Discussion of Ontology Around "Interface"

ST4SE Core Team Meeting
Jan 29, 2018

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V1.2.5

Contents

- Purpose of this material
- Brief background on S*Models, S*Patterns, INCOSE Patterns Working Group
- Focus of this discussion: Interface portion of S*Metamodel
- Translation to OWL, editing via Protégé, current status, related questions
- Discussion and plans
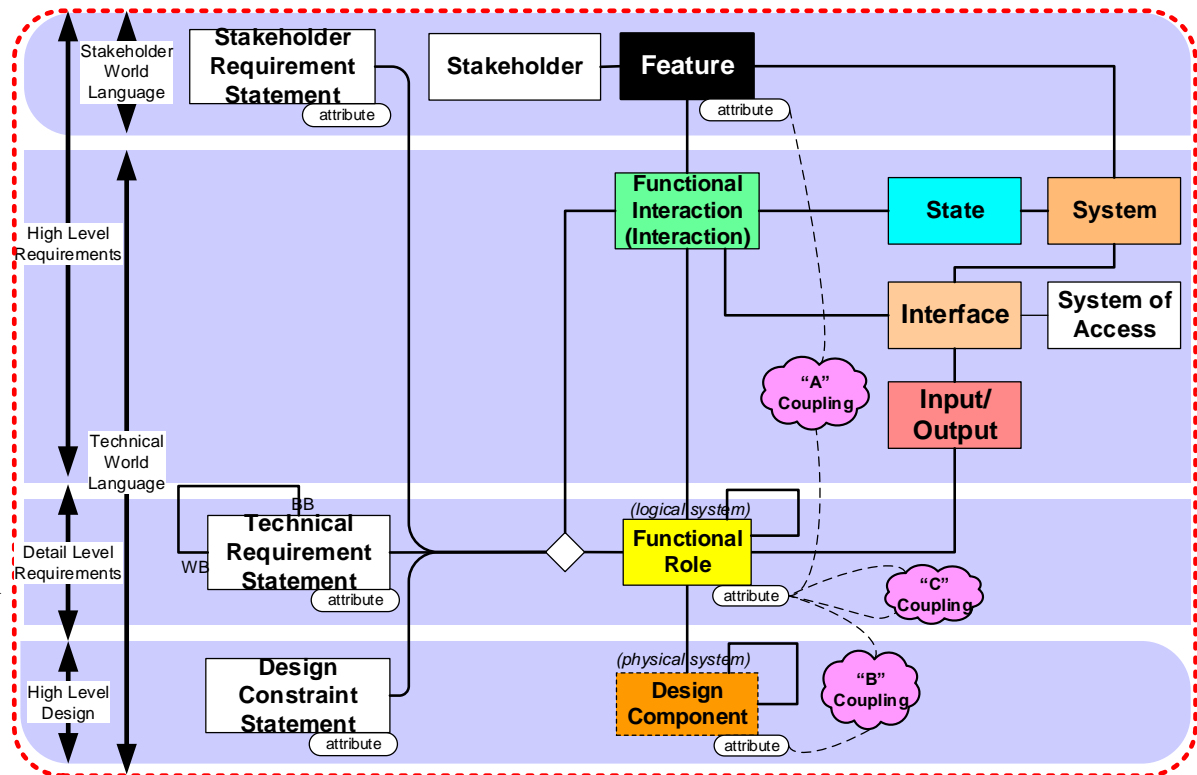
- References

Purpose of this material

- Discuss SE ontology related to Interface
- Observe how this has been expressed in the past in the S*Metamodel
- Observe how the S*Metamodel is being expressed in OWL
- Solicit input on OWL / Protégé editing to continue this process

Brief background on S*Models, S*Patterns, and INCOSE Patterns Working Group

We are concerned with _configurable, re-usable system models_: "S*Patterns"

1. Models containing a certain minimal set of elements are called S*Models (S* is short for "Systematica")

2. Those underlying elements are called the S*Metamodel, which was inspired by the physical sciences, seeking the smallest model necessary for life cycle engineering

3. S*Models using those elements may be (have been) expressed in any modeling language (e.g., SysML, or other languages)

4. S*Models can be (have been) created and managed in many different COTS modeling tools, engineering tools, requirements management and PLM systems.

5. Re-usable, configurable S*Models are called S*Patterns

6. By "Pattern-Based Systems Engineering" (PBSE) we mean MBSE enhanced by these generalized assets and utilizing the leverage of S*Patterns.

7. These are system-level patterns (models of whole managed platforms), not just smaller-scale component design patterns
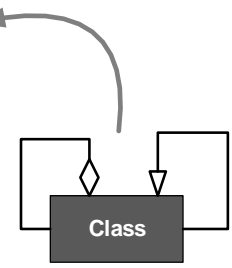
S*Metamodel for Model-Based Systems Engineering (MBSE)

Stakeholder World Language

High Level Requirements

Technical World Language

Detail Level Requirements

High Level Design

Stakeholder Requirement Statement — attribute

Stakeholder

Feature — attribute

Functional Interaction (Interaction)

State

System

Interface

System of Access

"A" Coupling

Input/ Output

Technical Requirement Statement — attribute

(logical system) Functional Role — attribute

"C" Coupling

Design Constraint Statement — attribute

(physical system) Design Component — attribute

"B" Coupling

BB

WB

Extract

**Systematica™ Meta-Model**

Meta-Model Version 7.1
Methodology Release 4.0

05/29/2009

Class

Every S*Metaclass shown is embedded in both a containment hierarchy and an abstraction (class) hierarchy.

Systematica™

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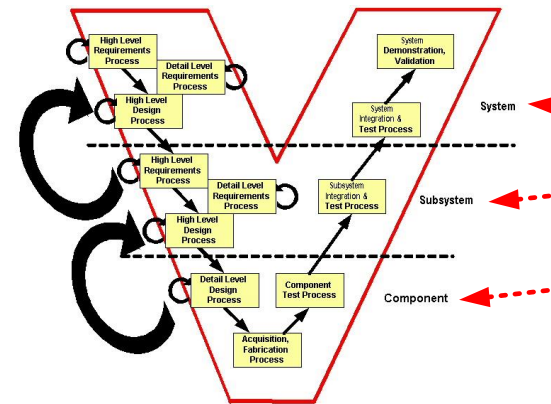
System Containment Hierarchy

