Document Instructions

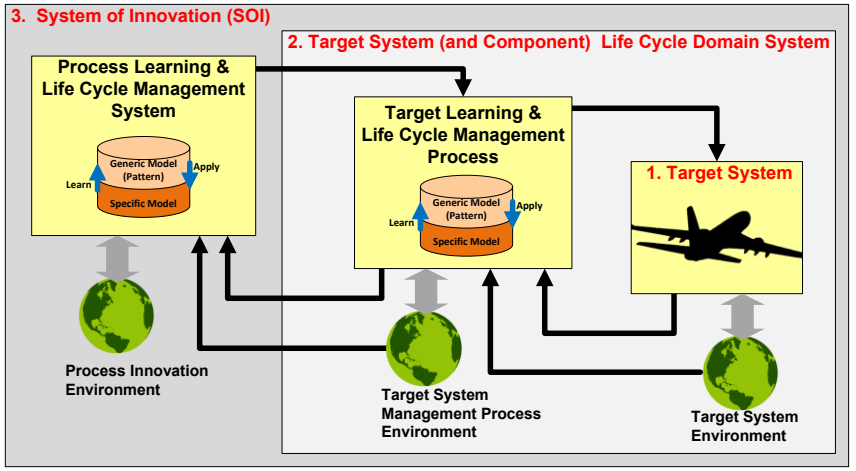
- Remove this page before use in the ATP Session.
- This is a configurable class template, not for use without configuring first.
- Globally replace items identified in arrows as shown: <<XYZ>>
  - includes company-specific names, logos, and homework pattern file names and locations

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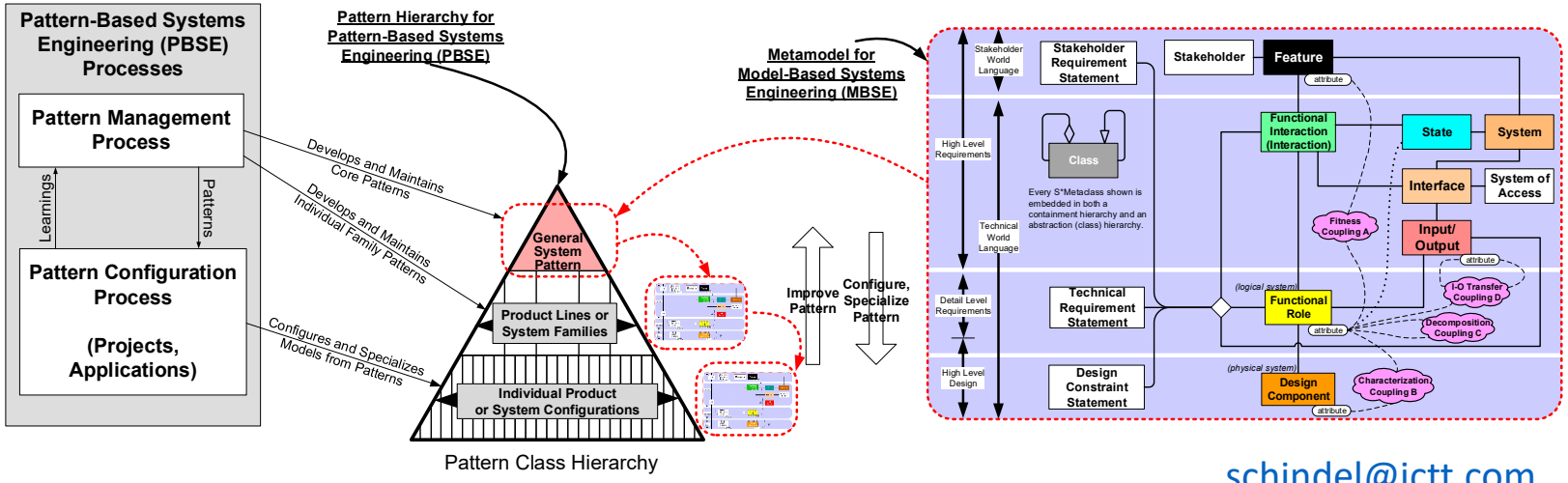
<<Company/Org. Logo>>

Phase II Session 3

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



Level 0 View, INCOSE ASELCM Pattern

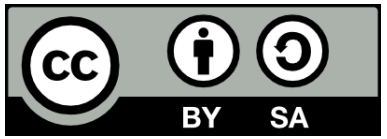


Pattern Class Hierarchy

schindel@ictt.com
lewis@ictt.com

V1.5.4

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Contents

- Recap of previous session:
  - Previous session take-aways, discussion, questions
- This session’s class content
- References

Recap of Previous Session:
Take-aways impacting actual practices

- ASELCM Features: System 2 and 3 Features
- ASELCM Interactions: System 2 and 3 Interactions of those features
- ASELCM Roles of those interactions
- Configuration rules of ASELCM Features, Interactions, Roles
- Consistency Management Thread



- 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?



Previous homework assignment was:

For programs you are involved in now or in the past . . .

1. Name two artifact types from the targeted list of synthesized artifacts for this project, which are to be compared for consistency, for which consistency amounts to something other than just occurrence of “equal values” in the two artifacts.
2. Describe in detail the consistency sought for that pair. How does a human reader of the artifacts know if they are consistent with each other?

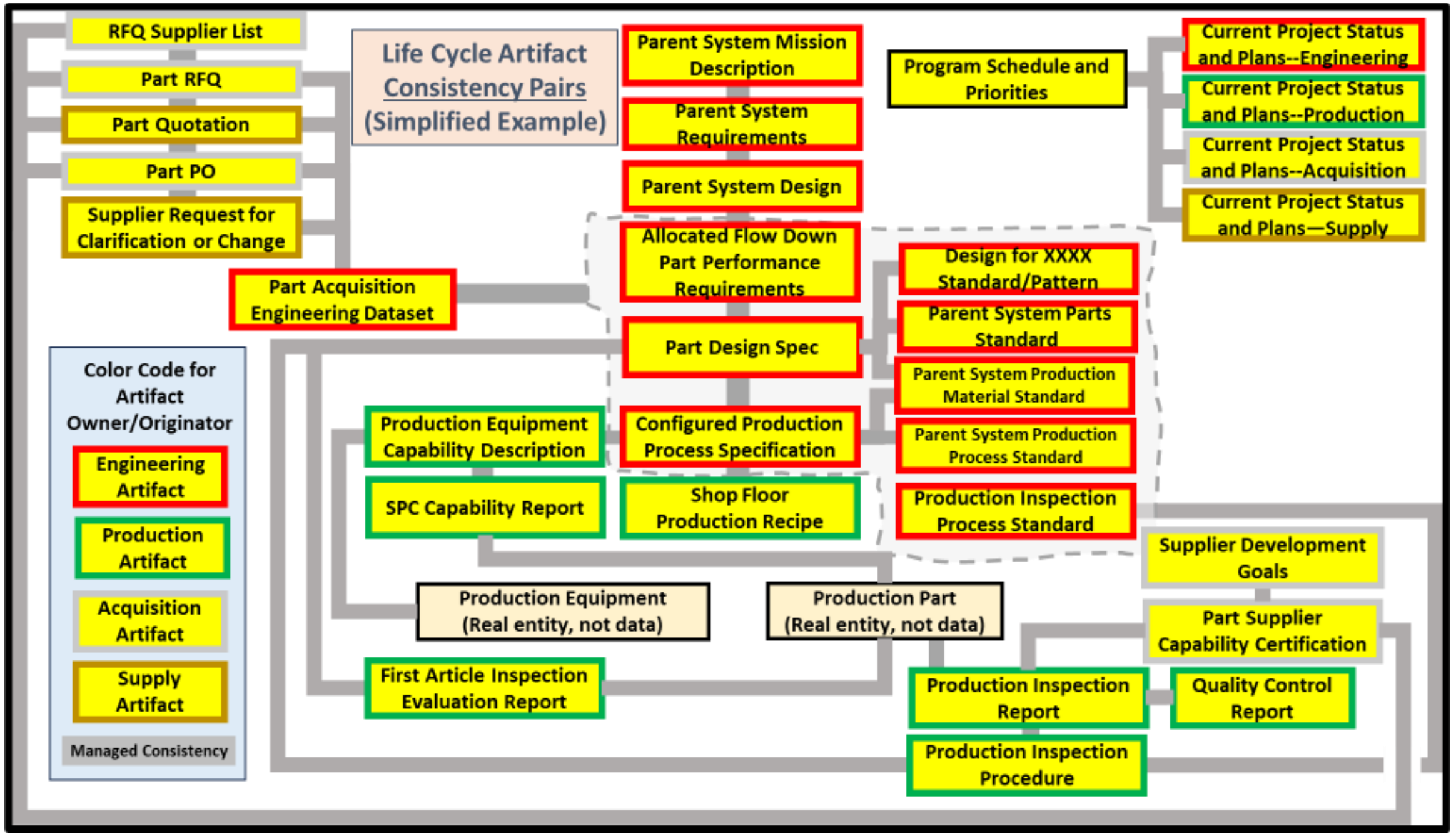
Phase II Class Sessions: Accountability, Macrostructure of Model-Based Ecosystem

- ASELCM Ecosystem S*Pattern: Nature, Intended Uses, Levels 0-4 Logical Arch
  - Session 1
- ASELCM Features, Interactions, Roles, Resources, in Consistency Management
  - Sessions 2-3 

- Configurable ASELCM Pattern Implemented in OMG SysML
  - Session 4
- Homework Presentation and Feedback
  - Distributed over above sessions

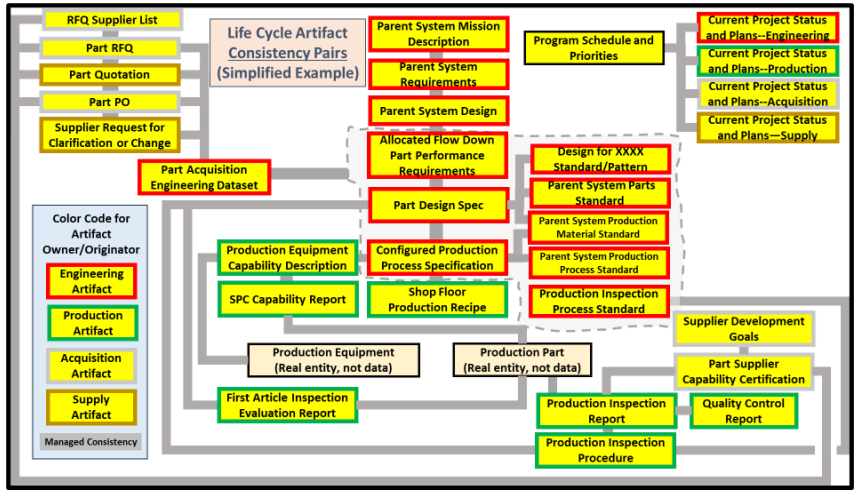
ASELCM: Features, Interactions, Roles, Design Components, in Consistency Management

- Intermediate goal
- Exercise: Generating an ASELCM configuration of System 2 in the earlier paradigm
- Expansion of ASELCM consistency management paradigm
- Recap of Consistency Management Core Interactions
- Related ASELCM Features, Including Decision Management
- Expanded Consistency Management Artifacts Pattern
- Initial Prototype of Expanded ASELCM Pattern and Configuration Wizard
- How Additional Learned Patterns Play into Consistency Detection and Reconciliation
- The Design Components of Systems 2 and 3
- Homework Assignment
- Discussion, Q&A.


Life Cycle Artifact Consistency Pairs (Simplified Example)
RFQ Supplier List
Part RFQ
Part Quotation
Part PO
Supplier Request for Clarification or Change
Part Acquisition Engineering Dataset
Parent System Mission Description
Parent System Requirements
Parent System Design
Allocated Flow Down Part Performance Requirements
Part Design Spec
Configured Production Process Specification
Shop Floor Production Recipe
Program Schedule and Priorities
Current Project Status and Plans--Engineering
Current Project Status and Plans--Production
Current Project Status and Plans--Acquisition
Current Project Status and Plans—Supply
Design for XXXX Standard/Pattern
Parent System Parts Standard
Parent System Production Material Standard
Parent System Production Process Standard
Production Inspection Process Standard
Production Equipment Capability Description
SPC Capability Report
Production Equipment (Real entity, not data)
Production Part (Real entity, not data)
First Article Inspection Evaluation Report
Supplier Development Goals
Part Supplier Capability Certification
Production Inspection Report
Quality Control Report
Production Inspection Procedure
Color Code for Artifact Owner/Originator
Engineering Artifact
Production Artifact
Acquisition Artifact
Supply Artifact
Managed Consistency

Intermediate goal: Auto-generate configured S2 model of consistency management artifact pairs and agents . . .

- Based on the System 1 to be designed, produced, managed.
- This would tell a project:
  - What instances of artifacts are required(*)
  - What artifact consistencies are required(*)
  - What instances of responsible consistency management agents are required(*)
- Such an auto-population capability would also be a first step toward semi-automated / digital "attention management" on the executing project's consistency:
  - It would not be automated consistency management.
  - It would be automated assistance in organizing of consistency management, whether manual, automated, hybrid—how the project does its work.

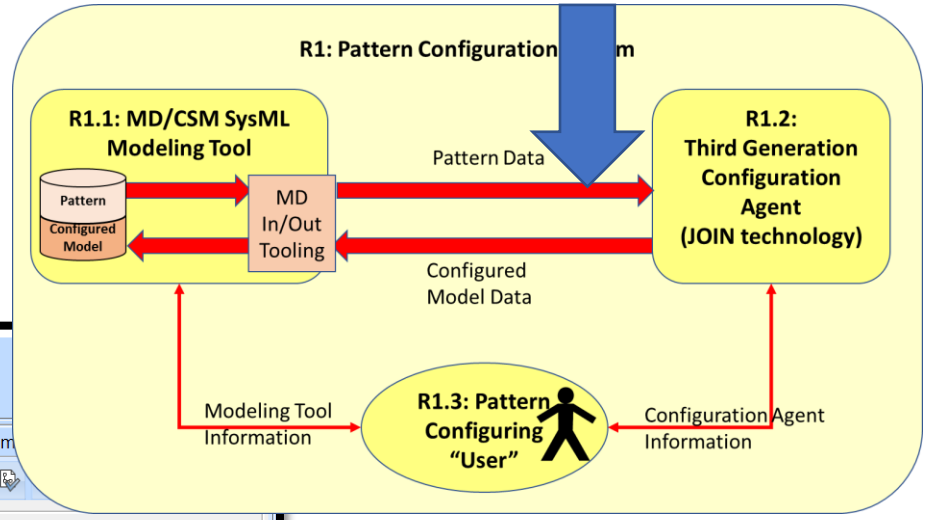


(*) Note that "required" here does not just mean required by the enterprise's SOPs, but rather what is necessary in order to achieve the goals of expanded consistency management.

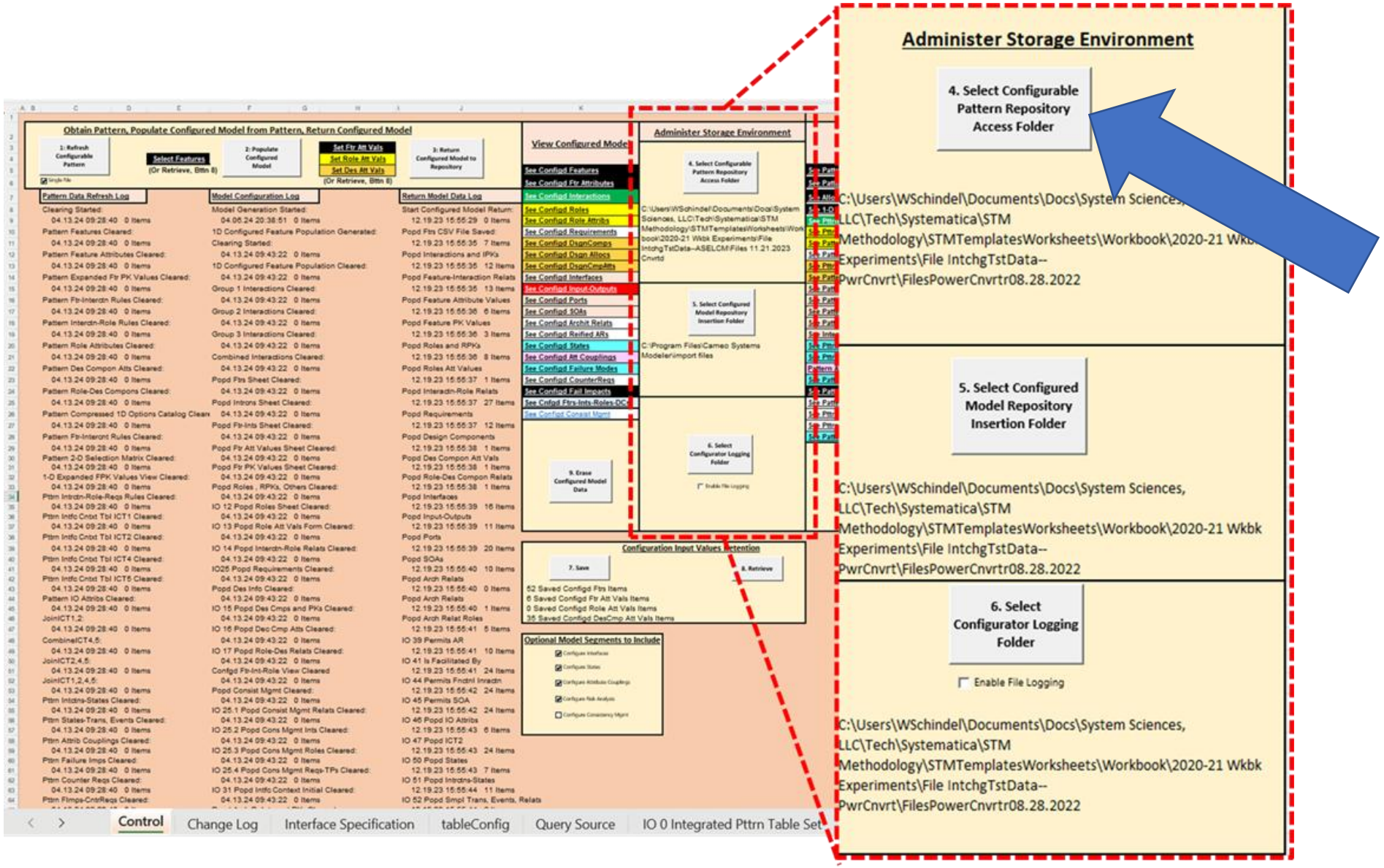
Exercise: Generating an ASELCM configuration of System 2 in the earlier paradigm

- Before getting into the newer ASELCM pattern content, let's gain some initial experience in generating an ASELCM configuration of artifacts and other instances.

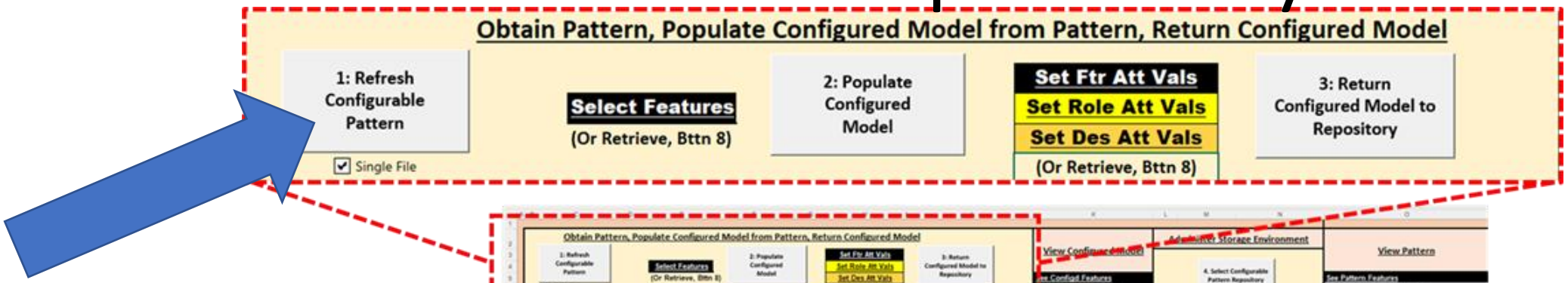
Export S* Pattern Tables using the Report Wizard

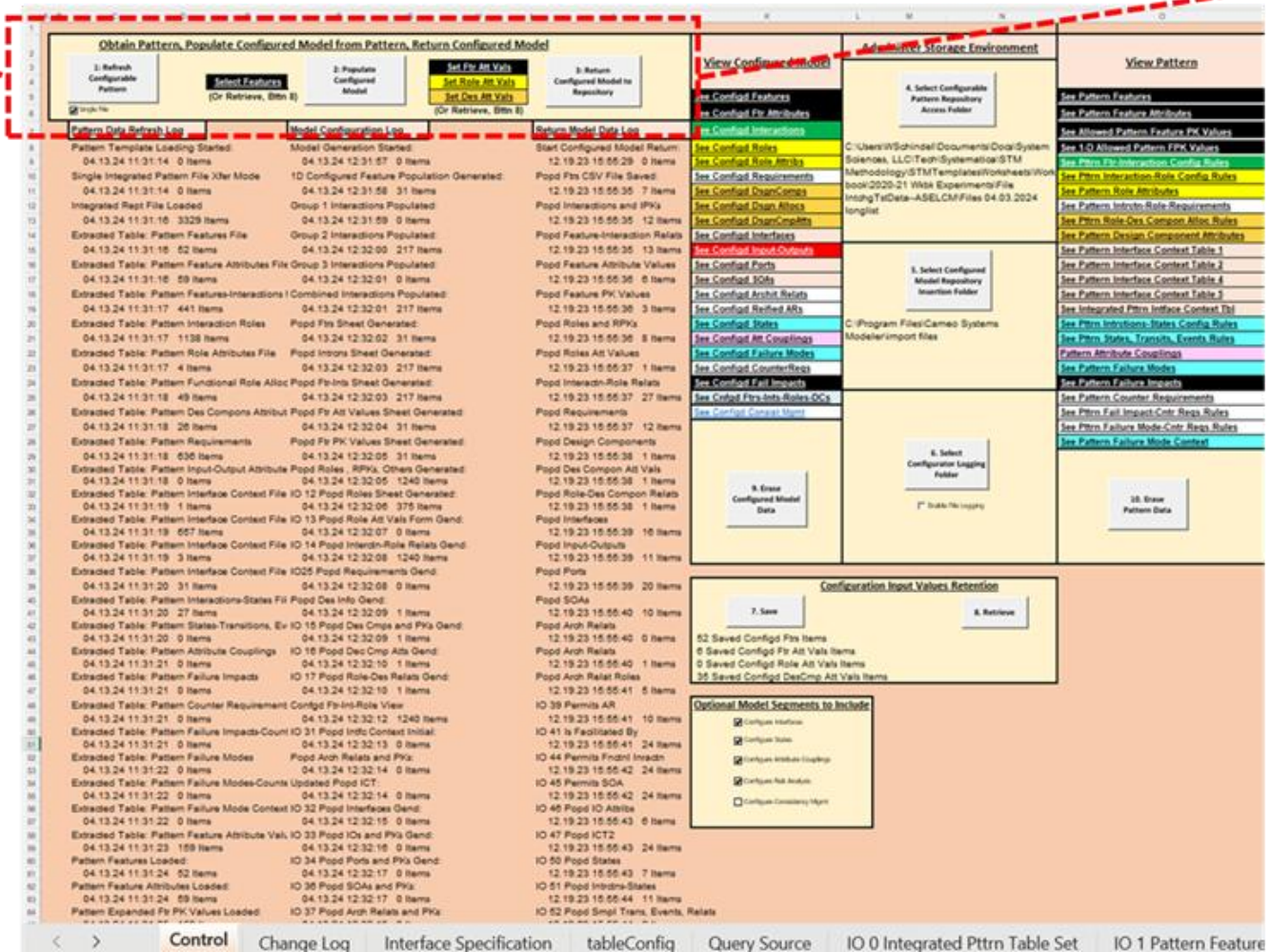


Pattern File Repository Location Selection

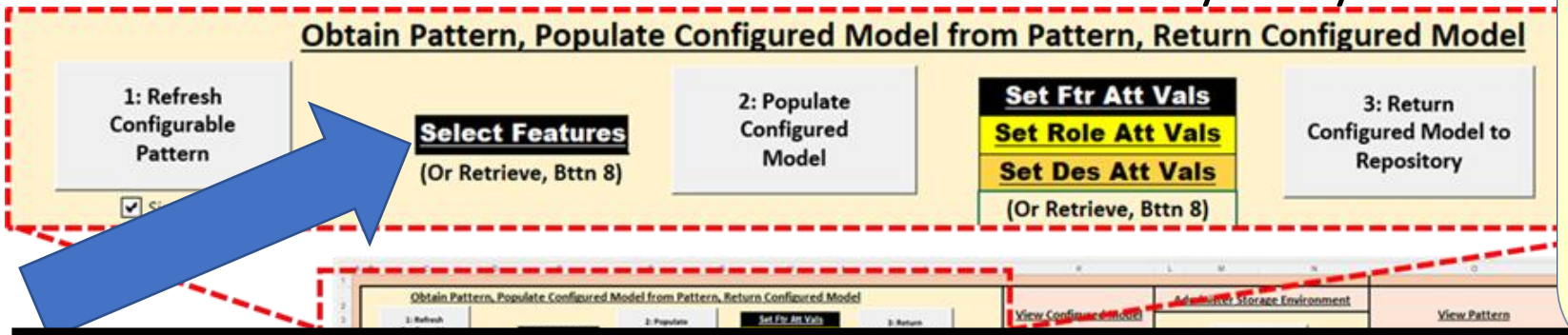


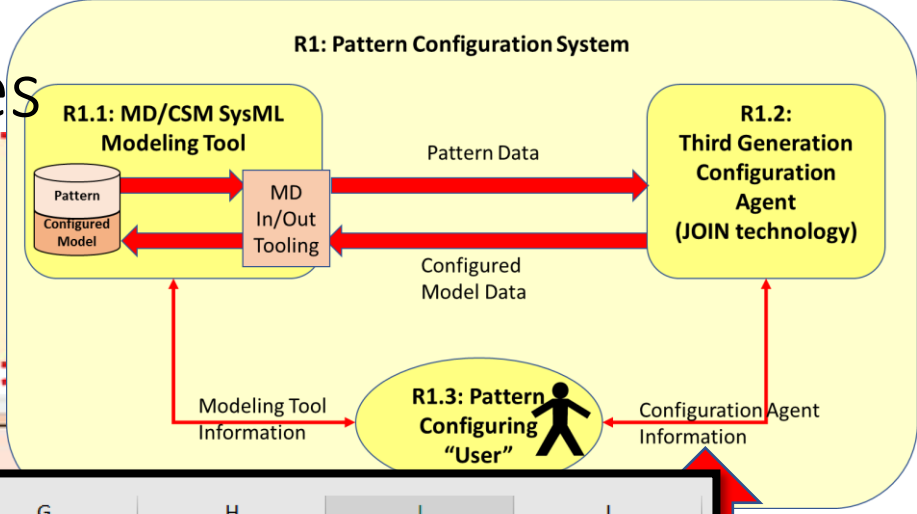
Pattern File Repository Access





Select Features & Feature Primary Key Values

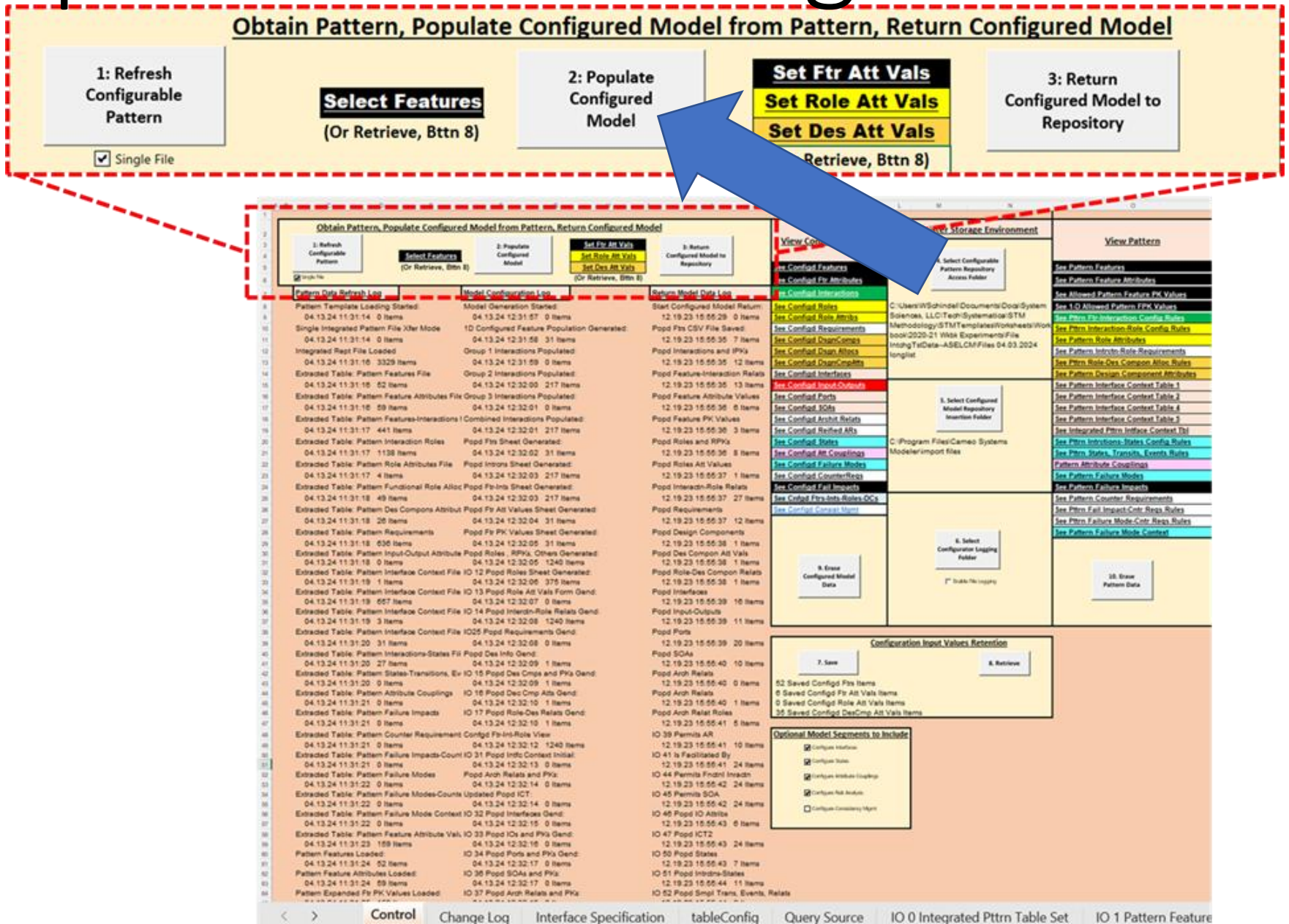




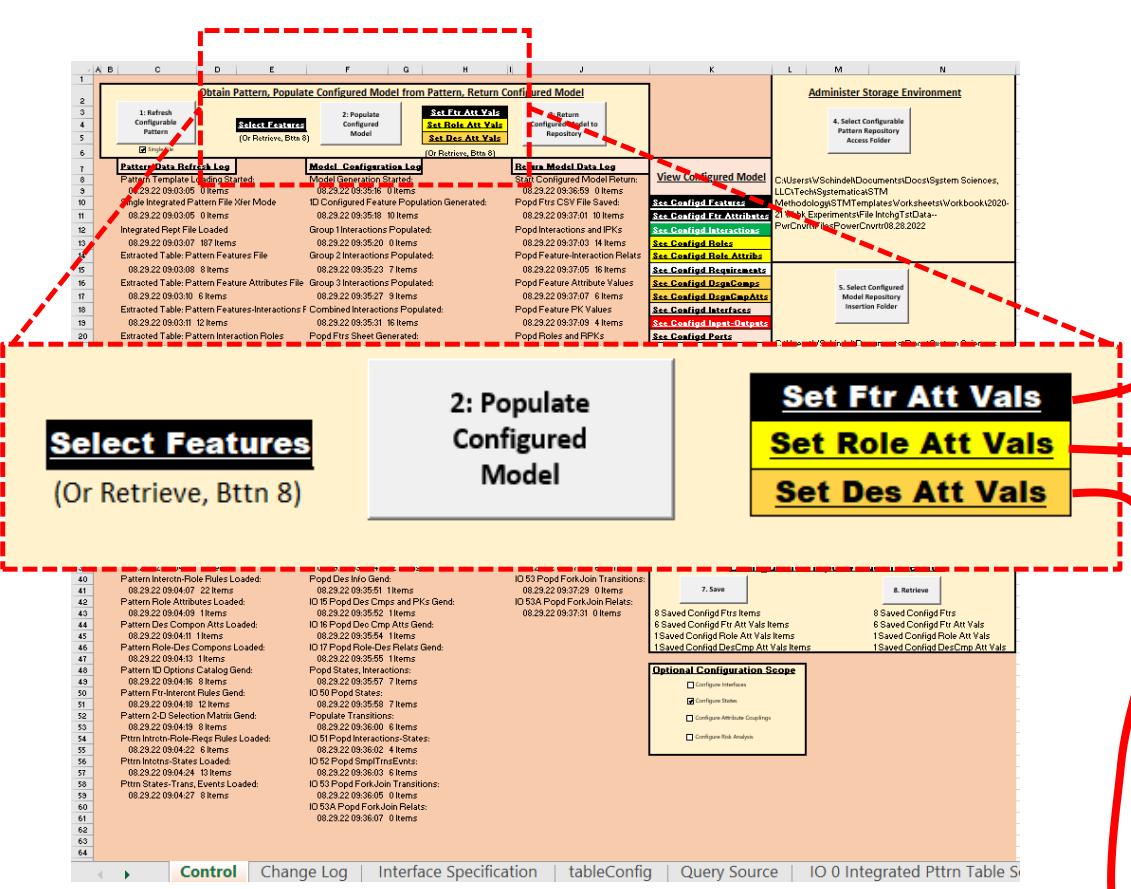
	B	C	D	E	F	G	H	I	J
1	Feature Name	Feature Attribute	Populate? Yes/No	Selection 1	Selection 2	Selection 3	Selection 4	Selection 5	Selection 6
3	Architectural Definition	Architectural Definition Capability							
4	Attention Management Feature								
5	Business or Mission Analysis	Mission Analysis Capability	Yes	Experience Pattern, Configurable	Experience Pattern, Personal	Experience Pattern, Standard	Observation	Simulation	Stakeholder
6	Configuration Management Feature								
7	Decision Management-Acquistion	DMA Capability	Yes	RFQ Supplier List-Part Supplier Capability Certification					
8	Decision Management-Engineering	DME Capability	Yes	Experience Pttrn, Config-Mission	Experience Pttrn, Personal-Mission	Observation-Mission	Stakeholder-Mission	Part Design Spec-Configured Production Process Spec	
9	Decision Management-Production	DMP Capability	Yes	Production Inspection Process Standard-Production Inspection Procedure					
10	Decision Management-Supply	DMS Capability	Yes	Part Quotation-Part Supplier Capability Certification					
11	Design Definition	Design Capability							

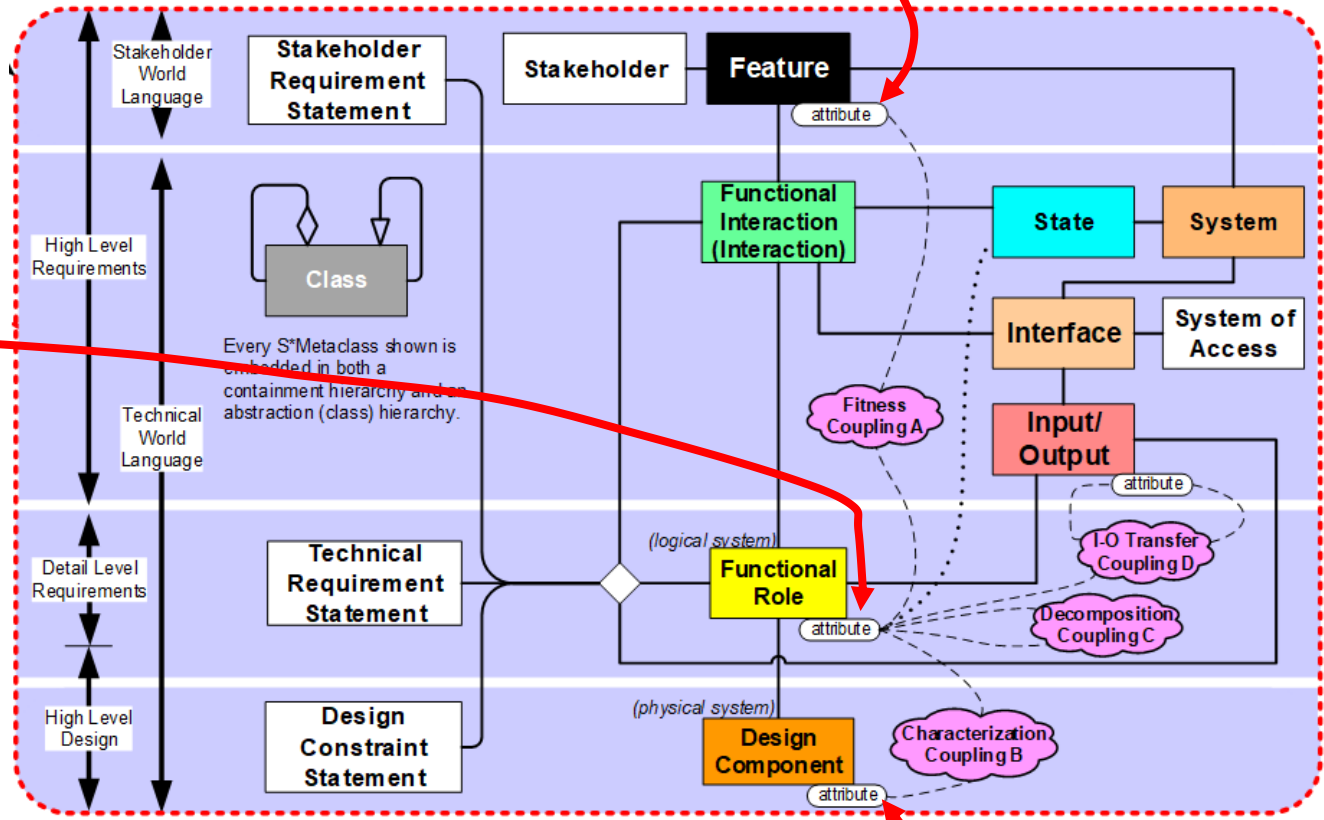
AcptdCInd Expnd Ftrs Ints Rule | Merge 1 Table | Merge 2 Table | Selected Ftrs with No FPK | Append 1 Table | IO 4.1 2D Ftr Selection Mtx | 1D Popd Ftr FPKA F ...

