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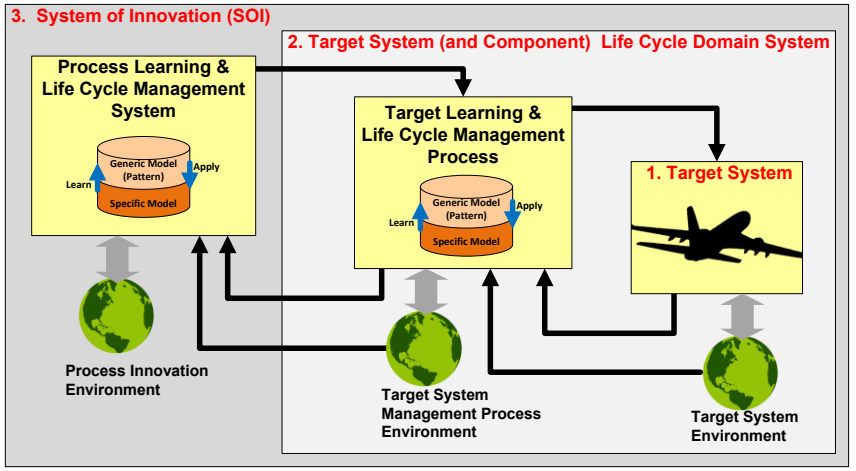
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  - includes company-specific names, logos, and homework pattern file names and locations

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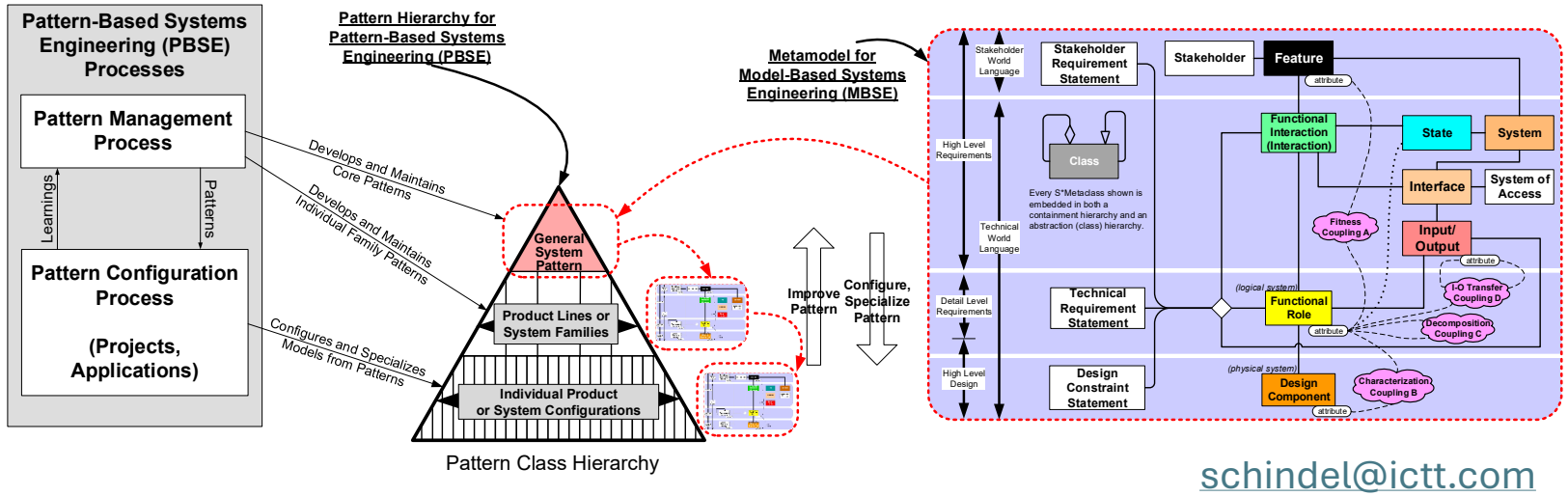
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Phase II Session 4

Introduction to S*Models, S*Metamodel, S*Patterns, Mappings to Languages & Tools, S*Configuration Wizard, ASELCM S*Pattern



Level 0 View, INCOSE ASELCM Pattern

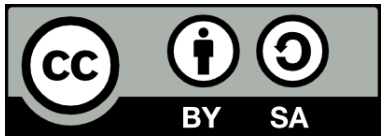


Pattern Class Hierarchy

schindel@ictt.com
lewis@ictt.com

V1.4.9

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Contents

- Summary of Previous Session
- Discussion of Homework from Previous Session
- Selecting Targeted Applications of the ASELCM Pattern
- Navigating Current ASELCM S*Pattern Configuration Rules of Interest
- Plans for What Comes Next in Project
- Homework Assignment

Phase II Class Sessions: Accountability, Macrostructure of Model-Based Ecosystem

- ASELCM Ecosystem S*Pattern: Nature, Intended Uses, Levels 0-4 Logical Arch
  - Session 1
- ASELCM Features, Interactions, Roles, Resources, Use in Consistency Mgmt., Configuration Stages, Accountability
  - Sessions 2-3
- Configurable ASELCM Pattern Implemented in OMG SysML
  - Session 4 

- Homework Presentation and Feedback
  - Distributed over above sessions

Recap of Previous Session: Take-aways impacting actual practices

What consistent practices seem possible *across this team*, *across different systems*, *customers*, and *projects*?

1. **Generic ASELCM Roles** for analyzing System 2, System 3.
2. **Generic ASELCM Design Components** for System 2, 3.
3. **Configuring System 2** ASELCM Models.
4. **Stages of ASELCM Configuration**, for Enterprises, Programs, Projects
5. **Ecosystem Analysis**, **Improvement**, and **Roadmap Planning**.



- Can a creative, talented team *align* its work?
- What should be *standard* about this, in your customer work?
- What should be *configurable* about this, in your customer work?



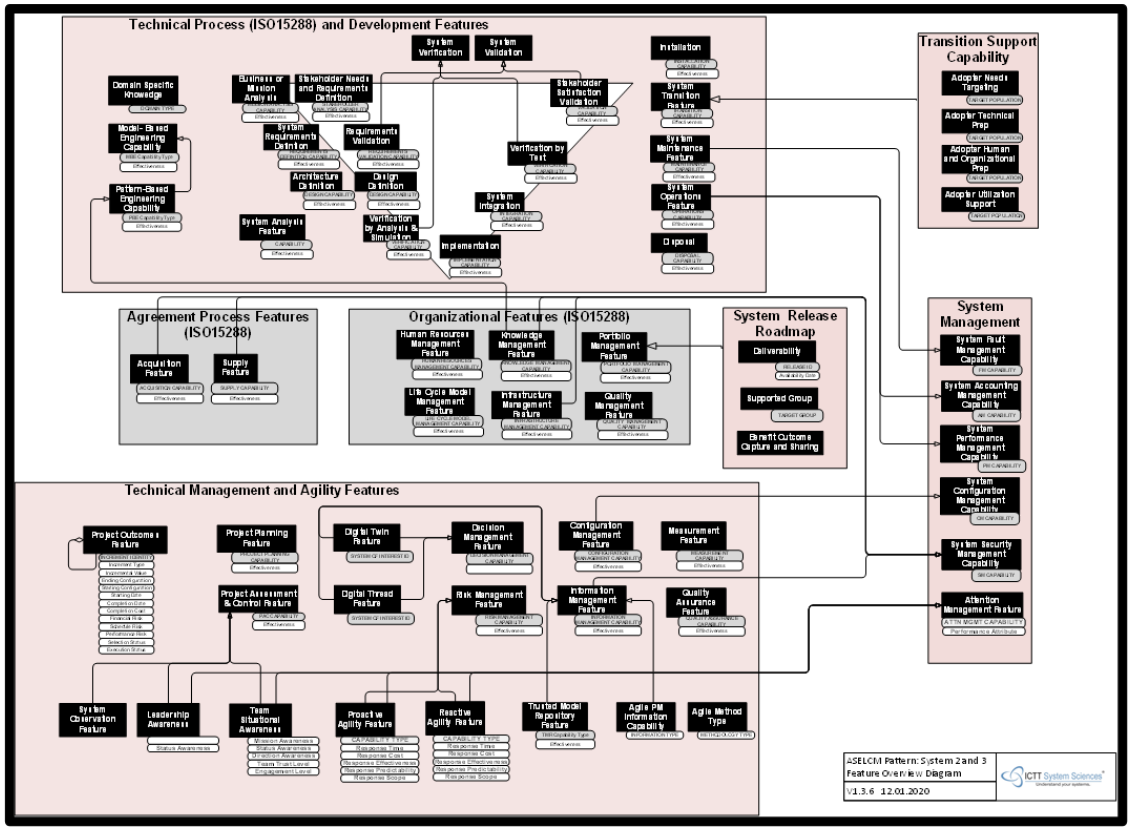
Homework assignment was:

1. Use the provided specific instance of the Configuration Wizard control tab link with existing bulk load consistency set (“See Cnfgd Ftrs-Ints-Roles-DCs”) to view the resulting configured Features-Interactions-Roles-Design Components table view, to see what artifact type roles and design components are generated.

How did it go? Questions? Discussion?

Selecting Targeted Priority Applications of ASELCM Pattern

1. Plan S2 Improvement
2. Analyze S2
3. Create S3 OCM Capability
4. Describe Project (Generate Systems Engineering Plan/SEP Content)
5. SE Education, Training
6. Plan/Analyze Digital Thread
7. Plan/Analyze Digital Twin
8. Plan/Analyze Digital Engineering
9. Understand, Plan, Improve Agility
10. Integrate Supply Chains, Consortia, Commands
11. Improve System Verification
12. Improve S2 Decision Support
13. Improve Acquisition Performance
14. Improve Supply Performance
15. Improve Model IP Management
16. Adopt Systems Engineering (SE)
17. Adopt MBSE
18. Adopt PBSE
19. Theoretical Foundations of SE Performance
20. Other ASELCM Applications

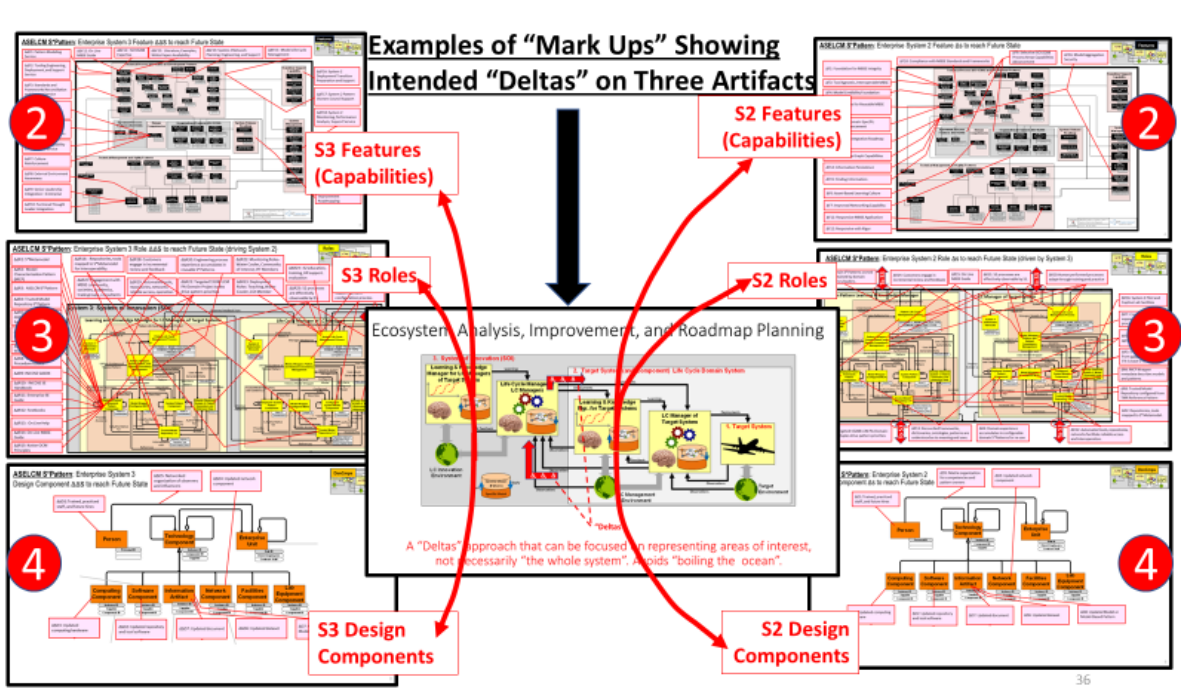


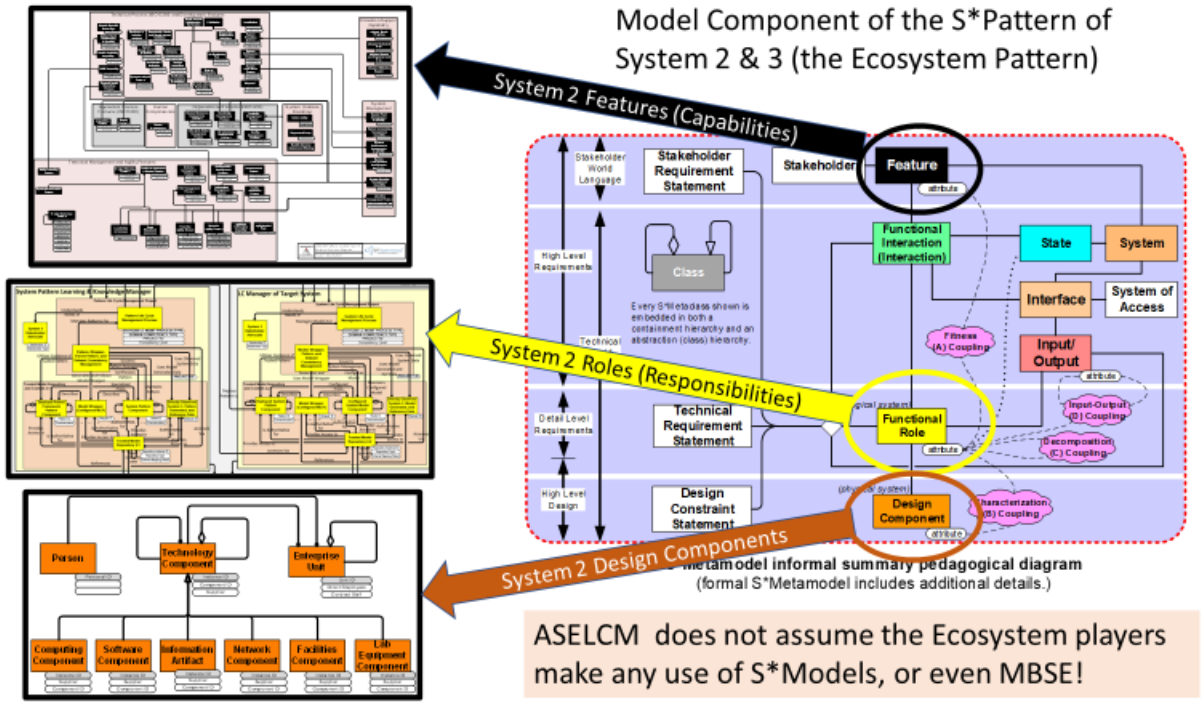
S2, S3 Features targeted by ASELCM Pattern Build-Out: Based on Priority ASELCM Applications.

Targeted Priority Applications of ASELCM Pattern

1. **Plan S2 Improvement**:

Plan improved System 2 capabilities for targeted aspects of the System 1 life cycle. This includes planning the related improvements to System 2 Features, Roles, Design Components, and Requirements.



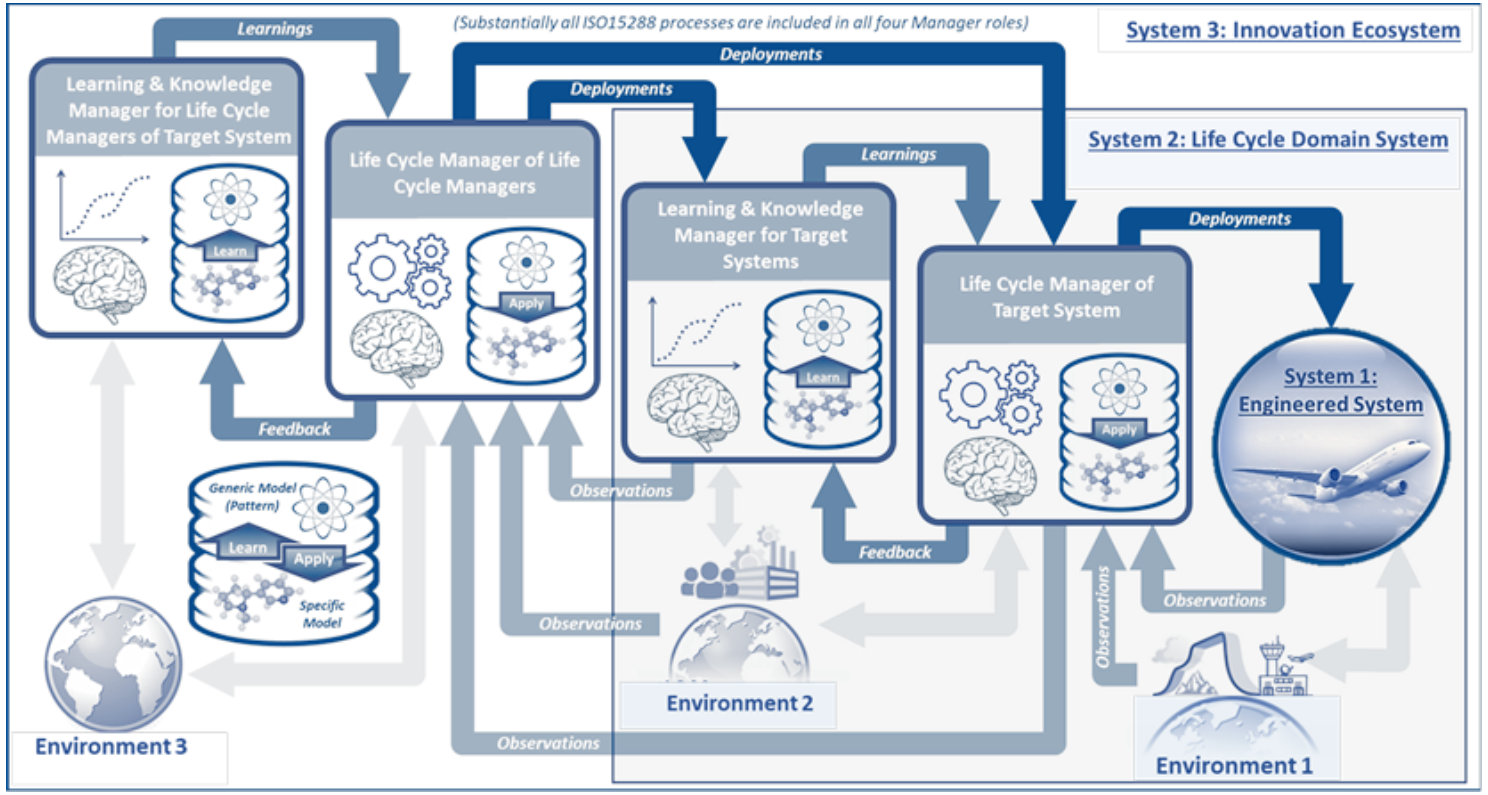


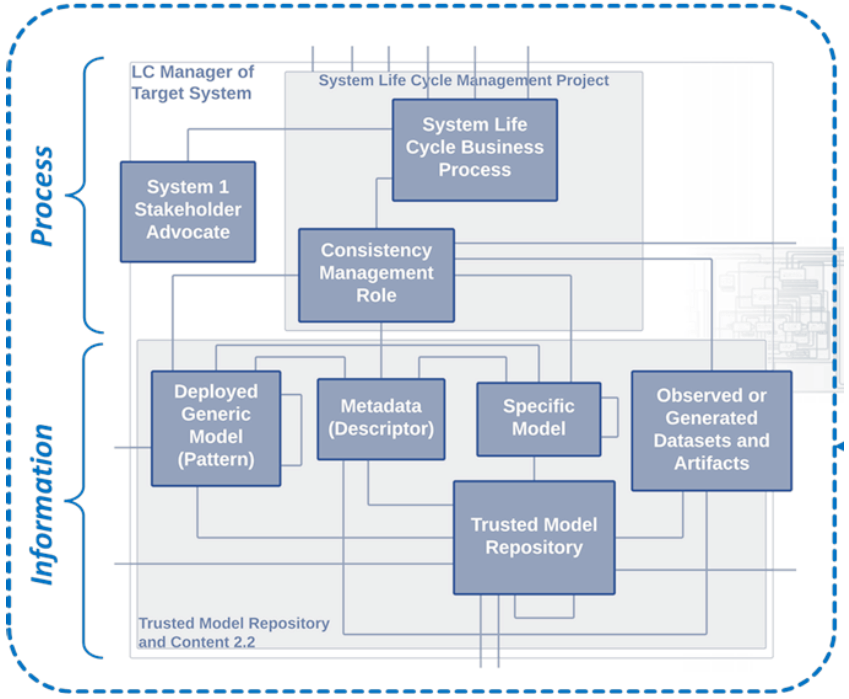
ASELCM does not assume the Ecosystem players make any use of S*Models, or even MBSE!

Targeted Priority Applications of ASELCM Pattern

2. **Analyze System 2**:

Represent and analyze situation(s) of a current real world Innovation Ecosystem System 2. This may include any aspect(s) of the life cycle management of System 1.

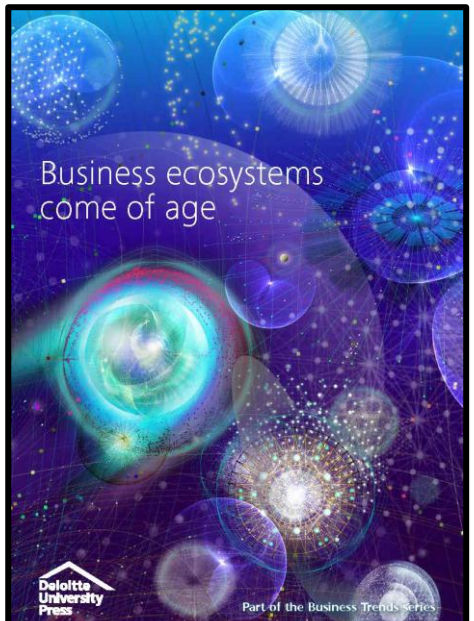


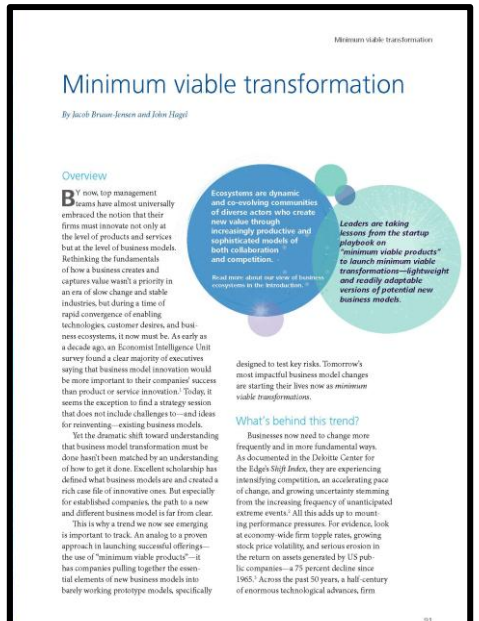


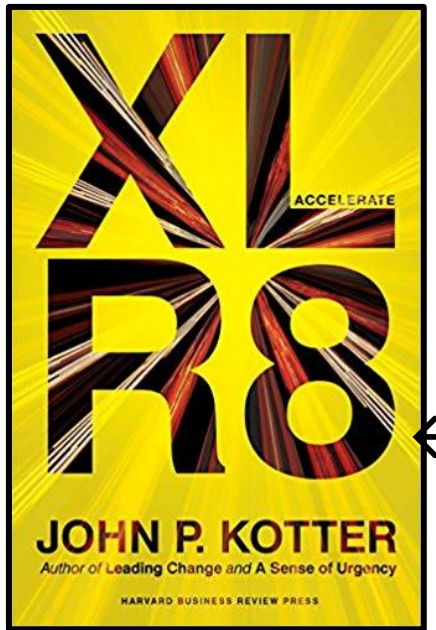
Targeted Priority Applications of ASELCM Pattern

3. Create System 3 Organizational Change Management Capability

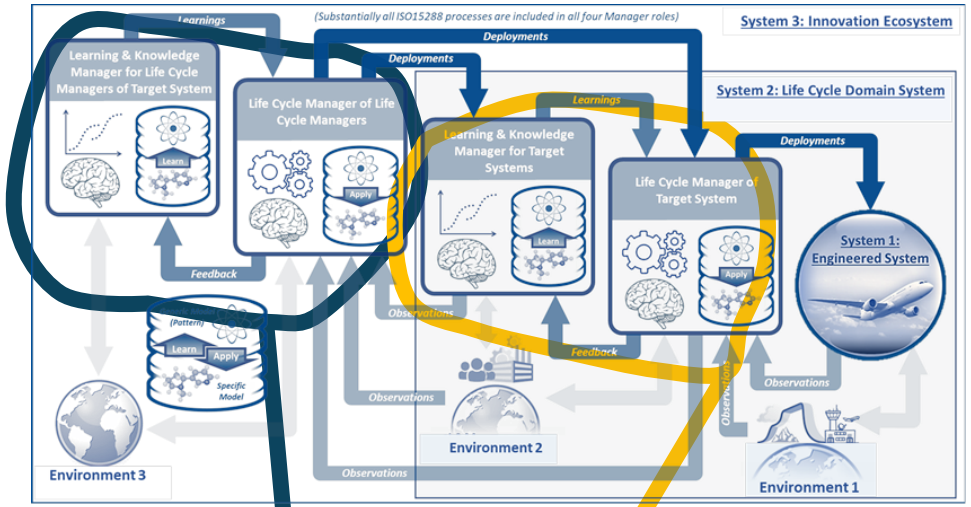
- System 3 is directly related to Organizational Change Management (OCM) for transformation.
- System 3 and 2 together reflect John Kotter's "dual operating system" approach to leading change. (Kotter 2014).
- System 2 roles include being transformable!





