Model Based Systems Engineering

SAE Aerospace Standards Summit
25th April 2017

Agenda and timings

- Introduction (5)
- Speakers
  - INCOSE view of standards for MBSE – Alan Harding (15)
  - Using MBSE to balance innovation, creativity and compliance – Duncan Kemp (15)
  - Innovation: Compliance or Creativity? - Isabella Panella UTAS (15)
  - New perspectives on MBSE – Stephan Marwedel (15)
- Panel Session (30)

INCOSE view on standards for MBSE

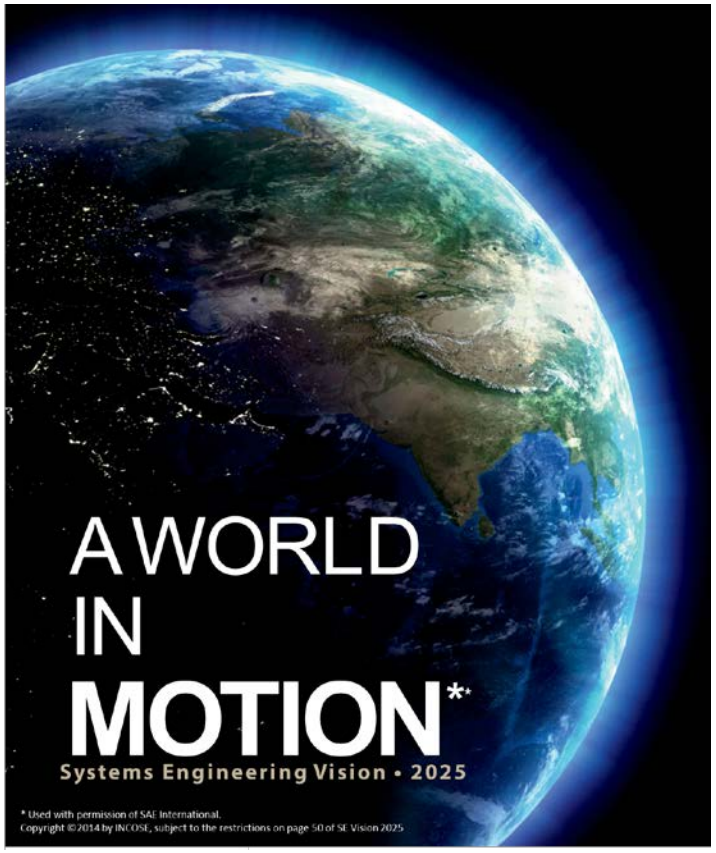
Alan Harding CEng FIET
INCOSE President

SAE Aerospace Standards Summit Spring 2017
25th April 2017

INCOSE Vision: A better world through a systems approach

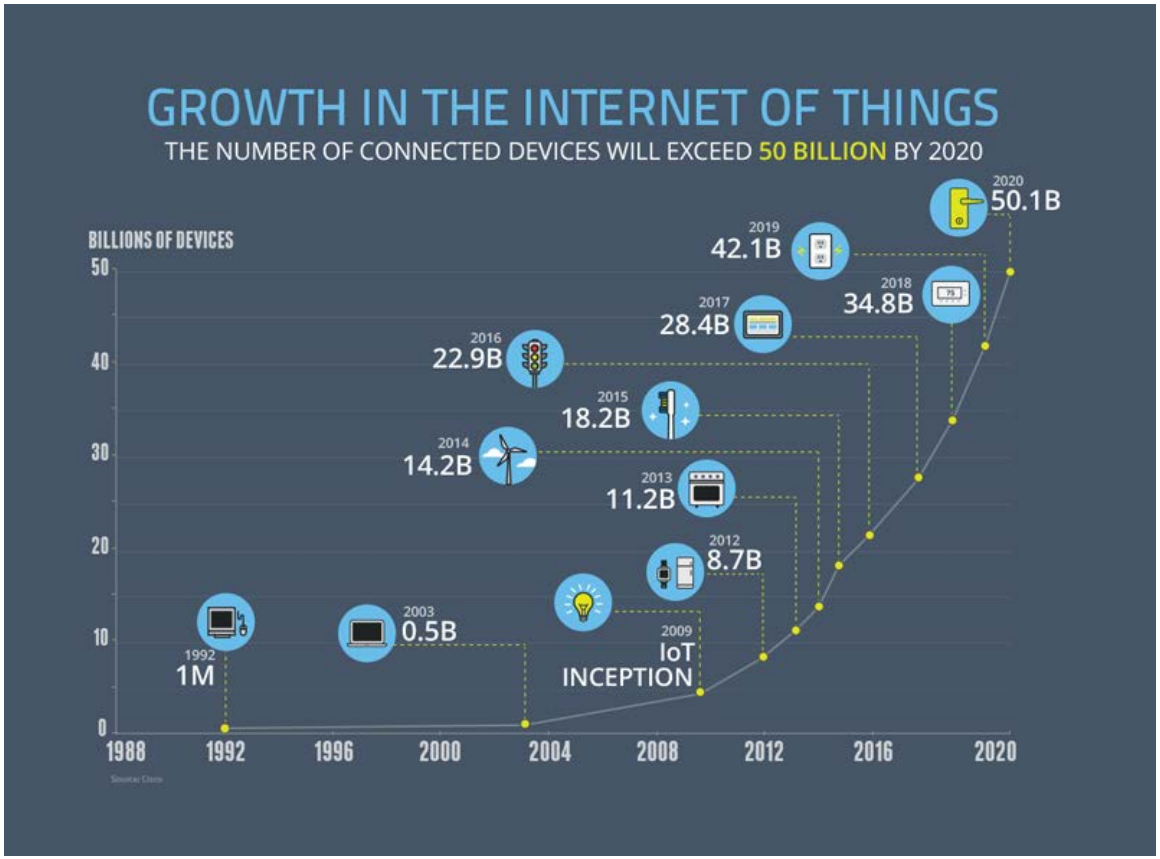
INCOSE Mission: To address complex societal and technical challenges by enabling, promoting, and advancing Systems Engineering and systems approaches

Systems Engineering Vision 2025



- "Inspiring and guiding the direction of systems engineering across diverse stakeholder communities"
- Basis for conversations on the future of systems and systems engineering
- Major influence on INCOSE's strategy and plans

