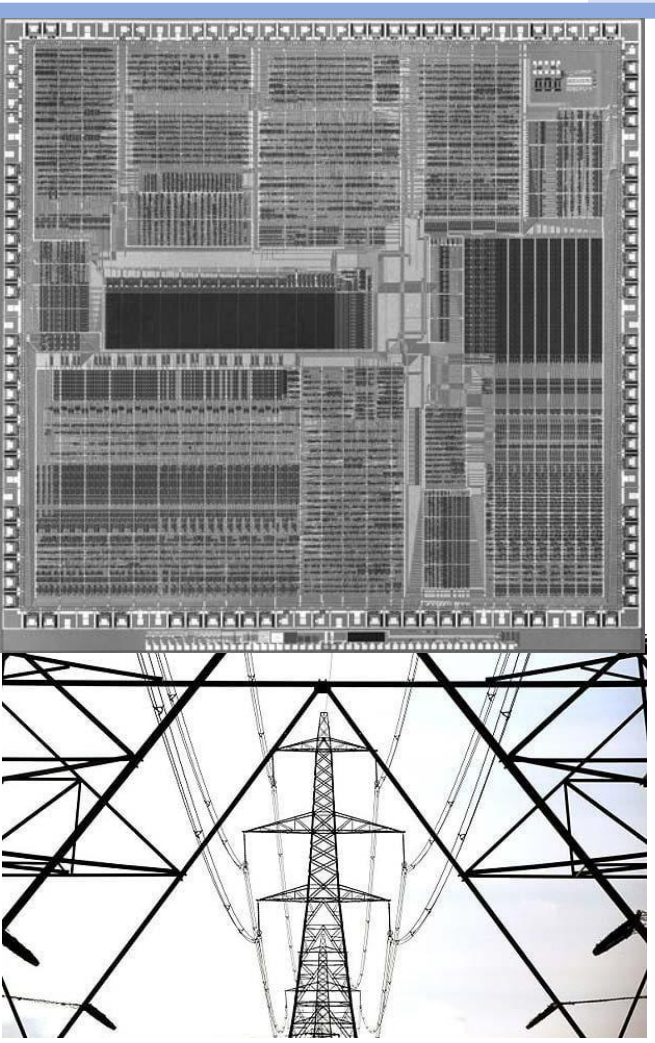
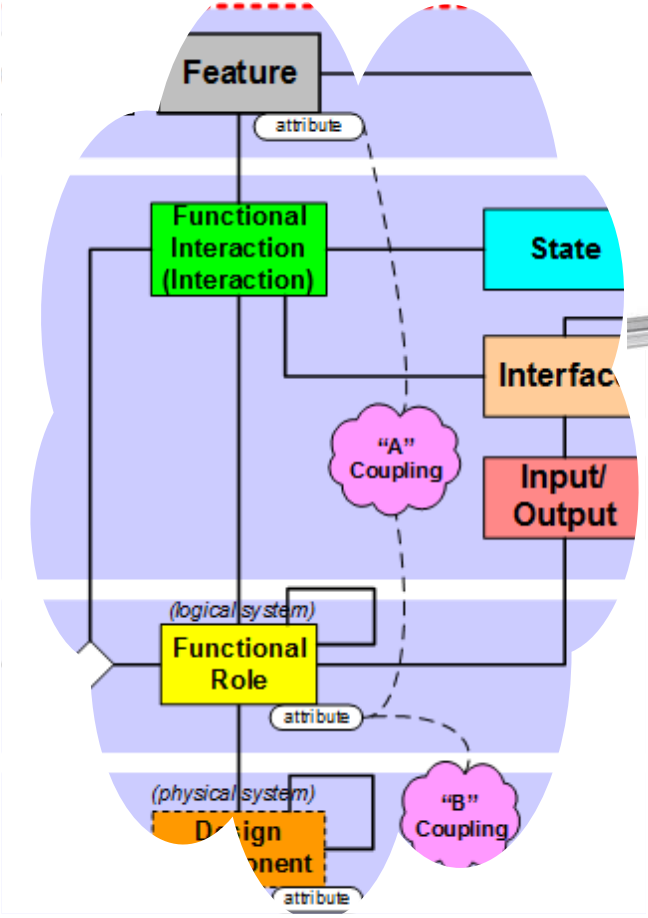
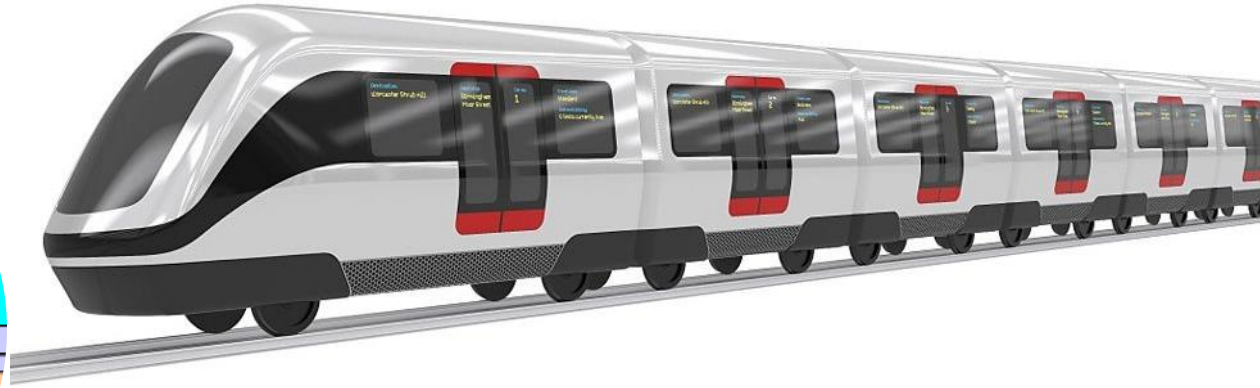
V1.2.3