ICTT System Sciences

S* Metamodel–Summary View, for MBSE

04-28-11 V1.5.9   Systematica Release 4.0

Systematica™

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Pattern-Based Systems Engineering:
Using Configurable S*Patterns to Create Configured S*Models
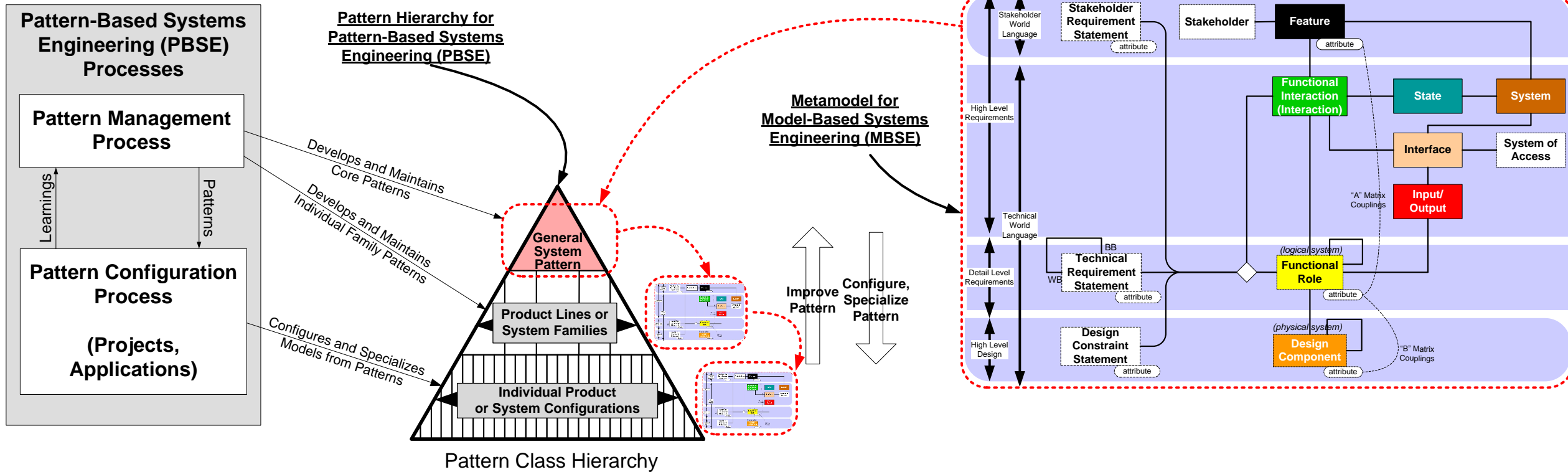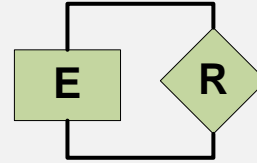
Emergence of Patterns from Patterns: S*Pattern Class Hierarchy

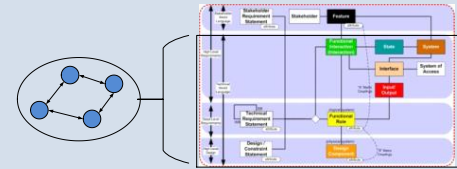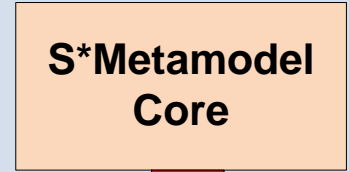Definition of **Relational Modeling Paradigm**

Entity-Relationship Paradigm

E=Entity
R= Relationship

Structured or unstructured semantic web

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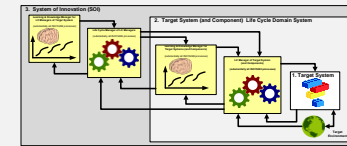
S*Metamodel Core

Core S*Metamodel

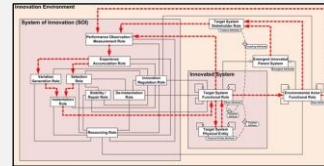Smallest model of a system, for engineering or science

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

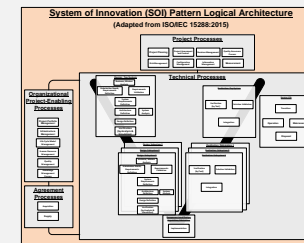**EI Pattern, SOI Pattern, Fitness, Value**

S*Purpose, Fitness, Value

Agile Sys Life Cycle Pattern

System of Innovation Pattern

ISO 15288 System Life Cycle Mgmt Pattern

Emergence & Definition of **Domain Specific Systems**

Domain Specific Pattern

Terrestrial Vehicle Domain Pattern

Manufacturing System Pattern

Product Service System Pattern

Space Tourism Pattern

Electrical Power Domain Pattern

Aircraft Flight Control Pattern

Medical Device Pattern

Distribution System Pattern

Socio-Technical Pattern

Critical Infrastructure Domain Pattern
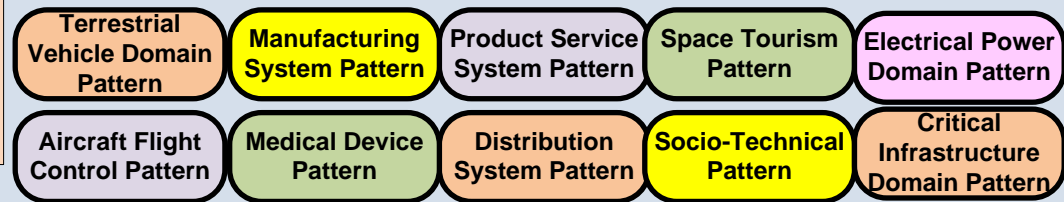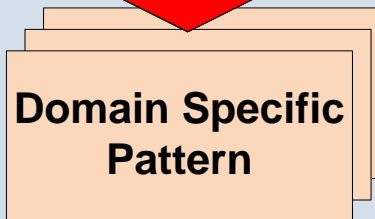
Example S*Pattern Content

- INCOSE PBSE Tutorial:
  - http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:pbse_tutorial_glrc_2016_v1.7.4.pdf
- More examples and materials on WG web wiki site:
  - http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns

The INCOSE Patterns Working Group began four years ago, as the MBSE Initiative Patterns Challenge Team:

- Part of the joint INCOSE/OMG MBSE Initiative, formed there initially as the MBSE Patterns Challenge Team.

- In 2016, our team formally became the INCOSE MBSE Patterns Working Group

- Because of our MBSE focus, and in order to continue to support the MBSE Initiative, we continue to also be listed as part of that INCOSE/MBSE Initiative

- WG web wiki site:
  http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns
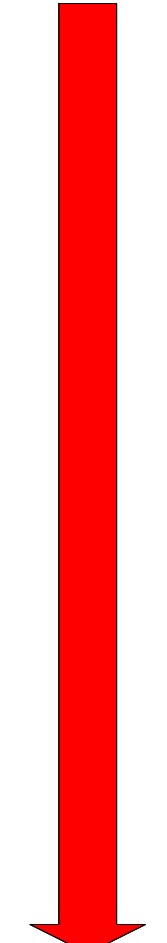
From Patterns WG Agenda at INCOSE IW2018:

Agenda, Partner Events of Interest: INCOSE MBSE Patterns Working Group, at IW2018, and Web Conferencing	US Eastern Time (ET)	Room	Global Meet

