GfSE SpecIF / MoTIF and prostep ivip DDP harmonization

2024-01-29 Uwe Kaufmann | ModelAlchemy Consulting / GfSE

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Agenda

- **Background – about OMG and the ManTIS DTF**
- **MBSE collaboration challenges and requirements**
- **SpecIF – the Specificaiton Integration Facility**
- **SpecIF – DDP harmonization and OMG standardisation for a MBE collaboration facility**

■Background

The world of (international) standardization

Organiz... **bles**

Domain I...

IIC

I4.0

GfSE

AG MBSE

AG PLM4MBSE

AG SAF

AG ...

Voluntary work

Funded work

PG MoTIF

PG ...

...equirements definition

...est practices, methodologies

...nplementer Forum

...pecification development

...atform / Ecosystem provision

...e.g. OMG's MDA)

W

International Standard

TC 184

JTC 1

IEC ISO

- Standards development
- Standards adoption

Why OMG – personal thoughts
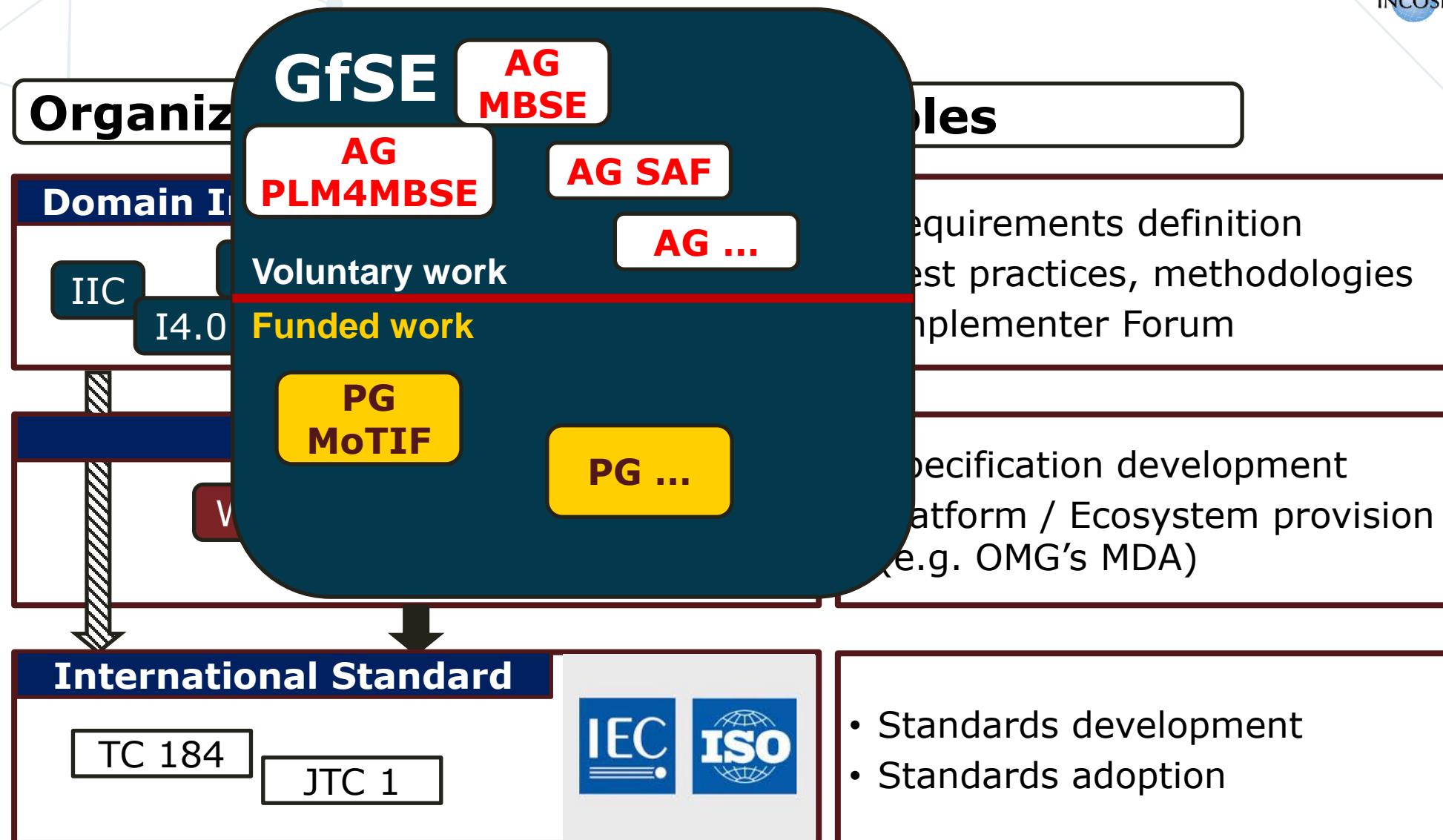
- **OMG considers ISO/IEC as the only international standardization organization**
  - OMG policies & procedures require OMG processes and **specifications** to be **compliant to ISO**
  - OMG decided to submit most of its specifications to ISO to become ISO standards
  - OMG specifications are freely available as opposed to many ISO standards (**OMG** submitted **specifications remain publicly available** (**PAS**))

- **OMG specifications are industry driven**
  - Assessed by the BoD (Board of Directors)
  - **Implementation** and commercial availability is **mandatory**

- **OMG maintains a well-defined quality control process**
  - Any OMG specification is evaluated by **OMG's Architecture Board** (AB)
  - **Policies & Procedures** require OMG specifications to **comply to MDA (Model Driven Architecture)** and certain other technical constraints to **ensure interoperable implementations**

Who is OMG?

OMG Standards Development Organization®

1989 founded

228 specifications

325 member organizations worldwide

13 specifications ratified as ISO standards

- **One of the largest and longest-standing not-for-profit, open-membership consortia developing and maintaining computer industry specifications.**

- **Continuously evolving to remain current while retaining a position of thought leadership.**

- **Long-term maintenance of proven standards**

OMG Organisation

OMG Board of Directors (BOD)		
Architecture Board (AB)	**Platform Technology Committee (PTC)**	**Domain Technology Committee (DTC)**
Liaison ABSC	Analysis & Design (AD PTF)	Business Modeling and Integration (BMI DTF)
Object & Reference Model ABSC	Artificial Intelligence (AI PTF)	Consultation, Command, Control, Communications & Intelligence (C4I DTF)
Specification Management ABSC	Architecture-Driven Modernization (ADM PTF)	Finance DTF
Intellectual Property Policy ABSC	Middleware and Related Services (MARS PTF)	Government Information Sharing & Services DTF
Process ABSC	System Assurance PTF	Healthcare DTF
Business Architecture ABSIG	Agents PSIG	Manufacturing Technology and Industrial Systems (ManTIS DTF)
Model Interchange ABSIG	Blockchain PSIG	Retail DTF
	Data Distribution Services PSIG	Robotics DTF
	Methods and Related Tools PSIG	Space DTF
	Ontology PSIG	Mathematical Formalism DSIG
		Regulatory Compliance DSIG
		Systems Engineering DSIG

DTC	Domain Technology Committee	SIG	Special Interest Group
PTC	Platform Technology Committee	SC	Subcommittee
AB	Architecture Board	TF	Task Force

OMG Standards (selection)
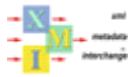
Platform

UML – Unified Modeling Language

SysML – Systems Modeling Language

CORBA – Common Object Request Broker Architecture

CWM – Common Warehouse Metamodel

MOF – Meta Object Facility

XMI – XML Metadata Interchange

ODM – Ontology Definition Metamodel

DDS – Data Distribution Services

…

Domain

BPMN – Business Process Model and Notation

UPDM / **UAF** - Unified Profile for DoDAF and MODAF

PLM Services – Product Lifecycle Management Services

ReqIF – Requirements Interchange Format

SoaML – Service Oriented Architecture Modeling Language

**NIEM** - UML Profile for National Information Exchange Model

…

ISO adopted OMG specifications

Specification Title	Version	ISO Number	OMG ID
Automated Function Points (AFP™)	1.0	19515:2019	formal/19-05-03
Business Process Model And Notation (BPMN™)	2.0.1	19510:2013	formal/13-11-03
Common Object Request Broker Architecture (CORBA®)	3.1.1		
CORBA Interfaces		19500-1:2012	formal/12-05-03
CORBA Interoperability		19500-2:2012	formal/12-05-04
CORBA Components		19500-3:2012	formal/12-05-05
Knowledge Discovery Metamodel (KDM)	1.3	19506:2012	formal/12-05-08
Meta Object Facility (MOF™)	1.4	19502:2005	formal/05-05-05
Meta Object Facility (MOF™)	2.4.2	19508:2014	formal/14-04-05
Object Constraint Language (OCL™)	2.3.1	19507:2012	formal/12-05-09
OMG System Modeling Language (SysML®)	1.4	19514:2017	formal/17-05-08
Unified Modeling Language (UML®)	1.4	19501:2005	formal/05-04-01
Unified Modeling Language (UML®)	2.4.1		
UML Infrastructure		19505-1:2012	formal/12-05-06
UML Superstructure		19505-2:2012	formal/12-05-07
Unified Profile for DoDAF and MODAF (UPDM™)	2.1.1	19513:2019	formal/19-05-04
XML Metadata Interchange (XMI®)	2.0	19503:2005	formal/05-05-06
XML Metadata Interchange (XMI®)	2.4.2	19509:2014	formal/14-04-06

