



prostep ivip

Recommendation



Recommendation SysML WF/IF

prostep ivip Recommendation 2023 PSI 28

SysML WF/IF

Version 1.0

Abstract

Collaboration based on SysML gets more and more important during the product development. On the one hand the importance of collaboration for system development is increasing and on the other hand the usage of SysML as standard for Model Based Systems Engineering (MBSE) is already considered in many companies.

In case of system modeling, the fact of having a common language does not mean at the same time, that there is a common exchange format available. Looking to current system development projects it is obvious, that collaboration scenarios where different system modeling tools are used, are not unusual. On top collaboration partners frequently use individual SysML profiles in combination with individual methodologies.

All the points make it a challenging situation for many companies to exchange system models and were reasons, why the SysML Workflow Forum (SysML WF) was founded in 2017. Besides the exchange of system models of course, related artefacts like requirements or test cases need also to be exchanged and bring the complexity of the exchange to an even higher level. The SysML WF decided to define three main use cases that were addressed in different work packages, to consider the main challenges of model exchange and the related artefacts. The three use cases are:

- Model Exchange
- Requirements Engineering & System Design
- Verification & Validation

In 2021 the SysML Implementor Forum (SysML IF) started its work, to have a closer look on the technical realization of the addressed use cases. Several vendors are participating inside the SysML IF representing different tool categories like authoring tools or traceability solution providers. Goal of the SysML IF is on the one hand to demonstrate current capabilities and approaches to the SysML WF and on the other hand to find technical solutions for the use cases and requirements addressed by the SysML WF.

This recommendation gives an overview on the findings and work results of both working groups, that have been elaborated so far. The different use cases are presented and an overview on the existing approaches for model exchange and existing exchange formats is given. The document closes with an outlook on the open points and the next steps.

Table of Contents

Abstract	II
Figures	V
Tables	VII
Abbreviations & Definitions	VIII
1 Management Summary	2
2 General Aspects of Systems Engineering and SysML	3
2.1 Model-based Systems Engineering (MBSE)	5
2.2 System Modeling Language (SysML)	6
2.3 Additional Standards for Collaborative MBSE	9
2.4 Working Groups for MBSE	10
2.5 Benefits, Challenges and Deployment of MBSE	10
2.6 Advanced Systems Engineering (ASE)	11
3 Use Cases and Requirements for SysML IF	12
3.1 Use Case "Model Exchange"	13
3.1.1 Details on Exchange Workflow	15
3.1.2 Overview of Exchanged Model Content	18
3.1.3 IP Protection for Model Exchange	19
3.2 Use Case "Requirements Engineering & System Design"	19
3.3 Use Case "Verification & Validation"	21
4 SysML Demo Model	23
4.1 Use Cases and Boundaries	23
4.2 Behavior	25
4.3 Requirements	25
4.4 Structure	26
4.5 Analysis	27
4.6 Summary	28
5 SysML IF Demonstrators	29
5.1 Overview of Existing Exchange Formats	29
5.1.1 XMI	29
5.1.2 SpecIF	31
5.1.3 Project MTIP	38
5.1.4 Tool-to-Tool integration	41
5.2 Demonstrators presented by IF vendors	41
5.2.1 LieberLieber Demonstrator	41
5.2.2 MID Demonstrator	43
5.2.3 Siemens Industry Software Demonstrator	47
5.2.4 AVL/CONWEAVER/T-Systems Demonstrator	49
5.2.5 AVL/Dassault Systèmes Demonstrator	51

Table of Contents

6 Feedback on Demonstrators	54
6.1 Generic Feedback	54
6.2 Demonstrator Specific Feedback	55
6.2.1 LieberLieber Demonstrator	55
6.2.2 MID Demonstrator	55
6.2.3 Siemens Industry Software Demonstrator	56
6.2.4 AVL/CONWEAVER/T-Systems Demonstrator	56
6.2.5 AVL/Dassault Systèmes Demonstrator	56
6.2.6 Summary	57
7 Recommendations and Next Steps	58
7.1 Recommendations	58
7.1.1 Recommendations to Collaboration Workflow	58
7.1.2 Recommendations to Tool Vendors	60
7.1.3 Recommendations to Committees (VDA/ivip)	61
7.2 Next Steps	61
8 Summary and Outlook	63
9 Bibliography	64