Patterns WG Pre-reading and Background:
Meeting events and materials for activities of the MBSE Patterns WG at IW2018:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns_challenge_team_mtg_01.28-31.17
Minutes of previous meeting of the WG---July, 2017, at IS2017:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:mbse_patterns_wg_team_mtg_07.17.16
INCOSE WG web site for MBSE Patterns WG:
http://www.incose.org/ChaptersGroups/WorkingGroups/Transformational/mbse-patterns
WG INCOSE/OMG mbse wiki site:
http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns
MBSE Patterns WG Charter:
http://www.incose.org/docs/default-source/Working-Groups/MBSE-Patterns-WG/mbse-patterns-wg-re-charter-2016-incose-approved-v2-2-1.pdf?sfvrsn=2
PBSE Methodology Summary from the Patterns WG:
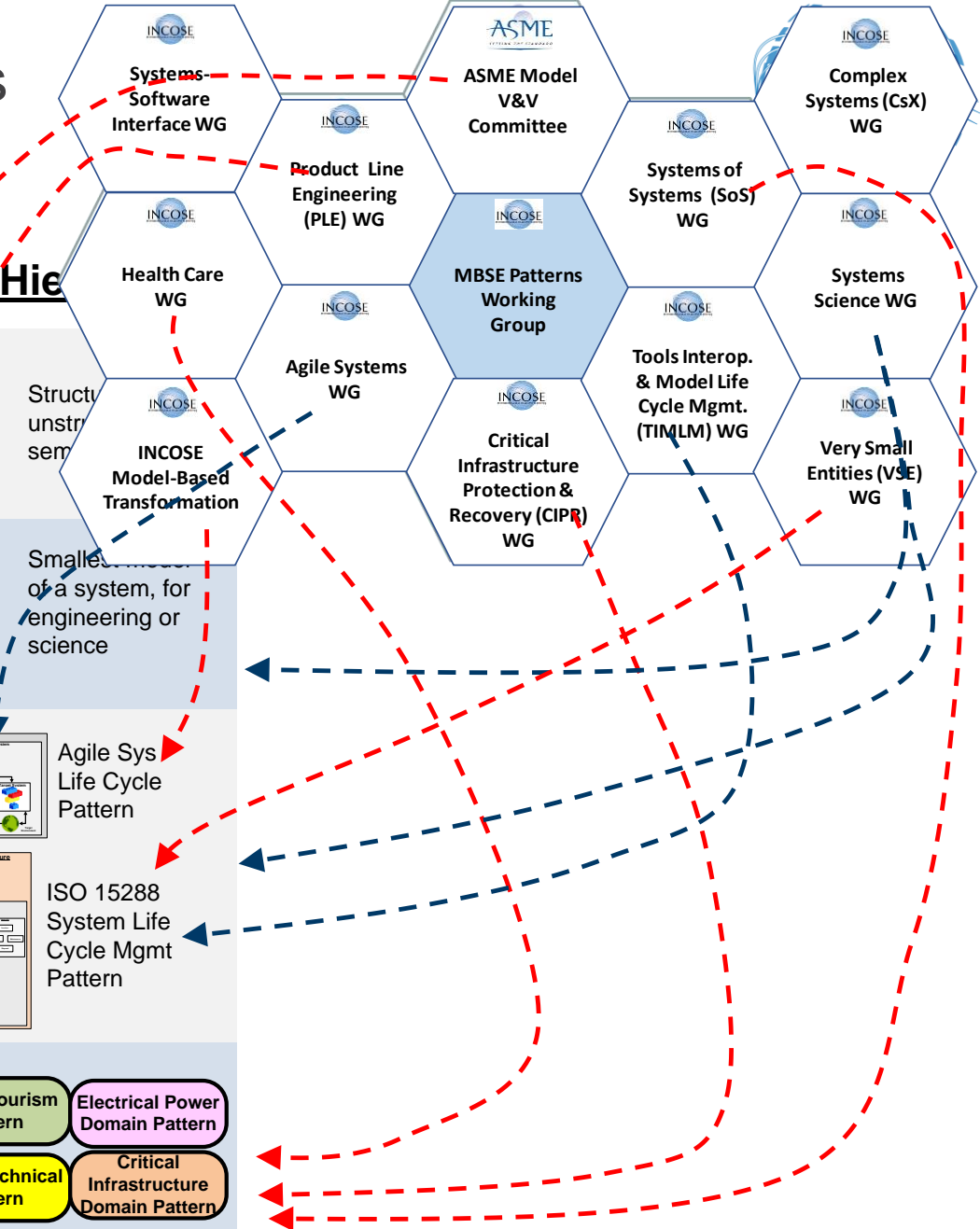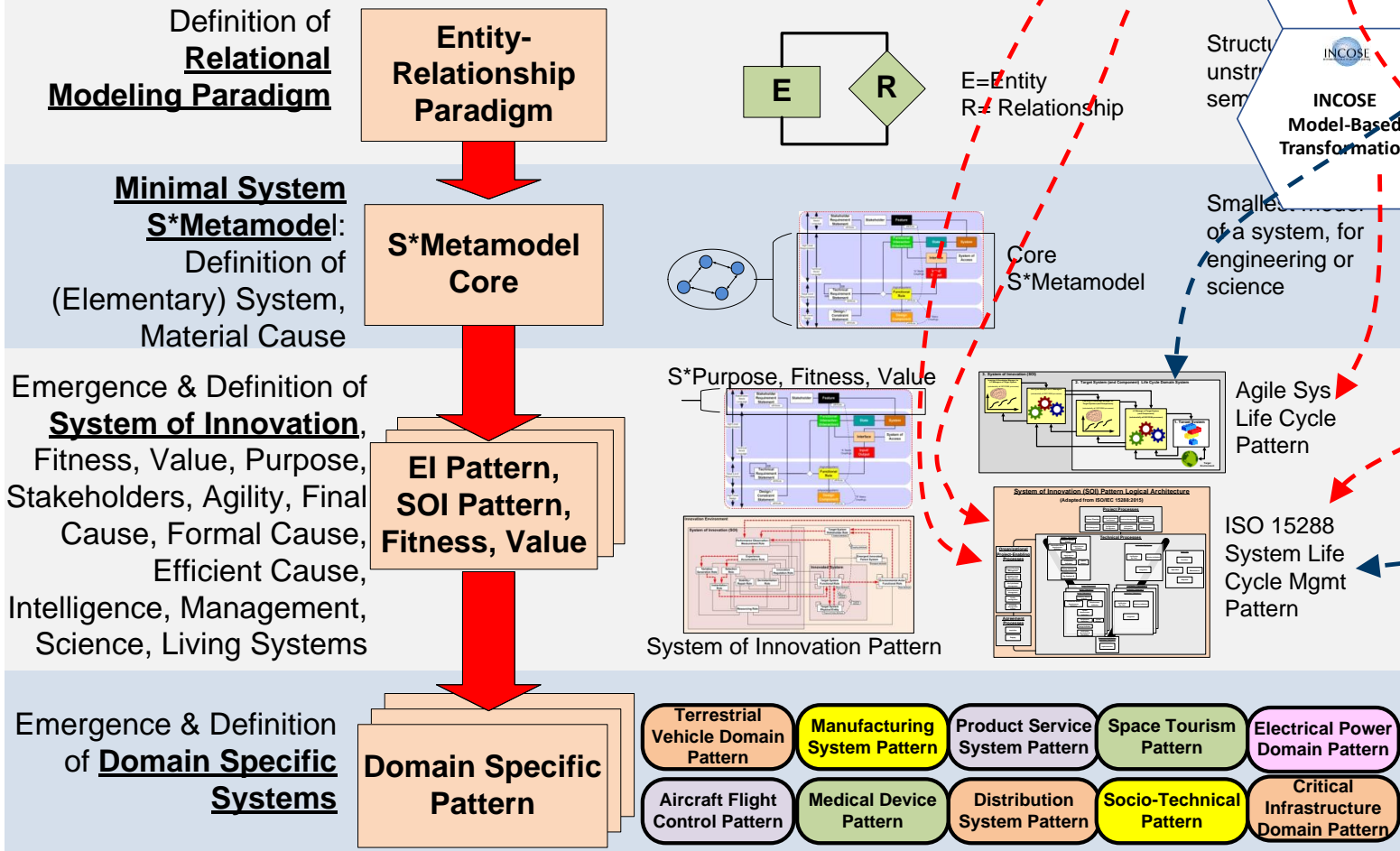http://www.omgwiki.org/MBSE/doku.php?id=mbse:pbse

