

Desco – a Tool for Education and Control of Discrete Event Systems

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Within the Control and Automation Laboratory at Chalmers, there has been developed a software suite to facilitate the manipulation of state automata and Petri nets for supervisor calculation (among other things). This suite of software tools includes a graphical automata/Petri net drawing tool, a commandline based automata/Petri net manipulation tool and a graphical visualisation tool. The two first tools (jointly named Desco, for *Discrete Event Systems COntroller*), consisting of the N'gin (that is, the mathematical manipulation engine) and the GUI (the graphical user interface) have been developed at the Control and Automation Laboratory. The third tool is a general graph drawing software, GrapViz, from AT&T research (see <http://www.research.att.com/sw/tools/graphviz/>) which is closely integrated with Desco.

The software suite is used in a course in "Control and Communication Systems" (Fabian (1999)) which is offered to the third year Automation Engineering students (it is compulsory, in fact). The course introduces the basic supervisory control theory with examples from manufacturing and batch processing industries, as well as communication protocols. Desco allows modelling of such systems, as both state automata and Petri nets in a comprehensible way. Arbitrary strings may label any element (automaton, Petri net, state, place, transition and event). This facilitates a mapping of the real-world concepts to the abstract elements. In addition, through the integration with GraphViz, Desco has the ability to visualise the results of the various manipulations, both the end result and intermediate results. For instance, the synchronous composition of two state machines is elegantly presented graphically as a new state machine, by a single command from Desco. Herein lies the educational strength of our software suite. From our

experience, sensible labelling and graphical presentation of results significantly raises the level of understanding.

In another context, Desco has also been used to control a number of industrial systems, by executing the supervisor (represented as a state machine) in synchrony with the plant. Åkesson (1999) describes an application where Desco adds supervisory control to a commercial batch control system, Satt Batch. The recipes that Satt Batch executes can be loaded by Desco and converted to statemachines. From this, a maximally permissive supervisor is generated and executed in synchrony with the batch control system. At each stage Satt Batch asks Desco for the possible resources to claim for a specific recipe. Desco replies with a set of resources guaranteed to keep the system safe and live, and Satt Batch chooses one of these and informs Desco of its choice. Thus, synchronisation is achieved.

Losito (1999) concerns an application where Desco controls and coordinates spot-welding robots of a work-cell at a car manufacturing plant. The robots compete for common resources, which in this case involves the spatial resources formed by the division of the workspace. The robot programs are modelled as "recipes", converted to statemachines and compose with the resource models. From this a supervisor is automatically synthesised. During execution the PLC cell controller asks for permission to access a single resource and Desco simply replies "yes" or "no".

In both applications, Desco communicates with the plant through the Manufacturing Message Specification (MMS (1990)). In both applications the choice of resource is arbitrary, but work is underway to integrate optimisation into Desco, see Liljenvall (1998).

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