Modeling Real-time Systems

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Modeling real-time systems raises non trivial problems for the definition of usable modeling languages and the application of model-based development approaches.

We identify key problems and present corresponding research directions for the incremental construction of timed models for real-time systems.
 We present a framework that may provide some solutions and an associated methodology for model construction. Timed models of real-time systems are obtained by adding timing constraints to their application software. These constraints take into account execution times of atomic statements, the dynamics of the external environment, as well as quality of service requirements. The framework combines two kinds of composition operators for timed components:

- Restriction operators which are unary operators parameterized by a safety property. Their application on a component restricts its behavior so as to meet the associated property. Dynamic priorities correspond to a class of restriction operators which preserve deadlock-freedom of their arguments.

- Parallel composition operators, parameterized by interaction models. These models describe interactions between actions offered by the composed components and their associated synchronization requirements.

We show that the combination of parallel composition and restriction operators allows compositional modeling of real-time systems, in particular of aspects related to heterogeneous interaction and execution, resource sharing and scheduling. Scheduling policies are modeled by dynamic priorities. The framework supports composition of scheduling policies and provides compositionality and composability results for deadlock-freedom of scheduled systems.

We show applications of these results, including model-based development of applications in Esterel and real-time Java, as well as a partial implementation of the framework in Verimag's IF toolset.

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