Some of the Patterns WG Projects with Other WGs

More General

More Specific

Emergence of Patterns from Patterns: S*Pattern Class Hierarchy

| Definition of **Relational Modeling Paradigm** | **Entity-Relationship Paradigm** | E=Entity R=Relationship |

E   R

E = Entity
R = Relationship

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

Smallest model of a system, for engineering or science

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

S*Purpose, Fitness, Value

Agile Sys Life Cycle Pattern

ISO 15288 System Life Cycle Mgmt Pattern

System of Innovation Pattern

Emergence & Definition of **Domain Specific Systems** — **Domain Specific Pattern**

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

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

12
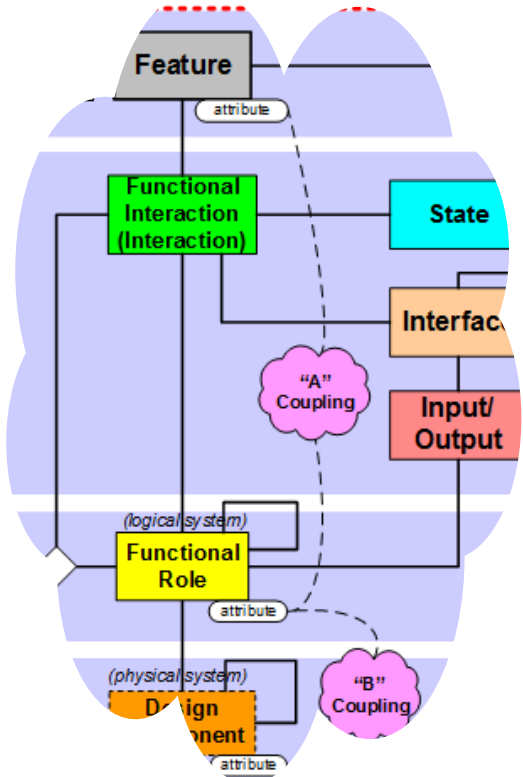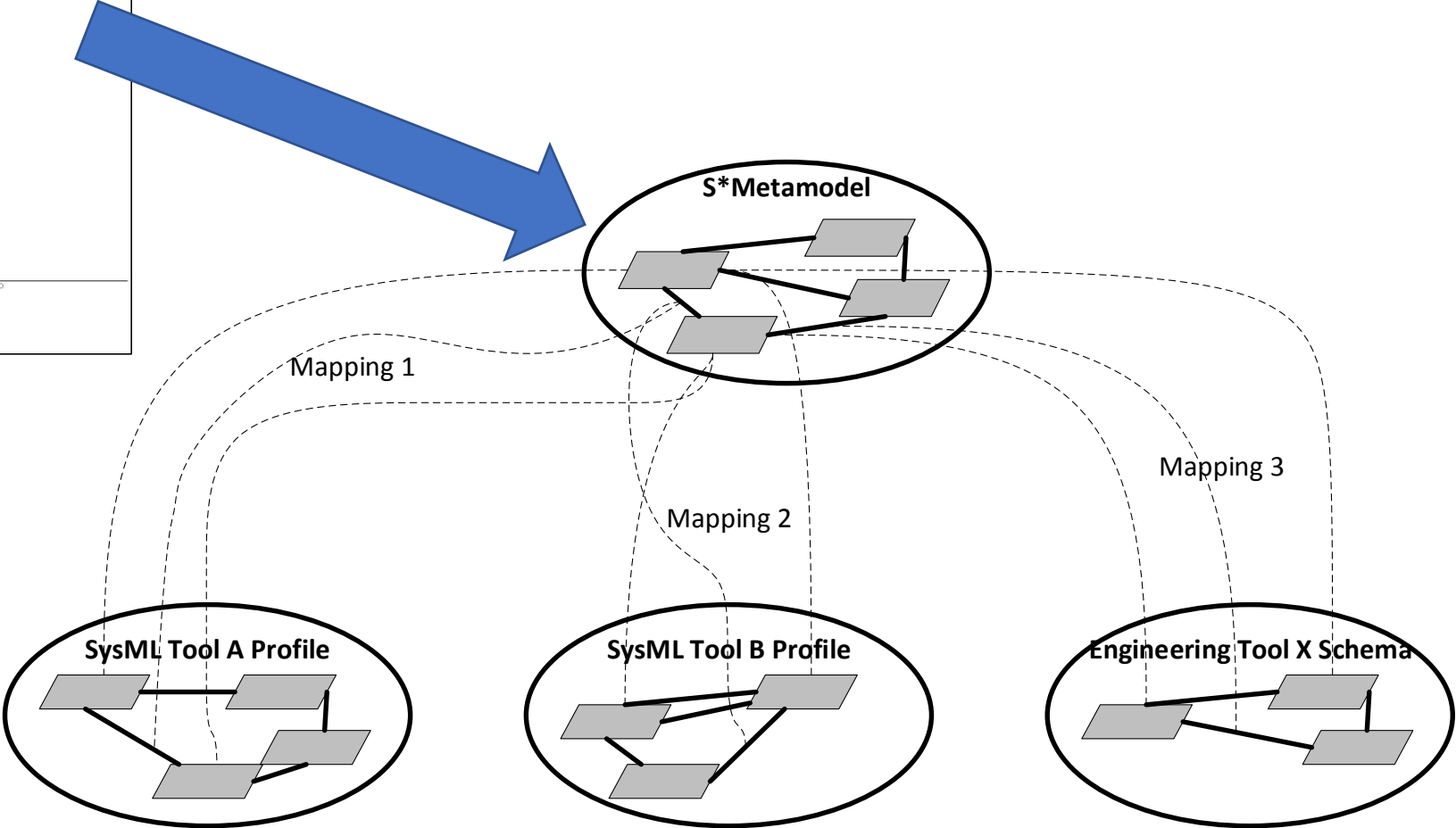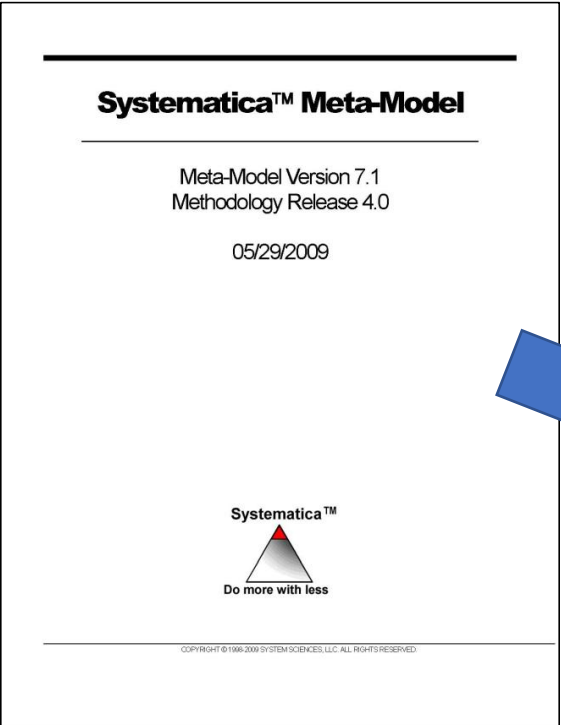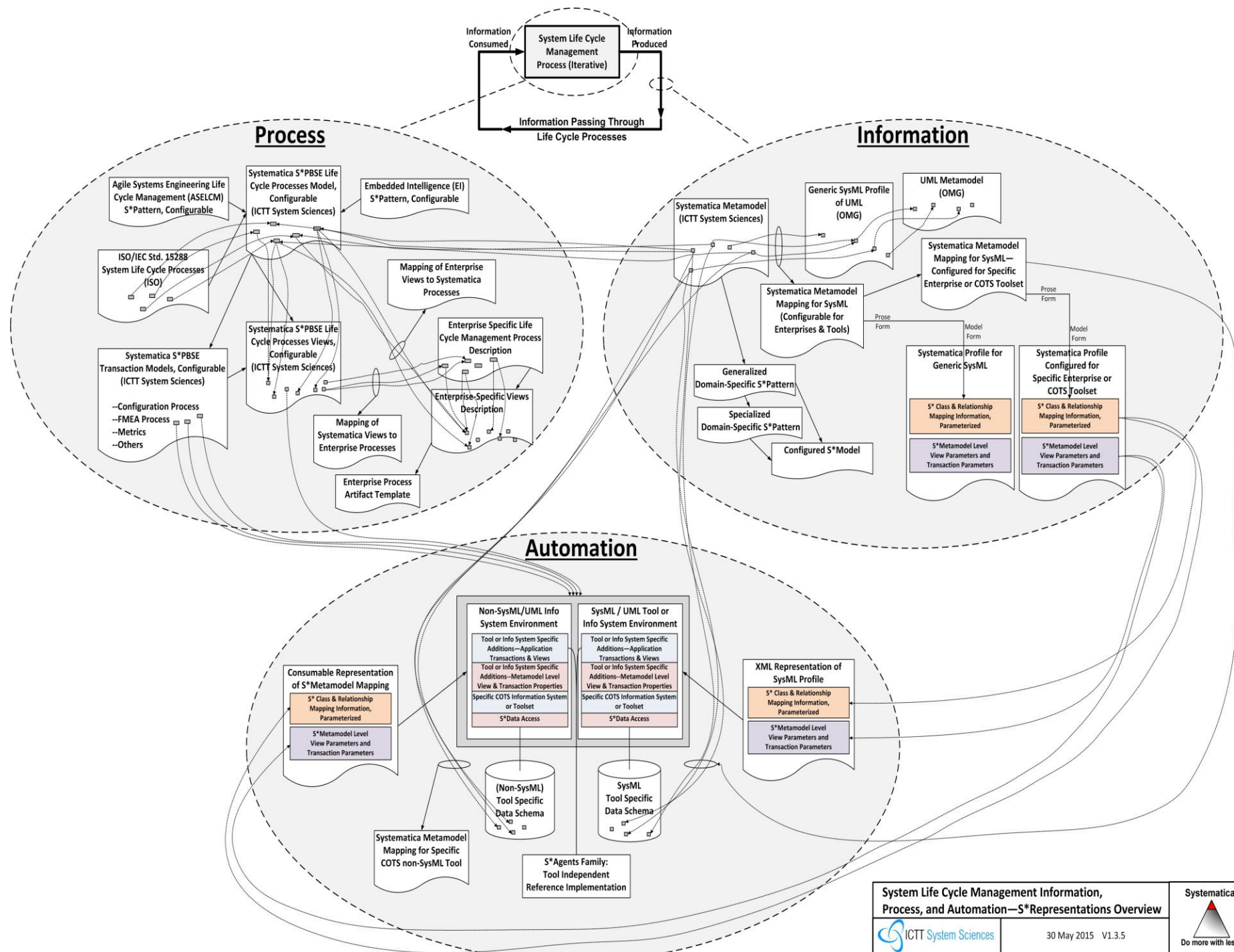
Status of WG Projects

