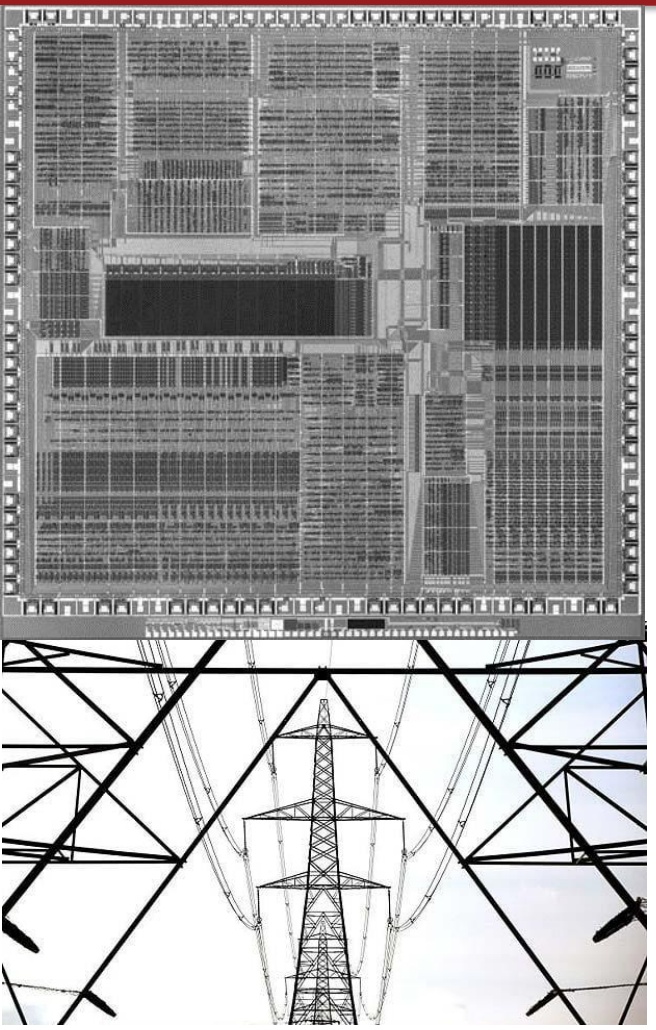
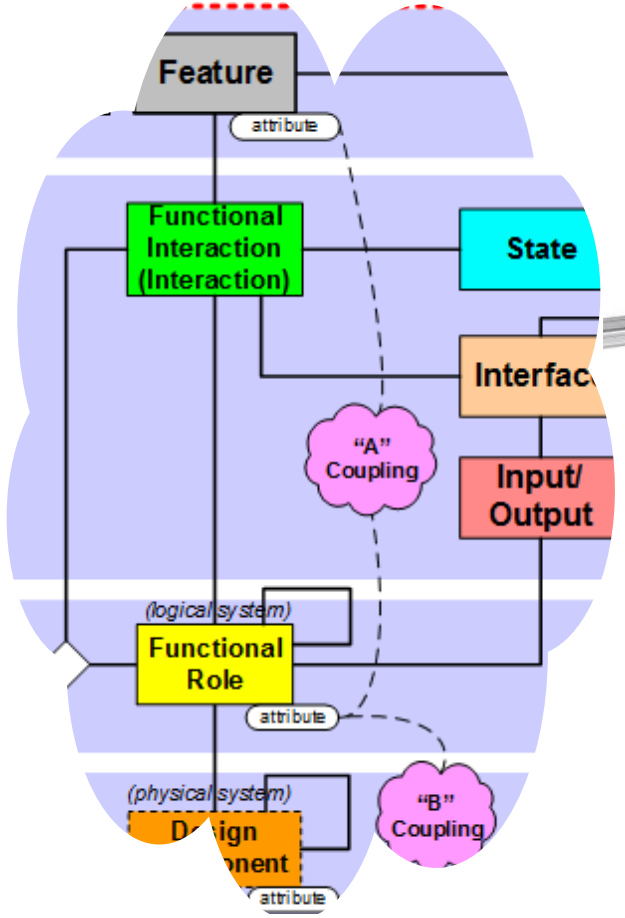
29th Annual INCOSE international symposium

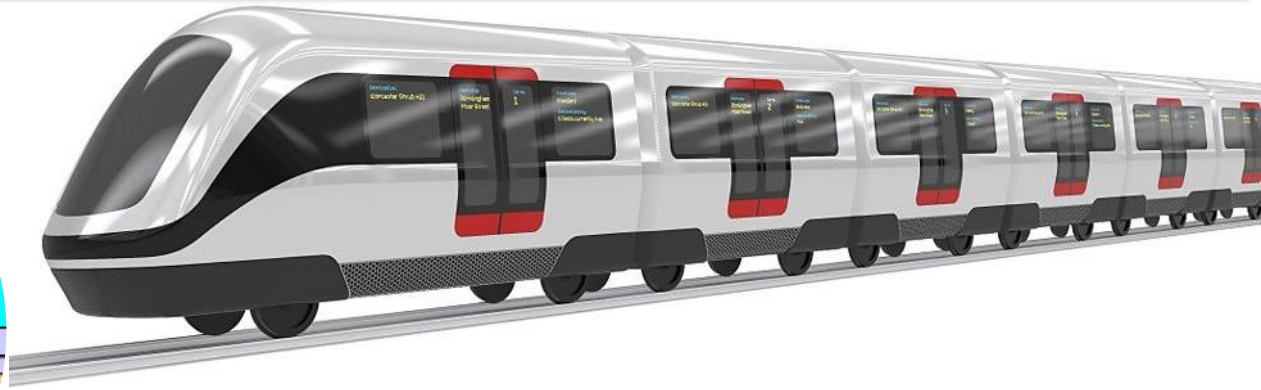
Orlando, FL, USA

July 20 - 25, 2019

MBSE Patterns Working Group







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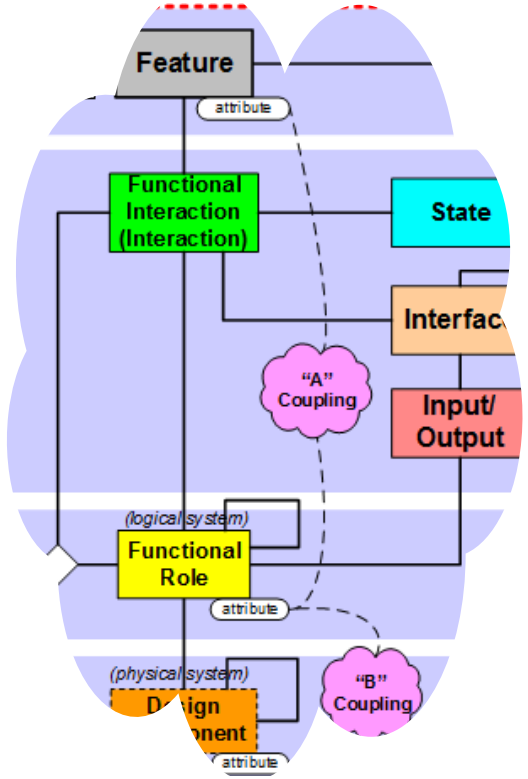
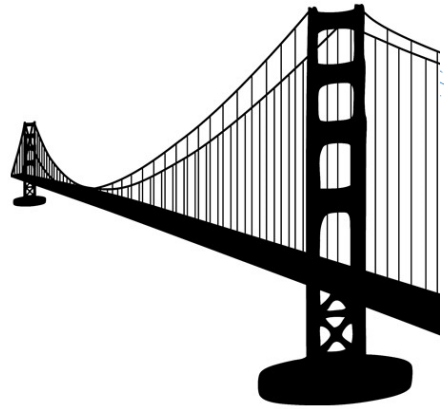
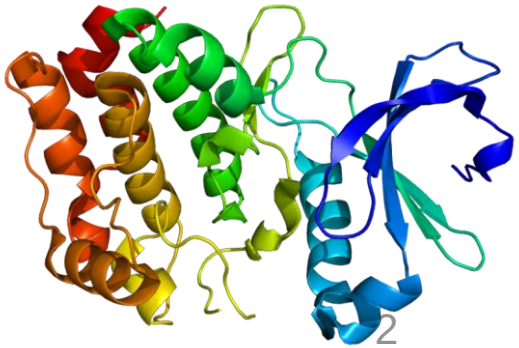




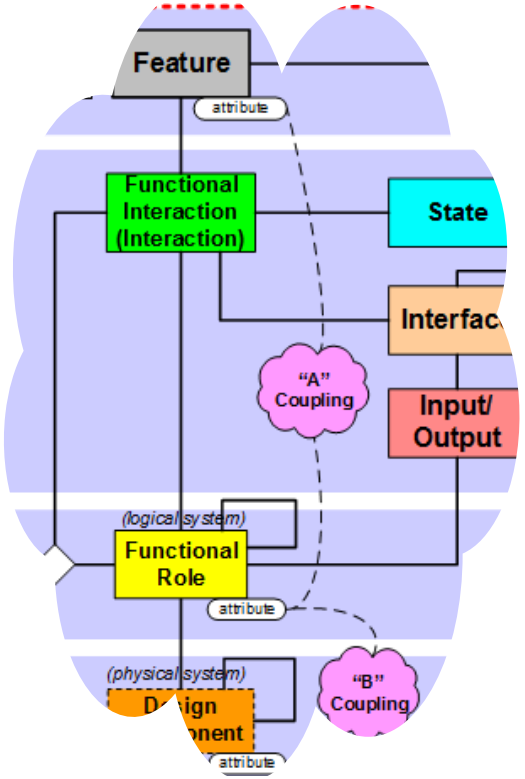
Contents

- Introduction to MBSE Patterns, and the Patterns WG
- Status of WG Projects
- Future Projects of Interest to Attendees
- References

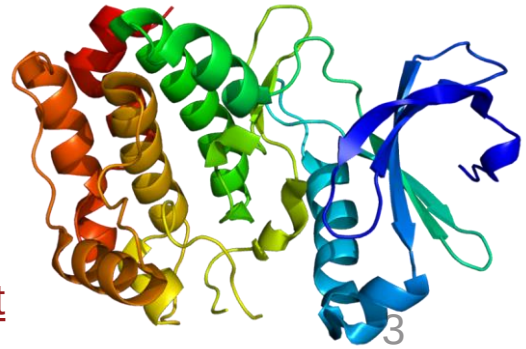
Patterns WG web site:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns
IW 2S2019 Patterns WG meeting web site:
https://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:mbse_patterns_wg_participation_in_incose_is2019



Introduction to MBSE Patterns, and the Patterns WG



- Who we are—including our partners
- Types of activities
- IS2019, recent, and future activities
- How to get involved
- "Patterns 101" references



Patterns WG web site:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns

IW 2S2019 Patterns WG meeting web site:
https://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:mbse_patterns_wg_participation_in_incose_is2019

We began six years ago, as the MBSE Initiative Patterns Challenge Team:

- Part of the joint INCOSE/OMG MBSE Initiative, formed years earlier as MBSE Patterns Challenge Team.
- Three years ago (2016), our team formally became the INCOSE MBSE Patterns Working Group
- Because of our MBSE focus, and in order to continue to support the MBSE Initiative, we continue to also be listed as part of that INCOSE/MBSE Initiative

This Working Group is concerned with *configurable, re-usable system models*: "S*Patterns"

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 physical sciences
3. S*Models using those elements may be (have been) expressed in any modeling language (e.g., SysML, or other languages)
4. S*Models can be (have been) created and managed in many different COTS modeling tools.
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
7. These are system-level patterns (models of whole managed platforms), not just smaller-scale component design patterns

The INCOSE Patterns Working Group: *Who are we?*

- Our most active members come from across diverse domains:
  - Automotive
  - Advanced Manufacturing
  - Aerospace
  - Consumer Products
  - Defense
  - Health Care, Medical Devices, Pharmaceuticals
  - Others
  - Today's attendees?
- During the last six years, over 200 colleagues have participated in Patterns Working Group activities:
  - Team meetings, work sessions, tutorials, meetings with other groups
  - Construction of system patterns
  - Writing related papers for IS, IW, and regional INCOSE conferences
  - Invited presentations of our team's work to INCOSE chapter meetings

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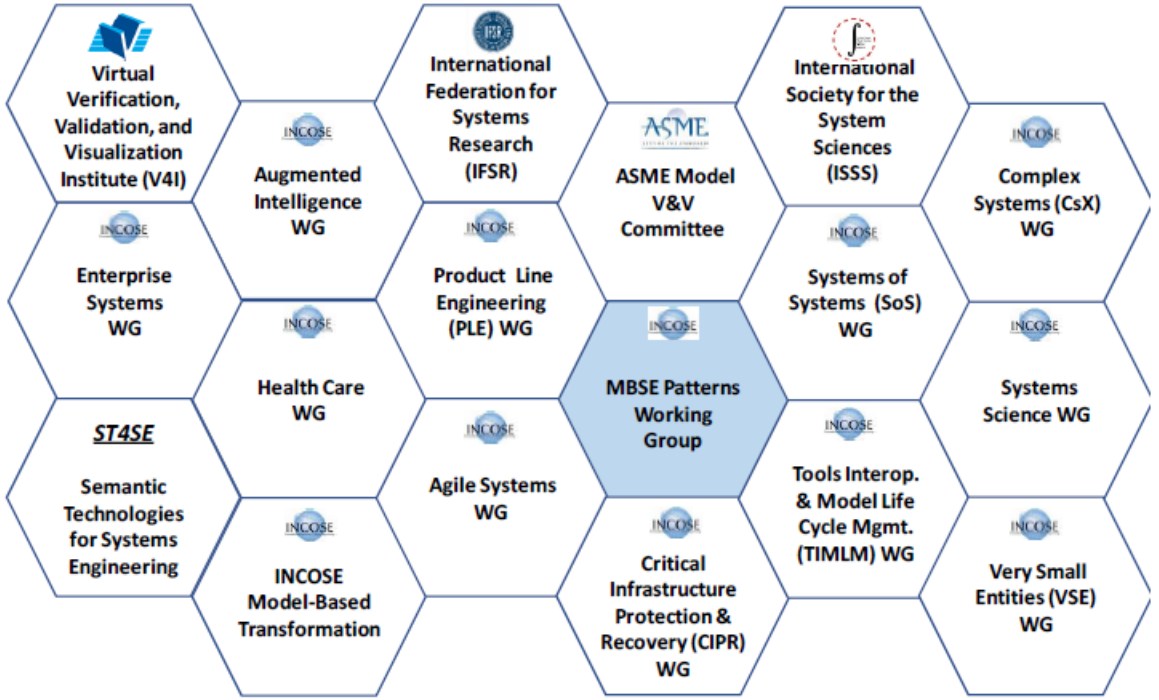
IS2019 WG activities

Working Group, at IW2019, and Web Conferencing	US Eastern Time (ET)	Room	Global Meet

MBSE Patterns WG: Joint IW activities, interests, conversations, project partners



Patterns WG Pre-reading and Background:

Meeting materials for MBSE Patterns WG meeting at IS2019, July 21-22, 2019:
https://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:mbse_patterns_wg_participation_in_incose_is2019

INCOSE WG web site for MBSE Patterns WG:
http://www.incose.org/ChaptersGroups/WorkingGroups/Transformational/mbse-patterns

WG INCOSE/OMG mbse wiki site:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns

MBSE Patterns WG Charter:
http://www.incose.org/docs/default-source/Working-Groups/MBSE-Patterns-WG/mbse-patterns-wg-re-charter-2016-incose-approved-v2-2-1.pdf?sfvrsn=2

PBSE Methodology Summary from the Patterns WG:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:pbse

Agenda, Partner Events of Interest: INCOSE MBSE Patterns Working Group, at IW2019, and Web Conferencing	US Eastern Time (ET)	Room	Global Meet
MBSE Patterns WG Meeting (Day 1 of 2 Days): following link provides meeting materials-- http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:mbse_patterns_wg_participation_in_incose_iw2019 **Patterns WG Collaborations and Projects: Current Status, Next Steps, Future Interests of Members - Spread over Sunday and Monday meetings of this Working Group, to include:** • System of Innovation Pattern, Links to Learning, VVUQ, and Future of SE (FuSE) • Progress in Model VVUQ Reference Pattern / Model Wrapper (with ASME Stds Cmtee & V4 Institute) • V4 Institute Collaboration on Virtual Verification • Universal Model Characterization Pattern (MCP) • S3 Pattern and INCOSE OCM—Enterprise WG collaboration • Medical Device Model VVUQ Application • Mappings to Frameworks and Tools (suggested by members at IS2018 meeting) • Semantic Technologies for SE (ST4SE) Collaboration • Interface Patterns Project • Patterns in the Public Square: Innovation in Regulated Markets • IFSR Conversation Product: An MBE Manifesto • Augmented Intelligence Challenge Team Collaboration • Agile Patterns Project and WG Collaboration, IS 2019 Report Paper (Monday morning session) • SysSciWG and ISSS Collaboration; FuSE; INCOSE EMEA Utrecht Oct 2019 • INCOSE outreach to Model Communities **Additional and Future Project or Topic Interests of Attendees** **(Note: The above agenda topics will be spread across the Sunday and Monday meetings of this WG—see second meeting Monday afternoon, below)**	***SUNDAY*** 1:30 – 4:30	*Grand Cypress Ballroom A*	YES, Link below
MBSE Patterns WG Meeting (Day 2 of 2 Days): **Patterns WG Collaborations and Projects: Current Status, Next Steps, Future Interests of Members - Spread over Sunday and Monday meetings of this Working Group, to include:** • • • **(continuing detailed topics list in Sunday meeting agenda *see above*)** • • **Additional and Future Project or Topic Interests of Attendees** **(Note: The above agenda topics will be spread across the Sunday and Monday meetings of this WG)**	**MONDAY** 1:30 – 3:30	*Palm DE*	YES, Link below

For more information, contact-- **MBSE Patterns WG:** Bill Schindel schindel@ictt.com Troy Peterson tpeterson@systemxi.com

To remotely access the above Patterns WG sessions marked "YES" above for Global Meet in far-right column of above agenda:

PARTICIPANT GlobalMeet Join Details - Join as GUEST
Meeting Details Web Address: https://incose.pgimeet.com/INCOSE_GMFive
Access Number: 1-719-325-2630
USA/Canada (toll free): 1-855-747-8824
Participant Passcode: 354 603 5311

Dial In Numbers:
USA: 1-605-475-5618
USA: 1-719-325-2630
Canada, Calgary : +1 403 407 5780
Canada, Montreal : +1 514 669 5909
Canada, Toronto : +1 416 915 3615
Canada, Vancouver : +1 604 205 5118
Argentina, Buenos Aires : +54 (0) 11 5172 6019
Argentina (toll free) : 0800 800 1250
Australia, Sydney : +61 (0) 2 8017 6391
Australia, Melbourne : +61 (0) 3 8687 0614
Australia, Brisbane : +61 (0) 7 3015 0608
Australia (toll free) : 1 800 720 493
Austria, Vienna : +43 (0)1 928 2722
Austria (toll free) : 0800 070 841
Bahrain, Manama : +973 1650 0402
Bahrain (toll free) : 8008 1214
Belarus (toll free) : 8 820 0011 0353
Belgium, Brussels : +32 (0) 2 400 1980
Belgium (toll free) : 0800 39 268
Bosnia and Herzegovina : +387 7031 1461
Brazil, Sao Paulo : +55 11 4935 7122
Brazil, Rio de Janeiro : +55 21 4560 0023
Brazil (toll free) : 0800 887 0283
Bulgaria, Sofia : +359 (0) 2 491 7244
Bulgaria (toll free) : 00800 111 4944
Cambodia, Phnom Penh : +855 23 962 579
Canada (toll free) : 1 855 950 3706
Chile, Santiago : +56 (0) 2 2666 0711
Chile (toll free) : 171 800 835 943
China (national) : +400 681 8104
China, Beijing : +86 10 5667 0005
China, Shanghai : +86 21 2039 7079
Colombia, Bogota : +57 1 508 8112
Colombia (toll free) : 01 800 755 0043
Costa Rica (toll free) : 800 542 5331
Croatia (toll free) : 0800 223 004
Cyprus (toll free) : 800 97400
Czech Republic, Prague : +420 225 986 505
Czech Republic (toll free) : 800 701 236
Denmark, Copenhagen : +45 32 71 16 70
Denmark (toll free) : 80 70 35 78
Egypt (toll free) : 0800 000 0401
Estonia, Tallinn : +372 622 6519
Estonia (toll free) : 800 011 1569
Fiji (toll free) : 00800 3317
Finland, Helsinki : +358 (0) 9 2310 1611
Finland (toll free) : 0800 772 230
France, Paris : +33 (0) 1 76 77 22 50
France (toll free) : 0800 946 112
France (national) : 0811 655 134
France (national) : 0821 231 687
Georgia, Tbilisi : +995 32 2 053 082
Germany, Frankfurt : +49 (0) 69 5060 9515
Germany, Munich : +49 (0) 89 24443 2900
Germany (national) : 01801 001 378
Germany (toll free) : 0800 588 9225
Greece, Athens : +30 211 181 3815
Greece (toll free) : 00800 128 811
Hong Kong : +852 3018 9103
Hong Kong (toll free) : 800 968 082
Hungary, Budapest : +36 1 808 8134
Hungary (toll free) : 068 001 9662
Iceland (toll free) : 800 9841
India, Delhi : +91 11 6310 0272
India, Mumbai : +91 22 6310 0274

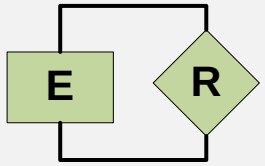
Emergence of Patterns from Patterns: S*Pattern Class Hierarchy

More General

More Specific

Definition of **Relational Modeling Paradigm**

Entity-Relationship Paradigm

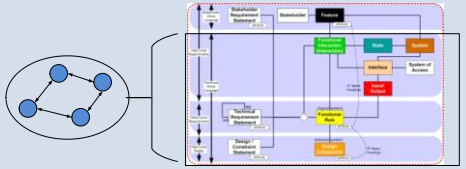


E=Entity
R= Relationship

Structured or unstructured semantic web

Minimal System S*Metamodel: Definition of (Elementary) System, Material Cause

S*Metamodel Core



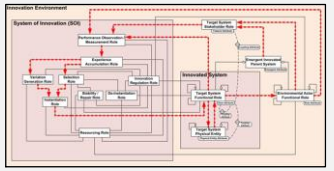
Core S*Metamodel

Smallest model of a system, for engineering or science

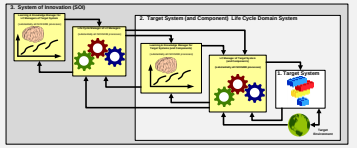
Emergence & Definition of **System of Innovation**, Fitness, Value, Purpose, Stakeholders, Agility, Final Cause, Formal Cause, Efficient Cause, Intelligence, Management, Science, Living Systems

EI Pattern, SOI Pattern, Fitness, Value

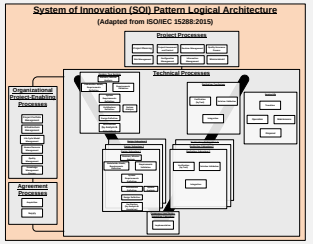
S*Purpose, Fitness, Value



System of Innovation Pattern



Agile Sys Life Cycle Pattern



ISO 15288 System Life Cycle Mgmt Pattern

Emergence & Definition of **Domain Specific Systems**

Domain Specific Pattern

- Terrestrial Vehicle Domain Pattern
- Manufacturing System Pattern
- Product Service System Pattern
- Space Tourism Pattern
- Electrical Power Domain Pattern
- Aircraft Flight Control Pattern
- Medical Device Pattern
- Distribution System Pattern
- Socio-Technical Pattern
- Critical Infrastructure Domain Pattern

Emergence of Patterns from Patterns: S*Pattern Class Hie

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Definition of **Relational Modeling Paradigm**

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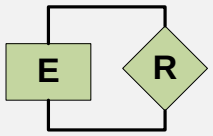

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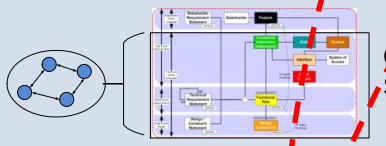

Core S*Metamodel

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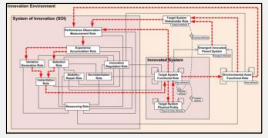
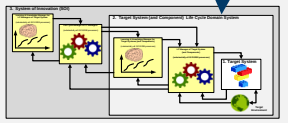
Emergence & Definition of **System of Innovation**, Fitness, Value, Purpose, Stakeholders, Agility, Final Cause, Formal Cause, Efficient Cause, Intelligence, Management, Science, Living Systems

EI Pattern, SOI Pattern, Fitness, Value

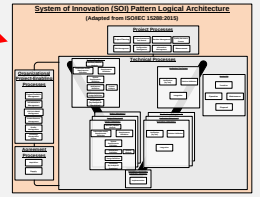
S*Purpose, Fitness, Value



System of Innovation Pattern



Agile Sys
Life Cycle Pattern



ISO 15288 System Life Cycle Mgmt Pattern

Emergence & Definition of **Domain Specific Systems**

Domain Specific Pattern

- Terrestrial Vehicle Domain Pattern
- Manufacturing System Pattern
- Product Service System Pattern
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- Medical Device Pattern
- Distribution System Pattern
- Socio-Technical Pattern
- Critical Infrastructure Domain Pattern

- INCOSE Systems-Software Interface WG
- ASME Model V&V Committee
- INCOSE Complex Systems (CsX) WG
- INCOSE Product Line Engineering (PLE) WG
- INCOSE Systems of Systems (SoS) WG
- INCOSE Health Care WG
- INCOSE MBSE Patterns Working Group
- INCOSE Systems Science WG
- INCOSE Agile Systems WG
- INCOSE Tools Interop. & Model Life Cycle Mgmt. (TIMLM) WG
- INCOSE INCOSE Model-Based Transformation
- INCOSE Critical Infrastructure Protection & Recovery (CIPR) WG
- INCOSE Very Small Entities (VSE) WG

Recent Patterns WG public activities

- ASME Model V&V Symposium (May, 2019)
- NASA JPL MBSE Symposium (Jan, 2019)
- INCOSE IW2019 (Jan, 2019)
- INCOSE Great Lakes Regional Conference (Oct, 2018)
- INCOSE IS2018 (July, 2018)
- Int'l Society for the System Sciences Annual Conf. 2018 (July, 2018)
- ASME Model V&V Symposium (May, 2018)
- INCOSE Health Care Systems Conference (April, 2018)
- INCOSE IW2018 (Jan, 2018)
- ASME VV 50 Model V&V Standards Committee (2016-Present)

How to get involved with Patterns WG

- If you'd like to participate in, or follow, a current WG project, . . .
- If you would like to suggest a new WG project, . . .

Contact:

WG chair: Bill Schindel schindel@ictt.com

WG co-chair: Troy Peterson tpeterson@systemxi.com

A “Patterns 101” Introduction

See listed References:

- PBSE Methods and Position in Related Subjects

http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:pbse_extension_of_mbse--methodology_summary_v1.5.5a.pdf

- MBSE Patterns Tutorial

http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:pbse_tutorial_glrc_2016_v1.7.4.pdf

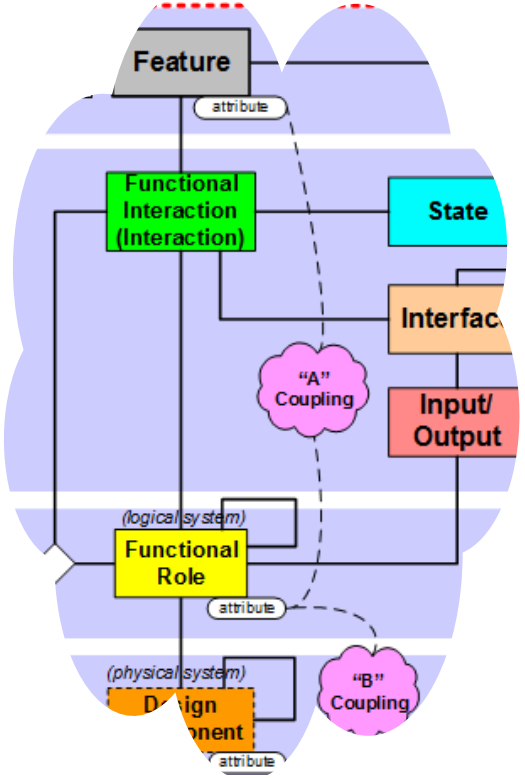
- Simple Content Example: Oil Filter System

http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:oil_filter_example_v1.4.3.ppt

- Patterns WG web site

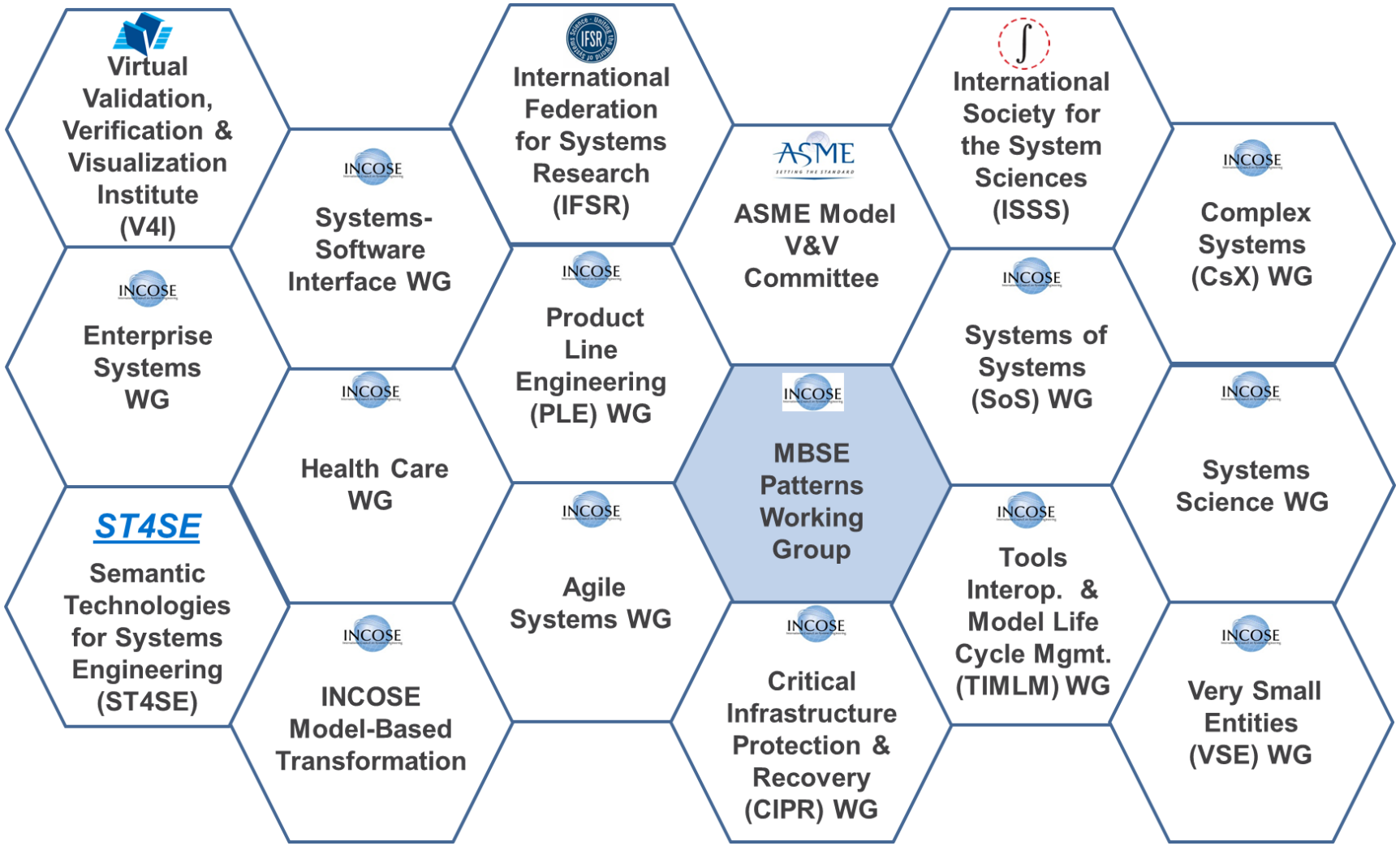
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns

Status of WG Projects



- System of Innovation Pattern, Links to Learning, VVUQ, and Future of SE (FuSE)
- Progress in Model VVUQ Reference Pattern / Model Wrapper (with ASME Stds Cmtee & V4 Institute)
- V4 Institute Collaboration on Virtual Verification
- Universal Model Characterization Pattern (MCP)
- S3 Pattern and INCOSE OCM—Enterprise WG collaboration
- Medical Device Model VVUQ Application
- Mappings to Frameworks and Tools (suggested by members at IS2018 meeting)
- Semantic Technologies for SE (ST4SE) Collaboration
- Interface Patterns Project
- Patterns in the Public Square: Innovation in Regulated Markets
- IFSR Conversation Product: An MBE Manifesto
- Augmented Intelligence Challenge Team Collaboration
- Agile Patterns Project and WG Collaboration, IS 2019 Report Paper (Monday morning session)
- SysSciWG and ISSS Collaboration; FuSE; INCOSE EMEA Utrecht Oct 2019
- INCOSE outreach to Model Communities

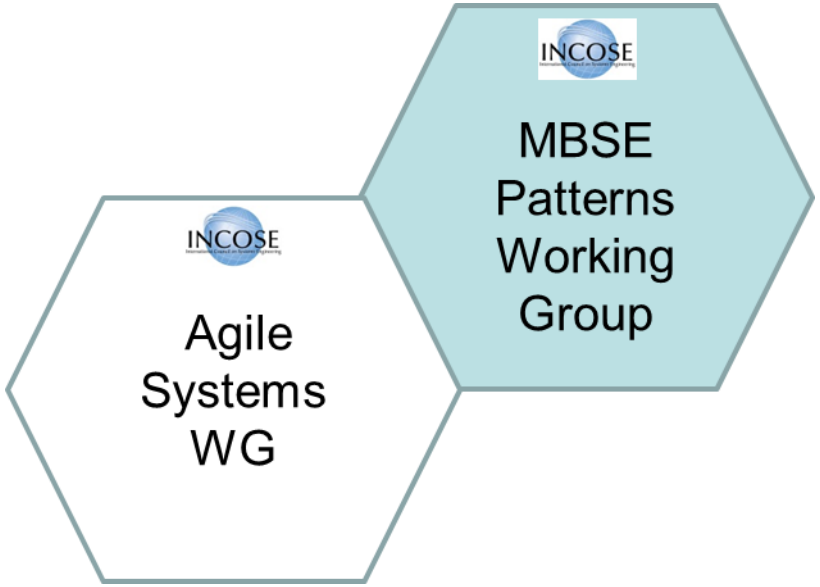
Working Group & External Partners in Progress



MBSE Patterns WG: Joint activities, interests, conversations, project partners

Working Group Partners in Progress

Primary Contact:
Rick Dove, Paradigm Shift, Intl.

