

# 15<sup>th</sup> Modlica Conference

## prostep SmartSE

### Building Blocks for Simulation based Cooperation between Partners



Aachen, October 2023  
Hans-Martin Heinkel, Bosch  
Pierre Mai, PMSF  
Martin Geissen, Unity

#### Process

*Structuring,  
assignment  
responsibilities*



#### Standards and Recommendations

*Simulation credibility, abstraction  
and modeling*



#### Information

*Harmonization  
metadata, semantics*



#### Data formats for exchange

*heterogeneous IT  
environments, collaboration*

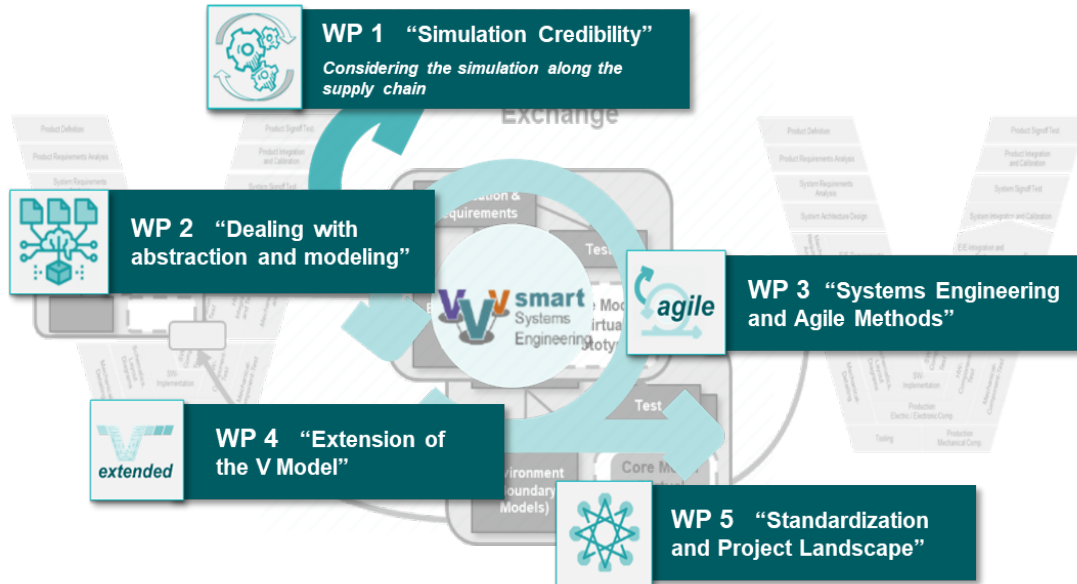


# Prostep SmartSE Project Consortium 2023

## Project phase 5: Work Packages and Fields of Action

*Mission Phase 5 (2022-2024)*

Enabling collaborative development and validation of complex products by simulation along a multi tier supply chain.

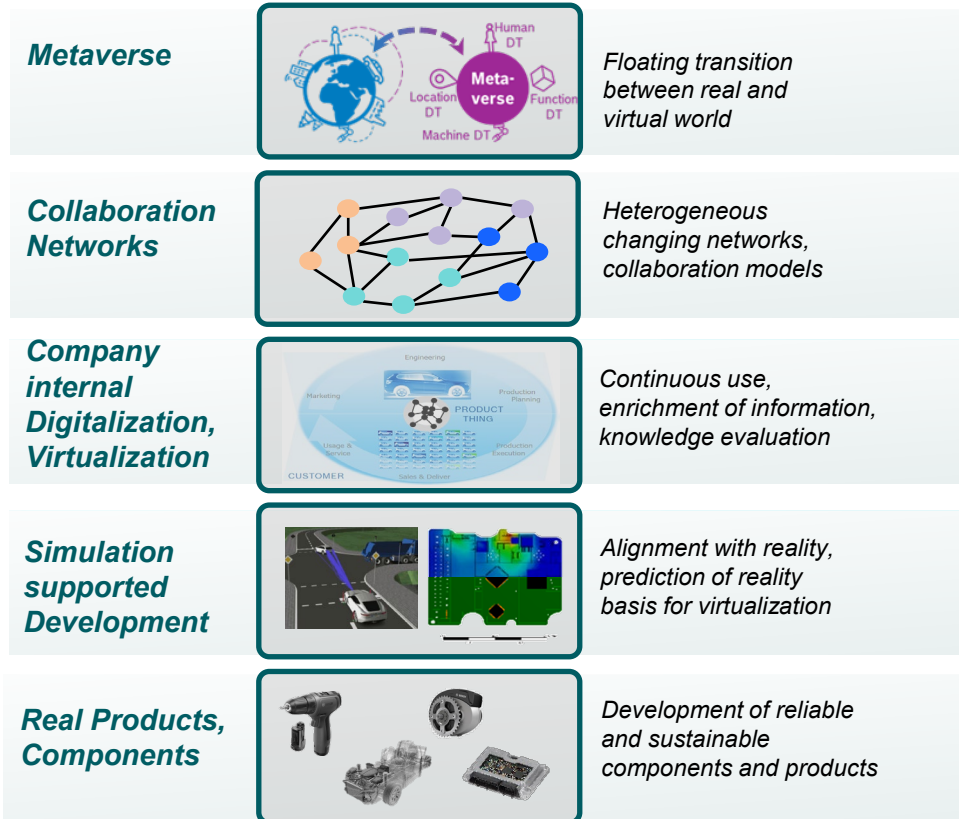


25+ project participants



# Prostep Smart Systems Engineering (SmartSE)

## Building Blocks for Simulation based Cooperation between Partners



**Strong involvement, interaction with users (people)**

**Availability of Information in heterogeneous IT environments,**

**Traceability, Simulation Credibility**

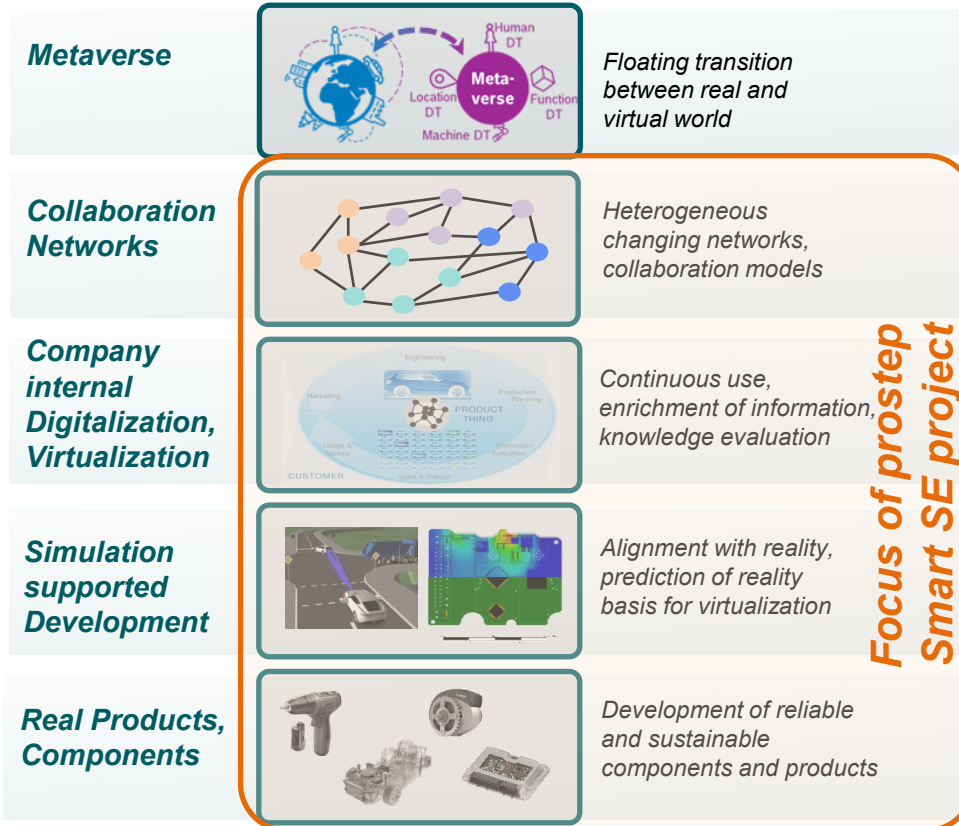
**Verification Validation of Models, Parameters, Simulation**

**Reduced number of real prototypes**

**We need Building blocks to support these challenges**

# Prostep Smart Systems Engineering (SmartSE)

## Building Blocks for Simulation based Cooperation between Partners



**Focus of prostep Smart SE project**



**Strong involvement, interaction with users (people)**

**Availability of Information in heterogeneous IT environments,**

**Traceability, Simulation Credibility**

**Verification Validation of Models, Parameters, Simulation**

**Reduced number of real prototypes**

**We need Building blocks to support these challenges**

# Building Blocks for Simulation based Cooperation Agenda

## Process

*Structuring,  
assignment  
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## Standards and Recommendations

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*Harmonization  
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## Data formats for exchange

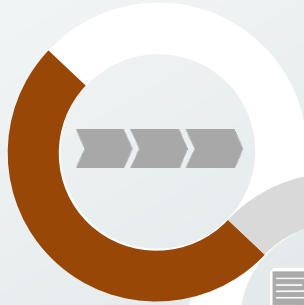
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environments, collaboration*



# Building Blocks for Simulation based Cooperation Agenda

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*Structuring,  
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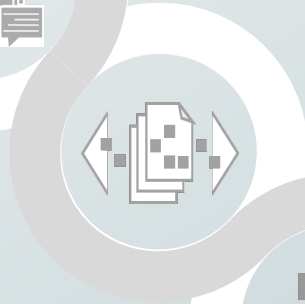
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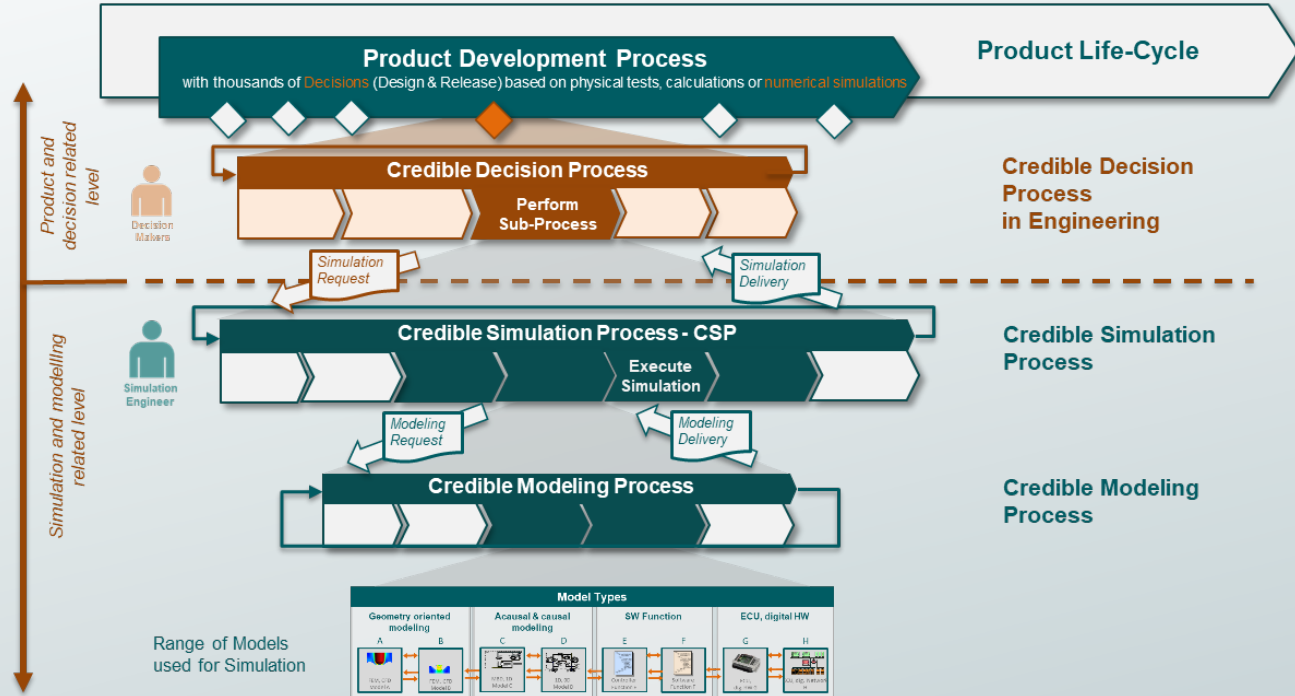


