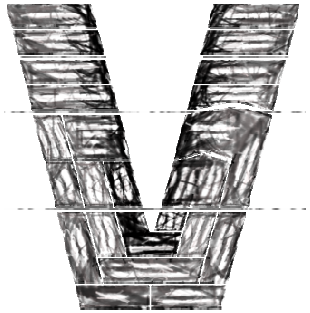
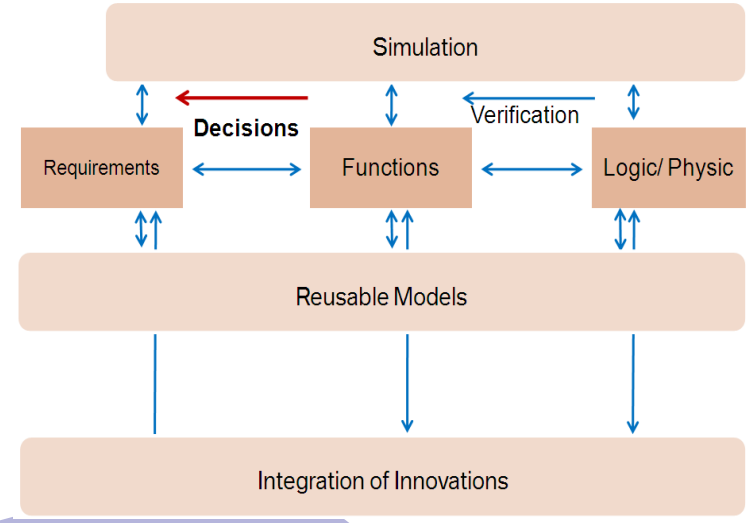


Chair:
Dr. Stefan Rude, BMW

SMART SYSTEMS ENGINEERING (SmartSE)

Remember: Roadmap Systems Engineering (SE)

Objective: Exchange of Systems Engineering Objects interfacing suppliers (solution partners) and OEMS



Actual focus of model based systems engineering

Legend:

FMI – Functional Mockup Interface
JT – Abbrev.: Jupiter Tesselation; ISO 14306:2012
ReqIF – Requirements Interchange Format (OMG)
CFD – Computational Fluid Dynamics
FEA – Finite Element Analysis

Functions (possibly solved by FMI and AutoSAR) tbd. → **Full SE**

Logic Behavioral Models FMI → **Closing gaps**

Requirements

ReqIF → **Structuring and linking models**

Geometrical Part of Physic JT → **Integration with CAE (FEA, CFD, ..)**

today

ProSTEP iViP – The Future Starts Today

Core Objectives: Smart Systems Engineering

- Identify existing technologies in the field of Systems Engineering with high potential for the industrial application
- Further development of applicable technologies for industrial use cases (focus on industrial utilization/users, e.g. FMI industrialization)
- Actually (project year 2014-2015) establish developed industry best practices to ease the required exchange of behavior models
- Ensure smooth process integration between partners and take other formats into account

Smart Systems Engineering (SmartSE)
Phase 2: Establish collaborative behavior modeling

- Scope:
  - Establish developed industry best practices to ease the required exchange of behavior models. Ensure smooth process integration between partners and take other formats into account
- Results:
  - Developed reference process and checklists in use.
  - Possibilities for standardization of FMI evaluated
  - Layer model for describing the possible interactions between different formats created
  - Requirements gathered to integrate behavior model into data management systems
  - Roadmap for further phases
- Duration:
  - January 2014-December 2015

AIRBUS Audi aras corp AVL BMW BOSCH Continental DAIMLER

Datenverarbeitung in der Konstruktion DASSAULT SYSTEMES dSPACE em engineering methods AG ETAS Fraunhofer IPK Ford

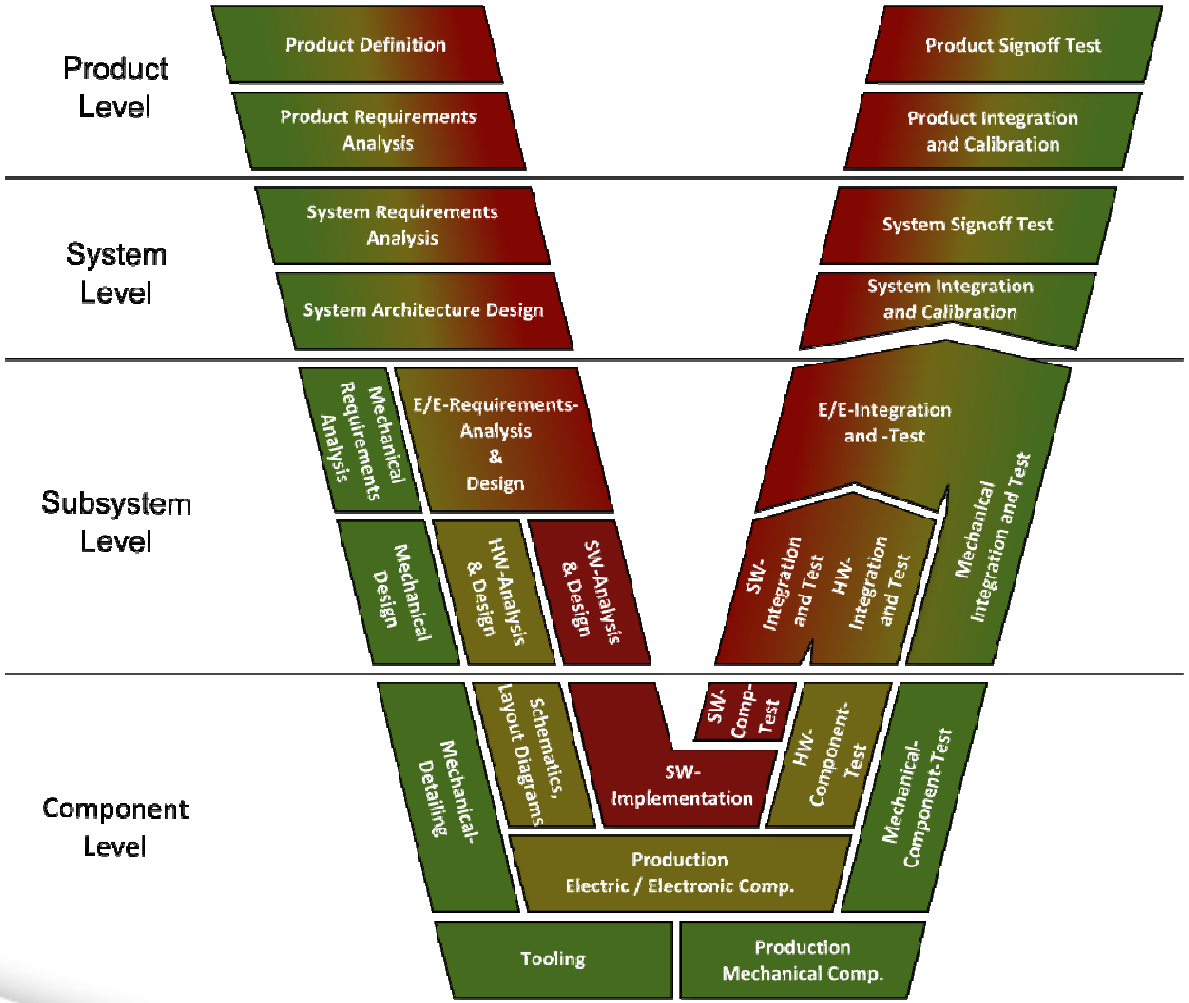
GT Gamma Technologies ith Supporting your visions PORSCHE PROSTEP integrate the future PTC SIEMENS

