DLR Projektträger

Collaborative Embedded Systems

CrESt

GEFÖRDERT VOM

Bundesministerium
für Bildung
und Forschung

From SPES to CrESt and … Beyond

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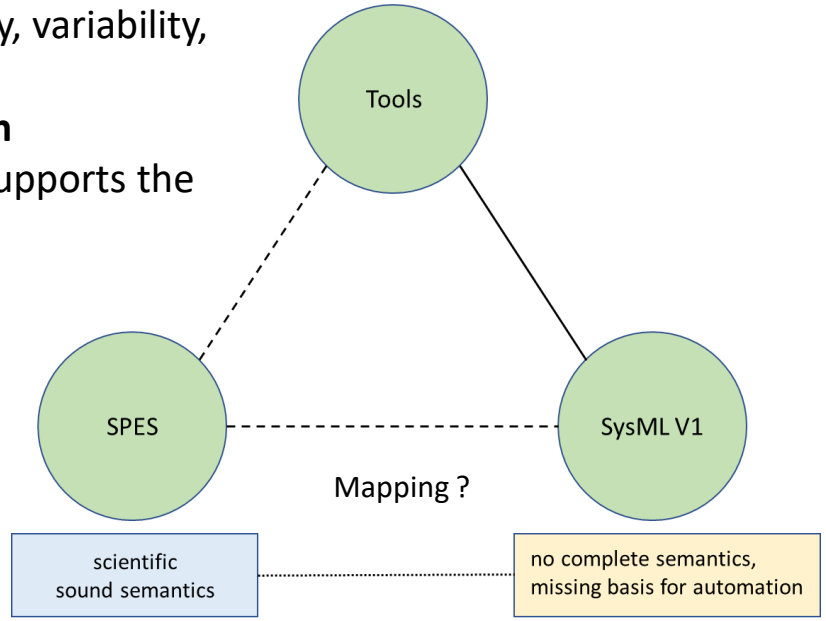
16.10.2020

SPES MBSE Implementation in Practice – Status quo – integration missing

- SPES methodology toolbox
- Solid scientific, semantic foundation
- Consistent
- **Language neutral**
- Multiple analyses
- Cross-cutting topics (safety, variability, etc.)
- **no SysML implementation**
- no commercial tool that supports the FOCUS semantics

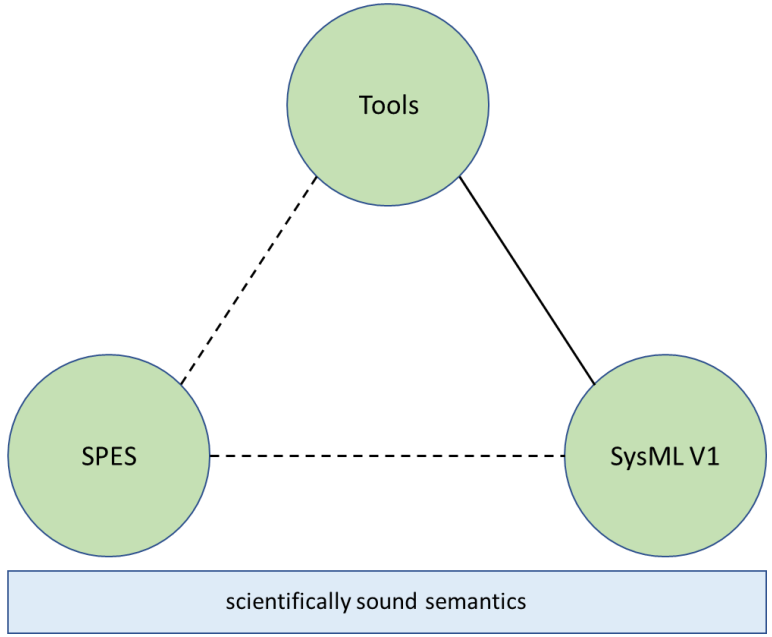
- **Mainly SysML "painting tools“**
- Often allow for more than one method or language
- Usually do not support a consistent methodology
- Some proprietary methods (IBM Harmony
- Complexity and costs
- Missing interoperability



- SysML is quasi industry standard as MBSE modeling language
- Generic model elements with only loose (missing) semantic foundation
- **Lack of precision and consistency**
- **Lack of semantic coherence**
- missing language elements to fully support a consistent MBSE methodology (e.g. SPES)
- unclear relationships between individual models

SpesML – SPES MBSE Implementation in Practice

- Syntactic adaptation of the modeling language SysML to the SPES methodology (SysML profile).
- Reducing the SysML language to the minimum required
- Reducing complexity and facilitating implementation in practice
- Identification of missing language elements
- Supplementing the standard
- Improvement / specification of the expressiveness of the individual language elements
- Mapping the SPES methodology to the SysML profile
- Semantic foundation of the SPES SysML profile through FOCUS/SPES semantics (creating semantic coherence)
- Prototypical implementation of a (lightweight) MBSE tool that supports the FOCUS semantics and lowers the hurdle for industrial use, especially for SMEs (e.g. by context-sensitive restriction of menu scopes)
- Further development of the MBSE maturity model towards SysML support



Challenges: Future Work

- Adaptation and extension of existing concepts, methodologies, and tools for the development of (collaborative) embedded systems for the development of (including)
  - (Self-) adaptive systems
  - Autonomous systems
  - Digital twins
  - Big data and data quality
  - System quality assurance at runtime
  - Human centric engineering
- Industrial spread of the SPES/CrESt modeling methodology
  - Mapping of the modeling framework to SysML (semantically consistent extension of SysML)
  - Development of concrete analyzes of the execution semantics
  - Consistent, lightweight tool support
  - Condition Systems Engineering methodology to provide a flexible and modular set of methods for SME

Challenges: Future Work

SPES/CrESt as a Basis for Advanced Systems Engineering (ASE)

- ASE: Integration of all engineering activities necessary for the development of advanced software intensive cyber-physical systems
  - Along the **whole product life-cycle** (including market and business models and system operations) and all elements of the **value network**.
  - Multi disciplinary design approach, providing **integrated methods and processes** for close cooperation of engineering disciplines (electrical and mechanical engineering and informatics including AI).
  - Integrated solutions for certification and operations approval.
  - Socio-technical systems: human-machine interaction.
- The SPES/CrESt methodology provides already an integrated, semantically sound modelling basis for development activities of collaborating embedded systems (including requirements, systems analysis, architecture design, validation and verification, simulation, …) that already supports the integration of engineering disciplines.
- SPES/CrESt ASE extensions towards a (complete) reproduction of the business environment:
  - Strategic product planning: market and business models.
  - Models for systems operation (runtime system information models).
  - Engineering process for inter-disciplinary engineering.
  - System qualification and certification.

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Questions ?