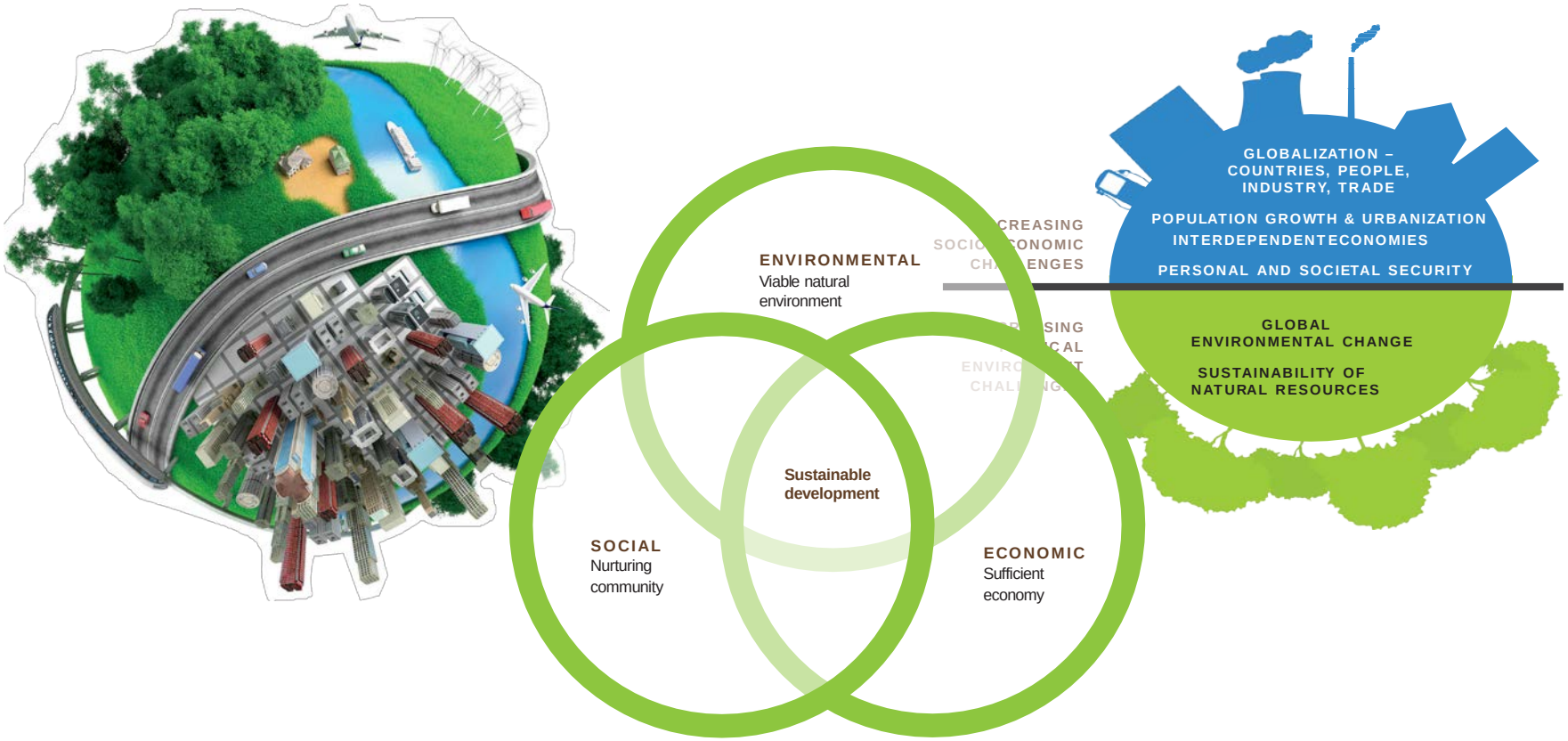
IoT explosion in connectivity



- Connected devices with self-knowledge
- Exponential growth
- Fantastic opportunities
- Unknown & emerging threats