Populate the Configured Model

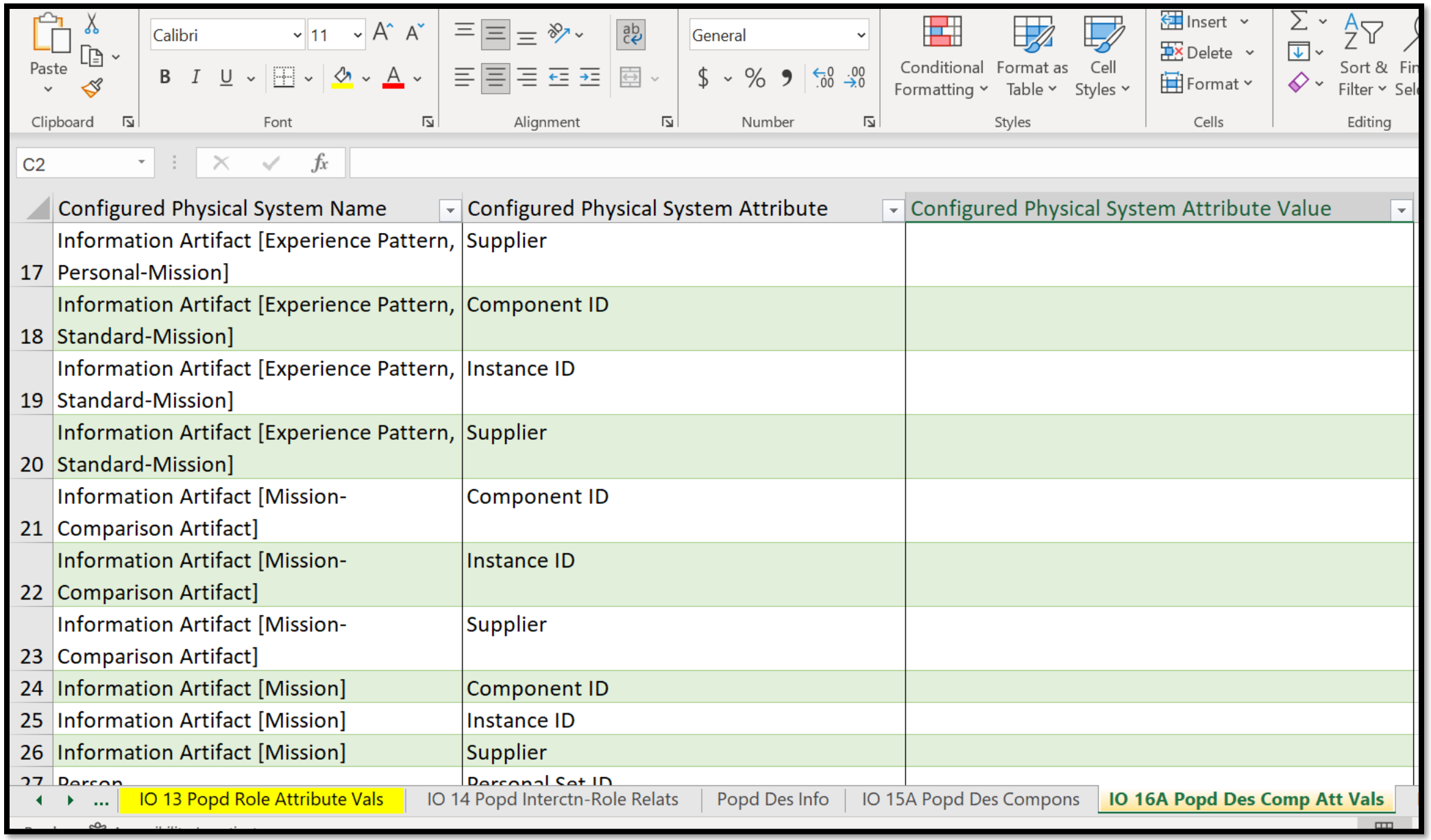


Links for user insertion (setting) of Attribute Values for configured Features, Roles, and Design Components:



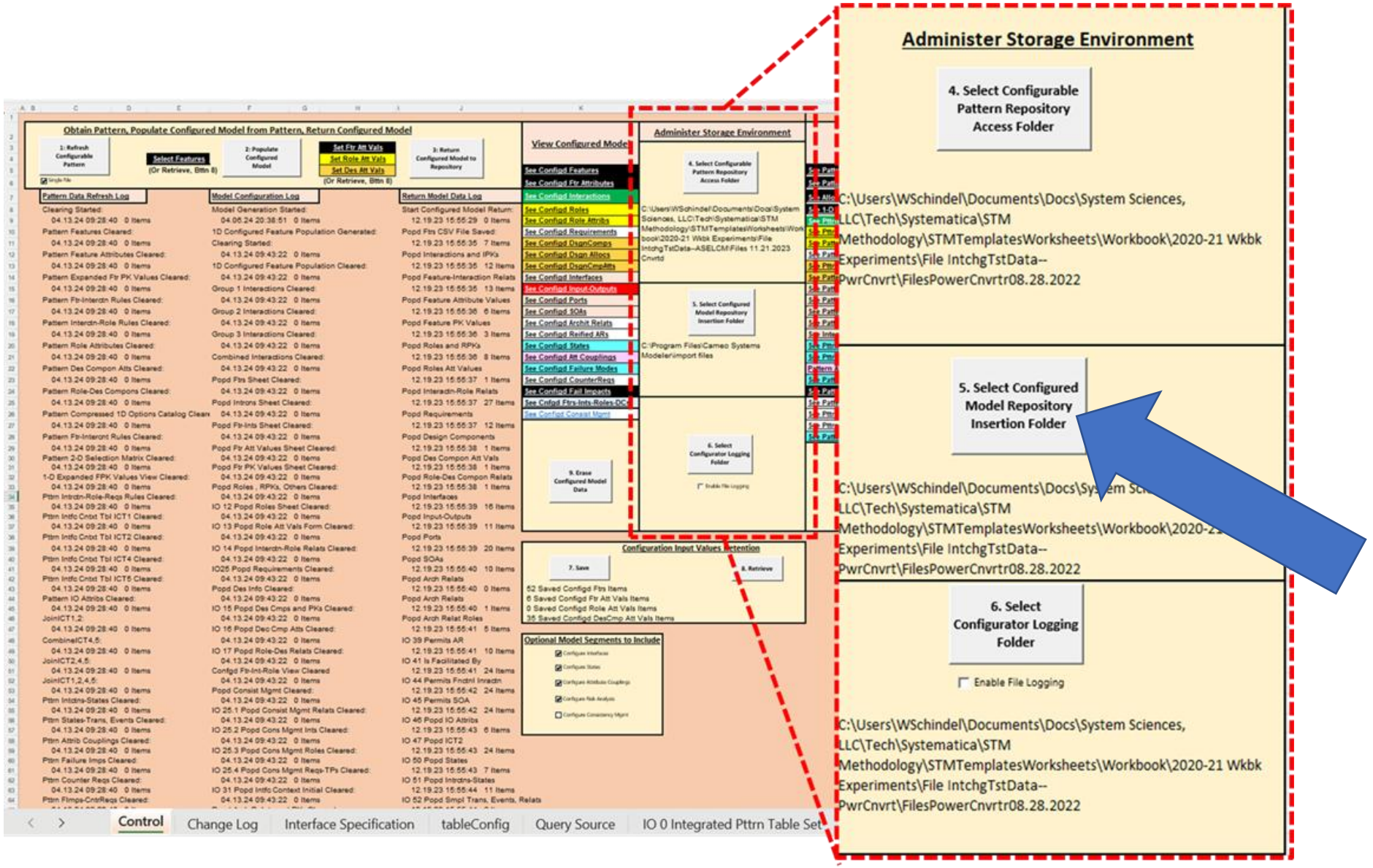


User insertion (setting) of Configured Attribute Values:

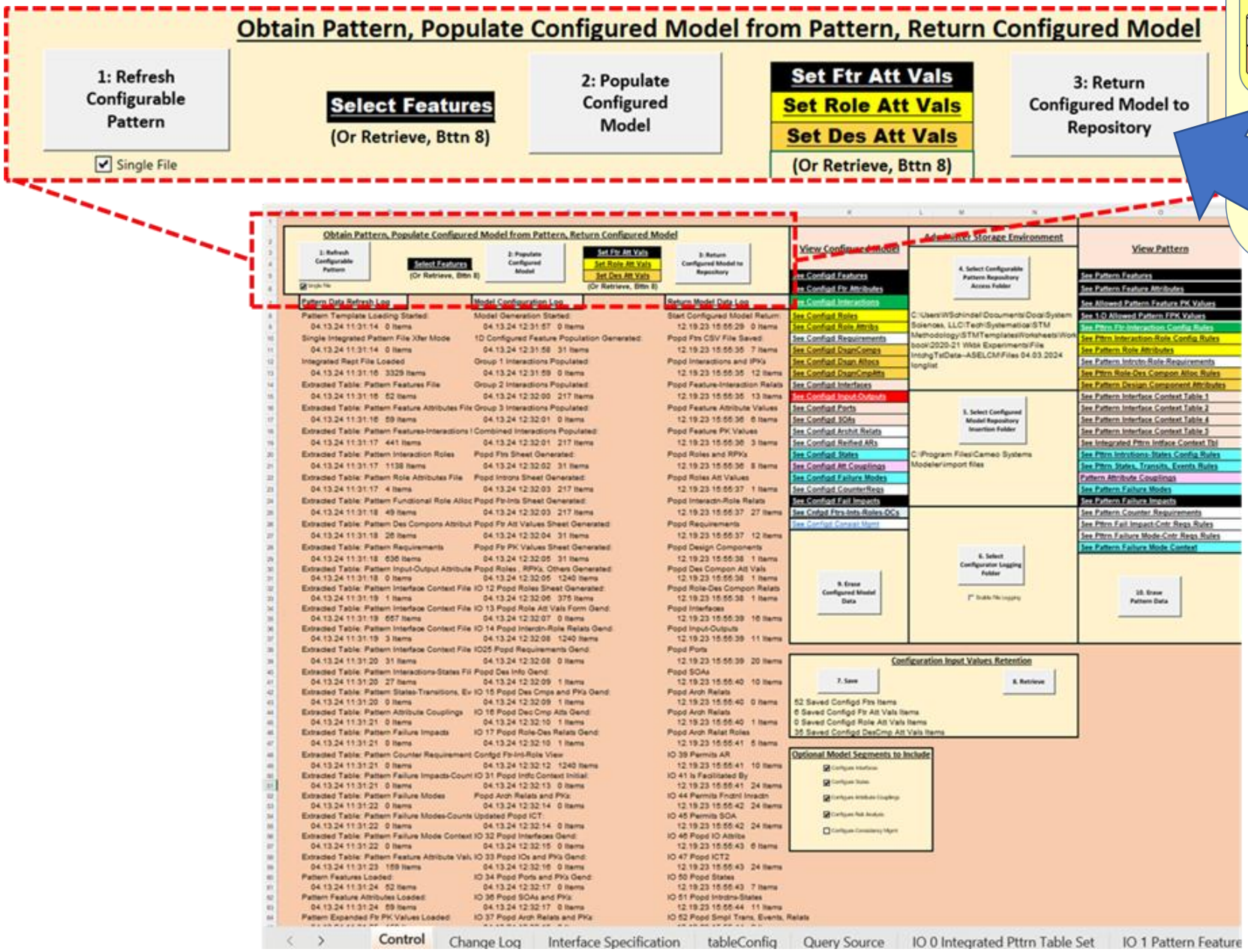


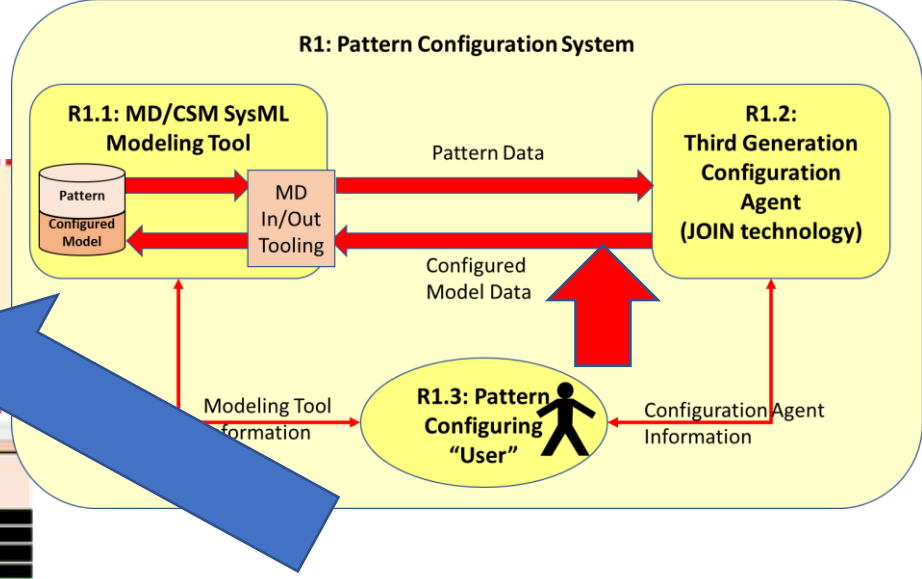
	Configured Physical System Name	Configured Physical System Attribute	Configured Physical System Attribute Value
17	Information Artifact [Experience Pattern, Personal-Mission]	Supplier	
18	Information Artifact [Experience Pattern, Standard-Mission]	Component ID	
19	Information Artifact [Experience Pattern, Standard-Mission]	Instance ID	
20	Information Artifact [Experience Pattern, Standard-Mission]	Supplier	
21	Information Artifact [Mission-Comparison Artifact]	Component ID	
22	Information Artifact [Mission-Comparison Artifact]	Instance ID	
23	Information Artifact [Mission-Comparison Artifact]	Supplier	
24	Information Artifact [Mission]	Component ID	
25	Information Artifact [Mission]	Instance ID	
26	Information Artifact [Mission]	Supplier	
27	Person	Personal Set ID	

Configured Model File Output Location Selection

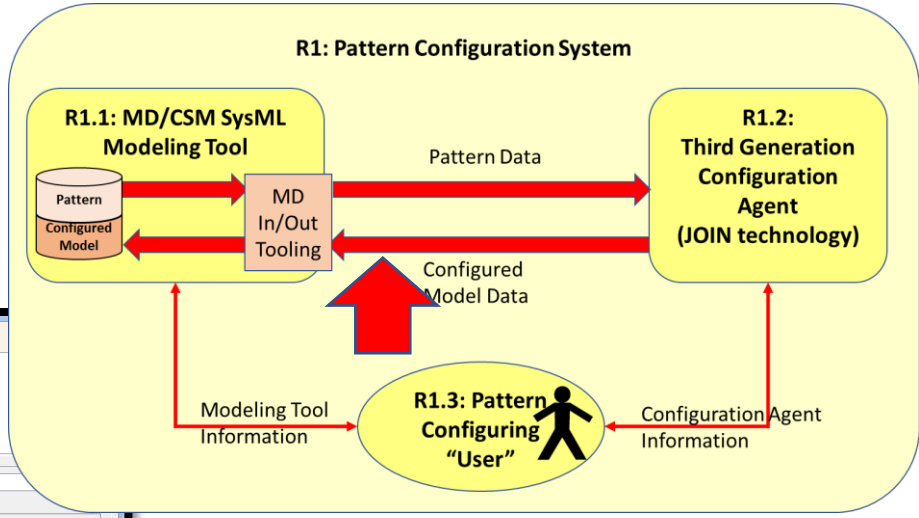


Configured Model Output to Files

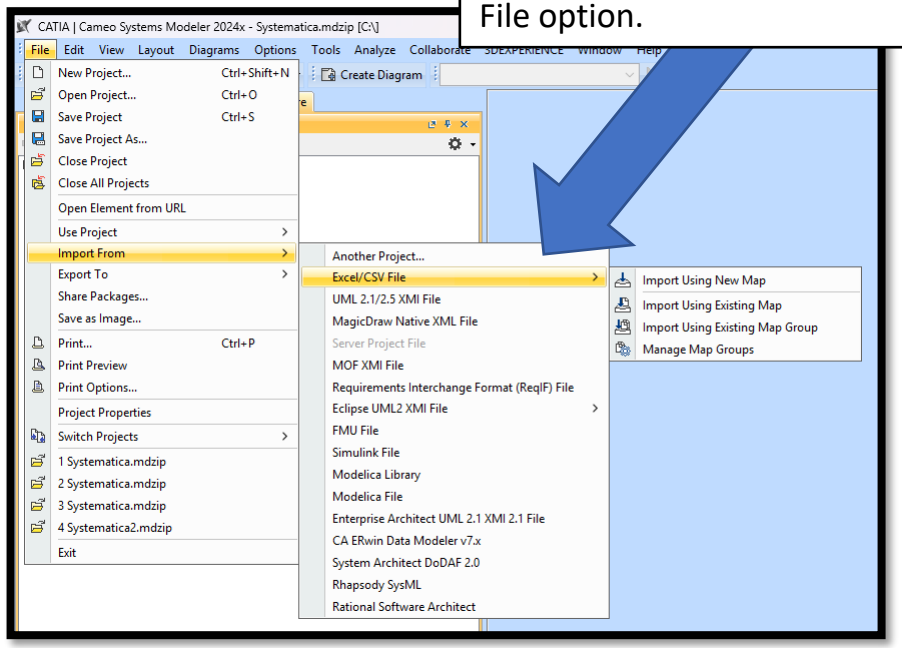


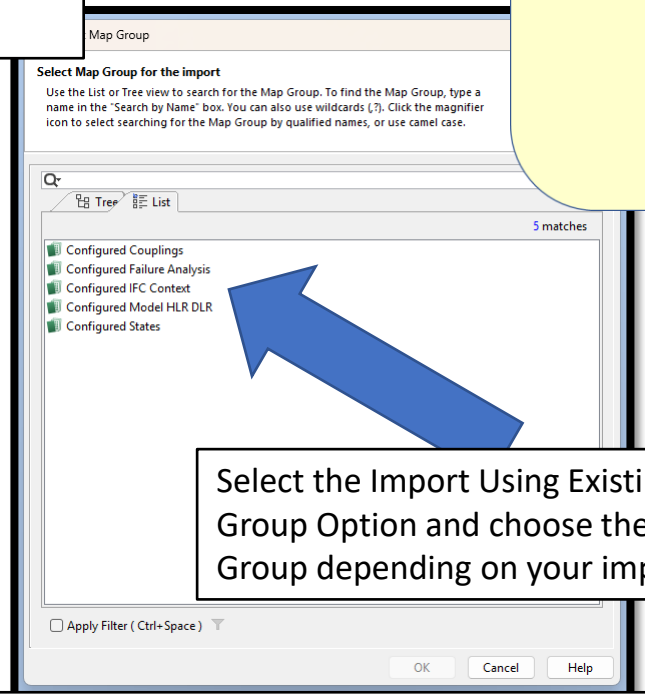


Import the Configured Model Files into Modeling Tool



Choose the Import From > Excel/CSV File option.

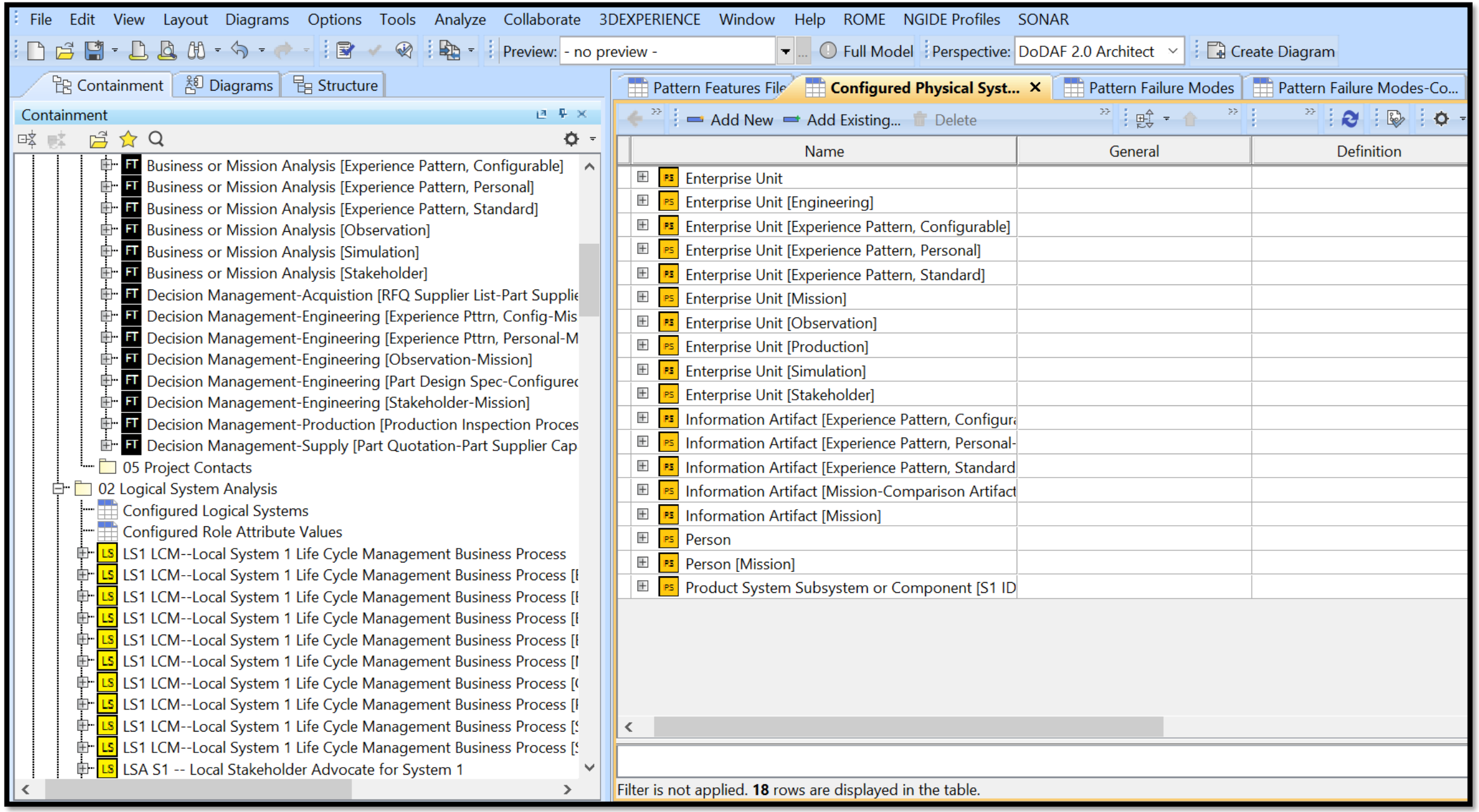




Select the Import Using Existing Map Group Option and choose the Map Group depending on your import needs.

-The Configured Model HLR DLR is the first one to select and imports a subset of the entire model including Features, Interactions, Roles, Requirements, and Design Components.
-Configured States includes importing States, Forks/Joins, Events, and Transitions.
-Configured IFC Context includes importing Interfaces, Input-Outputs, Architectural Relationships, Systems of Access, and Ports
-Configured Couplings includes Couplings, Constraint Parameters, and Connectors
-Configured Failure Analysis includes Counter Requirements, Failure Modes, and Failure Impacts
The Configuration Wizard control panel allows for similar configuration grouping choices. (See Wizard Guide)

Configured SysML Model Details in Modeling Tool



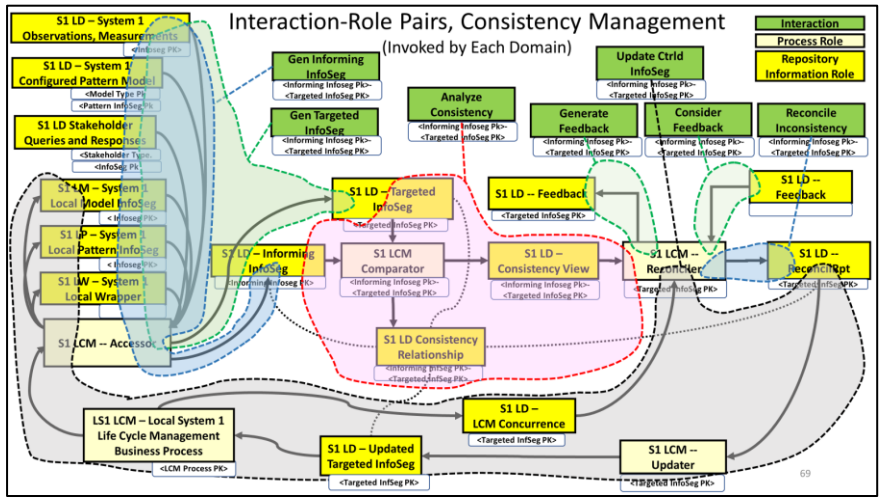
Expansion of ASELCM consistency management paradigm

- As discussed the previous class, the expanded view of Consistency Management is the human equivalent of the difference between earlier machine learning and generative AI.
- It is not an “AI pitch”:
  - Rather, it is an enlarged way to understand how human organizations already generate the content (missions, requirements, designs, etc.) they synthesize, whether as models or their prose predecessors.
  - It just happens to also be consistent with applying AI.
  - So, it provides an integration framework for evolutionary hybrid ecosystems.
- It begins by understanding reconciliation more broadly:
  - Reconciliation as learning
  - Reconciliation as stakeholder negotiation
  - Reconciliation as (generative) content synthesis
  - Reconciliation as control of production, sustainment, operations, retirement

Recap of Consistency Management Core Interactions

As discussed in the previous class, the expanded consistency management view includes--

- **7 Interactions:**
  - Gen Informing InfoSeg
  - Gen Targeted InfoSeg
  - Analyze Consistency
  - Consider Feedback
  - Reconcile Consistency
  - Generate Feedback
  - Update Ctrld InfoSeg



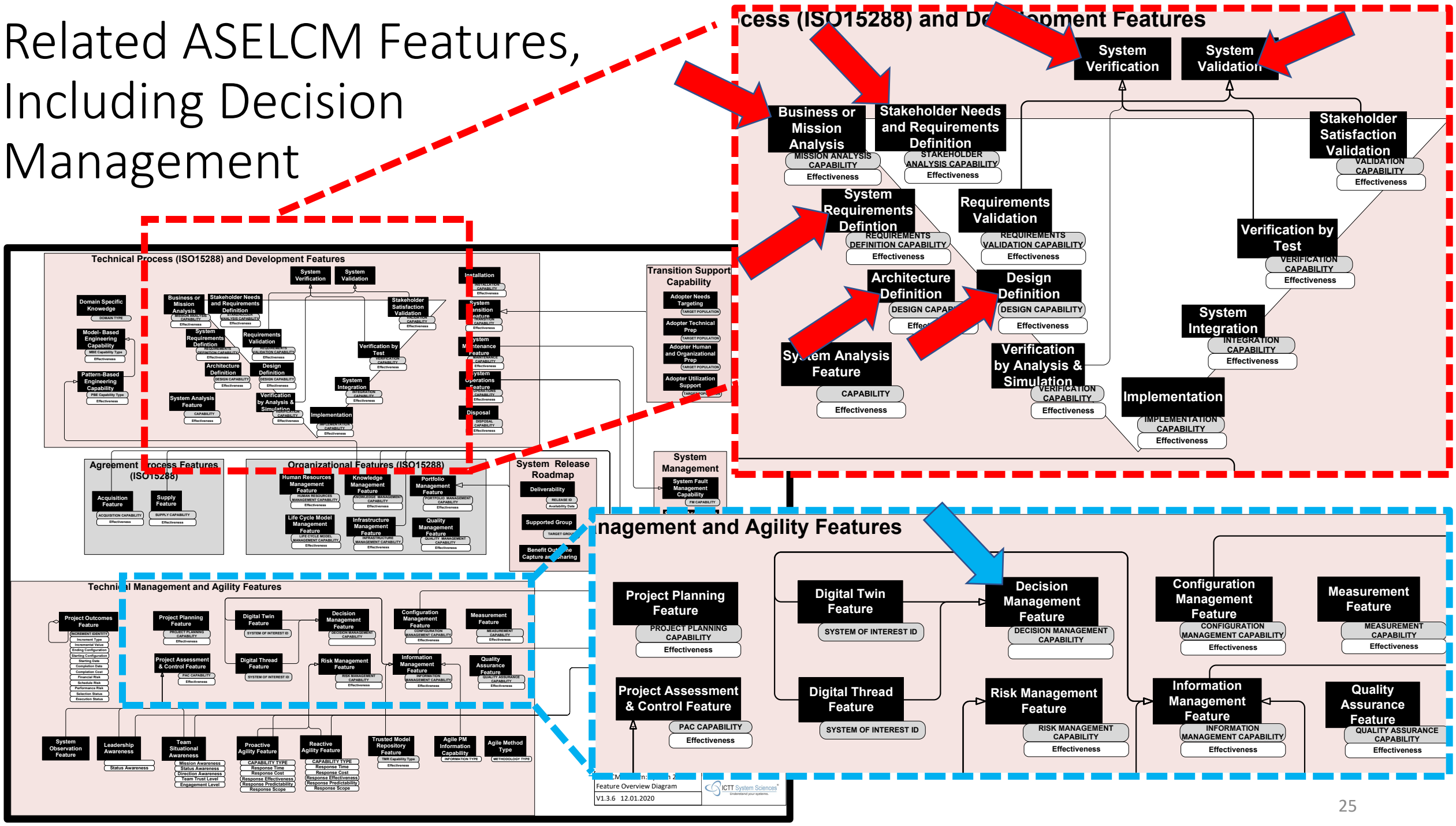
- **11 Roles:**
  - S1 LD—Targeted InfoSeg
  - S1 LD—Informing InfoSeg
  - S1 LD—Consistency View
  - S1 LD--Feedback
  - S1 LD—ReconcilRpt
  - S1 LD—LCM Concurrence
  - S2 LD—Updated Targeted InfoSeg

7 Information Roles

  - S1 LCM--Comparator
  - S1 LCM--Reconciler
  - S1 LCM--Updater
  - S1 LCM--Local System 1 Life Cycle Management Business Process

4 Process Roles

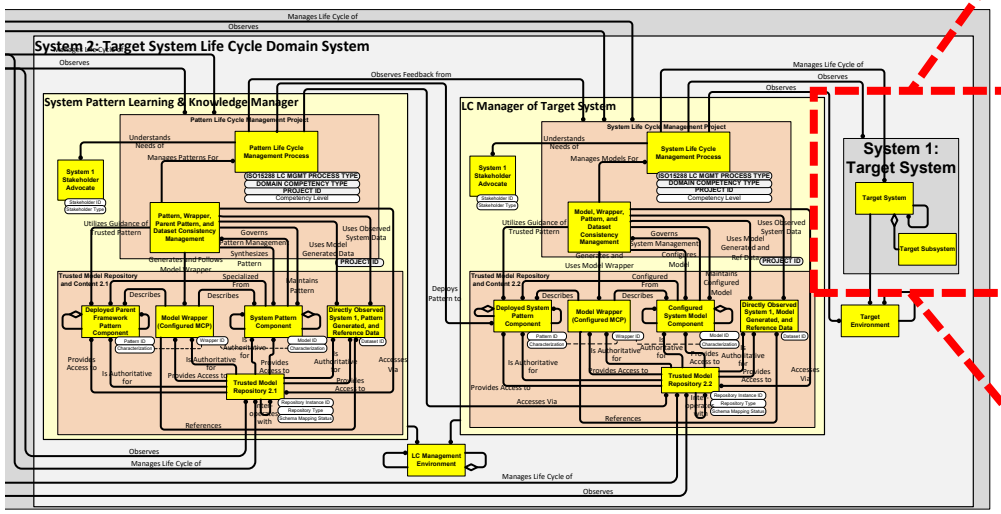
Related ASELCM Features, Including Decision Management

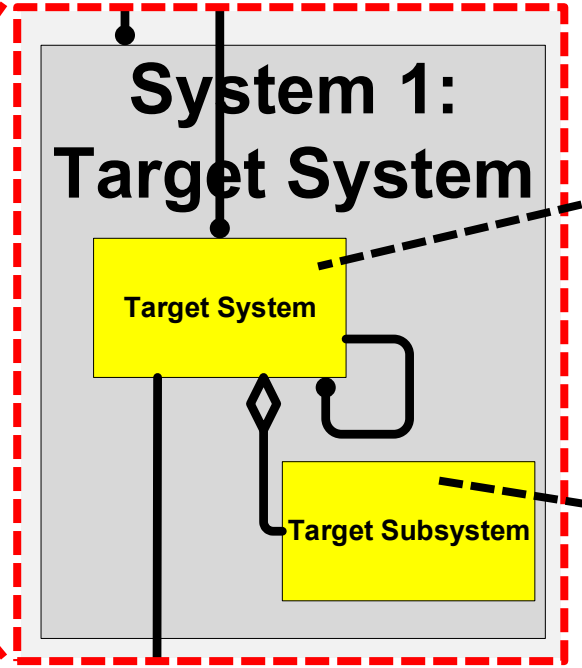


Expanded Consistency Management Artifacts Pattern

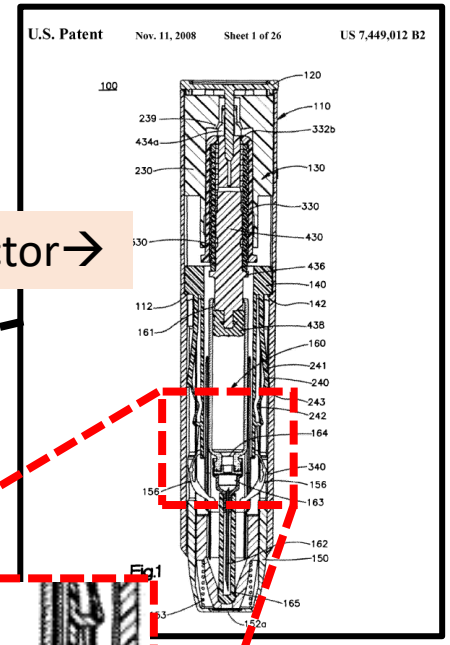
- The ASELCM Pattern is being expanded to include a pattern-based representation of the architecture of artifacts and artifact consistencies that are implied by the architecture of a System 1.
- Note that this goes through progressive stages of expansion as the project determines the structure of System 1.
- What is the general pattern of that expansion?

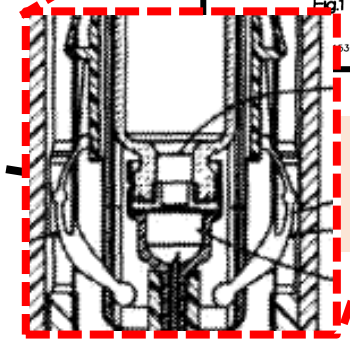
ASELCM Pattern





Auto Injector→





Subsystem Components

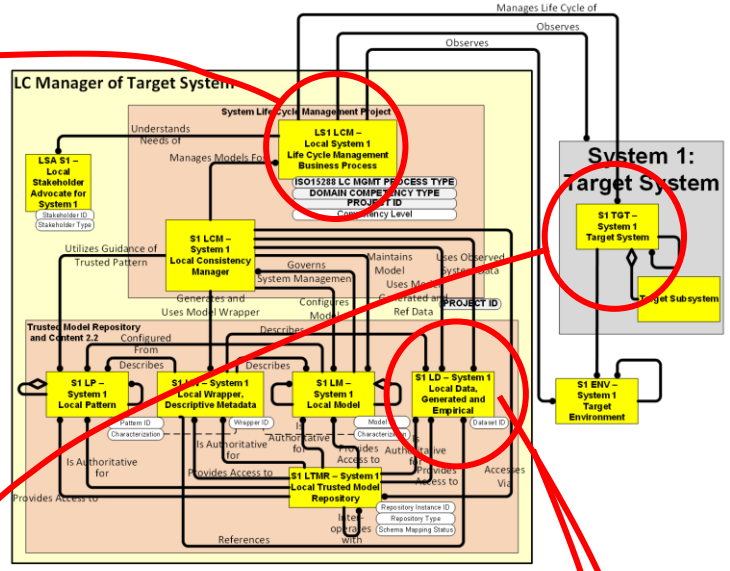
Expanded Consistency Management Artifacts Pattern

LS1 LCM – Local System 1 LC Mgmt Bus Process

- Mgmt Instance Name
- Technology Class
- Technology Subclass

S2-S1 Management Relationship

- Mgmt Relationship Type



Describes or Describes or

S2 TGT – System 1 Target System

- Name
- Part Number
- Technology Class
- Technology Subclass
- Hierarchy ID

Subject Artifact → **S1 LD -- Artifact** ← **Referent Artifact**

Subject — **Consistency Relationship** — Referent

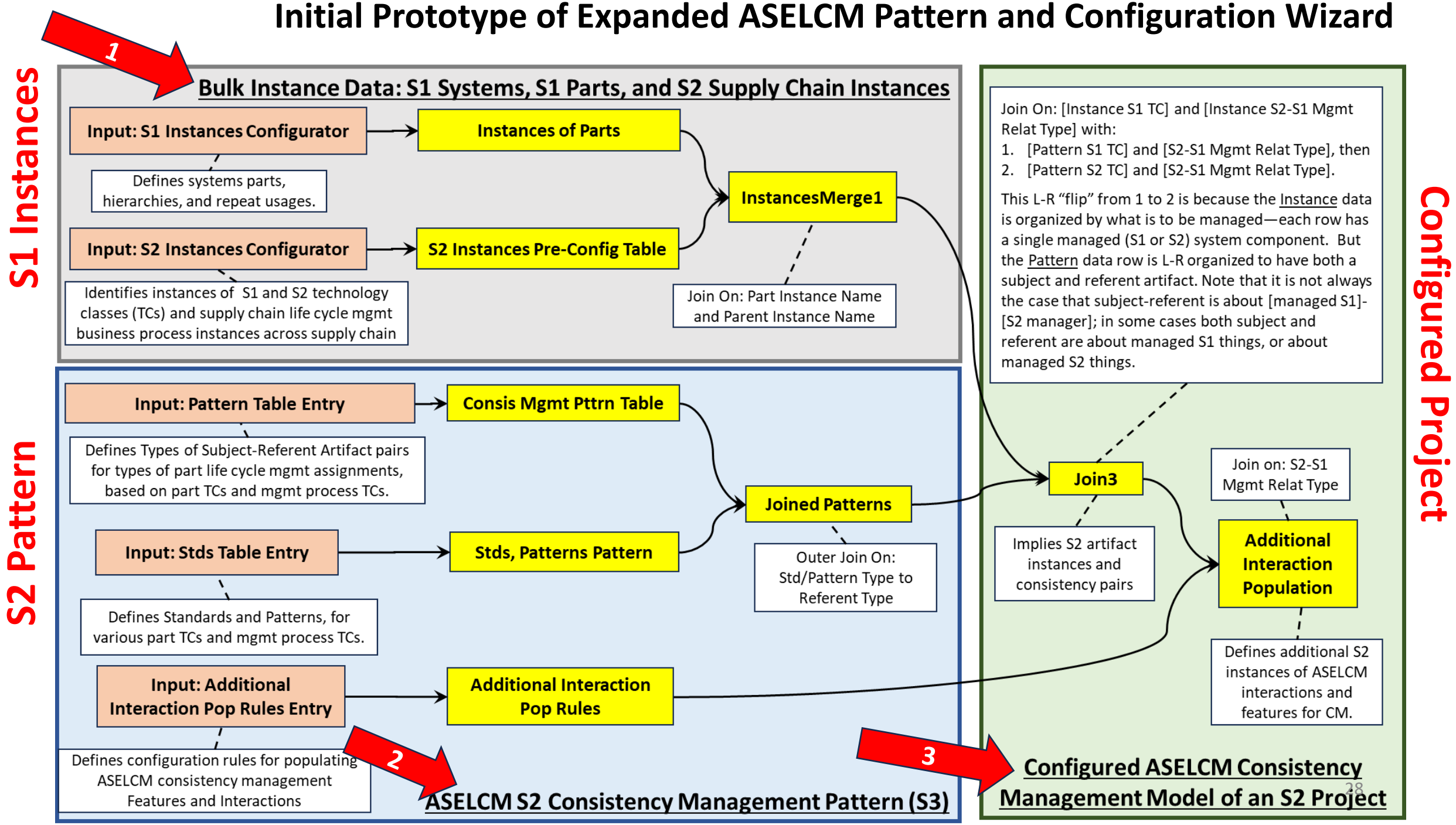
- Consistency Type

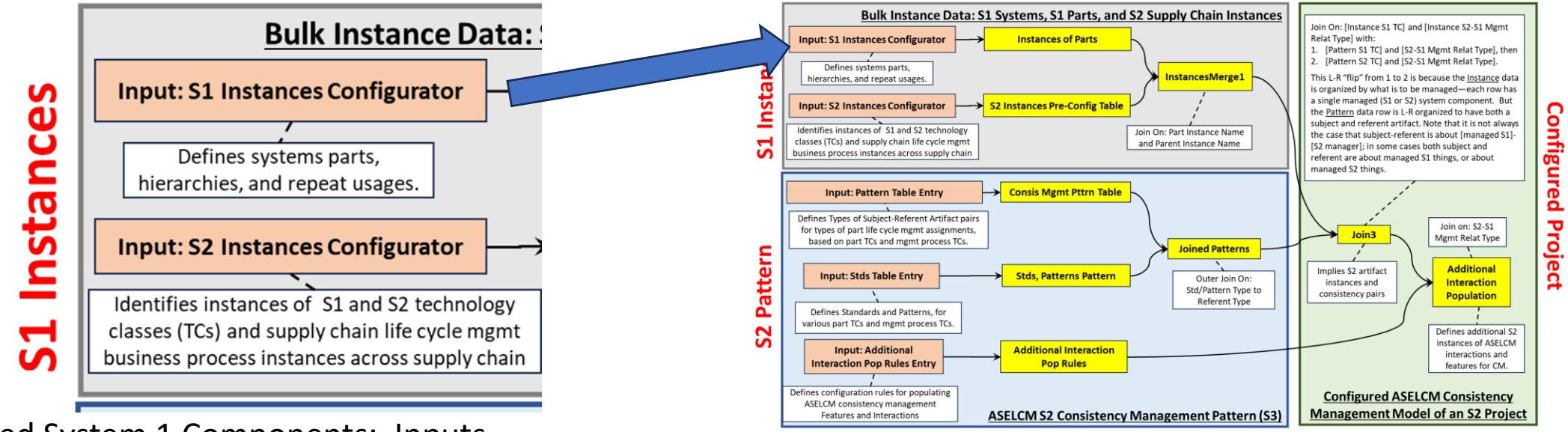
Notes:

(1) The described pair may both be S1 elements, or may be an S1 element and an S2 element, or two S2 elements.

(2) Even if both are S1 elements, the business process is still populated that is responsible for the subject artifact, and therefore its consistency with the referent artifact.

