Past and future of OMG's Manufacturing Technology and Industrial Systems DTF

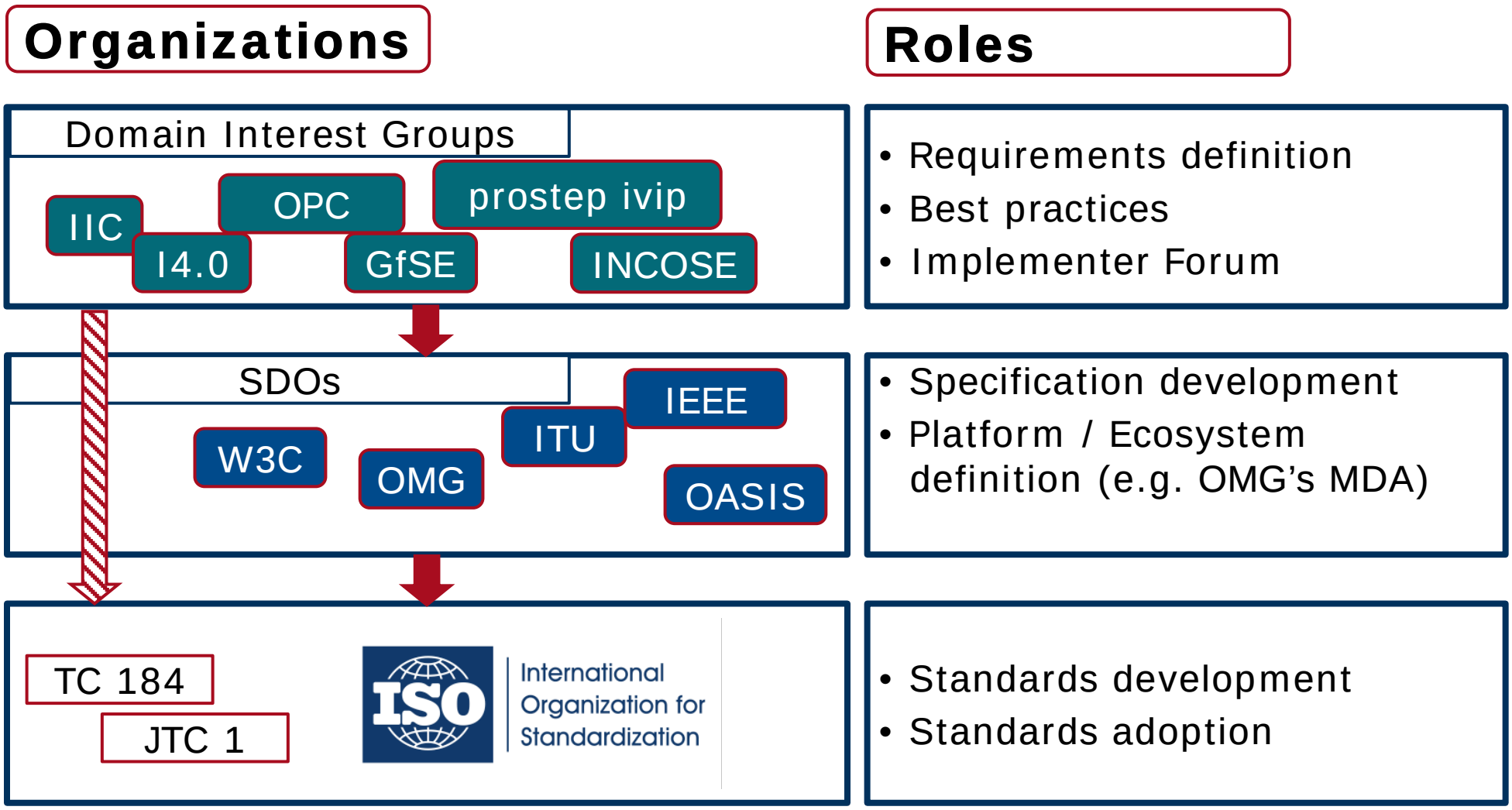
OMG Information Day on **Model-Based Engineering, Automation and IoT in Smart Manufacturing**