Siemens PLM Software SIEMENS UNITY CONSULTING & INNOVATION Lehrstuhl für Virtuelle Produktentwicklung VPE VW ZF

ProSTEP iViP

ProSTEP iViP – The Future Starts Today

V-Model for mechatronics systems development



- The V-model is a abstract description of the mechatronics systems development process
- The left side covers the design phase
- The right side covers the verification & validation phase
- From the top to the bottom the refinement from the product to system, subsystem and component level are depict
- The divergence into discipline specific process phases on the left side and the stepwise integration on the right side of the V are also reflected

Smart Systems Engineering - Phase 2
2014 & 2015 Project Plan (I/II)

WP 1 Networking with other organizations and projects

- VDA, Modelica Association, FMI Steering Committee, INCOSE, GfSE, ISO, OMG
- AGESYS, MoSSEC, mecPro², etc.

WP 1 Dissemination of project results and roadmap in:

- Publications: Produkt Daten Journal, Recommendation
- Conferences & congresses: ProSTEP iViP Symposium, SIA Congress 2015, …
- Newsletter: ProSTEP iViP

WP 2 Consequences of “SmartSE Check 2014” results

- Appendix to the recommendation "mech./elec. Use Cases"
- Report on potentials for standardization of simulation infrastructures in the SmartSE process
- Description of "Best Practice" usage of FMI including guideline to manage problems

Smart Systems Engineering - Phase 2
2014 & 2015 project Plan (II/II)

WP 3 FMI Industrialization

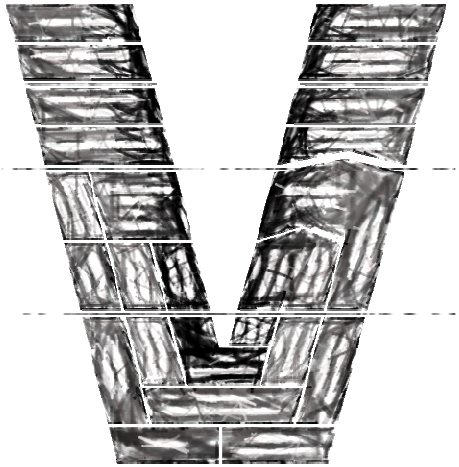
- Further actions to support the industry in the utilization of the Functional Mockup Interface (FMI)
- Collaboration strategy between ProSTEP iViP and the Modelica Association
- Is anything else needed to bring FMI in application?

WP 4 FMI and others in context

- Development of a guideline from the layer model
- Incorporation of other not yet considered formats
- Appendix to the recommendation “findings and classification of accurateness problems of solver solutions”