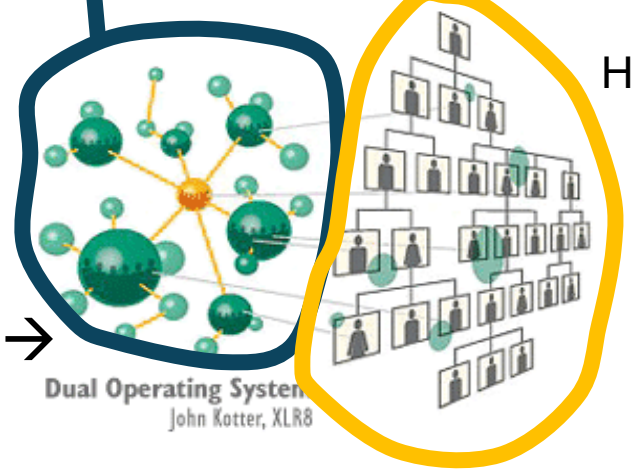


←Kotter 2014→



Network

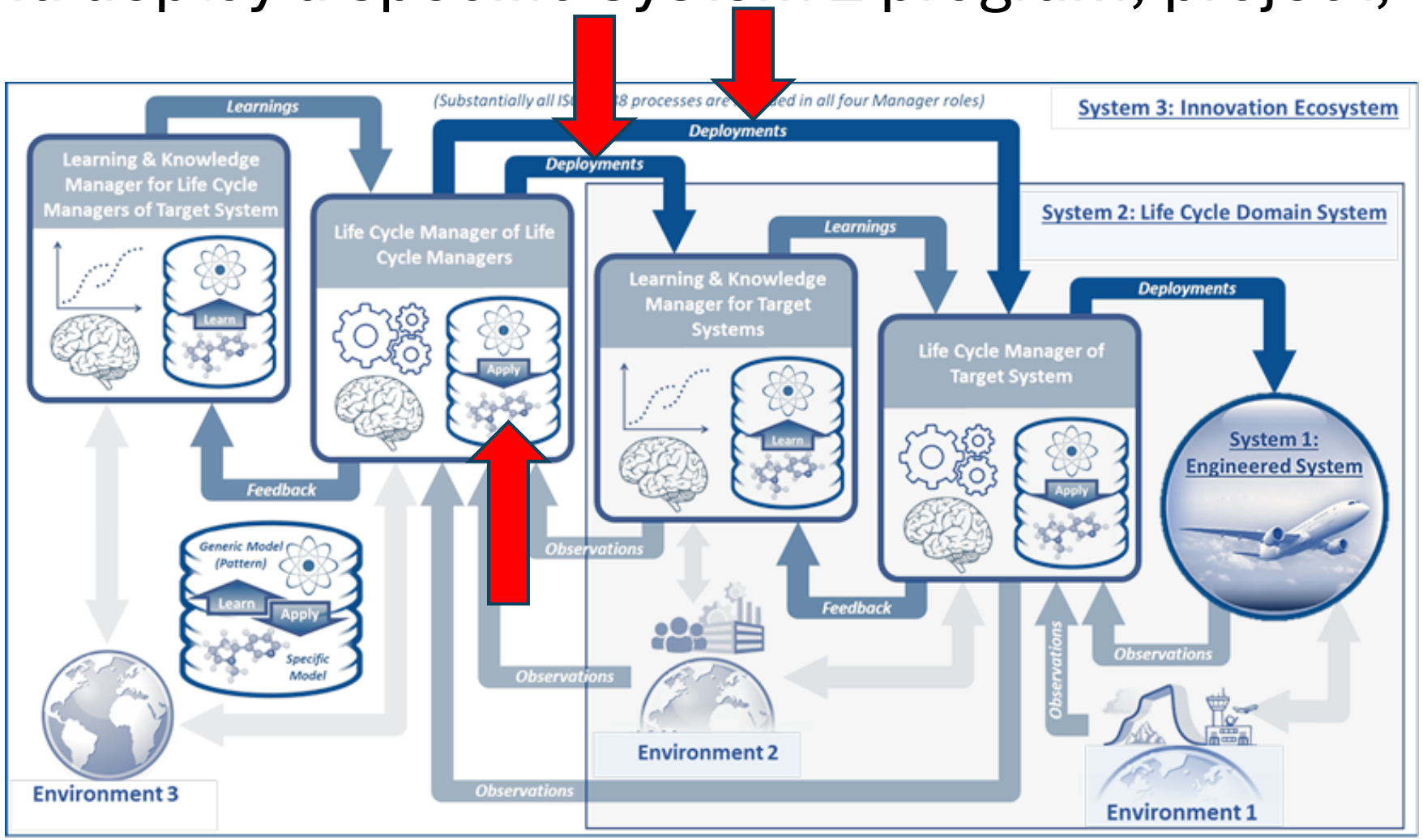
Hierarchy



Targeted Priority Applications of ASELCM Pattern

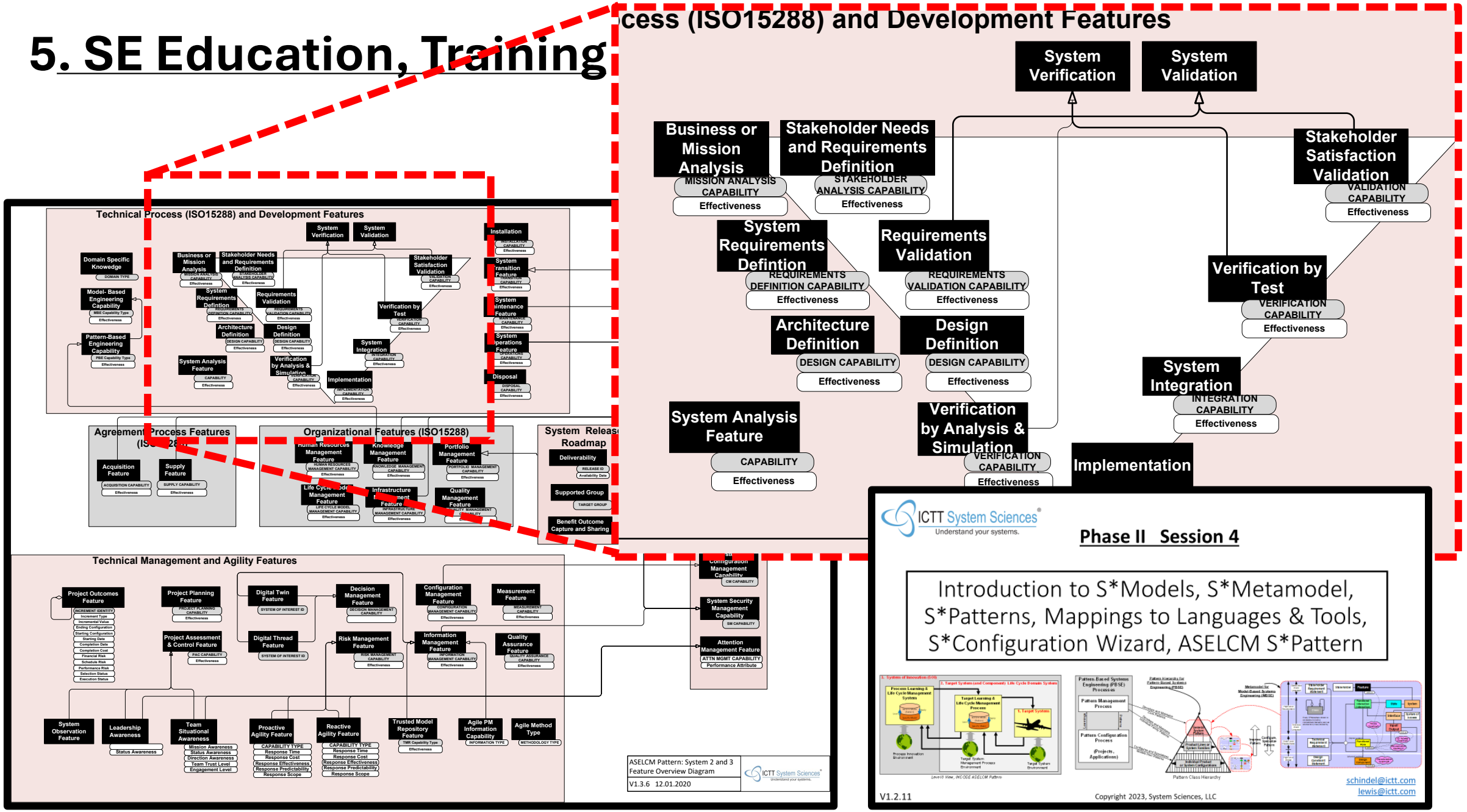
4. Describe a Project (Generate Systems Engineering Plan/SEP Content)

Configure and deploy a specific System 2 program, project, capability.



Targeted Priority Applications of ASELCM Pattern

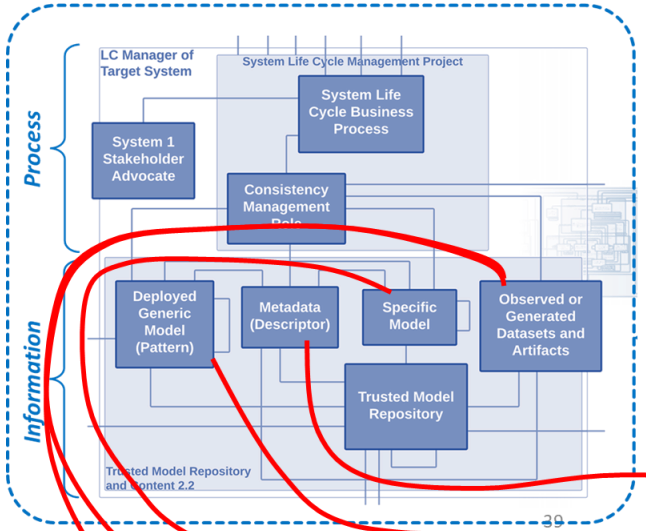
5. SE Education, Training



Targeted Priority Applications of ASELCM Pattern

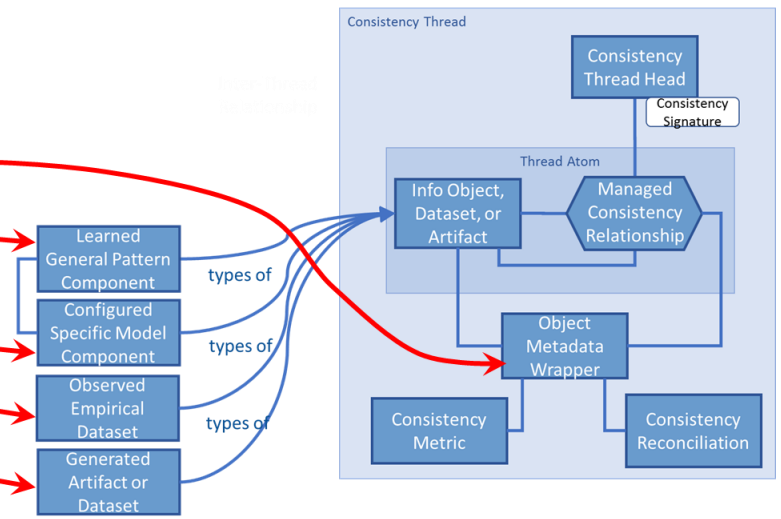
6. **Plan/Analyze Digital Thread**

Plan a new Digital Thread, plan its transition to service, analyze an existing one, plan enhanced services.



INCOSE ASELCM Level 2 Reference Model

INCOSE ASELCM Level 3 Reference Model—Consistency Thread Section



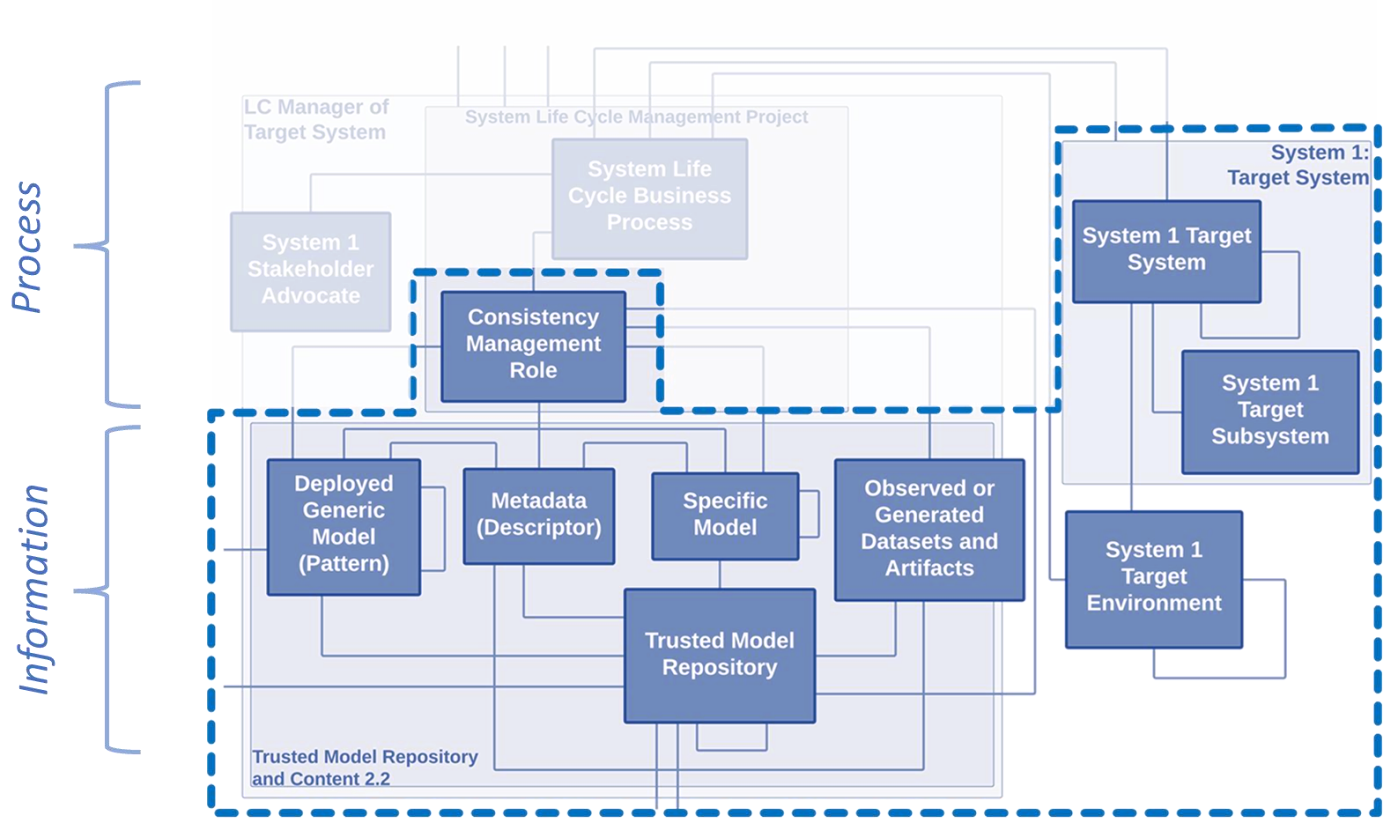


https://www.aiaa.org/resources/digital-thread-white-paper

Targeted Priority Applications of ASELCM Pattern

7. **Plan/Analyze Digital Twin**

Plan a new Digital Twin, plan its transition to service, analyze an existing one, plan enhanced services.



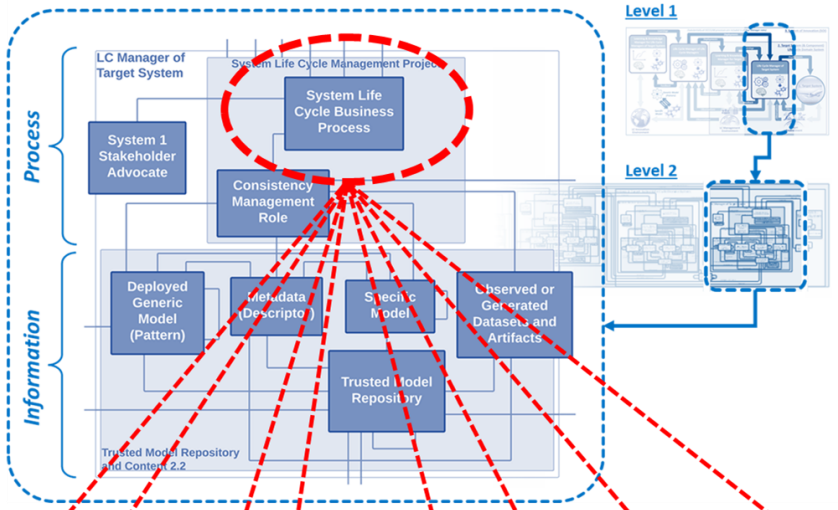


https://www.aiaa.org/resources/digital-twin-implementation-white-paper/

Targeted Priority Applications of ASELCM Pattern

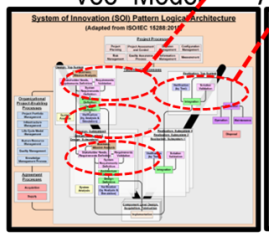
8. **Plan/Analyze Digital Engineering**

Plan other new aspects of Digital Engineering, plan transition to service, analyze existing capabilities, plan enhanced services.

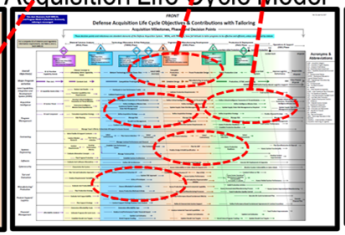


Configurable to specific life cycle management models---

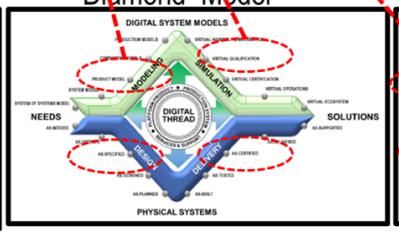
ISO15288 Life Cycle "Vee" Model[1]



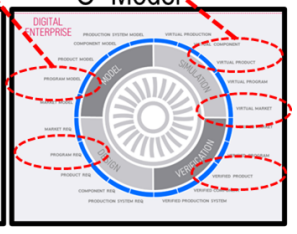
DoD 5000 Defense Acquisition Life Cycle Model[2]



Boeing "Diamond" Model[3]



Rolls-Royce "O" Model[4]



Excerpted or adapted from: (1) ISO15288 and INCOSE SE Handbook; (2) DoD5000 Wall Chart; (3) AIAA Sci Tech, 01.2020, J. Hatakeyama; (4) AIAA DEIC Digital Twin Subcommittee, 04.08.19 Donaldson, Flay, French, Matlik, Myer, Pond, Randjelovic

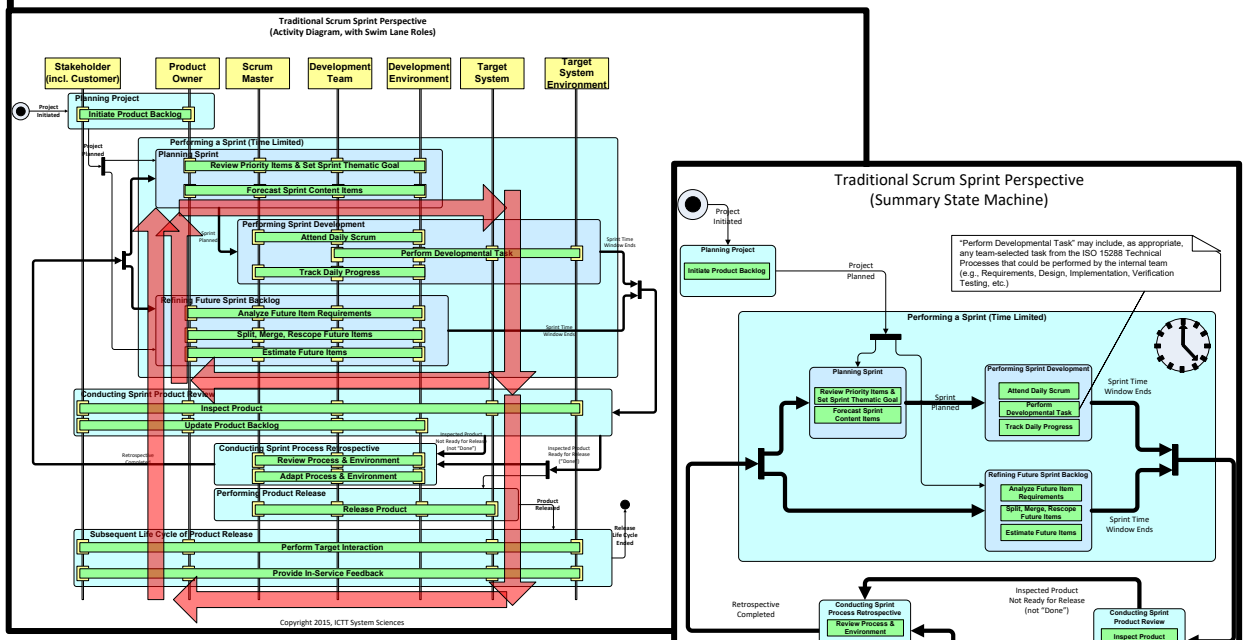




Targeted Priority Applications of ASELCM Pattern

9. **Understand, Plan, Improve Agility**

Improve agility, responsiveness, adaptability of innovation and life cycle management processes.





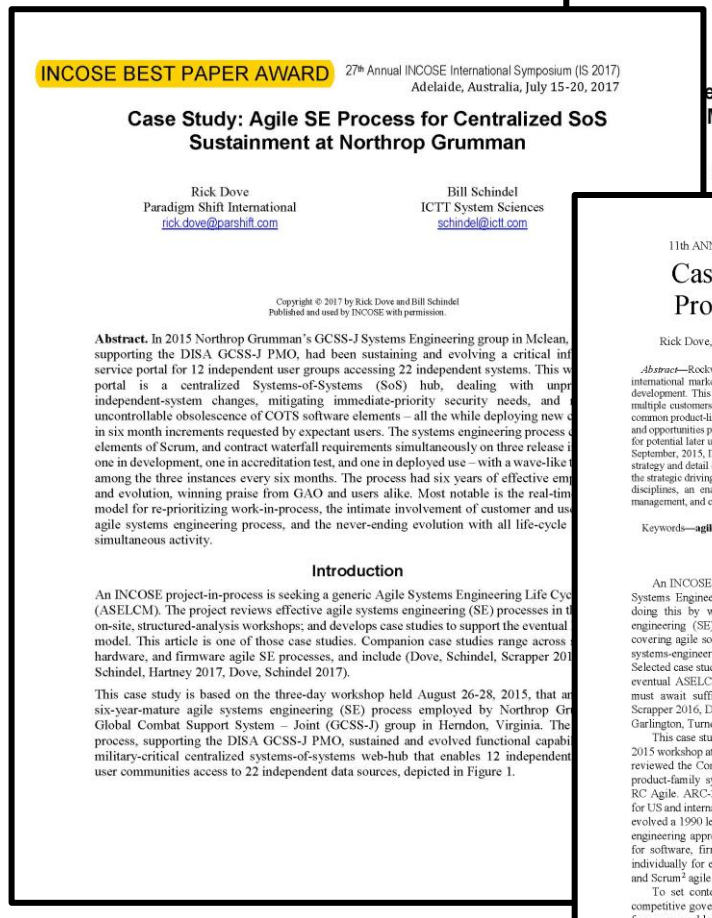
26th Annual INCOSE International Symposium (IS 2016)
Edinburg, Scotland, UK, July 18-21, 2016

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

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INCOSE BEST PAPER AWARD 27th Annual INCOSE International Symposium (IS 2017)
Adelaide, Australia, July 15-20, 2017

Case Study: Agile SE Process for Centralized SoS Sustainment at Northrop Grumman

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Abstract. In 2015 Northrop Grumman's GCSS-J Systems Engineering group in Mclean, supporting the DISA GCSS-J PMO, had been sustaining and evolving a critical inf service portal for 12 independent user groups accessing 22 independent systems. This w portal is a centralized Systems-of-Systems (SoS) hub, dealing with unpr independent-system changes, mitigating immediate-priority security needs, and uncontrollable obsolescence of COTS software elements – all the while deploying new in six month increments requested by expectant users. The systems engineering process elements of Scrum, and contract waterfall requirements simultaneously on three release one in development, one in accreditation test, and one in deployed use – with a wave-like among the three instances every six months. The process had six years of effective em and evolution, winning praise from GAO and users alike. Most notable is the real-tim model for re-prioritizing work-in-process, the intimate involvement of customer and us agile systems engineering process, and the never-ending evolution with all life-cycle simultaneous activity.

Introduction

An INCOSE project-in-process is seeking a generic Agile Systems Engineering Life Cyc (ASELCM). The project reviews effective agile systems engineering (SE) processes in t on-site, structured-analysis workshops; and develops case studies to support the eventual model. This article is one of those case studies. Companion case studies range across hardware, and firmware agile SE processes, and include (Dove, Schindel, Scrapper 201 Schindel, Hartney 2017, Dove, Schindel 2017).