- Huge complexity and scale
- Systems Engineering has a vital role to play

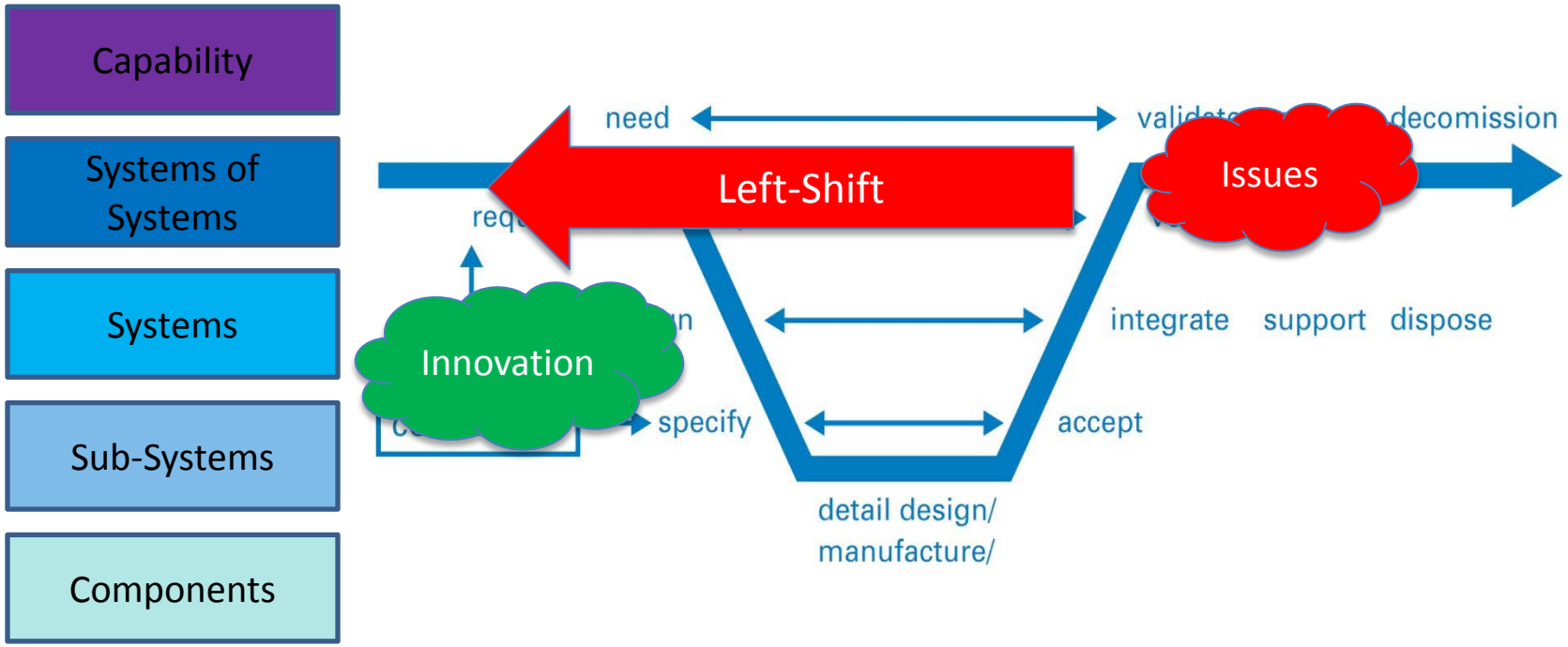
Today's Global Challenges



In the future SE will be …

- Relevant to broad range of domains and policy areas
- Comprehensively supporting stakeholder collaboration
- Supported by:
  - Comprehensive professional development and education
  - More encompassing foundation of theory
  - Sophisticated model-based methods and tools
- Together these changes will allow understanding of increasingly complex systems and decisions in the face of uncertainty

How we engineer systems



Vee diagram taken from INCOSE UK Z1 "What is Systems Engineering?"

The types of system we engineer

Capability

Systems of Systems

Systems

Sub-Systems

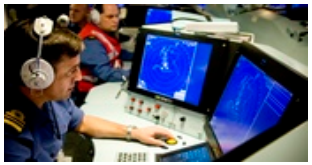
Components

Many and increasing domains of application

- Defence/aerospace
- Transport/automotive
- Infrastructure
- Biomedical
- Energy
- …