WP 5 Behavior models and Data Management Integration

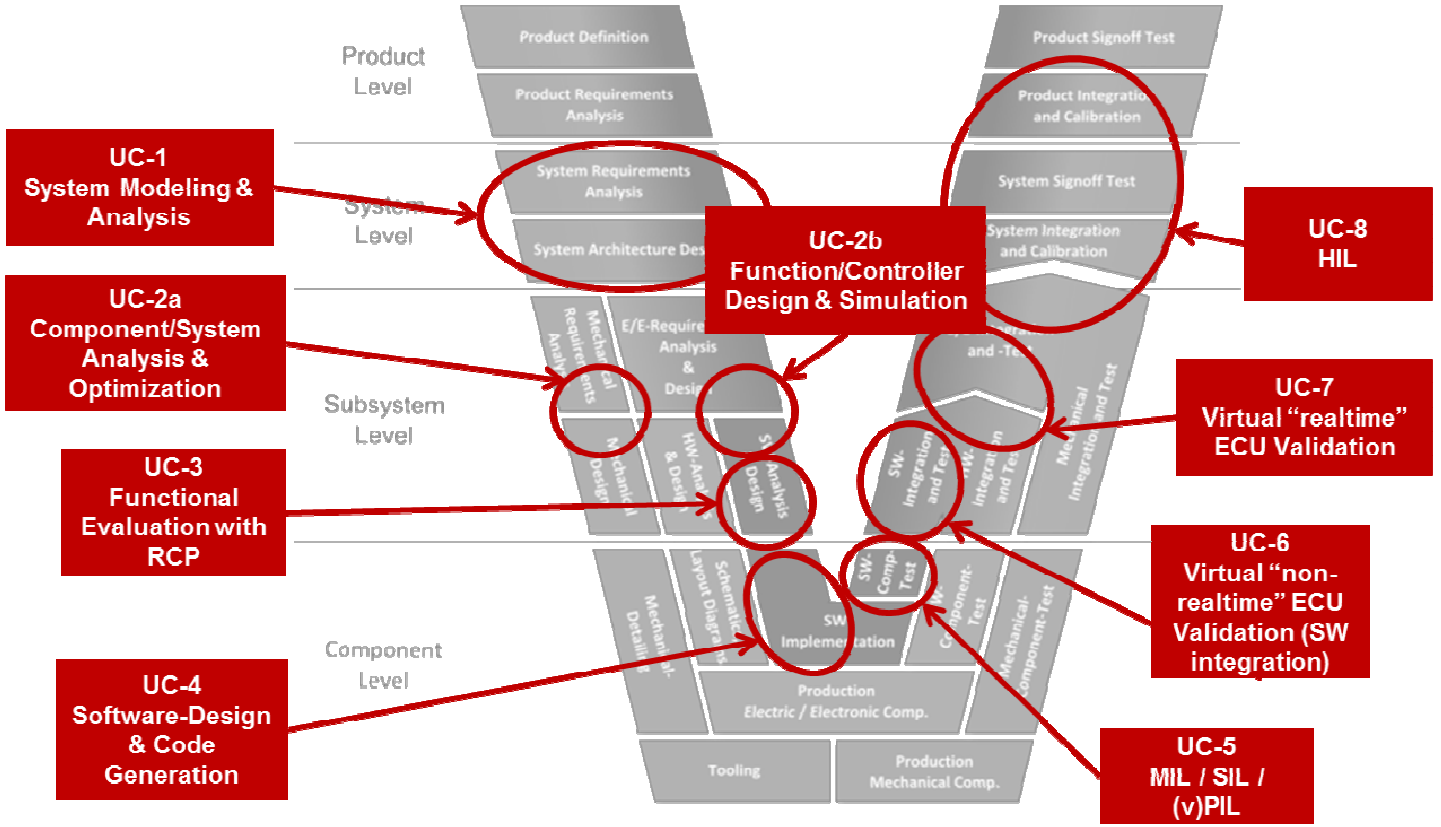
- PDM use cases and requirements from SE domains
- Definition of a standardized meta data model
- Development of an IT integration concept
- Build a demonstrator



WP 1 – Project Management & Public Relations

Defined Use Cases

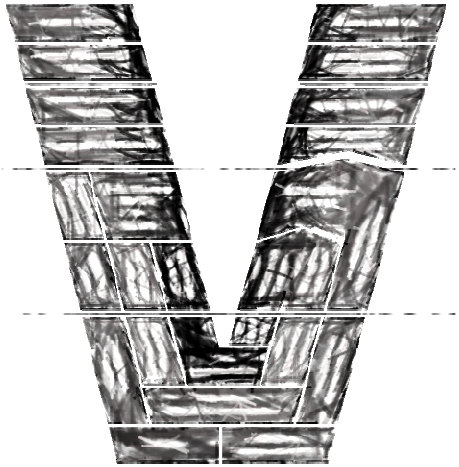
Definition and description of SmartSE use cases including the work share between two exchanging partners



Summary of findings: ProSTEP iViP Recommendation

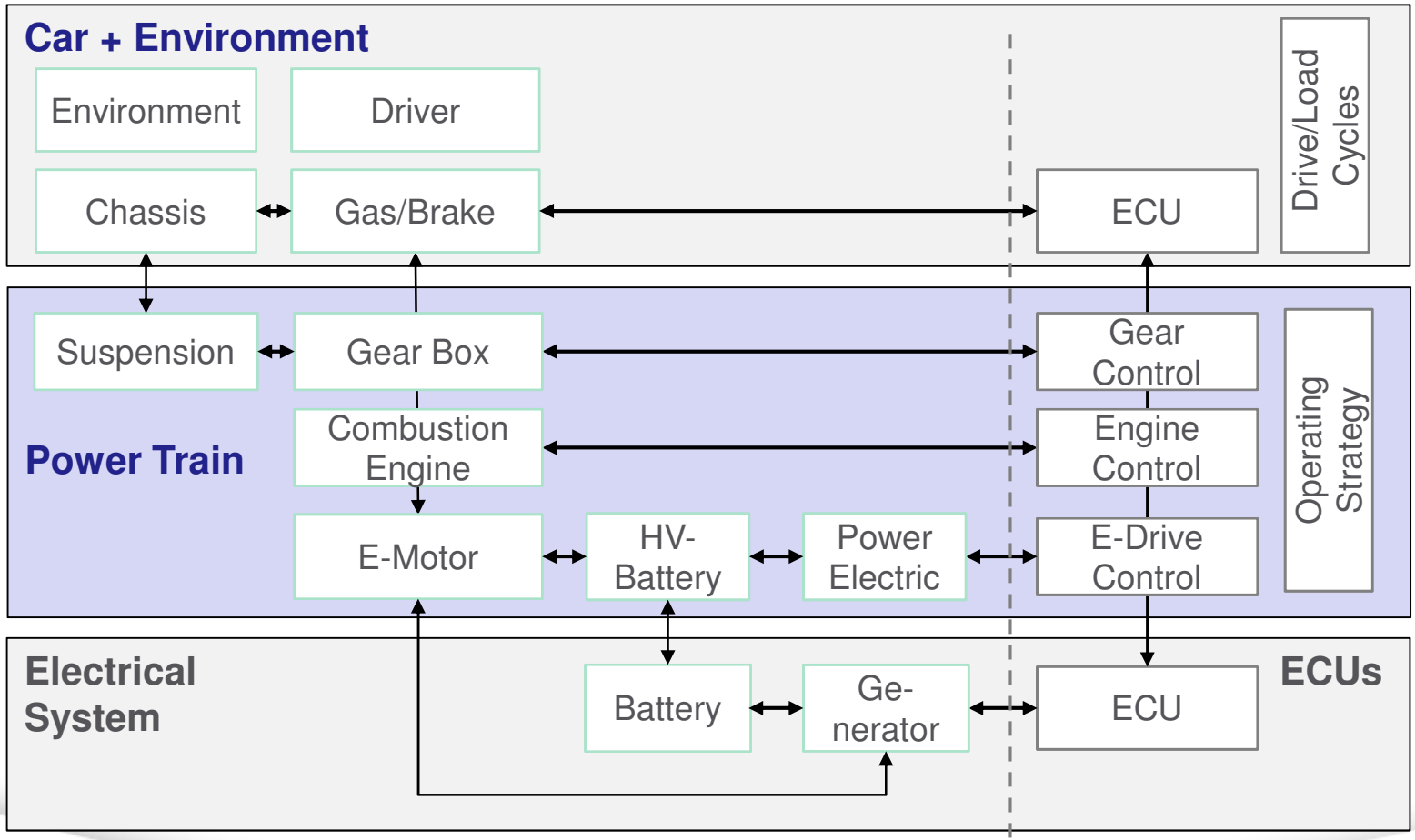
- ProSTEP iViP Recommendation PSI 11 „Smart Systems Engineering: Behavior Model Exchange“
  - Use case description
  - Reference model description
  - Templates
  - Glossary

