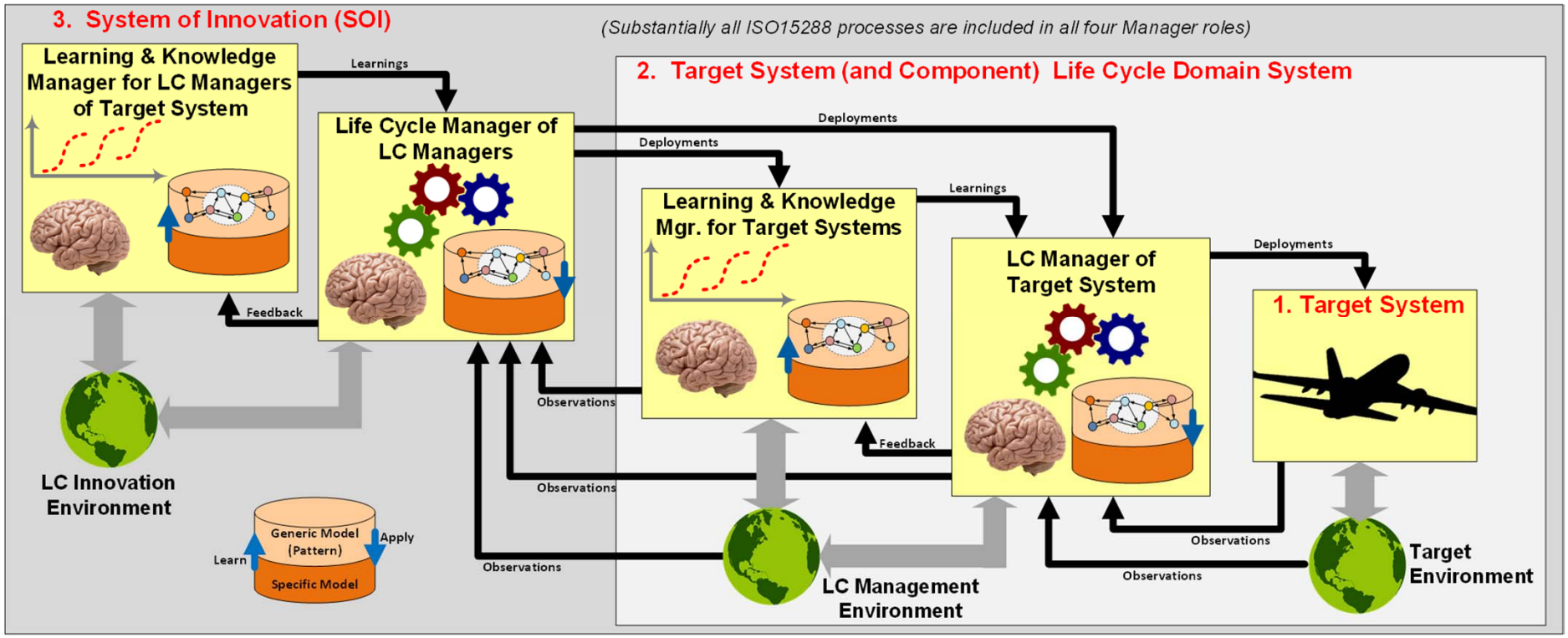
ASELCM Reference Pattern: Reference Configuration & Learning Life Cycle Stages for Models, Model Patterns, and the Real Systems They Represent



INCOSE MBSE Patterns Working Group

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V1.5.8

Purpose and scope

- The following material is a walk-through summary of pattern configuration and learning stages for the INCOSE Agile Systems Engineering Life Cycle Management (ASELCM) Reference Pattern.
- This material does not introduce or describe the purpose or nature of the ASELCM Pattern. For that introduction, see:

  https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:is2016_intro_to_the_aselcm_pattern_v1.4.8.pdf
- This material does not provide background on MBSE Patterns. For a background introduction to MBSE Patterns, see:

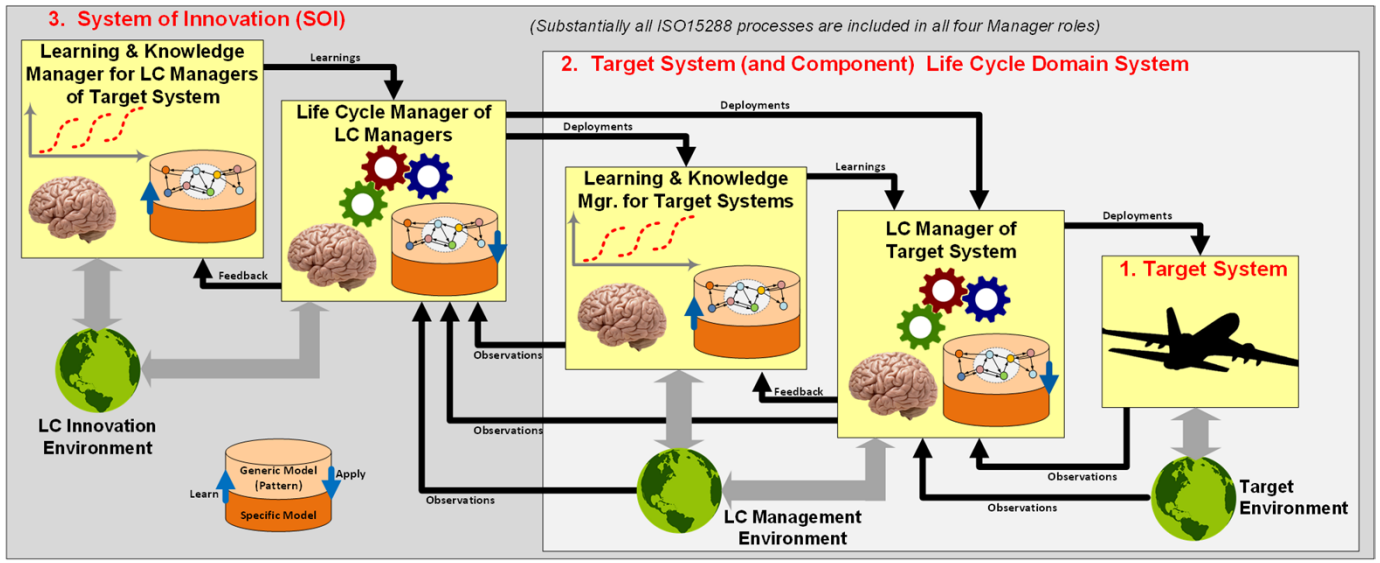
  https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:pbse_extension_of_mbse--methodology_summary_v1.6.1.pdf

  and

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

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



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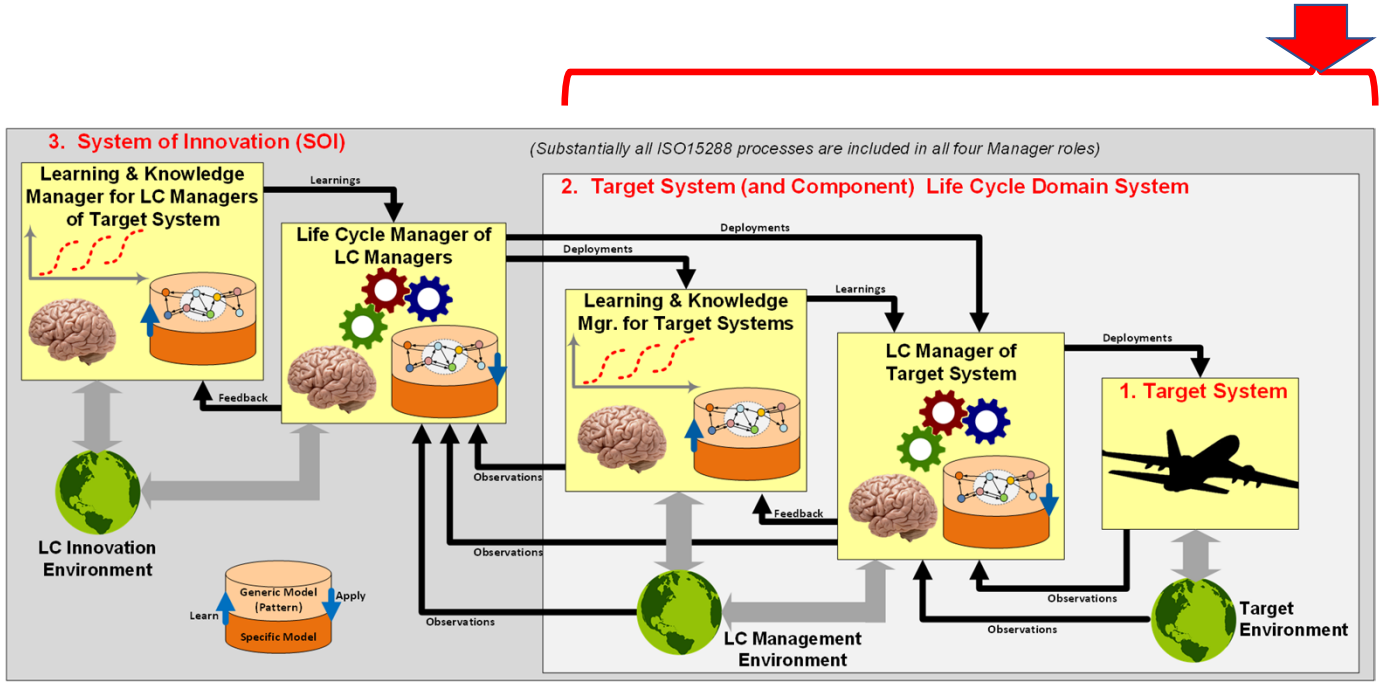
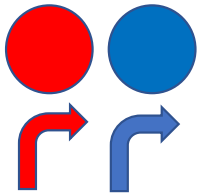
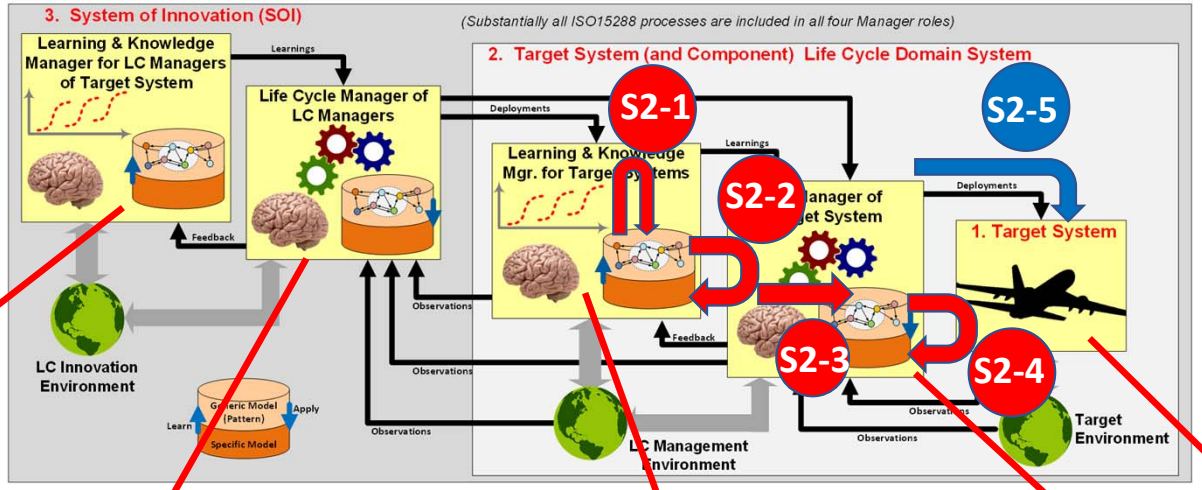


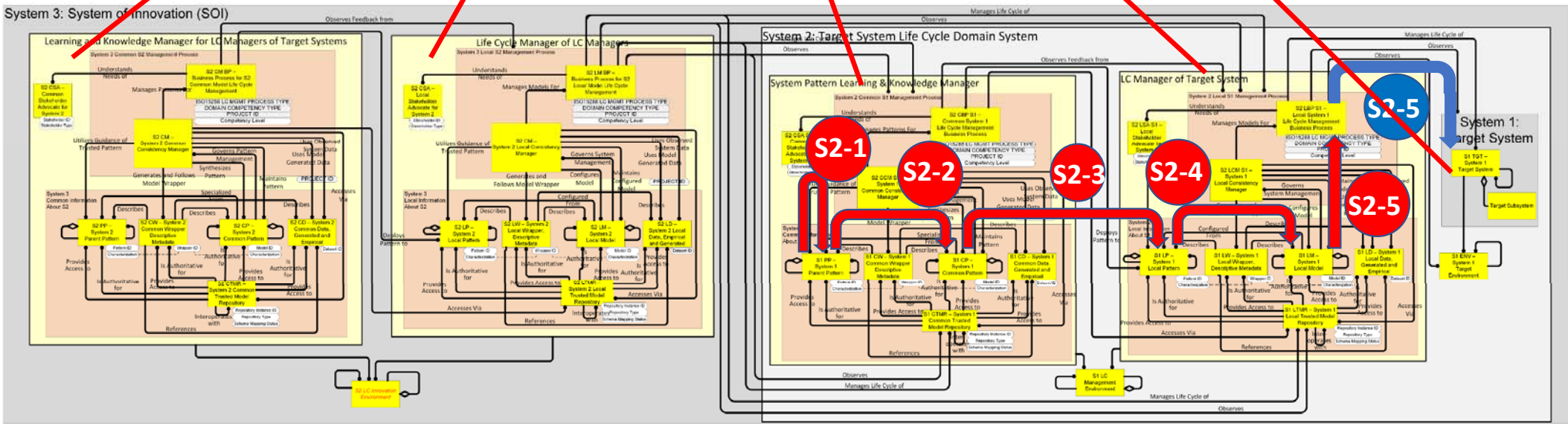
Stages of System 1 (Target System) Pattern & Model Configuration

- 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 . . .