https://www.omg.org/spec/

Status: May 2020

OMG technology adoption process

BoD approval

AB quality control

Requirement definition / Proposal

Technology Development

Finalization / Revision

TF Business

RFI	RFP

optional

RFC

Submission

Review

TC Business

FTF	RTF	OMG adopted specification

optional

ISO PAS
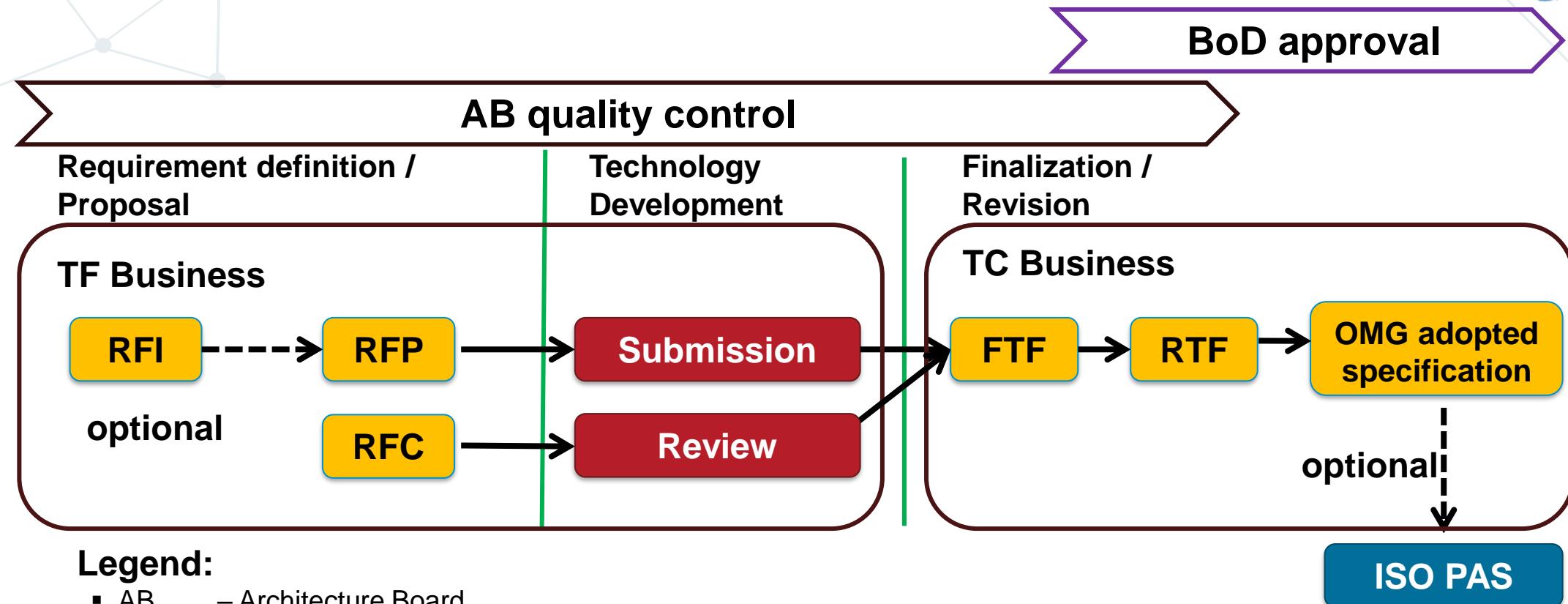
Legend:
- AB   – Architecture Board
- BoD   – Board of Directors
- TF   – Domain/Platform Task Force
- TC   – Domain/Platform Technical Committee
- RFI   – Request for Information
- RFP   – Request for Proposal
- RFC   – Request for Comment
- FTF   – Finalization Task Force
- RTF   – Revision Task Force

References:
- Policies and Procedures of the OMG
  - http://www.omg.org/cgi-bin/doc?pp
- Hitchhikers Guide to the OMG
  - http://www.omg.org/cgi-bin/doc?hh

OMG ManTIS DTF - Manufacturing Technology and Industrial Systems

ManTIS history

- chartered 1996:
  - **M**anufacturin**g D**omain **T**ask **F**orce (**Mfg DTF**)
- merged with Utilities DTF in 2002:
  - **ManTIS DTF**

ManTIS charter

The mission of the "Manufacturing Technology and Industrial Systems Domain Task Force", ManTIS DTF, is to foster the emergence of cost effective, timely, commercially available and interoperable software components for the Manufacturing and Industrial Systems domain through the development of standard specifications using the OMG process.

ManTIS co-chairs

Uwe Kaufmann, ModelAlchemy Consulting

Christian Muggeo, CONTACT Software

William C. Beavin, BOEING

mantis-chair@omg.org

- Web-site: www.omg.org/mantis
- E-Mail: mantis@omg.org

OMG ManTIS DTF - Manufacturing Technology and Industrial Systems

ManTIS specifications

CORBA

- **DAIS** – Data Acquisition from Industrial Systems (v1.1)
- **HDAIS** – Historical Data Acquisition from Industrial Systems (v1.0)
- **DSS** – Distributed Simulation Systems (v2.0)
- **PDM** (Product Data Management) **Enablers** (v1.3, v2.0 (*not adopted*))
- **CAD** (Computer Aided Design) **Services** (v1.2)

MDA

- **PLM** (Product Lifecycle Management) **Services** (v1.0.1, v2.1)
- **EXPRESS Modeling Language Metamodel** (v1.2; „MEXICO" project)
- **ReqIF** – Requirements Interchange Format (v1.2)
- **SysPhS** – SysML Extension for Physical Interaction and Signal Flow Simulation (v1.0)
- **SENSR** – Simple Electronic Notation for Sensor Readout (v1.0)

■ MBE collaboration challenges & requirements

Challenges in MBSE collaboration

Demand for a more pragmatic way to support engineering collaboration

- Engineering Collaboration traditionally based on (textual) requirements and accompanying documents (like CAD models, Schematics, PDFs, PPTs etc.)

- Need for a more **integrated**, **fine granular**, **interdisciplinary** approach raised with Model Based Systems Engineering – MBSE

- Today's challenges:
  - MBSE using SysML called for model interchange
  - OMG's native interchange format MOF-XMI turned out non-satisfactory
  - SysML v1 implementations differ due to a lack of precise semantics
  - SysML modelers use their domain ontologies

- SysML v2 may solve part of the above problems, but SysML v1 still in use

MBSE use case for model integration with SpecIF

AUTHORING

ReqIF, SysML, UAF, BPMN, …

Functional models
CAD
E/E Models
Embedded
Software
…

Contextual, semantic mapping

contextual, semantic mapping

INTEGRATION, VERIFICATION

SpecIF / MoTIF

- **Functional / System Mock-Up**
- **Trace-Links between models and elements**

SpecIF
Specification Integration Facility

Graph DB Repository

EVALUATION, VALIDATION

Digital Twin

Simulation

Corporate Sustainability Reporting (CSR)

DDP

ReqIF

Source: ModelAlchemy,
Adopted from:
ISYPROM project

High level objectives of MoTIF

- MoTIF (**Mo**del **T**ransformation and **I**ntegration **F**acility) seeks **pragmatic** solutions for:

  - ***Integration and Interchange of information captured in models in an (multidisciplinary) engineering collaboration process***

- MoTIF should provide

  - Semantic Integration of contained models

    - Linking between model elements, artefacts (traceability)

    - Common attribute typing using existing vocabularies / ontologies

  - Encapsulation / simplification of model elements (IP protection)

  - Serialization of models, e.g. for (long term) archival (to be aligned with LOTAR Part 550?)

- Rationale:

  - Transformation vs. Interchange – 1:1 exchange is a limited concept

  - Learn from Product Data Exchange (STEP)

  - Need for a flexible approach that separates semantics from representation / syntax

MoTIF is just a new name to show openness to new solutions other than **SpecIF**

MoTIF mandatory requirements summary 1/3

MoTIF shall:

1. Support both **asynchronous ("offline")** and **synchronous ("online")** collaboration
2. Support the extraction and exchange of **partial (transformed) models**
3. Support **simplified model** representations and abstractions (**IP protection**)
4. Support **change impact analysis** (e.g., **tracking of issues /changes** in a collaboration, review and approval processes)
5. Support for **versioning** of entities incl. links and associations
6. Manage and preserve **unique IDs** related to the contained entities and IDs from originating authoring tools
7. **Reuse** existing **dictionaries**, **vocabularies** and **ontologies** for classification of entities
8. Execute basic **consistency checks** (e.g., model validation rules, naming conflicts)
9. Support **selective versioning** of entities (some things related to changes need to be versioned and some not – management of mutabability)

MoTIF mandatory requirements summary 2/3

MoTIF shall:

10. Support **compression** and **secure** connections

11. Provide a (unique) **authorization** mechanism

12. Provide a **multi-language** mechanisms

13. Support M2 and M3 **MOF** level (meta-)metamodels (make use of **OO** methods for inheritance, metamodeling)

1. Following domain formats must be supported:
   - MOF based models (UML, SysML, …)
   - Textual artefacts (ReqIF, requirements in general)
   - Office formats (ODF, OOXML)
   - STEP (EXPRESS-based data)
   - Other ISO standard formats (e.g. PDF, ???)
   - W3C formats (RDF, OWL)
   - OPM (Object Process Modeling)
2. The following platforms shall be supported
   - File-based exchange, serialization (e.g. ReqIF)
   - OSLC / RDF
   - SysML v2 API

MoTIF non-mandatory requirements

MoTIF may:

1. Support **variability** modeling (e.g., OVM / ISO 26550 etc.)
2. Support **variant** and **configuration** management
3. Provide **search** facility to lookup artifacts

SpecIF – the specification integration facility

The Problem:
Many tools and work products in product life-cycle

Variant-Management

Issue-Management

Requirements
Engineering

**Data
integration?**

Data exchange?