- Available for download at: www.prostep.org



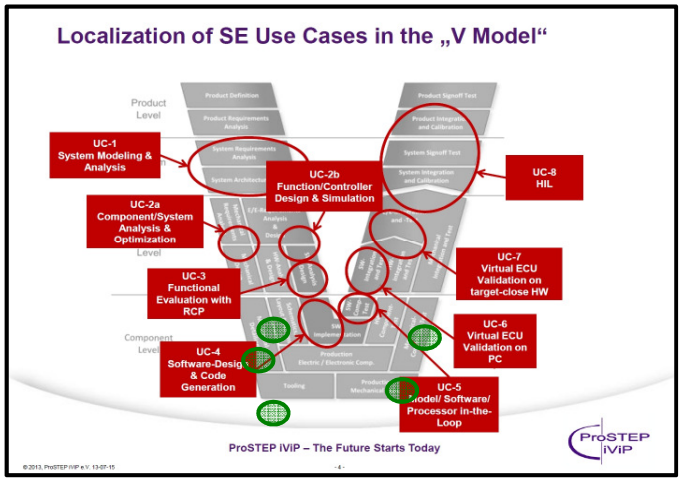
WP 2 Consequences of Smart SE check

Consequences of Smart SE Check
Different Vehicle Simulation Architectures needed
Example: Hybrid Power Train (in principle)

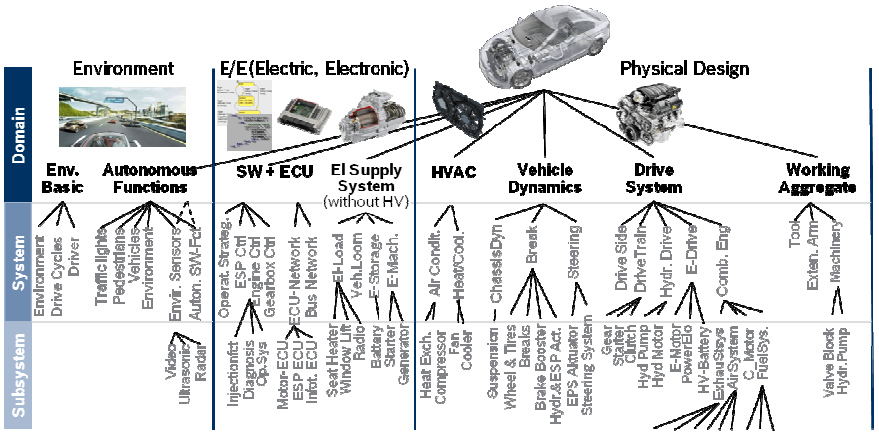


Next Steps

- Supplementing, completion use cases in V-model (Mechanics, HW/ECU)



- Questionary Smart SE check
  - Completion of evaluation questionary Smart SE Check
  - Paper for usage Smart SE check



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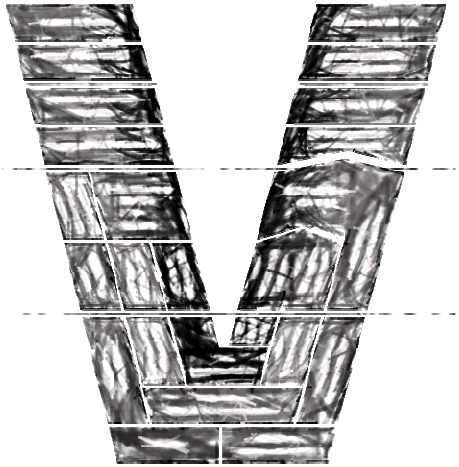


WP 3 FMI Industrialization

FMI Compliance & Industrialization

ProSTEP iViP "SmartSE"

FMI Industrialization

Assurance of user-required support of interaction scenarios between different simulation partners

- Reference Process
- Use Cases
- SmartSE Test Scenarios

- Support of FMI utilization in industry
- Users define SmartSE relevant test scenarios
- Vendors assure support, quality, interoperability of IT