This case study is based on the three-day workshop held August 26-28, 2015, that a six-year-mature agile systems engineering (SE) process employed by Northrop Gr Global Combat Support System – Joint (GCSS-J) group in Herndon, Virginia. The process, supporting the DISA GCSS-J PMO, sustained and evolved functional capabi military-critical centralized systems-of-systems web-hub that enables 12 independent user communities access to 22 independent data sources, depicted in Figure 1.



e Study: Agile Systems Engineering at Lockheed Martin Aeronautics Integrated Fighter Group

Rick Dove
Paradigm Shift International

William (Bill) Schindel
ICTT System Sciences

11th ANNUAL IEEE INTERNATIONAL SYSTEMS CONFERENCE Montréal, Québec, Canada, April 24-27, 2017

Case Study: Agile Hardware/Firmware/Software Product Line Engineering at Rockwell Collins

Rick Dove, *Fellow/Member INCOSE, Member IEEE*, William Schindel, *Fellow/Member INCOSE*, Robert (Will) Hartney

Abstract—Rockwell Collins, in Cedar Rapids, Iowa, is using a product line approach for a family of radios they produce for military and international markets, with an agile systems engineering process tailored individually for synchronized software, firmware, and hardware development. This mixed-discipline engineering group encompasses some 350 employees working on multiple projects simultaneously for multiple customers. The product line approach provides an agile systems target-context for the agile systems engineering process – re-using common product-line hardware, firmware, and software whenever possible, evolving the product line with both internally-funded development and opportunities presented by customer project work, and accommodating special customer needs that grow the knowledge and capability base for potential later use in product-line extension. This article focuses on the mixed-discipline agile systems engineering process reviewed in the September, 2015, INCOSE Agile Systems Engineering Life Cycle Model (ASELCM) discovery workshop, and doesn't address the proprietary strategy and detail of the product line architecture. Notable elements that will be discussed include a parallel evolving product line roadmap as the strategic driving function, a facilitating central relationship-management role for systems engineering, synchronization of mixed engineering disciplines, an enabling infrastructure for agile hardware development, strong opportunity management complimenting traditional risk management, and comparison to the ASELCM Model-Based Systems Engineering (MBSE) pattern.

Keywords—**agile systems engineering, agile architecture pattern, ASELCM pattern, military radio, product line engineering.**

I. Introduction

An INCOSE project-in-process is seeking a generic Agile Systems Engineering Life Cycle Model (ASELCM), and is doing this by workshop-review of effective agile systems engineering (SE) in a variety of applications, collectively covering agile software, firmware, hardware, and people-ware systems-engineering processes in experienced practice. Selected case studies of these reviews are written to support the eventual ASELCM and its core underlying principles, which must await sufficient multi-case analysis (Dove, Schindel, Scrapper 2016, Dove, Schindel, Kenney 2017, Dove, Schindel, Garlington, Turner 2017).

This case study article is based upon the September 21-23, 2015 workshop at Rockwell Collins in Cedar Rapids, Iowa, that reviewed the Communications Engineering group's ARC-210 product-family systems engineering process, which they call RC Agile. ARC-210 encompasses a family of airborne radios for US and international military markets. Rockwell Collins has evolved a 1990 legacy heritage into an integrated agile systems engineering approach, with coupled incremental development for software, firmware, and hardware development, tailored individually for each discipline, with inspiration from SAFe®[1] and Scrum[2] agile software development processes.

To set context, the RC Agile program serves a highly competitive government market, with customers that often ask DoD agencies may supply certain software and firmware non-developmental items (NDI) owned by DoD for required employment. The international military market is prohibited from employing ITAR protected technology, and requires different standards than the domestic market, especially for security features that international customers want independent of US government standards.

The competitive environment for military radios is already changing in the domestic market. Competition from established defense contractors is now augmented by competition from commercial firms, enabled by new government acquisition policies that keep the competition active even after initial contracts are established (http://breakingdefense.com/2016/03/armys-new-radio-strategy-is-unrelenting-competition/).

Typical clean-sheet projects average 3.5 years, with as many as 14 circuit boards, and 2-4 chasses. The Communications Engineering group encompasses some 250 engineers, including about 20 systems engineers. Figure 1 depicts the central role played by systems engineers and others in providing relationship management among the key elements of the process.

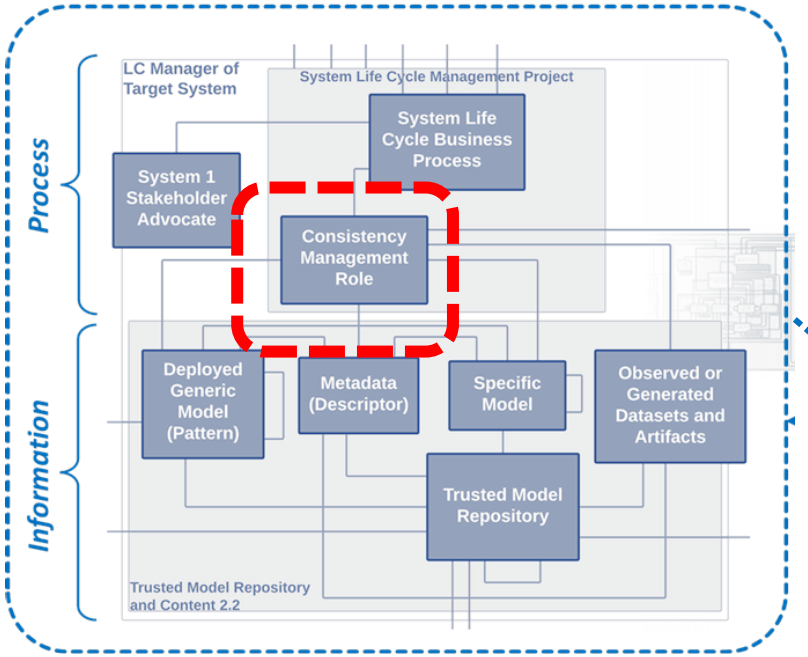
Notable process concepts that will be discussed include:

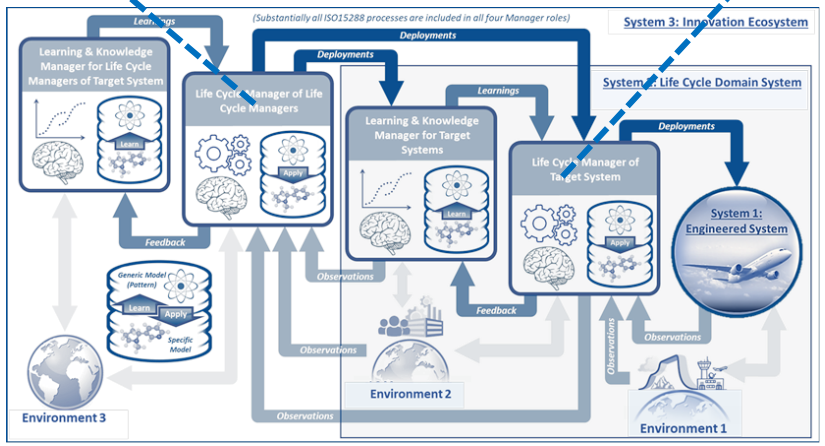
- Product line architecture and strategy, as agility-enabling concept.

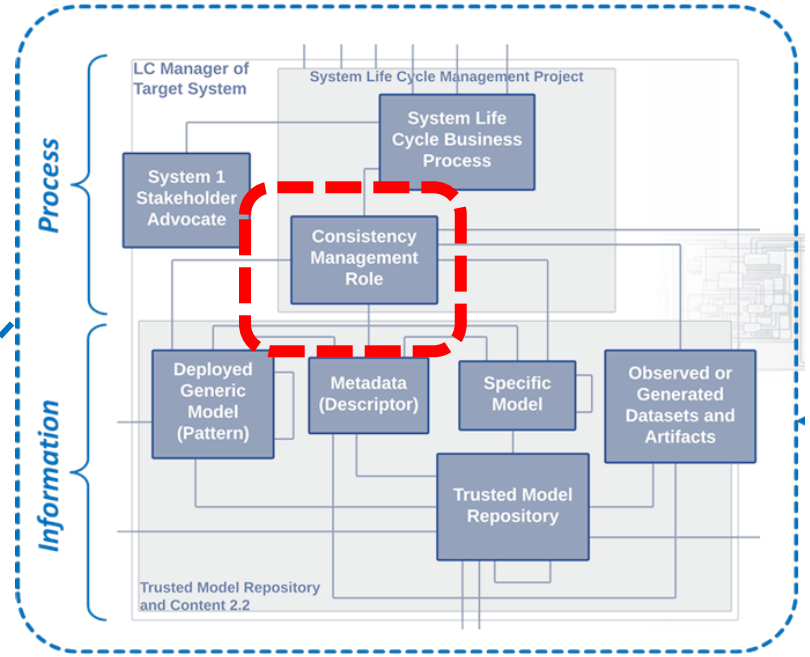
Targeted Priority Applications of ASELCM Pattern

10. **Integrate Supply Chains, Consortia, Commands:**

Improve the integrated performance of supply chain ecosystems, partner consortia, and multi-branch defense commands.



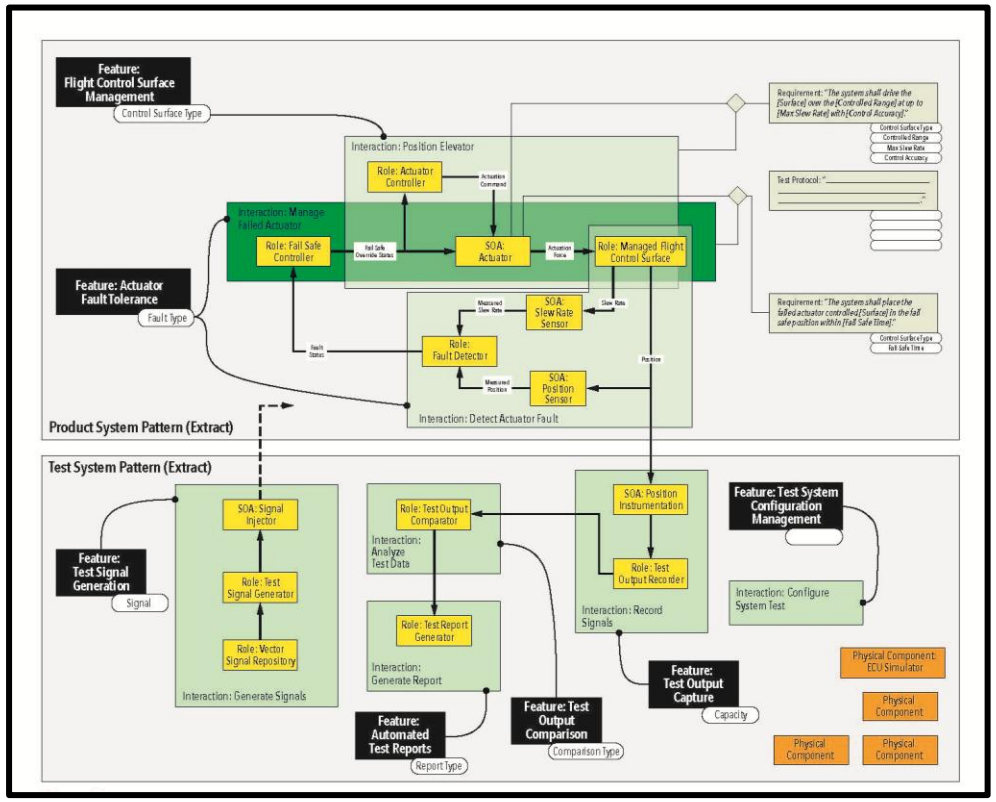


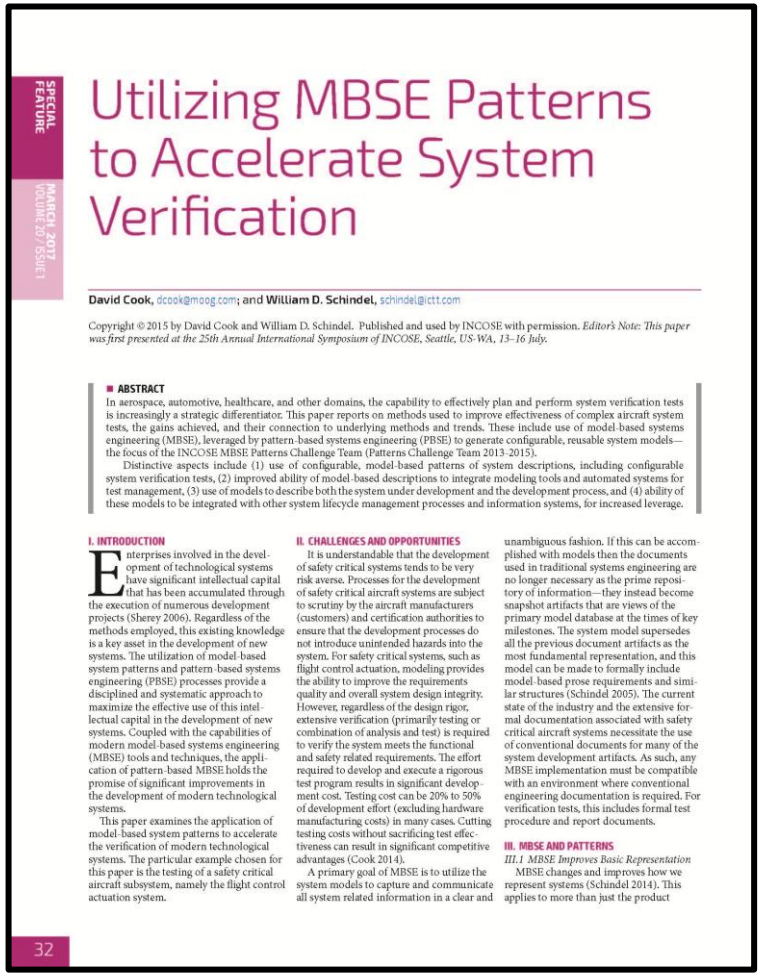


Targeted Priority Applications of ASELCM Pattern

11. **Improve System Verification Capability:**

Improve verification planning, implementation, flexibility.





SPECIAL FEATURE

MARCH 2017 VOLUME 20 ISSUE 1

Utilizing MBSE Patterns to Accelerate System Verification

David Cook, dcook@moog.com; and **William D. Schindel**, schindel@ictt.com

Copyright © 2015 by David Cook and William D. Schindel. Published and used by INCOSE with permission. *Editor's Note: This paper was first presented at the 25th Annual International Symposium of INCOSE, Seattle, US-WA, 13–16 July.*

ABSTRACT

In aerospace, automotive, healthcare, and other domains, the capability to effectively plan and perform system verification tests is increasingly a strategic differentiator. This paper reports on methods used to improve effectiveness of complex aircraft system tests, the gains achieved, and their connection to underlying methods and trends. These include use of model-based systems engineering (MBSE), leveraged by pattern-based systems engineering (PBSE) to generate configurable, reusable system models—the focus of the INCOSE MBSE Patterns Challenge Team (Patterns Challenge Team 2013-2015).

Distinctive aspects include (1) use of configurable, model-based patterns of system descriptions, including configurable system verification tests, (2) improved ability of model-based descriptions to integrate modeling tools and automated systems for test management, (3) use of models to describe both the system under development and the development process, and (4) ability of these models to be integrated with other system lifecycle management processes and information systems, for increased leverage.

I. INTRODUCTION

Enterprises involved in the development of technological systems have significant intellectual capital that has been accumulated through the execution of numerous development projects (Sherey 2006). Regardless of the methods employed, this existing knowledge is a key asset in the development of new systems. The utilization of model-based system patterns and pattern-based systems engineering (PBSE) processes provide a disciplined and systematic approach to maximize the effective use of this intellectual capital in the development of new systems. Coupled with the capabilities of modern model-based systems engineering (MBSE) tools and techniques, the application of pattern-based MBSE holds the promise of significant improvements in the development of modern technological systems.

This paper examines the application of model-based system patterns to accelerate the verification of modern technological systems. The particular example chosen for this paper is the testing of a safety critical aircraft subsystem, namely the flight control actuation system.

II. CHALLENGES AND OPPORTUNITIES

It is understandable that the development of safety critical systems tends to be very risk averse. Processes for the development of safety critical aircraft systems are subject to scrutiny by the aircraft manufacturers (customers) and certification authorities to ensure that the development processes do not introduce unintended hazards into the system. For safety critical systems, such as flight control actuation, modeling provides the ability to improve the requirements quality and overall system design integrity. However, regardless of the design rigor, extensive verification (primarily testing or combination of analysis and test) is required to verify the system meets the functional and safety related requirements. The effort required to develop and execute a rigorous test program results in significant development cost. Testing cost can be 20% to 50% of development effort (excluding hardware manufacturing costs) in many cases. Cutting testing costs without sacrificing test effectiveness can result in significant competitive advantages (Cook 2014).

A primary goal of MBSE is to utilize the system models to capture and communicate all system related information in a clear and unambiguous fashion. If this can be accomplished with models then the documents used in traditional systems engineering are no longer necessary as the prime repository of information—they instead become snapshot artifacts that are views of the primary model database at the times of key milestones. The system model supersedes all the previous document artifacts as the most fundamental representation, and this model can be made to formally include model-based prose requirements and similar structures (Schindel 2005). The current state of the industry and the extensive formal documentation associated with safety critical aircraft systems necessitate the use of conventional documents for many of the system development artifacts. As such, any MBSE implementation must be compatible with an environment where conventional engineering documentation is required. For verification tests, this includes formal test procedure and report documents.

III. MBSE AND PATTERNS

III.1 MBSE Improves Basic Representation

MBSE changes and improves how we represent systems (Schindel 2014). This applies to more than just the product



INSIGHT

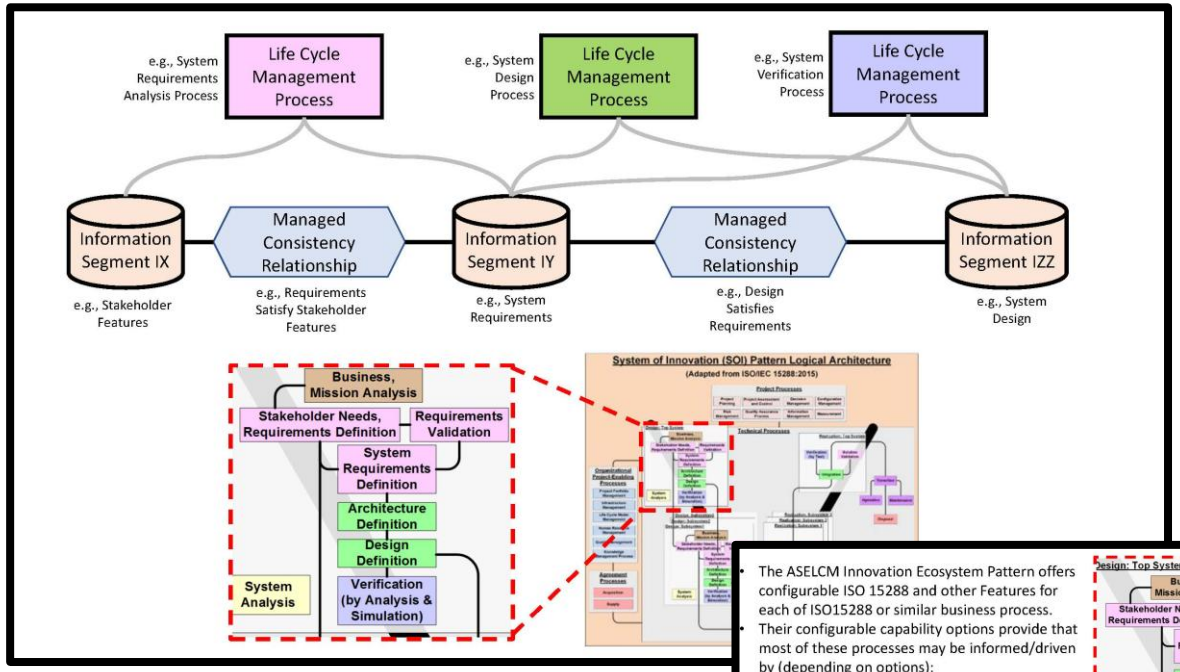
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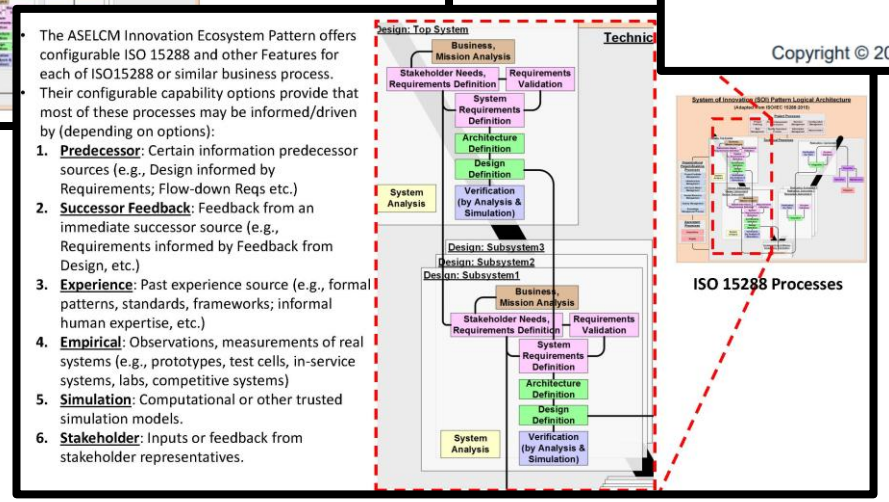
Verification & Validation

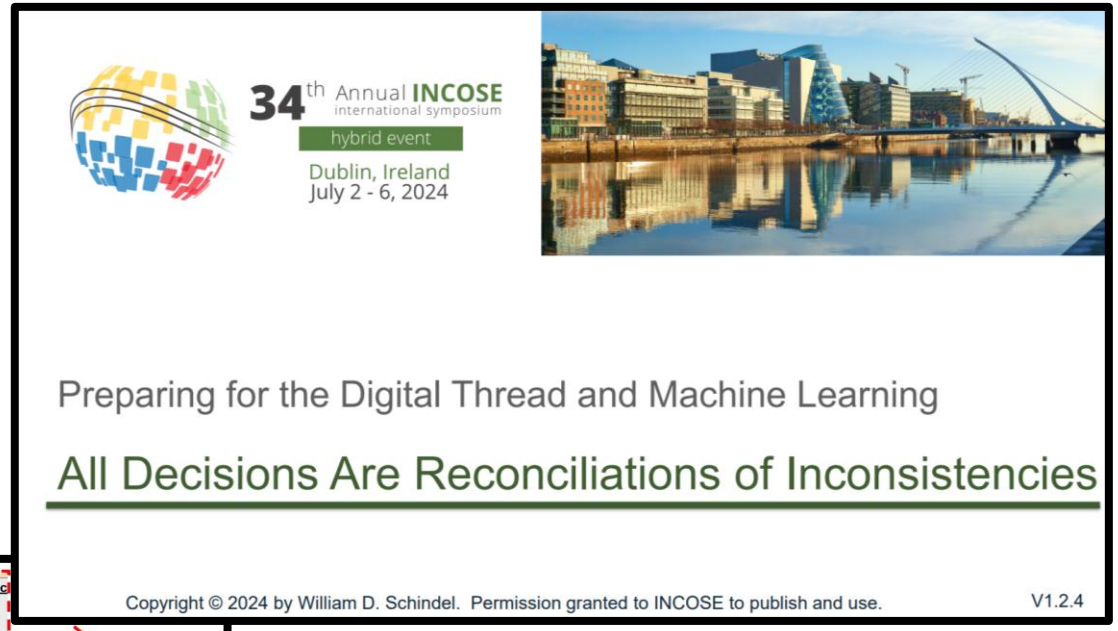
MARCH 2017
VOLUME 20 / ISSUE 1
A PUBLICATION OF THE INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING
INCOSE

Targeted Priority Applications of ASELCM Pattern

12. <u>Improve S2 Decision Support:</u> Unified approach to decision patterns across diverse life cycle stages, through consistency reconciliation.





