Bounded Retransmission Protocol (SPIN 2009/STTT)

AVACS S3
Phase 2

July 28, 2011

1 Description of the protocol

In the bounded retransmission protocol, a file to be sent is divided into N chunks. For each of these chunks, the number of allowed retransmissions is bounded by MAX. There are two lossy channels K and L for sending data and acknowledgements respectively. The model is a Parametric Markov Decision Process (PMDP) with two parameters p_K and p_L denoting the reliability of the channels K and L respectively. We implemented this model in $PARAM$ 2.0α [1] to answer the question: "What is the maximum reachability probability that eventually the sender does not report a successful transmission?".

2 Results

Statistics for several different instantiations of N and MAX are given in Table 1. The upper table states the number of states and transitions of the optimization of the original model. The column "Nd.Vars" gives the number of variables introduced additionally to encode the non-deterministic choices. As can be seen in the middle table, applying weak bisimulation reduces the state-space and the number of transitions drastically. The last column of the lower table gives the probability for $p_K = 0.98$ and $p_L = 0.99$, as the one in the $PRISM$ model. We observe that for all instances N and MAX, with an increasing reliability of channel K the probability that the sender does not finally report a successful transmission decreases. We give only running time if the optimisation is used. Otherwise, the algorithm does not terminate within one hour. Notably, we encode the non-deterministic choices via additional variables and apply the algorithm for the resulting parametric MC's. This approach may suffer from exponential enumerations in the number of these additional variables in the final rational function. However, the method works quite well in this case study. This is partly owed to the fact, that after strong and weak bisimulation on the encoding parametric Markov chain, the additional variables vanish.

References

[1] Ernst Hahn, Holger Hermanns, and Lijun Zhang. Probabilistic Reachability for Parametric Markov Models. *STTT*, pages 1–17, 2010.

N	MAX	Build(s)	Model		
			States	Trans.	Nd. Vars
64	4	2	8551	11564	137
64	5	2	10253	13916	138
256	4	4	33511	45356	521
256	5	4	40205	54620	522
512	4	12	66792	90412	1035
512	5	10	80142	108892	1036

N	MAX	Build(s)	Weak Bisimulation	
			States	Trans.
64	4	2	643	1282
64	5	2	771	1538
256	4	4	2563	5122
256	5	4	3075	6146
512	4	12	5123	10243
512	5	10	6147	12291

N	MAX	Build(s)	Lump (s)	Elim. (s)	Mem (MB)	Result
64	4	2	3	0	6	1.50E-06
64	5	2	3	0	6	4.48E-08
256	4	4	48	6	19	6.02E-06
256	5	4	58	8	22	1.79E-07
512	4	12	230	35	52	1.20E-05
512	5	10	292	52	56	3.59E-07

Table 1: Performance Statistics for Bounded Retransmission Protocol