Socio-technical systems

Systems of systems



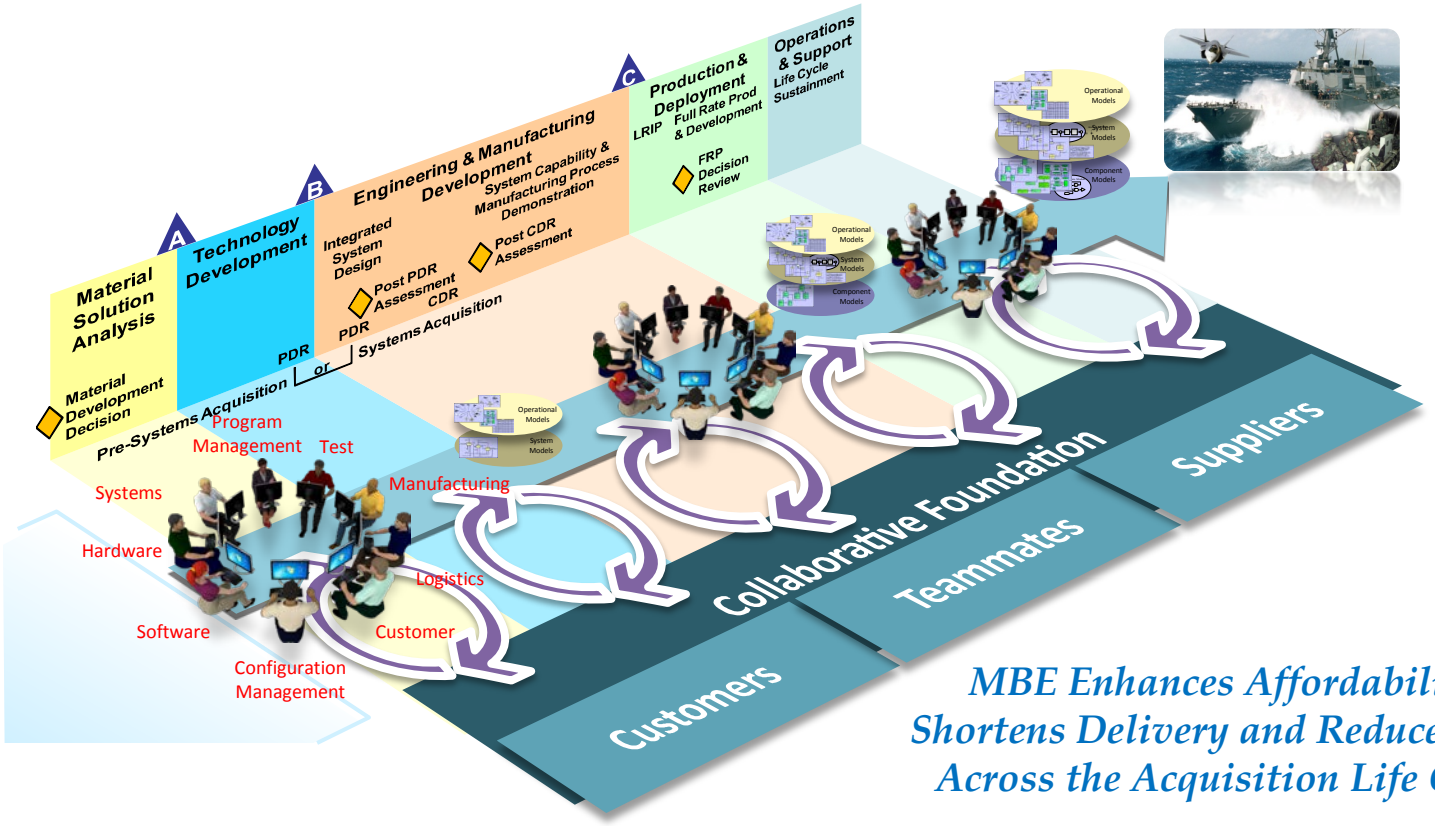
Integrated systems

Component systems

Standards provide:

- Common process framework
- Support for collaboration
- Interface protocols

