Architectural Frameworks for SysML

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Introduction

SysML defines neither an architecture framework nor a method. This opens discussions of how to structure the model, what views to build, which artifacts to deliver and in what sequence. Every company deals with the same issue a bit differently. Some use defense architecture frameworks like DoDAF, NAF, MODAF, others use FAS; however, saying there is no need for an architectural framework just doesn't work. You always end-up using an architectural framework whether you want one or not, or whether you intend to or not.

When analyzing available alternatives, the defense frameworks are considered to be heavyweight, although they do not require using a full set of views, and FAS is not as well-known and or used yet. Option number three is to define your own custom architectural framework (AF). This is what usually happens in reality. There are so many domains in system engineering; it is no wonder the approach for designing different types of systems differs.

Magic Pattern

In this paper, author, being a part of such framework developments in various organizations, defined a pattern (Magic Pattern) for a custom AF based on SysML (see figure 1).

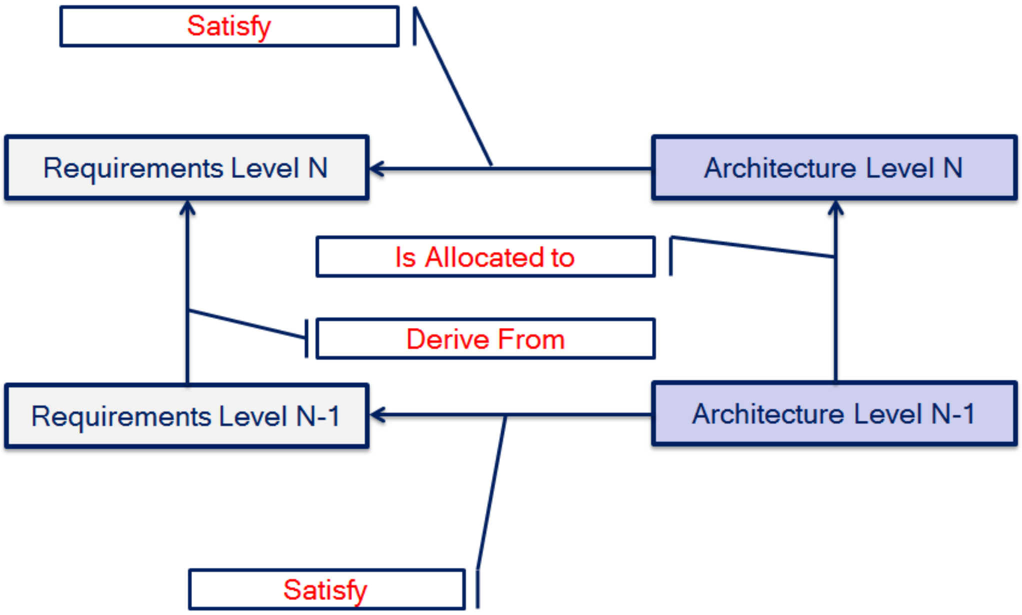

Figure 1 Magic Pattern

One can argue that instead of derivation he would use refinement. So go ahead, it is not against SysML. SysML provides a set of elements; however, it is up to you to interpret their usage in most of cases.

An example of the pattern shown in figure 1 could be a framework consisting of three levels of abstraction (see figure 2):

1. Conceptual - defines the core concepts of the system context and their interactions. The undoubted benefit of views created in the conceptual model is sharing core concepts of the system context between stakeholders.

2. Functional - defines functional analysis from the behavioral perspective, where functions instead of structural units are emphasized. Do not mix this up with the Logical architecture. They are different; however, explaining the difference requires another paper.

3. Physical - defines equipment, their physical interfaces and parameters. The physical model is usually a subject for simulation and model-based testing.

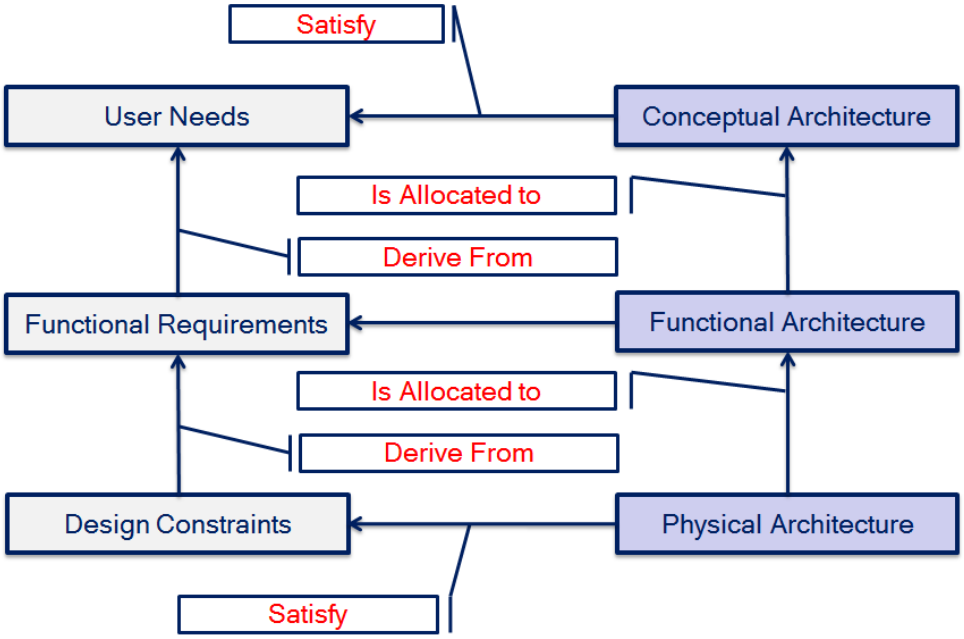

Figure 2 Example of Magic Pattern

Figure 2 shows a single possible instance of Magic Pattern shown in figure 1. Each of the architecture models and relationships among them can be represented in SysML using a different set of elements and views (diagrams, matrices, tables, etc.). E.g. functional requirements can be depicted in SysML Requirements Diagram or SysML Requirements Table; conceptual architecture can be depicted in IBD, Use Case diagram, Sequence Diagram etc. See the figure 3 for our recommendations.