Model-based Systems & Software
Engineering (MBSE)

ERP-Systems

BOMs

E-CAD
M-CAD

Testing

*Same product, but many
tools and formats!*
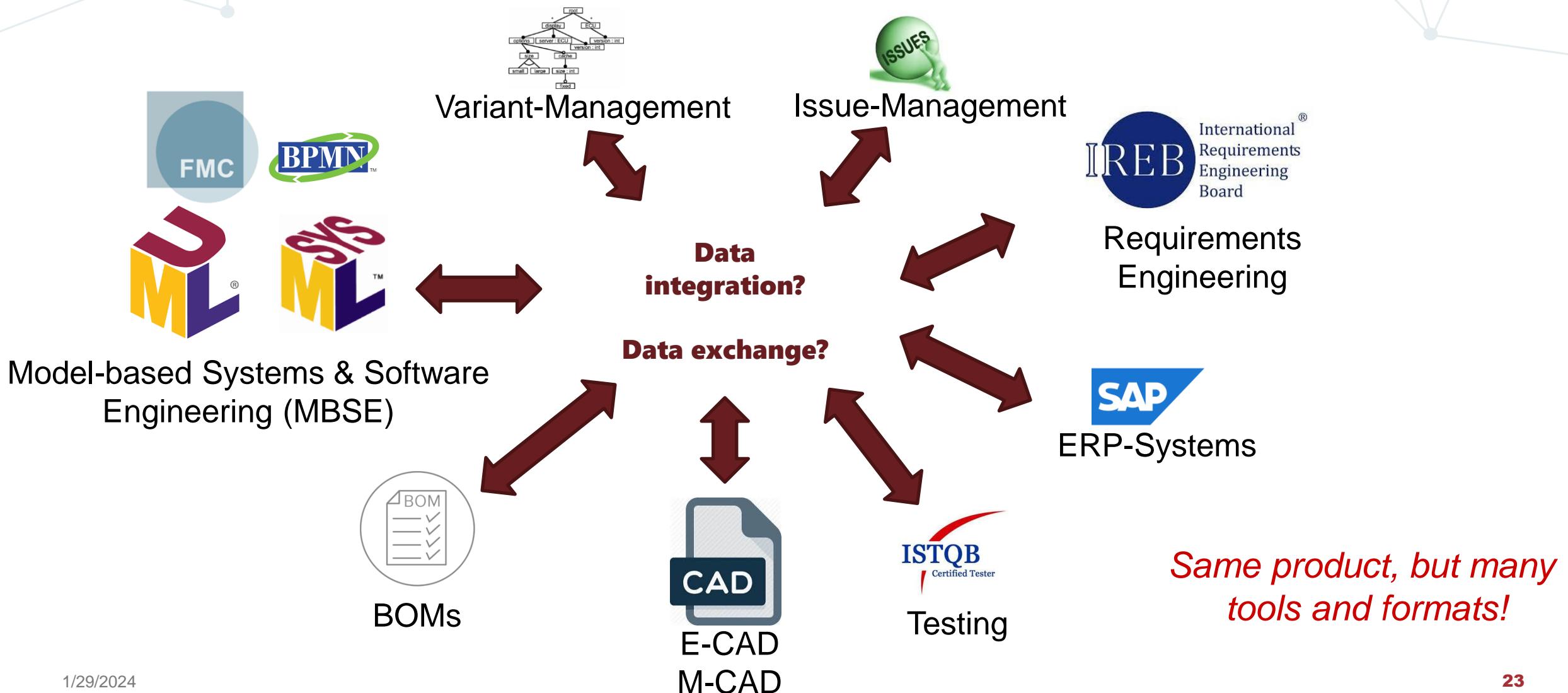
What we want to achieve…

- Data integration and data exchange over **the entire product life-cyle**

- Data exchange between different tools (semantic networks) – similar to RDF/semantic web approach

- Create semantic links between all data elements

- Navigate, search and validate the data

OMG ReqIF could be a solution…

- The OMG ReqIF standard comes with many good concepts that are applicable to solve our problem:

  + Graph-based data format

  + Possibility to define and transport the data structure of the data (metadata-support)

  + You can use ReqIF to transport any kind of PLM-data – not just requirements

- But we see some needs beyond ReqIF:

  – No standardized terms for naming the data elements beyond requirements (**vocabulary**) → Manual mapping is necessary on import and/or export

  – Missing revision management (versioning)

  – No support for multilanguage data

  – No support for inheritance when defining the data types

  – No standardized possibility for diagram exchange – important for graphical model exchange

SpecIF extends the concepts of ReqIF…

- We extend the concepts of ReqIF in the following way
  - **Generalization of application scenario** – transport all kind of data, not just (textual) Requirements
  - Introduction of a **standardized vocabulary of terms** to get well-defined semantics of the data – based on known terms where possible (OSLC, IREB, UML, Dublin Core, …)
  - Integrated **versioning** of all elements
  - **Multi-language support**
  - **Inheritance** usable for metadata definition
  - **Diagram-exchange using SVG** with integrated metadata
  - Using **JSON** instead of XML as persistence format – but XML is also possible to support in the future
  - Definition of a standardized **WebAPI** for online (real time) data exchange – beside SpecIF files

Data integration and exchange with SpecIF

SpecIF-Frontend

Integrated SpecIF Repository

Semantically integrated SpecIF data repository (files and/or data base)