FMI Compliance

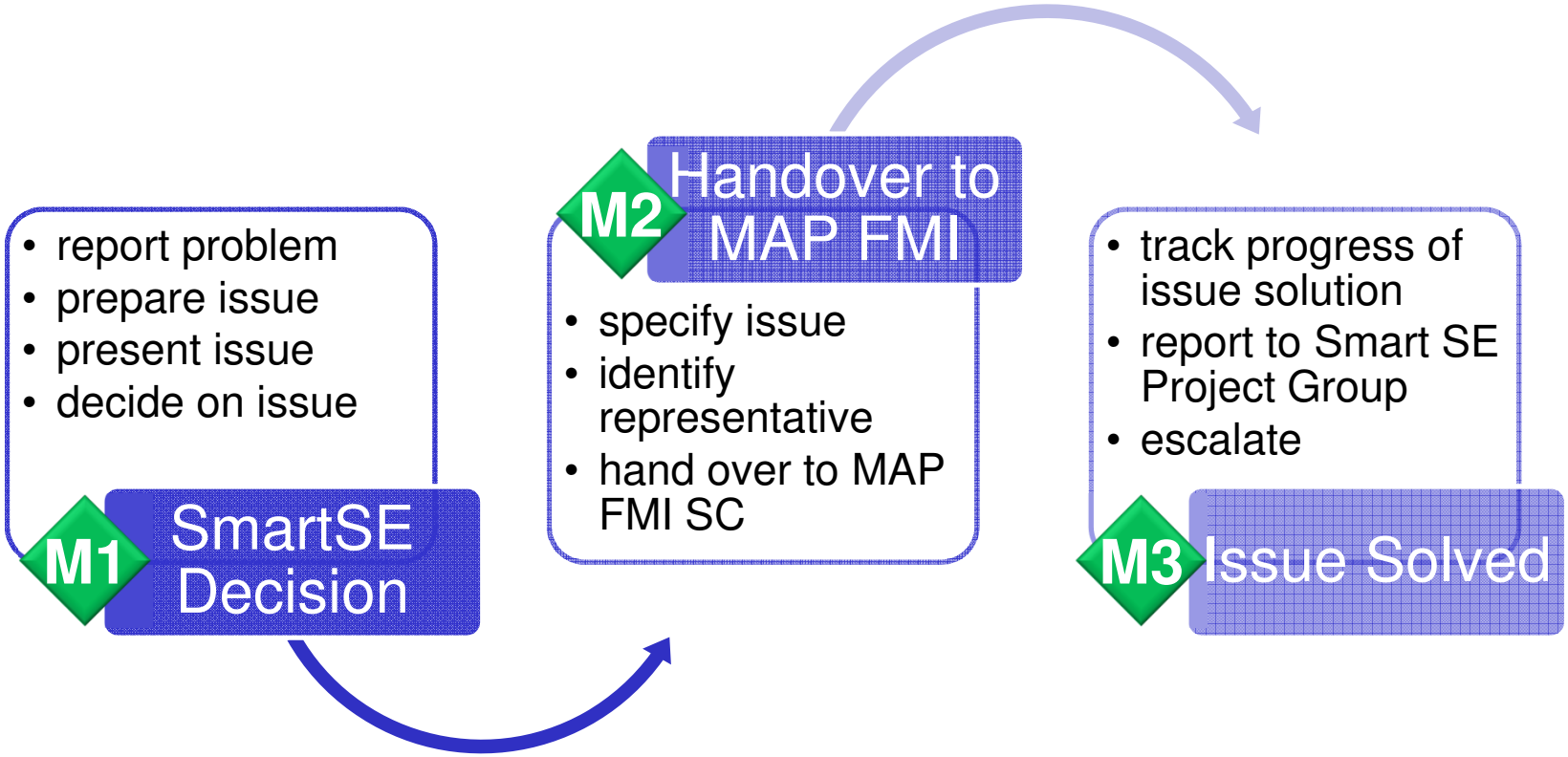
Specification, enhancement and verification of FMI implementation in different simulation tools

- FMI Tools Support
- FMI Cross Check
- Reference FMUs

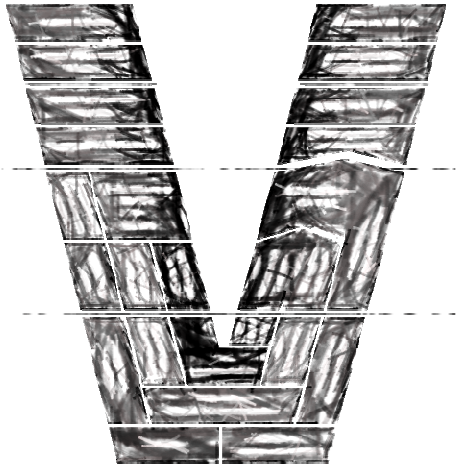
- Assurance of IP-secured exchange of simulation models
- Interoperability of simulation tools
- FMI dissemination to tool vendors
- Enable vendors to verify FMI implementation

Modelica Association Project "FMI"

