Chapter 10
Independent Verification and Validation of FPGA-Based Design for Airborne Electronic Applications

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ABSTRACT

Field programmable gate arrays (FPGAs) are finding increasing number of applications in high integrity safety critical systems of aerospace and defence industry. Though FPGA design goes through various development processes, it is widely observed that the critical errors are observed in the final stages of development, thereby impacting time and cost. The risk of failure in complex embedded systems is overcome by using the independent verification and validation (IV&V) technique. Independent verification and validation (IV&V) of FPGA-based design is essential for evaluating the correctness, quality, and safety of the airborne embedded systems throughout the development life cycle and provides early detection and identification of risk elements. The process of IV&V and its planning needs to be initiated early in the development life cycle. This chapter describes the IV&V methodology for FPGA-based design during the development life cycle along with the certification process.

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INTRODUCTION

Complex custom micro-coded components are becoming increasingly popular for use in high integrity safety critical systems. These complex custom micro-coded components include Application Specific Integrated Circuits (ASIC), Programmable Logic Devices (PLD), Field Programmable Gate Arrays (FPGA), or similar electronic components used in the design of aircraft systems. The extensive use of these Complex custom micro-coded components results in development and certification challenges. Hence, it's necessary to overcome these challenges to ensure that the potential for design errors is addressed in a more consistent and verifiable manner during both the development and certification phases.

Field Programmable Gate Arrays (FPGAs) are becoming more popular for use within high integrity and safety critical systems. FPGAs contain millions of programmable logic cells, which can be configured for a wide variety of tasks, and offer many benefits over traditional micro-processors, such as efficient parallel processing and very predictable performance.

FPGAs are configured using a Hardware Description Language (HDL), such as the VHDL (VHSIC Very High Speed Integrated Circuit Hardware Description Language), Verilog and System C to describe the required logic. This is converted into a configuration file which is loaded onto the FPGA device. DO-254 (RTCA/DO-254, 2000) guideline provides design assurance guidance for the development of airborne electronic hardware such that it shall safely performs its intended function, in its specified environments. However, DO-254 guideline is applicable to Line Replacement units, Circuit Board Assemblies, Custom micro-coded components, such as Application Specific Integrated Circuits (ASICs) and Programmable Logic Devices (PLD) and does not explicitly bring out the IV&V of development life cycle of FPGA based design.

This paper brings out the IV&V activities to be carried out during the FPGA development life cycle starting from planning phase to certification.

BACKGROUND

From references, (RTCA/DO-254, 2000) describes Design Assurance Guidance for Airborne Electronics Hardware for Line Replacement Units (LRUs), Circuit Board Assemblies, ASICs, PLDs, Integrated technology components such as hybrids and multichip modules and COTS components. (DoT FAA, 2015) focuses on the verification process and verification tools used for airborne electronic hardware (AEH) devices such as Field Programmable Gate Array (FPGAs), programmable logic devices (PLD) and application specific integrated circuits (ASICs).