Model based approach for design and analysis of systems has made great advances in the last decade. Model driven system development methodologies like model integrated computing (MIC) allow integration and manipulation of models with manageable complexity in various aspects of system design. Model based approach is used in embedded system design and analysis in order to integrate efforts in system specification, design, synthesis, validation, verification and design evolution. Mathematical models like hybrid automaton are used for analysis of embedded systems, which have tightly coupled discrete and continuous components. In order to perform design and analysis for hybrid systems, various approaches have been developed to explore hybrid state space. However, model checking algorithms designed using these state exploration techniques are constrained with the implementation details of the computation tools and that limits the creation of algorithms for some specific design and analysis purposes.

This thesis presents a metamodel based language and a computation platform for designing hybrid system models and designing analysis algorithms as models that are generic and implementation independent. The metamodel based modeling language provides well-defined abstract concepts such as continuous state sets, operators for reachability computation, and Boolean operations on state sets. This language uses multiple aspects to separate the concerns of analysis algorithms into programming logic, system models, and related data. On one hand, the models of analysis algorithms are abstract and therefore the design of algorithms can be made independent of implementation details.
On the other hand, translators are provided to automatically generate implementations from the models for computing analysis results based on computation kernels, which have been created by enriching the capabilities of existing computation tools such as d/dt and Level Set toolbox. This platform forms an integral part of a prospective integrated suite of tools that would be used in every step of model based design of embedded systems all the way from specification to production.