Process to adress FMI Specification Issues

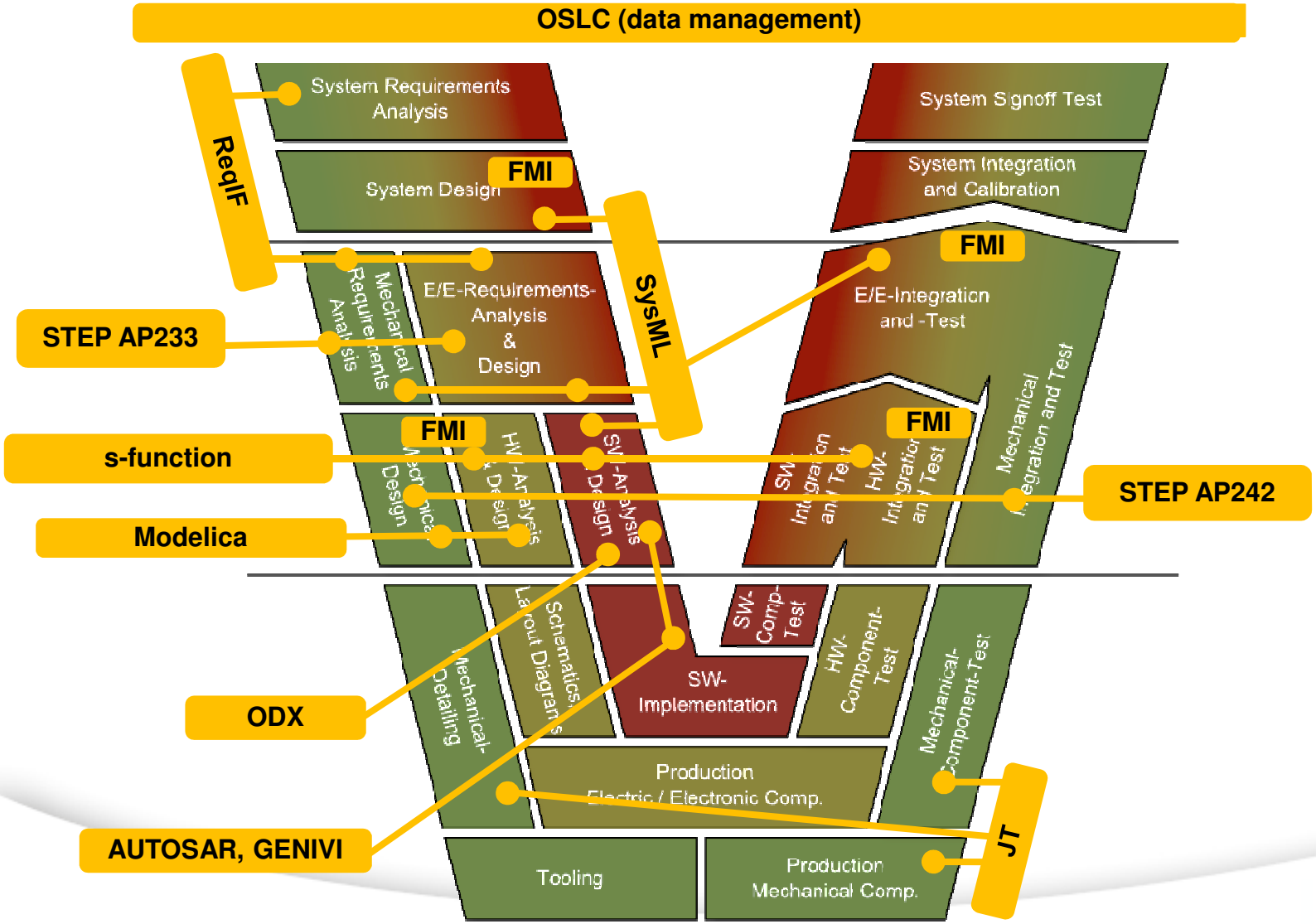


Mx Milestone



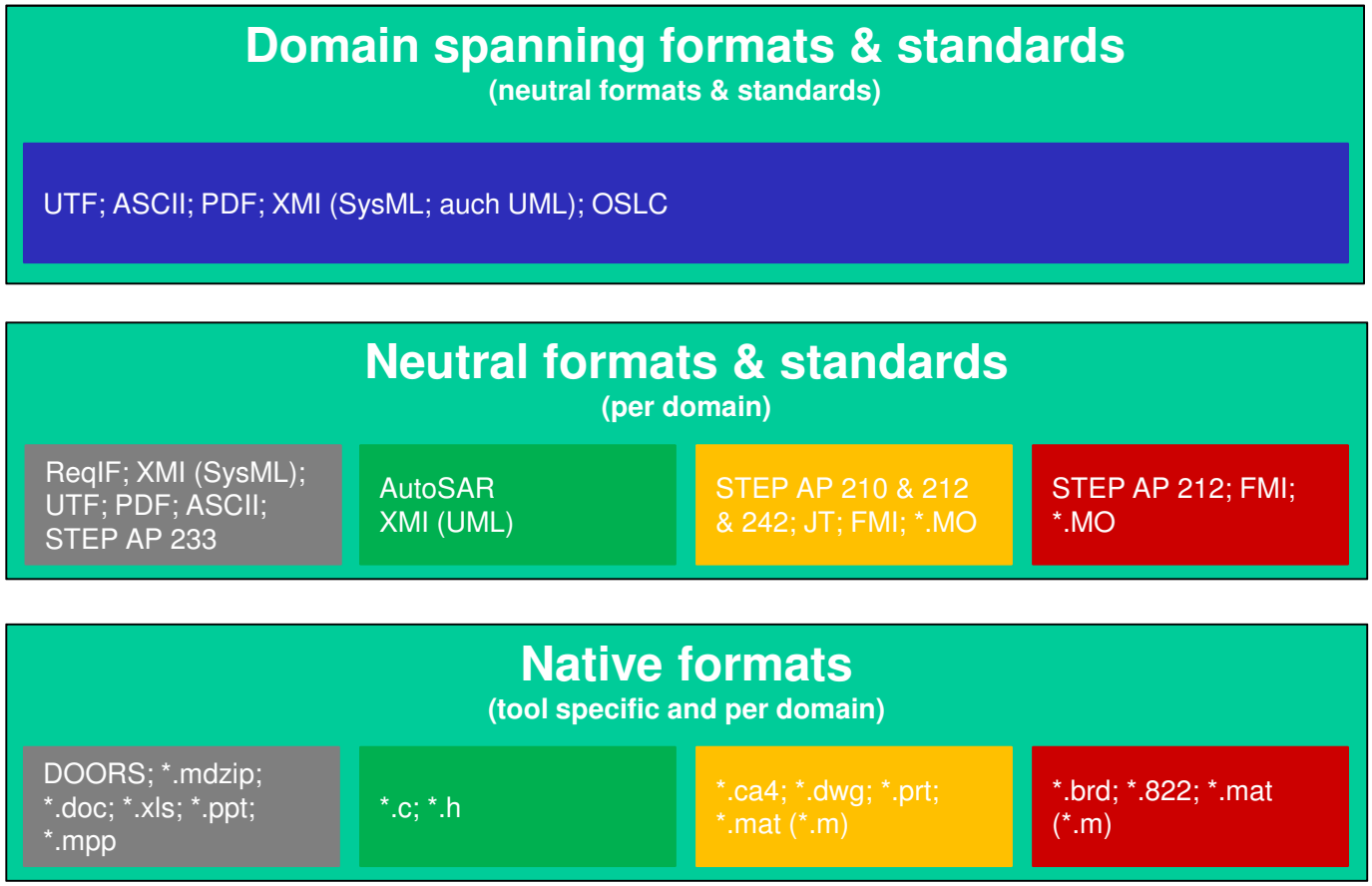
WP 4 FMI and others in context

Data and model formats in the SE process



ProSTEP iViP – The Future Starts Today

Formats & Standards Layer Model Concept



Those formats & standards are either suitable

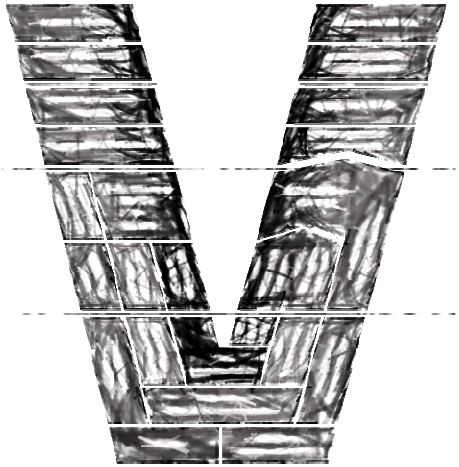
- for **coupling** of model content (OSLC) or
- for domain-spanning **control & coordination & information exchange** (PDF) or