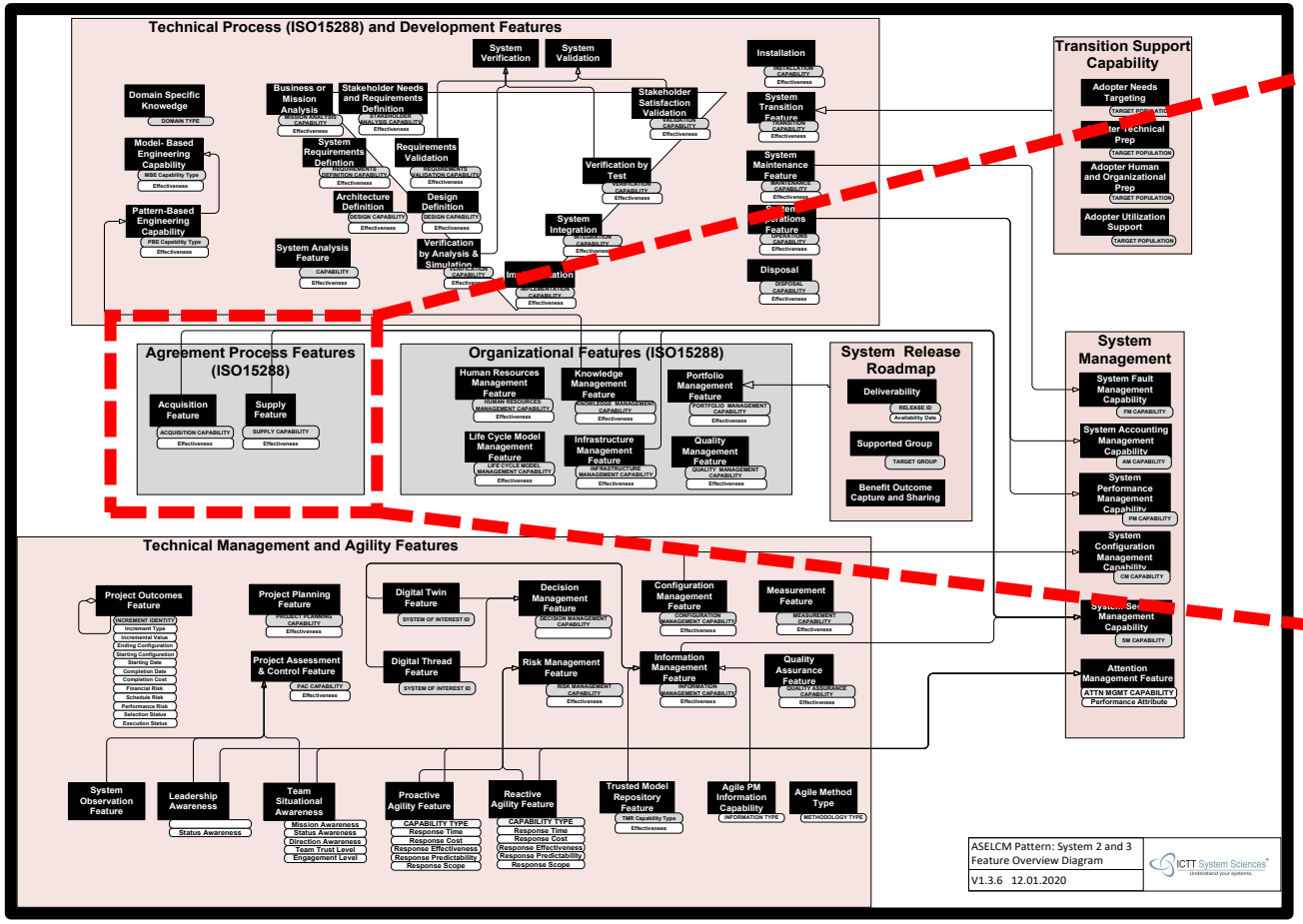


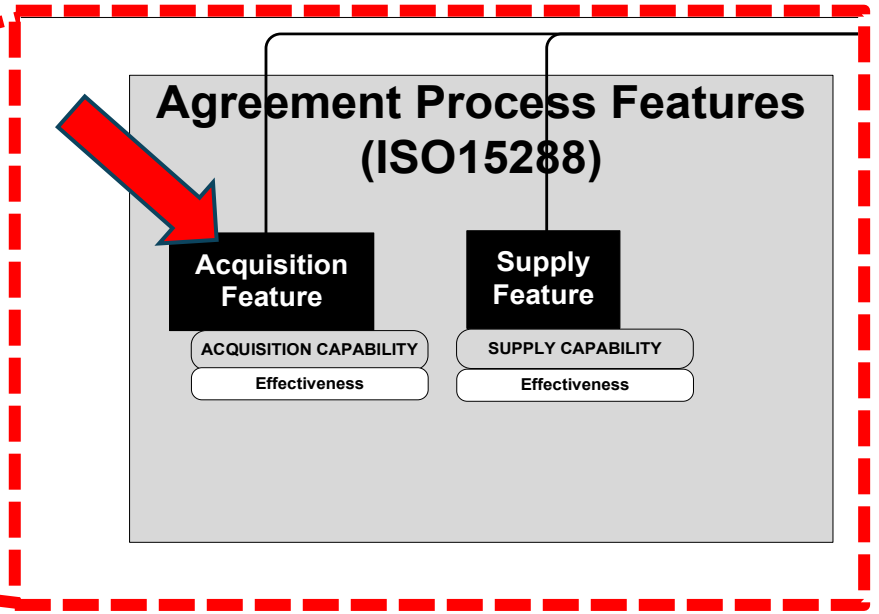
https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:decisions_threads_learning_--_presentation_v1.2.4.pdf

Targeted Priority Applications of ASELCM Pattern

13. **Improve Acquisition Performance:**

Enhanced RFPs, requirements based and agile contracting, multi-vendor coordination.

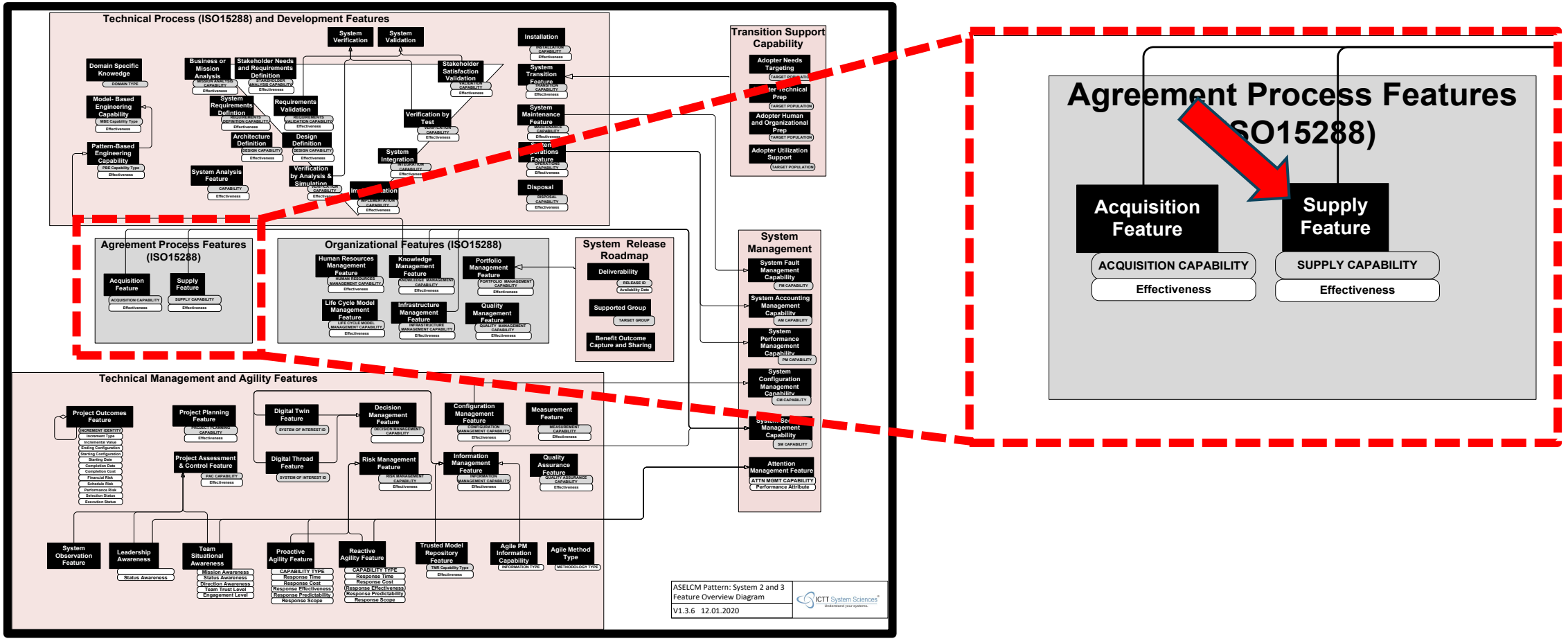




Targeted Priority Applications of ASELCM Pattern

14. **Improve Supply Performance:**

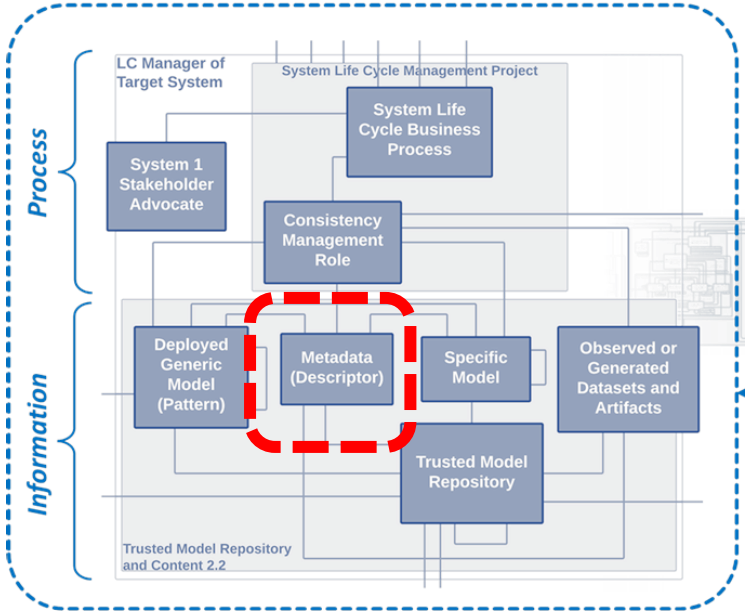
Enhanced proposals and RFP responses, requirements based and agile contracting, multi-vendor coordination.

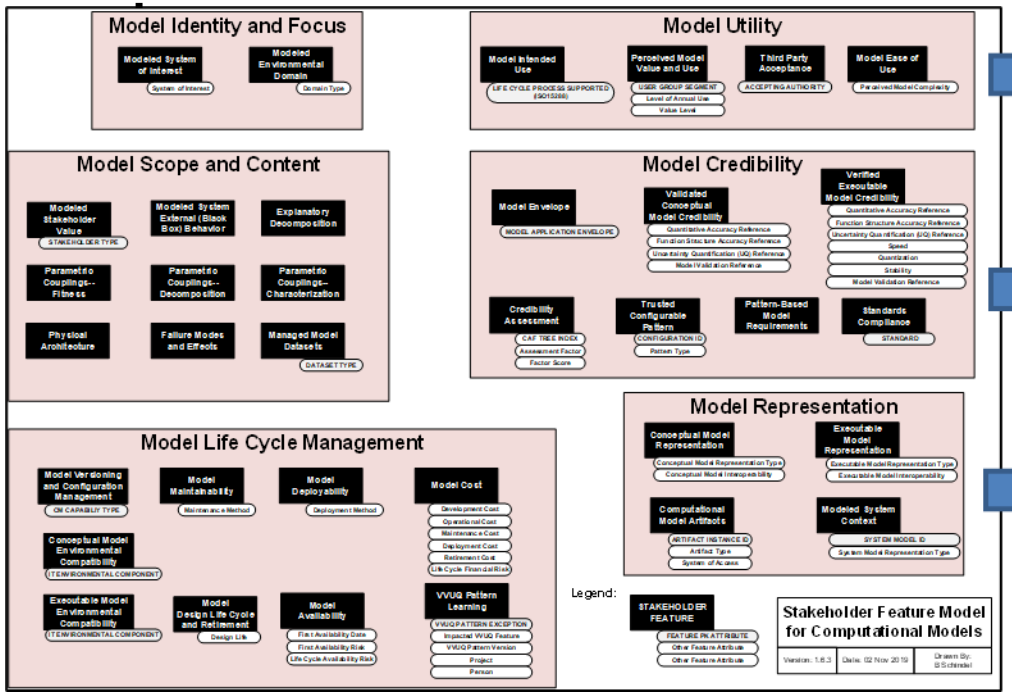


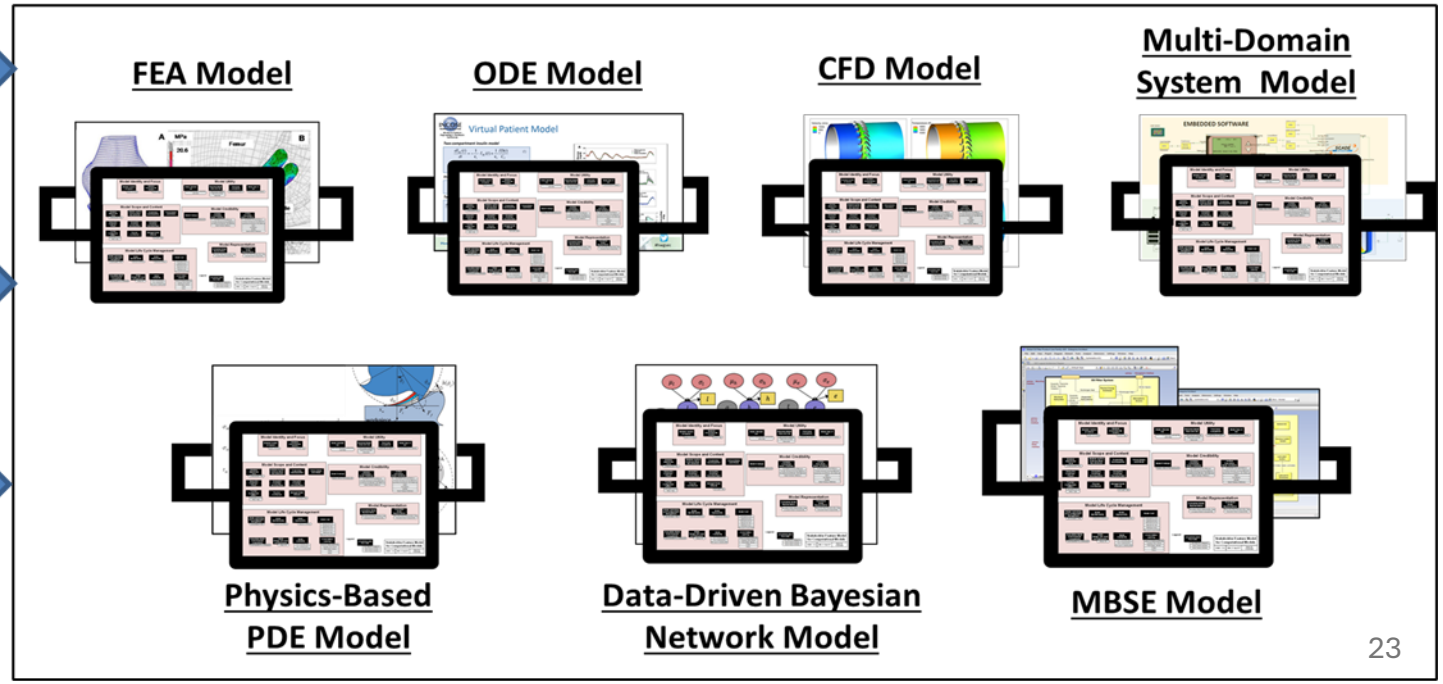
Targeted Priority Applications of ASELCM Pattern

15. **Improve Model IP Management:**

Model Characterization Pattern (MCP) configurable model metadata “label” (wrapper) for each model; semi-automatic generation of requirements for models; model credibility management across model life



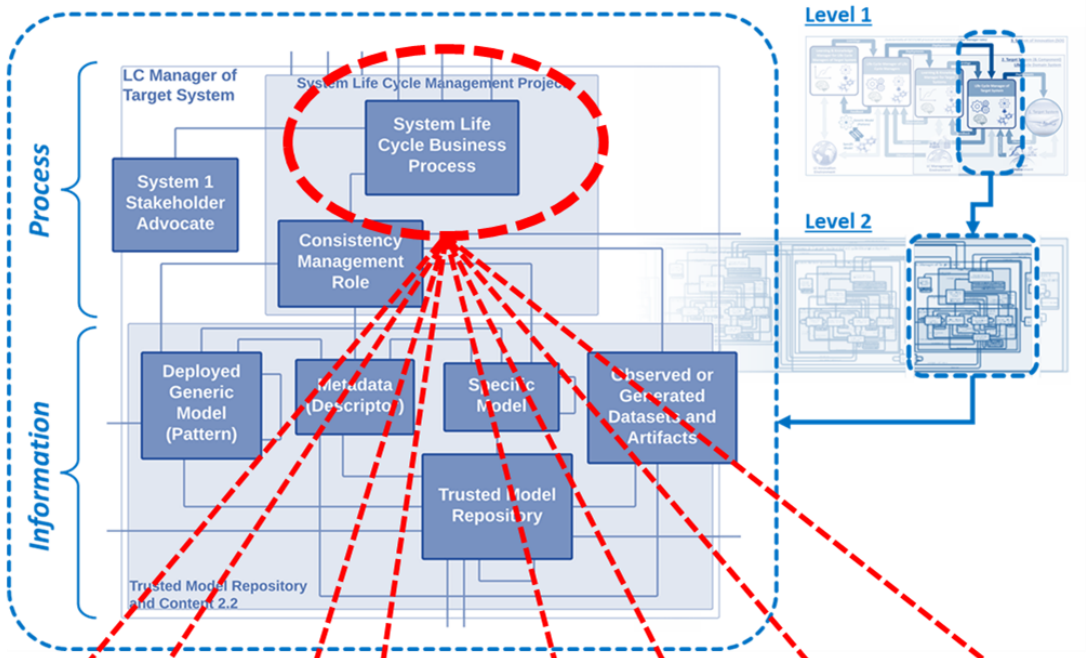




Targeted Priority Applications of ASELCM Pattern

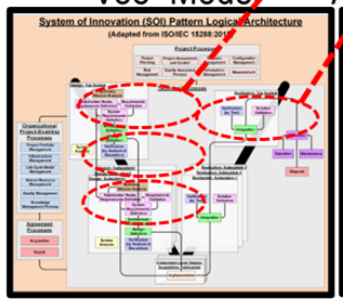
16. **Adopt Systems Engineering (SE):**

Performed across targeted stages of the system life cycle.



Configurable to specific life cycle management models---

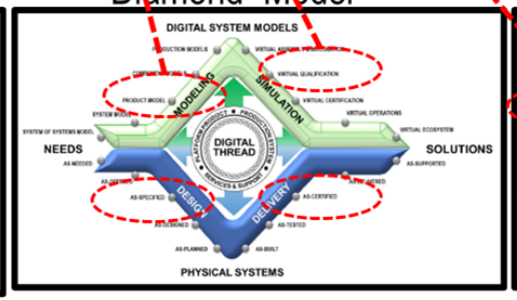
ISO15288 Life Cycle "Vee" Model[1]



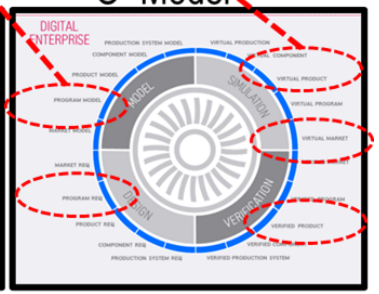
DoD 5000 Defense Acquisition Life Cycle Model[2]



Boeing "Diamond" Model[3]



Rolls-Royce "O" Model[4]

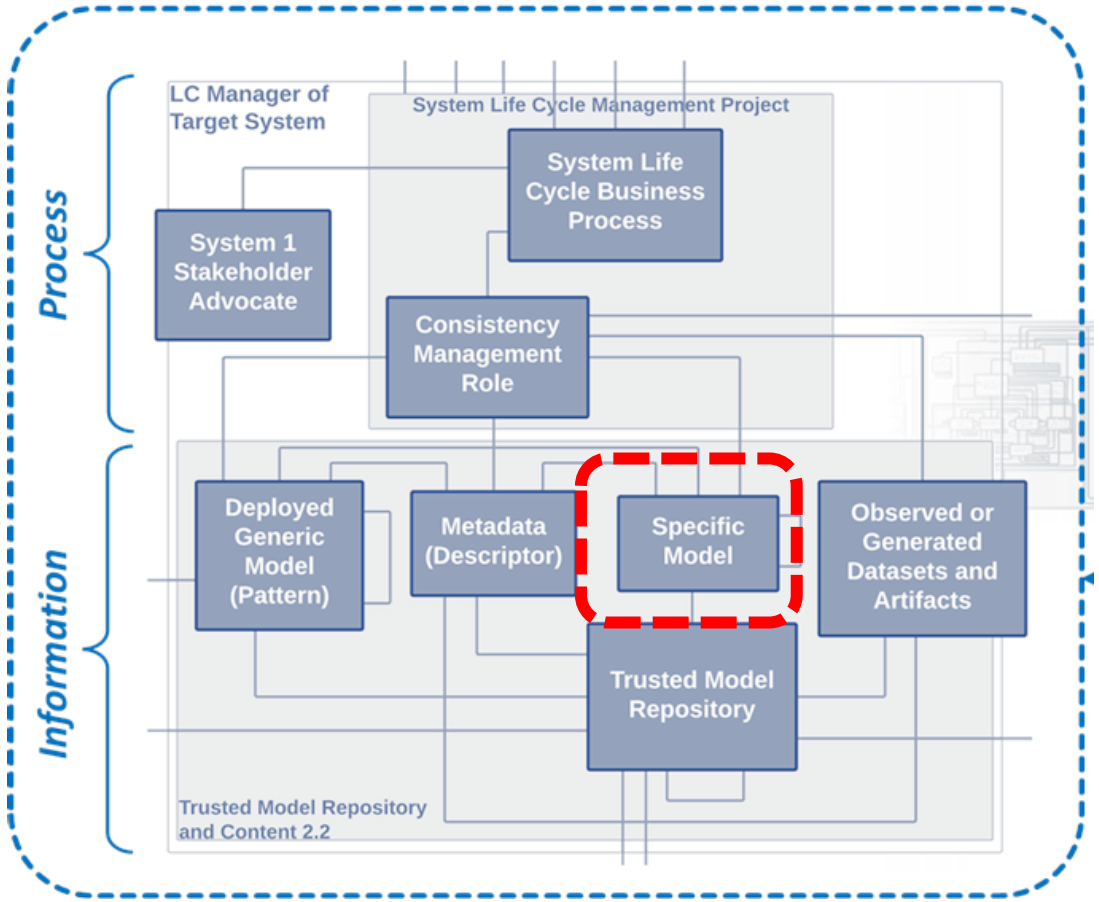


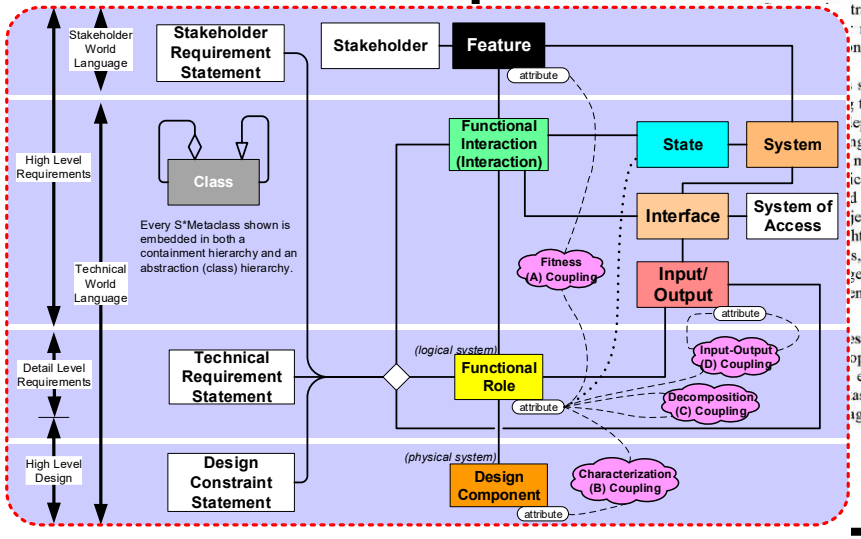
Excerpted or adapted from: (1) ISO15288 and INCOSE SE Handbook; (2) DoD5000 Wall Chart; (3) AIAA Sci Tech, 01.2020, J. Hatakeyama; (4) AIAA DEIC Digital Twin Subcommittee, 04.08.19 Donaldson, Flay, French, Matlik, Myer, Pond, Randjelovic

Targeted Priority Applications of ASELCM Pattern

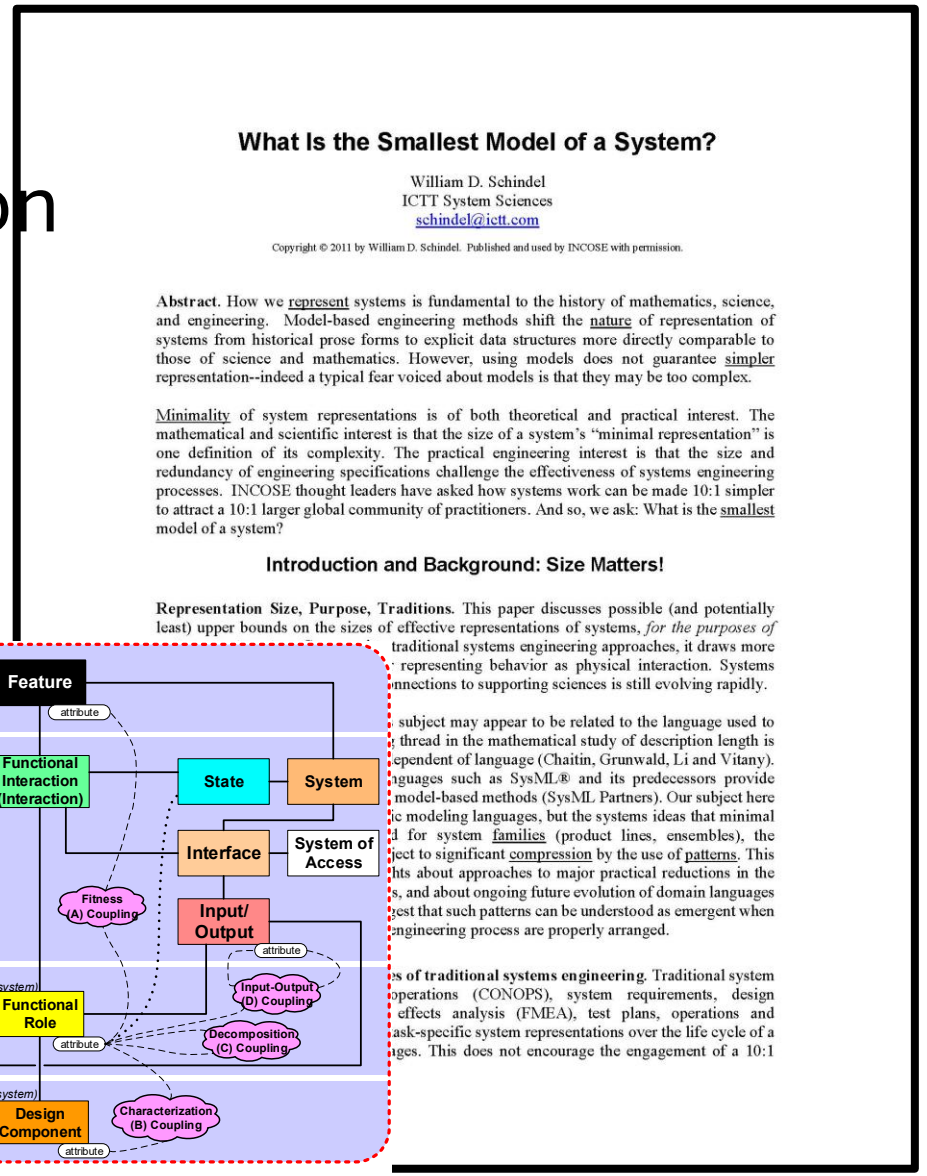
17. **Adopt Model-Based Systems Engineering (MBSE)**:

Adding expressiveness, rigor, and automation to the systems engineering processes.