Introduction to the INCOSE MBSE Patterns Working Group

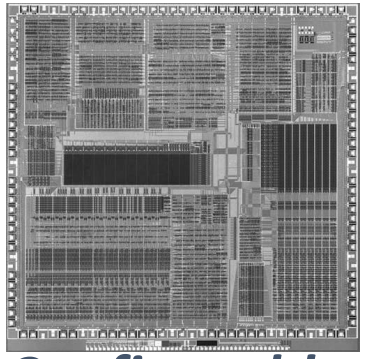






INCOSE N. Texas Chapter Meeting
May 21, 2024

Patterns Working Group Meeting at IS2024:
Thursday, July 4, 10:00 AM – 12:10 PM,
Dublin, Ireland Conference Time;
4:00 – 6:10 PM, US Eastern Time

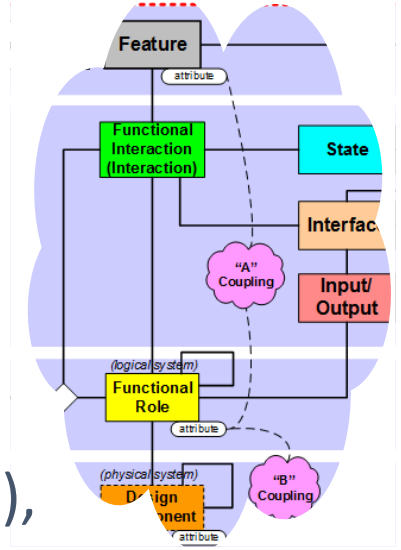


Focus of MBSE Patterns Working Group: S*Patterns

FOR MORE

***Configurable, re-usable system models*:**

1. Models containing a certain minimal set of elements are called S*Models (S* is short for “Systematica”).
2. Those underlying elements are called the S*Metamodel, which was inspired by the unmatched success of the physical sciences and impact of STEM.
3. S*Models using those elements may be expressed in any modeling language via formal mapping (e.g., in OMG SysML, or in other languages).
4. S*Models can be (have been) created and managed in many different COTS modeling tools using such diverse languages.
5. Re-usable, configurable S*Models are called S*Patterns.
6. By “Pattern-Based Systems Engineering” (PBSE) we mean MBSE enhanced by these generalized assets to enable model configuration from trusted patterns.
7. These are typically system-level patterns (models of whole managed platforms), not just smaller-scale component design patterns.