- Interface Patterns Project
- ASME Model V&V Patterns Project, VVUQ Pattern
- VSE Patterns Project
- Agile Patterns Project
- S3 Pattern and INCOSE OCM
- Patterns in the Public Square
- TIMLM Patterns
- HC WG Collaboration
- PLE WG Project
- CIPR Patterns
- IFSR Conversation
- SysSciWG Patterns
- SoS WG Collaboration

The S*Metamodel is formally mapped to specific modeling tools and languages

Systematica™ Meta-Model

Meta-Model Version 7.1
Methodology Release 4.0

05/29/2009

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S*Metamodel

Mapping 1

Mapping 3

Mapping 2

SysML Tool A Profile

SysML Tool B Profile

Engineering Tool X Schema

System Life Cycle Management Process (Iterative)

Information Consumed

Information Produced

Information Passing Through Life Cycle Processes

Process

Agile Systems Engineering Life Cycle Management (ASELCM) S*Pattern, Configurable

Systematica S*PBSE Life Cycle Processes Model, Configurable (ICTT System Sciences)

Embedded Intelligence (EI) S*Pattern, Configurable

ISO/IEC Std. 15288 System Life Cycle Processes (ISO)

Mapping of Enterprise Views to Systematica Processes

Systematica S*PBSE Transaction Models, Configurable (ICTT System Sciences)

--Configuration Process
--FMEA Process
--Metrics
--Others

Systematica S*PBSE Life Cycle Processes Views, Configurable (ICTT System Sciences)

Enterprise Specific Life Cycle Management Process Description

Mapping of Systematica Views to Enterprise Processes

Enterprise-Specific Views Description

Enterprise Process Artifact Template

Information

Systematica Metamodel (ICTT System Sciences)

Generic SysML Profile of UML (OMG)

UML Metamodel (OMG)

Systematica Metamodel Mapping for SysML— Configured for Specific Enterprise or COTS Toolset

Systematica Metamodel Mapping for SysML (Configurable for Enterprises & Tools)

Prose Form

Prose Form

Model Form

Model Form

Generalized Domain-Specific S*Pattern

Specialized Domain-Specific S*Pattern

Configured S*Model

Systematica Profile for Generic SysML

| S* Class & Relationship Mapping Information, Parameterized |
| S*Metamodel Level View Parameters and Transaction Parameters |

Systematica Profile Configured for Specific Enterprise or COTS Toolset

| S* Class & Relationship Mapping Information, Parameterized |
| S*Metamodel Level View Parameters and Transaction Parameters |

Automation

Non-SysML/UML Info System Environment

Tool or Info System Specific Additions—Application Transactions & Views

Tool or Info System Specific Additions--Metamodel Level View & Transaction Properties

Specific COTS Information System or Toolset

S*Data Access

SysML / UML Tool or Info System Environment

Tool or Info System Specific Additions—Application Transactions & Views

Tool or Info System Specific Additions--Metamodel Level View & Transaction Properties

Specific COTS Information System or Toolset

S*Data Access

Consumable Representation of S*Metamodel Mapping

| S* Class & Relationship Mapping Information, Parameterized |
| S*Metamodel Level View Parameters and Transaction Parameters |

XML Representation of SysML Profile

| S* Class & Relationship Mapping Information, Parameterized |
| S*Metamodel Level View Parameters and Transaction Parameters |

(Non-SysML) Tool Specific Data Schema

SysML Tool Specific Data Schema

Systematica Metamodel Mapping for Specific COTS non-SysML Tool

S*Agents Family: Tool Independent Reference Implementation

System Life Cycle Management Information, Process, and Automation—S*Representations Overview

ICTT System Sciences   30 May 2015   V1.3.5

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Informal semantics of S*Interface