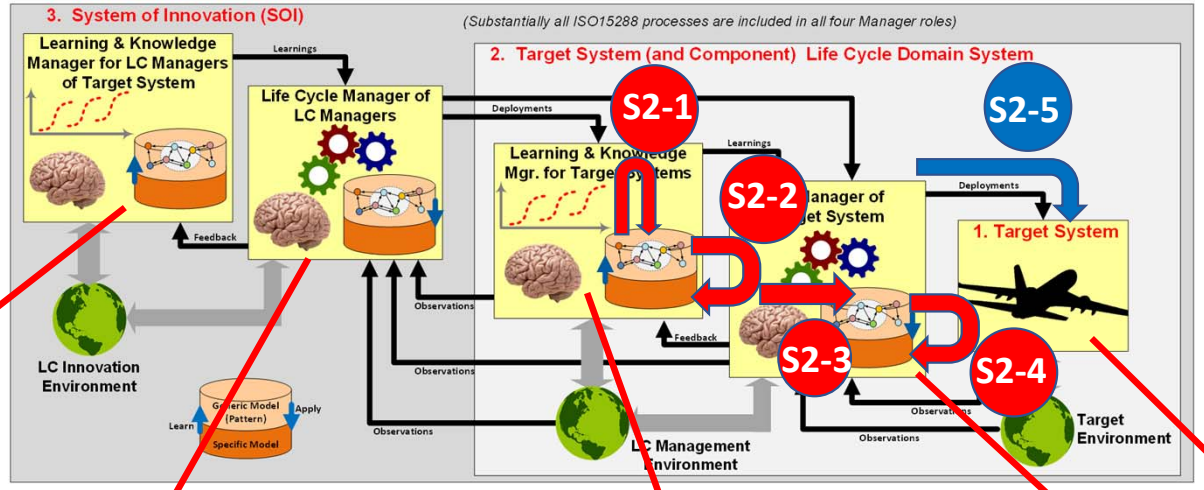
Transition stages:

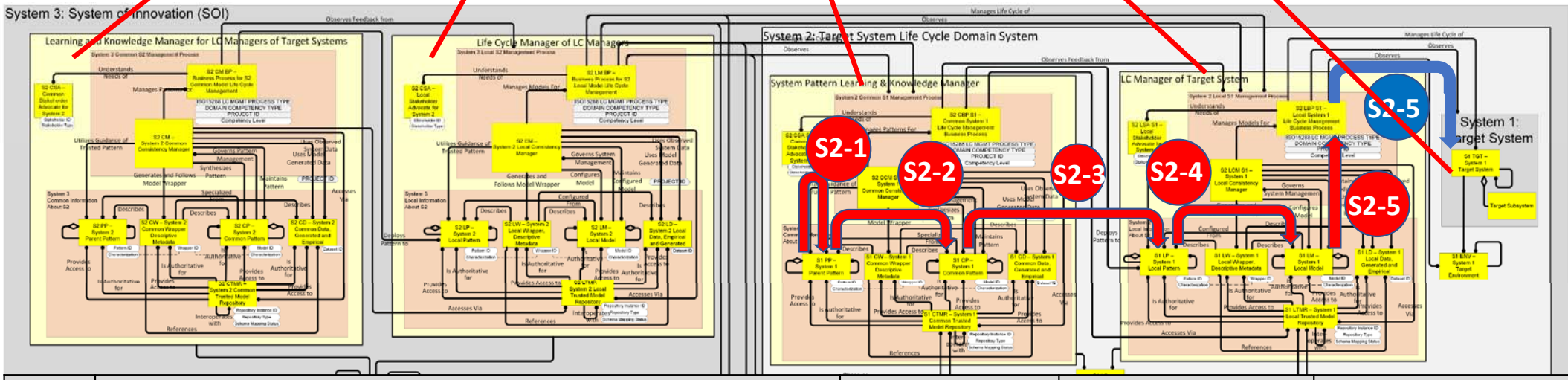




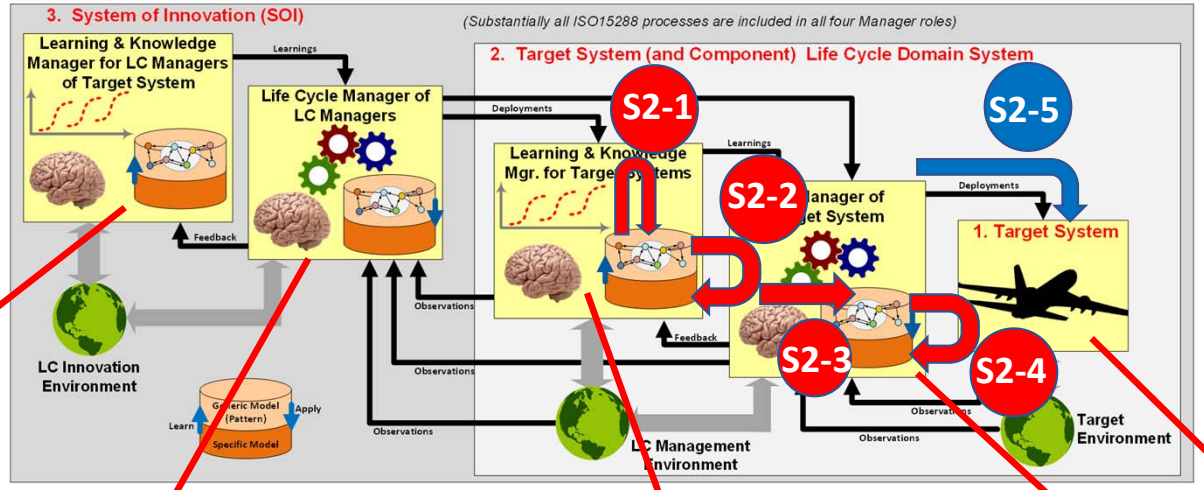


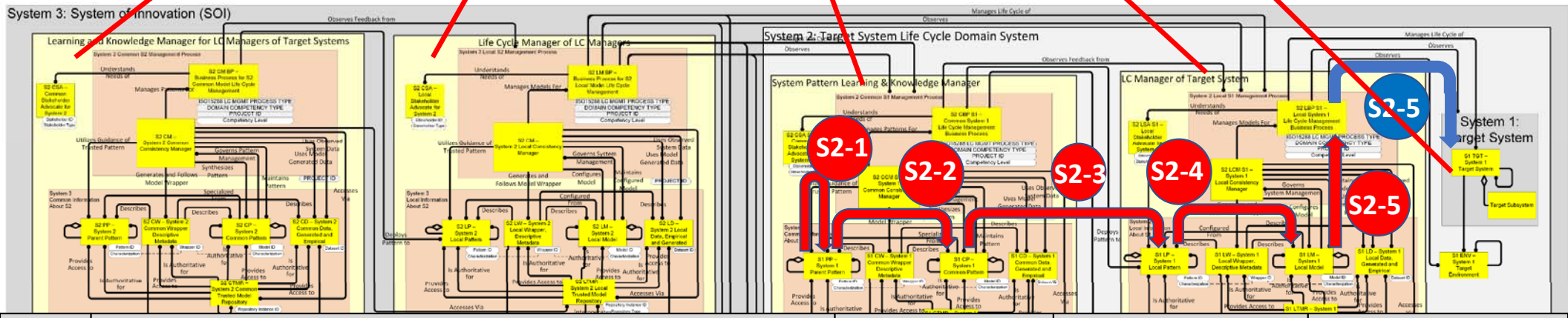
See next slides for definition of labeled stages.



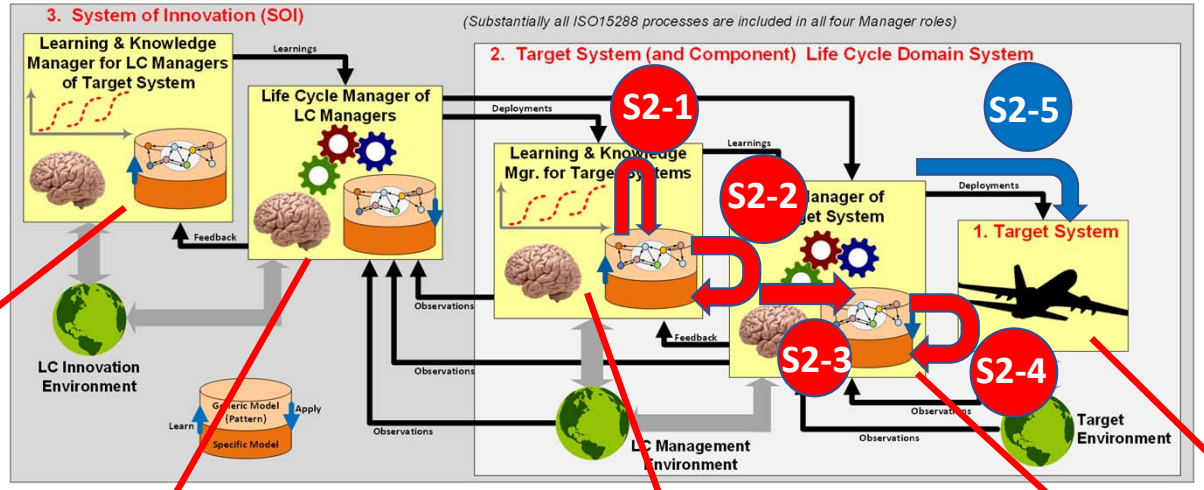


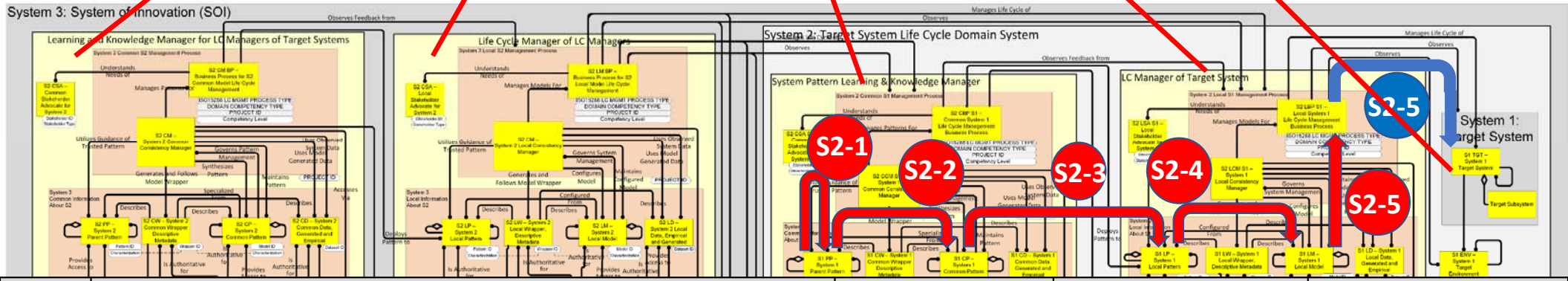
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-1	Parent Pattern version release as a Parent Pattern to an enterprise's System 2 Parent Pattern Library.	S*Patterns Community	S1 PP -- System 1 Parent Pattern (in S2)	Information Transfer



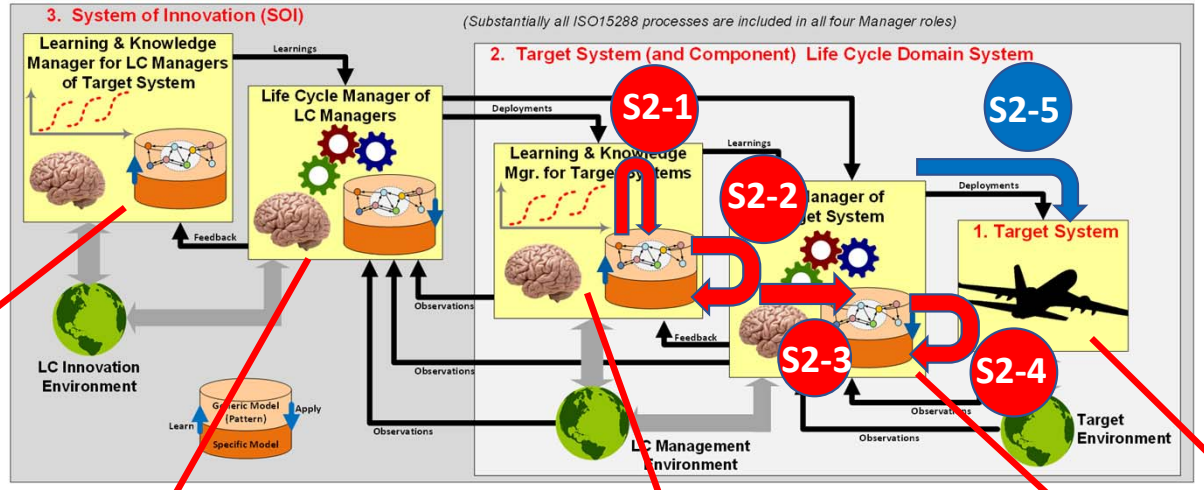


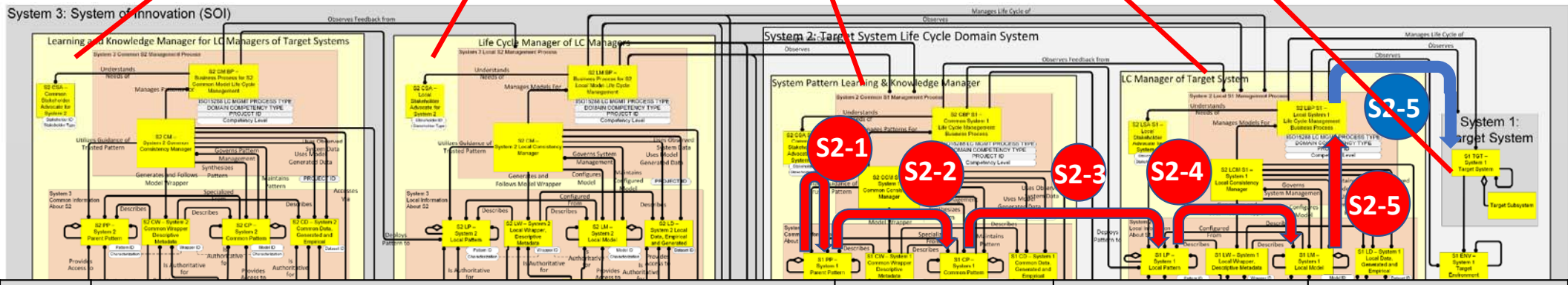
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-2	Configuration of Parent Pattern to one or more general System 1 patterns (in System 2) for use within the enterprise. Point of accumulation of future learning by observing S1 & environment during performance/life,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