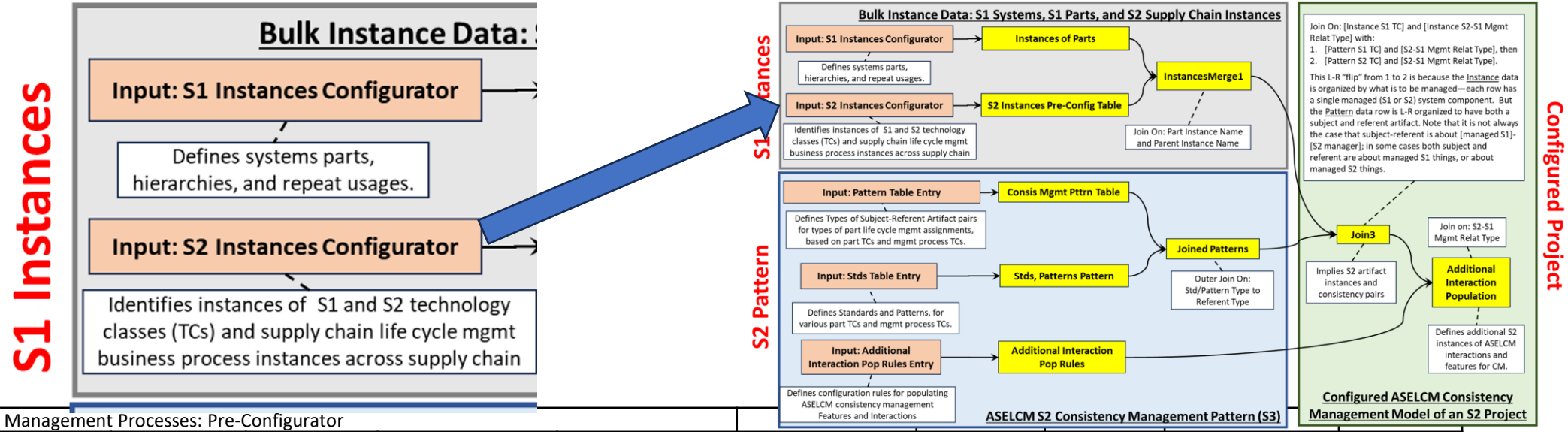
Initial Prototype of Expanded ASELCM Pattern and Configuration Wizard





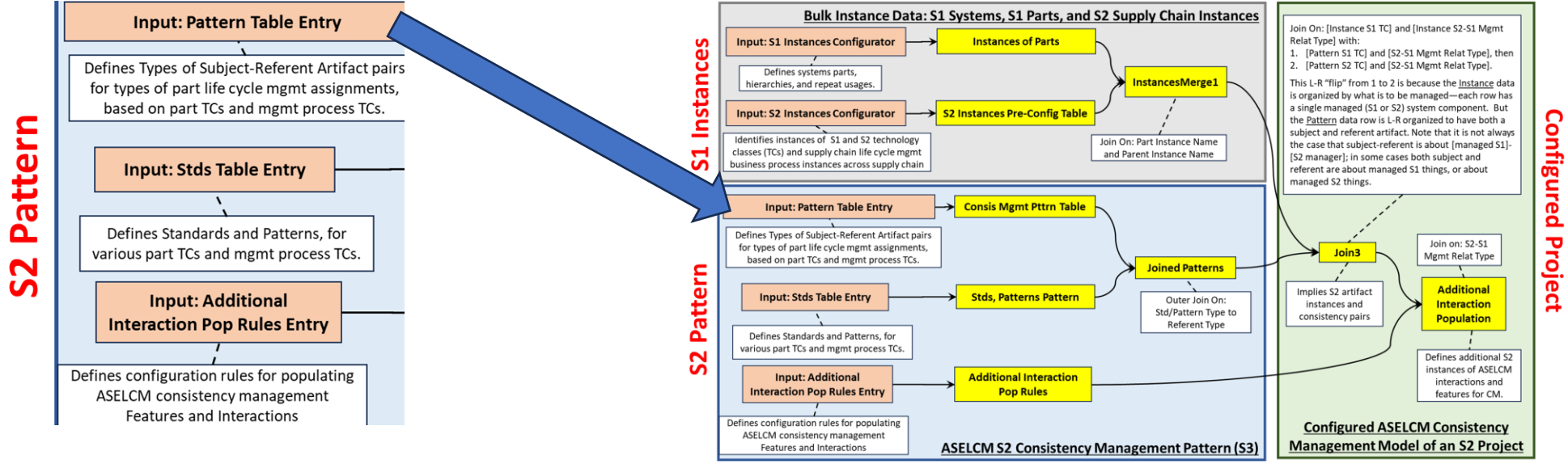
ASELCM Managed System 1 Components: Inputs

A system component whose life cycle is to be managed.	P/N of that System Component (or assembly ID).	For components used more than one time in system.	Where the system component appears in decomposed parent system.	The parent (immediate container system component) of this row's system component.	P/N of that Parent Instance.	For parents used more than one time in system.	Where the parent component appears in decomposed parent system.
System Component Instance Name	**Part Number**	**Part Usage ID**	**Part Hierarchy ID**	**Parent Instance Name**	**Parent Part Number**	**Parent Usage ID**	**Parent Hierarchy ID**
Autoinjector	AI.1MUN		1	Medical Device Application Domain System			
Autoinjector Containment Subsystem	AI.MUN12211B		1.1	Autoinjector	AI.1MUN		1
Needle	AI.NC23332244		1.1.1	Autoinjector Containment Subsystem	AI.MUN12211B		1.1
Cartridge	AI.ISB4793D0423		1.1.2	Autoinjector Containment Subsystem	AI.MUN12211B		1.1



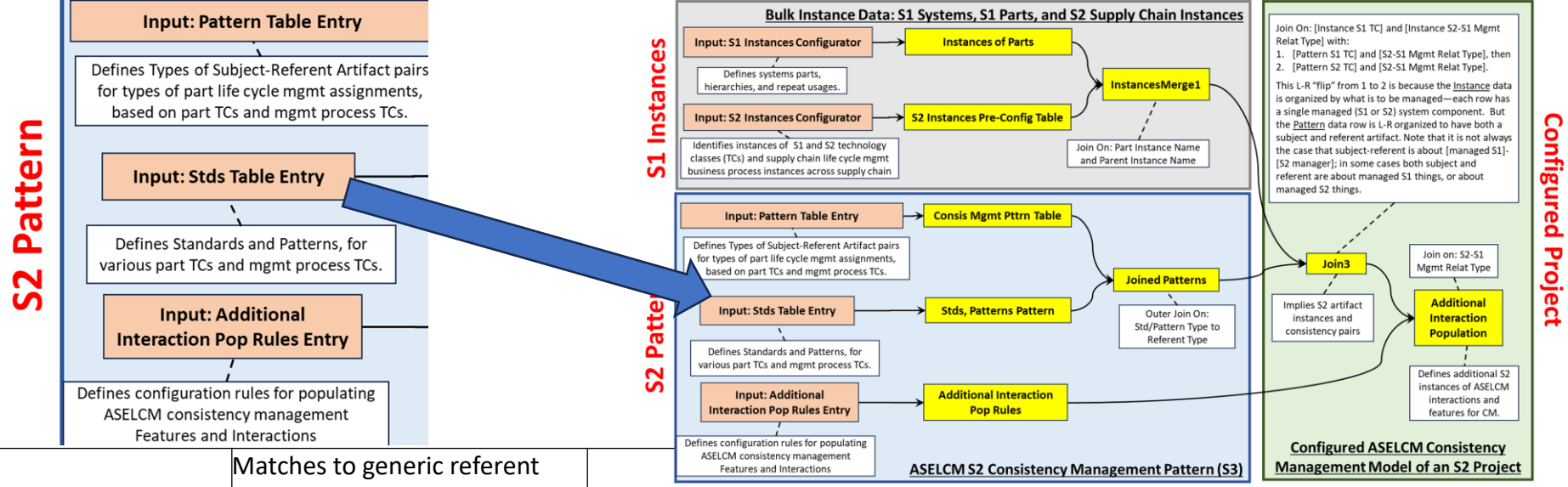
ASELCM System 1 Life Cycle Management Processes: Pre-Configurator

A system component whose life cycle is to be managed.	P/N of that System Component (or assembly ID).	The parent (immediate container system component) of this row's system component.	P/N of that Parent Instance.	The class of technology of the system component. It determines (1) What subject and referent artifacts will apply to this component; (2) What standards or patterns apply as additional referents.	A further specialization of TC which further determines applicable standards and patterns may apply.	What a management system that creates/owns a subject artifact is responsible for. Used to match up with rows of the pattern table to determine applicable artifacts for this system component.	A management system component whose life cycle is to be managed.		The class of technology of the management instance. Determines: (1) What subject and referent artifacts will apply to this management component; (2) What standards or patterns apply as additional referents.	A further specialization of TC which further determines applicable standards and patterns may apply.
S1 System Component Instance Name	**S1 Part Number**	**S1 Parent Instance Name**	**S1 Parent Part Number**	**S1 Technology Class**	**S1 Technology Subclass**	**S2-S1 Management Relationship Type**	**S2 Management Instance Name**	**S2 Management Instance Global Identifier**	**S2 Technology Class**	**S2 Technology Subclass**
Cartridge	AI.ISB4793D0423	Autoinjector Containment Subsystem	AI.MUN12211B	Machined Part		Specifies S2	OEM Engineering Group	ACME Engineering	Engineering Process	
Cartridge	AI.ISB4793D0423	Autoinjector Containment Subsystem	AI.MUN12211B	Machined Part		Fabricates, Constructs, Assembles, Implements, Produces S1	Part Supplier	Supplier 102	Production Process	
Cartridge	AI.ISB4793D0423	Autoinjector Containment Subsystem	AI.MUN12211B	Machined Part	Non-Destructive Inspection	Fabricates, Constructs, Assembles, Implements, Produces S1	Part Supplier	Supplier 102	Production Process	Non-Destructive Inspection
Cartridge	AI.ISB4793D0423	Autoinjector Containment Subsystem	AI.MUN12211B	Machined Part		Acquires S1	OEM Supply Chain Group	ACME GSC	Acquisition Process	
Cartridge	AI.ISB4793D0423	Autoinjector Containment Subsystem	AI.MUN12211B	Machined Part		Supplies S1	Part Supplier	Supplier 102	Supply Process	
Cartridge	AI.ISB4793D0423	Autoinjector Containment Subsystem	AI.MUN12211B	Machined Part		Sustains, Services, Maintains	OEM Support Group	ACME Support	Sustainment Process	
Autoinjector	AI.1MUN	Medical Device Application Domain System		Autoinjector-1		Specifies S1	OEM Engineering Group	ACME Engineering	Engineering Process	
		Autoinjector								



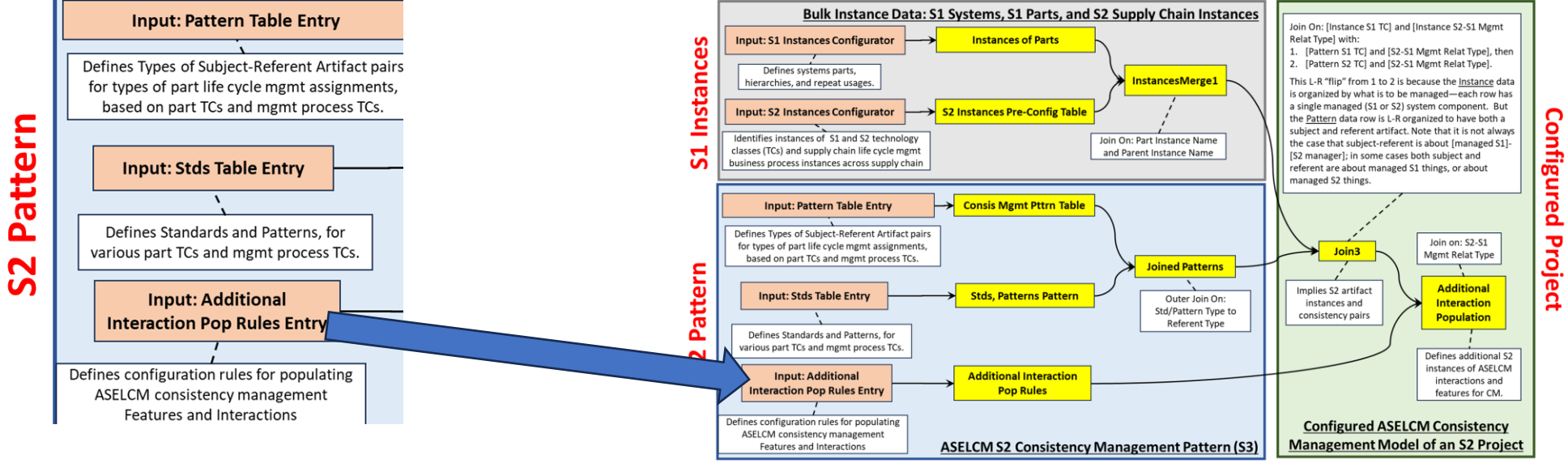
ASELCM S2 Consistency Management Pattern (S3) Configuration Rules Entry							
The system component that the subject artifact in this row is about or describes.	The system component that the referent artifact in this row is about or describes.	The class of technology that the subject system uses. Used to identify artifact pair rows that will apply to this system component. Also used to identify additional standards and patterns that apply to the subject system.	Specialization of TC.	The artifact type being "checked" by the referent artifact in this row. (This is a a generic artifact type whose name will be extended during pattern configuration to include the instance that the artifact is about.) The subject artifact in this column can also appear as a referent artifact in other rows of this table.	The artifact type used to "check" the subject artifact in this row. (This is a generic artifact type whose name will be extended during pattern configuration to include the instance that the artifact is about.) The referent artifact in this column can also appear as a subject artifact in other rows of this pattern table.	What consistency pair this row is about.	What the management system that creates the subject artifact is responsible for.
Subject System	**Referent System**	**Technology Class**	**Technology Subclass**	**Subject Artifact**	**Referent Artifact**	**Inter-Artifact Consistency**	**S2-S1 Management Relationship Type**
Self	System of Interest	Requirements	Missions Specification	Autoinjector-1		Autoinjector-1	
Parent	System Component	Allocated Flow Down Requriements	Design	Containment Subsystem		Autoinjector-1	
Self	System Component	Requirements	Allocated Flow Down Requriements	Containment Subsystem		Containment Subsystem	
Self	System Component	Design	Requirements	Containment Subsystem		Containment Subsystem	

Subject System	Referent System	Technology Class	Technology Subclass	Subject Artifact	Referent Artifact	Inter-Artifact Consistency	S2-S1 Management Relationship Type
Self	System of Interest	Design	Requirements	Autoinjector-1		Autoinjector-1	
Parent	System Component	Allocated Flow Down Requriements	Design	Machined Part	Finish	Containment Subsystem	
Self	System Component	Requirements	Allocated Flow Down Requriements	Machined Part	Finish	Machined Part	Finish
Self	System Component	Design	Requirements	Machined Part	Finish		
General System Component	System Component	Part Design Spec	Parts Standard	Machined Part	Finish	Machined Part	Finish
System Component	Production Process	Configured Production Process Specification	Part Design Spec	Machined Part		Machined Part	
System Component	Materials	Material Spec	Part Design Spec	Production Process		Inspection Process	
Inspection Process	Materials	Material Spec	Production Inspection Procedure	Machined Part		Machined Part	
Production Process	Materials	Material Spec	Configured Production Process Specification	Machined Part			
General Production Process	Production Process	Configured Production Process Specification	Production Process Standard	Machined Part			
General Production Process	Production Process	Configured Production Process Specification	Production Equipment Capability Description	Production Process		Inspection Process	
System Component	Production Process	Production Inspection Procedure	Part Design Spec	Production Process			
System Component	Production Process	Production Inspection Procedure	Inspection Process Standard	Inspection Process	Non-Destructive Inspection	Machined Part	
System Component	System Component	RFP Data Package	Engineering Data Package	Production Process	Non-Destructive Inspection	Inspection Process	Non-Destructive Inspection
			Supplier				



Entry of Standards and Refence Patterns

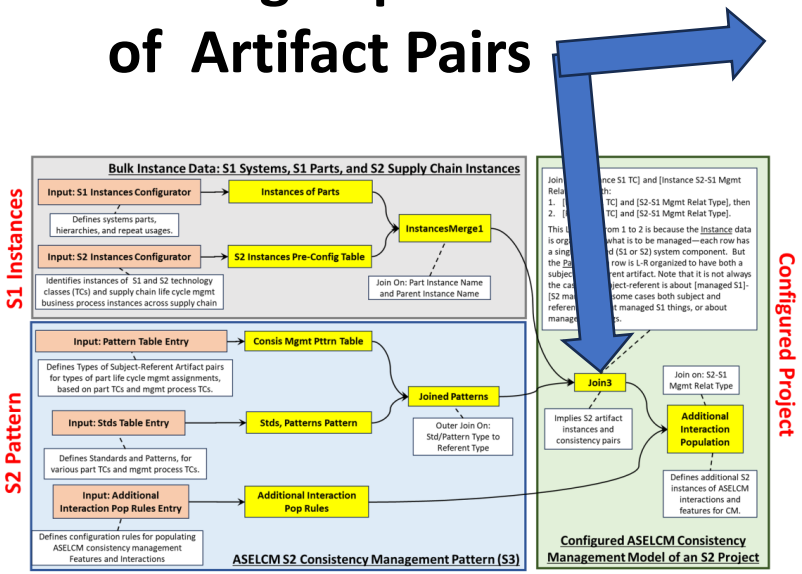
The class of technology of the system or component that the standard or pattern is about. Used to determine which components the standard or pattern applies to.	Further specializes the applicability of the standard or pattern, to this technology subclass.	Matches to generic referent artifact types appearing in the base pattern table. Helps determine when a standard or pattern applies as a referent artifact.	The name or ID of a specific standard or reference pattern that can be used as a specific referent artifact. This name is used to extend the generic name of a referent artifact type.
Technology Class	**Technology Subclass**	**General Artifact Type**	**Standard, Pattern**
Autoinjector-1		NA	
Autoinjector-2		NA	
Material-1		NA	
Material-2		NA	
Material-3		NA	
Material-4		NA	
NA		Process-1	
Production Process	Production Process 275 AFK	Production Process	Production Process 275 AFK
NA		Process-3	
NA		Process-4	
NA		Process-5	
NA		Process-6	
Inspection Process	Non-Destructive Inspection	Inspection Process	Non-Destructive Inspection
NA		Process-8	
Autoinjector-1		NA	



Entry of Configuration Rules for Generating Features and Interactions, Based on Bulk Instance Inputs and Pattern.

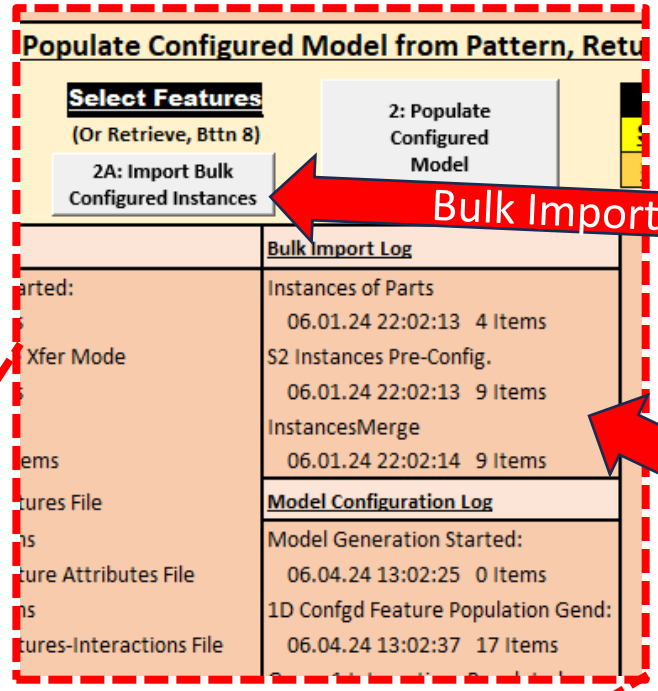
The type of management relationship that a management system is responsible for.	The type of management system technology employed by a management system.				The name of a consistency management feature to be populated if warranted.	The source of the FPK value for populating a Feature. For a two-part compound FPK value, this column describes the source of the first half of the FPK.	The source of the FPK value for populating a Feature. For a two-part compound FPK value, this column describes the source of the second half of the FPK.
S2-S1 Management Relationship Type	**S2 Technology Class**	**Interaction Name**	**IPK1 Source**	**IPK2 Source**	**Feature Name**	**FPK1 Source**	**FPK2 Source**
Specifies	Engineering Process				Decision Management-Engineering	Subject Artifact	Referent Artifact
Fabricates, Constructs, Assembles, Implements, Produces	Production Process				Decision Management-Production	Subject Artifact	Referent Artifact
Plans Project	Project Management Process				Decision Management-ProjMgmt	Subject Artifact	Referent Artifact

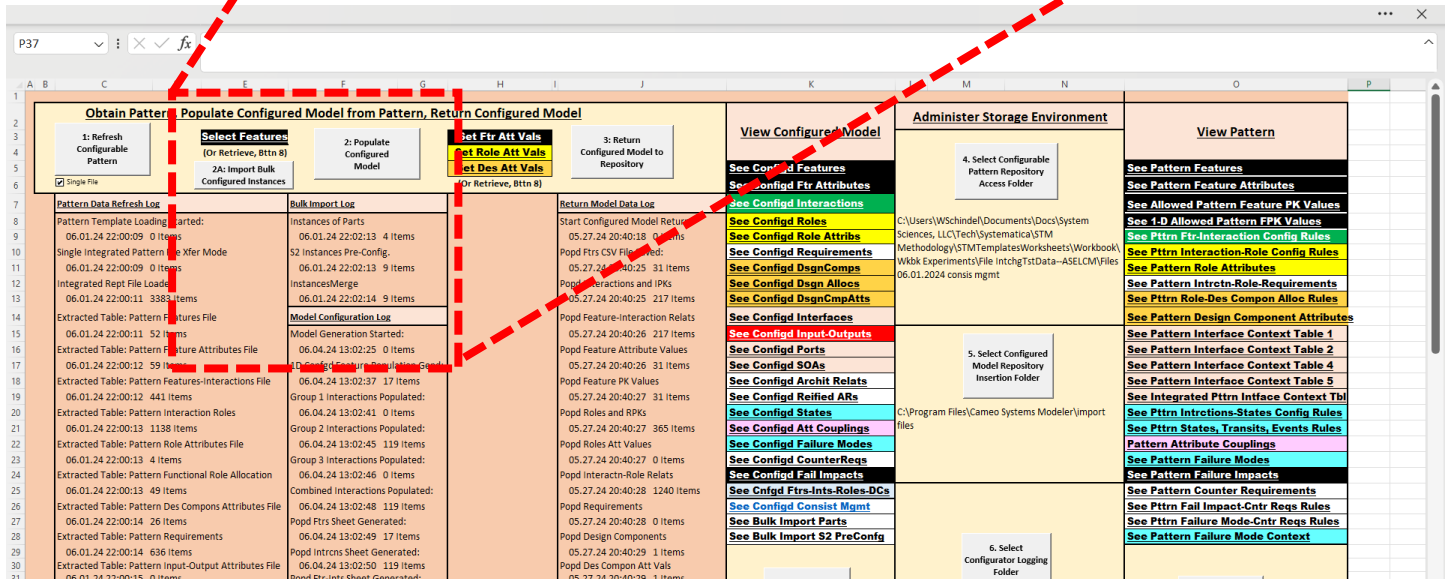
Resulting Population of Artifact Pairs



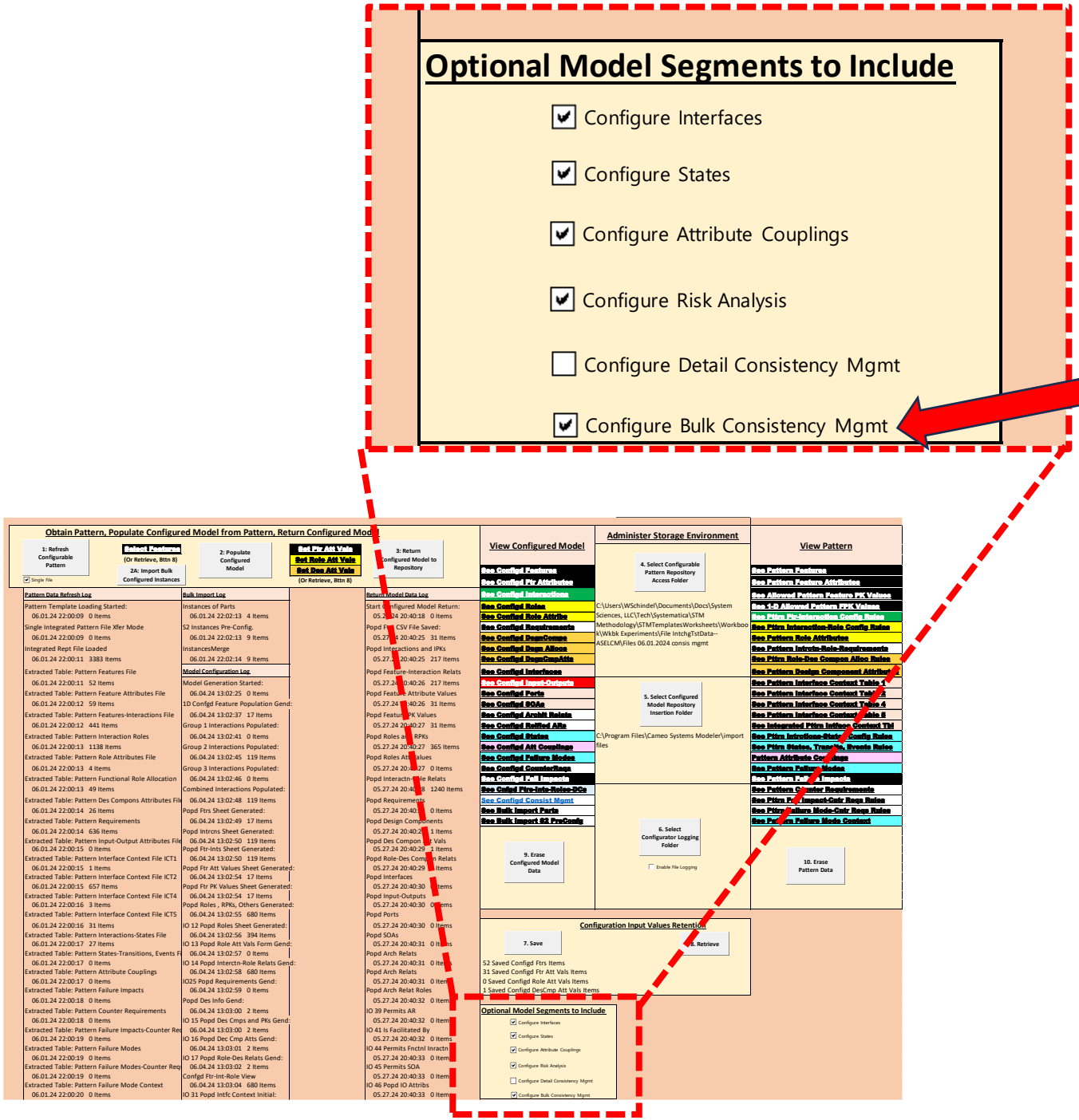
Subject Artifact	Referent Artifact
Requirements.Autoinjector.AI.1MUN	Missions Specification.Autoinjector.AI.1MUN
Design.Autoinjector.AI.1MUN	Requirements.Autoinjector.AI.1MUN
Material Spec.Cartridge.AI.ISB4793D0423	Production Inspection Procedure.Part Supplier.Supplier 102
Material Spec.Cartridge.AI.ISB4793D0423	Configured Production Process Specification.Part Supplier.Supplier 102
Material Spec.Cartridge.AI.ISB4793D0423	Production Inspection Procedure.Part Supplier.Supplier 102
Material Spec.Cartridge.AI.ISB4793D0423	Configured Production Process Specification.Part Supplier.Supplier 102
Material Spec.Cartridge.AI.ISB4793D0423	Production Inspection Procedure.Part Supplier.Supplier 102
Material Spec.Cartridge.AI.ISB4793D0423	Configured Production Process Specification.Part Supplier.Supplier 102
Material Spec.Cartridge.AI.ISB4793D0423	Production Inspection Procedure.Part Supplier.Supplier 102
Material Spec.Cartridge.AI.ISB4793D0423	Configured Production Process Specification.Part Supplier.Supplier 102
RFP Disribution Plan.Cartridge.AI.ISB4793D0423	Supplier Certification Record.Cartridge.AI.ISB4793D0423
Production Purchasing Agreement.Cartridge.AI.ISB4793D0423	Engineering Data Package.Cartridge.AI.ISB4793D0423
Request for Clarification Information.Cartridge.AI.ISB4793D0423	Engineering Data Package.Cartridge.AI.ISB4793D0423
Quotation.Cartridge.AI.ISB4793D0423	RFP Data Package.Cartridge.AI.ISB4793D0423

Bulk Instance Loading for the Configuration Wizard





- An option Button 2A has been added to the Configuration Wizard, to allow loading of bulk configuration instance data in addition to the use of the Feature Selection Matrix.
- An option Bulk Import Log has been added, to record the instance counts imported.



- An option check box for “Configure Bulk Consistency Management” has been added to the pattern configuration options.
- If selected, this causes execution of additional wizard operations to form the extended consistency management data.

How Additional Learned Patterns Play into Consistency Detection and Reconciliation

- The expanded consistency management paradigm increases our interest in methods for detecting as well as reconciling inconsistencies.
- This is historically a human-performed, labor-intense activity, with only spotty digital assistance, such as records of tracings and approval status.
- Not to be overlooked: Even performing in that mode may yield improved performance, if we are judicious about setting up the related framework in a project.
- But we are also interested in how to leverage information assets more effectively . . . .

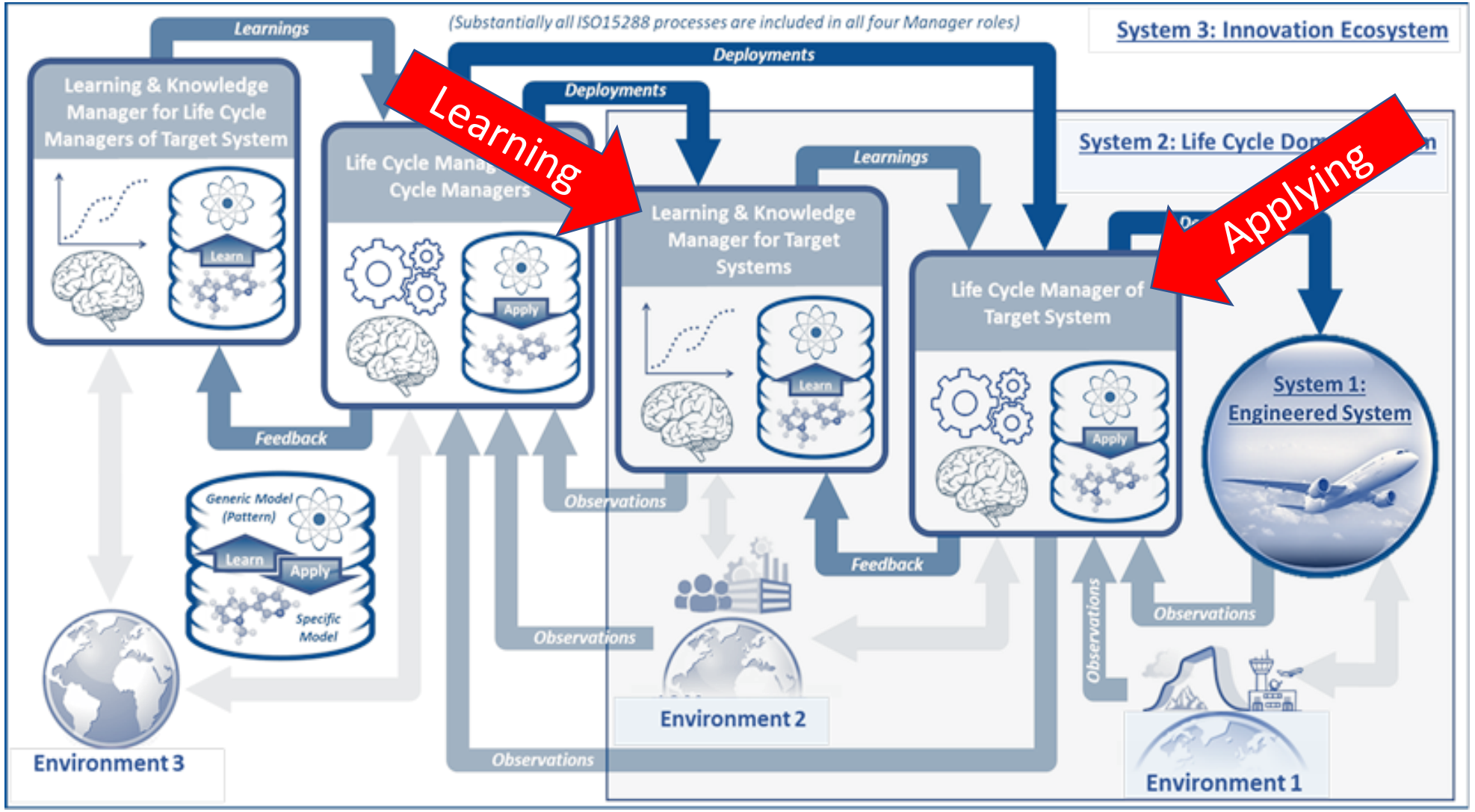
Additional learned patterns: Related observations

- Be aware that as used here, “patterns” in the broad sense refers to not just formal S*MBSE Patterns, but also to:
  1. Formal standards (industry, standards body, corporate, etc.)
  2. Other generic prose artifacts that might not be formalized as standards, but nevertheless are intended to describe general cases, such as architectural frameworks, product line descriptions, guidelines, etc.
  3. “Lessons Learned” libraries from past projects, if abstracted into general guidance for future application.
  4. Human-borne expertise in classes of experience (subject matter experts).
  5. Potentially, machine-learned patterns, provided they meet the credibility criteria being established for the cases of this above list.
- This helps us consider whether we are making effective enough use of previously accumulated information.

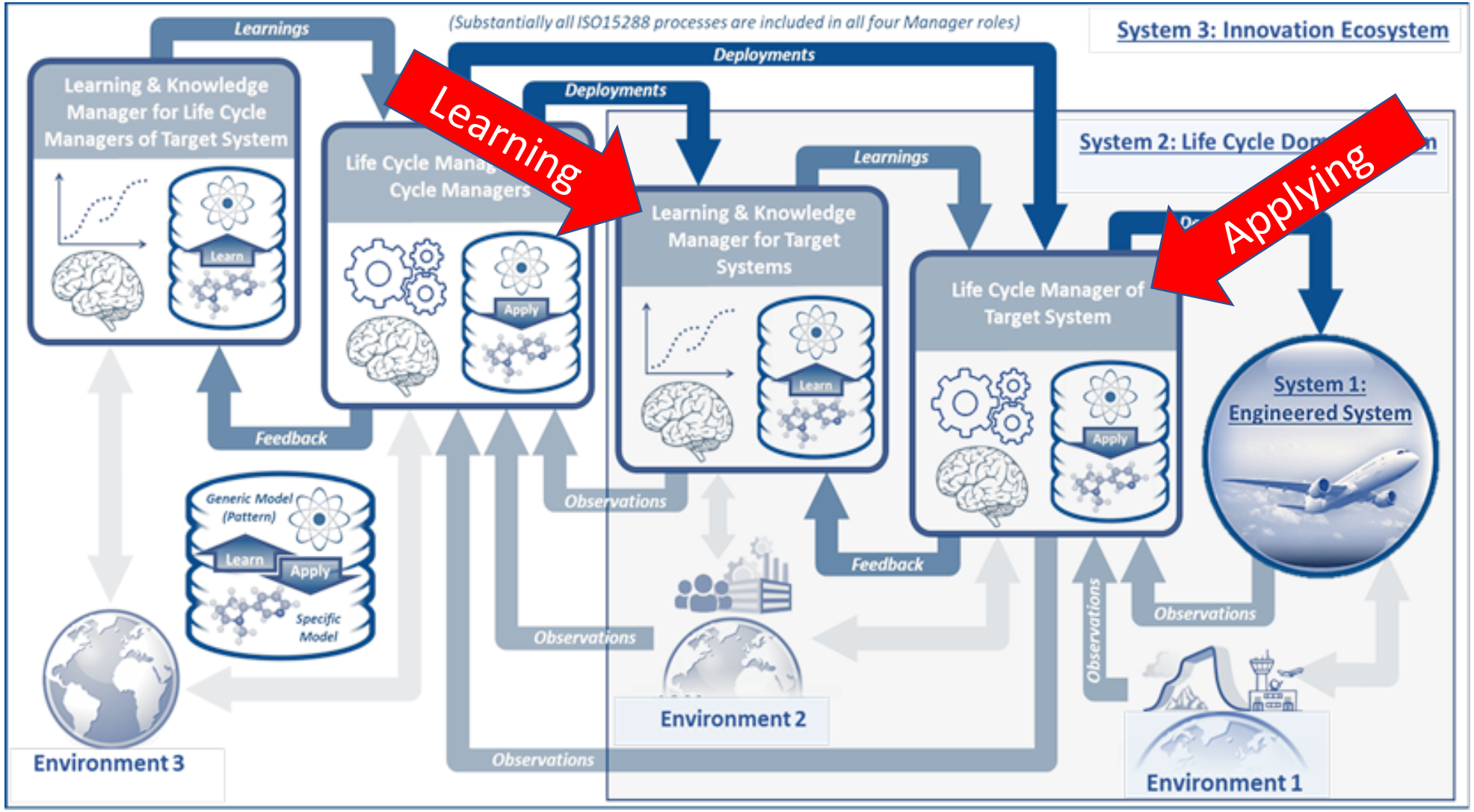
Additional learned patterns: Related observations

- Across large organizations, supply chains, markets, societies, and other groupings, there are well-known challenges to applying learning:
  - Discovery of information often occurs distant from the potential application of that information—distant across populations of people and organizations, and distant across time.'
  - This can effectively "disconnect" potential applications from initial learning.
  - Knowledge management efforts have attempted to address this with various forms of information technology and process.
  - PBSE approaches this by making configuration of existing patterns the explicit starting point of new projects, and making pattern management an explicit business asset management process—not just something that we "check" the "real work" against.
- Our interest in this project is especially how to use patterns further:
  - How can we use patterns in detection and reconciliation of inconsistency?

Notice the ASELCM diagram applies whether we have effective or ineffective coupling of learning to application transitions—it is not specific to PBSE, but about <u>all</u> the (effective or ineffective) cases of learning and application:



This project is about making effective use of existing information to avoid "surprises", extra cycles, delay. (Also includes avoiding burdensome "overuse" of information when something less would be "good enough" in urgent, crisis surges.)



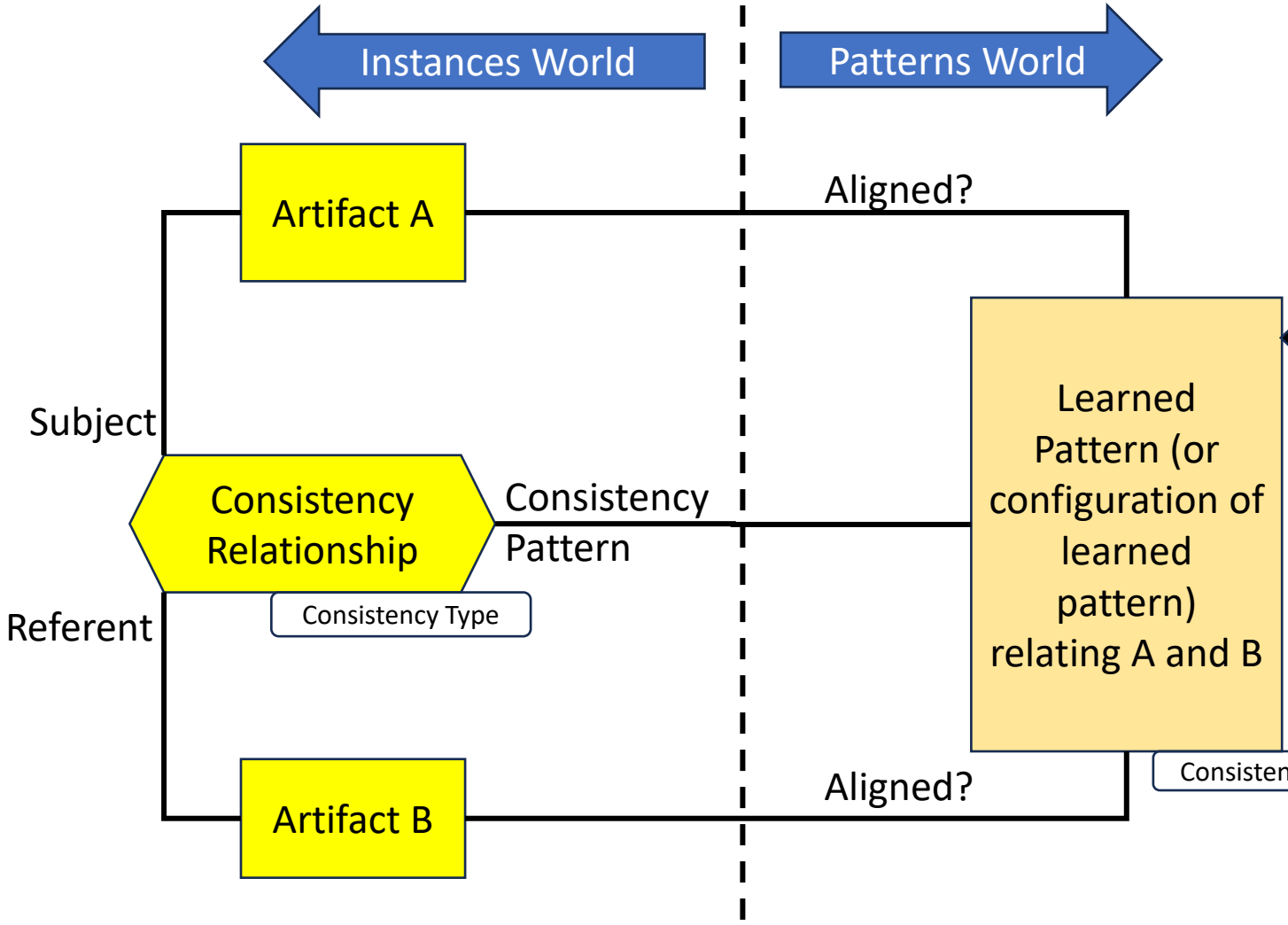
Additional learned patterns: Use in detection of inconsistency

- A few types of consistency are easy to check, but . . .
- Many types of artifact pair consistencies are challenging to detect; e.g.:
  1. consistency of a design with requirements;
  2. consistency of production process and materials with manufactured product design;
  3. consistency of system requirements and environment requirements (assumptions) with system mission.
- We assert that *no amount of "text processing" of these pairs can work for consistency checking, that does not include (at least informal) reference to additional "external learned patterns", such as . . . .*

Additional learned patterns: Use in detection of inconsistency

Consistency to Detect	Learned Reference Pattern for Consistency Detection
1. Consistency of a design with requirements	Learned emergent behavior based on STEM first principles, or simulation based on such foundations, or test, or other distillation of experience and observation
2. Consistency of a production process and materials with manufactured product design	Learned production transformation outcomes based on STEM first principles, or simulation based on such foundations, or test, or other distillation of experience and observation
3. Consistency of system requirements and environment requirements (assumptions) with system mission	Since mission descriptions are usually stakeholder (feature) language descriptions, and system and environment requirements are technical descriptions of external behaviors, their consistency inspection requires learned alignment of the outcomes of interacting system-environment behaviors compared to mission summary parameters.