OMG TC Meeting, Burlingame, CA, December 6, 2017

Uwe Kaufmann

ModelAlchemy
creativity via modelling

The world of (international) standardization



OMG ManTIS

OMG ManTIS DTF - Manufacturing Technology and Industrial Systems

Gesellschaft für Systems Engineering e.V.
GERMAN CHAPTER OF INCOSE

ManTIS history

- chartered 1996:
  - **M**anuf**a**cturin**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

Michael Pfenning, XPLM

mantis-chair@omg.org

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

INCOSE International Council on Systems Engineering

OMG ManTIS DTF - Manufacturing Technology and Industrial Systems

Gesellschaft für Systems Engineering e.V.
GERMAN CHAPTER OF INCOSE

ManTIS specifications

CORBA -2000

- **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 2000-

- **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 (Beta1 currently in RFC process)

INCOSE International Council on Systems Engineering

Gesellschaft für Systems Engineering e.V.
GERMAN CHAPTER OF INCOSE

ManTIS roadmap

- **MBSE – PLM integration**
  - IT Architecture, API's
  - MBSE Data Exchange
  - Model Management
  - Digital Master / Digital Twin
  - …
- **Anticipation of IIC & I4.0 Standardization**
- **Collaboration with IIC's Smart Factory Task Group**

PLM & MBSE

PLM definitions

- Source: wikipedia

EN

- **product lifecycle management** (**PLM**) is the process of managing the entire lifecycle of a product from its conception, through design and manufacture, to service and disposal
- PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise

GER

- **Product-Lifecycle-Management** (**PLM**) is a concept for the seamless integration of information concerning the whole lifecycle of a product
- The concept is based on coordinated methods, processes and organizational structures and is implemented using IT systems for authoring and maintenance of the data
- The term PLM originates from Product Data Management (PDM) and EDM