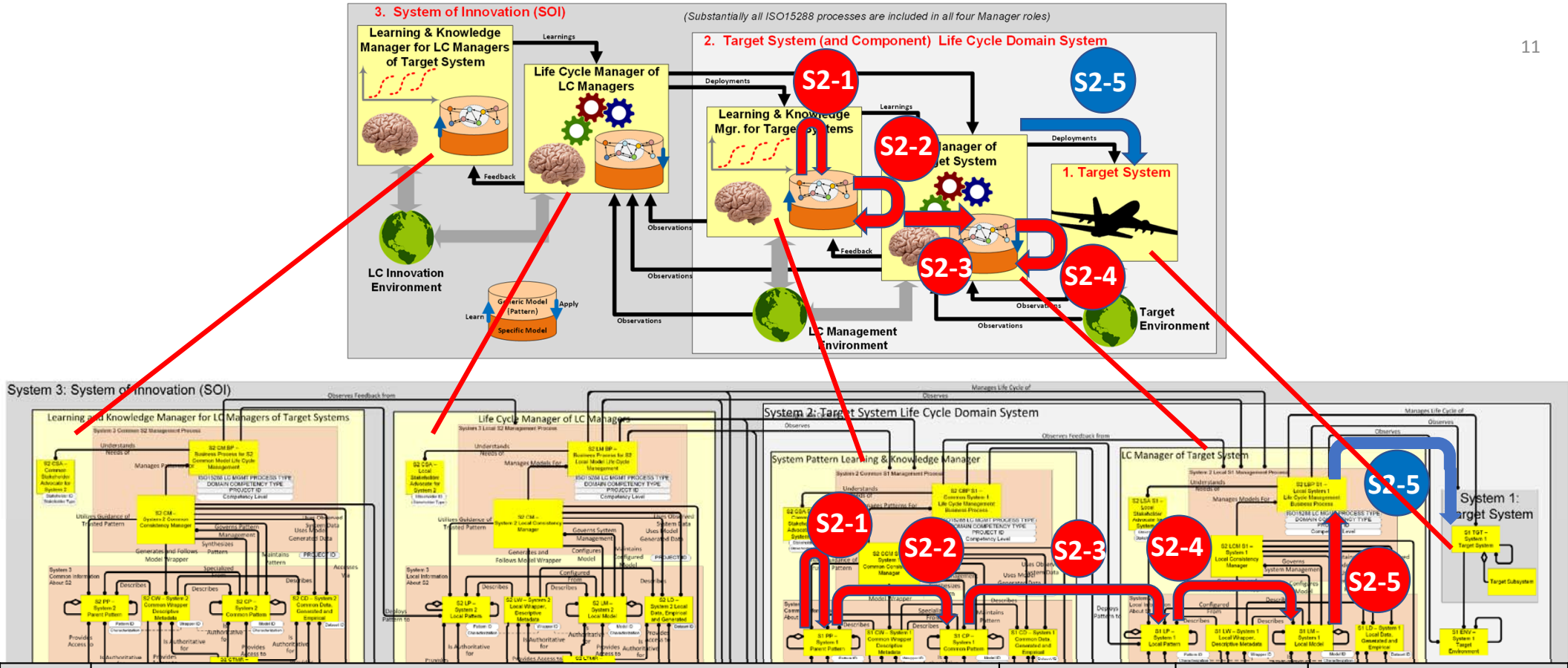


Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-3	Typically describes library of types of intended S1 capabilities, but not yet configured to be specific to individual S1 instances, projects, or programs as to their quantities or combinations of those capabilities, 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)



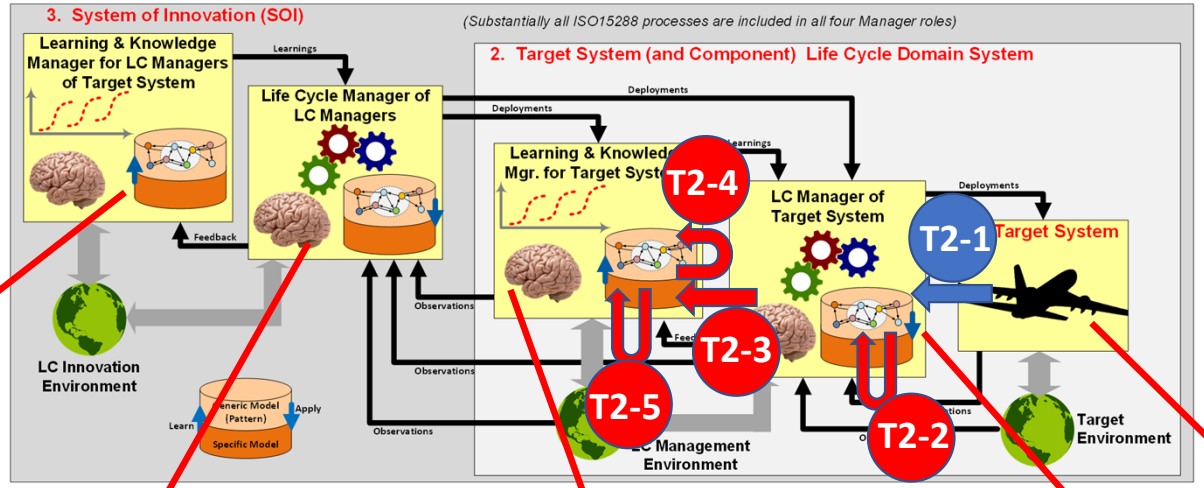
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-5	This is not primarily an information / model stage, but instead is use of the above S1 Local Model as "S1 blueprints", from which certain S2 Business Processes create and deploy real capabilities in S1, though 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

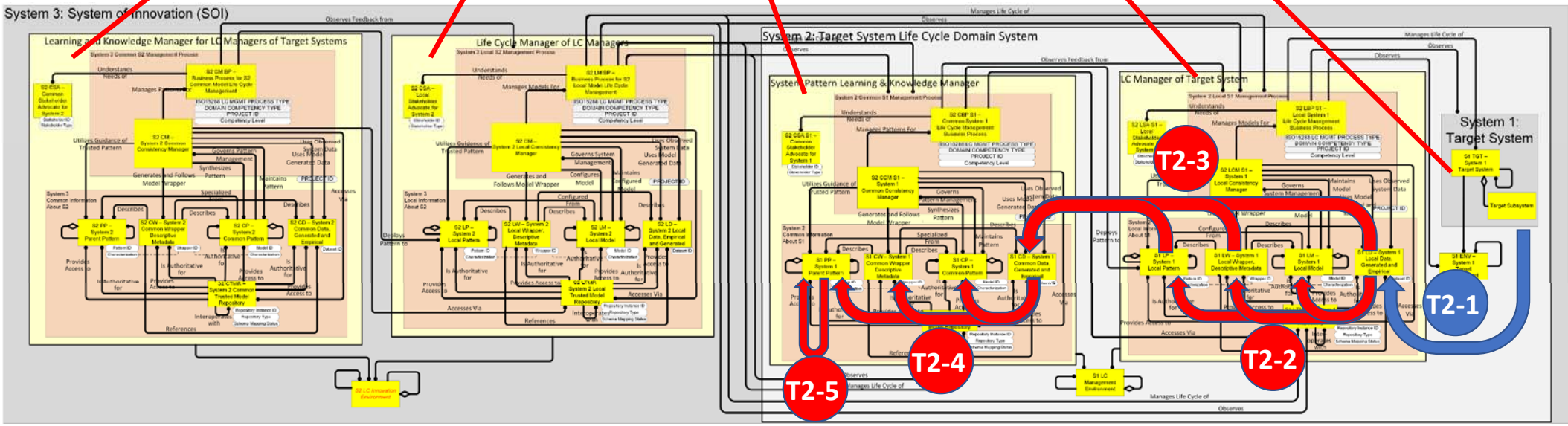
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S2-1	Parent Pattern version release as a Parent Pattern to an enterprise's System 2 Parent Pattern Library.	S*Patterns Community	S1 PP -- System 1 Parent Pattern (in S2)	Information Transfer
S2-2	Configuration of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

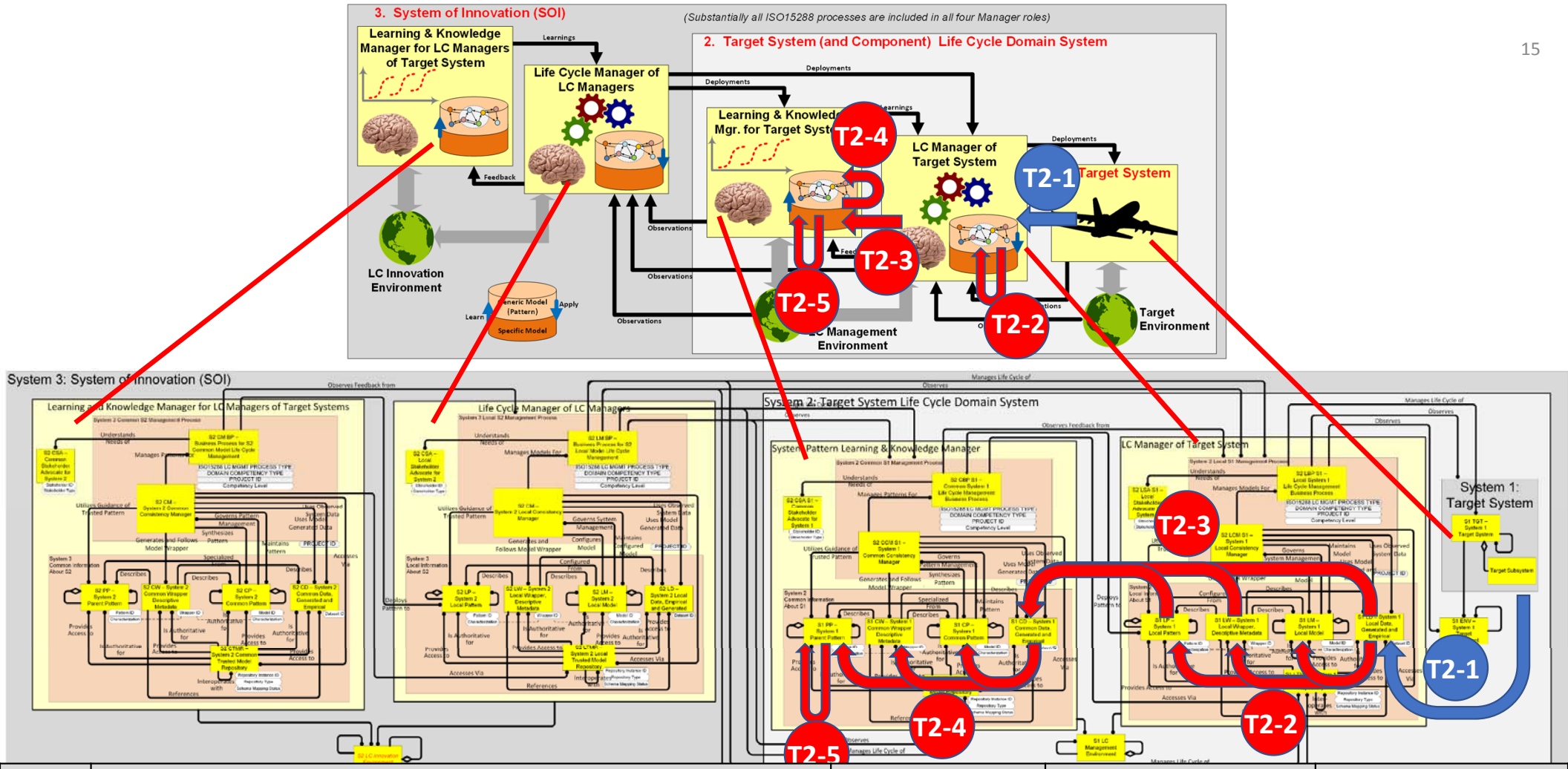
Stages of System 1 (Target System) Feedback, Pattern Uncertainty Management, and Group Learning

- 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 . . .

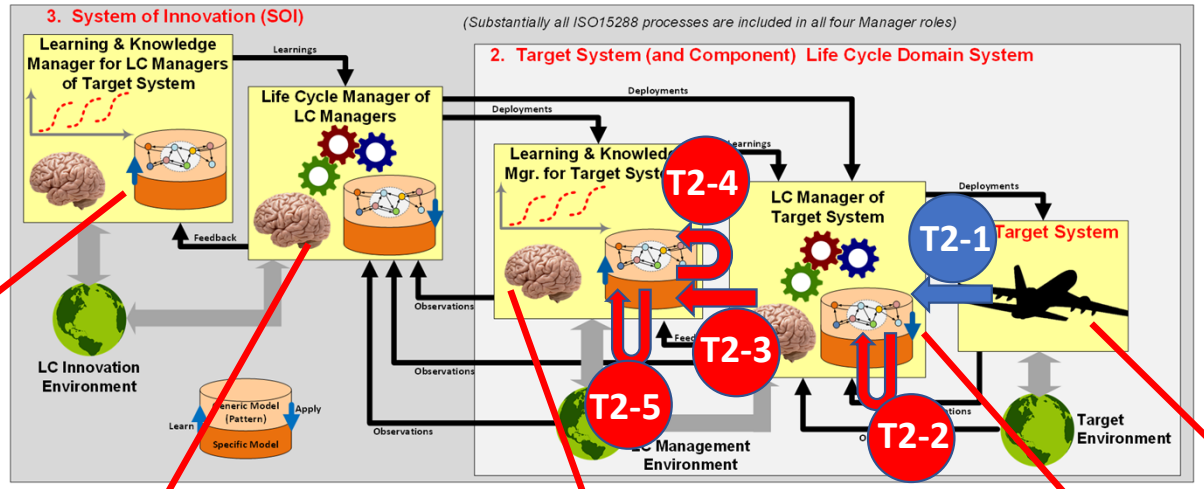


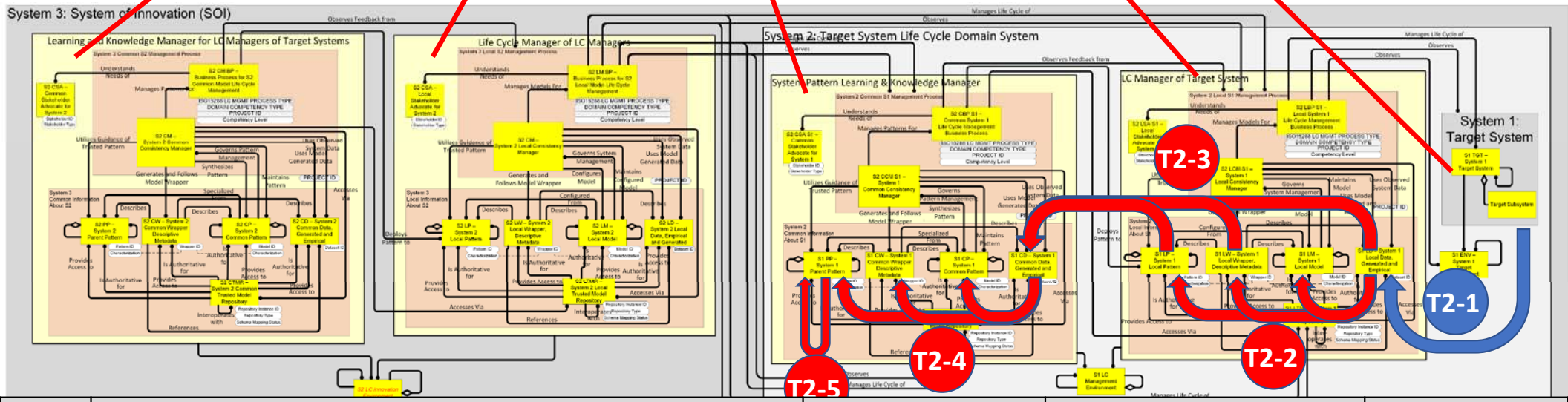
See next slides for definition of labeled stages.