# Building Blocks for Simulation based Cooperation

## Structuring, Assignment Responsibilities

### Process hierarchy with clear information structuring

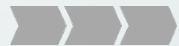
- Sub-processes can be integrated into specific company processes
- Clear assignment of responsibilities



# Building Blocks for Simulation based Cooperation Agenda

## Process

*Structuring,  
assignment  
responsibilities*



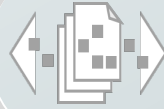
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## Information

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## Data formats for exchange

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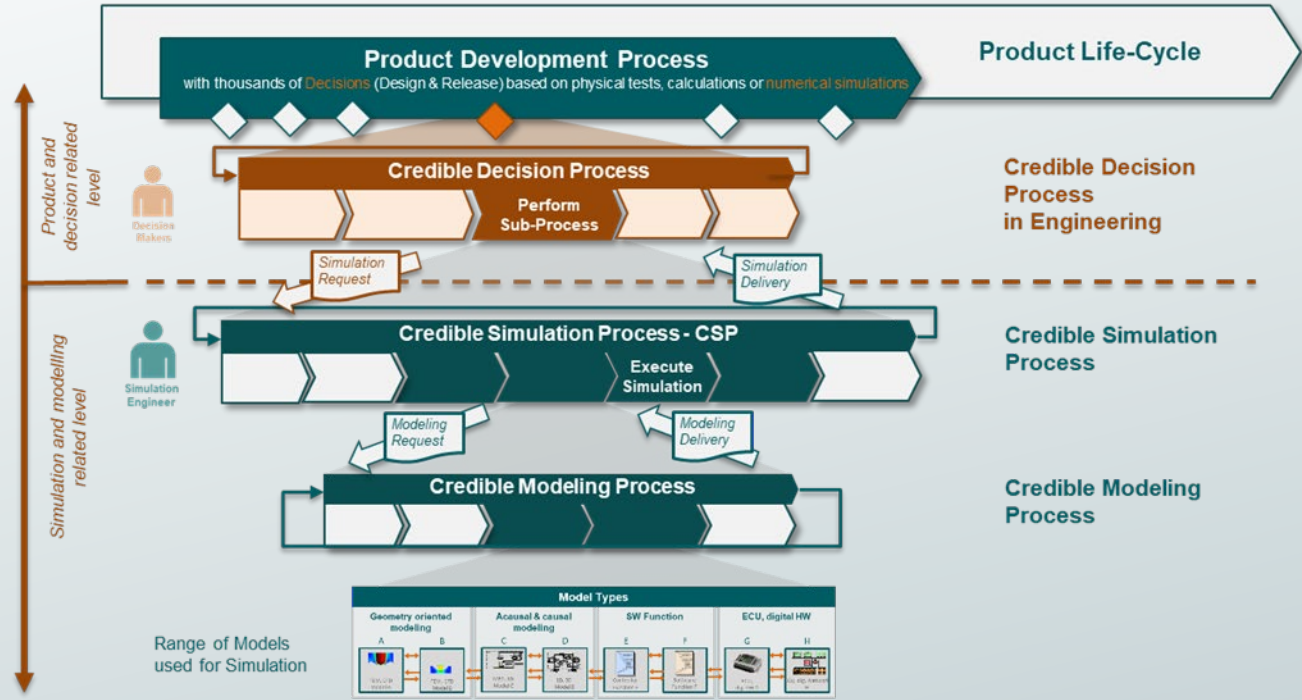
# Building Blocks for Simulation based Cooperation

## Standards and Recommendations for Simulation Credibility

Currently meetings for alignment “Big Picture and core terms” for Credible Decision Process Framework in Engineering with



as basis for domain specific credibility standards.



# Building Blocks for Simulation based Cooperation Agenda

## Process

*Structuring,  
assignment  
responsibilities*



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*Simulation credibility, abstraction  
and modeling*



## Information

*Harmonization  
metadata, semantics*



## Data formats for exchange

*heterogeneous IT  
environments, collaboration*



# Building Blocks for Simulation based Cooperation

## Harmonization Metadata, Semantics

### *Alignment of Model Metadata for Simulation and Traceability*

The exchange and reuse of simulation models within the company and with external partners is becoming increasingly important.

For efficient exchange and reuse

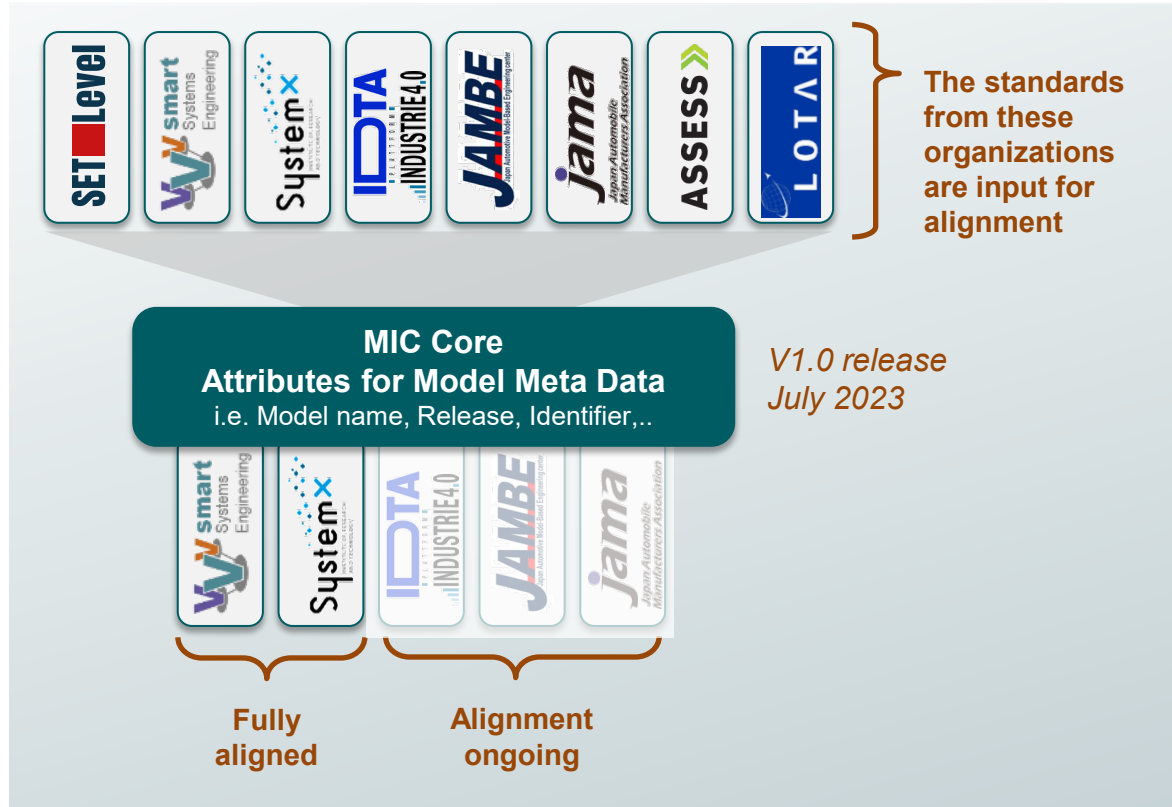
- Information, metadata about the properties of the models is required (what does the model represent, which effects are implemented)
- as well as administrative information (name, owner, version,...).

Currently there are several standards for model metadata, or they are being developed from these organisations



# Building Blocks for Simulation based Cooperation

## Alignment of Model Metadata for Simulation and Traceability



**Goal: not to have one standard**

**But:**

- to identify and harmonize the overlapping attributes
- so, there will be a common aligned part of attributes in every standard
- also, standard specific attributes according to the different use cases, domains

**The standards will stay independent but will have aligned parts**

# Building Blocks for Simulation based Cooperation

## SRMD Data Format and MIC Core Standard for Model Metadata

### Contents

#### 1. Introduction

- 1.1. Why MIC Core
- 1.2. What is MIC Core
- 1.3. Overview
- 1.4. Properties and Guiding Ideas
- 1.5. Versioning
- 1.6. How to Apply this Standard
- 1.7. How to Read This Document

#### 2. MIC Core Attributes

- 2.1. Administrative data
  - 2.1.1. Model name
  - 2.1.2. Model identifier
  - 2.1.3. Model description
  - 2.1.4. Release
  - 2.1.5. Release date
  - 2.1.6. Release type
  - 2.1.7. Model supplier
  - 2.1.8. Model confidentiality level
  - 2.1.9. Legal restriction
- 2.2. Purpose and objectives
  - 2.2.1. Model purpose
- 2.3. Subject information
  - 2.3.1. Modelled entity
- 2.4. Implementation
  - 2.4.1. Modeling choice
  - 2.4.2. Model limitations
  - 2.4.3. Model classification
  - 2.4.4. Software and hardware environment requirements
- 2.5. Verification and validation
  - 2.5.1. Verification status
  - 2.5.2. Validation status
  - 2.5.3. Verification & Validation procedure and criteria
  - 2.5.4. Verification & Validation report

#### 3. Conformance

#### References



## MIC Core Specification

Version 4528536, 2023-06-29

The MIC Core specification is a free standard that defines a set of harmonized model meta data attributes that meta-data standards can adopt to avoid ambiguity and incompatibility in common attributes across domains and standards. It is maintained as a joint undertaking of IRT SystemX and prostep ivip. Releases and issues can be found on [github.com/MIC-Core/MIC-Core](https://github.com/MIC-Core/MIC-Core).

Copyright © 2022-2023 IRT SystemX and 2022-2023 prostep ivip.

### 1. Introduction

#### 1.1. Why MIC Core

The exchange and reuse of simulation models within the company and with external partners is becoming increasingly important.

For efficient exchange and reuse

- Information, metadata about the properties of the models is required (what does the model represent, which effects are implemented)
- as well as administrative information (name, owner, version,...)

Currently there are several standards for model meta data, or they are being developed from several organisations

#### 1.2. What is MIC Core

Link to MIC Core specification

<https://mic-core.github.io/MIC-Core/main/>

# Building Blocks for Simulation based Cooperation

## SRMD Data Format and MIC Core Standard for Model Metadata

An implementation of the MIC Core Specification in the SRMD Standard is already available.

Simulation Resource Meta Data (SRMD) are part of the Modelica SSP-Traceability standard

### Implementation of MIC-Core in the SRMD metadata format

#### Introduction

In the following, an exemplary implementation of the MIC-Core standard into the SRMD metadata format will be shown. The SRMD (Simulation Resource Meta Data) metadata format is a subset of the SSP traceability STMD (Simulation Task Meta Data) format. These formats are part of the Modelica Association Project SSP (System Structuring and Parametrization). The SRMD format allows to specify any metadata, attributes in the form of key value pairs. The format description also specifies where this metadata file should be stored in an FMU or SSP (link to SSP traceability).