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

Interaction D

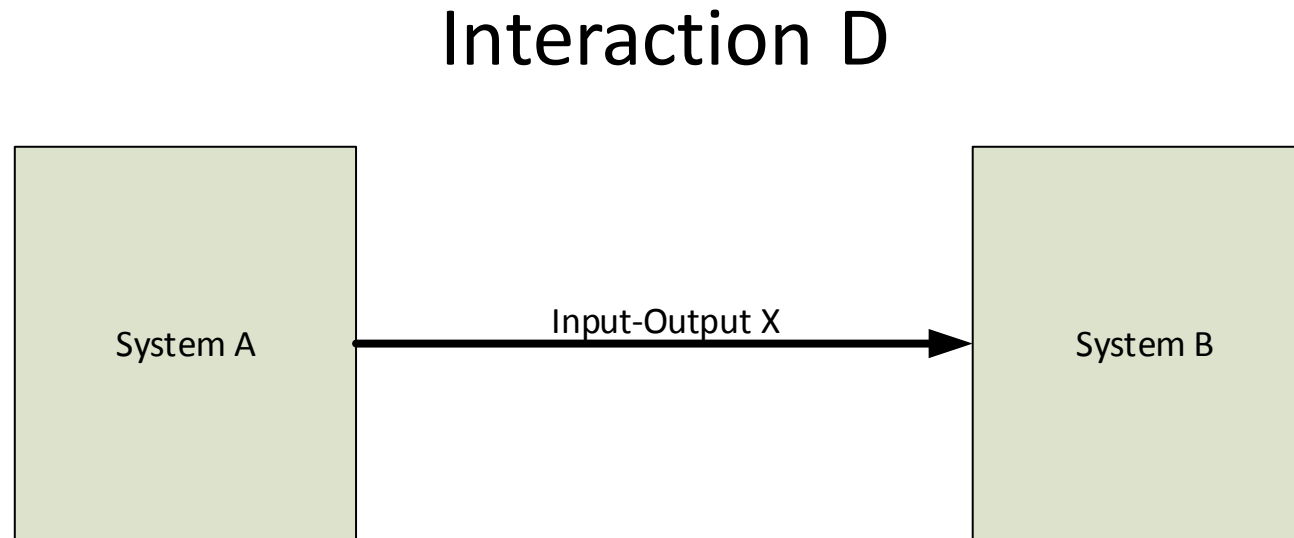System A — Input-Output X → System B

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

- In certain (important to identify) circumstances, we need to represent Interfaces involved in Interaction D.
- No matter what (graphical or other) modeling language or notation is used, the S*Metamodel tells us that an Interface is an association of:
  - A System, which "has" the Interface;
  - A (set of) Input-Output(s), which "pass through" the Interface;
  - A (set of) Interaction(s), which describe "behavior at the Interface";
  - A System of Access (SOA), providing the interaction "medium":
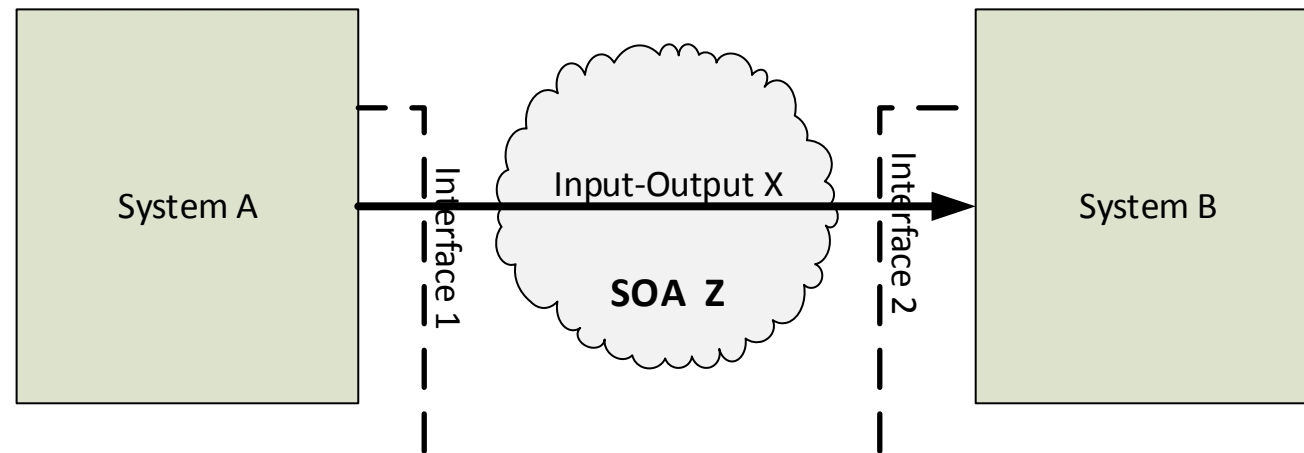
Figure 2: (Exact notation used not important to this discussion)

- However, there is a subtle inconsistency in the transition between Figure 1 and Figure 2 above:
  - Figure 1 and Figure 2 imply that the scope of "System A" must have changed between the two diagrams, . . .
  - Because, System A in Figure 2 can interact with an external-looking SOA Z, but . . . .
  - System A in Figure 1 implies that the scope of System A is such that it can interact directly with System B.
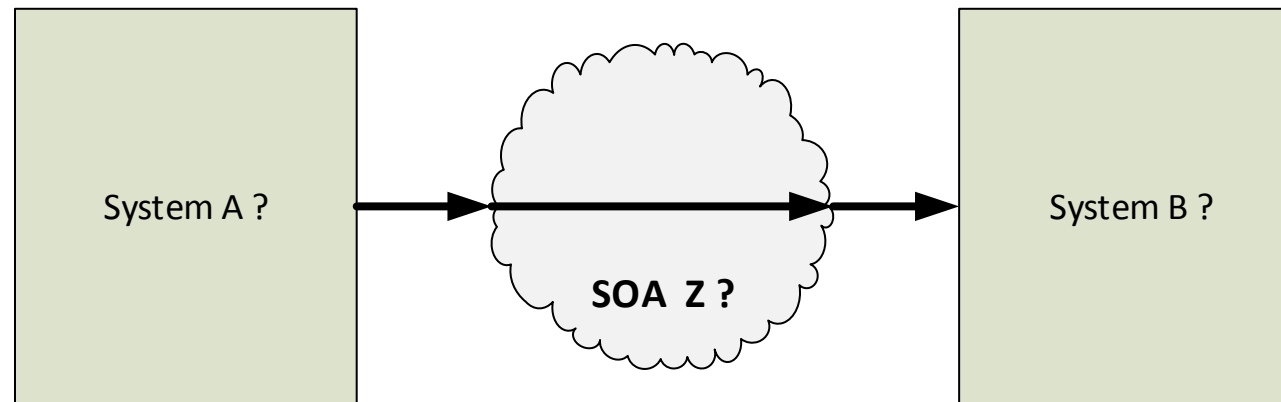
Figure 3: (Exact notation used not important to this discussion)

