Commercial Grade Item (CGI) Dedication – On Complex Electronic Equipment (CEC)

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1.0 Introduction

Because of a decrease in the number of qualified nuclear safety-grade vendors, there has been a change in the industry's procurement practices. The IT components which are manufactured regardless of the nuclear safety requirements are verified and validated for use in the safety-critical nuclear system. Thus the maintenance of program for design certification, verification and validation, and authorization procedure is hot issue to dedicate the IT technology-based hardware components to nuclear world. This paper reviews the trends and efforts of dedication such as Pre-Developed Hardware (PDH), Pre-Developed Software (PDS), Commercial-Off-The-Shelves (COTS), adaptation and Commercial Grade Item (CGI), which is already mentioned in other standard documents like [9], [10], [11], and [12].

The essential electronic equipments of digital power plants are designed with high density of functions and components with the rapid development of information technologies. For example, simple Programmable Logic Array (PLA) , FPGA, SOC, and ASIC which has thousands and millions of logic gates, combined single processor consisting of multi-core processors, various peripherals like USB and Bios in a single processor are the design trends in the industry. This kind of equipment is called Complex Electronic Components (CEC), and it is granted that the new approach is necessary to qualify these products to apply in digitalized nuclear power plants.

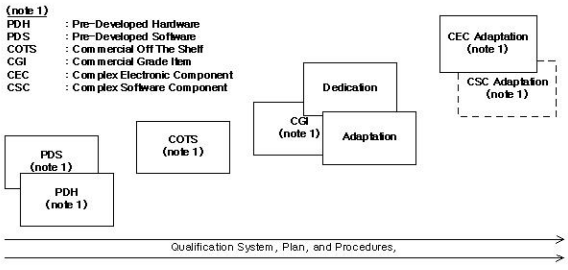

Figure 1 The transition of CGI dedication

The figure 1 indicates the transition of Commercial Grade Items (CGI) dedication in nuclear world. Especially multi-core/multithread microprocessor units had complicated internal interfaces so that it is not easy to identify the behaviours and qualify these products for dedication in power plants.

In this paper the trends of CEC dedication in other safety industries is introduced, then the considerations for CEC acceptance and qualifications will be described briefly.

2.0 Trends in other industries

With the advent of CEC, the complexity is going down to the component levels from the system levels. Thus we need the special interests for the dedication and the way of qualification for these components.

In some aviation area, it is true that a couple of regulatory requirements have been established. The document, "RTCA DO 254 Design assurance guidance for airborne electronic hardware [5]", is treating the requirements for components qualifications for airborne system. The analysis report of "DOT/FAA/AR-95/31 Design, Test, and Certification Issues for Complex Integrated Circuits (Federal Aviation Administration) [6]" is providing the sample cases about the design, qualification and authentication based on the engineering experiences. In addition, the documents, "European Space Agency : ASIC Design and Manufacturing Requirements [7] and DEF-STAN-0056 part2. Safety Management Requirements for Defence Systems (UK Ministry of Defence) [8]", describe the requirements for dedication programs, which do not exclude software sectors including the firmware.

3.0 Acceptance and rules of use of pre-developed CECs

It is recognized that any hardware development uses pre-developed components:

simple gates, complex integrated circuits, programmable circuits, electronic boards, libraries, IP cores and etc. Three kinds of requirements are identified: 1-analysis to verify that the complex pre-developed hardware component (PDH) is adequate for use, 2-rules of use within the project, 3-verification that all procured parts are identical to the accepted model [2].

Requirements applicable to all types of complex pre-developed hardware components are provided in §3.1, while paragraphs 3.2 to 3.5 give additional requirements for specific types of components.

3.1 Requirements applicable to all PDHs

The acceptance of any pre-developed hardware component (PDH) must comply with the following requirements.

- PDH requirements specification
- Rules of use
- PDH Analysis
- Documentation analysis
- Operating experience analysis
- Analysis of the conformity to the accepted model
- Analysis of the constraints induced on other components
- Review
- Modification for acceptance
- Modification after acceptance
- Acceptance and use documentation

3.2 Built-in-Software

In addition to the requirements applicable to any PDH, the acceptance and use of any pre-developed component including Built-in-Software must comply with these requirements.

3.3 Physical components: mono-core microprocessors or equivalents, multi-core microprocessors or equivalents, dedicated controllers and programmable circuits

In addition to the requirements applicable to any PDH, the acceptance and use of complex mono-core microprocessors or equivalents, multi-core microprocessors or equivalents, dedicated controllers, programmable circuits must comply with the requirements, plans and procedures specially established for CEC.

3.4 Electronic boards

The selection of a complex electronic board must comply with requirements regarding the hardware and the Built-in-Software ("system software" is a different issue).

3.5 Virtual complex components

Specific requirements for macros, IP cores, libraries and etc. must comply with appropriate standards.

4.0 Conclusion and future work

In future more complicated IT-based hardware and software is supposed to be used in the safety-grade systems in nuclear power plants. Also there are the efforts to establish the criteria for CGI dedications in NRC and CEC dedication in other standard organizations. The highly complicated components, i.e. CEC should be dedicated with different aspects of the qualification and dedication plans. Thus work to be done in later is to prepare the strategies, plans, guide and procedures that is more specific for CEC dedication

References

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[9] 10 CFR 50 Appendix B : Quality Assurance Program
[10] 10 CFR 21, CGI Dedication
[11] ASME NQA-la-1995, chap 10, Commercial Grade Items
[12] EPRI NP-5652, Utilization of commercial Grade Items in Nuclear Safety Related Applications.
[13] IAEA NS-G-1.3