#### Mapping of MIC-Core attributes to the SRMD format

The following table shows the implementation. In the first column the attributes defined in the MIC core are listed. The second column lists the conversion of the attribute names to SRMD. For easier machine processability, clustering via presented terms separated by period is used here. No spaces are used. In column 3 an abbreviated explanation of the attributes is listed

MIC-Core Name	SRMD Mapping	Short Explanation
Model name	administrative-data.model.name	Human-readable way of referring to the model. Usually short and clear. Not necessarily unique
Model identifier	administrative-data.model.identifier	Unique identifier for the model.
Model description	administrative-data.model.description	Human-readable, textual, general overview. Highlights important information about the model.
Model supplier	administrative-data.model.supplier	The responsible body and, if applicable, organizational unit within the body, that is responsible for supplying the model.
Model confidentiality level	administrative-data.model.confidentiality-level	Protection level to apply to the model.
Legal restriction	administrative-data.legal-restriction	Defines the rules governing the distribution and usage of the simulation model, including licensing.
Release	administrative-data.release	Unique identifier, preferably human-readable (i.e. semantically meaningful), for the release of a particular simulation model.
Release date	administrative-data.release.date	Date, and possibly time and timezone, of the release of a simulation model. Must respect ISO 8601.
Release type	administrative-data.release.type	Relates to the maturity of the model.

# Building Blocks for Simulation based Cooperation

## SRMD Data Format and MIC Core Standard for Model Metadata

Dymola

```

<?xml version="1.0" encoding="UTF-8" standalone="yes" ?>
<srmd:SimulationResourceMetadataData version="1.0.0-beta2" name="SSP-Model SRMD" generationTool="orchideo | easySSP (eXcellent solutions GmbH)" generationDa
<!-- MIC core attributes -->
<stc:Classification type="org.prostep.srmd.mic-core">
  <stc:ClassificationEntry keyword="administrative-data.model.name">Permanent Magnet Synchronous Machine in abc</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.model.identifier">EMPSM3E01MSEREF</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.model.description">This is a model of a Permanent Magnet Synchronous Machine - PMSM - in ab
  either in wye or delta connection, which considers linear magnetic condition
  (i.e., no magnetic saturation, hysteresis loss and spatial harmonics).</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.model.supplier">Robert Bosch GmbH, RB-CoC Simulation</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.model.confidentiality-level">C-SC 1</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.legal-restriction">BIOS License v4</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.release">20XX.Y.Z</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.release.date">May 1, 2022</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.release.type">internal-release</stc:ClassificationEntry>

  <stc:ClassificationEntry keyword="purpose-objectives.model">Requirement derivation resp. development of control strategies for electric powertra
  or around a given operation point (linearization)</stc:ClassificationEntry>

  <stc:ClassificationEntry keyword="implementation.modeling-choice">Refer to related user documentation, 'Features' section.</stc:ClassificationEnt
  <stc:ClassificationEntry keyword="implementation.modelled-entity">Small motors (~500W), but also motors with either low magnetic saturation
  or around a given operation point (linearization)</stc:ClassificationEntry>

  <stc:ClassificationEntry keyword="verification-validation.verification-status">has been verified.</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="verification-validation.validation-status">has been verified.</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="verification-validation.procedure-criteria">Verification: Refer to related 'test' documentation.</stc:Classific
  <stc:ClassificationEntry keyword="verification-validation.report">Verification: Refer to related 'test results' documentation.</stc:Classificati
  <stc:ClassificationEntry keyword="verification-validation.report">Validation: Refer to related library overview documentation, 'Validation' secti
  </stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="verification-validation.report">This model shall not be used to design electric machines.</stc:ClassificationEnt
</stc:Classification>

<!-- MSE core attributes -->
<stc:Classification type="de.bosch.srmd.mse">
  <stc:ClassificationEntry keyword="administrative-data.library-name">mseref.emachines.simulink</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.type">Physical principle</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.family">Electric machines</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="administrative-data.modelling-approach">Lumped-element considering only the electric part of a PMSM</stc:Classif
  <stc:ClassificationEntry keyword="administrative-data.use">Load 'mseref.emachines.simulink' library in Simulink. (Optional) Set paths to 'mseref'.
  <stc:ClassificationEntry keyword="administrative-data.release-status">Stable</stc:ClassificationEntry>

  <stc:ClassificationEntry keyword="implementation.format">Simulink (embedded blocks),
  possibility to export model as FMU (model exchange), as .exe-file resp. as S-function via Simulink coder.
  Internal MSEREF interface standard, refer to 'mseref.emachines.simulink' library, section 'E-machine interfaces'</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="implementation.performance-characteristics">No requirement regarding realtime capability</stc:ClassificationEnt

  <stc:ClassificationEntry keyword="development-history.feature">Link to related SSP-file</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="development-history.bug-fix">Link to related SSP-file</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="development-history.feature">Link to related SSP-file</stc:ClassificationEntry>
  <stc:ClassificationEntry keyword="development-history.creation">Link to related SSP-file</stc:ClassificationEntry>
</stc:Classification>
</srmd:SimulationResourceMetadataData>

<!-- MSE Standards | unreleased | Internal | © Robert Bosch GmbH 2023. All rights reserved, also regarding any disposal, exploitation, reproduction,
editing, distribution, as well as in the event of applications for industrial property rights. -->
  
```

SSP-Model SRMD

Key	Description
	<b>Type: org.prostep.srmd.mic-core.administrative-data</b>
model name	Permanent Magnet Synchronous Machine in abc
model identifier	EMPSM3E01MSEREF
model description	This is a model of a Permanent Magnet Synchronous Machine - PMSM - in abc coordinates, either in wye or delta connection, which considers linear magnetic condition (i.e., no magnetic saturation, hysteresis loss and spatial harmonics).
release	20XX.Y.Z
release date	May 1, 2022
release type	internal-release
model supplier	Robert Bosch GmbH, RB-CoC Simulation
model confidentiality-level	C-SC 1
legal restriction	BIOS License v4
	<b>Type: org.prostep.srmd.mic-core.purpose-objectives</b>
model purpose	Requirement derivation resp. development of control strategies for electric powertrain.
	<b>Type: org.prostep.srmd.mic-core.subject-information</b>
modelled-entity	Small motors (~500W), but also motors with either low magnetic saturation rates or around a given operation point (linearization).
	<b>Type: org.prostep.srmd.mic-core.implementation</b>
modeling-choice	Refer to related user documentation, 'Features' section.
model limitations	Refer to related user documentation, 'Model assumptions and limits' section.
model classification	Linear, causal.

orchideo | easySSP | MIC-Core-SRMD-Example.srmd

Read

org.prostep.srmd.mic-core

administrative-data	
model	
name	Permanent Magnet Synchronous Machine in abc
identifier	EMPSM3E01MSEREF
description	This is a model of a Permanent Magnet Synchronous Machine
supplier	Robert Bosch GmbH, RB-CoC Simulation
confidentiality-level	C-SC 1
legal-restriction	BIOS License v4
release	20XX.Y.Z
date	May 1, 2022
type	internal-release
purpose-objectives	
model	Requirement derivation resp. development of control strategies
subject-information	
modelled-entity	Small motors (~500W), but also motors with either low magnetic saturation rates or around a given operation point (linearization).
implementation	

Simulation Resource Meta Data (SRMD) are part of the Modelica SSP-Traceability standard

# Building Blocks for Simulation based Cooperation Agenda

## Process

*Structuring,  
assignment  
responsibilities*



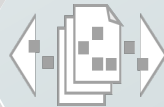
## Standards and Recommendations

*Simulation credibility, abstraction  
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## Information

*Harmonization  
metadata, semantics*



## Data formats for exchange

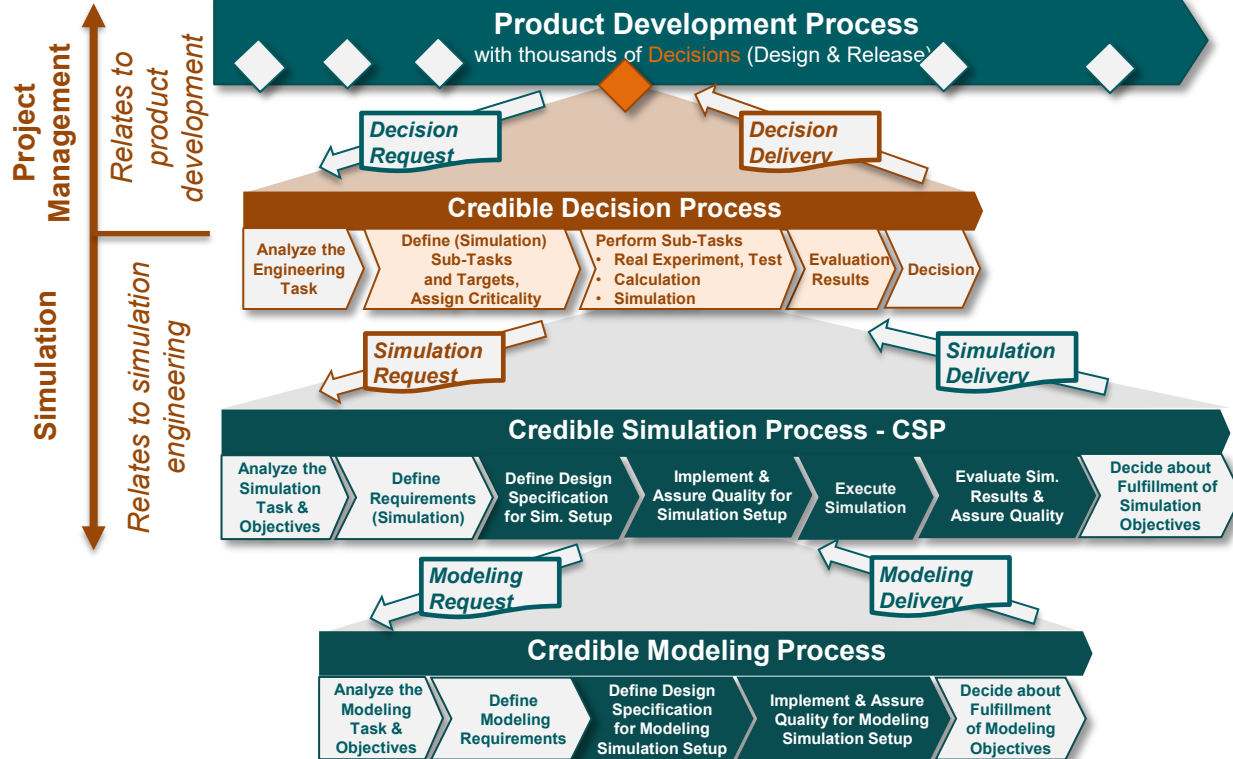
*heterogeneous IT  
environments, collaboration*