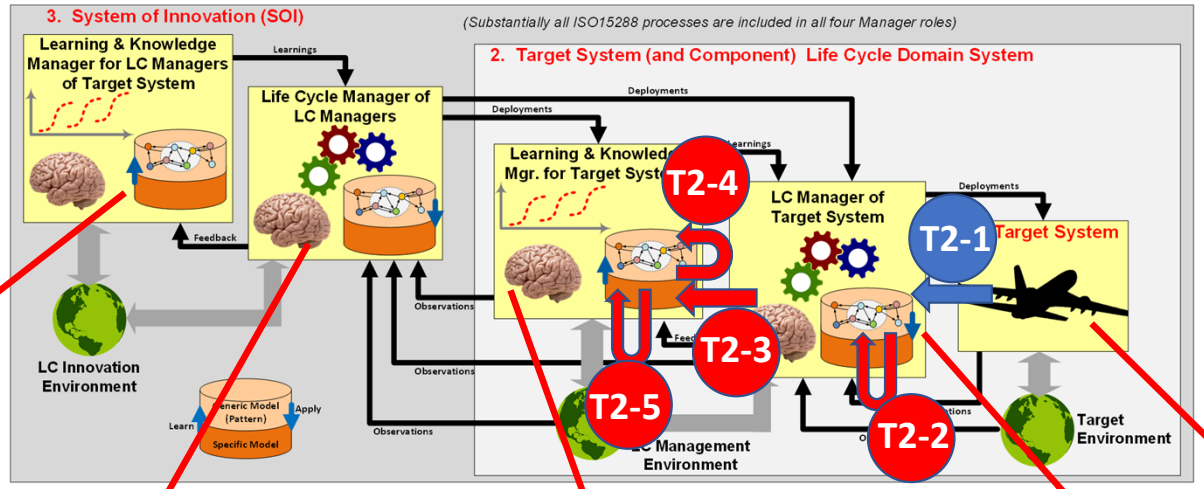


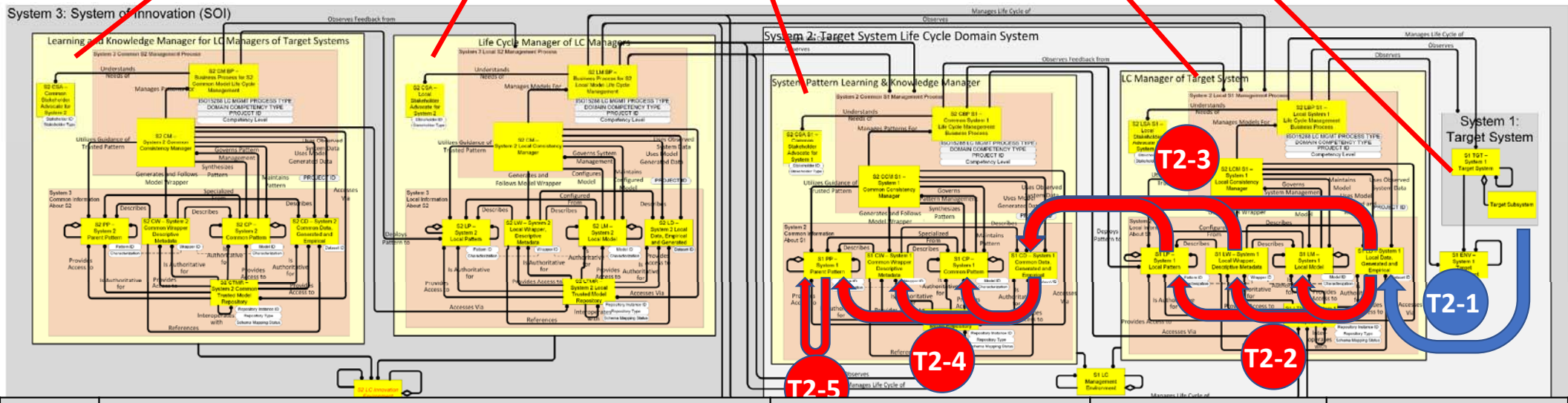
Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type & Qty
T2-1	Observations of System 1, and its interactions with its environment, are captured in the form of empirical data (e.g., measurement, etc.)	Observation of System 1+Environ	S1 LD -- System 1 Local Data, Empirical (in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



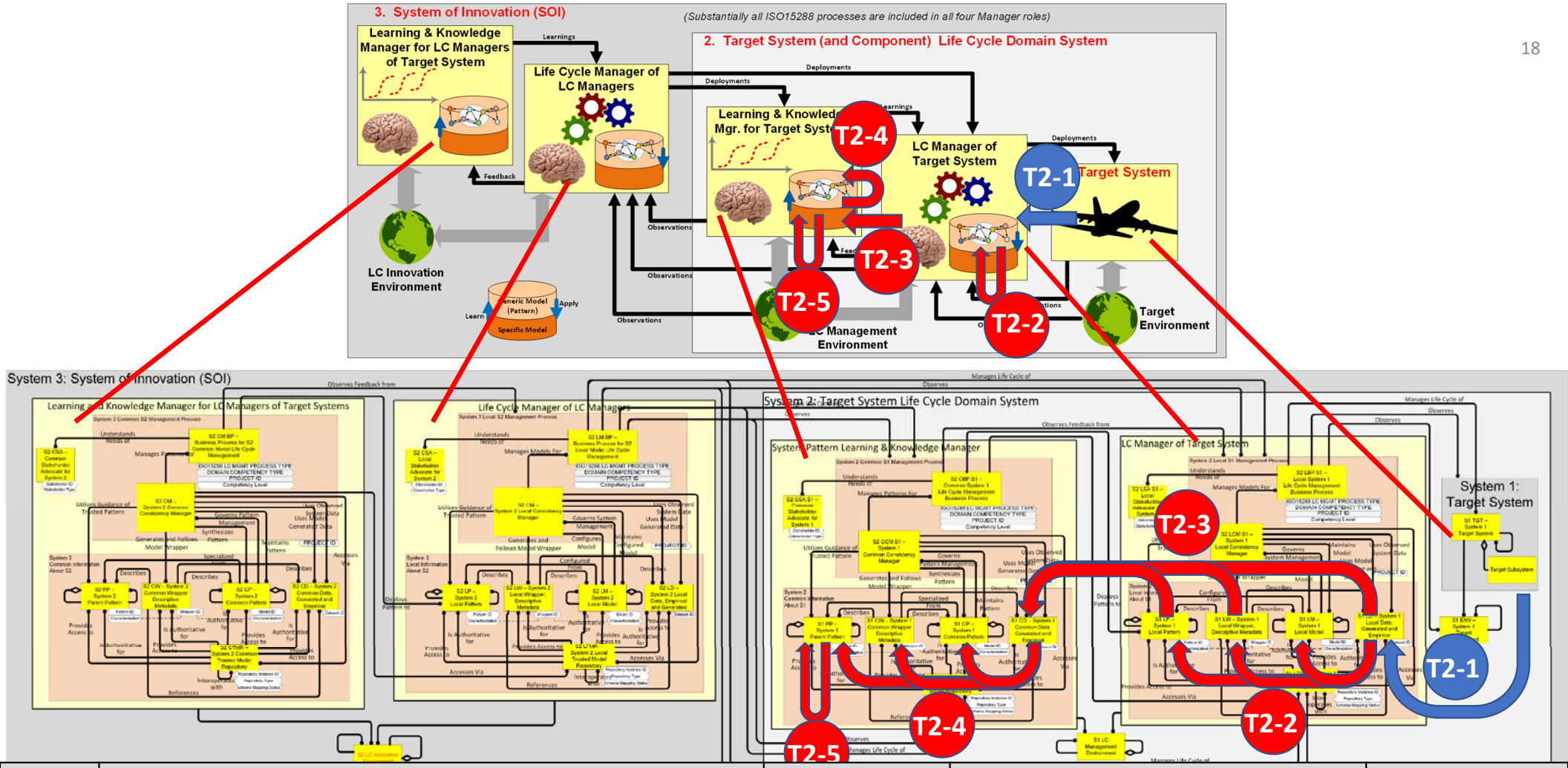


Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type, Qty
T2-2	Empirical observation is compared to local model and/or local pattern data, causing updates to them and uncertainty metadata	S1 LD—System 1 Local Empirical Data	S1 LP, S1 LM, S1 LW—Local Pattern, Model, Wrapper	Reconciliation

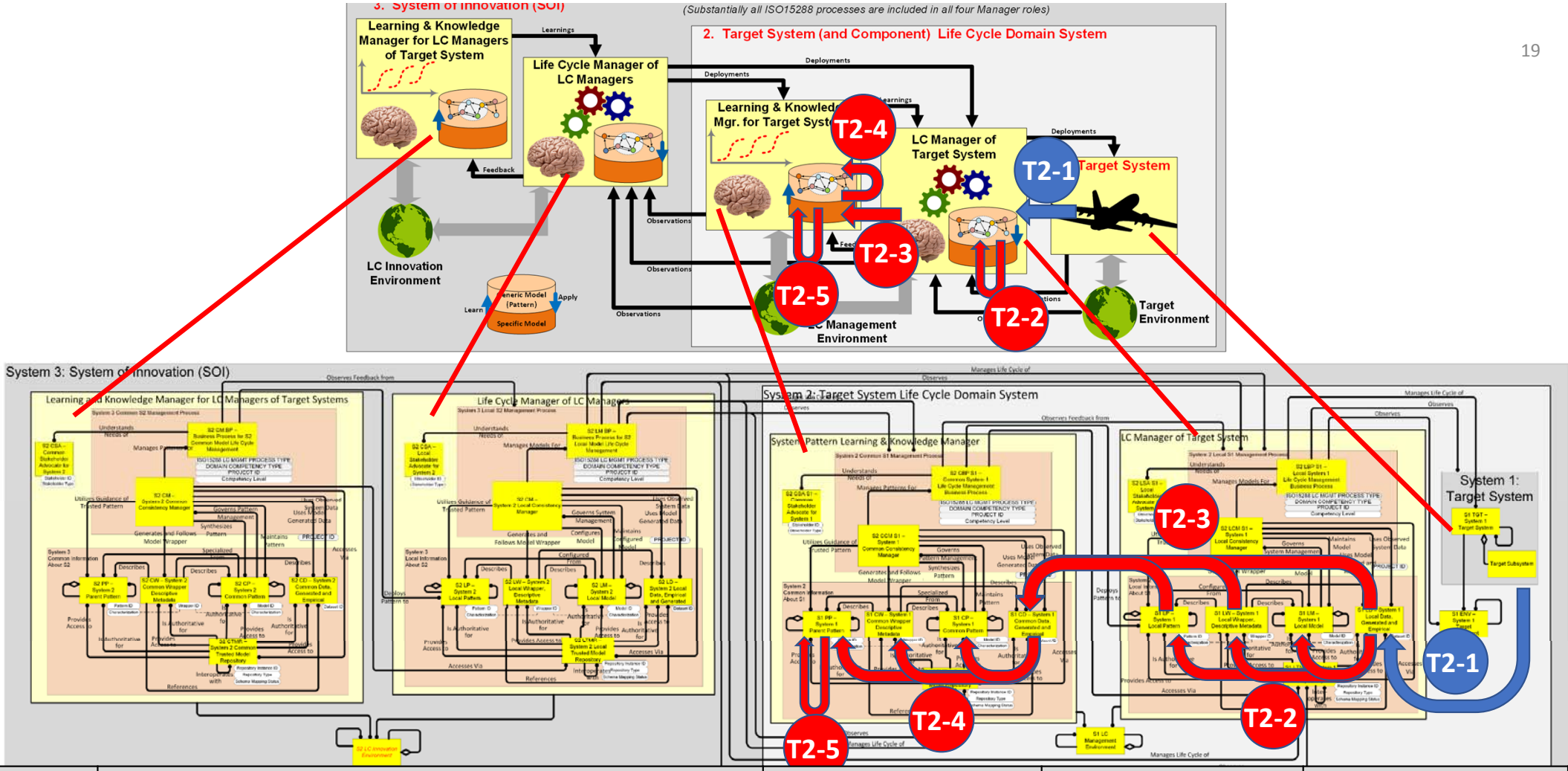




Stage	ASELCM Pattern Learning Life Cycle Stages	Source	Destination	Event Type, Qty
T2-3	Empirical observations, updated local pattern, and metadata local to a project/instance are provided to common dataset.	S1 LP, S1 LD, S1 LW—Local Pattern, Data, Wrapper	S1 CD—System Common Data	Data transfer, many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