Model Based Engineering



MBE Enhances Affordability, Shortens Delivery and Reduces Risk Across the Acquisition Life Cycle

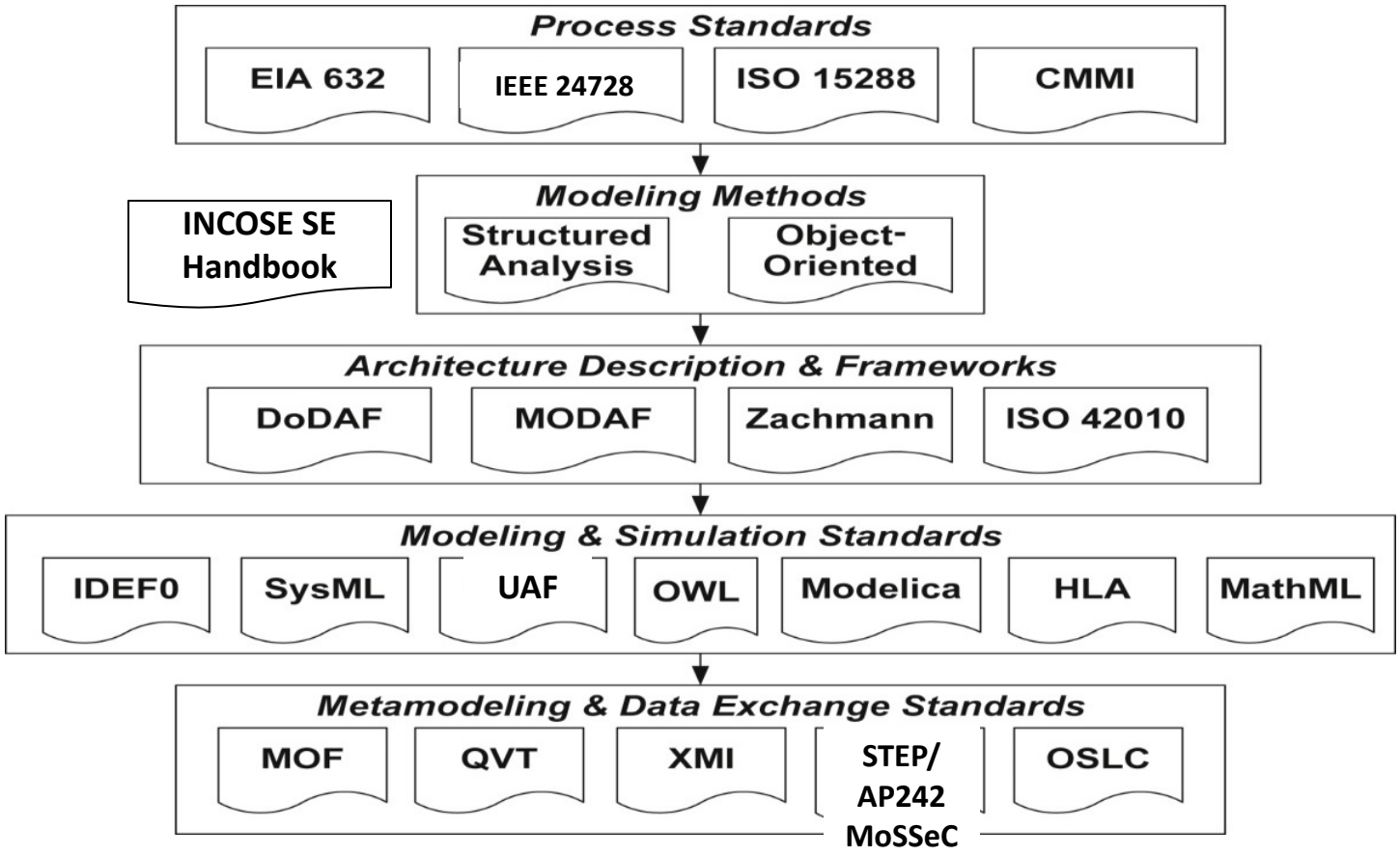
NDIA Model-Based Engineering Final Report, February 2011