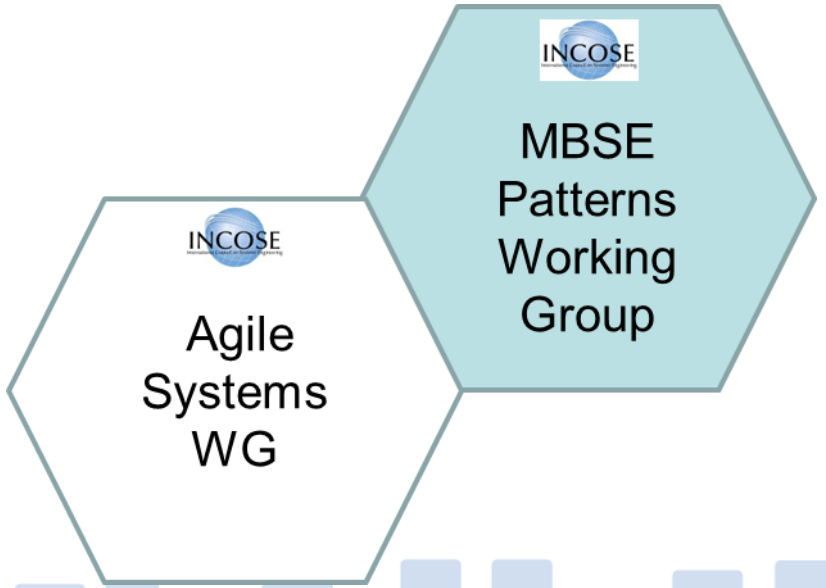


Agile Systems Engineering Life Cycle Management (ASELCM) Discovery Project: Creating, validating ASELCM S*Pattern

With Agile SE WG: Joint Activity Materials

- Agile Systems Engineering Life Cycle Management (ASELCM) Discovery Project: Creating, validating the ASELCM S*Pattern

Primary Contact:
Rick Dove, Paradigm Shift, Intl.

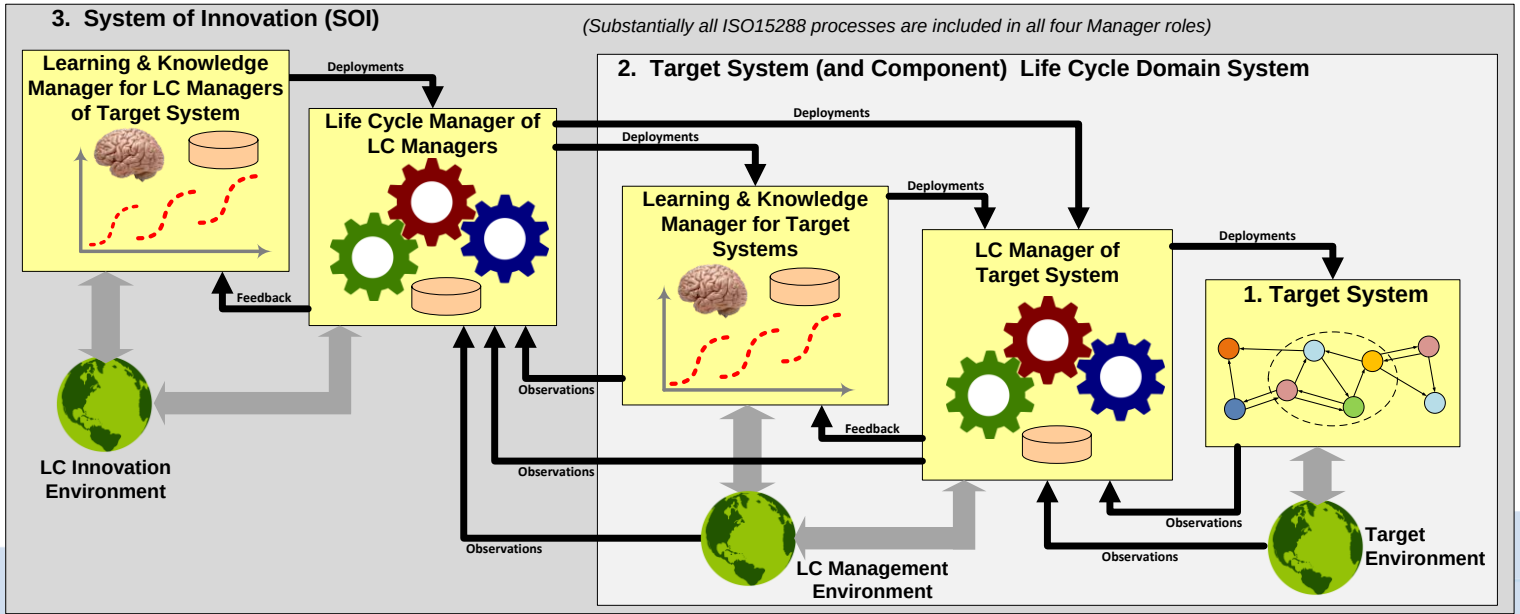


ASELCM Pattern Project: Jul 2019 Status

- ASELCM Pattern, specialized from ISO15288 Pattern, as been the basis of five co-authored INCOSE and IEEE case study papers, including an IS2017 best paper.
- Special issue of INCOSE INSIGHT in 2018 featured another article on use of this model in the Navy SPAWAR case studies.
- Additional Dove & Schindel paper presentation at IS2019.
- Has been successfully applied in multiple commercial projects during 2016-2019, establishing agile pattern-based SE frameworks for advanced manufacturing, automotive, consumer products, defense engineering, …
- S3 portion of ASELCM providing basis for reference model frameworks for study of challenges to innovation in Health Care (INCOSE Health Care Conferences of 2016, 2017), Electrical Power Grid and other Critical Infrastructure (INCOSE / IEEE / NASA ET 2016, 2017)
- Basis of V4 Institute Framework for advanced virtual-based innovation competencies
- S3 portion of ASELCM is providing basis for model-based reference framework for study of systems of innovation

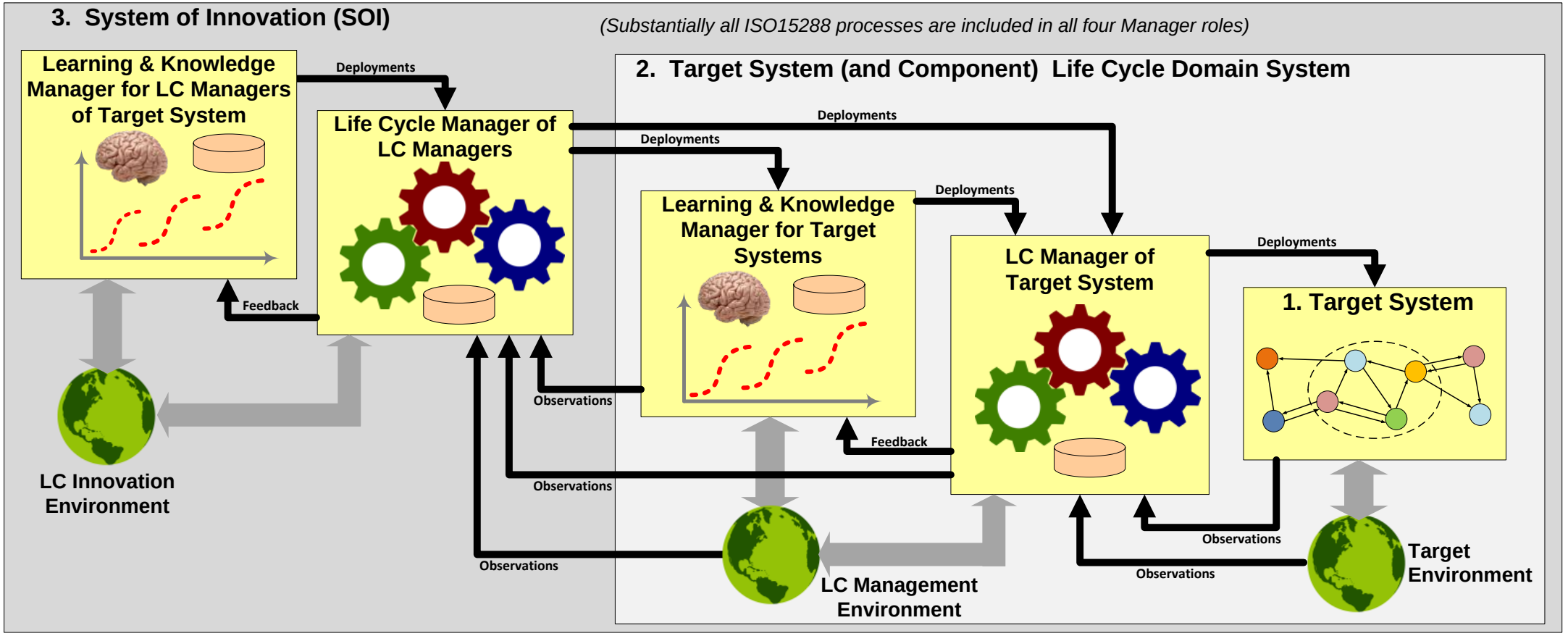
Using the ASELCM Reference Pattern on Four Case Study Sites: Model Highlights

1. Agile Systems Engineering Process Features Collective Culture, Consciousness, and Conscience at SSC Pacific Unmanned Systems Group
2. Transition to Scaled-Agile Systems Engineering at Lockheed Integrated Fighter Group
3. Agile SE Process for Centralized SoS Sustainment at Northrop Grumman (IS2017)
4. Agile Hardware/Firmware/Software Product Line Engineering at Rockwell Collins

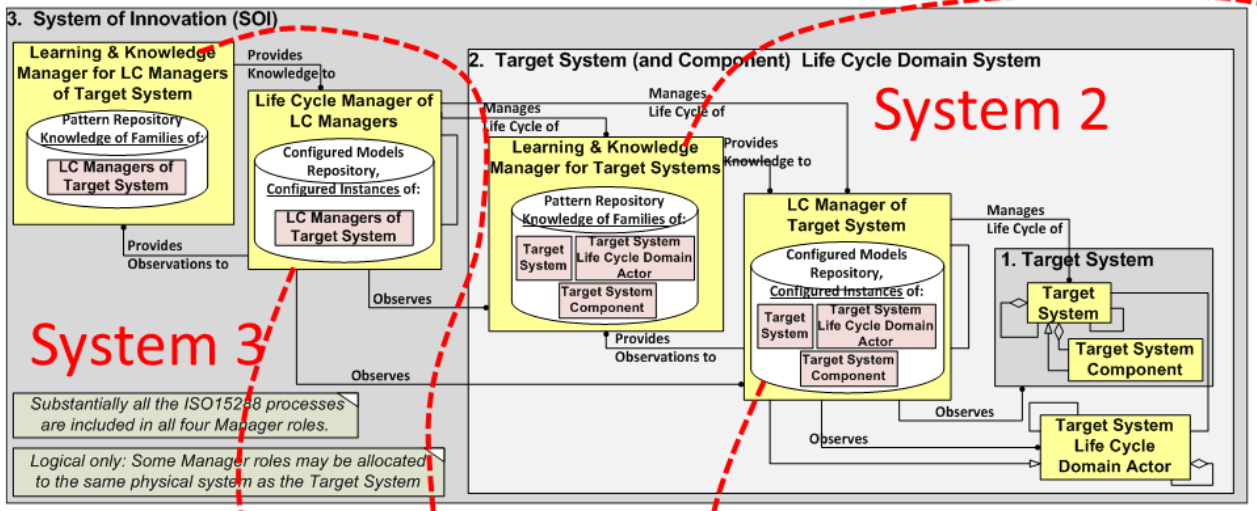


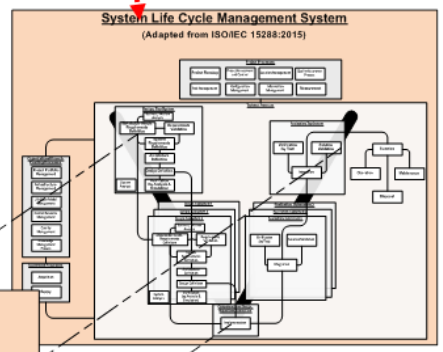
Agile Systems WG Meeting
INCOSE IW17, Jan 30, 2017
Bill Schindel schindel@ictt.com

ASELCM Pattern Logical Architecture



- System 1: Target system of interest, to be engineered or improved.
- System 2: The environment of (interacting with) S1, including all the life cycle management systems of S1, including learning about S1.
- System 3: The life cycle management systems for S2, including learning about S2.

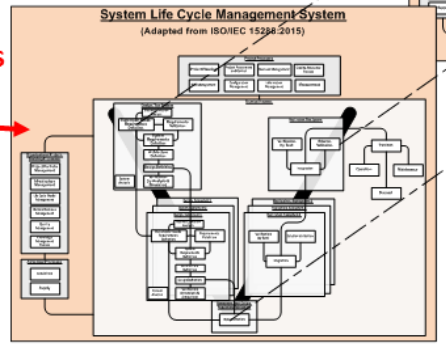




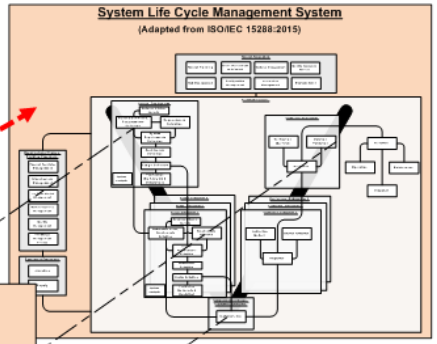
Performs most of these ISO processes, to manage what is being learned about S1 space.

Manages Target System Family Patterns

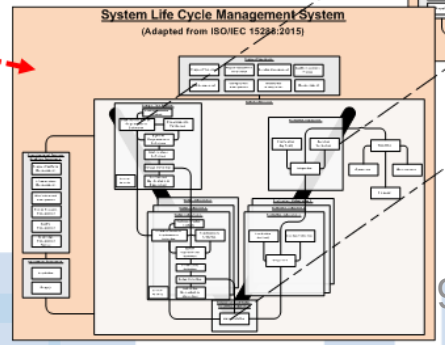
Performs most of these ISO processes, to manage S1 instances , using S1 patterns



Manages LC Management System Family Patterns



Performs most of these ISO processes, to manage S2 instances , using S2 patterns

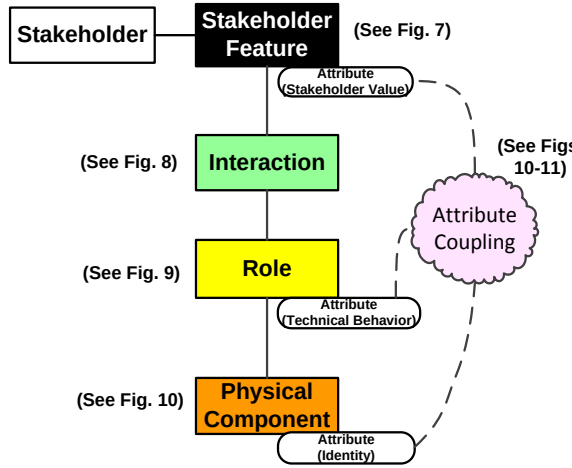


Performs most of these ISO processes, to manage what is being learned about S2 space.

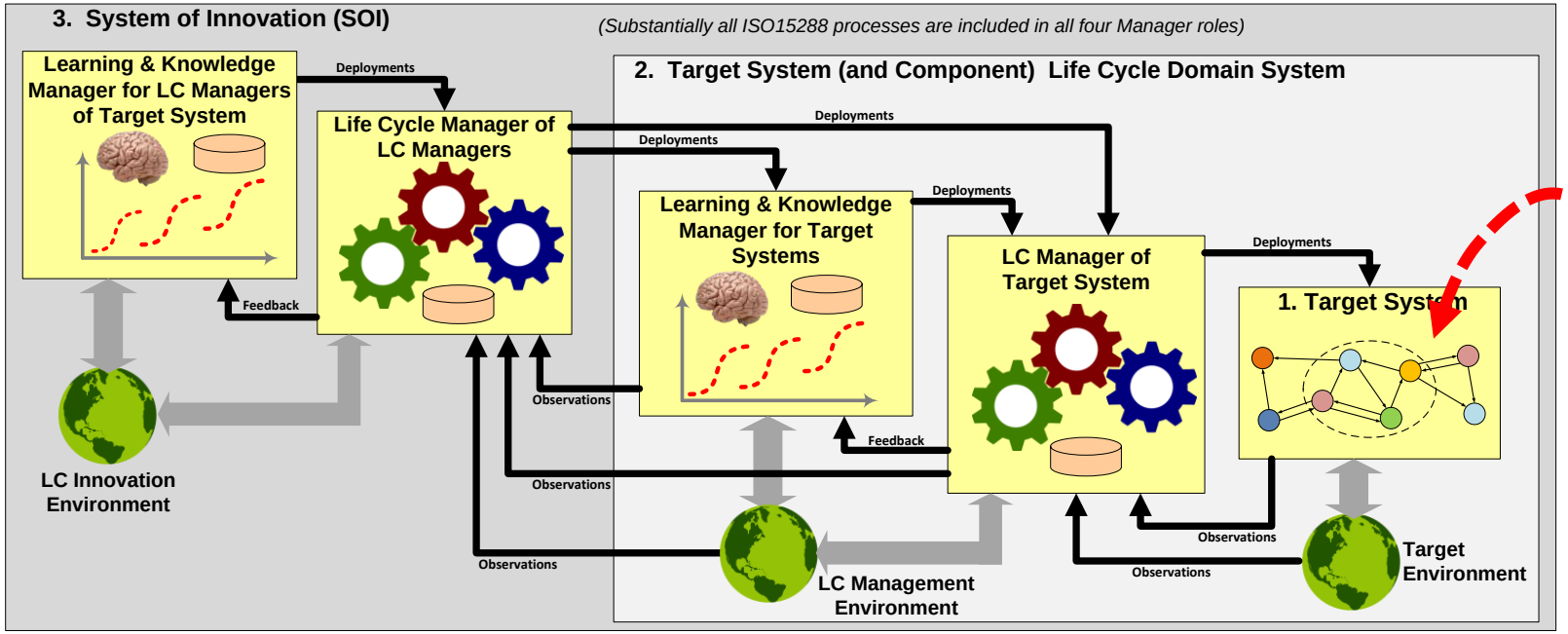
Four "Vees" in ASELCM

ASELCM Pattern: System 1 (Target System) agility, driven by System 2 (Life Cycle Management) and System 3 (System of Innovation).

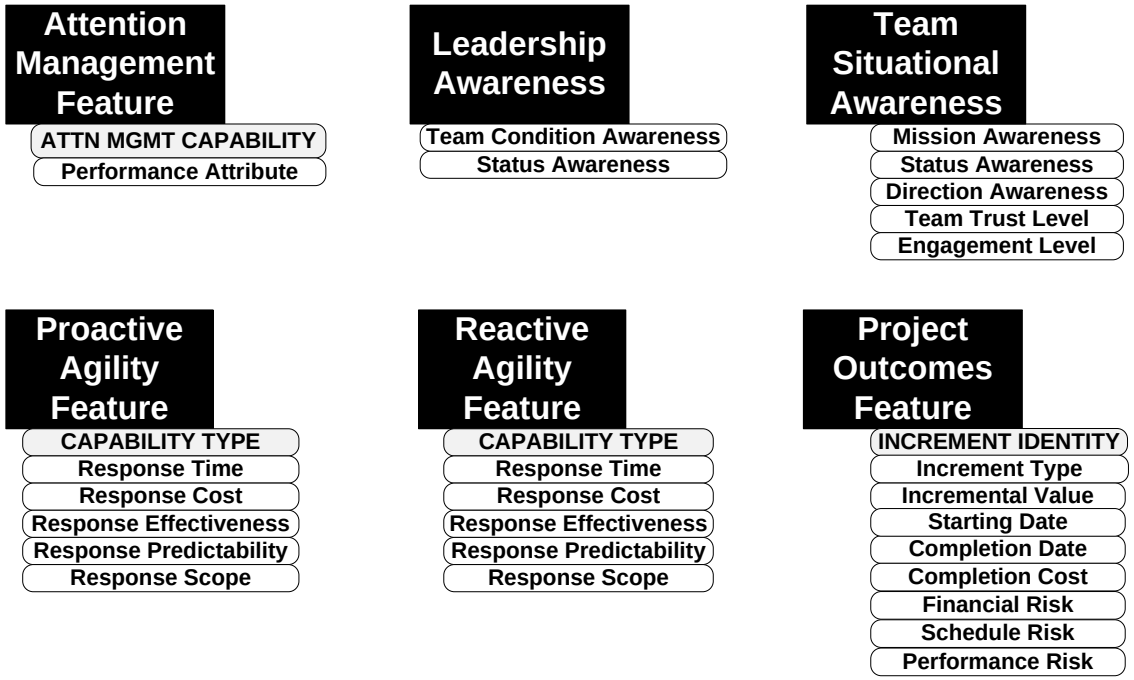
Central to the case studies: System 2, 3 Features, Interactions, Roles, Couplings



1. Agile Systems Engineering Process Features Collective Culture, Consciousness, and Conscience at SSC Pacific Unmanned Systems Group



Helped us understand/represent how their approach effectively addresses the “UURVE” environment. In the framework of the ASELCM Pattern, this can be seen as a “System-3 question”



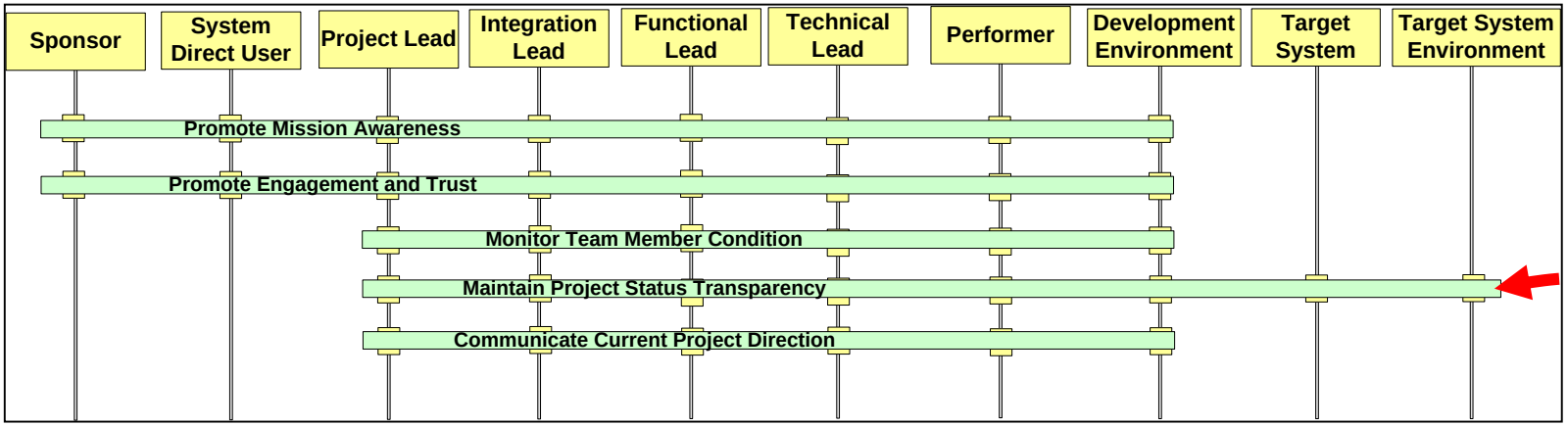
Selected Subset of System-2 Stakeholder Features and their Attributes

System 2’s “Agile Stakeholder Stories”:

“As a <*stakeholder role*> I want <*system behavior*> so that < *value statement*>.”

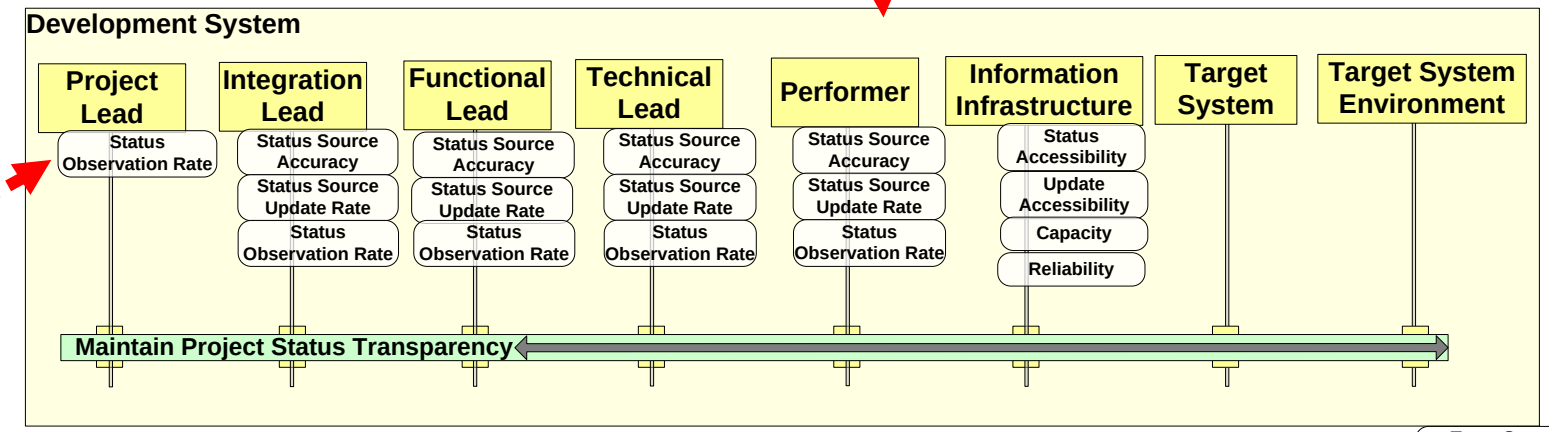
- “As a <*Sponsor*> I want <*timely project incorporation of emerging technologies*> so that <*I obtain a best-in-class autonomous vehicle system*>.”
- “As a <*Functional Lead*> I want <*to obtain timely project status*> so that <*I direct vehicle navigation system development in a timely manner*>.”
- “As a <*Project Performer*> I want to <*obtain timely project directional awareness*> so that <*I contribute responsively to the overall project*>."

SPAWAR System Center Pacific (SSC-Pac): Unmanned System Integration, Test, and Experimentation (UxS ITE): Interactions & Emergence --

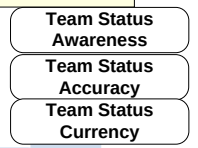


Selected Subset of ASELCM Interactions, System-2

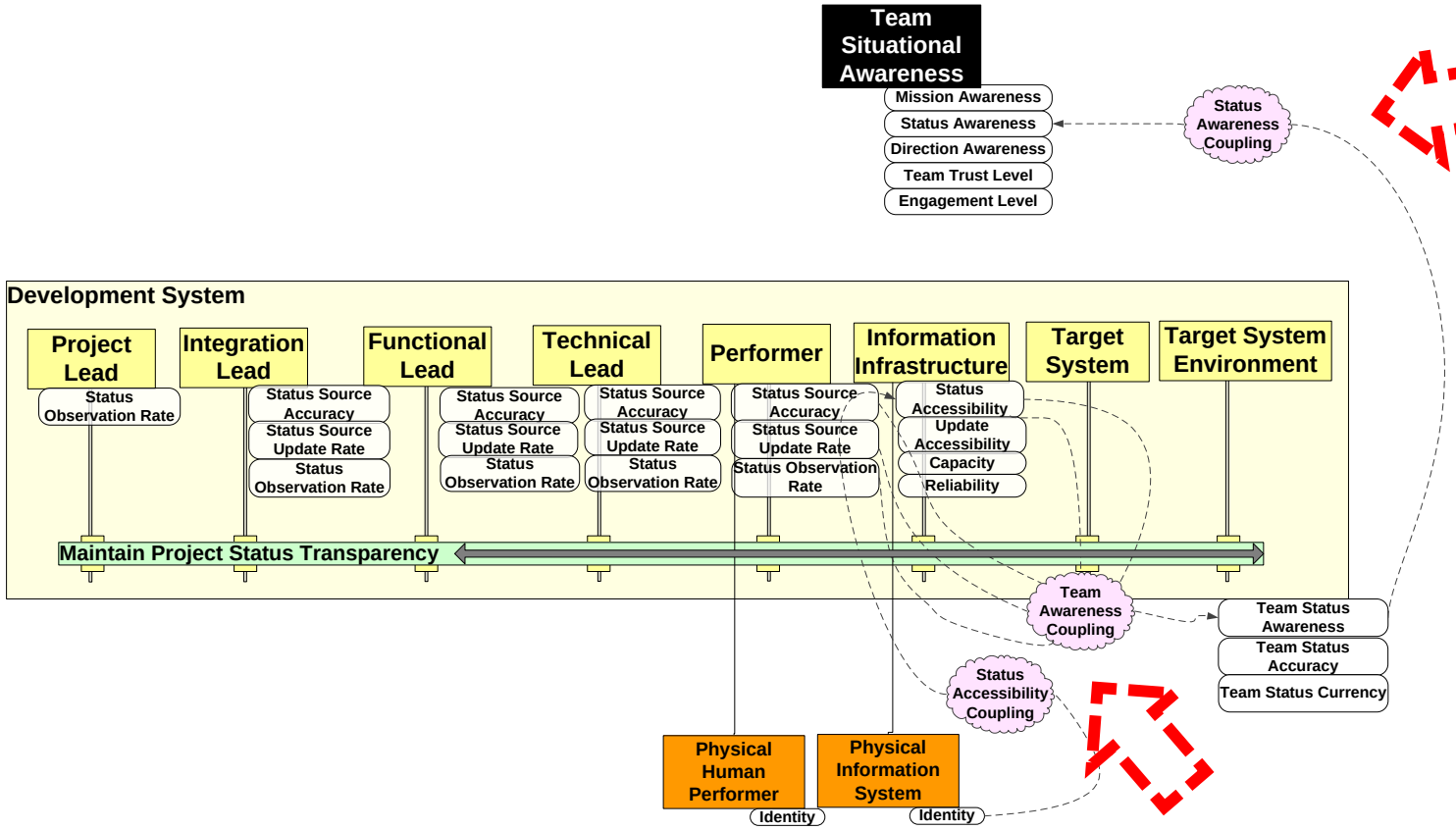
One Interaction

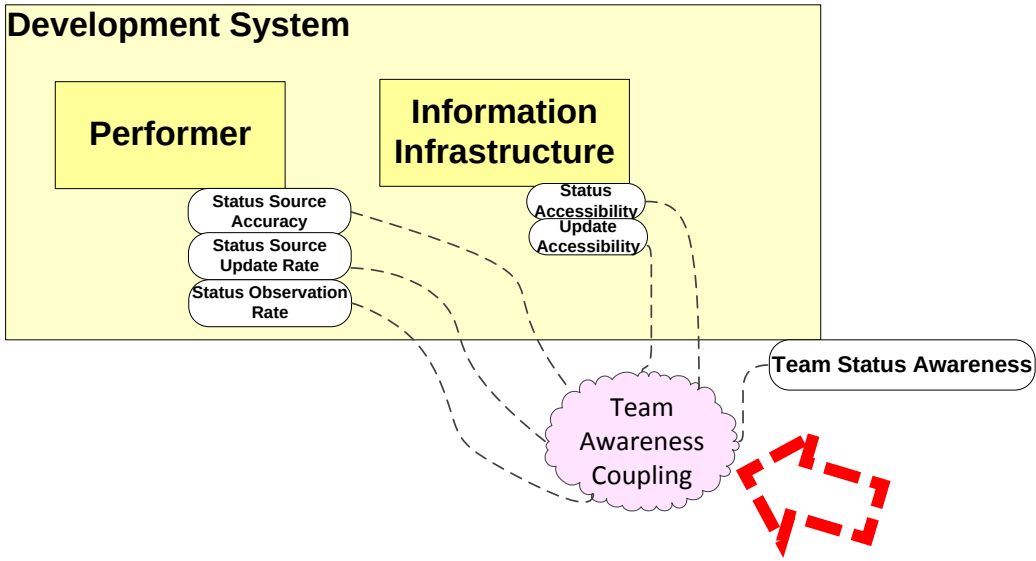


For “Maintain Project Status Transparency” Interaction, Attributes of Individual Component Roles, and Emergent Systemic Attributes



SPAWAR System Center Pacific (SSC-Pac): Unmanned System Integration, Test, and Experimentation (UxSITE) : Attribute Couplings