- for **Systems Modelling** (SysML)

PDF for example could be suitable for pure read-access data exchange, yet without interaction.

Native formats. Often only used and supported by one or a few tools. Usually incompatibly to each other

Source: Brandstätter, ProSTEP AG

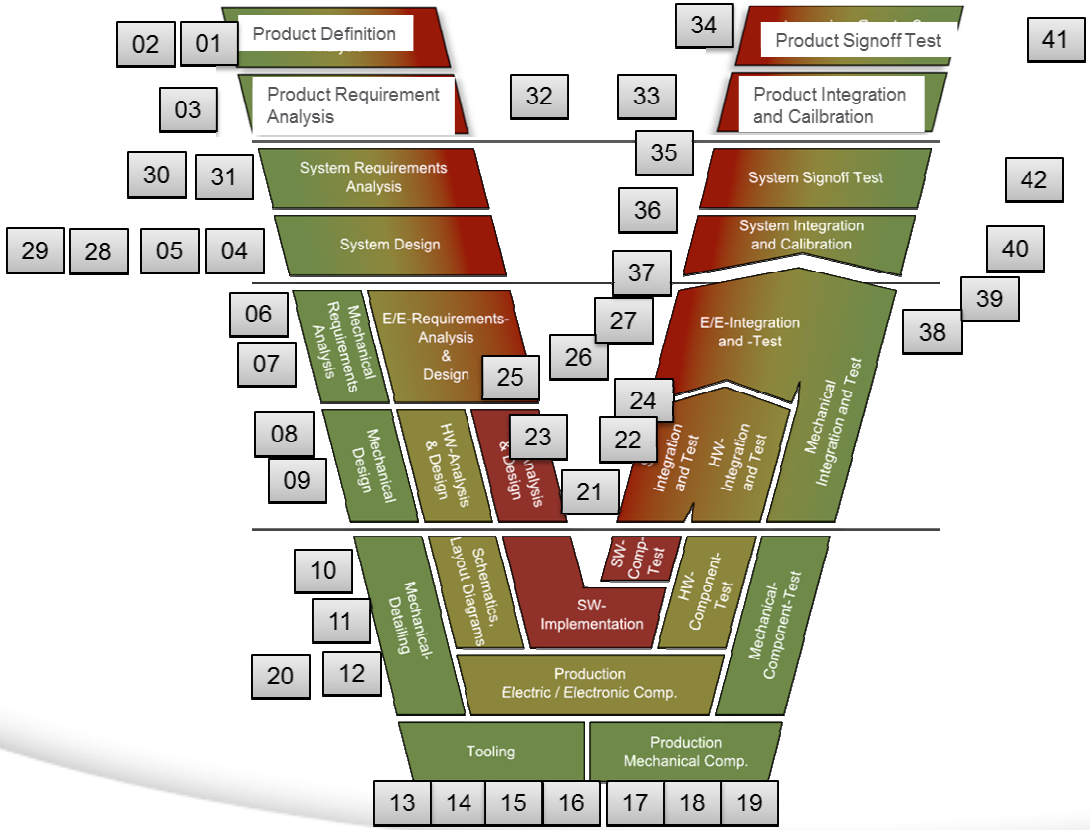
ProSTEP iViP – The Future Starts Today



WP 5 Behaviour Models and Data Management Integration

Behaviour Models in Data Management (DM)