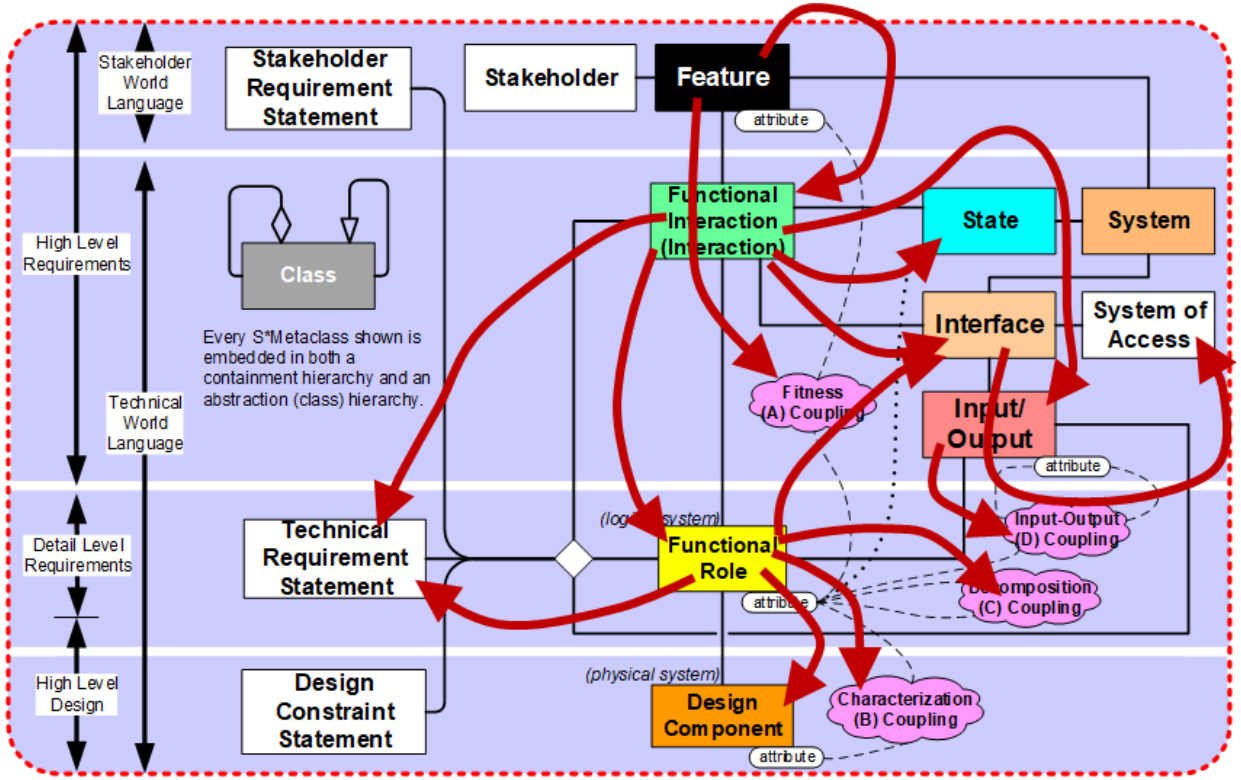
Additional learned patterns: Use in detection of inconsistency



Consistency to Detect	Learned Reference Pattern for Consistency Detection
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2. Consistency of a production process and materials with manufactured product design	Learned production transformation outcomes based on STEM first principles, or simulation based on such foundations, or test, or other distillation of experience and observation
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Additional learned patterns: Use in reconciliation of inconsistency

- For a given Subject Artifact, can we have access to enough Referent Artifacts to not only detect consistency, but to suggest synthesizing enough Subject Artifact content to generate the Subject Artifact in the first place, already consistent with those Referent Artifacts?
- A strong example of doing so already exists: the configuration of subject artifacts from S*Patterns—whether by the current configuration algorithm or other means.



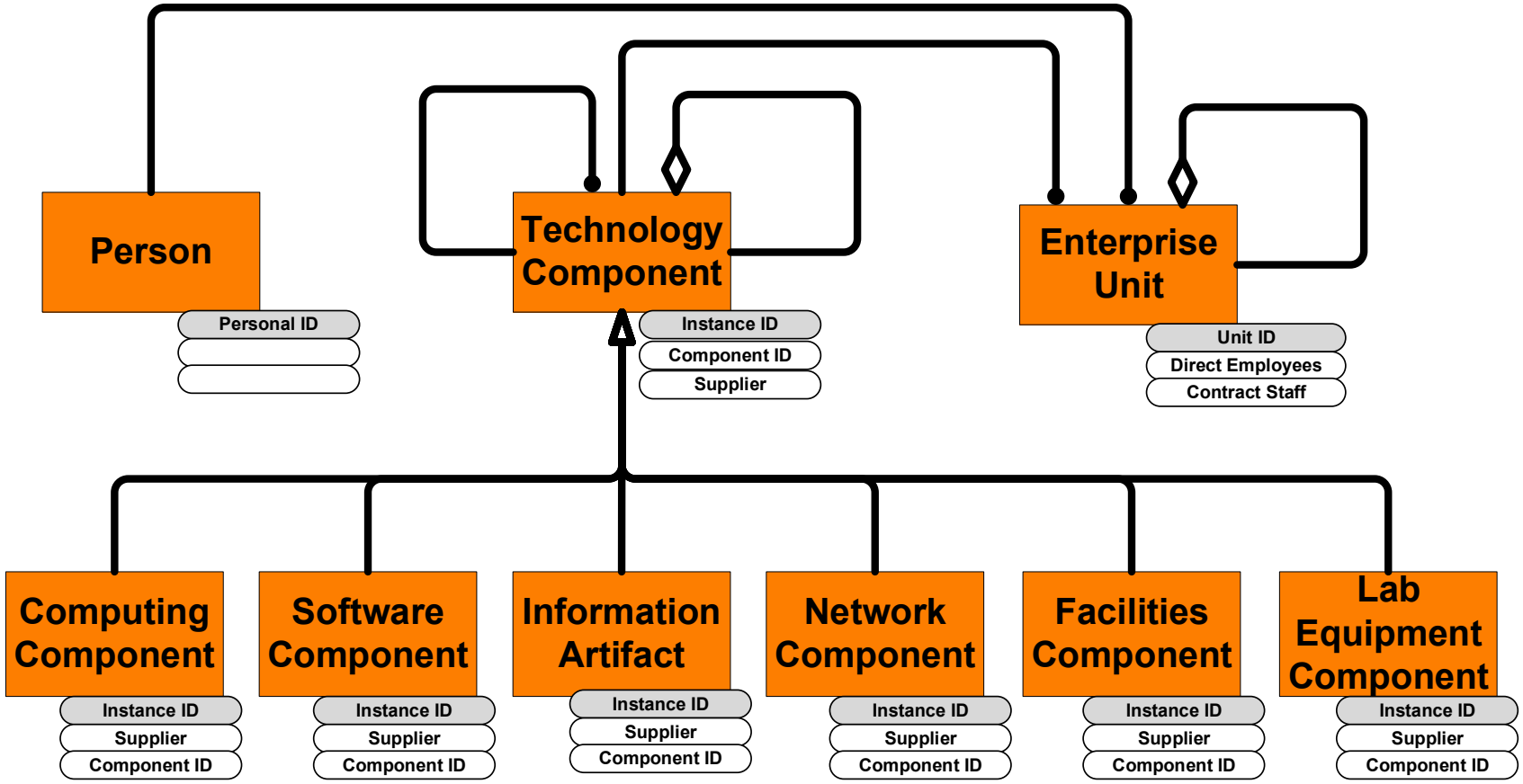
TRIGGERING METACLASSES ("IF")	POPULATED METACLASSES ("THEN")																								
	Feature	Interaction	Role	Design Component	Requirement Statement	State	Event	Transition	Interface	Architectural Relationship	Input/Output	Port	System of Access	Failure Impact	Counter Requirement Statement	Failure Mode	Feature Attribute	Role Attribute	Design Component Attribute	Input/Output Attribute	Fitness Attribute Coupling	Decomposition Attribute Coupling	Characterization Attribute Coupling	IO Attribute Coupling
Stakeholder Input																									
Feature																									
Interaction																									
Role																									
Design Component																									
Requirement Statement																									
State																									
Event																									
Transition																									
Interface																									
Architectural Relationship																									
Input/Output																									
Port																									
System of Access																									
Failure Impact																									
Counter Requirement Statement																									
Failure Mode																									
Feature Attribute																									
Role Attribute																									
Design Component Attribute																									
Input/Output Attribute																									
Fitness Attribute Coupling																									
Decomposition Attribute Coupling																									
Characterization Attribute Coupling																									
IO Attribute Coupling																									

Additional learned patterns: The critical question of formal pattern credibility

- For all the cases discussed above, credibility of the individual patterns (used to detect consistency or suggest reconciliation) will be a critical part of the overall framework.
- In the current state of practice, the credibility of models in general poses a serious industry problem, so expanding their use demands a stronger underlying framework:
  - https://nap.nationalacademies.org/login.php?record_id=13395
  - https://www.nationalacademies.org/our-work/foundational-research-gaps-and-future-directions-for-digital-twins
- The question is not whether a given model/pattern is perfect in its predictions, but whether its credibility is matched to the needs of the context of use.
- Appropriate frameworks for describing that credibility have been emerging, but are fragmented, and the subject of a joint project across ASME-INCOSE-AIAA-NAFEMS:
  - https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:asme_vvuq_2024--rosetta_stone_project_v1.7.3.pdf

The Design Components of Systems 2 and 3

- As the configuration of the ASELCM pattern becomes more familiar, keep in mind the types of configured Design Components that it populates in the configured model—including information artifacts and artifact pairs:



Systems Engineering Accounting and Accountability: Consistency Management, Digital Threads and Twins

- Consistent models can provide the "accounting" of Systems Engineering:
  - Just as a valid financial statement provides a financial accounting.

- A consistent collection of models, data, and real systems brings a form of accountability to an overall Innovation Ecosystem's life cycle management work:
  - A Consistency Thread becomes the SE equivalent of an accountant's financial statement.
  - Consistency Managers become the parties accountable for the various consistencies.
  - For those interested in overall plans for Digital Threads, this provides that framework

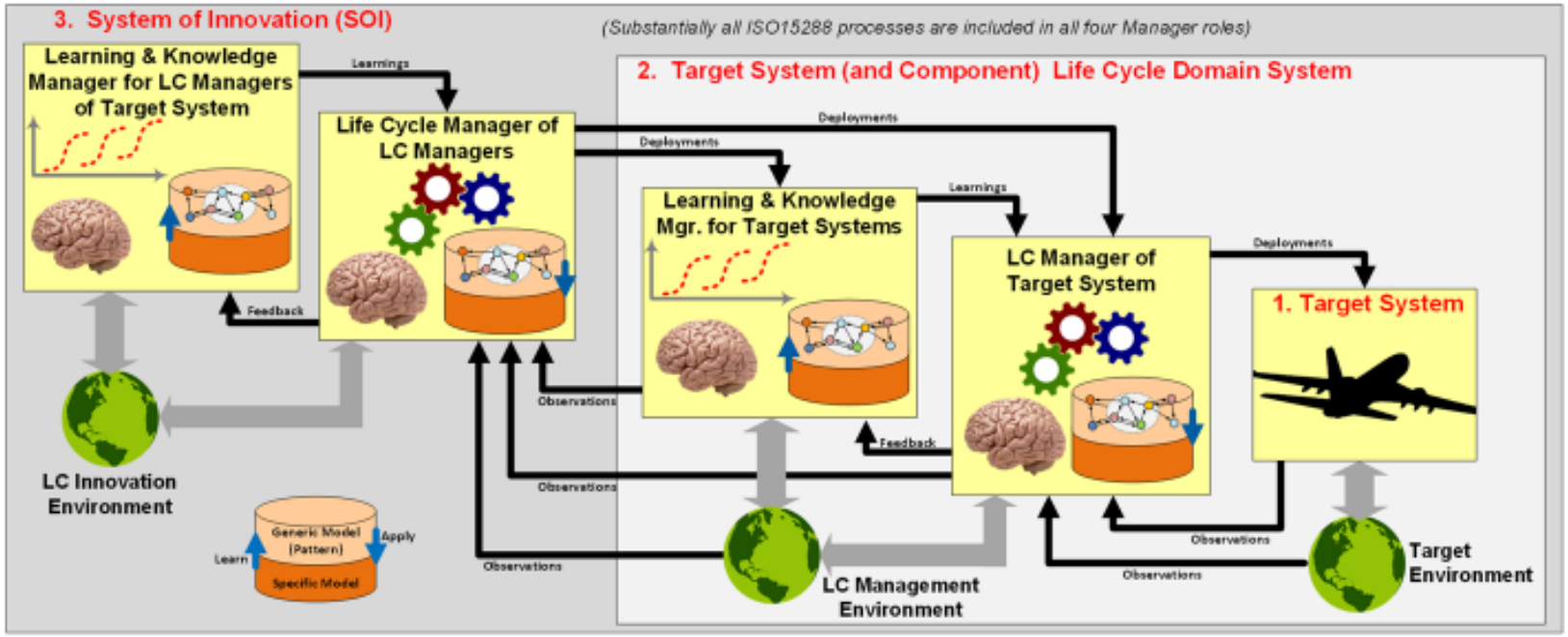
Homework assignment

1. Use the Wizard control tab link (“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 for a Bulk Consistency Management Configuration.

Discussion, Q&A

Attachment 1: Stages of Pattern Propagation, for Enterprises, Programs, Projects

ASELCM Reference Pattern: Reference Configuration & Learning Life Cycle Stages for Models, Model Patterns, and the Real Systems They Represent



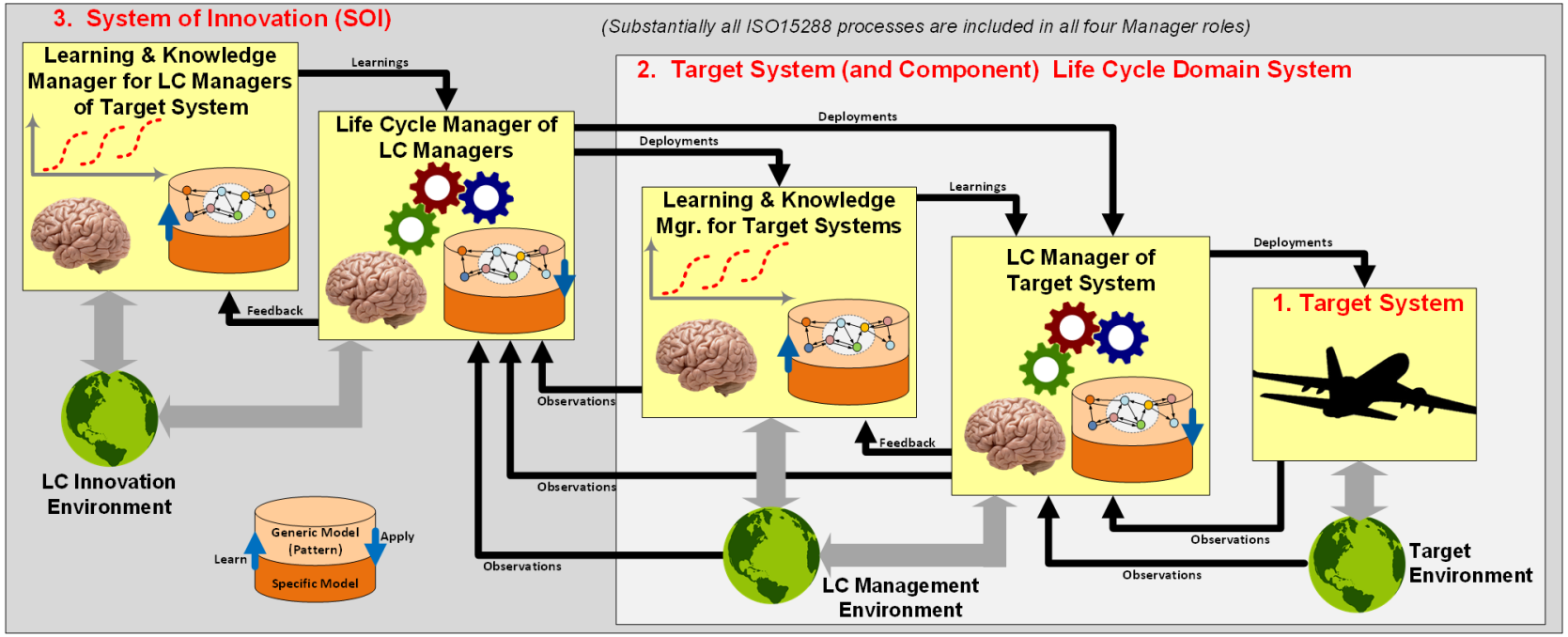
INCOSE MBSE Patterns Working Group

schindel@ictt.com

V1.5.8

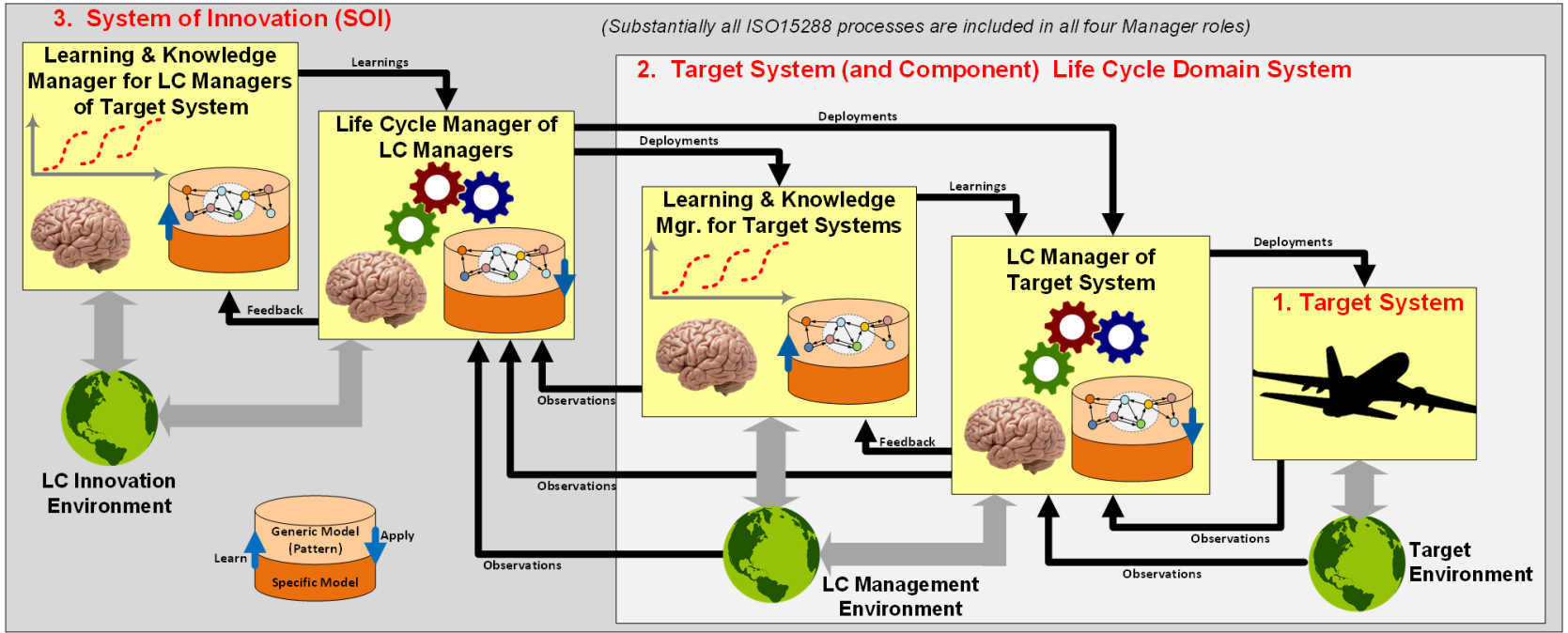
Subsections

I. System 1 Configuration by System 2; System 2 Learning
II. System 2 Configuration by System 3; System 3 Learning
III. Applicable System 3 data management tooling



Subsections

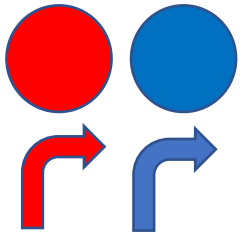
I. System 1 Configuration by System 2; System 2 Learning
II. System 2 Configuration by System 3; System 3 Learning
III. Applicable System 3 data management tooling

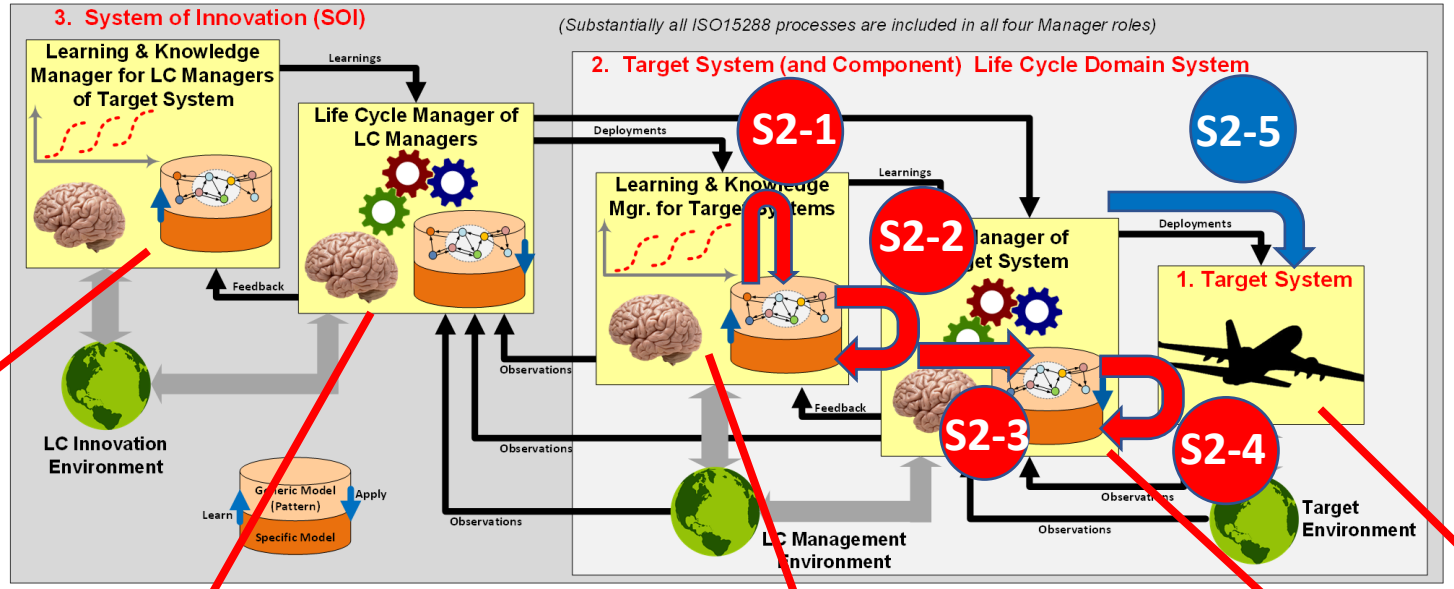


Stages of System 1 (Target System) Pattern & Model Configuration

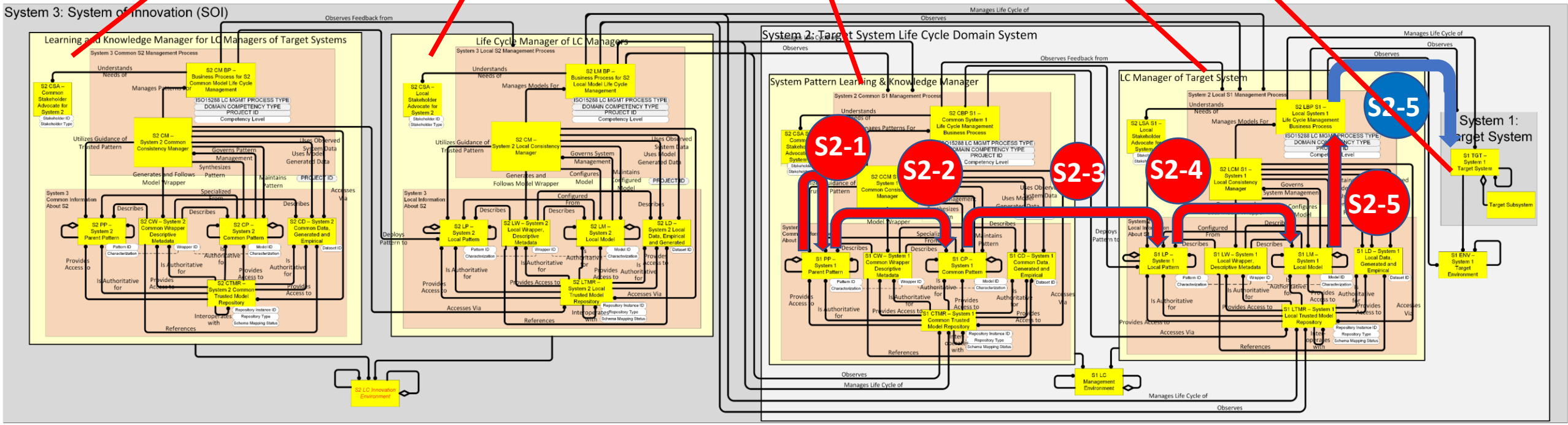
- The (System 1) Target System being engineered and life cycle managed is specified by models or other artifacts, having their own life cycle stages as they are progressively configured within an enterprise or other ecosystem.
- For any given single deployed System 1 configuration, there are a series of transition stages it will have passed through during the planning, implementing, deployment, and operation life of that configuration and its real System 1 capabilities.
- Those transition stages involve progressive stages of pattern specialization, which provide information in support of life cycle management processes that include engineering and other stages, referenced by the ASELCM Pattern.
- These stages also include updates to uncertainty about or confidence in modeled understanding, based on observations and feedback discussed in a later section below.
- The configuration transition stages are illustrated by the following diagram and subsequent table of definitions . . .

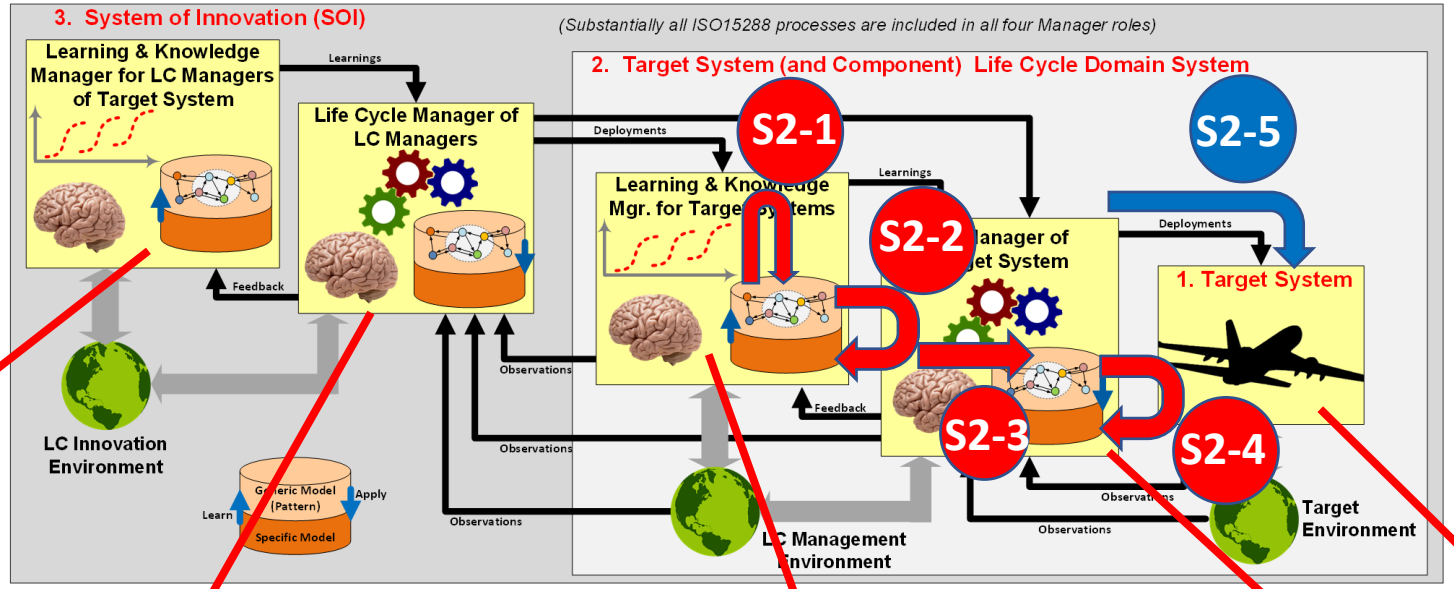
Transition stages:

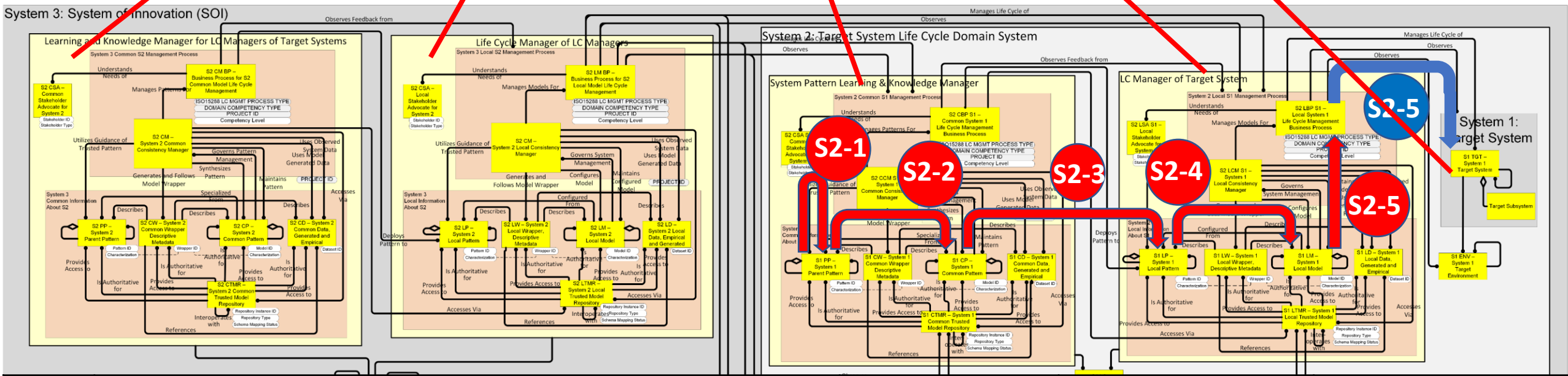




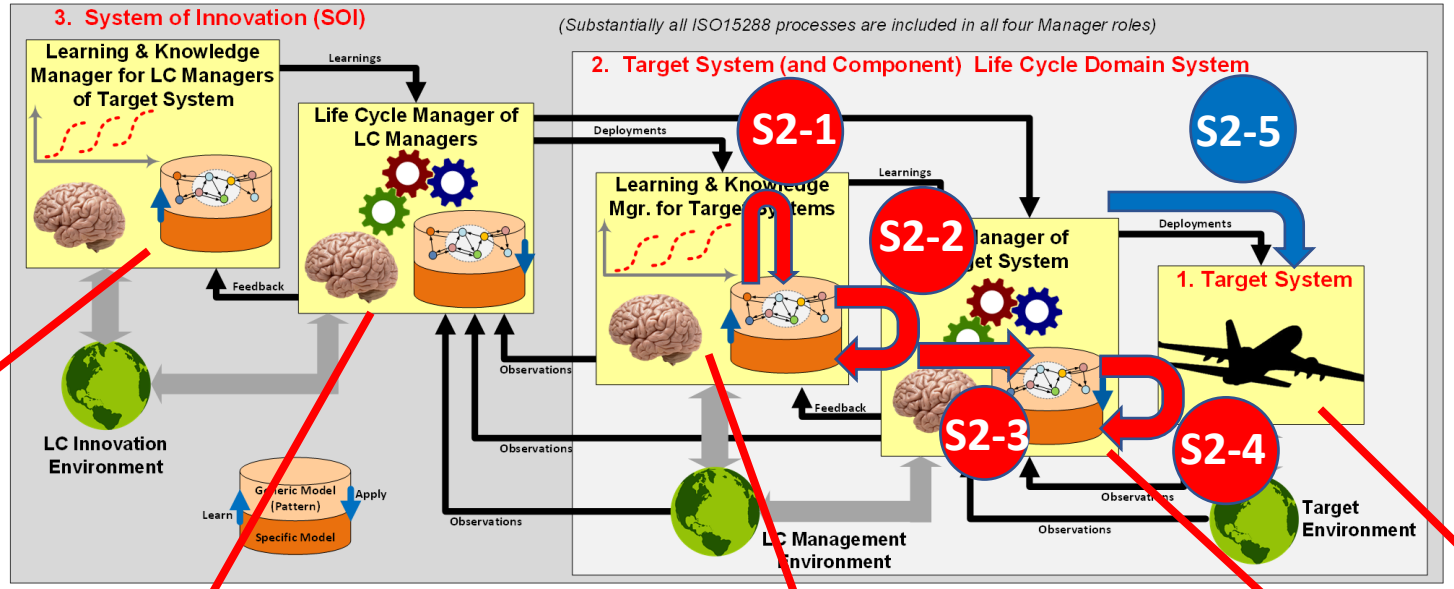
See next slides for definition of labeled stages.

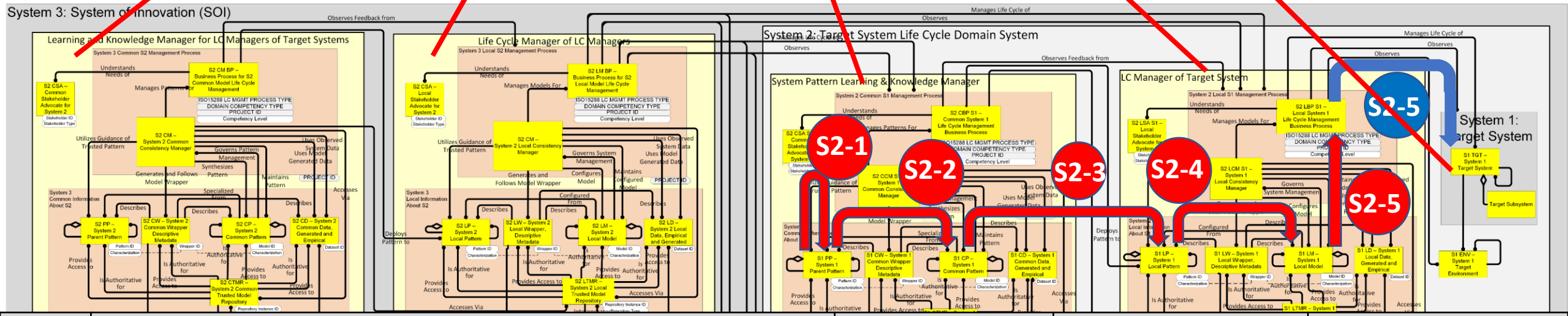




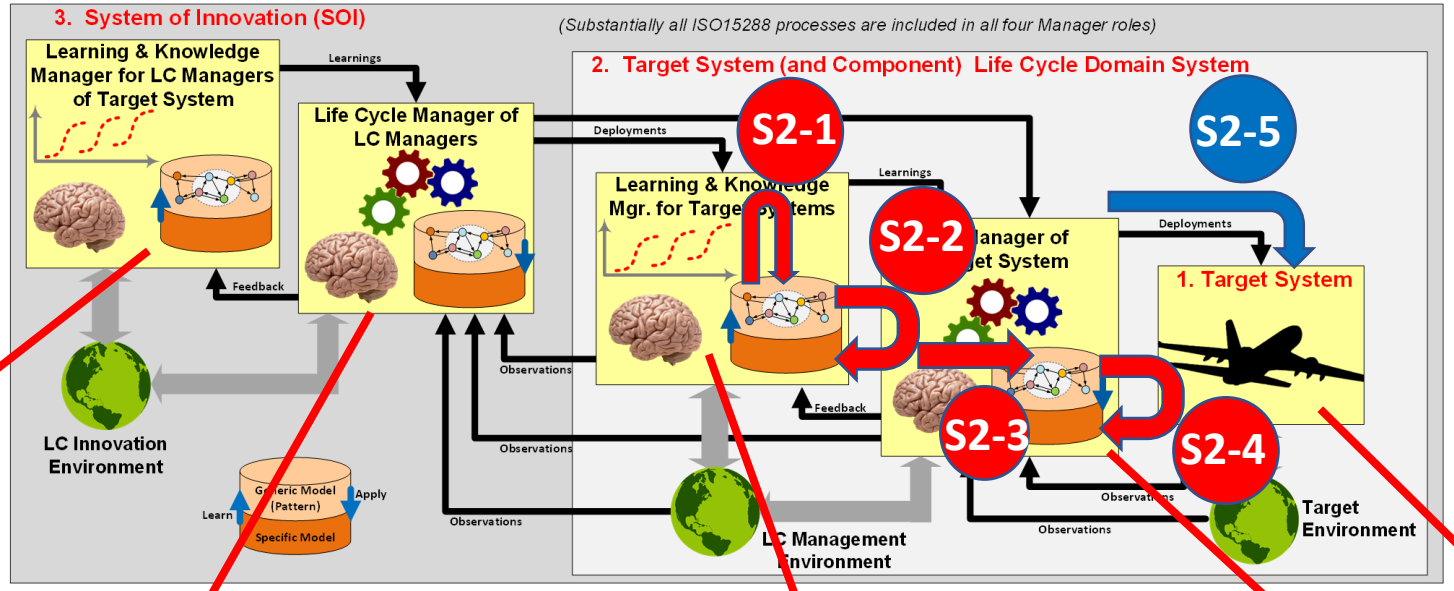


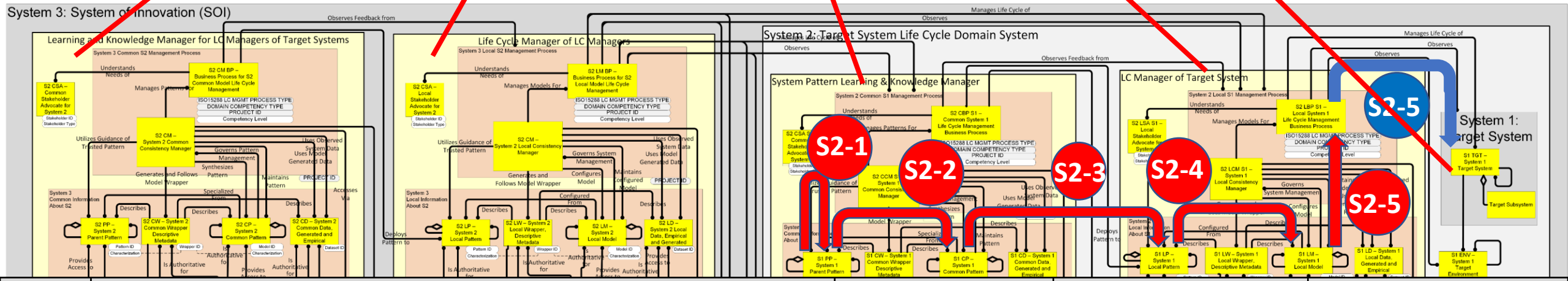
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-1	Parent Pattern version release as a Parent Pattern to an enterprise's System 2 Parent Pattern Library.	S*Patterns Community	S1 PP -- System 1 Parent Pattern (in S2)	Information Transfer