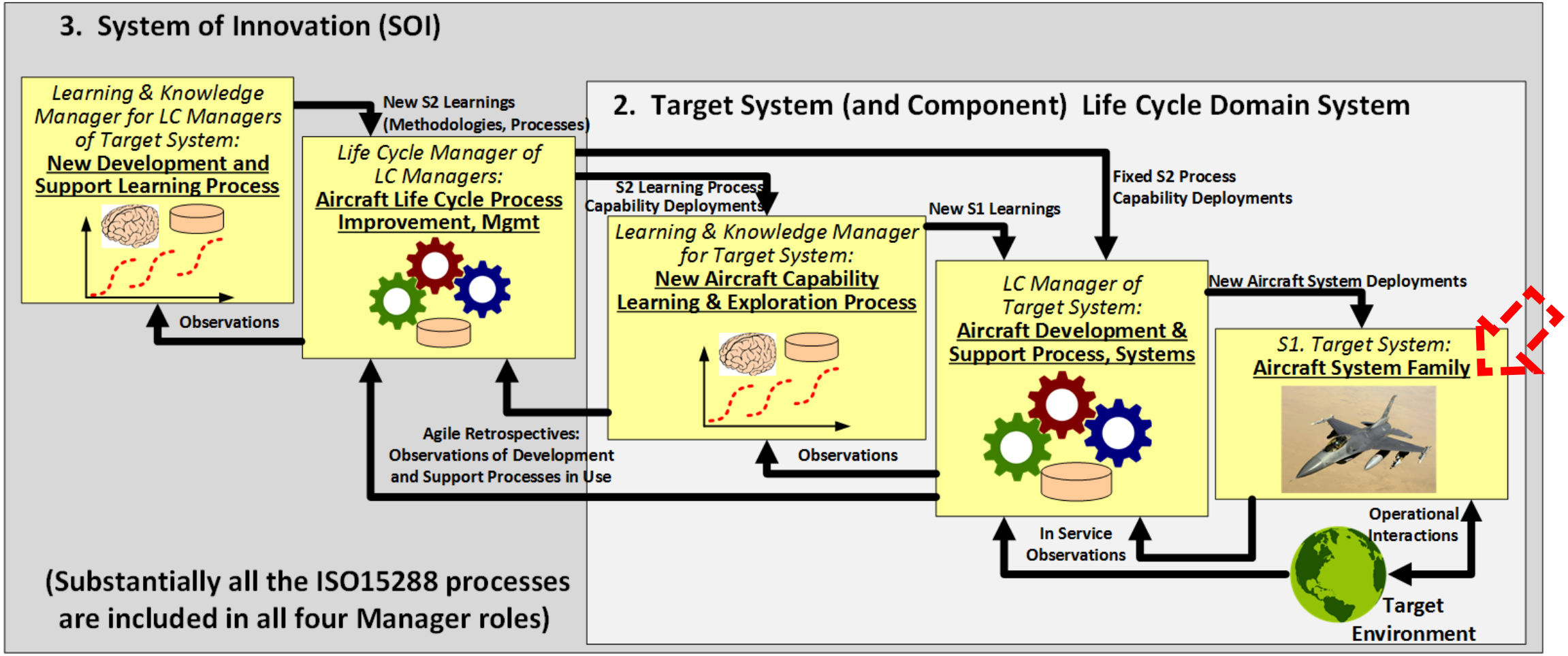




Modeled Parametric Couplings of ASELCM Features, Functional Roles, and Physical Components

Team Status Awareness Arises from Other Attributes

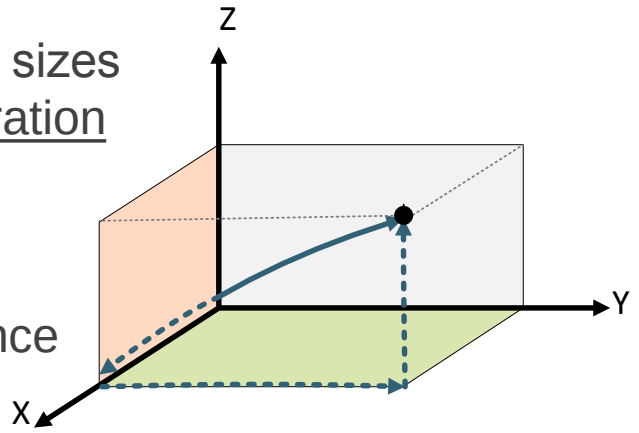
2. Transition to Scaled-Agile Systems Engineering at Lockheed Integrated Fighter Group



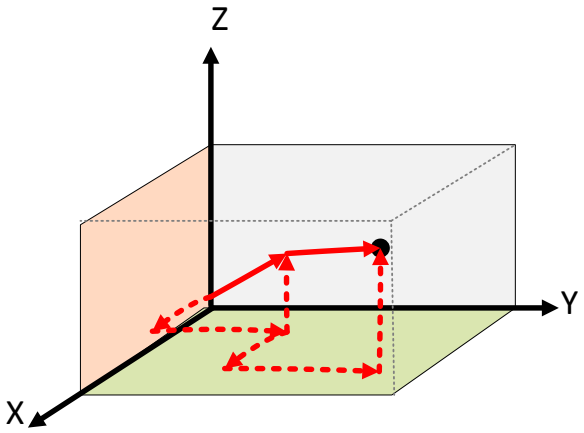
2. Transition to Scaled-Agile Systems Engineering at Lockheed Integrated Fighter Group: Configurations, Costs

Optimal "Flow": smaller batch sizes can result in different configuration trajectories:

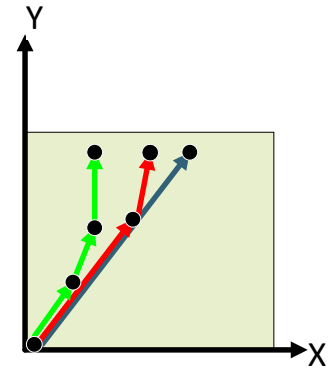
Example subspaces:
Reqs, Dsn, Performance



(a) Large "Batch" Increment

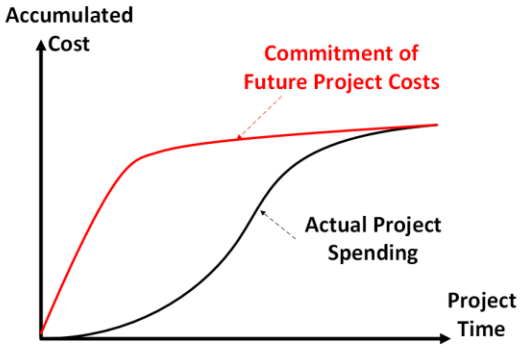


(b) Smaller "Batch" Increments

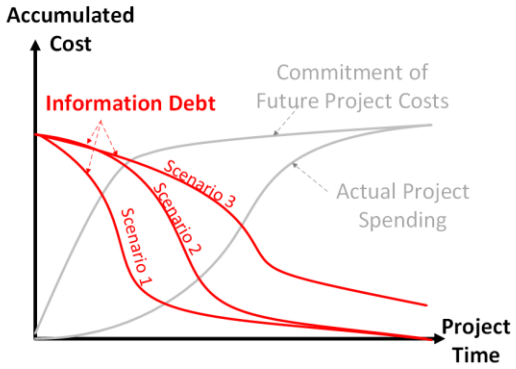


(c) Different "Batch" sizes can result in different trajectories, destinations

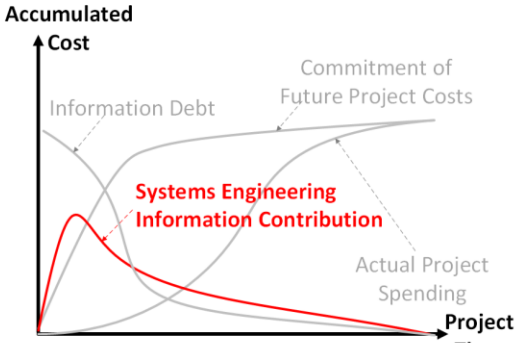
Information Debt: Balance Sheet Model of Learning



(a) When Project Costs Are Committed versus Incurred



(b) Information Debt is Reduced Over the Course of Project

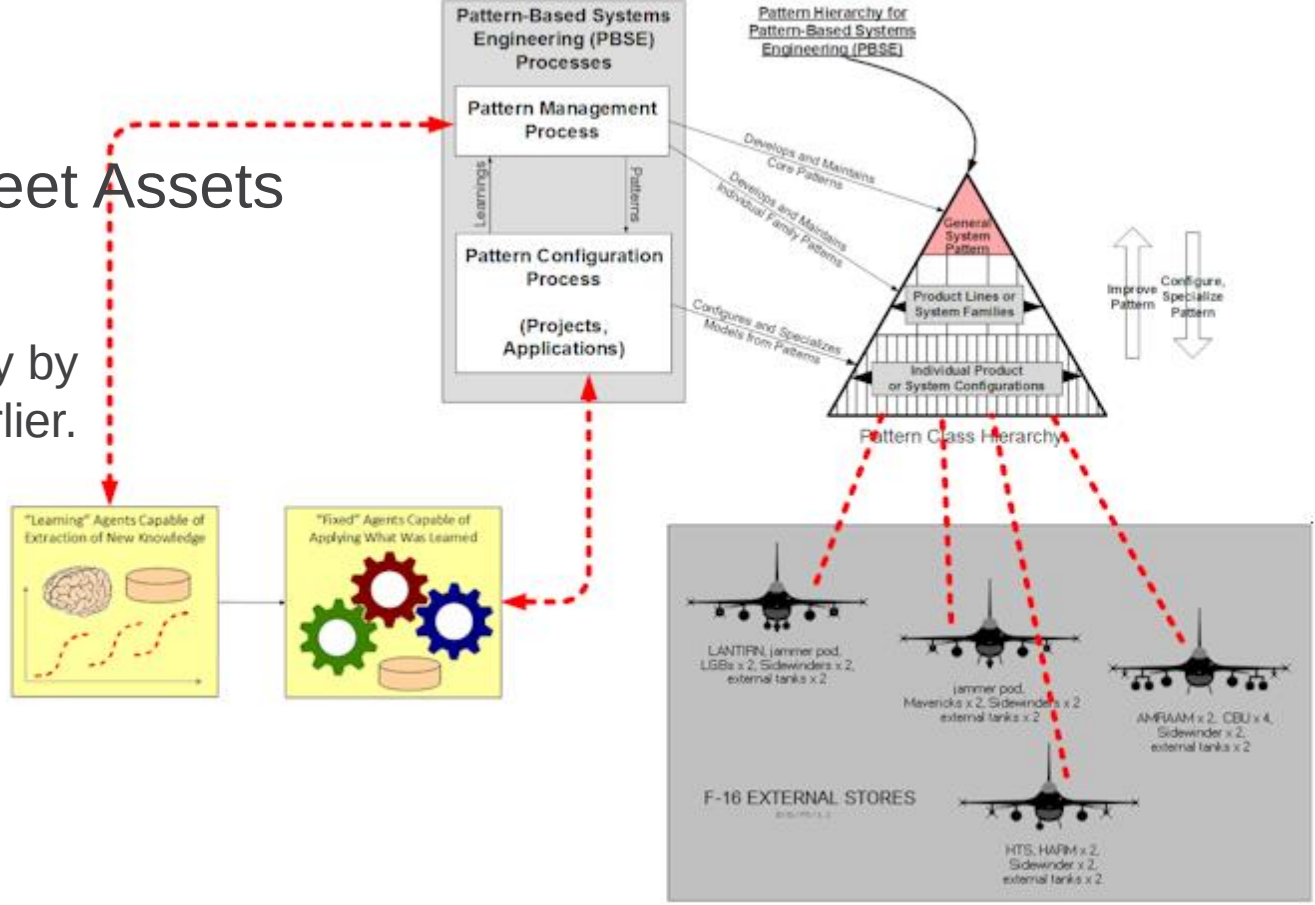


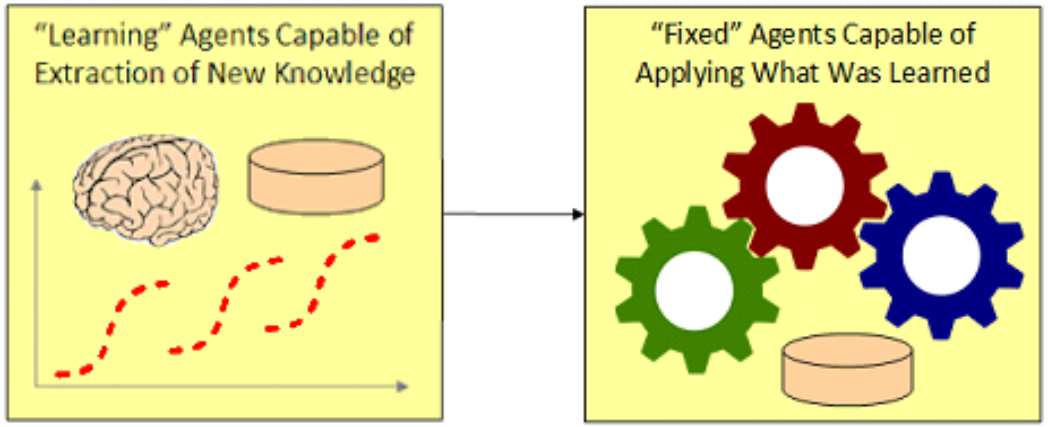
(c) Systems Engineering Information Is Generated to Reduce Information Debt

Financial Flows—Accumulated Project Costs, Information Debt, and SE Information Contribution.

System 2 Learning Observed: Explicit System 1 Patterns as Balance Sheet Assets

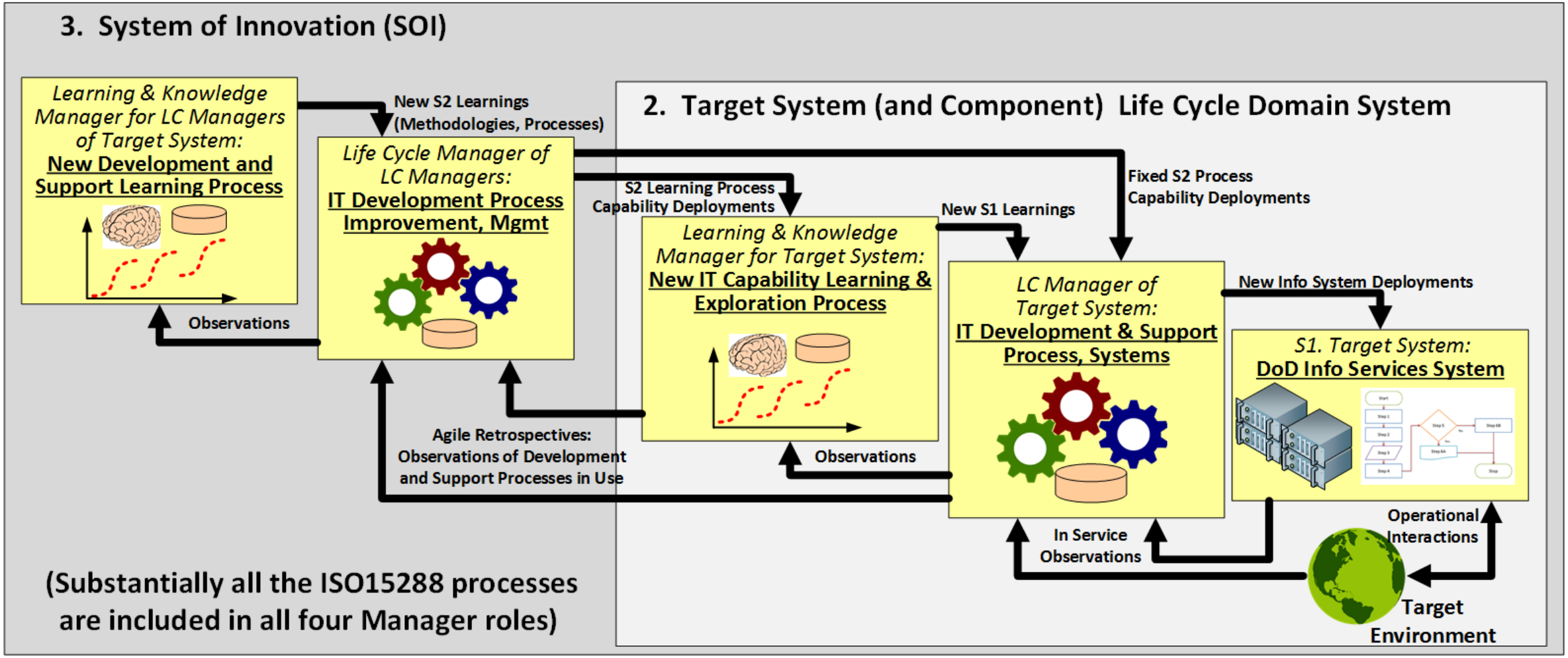
Platform architectures increase agility by rapidly lowering information debt earlier.



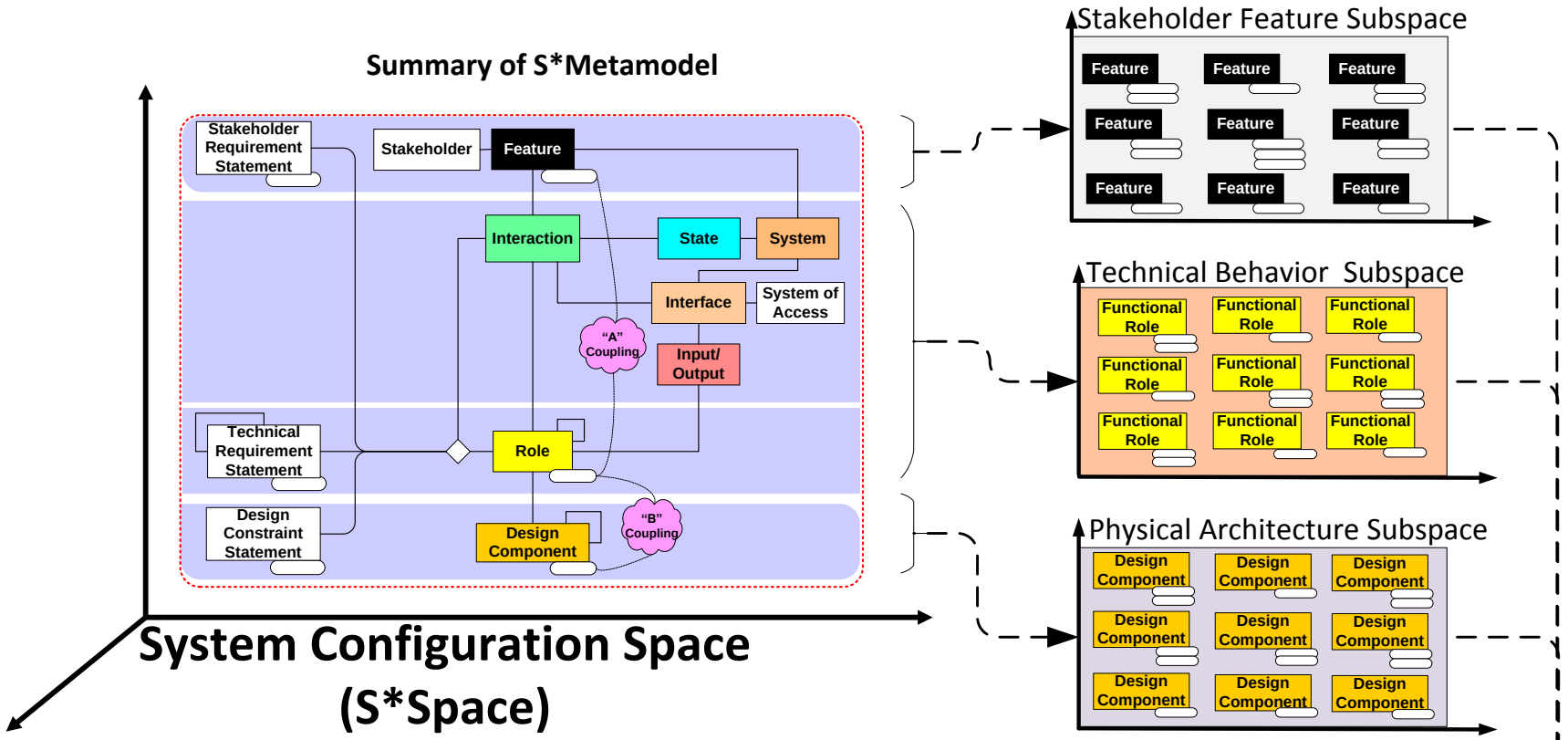


Where are the pattern assets accumulated? ASELCM human or other learning processes, learned assets, and their uses

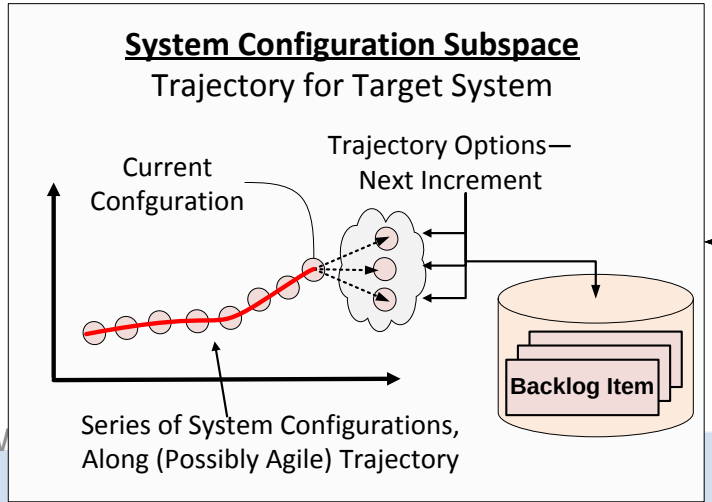
3. Agile SE Process for Centralized SoS Sustainment at Northrop Grumman



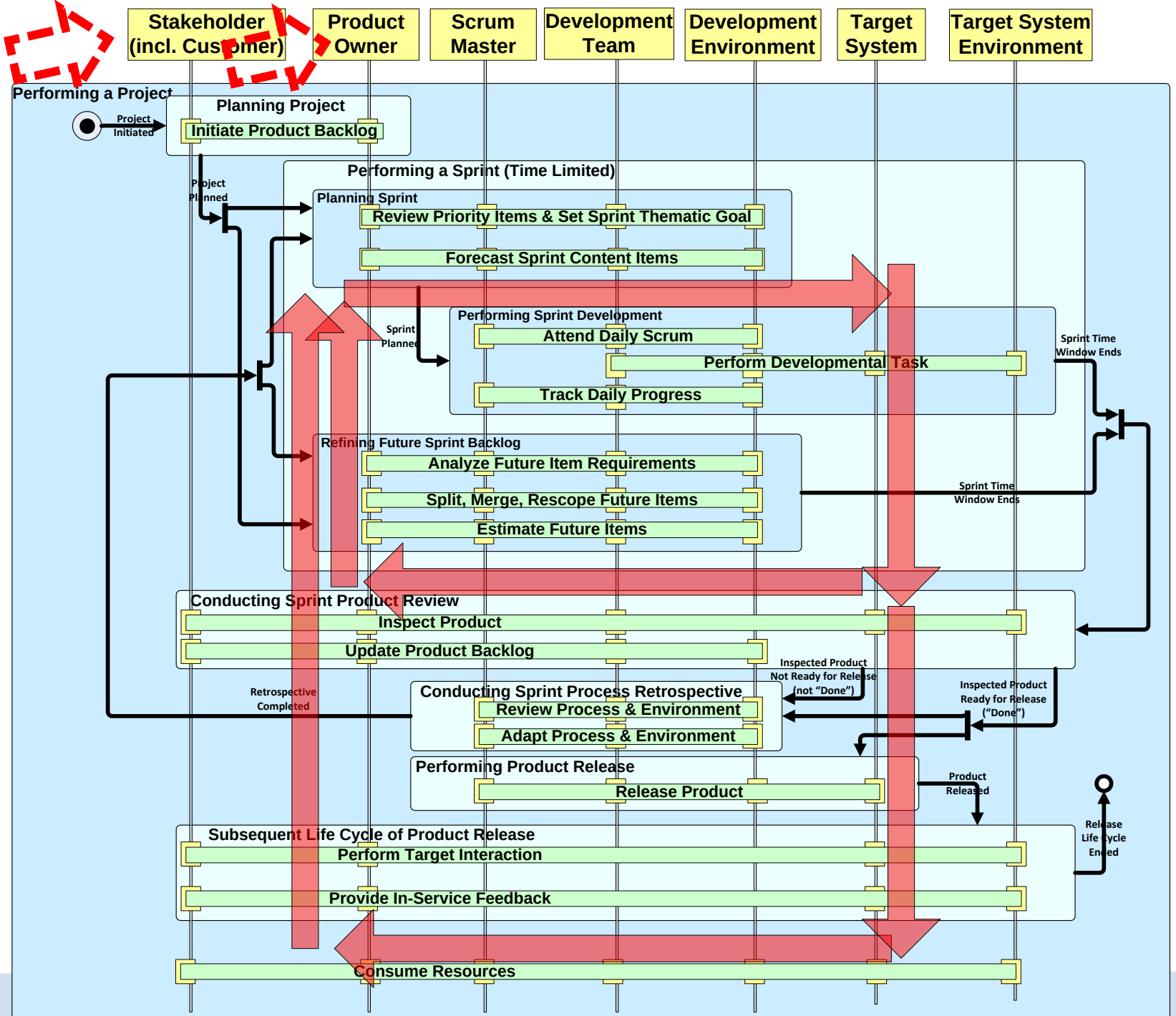
Agile trajectories in S1 Configuration Space: Optimal Control & Estimation



GCSS-J agile trajectory in system configuration space and sub-spaces

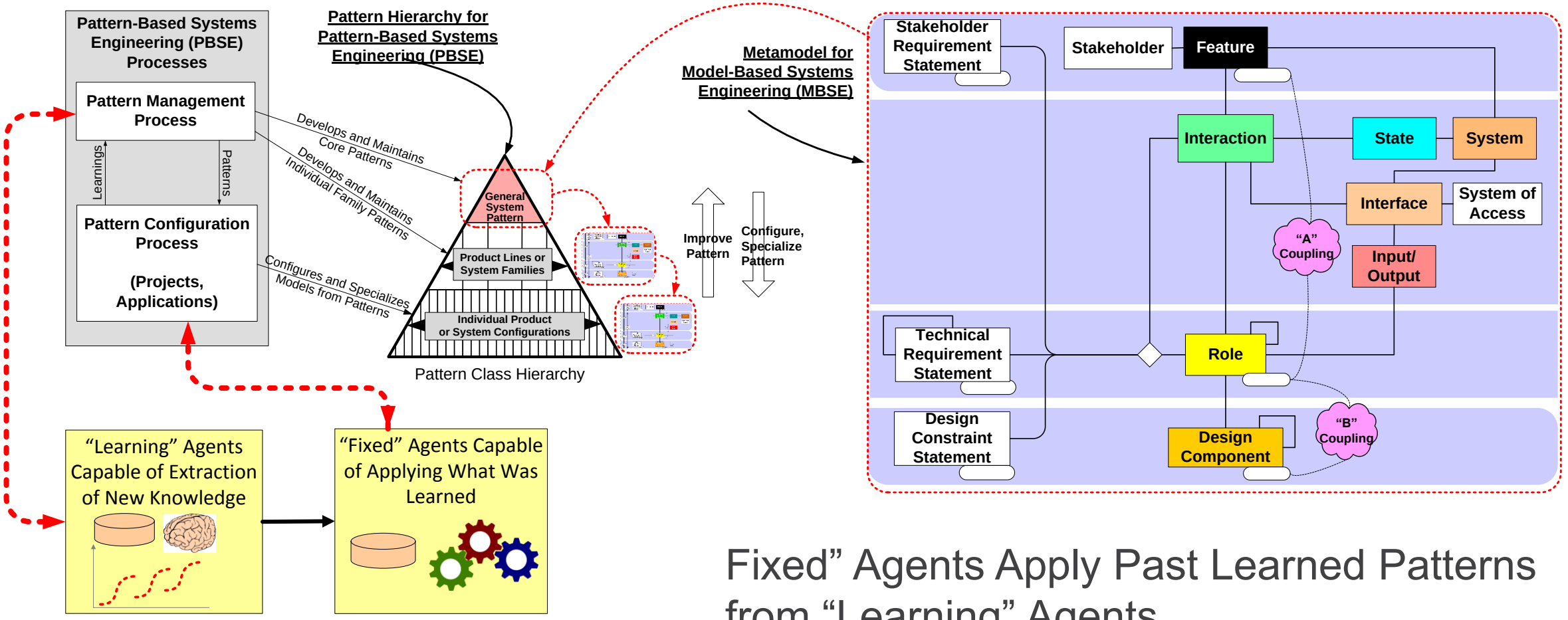


Trajectory uncertainty and risk: Trading and sharing risks, decisions



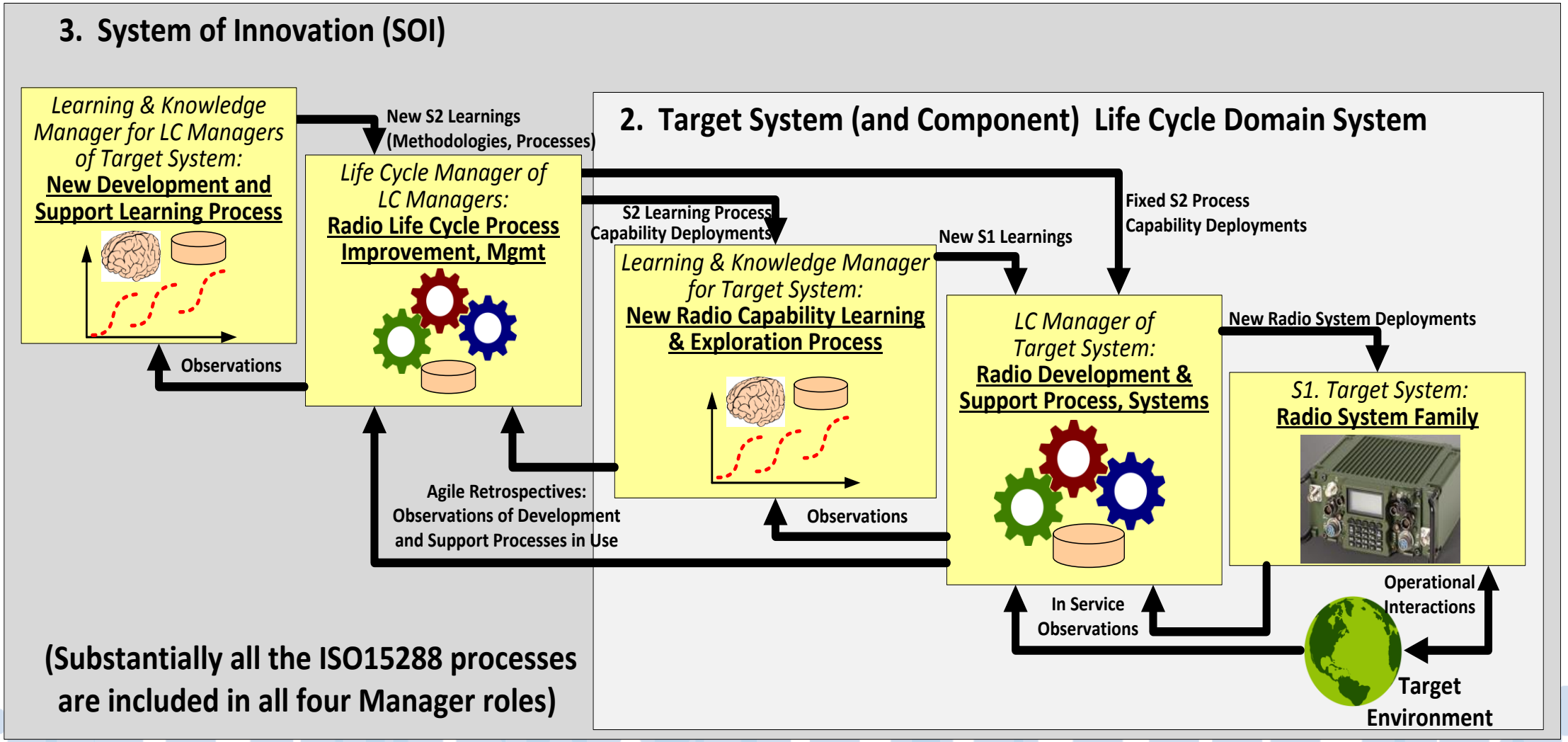
Nested feedback loop processes traverse system configuration space