Patterns WG projects, summarized here, plus others

The others

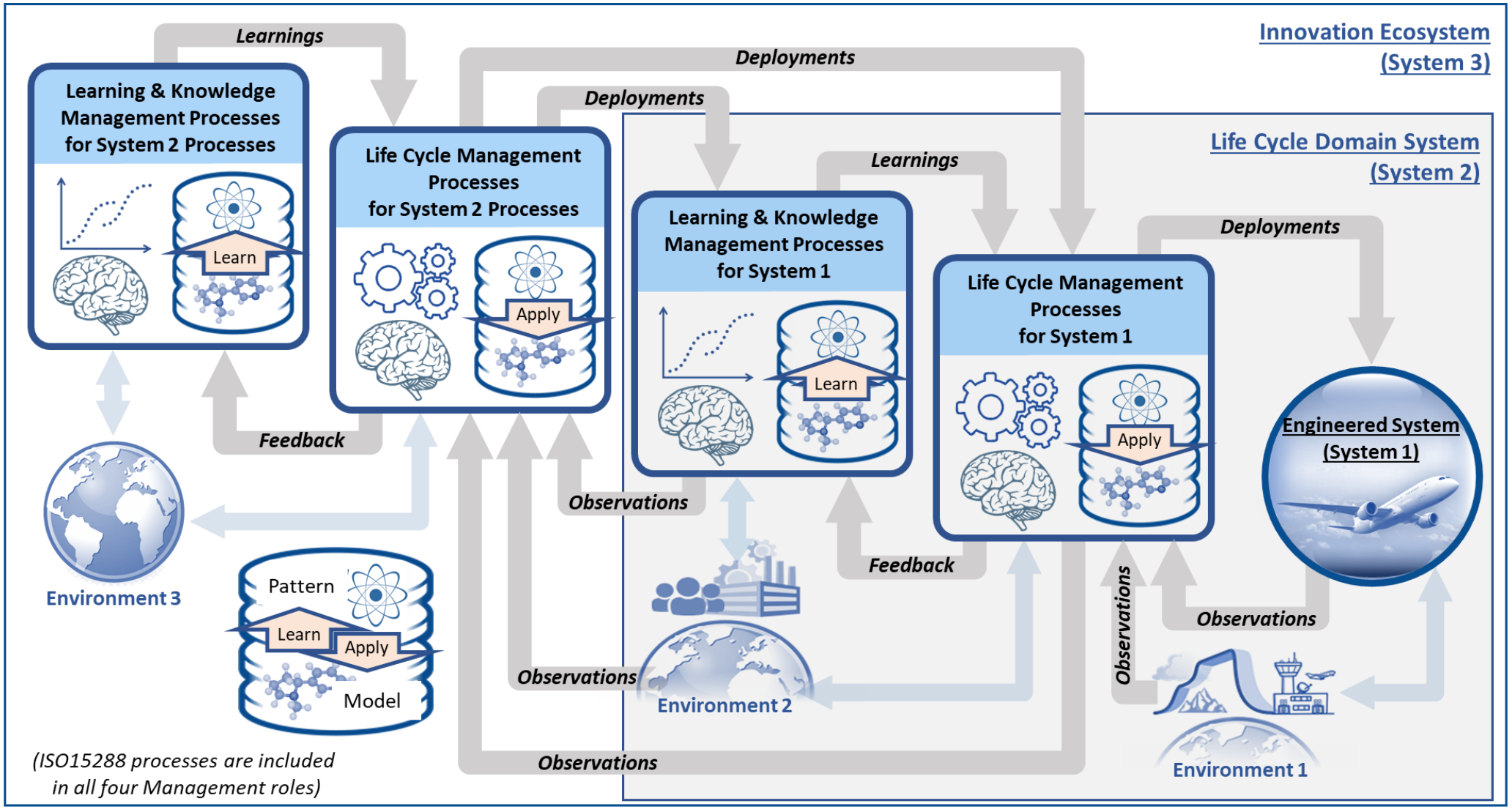
Patterns & Technologies:

1. Semantic Technologies for Systems Engineering (ST4SE) Project.
2. Adaptive Learning Ecosystem Pattern—the INCOSE ASELCM Reference Framework.
3. Trust in Models: The Rosetta Stone Project.
4. Universal Model Metadata Wrapper: Model Characterization Pattern (MCP), w/ASME VV Stds Cmte & V4 Inst.
5. S*Pattern Configuration Wizard.

Publications:

1. Minimal S*Models—A Primer (including S*Metamodel and its formal mappings to OMG SysML and tools)
2. S*Patterns Primer (second ed)
3. ASME Guideline for Managing Credibility of Models for Adv. Manufacturing, w/ASME VV50 Stds Working Grp.
4. AIAA Aerospace Digital Twins Case Studies Pub; Digital Twin Analysis and Planning Reference Pattern, w/AIAA.
5. AIAA Aerospace Digital Threads Position Pub; Digital Thread Analysis & Planning Reference Pattern, w/AIAA.
6. *Handbook of System Sciences*, for ISSS via Springer: Chapter: “Patterns in Science and Engineering”, w/ISSS.
7. *Handbook of Model-Based Systems Engineering*, Madni & Augustine, eds, Springer, Chapter: “MBSE Patterns”.
8. *INCOSE SE Handbook*, 5th Ed., for INCOSE, D. Walden et al, eds, material on S*Metamodel and ASELCM Pattern
9. Support for Vision 2035 Implementation Streams: FuSE--Innovation Applications, SE Foundations.
10. *INCOSE INSIGHT,* Dig. Engg. Issue, 2022, F. Salvatore, ed, Realizing the Promise of Digital Engineering: The Innovation Ecosystem Reference Pattern for Analysis, Planning, and Implementation.

Adaptive Learning Ecosystem Pattern—the Learning Ecosystem (ASELCM) Reference Framework