S*Metamodel informal summary pedagogical diagram
(formal S*Metamodel includes additional details.)



What Is the Smallest Model of a System?

William D. Schindel
ICTT System Sciences
schindel@ictt.com

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Abstract. How we represent systems is fundamental to the history of mathematics, science, and engineering. Model-based engineering methods shift the nature of representation of systems from historical prose forms to explicit data structures more directly comparable to those of science and mathematics. However, using models does not guarantee simpler representation--indeed a typical fear voiced about models is that they may be too complex.

Minimality of system representations is of both theoretical and practical interest. The mathematical and scientific interest is that the size of a system's "minimal representation" is one definition of its complexity. The practical engineering interest is that the size and redundancy of engineering specifications challenge the effectiveness of systems engineering processes. INCOSE thought leaders have asked how systems work can be made 10:1 simpler to attract a 10:1 larger global community of practitioners. And so, we ask: What is the smallest model of a system?

Introduction and Background: Size Matters!

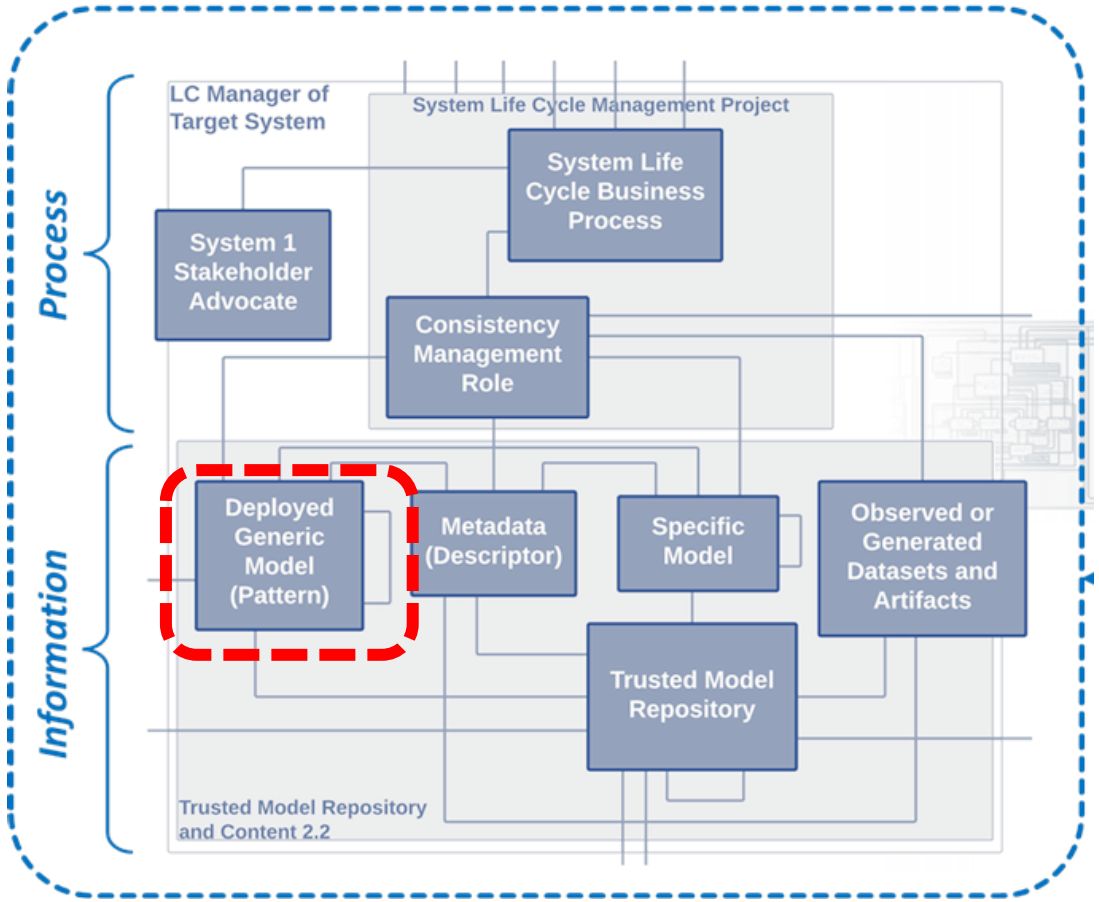
Representation Size, Purpose, Traditions. This paper discusses possible (and potentially least) upper bounds on the sizes of effective representations of systems, *for the purposes of*
traditional systems engineering approaches, it draws more
representing behavior as physical interaction. Systems
nnections to supporting sciences is still evolving rapidly.

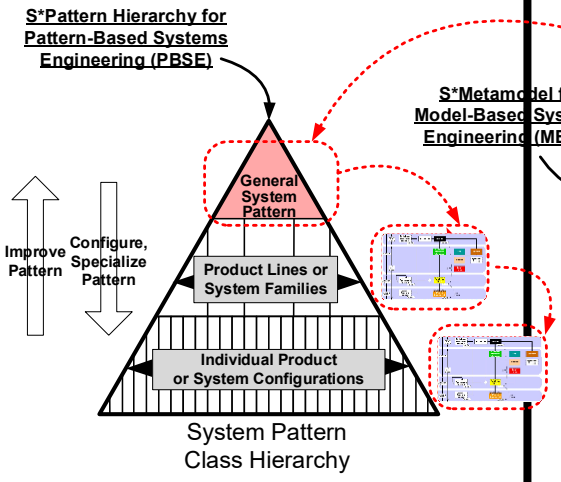
subject may appear to be related to the language used to
thread in the mathematical study of description length is
ependent of language (Chaitin, Grunwald, Li and Vitany).
nguages such as SysML® and its predecessors provide
model-based methods (SysML Partners). Our subject here
ic modeling languages, but the systems ideas that minimal
d for system families (product lines, ensembles), the
ject to significant compression by the use of patterns. This
hts about approaches to major practical reductions in the
s, and about ongoing future evolution of domain languages
gest that such patterns can be understood as emergent when
ngineering process are properly arranged.

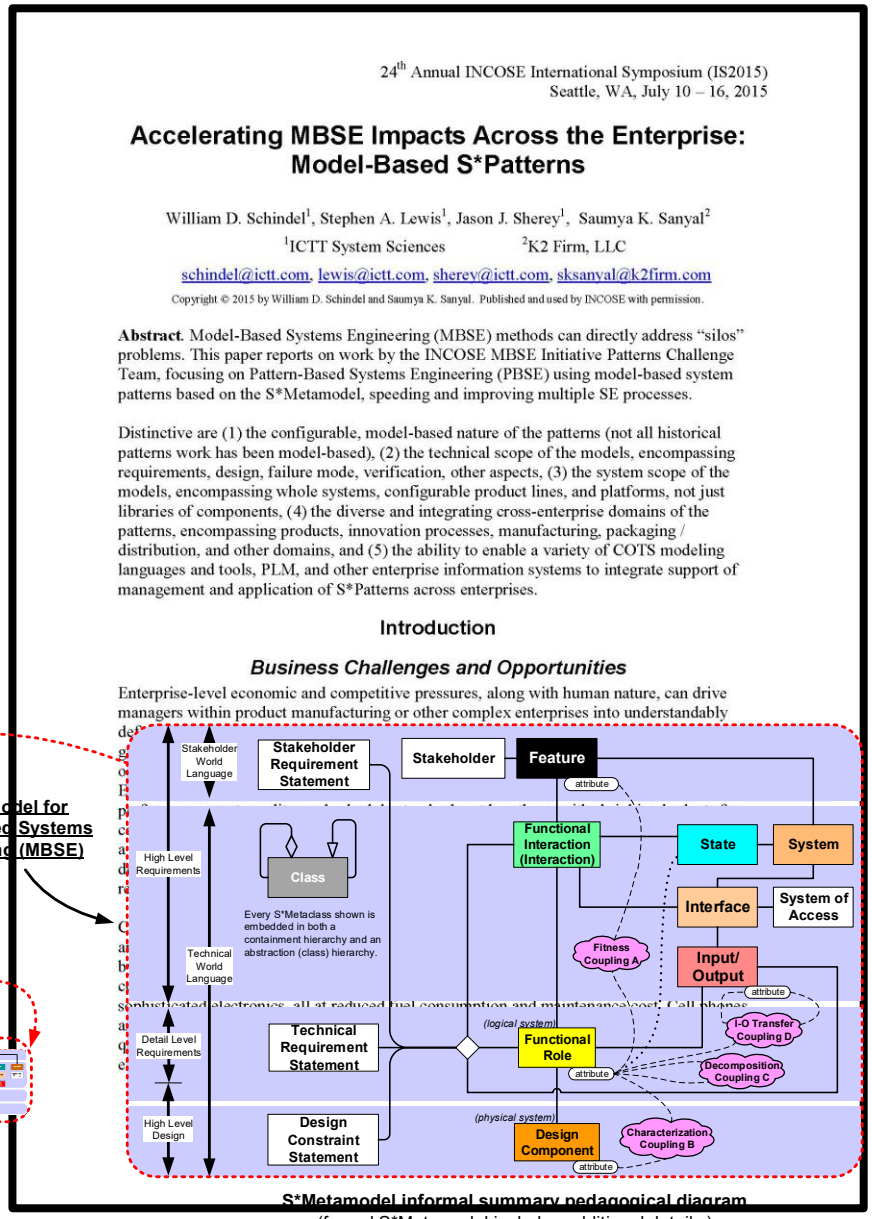
s of traditional systems engineering. Traditional system
perations (CONOPS), system requirements, design
effects analysis (FMEA), test plans, operations and
ask-specific system representations over the life cycle of a
ages. This does not encourage the engagement of a 10:1

Targeted Priority Applications of ASELCM Pattern

18. <u>Adopt Pattern-Based Systems Engineering (PBSE)</u>: The power of models generated by trusted recurring patterns.







24th Annual INCOSE International Symposium (IS2015)
Seattle, WA, July 10 – 16, 2015

Accelerating MBSE Impacts Across the Enterprise: Model-Based S*Patterns

William D. Schindel[1], Stephen A. Lewis[1], Jason J. Sherey[1], Saumya K. Sanyal[2]
[1]ICTT System Sciences [2]K2 Firm, LLC
schindel@ictt.com, lewis@ictt.com, sherey@ictt.com, sksanyal@k2firm.com

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Abstract. Model-Based Systems Engineering (MBSE) methods can directly address "silos" problems. This paper reports on work by the INCOSE MBSE Initiative Patterns Challenge Team, focusing on Pattern-Based Systems Engineering (PBSE) using model-based system patterns based on the S*Metamodel, speeding and improving multiple SE processes.

Distinctive are (1) the configurable, model-based nature of the patterns (not all historical patterns work has been model-based), (2) the technical scope of the models, encompassing requirements, design, failure mode, verification, other aspects, (3) the system scope of the models, encompassing whole systems, configurable product lines, and platforms, not just libraries of components, (4) the diverse and integrating cross-enterprise domains of the patterns, encompassing products, innovation processes, manufacturing, packaging / distribution, and other domains, and (5) the ability to enable a variety of COTS modeling languages and tools, PLM, and other enterprise information systems to integrate support of management and application of S*Patterns across enterprises.

Introduction

Business Challenges and Opportunities

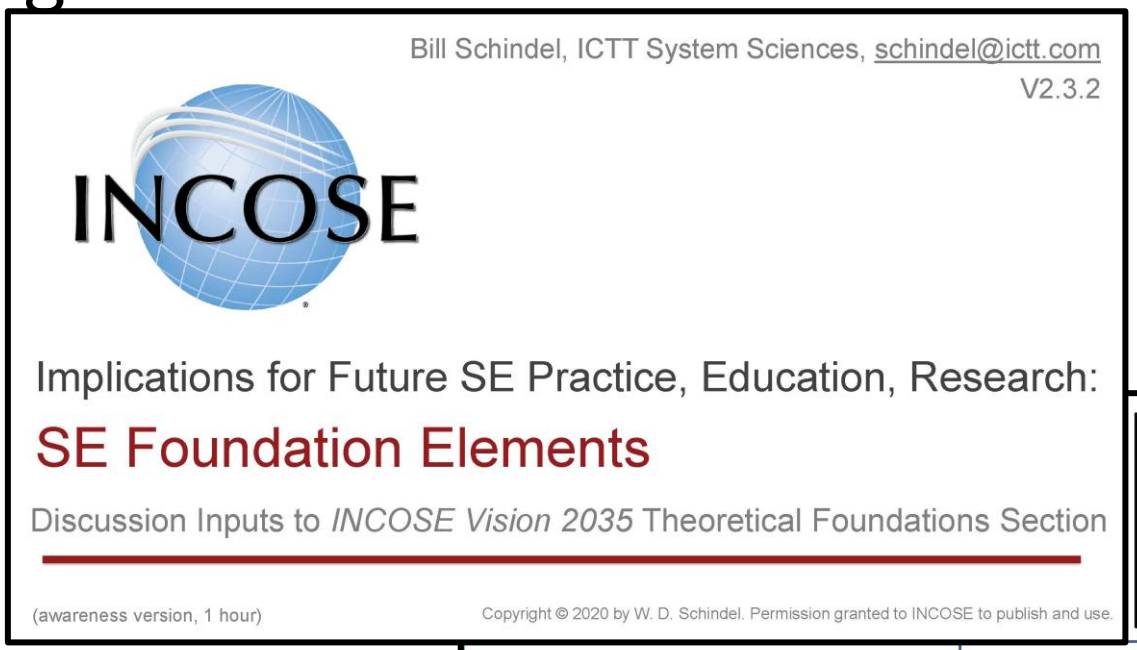
Enterprise-level economic and competitive pressures, along with human nature, can drive managers within product manufacturing or other complex enterprises into understandably

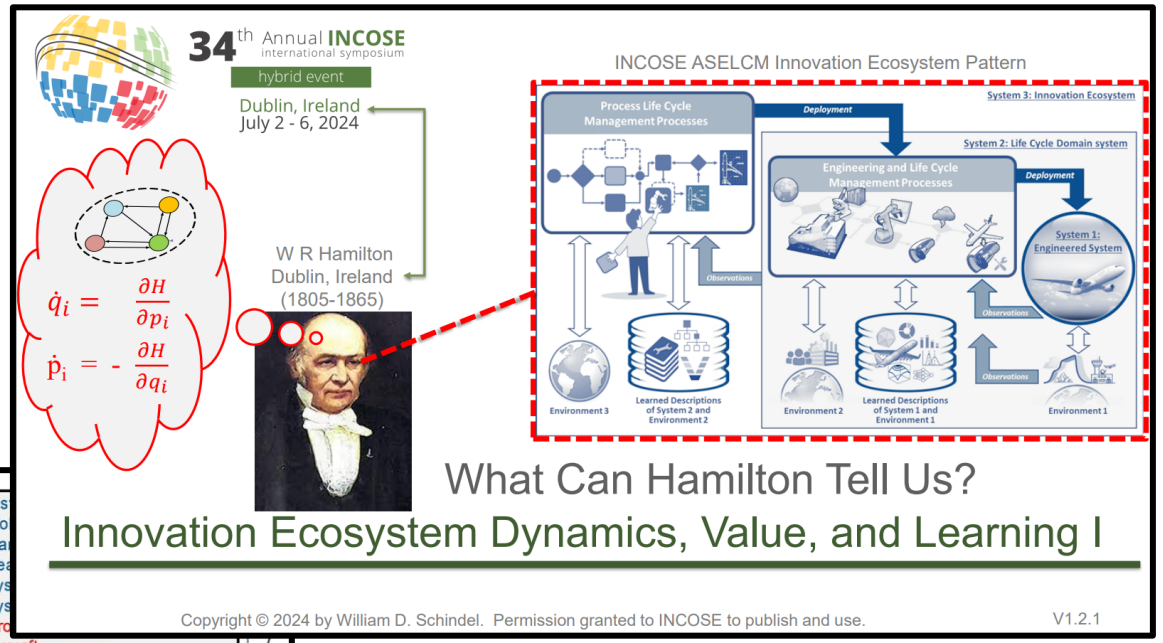
S*Metamodel informal summary pedagogical diagram
(formal S*Metamodel includes additional details.)

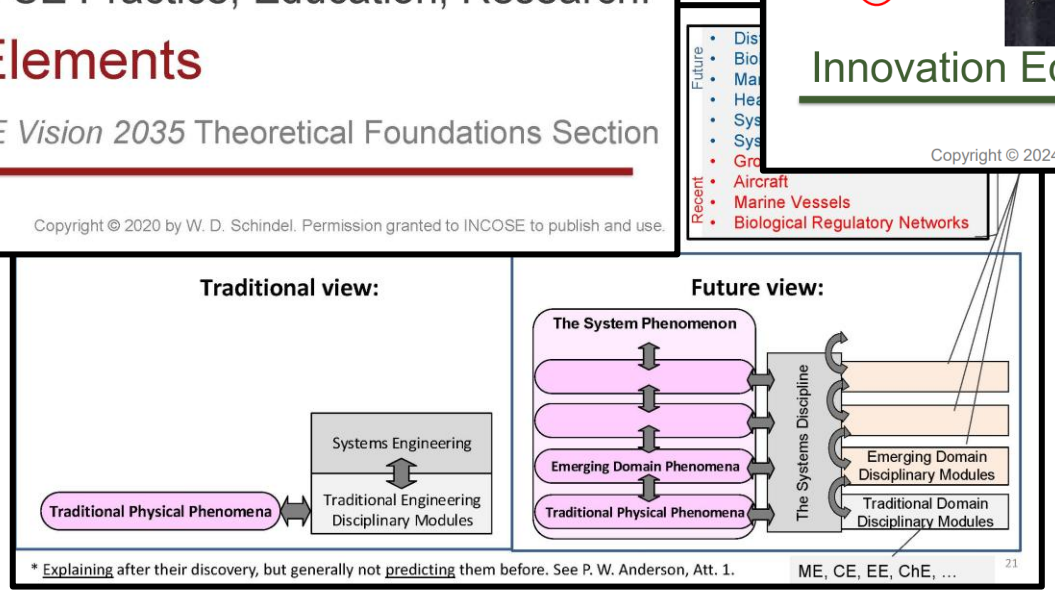
Targeted Priority Applications of ASELCM Pattern

19. Theoretical Foundations of SE Performance:

Strengthening traditional systems engineering using the foundations of STEM.





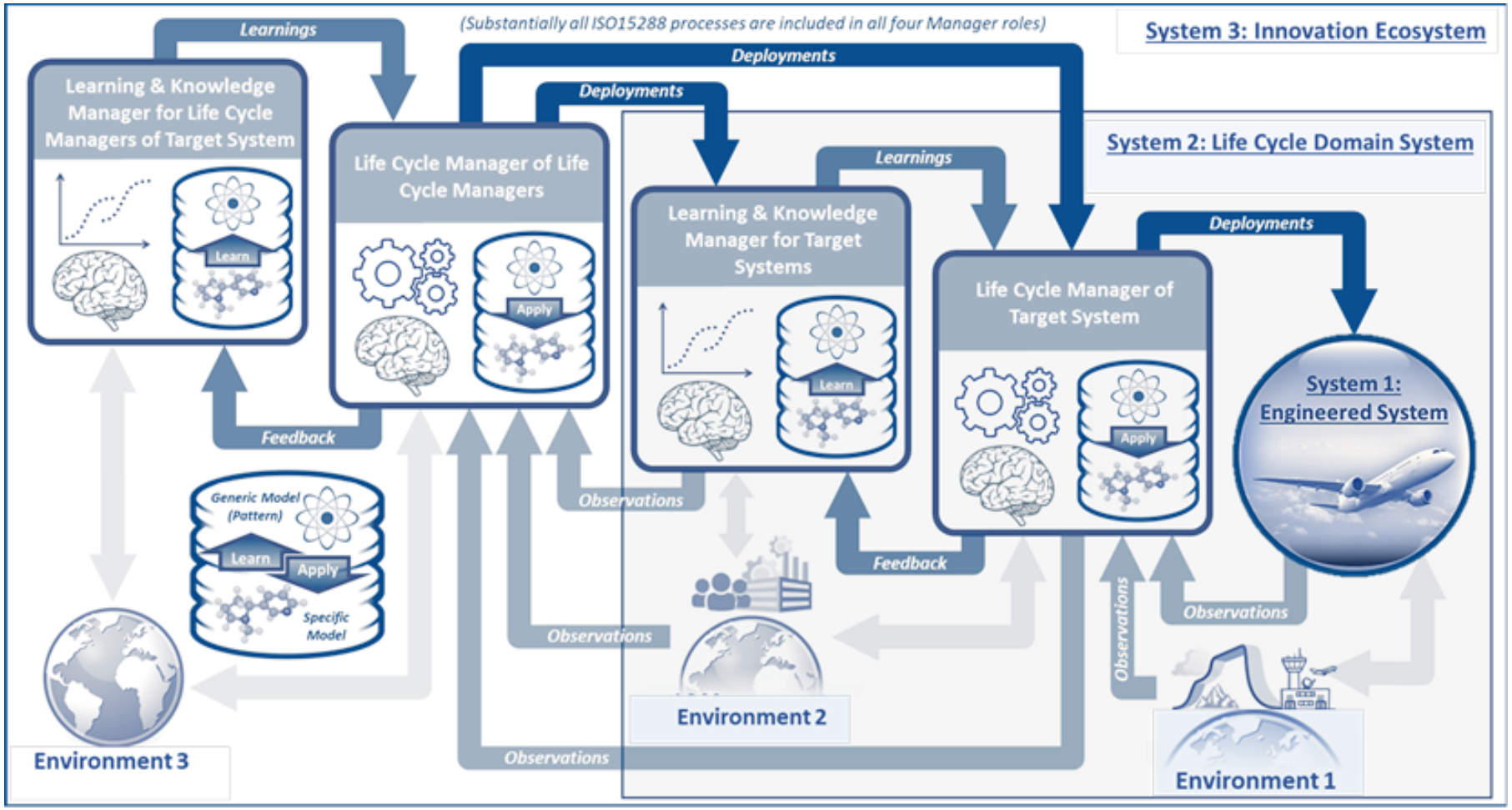


https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:is2024_hamiltonian_ecosystems_--_presentation_v1.2.1.pdf

Targeted Priority Applications of ASELCM Pattern

20. Additional Applications of the ASELCM Pattern:

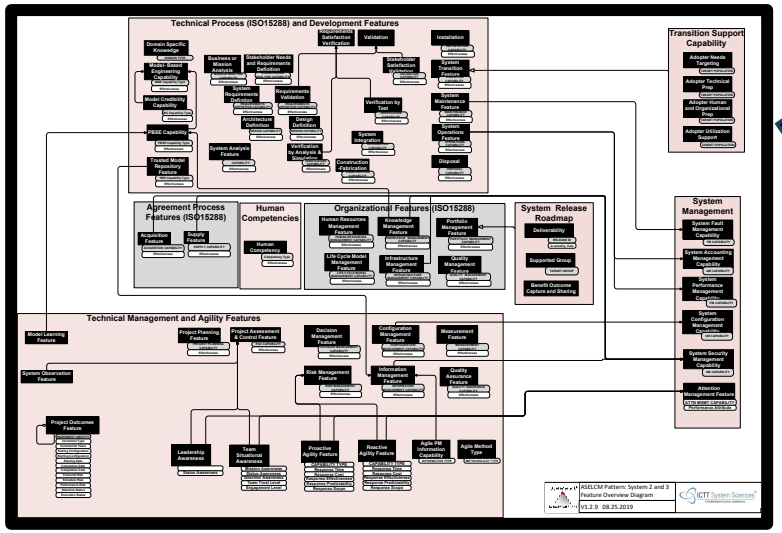
There are many other possibilities—what are the needs and opportunities?