File- or API-based data transfer

SpecIF-Adapter — Issue & Reqmnt. Managen Tool — ISSUES

SpecIF-Adapter — ERP — SAP

SpecIF-Adapter — MBSE — SysML, BPMN, UML

SpecIF-Adapter — CAD

Tool-API

Tools & work products

...
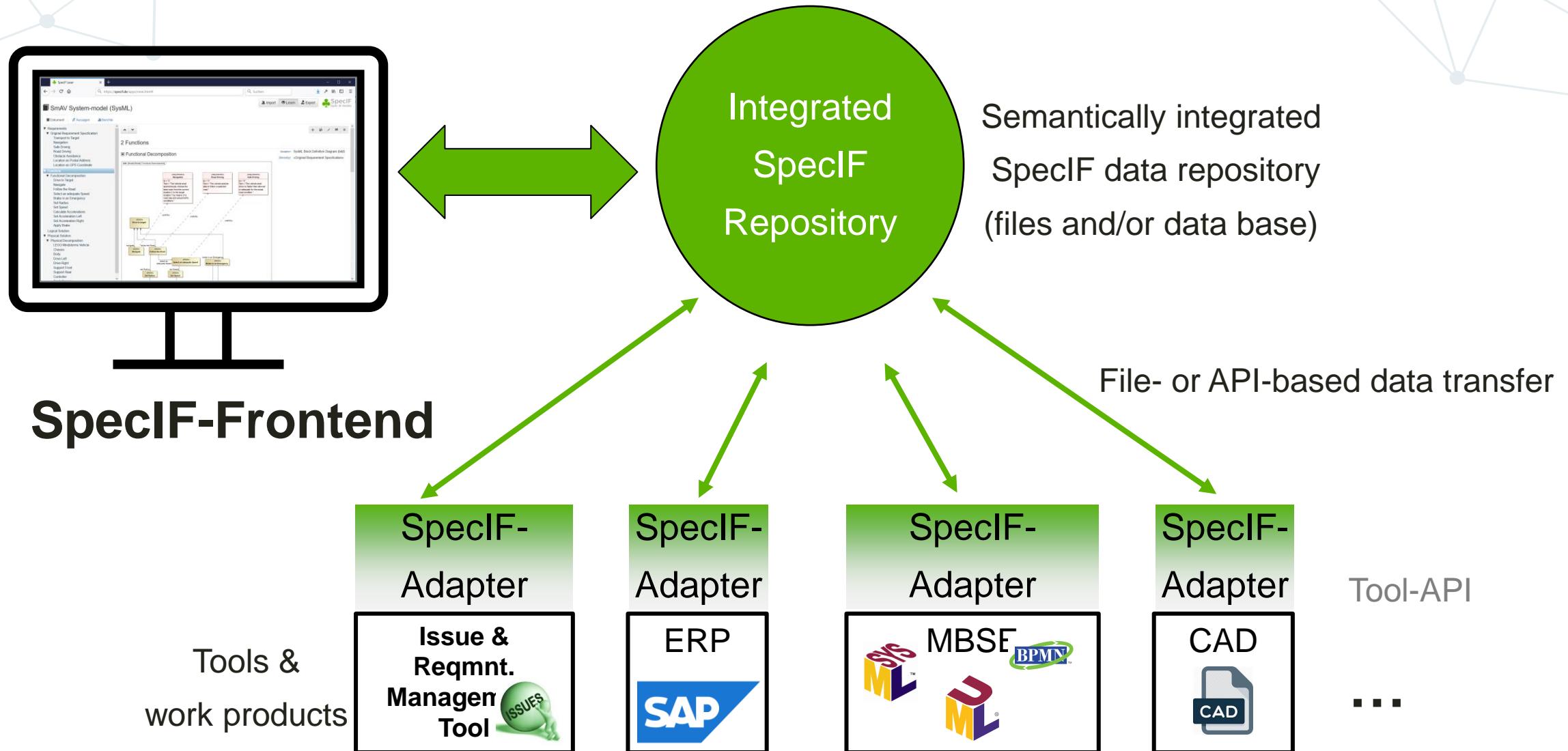
5 Principles of Model Integration

1. Separation of Model and View

2. Abstraction by typing of model elements

3. Use of vocabularies

4. Identification and fusion of identical model elements from different views

5. Weaving of model elements and corresponding associations to a semantic net using logical predication (ontology)

1. Separation of Model and View
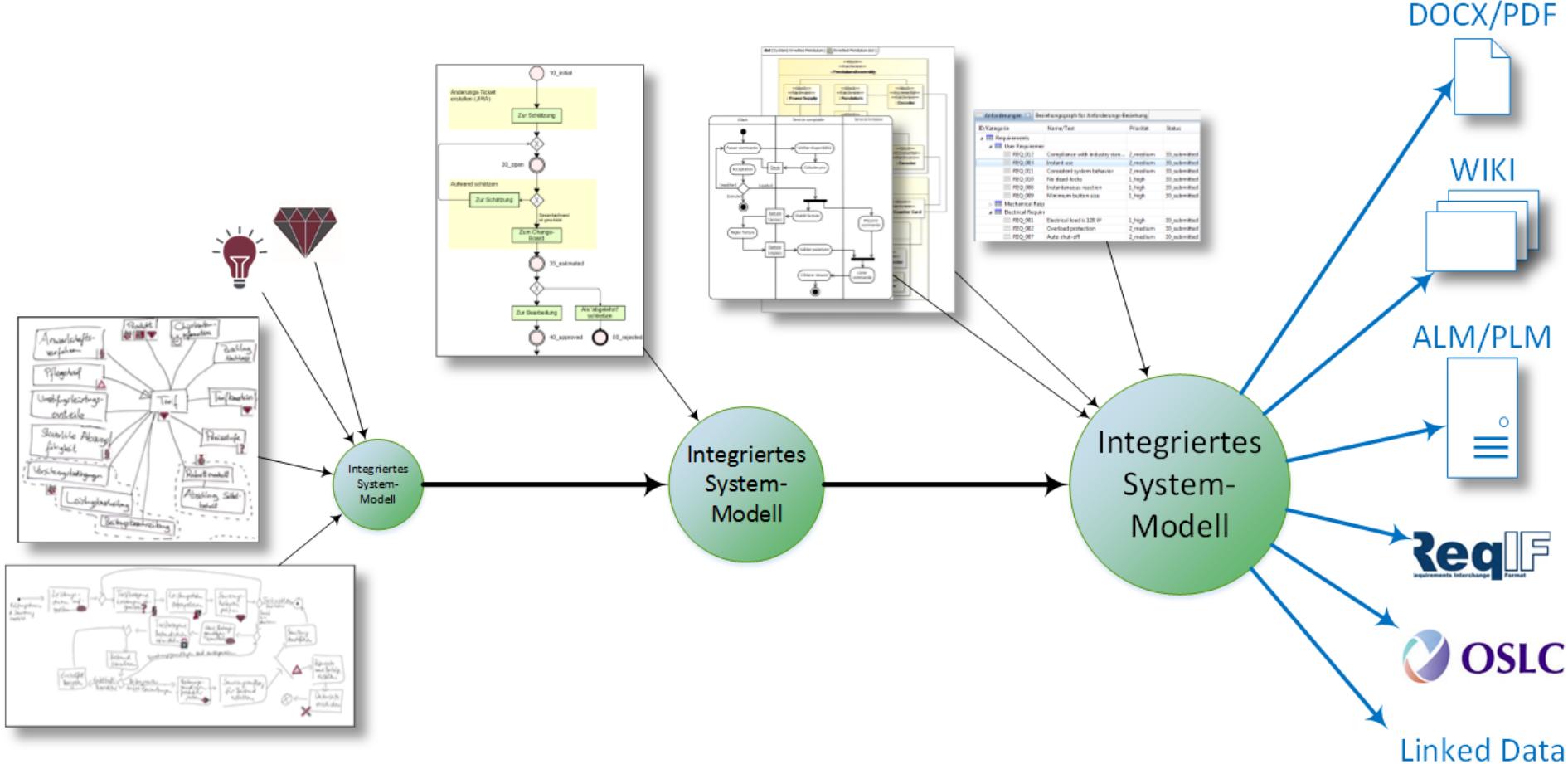
2. Abstraction by typing of model elements

- **Model Integration:**
  - Mapping of original model types to 3 Fundamental Model Types / Concepts (FMC):
    - ■ Actor
    - ● State
    - ♦ Event
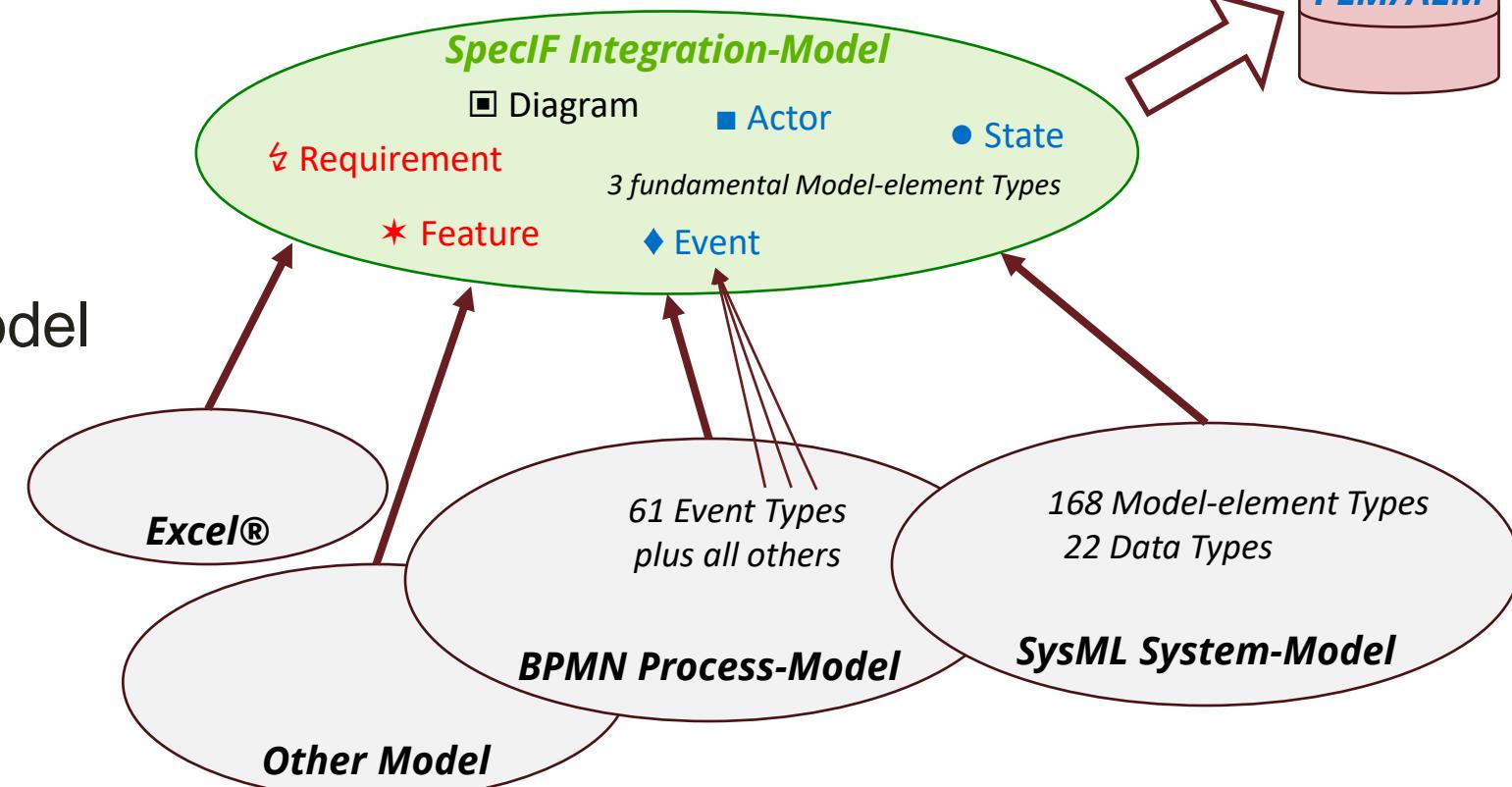
See Fundamental Modelling Concepts by S. Wendt:
http://www.fmc-modeling.org/

3. Use of vocabularies

- Assignment of semantics to terms in use

- Agreement about the semantics of the terms

- Carrying of semantics of terms across domains

- Translation of terms:

  - Into national Languages

  - Into terms used in different domains

→ Please contribute to a
  SpecIF System Engineering Ontology

Resource Class Names
- FMC:Actor
- IREB:Requirement

Statement Class Names
- oslc_rm:satisfies
- oslc_rm:refines

Property Class Names
- dcterms:title
- SpecIF:Priority

Property Values
- SpecIF:priorityHigh

Ontology defines the semantics of terms

SpecIF:LifecycleStatus

Der 'Lebenszyklusstatus' der Ressource.
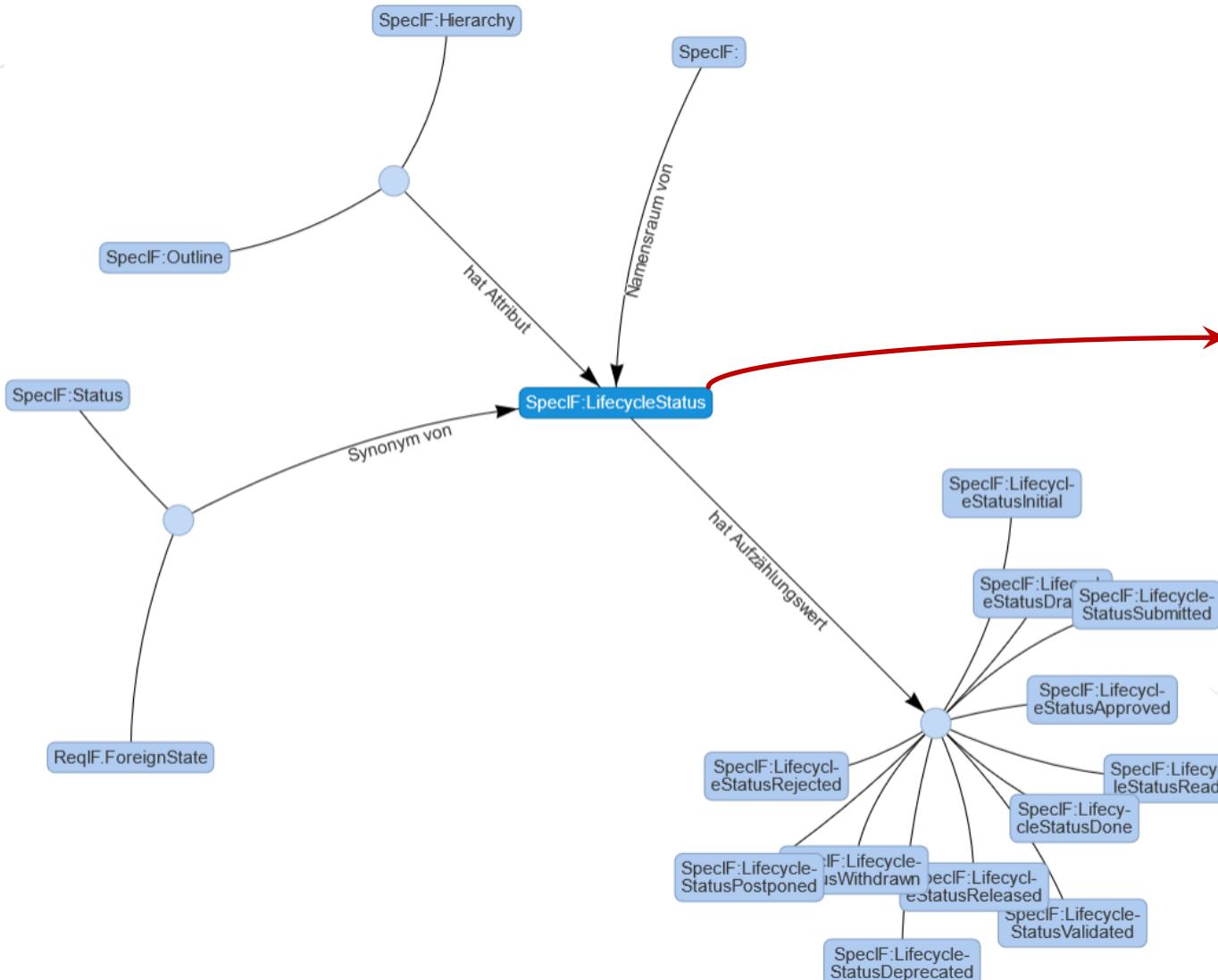
Ressource	Attribut (Text)
Identifikator	PC-LifecycleStatus
Revision	1.2
Domäne	Base, Requirement Engineering, Automotive Stakeholder Request Clarification Process, System Model Integration
Lebenszyklus	freigegeben
Lokaler Begriff	Lebenszyklus
multiple Werte	false
mehrsprachig	true
Textformat	plain
max. Länge	32

Attributes of terms

Relations / Associations between terms

... here: example of attribute values (propertyValues)

Source: Excel
- Local Language
- May be inconsistent

Persistence: e.g. JSON
- Ontological term
- → consistent

View: e.g. HTML
- Local Language
- → consistent

Same type + identical name
→ fusion!
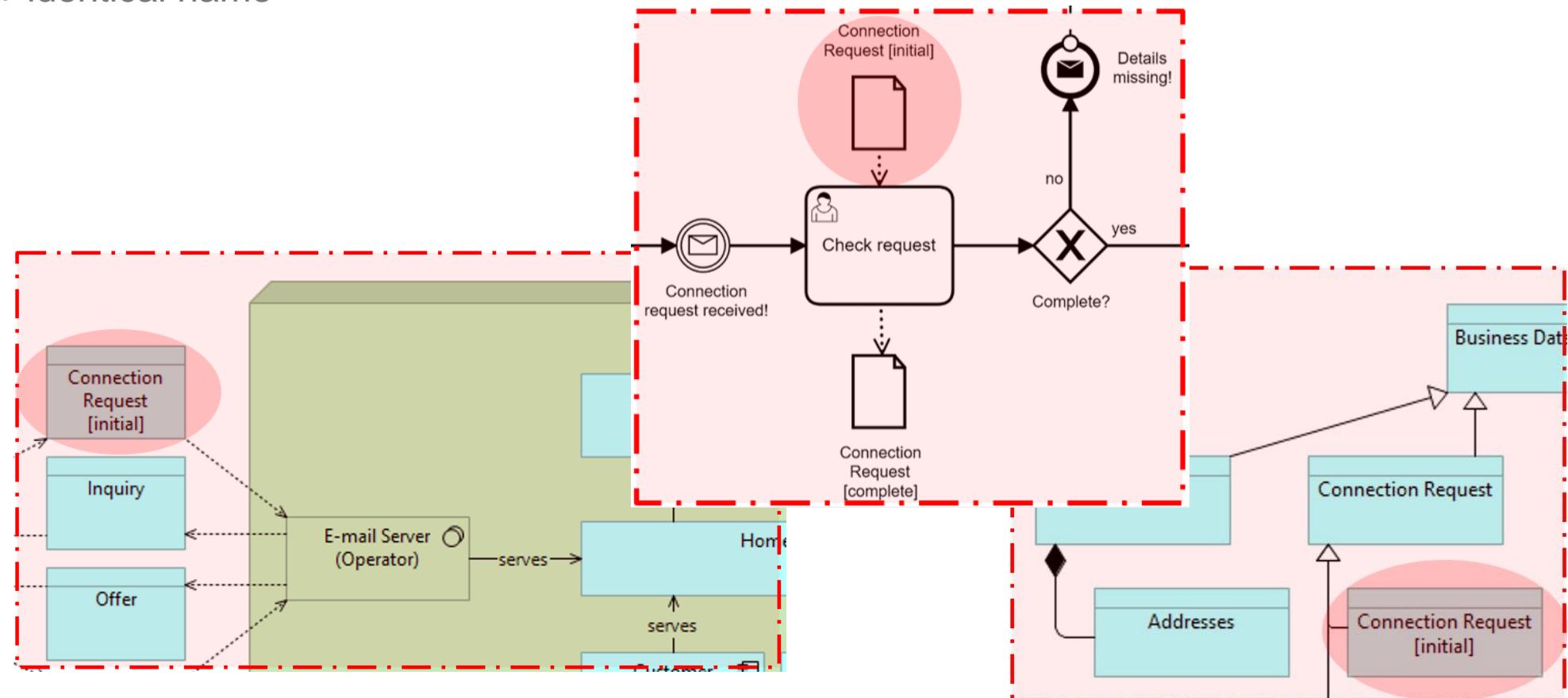
5. Weaving of model elements and corresponding associations to a semantic net using logical predication (ontology)

- All Imports of arbitrary notations result in a holistic semantic network.

- Qualifies for consistency checks and formal verification against constraints…

- As well as for semantic analysis:

  – What diagram shows a given element ?

  – Which component reads a given data object?
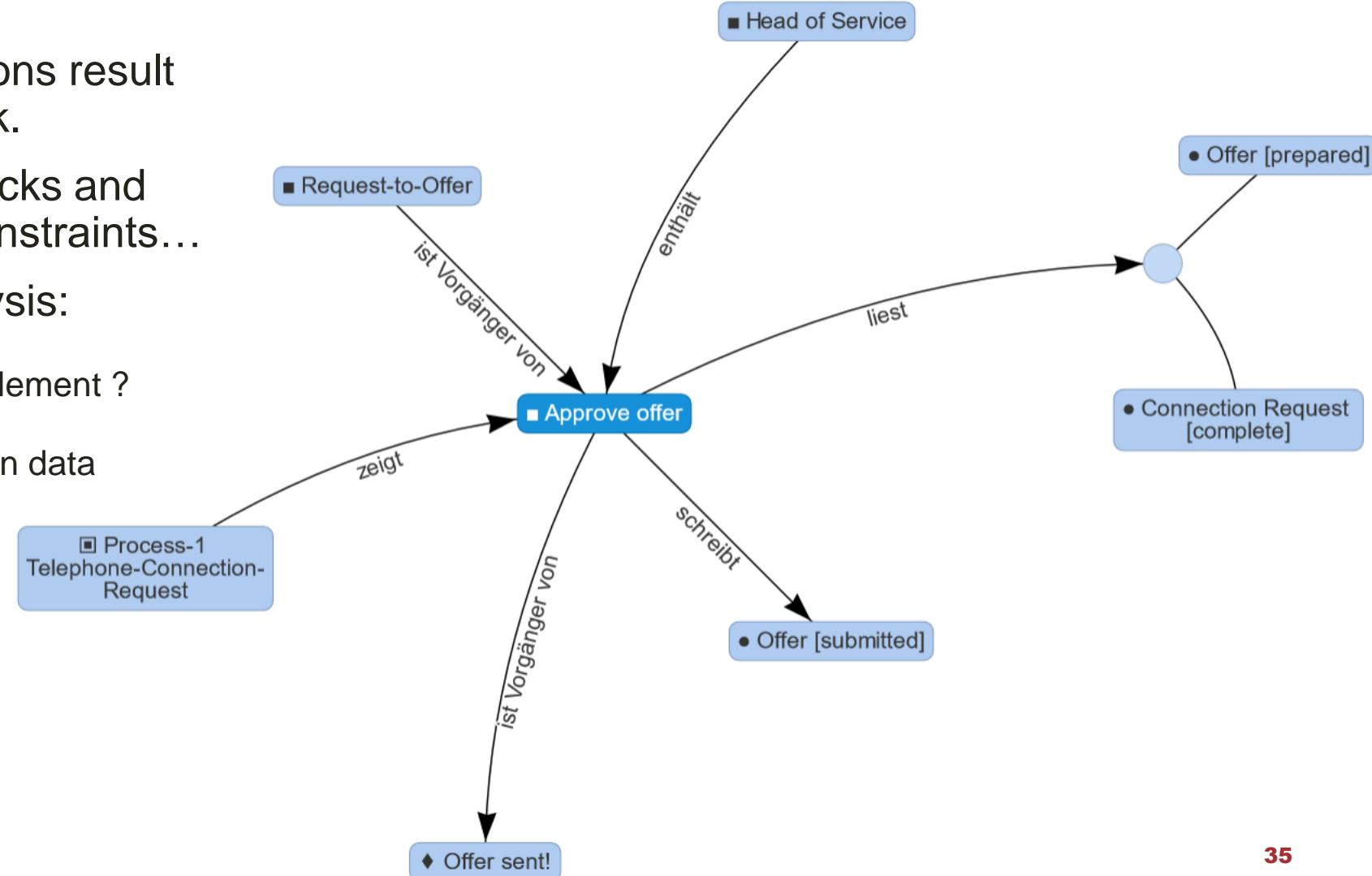
SpecIF adaptors for information integration

