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Introduction to SysML and application to the Nuclear Sector

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1. Introduction

The SysML(Systems Modeling Language)[1] is a visual modeling language which supports specification, analysis, design, verification and validation of broad range of complex systems. SysML have been developed for better communication between the systems engineers. Almost of the systems in nuclear sector is very complex which need systematic approach. The ISO 15288[2], EIA 632[3], IEEE 1220[4] are systematic approaches agreed by many experts in systems engineering. To follow those standards we need some modeling. So the SysML can be very effective in modeling the highest level of systems in nuclear sector.

2. Systems engineering and SysML

In this section some introduction to the systems engineering and an overview on the SysML are described.

2.1 Systems Engineering

Systems Engineering is an interdisciplinary approach and means to enable successful realization of the systems[5]. Almost modern systems are so complex that only one person hardly can manage the complexity of the system. So to cope with the complexity of the system we need a framework to work together. Systems engineering provides the framework for the development of complex systems. It can be regarded that we are trying to be systematic in development of the systems. Some approached may very effective and others may waste of time and efforts. Is there any approaches that are proven to be successful? It can be seen that the systems engineering standards[2][3][4] are proven approaches and agreed on approaches by experienced systems engineers.

The core of systems engineering is to transform the requirements into specification. The core process is composed of requirements analysis, functional analysis, and physical synthesis. To carry out those processes we need some modeling language.

2.2 Need of unified modeling language

Before the development of the SysML, systems engineers used many modeling languages, notation and semantics, according to their methodologies. Common examples of the languages are hierarchy diagram, data flow diagram, functional flow block diagram, IDEF0 etc. The use of many languages by systems engineer has been a high barrier for effective communication. And the students needed to study many languages to become a systems engineer. The SysML was developed to overcome these inefficiencies in the systems engineering society.

2.3 SysML Overview

SysML defines what kinds of diagrams can be used for modeling a system, and what kinds of modeling elements can be included in each diagram.

SysML was developed on the basis of the requirements of the systems engineering society[6]. The requirements are based on the standard systems engineering processes. The core process of systems engineering can be divided into three parts, requirement analysis, functional analysis and physical architecture synthesis. So there are three kinds of diagrams, behavior diagram, requirement diagram and structure diagram. Figure 1 shows detailed structure of diagrams.

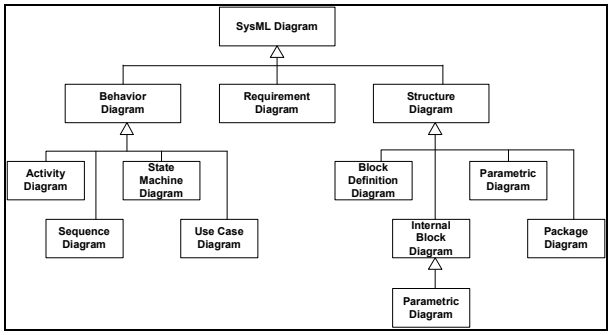

Figure 1 SysML Diagram Taxonomy

As shown in figure1, SysML is very similar to the UML[7]. The UML is the industrial standard language for modeling software intensive system. Actually SysML is a profile of UML. SysML is based on the UML because modern systems are software intensive and effective communication between the systems engineers and the software engineers is needed.

Table 1 is a short description for each diagram of the SysML.

Table 1 Description of the SysML Diagrams

Diagram Name	Represents
Block Definition Diagram	Feature of the block and the abstract relationships between the blocks and the modeling elements.

Diagram Name	Represents
Internal Block Diagram	Internal structure of the block and the physical interfaces of the blocks.
Parametric Diagram	Constraints on the block property and the mathematical equations between the block properties.
Package Diagram	Organization of the models.
Activity Diagram	Inputs, outputs, sequences and conditions for coordinating other behaviors.
Sequence Diagram	The flow of control between actors and systems(blocks) or between parts of a system.
State Machine Diagram	The behavior of a system as the state history of an object in terms of its transition and states.
Use Case Diagram	The usage of a system by its actors(environment) to achieve a goal, that is realized by the system.
Requirement Diagram	Text based requirements and the relationships between the requirements and the test cases.

In modeling a system, it is not necessary to use all the diagrams described in Table 1. It is desirable to use selected kinds of diagrams according to the characteristics of the system and the phase of the development the selection of the diagram.

The SysML are being implemented by many tool vendors and being verified the effectiveness by many systems engineers.

3. Conclusion

To develop a successful system, a systematic development process is very important. The proven development processes are systems engineering standards which need some tailoring. These standards need modeling and modeling language. SysML was developed to support systems engineering process, and unify the modeling languages. Many systems in nuclear sector are very complex to be developed by traditional experience based approaches. So we introduced systems engineering and SysML which can be used effectively in developing complex systems. And we expect that systems engineering and the SysML to be used in development of systems in nuclear sector to reduce waste of efforts and money caused by immature development process and absence of unified modeling language.

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