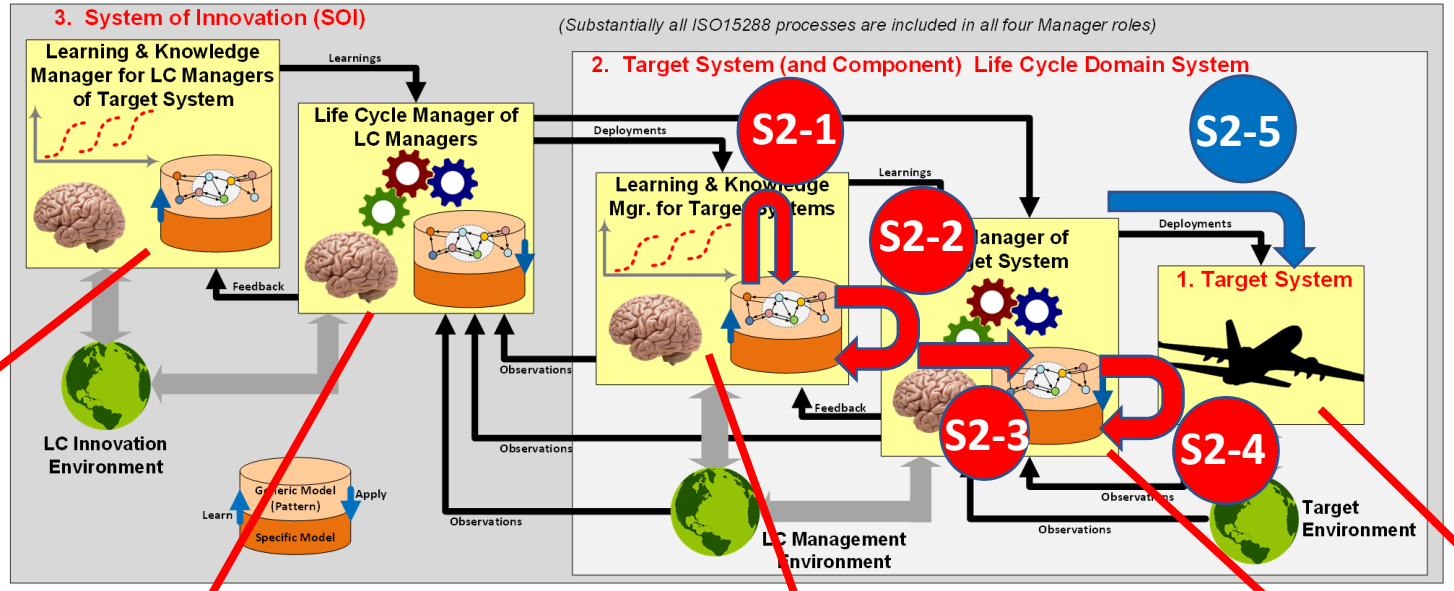


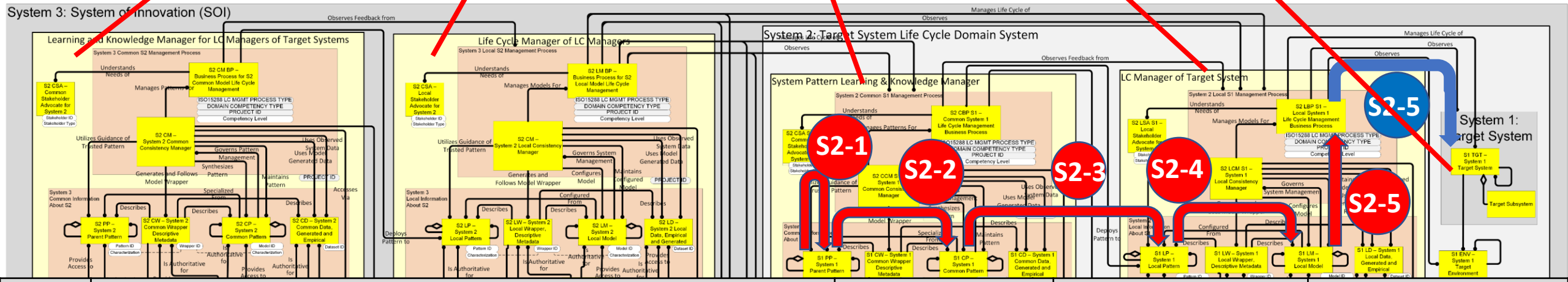
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-2	Configuration of Parent Pattern to one or more general System 1 patterns (in System 2) for use within the enterprise. Point of accumulation of future learning by observing S1 & environment during performance/life, or other sources of learning about S1.	S1 PP -- System 1 Parent Pattern (stored in S2)	S1 CP – System 1 Common Pattern (stored in S2)	Information Transformation (Pattern Configuration)



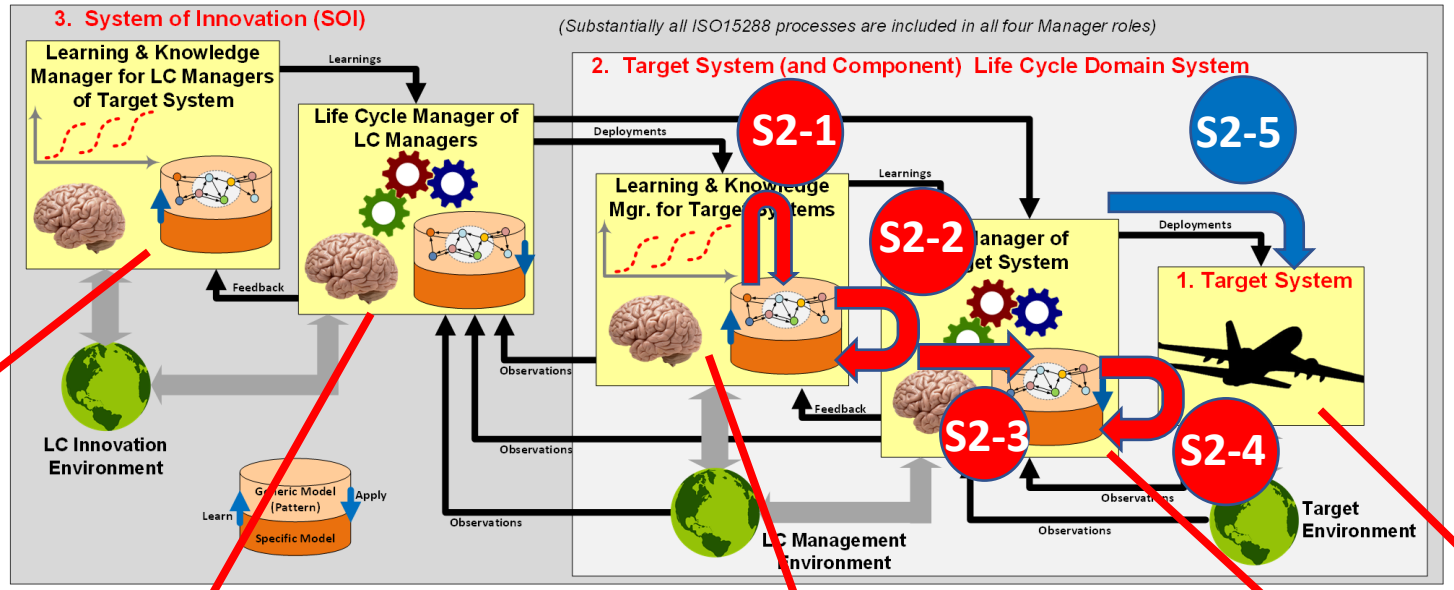


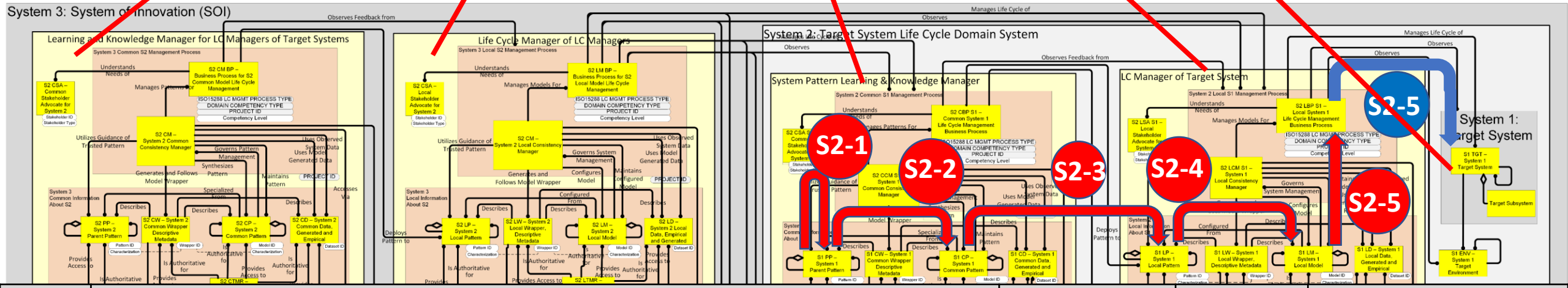
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-3	Typically describes library of types of intended S1 capabilities, but not yet configured to be specific to individual S1 instances, projects, or programs as to their quantities or combinations of those capabilities, projects, or programs. Types, but not quantities of instances or combinations of those types.	S1 CP – System 1 Common Pattern (stored in S2)	S1 LP – System 1 Local Pattern (stored in S2)	Information Transfer, but one to many





Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-4	Typically each model is specific to the enterprise's managed S1 projects and programs for individual S1 products, as to their quantities and combinations. Quantities of instances or combinations of instances for those S1 capabilities. May be instantiated as individual models for each S1 project or program.	S1 LP – System 1 Local Pattern (stored in S2)	S1 LM – System 1 Local Model (stored in S2)	Information Transformation (Pattern Configuration--usually many)





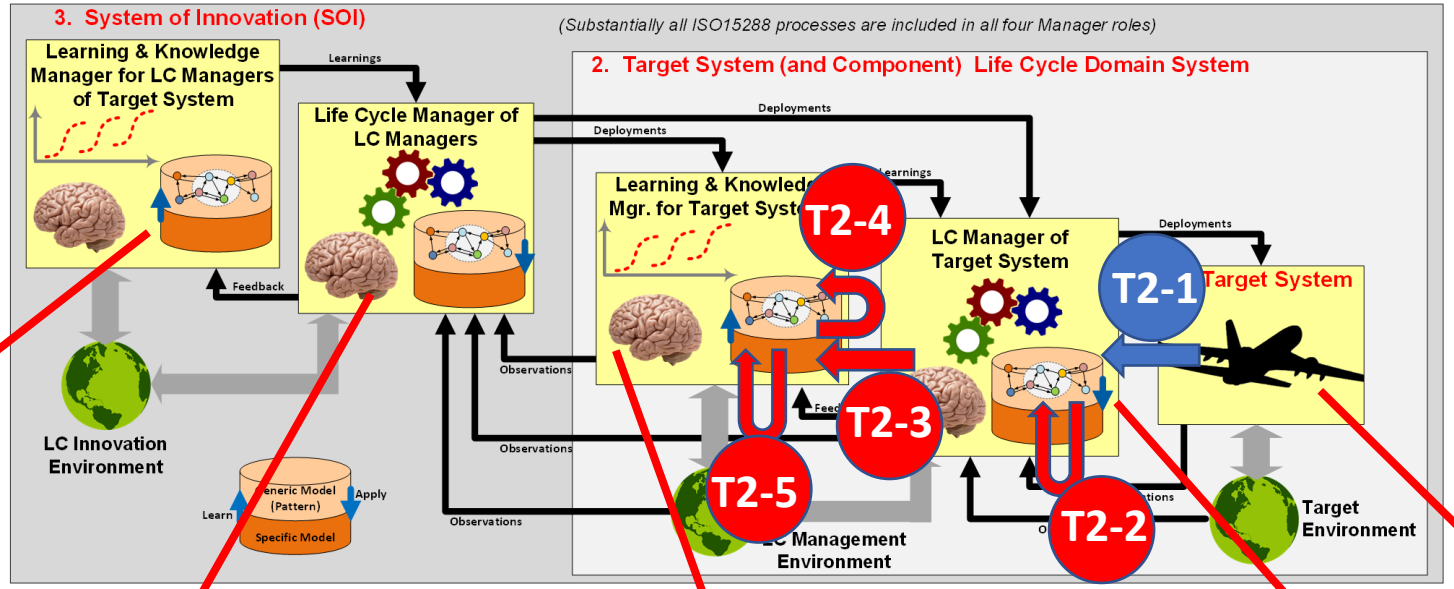
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-5	This is not primarily an information / model stage, but instead is use of the above S1 Local Model as "S1 blueprints", from which certain S2 Business Processes create and deploy real capabilities in S1, though S1 acquisition, fabrication, programming, staffing, education, other creation of real world S1 entities. Although many of these are not information but are real technology, a few can be information.	S2 Business Processes for S1 fabrication, acquisition, staffing.	S1 hardware, software, operators , facilities.	Deployment of real S1 hardware, software, operators, facilities that are described by S1 LM stored in S2.

Stages of System 1 (Target System) Pattern & Model Configuration

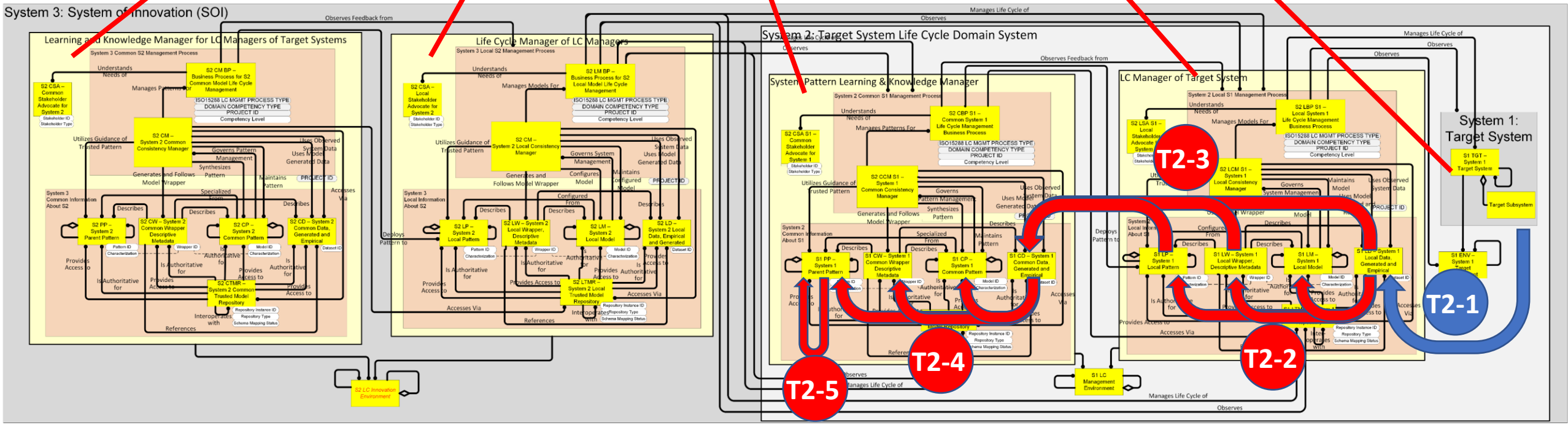
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-1	Parent Pattern version release as a Parent Pattern to an enterprise's System 2 Parent Pattern Library.	S*Patterns Community	S1 PP -- System 1 Parent Pattern (in S2)	Information Transfer
S2-2	Configuration of Parent Pattern to one or more general System 1 patterns (in System 2) for use within the enterprise. Point of accumulation of future learning by observing S1 & environment during performance/life, or other sources of learning about S1.	S1 PP -- System 1 Parent Pattern (stored in S2)	S1 CP – System 1 Common Pattern (stored in S2)	Information Transformation (Pattern Configuration)
S2-3	Typically describes library of types of intended S1 capabilities, but not yet configured to be specific to individual S1 instances, projects, or programs as to their quantities or combinations of those capabilities, projects, or programs. Types, but not quantities of instances or combinations of those types.	S1 CP – System 1 Common Pattern (stored in S2)	S1 LP – System 1 Local Pattern (stored in S2)	Information Transfer, but one to many
S2-4	Typically each model is specific to the enterprise's managed S1 projects and programs for individual S1 products, as to their quantities and combinations. Quantities of instances or combinations of instances for those S1 capabilities. May be instantiated as individual models for each S1 project or program.	S1 LP – System 1 Local Pattern (stored in S2)	S1 LM – System 1 Local Model (stored in S2)	Information Transformation (Pattern Configuration--usually many)
S2-5	This is not primarily an information / model stage, but instead is use of the above S1 Local Model as "S1 blueprints", from which certain S2 Business Processes create and deploy real capabilities in S1, though S1 acquisition, fabrication, programming, staffing, education, other creation of real world S1 entities. Although many of these are not information but are real technology, a few can be information.	S2 Business Processes for S1 fabrication, acquisition, staffing.	S1 hardware, software, operators, facilities.	Deployment of real S1 hardware, software, operators, facilities that are described by S1 LM stored in S2.

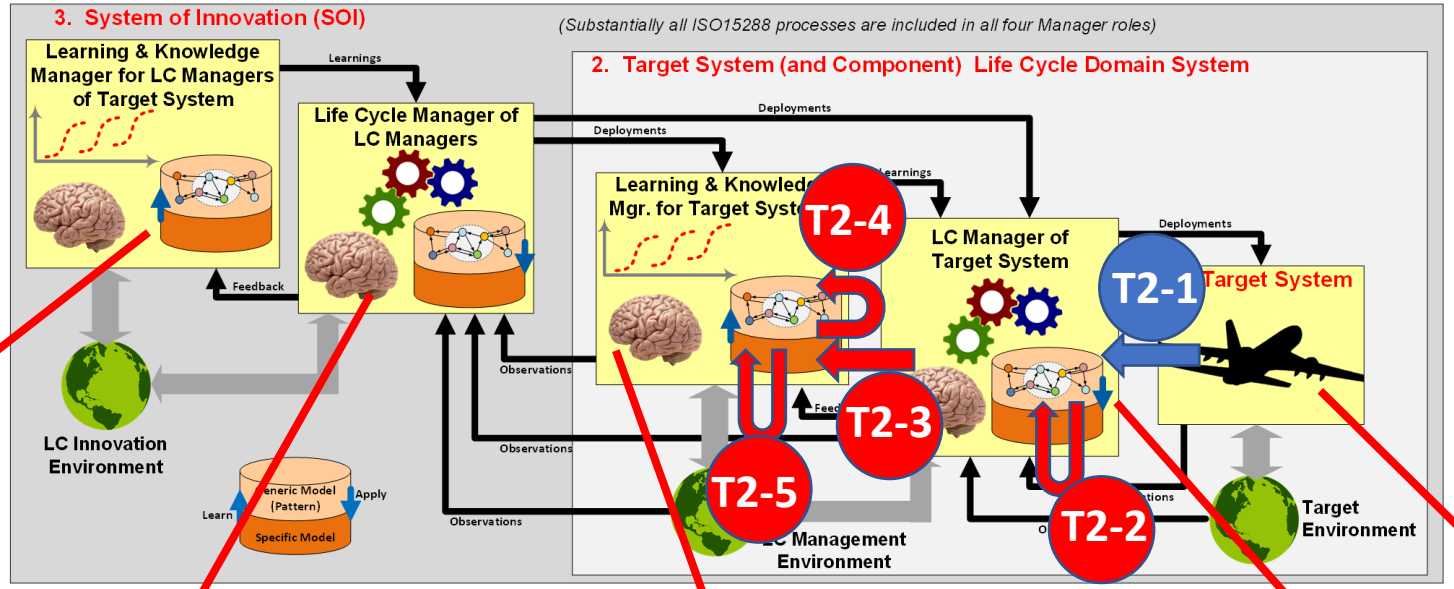
Stages of System 1 (Target System) Feedback, Pattern Uncertainty Management, and Group Learning

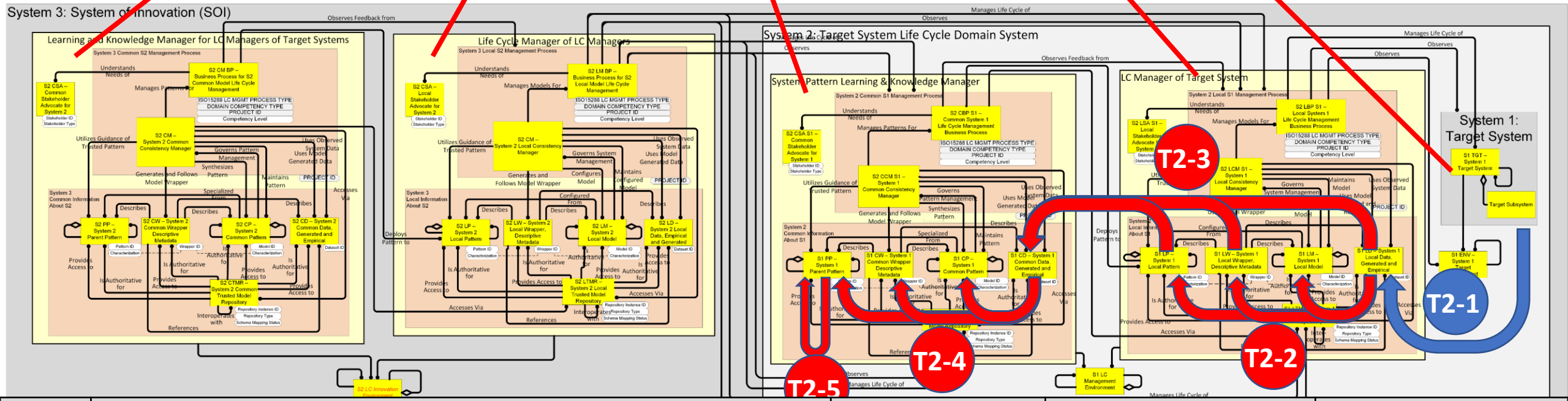
- Knowledge of the (System 1) Target System changes with experience and learning by (System 2) Engineering and Life Cycle Management Processes, through observation and experiments on System 1.
- This includes effects of inconsistencies between models or other descriptions/current understandings of System 1 compared to observations of the real System 1.
- Such inconsistencies may or may not justify updates to models and understanding, since observations and reports can be flawed/noisy/biased, or circumstances changing.
- This process changes not only the System 1 models or descriptions—it also evolves System 2 uncertainty about / confidence in the related System 1 models or descriptions.
- That uncertainty or confidence may be reflected by the Metadata role shown in the Level 2 ecosystem framework, in connection with model VVUQ (verification, validation, and uncertainty quantification).
- Balancing new or updated knowledge by combining past knowledge with new observation is the core idea of Bayesian or conditional probability, including updating estimates of uncertainty, managed as group level uncertainty.
- Beginning future projects by first configuring updated acquired generic patterns (to the next specific application) spreads learning to future performance of others (group learning).
- Those learning stages can also involve progressive stages of pattern generalization, based on feedback of specific case data, and are illustrated by the following diagram and subsequent table of definitions . . .



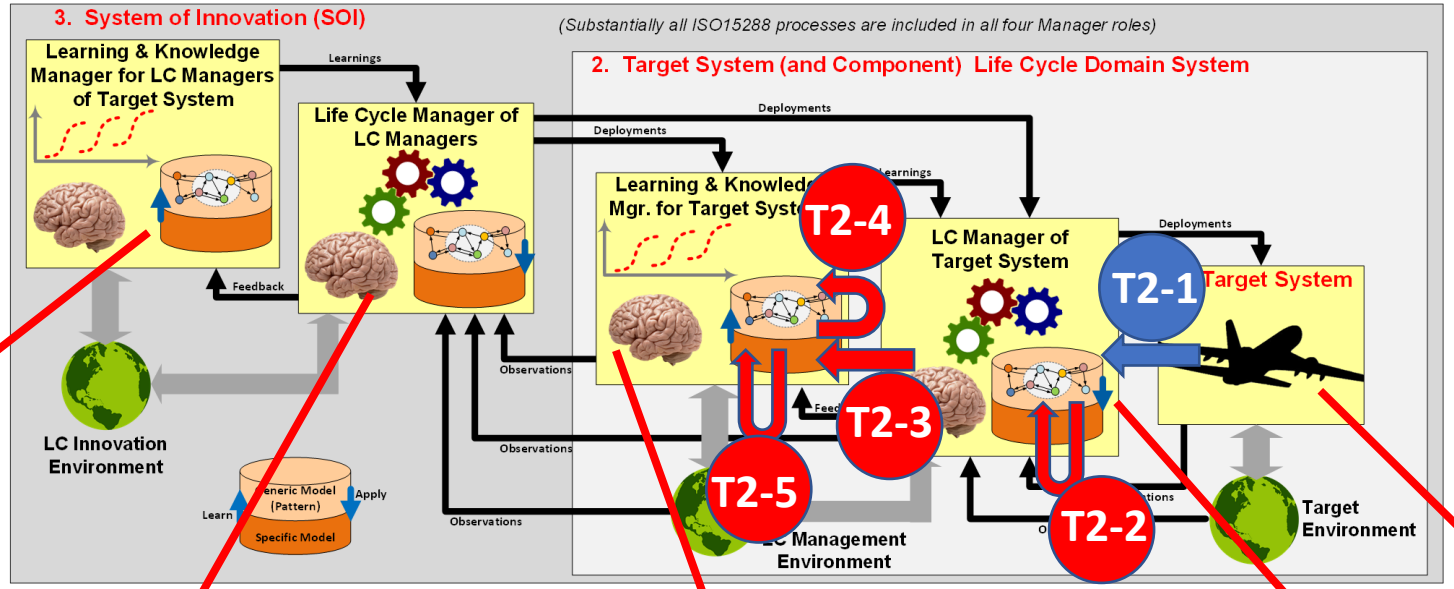
See next slides for definition of labeled stages.

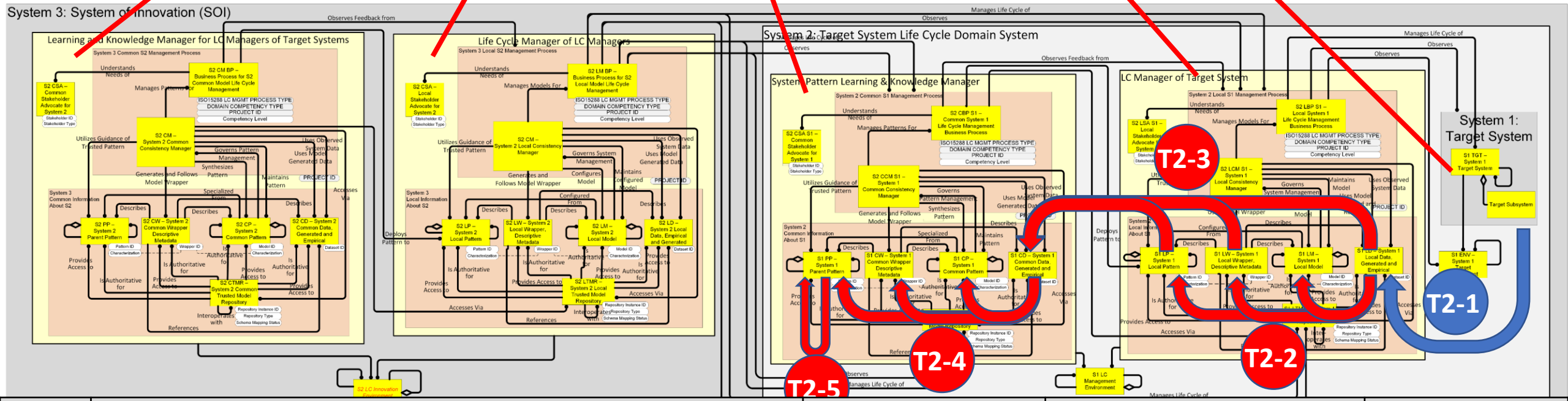




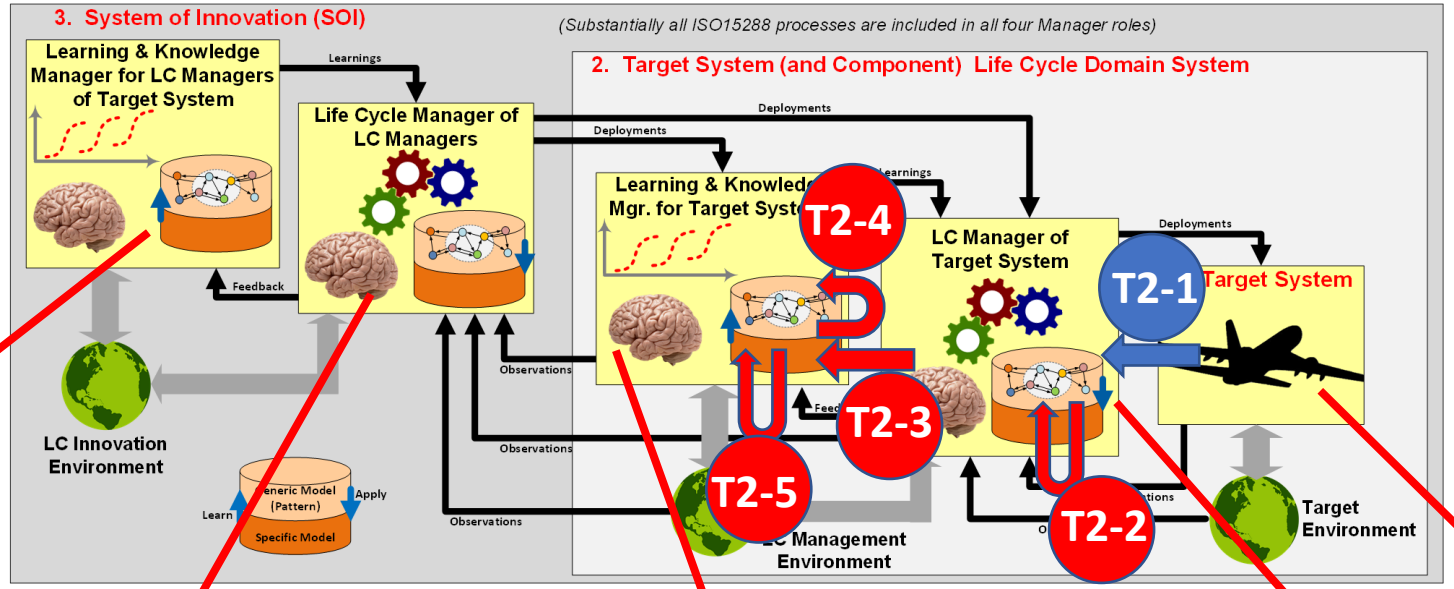


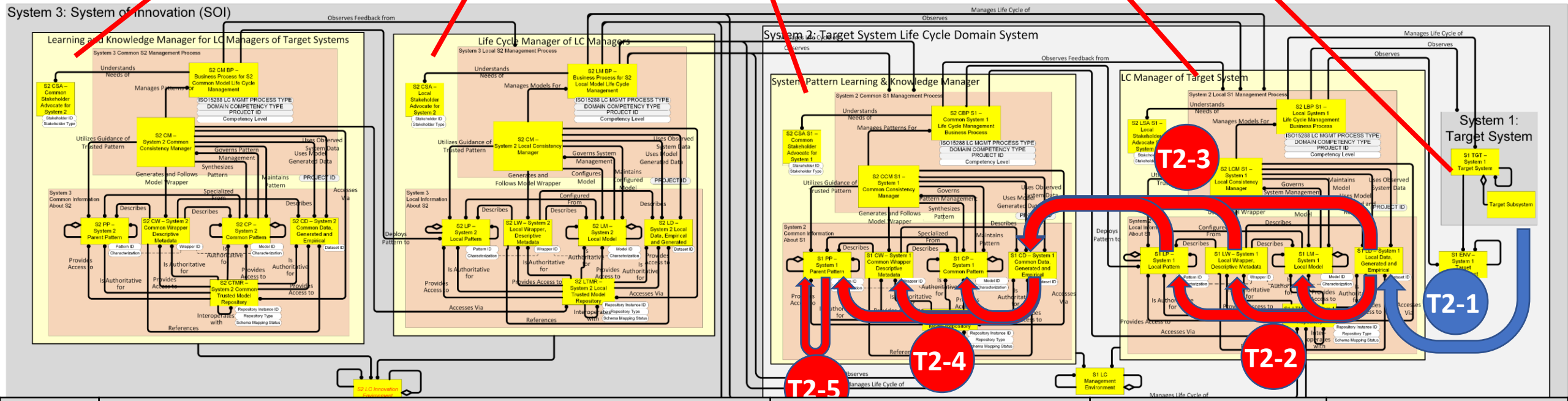
Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type & Qty
T2-1	Observations of System 1, and its interactions with its environment, are captured in the form of empirical data (e.g., measurement, etc.)	Observation of System 1+Environ	S1 LD -- System 1 Local Data, Empirical (in S2)	Observation, Info Xfer, many to one



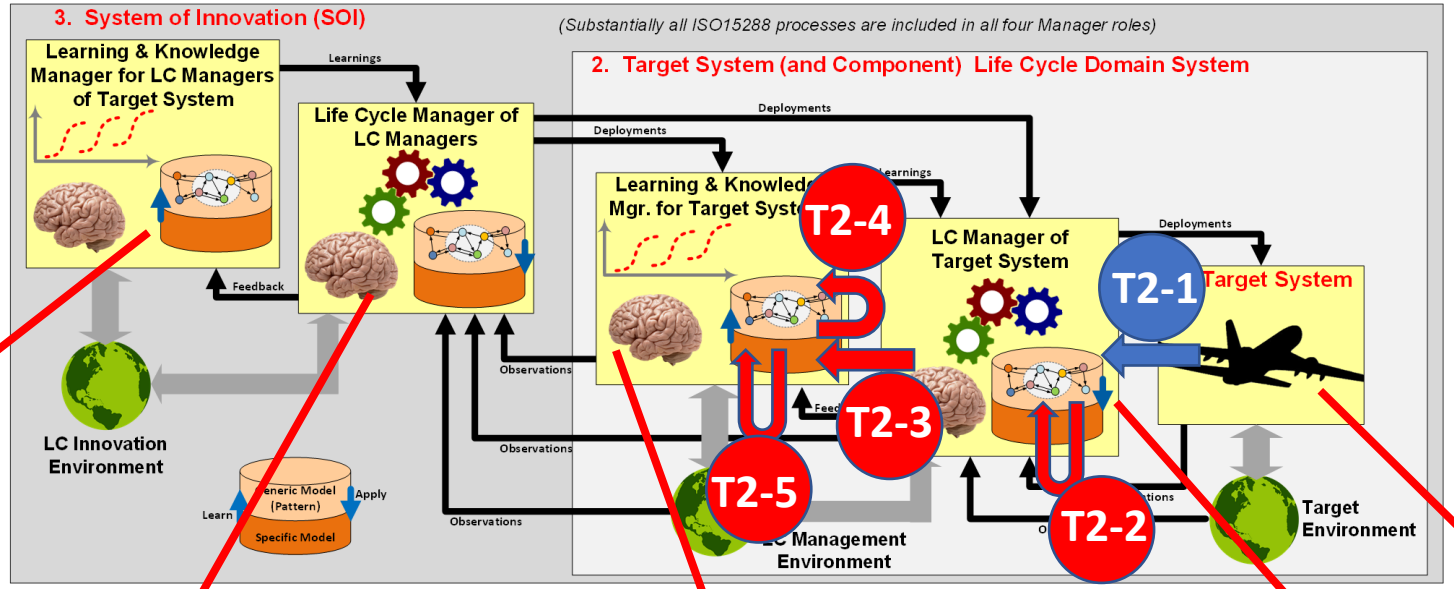


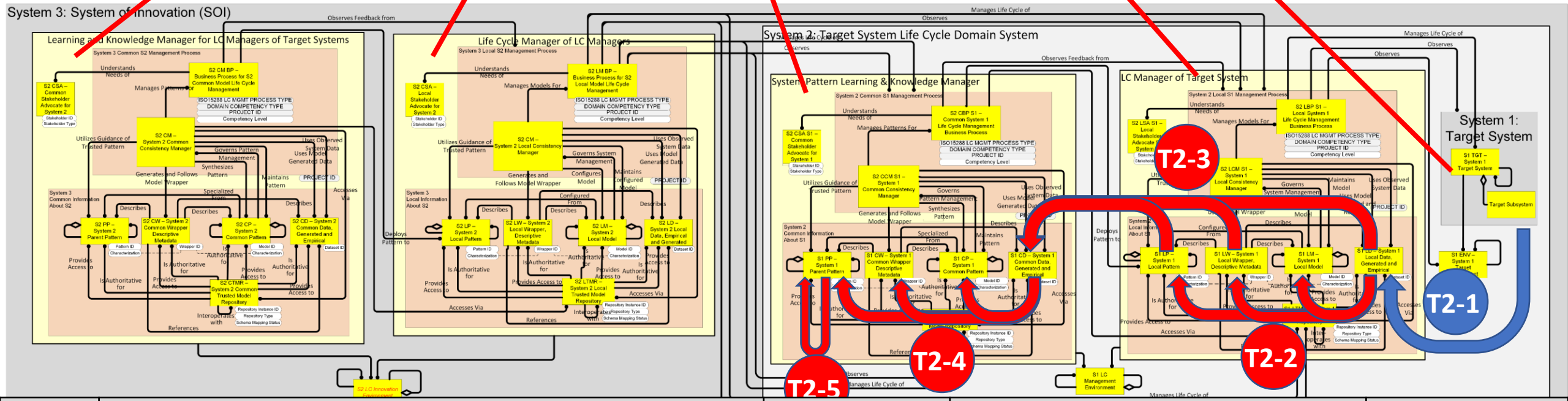
Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type, Qty
T2-2	Empirical observation is compared to local model and/or local pattern data, causing updates to them and uncertainty metadata	S1 LD—System 1 Local Empirical Data	S1 LP, S1 LM, S1 LW—Local Pattern, Model, Wrapper	Reconciliation



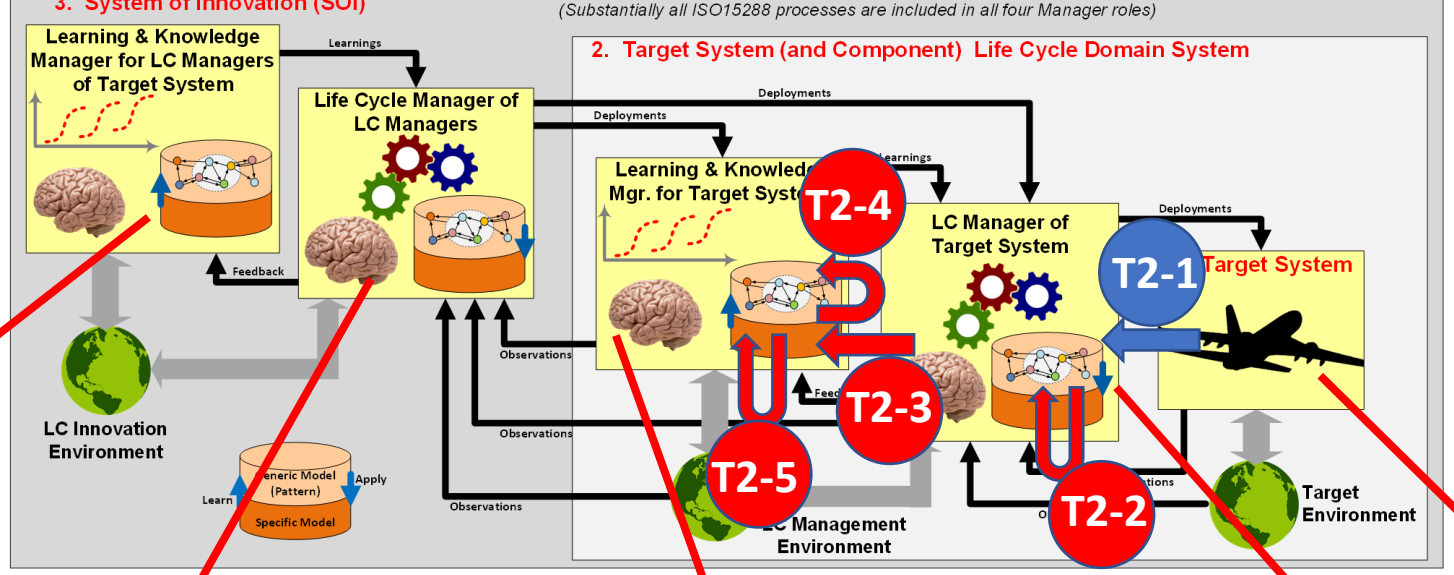


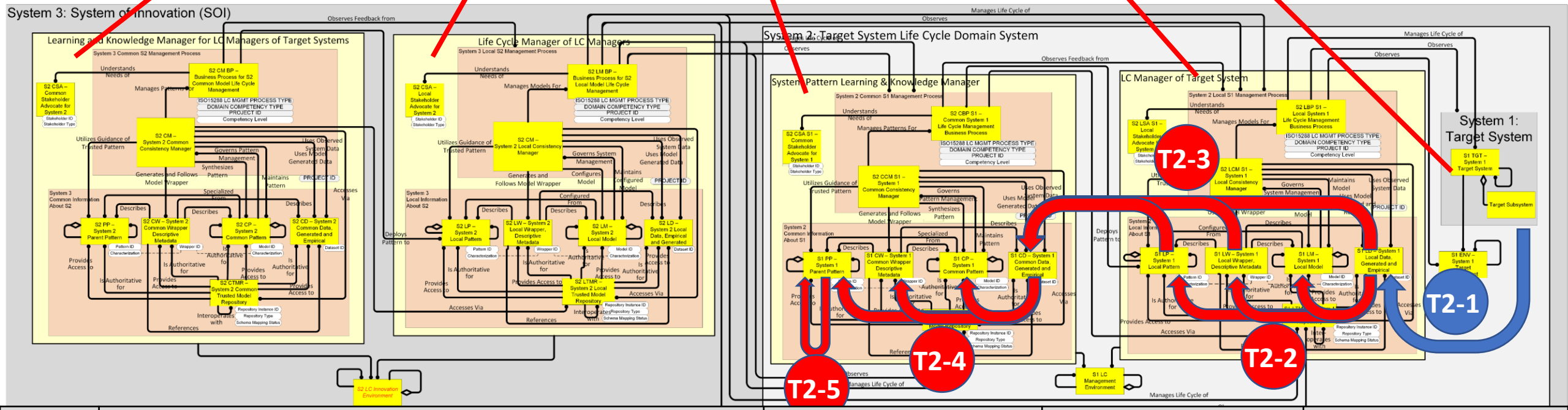
Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type, Qty
T2-3	Empirical observations, updated local pattern, and metadata local to a project/instance are provided to common dataset.	S1 LP, S1 LD, S1 LW—Local Pattern, Data, Wrapper	S1 CD—System Common Data	Data transfer, many to one





Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type, Qty
T2-4	Feedback is compared to common pattern and/or parent pattern, causing updates to them and uncertainty metadata.	S1 CD—System Common Data	S1 CP, S1 PP, S1 CW--S1 Common Pattern, Parent Pattern, Parent Wrapper	Reconciliation