# Building Blocks for Simulation based Collaboration

## Data Formats & Processes for Exchange: Heterogeneous IT Environments, Collaboration

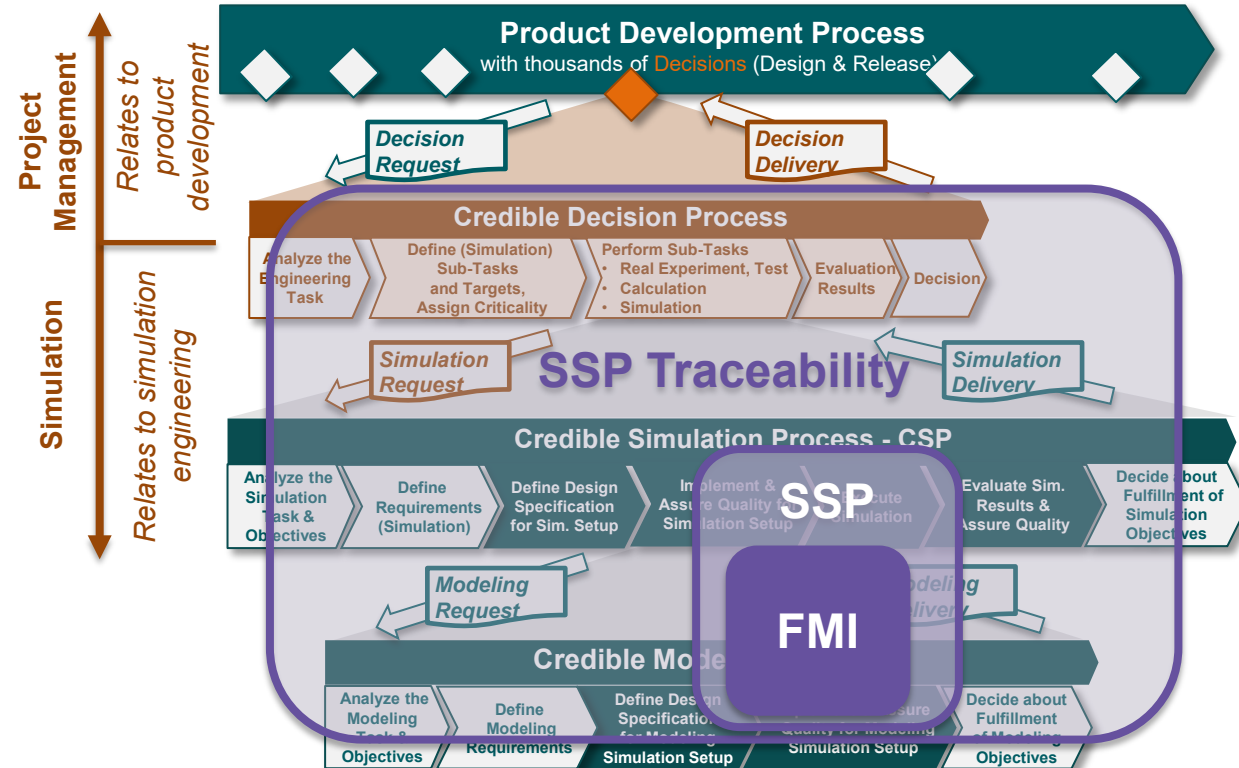


### Credible Simulation Process Framework

- Process hierarchy with clear information structuring
- Sub-processes can be integrated into specific company processes

# Building Blocks for Simulation based Cooperation

## Data Formats for Exchange: Heterogeneous IT Environments, Collaboration



Within the Modelica Association, data standards for the exchange of simulation artifacts between tools are developed and supported.

- **FMI project:**
  - Exchange of models on system level  
→ (FMI3.0)

- **SSP project**
  - Exchange of model architectures and parameter sets.  
→ SSP1.0 with standard layer  
SSP Traceability (GlueParticle)



# Building Blocks for Simulation based Cooperation

## From Process to Traceability in Heterogeneous IT Environments, Collaboration

### Process

- Reproducibility
- Traceability



### Workflow

- Concrete implemented process
- Repeatability

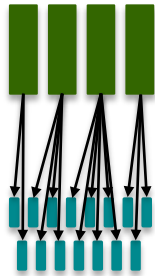


### Information Chain

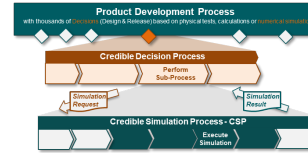
- Process-data-modell
- **GlueParticle**

### Information Artefacts

- Artefacts linked to information chain
- For traceability, reuse

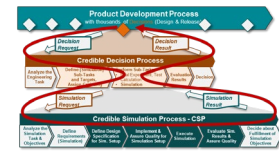


### From Process



to

### Traceability

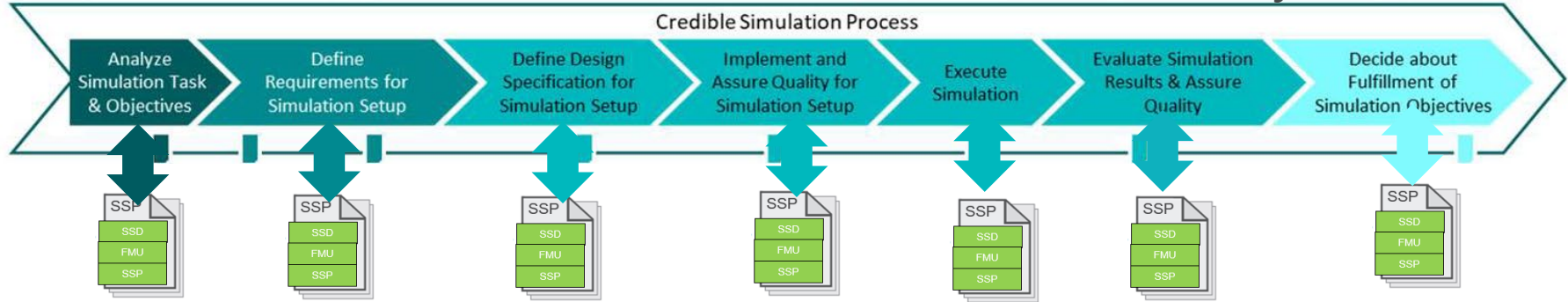


- ▶ Clear structuring of information
- ▶ Transparency of the information linkage of workflows, processes
- ▶ **With GlueParticle Approach**
  - ▶ Consistency of process chain and information chain
  - ▶ Is integrated part in workflow
  - ▶ After the workflow run, a filled information chain is available, no post documentation

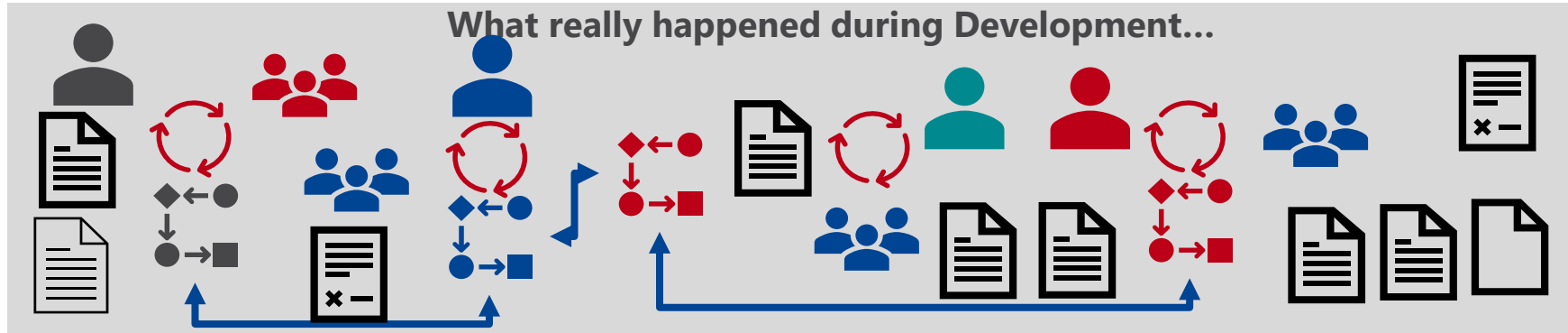
# Credible Simulation Process (CSP) + SSP-Traceability (GlueParticle)

## The CSP is a **Documentation** Standard to establish Traceability

How it is documented in a traceable and standardized way...

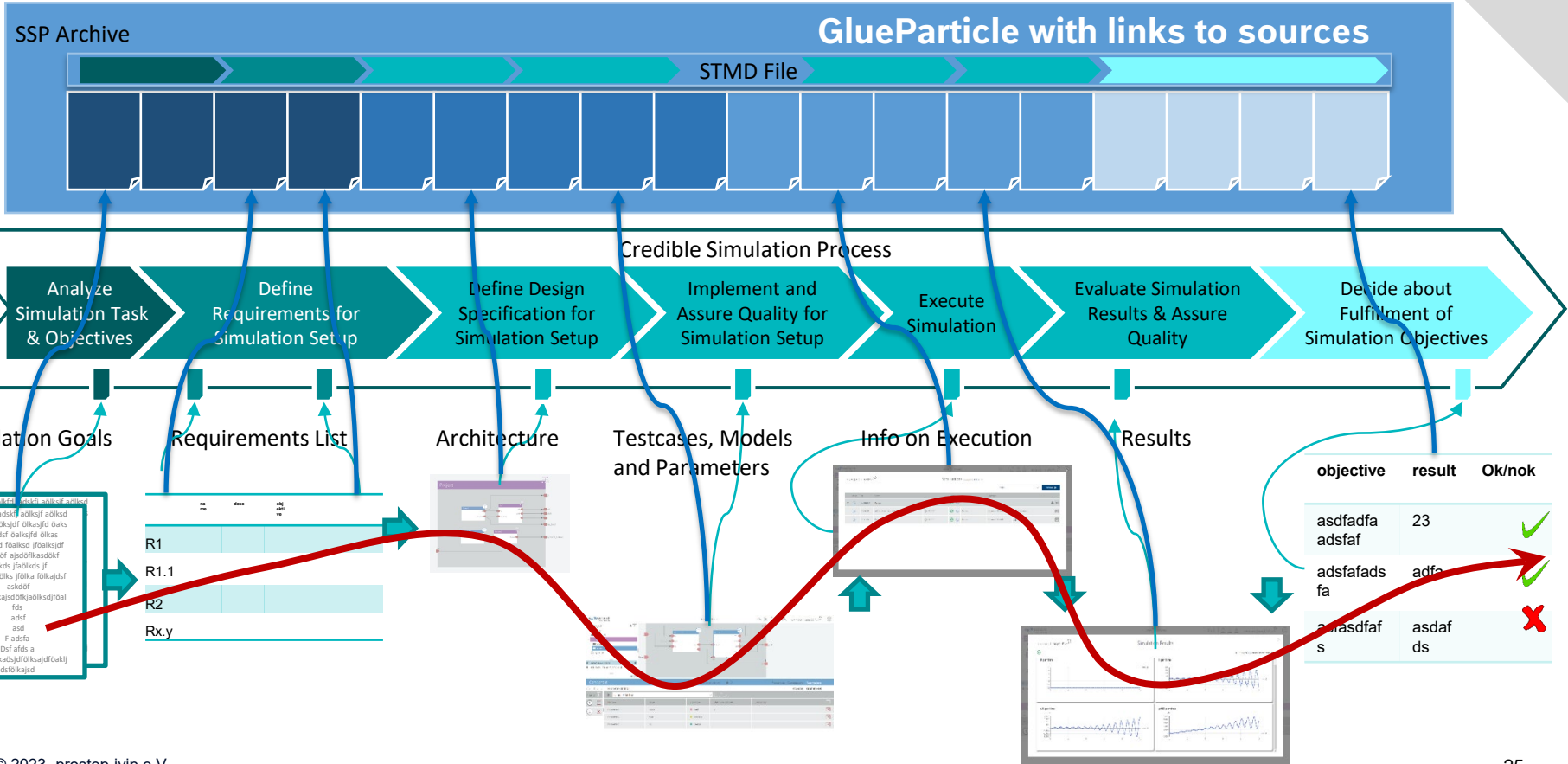


### What really happened during Development...



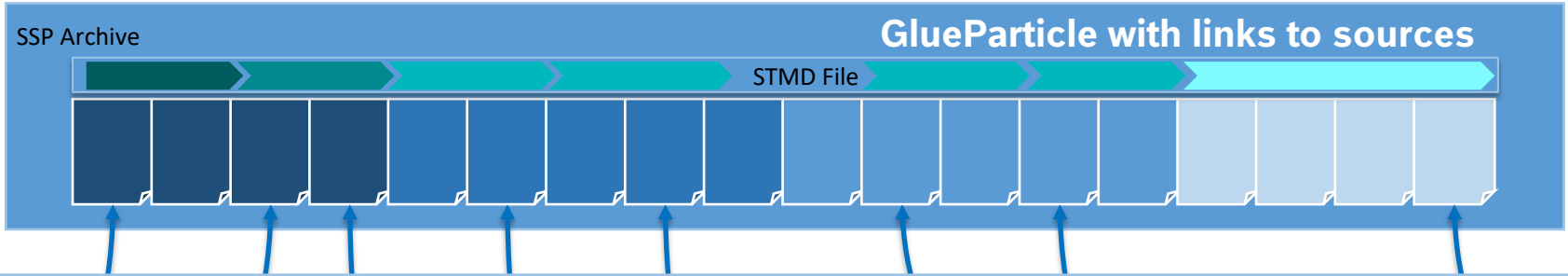
# Building Blocks for Simulation based Cooperation