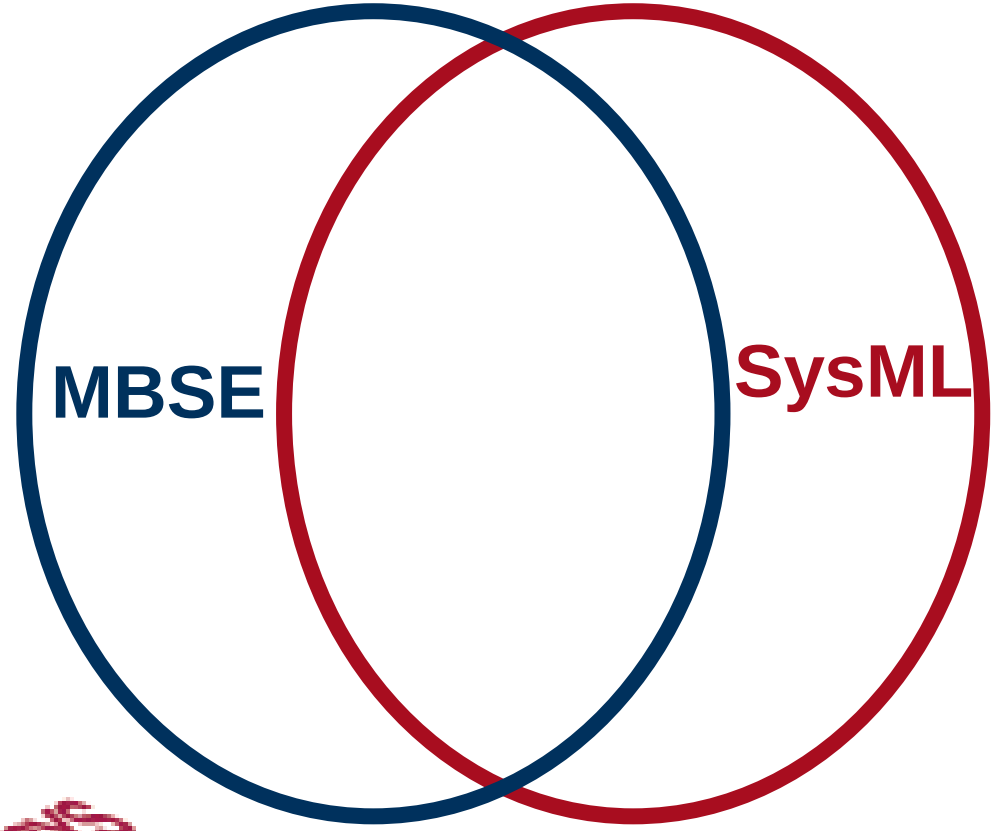
PLM origins

- PDM/PLM history:
  - PLM is considered being an extension of (traditional) PDM (cf. Model Management group)
  - PLM = Product Authoring + Data Management (incl. PDM) + Development Processes + Lifecycle Services
- PLM basic functionality
  - PDM = Product (defining) Data Management + Process Control
    - Product Structure (Assemblies, BOM, DMU, ...)
    - Engineering Change Management
    - Configuration Management
    - Variant Management

MBSE vs. SysML

MBSE Definition

"Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."
(INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007)



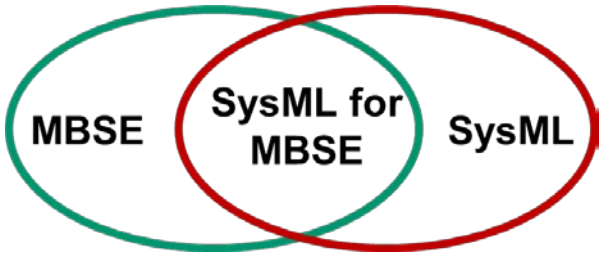
SysML

The Systems Modeling Language is a standardized graphical notation to describe system models in support of MBSE

Gap analysis: MBSE status and definition

MBSE fundamental principles:

- Any master-specification is a **formally** defined Model
- **Computationally executable** models are the basis for economically successful MBSE
- MBSE enables a **holistic** view on a product/ system (function, behavior, structure, ...)
- MBSE supports the migration from document-centered to model-centric development
- Evolve MBSE to the same level as MDSD in SW-Dev.



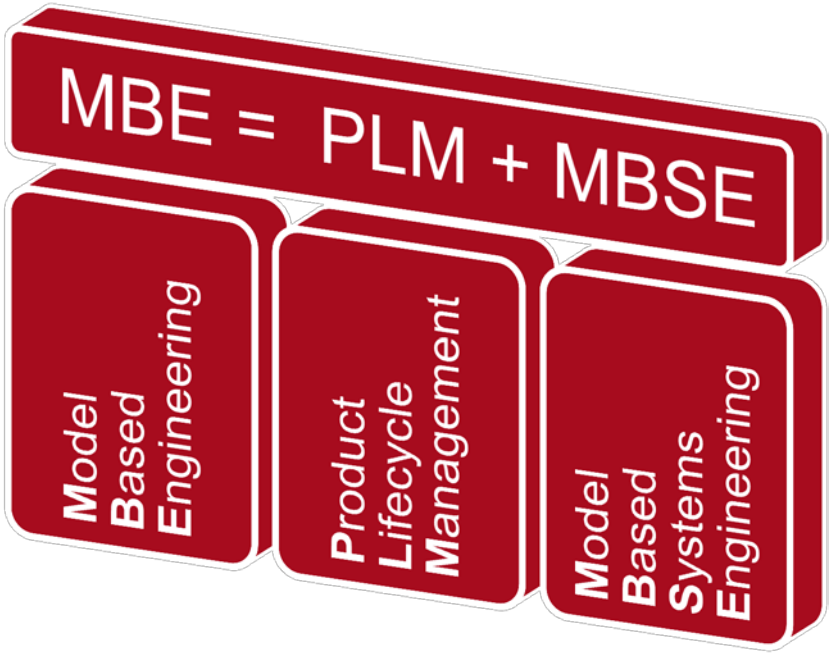
Theses about PLM and MBSE integration

- ➜PLM evolved from PDM to include other disciplines' data but lacks semantic representation
- ➜PLM objective: definition of a holistic product mock-up
- ➜MBSE objective: definition of a cross-discipline holistic system model of a product
- ➜MBSE authoring tools are able to define semantic representation of a product

Conclusion / Thesis:

- PLM and MBSE cover similar objectives
- PLM and MBSE need to converge
- MBE = MBSE+PLM!