- The problem here is that even intended "neutral" notations can be specific enough to mislead us, or create ambiguities.
- The real problem is that, independent of notation, the System of Access by definition has larger scope than Figure 2 implied:
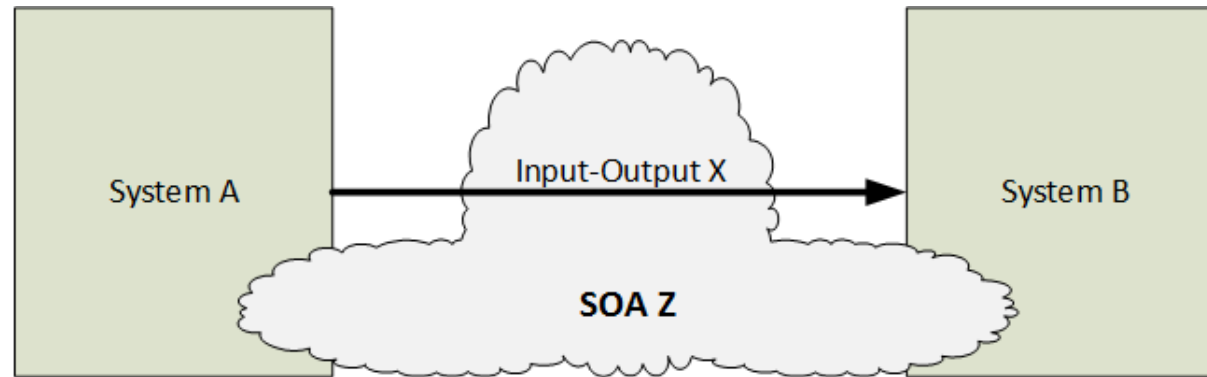
Figure 4: (Exact notation used not important to this discussion)

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

- So, to avoid conflicting or ambiguous definitions of the scope of System A, we have to recognize a slightly larger system, shown in Figure 5 as System A'

- The additional scope adds the SOA role shown here as SASOA:
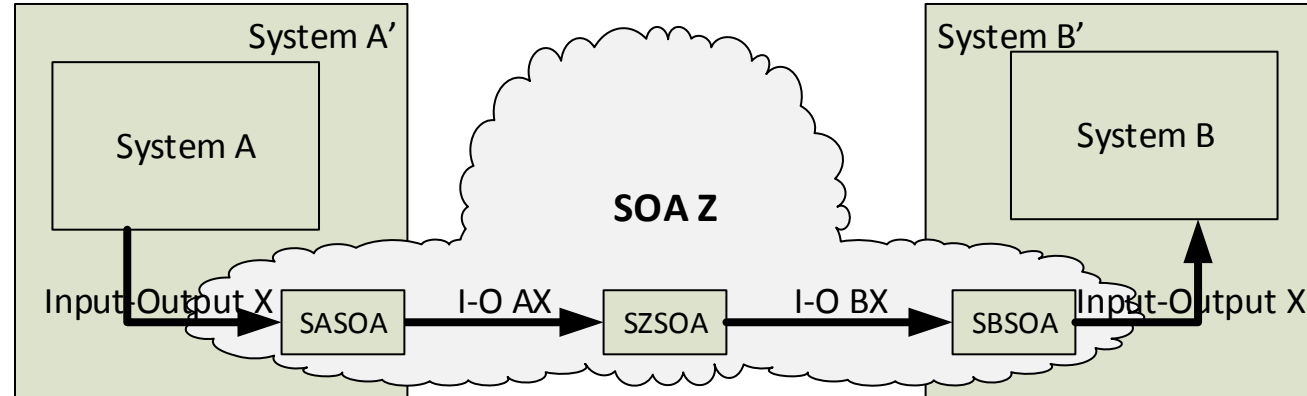
Figure 5: (Exact notation used not important to this discussion)

Interface portion of S*Metamodel
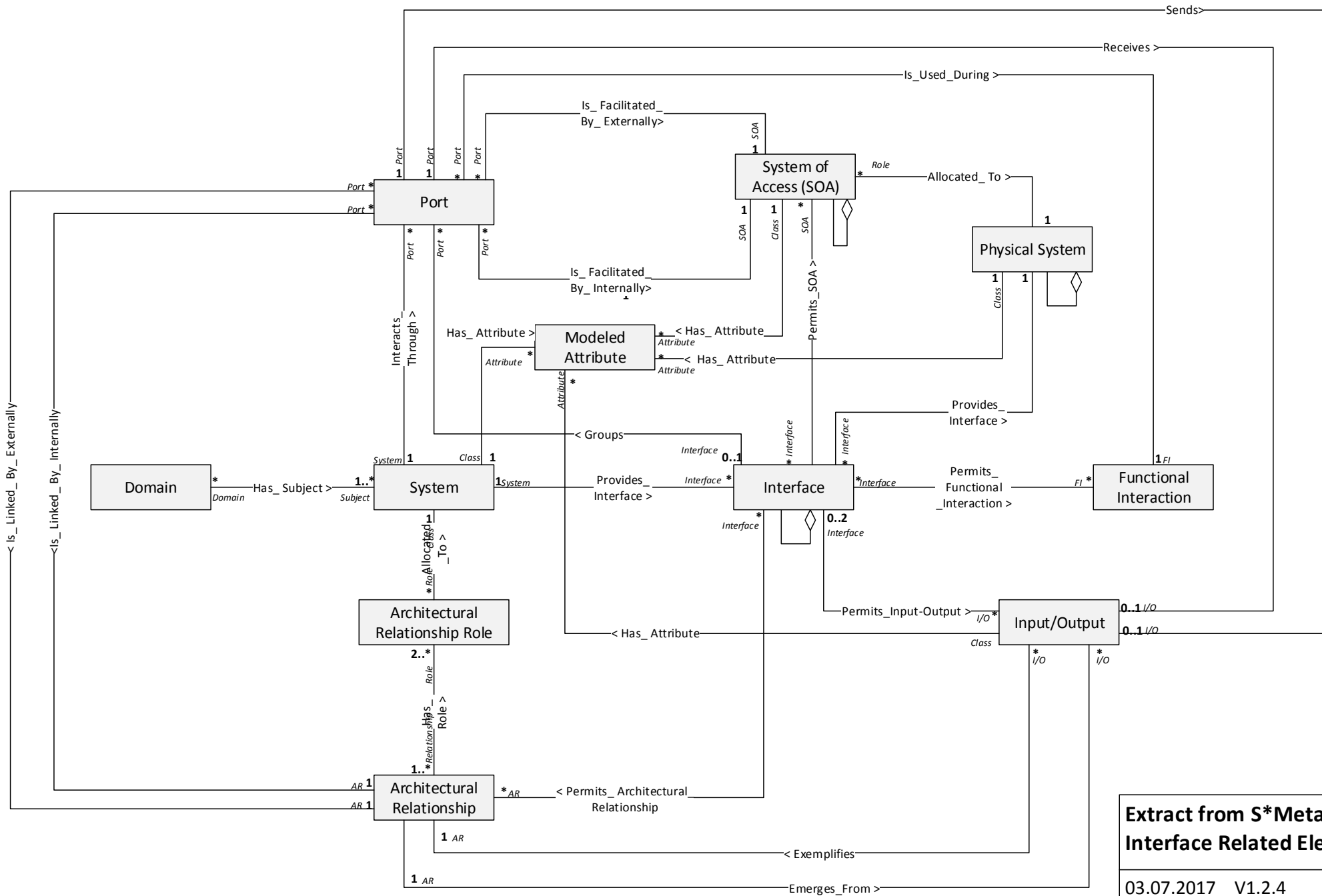
Extract from S*Metamodel:
Interface Related Elements
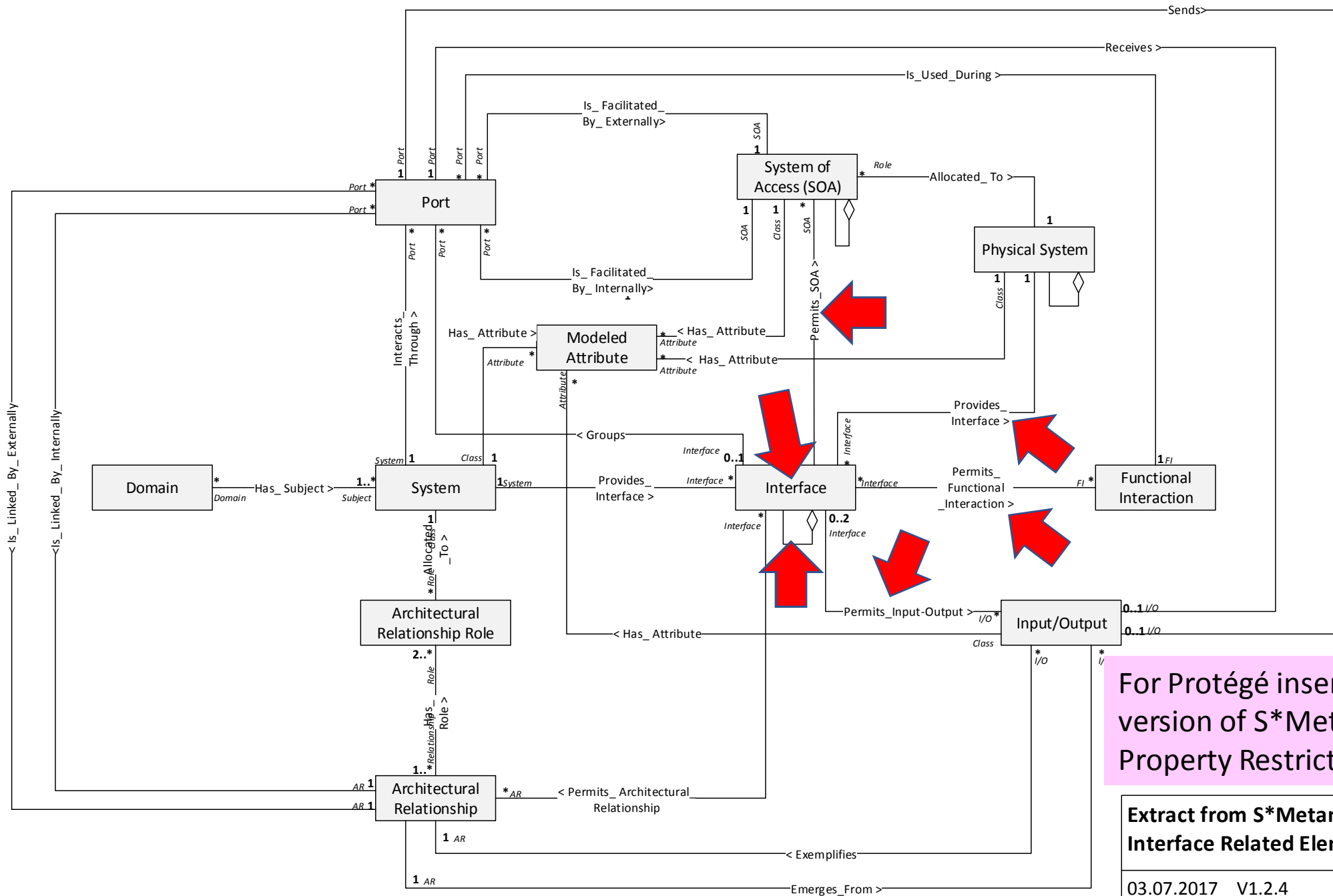
03.07.2017   V1.2.4

