A Family of Testbenches to Support Testing of Real-Time Avionics Systems

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Real-time avionics (RTA) systems are subject to strict requirements to functionality, dependability and real-time operation. To ensure fulfillment of these requirements, systematic testing of an RTA system is performed on different phases of RTA system development. In this paper we focus on the problems of testing of an RTA system as a hardware/software system, involving the software running on the target hardware, and present the tools for solving these problems.

Figure 1 shows a typical V-model of the RTA system's software lifecycle. Testing activities are performed on the phases shown on the right side of the "V" shape. While unit testing of RTA system software can be performed on instrumental computers, integration and acceptance testing, as well as testing of series-produced RTA systems, necessarily involve the real target hardware.

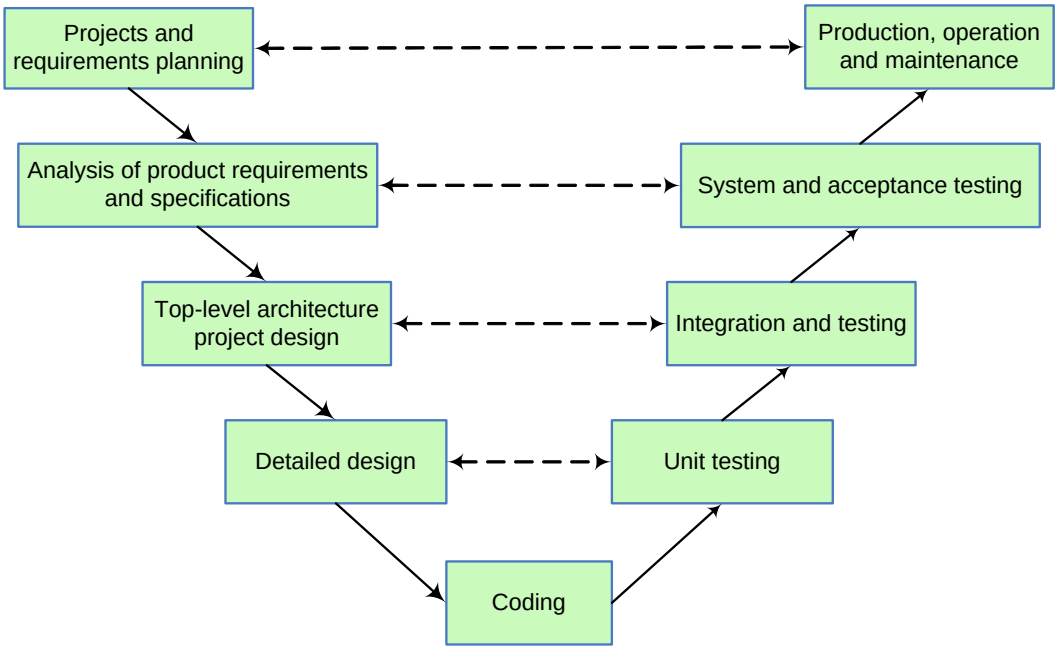

Fig. 1. The RTA system's software lifecycle V-model

General-purpose functional testing tools, such as Rational Test RealTime [1] or VectorCAST [2], require instrumentation of the RTA system's software to support testing the application software on the target hardware. Instrumentation includes loading of auxiliary software modules to the target hardware, which is incompatible with integration testing and acceptance testing.

In this paper we present a toolset which supports target hardware-based testing of RTA system's software, and a family of testbenches based on this toolset. The toolset is developed in the Computer Systems Laboratory (CS Lab) of Computational Mathematics and Cybernetics Department of Lomonosov Moscow State University, and is utilized by Sukhoi Design Bureau for testing of modern avionics systems.

The paper begins with a brief analysis of the RTA system testing specifics on different development phases. Requirements to the tools for functional testing of RTA systems are derived from these specifics. Two general-purpose functional testing tools are analyzed for meeting these requirements, with emphasis on target hardware-based testing. The testing toolset under consideration is introduced, with its software architecture and main features. Common architecture of the testbenches based on this toolset is described. A family of testbenches is presented, each testbench aimed at a specific phase of RTA system development. Methodological aspects of application of these testbenches on appropriate RTA system development phases are discussed.

The presented testing toolset is based on the hardware-in-the-loop technology described in [3]. The testbenches also utilize the channel monitoring tools introduced in [4].

The paper is concluded with description of the future work on the considered testing technology, such as support of declarative description of tests, and automatic analysis of exchange sequences recorded on channels for conformance to the reference schedules.

[1] IBM (2011) Embedded software test automation framework – IBM Rational Test RealTime. http://www-01.ibm.com/software/awdtools/test/realtime/. Accessed 17 December 2012

[2] Vector Software (2011) How to Improve Embedded Software Unit/Integration Testing with Automation. http://www.vectorcast.com/testing-solutions/unit-integration-embedded-software-testing.php. Accessed 17 December 2012

[3] Balashov V.V., Bakhmurov A.G., Chistolinov M.V., Smeliansky R.L., Volkanov D.Y., Youshchenko N.V. (2010) A hardware-in-the-loop simulation environment for real-time systems development and architecture evaluation. Int. J. Crit. Comput.-Based Syst. 1, No. 1/2/3:5–23

[4] Balashov V.V., Balakhanov V.A., Bakhmurov A.G., Chistolinov M.V., Shestov P.E., Smeliansky R.L., Youshchenko N.V. (2011) Tools for monitoring of data exchange in real-time avionics systems. Proc. European Conference for Aero-Space Sciences (EUCASS), 2011.