INCOSE

MBSE needs Standards

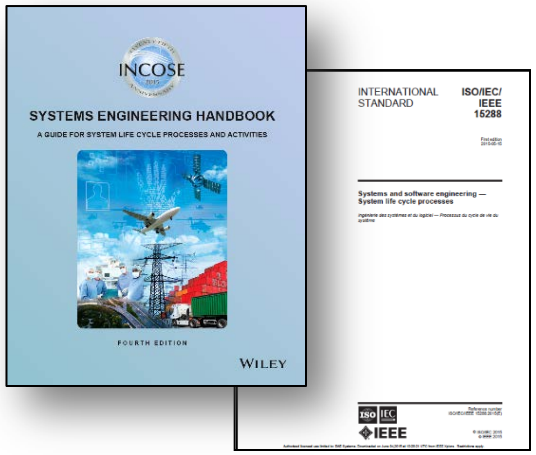
- **Modelling Languages and Frameworks** - to express and communicate models
  - For understanding and interpretation by people
  - For analysis and processing by computer programs
- **Mapping Specifications** - Integration of models across multiple domains and communities
  - Mappings across multiple sources and forms of models
- **Problem-specific frameworks, models, reference data**
  - Generated and shared by user communities for specific system and problem types
  - E.g. Architecture Modeling Language, Hardware/Software Systems, Continuous System Dynamics, …
- **Process Standards** – to share good practice

Partial SE Standards Taxonomy



INCOSE and MBSE standards

- INCOSE has driven MBSE standards development since 2001
  - INCOSE does not set standards
  - Works with standards developing organizations
  - INCOSE members serve as conveners to WGs as editors and experts of multiple standards.
- Main partnerships
  - ISO/IEC JTC 1/SC 7 (software and systems engineering)
  - ISO/IEC JTC1 SC 27 (IT security techniques)
  - Object Management Group (OMG)
  - NAFEMS



INCOSE and ISO

- INCOSE is a Category A liaison to ISO/IEC JTC 1/SC 7 (software and systems engineering)
  - Authors and SMEs for flagship ISO/IEC/IEEE 15288:2015 and associated IEEE 15288.1 and 15288.2
  - Strong input on coherence between SC 7 standards and elsewhere
  - INCOSE preparing guidelines for use of standards for MBSE approach.

- INCOSE SE Handbook 4th Edition is fully consistent with 15288
- INCOSE stewardship (with SERC and IEEE Sys Man) of Guide to the SE Body of Knowledge promotes SE information globally

- ISO/IEC JTC1 SC 27 (IT security techniques) - standards for the protection of information, as well as information and communications technology infrastructure

INCOSE and OMG

- An enduring partnership
- Original MOU with OMG and ISO TC184/SC4 (STEP) led directly to SysML and AP233
- With INCOSE's sponsorship and systems engineering domain expertise, OMG adopted the Systems Modeling Language (OMG SysML) in 2007
- Development of other modelling standards such as Unified Architecture Framework (UAF), previously UPDM, and Requirements Interchange Format (ReqIF).
- INCOSE/OMG now focused on the development of SysML v2.