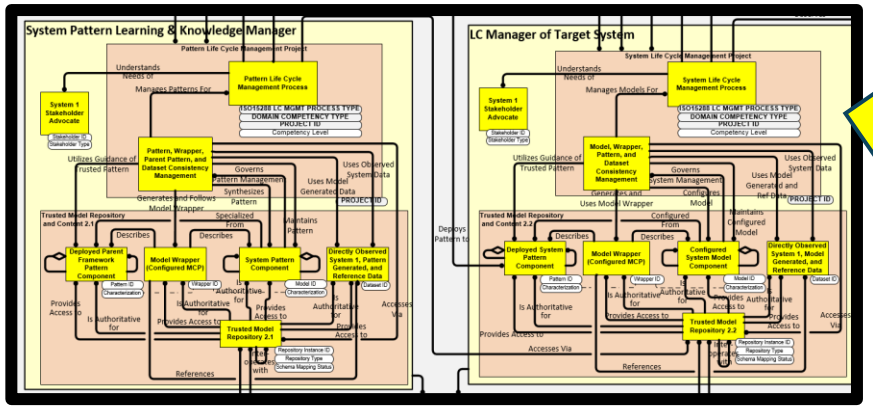


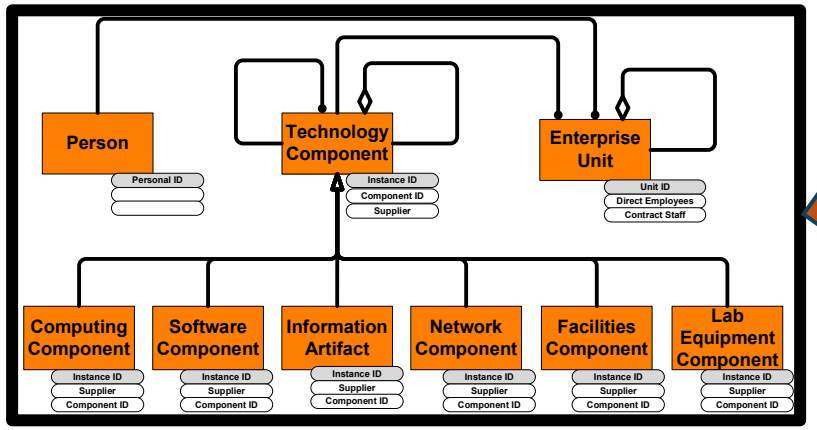
Navigating Current ASELCM S*Pattern Configuration Rules of Interest

- Environment assumed
- Supporting Assets
- General Status of the SysML Implementation of the ASELCM Pattern
- Features, Interactions, Roles, Requirements, Design Components
- What a processed ASELCM configuration looks like in Wizard
- Typical configuration run times

Model Component of the S*Pattern of System 2 & 3 (the Ecosystem Pattern)



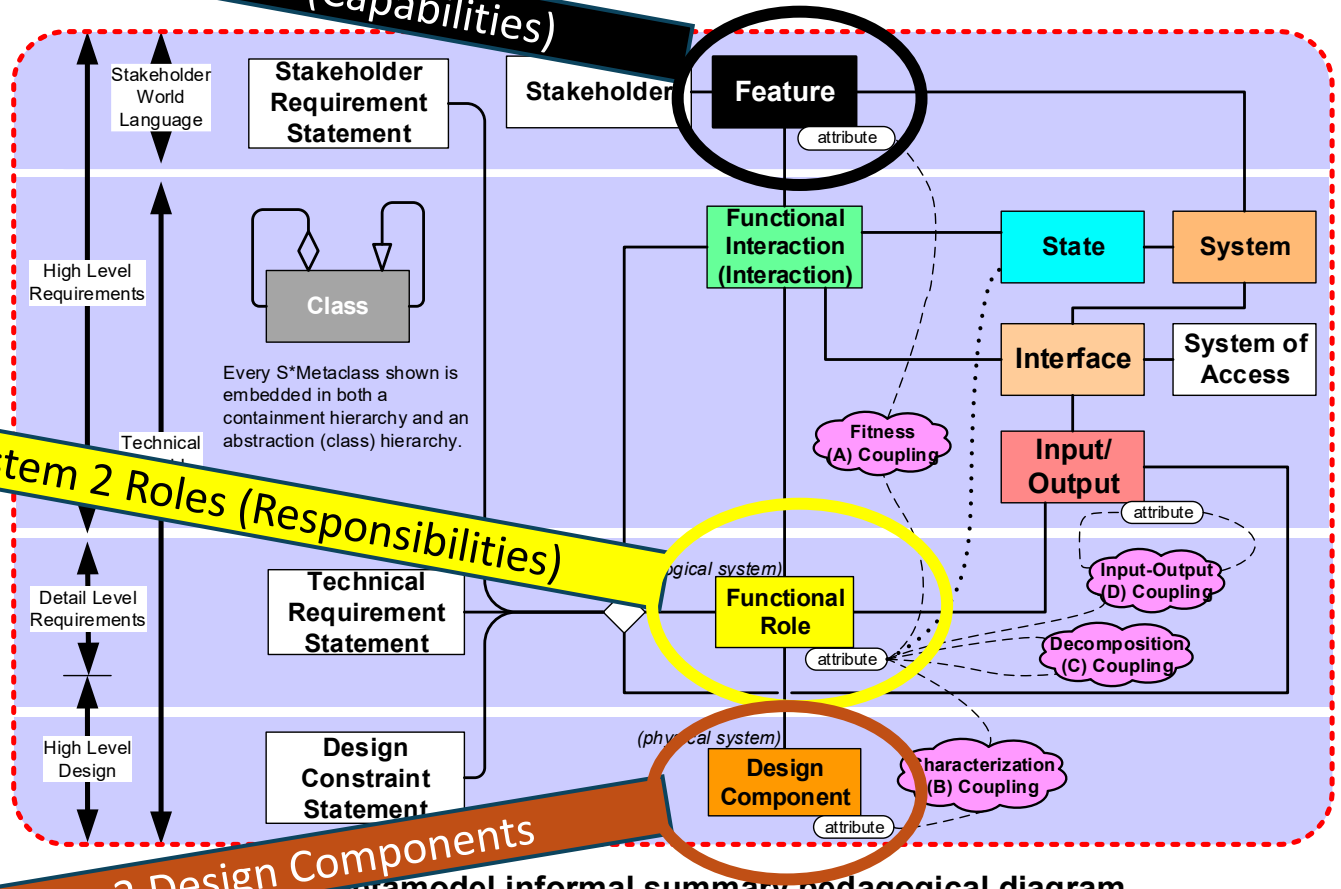




System 2 Features (Capabilities)

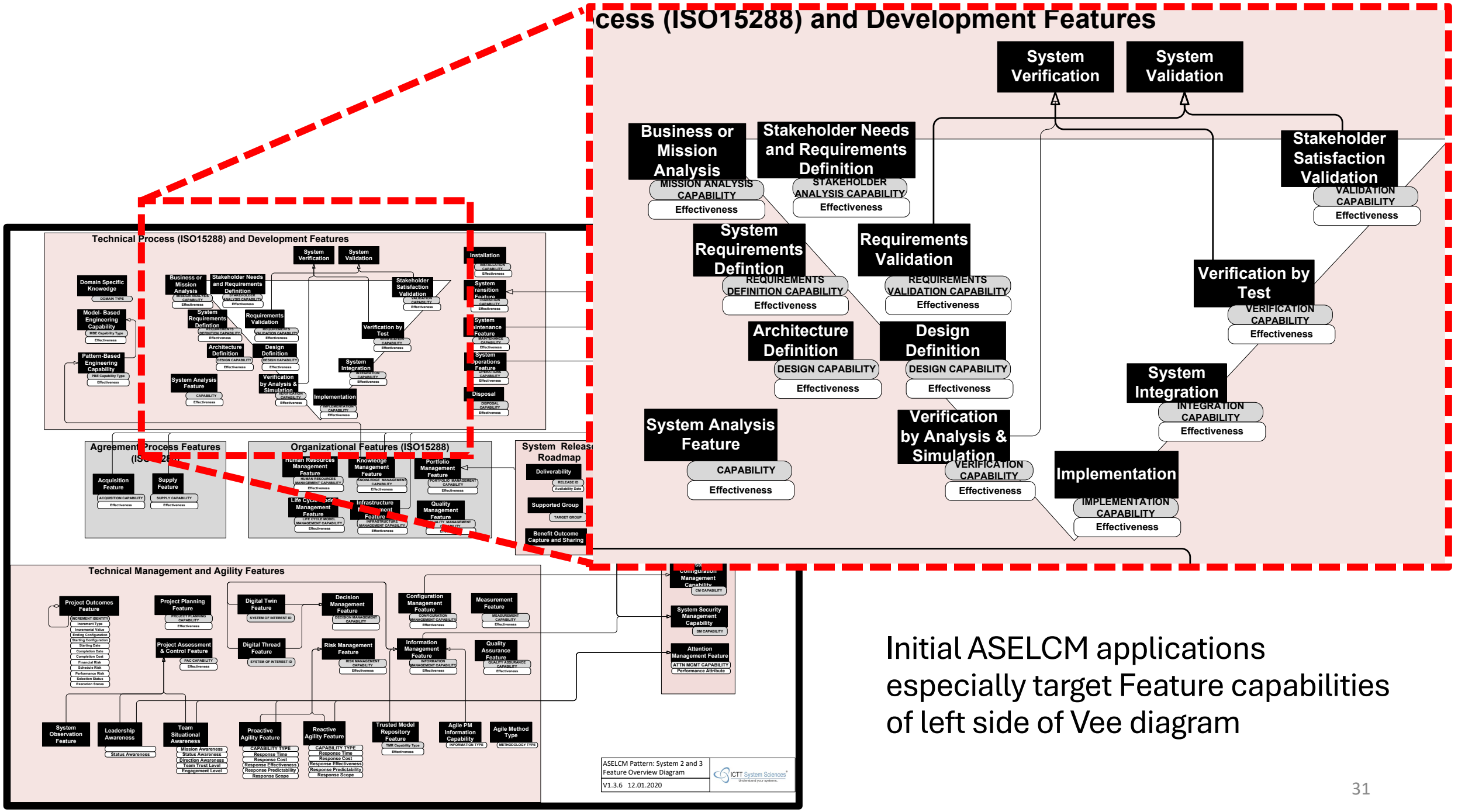
System 2 Roles (Responsibilities)

System 2 Design Components



Metamodel informal summary pedagogical diagram
(formal S*Metamodel includes additional details.)

ASELCM does not assume the Ecosystem players make any use of S*Models, or even MBSE!



Initial ASELCM applications especially target Feature capabilities of left side of Vee diagram

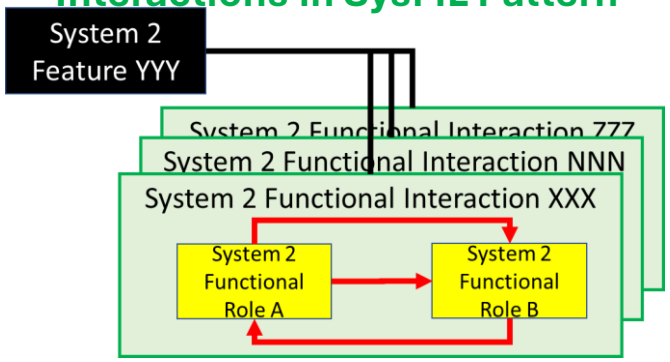
Emphasized Priorities of the ASELCM Pattern

Model Segment	Metaclass(es)	Current ASELCM Pattern Coverage, SysML Version	Configuration Rules Coverage for Populating this Segment or Metaclass
Base	Features	29 S2 / 21 S3	Populated by stakeholder
	Interactions	157 S2 or S3	95 S2/S3 Interactions populated by 14 S2 / 12 S3 Features
	Roles	17 S2 / 17 S3 L2 roles	>90% of populated Interactions populate Level 2 Roles
	Requirements	636 S2/S3 Requirements	146 Popd Interactions and 61 Roles populate 636 Requirements on 32 S2 and 29 S3 Role Types
	Design Components	100%	>90% of populated Roles have DCs
Base Updates in Progress	Above		Reallocation of configuration rules to reflect extension of Consistency Management Paradigm
Interface Context	Interfaces, Arch Relats, Ports, I-Os, SoAs	Limited Arch Relats	Future, as needed
State Model	States, Transitions, Events	Future, as needed	Future, as needed
Attribute Couplings	Parametric Couplings	Future, as needed	Future, as needed
Risk Analysis	Failure Modes, Failure Impacts Counter Requirements, Failure Context	Future, as needed	Future, as needed

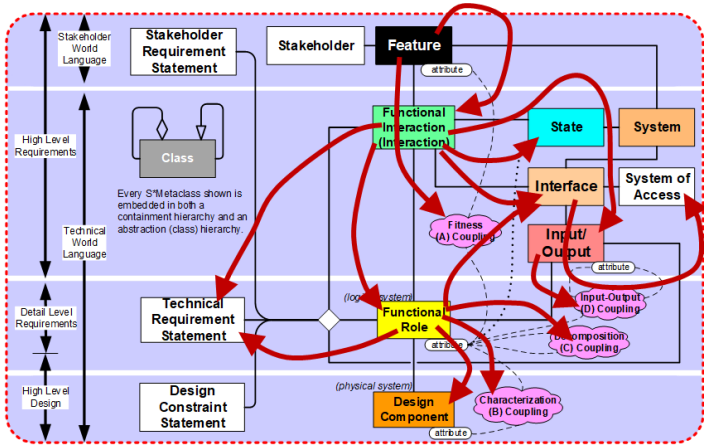
Pattern build-out priorities are driven by priorities of targeted ASELCM Applications

Selectable Stakeholder Features (Capabilities) of *System 2*

- ✓ **Feature Appears in SysML Pattern**
- ✓ **Feature Also Populates Interactions in SysML Pattern**

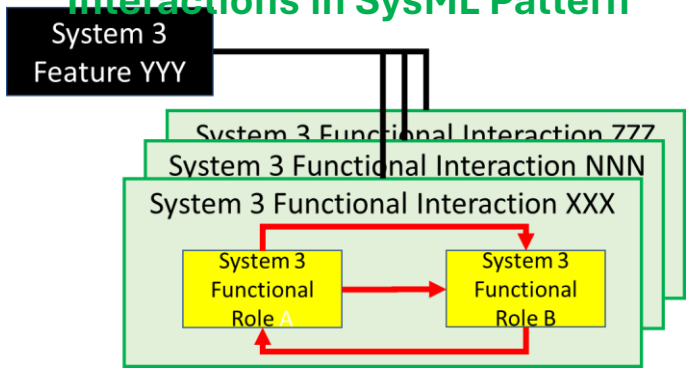


(Some S2 Interactions also involve S1 roles.)

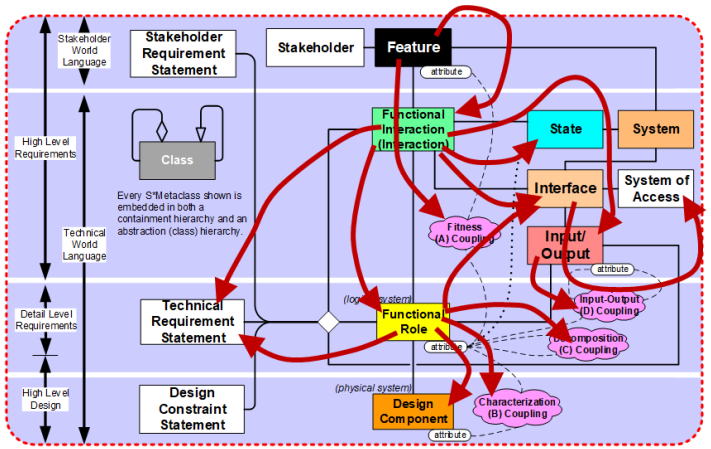


Selectable Stakeholder Features (Capabilities) of *System 3*

- ✓ **Feature Appears in SysML Pattern**
- ✓ **Feature Also Populates Interactions in SysML Pattern**



(Some S2 Interactions also involve S2 roles.)



ASELCM Pattern: System 2 and 3 Feature Overview Diagram
V1.4.1 07.13.2021
ICTT System Sciences
Understand your systems.

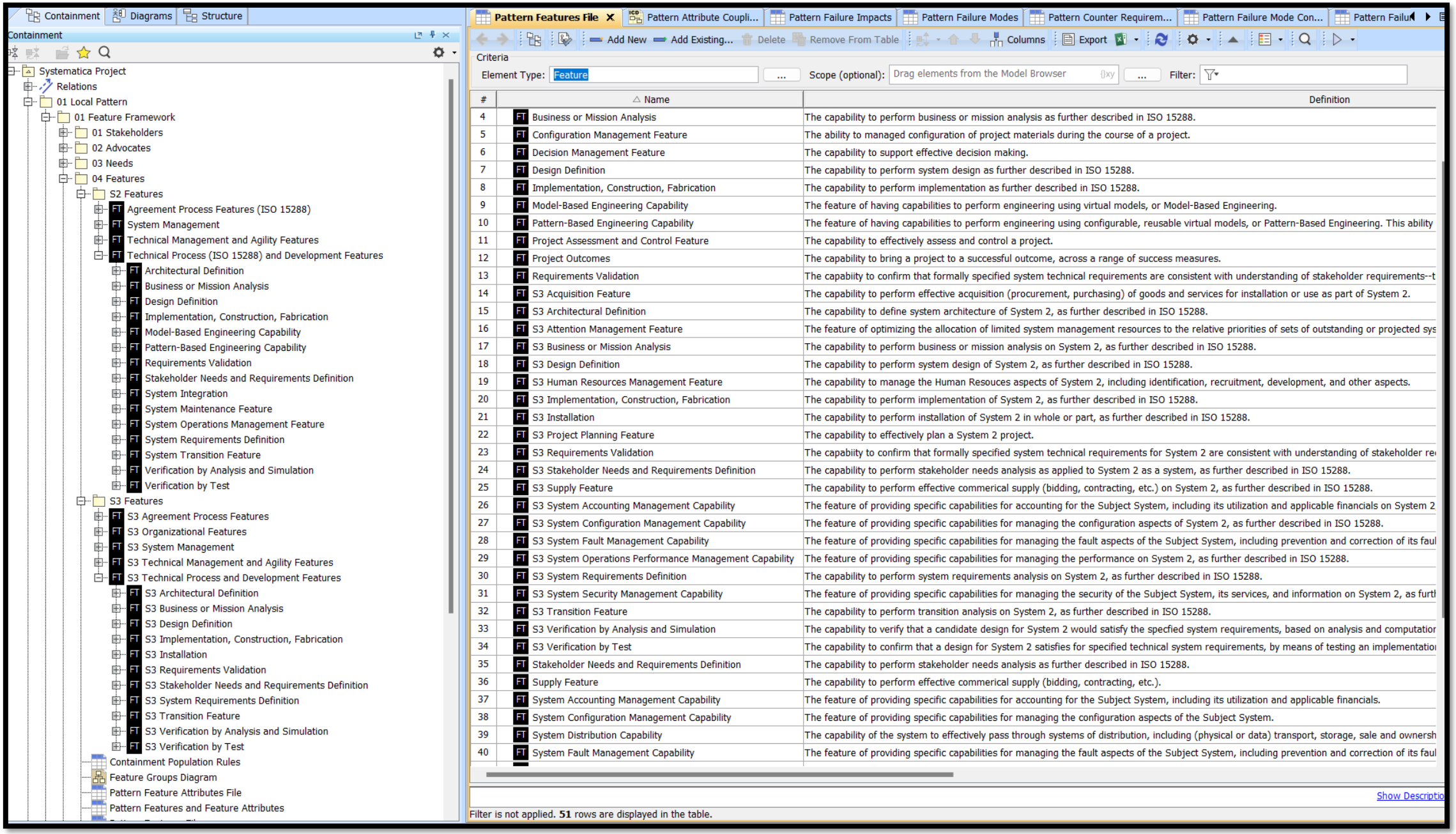
Current Feature & Interaction Conventions to help separate S2 and S3 cases

To make it easier to navigate S2 and S3 distinctions in the SysML model, some packaging and labeling updates is in progress:

Visible in the Pattern segment of browser:

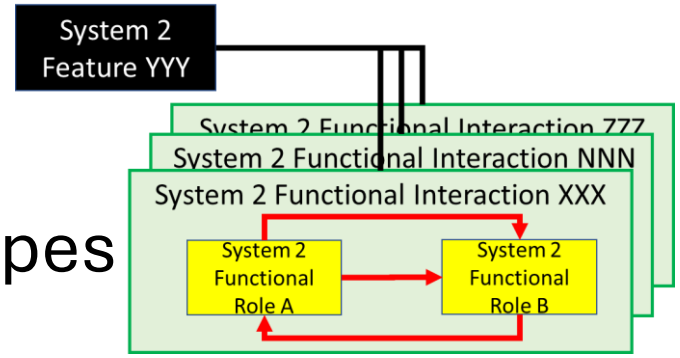
1. Separation of S2 versus S3 Features in different package folders.
2. Prefixing of Feature names for S3 Features only.
3. Separation of S2 versus S3 Interactions in different package folders.
4. Prefixing of Interaction names for S3 Interactions only.

Roles generally already had SysML labels which differentiate S2 and S3 roles.

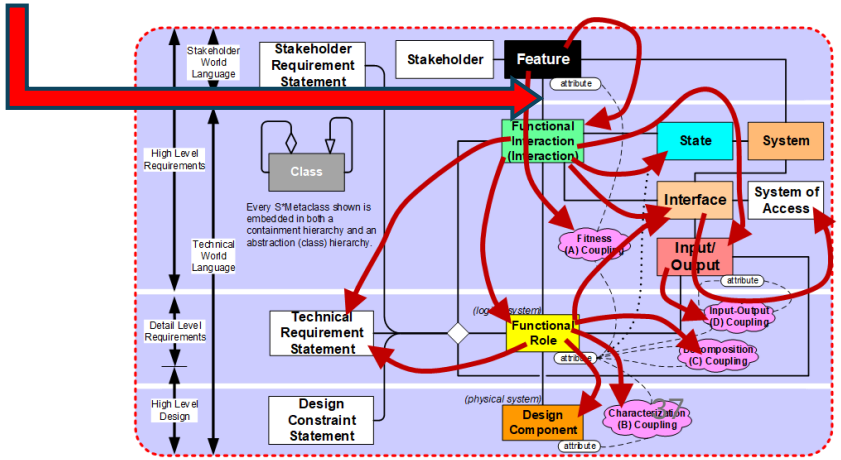


51 Total Pattern Feature Types

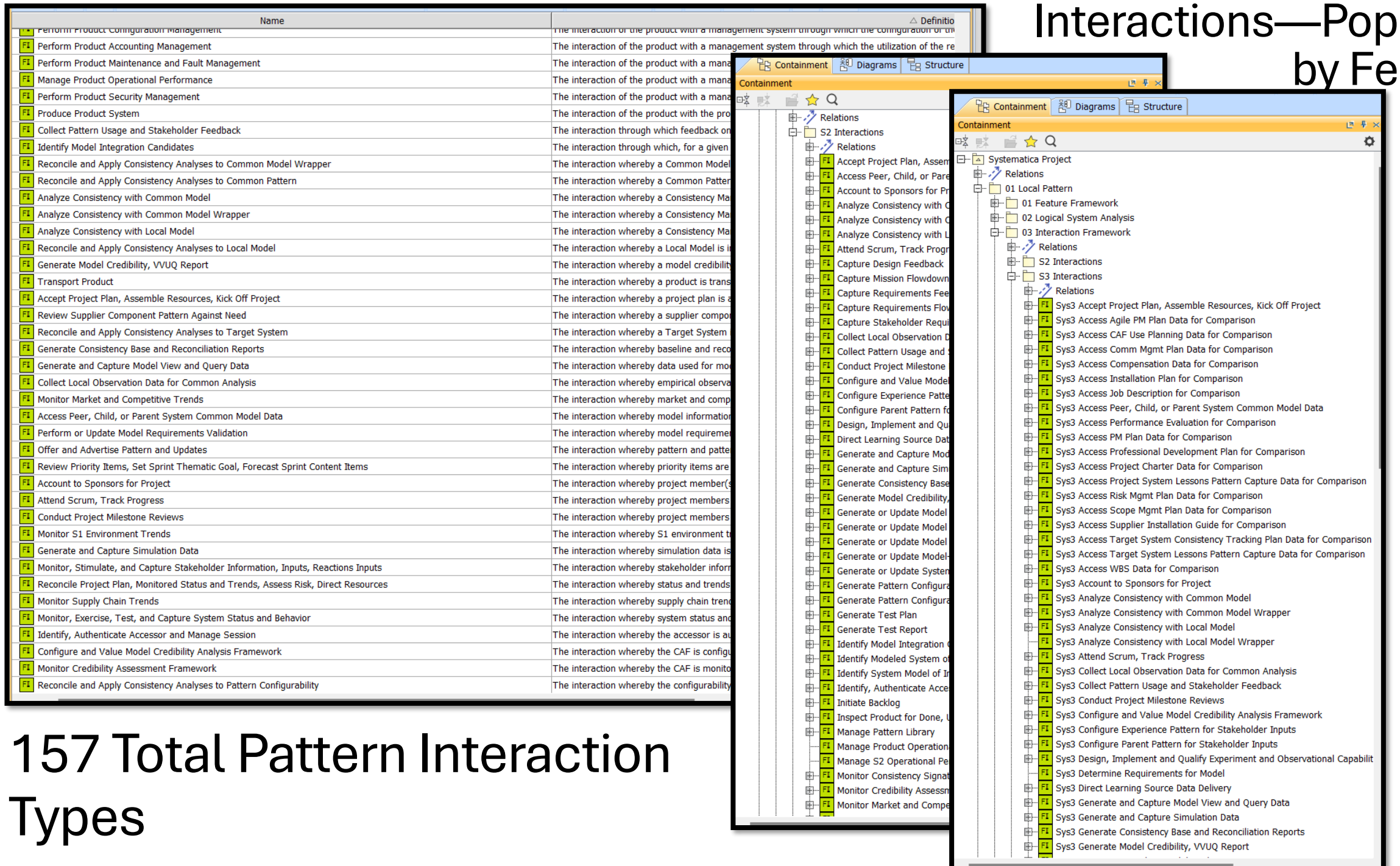
Feature-Interaction Configuration Rules



- 26 S2/S3 Features Populating 95 S2/S3 interaction types
- 325 S2 Feature-Interaction Rules:
  - 14 S2 Feature Types Populating S2/S3 Interaction Types
- 150 S3 Feature-Interaction Rules:
  - 12 S3 Feature Types Populating S2/S3 Interaction Types