## Traceability from Requirements to Simulation Result



# Building Blocks for Simulation based Cooperation

## Traceability from Requirements to Simulation Result



### SSP Traceability Specification

Layered on top of SSP Standard

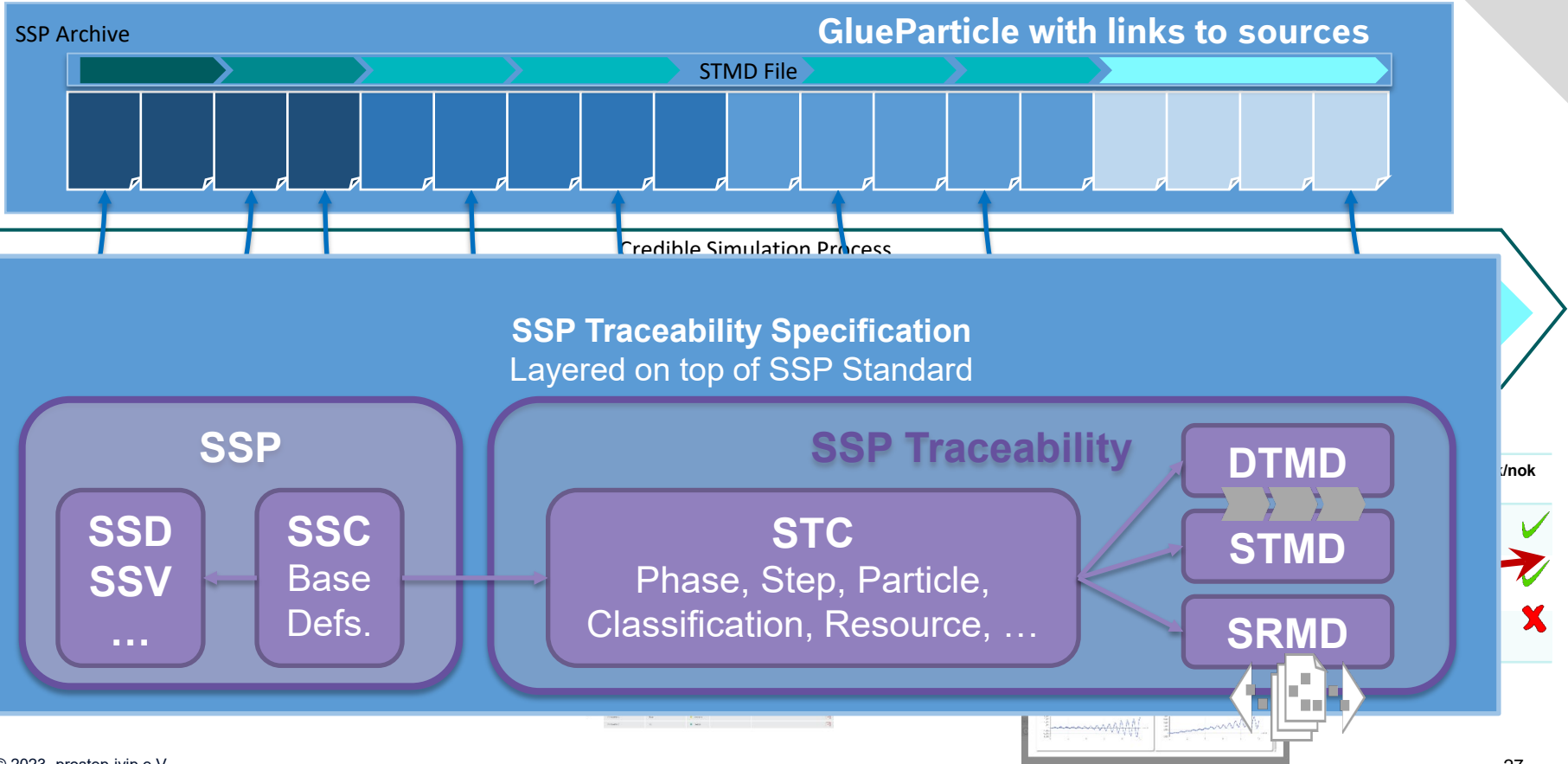
- Based on SSP formats and principles
- Generic approach of phases and steps
- Instantiated for CSP as STMD format
- Each step contains Input, Procedure, Output, Rationale information, referencing Resources
- Additional Linking, Life Cycle & Classification
- SSP ZIP packaging
- (Relative) URI references to resources
- Multi-format support for resources
- Common XML schema components
- Extensibility via annotations
- Devolves into pure SSP for pure SSP tools

/nok



# Building Blocks for Simulation based Cooperation

## Traceability from Requirements to Simulation Result



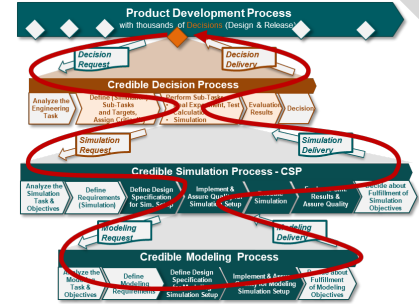
# Building Blocks for Simulation based Cooperation

## Data formats for exchange, heterogeneous IT Environments, Collaboration

Consistent data formats (SSP Traceability) for the Credible Simulation Framework are available. They support the cooperation between partners in heterogeneous environments.

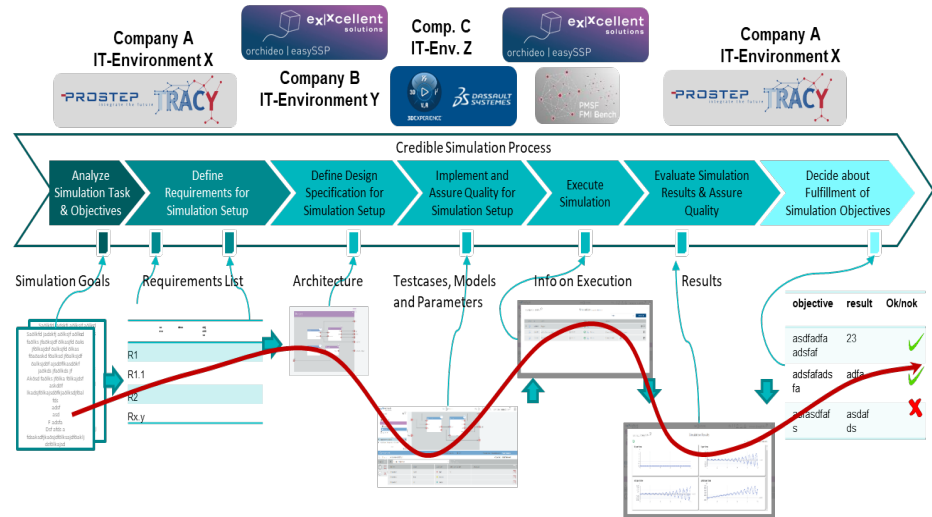
ID	Requirement	Value
01	Requirement 1	100
02	Requirement 2	200
03	Requirement 3	300
04	Requirement 4	400
05	Requirement 5	500
06	Requirement 6	600
07	Requirement 7	700
08	Requirement 8	800
09	Requirement 9	900
10	Requirement 10	1000

Tool support is already available.



## 2023-24: Establish realistic automotive use cases for SSP, CSP, traceability, meta data management

- Open to SmartSE partners to facilitate the collaborative development among us and along the value chain
- A communication medium between SmartSE and other consortia, e.g. JAMBE or CATENA-x





# Building Blocks for Simulation based Cooperation

## Data Formats for Exchange: Heterogeneous IT Environments, Collaboration

Consistent data formats (SSP-Traceability) for the Credible Simulation Framework are available.

They support the cooperation between partners in heterogenous environments

### SmartSE Use Case Proposal 2022 - 2024

CONFIDENTIAL

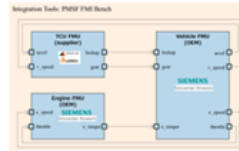
Collaborative Development and Engineering Data Management of a Transmission Control Unit (TCU) Design based on FMI/SSP

2021  
FMI/SSP proof of concept for TCU development

DENSO  
Crafting the Core

PMSF  
IT Consulting

em  
engineering  
Methods & AI



+ realistic example  
- part of value chain  
- no traceability

Traceability, Exchange of Simulation Tasks based on Glue Particle

BOSCH

CONVENSIA  
CONVENSIA

PROSTEP

PMSF  
IT Consulting

exiXcellent  
networks



+ traceability  
- part of value chain  
- simple example

DENSO  
Crafting the Core

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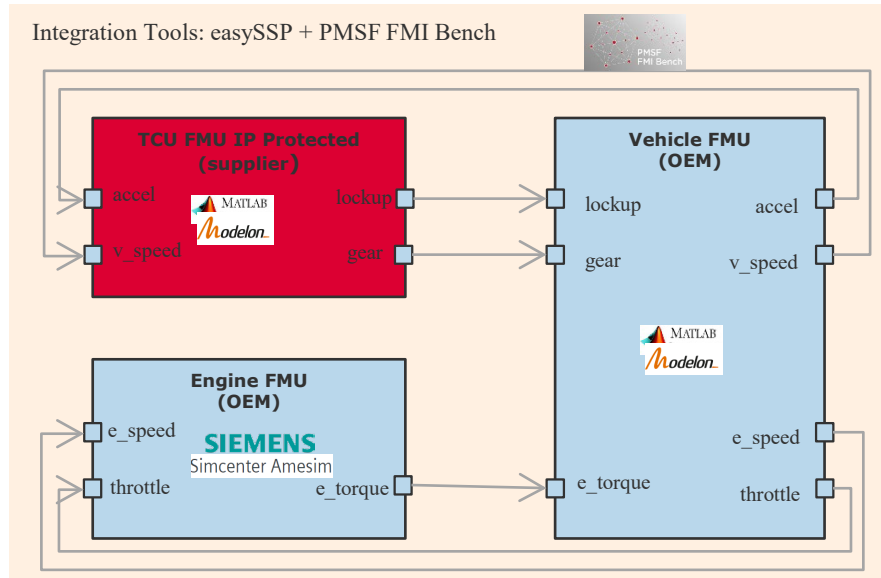
2022-2024

Establish a realistic automotive use case for ssp, csp, traceability, meta data management

- Open to SmartSE partners to facilitate the collaborative development among us and along the value chain
- A communication medium between SmartSE and other consortia, e.g. JAMBE or CATENA-x

# Collaborative Simulation-based Engineering

## Use Case\*: Collaborative Transmission Control Unit (TCU) Design



*\*This is an example use case. It does not represent any real business case.*

### Showcase

Supplier to design, test and calibrate TCU based on OEM specs and requests.

