

Title: Component-based modeling of real-time systems

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Description: We present a framework for the construction of timed models for real-time systems, encompassing the following:

- **composition of heterogeneous components.** Two deep sources of heterogeneity are identified: 1) heterogeneity of interaction and 2) heterogeneity of execution.
- compositionality and composability rules for **correctness-by-construction** with respect to generic properties such as deadlock-freedom, timelock-freedom and liveness.
- **incremental construction.** This is achieved by using a single associative composition operator.

In the framework, component models consist of three distinct layers. The first layer describes the component's behaviour. The second layer is an interaction model which defines the possible interactions of the component. The third layer is a scheduler which applies a scheduling policy so as to meet given QoS requirements. The composition of two components is obtained by composing separately the corresponding layers.

We show how the proposed framework can be applied to build models of real-time systems. These are obtained by compositionally adding timing constraints to components of 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.

We illustrate applications of these results by using the IF modeling toolset of Verimag on which the framework has been partially implemented.

Further reading from <http://www-verimag.imag.fr/~sifakis/>:

- Joseph Sifakis "Modeling real-time systems--challenges and work directions" EmSoft01, LNCS 2211, Tahoe City, October 2001.
- J. Sifakis, S. Tripakis, S. Yovine "Building models of real-time systems from application software" Proceedings of the IEEE, Special issue on modeling and design of embedded systems, 91(1):100-111, January 2003.
- K. Altisen, G. Goessler, J. Sifakis "Scheduler modeling based on the controller synthesis paradigm" Journal of Real-time Systems, Vol. 23, pp.55-84, 2002.
- E. Closse, M. Poize, J. Pulou, J. Sifakis, P. Vernier, D. Weil S. Yovine " TAXYS : a tool for the development and verification of real-time embedded systems " CAV01, LNCS 2102, Paris, July 2001.
- C.Kloulinas, C. Nakhli, S. Yovine "A methodology and tool support for generating scheduled native code for real-time java applications" EmSoft03, LNCS 2855, pages 274-289. Philadelphia, October 2003.
- G. Goessler, J. Sifakis. "Composition for Component-Based Modeling" Science of Computer Programming, vol. 55, pp. 161--183 (March 2005)
- G. Goessler, J. Sifakis. Priority Systems, Proceedings of FMCO'03, November 2003, Leiden, the Netherlands, LNCS 3188, pages 314-329.
- The IF toolbox <http://www-verimag.imag.fr/~async/IF/index.shtml.en>