Interactions—Populated by Features



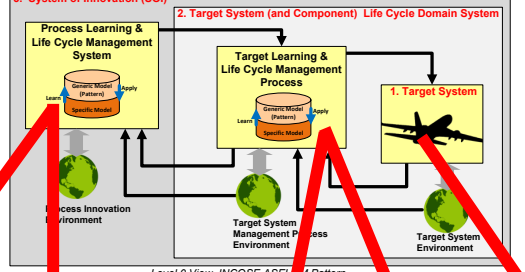
157 Total Pattern Interaction Types

Roles—Populated by Interactions

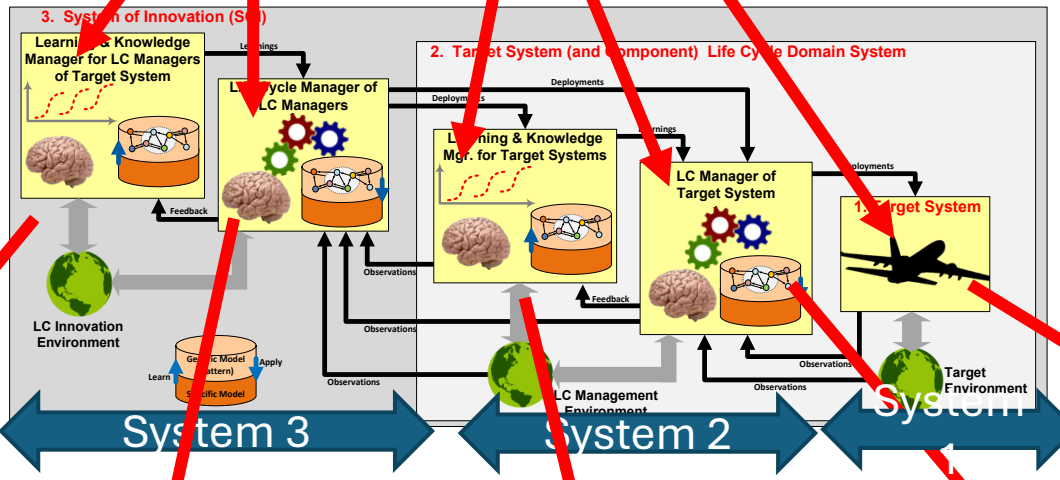
Level 0

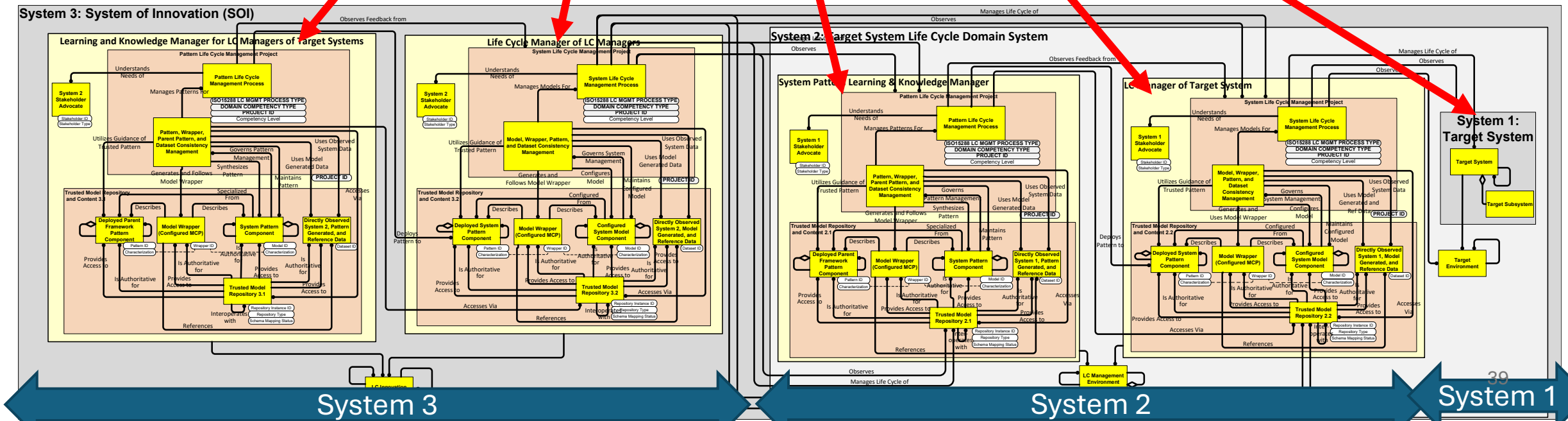
Level 1

Level 2

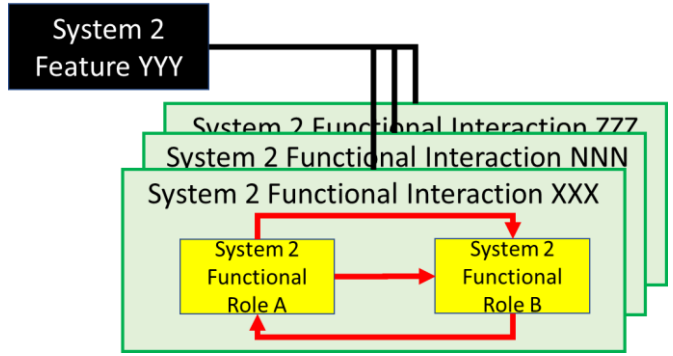


Level 0 View, INCOSE ASELCM Pattern



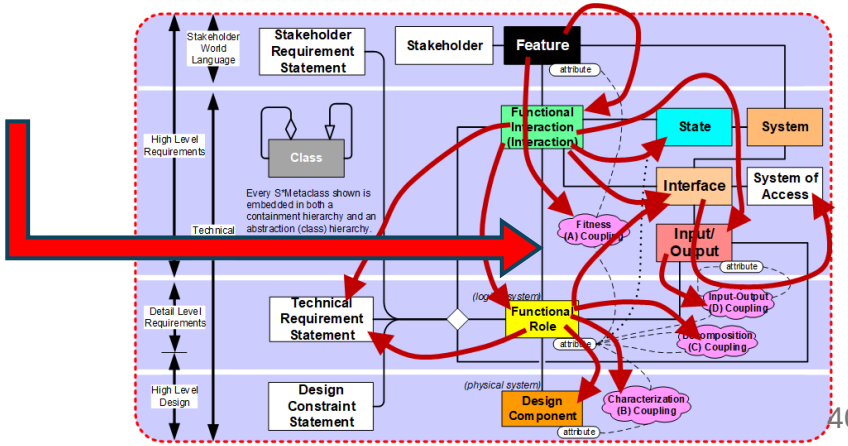


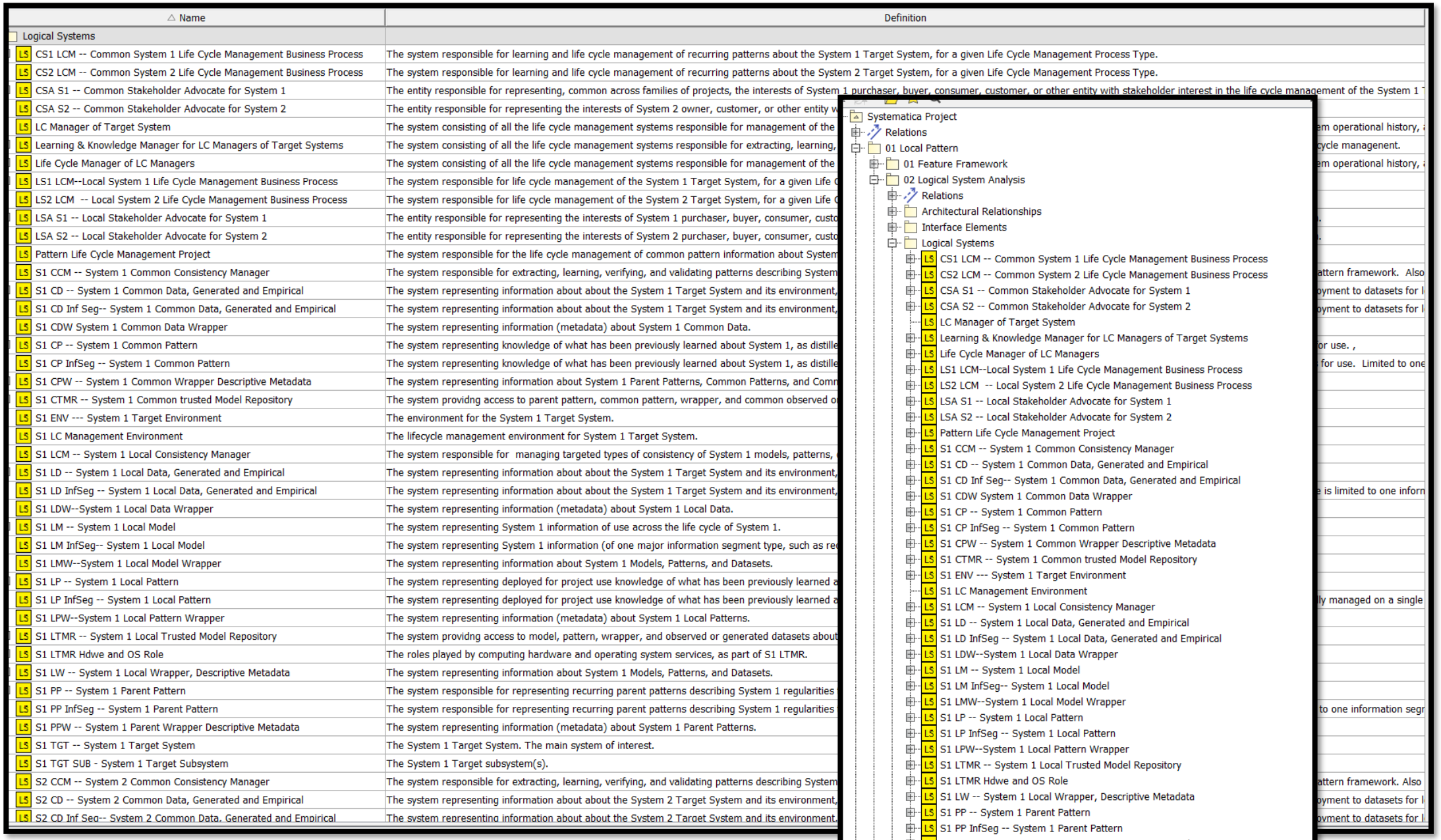
Interaction-Role Configuration Rules



- 353 S2 Interaction-Role Rules:
  - 48 S2 Interaction Types Populating 58 S2 and S3 Role Types

- 431 S3 Interaction-Role Rules:
  - 74 S3 Interaction Types Populating 58 S2 and S3 Role Types





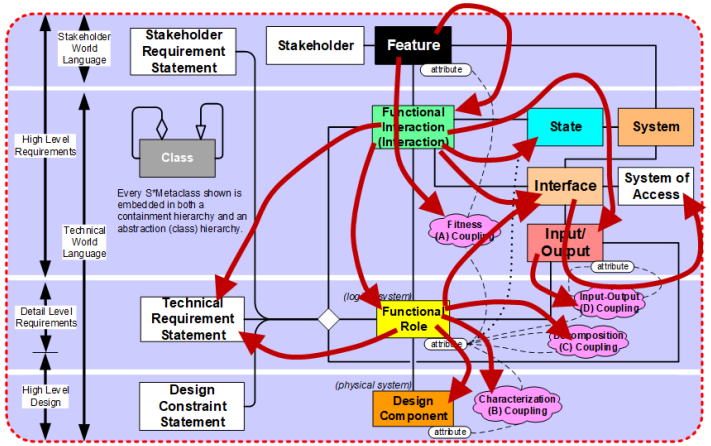
Name	Definition
Logical Systems	
CS1 LCM -- Common System 1 Life Cycle Management Business Process	The system responsible for learning and life cycle management of recurring patterns about the System 1 Target System, for a given Life Cycle Management Process Type.
CS2 LCM -- Common System 2 Life Cycle Management Business Process	The system responsible for learning and life cycle management of recurring patterns about the System 2 Target System, for a given Life Cycle Management Process Type.
CSA S1 -- Common Stakeholder Advocate for System 1	The entity responsible for representing, common across families of projects, the interests of System 1 purchaser, buyer, consumer, customer, or other entity with stakeholder interest in the life cycle management of the System 1
CSA S2 -- Common Stakeholder Advocate for System 2	The entity responsible for representing the interests of System 2 owner, customer, or other entity w
LC Manager of Target System	The system consisting of all the life cycle management systems responsible for management of the
Learning & Knowledge Manager for LC Managers of Target Systems	The system consisting of all the life cycle management systems responsible for extracting, learning,
Life Cycle Manager of LC Managers	The system consisting of all the life cycle management systems responsible for management of the
LS1 LCM--Local System 1 Life Cycle Management Business Process	The system responsible for life cycle management of the System 1 Target System, for a given Life C
LS2 LCM -- Local System 2 Life Cycle Management Business Process	The system responsible for life cycle management of the System 2 Target System, for a given Life C
LSA S1 -- Local Stakeholder Advocate for System 1	The entity responsible for representing the interests of System 1 purchaser, buyer, consumer, custo
LSA S2 -- Local Stakeholder Advocate for System 2	The entity responsible for representing the interests of System 2 purchaser, buyer, consumer, custo
Pattern Life Cycle Management Project	The system responsible for the life cycle management of common pattern information about System
S1 CCM -- System 1 Common Consistency Manager	The system responsible for extracting, learning, verifying, and validating patterns describing System
S1 CD -- System 1 Common Data, Generated and Empirical	The system representing information about about the System 1 Target System and its environment,
S1 CD Inf Seg-- System 1 Common Data, Generated and Empirical	The system representing information about about the System 1 Target System and its environment,
S1 CDW System 1 Common Data Wrapper	The system representing information (metadata) about System 1 Common Data.
S1 CP -- System 1 Common Pattern	The system representing knowledge of what has been previously learned about System 1, as distille
S1 CP InfSeg -- System 1 Common Pattern	The system representing knowledge of what has been previously learned about System 1, as distille
S1 CPW -- System 1 Common Wrapper Descriptive Metadata	The system representing information about System 1 Parent Patterns, Common Patterns, and Comm
S1 CTMR -- System 1 Common trusted Model Repository	The system providng access to parent pattern, common pattern, wrapper, and common observed o
S1 ENV --- System 1 Target Environment	The environment for the System 1 Target System.
S1 LC Management Environment	The lifecycle management environment for System 1 Target System.
S1 LCM -- System 1 Local Consistency Manager	The system responsible for managing targeted types of consistency of System 1 models, patterns,
S1 LD -- System 1 Local Data, Generated and Empirical	The system representing information about about the System 1 Target System and its environment,
S1 LD InfSeg -- System 1 Local Data, Generated and Empirical	The system representing information about about the System 1 Target System and its environment,
S1 LDW--System 1 Local Data Wrapper	The system representing information (metadata) about System 1 Local Data.
S1 LM -- System 1 Local Model	The system representing System 1 information of use across the life cycle of System 1.
S1 LM InfSeg-- System 1 Local Model	The system representing System 1 information (of one major information segment type, such as re
S1 LMW--System 1 Local Model Wrapper	The system representing information about System 1 Models, Patterns, and Datasets.
S1 LP -- System 1 Local Pattern	The system representing deployed for project use knowledge of what has been previously learned a
S1 LP InfSeg -- System 1 Local Pattern	The system representing deployed for project use knowledge of what has been previously learned a
S1 LPW--System 1 Local Pattern Wrapper	The system representing information (metadata) about System 1 Local Patterns.
S1 LTMR -- System 1 Local Trusted Model Repository	The system providng access to model, pattern, wrapper, and observed or generated datasets about
S1 LTMR Hdwe and OS Role	The roles played by computing hardware and operating system services, as part of S1 LTMR.
S1 LW -- System 1 Local Wrapper, Descriptive Metadata	The system representing information about System 1 Models, Patterns, and Datasets.
S1 PP -- System 1 Parent Pattern	The system responsible for representing recurring parent patterns describing System 1 regularities
S1 PP InfSeg -- System 1 Parent Pattern	The system responsible for representing recurring parent patterns describing System 1 regularities
S1 PPW -- System 1 Parent Wrapper Descriptive Metadata	The system representing information (metadata) about System 1 Parent Patterns.
S1 TGT -- System 1 Target System	The System 1 Target System. The main system of interest.
S1 TGT SUB - System 1 Target Subsystem	The System 1 Target subsystem(s).
S2 CCM -- System 2 Common Consistency Manager	The system responsible for extracting, learning, verifying, and validating patterns describing System
S2 CD -- System 2 Common Data, Generated and Empirical	The system representing information about about the System 2 Target System and its environment,
S2 CD Inf Seg-- System 2 Common Data, Generated and Empirical	The system representing information about about the System 2 Target System and its environment,

131 Total Pattern Role Types

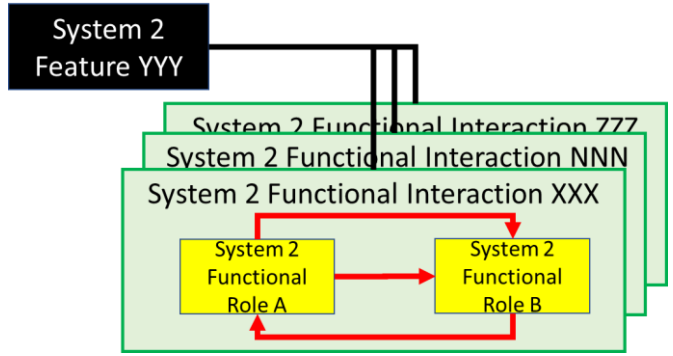
Requirements

Requirements—Populated by Interaction-Role Pairs

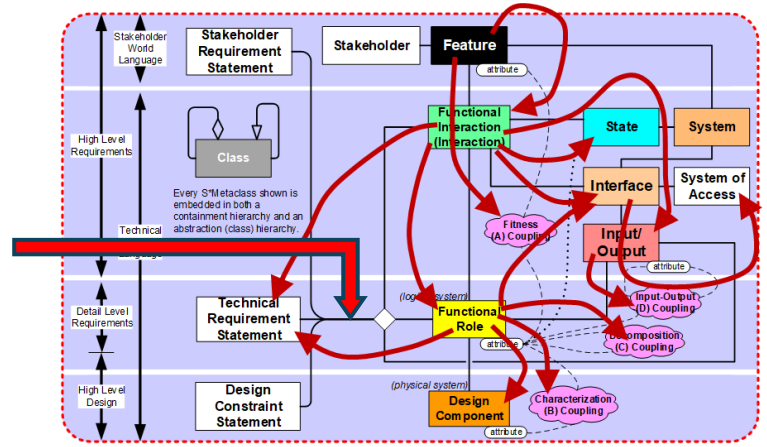
Functional Interaction	IPK Value	Functional Role	RPK Value	Name	RSPK Rule	Text
Analyze Consistency with Local Model	*ANY*	S1 LCM -- System 1 Local Consistency Manager	*ANY*	ACLM001	IPK	The system shall analyze consistency of the [Informed Capability Comparison Input] and the Local Model to produce the associated Consistency View and its Data Wrapper.
Analyze Consistency with Local Model	*ANY*	S1 LD InfSeg -- System 1 Local Data, Generated and Empirical	*ANY*	ACLM002	IPK	The System shall receive the Consistency View and maintain its persistence for future aecess.
Analyze Consistency with Local Model	*ANY*	S1 LDW--System 1 Local Data Wrapper	*ANY*	ACLM003	IPK	The system shall receive Data Wrapper metadata and maintain its persistence for future use.
Analyze Consistency with Local Model	*ANY*	S1 LM InfSeg-- System 1 Local Model	*ANY*	ACLM004	IPK	The system shall recall and present persistent Local Model information for use in Consistency Analysis.
Analyze Consistency with Local Model	*ANY*	S1 LMW--System 1 Local Model Wrapper	*ANY*	ACLM005	IPK	The System shall provide Model Wrapper metadata describing the Local Model and is credibility, for use in consistency analysis.
Configure Experience Pattern for Stakeholder Inputs	*ANY*	S1 LCM -- System 1 Local Consistency Manager	*ANY*	CEPSI001	IPK	The system shall request, accept, and apply the [Mission Configuration Stakeholder Input] to configure the Experience Pattern, retaining the configured result for consistency comparison.
Configure Experience Pattern for Stakeholder Inputs	*ANY*	S1 LD InfSeg -- System 1 Local Data, Generated and Empirical	*ANY*	CEPSI002	IPK	The System shall receive the Configured Experience Pattern and maintain its persistence for future access.
Configure Experience Pattern for Stakeholder Inputs	*ANY*	S1 LDW--System 1 Local Data Wrapper	*ANY*	CEPSI003	IPK	The system shall receive Data Wrapper metadata and maintain its persistence for future use.
Configure Experience Pattern for Stakeholder Inputs	*ANY*	LS1 LCM--Local System 1 Life Cycle Management Business Process	*ANY*	CEPSI004	IPK	The system shall request and receive the [Mission Configuration Input] and provide it as [Mission Configuration Stakeholder Input] to the experience pattern configuration process.
Configure Experience Pattern for Stakeholder Inputs	*ANY*	LSA S1 -- Local Stakeholder Advocate for System 1	*ANY*	CEPSI005	IPK	The system shall provide the [Mission Configuration Stakeholder Input] for use in configuring an experience pattern to the specific stakeholder needs and situation.
Configure Experience Pattern for Stakeholder Inputs	*ANY*	S1 LP -- System 1 Local Pattern	*ANY*	CEPSI006	IPK	The system shall provide Local Pattern experience data for subsequent configuration to the specific stakeholder needs and situation.
Configure Experience Pattern for Stakeholder Inputs	*ANY*	S1 LPW--System 1 Local Pattern Wrapper	*ANY*	CEPSI007	IPK	The system shall provide metadata describing the local experience pattern and its credibility.
Generate and Capture Simulation Data	*ANY*	S1 LCM -- System 1 Local Consistency Manager	*ANY*	GCSD001	IPK	The system shall request and accept Simulation Data, retaining it for consistency comparison.
Generate and Capture Simulation Data	*ANY*	S1 LD InfSeg -- System 1 Local Data, Generated and Empirical	*ANY*	GCSD002	IPK	The System shall receive the Simulation Data and maintain its persistence for future access



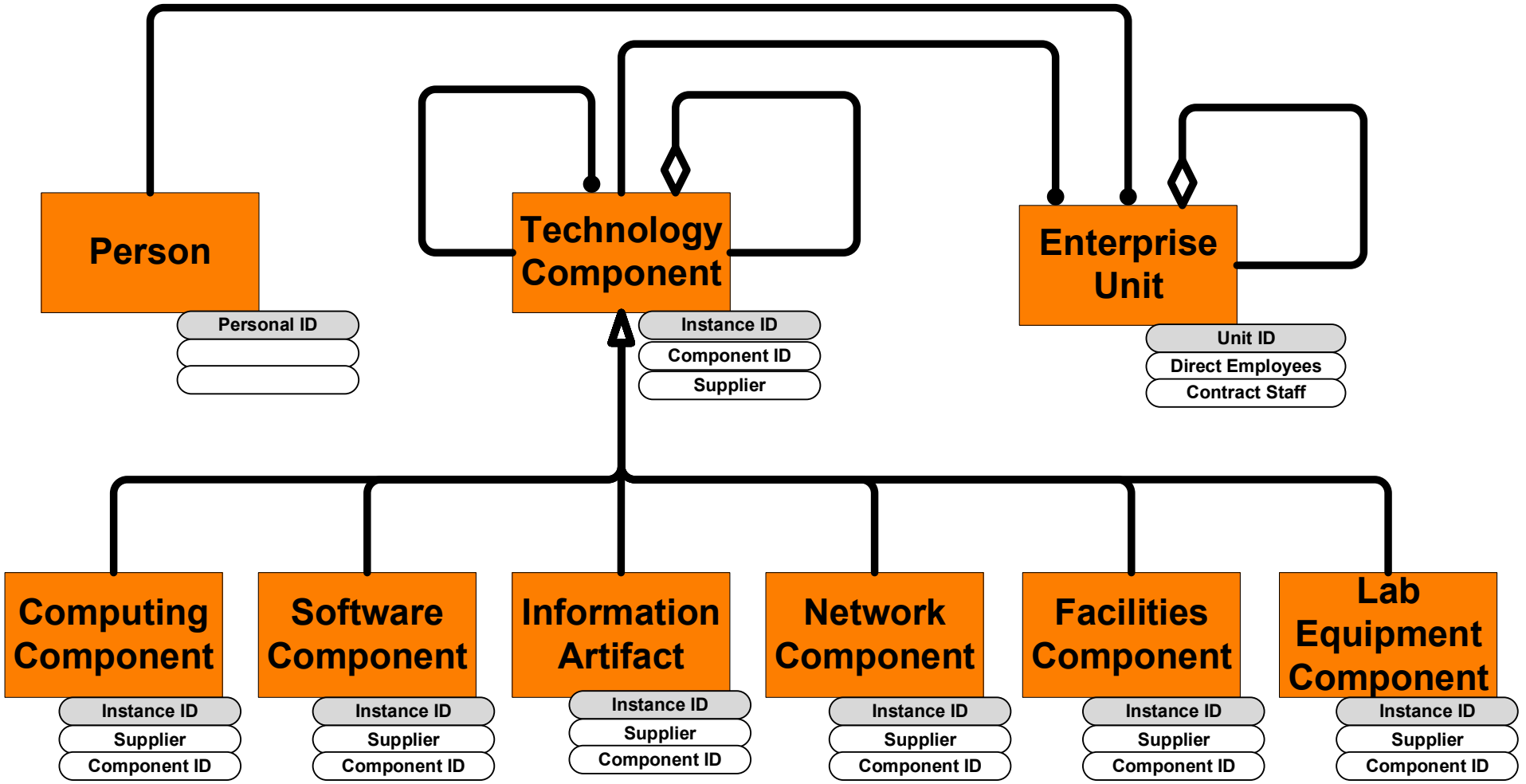
Interaction-Role-Requirement Configuration Rules