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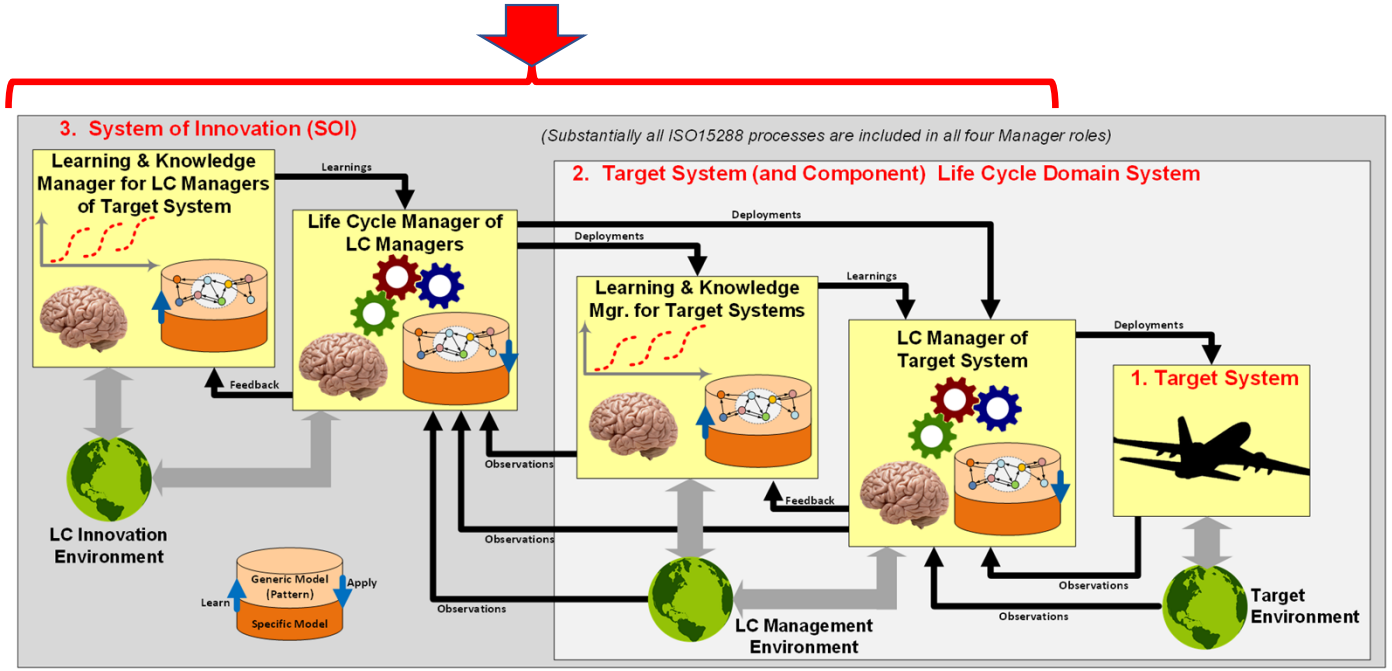
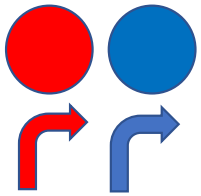
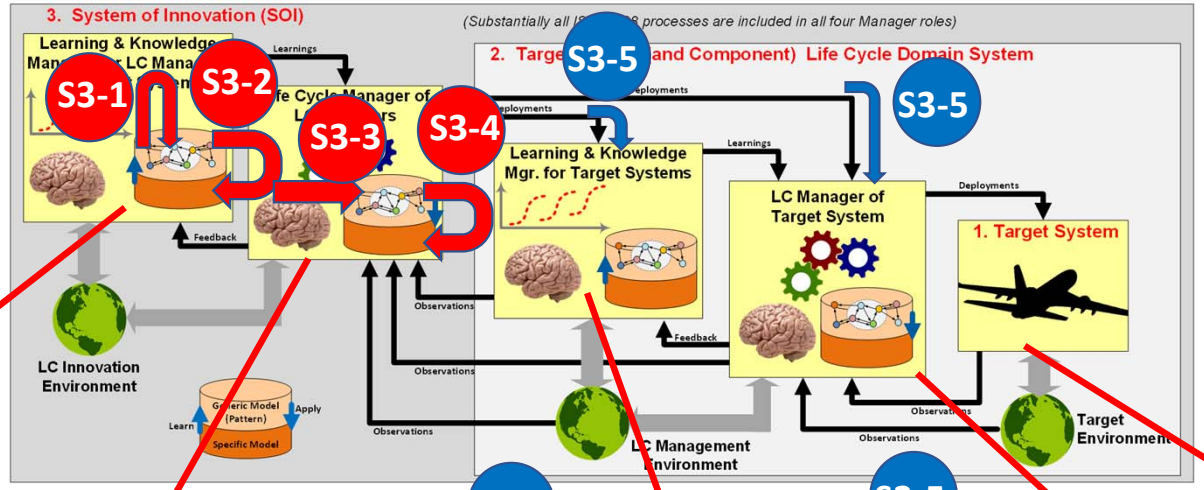


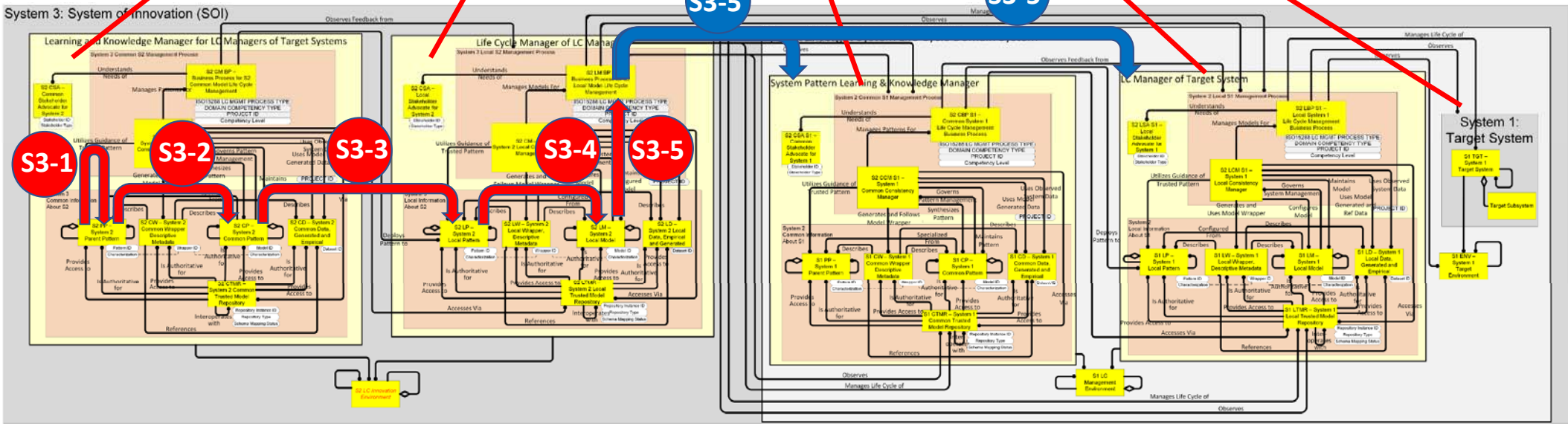
Stages of System 2 (Program/Project Ecosystem) Pattern & Model Configuration

- 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 . . .

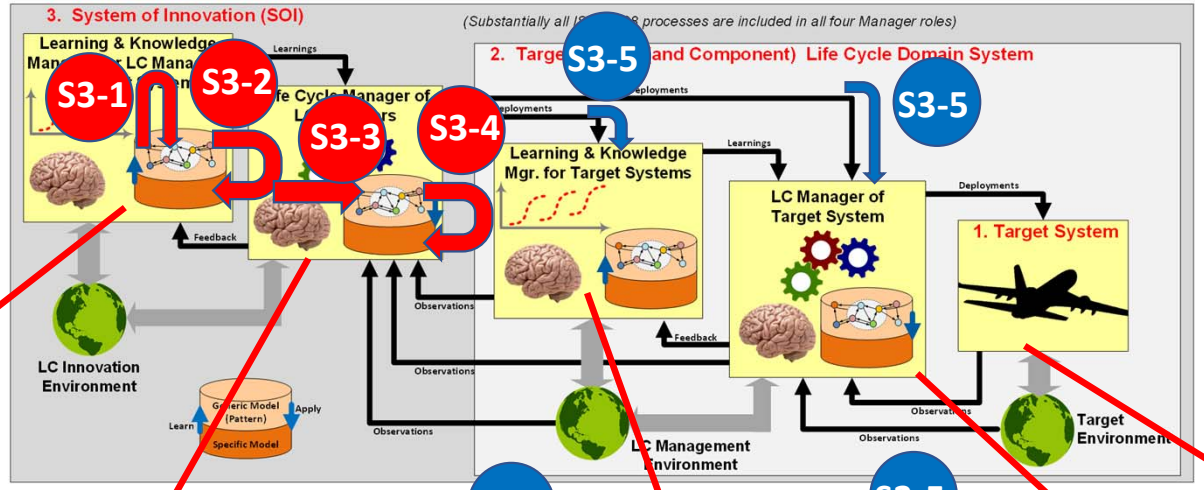
Transition stages:

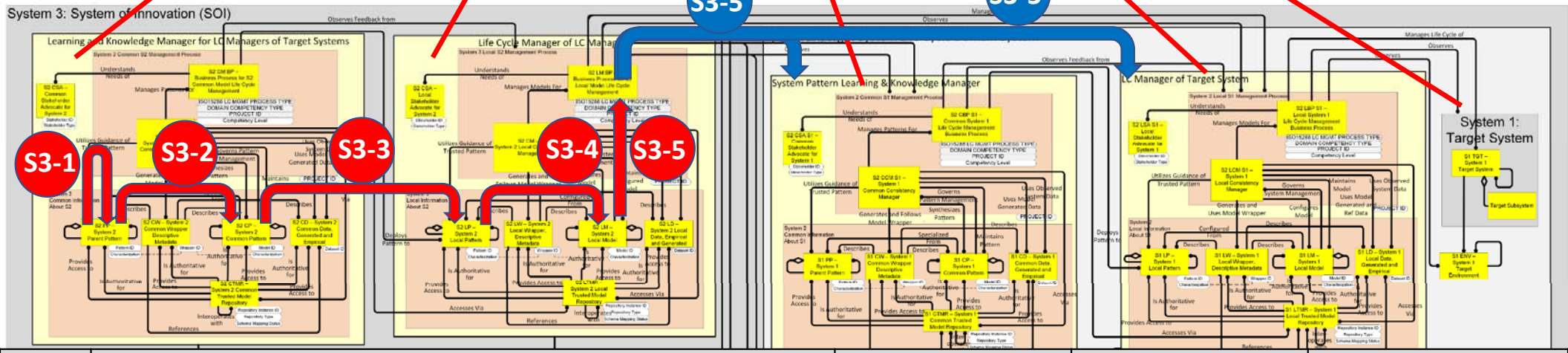




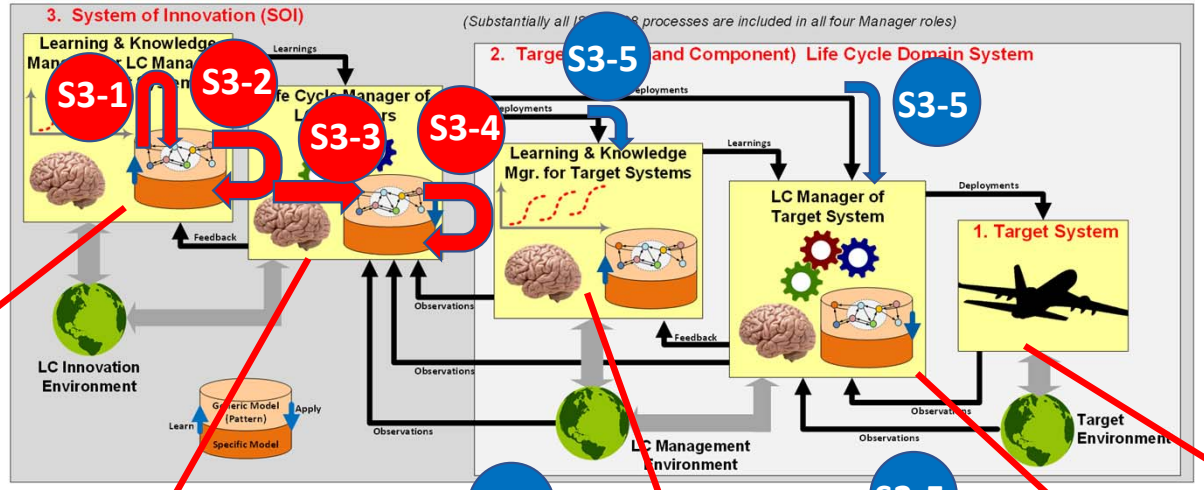


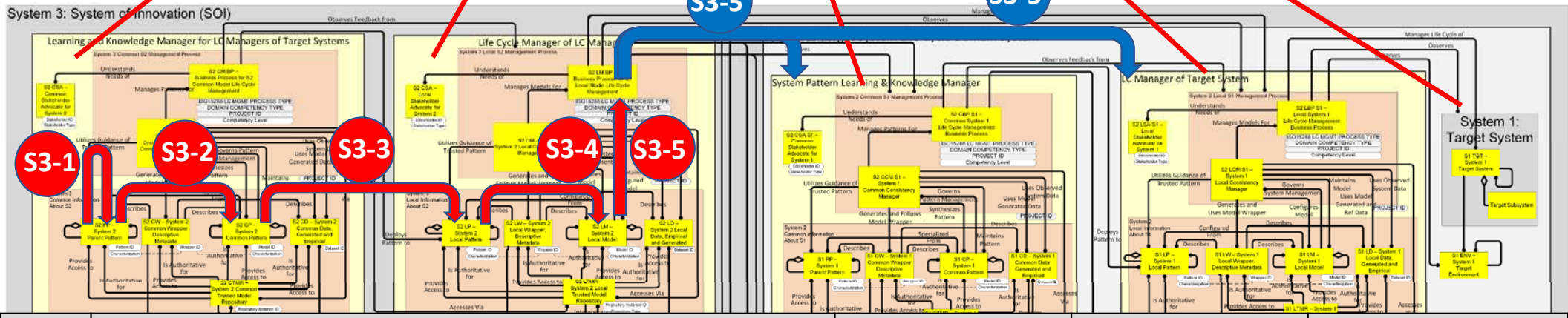
See next slides for definition of numbered stages.