GfSE PLM4MBSE - Motivation



PLM4MBSE Working Group Position Paper

10 theses about MBSE and PLM

Challenges and Benefits of Model Based Engineering (MBE)

1. MBE is *the* enabler for the "Internet of Things" and "Industrie 4.0".
2. Product liability and functional safety regulations are a driving factor for MBE.
3. Future PLM systems need a holistic view on a product as a multidisciplinary system.
4. Early design decisions must be logically and functionally validated using system models.
5. Results from MBSE must be made available over the whole product lifecycle.
6. MBE requires models with meaning.
7. The MBE tool chain must rely on technology independent standards.
8. Increasing complexity of products and production systems asks for new development processes, methods, and tools.
9. MBE requires changes in organization, methodology, technology and education.
10. Investments in MBE can deliver a ROI of 3:1.

1

Version 1.1 2015-09-09

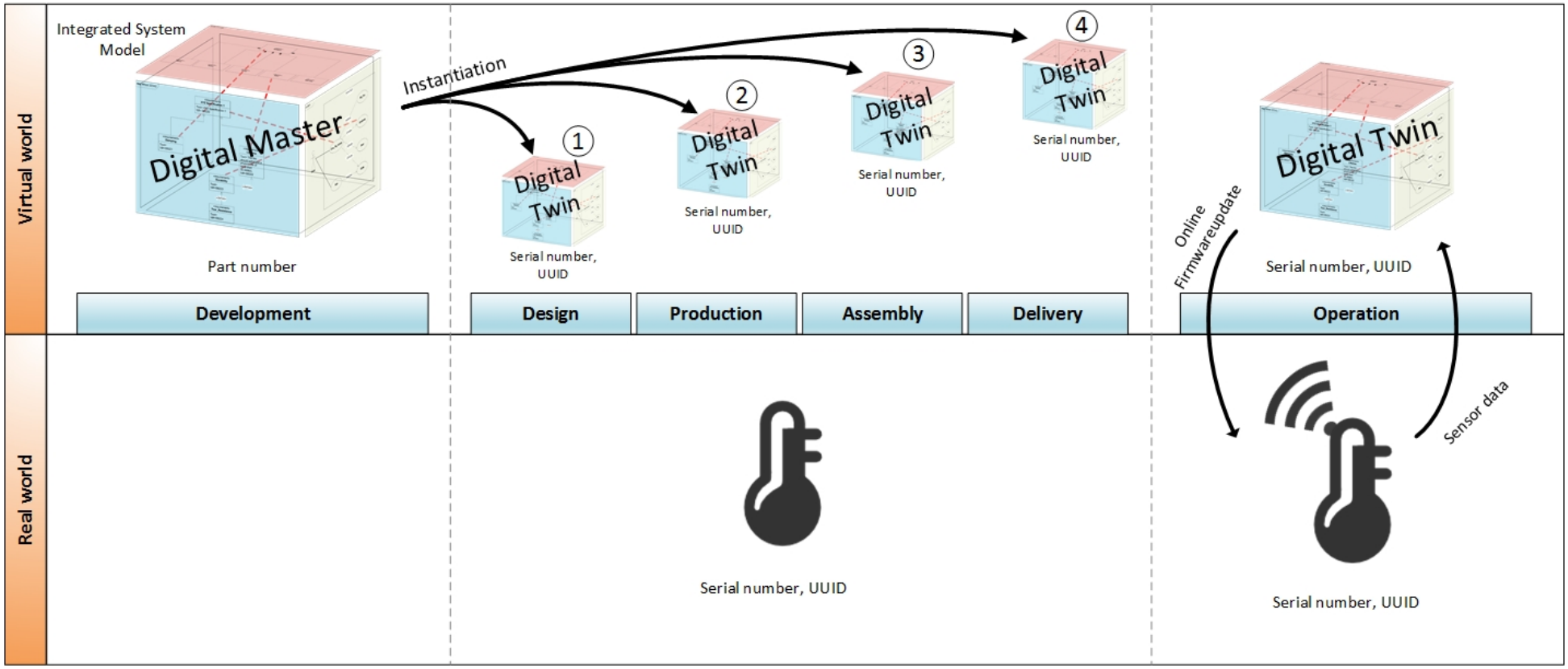
http://www.gfse.de/arbeitsgruppen.html#tab2-plm4mbse
http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:plm4mbse_position_paper_v1_0_july_2015.pdf

