Coupling of numerical and symbolic MOR techniques

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Besides purely numerical model order reduction methods there also exist symbolic ones, which are indeed costly to compute, but particularly for nonlinear DAEs they additionally allow a deeper insight into the functional relations between the circuit's components. Some symbolic methods for model order reduction will be presented.

However, the development during the last years, in particular the growing miniaturization and integration density of integrated circuits, shows that model descriptions based on DAEs have almost reached their limit and cannot model the occuring physical effects accurately enough. Thus, supplementary model descriptions based on PDEs are necessary. For discretized PDEs, dedicated numerical MOR techniques, e.g. reduction via the Arnoldi algorithm, already exist.

Further, by standard graph theoretical methods like, e.g., modified nodal analysis for transforming the circuit netlist into an equation system, the structure information of the in general hierarchical system is lost. Therefore a modelling approach is aspired that transmits this information into the set of equations. Thus, subsystems of the circuit can be reduced separately either with numerical or symbolic methods, according to their complexity level, and finally be combined to a reduced overall system. This approach intuitively facilitates the overall circuit's analysis.

An appropriate workflow that permits the exploitation of the circuit's hierarchical structure will be presented; starting with a circuit, a decomposition into subsystems will be made such that numerical or symbolic methods for the reduction of adequate subsystems are applicable. Because the already existing symbolic methods (in Analog Insydes) cannot be applied directly, a method to set up the subsystems for the use of these methods has been developed and will be presented. Furthermore, a procedure to transform a linear (linearized) subsystem into state space form is used to prepare it for appropriate numerical MOR methods. Finally, all the presented methods will be applied to some examples.