Notation

Presentation resp. Persistence

available	*available*	*available*	*ongoing*		*available*	*ongoing*	
ReqIF	FMC	Excel	SysML	Inter-action Room	BPMN	Archi-mate	Arca-dia
	ARCWAY		Cameo, EA, …		Camunda, Signavio, …	Archi; …	Capella

Specification Integration Facility

ReqIF	SpecIF native	OSLC	linked-data	WIKI	Docu-ment	ePub	RE
XML	JSON	RDF	Turtle, RDF, JSON-LD	Confluence	DOCX	XHTML	Jira
available	*available (with schema)*			*available*	*available*	*available*	*available*

Institut für Flugzeug-Kabinensysteme
FKS

TUHH
Technische Universität Hamburg

Das Lufttransportsystem: Ein Ökosystem einer Vielzahl unterschiedlicher Systeme und Prozesse

- Beispiel: Prozesse zur Vorbereitung eines Flugzeugs zwischen zwei Flügen (Turnaround) umfassen u. a. Tätigkeiten im Flugzeug, am Gate und auf dem Vorfeld
- Modelle decken häufig nur einen Aspekt des Ökosystems ab (z. B. Kabinen- oder Vorfeldprozesse, siehe rechts)
- Integration dieser Modelle über SpecIF zur Steigerung des Verständnisses der Zusammenhänge zwischen den Systemen und Prozessen

→ Möglichkeit zur Entwicklung neuer Services und zu Effizienzsteigerungen
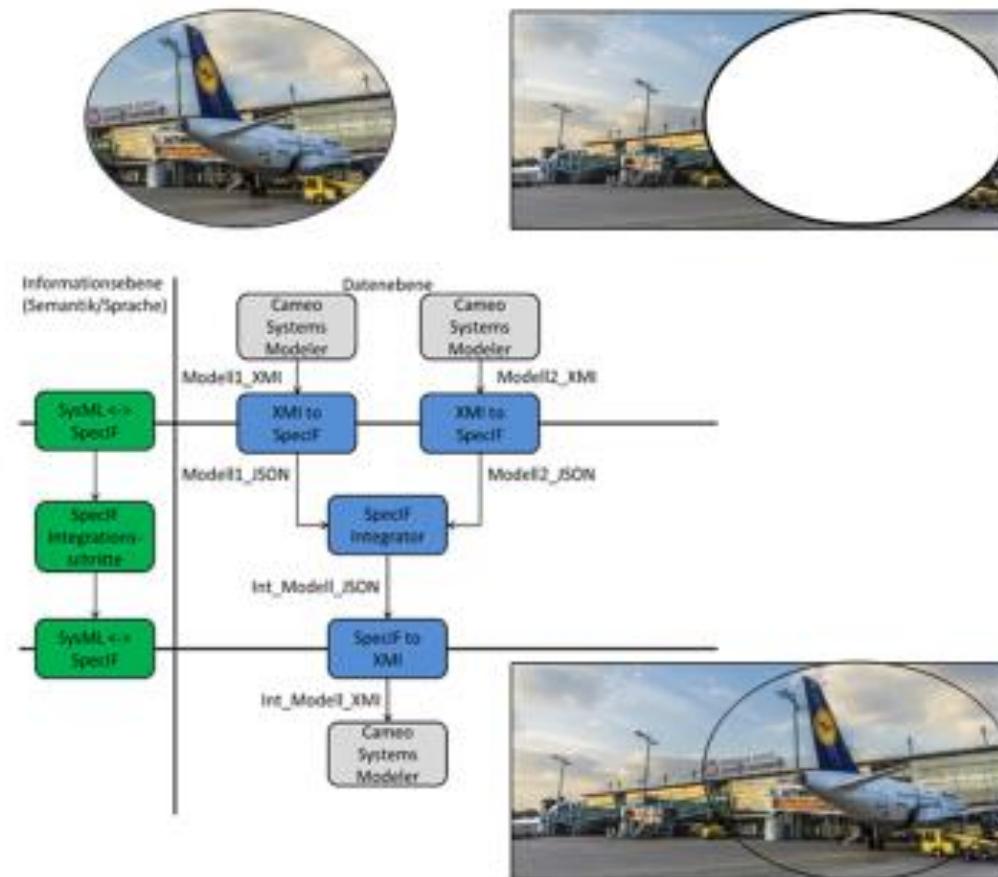
Grafik: reisen-experten.de

www.tuhh.de/fks

November 2020 - © Steffen Rüsch, Oliver C. Eichmann- Seite 1

SpecIF is open source

- Development on GitHub:
  - https://github.com/GfSE/SpecIF

- Available resources:
  - Documentation and metamodel / schema
  - Open Web API specification
  - SpecIF viewer

SpecIF Front-End available

- The „SpecIFicator" is available for download at:
  https://specificator.github.io/

- Windows executable, no installation needed (Windows 10 tested ☺)

- Automatically selects language based on Windows installation (German, English available)
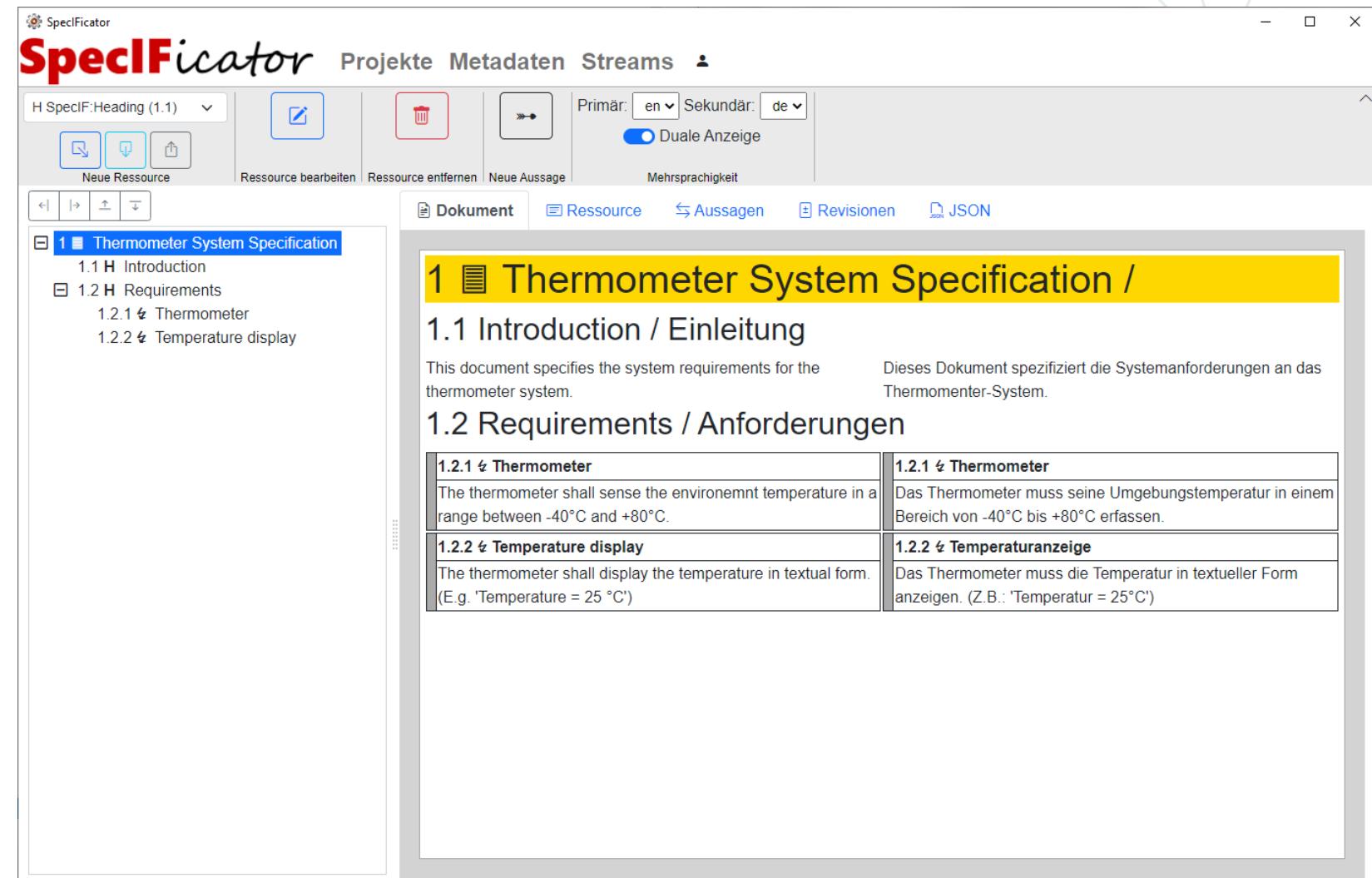
■ SpecIF – DDP harmonization and OMG standardisation