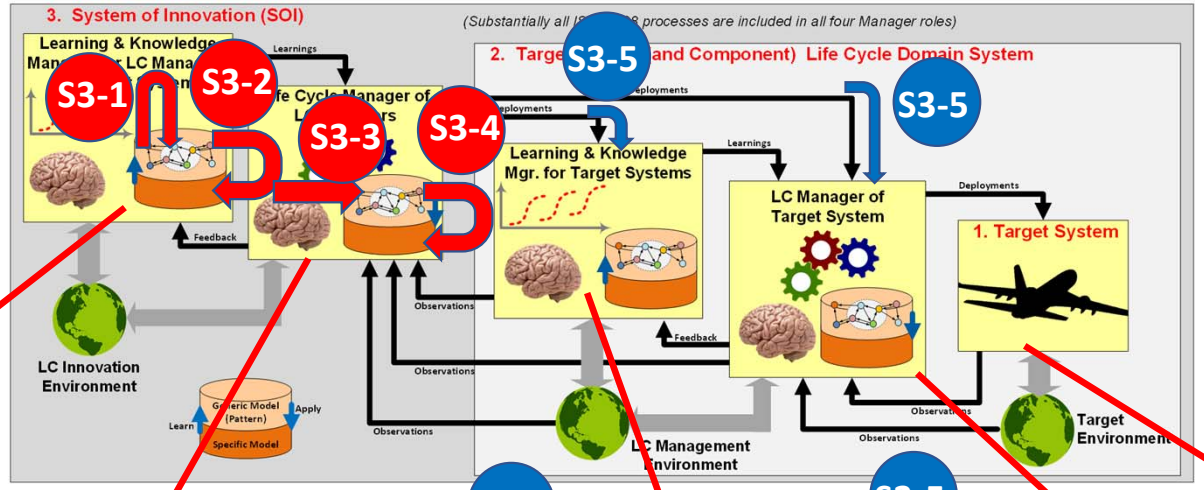


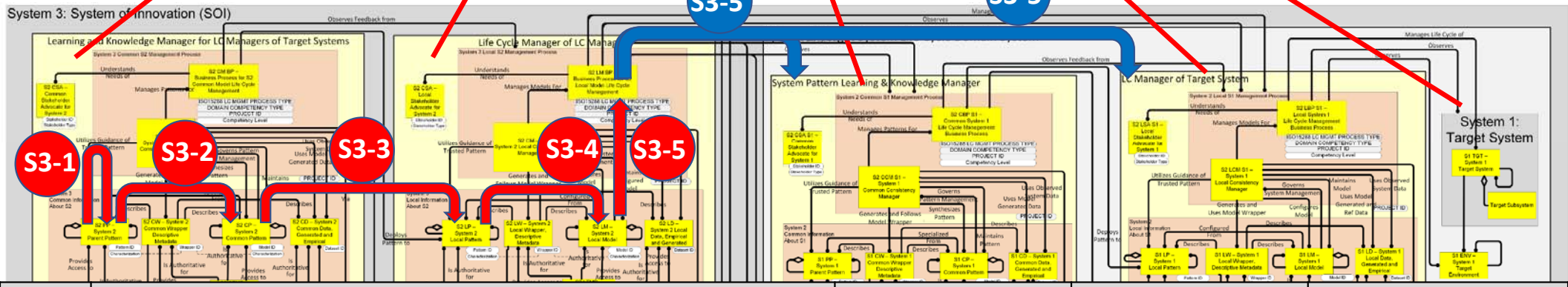
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-1	ASELCM Pattern version release as a Parent Pattern to an enterprise's System 3 Parent Pattern Library.	S*Patterns Community	S2 PP -- System 2 Parent Pattern (in S3)	Information Transfer



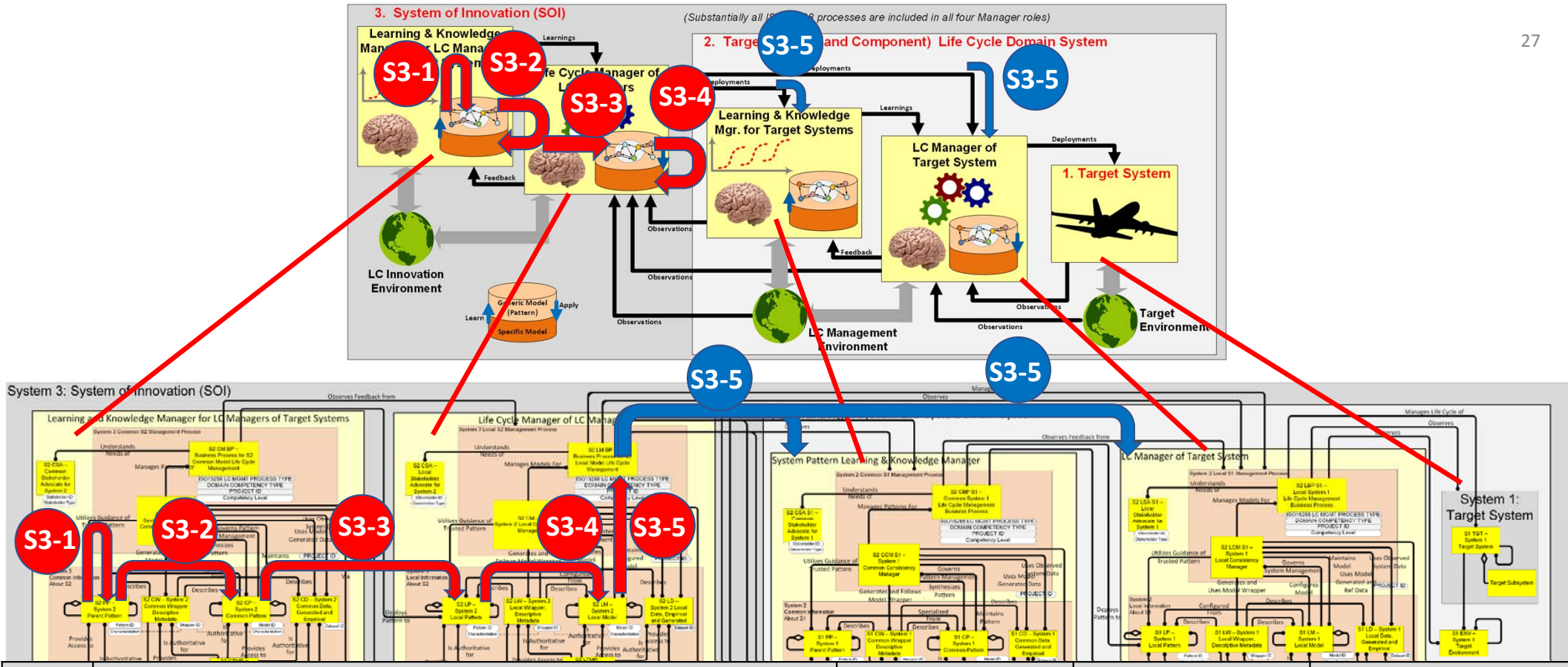


Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-2	Configuration of ASELCM Parent Pattern to one or more general System 2 patterns (in System 3) agreeable for use within the enterprise. Point of accumulation of future learning from observing S2 during its projects,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

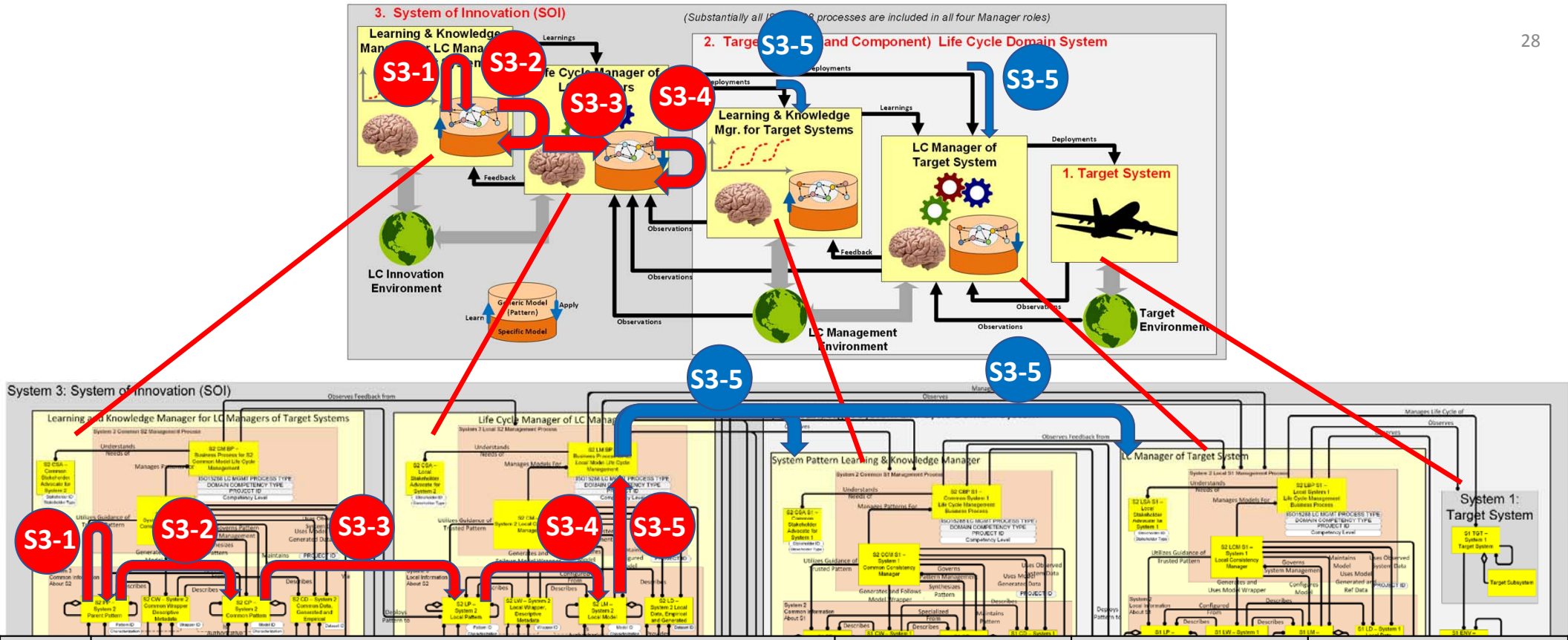




Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-3	Typically describes library of types of intended S2 capabilities, but not yet configured to be specific to individual S2 projects or programs as to their quantities or combinations of those capabilities, projects, 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)



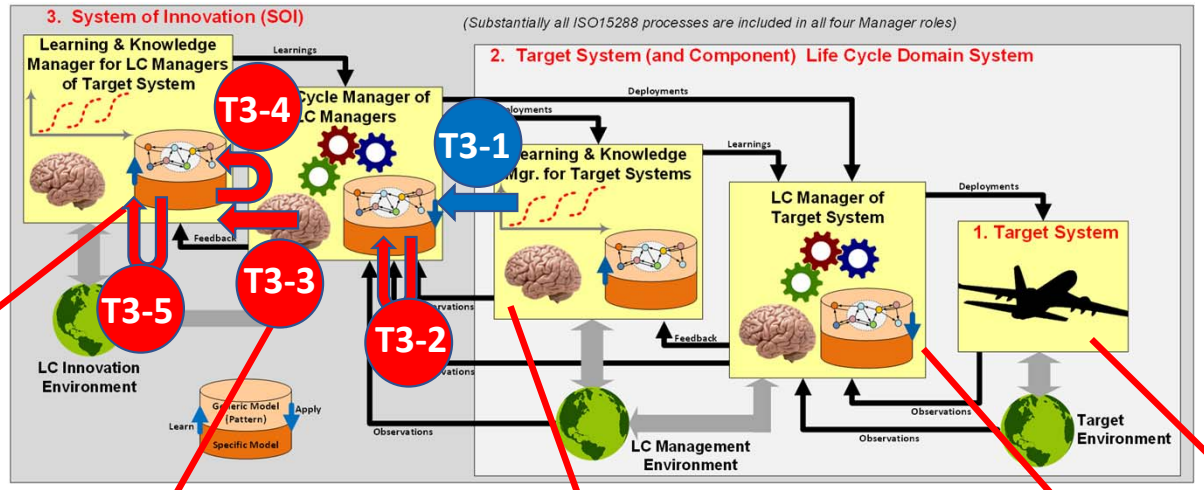
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-5	This is not primarily an information / model stage, but instead is use of the above S2 Local Model as "S2 blueprints", from which certain S3 Business Processes create and deploy real S2 human and facilities 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