### Fokus

Usage of Credible Simulation Process (CSP), SSP-Traceability, MIC-Core Metadata

### Engine Model →

Internal combustion engine

### Vehicle model →

rest of the vehicle. Maintains the engine state, vehicle state; provides accelerator and throttle positions

### TCU model →

provides transmission lockup and gear ratio information, based on the vehicle speed / acceleration information.

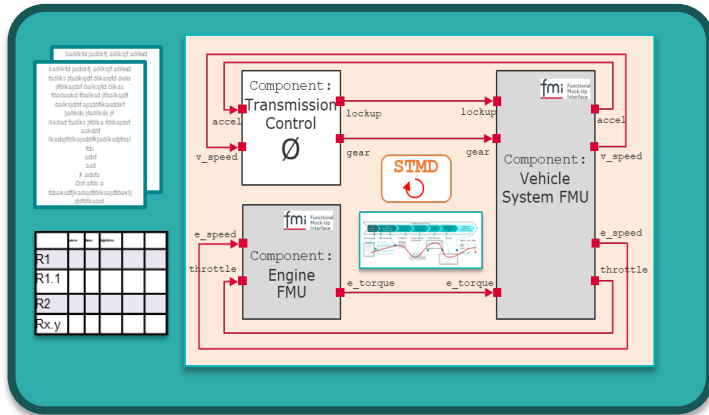
**In Scope: Exchange of all artefacts required for an efficient, cross-company simulation-based engineering like specifications, requirements, test cases, simulation models and model meta data.**

# Collaborative Simulation-based Engineering

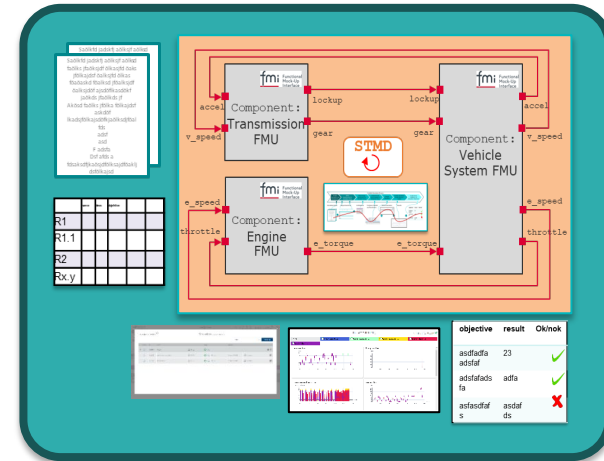
## Use Case\*: Collaborative Transmission Control Unit (TCU) Design

**Story:** Supplier to design, test and calibrate TCU based on OEM specs and requests.

### Request Package



### Delivery Package



The OEM submits the TCU specification as an envelope specification, as well as the other documents as an SSP container.

The supplier transfers the TCU model and the results as an SSP container. Here the SSP standard layer SSP-traceability (STMD format) is used.

*\*This is an example use case. It does not represent any real business case.*

# Collaborative Simulation-based Engineering

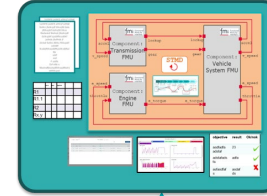
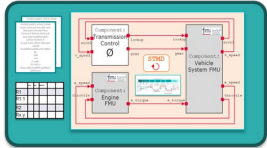
## Traceability from requirements to simulation result

Request Package

Exchange between Partners and Tools

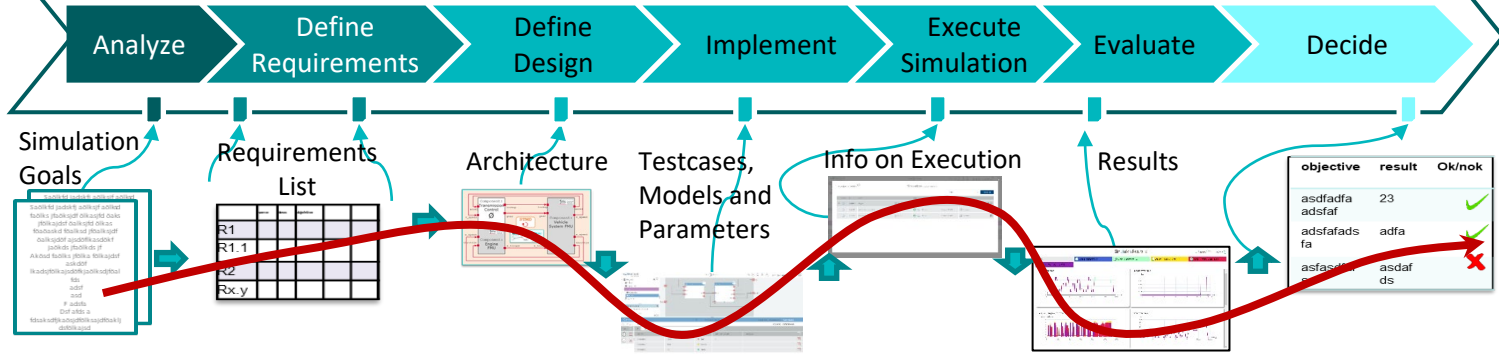
Delivery Package

Data Management



Import / Export Packages and merge Data

### Credible Simulation Process



This approach is based on the Credible Simulation Process Framework and open standards like FMI, SSP, SSP-Traceability



# Building Blocks for Simulation based Cooperation Agenda

## Process

*Structuring,  
assignment  
responsibilities*



## Standards and Recommendations

*Simulation credibility, abstraction  
and modeling*



## Information

*Harmonization  
metadata, semantics*



## Data formats for exchange

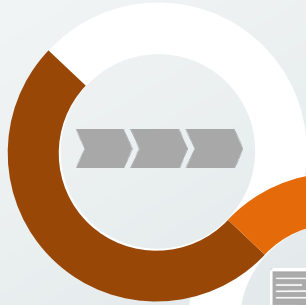
*heterogeneous IT  
environments, collaboration*



# Building Blocks for Simulation based Cooperation

## Where does it go?

**Process**  
**SmartSE**  
**2023/24**



**Standards and Recommendations**

**SmartSE + ASME & INCOSE & NAFEMS**  
**2023ff**



**Information**

**MIC-Core**  
**Q2/2023**



**Data formats for exchange**

**Modellica Association Prj. SSP**  
**SSP Traceability 1.0 Q4/2023**  
**SSP 2.0 Q4/2023**



# prostep ivip SmartSE Phase V

## Mission Phase 5

(2022-2024)

Enabling collaborative development and validation of complex products by simulation along a multi tier supply chain.

If you are interested in these topics: Get in contact with us during the conference



Hans-Martin Heinkel  
Robert Bosch GmbH



Pierre Mai  
PMSF



Peter Lobner  
eXXcellent solutions



Dag Brück  
Dassault Systèmes

### Or Contact

Melanie Kluge, [melanie.kluge@b-h-c.de](mailto:melanie.kluge@b-h-c.de)

Tel.: +49 7031 2050002

Thank you  
for your attention





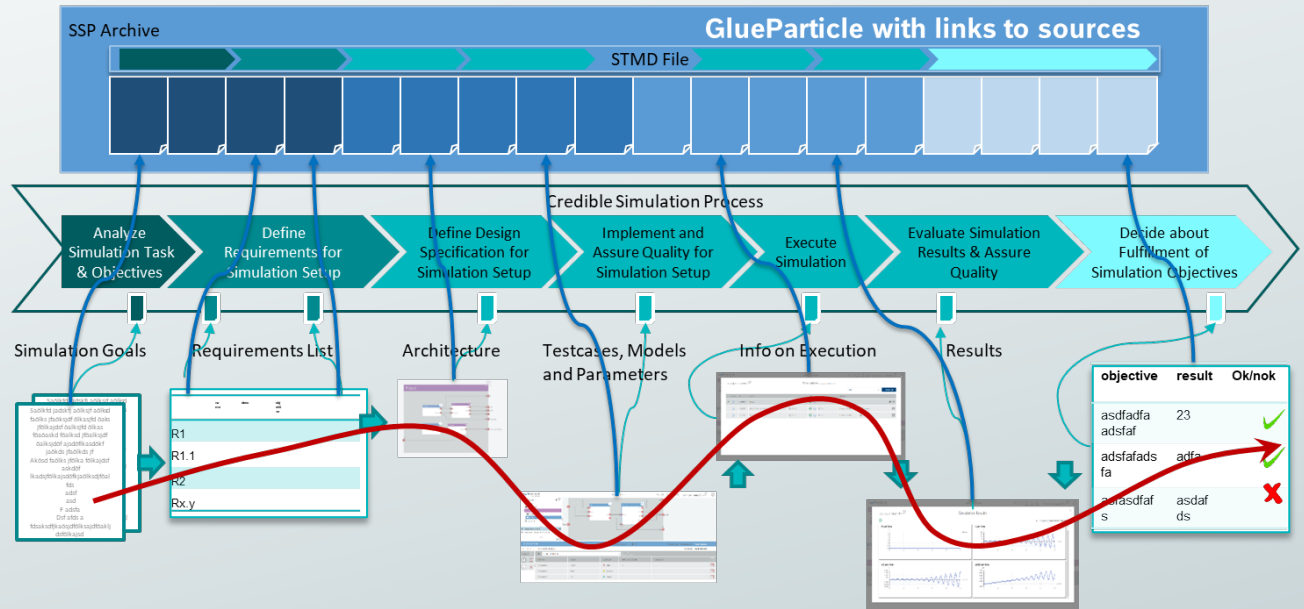
# Building Blocks for Simulation based Cooperation