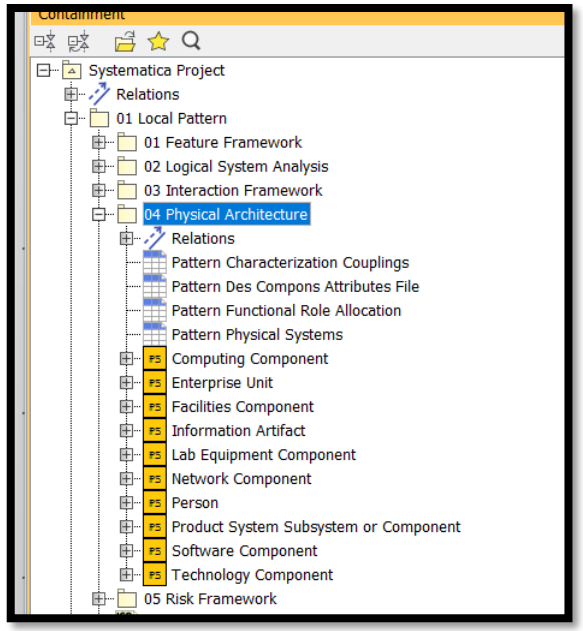
- 636 S2 and S3 Interaction-Role-Req Rules:
  - 146 S2/S3 Interaction Types and 61 S2/S3 Role Types Pop'ing 636 Req Types
    - Requirements on 32 S2 Role Types
    - Requirements on 29 S3 Role Types

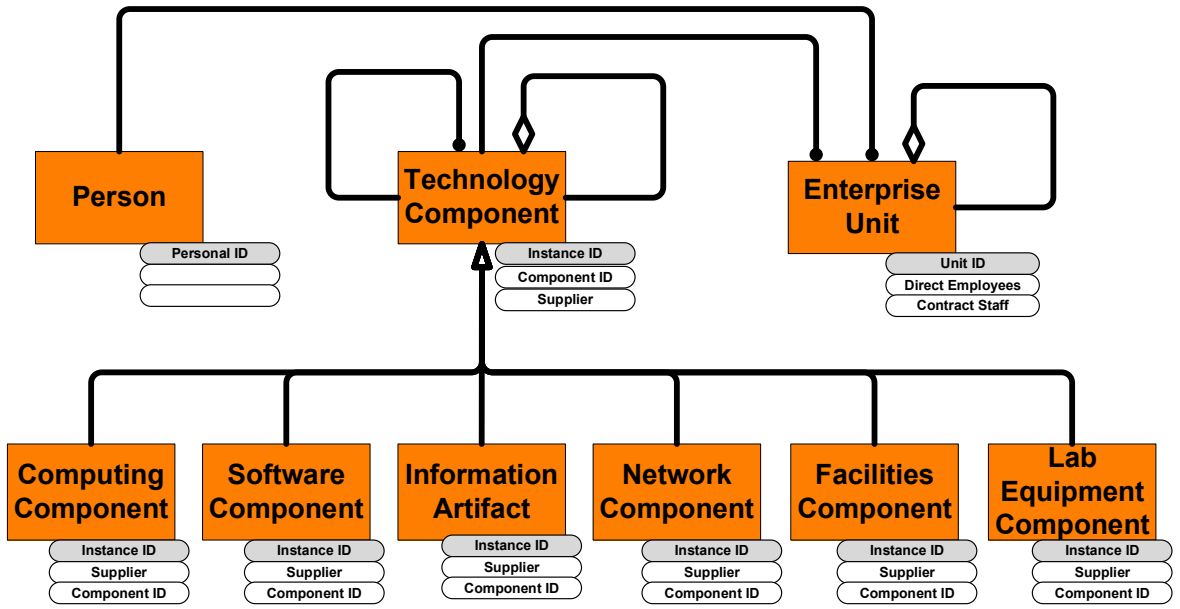


ASELCM Resources:
The Design Components of ASELCM Systems 2 and 3



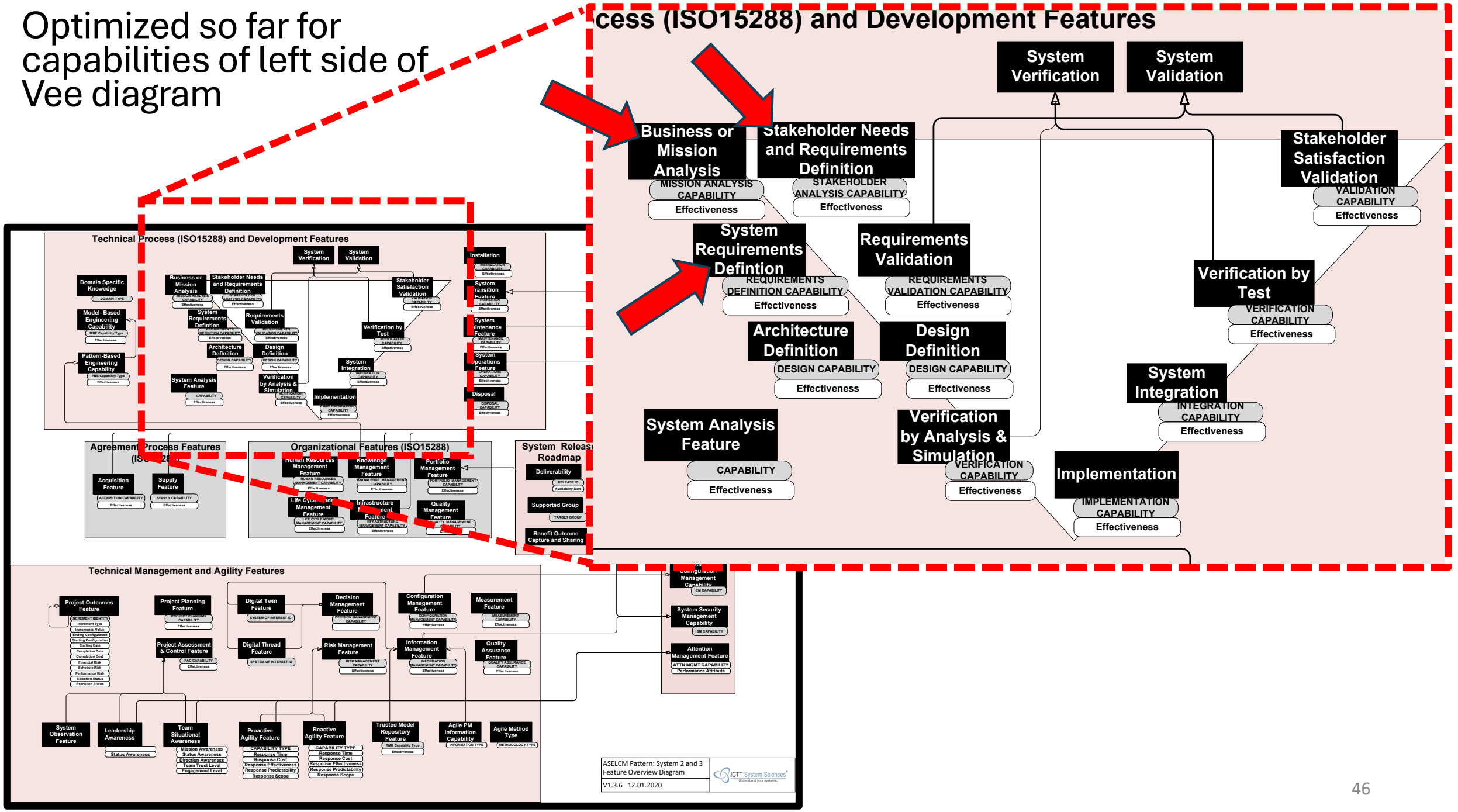
Name	Definition
Person	An identified person or set of people.
Enterprise Unit	A named organizational unit of an enterprise. May contain or be contained by another Enterprise Unit.
Software Component	A computing software component. May contain or be contained by anotehr Software Component.
Information Artifact	A document, digital file, or other information-bearing artifact of a process.
Network Component	An electronic communication network component. May contain or be contained by another Network Component.
Computing Component	A computing hardware component. May contain or be contained by another Computing Component
Product System Subsystem or Component	A component, subsystem, or all of a product system. May contain or be contained by another Product, System, or Component
Technology Component	A named technology component, including equipment, facilities, hardware, software. May contain or be contained by another Technology Component.
Facilities Component	A component of a building facility. May contain or be contained by another Facilities Component.
Lab Equipment Component	An equipment component which is part of a laboratory. May contain or be contained by another Lab Equipment Component.

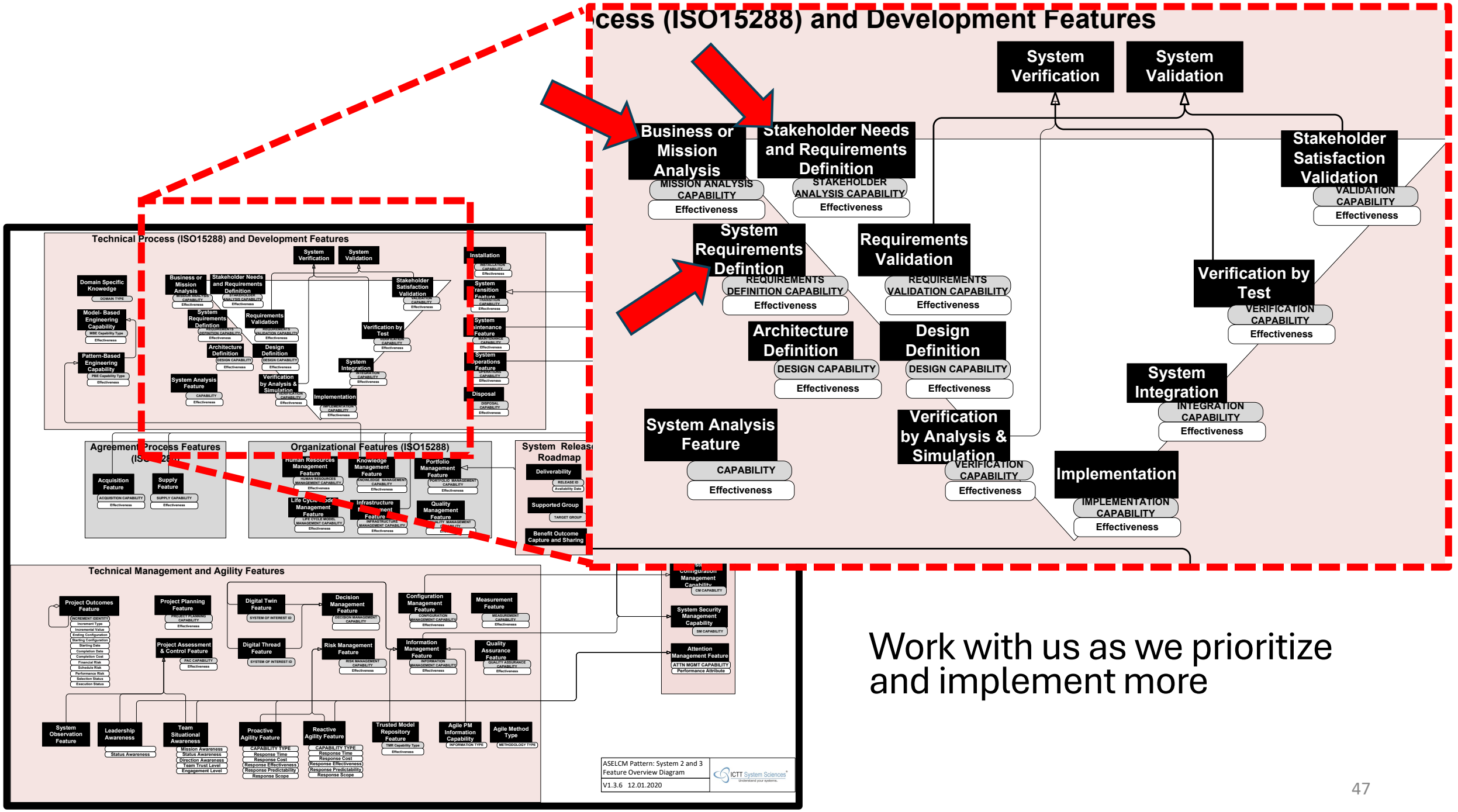




10 Pattern Design Component Types (9 for S2/S3, 1 for S1)

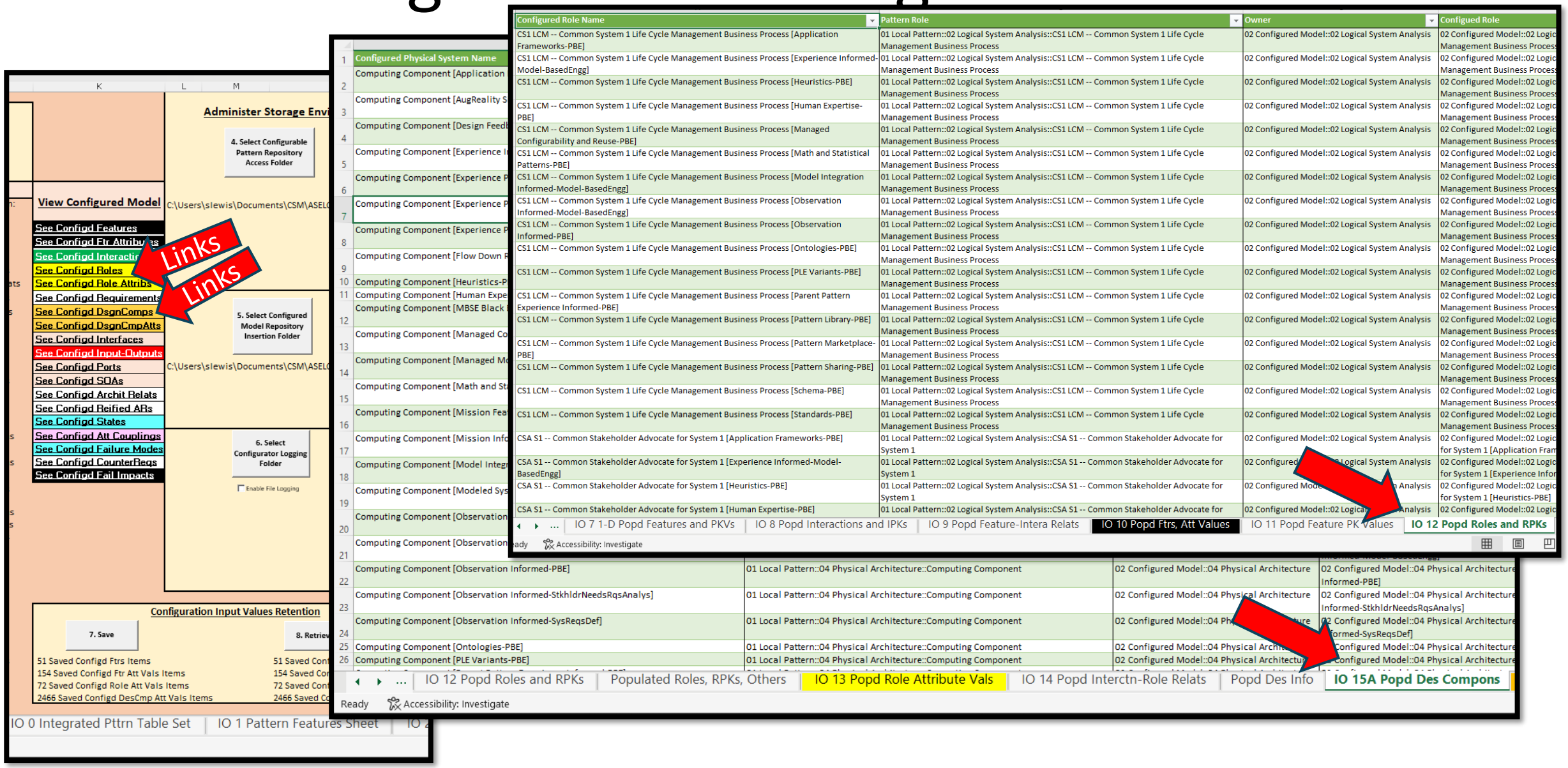
Optimized so far for capabilities of left side of Vee diagram





Work with us as we prioritize and implement more

ASELCM configuration in Configuration Wizard



Typical ASELCM Pattern Configuration Run Times

Times shown are for a simple 2.7 GHZ laptop running both applications locally. Faster performance has been observed when same applications run in cloud.

Configured ASELCM Model Size	Pattern Export from CSM	Load Exported Pattern into Configuration Wizard	Generate Configured Model Within Wizard	Configured Model Export by Wizard	Configured Model Import into CSM
Short (1 Feature / FPK Values)	< 1 minute (2805 items)	< 1 minute (10,418 items)	< 1 minute (1,514 items)	< 1 minute (842 items)	< 1 minute (1,068 items)
Example (5 Features / FPK Values)	< 1 minute (2805 items)	< 1 minute (10,418 items)	< 1 minute (11,146 items)	< 1 minute (6,651 items)	4 minutes (9,180 items)
Long (25 Features / FPK Values)	< 1 minute (2805 items)	< 1 minute (10,418 items)	1 minute (33,120 items)	< 1 minute (19,328 items)	2 minutes (27,261 items)

Growth

Growth

Some additional processing of pattern by wizard results in item expansion

Some configured model items import as multiple CSM items

Plans for What Comes Next

Manual inconsistency detection and reconciliation framework

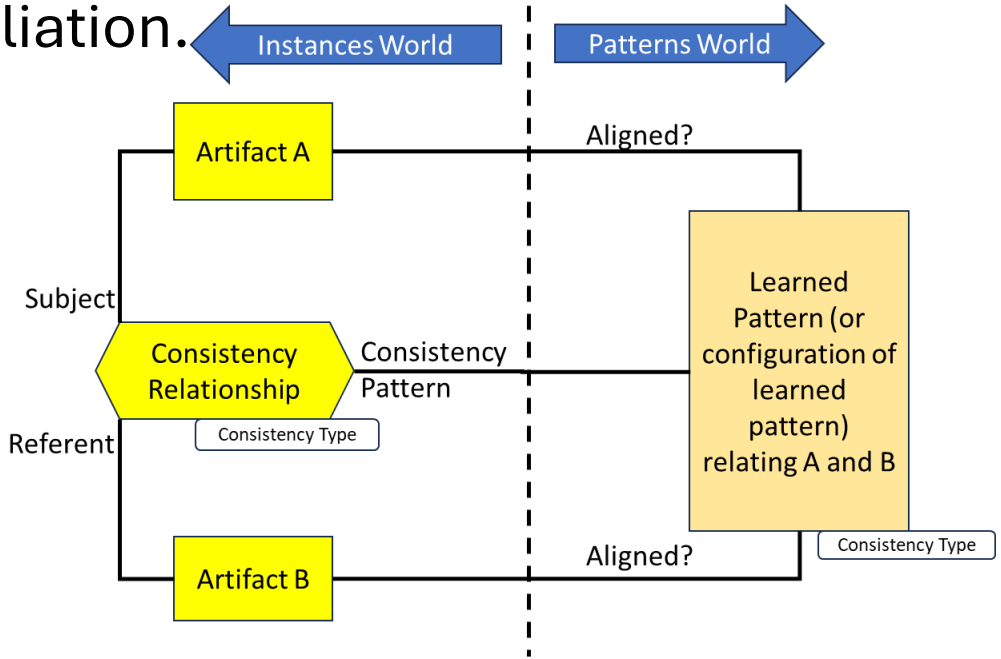
- Credible manual detection and reconciliation examples are required first, illustrating understanding of the artifact information and consistencies, even though human-borne.

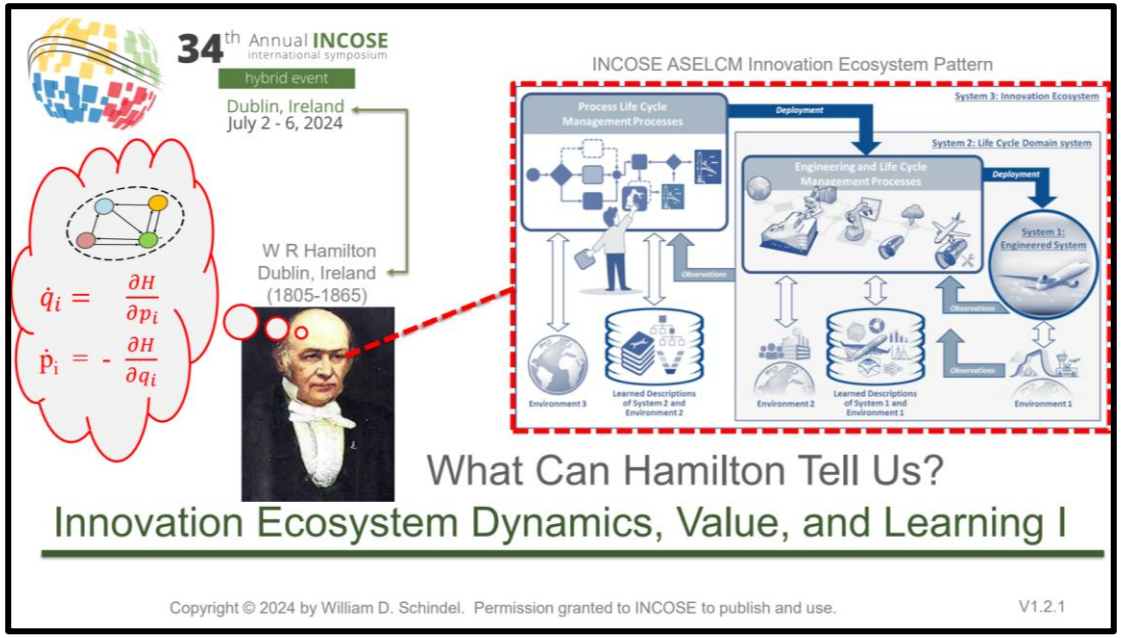
Basic automated inconsistency detection and reconciliation framework

- Limited automation of this framework should follow the manual case, after demonstrating understanding of the manual case first.

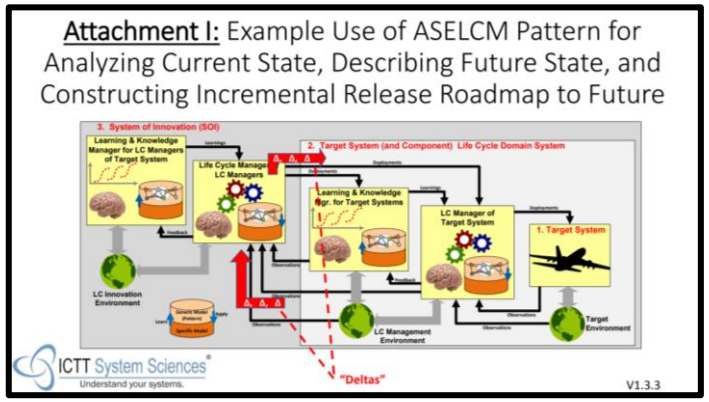
Investigating AI aids for inconsistency detection and reconciliation

- Patterns are what machine learning agents extract.
- Patterns are what physical sciences uncovered.
- Physics informed neural networks (PINNs) illustrate the combination.
- Patterns are applied to consistency detection and reconciliation.



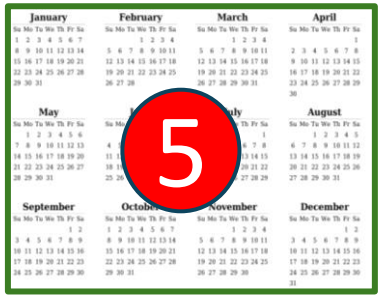


- https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:is2024_hamiltonian_ecosystems_--_presentation_v1.2.1.pdf
- https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:incose_is2024_hamiltonian_ecosystem_schindel_v1.6.2.pdf



https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:example_evolutionary_roadmap_v1.3.3a.pdf





Homework assignment:

1. Review the Analysis and Planning Procedure Application, in the context of ecosystem (System 2) or ecosubsystem of interest to you or your customer. Pick a System 2 Pattern Feature of interest to stakeholders for improvement.

2 Mark up the ASELCM Features to represent the desired deltas in the current capabilities of the existing System 2 organization.

3 Mark up the ASELCM Roles to represent the implied deltas to those Roles necessary to deliver the deltas to the ASELCM Features.

4 Mark up the ASELCM Design Components necessary to deliver the performance deltas of the ASELCM Roles.

5 Allocate the deltas identified above to series of capability releases over calendar time, as the basis of planning and implementation. (An incremental release train/roadmap.)

6. Perform 2-5 first for System 2. If System 3 is not already capable of causing those changes to System 2, then perform 2-5 to identify deltas to System 3.

Discussion, questions

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