DDP Goals

Support cross-company and cross-domain collaboration in Systems Engineering in order to realize the minimum digital thread based on linked MBSE-Data Exchange Standards

Chairs:
Daniel Krems (AVL)
Oliver Klaar (ZF)

Coordinator:
Torsten Schmied (PROSTEP)

Participants (14):
:em, Anark Corporation, AVL List, Conweaver, Dr. Ing. h.c. F. Porsche, Mercedes-Benz, PROSTEP, John Deere, Schaeffler, The Boeing Company, Uni Kaiserslautern, Uni Ruhr-Bochum, Volkswagen, ZF Friedrichshafen

Content Overview
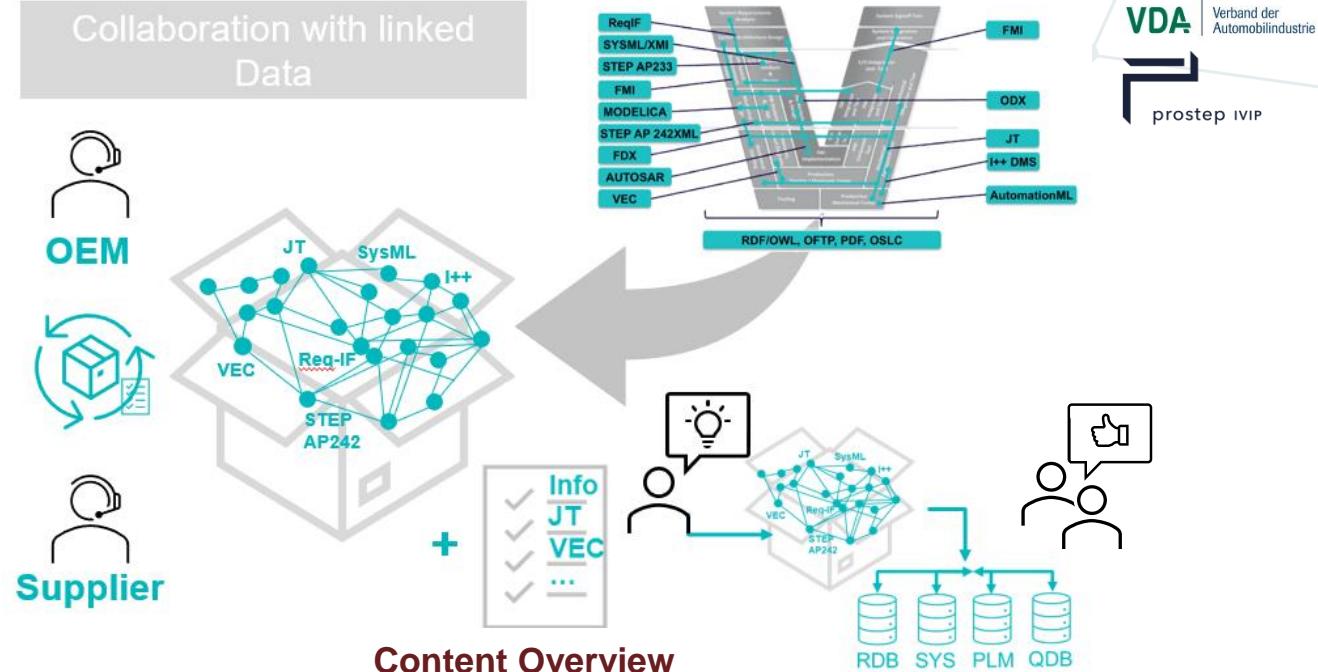
Goals 2022

- Support implementation on Vendor side
- Support DDP integration on user side
- Develop / publish Best Practices
- Enhance V&V and Supply Chain Use Cases & Data

DDP enables cross-domain collaboration in MBSE

Today various standards for exchanging domain-specific data in systems engineering exist. However, the items contained therein can't be linked and thus a cross-domain collaboration and data exchange is poorly supported
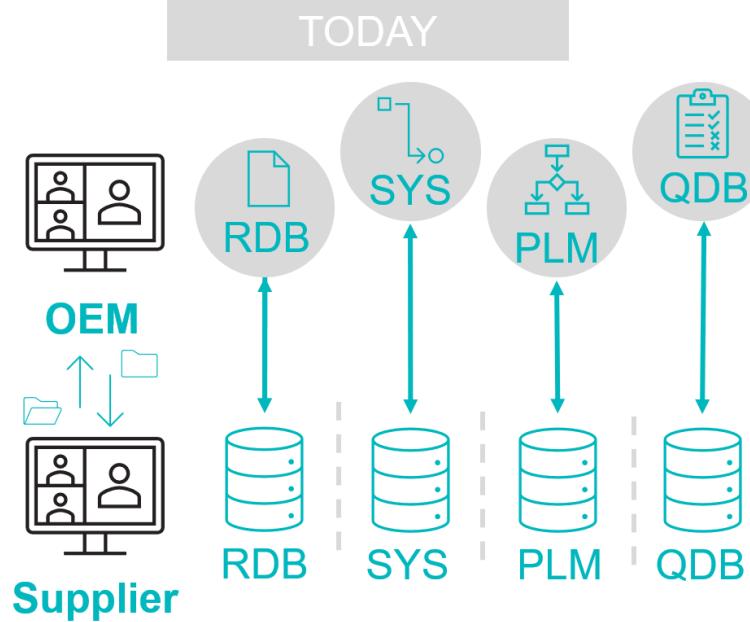
This project address the lake of a data exchange standard which allows for a cross-company and cross-domain exchange of linked systems engineering data under consideration of an end-to-end configuration management.
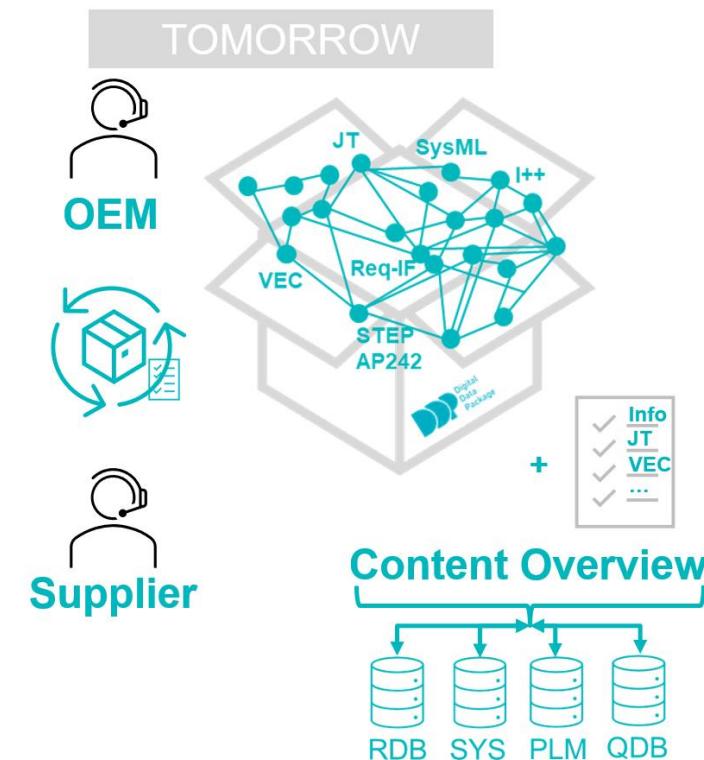
prostep ivip approach: DDP