## Data Formats for Exchange: Heterogeneous IT Environments, Collaboration

*Traceability supported by GlueParticle Approach*

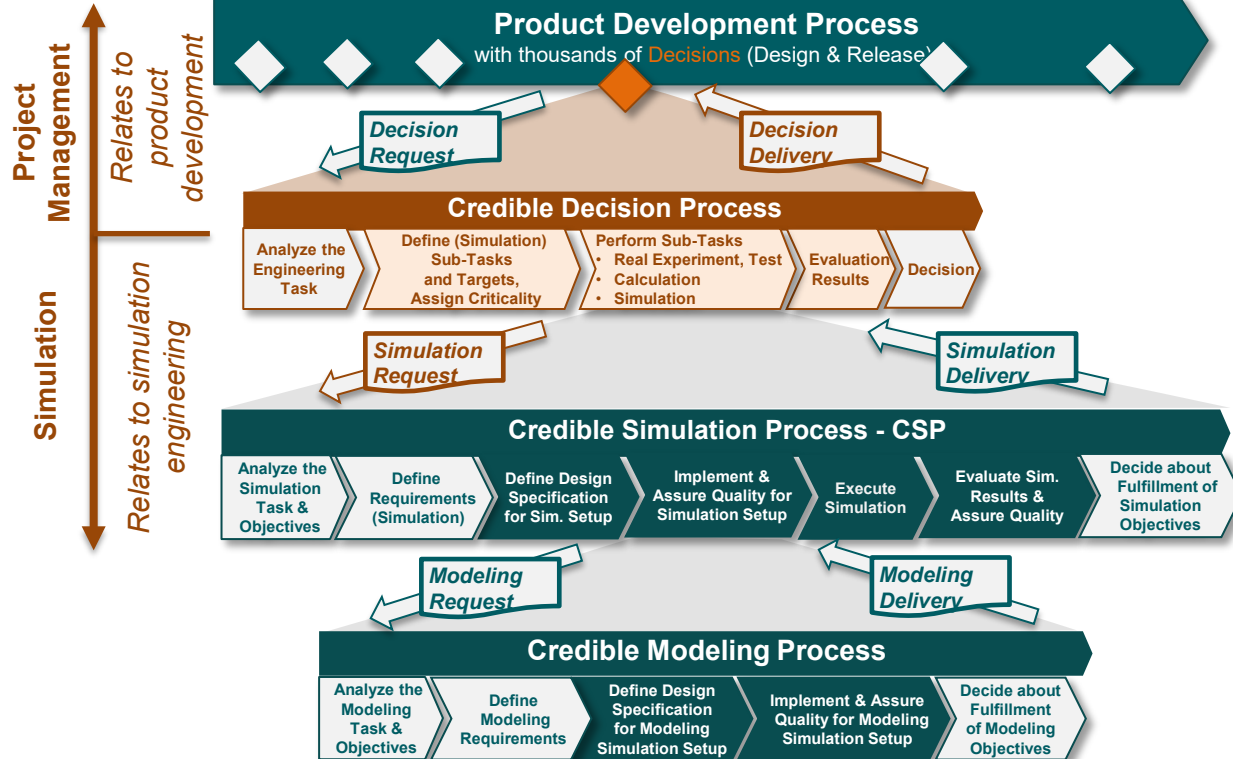


### Traceability from requirements to simulation result



# Building Blocks for Simulation based Collaboration

## Data Formats & Processes for Exchange: Heterogeneous IT Environments, Collaboration

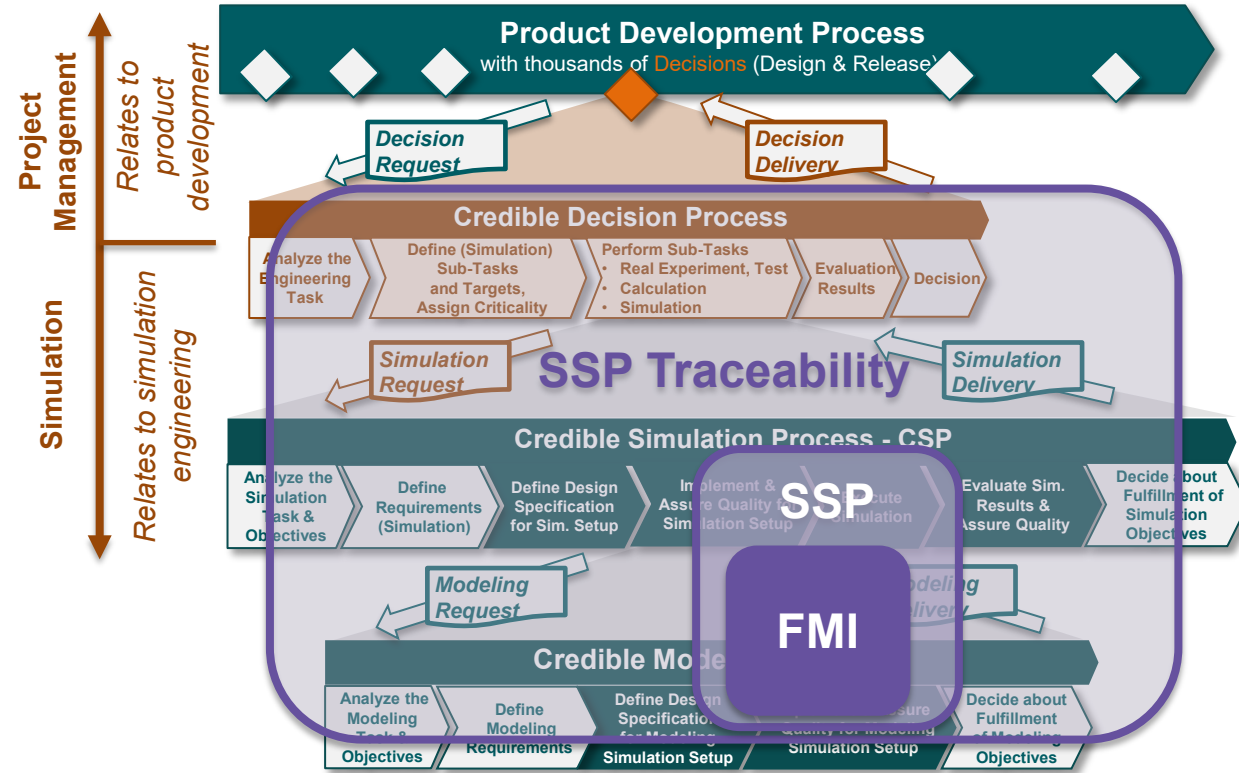


### Credible Simulation Process Framework

- Process hierarchy with clear information structuring
- Sub-processes can be integrated into specific company processes

# Building Blocks for Simulation based Collaboration

## Data Formats for Exchange: Heterogeneous IT Environments, Collaboration



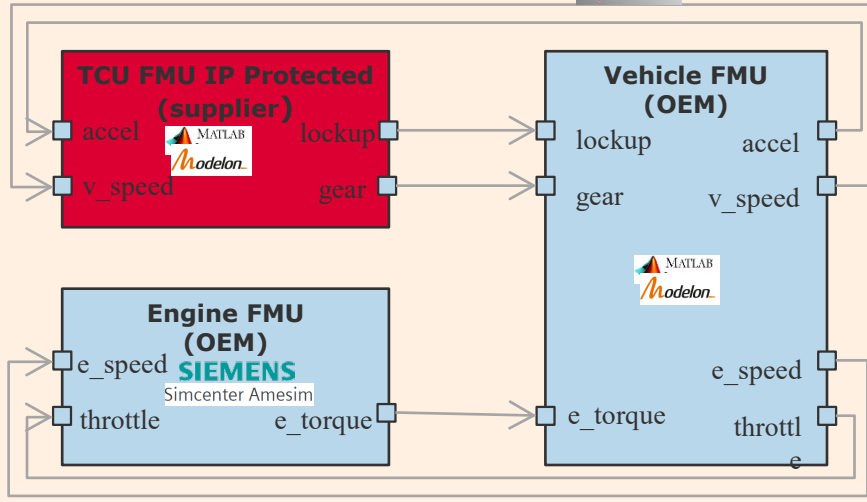
Within the Modelica Association, data standards for the exchange of simulation artifacts between tools are developed and supported.

- **FMI project:**
  - Exchange of models on system level → (FMI3.0)



# Motivation Smart Systems Engineering (SmartSE) Collaborative Simulation-based Engineering

Integration Tools: easySSP + PMSF FMI Bench



## Showcase 1

Supplier to design, test and calibrate TCU based on OEM specs and requests.

## Fokus

Usage of CSP, SSP-Traceability, MIC-Core Metadata

## Engine Model →

Internal combustion engine

## Vehicle model →

rest of the vehicle. Maintains the engine state, vehicle state; provides accelerator and throttle positions

## TCU model →

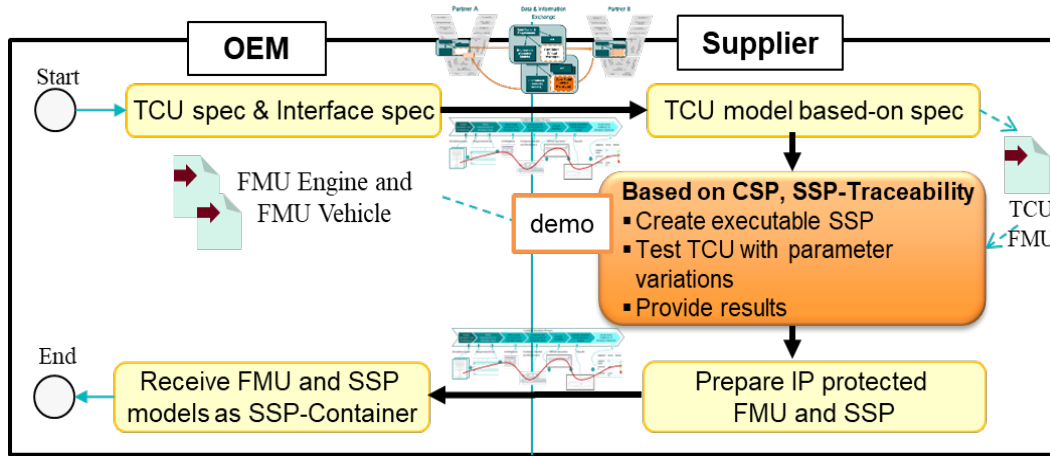
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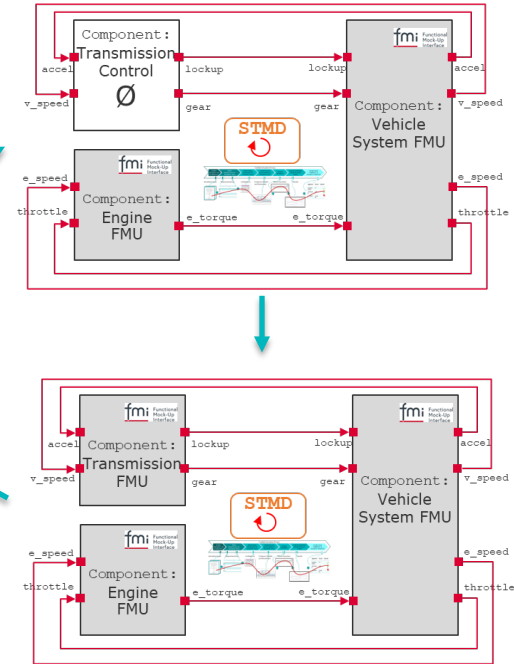
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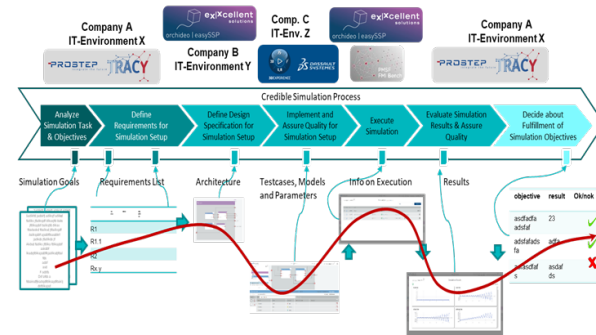
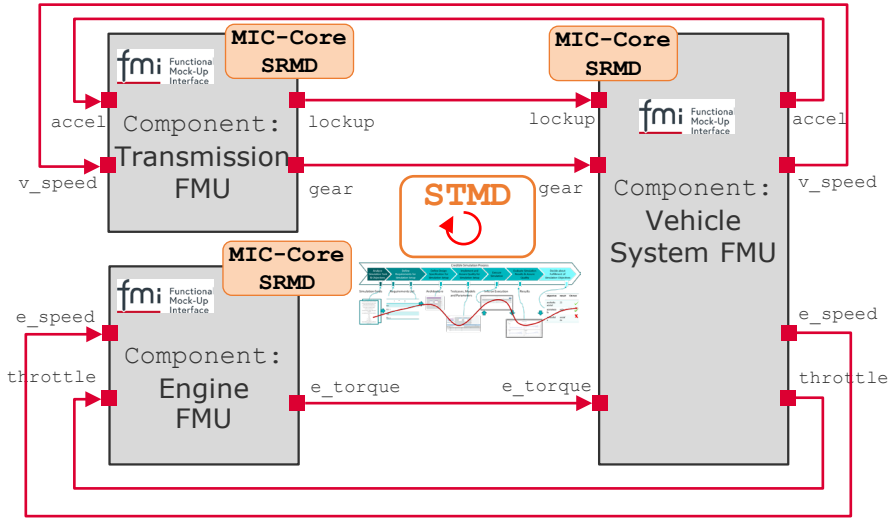