States, Modes, and Learning in System 2

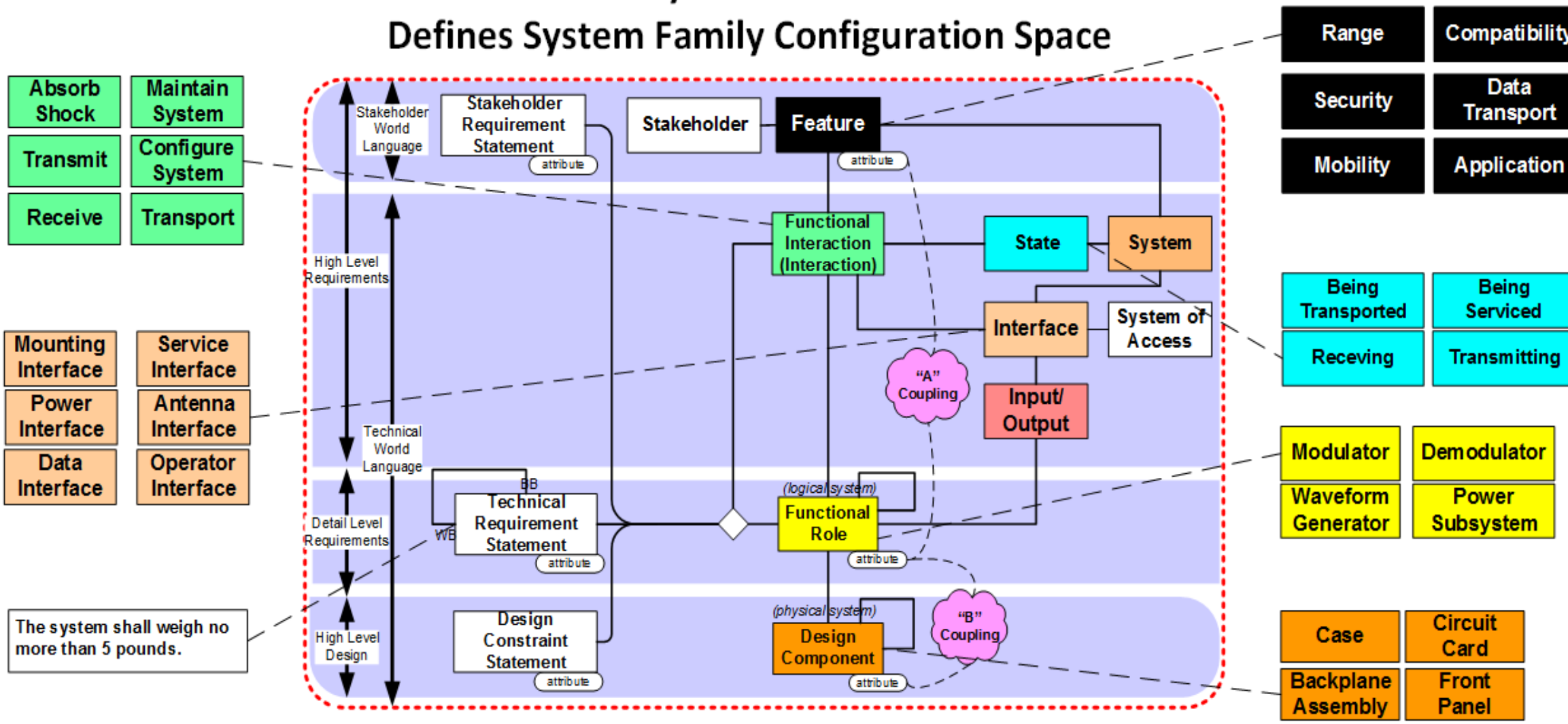


Fixed" Agents Apply Past Learned Patterns from "Learning" Agents

4. Agile Hardware/Firmware/Software Product Line Engineering at Rockwell Collins



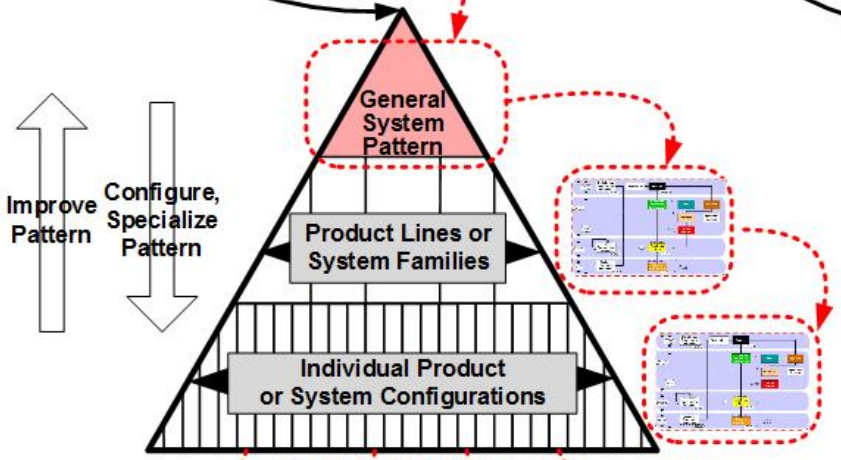
Summary of S*Metamodel
Defines System Family Configuration Space



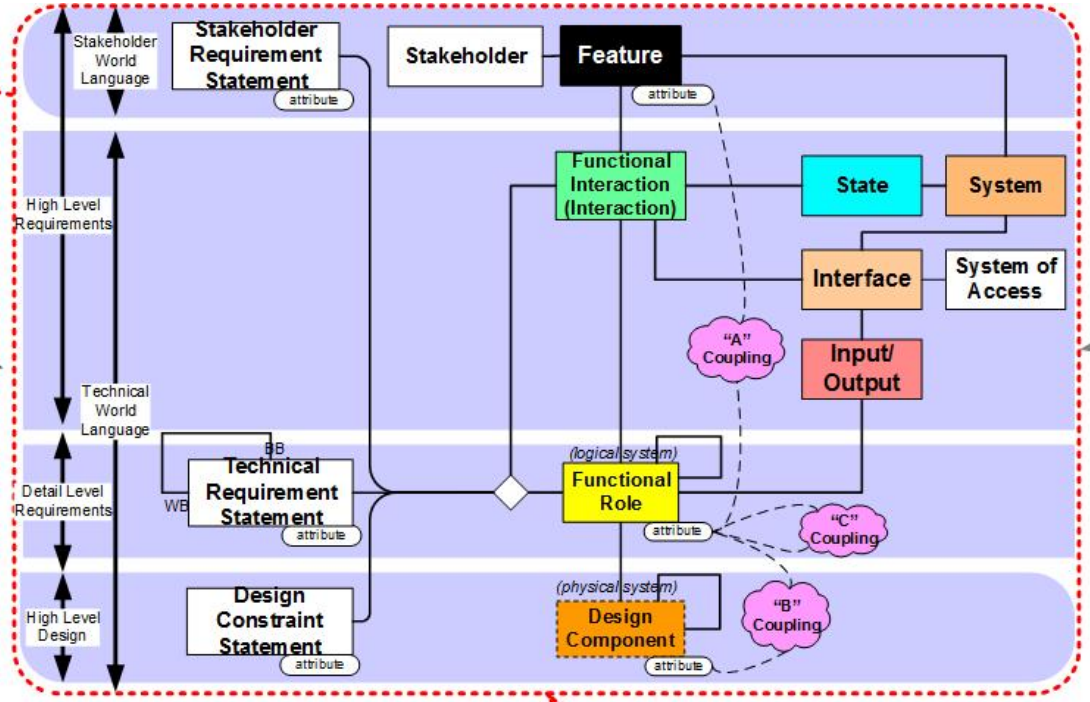
Product line family issues ultimately include the minimal system model issues (Illustrative examples for generic radio systems)

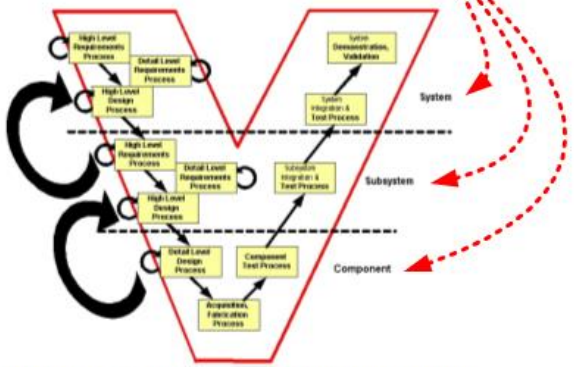
S*Pattern Hierarchy for Pattern-Based Systems Engineering (PBSE)

S*Metamodel for Model-Based Systems Engineering (MBSE)



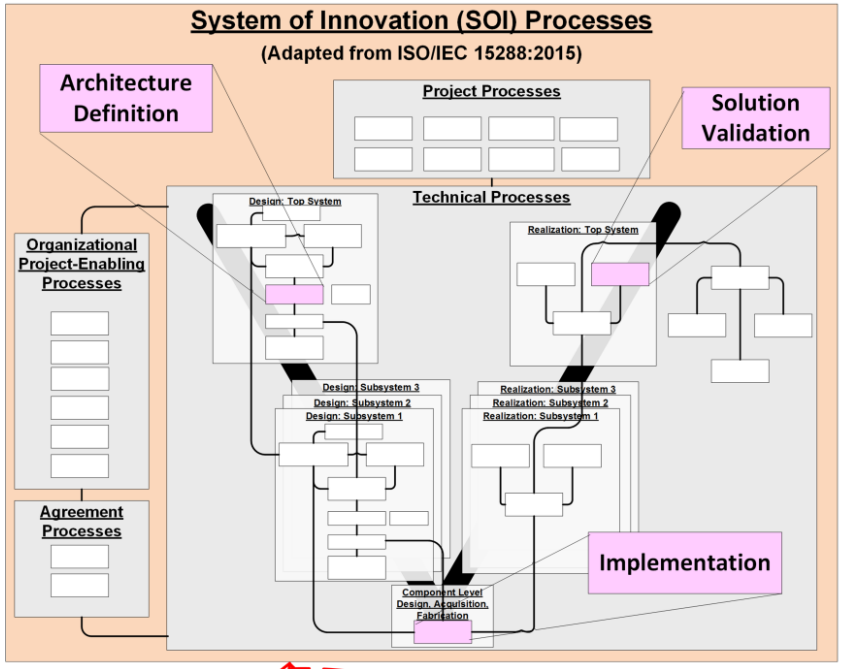
System Pattern Class Hierarchy

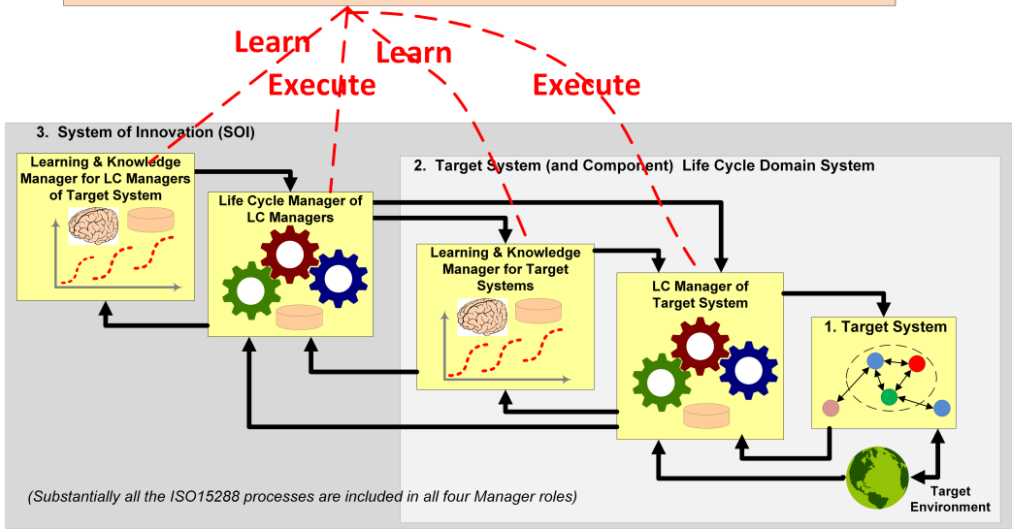




System Containment Hierarchy

Product lines configure varying products from those pattern assets.





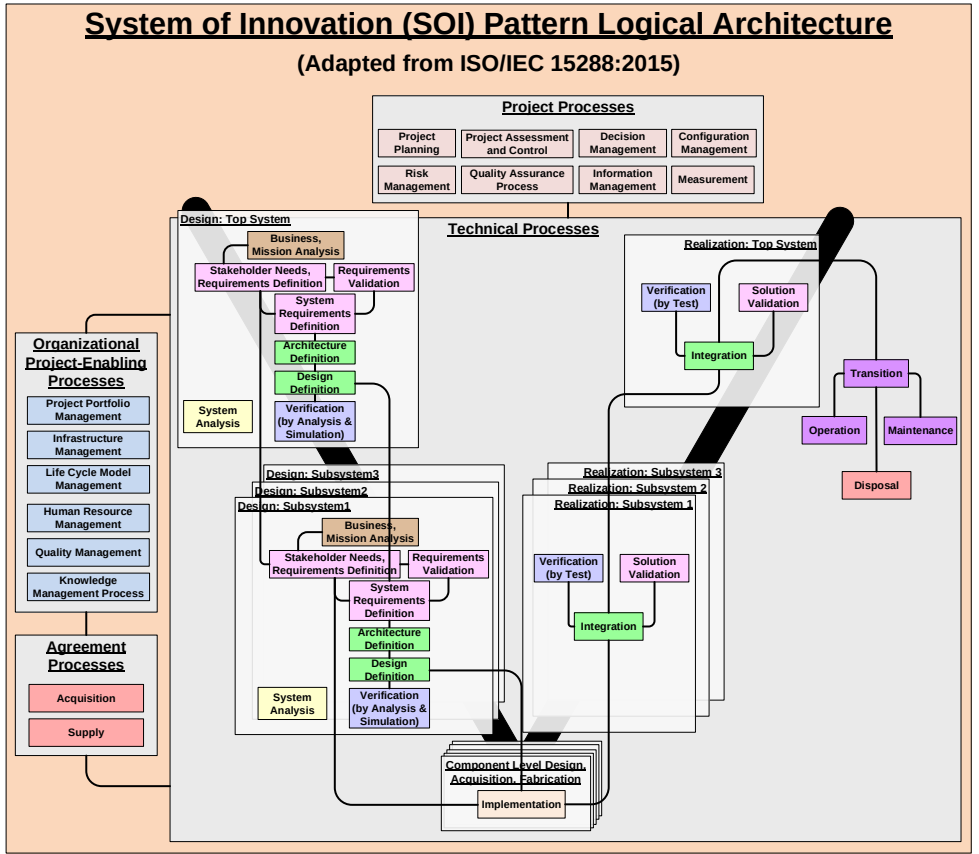
All ISO15288 life cycle processes are candidates for Product Line Engineering learning and configurability—e.g., Test

Additional Recent INCOSE ASELCM Applications

- Advanced Manufacturing sites in commercial world
- Aero & defense engineering systems ecosystems
- INCOSE Agile Health Care Systems Conferences 2016-2018:
  - Health Care Domain ASELCM Pattern
- INCOSE/IEEE/NASA EnergyTech 2016 Conf.:
  - Critical Infrastructure Domain ASELCM Pattern
  - Power Distribution Domain ASELCM Pattern

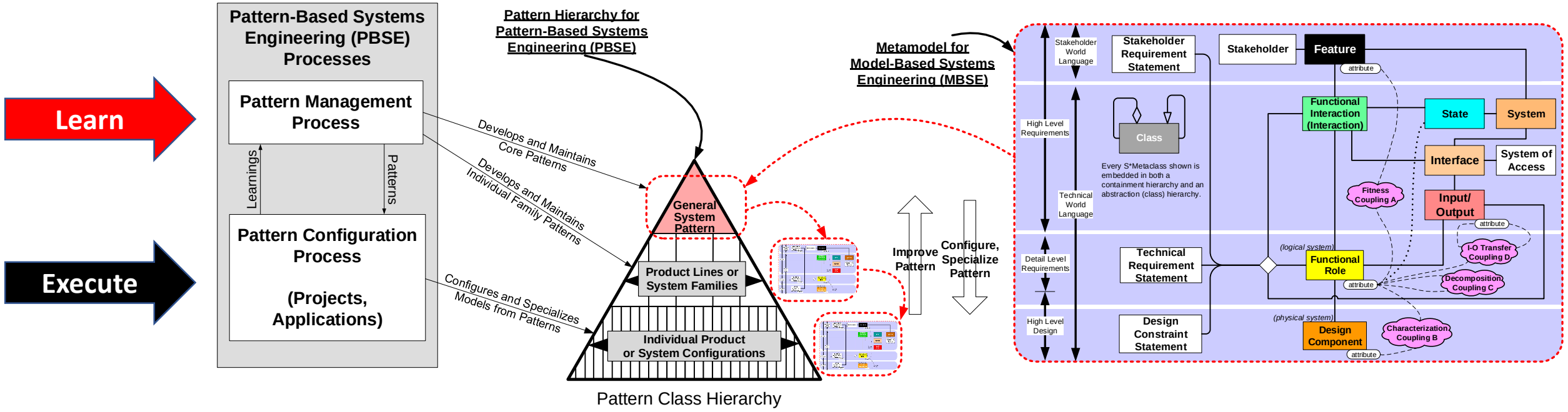
System 2 Logical Architecture

- A well-known logical decomposition of System 2 is the ISO15288 system life cycle management process structure.
- The ASELCM Pattern can be unfolded and viewed in more than one way, so it carries the historical ISO15288 LC Management Processes along:

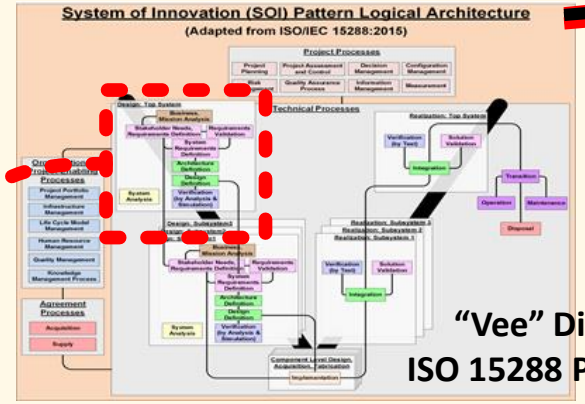


System 2 Logical Architecture

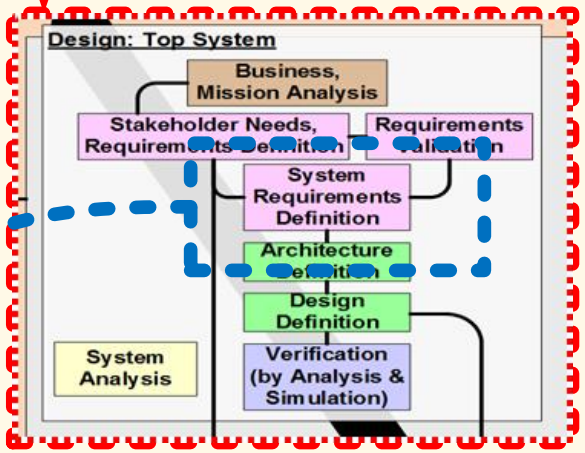
- ***However***, the ASELCM Pattern is most often of interest to understand and improve performance related to agility, learning, and re-use of learned knowledge, so it is most commonly unfolded along a different axis, emphasizing Learning versus Executing (the latter re-using what we have already learned and don't want to learn again):

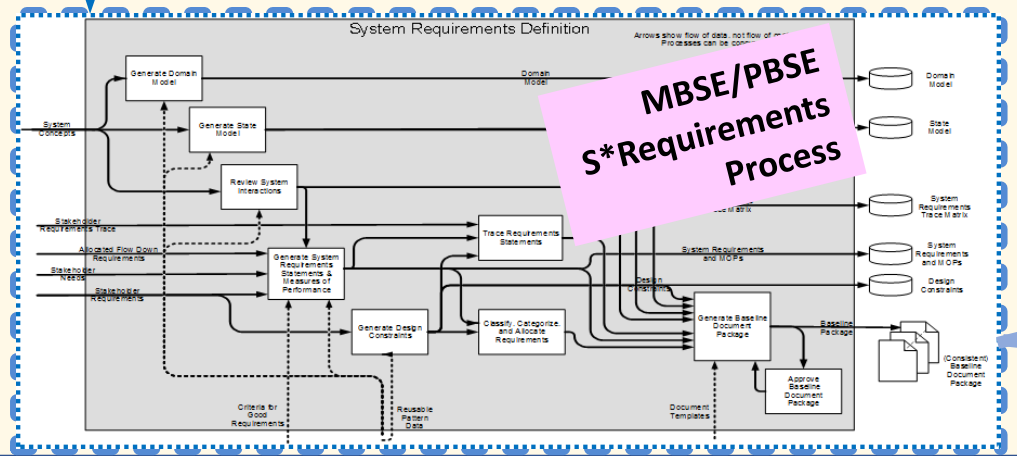


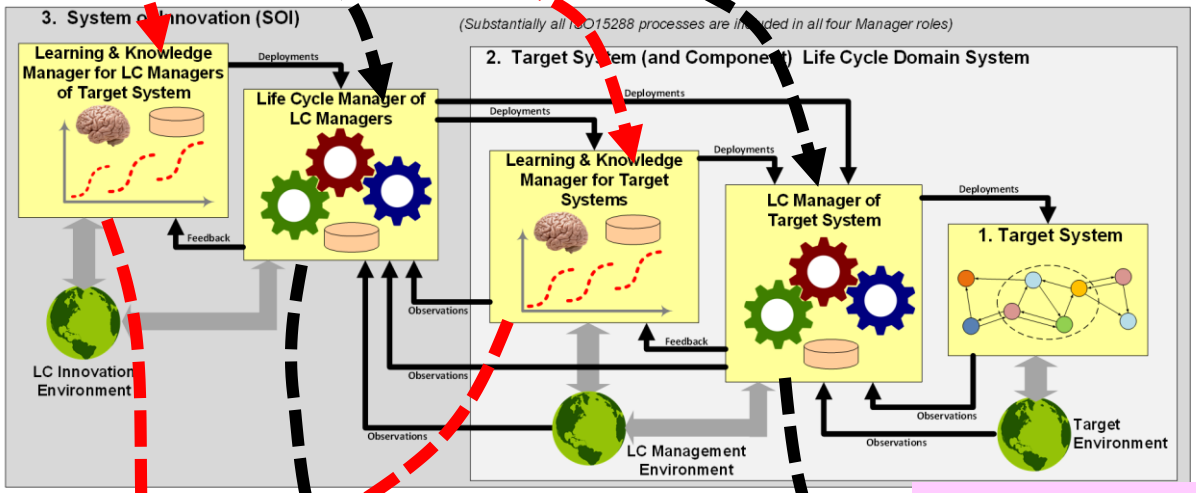
Learn vs. Execute Division



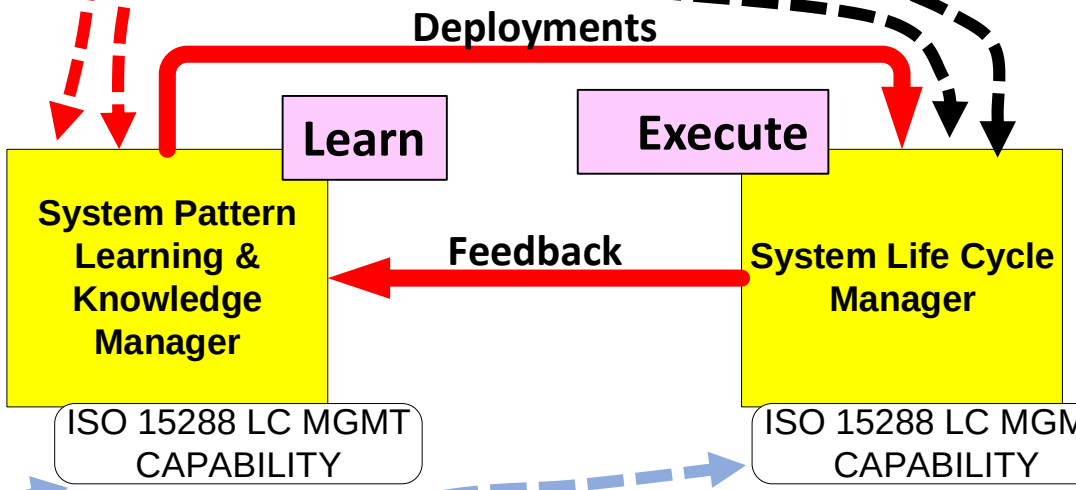
"Vee" Diagram of ISO 15288 Processes



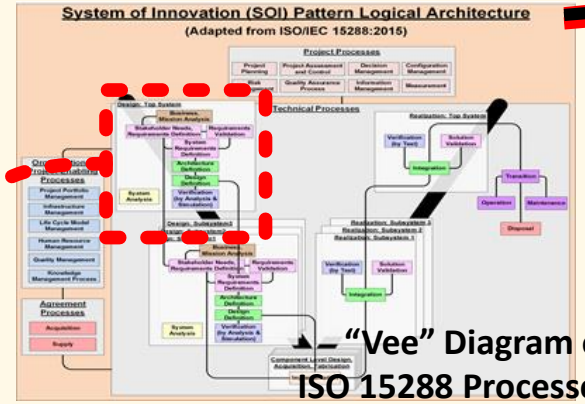




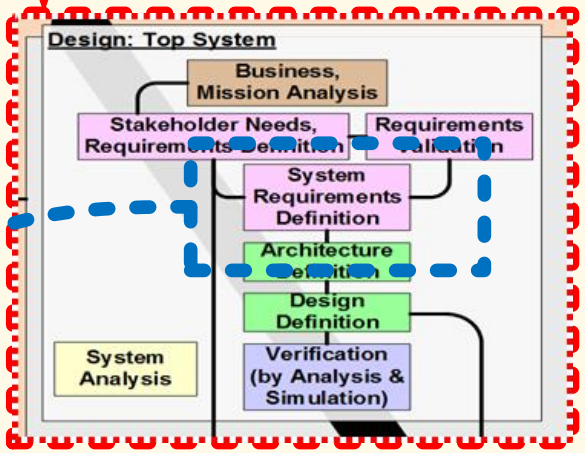
Top of ASELCM Pattern

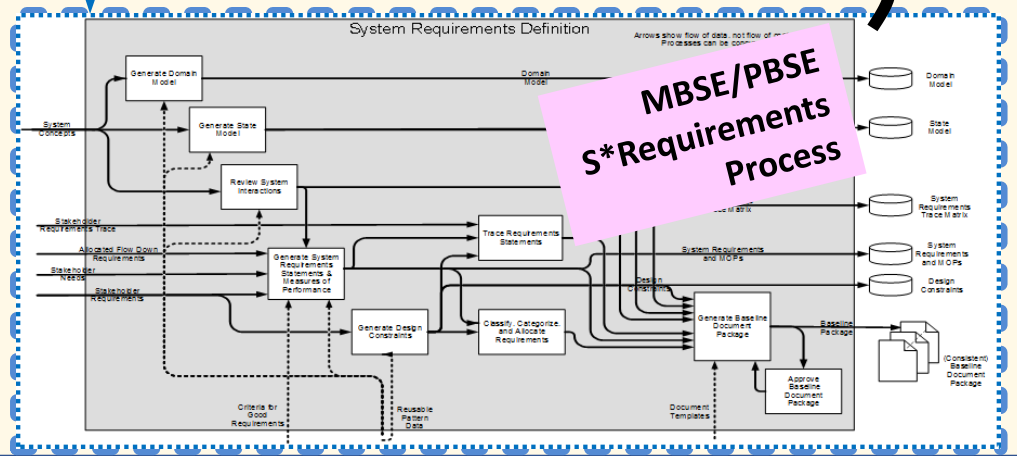


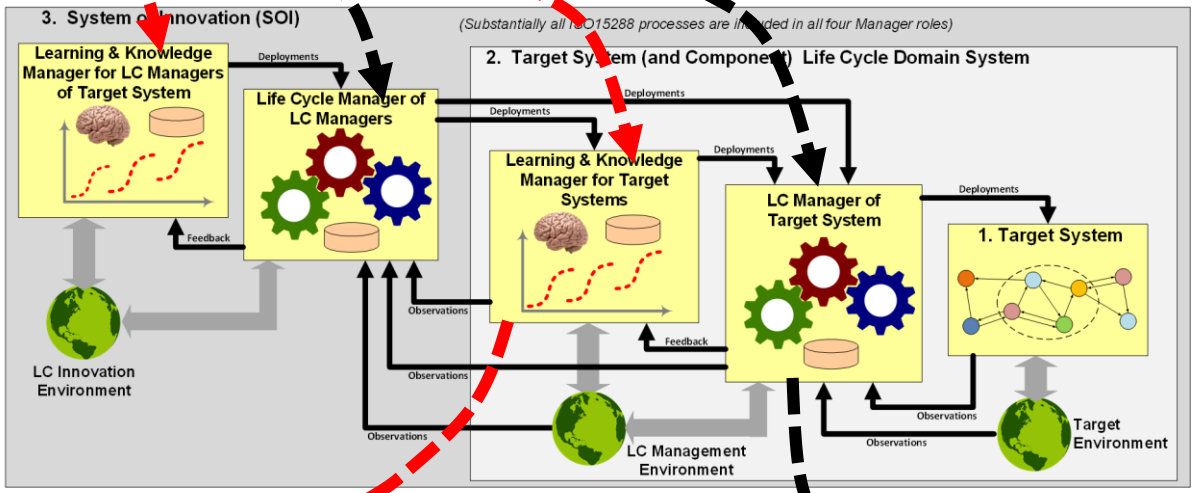
ASELCM Pattern logical architecture emphasizes the Learn-Execute division at its very top and its very bottom.