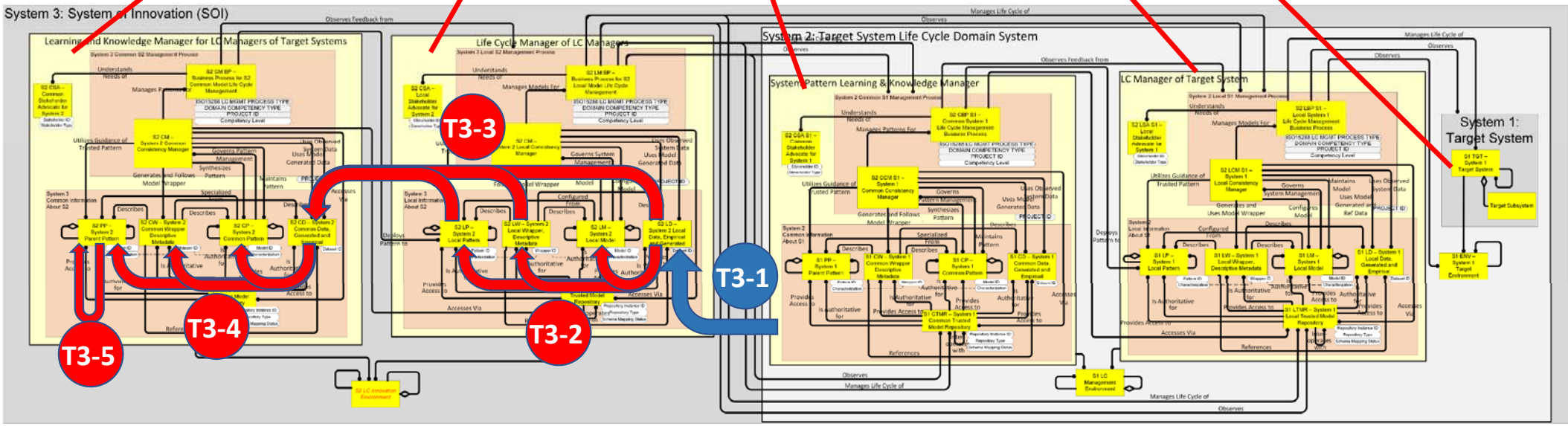
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
S3-1	ASELCM Pattern version release as a Parent Pattern to an enterprise's System 3 Parent Pattern Library.	S*Patterns Community	S2 PP -- System 2 Parent Pattern (in S3)	Information Transfer
S3-2	Configuration of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

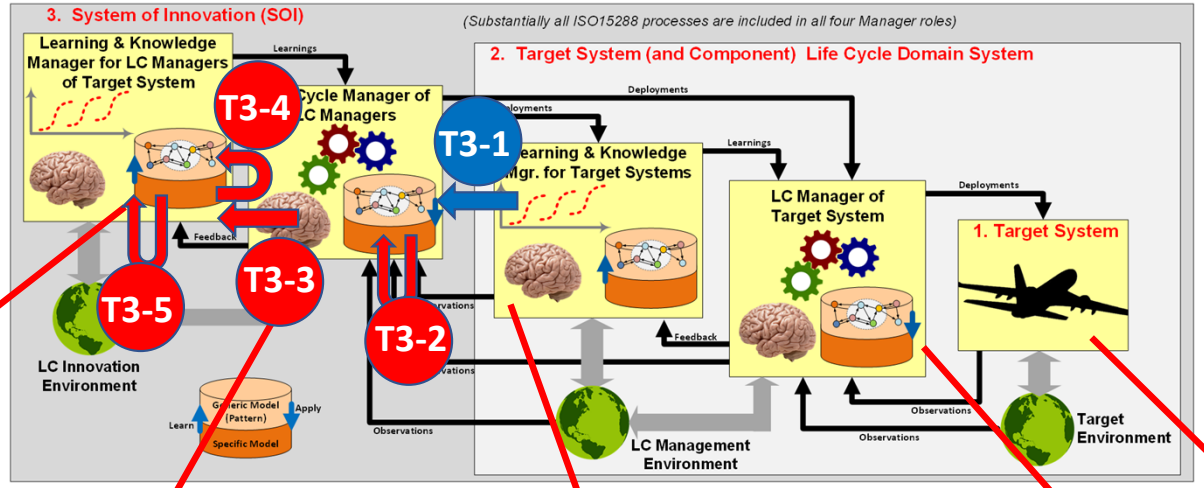
Stages of System 2 (Program/Project Ecosystem) Feedback, Pattern Uncertainty Management, and Group Learning

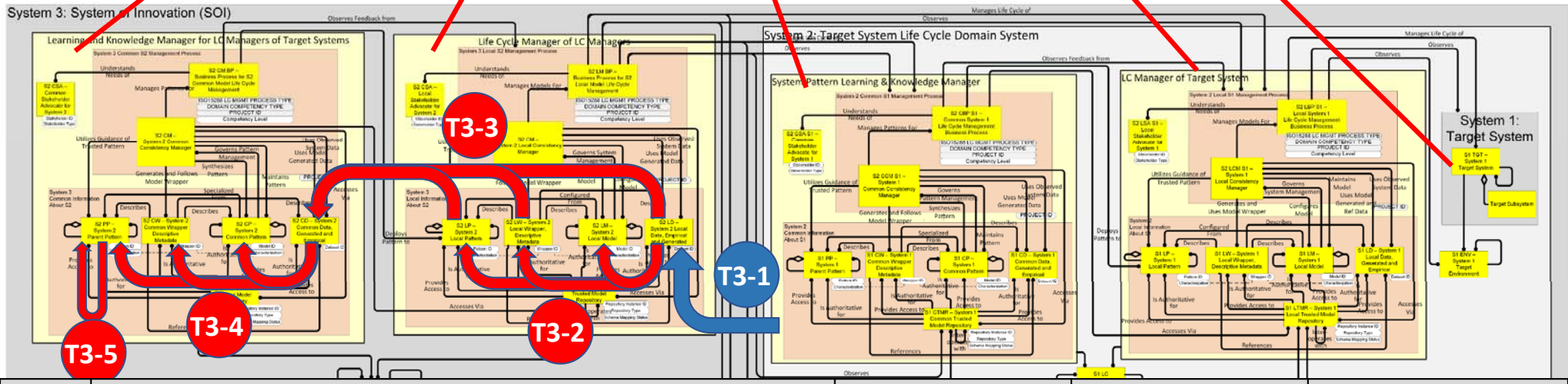
- Knowledge of the (System 2) Program/Project Ecosystem changes with experience and learning by (System 3) Engineering and Life Cycle Management Processes, through observation and experiments on System 2.
- This includes effects of inconsistencies between models or other descriptions/current understandings 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 . .



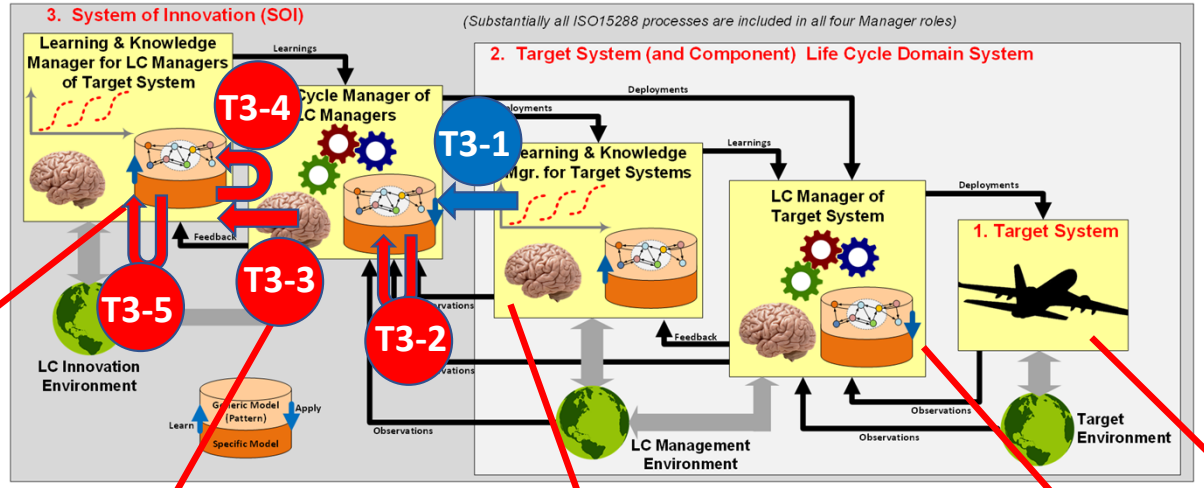
See next slides for definition of labeled stages.

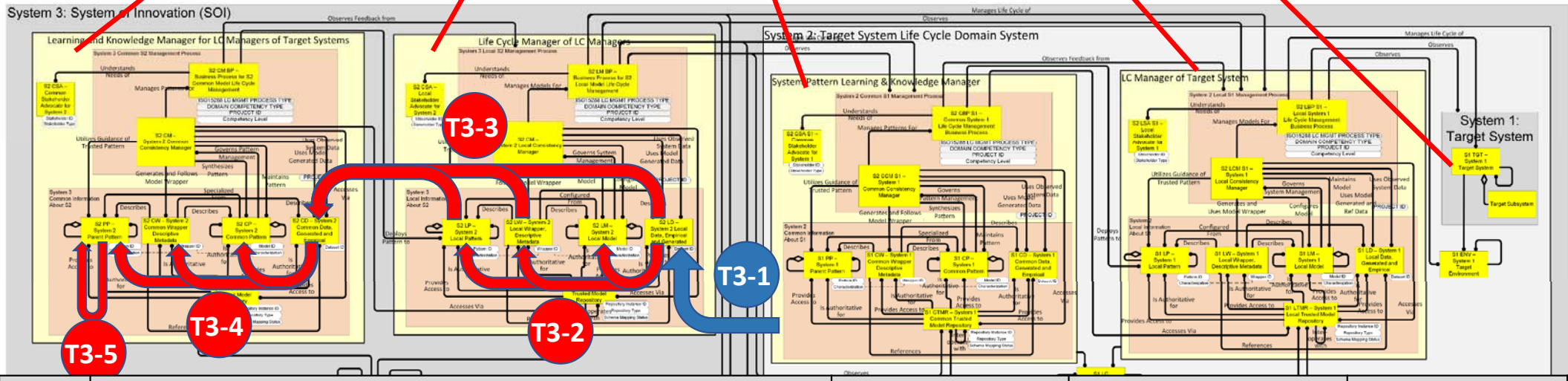




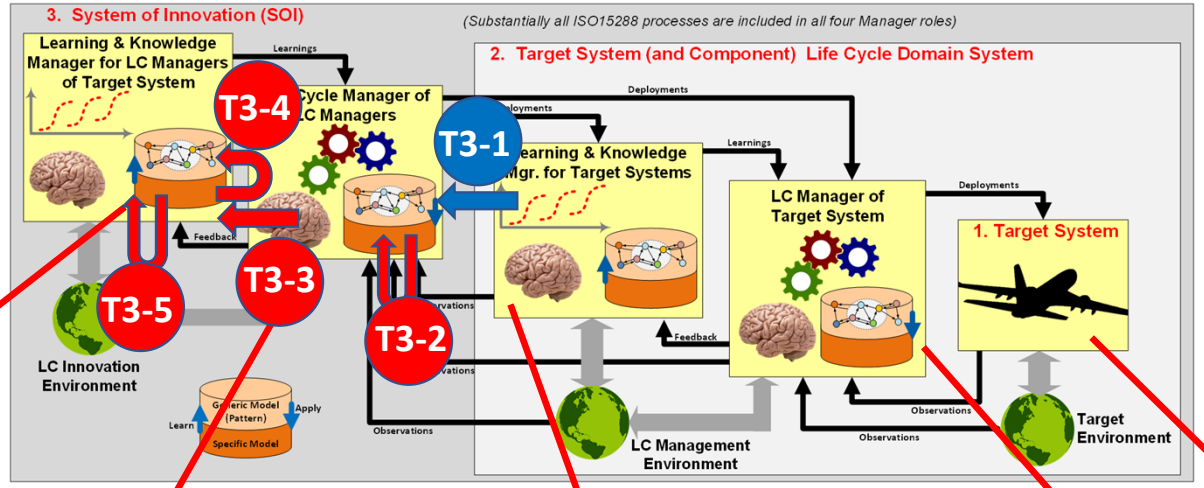


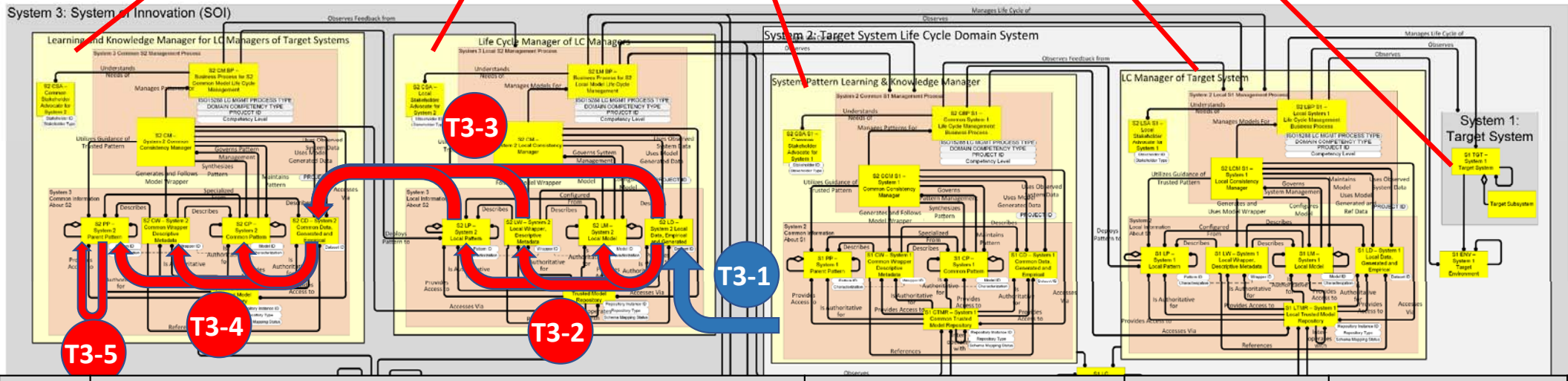
Stage	ASELCM Pattern Learning Life Cycle Stage	Source	Destination	Event Type & Qty
T3-1	Observation and measurement of System 2 (life cycle management system) behavior, interacting with its environment.	S2 Life Cycle Mgmt Processes	System 2 Local Data, Empirical	Observation, data xfer, many to one