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*\*This is an example use case. It does not represent any real business case.*



# Motivation Smart Systems Engineering (SmartSE) Collaborative Simulation-based Engineering



- Usage of STMD-format (GlueParticle SSP-Traceability) for collecting data in walkthrough simulation process
- Usage of SRMD-format and MIC-Core model Metadata as leaflet for simulation models
- → structured information and metadata

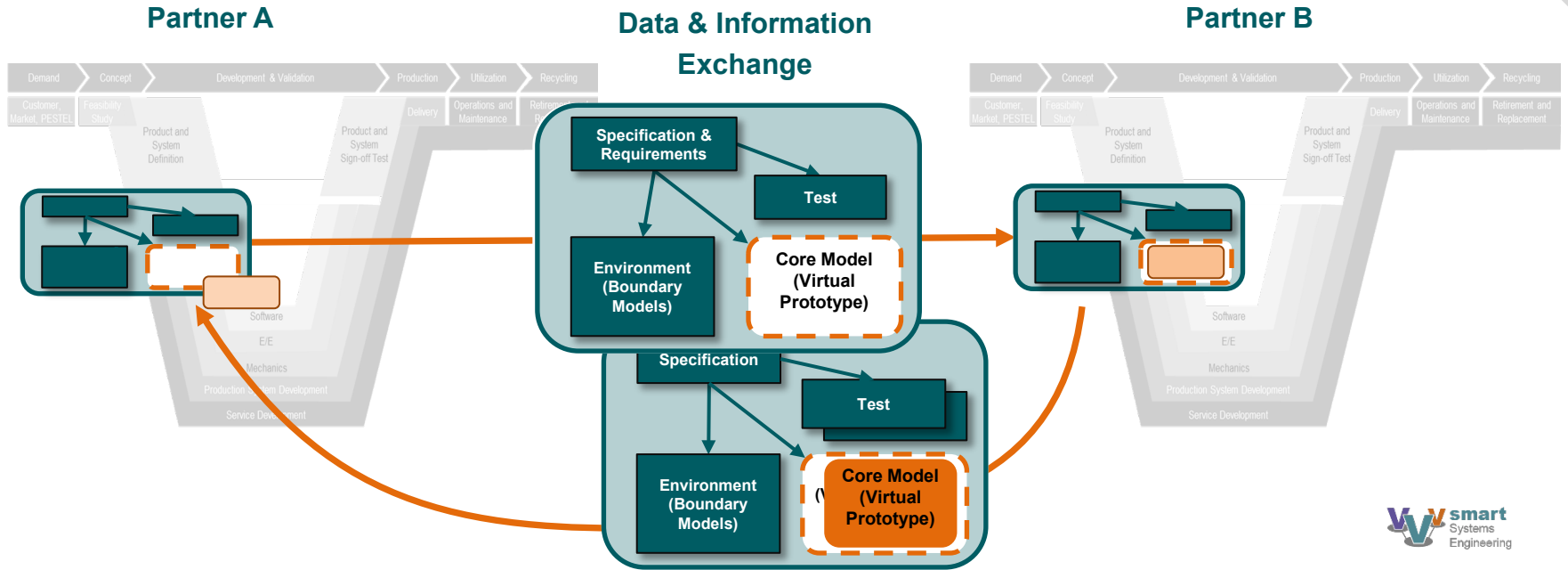
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## SmartSE Showcase

**Collaboration of Partners using Exchange Packages in heterogeneous IT-Environments**

# Motivation Smart Systems Engineering (SmartSE) Collaborative Simulation-based Engineering

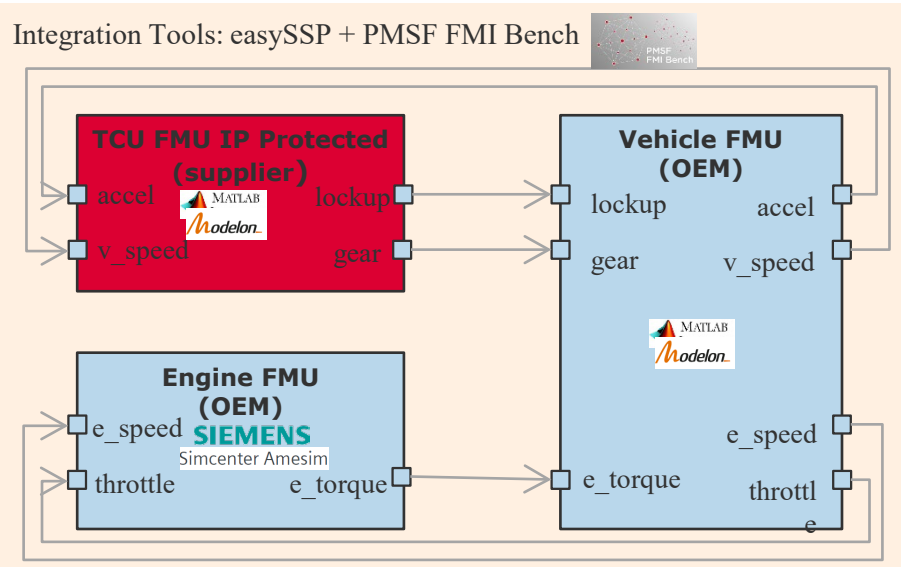


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# Collaborative Simulation-based Engineering

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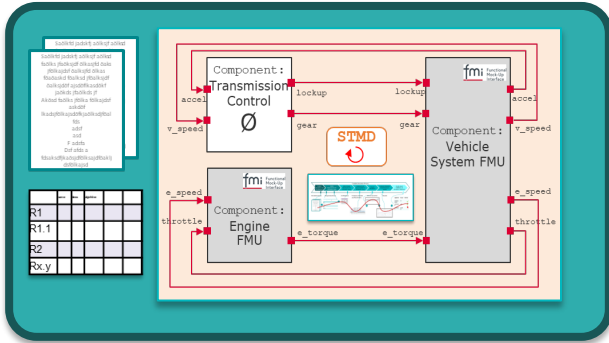
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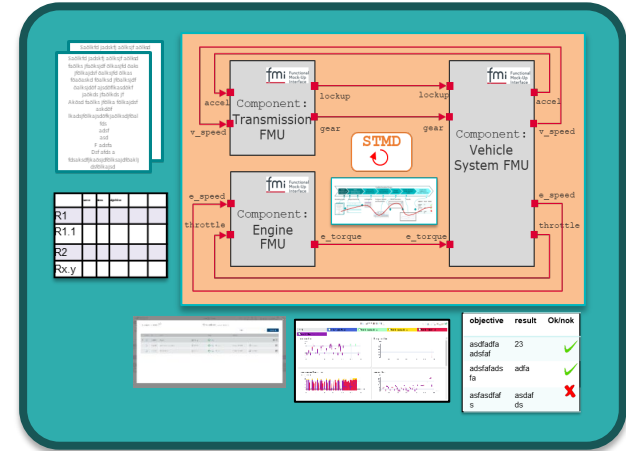
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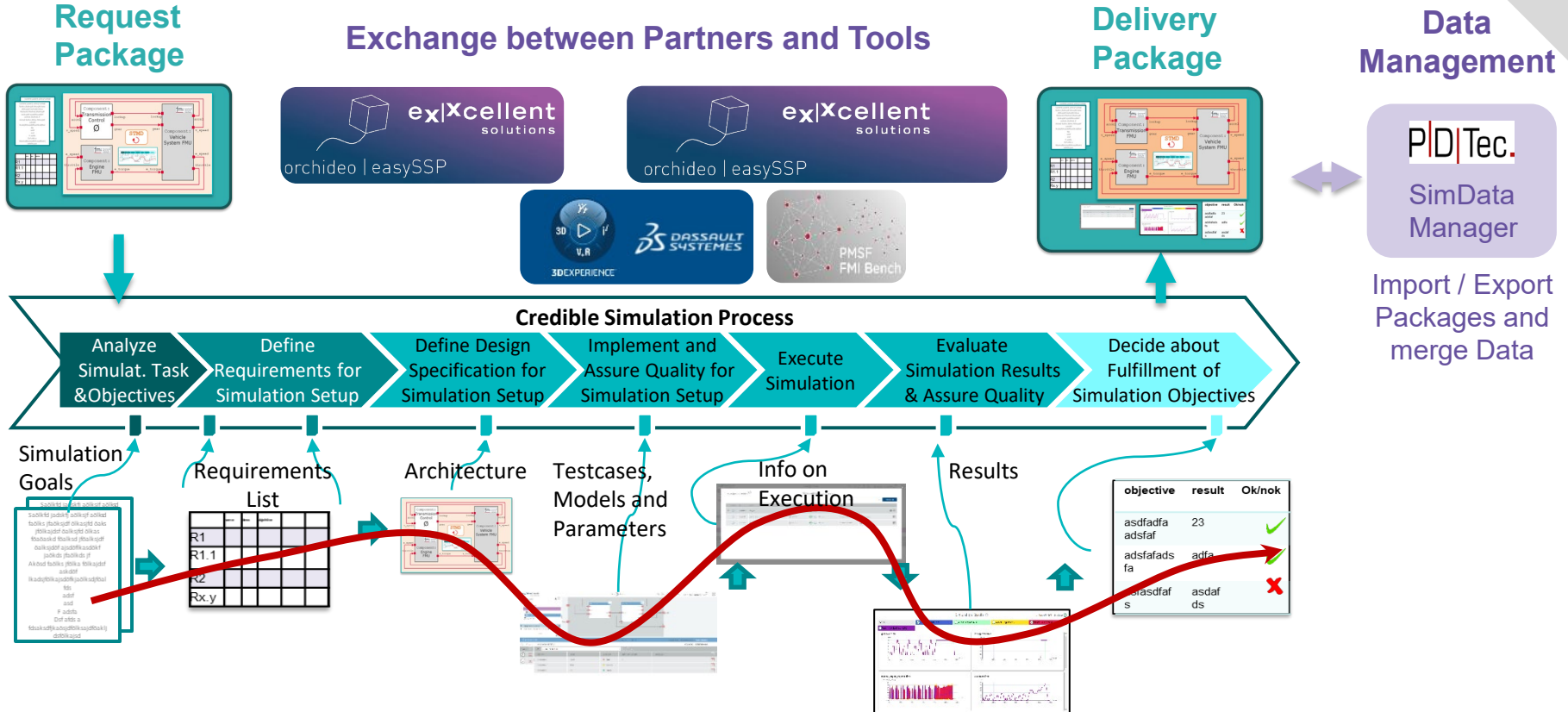
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# Collaborative Simulation-based Engineering

## Traceability from requirements to simulation result



- 1 Overview SmartSE project
- 2 New V-Model
- 3 Simulation Model Meta Data MIC-Core
- 4 Showcase using Exchange Packages in heterogeneous IT-Environments**
- 5 “Guard rails for Simulation credibility standards and recommendations”
- 6 New approach “Simulation credibility standards and recommendations “