Fault Effect Modeling in a Heterogeneous SystemC Virtual Platform Framework for Cyber-Physical Systems (WiP)

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Categories and Subject Descriptors
C.4 [Performance of Systems]: Fault-tolerance

1. INTRODUCTION

Cyber-physical and embedded systems applications, such as real-time control, are increasingly implemented on SW-intensive architectures. Today, electronic system level design flows [6] for such systems are typically model-based and platform-based, that is, development starts from a specification model of the application which needs to be mapped to a platform of generic and custom intellectual property components. Virtual platforms enable early software development and estimation before the actual platform is available by providing execution environments based on more or less abstract models. However, appropriate cyber-physical system methodologies must provide a holistic approach for the application, the platform, and the physical environment.

![Heterogeneous multilevel virtual platform](image)

Figure 1: Heterogeneous multilevel virtual platform.

2. VIRTUAL PLATFORM/FEM APPROACH

We present an advanced eight levels spanning SystemC [3] based virtual platform methodology and framework – referred to as HeroeS [3] – providing smooth application to platform mapping and continuous co-refinement of a virtual prototype with its physical environment model (see Fig. 1). For heterogeneity support, various SystemC extensions are combined covering continuous/discrete models of computation and different communication abstractions, such as analog mixed-signal models [5], abstract RTOS/HAL/middleware models [5], TLM bus models, and QEMU wrappers [2].

We enable dependability assessment by Fault Effect Modeling (FEM) at the virtual prototype in order to avoid risking physical injury or damage. Also, simulation results are deterministic and can be evaluated interactively or offline. We apply FEM to both the physical environment model and the different abstractions of the virtual prototype. Currently, we focus on sensor failures and application control flow errors.

3. CASE STUDY: AUTOMOTIVE CPS

First experiments were conducted on a fault-tolerant fuel control system example. For this, we developed a prototypic interface with a commercial AUTOSAR tool chain [1], that is, tools for system integration, code generation and experimentation. We considered two FEM use cases: (i) robustness/stress testing of the system under test and (ii) qualification of the test environment through mutation analysis.

4. ONGOING WORK

In the context of the recently launched research project Ef- fektiV our efforts focus on modeling/simulating the activation and propagation of run-time environment faults to errors and failures in the virtual prototype. For this, we will investigate real fault data from motion control case studies being provided by our industry partners Siemens and Bosch.

5. REFERENCES