OMG Standards related to SySML

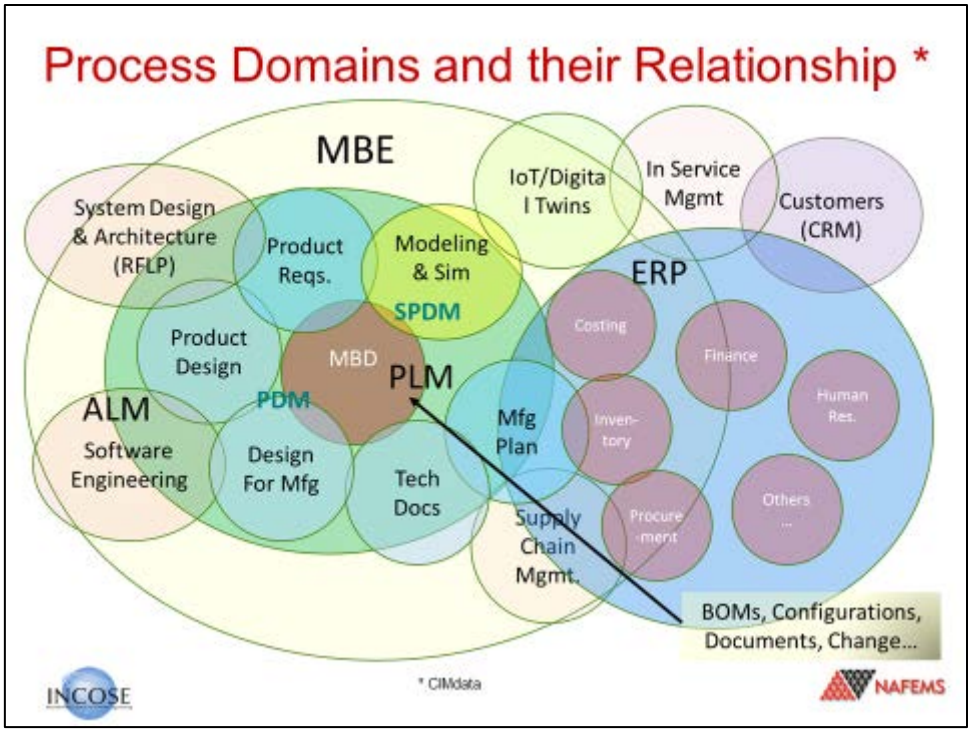
- Unified Modeling Language (UML)
- Unified Architecture Framework (UAF) – previously UPDM
- Business Process Model and Notation (BPMN)
- UML Testing Profile (UTP)
- Profile for Safety and Reliability – in process
- Requirements Interchange Format (ReqIF)
- Software and Systems Process Engineering Metamodel (SPEM)
- Reusable Asset Specification (RAS)
- MOF Versioning and Development Lifecycle (MOFVD)
- XML Metadata Interchange (XMI)
- Diagram Definition (DD)
- Object Constraint Language (OCL)

Whither SysML?

- SysML v1 available for 10 years
  - An enabler of MBSE
  - Strengths and limitations understood and basis for future improvements
- SysML v2 is being specified in the context of a System Modeling Environment to improve support for MBSE:
  - Precision
  - Interoperability
  - Usability
- SysML v2 specification will include
  - Meta-model, profile, and model libraries, concrete syntax
  - Standard API
  - Flexible view and viewpoint requirements for improved visualization
  - Reference model & test cases to demonstrate vendor conformance levels
  - Migration from SysML v1 to SysML v2

INCOSE and NAFEMS

- International Association for the Engineering Modelling, Analysis and Simulation Community
- MOU signed in 2012
- Joint Technical Working Group - System Modelling and Simulation



INCOSE NAFEMS

Main lines of travel

- Developing guidance for applying 15288 for use in MBSE
  - Generic
  - Within domains … e.g. aerospace, automotive
- Path to SySML 2.0
- Dependable systems
  - Standards to improve Security
  - Safety and Reliability profile

Thank-you

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