A new approach to master complexity in model driven Systems Engineering

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ABSTRACT

Companies in the Engineer-To-Order (ETO) business are facing various challenges [1][2]. The competitive pressure is rising, new competitors are emerging, and customers call for higher flexibility and global presence of ETO companies. Engineering [3]is a core activity of the ETO business, defining 50-60% [4]of the total life-cycle cost of the produced solutions, yet causing just 5-15% [5]of the internal delivery costs, engineering is the starting point to tackle complexity.

Siemens has started an internal initiative “Integrated Systems Development” in which proven systems engineering approaches and new practices are merged to master complexity in ETO and large development projects. An essential part of this approach is the so-called ‘core model’ [6] that is a minimal, comprehensible description of the challenge to be solved which is created in a joint approach with the involvement of all relevant stakeholders.

A core model characterizes the system of interest in two major aspects, the relevant user and their purposes/ tasks that are associated with the system (e.g. start moving, perform acceptance test) and the interests of relevant stakeholders (e.g. reduce processing time, ensure compliance to customer standards). This core is also forming the core for other models (i.e. requirement model, architecture model and test model).

Just like any other systems engineering method, core modeling must resolve the dilemma of supplying an adequately complete description on the one hand (all necessary requirements that are needed for the following steps and decisions) but, on the other hand, remaining transparent and communicable and also feasible in terms of scope and effort when creating it. The needed focus is achieved by the following characteristics:

- The core model only contains content from the problem space;
- The core model only contains content at a commonly agreed abstraction level, i.e. all descriptions are at the same level of detail;
- The core model only contains content that is relevant to economic success or a necessary prerequisite for implementation or boosts internal benefit (e.g. reducing production efforts).

By combining the two viewpoints (i.e. tasks, interests) a ‘core model matrix’ is created as a consistent view on the system. At the intersection (matrix cell) of an interest and a task, the specific requirements/impacts are described.

As a result, potential contradictions between requirements can be systematically detected, analyzed and resolved still in the problem space. The matrix representation also allows for precisely recognizing for which of the tasks which interest has to be considered in which way (i.e. interest only influences specific tasks). The complexity of the system architecture to be defined later can therefore be substantially reduced. Furthermore tasks and interest can be prioritized in order to ensure focus and enable trade-off analysis. The overall model can also be communicated in a structured way and a common understanding across all participating stakeholders can be achieved.

In the next step, the transition from the problem space to the solution space must be accomplished. This can happen in parallel and can be continuously reviewed for target achievement with the defined ‘core’. The core model approach provides also guidance for the architecture model as a suitable component structure can be obtained by weighing up tasks and interests and by balancing out conflicts from the core model to the best possible extent. Complex systems can be modeled by applying this model in a recursive approach on identified subsystem or component if necessary.

This approach has been piloted in different industrial domains and examples from these projects will be shown to illustrate the implementation of this new method.

Core modeling has proved to be helpful in practice as a highly efficient and target oriented method. This approach showed in the pilot projects, that an improved and common understanding of the overall system, fewer inconsistencies in communication thanks to a common basis, faster and more comprehensible decision making and continuous review of target achievement could be realized. The possibility to model the system on different, but well defined, levels of abstraction helps to manage and even to reduce the complexity. As the core model is situated in the problem space, the creativity of finding new solutions is strongly supported.

Above and beyond system development, core modeling also offers portfolio strategy advantages. Products can be aligned to the tasks to be performed, several products in one

domain are delimited from one another in relation to their purpose and in a clearly communicable manner, and unnecessary overlaps and product complexity (i.e. variants) are reduced and last but not least customer satisfaction can be improved as the products are addressing the ‘real’ user purpose and support them in fulfilling their tasks.

The linking between the core model and other relevant models (e.g. requirements model, test model), as well as the tool support for the core model and the implementation in existing tool landscape will be a topic for future research.

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