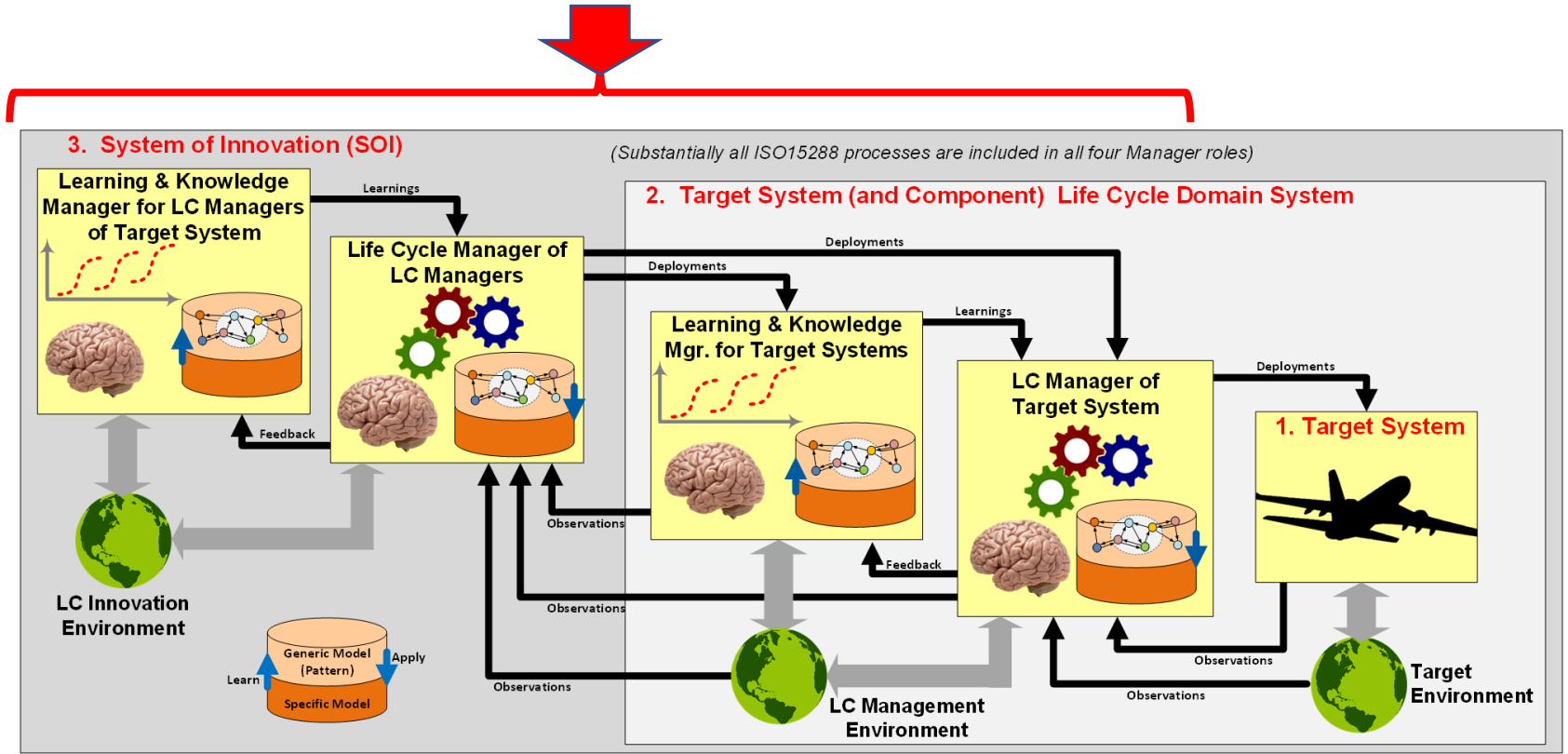
Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type, Qty
T2-5	Updated Parent Pattern is made available to S*Patterns Community for consideration.	S1 PP -- System 1 Parent Pattern (in S2)	S*Patterns Community	Information Transfer, many to one

Stages of System 1 (Target System) Feedback, Pattern Uncertainty Management, and Group Learning

Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type & Qty
T2-1	Observations of System 1, and its interactions with its environment, are captured in the form of empirical data (e.g., measurement, etc.)	Observation of System 1+Environ	S1 LD -- System 1 Local Data, Empirical (in S2)	Observation, Info Xfer, many to one
T2-2	Empirical observation is compared to local model and/or local pattern data, causing updates to them and uncertainty metadata	S1 LD—System 1 Local Empirical Data	S1 LP, S1 LM, S1 LW—Local Pattern, Model, Wrapper	Reconciliation
T2-3	Empirical observations, updated local pattern, and metadata local to a project/instance are provided to common dataset.	S1 LP, S1 LD, S1 LW—Local Pattern, Data, Wrapper	S1 CD—System Common Data	Data transfer, many to one
T2-4	Feedback is compared to common pattern and/or parent pattern, causing updates to them and uncertainty metadata.	S1 CD—System Common Data	S1 CP, S1 PP, S1 CW--S1 Common Pattern, Parent Pattern, Parent Wrapper	Reconciliation
T2-5	Updated Parent Pattern is made available to S*Patterns Community for consideration.	S1 PP -- System 1 Parent Pattern (in S2)	S*Patterns Community	Information Transfer, many to one

Subsections

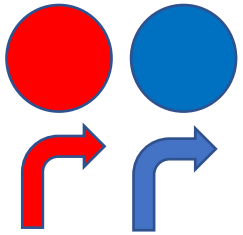
I. System 1 Configuration by System 2; System 2 Learning
II. System 2 Configuration by System 3; System 3 Learning
III. Applicable System 3 data management tooling



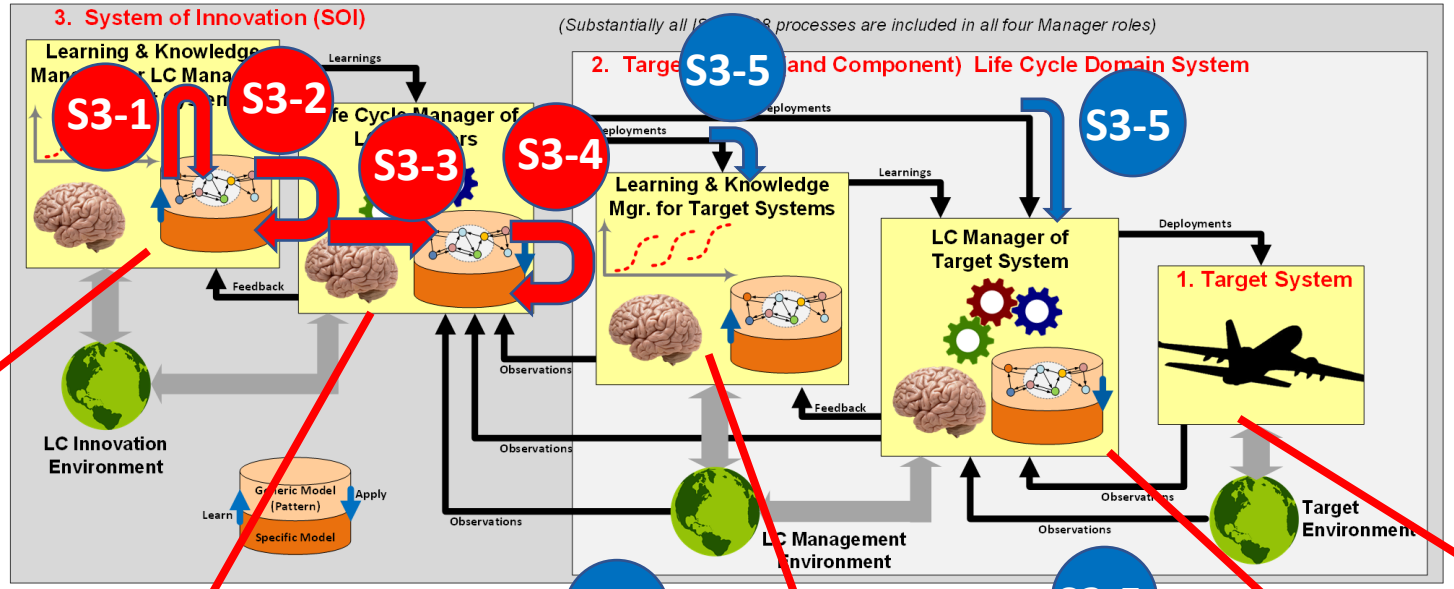
Stages of System 2 (Program/Project Ecosystem) Pattern & Model Configuration

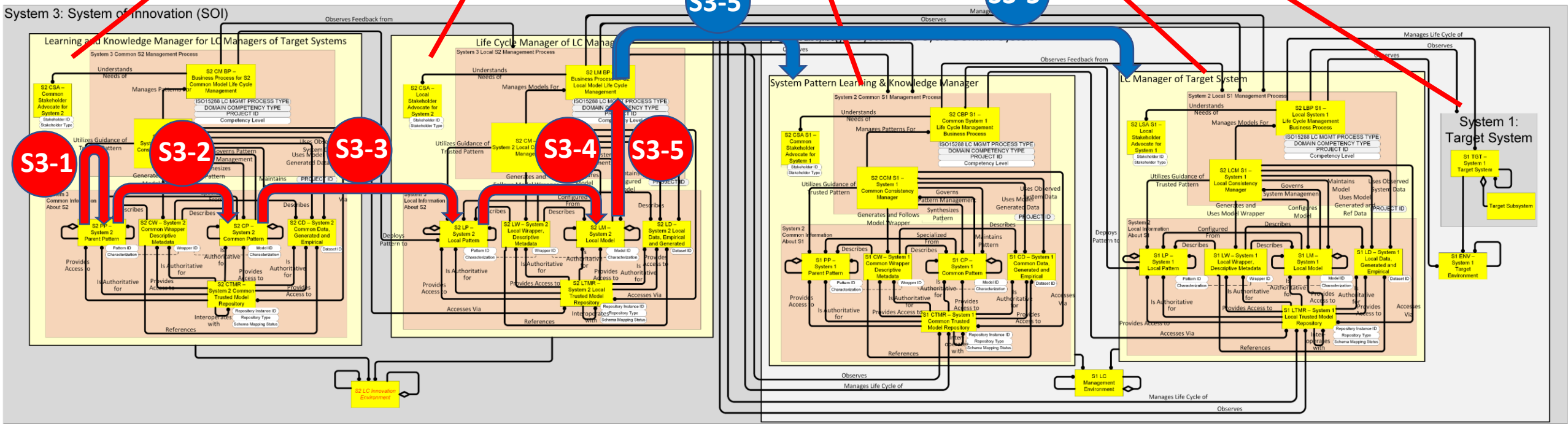
- System 2 capabilities to engineer and otherwise manage the life cycle of Target Systems is represented by the high level and detailed model of System 2—itself a system which can likewise be engineered and progressively configured with its own capabilities.
- For any given single configuration of System 2 capabilities, there are a series of transition stages it will have passed through during the planning, implementing, deployment, and operation life of that configuration as real ecosystem capability.
- Those transition stages involved progressive stages of System 2 pattern specialization, which provide information in support of deployment and governance of System 2.
- Those transition stages are illustrated by the following diagram and subsequent table of definitions . . .

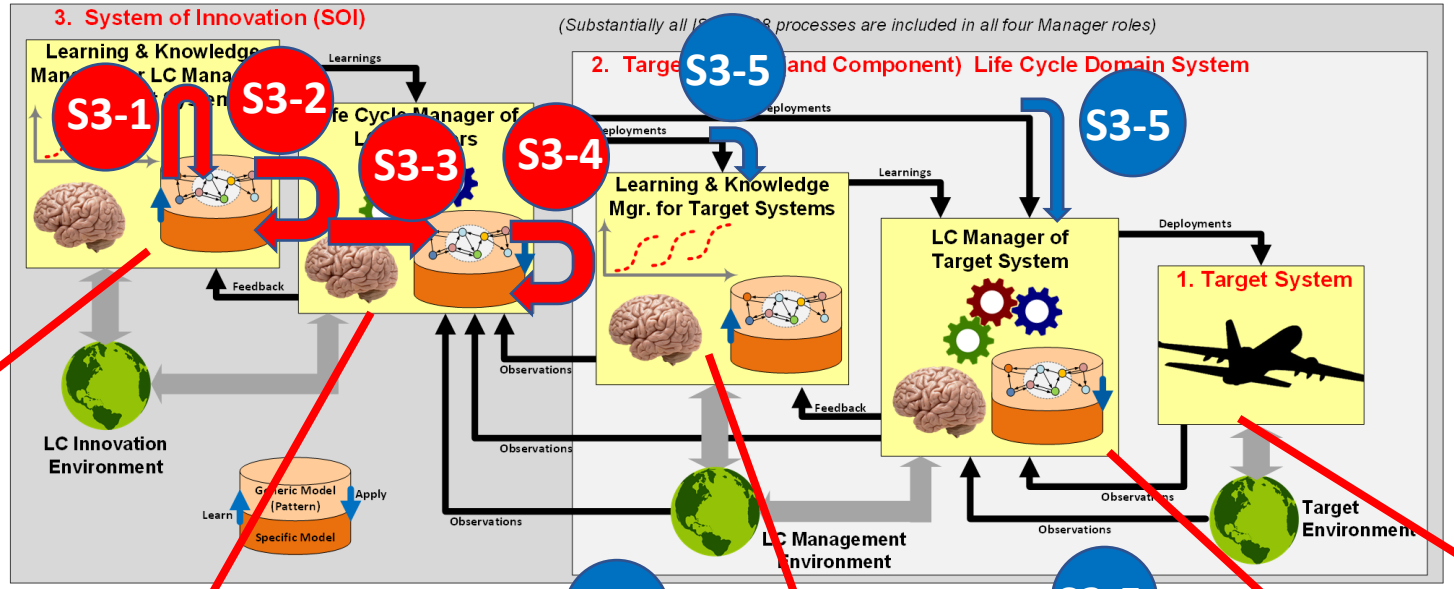
Transition stages:

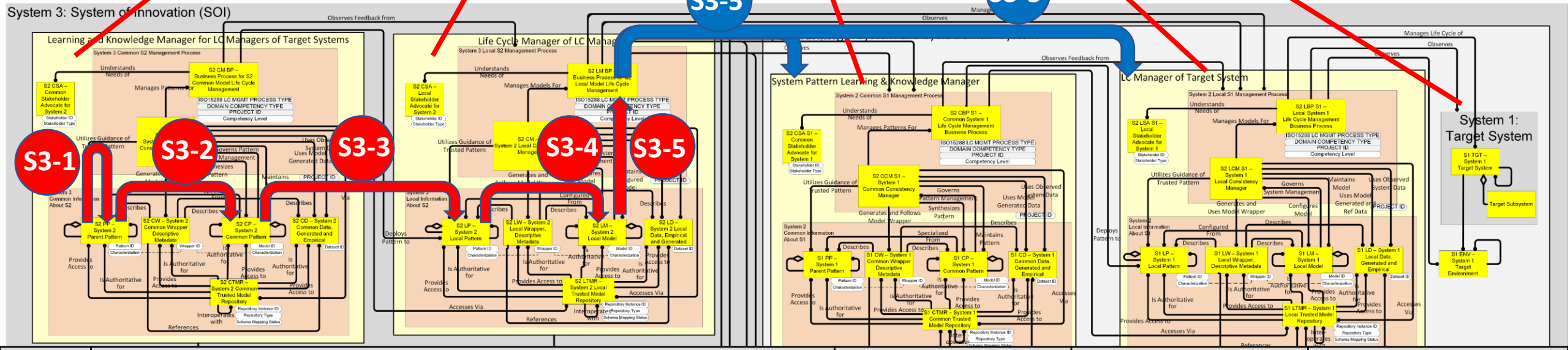


See next slides for definition of numbered stages.

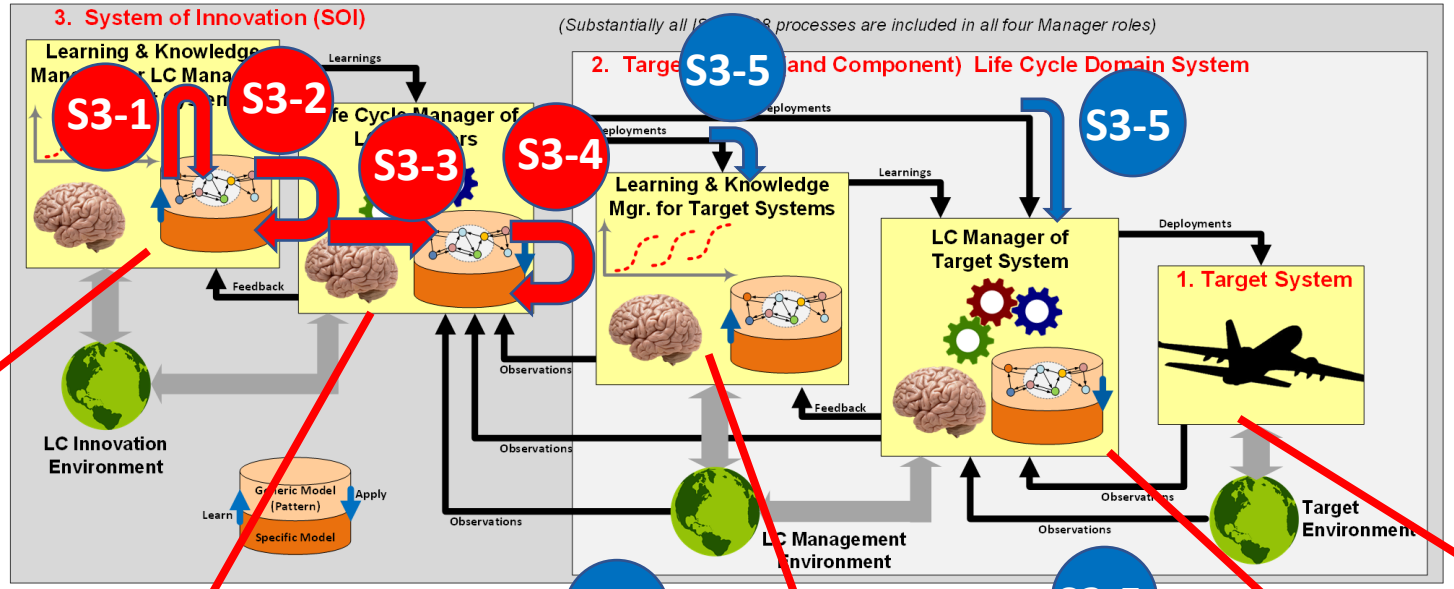


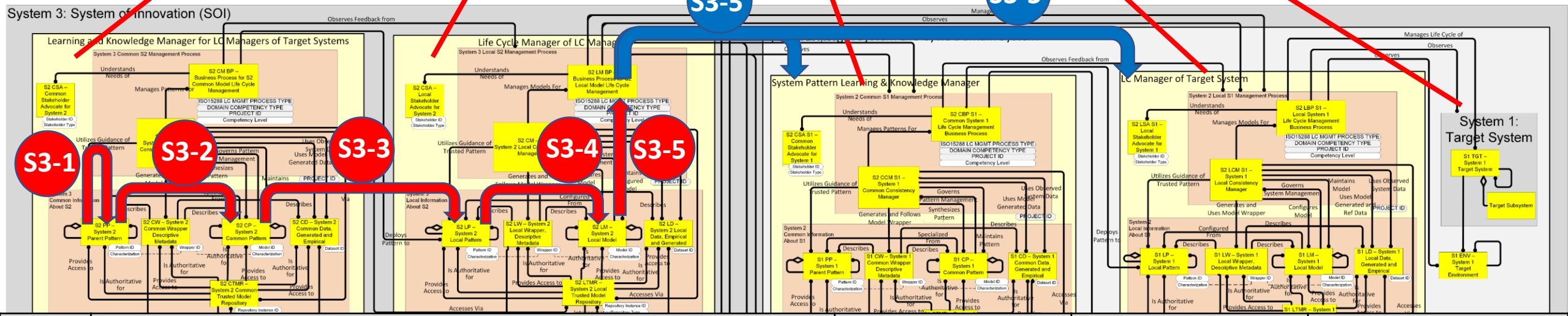




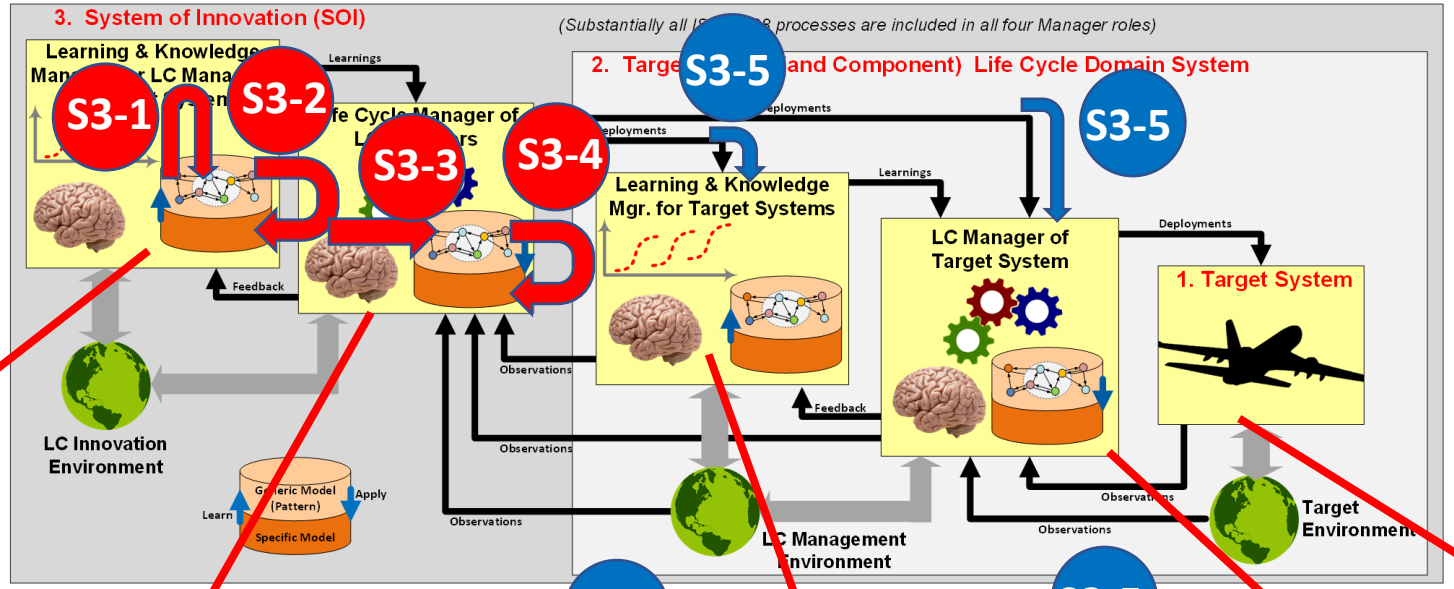


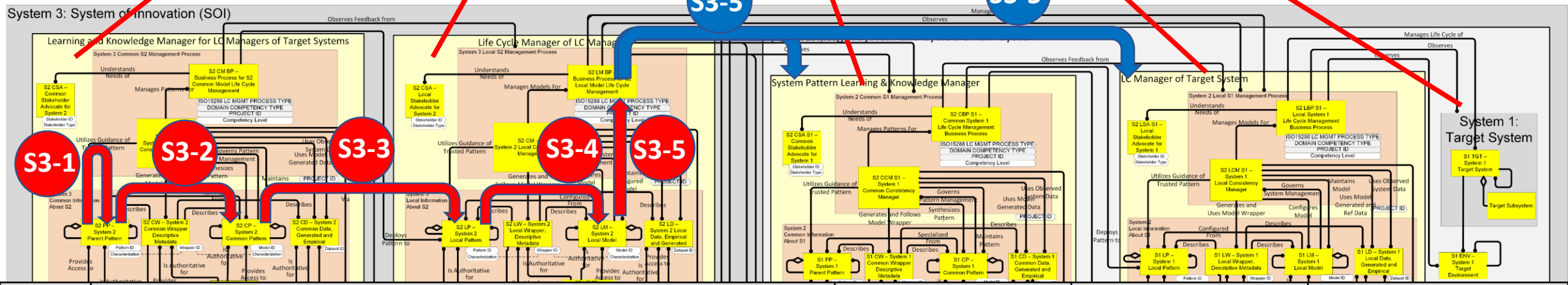
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-1	ASELCM Pattern version release as a Parent Pattern to an enterprise's System 3 Parent Pattern Library.	S*Patterns Community	S2 PP -- System 2 Parent Pattern (in S3)	Information Transfer



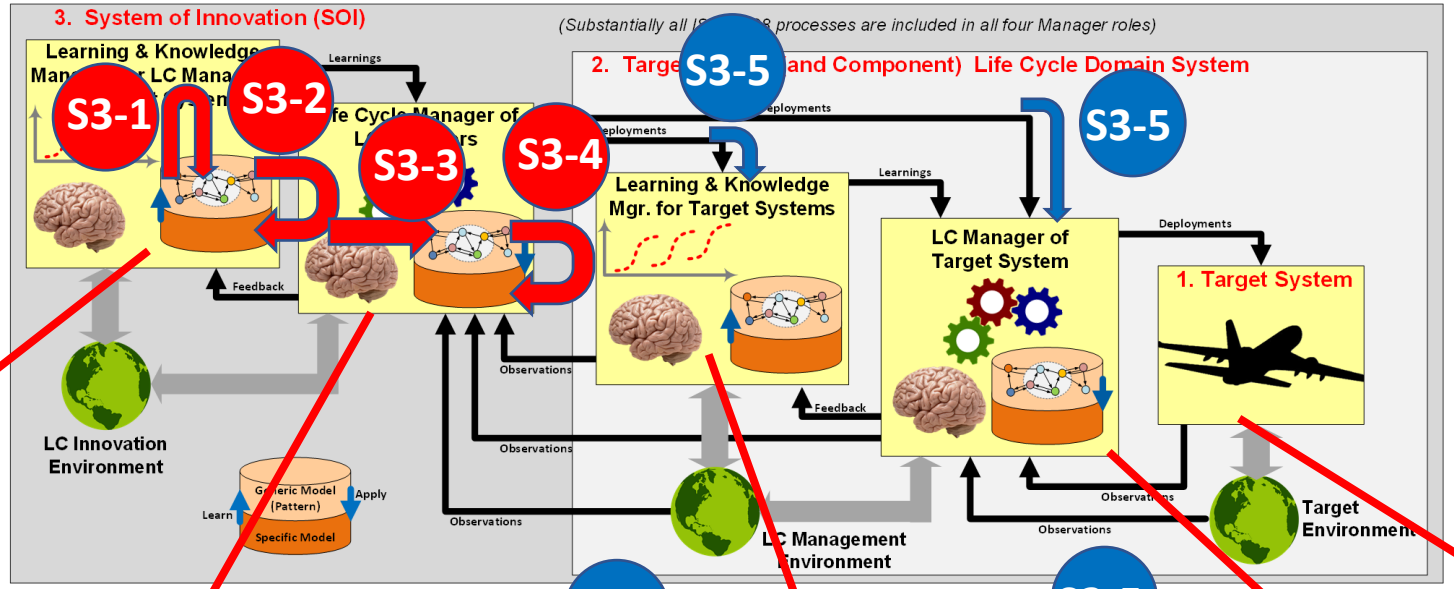


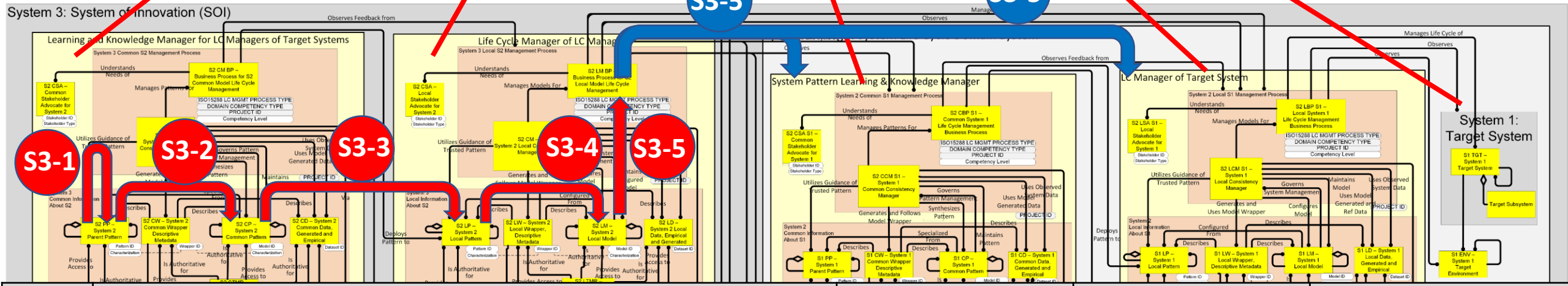
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-2	Configuration of ASELCM Parent Pattern to one or more general System 2 patterns (in System 3) agreeable for use within the enterprise. Point of accumulation of future learning from observing S2 during its projects, or other sources of learning about S2.	S2 PP -- System 2 Parent Pattern (stored in S3)	S2 CP – System 2 Common Pattern (stored in S3)	Information Transformation (Pattern Configuration)



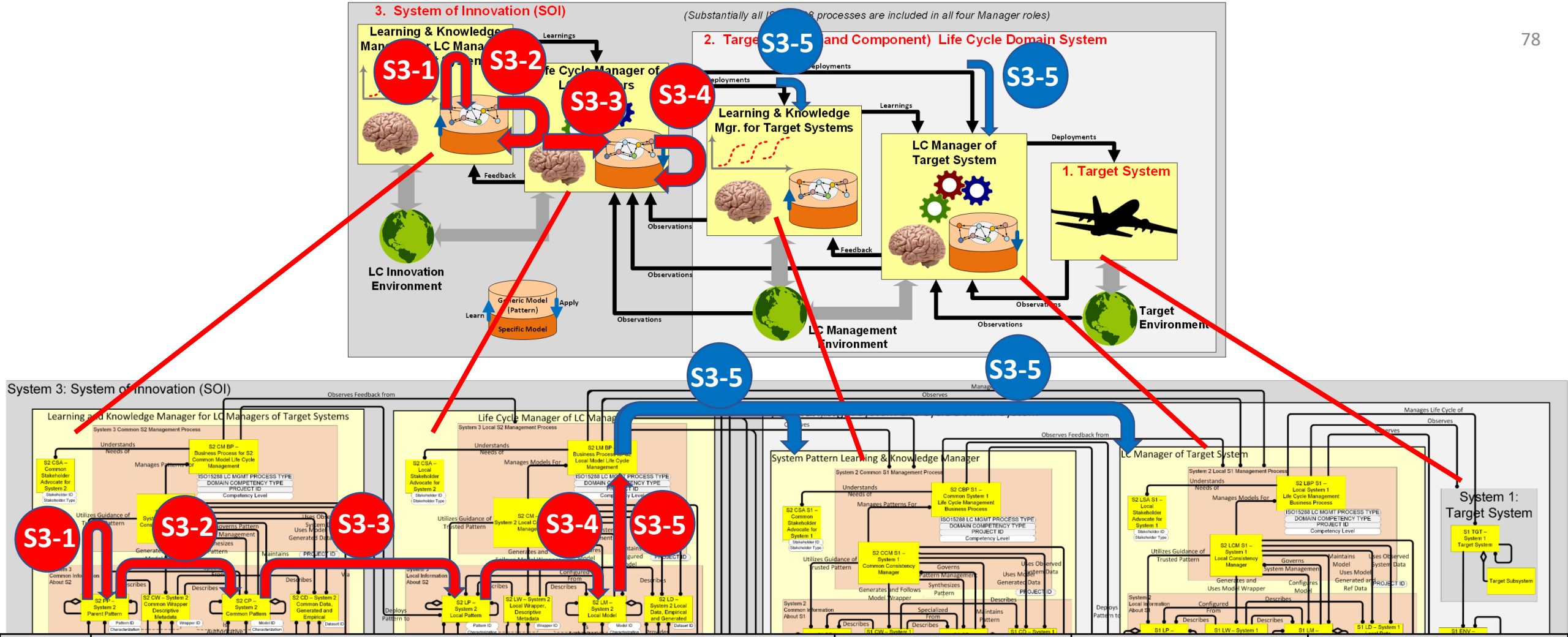


Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-3	Typically describes library of types of intended S2 capabilities, but not yet configured to be specific to individual S2 projects or programs as to their quantities or combinations of those capabilities, projects, or programs. Types, but not quantities of instances or combinations of those types.	S2 CP – System 2 Common Pattern (stored in S3)	S2 LP – System 2 Local Pattern (stored in S3)	Information Transfer, but one to many





Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-4	Typically each model is specific to the enterprise's managed S2 projects and programs for individual S1 products, as to their quantities and combinations. Quantities of instances or combinations of instances for those S2 capabilities. May be instantiated as individual models for each S2 project or program.	S2 LP – System 2 Local Pattern (stored in S3)	S2 LM – System 2 Local Model (stored in S3)	Information Transformation (Pattern Configuration--usually many)



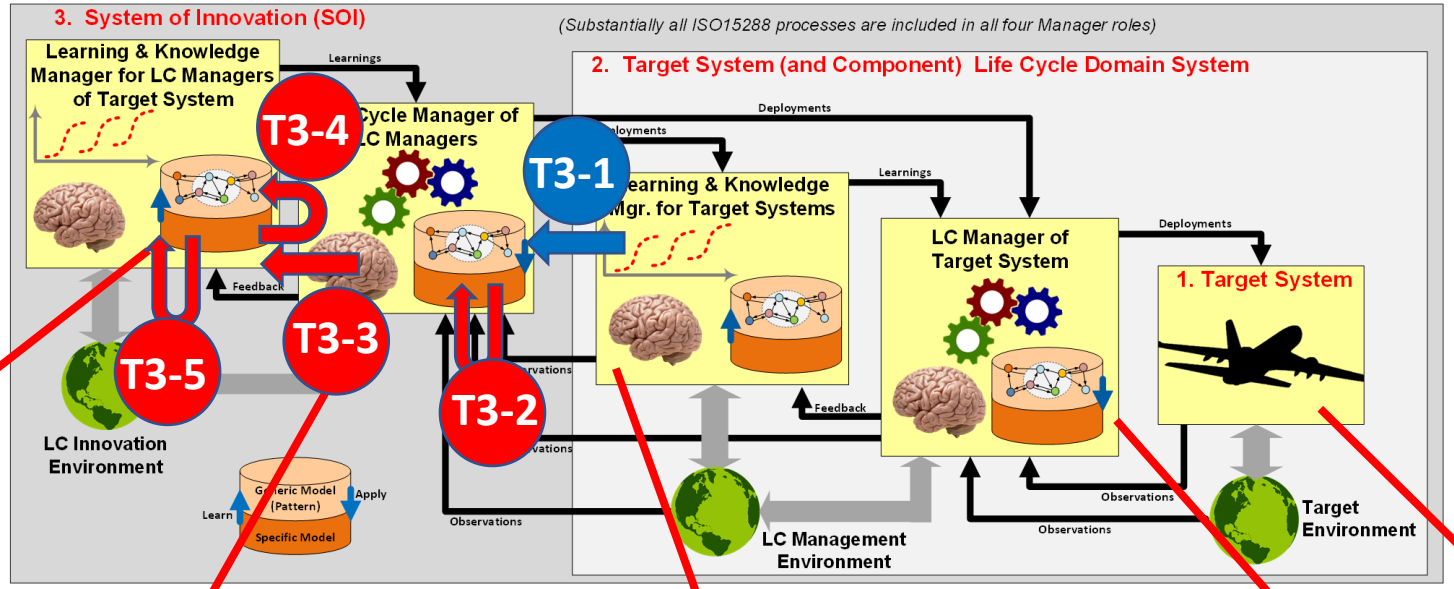
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-5	This is not primarily an information / model stage, but instead is use of the above S2 Local Model as "S2 blueprints", from which certain S3 Business Processes create and deploy real S2 human and facilities capabilities in S2, though S2 staffing, education, acquisition fabrication, programming, other creation of real world S2 entities. Although many of these are not information per se, a few can be.	S3 Business Processes for S2 staffing, education, acquisition, fabrication.	S2 human staff, computer hardware, software, facilities.	Deployment of real S2 people, capabilities, automation, facilities, as described by S2 LM stored in S3.

Stages of System 2 (Program/Project Ecosystem) Pattern & Model Configuration

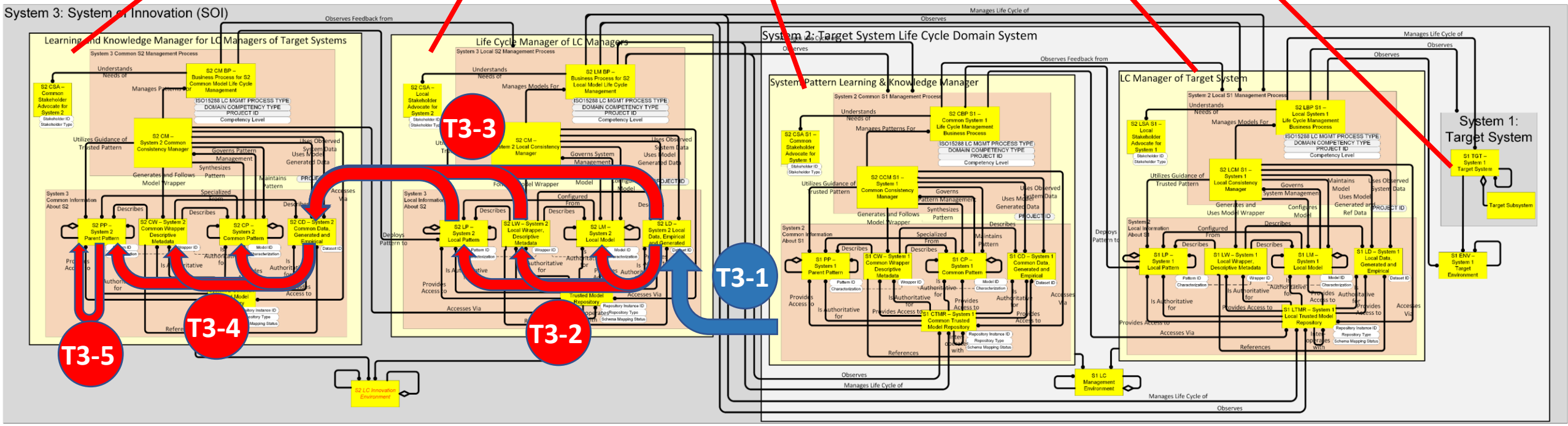
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-1	ASELCM Pattern version release as a Parent Pattern to an enterprise's System 3 Parent Pattern Library.	S*Patterns Community	S2 PP -- System 2 Parent Pattern (in S3)	Information Transfer
S3-2	Configuration of ASELCM Parent Pattern to one or more general System 2 patterns (in System 3) agreeable for use within the enterprise. Point of accumulation of future learning from observing S2 during its projects, or other sources of learning about S2.	S2 PP -- System 2 Parent Pattern (stored in S3)	S2 CP – System 2 Common Pattern (stored in S3)	Information Transformation (Pattern Configuration)
S3-3	Typically describes library of types of intended S2 capabilities, but not yet configured to be specific to individual S2 projects or programs as to their quantities or combinations of those capabilities, projects, or programs. Types, but not quantities of instances or combinations of those types.	S2 CP – System 2 Common Pattern (stored in S3)	S2 LP – System 2 Local Pattern (stored in S3)	Information Transfer, but one to many
S3-4	Typically each model is specific to the enterprise's managed S2 projects and programs for individual S1 products, as to their quantities and combinations. Quantities of instances or combinations of instances for those S2 capabilities. May be instantiated as individual models for each S2 project or program.	S2 LP – System 2 Local Pattern (stored in S3)	S2 LM – System 2 Local Model (stored in S3)	Information Transformation (Pattern Configuration--usually many)
S3-5	This is not primarily an information / model stage, but instead is use of the above S2 Local Model as "S2 blueprints", from which certain S3 Business Processes create and deploy real S2 human and facilities capabilities in S2, though S2 staffing, education, acquisition fabrication, programming, other creation of real world S2 entities. Although many of these are not information per se, a few can be.	S3 Business Processes for S2 staffing, education, acquisition, fabrication.	S2 human staff, computer hardware, software, facilities.	Deployment of real S2 people, capabilities, automation, facilities, as described by S2 LM stored in S3.