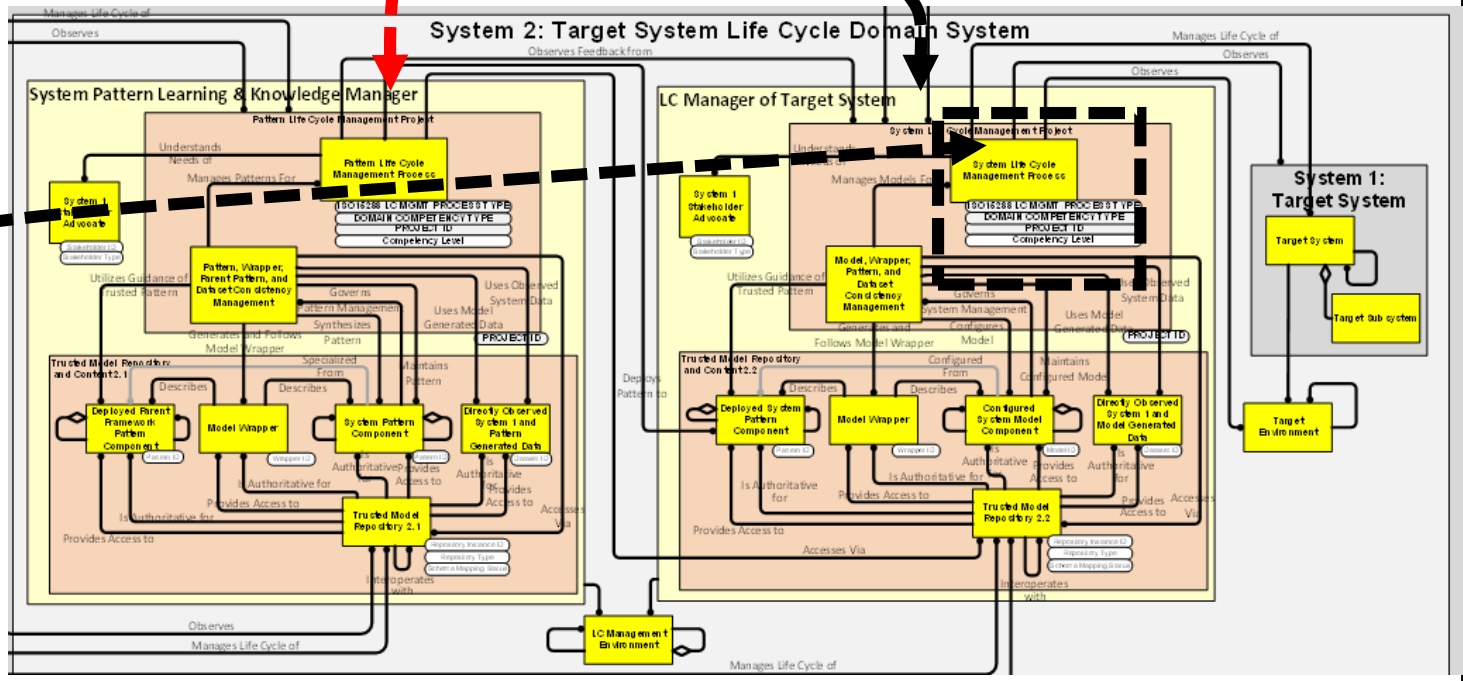


"Vee" Diagram of ISO 15288 Processes



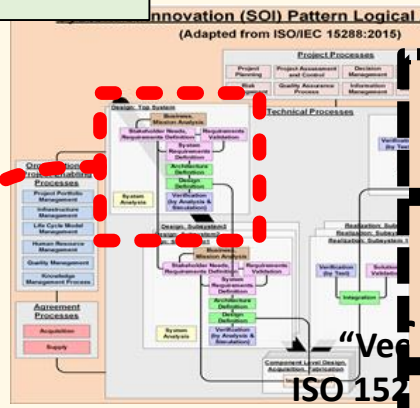






Hierarchical Division

Learn vs. Execute Division



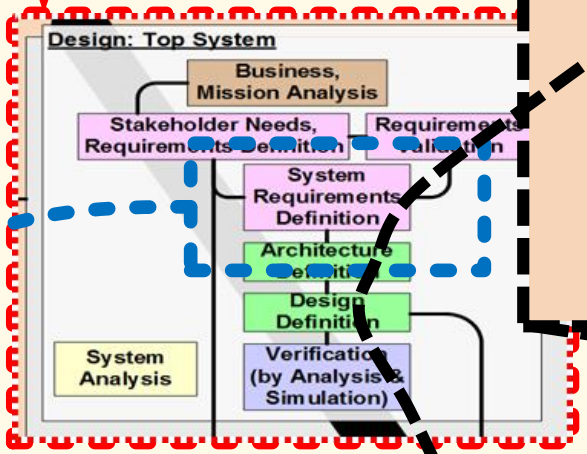
System Life Cycle Management Process

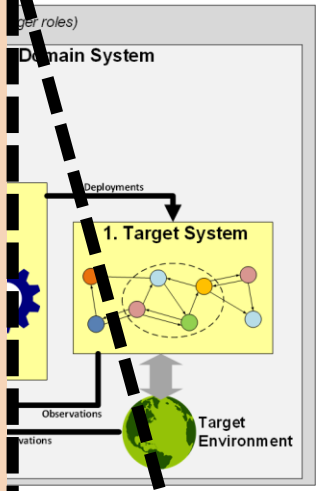
ISO15288 LC MGMT PROCESS TYPE

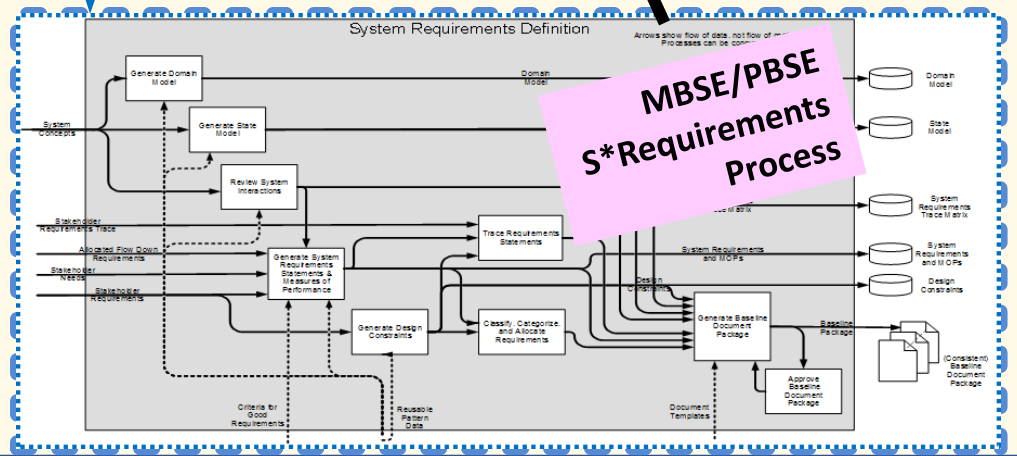
DOMAIN COMPETENCY TYPE

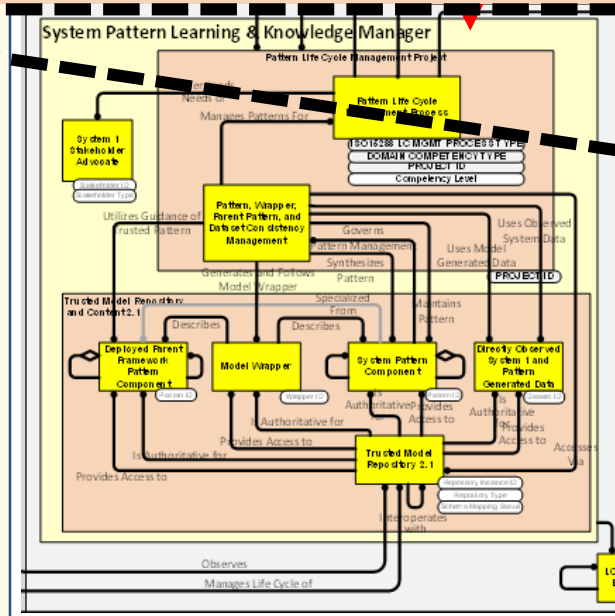
PROJECT ID

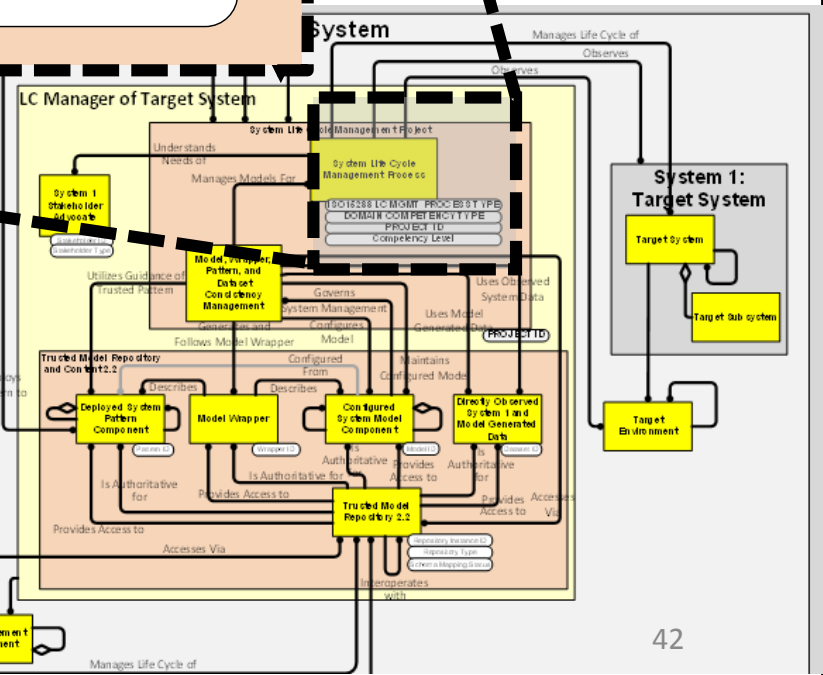
Competency Level



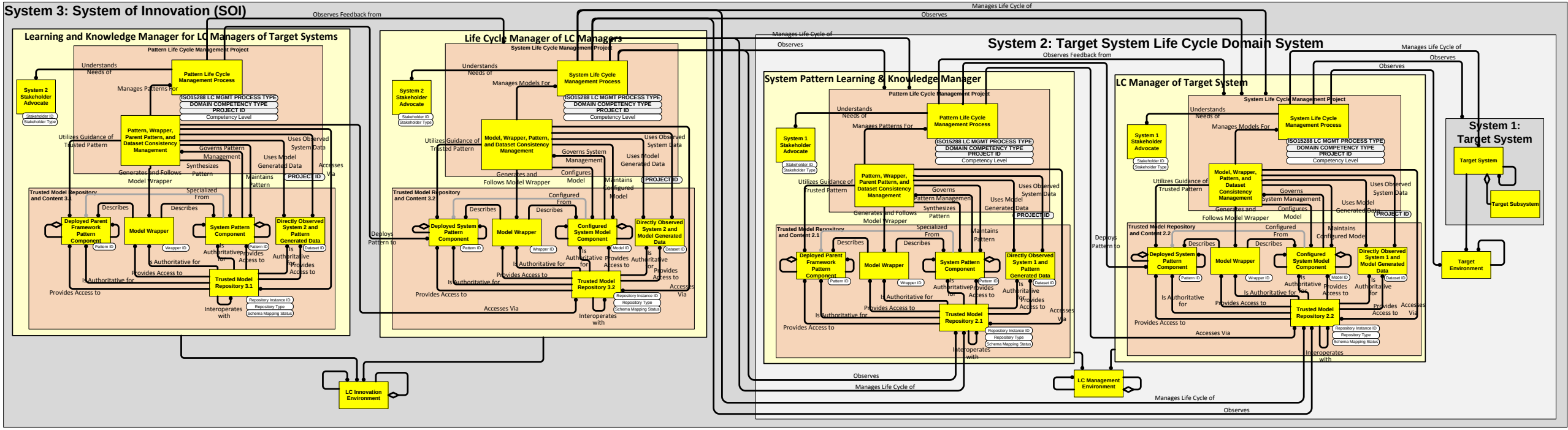




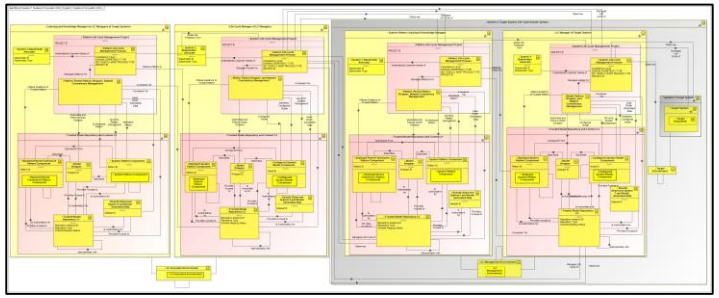




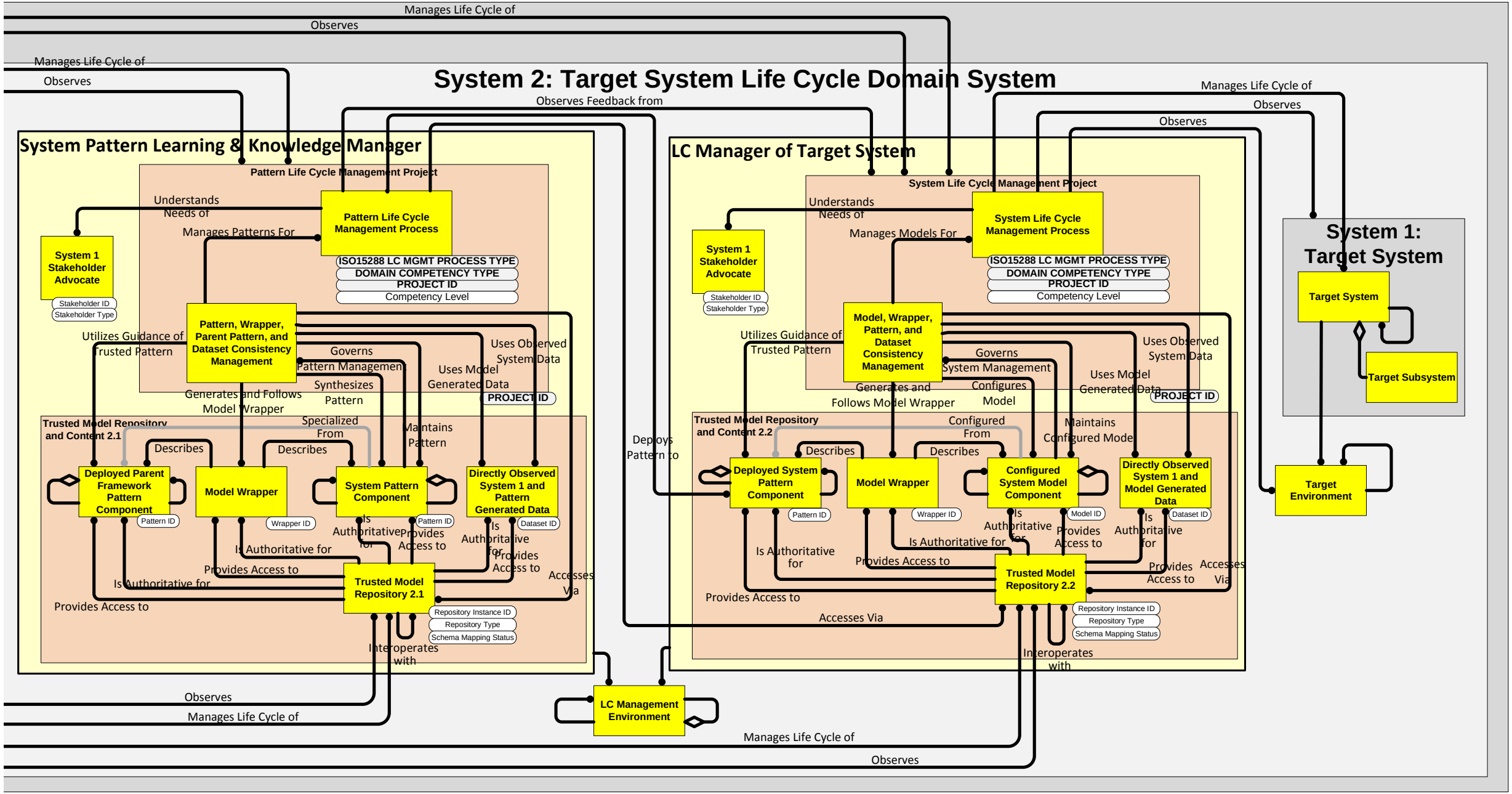
Levels of decomposition of the ASELCM Logical Architecture:

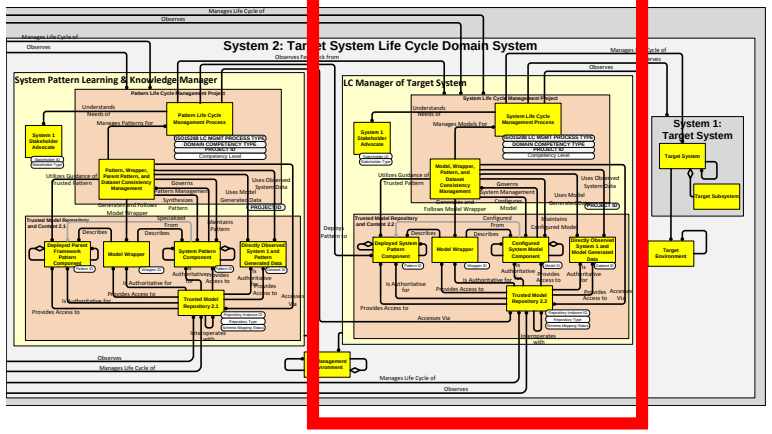


(Related SysML view)



The System 2 part of the ASELCM Logical Architecture:





LC Manager of Target System

System Life Cycle Management Project

Understands Needs of

Manages Models For

System 1 Stakeholder Advocate

Stakeholder ID

Stakeholder Type

System Life Cycle Management Process

ISO15288 LC MGMT PROCESS TYPE

DOMAIN COMPETENCY TYPE

PROJECT ID

Competency Level

Model, Wrapper, Pattern, and Dataset Consistency Management

Utilizes Guidance of Trusted Pattern

Governs System Management

Uses Observed System Data

Uses Model Generated Data

Generates and Follows Model Wrapper

Configures Model

PROJECT ID

Trusted Model Repository and Content 2.2

Configured From

Maintains Configured Model

Describes

Describes

Deployed System Pattern Component

Pattern ID

Model Wrapper

Wrapper ID

Configured System Model Component

Model ID

Directly Observed System 1 and Model Generated Data

Dataset ID

Is Authoritative for

Provides Access to

Is Authoritative for

Provides Access to

Is Authoritative for

Provides Access to

Provides Access to

Accesses Via

Trusted Model Repository 2.2

Provides Access to

Accesses Via

Repository Instance ID

Repository Type

Schema Mapping Status

System Pattern Learning & Knowledge Manager

Pattern Life Cycle Management Project

Understands Needs of

Manages Patterns For

Pattern Life Cycle Management Process

ISO15288 LC MGMT PROCESS TYPE

DOMAIN COMPETENCY TYPE

PROJECT ID

Competency Level

System 1 Stakeholder Advocate

Stakeholder ID

Stakeholder Type

Pattern, Wrapper, Parent Pattern, and Dataset Consistency Management

Utilizes Guidance of Trusted Pattern

Governs Pattern Management

Uses Observed System Data

Uses Model Generated Data

PROJECT ID

Synthesizes Pattern

Generates and Follows Model Wrapper

Trusted Model Repository and Content 2.1

Specialized From

Maintains Pattern

Describes

Describes

Deployed Parent Framework Pattern Component

Pattern ID

Model Wrapper

Wrapper ID

System Pattern Component

Pattern ID

Directly Observed System 1 and Pattern Generated Data

Dataset ID

Is Authoritative for

Provides Access to

Is Authoritative for

Provides Access to

Is Authoritative for

Provides Access to

Is Authoritative for

Provides Access to

Accesses Via

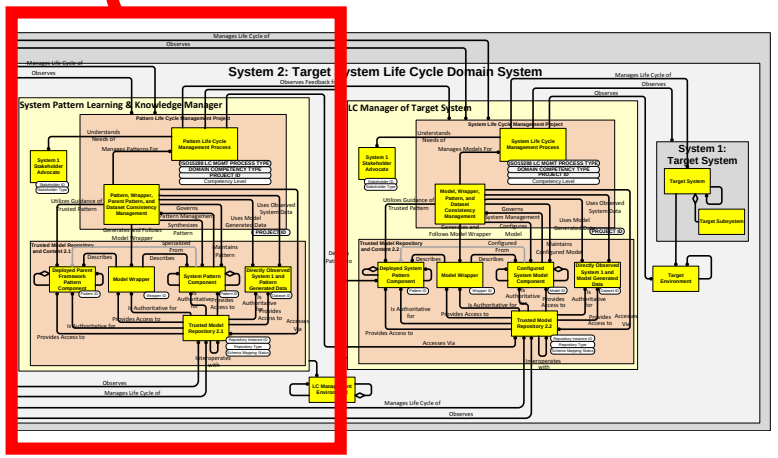
Trusted Model Repository 2.1

Repository Instance ID

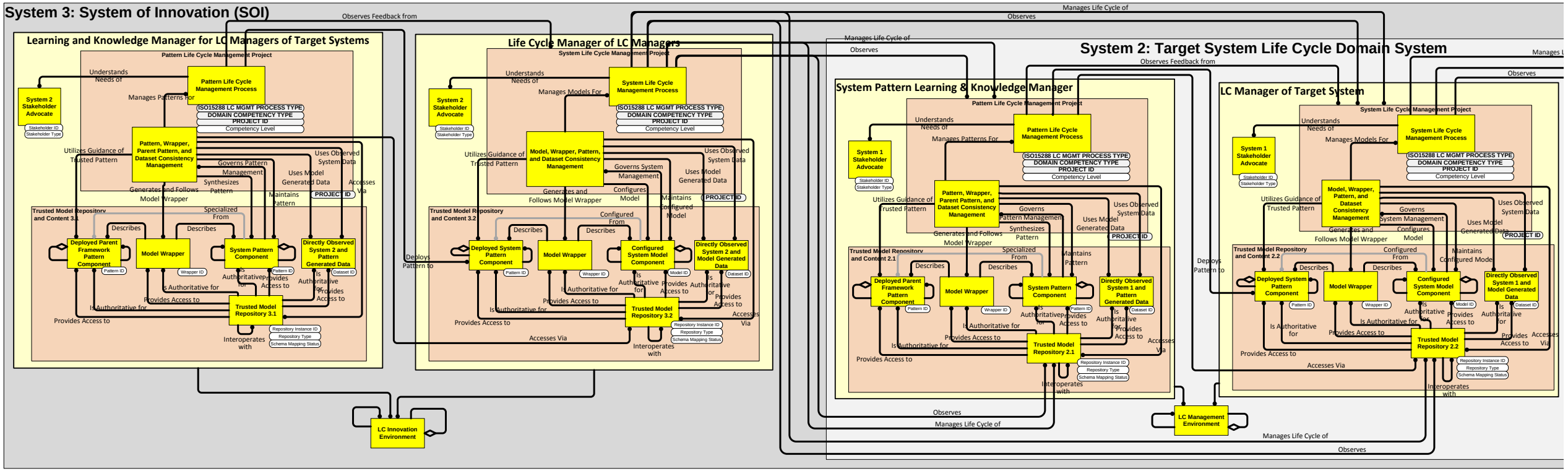
Repository Type

Schema Mapping Status

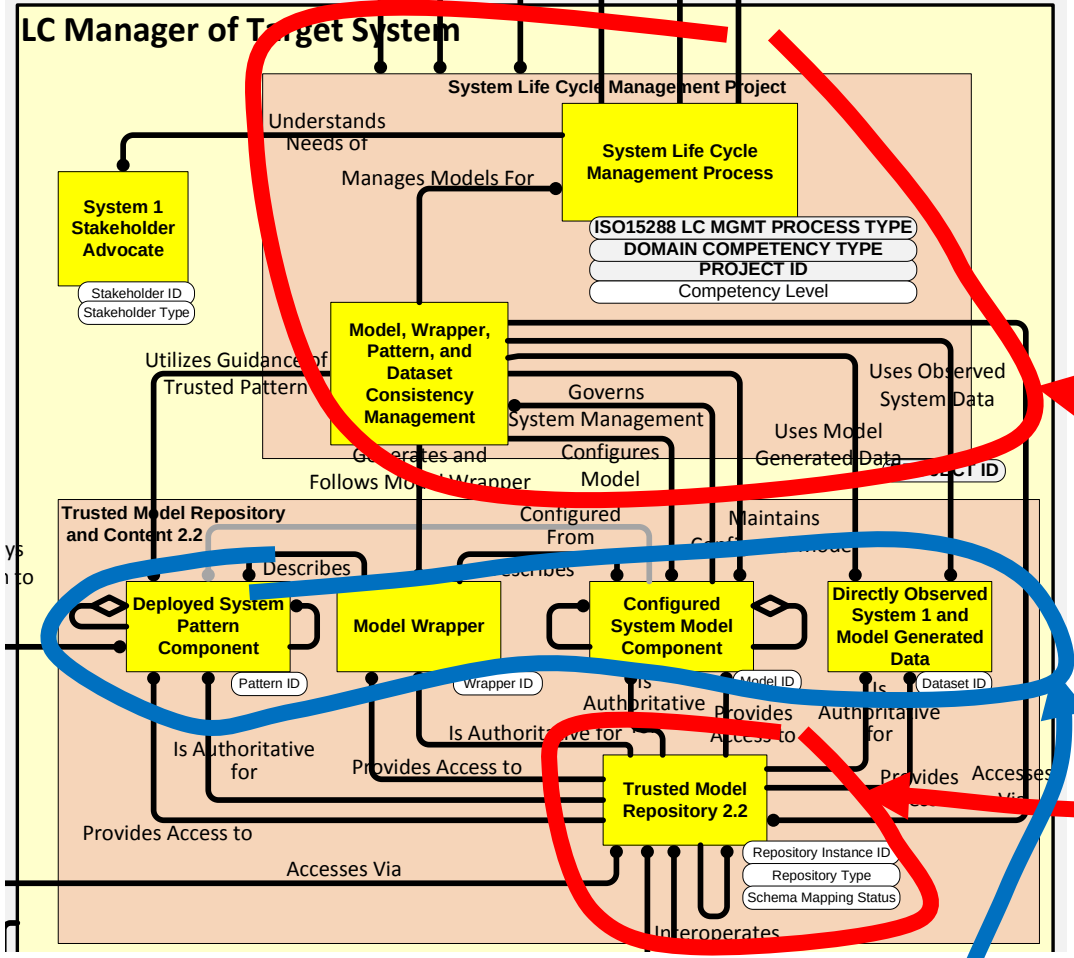
Interoperates with



Evolvability: System 3 part of the ASELCM Logical Architecture:



- Notice that System 3 manages the life cycles of the resources of System 2 that are not descriptions (e.g., models or model patterns) of S1—it does not manage the life cycles of the System 1 models or similar information about System 1.
- System 2 manages the life cycles of that information (models, etc.) describing System 1.
- Medical device example: System 3 manages the life cycle of the Requirements Process of System 2, but System 2 manages the Medical Device Requirements.



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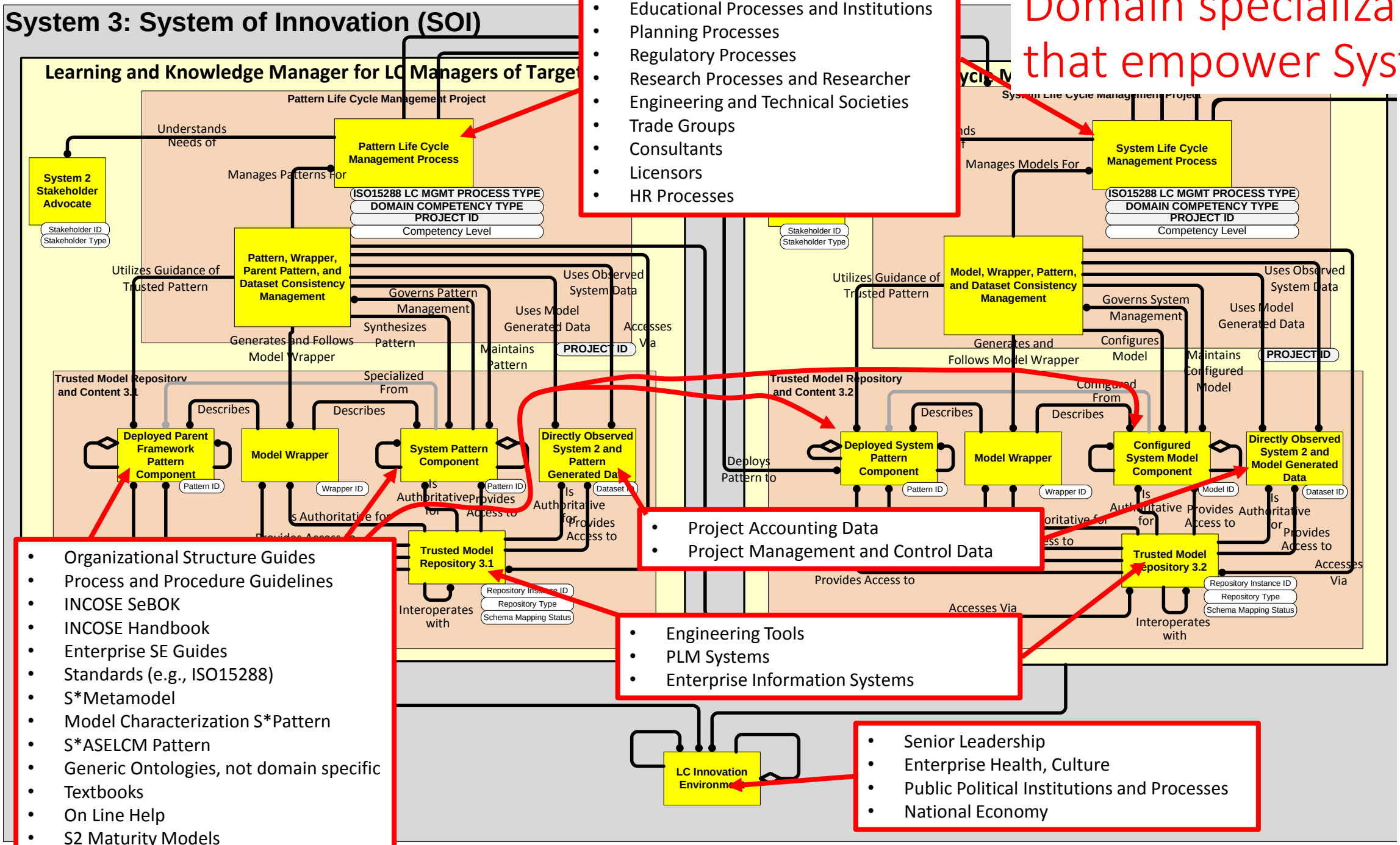
- Medical device example: System 3 manages the life cycle of the Requirements Process of System 2, but System 2 manages the Medical Device Requirements.

Domain specialties that empower System 3

- While S3's logical architecture may look a lot like S2's logical architecture, in the abstract senses of (1) "learning", (2) the ISO15288 processes, and (3) the "Vee" diagram, nevertheless . . .
- There are "domain specialty" versions of those abstract processes used for S3, because it is about life cycle management and innovation ***of the SE process*** (i.e., S2).
- This is similar to the idea that S2 may itself likewise have specializations, when S1 is a nuclear power generation station, versus an orbital satellite, versus a medical device.
- So, what are the specializations that are appropriate to S3's logical processes and information, given that S2 is an engineering and life cycle management system? . . .

Domain specializations that empower System 3



- Educational Processes and Institutions
- Planning Processes
- Regulatory Processes
- Research Processes and Researcher
- Engineering and Technical Societies
- Trade Groups
- Consultants
- Licensors
- HR Processes

- Project Accounting Data
- Project Management and Control Data

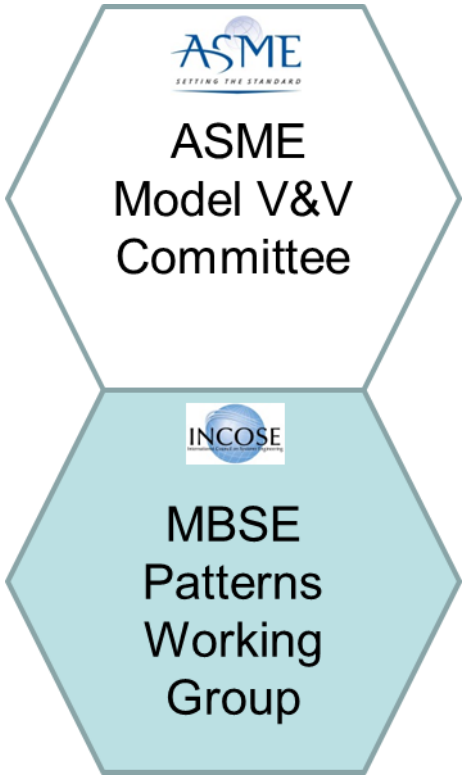
- Organizational Structure Guides
- Process and Procedure Guidelines
- INCOSE SeBOK
- INCOSE Handbook
- Enterprise SE Guides
- Standards (e.g., ISO15288)
- S*Metamodel
- Model Characterization S*Pattern
- S*ASELCM Pattern
- Generic Ontologies, not domain specific
- Textbooks
- On Line Help
- S2 Maturity Models

- Engineering Tools
- PLM Systems
- Enterprise Information Systems

- Senior Leadership
- Enterprise Health, Culture
- Public Political Institutions and Processes
- National Economy

Working Group Partners in Progress

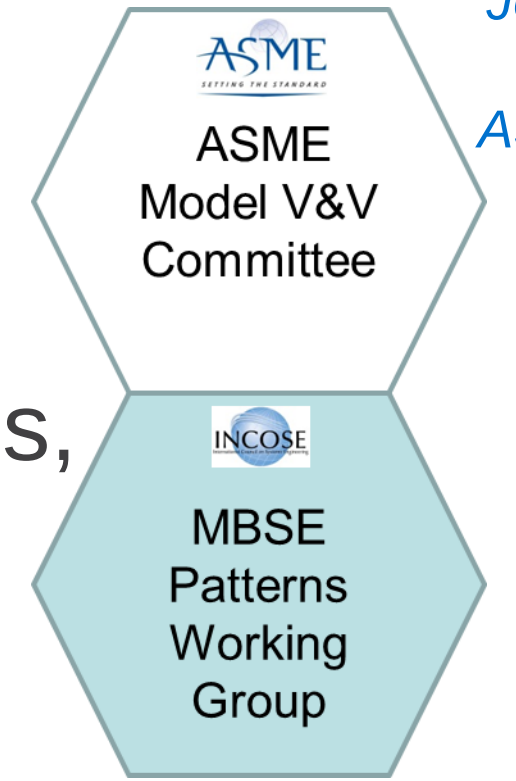
Primary Contact:
Joe Hightower, Boeing,
Gordon Shao, NIST,
ASME VV50 Committee



Supporting creation of ASME Guidelines & Standards for Verification, Validation, Uncertainty Quantification of Computational Models, over their Life Cycles

With ASME Model V&V Committees: Model V&V Joint Activity Materials

- Supporting creation of ASME Guidelines & Standards for Managing Credibility (Model VVUQ) of Computational Models, over their Life Cycles

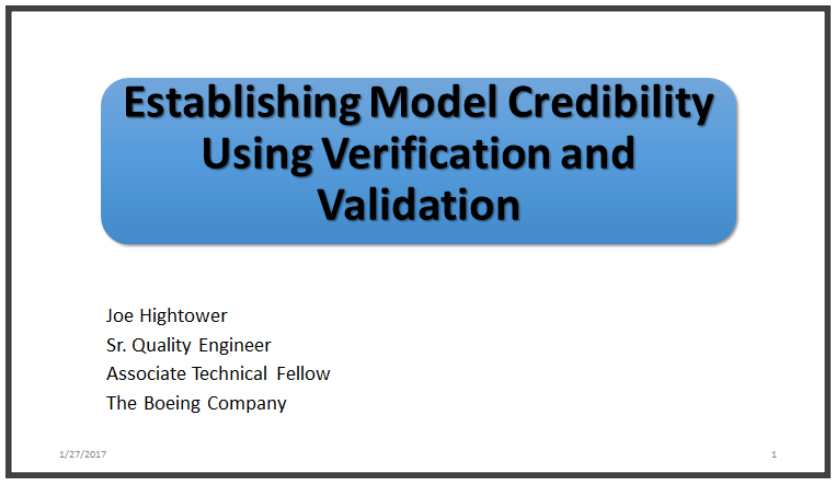


Primary Contacts:
Joe Hightower, Boeing,
Gordon Shao, NIST,
ASME VV50 Committee

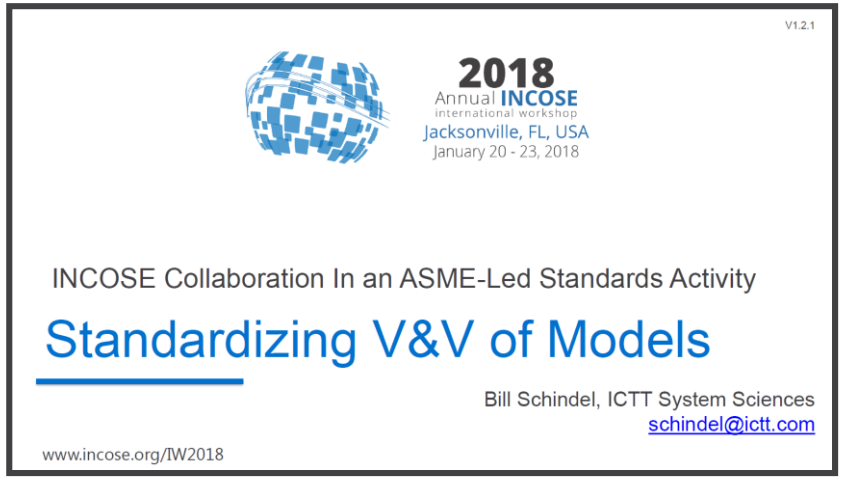
Model VVUQ Project Status July 2019

- Member ASME Model V&V Standards Committee: Presented related report to IW18 MBSE Workshop and IS2019 Strategic Planning sessions.
- Along with INCOSE and V4 Institute, have generated Model Characterization Pattern (MCP) extension of VVUQ Pattern, a computational model meta-framework providing a uniform wrapper of metadata connecting any science or engineering model to its intended uses (and related model VVUQ).
- Being used in INCOSE MB Transformation team to package a series of example models sampled by that team across literature
- Basis for current V4 Institute demonstration of concept projects.
- Basis of public 4 panel series, “Patterns in the Public Square”, with participation by ASME, INCOSE, SAE, FDA, FAA, DoD, on issues of credible / trustable models in regulated and other public markets (at GLRC 2017, ET 2017, IS 2018, GLRC 2018)
- Member of V4 Institute, under NCDMM, concerned with increasing competency to accelerate innovation using more virtual verification and validation of systems, based on trusted models. (Others include Rolls-Royce, Johnson & Johnson, Indiana University Pervasive Computing Scientific Gateways, Notre Dame University, Microsoft, others.)

