

Exercises on Coloured Petri Net Modelling

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The exercises below are concerned with CPN modelling and the aim is to make a number of modifications and extensions to the CPN model of the simple protocol described in Chapter 2 of [1]. The exercises are to be solved using CPN Tools.

It is recommended to work on the exercises in the order listed below. Use interactive and automatic simulation of the CPN models to validate that the modified models work as desired.

Exercise 1: Reception of Acknowledgements

When an acknowledgement is received by the sender, it updates the counter on the place NextSend according to the number contained in the acknowledgement. This implies that the counter on NextSend can be decreased when an "old" acknowledgement is received.

Use simulation to demonstrate a scenario where this situation occurs. Modify the CPN model such that the counter on NextSend will never be decreased.

Exercise 2: Bounded Retransmission

The CPN model of the simple protocol specifies no bound on the number of times that a packet can be transmitted.

Modify the CPN model such there is a bound on the number of times that a given packet can be retransmitted.

Exercise 3: Network Loss Rate

The CPN model of the simple protocol uses a Boolean variable *ok* to model the loss of packets and acknowledgements. If we assume that all enabled binding elements of a transition have equal probability of being chosen, this means that there is a 50 % probability of packet loss.

Modify the CPN model such that a packet loss rate of 10%, 20%, 30%, 40% etc. can be modelled.

Exercise 4: Packet Generation

The initial marking of the place PacketsToSend specifies six packets that are to be transmitted by the protocol. When modelling the sliding window protocol in Exercise 5 more packets will be required to explore the model.

Modify the CPN model of the simple protocol such that there is a transition that adds a packet to PacketsToSend whenever it occurs. The i 'th packet should be given sequence number i and the data content " i ". The latter makes it easy to check that the packets are accepted in the correct order by the receiver.

Exercise 5: Sliding Window Protocol

The simple protocol is a stop-and-wait protocol: The sender keeps sending the same packet until the matching acknowledgement is received. In *sliding window protocols*, it is possible for the sender to transmit several packets to the receiver before receiving an acknowledgement.

Modify the CPN model such that it models a sliding window protocol. It should only be necessary to modify the sender part of the CPN model.

References

[1] K. Jensen and L.M. Kristensen: Coloured Petri Nets – Modelling and Validation of Concurrent Systems. Draft manuscript. August 2005.