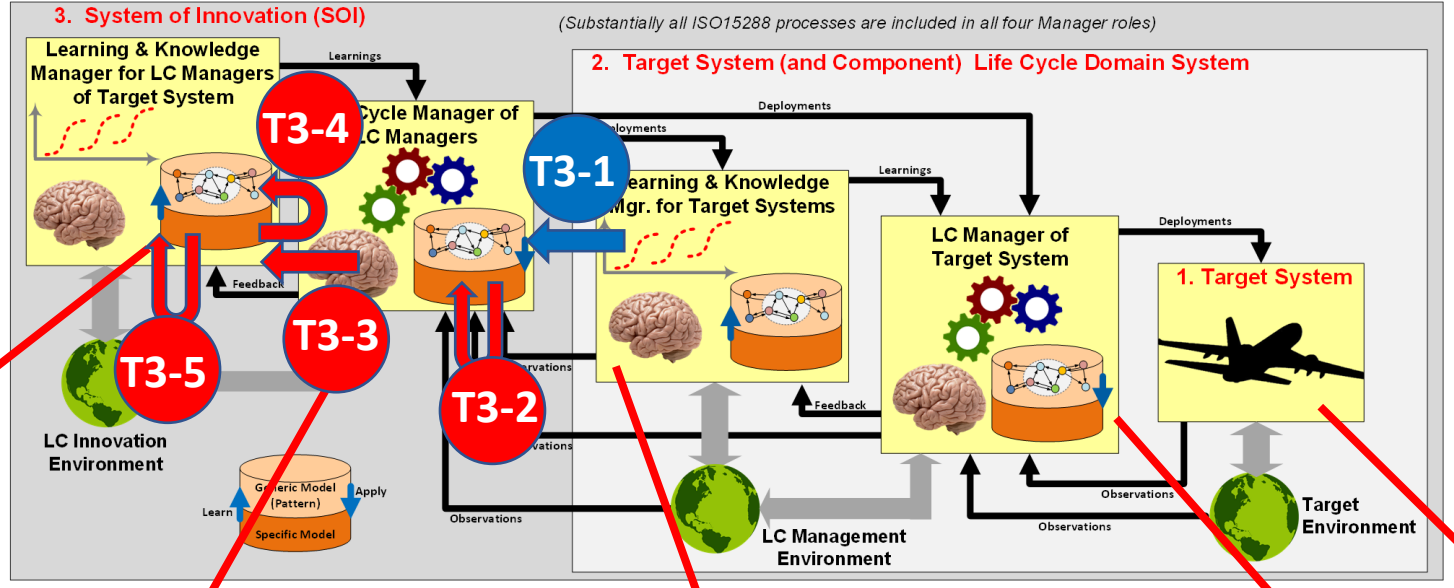
Stages of System 2 (Program/Project Ecosystem) Feedback, Pattern Uncertainty Management, and Group Learning

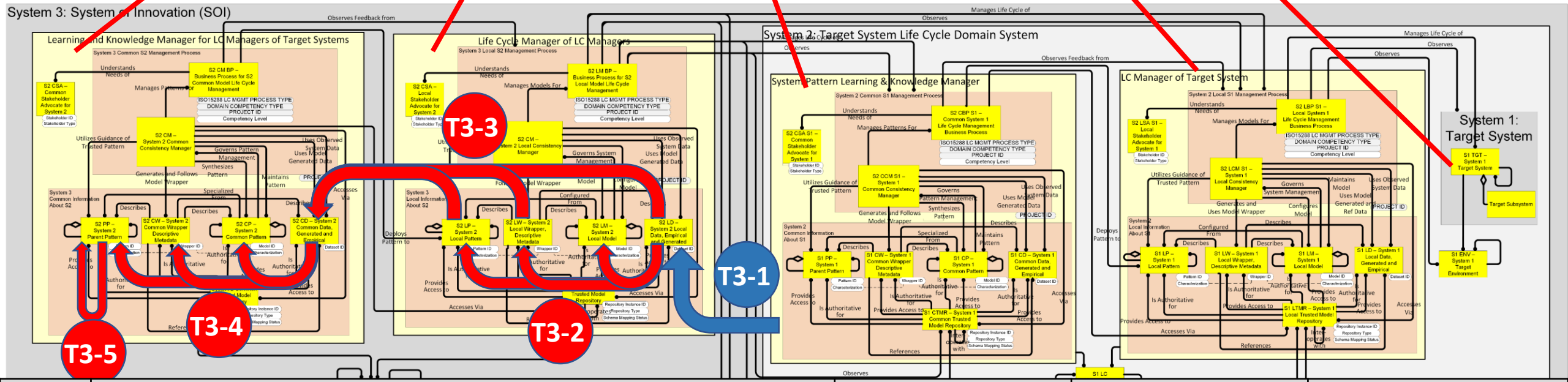
- Knowledge of the (System 2) Program/Project Ecosystem changes with experience and learning by (System 3) Engineering and Life Cycle Management Processes, through observation and experiments on System 2.
- This includes effects of inconsistencies between models or other descriptions/current understandings of System 2 compared to observations of the real System 2.
- Such inconsistencies may or may not justify updates to models and understanding, since observations and reports can be flawed/noisy/biased, or circumstances changing.
- This process changes not only the System 2 models or descriptions—it also evolves System 3 uncertainty about / confidence in the related System 2 models or descriptions.
- That uncertainty or confidence may be reflected by the Metadata role shown in the Level 3 ecosystem framework, in connection with model VVUQ (verification, validation, and uncertainty quantification).
- Balancing new or updated knowledge by combining past knowledge with new observation is the core idea of Bayesian or conditional probability, including updating estimates of uncertainty, managed as group level uncertainty.
- Beginning future S2 projects by first configuring updated acquired generic S2 process patterns (to the next specific project) spreads learning to future performance of others (group learning).
- Those learning stages can also involve progressive stages of pattern generalization, based on feedback of specific case data, and are illustrated by the following diagram and subsequent table of definitions . .



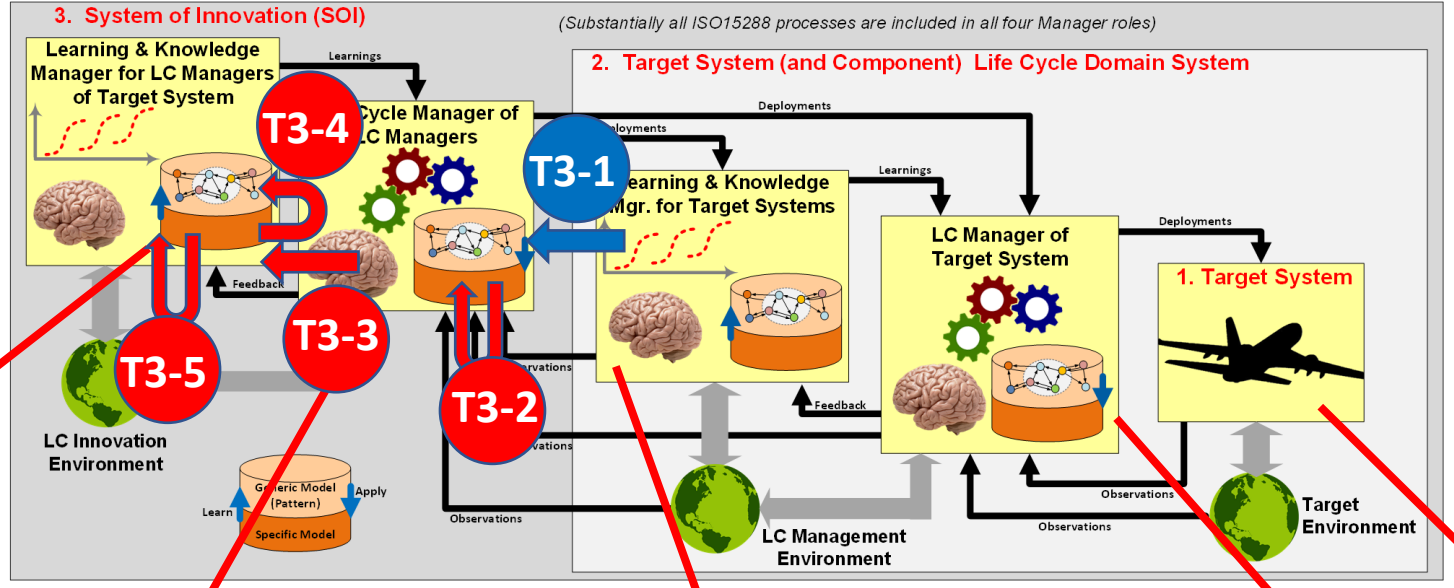
See next slides for definition of labeled stages.

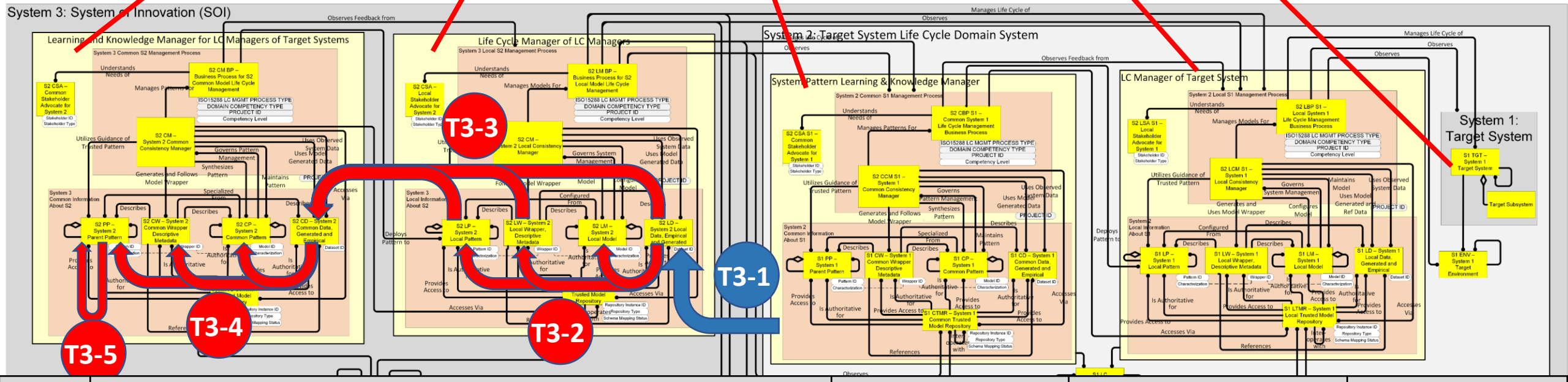




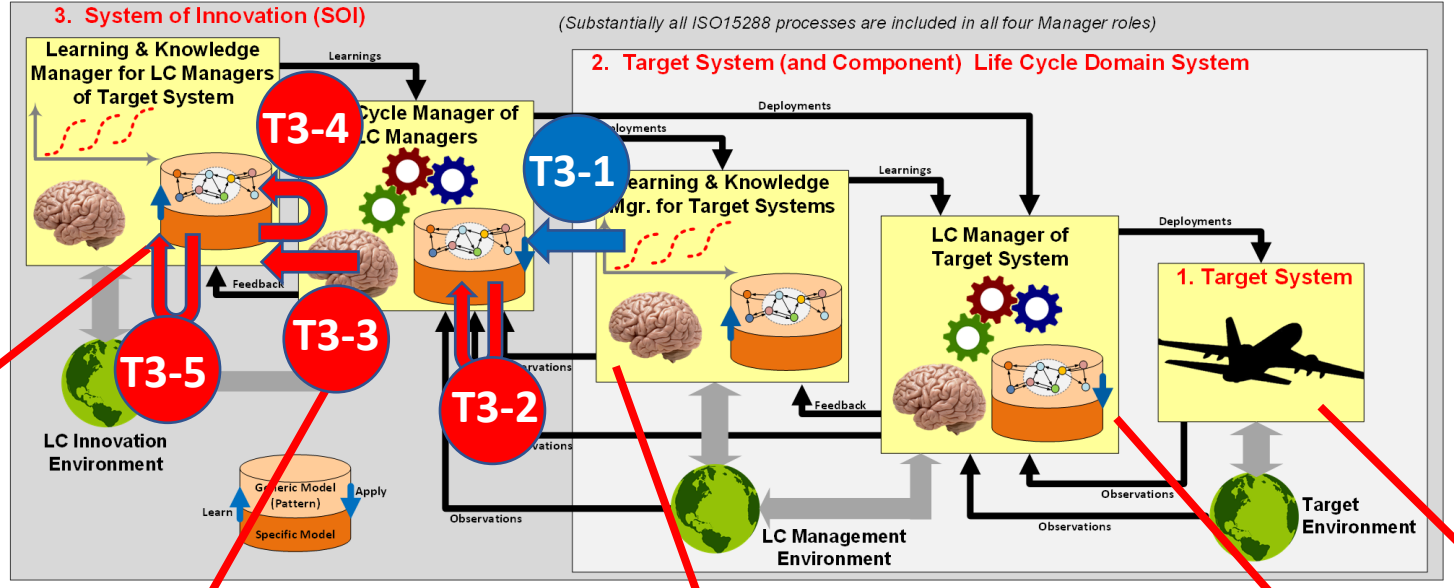


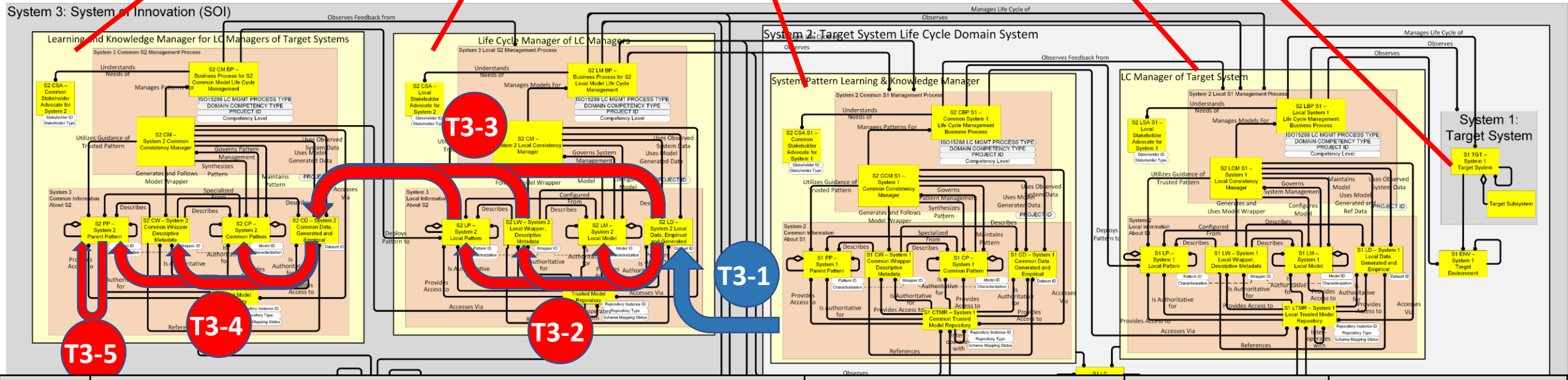
Stage	ASELCM Pattern Learning Life Cycle Stage	Source	Destination	Event Type & Qty
T3-1	Observation and measurement of System 2 (life cycle management system) behavior, interacting with its environment.	S2 Life Cycle Mgmt Processes	System 2 Local Data, Empirical	Observation, data xfer, many to one



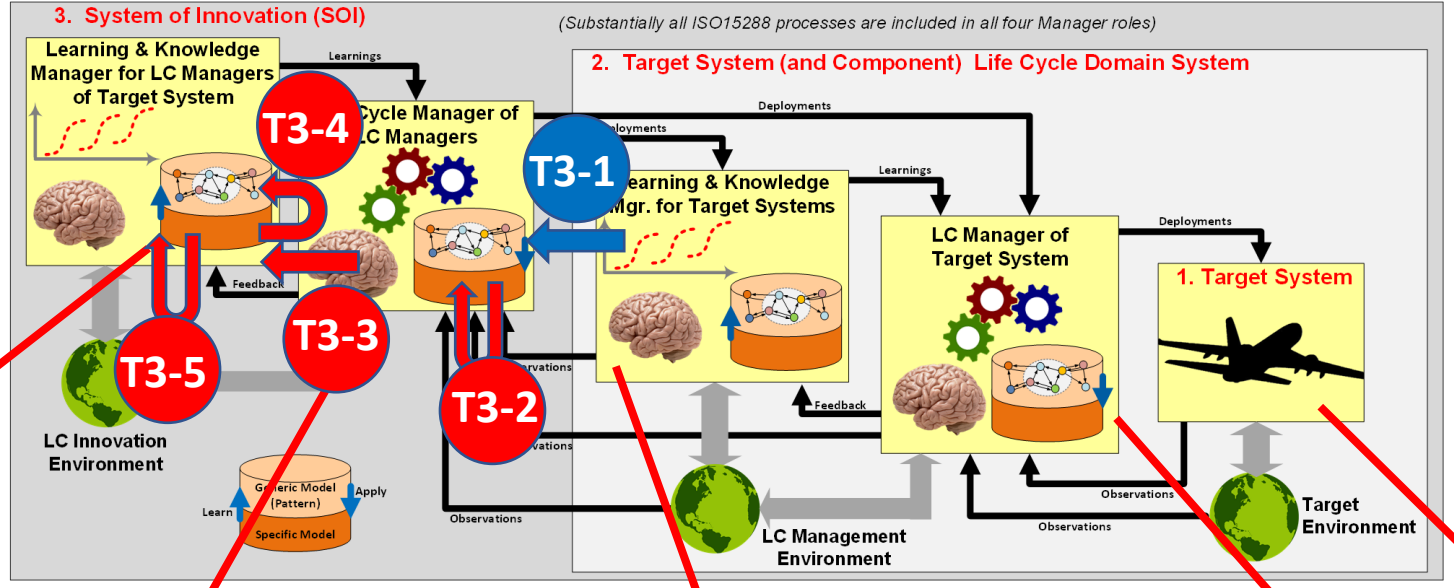


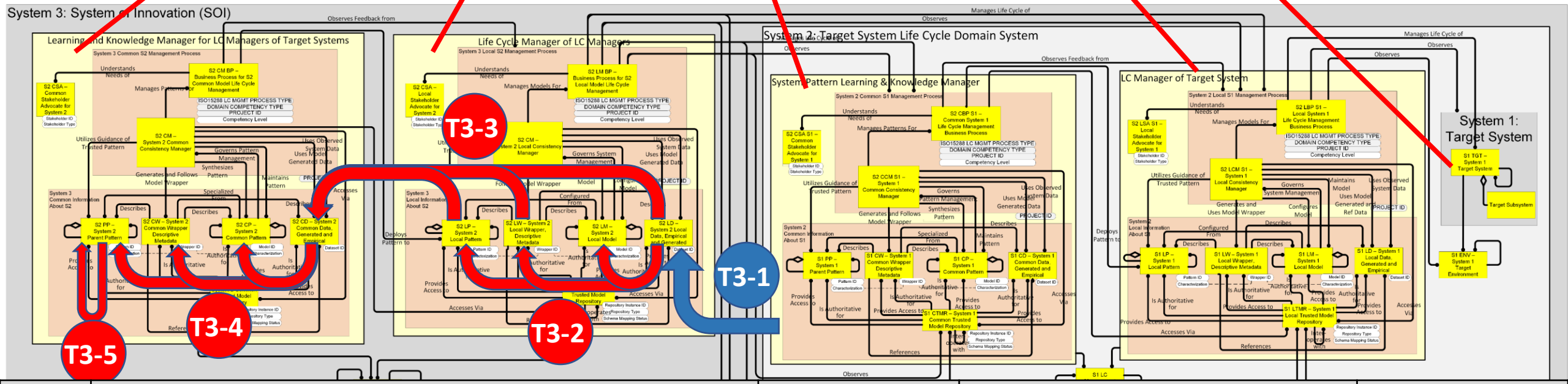
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
T3-2	Empirical observation of S2 is compared to local model and/or local pattern data, causing updates to them and uncertainty metadata	S2 LD—System 2 Local Empirical Data	S2 LP, S1 LM, S1 LW—Local Pattern, Model, Wrapper	Reconciliation



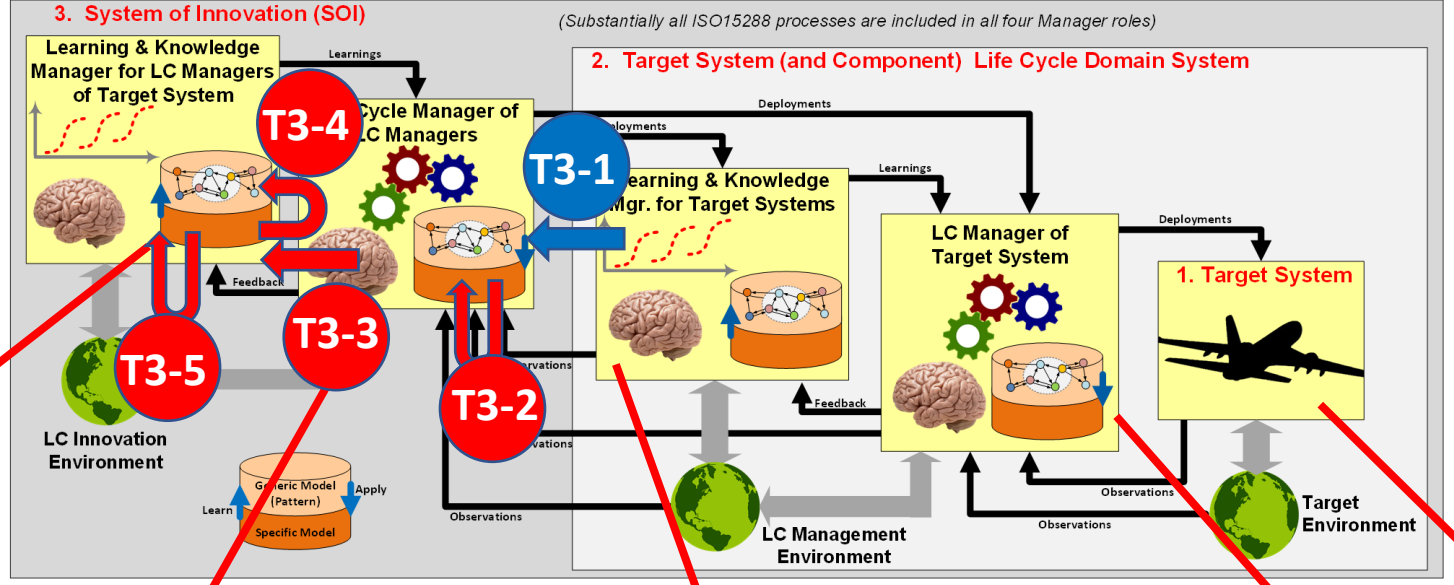


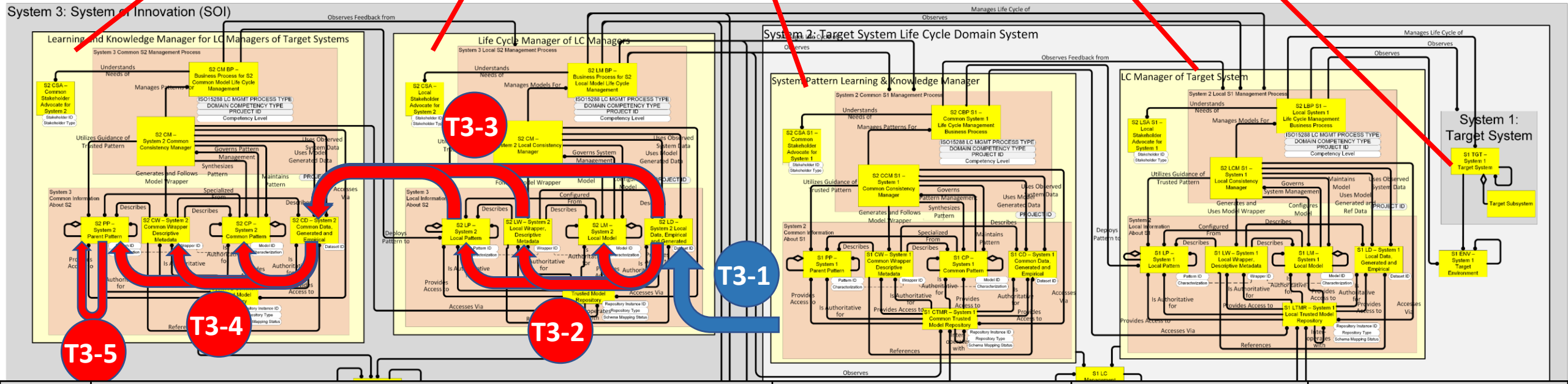
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
T3-3	Empirical observations, updated local pattern, and metadata local to a project/instance are provided to common dataset.	S2 LP, S2 LD, S2 LW—Local Pattern, Data, Wrapper	S2 CD—System Common Data	Data transfer, many to one





Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
T3-4	Feedback is compared to common pattern and/or parent pattern, causing updates to them and uncertainty metadata.	S2 CD—System 2 Common Data	S2 CP, S2 PP, S2 CW—S2 Common Pattern, Parent Pattern, Parent Wrapper	Reconciliation





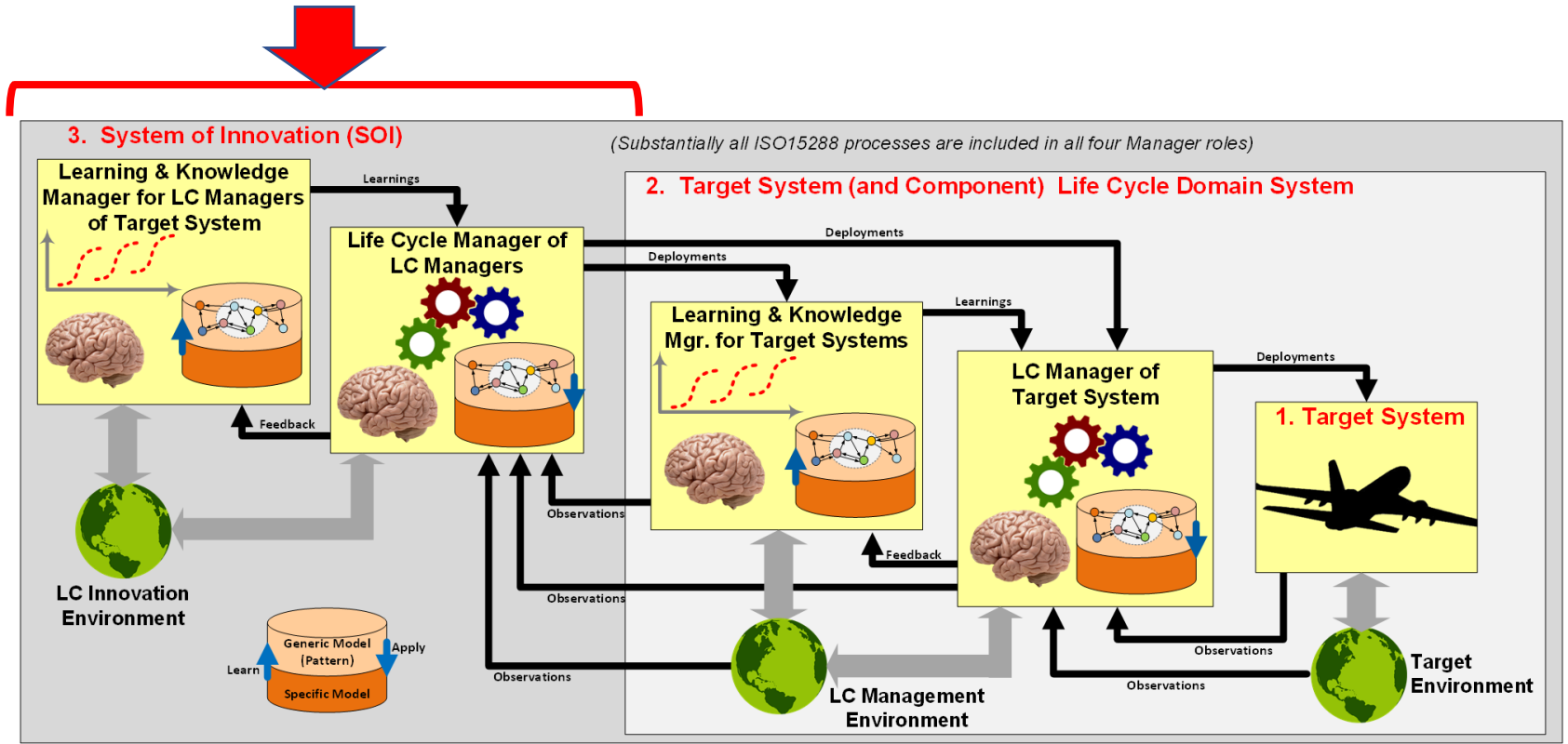
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
T3-5	Updated Parent Pattern is made available to S*Patterns Community for consideration.	S2 PP -- System 2 Parent Pattern (in S3)	S*Patterns Community	Information Transfer, many to one

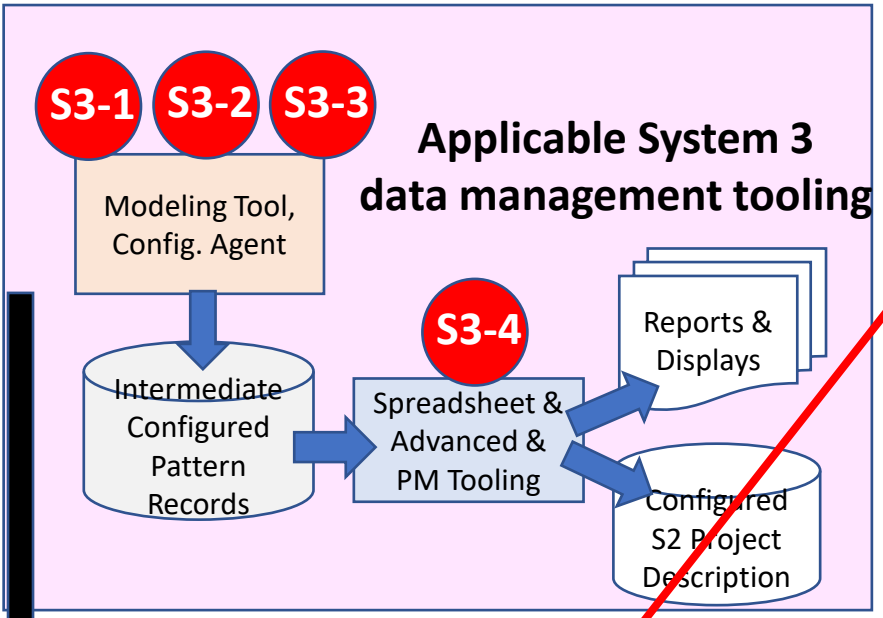
Stages of System 2 (Program/Project Ecosystem) Feedback, Pattern Uncertainty Management, and Group Learning

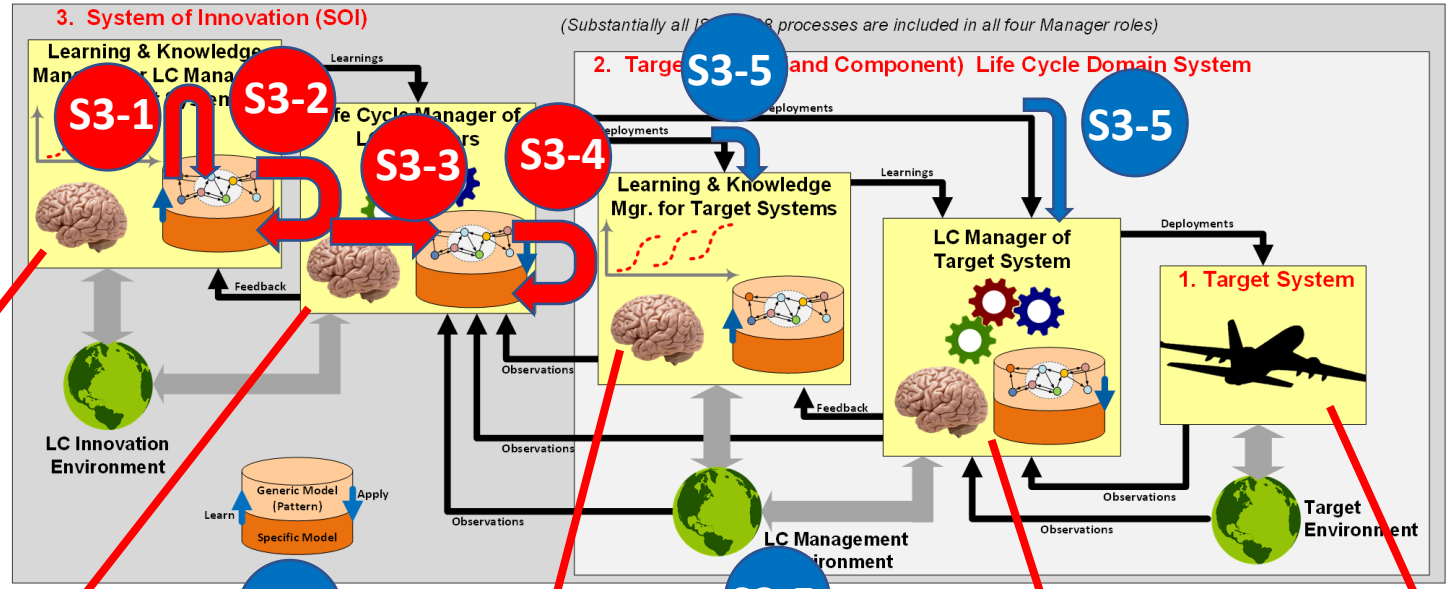
Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type & Qty
T3-1	Observation and measurement of System 2 (life cycle management system) behavior, interacting with its environment.	S2 Life Cycle Mgmt Processes	System 2 Local Data, Empirical	Observation, data xfer, many to one
T3-2	Empirical observation of S2 is compared to local model and/or local pattern data, causing updates to them and uncertainty metadata	S2 LD—System 2 Local Empirical Data	S2 LP, S1 LM, S1 LW—Local Pattern, Model, Wrapper	Reconciliation
T3-3	Empirical observations, updated local pattern, and metadata local to a project/instance are provided to common dataset.	S2 LP, S2 LD, S2 LW—Local Pattern, Data, Wrapper	S2 CD—System Common Data	Data transfer, many to one
T3-4	Feedback is compared to common pattern and/or parent pattern, causing updates to them and uncertainty metadata.	S2 CD—System 2 Common Data	S2 CP, S2 PP, S2 CW—S2 Common Pattern, Parent Pattern, Parent Wrapper	Reconciliation
T3-5	Updated Parent Pattern is made available to S*Patterns Community for consideration.	S2 PP -- System 2 Parent Pattern (in S3)	S*Patterns Community	Information Transfer, many to one

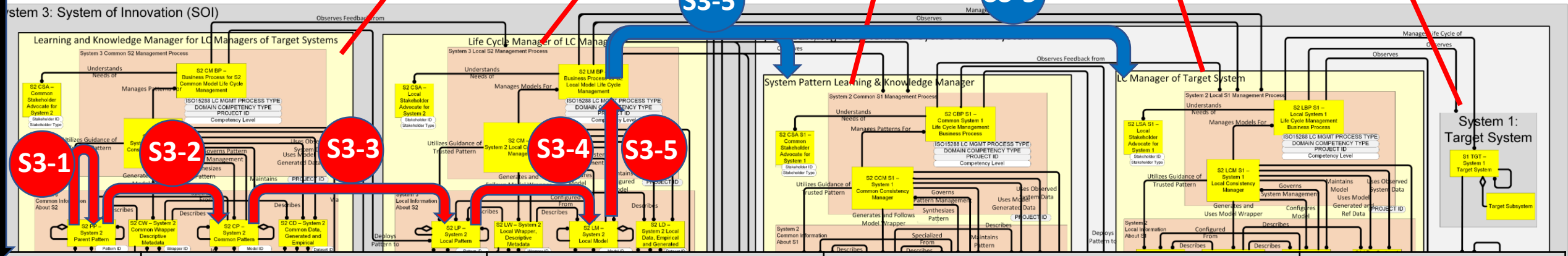
Subsections

I. System 1 Configuration by System 2; System 2 Learning
II. System 2 Configuration by System 3; System 3 Learning
III. Applicable System 3 data management tooling





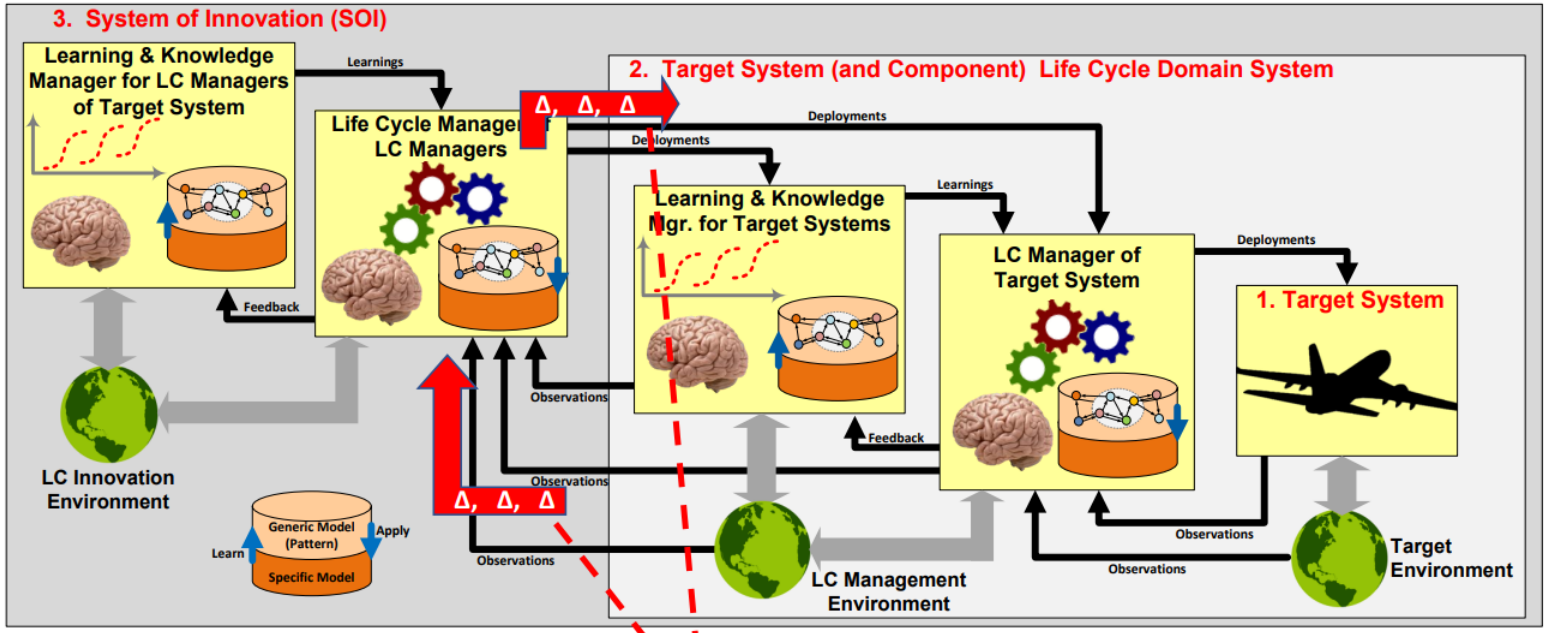




Stage	Use of Tooling	Originate Pattern Content Using	Configure Pattern Content Using	Generate Reports Using
S3-1, S3-2, S3-3	Originate, specialize, configure patterns describing S2.	Pattern Modeling Tool (e.g., SysML modeling tool)	Modeling Tool, Configuration Agent (e.g., SysML)	Spreadsheets, advanced downstream tooling (e.g., MS Excel, MS Project, Power BI, etc.)
S3-4	Configure specific S2 projects.	(Not applicable)	Spreadsheets, advanced downstream tooling (MS Excel, MS Project Power BI, etc.)	
S3-5	Real physical people, equipment, other facilities, not just information. Manage these using information in S3-4.			

Attachment 2: Planning System 2 Improvement Roadmaps, Analyzing, Implementing System 2 Improvement

Attachment I: Example Use of ASELCM Pattern for Analyzing Current State, Describing Future State, and Constructing Incremental Release Roadmap to Future



ICTT System Sciences®
Understand your systems.

V1.3.3

Analysis and planning procedure

illustrated by this example
(numbered red circles later pages)



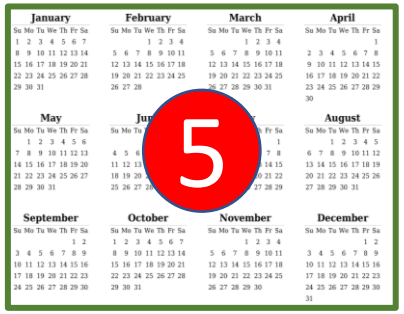
1. Learn about the ASELCM Pattern (see the above reference to start), using ASELCM reference materials.

2. Mark up the ASELCM Stakeholder Features to represent desired shift(s) (deltas) in the current **capabilities** of an existing organization;

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

4. Mark up the ASELCM Physical Architecture/**Design Components** necessary to deliver the performance deltas of the ASELCM Roles;

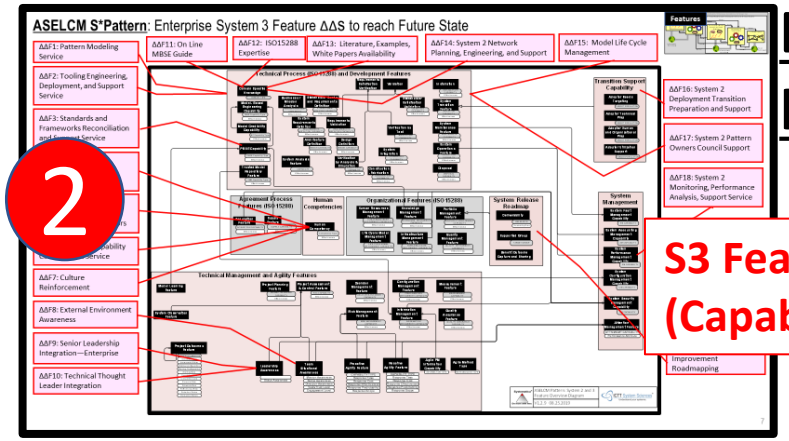
5. Allocate the deltas identified above to a series of **capability releases over calendar time**, as the basis of planning and implementation. (This is very similar to an Agile Release Train, in Agile Systems Engineering.)



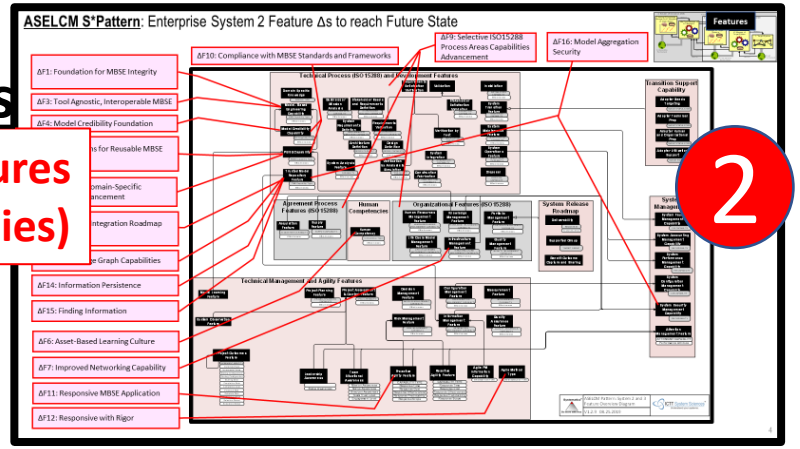
6. Perform 2-5 first for System 2. If System 3 is not already capable of causing those changes to System 2, then perform 2-5 to identify deltas to System 3.

7. In the following pages, the examples of “delta mark ups” listed above as shown as red overlays of boxes and lines, on top of the related ASELCM diagrams of Features, Roles, and Design Components. Your project may require different deltas!

