  4. checking whether a realization of α with a prescribed time duration exists,
  5. finding time restrictions which ensure that prescribed (dead) states in the system become unreachable.

The tool is written in C++ and it is running under UNIX.

References

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[2] P. Merlin. *A Study of the Recoverability of Communikation Protocols*. PhD thesis, University of California, Computer Science Dept., Irvine, 1974.

[3] L. Popova-Zeugmann. On Parametrical Sequences in Time Petri Nets. In H.-D. Burkhard, L. Czaja, and P. Starke, editors, *Proceedings of the CS&P'97 Workshop*, pages 105–111, Warsaw, 1997.

[4] P. H. Starke. *INA - Integrated Net Analyzer*. Berlin, 1997. Manual.