For Protégé insertion into OWL version of S*Metamodel, using Property Restrictions.

Extract from S*Metamodel: Interface Related Elements

03.07.2017   V1.2.4

Translation to OWL, editing via Protégé, current status, related questions

- S*Metamodel classes inserted to OWL using Protégé

- Working on Property restriction statements on Interface
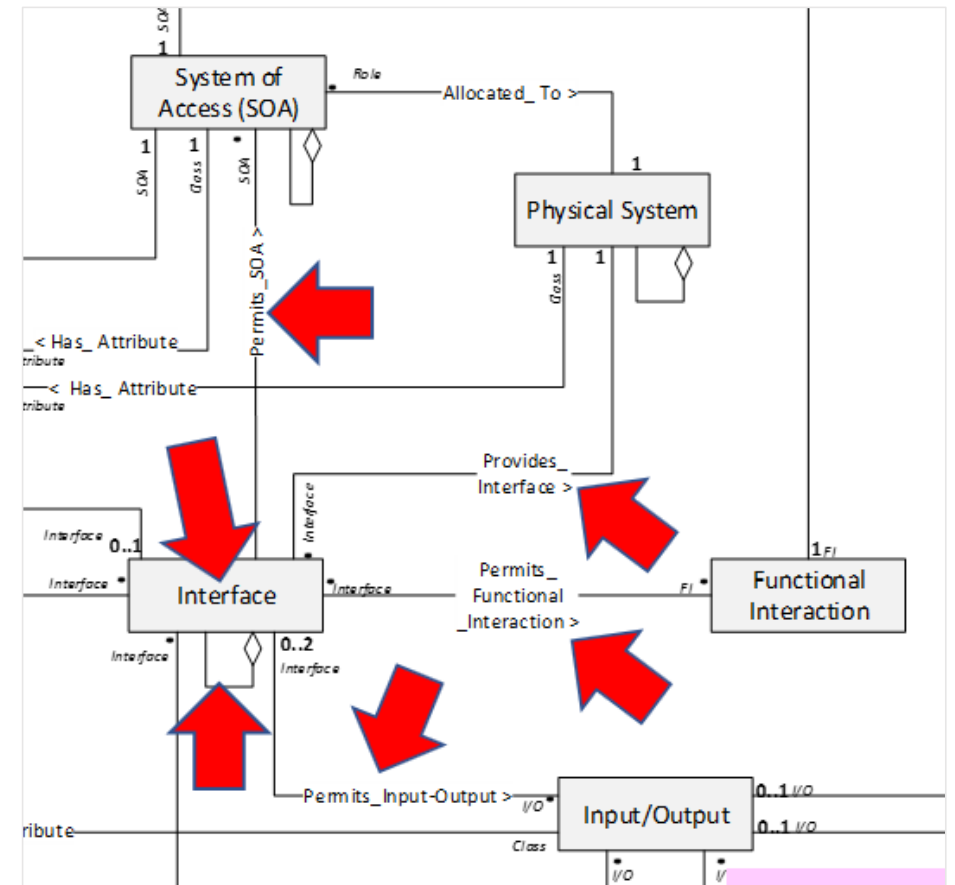
Current questions on OWL and Protege

- Where (what tool menu, etc.) does Protégé allow me to set up:
  - The Properties of Interface?
  - The restrictions on those Properties, for . . .
    - Containment (of Interface) shown
    - The four relationships shown

Discussion and plans

-
-
-
-
-

References

- "MBSE Methodology Summary: Pattern-Based Systems Engineering (PBSE), Based On S*MBSE Models", INCOSE Patterns Working Group, 2015. That document contains a more complete list of related references, and can be retrieved from http://www.omgwiki.org/MBSE/doku.php?id=mbse:methodology#mbse_benchmarking_survey
- INCOSE PBSE Tutorial: http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:pbse_tutorial_glrc_2016_v1.7.4.pdf
- More examples and materials on WG web wiki site: http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns
- "Reference Model: Information, Processes, and Automation Associated with S*Representations for System Life Cycle Management", ICTT System Sciences, 2015.