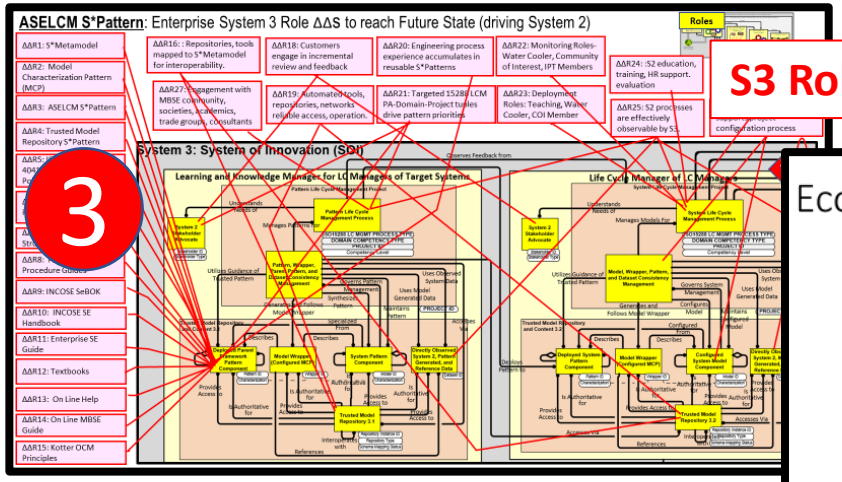
Examples of "Mark Ups" Showing Intended "Deltas" on Three Artifacts



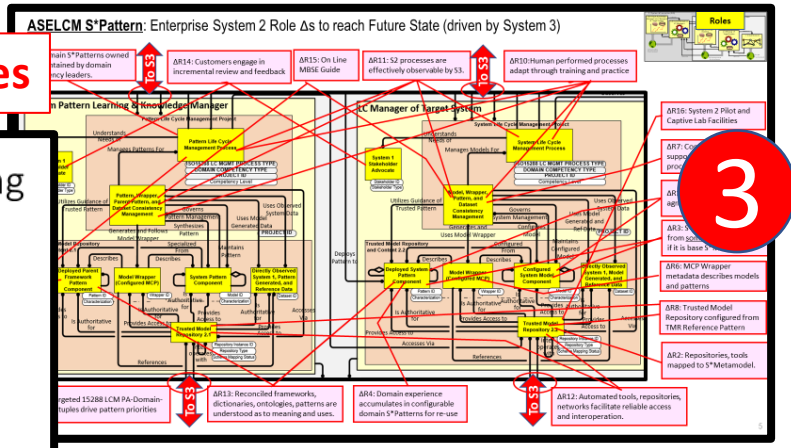
S3 Features (Capabilities)



S2 Features (Capabilities)

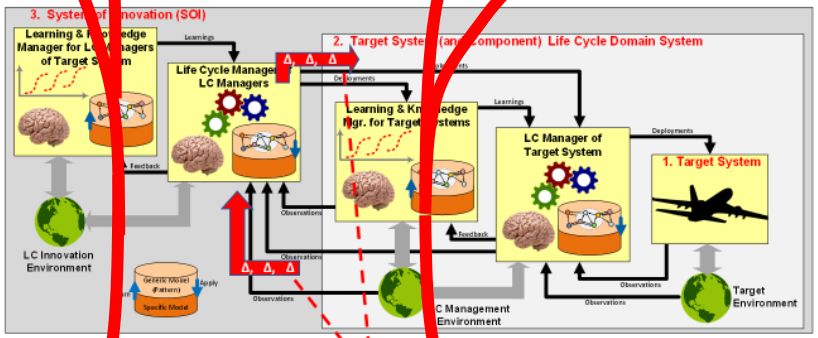


S3 Roles

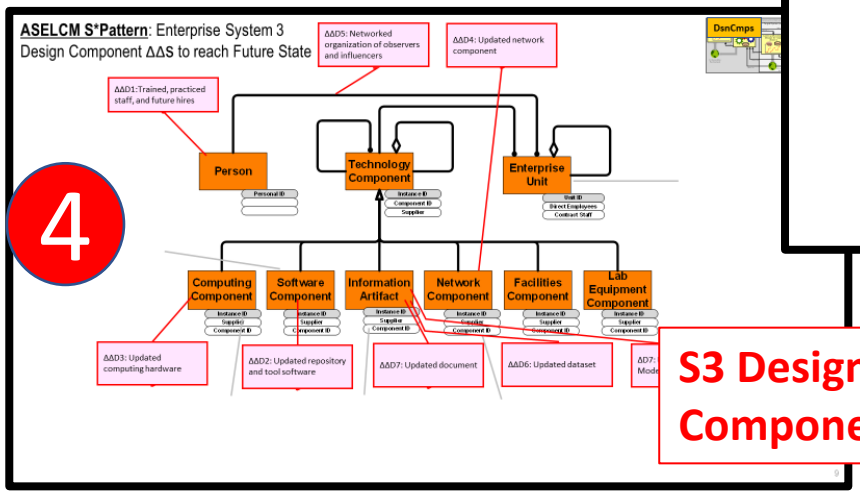


S2 Roles

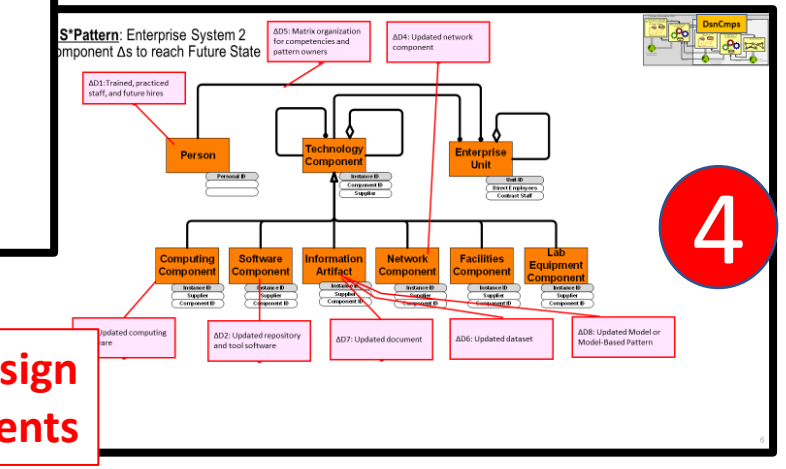
Ecosystem Analysis, Improvement, and Roadmap Planning



A "Deltas" approach that can be focused on representing areas of interest, not necessarily "the whole system". Avoids "boiling the ocean".

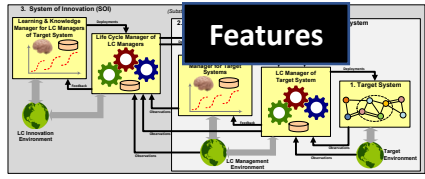


S3 Design Components



S2 Design Components

ASELCM S*Pattern: Enterprise System 2 Feature Δs to reach Future State



ΔF1: Foundation for MBSE Integrity

ΔF3: Tool Agnostic, Interoperable MBSE

ΔF4: Model Credibility Foundation

ΔF2: Foundations for Reusable MBSE Patterns

ΔF8: Selective Domain-Specific Capabilities Advancement

ΔF5: Toolchain Integration Roadmap Sequence

ΔF13: Knowledge Graph Capabilities

ΔF14: Information Persistence

ΔF15: Finding Information

ΔF6: Asset-Based Learning Culture

ΔF7: Improved Networking Capability

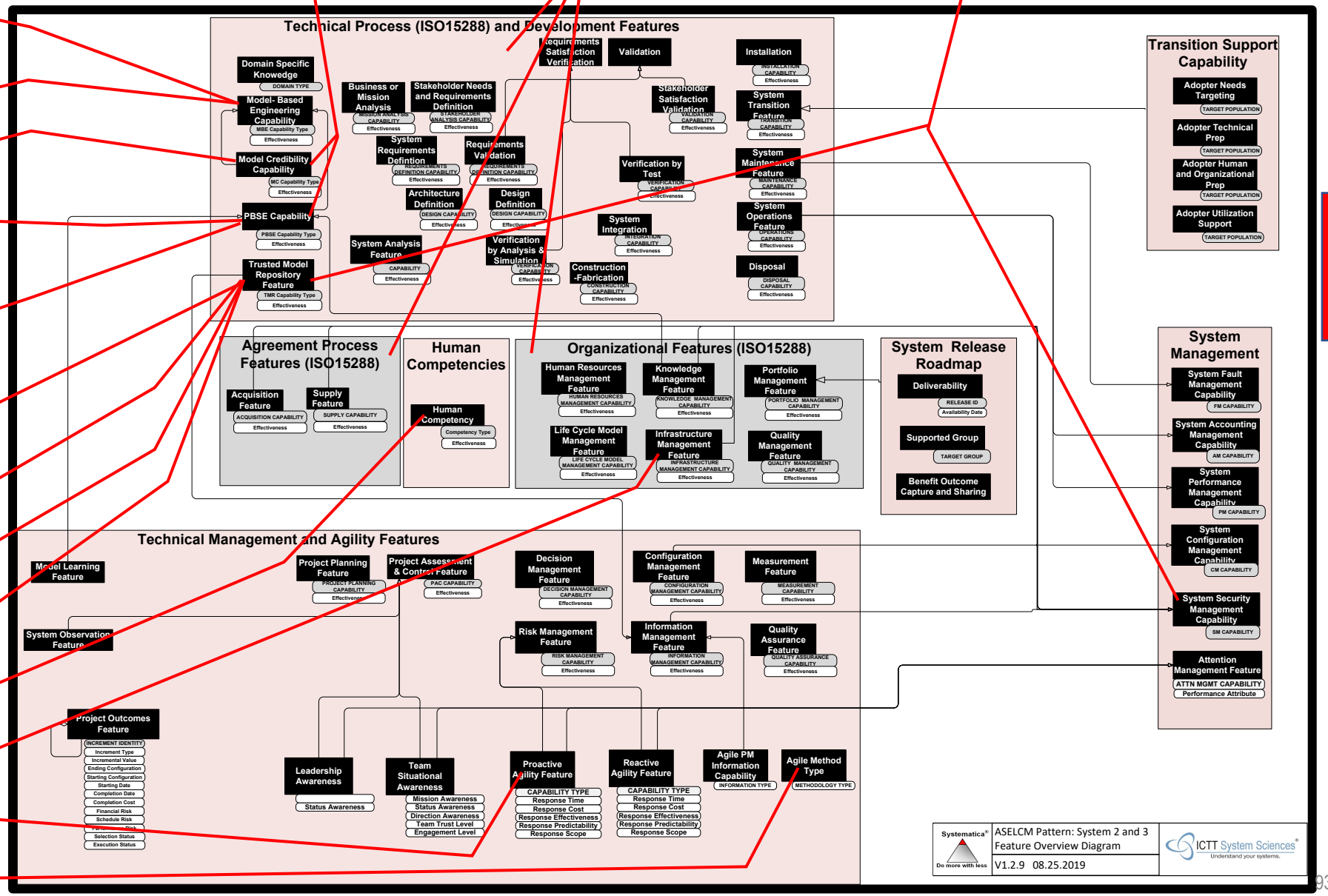
ΔF11: Responsive MBSE Application

ΔF12: Responsive with Rigor

ΔF10: Compliance with MBSE Standards and Frameworks

ΔF9: Selective ISO15288 Process Areas Capabilities Advancement

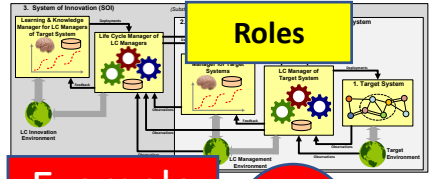
ΔF16: Model Aggregation Security



2

Example Mark Up

ASELCM S*Pattern: Enterprise System 2 Role Δs to reach Future State (driven by System 3)



Example Mark Up 3

ΔR5: Domain S*Patterns owned and maintained by domain competency leaders.

To S3

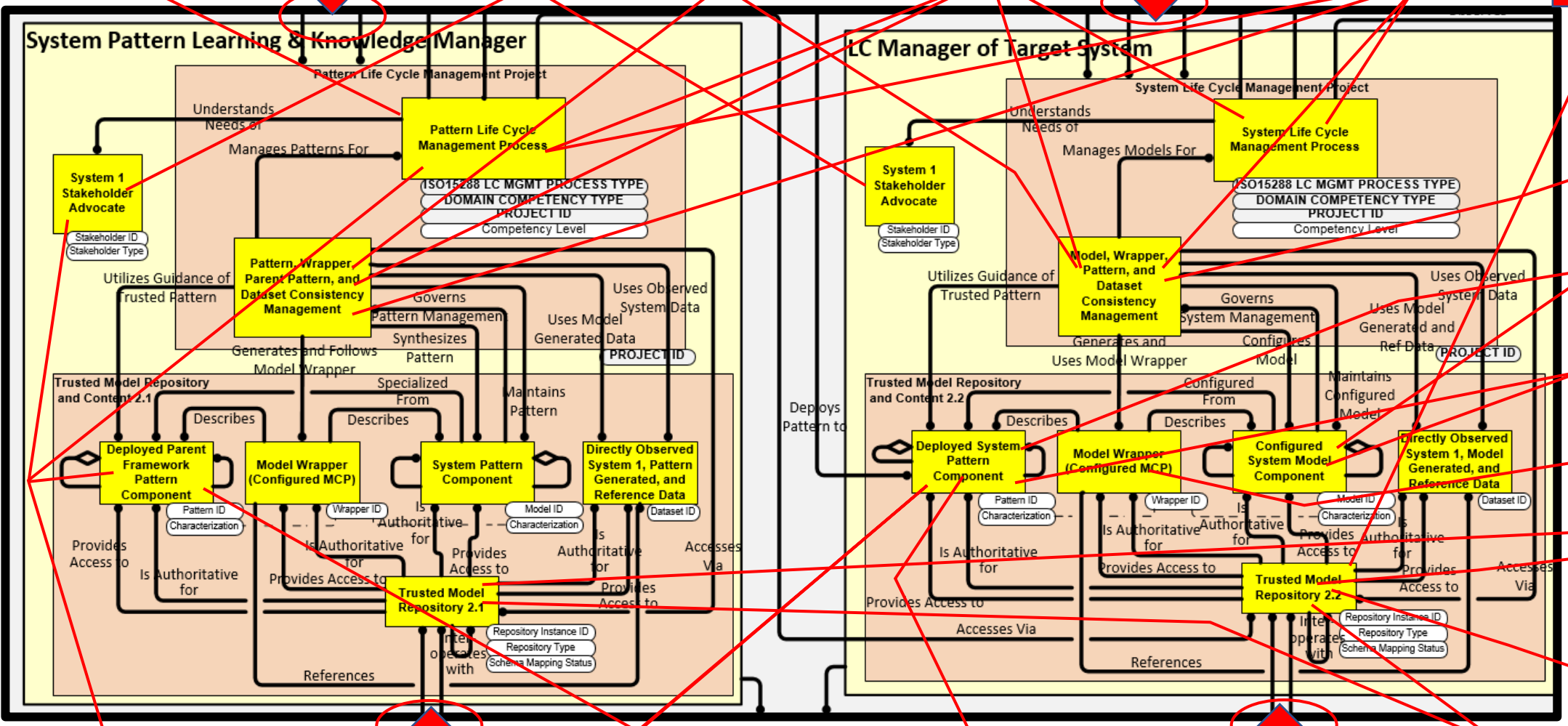
ΔR14: Customers engage in incremental review and feedback

ΔR15: On Line MBSE Guide

ΔR11: S2 processes are effectively observable by S3.

To S3

ΔR10:Human performed processes adapt through training and practice



ΔR16: System 2 Pilot and Captive Lab Facilities

ΔR7: Configuration agent supports configuration process

ΔR1: Models based on tool agnostic S*Metamodel

ΔR3: S*Models always start from some S*Pattern, even if it is base S*Metamodel.

ΔR6: MCP Wrapper metadata describes models and patterns

ΔR8: Trusted Model Repository configured from TMR Reference Pattern

ΔR2: Repositories, tools mapped to S*Metamodel.

ΔR9: Targeted 15288 LCM PA-Domain-Project tuples drive pattern priorities

To S3

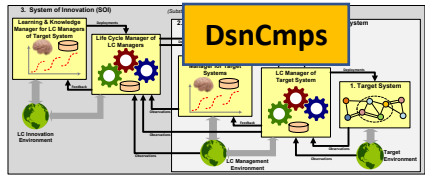
ΔR13: Reconciled frameworks, dictionaries, ontologies, patterns are understood as to meaning and uses.

ΔR4: Domain experience accumulates in configurable domain S*Patterns for re-use

To S3

ΔR12: Automated tools, repositories, networks facilitate reliable access and interoperation.

ASELCM S*Pattern: Enterprise System 2
Design Component Δs to reach Future State



ΔD5: Matrix organization for competencies and pattern owners

ΔD4: Updated network component

ΔD1:Trained, practiced staff, and future hires

Person
- Personal ID

Technology Component
- Instance ID
- Component ID
- Supplier

Enterprise Unit
- Unit ID
- Direct Employees
- Contract Staff

Computing Component
- Instance ID
- Supplier
- Component ID

Software Component
- Instance ID
- Supplier
- Component ID

Information Artifact
- Instance ID
- Supplier
- Component ID

Network Component
- Instance ID
- Supplier
- Component ID

Facilities Component
- Instance ID
- Supplier
- Component ID

Lab Equipment Component
- Instance ID
- Supplier
- Component ID

ΔD3: Updated computing hardware

ΔD2: Updated repository and tool software

ΔD7: Updated document

ΔD6: Updated dataset

ΔD8: Updated Model or Model-Based Pattern

4

Example Mark Up

ASELCM S*Pattern: Enterprise System 3 Feature ΔΔS to reach Future State

ΔΔF1: Pattern Modeling Service

ΔΔF2: Tooling Engineering, Deployment, and Support Service

ΔΔF3: Standards and Frameworks Reconciliation and Support Service

ΔΔF4: Basic S*MBSE Training and Coaching Service, for Model Users and Authors

ΔΔF5: PBSE Training and Coaching Service—for Pattern Users and Authors

ΔΔF6: System 2 Capability Certifications Service

ΔΔF7: Culture Reinforcement

ΔΔF8: External Environment Awareness

ΔΔF9: Senior Leadership Integration—Enterprise

ΔΔF10: Technical Thought Leader Integration

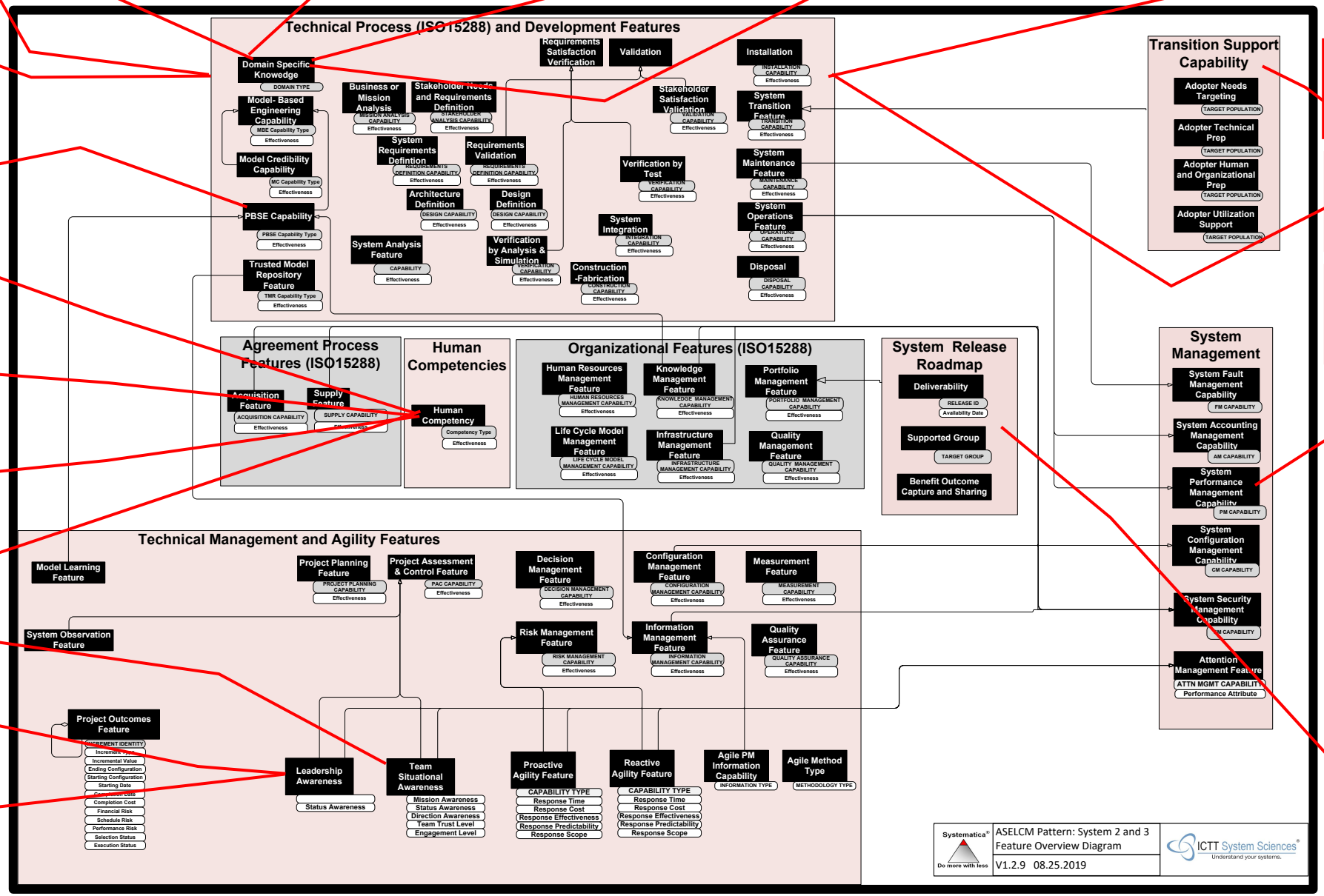
ΔΔF11: On Line MBSE Guide

ΔΔF12: ISO15288 Expertise

ΔΔF13: Literature, Examples, White Papers Availability

ΔΔF14: System 2 Network Planning, Engineering, and Support

ΔΔF15: Model Life Cycle Management

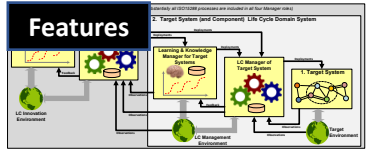


ΔΔF16: System 2 Deployment Transition Preparation and Support

ΔΔF17: System 2 Pattern Owners Council Support

ΔΔF18: System 2 Monitoring, Performance Analysis, Support Service

ΔΔF19: System 2 Improvement Roadmapping



2

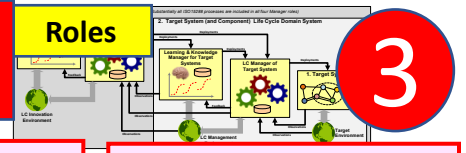
Example Mark Up

ASELCM Pattern: System 2 and 3 Feature Overview Diagram

V1.2.9 08.25.2019

ASELCM S*Pattern: Enterprise System 3 Role ΔΔS to reach Future State (driving System 2)

Example Mark Up



ΔΔR1: S*Metamodel

ΔΔR2: Model Characterization Pattern (MCP)

ΔΔR3: ASELCM S*Pattern

ΔΔR4: Trusted Model Repository S*Pattern

ΔΔR5: ISO 15288, ISO 40410, ISO 15289, Corp. Policy

ΔΔR6: Enterprise Schema, Frameworks, Dictionaries

ΔΔR7: Organizational Structure Guides

ΔΔR8: Process and Procedure Guides

ΔΔR9: INCOSE SeBOK

ΔΔR10: INCOSE SE Handbook

ΔΔR11: Enterprise SE Guide

ΔΔR12: Textbooks

ΔΔR13: On Line Help

ΔΔR14: On Line MBSE Guide

ΔΔR15: Kotter OCM Principles Literature

ΔΔR16: : Repositories, tools mapped to S*Metamodel for interoperability.

ΔΔR18: Customers engage in incremental review and feedback

ΔΔR20: Engineering process experience accumulates in reusable S*Patterns

ΔΔR22: Monitoring Roles- Water Cooler, Community of Interest, IPT Members

ΔΔR24: :S2 education, training, HR support. evaluation

ΔΔR26: Human performed processes adapt by training, practice, feedback

ΔΔR27: Engagement with MBSE community, societies, academics, trade groups, consultants

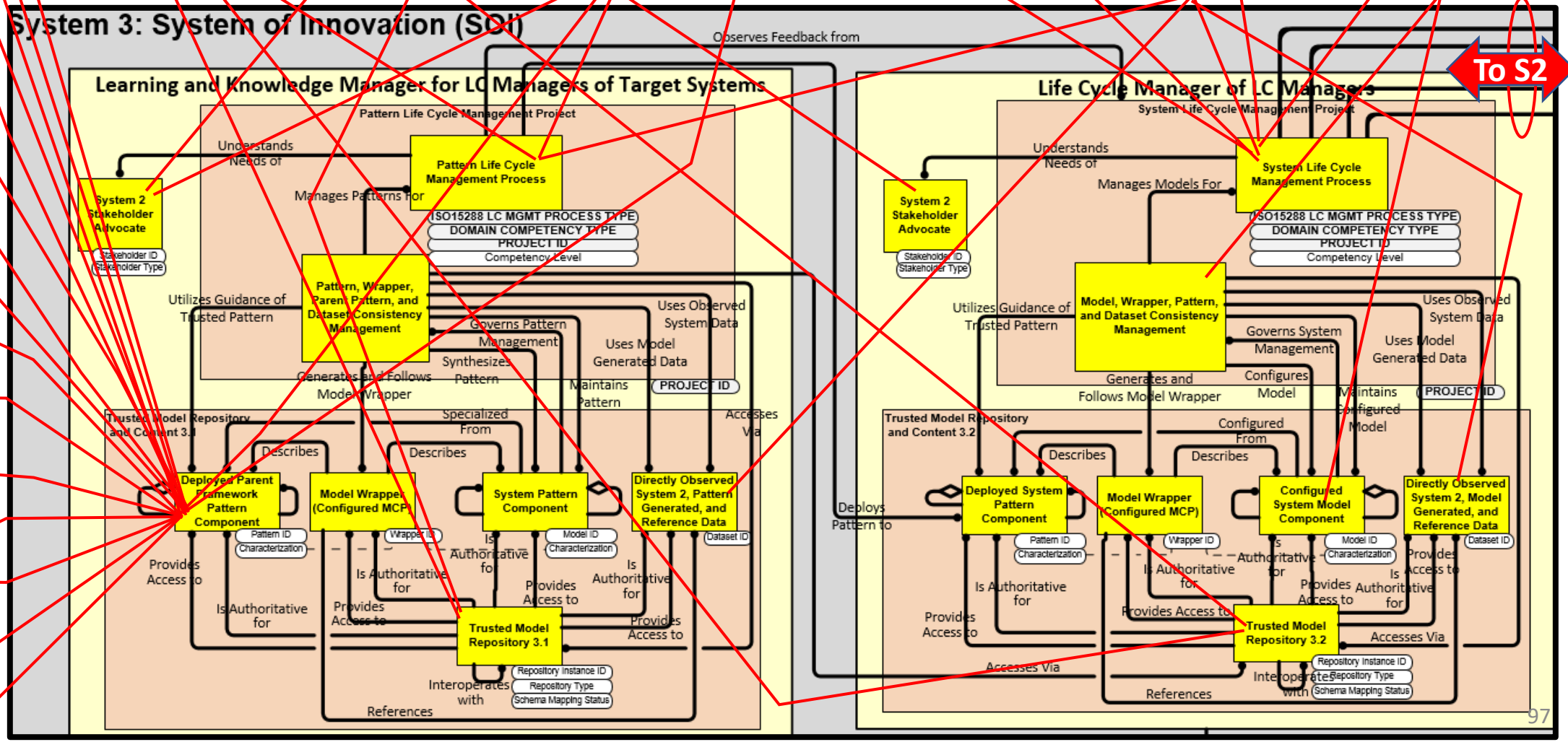
ΔΔR19: Automated tools, repositories, networks reliable access, operation.

ΔΔR21: Targeted 15288 LCM PA-Domain-Project tuples drive pattern priorities

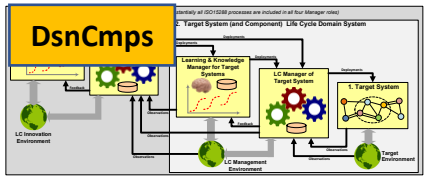
ΔΔR23: Deployment Roles: Teaching, Water Cooler, COI Member

ΔΔR25: S2 processes are effectively observable by S3.

ΔΔR17: Configuration agent supports project configuration process



ASELCM S*Pattern: Enterprise System 3
Design Component ΔΔS to reach Future State



ΔΔD5: Networked organization of observers and influencers

ΔΔD4: Updated network component

ΔΔD1:Trained, practiced staff, and future hires

Person
- Personal ID

Technology Component
- Instance ID
- Component ID
- Supplier

Enterprise Unit
- Unit ID
- Direct Employees
- Contract Staff

Computing Component
- Instance ID
- Supplier
- Component ID

Software Component
- Instance ID
- Supplier
- Component ID

Information Artifact
- Instance ID
- Supplier
- Component ID

Network Component
- Instance ID
- Supplier
- Component ID

Facilities Component
- Instance ID
- Supplier
- Component ID

Lab Equipment Component
- Instance ID
- Supplier
- Component ID

ΔΔD3: Updated computing hardware

ΔΔD2: Updated repository and tool software

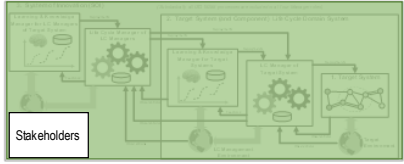
ΔΔD7: Updated document

ΔΔD6: Updated dataset

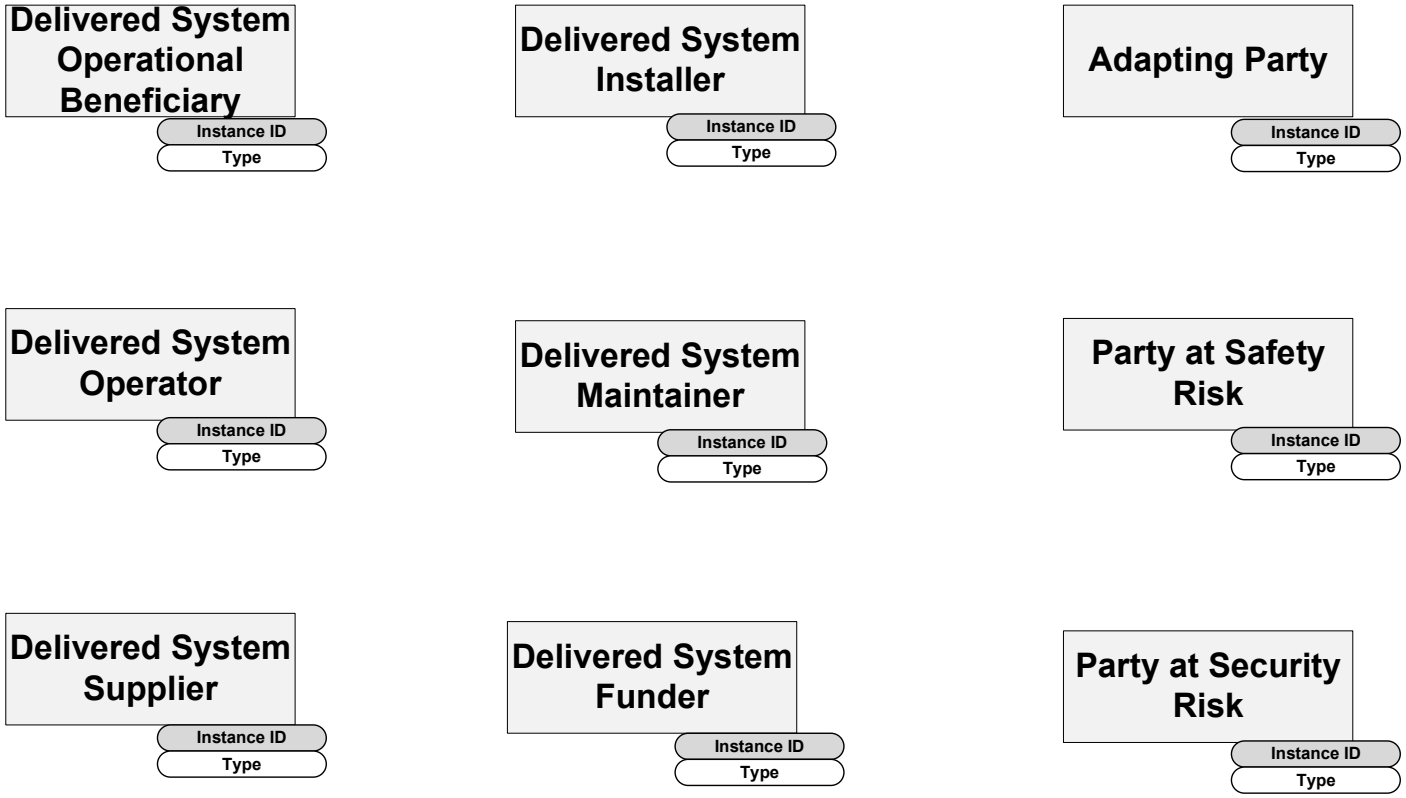
ΔD7: Updated Model or Model-Based Pattern

4

Example Mark Up



ASELCM Pattern: System 2 and 3 Stakeholders



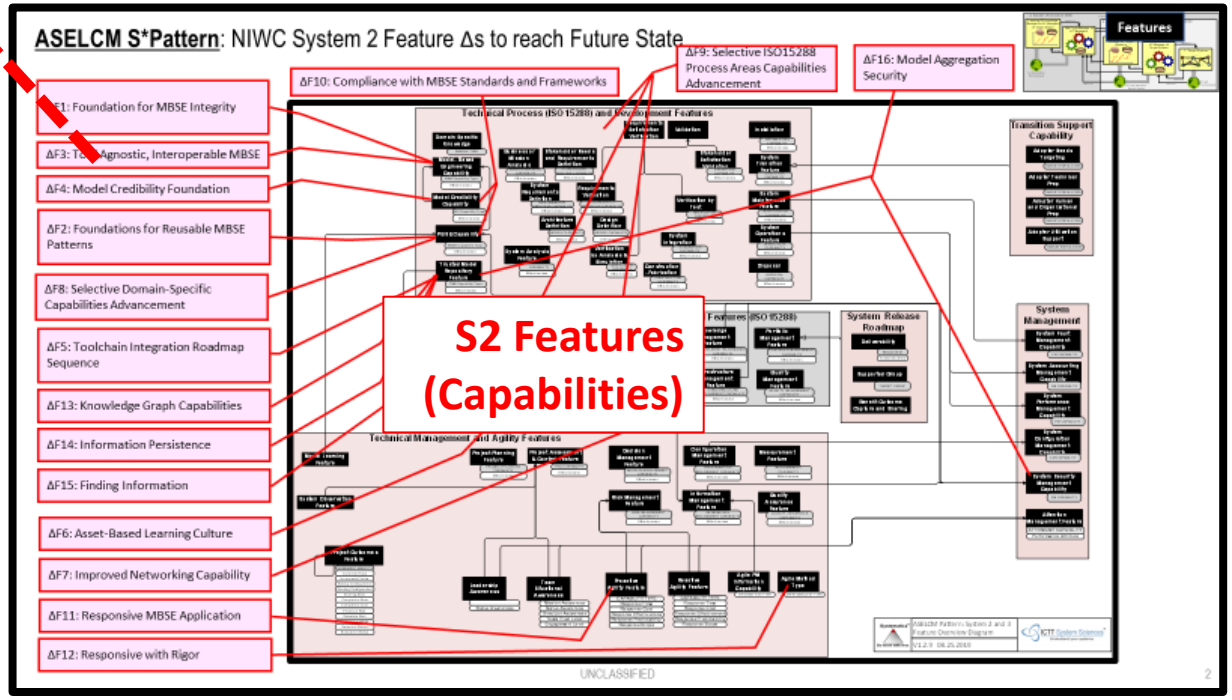
Deltas to S2 Features, Roles, Design Component

Diagram Ref	Δ Short Name	Impacted S2 Ftrs	Description of Enterprise S2 Feature Delta
ΔF1	Foundations for MBSE Integrity	Model-Based Engineering Capability	Adoption of S*Metamodel foundation and related methods for MBSE.
ΔF2	Foundations for Reusable MBSE Patterns	PBSE Capability	Adoption of S*PBSE information framework for reusable, configurable MBSE S*Patterns, and related methods for rapid configuration of S*Models from S*Patterns.
ΔF3	Tool Agnostic, Interoperable MBSE	Model-Based Engineering Capability	Establish S*Metamodel mappings for related tools and language schemas. S*Models and S*Patterns are tool agnostic by virtue of minimality of S*Metamodel, and its mapping into each system modeling tool's schema. Models are therefore semantically compatible if transported, imported, and interpreted consistent with the related mapping and
	Model Credibility	Model Credibility	Utilize Model Characterization Pattern (MCP) configured for each model, along with related

Deltas to S2 Features, Roles, Design Component

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ΔF4	Model Credibility Foundation	Model Credibility Capability	Utilize Model Characterization Pattern (MCP) configured for each model, along with related model VVUQ process, so that configured MCP establishes the provenance of the model as the basis for trust.
ΔF5	Toolchain Integration Roadmap Sequence	Trusted Model Repository Feature	Trust in a shared model requires trust in its provenance, which is in part dependent on trust in the repository(ies) in which it resides or from which it was obtained. Plans for that should include a roadmap plan for integration of the related tool chain.
ΔF6	Asset-Based Learning Culture	Human Competency	S*Patterns are information assets representing the collective learning of the organization, and also provide a foundation for individual learning from those same patterns. Required and optional learning for individual competencies about domains is reflected by the contents of the related S*Patterns, planned and constructed as learning assets.
ΔF7	Improved Networking Capability	Infrastructure Management Feature	Network connectivity, security, performance, and reliability should be planned, engineered, and supported consistent with internal and external information sharing and access
ΔF8	Selective Domain Specific Capabilities Advancement	PBSE Capability	Priority application domains (e.g., flight, communications, undersea, op centers, etc.) are selected as justifying capture of application domain knowledge in the form of system patterns of values, requirements, design, test, or other aspects, based on considerations such as frequency of use, changes in future staff, evolution of the domain, need for
ΔF9	Selective ISO15288 Process Areas Capabilities Advancement	Selective ISO15288 Process Areas Capabilities Advancement	Priority ISO 15288 systems management domains (e.g., Requirements, Design, Verification, etc.) are selected as justifying capture of related domain knowledge in the form of system patterns of key information types, views and artifacts, processes, stakeholders, sources and uses of information, or other aspects, based on considerations such as frequency of
ΔF10	Compliance with MBSE Standards and	PBSE Capability, Model Credibility	Careful selection standards, frameworks, or portions of them, and compliance with them on a selective basis, is based on criteria to improve speed, quality, group learning, or other

(S2 Capability Improvements)



Deltas to S2 Features, Roles, Design Component

(S2 Capability Improvements)

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ΔF9	Selective ISO15288 Process Areas Capabilities Advancement	Selective ISO15288 Process Areas Capabilities	Priority ISO 15288 systems management domains (e.g., Requirements, Design, Verification, etc.) are selected as justifying capture of related domain knowledge in the form of system patterns of key information types, views and artifacts, processes, stakeholders, sources

Time-based Roadmap of Capability Releases: Equivalent to an "Agile Release Train", as in SAFe Agile Methodology

4Q2019	1Q2020	2Q2020	3Q2020	4Q2020	1Q2021	2Q2021	3Q2021	4Q2021

Deltas to S2 Features, Roles, Design Components

	Diagram Ref	Δ Short Name	Impacted S2 Ftrs	Description of Enterprise S2 Feature Delta	4Q2019	1Q2020	2Q2020	3Q2020	4Q2020	1Q2021	2Q2021	3Q2021	4Q2021
S2 Feature Δs (S2 Capability Improvements)	ΔF1	Foundations for MBSE Integrity	Model-Based Engineering Capability	Adoption of S*Metamodel foundation and related methods for MBSE.									
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	ΔF9	Selective ISO15288 Process Areas Capabilities Advancement	Selective ISO15288 Process Areas Capabilities Advancement	Priority ISO 15288 systems management domains (e.g., Requirements, Design, Verification, etc.) are selected as justifying capture of related domain knowledge in the form of system patterns of key information types, views and artifacts, processes, stakeholders, sources and uses of information, or other aspects, based on considerations such as frequency of									
	ΔF10	Compliance with MBSE Standards and Frameworks	PBSE Capability, Model Credibility Capability	Careful selection standards, frameworks, or portions of them, and compliance with them on a selective basis, is based on criteria to improve speed, quality, group learning, or other aspects of performance, and minimizing blind adherence in the absence of rationale and									
	ΔF11	Responsive MBSE Application	Proactive Agility Feature	MBSE is applied in targeted areas (application domains and process areas) selected in advance for the ability of MBSE to improve effective responsiveness.									
	ΔF12	Responsive with Rigor	Agile Methodology Type	MBSE is applied with rigorous enough model content to assure that rapid response does not unduly sacrifice appropriate technical rigor for risks at hand.									
	ΔF13	Knowledge Graph Capabilities	Trusted Model Repository Feature	Tooling makes effective use of graph-based technologies to improve systems engineering performance associated with recognizing and exploiting knowledge relationships.									
	ΔF14	Information Persistence	Trusted Model	Confidence in the persistence of key data is improved.									

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Organizational learning is not "flipping a switch"

Calendar

Deltas to S2 Features, Roles, Design Components

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apability Improvements)

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