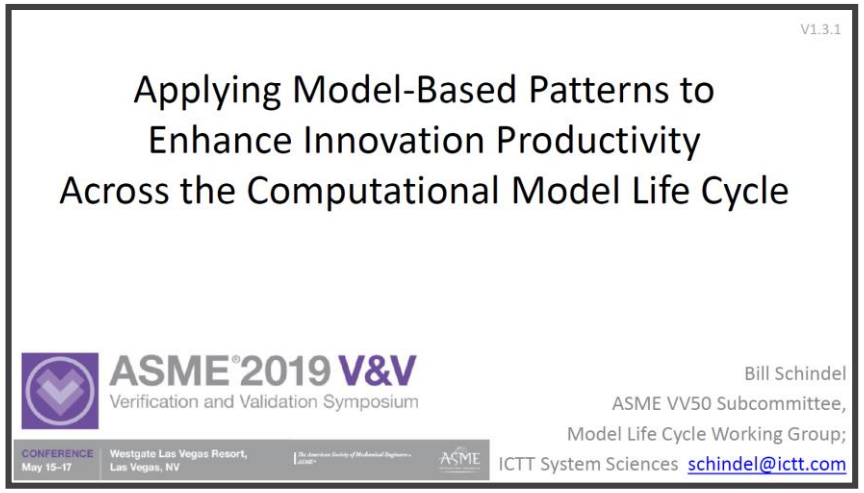
With ASME Model V&V Committees: Model V&V Joint Activity Reports



INCOSE IW2017
MBSE Workshop



INCOSE IW2018
MBSE Workshop



ASME 2019 Model
V&V Symposium

V&V of *Models*, Per Emerging ASME Model V&V Standards

Does the Model adequately describe what it is intended to describe?

Model Validation

Model validated?

Model

Model verified?

Model Verification

Does the Model implementation adequately represent what the Model says?

Describes Some Aspect of

System of Interest

V&V of *Systems*, Per ISO 15288 & INCOSE Handbook

Do the System Requirements describe what stakeholders need?

System Validation

Requirements validated?

Design verified?

System Verification

Does the System Design define a solution meeting the System Requirements?

Don't forget: A model (on the left) may be used for system verification or validation (on the right!)

Data Driven Models "Black Box"

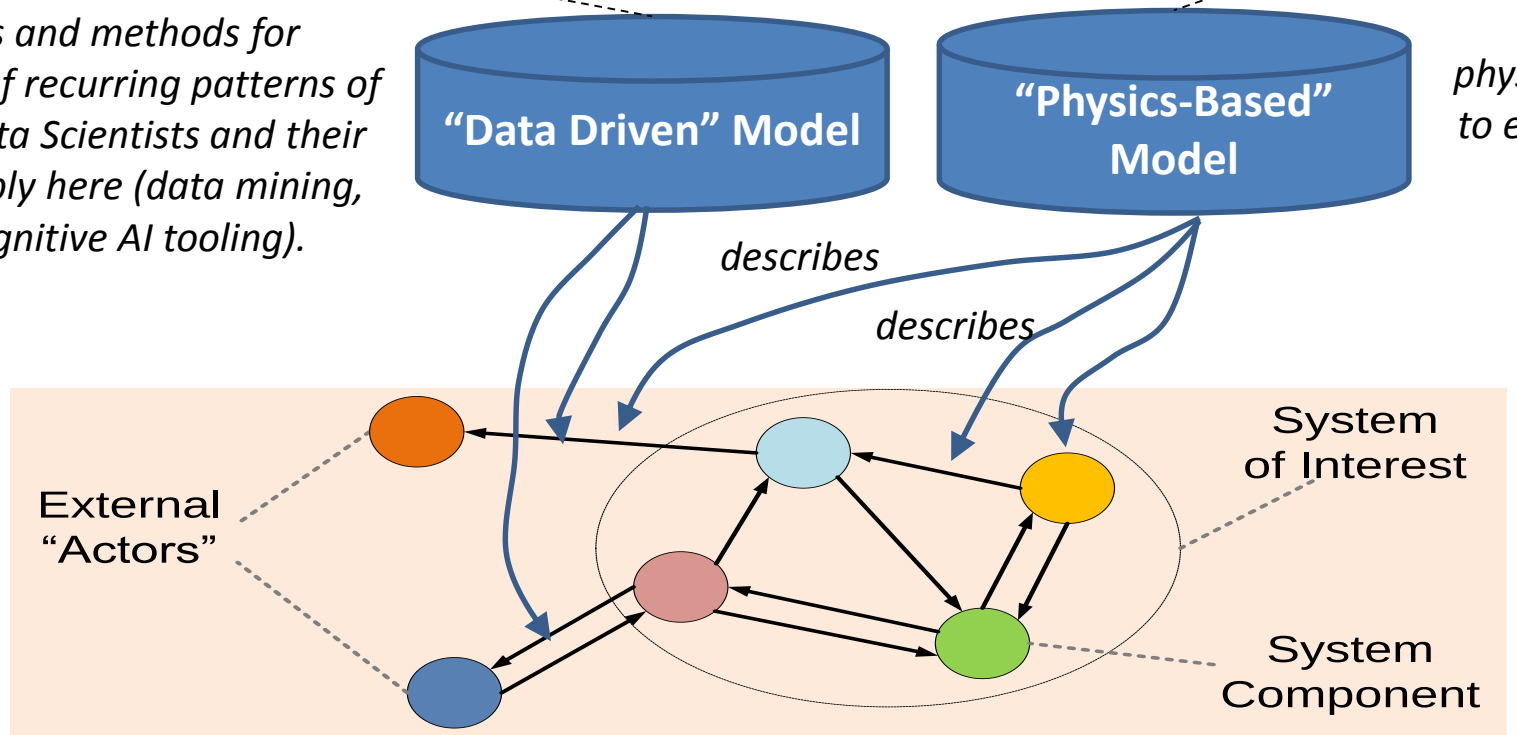
What is the behavior of the System of Interest, visible externally to the external actors with which it interacts?

Special interests: Tools and methods for discovery/extraction of recurring patterns of external behavior. Data Scientists and their newer IT tools can apply here (data mining, pattern extraction, cognitive AI tooling).

Physics Based "Internal Explanatory" Models

What are the internal interactions of the System of Interest, and how do they combine to cause/explain the behavior that is externally visible as interactions with external actors?

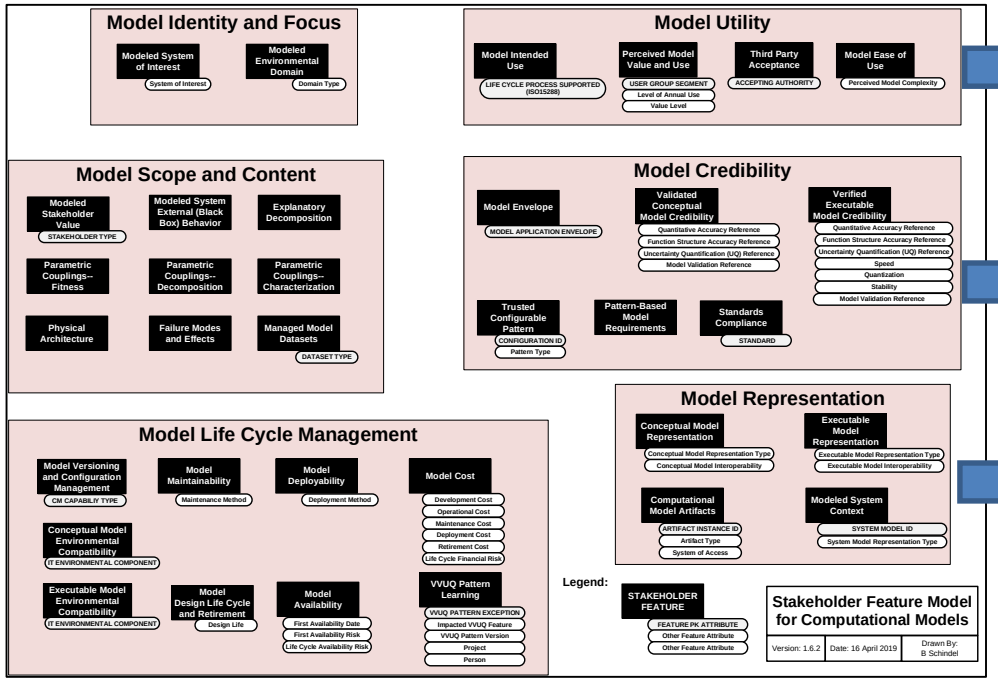
Special interests: The hard sciences physical laws, and how they can be used to explain the externally visible behavior of the System of Interest. Physical Scientists and models from their disciplines can apply here.

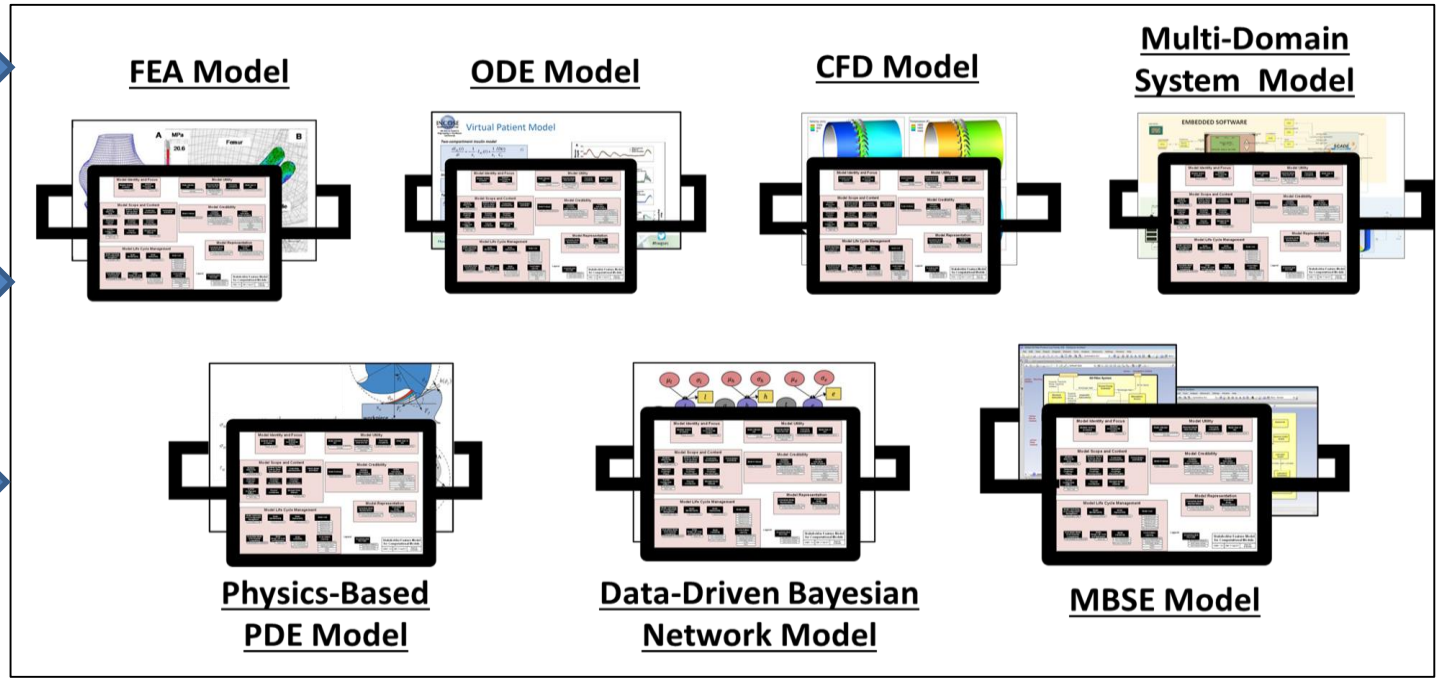


When expressed in S*Metamodel framework, the distinction and relationships of these two types of models becomes explicitly clear. It can be seen that this distinction retraces the history of the physical sciences, but with the latest tools. Remember the centuries-earlier studies of the night skies for patterns in the motion of stars and planets, followed later by the explanatory models of Newton and others.

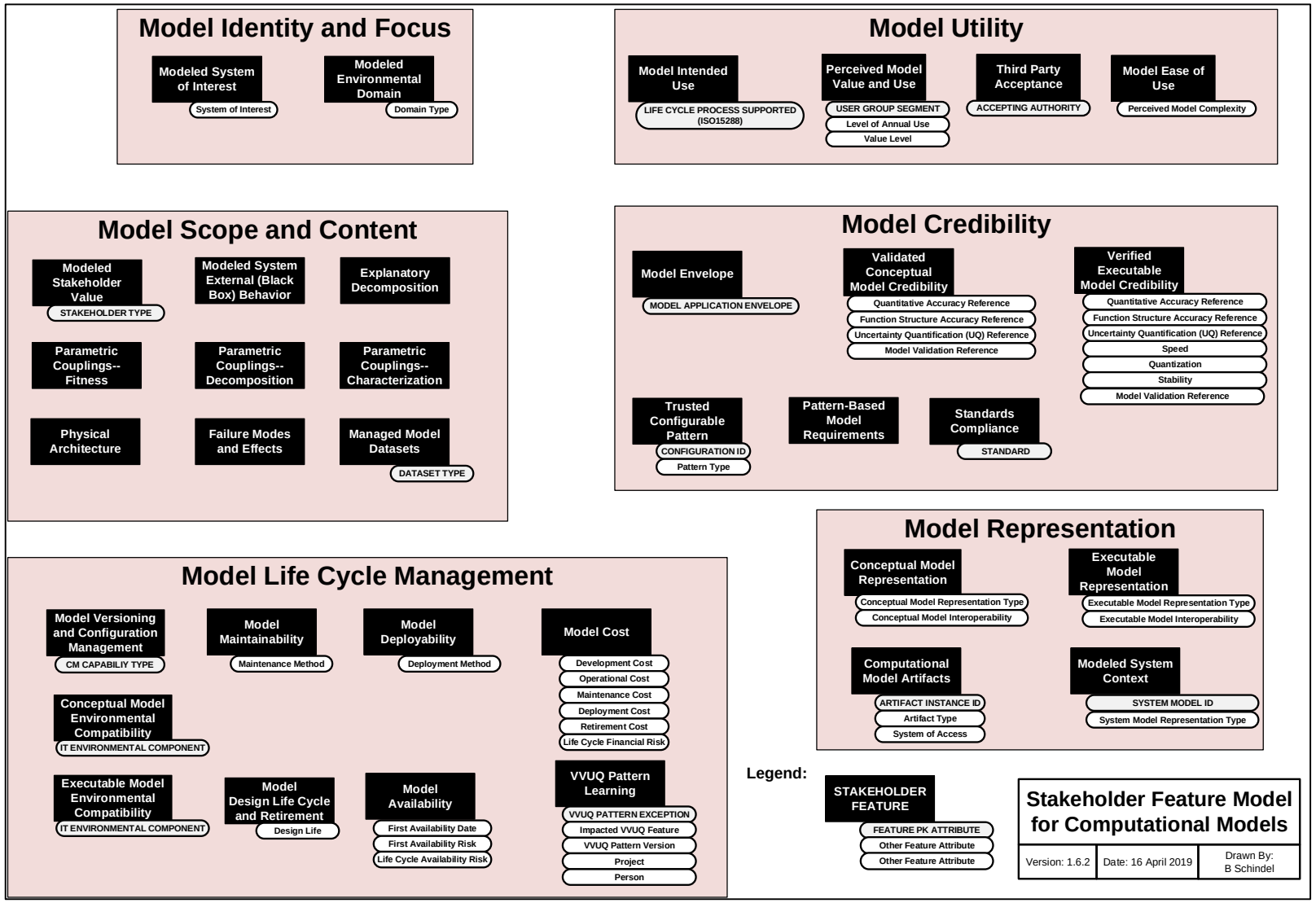
The Model Characterization Pattern (MCP)—an S*Pattern

- A universal “wrapper” across all computational model types.
- Provides a common characterization for all models.
- Key to managing the model’s entire life cycle, including but not limited to Model VVUQ.





Configurable MCP Feature Groups for Models (Computational Model's Stakeholder Requirements)



(See References for definitions.)

V1.4.3

28th annual INCOSE international symposium
Washington, DC, USA
July 7 - 12, 2018

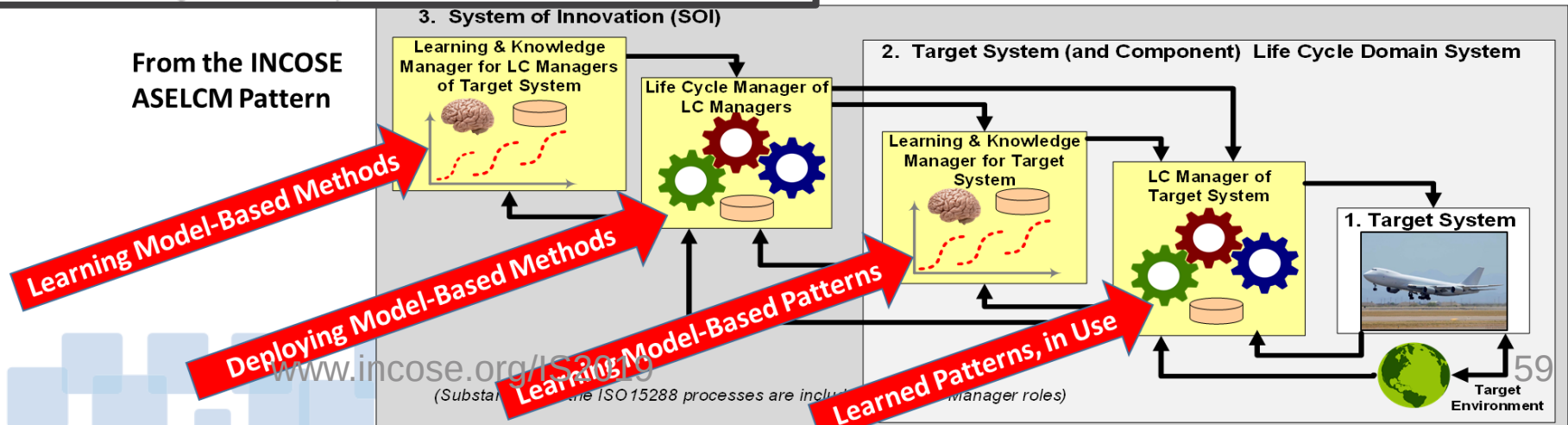
Accelerating Innovation Effectiveness: Model-Facilitated Collaboration by Regulators, Technical Societies, Customers, and Suppliers

INCOSE · ASME SETTING THE STANDARD · FDA · NAVAIR · SAE INTERNATIONAL

28th Annual INCOSE International Symposium
Delivering Systems in the Age of Globalization
July 7 – 12, 2018
Washington, DC

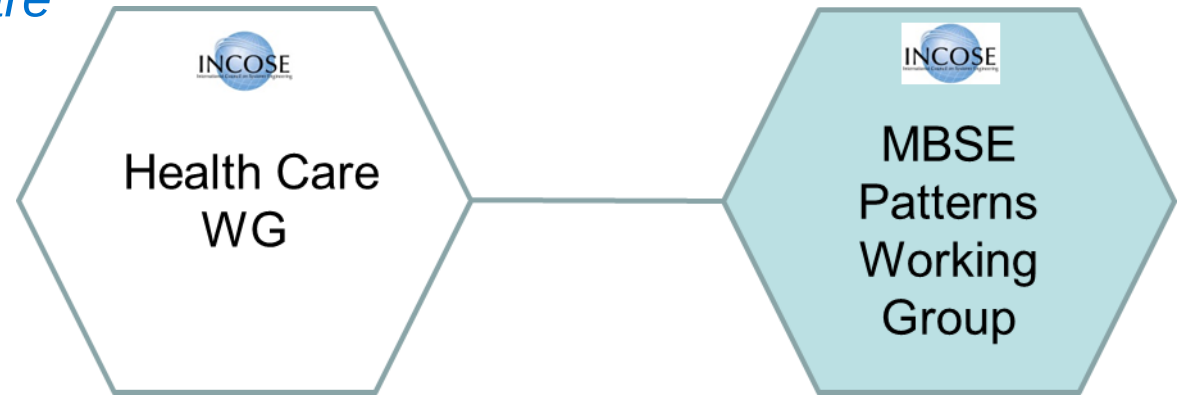
Panel Series: Patterns in the Public Square

From the INCOSE ASELCM Pattern



Working Group Partners in Progress

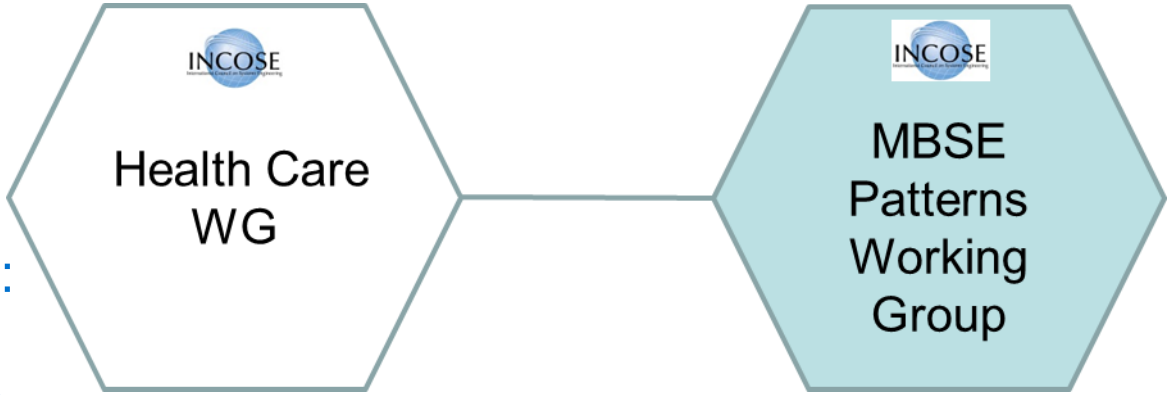
Primary Contact:
Chris Unger,
GE Health Care



Supporting the INCOSE Agile Health Care Systems Conference (third year) & the Health Care version of ASELCM Pattern

With Health Care WG: Joint Activity Materials

- Supporting the INCOSE Agile Health Care Systems Conference (third year) & the Health Care version of ASELCM Pattern



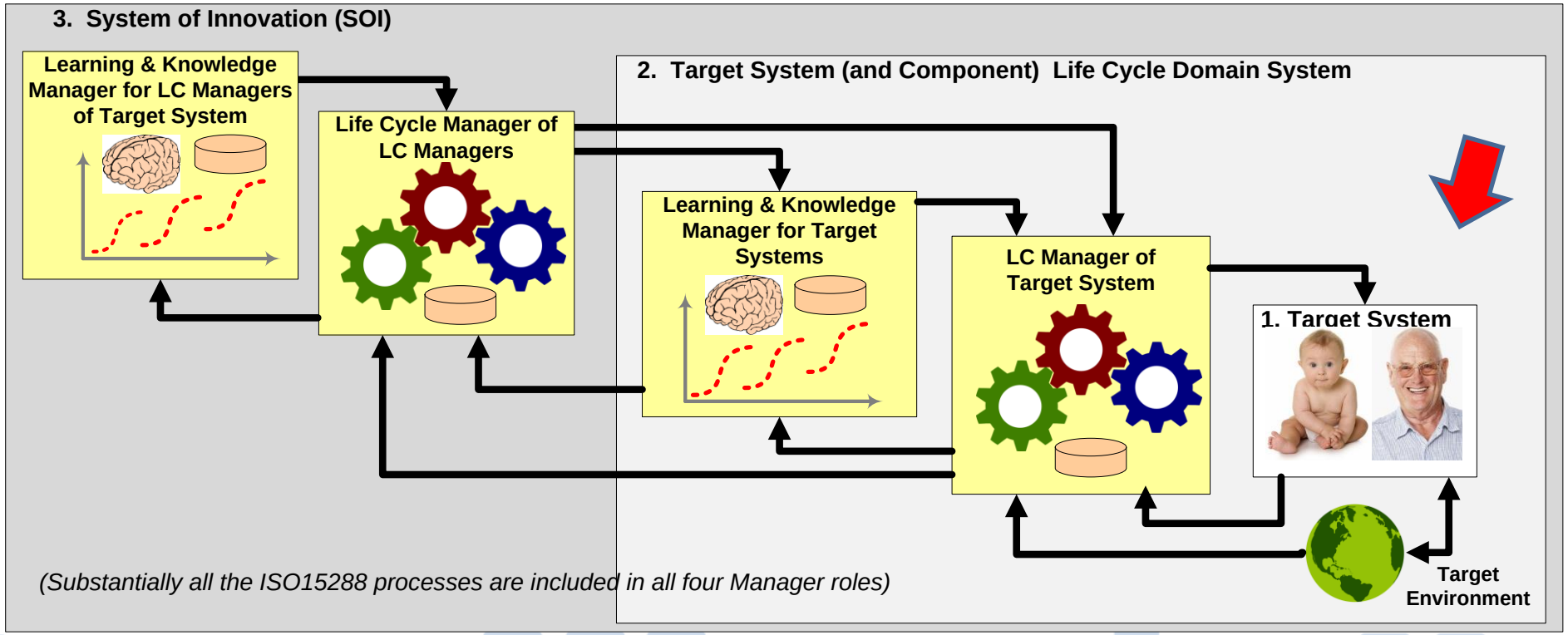
Primary Contact:
Chris Unger,
GE Health Care

Health Care WG Collab: Jul 2019 Status

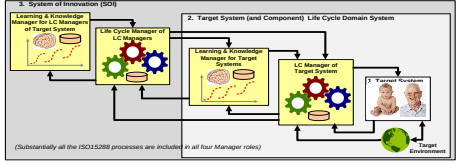
- Supported 2016, 2017, 2018 HC Conference, including ASELCM Pattern application to a HC Industry SOI Pattern:
  - Resulted in identification of a collection of S3 and S2 issues and opportunities, including a key observation about missing gateway
  - Will participate in an “after PCAST Report” session at the IISE conference in February, 2018, to pursue this further
- Approaching generic Medical Device Pattern Uncertainty Quantification Framework, model-based on ASME VV40:
  - Workshop at FDA held Oct, 2018
- Dr. Tina Morrison, FDA, and Chair of ASME Model V&V Committee, participated in our invited panel at IS2018, “Patterns in the Public Square”.

2016 Agile Health Care Systems Conference

- One session and break out group addressed the application of the ASELCM Pattern to assessing agility opportunities in the Health Care Domain:



Results of that 2016 break out group use of ASELCM Pattern:



Sticky Dots
- Needs for improved future agility (even if most difficult)
- Opportunities for improved future agility (low-hanging fruit)
- Already accomplished examples of improved agility progress (e.g., defense theater medicine, device software, etc.)

Sticky note: In the domain model, identify potential corrections or improvements to the model

3. Health Care System of Innovation (SOI)

Learning & Knowledge Manager for Health Care Delivery Systems
Pattern Repository, Describing Knowledge of Families of:
Health Care Delivery System

Provides Knowledge to

Life Cycle Manager of Health Care Delivery System
Configured Models Repository, Describing Configured Instances of:
Health Care Delivery System

Provides Observations to

Manages Life Cycle of

2. Patient Health Life Cycle Domain System

Learning & Knowledge Manager for Target Systems (and Components)
(substantially all ISO15288 processes)
Pattern Repository, Describing Knowledge of Families of:
Patient
Patient Environment
Patient Component

Provides Knowledge to

Health Care Delivery System
(Health Care equivalents of Agile (extended) ISO15288 Model, including HC equivalents of Performance, Fault, Configuration, Accounting, and Security Management Processes)
Configured Models Repository, Describing Configured Instances of:
Patient
Patient Environment
Patient Component

Provides Observations to

Observes

Manages Life Cycle of

1. Target System
Patient
Patient Subsystem
Patient Environment

Pharma Molecule Database
Health Care Research Web Site
Crowd-Sourced Health Care Web Site
Health Care Expert
Code of Federal Regulations & Guidances

Best Medical Practices Database
Evidence-Based Medicine Repository
Contract Research Organization (CRO)

Practice Management System Supplier
Medical School
Nursing School
Teaching Hospital
Health Care Organizational Change Consultant
Medical Practice Consultant
Health Care Delivery Holding Company
Health Care Systems Engineering, Fabrication, Construction & Installation
Provider Insurer
Health Care Certification Agent

Health Care Delivery Investor
Pharmaceutical Supplier
Medical Devices and Equipment Supplier
Orthopedics Manufacturer
Medical Information Technologies Supplier
Contractual Medical Trials Business
Contractual Medical Products Developer
Contract Medical Manufacturer
Health Care Systems Maintenance & Support
Health Care Regulator
Health Care Licenser
Medical Products Marketing
Health Care Policy

More Specialties or Types of Individuals That Are Involved
Life Scientist
Medical Journal
Life Sciences Textbook
Personal Genetics Is Limited
Genetics Database
Life Sciences Repository

Caregiver
HC Education Service
Health Care Payer
Insuring Employer
Insuring Family
Business Office
Facilities and Infrastructure
HR Role
Health Services Marketing
Safety, Quality Assurance
Pharmacy Benefit Management
Health Care Plan It Should Be ISO 15288
Episodic Care Does It Follow ISO 15288
Decision Support

Health Care Organization
Health Care Practitioner
Medical Record System
Diagnostic Service System
Care Plan Development
Therapeutic Service System
Pharmacy
Transcription Service System
Coding Process
Health Care Equipment
Medical Device
Drugs CFR312 Biologics
Outcomes Analyses
Patient Interface to Health Care (including insurance)

Hospital
Private Practice
Clinic

Home Environment
Occupational Environment
School Environment
Extracurricular Environment

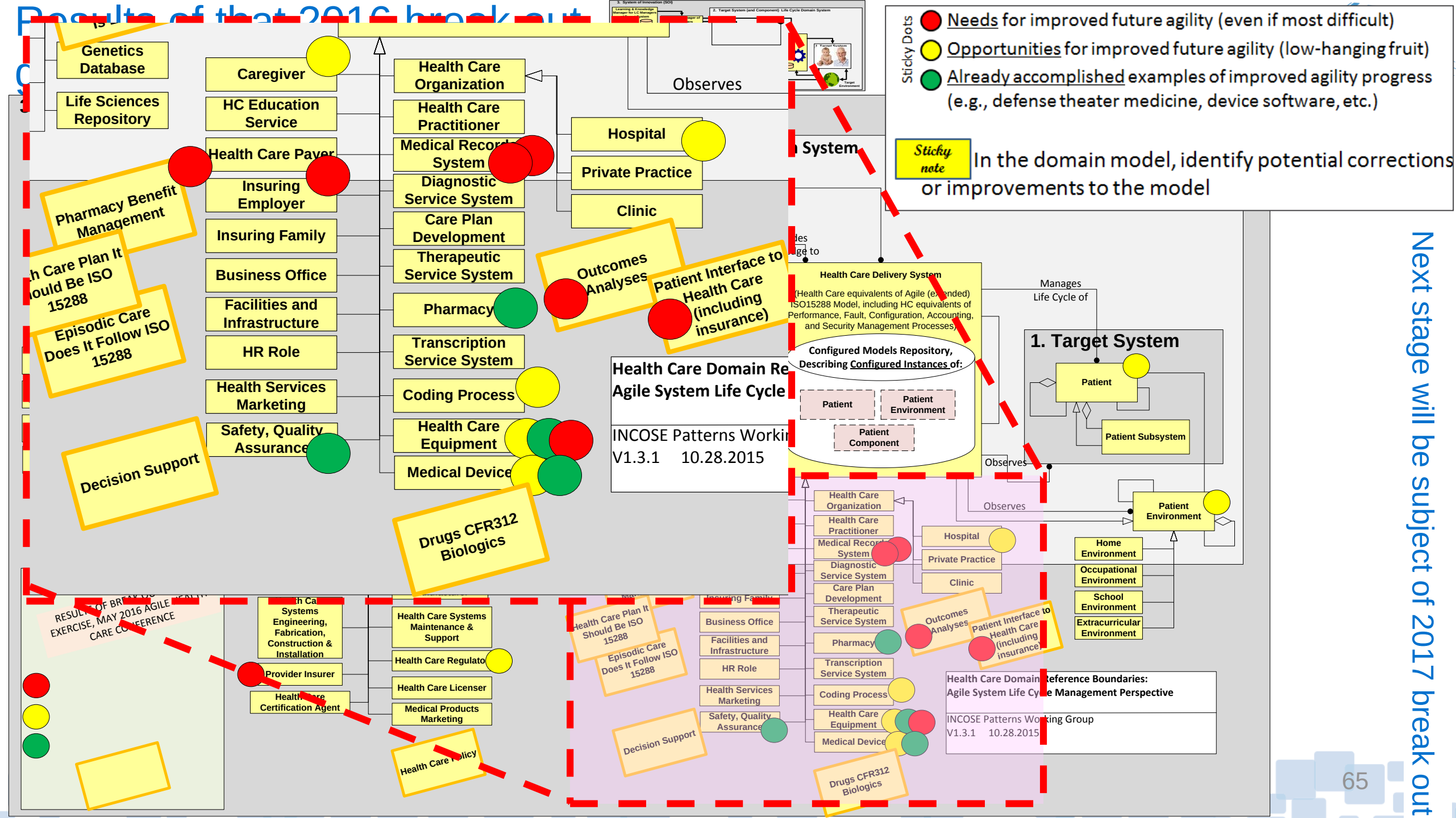
RESULTS OF BREAK OUT GROUP EXERCISE, MAY 2016 AGILE HEALTH CARE CONFERENCE

Health Care Domain Reference Boundaries: Agile System Life Cycle Management Perspective