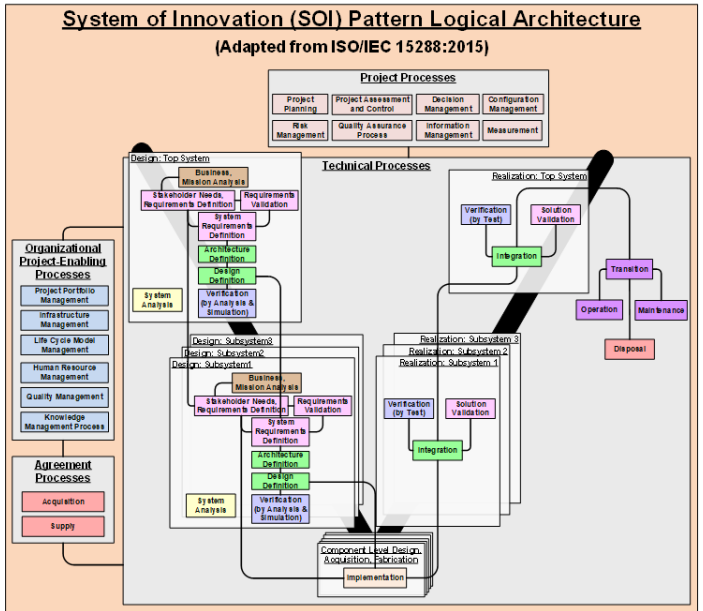


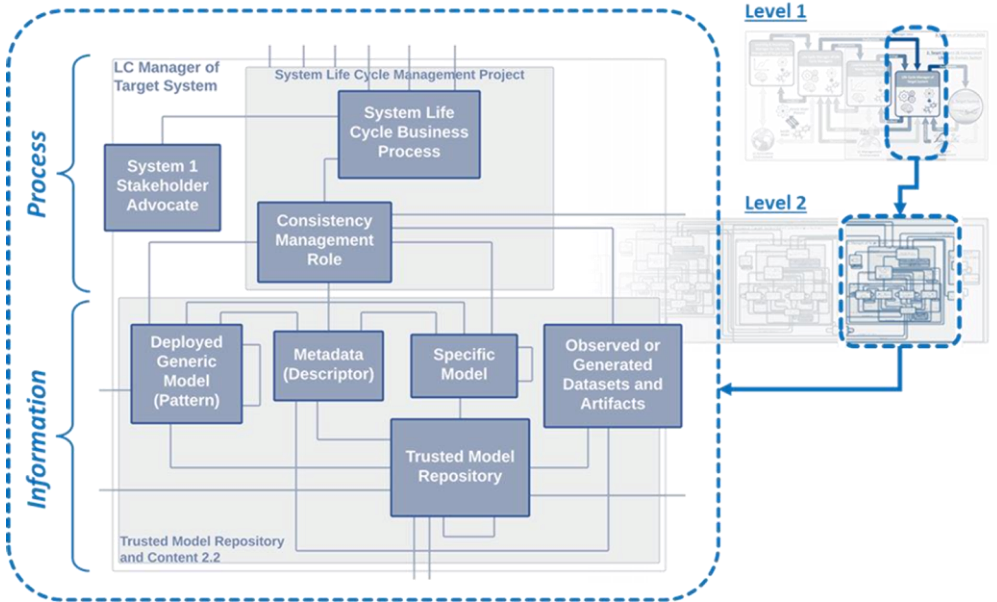
ASELCM Pattern Description

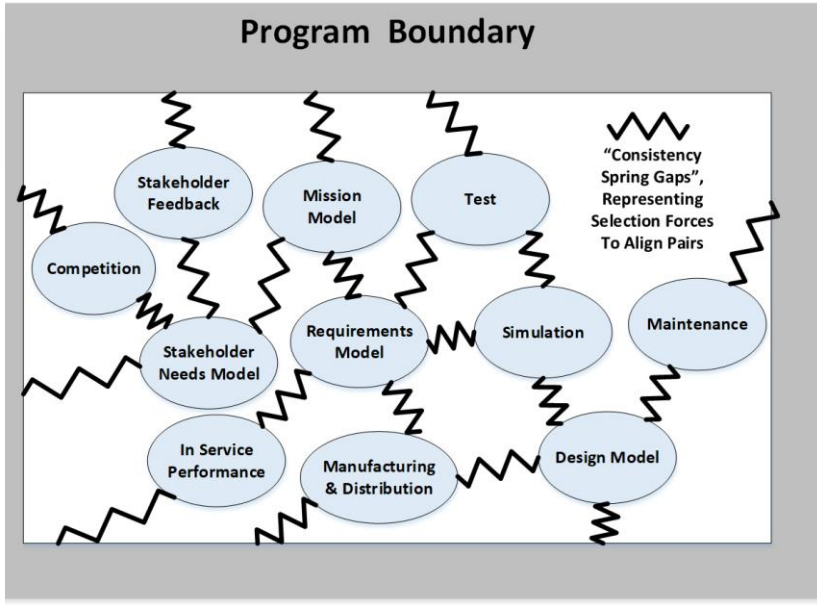
AIAA's Related Application (Digital Threads)

Consistency gap management paradigm for innovation ecosystems

- The consistency management paradigm is the central information thread running through the ASELCM pattern's representation of any engineering/life cycle management / supply chain system's primary activities.
- Including the digital thread and its many precursors.