Figures

Figure 1: System Environment (according to INCOSE SE Handbook)	3
Figure 2: Systems Engineering Processes according to INCOSE SE Handbook (:em)	4
Figure 3: V-Model according to (VDI/VDE 2206:2021-11)	4
Figure 4: Use cases for MBSE (Kleiner, Lindemann, Korobov, & Hamester, 2018)	5
Figure 5: SysML aspects and the four major pillars (Dumitrescu, Albers, Riedel, Stark, & Gausemeier, 2021)	6
Figure 6: SysML Diagram types (Object Management Group, 2019, S. S. 211)	7
Figure 7: SysML v1 timeline and v2 roadmap taken from Uwe Kaufmann, GfSE AG PLM4MBSE	8
Figure 8: SysML WF Use Case overview	12
Figure 9: Collaboration scenario WP4 „Model Exchange“	13
Figure 10: Detailed Exchange Workflow	15
Figure 11: Structural Context	16
Figure 12: Functional Context	17
Figure 13: State Diagram with Transitions	18
Figure 14: Overview of exchanged model content	18
Figure 15: Example IP protection based on SysML packages	19
Figure 16: Collaboration scenario: WP6 „Requirements Engineering“	20
Figure 17: Collaboration scenario: WP7 „Verification & Validation“	22
Figure 18: Package diagram showing the model structure and its views	23
Figure 19: Use Case diagram example of eHSUV	24
Figure 20: Context diagram of HSUV	24
Figure 21: Activity Diagram for the Accelerate Function	25
Figure 22: A requirement diagram depicting their hierarchy with an example of a textual requirement	25
Figure 23: The upper level domain described in a BDD	26
Figure 24: Breakdown of the subsystem of the eHSUV model	26
Figure 25: Internal Block Diagram of Power Subsystem	27

Figures

Figure 26: Parameter Diagram of eHSUV example	27
Figure 27: MOF model equivalent [UML]	30
Figure 28: Results of the SysML-Model exchange via XMI-Standard	31
Figure 29: SpecIF approach for Use Case „Requirements Engineering & System Design“	32
Figure 30: Relation between SysML and UML (OMG SysML, 2022)	38
Figure 31: Mapping of metamodels to a common schema (Severson, 2022)	38
Figure 32: SysML model exchange via HUDS XML (Severson, 2022)	39
Figure 33: MTIP Plugin for Cameo Systems Modeler and Sparx Enterprise Architect	39
Figure 34: Block Definition Diagram transferred via MTIP from Cameo to EA	40
Figure 35: OpenMBEE MDK for Cameo	41
Figure 36: Selection of files to be merged inside LemonTree	42
Figure 37: LemonTree merging an EA and OpenMBEE MDK model	42
Figure 38: MID exchange concept based on their Open MBSE Data Package, Source: MID	43
Figure 39: Extract of the Open MBSE Data Package for the eHSUV example	44
Figure 40: Showing a version diff inside smartfacts	44
Figure 41: Concept of MID collaboration platform, Source: MID	45
Figure 42: Global configuration concept, Source: MID	46
Figure 43: Smartfacts plugin for Cameo	46
Figure 44: Integrated MBSE Approach of Siemens Industry Software	47
Figure 45: System model managed in Teamcenter Active Workspace	47
Figure 46: Parameter definition under a requirement inside Active Workspace	48
Figure 47: Integration of requirements and verification information into the CAD environment	48
Figure 48: Demonstrator Architecture, Source: SysML WF/IF hand-over meeting	49
Figure 49: Conweaver Linksphere user interface showing the linked artifacts	50
Figure 50: Future demonstrator architecture, Source: SysML WF/IF hand-over meeting	50
Figure 51: Process description of AVL/Dassault Systèmes Demonstrator	51

Figures

Figure 52: Overview system model content	52
Figure 53: Definition of instances / configurations in Cameo	52
Figure 54: Simulation model imported using SSP in Model.CONNECT™	53
Figure 55: Verifying requirements based on calculated values	53
Figure 56: Main Challenges in collaboration according to V-Model	55
Figure 57: Separation of specification and design element in different packages	59
Figure 58: Specialization of the specification element (left) and a trace between specification and design element in case of different methods (right)	59

Tables

Table 1: Standards related to SysML and MBSE	9
Table 2: Working groups to consider for cooperation	10
Table 3: Overview High-Level Requirements WP4 „ Model Exchange	14
Table 4: Overview High-Level Requirements WP6 „Requirements Engineering“	21
Table 5: Discussion of Requirements with focus on SpecIF	36
Table 6: Collection of Decision Criteria and Motivation	37
Table 7: Summary of feedback on demonstrators	57