INCOSE Patterns Working Group
V1.3.1 10.28.2015

Next stage will be subject of 2017 break out

Results of that 2016 break-out



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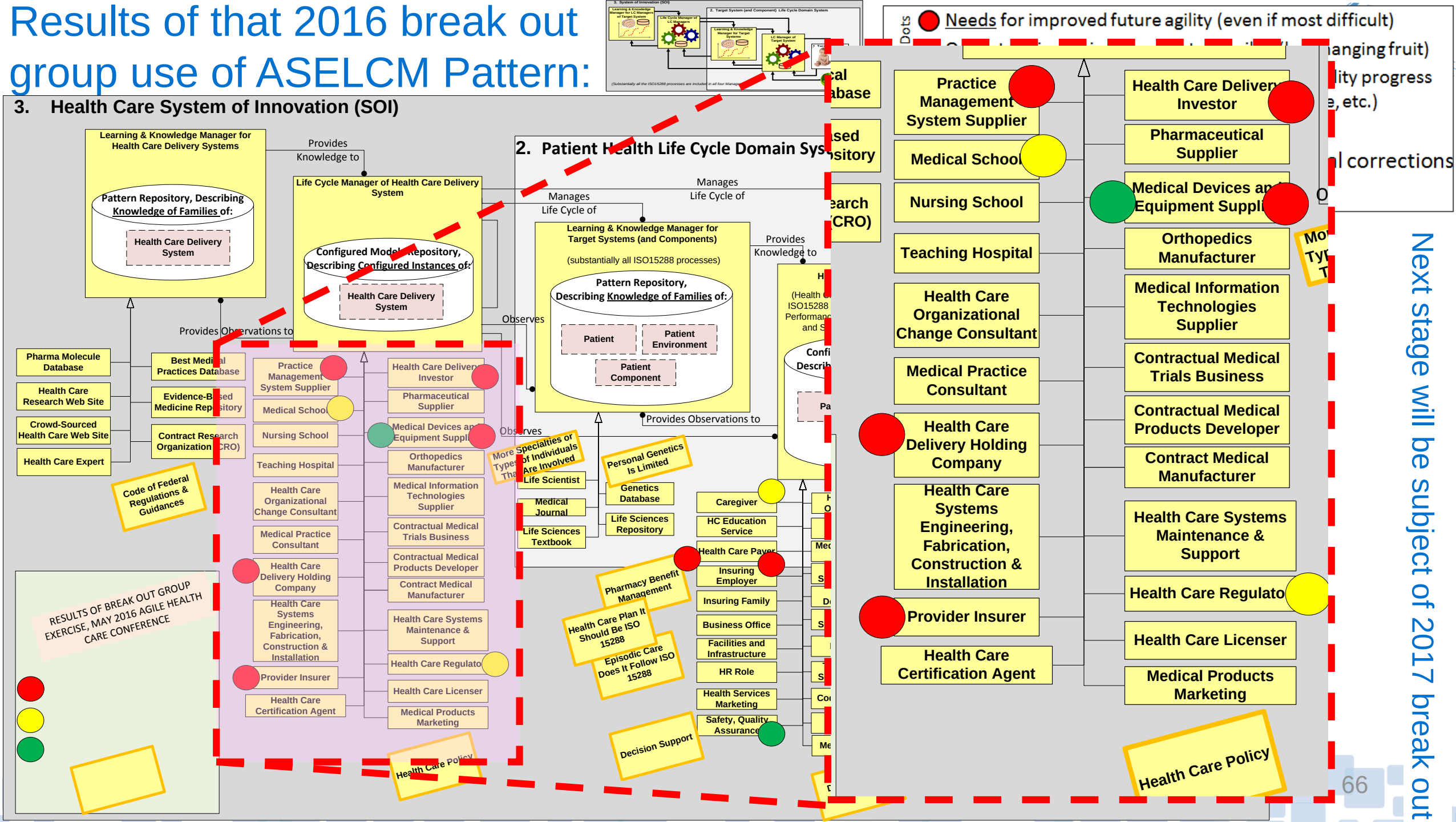
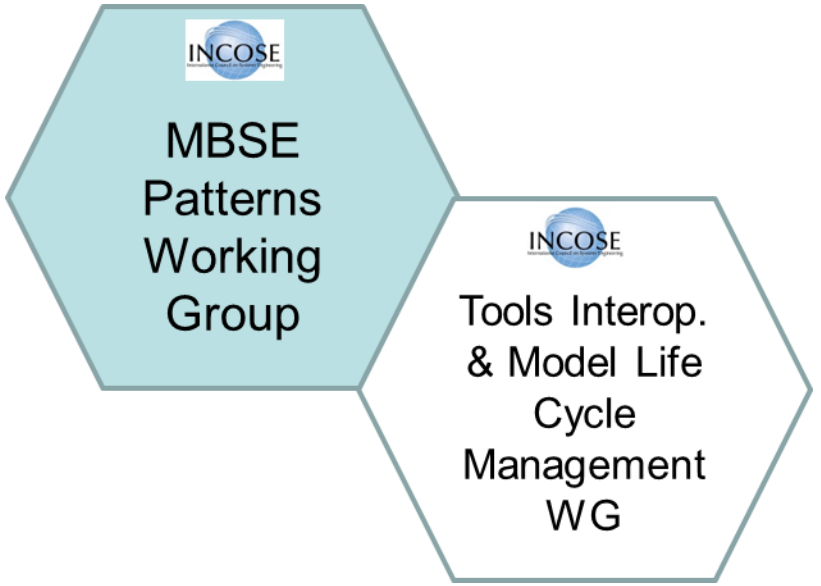
Results of that 2016 break out group use of ASELCM Pattern:



Working Group Partners in Progress

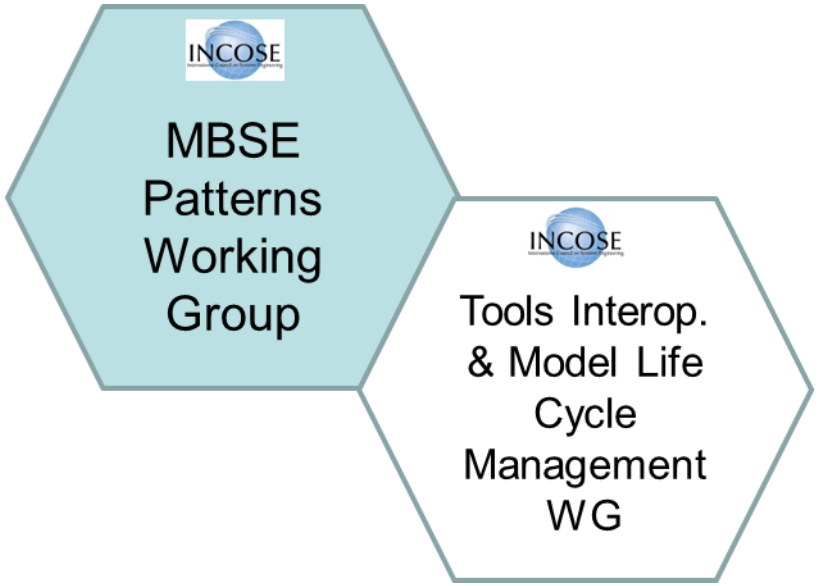


Primary Contact:
Lonnie VanZandt,
John Nallon

Patterns of collaboration in future innovation ecosystems, including illustrative content

With Tools Interoperability & Model Life Cycle Management WG: Joint Activity

- Patterns of collaboration in future innovation ecosystems, including illustrative content

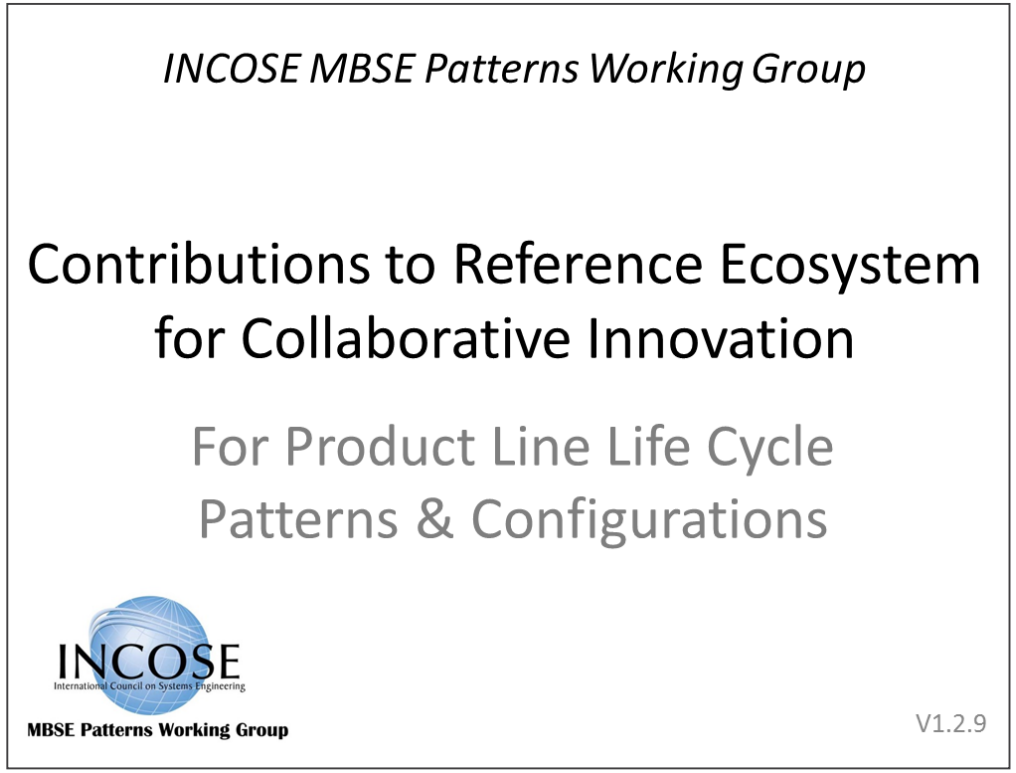


Primary Contact:
Lonnie VanZandt, Sodius

TIMLM Patterns Project: Jan 2018 Status

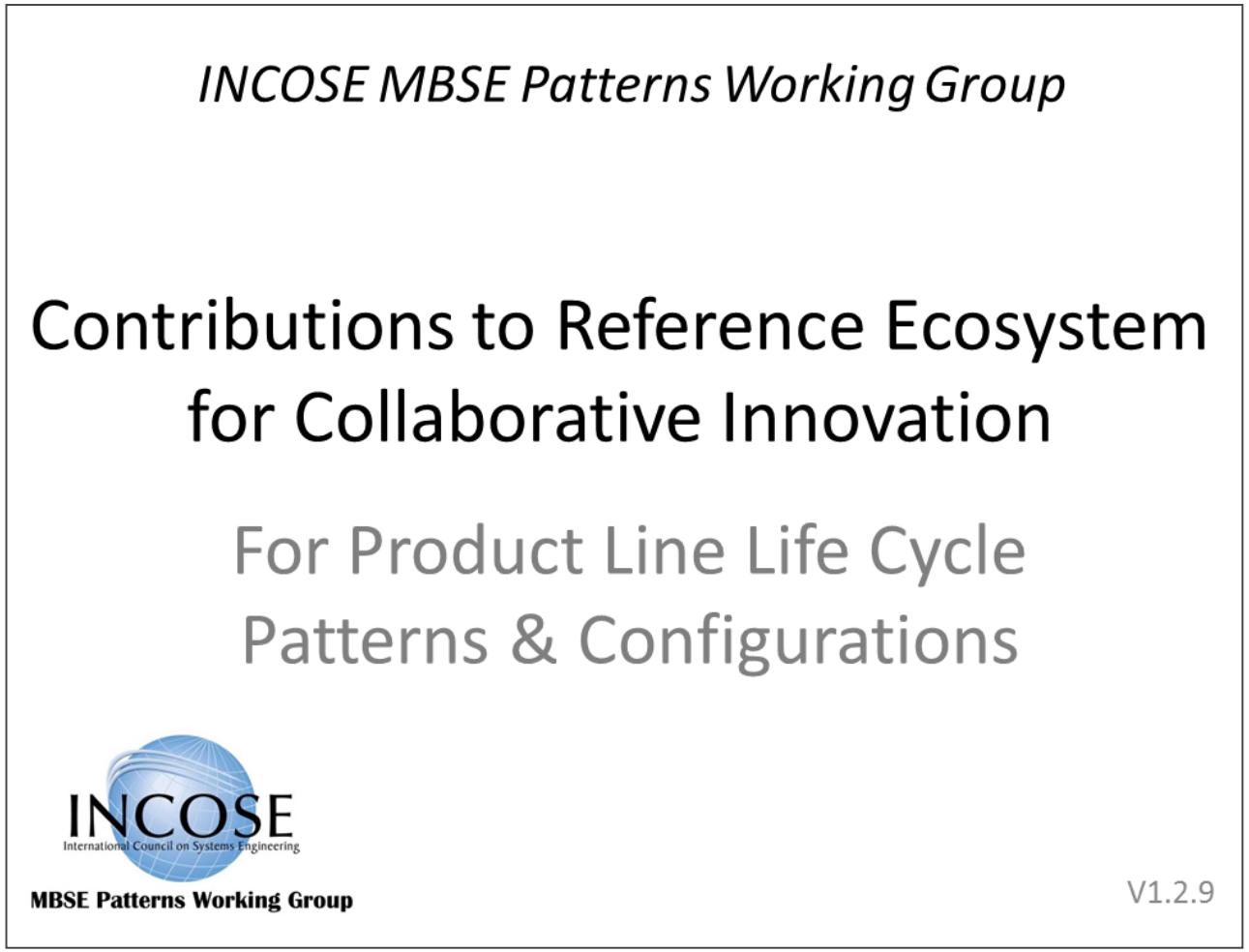
- Model Life Cycle Management:
  - Joined ASME VV50 Standards Committee, Model Life Cycle Working Group, in 2016
  - NIST, DOE, Boeing, ICTT System Sciences, Bosch, GE, others working on a model-based framework describing the life cycle management of models, with special emphasis on gaining and maintaining the credibility (VVUQ) of models over their life.
  - Part of this is also a model planning framework INCOSE beta product of the Patterns WG and INCOSE MBSE Transformation
- Mapping to COTS-based toolchain:
  - Demonstrated mapping of the underlying S*Metamodel underlying all S*MBSE Patterns to multiple third party COTS toolsets, including multiple SysML modeling tools, multiple PLM systems, engineering Requirements Management toolsets, etc. (steady flow of additions)
  - Part of the overall S*Patterns Reference Landscape for managing public, private, and hybrid IP

With Tools Interoperability & Model Life Cycle Management WG: Joint Activity



- More WG and other partners to be added.

Project 2: Demonstration Collaborative Innovation Ecosystem, for Product Line Life Cycle Patterns & Configurations



Project Objectives

1. Specify, construct, and demonstrate a reference ecosystem of product life cycle tools, processes, and example content . . .
2. Illustrating a vision (or set of visions) of future approaches to collaboration between people and information systems, integrated across the ISO15288 system life cycle processes . . .
3. Leveraging the concepts of sound systems engineering, model-based representations and patterns, product line engineering, and agility in the face of risk, variability, and uncertainty . . .
4. Integrating the work and resources of multiple INCOSE Working Groups in related areas . . .
5. By providing this point of reference, accelerating the Model-Based Transformation described by INCOSE Vision 2025 and encouraged by the INCOSE Board of Directors adopted strategic objective.

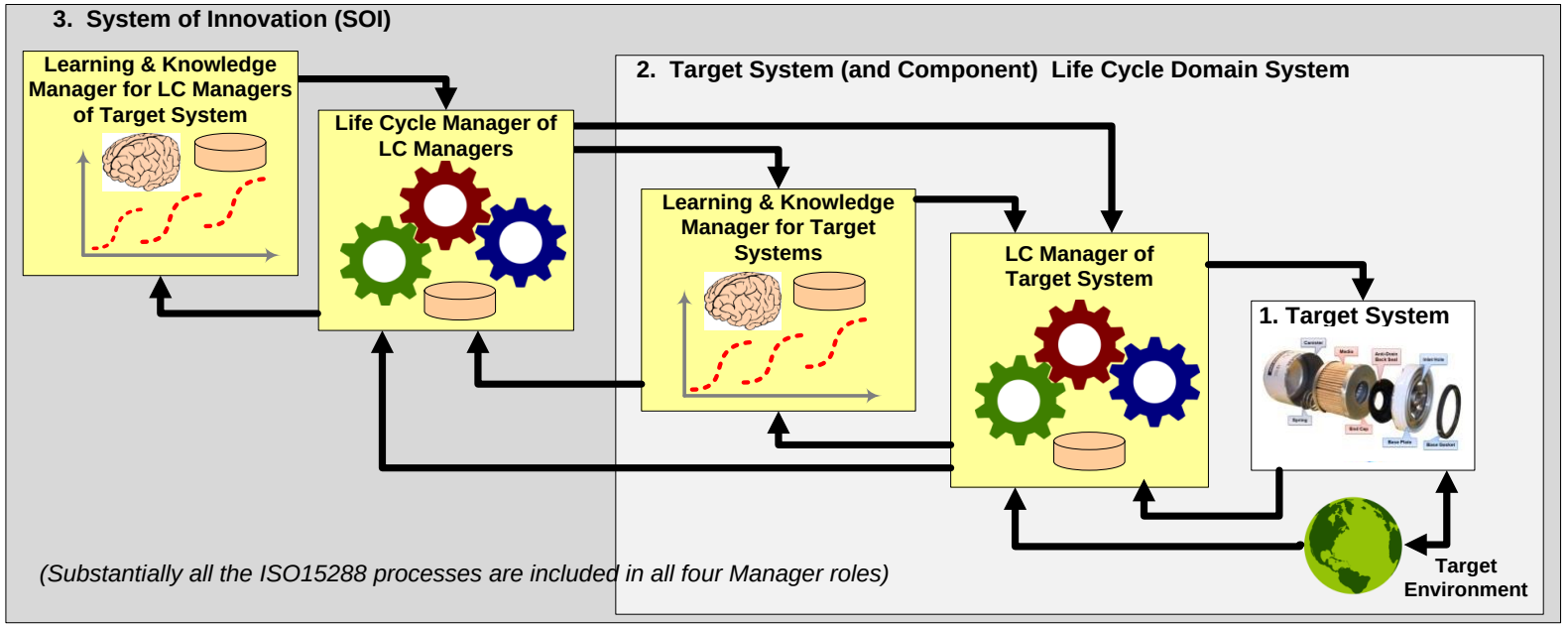
Working Groups Involved

- MBSE Patterns Working Group
- Product Line Engineering Working Group
- Tools Interoperability and Model Life Cycle Management Working Group

(*) Discussed by these three WGs at INCOSE IS2019.

Patterns Working Group Contributions to this Project

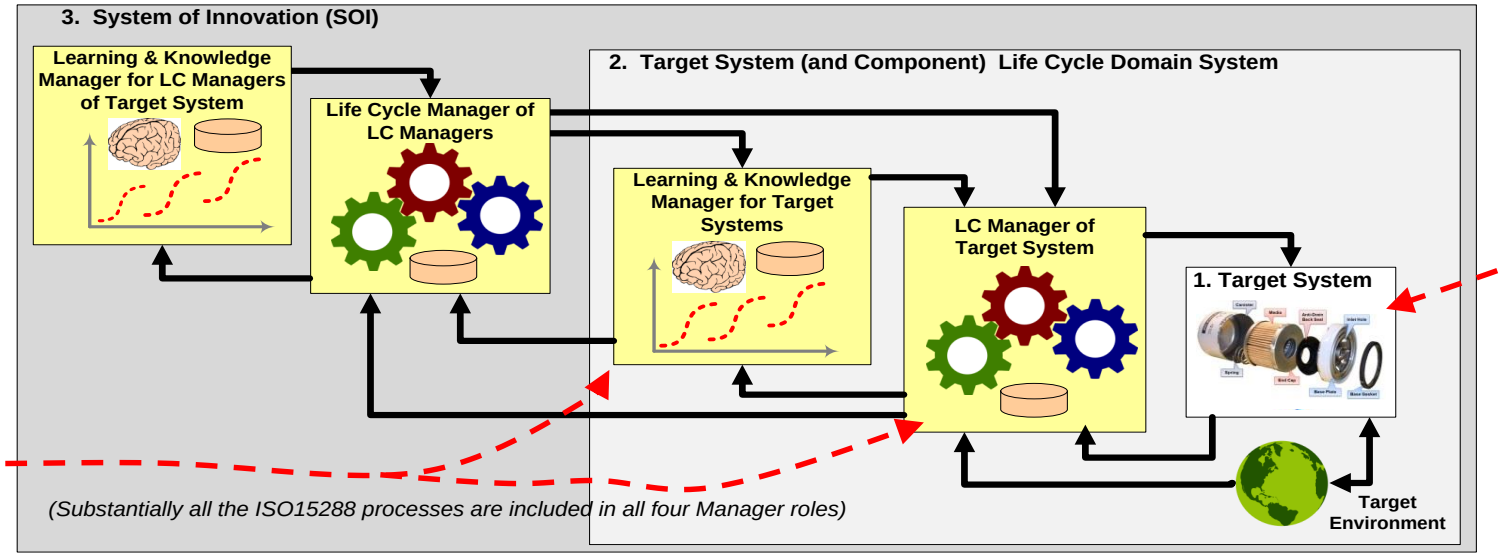
- ASELCM System 1 Patterns: S*Pattern-based representation of engineered systems, over their life cycle, including product line patterns and specific configurations thereof. (This is system 2 work.)
- ASELCM System 2 Patterns: S*Pattern-based representation of the systemic patterns of (human, machine) activity characterizing System 2 collaboration over System 1 life cycles; including general patterns and specific configurations thereof. (This is System 3 work.)



ASELCM Pattern

Patterns Working Group Contributions to this Project

- ASELCM System 1 Patterns: S*Pattern-based representation of engineered systems, over their life cycle, including product line patterns and specific configurations thereof. (This is system 2 work.)
- ASELCM System 2 Patterns: S*Pattern-based representation of the systemic patterns of (human, machine) activity characterizing System 2 collaboration over System 1 life cycles; including general patterns and specific configurations thereof. (This is System 3 work.)



ASELCM Pattern

We expect this project will involve contributions of ideas, effort, or otherwise from multiple external sources

- Currently in very early stage, using ideas, products, information, effort from the following, with more expected to get involved over time . . .

More to follow, especially to cover ISO15288 Life Cycle Processes

System 1 Model Content

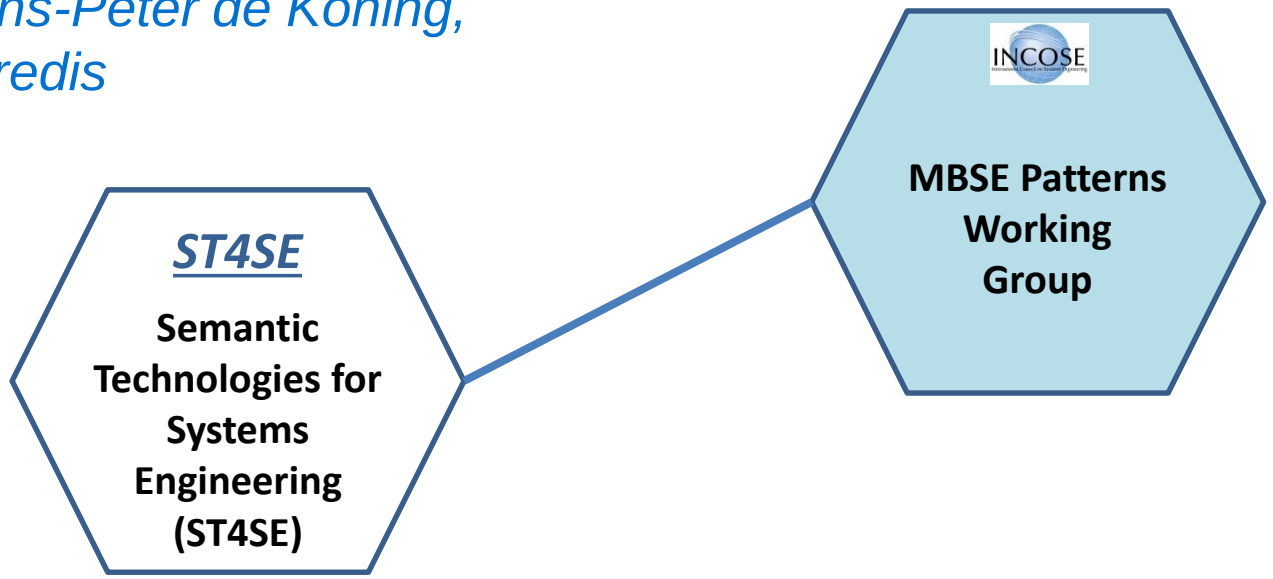
- Product Line Model S*Pattern—for Oil Filter Family Product Line:
  - And product configurations thereof, over their life cycles
- Related Manufacturing System S*Pattern—for Oil Filter Manufacturing Platform Product Line:
  - And system configurations thereof, over their life cycles
- Represented as S*Patterns and S*Models, in multiple COTS tools for model authoring, analysis, simulation, configuration management, and otherwise.

Preliminary System 1 Example Data

- Oil Filter S*Pattern:
  - Descriptive product line document samples
  - Modeled in multiple SysML modeling tools
  - Integrated with configuration agent capabilities, for creating configured S*Models from S*Patterns
- S*Examples of the above, in progress so far:
  - Magic Draw/CSM + Big Lever Gears
  - Enterprise Architect + Reference Configuration Agent
  - Other types of tools and information systems to follow

Working Group Partners in Progress

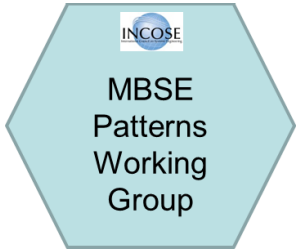
Primary Contacts:
Ph 1: Jon Torok, Frank Salvatore;
Ph 2: Steve Jenkins, Hans-Peter de Koning, Chris Paredis



Interface Patterns Content Project (Ph 1) + Semantic Technologies for Systems Engineering Project (Ph 2)

Ph 1 WG Project Team:
Jon Torok, Frank Salvatore, Jason Sherey, Stephen Lewis

Ph 2 WG Project Team:
Steve Jenkins, Hans-Peter de Koning, Bill Schindel, Chris Paredis



Interface Patterns Project: July 2019 Status

- Identified relevant subset of S*Metamodel providing a basis for S*Interface Patterns
- Have identified and framed a few interface types for initial attention, as configurable S*Interface Patterns (including initial use in ST4SE work)
- Reviewed related draft SysML 2.0 and JPL publications, and provided formal written feedback to SysML 2.0—in particular, on Interfaces, where some SysML updates are noted in direction of S*Interface metamodel.
- Gained agreement by Phase 2 (ST4SE) Team on same shared view of minimal Interface semantics.
- Team has agreed to target this and targeted this pattern for initial 2019 release.
- Begun encoding same Interface Pattern in OWL DL using Protégé tooling, for use in ST4SE phase (2) of project.
- In TPP discussion with INCOSE on whether to make INCOSE copyright owner on the open access basis sought by the team.

Current project example: Interface Patterns Project

INCOSE MBSE Patterns Working Group

Project Charter

1 Project Name:

The name of the project is the MBSE Interface Patterns Project.

2 Project Objectives and Summary:

The objectives of project are to:

1) Improve shared knowledge and more effective life cycle engineering of Interface-related aspects of systems, through the definition and use of Interface-related MBSE Patterns.
2) Make available S*Patterns related to Interfaces, expressing common configurable modeled aspects of systems, at different levels of abstraction:
    a. Most abstract: The S*Interface Pattern for all interfaces (S*Metamodel level)
    b. Domain specific or technology specific S*Interface Patterns
    c. Organized into a library illustrating the propagation upward and downward of modeled aspects at different levels of abstraction/specificity
    d. Suitable for use and support of targeted life cycle tasks (e.g., generation of Interface Control Documents, etc.)
    e. Suitable as guiding examples for other domains or technologies not directly addressed
3) Consistent with the Patterns Working Group precepts of:
    a. Seeking the simplest model representations necessary for practical use in targeted domains, having differing demand levels and expectations
    b. Maintaining portability and mappings across different modeling languages, tools, and information systems, as these continue to mature and evolve, and demonstrating that capability
    c. MBSE Patterns must be PBSE configurable for specific instances
    d. Interface Patterns should connect to the larger System Pattern representation that is the scope of the Patterns Working Group
4) Informed by the history of interface engineering across domains, the perceived current and future needs and priorities of the engineering community, and related efforts underway across different INCOSE and external working groups, standards bodies, trade groups, enterprises and institutions, and other communities of interest.

3 Project Deliverables:

1) General S*Interface Pattern (S*Metamodel level)
2) Targeted domain specific or technology specific S*Interface Patterns, to be identified
3) Library organization of these patterns, based large scale pattern structures to be explored
4) Demonstrations on targeted toolsets, modeling languages, and information systems, including generation of targeted priority views, documents, or extracts useful in the system life cycle
5) Joint deliverables with other working group projects (e.g., the Innovation Collaboration Ecology Demonstration Project)
6) Specific interface examples and teaching or educational materials.
7) Means of access to the Deliverables.

4 Project Team:

Jonathan Torok, NSWC Crane, jonathan.torok@navy.mil
Frank Desalvo, Engility Corp., Frank.Salvatore@engilitycorp.com
Jason Sherey, ICTT System Sciences, sherey@ictt.com
Bill Schindel, ICTT System Sciences, schindel@ictt.com

5 Project Schedule:

Schedule, including meetings, milestones, and overall is to be determined by the team. It is suggested that key milestones include INCOSE IS and IW events, along with regular periodic meetings and deliverables.

6 Project References:

Project web site:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:interface_patterns_team#interface_patterns_team

See other references listed on the project web site.

Current project example: Interface Patterns Project

INCOSE MBSE Patterns Working Group

4) Informed by the history of interface engineering across domains, the perceived current and future needs and priorities of the engineering community, and related efforts underway across different INCOSE and external working groups, standards bodies, trade groups, enterprises and institutions, and other communities of interest.

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3 Project Deliverables:

1) General S* Interface Pattern (S*Metamodel level)

Jonathan Torok, NSWC Crane, jonathan.torok@navy.mil
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6 Project References:

Project web site:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:interface_patterns_team#interface_patterns_team

See other references listed on the project web site.

We are interoperating with the OMG SysML 2.0 effort, among others

Current project example: Interface Patterns Project

Project Workstreams:

1. Identify interface aspects of the S*Metamodel (the most abstract interface pattern)
2. Create library of interface patterns of different types (specializations of 1) showing techniques in mechanical, communication, visual, etc.
3. Identify queries and views that are interface-based (e.g., ICD, etc.), what metadata should appear in each of these.
4. Identify interface-oriented tasks, activities in the engineering life cycle (the reasons we are doing this project)
5. Down the road, issues of governance of the resulting patterns, their life cycles
6. Tactical level tool specific items, not necessarily all interface-oriented, along with mappings to SysML or specific tools

Discussion of S*Interface System of Access (SOA) Semantics

Interface Patterns Project Meeting

06.30.2017

Purpose of Following Material

1. The purpose of this material is to define a question, and propose an answer to it, concerning the underlying nature and meaning of one aspect of Interfaces.
2. This subject is about the underlying nature of interfaces, and not about any specific modeling language or notation.
3. This discussion therefore uses some basic concepts from the S*Metamodel description of Interfaces, not specific to any modeling language, notation, etc.
4. If we agree on the question and answer proposed here, then a follow-up action would be to agree on how to map it into SysML representation.
5. Trying to answer (4) before (1) – (3) seems to lead to confusion of what are the underlying issues versus language-specific representation issues.