Trust in Models: The Rosetta Stone Project

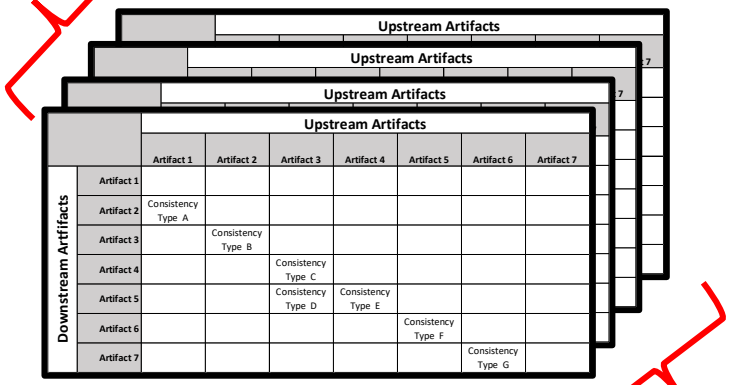
- Different discipline communities (e.g., ISO 15288 SE *versus* ASME VVUQ-1 computational modeling communities) have different consistency confirmation frameworks, nomenclatures, standards.
- This can present challenges to engineering rigor, when performed "together" for trust-critical integrated systems.
- Working groups of INCOSE, ASME, AIAA, and NAFEMS are collaborating on a comparative "Rosetta Stone" mapping of different consistency confirmation frameworks of different communities:

https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:asme_vvuq_2024_slides_schindel_et_al_v1.7.3.pdf

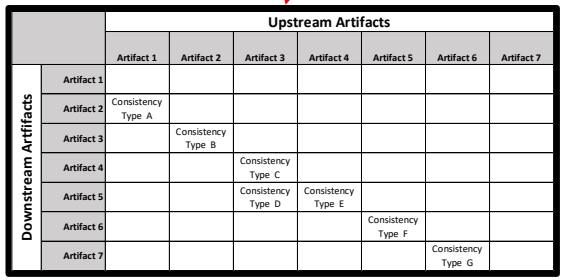
		Upstream Artifacts						
		Artifact 1	**Artifact 2**	**Artifact 3**	**Artifact 4**	**Artifact 5**	**Artifact 6**	**Artifact 7**
Downstream Artfifacts	**Artifact 1**							
	Artifact 2	Consistency Type A						
	Artifact 3		Consistency Type B					
	Artifact 4			Consistency Type C				
	Artifact 5			Consistency Type D	Consistency Type E			
	Artifact 6					Consistency Type F		
	Artifact 7						Consistency Type G	

For one discipline

Multiple disciplines



Merge



Merged multiple discipline mapping

American Institute of Aeronautics and Astronautics (AIAA) has released both its Digital Thread & Digital Twin Reference Models

June, 2023

Click to Download AIAA Digital Thread Reference Model

Both of these are based on the INCOSE MBSE Patterns Working Group Innovation Ecosystem (ASELCM) Pattern.

Click to Download Related INCOSE Publication

January, 2023

Click to Download AIAA Digital Twin Reference Model

Support for Vision 2035 Implementation Streams: INCOSE FuSE--Innovation Applications, SE Foundations

- Adopting W R Hamilton's "characteristic function" perspective enriches interpretation of the nature of momentum and energy, in additional settings:
  - By reasoning in the right order, Hamiltonians can be defined for IT (i.e., digital) and socio-technical systems, using observational data.
  - Managed consistency gaps provide the potential energy part of the ASELCM System 2 Hamiltonian, characterizing the ecosystem itself.
  - Besides providing theoretical foundations for the SE process, it also suggests the architecture for incorporating machine learning at enterprise project level.
- At IS2024 in Dublin (Hamilton's home), we'll detail it further:
  - Wednesday, July 3, IS2024 paper session: "Innovation Ecosystem Dynamics, Value and Learning I: What Can Hamilton Tell Us?"