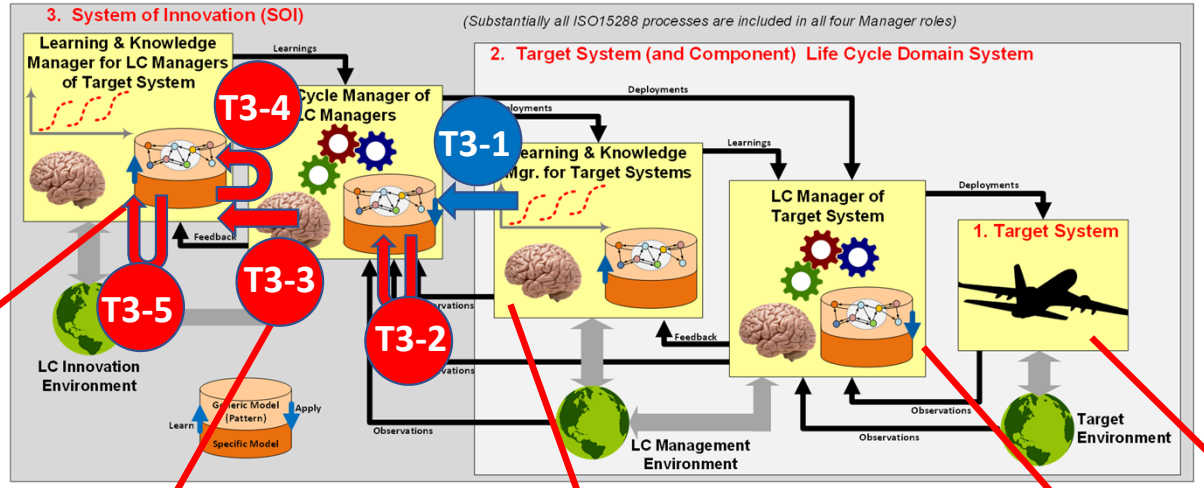


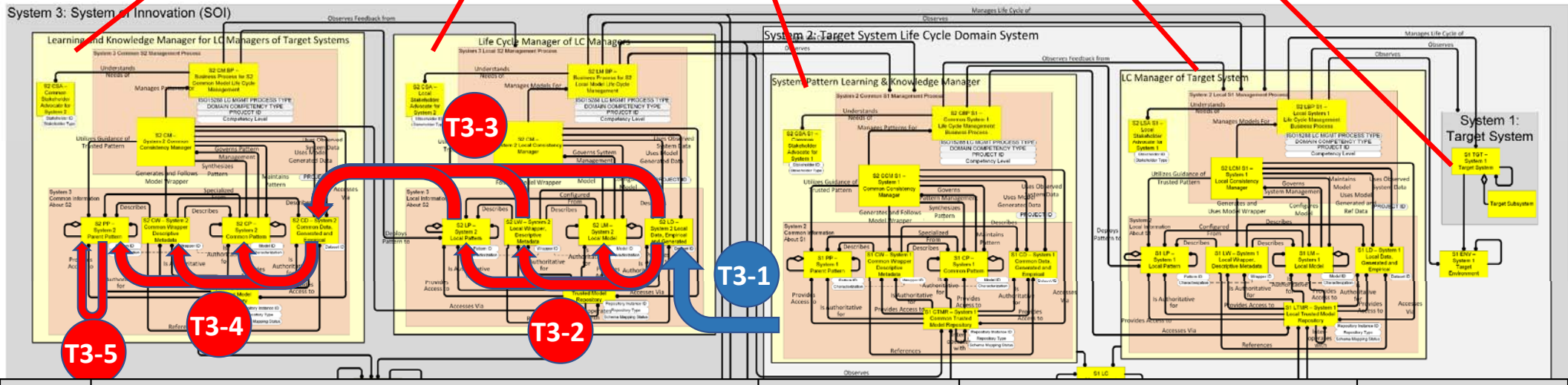
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
T3-2	Empirical observation of S2 is compared to local model and/or local pattern data, causing updates to them and uncertainty metadata	S2 LD—System 2 Local Empirical Data	S2 LP, S1 LM, S1 LW—Local Pattern, Model,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



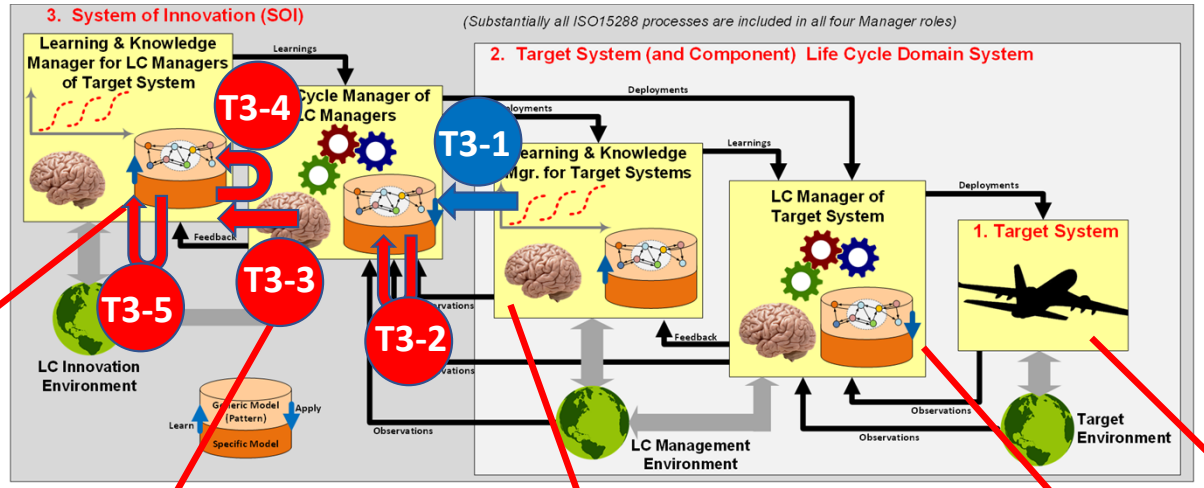


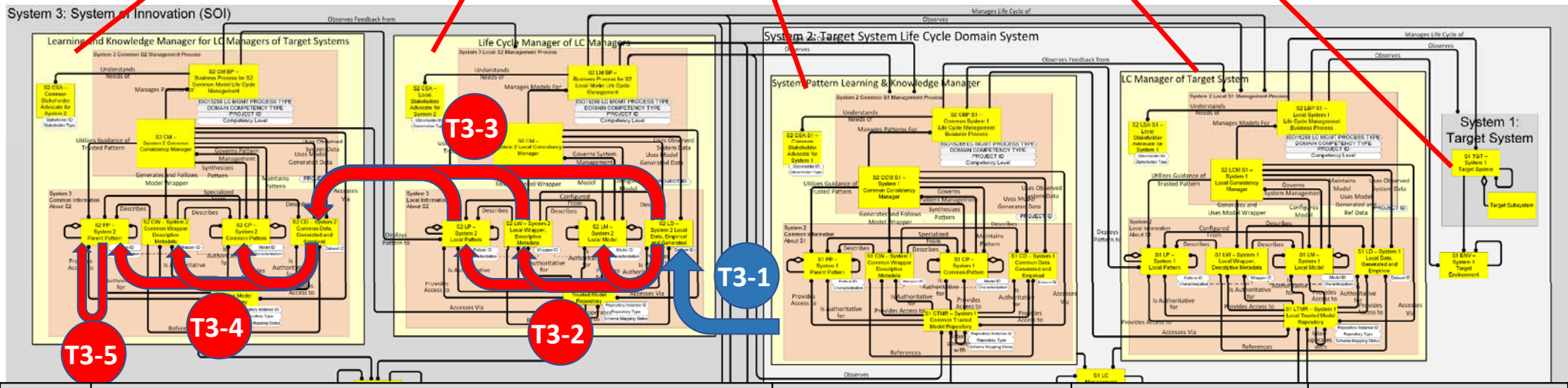
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
T3-3	Empirical observations, updated local pattern, and metadata local to a project/instance are provided to common dataset.	S2 LP, S2 LD, S2 LW—Local Pattern, Data, Wrapper	S2 CD—System Common Data	Data transfer,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





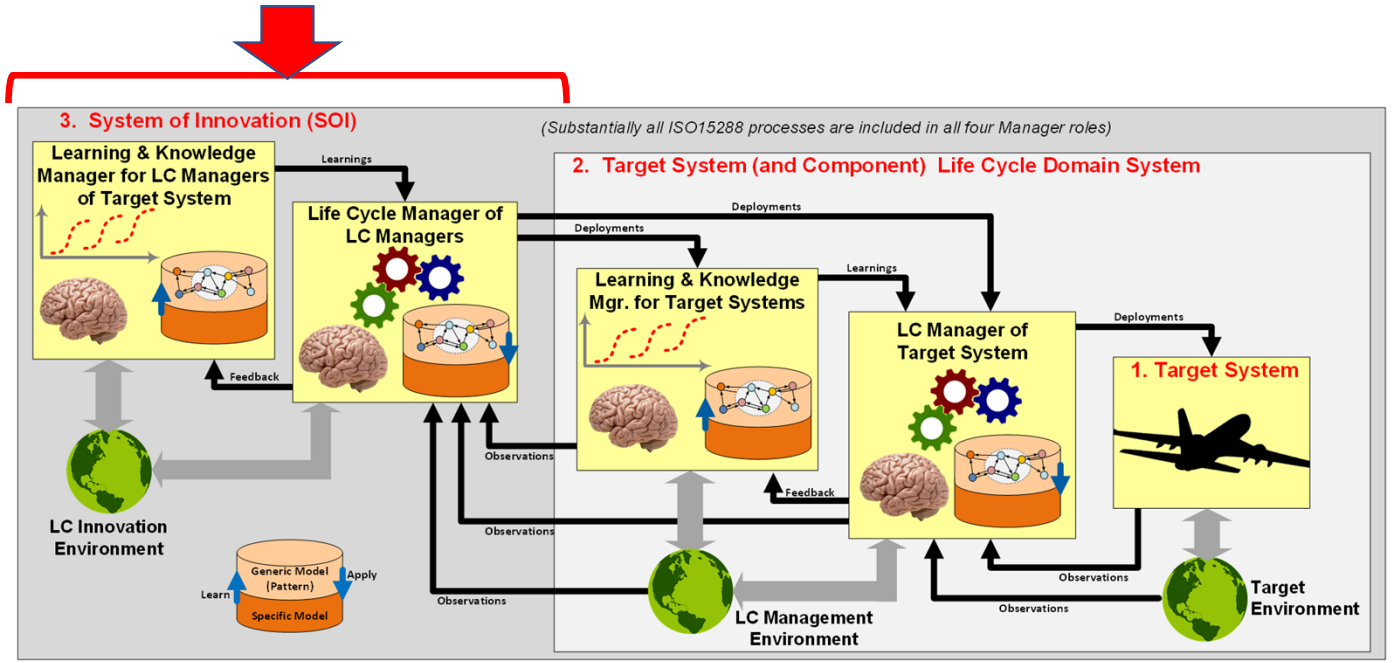
Stage	ASELCM Pattern Configuration Life Cycle Stages	Source	Destination	Event Type & Qty
T3-5	Updated Parent Pattern is made available to S*Patterns Community for consideration.	S2 PP -- System 2 Parent Pattern (in S3)	S*Patterns Community	Information Transfer, many to one

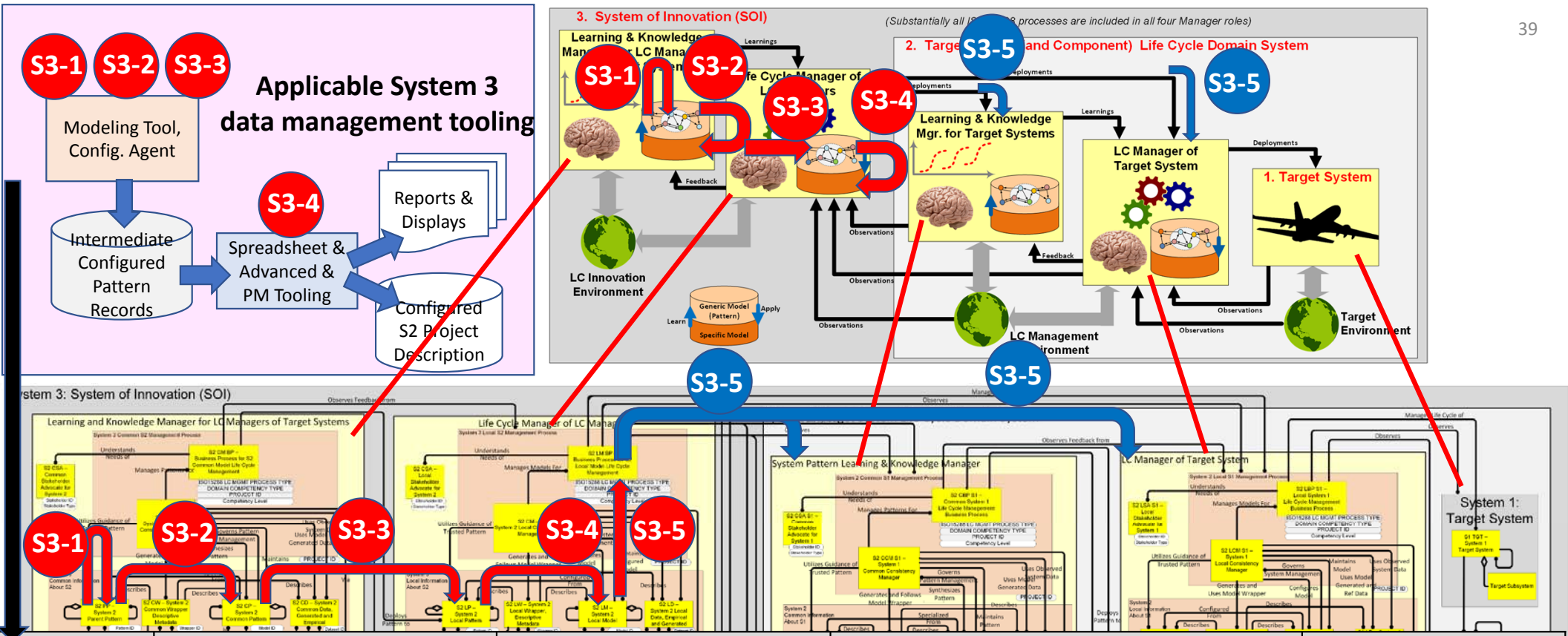
Stages of System 2 (Program/Project Ecosystem) Feedback, Pattern Uncertainty Management, and Group Learning

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.			