- DM Functionalities were identified along the SE process and detailed



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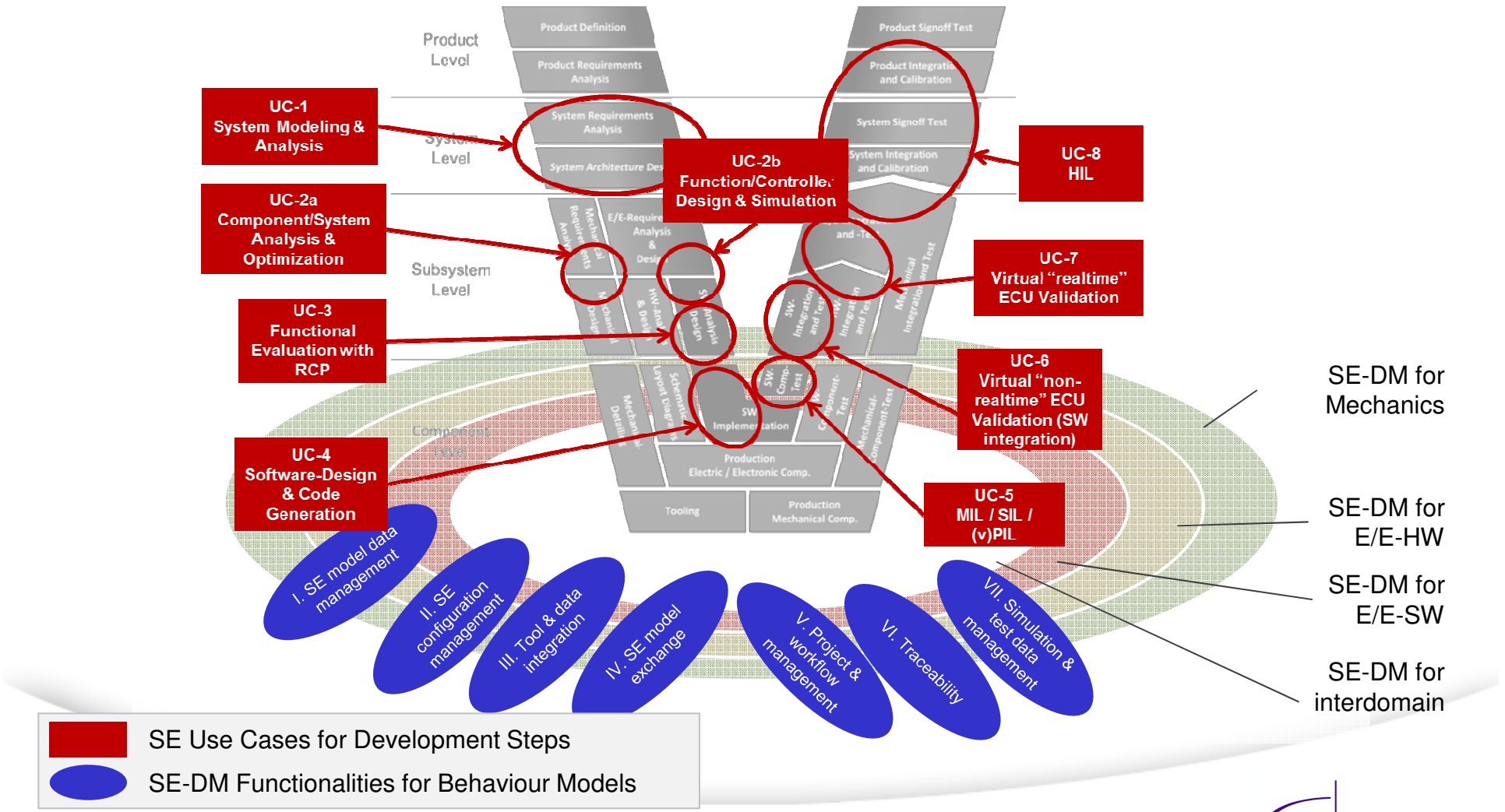
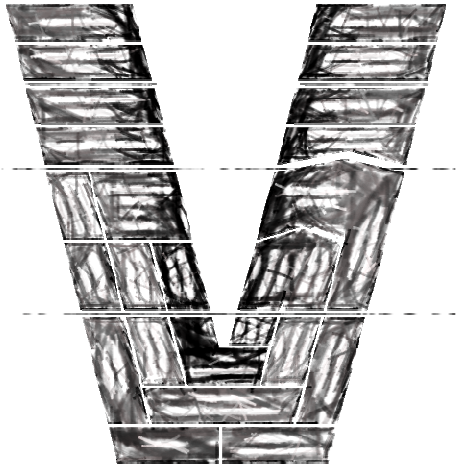
SE Uses Cases and Data Management (DM)





WP X – IP Protection in Behaviour Model Exchange

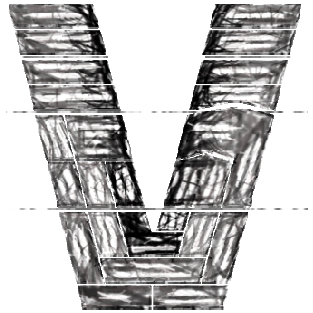
Roadmap WP IP Protection

2015: Clarify industrial demands on IP protection

- Short questionnaire, focusing on
  - guidelines for model exchange
  - IP protection technologies in use
  - show stoppers for model exchange

2016: Consequences for IP protection

- Evaluation of questionnaire
- Eliminate show stoppers for model exchange
  - Recommendation / Best practices for IP protection
  - Requirements to FMI / tools supporting FMI



Smart Systems Engineering – Phase 3

PLANNING 2016-2018

Project planning 2016-2018: Smart SE Phase 3 – Robust collaborative behavior modeling

WP 1 Project Management

Networking with other organizations and projects

- VDA, Modelica Association, FMI Steering Committee, INCOSE, GfSE, ISO, OMG
- AGESYS, MoSSEC, mecPro², etc.

Dissemination of project results and roadmap in:

- Publications: Produkt Daten Journal, Recommendation
- Conferences & congresses: ProSTEP iViP Symposium, SIA Congress 2016, …
- Newsletter: ProSTEP iViP

WP 2 Industrial Building Blocks in Vehicle Simulation Architectures

- Identification of standardization potentials in the area of mechatronic systems
- Differentiation between IP Protection or Standardization relevance of building blocks in vehicle simulation infrastructures
- Conceptualize an industrial building block system for vehicle simulation infrastructures

Project planning 2016-2018: Smart SE Phase 3 – Robust collaborative behavior modeling

WP 3 FMI Industrialization

- Business Case for FMI Industrialization
- Support the collaboration process between Smart SE and MAP FMI
- Prepare FMI Specification Issues: Compatibility, IP Protection, Interconnection of different FMUs etc.

WP 4 Challenges of Interdisciplinary Collaboration

- Business Case/ Potentials for SysML Industrialization
- Model-Based Traceability
- Human Factors

WP 5 Behavior models and Data Management Integration

- Enhance the concept for the PDM Integration of SE objects
- Enhance the behavior model exchange process with a FMI-Requirements-Specification Template

WP 6 IP Protection in Collaborative Behavior Modeling

- Analysis and proposal of technical measurements for an IP-secured collaborative behavior modeling