ManTIS roadmap (continued)

Continuous Engineering Toolchain from Product Development to Production and Use

- Continuous Engineering Toolchain means we need a carrier for the data throughout the product lifecycle
- Today‘s media breaks:
  - Textual defined requirements
  - Virtual Product and Virtual Factory developed separately
  - Transfer of Field/Maintenance information to product development
  - ...
- Need for single source of reference to product and production related engineering information
- No standard way to formally describe „Digital Master“, „Digital Twin“ (e.g. Industrie 4.0 RAMI: Administration Shell == Digital Twin)

Model-based definition of Digital Master & Twin



(1) Engineer-to-Order (2) Make-to-Order (3) Assemble-to-Order (4) Make-to-Stock

Source: Michael Pfenning, PhD Thesis

Need for Action in PLM / MBSE (selection)

- Establishment of a MBSE / SysML Ecosystem
  - Model Libraries, Standard “Parts” (compare to (3D) CAD of 90’es)
  - Support re-use in MBSE, ease MBSE migration projects
  - Rapid and automated generation of MBSE artefacts, “Systems Re-Engineering”
  - Elaboration of “pragmatic modeling” methods / tools
- Dissemination of MBSE Methodology
  - University courses based on standard modeling methodology (see also: Pahl/Beitz Konstruktionsmethodik)
- ...

Outlook

ManTIS Agenda for Burlingame

Thursday, 07 Dec.

09:00 – 17:00 ManTIS plenary

09:00 Introductions & agenda review

09:15 Presentations

- Report from PLM4MBSE WG (Uwe Kaufmann, ModelAlchemy)
- Update on the SysML extension for physical interaction and signal flow simulation – SysPhS aka SysPISF RFC (Conrad Bock, NIST)

10:15 Coffee Break

10:30 The Need for Data Lineage in Manufacturing (John C. Butler, Auxilium TG)

11:00 Ontology session

- The Problem with Using UML/SysML to Make an IDEAS/UAF Based Network Graph (William C. Beavin, Boeing)
- Discussion with Ontology PSIG

12:00-13:00 Lunch

13:00 – 17:00 ManTIS plenary continued

13:00 Presentations

- Status on work in ISO TC 184 SC4 Industrial Data and new SC4 subcommittee on digital manufacturing (Allison Barnard-Feeney, NIST)
- End User Testbed Opportunities from IIC (Smart Factory Task Group Chairs, IIC)
- Wrap-up from Information Day, identification of need for action, …

14:30 Coffee Break

15:00 Presentations and roadmap discussion

- *Tentative: Update on PLM – MBSE Integration proof of concepts (Christian Muggeo, ARAS / Lucas Kirsch, CONTACT Software)*
- Roadmap and future directions discussion

~17:00 Adjourn

GfSE
Gesellschaft für
Systems Engineering e.V.
GERMAN CHAPTER OF INCOSE

Thank you!

Uwe Kaufmann
uwe.kaufmann@modelalchemy.com