- **Digital Data Package can be persistent files or transient streams**
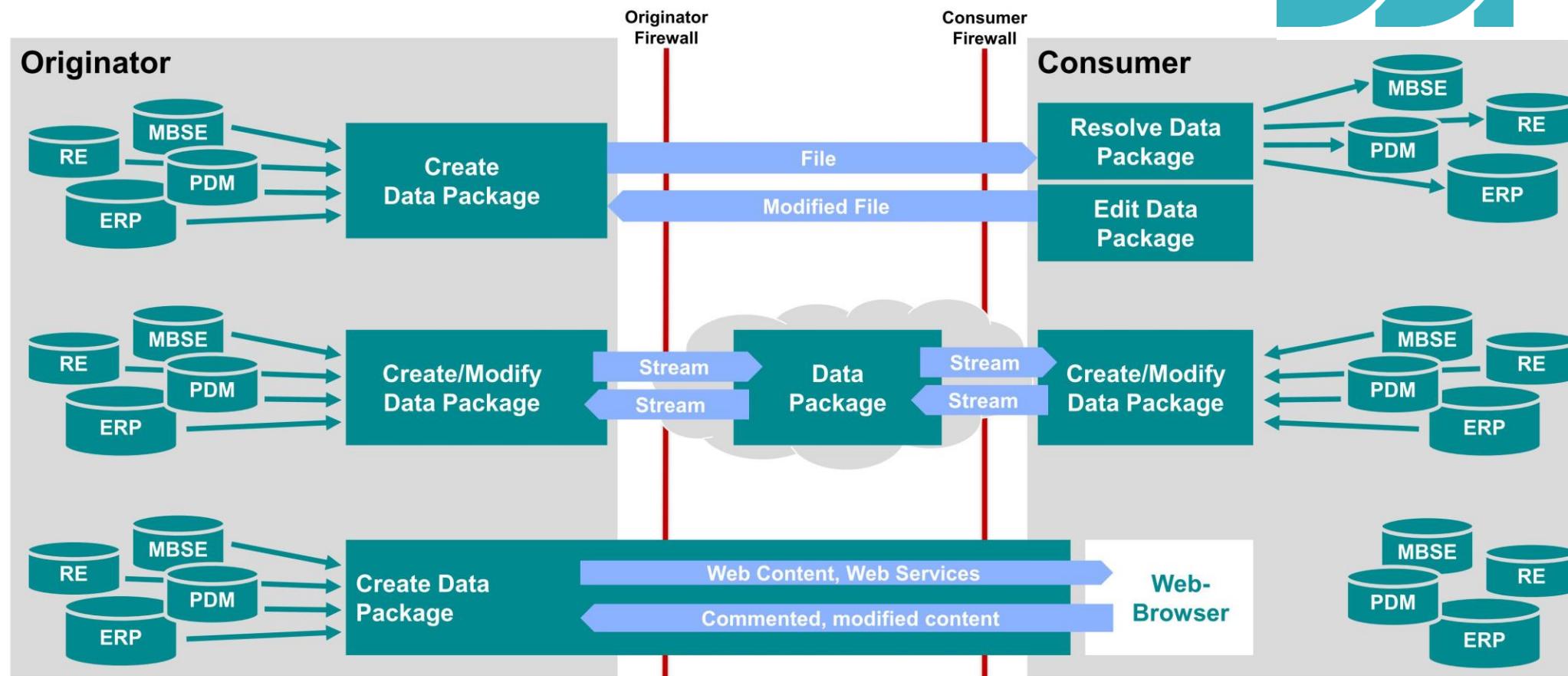
A simple example to illustrate the ideas behind a Digital Data Package
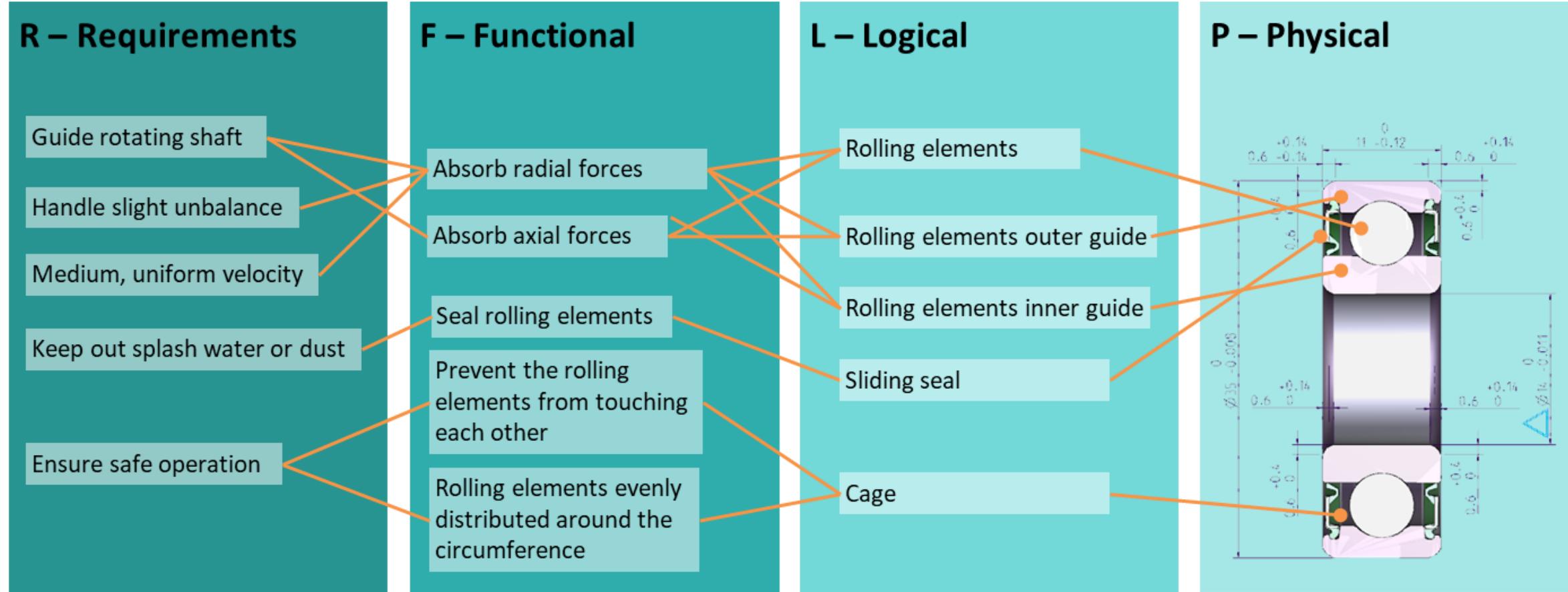
Alignement with other approaches

Need of alignment! - Digital Technical Data Packaging/Sharing

1. MoSSEC Implementers Forum (AP243) < MBSE IF

2. ProSTEP IVIP: Digital Data Package, Collaborative Digital Twins

3. OMG: SysMLV2, Model Based Acquisition Metamodel

4. INCOSE Digital Engineering Information Exchange: Digital view point Model, DE Guide

5. A&D PLM Action Group: Global Collaboration Checklist

+ 6. GfSE SpecIF / MoTIF

GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2023

GfSE cooperation for OMG standardization

prostep IVIP ← **MoU** → **GfSE** ---- **Contributing member of** → OMG Object Management Group

Consortia members / End Users

Use cases & examples for V&V

Knowledge & Industrial Best Practices

**Joint Project Group
MBE Collaboration Interoperability**

Draft Workplan:

WP1 Alignment / harmonization of requirements on MoTIF

WP2 Drafting of an OMG RFC/RFP for MoTIF

WP3 Elaboration of an OMG standard for MoTIF

WP4 Operation of an Implementer Forum + Certification

WP5 Ontologies / Vocabularies / Mappings

Working Title

MoTIF team → Project Lead: Uwe Kaufmann
uwe.kaufmann@gfse.de

SysML v2 SST

RAAML
OMG RISK ANALYSIS AND ASSESSMENT MODELING LANGUAGE

SysML 1.7 RTF

MoTIF team participates

MoTIF RFC / RFP

GfSE + prostep ivip + VDA project for standardization of an MBE collaboration „facility"

Roadmap

2024	2025	2026
RFP	Initial submission	Final submission and adoption
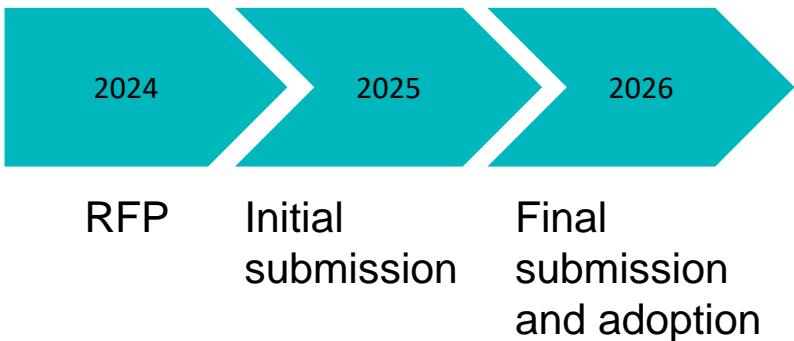
ISO as an Option **2** ← **1**

Standardization Body	Prio	ISO Standard	ISO PAS	DIN Spec	OMG RfC-RfP	IDTA	OpenSource: OASIS, Modelica, etc.	Others: VDA, VDI, SAE, ASAE, etc.
Examples		STEP, JT, PDF		JT Industrial Application Package	XML, ReqIF, SysML	AASX Submodel Templates	OSLC, FMI, SpecIF	VDA 4952-2, VDI 2206
User communities	3	Engineering	Engineering	Engineering	Engineering, Software, MBSE	Engineering, Manufacturing		
Content coverage	2					Content overview not covered		
Geographic coverage	2	international	international	Germany only	international	international		
Publishing effort & travelling	2	Mostly remote participation and sometimes on-site	Mostly remote participation	Mostly remote participation	US on-site participation (4 visits per year)			
Standardization cost	2	~150kEUR	~50kEUR	~50kEUR	~120kEUR + Travel expenses	~50kEUR	Free of charge	
Implementation Licensing Cost	2	Free of charge	Free of charge	Free of charge	Free of charge	Free of charge	Free of charge	
Usage Cost	1	Each standard must be purchased + Best Practice PSI	Each standard must be purchased + Best Practice PSI	Free of charge	Free of charge	Free of charge	Free of charge	
Motivation on user side	3							
Motivation on vendor side	2							
Procedure, Influence & Duration	2	3yrs	2yrs	2yrs	3yrs	1yrs		
Contacts, Supporters, Influencers	2	PSI (M. Ungerer)	PSI (M. Ungerer)	PSI (M. Ungerer)	GfSE (U. Kaufmann)	Members DDP & IDTA: Bosch, :em AG, ?		

Potential Stakeholders: PSI, VDA, GfSE

Outlook

- Next steps:
  - GfSE 2-day Workshop on "MBE collaboration needs" (Feb. 20-21, 2024, Hannover/Germany)
  - Further discussion in OMG ManTIS and SE-DSIG at Q1 2024 OMG TC Meeting (Mar. 18-22, 2024)
- Work plan / roadmap for standardization in OMG:
  - **WP1 Alignment / harmonization of requirements on MoTIF**
  - **WP2 Drafting of an OMG RFC/RFP for MoTIF**
  - **WP3 Elaboration of an OMG standard for MoTIF**
  - **WP4 optional: Operation of an Implementer Forum + Certification**
  - **WP5 optional: Domain specific adaptors**

- Formation of a project group
  - Acquisition of industrial interest
  - Fund raising

The Forum for Systems Engineering
in the German speaking Region