General Setting

- Consider two interacting systems, exchanging at least one Input-Output (e.g., a Force, Energy Flow, Mass Flow, or Information), during Interaction D:

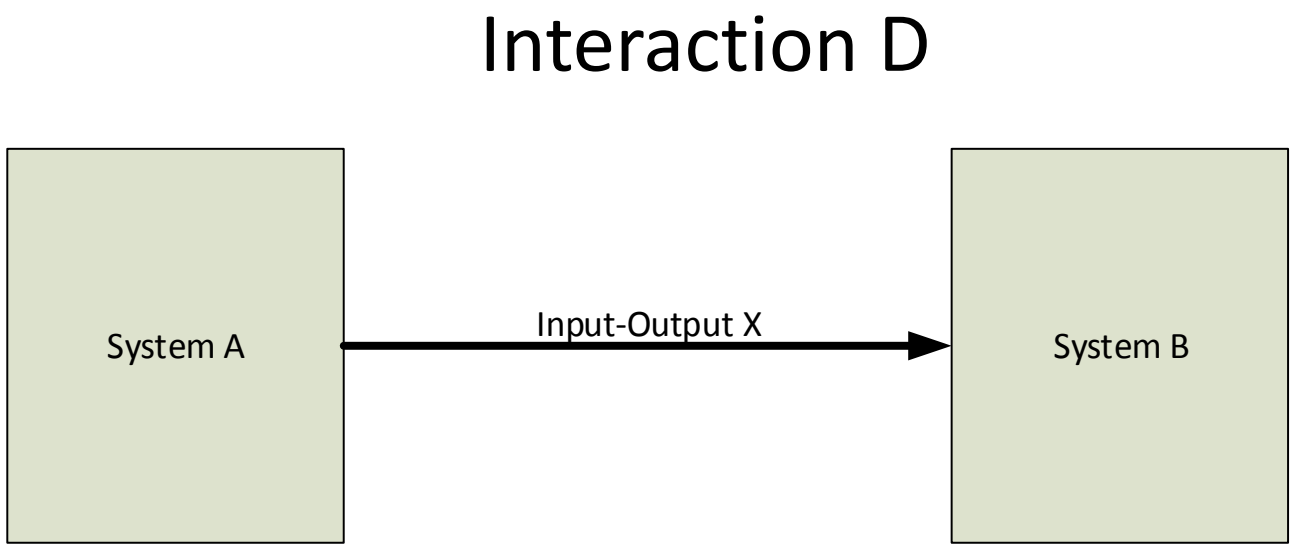


Figure 1: (Exact notation used not important to this discussion)

- In certain (important to identify) circumstances, we need to represent Interfaces involved in Interaction D.
- No matter what (graphical or other) modeling language or notation is used, the S*Metamodel tells us that an Interface is an association of:
  - A System, which “has” the Interface;
  - A (set of) Input-Output(s), which “pass through” the Interface;
  - A (set of) Interaction(s), which describe “behavior at the Interface;
  - A System of Access (SOA), providing the interaction “medium”:

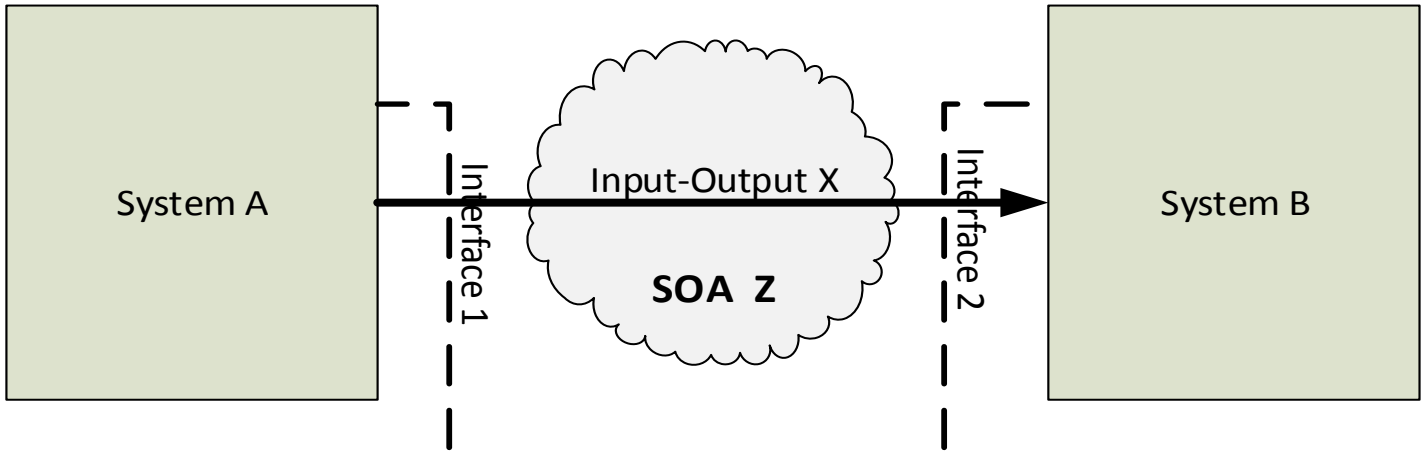


Figure 2: (Exact notation used not important to this discussion)

- However, there is a subtle inconsistency in the transition between Figure 1 and Figure 2 above:
  - Figure 1 and Figure 2 imply that the scope of “System A” must have changed between the two diagrams, . . .
  - Because, System A in Figure 2 can interact with an external-looking SOA Z, but . . . .
  - System A in Figure 1 implies that the scope of System A is such that it can interact directly with System B.

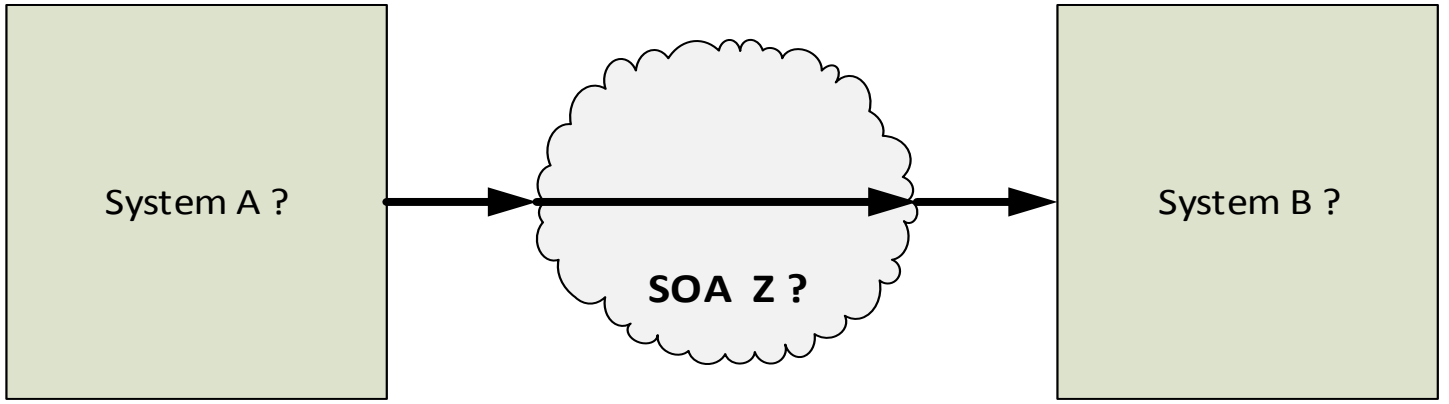


Figure 3: (Exact notation used not important to this discussion)

- The problem here is that even intended “neutral” notations can be specific enough to mislead us, or create ambiguities.
- The real problem is that, independent of notation, the System of Access by definition has larger scope than Figure 2 implied:

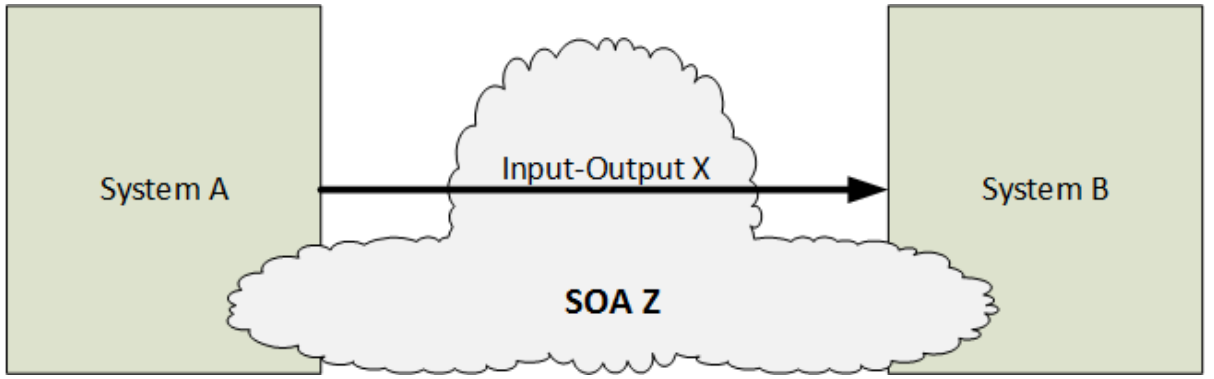


Figure 4: (Exact notation used not important to this discussion)

- Part of the scope of the System of Access for two interacting systems must necessarily be within the two interacting systems . . .

- So, to avoid conflicting or ambiguous definitions of the scope of System A, we have to recognize a slightly larger system, shown in Figure 5 as System A’
- The additional scope adds the SOA role shown here as SASOA:

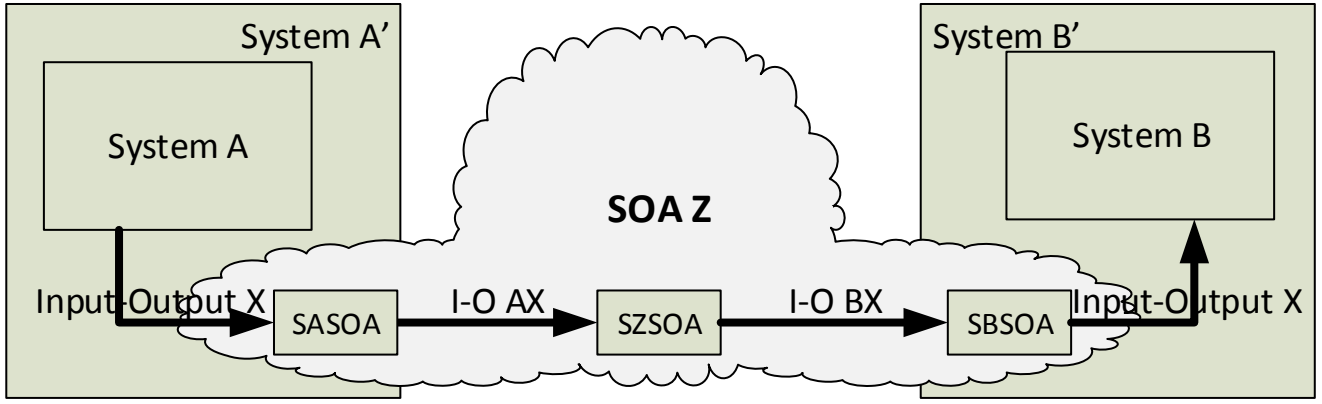


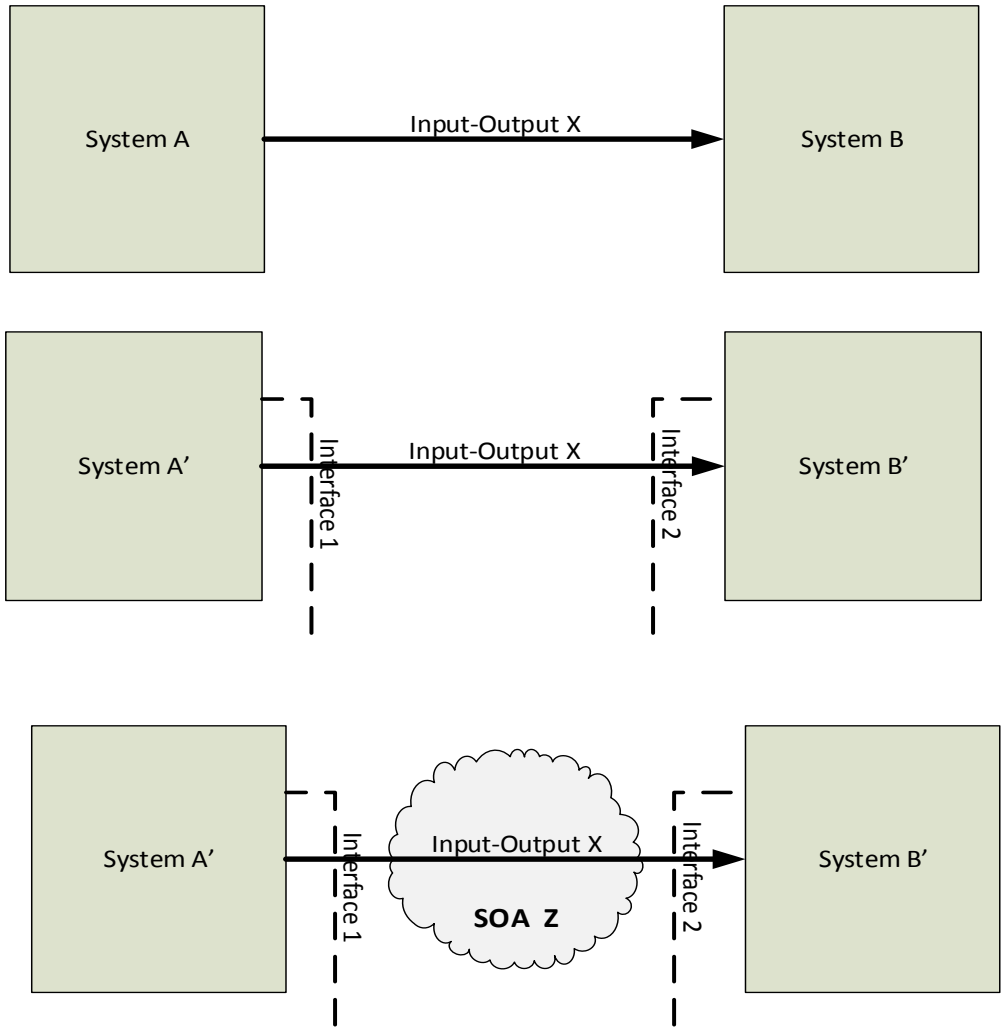
Figure 5: (Exact notation used not important to this discussion)

- The foregoing discussion simply reminds us that any system which we claim “has” an interface must include (inside it) the behavioral (SOA) role(s) necessary to support it (SASOA in Figure 5).
- And, if we model a system that “does not have” any interface (or does not have it “yet”), then we should not (later, or otherwise) see the same system boundary name and claim that it does have an interface—because the behavior boundary is different (System A versus System A’ in Figure 5.)

Implications for any Specific Language

- The above implies that, when we get ready to map to SysML or any specific modeling language/notation:
  - No matter what notation convention is used to show an Interface on a system boundary, applying it must mean that the named system includes the roles to support the interface; and . . .
  - When we show interacting systems that are not shown as having Interfaces, then those named system boundaries should not (even later in a design process) carry the same name as a system boundary that does have an interface.
- That is, System A is not System A':
  - System A' can show an Interface on its boundary (by whatever notational means is selected)
  - System A should not show any Interface on its boundary, but simply be shown as exchanging I/O with System B.

Valid Combinations



Not Valid Combinations

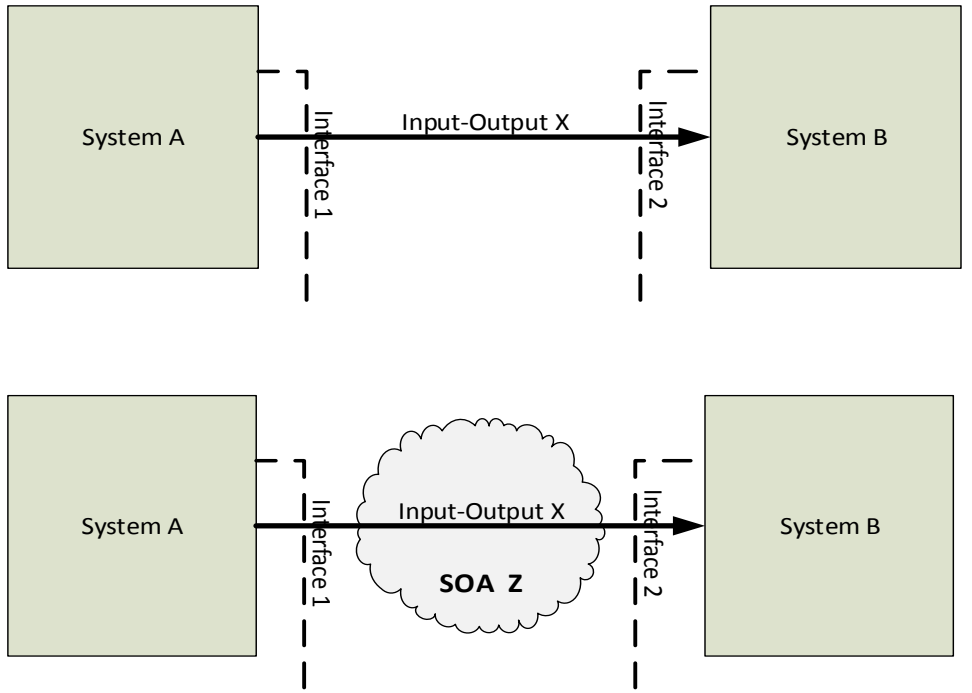
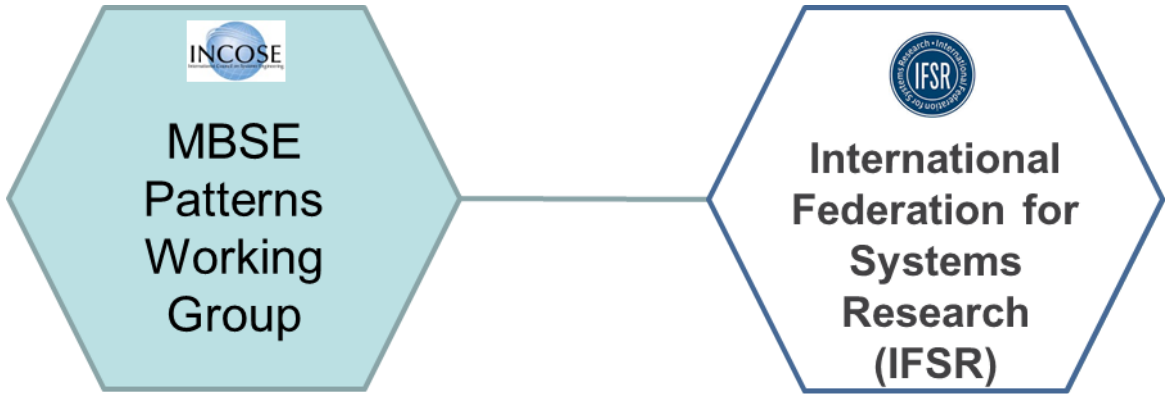


Figure 6: (Exact notation used not important to this discussion)

Working Group Partners in Progress



Primary Contact:
Ed Carroll, Sandia Laboratories

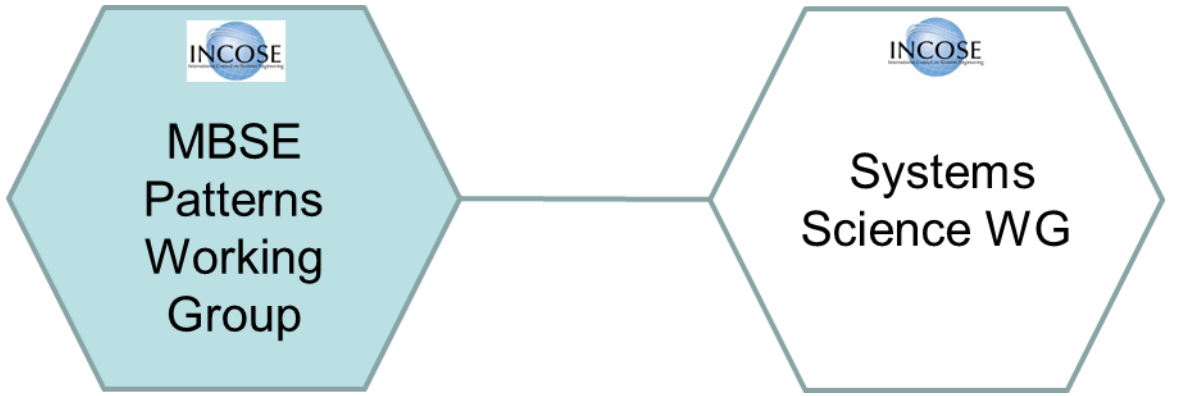
A stronger foundation for information in systems engineering practice.

IFSR 2018 Conversation, Linz, Austria

- Patterns WG participated in International Federation for Systems Research (IFSR) “Conversation” event April 13-18, 2018:
  - Organized by Ed Carroll, Sandia Laboratories
  - Seeking a stronger foundation for data-driven systems engineering
  - Very related to ASELCM Pattern, Model VVUQ Pattern, Systems Phenomenon Pattern
  - Based on results, the team published “MBE Manifesto”, exhibited at IS2018, Pentagon, other conferences—

http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:deix:mbe_manifesto_uur_final_180611b_.pdf

Working Group Partners in Progress



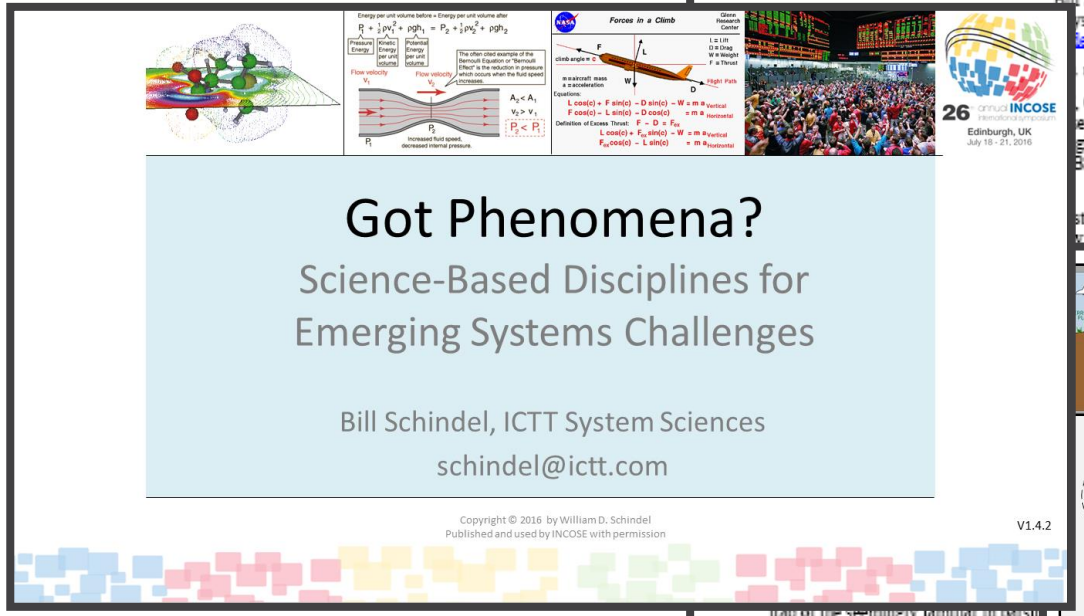
Primary Contacts:
James Martin,
David Rousseau

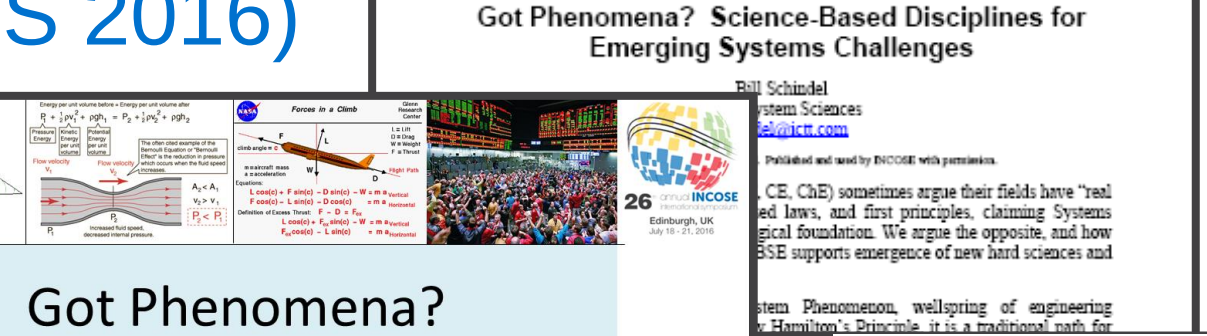
S*Interactions & S*Patterns as a basis for a hard science of systems, in support of stronger foundation for SE.

SSWG Collaboration Status Jul 2019

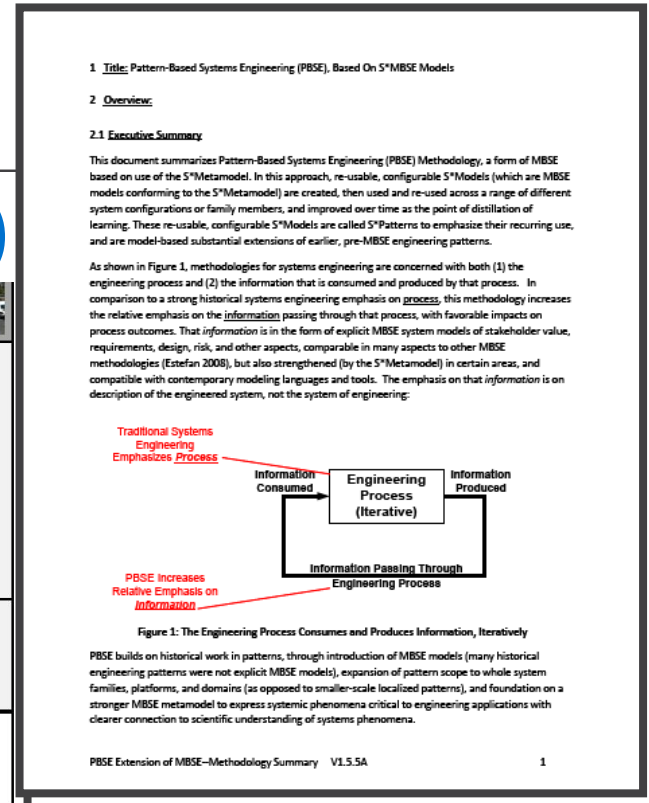
- Presented invited session to IW2018 SSWG, on System Phenomenon Pattern as the existing basis for the domain-specific hard sciences (mechanics, chemistry, et al)
  - Related INCOSE paper publication on System Phenomenon, IS2017.
  - Related INCOSE Fellows session at IS2019.
- Summary: Some systems people seem to be asserting there is a wonderful theory of systems not yet discovered. We assert that there is a wonderful theory of systems already discovered by the pioneers of physical sciences and mathematics, but it is being overlooked by some of the systems community.
- Using well-established existing frameworks from Hamilton (principle of stationary action, leading to fundamental equations at root of each physical science discipline), Noether (previous follows from symmetries, leading to conservation laws and emergent parameters), and later contributors.
- To participate in Oct, 2019, INCOSE EMEA System Summit and FuSE Session there.

Pres1 (IS 2016)

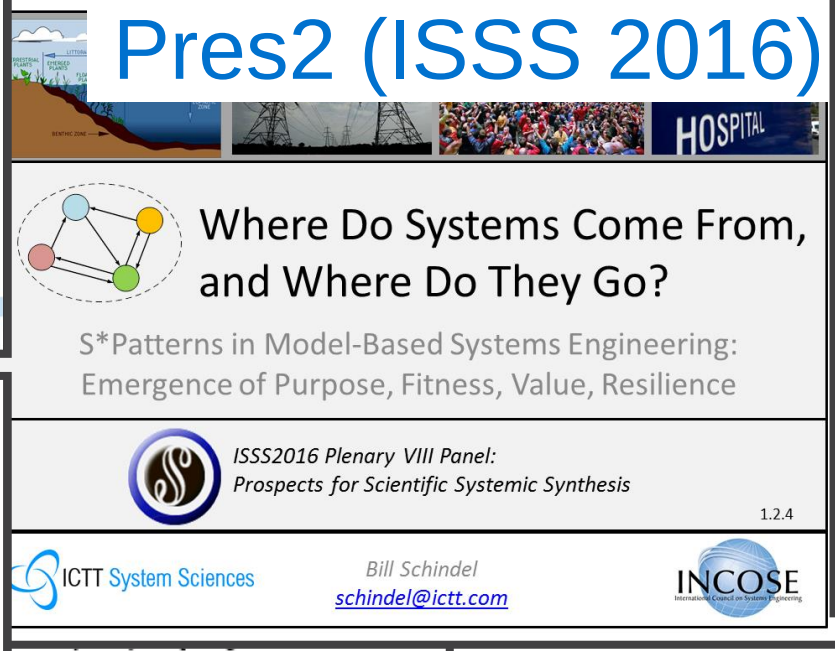




Doc 4 (2015)



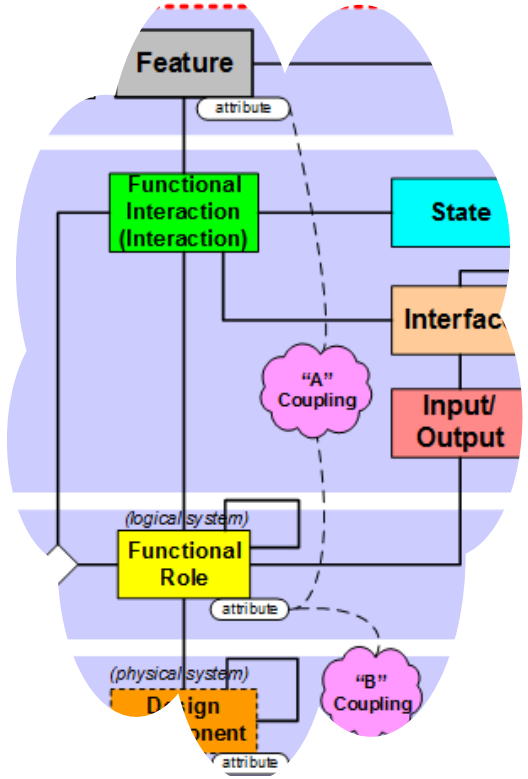
Pres2 (ISSS 2016)



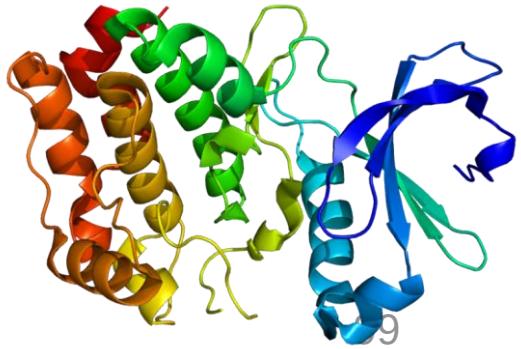
Pres3 (ISSS 2018)

Additional references:

Many additional references on Patterns WG web site:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns

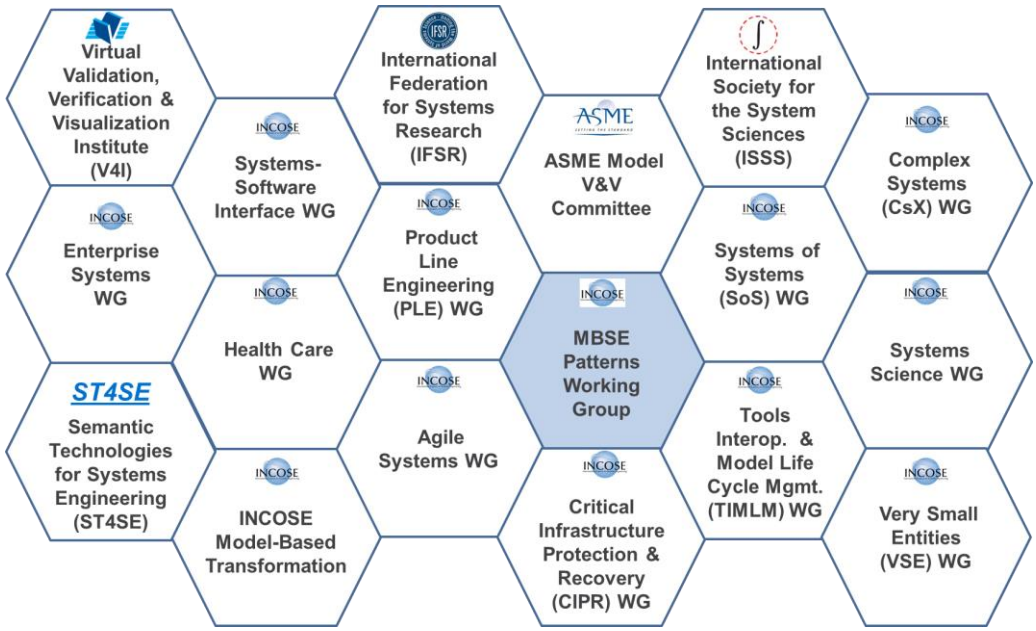


- Future Projects of Interest to Attendees:
  - Current and Future projects
  - PBSE Infrastructure
  - Open discussion



Patterns WG Planning and Support

- Future potential PWG Projects:
  - *Depends on your interest to work on them*
  - Existing interactions with partners
  - Others that our members have mentioned in the past:
    - Support for deliverables of the INCOSE MBSE Transformation Lead Team
    - Additional targeted system application domain patterns
    - Targeted science domain patterns
    - ISO 15288 Implications of PBSE
    - PBSE support for COTS Tools and Information Systems
    - Visualization
    - PBSE Implementation strategies & roadmaps, scenarios
    - PBSE contribution to SEBoK
- Interest in these or other projects
- Open Discussion



References

Mackinac, MI, 2016.

2. Schindel, W., and Dove, R., “Introduction to the Agile Systems Engineering Life Cycle MBSE Pattern”, in *Proc. of INCOSE 2016 International Symposium*, 2016.
3. Schindel, W., “What Is the Smallest Model of a System?”, in *Proc. of the INCOSE 2011 International Symposium*, International Council on Systems Engineering (2011).
4. INCOSE MBSE Initiative Patterns Working Group web site, at http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns
5. “Pattern-Based Systems Engineering (PBSE), Based On S*MBSE Models”, INCOSE PBSE Working Group, 2015: http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns_challenge_team_mtg_06.16.15
6. Schindel, W., “System Patterns: The System Phenomenon, Hamilton’s Principle, and Noether’s Theorem as a Basis for System Science”, in *Proc of 2018 Conference of International Societies of the System Sciences*, May, 2018.
7. Schindel, Morrison, Pellettiere, Donaldson, Peterson, Heller, Johnson, “Panel: Accelerating Innovation Effectiveness--Model-Facilitated Collaboration by Regulators, Technical Societies, Customers, and Suppliers”, in *Proc. of INCOSE 2018 International Symposium*, Washington, DC, July, 2018.
8. Schindel, Sanyal, Sherey, and Lewis, “Patterns Across the Enterprise”, in *Proc. of the INCOSE 2015 International Symposium*, Seattle, WA, 2015.
9. Schindel, W., “INCOSE Collaboration In an ASME-Led Standards Activity: Standardizing V&V of Models”, in *Proc. of INCOSE International Workshop*, Jacksonville, FL, Jan, 2018.

29th Annual INCOSE international symposium

Orlando, FL, USA

July 20 - 25, 2019