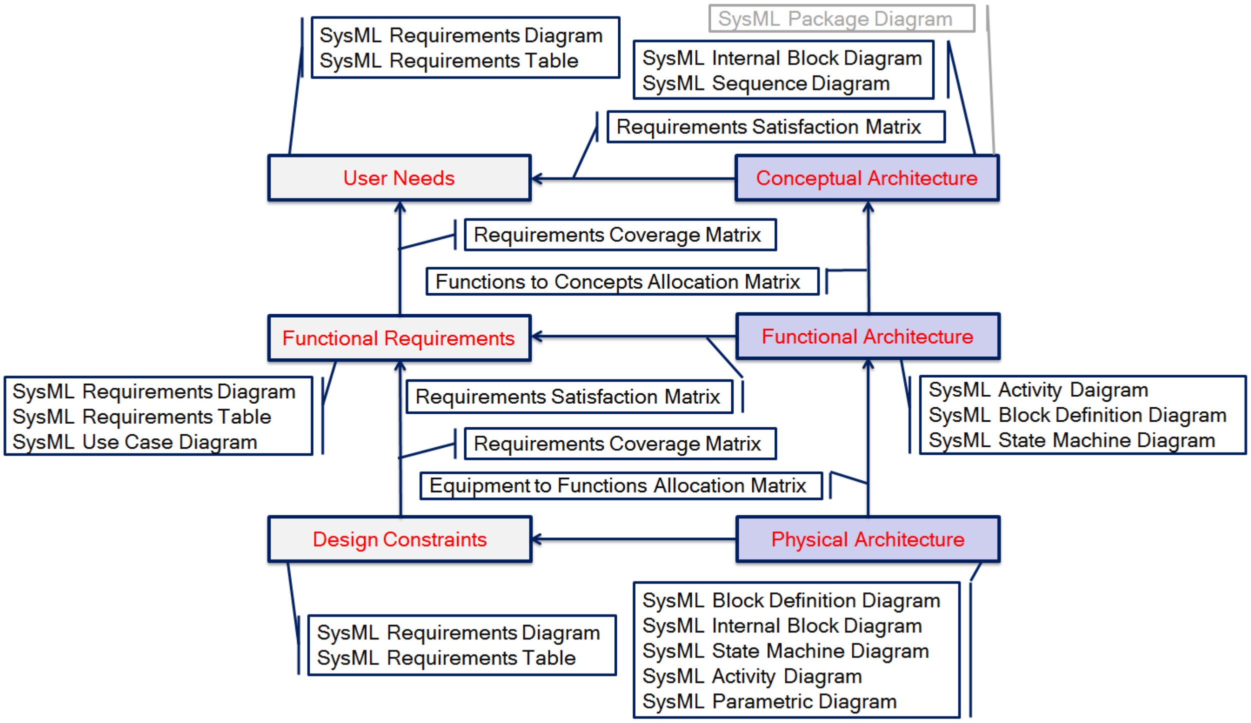
SysML Requirements Diagram
SysML Requirements Table
SysML Package Diagram
SysML Internal Block Diagram
SysML Sequence Diagram
Requirements Satisfaction Matrix
User Needs
Conceptual Architecture
Requirements Coverage Matrix
Functions to Concepts Allocation Matrix
Functional Requirements
Functional Architecture
SysML Requirements Diagram
SysML Requirements Table
SysML Use Case Diagram
Requirements Satisfaction Matrix
SysML Activity Daigram
SysML Block Definition Diagram
SysML State Machine Diagram
Requirements Coverage Matrix
Equipment to Functions Allocation Matrix
Design Constraints
Physical Architecture
SysML Requirements Diagram
SysML Requirements Table
SysML Block Definition Diagram
SysML Internal Block Diagram
SysML State Machine Diagram
SysML Activity Diagram
SysML Parametric Diagram

Figure 3 Architectural Models to SysML Diagrams Mapping

As you can see in the figure 3, the SysML Package Diagram is marked in Grey. This is because it can be created in any architecture model or can be skipped. The purpose of this diagram is to organize the model, thus generally it is created at the beginning and updated afterwards.

The SysML Use Case Diagram is sometimes used to define User Needs. There is a concept of Business Use Case used for such purpose.

Relationships between architecture models are derived from the relationships between model elements, e.g. functional requirement derivation from some user need implies the dependency of the functional requirements model from the user needs model.

Conclusion

Summarizing, it can be clearly seen that there are so many variations of architectures, models, diagrams and combinations of them (note that we have not touched the process yet), that crafting a custom architectural framework is not an easy task.

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Aurelijus is OMG Certified UML, Systems Modeling and BPM Professional. He has been with No Magic, Inc. since 2008. He started as a System Analyst for Enterprise Architecture solutions such as UPDM plugin for MagicDraw. In 2009 he moved to Product Manager position for the Cameo Enterprise Architecture product. By making it one of the most successful products on the market, he decided to work more on the customer side. Currently he is a solution architect for model-based systems engineering (mostly based on SysML, UML, and UPDM) and defense architectures (DoDAF, MODAF, NAF). He also participates actively in various modeling standards creation activities. He is a chairman and one of the leading architects for the current OMG UPDM standard development group. On the other side He is actively involved in educational activities. He teach Enterprise Architecture course in Kaunas University of Technology. He has gained PhD in Informatics Engineering at the same university in 2013.

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