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Systems and Software engineering — Methods and tools for model-based systems and software engineering

Ingénierie du logiciel et des systèmes — Méthodes et outils pour l'ingénierie du logiciel et des systèmes basée sur des modèles

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Introduction

As systems grow in scale and complexity, some in the systems engineering community turn to model-based systems and software engineering (MBSSE) to, among other objectives, manage complexity, maintain consistency, and help ensure traceability during system development. With an MBSSE approach, the systems and software engineering activities rely on evolving models that serve as the main or major source of knowledge about the system-of-interest and its life cycle processes, which could be any entity subject to a system model such as a program, project, product, or company.

MBSSE benefits differ significantly from 'engineering with models', which has been a common practice among the engineering disciplines for decades and that is mainly based on independent discipline-specific models that, even if very useful for each discipline and system analysis contribution, do not provide an overall understanding of the architecture of the system sharable among stakeholders, e.g. computer-aided design (CAD) for mechanical engineering, aerodynamics models, control loop simulations. In addition, due to the diversity of approaches and terminologies (e.g. model-driven development or MDD), MBSSE usually falls within the context of a specific engineering discipline (e.g. MDD for the software engineering community).

MBSSE is the formalized application of modelling to support systems engineering or software engineering activities. Faced with the issues and challenges linked to the growing complexity of the systems to be developed, document-centric approaches are less and less suitable. The MBSSE approach makes it possible to develop logically consistent multi-view architecture description. These serve as a bridge to enable the traceable, verifiable and dynamic correlation of the system-of-interest and/or software-of-interest models cross multidiscipline and throughout its entire life cycle, and to drive the system and software engineering processes, activities and tasks at all levels of its hierarchy from system-of-systems to system element across multiple engineering disciplines and throughout all stages of its life cycle

From MBSSE perspective, other engineering disciplines (mechanical, thermal, electronic, electrical, etc.) are also considered.

Thus, a need exists to specify the considerations necessary for undertaking the application of MBSSE within an organization. An organization needs to address the considerations necessary for supporting the establishment of each project environment within its overall ecosystem, and the exchange of models between stakeholder organizations.

This document addresses MBSSE-related processes by categorizing them into four process groups:

— Plan MBSSE

— Build models

— Perform MBSSE

— Support models

Each process is defined in terms of purpose, inputs, outcomes, and supporting tasks. The task descriptions include tool and method guidance and the recommended capabilities needed to successfully implement them. The relationships among the four process groups in this document, the four process groups in ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207, and the life cycle model and stages in ISO/IEC/IEEE 24748-1 are described in Annex A.

This document is intended to benefit those who acquire, supply, develop, operate, and maintain MBSSE tools and methods. It can be used by:

a) organizations that need to implement or build models – to understand, adopt, and enact the MBSSE processes, tools, and methods (it also helps to evaluate and select relevant tools and methods based on business- and user-related criteria);

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b) tool vendors who facilitate or leverage MBSSE practices – to provide a set of recommended tool capabilities for planning MBSSE, building models, MBSSE performance, and support.

Systems of systems are considered in this document to benefit from the same processes, methods and tool capabilities as any system.

The relationships between this document and other standards are described in Annex E.

NOTE 1 This document prescribes a way to engineer systems and software based on models thanks to a reference model and four process groups; however, other particular uses of models which are out of the scope of this document are used in "model engineering" in other ways: For example, in model-driven modernization [also called architecture-driven modernization (ADM) in object management group (OMG) terms], models are (automatically) generated from the existing code and artefacts of a running system in order to represent it and then build a new system in a different platform. Another usage scenario of models occurs in what is called "models@runtime" whereby the models are used to change the system and evolve with it; these are normally used in self-adaptive systems to achieve the required system self-adaptation features.

NOTE 2 The reference model does not take into account the system evolution (and that of its related models) as a fundamental phase of systems or software engineering in the maintenance and evolution of the system and its models.

NOTE 3 The design within the different domains, for example, mechanical, hydraulics, electrical, electronics, control algorithms, and software, has been performed using model-based techniques for decades. However, each domain uses specialized languages and tool chains for its modelling activities. The guideline to propose how the methods, modelling languages and tools apply in these domains is outside of the scope of this document. However, the interfaces of the engineering models and the system models are crucial and essential for applying MBSSE.

In this document, the following verbal forms are used:

— "shall" indicates a requirement;

— "should" indicates a recommendation;

— "may" indicates a permission;

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Systems and Software engineering — Methods and tools for model-based systems and software engineering

1 Scope

This document deals with the tool capabilities and methods for model-based systems and software engineering (MBSSE). This document:

— specifies a reference model for the overall structure and processes of MBSSE-specific processes, and describes how the components of the reference model fit together;

— specifies interrelationships between the components of the reference model;

— specifies MBSSE-specific processes for model-based systems and software engineering; the processes are described in terms of purpose, inputs, outcomes and tasks;

— specifies methods to support the defined tasks of each process;

— specifies tool capabilities to automate or semi-automate tasks or methods.

This document does not bring any additional life cycle processes for system and software but specifies an MBSSE reference model considered as activities, not only from the life cycle perspectives of systems engineering problem solving and the system-of-interest evolution, but also from the cognitive perspectives of modelling and model management, which can sustain and facilitate the system and software life cycle processes during digital transformation and in the digital age.

The processes defined in this document are applicable for a single project, as well as for an organization performing multiple projects or an enterprise. These processes are applicable for managing and performing the systems and software engineering activities based on models within any stage in the life cycle of a system-of-interest.

2 Normative references

There are no normative references in this document.

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